STRUCTURES

63-08.0100 GENERAL

The intent of this chapter is to provide guidance for administering the inspection of structures during construction adequately and uniformly. Primary emphasis is placed on the construction procedures and operations required to build bridges and culverts. Little or no discussion is specifically directed at the construction of headwalls, drainage boxes, etc. However, it is felt that the information contained herein on concrete, reinforcing steel, safety, and other related subjects can be equally applied to these areas of construction.

Intent is to provide information concerning best construction practices, but this chapter in no way addresses the time and personnel constraints that various construction crews work under. It is understood that the Resident Engineer must prioritize project inspection yet experience has shown that taking care of the details and trying to be proactive saves time and money in the long run.

.0110 Staking Structures – Chapter 4, "Construction Surveying" covers the staking of structures and related subjects and should be used in conjunction with this chapter.

.0120 Pay Quantities – Chapter 4, "Construction Surveying", and Chapter 12, "Post Construction Requirements" contain information related to this subject.

.0130 Submittals – The following is a list of submittals pertaining to structural work that should be requested from the contractor and forwarded to Central Office Construction. This is not an all inclusive list, but does generally cover general bridge/culvert construction. These should be sent in at the earliest opportunity so to allow appropriate time for review. Work on these items should not be started until proper approval is obtained. If the contractor elects to begin work without approvals, he does so at his own risk and any changes required will be at his cost. Please review other sections of this chapter for further information about particular submittals.

- **Pile reports**
- **Precast box or 3-sided culvert shop drawings/designs**
- **Metal arch or other metal culvert shop drawings/designs**
- **Deck falsework overhang design/drawings**
- **Pachometer testing (if completed by District)**
- **Revised pouring sequence**
- **Cofferdam or shoring design/drawings**
- **Jacking falsework design/drawings**
- **Changes in foundation elevations**
- **Culvert falsework if barrel width over 20 ft**
- **Any structural steel drawings**

- **Construction Revisions**
- **Pass through of electrical, loops, and other submittals which need approvals from other divisions.**

Please note that approved shop drawings and designs should be stamped by the appropriate Central Office Liaison Engineer who had reviewed it.

63-08.0200 SAFETY AND HEALTH

Safety and health are subjects of vital importance to all areas of construction and should be treated as such by the Contractor and the Department of Highways. The problems encountered in these areas involving structures are different from those encountered on grade work and merit special consideration. The conditions encountered in the building of structures range from working in trenches and cofferdams to working high above ground or water. The nature of the work often places a group of workers at the same location for extended periods. As a result, both safety and health protection should be implemented at each work site in a manner to best fit the existing conditions and with consideration of the quasi-permanent nature of the work site.

.0210 Ky. Safety and Health Standards - The Contractor is responsible for abiding by the "Kentucky Occupational Safety and Health Standards for the Construction Industry" as promulgated by the Kentucky Department of Labor (See the appropriate KAR). The Project Engineer will, likewise, utilize these standards in enforcement of the safety rules and regulations pertaining to the project. Sections particularly applicable to structures are - Excavations, Trenching, and Shoring, - Concrete, Concrete Forms, and Shoring, and - Tunnels and Shafts, Caissons, Cofferdams, and Compressed Air. For additional information concerning the enforcement of these requirements, refer to the appropriate section in Chapter One of this manual. The Standard Specification requirements pertaining to safety, health, sanitation, and air pollution are contained in Section 107 of the Standard Specifications.

63-08.0300 STRUCTURE EXCAVATION

.0310 General - The Standard Specifications for Road and Bridge Construction (Section 603) define how structure excavation is to be performed, and how it is to be measured and paid. The Project Engineer and the project inspectors should read and consult the specifications for specific details. The specifications state that structure excavation shall be classified as Structure Excavation Common or Structure Excavation Solid Rock for all bridge foundations and reinforced concrete box culverts. Structure Excavation necessary in the construction of crib walls, and retaining wall shall be Unclassified Structure Excavation, unless otherwise specified on the plans. Subsection 603.03, "Classification", should be consulted for exact definitions of each particular classification of structure excavation.

Foundation Preparation is a pay item that is also used for structures and as a Lump Sum can include several different phases of the excavation. This item is primarily used for culvert excavation and backfill although it has been used for bridge excavation. Refer to the Standard Specifications Section 603 for further details.

The Guidance Manual discussion of structure excavation is divided into separate discussions of the following types of structures: Bridges, Culverts, Retaining and Crib Walls, and the Removal of Existing Bridges, Culverts, and other incidental items of wet stone and dry stone masonry.

.0320 Bridges

.0321 General - The Project Engineer and the project inspectors should closely examine the plans for special notes and specific details concerning the structural requirements for the footing being excavated. Notes, arrows, or other symbols are frequently added to pier footings indicating the footing is to be placed against rock. For example, if notes indicate the footing is to be placed against solid rock and the Contractor excavates the rock outside the limits of the neat line, the Contractor must place additional concrete against solid rock at his the expense.

It is very important that the Project Engineer check existing site conditions, stream alignment, and existing roadway grades, *especially once the new structure is staked,* against the plans to determine if the new structure is in general alignment with on site conditions. Several factors such as the age of the design plans, improper staking, new roadway repairs, stream scour, etc. can change the conditions anticipated by the designers and must be addressed, before work begins, by the Cabinet.

Before excavating, a survey of the excavation site and examination of the plans should be made for location of existing utilities by both the Contractor and the Project Engineer. Utility companies should be contacted to provide the Contractor with elevations and precise locations regarding their installations. The Project Engineer or Inspector should check to be sure the Contractor is aware of the "Before-You-Dig" (BUD) service and its advantages in location of underground utilities. Each utility company should be requested to furnish the Contractor elevation, location, and any other pertinent information they may have on utilities near the work.

It is good practice for the Project Engineer to have the project inspector check plan grades and structure excavation quantities for arithmetic errors. The Project Engineer should take original ground elevations, top of rock elevations and bottom of rock elevations using methods outlined in Chapter 4 of this guidance manual. Exhibit No. 63-8-4 depicts procedures to be used in computing various pay items and pay quantities involving bridge excavation.

The Project Engineer and the project inspector should be safety conscious and impress upon the Contractor the importance of using good safety procedures. It is very important that the Contractor devise methods to keep the excavated area as dry as possible. This can be done by pumping, drainage ditches, etc. keeping in mind good erosion control practices. Also the excavated area shall be OSHA compliant meaning it is shored or sloped back. The Project Engineer and his inspectors are not OSHA inspectors – compliancy is the contractor's responsibility.

The footings for river crossings subject to scouring should extend into solid rock unless the plans specify otherwise. The bottom of the footings should be as level as possible. A sump may be cut into the rock outside the footing area to provide a low spot to collect water for pumping. Foundation seals may also be used.

.0322 Suitable Foundation – When the plan footing elevation is reached, have the contractor clean and de-water the footing so the surfaces can be visually inspected for suitable foundation material. The surfaces should have relatively few fractures or splits, no soil or mud should be present, and the surfaces should have a generally sound appearance. If the visual inspection shows suitable surface conditions, have the contractor drill at least one test hole a minimum of five feet below the surface. Observe the drilling operation and inspect the drillings as they are bored from the hole. If there is no evidence of a mud seam or voids, then no further drilling is required and construction of the footing can proceed. If there is evidence of a mud seam, voids or other unsuitable material; further investigation is required and the District and Central Construction Offices should be consulted. More holes should be drilled. Prepare a log of the drillings, so that the location of the voids or unsuitable material can be determined. Lowering of the footings may be required, but preferably the unsuitable material would be removed and mass concrete used to bring the footing base back to the plan elevation. Keep in mind the importance of the foundation in supporting the structure for decades to come and if there is any question whatsoever about the soundness of the supporting material, consult the District and Central Construction Offices.

In some cases suitable material may be encountered at a higher elevation than shown in the plans. Consult the District and Central Construction Offices before raising the elevation of the footing base. If the plans indicate the footing may not be raised, continue the excavation to the depth as shown regardless of the suitability of material encountered at higher elevations.

Maintain the plan footing thickness in cases where the footing is either raised or lowered. The height of the wall or column above the footing is adjusted. Lowering the footing and increasing the length of the wall or column may

require the adjustment in the reinforcement. Check the plan lengths of the vertical wall or column reinforcement, they may allow for a small adjustment in length. If not, the lengths must be adjusted or additional reinforcement of the same size must be ordered to provide an additional splice. It is critical to maintain the length of splice as shown in the plans. Additional horizontal reinforcement may be required, maintain the same size and spacing of the plan horizontal reinforcement.

.0323 Footings - The footing should be properly cleaned and as much water as possible pumped out prior to placing concrete. After the concrete has been placed, cured, forms removed, and patched, the excavated area should be cleaned of all mud, debris, etc. and properly backfilled to original ground elevation. It is very important to do this as soon as possible because, many times, standing water can cause foundation material to soften and deteriorate in a short period of time.

Good material should be used to backfill. It is acceptable, in a wet condition, to permit the contractor to begin backfill with a lift of stone at the Contractor's expense. The remainder of the backfill shall be done in a manner to comply with Specifications. Excavated material may be acceptable as backfill providing it meets requirements. Backfill material should be brought up in equal lifts all around the footing or stem so the structure will not be displaced. Backfill should be completed to a level in such a manner that water will drain away from the structure. Density of backfill is critical in all cases and especially under roadways; adequate compaction should be obtained to prevent excessive settlement or drainage problems.

.0330 Culverts

.0331 General - Structure plans should be closely examined for footing details such as special notes requiring the footing to be placed in rock, against rock or excavating rock to provide for an earth cushion.

It is very important that the Project Engineer check existing site conditions, stream alignment, and existing roadway grades, *especially once the new structure is staked*, against the plans to determine if the new structure is in general alignment with on site conditions. Several factors such as the age of the design plans, improper staking, new roadway repairs, stream scour, etc. can change the conditions anticipated by the designers and must be addressed, before work begins, by the Cabinet.

Before excavating, a survey of the excavation site and examination of the plans should be made for location of existing utilities by both the Contractor and the Project Engineer. Utility companies should be contacted to provide the Contractor with elevations and precise locations regarding their installations. The Project Engineer or Inspector should check to be sure the

Contractor is aware of the "Before-You-Dig" (BUD) service and its advantages in location of underground utilities.

The Project Engineer's survey party, or the inspector working with the contractor's crew, should take original ground elevations, top of rock elevations, bottom of footing elevations and any other information necessary to compute final pay quantities using methods outlined in Chapter 4 of this manual. Exhibit No.63-8-5 covers various situations and procedures for computing culvert excavation.

.0332 Excavation - The Contractor should excavate in accordance with sound safety practices and abide by all permits and laws governing stream pollution.

The Contractor should use care in blasting if the footing is to be cut into rock and concrete placed against the rock. No additional money will be paid for excavation outside the neat lines of the footing due to the Contractor's overblasting.

Test holes at least five feet deep should be drilled at least every 50 linear feet of footing as a test for suitable solid rock. In the case of culverts with parallel footings under the walls, or an extra wide footing, it may be necessary to drill more than one line of holes. In this case, the holes should be staggered between footings on 25-foot centers. More holes may be drilled if footing conditions dictate a need for them.

If the footing is designed for an earth foundation, soundings should be made to be sure the minimum earth cushion (2 ft) exists between the bottom of footing and top of solid rock. For solid rock foundation, it may be necessary to backfill the area under the paved flowline. Dry compactable materials or a fine shot rock should be used. The rock should be shot fine enough so no individual rock is so large that it creates a point bearing.

If the apron wall at the inlet or outlet end of a culvert with earth foundation hits rock, the rock should be excavated a minimum of one-foot so that the wall toes into rock. This does not apply to culverts with rock foundation designs since the apron wall toes into and rests on rock.

If the Contractor has completed the excavation for the bottom slab and footings of a culvert and the conditions of the foundation material becomes unsatisfactory because of rain or ground water, the Contractor shall place sufficient coarse aggregate or filter fabric to prevent the infiltration of mud into the concrete. Alternatively, the mud can be entirely removed and replaced with suitable stable material. These operations are performed at the expense of the Contractor. A wet condition resulting from the Contractor's operation is not to be confused with an unstable foundation, which requires stabilizing and/or undercutting and is generally considered a pay item. This

situation should be discussed with the District Construction Office before proceeding.

.0333 Backfilling - Backfill operations should begin on as dry a foundation as possible. Lifts should be placed as level as possible and the operation should keep the elevations of the backfill material on the 2 sides of the culvert equal in order to prevent displacement of the structure. Densities should be run on the backfill material, if practical and desired.

Geotextile wrapped backfill drains must be installed above weep holes prior to backfill. Since this product is subject to deterioration due to sunlight and other construction activities, it should be installed just prior to backfill. Ensure that the proper face is placed against the concrete. Ensure that special precautions are taken to seal the drain top and provide positive drainage into the weep hole. Consult geotextile wrapped backfill drain product literature for guidance relative to attachment to concrete walls and other special features.

If the height of fill above weep holes exceeds 30 feet, #57 stone drains must be used. Care should be exercised to keep the column of stone for the weep hole drains from being contaminated and also the be sure it extends to the elevation of the top of the culvert. If bags are stacked for the #57 stone column they must be bags that will not silt up and will be freely draining. Burlap and solid polyethylene bags are not acceptable. Large open meshed bags or chicken wire are considered acceptable containers.

All culverts should be backfilled as soon as possible to original ground elevations and should be graded such that water will drain away from the structure.

Backfill material should extend a minimum of 2 feet above the top slab of a culvert before any rock fill or heavy equipment are placed on it.

.0340 Retaining Walls and Crib Walls - Retaining walls and crib walls should be excavated as shown on the plans. It is very important that the Project Engineer check existing site conditions, stream alignment, and existing roadway grades, *especially once the new structure is staked,* against the plans to determine if the new structure is in general alignment with on site conditions. Several factors such as the age of the design plans, improper staking, new roadway repairs, stream scour, etc. can change the conditions anticipated by the designers and must be addressed, before work begins, by the Cabinet. Original ground elevations should be taken in accordance with Chapter 4 of this manual.

Bottom of excavation elevations should be taken so that excavation can be computed in accordance with the Specifications. See Exhibit No. 63-8-6 for details of pay limits.

The Project Engineer should be certain that the elevations of the weepholes are 6 inches above the backfill elevation on the exposed face of the retaining wall. For retaining walls without fill on the exposed face, weepholes should be located 6 inches above flow line. The Project Engineer should consult the District Construction Office if there are any questions concerning the adequacy of the drainage

If the Project Engineer determines that the height or length of retaining wall is not adequate to meet field conditions, the District Construction Engineer should be contacted who, in turn, may contact the Central Office Bridge Construction Engineer.

It is very important that water not be allowed to stand in the excavated area near the footing as saturation of the bearing material may cause the loaded retaining wall to fail.

The excavated area should be backfilled as soon as the concrete has gained sufficient strength. Densities should be run in the backfill material if possible to determine if compaction requirements are being fulfilled. Backfill will be drained by geotextile wrapped backfill drains. Refer back to Subsection .0333 in this chapter for additional information.

The Project Engineer should not permit the contractor to use heavy equipment in the area being backfilled unless it is kept a sufficient distance away to preclude damage.

.0350 Removal of Existing Structures - The Project Engineer should be familiar with existing bridges, culverts, and wet stone and dry stone masonry to be removed and should consult the plan notes, proposal notes, and specifications for the method of payment.

It is very important that the Project Engineer recognize the method of payment as it may be necessary to measure the volume of the removal item if it is to be paid by the cubic yard.

Special care should be taken to ensure the removal item does not get paid more than once. For example, if a culvert falls within the limits of the structure excavation for a new culvert and is to be paid as a lump sum item, it would be necessary to cross section it and deduct the volume from the quantity of structure excavation for the new culvert. The exhibits prepared for this section include examples of removing structures.

Detail sketches showing calculations, dimensions, and elevations should be made for record purposes. It is a good idea to let the Contractor know when this is being done, as they may want to have someone from their organization assist in

taking the measurements. This courtesy to the Contractor can prevent controversy about the exact pay quantity. The Standard Specifications for Road and Bridge Construction should be consulted for this type removal.

63-08.0400 COFFERDAMS

.0410 General - Cofferdams shall be erected and subsequently removed in accordance with the Standard Specifications.

Generally, any temporary structure driven or installed to a desired depth for keeping water and/or earth out of structure excavation by resistance of lateral pressures may be termed a cofferdam. Cofferdams shall be water tight as to permit dewatering by pumping and provide a reasonably dry work area for concrete masonry operations. A cofferdam is usually constructed of sheeting, wales and struts. These are generally structural steel members.

.0420 Design - The Contractor bears the entire responsibility for design, construction, maintenance and removal of a cofferdam. The Department of Highways, however, reserves the right to review all cofferdam designs before construction is started. Due to time and personnel constraints, our focus is primarily on shoring that restrains roadway/bridge fills or fall under constraints of another agency like the rail road. Accordingly, the following procedure shall be utilized.

The Contractor shall submit a minimum of 4 copies of cofferdam design to the Project Engineer. The design should be submitted at least 4 weeks before the contractor plans to begin construction of the cofferdam. The Project Engineer will check the plans with respect to the following points.

1. Completeness of design - Does the design provide sufficient data to build the cofferdam?
2. Completeness of design – Are connection types and details designed and shown in the drawings? (Whether bolted or welded.)
3. Sufficient clearance - Is the clearance between the neat lines of the foundation and the sheeting or wales sufficient to accommodate construction of forms and inspection?
4. High water - The lowest point on the top of the sheet piling should be sufficiently high above normal pool to provide adequate safety against flooding when a sudden rise occurs.
5. Do the project plans require a vented or flooded elevation? If so, is this vent shown in the design? This is a standard requirement when a foundation seal is necessary.
6. Tip elevation - Does the sheeting extend well below the bottom of the footing or is it keyed into rock satisfactorily?
7. Navigation requirements. Is sufficient channel clearance provided?
8. Railroad requirements. Has adequate track clearance been provided? Have railroad surcharge loads been considered?

9. Any obvious errors or omissions.

If the cofferdam design appears to be substantially complete, the Project Engineer should forward it, with recommendations, for review by the Central Office, Division of Construction. The Project Engineer should, however, return the design to the contractor for revision or clarification if it lacks essential details or contains obvious errors.

.0421 Design Review - The Central Office, Division of Construction, will review the design and any accompanying recommendation and will return the design to the contractor through the District Construction Office and the Project Engineer along with appropriate comments and recommendations. The time to review, whether 4 weeks or longer, must be planned for by the contractor and will not be considered a delay to the project.

.0422 Outside Agencies - Cofferdams adjacent to railroads must be approved by the railroad. Cofferdams in navigable streams must be reviewed and approved by the U. S. Coast Guard for navigation lighting and channel clearance. There may also be other agencies which need to review and approve shoring or cofferdams. The cofferdam plan will be forwarded to these agencies by the Central Office, Division of Construction who will liaison with them to obtain approvals.

.0430 Installation - Construction of a cofferdam usually begins by making a frame that, acts as a template to hold the sheets to plan dimension during driving. The Project Engineer should require the contractor to make the initial alignment of the frame as accurate and stable as possible so that any movement of the sheets during driving will be minimized and clearances will be maintained. Care should be taken to drive the sheets well below bottom of excavation. Usually, the same type of driving equipment used for driving piling may be used for driving sheeting with the driving head modified to accommodate the type of sheeting being used. Other types of driving equipment which may be used are the drop (gravity) hammer or the vibratory hammer. When the drop hammer is used, it is usually necessary to seat sheeting in rock with a power hammer. The vibratory hammer is increasing in popularity, particularly on bigger jobs, since it drives sheeting fast, at a uniform rate, and with minimum damage. It is also used in extracting sheeting.

The Project Engineer is cautioned that cofferdam sheeting is not satisfactory for use in establishing permanent line or grade references because of its tendency to slip, lean, or warp under pressure. The Project Engineer should become very familiar with the cofferdam construction; and should discuss all procedures with the contractor or project superintendent and make every effort to stay current with the construction. The cofferdam design plans and the structure plans should always be available at the work site. The design, as reviewed, should be followed closely. It is recognized that, on occasion, conditions change and it may become

necessary to strengthen the design. It is considered acceptable procedure to upgrade the design strength of a cofferdam to meet changed conditions, but a major re-design should be resubmitted for review. Under no conditions should the size of any member be decreased or eliminated without resubmission for a review of the revised design.

.0431 Safety - Safety during all phases of construction and use of the cofferdam should be of critical concern to the Project Engineer and a responsibility of the contractor. Thus should be discussed thoroughly with the contractor. Existing rules and regulations such as those found in the "Kentucky Occupational Safety and Health Standards for the Construction Industry," should be adhered to closely.

.0432 Removal - Removal of the cofferdam is not as exact as its installation. The Project Engineer should observe it closely, however, to be sure caution is used when working around in-place structural components. Partial or complete backfill will be required before cofferdam removal.

63-08.0500 BEARING PILES

.0510 General - Bearing piles are used to support structures where dependable foundation materials are deep below the ground surface which makes spread footings impractical or uneconomical. They transfer loads from the structure footing or foundations to the bearing material through friction, or point bearing or a combination of both.

Piles generally will be steel, or concrete as indicated in the plans. In the case of concrete, they may be precast or cast-in-place. Timber piles are generally used for temporary bridges or falsework. Construction procedures for all types of piles shall be in accordance with Section 604 of the Standard Specifications or, as in the case of drilled shafts, specified by Special Notes in the proposal. The material requirements for precast and prestressed piles are in Section 605 of the Standard Specifications. The material requirements for steel piles are in Subsection 812.01.01, A).

The Standard Drawings include pertinent dimensions, reinforcement requirements, splice details, types of concrete, etc., for all acceptable types of piling under the general heading of "Bridge Piling".

This manual should provide sufficient information to handle the majority of piling jobs. It is recognized, however, that there will be pile hammers used occasionally which are not included in this text, and that data will be required to be provided from contractors. This data will be provided if available in the Central Office.

.0520 Preparation for Driving - Preparation is very important in pile driving. A little extra time spent in preparation will help ensure a good pile installation.

The position of every pile is shown on the plans. Each pile should be located in the correct position and be vertical or battered as specified. Flanges of steel H-piles are to be oriented as shown on the plans. The contractor is responsible for the pile layout; however the piling inspector should thoroughly check the layout before pile driving begins. Typical layout procedures should consist of physical templates that can be fixed to the surface in which the pile is being driven. This is to ensure proper control of the location and orientation of the pile during the driving operation.

Alignment of each pile should be checked before driving starts. Vertical piles may be checked in the leads by a carpenter's level. This level should be at least four feet long to achieve the desired accuracy. Battered piles may be checked in the leads using a triangular template, which has been cut to the desired batter, in conjunction with a carpenter's level.

.0521 Pre-Drilling

Pre-drilling of the through the existing overburden may be required on projects prior to placing bearing piles. This is to create a pile socket to a depth in which to insure that the minimal pile tip elevation is met per the project documents. Once the pre-drilling is complete, install the pile into the socket to full depth and backfill with sand, pea gravel, or other material approved by the Project Engineer.

Placing a temporary casing may be required to prevent collapse of the pre-drilled socket. The casing must be removed once the piling is in place and the socket is backfilled, prior to driving.

Care should be taken during the driving of a pre-drilled pile. The initial strikes are generally taking place with the pile tip against rock. The driving process is to seat the pile tip and achieve refusal on the pile.

.0530 Material

.0531 Heat Numbers - The heat numbers on all steel H-piles, splice plates and shell piles must be checked against signed mill test reports. For approval, the contractor must provide the Project Engineer a copy of the mill test report signed by a representative of the producer. The Project Engineer will review these test reports and notify the contractor in writing of the approved heat numbers and forward a copy of the approval letter to the Division of Construction. If any material delivered to the job site does not have the required markings for heat numbers or signed mill test reports, these materials shall be automatically rejected.

.0532 Concrete Piles - Precast or prestressed concrete piles should be checked to ensure that they have been approved by the Division of Materials when they

are not cast at the job site. Check for presence of the Kentucky Oval Stamp. Review the section 63-08.1100 on Prestressed Concrete in this chapter.

.0533 Pile Splices - All pile splices should be made precisely in accordance with the plan details and applicable Standard Drawings. All welding must be performed by qualified and certified welders for the type of joint and position of weld being performed. Refer to the section 63-08.1000 on welding in this chapter. All splice plates must have mill test reports. Splicing of concrete piles should be avoided when possible. If unavoidable, concrete piles shall be spliced in accordance with the appropriate standard drawing or plan details. Groove weld joints must be beveled according to the required details. All welds must be visually inspected for size and quality.

.0534 Pile Points – All pile points should conform to the requirements of the current Standard Specification. All pile points should be attached precisely in accordance with the plan details and applicable Standard Drawings. All welding must be performed by qualified and certified welders for the type of joint and position of weld being performed. Refer to the section 63-08.1000 on welding in this chapter.

Follow the Standard Specification 604.02.06 by reviewing the current version of the LAM for approved pile point types and their suppliers.

NOTE: Contractors may propose to use other suppliers and other points. Sufficient information shall be submitted for Department review and approval. Substitution of points shall be at no additional cost to the Department. The contractor shall not be allowed any extension in contract time for Department review of proposed substitutions.

.0535 Stockpiling - Partial payments for materials on hand may be paid for bearing piles as stipulated in Subsection 109.05.01 of the Standard Specifications. The maximum quantity paid will be the design (plan) quantity increased or decreased by approved changes. Care shall be taken to record and preserve the heat numbers on each pile and or pile point (if not factory attached) during stockpiling. This will insure the ability to check the heat numbers to the signed mill reports just prior to placement.

.0540 Inspection - Administration and inspection of pile driving work requires sound judgment and complete familiarity with the plans and specifications. Discrepancies between plan requirements and observed results are not unusual. Decisions must be made promptly to avoid delays to the contractor. When in doubt, the Project Engineer should seek help from the District Construction Office in making required decisions, and the District Construction Office should discuss any unusual situations or problems with the Central Office, Division of Construction.

An inspector must be present at all times when pile driving is being performed. The inspector must be sufficiently familiar with contractual requirements as to be able to accept or reject each pile as it is driven. The pile inspector must determine and document pile pay lengths and record data to establish that the piles conform to contract requirements for penetration and bearing. Keep neat, accurate, and complete signed records in the project file (Exhibit No. 63-8-11). All piles of any type should be inspected for damage prior to, during, and after driving. The length of all piles and build-up should be accurately measured by the inspector prior to driving.

.0541 Piling Reports - Form TC 63-22, titled "Record of Test Pile" (Exhibit No. 63-8-10) should be completed at time of driving test pile and submitted to Central Office, Division of Construction and Geotechnical Section, Division of Structural Design.

After all the piling in a bent or pier has been driven, Form TC 63-8a, titled "Record of Piles Furnished and Driven" (Exhibit No. 63-8-11) should be completed by the inspector, reviewed by the Project Engineer, and submitted to the District Office for checking. This form is then submitted to the Central Office along with the final estimate. In making out this form, the length of cut-off shown on battered piles is the actual length of material cut-off, not the vertical difference between the original top (prior to cutting) of pile and cut-off elevation. Submit a completed copy of the Pile Record plan sheet to Division of Construction. It will then be forwarded to the Division of Structural Design for entry onto the original plans.

.0550 Equipment

.0551 Leads - Pile driving leads must be rigidly held in position by guys, stiff braces, templates or other satisfactory means to ensure support to the pile during driving. The axis of the leads must coincide with the axis of the piles. The leads should be of adequate length to reach the ground prior to beginning driving. The contractor should provide a batter template and carpenters level for determining plumbness and/or correct batter. Leads with heavy points that penetrate solid ground and hold the leads firmly in the correct position during driving generally are adequate and will not require templates. When templates are necessary it is suggested that a minimum of 10-inch by 10-inch timbers, securely anchored, be used. For additional information refer to the Standard Specification 604.02.07 B).

.0552 Pile Hammers - The hammers should be checked during driving to see that they actually provide the length of stroke and number of blows per minute which the hammer manufacturer indicates. Driving resistance values computed when these requirements are not met will be considered invalid. Bearing values should only be accepted when the equipment is working properly. The size and weight of the hammer should be checked to see that it

conforms to Subsection 604.02.07 A) of the Standard Specifications relative to the type of pile being used. The hammer must also satisfy any plan note requirements relative to its size and cushion material. Pile hammers should always have renewable shock cushions between the helmet and ram and a timber cap or cushion generally consisting of layers of plywood should be placed on the top of concrete piles to prevent damage to the pile.

Diesel or air hammers which have an enclosed ram shall be equipped with a gauge and charts which will evaluate the equivalent energy produced. A contractor must be able to prove the gauge is reliable and accurate before use. Recalibration may be required. If vibratory hammers are used, other types of hammers must seat the piles so bearing may be determined.

Exhibits No. 63-8-25, 26, 27 and 28 have been prepared to reflect the data required to determine bearing capacity for specific hammers. It is the contractor's responsibility to provide sufficient data on the hammer to determine its capacity.

.0560 Test Piles - Before driving test piles for a structure, the District Construction Office should be notified so that a representative may be present to assist the Project Engineer in determining when an adequate bearing is obtained. The subsurface data sheet of the plans should always be reviewed to verify the length of test pile specified. When an obvious error is detected, consult the Division of Construction-for advice.

The test pile should be marked in one foot increments starting from the bottom of the pile. The number of blows required for each foot of penetration should be recorded on the "Record of Test Pile", Form TC 63-22, Exhibit No. 63-8-10. The Project Engineer should provide a means of determining top of pile and cut-off elevations after piling are driven. This data is used for record purposes in determining the length of cut-off and should also be recorded on the Form TC 63-8. (Exhibit No. 63-8-11).

Additional test piles may be required by the Project Engineer when difficulty is encountered in obtaining the plan bearing capacity or pile lengths vary significantly. It is the contractor's responsibility to determine the pile length to order.

The nature of a test pile is such that it is normally driven deeper than a pile to provide the necessary information concerning bearing capacities of subsurface strata's. Test Piles are for the Engineer's use in determining capability of the Contractor's equipment and adequacy of design. The Contractor shall be responsible for determining pile lengths that may be necessary to obtain the required bearing values. The same model and size pile hammer shall be used to drive the remaining piles in the structure as the one used to drive the test pile. The same type of piles shall be used in the remainder of the group as the type

tested for the group. For addition information refer to Standard Specification 604.03.06.

.0561 Contractor's Order Length - The contractor shall determine the order length of production piles that may be necessary to obtain the required bearing values. The contractor may use subsurface data and the test pile results to determine the order lengths. The contractor does so at their own risk with no obligation by the Department of Highways' representatives. Pile splices must be held to a minimum. The contractor should not be permitted to routinely splice several short segments of piles.

.0562 Load Tests - When load tests are required in the contract, the Project Engineer should obtain from the contractor an outline of the method of performing the tests. The outline should include sketches and describe the method of test loading, the method of instrumentation for measuring test loads and the method of measuring the test pile settlement under load. All load tests should be completed prior to driving production piles. Sufficient time shall be provided for redesign of piling if bearing is less than indicated on the plans. See Exhibit No. 63-8-12 for suggested forms to record load tests.

.0570 Driving

.0571 Bearing Capacity - The bearing capacity of the pile should be determined by using the applicable formula for the pile hammer being used. The bearing capacity, either as required by plan notes or that which is determined to be required by the load test, must be obtained. A pile splice will be required when necessary to obtain bearing. The plan terminology “Required Driving Resistance” is synonymous with the traditional required bearing capacity.

.0572 Refusal - When the plans specify that piles are to be driven to REFUSAL, it must be realized that the pile will generally never completely stop. Care should be exercised to NOT overdrive piles. The bearing will be considered adequate when the pile obtains 150 tons for 12-inch steel piles, 180 tons for 14-inch steel piles, and 200 tons for 16-inch steel piles. The inspector should never just require 1/8-inch in 10 blows or some arbitrary requirement, but should always base the acceptance on an adequate bearing for the hammer being used. See Table .0572 A) below for a chart repeating the adequate bearing capacities listed above for ease of reference.

Table .0572 A)

Bearing Capacity (tons)	Steel Pile Flange Width (inches)
150	12
180	14
200	16

NOTE: See 0.05205 of this chapter for additional steps when pre-drilling is required.

.0573 Friction Pile - The minimum penetration of any pile is 10 feet or more in firm material and 20 feet or more in soft material. A penetration of 10 feet or more into original ground and 10 feet or more below stream bed is also required. When driving is hard and damage to the pile is expected, or where it is impossible to obtain minimum penetration, jetting or auguring should be used. When jets are used, the volume and pressure at the jet nozzles shall be sufficient to freely erode the material adjacent to the pile. If an outside jet is used, it should be used alternately around the perimeter of the pile to ensure accurate vertical alignment of the pile is maintained.

It has been noted that, in certain sections of the state, friction piling does not always attain “Required Driving Resistance” upon completion of driving. This condition appears to be a result of the "puddling" (liquefaction) of free water against the pile during driving. This tends to lubricate the pile and create a quick condition. Past experience has shown that if the pile is allowed to set for a short period of time (6-24 hours) it will tend to "set" or "freeze". The “Required Driving Resistance” will then increase significantly.

When this situation arises, driving should be stopped one or two feet above cut-off elevation. The pile shall be re-struck after a short period of time (6-24 hours) and driven to the “Required Driving Resistance” as called for in the project documents. The driving mentioned above is recommended to ensure that the pile will retain the “Required Driving Resistance”. Please note that this condition will only be accepted when free water is present, and a review of the boring log indicates similar material for a considerable depth. If the pile breaks loose during re-striking then the pile should be spliced and driving continued until “Required Driving Resistance” is obtained.

.0580 Concrete Piles - Particular attention should be given to methods of handling concrete piles. Details for handling and applicable pick-up are shown in the Standard Drawings for both reinforced concrete piles and prestressed concrete piles.

.0581 Two Foot Strip-down - Consideration must be given to a minimum 2-foot strip-down, where required to provide the exposed one-foot and 10 inches of reinforcing steel or strands in concrete pile.

When this two-foot strip-down is required to expose the reinforcement steel, that length is added to the length below cut-off elevation for purposes of payment. When the pile has been driven too low to provide the one-foot and 10 inches of exposed reinforcement and it is necessary to weld on the reinforcement bars, payment will be as though the one-foot and 10 inches of

length of pile had been provided. That will constitute full payment for exposing adequate length for splicing, making the splice and providing the material. (See Exhibit No. 63-8-13 for one method of acceptable welded reinforcement lap splice).

.0590 Cast-In-Place Piling

.0591 Shell Piling - The lengths of Seamless Steel or Welded Pipe Shell and Fluted Steel Pile Shell that may be driven with various hammers are not restricted as long as the hammer meets minimum energy requirements of the Specifications.

Steel shells must be carefully driven to avoid crushing or buckling of the shells. Collapse of the shells can be suspected when the top of pile suddenly gets out of line, or a noticeable difference in bearing capacity occurs. If bearing has been gradually increasing during driving, and suddenly starts to decrease, driving should be stopped and the pile inspected.

The contractor is responsible for selecting the pile shell wall thickness to withstand the driving forces required to obtain the minimum bearing and penetration required. In the event of pile collapse, the Central Office Division of Construction should be notified, to determine if a piling redesign will be required.

After driving and before placing concrete, all shell piles should be thoroughly inspected with a light to determine if the pile in place is in good condition and free of water, debris, bends, buckles, and etc. Mirrors can provide reflected sunlight on sunny days. Artificial light will be required otherwise.

.0592 Drilled Shafts - A drilled shaft is a foundation which is constructed by placing fresh concrete in a drilled hole. Reinforcing steel can be installed in the excavation, if desired or specified. Concern for scour of pile foundations or spread footings on rock has made drilled shafts more popular. Drilled shafts can allow deep foundations to be constructed without cofferdams, therefore, saving project costs.

A drilled shaft is similar to a cast-in-place or shell pile except it has a large diameter (usually 3 to 6 feet) and is generally not driven. Drilled shafts are reinforced similar to a circular column. They may bear on solid rock or entirely on soil. Steel casings may be either permanent or temporary. Drilling slurry may be used at the contractor's option or required by the contract depending on subsurface conditions.

Drilled shaft reinforcement and dimensional details are shown on the plans. Procedures for concrete placement are covered in .0737 of this chapter. This note is usually a part of the contract proposal. It contains preconstruction

submittal and material requirements. These notes also include requirements for construction methods, equipment, and subsurface exploration. Construction tolerances, method of measurement and basis of payment are also provided in these notes.

Carefully follow plan details, Special Note requirements, and other applicable project documents. Do not hesitate to contact the Division of Construction Central Office if you are unfamiliar with or have questions concerning drilled shafts.

63-08.0600 FALSEWORK AND FORMS

.0610 Falsework - The use of good falsework in construction cannot be over emphasized. Inadequate falsework is not only hazardous to the safety of workers, but may increase the ultimate cost of construction or result in damage to adjacent private or public property.

Falsework is composed of structural units such as beams, joists, bents, columns, studs, trusses, arches, bracings, and forms designed under standard engineering procedures. Each individual unit may act independently or in combination with other units in order to shore or support anticipated loads.

.0611 Falsework Design - The contractor is responsible for the design and stability of falsework, but it is important for the Project Engineer or an authorized project inspector to conduct a review of the contractor's falsework drawings to ensure that the falsework is constructed in accordance with the approved drawings.

Joints and connections are deemed critical, and shall be examined closely. The design calculations and the detail of the drawings should be explicit.

Information for bridge deck falsework have been prepared and incorporated with this manual as Exhibit No. 63-8-31. Detailed drawings must be submitted to the Project Engineer in triplicate for all units of the falsework needed to support the structure. The drawings shall include design calculations for all features that do not utilize the Departments tables. Exhibit No. 63-8-31 contains sufficient information for the Project Engineer to spot-check falsework submittals. Falsework designs must be prepared, and stamped, by a Kentucky Registered Professional Engineer in accordance with Subsection 601.03.11 of the Standard Specifications, and must adhere to all current OSHA regulations. The loading condition to be used in the design shall be in accordance with the current Standard Specifications, or if actual dead load, live load, and impact loading conditions prove to be greater, then the loading from such analysis should be used. Any design procedure for falsework that the contractor chooses shall be in accordance with the current accepted practice for timber, steel and concrete bridge design.

.0612 Design Review - A review of the falsework shall start with the Project Engineer. The Project Engineer should ensure that the drawings include all dimensions and sizes of the major members, as well as essential connections. The drawings and calculations should be checked for obvious errors and should be forwarded to the District Construction Office–for review, and the plans and calculations, with noted comments, should be endorsed and transmitted to the Central Office, Division of Construction for final review. If the Central Office finds that any part of the falsework is inadequate, the Project Engineer shall advise the contractor to revise that part or portions of the falsework plan and resubmit.

- The contractor should not be allowed to begin construction of the falsework until the review is complete.

- Spacing and size of load carrying members shall be closely checked as well as the load carrying capacity of all material used.

.0613 Falsework Erection - The Project Engineer should carefully study Subsection 601.03.11 of the Standard Specifications and should have a fully reviewed copy of the contractor's falsework plan at the erection site for reference as the falsework is erected.

Any comments noted by the Division of Construction on the reviewed copy of the falsework plan should be directed to the attention of the contractor's, engineer, and the superintendent in charge of erection. It is very important that this information not be laid aside in the Project Engineer's Office.

- The Project Engineer should examine all material which is to be used as a part of the falsework. It should be free of an excessive number of knots, checks, cracks, and holes, and should be straight and true. The material should have the dimensions called for in the falsework plan. Steel members must be of the proper shape and size noted in the plans and should be free of bent flanges, holes, splices, and lost cross section due to excessive rust. Steel falsework members must not be welded or tacked to the flange or web of any steel member of the bridge.

- The location of any splices in steel tension members should be directed to the attention of the District Office personnel for their approval. If the District Office has any doubt about the location of any splice and its effect on the integrity of the falsework, they should consult the Division of Construction personnel who reviewed the falsework plan.

- The Project Engineer should check the site to ensure the conditions at the site have not changed and to ensure that the falsework plan will be workable with the existing contours, elevations, etc. Any necessary

excavation or fill work should be completed before the falsework erection is started.

- The Project Engineer should be sure the material supporting the footings is as good as that which is represented by the contractor's falsework plan. When the supporting material has low bearing capacity, it shall be compacted or replaced as directed by the Engineer.

- Any sills used as footing should have true and even bearing on the supporting material. They should be firmly anchored and the material supporting them must be protected from settlement or lateral displacement.

- Any "deadmen" used in the falsework plan should be firmly anchored and should also be protected from any sort of displacement.

- All vertical members of the falsework shall be straight and plumb and cut-offs shall be accurately made to ensure uniform bearing at both the top and bottom. When a corbel is provided, attachment to the vertical member shall be rigid and the member shall be designed. Short stubs or blocks will not be permitted in these members when members are cut too short.

- Caps shall be placed so that they secure an even and uniform bearing over the tops of supporting posts.

- Beams spanning from cap to cap shall extend fully over the cap as detailed on the falsework plan and shall have the required bearing area.

As the falsework is being erected, the Project Engineer should check the dimensions to verify compliance with the falsework plan. Even though the falsework design is reviewed, the overall soundness of the falsework should be examined by the Engineer for any obvious omission or weakness.

- Plywood should not be used to block-up or provide vertical support for any load carrying member.

- A sufficient number of nails and bolts should be used to guarantee the stability of the structure.

- Load rating and spacing of the overhang brackets, which the contractor is using, should be checked to ensure they agree with those specified on the plans.

Good housekeeping during the falsework erection phase and while it is being maintained is essential to the safety of the workers. The falsework should be

examined from a safety to worker's viewpoint and any hazardous projecting members should be cut off.

No changes should be permitted in the reviewed falsework plans without being submitted and reviewed in the same manner as the original falsework plan.

The Project Engineer should check the falsework to ensure all clearances pertaining to roads, streams, railroad, etc. are properly observed and, where required, should ensure clearances are posted. Any illumination or other markings required by the plans, permits, ordinances, laws, or which may be deemed necessary by the Engineer to identify height or width restrictions should be timely installed on the falsework.

It is very important that the Project Engineer and the contractor do not forget about the maintenance of the falsework after it is installed.

The falsework should be periodically checked and closely examined prior to placing any extraneous loading on it. Checks should be made on the wedges and jacks to ensure they are properly positioned and tight.

The location of heaters during the curing operation and their proximity to falsework should be closely observed. It is very important that these devices be properly maintained and guarded to prevent fires and subsequent damage to the falsework and the structure.

Falsework centering and falsework supporting any concrete work, including wedges, shall not be removed or loosened without the permission of the Engineer. Subsection 601.03.14 of the Standard Specifications should be consulted concerning removal of falsework and forms.

After falsework has been removed, it should be neatly stacked and removed from the project site. All waste material should be cleaned up and the work site left in a good housekeeping condition.

.0620 Forms

.0621 Material - Form panels for exposed surfaces made of plywood shall conform to the requirements of the current U.S. Product Standard PS-1, for Exterior B-B, Class I or Class II concrete form, or any material suited for forming which will produce similar or better results. The plywood must have a stamped mark "Exterior B-B Concrete Form" or "Exterior Concrete Plyform." All other panel grade designations shall be subject to approval of the Central Office, Division of Construction. The plywood shall have a minimum of five plies and shall not be less than 3/4 inches thick.

.0622 Construction - Forms shall be built sufficiently tight to prevent leakage of mortar from the concrete. In addition to the detailed requirements mentioned in Section 601 of the current Standard Specifications, all formwork must be adequately braced, supported, and tied together in order to maintain the position and shape, true to the dimensions, lines, and grades of the structure. Form wedges shall be adequately secured and shall be rechecked during concrete placement to prevent distortion or failure of the formwork. Gaps exceeding 1/16 inch width should not be allowed between edges of form panels. Where gaps cannot be avoided, they should be covered by tin sheet strips, or other means approved by the Engineer, prior to the concrete placement. Never allow the use of aluminum as a method of gap correction or hole patch on forms. Aluminum reacts negatively with cement causing cracking and blisters. The studs or joists supporting the forms shall be spaced in such a way that the deflection of the form between adjacent supporting joints or studs shall not exceed 1/360 of the clear span.

In all cases, good housekeeping shall be maintained around and within the form system. The form system shall be cleaned of waste lumber, wire, nails, and other materials not intended to stay within the form. A quality finish on concrete revolves around the use of good formwork.

The Project Engineer should examine all used forms brought to the project site and those that are split, badly worn, and deteriorated should be rejected and the contractor not permitted to place them in the form system. An occasional hole may be patched with form patches or tin, but badly deteriorated forms are not to be used.

Forms to be used in the form system should be cleaned of all dirt, mortar, and foreign material. Removable forms should always be coated with form oil prior to use. This form oil will be a commercial quality form oil or other equivalent coating which will permit ready release of the forms without chipping and/or damage to the concrete and will not discolor the concrete.

.0623 Form Design - Form design is not usually checked as rigorously as falsework design. There are occasions, however, when the plans require it or circumstances deem it necessary. When this happens, the following guidelines are applicable.

The loading condition in the Standard Specifications must be adhered to, 50 pounds per square foot for live load and not less than 160 pounds per cubic foot for weight of concrete, steel, and forms. See Subsection 601.03.11 of the Standard Specifications for additional information. Form design shall have an adequate safety factor to accommodate additional form pressure resulting from vibrations of the form and/or concrete and impact during concrete placement from concrete buckets or any type of placing equipment. Primarily, forms shall be checked for flexure, shear, and deflection. The

computed deflection shall not exceed 1/360 of the clear span. Flexure and shear stresses shall not exceed the allowable stresses recommended by the American Institute for Timber Construction (AITC) for plyforms and by the American Institute for Steel Construction (AICS) for metal forms. Section properties of concrete plyforms shall refer to the Timber Construction Manual, prepared by the American Institute for Timber Construction, or the Plywood Design Specification, published by the American Plywood Association. The Project Engineer should not delay the endorsement of the design to the District Office for further review.

.0624 Stay-In Place Metal Bridge Deck Forms - The computed deflection is based on 1/180 of the form span rather than 1/360 as discussed above. The design of stay-in-place bridge deck forms are not required to be reviewed or checked by the Department. The design and drawing shall be submitted to the Resident Engineer who will use it to verify construction of formwork.

.0625 Form Liners – Form liners can be used to enhance the aesthetics of many concrete structures that will be visible to the public after construction is completed. The use of such forms requires detailed attention on both the Department and Contractor's level. Special concrete mix designs, concrete placement, concrete consolidation, and temperature requirements are a few of the details that must be addressed to ensure that a quality product is achieved. In all instances, the form liner manufacturer's product data sheets will provide the necessary guidance as to the proper installation, etc. of their product. The Contractor must provide the Department these data sheets prior to the use of the form liners, and they must be adhered to by the Department and the Contractor throughout the life of the form liners on the project.

63-08.0700 CONCRETE

.0710 General - Structural concrete shall conform to the Section 601 of the Standard Specifications.

The Project Engineer and his personnel should ensure that structural concrete is properly proportioned, mixed, transported, deposited, cured and finished. Sections 63-11.0200 thru 63-11.0400 of this manual and the Division of Materials Concrete Manual should be consulted for concrete plant inspector guidelines. Since these other references include concrete requirements at the batching plant, the remainder of this section will deal with job site concrete requirements.

One very important job-site requirement of the contractor is that job-site-plant communications *be* provided. This is critical during the early stages of a placement when mix design adjustments can be made by the plant inspector at the job-site inspector's request. This communication can make the difference in acceptable and unacceptable concrete, especially when long hauls are involved.

.0720 Inspection - Subsection 601.03.05 of the Standard Specifications should be consulted for pertinent information concerning the contractor's responsibility for adding admixtures and water to the mix.

If it becomes necessary to add water to the concrete mix at the job-site, the inspector should consult the water underrun on the trip ticket to determine the maximum water which can be added. After water is added, the amount should be noted on the trip ticket along with the subsequent slump test. It is important that this slump be recorded. An additional thirty mixing revolutions should be made each time water is added. Since trip tickets become a permanent part of the project files and may be audited at a later date, they should be thoroughly and legibly completed.

For Mass Concrete Pour projects, it is advised to have State personnel at both the concrete plant and the job-site. The plant inspector will convey required information to the job-site inspector via trip tickets. (Exhibit 63-11-1). Both the plant and job-site inspector should refer to this exhibit for instruction pertaining to filling out the ticket.

.0721 Time of Discharge - After cement is added to water or to the aggregate, whichever occurs first, the time intervals allowed in Subsection 601.03.07 of the Standard Specifications for placement of the concrete in its final position shall be followed.

Concrete delivery must satisfy these time requirements and meet the required slump, air content and visual inspection at the jobsite to be acceptable.

Truck mixers have metallic plates mounted in a visible location which give the manufacturer's recommendations regarding loading capacities, mixing and agitating speeds, etc. Each truck must have such a plate, and it must be legible for the truck to qualify to deliver concrete to the project. Both the plant inspector and the project inspector should check the plate and be sure that the truck operates within the required limits. Excessive mixing speed prevents adequate mixing due to centrifugal forces.

.0722 Concrete Mixer Performance Test - The Project Engineer shall run performance tests on all concrete mixers making delivery to the project in accordance with Kentucky Method (KM) 64-311 as stipulated in Subsection 601.02.16 C) of the Standard Specifications.

Anytime a Project Engineer deems it necessary, additional performance test may be run on a truck. If the truck does not pass the performance test, the sticker should be removed and use of the truck disallowed.

A satisfactory performance test shall be indicated by placing a sticker (Exhibit 63-8-34) in a protected and easily visible place in the applicable truck. The

inspector running the test should sign the sticker using the Project Engineer's name. The District Construction Office should maintain a supply of the stickers for distribution. The Project Engineer should keep the records of the performance tests in the office.

.0730 Placing Concrete

.0731 Unloading - Concrete is normally delivered from the transit mix truck or on-site plant by concrete bucket, conveyor, pump, or Georgia buggy. Whatever method is chosen prevent segregation and excessive drying of the mix. Aluminum pipes or chutes are prohibited because of an adverse chemical reaction between cement and aluminum.

.0732 Concrete Pump - If a concrete pump is used, the mix design may be modified to provide for more fine aggregate. The Division of Materials should be contacted for instructions concerning this modification. Usually a pump line is primed and lubricated with a grout mixture. Care should be taken to ensure this grout is not used in the structure and is disposed of properly. Use of a pump requires uniform concrete consistence, therefore, the plant inspector and job-site personnel should be made aware of the importance of a consistent concrete slump. Concrete which is either two wet or too dry can clog pump lines. Do not allow excessive slump just because a concrete pump operator requests it.

Since slump and entrained air content often changes during pumping operations, these properties should be monitored at the pump and/or at its location of final placement to ensure specification compliance. It is also important that an adequate supply of concrete be provided to ensure continual movement of the concrete within the pump lines. On deck pours, some type of protection may be required under *pump* line joints to prevent spillage on the deck forms and reinforcing steel when *pump* lines are broken and epoxy coated steel must be protected from damage that may be caused by pump line joints. The slump and air content target values should always be mid-range of the specifications to allow for variation and yet remain within the specifications.

Concrete pumps can place concrete very fast when the pumps are working properly. Past experience has shown that for concrete pumps to work without the lines "freezing up", there must be a constant supply of concrete. The concrete supply should be managed to avoid delays between trucks even if it requires one truck holding back its discharge until another truck is in sight. Generally two trucks can be at the hopper of a pump, but only one discharging at a time. The second truck can take over when the first empties out and keep the hopper filled while the first truck is switched out. The one-truck-at-a-time scenario forces the contractor to stage trucks, allows sampling of one truck only, and keeps the pump fed. Air loss is a concern when a pump has to stop.

Large mass concrete placements may require a different approach.

The Project Engineer should discuss *in a pre-pour meeting* with the Contractor *and all pertinent persons involved, all necessary steps* and standby equipment *required* to ensure a continuous pour in case *of* breakdown.

.0733 Deck Preparation - The forms and reinforcing steel should be moistened with a water spray immediately before concrete placement. This prevents excessive dehydration of the concrete adjacent to the forms and steel and also cools the steel. *S*praying should be done *in* a manner which will not allow excess water to stand where it will mix with the concrete.

.0734 Dropping Concrete - The contractor should plan his placement methods so that concrete is not segregated and neither steel, nor forms displaced. Concrete should never be allowed to free fall more than five feet. This tends to segregate the mixture. A pipe chute or tremie should be used when the concrete fall exceeds 5 feet. The flow of the concrete should be directed to prevent striking the reinforcing steel and causing segregation. Hoppers with flexible hoses may be adapted to most situations. Longer pipes and tremies usually come in sections that can be removed as the elevation of the concrete placement increases.

.0735 Using a Vibrator - Concrete should be deposited as near *to* its final position as possible and then compacted by vibration. Vibration shall be in accordance with Subsection 601.03.09 A) of the Standard Specifications. Over-vibration may cause entrapped air against forms and segregation and is almost as harmful as under-vibration which causes honeycombing. Vibrating methods should be closely observed and undesirable procedures such as moving concrete with the vibrator instead of shovels should be avoided. For tall or thin concrete placements, forms may have to be adapted for vibrator access. A concrete operation should never be started unless the contractor has at least one spud vibrator.

Concrete should be placed and vibrated in horizontal lifts not exceeding 12 inches in depth. Fresh lifts should be united into the previous layer by working the vibrator into the previous lift. This will prevent a cold joint. Unless provisions are made to retard the concrete mixture, a layer shall not be allowed to set more than 20 minutes before fresh concrete is placed against it. Workers must be discouraged from walking in concrete after it has been vibrated, *otherwise* the concrete should be re-vibrated

.0736 Bridge Seats - Bridge seats which will support steel spans should be finished in accordance with Subsection 601.03.09 of the Standard Specifications. See Section 63-08.0900 of this Guidance Manual.

.0737 Placing Underwater - Occasionally it becomes necessary to place concrete

under water. This is only allowed for foundation seals or drilled shafts. Usually this is required when a cofferdam cannot be dewatered by conventional methods. If this condition exists, the excavation and/or piling will be prepared for the concrete seal and the water level in the excavation or cofferdam will be allowed to stabilize. Moving water within an underwater placement is to be avoided. Concrete seals are shown on plans when their need is anticipated. Occasionally an unanticipated condition will arise which may require a seal; however, this condition must be discussed with the Central Office, Division of Construction.

Foundations where cofferdams cannot be de-watered, should be inspected by divers to ensure that all silt is removed prior to commencing the foundation seal pour.

Concrete placed under water will be of a Class A modified mixture *unless otherwise approved by Central Office Materials*. The concrete shall be placed through a tremie in accordance with Subsection 601.03.09 B) of the Standard Specifications. The tremie should extend approximately 3 feet into the plastic concrete. Tremie sections must be removed from the top, not the bottom, as the concrete is placed, thus, ensuring that the bottom remains in the fresh concrete. The contractor must devise some method of monitoring the elevation of the top of the fresh concrete to ensure that tremie sections will be raised as necessary to prevent them from being trapped in hardened concrete. *T*he tremie *should have* a sealed bottom flap-gate to prevent entrance of water. If open-ended, a ball, usually a basketball, is placed in the pipe and *is displaced by* concrete. The tremie should never be raised above the surface of the concrete during the pour, *else* the initial start-up procedures must be *repeated*. If an underwater placement is large, several tremies will be required. The concrete shall be placed continuously without delay and an approximately horizontal surface should be maintained. Contrary to above water concrete placement requirements, underwater concrete is not vibrated nor disturbed in any manner after placement. Concrete seals are not normally reinforced with steel prior to concrete placement but dowel bars may be required to be drilled and grouted into the hardened foundation seal.

Note: Never drop concrete into standing water more than a few inches deep. Do not vibrate the concrete along the edge adjacent to the water until the water is forced onward by the concrete mass to a drain or out the forms.

The cofferdam or excavation can be dewatered when the concrete has attained sufficient strength to withstand the upward hydrostatic pressure. Extra concrete test cylinders should be molded in order to determine the concrete's in-place strength at 3 days, or more, if necessary. The concrete must age at least 3 days before dewatering. After the water is removed, all undesirable material shall be cleaned from the top of the seal by a means which will not damage the green concrete.

Normally cores will be taken through the foundation seal into rock to ensure the integrity of the seal and to verify that all silt was removed before the seal began. If the contract did not require this, it should be determined whether the Department or the contractor should do this by supplemental agreement. This generally is not required if the footer is supported on drilled shafts or piles.

The undesirable material will look like the wash-out from a concrete truck. The top of the seal should be removed down to good sound concrete as determined by the Project Engineer.

Concrete seal thickness is generally 0.43 (62.4 PCF/144 PCF) of the hydrostatic head exerting pressure at the bottom of the seal. The seal corners may be as much as 6 inches lower than the center of the seal to permit drainage. Seals are not to be used at the contractor's discretion when a cofferdam fails to function properly. They will only be installed where shown on plans or at locations designated by the Central Office, Division of Construction.

Occasionally, the plans specify foundation seals in anticipation of wet conditions that do not develop and the contractor dewaters the cofferdam. In those cases, the foundation seal should be eliminated and the columns extended to save the *S*tate these costs. This requires review of the pier design for the increased height of column.

.0738 Construction Joints - When the placement of additional concrete against existing concrete has been delayed until existing concrete has attained its initial set, the contact surface between the two placements is known as a construction joint. Construction joints other than those shown on the plans are to be avoided if possible. Construction joints should not be placed in tension zones, because the joints tend to open and leak even though the reinforcement handles the stress. See Subsection 601.03.10 of the Standard Specifications.

Before concrete placement begins at a construction joint, the Project Engineer should ensure that forms are drawn up tight against the previous pour and that an approved bonding agent has been applied to the construction joint. This should prevent off-sets in alignment and is very important at surfaces such as bridge curb construction. Many times chamfer strips are required at a construction joint in order to provide a rustication groove. This groove tends to make the construction joint less noticeable. If the plans do not provide for such a groove, the exposed surface of the concrete should be smoothly finished. Feather edges at the intersection of sloped top surface and vertical construction joints such as in wingwalls can be avoided by blocking out the forms to create an inset into the pour at the top of the joint. Unless specified on the plans, no horizontal construction joint will be allowed within 18 inches of the top of any face.

.0740 Temperature Limitations and Protection of Concrete - When concrete is placed in extreme hot or cold weather, special conditions shall apply to the concrete mixture and its curing procedures. During placement, fresh concrete shall be between 50º F and 90ºF. The job-site inspector should have a thermometer so *that* concrete temperatures can be monitored. Subsection 601.03.09 D) of the Specifications requires an indoor-outdoor thermometer to monitor curing temperatures adjacent to the concrete and beneath the insulation.

.0741 Cold Weather Concrete - When concrete is placed in cold weather the minimum curing temperature of Subsection 601.03.09 D) of the Standard Specifications will apply. When required, the contractor should submit, *prior to cold weather concrete placement*, a written request to the Project Engineer including in detail, proposed methods of maintaining the minimum curing temperature and methods for keeping the concrete moist. In cold weather, some contractors may wish to cover concrete with insulating blankets to utilize the concrete's internal heat of hydration to help meet temperature requirements. If the placement is of sufficient mass and well protected, this method may be satisfactory. Heaters may also be necessary. It should be clearly understood that the required temperatures referred to as minimum curing temperatures, i.e. 45º F for 3 days and 40º F for 4 additional days, are the temperature of the concrete itself and not the surrounding air.

The Project Engineer should never demand a particular heating method in enforcing cold weather concrete specifications, but should maintain a position of approving or disapproving the contractor's proposed methods.

Temperatures of the concrete should be checked at least twice a day and these times and temperatures should be recorded on daily inspector reports. The contractor should be immediately advised of any deficient temperature readings and proper action taken to bring curing temperature within specifications requirements should be noted.

It is very important to avoid the possibility of a flash set when it *becomes* necessary to heat mix ingredients at the concrete plant. In order to do this, when water or aggregate is heated above 100º F, the water and aggregate shall be mixed prior to the addition of cement and the mixture of water and aggregate shall not exceed a temperature of 90º F when *the* cement is added.

If drilled or formed holes remain in concrete through the winter months, precautions shall be taken to prevent water from freezing in them. Several methods may be used to accomplish this and their effectiveness should be checked periodically throughout the winter.

.0742 Hot Weather Concrete - In hot weather, efforts *must* be made to maintain the temperature of the mixture below 90º F. This can be accomplished by many

methods and the Project Engineer should not direct the contractor to use a specific method. A position of approving or disapproving the contractor's methods should be maintained. Water should be sprayed on reinforcing steel and metal forms to keep them relatively cool.

.0750 Curing Concrete - All concrete other than that in pipe culvert headwalls requires curing. This is accomplished by wet curing or application of membrane curing compound. All surfaces which will receive a masonry coating, concrete stain, stone veneer, thin-film coating or additional concrete must be wet cured. The wet cure is required because the membrane curing compound *will* not allow a good bond at these surfaces. All other surfaces may be cured by application of a membrane curing compound, commonly called "curing compound". For bridge deck curing requirements, refer to Subsection 609.03.12 of the Standard Specifications. The Project Engineer may exert authority to suspend future concrete operations on a project until curing operations are adequate.

Concrete which cannot be cured by curing compound must be wet cured for not less than 7 days. A wet cure consists of covering the concrete with a double thickness of burlap or an acceptable substitute. This covering is kept continually wet for the duration of the 7-day curing period. When artificial heat is used, a means of maintaining moisture on the concrete and in the surrounding air is required.

White pigmented curing compound is only allowed on bridge decks and top or bottom slabs of box culverts. Other properly patched and approved structure surfaces may be sprayed with clear curing compound. Curing compounds must be agitated before use. The curing compound drums usually contain an agitator to which a crank can be attached. Dilution of curing compound is not permitted, but warming in a water bath to approximately 100º F to increase fluidity, is permitted.

Curing compound may be applied in one application. If uniform coverage is not obtained with one application, the contractor shall be required to make two applications. The first application should be applied as soon as practical after the concrete has been textured and is sufficiently stable to prevent the spray from damaging the surface or as soon as forms are removed and voids are patched. When required, the second application should immediately follow the first and be applied approximately ninety degrees in direction to the first application.

During the second application an effort should be made to spray extra compound on the light areas of the first application. The application rate should be continually monitored by the inspector to ensure thorough coverage. The curing compound must be applied by an approved pressure sprayer as described in Subsection 601.02.24 of the Standard Specifications.

Curing compound, like wet burlap, must be maintained for 7 days. Any areas of the compound which are damaged during this period must be resprayed, and areas

which are expected to receive heavy use should be protected. When curing compound overspray falls on areas which are to receive a masonry coating or additional concrete, these areas should be thoroughly cleaned.

Curing requirements are easily overlooked and the Project Engineer must exert an extra effort to ensure the Standard Specification requirements are enforced. Curing procedures and requirements should be thoroughly discussed with the contractor well in advance of concrete placement in order to ensure a mutual understanding of specification requirements.

Curing compound should never be applied to construction joints or to bridge decks that are to receive an overlay, nor onto reinforcement bars. If done, if must be completely removed by whatever means necessary.

.0760 Concrete Surface Finish

.0761 General - There are 3 types of concrete surface finish. These are ordinary, masonry coated and floated surface finish. All concrete surfaces require an ordinary surface finish. Some surfaces also require either a masonry or floated surface finish.

The contractor's finishing methods should result in a smooth, even textured concrete surface. As soon as the concrete has attained sufficient strength, all form ties, anchorages, and tie wires should be removed. All cavities and depressions must be cleaned, pointed, filled with mortar, cured, and finished in accordance with Subsection 601.03.18 A) of the Standard Specifications. Irregular projections, fins and form bulges shall be removed from all surfaces which will be exposed in the finished structure.

.0762 Ordinary Surface Finish - The ordinary surface finish *will* provide a surface uniform in color, texture, and smoothness. Each face of a structure should be inspected and accepted individually. If the contractor exerts care in form construction and vibrates and spades the concrete sufficiently during placement, it will save much finishing effort after form removal.

Many times a contractor will delay providing an ordinary surface finish. This should be strongly discouraged, because patches bond to "green" concrete much better than to hardened concrete. The specifications require the ordinary surface finish immediately after form removal. The Project Engineer will have to use discretion in determining when an ordinary surface finish should be provided during cold weather. The ordinary surface finish must be protected from freezing.

In order to make patches on an uncontaminated surface and *to* get the proper cure on these patches, the ordinary surface finish should not be delayed. The enforcement of *these* timely requirements will require a special effort by the

Project Engineer and his personnel.

.0763 Masonry Coating Surface Finish - After concrete surfaces have received an approved ordinary surface finish, some will also require a masonry coating surface finish. Surfaces to receive a masonry coating surface finish are depicted on the project plans or are specified in Subsection 601.03.18 B) of the Standard Specifications. These surfaces shall not be cured with curing compound. This surface finish consists of the application of a masonry coating by brush, roller, or sprayer in accordance with the manufacturer's recommended practice. Only coatings on the Division of Materials approved list should be used.

Care shall be taken to ensure that the surface to receive the coating is clean and free from dust and oil. Bridges which carry traffic before coating application could require extensive cleaning. Since the bond between the concrete and coating is critical, a clean surface is imperative.

It is a false concept that a masonry coating will cover deficiencies in the ordinary surface finish. Many times the coating will accentuate irregularities, therefore, a good ordinary surface finish is still absolutely important. Before the masonry coating is applied, air holes in the concrete should be filled with the coating or an approved mortar. Mortar must be thoroughly cured before the application of most masonry coatings.

Masonry coating shall be applied in strict conformance with the manufacturer's recommendations. These recommendations are found in the coating manufacturer's brochures which the contractor must provide the Project Engineer. Water based coatings require wetting the concrete surface prior to their application. This presents a special problem concerning protection of the applied coating during early spring and late fall when overnight temperatures may unexpectedly fall below freezing. An overnight freeze may cause the coating to spall off the concrete. Solvent based masonry coating requires dry surface for application but is less affected by cold temperatures.

The Project Engineer should ensure that abutment backwalls which will be made inaccessible by the erection of beams are coated before beam erection. The masonry coating must be applied to a depth of 6 inches below adjacent backfill. Therefore, the coating should be applied before final grading and dressing operations. An excessive thickness of coating should be avoided since it will not cure properly.

.0764 Floated Surface Finish - The third type of surface finish is floated. Surfaces such as tops of pier caps, bridge seats, tops of formed walls, culvert slabs, etc. will receive this type finish. The floated surface finish should be constructed in accordance with Subsection 601.03.18 C) of the Standard Specifications.

In order to provide this finish, a slight excess amount of concrete must be placed in the forms. Special care should therefore be taken to ensure that the concrete is finished to proper grade.

.0765 Surface Textures - Surfaces that receive wear from vehicles or pedestrians are given textures for skid resistance. The 2 most common textures are broomed and tined. New bridge decks are tined and most deck overlays and sidewalks are broomed. Refer to the project specifications to find which is required.

.0770 Construction Date, Load Design, and Drawing Number Identification - All bridges and box culverts require a stenciled construction date and drawing number. This date will be the year the contract was executed, not the year the structure was completed. The plan drawing number is different for each structure. Bridges with a clear span of 20 feet or more also require the bridge design load capacity be stenciled on them. All bridges require the stenciled name of the contractor and subcontractor, if applicable. All of these identifications shall be located and constructed in accordance with the plan referenced standard drawing and Subsection 601.03.19 of the Standard Specifications. The location of these identifications should be discussed with the contractor at an early date so that their placement will be correct. The stencils will always be on the inlet ends of box culverts unless the construction consists only of an extension on the outlet end, in which case the stencil should be on the outlet end. Refer to Section 63-08.1100 of this manual on Prestressed Concrete for locations on prefabricated deck sections that have no suitable location on the abutments for the stencil.

.0780 Investigations of Low Strength Concrete - If cylinder strengths indicate that low strength concrete may be present in a structure, the Project Engineer shall investigate the concrete in accordance with KM 64-314.

The District Materials Engineer should automatically investigate any in-place concrete which is represented by a low strength cylinder report. The Project Engineer should, however, pursue the problem and provide the DME necessary assistance. The District Materials Engineer will furnish the Project Engineer, *Branch Manager* for Construction, and Central Office Construction Engineer the results of the investigation. It will be the responsibility of these individuals to interpret these results, to decide on any action necessary, and to issue instructions to the contractor accordingly.

This does not relieve the Project Engineer from executing the other procedures outlined in KM 64-314.

63-08.0800 REINFORCING STEEL

.0810 General - Reinforcing steel is placed in concrete to resist stresses due to flexure, shear, tension, compression and temperature changes. In general, the furnishing

and placement of steel reinforcement shall be in accordance with Section 602 of the Standard Specifications. Material requirements for reinforcing steel are covered in Section 811.

Reinforcing Steel is specified by the bar number which indicates its diameter in eights of an inch. For example, a No. 4 bar has a diameter of one half-inch or a No. 11 bar will have a diameter of 1 3/8 inches, etc. The bar size is rolled in the bar at intervals along its length. The weight per foot and nominal dimensions according to bar size are to be found in Subsection 602.04.01 of the Specifications.

See Exhibit No. 63-8-37 for information pertaining to the grades and identification marks of reinforcing steel.

.0820 Checking Plans for Errors - As soon as possible after receiving bridge plans, the Project Engineer should ensure that the plan quantity and dimensions of bridge and culvert reinforcement is checked by an experienced inspector. This is very important. Bars omitted from the bill of reinforcement should be noted. Epoxy coated steel designations should be verified. If errors are noted, the District Construction Office and contractor should be immediately notified. This notification should prevent the contractor from ordering unnecessary reinforcing steel. Reinforcing steel errors caught after delivery to the job-site may be costly to the Department. After notification of an error, Central Office will verify the error through the Division of Structural Design, and a plan revision will be issued. Some minor errors may not require revised plans.

.0830 Quantity Adjustments - It is extremely desirable to discover any major errors in reinforcing steel before the steel is delivered to the project. When plan errors are not discovered prior to fabrication, any steel which cannot be utilized in the structure must be purchased by supplemental agreement. The unused steel will then be turned over to District Maintenance. Generally, any reinforcing steel of this nature will be paid by supplemental agreement. The price will be established by the contractor's invoice cost plus delivery and handling cost, if applicable. If the plan error involves a change in reinforcing steel quantity, the change order should also reflect this change.

.0831 Salvage Value - On Federal Aid Projects, federal participation may be withheld on the salvage value of the reinforcing steel that the state maintenance receives. If the nature of the reinforcing steel is such that Maintenance wants it, then the price previously mentioned, as being established by invoice, etc., should be entered in the supplemental agreement as a non-participating item. As has been the case in the past, Maintenance may be able to use the straight bars but may not want the bent bars. In this instance, an estimate of the steel poundage going to Maintenance would be made and entered in the supplemental agreement as a non-participating item. This remaining steel would not have a salvage value and should be entered as

a participating item with the contractor requested to dispose of it. This procedure is rather involved and should not be implemented unless a substantial quantity of reinforcing steel is involved.

.0840 Job-Site Storage - Reinforcing steel shall be protected at all times from damage. Bars bent out of shape in handling or shipping shall be straightened before being placed on the work. Sharp kinks are cause for rejection. Heat shall not be utilized in straightening steel.

Reinforcing steel shall be stored in a neat, workmanlike manner on the project. It should not be stored on the ground but should be supported off the ground in a manner satisfactory to the Project Engineer, usually on lumber. Dumping of steel from a truck or placing in haphazard piles is not to be tolerated. If possible, the steel should be stored near the structure in which it is to be used. Epoxy coated bars should cleaned by wire brush if necessary and any nicks, scrapes or cuts should be touched up before placing in deck.

.084l Epoxy Coated Steel - Epoxy coated reinforcing steel, when handled, requires special precautions to prevent damage to the epoxy coating. Bands which secure bar bundles should be lined. Nylon slings or protected cables should be used to lift epoxy steel. Care shall be taken to prevent adjacent bar bundles from shifting so that epoxy coating is not scratched. Extended outdoor storage of epoxy coated steel at the job-site should be avoided. If bars are stored outside, storage should be limited to 2 months or less. If the outdoor storage is expected to exceed 2 months, the bars should be kept off the ground and covered for protection against moisture and sunlight.

.0850 Sampling and Testing - Reinforcing steel shall be sampled and tested in accordance with Subsection 811.02.02 of the Standard Specifications and the procedures set forth in the Division of Material's "Field Sampling and Testing Guidance Manual." It is acceptable practice to either saw or burn a bar to obtain a sample. If burning is used, an extra inch of length should be added to each burned end. Do not burn epoxy coated steel. The epoxy coating is flammable and the fumes are toxic.

.0860 Placing and Fastening - All placing and fastening of reinforcing steel shall be in accordance with Subsection 602.03.04 of the Standard Specifications.

Reinforcing steel must be secured in the correct position before concrete placement is begun. The Project Engineer or the project inspector should check the steel for correct positioning before concrete placement is started and again during the concrete operation to be assured no shifting has occurred. The spacing and concrete cover on reinforcing steel are design features. Positions shown in the plans are necessary to obtain the required strength in the structure.

The contractor is responsible for placing the reinforcing steel and allowing a

sufficient time thereafter to permit inspection and approval by the Project Engineer or the Inspector prior to beginning concrete placing operations. Any concrete placed contrary to this requirement is subject to rejection in accordance with Subsection 105.12 of the Standard Specifications.

Special attention should be given to the location of steel which will be in the vicinity of drilled anchor bolt holes. Mislocated steel may require that it be severed or the anchor bolt relocated. Neither of these is desirable. All steel reinforcement, other than that for bridge slabs, shall be placed and tied to the requirements and tolerances of Subsection 602.03.04 of the Standard Specifications. Section 609 applies to bridge slabs. Exhibit 63-8-38 provides guidance for inspection and acceptance of epoxy coated reinforcing steel as well as recommended construction practices.

.086l Cleaning - When secured inside structure forms, steel reinforcement shall be free from dirt, loose rust, paint, oil, grease, and curing compound. Any substance which could prevent a good bond between the steel and concrete should be removed. Reinforcing steel should be thoroughly inspected as it is placed. Most foreign substances such as dirt and rust can be removed by wire brushing. Sometimes a contractor may prefer to sandblast the reinforcing steel when a large area is dirty or utilize a solvent or detergent to remove oily substances. Do not sandblast epoxy coated steel.

.0862 Splicing - Reinforcing steel shall be furnished according to plan lengths, with splices of the proper lap and at locations shown on the plans. Always ensure that the minimum specified lap is provided. Extra length may be provided for the possibility of lowering footings and extending column lengths. Spliced bars should be tightly wired together and should be in contact along the entire length of the lap.

All splices whether straight bar, spiral, or metal mesh shall be made in accordance with Subsection 602.03.06 and 602.03.07 of the Standard Specifications.

If mechanical or welded splices are allowed by structure plans, they shall be performed in strict compliance with the plans, Standard Specifications, and/or manufacturer's recommendations. When field added splices are used, special care shall be taken to ensure that enough clearance is left between adjacent bars to provide for complete concrete encasement of all steel. Generally all mechanical splices are sampled and tested to ensure that the splice develops more strength than the bar. It generally is required to exceed 125 percent of the tensile strength of the bar. If lap splices are used, ensure that that the splice does not interfere with the proposed cover.

.0870 Bridge Decks - The placement of reinforcing steel for bridge decks shall meet the tolerance stipulated in Subsection 609.03.03 of the Standard Specifications. See

Section 63-08.1200 of this chapter for information pertaining to bridge decks.

63-08.0900 STRUCTURAL STEEL

.0910 General - The Project Engineer should be thoroughly familiar with the details of all phases of bridges and be sure the project inspector is properly instructed in all phases of steel bridge construction prior to the beginning of work. Section 607 of the Standard Specifications governs the construction of steel bridges.

.0911 Mill Test Reports - All major structural steel, including bolts, is required to have mill test reports with actual physical and chemical test results. These test reports must be checked by the Division of Construction to verify compliance with the applicable specification. When structural steel is inspected by an outside testing agency, then that agency checks the test reports and the test reports will be distributed to the Project Engineer by the Division of Construction. Appearance of the inspection company's seal stamp on steel members signifies that test reports are approved.

Minor structural steel such as armored edges and build-up plates on expansion dams to accommodate overlays are only required to be commercial grade steel and neither mill test reports nor certifications are required.

Test reports for H Piles are reviewed and approved by the Project Engineer. This is the only steel, requiring test reports, which is accepted solely by field personnel because of the complexity of other specifications. See exhibit 63-8-15 for additional information.

.0920 Bridge Seats - Subsection 601.03.09 A) of the Standard Specifications require that bridge seats on pier or abutment risers which directly support steel bearings be constructed monolithically with the cap and 1/8 inch higher in elevation.

After the concrete has thoroughly hardened, it shall be ground down to the plan elevation using a Carborundum stone grinder until the finished surface, checked with a spirit level, shows no variation in excess of 1/32 inch above or below a true level plane. This is very important in order to assure a level uniform surface which will provide uniform bearing.

Precise location of the bearing lines and substructures is critical for steel construction due to design and fabrication concerns. Bridge seat elevations should be constructed to the elevation detailed on the plans so that holes for connection of the component sections of the steel superstructure will be properly aligned. The centerline of bearings of piers and abutments must be precisely located.

.0930 Fabrication - During the fabrication phase of steel bridges, the fabricator will

prepare shop drawings which will be submitted to the Division of Structural Design for their review. This review will be obtained before fabrication begins. Each reviewed drawing will be stamped by the Division of Structural Design. The steel will be assembled, checked by the Department's inspectors, and match marked as detailed on the shop drawings. Future erection in the field will be accomplished using the shop drawings which detail where each match marked piece fits in the structure. Prior to the structural steel being shipped from the fabrication shop, the inspector will determine its acceptability. If it meets approval, based on all of the contract requirements, the inspector will place the Inspection Agency seal signifying approval in a visible location on each member.

.0931 Prefabrication Meeting – As a function of Central Office Construction, a meeting will be held at the fabrication shop before any structural steel work is started. This meeting is to discuss the fabrication and delivery schedule, weld procedures, shop inspection by the Cabinet's consultant, testing types and frequencies, Requests for Informations (RFI's), shop drawings, etc. This meeting should be followed up by a general walk through of the shop which usually results in more communication of the shops processes. This meeting shall be attended by the fabricator, C.O. Construction, and the Cabinet's consultant inspection service. The contractor is not required nor is the District or the designer, but they can attend. The consultant is required to document the meeting and provide all with a report. C.O. Construction will generally run the meeting.

.0932 Shop Inspections – Another function of Central Office Construction is to conduct periodic shop inspections. These are not necessarily scheduled or conducted as a meeting. These inspections may coincide with the C.O. Field Engineer visit to deal with fabrication problems. Essentially C.O. is conducting a walk through of the shop to provide assurance of the quality of the fabrication and to provide a check of the Cabinet's consultant. See the Exhibit 63-8-32 that provides details of the inspection. The field engineer shall write a report of his visit.

.0933 Fabrication Documentation – The Central Office Construction Field Engineer in charge of the project shall keep the District and other entities informed of all reports, drawings, and other information although it will generally be for the records only.

.0940 Project Site Inspection - When the structural steel is received on the project, it is very important that the Project Engineer or the project inspector make a close visual inspection as soon as possible.

It must be recognized by the Project Engineer that, even though the structural steel must be stamped with the Inspection Agency Seal as pointed out above, the presence of this seal does not mean the steel should be automatically accepted as

delivered to the project. The field inspection is critical and must be thorough. It will be the last opportunity for anyone to really take a close look at the steel. The project contractor bears full responsibility for the condition of the steel. It should be inspected for shipping damage and any noticeable fabrication oversights. The following is a list of the most commonly noted deficiencies, which when found, should be reported to the Central Office Division of Construction for an opinion on correction or rejection of the steel:

1. Bearing stiffeners shall be milled or ground to secure an even bearing against the flanges. Open space between ends of bearing stiffeners and flange is not permitted.
2. Intermediate stiffeners shall fit sufficiently tight to exclude water after being painted.
3. Flanges not at right angles to webs.
4. Bows or kinks in web plates, flanges, and stiffeners. (Especially where it was tied down.)
5. Unacceptable welds such as weld overlaps that have not been properly faired, excessive porosity in welds, and cracked or broken welds. (Incomplete welds are sometimes found in the flange to web welds at end of girders when run-off tabs were not used.)
6. Weld efflorescence as evidenced by a gray-white deposit around welds and caused by lack of neutralization or incomplete cleaning of welds.
7. Fill plate or splice plates tack welded to girders. Tack welds should be removed and ground smooth prior to bolting.

.0950 Storing Structural Steel - The Project Engineer should be sure the steel is properly stored by checking to see that it is adequately supported and blocked above the ground. It should be stored in a properly drained area and adequately braced to prevent it from being blown over by high winds. An acceptable method of bracing girders should include braces from ground and connections between girders. This should be done in a satisfactory manner before any partial payment is made. The Project Engineer should make sure that the area is flagged or marked properly to protect against other construction activity. The stored steel should be checked regularly for settlement or damage.

.0960 Erecting Structural Steel - The Project Engineer or the project inspector should discuss the contractor's erection scheme in detail with the project superintendent prior to erection. Any necessary falsework bents should be checked and approved for load carrying ability and structural integrity. The contractor's proposed method of lifting the girders should be reviewed. Lifting points must be located in such a manner as to prevent buckling of the members.

Lifting lugs that damage the flanges by causing indentations in the steel will not be permitted.

Prior to erection of any structural steel, the distance between the centerlines of

bearing must be accurately measured. Any discrepancies must be satisfactorily resolved before erection is begun. The use of "Come Alongs" is sometimes necessary in steel erection but should not be permitted to fit or pull together members where excessive sweep or distortion occurs because it will leave excessive residual stresses in the steel.

Structural steel should be erected in accordance with approved erection drawings. The steel should be inspected to be sure the erection sequence will allow the required positioning for all members to be properly fitted. It is sometimes necessary to begin erecting girders from one particular side in order to be able to fit the diaphragms. Care should also be exercised in positioning the diaphragms on the correct side of the stiffener.

.0961 Steel Nuts and Bolts

1. High Strength Bolts - High strength bolts should be visually inspected to be sure they are A325. An A325 bolt can be identified by three radial lines on the top of the head (unless weathering steel is specified), the legend "A325" stamped on the head, and the manufacturer's mark. These identifying marks must be on the bolt heads. Heavy semi-finished hexagonal nuts, manufactured in accordance with ASTM A325 are identified on at least one face by the correct letter or mark symbol for that grade of nut. Bolts should also be clean and free of rust. Sampling and testing of bolt, nuts, and washers shall be in accordance with the Division of Material's Field Sampling and Testing Manual. The Division of Materials also has the ability to tension test bolts to assure strength characteristics, when requested.

2. Rotational Capacity (Lubricant) Test For Structural Steel Bolts - The Rotational Capacity Test is required for all plain, galvanized, and weathering structural steel bolts, nuts, and washers. This test is used to determine if the components of the structural fastener can be used together to obtain the required tension without damage to any parts of the assembly and without excessive torque.

   The Rotational Capacity Test is included in Subsection 813.09.02 of the Standard Specification. A detailed description of performing the R. C. Test is also included in this Manual as Exhibit 63-8-39. This exhibit includes a worksheet for performing the R. C. Test and a Certification Sheet for recording the results. Note the R. C. Test is to be performed by the contractor and should be witnessed by Department Personnel.

   The most common cause of rejection as determined by the Rotational Capacity Test is due to excessive torque. This is usually caused by lack of lubrication, and/or weathered or rusted bolts or nuts. Fasteners which fail the R. C. Test for these reasons may be cleaned and relubricated and

used in installation, provided they pass a subsequent R. C. Test.

The required tension and the turn test tension shown in the Standard Specification and the exhibits are for ASTM A325 bolts only. If the plans call for ASTM A490 High Strength Bolts, contact the Central Office, Division of Construction, to obtain the tensions required.

3. Storage - The bolts should be stored in a clean dry area protected from the elements as approved by the Project Engineer. Only the bolts necessary for use during a work shift should be removed from the storage area during that shift. Any left over bolt assemblies from a shift, especially from opened containers, should be considered a separate lot for testing during the next work shift.

.0962 Bolting Members - The project inspector shall observe the installation of bolts and determine that proper procedures are being followed. Never allow the bolt tightening to proceed under method of "ironworkers calibrated ear."

All joint contact surfaces shall be free of scale, burrs, dirt, paint and other foreign material, except tight mill scale on weathering steel, which would prevent solid seating of the parts. Splice plates should be checked and removed for cleaning, if necessary, prior to erection. Before final tightening of the bolts in a joint, the plates or members to be bolted should be brought into good, firm contact. If over tightening of bolts is necessary to pull members together all bolts that exceed 110 percent of required tension should be removed and replaced. (When using calibrated wrenches, an override is used to exceed the allowable or required cut-off.)

Bolts shall be tightened in a connection by progressing systemically from the most rigid part of the joint to the free edges. After all bolts have been installed in a joint with the calibrated wrench, the wrench shall be returned to "Touch Up" bolts previously tightened which may have loosened by the tightening of subsequent bolts, until all are torqued the required amount. A minimum 2 bolts in each connection and 10 percent of the bolts in large connections should be checked with the manual torque wrench, previously calibrated as specified.

If one or more of the bolts in the connection are below the minimum tension, all the bolts in the connection must be checked. Bolts may be torqued to the correct tension, loosened and retorqued one time. Bolts tightened more times than this must be discarded and not reused.

In making a connection, it is sometimes necessary to do a very slight amount of reaming on an occasional hole. However, excessive reaming shall not be permitted. Burning of holes to increase their size will not be permitted nor is burn cutting of any new steel to be permitted without prior approval by the

Central Office, Division of Construction. The inspector should check that the correct plates are being used and oriented properly at the correct location before allowing any reaming of holes.

.0963 Procedures for Tightening Bolts

1. Calibrated Wrenches - When this procedure is used to tighten bolts, the impact wrenches shall be calibrated wrenches which are properly adjusted to secure a bolt tension slightly in excess of the minimum required bolt tension given in Subsection 607.03.05 of the Standard Specifications. The wrenches must be calibrated twice daily.

   These wrenches shall be calibrated by tightening bolts in a device capable of indicating actual bolt tension. Not less than 3 typical bolts from the lot size being installed should be utilized in the calibration and the results averaged. Power wrenches must be of such design that they can be adjusted to stall or cut out at the selected tension in approximately 10 seconds. Sometimes "In Line" air regulators are not capable of performing this function satisfactorily, in which case, they should not be used. One such acceptable tensile testing device is the "Skidmore-Wilhelm Tensile Testing Device." Any similar device is satisfactory. The tensile testing device must also be used to check the manual torque wrench used by the inspector for either method of tightening bolts.

   When tightening bolts in the tensioning device for the purpose of calibration, a different bolt, nut and washer will be used each time. Additional use of the same bolt, nut and washer will result in widely varying tension-torque indications.

   The manual torque wrench may be calibrated at the same time the impact wrenches are calibrated using these tightened bolts. Nuts shall be in tightening motion when torque is measured. The average torque measured in the tests of three bolts shall be taken as the job inspection torque.

2. Turn-of-nut Tightening - A representative sample of not less than 3 bolts and nuts of each diameter, length and grade to be used in the work shall be checked at the start of work in a device capable of indicating bolt tension. The test shall demonstrate that the method of estimating the snug-tight condition and controlling turns from snug tight to be used by the bolting crews develops a tension not less than 5 percent greater than the tension required by Subsection 607.03.05 of the Standard Specifications.

   Bolts shall be installed in all holes of the connection and brought to a

snug-tight condition. Snug tight is defined as the tightness that exists when the plies of the joint are in firm contact. This may be attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Snug tightening shall progress systematically from the most rigid part of the connection to the free edges, and then the bolts of the connection shall be retightened in a similar systematic manner as necessary until all bolts are simultaneously snug tight and the connection is fully compacted. Following this initial operation, all bolts in the connection shall be tightened further by the applicable amount of rotation specified in Table 5 of the AISC Specifications for Structural Joints. During the tightening operation, there shall be no rotation of the part not turned by the wrench. Tightening shall progress systematically from the most rigid part of the joint to its free edges.

3. Direct Tension Indicators - Most projects will require checking the bolt tension by using direct tension indicators. There are many different types of tension indicators. The most commonly used direct tension indicators in steel structures are essentially washers with raised dimples that compress when the proper tension is applied to the bolt. The bolt tension is checked by inserting a feeler gage between the dimples of the DTI to see that it was properly compressed. The Project Engineer and inspector should become familiar with the manufacturer's specific instructions for installation. Normally, the DTI will be installed under the bolt head or the non-turned element of the bolt assembly. In some cases the bolt assembly may have to be oriented so that the bolt head and DTI are inaccessible to check for proper compression. In these rare cases the DTI may be installed under the nut or the turned element. Installation in this manner requires additional hard washers and bolt length. The manufacturer’s instructions should be consulted for additional installation requirements. Once the dimples of this type of DTI have been compressed to any extent, they may not be reused.

   Before installing any DTI bolt assemblies on a project, test at least three different bolt assemblies including the DTI in a device that will indicate the bolt tension. This will show that the DTI is compressing properly at the correct tension. Check at least 10 percent (not less than 2) of the bolt assemblies in each field connection with a feeler gage at the DTI according to the manufacturers directions. Generally, this means that the gage will not enter the gap of the DTI in at least half of the insertion points. Visually inspect the bolts not checked with the feeler gage to see that the DTI is compressed. If the bridge is to receive a field coat of paint, check that the gaps behind the indicators are sealed by the paint.

.0964 Field Welding - Field welding shall not be permitted on any portion of a steel structure unless specifically required by the plans or permitted in writing by a Central Office Construction Field Engineer upon checking with the Division

of Structural Design, and then only in the manner and at locations designated in the written authorization. Welding shall not be used to attach falsework support brackets, clips, gussets, filler plates, etc., to load carrying members.

.0965 Anchor Bolts - Anchor bolts holes shall not be drilled and anchor bolts shall not be set until all structural steel is erected and all bolts properly torqued throughout the structure. Exceptions may be made on large river crossings; however, these exceptions require the approval of the Central Office. Anchor bolt holes should be carefully located to avoid the steel reinforcement. Anchor bolt holes shall be covered or otherwise plugged to prevent water from standing. This will prevent formation of ice and the holes will be dry when hot molten lead is poured around the bolts. The anchor bolt should be heated so that it will not cool the molten lead before it reaches the bottom of the hole. The hole must be completely filled to the top of masonry plate. When the plans allow grouting of the anchor bolts, the grout must be an approved type and fluid, so that the hole can be partially filled and the anchor bolt inserted to cause the grout to flow out the top of the hole.

.0967 Bearings - Careful consideration should be given to the setting of bearings. Consult the plans for any notes pertaining to the bearings. Calculations may need to be made to determine the amount of expansion or contraction of the girders due to the temperature changes of the steel in order to obtain the proper inclination of each bearing for the temperature at the time of setting. Also, the anticipated elongation or angular change of the bottom flanges of simple span girders due to the dead load of the concrete slab should also be calculated in some cases, and this amount of elongation considered in setting the bearings so that they will be vertical at the temperature designated on the plans, usually 60˚ F. Steel rocker bearings are now used most only in railroad bridges. See Exhibit 63-8-40 for detailed instructions and an example of the necessary calculations in the setting of bridge rockers. Elastomeric bearing pads may scoot under extreme temperature changes before a deck is placed because of inadequate weight of beams to hold the pads in place. If slippage occurs or the beams are set during extreme temperatures, it may be necessary to jack up the beams for adjustment of elastomeric pads at "normal" temperatures.

63-08.1000 WELDING

.1010 General - The following statement is important and must be adhered to by the Project Engineer in every situation involving welding, "Except as shown on the plans, NO welding of any nature shall be performed on the load carrying members of a bridge without the written consent of the Central Office, Division of Construction, or an authorized representative, and then only in the manner and at the location designated in the authorization." This includes installation of stay-in-place forms and falsework.

Most structural steel welding in Kentucky bridges is performed in steel fabrication shops under the inspection of a qualified testing agency by consultant agreement. However, occasionally field welding is required and Department Engineers and Inspectors must have a working knowledge of the necessary requirements and good welding practices to properly inspect the work.

Inspectors should also be safety conscious in that welding arcs are brighter than the sun (causing eye injury) and that sparks and spatters can cause fires or burns. Sparks can spray up to 30 ft away. Thus inspectors should wear appropriate clothing and handle themselves accordingly.

All field welding shall be done as specified in the current specifications for Road and Bridge Construction, special provisions, plan notes and the applicable American Welding Society, (A.W.S.) Specifications for Highway and Railway Bridges. The ANSI/AASHTO/AW5 D1.5-2002 (or current edition) Bridge Welding code applies to welding main members. In order to avoid any confusion, the project engineer should discuss welders, procedures, and other details with the contractor prior to welding so everyone knows the ground rules.

All welding generally falls into one of 2 categories, either fillet or groove welds. Fillets welds are considered to be partial penetration welds and groove welds are either partial penetration or full penetration welds.

NOTE: Tack welds and ARC strikes on high tension members are known causes of cracks. These shall be prohibited!! Even when ground off, micro cracks may exist.

.1020 Qualifying Welding Operators - Before a welder can perform any field welding they must be qualified by possessing a valid certification.

.1021 Welder - Qualification and Certification - The Project Engineer must check the welder's certification to determine that the welder is qualified for making the specified type and position of weld. The certification must show that the welder has been qualified within the last 24 months and must have been tested and certified by a recognized state or private testing agency. The Division of Materials maintains a listing of approved vocational schools for testing welders and a listing of welders certified by that office, and may be contacted concerning their qualification.

The Project Engineer must retain a copy of the qualification papers or welder qualification number in the project files on each welder performing on the job. It can not be overstressed concerning the need to have qualified welders doing the work. Other welding on the project such as cofferdams, shoring, jack supports, etc. also need to be completed by a qualified welder due to large amount of stresses these welded joints are expected to handle. Keep in mind that allowable stresses for construction purposes generally are much

greater than that expected of permanent work.

One exception to welder qualification is welding of stay-in-place formwork. This thin gauge galvanized metal is easily burnt through by an inexperienced welder. Thus a welder *competent* in welding this type of formwork is preferred. Refer to the exhibits for examples of welds.

.1022 Welding Test - If the welder has no certification papers, or if they are invalid, the welder must pass a welder's qualification test before they can perform on the project. This test may be either conducted by an approved vocational school, testing agency or the Division of Materials. The Division of Materials maintains a list of approved testing agencies. Testing procedures shall be in accordance with KM 64-110 and the results shall be submitted to the Division of Materials with the Form TC 64-753.

NOTE: KM 64-110 is applicable for splicing piles and minor structural steel repair. Major structural steel repair shall require welder qualifications per AWS D1.5-2002 Bridge Welding Code (or current edition) which is more stringent.

.1030 Welding Position - The ability of a welder to make the required welds is vital; and before a welder is permitted to perform any welding, the welder must be qualified to make the specified weld according to the position in which the weld will be made.

.1031 Welds - All welds that will be encountered in actual construction shall be classified as (1) flat, (2) horizontal, (3) vertical, or (4) overhead in accordance with the definitions of welding positions described in Exhibit 63-8-41. Each qualification weld shall be made in the position in which the welding will be performed in the work, except that test welds made in the 1F or 1G positions qualify for flat and horizontal fillet welding.

.1032 Groove Weld Position - Plates shall be welded in the following positions:

1. Position 1G (flat). The plates shall be placed in an approximately horizontal plane and the weld metal shall be deposited from the upper side. See Exhibit 63-8-42 (Detail A).
2. Position 2G (horizontal). The plates shall be placed in an approximately vertical plane with the groove approximately horizontal. See Exhibit 63-8-42 (Detail B).
3. Position 3G (vertical). The plates shall be placed in an approximately vertical plane with the groove approximately vertical. See Exhibit 63-8-42 (Detail C).
4. Position 4G (overhead). The plates shall be placed in an approximately horizontal plane and the weld metal deposited from the underside. See Exhibit 63-8-42 (Detail D).

.1033 Fillet Weld Positions - Plates shall be welded in the following positions:

1. Position 1F (flat). The plates shall be so placed that each fillet weld is deposited from the upper side with its axis approximately horizontal and its throat approximately vertical. See Exhibit 63-8-42 (Detail A).
2. Position 2F (horizontal). The plates shall be so placed that each fillet weld is deposited on the upper side of the horizontal surface and against the vertical surface. See Exhibit 63-8-42 (Detail B).
3. Position 3F (vertical). The plates shall be placed in approximately vertical planes and each fillet weld shall be deposited on the vertical surfaces. See Exhibit 63-8-42 (Detail C).
4. Position 4F (overhead). The plates shall be so placed that each fillet weld is deposited on the underside of the horizontal surface and against the vertical surface. See Exhibit 63-8-42 (Detail D).

.1040 Welding Electrodes - Welding electrodes are classified by the letter "E" and 4-digit numbers, such as E 6010, E 7018, etc. The letter "E" denotes a welding "Electrode." The first two digits of the four digit number indicate the minimum tensile strength of the deposited weld metal in Kips per square inch (KSI). The third digit indicates the position or positions in which the electrode is capable of making satisfactory welds; for example, "1" is an all position electrode, "2" signifies flat and horizontal positions only, and "3" is the flat position only. The fourth digit relates to the composition of the flux and type current to be used; "5", "6", and "8" are low hydrogen. Only electrodes meeting the requirements of Part A and Part B of Chapter 4 of AWS D1.5-2002 Bridge Welding Code (or current edition) may be used. If there is any question regarding electrodes, the Central Office Division of Construction should be contacted prior to its' use.

During the welding process, the electrode coating serves two purposes. It forms a gas shield to prevent absorption of impurities from the atmosphere and flux in the coating purifies the molten metal. Two characteristics of this method of welding are solidified slag on the weld face and weld splatter which sticks to the surrounding metal. Both of these deposits are removed by chipping or scraping. Low hydrogen electrodes are susceptible to absorbing moisture and producing unacceptable welds. It is for this reason that it is extremely important that the electrodes be kept dry. The electrodes must be in tightly sealed metal containers when received and must be used within the specified time period (usually 4 hours) after opening or must be dried in an oven, as required.

.1050 Field Welding - Generally, when field welding is necessary other than that used for splicing piling, it will be stipulated in the structure plans and/or the shop drawings. The shop drawings will normally outline the complete approved welding procedure. The Project Engineer must see that the procedure is followed exactly. No changes in procedures may be made without prior approval of Central Office. Division of Construction.

Manual shielded metal arc welding (SWAW) is the most common form of welding in the field. It is sometimes referred to as manual, hand, or stick welding.

The sizes and lengths of welds shall not be less than those specified in detail drawings, nor shall they be substantially in excess of those requirements without approval. The location of welds shall not be changed without the approval of the Central Office, Division of Construction.

The base metal shall be prepared such that surfaces and edges to be welded shall be smooth, clean and free of rust, uniform, and free from fins, tears or cracks and shall meet all other requirements conforming to AWS Specifications. The limits of acceptability and the repair of visually observed edge defects in plates shall be determined by discussion with the Central Office, Division of Construction. Members to be welded shall be brought into correct alignment and held in position by bolts, clamps, wedges, struts, or tack welds (when permitted) until welding has been completed. (Tack welds that are welded over and melted into the final weld are permitted if properly performed.)

The quality of the finished weld must be closely inspected to determine if the completed weld is acceptable. The weld must have all slag removed so that the weld can be inspected. The weld profile and size must be correct. The welds must be free of cracks, and excessive porosity. There should not be overlap along edges of weld passes and no undercut into base metal along edge of weld.

Inspection tools can be made available from Central Office, Division of Construction to aide in weld inspection. These include weld size gages and temperature sticks. Please see the Exhibits for examples of welds and a discourse on non-destructive testing.

The Central Office, Division of Construction should be contacted for approval of methods for correcting defective or unsound welds. The minimum preheat and interpass temperatures shall be in accordance with the approved welding procedure. Questions concerning any deviations from these specified temperatures should be directed to the Central Office, Division of Construction.

Welds shall be cleaned and neutralized according to the current specifications prior to painting. Exhibit 63-8-43 is attached to give the Engineer and his inspector guidance in interpreting welding symbols on project structure plans and shop drawings.

.1051 Piling - Generally the use of welding is encountered more often by the Project Engineer in splicing piling than in any other case. The welders doing this type of welding have to be qualified for the types of welds being used. When steel bearing piling (H-pile) have to be spliced, the welder must be qualified for the overhead fillet position and the horizontal groove position for the

diamond plate splice and the horizontal groove and vertical fillet welds for "pile splicers". When cast-in-place (shell) pile need to be spliced, minimum requirements for a welder require qualification in the horizontal groove position.

63-08.1100 PRESTRESSED CONCRETE

.1110 General - Prestressed concrete members used for structures will generally be piles, I-beams, deck panels, box beam deck units, or box beam spread girders. I-beams and box beam spread girders are used to support conventional deck construction. Box Beam deck units are positioned side by side to form a deck, which may or may not be overlaid with a wearing surface, depending on the plans.

Section 605 of the Standard Specifications and the "Precast Prestressed Concrete Guidance Manual" provides complete and comprehensive requirements for prestressed and precast concrete members and should be read closely by the Project Engineer and any inspectors assigned to this type of work.

.1111 Materials - Prestressed concrete members are normally inspected at the casting plant by a representative of the Division of Materials. This inspector will stamp each member approved for shipment with the "Kentucky Oval" stamp. Members should not be unloaded from the delivery truck and certainly not erected if they do not bear this stamp, without first checking with the Division of Materials for an explanation. It must be recognized by the Project Engineer that existence of the stamp does not indicate automatic acceptance of the prestressed member nor does it relieve the contractor of his responsibilities regarding the member.

.1112 Test Reports and Certifications - Certifications for elastomeric bearing pads are transmitted to the Project Engineer during shipment of the members for a particular structure. The test reports for the beams are placed on the Division of Material's computer. The acceptability of the test reports should be verified with the District Materials Engineer, by the Project Engineer.

.1113 Engraved (Name) Plates - Difficulty is occasionally encountered in locating the design drawing number, construction date, design load and contractor's name on these type structures. Do not omit the installation of any required engraved plates. If no poured-in-place concrete is available which is satisfactory for these plates, they should be placed on the exterior fascia of the exterior girder at the fabricating plant. The following is a list of typical plate locations that are generally found satisfactory. Direct any questions to the Division of Construction, if there is a problem with these locations.

Beam Supplier -	Exterior face of exterior beam at abutment
Contractor Name -	Outside face of barrier wall near abutment

Date-Loading - Outside face of barrier wall near abutment
Bridge Drawing. No.- Outside face of barrier wall near abutment

Placement of any of the above inscriptions in an exterior beam is acceptable. Consult Standard Drawing BGX-006 for sizing the stencils.

.1114 Shop Drawings - Shop drawings are required on both prestressed I-beams, and deck units but not for piles. Shop drawings will be submitted to the Director, Division of Structural Design, for review in accordance with Subsection 605.03.05 B) of the Standard Specifications. These drawings will normally be submitted by the contractor's designated fabricator. The fabricator shall not begin work until review of the drawings is completed. A reviewed copy will be sent to the Project Engineer and the District Construction Office for their files and use. The contractor's shop drawings are also sent to the district office for distribution in most cases.

.1115 Matching Grades - Reconstruction of an existing structure involves matching the new and old grades. To avoid serious problems, profiles of the existing bridge should be taken and plotted. The new profile should then be plotted for comparison, to ensure correct slab depths, cross slopes, and profiles at centerline and gutterlines.

The use of precast pier caps and abutments to repair substructures requires careful consideration of the new seat elevations. The existing profile should be established and each element of the superstructure; slab, haunch, beam, and bearing can then be subtracted to obtain the correct cap seat elevation. Slight corrections can be made in the beam haunch to properly match the profile grade.

.1120 Pre-Construction Conference - In addition to the information presented in Section 63-03.1100 of this manual, there are some subjects related to this type of work which should be discussed at this meeting.

Normally, it is a plan requirement on superstructure replacement type projects that the contractor checks the plan grade, span lengths, girder skews, etc. against existing project conditions. Any problems or discrepancies the contractor may have encountered as a result of this check should be discussed.

All plan notes, proposal notes, etc. should be reviewed carefully along with any special information from the designer since each structure is a special case and may contain certain items to be done on an experimental basis. Inspection procedures for field checking the prestressed members should be discussed with the contractor as mentioned elsewhere in this Section and as deemed applicable to the particular situation by the District Construction Office and the Project Engineer. A common problem on projects with only proposal notes and without plans involves distances designated as clear spans which are mistaken for distance

out-to-out or centerline of bearing to centerline of bearing. The beam and span lengths on these projects should be checked closely.

.1130 Field Inspection

.1131 Preliminary Inspection - The Project Engineer or the Inspector should give the members a visual inspection after they are received at the job site and before they are unloaded. This inspection is primarily to check for shipping damage but any other obvious defects should be noted. If any member is damaged or otherwise judged to be unacceptable, the contractor should be informed immediately of its condition and advised that it is unacceptable before it is unloaded.

The reason for this inspection is to put the contractor on notice regarding a prestressed member that is obviously unacceptable before it is unloaded to afford a chance to return it to the fabrication plant with the least in-convenience and expense.

It must be recognized that some defects may be field corrected while others are uncorrectable. Any proposal to attempt to correct the defects in the field must be made by the contractor and will have some bearing upon the decision to unload the member or return it to the fabricator. If the contractor elects to make repairs in the field, they must outline the proposed repair procedure in a letter to the Project Engineer. Final review and approval of this procedure must be made in the Central Office, Division of Construction. The Project Engineer shall not render payment for any member that is unacceptable until it has been replaced with an acceptable member or is satisfactorily repaired. Under no circumstances should a member be set and anchored into place or have the lifting strands cut while its acceptance is in question.

.1132 Erection Inspection - Most contractors elect to set the members into place onto the structure from the trucks. This inspection will then, out of necessity, be after the members are in place. The Project Engineer and/or the inspector should give the beams a thorough inspection. Part of this examination should include a check to see that the fabricator finished the members as required by the specification. It is the contractor's responsibility to satisfactorily correct or complete any unfinished work on the part of the fabricator.

Another part of this inspection should include a close check of dimension tolerances. The tolerances for various prestressed members are given in Subsection 605.03.08 of the Standard Specification. A close check should be made for cracks, condition of the bearing area of the member, concrete patches on holes at draped strand hold-down devices, vertical camber in the member, length, etc.

No member judged to be out of the specification requirements shall be

incorporated into the structure on a permanent basis until investigated by the District Construction Office and the Central Office, Division of Construction and corrected in accordance with their recommendations.

The beams must be temporarily braced as they are set until permanent bracing can be established. The beams must be tied off to the caps and not just to the adjacent beams.

.1133 Finishing - The Project Engineer should inspect the prestressed units for the surface finish requirements of Section 605.03.07 of the Standard Specifications. The plant inspector will have checked the surface finish at the plant, but a field inspection should be made to ensure no damage to the finish occurred during shipping. Careful consideration should be given to surfaces directly outside the location of the prestressed strands. The masonry coating requirements of Section 601.03.18 should be followed after the girders are in place. Generally, only the exterior face and bottom of the exterior girder gets masonry coated.

.1140 Erection - The Project Engineer or the inspector should be sure the prestressed members are properly seated and bearing correctly. For box beam deck units this needs to be done prior to tensioning the transverse tension rods. The Project Engineer should check the contractor's falsework prior to placing the concrete deck on prestressed I-beams to be sure sufficient precautions have been taken to prevent exterior I-beams from overturning as the slab is placed. This is sometimes done by physically tying the tops of the exterior girders together using reinforcing steel in the slab. It is the contractor's responsibility to satisfy the condition and no additional pay is allowed for this work. The Project Engineer is reminded that temporary supports will not be permitted under prestressed members when placing the concrete deck slab.

.1150 Concrete Deck Placement - The steel stirrups protruding from the tops of prestressed I-beams or box beams should penetrate the reinforced concrete slab a minimum of 2 inches. The Project Engineer should contact the District Construction Office who may contact the Division of Construction for guidance if this is not possible.

Should the plans stipulate a pouring sequence, no changes in the sequence shall be permitted unless approved by the Central Office, Division of Construction and the designer.

Should the plans require the concrete deck to be placed in its entirety before any concrete is allowed to set, a lot of attention should be placed on the amount of retarder used and the Project Engineer should be satisfied that this requirement can be met before placing of the slab is started.

63-08.1200 REINFORCED CONCRETE BRIDGE SLABS

.1210 General - Much effort is required of a Project Engineer and assigned inspectors to ensure that bridge deck concrete is properly proportioned, mixed, transported, deposited, finished, and cured in such a manner as to provide a completed project in accordance with the applicable plans and specifications.

Sufficient equipment, in good working order, must be furnished *to* the inspection personnel. The importance of such equipment and its proper care must be impressed upon the inspectors. Backup equipment should be available for *all equipment.*

Information pertaining to concrete, reinforcing steel, and concrete bridges, in general, is contained in other sections of the guidance manual. These sections should be referred to even though the information may be very similar to the contents of this section.

.1211 Concrete Deck Placement - The steel stirrups protruding from the tops of prestressed I-beams or box beams should penetrate the reinforced concrete slab a minimum of 2 inches. The Project Engineer should contact the District Construction Office who may contact the Division of Construction for guidance if this is not possible.

Should the plans stipulate a pouring sequence, no changes in the sequence shall be permitted unless approved by the Central Office, Division of Construction and the designer. The Contractor shall submit his request with the following information: a) retarder schedule which can keep the concrete plastic between phases, b) concrete delivery/placement in CY/hr, c) manpower and equipment, and d) past history of placements of this size. The emphasis is to provide the Cabinet with assurances that the placement can take place without negatively affecting the bridge.

Should the plans require the concrete deck to be placed in its entirety before any concrete is allowed to set, a lot of attention should be placed on the amount of retarder used and the Project Engineer should be satisfied that this requirement can be met before placing of the slab is started.

.1220 Initial Project Review - A thorough preliminary review of the project is an important aspect in obtaining a good bridge deck. This review should include, but not necessarily be limited to, the following subjects.

.1221 Traffic Survey - Although the majority of the bridge slabs constructed will be on a new structure, some projects require that a new slab be constructed on an existing bridge while traffic is maintained. As soon as such a project is assigned, the Project Engineer should make an extensive review of the traffic at the bridge site. Any anticipated problems should be discussed with the

District Construction Office and the District Traffic Engineer. Recommendations or questions resulting from this review should be discussed with the contractor at the Pre-Construction Conference.

.1222 Checking plan Quantities - Section 63-08.0820 of the Guidance Manual emphasizes the importance of verifying the plan quantities at any early date. This is especially true since epoxy coated reinforcing steel is used in most bridge slabs and the time to reorder may be longer than for uncoated steel.

.1230 Inspection Upon Delivery - When reinforcing steel is delivered to the jobsite, spot checks should be made. Any damaged bars should be noted and repaired or replaced at this time. Bars with variations in excess of the allowable tolerances shown in the C.R.S.I. Manual of Standard Practice referred to in Subsection 602.03.03 of the Standard Specifications, should be rejected. If the quality of any reinforcing steel is in question contact the District Materials Engineer or Central Office Division of Materials.

