TRANSMITTAL MEMORANDUM 21-01

To: Division of Structural Design Staff
Division of Materials
Division of Construction
Design Consultants

From: Michael Carpenter
Director
Division of Structural Design

Date: June 1, 2021

Subject: Interim Guidance Manual

Effective immediately, the attached interim guidance manual and exhibits override all prior transmittal memorandums regarding design issues and the existing guidance manual and exhibits. All projects shall use the attached interim guidance and exhibits from this point forwards unless permission is granted otherwise. For projects currently under design, some may continue under the older guidance depending on what stage the design is at. Coordinate with the Division of Structural Design on specific instances where new guidance may differ from previous on what guidance is required on your projects currently under design

This interim guidance manual and exhibits are under review currently by KYTC and FHWA and are subject to change at the final issue to be released in the near future. A future memo will be released when the final edition of the guidance manual and exhibits are released.

MC/CVZ/JVZ

STRUCTURAL DESIGN	Chapter INDEXES
	Subject Table Of Contents

600 MISCELLANEOUS

9900 EXHIBITS

STRUCTURAL DESIGN	Chapter INDEXES
	Subject Alphabetical Index

A

B

C

D

E

F

G

H

I

X Y Z

STRUCTURAL DESIGN	Chapter INTRODUCTION Subject Design of This Guidance Manual

ORGANIZATION & NUMBERING:

Chapters – The subject matter in the manual is divided into chapters. The chapter title appears in the upper right-hand corner of the first page of a subject and in the upper left-hand corner of any subsequent page.

Sections – Some chapters are divided into sections. Each section title, instead of chapter title, appears in the upper right-hand corner of the first page of a subject and in the upper left-hand corner of any subsequent page.

Subjects – Chapters and sections are arranged by subjects.

Subject Number – Each subject is assigned a number, which appears in the upper right-hand corner of each page of the subject. For example, Chapter 500 includes subject 503, followed by subject 504, which is divided into section subjects 504-1 through 504-3.

"SD" Prefix – Preceding each subject number, this prefix stands for the manual title *Structural Design*.

Subject Title – The title of a subject appears in the upper right-hand corner of the first page of a subject and in the upper left-hand corner of any subsequent page.

Date – The latest issuance date of a subject appears at the bottom of each page of the subject. This date agrees with the latest issuance date shown for the subject in the Table of Contents **(SD-02)**.

Page Numbering – Each subject has its own page numbering, which appears at the bottom of each page.

LOCATING

INFORMATION:

Indexes –Each index entry includes the corresponding subject number in the manual where you will find detailed information for the entry.

- **Table of Contents (SD-01)** – This index lists the titles of the manual's chapters and sections and their subjects, as well as other information, in numerical order. It includes the latest issuance dates of all the subjects. As the manual matures, these dates change.
- **Alphabetical Index (SD-02)** – This index alphabetically lists key information in the manual. Generally, it directs you to subject titles and to margin, paragraph, and subparagraph headings within subjects. This index is your main tool for finding specific information in the manual.
- **List of Exhibits (SD-9900)** – This index lists the manual's exhibits. It includes the latest issuance date of each exhibit. As the exhibits are revised, the issuance dates change.

QUESTIONS:

Who to Contact – For answers to questions about the contents of the manual, please contact the Division of Structural Design at (502) 564-4560.

For copies of the manual, please contact:

Policy Support Branch
Transportation Cabinet Office Building
W4-26-02
200 Mero Street
Frankfort, KY 40622
(502) 564-3670

STRUCTURAL DESIGN	Chapter INTRODUCTION
	Subject Audience & Abbreviations

AUDIENCE FOR THIS MANUAL:

This Guidance Manual is written to the bridge designer. The sentences that direct the designer to perform work are written in the active voice, imperative mood. These directions to the designer are written as commands. For example, a requirement to provide minimum concrete cover is expressed as, “Provide minimum concrete cover,” rather than, “The designer shall provide minimum concrete cover.” In the imperative mood, the subject “the designer” is understood.

Other requirements to be performed by others have been written in the active voice. Sentences written in the active voice identify the party responsible for performing the action. For example, “The Geotechnical Engineer will recommend the approximate footing elevation.” Certain requirements of the designer may also be written in active voice, rather than active voice, imperative mood.

Sentences that define terms, describe a product or desired result, or describe a condition that may exist are not written in either the active voice or the imperative mood. These types of sentences, which describe a condition, use verbs requiring no action. For example, “The characteristics of the soils actually encountered in the subgrade may affect the quality of cement and depth of treatment necessary.”

ABBREVIATIONS:

The following abbreviations, when used in this Manual, represent the full text shown.

AASHTO	American Association of State Highway and Transportation Officials
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
AWS	American Welding Society
CRSI	Concrete Reinforcing Steel Institute

DGA	Dense Graded Aggregate
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
KAZC	Kentucky Airport Zoning Administration
MSE	Mechanically Stabilized Earth
NAVFAC	Naval Facilities
RCBC	Reinforced Concrete Box Culvert
USCG	United States Coast Guard
USGS	United States Geologic Survey

STRUCTURAL DESIGN	Chapter INTRODUCTION
	Subject Function, Organization & Location

FUNCTION:

The prime function of the Division of Structural Design is the design and preparation of contract plans for all highway structures, as well as any other special structures which may be necessary, that will be built as part of the Department of Highways' system of roads.

The Division of Structural Design also performs the design of and prepares repair plans for existing highway structures.

The Division of Structural Design's Geotechnical Branch performs geotechnical investigations. The Geotechnical Branch publishes its own Guidance Manual, which may be found on the Division's website.

DESIGN FUNCTION:

The design function of highway structures is subdivided into design performed by the Division of Structural Design personnel and design performed by private consultant engineering firms under contract to the Department of Highways.

Situation survey information gathered by the Department and/or private consultants is submitted to the Division of Structural Design.

The Structural Designer takes the survey information and develops contract plans which are architecturally pleasing, economically sound, and the best engineering solution to the structural situation presented.

The Division reviews the plans prepared by private engineering firms to assure that the plans are in general accordance with the Department's requirements.

STRUCTURE MAINTENANCE

& REPAIR FUNCTION: The Division of Structural Design has as an additional function: the design and preparation of repair plans for existing structures when repairs are of a major nature affecting the load-carrying capacity of the structure or when the replacement of deteriorated floor systems and other repairs are necessary for normal maintenance care and operation. The Division of Structural Design works closely with the Division of Maintenance in these regards.

GEOTECHNICAL BRANCH: The Geotechnical Branch is responsible for all functions relating to geotechnical engineering required for the planning, design, construction, and maintenance of roads and bridges under the jurisdiction of the Department of Highways.

ORGANIZATION: The Division of Structural Design is assigned to the Office of Project Development.

LOCATION: The Division of Structural Design is physically located on the Third Floor of the Transportation Cabinet Office Building at 200 Mero Street in Frankfort, Kentucky 40622. The telephone number is (502) 564-4560.

Submit presentations outlined in the following chapters to this office. Shop plan checking is also coordinated here.

STRUCTURAL DESIGN	Chapter INTRODUCTION Subject Services Performed by Consulting Engineers

AGREEMENT:

The engineering agreement for the particular project governs services performed by consulting engineers.

All work under an agreement is at all times subject to the general supervision and direction of the Director, Division of Structural Design, and is subject to review and approval. The term "Director, Division of Structural Design," means the Director of the Division of Structural Design or his/her authorized representative.

Follow the procedures of structural design set forth in this manual, unless otherwise instructed by contract or written instructions signed by an authorized representative of the Division of Structural Design. Even though any particular paragraph heading may not be addressed directly to the consultant, the instructions still apply.

CONSULTANT AGREEMENT CHANGE ORDERS:

When changes arise in structural design procedures that are not covered in the original consulting engineering agreements, the consultant must initiate a request to the Project Manager to approve a change order involving compensation for extra work.

PRE-DESIGN CONFERENCE WITH CONSULTANTS:

The consultant will be provided guidance, necessary forms, etc. to submit a proposal. The scope of the project will be developed, including applicable structure design criteria, progress reporting, normal review times, required submittals, contract completion date, and any other requirements relating to the development of structure plans for the project. The number and type of alternate structures that will be studied, if any, will also be determined.

If agreeable to all parties, the pre-design conference may be held via telephone and/or email.

Combination Roadway & Bridge Design Projects – See the Division of Highway Design Guidance Manual regarding pre-design conference procedures on projects which contain both roadway and bridge design. On combination projects, schedule a structure pre-design conference in the Division of Structural Design to discuss applicable design criteria and procedures when deemed necessary by the Division of Structural Design or the consultant.

Bridge Design Only Projects – For consultant proposals involving bridge design only, conduct the proposal conference in the Central Office, Division of Structural Design. Attendance by a district representative is not required, but may be desirable in some instances.

STRUCTURAL DESIGN	Chapter INTRODUCTION Subject Website

ADDRESS: The Division of Structural Design maintains a website, which may be accessed from the Transportation Cabinet's main website at www.transportation.ky.gov.

CURRENT GUIDANCE: The Division of Structural Design will post future transmittal memoranda and design guidance on the website. Check the web site for current guidance.

CONTENT: The Division's website contains links to the following useful information:

Specifications

- Standard Drawings
- Standard Specifications
- Special Notes and Special Provisions
- Division of Structural Design Guidance Manual
- Geotechnical Branch Guidance Manual
- Division of Structural Design Transmittal Memoranda

File Downloads

- Base Sheets
- MicroStation Resource Files
- Cell Libraries
- Miscellaneous Details

STRUCTURAL DESIGN	Chapter	SUBMITTAL FOR REVIEW AND APPROVAL
	Subject	Submittal Phases

Private consultant engineering firms present plans to the Division in **five phases**:

1) Situation Survey
2) Preliminary Plans, Stage 1
3) Preliminary Plans, Stage 2 (if required)
4) Final Plans, Stage 1
5) Final Plans, Stage 2

This Chapter outlines the data required for each presentation. Modification of these phases and/or their content requires written approval from the Director, Division of Structural Design or his/her authorized representative

STRUCTURAL DESIGN	Section ADVANCE SITUATION SURVEY Subject Procedure

GENERAL:

Submit an Advance Situation Survey for each structure to the Division of Structural Design after all outstanding issues have been settled. The Advance Situation Survey will serve as an 'order form' for structure plans. Submit in a digital format. The Project Manager will contact the Division of Structural Design prior to submitting the Advance Situation Survey if there are any questions concerning the proposed structure that would benefit from early involvement by the Division. These questions might include, but are not limited to, architectural treatments, utility placement and alternate span arrangements.

TIMING OF SUBMITTAL:

Submit the Advance Situation Survey to the Division of Structural Design a minimum of **10 months** before a scheduled letting for a normal, straight, prestressed concrete bridge.

This provides:

- 3 months to hire a consultant or work into the in-house schedule,
- 3 months to design the structure,
- 2 months for review/comment and still meet the required plans completion date which is usually
- 2 months before the letting.

The following conditions require **additional time**:

- A curved bridge will require an additional month.

- A bridge requiring phase construction will require an additional month.

- A steel bridge will require two additional months.

- A bridge over a railroad will require 6 additional months.

- If permits or approvals are required from other agencies, i.e. Coast Guard, FHWA, or the structure is complex, then additional time will be required and the Project Manager should contact the Division of Structural Design to set the letting schedule. This is particularly true if a Coast Guard Permit is required, as this process is very time consuming.

- If the Geotechnical Report has not been completed prior to the submittal date, then additional time will need to be allocated for that task.

ELECTRONIC SUBMITTALS: The Advance Situation Survey must be submitted electronically to both the Division of Structural Design and the Division of Highway Design, Drainage Branch.

REVIEW: The Division of Structural Design and the Division of Highway Design, Drainage Branch reviews the Advance Situation Survey for bridges and culverts.

DISPOSITION: Upon completion of the review of the Advance Situation Survey, the Division of Structural Design will resolve any outstanding issues with the Project Manager.

STRUCTURAL DESIGN	Section ADVANCE SITUATION SURVEY
	Subject Contents

GENERAL:

- When proposing a wall-type abutment, include an alternate for an integral end bent, if feasible. A longer bridge with integral end bents with spill-through slopes is generally more economical than a short span structure with tall abutments.
- When possible, provide 10" from top of slab to top of beam.
- Measure span lengths along centerline to the face of abutment and the centerline of pier.

ALL CROSSINGS: Submit the following information:

- A discussion of **critical features** governing the location
- **Design Executive Summary**
- **Typical section(s)**
- The **roadway plan and profile** of the route over, including the sheets before and after the structure. If the route over is a railroad, profile the low rail. Clearly mark utilities that are to remain in the vicinity of the structure.
- A **natural scale plan and elevation** along centerline of the proposed structure for each structure alternate. See **Exhibit 219** for examples. In dual bridge locations, include a section at the centerline of each bridge.
- Site **contours** with centerline of project and plan of proposed structure superimposed.

- **Architectural** and/or aesthetic requirements
- Lighting, signing, utility requirements
- Any non-standard **wing** details
- Copies of previous **correspondence** pertinent to the structure location and/or interchange approval.
- When applicable, show reference to the **existing structure** as it relates to the new and show if phased construction is required.

STREAM CROSSINGS: Submit the following additional information:

- **Drainage Inspection Report** along with other pertinent correspondence
- **Bridge and Culvert Summary** and a USGS Topography Sheet with alignment and drainage areas indicated (see Drainage Manual).
- **Drainage Design Summary Sheet**
- **Stream profile**
- If applicable, enclose a copy of the **Bridge Site Report** prepared by U.S. Geological Survey for some major stream crossings. The Drainage Section of the Division of Highway Design provides this report.
- For **culverts**, show the stream gradient and the flowline elevation at the intersection of centerline roadway and centerline culvert. Also include culvert equation and skew of baseline with centerline. When extending an existing culvert, show the distance from the new centerline to each end of the existing culvert barrel. Measure this distance normal to the new centerline of survey. Show the new skew angle, existing culvert barrel size, date of construction, drawing number, and condition of existing culvert.

GRADE SEPARATIONS: Submit the following additional information:

- **Design Executive Summary** showing roadway design of route under

- Roadway **plan and profile of the route under**. If the route under is a railroad, profile the high rail.

- Show in calculations and on the structure profile the ditch and berm **elevations** used to compute span lengths. Indicate controlling cut slopes or fill slopes.

- On railroad grade separations, show **milepost** tie-in to centerline survey station and locate centerline of track from tangent offsets at 25-foot intervals in each direction to establish track curvature within bridge site limits.

RAILROAD GRADE SEPARATIONS: The Project Manager will contact the railroad to determine required clearances and other requirements for the particular location.

BRIDGES ON CURVED ALIGNMENT: Generally, curve any bridge located in a curved roadway location to properly fit the curved roadway alignment. However, where the degree of curvature is slight and the bridge length provides only a small maximum offset, **consider using a straight bridge**. Perform a complete analysis of each curved roadway location before recommending a straight bridge, taking into consideration bridge length, degree of curvature, maximum offset, approach grade profiles, etc. Position the structure to provide the minimum required horizontal clearances. The maximum allowable widening to accommodate a straight bridge in a curved roadway section is 24 inches unless additional widening is approved by the Director of the Division of Structural Design.

Note that bridges located on curved alignments generally cost more to design and construct than straight bridges. **Roadway designers should attempt to keep bridges out of curves,** if possible. If economics prevent locating the structure outside a segment of curved roadway, locate the bridge outside of any pavement transitions. If pavement transitions must be made on a bridge, locate them at substructures.

STRUCTURAL DESIGN	Chapter SUBMITTAL FOR REVIEW AND APPROVAL
	Subject Subsurface Exploration

IMPORTANCE: The importance of reliable subsurface exploration information to the structural engineer is paramount. Even preliminary structure plans have no value if the foundation exploration is unreliable. The importance of dependable supervision of the foundation exploration phase by responsible geotechnical personnel cannot be overemphasized.

TIMING OF REQUEST: After preliminary line and grade, the Project Manager will request the geotechnical engineer to prepare subsurface exploration plans for all structures on the project, following procedures outlined in the Geotechnical Manual. Include in the subsurface exploration plans any viable alternate layouts. The Project Manager will contact the Division of Structural Design concerning the viability of alternate layouts.

SUBSURFACE DATA SHEET: Show the drill logs and laboratory test results on the subsurface data sheet, in accordance with the Geotechnical Manual. Show the subsurface exploration plan and subsurface data on the same sheet, if practical. Use a separate subsurface data sheet for each structure.

The geotechnical engineer will submit the **Subsurface Data Sheets** to the bridge designer with recommendations for structure foundation design for his/her review. Follow the guidance in the Geotechnical Manual in order to provide the required data. When alternate foundation types may apply, a meeting may be scheduled with the Divisions of Structural Design and Construction to discuss alternates prior to submitting the final report.

STRUCTURAL DESIGN	Chapter SUBMITTAL FOR REVIEW AND APPROVAL Subject Federal and State Agency Approvals

CORRESPONDENCE: The Department of Highways will handle all correspondence with the various federal and state agencies, unless otherwise directed. Request any information desired from these agencies through the Division of Structural Design.

NAVIGATION PERMIT APPLICATIONS: Navigation Permits will be required on the Green River to Mile 108.5, on the Cumberland River to mile 75, on the Big Sandy River to mile 8, and on the Ohio, Tennessee and Mississippi Rivers in their entirety. Tributaries and embayment areas which are lateral extensions of navigable waterways are considered navigable upstream to the limit of ordinary high water of the main waterway and should be considered questionable. **Exhibit 206** contains a list of waterways that should also be considered questionable. In these and any other questionable cases, request through the Division of Structural Design to the U. S. Coast Guard (USCG) for their comments regarding the need for a permit. In any questionable cases, request through the Division of Structural Design to the U. S. Coast Guard (USCG) for their comments regarding the need for a permit.

The Commander, USCG, handles all matters pertaining to navigation clearances and permit approvals. The address is Commander, Eighth Coast Guard District, 1222 Spruce Street, St. Louis, Missouri 63103.

The navigation permit application form and content follow the procedures set forth in the current USCG publication entitled, "Bridge Permit Application Guide," which may be found on the USCG website.

The construction of wharves, dolphins, boons, weirs, breakwaters, bulkheads, jetties, protective cells, or other structures infringing on navigable waters continues to require permit applications to be submitted to the Department of the Army, Corps of Engineers.

NAVIGATION LIGHTING APPROVAL:

With the issuance of the Instrument of Approval, the USCG prescribes permanent navigation lighting requirements regarding location and type. Incorporate the permanent navigation lighting requirements in the structure plans as a contract bid item. No USCG approval of the contract plans is required if all permit requirements are met. However, submit Stage 1 Final Plans of Permanent Navigation Lighting to the Division of Traffic Operations for review and approval. Note on the structure plans any construction contract requirements involving temporary navigation lighting.

PERMITS FOR AIRSPACE:

Indicate structures located in the vicinity of airports in the Preliminary Line and Grade Inspection Report and in the Final Plans-In-Hand Inspection Report.

Federal Aviation Administration Approval – Before completing preliminary plans for bridge superstructure or towers that might infringe on air space in the vicinity of airports, investigate the need for aviation warning lights. Forward a preliminary inquiry through the Division of Structural Design to the Federal Aviation Administration (FAA) as to requirements. The FAA will provide the necessary forms to complete for resubmittal. The FAA will then determine the requirements of aviation warning lights. Address any correspondence to Chief, Air Traffic Division, Federal Aviation Administration, Southern Region, P.O. Box 20636, Atlanta, Georgia 30320.

Kentucky Airport Zoning Commission (KAZC) Approval – Before completing preliminary plans for structures that may infringe on airspace in the vicinity of public use airports, forward a completed "Application for Permit to Alter or Construct a Structure," using the KYTC eForm or Form TC 55-2 through the Division of Structural Design to the Administrator, Kentucky Airport Zoning Commission,421 Buttermilk Pike, Covington, KY 41017. Prepare the form in accordance with KAZC's Book of Regulations.

The Commission assumes jurisdiction over airspace of the Commonwealth that exceeds 200 feet in height above ground level or 50 feet in height above surface of open water of the Ohio River, the Mississippi River, Kentucky Lake, Lake Barkley, Lake Cumberland, Barren River Lake, Nolin Lake Reservoir, Rough River Lake, Dale Hollow Reservoir (KY), Green River Lake, and Taylorsville Lake.

The Commission also assumes zoning jurisdiction over that airspace over and around the public use airports within the Commonwealth that lies above the imaginary surface that extends outward and upward at one of the following slopes:

- One hundred to one for a horizontal distance of 20,000 feet from the nearest point of the nearest runway of each public-use airport or military airport with at least one runway 3,200 or more feet in length

- Fifty to one for a horizontal distance of 10,000 feet from the nearest point of the nearest runway of each public-use airport or military airport with its longest runway less than 3,200 feet in length

AVIATION LIGHTING APPROVAL:

If the FAA or the KAZC determines that aviation lighting is necessary, they will prescribe permanent aviation lighting requirements. Incorporate these requirements in the structure plans as a contract bid item. No FAA or KAZC approval of the contract plans is required if all prescribed requirements are met. However, submit Stage 1 Final Plans for Permanent Aviation Lighting to the Division of Traffic Operations for review and approval. Note on the structure plans any construction contract requirements involving temporary aviation lighting.

Forms - On structures requiring aviation lighting, the FAA and the KAZC provide the Department of Highways with forms to be completed and returned to them before construction begins and when the structure reaches its maximum height. Forward these forms to the Division of Construction as soon as the project is let to contract.

STRUCTURAL DESIGN	Section PRELIMINARY PLANS Subject Procedure

GENERAL: All bridges require preliminary plans unless exempted by the Director, Division of Structural Design. Do not begin preliminary plans until drainage has been approved and the Geotechnical Report is complete. Submit an electronic copy which meets Division of Structural Design's Graphic Files Standards.

STAGE 1 SUBMITTAL: Submit the preliminary plans to the Division of Structural Design. The Division of Structural Design will return comments noting any changes. Upon completion of the review of Stage 1 Preliminary Plans, the Division of Structural Design will determine whether Stage 2 Preliminary Plans submittal is required. If not, Stage 1 Preliminary Plans will be considered also as Stage 2 Preliminary Plans.

STAGE 2 SUBMITTAL: If required, submit the Stage 2 Preliminary Plans to the Division of Structural Design.

REVIEW: The Division of Structural Design reviews preliminary plans according to the procedures outlined in this manual. The Director, Division of Structural Design, or his/her designee approves the preliminary plan of all structures before authorizing any detailing of the final structure plans.

Before the Division of Structural Design approves Stage 2 Preliminary Plans, the following agencies require further review and tentative approval when applicable. Submit all preliminary plans for structures to the Division of Structural Design, which forwards plans to the appropriate parties for comment.

The **Federal Highway Administration** reviews and approves the preliminary plans for all interstate bridges (route over or under) and some other structures.

The **Federal Aviation Agency** reviews and approves preliminary plans for aviation warning lighting for bridge superstructures or towers, in accordance with **Section SD-204**, “Permits for Airspace”.

Each **railroad** company affected by the bridge structure reviews and approves preliminary plans for structural details or specifications and for conformance to clearance requirements declared by the railroad during the situation survey review, as outlined in **Section SD-202-2**, “Railroad Grade Separations.” Submit the preliminary plans for the railroad company. Also, submit plans to the Railroad Coordinator in the Division of Highway Design.

Each **utility** company affected by the bridge structure reviews and approves preliminary plans concerning the relocation of overhead, surface or subsurface transmission lines. In particular, avoid any disruption of utility service by advance planning and scheduling. During the preparation of widening plans or maintenance repair plans for existing bridges, the Division of Structural Design will consult with the district utility agents concerning the ownership of easily observed utility lines and the possible location of utility lines not readily seen. The district utilities agent will manage all negotiations with utility companies using plan information furnished by the Division of Structural Design.

DISPOSITION: Upon completion of the review of Stage 2 Preliminary Plans, the Division of Structural Design will return a marked copy or any comments provided to the consultant, and forward an email copy of the return transmittal memorandum to the Project Manager (with copies to the central office location engineer, the central office construction engineer, and the district construction engineer) for their notification of completion of the review activity.

STRUCTURAL DESIGN	Section PRELIMINARY PLANS
	Subject Contents

11"x17"
SHEET ASSEMBLY: Submit the following information in pdf format:

- A **Title Sheet** from the roadway plans containing a vicinity map of the project and indicating the bridge location
- A **bridge layout** for the recommended structure showing all items of data listed in **Section SD-305**. Critical datum elevations may be estimated to the nearest tenth of a foot.
- **Sections** of the recommended structure (and any alternate structure if required) showing beam depths, roadway widths and sidewalks and any proposed utilities.
- Bearing details, pier types, and, for steel bridges, a girder elevation showing preliminary plate sizes, stiffener locations and splice locations.
- **Plan-profile sheets** for route over, and route under, if applicable
- Plan-profile sheets of the **alternate** plan or profile design study, if either varies from the recommended layout.

8 ½" x 11"
SHEET ASSEMBLY: Submit the following information:

- Preliminary **general notes** for specifications, design load, design method, foundation pressure, and materials design specifications if they are to be **non-standard**
- **Estimate of Quantities** On current closeout form downloaded from DOSD website for the recommended structure with cost extensions and separate subtotals for

the substructure and the superstructure

- **Estimate of Quantities** On current closeout form download from DOSD website for the **alternate** design study next lowest in cost to the recommended structure with cost extensions and separate subtotals for the substructure and superstructure

- List of special conditions of loading and material specifications not covered in the AASHTO Design Specification for Highway Bridges.

STRUCTURAL DESIGN	Section FINAL PLANS Subject Procedure

SUBMITTAL: Submit the final structure plans for review in **two stages**.

STAGE 1 REVIEW: The Division of Structural Design reviews Stage 1 Final Plans.

Before the Division of Structural Design approves Stage 1 Final Plans, the Division may request review and approval, when applicable, from other agencies:

The **District Construction Engineer** and the **Division of Construction** may review structure plans to avoid details which may create high maintenance costs, to avoid known construction difficulties, and to coordinate the bridge construction and inspection with either adjoining or concurrent work.

Each **railroad** company affected by the bridge structure reviews and approves final plans for structural details or specifications and for conformance to previously approved preliminary plans. Submit hard copy prints if required for this review. This review must be completed by the railroad and further plan changes required by them must be finished before contract agreements can be drafted for final execution by signatures of railroad and Department officials.

The **Division of Right of Way and Utilities** will contact each utility company affected by the bridge structure, using final plan sheets furnished by the Division of Structural Design. Final plans for suspending utility lines from structures must be finished before contract agreements can be drafted for final execution by signatures of utility and Department officials.

STAGE 1 DISPOSITION: Upon completion of the review of Stage 1 Final Plans, the Division of Structural Design will return a marked copy of the plans and special notes to the consultant for correction in pdf format. The Division of Structural Design will forward an email copy of the return transmittal memorandum to the Project Manager (with copies to the central office location engineer, the central office construction engineer, and the district construction engineer) for their notification of completion of the review activity.

STAGE 2 REVIEW: The Division of Structural Design reviews Stage 2 Final Plans for conformance to Stage 1 final Plan review and to make sure everything is in order for the letting.

STAGE 2 DISPOSITION: Before the Division of Structural Design approves Stage 2 Final Plans, the Division will establish with certainty that the final plans are acceptable to other agencies without further changes. The Federal Highway Administration reviews and approves the final plans on all interstate bridges (route over or under).

STRUCTURAL DESIGN	Section FINAL PLANS Subject Contents

STAGE 1 SUBMITTAL: Completely design, detail, check, and provide quantities for all structures submitted for Stage 1 review. Submit plans in .pdf format to the DOSD and other agencies as applicable. Also submit an electronic copy of the drawing CAD files which meets the Division of Structural Design's Graphic Files Standards upon request.

Submit the following items:

- A **list** of all items included in the submittal
- A .pdf of the structure design **calculations**, as described below
- Applicable **special notes**, if any, in pdf and WORD format
- **Identification** of Department of Highway Designer or Consulting Engineer Firm.
- Place the name of the Designer and the Checker in the proper location in the title block of each structure of separate drawing number. The names should be names, not initials. Additionally the engineer that did the design or the engineer that checked the design should check the plan details. Four names on the title block is considered poor quality control.

STAGE 2 SUBMITTAL: After resolving the suggested changes from the Stage 1 review, submit the final plans.

Submit the following items:

- A **list** of all items included in the submittal, including the number of sheets for each drawing number

- Submit a .pdf of the bridge plans in 22x36 size. This pdf must be submitted with individual sheet bookmarks conforming to the example in **Exhibit 217**. Also, submit an electronic copy of the CAD files which meets the Division of Structural Design's Graphic Files Standards.

- Submit .pdf and WORD versions of **special notes**, if any, and an electronic copy in WORD format

- Submit an electronic and .pdf copy of the **Close-Out Form**.

- Place the name of the Designer and the Checker in the proper location in the title block of each structure of separate drawing number. The names should be names, not initials. Additionally the engineer that did the design or the engineer that checked the design should check the plan details. Four names on the title block is considered poor quality control.

CALCULATIONS: Maintain a legible record of all structure design calculations in a .pdf format, which relate to structure layout, geometrics, clearance, design, and quantities. Submit the calculations with final structure plans as a permanent record for the Division of Structural Design's files..

- **Identify** on each calculation sheet heading the designer, the project number, the structure, the date, and the initials of the designer and checker.

- Maintain legible and organized calculations so that both method and results are self-explanatory and can be retrieved.

- Assemble calculations for each bridge or set of twin bridges in a separate .pdf file. Begin each calculation folder with an index sheet listing titles of the component folders and listing the detailed contents of the containing folder.

- Group all calculations for culverts on a project in one .pdf file.

- Submit calculations in .pdf file format with the first sheet showing the following information:

COUNTY, PROJECT NUMBER (State and Federal)
ROAD NAME
CROSSING NAME
STATION, DRAWING NUMBER
ITEM NUMBER
DESIGN SECTION or CONSULTANT IDENTITY

DOCUMENTS REQUIRING P. E. SEAL: The following documents, when prepared by consultants, require the signature and seal of a professional civil engineer registered in the Commonwealth of Kentucky by the State Board of Registration for Professional Engineers and Land Surveyors. Affix the signature and seal near the title block on plan sheets and in any appropriate space on other documents.

- The title sheet of each set of final plans assigned a separate drawing number for each individual bridge structure location

- The front sheet of each set of final plans assigned a separate drawing number for each individual culvert location

- The first sheet of each individual set of final design calculations for both bridges and culverts, preferably an index sheet

- The first sheet of final design specifications and/or special notes when prepared for projects where standard specifications and special provisions do not apply.

STRUCTURAL DESIGN	Chapter SUBMITTAL FOR REVIEW AND APPROVAL Subject Final Situation Folders

Requirements, if any, for Final Situation Folders will be set by the Division of Highway Design.

Do not send Final Folders to the Division of Structural Design for any reason at any time.

STRUCTURAL DESIGN	Chapter SUBMITTAL FOR REVIEW AND APPROVAL
	Subject Estimate of Quantities

BID ITEMS: The Division of Construction maintains a list of bid items and bid code numbers for use in structure plans. This list can be found on their website.

STRUCTURAL DESIGN	Chapter SUBMITTAL FOR REVIEW AND APPROVAL Subject Right-Of-Way

PLANS: For a bridge-only construction project, a set of right-of-way plans may need to be included in the construction plans to let the contractor know what right-of-way is available for construction and access purposes.

PHASING: When a second phase of a contract or another contractor will use the same right-of-way, ensure that any staging areas for the Phase 1 contract do not interfere with Phase 2.

STRUCTURAL DESIGN	Chapter SUBMITTAL FOR REVIEW AND APPROVAL
	Subject Progress Reports

SUBMITTAL: Report progress in the development of structure plans **each month** to the Review Branch of the Division of Structural Design. Submit a report for each structure **via email**.

PROGRESS PERCENTAGES: Apply the following progress percentages in reporting progress for structure plans and in evaluating fee invoices presented for payment:

Upon Department approval of Advance Situation............ 10%

Upon submittal of Stage 1 Preliminary Plans 15%

Upon Department and other agencies' (if required) approval of Stage 2 Preliminary Plans 20%

Between approval of Stage 2 Preliminary Plans and submittal of Stage 1 Final Plans, base Progress Percentages on Monthly Progress Reports. In general, a completion of 45% indicates that the design has been completed and checked but the drafting has not yet begun. A completion of 75% indicates that the drafting process has finished the first iteration.

Upon submittal of Stage 1 Final Plans 95%

Upon submittal and Department acceptance of Stage 2 Final Plans 100%

WEIGHTED PROGRESS FOR STRUCTURES: For projects which include multiple structure locations, submit preliminary plans for review and approval on a structure-by-structure basis at various times rather than at one time as an entire group. State which structure is the "controlling" factor for purposes of overall project development.

REVIEW TIMES:

When estimating completion dates and when determining claims for time extensions to design consultant's agreements, allow the following times and include them in the estimate. Note that these times are measured from the beginning of the review process. The Division of Structural Design will begin the review process in accordance with the Department's current project schedule.

USCG Permit.. 360 calendar days

Review of Advance Situation Survey........... 21 calendar days

Review of Stage 1 Preliminary Plans .... 21 calendar days

Review of Stage 2 Preliminary Plans .... 7 calendar days

FHWA Review of
Stage 2 Preliminary Plans .... 21 calendar days

Railroad Review .... 90 calendar days

Review of Stage 1 Final Plans..................... 31 calendar days

Review of Stage 2 Final Plans....................... 7 calendar days

STRUCTURAL DESIGN	Chapter PLAN DEVELOPMENT
	Subject Notes & Miscellaneous

PLAN EXAMPLES: The Division of Structural Design maintains a Structures Tracking Website (StruT). This site is useful for finding similar recent structure plans to the one you are working on. Access to this system may be granted upon request from the Division. (**https://apps.transportation.ky.gov/strut/Default.aspx**)

PLAN NOTES: StruT is a good place to find current standard of practice plan notes for the type of project you are working on.

GENERAL NOTES FOR PRELIMINARY PLANS: Preliminary plans require only **non-standard** general notes.

GENERAL NOTES FOR BRIDGE AND CULVERT PLANS: Maintain awareness of all current specifications, design specifications, supplemental specifications, special notes, special provisions, general notes, standard drawings, and transmittal memoranda that may be necessary for the design of structures.

Incorporate into the structure plans all notes used for project control or to modify, supplement, or otherwise change the specifications. Insert in the structure plans a separate sheet entitled "General Notes" immediately following the title sheet for bridges. Place general notes for culvert plans on the first plan sheet.

Evaluate each structure as to which notes apply. Certain circumstances may require additional notes to supplement the typical standard notes. Additional notes will require the approval of the Division of Structural Design. Compose additional notes clearly as to meaning and avoid conflict with any article of the Department of Highways' Standard Specifications for Road and Bridge Construction, unless exception from the Standard Specifications is the intent of the note.

ORDER OF GENERAL NOTES:

To facilitate review of notes for accuracy and thoroughness, place notes on the General Note Sheet by category in the following sequence:

1) **Specification Notes** – These notes refer to Department of Highways' Standard Specifications and AASHTO Standard Specifications for Highway Bridges used in the design of the structure.

2) **Material Specification Notes** – These notes contain specific information pertinent to the materials used in construction of the structure.

3) **General Specifications Notes** – These notes contain general information relative to material or construction for the structure.

4) **Superstructure Notes** – These notes contain specific and/or general information relative to the superstructure elements of the structure.

5) **Substructure Notes** – These notes contain specific and/or general information relative to the substructure elements of the structure.

6) **Miscellaneous Notes** – These are notes that do not belong in any of the above categories.

7) **Culvert Notes** – These notes contain specific and/or general information relative to culverts.

Place all applicable notes of a category upon the General Notes Sheet before placing notes for the following category.

STRUCTURAL DESIGN	Chapter PLAN DEVELOPMENT
	Subject Geometric Design Criteria

GENERAL: Design bridges to meet the geometric design criteria set forth for the project.

UNDERPASS/ OVERPASS DESIGN: **See section 403-3 for pier protection requirements.**

MSE WALLS Do not use Mechanically Stabilized Earth (MSE) walls to support structures without written permission of the Division of Structural Design.

In full cut sections requiring ditch drainage through the structure location, place the 2:1 fill slope toe at the normal ditch line, thereby eliminating the need for the fill slope transition and drainage pipe under the fill.

Where fill slope and/or ditch drainage pipe transitions are required, fully detail the transitions on the Roadway Plans and Profile Sheets at the applicable structure locations and further reference them on the structure Layout Sheet.

Place the top of pier footing 2 feet minimum below normal median ditch elevation.

Provide a minimum vertical clearance of 17'-0" (17'-6" desirable) for interstates and parkways and also for all bridges with a sidewalk. Provide a minimum of 16'-6" for all other roads. Exceptions may be made with the permission of the Director, Division of Structural Design.

In general, match the bridge width between gutters to the approach roadway width between faces of guardrail. For curb-and-gutter projects, match the bridge section to the approach roadway section.

GRADES AND

SUPERELEVATION: Limit profile grades to a minimum of **0.5%** on bridges to prevent water ponding.

Grades and superelevation on bridges are set by the project requirements. Highway designers may want to limit grades and superelevations on bridges due to the tendency for bridges to freeze before roadways.

CROSS SLOPES: Provide pavement cross slopes for roadway crown on bridges as shown on geometric design sheet (normally 0.02). See **Exhibit 308** for **parabolic crown** details.

Avoid placing superelevation transitions on bridges. They are difficult to construct and may result in a poor riding surface. Dialogue with the roadway designer should take place early in the design process to discuss all alternatives.

PEDESTRIAN ISSUES: To accommodate persons with disabilities, limit grades on ramps to pedestrian bridges to **8.33%** maximum. The maximum allowable rise for any run is 30 inches. Provide a level landing on ramps at the bottom and top of each run and a level landing at each turn. The minimum allowable landing length is 60 inches.

Standard detail requirement for pedestrian cages are available from the Director, Division of Structural Design, or on the Division's website.

For vehicular bridges with sidewalks that are located over another highway or over a railway, use a partial cage with details similar to the pedestrian bridge cage.

Maintain a recommended minimum vertical clearance of 17 feet when a pedestrian bridge crosses over a highway.

Do not use cages that extend over a portion of the roadway or drivable shoulder.

See Underpass/Overpass Section above for vertical clearance requirements.

Provide a 42 inch tall vertical face barrier at the fascia side of a sidewalk or shared use path. Do not use a curb taller than 8 inches. Separate pedestrians from traffic with a MASH tested railing when the design speed is over 45 mph. When a barrier is required at the inside of the sidewalk, use a metal railing on top of the concrete barrier to provide 42-inch minimum height on both sides of the pedestrian walkway.

STRUCTURAL DESIGN	Chapter PLAN DEVELOPMENT Subject Sign Supports, Electrical Systems, & Utilities on Bridges

OVERHEAD SIGN SUPPORTS ON BRIDGES: The Division of Highway Design will initiate any requirement that overhead signs be located on a bridge. Include any design and detail of the structural supports for the signs in the structure plans. Before approving the preliminary structure plans, the Division of Structural Design will request the Division of Highway Design to fix the location of the sign supports and the location of any conduit and/or junction boxes for lighting the signs on the bridge layout.

ELECTRICAL SYSTEMS ON BRIDGES: Show on the structure plans the details of luminaire pedestals or structural attachments and the details of the conduit encasements or structural attachments. Before approving the preliminary structure plans, the Division of Structural Design will request the Division of Traffic Operations to fix the location and size of the luminaire supports, conduit and junction boxes on the bridge layout.

Conduit Only – If lighting or signing is not a part of the initial construction, provide on the structure plans for a conduit to accommodate future lighting on all bridges on or over interstate highways and when directed by the Director, Division of Structural Design. Provide 3-inch diameter schedule 40 PVC conduit through both barriers. Provide pole bases and junction boxes at 250 feet maximum spacing. Provide Type A junction boxes off each end of the bridge and show conduit terminating in the junction boxes.

UTILITIES ON BRIDGES: Provide utility attachments when required. Do not attach gas lines to bridges.

STRUCTURAL DESIGN	Chapter PLAN DEVELOPMENT Subject Bridge Title Sheet

GENERAL: All bridges require a Bridge Title Sheet. Take care on this sheet and all sheets to provide details and text size that will be legible when reducing the plan sheet to half-size. **Exhibit 301** shows a typical title sheet. Sheet border is available for download on Division of Structural Design website.

ESTIMATE OF QUANTITIES: Use the correct bid item name. Indicate in the table subtotals for each substructure, for each superstructure, and for each bridge. Leave blank lines and columns for the addition of bid items.

INCIDENTAL MATERIALS: Do not include a bill of incidental materials. Include Completion of Structure General Note and dictate in plans how incidental materials are paid.

TITLE: Use the following format:

TRANSPORTATION CABINET
DEPARTMENT OF HIGHWAYS
COUNTY NAME
ROAD NAME
ROUTE NUMBER OVER CROSSING
STATION NUMBER

P.E. SEAL: Projects prepared by **consultants** require on the title sheet the signature and seal of a Professional Engineer registered in the Commonwealth of Kentucky by the State Board of Registration for Professional Engineers and Land Surveyors.

TITLE BLOCK: Begin all structure sheet numbers with the upper case S. Therefore, label any index of sheets S1, S2, etc. On projects with multiple structures, label the first sheet of each structure "S1". Use names for the designer and detailer, not just initials.

REFERENCES: List all standard drawings, with the current postscript used in the structure plans, on the title sheet. Reference the standard drawings elsewhere in the plans as “c.e.” (current edition) without the postscript. For example, "For details of HP12x53 piling see Standard Drawing BPS-003 c.e." This avoids having conflicting references on the same set of plans. List any applicable special provisions and special notes with the current number and name on the title sheet.

STRUCTURAL DESIGN	Chapter PLAN DEVELOPMENT
	Subject Bridge Layout Sheet

GENERAL:

Customarily, an adequate layout of the bridge is a plan view with the deck removed. By removing the deck from the bridge plan view, the survey lines, the control lines, and the dimensions may be clearly indicated without distracting detail. Field crews may then use this plan view to lay out the substructure units. For complex survey alignment and control, provide a separate survey control sheet in addition to the layout sheet.

From the plan view, orthographically project a structure elevation at the same scale. A typical bridge roadway section completes the layout sheet. Use the same scale on the plan and elevation views. See **Exhibit 311** for an example of a typical layout sheet.

BRIDGE PLAN:

Show the following items on the bridge plan:

- Centerline of survey, with stations increasing from left to right, and chord to curved centerline
- Station on centerline of survey of road over at the intersection of the centerline of survey of road under
- Station on centerline of survey of road under at the intersection of the centerline of survey of road over
- Centerline of roadways
- Horizontal curve data
- Stations at substructure units
- Skew angle
- North arrow
- Berm width
- Slope protection limits
- Stream name
- Direction of flow
- Span lengths
- Toe of embankment

- Geometrics of underlying crossing in grade separations
- Location of the points of minimum vertical clearance
- Working point layout control
- Milepost tie-in for RR grade separation
- Dimensions of out-to-out length of bridge
- Stations of termini of bridge
- Horizontal clearances for RR grade separations
- Bearing of centerline of survey or chord to centerline of survey.

BRIDGE ELEVATION: Show the following items on the bridge elevation view:

- Sea level datum reference
- Roadway profile data
- Datum elevations for each of the following:
  - Pile group cut-off
  - Low bridge seat at each substructure
  - Bottom of footings
  - Edge of berm. Normally, place the berm 12 inches below the low bridge seat. However, place the berm 2 feet minimum below the low bridge seat in rock cuts. See **Section SD-606**.
  - Extreme high water and normal pool
  - One datum line extended across the sheet
- Existing ground line along the centerline of the roadway
- Proposed ground line along the centerline of the roadway
- Existing rock line along the centerline of the roadway
- Label the substructure units and number the spans
- Fixed and expansion bearings
- Location of various expansion joints
- Road destination arrow
- Slope of embankments
- Slope Protection limits, type and thickness - see **Section SD-306** for details
- Vertical dimensions for:
  - Substructure heights
  - Grade separation clearances, allowable and actual
- List under the title "Elevation" span lengths and framing, design live load, roadway width, skew, shoulder width at bridge, fill slopes.
- Scour lines and elevations, if applicable

BRIDGE ELEVATION OF TWIN STRUCTURES: When detailing twin structures with only slight dissimilarities, a single profile view of the near right hand structure may be used to represent both structures. Note datum elevations in pairs, one for each structure, such as N.B. and S.B. for Northbound and Southbound Structures, or E.B. and W.B. for Eastbound and Westbound Structures. When twin structures are dissimilar in span length, skew, or foundation type, prepare separate Layout Sheets for each structure.

BRIDGE TYPICAL ROADWAY SECTION: Include the following items on the roadway section:

- Slab thickness
- Barrier height
- Beam depths
- Roadway width showing lanes and side clearances
- Barrier and median width
- Beam spacing
- Cross slopes
- Centerline of bridge
- Centerline of survey
- Long Chord, if applicable

SURVEY CONTROL FOR CURVED ALIGNMENT: For most locations of structures on curved alignment, the control deserves a detailed layout of the working points, allowably on a separate plan sheet. Base the control on a chord intersecting the centerline of survey. Extremities of the chord may be the centerline of survey intersections with the end bearing centerlines or the end bearing centerlines extended. Show the compass bearing and end stations of the chord. Show dimensions along the chord to intersections with other bearing centerlines. Show dimensions from these intersections to working points on the substructure units. Provide only one working point on each substructure unit.

SURVEY CONTROL FOR TWIN BRIDGES: When the centerline of survey is not on the bridge road, the line through the working points should form a closed geometric figure with the chord to the centerline of survey and the respective centerlines of bearing.

SCOUR DESIGN DATA: For all bridges on wet crossings, add the scour data to the layout sheet for future reference.