.1240 Storage and Handling - Reinforcing steel should be stored and handled in the manner described in Section 63-08.0840 of the Guidance Manual in order to minimize damage to the steel. Epoxy coated bars which require repair because of nicks or abrasions shall be repaired by the contractor using the epoxy repair material supplied by the manufacturer.

.1250 Sampling and Testing - Reinforcing steel shall be sampled and tested as described in Section 63-08.0850 of the Guidance Manual and in accordance with Subsection 811.02.02 of the Standard Specifications and the Division of Material's “Field Sampling and Testing Guidance Manual."

.1260 Steel Placement - The general conditions which apply to placing and fastening of reinforcing steel are described in section 63-08.0860 of the Guidance Manual and are to be followed where applicable. Reinforcing steel for bridge slabs shall be accurately located and firmly held in position to the tolerances specified in Subsection 609.03.03 of the Standard Specifications.

.126l Metal Supports - Generally an approved metal chair, as described in Section 811 of the Standard Specifications, is used to support the top and bottom mats of reinforcing steel. The Project Engineer should perform a close inspection to ensure that sufficient chairs are in place to prevent sagging of reinforcing steel under construction traffic.

.1262 Tying Down Steel - Both top and bottom mats of steel shall be securely tied down at intervals no greater than 8 feet in both the longitudinal and transverse direction in order to prevent movement of the steel during concrete placement. Wires used to tie the mats in place shall be no. 9 gauge (0.148 inch in diameter) and shall be coated as per Subsection 602.03.05 of the Standard Specifications. Ties should be as vertical as possible since those ties that are

at an angle with the deck are often not snug and may tend to permit shifting of the steel.

.1263 Splices - Early attention should be given to longitudinal splices in bridge decks since short splices found after the steel is in place will result in the contractor having to rehandle all of the longitudinal steel. Consult Section 63-08.0862 of this manual for additional guidance on splice lengths and the use of mechanical or welded splices.

.1270 Concrete Placement - Except for a few specific points, the guidelines which pertain to structural concrete in general, as discussed in chapter 63-08.0700 of the Guidance Manual, apply to Class "AA" concrete for bridge slabs also.

.1271 Temperature Limitations - In addition to the requirements for temperature limitations and protection of concrete discussed in Section 63-08.0740 of the Guidance Manual, Class "AA" concrete for bridge slabs shall not be placed during the months of January and February. Cold weather is, however, encountered during months other than January and February and the Project Engineer is encouraged to make use of a seven-day weather forecast. The Project Engineer is therefore directed to require a written request from a contractor detailing the proposed methods of maintaining minimum curing temperature, moist curing, and fire protection whenever there is a chance that cold weather may occur during deck placement and/or curing time.

.1272 Nighttime Placement - If a nighttime placement is required, the Project Engineer should check the number and intensity of the lights. Their location should be such as to satisfactorily illuminate all phases of the work. Of particular emphasis is the need for adequate lighting behind the finishing machine where it is necessary to inspect the straight edging and curing operations. A flashlight held by the inspector is not considered adequate. If traffic is maintained on an adjacent roadway, caution should be exercised to prevent blinding a passing motorist.

The availability of adequate inspection personnel may be a problem. The Project Engineer should review the inspection requirements well before the scheduled operation and convey the personnel needs, if any, to the District Construction Office.

Nighttime deck placements pose a special problem in inspection supervision of the operation. District Construction Office personnel should visit each operation at night and make every effort to furnish the Project Engineer with necessary guidance and direction.

Safety is an important aspect of all deck placements and may become even more critical after dark. Adequate preparation must be made during the daylight hours to provide safe access to all parts of the operation for the

necessary inspection.

.1273 Construction Joints - Except in cases of emergency, construction joints should be provided only as shown on the pouring sequence of the design plans. However, the plans usually permit the pouring sequence to be changed with the written approval of the Engineer. Although the pouring sequence may be changed, the construction joint locations are usually not altered. In cases of emergency, such as a mechanical breakdown or falsework failure, a construction joint may be provided in locations shown in Exhibit No. 63-8-45. If the emergency occurs where a joint cannot be permitted, it may be necessary to "wash out" the concrete back to a point where a joint is permissible. The construction joint as provided shall be subject to the requirements of Subsection 601.03.10 of the Standard Specifications and as discussed in Section 63-08.0738 of the Guidance Manual.

.1274 Expansion Joints and Armored Edges - The expansion joint dimension shown on the plans is usually the width of the joint for a specific temperature such as 60º F. For temperatures higher or lower than the specified temperature, the joint opening must be adjusted accordingly at the time of installation. Consideration for making this adjustment is similar to that for expansion rockers. If any welding is needed for the armored edge construction, the Project Engineer should consult with the Central Office Division of Construction for direction.

The plans often give the contractor an option to provide one of several types of neoprene expansion dams. The manufacturer’s recommendations should be followed closely in making these installations. It is very important that the bearing seat for these systems be constructed properly with consideration being given to the grade and alignment of the structure. The plans generally require the manufacturer's representative present when this type dam is set. The Project Engineer should never waive this requirement. If the structure is on a steep grade it is important that the top surface of the expansion dam or armored edge be parallel to the roadway grade. This may require the vertical leg of the angle to be slightly inclined.

.1275 Pre-Pour Check List - The following list is not intended to be all the preparation necessary for a concrete placement but is to alert the inspector to items which may be critical to obtaining a bridge slab consistent with the specification requirements.

1. Pre-Pour Meeting
2. Has the falsework been approved?
3. Has the reinforcement been tested and approved?
4. Has the contractor made preparation for temperature limitation and protection?
5. Are curing preparations adequate?

6. Are expansion dams, armored edges, and drains set to proper grade?
7. Are forms clean and mortar tight and adjusted to correct line and grade?
8. Check to see that transverse screed guides are parallel to the plan cross-section of the slab.
9. Check the finishing machine rails and rail supports, making sure that they do not deflect when the finishing machine runs over them.
10. Is construction joint material, keyway forms, and emergency bulkhead material available?
11. Check overhang brackets to make sure that they do not deflect when loaded.
12. Is the reinforcement correctly located, supported and tied? Are extra chairs available if needed?
13. Has the "Dry Run" been made with adjustment as necessary to obtain proper clearance to steel?
14. Does a visual (eyeball) inspection of the reinforcing steel and rails reveal good alignment and uniformity of installation?
15. If SIP forms are used, have they been approved and are they in accordance with the shop drawings and Special Provisions?
16. Are air vent tubes, if required, installed correctly?
17. Are the cable clamps connecting the PCI beams over the piers in place?
18. Have the tops of the PCI beams been properly tied together to prevent rotation of the exterior beams?
19. Have proper provisions been made if a concrete pump hose is to be utilized? i.e.- extra chairs, plywood over steel, etc.
20. Check the weather forecast. Make provisions for inclimate weather, if anticipated.

.1276 Finishing Machine "Dry Run" and Depth Checks - All reinforced concrete slabs shall be finished with a mechanical finishing machine meeting the requirements of Subsection 609.02.09 of the Standard Specifications. Before any concrete is placed, the contractor will have the rails installed and the finishing machine set for the specific grade and template. The setting of the machine will be checked by the Project Engineer and a "dry run" shall be made with the finishing machine fully operational and carrying a load similar to that imposed during the placing operation. The contractor or contractor's superintendent should witness this dry run. Unless another suitable method is proposed by the contractor and approved by the Engineer, the following procedure for making a "dry run" shall be utilized. It has been found to be an effective and complete check of the slab thickness and concrete cover over the reinforcing steel.

1. This procedure should be used when an oscillating screed or cylindrical type finishing machine is to be used. It should be performed after all steel reinforcement has been placed and properly tied in the slab and after the finishing machine has been set for the required line and grade.
2. A template block equal in depth to the plan dimension of the concrete

cover over the top mat of reinforcing steel must be attached to the bottom side of the screed. Since this attachment is temporary it can be made by clamps or similar devices. The template block must be attached to the bottom finishing surface of the screed that will be the closest to the steel when the screed passes over it. Normally, this will be the trailing end of the screed.

3. After the template block is installed a "dry run" of the entire bridge slab shall be made. At each location where the block cannot clear the reinforcement, the forms and/or the finishing machine rails should be adjusted to ensure the required cover and depth. No adjustment should be necessary in the reinforcing steel if the proper height chairs are used.

During the concrete placement, the inspector will make depth checks of the slab depth and concrete cover at numerous locations by use of a probe in the fresh concrete directly behind the finishing screed. Special care should be taken when SIP metal forms are used to ensure the probe is not being pushed down into the styrofoam in the corrugations resulting in erroneous depth readings.

Final adjustments shall be made to the machine and rails during the "dry run." It is very important that the Project Engineer and the contractor satisfy them selves that the machine and rails are properly set to obtain the correct grades, cover, and thickness at this time and that no further adjustments will be necessary during the placement operation except as may be required to transition from one cross section to another. Any necessary adjustments shall be made by the contractor.

When the bridge deck cross-section is not constant from one end of the bridge to other, such as going from a normal crown to a full super elevated section, it is necessary to adjust the finishing machine manually in order to make the transition. During the "dry run" as the machine is moved through the transition zone, <u>adjustments should be made to the machine at longitudinal intervals corresponding to the grid lines.</u> The amount the machine is adjusted at each breakpoint of the machine frame and the corresponding grid point locations should be marked on the forms in a location visible to the operator. Only these amounts of adjustment should be made during the actual concrete placement. The Project Engineer or the project inspector should observe the adjustments closely during the transition. As a final check just prior to concrete placement, the screed should be checked against an expansion dam or concrete header.

The depth of cover over the top mat of steel will be measured at a later date in accordance with Section 602 of the Standard Specifications and penalties assessed, if necessary, in accordance with Subsection 609.05. If there is any reason to suspect a deficiency in slab thickness, the Division of Construction should be notified to make arrangements for core drilling the slab.

.1280 Surface Finish - The Project Engineer should check the plans and proposal to determine whether texturing, waterproofing membrane, or a wearing surface is required for the concrete deck. Regardless of the type of finish required, the entire surface shall be checked with an approved 10-foot floating straightedge or finishing tool. Any variations or ridges greater than 1/8 inch shall be eliminated by using a long handled bull-float and rechecked with the 10-foot straightedge.

If the plans specify that a waterproofing membrane or surface course is to be applied, texturing will not be required and the application of a liquid curing compound will not be permitted. See Subsection 609.03.11 of the Standard Specifications.

When texturing is not required, a burlap drag shall follow the straight edging operation with the direction of the drag being the same as the placing operation. It is important that the burlap drag be kept damp and free of hardening concrete.

If a waterproofing membrane or surface course is not required, the surface shall then be textured or grooved as described in Subsection 609.03.10 of the Standard Specifications unless otherwise provided in the contract.

.1290 Curing - Curing of structural concrete in general is discussed more fully in Section 63-08.0750 of the Guidance Manual. However, there are certain specific points which pertain to bridge slabs that are again emphasized here.

Immediately after finishing, and while slightly damp, the surface shall be coated with a white pigmented membrane-forming curing compound conforming to the requirements of Subsection 823.02 of the Standard Specifications. The curing compound shall be applied at the rate described in Subsection 609.03.12 of the Specifications and with spray meeting the requirements of subsection 63-08.0750 of this manual.

Care shall be taken to prevent the compound from being applied to surfaces which are to bond to other concrete or from getting on the reinforcing steel. Special care should be exercised around epoxy coated steel. Sandblasting is required to remove curing compound from these areas with the exception that epoxy coated steel should not be sandblasted.

As soon as *practical* after application of the compound, the entire area of the slab between the curb lines shall be covered with two layers of wet burlap, or one layer of wet burlap and one layer of burlene, and kept wetted continuously for 7 calendar days after the concrete has been placed. If no burlene is available, the Project Engineer should encourage the use of a layer of plastic. The Project Engineer will need to exercise some judgment in determining the correct time to apply the burlap so as not to damage the green concrete surface. When concrete is placed in cold weather, the Engineer should make sure that all insulating

material is placed on top of the curing material.

63-08.1300 BRIDGE DECK OVERLAY

Section 606 of the Standard Specifications addresses bridge deck overlays.

.1310 General - The Project Engineer must be thoroughly familiar with the project plans, proposal and applicable special provisions. The nature of overlays requires that much of the critical work be done at night. This magnifies the problems and responsibilities of the Project Engineer. Thorough planning and initial preparation are critical if adequate supervision and inspection are to be furnished for these nighttime operations.

.1320 Initial Project Review

.1321 General - A thorough preliminary review by the Project Engineer and crew is critical in obtaining a good bridge deck overlay placed in accordance with applicable plans and specifications. This review should include, but not necessarily be limited to, the following subjects.

.1322 Traffic Survey - As soon as assigned a bridge deck overlay project, the Project Engineer should make an extensive traffic review of the bridge site. This survey should include a study of possible traffic problems such as sight distance, driving lane widths, signing requirements, and any other traffic related peculiarities that might influence the safe and expedient handling of traffic. The plans and/or proposal requirements should be reviewed and any anticipated problems should be discussed with the District Construction Office and possibly the District Traffic Engineer. The need for traffic signals and their applicability to the situation should be studied. Any recommendations resulting from this review should be discussed with the contractor at the Pre-Construction Conference.

.1323 Checking Plan Quantities - All quantities for use in constructing the bridge deck overlay should be checked. The Project Engineer should have the survey party profile the existing deck by running a profile in the vicinity of each gutter line and on the centerline. This profile is referred to as a "3 Point Profile"; however, additional profile lines may be necessary if the bridge includes more than 2 lanes. Each profile should include shots no further apart than 10 feet and be plotted on an exaggerated scale of one inch to 10 feet horizontal and one inch to 0.2 of a foot vertical. Utilizing this information, the Project Engineer should make a determination concerning the following:

1. Drainage - existing drainage capabilities of the deck can be studied and a determination made concerning any improvements that may be necessary to provide adequate drainage.
2. Riding Surface - The quality and configuration of the riding surface

should be studied. The existing roadway crown, cross-slopes, super-elevation if any, and any sags or bumps will be evident and subject to consideration for correction in the overlay placement. The Project Engineer must determine whether placing the overlay parallel to the existing surface will yield a good riding surface or if it will be necessary to design new grades. The Project Engineer should keep in mind that it may not be practical or economical in some cases to restore the deck of an old bridge to new configuration without encountering an undue overrun of overlay material.

3. Overlay Quantities - The Project Engineer should estimate the quantity of overlay material necessary to do the work and compare this with plan quantities. If additional quantities are required, the Project Engineer should contact the District Construction Office who may contact the Central Office, Division of Construction, for direction concerning this additional quantity. Funds should be made available for any additional quantities before the work is performed or the decision should be made to parallel existing grade and minimize overruns.

The quantity of structural steel, which is usually related to adjustments in armored edges and expansion dams, should be field checked for length, width and thickness. If any discrepancies in plan dimensions are discovered, the contractor should be notified immediately and proper action taken to correct the error.

Surface measurements should be taken of the deck and computations made to check the amount of deck area specified by the plans to be scarified. Similarly, the area of the curb and gutter to be sealed with epoxy, if required, should be calculated and checked against plan quantity.

A close check should be made of the deck condition with respect to the possible need for full depth patching. It is not practical to arrive at exact quantities of full depth patching before work starts. It is possible, however, to get an approximation of quantities. Possible areas that may require full depth patching will show under the deck by spalling of the concrete or by cracks which will be delineated in white caused by calcium leaching through the cracks. Special attention should be given to any joints and drains for this type problem.

A change order should be executed as soon as possible to obtain approval of any increase in quantities that are recommended as a result of this preliminary investigation. Additional time, if applicable, should be included in the change order.

.1330 Pre-Construction Conference

.1331 General - A pre-construction conference should be held on every project. It

is not possible to touch on every aspect of this type work herein because of different problems encountered. Several subjects for discussion will be mentioned, however, in addition to those required in Section 63-03.1100 of this manual.

.1332 Preliminary Inspection Results - The results of the Project Engineer's preliminary inspection should be discussed thoroughly with emphasis on any problems or changes encountered. The contractor's plans for handling traffic should be discussed in detail.

.1333 Plan Requirements - All plan and proposal requirements should be discussed with the contractor in detail. The applicable special provisions should be reviewed carefully, particularly since they are subject to change from one project to the next.

.1334 Material Stockpiling - The remoteness of some overlay projects make this a subject of special consideration. The contractor should be cautioned that his material will have to be available for sampling and testing early enough so these procedures won't delay the operation. The stockpile should also have sufficient lighting to permit proper inspection of the materials being loaded. Truck lights alone are often not adequate. Also tarps or some other means to prevent the contamination of the stockpiles shall be used.

.1335 Trucks - The truck mixers to be used should be discussed in detail. Their condition is very important. Limitations involving loading and unloading should be reviewed to determine that sufficient trucks will be available to ensure continuous operations.

.1336 Supervisory Personnel - A supervisor must be available, particularly during actual overlay placements, to carry out instructions of the Project Engineer and/or the inspector. It is not satisfactory for any supervisor to operate any equipment or perform any other function which renders them unavailable to the Engineer. Failure to meet this requirement may be justification for postponing or suspending operations under authority of Subsection 105.06 and 108.06 of the Standard Specifications.

.1340 Overruns

.1341 General - The Project Engineer must monitor quantities closely and make every effort to minimize overruns. It is recognized, however, that the condition of an old bridge may be worse than anticipated so it is often difficult to avoid overruns.

The nature of full depth patching makes it difficult to determine the quantity of concrete needed until the removal of unsound concrete is fairly well advanced. Because of this, the Project Engineer must monitor this operation

closely, both to ensure that only unsound concrete is removed and to keep up with the quantities involved. It is suggested that a suitable basis on which to estimate the total amount of full depth patching needed for a bridge is to base the needs of the last half of the bridge on the quantity used in the first half. Past experience has indicated this approach to be reasonably accurate subject to obvious differences observed.

.1342 Change Orders - Additional Funds must be approved for any predictable overruns or construction changes before the work is initiated. As mentioned previously, some unanticipated overruns will occur, however these additional quantities should be included in a change order at the earliest practical date. Additional time, if applicable, should be included in the change order.

.1343 Excessive Overrun Formula - It may be desirable to submit change orders for additional quantities of major items and in particular of overlay materials when it is not quite clear whether the overrun formula will be ultimately applicable. When this situation occurs and the formula is not utilized, the following statement should be included in the change order: "It is understood by all concerned that the additional quantities described herein may be subject to unit price adjustments as directed in Subsection 104.02.02 of the Standard Specifications."

.1350 Deck Preparation Prior to Placing Overlay

.1351 General - The methods used, attention to details, and effort exerted on this phase of the operation is crucial to the performance and durability of the completed project.

.1352 Monitoring the Scarification Process - It is the contractor's responsibility to provide a uniformly scarified deck. Scarifier teeth should be examined closely before starting work to be sure all teeth are in place and reasonably uniform in length. The Project Engineer should utilize positive methods to monitor the depth of material removed from the deck during the scarification process. One way to accomplish this is to have the contractor make alternate passes with the scarification equipment, leaving strips of the old deck for purpose of comparison. The strips of old deck can then be removed to the level of the previous passes thus giving positive control of the depth removed. Another method is to use a string line from pre-determined points with elevations recorded along the string line at these points. By comparison of elevations, the inspector can determine how much material has been removed. This method has worked well in cutting the transition in bridge decks when approach slabs are rigid pavement.

.1353 Sounding the Deck - The Project Engineer should be very thorough in sounding the old deck and careful to mark the limits of unsound concrete to be removed. All areas should be closely checked to be certain all weak or loose

concrete has been removed. This is a critical aspect of the deck preparation and warrants close inspection since any unsound or loose concrete not removed is likely to cause the overlay to lose bond. If the condition of the deck is worse than anticipated, the Project Engineer should make an estimate of the quantities and funds needed and contact the District Construction Office.

The deck should be thoroughly sounded with a hammer, or reinforcement bar or by dragging a chain across the entire area of the deck and marking any loose or unsound concrete with paint for later removal during the jack hammering phase of deck preparation. Debonded loose concrete gives a thud or dull rattling sound instead of a ringing sound. Bouncing sand particles while sounding with a hammer is a sure way of determining lack of bond.

The jackhammer operation should be closely inspected with special attention given to the weight of the hammers used. Section 606.02.10B requires that the hammers provided weigh 40 lbs or less. While it is desirable to remove any unsound concrete, care should be exercised to minimize the removal of sound concrete. Special precaution should be utilized when using jackhammers around reinforcing steel and copper strips (water stops) to avoid any damage. Any reinforcing steel or copper strips damaged should be replaced or repaired and securely tied down before the overlay is placed. Partial and/or full depth removal of concrete may be accomplished using hydrodemolition. Refer to Section 606.03.03 for hydrodemolition. The deck should be sounded one additional time after the overlay is placed before opening the deck.

.1354 Blast Cleaning - The blast cleaning operation should not be started until all the above work has been satisfactorily completed. Blast clean the entire area of the deck surface according to Section 606.03.04. As a general rule, a contractor will schedule the blast cleaning operation to barely precede the overlay placement. This is understandable in view of the plan requirement for the entire deck including all exposed reinforcing steel, copper strips, etc., to be absolutely clean when the overlay is placed. In general, a blast cleaning operation shall remove all rust from expansion dams, reinforcing steel and drains. All laitance should be removed from the concrete including any new full depth concrete in place. Special attention should be given to the vertical sides of curbs and adjacent overlays since a good bond there is critical. The deck must be blown off with air that is clean and oil free just prior to overlay placement. If traffic is maintained on the bridge, blast cleaning must occur within the 12 hours just prior to overlay placement.

.1360 Preliminary Preparation

.1361 General - The contractor and the Project Engineer should meet and schedule the overlay placement for a realistic and definite time. Consideration should

be given to determining if all materials are stockpiled, properly maintained, and certified or tested. Is all necessary equipment on the job and in working condition? Does the contractor have sufficient personnel available to perform the work? Is satisfactory lighting at the job site?

.1362 Calibrating the Truck Mixer - The truck mixer should be calibrated in accordance with KM 64-312. It should then be charged with material and covered to control the moisture content. Stockpiles should be protected to maintain a uniform moisture content. Care should be taken in removing material from the stockpile to be sure the operator does not get too low in the stockpile and charge the truck with contaminated material. It may be necessary for the contractor to provide additional lighting beyond that available from the truck to facilitate adequate inspection of the truck loading operation.

KM 64-312 stipulates in detail the equipment needed and procedures to be used in the calibration of Continuous-Type Mixers (Concrete Mobiles) used in the production of Latex Concrete and Portland Cement (low slump) Concrete. Both the Project Engineer and the Inspector(s) should be thoroughly familiar with these procedures. For additional information see Exhibit No. 63-8-47.

The equipment needed to calibrate the concrete mobile shall be furnished by the contractor in accordance with the Standard Specifications. The equipment must be clean and in good working order. The Project Engineer should review equipment requirements with the contractor at the Pre-Construction Conference. Refer to KM 64-312 for the necessary equipment. See Exhibit 63-8-48 for a concrete mobile mixer check list.

Ensure that the continuous mixer calibration is verified by a yield check early during each overlay placement. The contractor must provide a 1/4 cubic yard box and the yield is checked in accordance with section 10 of KM 64-312.

.1363 Finishing Machine Rails - Finishing machine rails should be erected and adjusted to grade under the supervision of the Engineer. The rails should be inspected to be sure they are not damaged or bent. Individual chairs should be checked to be sure they are in contact with the rail when the machine passes over them. The system used to support the rails off the end of the bridge should be examined for its lateral stability as well as its ability to support the load without settling. A string line may be used to set intermediate rail chairs between extreme chairs at expansion dams or span ends. This method should prevent irregularities in the existing sidewalk or deck becoming incorporated in the overlay.

.1364 The Finishing Machine - The Project Engineer should check the finishing machine to see that the screeds are straight and clean, that there are no hydraulic leaks, particularly when it is revved up to operational RPMs, that it

moves smoothly in forward and reverse on the rails, that it has sufficient vibratory capacity in good working order, that the screed and strike-off mechanisms operate smoothly and that the machine is in generally good operating condition.

The finishing machine must be set for the specified grade and template by the contractor and checked by the Project Engineer. A dry run shall be made with the finishing machine fully operational and carrying a load similar to that imposed during placing operations. That is, the finishing machine should be carrying the operator, the light plant, if applicable, and any other equipment it will have to carry during an actual placing operation. The grade of the finishing machine must be adjusted to the existing expansion dams. Final adjustments shall be made to the machine and the rails during this dry run to ensure that the overlay will have the proper grades and minimum thickness. It is very important that the Project Engineer and contractor satisfy themselves that the machine and rails are properly set at this time so that no further adjustments will be necessary during placing operations. After the dry run is satisfactorily completed, handles which adjust the grade of finishing machine legs must be positively "locked off" in order to prevent their accidental movement. This "lock off" must be monitored by the inspector during overlay placement.

.1365 Nighttime Operation - If nighttime operations are required, the Project Engineer should check the number and intensity of lights; and also determine whether or not their location is satisfactory to furnish adequate lighting to properly illuminate the work. Caution should be exercised to be sure that lights do not blind passing motorists.

.1366 Work Bridges - The number and condition of work bridges should be checked by the Project Engineer. A minimum of two bridges should be furnished by the contractor. The Project Engineer may request additional bridges if the nature of the operation and/or inspection procedures make it necessary. Section 105.01.03 requires the contractor to provide assistance as required to make a complete and detailed inspection.

.1367 Miscellaneous Equipment - The quantity and condition of burlap, wheel barrows, plastic sheeting, hoses, brooms and water for curing should be checked. Sufficient materials and equipment of this type must be readily available and in usable condition before starting the overlay placement.

.1368 Oil Leaks - The mixer truck and any other piece of equipment the contractor will have on the deck during placement operations should be checked for hydraulic or oil leaks. Preventive measures will be utilized to keep the equipment from leaking or tracking foreign material on the deck. The contractor should also be advised that it is a good practice to keep tarps available in the event a leak is discovered.

.1369 Access to Work - In some cases, particularly when the overlay is placed full width, problems arise related to the Project Engineer having ready access for inspection of the work. More specifically, with the finishing machine operating from curb to curb, there is no ready access from the rear of the operation to the front and vice versa. According to Subsection 105.01.03, when such a situation exists, access for inspection must be furnished and the primary requirements are accessibility, safety, and non-interference with the contractor's operation.

.1370 General Procedure for Placing Overlay

.1371 General - Many of the requirements for placing latex and low slump concrete overlays are similar in nature and will, therefore, be discussed jointly as follows:

.1372 Job Control Sampling and Testing - Thought should be given to preliminary preparation for job control sampling and testing. If the bridge is subject to vibration from traffic, all material testing should be done on solid ground off the bridge deck. All testing should be done with as little interference in the contractor's operation as possible. Samples of latex should be taken at random times during each placement. This is to ensure that the latex is not accidentally becoming diluted.

.1373 Applying Grout - Grout shall be applied as stipulated in the Standard Specifications. It is very important that grout is applied properly (scrubbed in) to all vertical surfaces such as curbs, drains, or a previously placed overlay since the resulting joints are extremely susceptible to water penetration. Grout should not be allowed to puddle or dry out and fresh grout should always be available. The final grout coating of all longitudinal and transverse joint top surfaces shall be neatly brushed and properly cured. Do not apply grout when using Hydrodemolition.

.1374 The Finishing Machine - The finishing machine shall be observed closely to be sure it is properly consolidating the overlay and leaving a good finish. Random depth checks of the finished overlay thickness should be made and recorded. Excessive variations from the predetermined depth (the dry run) are sufficient reason for suspending operations until the contractor can correct the problem.

.1375 The Finished Surface - The finishing behind the finishing machine should be inspected to be sure proper grades are being obtained around drains, expansion dams, and the gutter line(s). The grooving or texturing operation should be observed closely to be sure the required width and depth are being obtained and that the termination points are correct. Special attention should be directed to the timing of the texturing or grooving as related to the passage

of the finish machine. Waiting too long to perform either of these operations may result in tearing of the surface and/or displacement of the aggregate. Texturing too early may result in the overlay flowing back together, thus eliminating the grooves or texturing. Some trial and error may be necessary to establish the proper timing but it should be established as early as possible and maintained throughout the operation.

The overlay should be straight-edged the following day in accordance with Subsection 609.03.08 of the Standard Specifications and appropriate action taken as specified in this section. Tolerances for the straight edging shall be obtained from the Standard Specifications.

The overlay shall be sounded one last time to determine if there are any unbonded areas. If any are found, cut these out, square up the hole, apply a bond coat, and patch with overlay material.

.1380 Low Slump Concrete Overlay

.1381 A Dry Deck - The dryness of the original deck is critical in this operation. Special attention should be directed to this requirement and it should be rigidly enforced.

.1382 The Grout - The mixing of grout should be closely observed. A determination should be made early in the operation for the amount of water required to be added to the sand and cement to achieve a grout of acceptable consistency. Haphazard mixing of unknown quantities of materials is not to be permitted. The grout should be agitated continuously and kept thoroughly mixed.

.1383 Density Tests - The contractor should be required to furnish a work bridge from which density tests may be run that is separate from those used to finish the overlay. Density tests shall be taken at the pre-determined locations and calculations expeditiously made to determine if density has been obtained. The linear distances between tests shall not exceed the limits set forth in the Division of Materials Manual on Field Sampling and Testing Practices. Procedures for density tests shall be in accordance with Exhibit 63-8-49 of this manual. When a failing density test is obtained, the following procedure shall be followed unless otherwise directed:

1. Immediately stop all forward motion of the overlay operation. Record the location of this action.
2. Make additional passes with finishing machine to consolidate overlay to specified density. The passes must run back to the vicinity of overlay compacted to satisfactory density as evidenced by the last passing test.
3. If satisfactory density is obtained, the operation may resume. It should be recognized that the recompacted section may be too hard to achieve

satisfactory grooving or texturing. Appropriate action will have to be taken depending on plan requirements and the condition of the overlay. When the operation resumes normal progress, slow the finishing machine down and density test results should improve.

4. If recompaction of the overlay fails to achieve passing density, the failing material must be removed and replaced with acceptable concrete at the contractor's expense as required in the Standard Specifications. The area of suspect material is defined to extend from the point of ceasing operation (as defined in step no. 1 above) to the immediate vicinity of the nearest passing test. In this event, it is considered acceptable procedure to take additional density tests at 10-foot increments both forward and backward from the point of failure to determine the limits of failing material. If this procedure is used, the base density test to be used in the computations should be the one nearest the test being run. An alternate procedure would be to remove all material back to the previously passing test without taking any intermediate tests. The choice of procedure is at the discretion of the Project Engineer.
5. If it is necessary to implement step no. 4 above, this action should be undertaken immediately if at all possible. Under no circumstances should work be allowed to proceed to another lane or section of the deck without finishing the section or lane in question including replacement of all unacceptable concrete. Nuclear density tests for low slump concrete can be reported on sample form as shown by Exhibit 63-8-47 page 9 of 11. See Chapter 6 in this manual for additional information regarding the use of nuclear gauges.

.1384 Curing - Care should be exercised in determining the correct time to apply burlap and start the fogging operation. The burlap applied to the concrete should be thoroughly wet but allowed to drain before using. Curing shall be done in accordance with Subsection 606.03.18 A) 4) of the Standard Specifications.

.1390 Latex Concrete Overlay

.1391 Pre-wetting the Deck - The original deck should be pre-wetted as required in the Standard Specifications. It is a further requirement that the deck be kept constantly wet preceding the overlay operation. The problem encountered in keeping the deck wet is disposal of accumulated water. This problem is particularly acute if the overlay operation is moving upgrade, on a superelevated section, or partial depth patches exist. The inspector should watch this operation closely and not permit any accumulation of water.

.1392 Latex Grout - The operation of scrubbing the latex grout from the latex concrete mixture into the deck results in a sizeable quantity of coarse aggregate left over. This aggregate shall be collected and disposed of outside

the overlay operation. The latex grout should remain fluid until covered by the overlay material. The finishing and texturing operations should closely follow the finishing machine so they can be completed prior to the latex concrete "setting" at its surface.

.1393 Curing - The burlap should be thoroughly wet, but allowed to drain before being applied to the deck. Be sure water is not running since latex will be washed from the surface leaving coarse aggregate exposed. This curing shall be done in accordance with Subsection 606.03.17 A) 4) of the Standard Specifications.

63-08.1400 BRIDGE PAINTING

.1410 General - A paint coating serves the dual functions of metal preservation and improvement of appearance. Paint forms a protective coating which separates the corrodible metal surface from the corrosive action of oxygen and moisture thereby reducing or preventing structural component section loss. The service life of a paint coating is governed by many factors such as severity of exposure, degree of surface preparation, composition and thickness of paint layer, method of application, and quality of application.

The cleaning and painting of structural steel requires knowledgeable and **close** supervision by the Project Engineer and the project inspectors. Every Project Engineer should have at least one inspector on the crew with in-depth experience and education in bridge paint project inspection and administration, or consider use of consultant project administration management and/or inspection.

.1420 Protection of the Public - Regardless of the size of the bridge or its location, painting contractors will invariably find themselves involved with the traveling public. In accordance with the Standard Specifications, the contractor is solely responsible for any damage resulting from the operations. The contractor is required to protect their staff, our personnel, the public, public and private property, and the environment against damage or disfigurement by paint or paint materials.

Despite all possible precautions on the part of the contractor, accidents do happen. Preparations should be made by the contractor to handle the complaints or emergency situations before starting the cleaning or painting operation.

The contractor should be asked at the pre-construction conference to furnish the name of the responsible person(s) that will be available at all times to handle any inquiries, problems or emergencies. It should also be clarified how problems will be handled when they occur. If no conference is held, the Project Engineer should obtain this information for the project diary prior to the contractor starting work.

The Project Engineer and, in particular the painting inspector, may find that they

are approached by irate citizens regarding paint damage or other claims. In this event, they should listen politely but should refrain from judging on the validity of the claim. They should, however, give the name of the contractor's employee responsible for handling paint damage or other claims and/or the contractor's liability insurance company's name if the contractor is no longer on the project.

.1430 Cleaning/Surface Preparation - The nature of painting work makes skillful and continuous inspection mandatory during the Surface Preparation operation. The best coating of paint possible will be rendered ineffective if applied over poorly prepared steel.

To get a good paint job, it is essential that the surface be clean and dry and have acceptable surface preparation. This provides a suitable foundation for coating adherence. This is not only critical to the first coat, but to additional coats as well. Grease or oil, dirt, rust, loose scale, old paint coating and dampness are the principal causes for the breaking of bond between the metal and the paint, or between the various films of paint.

Properly working inspection equipment is essential for project inspection. Each project shall have available for the inspectors; at least one sling psychrometer, one copy of the U.S. Weather Bureau Psychrometric Tables, and one surface temperature thermometer for determining when ambient weather conditions and temperatures meet the requirements listed in the Standard Specifications or Manufacture's Product Data Sheets (PDS), Dry Film Thickness Gauges, both electronic magnetic nondestructive and a Tooke type destructive, a micrometer and sufficient replica tape to measure anchor pattern, (surface profile) ASTM D 4417 Method C, as required in the Standard Specifications, a dull 2 inch scraper or putty knife, mirrors, clear glass or plastic bottles, and additional equipment as required.
Cleaning methods shall conform to the Standard Specifications, plans, or proposal. It is essential that each Project Engineer have available inspection staff with knowledge of accepted industry standards i.e. SSPC, NACE, to provide Quality Assurance inspection of the Surface Preparation. Copies of these Standards are available through Central Office Division of Construction and Division of Maintenance.

.1440 Paint/Coating - All paint shall conform to the applicable section of the Standard Specifications or as otherwise designated in the contract.

1. All coatings will be inventoried and inspected for container and contents integrity when delivered to the contractor's storage site
2. Any paint which is rejected shall be removed from the job before any painting is started.
3. All coatings will be sampled for approval by Central Office Division of Materials.
4. Coatings which fail will be remover from the storage site and not permitted

on the project site. Some coatings may be approved but with a deduction, refer to section 821 of the Standard Specification Book

Occasionally a Project Engineer may be requested to accept paint which has been job tested on the basis of a transfer of materials. In this event, a Project Engineer must proceed with caution. Generally, the transfer of paint by this procedure between Project Engineers in the same district or even between neighboring Project Engineers in different districts may be accomplished with less effort than re-sampling. When paint is transferred over distances greater than this however, problems may arise such as relating paint received to that transferred, mix-ups in quantities or other confusing factors. Unless the Project Engineer is absolutely sure of a satisfactory relationship between the transfer of materials and the paint received, the paint should be sampled before used on the project.

A contractor my desire to use paint/coating thinner or reducer, if so, he must submit a written request through the Engineer to the Central Office Division of Materials. Thinner/reducer may only be used with written approval from the Central Office Division of Materials. If approved, paint/coating thinner may be used as specified in the manufacturer's written application instructions. The thinner used must be the type recommended in the written instructions and must not exceed the maximum amount specified and/or approved. In the event the contractor has not supplied the application instructions, no thinner may be added. When mixing and applying coatings, inspectors will ensure that the coating manufactures procedures, recommendations, and methods are adhered to.

.1450 Inspection - The Project Engineer shall see that the inspectors assigned to bridge painting jobs have a thorough understanding of the job and their responsibilities. Experience is a very important asset to a bridge painting inspector since decisions must be made concerning the quality of a contractor's work based on visual interpretations and comparisons.

The Inspector should fill out the "Daily Inspector's Report" Form TC 63-28 and Form TC 63-14 "Daily Inspector's Report for Bridge Painting" (Exhibit 63-8-56) daily. The total number of gallons and inventory identifier of each type of coating used should be recorded on a daily basis with running totals kept from day to day. The areas accepted and any problems encountered should also be indicated along with other required information.

.1451 Final Inspection - On site inspectors should coordinate with Central Office personnel to schedule Partial Final and Final Inspections. Large projects with many structures or numerous portions of a large structure may require multiple moves by the contractor facilitating the need to perform multiple Partial Final Inspections. Central Office Personnel will perform multiple inspections as well as regular in-progress project reviews. The project will not be considered complete until a final review of Partial Finals, complete Project walk-through, and Final Inspection has been completed.

.1460 New Structural Steel - The cleaning and painting of new structural steel shall be in accordance with Subsection 607.03.23 of the Standard Specifications and applicable plan and proposal notes.

All steel shall be inspected by the Project Engineer or a designated representative when delivered to the job site for compliance with Subsection 607.03.23 C) of the Standard Specification. Field cleaning and painting shall be done in accordance with Part "D and E" of this Specification.

Generally, the presence of the shop inspector's stamp indicates that the paint meets the specifications. However, occasionally, steel will get shipped that differs significantly from the specification requirements. In this case, the presence of a shop inspector's stamp on the steel does not automatically mean that the Project Engineer has to accept the steel as delivered to the project. The field inspection, prior to erection, should be critical and thorough since it will be the last opportunity for anyone to really take a close look at the steel. The project contractor bears full responsibility for all work, including the first coat of paint done in the shop.

All cleaning and painting of a new bridge must proceed in an orderly fashion with each operation, whether it be cleaning or individual paint coats, being completed by bays, sections, or other readily identifiable sections of the structure before commencing with the next operation.

.1470 Maintenance Cleaning and Painting Steel Bridges - The cleaning and painting of existing steel bridges shall be done in accordance with Section 614 of the Standard Specifications and applicable plan and proposal notes.

63-08.1500 SIGNING, LIGHTING, SIGNALS

.1510 Permanent Signing - Signing Contracts shall be done in accordance with Section 715 of the Standard Specifications, the MUTCD, KYTC standard drawings, and the plans. All sign trusses, posts, panels, sheets, reflective material and messages should be thoroughly inspected prior to erection. All members should be verified for size, thickness, size of weld, proper galvanizing and etc. Mill Test reports will be approved by Project Engineer. Shop drawings must be submitted to the Division of Traffic for sign message and post details. The Division of Bridges reviews sign truss shop drawings.

The location of all signs should be checked by the Project Engineer when they are staked to ensure that the sign is clearly visible and that clear zone requirements are met. Standard beam supports that are set into concrete bases must be behind guardrail or beyond the clear zone from edge of pavement. The break-away beam supports are required for all signs that are unprotected by guardrail or barrier wall and within the clear zone. It is very important that all break-away components be

installed exactly according to the plans so that the sign will yield when impacted by a vehicle but will not yield from wind loads below the design wind speed. The correct bolt torque is critical to the break-away connection functioning correctly.

Signs that must be covered to prevent conveying the incorrect message must follow the manufacturer's recommendation for covering material. If signs must be covered a long time, then they should not be installed until near the time that the road is ready to be opened to traffic because many materials used to cover a sign will damage its reflectivity.

.1520 Lighting - Roadway lighting must be constructed in accordance to the plans and Section 716 of the Standard Specifications. Lighting projects require close coordination between the Division of Traffic, the District Traffic Engineer, the Project Engineer and the Contractor. **Any questions about pole placement, splicing, etc. should be answered with coordination from the Division of Traffic.**

The light standards or poles, break-away transformer bases, luminaries, control cabinet; conduit, fuse connections, photoelectric switches, junction boxes and etc. are approved by brochures, shop drawings or catalog cuts. Five sets of drawings etc. for the materials that the contractor proposes to use are submitted by the Project Engineer to Central Office Construction. The Division of Construction will submit as necessary to the Division of Traffic and/or Planning for approval. The Project Engineer is responsible to see that the materials installed are the same as approved. Section 834 of the Standard Specifications should be referred to for material requirements. The catalog and model numbers, power ratings, etc. should be closely checked for compliance. Generally, anchor bolts and connecting bolts are the only materials that require mill test reports for acceptance on lighting work. **The inspector should pay particular attention to the construction of concrete bases and ensure that the anchor bolt patterns match the transformer base bolt pattern.** The following is minimum inspectors check list.

1. Concrete pole bases - correct size, rebar cage, anchor bolt size and pattern, anchor bolt nuts all tight, projection above ground, anchor bolt test reports, leveling nuts if required, grouting between transformer base and concrete base if required, shims (if required) galvanized. **It is critical that ground rods be installed according to plan.**
2. Light Pole Standards - plumb, clean and unmarred finish, pole caps, correct height pole, and length of arm, correct wattage luminaire, pole arm and luminaire are the same model as approved; correct size fuse in fused connector in base, transformer base grounded, spare conduits are installed as indicated in the plans and notes, **and make sure that pole hardware is installed according to manufactures recommendations (for example, clevis hook is placed the appropriate distance from the winch in high**

mast poles).

3. Service Pole and Control Cabinet - Ensure correct size pole and cabinet, ground rod, lighting arrester, photoelectric switch, cabinet is aluminum or galvanized finish as required and good finish, no rusting of hardware, correct switches and controls in cabinet, circuits are numbered correctly, **all wires are identified with appropriate labeling**, project inspected by power company and state inspector of State Fire Marshall's Office.
4. Conduit, Wires, Trenching and Junction Boxes - The conduit, wires and junction boxes must be the size and type specified and approved. **All wire should be identified by labels at all locations the wire is visible, such as junction boxes, poles, and cabinets. Splicing should only be allowed at locations specified on the plans.** The trenches should be properly backfilled (pay particular attention to the size and type of backfill) to original ground elevation, graded and seeding restored.

.1530 Signalization - Traffic signalization projects require close coordination between the Division of Traffic, the District Traffic Engineer, the Project Engineer and the Contractor. **Any questions about pole placement, splicing, etc. should be answered with coordination from the Division of Traffic. Splicing should only be allowed at locations specified on the plans.** The contract will provide details for the number and location of signals, support poles, and traffic loop sensors and controllers.

The contractor will be required to submit 5 sets of catalog cuts and drawings for the materials that are proposed to be used to the Project Engineer for submission to Central Office Division of Construction who will pass along to the appropriate Division for approval. Section 835 of the Standard Specifications should be referred to for material requirements. The contractor must indicate which model of a particular product is proposed, because there are numerous models listed on submitted literature. The Project Engineer should verify that all materials provided are the ones that were approved for use.

The Project Engineer should be sure the vertical clearance to all signals meet the contract requirements and that all strain poles, control cabinets, hardware and etc. are rust proof and are the type required and unmarred. All wires should have drip loops as specified. Signal heads must be properly located and oriented to match approaching traffic alignment. Whenever possible, poles should be placed behind guardrail or beyond the clear zone from edge of pavement.

Please refer to the previous section on Lighting (.1520) for the inspectors minimum checklist for inspection for all items that apply.

The project must be inspected and approved by Central Office and District Traffic for conformance to the specifications, drawings, and plans. It should be properly dressed and restored before calling the job complete.

63-08.1600 Precast or Prefabrications Culverts

See Exhibits 63-8-57 and 64-8-58

.1610 Precast 3-Sided Culverts - These types of culverts have gained in popularity due to the ease and, more importantly, the speed of construction. This is especially evident in road closure situations. These culverts are cast generally in 8 ft sections and placed on strip concrete footings. These culverts are considered to be soil interactive meaning that the shape of the culvert, which tends toward an arch, allows the soil forces to place the walls in compression similarly to a dried laid stone arch.

Approved systems include: Con Span, Bebo, Hyspan, and Omega culverts. The Division of Material maintains a list of approved producers and facilities.

The project engineer should be aware that the Cabinet does not consider these types of structures as an equal alternate to cast-in-place culverts. It is true that precasting lends itself to higher quality of the product, but the assembled culvert has joints, lift holes, a potential for differential settlement and possibly different stream flow characteristics. If the contractor wishes to change out a cast-in-place culvert for a precast, he needs to negotiate with the project engineer the details (to include a reduction in price) for the change. Central Office, Division of Construction will have final approval.

The proposal or plans may have come from different Divisions of the Cabinet. As such pertinent information such as geotechnical or water flow may not be included. It is the contractor's responsibility to provide assurance to the Cabinet that the system will meet site conditions. In particularly, the Division of Highway Design will put out plans with a generic structure, giving the contractor the freedom to choose among several alternates, but what is chosen must meet site requirements.

Prior to the contractor submitting shop drawings, it is very important that the Project Engineer check existing site conditions, stream alignment, and existing roadway grades, *especially once the new structure is staked*, against the plans or proposal to determine if the new structure will be in general alignment with on site conditions. Several factors such as the age of the design plans/proposal, improper staking, new roadway repairs, stream scour, etc. can change the conditions anticipated by the designers and must be addressed, before work begins, by the Cabinet. Of primary importance are the stream or rock elevations *and* the roadway elevations. These culverts have a very definitive amount of fill height that must be met and the criteria for that height will very on the type of culvert. One of the more prevalent problems found is installing the culvert then finding that additional fill or cover is needed leading to costly grade adjustments.

Before excavating, a survey of the excavation site and examination of the plans

should be made for location of existing utilities by both the Contractor and the Project Engineer. Utility companies should be contacted to provide the Contractor with elevations and precise locations regarding their installations. The Project Engineer or Inspector should check to be sure the Contractor is aware of the "Before-You-Dig" (BUD) service and its advantages in location of underground utilities. Each utility company should be requested to furnish the Contractor elevation, location, and any other pertinent information they may have on utilities near the work.

Generally the contractor will begin work on the excavation (generally the LS of Foundation Prep) and placing the concrete strip footings while the producer works toward precasting and delivering the units. This makes it imperative that consideration is given to the timely delivery of submittals which should include: design, shop drawings, placement, backfill requirements, and a letter confirming existing site conditions meet system requirements. These will be reviewed and given approval by the Central Office Division of Construction who will distribute the approvals to the appropriate agencies.

The Division of Materials will conduct plant inspections during fabrication and provide feedback to the Division of Construction of fabricating problems and delivery times. The project inspector shall look for the appropriate KY Oval on all units delivered signifying acceptance material wise.

The units can be erected by the contractor generally in just a few hours. Thus it would be beneficial for all to work out the details of the placement to include: access for trucks, crane location, manipulation of units to an upright position, placement grade and alignment, and shimming of units. Project inspectors should inspect the units on the truck as they are delivered for cracks, spalls, chipped corners, and the KY Oval. Do not allow offload of a unit if a problem is found.

Once the culvert has been erected, the culverts joints shall be sealed per the manufactures specifications, the keyway where the unit rests shall be grouted with a non shrink grout, and all holes for erection or shipping be filled with grout.

No field modification of these culverts will be allowed to include cutting or drilling to accommodate misfits, utilities, or pipe drainage. This should have been planned for and detailed in the shop drawings.

Backfilling of the culvert should proceed per the requirements laid out in the approved drawings. Since this is a soil interaction structure, backfilling is very critical and generally proceeds with a well graded material in equal lifts on either side of the structure. The contractor generally will use stone instead of soil in that fill requirements are easier to achieve. The Cabinet may stipulate stone or even flowable fill as an assurance against future settlement over the structure. Do not allow equipment to cross the culvert until the fill over the culvert has been placed. The culvert is not designed to resist loading without adequate backfill.

Miscellaneous work, such as weep holes, erosion control, etc. should be completed per specifications and other criteria of this manual.

.1620 Metal Arch Culverts - These types of culverts have gained in popularity due to the ease and, more importantly, the speed of construction similar to the 3-Sided Precast culvers. These culverts are furnished as either aluminum or steel plate and may include a concrete flow line or an asphalt coating. These culverts are considered to be soil interactive meaning that the shape of the culvert, which tends toward an arch, allows the soil forces to place the walls in compression similarly to a corrugated pipe.

Special Note 9V – for Aluminum and Steel Structural Plate Box Culvert applies.

Approved systems include: Contech Construction Products and Lane Metal Company. The Division of Material maintains a list of approved producers and facilities.

The proposal or plans may have come from different Divisions of the Cabinet. As such pertinent information such as geotechnical or water flow may not be included. It is the contractor's responsibility to provide assurance to the Cabinet that the system will meet site conditions.

Prior to the contractor submitting shop drawings, it is very important that the Project Engineer check existing site conditions, stream alignment, and existing roadway grades, *especially once the new structure is staked*, against the plans or proposal to determine if the new structure will be in general alignment with on site conditions. Several factors such as the age of the design plans/proposal, improper staking, new roadway repairs, stream scour, etc. can change the conditions anticipated by the designers and must be addressed, before work begins, by the Cabinet. Of primary importance are the stream or rock elevations *and* the roadway elevations. These culverts have a very definitive amount of fill height that must be met and the criteria for that height will very on the type of culvert. One of the more prevalent problems found is installing the culvert then finding that additional fill or cover is needed leading to costly grade adjustments.

Before excavating, a survey of the excavation site and examination of the plans should be made for location of existing utilities by both the Contractor and the Project Engineer. Utility companies should be contacted to provide the Contractor with elevations and precise locations regarding their installations. The Project Engineer or Inspector should check to be sure the Contractor is aware of the "Before-You-Dig" (BUD) service and its advantages in location of underground utilities. Each utility company should be requested to furnish the Contractor elevation, location, and any other pertinent information they may have on utilities near the work.

Generally the contractor will begin work on the excavation (generally the LS of Foundation Prep) and placing bedding while the producer works toward fabricating and delivery. This makes it imperative that consideration is given to the timely delivery of submittals which should include: design, shop drawings, placement, backfill requirements, and a letter confirming existing site conditions meet system requirements. These will be reviewed and given approval by the Central Office Division of Construction who will distribute the approvals to the appropriate agencies.

The sections can be assembled and erected by the contractor generally in just a few hours. Thus it would be beneficial for all to work out the details of the placement to include: lifting supports, crane location, and placement grade and alignment.

No field modification of these culverts will be allowed to include cutting or drilling to accommodate misfits, utilities, or pipe drainage. This should have been planned for and detailed in the shop drawings.

Backfilling of the culvert should proceed per the requirements laid out in the approved drawings. Since this is a soil interaction structure, backfilling is very critical and generally proceeds with a well graded material in equal lifts on either side of the structure. The contractor generally will use stone instead of soil in that fill requirements are easier to achieve. The Cabinet may stipulate stone or even flowable fill as an assurance against future settlement over the structure. Do not allow equipment to cross the culvert until the fill over the culvert has been placed. The culvert is not designed to resist loading without adequate backfill.

Miscellaneous work, such as stone for outlets, erosion control, etc. should be completed per specifications and other criteria of this manual.

CHAPTER EIGHT

Note: Due to the nature of working with pdf files, exhibits have been edited to conform to current construction practices by white-out and marking up pertinent information. Specification references removed to eliminate any confusion between exhibits and the Specification Manual.

TITLE		EXHIBIT NUMBER
Structure Excavation Exhibits		
Bridges		63-8-4
Culverts		63-8-5
Retaining Walls and Crib Walls		63-8-6
Pipe		63-8-7
Cofferdam Exhibit		63-8-8
Piling Exhibits		
Record of Test Pile (TC 63-22E)		63-8-10
Record of Piles Furnished and Driven (TC 63-8E)		63-8-11
Welded Reinforcement Pile Splice		63-8-13
Steel Piling Driven Below Cutoff		63-8-14
Pile Acceptance – Mill Test Reports		63-8-15
Estimate Table for Battered Pile Lengths		63-8-16
Data on Pile Drivers and Extractors:	Air/Steam Hammers	63-8-17
	Diesel Hammers	63-8-18
	Impact & Vibrator Pile Drive/Extractors	63-8-19
	Typical Augur Drilling Operation	63-8-20
	Updated Pile Driver Types (1/07)	63-8-21
Manufacturer's Data:	Kobe Diesel Pile Hammer	63-8-25
	Mkt	63-8-26
	Ice	63-8-27
	Vulcan	63-8-28
Falsework		
Stay-In-Place Metal Forms		63-8-29
Typical Overhang Installation/Calculations		63-8-30
Dayton Superior Data		63-8-31

Other Exhibits

Fabrication Construction Memo 63-8-32

Concrete Mixer Approval Sticker 63-8-34
Concrete Mix – "Rules of Thumb" 63-8-35

Reinforcing Steel Identification Marks 63-8-37

Inspection Guidelines for Epoxy Coated Reinforcing Steel 63-8-38

Rotational Capacity Testing 63-8-39

Temperature Adjustments – Bridge Rockers 63-8-40

Welding Exhibits

Definition of Welding Positions/Symbols/Definitions 63-8-41
Examples/Criteria 63-8-42
Nondestructive Testing 63-8-43

More Other Exhibits

Emergency Construction Joints 63-8-45

Bridge Deck Overlay Exhibits

Cement Concrete Overlay – Sequence of Events 63-8-47
Concrete Mobile – Check List 63-8-48
Instructions for Taking Densities 63-8-49
Computing Theoretical Absolute Volume 63-8-50
Chart No. 1 – Target Density 63-8-51
Thin Lift Overlay Nomograph 63-8-52
Water Cement Ratio - Cement Concrete 63-8-53
Water Cement Ratio – Latex Concrete 63-8-54
Design Data Form – Concrete Mobile 63-8-55

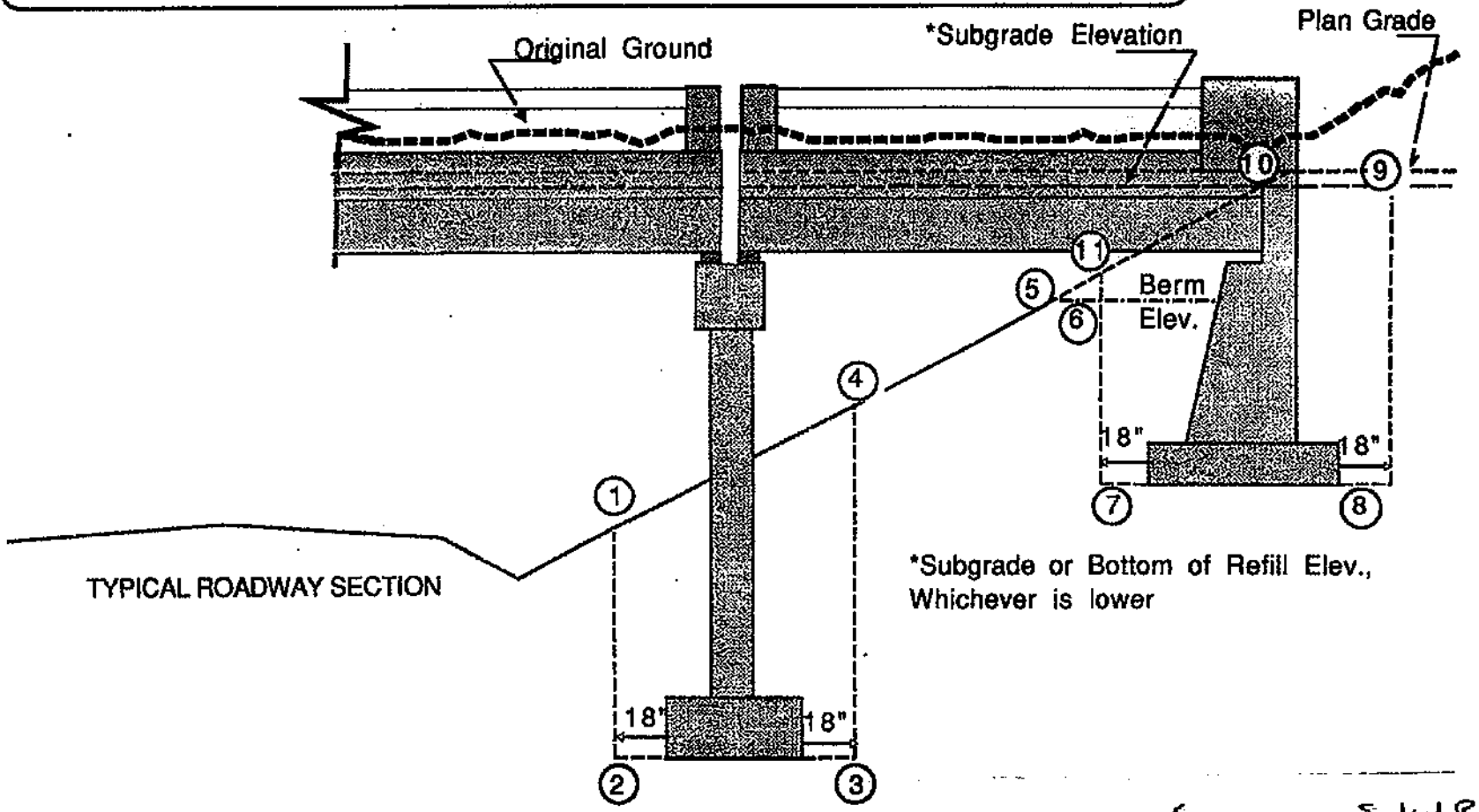
More and More other Exhibits

Daily Inspectors Report for Bridge Painting 63-8-56

Precast 3-Sided Culvert 63-8-57

Metal Arch Culvert 63-8-58

BRIDGE EXCAVATION INVOLVING CONSTRUCTION OF A ROAD UNDER OR OVER ANOTHER ROAD



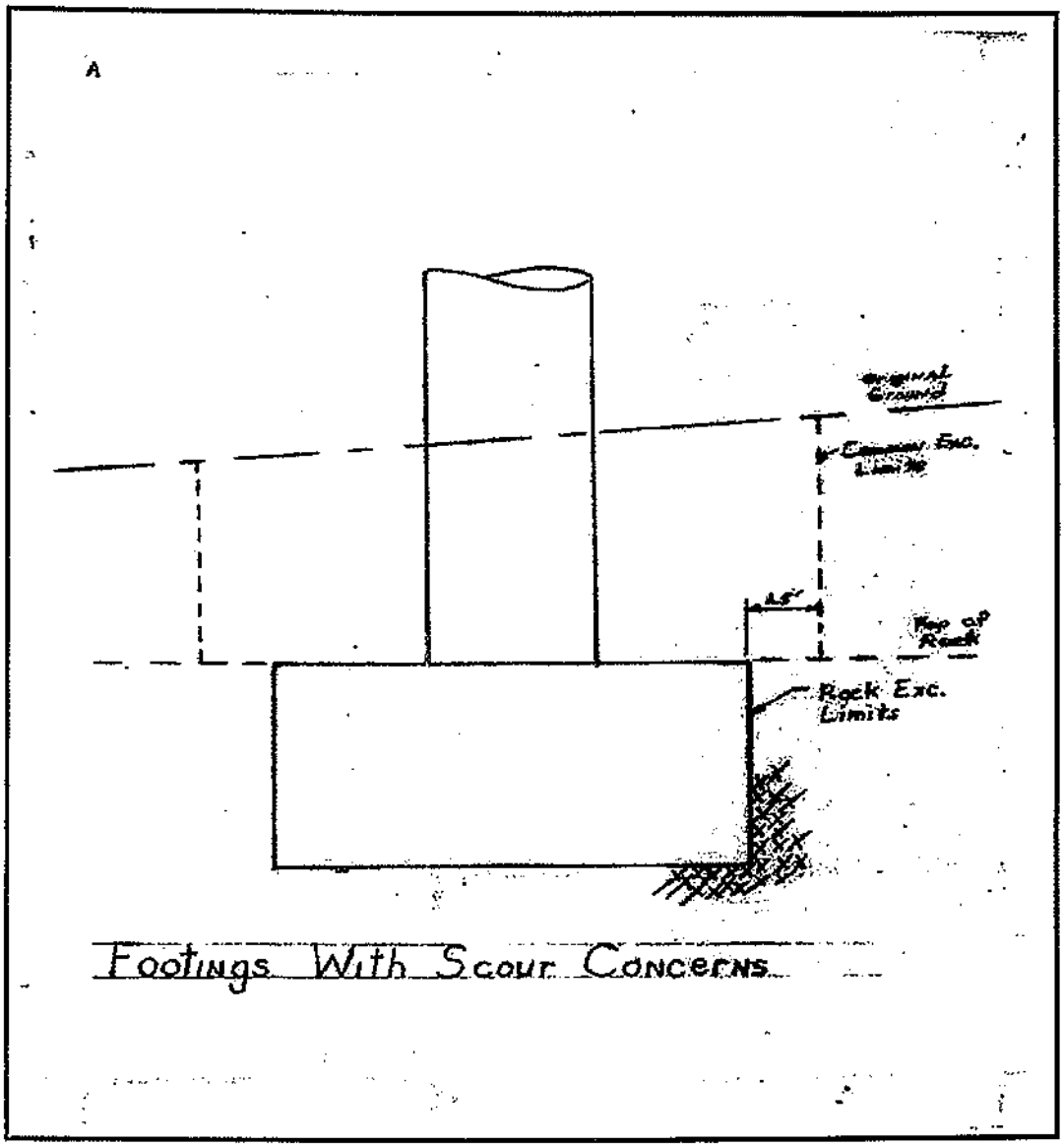
18" = Max. Limits of Structure Exc., ~~SECT. 206.10~~ Common or Solid Rock

REFERENCE TABLE

LOCATION	CLASSIFICATION
1,4,5,6,11,10,9	Roadway & Drainage Exc.
6,7,8,9,10,11	**Structure Exc.
1,2,3,4	**Structure Exc.

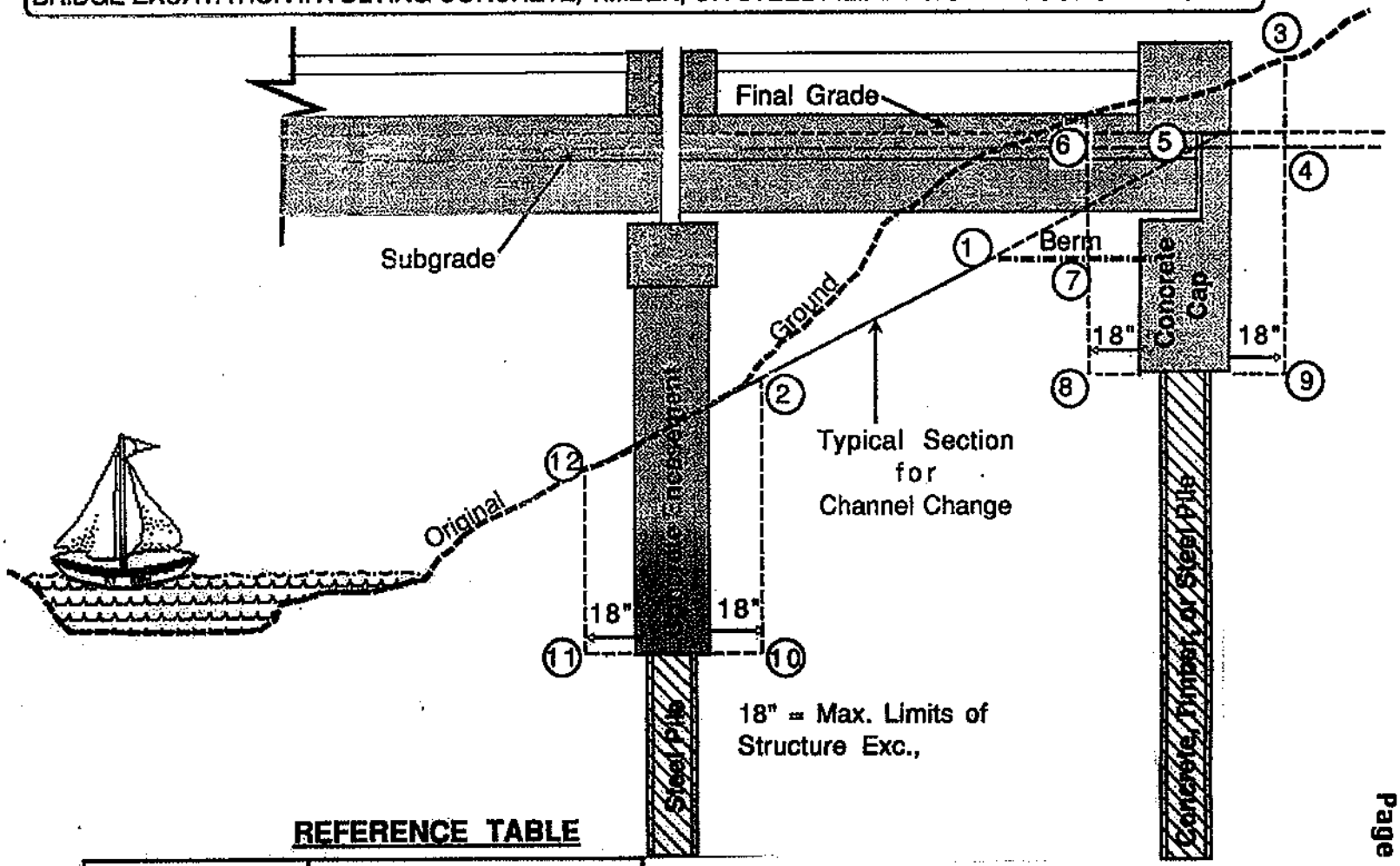
EXHIBIT 63-8-4
Page 1 of 9

BRIDGE EXCAVATION INVOLVING SCOUR CONCERNS



When the plans require, excavate footing to the full limits of the plan dimensions. Then the concrete should be placed against the rock face. This seals the concrete/rock interface reducing scour. When this is required, the payment of structural excavation – solid rock is to the neat limits of the plan footing.

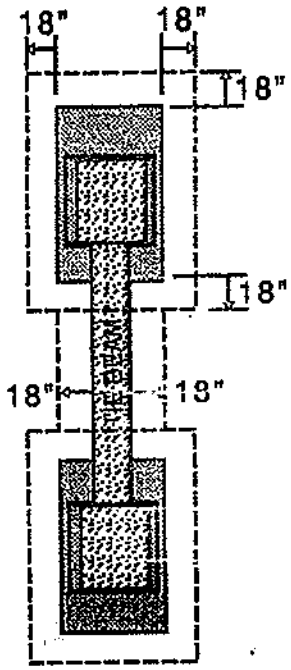
BRIDGE EXCAVATION INVOLVING CONCRETE, TIMBER, OR STEEL PILE BENTS WITH CONCRETE CAPS



REFERENCE TABLE

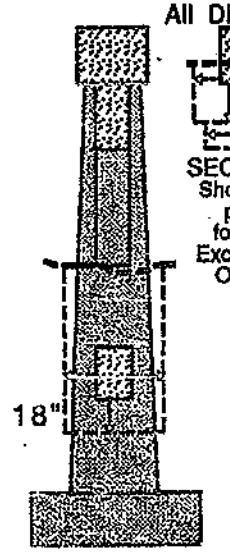
LOCATION	CLASSIFICATION
1,2,3,4,5,6,7	Roadway & Drainage Exc.
4,5,6,7,8,9	*Structure Exc.
2,10,11,12	No Direct Payment

BRIDGE EXCAVATION INVOLVING WEBWALLS, TIE BEAMS, STRUTS, OVERHANGS, & FOUNDATION REVISIONS



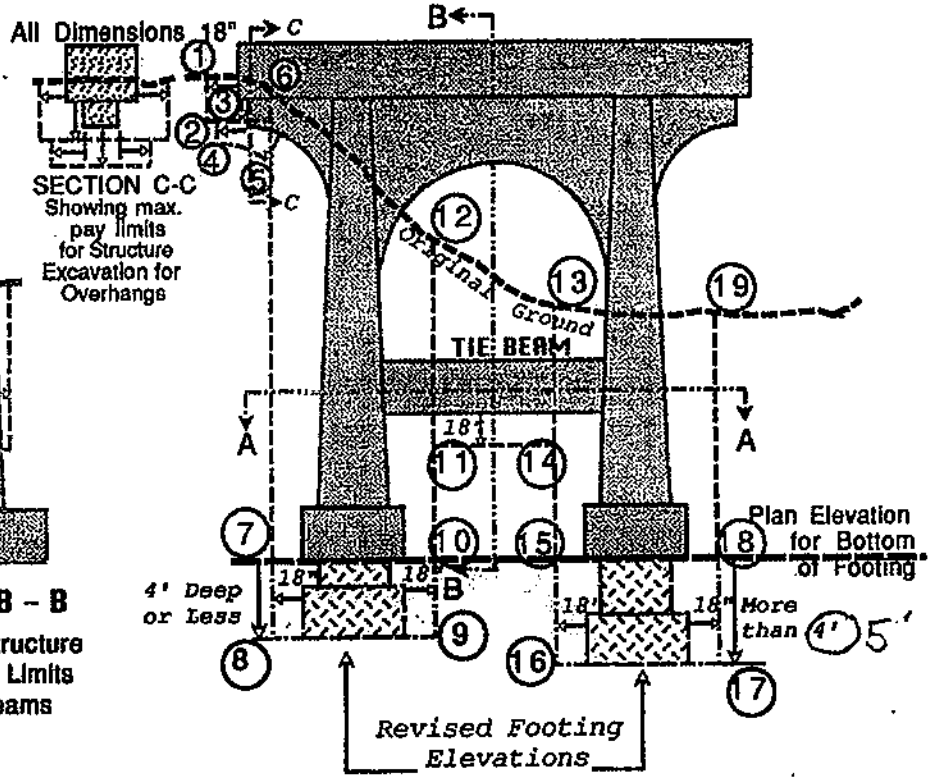
SECTION A – A

Showing Maximum Pay Limits for Structure Excavation for Tie Beams, Web Walls, etc. and Column Footings



SECTION B – B

Showing Structure Excavation Limits for Tie Beams



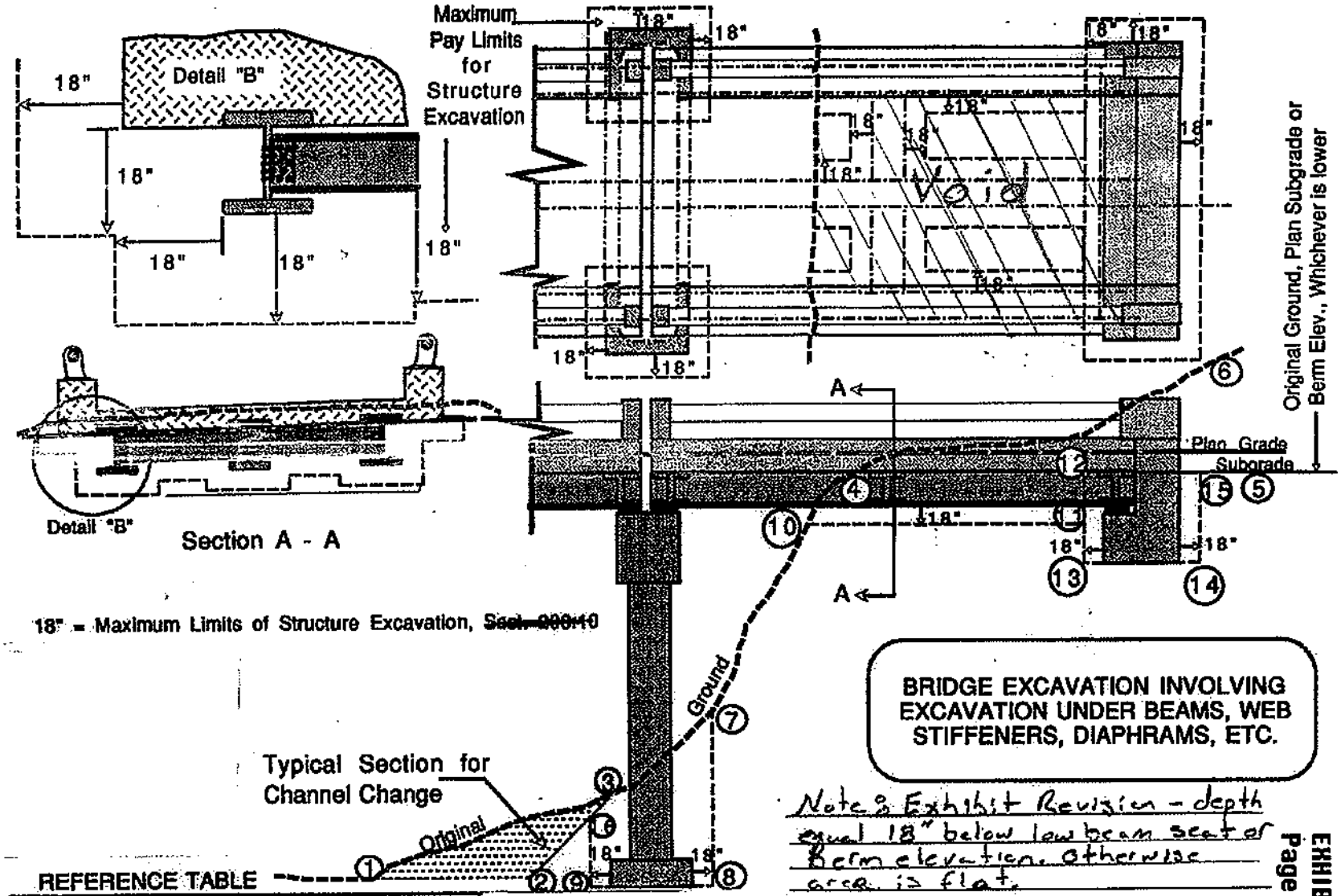
18" = Maximum Limits of Structure Excavation, ~~Sect. 200.10~~

REFERENCE TABLE

LOCATION	CLASSIFICATION
1,2,3,4,5,6	*Structure Excavation
6,7,8 9,10,11,12	*Structure Excavation
11,12,13,14	*Structure Excavation
13,14,15,18,19	*Structure Excavation
15,16,17,18	Supplemental Agreement

*SOLID ROCK OR COMMON STRUCTURE EXCAVATION, ~~Sect. 200.08~~

EXHIBIT 63-8-4
Page 3 of 9



BRIDGE EXCAVATION INVOLVING EXCAVATION UNDER BEAMS, WEB STIFFENERS, DIAPHRAMS, ETC.

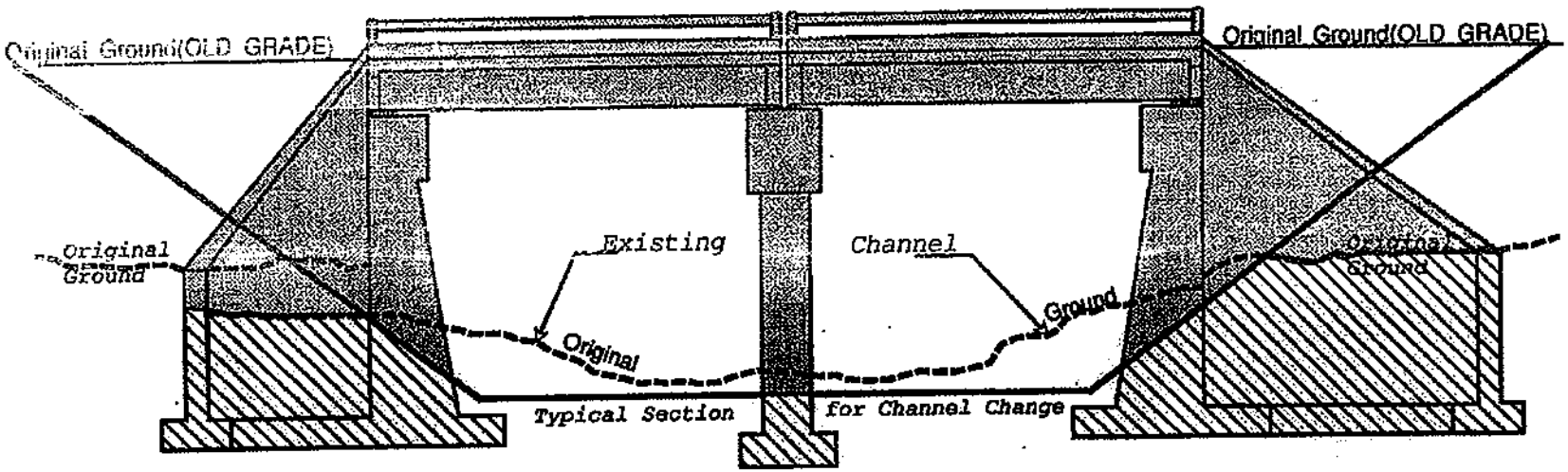
Note: Exhibit Revision - depth equal 18" below low beam seat or Berm elevation. otherwise area is flat.

REFERENCE TABLE

LOCATION	CLASSIFICATION
1, 2, 3	Roadway & Drainage Exc.
4, 5, 6	Roadway & Drainage Exc.
3, 16, 9, 8, 7	*Structure Excavation
4, 10, 11, 12	*Structure Excavation
12, 13, 14, 15	*Structure Excavation

*SOLID ROCK OR COMMON STRUCTURE EXCAVATION,

REMOVAL OF EXISTING STRUCTURE(BRIDGE) INVOLVING CHANNEL CHANGE



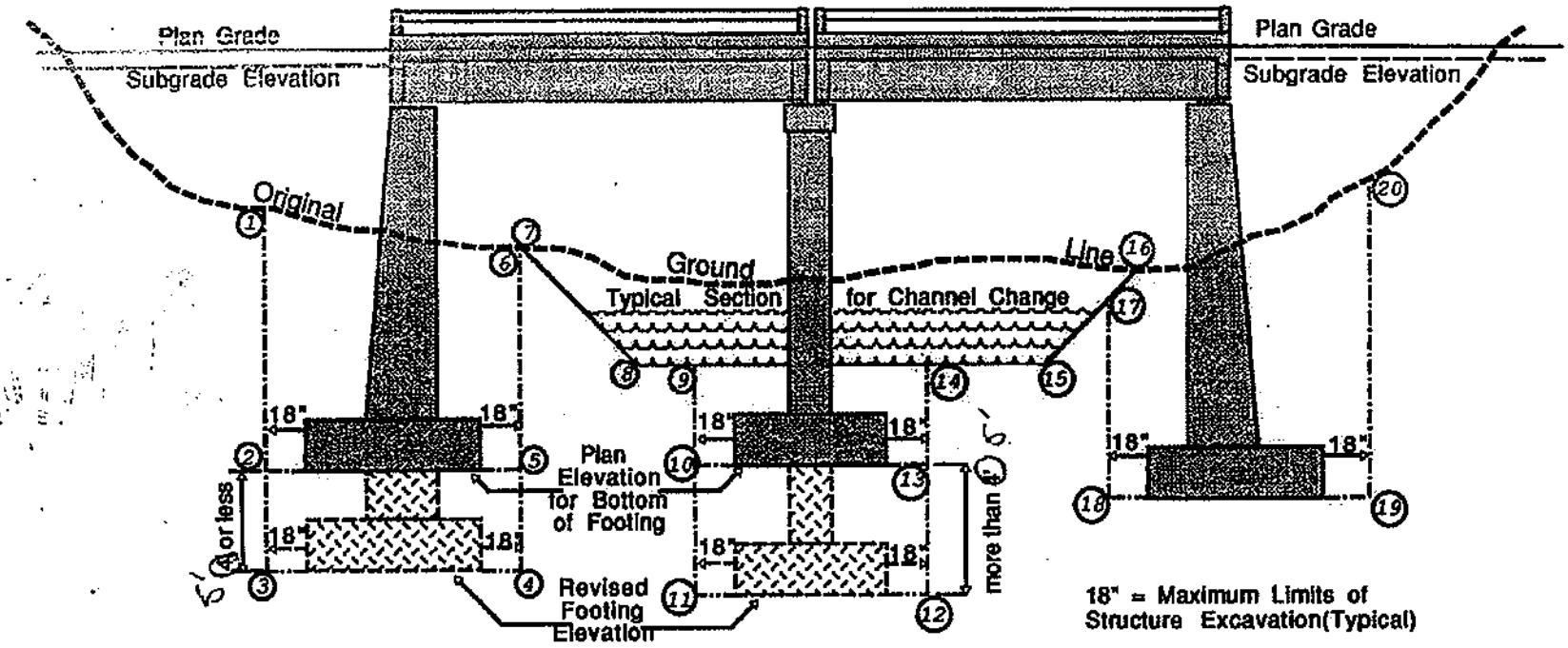
LEGEND

Remove Existing Structure, Section 203.[illegible] of the Standard Specifications ~~when removal of entire structure or removal of footings is specified.~~

Typical section of channel change before channel lining is placed

Note: Exhibit revision – Remove entire structure to include footings except as noted in plans.

BRIDGE EXCAVATION INVOLVING CHANNEL CHANGE AND FOUNDATION REVISIONS



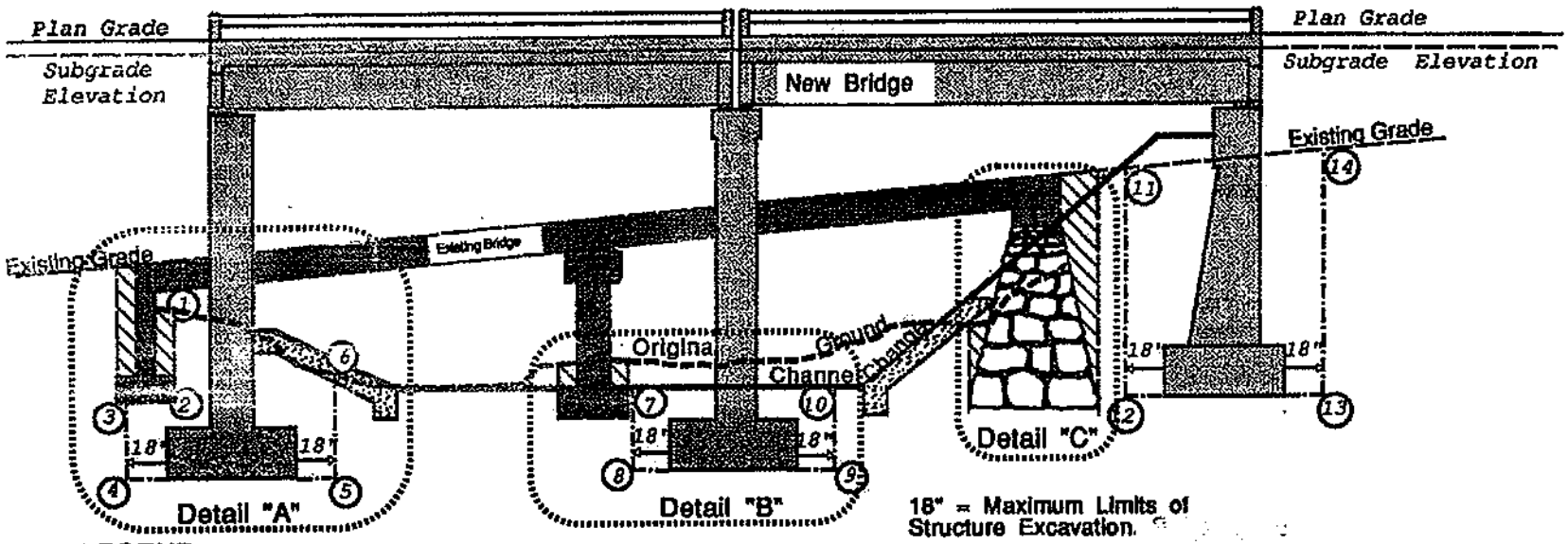
REFERENCE TABLE

LOCATION	CLASSIFICATION
1,2,5,6	*Structure Excavation
9,10,13,14	*Structure Excavation
18,17,18,19,20	*Structure Excavation
2,3, 4, 5	*Structure Excavation
10,11,12,13	Supplemental Agreement
7,8,15,16	Roadway Excavation

*SOLID ROCK or COMMON STRUCTURE EXCAVATION, [illegible]

EXHIBIT 63-8-4
Page 6 of 9

BRIDGE EXCAVATION INVOLVING REMOVING EXISTING BRIDGE, CHANNEL IMPROVEMENT & EROSION CONTROL



18" = Maximum Limits of Structure Excavation.

LEGEND

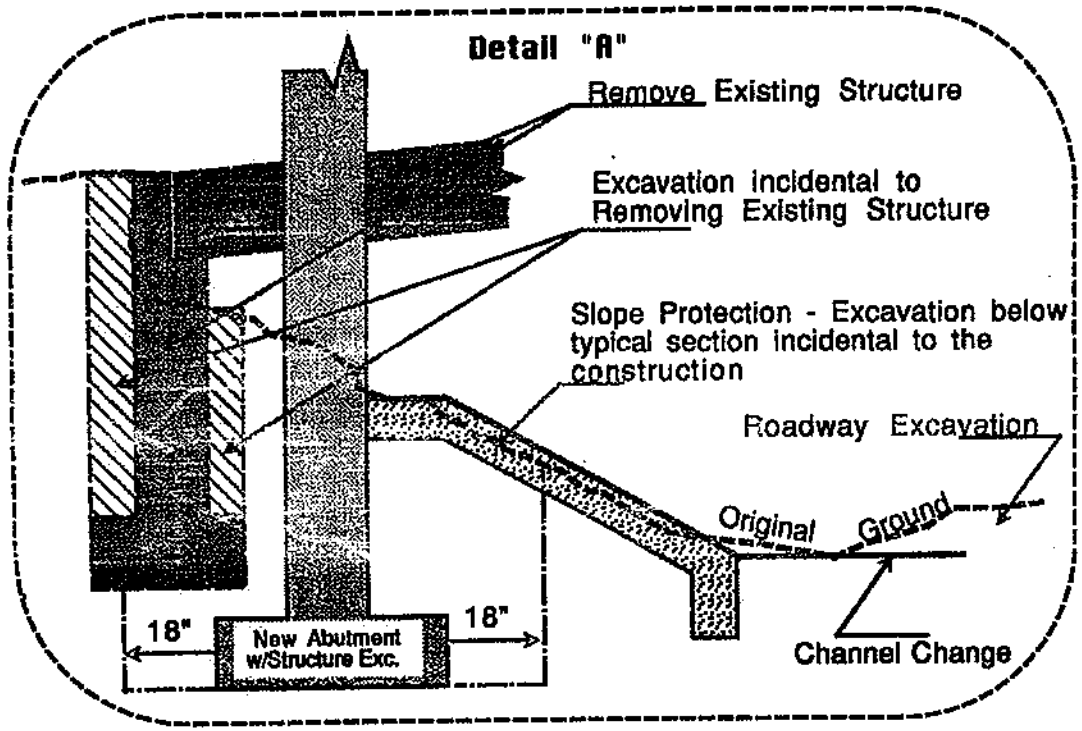
- New Bridge
- Remove Existing Structure,
- Excavation incidental to "Remove Existing Structure",
- Rip-Rap, Excavation incidental to the construction,
- Typical Section for Channel Change, Roadway Excavation,

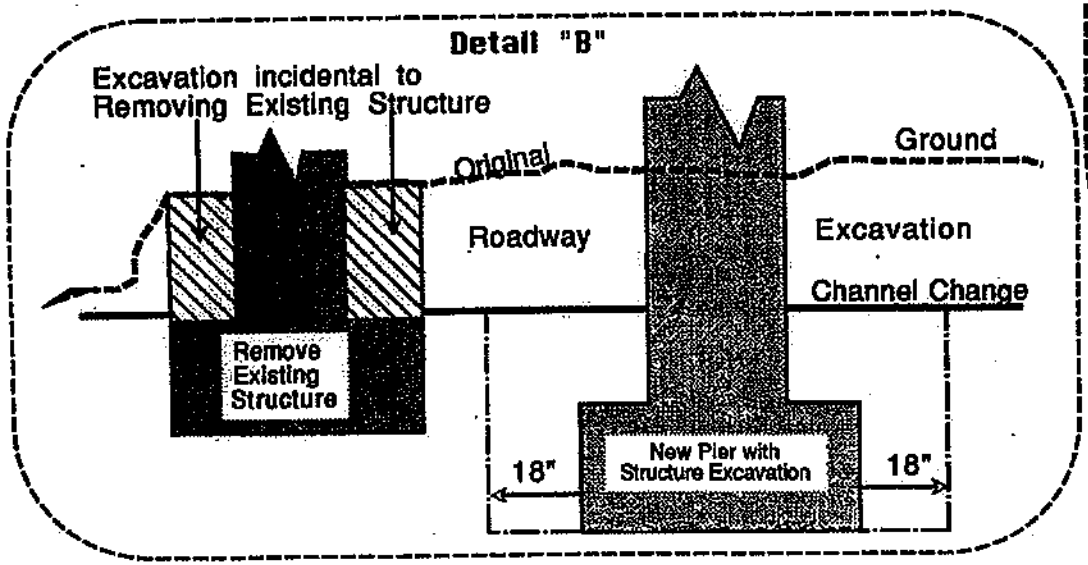
See Page 7a(next page) for Details "A", "B" & "C"

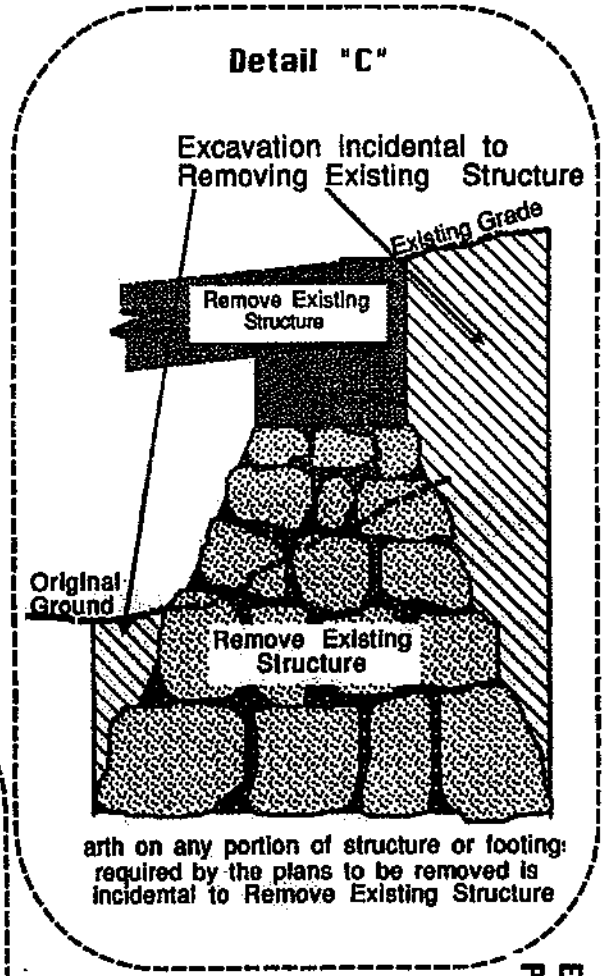
REFERENCE TABLE

LOCATION	CLASSIFICATION
1,2,3,4,5,6	*Structure Excavation
7,8,9,10	*Structure Excavation
11,12,13,14	*Structure Excavation

*SOLID ROCK or COMMON STRUCTURE EXCAVATION, ~~SBOT-200.03~~

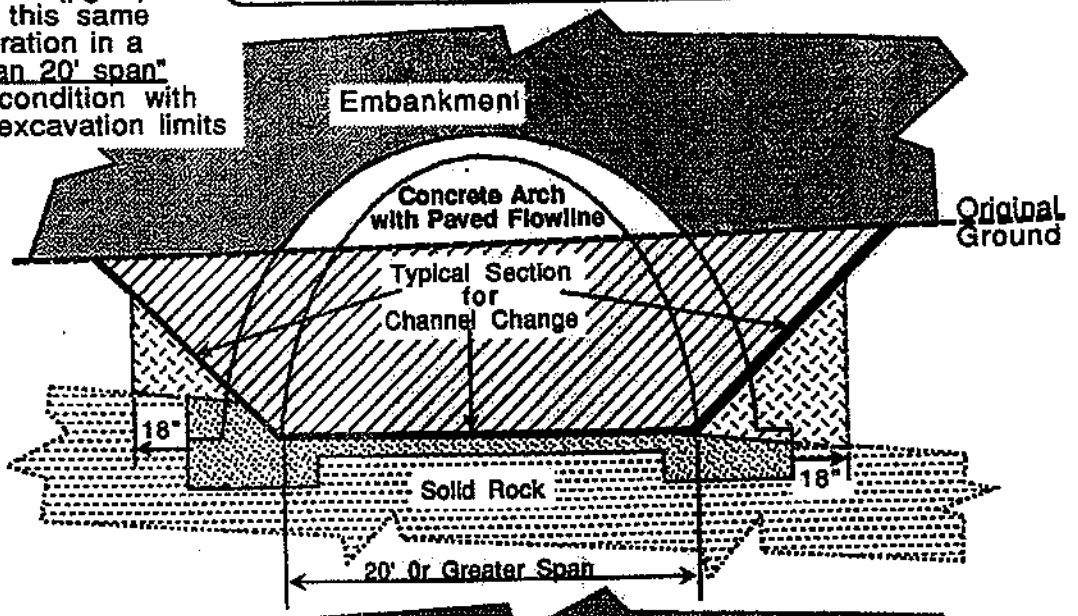

Detail "A"
Remove Existing Structure
Excavation incidental to Removing Existing Structure
Slope Protection - Excavation below typical section incidental to the construction
Roadway Excavation
Original Ground
Channel Change
18"
New Abutment w/Structure Exc.
18"

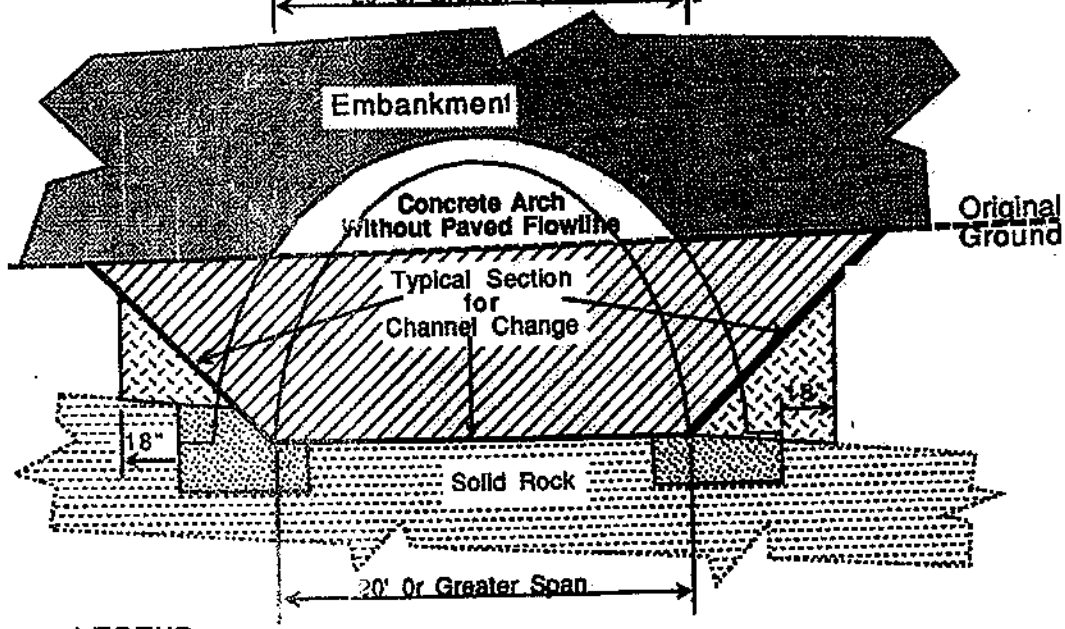

Detail "B"
Excavation incidental to Removing Existing Structure
Original
Ground
Roadway
Excavation
Channel Change
Remove Existing Structure
18"
New Pier with Structure Excavation
18"


Detail "C"
Excavation incidental to Removing Existing Structure
Existing Grade
Remove Existing Structure
Original Ground
Remove Existing Structure
arth on any portion of structure or footing required by the plans to be removed is incidental to Remove Existing Structure

BRIDGE EXCAVATION INVOLVING ARCH FOOTINGS KEYED INTO SOLID ROCK

NOTE: Exhibit No. 63-8-5(pg. 1) shows this same configuration in a "less than 20' span" (Culvert) condition with applicable excavation limits





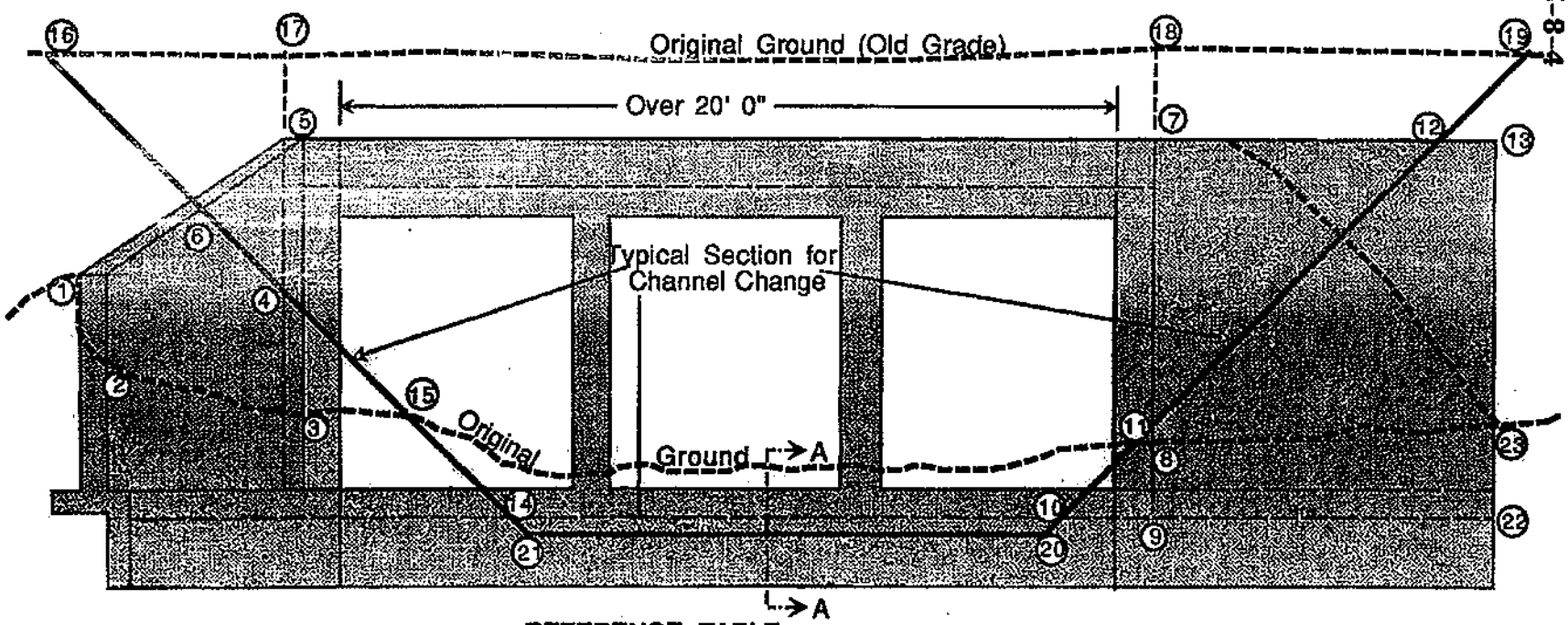
LEGEND

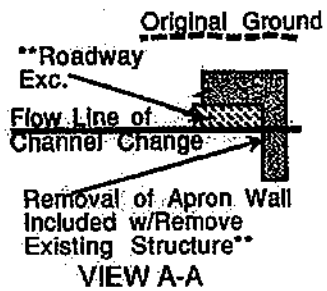
- Embankment
- Solid Rock
- Roadway Excavation.
- Structure Excavation, Common.
- Structure Excavation, Solid Rock.

18" = Maximum Limits of Structure Excavation.

NOTE: (1) Excavation of solid rock outside of neatline of footing of arch shall be avoided
(2) If no channel change, i.e. Roadway Exc., is involved, the area shown as Roadway Exc. shall be paid as the appropriate Structure Excavation. See Exhibit 63-8-5, pg. 1 for an example of this method.
(3) Excavation may also be paid as Foundation Prep

REMOVAL OF EXISTING STRUCTURE (ARCH OR LARGE CULVERT) CLASSIFIED AS A BRIDGE





VIEW A-A

REFERENCE TABLE

LOCATION	CLASSIFICATION
1,2,3 ,5 *	Remove Existing Structure
7,8,23,13 *	Remove Existing Structure
4,17,18,9,14	Remove Existing Structure
10,14,21,20 **	Remove Existing Structure
4,16,17	Roadway Excavation
9,10,19,18	Roadway Excavation
10,14,21,20 **	Roadway Excavation

May also be paid as Foundation Prep

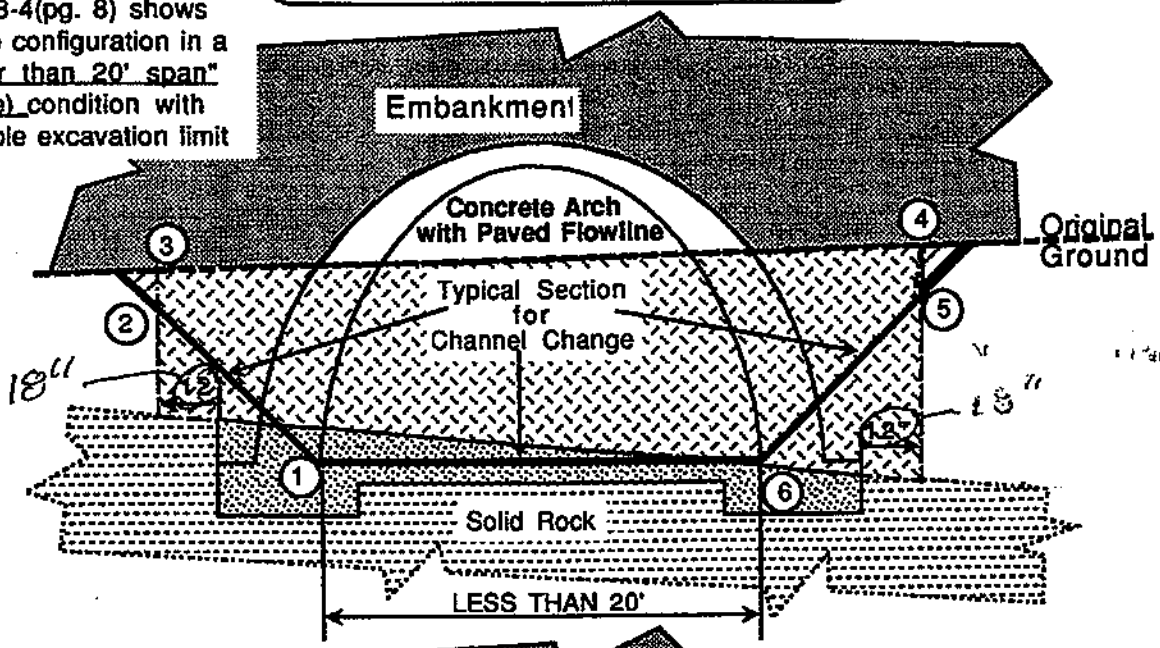
Section for wings or attached retaining walls

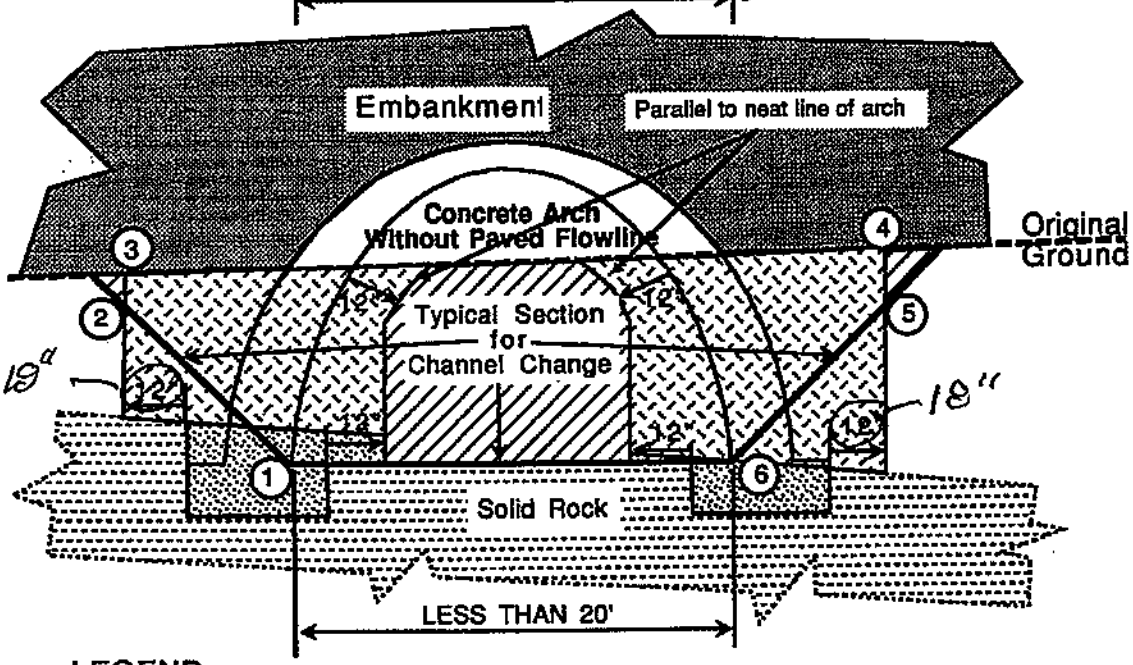
*Section is included in Removal of Existing Structure through apron wall, Channel Exc. included in Roadway Excavation elsewhere

EXHIBIT NO. 63-8-4
PAGE 9 of 9

CULVERT EXCAVATION INVOLVING ARCH FOOTINGS KEYED INTO SOLID ROCK

NOTE: Exhibit No. 63-8-4(pg. 8) shows this same configuration in a "greater than 20' span" (Bridge) condition with applicable excavation limit





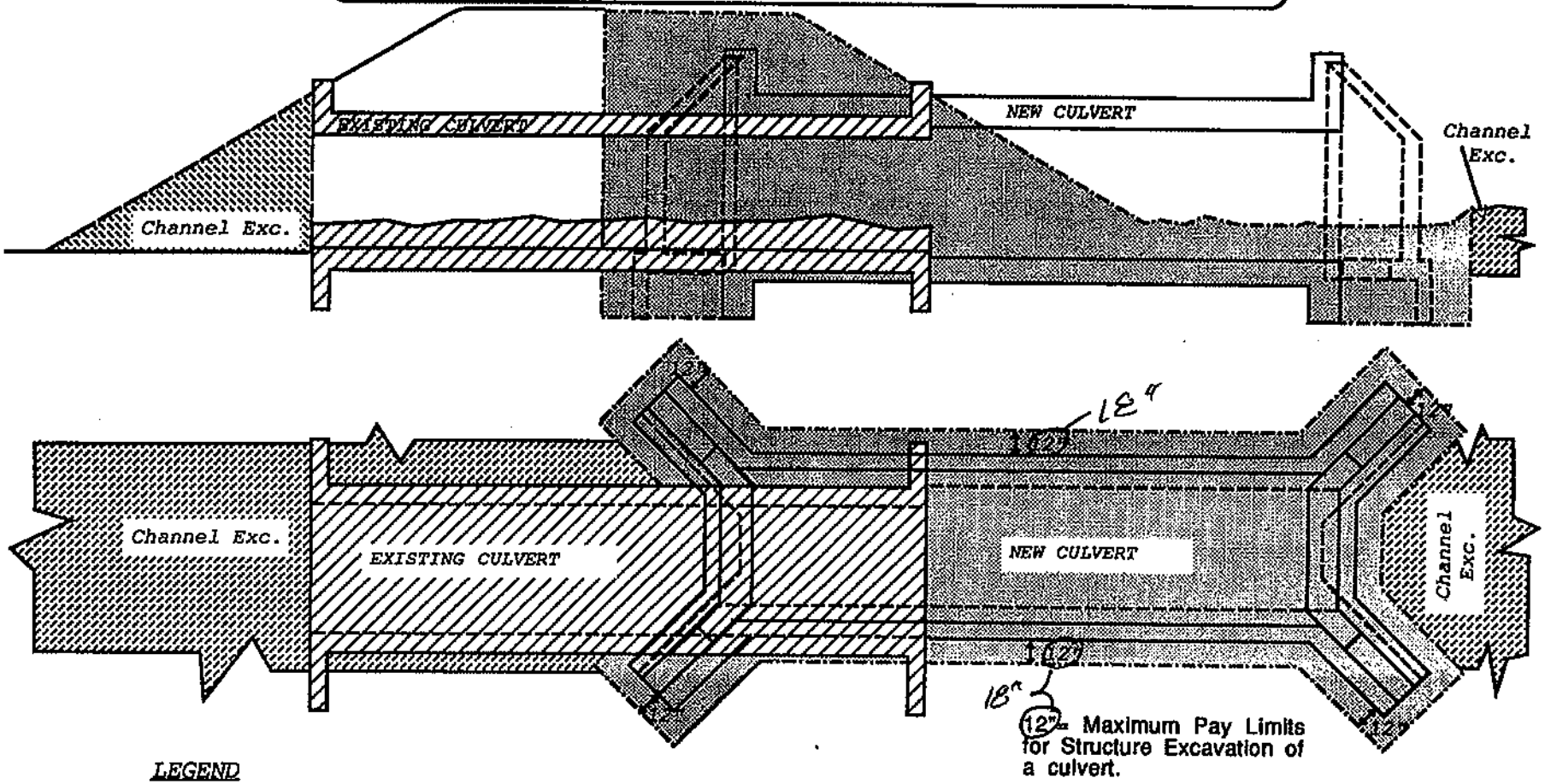
LEGEND

- Embankment
- Roadway Excavation,
- Structure Excavation, Common,
- Structure Excavation, Solid Rock,
- Solid Rock

NOTE: The area bounded by the points 1, 2, 3, 4, 5, & 6 will be calculated as "Roadway Excavation" when the finished cross section governs per Spec. 206.10.01. In the event plans designate that "Structure Excavation" takes precedence over Roadway Excavation, the areas designated by the "LEGEND" will govern.

Note: Payment may also be as Foundation Prep - LS

CULVERT EXCAVATION INVOLVING REMOVING EXISTING CULVERT AS *INCIDENTAL ITEM



LEGEND

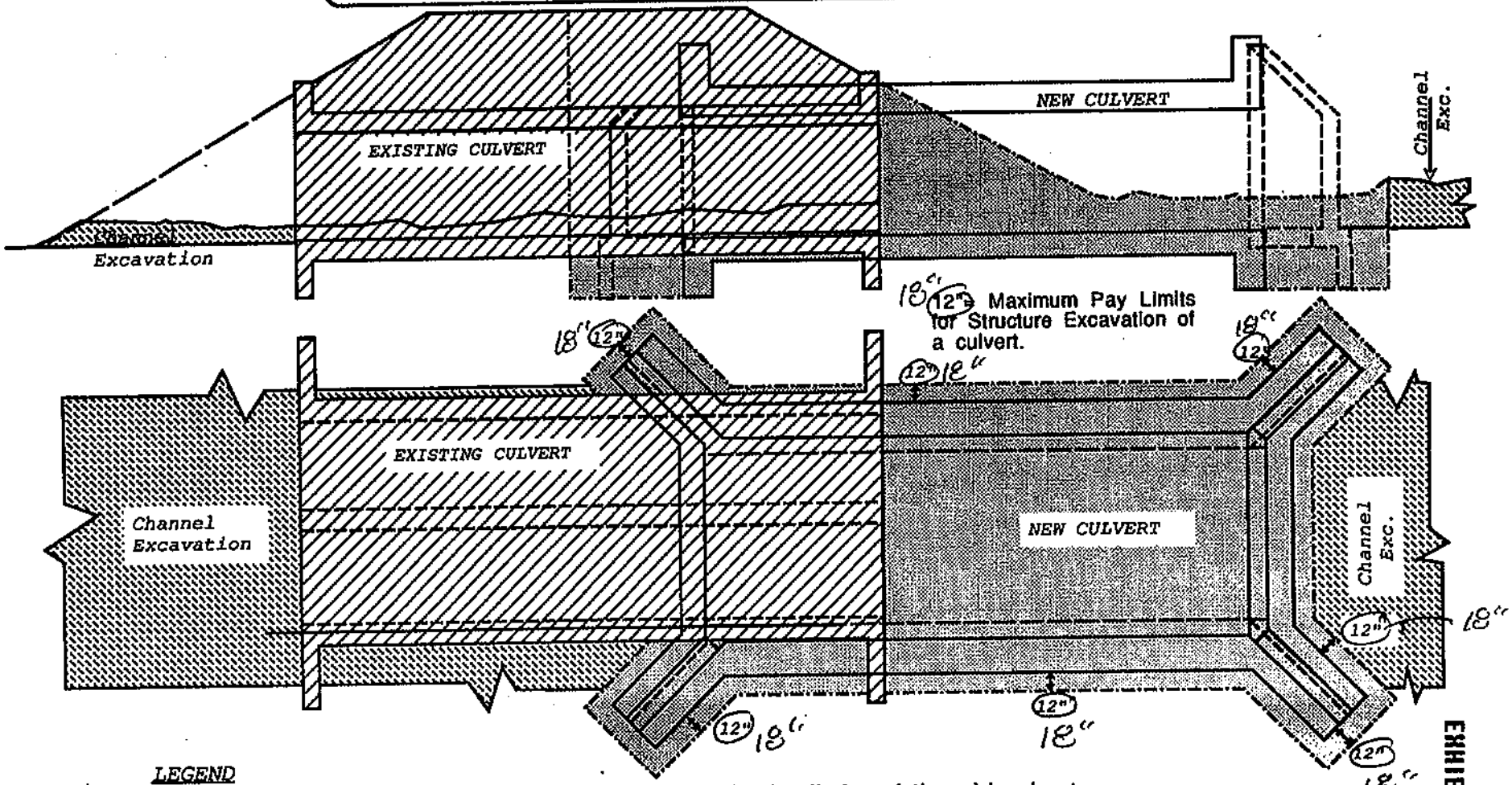
- Roadway Excavation- May extend outside the limits of the old culvert to construct new channel and slopes.,
- No Pay Item, Incidental to the contract unless included as a bid item in the proposal - Includes excavation over culvert and in barrel.
- Common or Solid Rock Structure Excavation -

*Incidental is defined as being specified as such in the contract or as not being shown as a pay item,

Note: Payment may also be as Foundation Prep - LS

EXHIBIT NO. 63-8-5
Page 2 of 6

CULVERT EXCAVATION INVOLVING REMOVAL OF EXISTING CULVERT PAID AS A LUMP SUM



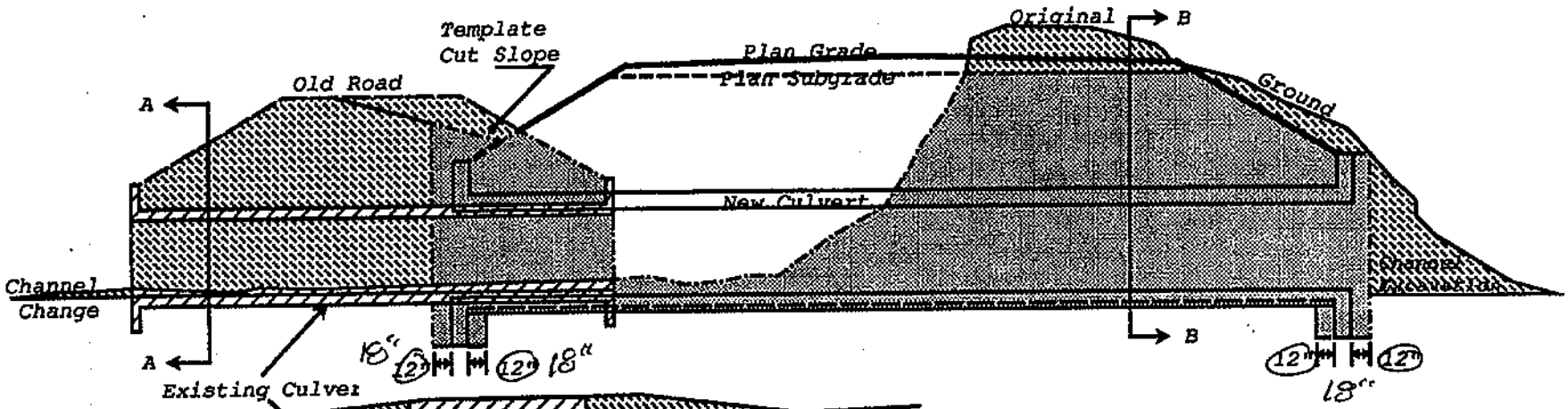
LEGEND

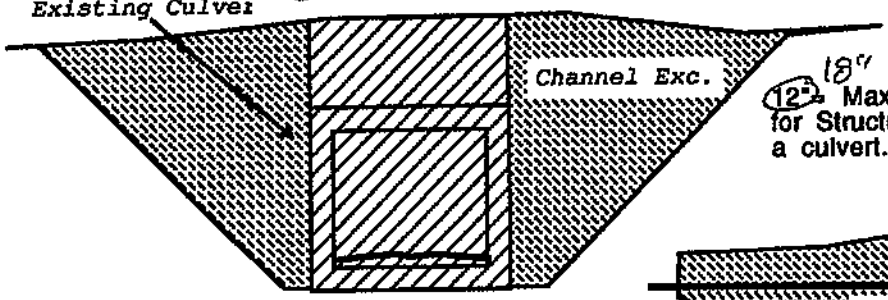
- Roadway Excavation- May extend outside the limits of the old culvert to construct new channel and slopes,
- Remove Existing Structure, Includes excavation over culvert and in barrel.
- Commor or Solid Rock Structure Excavation -

Note: May also be paid as Foundation Prep - LS

EXHIBIT NO. 63-8-5
Page 3 of 6

CULVERT EXCAVATION INVOLVING CUT TEMPLATE CHANNEL EXC. AND INCIDENTAL REMOVAL OF EXISTING STRUCTURE

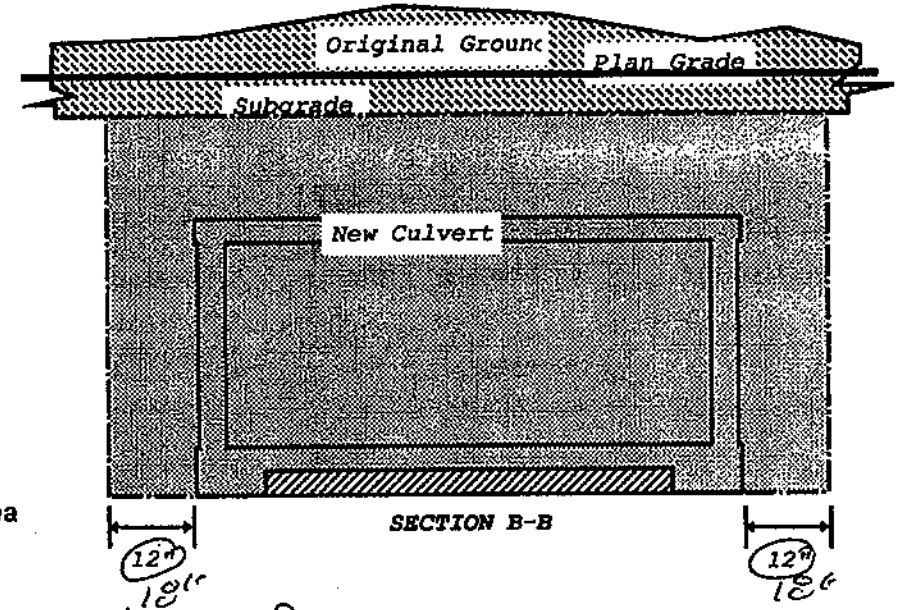




SECTION A-A

18"
12" Maximum Pay Limits for Structure Excavation of a culvert.

NOTE: To calculate Structure Excavation using the Metric System, use 300 millimeters(mm)(or .3 meters(M)) in lieu of 12".



SECTION B-B

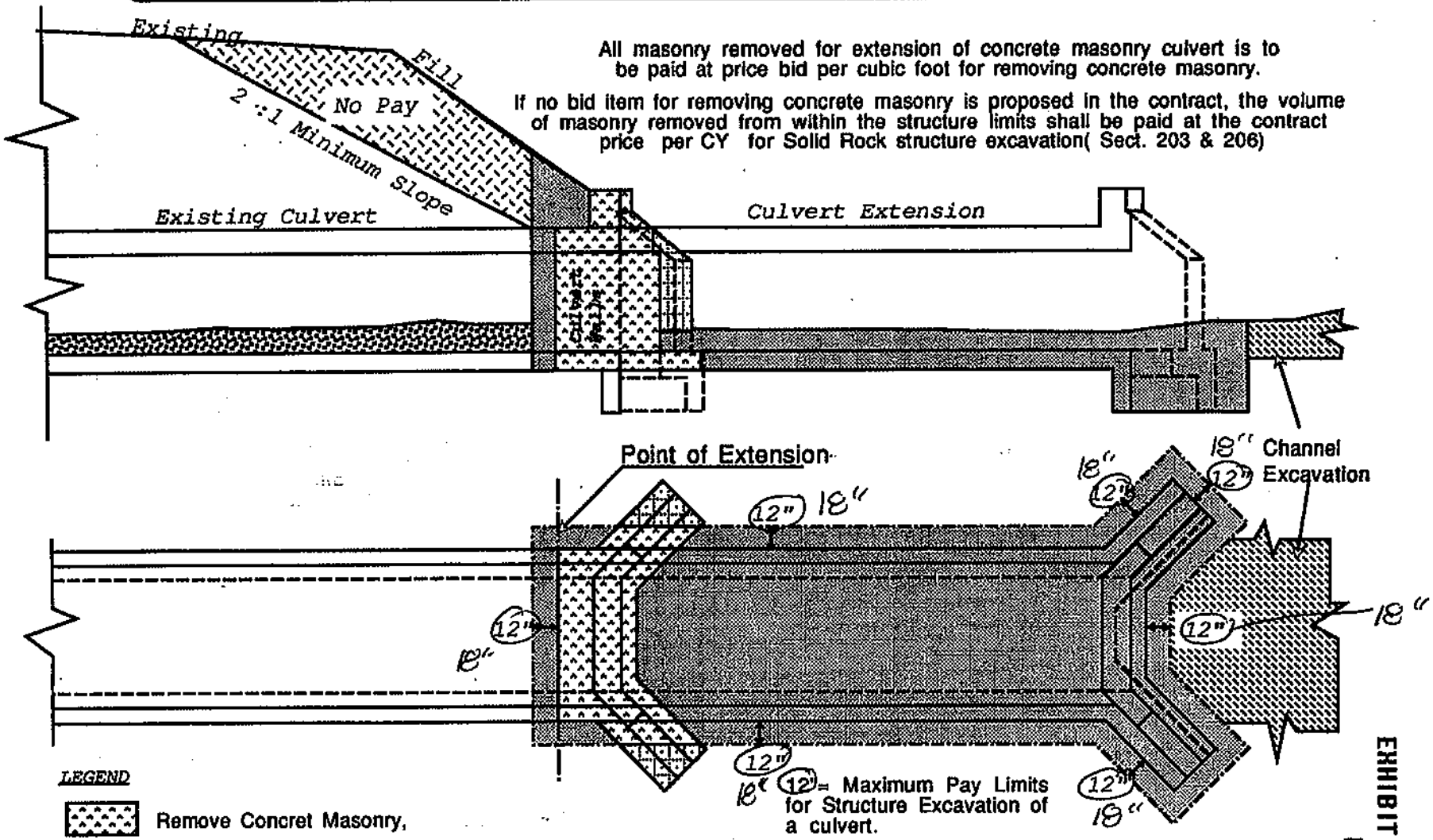
LEGEND

- Roadway Excavation, Std.
- Common or Solid Rock Structure Excavation
- Removal Incidental,
- When designed for solid rock footings, this area should not be excavated. This area does not qualify for pay.

Note: Payment may also be as Foundation Prep - LS

EXHIBIT NO. 63-8-5
Page 4 of 6

CULVERT EXCAVATION INVOLVING EXTENSION TO EXISTING CULVERT



All masonry removed for extension of concrete masonry culvert is to be paid at price bid per cubic foot for removing concrete masonry.

If no bid item for removing concrete masonry is proposed in the contract, the volume of masonry removed from within the structure limits shall be paid at the contract price per CY for Solid Rock structure excavation(Sect. 203 & 206)

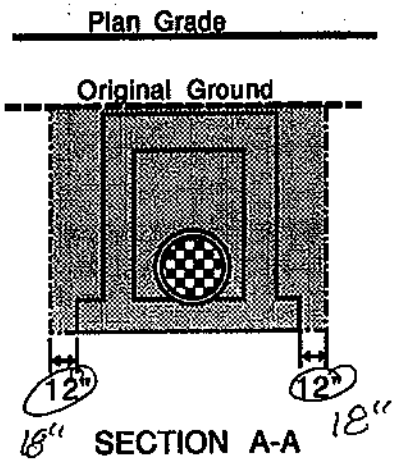
LEGEND

- Remove Concret Masonry,
- Common or Solid Rock Structure Excavation
- Lay back existing slope to clear work area, may be modified to maintain traffic, No Pay
- Cleaning waterway incidental to other bid items
- Concrete outside limit of culvert extension (~~Sect. 208.10.01~~) is not a pay item unless indicated otherwise on the plans or directed by the Engineer
- Roadway Exc.(Channel Excavation)

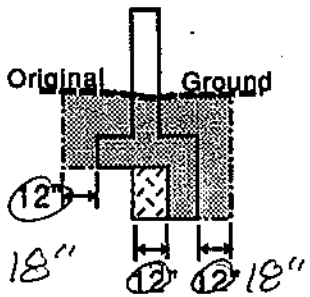
Note: Payment may also be as Foundation Prep - LS.

EXHIBIT NO. 63-8-5
Page 5 of 6

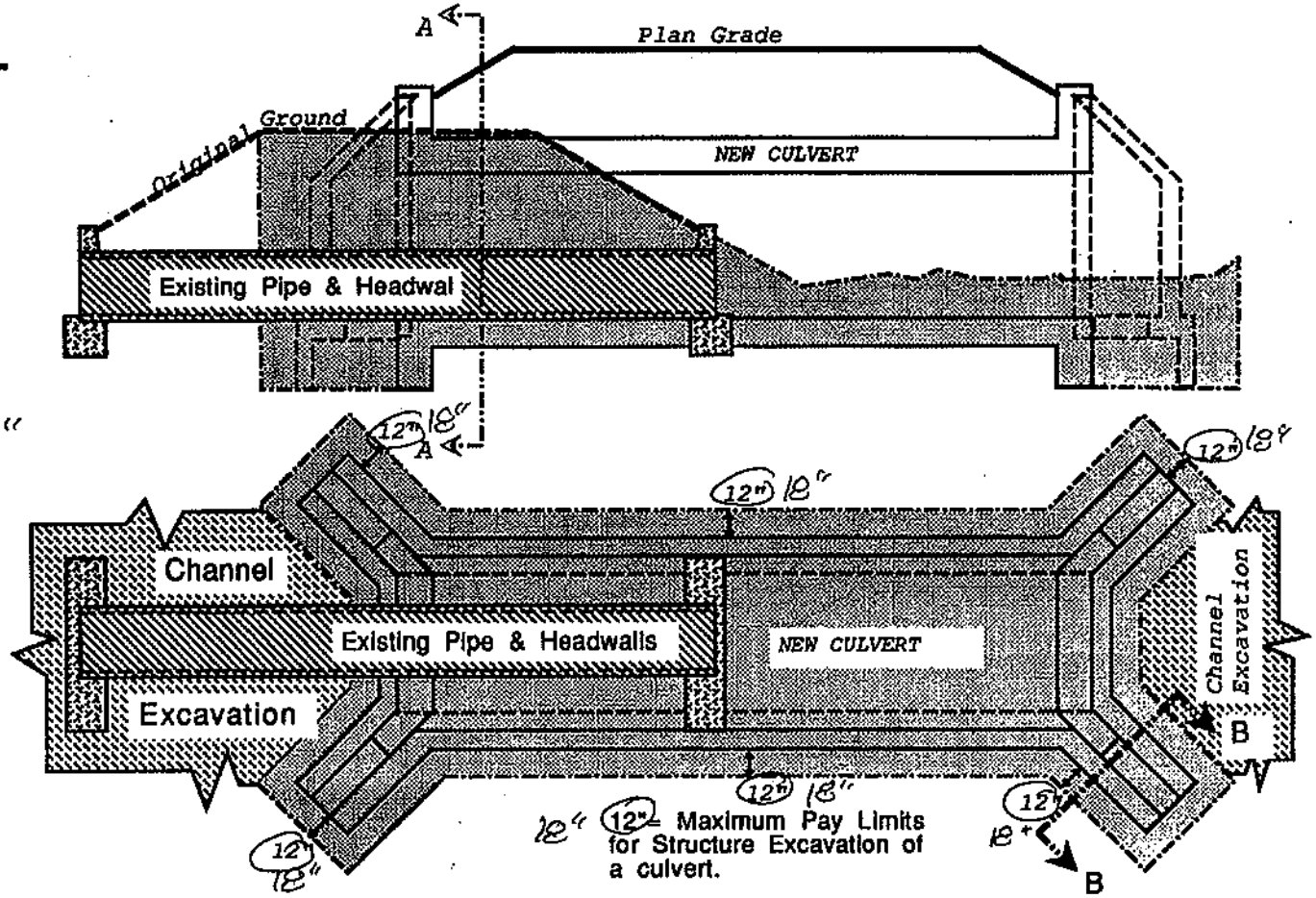
CULVERT EXCAVATION INVOLVING REMOVING PIPE AND HEADWALLS



SECTION A-A



SECTION B-B



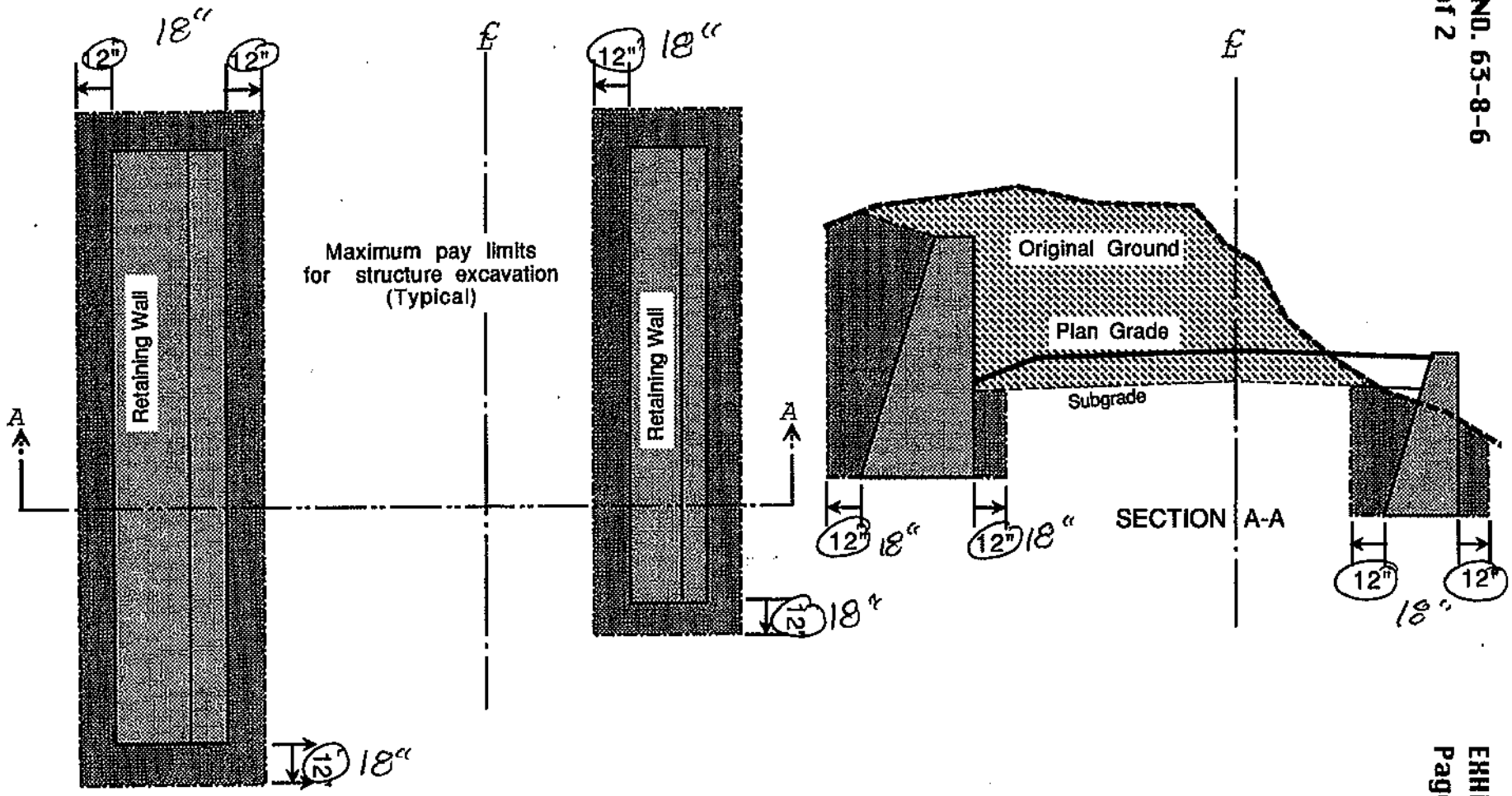
LEGEND

- Roadway Excavation, ~~Standard Specs. Sect. 204.02~~
- No Pay for Volume of Pipe Opening, ~~Standard Specs. 203.09~~
- Common or Solid Rock Structure Excavation - ~~Sect 206.02 & 206.10.01~~
- Pay Structure Exc. only if forms are necessary and used, ~~Sect. 610.05~~
- Removal of Pipe paid ~~per Sec. 203.09 & Sect. 707~~
- Headwall removal not measured for Payment, ~~Sect. 203.08 & 707.04~~

Note: Payment may also be as Foundation Prep - LS

EXHIBIT NO. 63-8-5
Page 6 of 6

RETAINING WALL EXCAVATION



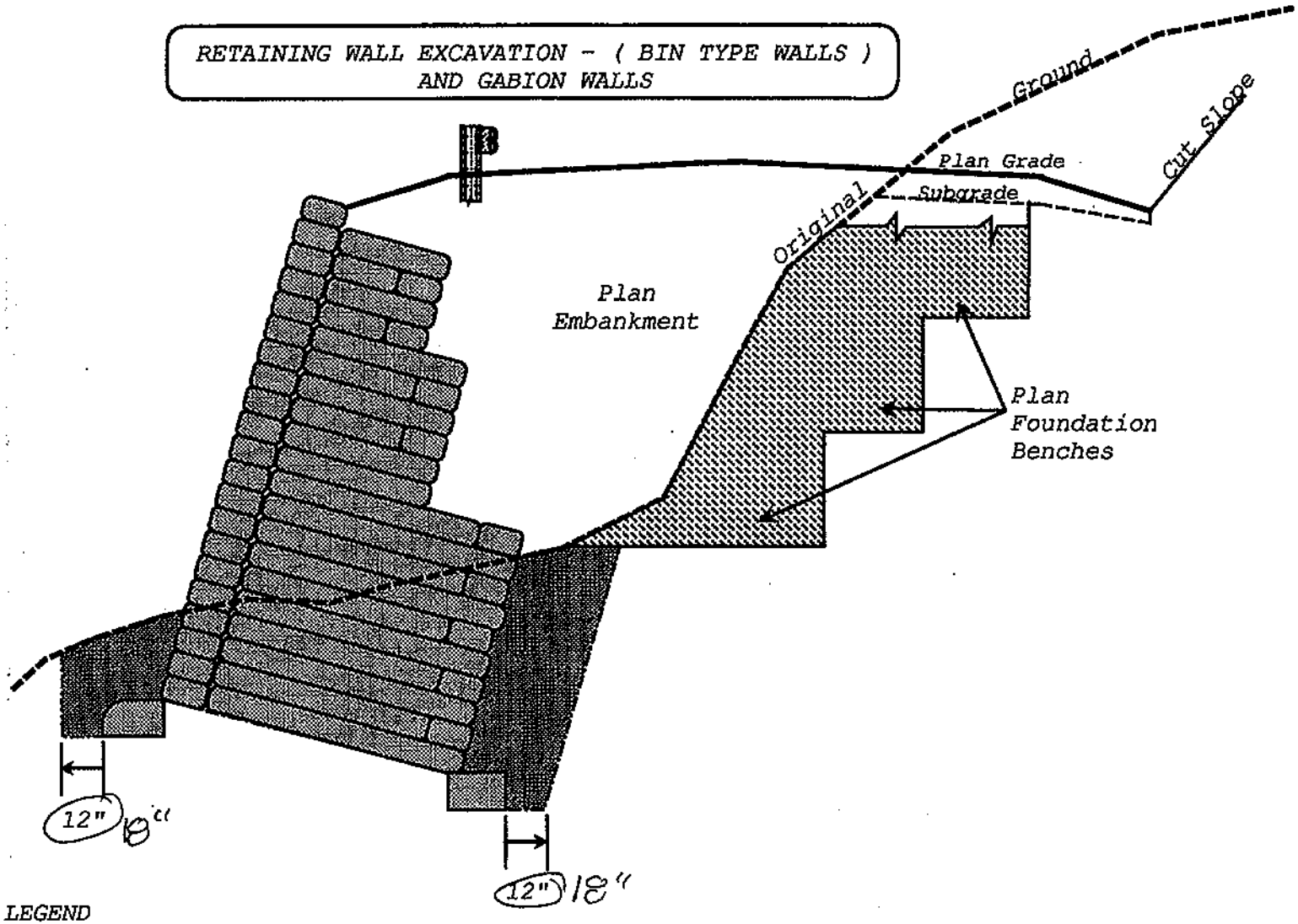
LEGEND

- Roadway Excavation, ~~S'td. Specs. Sect. 204.02, 204.10 & 204.11~~
- Structure Excavation, Unclassified, ~~St'd Specs. Sect. 206.03, 206.10.01 & 610.12~~
- Concrete Retaining Wall

Note: May also be Paid as Foundation Prep-LS

EXHIBIT NO. 63-8-6
Page 1 of 2

RETAINING WALL EXCAVATION - (BIN TYPE WALLS)
AND GABION WALLS



LEGEND

Roadway Exc, ~~St'd. Spec. Sect. 204.02~~

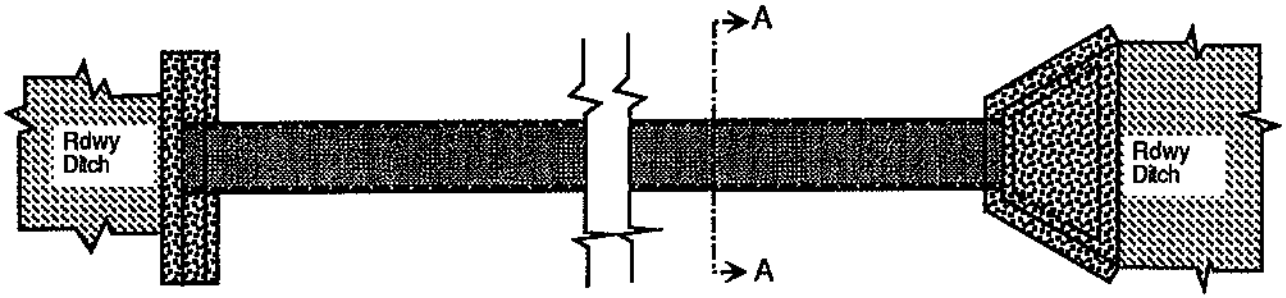
Common or Solid Rock Structure Excavation, ~~St'd. Spec. Sect. 206.11 & 702.04~~

Retaining Wall

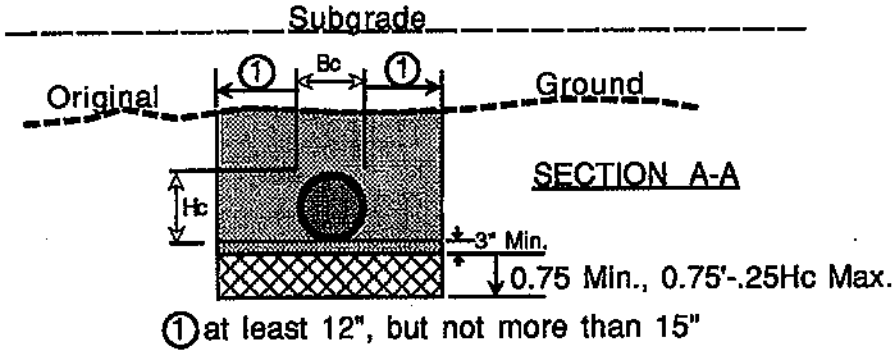
Note: Payment may also be as Foundation Prep-LS

EXHIBIT NO. 63-8-6
Page 2 of 2

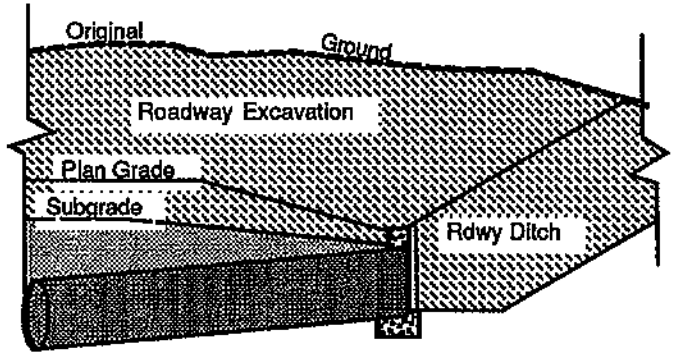
EXCAVATION FOR PIPE CULVERTS, STORM DRAINS, SEWERS, HEADWALLS, ANCHORS, BOXES, ETC.



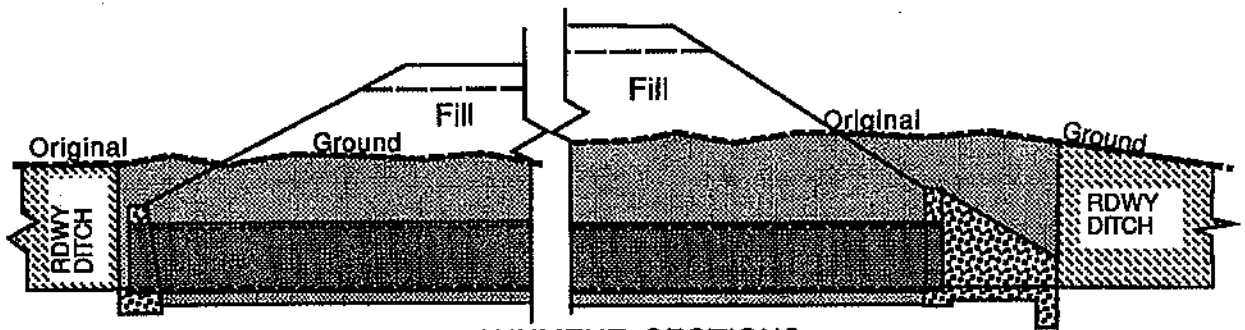
NOTE: See Standard Drawing RDI-020(applicable version) for pipe bedding and excavation details.



SECTION A-A



CUT SECTION



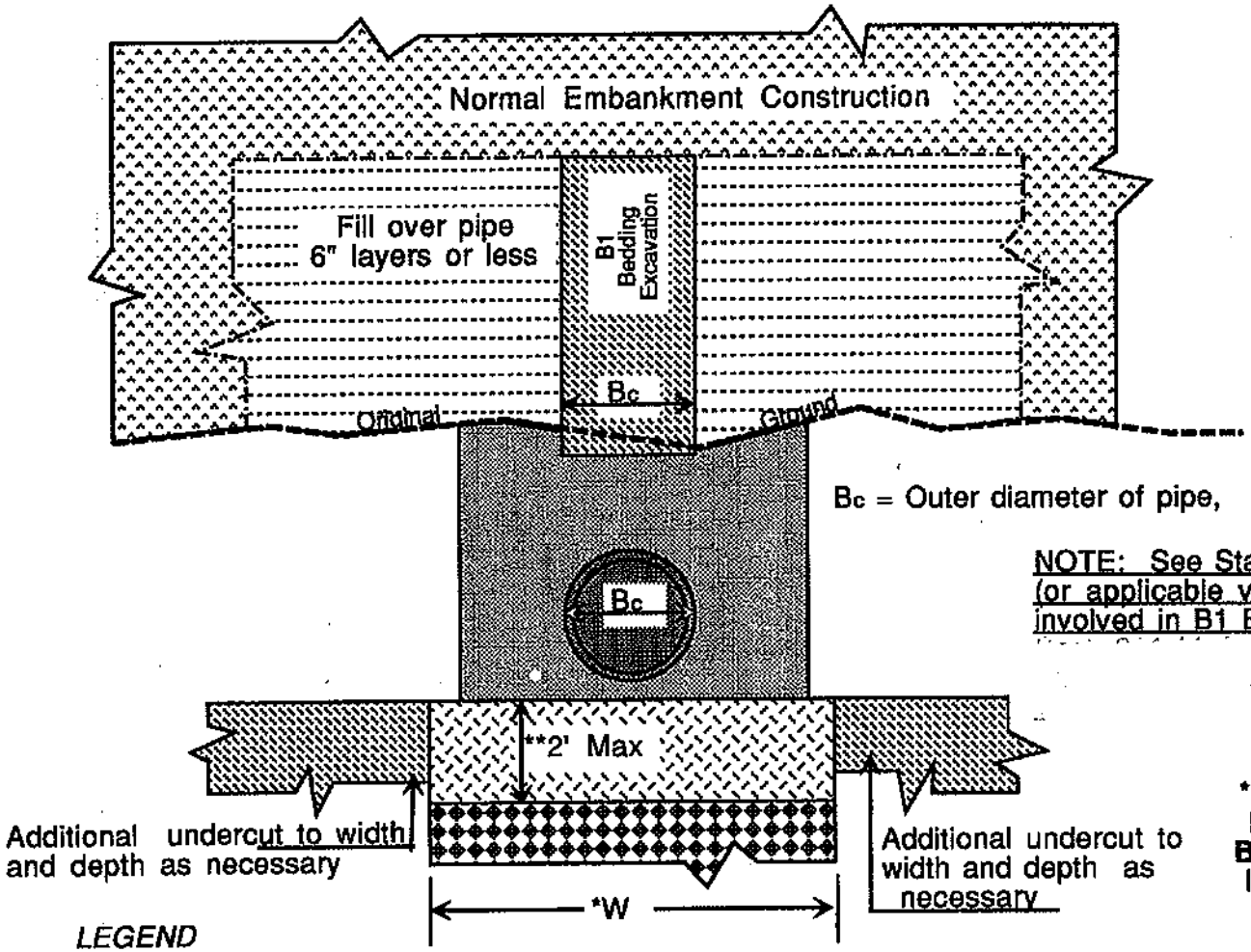
EMBANKMENT SECTIONS

LEGEND

- Culvert Pipe
- Rock Foundation - Bid price for pipe includes excavation,
- Pipe and/or headwall exc.- Excavation included in applicable bid price,
- Headwalls -
- Roadway Excavation

EXHIBIT NO. 63-8-7
PAGE 1 OF 3

PIPE EXCAVATION INVOLVING B1 BEDDING AND/OR UNDERCUTTING UNSTABLE FOUNDATION



Bc = Outer diameter of pipe,

NOTE: See Standard Drawing No. RDI-020-04 (or applicable version) for procedures and limits involved in B1 Bedding.

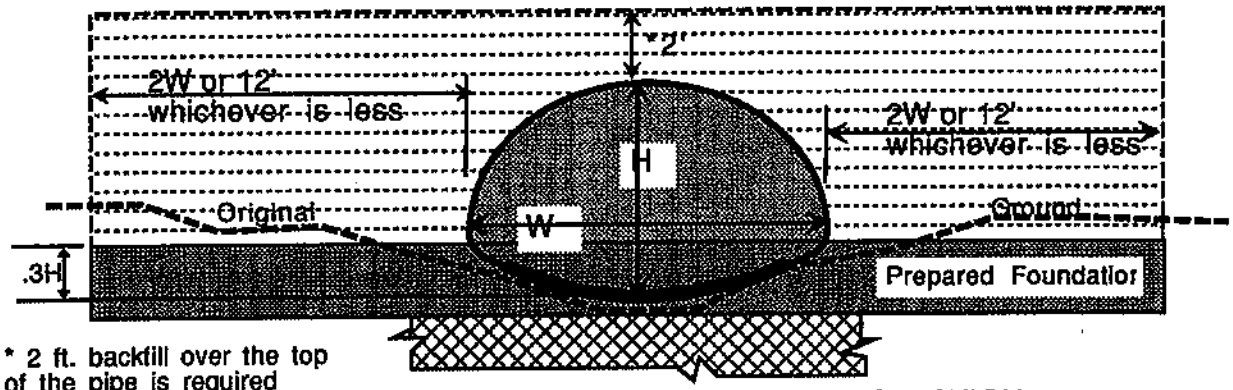
*Undercut Unstable Material Max. Width(W) of **3 x Bc** or **Bc + 4'**, whichever is smaller. It is not necessary that the undercut be centered on the pipe

LEGEND

- Culvert Pipe -
- **Pipe Undercut - Max of 2 ft. paid at Agreed Unit Price
- Portion of pipe undercut in excess of 2 ft.
- Pipe Excavation.- Excavation included in pipe bid price,
- Roadway Excavation -
- Compacted soils over pipe,

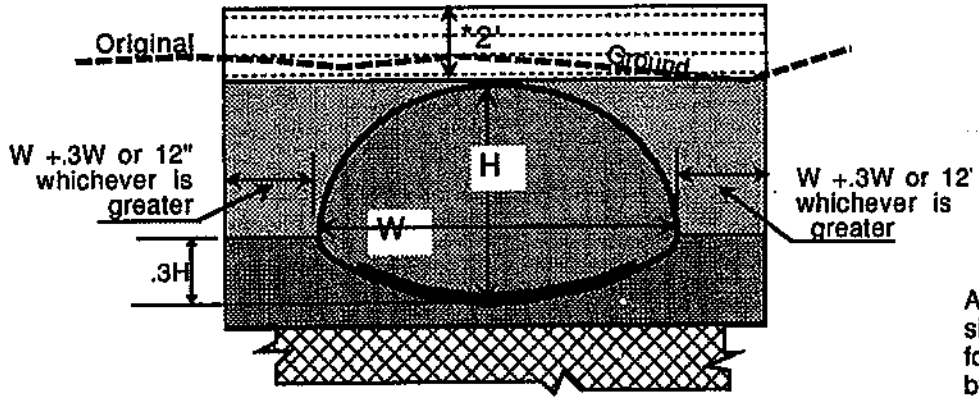
EXHIBIT NO. 63-8-7
PAGE 2 OF 3

EXCAVATION AND BACKFILLING FOR STRUCTURAL PLATE PIPES, PIPE ARCHES, AND ARCHES



* 2 ft. backfill over the top of the pipe is required except where the road grade dictates otherwise. See Spec. 612.05 or 612.06

STANDARD BEDDING, POSITIVE PROJECTION



A Negative Projection situation may be created for a Positive Projection pipe by construction of embankment

STANDARD BEDDING, NEGATIVE PROJECTION

LEGEND

- Pipe
- Pipe Exc.- Excavation included in applicable bid price,
- Rock Foundation - Bid price for pipe includes excavation,
- Foundation Preparation -Excavation and backfilling incl. in bid price,
- Compacted soils over pipe,
- Paved Invert

EXHIBIT NO. 63-8-7
PAGE 3 OF 3

Inspection of Sheet Pile Cofferdams During Construction

Roy Jorgenson
Roy Jorgenson and Associates
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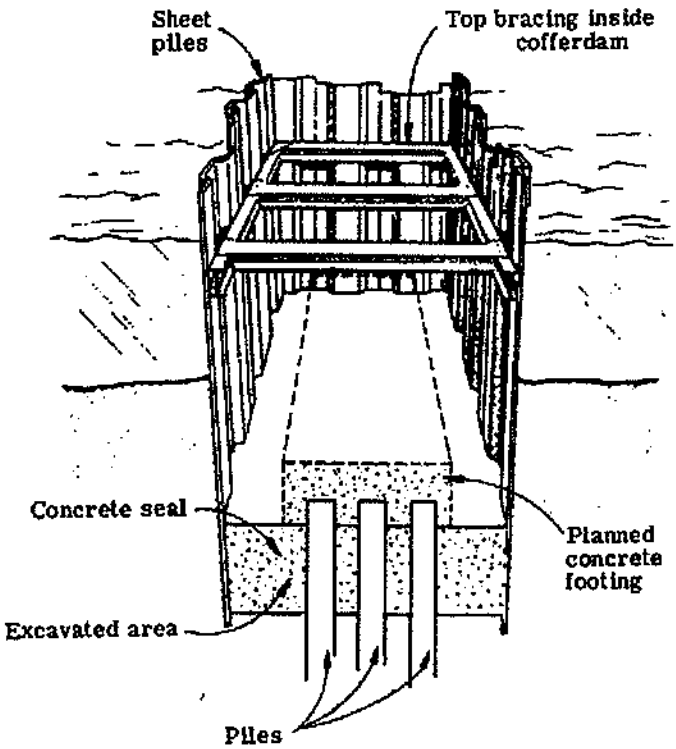
Basic Information

Cofferdams are temporary structures constructed to keep water and soil out of excavations in which bridge piers or other substructures are to be built. Usually, cofferdams are dewatered so that the substructures can be built under dry conditions. After the substructures have been completed, the cofferdams are removed.

As an inspector, your task is to inspect the work done by the contractor during construction, dewatering and removal of cofferdams. One important point needs to be made at the start: a cofferdam is a tool of the contractor. He or she is responsible for its design and construction.

The diagram below shows some of the important parts of a cofferdam. We will discuss the construction and use of these parts and your inspection duties. The design of cofferdams will vary from project to project, but the basic functions shown here will be a a part of every design.



The design of a cofferdam is left to the contractor; however, this design can be subject to approval by the engineer. If the engineer requests a design review, the contractor must submit the working drawings for approval.

The working drawings will show the type of cofferdam planned and the amount of clearance inside the cofferdam. This clearance is important; there must be enough room for the substructure to be built, including room for equipment and personnel. Additionally, the cofferdam must be deep enough to allow footing placement at the proper elevation. If you have questions about the working drawings or the size and depth of the cofferdam, ask your project engineer.

Locating the Cofferdam

It is the contractor's responsibility to initially establish horizontal and vertical control. This is done by setting up reference points and benchmarks, either on land or adjacent structures. The contractor is responsible for transferring these controls to the cofferdam. This may be easy or hard depending upon how far away the cofferdam is from the reference points.

Once the foundation and sheet piles are driven, the contractor will establish permanent points on the sheet piling or bracing. These points may be either painted or scratched on the material, but any points should be marked so that you can easily read them. These reference points are important; they give you the information needs to check:

- Alignment of the template (sometimes spelt templet) for the piles and footing;
- Dimensions of the excavation and the footing; and

- Elevations of the piles, the seal and the footing.

Once the footing is in place, the reference points can be transferred to a point on the footing, from which the remaining structure elevations and dimensions can be checked.

General Sequence

Before describing the inspection of specific steps of cofferdam work, we will deal with the basic sequence of the work. These steps may vary from project to project, but for our purposes they will serve as a typical example. These steps are as follows:

1. Temporary piles are driven to hold the template for the cofferdam.

2. The template is set on the temporary pile. This template can be remain in the cofferdam as bracing.

3. Sheet piles are set in place and driven. The sheet piles will be placed around the template or bracing that will hold them in position.

4. The foundation pit is excavated inside the cofferdam. If needed, excavation will go beyond plan grade if unsuitable material is encountered. Suitable materials will be used as backfill.

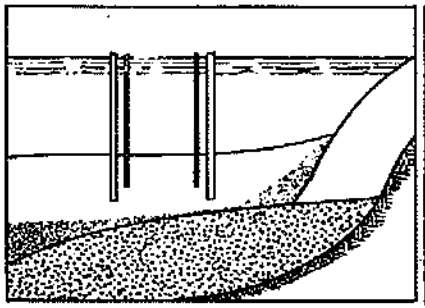
5. Foundation piles are driven, using the top ring of bracing as a template for spacing and positioning. After pile driving, more excavation may be needed. If a foundation pile tip's elevation is higher than the cofferdam sheet pile tips, notify the geotechnical engineer.

6. The concrete seal is placed on the bottom of the foundation pit. The concrete is placed underwater to form a seal, which keeps the water from seeping through the foundation.

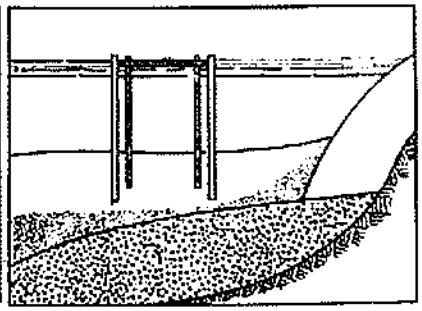
7. The cofferdam is dewatered (pumped dry) so that work can begin on the substructure.

8. When the substructure is completed, the cofferdam is flooded and sheet piling is extracted.

They are illustrated in the following drawings.

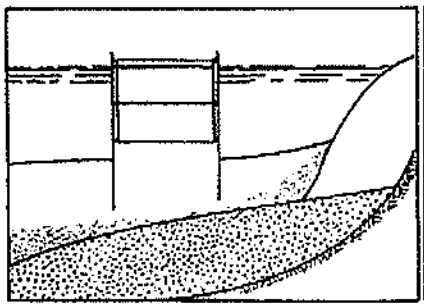


Step 1. Temporary piles are driven.

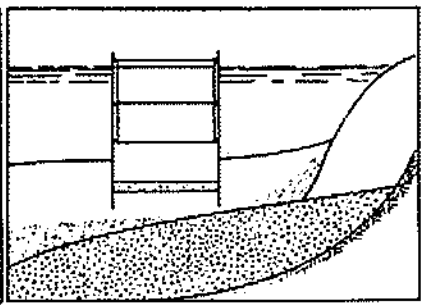


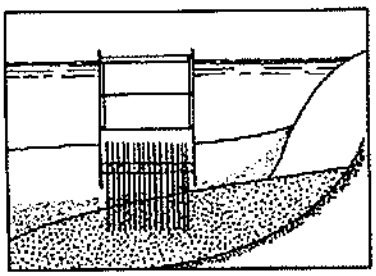
Step 2. Template set on temporary piles.

Step 3. Set and drive sheet piles.

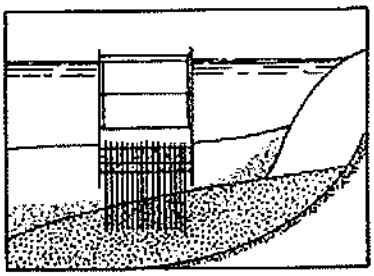


Step 4. Excavate and backfill, if needed.

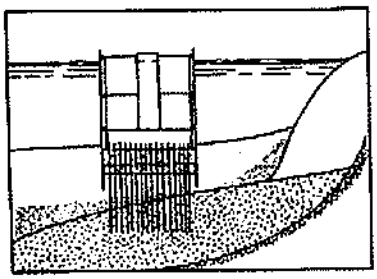




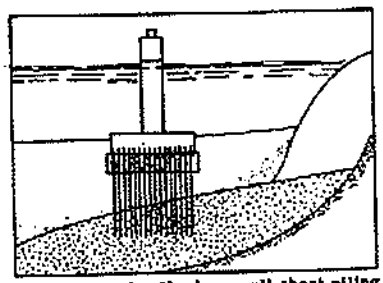
Step 5. Drive foundation piles.



Step 6. Pour concrete seal.



Step 7. Dewater and build pier.



Step 8. Flood cofferdam, pull sheet piling. Remove bracing frame, complete pier.

Placing Steel Sheet Piles

Materials

Most cofferdams are constructed of steel sheet piles. Steel offers the most strength and durability—and it can be removed and used again. The type of steel sheet piles used is up to the contractor, but you should be familiar with the characteristics of the piling. Most sheet piles are the deep-arch types that interlock as shown below:

You will have to make a few checks on the piles both before and during installation:

- Check the sizes of the steel sheet piles. They must be long enough and have the dimensions shown on the working drawings.

- Check for crimped flanges or damaged interlocks. On regular steel H-piles, minor damage will not affect the driving or strength of the piles, but on steel sheet piles, even small crimps or bends can make driving and interlocking difficult and dangerous.

- Check the handling holes and other openings in the sheets. All holes that will be below the water level must be plugged or welded so that the cofferdam will remain dry after it is dewatered.

It is a good idea to check the steel sheet piles before installation, since damage can occur during storage and handling.

Setting and Driving

The most important step in setting and driving sheet piles is the construction of a well-built guide structure. In many cases, the guide structure may be a top level of bracing that is constructed between struts—extended foundation piles.

First, a few struts are driven around the perimeter of the planned cofferdam. These piles will extend above the water level. After this, a bracing framework is set up between these struts. This guide structure should be checked for proper location.

There may be a need for more than one guide structure. When the top bracing is placed after the sheet piles are driven, a temporary inside guide frame may be used. Alternatively, if the sheet piles extend much higher than the water level, a guide frame may be place on top of the bracing.

As mentioned earlier, the actual construction of the cofferdam—including setting and driving the sheet piles—is the responsibility of the contractor. Still, you should be familiar with the work. Some of the important steps are listed below:

- The entire cofferdam should be set in place before the bulk of the driving is done.

- Setting should begin at one corner and continue around the cofferdam. Some of the sheet piles may need to be driven more, so that the structure will hold in place. Be sure the corners are vertical and placed in the right locations. This will ensure the proper positioning of the remaining sheet piling.

- All of the sheet piles must be set vertically. The corners are more rigid and the walls will adjust to fit them. This is why it is especially important to keep the corners vertical. If any piles begin to lean, they should be reset.

- The actual driving of the sheet piles should be done a few feet at a time, working around the cofferdam and driving the sheet piles at approximately the same time.

Cofferdam construction procedures will vary from one contractor to another.

Length and Penetration

The proper length and penetration of the steel sheet piles in the cofferdam will be shown on the working drawings. You will not need to compute bearing or check blow counts, but you should inspect the final driven sheet piles for some general conditions:

- If the cofferdam is to be dewatered, the sheet piles must be driven to sufficient depth to insure a dry seal. Additionally, it must have adequate bracing to keep it from collapsing under water pressure.

- No matter how deep a sheet pile is to be driven, it must have enough bearing capacity to support the weight of the pile, the top brace or other guide frames, and other construction equipment.

- Cofferdams must not tilt or move laterally during driving. If they do, they must be righted or enlarged to provide the necessary clearance.

- Welding at interlocks should be avoided where possible. If welding is done, however, no welding material should be placed inside the interlock. Otherwise, free movement will be blocked.

TC 63-22E
Rev. 3/83 Mod. 05/02

KENTUCKY TRANSPORTATION CABIN
DEPARTMENT OF HIGHWAYS
DIVISION OF CONSTRUCTION
RECORD OF TEST PILE

Test Pile No: 26 (Revised Dwg)
Location of Structure: Endbent 2

Project Number	BRO 5137 (33)
Project Code Number	07~1003
County	Jefferson
Road Name	U.S. 60
Bridge Over	Floyd's Fork
Station	120 + 49
Hammer (Size, Make)	Berminghammer B-300
Formula	P=2WH/S+0.1
Actual Stroke Length	10.8
Weight of Ram (lbs.)	3750
Fall (ft)	
Type of Pile	H 12 X 53
Orientation	Vertical
Gauge Pressure (psi)	200.00
Energy/Blow (ft./lbs.)	40300.00
Blows Per Minute	38 to 60
Plan Bearing (tons)	150.00
Concrete Mix Used	
Orig. Length of Pile (ft.)	30.00
Build Up (ft.)	
Cut-Off Elevation	597.95
Cut-Off Length	2.25
Final Elev. Tip of Pile	570.20
**Pay Length (ft.)	27.75
Plan Qty. Length (ft.)	30.00
Drawing Number	25855
Date Driven	7/30/2007

**(Test Pile was used in the footing, therefore the length to be paid is 30 ft due to section 604.04.03. and the request by the contractor to use 30 ft instead of the 35 ft originally directed in the plans.)

Penetration (Feet)	No. of Blows per foot	Average Height of Fall**	Theoretical Bearing (Tons)	Penetration (Feet)	No. of Blows per foot	Average Height of Fall**	Theoretical Bearing Tons
					BUTT		
35							
34				65			
33				64			
32				63			
31				62			
30				61			
29				60			
28				59			
27				58			
26	52			57			
25	20			56			
24	11			55			
23	8			54			
22	8			53			
21	10			52			
20	9			51			
19	8			50			
18	8			49			
17	7			48			
16	7			47			
15	7			46			
14	6			45			
13	6			44			
12	5			43			
11	6			42			
10	6			41			
9	5			40			
8	6			39			
7	5			38			
6	3			37			
5	7			36			
	TIP						

Date Submitted

Dav Kessinger
Project Engineer

cc: District TEBM for Construction
Division of Construction

**Insert gauge pressure for hammers with enclosed rams.

Total Penetration - Last 10 blows 0.38 in.@ 10.00 ft. Theo. Bearing 272.73 Tons

FORMULAS:

$P = \frac{2WH}{S+1.0}$ for gravity hammers.

$P = \frac{2WH}{S+0.1}$ for single-acting steam hammers.

$P = \frac{2WH}{S+0.1}$ for single-acting air hammers.

$P = \frac{2E}{S+0.1}$ for double-acting steam hammers.

$P = \frac{2WH}{S+0.1}$ diesel hammers (having unrestricted rebound of ram).

$P = \frac{2E}{S+0.1}$ diesel hammers (having enclosed ram).

Where P=Safe bearing power in pounds.
W=Weight, in pounds, of striking parts of hammer.
H=Height of fall in feet.
S=Penetration in inches per blow for the last 5 to 10 blows for gravity hammers and the last 10 to 20 blows for steam, air or diesel hammers.

E=90% of the average equivalent energy in foot pounds as determined by gauge attached to pile hammer and recorded during the period when the penetration per blow is being observed but not to exceed 13,500 foot-pounds for the enclosed ram type diesel hammers having a manufacturers rating of 18,000 foot-pounds and 23,600 foot-pounds for the enclosed ram type diesel hammers having a manufacturers rating of 30,000 foot-pounds.

The above formulas are applicable only when:

(a) The hammer has a free fall.
(b) The head of the pile is not broomed or crushed.
(c) The penetration is reasonably quick and uniform.
(d) There is no sensible bounce after the blow.

NOTE: For structural steel bearing piles, the contractor shall furnish the Department with three (3) copies each of mill orders, mill shipping statements and mill test reports.

The test reports shall be certified before a Notary Public.

KENTUCKY TRANSPORTATION CABINET
DEPARTMENT OF HIGHWAYS
DIVISION OF CONSTRUCTION
RECORD OF PILES FURNISHED AND DRIVEN

Drawing No. 25855
Project Number BRO 5137 (33) PCN 07~1003 County Jefferson Location of Structure Endbent 2
Road Name U.S. 60 Bridge Over Floyd's Fork Station 120 + 49
Hammer(Size,Make) Berminghammer B-300 Actual Stroke Lgth. 10.8 Weight of Ram 3750 lbs. Fall
Type of Pile H 12 X 53 Batter 3 to 1 Gauge Pressure 200.00 Energy/Blow 40,300

Pile No.	Pile Orien.	Date Driven	Original Length of Pile (Feet)	Build Up (Feet)	Cut-Off Elev. (Feet)	Cut-Off Length (Feet)	Final Elev. Tip of Pile (Feet)	**Pay Length Test (Feet)	**Pay Length Production (Feet)	Heat (Steel Pile)	Penc. Last 10 Blows (Inches)	Avg. Fall Last 10 Blows (Feet)	Bearing Capacity (Tons)
26	VT	07/30/07	30.00		597.95	2.25	570.20	27.75		274139	0.38	10.00	272.73
25	V	07/30/07	30.00		597.95	2.06	570.01		27.94	289294	0.50	10.00	250.00
24	V	07/30/07	30.00		597.53		567.53		30.00	289294	0.25	10.00	300.00
23	V	07/30/07	30.00		597.95	1.25	569.20		28.75	289294	0.38	10.00	272.73
22	B	07/30/07	35.00		597.95	1.18	565.87		33.82	296826	0.75	10.00	214.29
21	B	07/30/07	35.00		597.95	5.69	570.14		29.31	296826	0.50	10.00	250.00
20	B	07/30/07	35.00		597.95	1.71	566.37		33.29	289258	0.38	10.00	272.73
19	B	07/30/07	35.00		597.95	5.70	570.15		29.30	289258	0.50	10.00	250.00
18	B	07/30/07	35.00		597.95	5.71	570.16		29.29	289258	0.88	10.00	200.00
17	B	07/30/07	35.00		597.95	5.19	569.67		29.81	289258	1.00	10.00	187.50
16	B	07/30/07	35.00		597.95	5.73	570.18		29.27	296826	0.63	10.00	230.77
15	B	07/30/07	35.00		597.95	0.92	565.62		34.08	289295	0.50	10.00	250.00
Total This Page			400.00)		----	37.39	----	27.75	334.86	----	----	---	---
Total Continuation Page(s)			0.00	0.00	----	0.00	Plan Qty	0.00	0.00	----	----	----	
Grand Total			400.00)		----	37.39	(30.00)	30.00	334.86	----	----	----	

**(Test Pile was used in the footing, therefore the length to be paid is 30 ft due to section 604.04.03. and the request by the contractor to use 30 ft instead of the 35 ft originally directed in the plans.)

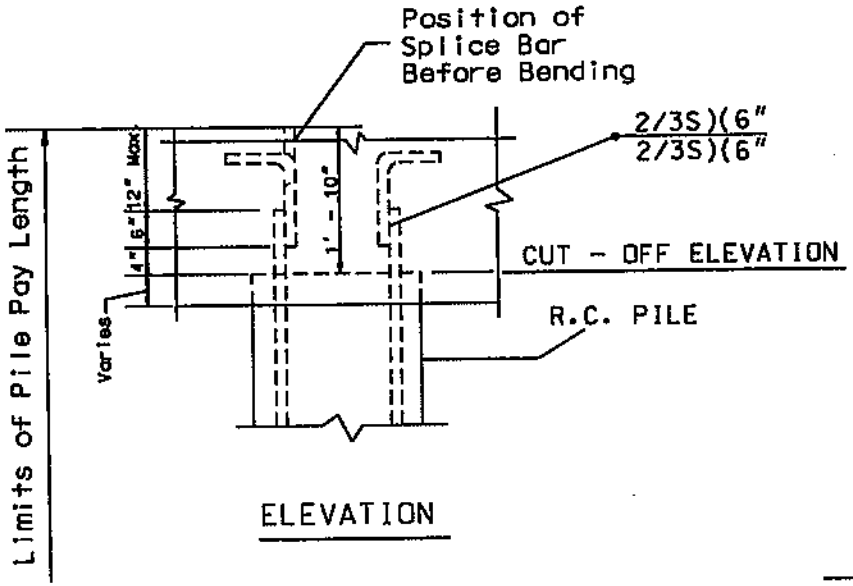
cc: District TEBM for Construction
Division of Construction

Submitted By: Dav Kessinger 7/31/2007
Project Engineer Date

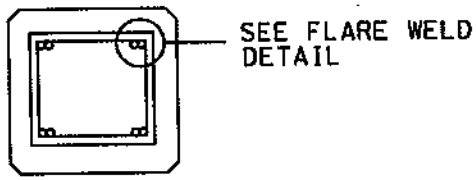
Checked By:
District TEBM for Construction Date

Exhibit 63-8-11
Page 1 of 1

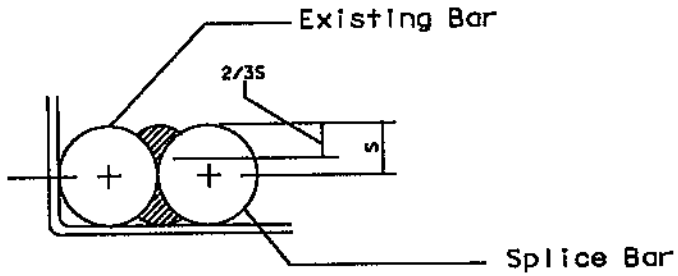
WELDED REINFORCEMENT PILE SPLICE



ELEVATION



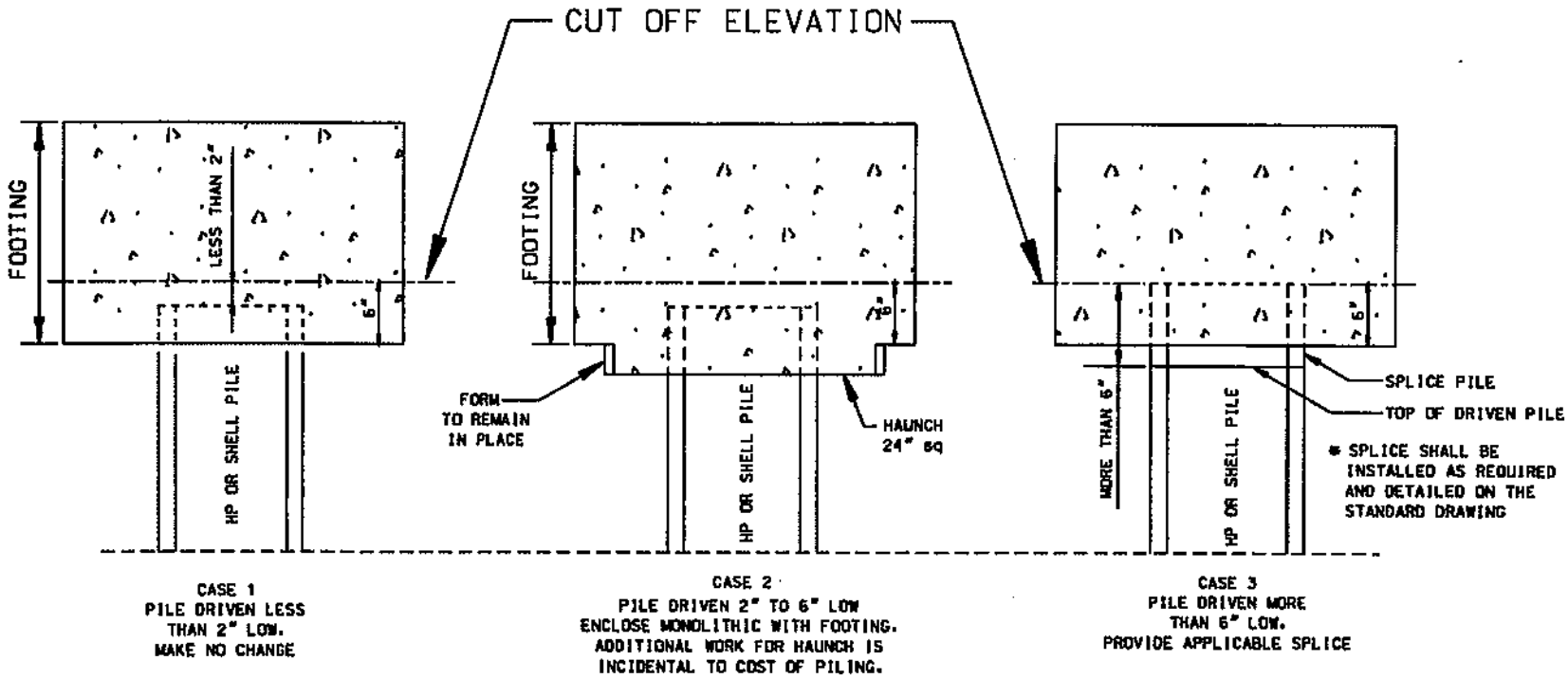
TOP VIEW



FLARE WELD DETAIL.

The welded reinforcement splice will be used when the pile is not driven below cut-off, but is driven too low to provide the 1'-10" reinforcement strip-down. All necessary work to provide this splice will be incidental to the cost of the pile.

EXHIBIT NO. 63-8-13



1) FOR 14" HP PILING CASE 2 MAY APPLY FOR 2" TO 7" RANGE
2) FOR END BENTS OR ABUTMENTS. BUILD UP PILES TO CUT-OFF LENGTH UNLESS THE REQUIRED LENGTH OF THE BUILD UP IS INSUFFICIENT TO ALLOW INSTALLATION OF THE STANDARD DRAWING INDICATED SPLICE. IN THIS CASE MAKE NO CHANGE IN AS-DRIVEN PILE.
3) FOR PILE BENTS, BUILD UP ALL PILES TO CUT-OFF. IF THE LENGTH OF BUILD UP IS INSUFFICIENT TO ALLOW INSTALLATION OF THE STANDARD DRAWING INDICATED SPLICE. REMOVE ENOUGH OF THE DRIVEN PILE TO AFFORD INSTALLATION OF THE SPLICE. NO PAYMENT WILL BE ALLOWED FOR THE REMOVED LENGTH.

STEEL PILING DRIVEN BELOW CUT-OFF

EXHIBIT NO. 63-8-14

COMMONWEALTH OF KENTUCKY
TRANSPORTATION CABINET
FRANKFORT, KENTUCKY 40622

MILO D. BRYANT
SECRETARY
AND
COMMISSIONER OF HIGHWAYS

WALLACE G. WILKINSON
GOVERNOR

Construction Memo No. 3-91

MEMO TO: Chief District Engineers
District Branch Managers for Construction
Resident Engineers
Consultant Engineers for Construction

FROM: Paul Gravely, P. E. P.D. Gravely
Director,
Division of Construction

DATE: March 6, 1991

SUBJECT: Mill Test Reports
Steel "H" Piles

Effective immediately, mill test reports for steel "H" piles shall be checked for compliance with the specifications by the resident engineer's office instead of sending to the Division of Construction. The standard drawings require "H" piles to conform to the requirements of ASTM-A36.

The test report should be checked for the following:

(1) Made in America
(2) Size of Shape: HP 12x53, HP 14x73, etc.
(3) Tensile Requirements: Yield Strength, Tensile Strength, Elongation
(4) Chemical Requirements: Carbon (C), Phosphorus (P), Sulphur (S) (Copper is only required when Standard Drawings BSP 005-04 and BSP 006-04 are required by the plans and Manganese (MN), Silicon (Si) are not required for steel shapes)
(5) Test Report is signed by responsible representative of Company.

Upon verification of compliance with the ASTM A36 requirements, advise the contractor in writing of the approval and list the heat numbers that are approved. A copy of this approval letter should be sent to Division of Construction and Division of Materials. All test reports must be reviewed and approved <u>before</u> the piles represented by the test report are driven.

Copies of ASTM A36-89 requirements, an example mill test report, and an example letter of approval are attached for reference.

cc: Roy Back
Division of Materials
Federal Highway Administration

D12

United States Steel Corporation

MAR 16

01.000.0772 (REV. 7-78)

Metallurgical Test Report

Homestead Borough, Allegheny
My Commission Expires Apr 83
Member, Pennsylvania Association of Notaries

..., JOB, CONTRACT NO.	P. O. DATE	PURCHASE ORDER NO.	
		100 02/05/81	
	SHIPPERS NO.	MILL ORDER NO.	INVOICE NO.
	5319 3/10/81	FC39375	163-27325
	VEHICLE IDENTITY	OBL 1269	

VENDOR
HOMESTEAD WORKS
HOMESTEAD, PA. 15120

SOLD TO
[redacted] JOINT VENTURE
P O BOX 85
LEBANON JUNCTION KY 40150

SHIP TO
[redacted] JOINT VENTURE
C/O JOBSITE APPROX MILE
POST 102 ON I-65
COLESBURG KY

BEING DULY SWORN ACCORDING TO LAW, DEPOSES AND SAYS THAT THE CHEMICAL ANALYSES AND/OR TEST RESULTS SHOWN IN THIS REPORT ARE CORRECT AS CONTAINED IN THE RECORDS OF THE COMPANY.

A.J. JOSEPH, CH. MET.

DATE 03/10/81

SPEC. & SP. ASTM A36-77A

SHAPES
01 MILL SWORN T/R - ANALYSIS - REPORT TEST RESULTS PER PRODUCT SPECN CAPTION

STATE OF PENNSYLVANIA
COUNTY OF ALLEGHENY
SUBSCRIBED AND SWORN TO BEFORE ME
THIS 11 DAY OF March 1981

Eugene E Boyle

ITEM NO.	MATERIAL DESCRIPTION: THICKNESS OR SECTION	WIDTH, DIA. OR FT. WT.	LENGTH	QUANTITY	WEIGHT	HEAT NO.	TEST OR PIECE IDENTITY	YIELD PT. PSI	TENSILE STR. PSI	ELONGATION % IN 8"	ELONGATION % IN 2"	% RED. OF AREA	BEND
01	HP12X53		60-00.00	12	38160	74B055	HP12X53	43800	63900	28.0			
							HP12X53	42200	64800	29.0			
01	HP12X53		60-00.00	5	15900	75B130	HP12X53 ✓	43800	64000	30.5			
							HP12X53	42000	63300	29.5			
01	HP12X53		60-00.00	8	25440	75B130	HP12X53	42000	63300	29.5			
							HP12X53	43800	64000	30.5			
02	HP12X53		40-00.00	13	27560	65B144	HP12X53	41700	61900	32.5			
							HP12X53	44400	63800	26.5			

HEAT NO.	TYPE	C	MN	P	S	SI	CU	NI	OR	MO	SN	AL	N	V	B	TI	CB	CO
74B055	HEAT	23	68	004	019	052												
75B130 ✓	HEAT	22	72	006	019	047												
65B144	HEAT	20	71	005	017	026												

015096 7-3-0-0 DECIMAL POSITIONS FOR ELEMENTS ARE INDICATED BY THE LEFT MARGIN VERTICAL DOTTED LINE OR DECIMAL POINT

Exhibit 63-8-15
Page 2 of 6

Attach to Construction Memo 3-91

S A M P L E

January 2, 1992

Inahurry Construction Company
P. O. Box XXX
Bardstown, KY

SUBJECT: Hardin County
BRZ 999(000)
Bridge @ Station 50+00
Test Report - Steel Piling

Gentlemen:

The attached mill test report for the HP 12x53 steel piling has been reviewed. The test report indicates that this material conforms to ASTM A36 as required by Standard Drawing BPS-003-04 and is satisfactory to use.

The following heat numbers are approved:

74B055
75B130
65B144

Sincerely,

Jim Dandy
Resident Engineer

cc: District Office Construction
Division of Materials
Division of Construction

Standard Specification for Carbon Structural Steel[1]

This standard is issued under the fixed designation A 36/A 36M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense. Consult the DoD Index of Specifications and Standards for the specific year of issue which has been adopted by the Department of Defense.

1. Scope

1.1 This specification[2] covers carbon steel shapes, plates, and bars of structural quality for use in riveted, bolted, or welded construction of bridges and buildings, and for general structural purposes.

1.2 Supplemental requirements are provided where improved internal quality and notch toughness are important. These shall apply only when specified by the purchaser in the order.

1.3 When the steel is to be welded, it is presupposed that a welding procedure suitable for the grade of steel and intended use or service will be utilized. See Appendix X3 of Specification A 6/A 6M for information on weldability.

1.4 The purchaser should consider specifying supplemental requirements, such as fine austenitic grain size and Charpy V-Notch Impact requirements, when Group 4 or Group 5 wide flange shapes are specified for use in other than column or compression applications.

1.5 The values stated in either inch-pound units or SI (metric) units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents, therefore, each system must be used independent of the other. Combining values from the two systems may result in nonconformance with this specification.

2. Referenced Documents

2.1 *ASTM Standards:*

A 6/A 6M Specification for General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use[3]

A 27/A 27M Specification for Steel Castings, Carbon, for General Application[4]

A 307 Specification for Carbon Steel Bolts and Studs, 60 000 psi Tensile Strength[5]

A 325 Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength[5]

A 325M Specification for High-Strength Bolts for Structural Steel Joints [Metric][5]

A 500 Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes[6]

A 501 Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing[6]

A 502 Specification for Steel Structural Rivets[5]

A 563 Specification for Carbon and Alloy Steel Nuts[5]

A 563M Specification for Carbon and Alloy Steel Nuts [Metric][5]

A 570/A 570M Specification for Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality[7]

A 668 Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use[8]

F 568 Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners[5]

TABLE 1 Appurtenant Material Specifications

NOTE—The specifier should be satisfied of the suitability of these materials for the intended application. Composition and/or mechanical properties may be different than specified in A 36/A 36M.

Material	ASTM Designation
Steel rivets	A 502, Grade 1
Bolts	A 307, Grade A or F 568, Class 4.6
High-strength bolts	A 325 or A 325M
Steel nuts	A 563 or A 563M
Cast steel	A 27/A 27M, Grade 65–35 [450–240]
Forgings (carbon steel)	A 668, Class D
Hot-rolled sheets and strip	A 570/A 570M, Grade 36
Cold-formed tubing	A 500, Grade B
Hot-formed tubing	A 501

3. Appurtenant Materials

3.1 When components of a steel structure are identified with this ASTM designation but the product form is not listed in the scope of this specification, the material shall conform to one of the standards listed in Table 1 unless otherwise specified by the purchaser. Table 1 does not provide any specification requirements to a manufacturer or processor. Orders to a manufacturer or processor should describe the required ASTM designation for product forms not listed in the scope of this specification. Unless otherwise specified, all plain and threaded bars used for anchorage purposes shall be subjected to mechanical tests and shall conform to the tensile requirements of Section 8; headed bolts used for anchorage purposes shall conform to Specification A 307 or F 568; and all nuts shall conform to the

[1] This specification is under the jurisdiction of ASTM Committee A-1 on Steel, Stainless Steel, and Related Alloys, and is the direct responsibility of Subcommittee A01.02 on Structural Steel for Bridges, Buildings, Rolling Stock, and Ships.

Current edition approved June 15, 1994. Published August 1994. Originally published as A 36 – 60 T. Last previous edition A 36/A 36M – 93b.

[2] For ASME Boiler and Pressure Vessel Code Applications, see related Specifications SA-36 in Section II of that Code.

[3] *Annual Book of ASTM Standards*, Vol 01.04.

[4] *Annual Book of ASTM Standards*, Vol 01.02.

[5] *Annual Book of ASTM Standards*, Vol 15.08.

[6] *Annual Book of ASTM Standards*, Vol 01.01.

[7] *Annual Book of ASTM Standards*, Vol 01.03.

[8] *Annual Book of ASTM Standards*, Vol 01.05.

TABLE 2 Chemical Requirements

NOTE—Where "..." appears in this table there is no requirement. The heat analysis for manganese shall be determined and reported as described in the heat analysis section of Specification A 6/ A 6M.

Product	Shapes[A]	Plates[B]					Bars			
Thickness, in. [mm]	All	To ¾ [20], incl	Over ¾ to 1½ [20 to 40], incl	Over 1½ to 2½ [40 to 65], incl	Over 2½ to 4 [65 to 100], incl	Over 4 [100]	To ¾ [20], incl	Over ¾ to 1½ [20 to 40], incl	Over 1½ to 4 [100], incl	Over 4 [100]
Carbon, max, %	0.26	0.25	0.25	0.26	0.27	0.29	0.26	0.27	0.28	0.29
Manganese, %	...	...	0.60–1.20	0.60–1.20	0.85–1.20	0.85–1.20	...	0.60–0.90	0.60–0.90	0.60–0.90
Phosphorus, max, %	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Sulfur, max, %	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Silicon, %	0.40 max	0.40 max	0.40 max	0.15–0.40	0.15–0.40	0.15–0.40	0.40 max	0.40 max	0.40 max	0.40 max
Copper, min, % when copper steel is specified	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20

[A] Manganese content of 0.85–1.35 % and silicon content of 0.15–0.40 % is required for shapes over 426 lb/ft [634 kg/m].

[B] For each reduction of 0.01 % below the specified carbon maximum, an increase of 0.06 % manganese above the specified maximum will be permitted up to the maximum of 1.35 %.

requirements of Specification A 563, Grade A, or A 563M, Class 5.

4. General Requirements for Delivery

4.1 Material furnished under this specification shall conform to the requirements of the current edition of Specification A 6/A 6M, for the ordered material, unless a conflict exists in which case this specification shall prevail.

5. Bearing Plates

5.1 Unless otherwise specified, plates used as bearing plates for bridges shall be subjected to mechanical tests and shall conform to the tensile requirements of Section 8.

5.2 Unless otherwise specified, mechanical tests shall not be required for plates over 1½ in. [40 mm] in thickness used as bearing plates in structures other than bridges, subject to the requirement that they shall contain 0.20 to 0.33 % carbon by heat analysis, that the chemical composition shall conform to the requirements of Table 2 in phosphorus and sulfur content, and that a sufficient discard shall be made to secure sound plates.

6. Process

6.1 The steel shall be made by one or more of the following processes: open-hearth, basic-oxygen, or electric-furnace.

6.2 No rimmed or capped steel shall be used for plates and bars over ½ in. [12.5 mm] thick or for shapes other than Group 1.

7. Chemical Requirements

7.1 The heat analysis shall conform to the requirements prescribed in Table 2, except as specified in 5.2.

7.2 The steel shall conform on product analysis to the requirements prescribed in Table 2, subject to the product analysis tolerances in Specification A 6/A 6M, except as specified in 7.3.

7.3 Product analysis is not applicable for bar-size shapes or flat bars ½ in. [12.5 mm] and under in thickness.

7.4 When tension tests are waived in accordance with 8.2, chemistry consistent with the requirements in Table 2, and with the mechanical properties desired must be applied.

8. Tensile Requirements

8.1 The material as represented by the test specimen, except as specified in 5.2 and 8.2, shall conform to the requirements as to the tensile properties prescribed in Table 3.

8.2 Shapes less than 1 in.^{2} [645 mm^2] in cross section and bars, other than flats, less than ½ in. [12.5 mm] in thickness or diameter need not be subjected to tension tests by the manufacturer.

9. Keywords

9.1 bars; bolted construction; bridges; buildings; carbon; plates; riveted construction; shapes; steel; structural steel; welded construction

TABLE 3 Tensile Requirements[A]

Plates, Shapes,[B] and Bars:	
Tensile strength, ksi [MPa]	58–80 [400–550]
Yield point, min, ksi [MPa]	36 [250][C]
Plates and Bars[D,E]:	
Elongation in 8 in. [200 mm], min, %	20
Elongation in 2 in. [50 mm], min, %	23
Shapes:	
Elongation in 8 in. [200 mm], min, %	20
Elongation in 2 in. [50 mm], min, %	21[B]

[A] See Specimen Orientation under the Tension Tests section of Specification A 6/A 6M.

[B] For wide flange shapes over 426 lb/ft [634 kg/m], the 80 ksi [550 MPa] maximum tensile strength does not apply and a minimum elongation in 2 in. [50 mm] of 19 %, applies.

[C] Yield point 32 ksi [220 MPa] for plates over 8 in. [200 mm] in thickness.

[D] Elongation not required to be determined for floor plate.

[E] For plates wider than 24 in. [600 mm], the elongation requirement is reduced two percentage points. See elongation requirement adjustments under the Tension Tests section of Specification A 6/A 6M.

SUPPLEMENTARY REQUIREMENTS

These requirements shall not apply unless specified in the order.

Standardized supplementary requirements for use at the option of the purchaser are listed in Specification A 6/A 6M. Those that are considered suitable for use with this specification are listed by title:

S5. Charpy V-Notch Impact Test.

S14. Bend Test.

ADDED SUPPLEMENTARY REQUIREMENTS

In addition, the following optional supplementary requirements are also suitable for use with this specification.

S91. Fine Austenitic Grain Size

S91.1 The steel shall be killed and have a fine austenitic grain size.

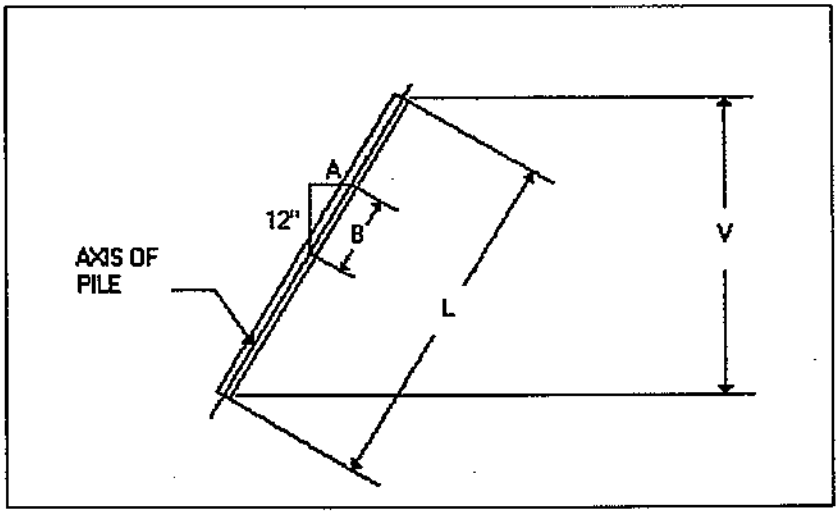
S97. Limitation on Rimmed or Capped Steel

S97.1 The steel shall be other than rimmed or capped.

The American Society for Testing and Materials takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, 1916 Race St., Philadelphia, PA 19103.

TABLE FOR ESTIMATING LENGTHS OF BATTERED PILES



BATTER	DIMENSIONS			DIMENSION OF PILE	
		A	B	V (ft)	L (ft)
4" in 12"		4"	1.05409' or 12.6492"	10	10.54
				20	21.08
				30	31.62
				40	42.16
				50	52.70
3" in 12"		3"	1.03078' or 12.3693"	10	10.31
				20	20.61
				30	30.92
				40	41.23
				50	51.54
2-1/2" in 12"		2-1/2"	1.02147' or 12.2577"	10	10.22
				20	20.43
				30	30.65
				40	40.86
				50	51.08
2" in 12"		2"	1.01379" or 12.1655"	10	10.14
				20	20.28
				30	30.42
				40	40.56
				50	50.69
1-1/2" in 12"		1-1/2"	1.00778" or 12.0934"	10	10.08
				20	20.16
				30	30.23
				40	40.31
				50	50.39
1" in 12"		1"	1.00347' or 12.0416"	10	10.03
				20	20.07
				30	30.10
				40	40.14
				50	50.17

AIR OR STEAM HAMMERS

MFGR.	MODEL	RATED ENERGY (FT.-LBS.)	TYPE	BLOWS PER MINUTE	WEIGHT OF RAM (LBS.)	MAX. STROKE (FT.-IN.)	AIR[1] REQ'D (CFM)	REC.[2] COMP. (CFM)	BOILER HP ASME	AIR OR STEAM (PSI)	HOSE SIZE (IN.)	WEIGHT[3] (LBS.)	LENGTH[3] (FT.-IN.)	WIDTH AT LEAD RAILS (INCHES)
CONMACO	300	90,000	SGL.ACT.	55	30,000	36	1,905		247	150	3	55,390	16-5	56
	209	65,000	SGL.ACT.	60	20,000	36	1,634		217	120	3	44,560	15-0	56
	160	48,750	SGL.ACT.	60	16,250	36	1,275	1,800	198	120	3	33,200	13-0	42
	140	42,000	SGL.ACT.	60	14,000	36	1,164	1,500	179	110	3	30,750	12-10	42
	160D	41,280	DIFFER.	103	16,000	15 1/2	1,550	2,000	237	160	3	35,400	13-7 1/2	42
	125	40,625	SGL.ACT.	50	13,500	39	940	1,500	120	125	2 1/2	21,940	14-10	33
	115	37,375	SGL.ACT.	50	11,500	39	910	1,200	99	120	2 1/2	20,780	15-0	32
	140D	36,000	DIFFER.	103	14,000	15 1/2	1,425	1,800	211	140	3	31,200	12-5	42
	100	32,500	SGL.ACT.	50	10,000	39	820	1,050	85	100	2 1/2	19,280	14-2	33
	80	26,000	SGL.ACT.	50	8,000	39	730	1,050	75	85	2 1/2	17,280	14-2	33
	65	19,500	SGL.ACT.	60	6,500	36	650	750	67	100	2	12,100	13-0	26
	50	15,000	SGL.ACT.	60	5,000	36	565	600	54	80	2	10,600	13-0	26
MKT	820	60,000	SGL.ACT.	60	20,000	36			190	150	3	38,650	15-6	36
	814	37,500	SGL.ACT.	60	14,000	32			155	100	3	31,700	13-7	36
	810	32,500	SGL.ACT.	55	10,000	39	1,000	1,500	130	80	2 1/2	20,380	14-1	30
	11B-3	19,150	DBL.ACT.	95	5,000	19	900	1,200	128	100	2 1/2	14,000	11-1 1/2	26
	10B-3	13,100	DBL.ACT.	105	3,000	19	750	1,200	104	100	2 1/2	10,850	9-2	24
	9B-3	8,750	DBL.ACT.	145	1,600	17	600	900	85	100	2	7,600	8-3 3/4	20
	7	4,150	DBL.ACT.	215	800	9 1/2	450	750	65	100	1 1/2	5,000	6-0 1/2	21
	6	2,500	DBL.ACT.	275	400	8 3/4	400	600	45	100	1 1/4	2,900	5-3 1/8	15
	5	1,000	DBL.ACT.	300	200	7	250	450	35	100	1 1/4	1,500	4-9	11
VULCAN	530	150,000	SGL.ACT.	42	30,000	60	2,076	2,400	340	150	5	55,160	21-5	37
	520	100,000	SGL.ACT.	42	20,000	60	1,652	2,000	250	102	5	45,160	21-6	37
	400C	113,884	SGL.ACT.	100	40,000	16 1/2	4,652		700	150	5	91,200	16-3 1/2	80
	050	90,000	SGL.ACT.	55	30,000	36	1,833	2,000	247	150	3	55,410	16-4	54
	512	60,000	SGL.ACT.	41	12,000	60	1,094	1,200	200	100	2 1/2	29,400	18-5	26
	020	60,000	SGL.ACT.	60	20,000	36	1,634	2,000	217	120	3	40,785	15-0	54
	300C	50,200	DBL.ACT.	98	20,000	15 1/2	1,746	2,000	240	142		39,000	13-2	37
	510	50,000	SGL.ACT.	41	10,000	60	852	1,050	160	85	2 1/2	21,480	18-5	26
	016	48,750	SGL.ACT.	60	16,250	36	1,282	1,500	210	120	3	33,300	14-6	32
	014	42,000	SGL.ACT.	60	14,000	36	1,200	1,500	200	110	3	27,500	14-6	32
	508	40,000	SGL.ACT.	41	8,000	60	818	900	150	65	2 1/2	19,480	18-5	26
	140C	36,000	DBL.ACT.	103	14,000	15 1/2	1,425	1,750	211	140	3	27,954	12-3	32
	506	32,500	SGL.ACT.	46	6,500	60	744	900	112	100	2	13,025	17-5	20
	010	32,500	SGL.ACT.	50	10,000	39	1,002	1,200	157	105	2 1/2	18,750	15-0	26
	08	30,225	SGL.ACT.	55	9,300	39	1,020	1,200	148	2 1/2	100	18,050	15-0	26
	505	25,000	SGL.ACT.	46	5,000	60	563	600	92	77	2	11,800	17-5	20
	80C	24,450	DBL.ACT.	111	8,000	16 1/2	1,245	1,500	163	120	2 1/2	17,885	13-1 5/8	26
	0	24,375	SGL.ACT.	50	7,500	39	841	900	128	80	2 1/2	16,250	15-0	26
	06 (100)	19,500	SGL.ACT.	60	6,500	36	625	900	94	100	2	1,200	13-9	20
	65C	19,200	DBL.ACT.	117	6,500	15 1/2	991	1,200	152	150	2	14,886	12-1	20
	50C	15,100	DBL.ACT.	120	5,000	15 1/2	884	900	125	120	2	11,782	20-0	20
	1 (100)	15,000	SGL.ACT.	60	5,000	36	565	600	81	80	2	8,700	12-9	20
	30C	7,260	DBL.ACT.	135	3,000	19 1/2	488	600	40	120	1 1/2	7,036	8-11	19
	2	7,260	SGL.ACT.	79	3,000	29	336	450	49	80	1 1/2	6,790	11-6	19
	DGH-900	5,750	DBL.ACT.	360	900	10	877	900	115	78	1 1/2	5,000	6-9	18
	18C	3,600	DBL.ACT.	159	1,800	10 1/2	568	450	45	120	1 1/4	4,139	8-3 1/8	6 1/4
	DGH-100D	643	DBL.ACT.	595	100	6	120	125		100	1	786	4-2	8 3/4

NOTES:

1 Air required at the hammer or extractor. See Note 2.

2 Compressor output must exceed air required at hammer due to line and efficiency losses. Vulcan states " It is advisable that the adiabatic consumption figure be increased by approximately 30 per cent in the determination of the required compressor size." MKT states "Generally, to assure satisfactory hammer operation, your compressor should be able to deliver 150 per cent of this actual compressed volume.

3 MKT hammers are listed with flat anvils. Vulcan and Conmaco hammers are listed with standard base, no drive cap. Menck hammers are listed without drive cap.

DIESEL HAMMERS

MFGR.	MODEL	RATED ENERGY [1] (FT.-LBS.)	TYPE	BLOWS [1] PER MINUTE	WEIGHT OF RAM (LBS.)	MAX [1,2] STROKE (INCHES	EIGHT (LBS.)	ENGTH (FT.-IN.)	WIDTH AT [4] LEAD GUIDES (INCHES)
DELMAG	D46-02	48,400 to 105,000	SGL.ACT.	37-53	10120	128	19900	17-3	32
	D44	43,500 to 87,000		37-56	9500	137	22300	15-10	37
	D36-02	38,000 to 83,100		37-53	7900	128	17700	17-3	32
	D30-02	31,800 to 62,900		38-54	6600	127	13150	17-2	26
	D30	23,800 to 54250		39-60	6600	126	12350	14-2	26
	D22-02	24,600 to 48,400		38-54	4850	127	11400	17-2	26
	D22	39700		40-60	4850	127	11200	14-2	26
	D15	27100		40-60	3300	132	6600	13-11	20
	D12	22500		40-60	2750	130	6050	13-11	20
	D5	9100		42-60	1100	116	2750	12-6	15 3/8
KOBE	K45	91100		39-60	9920	110	25600	18-6	36
	K42	79000		40-60	9260	102	24000	18-6	36
	K35	70800		39-60	7720	110	18700	17-8	36
	K32	60100		40-60	7050	102	17750	17-8	30
	K25	50700		39-60	5510	110	13100	17-6	26
	K22	41300		40-60	4850	102	12350	17-6	26
	K13	25200		40-60	2870	106	8000	16-8	26
I.C.E. / LINK BELT	1070	70000	DBL.ACT.	64-68	10000	7-0	21500	17-10	30
	660	50000		84-88	7564	6-7	24480	17-0 4/3	30
	640	40000		74-77	6000	6-8	15600	16-2	26
	520	30000		80-84	5070	5-11	14200	14-4	26
	422	22500		76-82	4000	5-8	9750	13-11	22
	440	18100		88-92	4000	4-8	9839	13-6	20
	312	18000		100-105	3857	4-7	10375	10-9	26
	180	8100		90-95	1725	4-9	4645	11-3	20
MITSUBISHI	MB70	141000	SGL.ACT.	38-60	15840	107	46000	19-6	42
	MH45	84300		42-60	9920	102	24500	15-8	37
	M43	84000		40-60	9460	107	22660	16-3	37
	MH35	65600		42-60	7720	102	18500	15-1	32
	M33	64000		40-60	7260	106	16940	15-8	32
	MH25	46900		42-60	5510	102	13200	14-6	28
	M23	45000		42-60	5060	107	11220	14-0	26
	MH15	28100		42-60	3310	102	8400	13-11	26
	M145	26000		42-60	2970	105	7260	13-6	26
MKT	DE70B/50B[5]	59500		40-50	7000	8-6	14700	16-11	26
	DE70B/50B[5]	42500		40-50	5000	8-6	12700	16-11	26
	DA55C[6]	42500	DBL.ACT.	40-50	5000	8-6	17000	17-4	26
	DA55C[6]	38200		78-82	5000		17000	17-4	26
	DE33/30B/20B[5]	28050		40-50	3300	8-6	7750	15-11	20
	DE33/30B/20B[5]	23800		40-50	2800	8-6	7250	15-11	20
	DA35C[6]	23800		40-50	2800	8-6	10800	17-0	20
	DA35C[6]	21000	DBL.ACT.	78-82	2800		10800	17-0	20
	DE33/30B/20B[5]	17000	SGL.ACT.	40-50	2000	8-6	6450	15-11	20

NOTES:

1 Rated energy, blows per minute and stroke vary with soil resistance and fuel setting.

2 Equivalent stroke for double-acting hammers.

3 Without drive caps.

4 For box leads, Delmag hammers require adapters to fit box leads.

5 Different rams useable with same hammer.

6 Convertible from single-acting to double-acting.

VIBRATORY DRIVER/EXTRACTORS

MFGR	MODEL	ECCENTRIC MOMENT IN-LBS	TYPE	FREQUENCY	AMPLITUDE INCHES	HP	MAX LINE PULL FOR EXTRACTION	PILE CLAMPING FORCE TONS	SUSPENDED WEIGHT LBS.	SHIPPING WEIGHT	LENGTH FT. - IN.	WIDTH FT. - IN.
I.C.E.	1412	8000	HYDRAULIC	400-1200	1-1 1/2	780	80	250	31700	52300	13 - 08	8 - 0
	812	4000	HYDRAULIC	400-1600	1/2-1	570	40	100	15600	30500	9 09	8 - 0
	612	4000	HYDRAULIC	400-1200	1/4-1	250	40	100	15600	24500	8 - 0	2 - 0
	416	2000	HYDRAULIC	400-1600	1/4-1	325	40	100	13100	22000	8 - 09	8 - 0
	216	1000	HYDRAULIC	400-1600	1/4 - 3/4	185	30	50	4825	12450	6 - 06	3 - 11
	116	600	HYDRAULIC	400-1600	1/4 - 5/8	105	20	50	4200	10100	5 - 09	3 - 09
VULCAN	1150	1150	HYDRAULIC	1600	3/4	131	33	50	6500	13500	9 - 09	3 - 09
	2300	2300	HYDRAULIC	1600	1	258	33	87	8200	18700	10 - 10	3 - 09
	4600	4600	HYDRAULIC	1600	1 1/4	515	66	176	16000	32500	11 - 02	6 - 03
H & M	H-75A		HYDRAULIC	18-2300	3/8 - 1/2	175	20	62	400/7500	12500	5 - 07	3 - 01
	H-2750	3400	HYDRAULIC	900-1000	3/4 - 1	250	30	100	11000	17500		
MKT	V-36	5000	HYDRAULIC	1600	0.75	580	80	100	18800	36300	12 - 03	9 - 11
	V-20	2600	HYDRAULIC	1700	0.63	310	60	70	12500	23900	10 - 11	8 - 00
	V-5	1000	HYDRAULIC	1640	0.50	79	25	62	6800	10800	8 - 03	6 - 07

NOTES:

1 Includes vibrator, typical hydraulic clamp, and power cables or horses.

2 Includes vibrator, clamp, generator or hydraulic power pack, power cables or hoses.

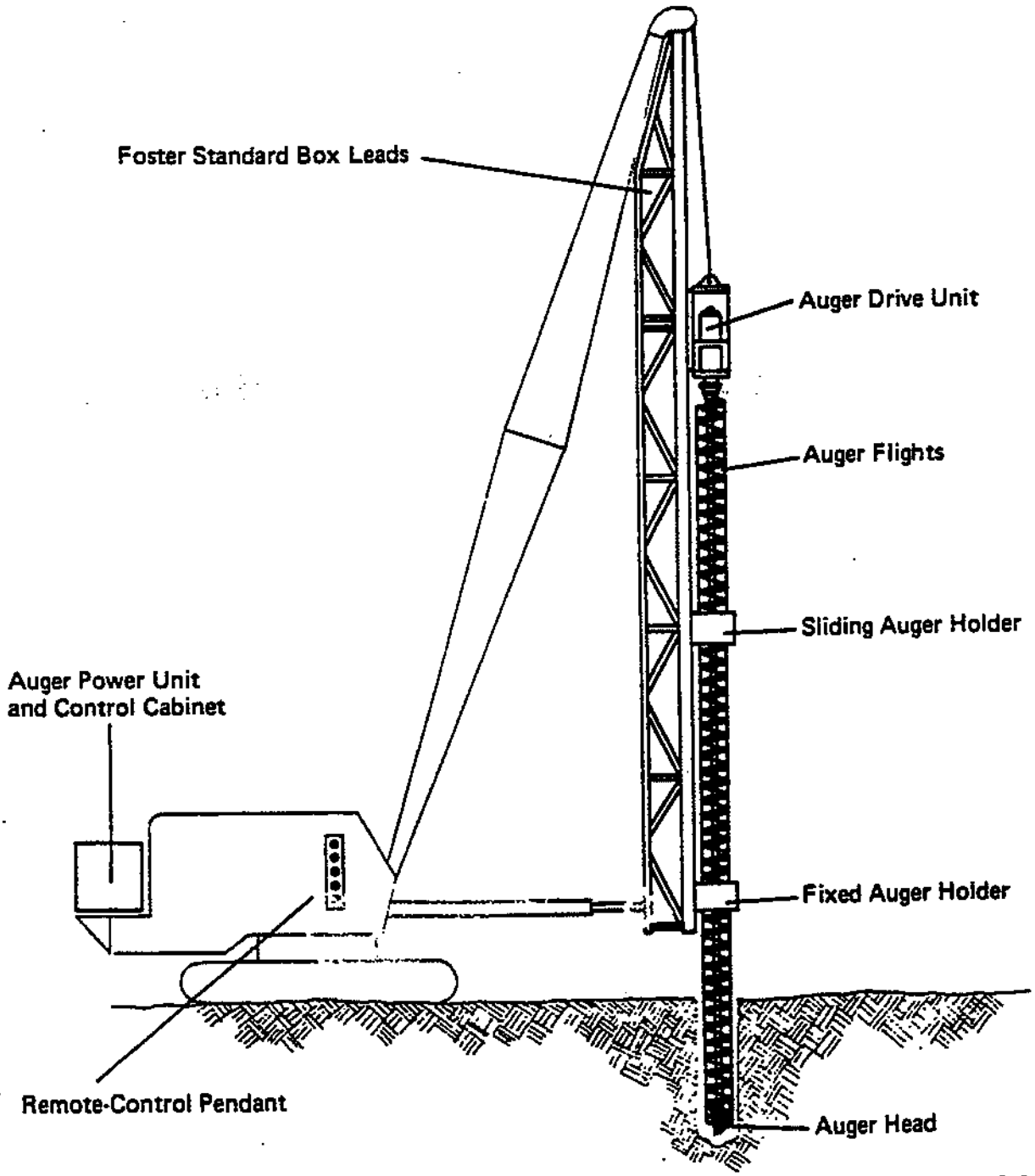
3 For standard sheet piling clamp.

4 Distributed in United States by L.B. Foster Co.

TYPICAL AUGER OPERATING CONFIGURATION

A typical auger set-up in standard pile driving leads is shown below. The Auger Drive Unit is equipped with guide channels for 26" box leads. The Auger Flights are supported during drilling by a Fixed Auger Holder attached to the bottom of the leads and a Sliding Auger Holder which moves downward during drilling. The Auger Head cuts through the soil and feeds it onto the Auger Flights. The Auger Power Unit is normally mounted on the back of the crane for maximum mobility. The augering operation is controlled by the Remote-Control Pendant which can be located in the crane cab.

For predrilling for piling, the auger is often mounted on the side of standard box leads as pictured in the photograph at the left. This permits the pile hammer to operate in its normal position. On larger jobs, separate cranes may be used for augering and for pile driving.