STRUCTURAL DESIGN	Chapter PLAN DEVELOPMENT
	Subject Slope Protection

GENERAL: Three types of slope protection are approved for general use. Two of these are for route crossings and one for stream crossings. Specify the type of slope protection used in the quantity description on the Title Sheet. Show the limits, type and thickness of the slope protection on the layout sheet.

STREAM CROSSINGS: Use **Dry Cyclopean Stone Riprap** underlain by Geotextile Fabric Class 1. Note on the plans that the Geotextile Fabric is incidental to the slope protection. When the fill in front of the abutments is a durable rock fill, do not use slope protection. Where the new earth fill in front of the abutments is entirely above high water, slope protection ordinarily need not be used, but obtain approval of the Drainage Branch, Division of Highway Design. The limits of slope protection are 2 feet above high water and 15 feet back along the sides of the fill from the back edge of the abutment. See **Exhibit 313** for details.

ROUTE CROSSINGS: The lateral limits of slope protection for route crossings are 18 inches outside the fascia lines. Special consideration to this limit is noted for the median between twin bridges.

- Use a **6-inch Reinforced Concrete Slopewall** only in urban areas with easy pedestrian access and at railroad crossings when requested by the railroad. The upper limit of this slope protection is the front edge of the berm. Reference Standard Drawing BGX-004 or BGX-005 on the title sheet.

- Use **Crushed Aggregate** underlain by Geotextile Fabric Class 1 at all other route crossings. Note on the plans that the Geotextile Fabric is incidental to the slope protection. The upper limit of this type of slope protection is the back edge of the berm. See **Exhibit 314** for a typical section.

BETWEEN TWIN BRIDGES ON DIVIDED HIGHWAYS:

To avoid excessive maintenance costs and problems, extend the slope protection to include the slope between the bridges on all projects that have a median 64 feet or less in width. For railroad grade separations, provide slope protection for all medians, unless the roadway section is bifurcated.

Consider protecting the slope between bridges where the median is greater than 64 feet; however, study costs and other maintenance problems carefully.

On interstate projects, obtain FHWA approval on a structure-by-structure basis in the preliminary stage (probably on the joint field inspection) and include the approval in the inspection report.

STRUCTURAL DESIGN	Chapter PLAN DEVELOPMENT
	Subject Content of Bridge Plans

SCALE: Use scales such as may be read on 11” x 17” prints.

REINFORCED CONCRETE DETAILS: Include the following items on reinforced concrete structure details:

- Full dimensioning, both vertical and horizontal, of all concrete surfaces
- Location of all reinforcement by dimensions
- Identification of all reinforcement by bar marks
- Location of construction joints
- Dimensioning of construction keys. Avoid the use of raised keys - wherever possible use recessed keys.
- Clearances from concrete surfaces to reinforcement
- Datum elevations on the substructure at important levels and control points
- Bar splices and embedments
- Do not use crankshaft type reinforcement in bridge decks
- Bill of Reinforcement with bar-bending details
- Hooks on ends of reinforcement terminated in tension concrete or terminated in a distance not sufficient to develop bond
- Location of the top of cap bars so that they will not interfere with the drilling of the holes for anchor bolts
- Dimensions from working points to related details.

STRUCTURAL STEEL DETAILS: Include the following items on structural steel details:

- Framing plan with control dimensions
- Rolled sections, sizes, and weights
- Plate sizes
- Flange plate cut-off points
- Field splice location and details

- Joint details at connections
- Stiffener spacing
- Bolt spacing and gauge lines
- Blocking diagram and Dead Load Camber diagram
- Shear connector details and spacing
- Bolt sizes and size of open holes
- Details of welded connections
- Material specifications
- Welding notes and procedure specifications
- Estimate of structural steel weight
- Dimensions from working points to related details.

ABUTMENT DETAILS: This article describes the items to include on structure plans for abutments in addition to those described in "Reinforced Concrete Details" above. Detail each abutment separately in the structure plans. Provide a Bill of Reinforcement at each abutment. Detail and dimension breastwalls sufficiently so that calculations for foundation layout by field personnel are unnecessary.

- Plan of cap showing bearing details in position. Design the cap wide enough to accommodate a 3-inch setback for the bearing device.
- Front elevation
- Sectional views as needed. The section through the end wall shows the roadway notch, if required.
- Use a **roadway notch** only when using a rigid approach slab. Place the top of the roadway notch parallel to the cross slope.

PIER DETAILS: This section describes the items to include on structure plans for piers in addition to those described in "Reinforced Concrete Details" above. Detail each pier separately in the structure plans. Provide a Bill of Reinforcement for each pier.

- Plan of cap showing the bearing details
- Front elevation
- Side elevation, if necessary
- Cap and column interaction diagram
- Footing plan or piling plan
- Sections as required

SOUNDING LAYOUT SHEET: Show the location of all geotechnical borings on the sounding layout. Show a sounding log with the soil materials encountered. For additional information on soundings, see **Section SD-203**.

FOUNDATION LAYOUT SHEET:

See **Exhibit 318** and/or the Division's website for an example. Detail and dimension substructure layouts sufficiently so that calculations for foundation layout by field personnel are unnecessary. Forward the completed tables to the Division of Structural Design after construction is complete.

Spread Footings – Show the "Spread Footing Record". For foundation units with multiple spread footings, provide a space in the table for each footing. Provide additional lines in the table for foundations on continuous spread footings, in case the continuous footing is stepped in the field.

Piles – Show the "Pile Record". Indicate the test pile locations and lengths on the pile layout. See the Pile Record base sheet's "Definition of Terms" for the method of calculating Required Calculated Field Bearing or determining practical refusal.

SPAN DETAILS:

This section describes the items to include on superstructure plans in addition to those listed in "Reinforced Concrete Details" and "Structural Steel Details" above. Include the following items on span details:

- Framing plan
- Elevation view of girder and haunch or soffit geometrics
- Girder sections
- Slab Plan – detail bridge deck slabs from end to end. Do not use "Similar by rotating symmetrical about centerline of structure" or "Similar but opposite hand."
- Slab section, crown geometrics (parabolic crown)
- Elevation view of diaphragms (See **Exhibits 619 and 620** for examples).
- Unless otherwise directed by the Director, Division of Structural Design, provide all stream crossings with an adequate deck drainage system. See the next section for details.

DRAINS:

Do not place floor drains on spans directly over railroad tracks or over another highway unless special conditions warrant their use. When special conditions prevail, obtain approval from the Director, Division of Structural Design.

ELASTOMERIC BEARING PADS: Elastomeric bearing pads are preferred for all beam types. Unless design or geometric considerations indicate otherwise, provide bearing pads under PCI-Beams as indicated on Standard Drawing BBP-001, current edition. Provide bearing pads under box beams as indicated on Standard Drawing BBP-003, current edition. Use only rectangular bearing pads and place them under the girder perpendicular to the centerline of girder. Detail and dimension non-standard elastomeric bearing pads on the plans.

STEEL SHOE BEARINGS: Include on the plans material specifications, surface finish specifications, and an estimate of quantities with individual estimates of the weight of each assembly. Indicate the maximum allowable reaction capacity of each shoe. Shop drawings for the steel shoes are required.

ANCHOR BOLT PLAN: Show the size and location of the drilled holes for the entire bridge. On structural steel bridges, place the anchor bolts far enough outside the edge of the flange to allow the drilling of the anchor bolt hole after the girder is in place.

HANDRAIL DETAILS: Include the following items on handrail details:

- Material specifications
- Post spacing
- Estimate of quantities
- Where expansion joints are permitted in bridge decks, use open joints in plinths.
- Shop drawings for metal handrails are required.

BARRIER CURB DETAILS: Where expansion joints are permitted in bridge decks, use open joints in the barrier curbs.

SLAB ELEVATIONS: Show the following information on the **Construction Elevation Sheet**:

1) Plan view with longitudinal lines representing:
   a) beam or girder lines

   and with transverse lines representing:
   b) centerlines of substructure units
   c) end wall lines
   d) other lines forming a grid spacing of approximately 8

feet.

The transverse lines for (b) and (c) above are always parallel to skew. The other transverse lines are perpendicular to the longitudinal lines or long chord if bridge is on a curve.

2) List elevations in tabular form for the top of slab at the intersections.

3) List elevations for the bottom of girder on cast-in-place reinforced concrete girders.

4) Detail of parabolic crown when applicable.

CORNER REINFORCEMENT: On skewed bridges place additional reinforcement in a radial manner to eliminate diagonal cracks which form in the acute corners. See **Exhibit 315**.

DECK SLAB OVERHANG: Show the bottom of bridge deck slab overhang at exterior beams as level or parallel to cross slope. If the design requires a thicker section for the overhang, show this dimension on the plans.

INSERTS: Show on the plans the required minimum capacity of inserts, where used or allowed.

Do not use inserts in the ends of beams that are continuous at piers or where the ends are encased by at least 6" of concrete.

BILLS OF REINFORCEMENT: Bills of reinforcement are required on all bridge and culvert plans. Cantilever retaining walls are not required to have bills of reinforcement as long as bar details are sufficiently shown within the plans. Bills of reinforcement shall detail all bars sufficiently that the bar fabricator can use the dimensions in the bar bill to fabricate the steel without separate drawings or calculations. All bars must be included in the bill of reinforcement separately. Bar series are not allowed.

STRUCTURAL DESIGN	Chapter PLAN DEVELOPMENT Subject Content of Culvert Plans

GENERAL NOTES: Place the General Notes on the title sheet for culverts.

LAYOUT SHEET: The layout sheet is mandatory for culverts. This article describes the items to include on the layout sheet. See **Exhibit 312** for an example of a typical culvert layout sheet.

Include the following items on the culvert plan sheets:

- Centerline of survey and tangent to curved centerline with compass bearing and advancing stations indicated
- Inlet, outlet, and total lengths dimensioned
- Station of culvert
- Skew angle
- North arrow
- Direction of stream flow
- Sounding locations, if necessary
- Proposed structure plan
- Slope protection limits

Orthographically project a longitudinal section from the culvert plan and include the following items:

- Sea level datum
- Culvert structure in section or elevation
- Datum elevations for each of the following:
    - Inlet invert
    - Outlet invert
    - Finished grade elevation at centerline of culvert
- Finished fill section over culvert
- Location of changes in type of culvert footings, steps, etc.
- Location of selected fill for bedding when necessary
- A list under the title of this section including:
    - Barrel opening height, width, and length
    - Foundation

- o Skew
- o Design loading
- o Shoulder width
- o Fill slopes.

CULVERT DETAILS: This article describes the items to include on culvert plans in addition to the details described above. Use scales such as may be read on 11” x 17” prints. Detail and dimension culverts sufficiently so that calculations for foundation layout by field personnel are unnecessary.

- Plan showing reinforcement in top and bottom slab
- Longitudinal barrel sections
- Typical and special transverse barrel sections
- Wing elevations, wing plans and wing sections
- Bill of Reinforcement.

STRUCTURAL DESIGN	Chapter PLAN DEVELOPMENT
	Subject Existing Structures

GENERAL:

When applicable, show reference to the existing structure as it relates to the new. This helps in determining whether wings can be constructed fully or if phased construction of the wings is required to avoid hitting the existing structure.

Except for culvert extensions, do not include any bid quantity for these items on the structure plans unless there are no roadway plans. Structure plans may reference the roadway plans for these items.

REMOVAL OF STRUCTURES OUTSIDE EXCAVATION LIMITS:

Remove existing structures of any size or description that lie outside the excavation limits for the new structure in accordance with Section 203 of the Standard Specifications. Note if an existing steel bridge requires match marking (generally not required). Reference the removal of an existing structure and the pay items for removing the existing structure in the General Summary Sheet and not on the Bridge and Culvert Summary Sheet. Notes for the removal will appear on the roadway plans.

REMOVAL OF PIPE:

Remove pipe in accordance with the roadway plans.

REMOVAL OF CULVERT:

Ensure that removal of any culvert is sufficiently noted in either the Roadway or Structure Design plans. Payment for removal of a culvert is generally lump sum.

CULVERT EXTENSIONS:

Payment for removal of concrete from an existing culvert to allow for an extension to tie in is paid for by Remove Concrete Masonry or Lump Sum – Remove Headwall. Include a plan note to this effect.

STRUCTURAL DESIGN	Chapter PLAN DEVELOPMENT Subject Use of Trade Names

USAGE: Avoid the use of proprietary items or trade names unless directed by the Transportation Cabinet, and wherever feasible, word the specifications to provide opportunity for competition among equivalent materials.

EXCEPTIONS: In exceptional cases where satisfactory specifications cannot be developed, the use of trade name designations is permitted, if at least three alternates are named and a provision made for other acceptable alternates.

FHWA APPROVAL: When proposing less than three trade-name type articles, obtain approval from the FHWA and submit this approval to the Division of Structural Design prior to submitting final plans. Submit the request for approval to FHWA as early as possible during plan development to allow ample time for FHWA review and approval.

STRUCTURAL DESIGN	Chapter PLAN DEVELOPMENT	
	Subject Maintenance Inspection Manual	

Develop a Maintenance Inspection Manual for structures that have **unusual** maintenance requirements.

STRUCTURAL DESIGN	Chapter: PLAN DEVELOPMENT
	Subject: Graphic File Standards

FORMAT: Use the following procedures for any requested electronic transfer. The Transportation Cabinet's CADD format is **MicroStation** (.dgn).

WORKING UNITS RESOLUTION: Set the Working Units Resolution to 12000 units per foot.

REFERENCE FILES: Do not use reference files for the final design file.

SHEET LOCATIONS: **Seed files are available from the Division of Structural Design upon request.** Place sheets in a design file according to the sheet locations shown **in the seed file.** Set the beginning coordinates for the sheet grid to 1000,1000 and space the sheets on a grid interval of 50 master units. Sheet size in design file units is 36 by 22. Organize the design file in columns beginning with Sheet S1 on the top left and continuing from top to bottom and left to right until all sheets are placed. Place the sheets in order as follows:

Title Sheet
General Note Sheets
Layout
Sounding Sheets
Foundation Layout
Abutment/End Bent #1
Piers
Abutment/End Bent #2
Framing Plan
Beam and/or Structural Steel Details
Superstructure Details
Miscellaneous Details
Construction Elevations
Sepias

STRUCTURAL DESIGN	Chapter INTERPRETATION OF AASHTO SPECIFICATIONS
	Subject General

REFERENCES: This chapter lists Division of Structural Design policies and interpretations of the AASHTO Specifications on a paragraph-by-paragraph basis. The subjects in this chapter reference the AASHTO article by number.

INCLUSIONS & OMMISSIONS: The wording of the Specifications provokes many questions. These comments represent an attempt to answer some of the questions most frequently asked and to establish our preference where the wording of the Specification permits.

If an AASHTO article does not have a corresponding section in this chapter, then the Division of Structural Design does not have a specific policy relating to the article or the subject is covered elsewhere in this manual. Direct any questions regarding the interpretation of the AASHTO articles or the omission of any interpretation to the Director, Division of Structural Design.

DESIGN: The articles of the AASHTO LRFD Bridge Design Specifications govern the design of structures for highway bridges and for highway drainage for the Department, unless the plan General Notes specifically provide exceptions.

CONSTRUCTION: With few exceptions (most notably bearings), Kentucky does not use AASHTO construction specifications.

DESIGN ANALYSIS: When proposing structures of such a special nature that the AASHTO Specifications is not adequate, submit an outline of AASHTO paragraph revisions and addendum to the Director, Division of Structural Design, for approval before proceeding with the design of the structure.

SD-402

STRUCTURAL DESIGN	Chapter INTERPRETATION OF AASHTO SPECIFICATIONS
	Subject Section 1 – Introduction

1.1
SCOPE:

In that the specifications only state minimum requirements, for Design Build projects the Designer must use details and interpretations that result in a structure equal to that which would have been designed and reviewed in the normal process.

1.3.2.1
Load Modifiers

Load modifiers for ductility and operational importance shall be 1.0 for all limits states. Load modifier for redundancy shall be 1.0 for conventional structures and 1.05 for any non-redundant member for the strength limit state only. Use a redundancy load modifier of 1.0 for service limit states.

STRUCTURAL DESIGN	Chapter INTERPRETATION OF AASHTO SPECIFICATIONS
	Subject Section 2 – General Features of Design

2.3
LOCATION FEATURE: In general, location features are dictated by the project requirements, but avoiding curves, transitions, and skews will result in a more economical structure. Flared decks and decks with a curve at one end should be avoided if possible due to the extra cost required to build those structures.

2.3.2.2.2
RAILINGS: Use MASH tested railings approved by the Division of Structural Design unless permission is granted from the Director, Division of Structural Design and the project team.

Use railings appropriate for the road class and test level.

Use the T631 rail where a guardrail system is required on an 8 inch thick or greater deck with spread beams. The T631 meets TL-3 with 3'-1 ½" post spacing and TL-2 with 6'-3" post spacings. No guardrail transition is required for this rail and it ties directly into normal guardrail installations off the end of the bridge. This bridge rail does require a minimum of 25 feet of guardrail off each end of the bridge. See Standard Drawing BHS-012, c.e. for details.

Use the side mounted MGS rail for all side by side box beams where a side mounted rail is desirable. This rail meets TL-3 and also requires 25 feet of guardrail off the ends of the bridge. See Standard Drawing BHS-011, c.e. for details.

Use the 40 inch single slope concrete railing as the normal concrete barrier installation on all structures. This railing meets MASH TL-4. This railing requires a thrie beam guardrail connector. See Standard Drawing BHS-010, c.e. and **Exhibit 600** for details.

Use the 36 inch single slope concrete railing where sight distance constraints require a shorter railing. When this railing is used, also include bid items and details for either the steel or aluminum handrail to be installed on top. This railing meets MASH TL-4 and also requires a thrie beam guardrail connector. See Standard Drawing BHS-009, c.e. for single slope details, Standard Drawings BHS-015 and BHS-016, c.e. for handrail details. See **Exhibit 600** for single slope example.

Use the Texas Type C411 (also known as a classic rail) where a historical rail is required. This rail meets MASH TL-2 and can only be used where the speed limit is 45 mph or less.

Use the Texas Type C412 where a historical rail is required on roadways with greater speed limits. This rail meets MASH TL-5.

The following railings are not MASH tested, but are still in use and may be applicable for county or other low-volume roads. Use only with permission.

Use **Railing System Type II** (Standard Drawing BDP-005) with “Railing System Type II Guardrail Treatment” (Standard Drawing BHS-007) on side-by-side box beam bridges and on short structures where constraints may not allow 25 feet of guardrail to be installed off the ends of the bridge.

Use **Railing System Type III** (**Exhibit 601**) on all other bridges where repairs to existing railing may be required.

In maintenance situations where the entire existing rail is removed, a MASH tested rail should be reinstalled. If only a small section is removed due to damage or other reasons, the existing rail may be reinstalled in kind.

2.3.3.2
Highway Vertical: See Section 302 for vertical clearance requirements.

2.4
Geotech Investigation: Foundation investigation shall be in accordance with the Division of Structural Design’s Geotechnical manual.

2.5.2.3
Maintainability: Bridges shall be designed to facilitate future deck replacement. If it is not practical to remove and replace the deck in phased construction, then provisions shall be made

for a full depth structural overlay in accordance with Section 404.

2.5.2.6.2 Deflection: Live Load Deflection criteria shall apply.

2.5.2.6.3 Span to Depth Ratios: The span to depth ratio criteria shall apply.

2.5.3 Constructability: Bridges of unusual complexity, such as continuous trusses, curved plate girders, cable stays, post tensioned girders, etc. require the designer to assume a certain sequence of construction to maintain stability and stay within calculated stresses. The designer shall include at least one feasible erection sequence within the plans. The erection sequence shall show locations of temporary towers, holddown or jacking forces, and the specific sequence of construction. Place a note within the plans that the contractor is also responsible for retaining their own erection engineer to check and/or modify the erection sequence as necessary. The contractors erection sequence shall be submitted and reviewed by the original designer for conformance to the project requirements.

2.5.4 Economy: The cabinet requires a structure to last at least 75 years and should do so with minimal maintenance over the life of the structure. This is achieved through careful design considering materials, reducing joints, etc. Lowest first cost such as is normally achieved in a design build or a value engineering situation may lead to higher costs to the cabinet later on. When the cabinet considers a value engineering proposal, careful thought must be taken to ensure the cabinet is receiving a structure that is equal or better than what was originally designed and will not cause higher long term maintenance costs later on.

2.5.5 Bridge Aesthetics: Form liners or other types of aesthetic treatments shall be applied as required by the project team.

2.6 Hydraulics: Hydrology and Hydraulics shall be in accordance with the Division of Highway Design's Drainage Manual.

STRUCTURAL DESIGN	Chapter INTERPRETATION OF AASHTO SPECIFICATIONS
	Subject Section 3 - Loads

3.5.1
FUTURE WEARING SURFACE:

Provide a minimum of 15 psf where the deck is replaceable in phases. For 3 beam structures or bridges where the structure must be fully closed for a deck replacement, use 60 psf. See **Section SD-501-1** for additional wearing surface requirements.

3.6.1.2
MINIMUM LIVE LOAD:

Design all new structures for KYHL-93* loading. Use KYHL-93 loading for fatigue design.

*NOTE: Calculate KYHL-93 loads by increasing the standard HL-93 truck, tandem, and lane loads by 25%. For fatigue loads calculate KYHL-93 loads by increasing the standard HL-93 fatigue truck 25%.

3.6.1.3.2
LL Deflection:

Calculate live load deflection on beams by following method described in section 2.5.6.2 of the code.

3.6.1.6
Pedestrian Load:

Consider all sidewalks as being susceptible to removal in the future and run full design checks on all beams as if sidewalks were not present on bridge. Any bridge without a full height barrier between the roadway and sidewalk shall also be checked for the case of a truck on the sidewalk. Do not reduce multi-presence factors, load factors, and include full dynamic load allowance.

3.6.5
Vehicle Collision:

All substructures within 30' of the edge of the roadway, shall be investigated for collision in accordance with Section 3.6.5 of the AASHTO LRFD Bridge Design Specifications. This protection shall be provided on all new designs. Protection shall also be applied to the entire existing substructures when the roadway is widened or the bridge is rehabilitated unless the project team dictates otherwise.

In accordance with Section 3.6.5, the designer must choose whether to isolate the pier from collision with an embankment or structurally independent barrier or to provide a crashwall and design the pier for the collision force. Design for vehicular collision for the final condition and not temporary traffic conditions during phased construction. A bridge deck adjacent to a column (such as may be found on tiered overpasses) is considered an adjacent roadway for collision purposes.

The designer may use the commentary and forego collision investigation if the calculated annual frequency of being hit by a heavy vehicle (AF_{HBP}) is less than 0.001 using equation C3.6.5.1-1 for a normal bridge or AF_{HBP} is less than 0.0001 for critical or essential bridges. Unless project team dictates otherwise, all bridges spanning or carrying interstates and freeways shall be considered critical or essential.

Any structurally independent barrier must be offset at least 6” from the pier and shall not be connected to the pier in any manner. A structurally independent barrier with the gutterline set 10 feet or less from any portion of the pier must be at least 54” tall. A barrier with the gutterline set more than 10 feet from the pier may be 42” tall. The barrier must be crash tested and designed to MASH TL-5 minimum.

When the designer chooses to design for the collision force, design for the 600 kip equivalent static load. The load shall be applied to the substructure in a direction of 0 to 15 degrees with the direction of traffic at a distance of 5 feet above the ground. In accordance with the code, this loading is to be considered an Extreme Event II limit state. Design the column to withstand the collision force in shear only. Do not design for flexure and do not transfer the load to other elements such as caps, footings, piles, drilled shafts, etc. Use a 0.9 load factor for all dead load and do not include any live load that produces axial compression for the shear check. For piers with three or more columns that provide sufficient redundancy against partial or total collapse of the bridge if one column were removed or damaged, use two shear planes to distribute the collision force. For piers with two or fewer columns, piers with column spacing greater than 15 feet, straddle bents, or other non-redundant substructures, use only one shear plane for the collision force resistance. A crashwall poured between all columns may be used to distribute the shear force between all columns for the component of the force that is in line with the pier. Each column or crashwall spanning between columns must be designed to resist the component of the collision force perpendicular to the centerline of the substructure. Any crashwall must extend at least 8 feet above the ground and a minimum of 2 feet below ground and shall be connected to the columns and footings as required by the design.

Any column with a gross cross sectional area of 40 square feet minimum, no dimension less than 5 feet, and transverse reinforcement of at least #4 ties at 12 inch maximum spacing or a #4 spiral at 9 inch maximum pitch may be assumed to have sufficient mass to meet the requirements of Article 3.6.5 and no collision analysis is required. A solid concrete breastwall abutment with the wall at least 2’ thick shall be assumed to meet all collision/protection requirements with no further analysis.

Bridges over railroads shall incorporate substructure protection required by the railroad or AREMA requirements.

3.9
Ice Loads: Do not design for Ice Loads in Kentucky.

3.10
Earthquake Effects: Design for the maximum credible earthquake (MCE) from the seismic hazard maps contained in the Kentucky Transportation Center Report KTC-07-07/SPR246-02-6F unless permission is granted by the Director, Division of Structural Design.

3.11
Earth Pressure: Determine lateral pressures by using the methods shown in NAVFAC DM-7.2, MAY 1982, Chapter 3. Figures 16 and 17, which apply to walls of less than 20 feet in height, appear in

Exhibit 413. When using **Exhibit 413**, assume soil type 3 unless a special backfill is specified or the subsurface investigation report states differently. Apply pressure to twice the column width for open column frames when the aspect ratio of depth to width is three or more. Also double the pressure on portions of piers above natural ground line extending through man made fills which may likely shift or move. Do not count on passive pressure above the bottom of footings for retaining walls or behind end bridge substructures unless approval is granted by the Director, Division of Structural Design.

All walls and retaining structures shall be designed for a minimum of 2 feet of equivalent soil height for live load surcharge to cover construction compaction. Follow the tables in Section 3.11.6.4 for more stringent loadings required when the structure is next to a highway.

3.12
THERMAL FORCES:

For temperature ranges, consider Kentucky a cold climate using a median temperature of 60 degrees Fahrenheit. Design concrete bridges for a temperature range of 0^0F to 110^0F. Design Steel bridges for a temperature range of -30^0F to 120^0F. Do not design for the temperature gradient specified in Section 3.12.3 unless specifically requested to do so or special concerns require it.

STRUCTURAL DESIGN	Chapter INTERPRETATION OF AASHTO SPECIFICATIONS Subject Section 4 – Structural Analysis and Evaluation

4.4
Acceptable methods
Of Structural Analysis: Designers do not need to include computer program information in the contract documents.

4.5.3.2
Large Deflection
Theory: In general, do not design columns with KL/r>100. Where there is no option, obtain approval from the Director, Division of Structural Design. Design the columns with no limits on movement and account for creep and shrinkage. Run a P-delta analysis with staged loadings and if stresses in the pier are above the elastic zone, perform a full non-linear analysis.

4.5.3.2.2a
Approximate Methods
General: Use moment magnification on columns with KL/r <100 and do not limit the movement for the design.

4.5.4
Modeling Boundary
Conditions: For service and strength load cases, do not count on passive pressure at the ends of the bridge when distributing loads to piers or intermediate substructures. If the end substructures are modeled to take a portion of the loading, ensure they are designed for the loadings. Model bearing pads with shear moduli of 1G and 4G to account for varying temperatures and design the substructures for the worst case loadings.

4.6.2.2.1
Application Distribution factors for side by side box beams without a structural overlay shall not be less than 0.5.

4.6.3.3.2 &

4.6.3.3.3
Curved and Skewed Steel Bridges:

For steel superstructures with skews between 30^0 and 45^0 or varying skewed supports a refined analysis may be required. Designers shall compare the line girder differential deflections due to deck placement loading at each cross frame location with (beam spacing/100). Excessive differential deflections may require a refined analysis. Curved girders are required to have a refined analysis.

For plate girders with skews>45^0, a refined analysis of the superstructure is required.

For structures requiring a refined analysis, the intermediate crossframe members shall be designed for the calculated loads.

4.6.4
Redistribution of Negative Moments:

Do not redistribute negative moments in continuous beam bridges unless approval is granted by the Director, Division of Structural Design.

5.4.2
CONCRETE:

a) Class "A" f`c = 3500 psi
for culverts, bridge substructures and retaining walls.

b) Class "AA" f`c = 4000 psi
for bridge superstructures and slabs.

Do not use lightweight concrete for any portions of any structure without approval from the Director, Division of Structural Design.

On prestressed elements, design for a maximum concrete strength of 8,000 psi and a maximum concrete strength at stress transfer of 7,000 psi.

5.4.3
REINFORCEMENT:

Use ASTM A615 Grade 60 reinforcement. Investigate cost savings of using higher yield strength reinforcement if more than 100 tons of one size bar will be used. Otherwise, if the 100 tons cannot be met, do not specify higher yield strength reinforcement without the approval from the Director, Division of Structural Design. Where ductility or welding is required, use ASTM A706.

5.4.4
PRESTRESSING STEEL:

In general, use 270ksi low relaxation prestressing strand on prestressed members. Use ½" oversize strand (Area=0.167in^2) for most members. Use 0.6" diameter strand when necessary on larger Hybrid sections with 8" minimum web width.

5.6.7
CRACK CONTROL:

Use Class 2 exposure condition on culvert barrels, bridge decks, or other locations that may have exposure to salt (under joints). Use Class 1 exposure condition for all other areas.

5.7.3
SHEAR DESIGN: Use whichever shear method gives the most steel required. In general, do not space shear reinforcement more than 12”.

5.10.1
CONCRETE COVER: Use 3” clear cover where concrete is poured against soil or rock. Use 2 ½” clear cover to the top of a bridge deck. Use 1” clear cover to the bottom of the bridge deck. Use 2” clear cover for all other locations on bridges. On culverts, use 1” clear cover to the bottom of the top slab, use 2” clear cover to the top of the top slab where the culvert is buried. If it is a drive on top slab, use 2 ½” clear cover with epoxy steel in the top slab. Use 1 ½” clear cover on sidewalls of the barrel. Use 2” clear cover for all other locations.

Use epoxy coated or galvanized reinforcement where the structure is exposed to salt or salt spray. Other corrosion resistant types of reinforcement may be used with approval from the Director, Division of Structural Design. At all other locations, use black steel.

5.12.5
SEGMENTAL
CONCRETE BRIDGES: Use segmental concrete bridges only with the permission of the Division of Structural Design. All ducts shall be completely filled with flexible filler instead of grout. Provisions shall be made for strand replacement. Obtain current design specifications from the Division of Structural Design.

5.12.3.3.2
RESTRAINT MOMENTS: When bridges are fabricated with normal dimensions and detailed using the office standard beam connection details, restraint moment need not be considered in the design.

5.12.3.3.8
NEGATIVE MOMENT
CONNECTIONS: Only count on the top mat of longitudinal steel in the strength calculations. Ensure longitudinal bar spacing in the top of the slab over an interior pier is not greater than 6” and not greater than 12” elsewhere. Account for all live load and composite dead load moments and do not use the beam and slab weight to reduce negative moments near midspan. Do not use a bar smaller than a #5.

5.12.3.3.9
POSITIVE MOMENT CONNECTIONS:

Extend strands into the diaphragm and cable clamps in accordance with the standard base sheets where possible. Where this is not possible, design mild reinforcement positive moment connections and detail in the plans.

5.13
ANCHORS:

Adhesive anchors are not allowed where the reinforcement is designed to be in sustained tension without approval from the Director, Division of Structural Design. This includes pier caps, decks, etc. Bars in these locations shall use mechanical couplers, laps splices, etc. If approval is given, the cabinet will dictate installer qualifications, testing requirements, etc. A design must be performed and submitted for approval in accordance with the AASHTO LRFD Bridge Design Specifications or any other current technical guidance that may be in place. Designers should review the AASHTO LRFD Bridge Design Specifications as well as the current FHWA technical advisory regarding the use and inspection of adhesive anchors on federal aid projects.

POST-TENSIONING REQUIREMENTS:

Use internal ducts on all post tensioning. No external ducts or bars are allowed without written permission from the Director, Division of Structural Design. All strands or bars shall be inspectable, replaceable, and shall not be grouted. Use only flexible filler to completely fill all ducts. Any deviation from these requirements requires written approval from the Director, Division of Structural Design.

STRUCTURAL DESIGN	Section INTERPRETATION OF AASHTO SPECIFICATIONS
	Subject Section 6 – Steel Structures

6.4.1
STRUCTURAL STEELS: AASHTO designation M270 Grade 50 and 50W are the basic structural steels recommended for use in Kentucky's steel bridges. Galvanized steel shall use M270 Grade 50 and any painted or steel left to weather shall use M270 Grade 50W.

Use AASHTO M270 Grades 70, 70W, 100 and 100W only with approval of the Director, Division of Structural Design.

6.4.3.1
HIGH STRENGTH FASTENERS: Use 1 inch diameter ASTM F3125 Grade A325 as the normal structural bolt. Use hot dipped galvanized Type 1 bolts when the steel is galvanized or painted. Use Type 3 bolts with weathering steel. Use other size bolts when design constraints require it.

6.4.3.1.4
DIRECT TENSION INDICATORS: Use Direct Tension Indicators on all structural bolts .

6.6.1
FATIGUE: Design the main load carrying bridge members as continuous and redundant, i.e., multi-girder (three or more girders). Use non-redundant main load carrying bridge members only with the approval of the Director, Division of Structural Design.

Use Category E Details only with approval from the Director, Division of Structural Design.

Design for infinite fatigue life. Obtain approval from the Director, Division of Structural Design for a finite fatigue life design.

6.6.2
CHARPY V-NOTCH REQUIREMENTS:

Require the main load carrying tension members of steel bridges to meet the requirements for notch toughness for fracture critical steel in temperature zone 2. All non main load carrying tension members (diaphragm gusset plates, secondary diaphragm members, etc) shall meet the requirements for non fracture critical steel in temperature zone 2.

Designate main tensile members, including flanges, webs, and splice plates, on the plans by "CVN" with an explanation of these letters on the sheet.

6.7.2
CAMBER AND DETAILING:

Most shorter spans can be designed and built without cambering the beams by varying the haunch thickness. Ensure shear connectors are long enough to project at least 2” into the slab. Place a note in the plans directing to place mill or shop camber upwards. Cold cambering is not allowed. Heat camber rolled steel beams only with the approval of the Director, Division of Structural Design. Welded plate girders shall be cambered to accommodate dead load deflections and vertical curves, when present. Show blocking diagrams on the plans when the bridge is in a vertical curve and provide camber dimensions at tenth points on shorter spans (<100ft) and twentieth points on longer spans (>100ft). Provide all camber dimensions necessary to ensure the final product meets the roadway grade and accounts for all slope transitions, vertical curves, etc.

Place a note in the plans for the steel to be fabricated for the Steel Dead Load Fit for ease of construction.

6.7.3
MINIMUM THICKNESS OF STEEL:

Minimum thickness of flanges should be ¾” on welded girders with a minimum width of 12 inches. Minimum web thickness is ½” on welded girders. If possible, make width and thickness changes at bolted field splices. See requirements on section 6.13.6.2 below.

Do not drop more than 50% of flange area at a field splice.

Splice plates on a plate girder flange or web shall have a gross area at least equal to the smaller connecting plate.

Gusset plates on trusses shall be no thinner than the thickest plate or flange framing into the connection.

6.7.4
DIAPHRAGMS AND CROSS FRAMES:

See **Exhibit 409** for typical intermediate diaphragm details. Cross Frames and/or diaphragms shall be placed at each substructure and intermediately spaced such that the deck can be cast without falsework. Cross frames at the piers shall be designed as jacking supports in case bearing replacement is necessary. Place allowable jacking locations and required jacking loads in the plans. Concrete diaphragms are preferred as end diaphragms. For concrete end diaphragms, provide a 6 inch minimum end cover past the ends of the steel beams and 1-inch diameter holes in the girder web at 12 inch maximum spacing to provide for a minimum #5 rebar continuous front face diaphragm reinforcement.

Place all intermediate diaphragms and cross frames at right angles to the girders. Where two adjacent girders are not parallel, place the diaphragms and cross frames at right angles to one of the girders, if feasible.

To prevent development of fatigue cracking in the webs, give special consideration to the connection between the floor beams and the main girder for two-girder system bridges.

If the deck of the superstructure is superelevated at a rate greater than 0.02 ft/ft, place the end diaphragms on a constant slope across the structure. In such cases, do not step the end diaphragm, which supports the drop slab, at the end of the concrete deck. Such steps are difficult to form, and the abrupt change in section could introduce cracking in the concrete deck.

6.7.5
LATERAL BRACING:

For details, see **Exhibit 411**.

6.10.1.1
COMPOSITE SECTIONS:

Design structural steel bridges composite. Erect beams without temporary shoring to eliminate the possibility of dead load acting on the composite section.

When the concrete slab in a simple span is poured in multiple pours, advance the pours from the middle of the span outward toward the supports.

When the concrete slab in a continuous span is poured in multiple pours, advance the pours from points of low dead load shear toward points of high dead load shear.

Achieve closer control over dead load camber by completing the slab pour for a single simple composite span or by completing the slab pour for a multi-span continuous composite unit prior to final set of the concrete in a single day's operation. (400 cubic yards is the average amount that can be placed in one day.) If more than 400 cubic yards of concrete is required in the deck, detail a pouring sequence in the plans.

If proper slab pouring sequences are observed, computed deflections will approximate actual deflections.

6.10.1.4 VARIABLE WEB DEPTH MEMBERS:

For economic reasons, do not consider haunched girders until span length exceeds 300 feet unless vertical clearance requires haunches.

6.10.1.7 MINIMUM NEGATIVE MOMENT REINFORCEMENT:

On continuous structural steel bridges, continue the required 1% minimum reinforcement the entire length of the bridge.

6.10.11.1 TRANSVERSE STIFFENERS:

The minimum allowable thickness of transverse intermediate stiffeners is 1/2 inch. In general, match the web thickness of the plate girder. Use transverse intermediate stiffeners in pairs, with one stiffener fastened on each side of the web plate, or with a single stiffener fastened to one side of the web plate. Place transverse stiffeners normal to flange. See **Exhibit 410** for details.

When using transverse intermediate stiffeners as connecting plates for cross frames, weld the stiffener to both flanges and investigate the flange stress at that location for fatigue under

Category C.

See **Exhibit 409** for cross frame details.

Generally, design girder webs as partially stiffened so that the web requires transverse stiffeners for shear only within (3 x web depth) of the supports.

6.10.11.2
BEARING STIFFENERS: Do not weld bearing stiffeners to either flange on rolled beams or welded plate girders, except as indicated hereafter. Mill bearing stiffeners on the bearing end and provide a tight fit on the other end. Detail bearing stiffeners as plumb.

Weld the bearing stiffeners to both flanges when using these stiffeners as connection plates for cross frames or diaphragms.

See **Exhibit 410** for details.

6.10.11.3
LONGITUDINAL
STIFFENERS: Use longitudinal stiffeners only with approval from the Director, Division of Structural Design. If longitudinal stiffeners are necessary, provide similar treatment as for transverse intermediate stiffeners. Do not splice longitudinal stiffeners. Terminate stiffener to web welds at a point six times the web thickness from a vertical stiffener to web weld, and clip the longitudinal stiffener.

6.10.12
COVER PLATES: Do not use welded cover plates. Only design bolted cover plates. Obtain prior approval from the Director, Division of Structural Design before using a cover plate.

6.10.3
CONSTRUCTABILITY: Add 10% of the concrete dead load to allow for weight of forms when computing steel dead load stress. Do not assume that the concrete slab supports the steel flange when computing the allowable steel compressive dead load stress. For most cases a concentrated load of 5000 pounds is sufficient to account for the effects of screed machines and live loads during the pouring operation. Note that pouring procedures can cause girder stresses due to wet concrete on portions of the structure to be significantly greater than girder stresses

due to wet concrete on the entire structure.

For plate girders with webs up to 84 inches tall, the designer shall place a note in the plans that the overhang brackets may not be placed more than 8 inches above the web/flange junction. For plate girders with webs greater than 84 inches tall, the designer shall dictate in the plans allowable locations for overhang brackets and if temporary bracing is required to prevent web “Oil Canning” during construction.

6.10.7
YIELD STRESSES: Design all steel beams such that no stresses in the beams go over the yield stresses of the steel under factored loads. Do not design beams for plastic moment capacity without written permission from the Director, Division of Structural Design.

6.10.10
SHEAR CONNECTORS: For the usual composite design, use ¾ inch round stud shear connectors, a minimum of 4 inches long. However, excessive haunch heights may dictate the use of a longer stud. In all cases, extend the top of the stud a minimum of 2 inches above the bottom of the deck slab and ensure a minimum clear cover to the top of slab of 2 ½ inches. Show a detail similar to the one shown on **Exhibit 412** on the plans.

In continuous wide flange beams and plate girders, use composite design in negative moment areas.

6.11
BOX SECTION
FLEXURAL MEMBERS: Because of fabrication costs, box girders are usually not economical. Use this type of structure only with approval from the Director, Division of Structural Design.

6.13.2
BOLTED
CONNECTIONS: In general, ensure all connections are designed as slip-critical.

6.13.2.8
SLIP RESISTANCE: In the design of **slip-critical joints**, consider the contact surface of a bolted part as Class “A” coating for painted and weathering steel. Use Class “C” contact surfaces for galvanized structures. Use Class “B” and “D” only with written approval from the Director, Division of Structural Design.

Indicate on the plans the joints designed as slip critical and the slip coefficient used. If a Class “B” or “D” contact surface is used in the design, note on the plans the requirement for test data on the coating system to verify that it meets the design slip coefficient.

6.13.3 WELDED CONNECTIONS:

Design all welds according to section 6.13.3 in the code and the current edition of the AASHTO/AWS D1.5 Bridge Welding Code.

Welding that uses base metal materials and processes not covered by these specifications requires approval by the Director, Division of Structural Design, prior to the design of the project.

Absolutely no field welding is allowed except with written permission from the Director, Division of Structural Design.

Use General Notes or Special Provisions to specify construction-related exceptions to the AASHTO/AWS Specifications.

Design-related exceptions to the AASHTO/AWS Specifications are as follows, by paragraph:

(2.17.5.1) Transition of Thicknesses or Widths at Butt Joints

> Design plate girders (built-up I-sections) with one plate in each flange, i.e., without cover plates. Vary the thickness and width of a flange by butt welding parts of different thickness or width with transitions conforming to AWS 2.17.5, except when there is more than ½ inch difference in plate thickness or 4 inches in plate width. Under these conditions, use a 4:1 plate taper to increase fatigue strength. Limit the thickness of the thicker plate to 1.75 to 2.0 times the thickness of the thinner plate.

6.13.6.2 WELDED SPLICES:

Use welded field splices only with approval from the Director, Division of Structural Design.

Approximately 500 pounds to 700 pounds of flange material should be saved before specifying a welded butt splice in a flange plate. Use a minimum length of 20 feet between splices for flange plates in most cases. Avoid splicing flanges of different widths. Splicing flanges of different widths should be done at bolted field splices.

Transition materials of different widths and thicknesses, spliced by butt welds, according to AASHTO 6.13.6.2, except when there is more than ½ inch difference in plate thickness or 4 inches in plate width. Under these conditions, use a 4:1 plate taper to increase fatigue strength.

At butt weld splices that join material of different thickness, limit the thickness of the thicker plate to 1.75 to 2.0 times the thickness of the thinner plate.

9.4.3
CONCRETE APPURTENANCES: Concrete barriers shall be placed continuous without any joints.

9.4.4
EDGE BEAMS: Edge beams are required transversely where there is a break in the longitudinal continuity of the slab. For example, joints at the ends or middle of the bridge all require edge beams. The edge beam shall be designed for all dead load and all live load.

9.6.1
METHOD OF ANALYSIS: The approximate method of 4.6.2.1 shall be used.

9.7.1
MINIMUM DEPTH AND COVER: Use 8 inch minimum deck thickness on spread beams. Use 5 inch minimum deck thickness on side by side box beams. The upper ½ inch is considered a wearing surface (see section 501-1).

9.7.1.3
SKEWED DECKS: For bridges with skews not exceeding 25 degrees, the transverse reinforcement may be designed and placed in the direction of the skew. This can be helpful to reduce the number of bar marks required and make detailing easier where phase construction is required.

9.7.2
EMPIRICAL DESIGN: Do not use the empirical design method.

9.7.4

STAY IN PLACE FORMWORK: Stay in place formwork shall not be considered as part of the structure and if used are the responsibility of the contractor.

9.7.5 PRECAST DECK SLABS ON GIRDERS: Do not use precast deck slabs on girders without prior approval of the Director, Division of Structural Design. When permission is given to use, apply a latex concrete overlay to the entire deck to fully seal off all joints prior to allowing traffic on the bridge. Other methods of sealing may be allowed with prior approval from the Director, Division of Structural Design.

9.7.6 DECK SLABS IN SEGMENTAL CONSTRUCTION: Do not use dry joints. Apply a latex concrete overlay to the entire deck to fully seal off all joints prior to allowing traffic on the bridge. Other methods of sealing may be allowed with prior approval from the Director, Division of Structural Design.

STRUCTURAL DESIGN	Chapter INTERPRETATION OF AASHTO SPECIFICATIONS
	Subject Section 10 – Foundations

10.1
SCOPE:

Successful foundation design requires coordination between the geotechnical engineer and the structural engineer. The following contains some guidelines in the respective roles but project requirements will dictate the actual roles of each discipline. The Geotechnical Branch provides a Geotechnical Report to assist in determining which types of foundations to consider for the structure.

Culverts are routinely placed on earth foundations. Only consider simple span bridges on dry crossings for using spread footings on earth foundations. When considering an earth foundation, a more detailed geotechnical investigation is necessary. The Geotechnical Branch conducts field drilling and sampling combined with laboratory testing to assist in determining the bearing resistance of the soil. Bearing resistance is a function of the unconfined compressive strength for cohesive or fine-grained soils such as silt and clay. For cohesionless or coarse-grained soils, such as sand and gravel, bearing capacity, if based on the relative density, is estimated from the "N" count as obtained from a Standard Penetration Test of the soil.