Updated January 2007

				English Units			SI Units		
ID	Hammer Manufacturer	Hammer Model	Hammer Type	Energy/Power (klp-ft)/(kW)	Ram Weight (klps)	Stroke (ft)	Energy/Power (kJ)/(kW)	Ram Weight (kN)	Stroke (m)
777	APE	100	VIB	194	0.318	30	194	1.415	30
778	APE	100E	VIB	194	0.144	30	194	0.642	30
779	APE	100HF	VIB	260	0.144	43	260	0.642	43
595	APE	Oct-60	ECH	80	20	4	108.48	89	1.22
772	APE	15	VIB	59.67	0.108	30	59.67	0.481	30
780	APE	150	VIB	260	0.144	30	260	0.642	30
782	APE	150HF	VIB	466	0.32	43	466	1.424	43
781	APE	150T	VIB	260	0.17	30	260	0.759	30
594	APE	15-60	ECH	150	30	5	203.4	133.5	1.52
773	APE	20	VIB	59.67	0.15	38.3	59.67	0.668	38.3
783	APE	200	VIB	466	0.289	30	466	1.284	30
784	APE	200T	VIB	466	0.341	30.83	466	1.517	30.83
785	APE	200T HF	VIB	738	0.341	43	738	1.517	43
774	APE	20E	VIB	59.67	0.15	38.3	59.67	0.668	38.3
770	APE	3	VIB	10.58	0.004	38.3	10.58	0.019	38.3
786	APE	300	VIB	738	0.342	25	738	1.522	25
787	APE	400B	VIB	738	0.78	23.33	738	3.471	23.33
591	APE	5.4mT	ECH	26	12	2.17	35.26	53.4	0.66
775	APE	50	VIB	194	0.233	30	194	1.037	30
776	APE	50E	VIB	194	0.233	30	194	1.037	30
771	APE	6	VIB	10.58	0.009	38.3	10.58	0.038	38.3
788	APE	600	VIB	800	1.052	23.3	800	4.681	23.3
592	APE	7.2mT	ECH	51.3	16.2	3.17	69.56	72.09	0.97
570	APE	D 1	OED	1.95	0.308	6.67	2.65	1.371	2.03
577	APE	D 100-13	OED	246.3	22.03	11.18	333.98	98.034	3.41
584	APE	D 12-42	OED	34	2.83	12.36	46.11	12.593	3.77
582	APE	D 125-32	OED	307.29	27.56	11.15	416.69	122.642	3.4
579	APE	D 16-32	OED	39.36	3.53	11.25	53.37	15.708	3.43
571	APE	D 19-32	OED	42.82	4.19	10.25	58.07	18.646	3.12
580	APE	D 19-42	OED	42.82	4.19	10.6	58.07	18.646	3.23
581	APE	D 25-32	OED	57.88	5.512	10.5	78.48	24.528	3.2
572	APE	D 30-32	OED	70.07	6.61	10.6	95.01	29.414	3.23
573	APE	D 36-32	OED	84.06	7.93	10.6	113.98	35.288	3.23
574	APE	D 46-32	OED	107.48	10.14	10.6	145.75	45.123	3.23
583	APE	D 50-32	OED	115.76	11.025	13.1	156.97	49.061	3.99
575	APE	D 62-22	OED	161.46	13.66	11.82	218.94	60.787	3.6
576	APE	D 80-23	OED	196.99	17.62	11.18	267.12	78.409	3.41
569	APE	D 8-22	OED	17.94	1.764	12.5	24.32	7.848	3.81
578	APE	D 8-32	OED	18	1.76	10.25	24.41	7.832	3.12
596	APE	HI 400U	ECH	400	80	5	542.4	356	1.52
789	APE	Tan 400	VIB	1476	1.368	23.33	1476	6.088	23.33
790	APE	Tan 600	VIB	1800	2.105	23.3	1800	9.367	23.3
541	BANUT	3 Tonnes	ECH	17.34	6.61	2.62	23.52	29.414	0.8
542	BANUT	4 Tonnes	ECH	23.14	8.82	2.62	31.38	39.249	0.8
543	BANUT	5 Tonnes	ECH	28.92	11.02	2.62	39.21	49.039	0.8
544	BANUT	6 Tonnes	ECH	34.72	13.23	2.62	47.07	58.873	0.8
545	BANUT	7 Tonnes	ECH	40.49	15.43	2.62	54.9	68.663	0.8

540	BANUT	S10000	ECH	86.81	22.05	3.94	117.72	98.122	1.2
535	BANUT	S3000	ECH	26.04	6.615	3.94	35.31	29.437	1.2
536	BANUT	S4000	ECH	34.72	8.82	3.94	47.09	39.249	1.2
537	BANUT	S5000	ECH	43.41	11.025	3.94	58.86	49.061	1.2
538	BANUT	S6000	ECH	52.09	13.23	3.94	70.63	58.873	1.2
539	BANUT	S8000	ECH	69.45	17.64	3.94	94.17	78.498	1.2
402	BERMINGH	B200	OED	18	2	9	24.41	8.9	2.74
422	BERMINGH	B200 5	OED	21	2	10.5	28.48	8.9	3.2
423	BERMINGH	B2005	OED	24.12	2.68	9	32.71	11.926	2.74
406	BERMINGH	B21	OED	53.25	4.63	11.5	72.2	20.604	3.51
403	BERMINGH	B225	OED	29.25	3	9.75	39.66	13.35	2.97
401	BERMINGH	B23	CED	22.99	2.8	8.21	31.17	12.46	2.5
414	BERMINGH	B23 5	CED	22.99	2.8	8.21	31.17	12.46	2.5
415	BERMINGH	B250 5	OED	26.25	2.5	10.5	35.59	11.125	3.2
424	BERMINGH	B2505	OED	35.4	3	11.8	48	13.35	3.6
404	BERMINGH	B300	OED	40.31	3.75	10.75	54.66	16.688	3.28
410	BERMINGH	B300 M	OED	40.31	3.75	10.75	54.66	16.688	3.28
425	BERMINGH	B3005	OED	35.4	3	11.8	48	13.35	3.6
416	BERMINGH	B3505	OED	47.2	4	11.8	64	17.8	3.6
405	BERMINGH	B400	OED	53.75	5	10.75	72.88	22.25	3.28
412	BERMINGH	B400 4.8	OED	43.2	4.8	9	58.58	21.36	2.74
413	BERMINGH	B400 5.0	OED	45	5	9	61.02	22.25	2.74
411	BERMINGH	B400 M	OED	53.75	5	10.75	72.88	22.25	3.28
417	BERMINGH	B4005	OED	59	5	11.8	80	22.25	3.6
418	BERMINGH	B4505	OED	77.88	6.6	11.8	105.61	29.37	3.6
419	BERMINGH	B5005	OED	92.04	7.8	11.8	124.81	34.71	3.6
421	BERMINGH	B550 C	OED	88	11	8	119.33	48.95	2.44
420	BERMINGH	B5505	OED	108.56	9.2	11.8	147.21	40.94	3.6
431	BERMINGH	B6005	OED	160.95	13.64	11.8	218.25	60.698	3.6
433	BERMINGH	B6505	OED	207.68	17.6	11.8	281.61	78.32	3.6
432	BERMINGH	B6505 C	OED	253	22	11.5	343.07	97.9	3.51
530	BRUCE	SGH-0312	ECH	26.04	6.61	3.94	35.31	29.414	1.2
531	BRUCE	SGH-0512	ECH	43.42	11.02	3.94	58.88	49.039	1.2
532	BRUCE	SGH-0712	ECH	60.8	15.432	3.94	82.45	68.672	1.2
533	BRUCE	SGH-1012	ECH	86.86	22.046	3.94	117.78	98.105	1.2
625	BRUCE	SGH-1212	ECH	104.25	26.46	3.94	141.37	117.747	1.2
626	BRUCE	SGH-1312	ECH	112.92	28.66	3.94	153.12	127.537	1.2
627	BRUCE	SGH-1315	ECH	141.01	28.66	4.92	191.21	127.537	1.5
628	BRUCE	SGH-1412	ECH	121.63	30.87	3.94	164.93	137.371	1.2
629	BRUCE	SGH-1415	ECH	151.88	30.87	4.92	205.95	137.371	1.5
630	BRUCE	SGH-1612	ECH	138.96	35.27	3.94	188.43	156.951	1.2
631	BRUCE	SGH-1615	ECH	173.53	35.27	4.92	235.3	156.951	1.5
632	BRUCE	SGH-1618	ECH	208.09	35.27	5.9	282.17	156.951	1.8
633	BRUCE	SGH-1619	ECH	219.73	35.27	6.23	297.96	156.951	1.9
634	BRUCE	SGH-1812	ECH	156.34	39.68	3.94	212	176.576	1.2
635	BRUCE	SGH-1815	ECH	195.23	39.68	4.92	264.73	176.576	1.5
636	BRUCE	SGH-2012	ECH	173.71	44.09	3.94	235.56	196.2	1.2
637	BRUCE	SGH-2015	ECH	216.92	44.09	4.92	294.15	196.2	1.5
638	BRUCE	SGH-2312	ECH	199.8	50.71	3.94	270.93	225.659	1.2
639	BRUCE	SGH-2315	ECH	249.49	50.71	4.92	338.31	225.659	1.5
640	BRUCE	SGH-3012	ECH	260.59	66.14	3.94	353.36	294.323	1.2
641	BRUCE	SGH-3013	ECH	282.42	66.14	4.27	382.96	294.323	1.3

642	BRUCE	SGH-3015	ECH	325.41	66.14	4.92	441.25	294.323	1.5
643	BRUCE	SGH-4012	ECH	347.47	88.19	3.94	471.17	392.445	1.2
644	BRUCE	SGH-4212	ECH	364.84	92.6	3.94	494.73	412.07	1.2
645	BRUCE	SGH-5012	ECH	434.31	110.23	3.94	588.92	490.523	1.2
396	BSP	CG180	ECH	131.92	26.454	4.99	178.89	117.72	1.52
397	BSP	CG210	ECH	153.91	30.863	4.99	208.7	137.34	1.52
398	BSP	CG240	ECH	175.9	35.272	4.99	238.52	156.96	1.52
399	BSP	CG270	ECH	197.88	39.681	4.99	268.33	176.58	1.52
400	BSP	CG300	ECH	219.87	44.09	4.99	298.14	196.2	1.52
379	BSP	CX110	ECH	78.11	19.84	3.94	105.92	88.29	1.2
600	BSP	CX165	ECH	120.93	24.249	4.99	163.98	107.91	1.52
601	BSP	CX180	ECH	131.92	26.454	4.99	178.89	117.72	1.52
602	BSP	CX210	ECH	153.91	30.863	4.99	208.7	137.34	1.52
603	BSP	CX240	ECH	175.9	35.272	4.99	238.52	156.96	1.52
604	BSP	CX270	ECH	197.88	39.681	4.99	268.33	176.58	1.52
605	BSP	CX300	ECH	219.87	44.09	4.99	298.14	196.2	1.52
374	BSP	CX40	ECH	28.21	6.613	4.27	38.25	29.43	1.3
375	BSP	CX50	ECH	37.61	8.818	4.27	51	39.24	1.3
376	BSP	CX60	ECH	47.01	11.022	4.27	63.75	49.05	1.3
377	BSP	CX75	ECH	52.07	13.227	3.94	70.61	58.86	1.2
378	BSP	CX85	ECH	60.75	15.431	3.94	82.38	68.67	1.2
391	BSP	HA30	ECH	260.37	66.135	3.94	353.07	294.3	1.2
392	BSP	HA40	ECH	347.16	88.18	3.94	470.76	392.4	1.2
380	BSP	HH1.5	ECH	16.25	3.303	4.92	22.04	14.698	1.5
386	BSP	HH11-1.2	ECH	95.54	24.25	3.94	129.56	107.912	1.2
393	BSP	HH11-1.5	ECH	119.31	24.25	4.92	161.78	107.912	1.5
387	BSP	HH14-1.2	ECH	121.59	30.86	3.94	164.87	137.327	1.2
394	BSP	HH14-1.5	ECH	151.83	30.86	4.92	205.88	137.327	1.5
388	BSP	HH16-1.2	ECH	138.87	35.272	3.94	188.3	156.96	1.2
395	BSP	HH16-1.5	ECH	173.54	35.272	4.92	235.32	156.96	1.5
389	BSP	HH20	ECH	173.58	44.09	3.94	235.38	196.2	1.2
390	BSP	HH20S	ECH	173.58	44.09	3.94	235.38	196.2	1.2
381	BSP	HH3	ECH	26.02	6.611	3.94	35.29	29.42	1.2
382	BSP	HH5	ECH	43.37	11.02	3.94	58.82	49.039	1.2
383	BSP	HH7	ECH	60.78	15.427	3.94	82.42	68.65	1.2
384	BSP	HH8	ECH	69.5	17.64	3.94	94.24	78.498	1.2
385	BSP	HH9	ECH	78.17	19.84	3.94	106	88.288	1.2
369	BSP	SL20	ECH	14.11	3.308	4.27	19.13	14.72	1.3
370	BSP	SL30	ECH	21.69	5.51	3.94	29.42	24.52	1.2
176	CONMACO	C 100	ECH	32.5	10	3.25	44.07	44.5	0.99
179	CONMACO	C 100E5	ECH	50	10	5	67.8	44.5	1.52
177	CONMACO	C 115	ECH	37.38	11.5	3.25	50.68	51.175	0.99
180	CONMACO	C 115E5	ECH	57.5	11.5	5	77.97	51.175	1.52
181	CONMACO	C 125E5	ECH	62.5	12.5	5	84.75	55.625	1.52
182	CONMACO	C 140	ECH	42	14	3	56.95	62.3	0.91
183	CONMACO	C 160	ECH	48.75	16.25	3	66.1	72.312	0.91
191	CONMACO	C 160 **	ECH	51.78	17.26	3	70.21	76.807	0.91
184	CONMACO	C 200	ECH	60	20	3	81.36	89	0.91
194	CONMACO	C 200E5	ECH	100	20	5	135.6	89	1.52
185	CONMACO	C 300	ECH	90	30	3	122.04	133.5	0.91
195	CONMACO	C 300E5	ECH	150	30	5	203.4	133.5	1.52
171	CONMACO	C 50	ECH	15	5	3	20.34	22.25	0.91

192	CONMACO	C 50E5	ECH	25	5	5	33.9	22.25	1.52
186	CONMACO	C 5200	ECH	100	20	5	135.6	89	1.52
187	CONMACO	C 5300	ECH	150	30	5	203.4	133.5	1.52
188	CONMACO	C 5450	ECH	225	45	5	305.1	200.25	1.52
173	CONMACO	C 550	ECH	25	5	5	33.9	22.25	1.52
174	CONMACO	C 565	ECH	32.5	6.5	5	44.07	28.925	1.52
189	CONMACO	C 5700	ECH	350	70	5	474.6	311.5	1.52
172	CONMACO	C 65	ECH	19.5	6.5	3	26.44	28.925	0.91
193	CONMACO	C 65E5	ECH	32.5	6.5	5	44.07	28.925	1.52
190	CONMACO	C 6850	ECH	510	85	6	691.56	378.25	1.83
175	CONMACO	C 80	ECH	26	8	3.25	35.26	35.6	0.99
178	CONMACO	C 80E5	ECH	40	8	5	54.24	35.6	1.52
521	DAWSON	HPH1200	ECH	8.72	2.3	3.79	11.82	10.235	1.16
522	DAWSON	HPH1800	ECH	13.72	3.3	4.16	18.61	14.685	1.27
523	DAWSON	HPH2400	ECH	17.32	4.189	4.13	23.48	18.64	1.26
525	DAWSON	HPH4500	ECH	32.56	7.716	4.22	44.15	34.338	1.29
524	DAWSON	HPH6500	ECH	46.98	10.25	4.58	63.7	45.612	1.4
526	DAWSON	HPH9000	ECH	66.3	10.471	6.33	89.91	46.596	1.93
3	DELMAG	D 12	OED	22.61	2.75	10.8	30.65	12.237	3.29
37	DELMAG	D 12-32	OED	31.33	2.82	11.81	42.48	12.549	3.6
38	DELMAG	D 12-42	OED	33.3	2.82	11.81	45.16	12.549	3.6
39	DELMAG	D 14-42	OED	34.5	3.086	11.81	46.78	13.733	3.6
4	DELMAG	D 15	OED	27.09	3.3	10.8	36.74	14.685	3.29
5	DELMAG	D 16-32	OED	40.2	3.52	11.76	54.51	15.664	3.58
40	DELMAG	D 19-32	OED	42.44	4	11.76	57.55	17.8	3.58
41	DELMAG	D 19-42	OED	43.24	4	11.86	58.63	17.8	3.61
35	DELMAG	D 19-52	OED	43.24	4	11.86	58.63	17.8	3.61
46	DELMAG	D 21-42	OED	55.75	4.63	14	75.59	20.604	4.27
6	DELMAG	D 22	OED	40.61	4.91	9.5	55.06	21.849	2.9
7	DELMAG	D 22-02	OED	48.5	4.85	13.44	65.77	21.582	4.1
8	DELMAG	D 22-13	OED	48.5	4.85	13.44	65.77	21.582	4.1
9	DELMAG	D 22-23	OED	51.22	4.85	13.44	69.45	21.582	4.1
10	DELMAG	D 25-32	OED	66.34	5.51	13.76	89.96	24.52	4.19
11	DELMAG	D 30	OED	59.73	6.6	9.5	80.99	29.37	2.9
12	DELMAG	D 30-02	OED	66.2	6.6	13.44	89.76	29.37	4.1
13	DELMAG	D 30-13	OED	66.2	6.6	13.44	89.76	29.37	4.1
14	DELMAG	D 30-23	OED	73.79	6.6	13.44	100.06	29.37	4.1
15	DELMAG	D 30-32	OED	75.44	6.6	13.73	102.29	29.37	4.18
16	DELMAG	D 36	OED	83.82	7.93	10.57	113.66	35.288	3.22
17	DELMAG	D 36-02	OED	83.82	7.93	12.98	113.66	35.288	3.96
18	DELMAG	D 36-13	OED	83.82	7.93	19.98	113.66	35.288	6.09
19	DELMAG	D 36-23	OED	88.5	7.93	12.98	120	35.288	3.96
20	DELMAG	D 36-32	OED	90.56	7.93	13.14	122.8	35.288	4.01
21	DELMAG	D 44	OED	90.15	9.5	9.52	122.25	42.275	2.9
22	DELMAG	D 46	OED	107.08	10.14	10.57	145.2	45.123	3.22
23	DELMAG	D 46-02	OED	107.08	10.14	12.94	145.2	45.123	3.94
24	DELMAG	D 46-13	OED	96.53	10.14	12.94	130.9	45.123	3.94
25	DELMAG	D 46-23	OED	107.08	10.14	12.94	145.2	45.123	3.94
26	DELMAG	D 46-32	OED	122.19	10.14	13.1	165.69	45.123	3.99
1	DELMAG	D 5	OED	10.51	1.1	9.62	14.24	4.895	2.93
47	DELMAG	D 5-42	OED	10.56	1.1	9.6	14.32	4.895	2.93
27	DELMAG	D 55	OED	125	11.86	11.15	169.51	52.777	3.4

28	DELMAG	D 62-02	OED	152.45	13.66	12.71	206.72	60.787	3.87
29	DELMAG	D 62-12	OED	152.45	13.66	12.71	206.72	60.787	3.87
30	DELMAG	D 62-22	OED	164.6	13.66	13.26	223.2	60.787	4.04
36	DELMAG	D 6-32	OED	13.52	1.322	10.23	18.34	5.883	3.12
31	DELMAG	D 80-12	OED	186.24	17.62	12.87	252.55	78.409	3.92
32	DELMAG	D 80-23	OED	212.5	17.62	13.05	288.15	78.409	3.98
2	DELMAG	D 8-22	OED	20.1	1.76	12.05	27.25	7.832	3.67
33	DELMAG	D100-13	OED	265.67	22.066	13.5	360.25	98.194	4.11
43	DELMAG	D120-42	OED	301.79	26.45	11.81	409.23	117.702	3.6
45	DELMAG	D125-42	OED	313.63	27.56	13.6	425.29	122.642	4.15
44	DELMAG	D150-42	OED	377.33	33.07	11.81	511.66	147.161	3.6
42	DELMAG	D200-42	OED	492.04	44.09	16.83	667.21	196.2	5.13
804	DKH	PH-10	ECH	86.79	22.045	3.94	117.69	98.1	1.2
805	DKH	PH-13	ECH	112.83	28.658	3.94	153	127.53	1.2
806	DKH	PH-20	ECH	216.98	44.09	4.92	294.22	196.2	1.5
807	DKH	PH-30	ECH	325.47	66.135	4.92	441.33	294.3	1.5
808	DKH	PH-40	ECH	433.96	88.18	4.92	588.44	392.4	1.5
801	DKH	PH-5	ECH	43.4	11.023	3.94	58.84	49.05	1.2
802	DKH	PH-7	ECH	60.75	15.432	3.94	82.38	68.67	1.2
803	DKH	PH-7S	ECH	60.75	15.432	3.94	82.38	68.67	1.2
372	FAIRCHLD	F-32	ECH	32.55	10.85	3	44.14	48.283	0.91
371	FAIRCHLD	F-45	ECH	45	15	3	61.02	68.75	0.91
56	FEC	D-18	OED	39.7	3.97	11.76	53.83	17.667	3.58
50	FEC	FEC 1200	OED	22.5	2.75	8.18	30.5	12.237	2.49
51	FEC	FEC 1500	OED	27.09	3.3	8.21	36.74	14.685	2.5
52	FEC	FEC 2500	OED	50	5.5	9.09	67.79	24.475	2.77
53	FEC	FEC 2800	OED	55.99	6.16	9.09	75.93	27.412	2.77
54	FEC	FEC 3000	OED	63.03	6.6	9.55	85.47	29.37	2.91
55	FEC	FEC 3400	OED	73	7.48	9.76	98.99	33.286	2.97
350	HERA	1250	OED	25.34	2.809	9.02	34.36	12.5	2.75
351	HERA	1500	OED	30.4	3.371	9.02	41.23	15	2.75
349	HERA	1900	OED	44.41	4.19	10.6	60.23	18.646	3.23
352	HERA	2500	OED	50.67	5.618	9.02	68.71	25	2.75
353	HERA	2800	OED	56.76	6.292	9.02	76.96	28	2.75
354	HERA	3500	OED	70.94	7.865	9.02	96.2	35	2.75
355	HERA	5000	OED	101.35	11.236	9.02	137.43	50	2.75
356	HERA	5700	OED	115.54	12.809	9.02	156.67	57	2.75
357	HERA	6200	OED	125.67	13.933	9.02	170.41	62	2.75
358	HERA	7500	OED	152.02	16.854	9.02	206.14	75	2.75
359	HERA	8800	OED	178.37	19.775	9.02	241.87	88	2.75
92	HITACHI	HNC100	ECH	86.79	22.045	3.94	117.69	98.1	1.2
93	HITACHI	HNC125	ECH	108.49	27.557	3.94	147.12	122.63	1.2
90	HITACHI	HNC65	ECH	56.42	14.33	3.94	76.5	63.77	1.2
91	HITACHI	HNC80	ECH	69.43	17.636	3.94	94.15	78.48	1.2
734	HMC	115+800	VIB	597	1.347	20.4	597	5.994	20.4
564	HMC	119	ECH	88	22	4	119.33	97.9	1.22
722	HMC	13+200	VIB	149	0.353	26.7	149	1.569	26.7
724	HMC	13H+200	VIB	164	0.353	29.8	164	1.569	29.8
723	HMC	13S+200	VIB	149	0.353	26.7	149	1.569	26.7
565	HMC	149	ECH	110	27.5	4	149.16	122.375	1.22
566	HMC	187	ECH	138	34.5	4	187.13	153.525	1.22
567	HMC	19D	ECH	14	3.5	4	18.98	15.575	1.22

735	HMC	230+1600	VIB	1193	2.694	20.4	1193	11.988	20.4
725	HMC	25+220	VIB	164	0.605	20.9	164	2.694	20.9
726	HMC	26+335	VIB	242	0.705	25.6	242	3.139	25.6
727	HMC	26S+335	VIB	242	0.705	25.6	242	3.139	25.6
560	HMC	28A	ECH	28	7	4	37.97	31.15	1.22
561	HMC	28B	ECH	21	7	3	28.48	31.15	0.91
720	HMC	3+28	VIB	21	0.108	26.8	21	0.483	26.8
721	HMC	3+75	VIB	56	0.108	36.1	56	0.483	36.1
568	HMC	38D	ECH	28	7	4	37.97	31.15	1.22
728	HMC	51+335	VIB	242	1.211	19.5	242	5.389	19.5
729	HMC	51+535	VIB	377	1.211	26.4	377	5.389	26.4
731	HMC	51+740	VIB	485	1.211	27.5	485	5.389	27.5
730	HMC	51S+535	VIB	377	1.211	26.4	377	5.389	26.4
562	HMC	62	ECH	46	11.5	4	62.38	51.175	1.22
732	HMC	76+740	VIB	485	1.816	21.7	485	8.083	21.7
733	HMC	76+800	VIB	597	1.816	26.1	597	8.083	26.1
563	HMC	86	ECH	64	16	4	86.78	71.2	1.22
507	HPSI	1000	ECH	50	10	5	67.8	44.5	1.52
501	HPSI	110	ECH	44	11	4	59.66	48.95	1.22
502	HPSI	150	ECH	60	15	4	81.36	66.75	1.22
503	HPSI	154	ECH	61.6	15.4	4	83.53	68.53	1.22
508	HPSI	1605	ECH	83	16.6	5	112.55	73.87	1.52
504	HPSI	200	ECH	80	20	4	108.48	89	1.22
512	HPSI	2000	ECH	80	20	4	108.48	89	1.22
509	HPSI	2005	ECH	95.1	19.02	5	128.96	84.639	1.52
505	HPSI	225	ECH	90	22.5	4	122.04	100.125	1.22
510	HPSI	3005	ECH	154.32	30.865	5	209.26	137.349	1.52
511	HPSI	3505	ECH	176.32	35.265	5	239.1	156.929	1.52
506	HPSI	650	ECH	32.5	6.5	5	44.07	28.925	1.52
998	HYPOTHET	EX 4	OED	23.38	2.75	8.5	31.7	12.237	2.59
134	ICE	100-S	OED	100	10	12	135.6	44.5	3.66
126	ICE	1070	CED	72.6	10	7.26	98.45	44.5	2.21
552	ICE	110-SH	ECH	37.72	11.5	3.28	51.15	51.175	1
703	ICE	23-Nov	VIB	164	0.46	31.7	164	2.047	31.7
554	ICE	115	ECH	46	11.5	4	62.38	51.175	1.22
553	ICE	115-SH	ECH	37.95	11.5	3.3	51.46	51.175	1.01
135	ICE	120-S	OED	120	12	12.42	162.72	53.4	3.79
140	ICE	120S-15	OED	132.45	15	12.25	179.6	66.75	3.73
715	ICE	125	VIB	984	1.042	25.8	984	4.637	25.8
713	ICE	1412B	VIB	597	2.036	21	597	9.06	21
881	ICE	1412BT	VIB	1193	1.667	21.7	1193	7.418	21.7
714	ICE	1412C	VIB	470	2.022	23	470	9	23
717	ICE	14-23	VIB	164	1.165	35	164	5.184	35
716	ICE	14RF	VIB	242	1.013	38.3	242	4.508	38.3
556	ICE	160	ECH	64	16	4	86.78	71.2	1.22
555	ICE	160-SH	ECH	64	16	4	86.78	71.2	1.22
120	ICE	180	CED	8.13	1.73	4.7	11.03	7.698	1.43
136	ICE	200-S	OED	100	20	6	135.6	89	1.83
137	ICE	205-S	OED	170	20	10.5	230.52	89	3.2
701	ICE	216	VIB	130	0.46	26.7	130	2.047	26.7
702	ICE	216E	VIB	130	0.46	26.7	130	2.047	26.7
557	ICE	220	ECH	88	22	4	119.33	97.9	1.22

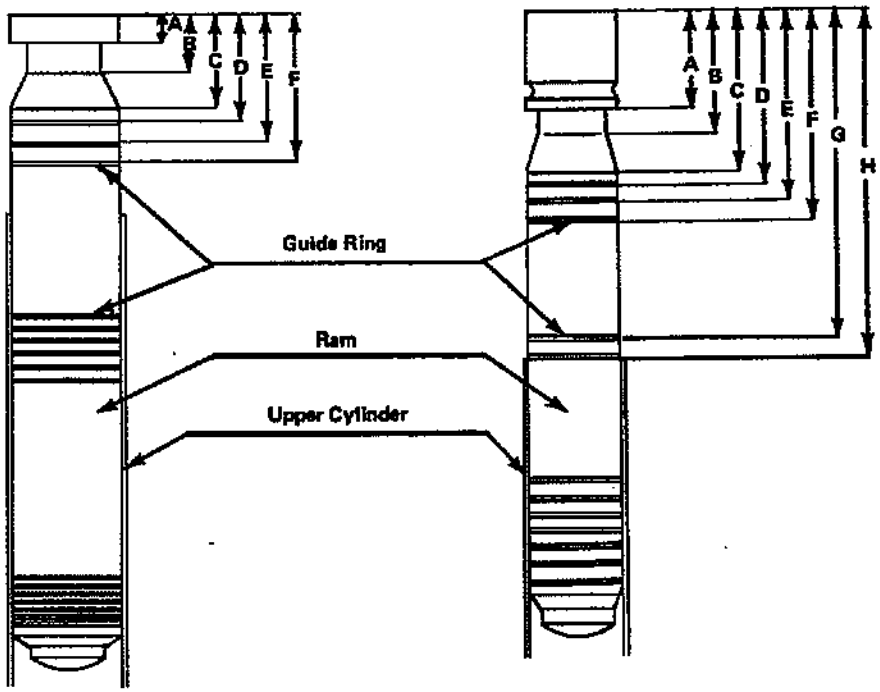
FOSTER CONSTRUCTION PRODUCTS

KOBE DIESEL PILE HAMMER

KOBE - TECHNICAL
KT - 0012

MEASUREMENT OF RAM STROKE

FOSTER PRODUCT DATA SHEET



K60 K13, K25, K35, K45

The ram of the Kobe hammer has several easily identifiable features which serve as useful guides in observing the stroke of the hammer during operation. The figures and table below give the actual stroke at several of these observable guide points.

Distance Ram Extends Above Top Of Upper Cylinder	RAM STROKE (FEET)				
	K13*	K25	K35	K45	K60
At Top	3.62	3.21	3.17	3.61	6.15
A	5.35	5.39	5.30	5.55	6.64
B	5.59	5.78	5.79	6.12	7.30
C	6.12	6.21	6.29	6.69	7.96
D	6.32	6.55	6.45	6.92	8.28
E	6.63	6.88	6.78	7.25	8.61
F	--	7.21	7.11	7.58	8.94
G	8.51	9.83	9.40	9.42	10.75
H	8.81	10.16	9.73	9.74	--

** Serial numbers above 10-1638*

Measurement of Ram Stroke

Kobe diesel pile hammers are rated at an energy per blow equal to the weight of the ram multiplied by the length of the stroke. Counting the blows for a one-minute period or observing the height of the ram stroke will give an accurate rated energy and can be translated into bearing capacity by use of the Kobe Bearing Charts* which employ the commonly used Engineering News formula or by computation using any other of the many dynamic formulae.

BLOWS PER MINUTE	STROKE (FEET)	RATED ENERGY (FT-LBS)				
		K13	K25	K35	K45	K60
52	4.92'	14,120	27,109	37,982	48,806	64,944
51	5.12'	14,694	28,211	39,526	50,790	67,584
50	5.35'	15,355	29,479	41,302	53,072	70,620
49	5.55'	15,929	30,581	42,846	55,056	73,260
48	5.78'	16,589	31,848	44,622	57,338	76,296
47	6.04'	17,335	33,280	46,624	59,917	79,728
46	6.30'	18,081	34,713	48,636	62,496	83,160
45	6.60'	18,942	36,366	50,952	65,472	87,120
44	6.89'	19,774	37,964	53,191	68,349	90,948
43	7.22'	20,721	39,782	55,738	71,622	95,304
42	7.55'	21,669	41,601	58,286	74,896	99,660
41	7.94'	22,788	43,749	61,297	78,765	104,808
40	8.33'	23,907	45,898	64,308	82,634	109,956
39	8.76'	25,141	48,268	67,627	86,899	115,632
38	9.25'	26,548	50,968	71,410	91,760	112,100
37	9.75'	27,983	53,723	75,270	96,720	128,700

* *Kobe Product Data Sheet KD-0021*

NOTE: Maximum Ram Stroke which Kobe will honor under warranty is as follows:

MODEL NUMBER	WEIGHT OF RAM	STROKE OF RAM	ENERGY
K-13	2,870 lbs.	8.86 ft.	25,428 ft-lbs.
K-25	5,510 lbs.	9.35 ft.	51,519 ft-lbs.
K-35	7,720 lbs.	9.35 ft.	72,182 ft.lbs.
K-45	9,920 lbs.	9.35 ft.	92,752 ft-lbs.
K-60	13,200 lbs.	9.35 ft.	123,420 ft-lbs.

Note: The information set forth herein has been obtained from source (s) which are believed to be reliable. L. B. Foster Company assumes no responsibility whatsoever for the accuracy or reliability of the information.

BEARING CAPACITY CHARTS

USING THE ENGINEERING NEWS FORMULA

Assume the piles are to be driven with a Kobe K13 hammer. The ram weight (W) will then be 2860 lbs. Further assume that a bearing capacity (R) of 76 tons is required for each pile.

If the K13 is observed to be driving with an 8 foot stroke, the graph shows that to obtain a 76 ton bearing, a set of 0.2 inches per blow (or 5 blows to the inch) is required. Therefore, if the penetration is at or below 0.2 inches per blow (or at or above 5 blows per inch), the pile will support the required 76 tons.

At an 8 foot stroke and a set of 0.3 inch per blow (or about 3 blows per inch), the pile will only support 57 tons and driving should continue.

At a 6 foot stroke and a set of 0.1 inch per blow (or 10 blows per inch), the pile will support 86 tons, well above the required bearing.

Note: A set of 0.1 inch per blow or 10 blows to the inch is normally considered refusal for any pile hammer. Driving beyond this point is not considered "normal and proper use" as covered by the Kobe warranty.

KOBE K13

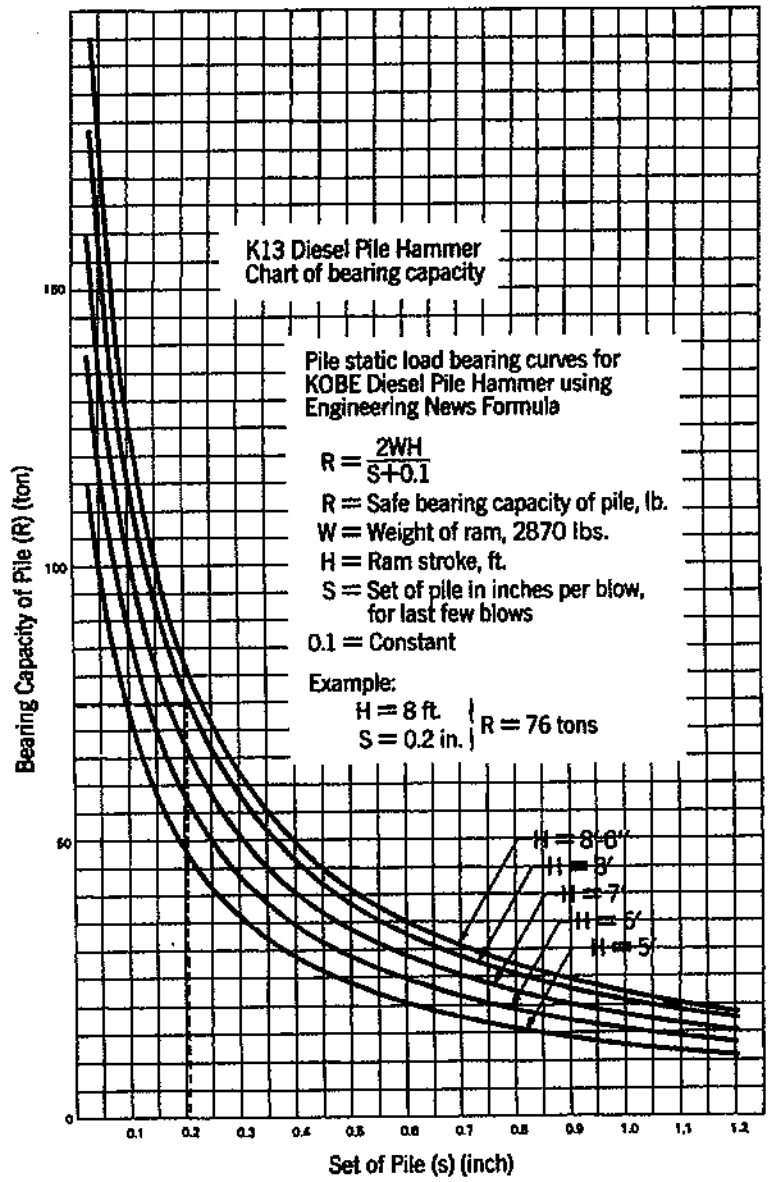
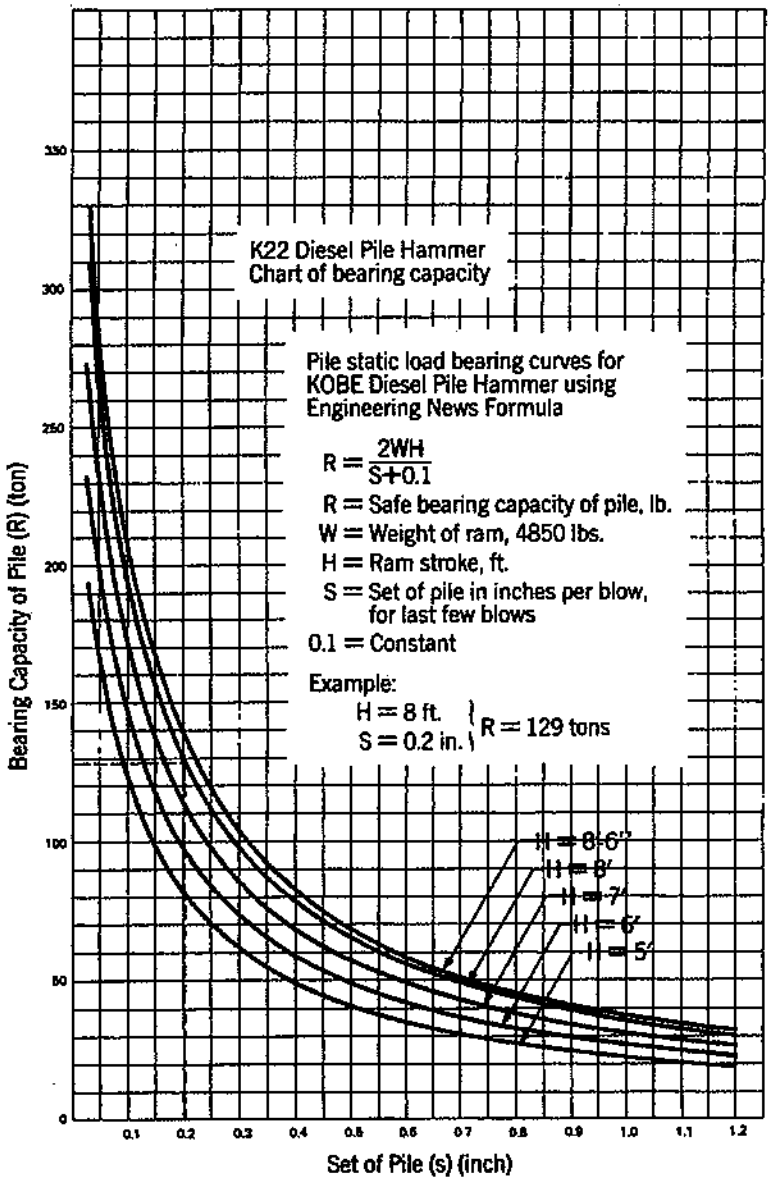


Exhibit 63-8-25

KOBE K22



KOBE K25

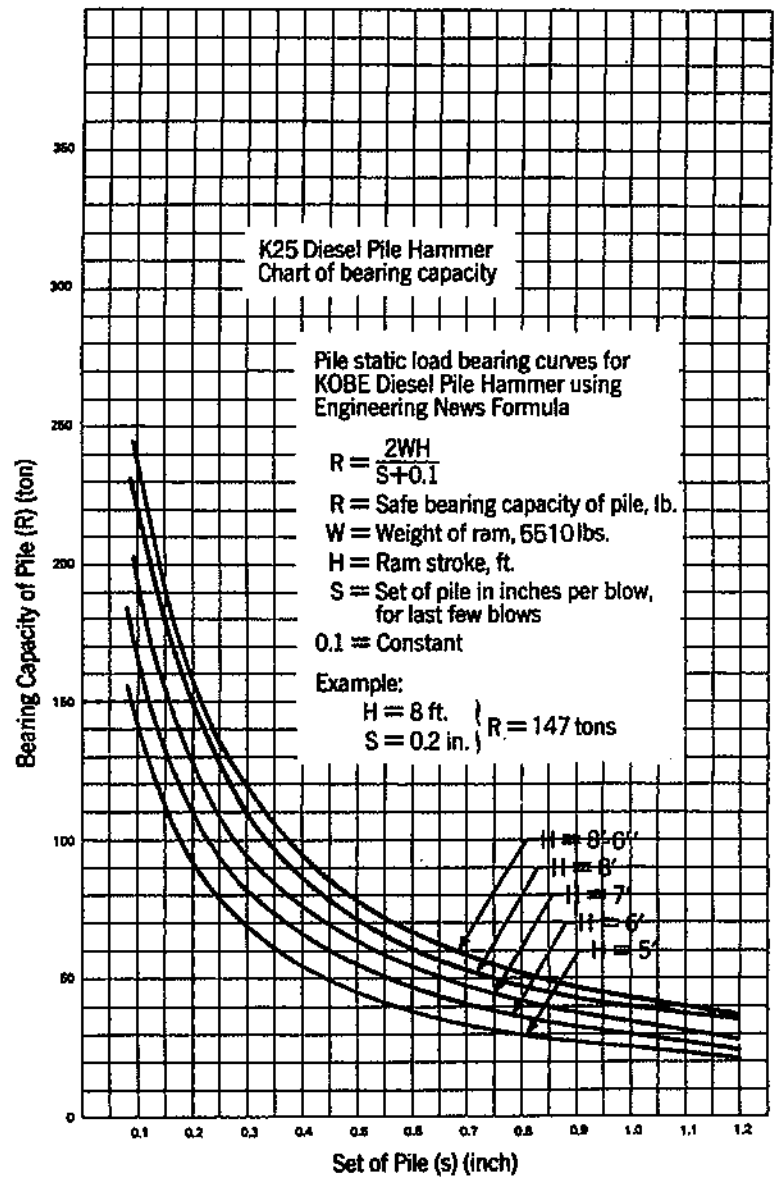
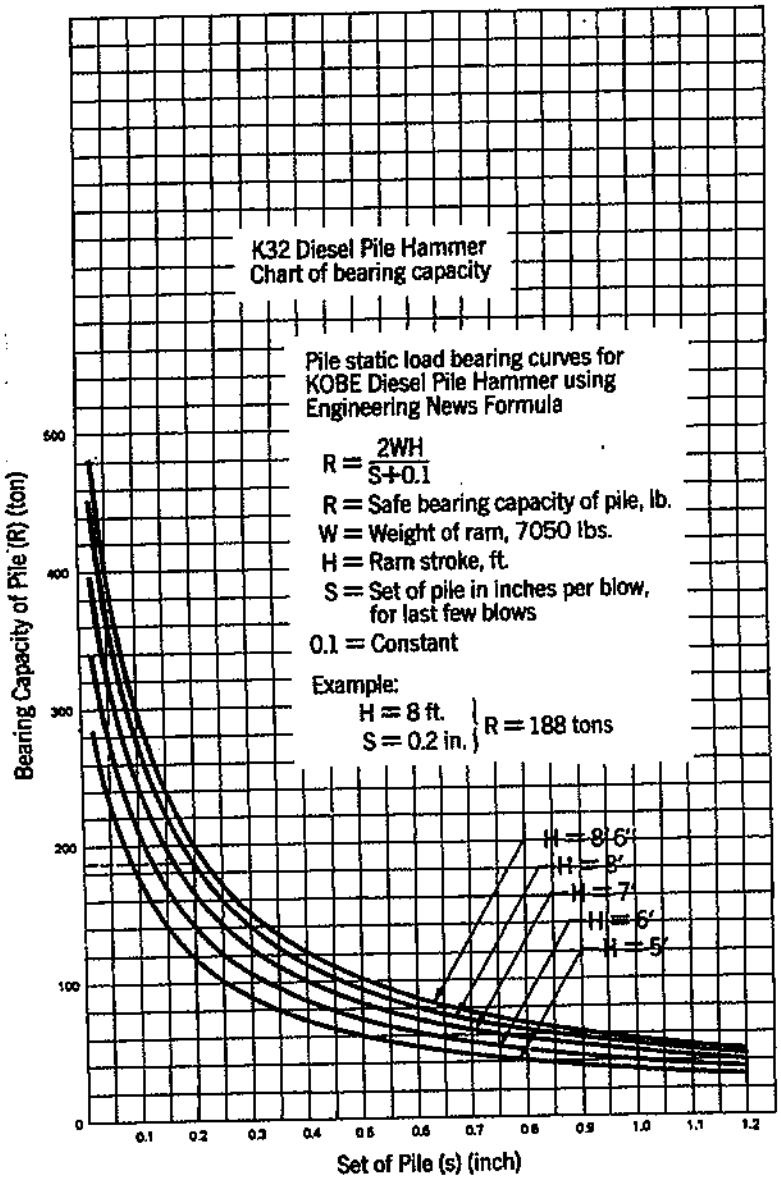
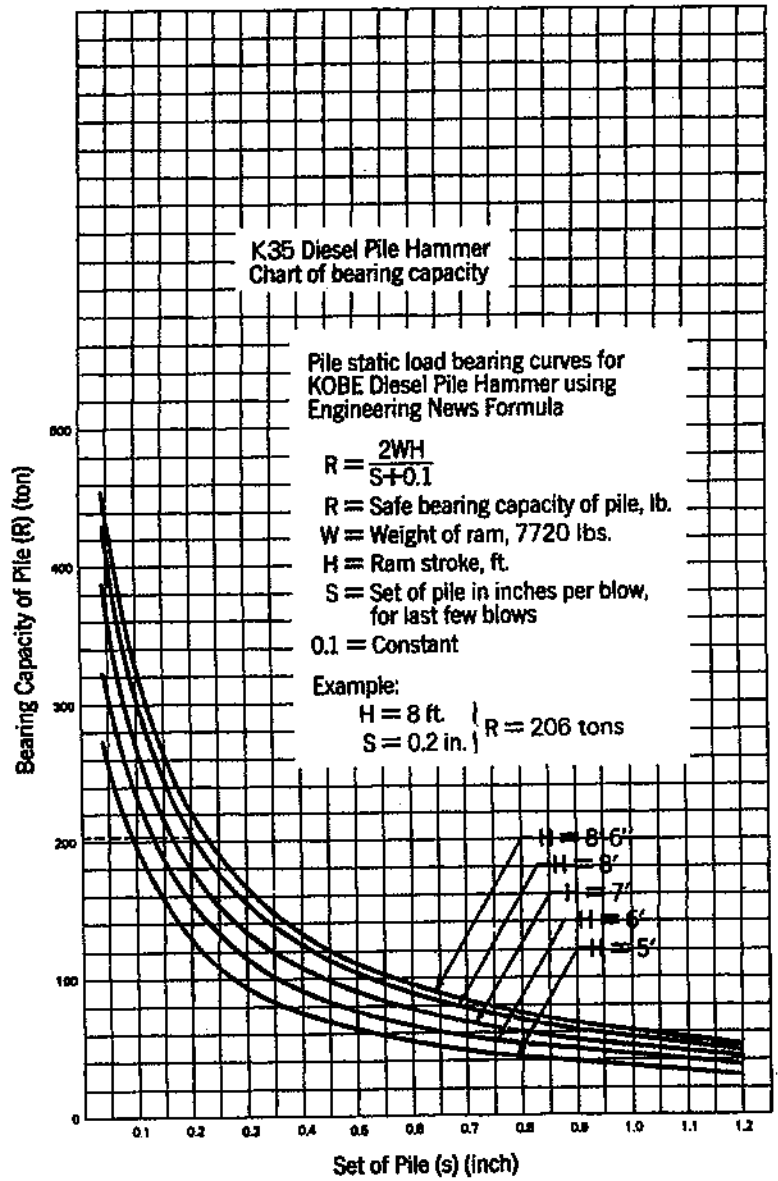


Exhibit 63-8-25

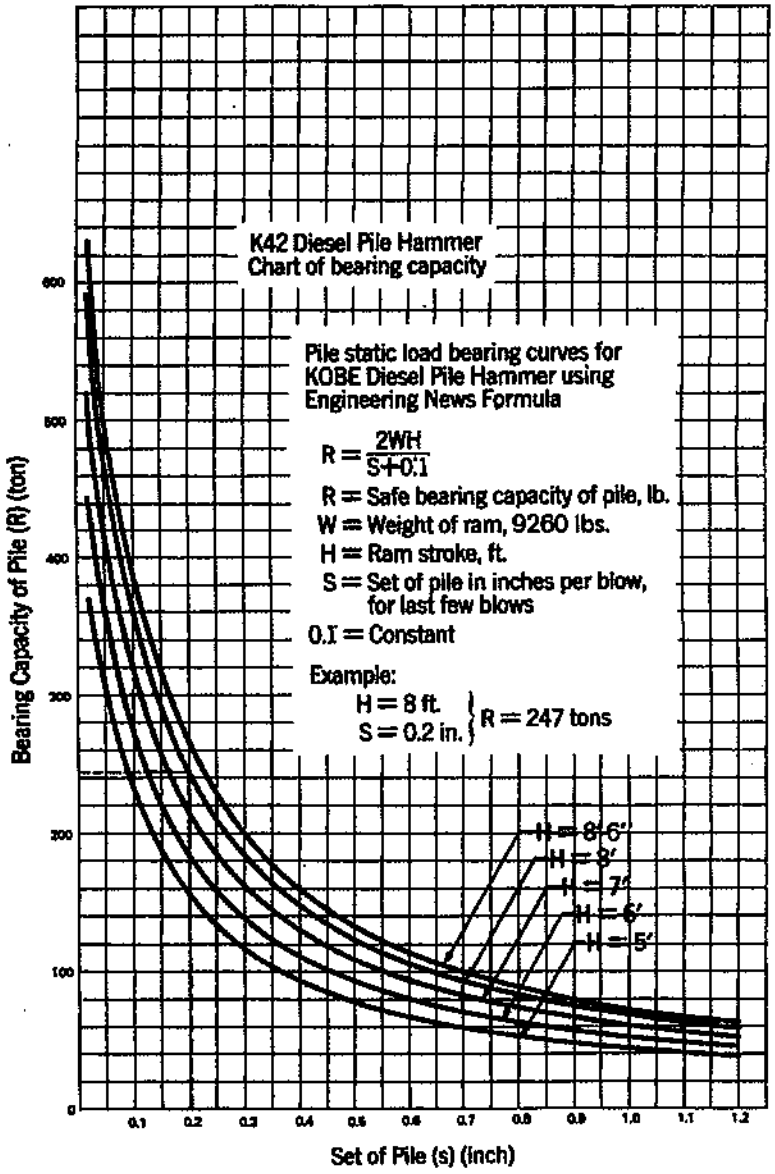
KOBE K32



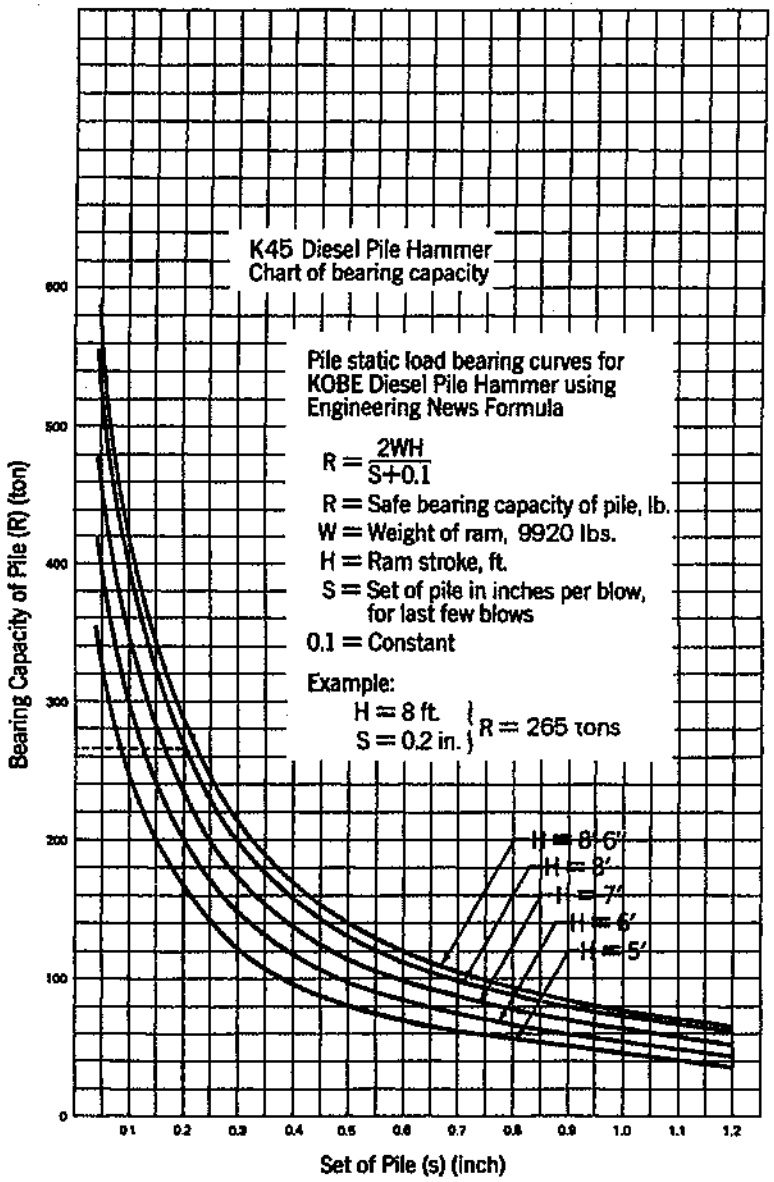
KOBE K35



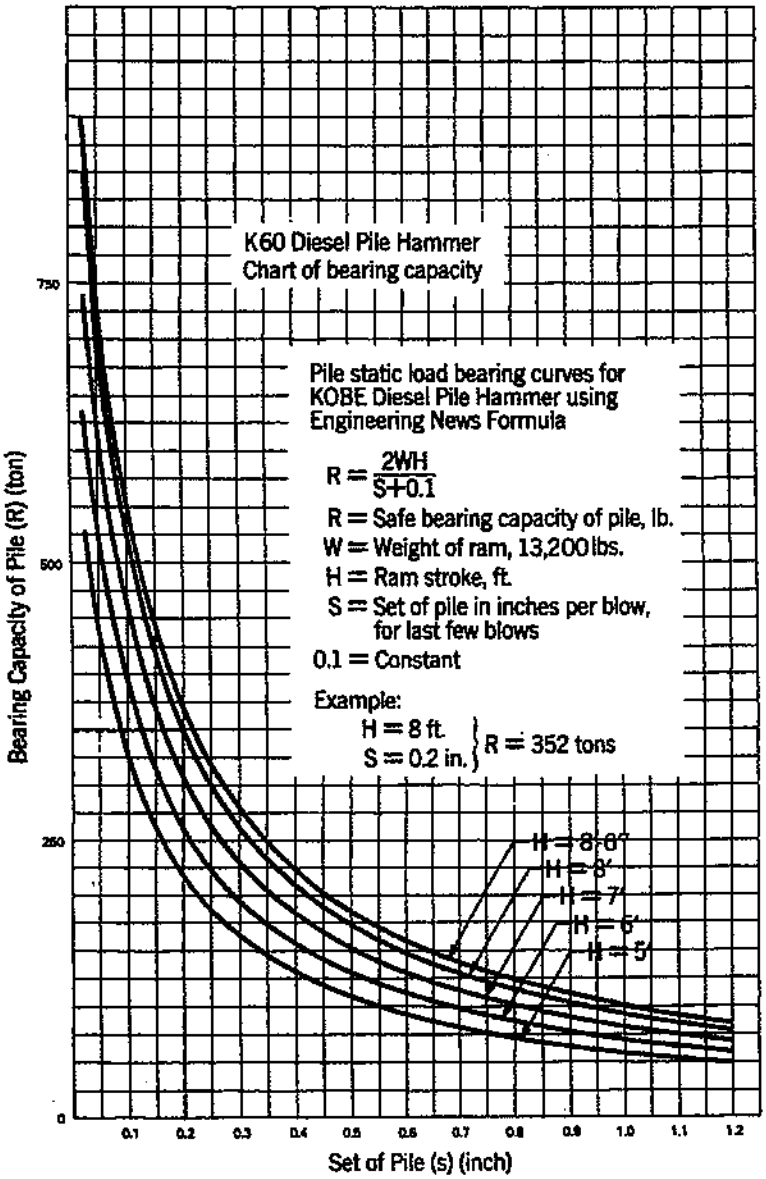
KOBE K42



KOBE K45



KOBE K60



L. B. Foster Construction Products include:

Piling Products
- Steel Sheet Piling
- H-Bearing Piles
- Pipe Piling
- Piling Accessories

Pile Driving Equipment
- IHC Hydrohammer
- Vibro® Drivers/Extractors
- Kobelco Diesel Hammers
- Pile Threaders
- Pile Driving Parts and Accessories

Fabricated Products
- Steel Grid Bridge Decking
- Bridge Railing
- Bridge Components

Note: The information set forth herein has been obtained from source (s) which are believed to be reliable. L. B. Foster Company assumes no responsibility whatsoever for the accuracy or reliability of the information.

FOSTER
L.B. FOSTER COMPANY
415 Holiday Drive, Pittsburgh, PA 15220
Phone 1-800-255-4500, or call your local Foster Sales Office

W-4188 10/90 2.5M

Kobelco Operation

Kobelco diesel's powerful striking force has three phases — compression, impact and combustion. Here's how it works.

Fuel Injection and Compression

When the ram is lifted by the tripping device to a predetermined height, it is automatically released. The ram falls under its own weight and actuates the cam of the fuel pump which injects a measured amount of fuel into a specially designed receptacle in the anvil. Continuing its downward fall, the ram closes the intake-exhaust ports and compresses the air in the cylinder ahead of the ram. The compression of the trapped air tightens the anvil and drive cap against the top of the pile in preparation for the impact blow. Compression also assists in starting the pile downward.

Impact Blow

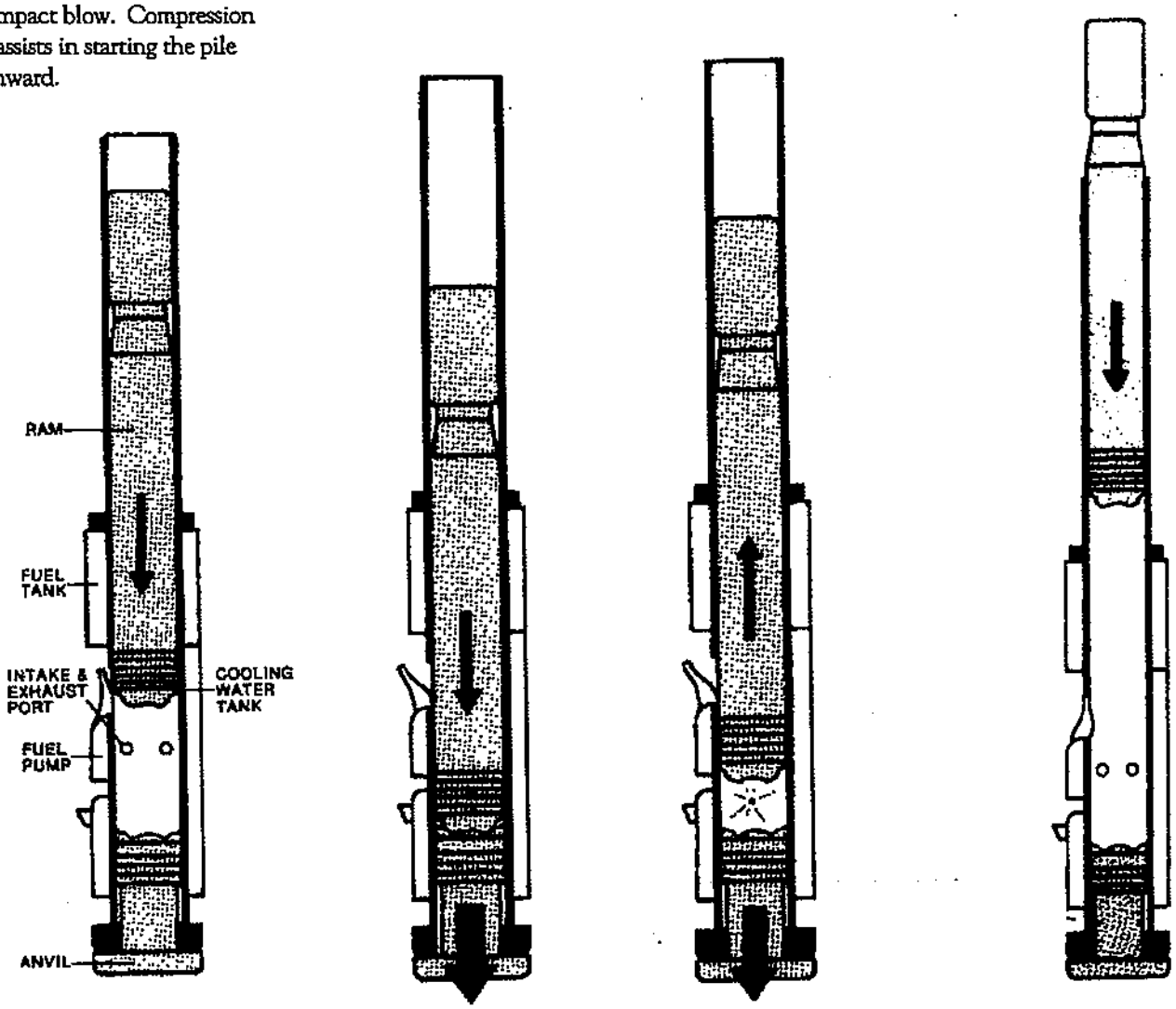
The falling ram strikes the anvil and delivers its impact energy to the pile, driving the pile rapidly downward.

Combustion and Power Stroke

As the ram impacts with the anvil, the fuel atomizes into the annular combustion chamber around the ram and anvil. The hot compressed air ignites the air-fuel mixture. The resulting explosive force pushes the pile further downward and propels the ram upward. The expanding gas in the cylinder is discharged when the rising ram opens the intake-exhaust ports.

Fresh Air Intake

As the ram rises above the intake-exhaust ports, fresh air is drawn into the cylinder. The fuel pump cam returns to its original position in preparation for injection on the next stroke. The ram continues freely upward until arrested by gravity and then again begins its downward stroke.



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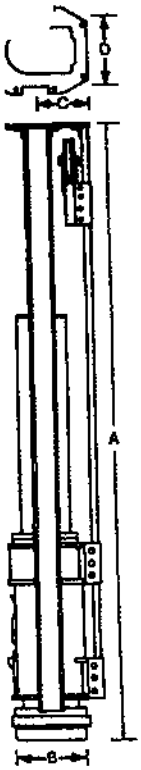
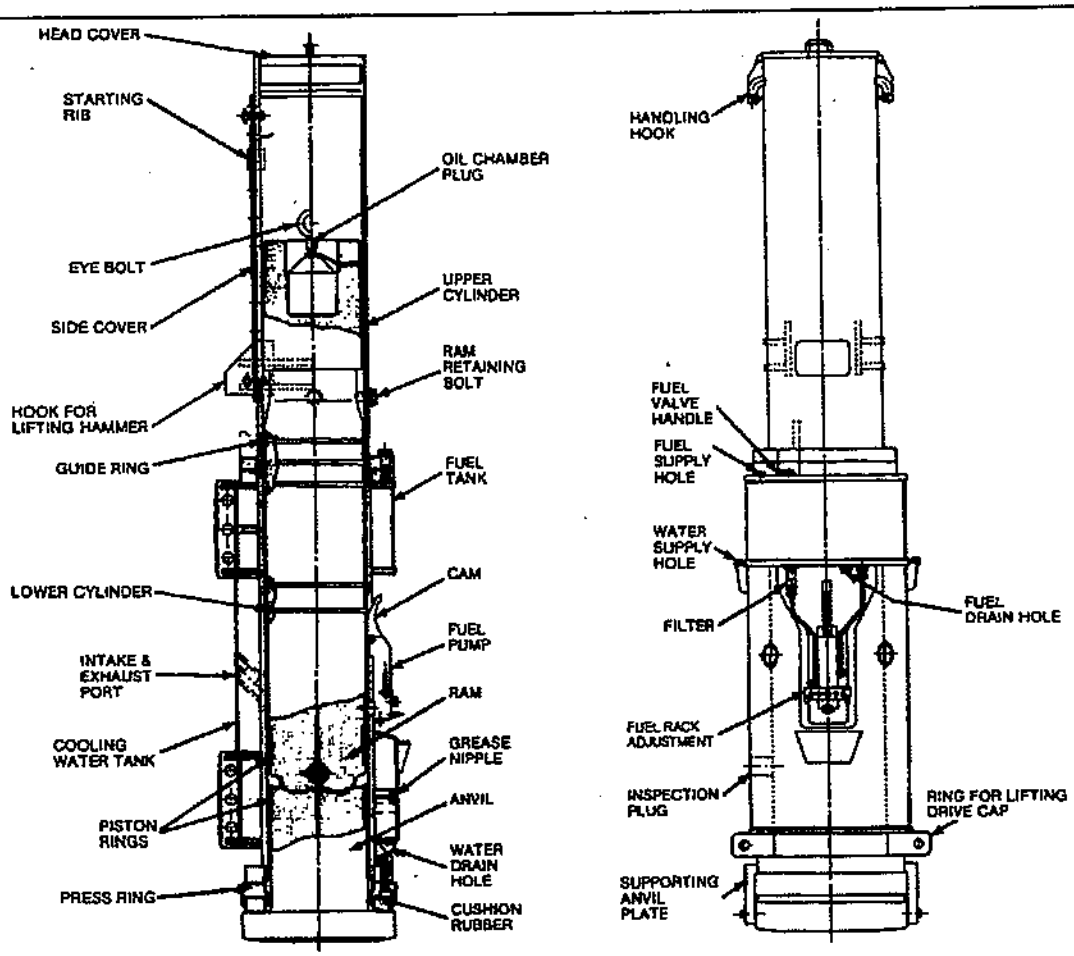
›belco Specifications



		K13	K25	K35	K45
Total length, A	Ft. - in.	16 - 8	17 - 6	17 - 8	18 - 7
Diameter of anvil, B	In.	19.25	23.25	27.50	31.50
Depth, center to back, C	In.	17.00	19.25	21.75	25.25
Width between guide rails, D	In.	26	26	36	36
Total weight	Lb.	7,800	13,200	19,100	25,300
Weight of ram	Lb.	2,870	5,510	7,720	9,920
Energy per blow (min-max)	Ft. - Lb.	13,200 - 25,390	23,500 - 51,540	31,700 - 72,150	39,000 92,760
Ram Stroke (min-max)	Ft.	4.60 - 8.85	4.26 - 9.35	4.11 - 9.35	3.93- 9.35
Number of blows	Blows/min.	40 - 60	39 - 60	39 - 60	39 - 60
Explosive force	Lb.	149,900	238,100	330,800	421,200
Fuel tank capacity	Gal.	10.6	10.6	12.5	17.00
Lube oil tank capacity, ram	Gal.	1.3	1.85	2.50	3.56
Water tank capacity	Gal.	18.5	21.1	37.0	45.0
Fuel consumption	Gal./hr.	.8 - 2.1	2.4 - 3.2	3.2 - 4.3	4.5 - 5.5
Lube oil consumption, ram	Gal./hr.	.25	.4	.5	.66

Model KB60 and KB80 - Special order by request

L. B. Foster Company reserves the right to make revisions to the specifications without notification.



KOBE K-13 DIESEL HAMMER

$P = \frac{2WH}{S + 0.1}$ WEIGHT OF RAM = 2870
REFUSAL SHALL BE BETWEEN 150 - 180 TONS

AVG. HT. OF FALL	3.5	5	6	7	8	8.5	S
BLOWS PER FOOT	BEARING IN TONS						
4	3	5	6	6	7	8	3.000
8	6	9	11	13	14	15	1.500
12	9	13	16	18	21	22	1.000
16	12	17	20	24	27	29	0.750
20	14	21	25	29	33	35	0.600
24	17	24	29	33	38	41	0.500
28	19	27	33	38	43	46	0.429
32	21	30	36	42	48	51	0.375
36	23	33	40	46	53	56	0.333
40	25	36	43	50	57	61	0.300
44	27	39	46	54	62	65	0.273
48	29	41	49	57	66	70	0.250
52	30	43	52	61	69	74	0.231
56	32	46	55	64	73	78	0.214
60	33	48	57	67	77	81	0.200
64	35	50	60	70	80	85	0.188
68	36	52	62	73	83	88	0.176
72	38	54	65	75	86	91	0.167
76	39	56	67	78	89	95	0.158
80	40	57	69	80	92	98	0.150
84	41	59	71	83	95	100	0.143
88	42	61	73	85	97	103	0.136
92	44	62	75	87	100	106	0.130
96	45	64	77	89	102	108	0.125
100	46	65	78	91	104	111	0.120
104	47	67	80	93	107	113	0.115
108	48	68	82	95	109	116	0.111
110	48	69	82	96	110	117	0.109
120	50	72	86	100	115	122	0.100
130	52	75	90	104	119	127	0.092
140	54	77	93	108	124	131	0.086
150	56	80	96	112	128	136	0.080
160	57	82	98	115	131	139	0.075
170	59	84	101	118	135	143	0.071
180	60	86	103	121	138	146	0.067
190	62	88	106	123	141	150	0.063
200	63	90	108	126	144	152	0.060
225	66	94	112	131	150	159	0.053
250	68	97	116	136	155	165	0.048
275	70	100	120	140	160	170	0.044
300	72	103	123	144	164	174	0.040
325	73	105	126	147	168	178	0.037
350	75	107	128	150	171	182	0.034
375	76	109	130	152	174	185	0.032
400	77	110	132	155	177	188	0.030
425	78	112	134	157	179	190	0.028
450	79	113	136	159	181	193	0.027
475	80	115	137	160	183	195	0.025
500	81	116	139	162	185	197	0.024
525	82	117	140	164	187	199	0.023

KOBE K-25 DIESEL HAMMER

$P = \frac{2WH}{S + 0.1}$ WEIGHT OF RAM = 5510
REFUSAL SHALL BE BETWEEN 150 - 180 TONS

AVG. HT. OF FALL	3.5	5	6	7	8	8.5	S
BLOWS PER FOOT	BEARING IN TONS						
4	6	9	11	12	14	15	3.000
8	12	17	21	24	28	29	1.500
12	18	25	30	35	40	43	1.000
16	23	32	39	45	52	55	0.750
20	28	39	47	55	63	67	0.600
24	32	46	55	64	73	78	0.500
28	36	52	63	73	83	89	0.429
32	41	58	70	81	93	99	0.375
36	45	64	76	89	102	108	0.333
40	48	69	83	96	110	117	0.300
44	52	74	89	103	118	126	0.273
48	55	79	94	110	126	134	0.250
52	58	83	100	117	133	142	0.231
56	61	88	105	123	140	149	0.214
60	64	92	110	129	147	156	0.200
64	67	96	115	134	153	163	0.188
68	70	100	120	140	159	169	0.176
72	72	103	124	145	165	176	0.167
76	75	107	128	150	171	182	0.158
80	77	110	132	154	176	187	0.150
84	79	113	136	159	182	193	0.143
88	82	117	140	163	186	198	0.136
92	84	120	143	167	191	203	0.130
96	86	122	147	171	196	208	0.125
100	88	125	150	175	200	213	0.120
104	90	128	153	179	205	217	0.115
108	91	131	157	183	209	222	0.111
110	92	132	158	184	211	224	0.109
120	96	138	165	193	220	234	0.100
130	100	143	172	201	229	244	0.092
140	104	148	178	208	237	252	0.086
150	107	153	184	214	245	260	0.080
160	110	157	189	220	252	268	0.075
170	113	162	194	226	258	276	0.071
180	116	165	198	231	264	281	0.067
190	118	169	203	236	270	287	0.063
200	121	172	207	241	276	293	0.060
225	126	180	216	252	287	305	0.053
250	130	186	223	261	298	316	0.048
275	134	192	230	269	307	326	0.044
300	138	197	236	276	315	335	0.040
325	141	201	241	282	322	342	0.037
350	144	205	246	287	328	349	0.034
375	146	209	250	292	334	355	0.032
400	148	212	254	297	339	360	0.030
425	150	215	258	301	344	365	0.028
450	152	218	261	305	348	370	0.027
475	154	220	264	308	352	374	0.025
500	156	222	267	311	355	378	0.024
525	157	224	269	314	359	381	0.023

KOBE K-35 DIESEL HAMMER

$P = \frac{2WH}{S + 0.1}$ WEIGHT OF RAM = 7720
REFUSAL SHALL BE BETWEEN 150 - 180 TONS

AVG. HT. OF FALL	3.5	5	6	7	8	8.5	S
BLOWS PER FOOT	BEARING IN TONS						
4	9	12	15	17	20	21	3.000
8	17	24	29	34	39	41	1.500
12	25	35	42	49	56	60	1.000
16	32	45	54	64	73	77	0.750
20	39	55	66	77	88	94	0.600
24	45	64	77	90	103	109	0.500
28	51	73	88	102	117	124	0.429
32	57	81	98	114	130	138	0.375
36	62	89	107	125	143	151	0.333
40	68	97	116	135	154	164	0.300
44	72	104	124	145	166	176	0.273
48	77	110	132	154	176	187	0.250
52	82	117	140	163	187	199	0.231
56	86	123	147	172	197	209	0.214
60	90	129	154	180	206	219	0.200
64	94	134	161	188	215	228	0.188
68	98	140	168	195	223	237	0.176
72	101	145	174	203	232	246	0.167
76	105	150	180	210	239	254	0.158
80	108	154	185	216	247	262	0.150
84	111	159	191	223	254	270	0.143
88	114	163	196	229	261	278	0.136
92	117	168	201	235	268	285	0.130
96	120	172	206	240	274	292	0.125
100	123	175	211	246	281	298	0.120
104	125	179	215	251	287	305	0.115
108	128	183	219	256	293	311	0.111
110	129	185	222	258	295	314	0.109
120	135	193	232	270	309	328	0.100
130	141	201	241	281	321	341	0.092
140	145	208	249	291	333	353	0.086
150	150	214	257	300	343	365	0.080
160	154	221	265	309	353	375	0.075
170	158	226	272	317	362	385	0.071
180	162	232	278	324	371	394	0.067
190	166	237	284	331	379	402	0.063
200	169	241	290	338	386	410	0.060
225	176	252	302	352	403	428	0.053
250	183	261	313	365	417	443	0.048
275	188	269	322	376	430	457	0.044
300	193	276	331	386	441	468	0.040
325	197	282	338	395	451	479	0.037
350	201	287	345	402	460	489	0.034
375	205	292	351	409	468	497	0.032
400	208	297	356	416	475	505	0.030
425	211	301	361	421	482	512	0.028
450	213	305	366	427	488	518	0.027
475	216	308	370	431	493	524	0.025
500	218	311	374	436	498	529	0.024
525	220	314	377	440	503	534	0.023

KOBE K-45 DIESEL HAMMER

$P = \frac{2WH}{S + 0.1}$ WEIGHT OF RAM = 9920
REFUSAL SHALL BE BETWEEN 150 - 180 TONS

AVG. HT. OF FALL	3.5	5	6	7	8	8.5	S
BLOWS PER FOOT	BEARING IN TONS						
4	11	16	19	22	26	27	3.000
8	22	31	37	43	50	53	1.500
12	32	45	54	63	72	77	1.000
16	41	58	70	82	93	99	0.750
20	50	71	85	99	113	120	0.600
24	58	83	99	116	132	141	0.500
28	66	94	113	131	150	160	0.429
32	73	104	125	146	167	178	0.375
36	80	114	137	160	183	195	0.333
40	87	124	149	174	198	211	0.300
44	93	133	160	186	213	226	0.273
48	99	142	170	198	227	241	0.250
52	105	150	180	210	240	255	0.231
56	110	158	189	221	253	268	0.214
60	116	165	198	231	265	281	0.200
64	121	173	207	242	276	293	0.188
68	126	179	215	251	287	305	0.176
72	130	186	223	260	298	316	0.167
76	135	192	231	269	308	327	0.158
80	139	198	238	278	317	337	0.150
84	143	204	245	286	327	347	0.143
88	147	210	252	294	336	357	0.136
92	151	215	258	301	344	366	0.130
96	154	220	265	309	353	375	0.125
100	158	225	271	316	361	383	0.120
104	161	230	276	322	368	391	0.115
108	164	235	282	329	376	399	0.111
110	166	237	285	332	380	403	0.109
120	174	248	298	347	397	422	0.100
130	181	258	310	361	413	438	0.092
140	187	267	320	374	427	454	0.086
150	193	276	331	386	441	468	0.080
160	198	283	340	397	453	482	0.075
170	204	291	349	407	465	494	0.071
180	208	298	357	417	476	506	0.067
190	213	304	365	426	486	517	0.063
200	217	310	372	434	496	527	0.060
225	226	323	388	453	518	550	0.053
250	235	335	402	469	536	570	0.048
275	242	345	414	483	553	587	0.044
300	248	354	425	496	567	602	0.040
325	254	362	435	507	580	616	0.037
350	259	369	443	517	591	628	0.034
375	263	376	451	526	601	639	0.032
400	267	382	458	534	610	649	0.030
425	271	387	464	542	619	658	0.028
450	274	392	470	548	627	666	0.027
475	277	396	475	554	634	673	0.025
500	280	400	480	560	640	680	0.024
525	283	404	484	565	646	686	0.023

KOBE K-60 DIESEL HAMMER

$P = \frac{2WH}{S + 0.1}$ WEIGHT OF RAM = 13200
REFUSAL SHALL BE BETWEEN 150 - 180 TONS

AVG. HT. OF FALL	3.5	5	6	7	8	8.5	S
BLOWS PER FOOT	BEARING IN TONS						
4	15	21	26	30	34	36	3.000
8	29	41	50	58	66	70	1.500
12	42	60	72	84	96	102	1.000
16	54	76	93	109	124	132	0.750
20	66	94	113	132	151	160	0.600
24	77	110	132	154	176	187	0.500
28	87	125	150	175	200	212	0.429
32	97	139	167	195	222	236	0.375
36	107	152	183	213	244	259	0.333
40	116	166	198	231	264	281	0.300
44	124	177	212	248	283	301	0.273
48	132	189	226	264	302	321	0.250
52	140	200	239	279	319	339	0.231
56	147	210	252	294	336	357	0.214
60	154	220	264	308	352	374	0.200
64	161	230	275	321	367	390	0.188
68	167	239	286	334	382	406	0.176
72	173	248	297	347	396	421	0.167
76	179	256	307	358	409	435	0.158
80	185	264	317	370	422	449	0.150
84	190	272	326	380	435	462	0.143
88	195	279	335	391	447	475	0.136
92	200	286	344	401	458	487	0.130
96	205	293	352	411	469	499	0.125
100	210	300	360	420	480	510	0.120
104	215	306	368	429	490	521	0.115
108	219	313	375	438	500	531	0.111
110	221	316	379	442	505	537	0.109
120	231	330	396	462	528	561	0.100
130	240	343	412	480	549	583	0.092
140	249	355	426	498	569	604	0.086
150	257	367	440	513	587	623	0.080
160	264	377	453	528	603	641	0.075
170	271	387	464	542	619	658	0.071
180	277	396	475	554	634	673	0.067
190	283	405	485	566	647	688	0.063
200	289	413	495	576	660	701	0.060
225	301	430	517	603	689	732	0.053
250	312	446	535	624	714	758	0.048
275	322	459	551	643	735	781	0.044
300	330	471	566	660	754	801	0.040
325	337	482	578	675	771	819	0.037
350	344	491	590	688	786	836	0.034
375	350	500	600	700	800	850	0.032
400	355	508	609	711	812	863	0.030
425	360	515	618	721	823	875	0.028
450	365	521	625	729	834	886	0.027
475	369	527	632	738	843	896	0.025
500	373	532	639	745	852	905	0.024
525	376	537	645	752	860	913	0.023

KOBE K-13 DIESEL HAMMER

P = 2 W H / S + 0.1 WEIGHT OF RAM = 2870
REFUSAL SHALL BE BETWEEN 150 - 180 TONS

PENETRATION (INCHES)		AVERAGE HEIGHT OF FALL (FT.)					
10 BLOWS	20 BLOWS	3.5	5	6	7	8	8.5
		BEARING IN TONS					
2 1/2	5	29	41	49	57	66	70
2 7/16	4 7/8	29	42	50	58	67	71
2 3/8	4 3/4	30	43	51	60	68	72
2 5/16	4 5/8	30	43	52	61	69	74
2 1/4	4 1/2	31	44	53	62	71	75
2 3/16	4 3/8	32	45	54	63	72	77
2 1/8	4 1/4	32	46	55	64	73	78
2 1/16	4 1/8	33	47	56	66	75	80
2	4	33	48	57	67	77	81
1 15/16	3 7/8	34	49	59	68	78	83
1 7/8	3 3/4	35	50	60	70	80	85
1 13/16	3 5/8	36	51	61	71	82	87
1 3/4	3 1/2	37	52	63	73	83	89
1 11/16	3 3/8	37	53	64	75	85	91
1 5/8	3 1/4	38	55	66	77	87	93
1 9/16	3 1/8	39	56	67	78	90	95
1 1/2	3	40	57	69	80	92	98
1 7/16	2 7/8	41	59	71	82	94	100
1 3/8	2 3/4	42	60	73	85	97	103
1 5/16	2 5/8	43	62	74	87	99	105
1 1/4	2 1/2	45	64	77	89	102	108
1 3/16	2 3/8	46	66	79	92	105	112
1 1/8	2 1/4	47	68	81	95	108	115
1 1/16	2 1/8	49	70	83	97	111	118
1	2	50	72	86	100	115	122
15/16	1 7/8	52	74	89	104	119	128
7/8	1 3/4	54	77	92	107	122	130
13/16	1 5/8	55	79	95	111	127	135
3/4	1 1/2	57	82	98	115	131	139
11/16	1 3/8	60	85	102	119	136	145
5/8	1 1/4	62	88	106	124	141	150
9/16	1 1/8	64	92	110	129	147	156
1/2	1	67	96	115	134	153	163
7/16	7/8	70	100	120	140	160	170
3/8	3/4	73	104	125	146	167	177
5/16	5/8	77	109	131	153	175	186
1/4	1/2	80	115	138	161	184	195
3/16	3/8	85	121	145	169	193	205
1/8	1/4	89	128	153	179	204	217
1/16	1/8	95	135	162	189	216	230
0	0	100	144	172	201	230	244

KOBE K-25 DIESEL HAMMER

P = 2 W H / S + 0.1 WEIGHT OF RAM = 5510
REFUSAL SHALL BE BETWEEN 150 - 180 TONS

PENETRATION (INCHES)		AVERAGE HEIGHT OF FALL (FT.)					
10 BLOWS	20 BLOWS	3.5	5	6	7	8	8.5
		BEARING IN TONS					
2 1/2	5	55	79	94	110	126	134
2 7/16	4 7/8	56	80	96	112	128	136
2 3/8	4 3/4	57	82	98	114	131	139
2 5/16	4 5/8	58	83	100	116	133	141
2 1/4	4 1/2	59	85	102	119	136	144
2 3/16	4 3/8	61	86	104	121	138	147
2 1/8	4 1/4	62	88	106	123	141	150
2 1/16	4 1/8	63	90	108	126	144	153
2	4	64	92	110	129	147	156
1 15/16	3 7/8	66	94	113	131	150	159
1 7/8	3 3/4	67	96	115	134	153	163
1 13/16	3 5/8	69	98	118	137	157	167
1 3/4	3 1/2	70	100	120	140	160	170
1 11/16	3 3/8	72	103	123	144	164	174
1 5/8	3 1/4	73	105	126	147	168	178
1 9/16	3 1/8	75	108	129	151	172	183
1 1/2	3	77	110	132	154	176	187
1 7/16	2 7/8	79	113	136	158	181	192
1 3/8	2 3/4	81	116	139	162	186	197
1 5/16	2 5/8	83	119	143	167	191	203
1 1/4	2 1/2	86	122	147	171	196	208
1 3/16	2 3/8	88	126	151	176	202	214
1 1/8	2 1/4	91	130	156	182	207	220
1 1/16	2 1/8	94	134	160	187	214	227
1	2	96	138	165	193	220	234
15/16	1 7/8	100	142	171	199	228	242
7/8	1 3/4	103	147	176	206	235	250
13/16	1 5/8	106	152	182	213	243	258
3/4	1 1/2	110	157	189	220	252	268
11/16	1 3/8	114	163	196	229	261	278
5/8	1 1/4	119	170	203	237	271	288
9/16	1 1/8	123	176	212	247	282	300
1/2	1	129	184	220	257	294	312
7/16	7/8	134	192	230	268	307	326
3/8	3/4	140	200	240	281	321	341
5/16	5/8	147	210	252	294	336	357
1/4	1/2	154	220	264	309	353	375
3/16	3/8	162	232	278	325	371	394
1/8	1/4	171	245	294	343	392	416
1/16	1/8	182	259	311	363	415	441
0	0	193	276	331	386	441	468

KOBE K-35 DIESEL HAMMER

P = 2 W H / S + 0.1 WEIGHT OF RAM = 7720
REFUSAL SHALL BE BETWEEN 150 - 180 TONS

PENETRATION (INCHES)		AVERAGE HEIGHT OF FALL (FT.)					
10 BLOWS	20 BLOWS	3.5	5	6	7	8	8.5
		BEARING IN TONS					
2 1/2	5	77	110	132	154	176	187
2 7/16	4 7/8	79	112	135	157	180	191
2 3/8	4 3/4	80	114	137	160	183	194
2 5/16	4 5/8	82	117	140	163	186	198
2 1/4	4 1/2	83	119	143	166	190	202
2 3/16	4 3/8	85	121	145	170	194	206
2 1/8	4 1/4	86	124	148	173	198	210
2 1/16	4 1/8	88	126	151	176	202	214
2	4	90	129	154	180	206	219
1 15/16	3 7/8	92	131	158	184	210	223
1 7/8	3 3/4	94	134	161	188	215	228
1 13/16	3 5/8	96	137	165	192	220	233
1 3/4	3 1/2	98	140	168	197	225	239
1 11/16	3 3/8	101	144	172	201	230	244
1 5/8	3 1/4	103	147	176	206	235	250
1 9/16	3 1/8	105	151	181	211	241	256
1 1/2	3	108	154	185	216	247	262
1 7/16	2 7/8	111	158	190	222	253	269
1 3/8	2 3/4	114	163	195	228	260	276
1 5/16	2 5/8	117	167	200	234	267	284
1 1/4	2 1/2	120	172	206	240	274	292
1 3/16	2 3/8	124	178	212	247	282	300
1 1/8	2 1/4	127	182	218	254	291	309
1 1/16	2 1/8	131	187	225	262	299	318
1	2	135	193	232	270	309	328
15/16	1 7/8	139	199	239	279	319	339
7/8	1 3/4	144	206	247	288	329	350
13/16	1 5/8	149	213	256	298	341	362
3/4	1 1/2	154	221	265	309	353	375
11/16	1 3/8	160	229	274	320	366	389
5/8	1 1/4	166	238	285	333	380	404
9/16	1 1/8	173	247	296	346	395	420
1/2	1	180	257	309	360	412	437
7/16	7/8	188	269	322	376	430	456
3/8	3/4	197	281	337	393	449	477
5/16	5/8	206	294	353	412	471	500
1/4	1/2	216	309	371	432	494	525
3/16	3/8	228	325	390	455	520	553
1/8	1/4	240	343	412	480	549	583
1/16	1/8	254	363	436	509	581	618
0	0	270	386	463	540	618	656

KOBE K-45 DIESEL HAMMER

P = 2 W H / S + 0.1 WEIGHT OF RAM = 9920
REFUSAL SHALL BE BETWEEN 150 - 180 TONS

PENETRATION (INCHES)		AVERAGE HEIGHT OF FALL (FT.)					
10 BLOWS	20 BLOWS	3.5	5	6	7	8	8.5
		BEARING IN TONS					
2 1/2	5	99	142	170	198	227	241
2 7/16	4 7/8	101	144	173	202	231	245
2 3/8	4 3/4	103	147	176	206	235	250
2 5/16	4 5/8	105	150	180	210	240	255
2 1/4	4 1/2	107	153	183	214	244	259
2 3/16	4 3/8	109	156	187	218	249	265
2 1/8	4 1/4	111	159	190	222	254	270
2 1/16	4 1/8	113	162	194	227	259	275
2	4	116	165	198	231	265	281
1 15/16	3 7/8	118	169	203	236	270	287
1 7/8	3 3/4	121	173	207	242	276	293
1 13/16	3 5/8	123	176	212	247	282	300
1 3/4	3 1/2	126	180	216	253	289	307
1 11/16	3 3/8	129	185	221	258	295	314
1 5/8	3 1/4	132	189	227	265	302	321
1 9/16	3 1/8	135	194	232	271	310	329
1 1/2	3	139	198	238	278	317	337
1 7/16	2 7/8	142	203	244	285	326	346
1 3/8	2 3/4	146	209	251	292	334	355
1 5/16	2 5/8	150	214	257	300	343	365
1 1/4	2 1/2	154	220	265	309	353	375
1 3/16	2 3/8	159	227	272	317	363	385
1 1/8	2 1/4	163	233	280	327	373	397
1 1/16	2 1/8	168	240	289	337	385	409
1	2	174	248	298	347	397	422
15/16	1 7/8	179	256	307	358	410	435
7/8	1 3/4	185	265	317	370	423	450
13/16	1 5/8	192	274	328	383	438	465
3/4	1 1/2	198	283	340	397	453	482
11/16	1 3/8	206	294	353	411	470	500
5/8	1 1/4	214	305	366	427	488	519
9/16	1 1/8	222	317	381	444	508	540
1/2	1	231	331	397	463	529	562
7/16	7/8	242	345	414	483	552	587
3/8	3/4	253	361	433	505	577	613
5/16	5/8	265	378	453	529	605	642
1/4	1/2	278	397	476	556	635	675
3/16	3/8	292	418	501	585	668	710
1/8	1/4	309	441	529	617	705	750
1/16	1/8	327	467	560	654	747	794
0	0	347	496	595	694	794	843

KOBE K-60 DIESEL HAMMER

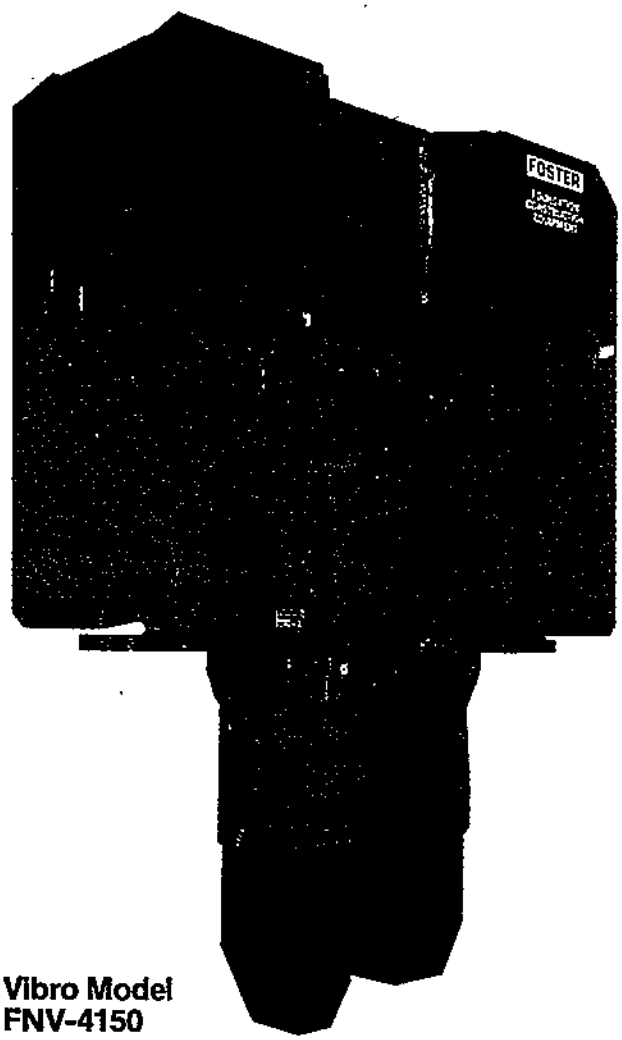
$P = \frac{2WH}{S + 0.1}$ WEIGHT OF RAM = 13200
REFUSAL SHALL BE BETWEEN 150 - 180 TONS

PENETRATION (INCHES)		AVERAGE HEIGHT OF FALL (FT.)					
10 BLOWS	20 BLOWS	3.5	5	6	7	8	8.5
		BEARING IN TONS					
2 1/2	5	132	189	228	264	302	321
2 7/16	4 7/8	134	192	230	269	307	326
2 3/8	4 3/4	137	196	235	274	313	332
2 5/16	4 5/8	139	199	239	279	319	339
2 1/4	4 1/2	142	203	244	284	325	345
2 3/16	4 3/8	145	207	248	290	331	352
2 1/8	4 1/4	148	211	253	296	338	359
2 1/16	4 1/8	151	216	259	302	345	366
2	4	154	220	264	308	352	374
1 15/16	3 7/8	157	225	270	315	359	382
1 7/8	3 3/4	161	230	275	321	367	390
1 13/16	3 5/8	164	235	282	329	375	399
1 3/4	3 1/2	168	240	288	336	384	408
1 11/16	3 3/8	172	246	295	344	393	417
1 5/8	3 1/4	176	251	302	352	402	427
1 9/16	3 1/8	180	258	309	361	412	438
1 1/2	3	185	264	317	370	422	449
1 7/16	2 7/8	190	271	325	379	433	460
1 3/8	2 3/4	195	278	333	389	445	472
1 5/16	2 5/8	200	285	342	400	457	485
1 1/4	2 1/2	205	293	352	411	469	499
1 3/16	2 3/8	211	302	362	422	483	513
1 1/8	2 1/4	217	311	373	435	497	528
1 1/16	2 1/8	224	320	384	448	512	544
1	2	231	330	396	462	528	561
15/16	1 7/8	238	341	409	477	545	579
7/8	1 3/4	246	352	422	493	563	598
13/16	1 5/8	255	364	437	510	583	619
3/4	1 1/2	264	377	453	528	603	641
11/16	1 3/8	274	391	469	548	626	665
5/8	1 1/4	284	406	487	569	650	690
9/16	1 1/8	296	422	507	591	676	718
1/2	1	308	440	528	616	704	748
7/16	7/8	321	459	551	643	735	781
3/8	3/4	336	480	576	672	768	816
5/16	5/8	352	503	603	704	805	855
1/4	1/2	370	526	634	739	845	898
3/16	3/8	389	556	667	778	889	945
1/8	1/4	411	587	704	821	939	997
1/16	1/8	435	621	745	870	994	1056
0	0	462	660	792	924	1056	1122

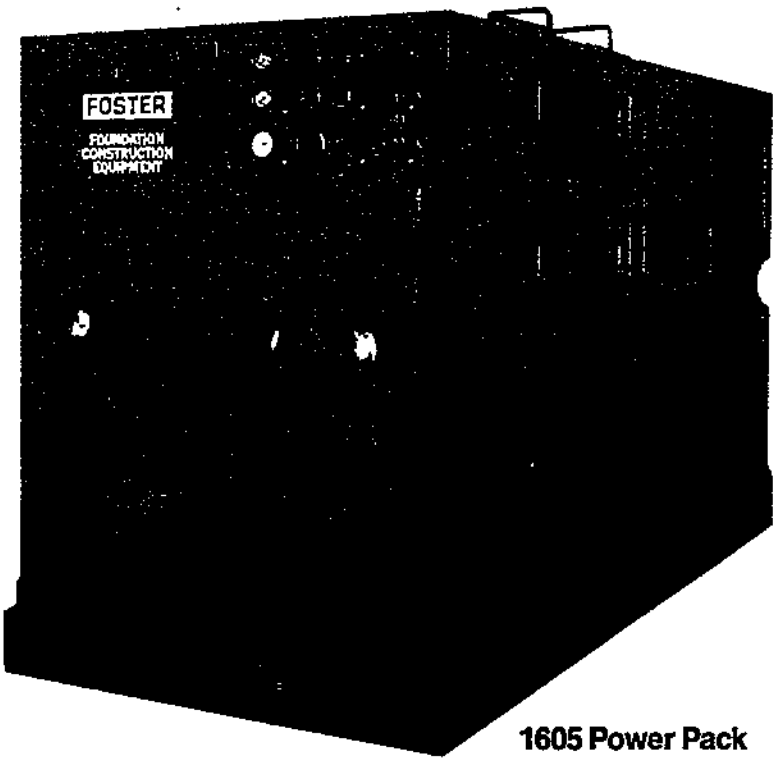
FOSTER L.B.FOSTER COMPANY

PILE DRIVING EQUIPMENT

VIBRO DRIVER®/ EXTRACTOR



Vibro Model FNV-4150



1605 Power Pack

The state of the art in hydraulic vibratory technology.

Foster's new **full power hydraulic control system** utilizes a constant horsepower control to deliver full available power in over 95 percent of all driving conditions. Other vibros deliver full available horsepower to the work of vibration only a very small percentage of the time. So Foster gives you the best performance on sheeting, H-beams, caissons and other driving/extracting jobs.

The new full power design provides an **increased maximum torque to eccentric moment ratio.** This ratio gives you a good idea of the machine's ability to maintain its rated speed.

Remote control of engine speed lets the operator select the optimum driving frequency and permits throttling back to low idle in order to save fuel and reduce noise during pile handling intervals.

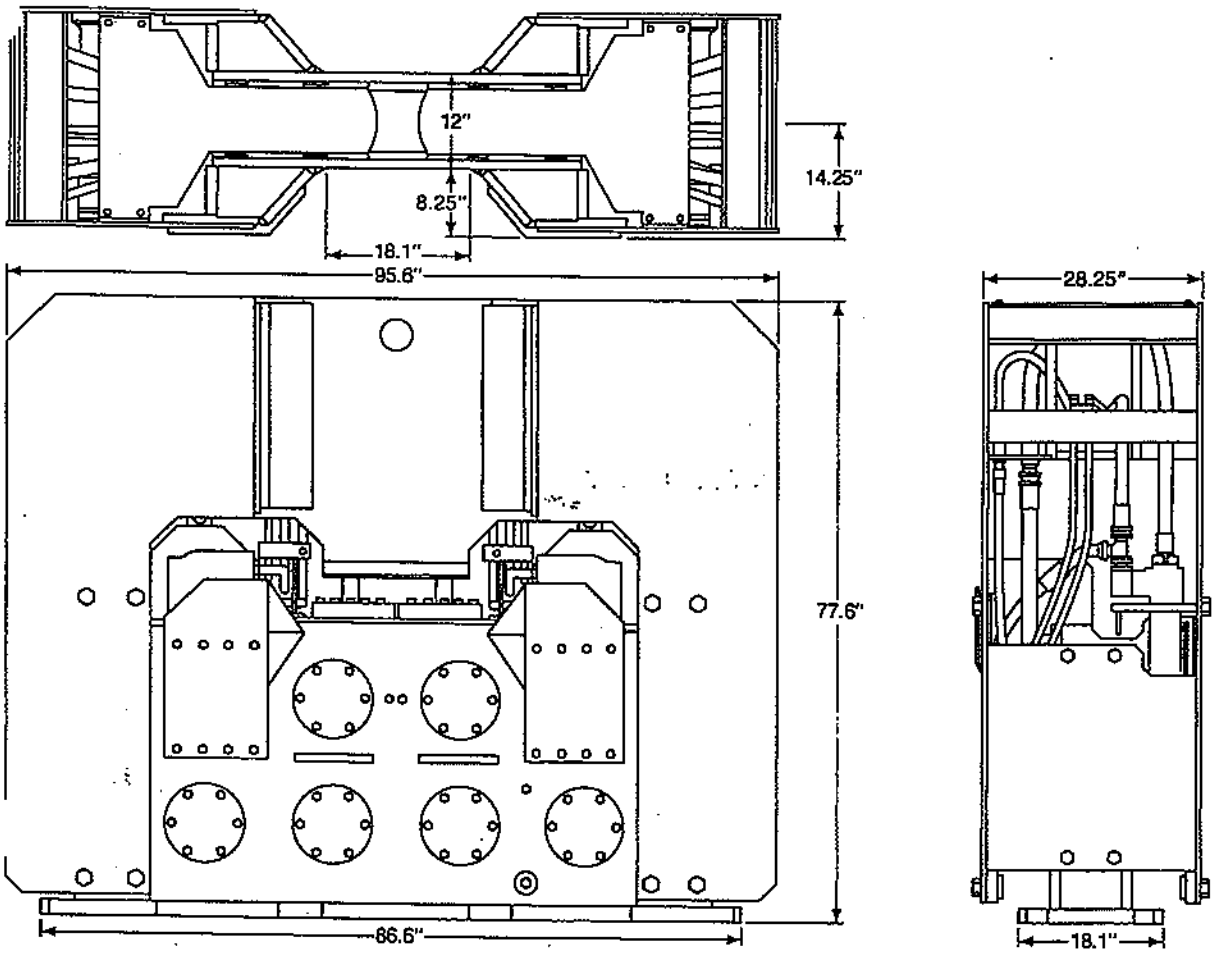
There have been major advances in **transmission design,** including specially strengthened gears cut in a manner to reduce noise and increase gear life. Moreover, the new transmission design eliminates key and keyway failure.

The new full power hydraulic control system offers **built-in protection.** A safety shut-down system protects hydraulic components from contamination, loss of oil, overspeed and overheating. Indicator lights make short work of trouble shooting and repair.

A duplex pendant station allows full control from the remote pendant or the control panel itself, thus eliminating downtime from pendant malfunctions.

Finally, a duplex main return filter allows continued work on a second clean element to minimize downtime.

Dimensions and Specifications



SPECIFICATIONS FOR MODEL FNV-4150 VIBRO DRIVER/EXTRACTOR:

Type—Hydraulic
Eccentric Moment—4166/3125 in./lbs.
Frequency—900-1500 Vpm
Amplitude—5/16 in.-1¼ in.
Driving Force—134 tons
Maximum Operating Pressure—5000 psi
Maximum Flow—160 gpm
Working Line Pull for Extraction—55 tons

Type of Suspension—Elastomeric
Pile Clamping Force—145/200 tons
Suspended Weight (A)—16495 lbs.
Shipping Weight (B)—31995 lbs.
Length—95.6 in.
Width—27.25 in.
Throat Width—12 in.
Hammer Height—77.6 in.

A. Suspended weight includes Driver/Extractor, Typical Driving/Extracting Head, and 1½ in. Hydraulic Hoses.

B. Shipping weight includes Driver/Extractor, Power Pack, Driving/Extracting Head, and Hydraulic Hoses.

SPECIFICATIONS FOR MODEL 1605 HYDRAULIC POWER PACK

ENGINE SPECIFICATIONS:
Type—Caterpillar, Model 3408 DITA
Engine Horsepower—570 hp
Maximum rpm—2100 rpm

HYDRAULIC PUMP SPECIFICATIONS:
Type—Rexroth Tandem A7V225
Maximum Output Pressure—5000 psi
Maximum Output Flow—160 gpm
Clamp Pressure—5000 psi

GENERAL SPECIFICATIONS:
Hydraulic Oil Tank Capacity—300 gal.
Fuel Tank Capacity—125 gal.
Approximate Fuel Consumption at Maximum Output—17.6 gal./hr.
Overall Length—12'
Overall Width—5'4"
Overall Height—6'10"
Weight (Wet)—16680 lbs.
Weight (Dry)—13880 lbs.
Skid Type Fuel Tank
Totally enclosed with locking doors
Engine Precleaner

Hydraulic Hose Quick Disconnects.
Duplex Control Circuit.
Automatic Shutdown on contamination, loss of oil, overspeed and overheating.
Hand Held Control Pendant.

For further information write:
L. B. FOSTER COMPANY
415 Holiday Drive
Pittsburgh, PA 15220
Phone 412/928-3400, or call your local Foster Sales Office.

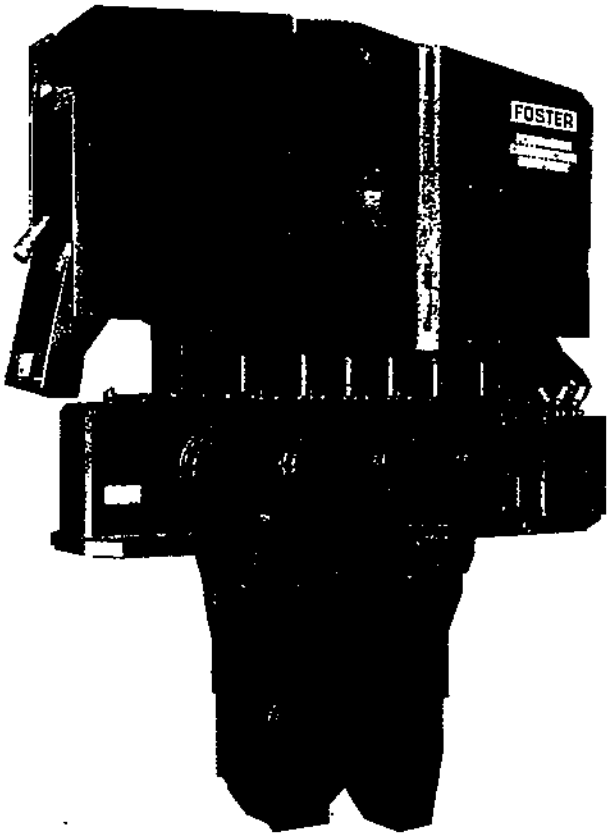
FOSTER **L.B.FOSTER COMPANY**

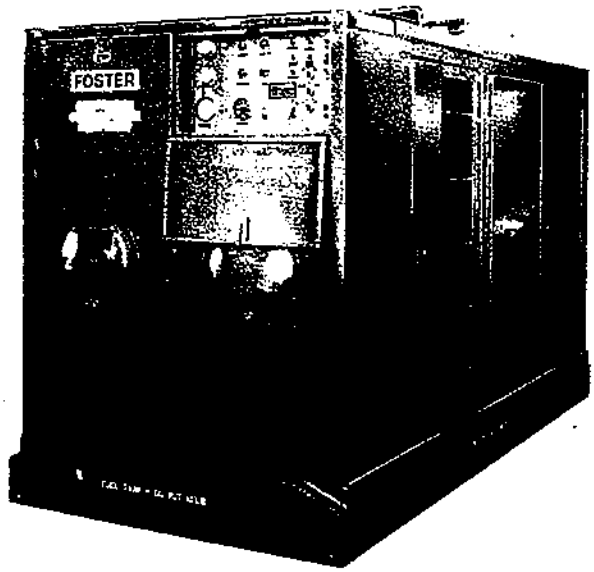
W-2460 9/88 2.5M

FOSTER CONSTRUCTION PRODUCTS

PILE DRIVING EQUIPMENT

VIBRO DRIVER®/EXTRACTOR





Vibro Model FMV-1800

805 Power Pack

The state of the art in hydraulic vibratory technology!

Foster's new **full power hydraulic control system** utilizes a constant horsepower control to deliver full available power in over 95 percent of all driving conditions. Unlike other vibros, the Foster Vibro Model FMV-1800 delivers full available horsepower to the pile. You get the best performance possible on sheeting, H-beams, caissons and other driving/extracting jobs.

Foster's full power design provides an **increased maximum torque to eccentric moment ratio.** This ratio illustrates the machine's excellent ability to maintain its rated speed.

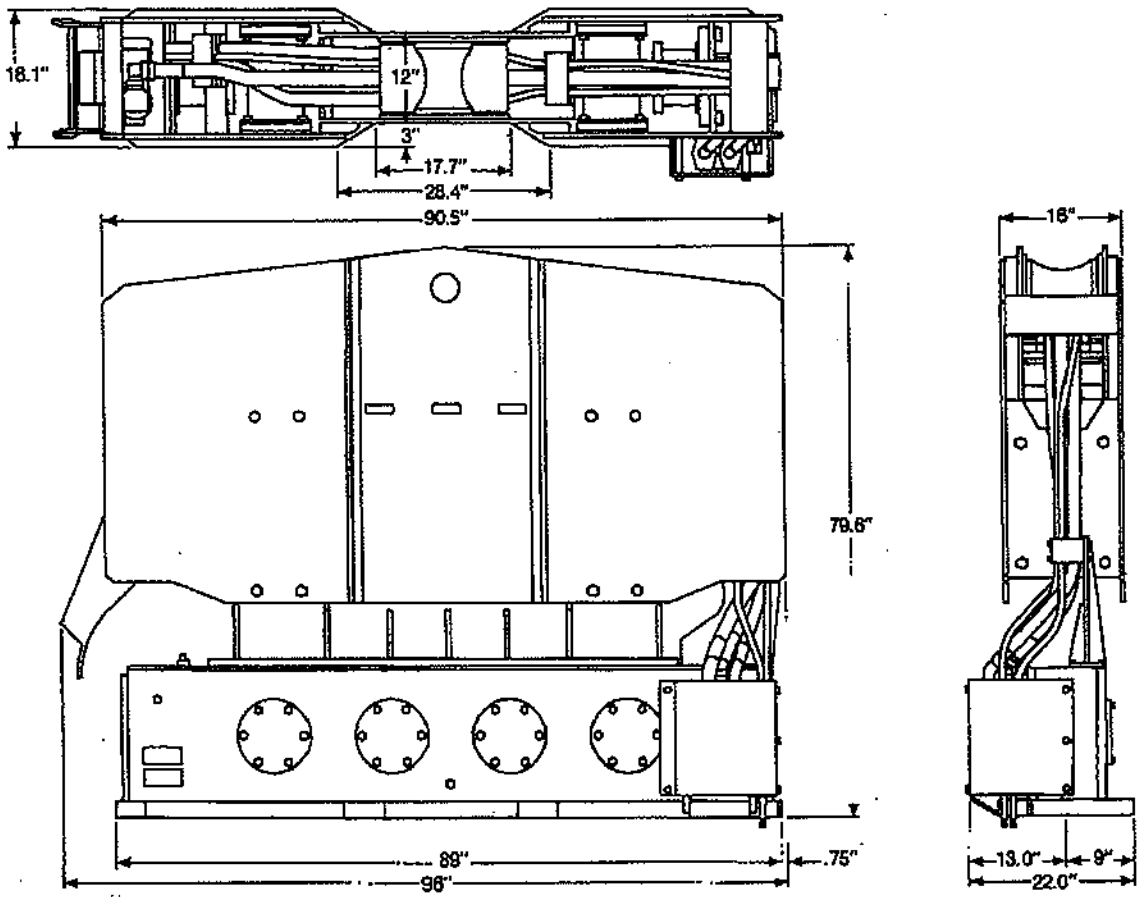
Through **remote control of the engine speed,** the operator selects the optimum driving frequency and can throttle back to low idle, saving fuel and reducing noise during pile handling intervals.

Major advances in transmission design include specially strengthened gears cut to reduce noise and increase gear life. Moreover, the transmission design eliminates key and keyway failure.

Foster's full power hydraulic control system offers **built-in protection.** A safety shut-down system protects hydraulic components from contamination, loss of oil, and overheating. Indicator lights provide at-a-glance trouble shooting and repair.

Finally, a duplex pendant station allows full control from the remote pendant of the control panel itself, thus eliminating downtime from pendant malfunctions.

Dimensions and Specifications



SPECIFICATIONS FOR MODEL FMV-1800 VIBRO DRIVER/EXTRACTOR

Type - Hydraulic
Eccentric Moment - 1800 in./lbs.
Frequency - 1000 - 1600 Vpm
Amplitude - 5/16 in. - 3/4 in.
Driving Force - 65 tons
Maximum Operating Pressure - 5000 psi
Maximum Flow - 80 gpm
Working Line Pull for Extraction - 30 tons

Type of Suspension - Elastomeric
Pile Clamping Force - 90/120 tons
Suspended Weight (A) - 11000 lbs.
Shipping Weight (B) - 24375 lbs.
Length - 96 in.
Width - 21.1 in.
Throat Width - 12 in.
Hammer Height - 79.6 in.

A. Suspended weight includes Driver/Extractor, Typical Driving/Extracting Head, and 1-1/4 in. Hydraulic Hoses.

B. Shipping weight includes Driver/Extractor, Power Pack, Driving/Extracting Head, and Hydraulic Hoses.

SPECIFICATIONS FOR MODEL 805 HYDRAULIC POWER PACK

ENGINE SPECIFICATIONS

Type - Caterpillar 3208
Engine Horsepower - 220 hp
Maximum rpm - 2800 rpm

HYDRAULIC PUMP SPECIFICATIONS

Type - Rexroth A7V225
Maximum Output Pressure - 5000 psi
Maximum Output Flow - 80 gpm
Clamp Pressure - 5000 psi

GENERAL SPECIFICATIONS

Hydraulic Oil Tank Capacity - 170 gal.
Fuel Tank Capacity - 110 gal.
Appoximate Fuel Consumption at Maximum Output - 12 gal./hr.
Overall Length - 10'6"
Overall Width - 5'4"
Overall Height - 5'10"
Weight (Wet) - 13000 lbs.
Weight (Dry) - 11000 lbs.
Skid Type Fuel Tank
Totally enclosed with locking doors

Hydraulic Hose Quick Disconnects.
Automatic Shutdown on contamination, loss of oil, and overheating.
Hand Held Control Pendant.
Duplex Control Unit.

L. B. Foster is a manufacturer, fabricator and distributor of construction and highway products, tubular products and rail products.

FOSTER
L.B. FOSTER COMPANY

CORPORATE OFFICES
415 Holiday Drive
Pittsburgh, PA 15220
Phone: 1-800-255-4500

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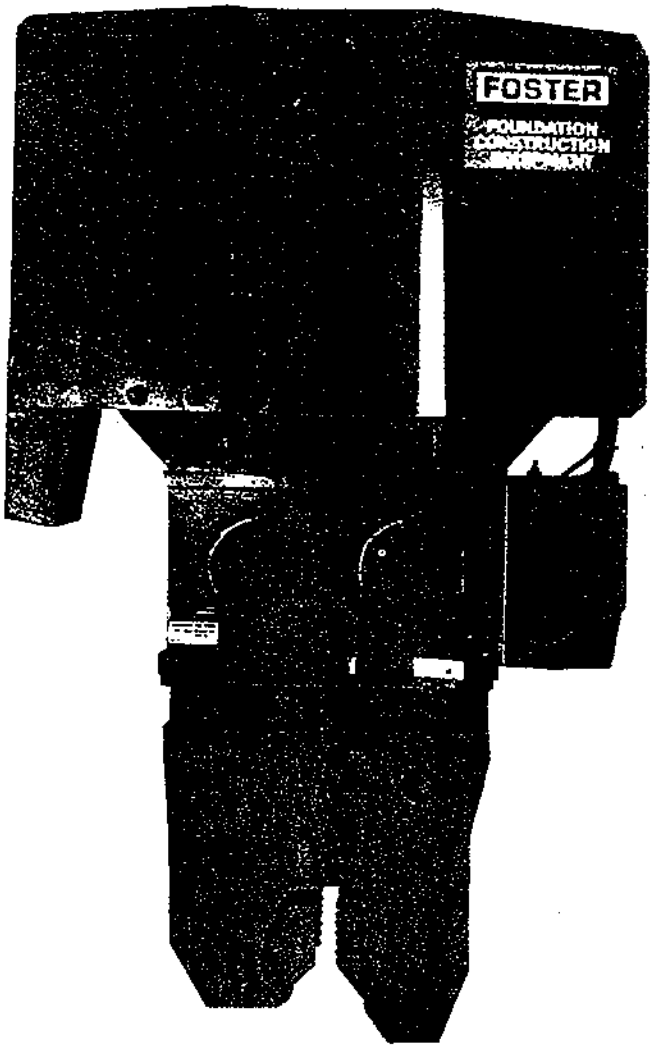
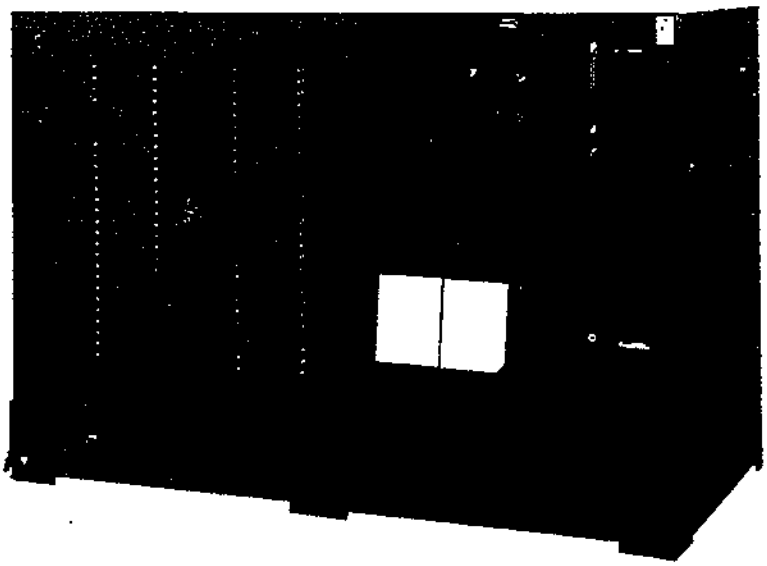
FOSTER L.B.FOSTER COMPANY

PILE DRIVING EQUIPMENT

VIBRO DRIVER®/ EXTRACTOR



VIBRO MODEL FNV-1000



753 HYDRAULIC POWER PACK

The **Foster Vibro Driver® /Extractor** is designed to drive or extract sheet piling, pipe, timber, concrete pile, caisson pile, H, I and wide-flange beams.

The slim Foster Vibro can drive a single sheet pile between piles already in place. Concentration of the vibro's full power on a single sheet pays off in greater **efficiency** when it is impossible to drive or extract pairs.

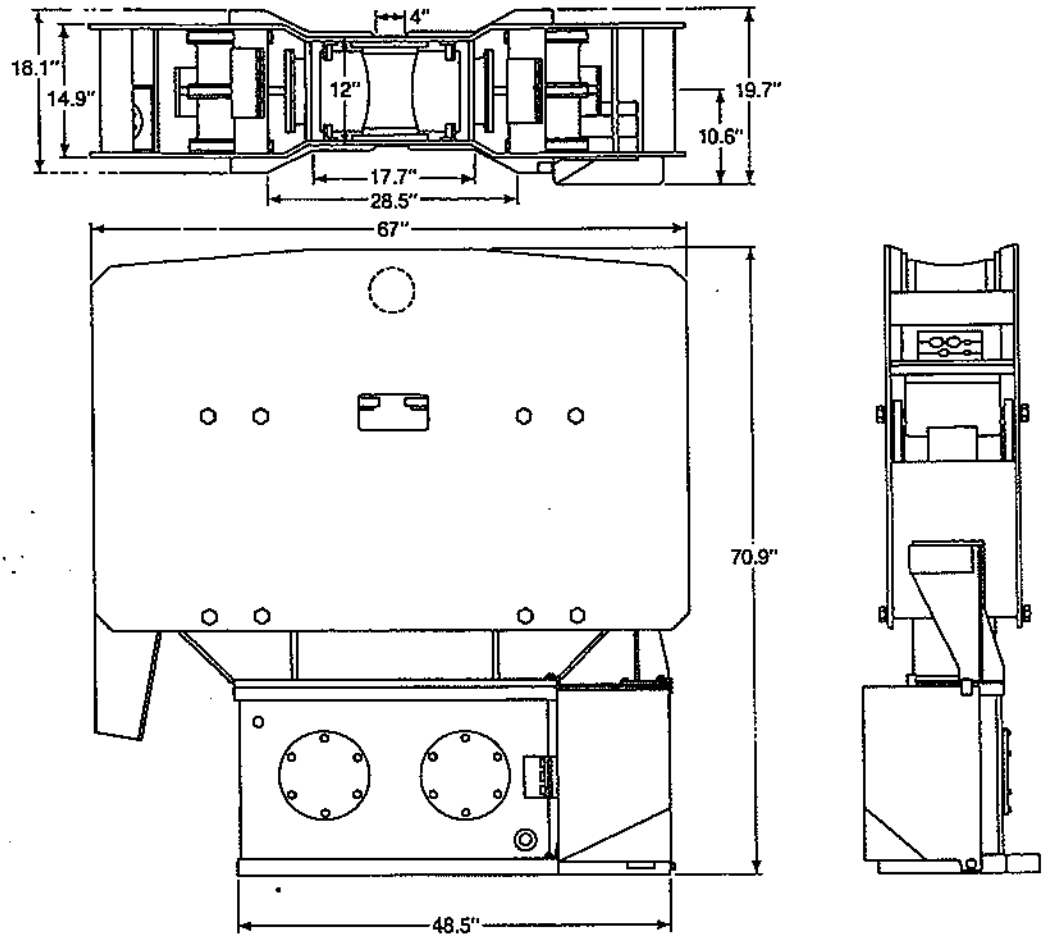
The positive hydraulic gripping action of the clamping head practically **eliminates top-end battering, brooming or distortion** of piling. Foster Vibros are available on request with proper mountings to operate on box type leaders.

There have been major advances in **transmission design,** including specially strengthened gears cut in a manner to reduce noise and increase gear life. Moreover, the new transmission design eliminates key and keyway failure and allows field bearing replacement without transmission disassembly.

The new full power hydraulic control system offers **built-in protection.** A safety shut-down system protects components from overspeed and overheating.

A duplex pendant station allows full control from the remote pendant or the control panel itself, thus eliminating downtime from pendant malfunctions.

Dimensions and Specifications



SPECIFICATIONS FOR MODEL FNV-1000 VIBRO DRIVER/EXTRACTOR:

Type—Hydraulic
Eccentric Moment—1000 in./lbs.
Frequency—1000-1600 Vpm
Amplitude—¼ in. - ¾ in.
Driving Force—37 tons
Maximum Operating Pressure—3000 psi
Maximum Flow—70 gpm
Working Line Pull for Extraction—20 tons

Type of Suspension—Elastomeric
Pile Clamping Force—90 tons
Suspended Weight (A)—6094 lbs.
Vibratory Weight W/Head—3400 lbs.
Shipping Weight (B)—10500 lbs.
Length—67 in.
Width—19.7 in.
Throat Width—12 in.
Hammer Height—70.9 in.

A. Suspended weight includes Driver/Extractor, Typical Driving/Extracting Head, and 1 in. Hydraulic Hoses.

B. Shipping weight includes Driver/Extractor, Power Pack, Driving/Extracting Head, and Hydraulic Hoses.

SPECIFICATIONS FOR MODEL 753 HYDRAULIC POWER PACK

ENGINE SPECIFICATIONS:
Type—Caterpillar 3208
Horsepower—185 hp
Maximum rpm—2800 rpm

HYDRAULIC PUMP SPECIFICATIONS:
Type—Uchida-Rexroth GXP
Maximum Output Pressure—3000 psi (@ 2400 rpm)
Maximum Output Flow—75 gpm
Clamp Pressure—3000 psi

GENERAL SPECIFICATIONS:
Hydraulic Oil Tank Capacity—100 gal.
Fuel Tank Capacity—55 gal.
Approximate Fuel Consumption at Maximum Output—9.0 gal./hr.
Overall Length—96"
Overall Width—47"
Overall Height—65"
Weight (Wet)—6800 lbs.
Weight (Dry)—5700 lbs.
Skid Type Fuel Tank
Hydraulic Hose Quick Disconnects

Automatic shutdown on overspeed and overheating
Hand held Control Pendant
Duplex Control Circuit

For further information write:
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Pittsburgh, PA 15220
Phone 412/928-3400, or call your local Foster Sales Office.

PILE DRIVING EQUIPMENT

DIESEL PILE HAMMERS

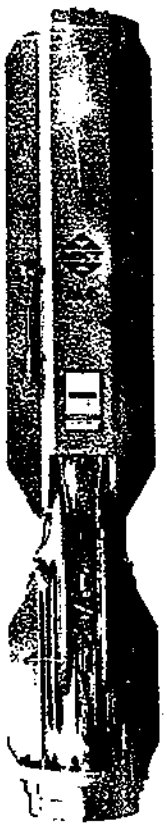
SINGLE-ACTING WITH INTERCHANGEABLE RAM SIZES

One cylinder . . . multiple ram sizes and energy ranges. Another MKT first to meet the contractor's requirement for hammer size flexibility. Reduced equipment investment costs.

Uses include driving H-beam, concrete, pipe, wood or sheet pile for highway bridges, building foundation: retaining walls, sewer line excavations and cofferdams.

MODEL	DE-33/30/20C				DE-70/50C		DE-150/110	
	DE-20	DE-30	DE-33		DE-50	DE-70	DE-110	DE-150
ENERGY RATING (ft.lbs.)	12,000-20,000	16,800-28,000	19,800-33,000	24,000-40,000	30,000-50,000	42,000-70,000	66,600-93,500	90,000-127,5
ENERGY RATING (kg-m)	1,660-2,766	2,323-3,872	2,738-4,561	3,317-5,529	4,149-6,915	5,809-9,682	9,125-12,930	12,450-17,56
RAM WEIGHT (lbs.)	2,000	2,800	3,300	4,000	5,000	7,000	11,000	15,000
RAM WEIGHT (kg)	907	1,270	1,495	1,814	2,268	3,175	5,000	6,804
STROKES/MINUTE	40-50	40-50	40-50	40-50	40-50	40-50	40-50	40-50
WIDTH OVERALL (in.)	20	20	20	20	26	26	32	32
WIDTH OVERALL (mm)	508	508	508	508	660	660	813	813
LENGTH OVERALL (ft.)	15-11	15-11*	15-11	15-11	17-11	17-11	17-10½	19-10½
LENGTH OVERALL (mm)	4,850	4,850	4,850	4,850	5,460	5,460	5,448	6,058
SHIPPING WEIGHT W/DRIVE CAP (lbs.)	7,400	8,200	8,700	9,400	14,285	16,285	27,150	32,150
SHIPPING WEIGHT W/DRIVE CAP (kg)	3,356	3,719	3,946	4,263	6,479	7,386	12,315	14,583

ENERGY RATING CLARIFICATION: MKT ratings of impact atomization, single-acting diesel hammers, a based upon the observed ram stroke on the MKT factory test stand. Published energy is equal to ram weig x stroke. Actual energies per blow of diesel hammers are a function of the quality and quantity of fuel explod in their combustion chambers and the physical condition of the combustion chambers. Since these varia are normally unmeasurable in the field, the ram stroke obtainable when operating an open-end diesel hamm at nominal refusal (on a test stand, driven pile or mat providing refusal) multiplied times its weight is considere a reasonable, conservative indicator of the minimum energy per blow delivered by an open-end diesel hamme



DOUBLE-ACTING . . . CONVERTIBLE TO SINGLE-ACTING

An exclusive MKT first . . . Select the driving mode best suited to soil conditions. Increase return on investme by lowering equipment investment costs.

Uses include driving H-beam, concrete, pipe, wood or sheet pile for highway bridges, building foundation retaining walls, sewer line excavations and cofferdams. Conversion time is approximately two hours. The hammers also have fully automatic lubrication systems.

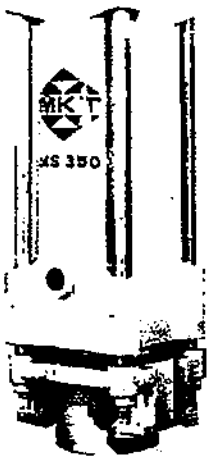
MODEL	DA-15C		DA-35C		DA-45		DA-55C	
	DOUBLE ACTING	SINGLE ACTING	DOUBLE ACTING	SINGLE ACTING	DOUBLE ACTING	SINGLE ACTING	DOUBLE ACTING	SINGLE ACTING
ENERGY RATING (ft. lbs.)	6,600-8,200	6,600-9,350	15,600-21,000	16,800-23,800	18,500-30,700	24,000-34,000	31,200-38,200	30,000-42,5
ENERGY RATING (kg-m)	913-1,134	913-1,293	2,157-2,904	2,323-3,291	2,558-4,245	3,319-4,701	4,314-5,282	4,148-5,87
RAM WEIGHT (lbs.)	1,100		2,800		4,000		5,000	
RAM WEIGHT (kg)	500		1,270		1,815		2,268	
STROKES/MINUTE	86-92	40-50	78-82	40-50	78-82	40-50	78-82	40-50
WIDTH OVERALL (in.)	20		20		26		26	
WIDTH OVERALL (mm)	508		508		660		660	
LENGTH OVERALL (ft.)	13-11		17		15-1		17-4	
LENGTH OVERALL (mm)	4,242		5,182		4,597		5,283	
SHIPPING WEIGHT W/DRIVE CAP (lbs.)	6,000		12,100		15,900		18,800	
SHIPPING WEIGHT W/DRIVE CAP (kg)	2,722		5,489		7,214		8,528	

STEAM/AIR PILE DRIVERS

MS 350 and 500 VARIABLE STROKE

Unique design, single acting hammers. Differential valving reduces steam/air consumption . . . lowers operating cost. One-piece ram/cylinder offers 40% weight reduction vs. competitive models . . . permits use of smaller crane. Extra large ram impact area provides greater production . . . less pile and hammer damage. Remote air-controlled variable stroke (12 to 48 inches) allows exact energy selection matching hammer blows to soil conditions.

MODEL	ENERGY RATING	RAM WEIGHT	STROKES/ MINUTE	COMPRESSOR SIZE	WIDTH OVERALL	LENGTH OVERALL	NET WEIGHT
MS-350	7,716-30,800 (ft. lbs.) 1,067-4,200 (kg-m)	7,716 (lbs.) 3,500 (kg)	40-50	900 (CFM) 25.5 (CMM)	26 (in.) (mm)	180⅝ (in.) (mm)	10,500 (lbs.) 4,763 (kg)
MS-500	22,000-44,000 (ft. lbs.) 3,043-6,085 (kg-m)	11,000 (lbs.) 5,000 (kg)	40-50	1,200 (CFM) 34 (CMM)	26 (in.) (mm)	181 (in.) (mm)	15,500 (lbs.) 7,030 (kg)



DOUBLE-ACTING SHEET PILE HAMMERS

Applications include driving wood or steel sheeting for shallow-cut water line, gas line or sewer construction. Will drive light or short sections of H-beam, pipe and timber piling for piers, docks or quays, retaining walls and the underpinning of buildings where there is limited head room. Used by well drillers as casing drivers; by the mining industry to break up material too large for the crushers; by the steel industry as skull breakers and core strippers; by state highway departments for soil samplers and post drivers, and below water. The hammers can also be inverted for use as a pile extractor.

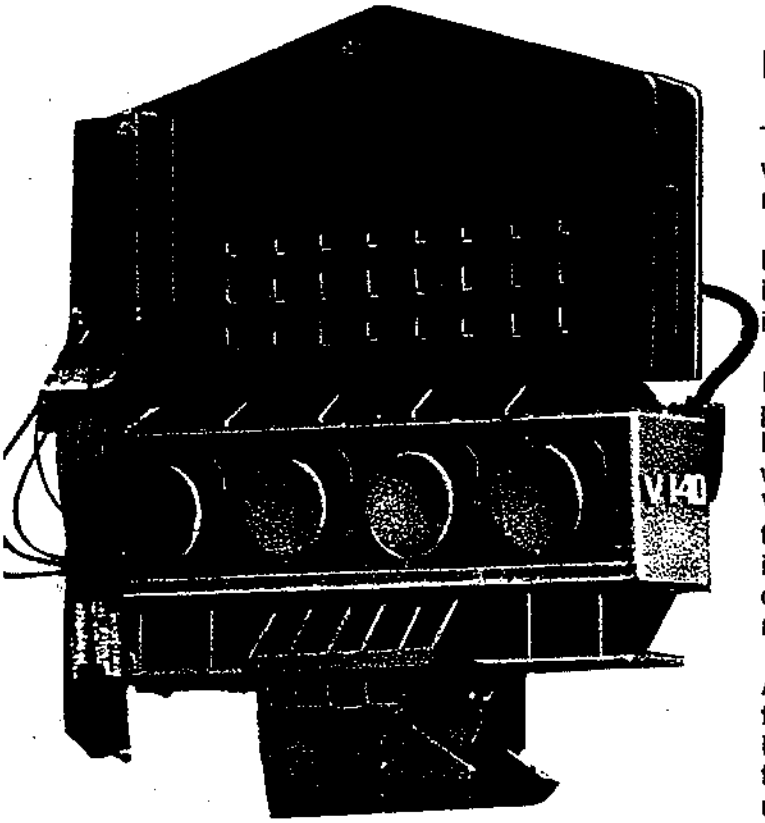
MODEL	ENERGY RATING	RAM WEIGHT	STROKES/ MINUTE	AIR COMSUMPTION	COMPRESSOR SIZE	NET WEIGHT	SHIPPING WEIGHT W/FITTINGS
#5	1,000 (ft. lbs.) 138 (kg-m)	200 (lbs.) 91 (kg)	300	250 (CFM) 7.08 (CMM)	365 (CFM) 10.34 (CMM)	1,500 (lbs.) 680 (kg)	1,560 (lbs.) 708 (kg)
#6	2,500 (ft. lbs.) 346 (kg-m)	400 (lbs.) 181 (kg)	275	400 (CFM) 11.33 (CMM)	600 (CFM) 16.99 (CMM)	2,900 (lbs.) 1,315 (kg)	2,970 (lbs.) 1,347 (kg)
#7	4,150 (ft. lbs.) 574 (kg-m)	800 (lbs.) 363 (kg)	225	450 (CFM) 12.74 (CMM)	750 (CFM) 21.24 (CMM)	5,000 (lbs.) 2,268 (kg)	5,075 (lbs.) 2,302 (kg)

DOUBLE-ACTING PILE HAMMERS

Another first! The double-acting pile hammer was introduced to the contractor by McKiernan-Terry in 1897. Used to drive steel sheet pile for deep cut water main or trunk sewer line construction, cofferdams, retaining walls. High productivity through rapid impact blows. Also commonly used to drive H-beams, timber and steel pipe. All models have underwater driving capability. Equipped with moil or chisel points, underwater rock demolition is another special application. Fully enclosed for protection of working parts and personnel safety.

MODEL	ENERGY RATING	RAM WEIGHT	STROKES/ MINUTE	AIR CONSUMPTION	COMPRESSOR SIZE	NET WEIGHT	SHIPPING WEIGHT W/FITTINGS
9B3	8,750 (ft. lbs.) 1,210 (kg-m)	1,600 (lbs.) 726 (kg)	145	600 (CFM) 16.99 (CMM)	900 (CFM) 25.49 (CMM)	7,000 (lbs.) 3,175 (kg)	7,100 (lbs.) 3,221 (kg)
[illegible]B3	13,100 (ft. lbs.) 1,812 (kg-m)	3,000 (lbs.) 1,361 (kg)	105	750 (CFM) 21.24 (CMM)	1,200 (CFM) 33.98 (CMM)	10,850 (lbs.) 4,922 (kg)	11,000 (lbs.) 4,990 (kg)
11B3	19,150 (ft. lbs.) 2,648 (kg-m)	5,000 (lbs.) 2,268 (kg)	95	900 (CFM) 25.49 (CMM)	1,200 (CFM) 33.98 (CMM)	14,000 (lbs.) 6,350 (kg)	14,200 (lbs.) 6,441 (kg)

VIBRATORY PILE DRIVER/EXTRACTOR



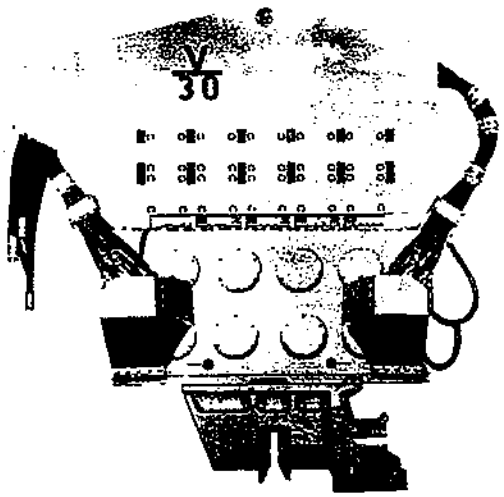
HYDRAULIC POWERED

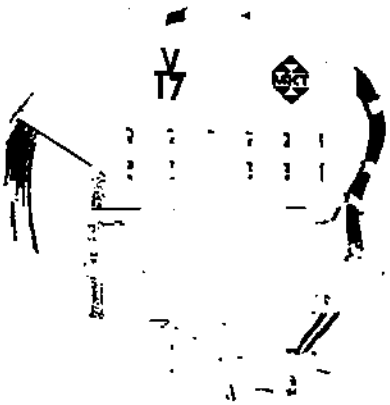
The application of hydraulic power to the principle of vibratory pile installation was conceived, engineered, manufactured and first offered to the contractor by MKT.

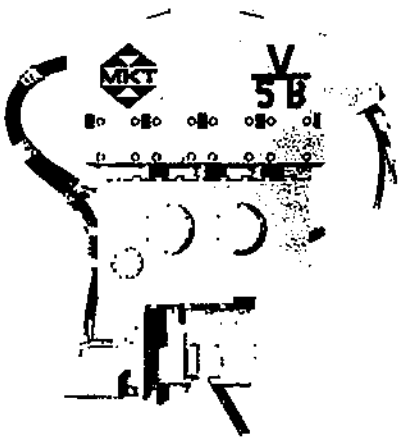
Drive by slacking holding line. Extract by pulling in holding line. Fast acting clamp, quiet operation, crane boom isolation from vibration.

In application the Model V-2A is ideal for lightweight sheet piling, guard rail posts, timber sheeting and low headroom projects. The Model V-5B is typically used where the sheet pile length varies from 20 to 40 feet. The V-17 is used on projects where the sheeting will range from 40 to 60 feet. The V-30 is best for the tougher jobs in soils with blow counts exceeding 60 per foot. V-140 is designed extra **tough** for the toughest jobs. (Note: V-2A not shown.)

All models are used for driving and/or extracting of pile for: foundations, cellular cofferdams, sewer and water lines, retaining walls, and driving and extracting caissons for building and transmission tower foundations. Also used to drive end-bearing: H-beams, wood or pipe pile. Can be operated to drive or extract piles under water after proper sealing.





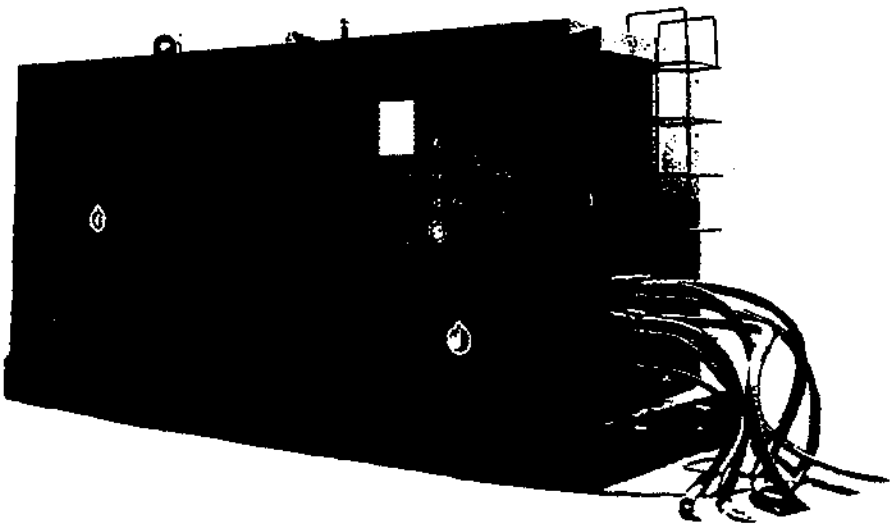


MODEL		V-2A	V-5B	V-17	V-30	V-140
DRIVING FORCE	(tons) (tonnes)	18 16.3	50 45.4	80 72.6	160 145.3	390 353.9
MAX. HYDRAULIC HP	(hp)	44	135	275	550	1,400
FREQUENCY	(cpm)	1,800	1,800	1,600	1,600	1,400
AMPLITUDE	(in.) (mm)	.75 19	.75 19	.75 19	1.0 25.4	1.0 25.4
MAXIMUM LINE PULL	(tons) (tonnes)	8 7.26	30 27.2	60 54.5	80 72.6	150 136.1
WEIGHT	(lbs.) (kg)	2,400 1,088	7,200 3,265	12,000 5,443	15,000 6,805	42,000 19,050

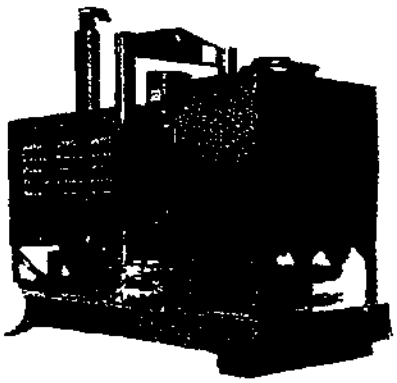
HYDRAULIC POWER UNITS

. ›m, hydraulic power units are offered by MKT for: hydraulic augers, hydraulic vibratory driver/extractors, and hydraulic-›owered bottom braces. Although designed for MKT products, MKT hydraulic power units can be used as the prime-movers or other hydraulic equipment designed to operate within their pressure and flow specifications.

HYDRAULIC POWER UNIT	USED WITH EQUIPMENT MODEL	DIESEL ENGINE	RPM	OPERATING PRESSURE PSI	OPERATING FLOW GPM	WEIGHT (lbs.)
HP-50	V-2	DEERE 3179D	2,200	2,500	30	2,500
HP-175	V-58	DEERE 6068T or 6359A	2,200	3,000	75	4,000
HP-175	H-1200B	DEERE 6068T or 6359A	2,200	3,000	75	4,000
HP-240	HA-18	DEERE 6076A	2,200	2,500	130	7,500
HP-280A	HVA-36	GM 6-71T	2,100	5,000	80	9,000
HP-325	V-17	GM 6V-92T	2,100	5,000	94	14,500
HP-550	V-30	GM 12V-71TA	2,100	5,000	178	17,500
HP-600	V-30	GM 12V-71TA	2,100	5,000	188	17,000
HP-650	V-30	GM 12V-92T/CAT 3412	2,000	5,000	200	17,500
''P-1800	V-140	GM 16V149T1	1,900	5,000	400	43,000

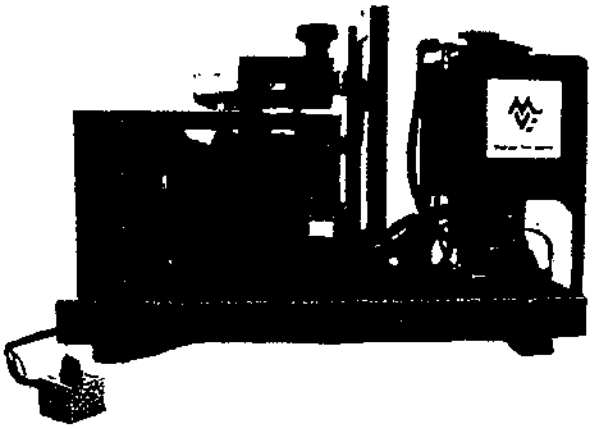


HP-600



HP-175

HYDRAULIC AUGER SYSTEMS



MKT offers three models of hydraulic augers, all with proportionate torque to speed combinations.

Contractors are discovering many uses for our augers such as pre-drilling for the ease of placement of steel or concrete piles. Other frequent uses have been the drilling out of driven pipe, angular operation for the installation of tiebacks, and through the use of our hollow output shaft, auger cast piles may be installed.

As in all MKT equipment our augering systems are dependable, highly productive and versatile (i.e. MKT augers operate within leads, on a spud beam or on the side of leads. MKT auger systems include a skid mounted, diesel driven hydraulic power unit. These units feature simple and dependable design utilizing hydraulic - over - hydraulic remote controls.

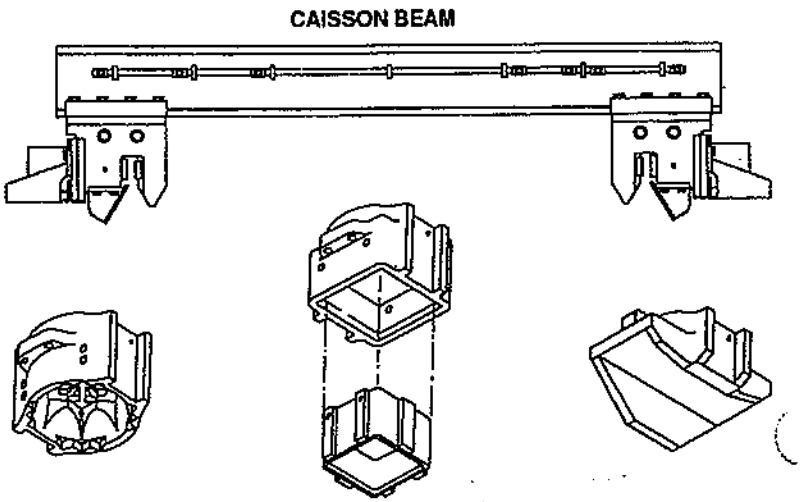
	OUTPUT TORQUE			OPERATING PRESSURE		
MODEL	(ft. lbs.)	(kg/m)	AUGER RPM	PSI	BARS	WEIGHT
H-1200B	12,000	1,660	40	3,000	207	1,900 lbs.
HA-18	18,000	2,560	60	2,500	172	2,250
HVA-36	16,000/36,000	2,200/4,980	80/35	5,000	345	3,250

ACCESSORIES

DRIVE CAPS AND CLAMP ASSEMBLIES

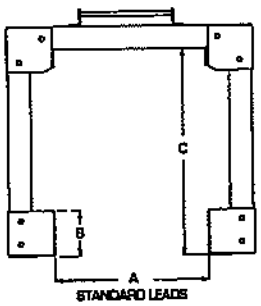
A variety of Drive Caps, Clamp Assemblies and other Accessories is available for each size Hammer. Most fit more than one pile size or type.

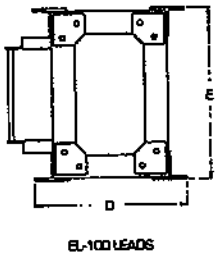
A Drive Cap is an accessory to Diesel and Double-Acting Pile Hammers. Drive Caps are slung under an Anvil by cable that is fastened to the Hammer.



QUALITY LEADS FEATURE

Sections are manufactured from rigid ASTM A-500 square and rectangular tubing, A-36 angle and plate for maximum strength and minimum weight. Sections are assembled and drilled in jigs for interchangeability. Lead sections are available from 5 to 30 feet in five-foot increments, with full-length ladders designed to provide safe toe-room. In addition to standard sections, MKT offers custom designed leads for many special pile driving applications.





SIZE	A	B	C	D	E	WEIGHT/FOOT
8 x 20	21"	8"	32"	—	—	115
8 x 26	27"	8"	36"	—	—	150
8 x 32	33"	8"	44"	—	—	180
11 x 32	33"	11"	44"	—	—	205
11 x 37	37"	11"	53"	—	—	260
EL-100	—	—	—	26"	30"	100

SWINGING LEAD SYSTEMS

Swinging Leads are suspended from a crane line and either hang freely, stab into the ground, or are held by a bottom brace. MKT Swinging Leads are lightweight and can lay down easily to free the crane for other uses. Maximum flexibility allows driving in a hole or over the edge of your excavation.

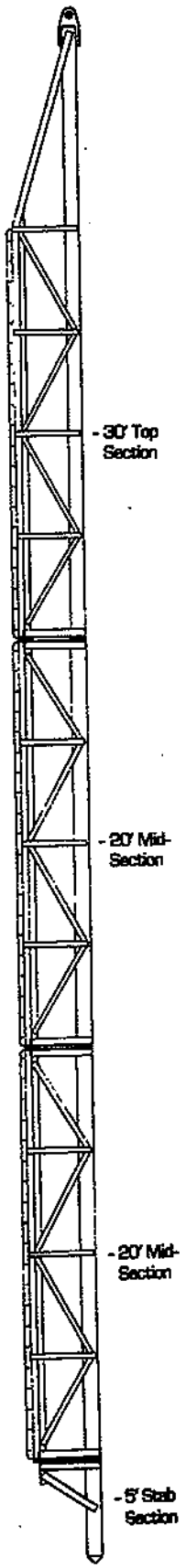
While precise pile positioning is slow and difficult, swinging leads are the most inexpensive and simple lead system available. MKT recommends the use of a 3 drum crane, using lines for hammer, pile, and leads respectively for optimum productivity. MKT Swinging Leads assemble from three basic sections - a 30-foot top section, a 5-foot stab section, and standard mid sections. The 30-foot top section is tapered to provide adequate crane boom clearance. A ball attachment to accept standard shackles is standard with the top section. A 5-foot stab section is located at the bottom of the system to help stabilize the leads. Mid sections are available in 5 to 30-foot lengths in 5-foot increments.

FIXED LEAD SYSTEMS

MKT Fixed Lead Systems provide maximum production where job conditions call for long pile lengths, extremely heavy piles, or accurate batters. Fixed leads are attached to the crane boom and supported by a bottom brace at the base of the leads. Three other special components are required for the fixed leads: (1) a head sheave assembly, (2) boom adapter, and (3) base plate. Many optional features can be added to a fixed lead system to meet the specific needs for any pile driving application. Examples of some options are: Hydraulic Pile Gates (for locating and holding the pile in place within the leads.) Side-Mounted Auger Tracks (for pre-drilling and pile driving from the same crane), and Lead Slides (for allowing the leads to be raised or lowered to work at varying grades). MKT's engineering department can assist with other options designed to minimize job time and increase productivity utilizing the latest in CAD technology.

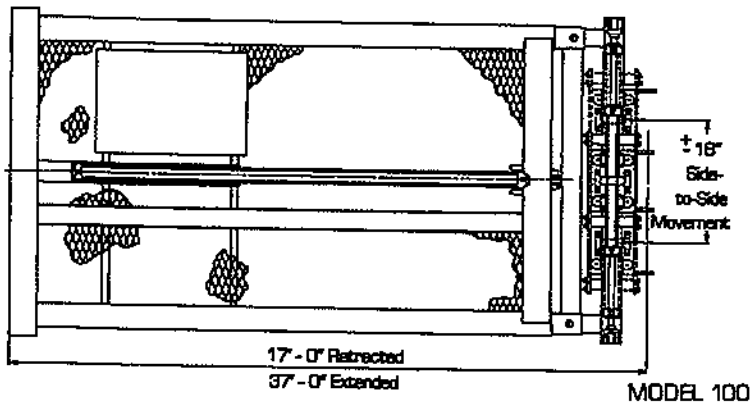
RAILROAD LEAD SYSTEMS

MKT Railroad Lead Systems were designed with the precise needs of a railroad pile driving application in mind. Our Railroad Leads feature lightweight components with the capability of rapid set-up and fold-down. The MKT Railroad Systems need only a three drum crane while most other systems require a four drum crane. MKT Railroad Systems use 1 line for the hammer, 1 line for the pile and 1 line for lead slide capability. In addition MKT Railroad Systems feature remote controls for direction of the entire pile driving operation from within the crane cab.

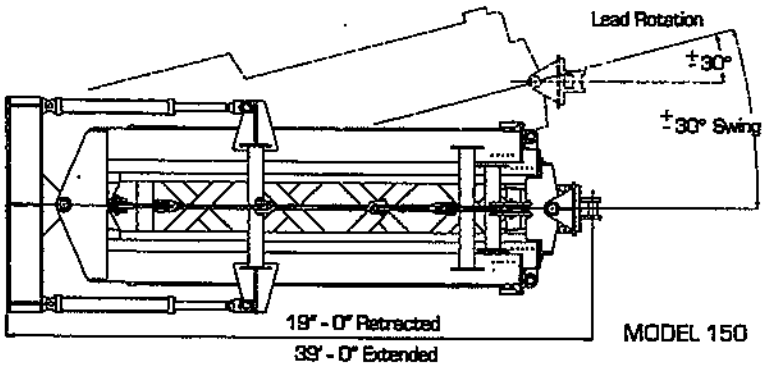


SWINGING LEAD SYSTEM

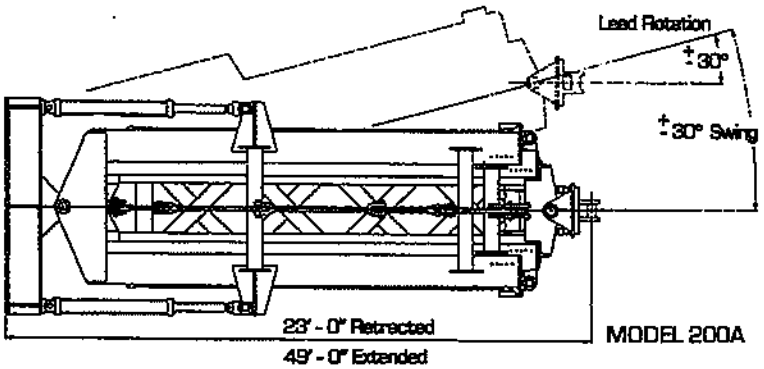
HYDRAULIC BOTTOM BRACES



MODEL 100



MODEL 150



MODEL 200A

MKT Hydraulic Bottom Braces provide quick and accura lead adjustment for most batter conditions. Each Botto Brace is remote controlled allowing the crane operator direct the entire pile driving operation. MKT offers fo standard Bottom Brace models to meet the needs of a wic range of fixed lead applications. Each Bottom Brace available with its own self-contained hydraulic power ur or several external sources may be modified for use. (i. crane engine, auger power unit.) Model 125 not shown

CAUTION: All bottom braces and fixed lead componen are intended to be used as a complete system. Whe separating components from a system, a comple engineering review must be done.

MKT MODEL 100 HYDRAULIC BOTTOM BRACE

The Model 100 Bottom Brace provides 20 feet of extensi (10 feet hydraulic and 10 feet manual) and plus or min $1^1/_2$ feet hydraulic side-to-side movement. The Model 1 is most productive on small to medium pile drivi applications where only fore, plumb, and aft batter pil will be driven.

MKT MODEL 150 HYDRAULIC BOTTOM BRACE

The Model 150 Bottom Brace provides a fully hydrau extension of 20 feet, plus or minus 30 degree swing, ar plus or minus 30 degree lead rotation. The Model 15 is most productive on medium to large pile drivir applications where a full range of batter piles will be drive

MKT MODEL 200A HYDRAULIC BOTTOM BRACE

The Model 200A Bottom Brace provides a fully hydrau extension of 26 feet, plus or minus 30 degree swing, ar plus or minus 30 degree lead rotation. The Model 200A most productive on large pile driving applications where full range of batter piles will be driven.

DISTRIBUTED BY:

MKT
MANUFACTURING INC.
1188 Pershall Road
St. Louis, Missouri 63137

We reserved the right to amend these specifications at any time without notice. The only warranty applicable is our standard written warranty. We make no other warranty - expressed or implied.

MKT DE-20 DIESEL HAMMER

$P = \frac{2WH}{S + 0.1}$ WEIGHT OF RAM = 2000
REFUSAL SHALL BE BETWEEN 150 - 180 TONS

AVG. HT. OF FALL	3.5	5	6	7	8	8.5	S
BLOWS PER FOOT	BEARING IN TONS						
4	2	3	4	5	5	5	3.000
8	4	6	8	9	10	11	1.500
12	6	9	11	13	15	15	1.000
16	8	12	14	16	19	20	0.750
20	10	14	17	20	23	24	0.600
24	12	17	20	23	27	28	0.500
28	13	19	23	26	30	32	0.429
32	15	21	25	29	34	36	0.375
36	16	23	28	32	37	39	0.333
40	18	25	30	35	40	43	0.300
44	19	27	32	38	43	46	0.273
48	20	29	34	40	46	49	0.250
52	21	30	36	42	48	51	0.231
56	22	32	38	45	51	54	0.214
60	23	33	40	47	53	57	0.200
64	24	35	42	49	56	59	0.188
68	25	36	43	51	58	61	0.176
72	26	38	45	53	60	64	0.167
76	27	39	47	54	62	66	0.158
80	28	40	48	56	64	68	0.150
84	29	41	49	58	66	70	0.143
88	30	42	51	59	68	72	0.136
92	30	43	52	61	69	74	0.130
96	31	44	53	62	71	76	0.125
100	32	45	55	64	73	77	0.120
104	33	46	56	65	74	79	0.115
108	33	47	57	66	76	81	0.111
110	33	48	57	67	77	81	0.109
120	35	50	60	70	80	85	0.100
130	36	52	62	73	83	88	0.092
140	38	54	65	75	86	92	0.086
150	39	56	67	78	89	94	0.080
160	40	57	69	80	91	97	0.075
170	41	59	70	82	94	100	0.071
180	42	60	72	84	96	102	0.067
190	43	61	74	86	98	104	0.063
200	44	63	75	88	100	106	0.060
225	46	65	78	91	104	111	0.053
250	47	68	81	95	108	115	0.048
275	49	70	84	97	111	118	0.044
300	50	71	86	100	114	121	0.040
325	51	73	88	102	117	124	0.037
350	52	74	89	104	119	127	0.034
375	53	76	91	106	121	129	0.032
400	54	77	92	108	123	131	0.030
425	55	78	94	109	125	133	0.028
450	55	79	95	111	126	134	0.027
475	56	80	96	112	128	136	0.026
500	56	81	97	113	129	137	0.024
525	57	81	98	114	130	138	0.023

MKT DE-30 DIESEL HAMMER

$P = \frac{2WH}{S + 0.1}$ WEIGHT OF RAM = 2800
REFUSAL SHALL BE BETWEEN 150 - 180 TONS

AVG. HT. OF FALL	3.5	5	6	7	8	8.5	S
BLOWS PER FOOT	BEARING IN TONS						
4	3	5	5	6	7	8	3.000
8	6	9	11	12	14	15	1.500
12	9	13	15	18	20	22	1.000
16	12	16	20	23	26	28	0.750
20	14	20	24	28	32	34	0.600
24	16	23	28	33	37	40	0.500
28	19	26	32	37	42	45	0.429
32	21	29	35	41	47	50	0.375
36	23	32	39	45	52	55	0.333
40	25	35	42	49	56	60	0.300
44	26	38	45	53	60	64	0.273
48	28	40	48	56	64	68	0.250
52	30	42	51	59	68	72	0.231
56	31	45	53	62	71	76	0.214
60	33	47	56	65	75	79	0.200
64	34	49	58	68	78	83	0.188
68	35	51	61	71	81	86	0.176
72	37	53	63	74	84	89	0.167
76	38	54	65	76	87	92	0.158
80	39	56	67	78	90	95	0.150
84	40	58	69	81	92	98	0.143
88	41	59	71	83	95	101	0.136
92	43	61	73	85	97	103	0.130
96	44	62	75	87	100	106	0.125
100	45	64	76	89	102	108	0.120
104	46	65	78	91	104	111	0.115
108	46	66	80	93	106	113	0.111
110	47	67	80	94	107	114	0.109
120	49	70	84	98	112	119	0.100
130	51	73	87	102	116	124	0.092
140	53	75	90	106	121	128	0.086
150	54	78	93	109	124	132	0.080
160	56	80	96	112	128	136	0.075
170	57	82	98	115	131	140	0.071
180	59	84	101	118	134	143	0.067
190	60	86	103	120	137	146	0.063
200	61	88	105	123	140	149	0.060
225	64	91	110	128	146	155	0.053
250	66	95	114	132	151	161	0.048
275	68	97	117	136	156	166	0.044
300	70	100	120	140	160	170	0.040
325	72	102	123	143	164	174	0.037
350	73	104	125	146	167	177	0.034
375	74	106	127	148	170	180	0.032
400	75	108	129	151	172	183	0.030
425	76	109	131	153	175	186	0.028
450	77	111	133	155	177	188	0.027
475	78	112	134	156	179	190	0.026
500	79	113	135	158	181	192	0.024
525	80	114	137	160	182	194	0.023

MKT DE-33 DIESEL HAMMER

$P = \frac{2WH}{S + 0.1}$ WEIGHT OF RAM = 3300
REFUSAL SHALL BE BETWEEN 150 - 180 TONS

AVG. HT. OF FALL	3.5	5	6	7	8	8.5	S
BLOWS PER FOOT	BEARING IN TONS						
4	4	5	6	7	9	9	3.000
8	7	10	12	14	17	18	1.500
12	11	15	18	21	24	26	1.000
16	14	19	23	27	31	33	0.750
20	17	24	28	33	38	40	0.600
24	19	28	33	39	44	47	0.500
28	22	31	37	44	50	53	0.429
32	24	35	42	49	56	59	0.375
36	27	38	46	53	61	65	0.333
40	29	41	50	58	66	70	0.300
44	31	44	53	62	71	75	0.273
48	33	47	57	66	75	80	0.250
52	35	50	60	70	80	85	0.231
56	37	53	63	74	84	89	0.214
60	39	55	66	77	88	94	0.200
64	40	57	69	80	92	98	0.188
68	42	60	72	84	95	101	0.176
72	43	62	74	87	99	105	0.167
76	45	64	77	90	102	109	0.158
80	46	66	79	92	106	112	0.150
84	48	68	82	95	109	116	0.143
88	49	70	84	98	112	119	0.136
92	50	72	86	100	115	122	0.130
96	51	73	88	103	117	125	0.125
100	53	75	90	105	120	128	0.120
104	54	77	92	107	123	130	0.115
108	55	78	94	109	125	133	0.111
110	55	79	95	110	126	134	0.109
120	58	83	99	116	132	140	0.100
130	60	86	103	120	137	146	0.092
140	62	89	107	124	142	151	0.086
150	64	92	110	128	147	156	0.080
160	66	94	113	132	151	160	0.075
170	68	97	116	135	155	164	0.071
180	69	99	119	139	158	168	0.067
190	71	101	121	142	162	172	0.063
200	72	103	124	144	165	175	0.060
225	75	108	129	151	172	183	0.053
250	78	111	134	156	178	190	0.048
275	80	115	138	161	184	195	0.044
300	83	118	141	165	189	200	0.040
325	84	121	145	169	193	205	0.037
350	86	123	147	172	197	209	0.034
375	88	125	150	175	200	213	0.032
400	89	127	152	178	203	216	0.030
425	90	129	154	180	206	219	0.028
450	91	130	156	182	208	221	0.027
475	92	132	158	184	211	224	0.025
500	93	133	160	186	213	226	0.024
525	94	134	161	188	215	228	0.023

MKT DE-33 DIESEL HAMMER (4000 # RAM)

$P = \frac{2WH}{S + 0.1}$ WEIGHT OF RAM = 4000
REFUSAL SHALL BE BETWEEN 150 - 180 TONS

AVG. HT. OF FALL	3.5	5	6	7	8	8.5	S
BLOWS PER FOOT	BEARING IN TONS						
4	5	6	8	9	10	11	3.000
8	9	13	15	18	20	21	1.500
12	13	18	22	25	29	31	1.000
16	18	24	28	33	38	40	0.750
20	20	29	34	40	46	49	0.600
24	23	33	40	47	53	57	0.500
28	26	38	45	53	61	64	0.429
32	29	42	51	59	67	72	0.375
36	32	46	55	65	74	78	0.333
40	35	50	60	70	80	85	0.300
44	38	54	64	75	86	91	0.273
48	40	57	69	80	91	97	0.250
52	42	60	73	85	97	103	0.231
56	45	64	76	89	102	108	0.214
60	47	67	80	93	107	113	0.200
64	49	70	83	97	111	118	0.188
68	51	72	87	101	116	123	0.176
72	53	75	90	105	120	128	0.167
76	54	78	93	109	124	132	0.158
80	56	80	96	112	128	136	0.150
84	58	82	99	115	132	140	0.143
88	59	85	102	118	135	144	0.136
92	61	87	104	122	139	148	0.130
96	62	89	107	124	142	151	0.125
100	64	91	109	127	145	155	0.120
104	65	93	111	130	149	158	0.115
108	66	95	114	133	152	161	0.111
110	67	96	115	134	153	163	0.109
120	70	100	120	140	160	170	0.100
130	73	104	125	146	166	177	0.092
140	75	108	129	151	172	183	0.086
150	78	111	133	156	178	189	0.080
160	80	114	137	160	183	194	0.075
170	82	117	141	164	188	199	0.071
180	84	120	144	168	192	204	0.067
190	86	123	147	172	196	208	0.063
200	88	125	150	175	200	213	0.060
225	91	130	157	183	209	222	0.053
250	95	135	162	189	216	230	0.048
275	97	139	167	195	223	237	0.044
300	100	143	171	200	229	243	0.040
325	102	146	175	204	234	248	0.037
350	104	149	179	209	238	253	0.034
375	106	152	182	212	242	258	0.032
400	108	154	185	215	246	262	0.030
425	109	156	187	218	250	265	0.028
450	111	158	189	221	253	268	0.027
475	112	160	192	224	255	271	0.025
500	113	161	194	226	258	274	0.024
525	114	163	195	228	260	277	0.023

MKT DE-50 DIESEL HAMMER

$P_u = \frac{2WH}{S + 0.1}$ WEIGHT OF RAM = 5000
REFUSAL SHALL BE BETWEEN 160 - 180 TONS

AVG. HT. OF FALL	3.5	5	6	7	8	8.5	S
BLOWS PER FOOT	BEARING IN TONS						
4	6	8	10	11	13	14	3.000
8	11	16	19	22	26	27	1.500
12	16	23	27	32	36	39	1.000
16	21	29	35	41	47	50	0.750
20	25	36	43	50	57	61	0.600
24	29	42	50	58	67	71	0.500
28	33	47	57	66	76	80	0.429
32	37	53	63	74	84	89	0.375
36	40	58	69	81	92	98	0.333
40	44	63	75	88	100	106	0.300
44	47	67	80	94	107	114	0.273
48	50	71	86	100	114	121	0.250
52	53	76	91	106	121	128	0.231
56	56	80	95	111	127	135	0.214
60	58	83	100	117	133	142	0.200
64	61	87	104	122	139	148	0.188
68	63	90	108	127	145	154	0.176
72	66	94	113	131	150	159	0.167
76	68	97	116	136	155	165	0.158
80	70	100	120	140	160	170	0.150
84	72	103	124	144	165	175	0.143
88	74	106	127	148	169	180	0.136
92	76	108	130	152	174	184	0.130
96	78	111	133	156	178	189	0.125
100	80	114	136	159	182	193	0.120
104	81	116	139	163	186	197	0.115
108	83	118	142	166	189	201	0.111
110	84	120	143	167	191	203	0.109
120	88	125	150	175	200	213	0.100
130	91	130	156	182	208	221	0.092
140	94	135	162	188	215	229	0.086
150	97	139	167	194	222	236	0.080
160	100	143	171	200	229	243	0.075
170	103	147	176	205	234	249	0.071
180	105	150	180	210	240	255	0.067
190	107	153	184	215	245	260	0.063
200	109	156	188	219	250	266	0.060
225	114	163	196	228	261	277	0.053
250	118	169	203	236	270	287	0.048
275	122	174	209	244	278	296	0.044
300	125	179	214	250	286	304	0.040
325	128	183	219	256	292	310	0.037
350	130	186	223	261	298	316	0.034
375	133	189	227	265	303	322	0.032
400	135	192	231	269	308	327	0.030
425	136	195	234	273	312	331	0.028
450	138	197	237	276	316	336	0.027
475	140	200	239	279	319	339	0.025
500	141	202	242	282	323	343	0.024
525	142	203	244	285	326	346	0.023

MKT DE-20 DIESEL HAMMER

P = 2 W H / S + 0.1 WEIGHT OF RAM = 2000
REFUSAL SHALL BE BETWEEN 150 - 180 TONS

PENETRATION (INCHES)		AVERAGE HEIGHT OF FALL (FT.)					
10 BLOWS	20 BLOWS	3.5	5	6	7	8	8.5
		BEARING IN TONS					
2 1/2	5	20	29	34	40	46	49
2 7/16	4 7/8	20	29	35	41	47	49
2 3/8	4 3/4	21	30	36	41	47	50
2 5/16	4 5/8	21	30	36	42	48	51
2 1/4	4 1/2	22	31	37	43	49	52
2 3/16	4 3/8	22	31	38	44	50	53
2 1/8	4 1/4	22	32	38	45	51	54
2 1/16	4 1/8	23	33	39	46	52	56
2	4	23	33	40	47	53	57
1 15/16	3 7/8	24	34	41	48	54	58
1 7/8	3 3/4	24	35	42	49	56	59
1 13/16	3 5/8	25	36	43	50	57	60
1 3/4	3 1/2	25	36	44	51	58	62
1 11/16	3 3/8	26	37	45	52	60	63
1 5/8	3 1/4	27	38	46	53	61	65
1 9/16	3 1/8	27	39	47	55	62	66
1 1/2	3	28	40	48	56	64	68
1 7/16	2 7/8	29	41	49	57	66	70
1 3/8	2 3/4	29	42	51	59	67	72
1 5/16	2 5/8	30	43	52	61	69	74
1 1/4	2 1/2	31	44	53	62	71	76
1 3/16	2 3/8	32	46	55	64	73	78
1 1/8	2 1/4	33	47	56	66	75	80
1 1/16	2 1/8	34	48	58	68	78	82
1	2	35	50	60	70	80	85
15/16	1 7/8	36	52	62	72	83	88
7/8	1 3/4	37	53	64	75	85	91
13/16	1 5/8	39	55	66	77	88	94
3/4	1 1/2	40	57	69	80	91	97
11/16	1 3/8	41	59	71	83	95	101
5/8	1 1/4	43	62	74	86	98	105
9/16	1 1/8	45	64	77	90	102	109
1/2	1	47	67	80	93	107	113
7/16	7/8	49	70	83	97	111	118
3/8	3/4	51	73	87	102	116	124
5/16	5/8	53	76	91	107	122	130
1/4	1/2	56	80	96	112	128	136
3/16	3/8	59	84	101	118	135	143
1/8	1/4	62	89	107	124	142	151
1/16	1/8	66	94	113	132	151	160
0	0	70	100	120	140	160	170

MKT DE-30 DIESEL HAMMER

P = 2 W H / S + 0.1 WEIGHT OF RAM = 2800
REFUSAL SHALL BE BETWEEN 150 - 180 TONS

PENETRATION (INCHES)		AVERAGE HEIGHT OF FALL (FT.)					
10 BLOWS	20 BLOWS	3.5	5	6	7	8	8.5
		BEARING IN TONS					
2 1/2	5	28	40	48	56	64	68
2 7/16	4 7/8	29	41	49	57	65	69
2 3/8	4 3/4	29	41	50	58	66	71
2 5/16	4 5/8	30	42	51	59	68	72
2 1/4	4 1/2	30	43	52	60	69	73
2 3/16	4 3/8	31	44	53	61	70	75
2 1/8	4 1/4	31	45	54	63	72	76
2 1/16	4 1/8	32	46	55	64	73	78
2	4	33	47	56	65	75	79
1 15/16	3 7/8	33	48	57	67	76	81
1 7/8	3 3/4	34	49	58	68	78	83
1 13/16	3 5/8	35	50	60	70	80	85
1 3/4	3 1/2	36	51	61	71	81	87
1 11/16	3 3/8	36	52	63	73	83	89
1 5/8	3 1/4	37	53	64	75	85	91
1 9/16	3 1/8	38	55	66	76	87	93
1 1/2	3	39	56	67	78	90	95
1 7/16	2 7/8	40	57	69	80	92	98
1 3/8	2 3/4	41	59	71	83	94	100
1 5/16	2 5/8	42	61	73	85	97	103
1 1/4	2 1/2	44	62	75	87	100	106
1 3/16	2 3/8	45	64	77	90	102	109
1 1/8	2 1/4	46	66	79	92	105	112
1 1/16	2 1/8	48	68	81	95	109	115
1	2	49	70	84	98	112	119
15/16	1 7/8	51	72	87	101	116	123
7/8	1 3/4	52	75	90	105	119	127
13/16	1 5/8	54	77	93	108	124	131
3/4	1 1/2	56	80	96	112	128	136
11/16	1 3/8	58	83	100	116	133	141
5/8	1 1/4	60	86	103	121	138	146
9/16	1 1/8	63	90	108	125	143	152
1/2	1	65	93	112	131	149	159
7/16	7/8	68	97	117	136	156	166
3/8	3/4	71	102	122	143	163	173
5/16	5/8	75	107	128	149	171	181
1/4	1/2	78	112	134	157	179	190
3/16	3/8	83	118	141	165	189	200
1/8	1/4	87	124	149	174	199	212
1/16	1/8	92	132	158	184	211	224
0	0	98	140	168	196	224	238

MKT DE-33 DIESEL HAMMER

P = 2 W H / S + 0.1 WEIGHT OF RAM = 3300
REFUSAL SHALL BE BETWEEN 150 - 180 TONS

PENETRATION (INCHES)		AVERAGE HEIGHT OF FALL (FT.)					
10 BLOWS	20 BLOWS	3.5	5	6	7	8	8.5
		BEARING IN TONS					
2 1/2	5	33	47	57	66	75	80
2 7/16	4 7/8	34	48	58	67	77	82
2 3/8	4 3/4	34	49	59	68	78	83
2 5/16	4 5/8	35	50	60	70	80	85
2 1/4	4 1/2	36	51	61	71	81	86
2 3/16	4 3/8	36	52	62	72	83	88
2 1/8	4 1/4	37	53	63	74	84	90
2 1/16	4 1/8	38	54	65	75	86	92
2	4	39	55	66	77	88	94
1 15/16	3 7/8	39	56	67	79	90	95
1 7/8	3 3/4	40	57	69	80	92	98
1 13/16	3 5/8	41	59	70	82	94	100
1 3/4	3 1/2	42	60	72	84	96	102
1 11/16	3 3/8	43	61	74	86	98	104
1 5/8	3 1/4	44	63	75	88	101	107
1 9/16	3 1/8	45	64	77	90	103	109
1 1/2	3	46	66	79	92	106	112
1 7/16	2 7/8	47	68	81	95	108	115
1 3/8	2 3/4	49	69	83	97	111	118
1 5/16	2 5/8	50	71	86	100	114	121
1 1/4	2 1/2	51	73	88	103	117	125
1 3/16	2 3/8	53	75	91	106	121	128
1 1/8	2 1/4	54	78	93	109	124	132
1 1/16	2 1/8	56	80	96	112	128	136
1	2	58	83	99	116	132	140
15/16	1 7/8	60	85	102	119	136	145
7/8	1 3/4	62	88	106	123	141	150
13/16	1 5/8	64	91	109	127	146	155
3/4	1 1/2	66	94	113	132	151	160
11/16	1 3/8	68	98	117	137	156	166
5/8	1 1/4	71	102	122	142	162	173
9/16	1 1/8	74	106	127	148	169	180
1/2	1	77	110	132	154	176	187
7/16	7/8	80	115	138	161	184	195
3/8	3/4	84	120	144	168	192	204
5/16	5/8	88	126	151	176	201	214
1/4	1/2	92	132	158	185	211	224
3/16	3/8	97	139	167	195	222	236
1/8	1/4	103	147	176	205	235	249
1/16	1/8	109	155	186	217	248	264
0	0	116	165	198	231	264	281

MKT DE-33 DIESEL HAMMER (4000# RAM)

P = 2 W H / S + 0.1 WEIGHT OF RAM = 4000
REFUSAL SHALL BE BETWEEN 150 - 180 TONS

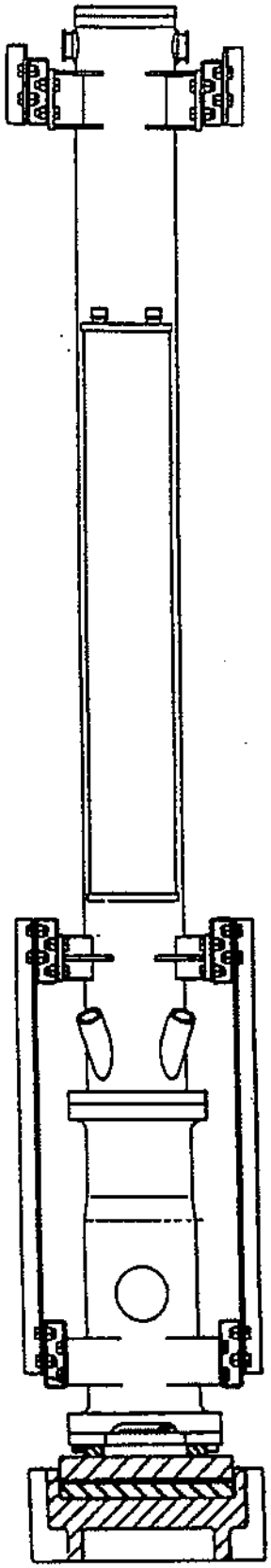
PENETRATION (INCHES)		AVERAGE HEIGHT OF FALL (FT.)					
10 BLOWS	20 BLOWS	3.5	5	6	7	8	8.5
		BEARING IN TONS					
2 1/2	5	40	57	69	80	91	97
2 7/16	4 7/8	41	58	70	81	93	99
2 3/8	4 3/4	41	59	71	83	95	101
2 5/16	4 5/8	42	60	72	85	97	103
2 1/4	4 1/2	43	62	74	86	98	105
2 3/16	4 3/8	44	63	75	88	100	107
2 1/8	4 1/4	45	64	77	90	102	109
2 1/16	4 1/8	46	65	78	91	104	111
2	4	47	67	80	93	107	113
1 15/16	3 7/8	48	68	82	95	109	116
1 7/8	3 3/4	49	70	83	97	111	118
1 13/16	3 5/8	50	71	85	100	114	121
1 3/4	3 1/2	51	73	87	102	116	124
1 11/16	3 3/8	52	74	89	104	119	127
1 5/8	3 1/4	53	76	91	107	122	130
1 9/16	3 1/8	55	78	94	109	125	133
1 1/2	3	56	80	96	112	128	136
1 7/16	2 7/8	57	82	98	115	131	139
1 3/8	2 3/4	59	84	101	118	135	143
1 5/16	2 5/8	61	86	104	121	138	147
1 1/4	2 1/2	62	89	107	124	142	151
1 3/16	2 3/8	64	91	110	128	146	155
1 1/8	2 1/4	66	94	113	132	151	160
1 1/16	2 1/8	68	97	116	136	155	165
1	2	70	100	120	140	160	170
15/16	1 7/8	72	103	124	145	165	175
7/8	1 3/4	75	107	128	149	171	181
13/16	1 5/8	77	110	132	154	177	188
3/4	1 1/2	80	114	137	160	183	194
11/16	1 3/8	83	119	142	166	190	201
5/8	1 1/4	86	123	148	172	197	209
9/16	1 1/8	90	128	154	179	205	218
1/2	1	93	133	160	187	213	227
7/16	7/8	97	139	167	195	223	237
3/8	3/4	102	145	175	204	233	247
5/16	5/8	107	152	183	213	244	259
1/4	1/2	112	160	192	224	256	272
3/16	3/8	118	168	202	236	269	286
1/8	1/4	124	178	213	249	284	302
1/16	1/8	132	188	226	264	301	320
0	0	140	200	240	280	320	340

MKT DE-50 DIESEL HAMMER

$P = \frac{2WH}{S + 0.1}$ WEIGHT OF RAM = 5000
REFUSAL SHALL BE BETWEEN 150 - 180 TONS

PENETRATION (INCHES)		AVERAGE HEIGHT OF FALL (FT.)					
10 BLOWS	20 BLOWS	3.5	5	6	7	8	8.5
		BEARING IN TONS					
2 1/2	5	50	71	86	100	114	121
2 7/16	4 7/8	51	73	87	102	116	124
2 3/8	4 3/4	52	74	89	104	119	126
2 5/16	4 5/8	53	75	91	106	121	128
2 1/4	4 1/2	54	77	92	108	123	131
2 3/16	4 3/8	55	78	94	110	125	133
2 1/8	4 1/4	56	80	96	112	128	136
2 1/16	4 1/8	57	82	98	114	131	139
2	4	58	83	100	117	133	142
1 15/16	3 7/8	60	85	102	119	136	145
1 7/8	3 3/4	61	87	104	122	139	148
1 13/16	3 5/8	62	89	107	124	142	151
1 3/4	3 1/2	64	91	109	127	145	155
1 11/16	3 3/8	65	93	112	130	149	158
1 5/8	3 1/4	67	95	114	133	152	162
1 9/16	3 1/8	68	98	117	137	156	166
1 1/2	3	70	100	120	140	160	170
1 7/16	2 7/8	72	103	123	144	164	174
1 3/8	2 3/4	74	105	126	147	168	179
1 5/16	2 5/8	76	108	130	151	173	184
1 1/4	2 1/2	78	111	133	156	178	189
1 3/16	2 3/8	80	114	137	160	183	194
1 1/8	2 1/4	82	118	141	165	188	200
1 1/16	2 1/8	85	121	145	170	194	206
1	2	88	125	150	175	200	213
15/16	1 7/8	90	129	155	181	206	219
7/8	1 3/4	93	133	160	187	213	227
13/16	1 5/8	97	138	166	193	221	234
3/4	1 1/2	100	143	171	200	229	243
11/16	1 3/8	104	148	178	207	237	252
5/8	1 1/4	108	154	185	215	246	262
9/16	1 1/8	112	160	192	224	256	272
1/2	1	117	167	200	233	267	283
7/16	7/8	122	174	209	243	278	296
3/8	3/4	127	182	218	255	291	309
5/16	5/8	133	190	229	267	305	324
1/4	1/2	140	200	240	280	320	340
3/16	3/8	147	211	253	295	337	358
1/8	1/4	156	222	267	311	356	378
1/16	1/8	165	235	282	329	376	400
0	0	175	250	300	350	400	425

ICE MODEL 40S DIESEL PILE HAMMER



WORKING SPECIFICATIONS

Rated energy	40,000 ft-lbs (5,530 kg-m)
Minumum energy	16,000 ft-lbs (2,212 kg-m)
Stroke at rated energy	10'(3.04 m)
Maximum obtainable stroke	10'2"(3.1 m)
Speed (blows per minute)	38-55
Bearing based on EN formula	200 tons (181 tons)

WEIGHTS

Bare hammer	7,500 lbs (3,402 kg)
Ram	4,000 lbs (1,814 kg)
Anvil	545 lbs (247 kg)
Typical operating weight with cap	8,600 lbs (3,900 kg)

CAPACITIES (adequate for normal day)

Diesel fuel tank	11 gal (42 l)
Lube oil tank	5 gal (19 l)

DIMENSIONS OF HAMMER

Width (side to side)	20"(508 mm)
Depth	29"(737 mm)
Centerline to front	13 3/4"(349 mm)
Centerline to rear	15 1/4"(387 mm)
Length (hammer only)	15'9"(4.80 m)
Operating length (top of ram at max. stroke to pile)	27'2"(8.28 m)

DIMENSIONS OF LEADS

Face width of guide rails	4-8"(100-200 mm)
Distance between guide rails	20 1/2-26 1/2"(520-670 mm)

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ICE 40S DIESEL PILE HAMMER BEARING CHART

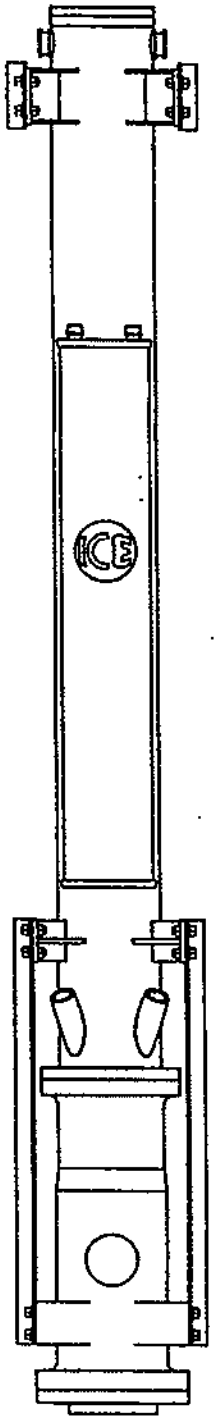
This chart is based on the Engineering News formula for pile bearing and is provided as a convenience only for those applications where this formula is specified. ICE has no preference for this particular formula over any other.

Pile bearing (tons) = 2E/(S+0.1)/2000, where E = Hammer energy (ft-lbs) and S = Pile set (inches per blow)

Blows per minute	Stroke (feet)	Energy (ft-lbs)	Pile set (Blows per inch) 2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
38	10.00	40,000	66	92	114	133	150	164	177	189	200	209	218	226	233	240	246	251	257	262	266
39	9.90	39,600	66	91	113	132	148	163	176	187	198	207	216	223	231	237	243	249	254	259	264
40	9.36	37,440	62	86	106	124	140	154	166	177	187	196	204	211	218	224	230	235	240	245	249
41	8.83	35,320	58	81	100	117	132	145	156	167	176	185	192	199	206	211	217	222	227	231	235
42	8.39	33,560	55	77	95	111	125	138	149	158	167	175	183	189	195	201	206	211	215	219	223
43	7.97	31,880	53	73	91	106	119	131	141	151	159	166	173	180	185	191	196	200	204	208	212
44	7.57	30,280	50	69	86	100	113	124	134	143	151	158	165	171	176	181	186	190	194	198	201
45	7.20	28,800	48	66	82	96	108	118	128	136	144	150	157	162	168	172	177	181	185	188	192
46	6.84	27,360	45	63	78	91	102	112	121	129	136	143	149	154	159	164	168	172	175	179	182
47	6.54	26,160	43	60	74	87	98	107	116	123	130	137	142	147	152	156	160	164	168	171	174
48	6.23	24,920	41	57	71	83	93	102	110	118	124	130	135	140	145	149	153	156	160	163	166
49	5.91	23,640	39	54	67	78	88	97	105	111	118	123	128	133	137	141	145	148	151	154	157
50	5.63	22,520	37	51	64	75	84	92	100	106	112	117	122	127	131	135	138	141	144	147	150
51	5.33	21,320	35	49	60	71	79	87	94	100	106	111	116	120	124	127	131	134	137	139	142
52	5.07	20,280	33	46	57	67	76	83	90	96	101	106	110	114	118	121	124	127	130	132	135
53	4.80	19,200	32	44	54	64	72	79	85	90	96	100	104	108	112	115	118	120	123	125	128
54	4.52	18,080	30	41	51	60	67	74	80	85	90	94	98	102	105	108	111	113	116	118	120
55	4.24	16,960	28	39	48	56	63	69	75	80	84	88	92	95	98	101	104	106	109	111	113
56	3.93	15,720	26	36	44	52	58	64	69	74	78	82	85	88	91	94	96	98	101	102	104

CAUTION: Driving at ten blows per inch (set of 0.1 inch per blow) is considered practical refusal. Driving in excess of ten blows per inch for more than six inches of driving or driving in excess of 20 blows per inch at all is considered improper use and will void the hammer warranty.

ICE MODEL 42S DIESEL PILE HAMMER



WORKING SPECIFICATIONS

Rated energy	42,000 ft-lbs (5807 kg-m)
Minumum energy	16,000 ft-lbs (2212 kg-m)
Stroke at rated energy	10'-3" (312 cm)
Maximum obtainable stroke	10'-5" (318 cm)
Speed (blows per minute)	37-55
Bearing based on EN formula	210 tons (190 tons)

WEIGHTS

Bare hammer	7,610 lbs (3452 kg)
Ram	4,088 lbs (1854 kg)
Anvil	545 lbs (247 kg)
Typical operating weight with cap	8,710 lbs (3950 kg)

CAPACITIES (adequate for normal day)

Diesel fuel tank	11 gal (42 l)
Lube oil tank	5 gal (19 l)

DIMENSIONS OF HAMMER

Width (side to side)	20" (508 mm)
Depth	29" (737 mm)
Centerline to front	13 3/4" (349 mm)
Centerline to rear	15 1/4" (387 mm)
Length (hammer only)	16'-1" (490 cm)
Operating length (top of ram to top of pile)	27'-9" (846 cm)

DIMENSIONS OF LEADS

Face width of guide rails	4-8"(100-200 mm)
Distance between guide rails	20 1/2-26 1/2"(520-670 mm)

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ICE 42S DIESEL PILE HAMMER BEARING CHART

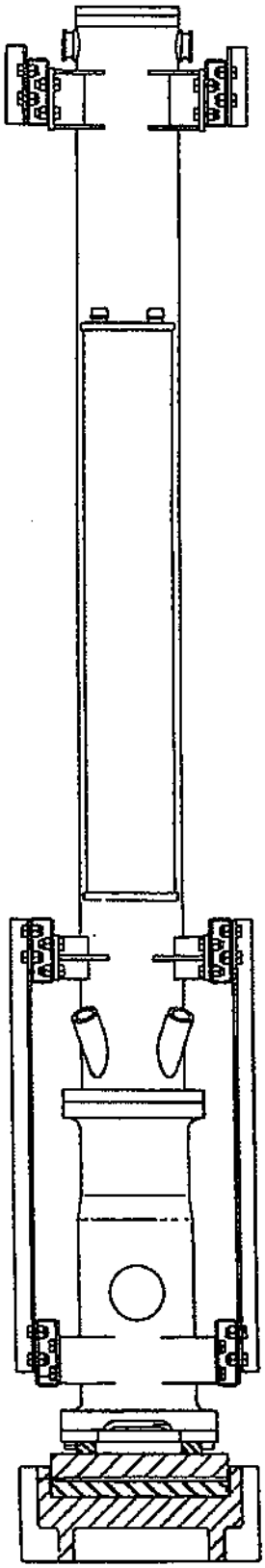
This chart is based on the Engineering News formula for pile bearing and is provided as a convenience only for those applications where this formula is specified. ICE has no preference for this particular formula over any other.

Pile bearing (tons) = 2E/(S+0.1)/2000 where E=Hammer energy (ft-lbs) and S=Pile set (inches per blow)

Blows Per Minute	Ram Stroke (Feet)	Hammer Energy (ft-lbs)	Pile Set (Blows per Inch)																		
			2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
37	10.28	42,000	70	97	120	140	158	173	187	199	210	220	229	237	245	252	258	264	270	275	280
38	10.00	40,880	68	94	117	136	153	168	182	194	204	214	223	231	238	245	252	257	263	268	273
39	9.90	39,600	66	91	113	132	149	163	176	188	198	207	216	224	231	238	244	249	255	259	264
40	9.36	37,440	62	86	107	125	140	154	166	177	187	196	204	212	218	225	230	236	241	245	250
41	8.83	35,320	59	82	101	118	132	145	157	167	177	185	193	200	206	212	217	222	227	231	235
42	8.39	33,560	56	77	96	112	126	138	149	159	168	176	183	190	196	201	207	211	216	220	224
43	7.97	31,880	53	74	91	106	120	131	142	151	159	167	174	180	186	191	196	201	205	209	213
44	7.57	30,280	50	70	87	101	114	125	135	143	151	159	165	171	177	182	186	191	195	198	202
45	7.20	28,800	48	66	82	96	108	119	128	136	144	151	157	163	168	173	177	181	185	189	192
46	6.84	27,360	46	63	78	91	103	113	122	130	137	143	149	155	160	164	168	172	176	179	182
47	6.54	26,160	44	60	75	87	98	108	116	124	131	137	143	148	153	157	161	165	168	171	174
48	6.23	24,920	42	58	71	83	93	103	111	118	125	131	136	141	145	150	153	157	160	163	166
49	5.91	23,640	39	55	68	79	89	97	105	112	118	124	129	134	138	142	145	149	152	155	158
50	5.63	22,520	38	52	64	75	84	93	100	107	113	118	123	127	131	135	139	142	145	148	150
51	5.33	21,320	36	49	61	71	80	88	95	101	107	112	116	121	124	128	131	134	137	140	142
52	5.07	20,280	34	47	58	68	76	84	90	96	101	106	111	115	118	122	125	128	130	133	135
53	4.80	19,200	32	44	55	64	72	79	85	91	96	101	105	109	112	115	118	121	123	126	128
54	4.52	18,080	30	42	52	60	68	74	80	86	90	95	99	102	105	108	111	114	116	118	121
55	4.24	16,960	28	39	48	57	64	70	75	80	85	89	93	96	99	102	104	107	109	111	113
56	3.93	15,720	26	36	45	52	59	65	70	74	79	82	86	89	92	94	97	99	101	103	105

CAUTION: Driving at ten blows per inch (set of 0.1 inch per blow) is considered practical refusal. Driving in excess of ten blows per inch for more than six inches of driving or driving in excess of 20 blows per inch at all is considered improper use and will void the hammer warranty.

ICE MODEL 70S DIESEL PILE HAMMER



WORKING SPECIFICATIONS

Rated energy	70,000 ft-lbs (9,677 kg-m)
Minumum energy	28,000 ft-lbs (3,872 kg-m)
Stroke at rated energy	10'(3.04 m)
Maximum obtainable stroke	10'2"(3.1 m)
Speed (blows per minute)	38-55
Bearing based on EN formula	350 tons (318 tons)

WEIGHTS

Bare hammer	14,100 lbs (6,396 kg)
Ram	7,000 lbs (3,175 kg)
Anvil	1,220 lbs (553 kg)
Typical operating weight with cap	16,000 lbs (7,258 kg)

CAPACITIES (adequate for normal day)

Diesel fuel tank	18 gal (68 l)
Lube oil tank	8 gal (30 l)

DIMENSIONS OF HAMMER

Width (side to side)	26"(660 mm)
Depth	37 1/2"(953 mm)
Centerline to front	17"(432 mm)
Centerline to rear	20 1/2"(521 mm)
Length (hammer only)	16'8"(5.08 m)
Operating length (top of ram at max. stroke to pile)	27'2"(8.28 m)

DIMENSIONS OF LEADS

Face width of guide rails	8"(200 mm)
Distance between guide rails	26 1/2"(670 mm)

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ICE 70S DIESEL PILE HAMMER BEARING CHART

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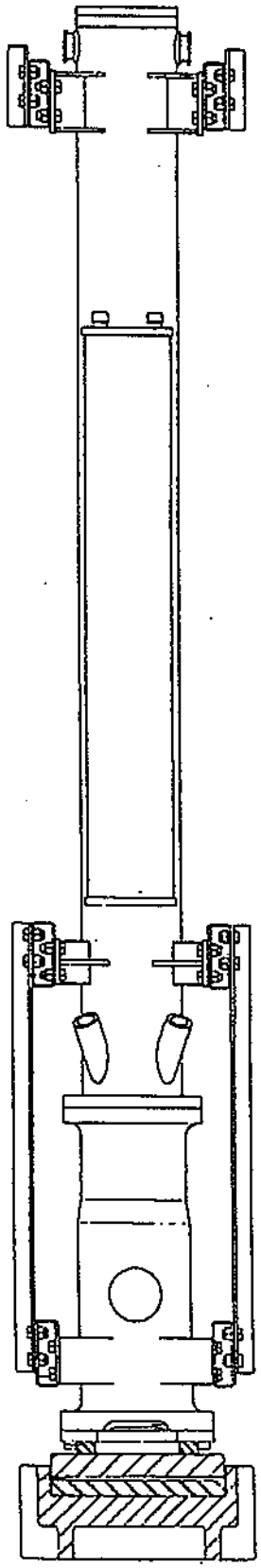
Pile bearing (tons) = 2E/(S+0.1)/2000, where E = Hammer energy (ft-lbs) and S = Pile set (inches per blow)

Blows per minute	Stroke (feet)	Energy (ft-lbs)	Pile set (Blows per inch) 2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
38	10.00	70,000	116	161	200	233	262	288	311	331	350	366	381	395	408	420	430	440	450	458	466
39	9.90	69,300	115	159	198	231	259	285	308	328	346	363	378	391	404	415	426	436	445	454	462
40	9.36	65,520	109	151	187	218	245	269	291	310	327	343	357	370	382	393	403	412	421	429	436
41	8.83	61,810	103	142	176	206	231	254	274	292	309	323	337	349	360	370	380	389	397	404	412
42	8.39	58,730	97	135	167	195	220	241	261	278	293	307	320	331	342	352	361	369	377	384	391
43	7.97	55,790	92	128	159	185	209	229	247	264	278	292	304	315	325	334	343	351	358	365	371
44	7.57	52,990	88	122	151	176	198	218	235	251	264	277	289	299	309	317	326	333	340	347	353
45	7.20	50,400	84	116	144	168	189	207	224	238	252	264	274	284	294	302	310	317	324	330	336
46	6.84	47,880	79	110	136	159	179	197	212	226	239	250	261	270	279	287	294	301	307	313	319
47	6.54	45,780	76	105	130	152	171	188	203	216	228	239	249	258	267	274	281	288	294	299	305
48	6.23	43,610	72	100	124	145	163	179	193	206	218	228	237	246	254	261	268	274	280	285	290
49	5.91	41,370	68	95	118	137	155	170	183	195	206	216	225	233	241	248	254	260	265	271	275
50	5.63	39,410	65	90	112	131	147	162	175	186	197	206	214	222	229	236	242	248	253	258	262
51	5.33	37,310	62	86	106	124	139	153	165	176	186	195	203	210	217	223	229	234	239	244	248
52	5.07	35,490	59	81	101	118	133	146	157	168	177	185	193	200	207	212	218	223	228	232	236
53	4.80	33,600	56	77	96	112	126	138	149	159	168	176	183	189	196	201	206	211	216	220	224
54	4.52	31,640	52	73	90	105	118	130	140	149	158	165	172	178	184	189	194	199	203	207	210
55	4.24	29,680	49	68	84	98	111	122	131	140	148	155	161	167	173	178	182	186	190	194	197
56	3.93	27,510	45	63	78	91	103	113	122	130	137	144	150	155	160	165	169	173	176	180	183

CAUTION: Driving at ten blows per inch (set of 0.1 inch per blow) is considered practical refusal. Driving in excess of ten blows per inch for more than six inches of driving or driving in excess of 20 blows per inch at all is considered improper use and will void the hammer warranty.

ICE MODEL 90S DIESEL PILE HAMMER



WORKING SPECIFICATIONS

Rated energy	90,000 ft-lbs (12,472 kg-m)
Minumum energy	36,000 ft-lbs (4,989 kg-m)
Stroke at rated energy	10'(3.04 m)
Maximum obtainable stroke	10'2"(3.1 m)
Speed (blows per minute)	38-55
Bearing based on EN formula	450 tons (409 tons)

WEIGHTS

Bare hammer	16,800 lbs (7,636 kg)
Ram	9,000 lbs (4,091 kg)
Anvil	1,790 lbs (813 kg)
Typical operating weight with cap	20,000 lbs (9,091 kg)

CAPACITIES (adequate for normal day)

Diesel fuel tank	22 gal (83 l)
Lube oil tank	9 gal (34 l)

DIMENSIONS OF HAMMER

Width (side to side)	29"(737 mm)
Depth	39"(991 mm)
Centerline to front	19 1/2"(495 mm)
Centerline to rear	19 1/2"(495 mm)
Length (hammer only)	17'3"(5.26 m)
Operating length (top of ram at max. stroke to pile)	28'9"(8.76 m)

DIMENSIONS OF LEADS

Face width of guide rails	8"(203 mm)
Distance between guide rails	32 1/2"(825 mm)

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ICE 90S DIESEL PILE HAMMER BEARING CHART

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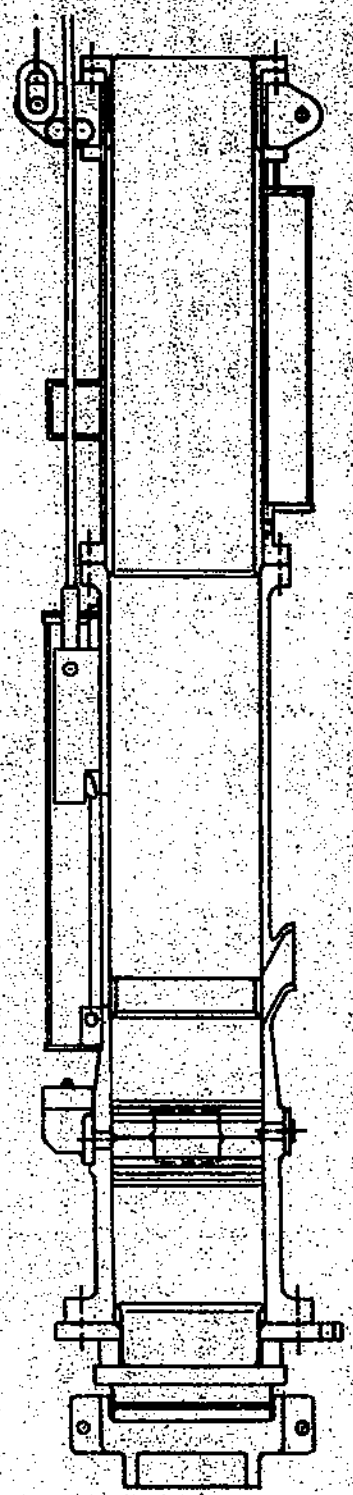
Pile bearing (tons) = 2E/(S+0.1)/2000, where E = Hammer energy (ft-lbs) and S = Pile set (inches per blow)

Blows per minute	Stroke (feet)	Energy (ft-lbs)	Pile set (Blows per inch) 2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
38	10.00	90,000	150	207	257	300	337	370	400	426	450	471	490	508	525	540	553	566	578	589	600
39	9.90	89,100	148	205	254	297	334	366	396	422	445	466	486	503	519	534	548	561	572	583	594
40	9.36	84,240	140	194	240	280	315	346	374	399	421	441	459	476	491	505	518	530	541	551	561
41	8.83	79,470	132	183	227	264	298	327	353	376	397	416	433	449	463	476	489	500	510	520	529
42	8.39	75,510	125	174	215	251	283	310	335	357	377	395	411	426	440	453	464	475	485	494	503
43	7.97	71,730	119	165	204	239	268	295	318	339	358	375	391	405	418	430	441	451	461	469	478
44	7.57	68,130	113	157	194	227	255	280	302	322	340	356	371	385	397	408	419	428	437	446	454
45	7.20	64,800	108	149	185	216	243	266	288	306	324	339	353	366	378	388	398	408	416	424	432
46	6.84	61,560	102	142	175	205	230	253	273	291	307	322	335	347	359	369	378	387	395	403	410
47	6.54	58,860	98	135	168	196	220	242	261	278	294	308	321	332	343	353	362	370	378	385	392
48	6.23	56,070	93	129	160	186	210	230	249	265	280	293	305	316	327	336	345	353	360	367	373
49	5.91	53,190	88	122	151	177	199	219	236	251	265	278	290	300	310	319	327	334	341	348	354
50	5.63	50,670	84	116	144	168	190	208	225	240	253	265	276	286	295	304	311	319	325	331	337
51	5.33	47,970	79	110	137	159	179	197	213	227	239	251	261	271	279	287	295	302	308	314	319
52	5.07	45,630	76	105	130	152	171	187	202	216	228	239	248	257	266	273	280	287	293	298	304
53	4.80	43,200	72	99	123	144	162	177	192	204	216	226	235	244	252	259	265	272	277	283	288
54	4.52	40,680	67	93	116	135	152	167	180	192	203	213	221	229	237	244	250	256	261	266	271
55	4.24	38,160	63	88	109	127	143	157	169	180	190	199	208	215	222	228	234	240	245	250	254
56	3.93	35,370	58	81	101	117	132	145	157	167	176	185	192	199	206	212	217	222	227	231	235

CAUTION: Driving at ten blows per inch (set of 0.1 inch per blow) is considered practical refusal. Driving in excess of ten blows per inch for more than six inches of driving or driving in excess of 20 blows per inch at all is considered improper use and will void the hammer warranty.

ICE MODEL 200S DIESEL PILE HAMMER



WORKING SPECIFICATIONS

Rated energy	100,000 ft-lbs (13,830 kg-m)
Minimum energy	40,000 ft-lbs (5,520 kg-m)
Stroke at rated energy	5' (1.52 m)
Maximum obtainable stroke	5'6" (1.67 m)
Speed (blows per minute)	53-70
Bearing based on EN formula	500 tons (454 tonnes)

WEIGHTS

Bare hammer	33,600 lbs (15,240 kg)
Ram	20,000 lbs (9,073 kg)
Anvil	3,900 lbs (1,770 kg)
Typical operating weight	39,000 lbs (17,690 kg)

CAPACITIES (adequate for normal day)

Diesel fuel tank	26 gal (98 l)
Lube oil tank	9 gal (34 l)

DIMENSIONS OF HAMMER

Width (side to side)	32" (813 mm)
Depth	49" (1,245 mm)
Centerline to front	24" (610 mm)
Centerline to rear	25" (635 mm)
Length (hammer only)	17' (5.1 m)
Operating length (top of ram at maximum stroke to pile)	27'2" (8.2 m)

DIMENSIONS OF LEADS (see Note)

Face width of guide rails	8" (200 mm)
Distance between guide rails	32 1/2" (670 mm)

Note: Pads for wider leads and guide angles for other width leads available.

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ICE 200S DIESEL PILE HAMMER BEARING CHART

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Pile bearing (tons) = 2E/(S+0.1)/2000, where E = Hammer energy (ft-lbs) and S = Pile set (inches per blow)

Blows per minute	Stroke (feet)	Energy (ft-lbs)	Pile set (Blows per inch) 2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
52	5.22	104,400	174	240	298	348	391	429	464	494	522	546	569	590	609	626	642	657	671	684	696
53	5.01	100,200	167	231	286	334	375	412	445	474	501	524	546	566	584	601	616	630	644	656	668
54	4.81	96,200	160	221	274	320	360	396	427	455	480	503	524	543	561	577	592	605	618	630	641
55	4.62	92,400	154	213	264	308	346	380	410	437	462	484	504	522	539	554	568	581	594	605	616
56	4.45	89,000	148	205	254	296	333	366	395	421	445	466	485	503	519	534	547	560	572	583	593
57	4.28	85,600	142	197	244	285	321	352	380	405	428	448	466	483	499	513	526	538	550	560	570
58	4.11	82,200	137	189	234	274	308	338	365	389	411	430	448	464	479	493	505	517	528	538	548
59	3.96	79,200	132	182	226	264	297	326	352	375	396	414	432	447	462	475	487	498	509	518	528
60	3.79	75,800	126	174	216	252	284	312	336	359	379	397	413	428	442	454	466	477	487	496	505
61	3.66	73,200	122	168	209	244	274	301	325	346	366	383	399	413	427	439	450	460	470	479	488
62	3.52	70,400	117	162	201	234	264	289	312	333	352	368	384	397	410	422	433	443	452	461	469
63	3.38	67,600	112	156	193	225	253	278	300	320	338	354	368	382	394	405	416	425	434	442	450
64	3.25	65,000	108	150	185	216	243	267	288	307	325	340	354	367	379	390	400	409	417	425	433
65	3.11	62,200	103	143	177	207	233	256	276	294	311	325	339	351	362	373	382	391	399	407	414
66	2.99	59,800	99	138	170	199	224	246	265	283	299	313	326	338	348	358	368	376	384	391	398
67	2.85	57,000	95	131	162	190	213	234	253	270	285	298	310	322	332	342	350	358	366	373	380
68	2.72	54,400	90	125	155	181	204	224	241	257	272	284	296	307	317	326	334	342	349	356	362
69	2.59	51,800	86	119	148	172	194	213	230	245	259	271	282	292	302	310	318	326	333	339	345
70	2.45	49,000	81	113	140	163	183	201	217	232	245	256	267	276	285	294	301	308	315	321	326

CAUTION: Driving at ten blows per inch (set of 0.1 inch per blow) is considered practical refusal. Driving in excess of ten blows per inch for more than six inches of driving or driving in excess of 20 blows per inch at all is considered improper use and will void the hammer warranty.

ICE MODEL 40S DIESEL HAMMER

$P = \frac{2WH}{S + 0.1}$ WEIGHT OF RAM = 4000
REFUSAL SHALL BE BETWEEN 150 - 180 TONS

AVG. HT. OF FALL	3.5	5	6	7	8	8.5	S
BLOWS PER FOOT	BEARING IN TONS						
4	5	6	8	9	10	11	3.000
8	9	13	16	18	20	21	1.500
12	13	18	22	25	29	31	1.000
16	16	24	28	33	38	40	0.750
20	20	28	34	40	46	49	0.600
24	23	33	40	47	53	57	0.500
28	26	38	45	53	61	64	0.429
32	29	42	51	59	67	72	0.375
36	32	46	56	65	74	78	0.333
40	35	50	60	70	80	85	0.300
44	38	54	64	75	86	91	0.273
48	40	57	69	80	91	97	0.250
52	42	60	73	85	97	103	0.231
56	45	64	76	89	102	108	0.214
60	47	67	80	93	107	113	0.200
64	49	70	83	97	111	118	0.188
68	51	72	87	101	116	123	0.176
72	53	75	90	105	120	128	0.167
76	54	78	93	109	124	132	0.158
80	56	80	96	112	128	136	0.150
84	58	82	99	116	132	140	0.143
88	59	85	102	118	135	144	0.136
92	61	87	104	122	139	148	0.130
96	62	89	107	124	142	151	0.125
100	64	91	109	127	145	155	0.120
104	65	93	111	130	149	158	0.115
108	66	95	114	133	152	161	0.111
110	67	96	116	134	153	163	0.109
120	70	100	120	140	160	170	0.100
130	73	104	125	146	166	177	0.092
140	75	108	129	151	172	183	0.086
150	78	111	133	156	178	189	0.080
160	80	114	137	160	183	194	0.075
170	82	117	141	164	188	199	0.071
180	84	120	144	168	192	204	0.067
190	86	123	147	172	196	208	0.063
200	88	125	150	175	200	213	0.060
225	91	130	157	183	209	222	0.053
250	95	135	162	189	216	230	0.048
275	97	139	167	195	223	237	0.044
300	100	143	171	200	228	243	0.040
325	102	146	175	204	234	248	0.037
350	104	149	179	209	238	253	0.034
375	106	152	182	212	242	258	0.032
400	108	154	185	215	246	262	0.030
425	109	156	187	218	250	265	0.028
450	111	158	189	221	253	268	0.027
475	112	160	192	224	255	271	0.025
500	113	161	194	226	258	274	0.024
525	114	163	195	228	260	277	0.023

ICE MODEL 42S DIESEL HAMMER

$P = \frac{2WH}{S + 0.1}$ WEIGHT OF RAM = 4088
REFUSAL SHALL BE BETWEEN 160 - 180 TONS

AVG. HT. OF FALL	3.5	5	6	7	8	8.5	S
BLOWS PER FOOT	BEARING IN TONS						
4	5	7	8	9	11	11	3.000
8	9	13	15	18	20	22	1.500
12	13	19	22	26	30	32	1.000
16	17	24	29	34	38	41	0.750
20	20	29	35	41	47	50	0.600
24	24	34	41	48	55	58	0.500
28	27	39	46	54	62	66	0.429
32	30	43	52	60	69	73	0.375
36	33	47	57	66	75	80	0.333
40	36	51	61	72	82	87	0.300
44	38	55	66	77	88	93	0.273
48	41	58	70	82	93	99	0.250
52	43	62	74	87	99	105	0.231
56	46	65	78	91	104	111	0.214
60	48	68	82	95	109	116	0.200
64	50	71	85	100	114	121	0.188
68	52	74	89	104	118	126	0.176
72	54	77	92	107	123	130	0.167
76	55	79	95	111	127	135	0.158
80	57	82	98	114	131	139	0.150
84	59	84	101	118	135	143	0.143
88	61	86	104	121	138	147	0.136
92	62	89	106	124	142	151	0.130
96	64	91	109	127	145	154	0.125
100	65	93	111	130	149	158	0.120
104	66	95	114	133	152	161	0.115
108	68	97	116	136	155	165	0.111
110	68	98	117	137	156	166	0.109
120	72	102	123	143	164	174	0.100
130	74	106	128	149	170	181	0.092
140	77	110	132	154	176	187	0.086
150	79	114	136	159	182	193	0.080
160	82	117	140	164	187	199	0.075
170	84	120	144	168	192	204	0.071
180	86	123	147	172	196	208	0.067
190	88	125	150	175	200	213	0.063
200	89	128	153	179	204	217	0.060
225	93	133	160	187	213	227	0.053
250	97	138	166	193	221	235	0.048
275	100	142	171	199	228	242	0.044
300	102	146	176	204	234	248	0.040
325	104	149	179	209	239	254	0.037
350	107	152	183	213	244	259	0.034
375	108	155	186	217	248	263	0.032
400	110	157	189	220	252	267	0.030
425	112	159	191	223	256	271	0.028
450	113	161	194	226	258	274	0.027
475	114	163	196	228	261	277	0.025
500	115	165	198	231	264	280	0.024
525	116	166	200	233	266	283	0.023

ICE MODEL 70S DIESEL HAMMER

$P = \frac{2WH}{S + 0.1}$ WEIGHT OF RAM = 7000
REFUSAL SHALL BE BETWEEN 150 - 180 TONS

AVG. HT. OF FALL	3.5	5	6	7	8	8.5	S
BLOWS PER FOOT	BEARING IN TONS						
4	8	11	14	16	18	19	3.000
8	15	22	26	31	35	37	1.500
12	22	32	38	46	51	54	1.000
16	29	41	49	58	66	70	0.750
20	35	50	60	70	80	85	0.600
24	41	58	70	82	93	99	0.500
28	48	66	79	93	106	113	0.429
32	52	74	88	103	118	125	0.375
36	57	81	97	113	129	137	0.333
40	61	88	105	123	140	149	0.300
44	66	94	113	131	150	160	0.273
48	70	100	120	140	160	170	0.250
52	74	106	127	148	169	180	0.231
56	78	111	134	156	178	189	0.214
60	82	117	140	163	187	198	0.200
64	85	122	146	170	195	207	0.188
68	89	127	152	177	203	215	0.176
72	92	131	158	184	210	223	0.167
76	95	136	163	190	217	231	0.158
80	98	140	168	196	224	238	0.150
84	101	144	173	202	231	245	0.143
88	104	148	178	207	237	252	0.136
92	106	152	182	213	243	258	0.130
96	109	156	187	218	249	264	0.125
100	111	159	191	223	255	270	0.120
104	114	163	195	228	260	276	0.115
108	116	166	199	232	265	282	0.111
110	117	167	201	234	268	285	0.109
120	123	175	210	245	280	298	0.100
130	127	182	218	255	291	309	0.092
140	132	188	226	264	302	320	0.086
150	136	194	233	272	311	331	0.080
160	140	200	240	280	320	340	0.075
170	144	205	246	287	328	349	0.071
180	147	210	252	294	336	357	0.067
190	150	215	257	300	343	365	0.063
200	153	219	263	306	350	372	0.060
225	160	228	274	320	365	388	0.053
250	166	236	284	331	378	402	0.048
275	171	244	292	341	390	414	0.044
300	175	250	300	350	400	425	0.040
325	179	256	307	358	409	435	0.037
350	182	261	313	365	417	443	0.034
375	186	265	318	371	424	451	0.032
400	188	269	323	377	431	458	0.030
425	191	273	328	382	437	464	0.028
450	193	276	332	387	442	470	0.027
475	196	279	335	391	447	475	0.025
500	198	282	339	395	452	480	0.024
525	199	285	342	399	456	484	0.023

ICE MODEL 90S DIESEL HAMMER

$P = \frac{2WH}{S + 0.1}$ WEIGHT OF RAM = 9000
REFUSAL SHALL BE BETWEEN 150 - 180 TONS

AVG. HT. OF FALL	3.5	5	6	7	8	8.5	S
BLOWS PER FOOT	BEARING IN TONS						
4	10	15	17	20	23	25	3.000
8	20	28	34	39	45	48	1.500
12	29	41	49	57	65	70	1.000
16	37	53	64	74	85	90	0.750
20	45	64	77	90	103	109	0.600
24	53	75	90	105	120	128	0.500
28	60	85	102	119	136	145	0.428
32	66	95	114	133	152	161	0.375
36	73	104	125	145	166	177	0.333
40	79	113	135	158	180	191	0.300
44	85	121	145	169	193	205	0.273
48	90	128	154	180	206	219	0.250
52	95	136	163	190	218	231	0.231
56	100	143	172	200	229	243	0.214
60	105	150	180	210	240	255	0.200
64	110	157	188	219	250	266	0.188
68	114	163	195	228	260	277	0.176
72	118	169	203	236	270	287	0.167
76	122	174	209	244	279	297	0.158
80	126	180	216	252	288	306	0.150
84	130	185	222	259	296	315	0.143
88	133	190	228	267	305	324	0.136
92	137	195	234	273	312	332	0.130
96	140	200	240	280	320	340	0.125
100	143	205	245	286	327	348	0.120
104	146	209	251	293	334	355	0.115
108	149	213	256	298	341	362	0.111
110	151	215	258	301	344	366	0.109
120	158	225	270	315	360	383	0.100
130	164	234	281	328	374	398	0.092
140	170	242	291	339	388	412	0.086
150	175	250	300	350	400	425	0.080
160	180	257	309	360	411	437	0.075
170	185	264	317	369	422	448	0.071
180	189	270	324	378	432	459	0.067
190	193	276	331	386	441	469	0.063
200	197	281	338	394	450	478	0.060
225	205	293	352	411	470	499	0.053
250	213	304	365	426	488	517	0.048
275	219	313	376	439	501	533	0.044
300	225	321	386	450	514	546	0.040
325	230	328	394	460	526	559	0.037
350	235	335	402	469	536	570	0.034
375	239	341	409	477	545	580	0.032
400	242	346	415	485	554	588	0.030
425	246	351	421	491	561	597	0.028
450	249	355	426	497	568	604	0.027
475	251	359	431	503	575	611	0.025
500	254	363	435	508	581	617	0.024
525	256	366	440	513	586	623	0.023

ICE MODEL 200S DIESEL HAMMER

$P = \frac{2WH}{S + 0.1}$ WEIGHT OF RAM = 20000
REFUSAL SHALL BE BETWEEN 150 - 180 TONS

AVG. HT. OF FALL	3.5	5	6	7	8	8.5	S
BLOWS PER FOOT	BEARING IN TONS						
4	23	32	39	45	52	55	3.000
8	44	63	75	88	100	106	1.500
12	64	91	109	127	145	155	1.000
16	82	118	141	165	188	200	0.750
20	100	143	171	200	229	243	0.600
24	117	167	200	233	267	283	0.500
28	132	189	227	265	303	322	0.429
32	147	211	253	295	337	358	0.375
36	162	231	277	323	369	392	0.333
40	175	250	300	350	400	425	0.300
44	188	268	322	376	429	456	0.273
48	200	286	343	400	457	486	0.250
52	212	302	363	423	484	514	0.231
56	223	318	382	445	509	541	0.214
60	233	333	400	467	533	567	0.200
64	243	348	417	487	557	591	0.188
68	253	362	434	506	579	615	0.176
72	263	375	450	525	600	638	0.167
76	271	388	465	543	620	659	0.158
80	280	400	480	560	640	680	0.150
84	288	412	494	576	659	700	0.143
88	296	423	508	592	677	719	0.136
92	304	434	521	608	694	738	0.130
96	311	444	533	622	711	756	0.125
100	318	455	545	636	727	773	0.120
104	325	484	557	650	743	789	0.115
108	332	474	568	663	758	805	0.111
110	335	478	574	670	765	813	0.109
120	350	500	600	700	800	850	0.100
130	364	520	624	728	832	884	0.092
140	377	538	646	754	862	915	0.086
150	389	556	667	778	889	944	0.080
160	400	571	686	800	914	971	0.075
170	410	586	703	821	938	997	0.071
180	420	600	720	840	960	1020	0.067
190	429	613	735	858	981	1042	0.063
200	438	625	750	875	1000	1063	0.060
225	457	652	783	913	1043	1109	0.053
250	473	676	811	948	1081	1149	0.048
275	487	698	835	975	1114	1184	0.044
300	500	714	857	1000	1143	1214	0.040
325	511	730	876	1022	1169	1242	0.037
350	521	745	894	1043	1191	1266	0.034
375	530	758	909	1061	1212	1288	0.032
400	539	769	923	1077	1231	1308	0.030
425	548	780	936	1092	1248	1326	0.028
450	553	789	947	1105	1263	1342	0.027
475	559	798	958	1118	1277	1357	0.025
500	565	806	968	1129	1290	1371	0.024
525	570	814	977	1140	1302	1384	0.023

ICE MODEL 40S DIESEL HAMMER

$P = \frac{2WH}{S + 0.1}$ WEIGHT OF RAM = 4000

REFUSAL SHALL BE BETWEEN 150 - 180 TONS

PENETRATION (INCHES)		AVERAGE HEIGHT OF FALL (FT.)					
10 BLOWS	20 BLOWS	3.5	5	6	7	8	8.5
		BEARING IN TONS					
2 1/2	5	40	57	69	80	91	97
2 7/16	4 7/8	41	58	70	81	93	99
2 3/8	4 3/4	41	59	71	83	95	101
2 5/16	4 5/8	42	60	72	85	97	103
2 1/4	4 1/2	43	62	74	86	98	105
2 3/16	4 3/8	44	63	75	88	100	107
2 1/8	4 1/4	45	64	77	90	102	109
2 1/16	4 1/8	46	65	78	91	104	111
2	4	47	67	80	93	107	113
1 15/16	3 7/8	48	68	82	95	109	116
1 7/8	3 3/4	49	70	83	97	111	118
1 13/16	3 5/8	50	71	85	100	114	121
1 3/4	3 1/2	51	73	87	102	116	124
1 11/16	3 3/8	52	74	89	104	119	127
1 5/8	3 1/4	53	76	91	107	122	130
1 9/16	3 1/8	55	78	94	109	125	133
1 1/2	3	56	80	96	112	128	136
1 7/16	2 7/8	57	82	98	115	131	139
1 3/8	2 3/4	59	84	101	118	135	143
1 5/16	2 5/8	61	86	104	121	138	147
1 1/4	2 1/2	62	89	107	124	142	151
1 3/16	2 3/8	64	91	110	128	146	155
1 1/8	2 1/4	66	94	113	132	151	160
1 1/16	2 1/8	68	97	116	136	155	165
1	2	70	100	120	140	160	170
15/16	1 7/8	72	103	124	145	165	175
7/8	1 3/4	75	107	128	149	171	181
13/16	1 5/8	77	110	132	154	177	188
3/4	1 1/2	80	114	137	160	183	194
11/16	1 3/8	83	119	142	166	190	201
5/8	1 1/4	86	123	148	172	197	209
9/16	1 1/8	90	128	154	179	205	218
1/2	1	93	133	160	187	213	227
7/16	7/8	97	139	167	195	223	237
3/8	3/4	102	145	175	204	233	247
5/16	5/8	107	152	183	213	244	259
1/4	1/2	112	160	192	224	256	272
3/16	3/8	118	168	202	236	269	286
1/8	1/4	124	178	213	249	284	302
1/16	1/8	132	188	226	264	301	320
0	0	140	200	240	280	320	340

ICE MODEL 42S DIESEL HAMMER

P = 2 W H / S + 0.1 WEIGHT OF RAM = 4088
REFUSAL SHALL BE BETWEEN 150 - 180 TONS

PENETRATION (INCHES)		AVERAGE HEIGHT OF FALL (FT.)					
10 BLOWS	20 BLOWS	3.5	5	6	7	8	8.5
		BEARING IN TONS					
2 1/2	5	41	58	70	82	93	99
2 7/16	4 7/8	42	59	71	83	95	101
2 3/8	4 3/4	42	61	73	85	97	103
2 5/16	4 5/8	43	62	74	86	99	105
2 1/4	4 1/2	44	63	75	88	101	107
2 3/16	4 3/8	45	64	77	90	103	109
2 1/8	4 1/4	46	65	78	92	105	111
2 1/16	4 1/8	47	67	80	93	107	113
2	4	48	68	82	95	109	116
1 15/16	3 7/8	49	70	83	97	111	118
1 7/8	3 3/4	50	71	85	100	114	121
1 13/16	3 5/8	51	73	87	102	116	124
1 3/4	3 1/2	52	74	89	104	119	126
1 11/16	3 3/8	53	76	91	106	122	129
1 5/8	3 1/4	55	78	93	109	125	132
1 9/16	3 1/8	56	80	96	112	128	136
1 1/2	3	57	82	98	114	131	139
1 7/16	2 7/8	59	84	101	117	134	143
1 3/8	2 3/4	60	86	103	120	138	146
1 5/16	2 5/8	62	88	106	124	141	150
1 1/4	2 1/2	64	91	109	127	145	154
1 3/16	2 3/8	65	93	112	131	150	159
1 1/8	2 1/4	67	96	115	135	154	164
1 1/16	2 1/8	69	99	119	139	159	168
1	2	72	102	123	143	164	174
15/16	1 7/8	74	105	127	148	169	179
7/8	1 3/4	76	109	131	153	174	185
13/16	1 5/8	79	113	135	158	180	192
3/4	1 1/2	82	117	140	164	187	199
11/16	1 3/8	85	121	145	170	194	206
5/8	1 1/4	88	126	151	176	201	214
9/16	1 1/8	92	131	157	183	209	222
1/2	1	95	136	164	191	218	232
7/16	7/8	100	142	171	199	228	242
3/8	3/4	104	149	178	208	238	253
5/16	5/8	109	156	187	218	249	265
1/4	1/2	114	164	196	229	262	278
3/16	3/8	120	172	207	241	275	293
1/8	1/4	127	182	218	254	291	309
1/16	1/8	135	192	231	269	308	327
0	0	143	204	245	286	327	347

ICE MODEL 70S DIESEL HAMMER

$P = \frac{2WH}{S + 0.1}$ WEIGHT OF RAM = 7000
REFUSAL SHALL BE BETWEEN 150 - 180 TONS

PENETRATION (INCHES)		AVERAGE HEIGHT OF FALL (FT.)					
10 BLOWS	20 BLOWS	3.5	5	6	7	8	8.5
		BEARING IN TONS					
2 1/2	5	70	100	120	140	160	170
2 7/16	4 7/8	71	102	122	143	163	173
2 3/8	4 3/4	73	104	124	145	166	176
2 5/16	4 5/8	74	106	127	148	169	180
2 1/4	4 1/2	75	108	129	151	172	183
2 3/16	4 3/8	77	110	132	154	176	187
2 1/8	4 1/4	78	112	134	157	179	190
2 1/16	4 1/8	80	114	137	160	183	194
2	4	82	117	140	163	187	198
1 15/16	3 7/8	83	119	143	167	191	203
1 7/8	3 3/4	85	122	146	170	195	207
1 13/16	3 5/8	87	124	149	174	199	212
1 3/4	3 1/2	89	127	153	178	204	216
1 11/16	3 3/8	91	130	156	182	208	221
1 5/8	3 1/4	93	133	160	187	213	227
1 9/16	3 1/8	96	137	164	191	219	232
1 1/2	3	98	140	168	196	224	238
1 7/16	2 7/8	101	144	172	201	230	244
1 3/8	2 3/4	103	147	177	206	236	251
1 5/16	2 5/8	106	151	182	212	242	257
1 1/4	2 1/2	109	156	187	218	249	264
1 3/16	2 3/8	112	160	192	224	256	272
1 1/8	2 1/4	115	165	198	231	264	280
1 1/16	2 1/8	119	170	204	238	272	288
1	2	123	175	210	245	280	298
15/16	1 7/8	126	181	217	253	289	307
7/8	1 3/4	131	187	224	261	299	317
13/16	1 5/8	135	193	232	270	309	328
3/4	1 1/2	140	200	240	280	320	340
11/16	1 3/8	145	207	249	290	332	353
5/8	1 1/4	151	215	258	302	345	366
9/16	1 1/8	157	224	269	314	358	381
1/2	1	163	233	280	327	373	397
7/16	7/8	170	243	292	341	390	414
3/8	3/4	178	255	305	356	407	433
5/16	5/8	187	267	320	373	427	453
1/4	1/2	196	280	336	392	448	476
3/16	3/8	206	295	354	413	472	501
1/8	1/4	218	311	373	436	498	529
1/16	1/8	231	329	395	461	527	560
0	0	246	350	420	490	560	595

ICE MODEL 90S DIESEL HAMMER

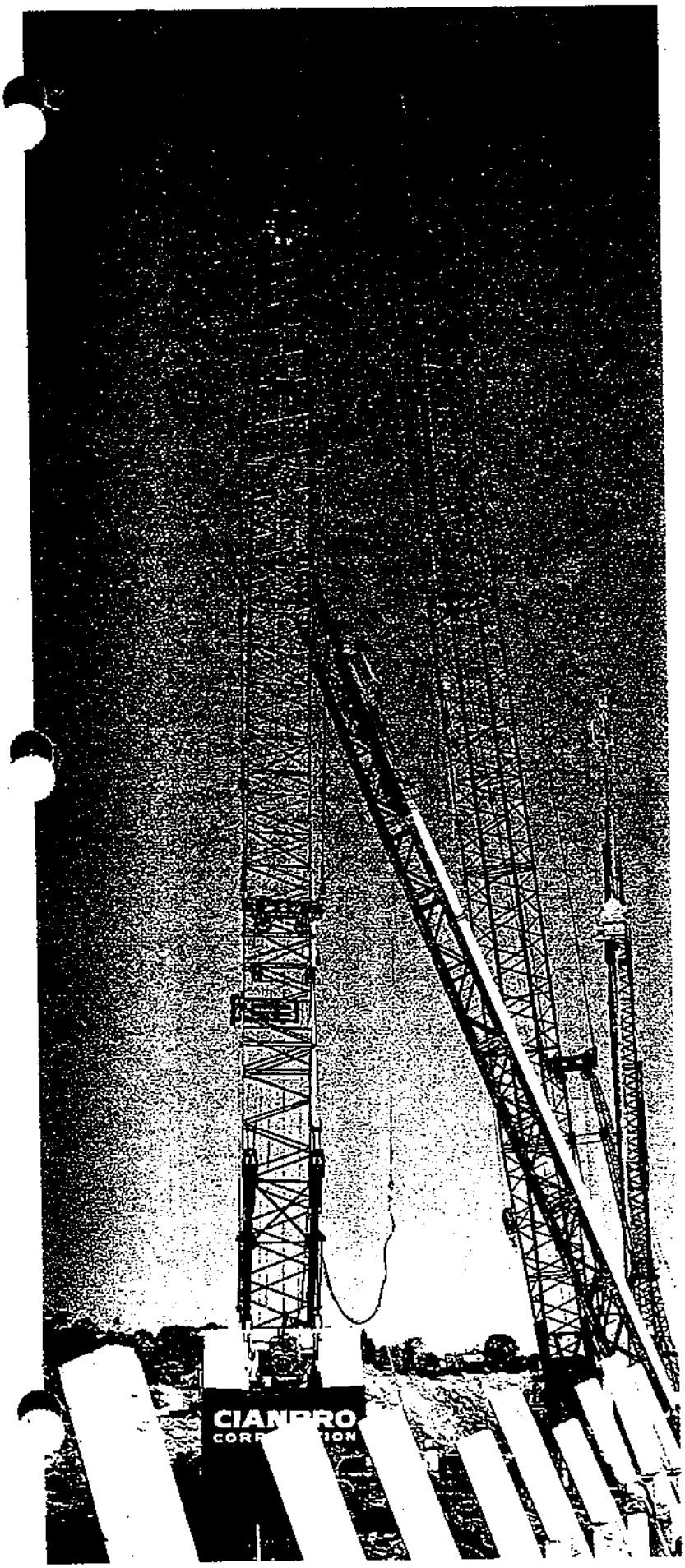
$P = \frac{2WH}{S + 0.1}$ WEIGHT OF RAM = 9000
REFUSAL SHALL BE BETWEEN 150 - 180 TONS

PENETRATION (INCHES)		AVERAGE HEIGHT OF FALL (FT.)					
10 BLOWS	20 BLOWS	3.5	5	6	7	8	8.5
		BEARING IN TONS					
2 1/2	5	90	129	154	180	206	219
2 7/16	4 7/8	92	131	157	183	209	223
2 3/8	4 3/4	93	133	160	187	213	227
2 5/16	4 5/8	95	136	163	190	217	231
2 1/4	4 1/2	97	138	166	194	222	235
2 3/16	4 3/8	99	141	169	198	226	240
2 1/8	4 1/4	101	144	173	202	230	245
2 1/16	4 1/8	103	147	176	206	235	250
2	4	105	150	180	210	240	255
1 15/16	3 7/8	107	153	184	214	245	260
1 7/8	3 3/4	110	157	188	219	250	266
1 13/16	3 5/8	112	160	192	224	256	272
1 3/4	3 1/2	115	164	196	229	262	278
1 11/16	3 3/8	117	167	201	234	268	285
1 5/8	3 1/4	120	171	206	240	274	291
1 9/16	3 1/8	123	176	211	246	281	299
1 1/2	3	126	180	216	252	288	306
1 7/16	2 7/8	129	185	222	258	295	314
1 3/8	2 3/4	133	189	227	265	303	322
1 5/16	2 5/8	136	195	234	272	311	331
1 1/4	2 1/2	140	200	240	280	320	340
1 3/16	2 3/8	144	206	247	288	329	350
1 1/8	2 1/4	148	212	254	296	339	360
1 1/16	2 1/8	153	218	262	305	349	371
1	2	158	225	270	315	360	383
15/16	1 7/8	163	232	279	325	372	395
7/8	1 3/4	168	240	288	336	384	408
13/16	1 5/8	174	248	298	348	397	422
3/4	1 1/2	180	257	309	360	411	437
11/16	1 3/8	187	267	320	373	427	453
5/8	1 1/4	194	277	332	388	443	471
9/16	1 1/8	202	288	346	403	461	490
1/2	1	210	300	360	420	480	510
7/16	7/8	219	313	376	438	501	532
3/8	3/4	228	327	393	458	524	556
5/16	5/8	240	343	411	480	549	583
1/4	1/2	252	360	432	504	576	612
3/16	3/8	265	379	455	531	606	644
1/8	1/4	280	400	480	560	640	680
1/16	1/8	296	424	508	593	678	720
0	0	315	450	540	630	720	765

ICE MODEL 200S DIESEL HAMMER

P = 2 W H / S + 0.1 WEIGHT OF RAM = 20000
REFUSAL SHALL BE BETWEEN 150 - 180 TONS

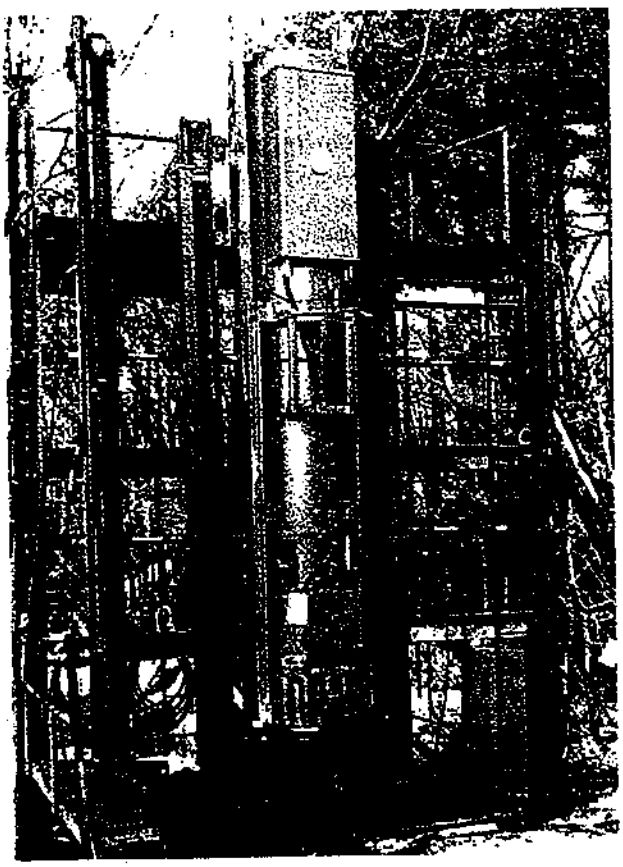
PENETRATION (INCHES)		AVERAGE HEIGHT OF FALL (FT.)					
10 BLOWS	20 BLOWS	3.5	5	6	7	8	8.5
		BEARING IN TONS					
2 1/2	5	200	288	343	400	457	486
2 7/16	4 7/8	204	291	349	407	465	495
2 3/8	4 3/4	207	296	356	415	474	504
2 5/16	4 5/8	211	302	362	423	483	513
2 1/4	4 1/2	215	308	369	431	492	523
2 3/16	4 3/8	220	314	376	439	502	533
2 1/8	4 1/4	224	320	384	448	512	544
2 1/16	4 1/8	228	327	392	457	522	555
2	4	233	333	400	467	533	567
1 15/16	3 7/8	238	340	409	477	545	579
1 7/8	3 3/4	243	348	417	487	557	591
1 13/16	3 5/8	249	356	427	498	569	604
1 3/4	3 1/2	255	364	436	509	582	618
1 11/16	3 3/8	260	372	447	521	595	633
1 5/8	3 1/4	267	381	457	533	610	648
1 9/16	3 1/8	273	390	468	546	624	663
1 1/2	3	280	400	480	560	640	680
1 7/16	2 7/8	287	410	492	574	656	697
1 3/8	2 3/4	295	421	505	589	674	716
1 5/16	2 5/8	303	432	519	605	692	735
1 1/4	2 1/2	311	444	533	622	711	756
1 3/16	2 3/8	320	457	549	640	731	777
1 1/8	2 1/4	329	471	565	659	753	800
1 1/16	2 1/8	339	485	582	679	776	824
1	2	350	500	600	700	800	850
15/16	1 7/8	361	516	619	723	826	877
7/8	1 3/4	373	533	640	747	853	907
13/16	1 5/8	386	552	662	772	883	938
3/4	1 1/2	400	571	686	800	914	971
11/16	1 3/8	415	593	711	830	948	1007
5/8	1 1/4	431	615	738	862	985	1046
9/16	1 1/8	448	640	768	896	1024	1088
1/2	1	467	667	800	933	1067	1133
7/16	7/8	487	696	835	974	1113	1183
3/8	3/4	509	727	873	1018	1164	1236
5/16	5/8	533	762	914	1067	1219	1295
1/4	1/2	560	800	960	1120	1280	1360
3/16	3/8	589	842	1011	1179	1347	1432
1/8	1/4	622	889	1067	1244	1422	1511
1/16	1/8	659	941	1129	1318	1506	1600
0	0	700	1000	1200	1400	1600	1700



DIESEL PILE HAMMERS

DOUBLE-ACTING FOR HIGH PRODUCTION

8,100-70,000 FT-LBS
1,120-9,700 KG-M



ICE'S COMPLETE RANGE OF DOUBLE-ACTING DIESEL PILE HAMMERS

• SEVEN MODELS

Seven models with a maximum energy range from 8,100 to 70,000 ft.-lbs. allow the proper hammer to be selected for every job.