For spread footings on soil, the geotechnical branch (or geotechnical consultant) should generally provide the soil parameters needed to calculate the bearing resistance using equation 10.6.3.1.2a-1 and provide a maximum (i.e. allowable) bearing pressure necessary to control settlement.

Competent rock for bearing is available in large portions of Kentucky. For spread footings on rock, the geotechnical branch (or geotechnical consultant) should generally provide the factored bearing resistance.

When competent rock is unavailable, or the depth to competent rock is excessive, use piles or drilled shafts to transfer the bridge loads to deep rock or to the surrounding soil. Normally, use point-bearing piles to transfer the bridge loads to deep layers of competent rock wherever possible. Where point-bearing piles are not appropriate, use friction piles or drilled shafts. The Geotechnical Report includes an anticipated pile tip elevation for point-bearing piles. For friction piles, the Geotechnical Report includes charts or graphs to assist in selecting the pile type and in estimating the pile length.

For footings on friction piles the geotechnical branch (or geotechnical consultant) should generally provide the maximum service load necessary to control settlement and the factored geotechnical resistance. They should also provide the controlling tip elevation. The designer shall show in the plans the method used to determine the factored geotechnical resistance.

For footings on point bearing piles the geotechnical branch (or geotechnical consultant) should generally provide the nominal geotechnical resistance, resistance factor and tip elevation for the strength limit state if there is a possibility that it is less than the structural limit. For piles of any sort, the geotechnical branch (or geotechnical consultant) should generally provide the drivability analysis.

For structures on point bearing drilled shafts the geotechnical branch (or geotechnical consultant) should generally provide the nominal geotechnical resistance, resistance factor and tip elevation for the strength limit state.

10.4 SOIL AND ROCK PROPERTIES:

See the Geotechnical Guidance Manual.

10.5.2 SERVICE LIMIT STATE:

Settlements shall be controlled for spread footings on soil by keeping the service pressures under the recommended pressure.

10.5.2.1

GENERAL: Overturning and excessive loss of contact shall be checked at the Service Limit State.

10.5.3.1
GENERAL: The design at the Strength Limit State shall not consider deformations required to mobilize the nominal resistance unless a definition of failure based on deformation is specified. Design for all calculated loads and deflections unless granted prior approval from the Director, Division of Structural Design.

10.5.3.2
STRENGTH LIMIT STATE: Overturning and excessive loss of contact shall be checked at the Service Limit State.

10.5.3.4
DRILLED SHAFTS: The design of the drilled shafts shall ensure that geotechnical and structural resistance used for design will be provided in the constructed product.

10.5.5.2.4
DRILLED SHAFTS: For single drilled shafts supporting a pier, increase strength loads on the column and shaft by 20%.

Contrary to Table 10.5.5.2.4-1, use a resistance factor of 0.67 for a geotechnical resistance load case to ensure drilled shafts will not “fence post”. This is normally achieved by using the soil properties in a p-y analysis program and increasing the strength loads by 150%.

10.7
DRIVEN PILES: See **Section SD-504**.

10.7.1.3
PENETRATION: Note minimum allowable penetration:

Hard Material – 10 feet
Soft Material – 20 feet

Since material at stream crossings is generally saturated and soft, use a minimum allowable penetration of 20 feet. At grade separation structures, the minimum 10-foot penetration may be applied in suitable materials. Fill material is considered soft material. Note requirement for piles to penetrate hard material a sufficient distance to rigidly fix the ends. At abutment locations where the distance from original ground line to rock is not sufficient to adequately fix the pile ends or where other strata is present which would prevent driving of piles, consider using one of the following substructure types in lieu of traditional Pile Bent Abutments: Breastwall Abutments, or Pile Bents constructed by driving piles into a rock-socketed, pre-drilled hole filled with sand or concrete.

10.7.1.4
BATTER PILES: See **Section SD-504-1**, “Batter”.

10.7.1.6.2
DOWNDRAG: For steel piles driven to rock the pile shall be checked using the resistance factor for a steel column (0.9).

10.8.3.9.3
REINFORCEMENT: The permanent steel casing shall not be considered as load bearing.

10.8.3.9.4
TRANSVERSE REINFORCEMENT: The steel casing, minus a 1/8” thick sacrificial layer, may be considered effective when applying seismic provisions.

10.9
MICROPILES: Do not use micropiles without prior approval of the Director, Division of Structural Design. Generally predrilled H-piles should be used instead of micropiles.

STRUCTURAL DESIGN	Chapter INTERPRETATION OF AASHTO SPECIFICATIONS Subject Section 11 – Abutments, Piers, and Walls

11.5.1
GENERAL: In order to provide for their reuse and in recognition that foundations are difficult to inspect, the design life shall be 100 years for abutments, piers, and walls that support bridges.

11.5.2
SERVICE LIMIT STATES: Excessive loss of base contact shall be checked at the service limit state:

11.5.3
STRENGTH LIMIT STATES: Excessive loss of base contact shall be checked at the service limit state.

11.5.5
LOAD COMBINATIONS AND LOAD FACTORS: A component should not be split so as to have different load factors, i.e., a soil mass should either use the maximum or minimum load factor.

11.6
ABUTMENTS AND CONVENTIONAL RETAINING WALLS: Use solid Breastwall Abutments or Pile Abutments. Do not taper abutment walls or wings without written permission from the Director, Division of Structural Design.

The design of abutments except integral abutments includes, but is not limited to, the three loading conditions which follow:

1) **Surcharge, No Span:** The approach embankment complete to the top of the parapet elevation with the code required equivalent soil surcharge to allow for construction equipment. With no Superstructure component in place.

Design for a factor of safety against overturning of 1.25.

2) **Surcharge, Span DL:** Completed approach embankment plus the code required equivalent soil surcharge, and the span in place, considering dead load only. Design for a factor of safety against overturning of 1.5.

3) **No Surcharge, Span DL + LL:** Completed approach embankment with no surcharge. Span in place, considering dead load and live load. Design for a factor of safety against overturning of 1.5.

11.6.1.2 LOADING:

Lateral live load and vertical live load from the superstructure need not be applied simultaneously.

11.6.1.3 INTEGRAL ABUTMENTS:

Integral abutments with a height of 6 feet or less from the low seat elevation to the bottom of cap may be designed for vertical load only.

Integral abutments with a height greater than 6 feet from the low seat elevation to the bottom of cap shall be designed as a non-gravity cantilevered wall and will require a lateral loading analysis in a program capable of p-y analysis to design the piling and pile embedment. Do not count on any lateral bracing from the bridge superstructure when designing the piling.

Integral abutments with a height from the low seat elevation to the bottom of cap of 4 feet or less should have the webs of the piles parallel to the center line of bearing. Integral abutments with a height from the low seat elevation to the bottom of cap greater than 4 feet tall shall have the webs of the piles perpendicular to the center line of bearing. Piling shall be cut off 1 foot below low seat elevation.

11.6.1.4 WINGWALLS:

Wingwalls on bridge abutments and culvert headwalls should be attached to the abutment or headwall. Bridge wingwalls shall be designed for the full maximum height of the wing. The wing shall be designed as a stand-alone feature.

Culvert wingwalls may be designed assuming that the culvert barrel and headwall help resist the overturning. Calculate the design height of the wall as the height where a 45-degree line (beginning where the wall meets the supporting structure) intersects the top of the wall. See **Exhibit 514**.

At the service limit state, use a factor of safety of 1.5 against overturning and sliding.

11.6.1.6 EXPANSION AND CONTRACTION JOINTS: Do not use expansion and contraction joints in the front faces of abutments.

11.6.2 MOVEMENT AND STABILITY AT THE SERVICE LIMIT STATE: Overturning should be checked at the Service Limit State as well as the Strength Limit State. For Foundations on soil, the location of the reaction forces shall be within the middle one-third of the base width. For Foundations on rock, the location should be in the middle one-half.

11.6.3 BEARING RESISTANCE AND STABILITY AT THE STRENGTH LIMIT STATE: Overturning should be checked at the service limit state.

11.6.4 SAFETY AGAINST STRUCTURAL FAILURE: Actual pressure distributions should be used in the structural design of the footing.

11.6.3.3 ECCENTRIC LOADING LIMITATIONS: In addition to the eccentricity limits to be checked at the Strength limit state in section 11.6.3.3, eccentric loadings at the Service Limit State shall not exceed:

> For foundations on soil, the location of the resultant forces shall be within the middle one-third of the base width.
>
> For foundations on rock, the location of the resultant forces shall be within the middle one-half of the base width.

11.7
PIERS:

Proper pier design often involves frame analysis and complex strength computations. Of major importance in pier design, however, is the exercise of good judgment.

Use **webwalls** to eliminate drift traps from 2 feet below ground or normal pool to 2 feet above the 100-year flood.

Some rules-of-thumb for rapid pier design are as follows:

- Footing depth equals or exceeds column width.
- Footing length for expansion piers or short span fixed piers equals approximately 1/5 pier height.
- Footing length for most fixed piers equals approximately 1/4 pier height.

11.8
NONGRAVITY CANTILEVERED WALLS:

Where rock is greater than 15 feet deep from roadway grade and spans cannot be added to the bridge or the presence of adjacent roadways or features prohibit excavations for breastwall abutments, designers should consider using a vertical wall with drilled in piling to support the bridge and earth loads. These walls must be designed to support all loads from the dead, earth, and live loadings present. Do not count on the bridge as bracing the wall against any lateral loads. Generally piling is drilled into solid rock and concrete is poured around the rock socket to lock the piling in place. The piling and embedment into rock is designed using a program capable of performing a p-y analysis. Generally a 3 foot thick concrete wall is then poured around the piling to provide a bridge seat and retain all backfill. Piling shall be cut off 1-2 feet below the low seat elevation.

11.10
MSE WALLS:

Due to the difficulties in inspecting a system that needs to have a life span of 100 years, MSE walls shall not be used as bridge abutments without prior approval although they may be used as wing walls. If they are used, the bridge shall be designed to sit on piles behind the MSE wall and the piling shall extend below the base of the MSE wall. Provisions must be made so that the bridge structure does not pull on the MSE wall straps as it moves by placing all piling within CMP pipes. Bridge substructures must be completely isolated from CMP pipes. Other methods may be approved by the Director, Division of Structural Design.

11.11 PREFABRICATED MODULAR WALLS: Do not use prefabricated modular walls as bridge abutments without prior approval.

STRUCTURAL DESIGN	Chapter INTERPRETATION OF AASHTO SPECIFICATIONS
	Subject Section 12 – Buried Structures and Tunnel Liners

12.2
DEFINITIONS:

A buried structure as defined in section 12.2 remains a buried structure if additional fill is added at some time in the future even if it is retrofitted with tunnel liner plates.

12.8
LONG-SPAN STRUCTURAL PLATE STRUCTURES:

Long-span structural plate structures should not be used without prior approval.

12.9
STRUCTURAL PLATE BOX STRUCTURES:

Structural plate box structures should not be used without prior approval.

12.11.2.2
MODIFICATION OF EARTH LOADS FOR SOIL STRUCTURE INTERACTION:

Culverts shall be designed assuming embankment installation with Fe=1.15. Do not design for the trench condition without obtaining approval from the Director, Division of Structural Design.

14.4.1
GENERAL: Use of tabulated form is not required for standard bearings.

14.5.5.3
FIELD SPLICES: When joints are field spliced, the field splice shall be designed for the same infinite fatigue life the rest of the structure is required to be designed for.

14.5.6.9
MODULAR BRIDGE JOINT SYSTEMS: Modular bridge joints should not be used without prior approval from the Director, Division of Structural Design.

14.6
REQUIREMENTS FOR BEARINGS: Use 1/2” thick lead plates in Integral Abutments. Steel reinforced elastomeric bearings are generally used everywhere else, where possible. Any other bearing type shall be approved by the Director, Division of Structural design prior to utilizing on any structure.

14.6.3
FORCE EFFECTS FROM RESTRAINT OF MOVEMENT AT BEARING: Designer should design substructures taking into account increased forces from higher shear modulus, G, for temperatures below 73^0F. Designers shall design for G and 4xG and design for worst case.

14.6.3.2
MOMENT: In general, substructures and superstructures need not be

designed for moment transferred by the bearing.

14.7.5 STEEL REINFORCED ELASTOMERIC BEARINGS – METHOD B AND 14.7.6 STEEL REINFORCED ELASTOMERIC BEARINGS – METHOD A:

In general, use method B for larger, non-standard bearings. Use method A for smaller standard bearings. Use a G (Shear Modulus) of 95 psi generally, but adjust G as necessary for design with approval from the Director, Division of Structural Design.

Do not taper bearings. Generally, for concrete beams, slope the seats when the longitudinal grade is over 0.5%. Provide calculated seat elevations at all four corners in a tabular format. On steel girder bridges, taper the sole plate to match the grade. For slopes greater than 4.5%, provide positive restraint of the beam to prevent slippage of the beam down grade.

Dimension bearings to the nearest thousandth of a foot. Manufacturers must fabricate bearings within tolerances allowed in the specifications.

Check beam clearances at the edge of cap at all substructure units to provide a minimum ½ inch clearance.

When calculating rotation, use a single truck load for live load rotations.

14.8.3 ANCHORAGE AND ANCHOR BOLTS:

Design and detail bearing devices to permit pneumatic drilling into the concrete bridge seat for placing the anchor bolts after the structural steel has been erected and adjusted to position. Specify non-shrink grout to bond anchor bolts in drilled holes.

14.9 CORROSION

PROTECTION: Be aware that debris collecting on abutment seats holds moisture and can cause damage to bearing devices and girder flanges. Galvanizing is preferred, but cannot be done where bearing pads are vulcanized to the steel plates or where plates must be welded. In those cases, paint all exposed portions of steel plates.

STRUCTURAL DESIGN	Section BRIDGE SUPERSTRUCTURE Subject Slabs

The purpose of this chapter is to outline preferred structural relationships, proportions, and details. It is not intended to be a definitive guide to design, and alternates to these preferences may be considered. Approval may be granted by the Director, Division of Structural Design for an alternate demonstrated to be beneficial.

DEPTH: The minimum allowable Class "AA" slab depth is 8 inches for slabs with epoxy-coated or galvanized reinforcement.

REINFORCEMENT COVER: For Class "AA" concrete slabs, provide a minimum cover of 2 ½ inches to the top of the slab and use epoxy-coated or galvanized reinforcement. Use 1 inch clear cover to the bottom of the slab.

WEARING SURFACE: Deduct a ½ inch design wearing surface when designing slabs and girders. This wearing surface adds weight, but is not accounted for strength.

GENERAL NOTE: Designate the type of concrete in the general notes.

MINIMUM REINFORCEMENT: The minimum reinforcement allowed in the top mat of all concrete bridge deck slabs is #5 bars on one-foot centers in both directions. Longitudinal bars in the top mat of steel over piers shall be spaced no greater than 6 inches to control cracks.

POURING SEQUENCE: Provide on the plans a pouring sequence for the slab when the slab contains more than 400 cubic yards of concrete.

CANTILEVER DESIGN: Check the cantilever portion of the deck using the reinforcement from normal bridge deck design. If this reinforcement is inadequate to carry the cantilever loads, add additional reinforcement to the cantilever portion. Do not thicken the cantilever slab beyond normal deck thickness unless absolutely necessary.

BRIDGE DECK CORROSION PROTECTION:

The **standard** system of corrosion protection for new cast-in-place decks is to construct the slab with “AA” concrete, epoxy-coated or galvanized reinforcement (top and bottom mats), and provide 2 ½ inches minimum cover for the top mat of reinforcement.

Consider additional levels of protection such as corrosion inhibiting admixtures, exotic overlay materials, high performance concrete, shrinkage compensating cement, etc. for use on **critical structures**. A critical structure is defined as a structure whose size, design, location or importance to the transportation network would create unusual owner and/or user costs if its use were restricted for deck repairs. Examples of critical structures include high volume facilities, major stream crossings, precast segmental concrete bridges, cast-in-place box girder bridges, etc. Determine the extent of protection on a project-by-project basis.

DESIGN FOR BRIDGE DECK REPLACEMENT:

Design all bridge decks to be replaced under traffic.

For post-tensioned segmental girders, cast-in-place box girders, cable stayed structures or other special considerations, design the structure for 60 psf future wearing surface. The Director, Division of Structural Design, decides this on a project-by-project basis.

EPOXY-COATED REINFORCEMENT:

In any case where epoxy-coated reinforcement is used in the deck, specify it in all locations in the superstructure where Class “AA” Concrete is specified. (See **Section SD-502** for “Epoxy Coating in Substructure.”) Indicate epoxy-coated bars on the plans by adding the suffix (e) to the bar designation in the Bill of Reinforcement table. Use straight bars in both top and bottom reinforcing mats in bridge decks. Do not hook ends of top transverse reinforcement unless required by design. If hooked bars are required in the transverse steel, drop in shorter hooked bars at the ends of the longer transverse bars. Compute the quantity of epoxy-coated reinforcement steel separately as "Steel Reinforcement Epoxy Coated."

CONCRETE SEALING: Seal all new bridges decks with an approved silane sealer. Contact the Division of Structural Design for the latest special note for Concrete Sealing. Include an epoxy or High Molecular Weight Methyl Methacrylate sealer to seal off all longitudinal phase joints in new decks to prevent future water intrusion. Provide notes in plans that construction joint sealers are incidental to the concrete. Provide a latex overlay on all decks composed of precast panels or bridges built in segments where multiple transverse construction joints are present at the deck surface.

Where a bridge is widened and the existing structure has an epoxy or latex overlay, provide an epoxy or latex overlay over the new portion of slab to match existing.

STRUCTURAL DESIGN	Section BRIDGE SUPERSTRUCTURE
	Subject Expansion Joints

BRIDGES WITH ½" MOVEMENT OR LESS AT END OF BRIDGE:

For bridges with ½" thermal movement or less at the end of the bridge, avoid joints between abutments and slabs by using integral end bents or abutments without back walls.

BRIDGES WITH MORE THAN ½" MOVEMENT AND LESS THAN 1" MOVEMENT AT THE END OF BRIDGE:

For bridges with thermal movement at the end of the bridge more than ½" and less than 1", design the bridge without a joint by using integral end bents or abutments without backwalls, but specify GRS backfill with the EPS inclusion if the Geotechnical Branch concurs. If there will be excessive settlement, this may not be a good option and approach slabs may be required as discussed in section below.

BRIDGES WITH MORE THAN 1" MOVEMENT AND 4" OR LESS TOTAL MOVEMENT OR EXCESSIVE SETTLEMENT:

Preferably, use 25 foot long drive on approach slabs with a sleeper slab at the end in general accordance with the Standard Drawing.

JOINTS BETWEEN SLABS MID-BRIDGE:

Generally, place joints at the ends of the bridge when a joint is required. It is preferred to design beams as continuous for live load and composite for dead loads. When beams are designed as simple spans, use a link slab over the pier. Do not place a concrete diaphragm at the pier when using a link slab. Ensure reinforcing steel in the link slab over the pier is spaced no greater than 6 inches to control cracking.

When the slab cannot be designed continuous, design the joints between spans to accommodate thermal movement. Approval must be obtained from the Director, Division of Structural Design before designing joints between spans.

JOINTS FOR 4 INCHES OR LESS MOVEMENT:

When an expansion dam is required for movements of 4 inches or less, use joints in accordance with the Standard Drawings. Use manufacturer data to determine applicability of chosen joint for each structure.

JOINTS FOR MOVEMENTS GREATER THAN 4 INCHES:

When movements greater than 4 inches are predicted for a bridge expansion joint, specify a **steel finger expansion dam**. Completely design and detail the steel finger expansion dams as the fully cantilevered type with no sliding parts in the roadway portion. Sliding plates may be used on sidewalks and barrier curbs. Use a trough under the finger expansion dam and slope it down from the gutterline to the centerline of bridge. Extend the trough or carry the water from the trough to the ground by pipes. Submit preliminary details for the expansion joint to the Division of Structural Design for approval. Use **modular joints** only with written approval from the Director, Division of Structural Design.

UNSEALED EXPANSION JOINTS:

Do not use unsealed expansion joints.

BRIDGE DECK BLOCK OUT:

Generally, bridge deck blockouts are only shown for modular joints where the blockout is critical to proper installation.

LENGTH CONTRIBUTING TO EXPANSION OR CONTRACTION:

For bridges with an even number of spans and all piers fixed, measure the length of bridge contributing to expansion or contraction from the centerline of the center pier to the end of the bridge. For bridges with an odd number of spans and all piers fixed, measure the length of the bridge contributing to expansion or contraction from the centerline of the center span to the end of the bridge. For highly unsymmetrical bridges, base expansion and contraction on a more detailed analysis considering the influence of pier heights, pier geometry, bearing types (i.e. bearing stiffnesses), and span arrangement.

SLAB OVER BACKWALL:

For bridges with existing joints at the end, remove all joints possible by removing portions of slab and backwall and continuing the slab over the backwall as shown in **Exhibit 616**. The barrier must continue to the end of the proposed slab as well so no joint is used anywhere between the slab and barrier or between ends of barriers over the substructure.

STRUCTURAL DESIGN	Section BRIDGE SUPERSTRUCTURE Subject Structural Steel

PAINTING:

On painted steel bridges, Apply, repair, and remove paint on structural steel in accordance with the current edition Department of Highways Standard Specifications (Section 607.03.23 for new construction or Section 614 for maintenance painting), Supplemental Specifications, Special Provisions and Special Notes. Direct all paint questions to the Director, Division of Structural Design, who coordinates with the Division of Construction's paint section.

WEATHERING STEEL:

All structural steel bridges shall be designed with unpainted weathering steel unless site conditions are unfavorable as described in FHWA Technical Advisory T 5140.22 "Uncoated Weathering Steel in Structures".

Some unfavorable site conditions that may apply are the following:

• Industrial areas where concentrated chemical fumes may drift directly onto the bridge,

• Grade separations in "tunnel-like" conditions

• Low level water crossings defined as where normal flow is less than 10 feet below the low chord or the calculated 2 year storm high water elevation is within 2 feet of the low chord.

Particular consideration shall be given to grade separations with "tunnel like" conditions when all the following are present:

• Vertical clearance is 20 feet or less, because these bridges are more susceptible to "tunnel-like" conditions which lends itself to increased chloride deposits on beams.

• Bridges over interstates in urban corridors since deicer treatment in these areas is typically more concentrated.

• ADTT = 10% or more under the bridge, since trucks generate more misting with deicers than cars typically do.

• Posted speed limit of 55 mph or greater, since higher speeds generate more misting with deicers.

When bridges meet these criteria, use painted weathering steel for the whole bridge. Painted weathering steel is preferred since uncoated Grade 50 and 50W steel have minimal cost difference. The final decision on material type and usage will be up to the Division of Structural Design and the KYTC project team for all jobs.

GALVANIZATION: Where practical all rolled beam superstructures will be galvanized unless the Division of Structural Design and the KYTC project team approve another anticorrosion system. Where galvanizing will be utilized, contact the Division of Structural Design for the latest steel galvanizing special note.

BOLTED CONNECTIONS: Specify hot dipped galvanized bolts, nuts and washers for all bolted connections for painted and galvanized steel structures. Specify **Direct Tension Indicators (DTI's)** for all connections. For painted and galvanized structures, use galvanized DTI's. For weathering steel structures, use weathering steel DTI's.

GAP BETWEEN PLATES AT FIELD SPLICES: With the increased usage of 1-inch diameter bolts, a problem has occurred with fit up between plates. For 7/8-inch diameter bolts, the dimension from the center of the splice to the first row of bolts has been 2 inches traditionally and has served adequately. When 1-inch diameter bolts are used, this dimension needs to be increased to 2 ¼ inches to accommodate the additional required edge distance.

STRUCTURAL DESIGN	Section BRIDGE SUPERSTRUCTURE Subject Intermediate Diaphragms

MATERIAL: When spread box beam or PCI beam spans require intermediate diaphragms, use **steel diaphragms** in accordance with the Standard Drawings. Do not use concrete diaphragms.

LOCATION: Place diaphragms at the midpoint of the beam for PCI beams with a length of 40 feet to 80 feet. For PCI spans longer than 80 feet and less than 120 feet, place diaphragms at the quarter points of the beams. For PCI spans greater than 120 feet, place diaphragms at sixth points. Place diaphragms at the midpoint of the beam for spread box beam spans with a length greater than 80 feet when the clear distance between the beams is greater than 4 feet. For consistent detailing practice, consider the length of the beam along centerline of beam to arrive at the midpoint, quarter, and sixth points.

INSERTS: Check the location of inserts on small skews and narrow beam spacings. If it is obvious that inserts may be too closely placed, consider eliminating the offset of the diaphragms to avoid fabrication congestion.

STRUCTURAL DESIGN	Section BRIDGE SUPERSTRUCTURE
	Subject Spread PPC Beams

BASE SHEETS: Base sheets for I-beams are available in Micro Station (.dgn) format and may be obtained on the Division's website. Detail box beams as closely as possible to the composite box beams used as concrete deck units.

DRAPED STRANDS: When draped strands are necessary in prestressed beams, locate the hold-down points as close to the center of the span as possible. Hold-down points located 5 feet either side of the center of the span give satisfactory results in most cases. Limit the vertical component of the prestress force at the hold-down points to 4 kips per strand or less so that the capacity of the hold-down devices will not be exceeded. This requires a slope on the draped strands flatter than 1:7 in most beams. Do not drape strands in box beams. Use debonded strands only with approval from the Director, Division of Structural Design.

HAUNCH & CAMBER: When determining bridge seat elevations, consider the camber of the beams, the vertical alignment of the roadway, the roadway cross slope and the effect of placing straight girders on curved alignments. Ensure the haunch depth at the edge of the girder flange at midspan is at least ¾" deep for design purposes and to allow for a bit of potential camber growth. A minimum haunch at the centerline of the beam of 2 inches at the support is recommended. Girders that are stretched to their limits may require more. This consideration prevents most occurrences where the PCI-Beam intrudes into the bridge deck.

A column on the PCI-Beam base sheets, titled "**Maximum Allowable Camber**," takes into account the haunch, deflection assumed in construction elevations, effects of vertical curve, roadway cross slope, and the beam centerline not paralleling the roadway centerline. Notes on the elevation sheet have been revised to refer to this value. The purpose of this column is to assist the Resident Engineer in determining whether the grade needs to be adjusted due to excessive beam camber.

MILD REINFORCING STEEL:

When designing beams, investigate the beam camber and vertical geometry to provide 2 inches minimum **embedment of the stirrup bar above the top of haunch**.

When designing spread box beams, note that the CRSI-recommended 180-degree pin **diameters for stirrup bends** may cause fabrication problems. To accommodate fabrication, the standard box beams use stirrup bend diameters for the 180-degree bends of bars. This may be done in spread boxes also, or the webs may be thickened to eliminate this problem. The prestress manufacturers indicate that they have no problem accommodating a thicker web.

Detail the reinforcing steel for spread box beams as plain instead of epoxy-coated except the stirrup bar extending into the bridge slab, which is epoxy-coated. This matches the details for PCI beam reinforcement.

STRUCTURAL DESIGN	Section BRIDGE SUPERSTRUCTURE
	Subject Side-By-Side PPC Deck Units

STANDARDS: See Standard Drawings BDP-001 through BDP-013 for 48-inch wide box beams.

NON-COMPOSITE BOX BEAMS: Use the Standard Drawings for non-composite box beams only on projects where the current ADT is 400 or less and must have approval from the Director, Division of Structural design. Use Non-composite construction only as a last resort. Use composite box beams wherever possible.

COMPOSITE BOX BEAMS: The standard box beams with a composite concrete deck may be used on all roadway classifications when they are economically competitive with other types of bridges and when the geometry is compatible. Study bridges on vertical curves to determine the amount of slab concrete required. If an excessive amount of concrete is required, redesign the box girders, since the standard box beams were designed using a 5-inch cast-in-place concrete deck and a 1-inch haunch at the ends.

Epoxy-coat or galvanize all reinforcement.

Develop a construction elevation sheet with a minimum of 3 lines of construction elevations (centerline and each fascia line) to maintain the proper grade and a minimum 5-inch deck slab thickness.

Calculate the quantity of Class “AA” Concrete in the composite concrete deck and include this quantity in the Plan Estimate of Quantities.

Construct the substructure bridge seat parallel to grade to obtain even bearing on the bearing pads.

STRUCTURAL DESIGN	Section	BRIDGE SUPERSTRUCTURE
	Subject	Bridge Deck Drains

SPACING & TYPE: Space bridge deck drains to meet hydraulic considerations in accordance with the Division of Highway Design's Drainage Manual. Use one of the three types of bridge deck drains outlined in this section. A different type of drain may be used with the approval of the Director, Division of Structural Design, if conditions warrant.

THROUGH-BARRIER DECK DRAINS: Use through-barrier deck drains for bridges with concrete girders 4.5 feet deep or less, when aesthetics are a design consideration, and when through deck drains are not an option due to beam flanges being in the way. See Standard Drawing BGX-015.

To prevent excessive concrete cover in the area of the drains, follow special procedures in detailing and placing the reinforcement. Bend down the transverse reinforcement about 12 inches from the gutterline to maintain adequate cover at the drain. When tying large diameter negative moment reinforcement to the transverse reinforcement, the entire top mat is forced down in this region causing excessive cover. To alleviate this problem, place the drains away from the pier, thereby placing the drain in an area where some of the negative moment reinforcement can be reduced. If longitudinal reinforcement larger than a number 5 bar can be eliminated between the gutterline and a line 12 inches from the gutterline, use through-barrier deck drains. Otherwise, use a metal drain through the deck.

STEEL TUBE DECK DRAINS: Use Steel Tube Deck Drains when possible on all structures. See Standard Drawing BGX-015 for details. These drains may also be used on steel girder bridges. Details are also available for placement of these drains under the barrier.

CAST IRON OR STEEL DECK DRAINS: Cast iron or steel deck drains are available for certain specific conditions. See **Exhibit 519** for details.

STRUCTURAL DESIGN	Section BRIDGE SUPERSTRUCTURE
	Subject Miscellaneous

SUPERSTRUCTURE CONCRETE: Use **Class "AA" Concrete** in the design of all concrete bridge decks and cast-in-place girders. See **Section SD-406** for strength of Class "AA" Concrete. Use Class "S" or other high performance concrete only with written approval from the Director, Division of Structural Design.

LONGITUDINAL JOINTS: The finishing machines now in use govern the maximum slab width without a longitudinal joint. Divide the bridge deck with a longitudinal construction joint or open joint when the slab width between gutter lines is greater than 86 feet. For skewed steel bridges, the maximum allowable slab width without a longitudinal joint is reduced. For example, a bridge skewed 45 degrees has a maximum allowable slab width of 86 feet * cos(45°) or 60.8 feet without a longitudinal joint.

Locate the open joint in the center of the bridge deck and space the supporting girders accordingly. If this is not possible, locate the joint outside the through-traveled lanes. If a situation occurs that does not meet the above criteria, consult the Director, Division of Structural Design.

Locate the longitudinal construction joint, whether generated by staged construction or by the criteria shown above, over the top of a beam.

Where significant deflections due to slab loads are anticipated, consider using two construction joints and a closure pour.

STAY-IN-PLACE DECK FORMS (SIPDF): Precast Prestressed Concrete SIPDF may be allowed as a deck forming option. Obtain approval from the Director, Division of Structural Design before using.

Steel SIPDF may be used, provided that the valleys of the corrugations are filled with Styrofoam.

BEAM CLEARANCES AT EDGE OF CAPS:

Check beam clearances at the edge of cap at all substructure units. Some sharply skewed bridges on steep grades have had beams come into contact with the edge of the cap. Provide a minimum of ½ inch clearance from the bottom of beam to edge of cap. Provide elevations at cap corners when sloping cap is necessary to maintain proper clearance.

STRUCTURAL DESIGN	Chapter STRUCTURE DESIGN CRITERIA Subject Bridge Substructure

ABUTMENTS: Use solid Breastwall Abutments. See **Exhibit 619** for example details of diaphragms at abutments.

PILE BENT ABUTMENTS: Pile Bent Abutments are generally more economical than tall Abutments on spread footings. It is often appropriate to perform an analysis to determine the most cost effective option.

Preferably, use Integral Pile Bent Abutments. See **Exhibit 617 and 618** for example details. Before beginning design, contact Division of Structural Design to obtain current accepted details from the Division of Structural Design. Embed piles to 1 foot below the low beam seat elevation. See Section 410 for design criteria.

Reference the following on the Title Sheet: Special Provision 69, “Embankment at Bridge End Bent Structures,” and Standard Drawings RGX-100 and RGX-105, “Treatment of Embankment at Bridge End-Bent Structures.” Calculate the quantity of Structure Granular Backfill needed at each Pile Bent Abutment.

PIERS: See **Sections SD-603** and **SD-410** and **Exhibits 604 through 611 and 621**. In general, limit pier dimensions to multiples of 6 inches.

Perform cost analyses on pier substructure types. Piers built next to streams, roads, or railroads typically require sheeting, shoring, cofferdams, and/or dewatering for construction and can be quite costly. Spread footings tend to be economical when depth to rock is fairly shallow and slopes may be laid back with little chance of water infiltrating the excavation. When depth to rock is greater than 6 feet and slopes cannot be easily laid back, consider either drilled shafts or piling under the piers. Where rock is shallow enough that piling would need to be predrilled, drilled shafts should be used. Place bottom of footings below design scour such that piling will not be exposed. When excessive scour is anticipated and depth to rock is deep, use drilled shafts. Key spread footings into solid rock in accordance with Geotech recommendations. Where situations may be such that it is not immediately clear what foundation type to use, consult with the bridge office. Further consultation with the Geotechnical Branch and Construction may be required. The Cabinet reserves the right to require redesign to another foundation type at no extra cost if consultation with the bridge office is not performed. When the structure is next to a railroad use drilled shafts anywhere that sheeting or shoring would be required. Avoid excavations adjacent to railroad tracks.

Maintain the **effective slenderness ratio**, kl/r, less than or equal to 100. Request written approval from the Director, Division of Structural Design, to exceed this limit. For piers with stepped or tapered columns, maintain the ratio no less than that which would occur in a constant section design with kl/r less than 100. In general, it is more economical to use the same column section full height or provide steps than it is to construct a tapered column. Investigate H-section concrete columns for column heights greater than 150 feet.

When extending column reinforcement into the cap, check the intersection of column reinforcement and bottom cap reinforcement to prevent conflict. Detail this intersection. Always use an even number of bars in a round column.

See **Exhibit 620** for example Pier Diaphragm details for Prestress beams made continuous for live loads.

PILE BENT PIERS: See **Exhibit 611**. When placing a concrete webwall around the piles in a Pile Bent Pier, provide a minimum webwall thickness of 3 feet for 12-inch piles to allow for potential misalignment of driven piles.

SHEAR KEYS: Specify expanded polystyrene as a bond breaker and form on top of shear keys on substructure caps.

CAST-IN-PLACE RETAINING WALLS: Provide **expansion joints** in continuous cast-in-place walls at about 100-foot intervals. Provide **contraction joints** at about

30-foot intervals. See **Exhibit 516** for typical details.

MSE WALLS: Do not use Mechanically Stabilized Earth (MSE) walls to support structures without permission of the Director, Division of Structural Design. MSE walls may be used for wings (see **Exhibit 517**).

PEDESTALS: Pedestals as detailed in **Exhibit 602** may be used on any pier type. When using shop-fabricated structural steel spans, use raised pedestal-type concrete bearing areas on piers and abutments. Raised pedestals permit grinding, without pocketing, in the bearing areas as an adjustment for errors made during substructure construction.

The minimum allowable height of the pedestal is 4 inches. If pedestal height exceeds 15 inches, consider sloping the pier caps. Where this is not practical, detail a joint in the pedestal 4 inches above the cap.

EPOXY OR GALVANIZED COATING IN SUBSTRUCTURE: Use epoxy, hot dipped galvanized, or continuously galvanized coated reinforcement in the following cases:

- The dowel bars which extend from abutment or pier caps into the abutment or pier diaphragms and which fix the superstructure
- Pile Bent Abutment with backwall and expansion joint: all reinforcement, including reinforcement in wings
- Integral Pile Bent Abutments: all reinforcement, including reinforcement in wings
- Breastwall Abutments with a backwall: all backwall reinforcement
- Pier caps under expansion joints: all cap reinforcement above bottom of cap except column reinforcement extending into cap.
- Pier columns and crashwalls adjacent to roadways if designer feels extra corrosion protection is warranted.

Use Epoxy coated Reinforcement unless permission is granted by Director, Division of Structural Design to use galvanized.

STRUCTURAL DESIGN	Chapter STRUCTURE DESIGN CRITERIA
	Subject Drilled Shafts

POLICIES & DETAILS: The design shall be done with a lateral load analysis using a program capable of a p-y non-linear analysis. Use the moments and shears from the analysis to design the drilled shaft. Include all design program output in the calculations submitted to the Division of Structural Design. Instead of designing for the maximum shear spike that occurs when using a non-linear p-y analysis, the designer is allowed to design for the average shear within 1 shaft diameter of the maximum shear location. Design for all anticipated scour. See **Exhibit 518** for general details.

CLEARANCES & TOLERANCES: Detail the Drilled Shaft to accommodate a construction tolerance on the location of the shaft of 3 inches, more tolerance is desirable in some situations where construction activity might be more difficult such as construction from floating equipment. Maintain a constant diameter of the drilled shaft core steel from the bottom of the rock socket to just below the top of the cap or footing. Detail the longitudinal steel 6 inches clear to the sides of the rock socket.

For non-seismic design, detail the shaft spiral with a 6-inch pitch and design the shaft as a tied column (Φ=0.70). For seismic design, design and detail in accordance with AASHTO. Carefully consider the difficulties encountered on construction with a small spiral pitch and small bar spacings that result from too numerous longitudinal bars.

THROUGH SOIL: Where drilled shafts pass through soil and are socketed into bedrock, use permanent casing. Detail the inside diameter of the casing 6” greater than the rock socket diameter. When a column is continuous with the drilled shaft (as opposed to using a footing), detail the column diameter 6” less than the rock socket diameter and place a note on the plans requiring that the rebar cage be held centered in the rock socket and shifted such that it is at plan location at the bottom of the column.

ROCK ONLY: Where rock is close to the ground surface, columns may sit directly above drilled shaft rock sockets. In that case, detail the rock socket diameter 18 inches greater than the core steel diameter. Detail the column diameter 12 inches less than the rock socket diameter and place a note on the plans requiring that the rebar cage be placed at plan location.

STRUCTURAL DESIGN	Section: PILE DESIGN
	Subject: General

SPACING: Regardless of pile spacing dictated by the criteria outlined in the following paragraphs, space adjacent piles no closer than 3 times the pile size, center-to-center of piles. Do not space piles more than 8 feet apart without prior approval from the Director, Division of Structural Design.

EMBEDMENT: Embed piles a minimum of 10' below footings or caps. Predrill where 10' minimum embedment cannot be obtained due to higher solid rock lines or boulders.

PILE POINTS: Use pile points on all point-bearing piles. Indicate the required type of pile point on the foundation layout sheet. Do not use pile points with Friction Piles unless directed to do so by the geotechnical engineer.

BATTER: Use only vertical piles in integral abutments.

In abutments with two rows of piles, batter the front row 1 to 3. In abutments with three rows of piles, batter the front row 1 to 3 and the second row at a lesser batter. Batter piles in piers (maximum 1 to 3) to provide as stable a pier design as possible.

DESIGN PILE LOAD: Show the actual computed factored strength design pile load on the plans.

POINT-BEARING PILES: When the subsurface exploration indicates that point-bearing piles are appropriate, use **steel HP 12x53 or HP 14x89**. Base the pile size and arrangement on economics. When necessary to preclude overstressing the piles during driving, the geotechnical engineer should perform a Pile Driving Resistance Analysis as described below.

FRICTION PILES: Typically, use **Steel H-Piles**, although certain conditions may warrant consideration of **Steel Pipe Piles**. When pipe piles are used, use the standard 16 inch pipe pile with a ½" wall in accordance with the current standard details. If other pipe pile sizes are required, obtain approval from the Director, Division of Structural Design. Fill the pipe piles with sand or gravel to the bottom of footing or cap elevation. Use concrete only if structural design requires it. When using friction piles, base their design on two static analyses. The first analysis determines the design pile length required for permanent support of the structure. The second analysis determines the soil resistance to be overcome during driving to achieve the estimated length. The results of these analyses are provided by either the Geotechnical Branch or by a geotechnical consultant. The designer may also perform the analyses based on the results of an adequate geotechnical investigation of the site.

STRUCTURAL DESIGN	Section: PILE DESIGN
	Subject: Design Pile Loads

GENERAL:

Design Pile Loads are based on past experience and calculations in accordance with the code, and their values should maintain the relationships outlined in this article.

Limit the Design Pile Loads for all piles to less than the minimum allowable value determined by:

- the capacity of the pile as a structural member,
- the capacity of the pile to transfer load to the soil or rock, and
- the capacity of the soil or rock to support the load delivered by the pile.

DESIGN:

Piles are designed according to the code as braced column members if fully encased by soil. If scour or excavation will expose piling, design the exposed portions as unbraced members.

POINT BEARING PILES:

Piles driven to bearing on solid rock are driven to practical refusal. There are three different refusal cases for hard rock, soft rock, and extremely soft rock. The case to be placed in the plans is noted in the geotech report. Use a resistance factor on the capacity of the pile as noted in the geotech report.

FRICTION PILES:

Piles driven as friction piling use one of two different field verification methods: Modified Gates Method, or Dynamic Pile Testing. These methods have different resistance factors and the pile capacities for each method will be shown on the pile capacity chart in the geotech report.

Due to ease of use, shorter construction time, and the fact that a specialty testing consultant is not required, the Gates

Method should generally be used unless there are more than 50 piles or the maximum required nominal resistance exceeds 600 kips. In these cases, use Dynamic Pile Testing.

The dynamic pile testing requires a specialty contractor with a Pile Driving Analyzer to monitor the pile as it is driven. The data is analyzed after the initial drive and again after a restrike a certain time later. Using this data, a very accurate assessment of the pile capacity is achieved and is reflected in a higher resistance factor. This method is not preferred due to the required wait period between the analyses and the testing costs.

LOAD COMBINATIONS: Factor the Design Pile Loads for the various combinations of loading as specified in AASHTO. For the load combination with downdrag, see the next section.

NEGATIVE SKIN RESISTANCE: Evaluate all piles for overload due to soil **downdrag**. Downdrag typically occurs when piles are driven through approach fills to bearing below soft compressible clay layers. The downdrag load equals the sum of loads from all soil layers above the "neutral point." The neutral point is the point below which there is insufficient downward movement of the soil in relation to the pile to produce drag. For excessive downdrag loads, increase the number of piles or increase the pile size. Do not batter piles when excessive downdrag is predicted. If pile driving can be delayed until 90 percent of the predicted settlement has occurred, additional piles or larger piles may not be necessary and battered piles may be used.

Design piles for downdrag loads as follows:

Step 1 – Ignore the downdrag load and design in accordance with standard practice. Use the piling resistance factor as specified in the geotech report. It is generally 0.3, 0.5, or 0.6 depending on the driving conditions.

Step 2 – Check the design by adding the downdrag load to the axial pile load calculated for the condition of substructure and superstructure dead load plus live load without impact. Use a resistance factor of 0.9 for the downdrag load case only.

If satisfying Step 2 increases the number of piles required by

20% or more or increases the size of pile by two increments or more, obtain approval of the Director, Division of Structural Design.

Report the maximum factored strength loads on the piles on the foundation layout sheet charts.

LUGS, SCABS, & CORE-STOPPERS: Do not use these to increase the bearing capacity of steel piles used for friction piles.

GROUP EFFECT: Normally, group effects need not be considered when the pile spacing exceeds 3*B.

STRUCTURAL DESIGN	Section PILE DESIGN
	Subject Pile Resistance to Horizontal Thrust

GENERAL:

In non-integral abutments, design piles to resist horizontal thrust by battering the front row of piles 1 to 3. Use vertical piles in the back row. For abutments requiring a backwall separate from the span endwall, the minimum allowable horizontal dimension between the front row and back row of piling at the level of the bottom of the pile cap is 3 feet. This article includes a method of design for the abutments on piling with a backwall.

DESIGN METHOD:

1) Compute vertical and horizontal loads, thrusts, and moments about some point in the plane of the bottom of footing or bottom of cap. Neglect the passive earth pressure of any earth mass
   a) that slopes sharply away from the pile group,
   b) in front of each pile,
   c) which may possibly slide or crack away, or
   d) that is above the scour line.

   Do not neglect the vertical weight of such an earth mass.

2) From the preliminary pile grouping, compute the center of gravity, moment of inertia, and other physical constants necessary to compute vertical components of pile stresses.

3) Find vertical component of pile stresses and translate component into axial stress in the battered piles to check against overstress.

4) From computed vertical and axial stresses in the battered piles, compute the horizontal component as a function of the batter slope. Fully balance the sum of the horizontal components of the computed stress in the battered piling with the total horizontal earth pressure for the dead load condition of loading. For lateral loads of short duration, any available passive earth pressure may be considered

part of the resistance.

5) The passive shear resistance of the earth in front of each pile may be considered in the design. See **Exhibit 502** for the allowable Horizontal Resistance per pile. The soil strength value used to enter the graph equals the weighted average of those values for the in-situ soils in relation to the strength value and layer thickness as presented in the Geotechnical Engineering Report. When N-Counts and cohesion are presented, use the weighted average of the Horizontal Resistance values separately obtained for the two strength values. With the soil strength value for Cohesion, C (psf) or standard penetration, N-Count, the Horizontal Resistance per pile is given in kips. (The Geotechnical Branch provides the "C" or N-Count values.)