Model 180 — 8,100 ft.-lbs. for timber piles and shorter sheet piling.

Model 440 — 18,100 ft.-lbs. for mid-length sheets, H-Beams, and pipe piles. Scavenging system permits efficient operation in very soft soils where other diesels will not start and run.

Model 422— 22,500 ft.-lbs. with low overall weight.

Model 520 — 30,000 ft.-lbs., long the standard on H-Beams is also unmatched on sheet piling and concrete piles.

Model 640 — 40,000 ft.-lbs., the big brother of the 520 for those jobs where extra energy is needed.

Model 660 — 50,000 ft.-lbs., high energy plus the scavenging system for outstanding soft-soil performance.

Model 1070— 70,000 ft.-lbs., hammer features a 10,000 pound ram for big concrete piles and other large hammer requirements. High speed—64/68 blows per minute—is almost twice that of single-acting diesels.

• HIGH-OUTPUT ENERGIES
• DOUBLE-ACTING DESIGN

The double-acting design provides high output energies at up to twice the number of blows per minute of other diesel hammers. Power cylinder scavenging and high-pressure fuel injection assures starting and continued running in soft soils. Energy is infinitely adjustable from half to full rated energy.

• HIGH PRESSURE FUEL INJECTION

Fuel under high pressure is injected into the hammer at the proper time to provide the best fuel-air mixture for efficient combustion. This results in a cleaner running hammer as well as easy starting and excellent soft soil performance. Pre-ignition is eliminated.

• OUTPUT ENERGY GAGE

The remote-reading output energy gage and charts give accurate and precise reading in foot-pounds of energy. It is not necessary to estimate energy by watching the ram stroke.

• RUGGED, LONG-LASTING DESIGN

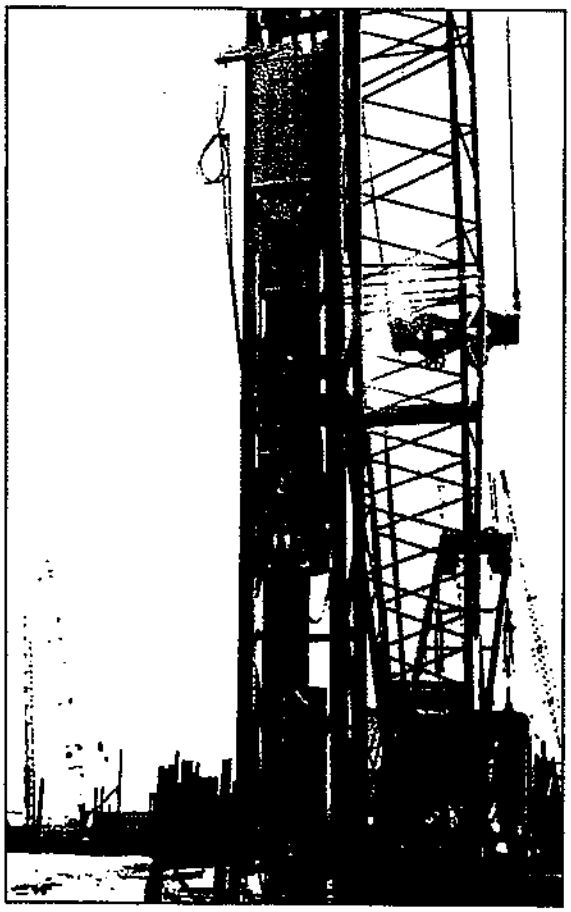
Enclosed cylinder top helps keep dirt and sand out of the hammer eliminating unneccessary wear of internal parts.
Protective wear rings at top and bottom of ram center the cylinder, eliminating ram-to-cylinder wall contact and greatly increasing the life of hammer.
Positive lubrication from a lube oil pump activated by the ram.
Shock reducing elastomer and cushion assembly. Elastomer protects the hammer from pile rebound. Plastic disc cushions and protects both piling and hammer.

• ONE-MAN OPERATION

With hammer throttle control mounted in operator's cab, crane operator controls the hammer operation.

• QUIETER OPERATION

Tests show that ICE double-acting diesels are over 50% quieter (4 dBA) than comparable single-acting diesel hammers.



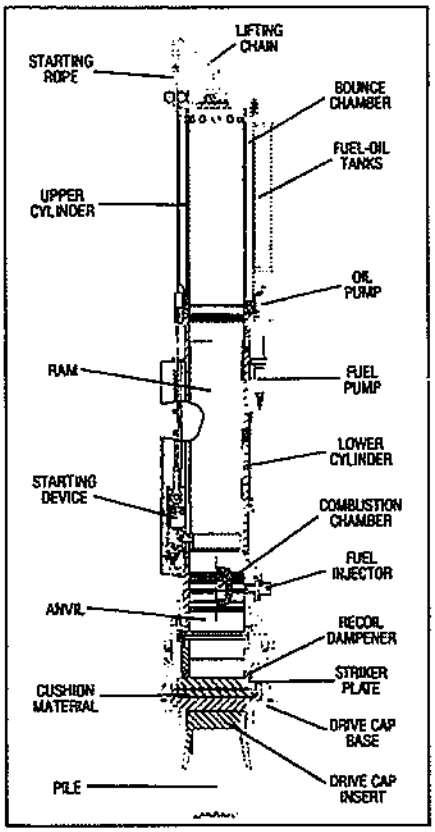
MODEL 1070 DRIVING 14" PIPE

OPERATION

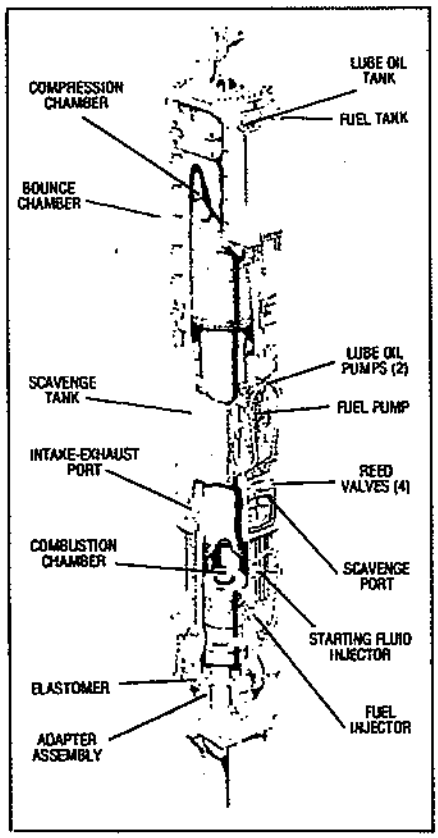
Whatever your driving requirement there's an ICE diesel pile hammer to match it. And all ICE diesel hammers are rated highest in horsepower in their class. The result: faster driving, lower operating costs, greater profits.

The ICE self-contained, free-piston diesel pile hammers operate on the two-cycle principle and are designed to deliver driving energy to the pile head in three forms . . . compression pre-load, impact, and explosive force.

To begin operation, the ram (free piston) is raised toward the top of the enclosed cylinder by a crane hoist line, compressing air above the ram in the cylinder and the connecting air tanks (bounce chamber) located on the outside of the cylinder. The ram is released and accelerated downward by the force of gravity plus the expansion of air from the bounce chambers above the ram into the upper cylinder. During the downward stroke, the ram closes off the intake-exhaust ports and compresses the trapped air in the power cylinder between the bottom of the ram and the anvil. Compressing the trapped air causes a heat rise in the combustion chamber and also creates a pre-loading force on the anvil and the pile.



Models 180, 422, 520, 640 and 1070



Models 440 and 660

As the ram nears the end of its downward stroke, it activates a fuel pump which injects atomized fuel under high pressure into the highly heated air in the combustion chamber(s) in the top of the anvil. The ram strikes the anvil, delivering impact energy to the pile. The combustible gases ignite and explode, sending the ram upward and the pile downward. This also transmits energy to the pile in addition to the output energy obtained from the ram's striking the anvil . . . keeps the pile in motion longer. The ram also actuates the lubricating oil pump to provide positive lubrication.

When the ram travels upward from combustion, the intake-exhaust ports are cleared. The burned gases blow out these ports. Simultaneously, air is compressed in the upper cylinder and bounce chamber tanks to complete the cycle.

The models 440 & 660 have a unique (patented) self-scavenging feature. As the ram rises, reed valves are closed by the partial vacuum in the scavenge chamber caused by the raising ram. When the scavenge ports are cleared; clean, fresh air is drawn into the lower cylinder, down across the combustion chamber and up through the scavenge chamber into the upper cylinder. When the ram begins its down stroke, the highly diluted air in the scavenge system rushes ahead of the ram, down across the combustion chamber and out through the intake-exhaust ports, further scavenging the cylinder and assuring a fresh supply of air.

*Internal elastomer on Model 180.
Other models have external elastomer.

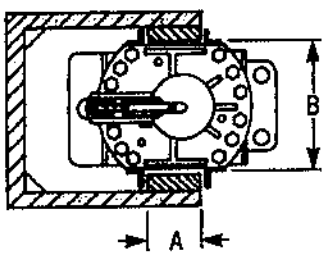
SPECIFICATIONS

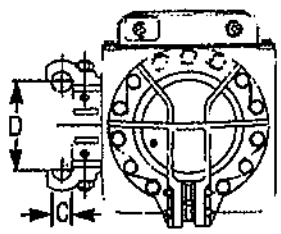
	UNITS		MODEL 180		440		422		520		640		660		1070	
Working Specifications																
Rated equivalent WH energy	ft.-lbs.	kg.-m.	8,100	1,120	18,100	2,517	22,500	3,112	30,000	4,149	40,000	5,533	50,000	6,916	70,000	9,700
Minimum operating energy	ft.-lbs.	kg.-m.	4,060	561	7,700	1,065	9,000	1,247	17,700	2,448	25,400	3,513	25,100	3,471	36,100	4,992
Rated equivalent ram stroke	ft.-in.	m.	4-9	1.45	4-8	1.42	5-8	1.71	5-11	1.80	6-8	2.03	6-7	2.02	7-0	2.13
Speed	blows per minute		90-95	90-95	88-92	88-92	76-82	76-82	80-84	80-84	74-77	74-77	84-88	84-88	64-68	64-68
Power rating	HP	KW	23.3	17.4	49.6	37.0	51.8	38.6	76.3	56.9	90	67	133.3	99.5	136	101
Bearing based on ENR formula	Tons	Tons	40.5	36.7	91.0	82.5	110	102	150.0	136.1	200	182	250.0	226.8	350	318
Weights																
Bare hammer	lbs.	kg.	4,645	2,062	9,840	4,463	9,750	4,431	13,400	6,078	14,460	6,560	24,480	11,104	21,500	9,700
Ram	lbs.	kg.	1,725	782	4,000	1,814	4,000	1,814	5,070	2,300	6,000	2,730	7,584	3,431	10,000	4,545
Anvil	lbs.	kg.	377	171	705	320	1,380	627	1,740	790	1,575	715	2,145	973	3,100	1,410
Typical operating weight with cap	lbs.	kg.	5,208	2,362	12,514	5,676	12,200	5,545	15,870	7,200	16,930	7,680	28,545	12,948	25,500	11,590
Capacities (adequate for normal day)																
Diesel fuel tank	gal.	lit.	5.5	20.8	13	49.2	13.8	52.2	11	41.6	11	41.6	26.0	98.4	35	133
Lube oil tank	gal.	lit.	1.9	7.2	1.8	6.8	4.5	17	2	7.6	2	7.6	4.2	16.1	10	38
Dimensions of Hammer																
Width (side to side)	in.	mm.	20	510	20	510	22	559	26	660	26	660	30	760	30	760
Depth	in.	mm.	24¼	620	34⅛	870	32¼	819	34⅜	870	34⅜	870	51	1,300	44	1,120
Centerline to front	in.	mm.	13⅛	330	17 1/16	430	16¼	413	17	430	17	430	25½	650	21½	545
Centerline to rear	in.	mm.	11¼	280	17 1/16	430	16	406	17⅜	440	17⅜	440	25½	650	22½	575
Length (hammer only)	ft.-in.	m.	11-3	3.43	13-6	4.11	13-11	4.24	13-9	4.19	15-7	4.75	17-4	5.28	17-10	5.44
Operating length (top of Y-hitch lifting eye to pile driving surface of cap)	ft.-in.	m.	16-3	4.95	19-2	5.84	19-8	5.99	19-9	6.02	21-7	6.58	25-0	7.62	25-5	5.90
Dimensions of Leads (See Note 1)																
Face width of guide rails (A)	in.	mm.	4-8	100-200	4-8	100-200	4-8	100-200	8	200	8	200	8	200	8	200
Distance between guide rails (B)	in.	mm.	20½	520	20½/26½	520/670	22½/26½	570/670	26½	670	26½	670	30½/32½	775/825	30½/32½	775/825
Diameter of guide pipes (C)	in.	mm.	2¾	70	2¾	70	2¾	70	2¾	70	2¾	70	2¾	70	2¾	70
Center to center of guide pipes (D)	in.	mm.	13	330	13	330	13	330	13	330	13	330	13	330	13	330

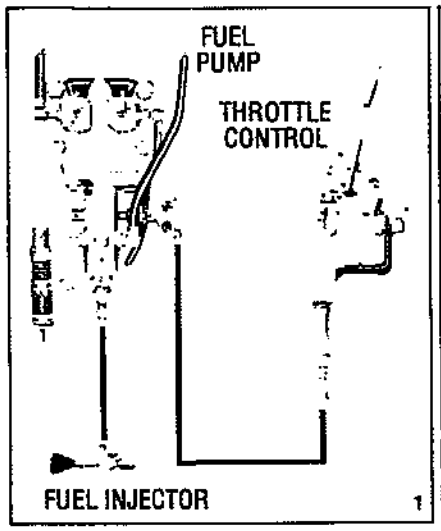
Note:

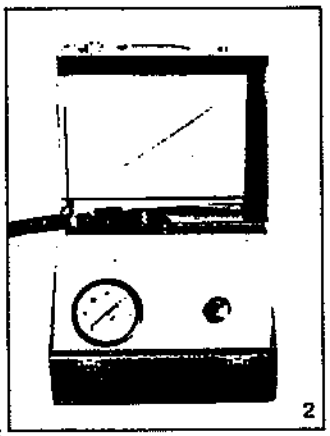
1: Pads for wider leads, guide angles for other width rails, and guide clips for spud type leads are available.

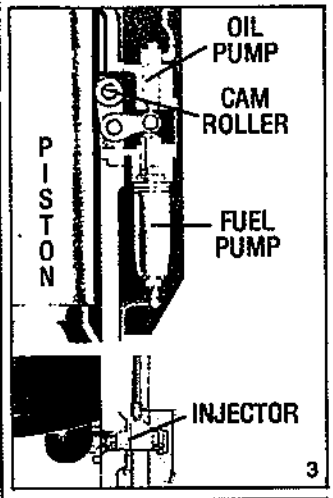
Constant improvement and engineering progress make it necessary that we reserve the right to make specification, equipment, and price changes without notice.

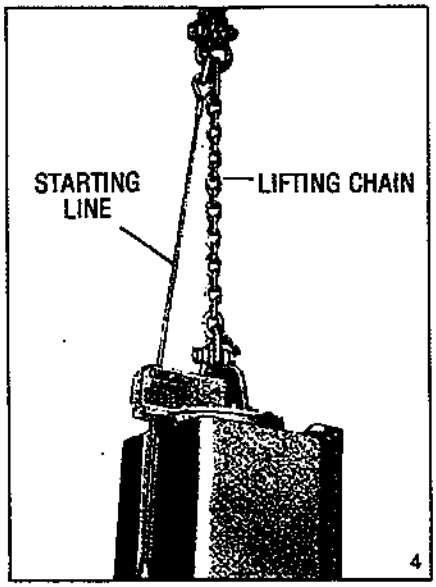


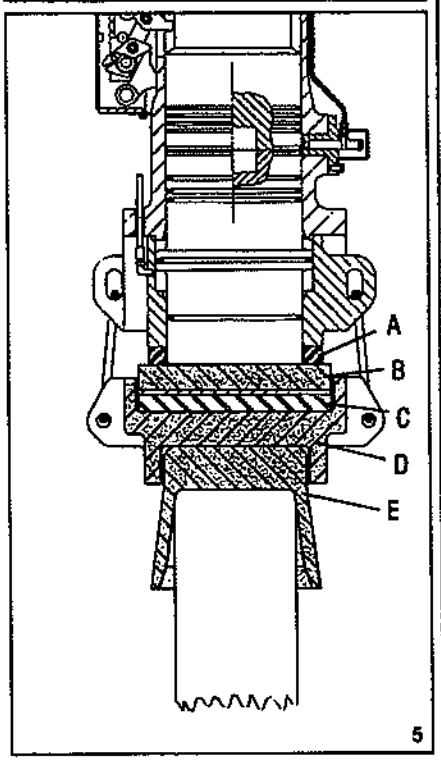


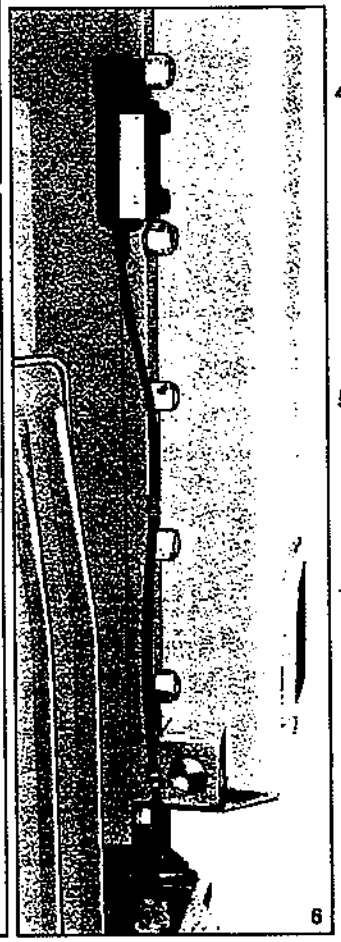












1. ICE diesel pile hammers are supplied with a hydraulic throttle control connected to a fuel injection pump located on the hammer. The pump supplies high pressure fuel to the fuel injector nozzle which sprays fuel into the combustion chamber. With the throttle control, it is possible to control the hammer energy output by varying the amount of atomized fuel injected, thus varying the ram stroke. The blow rate stays relatively constant. The operator can make throttle adjustments for different driving conditions.

2. The output energy gage provides a fast reading of hammer output energy during driving. A hose is connected from the compression tank to the gage. When the hammer energy output reading is desired, merely depress the gage button and a measurement of air pressure above the ram and in the compression tank is obtained. Referencing the energy graph, the equivalent WH energy (stored and potential) in ft.-lbs. is obtained from the dial reading.

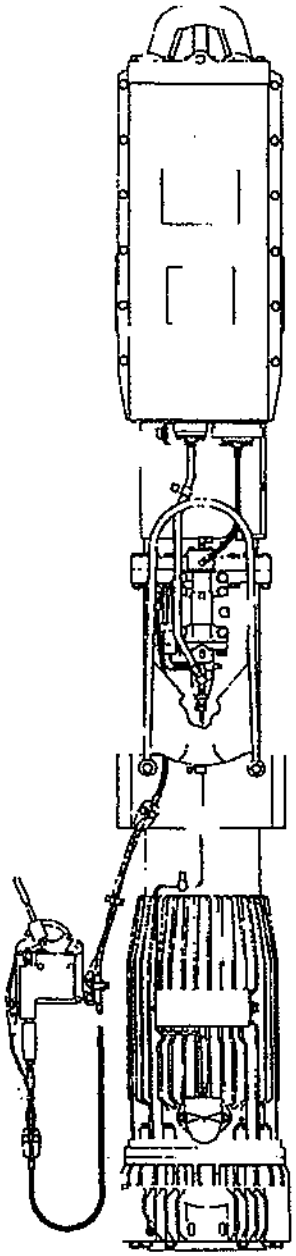
3. The fuel pump is cam or gas-pressure operated by the falling ram. Diesel fuel under high pressure is sent to the fuel injectors at the precise instant for optimum combustion. Special fuel-injection nozzles spray fuel into the combustion chamber in a pattern designed specifically for the ICE diesel hammer. At the same time, the oil pump is activated to lubricate the ram. The cam roller-bearing contacts the ram only between the compression rings, thereby eliminating the ring wear caused by the fuel pump cam of other diesel hammers.

4. The "Y" hitch is standard on all hammers. With the "Y" hitch, the lifting chain and starting line are connected to the single hoist line. This allows the single hoist line to serve the dual purpose of starting the hammer and centrally lifting the hammer when positioning in the leads. Auxiliary crane lines are free to handle piling or leads. An optional center-line lifting and starting line is available. Hydraulic starting devices are also available for most models.

5. The ICE drive cap system protects hammer and pile from damage, while providing an economical drive cap for most types of piling. The recoil dampener (A) protects the hammer from pile rebound. The strike plate (B) transmits hammer energy to the pile. The plastic cushion block (C) helps prevent damage to the pile and hammer. The drive cap base (D) contains the cushion material and accepts various types of drive cap inserts (E). Inserts are available for most types and sizes of piling.

6. For easier, quicker starting in cold weather, ICE diesel pile hammers are supplied with a patented starting fluid injection system. As the ram is raised, starting fluid is injected into the combustion chamber. The amount of fluid is controlled by a simple, vacuum actuated check valve connected to the fluid supply tank. For convenience, fluid tank can be filled with the hammer resting on the ground.

ICE MODEL 180 DIESEL PILE HAMMER



WORKING SPECIFICATIONS

Rated energy	8,100 ft-lbs (1,120 kg-m)
Minimum energy	4,060 ft-lbs (561 kg-m)
Rated equivalant ram stroke	4'9"(1.45 m)
Speed (blows per minute)	90-95
Power rating	23.3 HP (17.4 KW)
Bearing based on EN formula	40.5 tons (36.7 tons)

WEIGHTS

Bare hammer	4,645 lbs (2,062 kg)
Ram	1,725 lbs (782 kg)
Anvil	377 lbs (171 kg)
Typical operating weight	5,208 lbs (2,362 kg)

CAPACITIES (adequate for normal day)

Diesel fuel tank	5.5 gal (20.8 l)
Lube oil tank	1.9 gal (7.2 l)

DIMENSIONS OF HAMMER

Width (side to side)	20"(510 mm)
Depth	24 1/4"(620 mm)
Centerline to front	13 1/8"(330 mm)
Centerline to rear	11 1/8"(280 mm)
Length (hammer only)	11'3"(3.43 m)
Operating length (top of chain to drive cap)	16'3"(4.95m)

DIMENSIONS OF LEADS

Face width of guide rails	4-8"(102-203 mm)
Distance between guide rails	20 1/2-22 1/2"(520-570 mm)

HERCULES MACHINERY CORPORATION
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Fort Wayne, Indiana 46895
(219) 424-0405

ICE 180 DIESEL PILE HAMMER BEARING CHART

This chart is based on the Engineering News formula for pile bearing and is provided as a convenience only for those applications where this formula is specified. ICE has no preference for this particular formula over any other.

Pile bearing (tons) = 2E/(S+0.1)/2000, where E = Hammer energy (ft-lbs) and S = Pile set (inches per blow)

The gauge reading to energy correlation per the table below is based upon an energy gauge hose length of 50'. For other hose lengths, contact ICE.

Gauge reading (psig)	Energy (ft-lbs)	Pile set (Blows per inch) 2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
10	4,060	6	9	11	13	15	16	18	19	20	21	22	22	23	24	24	25	26	26	27
11	4,370	7	10	12	14	16	17	19	20	21	22	23	24	25	26	26	27	28	28	29
12	4,680	7	10	13	15	17	19	20	22	23	24	25	26	27	28	28	29	30	30	31
13	4,970	8	11	14	16	18	20	22	23	24	26	27	28	28	29	30	31	31	32	33
14	5,250	8	12	15	17	19	21	23	24	26	27	28	29	30	31	32	33	33	34	35
15	5,530	9	12	15	18	20	22	24	26	27	28	30	31	32	33	34	34	35	36	36
16	5,800	9	13	16	19	21	23	25	27	29	30	31	32	33	34	35	36	37	38	38
17	6,060	10	13	17	20	22	24	26	28	30	31	33	34	35	36	37	38	38	39	40
18	6,320	10	14	18	21	23	26	28	29	31	33	34	35	36	37	38	39	40	41	42
19	6,560	10	15	18	21	24	27	29	31	32	34	35	37	38	39	40	41	42	42	43
20	6,810	11	15	19	22	25	28	30	32	34	35	37	38	39	40	41	42	43	44	45
21	7,050	11	16	20	23	26	29	31	33	35	36	38	39	41	42	43	44	45	46	47
22	7,280	12	16	20	24	27	29	32	34	36	38	39	41	42	43	44	45	46	47	48
23	7,500	12	17	21	25	28	30	33	35	37	39	40	42	43	45	46	47	48	49	50
24	7,730	12	17	22	25	28	31	34	36	38	40	42	43	45	46	47	48	49	50	51
25	7,940	13	18	22	26	29	32	35	37	39	41	43	44	46	47	48	49	51	52	52
26	8,160	13	18	23	27	30	33	36	38	40	42	44	46	47	48	50	51	52	53	54

CAUTION: Driving at ten blows per inch (set of 0.1 inch per blow) is considered practical refusal. Driving in excess of ten blows per inch for more than six inches of driving or driving in excess of 20 blows per inch at all is considered improper use and will void the hammer warranty.

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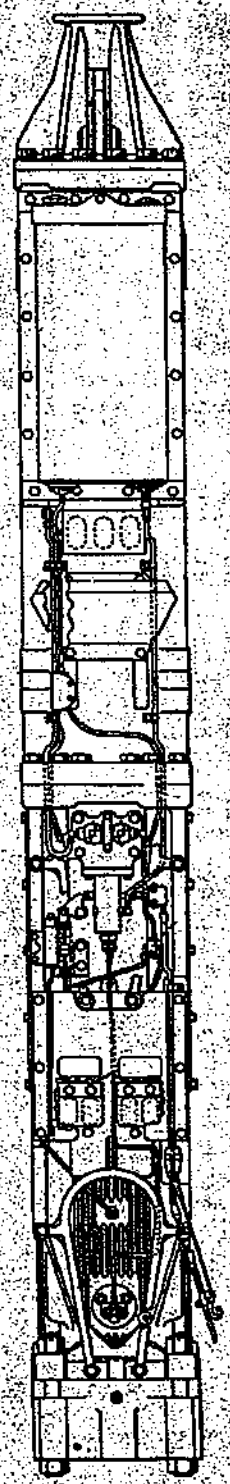
ICE MODEL 440 DIESEL PILE HAMMER



WORKING SPECIFICATIONS

Rated energy	18,100 ft-lbs (2,517 kg-m)
Minimum energy	7,700 ft-lbs (1,065 kg-m)
Rated equivalant ram stroke	4'8"(1.42 m)
Speed (blows per minute)	88-92
Power rating	49.6 HP (37 KW)
Bearing based on EN formula	91 tons (82.5 tons)

WEIGHTS

Bare hammer	9,840 lbs (4,463 kg)
Ram	4,000 lbs (1,814 kg)
Anvil	705 lbs (320 kg)
Typical operating weight	12,514 lbs (5,676 kg)

CAPACITIES (adequate for normal day)

Diesel fuel tank	13 gal (49.2 l)
Lube oil tank	1.8 gal (6.8 l)

DIMENSIONS OF HAMMER

Width (side to side)	20"(510 mm)
Depth	34 1/8"(870 mm)
Centerline to front	17 1/16"(430 mm)
Centerline to rear	17 1/16"(430 mm)
Length (hammer only)	13'6"(4.11 m)
Operating length (top of chain to drive cap)	19'2"(5.84m)

DIMENSIONS OF LEADS

Face width of guide rails	4-8"(100-200 mm)
Distance between guide rails	20 1/2-26 1/2"(520-670 mm)

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ICE 440 DIESEL PILE HA...IER BEARING CHART

This chart is based on the Engineering News formula for pile bearing and is provided as a convenience only for those applications where this formula is specified. ICE has no preference for this particular formula over any other.

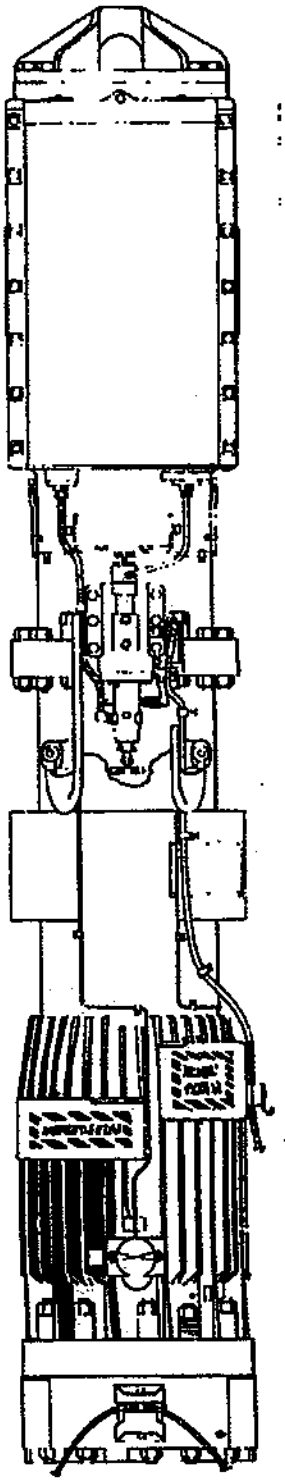
Pile bearing (tons) = 2E/(S+0.1)/2000, where E = Hammer energy (ft-lbs) and S = Pile set (inches per blow)

The gauge reading to energy correlation per the table below is based upon an energy gauge hose length of 50'. For other hose lengths, contact ICE.

Gauge reading (psig)	Energy (ft-lbs)	Pile set (Blows per inch) 2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
6	6,900	11	15	19	23	25	28	30	32	34	36	37	39	40	41	42	43	44	45	46
7	7,850	13	18	22	26	29	32	34	37	39	41	42	44	45	47	48	49	50	51	52
8	8,770	14	20	25	29	32	36	38	41	43	45	47	49	51	52	53	55	56	57	58
9	9,650	16	22	27	32	36	39	42	45	48	50	52	54	56	57	59	60	62	63	64
10	10,510	17	24	30	35	39	43	46	49	52	55	57	59	61	63	64	66	67	68	70
11	11,340	18	26	32	37	42	46	50	53	56	59	61	64	66	68	69	71	72	74	75
12	12,150	20	28	34	40	45	50	54	57	60	63	66	68	70	72	74	76	78	79	81
13	12,930	21	29	36	43	48	53	57	61	64	67	70	73	75	77	79	81	83	84	86
14	13,700	22	31	39	45	51	56	60	64	68	71	74	77	79	82	84	86	88	89	91
15	14,440	24	33	41	48	54	59	64	68	72	75	78	81	84	86	88	90	92	94	96
16	15,170	25	35	43	50	56	62	67	71	75	79	82	85	88	91	93	95	97	99	101
17	15,870	26	36	45	52	59	65	70	75	79	83	86	89	92	95	97	99	102	103	105
18	16,570	27	38	47	55	62	68	73	78	82	86	90	93	96	99	101	104	106	108	110
19	17,240	28	39	49	57	64	70	76	81	86	90	94	97	100	103	106	108	110	112	114
20	17,910	29	41	51	59	67	73	79	84	89	93	97	101	104	107	110	112	115	117	119
21	18,550	30	42	53	61	69	76	82	87	92	97	101	104	108	111	114	116	119	121	123

CAUTION: Driving at ten blows per inch (set of 0.1 inch per blow) is considered practical refusal. Driving in excess of ten blows per inch for more than six inches of driving or driving in excess of 20 blows per inch at all is considered improper use and will void the hammer warranty.

ICE MODEL 520 DIESEL PILE HAMMER



WORKING SPECIFICATIONS

Rated energy	30,000 ft-lbs (4,149 kg-m)
Minimum energy	17,700 ft-lbs (2,448 kg-m)
Rated equivalant ram stroke	5'11"(1.80 m)
Speed (blows per minute)	80-84
Power rating	76.3 HP (56.9 KW)
Bearing based on EN formula	150 tons (136 tons)

WEIGHTS

Bare hammer	13,400 lbs (6,078 kg)
Ram	5,070 lbs (2,300 kg)
Anvil	1,740 lbs (789 kg)
Typical operating weight	15,870 lbs (7,198 kg)

CAPACITIES (adequate for normal day)

Diesel fuel tank	11 gal (42 l)
Lube oil tank	2 gal (7.6 l)

DIMENSIONS OF HAMMER

Width (side to side)	26"(660 mm)
Depth	34 3/8"(870 mm)
Centerline to front	17"(430 mm)
Centerline to rear	17 3/8"(440 mm)
Length (hammer only)	13'7"(4.14 m)
Operating length (top of chain to drive cap)	19'9"(6.02 m)

DIMENSIONS OF LEADS

Face width of guide rails	8"(200 mm)
Distance between guide rails	26 1/2"(670 mm)

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Fort Wayne, Indiana 46895
(219) 424-0405

ICE 520 DIESEL PILE HAM...R BEARING CHART

This chart is based on the Engineering News formula for pile bearing and is provided as a convenience only for those applications where this formula is specified. ICE has no preference for this particular formula over any other.

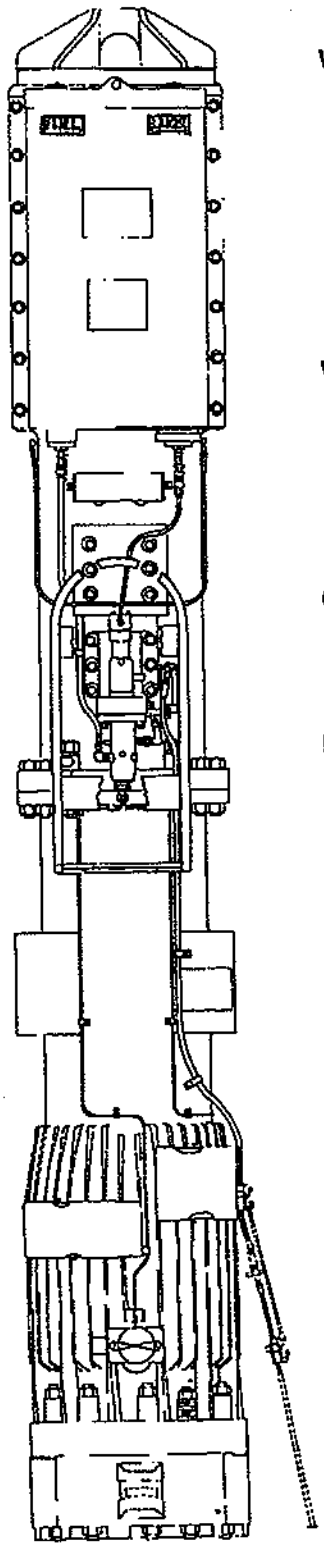
Pile bearing (tons) = 2E/(S+0.1)/2000, where E = Hammer energy (ft-lbs) and S = Pile set (inches per blow)

The gauge reading to energy correlation per the table below is based upon an energy gauge hose length of 50'. For other hose lengths, contact ICE.

Gauge reading (psig)	Energy (ft-lbs)	Pile set (Blows per inch) 2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
17	21,380	35	49	61	71	80	88	95	101	106	111	116	120	124	128	131	134	137	140	142
18	22,230	37	51	63	74	83	91	98	105	111	116	121	125	129	133	136	139	142	145	148
19	23,070	38	53	65	76	86	94	102	109	115	120	125	130	134	138	141	145	148	151	153
20	23,880	39	55	68	79	89	98	106	113	119	125	130	134	139	143	146	150	153	156	159
21	24,680	41	56	70	82	92	101	109	116	123	129	134	139	143	148	151	155	158	161	164
22	25,450	42	58	72	84	95	104	113	120	127	133	138	143	148	152	156	160	163	166	169
23	26,200	43	60	74	87	98	107	116	124	131	137	142	148	152	157	161	164	168	171	174
24	26,940	44	62	76	89	101	110	119	127	134	141	146	152	157	161	165	169	173	176	179
25	27,660	46	63	79	92	103	113	122	131	138	144	150	156	161	165	170	174	177	181	184
26	28,360	47	65	81	94	106	116	126	134	141	148	154	160	165	170	174	178	182	185	189
27	29,050	48	67	83	96	108	119	129	137	145	152	158	164	169	174	178	182	186	190	193
28	29,730	49	68	84	99	111	122	132	140	148	155	162	168	173	178	182	187	191	194	198
29	30,390	50	70	86	101	113	125	135	143	151	159	165	171	177	182	187	191	195	199	202

CAUTION:Driving at ten blows per inch (set of 0.1 inch per blow) is considered practical refusal. Driving in excess of ten blows per inch for more than six inches of driving or driving in excess of 20 blows per inch at all is considered improper use and will void the hammer warranty.

ICE MODEL 640 DIESEL PILE HAMMER



WORKING SPECIFICATIONS

Rated energy	40,000 ft-lbs (5,533 kg-m)
Minimum energy	25,400 ft-lbs (3,513 kg-m)
Rated equivalant ram stroke	6'8"(2.03 m)
Speed (blows per minute)	74-77
Power rating	90 HP (67 KW)
Bearing based on EN formula	200 tons (182 tons)

WEIGHTS

Bare hammer	14,460 lbs (6,560 kg)
Ram	6,000 lbs (2,730 kg)
Anvil	1,575 lbs (1,192 kg)
Typical operating weight	16,930 lbs (7,680 kg)

CAPACITIES (adequate for normal day)

Diesel fuel tank	11 gal (42 l)
Lube oil tank	2 gal (7.6 l)

DIMENSIONS OF HAMMER

Width (side to side)	26"(660 mm)
Depth	34 3/8"(870 mm)
Centerline to front	17"(430 mm)
Centerline to rear	17 3/8"(440 mm)
Length (hammer only)	15'7"(4.75 m)
Operating length (top of chain to drive cap)	21'7"(6.58m)

DIMENSIONS OF LEADS

Face width of guide rails	8"(200 mm)
Distance between guide rails	26 1/2"(670 mm)

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INTERNATIONAL CONSTRUCTION EQUIPMENT, INC.

Corporate offices: 301 Warehouse Drive, Matthews, NC 28105, USA
800 438-9281 & 704 821-8200 FAX 704 821-6448
Telex 572385 ICE INTL

ICE 640 DIESEL PILE HAMMER BEARING CHART

This chart is based on the Engineering News formula for pile bearing and is provided as a convenience only for those aplicaations where this formula is specified. ICE has no preference for this particular formula over any other.

Pile bearing (tons) = 2E/(S+0.1)/2000, where E = Hammer energy (ft-lbs) and S = Pile set (inches per blow)

The gauge reading to energy correlation per the table below is based upon an energy gauge hose length of 50'. For other hose lengths, contact ICE.

Gauge reading (psig)	Energy (ft-lbs)	Pile set (Blows per inch) 2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
14	25,390	42	58	72	84	95	104	112	120	126	132	138	143	148	152	156	159	163	166	169
15	26,400	44	60	75	88	99	108	117	125	132	138	144	149	154	158	162	166	169	172	176
16	27,370	45	63	78	91	102	112	121	129	136	143	149	154	159	164	168	172	175	179	182
17	28,310	47	65	80	94	106	116	125	134	141	148	154	160	165	169	174	178	181	185	188
18	29,230	48	67	83	97	109	120	129	138	146	153	159	165	170	175	179	184	187	191	194
19	30,120	50	69	86	100	112	124	133	142	150	157	164	170	175	180	185	189	193	197	200
20	30,980	51	71	88	103	116	127	137	146	154	162	168	175	180	185	190	195	199	202	206
21	31,820	53	73	90	106	119	131	141	150	159	166	173	179	185	190	195	200	204	208	212
22	32,650	54	75	93	108	122	134	145	154	163	171	178	184	190	195	200	205	209	213	217
23	33,450	55	77	95	111	125	137	148	158	167	175	182	189	195	200	205	210	215	219	223
24	34,230	57	78	97	114	128	140	152	162	171	179	186	193	199	205	210	215	220	224	228
25	35,000	58	80	100	116	131	144	155	165	175	183	190	197	204	210	215	220	225	229	233
26	35,740	59	82	102	119	134	147	158	169	178	187	194	202	208	214	219	225	229	234	238
27	36,470	60	84	104	121	136	150	162	172	182	191	198	206	212	218	224	229	234	238	243
28	37,190	61	85	106	123	139	153	165	176	185	194	202	210	216	223	228	234	239	243	247
29	37,890	63	87	108	126	142	156	168	179	189	198	206	214	221	227	233	238	243	248	252
30	38,580	64	89	110	128	144	158	171	182	192	202	210	218	225	231	237	242	248	252	257
31	39,250	65	90	112	130	147	161	174	185	196	205	214	221	228	235	241	247	252	257	261
32	39,910	66	92	114	133	149	164	177	189	199	209	217	225	232	239	245	251	256	261	266
33	40,560	67	93	115	135	152	167	180	192	202	212	221	229	236	243	249	255	260	265	270

CAUTION: Driving at ten blows per inch (set of 0.1 inch per blow) is considered practical refusal. Driving in excess of ten blows per inch for more than six inches of driving or driving in excess of 20 blows per inch at all is considered improper use and will void the hammer warranty.

PILE POINTS & SPLICERS

- Reduce Pile Installation Cost
- Increase Pile Reliability

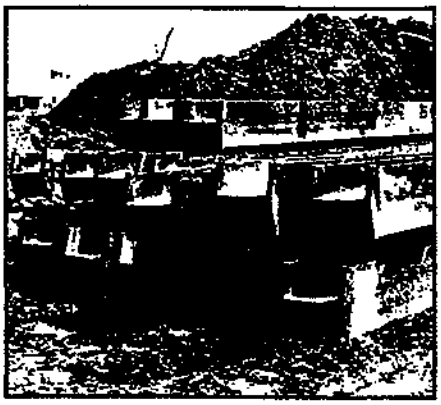
In these tight economic times with ever increasing labor, equipment and materials costs, all available products and techniques must be employed to reduce pile installation time and costs to insure the integrity of the piles being driven.

ICE offers a complete line of pile accessories including points, boots, couplers, splicers, cutting rings and edge protectors to help speed pile installation time and to help guarantee the load bearing capacity of driven piles. Often a small added investment in pile points or splicers will be returned several times over in reduced pile costs and/or reliability.

All ICE pile accessories are manufactured from high-strength materials and are made in sizes to fit all standard sizes and types of piles.

H-BEAM POINTS

The load bearing capacity of driven H-Beams can be greatly reduced if the pile is damaged during driving due to impact with rocks, boulders, rubble or other obstructions. ICE H-Beam points provide pile tip protection to minimize this type of damage. ICE points increase the bending strength of pile flanges and web from 2 to 6 times thereby helping insure that the pile reaches final bearing in position and in good condition.

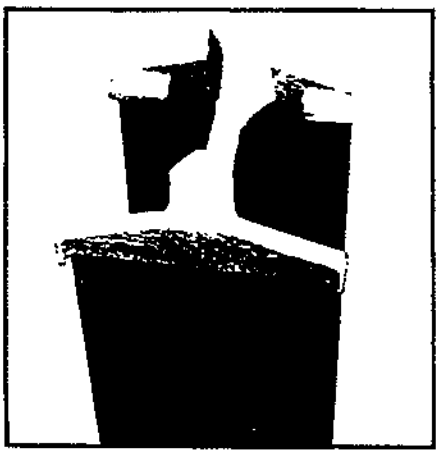


- Made of tough cast steel (ASTM A27 65/35).
- Maximum protection for critical outer corners of beam.
- Wide surface to support beam flanges.
- Quick and easy to attach.
- Assures undamaged piles.
- Sizes available for all H-Beam sections.

ROCK-BITE™ POINTS

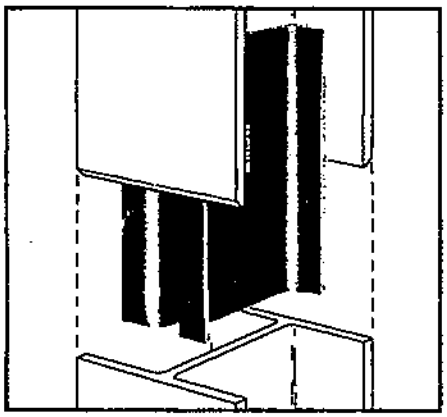
In response to market demand for H-Beam point protection beyond our standard points, ICE manufactures the ROCK-BITE cast steel point. The ROCK-BITE point provides added ability to punch through obstructions and to set the pile into harder bearing materials. ROCK-BITE teeth bite into sloping bearing strata with both vertical and batter piles. Available for all H-Beam sections.

- Thicker flanges and web for even greater protection than standard points.
- Heavy stabbing points for rock penetration on sloping surfaces.
- Increased flange tip depth for added strength.

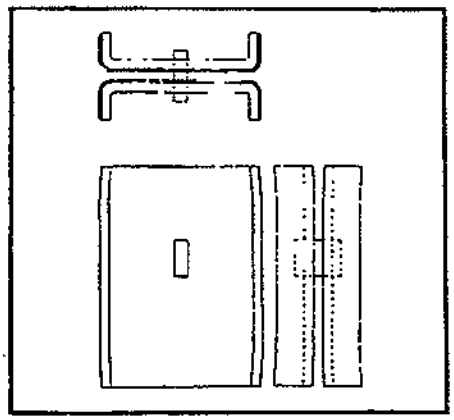


H-BEAM SPLICERS

On many pile jobs where splices are required in H-Beams, the time required to make the splice can equal or exceed pile driving time. ICE H-Beam splicers substantially reduce splicing time in two ways. First, pile alignment is quick and easy as the splicer also serves as the welding template. The splicer slips over the driven pile section and the new section easily slides into the top of the splicer providing quick and accurate alignment. Second, welding time is greatly reduced—often by up to 75% as only a fraction of the weld is required.



- Quick and easy to attach.
- Made of A-36 steel for easy welding.
- Tapered ends slide easily onto beam.
- Minimum delay time for pile driving crew.
- Splice stronger than unspliced beam.
- Sizes available for all H-Beam sections.



ROUND-TITE™ PILE COUPLINGS & BOOTS

ROUND-TITE fittings for pipe piles are designed to expand over the pipe and form a watertight fit; they do not deform the pipe as other available fittings do.

The ROUND-TITE boot and coupling also eliminate the necessity for any welding—in the shop or in the field. They attach easily and very quickly, thus saving considerable field time. This total time and labor cost reduction creates a tremendous savings for the contractor and the owner.

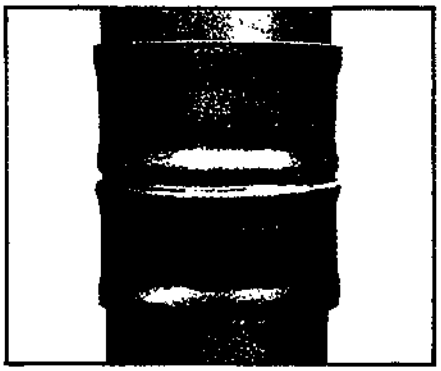
The ROUND-TITE boot is ideally suited for mandrel driving as well as the conventional driving method. The ROUND-TITE coupling virtually eliminates the problems connected with field welded pipe pile sections and those sections connected with other fittings. Because it expands over the pipe pile end, the ROUND-TITE coupling also seats easily and tightly over concrete-filled pipe sections.

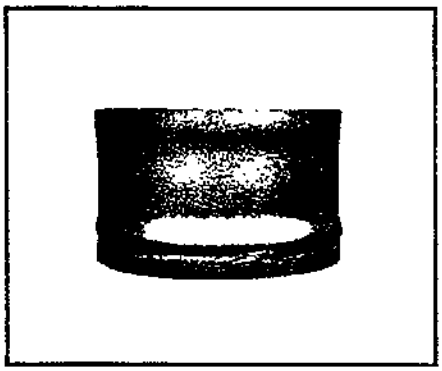
ROUND-TITE Coupling

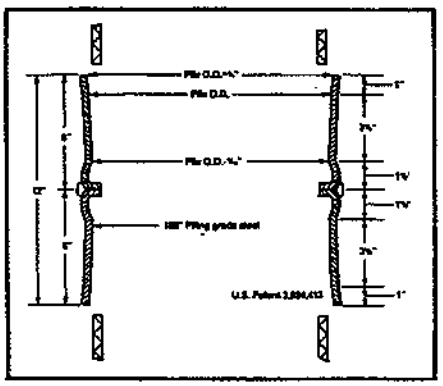
- Much longer than conventional couplers—has more bending resistance—piles drive straighter.
- Designed so that coupling, not the pile, is deformed slightly when two pile sections are driven together. Result: piles can be driven much harder without danger of telescoping.
- Creates a watertight joint. Tight fit results from slightly undersized sleeve being expanded as pile sections are driven together.

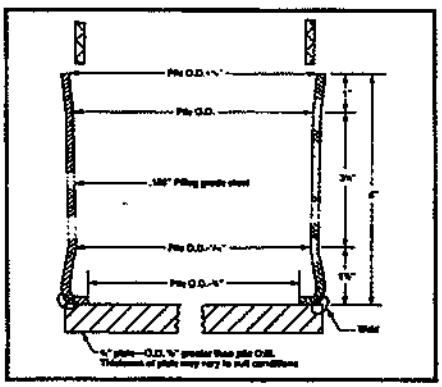
ROUND-TITE Boot

- Like the ROUND-TITE coupling, boot expands to create watertight fit on pile end.
- Eliminates shop and field welding; saves time in field, thus is more economical method of attaching bottom closure on pipe pile.
- Ideally suited for mandrel driving pipe piles as well as conventional method.





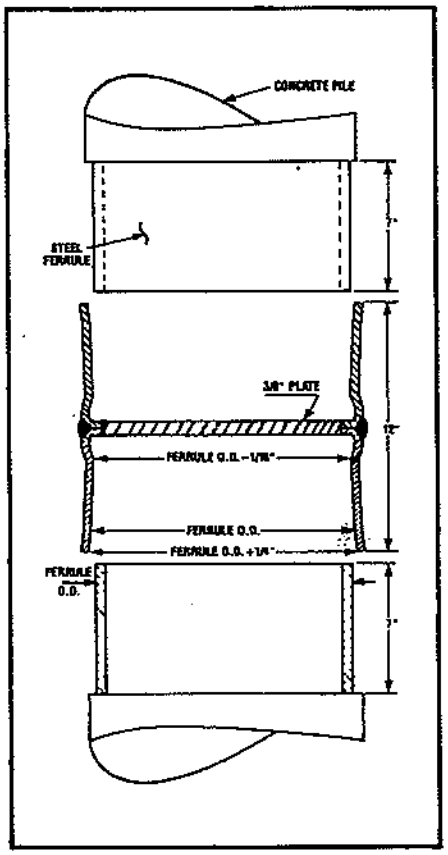




ROUND-TITE™ CONCRETE PILE COUPLINGS

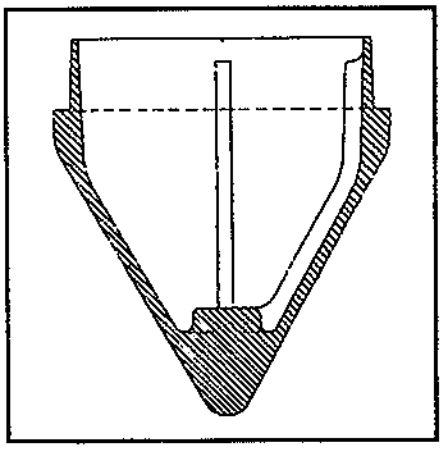
The ROUND-TITE coupling design is also available for use with concrete piles. During casting, the concrete pile is made with a steel ferrule on the end to be spliced. For multiple splices, ferrules are installed on both ends of the pile section. During driving, the coupling works exactly like the ROUND-TITE pipe coupling described on the previous page.

- No welding—in the shop or in the field.
- Attaches quickly and easily.
- Pile sections can be made in any length.
- Full strength coupling.
- Available in all regular pile sizes.

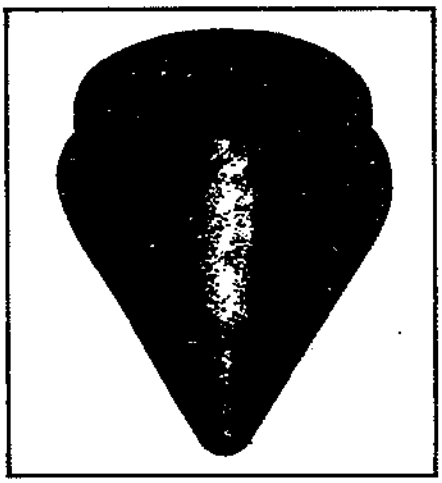


CONICAL POINTS FOR PIPE PILES

Where maximum pile bearing and minimum soil disturbance are required in addition to pile point protection, the ICE conical pipe pile point fills the bill.

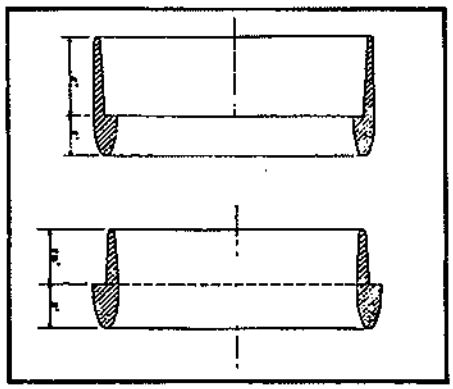


- Most dependable pile point protection. Distributes load over full circumference of pipe.
- Minimizes soil disturbance resulting in maximum friction bearing.
- Allows seating into rock without pile damage.
- Cast from tough alloy steel (ASTM A27 65/35).
- Driving force directed to flat ledge of shoe.
- Tapered lead allows quick, easy installation on pipe.
- Attach with friction fit or single, simple circumferential weld with a 5/16" fillet weld using a 70 series rod.



CUTTING SHOES FOR PIPE PILES

Cutting shoes are available for open-end piles, caissons and well pipes.

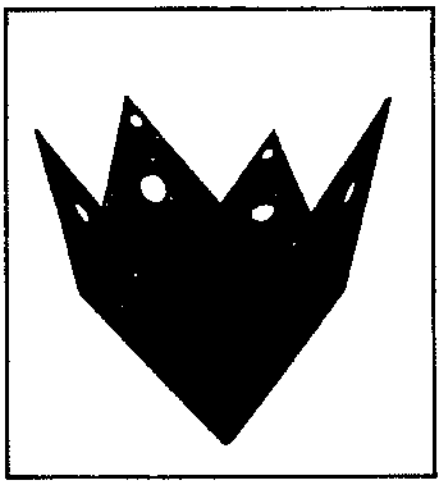


- Protects pile tip during driving.
- Allows seating into rock without pile damage.
- Cast from tough alloy steel (ASTM A148 90/60).
- Open end makes driving easier.
- Open end allows drilling below pile tip if required.
- Driving force directed to flat ledge of shoe.
- Tapered lead allows quick, easy installation on pipe.
- Attach with friction fit or single, simple circumferential weld with a 5/16" fillet weld using a 70 series rod.

TIMBER PILE POINTS

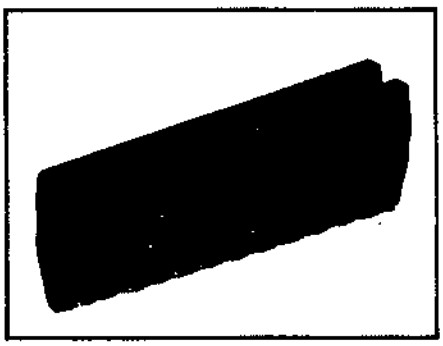
If soil data indicates possible pile damage due to obstructions or a stiff layer which must be penetrated, ICE timber pile points provide the required assurance that the pile will reach required bearing in good condition.

- Prevents pile splitting and brooming.
- Quick and easy to attach.
- Available for all timber pile sizes.
- Made of ASTM A-36 steel plate.



SHEET PILING PROTECTORS

ICE cast steel sheet pile edge protectors help insure pile penetration and at the same time provide significant protection for the leading edge of the pile.



- Edge fluting aids in keeping pile vertical while driving.
- Wedge shape opens slot to ease driving and reduces abrasion of pile coatings.
- Strong cast steel shoe protects pile edge from damage (ASTM A148 80/40).
- May be installed with tack-weld or drive fit.

OTHER ICE FOUNDATION CONSTRUCTION EQUIPMENT & PRODUCTS FOR SALE AND RENTAL

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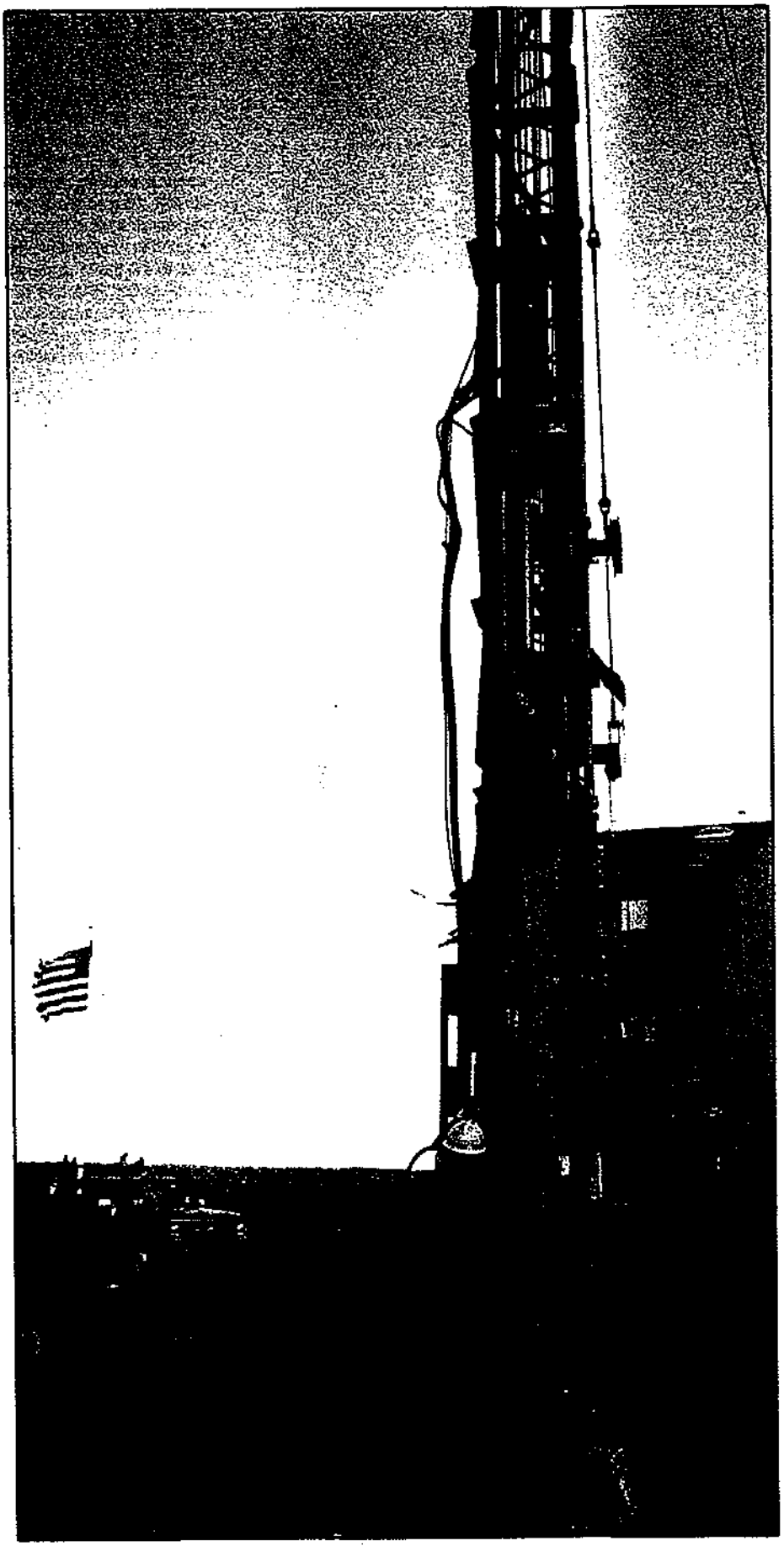
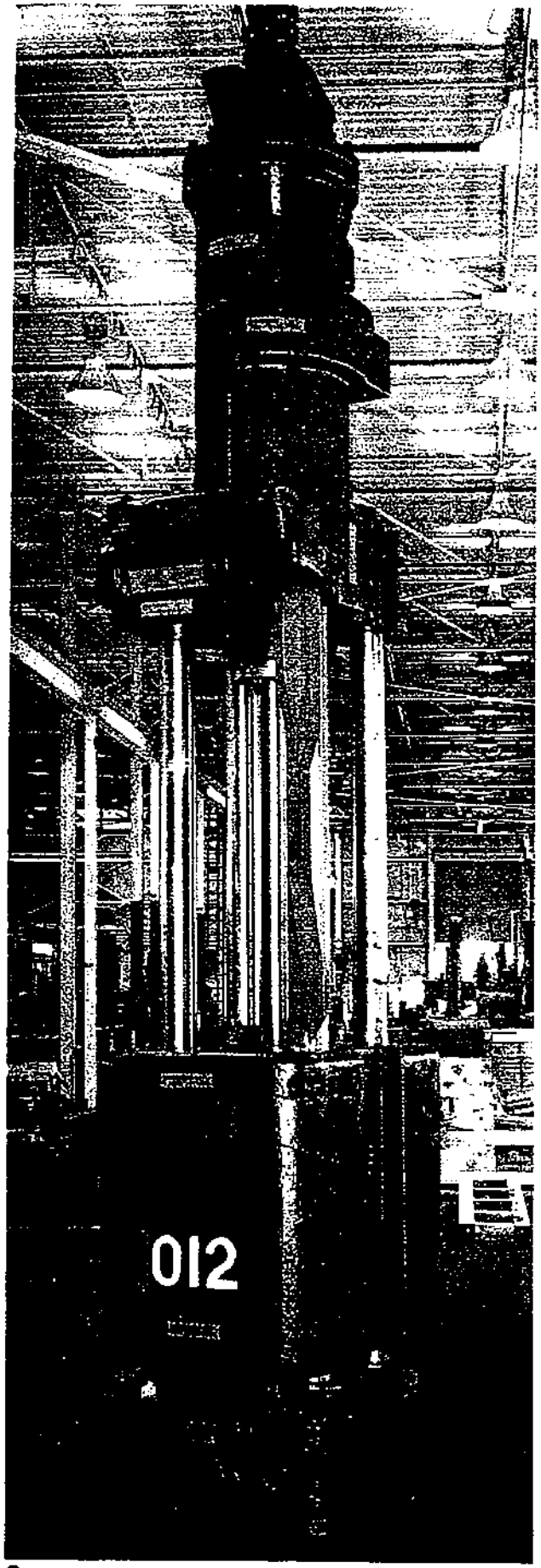


Specifications for Onshore Pile Hammers



INTRODUCTION

In 1887 Vulcan Iron Works manufactured and sold the first #1 hammer, the beginning of a long line of single-acting air/steam hammers. A half century later the first differential-acting hammer was produced, thus greatly adding to the versatility and range of the Vulcan open-style hammer line. Today the Vulcan air/steam driven pile hammers represent a century of development, refinement, and improvement while still adhering to the basic concept of a hammer that is simple to operate, service, and use, and that is basically free of persistent breakdown thus avoiding expensive and embarrassing delays. The result of all this is the long standing reputation of the Vulcan air/steam hammer for reliability and pile driving capability. In addition to the characteristics of the hammer itself, the owner is backed by a system of stocking and servicing dealerships to meet the needs of the contractor whenever and wherever needed.

There are basically two types of Vulcan air/steam hammers which are as follows:

1) Single Acting Hammers: These rely on gravity acting on the striking weight through a distance to achieve their striking energy. These are by far the more commonly used type of hammer. There are sixteen sizes available, from the original #1 with a rated striking energy of 15,000 ft-lbs (20.3kJ) to the 530 pile hammer which has a rated striking energy of 150,000 ft-lbs (203.4).

2) Differential Acting Hammers: These hammers use the steam or air pressure acting on the piston in addition to gravity to achieve their striking energy. Their striking energy is given by the formula:

$$E_r=(W_s + A_{sp}p_i)s$$

where E_r= rated striking energy, ft-lbs
W_s= weight of striking parts, lbs
A_{sp}= area of small piston, sq. in.
P_i= rated operating pressure at the hammer, psi
s= hammer stroke, ft.

These are available on special order; consult the factory for specifications.

Pile ranging up to 34" (864mm) diameter may be driven within the limits of the series of air/steam hammers. The specifications showing this and other data are given on pages 4 and 5. The operating principles of the hammers are shown on the opposite page. Special features of the hammers, including the new cable tie feature which allows the advantage of eliminating column keys without changing leaders, are shown on page 6. The complete set of driving accessories for the hammers, essential to any pile driving operation, are shown on page 7.

WARRANTY

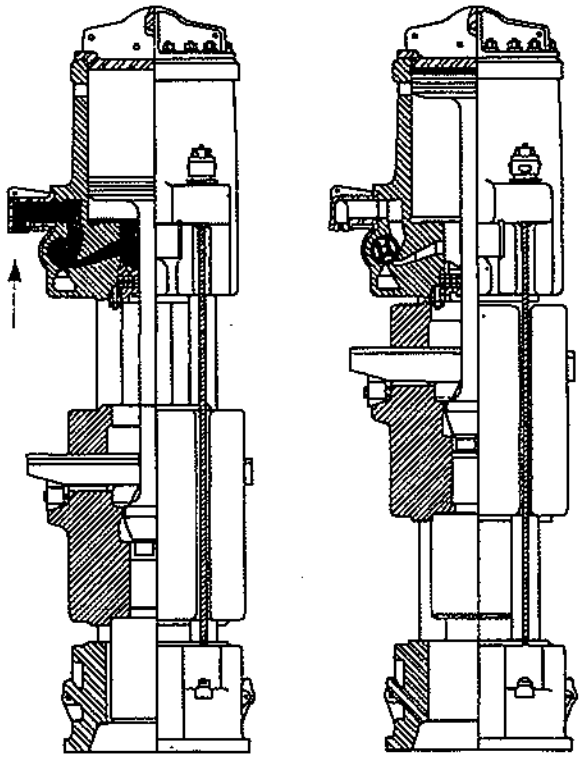
Vulcan Iron Works Inc. warrants these products to be in accordance with our published specifications or those specifications agreed to by Vulcan in writing at the time of the sale. Vulcan makes no other warranty, express or implied. THE IMPLIED WARRANTIES OF MERCHANTABILITY AND OF FITNESS FOR ANY PARTICULAR PURPOSE ARE EXCLUDED FROM THIS WARRANTY. Our obligation and liability under this warranty is expressly limited to repairing or replacing, at Vulcan's option, any product which fails to meet these specifications within 180 days from date of initial use, but not to exceed one year from date of delivery. This remedy is exclusive and Vulcan's obligation does not include any transportation charges or costs of installation or any liability from direct, indirect or consequential damage or delay. If requested by Vulcan, products or parts for which a warranty claim is made are to be returned transportation prepaid to Vulcan. Any improper use, operation beyond rated capacity as stated in the written specifications, substitution of parts not approved by Vulcan in writing, or any alteration or repair by anyone other than a duly authorized representative of Vulcan shall void this warranty.

OPERATION

SINGLE ACTING HAMMERS

The cycle begins at impact. The valve is rotated in such a way as to admit steam or air into the cylinder below the piston. This raises the ram, the ram upwardly accelerating as shown in view 1. This continues until the exhaust wedge on the slide bar actuates the trip and rotates the valve to close off the steam or air inlet and open the area of the cylinder below the piston to the atmosphere where the compressed air or steam is exhausted. The ram continues a free rise upward, decelerating with gravity until the top of the piston passes the relief ports and closes in the dashpot at the top of the cylinder. This trapped air, shown in view 2, compresses and brings the rising ram to a halt. The ram then makes a free drop to impact. Shortly before impact the intake wedge rotates the valve to admit steam or air to the cylinder and the cycle starts once again.

For strokes less than full, the Vari-Cycle is used. This provides an additional exhaust wedge and trip shifting so that the distance the ram accelerates upward is shorter and thus the stroke as well. In most cases the use of a shorter stroke will eliminate the dashpot compression and the ram simply comes to rest in gravity.

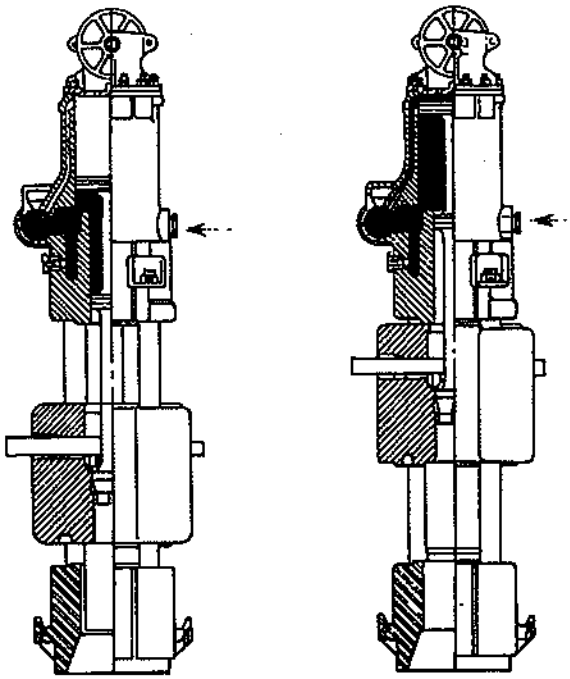


1 2

DIFFERENTIAL ACTING HAMMERS

The cycle begins at impact, the valve rotated so that the area above the large piston is open to the atmosphere and exhausting the compressed air or steam from the previous stroke, as shown in view 3. The area in the cylinder between the large and small pistons is always pressurized, and, as in the beginning of the cycle, when there is only atmospheric pressure on the top of the large piston, this creates an unbalanced force on the piston and the ram accelerates upward. As the ram moves upward the intake wedge actuates the trip, rotating the valve and admitting steam to the cylinder above the large piston as shown in view 4. This produces an unbalanced force downward on the ram, bringing the ram to a halt at the top of the stroke. The ram is then forced downward, gaining kinetic energy both from gravity and the downward acting steam or air force, to impact. Just before impact the exhaust wedge rotates the valve once again to exhaust the compressed air or steam above the large piston and the cycle starts once again.

For shorter strokes and lesser striking energies one need only reduce the pressure on the hammer. For the relation between lower operating pressure and reduced striking energy please consult your nearest Vulcan representative.



3 4

SPECIFICATIONS

OPERATING DATA	1	06	505	08	506	010
Rated Striking Energy, ft.-lbs.	15,000	19,500	25,000	26,000	32,500	32,500
kJ	20.3	26.4	33.9	35.3	44.1	44.1
Blows per Minute-Normal Stroke, No Set	60	60	46	50	46	50
Nominal Stroke, in.	36	36	60	39	60	39
mm	914	914	1524	991	1524	991
Rated Operating Pressure at Hammer, psi	80	100	100	83	120	105
bar	5.52	6.89	6.89	5.72	8.27	7.24
Steam Consumption, lb/hr	2,794	3,230	3,176	4,158	3,843	5,022
Kg/hr	1,267	1,465	1,441	1,886	1,743	2,278
Required Boiler Horsepower	81	94	92	125	112	150
Air Consumption (Adiabatic), cfm	565	625	563	880	744	1,002
m^3/min	16.0	17.7	15.9	24.9	21.06	28.4
Required Air Compressor Size, cfm	600	750	600	900	900	1,050
m^3/min	17.0	21.2	17.0	25.5	25.5	28.4
DIMENSIONAL DATA						
Bore, in.	13.5	13.5	13.5	16.5	13.5	16.5
mm	343	343	343	419	343	419
Net Area of Piston, sq. in.	133.51	133.51	133.51	197.92	133.51	197.92
cm^2	861.4	861.4	861.4	1276.9	861.4	1276.9
Length of Hammer (overall), ft.-in.	12'-9"	12'-9"	17'-5"	14'-10"	17'-5"	15'-7"
m	3.88	3.88	5.31	4.52	5.31	4.75
Distance Across Female Jaws, in.	20	20	20	26	20	26
mm	508	508	508	660	508	660
Width of Female Jaws, in.	8¼	8¼	8¼	9¼	8¼	9¼
mm	210	210	210	235	210	235
Largest Outside Diameter of Pile, in.	18	18	18	24	18	24
(Permitted by Standard Jaws) mm	457	457	457	610	457	610
Size of Hose, in.	2	2	2	2½	2	2½
mm	51	51	51	64	51	64
WEIGHT DATA						
Weight of Striking Parts, lb.	5,000	6,500	5,000	8,000	6,500	10,000
Kg.	2,268	2,948	2,268	3,629	2,948	4,536
Net Weight of Hammer, lb.	9,700	11,200	11,800	16,750	13,025	18,750
Kg.	4,400	5,080	5,352	7,598	5,908	8,505
Shipping Weight of Hammer, lb.	10,100	12,100	12,700	17,500	14,000	19,500
Kg.	4,581	5,488	5,761	7,938	6,350	8,845

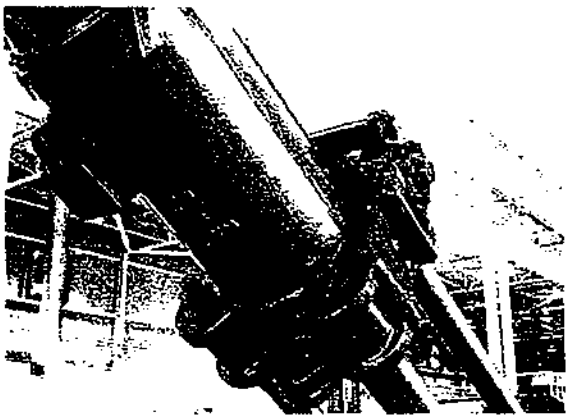
HAMMER SIZE

012	508	014	016	510	512	320	330	520	530
39,000 52.9	40,000 54.2	42,000 57.6	48,750 66.1	50,000 67.8	60,000 81.3	60,000 81.3	90,000 122.0	100,000 135.6	150,000 203.4
50	41	59	58	41	41	55	54	42	42
39 991	60 1524	36 914	36 914	60 1524	60 1524	36 914	36 914	60 1524	60 1524
125 8.62	65 4.48	110 7.58	120 8.27	83 5.72	100 6.89	102 7.04	150 10.34	102 7.04	150 10.34
5,835 2,647	4,542 2,060	6,111 2,772	6,814 3,091	5,480 2,486	5,940 2,694	6,200 2,812	8,280 3,756	7,160 3,248	8,680 4,391
175	150	200	210	160	200	200	250	250	300
1,075 30.4	818 23.2	1,161 32.9	1,275 36.1	932 26.4	1,094 31.0	1,432 35.3	1,795 50.8	1,652 46.8	2,076 58.8
1,200 34.0	900 25.5	1,300 36.8	1,300 36.8	1,050 29 7	1,200 34.0	1,600 45.3	2,000 56.6	2,000 56.6	2,400 68.0
16.5 419	16.5 419	19 483	19 483	16.5 419	16.5 419	21.75 552	21.75 552	21.75 552	21.75 552
197.92 1276.9	197.92 1276.9	255.26 1646.8	255.26 1646.8	197.92 1276.9	197.92 1276.9	335.75 2166.1	335.75 2166.1	335.75 2166.1	335.75 2166.1
15'-7" 4.75	18'-5" 5.61	13'-11" 4 24	13'-11" 4 24	18'-5" 5 61	18'-5" 5.61	17'-5½" 5 32	17'-5½" 5 32	21'-6" 6.55	21'-5½" 6 54
26 660	26 660	32 813	32 813	26 660	26 660	37 940	37 940	37 940	37 940
9¼ 235	9¼ 235	11¼ 286	11¼ 286	9¼ 235	9¼ 235	11¼ 286	11¼ 286	11¼ 286	11¼ 286
24 610	24 610	29 737	29 737	24 610	24 610	34 864	34 864	34 864	34 864
2½ 64	2½ 64	3 76	3 76	2½ 64	2½ 64	3 76.2	3 76.2	3 76.2	3 76.3
12,000 5,443	8,000 3,629	14,000 6,350	16,250 7,371	10,000 4,536	12,000 5,433	20,000 9,072	30,000 13,608	20,000 9,072	30,000 13,608
20,750 4,412	19,480 8,836	27,500 12,474	30,250 13,721	21,480 9,743	23,480 10,650	43,500 19,732	53,500 24,268	45,160 20,485	55,160 25,021
21,500 9,752	20,230 9,176	28,250 13,041	32,000 14,515	22,230 10,083	24,230 10,991	44,900 20,367	55,000 24,948	45,560 21,120	56,660 25,701

FEATURES

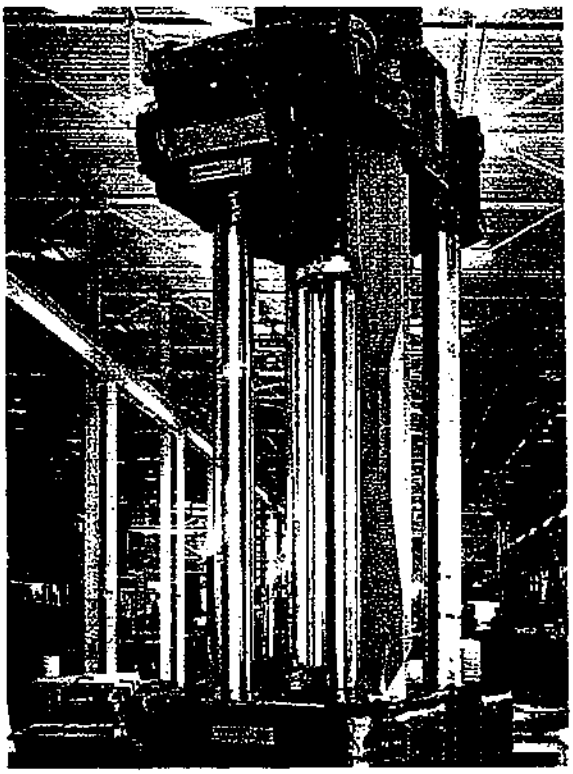
VARI-CYCLE (Single-Acting Hammers only)
As described previously (see "Operation") the Vari-Cycle provides an additional exhaust wedge and movable trip to give the user another available striking energy less than the full one. This trip is shifted from one wedge to another by means of a simple air cylinder attached to the main hammer cylinder. The availability of this lesser energy is almost essential when driving pile through soil where the resistance increases with the driven depth, which is generally the case. Any energy from one-third to full rated striking energy is available.

From all this the Vari-Cycle affords the contractor with a simple and reliable way of varying the energy of the hammer during driving.



CABLE TIES (All hammers)
All Vulcan onshore air/steam hammers are now furnished with cable ties to hold the cylinder, base, and columns together. These replace the column keys and as such they represent a major benefit to the contractor in terms of reduced maintenance. The cables are threaded through the columns and clamp the hammer together through the use of fittings, the cylinder end having a threaded fitting with a cable nut for simple tightening.

In the past adding cable ties has meant the necessity of widening the jaws on the hammer to accommodate them. With the Vulcan configuration this is eliminated and the hammer maintains its same clearance and leader configuration for both cable and keyed type hammers. The Vulcan design affords the best convenience and durability.



NYLON SLIDE BARS (All hammers)
An outgrowth from marine hammers, the nylon slide bar is now the standard slide bar for all Vulcan pile hammers. Made in one piece from a tough nylon, the slide bars are flexible to withstand whip, eliminate weld breakage, and afford the trip a more frictionless surface to slide on. In addition to being standard on new Vulcan hammers, the nylon slide bars may be used on used ones as well provided that the dovetail has been built up to its original configuration.

ACCESSORIES

Vulcan manufacturers a complete line of accessories to adapt its hammers to the driving of all normally used types of piling. The maximum size of pile that any given size of hammer is capable of driving is shown in the specifications of each hammer. Vulcan configures its accessories in such a way that all hammers with a common standard jaw size use the same accessory for a given pile. This adds to the versatility of Vulcan accessories and pile hammers alike.

Shown below are some of the type of accessories Vulcan manufactures for the different type pile:

(1) Pipe Caps: These are normally supplied with three steps, although more can be added or deleted upon request. They may be ordered without or with jaws, although in ordering any pipe cap it is necessary to specify the outside diameter and wall thickness of the pipe being driven.
(2) H-Beam Helmets: These are configured for all types of H-Beams supplied. In addition to the above with islands a flat face helmet is also supplied for greater versatility.
(3) Concrete Pile Driving Heads: These are sized for all sizes of standard concrete pile, whether square, round, or octagonal. The deep well in these accessories is to accommodate the pile cushion necessary to prevent spalling when driving concrete pile. If there is protruding reinforcing bar coming out of the top of the pile a pedestal driving head may be ordered, which makes from between the hammer and the pile for the re-bar.
(4) Wood Pile Driving Heads: These make the driving of wood pile as simple as that of concrete (without the pile cushion). eliminating McDermid bases and dished caps.
(5) Sheet Pile Helmets: These are available for all configurations of American and other sheet piling.

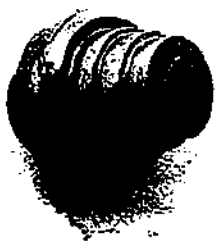
CUSHION MATERIAL

All Vulcan accessories are supplied with a well for cushion material. This is essential to avoid both hammer and pile damage, and moreover is now frequently used to improve the drivability of the pile by changing out cushion materials. There are two configurations of these wells which are as follows:

(A) Integral Ring and Pot: This is the preferred configuration, usable with the softer cushion materials.

(B) Capblock Follower w/Matching Accessory: This is used with harder cushion materials such as the Micarta & aluminum cushion combination.

Vulcan does not market or recommend any specific cushion material. However most hammer breakages can be attributed to cushion material that is either too hard to begin with or has been allowed to compact excessively thus making it that way.

1


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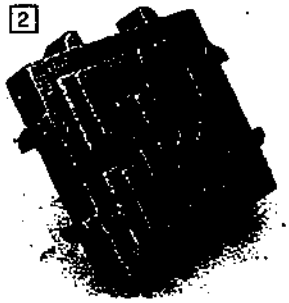

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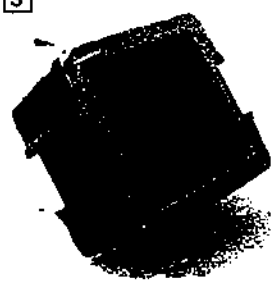

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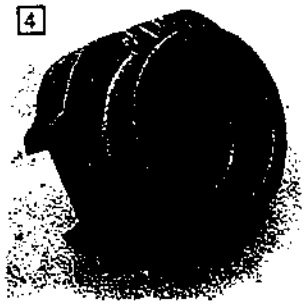

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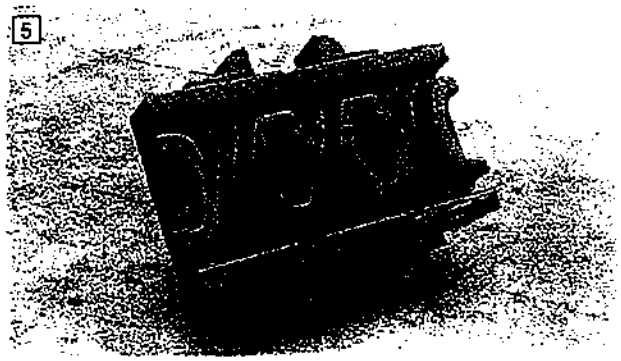

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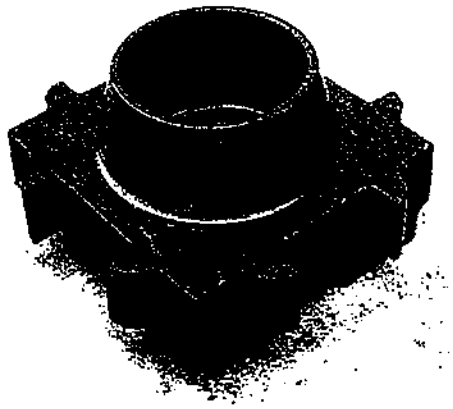

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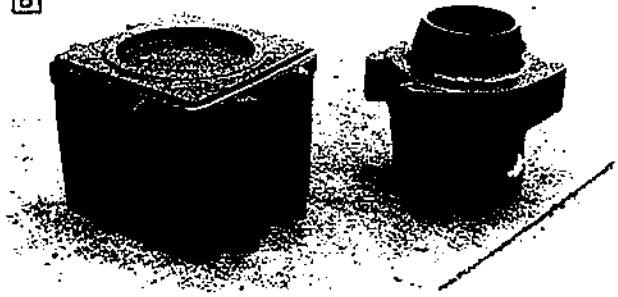


VULCAN AIR/STEAM HAMMERS

$$P = \frac{2WH}{S + 0.1}$$ REFUSAL SHALL BE BETWEEN 150 - 180 TONS

MODEL #	1	06	505	08	506	010	012
Wt. of RAM	5000	6500	5000	8000	6500	10000	12000
AVG. HT. OF FALL	3	3	5	3.25	5	3.25	3.25
BLOWS PER FOOT	BEARING IN TONS						
4	5	6	8	8	10	10	13
8	9	12	16	16	20	20	24
12	14	18	23	24	30	30	35
16	18	23	29	31	38	38	46
20	21	28	36	37	46	46	56
24	25	33	42	43	54	54	65
28	28	37	47	49	61	61	74
32	32	41	53	55	68	68	82
36	35	45	58	60	75	75	90
40	38	49	63	65	81	81	98
44	40	52	67	70	87	87	105
48	43	56	71	74	93	93	111
52	45	59	76	78	98	98	118
56	48	62	80	83	103	103	124
60	50	65	83	87	108	108	130
64	52	68	87	90	113	113	136
68	54	71	90	94	118	118	141
72	56	73	94	98	122	122	146
76	58	76	97	101	126	126	151
80	60	78	100	104	130	130	156
84	62	80	103	107	134	134	161
88	63	83	106	110	138	138	165
92	65	85	108	113	141	141	169
96	67	87	111	116	144	144	173
100	68	89	114	118	148	148	177
104	70	91	116	121	151	151	181
108	71	92	118	123	154	154	185
110	72	93	120	124	155	155	187
120	75	98	125	130	163	163	195
130	78	101	130	135	169	169	203
140	81	105	135	140	175	175	210
150	83	108	139	144	181	181	217
160	86	111	143	149	186	186	223
170	88	114	147	152	191	191	229
180	90	117	150	156	195	195	234
190	92	120	153	159	199	199	239
200	94	122	156	163	203	203	244
225	98	127	163	170	212	212	254
250	101	132	169	176	220	220	264
275	104	136	174	181	226	226	272
300	107	139	179	186	232	232	279
325	110	142	183	190	237	237	285
350	112	145	186	194	242	242	290
375	114	148	189	197	246	246	295
400	115	150	192	200	250	250	300
425	117	152	195	203	253	253	304
450	118	154	197	205	257	257	308
475	120	156	200	208	259	259	311
500	121	157	202	210	262	262	315
525	122	159	203	212	265	265	317

VULCAN AIR/STEAM HAMMERS

$$P = \frac{2WH}{S + 0.1}$$ REFUSAL SHALL BE BETWEEN 150 - 180 TONS

MODEL #	508	014	016	510	512	320	330
Wt. of RAM	8000	14000	16250	10000	12000	20000	30000
AVG. HT. OF FALL	5	3	3	5	5	3	3
BLOWS PER FOOT	BEARING IN TONS						
4	13	14	16	16	19	19	29
8	25	26	30	31	38	38	58
12	38	38	44	45	55	55	82
16	47	49	57	59	71	71	106
20	57	60	70	71	86	86	129
24	67	70	81	83	100	100	150
28	76	79	92	95	114	114	170
32	84	88	103	105	126	126	189
36	92	97	113	115	138	138	208
40	100	105	122	125	150	150	225
44	107	113	131	134	161	161	241
48	114	120	139	143	171	171	257
52	121	127	147	151	181	181	272
56	127	134	155	159	191	191	286
60	133	140	163	167	200	200	300
64	139	146	170	174	209	209	313
68	145	152	176	181	217	217	326
72	150	158	183	188	225	225	338
76	155	163	189	194	233	233	349
80	160	168	195	200	240	240	360
84	165	173	201	206	247	247	371
88	169	178	206	212	254	254	381
92	174	182	212	217	260	260	391
96	178	187	217	222	267	267	400
100	182	191	222	227	273	273	409
104	186	195	226	232	279	279	418
108	189	199	231	237	284	284	426
110	191	201	233	239	287	287	430
120	200	210	244	250	300	300	450
130	208	218	254	260	312	312	468
140	215	226	263	269	323	323	485
150	222	233	271	278	333	333	500
160	228	240	279	286	343	343	514
170	234	246	286	293	352	352	528
180	240	252	293	300	360	360	540
190	245	257	299	306	368	368	552
200	250	263	305	313	375	375	563
225	261	274	318	326	391	391	587
250	270	284	329	338	405	405	608
275	278	292	339	348	418	418	627
300	286	300	348	357	429	429	643
325	292	307	356	365	438	438	657
350	298	313	363	372	447	447	670
375	303	318	369	379	455	455	682
400	308	323	375	385	462	462	692
425	312	328	380	390	468	468	702
450	316	332	385	395	474	474	711
475	319	335	389	399	479	479	718
500	323	339	393	403	484	484	726
525	326	342	397	407	488	488	733

VULCAN AIR/STEAM HAMMERS

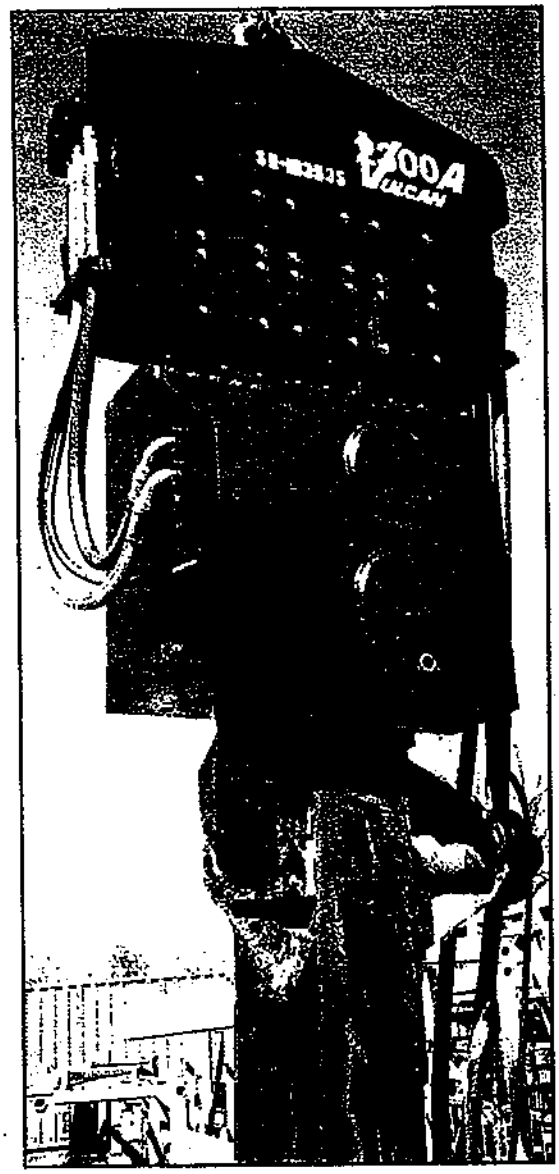
	P = 2WH / S + 0.1 REFUSAL SHALL BE BETWEEN 150 - 180 TONS						
MODEL #	1	08	505	09	508	010	012
Wt. of RAM	5000	6500	5000	8000	6500	10000	12000
	AVERAGE HEIGHT OF FALL (FT.)						
PENETRATION IN 10 BLOWS (INCHES)	3	3	5	3.25	5	3.25	3.25
	BEARING IN TONS						
2 1/2	43	56	71	74	93	93	111
2 7/16	44	57	73	76	95	95	113
2 3/8	44	58	74	77	96	96	116
2 5/16	45	59	75	78	98	98	118
2 1/4	46	60	77	80	100	100	120
2 3/16	47	61	78	82	102	102	122
2 1/8	48	62	80	83	104	104	125
2 1/16	49	64	82	85	106	106	127
2	50	65	83	87	108	108	130
1 15/16	51	66	85	89	111	111	133
1 7/8	52	68	87	90	113	113	136
1 13/16	53	69	89	92	116	116	139
1 3/4	55	71	91	95	118	118	142
1 11/16	56	73	93	97	121	121	145
1 5/8	57	74	95	99	124	124	149
1 9/16	59	76	98	101	127	127	152
1 1/2	60	78	100	104	130	130	156
1 7/16	62	80	103	107	133	133	160
1 3/8	63	82	105	109	137	137	164
1 5/16	65	84	108	112	141	141	169
1 1/4	67	87	111	116	144	144	173
1 3/16	69	89	114	119	149	149	178
1 1/8	71	92	118	122	153	153	184
1 1/16	73	95	121	126	158	158	189
1	75	98	125	130	163	163	195
15/16	77	101	129	134	168	168	201
7/8	80	104	133	139	173	173	208
13/16	83	108	138	143	179	179	215
3/4	86	111	143	149	186	186	223
11/16	89	116	148	154	193	193	231
5/8	92	120	154	160	200	200	240
9/16	96	125	160	166	208	208	250
1/2	100	130	167	173	217	217	260
7/16	104	136	174	181	226	226	271
3/8	109	142	182	189	236	236	284
5/16	114	149	190	198	248	248	297
1/4	120	156	200	208	260	260	312
3/16	126	164	211	219	274	274	328
1/8	133	173	222	231	289	289	347
1/16	141	184	235	245	306	306	367
0	150	195	250	260	325	325	390

VULCAN AIR/STEAM DIESEL HAMMERS

	P = 2 W H / S + 0.1 WEIGHT OF RAM = REFUSAL SHALL BE BETWEEN 150 - 180 TONS						
MODEL #	508	014	016	510	512	320	330
Wt. of RAM	8000	14000	16250	10000	12000	20000	30000
	AVERAGE HEIGHT OF FALL (FT.)						
PENETRATION IN 10 BLOWS (INCHES)	5	3	3	5	5	3	5
	BEARING IN TONS						
2 1/2	114	120	139	143	171	171	429
2 7/16	116	122	142	145	175	175	436
2 3/8	119	124	144	148	178	178	444
2 5/16	121	127	147	151	181	181	453
2 1/4	123	129	150	154	185	185	462
2 3/16	125	132	153	157	188	188	471
2 1/8	128	134	156	160	192	192	480
2 1/16	131	137	159	163	196	196	490
2	133	140	163	167	200	200	500
1 15/16	136	143	166	170	204	204	511
1 7/8	139	146	170	174	209	209	522
1 13/16	142	149	173	178	213	213	533
1 3/4	145	153	177	182	218	218	545
1 11/16	149	156	181	186	223	223	558
1 5/8	152	160	186	190	229	229	571
1 9/16	156	164	190	195	234	234	585
1 1/2	160	168	195	200	240	240	600
1 7/16	164	172	200	205	246	246	615
1 3/8	168	177	205	211	253	253	632
1 5/16	173	182	211	216	259	259	649
1 1/4	178	187	217	222	267	267	667
1 3/16	183	192	223	229	274	274	686
1 1/8	188	198	229	235	282	282	706
1 1/16	194	204	236	242	291	291	727
1	200	210	244	250	300	300	750
15/16	206	217	252	258	310	310	774
7/8	213	224	260	267	320	320	800
13/16	221	232	269	276	331	331	828
3/4	229	240	279	286	343	343	857
11/16	237	249	289	296	356	356	889
5/8	246	258	300	308	369	369	923
9/16	256	269	312	320	384	384	960
1/2	267	280	325	333	400	400	1000
7/16	278	292	339	348	417	417	1043
3/8	291	305	355	364	436	436	1091
5/16	305	320	371	381	457	457	1143
1/4	320	336	390	400	480	480	1200
3/16	337	354	411	421	505	505	1263
1/8	356	373	433	444	533	533	1333
1/16	376	395	459	471	565	565	1412
0	400	420	488	500	600	600	1500

Since 1852

VULCAN IRON WORKS INC.



Specifications for Vibratory Pile Drivers/Extractors

Sizes 1150A, 2300A and 4600A

OVERVIEW OF FEATURES

Vulcan vibratory hammers continue a long tradition of simple but effective equipment to vibrate piling into the ground. (For an explanation of the operating principle, see back cover.) There are two main components of a Vulcan vibratory hammer system: the exciter, which produces the actual vibrating force, and the power pack, which provides the energy for the motor(s). on the hammer to turn the eccentrics. Both of these components are designed with a wide variety of features to make pile driving more productive for the customer; some of these are as follows:

Exciter

Simple gear and eccentric design includes teeth designed for quiet and reliable operation, additional lubrication of the bearings by the eccentrics, and easy replacement of individual components without having to replace entire assemblies of parts.

Suspension uses reliable and proven rubber springs for isolation of vibrations from the crane. Bias weight mounting is easy and unobtrusive. Crane connection through an anchor shackle which is both strong and replaceable if necessary.

Hoses are reduced to a minimum but are positioned for easy access if repair should be required.

Clamp is designed with integral cylinder for reliable operation and safety check valve in case of clamp hose cut (see back cover for other accessory information).

Power Pack

Hydraulic circuit design is simple and modern to reduce failure possibilities. Open loop hydraulics are simple to operate and service. Power packs are designed for maximum interchangeability and consistency of components.

Detroit Diesel engines are standard to provide for reliable operation and economical servicing. Pump and engine are matched so to eliminate gearbox pump drive and thus eliminate unnecessary power losses.

Controls are electric with remote control pendant connected to the power pack with a 30' (9140mm) long cord which is detachable at both ends for easy replacement. Power pack can be run from either the pendant or from the power pack itself. Like the hydraulics, the electric circuit design is simple for reliable operation and ready servicing.

ACCESSORIES AND SUPPORT

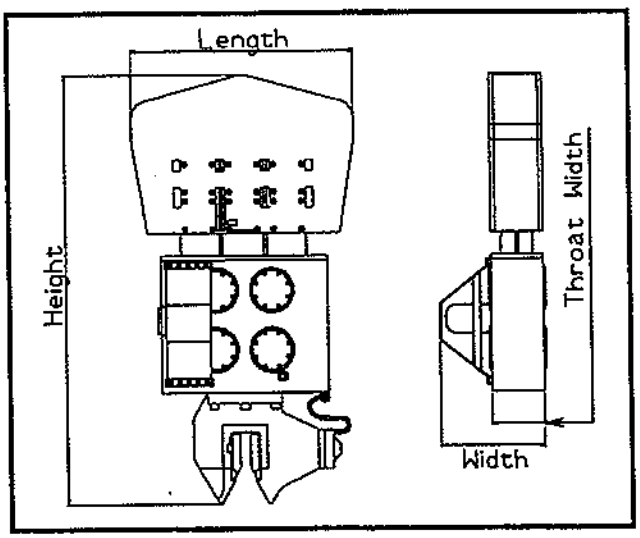
Vulcan produces a variety of accessories for its vibratory pile driving equipment. Some of these are as follows:

Sheeting Clamps: Vulcan produces two sizes of sheeting clamps; the 7" clamp, which is primarily for the 1150A and 2300A, and the 10" clamp, which is for the 4600A. The size refers to the bore of the clamp cylinder. Both of these clamps are simple and light weight for maximum performance. Sheeting clamps are also used with H-Beams as well as sheet piles, and a variety of jaws can be furnished for special applications.

Caisson Beams and Clamps: Vulcan manufactures caisson beams for the installation of caissons, along with a clamp that is both simple and reliable. The clamps can be moved and locked onto the beams and are infinitely adjustable for the various sizes of caissons. The beams are rugged and rigid to prevent breakage and excessive flexing.

Wood Clamps: We can furnish clamps for wood pile driving and extracting.

Field Service and Parts -- Vulcan maintains a qualified field service staff for worldwide service and support of Vulcan pile driving equipment. Vulcan also maintains a large inventory of spare parts for all vibratory hammers.



SPECIFICATIONS

		Hammer Size		
		1150A	2300A	4600A
Exciter				
Dynamic Force	U.S. Tons	41.8	83.6	167.2
	kN	*371.9*	*743.7*	*1487.5*
Frequency	RPM	1200-1600	1200-1600	1200-1600
	Hz	*20-26.7*	*20-26.7*	*20-26.7*
Sheeting Clamp Bore	in.	7	7	10
	mm	*178*	*178*	*254*
Maximum Clamp Pressure	psi	2500	5000	4500
	bar	*172*	*345*	*310*
Clamp Force	U.S. Tons	48	87	177
	kN	*427*	*774*	*1575*
Maximum Crane Pull	U.S. Tons	32	48	80
	kN	*285*	*427*	*712*
Dynamic Weight (w/o clamp)	lbs.	2950	4200	6400
	kg.	*1338*	*1905*	*2903*
Sheeting Clamp Weight	lbs.	1350	1350	3000
	kg.	*612*	*612*	*1361*
Static Weight	lbs.	2000	3000	5600
	kg.	*907*	*1361*	*2540*
Free Hanging Amplitude	in.	1/2"-3/4"	3/4"-1 1/8"	1"-1 3/8"
	mm	*13-19*	*19-29*	*25-35*
Total Suspended Weight	lbs.	6300	8550	16000
	kg.	*2858*	*3878*	*7257*
Length (see left)	in.	60	60	87
	mm	*1524*	*1524*	*2210*
Width (see left)	in.	24 1/2	28	28
	mm	*622*	*711*	*711*
Throat Width (see left)	in.	14	14	14
	mm	*356*	*356*	*356*
Height (see left)	in.	95	115½	134
	mm	*2413*	*2994*	*3404*
Power Pack				
Engine		Detroit Diesel 4-71N	Detroit Diesel 6V92-T	Detroit Diesel 12V-92TA
Maximum Engine Power	HP	155	305	625
	kW	*116*	*227*	*466*
Engine Speed @ Max. Power	RPM	2100	2100	2100
Maximum Drive Pressure	psi	2500	5000	5000
	bar	*172*	*345*	*345*
Weight	lbs.	7,500	11,000	16,500
	kg	*3402*	*4990*	*7484*
Length	in.	120	120	186
	mm	*3048*	*3048*	*4724*
Width	in.	72	72	72
	mm	*1829*	*1829*	*1829*
Height	in.	65	69	96
	mm	*1651*	*1753*	*2438*

OPERATING PRINCIPLE

Vulcan vibratory hammers move piling in soil by applying a rapidly alternating force to the pile by rotating eccentric weights about horizontal shafts. Each eccentric produces centrifugal, dynamic force acting in a single plane and directed toward the centerline of the shaft. The weights are mounted on timing gears, off center of the axis of rotation by the eccentric arm. The eccentrics are paired so the horizontal forces cancel each other, leaving us with only vertical force for the pile. For this purpose the Vulcan 1150A has one pair of eccentrics, the 2300A four and the 4600A eight, and all components are identical for maximum parts interchangeability.

Dynamic Force Equation

$$F_{dyn}=(RPM)^2K/70{,}423{,}000$$

where Fdyn = dynamic force of eccentics, U.S. Tons
RPM = eccentric rotation speed, RPM
K = eccentric moment, in-lbs

$$F_{dyn} = (\pi\theta)^2K/250$$

where F_{dyn} = *dynamic force of eccentrics, kN*
θ = *frequency of vibrations, Hz*
K = eccentric moment, kg-m

This force moves the pile up and down; the length of this movement is called the amplitude.

Amplitude Equation

$$A = 2K/W_v$$

where A = Peak-to-Peak Amplitude, in.
W_v=Vibrating Weight, lbs.

$$A = 2K/M_v$$

where *A = Peak-to-peak Amplitude, m*
M_v = *Vibrating Mass, kg*

Once the alternating force is made by the rotating eccentrics, the soil around the pile is weakened and the pile/hammer system pushes itself into the ground by its own weight. This pushing action can be augmented by static bias weights which are mounted on the suspension; these are available from Vulcan.

WARRANTY

Vulcan Iron Works Inc. warrants these products to be in accordance with our published specifications or those specifications agreed to by Vulcan in writing at the time of sale. Vulcan makes no other warranty, express or implied. **THE IMPLIED WARRANTIES OF MERCHANTABILITY AND OF FITNESS FOR ANY PARTICULAR PURPOSE ARE EXCLUDED FROM THIS WARRANTY.** Our obligation and liability under this warranty is expressly limited to repairing or replacing, at Vulcan's option, any product which fails to meet these specifications within ninety (90) days from date of delivery. This remedy is *exclusive* and Vulcan's obligation does not include any transportation charges or cost of installation or any liability from direct, indirect, or consequential damage or delay. If requested by Vulcan, products or parts for which a warranty claim is made are to be returned transportation prepaid to Vulcan. Any improper use, operation beyond rated capacity as stated in the written specifications, substitution of parts not approved by Vulcan in writing, or any alteration or repair by anyone other than a duly authorized representative of Vulcan shall void this warranty.

Since 1852

VULCAN IRON WORKS INC.
2909 Riverside Drive
P.O. Box 5402
Chattanooga, TN 37406 U.S.A.
Telephone (615) 698-1581
Toll Free (800) 742-6637
Facsimile (615) 698-1587

Bulletin 300B -- 9 April, 1992

Specifications subject to change without notice.

Authorized Representative

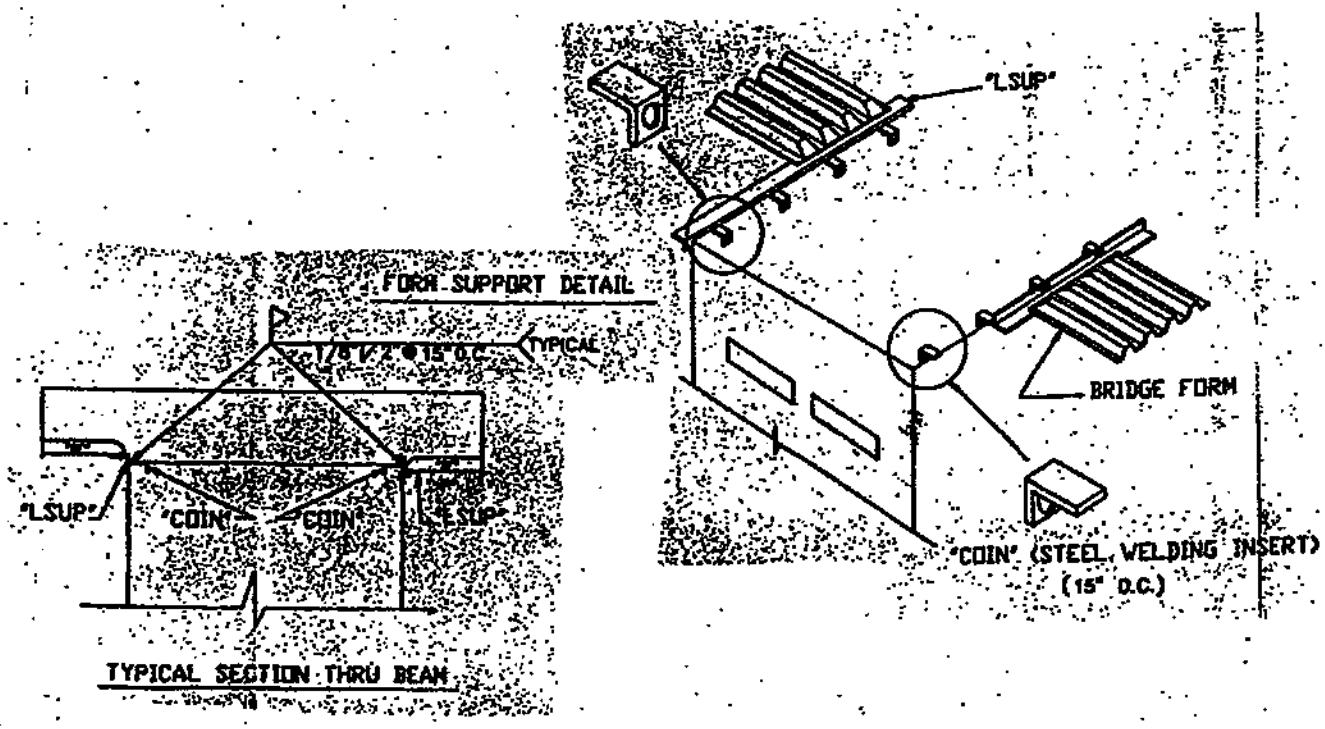
STAY-IN-PLACE METAL FORMS

Take "x-dimensions" as soon as possible. Stay-In-Place forms can not be adjusted. Must be right the first time.

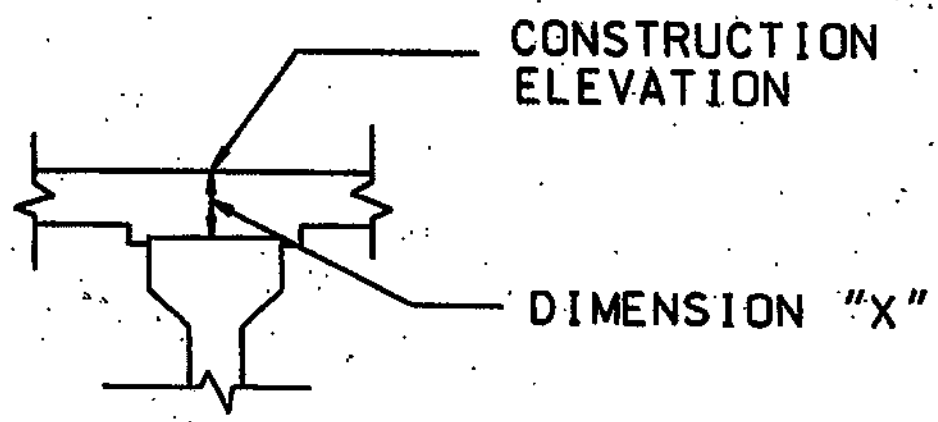
Shop Drawings for SIP Metal Forms no longer need to be approved by the Division of Bridge Design. Forward one copy to C.O. Construction.

Be careful about welds. Make sure the weld does not burn through the support angle.

The support angle can be turned either direction as shown in the drawing. Most shop drawings should show this.



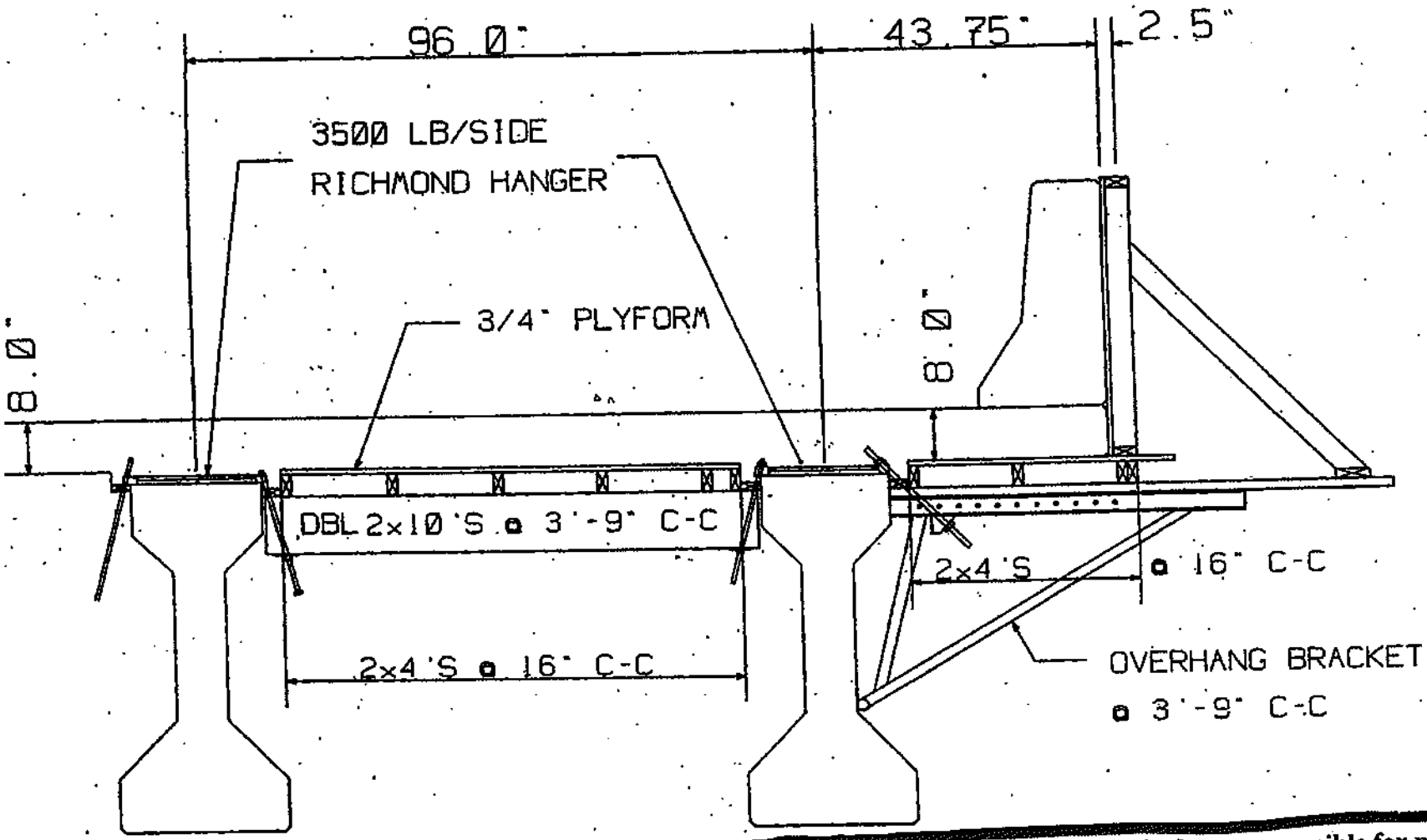
"X" DIMENSIONS



CONTRARY TO NOTES ON PLANS, TAKE "X" DIMENSIONS AS SOON AS POSSIBLE WHEN USING SIP METAL FORMS

LOOK FOR "X" DIMENSIONS BETWEEN 8" AND 10"

EXPECT "X" DIMENSIONS TO BE LESS AT MID-SPAN AND DEEPER CLOSE TO PIERS DUE TO BEAM CAMBER. IF "X" DIMENSION IS DEEPER AT MID-SPAN, NEED TO DOUBLE CHECK PLANS FOR VERTICAL CURVE, SUPER-ELEVATION, ETC.



NOTE: TIE TOPS OF BEAMS
TO PREVENT ROTA
OF EXTERIOR BEA

Brackets shall be placed as low on the beam as possible for minimum deflection. All brackets shall be installed with the same configuration.

For steel plate girders, there is a concern that the contact with the web of the girder will cause buckling. This part of the bracket shall not be a button or bolt head and must be spread over an area. Also this point of contact shall be near the bottom of the web – on the weld if possible.

DWG. # 23132
DECKFORMING PLANS

FD 04-118
DRAWING NUMBER 23132
DECK FALSEWORK

P.E. 5403
2/15/95
9/16/94 LETTING

BEAM SPACING------ 96 INCHES
FLANGE WIDTH------ 20 INCHES
CLEAR DISTANCE---- 76 INCHES
SLAB THICKNESS---- 8 INCHES

CANTILEVER---------- 43.75 INCHES
CLEAR CANTILEVER----- 33.75 INCHES
CANTILEVER THICKNESS-- 8 INCHES

----------LOADS----------

SLAB LOAD---------- =(8 /12)(160)= 106.6667 P.S.F.
CANTILEVER SLAB LOAD-- =(8 /12)(160)= 106.6667 P.S.F.
LIVE LOAD---------- = 50 P.S.F.
SCREED LOAD---------- = 800 LBS.
TWO SPAN CONTINUOUS LOADING FACTOR = 1.25

----------CHECK OVERHANG BRACKETS----------

SPACE BRACKETS AT 3.75 FT.
UNIFORM LOAD=(1.25)(106.6667 + 50)(3.75)(33.75 /12)= 2065.43 LBS.
ACTING AT 33.75 /2= 16.875 INCHES FROM EDGE OF FLANGE
SCREED LOAD = 800 LBS.
ACTING AT 33.75 +2.5 = 36.25 INCHES FROM EDGE OF FLANGE
TOTAL BRACKET LOAD= 2065.43 + 800 = 2865.43 LBS.
ACTING AT (2065.43 X 16.875 + 800 X 36.25)/ 2865.43 = 22.28431
USE OVERHANG BRACKET WITH A RATED CAPACITY OF 2865.43 LBS. AT 22.28431 IN. FROM EDGE OF BEAM

----------CHECK WALES----------

USE DBL. 2 X 10 'S AT 3.75 FT.
DESIGN SPAN LENGTH L= 76 IN.
W=(1.25)(106.6667 + 50)(3.75)/12= 61.19792 LBS./IN.
M=W X L X L /8=(61.19792)(76)(76)/8= 44184.9 IN-LBS
H=.75(W X (L-2D)/2bd => => =>
=> =>H=.75(61.19792)(76 -(2 X 9.25))/2(1.5)(9.25)= 95.10488 PSI
FOR DBL. 2 X 10 'S ALLOWABLE MOMENT= 68450 IN-LBS
ALLOWABLE HORIZ. SHEAR= 125 PSI

----------CHECK TIE RODS----------

IN OVERHANG BRACKETS R= 2865.43 /COS(45)= 4052.942 LBS.
IN WALES R=(61.19792)(76)/2= 2325.521 LBS.
USE .5 IN. DIAMETER 6000 LB. CAPACITY RODS IN OVERHANG
USE 1/2 IN. DIAMETER 6000 LB. CAPACITY RODS WITH WALES

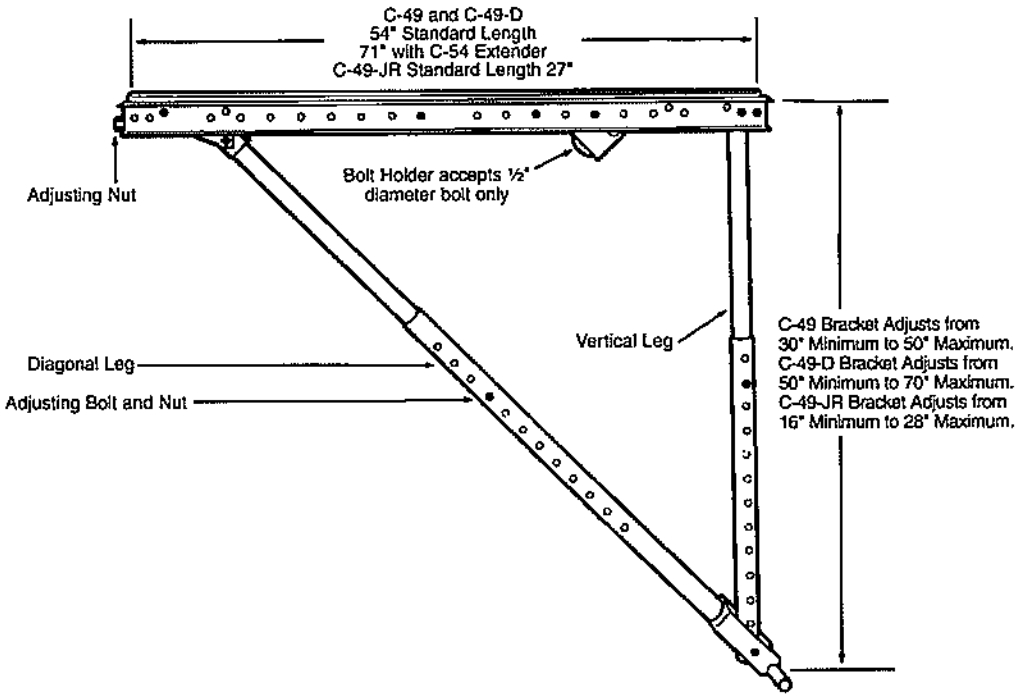
----------CHECK 2 X 4'S----------

SPAN LENGTH = 41.5 INCHES
IN CANTILEVER USE 16 INCH SPACING
W=(16 /12)(106.6667 + 50)/12= 17.40741 LBS/IN
M=(17.40741)(41.5)(41.5)/8= 3747.489 IN-LBS
H=(.75)(17.40741)(41.5 -(2 x 3.5))/(1.5)(3.5)= 85.79365 PSI
IN BETWEEN BEAMS USE 16 INCH SPACING
W=(16 /12)(106.6667 + 50)/12= 17.40741 LBS/IN
M=(17.40741)(41.5)(41.5)/8= 3747.489 IN-LBS
H=(.75)(17.40741)(41.5 -(2 X 3.5))/(1.5)(3.5)= 85.79365 PSI
FOR 2 X 4 'S ALLOWABLE MOMENT = 4900 IN-LBS.
ALLOWABLE HORIZ. SHEAR = 125 PSI

Bridge Overhang Brackets

DAYTON SUPERIOR

C-49, C-49-D and C-49-JR Bridge Overhang Brackets



Features:

Dayton Superior Bridge Overhang Brackets are designed with maximum adjustability to meet the varied overhang forming requirements on structural steel and precast/prestressed concrete beams. The C-49 and C-49-D Bridge Overhang Brackets accommodate an adjustment range of 30" to 70" and can be mounted to steel beams, precast concrete beams and concrete box beams with the appropriate hanger devices. Both of the bracket models can be easily and quickly preset on the ground and then set in place as needed.

The C-49-D Bridge Overhang Bracket has all of the features of the C-49 bracket but has longer vertical and diagonal legs. The longer legs, and resulting increase in adjustment, allow the bracket to be used on deep structural steel beams to position the construction load transfer near the beam's bottom flange.

Various accessories are available for the C-49 and C-49-D brackets. The Extender, Guardrail Receptacles and Wall Plate Assembly all add to the versatility of the Dayton Superior Bridge Overhang Brackets.

The C-49-JR Bridge Overhang Bracket is a small version of the C-49 bracket designed for use on smaller bridge beams. The C-49-JR has all the versatile design features of the bigger C-49 bracket and a vertical adjustment range of 16" to 28".

When requested, the C-49, C-49-D and C-49-JR brackets can both be shipped "knocked down" for ease in handling and shipping. Final assembly can be easily accomplished at the job site during the presetting operation.

Warning: Overhang brackets should be adjusted to proper grade during the normal "dry run" operation. DO NOT attempt an upward adjustment during the concrete pouring operation. Lowering the bracket adjustment is permissible during the concrete pour.

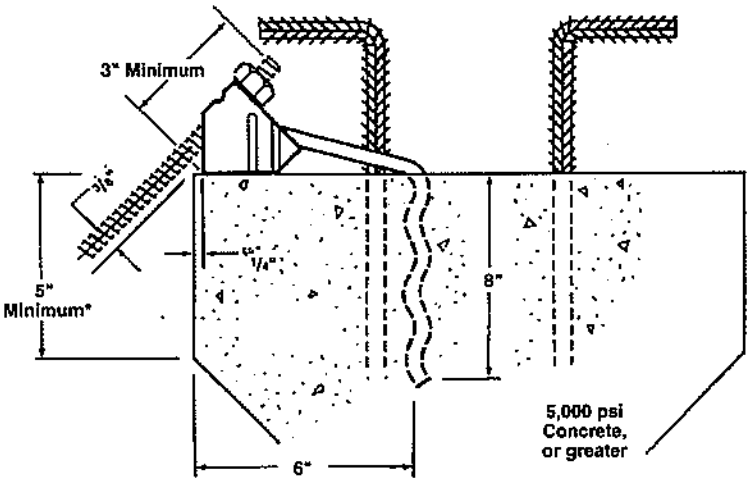
To Order:
Specify: (1) quantity, (2) name.

Example:
60 pcs. C-49 Bridge Overhang Brackets.

Exterior Hangers

DAYTON SUPERIOR

C-24 45° Pres-Steel Precast Half Hanger

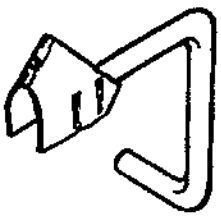


C-24 Type 4-AP

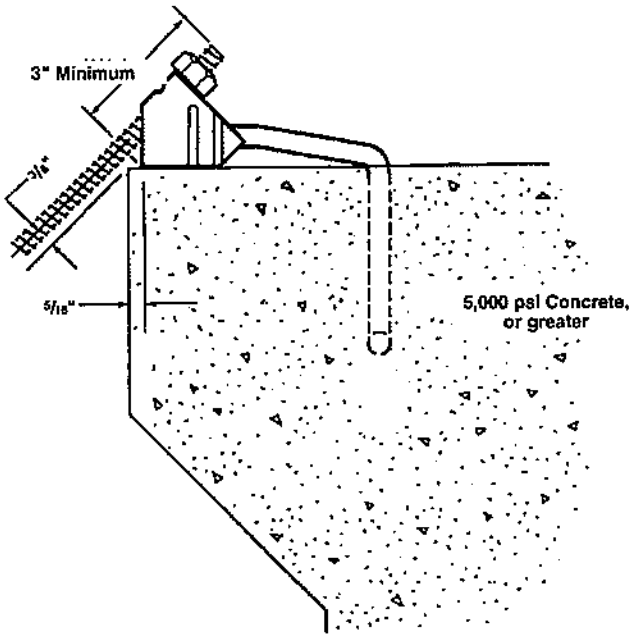
The C-24 45° Pres-Steel Precast Half Hangers are fabricated with a 45° 1/2" end section welded to a shaped strut. These units are designed to be cast into the top of a precast concrete beam and subsequently support the fascia overhang formwork. The C-24 45° precast half hanger is available in two styles.

C-24 45º Pres-Steel Precast Half Hanger		
Hanger Type	Safe Working Load	Bolt Diameter
4-AP	3,300 lbs.	1/2"
4-APR	6,000 lbs.*	1/2"
5-APR	6,000 lbs.*	3/4"

S.W.L. provides a factor of safety of approximately 2 to 1.



C-24 Type 4-APR
and
Type 5-APR



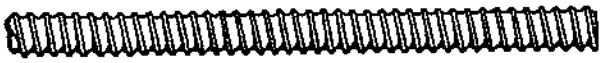
C-24 Type 4-APR
and
Type 5-APR

To Order:
Specify: (1) quantity, (2) name, (3) type.
Example:
400 C-24 45° Pres-Steel Precast Half Hanger, Type 4-APR.

Working Parts

DAYTON SUPERIOR

B-12 Continuous Coil Threaded Rod



The B-12 Continuous Coil Threaded Rod is manufactured from high strength steel and is available in precut lengths or in 10' or 12' lengths for field cutting. The B-12 rod can be used for form tying or hanging applications where various lengths of attachments are required.

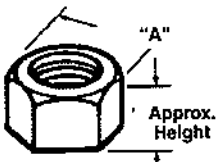
B-12 Continuous Coil Threaded Rod Selection Chart				
Coil Rod Diameter	Safe Working Load Tension (lbs.)	Minimum Area (sq. in.)	Minimum Coil Penetration	Stock Lengths
1/2"	9,000	.1385	2"	12'—0"
3/4"	18,000	.3079	2 1/4"	12'—0"

S.W.L. provides a factor of safety of approximately 2 to 1.

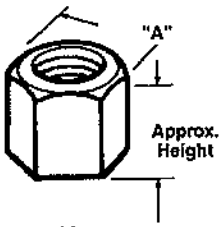
To Order:
Specify: (1) quantity, (2) strength designation, (3) diameter, (4) name, (5) length.

Example:
500 pcs. (6,000 ft.) 12M, 1/2" diameter B-12 Cont. Coil Threaded Rod x 12'-0" long.

B-13 Coil Nut and B-25 Heavy Coil Nut



B-13 Standard Coil Nut



B-25 Heavy Coil Nut

B-13 and B-25 Coil Nut Selection Chart					
Coil Nut Type	Dia.	Approx. Height	A Width Across Flats	Safe Working Load Tension (lbs.)	
				Using One B-13 Nut	Using Two B-13 Nuts or One B-25 Heavy Nut
B-13	1/2"	7/16"	3/4"	6,000	9,000
B-25	1/2"	1 3/16"	1 1/8"	—	9,000
B-13	3/4"	5/8"	1 1/8"	9,000	18,000
B-25	3/4"	1 3/16"	1 1/8"	—	18,000

S.W.L. provides a factor of safety of approximately 2 to 1.

The B-13 Coil Nut and B-25 Heavy Coil Nut are manufactured with coil thread and are used in conjunction with other coil threaded products to support bridge deck formwork.

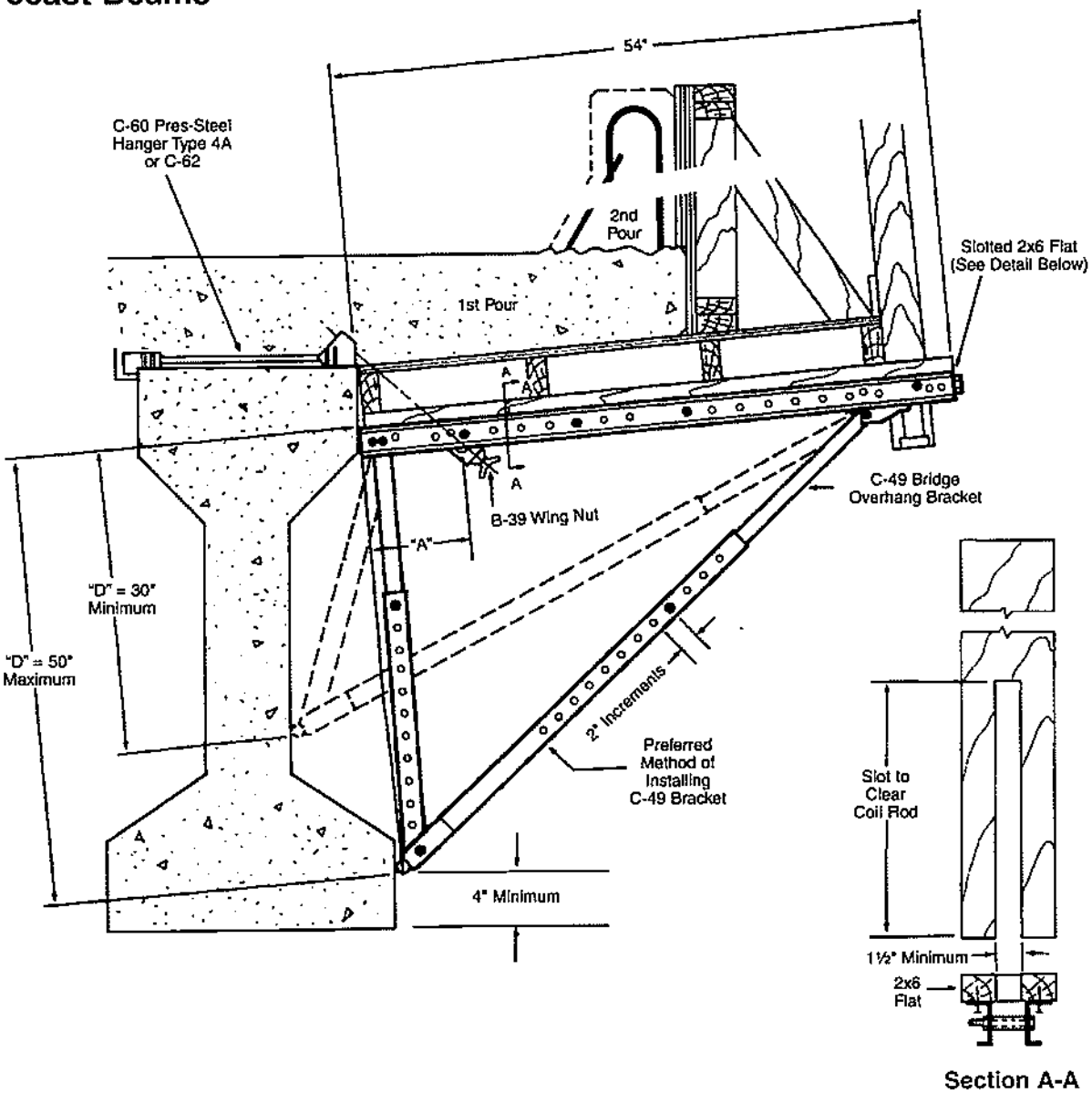
To Order:
Specify: (1) quantity, (2) name, (3) bolt diameter.

Example:
200 pcs. B-13 Coil Nut, 3/4".

Bridge Overhang Brackets

DAYTON SUPERIOR

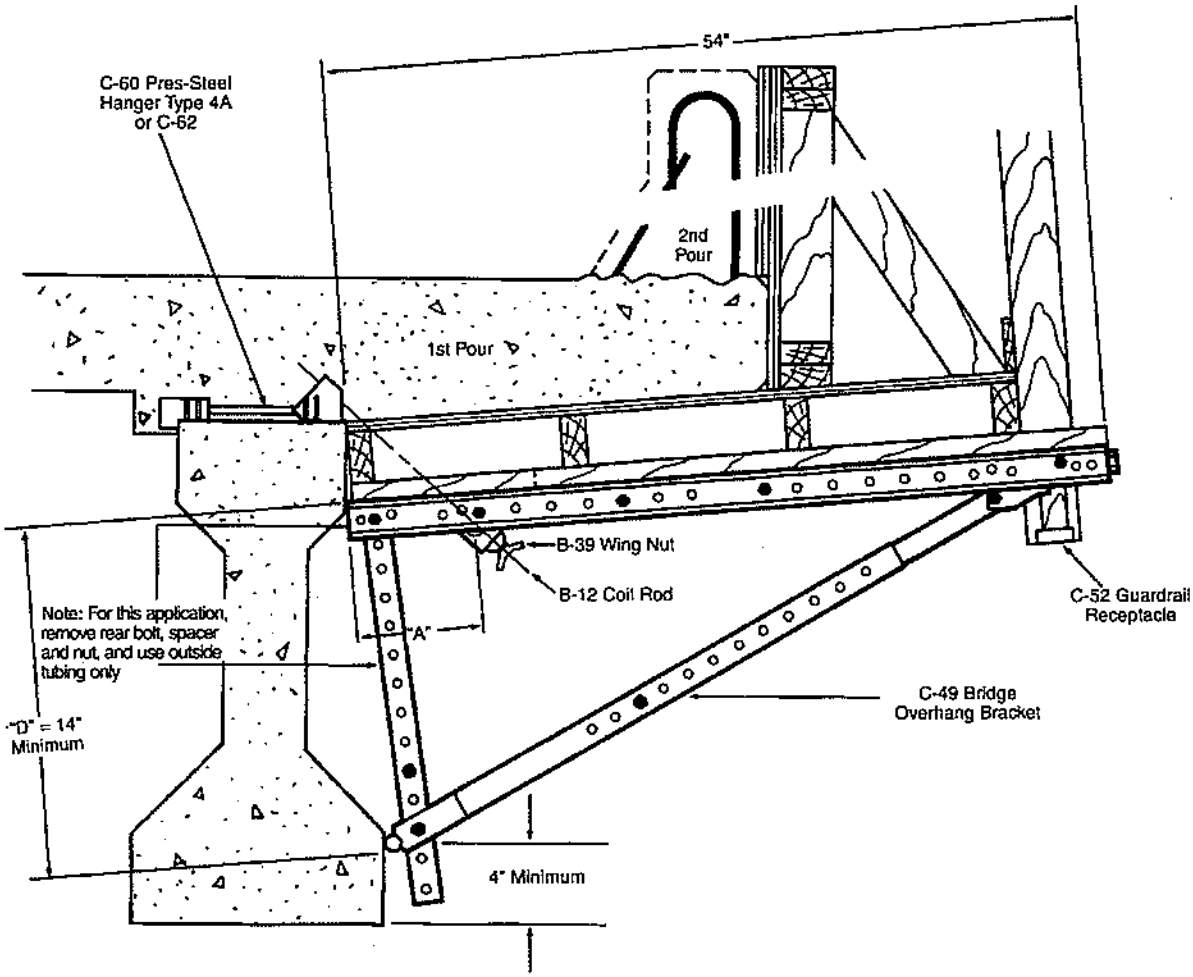
C-49 Bridge Overhang Bracket Used on AASHTO Type III or Larger Precast Beams



The C-49 bracket is very versatile and can be easily and quickly adjusted and configured to fit most types and sizes of precast/prestressed concrete bridge beams to support the required deck overhang formwork.

Bridge Overhang Brackets

C-49 Bridge Overhang Bracket Used on AASHTO Type II Precast Beams

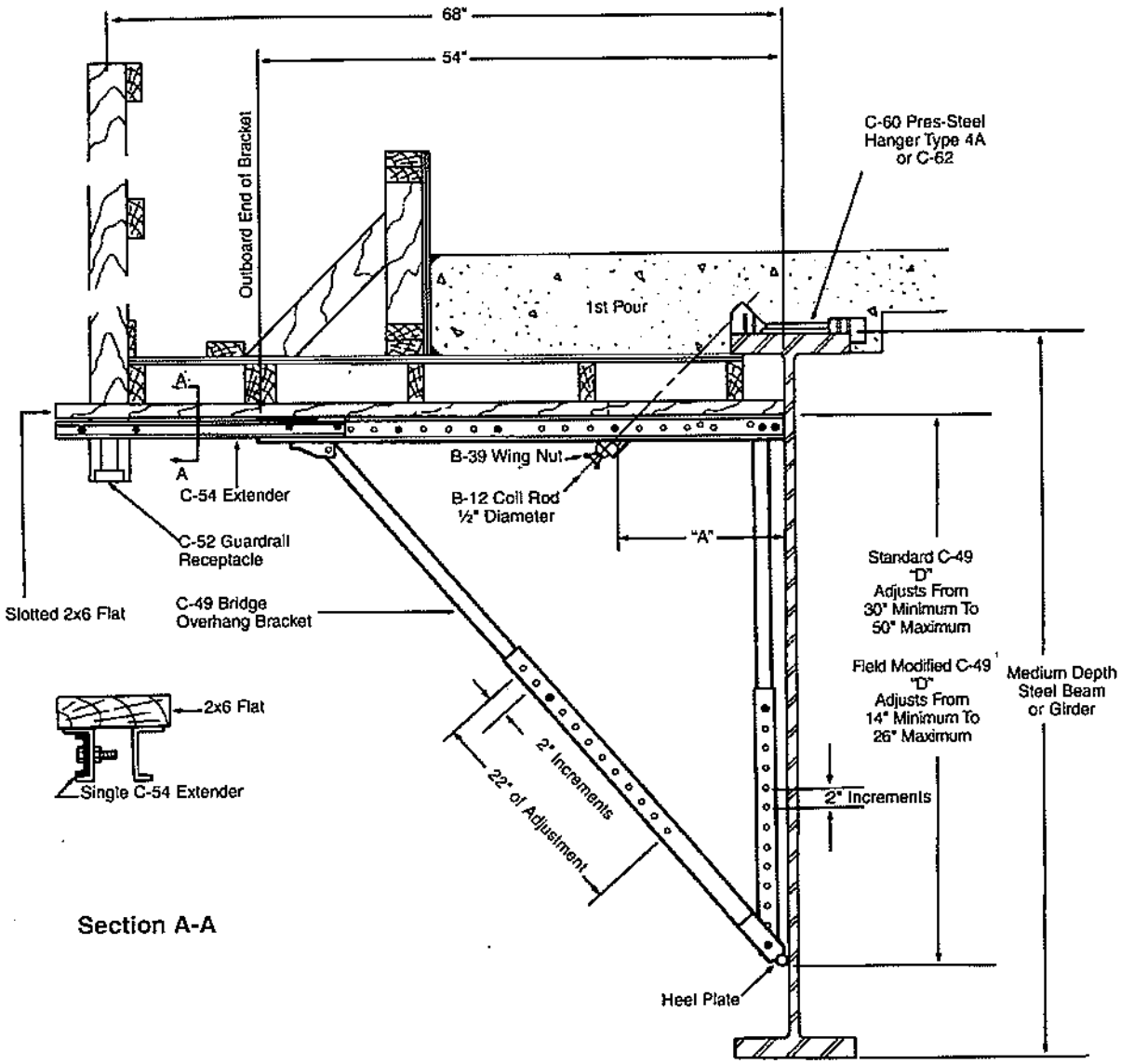


The C-49 bracket's versatility serves the smaller precast beams very well. By using only the outside tube of the vertical leg, the vertical height of the bracket can be reduced to a minimum of 14".

Bridge Overhang Brackets

DAYTON SUPERIOR

C-49 Bridge Overhang Bracket Used on Mid Depth Structural Steel



The vertical height of the C-49 bracket can be quickly and easily adjusted to transfer construction loads closer to the bottom flange. Moving the construction loads to the lower flange area reduces the twisting and bending tendency of the beam

General and Technical Information

Safety Notes and Product Application

Dayton Superior strives to ensure that all products supplied from its manufacturing plants meet or exceed the safety requirements inherent in the proper use of its products. However, the performance of a product can be greatly affected by the manner in which the product is used. It is imperative that the user be instructed in the proper installation and use of the products displayed in this handbook prior to job application.

Product production runs are constantly sampled and tested to assure the user a high standard of quality. Samples are tested in Dayton Superior test facility or at independent testing laboratories. The safe working loads listed in this handbook were determined from the results of the testing programs and other sources.

The safety factor to be applied to a particular product is a variable dependent on the degree of hazard or risk involved in the application of the product. Job site conditions can often increase the degree of risk. Concentrated loads, such as construction materials stacked on the formwork, unsymmetrical placement of concrete, uplift, impact of machine delivered concrete, use of motorized carts, and formwork height, are examples that produce high risk factors. The user must adjust the safety factors accordingly to accommodate these risks.

Dayton Superior publishes the safe working loads and the associated minimum safety factors of its products and strongly advises that the minimum safety factors displayed in the table below not be compromised. When there are unusual job conditions, such as mentioned above, the minimum safety factors must be increased by the user. Refer to the provisions of the American National Standards Institute (ANSI A 10.9), the Occupational Safety and Health Administration (OSHA) Act, Part 1910 and 1926 and the American Concrete Institute (ACI) *Recommended Practice for Concrete Formwork* (ACI 347) when considering product safety factors.

Minimum Safety Factors of Formwork Accessories

Accessory	Safety Factor	Type of Construction
Form Tie	2.0 to 1	All applications.
Form Anchor	2.0 to 1	Formwork supporting form weight and concrete pressures only.
Form Anchor	3.0 to 1	Formwork supporting form weight, concrete, construction live loads and impact.
Form Hangers	2.0 to 1	All applications.
Anchoring Inserts (Used as Form Ties)	2.0 to 1	Precast concrete panels when used as formwork

Dayton Superior Technical Services

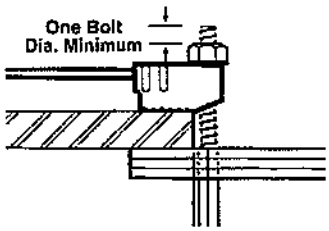
Dayton Superior maintains two strategically located technical service departments that are well staffed with trained personnel to service inquiries, take-offs and details for the users of Dayton Superior quality bridge deck accessories. See the back cover for addresses and phone numbers.

General and Technical Information

Safe Working Load Considerations

All safe working loads shown in this handbook were established with the following factors considered:

1. All safe working loads shown in this handbook are based on the item being new or in "as new" condition. The safe working load is considered to be the greatest load that should be applied to a product.
2. All hangers shall have full bearing under the end section and shall be used only on the size beam for which they are manufactured.
3. Hangers must be correctly positioned on top of the beam so that the Coil Bolts or Coil Rods are the proper distance from the edge of the beam flange. This is normally ⅜" from the beam flange to the centerline of a ½" Coil Bolt or Coil Rod. Improper positioning of the hanger can seriously compromise the hanger's safe working load. Refer to the various product application sketches in this handbook.
4. Coil Nuts must have full bearing on hanger end sections. Use caution to ensure that the hangers and related hardware are not subjected to side loading.
5. All Coil Bolts, Coil Rods and related hardware shall be of proper length, diameter and capacity.
6. All Coil Bolts and Coil Rods must fully penetrate and extend through the Coil Nuts a minimum of one diameter (½" for a ½" diameter Coil Bolt or Coil Rod). Note sketch.
7. A qualified person must calculate all hanger and bracket live and dead loads. Refer to American Concrete Institute ACI 347.
8. When hangers and related items are electro-plated or hot-dip zinc galvanized, they must be properly baked to relieve hydrogen embrittlement. Failure to do so may result in a drastic reduction of the product's safe working load.



9. Extreme caution must be used when field welding. Welding may reduce material integrity and result in product failure. Dayton Superior recommends the use of a certified welder with a good working knowledge of materials, heat treatment and welding procedures. Since Dayton Superior is not able to control field conditions or workmanship, Dayton Superior DOES NOT guarantee any product altered after leaving the factory.
10. Impact wrenches are not to be used to tighten Coil Bolts or Coil Rods that are part of the bridge deck forming system.

The user of Dayton Superior products must evaluate the product application, determine the appropriate safety factor, calculate the applied loads and control all field conditions to prevent application of loads in excess of the products' safe working loads.

Hanger Considerations When Suspending Overhang Brackets

Dayton Superior recommends that interlock type hangers, i.e., a C-60 Type 4-A Pres-Steel Hanger, be used to suspend bridge overhang brackets when a finishing machine is supported on the overhang formwork. The user shall install the overhang brackets, hangers and form materials in such a manner that the Coil Bolts or Coil Rods make a 45° ± 5° angle with the top surface of the bridge beam.

Qualified personnel must accurately calculate the hanger and overhang bracket spacing so that the applied load passing through the Coil Bolt or Coil Rod is equal to, or less than the safe working load of the hanger.

Interior span loads must be calculated to determine the proper hanger spacing. When calculating interior span loads, always add a minimum of 50 pounds per square foot live load to the dead weight of the concrete.

General and Technical Information

Safety Concerns

Incorrect use of hangers; insufficient bolt penetration through a coil nut; or altering a hanger in any way can result in premature failure and expose workers to unsafe conditions.

Reusable bridge deck forming accessories such as coil bolts, coil rods, etc., are subject to wear, misuse, overloading, corrosion, deformation, alteration and other factors that may affect safe working loads.

It is the responsibility of the user to continually inspect reusable accessories for wear and/or misuse and to discard them if wear or misuse is detected. Do not straighten bent forming accessories – discard them. Discard any reusable forming accessory that has been subjected to 70% or more of ultimate load of the product. Such items may have been stretched to a point where they have become brittle hard.

Dayton Superior recommends that all users of Dayton Superior deck forming products establish a quality control program to monitor and inspect their deck forming accessories. The frequency of inspections is best determined by the user and is dependent on the type of product use, frequency of use, duration of use and the environmental conditions during use.

The user of Dayton Superior products must evaluate the product application, determine appropriate safety factor, calculate the applied loads and control all field conditions to prevent application of loads in excess of the products' safe working loads.

Vertical Load for Design of Slab Forms

DESIGN LOAD — Based on 150 lbs. per Cubic Foot Concrete										
Slab Thickness, Inches	2	4	6	8	10	12	14	16	18	20
Pounds per Square Foot (See Note 1)	75	100	125	150	175	200	225	250	275	300
Pounds per Square Foot (See Note 2)	100	125	150	175	200	225	250	275	300	325

Note 1: Includes weight of concrete and reinforcing steel plus construction live load of 50 psf; weight of formwork not included.
Note 2: Includes weight of concrete and reinforcing steel plus construction live load of 75 psf; weight of formwork not included.

The American Concrete Institute publication, *Recommended Practice for Concrete Formwork*, (ACI 347) recommends that a minimum live load of 50 pounds per square foot (psf) be used in calculating formwork design loads. However, several states require higher live loads.

The American Concrete Institute publication, *Formwork for Concrete (ACI SP-4)* is a good reference for general formwork design, planning, materials, accessories, loading and pressure information, design tables and much more. Available from American Concrete Institute, P.O. Box 9094 Farmington Hills, MI 48333.

COMMONWEALTH OF KENTUCKY
TRANSPORTATION CABINET
FRANKFORT, KENTUCKY 40622

MILO D. BRYANT
SECRETARY
AND
COMMISSIONER OF HIGHWAYS

WALLACE G. WILKINSON
GOVERNOR

MEMORANDUM

TO: Bridge Construction Engineers

FROM: D. L. Gaines, P. E.
Trans. Engr. Br. Mgr.
Bridge Const. Branch

DATE: January 18, 1991

SUBJECT: Structural Steel
Fabrication Shop Inspections

Past fabrication problems have revealed a necessity for thoroughness in fabrication shop inspections.

We must get into the fine details for thoroughness of compliance with the plans, specifications and good fabrication practices. Routine inspections should be patterned after complete in-depth inspections but without documentation of all findings.

The following items are the minimum to be checked unless the trip is for sole purpose of addressing a specific problem.

1) Material Layout Area
   A. Check to see that inspector has received mill test reports and has checked them for compliance prior to use of material. Be sure that high strength bolts are included.
   B. Check several different flange and web plate heat numbers for traceability to the test report, piece mark, etc. This must be reliable for future reference. Be sure to check the charpy v-notch properties for compliance with plan requirements.
2) Check automatic submerged-arc welding (saw) against approved welding procedure. Check type of wire, and/or electrode, type of flux, speed of travel, joint preparation, voltage, preheating, post heating, etc.
3) Check to make sure all manual electrodes for SMAW and flux for submerged arc welds are being adequately dried in ovens per the specifications. The ovens must have thermometers!
4) Check fit-up of stiffeners, size of welds, surface finish of machined part, weld profiles, distortion of components, surface irregularities, bolt-hole patterns, etc. Ensure that there are no tack welds on any completed members. Check for indiscriminate arc strikes and be sure that blemishes and cracks from same are ground out. Check completed girders for sweep, and shear connector studs for weld quality. Ensure that camber and girder lay-down measurements are within tolerances.

- continued -

BRIDGE CONSTRUCTION ENGINEERS
Janurary 18, 1991
Page Two

5) A. Check blast cleaning for steel painting for compliance with the pictorial standards. Observe the inspector take paint thickness checks with proper gauge. Note that the required thickness is 3.0 mils (tolerance = +2 and - .5) for normal surfaces and 1.5 mils ± 0.5 mils on splice plates. The reduced thickness for connections of cross frames, diaphragms and wind bracing to gussets and stiffeners may be waived provided that connection is not slip critical.
   B. Check to see if shop and/or inspector has sling psycrometer, charts and thermometer for measuring dew point and steel temperature.
   C. Check to see if surface profile is being measured and recorded and added to minimum paint thickness or paint thickness gauge may be zeroed on blasted steel before paint is applied.
   D. Check for mud cracking of paint and coverage in difficult locations. (Back of stiffener snipe cuts, bolt holes, etc.)
   E. Check paint storage areas. Must be in heated building.
   F. Check for cleaning (with detergent) of all oil from steel before steel is wheel-brated and check compressed air used for cleaning off dust by blotter test for moisture and oil.
6) Check the inspector's credentials for non-destructive testing.
   A. Check our computer file to see if all inspector's qualifications are up to date, and that he has been approved for use on KY work by letter by this section. Each inspector must be an AWS CWI welding inspector and ASNT Level II qualified and certified non-destructive testing for MT and RT or MT and UT.
   B. Insure that the correct non-destructive testing acceptance criteria is being used.
   C. Check to insure that the inspector is advising the fabricator of all deficiencies. The inspector should retain a record that the fabricator was so advised and how he was advised.
   D. Your visits to the fabrication shop should be unannounced, and you should be there early and late to observe the inspector's work hours.
   E. Note the number of days/week and hours/day worked by fabricator and these checked against the time sheets submitted by shop inspector. Inspectors should not regularly work more than 10 hours per day without approval of Division of Construction. If more than 12 hours per day is required then additional inspector must be required. Report any discrepancies immediately!
7) Check to see that the fabricator and shop inspector has available the following:

   A. Design Drawings and any Special proposal notes
   B. Approved Shop Drawings and Welding Procedures
   C. ANSI/AASHTO/AWS D 1.5-88 Specifications.
   D. Applicable Edition of Special Provision 4.

- continued -

E. The Pictorial Standards for Surface Preparation
F. The Kentucky Standard Specification for Road and Bridge Construction (Applicable Edition)
G. His own Non-destructive testing equipment, paint gauges, calibration plates, micrometer, inspection mirror, tapes, flashlight, weld gauge, etc.
H. The applicable ASTM or AASHTO Materials Specification for the structural steels being used.
I. The Appendix "D" of shop Inspection Agreement
J. AASHTO Fracture Critical Guide if applicable.

8) Observe the inspector perform actual non-destructive testing and become familiar with testing procedures. Discuss the quality of welds and the test frequency. Ensure that the welds comply with the contract requirements.
9) Check shop's quality control organization. The number of people, and their qualification who they report to, whether they monitor all work as it progresses, capabilities for non-destructive testing, etc. and whether the approved quality control organization is actually performing per AASHTO.

Upon completion of inspection, meet with the fabricator and shop inspector to discuss overall performance, existing problems, anticipated problems, progress, etc.

A follow-up written brief summary report should be made of your findings upon return from your trip. The report should be placed in project files and shop inspection file and sent to inspection agency.

The above guidelines should be followed and normally one afternoon and the next morning in the shop will be adequate time for this type inspection. Each major project should have the fabrication shop visited at the Prefabrication Conference, again shortly after the fabrication gets in full production and on 4-6 week intervals thereafter.

cc: Paul Gravely
Roy Back, Jr.

SSFABINS

KENTUCKY TRANSPORTATION CABINET
Department of Highways
DIVISION OF CONSTRUCTION

TC 63-55
Rev. 4/87

CONCRETE MIXER

PERFORMANCE AND CONDITION APPROVAL

SLUMP DEVIATION SATISFACTORY ____ YES ____ NO

METAL PLATE FOR DRUM SPEEDS ____ YES ____ NO

AUTOMATIC REV. COUNTER ____ YES ____ NO

WATER MEASURING DEVICE ____ YES ____ NO

MIXER DRUM FREE OF CONCRETE ____ YES ____ NO

DATE APPROVED _____ BY _____

THIS APPROVAL EXPIRES 1 YEAR FROM THIS DATE

TRUCK NUMBER _____

CONCRETE PRODUCER NAME _____

MIXER DRUM INSPECTED FOR HARDENED CONCRETE

	DATE	INITIAL		DATE	INITIAL
JAN			JULY		
FEB			AUG		
MAR			SEPT		
APR			OCT		
MAY			NOV		
JUNE			DEC		

Concrete Mix – Rules of Thumb

Use these rules of thumb for quick evaluations of concrete mix changes. Don't forget that these general guidelines may not apply to all situations.

Adding 1 gallon of water to a cubic yard of concrete will...

- Increase slump about 1 inch
- Decrease compressive strength by 200 to 300 psi
- Increase shrinkage potential about 10%
- Waste as much as ¼ bag of cement

If fresh concrete temperature increases 10° F then...

- About 1 gallon of water per cubic yard maintains equal slump
- Air content decreases about 1%
- Compressive strength decreases 150 to 200 psi

If air content of fresh concrete...

- Increases 1% then compressive strength decreases about 5%
- Decreases 1% then yield decreases about ¼ cubic foot per cubic yard
- Decreases 1% then slump decreases about ½ inch
- Decreases 1% then durability increases about 10%

REINFORCING BARS AND SPIRALS (Cont.)

IDENTIFICATION MARKS — ASTM STANDARD BARS

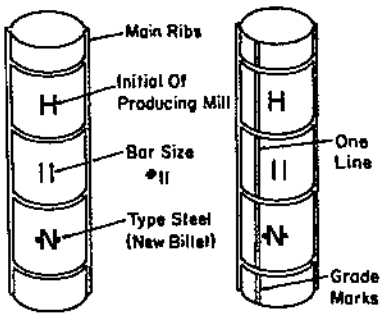
The ASTM specifications for billet steel, rail steel, axle steel and low alloy steel reinforcing bars (A615, A616, A617 and A706) require identification marks to be rolled into the surface of one side of the bar to denote the producer's mill designation, bar size, type of steel and, for Grade 60, a grade mark indicating yield strength.* Grade 40 and Grade 50 bars show only three marks (no grade mark) in the following order:

1st — Producing Mill (usually an initial)
2nd — Bar Size Number (#3 through #18)
3rd — Type Steel: N for New Billet (S for Supplementary Requirements A615—#14 and #18 only)
A for Axle
I for Rail
W for Low Alloy

Grade 60 bars must also show a minimum yield designation grade mark of either the number 60 or one (1) grade mark line.

A grade mark line is smaller and between the two main ribs which are on opposite sides of all U. S. made bars. When a number grade mark is used, it is 4th in order.

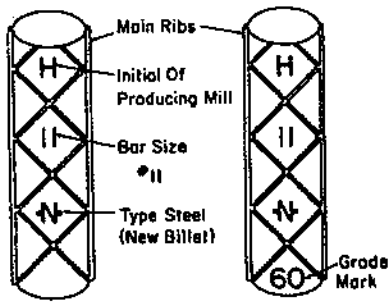
LINE SYSTEM — GRADE MARKS



Grade 40
Grade 50

Grade 60

NUMBER SYSTEM — GRADE MARKS



Grade 40
Grade 50

Grade 60

VARIATIONS: Bar identification marks may also be oriented to read horizontally (at 90° to those illustrated above).
Grade mark lines must be continued at least 5 deformation spaces.
Grade mark numbers may be placed within separate consecutive deformation spaces to read vertically or horizontally.

*See Appendix A for complete bar marks of concrete reinforcing bars produced by all U.S. manufacturers. The marks, listed alphabetically by producing mill, include the identification requirements of ASTM and the deformation pattern used by each mill.

INSPECTION

Epoxy-coated reinforcing bars should be inspected for damaged coating when the bars are received at the job site. The bars should also be inspected for damaged coating after they are placed in the structure, before concrete is poured.

Upon receipt of epoxy-coated bars at the job site, the Buyer should carefully check the quantities of bars against the bill of materials. The Buyer should also inspect the bars for damage to the coating.

Field inspection personnel should realize that the coated bars received at the job site have undergone considerable processing and testing. The material specifications require that certain acceptance tests be made at the Coating Applicator's Facility. The required acceptance tests are for thickness, continuity, and adhesion of coating.

Periodically during the coating application process, the coating thickness is measured to assure that it is within the specification limits. Continuity of coating involves monitoring of the coated bars for holidays. A holiday is defined as a pinhole in the coating that is not visible to the naked eye. Bend tests are made periodically on sample coated bars to check on the adhesion of the coating to the bar.

The specifications also require that damaged coating resulting from handling in the coating plant and fabrication operations be repaired if the damage exceeds specified limits.

At the job site, coated bars should not be subject to any of the above acceptance tests. In addition, there are no limits on the thickness of the patched areas where damaged coating is repaired.

Uncoated ends of bars. Occasionally touching up of sheared ends of epoxy-coated reinforcing bars may be missed during the fabrication process. The uncoated ends must then be touched up at the job site. They should be coated with the same patching material that is used for the repair of damaged coating.

Damaged coating. It should not be expected that epoxy-coated bars will be completely free of damaged coating. No doubt some damage will be incurred during shipment, and from handling and placing operations. In fact, most project specifications permit individual damaged spots up to a certain area or size without requiring repair of the damaged spots. Typically, the limit in project specifications on acceptable spots of damaged coating is in the order of 0.063 square inches (1/4 in. by 1/4 in.). Individual damaged spots larger than this limit would have to be repaired. In addition, project specifications usually limit the maximum amount of total coating damage to 2 percent of the total surface area per linear foot of the coated bar. In other words, the maximum amount of damaged coating, including repaired and unrepaired areas, should not exceed 2 percent of the surface area per foot of bar. Table 1 gives the maximum damaged areas based on 2 percent of the surface area in one-foot lengths for each bar size.

Based upon observations of practice and experience over many years, the amount of actual total damaged coating on bars at the job site is typically much less than the specification limit of 2 percent.

SHEARED ENDS OF COATED BARS — Bar Size #5

Properly coated end.

Minor damage, no touch-up is required.

Uncoated end, touch-up is required.

INSPECTION CONT'D

ACCEPTABLE COATED STRAIGHT BARS
Bar Size #5 Length = 6 in.

No damage

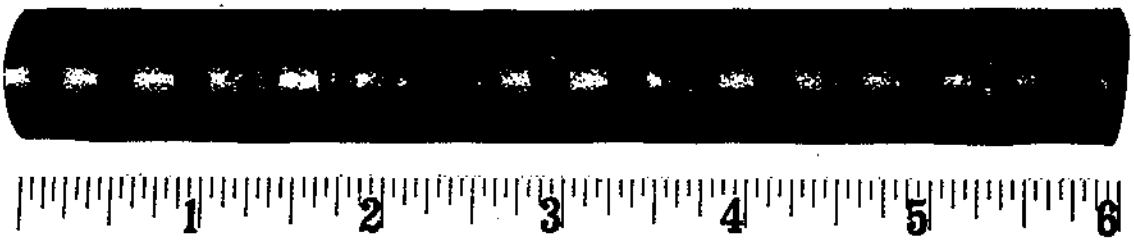
Minor damage; no touch-up is required

Total damage is approximately 1% of surface area of bar in 1-ft. length; no damaged spots are larger than ¼ in. by ¼ in.; no touch-up is required

Total damage is approximately 1% of surface area of bar in 1-ft. length; damaged spot is larger than ¼ in. by ¼ in.; touch-up of damaged spot is required

Total damage is nearly 2% of surface area of bar in 1-ft. length; no damaged spots are larger than ¼ in. by ¼ in.; no touch-up is required

Total damage is nearly 2% of surface area of bar in 1-ft. length; damaged spot is larger than ¼ in. by ¼ in.; touch-up of damaged spot is required



INSPECTION CONT'D

Bent bars. Examination of the physical condition of the coating on the outside radii of standard hooks and other bends might reveal cracks in the coating. The bars are acceptable if only hairline cracking is present and there is no discernible loss of bond (loss of adhesion) of the coating to the bar in the bent portion. When disbondment of the coating is evident, the disbonded coating should be removed from the bar. After removal of the coating, the affected areas should be cleaned and repaired with touch-up material.

Fading of color of coating. When epoxy-coated reinforcing bars are exposed to sunlight over a period of time, fading of the color of some epoxy coatings may occur. Since the discoloration does not harm the coating nor affect its corrosion-protection properties, such fading should not be cause for rejection of the coated bars.

ACCEPTABLE COATED BENT BARS
Bar Size #5 Standard Hooks

No damage

Minor damage, hairline cracking, no touch-up is required.

Total damage is approximately 1% of surface area of bar in 1-ft. length, no damaged spots are larger than 1/4 in. by 1/4 in., no touch-up is required.

Total damage is approximately 1% of surface area of bar in 1-ft. length, damaged spot is larger than 1/4 in. by 1/4 in., touch-up of damaged spot is required.

Total damage is nearly 2% of surface area of bar in 1-ft. length, no damaged spots are larger than 1/4 in. by 1/4 in., no touch-up is required.

Total damage is nearly 2% of surface area of bar in 1-ft. length, damaged spot is larger than 1/4 in. by 1/4 in., touch-up of damaged spot is required.

INSPECTION CONT'D

The preceding discussion of inspection is concerned essentially with evaluating the physical condition of the coating bars. On some projects, several other items directly related to epoxy-coated reinforcing bars might be included in the scope of field inspection. These other items involving inspection would depend upon the requirements for reinforcement, and the arrangements and details of the bars in the particular project.

For example, both uncoated and coated bars will be used on many projects. To avoid confusion, it is the responsibility of the Architect-Engineer to be precise on the design drawings in indentifying those bars which are to be coated. The placing drawings should show the locations of uncoated and coated bars. On the job site, the inspector should make sure that both types of bars, uncoated and coated, are placed where required by the placing drawings. Similarly, the inspector should check that the bar supports being used on the job conform to the requirements in the project specifications.

TABLE 1–MAXIMUM DAMAGED AREA

Bar Size	Diameter, in.	Perimeter, in.	Surface Area, sq. in./ft.	2% of Surface Area sq. in./ft.
#3	0.375	1.18	14.14	0.28
#4	0.500	1.57	18.85	0.38
#5	0.625	1.96	23.56	0.47
#6	0.750	2.36	28.27	0.57
#7	0.875	2.75	32.99	0.66
#8	1.000	3.14	37.70	0.75
#9	1.128	3.54	42.53	0.85
#10	1.270	3.99	47.88	0.96
#11	1.410	4.43	53.16	1.06
#14	1.693	5.32	63.84	1.28
#18	2.257	7.09	85.08	1.70

Recommended construction practices for coated bars are described in the following section. This section includes the repair of damaged coating on the bars and other touch-up work when coated bars are spliced with mechanical connections or by welding, if coated bars are field bent or straightened, and if coated bars are cut in the field. Such repair and touch-up work should be inspected to assure that it was done properly.

RECOMMENDED CONSTRUCTION PRACTICES

Handling and Storage

In unloading epoxy-coated reinforcing bars from a truck, care must be exercised to minimize scraping of the bundles or bar-to-bar abrasion from sags in the bundles. Do not skid the bundles of bars from the truck bed to the ground ("bar off"). Use power hoisting equipment for unloading and handling the bundles. Equipment for handling the bars should have protected contact areas. Nylon slings or padded wire rope slings should be used. Bundles of coated bars should be lifted at multiple pick-up points. Hoisting with a spreader beam or similar device is an effective method of preventing sags in bundles of coated bars.

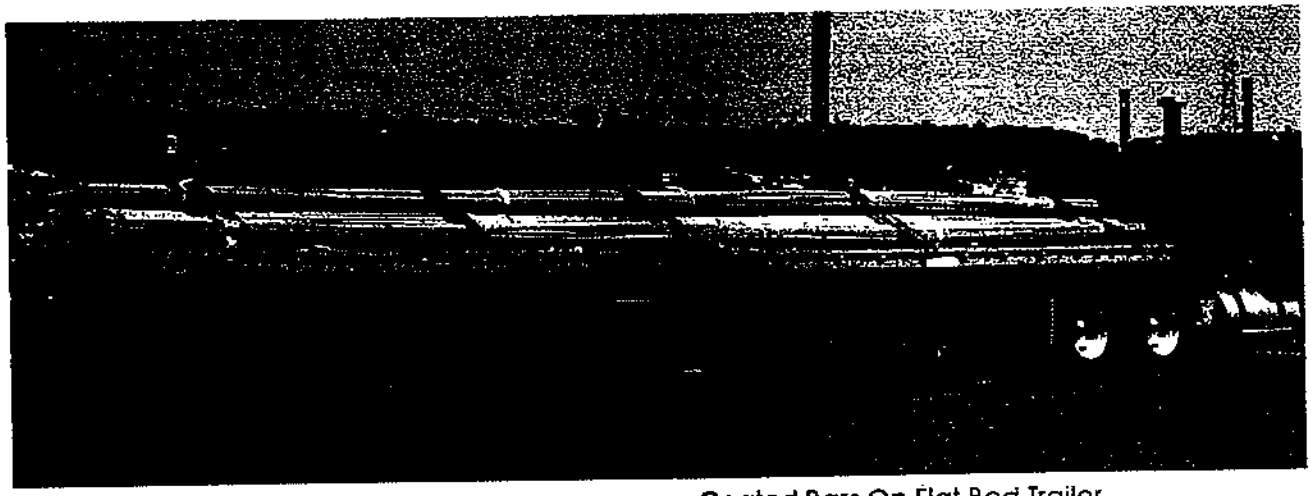
Epoxy-coated bars should be stored on timbers or other suitable protective cribbing. Reinforcing bars, and in particular coated bars, should be stored as close as possible to the area where they will be placed in the structure to keep handling operations to a minimum. Coated bars or bundles of coated bars should not be dropped or dragged.

Long-term storage of epoxy-coated reinforcing bars at the job site, such as from one construction season to the next, is not recommended. Deliveries of coated bars to the job site should be scheduled and coordinated with placing the bars in the structure to avoid any need for long-term storage. If circumstances or other conditions make it absolutely necessary to store coated bars outdoors for an extended period of time, the bars should be protected from direct rays of sunlight and sheltered from the weather. The following storage practices are suggested to prevent deterioration of the coating.

1. Store the bars above the ground on timbers or other suitable protective cribbing, space the dunnage close enough to prevent sags in the bundles.

2. If a relatively large quantity of bars has to be stored in a small area, bundles of straight bars should be stacked with adequate blocking placed between the layers of bundles.

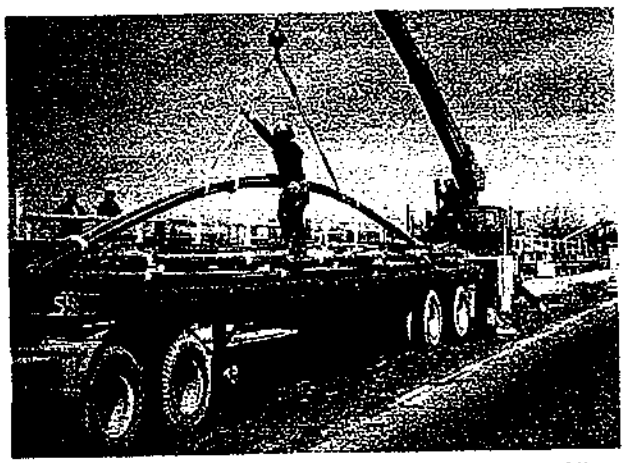
RECOMMENDED CONSTRUCTION PRACTICES CONT'D



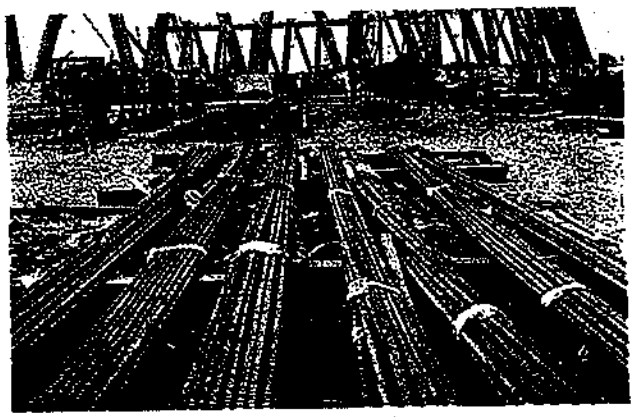
Coated Bars On Flat Bed Trailer

3. Cover the bars or bundles with opaque polyethylene sheeting or other suitable protective material. For stacked bundles, drape the protective covering over the sides of the bundles around the perimeter of the stack. Secure the covering adequately, and make provisions for adequate air circulation around the bars to prevent condensation under the polyethylene sheeting.

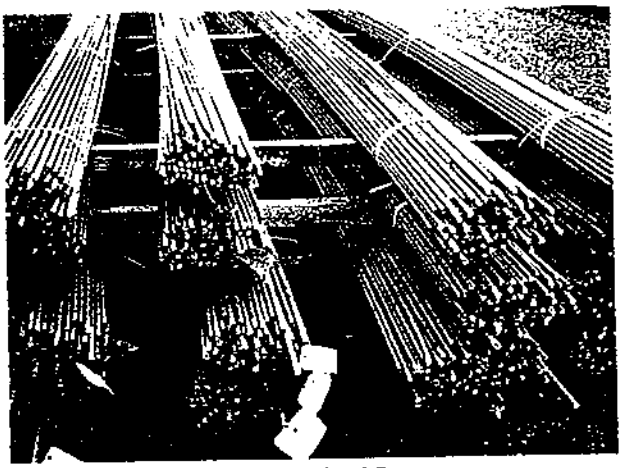
To maintain and assure identification of the stored bars, non-metallic tags on the bundles should be protected, or consideration should be given to attaching additional back-up galvanized metal tags on all bundles of bars. Since there are various possible shapes and dimensions of bent bars, some of the above suggested practices, such as stacking of bundles, may not be directly applicable nor practical for the storage of bent bars.



Unloading Coated Bars From Truck At Job Site



Coated Bars Stored At Job Site



Stacked Bundles of Coated Bars

RECOMMENDED CONSTRUCTION PRACTICES CONT'D

Placing

In general, placing of epoxy-coated reinforcing bars is done similarly as for uncoated bars. The key exception is that coated bars require more careful handling and placing. The same hoisting and handling methods and precautions as discussed above for unloading coated bars from a truck should be used and followed during all placing operations. Once bundles of coated bars have been broken, dragging one bar over another, or over any abrasive surface should be avoided. Using common-sense precautions should minimize coating damage during placing operations. Experience has shown that with such normal common-sense considerations, repair of damaged coating or field touch-up is seldom necessary.

Coated Bars Placed
In Bridge Deck.
Ready For Concrete Pour

Iron Workers Completing Placement of Coated Bars
In Large Bridge Deck

RECOMMENDED CONSTRUCTION PRACTICES CONT'D

Bar Supports and Tie Wire

Non-corrosive (compatible) bar supports and tie wire are usually used for epoxy-coated reinforcing bars. The requirements for these materials should be included in the project specifications. The purpose of the particular or compatible types of bar supports is to minimize damage to the coating on the bars during field placing of the coated bars, and not to introduce a potential source of corrosion at and in close proximity to the point of contact of the bar supports with the coated rebars. Usually wire bar supports or portions of them will be coated with epoxy or vinyl (plastic) material. It should not be expected that coated wire bar supports will be completely free of damaged coating. Bar supports on the job might be made of nonmetallic material. Reinforcing bars that are used as support bars should be epoxy-coated. CRSI recommendations for bar supports for supporting epoxy-coated reinforcing bars are:

A. Wire bar supports should be coated with dielectric material such as epoxy or plastic, compatible with concrete, for a distance of at least 2 inches from the point of contact with the epoxy-coated reinforcing bars, or,
B. Bar supports should be made of dielectric material, if precast concrete blocks with embedded tie wires or precast concrete doweled blocks are used, the wires or dowels should be epoxy-coated or plastic-coated, or,
C. Reinforcing bars that are used as support bars should be epoxy-coated. In walls reinforced with epoxy-coated bars, spreader bars where specified by the Architect-Engineer, should be epoxy-coated. Proprietary combination bar clips and spreaders that are used in walls with epoxy-coated reinforcing bars should be made of corrosion-resistant material or coated with dielectric material.

Coated tie wire is often required to minimize damage or cutting into the bar coating. Tie wire is typically black-annealed wire, 16-1/2 gauge or heavier. The coating material on the wire is usually plastic, epoxy, or nylon.

Splices

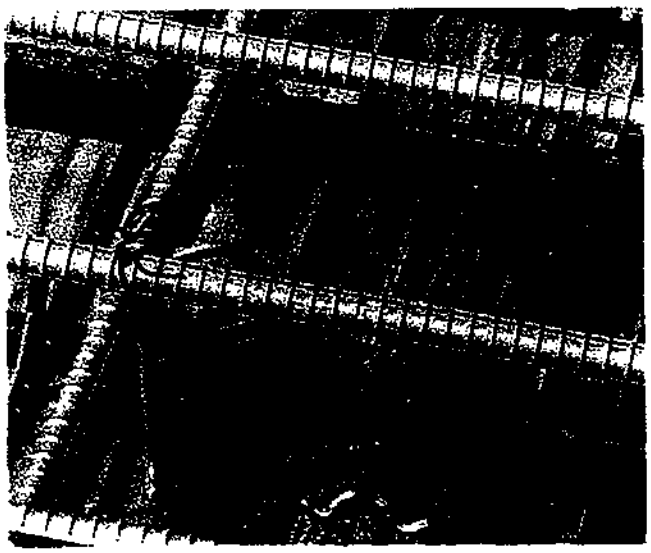
Splices of epoxy-coated bars are essentially the same as those for uncoated bars. The project specifications should contain any special requirements. For mechanically-coupled splices, the project specifications might require that after installing the couplers, all parts of the connections including steel splice sleeves, bolts and nuts must be coated with the same patching material which is used for the repair of damaged coating on the bars, and coating damage on the bars in the vicinity of the couplers must be repaired. For welded splices, the specifications might require that after completion of welding, all welds and all steel splice members when used to splice bars must be coated with the same patching material as that used for the repair of damaged coating on the bars, coating damage on the bars in the vicinity of the welded splices must be repaired, and suitable ventilation must be provided when welding coated bars.

Field Cutting

Field cutting of reinforcing bars, whether uncoated or coated, should be done only if permitted by the Architect-Engineer. The project specifications should cover field cutting, and in the case of epoxy-coated bars, the specifications should require coating of the cut ends with the same material that is used for the repair of damaged coating. Coating damage and field touch-up can be reduced by saw cutting rather than flame cutting.

Field Bending or Straightening ("Field Corrections")

The project specifications should also contain any special requirements for field bending or straightening of epoxy-coated bars which are partially embedded in hardened concrete. The specifications might require repair of damaged coating after the bending or straightening has been completed. If the Architect-Engineer approves the use of heat for the field bending or straightening, suitable ventilation should be provided.



Plastic-Coated Wire Bar Support
And Coated Tie Wire

RECOMMENDED CONSTRUCTION PRACTICES CONT'D

Other Precautions

After the epoxy-coated bars are placed, walking on the bars by workmen should be held to a minimum. Workmen should be careful not to drop large-hand tools or other heavy construction materials on the bars in place. Care should be exercised so that concrete conveying and placement equipment does not damage the coated bars. Runways for concrete buggies, hoses for pumping concrete, etc., should be set up, supported and moved carefully to minimize damage to the coating and not knock the bars out of their intended position.

Repair of Damaged Coating

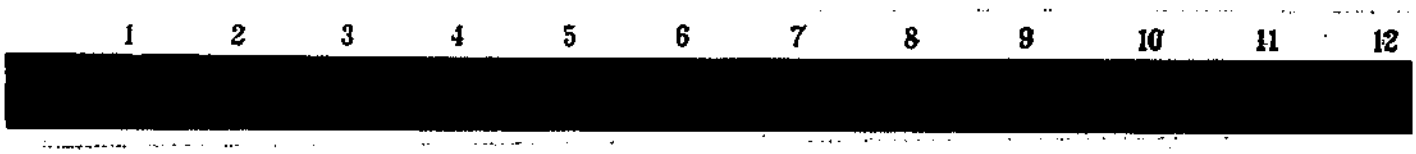
When damaged coating must be repaired, the patching or touch-up material should be applied in strict accordance with the instructions furnished by the manufacturer of the patching material. Generally, surface preparation consists of thorough manual cleaning of damaged spots and complete removal of rust. Cleaning is usually done with a wire brush and emery paper. Care should be exercised during the surface preparation so that the bare areas are not made larger than necessary to accomplish the repair of the damaged spots. Repaired areas do not have as much corrosion resistance as the factory-applied epoxy coating.

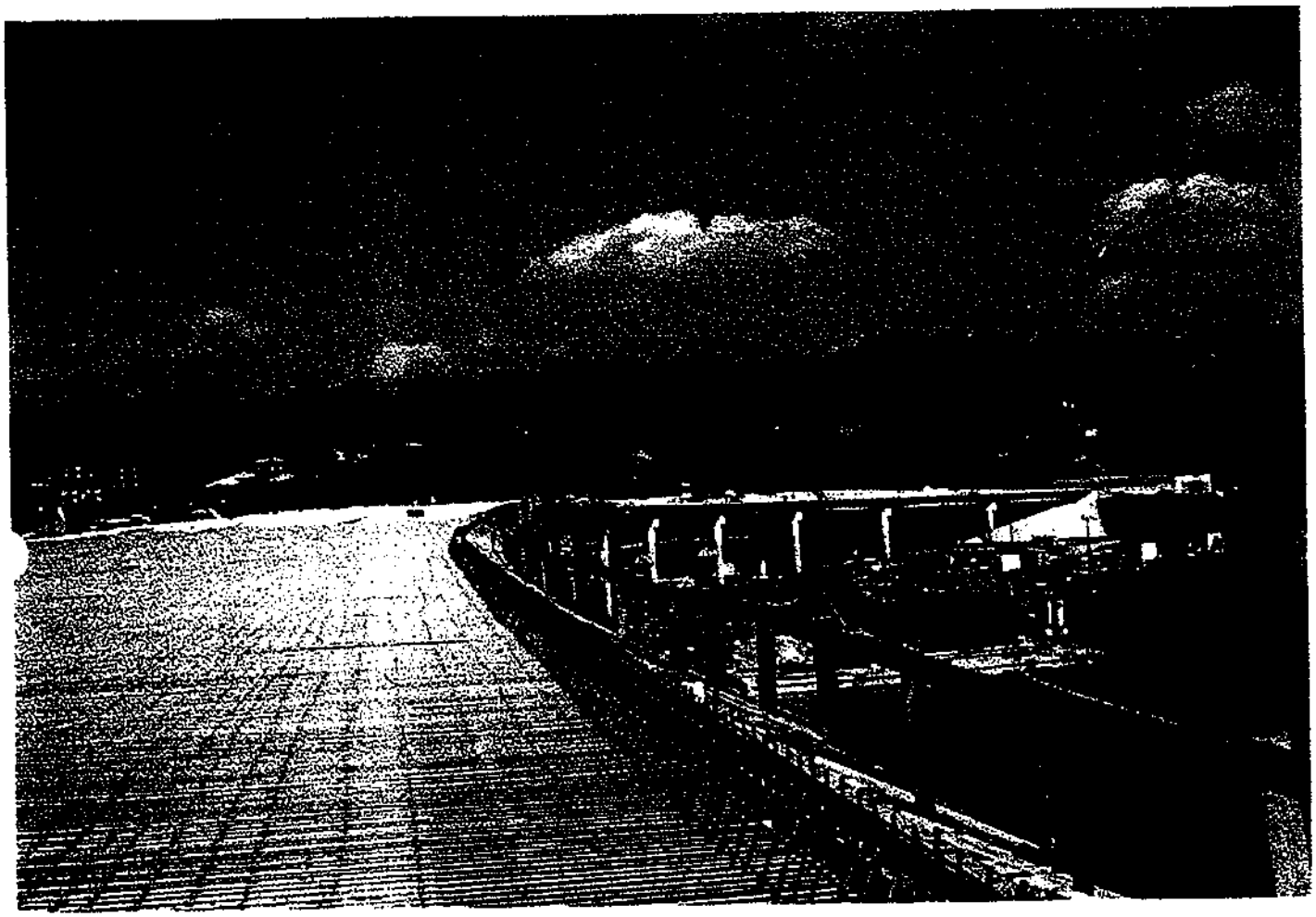
REPAIR OF DAMAGED COATING
Bar Size #5 Length = 12 in.

Damaged spots requiring touch-up

Damaged spots cleaned and ready for touch-up

Touch-up completed





PROCEDURE FOR PERFORMING ROTATIONAL CAPACITY TEST BOLTS TO SHORT TO FIT TENSION CALIBRATOR

EQUIPMENT REQUIRED:

1. Calibrated torque wrench and an spud wrench or equivalent.
2. Spacers and/or washers with hole size no larger than 1/16 in. greater than bolt to be tested.
3. Steel section with normal size hole to install bolt. Any available splice hole can be used with a plate thickness that will provide the number of threads under the nut required in Step 1 below. Mark off a vertical line and lines 1/3 of a turn, 120 degrees; 1/2 of a turn, 180 degrees; and 2/3 of a turn, 240 degrees, from vertical in a clockwise direction on the plate.

PROCEDURE:

1. Install nut on bolt and measure stick out of bolt when 3 to 5 full threads of the bolt are located between the bearing face of the nut and the bolt head. Measure the bolt length, the distance from the end of the threaded shank to the underside of the bolt head.
2. Install the bolt into the hole and install the required number of shim plates and/or washer (one washer under the nut must always be used) to produce the thread stickout measured in Step 1.
3. Snug the bolt using a hand wrench. The snug condition should be the normal effort applied to a 12 inch long wrench. The applied torque should not exceed 20% of the torque determined in Step 5.
4. Match mark the nut to the vertical stripe on the plate.
5. Tighten the bolt by turning the nut using the torque wrench to the rotation listed below. A second wrench must be used to prevent rotation of the bolt head during tightening. Record the torque required to reach this rotation. Torque must be mesured with the nut in motion.

Bolt Length (measured in Step 1)	4 x bolt dia. or less	Greater than 4 but no more than 8 x bolt dia.	Greater than 8 x bolt dia.
Required Rotation	1/3	1/2	2/3

The measured torque should not exceed the values listed below. Assemblies which exceed the listed torques have failed the test.

Bolt Dia. (in.)	1/2	5/8	3/4	7/8	1	1-1/8	1-1/4	1-3/8	1-1/2
Torque (ft-lbs)	150	290	500	820	1230	1500	2140	2810	3690

6. Tighten the bolt further to the rotation required below. The rotation is measured from the initial marking in Step 4. Assemblies which fail prior to this rotation either by stripping or fracture fail the test.

Bolt Length (measured in Step 1)	4 x bolt dia. or less	Greater than 4 but no more than 8 x bolt dia.	Greater than 8 x dia.
Required Rotation	2/3	1	1-1/3

7. Loosen and remove nut, and examine thread on the nut and bolt. No signs of thread shear failure, stripping or torsional failure of the bolt should be evident. Assemblies which have evidence of stripping have failed the test.

ROTATIONAL CAPACITY TEST WORKSHEET

SHORT BOLT

FOR 3/4 X 2 BOLT:

FROM STEP 5

MEASURED TORQUE -
(AT 1/3 TURN)

MAXIMUM TORQUE = 0.25 PD
WHERE: P = TURN TEST TENSION
FROM TABLE D4.1g (lbs.)
D = NOMINAL BOLT
DIAMETER (FEET)

MAX. TORQUE =
0.25 X 32,000 X (0.75/12)

MAX. TORQUE = 500 FT. LBS.

APPENDIX A1

PROCEDURE FOR PERFORMING ROTATIONAL CAPACITY TEST LONG BOLTS IN TENSION CALIBRATOR

'IPMENT REQUIRED:

1. Calibrated bolt tension measuring device of size required for bolts to be tested. Mark off a vertical line and lines 1/3 of a turn, 120 degrees; and 2/3 of a turn, 240 degrees, from vertical in a clockwise direction on the face plate of the calibrator.
2. Calibrated torque wrench.
3. Spacers and/or washers with hole size no larger than 1/16 in. greater than bolt to be tested.
4. Steel section to mount bolt calibrator. Flange of girder or cross frame accessible from the ground is satisfactory.

PROCEDURE:

1. Install nut on bolt and measure stick out of bolt when 3 to 5 full threads of the bolt are located between the bearing face of the nut and the bolt head. Measure the bolt length, the distance from the end of the threaded shank to the underside of the bolt head.
2. Install the bolt into the tension calibrator and install the required number of shim plates and/or washer (one washer under the nut must always be used) to produce the thread stickout measured in Step 1.
3. Tighten bolt using a hand wrench to the snug tensions listed below -0 kips,+2 kips.

Bolt Dia. (in.)	1/2	5/8	3/4	7/8	1	1-1/8	1-1/4	1-3/8	1-1/2
Snug Tension (kips)	1	2	3	4	5	6	7	9	10

4. Match mark the nut to the vertical stripe on the face plate of the bolt calibrator.
5. sing the calibrated manual torque wrench, tighten the bolt to at least the tension listed below and record the torque required to reach the tension and the value of the bolt tension. Torque must be measured with the nut in motion.

Bolt Dia. (in.)	1/2	5/8	3/4	7/8	1	1-1/8	1-1/4	1-3/8	1-1/2
Tension (kips)	12	19	28	39	51	56	71	85	103

. Further tighten the bolt to the rotation listed below. The rotation is measured from the initial marking in Step 4. Record the bolt tension. Assemblies which fail prior to this rotation either by stripping or fracture fail the test.

Bolt Length (measured in Step 1)	4 x bolt dia. or less	Greater than 4 but no more than 8 x bolt dia.	Greater than 8x bolt dia.
Required Rotation	2/3	1	1-1/3

. The bolt tension measured in Step 6 after the required rotation must equal or exceed the values in the table shown below. Assemblies which do not meet this tension have failed the test.

Bolt Dia. (in.)	1/2	5/8	3/4	7/8	1	1-1/8	1-1/4	1-3/8	1-1/2
Tension (kips)	14	22	32	45	59	64	82	98	118

Loosen and remove nut, and examine the threads on the nut and bolt. No signs of thread shear failure, stripping, or torsional failure of the bolt should be evident. Assemblies which have evidence of stripping have failed the test.

culate and record the value of 0.25x the tension (pounds=kips x 1000) measured in Step 5 x the bolt diameter in feet. The torque measured and recorded in Step 5 must be equal to or less than this calculated value. Assemblies with torque values exceeding this calculated value failed the test.

ROTATIONAL CAPACITY TEST WORKSHEET
LONG BOLT

FOR 3/4 X 2 3/4 BOLT:

FROM STEP 5

MEASURED TENSION -
(28,000 - OR HIGHER)

MEASURED TORQUE -

MEASURED TORQUE - 0.25 PD
WHERE: P = MEASURED BOLT TENSION (lbs.)
D = NOMINAL BOLT DIAMETER (ft.)

MAX. TORQUE

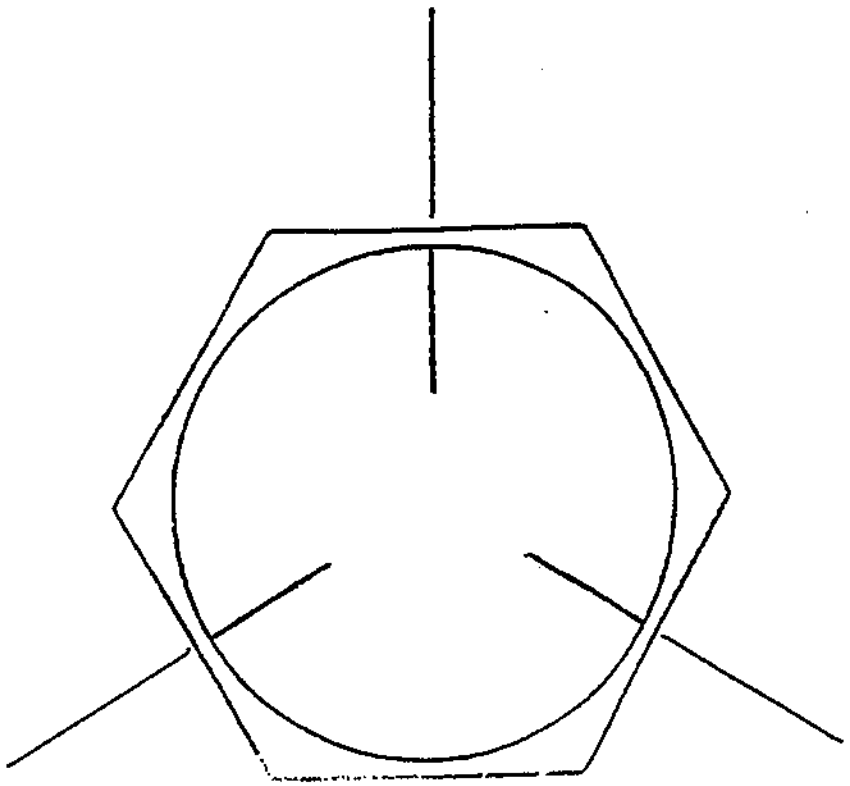
$$= 0.25X \underset{\text{(TENSION)}}{} \frac{X\,(0.75)}{12}$$

$$= 0.0156X$$
(TENSION)

MAX. TORQUE =

ROTATIONAL CAPACITY TEST REQUIREMENTS

TORQUE $\leq$ .25 P.D.



TENSION $\geq$1.15 X REQUIRED INSTALLATION TENSION

NO STRIPPING

The following is the data that should be included in the rotational capacity test certification. The information may be presented in any form the certifier chooses.

ROTATIONAL CAPACITY TEST CERTIFICATION

DATE OF TEST_____ TESTING FIRM_____
LOCATION OF TEST_____ TESTER NAME_____

	BOLT	NUT	WASHER
MANUFACTURER	_____	_____	_____
LOCATION OF MANUF	_____	_____	_____
LOT NO.	_____	_____	_____
SPEC.(ASTM)	_____	_____	_____
GRADE(NUT)	_____	_____	_____

BOLT SIZE : DIA x LENGTH_____
TEST:(FHWA)_____ (ASTM)____ REQUIRED ROTATION_____

Test Notes:
1. Torque/Tension comparison between minimum tension (proof load) and full required rotation in test.
2. Tension at required turn>1.15 proof load.
3. Stripping (must turn with fingers after test) - no stripping passes.
4. Two samples are required to be tested.

SAMPLE I:
1. MEASURED TORQ____TENSION_____MAX.ALLOW.TORQUE @ T=.25PD____
2. MEASURED TENSION @ REQ. TURN_____ MIN. REQ. TENSION_____
3. STRIPPING YES_____ NO____

SAMPLE II:
1. MEASURED TORQ____TENSION_____MAX.ALLOW.TORQUE @ T=.25PD____
2. MEASURED TENSION @ REQ. TURN_____ MIN. REQ. TENSION_____
3. STRIPPING YES____ NO____

R/C TEST LOT NO._____ TEST PASSED_____

SIGNATURE OF TESTER_____

NOTARY PUBLIC:
(Optional)

ROTATIONAL CAPACITY TEST / MAXIMUM TORQUE			
¾ INCH BOLT		⅞ INCH BOLT	
TENSION (KIPS)	TORQUE (FT-LBS)	TENSION (KIPS)	TORQUE (FT-LBS)
28	437	39	711
29	453	40	729
30	469	41	747
31	484	42	766
32	500	43	784
33	516	44	802
34	531	45	820
35	547	46	839
36	562	47	857
37	578	48	875
38	594	49	893
39	609	50	911
40	625	51	930
41	641	52	948
42	656	53	966
43	672	54	984
44	688	55	1003
45	703	56	1021

TEMPERATURE ADJUSTMENTS

BRIDGE ROCKERS

This exhibit consists of instructions pertaining to the installation and/or checking of bridge rockers for continuous span units. The proper setting of rockers is a critical factor in the long life of a bridge and should be given careful consideration and attention.

INSTRUCTIONS FOR SETTING ROCKERS

1. Strike centerline bearing on pier and abutment caps and set masonry bearing assemblies in place. (Do not drill anchor bolts yet)

2. Set structural steel and completely bolt up and position steel in its final location.

3. Jack up structural steel and reposition bottom masonry plate such that the rockers are inclined according to the temperature correction for the temperature of the steel (not the air). See example on Page 2 of this exhibit.

4. Drill anchor bolt holes.

5. Check setting of rockers and lead in the anchor bolts in accordance with the instructions in Section 63-08.0900 of this manual.

NOTE:

a. If the anchor bolts are leaded in and the rockers are incorrectly set, contact the District Construction Office for further instructions.

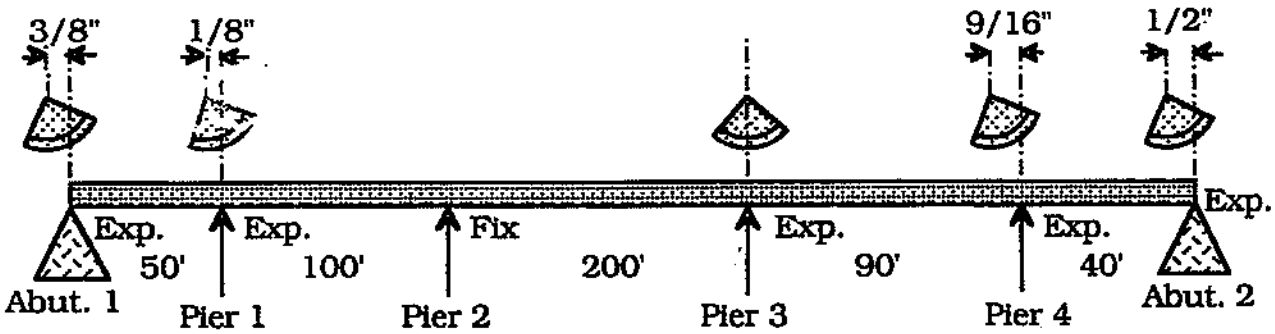
b. Total rocker corrections of simple spans are more involved than those described herein for continuous units. Bottom flange elongation and temperature correction should be considered. Normally, a correction chart will be included in the plans for this purpose. If no such chart is provided or if additional information is needed, the Project Engineer should contact the District Construction Office for instructions.

c. In rare cases, adequate clearance may not be available to drill the anchor bolt holes after the structural steel is set. In this event, the Project Engineer should contact the District Construction for guidance.

d. This example does not include steel elongation from dead load applications with the resulting camber reduction. Normally this situation is encountered on long river bridges and the plans will contain a chart for rocker settings. When this situation is encountered or when there is any question regarding elongation resulting from camber reduction, the Project Engineer should contact the District Construction Office.

TEMPERATURE ADJUSTMENTS

BRIDGE ROCKERS



Correction Factor in Feet(C) = .00000645 (T) (L)
T = Temperature Differential of the steel from 60°F
L = Distance from fixed point

NOTE: (1) The rocker will be in the expanded position with the rocker leaning away from the fixed point (Pier No. 2 in the example) when the temperature of the steel is greater than 60°F as in Abut. No. 1 and Pier No. 1. Conversely, the rocker will lean toward the fixed point when the temperature of the steel is less than 60°F as in Pier No. 4 and Abut. No. 1

Abut. No. 1:
Set at 90°F
T = 90°F - 60°F = 30°
L = 50' + 100' = 150'
C = .00000645 x 30 x 150 = .03 ' = 3/8"

Pier No. 1:
Set at 80°F
T = 80°F - 60°F = 20°
L = 100'
C = .00000645 x 20 x 100 = .012' = 1/8"

Pier No. 3:
Set at 60°F
Set Rocker Vertical

Pier No. 4:
Set at 35°F
T = 60°F - 35°F = 25°
L = 200' + 90' = 290'
C = .00000645 x 25 x 290 = .047' = 9/16"

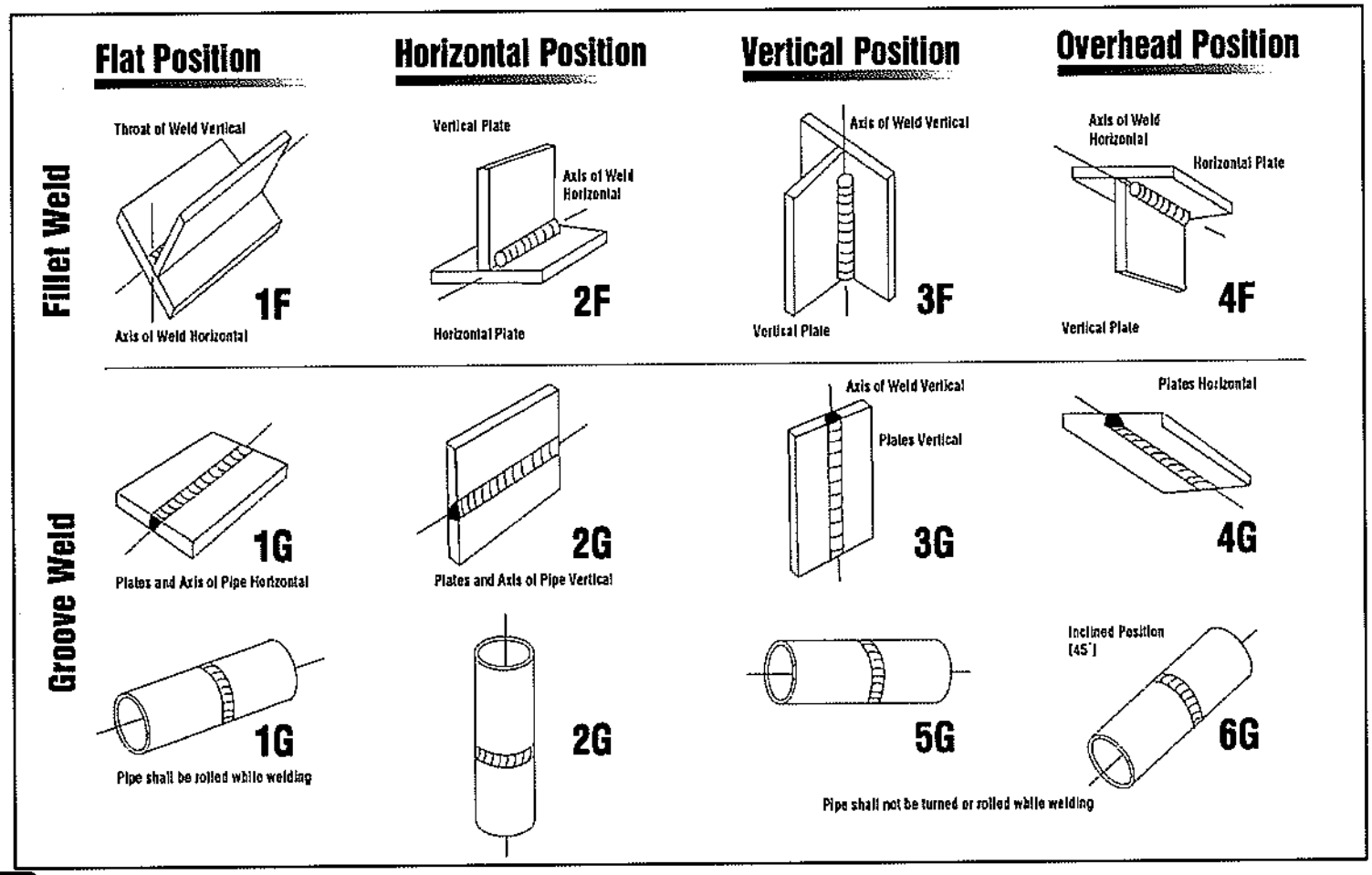
Abut. No. 2:
Set at 40°F
T = 60°F - 40°F = 20°
L = 200' + 90' + 40' = 330'
C = .00000645 x 20 x 330 = .043' = 1/2"

NOTE: Use steel temperature, not air temperature. Do not use temperature in Celsius with this formula.

WELDING connects your world

What are Welding Positions?

- There are various positions that a weld can be made in:



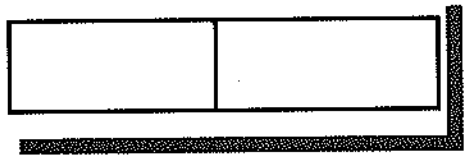
LINCOLN ELECTRIC

Exhibit 63-8-41
Page 1 of 6

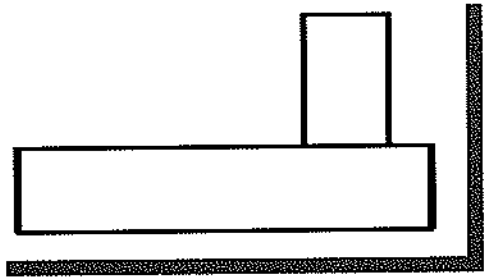
Types of Joints

- There are 5 types of joints …

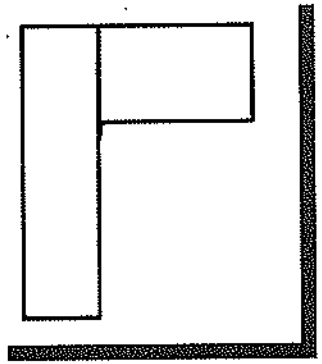
Butt



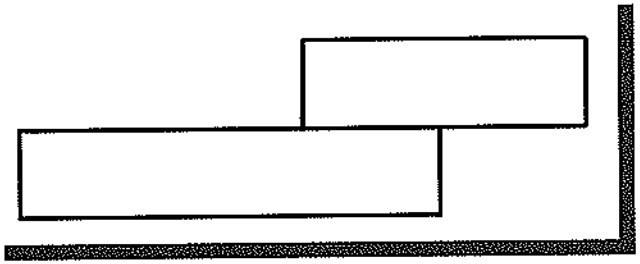
Tee



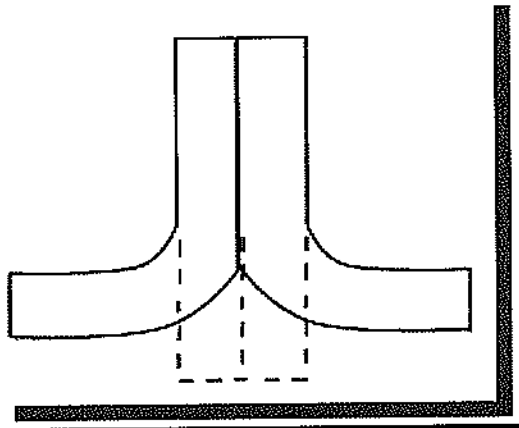
Corner



Lap

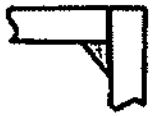
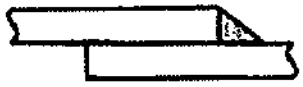


Edge

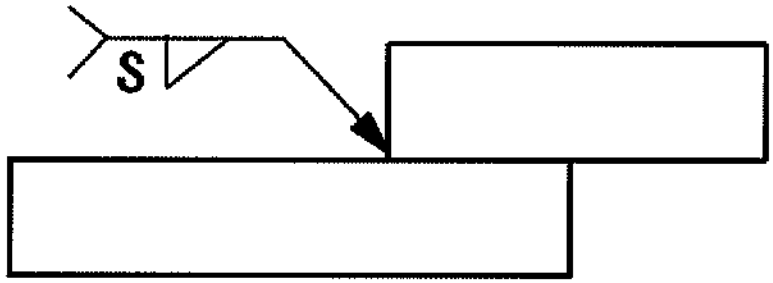


Fillet and Groove Welds

- Groove and fillet welds can be made on many types of joints

	Fillet	Groove
Butt	N.A.	
Tee		
Corner		
Lap		N.A.

Welding Symbols



- Welding symbols contain information about the weld to be made
  - *S – leg dimension of the weld*
  - *Triangle – the weld is to be made on the arrow side of this joint*
  - *Tail – any additional information required (i.e. position the weld is to be made)*
  - *Arrow - the joint the welding symbol applies to*

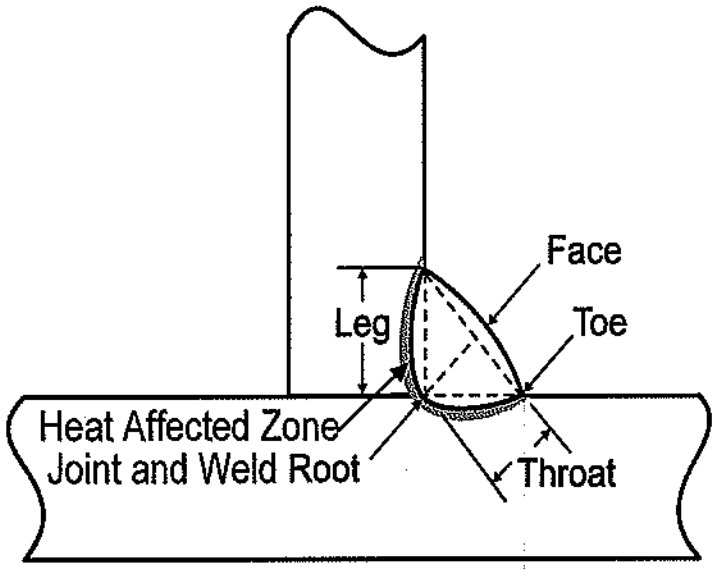
WELD SYMBOLS

SQUARE BUTT WELD	SINGLE V BUTT WELD	SINGLE BEVEL BUTT WELD
SINGLE-U BUTT WELD	SINGLE-J BUTT WELD	BACKING RUN
FILLET WELD	PLUG WELD	SPOT WELD

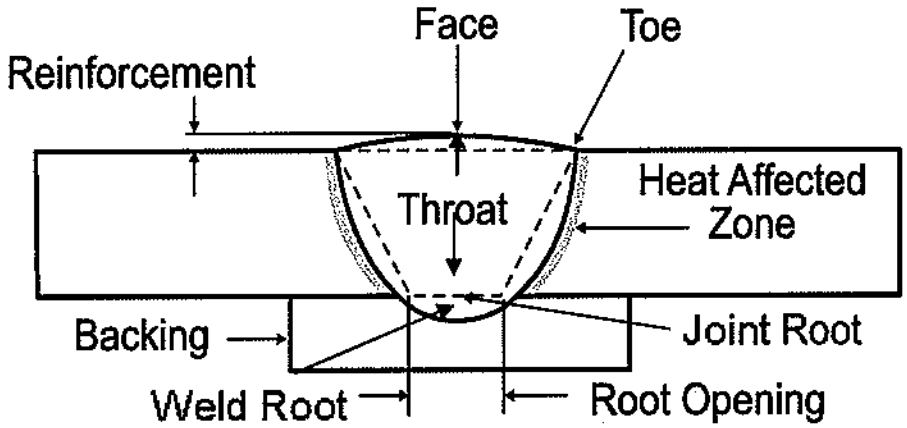
SUPPLEMENTARY INDICATIONS

SITE WELD	WELD ALL ROUND	WELD PROCESS IDENT
		11

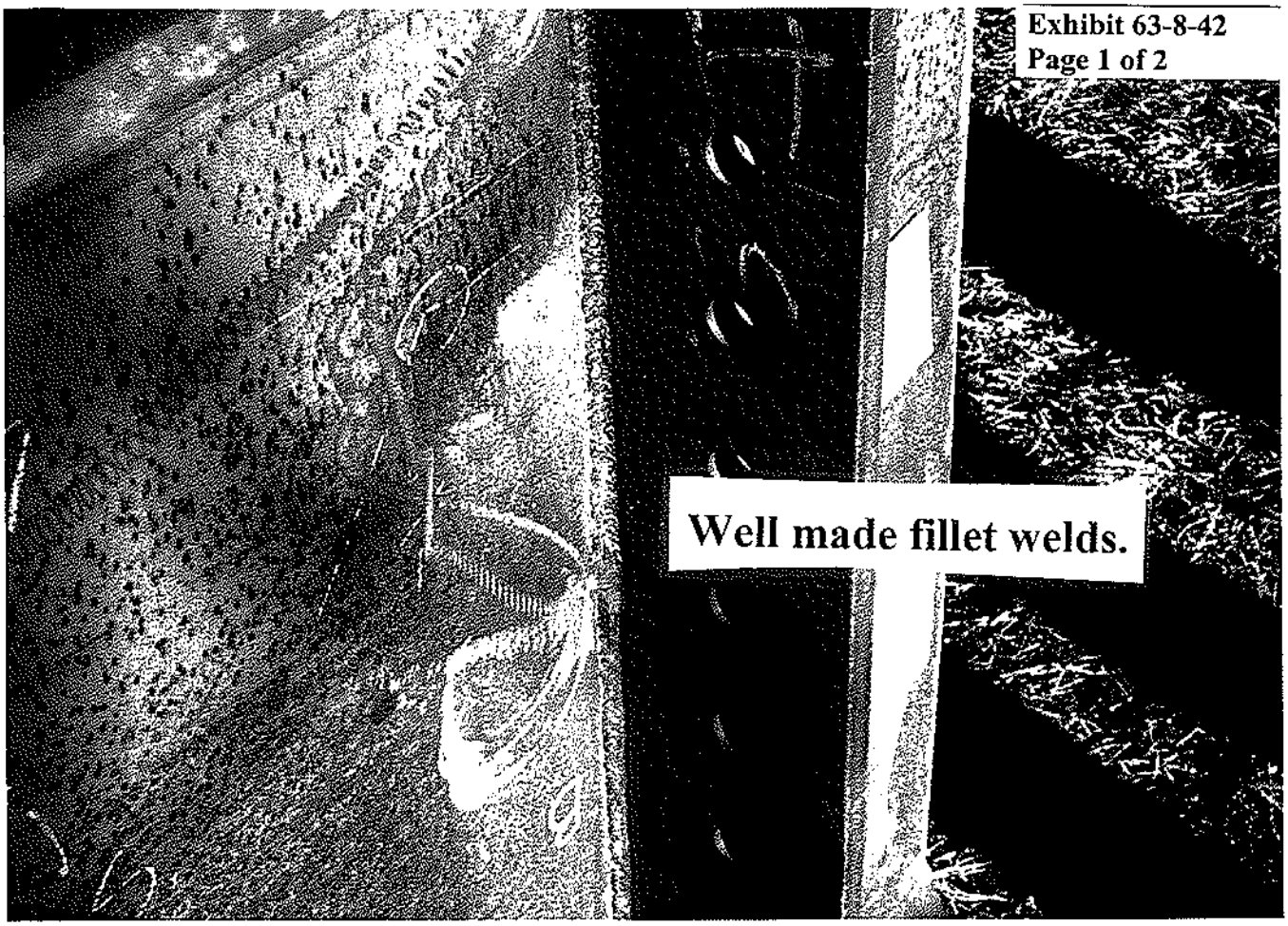
Parts of a Weld

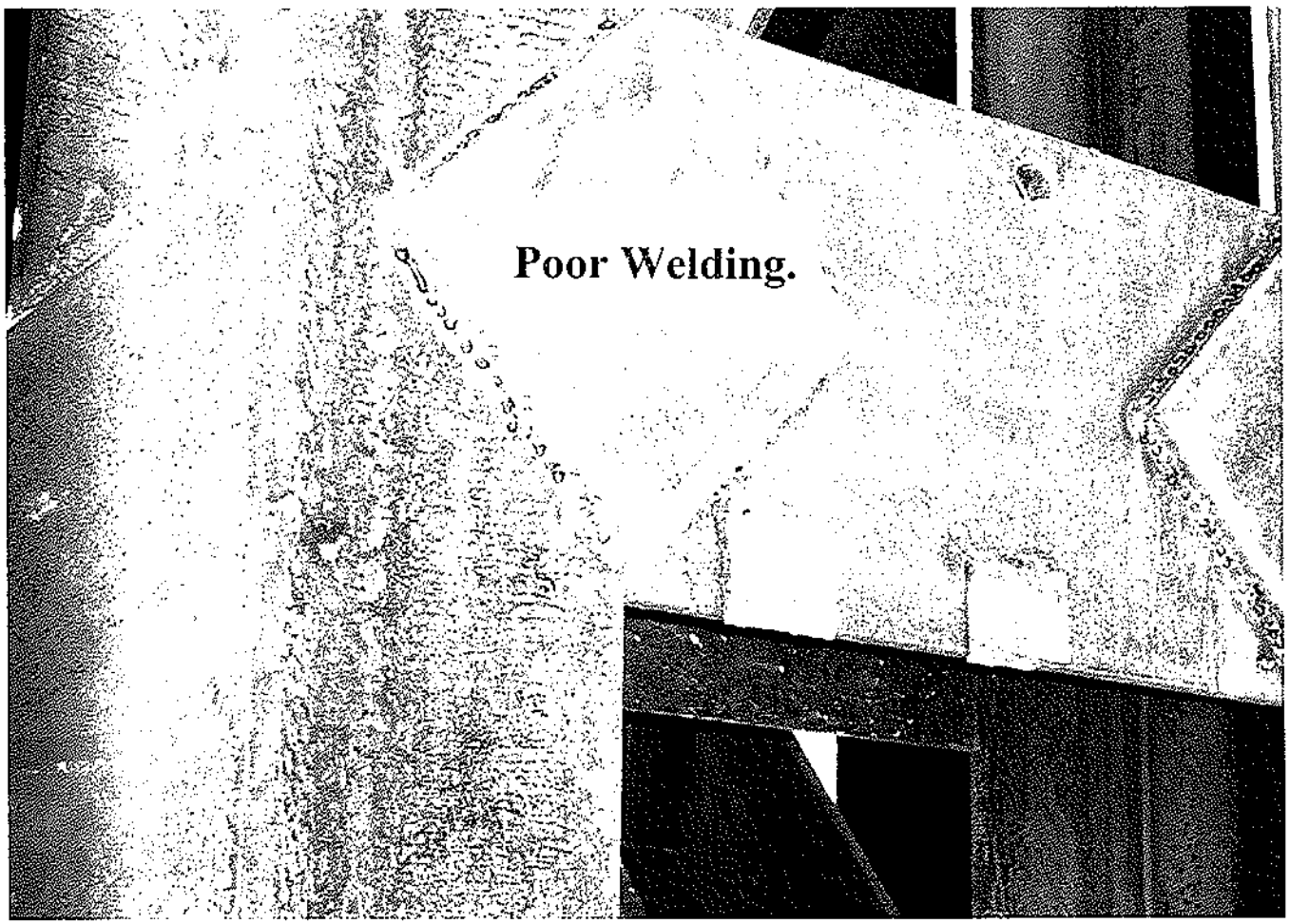


Fillet Weld Terminology



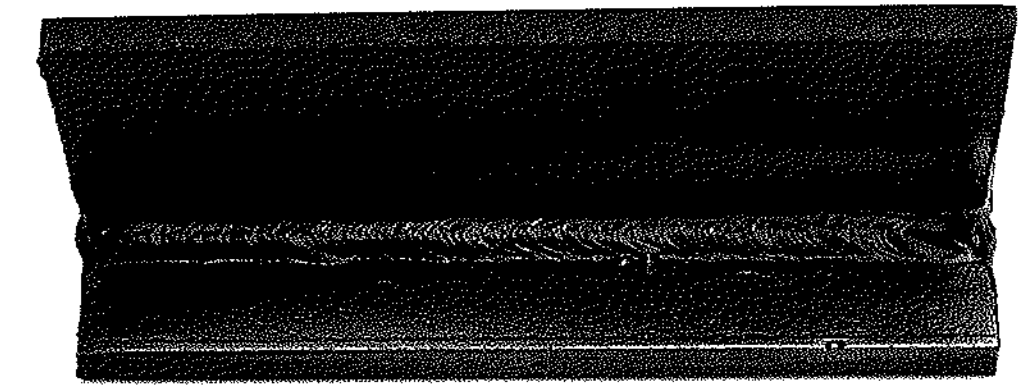
Groove Weld Terminology


Well made fillet welds.