6) Read directly from the graph the allowable Horizontal Resistance per pile for construction loading conditions.

7) For all other loading conditions, the value of Horizontal Resistance, as given in the graph, may be increased by fifty percent, except that in no case may the maximum allowable Horizontal Resistance allowed per pile exceed 10 kips. The minimum allowable Horizontal Resistance per pile may be raised to 4 kips.

SPECIAL CONDITIONS: Since piling longer than 75 feet in abutments may be extremely vulnerable to lateral translation, use more conservative design criteria on the capacity of each pile to resist horizontal loads by means other than the thrust of battered piles.

Additionally, where sounding data, soil reports, or construction conditions indicate an extremely poor quality of earth material surrounding the pile group, use more conservative criteria. A non-linear p-y analysis is required on vertical piling subjected to horizontal loadings to design the piling.

STRUCTURAL DESIGN	Section REINFORCED CONCRETE BOX CULVERTS Subject General

CULVERT LENGTH: Calculate the culvert length such that the roadway fill hits 6 inches below the top of the parapet. Round the total length of culvert to the next highest 6 inches, unless designing a culvert extension.

MINIMUM FILL: Design the top slab in accordance with the AASHTO Specifications.

MINIMUM LENGTH: For culverts with driven guardrail posts or culverts with guardrail posts attached to the top slab, establish a minimum length to provide 4 feet clearance from the front face of the guardrail to the face of the parapet. On projects where safety criteria are being applied, avoid locating any culvert headwall within the clear zone. Measure the clear zone from the edge of pavement. In cases where a combination of fill height and culvert size would normally locate the headwall within this clear zone, extend the culvert by transitioning the fill slope to a flatter slope at the culvert or change the size or type of drainage structure. If no solution can be found by the aforementioned methods, request exception from the FHWA on an individual structure basis. Exceptions will only be considered where the headwall is adequately protected with guardrail or other protection designed to ensure the safety of the motorist. The Preliminary Line and Grade Inspection Report, Geometric Design Sheet, and Roadway Typical Section will indicate whether to apply the clear zone criteria.

GUARDRAIL ATTACHMENT TO TOP SLAB: When fill over culvert is less than required to develop guardrail post stability, attach the post to the top slab.

END CONDITIONS: Detail the ends of RCBC as specified in the drainage folder on Design Summary Sheet, Form TC 61-100, sheet 1. The use of a different end condition requires approval from the Drainage Section.

WING LENGTH: Calculate culvert wing length and associated dimensions as shown in **Exhibits 504 through 506**. Assume the slope of channel equals 0.5 ft/ft unless otherwise specified in the drainage folder.

PAVED INLETS & OUTLETS: Provide paved inlets and/or outlets on all culverts unless approved by the Director, Division of Structural Design and Drainage. See **Exhibit 507**. High velocities may require an "energy dissipater" on the outlet end of a culvert. Special outlet designs require recommendation or approval by the Drainage Section of the Division of Highway Design Special.

IMPROVED INLETS: Use improved inlets only when absolutely necessary.

ACID WATER AND/OR HIGHLY ABRASIVE SITUATIONS: When the Design Summary Sheet (Form TC 61-100 in the drainage folder) identifies either of these conditions, provide an additional 2 inches of cover on the bottom slab and the toe of the wing footings. Increase the thickness of the sidewalls, interior walls, and wing walls 2 inches for a height of 12 inches above the flow line. For this design, place the construction joint between the walls and the bottom slab 12 inches above the flow line. See **Exhibit 508**. For acid water, ensure the note for sulfate resistant cement is included in the plans when noted in the geotechnical report.

GENERAL NOTES: See **Section SD-301**.

CULVERTS WITHOUT WINGS: When a culvert is located where the foundation material is too unstable to support wings, extend the culvert barrel sufficiently through the fill so that wings and wing footings are not required.

DESIGN METHOD: Design culverts as simple frames without shear reinforcement unless fill over the culvert is 30 feet or greater. With larger fills, add shear reinforcement as necessary to give the most economical design possible. Culverts may be designed with shear reinforcement as a simple frame, as a rigid frame box, or as an arch if this would result in a more economical design, with the permission of the Director, Division of Structural

Design. See **Exhibit 509** for additional reinforcement needed in a rigid frame box culvert.

DESIGN STRESSES: f`c = 3,500 psi
fy = 60,000 psi

DEAD LOADS: See AASHTO Sections 3 and 12 and **Section SD-411**. Foundation Types change the analysis. See **Section 505-5**.

LIVE LOADS: See AASHTO Sections 3, 4, and 12.

HORIZONTAL LOADS: Design wings and sidewalls using earth pressure loads as outlined in **Section SD-404**, “3.11, Earth Pressure”. Calculate design height of culvert wings in accordance with **Exhibit 514**.

CULVERT TOP SLABS WHICH ACT AS RIDING SURFACES: Epoxy coat all steel in the top slab. Use guardrail anchored into the top slab or Rail System Type T631.

REINFORCEMENT IN PAVED FLOW LINES, INLETS & OUTLETS: Use #4 bars at 18 inches in each direction with an option for WWF 6x6 - D7xD7. This reinforcement is typically incidental to the Class A concrete in the paved flow line and a general note should be included to state such.

SETTLEMENT: Where the culvert barrel is expected to undergo differential settlement, provide joints in the barrel and collars surrounding the entire barrel at the joint to allow the culvert to settle without cracking and damaging the barrel. The department will provide preferred details upon request. Camber culvert as required to achieve proper flowline grade under final settled condition.

STRUCTURAL DESIGN	Section REINFORCED CONCRETE BOX CULVERTS
	Subject Barrel Design

APPLICATION:

This article applies to RCBC other than ones of rigid frame design. See **Exhibit 510** for details of single span barrels and **Exhibit 511** for details of multiple span barrels.

GENERAL:

All main reinforcement, any part of which lies in the bottom part of the slab, requires hooks on each end.

Detail keyed construction joints between the top slab and vertical walls. Turn the keys down.

Design the longitudinal reinforcement in culvert barrels (E Bars) to transfer the full axial tension from the wings to the barrel. This tension is caused by earth pressure against the inlet and outlet wings.

TOP SLAB FOR SINGLE SPAN CULVERTS:

Unless the culvert is designed as a rigid frame, design the slab as a simply supported beam, with the span length equal to the distance center-to-center of sidewalls but not to exceed the clear span length plus the depth of the slab. The minimum allowable slab depth is 7 inches.

Assume the maximum shear to occur at a distance d equal to the effective depth of the slab from the inner face of the vertical wall, unless the culvert is rigidly supported on rock. In the latter case, assume the maximum shear to occur at a distance of 1/12 x clear span from the inner face of the vertical wall. If shear reinforcement is used, bend up alternate bars at an angle of 45 degrees, beginning at a distance 1.5d from the face of the wall. Investigate whether shear reinforcement provides a more economical design. Generally under large fills, it is more economical to provide shear reinforcement than to thicken the slabs for shear capacity.

TOP SLAB FOR MULTIPLE SPAN CULVERTS:

Design the slab as a simply supported beam continuous over the interior supports, with a span length equal to the distance center to center of sidewalls but not to exceed the clear span plus the depth of the slab.

Details of Reinforcement – Bend down the truss bar in the slab at the fifth point of the clear span. When the depth of fill is 3 feet or less, extend bars N to the centerline of the clear span. When the depth of fill exceeds 3 feet, extend bars N 12 inches beyond the quarter point of the clear span. Do not hook ends of bars N.

Assume the maximum shear to occur at a distance d equal to the effective depth of the slab from the inner face of the vertical wall, unless the culvert is rigidly supported on rock. In the latter case, assume the maximum shear to occur at a distance of 1/12 x clear span from the inner face of the vertical wall. If shear reinforcement is used, add bent bars spaced with bars N. Bend up the stirrups at an angle of 45 degrees beginning at a distance 1.5 d from the faces of the interior wall. Treat the slab over the exterior walls as in the second paragraph of the above section, "Top Slab for Single-Span Culverts." Investigate whether shear reinforcement provides a more economical design. Generally under large fills, it is more economical to provide shear reinforcement than to thicken the slabs for shear capacity.

BOTTOM SLABS:

Provide the same reinforcement and effective depth in the bottom slab as the top slab. However, increase the total depth of the bottom slab by 1 inch for single span culverts and 2 inches for multiple span culverts.

Detail roughened construction joints between the bottom slab and vertical walls.

SIDEWALLS:

Design the wall as a simply supported beam with the span length equal to the clear wall height. Check as a column with no end restraint, with the height equal to the clear wall height and with bending and axial stresses. Design the sidewall thicknesses no less than 1/12 of the clear height of the culvert or 10 inches.

Reinforcement – Provide minimum reinforcement of #5 bars at 12-inch spacing. When the clear wall height is less than 7 feet, extend wall reinforcement into both top and bottom slabs with no hooks required. When clear wall height is 7 feet or more, use dowels from the bottom slab into the vertical wall with hooks in bottom slab end of the dowels. Use at rest pressures. At no point shall equivalent fluid pressures less than 45pcf be used. Include a minimum of 2 foot of live load surcharge in conjunction with maximum sidewall pressures. Do not design for water pressure outside the box due to weep hole drains being required.

INTERIOR WALLS: Limit the thickness of interior walls of multiple span culverts to 10 inches minimum with minimum vertical reinforcement of #5 bars at 12-inch spacing. Design interior walls as short columns. The second paragraph of the above section, “Top Slab for Single-Span Culverts,” applies to interior walls. Unless otherwise specified, detail the inlet ends of the interior walls rounded to a half circle and set back to clear the rounded treatment of the parapet.

WALL DRAINS: Place 4-inch diameter weep hole drains in the sidewalls of all culverts 6 feet in height and greater, or culverts over 125 feet in length regardless of height. Place the same drains in all wings 10 feet in length or greater. Place the center of the drain 6 inches above the flow line and at 8 feet on center.

HEADWALLS (PARAPETS): Unless special conditions warrant otherwise, set the thickness of the headwall to 12 inches and the height above the bottom of the top slab to 2 feet 6 inches. Provide vertical bars, usually designated by an R, as stirrups at not less than #5 at 12 inches. Locate two bars in the top of the headwall: #6 bars in single span culverts and the same size as bars N in multiple span culverts. See **Exhibit 512**.

EDGE BEAMS: Provide Edge beams as required by the Code. Section 4.6.2.1.4b states the edge beam shall be designed to support one line of wheels. Design Edge beams to also support the tributary area of dead load on skewed headwall culverts where the reinforcement is designed perpendicular to the barrel and the edge beam must support one end of the reinforcement. Provide Edge beams at each side of a phase line where a culvert is designed to be constructed in phases. Generally, design the parapet to act as the edge beam.

CULVERT EXTENSIONS: Leave the existing headwall and as much of the wings as possible in place to retain the fill on the culvert and behind the parapets and wings during construction. Drill and epoxy grout all longitudinal reinforcement into the existing culvert or provide 1” diameter dowels spaced at 12” maximum around the entire perimeter of the culvert barrel. Study the existing culvert plans to figure out how the existing reinforcement was designed. If the existing parapet is skewed to the centerline of the culvert and the existing reinforcement is designed perpendicular to the culvert, then either place a new edge beam adjacent to the existing parapet/edge beam to the support the loads from the new culvert or design and place the new reinforcement in the extension parallel to the skew.

Alternatively to doweling, remove headwalls and portions of barrel until minimum lap lengths with existing longitudinal barrel steel can be obtained with new steel. If culvert barrel or headwall is in bad shape, removal must be done instead of doweling.

APRONS: Aprons are normally 12 inches thick. Extend aprons 4 feet below the flow line on culverts with 6 feet high openings or greater and 3 feet below the flow line on culverts with openings less than 6 feet in height. Embedment to, or into, bedrock as specified by the Geotechnical report may be required. In multiple span culverts, detail two bars the same size as bottom slab bars N at 6 inches above the bottom of the apron to reinforce the negative moment. In single span culverts, detail two bars the same size as bottom slab bars B at 6 inches above the bottom of the apron to reinforce the positive moment. See **Exhibit 513** for apron details.

STRUCTURAL DESIGN	Section: REINFORCED CONCRETE BOX CULVERTS
	Subject: Wing Design

WING TYPE: Use one of two wing types on culvert ends. One type is the traditional wing, defined as wings flared by varying angles from headwalls that are parallel to the centerline of roadway. The second type is the 30-degree flared wing, flared 30 degrees from the centerline of the barrel with the headwall perpendicular to the centerline of the barrel. This type of end condition has been designated to orient the culvert to the hydraulic flow.

WING WALLS: Design the thickness of wall 1/12 height of wall with a minimum thickness of 10 inches. Design the wall as a retaining wall with a sloping surcharge, reducing the pressure as a function of the skew.

Provide two #6 bars T in the top of all wing walls of culverts with openings 7 feet high or higher and all wings 10 feet long or longer. Begin spacing of horizontal bars M 9 inches above footing.

Provide vertical bars in both faces of wing walls of culverts with openings 7 feet high or higher. Use dowels in the back face with hooks in the wing footing. In the front face use no dowels, but use vertical and horizontal bars for the entire length of the wing.

See **Exhibits 514** for typical wing details.

WING FOOTINGS: Calculate the culvert foundation pressures for full dead load and live load if applicable.

HAUNCHES: Do not use haunches.

EXPANSION OR CONTRACTION

JOINTS: Use these joints in culverts only with approval from the Director, Division of Structural Design.

STRUCTURAL DESIGN	Section REINFORCED CONCRETE BOX CULVERTS
	Subject Excavation

CLASSIFICATION: Specify structure excavation for culverts as one or both of two classes: Foundation Preparation (see **Section SD-605**) and Structure Excavation Solid Rock.

STRUCTURE EXCAVATION: Excavate according to Section 603 of the Standard Specifications. Terminate aprons for earth bearing culverts at the rock line rather than excavating rock. If the geotechnical report requires a certain depth of embedment into solid rock, excavate the rock and pour the apron against solid rock on all sides to prevent scour.

ROADWAY EXCAVATION, CHANNEL CHANGE: Do not specify this type of excavation on the structure plans unless there are no roadway plans. If channel change excavation is required, then reference this type of excavation to the roadway plans.

STRUCTURAL DESIGN	Section REINFORCED CONCRETE BOX CULVERTS
	Subject Foundations

VARYING FOUNDATIONS:

The following two alternative methods are available. Include a comparative cost estimate of the alternatives with the calculations.

- **Make Total Foundation Yielding** – To make the total foundation yielding throughout, remove rock and replace with selected earth backfill of sufficient depth and width. See **Exhibit 515** for dimensions and construction sequence. Provide a uniform foundation over a width to include the exterior prisms, i.e. for a distance equal to the width of the structure on each side. Classify the excavation as Structure Excavation Solid Rock. Design the culvert according to the AASHTO Specifications and **Section SD-411**.

- **Make Total Foundation Unyielding** – If conditions warrant, e.g. the distance from the flow line to the rock line is not too far, excavate the earth between the rock line and the flow line and fill with selected uncompressible backfill. Classify the excavation as Structure Excavation, Common and paid under Foundation Preparation and place the backfill at the approval and direction of the engineer. Design the culvert in accordance with **Section SD-411** and the following procedures.

YIELDING FOUNDATIONS: Use a full bottom slab for the full length of the barrel. Use a unit weight of 120 pcf for fill.

UNYIELDING FOUNDATIONS: When a RCBC is rigidly supported on rock, design according to the following parameters:

Distribute a uniform load P1 in psf, equal to 84 pcf * H, over design span L1. Supplement this uniform load P1 by two additional uniform loads P2. The value of P2 in psf is equal to [(120 pcf * K1 * K2 * K3) – 84 pcf] * H. See **Exhibit 403** for locations of load P2 and design span L1. H is equal to fill height over culvert. Interpolate the values of K1, K2, and K3 from graphs on **Exhibit 404**.

Check shear at the distance 1/12 the clear width of culvert, or "d" depth of the slab, measured from the inner face of the vertical wall, whichever is closer to the face of the wall.

The moments and shears calculated shall not be less than those calculated when using a uniform load of (120 pcf * H) distributed over design length "L1".

The loads shown above are based on Research Report UKTRP-84-22. Note that checking shears at the distance L2/12 is intended to be applied only with the loading proposed by UKTRP-84-22 and applies only to slab shear at exterior walls. Check slab shear at interior walls at distance "d".

Unyielding culverts may be designed with either separate footings under each sidewall embedded in rock or with a full bottom slab.

When culvert sidewalls bear on separate footings embedded in rock, use a 6-inch paved bottom slab. Check bearing pressure under footings. Check for the possibility of side pressure on the footings buckling or cracking the bottom paving. This possibility is especially dangerous for culverts under high fills and for rock situations where having a vertical rock face to pour the footings against is doubtful. If there is risk of future cracking of the bottom paving, then design struts between footings or use a full bottom slab. Use a full bottom slab on all culverts with less than a 6-foot span and any culvert where bearing pressure under spread footings under each sidewall cannot remain less than the factored bearing resistance stated in Geotechnical report.

LIGHTWEIGHT FILL: When placing additional fill over a culvert and increasing the loads over the existing condition, lightweight fill is required to maintain the same pressures on the top slab and sidewalls. Select lightweight fill of the type(s) provided in the Geotechnical Report in accordance with the Geotechnical Branch requirements and Lightweight Fill Special Notes Published on the KYTC, Division of Structural Design's website. Transversely to the culvert barrel, place lightweight fill above a calculated elevation within the limits of 1:1 slopes extending away from the culvert on each side starting at the bottom of both sidewalls. Along the length of the culvert, the line extends upwards from the bottom of the culvert directly under the step or critical point in the top slab at a 1:1 slope to the ground or road surface, or to the overlying lightweight fill zone for multi-stepped culverts. Perform calculations and draw up limits for review and approval by the Cabinet. The Cabinet reserves the right to require more lightweight fill or adjust limits in all cases.

With permission from the Director, Division of Structural Design, perform an analysis to show the existing culvert can withstand the extra pressures with no lightweight fill. Perform an in-depth inspection to show no degradation to the existing culvert. Use the same code the culvert was originally designed with. Ensure the original design material strengths are used in the analysis. Submit stamped analysis for review. The Cabinet reserves the right to require lightweight fill regardless of the results of the analysis.

STRUCTURAL DESIGN	Chapter STRUCTURE DESIGN CRITERIA
	Subject Material Specifications

MATERIALS: Use AASHTO and/or ASTM materials specifications. See KYTC Standard Specifications, AASHTO LRFD Bridge Design Specifications, and the Division of Materials List of Approved Materials for specific material specifications. Materials not covered by the Standard Specifications must be specifically noted on the plans.

STRUCTURAL DESIGN	Chapter MISCELLANEOUS
	Subject Rustication

GENERAL: A rustication groove provides a location for cracks that occur in concrete walls at or near changes in wall alignment and also obscures the cracks. Detail the rustication on the plans where necessary.

CULVERTS: Do not use rustication grooves on culverts.

WALLS: Use rustication at the expansion, construction, and contraction joints of cast-in-place walls. See **Exhibit 516** for details.

PIERS: Use horizontal bands of V-joint rustication grooves at construction joints in exposed portions of pier columns and pier web walls.

BARRIER WALLS: Use rustication grooves in the outside face of barrier walls at all horizontal construction joints. Detail rustication grooves as continuous throughout the bridge, including wings. See **Exhibit 600 and 601** for details.

PEDESTALS: Use rustication grooves at the top of cap where using pedestals.

STRUCTURAL DESIGN	Chapter MISCELLANEOUS
	Subject Aesthetics

PLAN NOTE: When including aesthetics as part of the structure, place a note on the plans documenting the aesthetic items and note that these items are not subject to value engineering proposals.

USAGE: Provide aesthetic treatments for projects in scenic, historic or recreational areas or other special considerations within reasonable fiscal restraints. Consider aesthetic treatment early in the environmental and/or design process. Project engineers should provide the bridge designer as much information as possible relative to the goals of the aesthetic treatment.

SURFACE TREATMENT: In urban areas, where retaining walls or large breastwall abutments are adjacent to ramps and heavily traveled routes, consider the surface treatment of the walls. Consider various treatments that are inexpensive to implement, such as shadow boxes or corrugation patterns. Submit the proposed treatment with Preliminary Plans, Stage 1, for approval.

Treatments to consider include but are not limited to form liners for exposed concrete surfaces, structure type and shape, material color and texture, and proportion of the elements. On rehabilitation projects, design for compatibility between the existing and proposed portions of the structure.

STONE FACED BARRIERS: When using stone faced barriers for aesthetics, note the following on the plans: attach the guardrail prior to stone placement and place the crush tube after stone placement.

DRY STONE MASONRY: For projects containing work on existing dry stone masonry walls, specify that work done on these walls be performed by a certified Dry Stone Mason where required.

MASONRY COATING: Calculate quantities in square yards for Masonry Coating according to Standard Specifications Section 601.03.18 (B). In the Estimate of Quantities on the Title Sheet, show quantities for the superstructure and for each substructure as needed.

MEDIAN BARRIERS: Match the geometry of the Bridge Median Barrier System to the median barrier on the road. See Median Barrier details for methods for doweling into deck. See **Exhibit 603** for one method of attaching raised median to bridge deck.

SD-603

STRUCTURAL DESIGN	Chapter MISCELLANEOUS
	Subject Bridge Pier Types

TYPES: Bridge pier details appear as **Exhibits 605 through 611**. In general, piers of these types are approved for use in bridges in Kentucky. Other pier types may be approved or recommended by the Director, Division of Structural Design.

CODING: **Exhibit 604** shows the standard coding for bridge piers. Use this coding when listing piers on the closeout forms.

TALL PIERS: All of the architectural pier types do not lend themselves for use as tall piers, i.e., piers 50 feet or greater in height. Consider this before designing a tall pier. Make preliminary sketches or architectural studies for all piers 50 feet or greater in height.

PIER CRASHWALL, HIGHWAY: For details of highway crashwall, see **Exhibit 612**. For details of guardrail attachment, see Standard Drawing RBI-005, “Guardrail Installation At Bridge Columns.”

PIER CRASHWALL, RAILROAD: When locating a bridge pier less than 25 feet from the centerline of a railroad, use a crashwall for the pier. For details of railroad crashwall, see **Exhibit 613**.

STRUCTURAL DESIGN	Chapter MISCELLANEOUS Subject Bridge Approach Slabs

USE: Use approach slabs as directed by the Project Manager or as necessary for thermal movements / settlement (See SD 501-2). Use drive on approach slabs with sleeper slabs in accordance with the Standard Drawings.

DESIGN CRITERIA: Determine the length of approach slab as a function of the depth of fill adjacent to the bridge and the type of soil under fill. The minimum allowable length of bridge approach slab is 25 feet. Obtain current details for approach slabs from the Division of Structural Design.

Live load surcharge at the abutment may be disregarded when providing an adequately designed reinforced concrete approach slab, supported at one end by the bridge.

To coordinate the preconstruction activities required to develop contract plans for the bridge approach slabs, use the following parameters and procedures:

- Include approach slabs in the structure plans. Payment is per square yard of approach slab.
- Include the provisions for the embankment required under the approach slab in the structure plans.
- For skewed bridges, skew the roadway end of the approach slab to match the bridge skew.

STRUCTURAL DESIGN	Chapter MISCELLANEOUS Subject Foundation Preparation

BID ITEMS: Foundation Preparation is a bid item in Section 603 of the Standard Specification. All sheeting, shoring, dewatering, common excavation, and backfill are incidental to this lump sum item. Set up one lump sum item per structure. Provide separate bid items for partial removal of structure for culvert extensions, solid rock excavation and any undercut of unsatisfactory material and refill.

STRUCTURE EXCAVATION COMMON: Some plans may continue to show structure excavation common in lieu of Foundation Preparation. This is still allowed by the specification. Eighteen-inch excavation limits now apply to all structures regardless of classification.

END BENT BACKFILL: Although not covered in Section 603, it is intended that End Bent Backfill (Structure Granular Backfill) remain a bid item and that any excavation at end bents placed over fills remain incidental to this item. Any excavation at end bents in existing ground shall be paid as Foundation Preparation.

COFFERDAMS: On stream crossings where it cannot be definitely determined that a cofferdam is required, use a note that clearly states that a cofferdam may be necessary and specifies that the cost of any cofferdam required is **incidental** to the cost of Foundation Preparation.

When a project includes a large stream crossing which requires a deep excavation at the substructure units, and when it is determined that a cofferdam is definitely required, specify a **separate lump sum bid item** for each cofferdam required. Use General Note #300, "Cofferdams for Piers," in the General Note Library. If the note does not fit a particular project location, adapt the note to fit.

Consider the use of alternate foundations, such as drilled shafts, where cofferdams might be required otherwise.

STRUCTURAL DESIGN	Chapter MISCELLANEOUS
	Subject Berms

ISSUES:

To reduce the length of bridges without compromising the integrity of the structure, use the following procedures for determining berm widths.

Develop the type of wing and berm width individually to satisfy economics, aesthetics and site conditions such as:

- the length of wings for a bridge with a large skew angle,
- the depth of the superstructure, and
- the complexity of the bridge cone geometrics.

MINIMUM WIDTH:

Use a minimum berm width of 3 feet perpendicular to the abutment cap on stream crossings. This provides a factor of safety against stream action and provides space for placement of slope protection.

Use a minimum berm width of 12 inches perpendicular to the abutment cap on grade separation structures not subject to stream actions.

EXHIBIT:

See **Exhibit 615 Sheet 1** for Pile Bent Abutments with wings parallel to centerline.

See **Exhibit 615 Sheet 2** for Pile Bent Abutments with wings parallel to skew.

See **Exhibit 615 Sheet 3** for Breastwall Abutments.

STRUCTURAL DESIGN	Chapter MISCELLANEOUS
	Subject Shop Plans

GENERAL NOTE: Place a "Shop Drawing" General Note on plans requiring shop drawings.

STRUCTURES DESIGNED BY THE DEPARTMENT OR BY CONSULTANTS: The design engineer will review any shop plans required for structures or structure components. This review ensures conformance with the design plans.

Procedure – The fabricators will send three sets of shop plans to the designer. The designer will review the submittal and send a set with comments back to the fabricator. If the designer is satisfied that the construction can proceed, the designer will request the fabricator to send the required number of sets for distribution. The designer will stamp the plans:

Authorized to Proceed
Firm name
Date

and distribute as shown on the Division's website.

In addition, place the following note on all structure plans

> Disclaimer: Acceptance of any contractor's submission required on this project does not constitute endorsement or approval. The acceptance is acknowledgement of the work performed and authorization for the contractor to proceed. The Department is not bound by acceptance of any submissions required. Final acceptance or approval will be contingent on the satisfactory completion of the project.

PROPRIETARY STRUCTURES OR STRUCTURE COMPONENTS:

The Department currently uses many structures or structure components that are proprietary products of various companies. The Department may provide a review of the design and details of these various products prior to approving them for use on projects. Once approved for use, the Department normally does not provide a detailed review of the product on each project in which they may be used. Any review generally consists of ensuring general conformance with project requirements such as wall height and length, culvert barrel size, expansion joint movement capacity, bearing load capacity, etc. The supplier or manufacturer is responsible for the design of the product.

Examples of these products include, but are not limited to, the following: proprietary precast concrete culverts; steel or aluminum long span structural plate structures; wood or concrete sound barriers; concrete retaining walls (such as MSE walls); aluminum or steel structural plate box culverts; pot, disc or spherical bearings; modular expansion joints or other expansion joints with structural supports carrying wheel loads; metal deck forms; and various signing or lighting structural components.

The supplier of these products will stamp the shop plans indicating that they meet all design requirements. The Department may review the shop plans for conformance with general project requirements. All shop plans will contain the stamp of the supplier and the stamp of the designer, when applicable.

PPC BEAM SHOP DRAWING CHECK LIST:

In reviewing shop plans for Precast Prestressed Concrete Beams, check for the following information:

- AASHTO load design specification used
- Type of prestressed beam
- Detailed drawing for each different mark number including the total number of stirrups
- Dimensions of each beam
- Quantity, size, and location of strand
- Class of concrete

- Detensioning and design concrete strength for each mark number
- Drawing of each fabricated bar
- Type of prestressing strand, preload, and initial force for each mark number
- Drawing showing location and amount of debonding for all debonded strands
- Bed layout drawing when draped strands are used
- Drawings for voids in box beams showing location and dimensions
- Drawing of leveling device for side-by-side box beams
- Detail showing location of proposed tack welding
- List of separate or loose items shipped with beams
- Types of hold-down devices
- Type and location of inserts
- Indicate whether deck will be formed conventionally or with stay-in-place (SIP) forms - detail of weld tabs or concrete inserts if SIP forms are used
- Clearances from steel reinforcement to face of concrete
- Location of name or trademark of beam fabricator
- Diagram of detensioning procedure including order of strand release
- Procedure for detensioning draped strands in relation to time of release of hold-down devices (critical unless weight of beam is twice the total of the forces to hold the strand in the low position in the beam)
- Type of end treatment
- Bridge bearing pad type, and dimensions for non-standard pads
- Treatments for shipping (e.g. holes through web) and final treatments (e.g. patching of holes through web).

STRUCTURAL DESIGN	Section: MISCELLANEOUS
	Subject: Pedestrian Bridges

DESIGN: Design all pedestrian bridges on or over right of way or let by KYTC in accordance with the AASHTO LRFD Guide Specifications for the Design of Pedestrian Bridges and the AASHTO LRFD Bridge Design Specifications.

SERVICE LIFE: Pedestrian bridges shall be designed to achieve a minimum service life of 75 years.

MAINTENANCE: Pedestrian bridges shall be designed to allow ease of inspection and maintenance.

MATERIALS: Pedestrian bridges shall be made from materials that will achieve the minimum service life with little to no maintenance required over the life of the structure. Steel bridges shall be galvanized if passing over a roadway or within 150 feet of a roadway. If colors other than silver are required, the galvanizing may be painted.

PROFILE AND GRADE: All ADA guidelines are to be followed on the structure and ramps when setting grades.

VERTICAL CLEARANCE: Pedestrian bridges shall have a vertical clearance 1 foot taller than that required for vehicular bridges on the roadway below per the Green Book.

LIVE LOADS: Pedestrian loads shall follow the current edition of the AASHTO LRFD Guide Specifications for the Design of Pedestrian Bridges.

If vehicular access is not prevented by permanent physical methods such as bollards cast in concrete at each end, the bridge shall be designed for vehicular live loads. If the pedestrian bridge will be expected to carry emergency vehicles, then the largest emergency vehicle shall be designed for. Place a note in the plans stating the vehicular load the structure is designed for.

COLLISION: The superstructure shall be provided with a means to prevent sliding in the event of a collision. This can be done through keeper blocks, shear keys, or anchor bolts.

Follow the requirements of SD-404 for pier protection if the pier or support is within 30 feet of the roadway.

DRAINAGE: Provide drains if necessary on pedestrian bridges. Place drain outlets outside of driving lanes.

DECK: Use a solid deck with a non-skid surface. Do not use open grid decks.

RAILINGS: All railing shall follow all ADA and AASHTO requirements for height. All pedestrian bridges shall have a cage extending at least 8 feet from the walking surface with openings no greater than 2 inches by 2 inches unless given approval from the Director, Division of Structural Design or KYTC project team determines it is not necessary. It is preferred if the cage can curve inwards at the top to help prevent climbing. A full cage on all sides shall be provided where required by railroads.

NAVIGABLE STREAMS IN KENTUCKY

Submit an inquiry to the Coast Guard regarding any crossing over those waterways listed below so that they may comment on the need for a permit at that time and place.

WATERWAYS THAT HAD REQUIRED BRIDGE PERMITS

WATERWAYS	UPPER LIMIT
Barren River	Bowling Green, KY Mile 30.0
Benson Creek	Mouth to Mile 1.9
Big Sandy River	Mile 8.0 to Confluence of Tug and Levisa Forks, Mile 26.83
Big Sandy River, Levisa Fork	Mile 19.4
Big Sandy River, Tug Fork	Williamson, WV, Mile 58.0
Craig's Creek	Mile 0 to 5.6
Cumberland River	Mile 385.4 to Mile 552
Cumberland River, Big South Fork	In Its Entirety
Cumberland River, Clover Fork	Mouth to Mile 10.8
Cumberland River, Martin's Fork	Mouth to Mile 19.5
Cumberland River, Poor Fork	Mile 30.6
Green River	Mile 108.5 to Mouth of Barren River, Mile 150.0
Flat Creek	Mouth to 1.3
Eddy Creek	Mile 4.9, I-24 Bridge
Hammond Creek	Mouth to Mile 1.6
Harrods Creek	Mile 0 to mile 3.75
Kentucky River	Confluence North and Middle Forks, Mile 258.6 Mile 0 to Mile 82.2
Knob Creek	Mouth to Mile 1.1
Lawrence Creek	Mouth to Mile 2.6
Lead Creek	Mouth to Mile 3.8
Lick Creek, Arm Barkley Lake	Mile 1.25
Licking River	Mile 0 to Mile 7
Licking River	Mile 18.3
Little River	Mile 25.0
Rough River	Dam No. 1, Mile 7.0
Pond River	Mile 12.5
Tradewater River	0.5 Miles Downstream from Mouth Caney Branch, Mile 2.8
Beaver Creek (Trib. of Lake Cumb.)	Mile 11.5
Otter Creek (Trib. of Lake Cumb.)	Mile 10.0

WATERWAYS THAT HAD BEEN IN ADVANCE APPROVAL CATEGORY

LOCATION OF MOUTH OF WATERWAY	NAME OF WATERWAY	LOWER LIMIT	UPPER LIMIT
Cumberland River, Mile 380.9	Dale Hollow Lake	7.3	58.3
Cumberland River, Mile 546.4	Rock Castle River	Mouth	13.1
Cumberland River, Mile 552.1	Laurel River	Mouth	21.5
Cumberland River, Mile 59.0	Little River	25.0	59.0
Green River, Mile 108.6	Mud River	Mouth	14.0
Green River, Mile 149.5	Barren River	30.0	37.5
Green River, Mile 168.5	Bear Creek	Mouth	11.0
Green River, Mile 183.5	Nolin River	Mouth	7.8
Green River, Mile 71.3	Rough River	7.0	29.0
KY River, Mile 190.3	Red River	Mouth	5.5
KY River, Mile 258.6	KY River, Middle Fork	Mouth	4.7
KY River, Mile 258.6	KY River, North Fork	Mouth	4.7
KY River, Mile 258.6	KY River, South Fork	Mouth	4.0
Ohio River, Mile 336.4	Little Sandy River	Mouth	12.2
Ohio River, Mile 368.2	Kinniconnick Creek	Mouth	0.9
Ohio River, Mile 378.4	Salt Lick River	Mouth	0.4
Ohio River, Mile 426.4	Bracken Creek	Mouth	0.4
Ohio River, Mile 432.8	Big Locust Creek	Mouth	2.0
Ohio River, Mile 512.0	Lick Creek	Mouth	1.0
Ohio River, Mile 513.6	Gunpowder Creek	Mouth	1.0
Ohio River, Mile 514.6	Landing Creek	Mouth	0.7
Ohio River, Mile 516.7	Big Bone Creek	Mouth	1.0
Ohio River, Mile 521.3	Paint Lick Creek	Mouth	1.4
Ohio River, Mile 522.7	Little Sugar Creek	Mouth	0.7
Ohio River, Mile 522.8	Big Sugar Creek	Mouth	0.8
Ohio River, Mile 529.9	Craigs Creek	Mouth	2.7
N/A	Dry Creek (Trib of Craigs Creek)		
Ohio River, Mile 546.6	Little KY River	Mouth	1.0
Ohio River, Mile 596.0	Harrods Creek	Mouth	2.0
Ohio River, Mile 629.0	Salt River	Mouth	5.0
Ohio River, Mile 784.5	Green River	150.0	199.0
Ohio River, Mile 873.5	Tradewater River	2.8	41.5
Tenn. River, Mile 4.3	Clark River	Mouth	13.0
Tenn. River, Mile 51.6	Blood River	Mouth	5.3

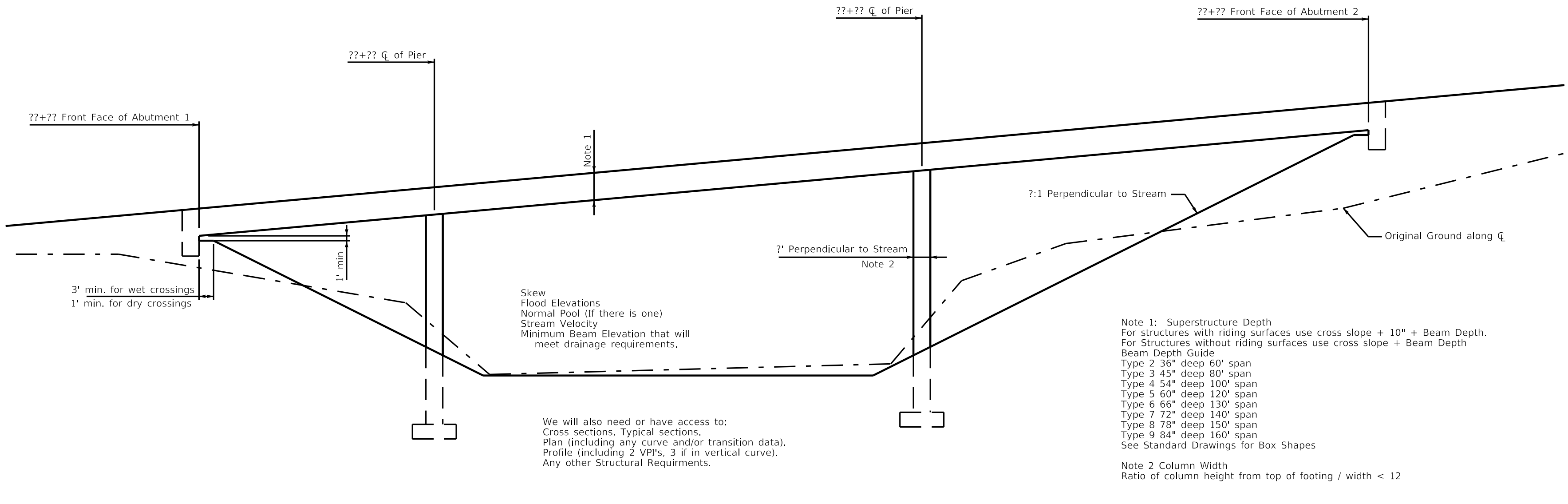
WATERWAYS THAT HAD BEEN CONSIDERED NON-NAVIGABLE

WATERWAY	LIMIT
Rough River	Above Mile 29.0
Rough River Reservoir	In Its Entirety
Long Pond Branch	In Its Entirety
Middle Fork, Kentucky River	Mile 4.7 to Mile 79.5

EXHIBIT 217

PDF BOOKMARKS

NATURAL SCALE ELEVATION - BRIDGE



COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS

REVISION	DATE

PREPARED BY
Division of Structural Design

DATE:	CHECKED BY
DESIGNED BY:	
DETAILED BY:	

CROSSING

ROUTE

ITEM NO.	COUNTY OF
SHEET NO.	DRAWING NUMBER

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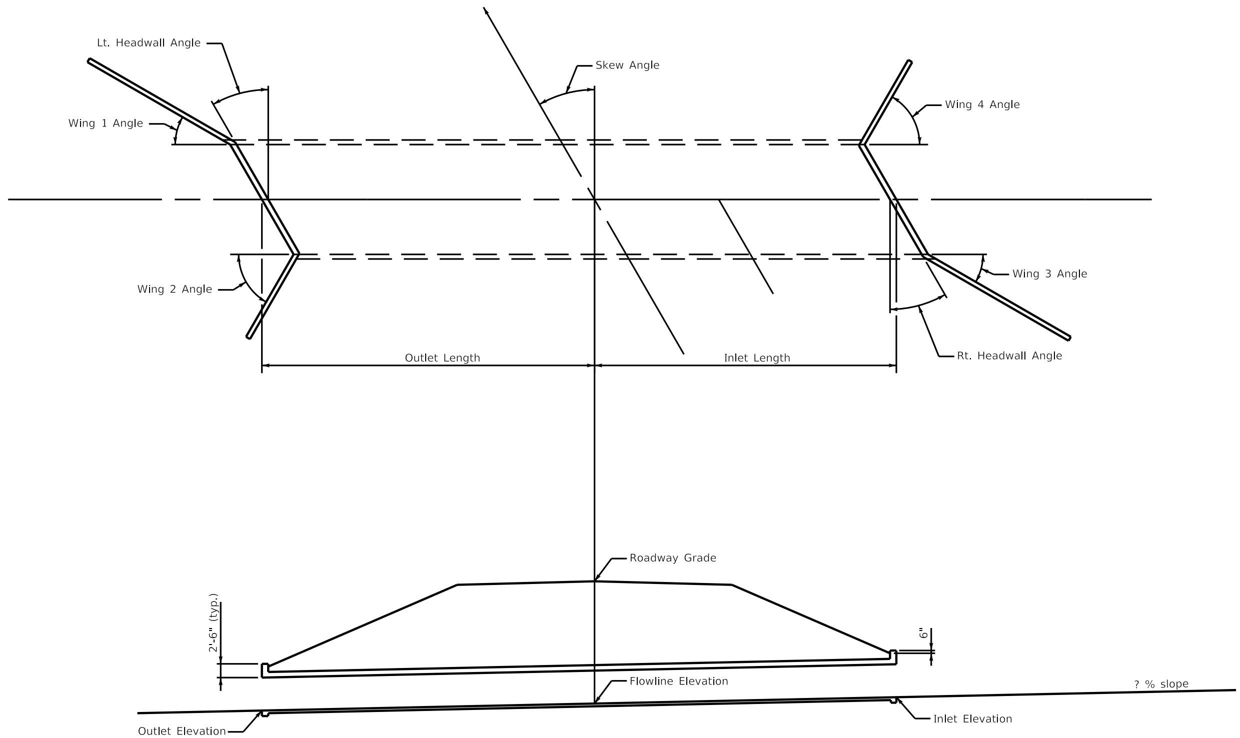

We will also need or have access to:
Cross sections, Typical sections.
Plan (including any curve and/or transition data).
Profile (including 2 VPI's, 3 if in vertical curve).
Any other Structural Requirments.

COMMONWEALTH OF KENTUCKY DEPARTMENT OF HIGHWAYS	REVISION	DATE	PREPARED BY Division of Structural Design	DATE:	CHECKED BY	CROSSING	ROUTE	ITEM NO.	COUNTY OF
				DESIGNED BY:				SHEET NO.	DRAWING NUMBER
				DETAILED BY:					

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NATURAL SCALE PLAN/ELEVATION - CULVERT

LETTING DATE

CONSTRUCTION PROJECT NO.

TRANSPORTATION CABINET
DEPARTMENT OF HIGHWAYS

COUNTY
ROAD
OVER
STA. 0+00.00

ESTIMATE OF QUANTITIES

	BID ITEM CODE	08100	08104	08150	08151	08001	08002	08019	08020	02231	02998	08046	08051	08033	08160	03299	21532ED
	BID ITEM	Concrete Class "A"	Concrete Class "AA"	Steel Reinforcement	Steel Reinforcement, Epoxy Coated	Structure Excavation, Common	Structure Excavation, Solid Rock	Cyclopean Stone Rip Rap	Crushed Aggregate Slope Protection	Structure Granular Backfill	Masonry Coating	Piles - Steel HP 12 x 53	Piles - Steel HP 14 x 89	Test Piles	Structural Steel ①	Armored Edge for Concrete	Railing System Type 3
	UNIT	C.Y.	C.Y.	LBS.	LBS.	C.Y.	C.Y.	Tons	Tons	C.Y.	S.Y.	L.F.	L.F.	L.F.	L.S.	L.F.	L.F.
Substructure	Integral End Bent #1																
	Pier #1																
	Pier #2																
	Integral End Bent #2																
	Superstructure																
	BRIDGE TOTALS																

① Estimated Weight of Structural Steel = 0000 lbs.

INDEX OF SHEETS

Sheet No.	Description
S1	Title Sheet
S2	General Notes
S3	Layout
	Subsurface Data
	Foundation Layout
	Integral End Bent #1
	Integral End Bent #2
	Framing Plan
	PPC I-Beam, Type 2 Details
	Superstructure
	Construction Elevations

SPECIAL NOTES

SPECIAL PROVISIONS

69 Embankment at Bridge End Bent Structures

STANDARD DRAWINGS

BBP-001-12	Elastomeric Bearing Pads for Prestressed Beams
BBP-002-04	Bearing Details
BBP-003-02	Elastomeric Bearing Pads for Box Beams
BGX-006-10	Stencils for Structures
BGX-012-02	Geotechnical Legend
BGX-015-04	Bridge Drains
BJE-001-14	Neoprene Expansion Dams and Armored Edges
BPC-002-08	14" Reinforced Concrete Pile
BPC-011-07	14" Precast Prestressed Concrete Pile
BPS-003-09	HP12x53 Steel Pile
BPS-009-08	HP14x73 Steel Pile
BPS-011-04	HP14x89 Steel Pile

SPECIFICATIONS

2019 Standard Specifications for Road and Bridge Construction.

2017 AASHTO LRFD Bridge Design Specifications

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS

KENTUCKY TRANSPORTATION CABINET

REVISION | DATE

PREPARED BY
Division of Structural Design

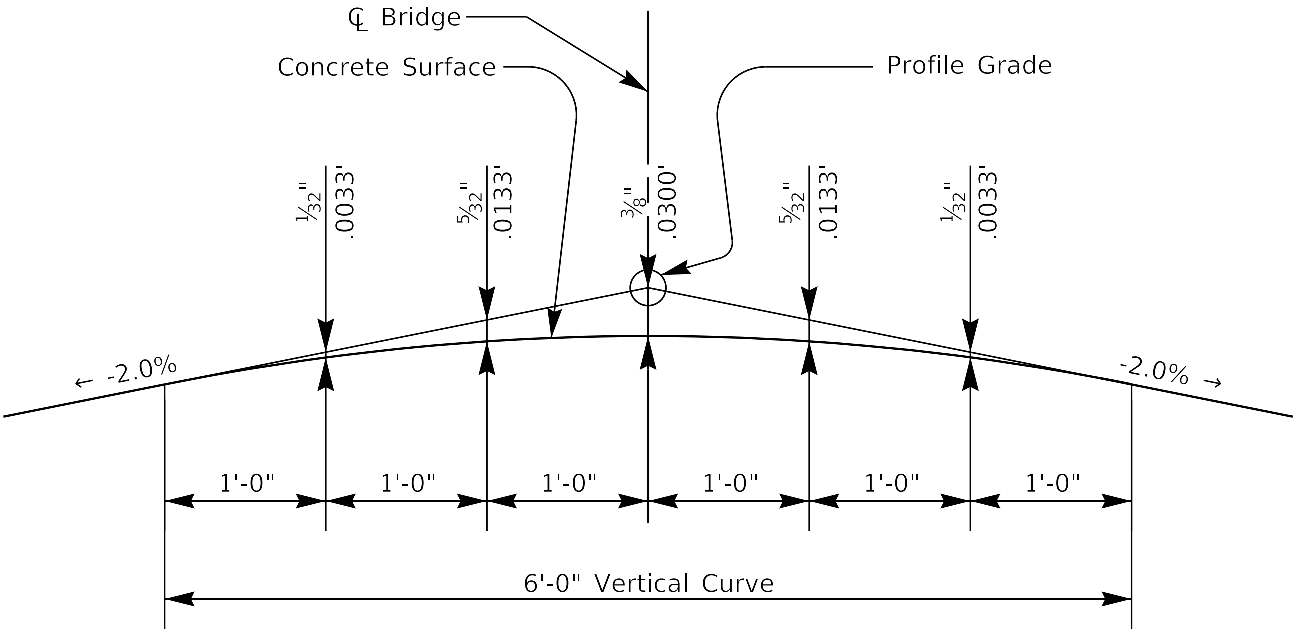
DATE: | CHECKED BY
DESIGNED BY:
DETAILED BY:

TITLE SHEET
CROSSING

ROUTE | ITEM NO. | COUNTY OF
SHEET NO. S1 | DRAWING NUMBER

MicroStation v10.15.0.74 USER: EarlW.Downey DATE PLOTTED: 4/12/2021 1:21:17 PM FILE NAME: H:\ADMINISTRATION\BRIDGE_OFFICE\GUIDANCE MANUAL\2020\ALL.DGN

BRIDGE TITLE SHEET



PARABOLIC CROWN

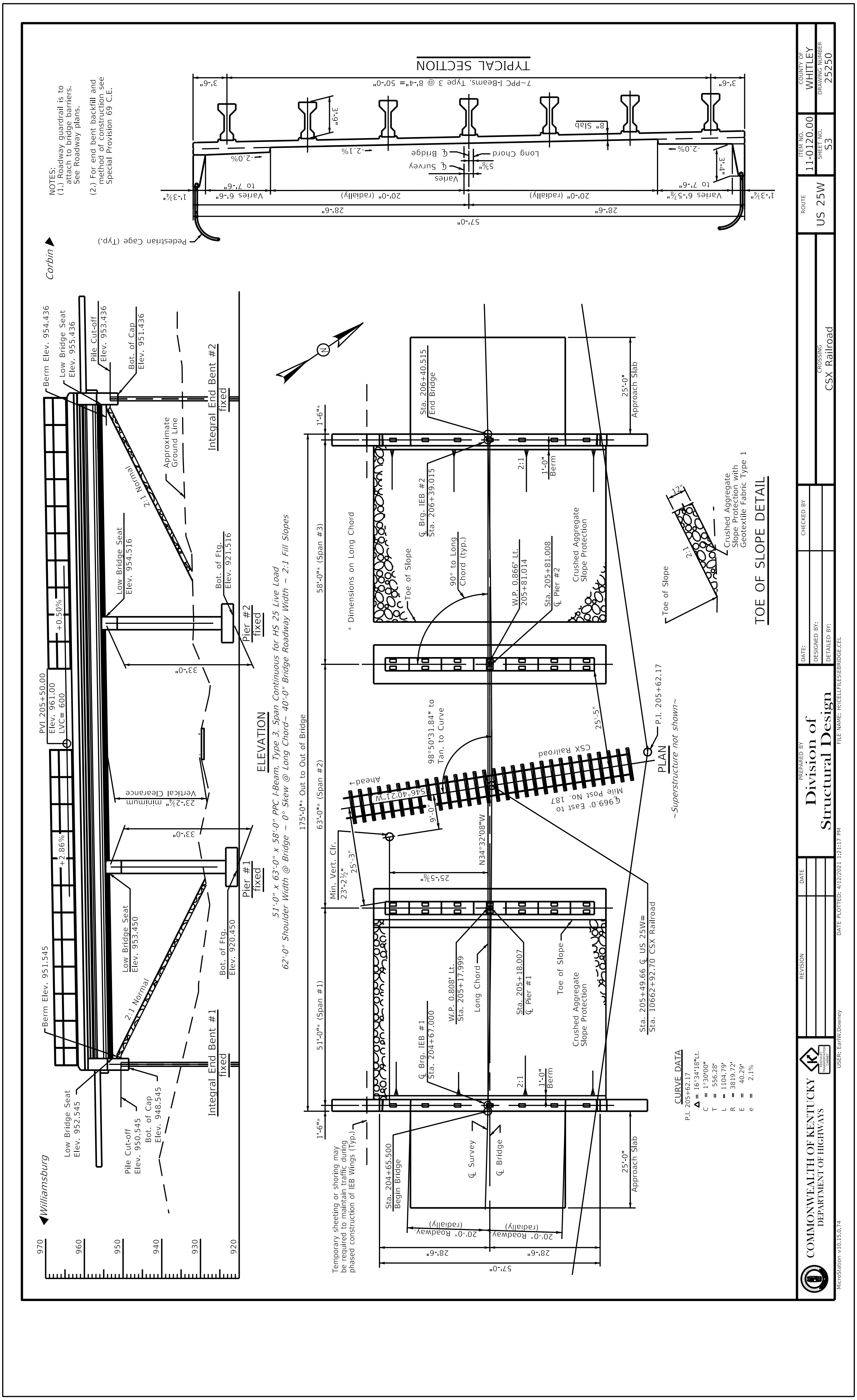
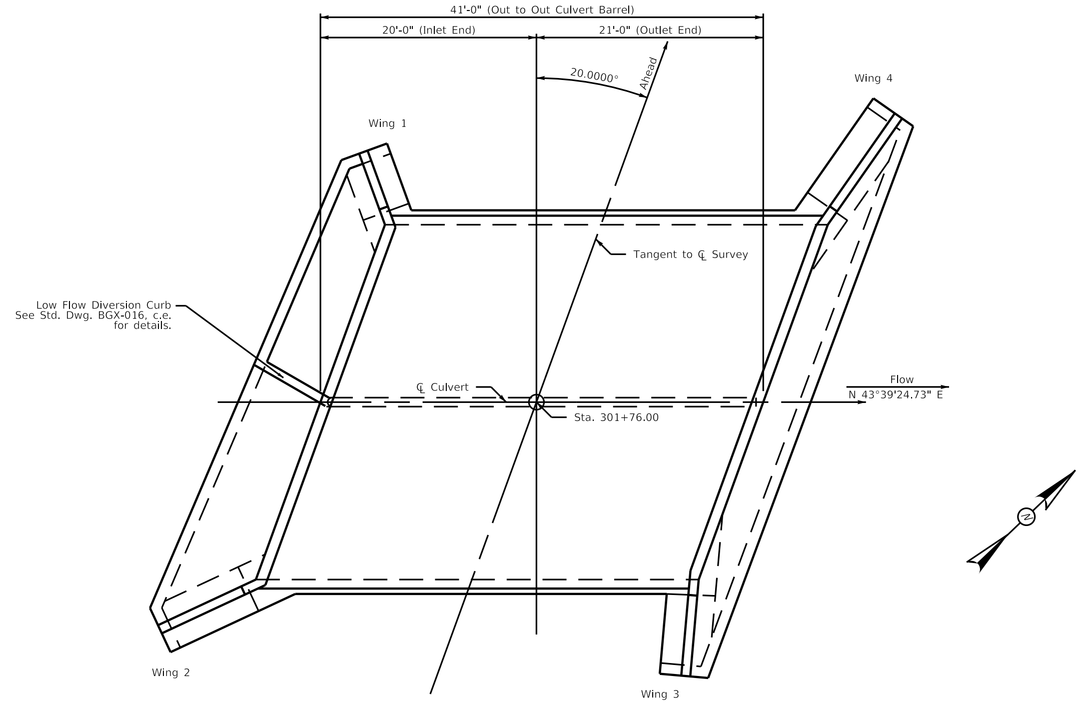
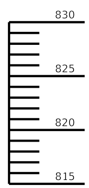
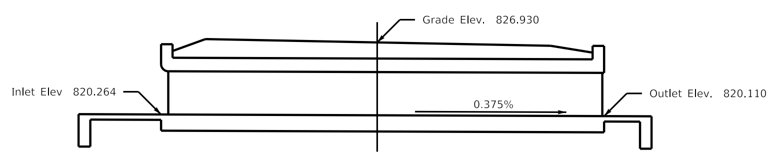

BRIDGE LAYOUT SHEET
TYPICAL SECTION
7~PPC I-Beams, Type 3 @ 8'-4" = 50'-0"
Pedestrian Cage (Typ.)
NOTES:
(1.) Roadway guardrail is to attach to bridge barriers. See Roadway plans.
(2.) For end bent backfill and method of construction see Special Provision 69 C.E.
ELEVATION
51'-0" x 63'-0" x 58'-0" PPC I-Beam, Type 3, Span Continuous for HS 25 Live Load
62'-0" Shoulder Width @ Bridge ~ 0° Skew @ Long Chord~ 40'-0" Bridge Roadway Width ~ 2:1 Fill Slopes
PVI 205+50.00
Elev. 961.00
LVC= 600
+2.86%
+0.50%
Berm Elev. 951.545
Berm Elev. 954.436
Low Bridge Seat Elev. 952.545
Low Bridge Seat Elev. 955.436
Low Bridge Seat Elev. 953.450
Low Bridge Seat Elev. 954.516
Pile Cut-off Elev. 950.545
Pile Cut-off Elev. 953.436
Bot. of Cap Elev. 948.545
Bot. of Cap Elev. 951.436
Bot. of Ftg. Elev. 920.450
Bot. of Ftg. Elev. 921.516
Integral End Bent #1 fixed
Pier #1 fixed
Pier #2 fixed
Integral End Bent #2 fixed
Approximate Ground Line
23'-2¼" minimum Vertical Clearance
Williamsburg
Corbin
PLAN
~Superstructure not shown~
175'-0"* Out to Out of Bridge
51'-0"* (Span #1)
63'-0"* (Span #2)
58'-0"* (Span #3)
* Dimensions on Long Chord
Sta. 204+65.500 Begin Bridge
Sta. 206+40.515 End Bridge
℄ Brg. IEB #1 Sta. 204+67.000
℄ Brg. IEB #2 Sta. 206+39.015
W.P. 0.808' Lt. Sta. 205+17.999
W.P. 0.866' Lt. 205+81.014
Sta. 205+18.007 ℄ Pier #1
Sta. 205+81.008 ℄ Pier #2
Sta. 205+49.66 ℄ US 25W= Sta. 10662+92.70 CSX Railroad
P.I. 205+62.17
N34°32'08"W
S46°40'21"W
98°50'31.84" to Tan. to Curve
CSX Railroad
℄ 969.0' East to Mile Post No. 187
Min. Vert. Clr. 23'-2½"
Crushed Aggregate Slope Protection
Toe of Slope
25'-0" Approach Slab
Temporary sheeting or shoring may be required to maintain traffic during phased construction of IEB Wings (Typ.)
CURVE DATA
P.I. 205+62.17
Δ = 16°34'18" Lt.
C = 1°30'00"
T = 556.28'
L = 1104.79'
R = 3819.72'
E = 40.29'
e = 2.1%
TOE OF SLOPE DETAIL
Crushed Aggregate Slope Protection with Geotextile Fabric Type 1
COMMONWEALTH OF KENTUCKY DEPARTMENT OF HIGHWAYS
Division of Structural Design
COUNTY OF WHITLEY
ITEM NO. 11-0120.00
DRAWING NUMBER 25250
SHEET NO. S3
ROUTE US 25W
CROSSING CSX Railroad

EXHIBIT 312



PLAN
SCALE = 1:60





SECTION ON ℄
Double 16'-0" x 4'-0" x 41'-0" R.C.B.C.
20'-0" Inlet End and 21'-0" Outlet End
20.0000° Lt. Skew ~ KYHL-93 Loading ~ 0.50 Fill Slope
Yielding Foundation

COMMONWEALTH OF KENTUCKY DEPARTMENT OF HIGHWAYS	REVISION	DATE	PREPARED BY Division of Structural Design	DATE:	CHECKED BY	CROSSING PINSON FORK	ROUTE KY 199	ITEM NO. 12-298.30	COUNTY OF PIKE
				DESIGNED BY:				SHEET NO. S2	DRAWING NUMBER 27947
				DETAILED BY:					

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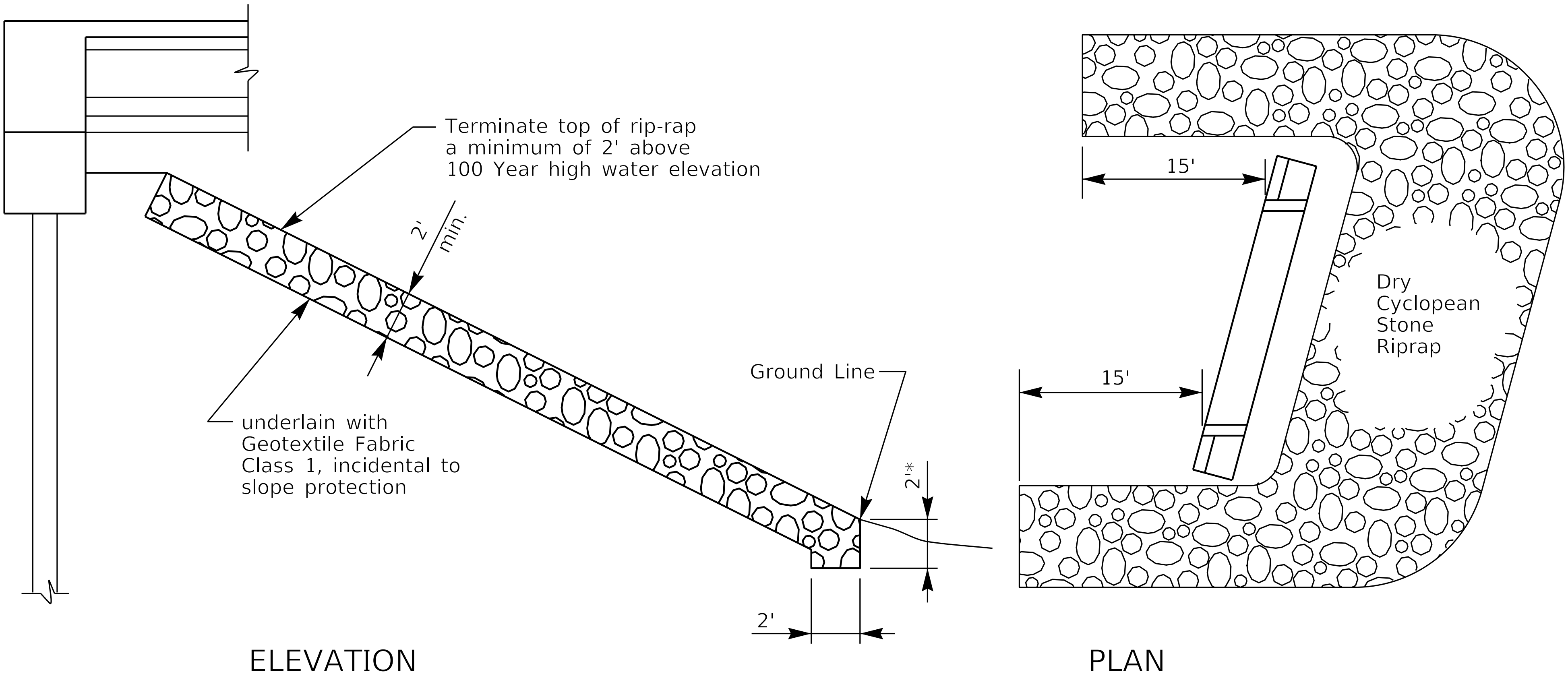
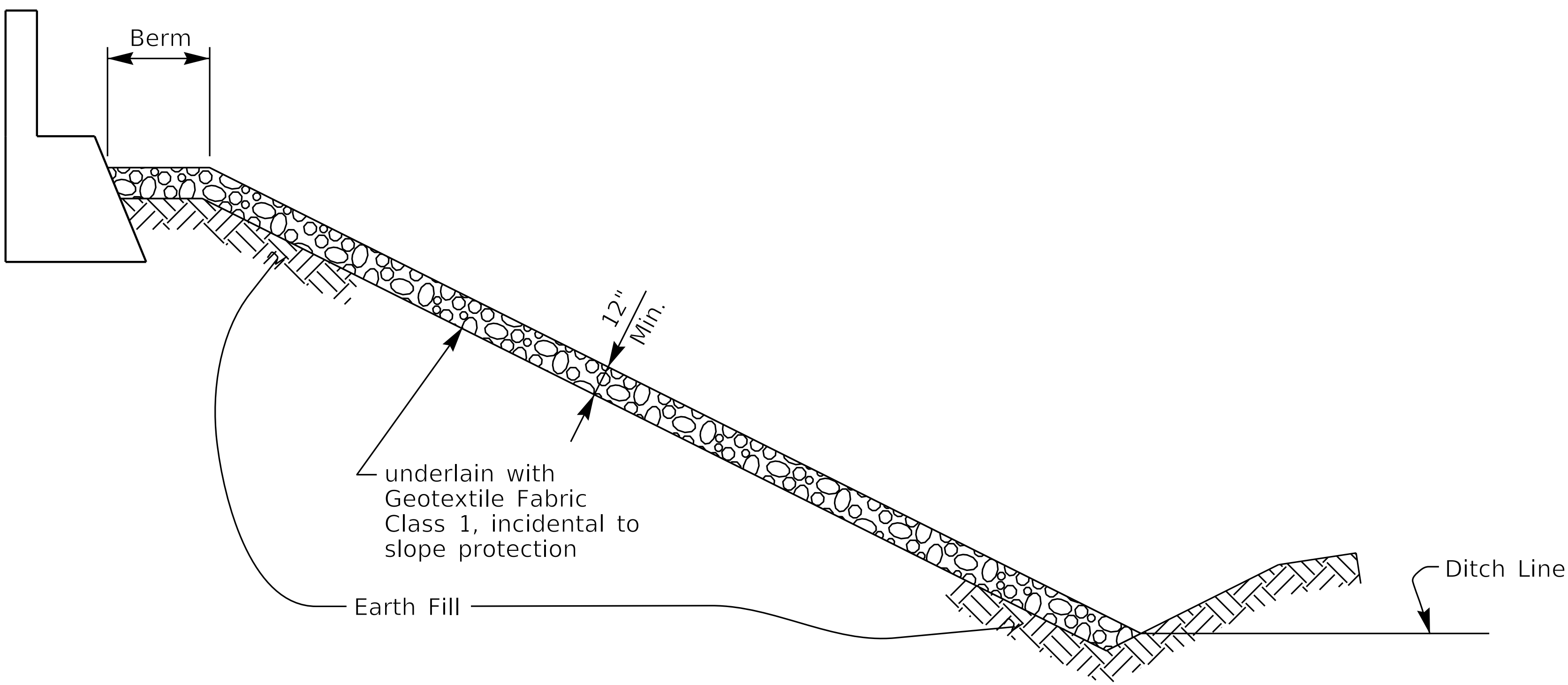
CULVERT LAYOUT SHEET



* when solid rock is encountered, terminate at the rock line

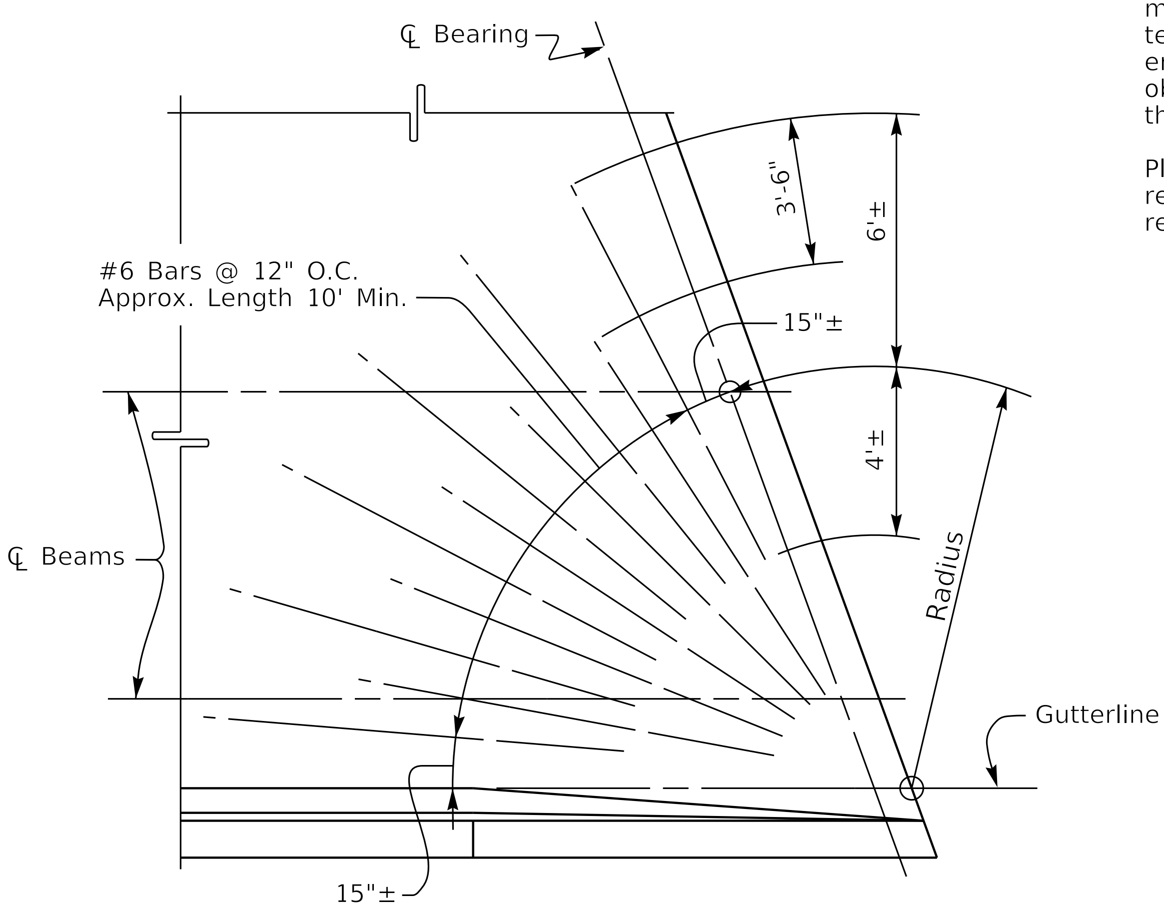
Include Bid Item for Cyclopean
Stone Rip Rap quantities in plans.

DRY CYCLOPEAN STONE RIPRAP SLOPE PROTECTION



Include bid item for crushed aggregate slope protection quantities in plans.

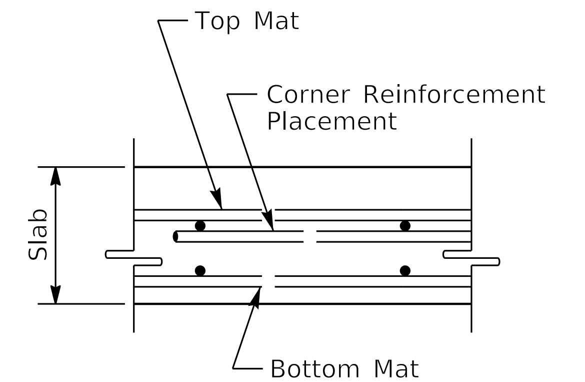
CRUSHED AGGREGATE SLOPE PROTECTION



TYPICAL FOR SLAB CORNERS OF 75° OR LESS

The objective of the reinforcement fan is to offset buildup of shrinkage across the long diagonal dimension of the slab which would pull a shrinkage crack across the weak corner of the slab. A portion of the bars must extend back into the corner sufficiently to terminate above the junction of exterior beam and endwall. Adjust lengths and/or offsets as necessary to obtain proper termination location over the junction of the exterior beam and end wall.

Place a note on the plans that states "Place the corner reinforcement beneath the longitudinal and transverse reinforcement in the top of the slab."



CORNER REINFORCEMENT DETAIL

EXHIBIT 318

PILE RECORD FOR POINT BEARING PILES

Pile No.	Pile Cut-off Elevation	Pile Length In Place	Point of Pile Elevation As Driven	Design Axial Load	Required Field Bearing	Calculated Field Bearing
	FEET	FEET	FEET	TONS	TONS	TONS
INTEGRAL END BENT #1						
1	950.545			62	150	
2	950.545			62	150	
3	950.545			62	150	
4	950.545			62	150	
5	950.545			62	150	
6	950.545			62	150	
7	950.545			62	150	
8	950.545			62	150	
9	950.545			62	150	
10	950.545			62	150	
11	950.545			62	150	

Definitions of Terms

PILE CUT-OFF ELEVATION: Elevation of the top of pile in the finished structure.

PILE LENGTH IN PLACE: Actual pile length below the Pile Cut-Off Elevation in the finished structure.

POINT OF PILE ELEVATION AS DRIVEN: Actual point of pile elevation in the finished structure.

DESIGN AXIAL LOAD: Service load carried by each pile as estimated from structural design calculations.

REQUIRED FIELD BEARING: Pile bearing value required to achieve "refusal" for the size of pile used. According to the Division of Construction Guidance Manual, this value is taken as 150 tons for 12-inch steel H-Piles and 180 tons for 14 inch steel H-Piles.

CALCULATED FIELD BEARING: Pile bearing value in place calculated using the appropriate pile driving formula in Section 604.03.07(B) of the Standard Specifications.

Driving Criteria

DRIVING CRITERIA: Drive point bearing piles to refusal and verify that the Calculated Field Bearing equals or exceeds the Required Field Bearing.

Field Data

For each pile, the Project Engineer shall record the following on this sheet: Pile Length in Place, Point of Pile Elevation as Driven, and the Calculated Field Bearing. Submit this record to:

Director, Division of Structural Design
3rd Floor East
200 Mero Street
Frankfort, KY 40622-0001

This pile record does not replace other pile records the Project Engineer is required to keep and submit.

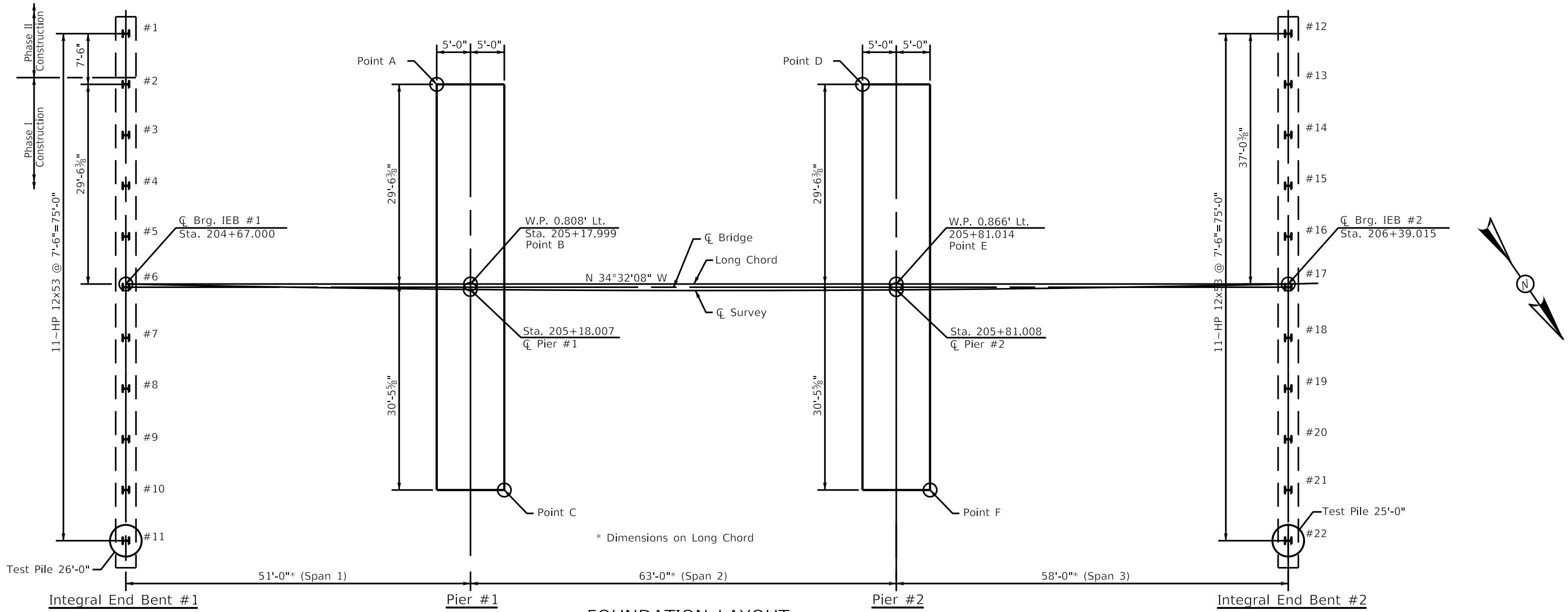
Use HP12x53 in accordance with BPS-003 C.E.

Use reinforced pile points capable of keying into sloping rock surfaces and seating the piles in the shale.

Any commonly utilized hammer allowed by the Division of Construction will be adequate to drive the piles to bedrock without encountering excessive blow counts and over-stressing the piles. The Contractor shall submit his pile driving system to the Department for approval prior to the installation of the first pile. Approval of the pile driving system by the Engineer will be subject to satisfactory field performance of the pile driving procedures.

PILE RECORD FOR POINT BEARING PILES

Pile No.	Pile Cut-off Elevation	Pile Length In Place	Point of Pile Elevation As Driven	Design Axial Load	Required Field Bearing	Calculated Field Bearing
	FEET	FEET	FEET	TONS	TONS	TONS
INTEGRAL END BENT #2						
12	953.436			66	150	
13	953.436			66	150	
14	953.436			66	150	
15	953.436			66	150	
16	953.436			66	150	
17	953.436			66	150	
18	953.436			66	150	
19	953.436			66	150	
20	953.436			66	150	
21	953.436			66	150	
22	953.436			66	150	



FOUNDATION LAYOUT

Spread Footing Pier #1

Point	Plan Footing Elevation	As-Built Footing Elevation
A	920.450	
B	920.450	
C	920.450	

Footing is designed for a maximum pressure of 5.6 KSF.

The allowable bearing capacity is 20 KSF.

NOTE: After all foundations have been placed, the Project Resident Engineer shall record the bottom of footing elevation "As-Built" and shall submit one copy of this sheet with this data to:

Director, Division of Structural Design
3rd Floor East
200 Mero Street
Frankfort, KY 40622-0001

NOTE: If the spread footing foundation is stepped due to unsuitable material found at the given elevation, the location and elevation of the step shall be shown on this sheet and submitted along with as-built elevations.

Spread Footing Pier #2

Point	Plan Footing Elevation	As-Built Footing Elevation
D	921.516	
E	921.516	
F	921.516	

Footing is designed for a maximum pressure of 5.6 KSF.

The allowable bearing capacity is 20 KSF.

COMMONWEALTH OF KENTUCKY DEPARTMENT OF HIGHWAYS	REVISION	DATE	PREPARED BY Division of Structural Design	DATE: / DESIGNED BY: / DETAILED BY:	CHECKED BY	FOUNDATION LAYOUT / CROSSING CSX Railroad
ROUTE US 25W	ITEM NO. 11-0120.00	SHEET NO. S6	COUNTY OF WHITLEY	DRAWING NUMBER 25250		

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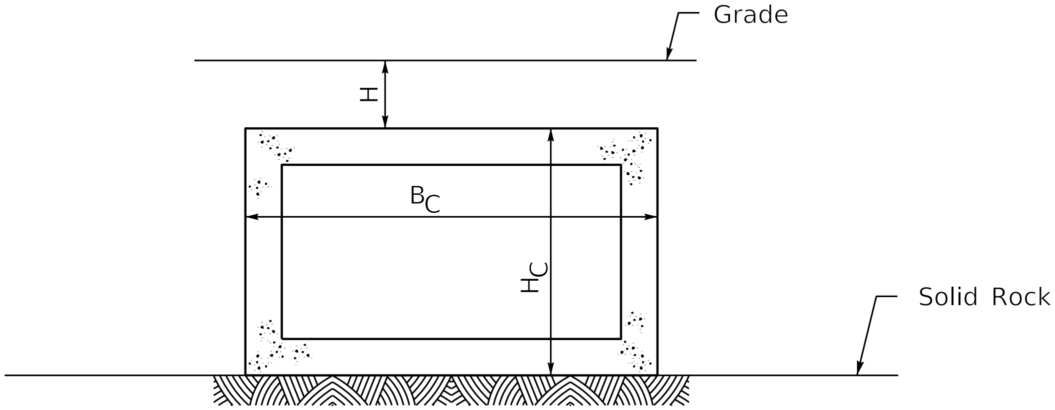
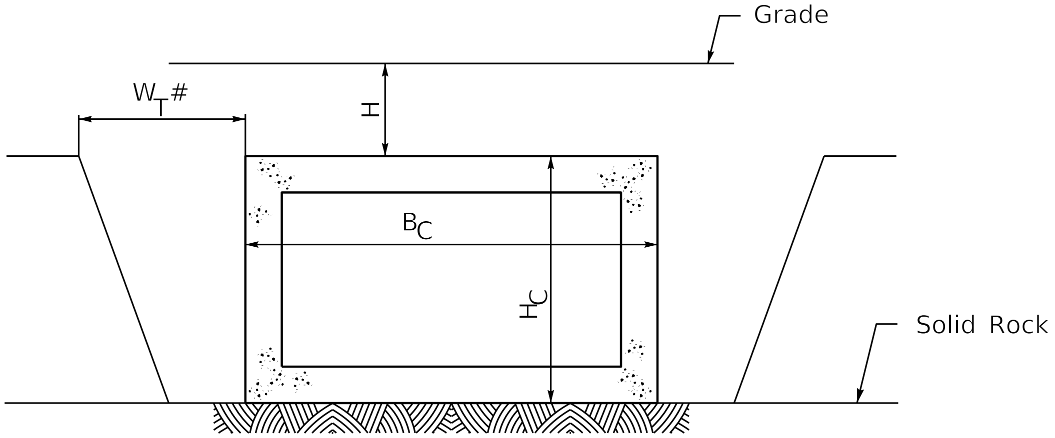
FOUNDATION LAYOUT SHEET

GRAPHIC SHEET LOCATION GRID

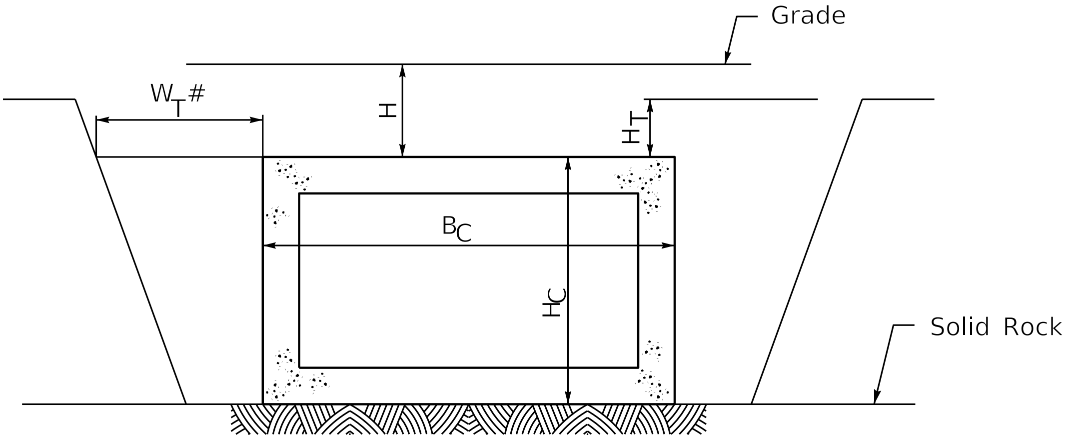
S1 1000, 1500	**S12** 1050, 1500	**S23** 1100, 1500	**S34** 1150, 1500	**S45** 1200, 1500	**S56** 1250, 1500	**S67** 1300, 1500	**S78** 1350, 1500	**S89** 1400, 1500	**S100** 1450, 1500	**S111** 1500, 1500
S2 1000, 1450	**S13** 1050, 1450	**S24** 1100, 1450	**S35** 1150, 1450	**S46** 1200, 1450	**S57** 1250, 1450	**S68** 1300, 1450	**S79** 1350, 1450	**S90** 1400, 1450	**S101** 1450, 1450	**S112** 1500, 1450
S3 1000, 1400	**S14** 1050, 1400	**S25** 1100, 1400	**S36** 1150, 1400	**S47** 1200, 1400	**S58** 1250, 1400	**S69** 1300, 1400	**S80** 1350, 1400	**S91** 1400, 1400	**S102** 1450, 1400	**S113** 1500, 1400
S4 1000, 1350	**S15** 1050, 1350	**S26** 1100, 1350	**S37** 1150, 1350	**S48** 1200, 1350	**S59** 1250, 1350	**S70** 1300, 1350	**S81** 1350, 1350	**S92** 1400, 1350	**S103** 1450, 1350	**S114** 1500, 1350
S5 1000, 1300	**S16** 1050, 1300	**S27** 1100, 1300	**S38** 1150, 1300	**S49** 1200, 1300	**S60** 1250, 1300	**S71** 1300, 1300	**S82** 1350, 1300	**S93** 1400, 1300	**S104** 1450, 1300	**S115** 1500, 1300
S6 1000, 1250	**S17** 1050, 1250	**S28** 1100, 1250	**S39** 1150, 1250	**S50** 1200, 1250	**S61** 1250, 1250	**S72** 1300, 1250	**S83** 1350, 1250	**S94** 1400, 1250	**S105** 1450, 1250	**S116** 1500, 1250
S7 1000, 1200	**S18** 1050, 1200	**S29** 1100, 1200	**S40** 1150, 1200	**S51** 1200, 1200	**S62** 1250, 1200	**S73** 1300, 1200	**S84** 1350, 1200	**S95** 1400, 1200	**S106** 1450, 1200	**S117** 1500, 1200
S8 1000, 1150	**S19** 1050, 1150	**S30** 1100, 1150	**S41** 1150, 1150	**S52** 1200, 1150	**S63** 1250, 1150	**S74** 1300, 1150	**S85** 1350, 1150	**S96** 1400, 1150	**S107** 1450, 1150	**S118** 1500, 1150
S9 1000, 1100	**S20** 1050, 1100	**S31** 1100, 1100	**S42** 1150, 1100	**S53** 1200, 1100	**S64** 1250, 1100	**S75** 1300, 1100	**S86** 1350, 1100	**S97** 1400, 1100	**S108** 1450, 1100	**S119** 1500, 1100
S10 1000, 1050	**S21** 1050, 1050	**S32** 1100, 1050	**S43** 1150, 1050	**S54** 1200, 1050	**S65** 1250, 1050	**S76** 1300, 1050	**S87** 1350, 1050	**S98** 1400, 1050	**S109** 1450, 1050	**S120** 1500, 1050
S11 1000, 1000	**S22** 1050, 1000	**S33** 1100, 1000	**S44** 1150, 1000	**S55** 1200, 1000	**S66** 1250, 1000	**S77** 1300, 1000	**S88** 1350, 1000	**S99** 1400, 1000	**S110** 1450, 1000	**S121** 1500, 1000



a. POSITIVE PROJECTION



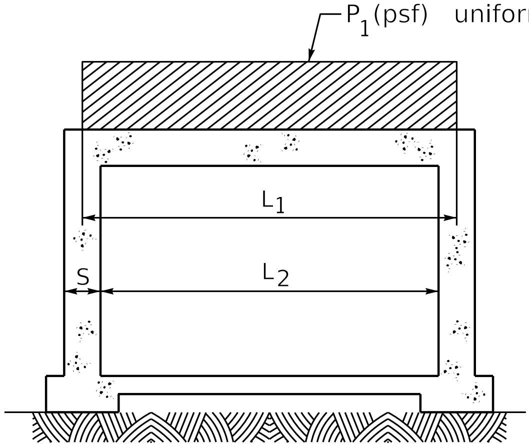
b. ZERO PROJECTION



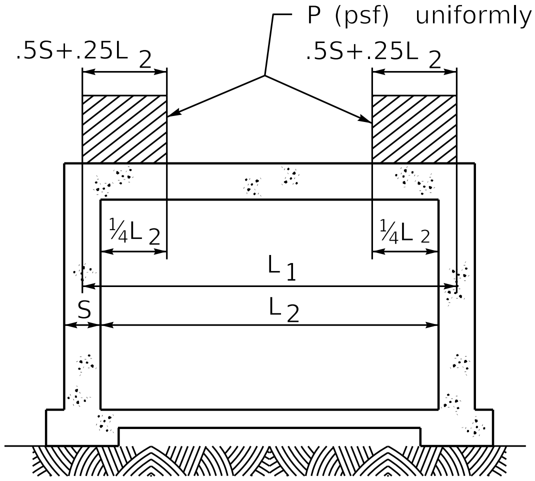
c. NEGATIVE PROJECTION

If W_T exceeds 6' consider the culvert to be in a Positive Projection

CULVERT PROJECTIONS



SKETCH 1



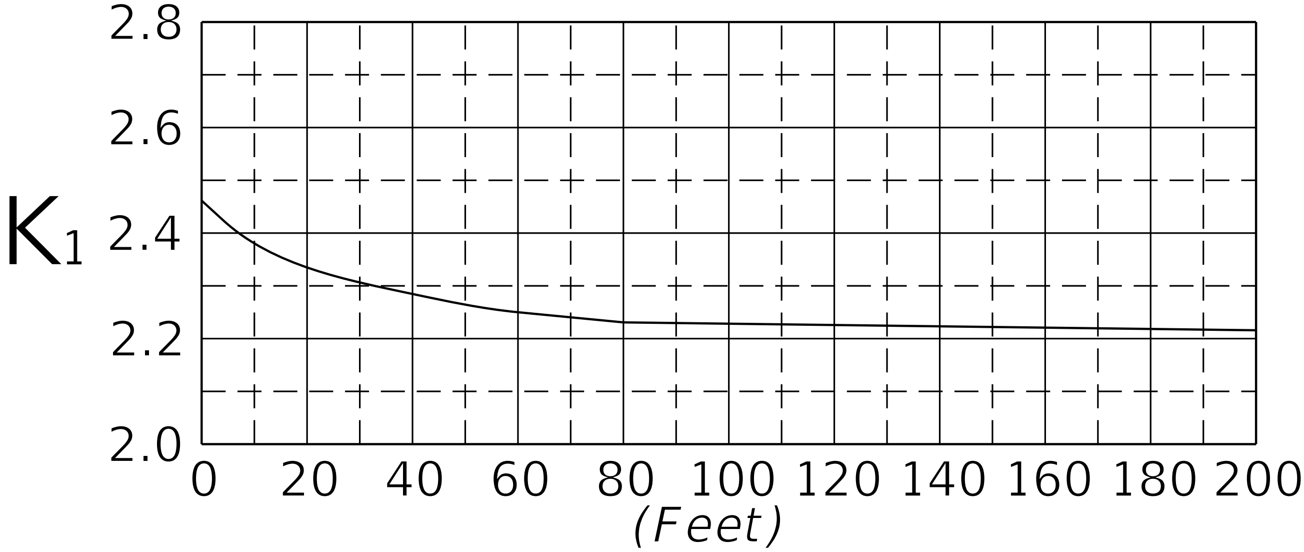
SKETCH 2

On multiple barrel culverts : L_1 = Distance center to center of Exterior Walls

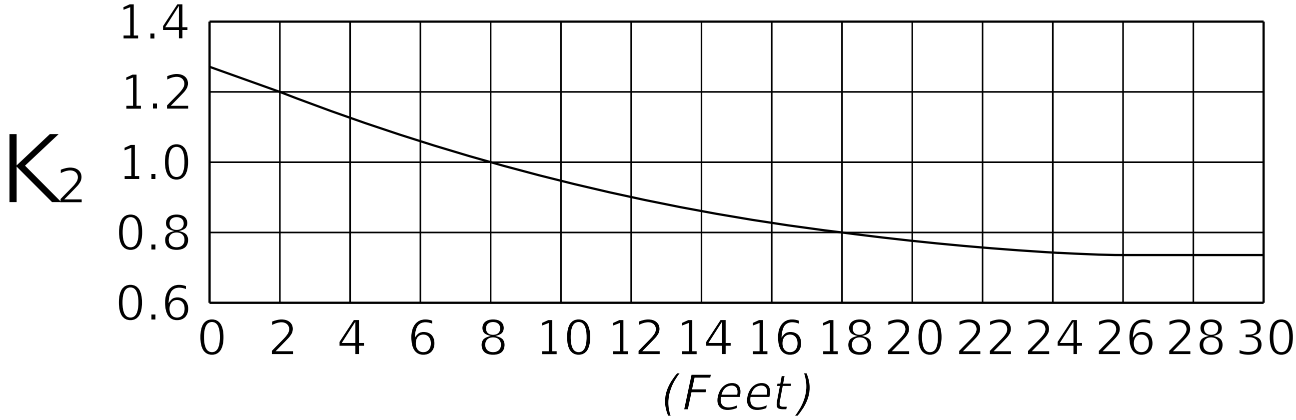
L_2 = Distance from inside of Exterior Wall to inside of Exterior Wall