Poor Welding.

Fillet Weld Inspection

- Fillet welds should:
  - *Have a flat to slightly convex face*
  - *Be uniform in appearance*
  - *Have equal leg size*
  - *Have good wash-in into base materials*
- This is an example of a good fillet weld:



The ABC's of Nondestructive Weld Examination

Reprinted courtesy of *Welding Journal* magazine.

An understanding of the benefits and drawbacks of each form of nondestructive examination can help you choose the best method for your application

By Charles Hayes

The philosophy that often guides the fabrication of welded assemblies and structures is "to assure weld quality." However, the term "weld quality" is relative. The application determines what is good or bad. Generally, any weld is of good quality if it meets appearance requirements and will continue indefinitely to do the job for which it is intended. The first step in assuring weld quality is to determine the degree required by the application. A standard should be established based on the service requirements.

Standards designed to impart weld quality may differ from job to job, but the use of appropriate weld techniques can provide assurance that the applicable standards are being met. Whatever the standard of quality, all welds should be inspected, even if the inspection involves nothing more than the welder looking after his own work after each weld pass. A good-looking weld surface appearance is many times considered indicative of high weld quality. However, surface appearance alone does not assure good workmanship or internal quality.

Nondestructive examination (NDE) methods of inspection make it possible to verify compliance to the standards on an ongoing basis by examining the surface and subsurface of the weld and surrounding base material. Five basic methods are commonly used to examine finished welds: visual, liquid penetrant, magnetic particle, ultrasonic and radiographic (X-ray). The growing use of computerization with some methods provides added image enhancement, and allows real-time or near real-time viewing, comparative inspections and archival capabilities. A review of each method will help in deciding which process or combination of processes to use for a specific job and in performing the examination most effectively.

Visual Inspection (VT)

Visual inspection is often the most cost-effective method, but it must take place prior to, during and after welding. Many standards require its use before other methods, because there is no point in submitting an obviously bad weld to sophisticated inspection techniques. The ANSI/AWS D1.1, Structural Welding Code - Steel, states, "Welds subject to nondestructive examination shall have been found acceptable by visual inspection." Visual inspection requires little equipment. Aside from good eyesight and sufficient light, all it takes is a pocket rule, a weld size gauge, a magnifying glass, and possibly a straight edge and square for checking straightness, alignment and perpendicularity.

Before the first welding arc is struck, materials should be examined to see if they meet specifications for quality, type, size, cleanliness and freedom from defects. Grease, paint, oil, oxide film or heavy scale should be removed. The pieces to be joined should be checked for flatness, straightness and dimensional accuracy. Likewise, alignment, fit-up and joint preparation should be examined. Finally, process and procedure variables should be verified, including electrode size and type, equipment settings and provisions for preheat or postheat. All of these precautions apply regardless of the inspection method being used.

During fabrication, visual examination of a weld bead and the end crater may reveal problems such as cracks, inadequate penetration, and gas or slag inclusions. Among the weld defects that can be recognized visually are cracking, surface slag inclusions, surface porosity and undercut.

On simple welds, inspecting at the beginning of each operation and periodically as work progresses may be adequate. Where more than one layer of metal filler is being deposited, however, it may be desirable to inspect each layer before depositing the next. The root pass of a multipass is most critical to weld soundness. It is especially susceptible to cracking, and because it solidifies quickly, it may trap gas and slag. On subsequent passes, conditions caused by the shape of the weld bead or changes in the joint configuration can cause further cracking, as well as undercut and slag trapping. Repair costs can be minimized if visual inspection detects these flaws before welding progresses.

Visual inspection at an early stage of production can also prevent underwelding and overwelding. Welds that are smaller than called for in the specifications cannot be tolerated. Beads that are too large increase costs unnecessarily and can cause distortion through added shrinkage stress.

After welding, visual inspection can detect a variety of surface flaws, including cracks, porosity and unfilled craters, regardless of subsequent inspection procedures. Dimensional variances, warpage and appearance flaws, as well as weld size characteristics, can be evaluated.

Before checking for surface flaws, welds must be cleaned of slag. Shotblasting should not be done before examination, because the peening action may seal fine cracks and make them invisible. The AWS D1.1 Structural Welding Code, for example, does not allow peening "on the root or surface layer of the weld or the base metal at the edges of the weld."

Visual inspection can only locate defects in the weld surface. Specifications or applicable codes may require that the internal portion of the weld and adjoining metal zones also be examined. Nondestructive examinations may be used to determine the presence of a flaw, but they cannot measure its influence on the serviceability of the product unless they are based on a correlation between the flaw and some characteristic that affects service. Otherwise, destructive tests are the only sure way to determine weld serviceability.

Radiographic Inspection

Radiography (X-ray) is one of the most important, versatile and widely accepted of all the nondestructive examination methods - Fig. 1. X-ray is used to determine internal soundness of the welds. The term "X-ray quality," widely used to indicate high quality in welds, arises from this inspection method.

Radiography is based on the ability of X-rays and gamma rays to pass through metal and other materials opaque to ordinary light, and produce photographic records of the transmitted radiant energy. All materials will absorb known amounts of this radiant energy and, therefore, X-rays and gamma rays can be used to show discontinuities and inclusions within the opaque material. The permanent film record of the internal conditions will show the basic information by which weld soundness and be determined.

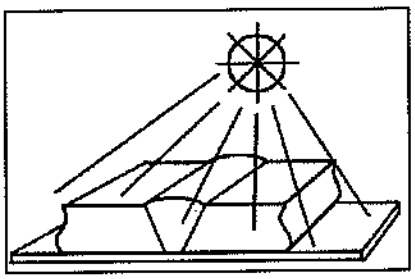


Fig. 1 - Radiography is one of the most important, versatile and widely accpeted examination methods.

X-rays are produced by high-voltage generators. As the high voltage applied to an X-ray tube is increased, the wavelength of the emitted X-ray becomes shorter , providing more penetrating power. Gamma rays are produced by the atomic disintegration of radioisotopes. The radioactive isotopes most widely used in industrial radiography are Cobalt 60 and Iridium 192. Gamma rays emitted from these isotopes are similar to X-rays, except their wavelengths are usually shorter. This allows them to penetrate to greater depths than X-rays of the same power, however, exposure times are considerably longer due to the longer intensity.

When X-rays or gamma rays are directed at a section of weldment , not all of the radiation passes are through the metal. Different materials, depending on their density, thickness and atomic number, will absorb different wavelengths of radiant energy.

The degree to which the different materials absorb these rays determines the intensity of the rays penetrating through the material. When variations of these rays are recorded, a means of seeing inside the material is available. The image on a developed photo-sensitized film is known as a radiograph. Thicker areas of the specimen or higher density material (tungsten inclusion), will absorb more radiation and their corresponding areas on the radiograph will be lighter - Fig 2.

Whether in the shop or in the field, the reliability and interpretive value of radiographic images are a function of their sharpness and contrast. The ability of an observer to detect a flaw depends on the sharpness of its image and its contrast with the background. To be sure that a radiographic exposure produces acceptable results, a gauge known as an Image Quality Indicator (IQI) is placed on the part so that its image will be produced on the radiograph.

IQI's used to determine radiographic quality are also called penetrameters. A standard hole-type penetrameter is a rectangular piece of metal with three drilled holes of set diameters. The thickness of the piece of metal is a percentage of the thickness of the specimen being radiographed. The diameter of each hole is different and is a given multiple of the penetrameter thickness. Wire-type penetrameters are also widely used, especially outside the United States. They consist of several pieces of wire, each of a different diameter. Sensitivity is determined by the smallest diameter of wire that can be clearly seen on the radiograph.

A penetrameter is not an indicator or gauge to measure the size of a discontinuity or the minimum detectable flaw size. It is an indicator of the quality of the radiographic technique.

Radiographic images are not always easy to interpret. Film handling marks and streaks, fog and spots caused by developing errors may make it difficult to identify defects. Such film artifacts may mask weld discontinuities.

Surface defects will show up on the film and must be recognized. Because the angle of exposure will also influence the radiograph, it is difficult or impossible to analyze fillet welds by this method. Because a radiograph compresses all the defects that occur throughout the thickness of the weld into one plane, it tends to give an exaggerated impression of scattered type defects such as porosity or inclusions.

An X-ray image of the interior of the weld may be viewed on a fluorescent screen, as well as on developed film. This makes it possible to inspect parts faster and at a lower cost, but the image definition is poorer. Computerization has made it possible to overcome many of the shortcomings of radiographic imaging by linking the fluorescent screen with a video camera. Instead of waiting for film to be developed, the images can be viewed in real time. This can improve quality and reduce costs on production applications such as pipe welding, where a problem can be identified and corrected quickly.

By digitizing the image and loading it into a computer, the image can be enhanced and analyzed to a degree never before possible. Multiple images can be superimposed. Pixel values can be adjusted to change shading and contrast, bringing out small flaws and discontinuities that would not show up on film. Colors can be assigned to the various shades of gray to further enhance the image and make flaws stand out better. The process of digitizing an image taken from the fluorescent screen - having that image computer enhanced and transferred to a viewing monitor - takes only a few seconds. However, because there is a time delay, we can no longer consider this "real time." It is called "radioscopy imagery."

Existing films can be digitized to achieve the same results and improve the analysis process. Another advantage is the ability to archive images on laser optical disks, which take up far less space than vaults of old films and are much easier to recall when needed.

Industrial radiography, then, is an inspection method using X-rays and gamma rays as a penetrating medium, and densitized film as a recording medium, to obtain a photographic record of internal quality. Generally, defects in welds consist either of a void in the weld metal itself or an inclusion that differs in density from the surrounding weld metal.

Radiographic equipment produces radiation that can be harmful to body tissue in excessive amounts, so all safety precautions should be followed closely. All instructions should be followed carefully to achieve satisfactory results. Only personnel who are trained in radiation safety and qualified as industrial radiographers should be permitted to do radiographic testing.

More | Article Index

The ABC's of Nondestructive Weld Examination

Reprinted courtesy of *Welding Journal* magazine.

Magnetic Particle Inspection (MT)

Magnetic particle inspection is a method of locating and defining discontinuities in magnetic materials. It is excellent for detecting surface defects in welds, including discontinuities that are too small to be seen with the naked eye, and those that are slightly subsurface.

This method may be used to inspect plate edges prior to welding, in process inspection of each weld pass or layer, postweld evaluation and to inspect repairs - Fig. 3.

It is a good method for detecting surface cracks of all sizes in both the weld and adjacent base metal, subsurface cracks, incomplete fusion, undercut and inadequate penetration in the weld, as well as defects on the repaired edges of the base metal. Although magnetic particle testing should not be a substitute for radiography or ultrasonics for subsurface evaluations, it may present an advantage over their methods in detecting tight cracks and surface discontinuities.

With this method, probes are usually placed on each side of the area to be inspected, and a high amperage is passed through the workplace between them. A magnetic flux is produced at right angles to the flow of current - Fig. 3. When these lines of force encounter a discontinuity, such as a longitudinal crack, they are diverted and leak through the surface, creating magnetic poles or points of attraction. A magnetic powder dusted onto the surface will cling to the leakage area more tenaciously than elsewhere, forming an indication of the discontinuity.

For this indication to develop, the discontinuity must be angled against the magnetic lines of force. Thus, when current is passed longitudinally through a workpiece, only longitudinal flaws will show. Putting the workpiece inside a solenoid coil will create longitudinal lines of force (Fig. 3) that cause transverse and angular cracks to become visible when the magnetic powder is applied.

Although much simpler to use than radiographic inspection, the magnetic particle method is limited to use with ferromagnetic materials and cannot be used with austenitic steels. A joint between a base metal and a weld of different magnetic characteristics will create magnetic discontinuities that may falsely be interpreted as unsound. On the other hand, a true defect can be obscured by the powder clinging over the harmless magnetic discontinuity. Sensitivity decreases with the size of the defect and is also less with round cracks such as gas pockets. It is best with elongated forms, such as cracks, and is limited to surface flaws and some subsurface flaws, mostly on thinner materials.

Because the field must be distorted sufficiently to create the external leakage required to identify flaws, the fine, elongated discontinuities, such as hairline cracks, seams or inclusions that are parallel to the magnetic field, will not show up. They can be developed by changing the direction of the field, and it is advisable to apply the field from two directions, preferably at right angles to each other.

Magnetic powders maybe applied dry or wet. The dry powder method is popular for inspecting heavy weldments, while the wet method is often used in inspecting aircraft components. Dry powder is dusted uniformly over the work with a spray gun, dusting bag or atomizer. The finely divided magnetic particles are coated to increase their mobility and are available in gray, black and red colors to improve visibility. In the wet method, very fine red or black particles are suspended in water or light petroleum distillate. This can be flowed or sprayed on, or the part may be dipped into the liquid. The wet method is more sensitive than the dry method, because it allows the use of finer particles that can detect exceedingly fine defects. Fluorescent powders may be used for further sensitivity

and are especially useful for locating discontinuities in corners, keyways, splines and deep holes.

Liquid Penetrant Inspection (PT)

Surface cracks and pinholes that are not visible to the naked eye can be located by the liquid penetrant inspection. It is widely used to locate leaks in welds and can be applied with austentic steels and nonferrous materials where magnetic particle inspection would be useless.

Liquid penetrant inspection is often referred to as an extension of the visual inspection method. Many standards, such as the AWS D.1. Code, say that "welds subject to liquid penetrant testing·shall be evaluated on the basis of the requirements for visual inspection."

Two types of penetrating liquids are used - fluorescent and visible dye. With fluorescent penetrant inspection, a highly fluorescent liquid with good penetrating qualities is applied to the surface of the part to be examined. Capillary action draws the liquid into the surface openings, and the excess is then removed. A "developer" is used to draw the penetrant to the surface, and the resulting indication is viewed by ultraviolet (black) light. The high contrast between the fluorescent material and the object makes it possible to detect minute traces of penetrant that indicate surface defects.

Dye penetrant inspection is similar, except that vividly colored dyes visible under ordinary light are used - Fig. 4. Normally, a white developer is used with the dye penetrants that creates a sharply contrasting background to the vivid dye color. This allows greater portability by eliminating the need for ultraviolet light.

The part to be inspected must be clean and dry, because any foreign matter could close the cracks or pinholes and exclude the penetrant. Penetrants can be applied by dipping, spraying or brushing, but sufficient time must be allowed for the liquid to be fully absorbed into the discontinuities. This may take an hour or more in very exacting work.

Liquid penetrant inspection is widely used for leak detection. A common procedure is to apply fluorescent material to one side of a joint, wait an adequate time for capillary action to take place, and then view the other side with ultraviolet light. In thin-walled vessels, this technique will identify leaks that ordinarily would not be located by the usual air test with pressures of 5-20 lb/in.2 When wall thickness exceeds ¹ in., however, sensitivity of the leak test decreases.

Ultrasonic Inspection (UT)

Ultrasonic inspection is a method of detecting discontinuities by directing a high-frequency sound beam through the base plate and weld on a predictable path. When the sound beam's plate path strikes an interruption in the material continuity, some of the sound is reflected back. The sound is collected by the instrument, amplified and displayed as a vertical trance on a video screen - Fig. 5.

Both surface and subsurface detects in metals can be detected, located and measured by ultrasonic inspection, including flaws too small to be detected by other methods.

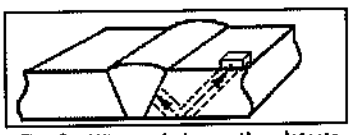


Fig. 5 - Ultrasonic inspection detects discontinuities both on and below the weld surface. Compact, portable equipment makes it easy to use in the field.

The ultrasonic unit contains a crystal of quartz or other piezoelectric material encapsulated in a transducer or probe. When a voltage is applied, the crystal vibrates rapidly. As an ultrasonic transducer is held against the metal to be inspected, it imparts mechanical vibrations of the same frequency as the crystal through a couplet material into the base metal and weld. These vibrational waves are propagated through the material until they reach a discontinuity or change in density. At these points, some of the vibrational energy is reflected back. As the current that causes the vibration is shut off and on at 60-1000 times per second, the quartz crystal intermittently acts as a receiver to pick up the reflected vibrations. These cause pressure on the crystal and generate an electrical current. Fed to a video screen, this current produces vertical deflections on the horizontal base line. The resulting pattern on the face of the tube represents the reflected signal and the discontinuity. Compact portable ultrasonic equipment is available for field inspection and is commonly used on bridge and structural work.

Ultrasonic testing is less suitable than other NDE methods for determining porosity in welds, because round gas pores respond to ultrasonic tests as a series of single point reflectors. This results in low-amplitude responses

that are easily confused with "base-line noise" inherent with testing parameters. However, it is the preferred test method for detecting plainer-type discontinuities and lamination.

Portable ultrasonic equipment is available with digital operation and microprocessor controls. These instruments may have built-in memory and can provide hard-copy printouts or video monitoring and recording. They can be interfaced with computers, which allows further analysis, documentation and archiving, much as with radiographic data. Ultrasonic examination requires expert interpretation from highly skilled and extensively trained personnel.

Choices Control Quality

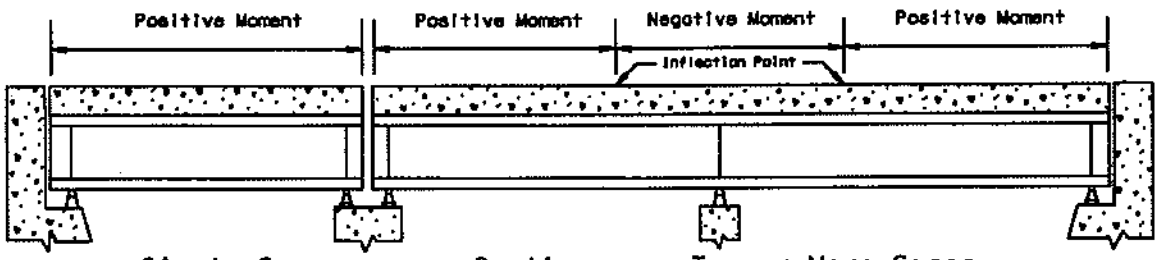
A good NDE inspection program must recognize the inherent limitations of each process. For example, both radiography and ultrasound have distinct orientation factors that may guide the choice of which process to use for a particular job. Their strengths and weaknesses tend to compliment each other. While radiography is unable to reliably detect lamination-like defects, ultrasound is much better at it. On the other hand, ultrasound is poorly suited to detecting scattered porosity, while radiography is very good.

Whatever inspection techniques are used, paying attention to the "Five P's" of weld quality will help reduce subsequent inspection to a routine checking activity. Then, the proper use of NDE methods will serve as a check to keep variables in line and weld quality within standards.

The Five P's are:

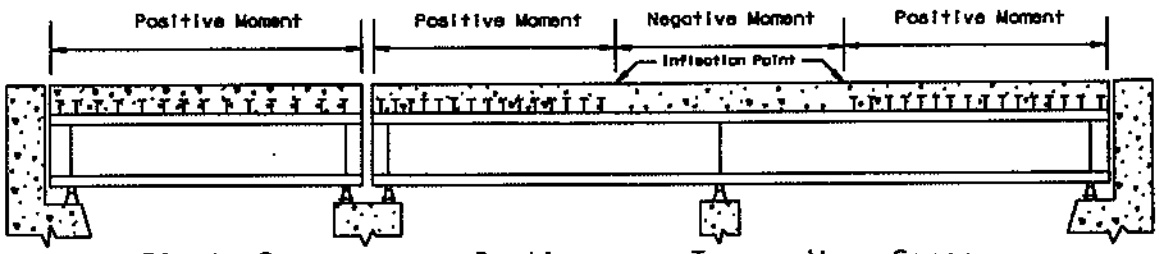
1) Process Selection. The process must be right for the job.
2) Preparation. The joint configuration must be right and compatible with the welding process.
3) Procedures. The procedures must be spelled out in detail and followed religiously during welding.
4) Pretesting. Full-scale mockups or simulated specimens should be used to prove that the process and procedures give the desired standard of quality.
5) Personnel. Qualified people must be assigned to the job.

Previous [illegible]



Simple Span Continuous - Two or More Spans

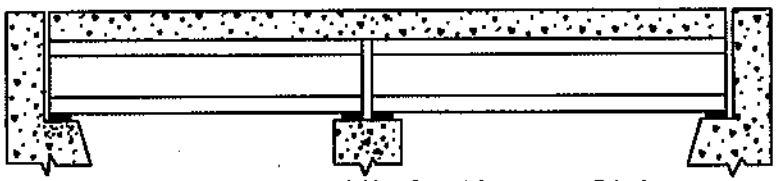
NON - COMPOSITE STEEL



Simple Span Continuous - Two or More Spans

COMPOSITE STEEL

(Or Reinforced Concrete Girder Span)



Simple Span with Continuous Slab

PRESTRESSED CONCRETE

EMERGENCY
CONSTRUCTION JOINTS
SLAB ONLY

Exhibit No. 63-8-45
Sheet 1 of 3

EMERGENCY CONSTRUCTION JOINTS FOR BRIDGE SLABS

Definition of Terms

Inflection Point: An inflection point is the point where the bending moment changes from positive to negative and occurs at approximately 1/5th of the clear span distance from the face of the pier on multi-span, continuous units.

Negative Moment Area: The negative moment area is that section of a bridge slab located over a pier with the limits defined by inflection points, one of which is located on each side of the pier as explained above. The top of beams and the deck is in tension in the longitudinal direction an a negative moment area.

Composite Bridge Deck: A bridge in which the slab and beams are rigidly connected to cause the slab and beams to act together as a tee unit. This action is achieved on steel beam bridges with the use of shear connectors and on concrete beam bridges with reinforcing stirrup bars protruding form the top of the beams.

Non-Composite Bridge Deck: A non-composite bridge deck is a slab which is not tied to the beams. The design of the bridge is not based upon a tee unit.

Emergency Construction Joint Location

1. For the following types of structures an emergency construction joint may be made at any location in the slab except that no joint may be located within ten (10) feet of another construction joint:

   1) Simple Reinforced Concrete Deck Girder Spans
   2) Non-Composite Simple Steel Girder Spans
   3) Simple Prestressed Concrete Girder Spans.

2. For continuous girder spans it is desirable to locate an emergency construction joint prior to the negative moment area over the pier. This may require that some of the fresh concrete be "washed out" back to a desired joint location.

3. Composite Simple Steel Girder Spans: This type of structure will have shear connectors from end to end of span. No joints are allowed except as detailed on the plans. If a breakdown occurs, the contractor may elect to wash the concrete out if the quantity placed is small. If the quantity placed is a significant amount, the contractor may elect to install an emergency construction joint. In this event the project engineer should immediately contact the District Construction Office who in turn should contact the Central Office Division of Construction Bridge Engineer for direction. No more concrete shall be placed until the situation is resolved.

4. Composite Continuous Steel Girder Spans: This type of structure will have shear connectors located only in the positive moment areas. Usually there will be a pouring sequence on the plans or the plans may require that the concrete be kept in a plastic state by the addition of a set retarder until the entire deck is placed.

   An emergency construction joint may be made in the negative moment areas provided all the positive moment areas have been placed. If it is necessary to provide an emergency construction joint in a positive moment area, the Project Engineer should immediately contact the District Construction Office who in turn should contact the Central Office Division of Construction Bridge Engineer for guidance. No more concrete is to be placed until the situation is resolved.

General Note:

An approved epoxy grout should be used as an aid to bonding at all emergency construction joint locations.

CEMENT (Low Slump) CONCRETE OVERLAY

This exhibit has been prepared to explain as in-depth as possible the necessary computations involved in a Low Slump Concrete operation. The information presented here-in is from an actual project and is realistic. It is anticipated that the Inspector will make his own graphs to reflect his concrete truck calibration data, however, the forms used for the "Design Data For Concrete Mobiles" and for the "Water Cement Ratio" are available from the Central Office, Division of Construction. Blank copies of these forms have also been included as Exhibits 63-8-53, 54, & 55 and may be copied for use if the need arises.

It must be noted that this exhibit does not cover Latex Concrete, however, the procedures and computations for Latex Concrete are similar to those for Low Slump concrete and the transition should be made with little difficulty.

Accordingly, a sequence of events pertaining to a Low Slump Concrete operation has been prepared to aid in clarification of this exhibit. This information is presented as follows:

Sequence of Events

1. Inspect and calibrate Concrete Mobile Truck in accordance with KM 64-312. Use Form 64-317. See page 3 of this exhibit.

2. Determine the following data Form 64-105 (Concrete Mix Design) - Refer to Material's "Manual of Field Sampling and Testing Practices" for example.

   (A) Specific gravity of fine aggregate and coarse aggregate.

   (B) Percent absorption of coarse aggregate.

   (C) Weight per bag of each aggregate.

   (D) Ratio of aggregates.

3. Design the concrete mix using the "Concrete Mix Design" Form TD 64-305 (See Page 4 of this exhibit). Utilize information from the Special Provision applicable to the project and the Form TD 64-105 (Step 2 above) in making the calculations.

   (A) Calculate the free moisture of the fine and the coarse aggregate. Use whichever method prescribed in KM 64-306 that is applicable to the situation.

4. Obtain the Adjusted Aggregate weights due to moisture content from step 6 of Form 64-305. Plot this information on the form for "Design Data for Concrete Mobile", Page 10 of this exhibit.

5. Since this example concerns a low slump concrete overlay, compute the Design water/cement ratio on the form designed for this purpose (Page 11 of this exhibit). A similar form for latex overlay water/cement overlay has been included in this section as Exhibit No. 63-8-54.

6. Calculate the target density as follows; Compute the Average Combined Specific Gravity of the fine and coarse aggregates. Obtain the design added water in gal./C.Y. from the water/cement ratio form utilized in Step 5 above. Using this information, go to Chart No. 1 (Exhibit No. 63-8-51) to obtain the target density.

7. Upon completion of each truck load, the inspector will remove ticket from cement meter, verify reading and record the following data on the form titled "Design Data For Concrete Mobile" (See step 4 above)

   A. Meter Reading
   B. Water Meter Reading
   C. C.Y. produced (place in comments)

   When entire placement is completed, the inspector will summarize and record on the Water/Cement Ratio Form (Step 5 above) the following data:

   D. Total water used for entire placement
   E. Total C.Y. produced
   F. Compute water/cement ratio for entire placement

   A comparison may be made of the Design and Actual Water/Cement ratios and also of the Gal./C.Y. in each case.

8. Exhibit No. 63-8-54 is essentially the same Exhibit No. 68-8-53 which was used in Step 5 above, except it is for Latex Concrete. It should be noted that Form TD 64-305 (Mix Design Report) is not prepared for Latex. Weights of aggregates are obtained from the Special Provision applicable to the project.

TC 64-317
Rev. 1/78

KENTUCKY DEPARTMENT OF TRANSPORTATION
BUREAU OF HIGHWAYS
DIVISION OF MATERIALS
CONCRETE MOBILE CALIBRATION DATA SHEET

COUNTY	Caldwell	Project No.	MP 17-0175-B0012
CONTRACTOR	Golden Bridge	Date	5/2/79
TRUCK NO.	2	SERIAL NO. & CAPACITY	6CM5163 DH/24f 8cy-75.5-32
TRUCK R.P.M.	Hyd.	CALIBRATED BY	Roy J. White

CEMENT

Container Wt. 28.1 lb.

	LBS.	COUNT	SECS.
1	103.4	80	32.2
2	99.6	80	32.2
3	97.2	80	32.4
4	98	80	32.2
5	97.8	80	32.3
TOTALS	496	400	161.3

Lbs./count = Total Lbs. / Total Counts = 496 / 400 = 1.2240

Lbs./sec. = Total Lbs. / Total Secs. = 496 / 161.3 = 3.0750

Sec. for 94 Lbs. = 94 / Lbs./County = 496 / 1.24 = 75.80 = 76

Sec. for 94 Lbs. = 94 / Lbs./Sec. = 94 / 3.075 = 30.57 = 31

SAND — Sec. for Calibration 31 Container Wt. 23.0# Moisture Content 3%

Dial Setting	2.5	3	3.5		
Lbs. of Sand	1340	166.4	197.5		
	132.1	166.3	195.9		
	130.4	165.6	194.2		

STONE — Sec. for Calibration 31 Container Wt. 23.0# Moisture Content 0%

Dial Setting	3.5	3.8	4	4.5	
Lbs. of Stone	150.6	166.5	182	203.8	
	151.2	167.1	181.9	202.2	
	151.8	167.7	181.8	200.6	

AIR — Sec. for Calibration 31 MB-YR Diluted 1 TO 5

Setting	0.4	0.6	0.8	1	1.2					
Fl. Ozs. or Lbs.	2.5	5	6.8	9	11.25					

PE "A" or TYPE "D" ADMIXTURE — Sec. for Calibration 31 Pozz 300-R Diluted 1 to 5

Setting	0.4	0.6	0.8	1						
Fl. Ozs.	6	9	12.5	16						

WATER — Sec. for Calibration 31 Container Wt. 3.75 lbs.

Setting	3	4	5	6						
Lbs.	21.31	27.2	32.61	39.14						

2.5	3.2	3.85	4.65	
20.85	26.69	32.11	38.78	
0.46#	0.51#	0.50#	0.36#	

Counts Per C.Y. = 665
Counts Yield Test = 166

TC 64-305
Rev. 3/92

KENTUCKY TRANSPORTATION CABINET
DIVISION OF MATERIALS

CONCRETE MIX DESIGN

County: Caldwell
Date: 5-2-79
Project No.: MP 17-0175-B0012
Concrete Class: Portland O. L.
Concrete Producer: Golden Bridge Company
Min. Cement Factor Bags/CY: 8.75
Plant Location: Concrete Mobile
Min. Cement Factor Lbs/CY: 823
Cement Brand: Marquetta
Max. Water Lbs/CY: 288
A or D Admix Brand: Master Builders Pozz 300-R 2/.88 oz./CY
Air Entraining Brand: Master Builders MB-VR 8 3/4 oz./CY
Fly Ash Source:
Class of Fly Ash:
Fly Ash % Reduction By Weight:
Replacement Ratio:
Fly Ash Sp. Gr.:

	FINE AGGREGATE DATA	COARSE AGGREGATE DATA
Source	Little River Sand Co.	Interstate Stone Co.
Bulk Sp. Gr. (S.S.D.)	2.63	2.68
Absorption, %	0.8	0.7
Free Moisture Content, %	3.0	0.0

MIX CALCULATIONS

1. Calculate Volume of Cement, Fly Ash and Total Water: Volume = V = $\frac{\text{Weight}}{\text{Sp. Gr.} \times 62.4}$

	MIX NO. 1	TIME		MIX NO. 2	TIME	
	Weight, Lbs	%	Volume, CF	Weight, Lbs	%	Volume, CF
Cement	823	—	4.187		—	
Fly Ash		—			—	
Water (*Total*)	262	—	4.199		—	
Air Content	0	5.5	1.485	0	5.5	1.485
2. Subtotals, Weight & Volume	1085	—	9.871		—	
3. 27 CF – Volume Total	—	—	17.129	—	—	

4. Calculate Fine and Coarse Aggregate Volumes: % Fine x Volume in Step 3 and % Coarse x Volume in Step 3. Calculate Fine and Coarse Aggregate Weight = Volume x Sp. Gr. x 62.4.

Fine Aggregate, SSD	1405	50	8.564			
Coarse Aggregate, SSD	1432	50	8.564			
5. Totals, Weight & Volume (*Step 2 + Step 4*)	3922	—	26.999		—	

6. Calculate Adjusted Aggregate Weights Due to Moisture Content: SSD Aggregate Weights x 1.00 ± % Moisture in Decimal Form.

Adjusted Fine Agg. Wt.	1447	
Adjusted Coarse Agg. Wt.	1432	

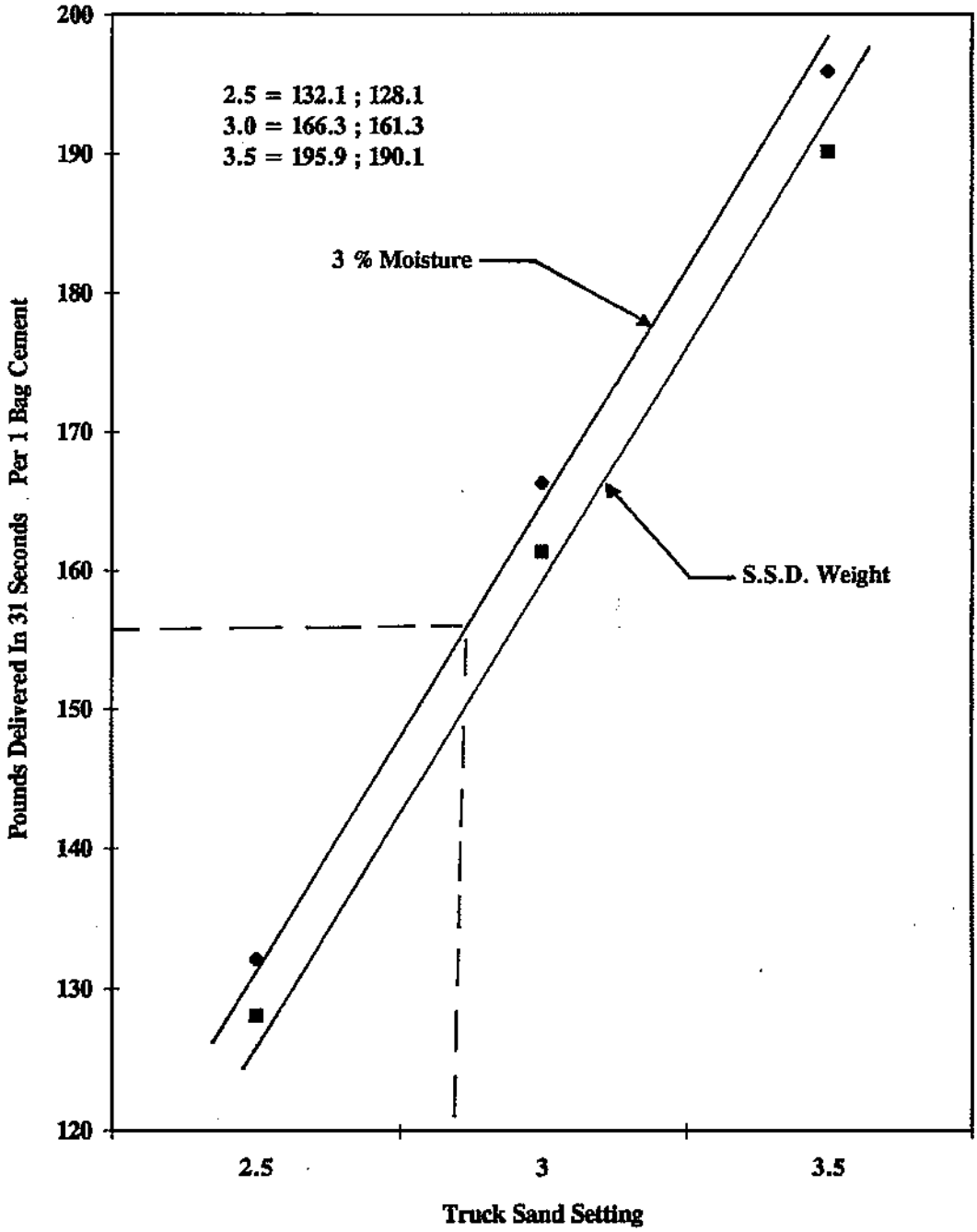
7. Calculate Water Added at Mixer: Subtract SSD Aggregate Weights from Adjusted Aggregate Weights, Total and Subtract from Total Water in Step 1.

Water Added at Mixer (*Lbs., Gals.*)	220 : 26.38	:

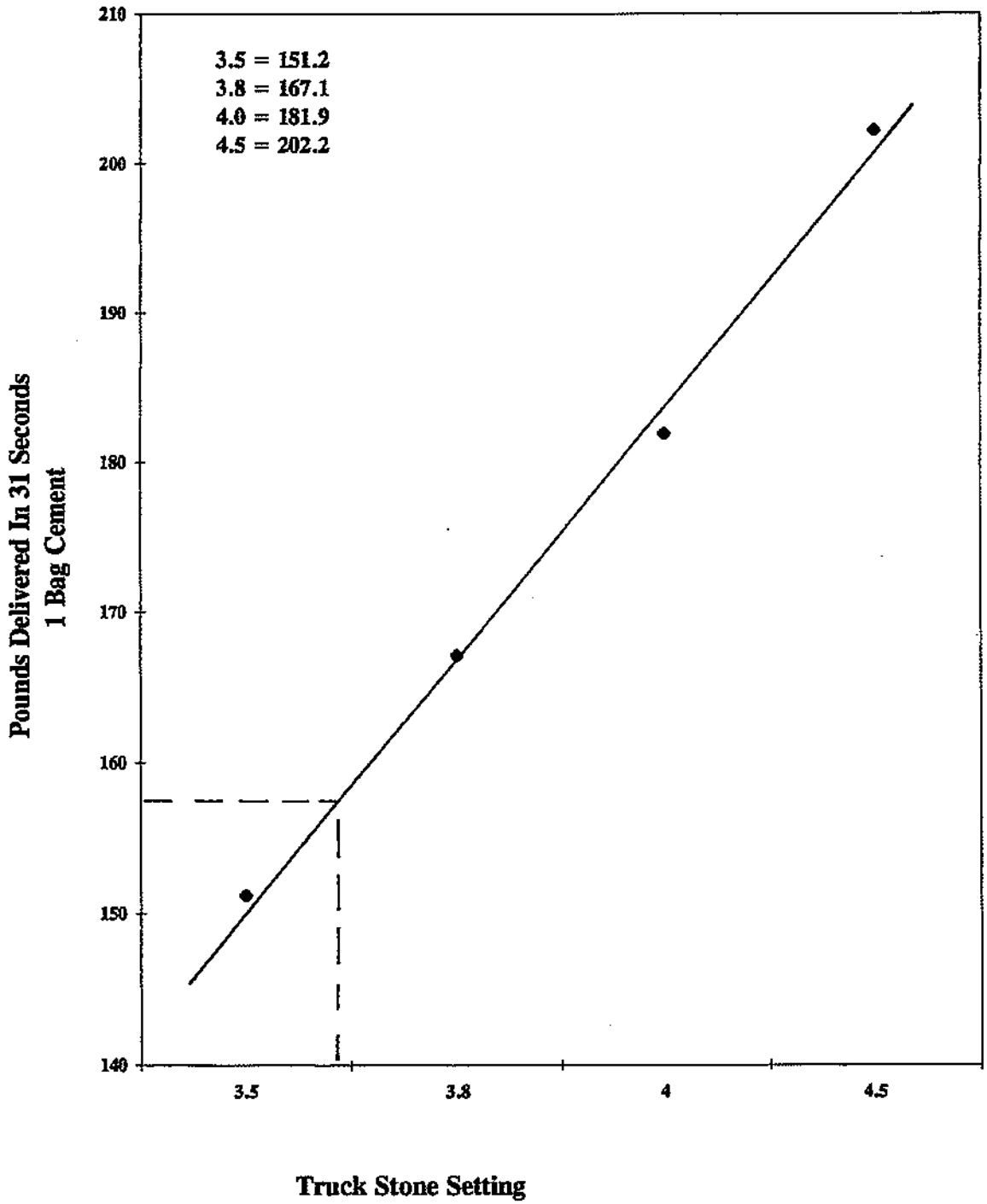
TEST RESULTS AT PLANT
Slump: 1/2 inch
Air Content: 5.6%
Concrete Temperature: 78 degrees
Water Underrun (Max – Step 1 Total): 26 lbs. : 3.12 Gal.
Plant Inspector:

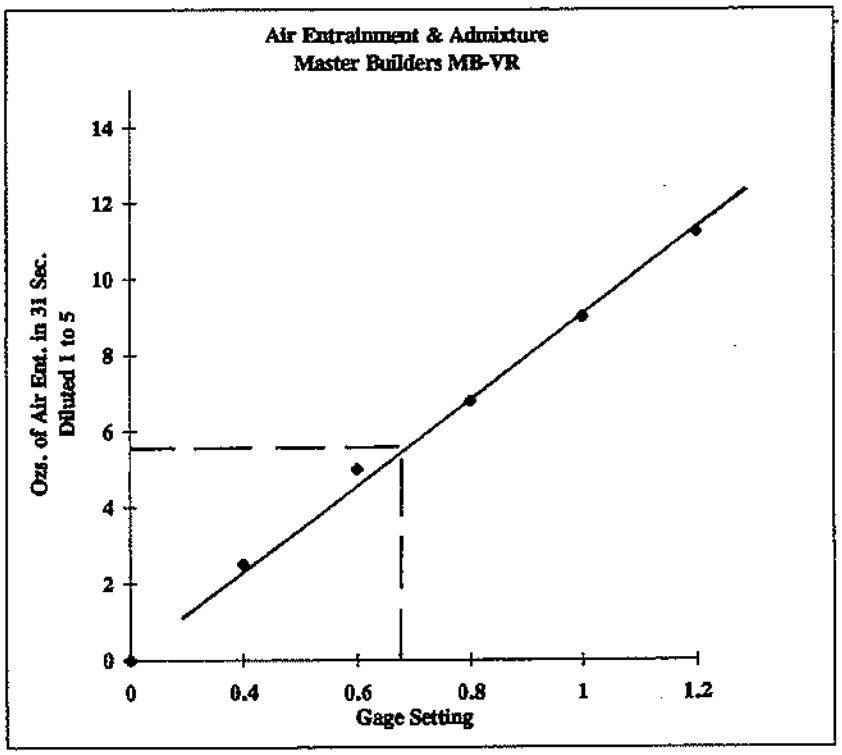
SAND

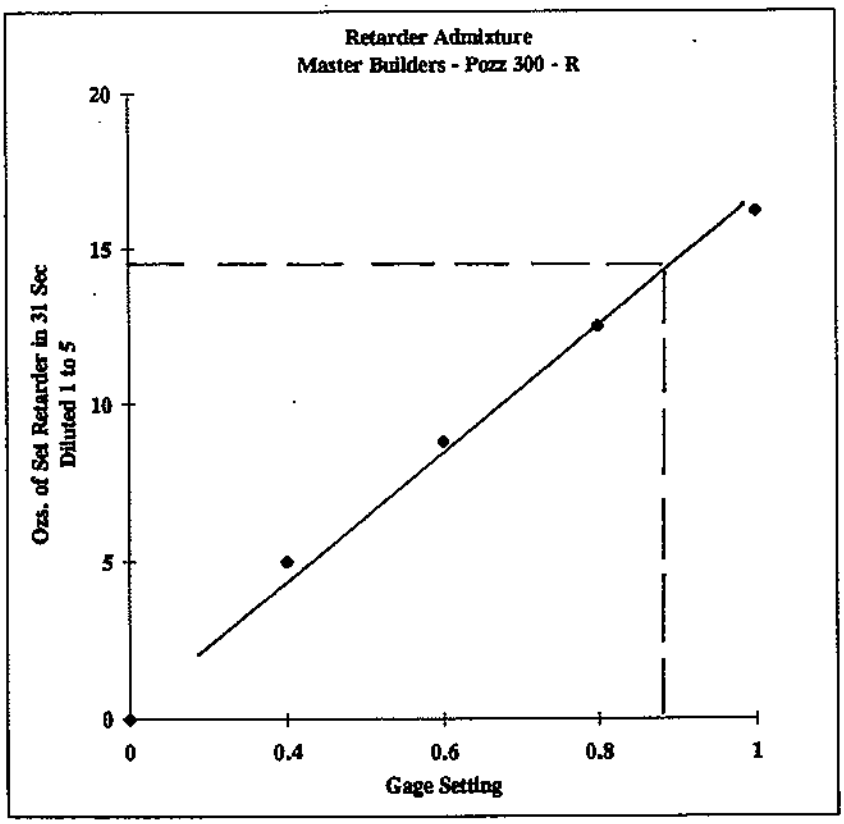
Sand Moisture = 3.0 %

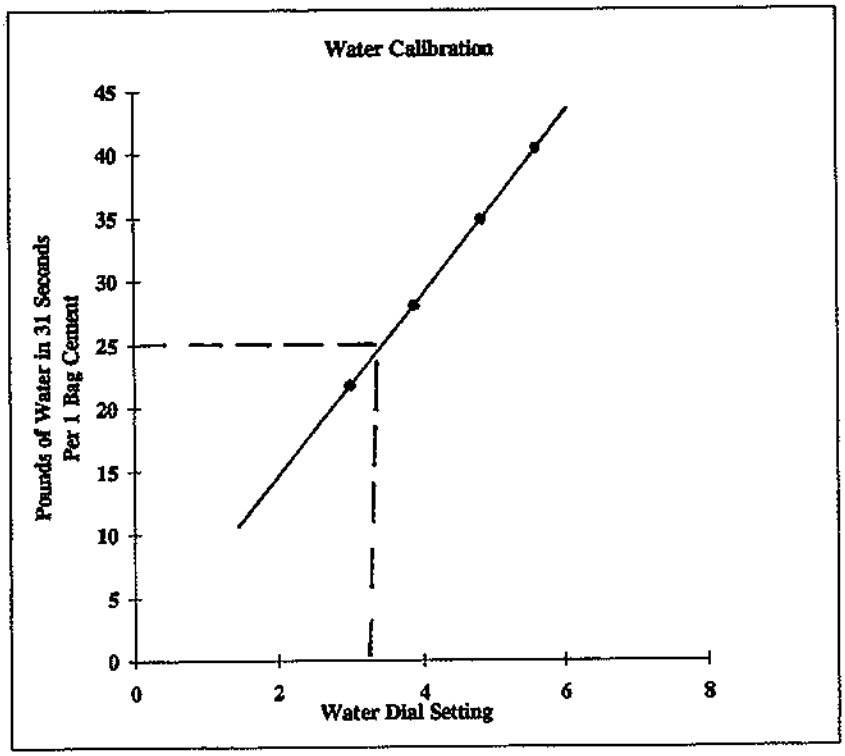


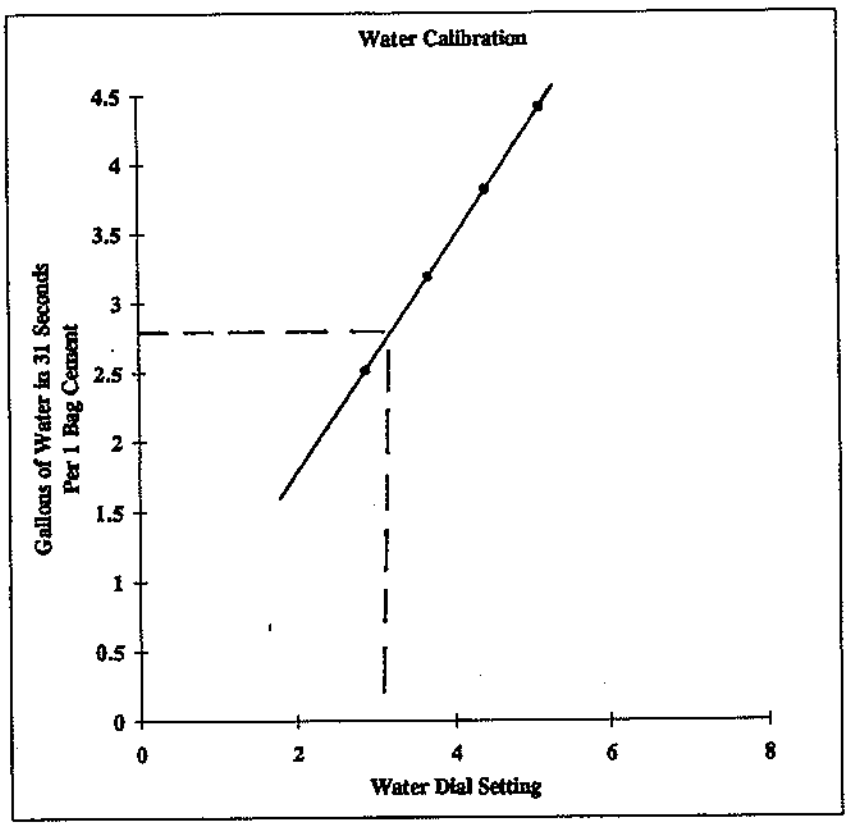
STONE


3.5 = 151.2
3.8 = 167.1
4.0 = 181.9
4.5 = 202.2
210
200
190
180
170
160
150
140
3.5
3.8
4
4.5
Pounds Delivered In 31 Seconds
1 Bag Cement
Truck Stone Setting


Air Entrainment & Admixture
Master Builders MB-VR
Ozs. of Air Ent. in 31 Sec.
Diluted 1 to 5
14
12
10
8
6
4
2
0
0
0.4
0.6
0.8
1
1.2
Gage Setting


Retarder Admixture
Master Builders - Pozz 300 - R
Ozs. of Set Retarder in 31 Sec
Diluted 1 to 5
20
15
10
5
0
0
0.4
0.6
0.8
1
Gage Setting


Water Calibration
Pounds of Water in 31 Seconds
Per 1 Bag Cement
45
40
35
30
25
20
15
10
5
0
0
2
4
6
8
Water Dial Setting


Water Calibration
Gallons of Water in 31 Seconds
Per 1 Bag Cement
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
2
4
6
8
Water Dial Setting

TROXLER

NUCLEAR C(ΛPACTION TEST DATA

PROJECT MP 17-0175-B0012
JOB NUMBER
DATE May 2, 1979
TAKEN BY

TEST NUMBER	1	2	3	4	5	6	7	8	9	10
STATION	100+00									
OFFSET	15' Rt.									
ELEVATION										
MODE & DEPTH	B.S.									
DENS. CNT.	2760									
WET DENS.	147.7									
MSTRE. CNT.	609									
MOISTURE	–									
DRY DENS.	–									
% MOISTURE	–									
STD. DENS.	–									
OPT. MSTRE.	–									
% COMP.	–									
MSTRE. CORR.	–									

TEST NUMBER	11	12	13	14	15	16	17	18	19	20
STATION										
OFFSET										
ELEVATION										
MODE & DEPTH										
DENS. CNT.										
WET DENS.										
MSTRE. CNT.										
MOISTURE										
DRY DENS.										
% MOISTURE										
STD. DENS.										
OPT. MSTRE.										
% COMP.										
MSTRE. CORR										

DENSITY	MOISTURE

REMARKS:

EXHIBIT NO. 63-8-47
PAGE 9 OF 11

DESIGN DATA FOR CONCRETE MOBILE

Un. Proj. No. MP 17-0175-B0012 Date May 2, 19 79

Truck Operator U. Kno Hu Contractor Golden Bridge Company

	Truck No. 1	Truck No. 2		Truck No. 1	Truck No. 2
Sand Dial Setting	2.97		Stone Dial Setting	3.7	
Pounds 165			Pounds 163		
Seconds 31			Seconds 31		
Moisture 3.0			Moisture 0.0		
Water Setting	3.5		Latex Steeling	N/A	
Pounds 25			Pounds		
Gallons 2.99			Gallons		
Seconds 31			Seconds		
Air Setting	0.7		Retarder Setting	0.95	
Oz. Pure 1			Oz. Pure 2.5		
Oz. Mix 6			Oz. Mix 15		
Seconds 31			Seconds 31		

	No. 1	No. 2
Counts Per Box Cement	76	
Counts Per Cu. Yd.	665	
Counts Per 1/4 C.Y. Yield Test	166	

	Load 1	Load 2	Load 3	Load 4
Total Water Meter R'dg.	267.2			
Total Latex Meter R'dg.	N/A			
Meter Register R'dg.	6783			
Comp. Test Cyl. No.	01-01-0A			
Truck No.	No. 1			

CALCULATIONS

COMMENTS: _____

_____

INSPECTOR

WATER CEMENT RATIO
CEMENT CONCRETE OVERLAY

'JN. PROJ. NO. MP 17-0175-B0012 CONTRACTOR Golden Bridge Company

DATE May 2, 1979 INSPECTOR

Design Cement (From Spec. Prov.) = (A) 8.75 Bags/C.Y.

Final Overlay Quantity = (B) 10.20 C.Y.

	DESIGN LBS./C.Y.	FINAL LBS.
WATER ADDED AT MIXER		
Meter Setting 3.5 Lbs./Bag x (A) 8.75 Bags/C.Y. =	(C) 218.75	
Final Water Meter Reading 267.2 Gal. X 8.34 Lb/Gal. =		(D)2228.
WATER ADDED IN AIR MIXER Type MB-VR		
Dilution 1 Oz. Admix. To 5 Oz. Water =)E) 6 Total Oz. Mixture		
Dispenser Setting 0.7 From Cal. Chart = (F) 6 Total Oz. Mix/Bag		
(F) 6 ÷ (E) 6 = (G) 1 Oz. Air Added		
(F) 6 - (G) 1 = (H) 5 Oz. Water Added		
(H) 5 x (A) 8.75 Bags/C.Y. ÷ 128 Oz./Gal. = (I) 0.34179 Gal./Water		
(I) .34179 Gal. Water x 8.34 lb./Gal. =	(J) 2.85	
Final Overlay Quan. (B) 10.20 C.Y. x (J) 2.85 =		(K)29.0
WATER ADDED IN WATER REDUCING ADMIX. (RETARDER)		
Dilution 1 Oz. Admix. To 5 Oz. Water = (L) 6 Total Oz. Mixture		
Dispenser Setting 0.95 From Cal. Chart = (M) 6 Total Oz. Mix/Bag		
(M) 15 ÷ (L) 6 = (N) 2.5 Oz. Of Reducer Added		
(M) 15 - (N) 2.5 = (O) 12.5 Oz. Water Added		
(O) 12.5 x (A) 8.75 Bags/C.Y. ÷ 128 Oz./Gal. = (P) 0.8545 Gal. Water		
(P) .8545 Gal. Water x 8.34 Lb./Gal. =	(Q) 7.13	
Final Overlay Quan. (B) 10.20 C.Y. x (Q) 7.13 =		(R) 72.7
WATER IN SAND		
Design Wgt./Bag = (S) 165 Lbs. Moisture = 3.0 % ÷ 100 = (T) 0.03		
(S) 165 Lbs. X (T) 0.03 x (A) 8.75 Bag/C.Y. =	(U) 43.31	
Final Overlay Quan. (B) 10.20 C.Y. x (U) 43.31 =		(V) 441.7
WATER IN STONE		
Design Wgt./Bag = (W) 163 Lbs. Moisture = 0.0 % ÷ 100 = (X) 0.0		
(W) 163 Lbs. X (X) 0.0 x (A) 8.75 Bags/C.Y. =	(Y) 0.0	
Final Overlay Quan. (B) 10.20 C.Y. x (Y) 0.0 =		(Z) 0.0
Total Design Water in Overlay = [Total of (C) + (J) + (Q) + (U) + (Y)] =	(AA) 272.04	

Design W/C Ratio = (AA) 272.04 Lbs/C.Y.
(A) 8.75 Bags/C.Y. x 94 Lbs./Bag = 0.3307

Total Water Used for Entire Pour = [Total of (D) + (K) + (R) + (V) + (Z)] = (BB) 2772.

Cement Used = (B) 10.20 C.Y. x (A) 8.75 Bags/C.Y. X 94 Lbs./Bag = (CC) 8389.5 Lbs.

Actual Water = (BB) 2772.00 Lbs. + 0.33045
(CC) 8389.50 Lbs.

Total Water = (BB) 2772.34 Lbs. = 0.33045 Gal./C.Y.
8.34 Lb./Gal x (B) 102.0 C.Y.

Design = (AA) 272.04 Lbs. = 32.62 Gal./C.Y.*
8.34 Lb./Gal

* Use this design Gal./C.Y. when calculating Theoretical Density. Note: Max. w/c Ration = 0.354

CONCRETE MOBILE - CHECK LIST

1. Incorporate check list specified by KY Method (KM) 64-312.

2. Sand and Stone should be placed in proper bins. Some trucks have vibrators only on sand bin.

3. Admixtures should be premixed at a predetermined ratio before pouring into truck tanks.

4. The gate openings should be checked to be sure they are within the proper operating range before beginning calibration of concrete mobile. The test gauge provided with the equipment (3" x 3" x 8") wooden block should be placed under the gate, and the gate lowered by means of hand wheel until it just touches the block. Increase the pressure on the hand wheel by one tenth on the dial. The pointer should indicate 6.4 ($\pm$.2) on both stone and sand dials. Use 1 ll/16 inch thick block for magnum units in which sand dial should read 7.8 and stone dial reading should be 7.4.

NOTE: If necessary to adjust the pointers to bring dials within specifications the inspector should note pointer setting in reference to hand wheels and mark same with magic marker.

(It is possible to move the hand wheel and reset pointer to give a lower gate setting yet pointer be on correct calibration setting. Lower gate setting will cause less material per cu yard and should be caught when yield check is performed.)

5. Mix Conveyor

   A. Auger wear plates and blades on the mixing paddles and flighting plates must be within the specified limits of 1/4" above the mounting holes. This should be checked with wear gauge furnished by the truck operator. (Inspector can make one from right angle triangle).

   B. The angle of the mix conveyor should be no less than 15° will result in improper mixing. The inclinometer is located on the left side of the mix-conveyor but on many trucks has been removed or is no longer operative. The inspector should request the contractor to provide the means to determine the angle of incline in the case. This is most important for proper mixing.

INSTRUCTIONS FOR TAKING DENSITIES PRIOR AND DURING PLACEMENT OF CONCRETE OVERLAY

1. READ PROPOSAL AND SPECIAL NOTES APPLICABLE TO PROJECT.

2. Determine width of placement.

3. Make diagram, not to scale, of bridge deck showing lanes of concrete placement.

4. A base density test shall be taken every 50' in each lane of placement which has been machined prepared. These shall be numbered in such a way that the actual location of each test may be accurately determined.

5. The results of the base density tests should be recorded in a field book for future references along with such necessary data as location of test, direct reading, and actual wet density.

6. The densities taken on the existing bridge deck shall not be less than 140 PCF or more than 153 PCF. Move meter until the base densities are within the specified range.

7. Target Density shall be computed prior to beginning concrete placement. Use Charge No. 1 (Exhibit No. 63-8-51). A density, slump and air test is required every 50 ft. Per lane of concrete placement or one test per mobile mixed load, whichever will require the greater numbeer of testing.

Note: These instructions for taking densities is based on the Troxler 3400 - B Series Nuclear Density Gauges. If any other Troxler gauges or gauges from other manufacturers are used, concult the gauge's instruction manual for the proper method for taking densities on thin lift overlays.

8. When placement of concrete is begun, a density test shall be taken at the same location as those taken on the existing bridge deck by using Styrofoam in lieu of air gap stand.

9. Nuclear gauges, when used in the backscatter mode on overlays less than 3 inches, have certain limitations which must be overcome in order to obtain correct densities. The problem arises because the gauge "sees" through the thin overlay and the underlying material influences the gauge reading.

Recognizing this problem, a nomograph was developed which allows rapid determination of overlay density. To use the nomograph, it is necessary to know the density of the bottom layer and the thickness of the top layer. The simplest method of determining the bottom layer density is by taking nuclear density tests before the overlay is applied. Concrete is then placed and compacted. Backscatter density tests are on the top of the new pavement and the mat thickness determined. With this data, the density of the top layer may be determined from the nomograph. See Exhibit No. 63-8-49, page 3 of 3 for example. A blank copy of this nomograph is included as Exhibit No. 63-8-52.

(Material taken from the Troxler 3400-B Series Instruction Manual)

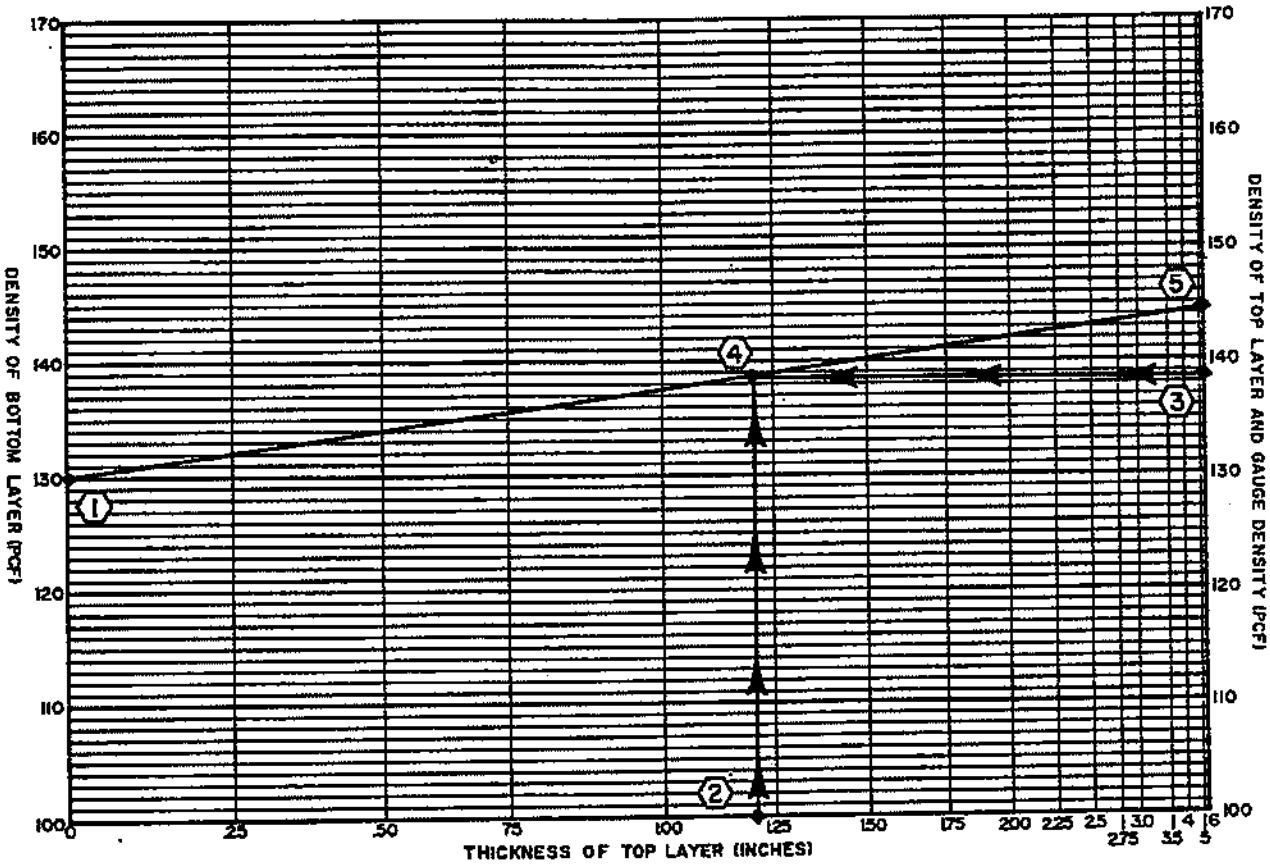
10. This in-place density will then be adjusted using the following formular as per Section 741.05 (D) of the Standard Specifications.

$$\text{Adjusted Density} = \frac{\text{in-place density} \times 0.945}{1.00 - \text{actual air content *}}$$

* Express actual air content as a decimal.

V-D-2. OVERLAY EXAMPLE - U.S. Customary Units

In this example the bottom layer density (left scale) is 130 PCF with a mat 1.2 inches thick overlaying it. A backscatter density test on the top of the mat (right scale) yielded a result of 138.5 PCF. A line is then drawn from 130 PCF on the left scale through the intersection of 1.2 inches (bottom) and 138.5 PCF (right) and extended to the right. The correct density for the top layer is then read from the nomograph as 144.5 on the right scale.



THIN LIFT OVERLAY NOMOGRAPH
(US CUSTOMARY UNITS)

Nomograph for Thin Lift Overlays
U.S. Customary Units

Figure 5-2

METHOD OF COMPUTING THEORETICAL BASIC ABSOLUTE VOLUME

Portland Cement Low Slump Concrete (Overlay)

Cement Volume = $\frac{\text{Bags/CY}}{27} \times \frac{\text{94 (wt. Of 1 bag)}}{3.15 \times 62.4}$

Liquid Volume = Design water (in pounds) per bag of cements plus all additives (in pounds) times bags per cubic yard divided by 27 equals liquid weights per cubic foot.

$\frac{\text{Liquid wt./C.F.}}{8.34}$ = volume of Liquid/C.F.

If design criteria is in gallons per cubic yard, compute as follows:

$\frac{\text{Gallons/CY}}{27} \times \frac{8.34}{62.4}$ = Volume/C.F.

Air = Use theoretical volume - no weight

Fine and coarse aggregate - Use total volume as one (1). Add cement volume, liquid volume and air volume together and subtract from one (1). This leaves the volume of fine and coarse aggregates. Since low slump concrete has 50% of fine aggregate and 50% of coarse aggregate, take the specific gravity of each and determine average combined specific gravities.

Compute weight of cement, liquids, and aggregates as shown in example below to determine target density.

EXAMPLE

Design Criteria -
Cement - 8.75 bags/CY
Total Liquid - 33.8 gals/CY
Air - 5.5%
Specific Gravity Fine Aggregate - 2.64
Specific Gravity Coarse Aggregate - 2.72

Cement Volume - $\frac{8.75}{27} \times \frac{94}{3.15 \times 62.4}$ = .15498 C.F.

Liquid Volume - $\frac{33.8}{27} \times \frac{8.34}{62.4}$ = .16731 C.F.

Air Volume - .05500 C.F.

.37729

Total Unit Volume -	1.00000
Total Volume Cement, Liquid and Air	0.37729
Total Volume Aggregates	0.62271

Specific Gravity of Fine Aggregate -	2.64
Specific Gravity of Coarse Aggregate -	2.72
Average combined Specific Gravities	5.36 ÷ 2 = 2.68

Theoretical Weight (Target Density)

Cement -	0.15498 x 3.15 x 62.4	=	30.46
Liquids -	0.16731 x 62.4	=	10.44
Air -	0.05500 x 00.0	=	0.00
Aggregates -	0.62271 x 2.68 x 62.4	=	104.14
	1.00000 Cubic Foot	=	145.04 Lbs.

Constants Used in Calculations

1 gal. water weighs 8.34 lb/gal.

1 cubic foot water weighs 62.4 lbs/C.F.

1 cubic yard = 27 cubic feet

weight one (1) bag cement = 94 lbs/bag

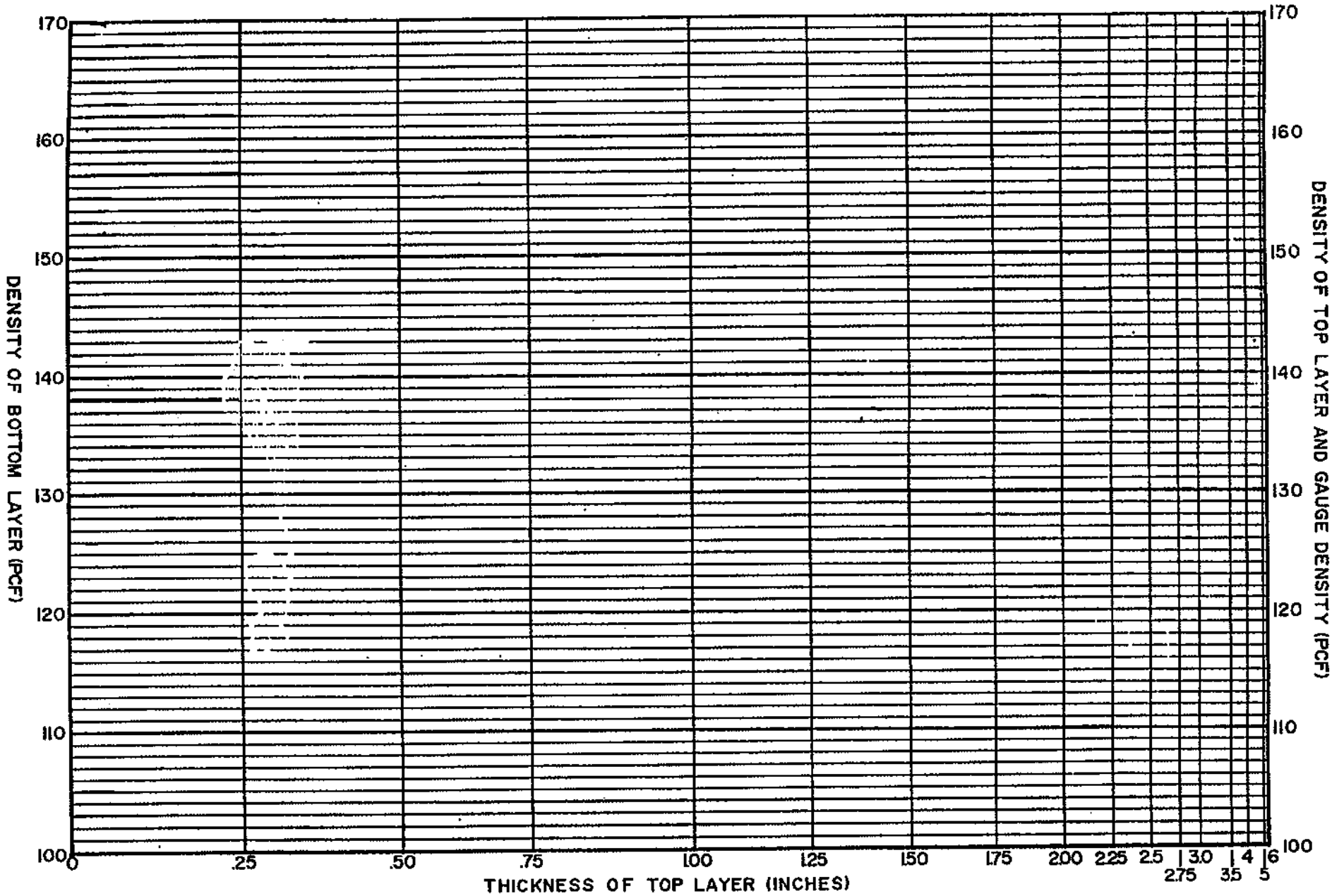
TARGET DENSITY BASED ON 5.5% AIR CONTENT WITH VARING SPECIFIC GRAVITIES AND VARYING AMOUNTS OF ADDED WATER, FREE WATER, SET RETARDER, WATER REDUCING AGENT, AND AIR ENTRAINED ADMIXTURE.

TOTAL WATER IN		AVERAGE COMBINED SPECIFIC GRAVITIES								
Gal./C.Y.	Lbs./C.Y.	2.61	2.62	2.63	2.64	2.65	2.66	2.67	2.68	2.69
30.4	253.54	144.01	144.41	144.81	145.21	145.61	146.01	146.4	146.8	147.2
30.6	255.2	143.91	144.31	144.71	145.11	145.5	145.9	146.3	146.7	147.1
30.8	256.87	143.81	144.21	144.61	145	145.4	145.8	146.2	146.6	146.99
31	258.54	143.71	144.11	144.51	144.9	145.3	145.7	146.1	146.49	146.89
31.2	260.21	143.61	144.01	144.41	144.8	145.2	145.6	145.99	146.39	146.79
31.4	261.88	143.51	143.91	144.3	144.7	145.1	145.49	145.89	146.28	146.68
31.6	263.55	143.41	143.81	144.2	144.6	144.99	145.39	145.79	146.18	146.58
31.8	265.22	143.31	143.71	144.1	144.5	144.89	145.29	145.68	146.08	146.47
32	266.89	143.21	143.61	144	144.4	144.79	145.19	145.58	145.97	146.37
32.2	268.55	143.12	143.51	143.9	144.3	144.69	145.08	145.48	145.87	146.26
32.4	270.22	143.02	143.41	143.8	144.19	144.59	144.98	145.37	145.77	146.16
32.6	271.88	142.92	143.31	143.7	144.09	144.49	144.88	145.27	145.66	146.05
32.8	273.55	142.82	143.21	143.6	143.99	144.38	144.77	145.17	145.56	145.95
33	275.22	142.72	143.11	143.5	143.89	144.28	144.67	145.06	145.45	145.85
33.2	276.89	142.62	143.01	143.4	143.79	144.18	144.57	144.96	145.35	145.74
33.4	278.56	142.52	142.91	143.3	143.69	144.08	144.47	144.86	145.25	145.64
33.6	280.22	142.42	142.81	143.2	143.59	143.98	144.36	144.75	145.14	145.53
33.8	281.89	142.32	142.71	143.1	143.49	143.87	144.26	144.65	145.04	145.43
34	283.56	144.22	142.61	143	143.38	143.77	144.16	144.55	144.94	145.32
34.2	285.23	142.12	142.51	142.9	143.28	143.67	144.06	144.44	144.83	145.22
34.4	286.9	142.02	142.41	143.79	143.18	143.57	143.95	144.34	144.73	145.11
34.6	288.56	141.92	142.31	142.69	143.08	143.47	143.85	144.24	144.62	145.01
34.8	290.23	141.82	142.21	142.59	142.98	143.36	143.75	144.13	144.52	144.91
35	291.9	141.72	142.11	142.49	142.88	143.26	143.65	144.03	144.42	144.8

NOTE: The Average Combined Specific Gravity is based on 50% Coarse and 50% Fine Aggregate
One Gal. Water Weighs 8.34 lb/gal.

CHART NO. 1

EXHIBIT NO. 63-8-51



THIN LIFT OVERLAY NOMOGRAPH

(U.S. CUSTOMARY UNITS)

EXHIBIT NO. 63-8-52

WATER CEMENT RATIO
CEMENT CONCRETE OVERLAY

UN. PROJ. NO. _____ CONTRACTOR _____

DATE _____ INSPECTOR _____

Design Cement (From Spec. Prov.) = (A) _____ Bags/C.Y.

Final Overlay Quantity = (B) _____ C.Y.

	DESIGN LBS./C.Y.	FINAL LBS.
WATER ADDED AT MIXER		
Meter Setting ____ Lbs./Bag x (A) _____ Bags/C.Y. =	(C)_____	
Final Water Meter Reading _____ Gal. X 8.34 Lb/Gal. =		(D)_____
WATER ADDED IN AIR MIXER Type _____		
Dilution _____Oz. Admix. To _____Oz. Water =)E) _____Total Oz. Mixture		
Dispenser Setting _____ From Cal. Chart = (F) _____ Total Oz. Mix/Bag		
(F) _____ ÷ (E) _____ = (G) _____Oz. Air Added		
(F) _____ - (G) _____ = (H) _____ Oz. Water Added		
(H) _____ x (A) _____ Bags/C.Y. ÷ 128 Oz./Gal. = (I) _____ Gal./Water		
(I) _____ Gal. Water x 8.34 lb./Gal. =	(J) _____	
Final Overlay Quan. (B) _____ C.Y. x (J) _____ =		(K) _____
WATER ADDED IN WATER REDUCING ADMIX. (RETARDER)		
Dilution _____Oz. Admix. To _____ Oz. Water = (L) _____Total Oz. Mixture		
Dispenser Setting _____ From Cal. Chart = (M) _____ Total Oz. Mix/Bag		
(M) _____ ÷ (L) _____ = (N) _____ Oz. Of Reducer Added		
(M) _____ - (N) _____ = (O) _____ Oz. Water Added		
(O) _____ x (A) _____ Bags/C.Y. ÷ 128 Oz./Gal. = (P) _____ Gal. Water		
(P) _____ Gal. Water x 8.34 Lb./Gal. =	(Q) _____	
Final Overlay Quan. (B) _____ C.Y. x (Q) _____ =		(R) _____
WATER IN SAND		
Design Wgt./Bag = (S) _____ Lbs. Moisture = _____ % ÷ 100 = (T) _____		
(S) _____ Lbs. X (T) _____ x (A) _____ Bag/C.Y. =	(U) _____	
Final Overlay Quan. (B) _____ C.Y. x (U) _____ =		(V) _____
WATER IN STONE		
Design Wgt./Bag = (W) _____ Lbs. Moisture = _____ % ÷ 100 = (X) _____		
(W) _____ Lbs. X (X) _____ x (A) _____ Bags/C.Y. =	(Y) _____	
Final Overlay Quan. (B) _____ C.Y. x (Y) _____ =		(Z) _____
Total Design Water in Overlay = [Total of (C) + (J) + (Q) + (U) + (Y)] =	(AA) _____	

Design W/C Ratio = (AA)_____ Lbs/C.Y.
(A) _____ Bags/C.Y. x 94 Lbs./Bag = _____

Total Water Used for Entire Pour = [Total of (D) + (K) + (R) + (V) + (Z)] = (BB) _____

Cement Used = (B) _____ C.Y. x (A) _____ Bags/C.Y. X 94 Lbs./Bag = (CC) _____ Lbs.

Actual Water = (BB) _____ Lbs. + _____
(CC) _____ Lbs.

Total Water = (BB) _____ Lbs. _____ = _____ Gal./C.Y.
8.34 Lb./Gal x (B) _____ C.Y.

Design = (AA) _____ Lbs. _____ = _____ Gal./C.Y.*
8.34 Lb./Gal

* Use this design Gal./C.Y. when calculating Theoretical Density. Note: Max. w/c Ration = 0.354

WATER CEMENT RATIO

LATEX CONCRETE OVERALY

UN. PROJECT NO. _____ CONTRACTOR_____

DATE _____ INSPECTOR _____

Design Cement (From Spec. Prov.) = (A) ___ Bags/C.Y. Final Overlay Quan. = (C) ____ C.Y.

Design Latex (From Spec. Prov.) = (B) ___ Gal./Bags Cement

Wgt. Latex = (D) ___ Lb./Gal.

	DESIGN LBS./C.Y.	FINAL LBS.
WATER ADDED AT MIXER		
Meter Setting _____ = _____ Lb./Bag x (A) ____ Bags/C.Y. =	(E) _____	
Final Meter R'dg. _____ Gals. x 8.34 Lbs./Gal. =		(F) _____
WATER ADDED IN LATEX		
% Water = 100% - Solids _____% = (G) _____ %		
(B) _____ Gal./Bag x (G) _____% x (D) _____ Lb./Gal. X 7 bags	(H) _____	
Final Latex Meter R'dg. _____ Gals. x (G) _____% x (D) _____ Lb./Gal. =		(I) _____
WATER IN SAND		
Design Wgt./Bag = (J) _____ Lbs. : Moisture = _____% ÷ 100 = (K) _____		
(J) _____ Lbs. x (K) _____ x (A) _____ Bags/C.Y. =	(L) _____	
Final Overaly Quan. (C) _____ C.Y. x (L) _____ =		(M)
WATER IN STONE		
Design Wgt./Bag = (N) _____ Lbs. : Moisture = _____ % ÷ 100 = (O)		
(N) _____ Lbs. x (O) _____ x (A) _____ Bags/C.Y. =	(P) _____	
Final Overaly Quan. (C) _____ C.Y. x (P) _____ =		(Q) _____
Total Design Water in Overaly [Total of (E) + (H) + (L) + (P)] =	(R) _____	
Total Water Used [Total of (F) + (I) + (M) + (Q)] =		(S) _____

Design W/C Ration = (R) _____ Lbs./C.Y. _____
(A) _____ Bags/C.Y. x 94 Lb./Bag = _____
Cement Used = (C) _____ C.Y. x (A) _____ Bags/C.Y. x 94 Lbs./Bags = (T) _____ Lbs.

NOTE: Max. W/C Ratio = 0.400 Actual W/C Ratio = (S) _____ Lbs. ÷ (T) _____ Lbs. = _____

Truck Settings from Design Calibration

	Truck No. 1	Truck No. 2	
Water Meter Setting _____ Lbs.	_____	_____	
Latex Meter Setting _____ Gal.	_____	_____	Total Water _____ Gal.
Sand Gate Setting _____ Lbs.	_____	_____	Total Latex _____ Gal.
Stone Gate Setting _____Lbs.	_____	_____	Total C.Y. _____ Gal.
Seconds Per 94 Lbs. Cement	_____	_____	
Counts Per C.Y. Overlay	_____	_____	
Counts Per 1/4 C.Y. Overlay	_____	_____	

	Load No. 1	Load No. 2
Final Water Meter Reading	_____	_____
Final Latex Meter Reading	_____	_____
Cement Meter Reading	_____	_____
C.Y. Produced	_____	_____

DESIGN DATA FOR CONCRETE MOBILE

Un. Proj. No. _____ Date _____, 19 ____

Truck Operator _____ Contractor _____

	Truck No. 1	Truck No. 2		Truck No. 1	Truck No. 2
Sand Dial Setting	_____	_____	Stone Dial Setting	_____	_____
Pounds _____			Pounds _____		
Seconds _____			Seconds _____		
Moisture _____			Moisture _____		
Water Setting	_____	_____	Latex Steeling	_____	_____
Pounds _____			Pounds _____		
Gallons _____			Gallons _____		
Seconds _____			Seconds _____		
Air Setting	_____	_____	Retarder Setting	_____	_____
Oz. Pure _____			Oz. Pure _____		
Oz. Mix _____			Oz. Mix _____		
Seconds _____			Seconds _____		

	No. 1	No. 2
Counts Per Box Cement	_____	_____
Counts Per Cu. Yd.	_____	_____
Counts Per 1/4 C.Y. Yield Test	_____	_____

	Load 1	Load 2	Load 3	Load 4
Total Water Meter R'dg.	_____	_____	_____	_____
Total Latex Meter R'dg.	_____	_____	_____	_____
Meter Register R'dg.	_____	_____	_____	_____
Comp. Test Cyl. No.	_____	_____	_____	_____
Truck No.	_____	_____	_____	_____

CALCULATIONS

COMMENTS: _____

_____

_____

_____

INSPECTOR

EXHIBIT 63-8-56

TC NO. 63-14
1 / 90

KENTUCKY TRANSPORTATION CABINET
DEPARTMENT OF HIGHWAYS
DIVISION OF CONSTRUCTION

DAILY INSPECTORS REPORT FOR BRIDGE PAINTING

COUNTY: _____ DATE: _____ DIST NO.: _____

PROJECT NO.: _____ HOURS WORKED: _____

CONTRACTOR: _____ NO. OF WORKERS: _____

TIME				
DRY BULB (°F)				
WET BULB (°F)				
STEEL TEMP. (°F)				
RELATIVE HUMIDITY (%)				
DEW POINT (°F)				
WEATHER COMMENTS:				

COMPRESSOR TYPE	
COMPRESSOR CAPACITY	
NO. OF BLASTERS	
PRESSURE @ COMPRESSOR	
BLOTTER TESTS PERFORMED	
COMMENTS:	

SURFACE PROFILE				ATTACH TAPES HERE
LOCATION				
ANCHOR PATTERN (MILS)				
VISUAL STANDARD				
WET FILM THK CK (MILS)				

RESULTS OF DRY FILM MEASUREMENTS (MILS): _____

COATING MANUFACTURER	TYPE OF COATING	LOT NO.	BATCH NO.	NO. GAL. USED

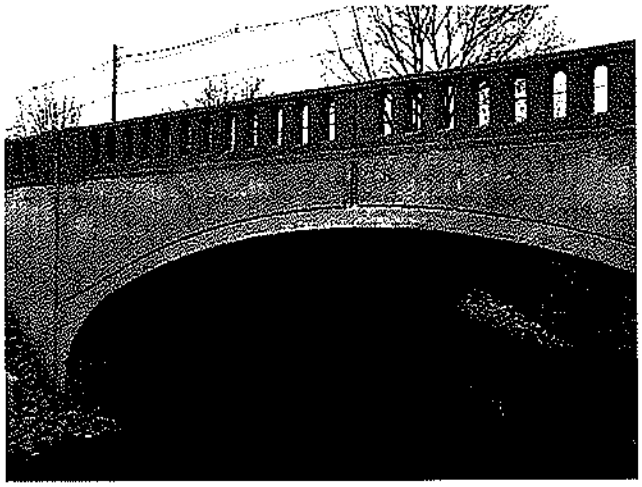
COMMENTS: (Include areas reblasted, special instructions to contractor, problems, etc.)

_____

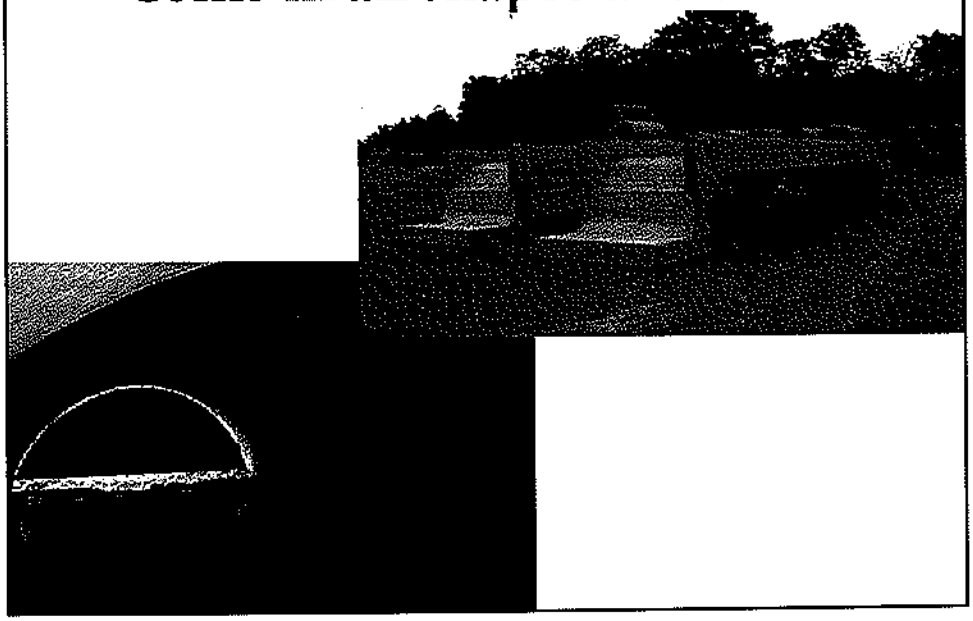
INSPECTED BY: _____ RESIDENT ENGINEER: _____

NOTE: This form is to be used as supplement to Daily Inspectors Report TC NO. 63-28

3-SIDED PRECAST STRUCTURES

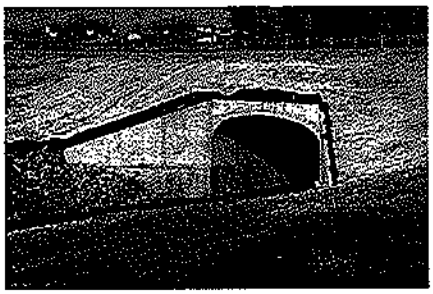


Come in all shapes and sizes:



Types Include:

- *BEBO* Arch Systems
- CON/SPAN
- OMEGA Culverts
- HY-SPAN



PROS

- LOW MAINTENANCE
- ECONOMICAL
- AESTHETIC
- FAST TRACK INSTALLATION
- EASE OF CONSTRUCTION
- MINIMIZES CREEK BED DISTURBANCE

CONS

- NO STANDARD DESIGNS
- LITTLE OR NO PRE-CONSTRUCTION GEOTECNICAL STUDIES
- EROSION CONTROL DURING CONSTRUCTION
- SCOUR CONSIDERATIONS
- CRITICAL FILL INSTALLATION

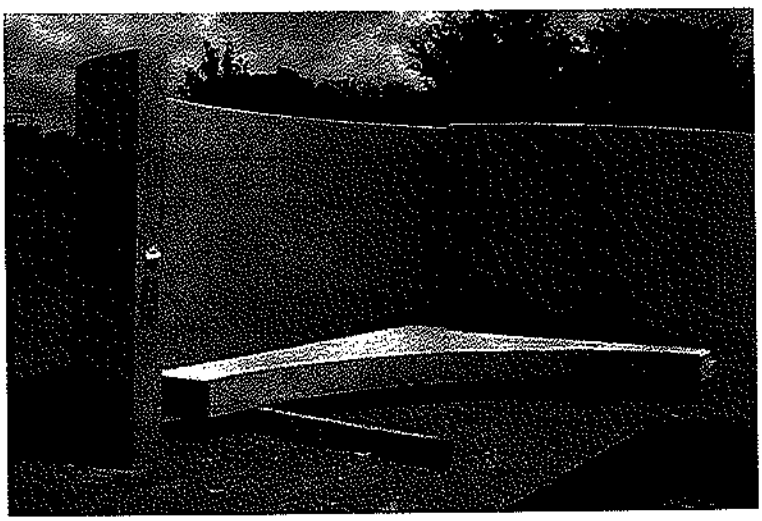
Special Construction Conditions:

1. Submission required by the contractor of: shop drawings, design, placement, backfill, and letter confirming existing site conditions. 5 sets.

Manufacturing Process

- Fabrication to be by an "Approved Precaster"
- Division of Materials to inspect and stamp with "KY Oval" prior to shipment

Typically Cast on Side

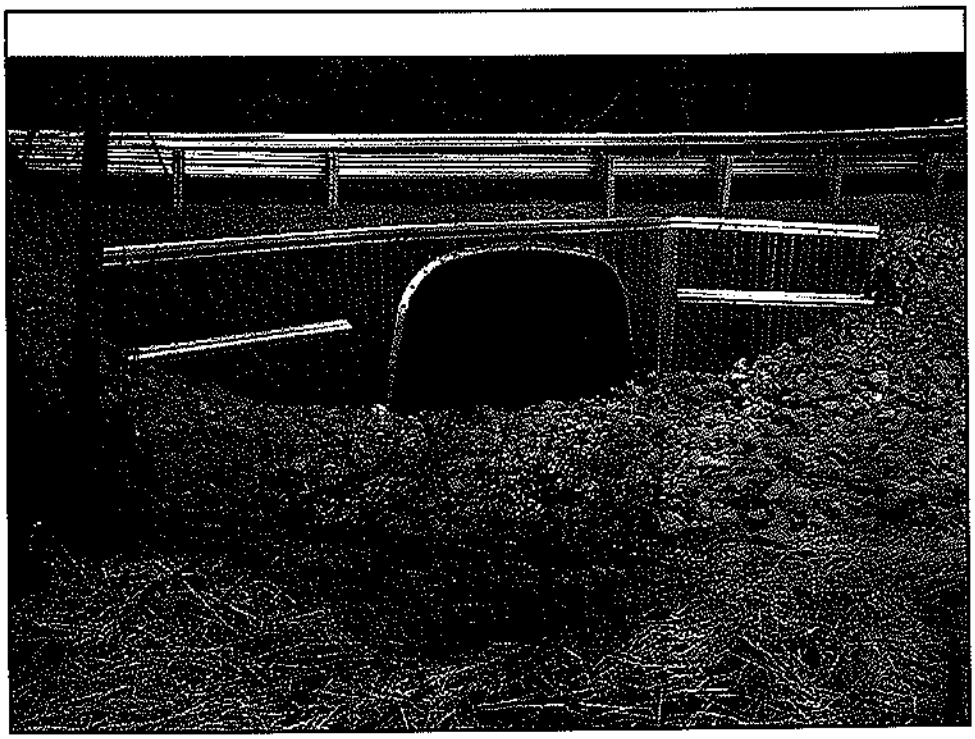


Possible Problems

- Not enough fill cover – lower footings or adjust the grade
- Improper casting- Check each unit for markings
- Wrong type (s) of fill material
- Fill not installed or compacted per plan
- Contractor drives equipment across early causing cracking or spalling – may need to replace, consult C.O. Construction.

Metal Arch and other Misc. Structures

Nasby Stroop



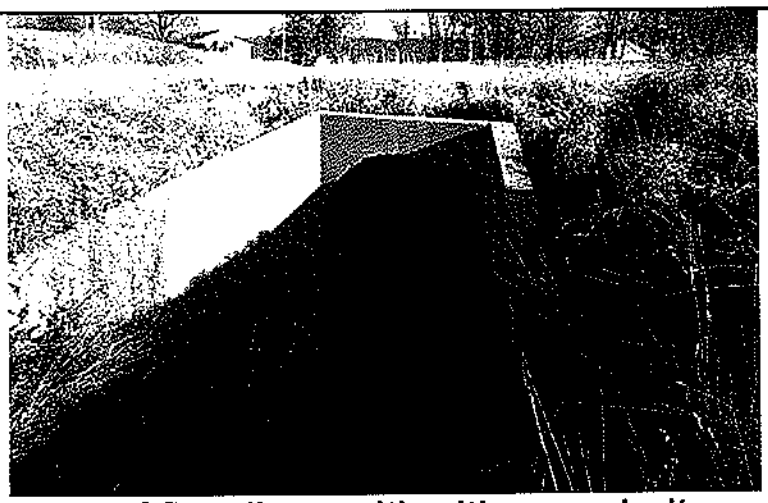
Section 612 of the Standard Specifications

- Structural Plate Soil Interaction Structures
  - Pipes
  - Pipe Arches
  - Arches

Materials Used

- Corrugated Aluminum Alloy
- Corrugated Steel

- Prefabricated sections that are assembled and erected on site.
- 612.03.03 – Shop drawing submittal and approval required.



- Paving of flow lines with either asphalt or concrete may be required. Total asphalt coating of the circumference of the pipe may also be required. See proposal/approved submittals.

Special Note 9V

- Provided with no field modifications
- Producers – Contech or Lane Metal Products
- Submittals required for C.O. approval

SPECIAL NOTE FOR ALUMINUM AND STEEL STRUCTURAL PLATE BOX CULVERTS

This Special Note will apply when indicated on the plans or in the proposal. Section references herein are to the Department's 2004 Standard Specifications for Road and Bridge Construction.

1.0 DESCRIPTION. Furnish and install either an aluminum or a steel structural plate box culvert as the Contract specifies.

2.0 MATERIALS.

2.1 Structure. These structures consist of prefabricated sections assembled and erected at the site. Prefabricated sections consist of corrugated aluminum or steel plates, as the Contract specifies, which have been factory shaped, punched, and coated when required. The Department will not permit field modification except for tapping saddles or other devices to permit passage of other conduits or utilities through the structure. Furnish and install all ancillary items such as ribs, webs, stiffeners, footing pads, etc. that the design requires. Furnish and install endwalls and wingwalls when the plans require them. When endwalls are required, construct full height wing sections. Do not field bevel wing sections.

Before beginning erection, furnish to the Engineer applicable shop drawings, erection layouts, and manufacturer's brochures. The Department will accept plates and accessories by certificate of compliance from the manufacturer.

2.1.1 Aluminum Structure. Obtain the aluminum structural plate box culvert, and aluminum endwalls or wingwalls when required, from Contech Construction Products, Inc.

The Department will accept comparable aluminum structures produced by other companies when the Engineer approves. For such approval, submit sufficient data and design calculations to show that the proposed structures are equal in all respects to the Contech product and also include evidence of actual installations now in service that are performing satisfactorily.

Use aluminum accessories and plates, of the plan specified thickness, that conform to AASHTO M 219 or ASTM B 308 as applicable.

Where non-aluminum utilities are passed through, insulate with an electrolytic compound or approved equal, to prevent bi-metallic contact.

2.1.2 Steel Structure. Use either (1) Contech Construction Products' Metal-Plate Steel Box Culvert, or (2) Lane Metal Products Company's Low Profile Box Culvert.

The Department will accept comparable steel structures produced by other companies when the Engineer approves. For such approval, submit sufficient data and design calculations to show that the proposed structures are equal in all respects to those specified above and also include evidence of actual installations now in service that are performing satisfactorily.

Use steel accessories and plates, of the plan specified thickness, that conform to AASHTO M 167 for galvanized steel.

2.2 Asphalt Coating. On all steel drainage structures, except those installed as railroad tunnels, cattle underpasses, bicycle or pedestrian underpasses, or similar dry conditions, apply an asphalt coating conforming to Subsection 806.11.

2.3 Bedding Material. Use sand that conforms to Subsection 804.08.

Special Note 9V

- Backfill requirements are CRITICAL.
- Many proposals contradict 9V for backfill.
- Study Site Preparation Notes.

2.4 Backfill Material. Select any of the following alternates and obtain the Engineers approval.

1) well graded or uniformly graded bank or creek gravel, crushed or uncrushed, up to 3 inches maximum size;
2) well graded or uniformly graded natural or crushed sand;
3) finely shot limestone or sandstone providing no individual fragment is larger than 3 inches and the material contains no more than 5 percent dirt and/or shale, as determined by visual inspection by the Engineer;
4) crushed stone or crushed slag up to 3 inches maximum size (except DGA or Size No. 610);
5) other locally available materials meeting the approval of the Engineer (local soils conforming to soil classifications A-1 or A-3 from AASHTO M 145 will be acceptable). Do not use plastic soils, or materials containing significant amounts of nondurable shale (SDI < 95 by KM 64-513); or
6) flowable fill conforming to Subsection 601.03.03, B), 5)

2.5 Foundation Material. Use material capable of supporting the imposed loads due to backfill weight and footing pressures of 2 tons per square foot

3.0 CONSTRUCTION.

3.1 Technical Representative. Provide a technical representative from the structure producer to advise at the start of the project. Ensure the technical representative is available thereafter to assist in the event problems or special circumstances arise. Technical assistance shall be provided at no additional cost to the Department.

3.2 Site Preparation. Perform structure excavation according to Section 206, except as modified herein.

On structures with footing pads, excavate trenches 3 inches below the elevation shown on the plans, and level the bottom of the trench with 3 inches of bedding material before placing the footing pads.

On structures with a full metal invert, excavate the entire area covered by the invert plates to a point 3 inches below grade and level with 3 inches of bedding material before placing the invert plates.

Take soundings for foundation design at the inlet and outlet of each culvert and at intervals no greater than 20 feet along the grade line of the bottom of the culvert, to a depth of one foot. Make soundings on the centerline and at each edge of the culvert. Where ledge rock, gravel, hardpan, or other unyielding material is encountered or known to exist within the limits stated, perform excavation in the area under the invert plates or footing pads. Extend the additional excavation to a depth of 0.042 H below the bottom of the metal plates, where H is the height of fill above the top of the culvert. However, regardless of the height of fill, the Department will require the additional depth to be a minimum of one foot and will not require it to be more than 0.75 Hc, where Hc is the total height of the culvert.

Backfill the additional excavation with an earth cushion of firmly compacted fine soils in layers of 6 inches or less, prior to placing the 3 inches used bedding layer.

Excavate cross trenches as necessary to place metal toewalls when the plans require them.

Excavate a minimum width of the outside dimension of the box culvert including footing pads or invert plates plus 6 inches on each side.

Proper bedding preparation is critical for satisfactory performance of the box culvert. Place the bed for footing pads or invert plates to uniform lines and grade to avoid distortions

Special Note 9V

- Concentrate on Manufacture's Specifications and recommendations.

specifications.

3.3 Installation. Erect the culvert, and endwalls when required, in strict accordance with the manufacturer's recommendations. The Department will allow offsite assembly of the structure, provided prior approval is obtained, and assembly is in accordance with the manufacturer's instructions. Align plates circumferentially to avoid permanent distortion from the specified shape. Ensure the width and height of the completed structure is within 2 percent of the specified dimensions or 2 inches, whichever is greater.

Tighten bolts in the erected structure according to the manufacturer's recommendations, with good seam laps, while in proper shape, using nuts and bolts the manufacturer supplies. Construct concrete footings and headwalls in accordance with the plans.

Install the ribs, wales, and toewalls when required, according to the manufacturer's recommendations.

In side by-side installations, install the box culverts with footing pads or invert plates of each culvert no closer than 2 feet to the footing pads or invert plates of the adjacent culvert, unless the plans show otherwise. Excavate the entire volume between the culverts and place backfill.

3.4 Backfill. Proper placement and compaction of backfill are essential to obtain maximum strength and stability of the finished structure. Use equipment and construction procedures to prevent excessive structure distortion from occurring. The manufacturer of the structure will specify the magnitude of allowable shape changes during backfill. Monitor the shape of the structure to control distortion until all backfilling operations are completed.

On structures with concrete footing pads, backfill the trench for the pads to the flowline inside the culvert before outside backfilling begins.

Place granular backfill material in horizontal layers not exceeding 6 inches loose depth, and bring up uniformly on both sides of the structure. Compact each layer to the same level on all sides before proceeding to the next lift. Do not use compaction equipment or methods that produce earth pressures that cause distortion or damage. Place material on top of the structure at right angles to the centerline of the structure. Compact each layer of backfill to a density of at least 95 percent of the maximum density according to KM 64-511. The Department will determine the in-place density using nuclear gages. The Engineer may waive density testing when not feasible due to the nature of the material. When using flowable fill, place according to Subsection 601.03.09, C).

If the structure is not installed in a full depth trench, use backfill material for embankment adjacent to the structure for a distance equal to the span width on each side of the box culvert and to a height of 2 feet or subgrade elevation, whichever is lower, above the structure.

3.5 Construction Loads. Do not allow construction loads in excess of HS-20 vehicles to cross the completed box culvert unless it is internally braced. Design the support for such bracing so as not to impair the structural integrity or severely interfere with the hydraulics of the box culvert or its invert. Have the culvert manufacturer review the details of the bracing and submit them to the Engineer for approval.

3.6 Headwalls. Construct concrete headwalls, when required, according to the plans. Apply masonry coating to exposed surfaces of the headwalls when required by Subsection 601.03.18, B). When using an aluminum structure, cost aluminum surfaces that will be in contact with concrete with alumilastic compound or an approved equal prior to placing concrete.

3

Special Note 9V

- Measured per LF with lots of 'incidentals'.

4.0 MEASUREMENT.

4.1 Structure Excavation. The Department will measure Structure Excavation as Structure Excavation, Common or Structure Excavation, Solid Rock according to Subsection 206.04.01, except on the sides of the structure the volume will be bounded by vertical planes 6 inches outside the footing pads or invert plates and parallel thereto.

The Department will measure material necessary for backfill in excess of the material excavated in Borrow Excavation, Roadway Excavation, or Embankment-in-Place, as applicable.

The Department will measure granular material used to replace excavated material that is unsuitable for backfill as Borrow Excavation, Roadway Excavation, or Embankment-in-Place. The Department will not measure earthwork for payment when the bid item is Embankment-in-Place unless the unsuitable material is wasted.

The Department will not measure flowable fill for payment and will consider it incidental to the structure.

The Department will not measure bedding for payment and will consider it incidental to the structure.

4.2 Aluminum Structural Plate Box Culvert. The Department will measure the quantity in linear feet at each location. The Department will consider the number of linear feet in each installation to be the plan length, increased or decreased by authorized adjustments. The Department will not measure ribs, webs, stiffeners, footing pads, toewalls, internal braces, or asphalt coating for payment and will consider them incidental to the structure.

4.3 Steel Structural Plate Box Culvert. See 4.2.

4.4 Class A Concrete. The Department will measure Class A Concrete in footings and headwalls according to Subsection 601.04.

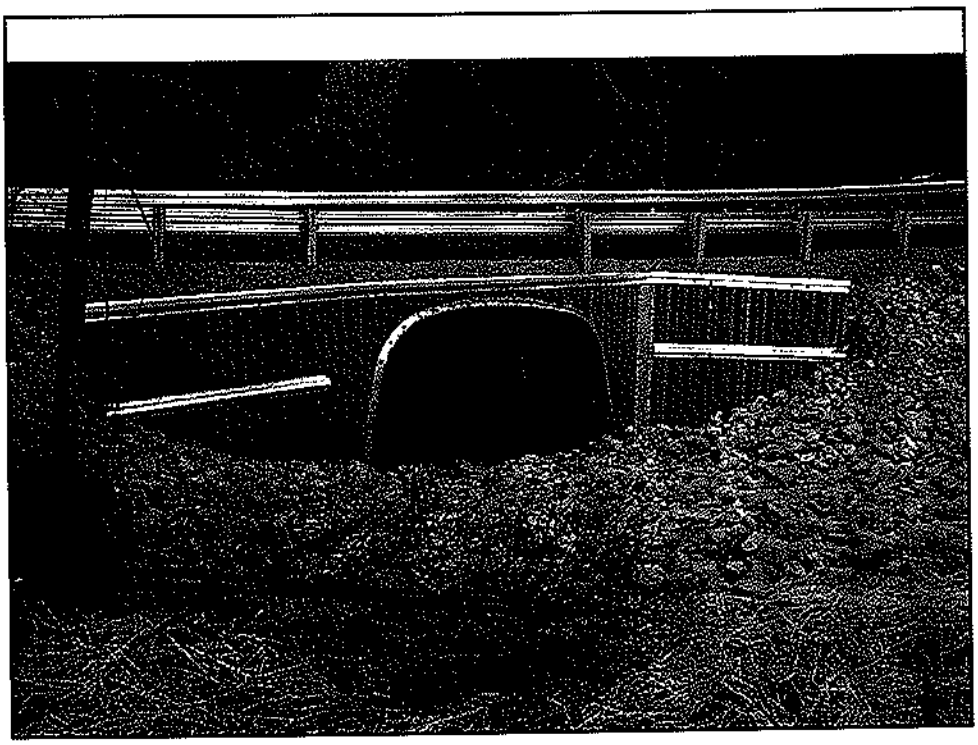
4.5 Reinforcement. The Department will measure Steel Reinforcement in the footings and headwalls according to Subsection 602.04.

4.6 Aluminum Box Culvert Endwalls. When endwalls are required by the plans, the Department will measure the endwalls in individual units at each location.

4.7 Steel Box Culvert Endwalls. See 4.6.

5.0 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

Code	Pay Item	Pay Unit
—	Aluminum Structural Plate Box Culvert	Linear Foot
—	Steel Structural Plate Box Culvert	Linear Foot
—	Structure Excavation, as classified	See Section 206.05
—	Concrete, Class	See Section 601.05
—	Steel Reinforcement	See Section 602.05
—	Aluminum Box Culvert Endwall	Each
—	Steel Box Culvert Endwall	Each

The Department will consider payment as full compensation for all work required in this note.

March 1, 2004