LOAD DISTRIBUTION ON CULVERT SLAB

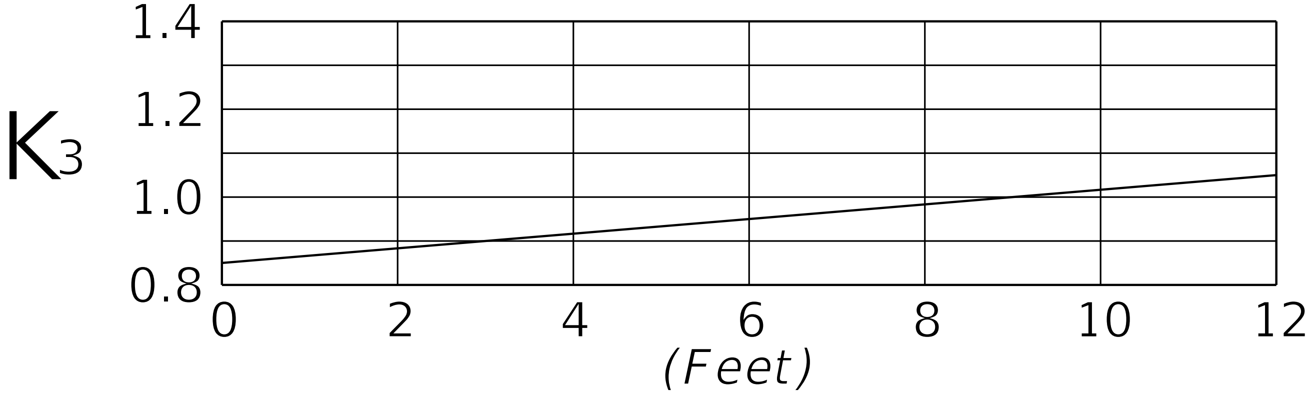
TOP SLAB COEFFICIENT



(H) Fill Height



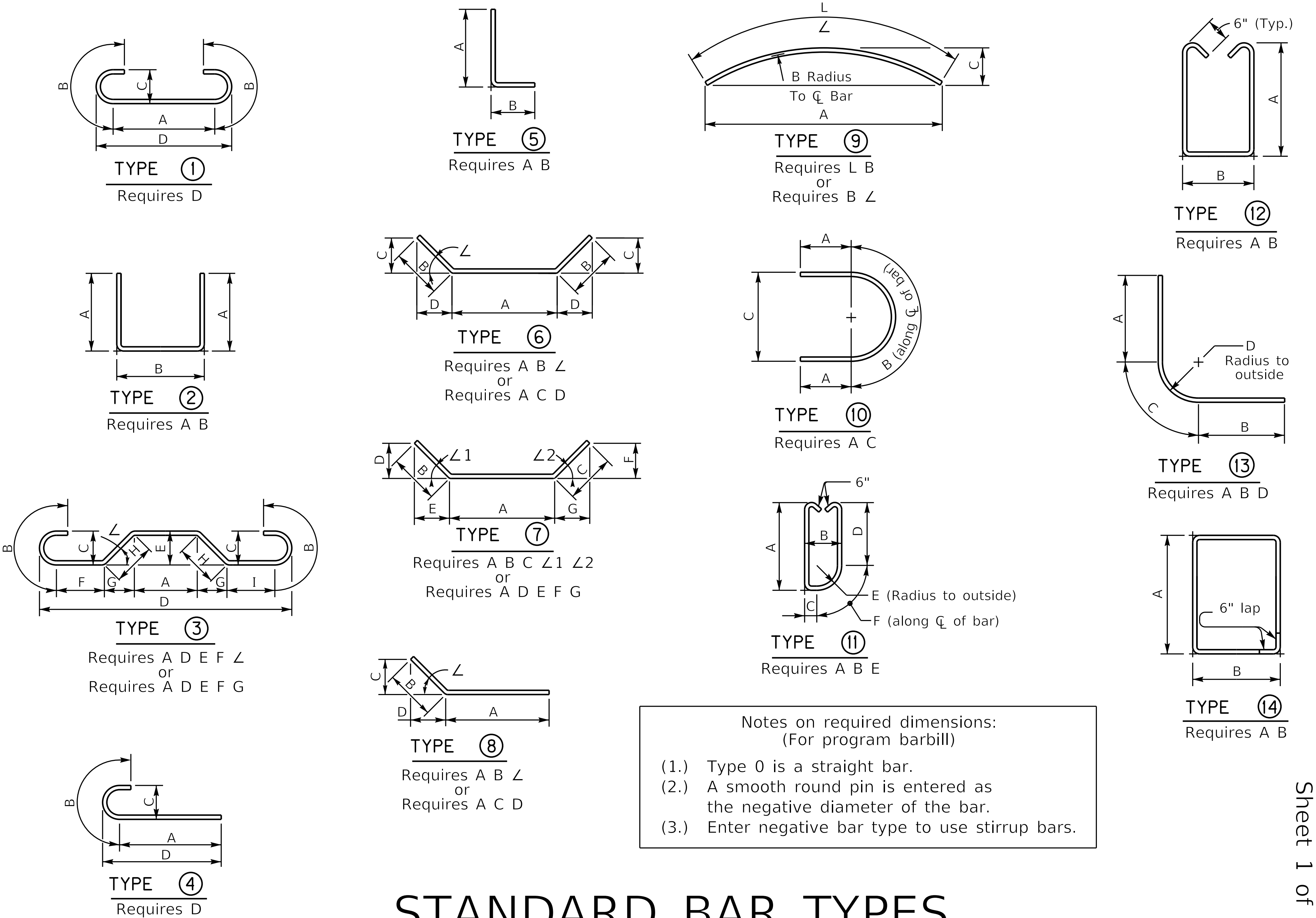
(B_c) Box Width



(H_c) Box Height

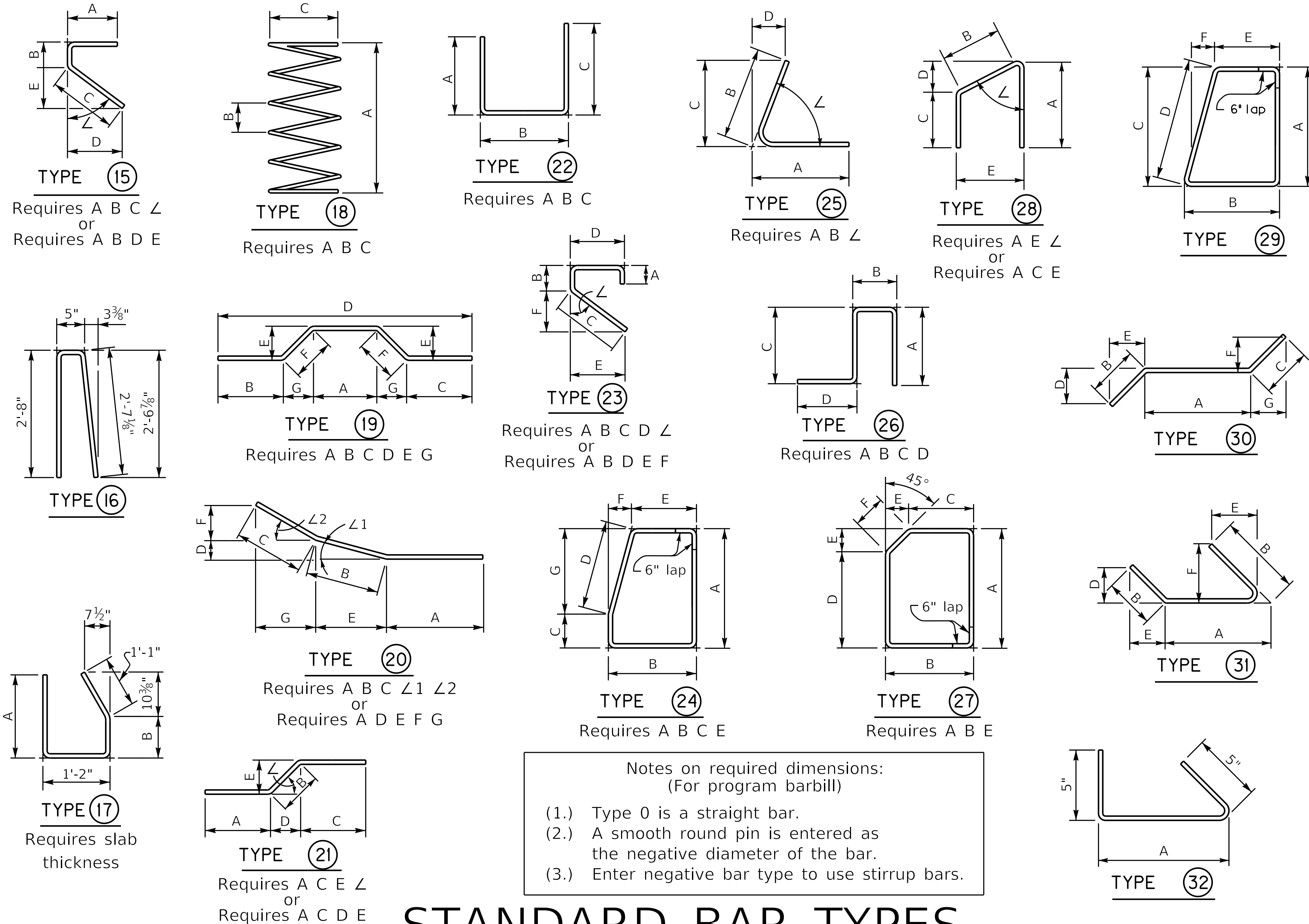
CULVERT LOAD COEFFICIENTS

STANDARD BAR TYPES



Notes on required dimensions:
(For program barbill)

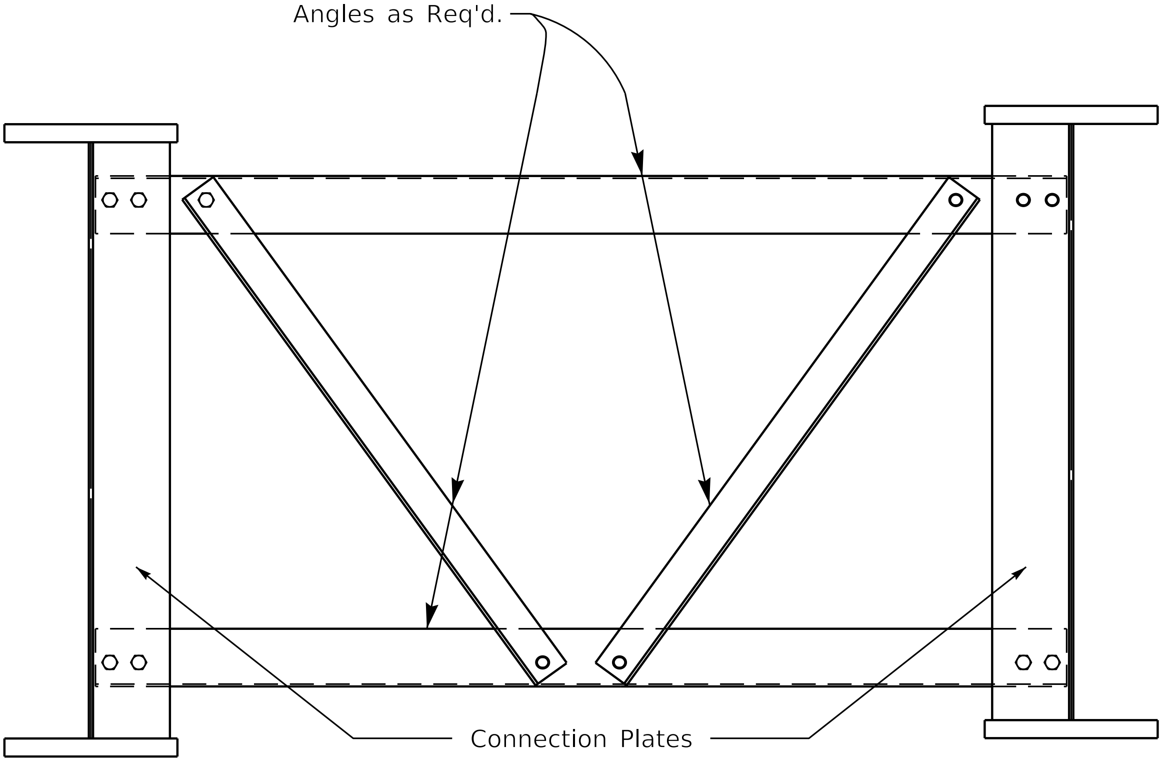
(1.) Type 0 is a straight bar.
(2.) A smooth round pin is entered as the negative diameter of the bar.
(3.) Enter negative bar type to use stirrup bars.

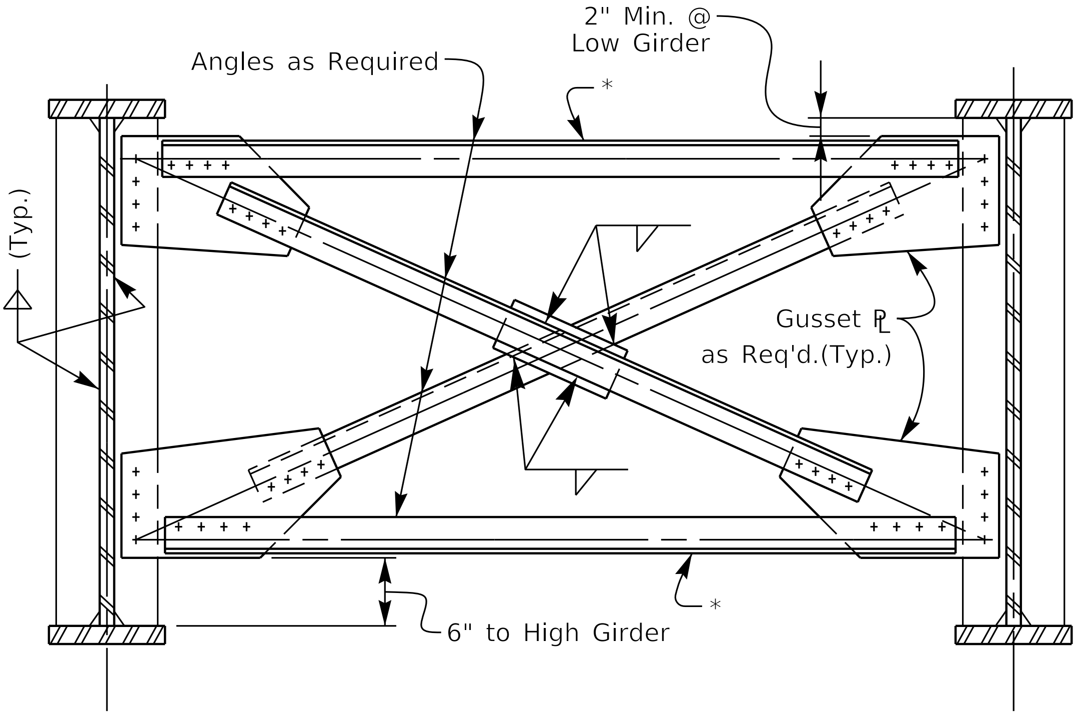


Notes on required dimensions:
(For program barbill)

(1.) Type 0 is a straight bar.
(2.) A smooth round pin is entered as the negative diameter of the bar.
(3.) Enter negative bar type to use stirrup bars.

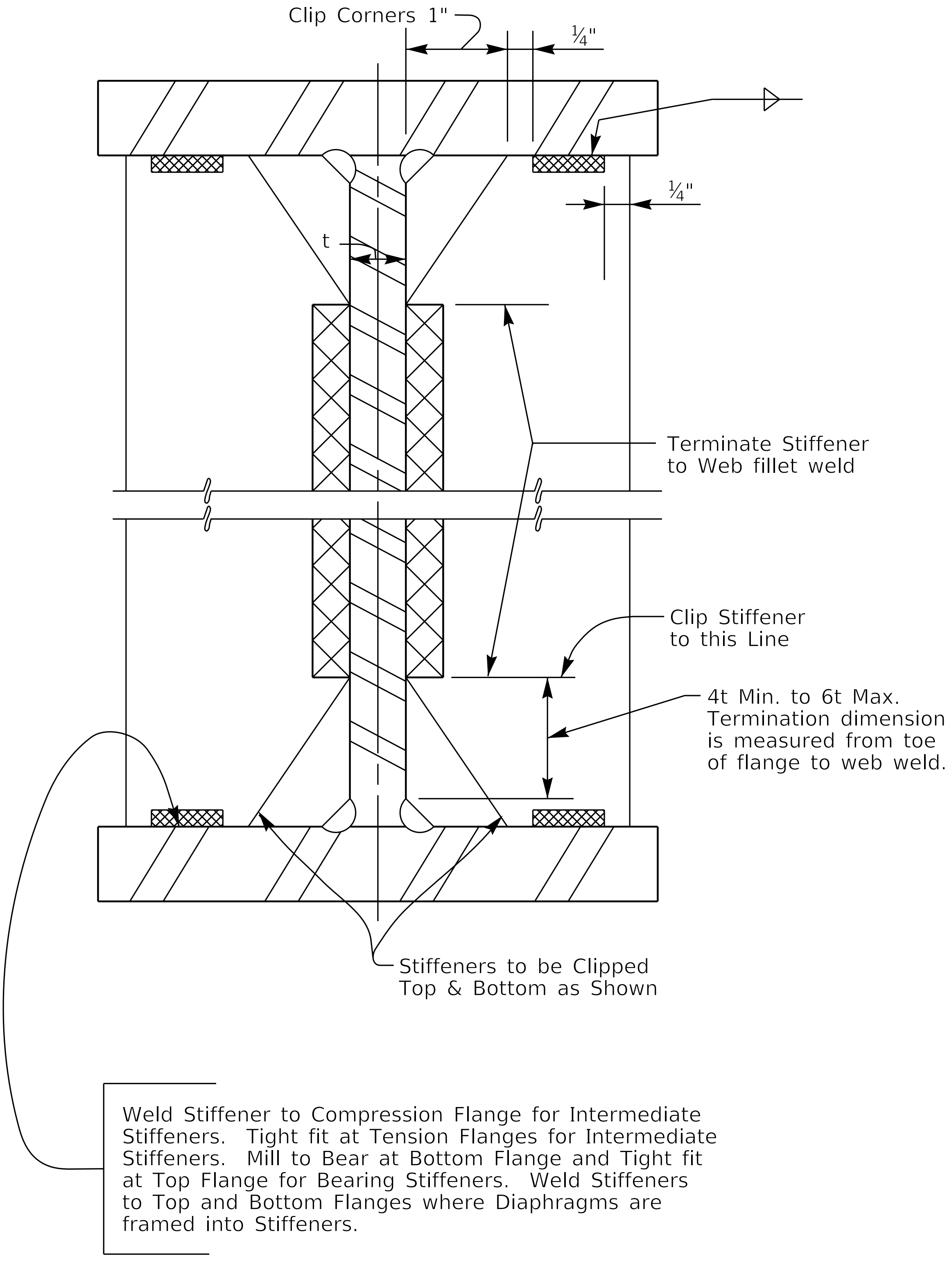
STANDARD BAR TYPES





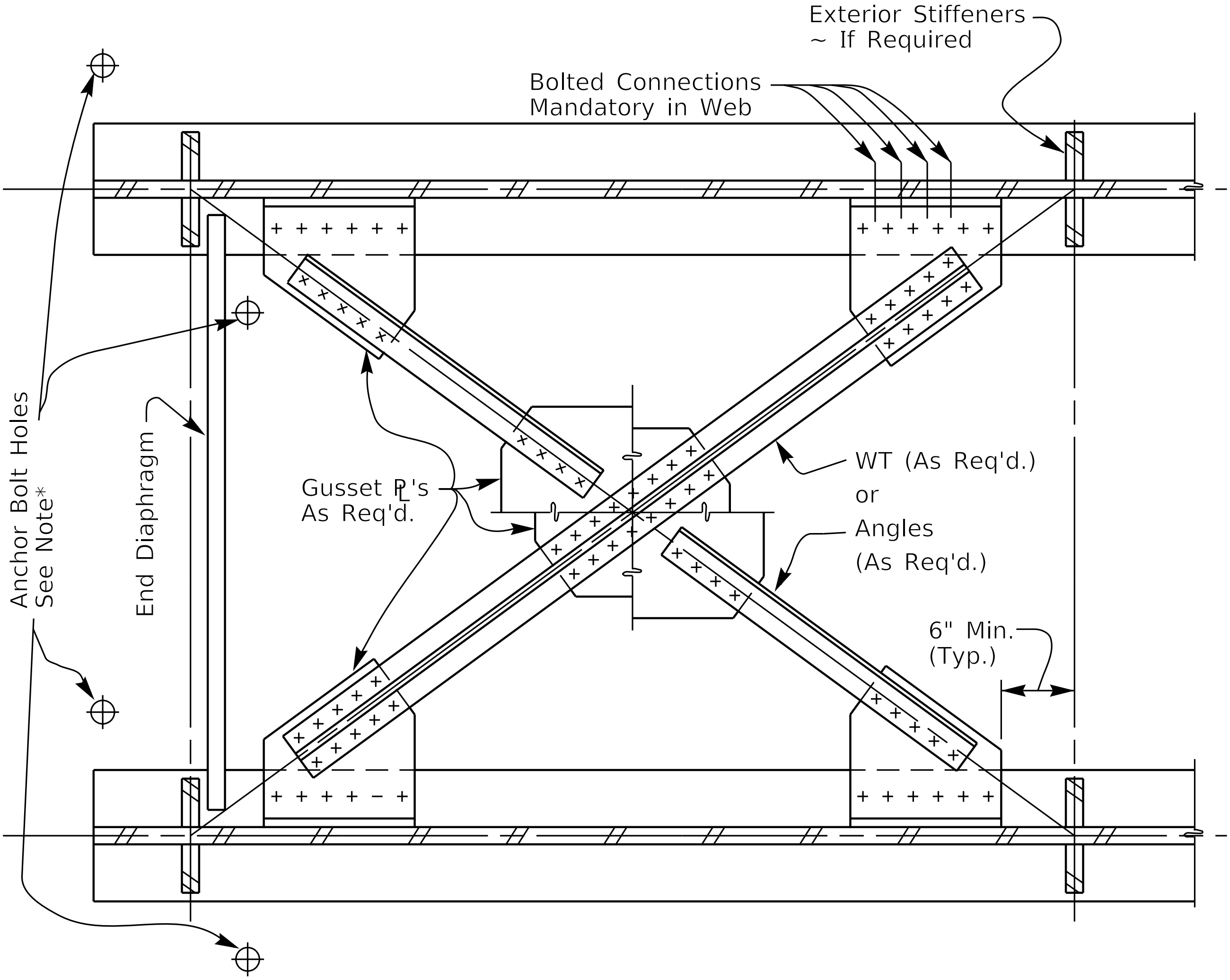
Fasteners Shown are for illustration only.

DIAPHRAGM DETAILS



STIFFENER DETAILS

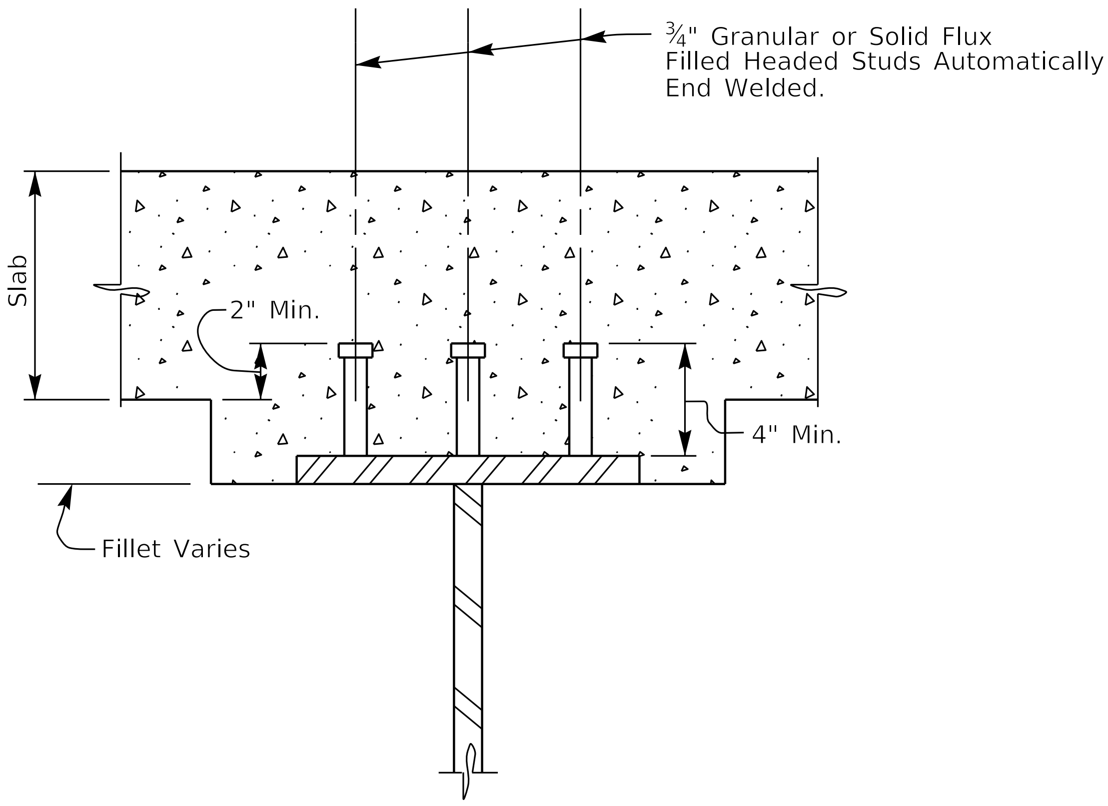
* Exercise caution in placing Anchor Bolt Holes, so that Anchor Bolt Holes may be drilled, in place, without interference from Cross-Frames, Gusset Plates, or other Structural Steel Member.



Fasteners shown are for illustration only. WT's may be welded to Gussets

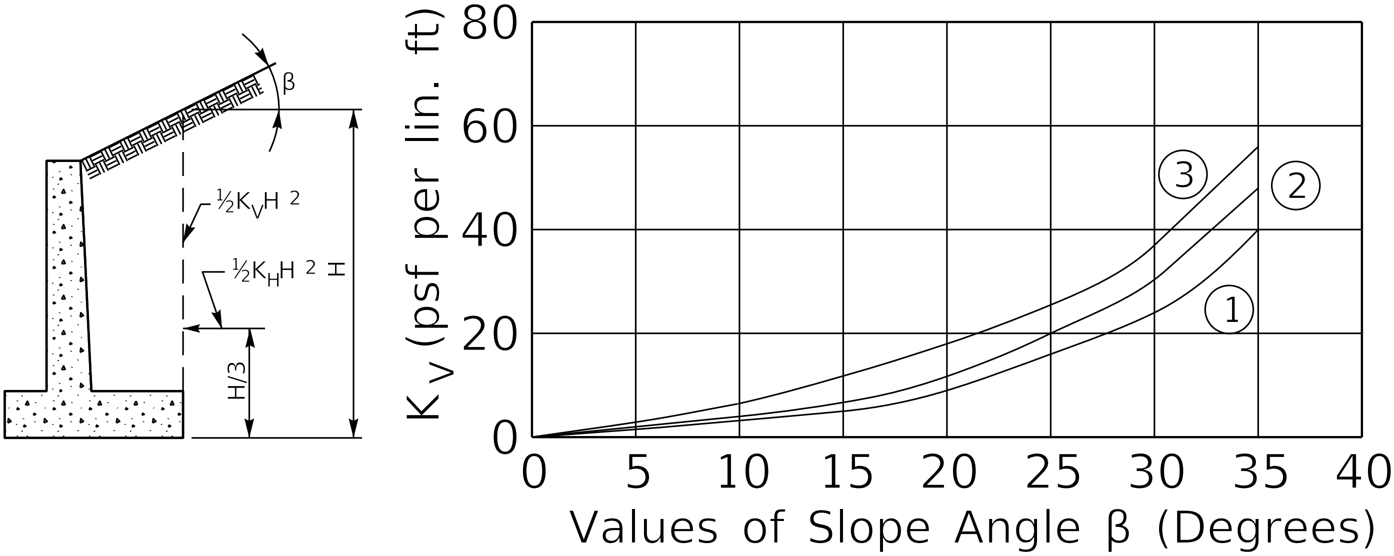
PLAN VIEW
(NORMAL OR SKEWED)

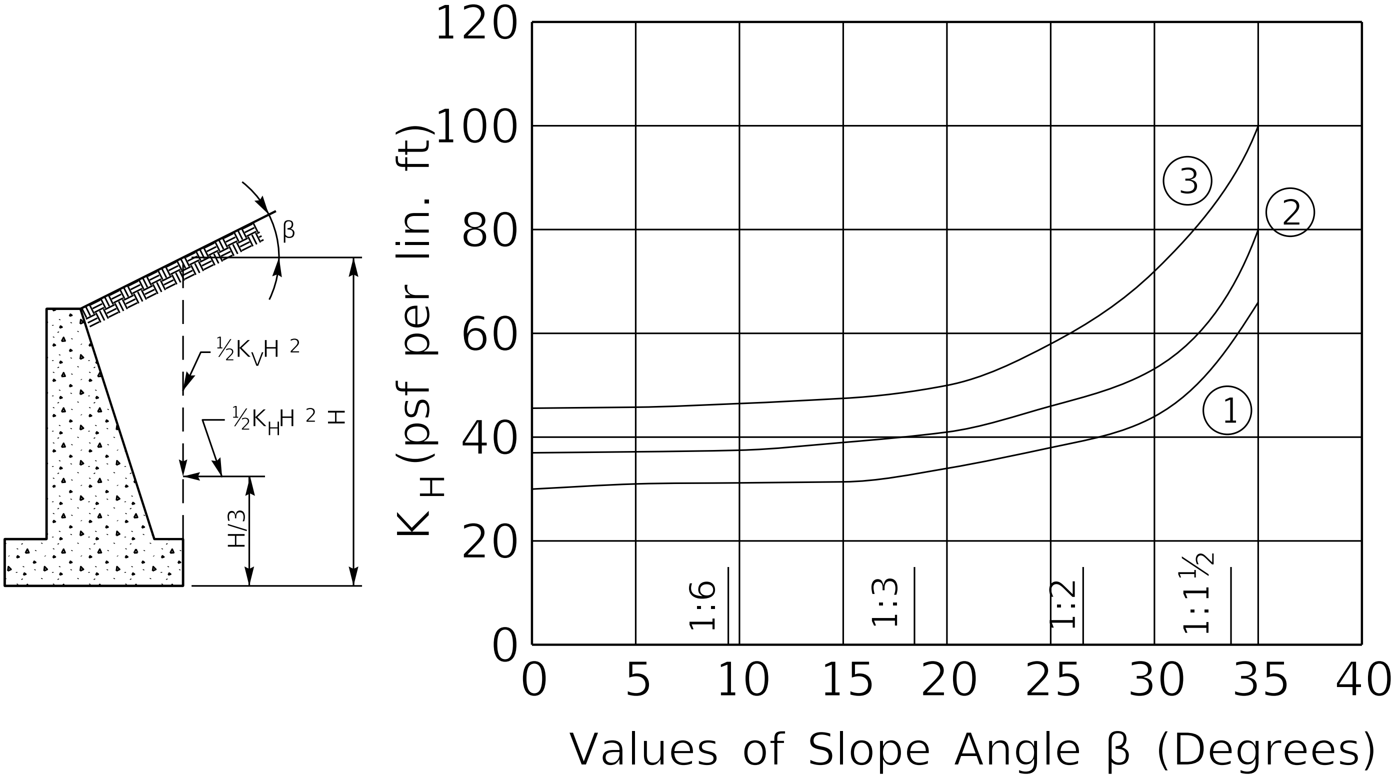
LATERAL BRACING DETAILS



SHEAR CONNECTIONS

Straight Slope Backfill





CIRCLED NUMBERS INDICATE THE FOLLOWING SOIL TYPES

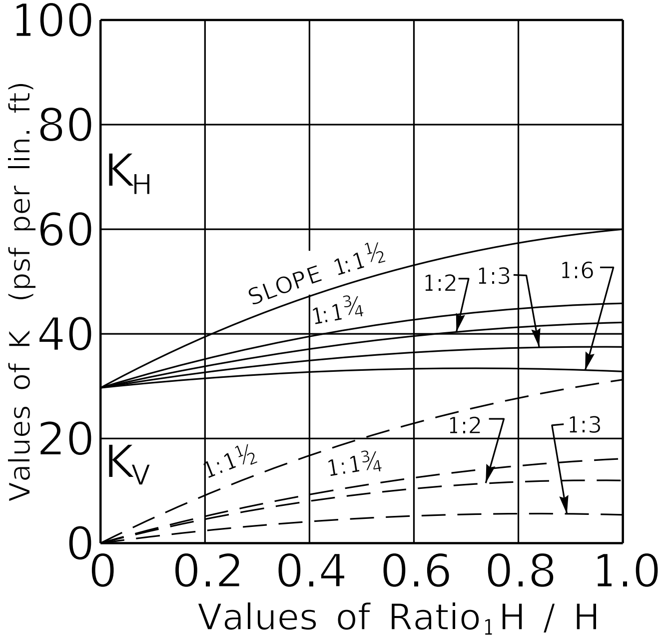
1. CLEAN SAND AND GRAVEL: GW, GP, SW, SP.
2. DIRTY SAND AND GRAVEL OF RESTRICTED PERMEABILITY: GM, GM-GP, SM-SP, SM
3. STIFF RESIDUAL SILTS AND CLAYS, SILTY FINE SANDS, CLAYEY SANDS AND GRAVELS: CL, ML, CH, MH, SM, SC, GC.

DESIGN LOADS FOR LOW RETAINING WALLS

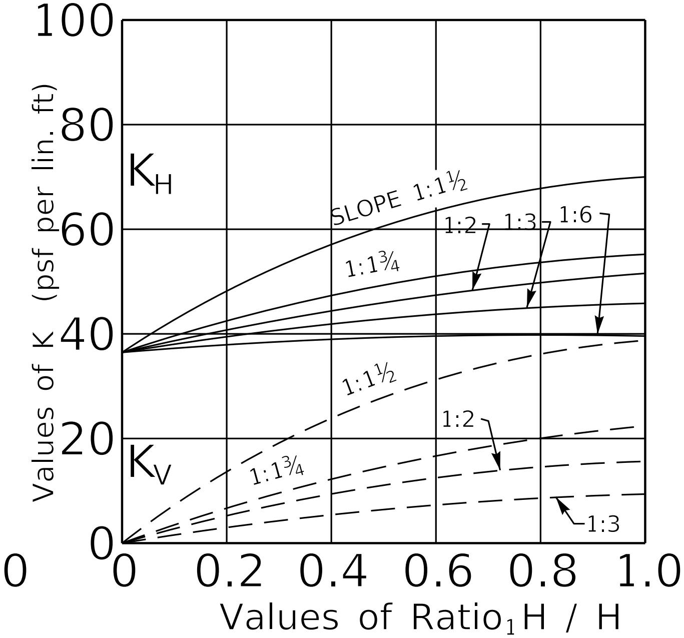
DESIGN LOADS FOR LOW RETAINING WALLS

Broken Slope Backfill

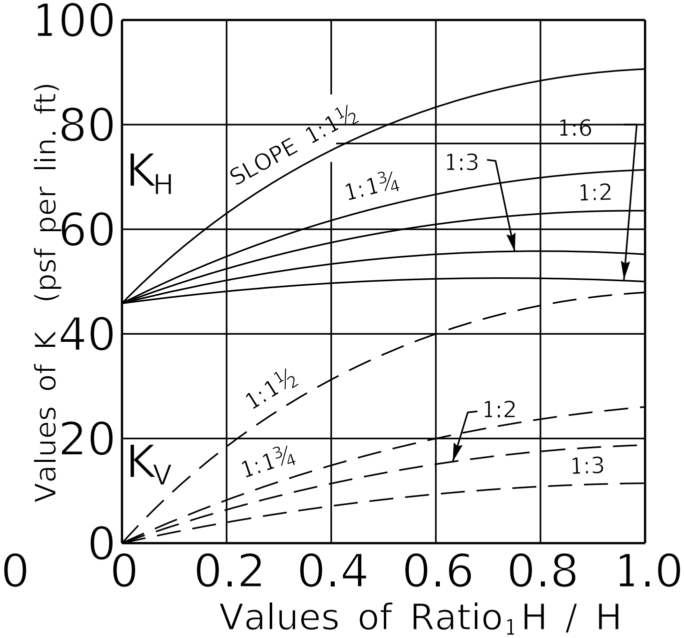
SOIL TYPE 1

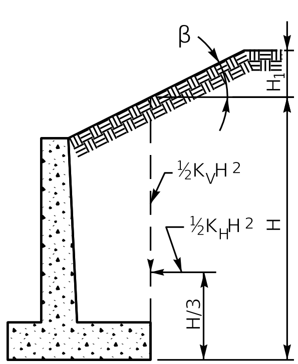


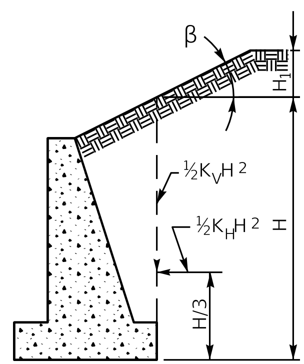
SOIL TYPE 2

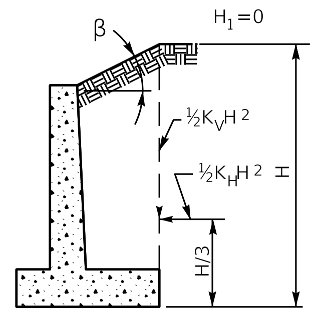


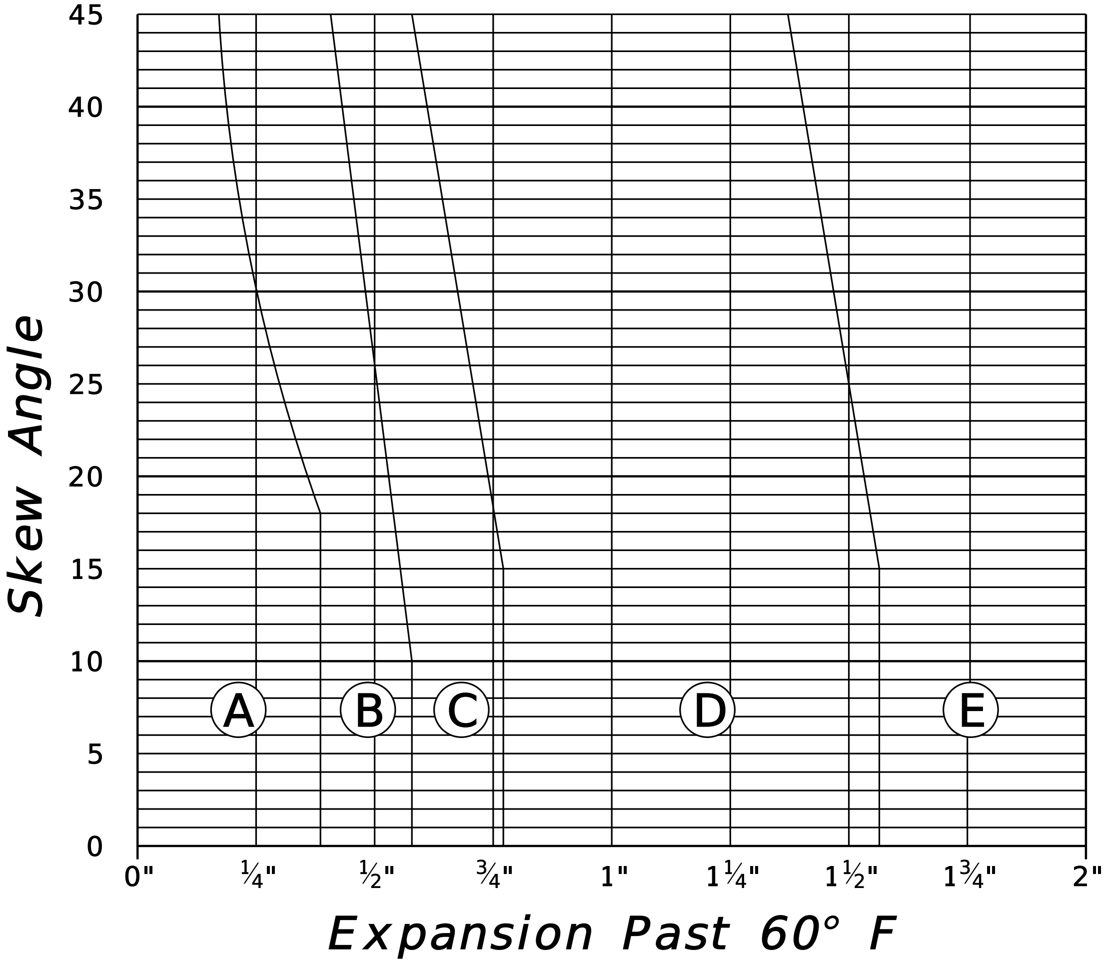
SOIL TYPE 3











(A) 1.5" Precompressed Foam *

(B) 2.0" Precompressed Foam *

(C) 2.5" Precompressed Foam *

(D) 4.0" Neoprene Strip Seal

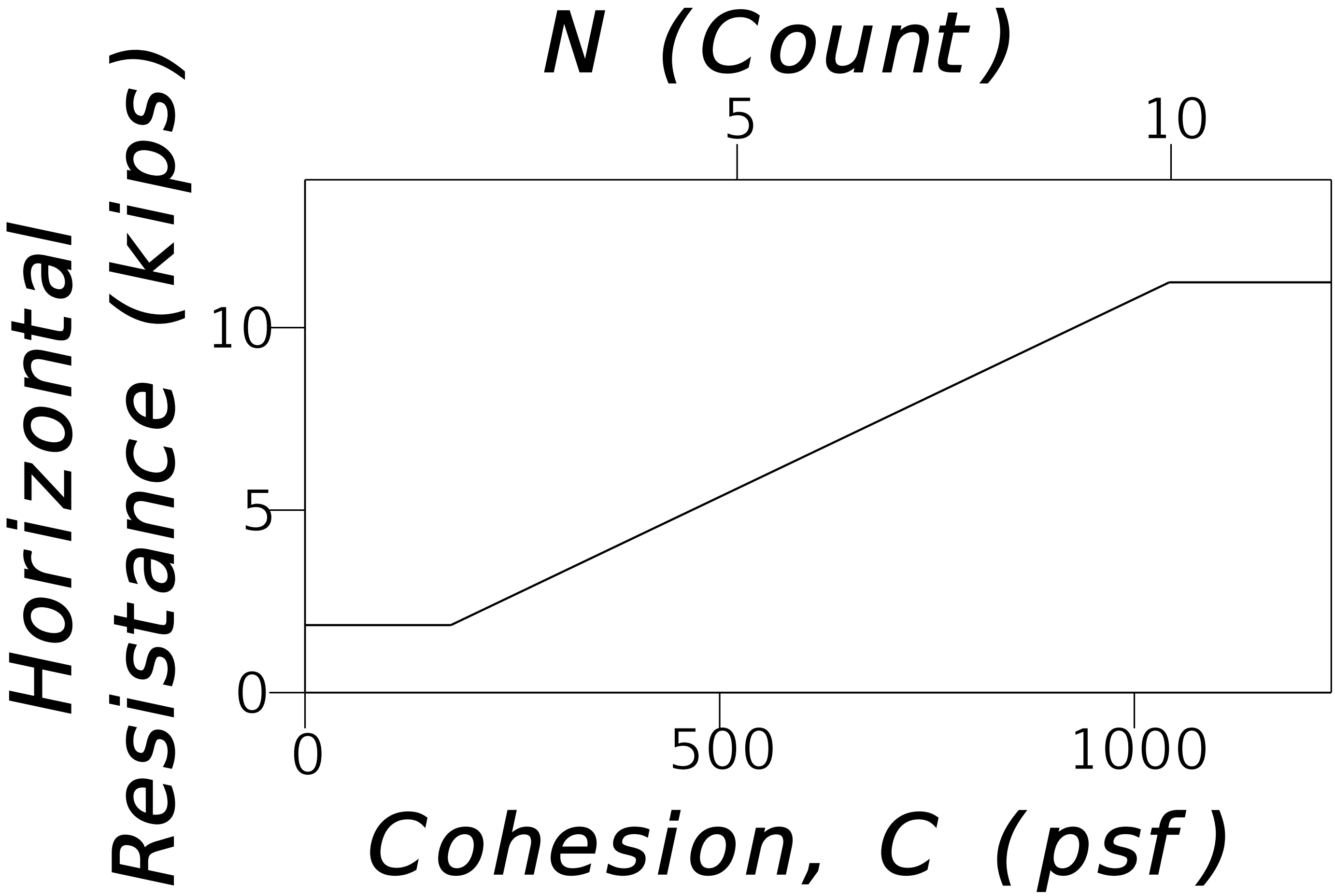
(E) Steel Finger Expansion Dam or **Modular Expansion Joints

** Modular Expansion Joints should only be used with prior permission from the Director, Division of Structural Design.

Expansion Past 60° F is the sum of the calculated expansion from the continuous units at the joint location.

* Every effort must be made to reduce/eliminate as many joints as possible on all structures while also keeping damage to the structure/roadway in mind. Contact the Division of Structural Design for current policy if necessary. Joints on the structure should only be used with prior permission from the Director, Division of Structural Design. The Division of Structural Design reserves the right to require changes if necessary to meet current policy.

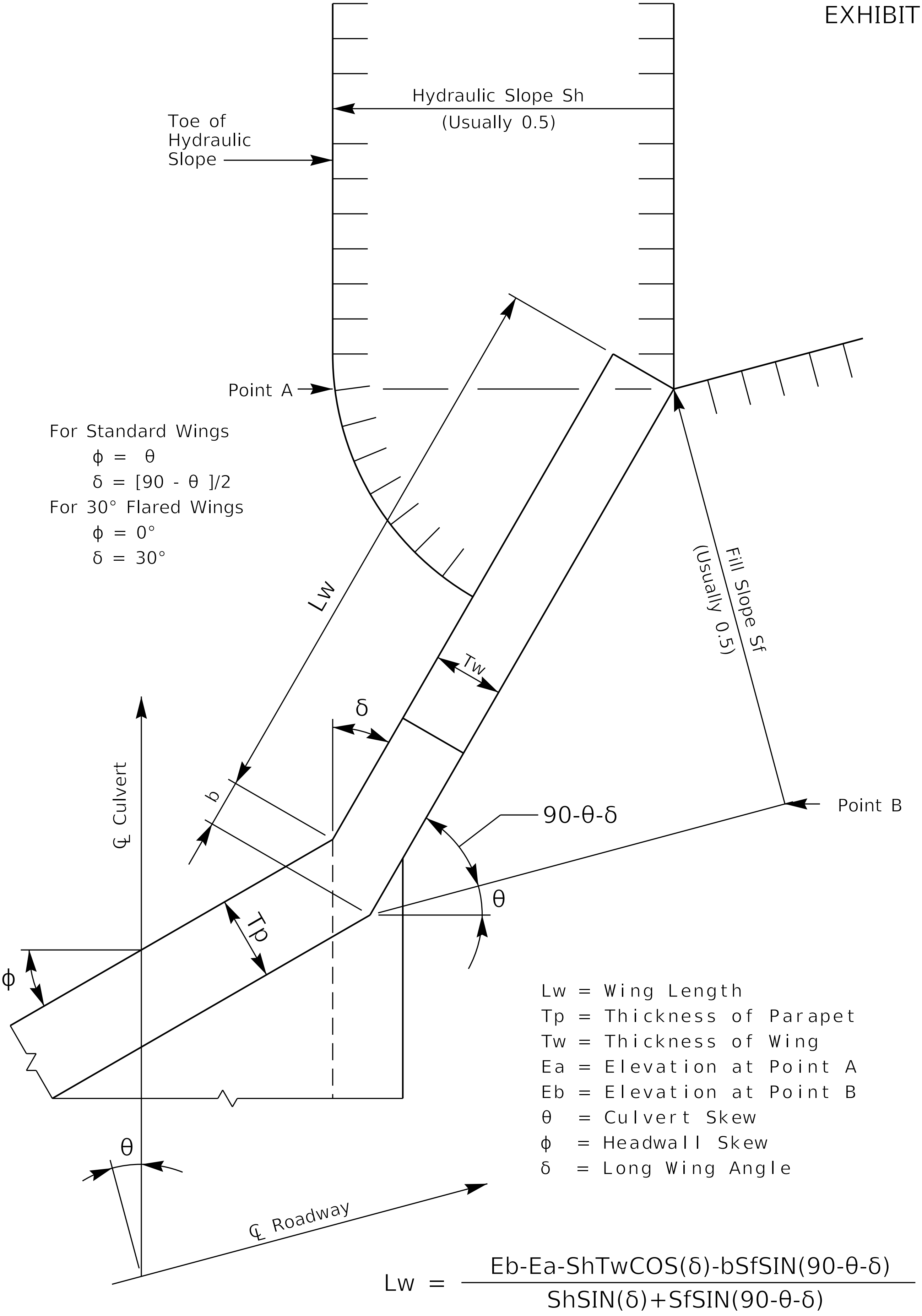
EXPANSION JOINT CHART



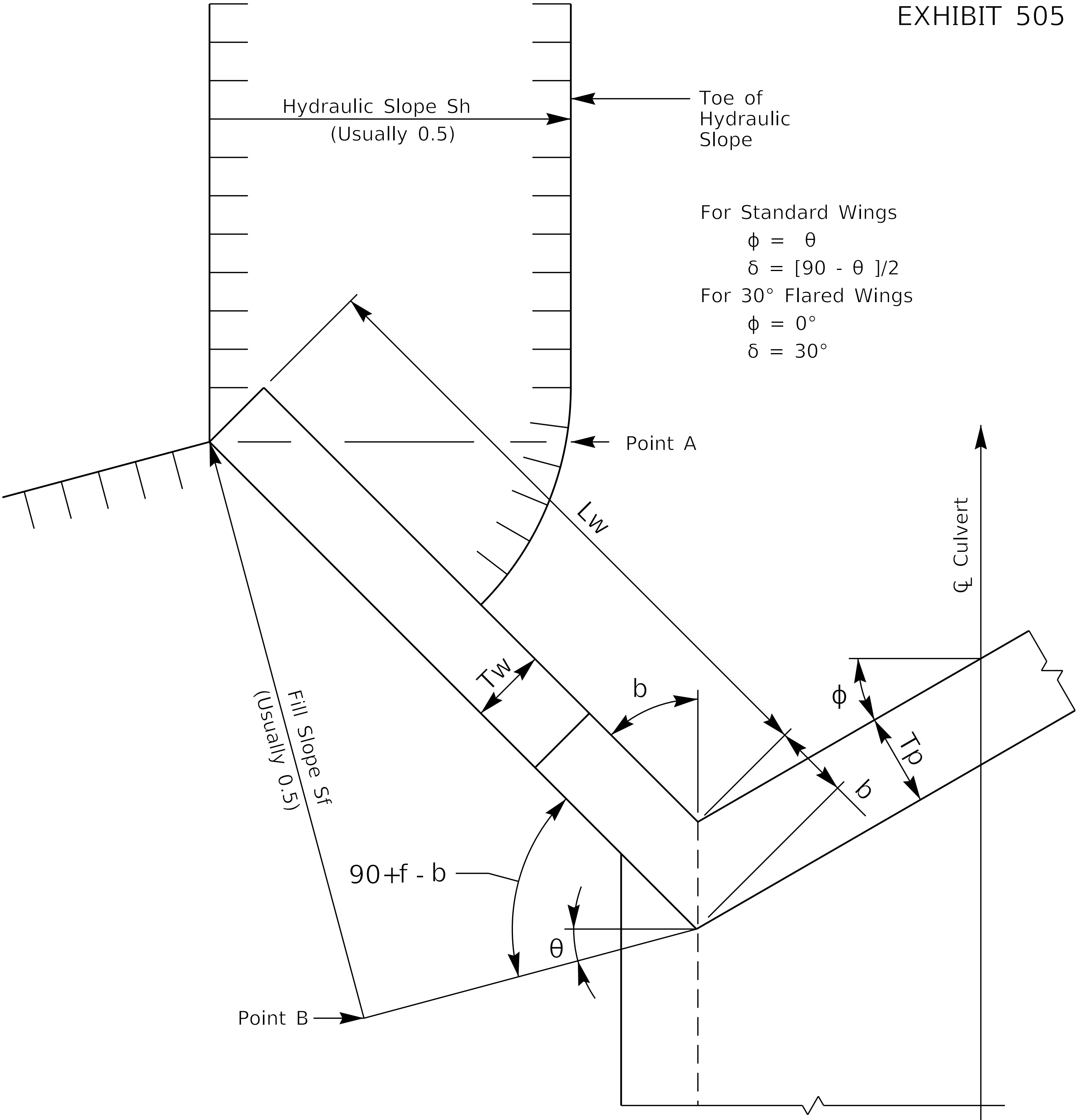
Use for preliminary design only.
Evaluate final design with L pile.

PERMISSIBLE HORIZONTAL RESISTANCE PER PILE

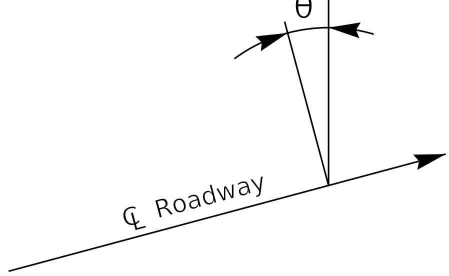
EXHIBIT 504



LAYOUT OF "LONG" WINGS

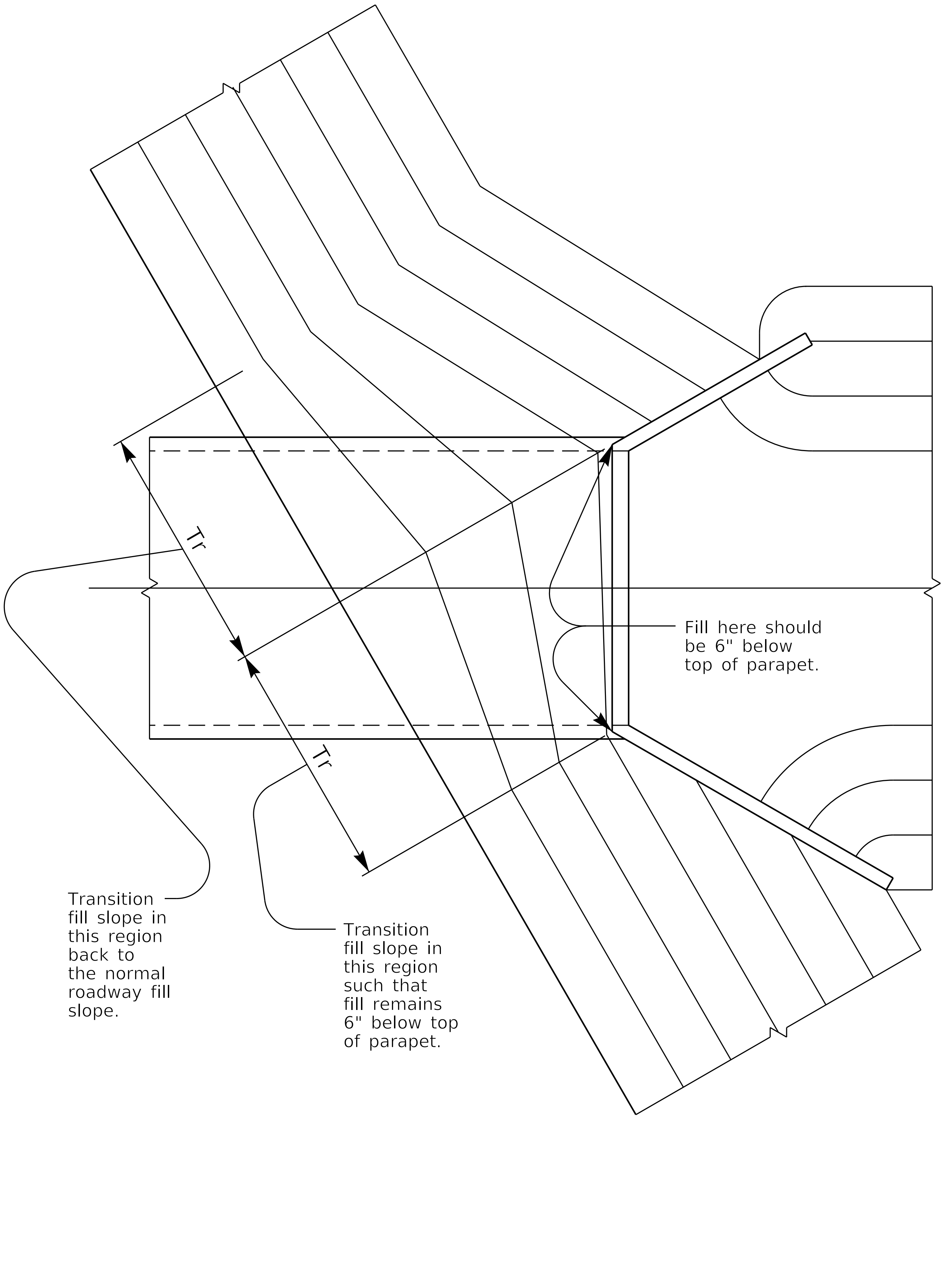


Lw = Wing Length
Tp = Thickness of Parapet
Tw = Thickness of Wing
Ea = Elevation at Point A
Eb = Elevation at Point B
θ = Culvert Skew
φ = Headwall Skew
δ = Long Wing Angle

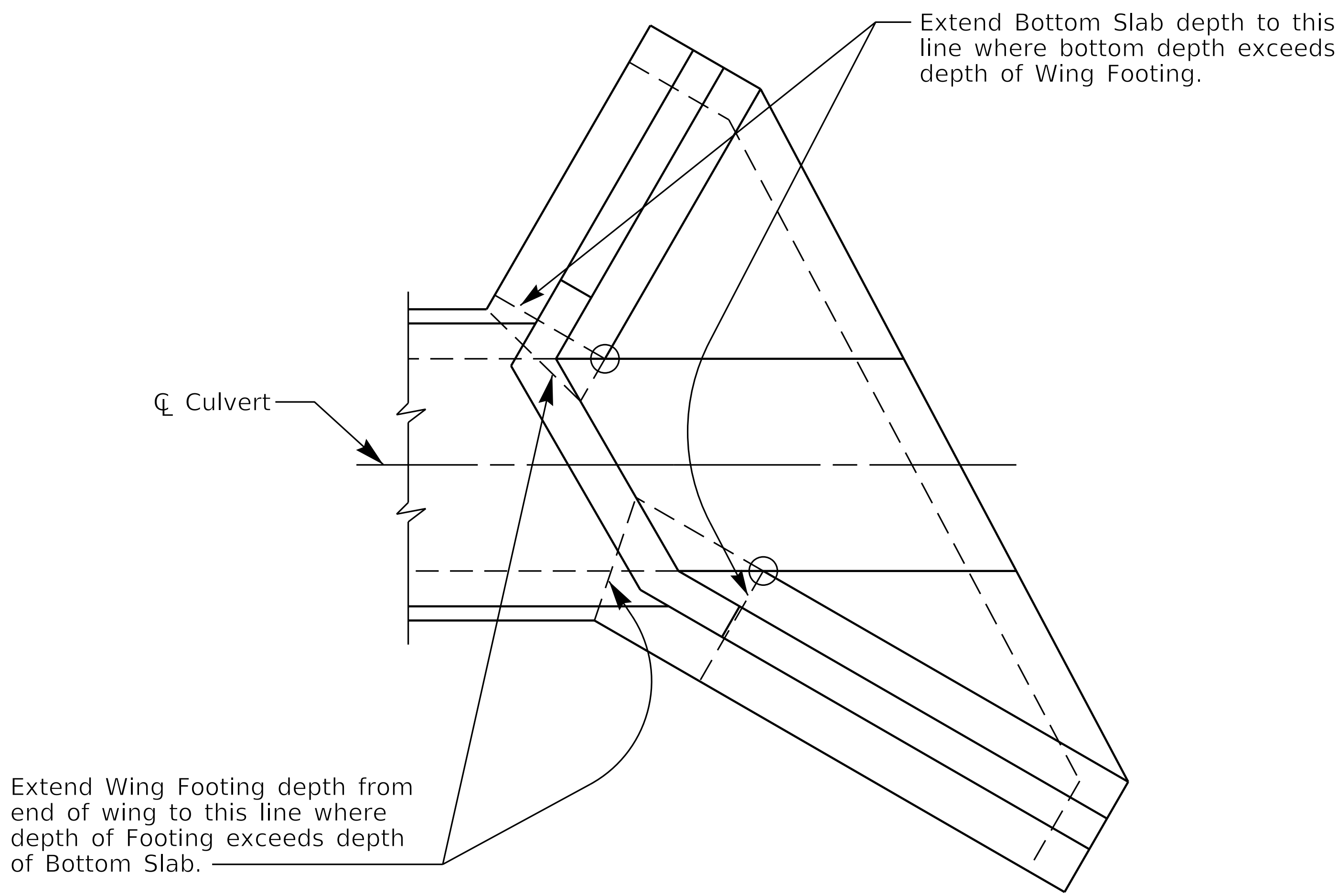


$$Lw = \frac{Eb - Ea - ShTw\cos(\delta) - bSf\sin(90-\theta-\delta)}{Sh\sin(\delta) + Sf\sin(90-\theta-\delta)}$$

LAYOUT OF "SHORT" WINGS

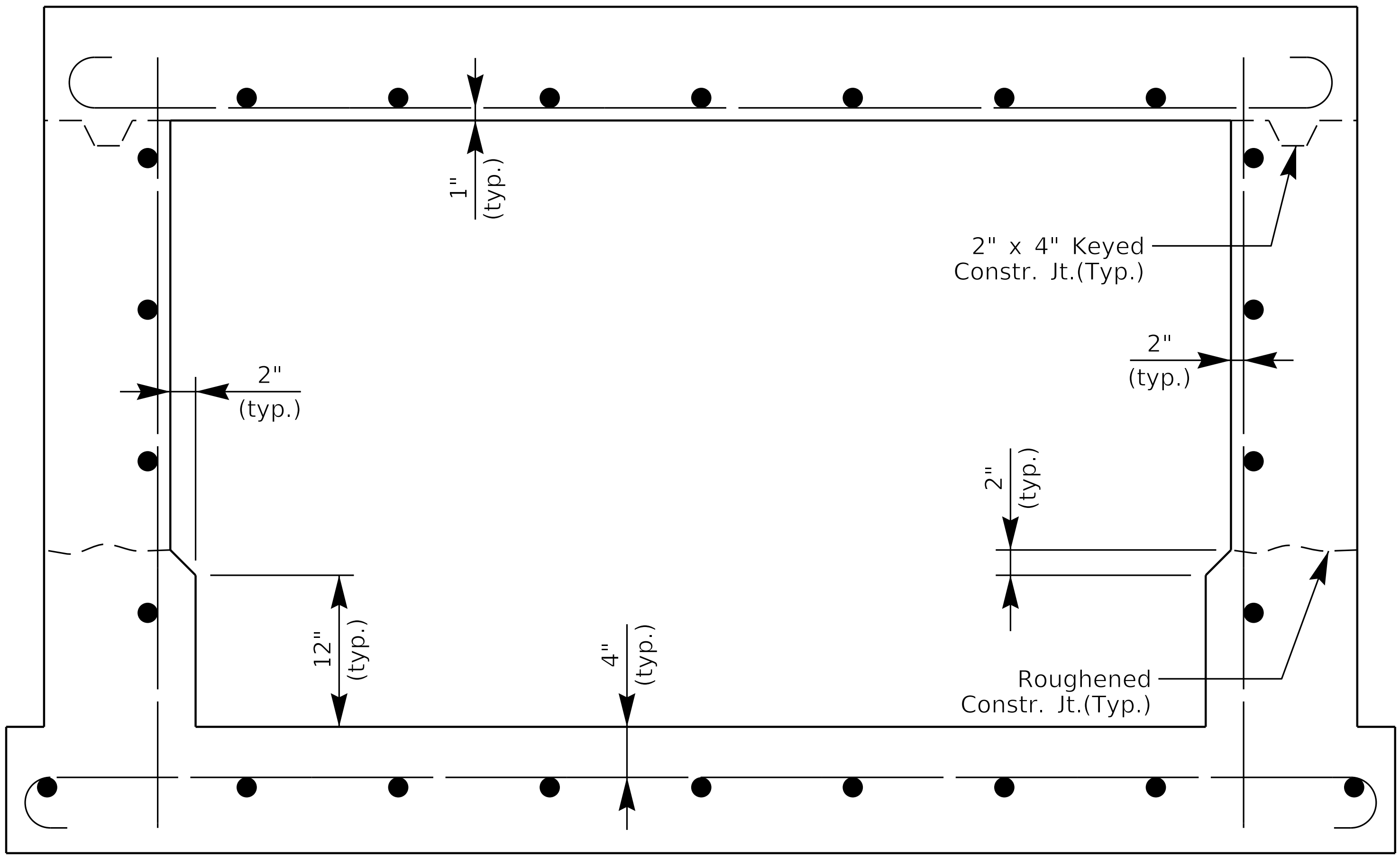


CULVERTS WITH 30° FLARED WINGS



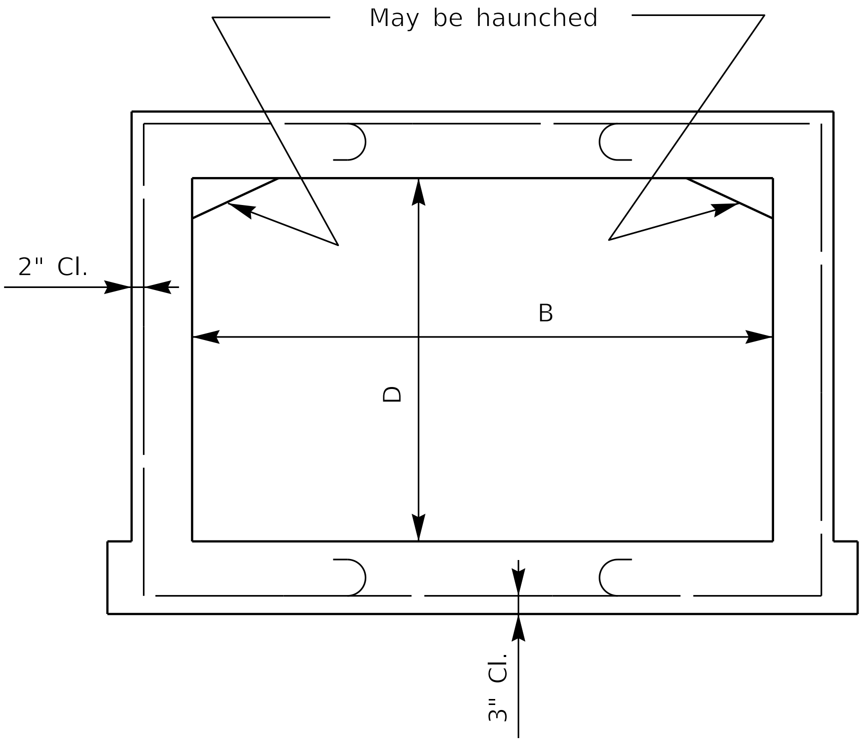
DETAIL OF INTERSECTION OF BOTTOM OF BOTTOM SLAB AND BOTTOM OF WING FOOTING

CULVERT FOOTING DETAIL



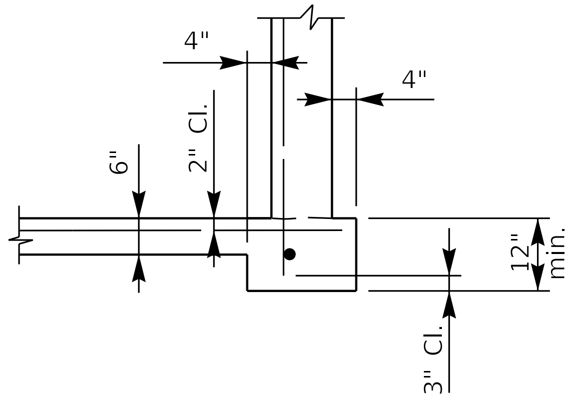
CULVERT SECTION
ACID WATER and/or HIGHLY ABRASIVE SITUATION

Showing only additional reinforcement for Frame Condition.

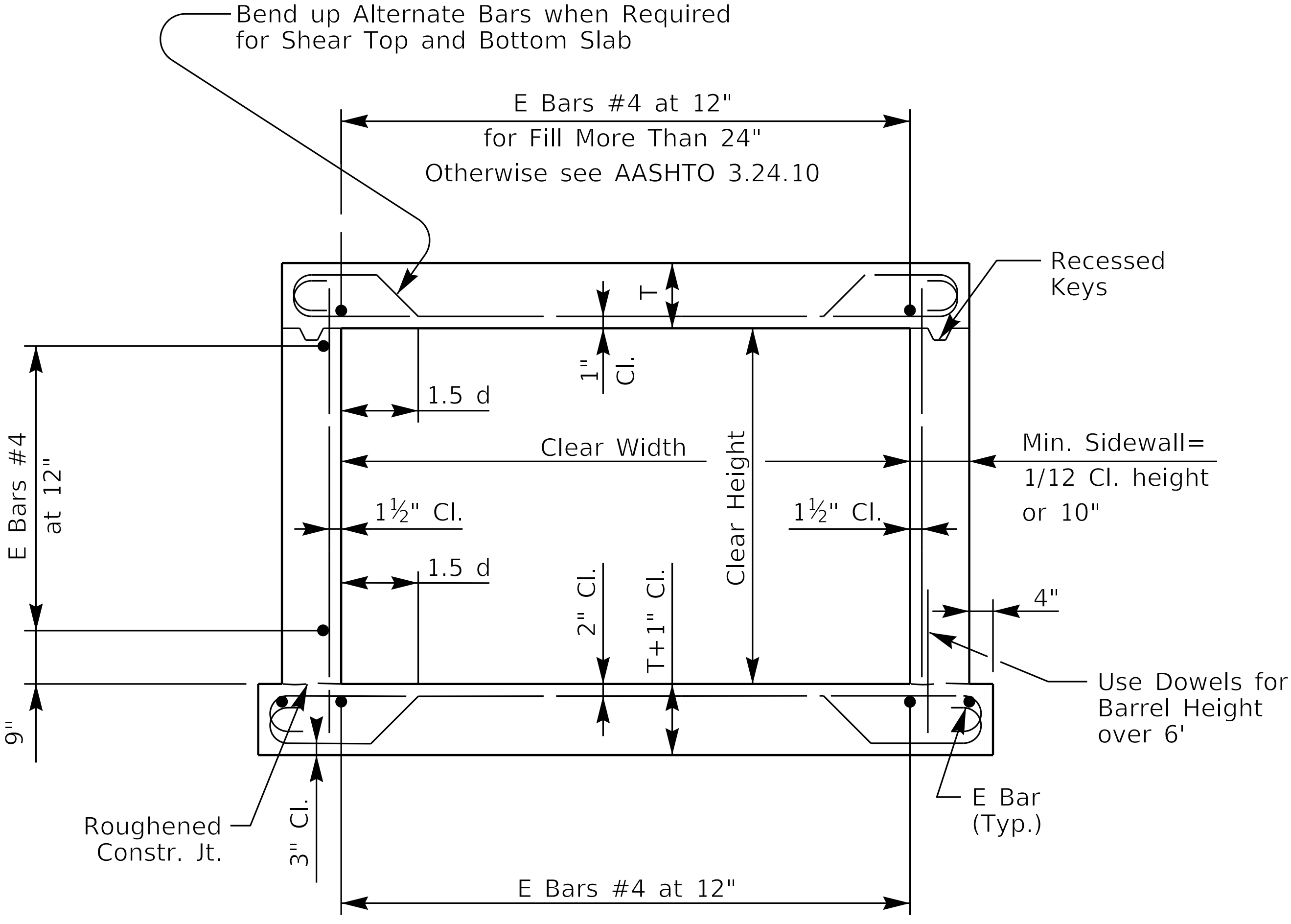


Reinforcement for Corners may be hooked rather than continuous across slab to facilitate placement.

CULVERT SECTION
RIGID FRAME SINGLE BARREL



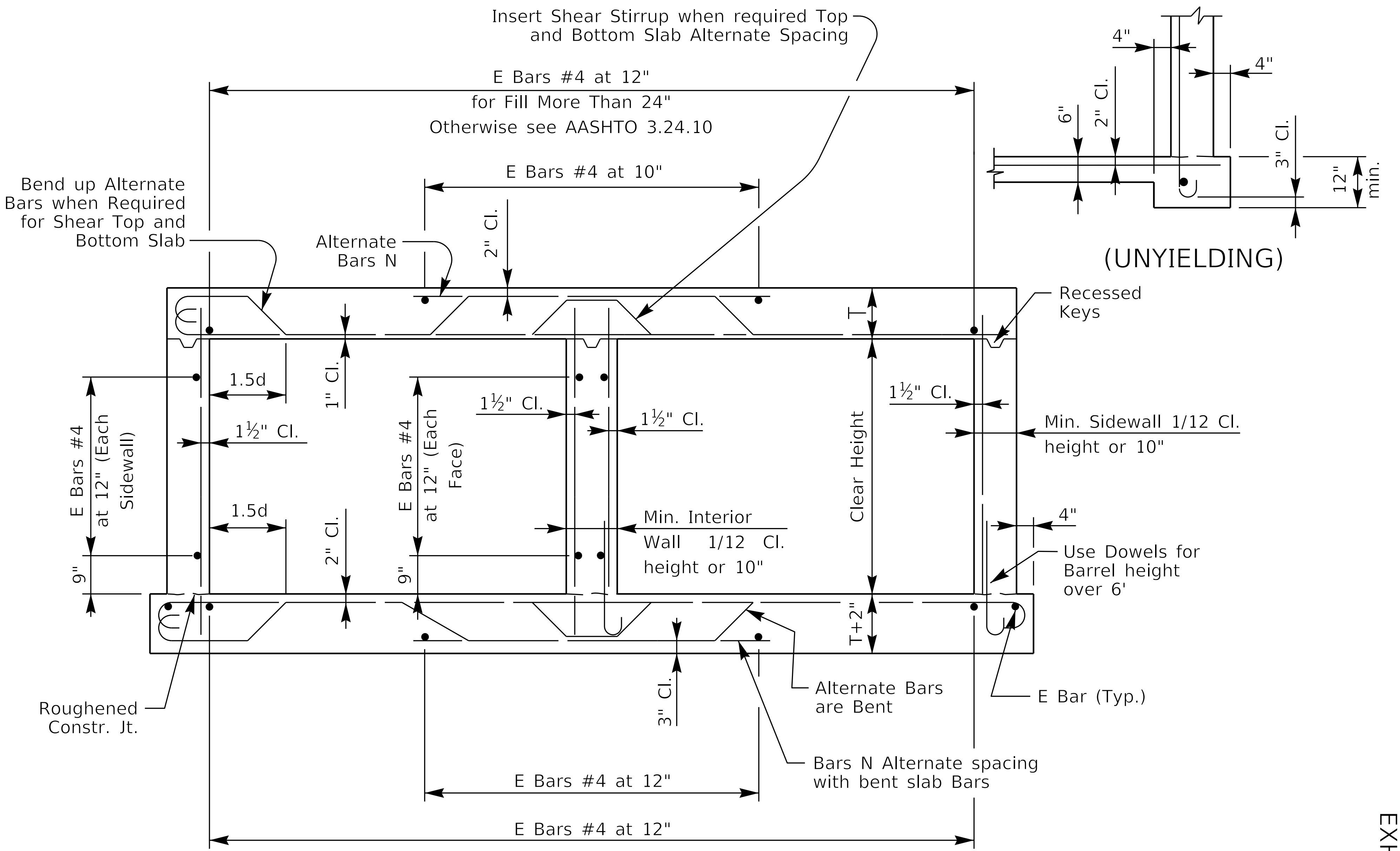
(UNYIELDING)



d= Distance from the extreme compression fiber to the centroid of tension steel.

(YIELDING)

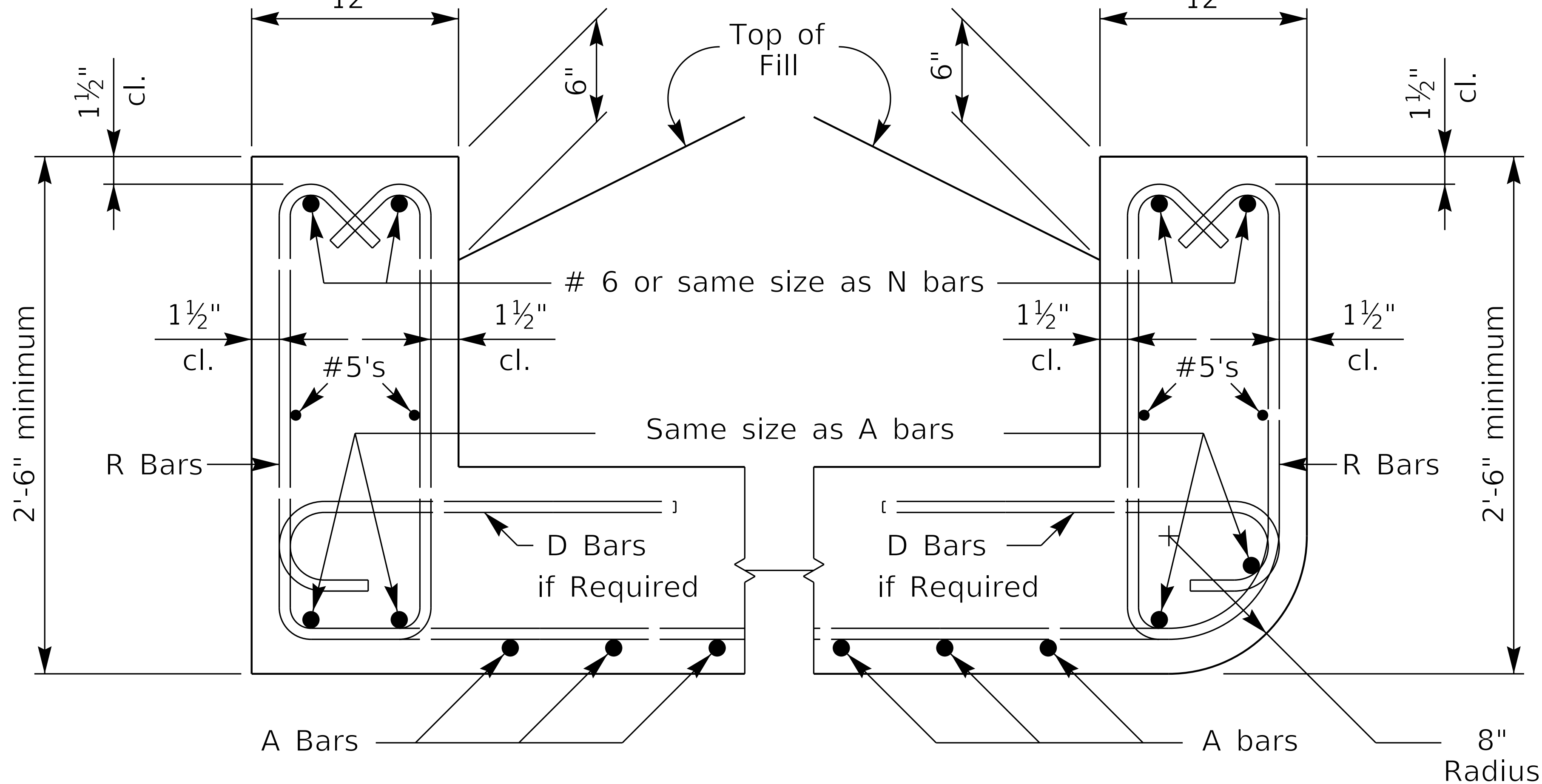
CULVERT SECTION
STANDARD SINGLE BARREL



d= Distance from the extreme compression fiber to the centroid of tension steel.

(YIELDING)

CULVERT SECTION - STANDARD MULTIPLE BARREL

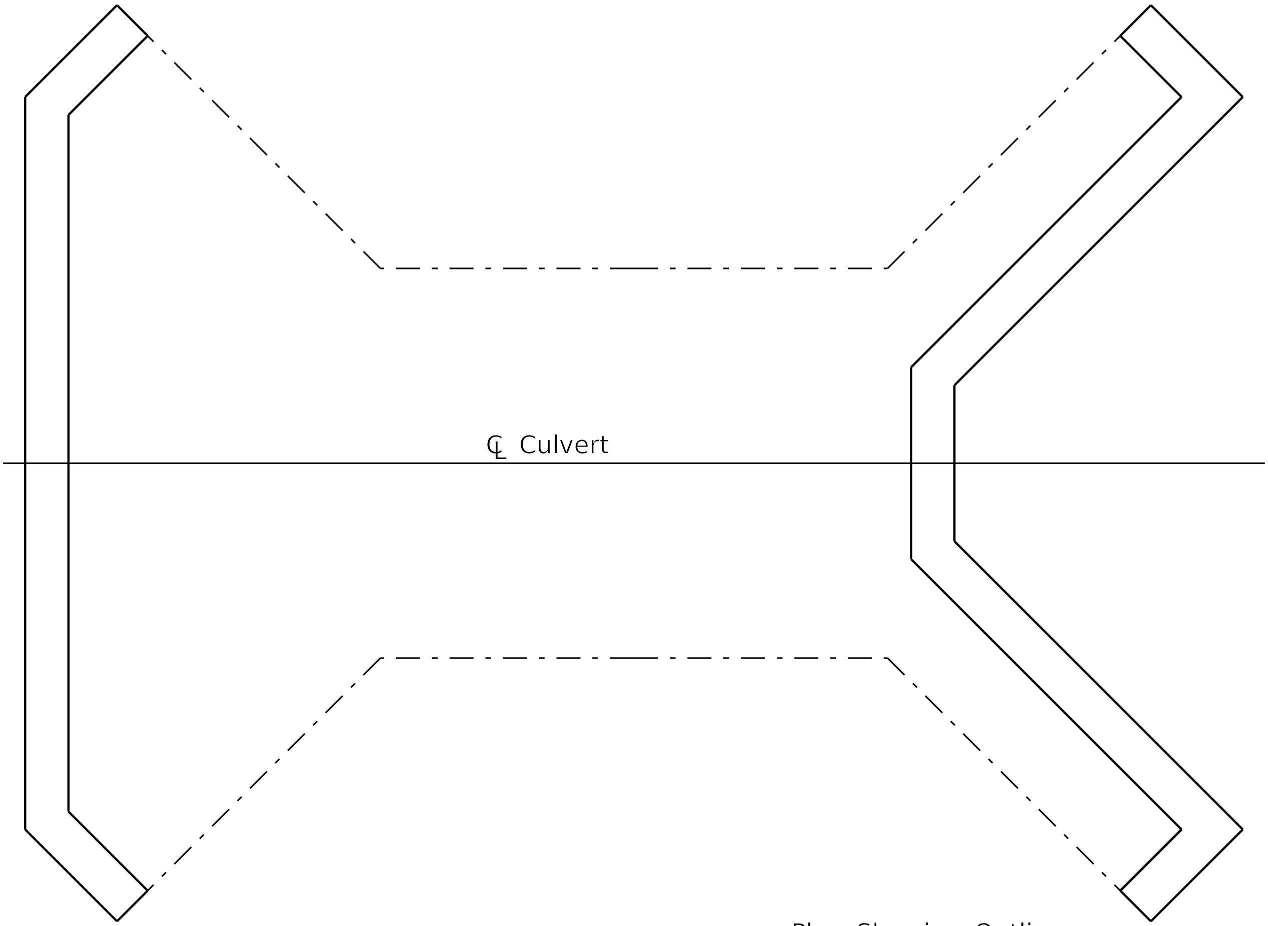


Outlet Parapet Detail

Inlet Parapet Detail

R Bars - # 5 @ 12" minimum
D Bars - # 5 minimum (space with R Bars)

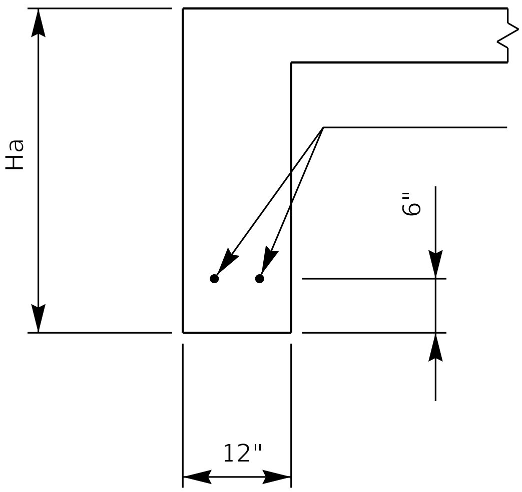
PARAPET DETAILS



Plan Showing Outline of Apron for Culverts with Paved Inlet/Outlet

Plan Showing Outline of Apron for Culverts without Paved Inlet/Outlet. Use only with permission of the Division of Structural Design.

Ha = Depth of Apron *
= 3' for Barrel heights less that 6'
= 4' for Barrel heights 6' or greater



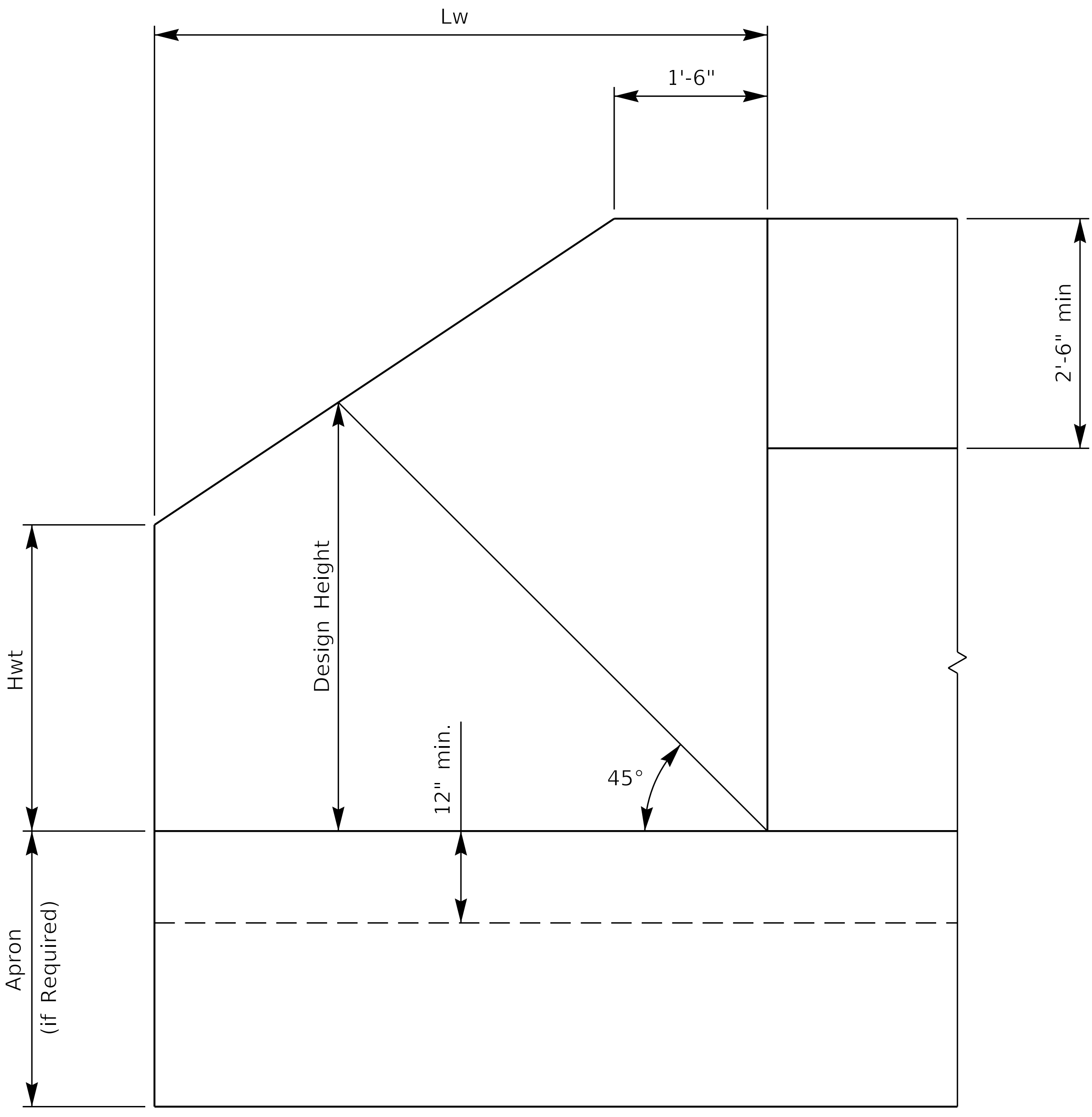
Use two bars same size as N bars in multiple span culverts.
In single span culverts use two bars the same size as A bars.

Section

* If bedrock is encountered embed in accordance with geotechnical recommendations.

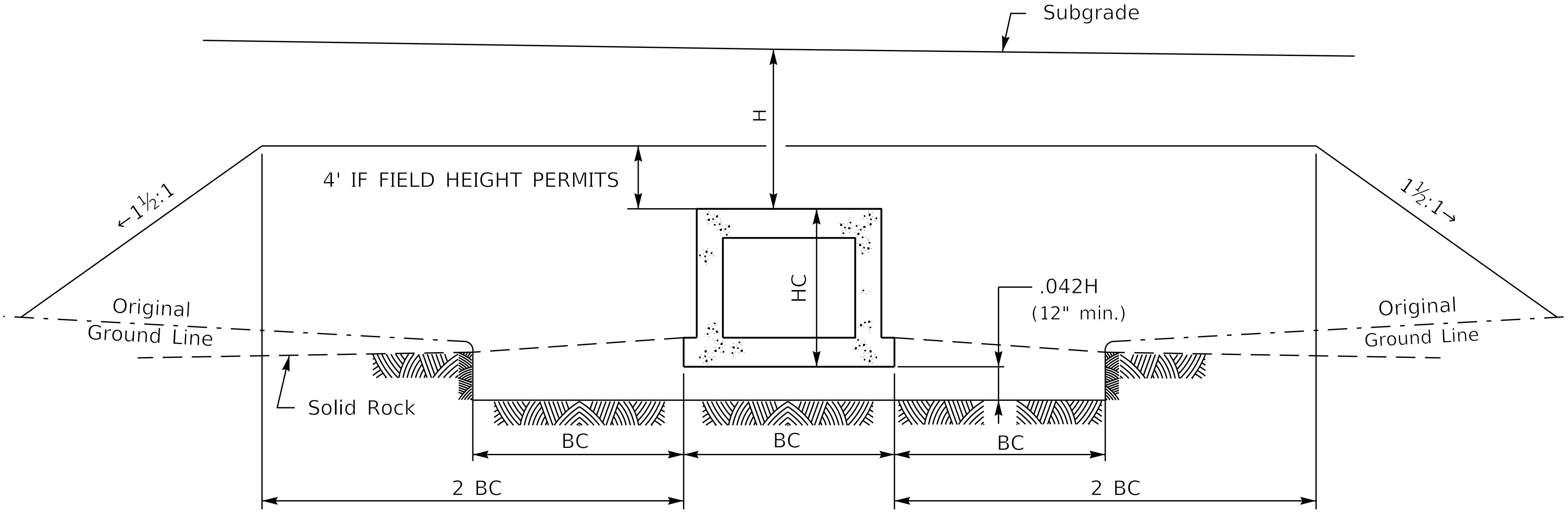
APRON DETAILS

Hwt is set such that the fill is a minimum of 6" below the top of the wing (round up to nearest foot)



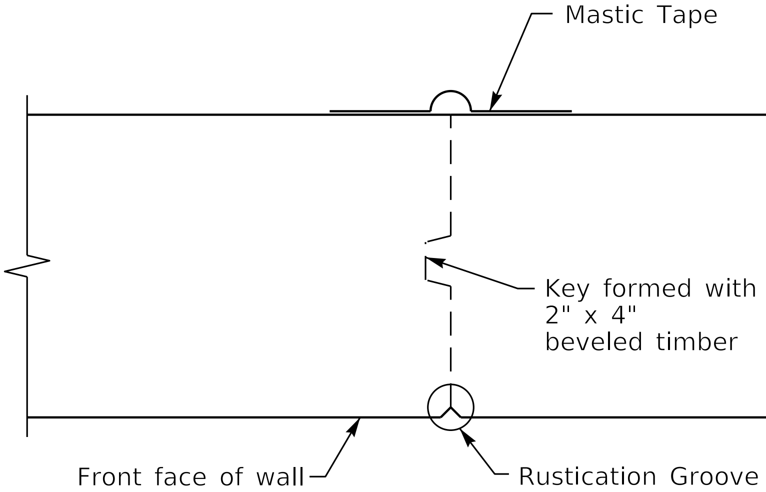
TYPICAL WING ELEVATION

(a.) Remove solid rock to a depth of .042H and width 3BC (However depth will not be required to be more than .75HC)
(b.) Compact selected fine soil to bottom of culvert elevation over the 3BC width
(c.) Construct box culvert.
(d.) Compact selected fine soil to an elevation 4' above top of culvert in layers of 6" or less to meet density requirements specified for adjacent embankment.
(e.) Proceed with normal roadway construction.



CONSTRUCTION SEQUENCE FOR MAKING CULVERT FOUNDATION YIELDING

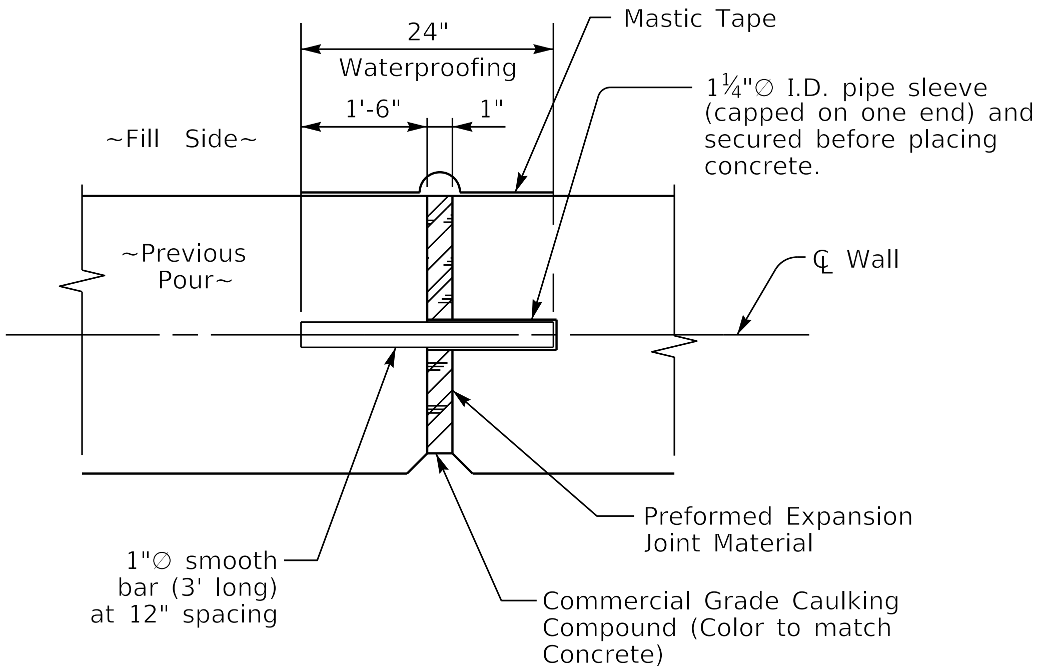
EXHIBIT 516



CONTRACTION JOINT DETAIL

~Spaced at 30' intervals~

Waterproofing Materials consist of Mastic tape. Use 12" width for contraction joints and 24" width for expansion joints.

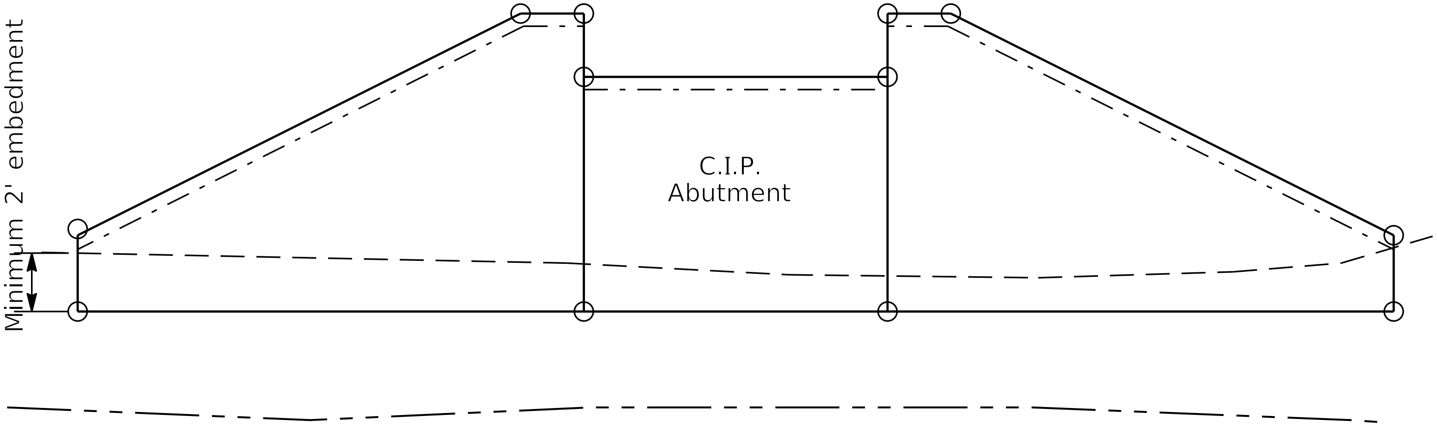


EXPANSION JOINT DETAIL

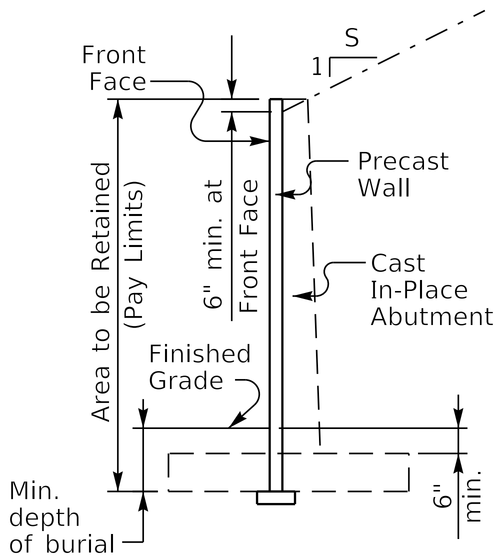
~Spaced at 100' intervals~

All preformed expansion joint material, caulking, waterproofing materials, pipe sleeve, and equipment and labor necessary to complete the joints are incidental to the square foot bid for Retaining Walls.

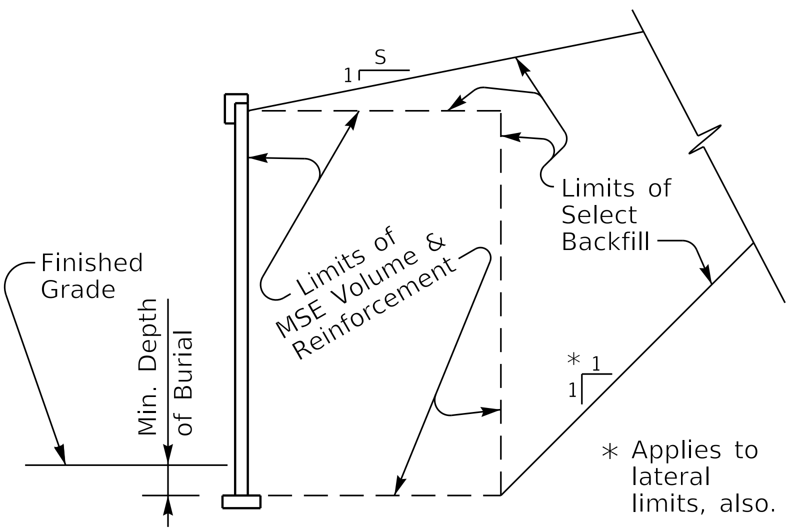
WALL EXPANSION & CONTRACTION JOINT



ELEVATION



TYPICAL SECTION



TYPICAL SECTION
WITH SELECT BACKFILL

~ LEGEND ~

- ○ Points where Station, Elevation, & Offset are given
- ——— Pay Limits of Area to be Retained
- — — — Finished Grade in front of Wall
- — · — Finished Grade behind Wall
- - - - Projected Rock Line

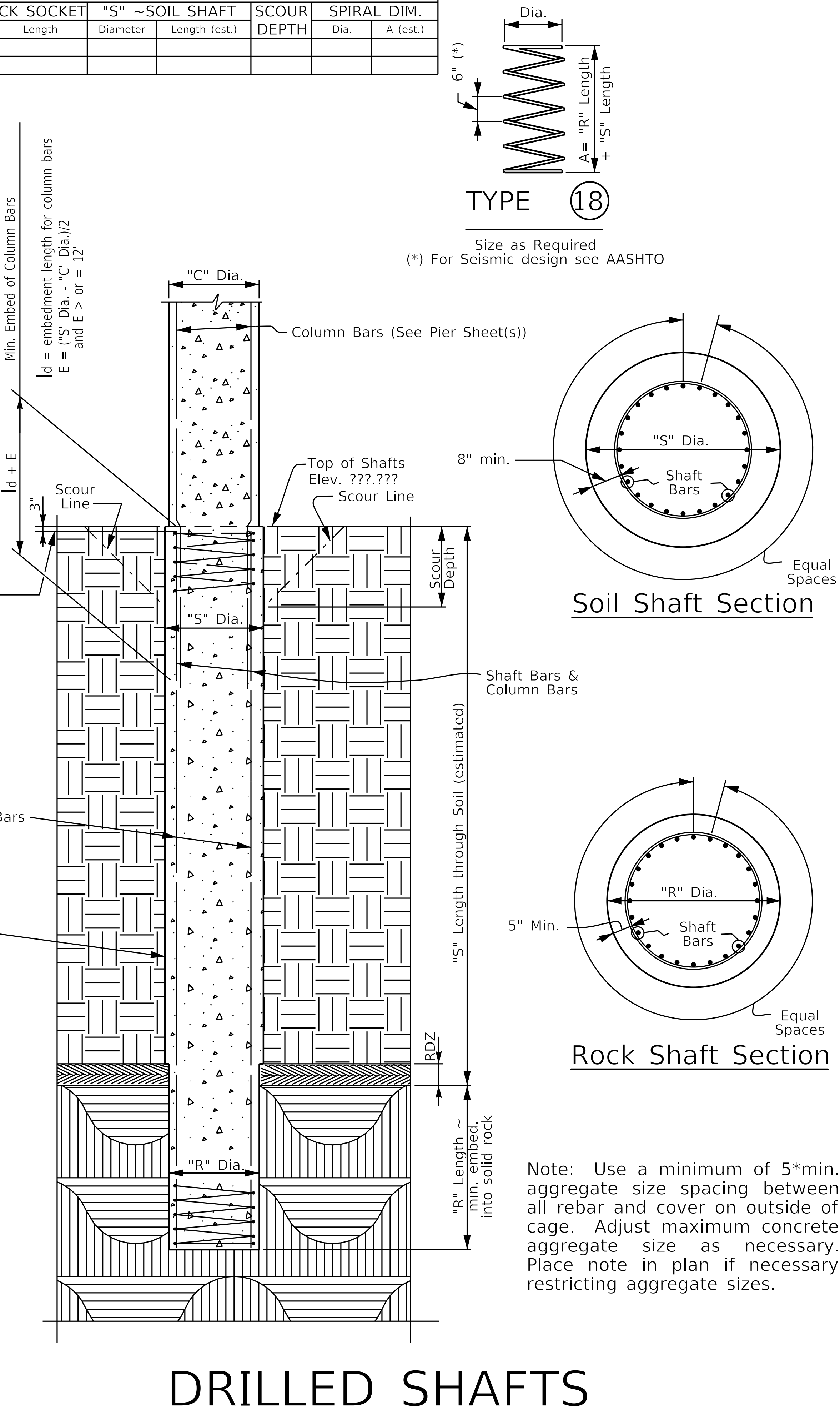
NOTE: MSE Volume extends 12" minimum past ends of MSE Reinforcement.

NOTE: Additional panel area outside pay limits (if Permitted) at no cost to the Department.

MSE WALLS

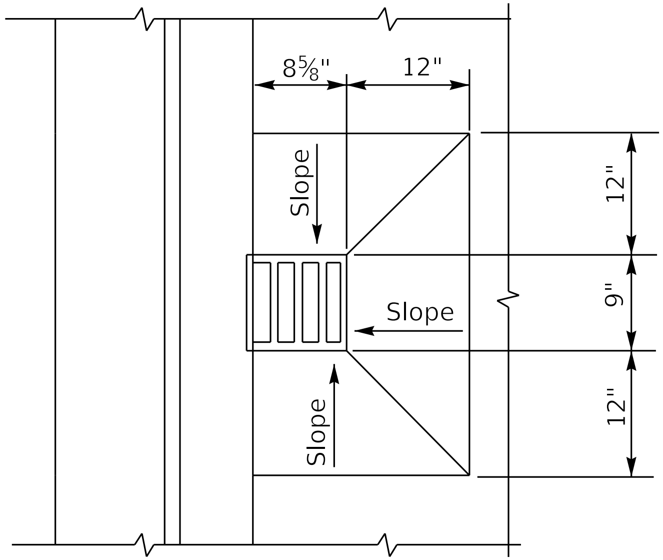
TABLE OF DIMENSIONS

PIER NO.	"R" ~ ROCK SOCKET Diameter	Length	"S" ~SOIL SHAFT Diameter	Length (est.)	SCOUR DEPTH	SPIRAL DIM. Dia.	A (est.)
1							
2							

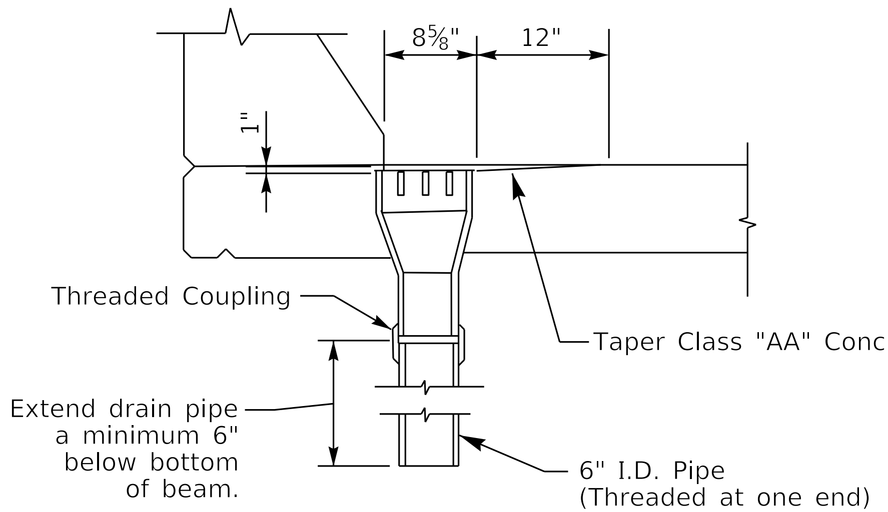


Note: Use a minimum of 5*min. aggregate size spacing between all rebar and cover on outside of cage. Adjust maximum concrete aggregate size as necessary. Place note in plan if necessary restricting aggregate sizes.

DRILLED SHAFTS

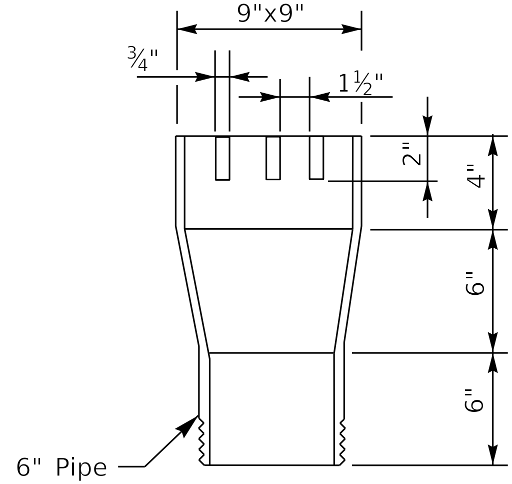


PLAN OF DRAIN



DRAIN SECTION

NOTE:
Drain Pipe and Fittings are 6" I.D., 0.25" minimum wall thickness, wound with fiberglass epoxy resin formulation with ultraviolet inhibitors. Supply the pipe pigmented to match the final color of the structure.



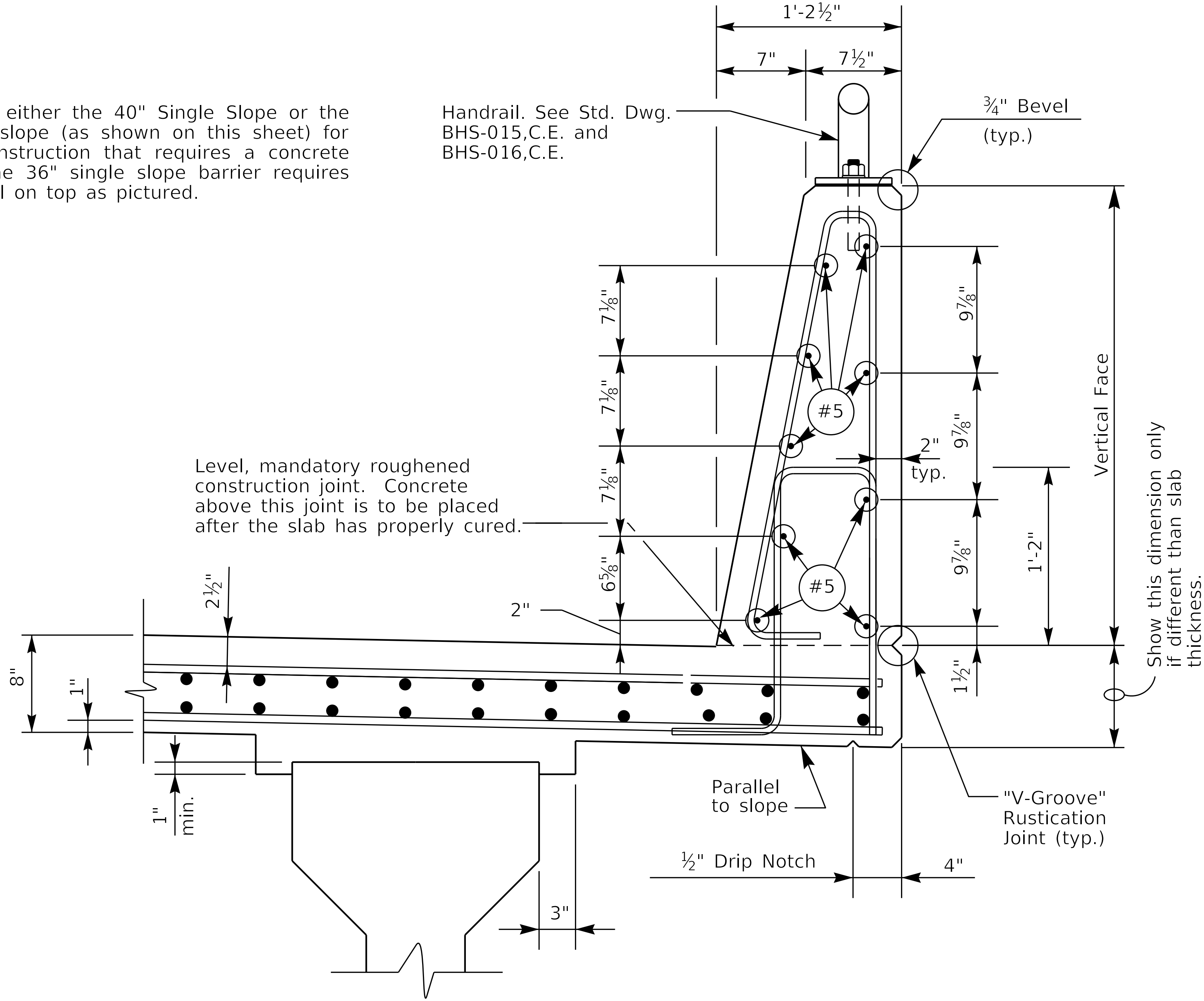
DRAIN CASTING

Weight = 60#

Use Through Deck Drain Details as shown on Standard Drawing BGX-015,C.E. Use these details only with permission from the Director, Division of Structural Design.

STEEL OR CAST IRON DECK DRAINS

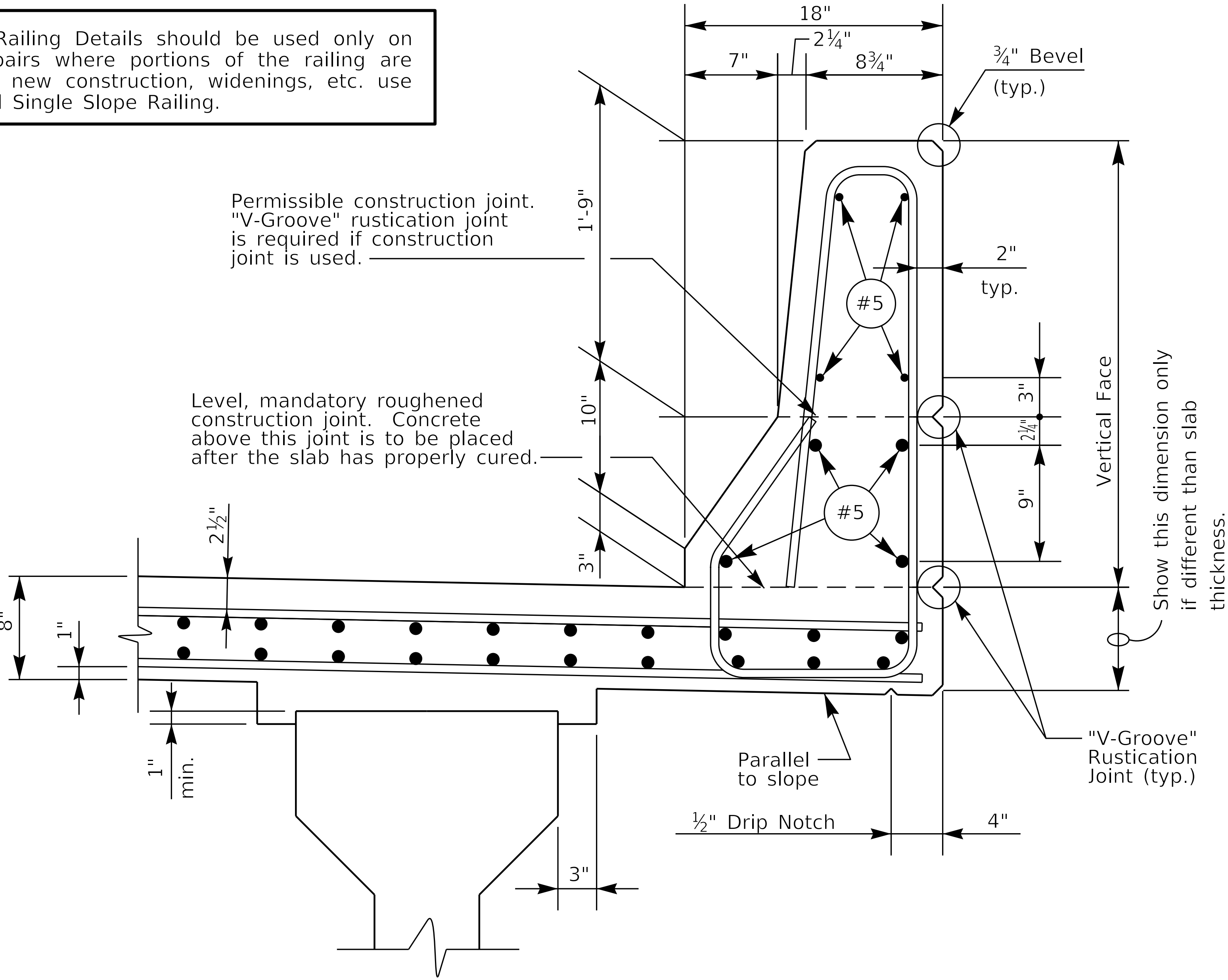
Note: Use either the 40" Single Slope or the 36" single slope (as shown on this sheet) for all new construction that requires a concrete barrier. The 36" single slope barrier requires the handrail on top as pictured.



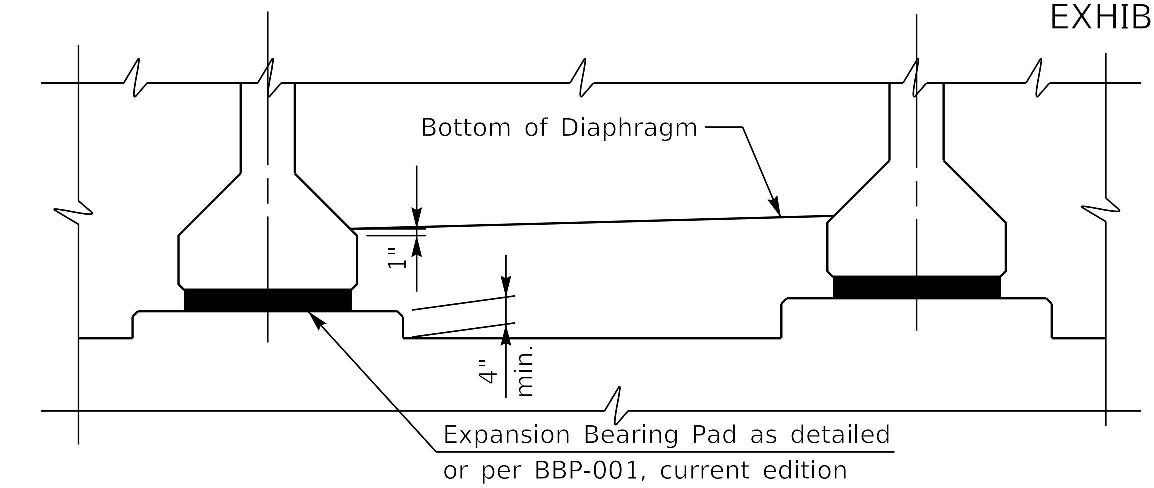
RAILING SYSTEM 36" SINGLE SLOPE & SLAB DETAILS

EXHIBIT 600

Note: Type 3 Railing Details should be used only on Maintenance repairs where portions of the railing are repaired. On all new construction, widenings, etc. use the MASH tested Single Slope Railing.

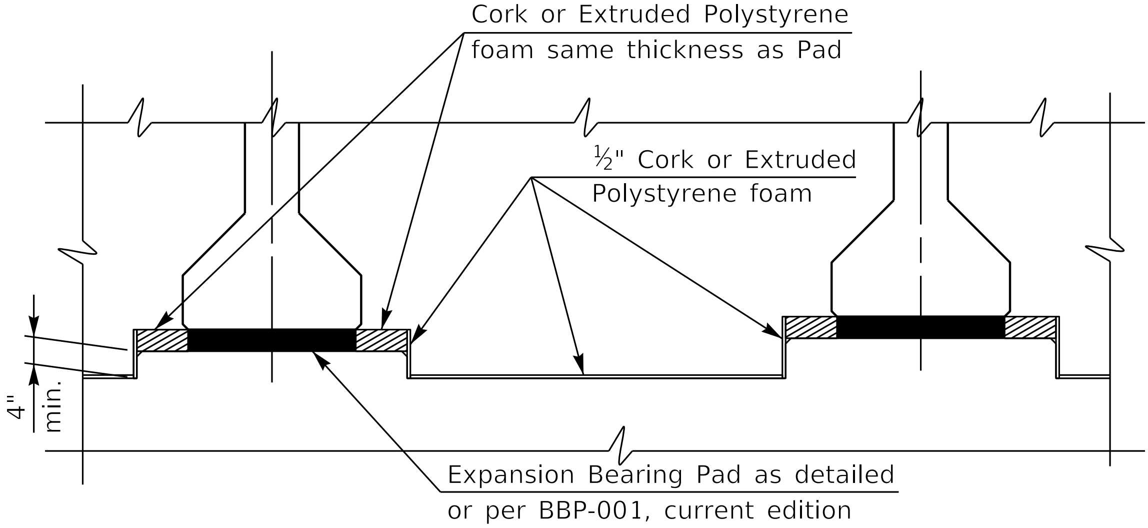


RAILING SYSTEM TYPE 3 & SLAB DETAILS



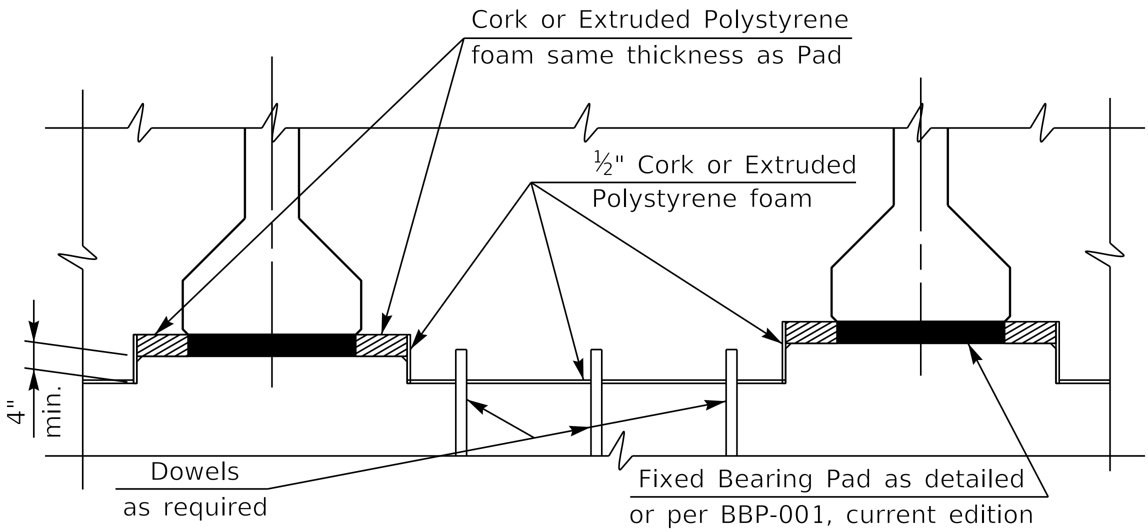
EXPANSION PIER

~With Joint~



EXPANSION PIER

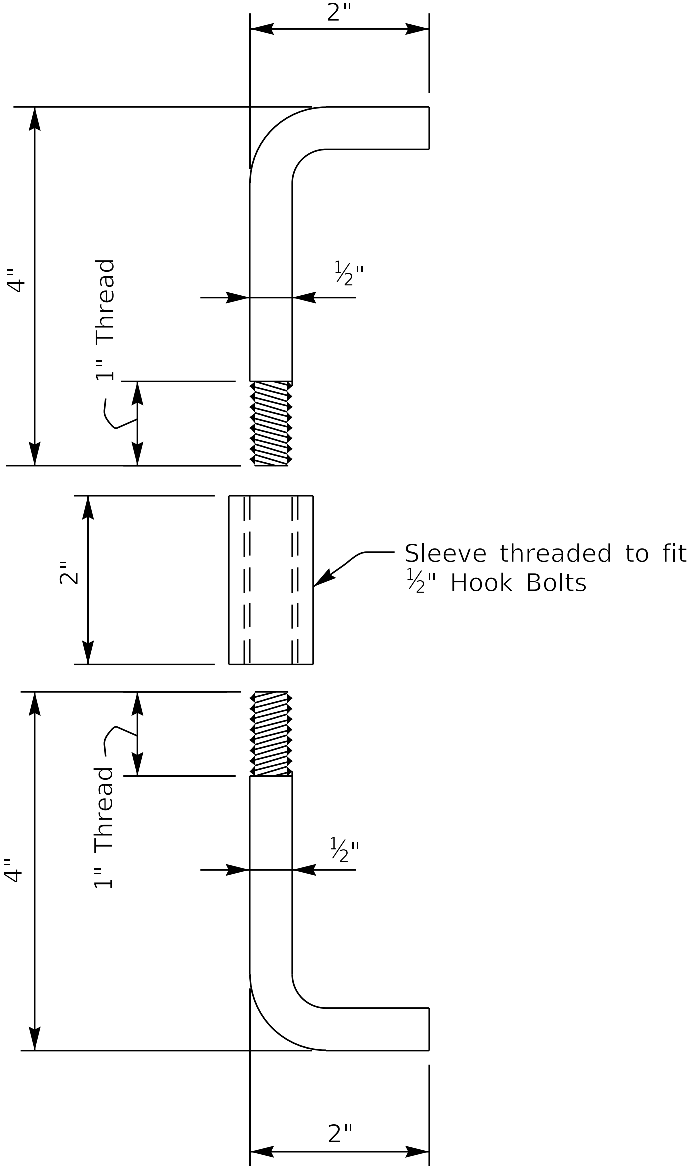
~Without Joint~



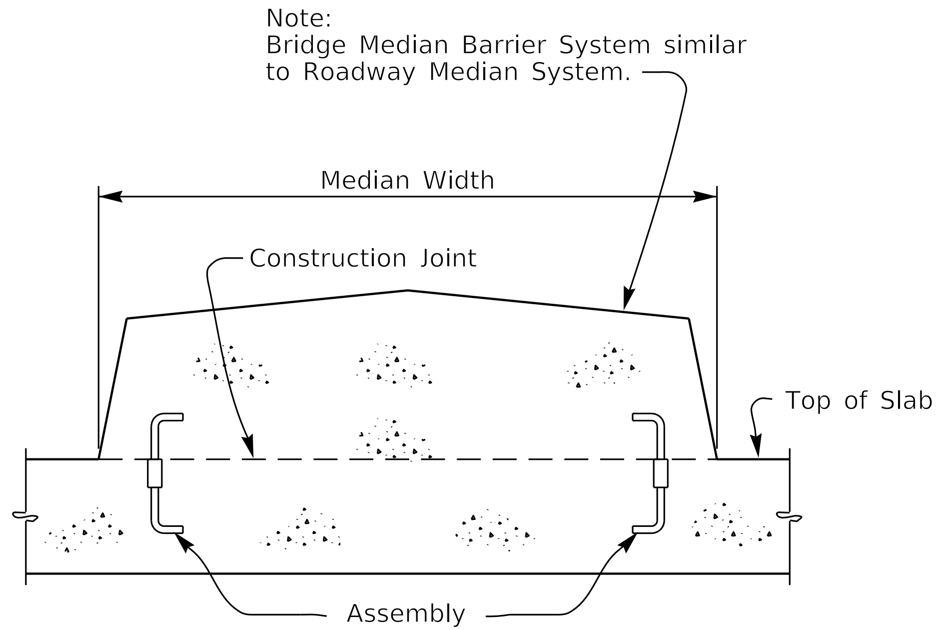
FIXED PIER

PEDESTAL ON PIER CAP

Hook Bolt Assembly requires a minimum tensile strength of 4 kips when assembled as a unit. Both Hook Bolts and Sleeve are made of steel and meet the requirements of ASTM A307.

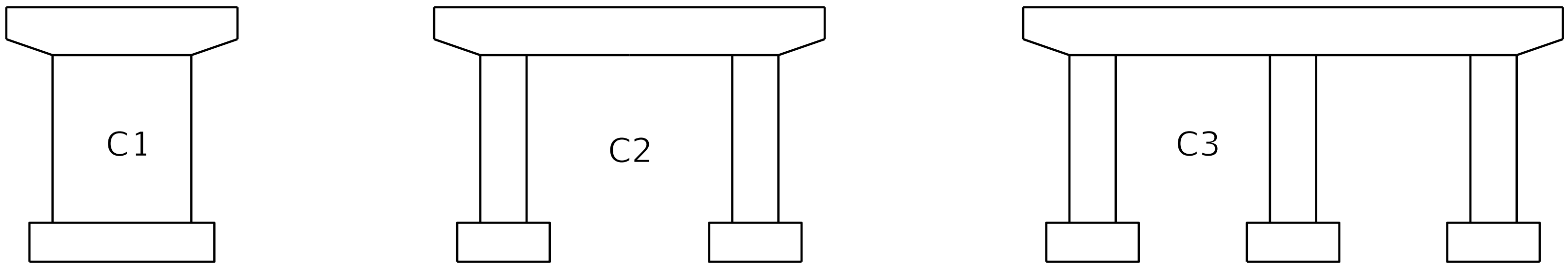


ASSEMBLY DETAIL

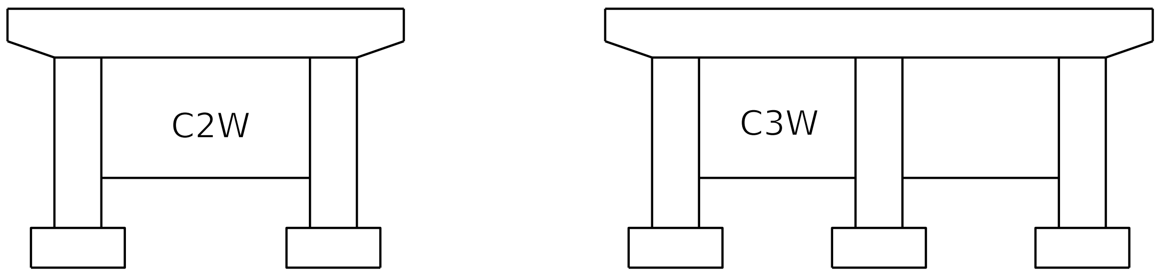


SECTION THROUGH MEDIAN
SHOWING ASSEMBLY IN PLACE

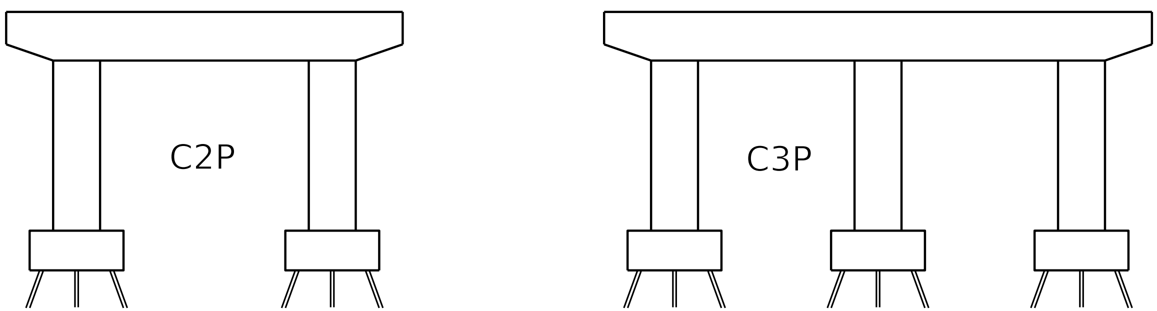
HOOK BOLT ASSEMBLY



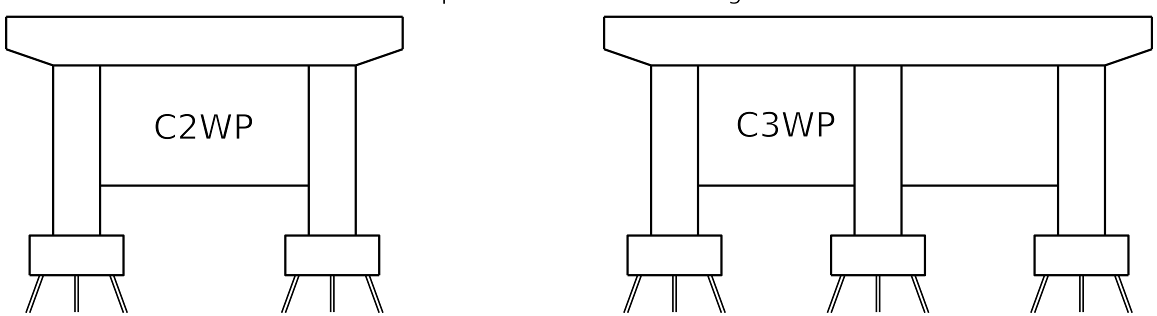
The first character ("C" in this example) Denotes Architectural type.
The second character (2,3,4,5 etc.) Indicates number of Pier columns.



"W" as third character Indicates a webwall between Pier columns.



"P" as third character Indicates piles under Pier footings.

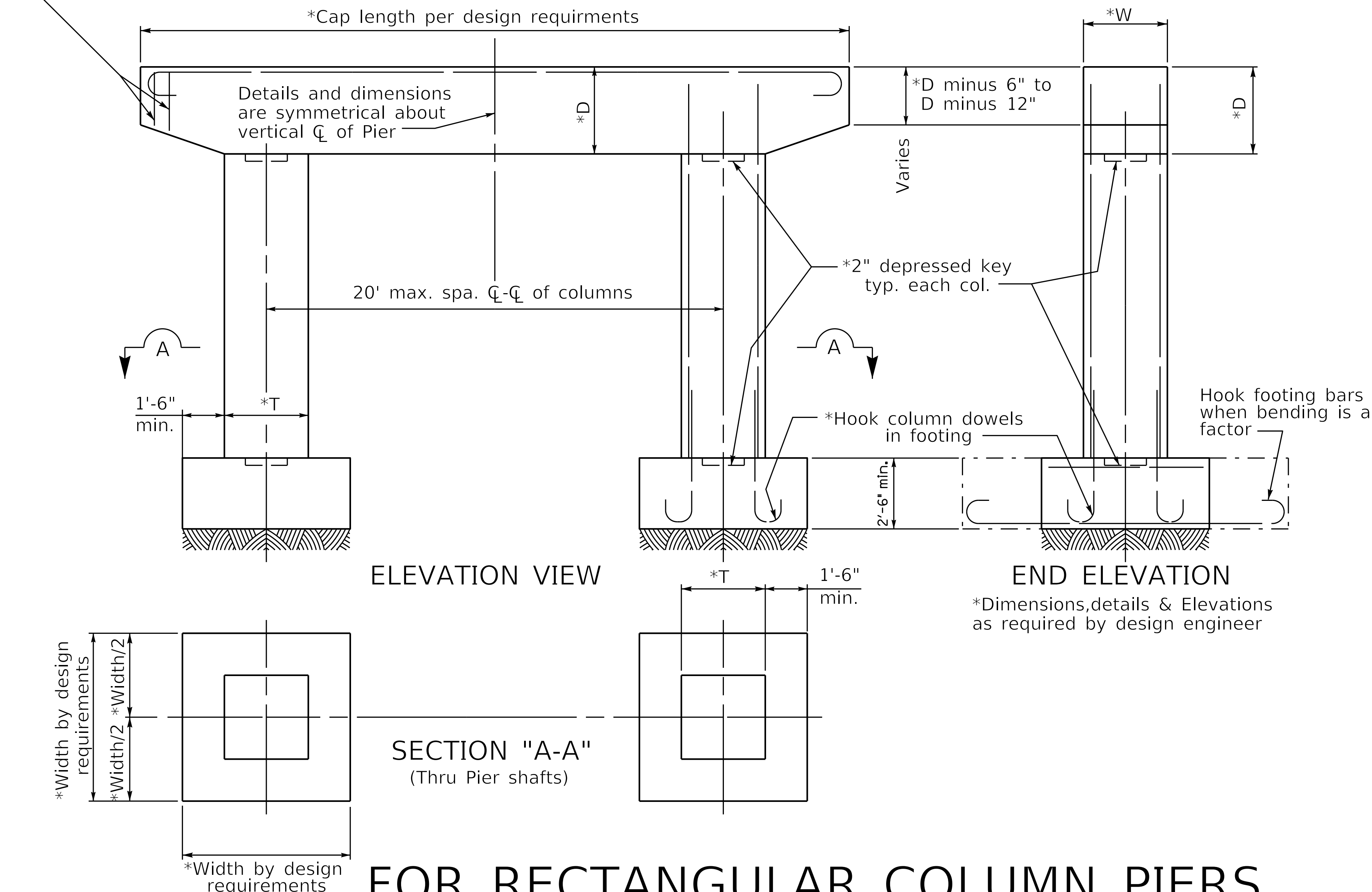


A full four character code word Indicates presence of both webwall and a pile foundation.

METHOD OF CODING BRIDGE PIER TYPES

Provide cap long enough to place at least 2-stirrups between anchor bolts of exterior girder bearing and end of cap.

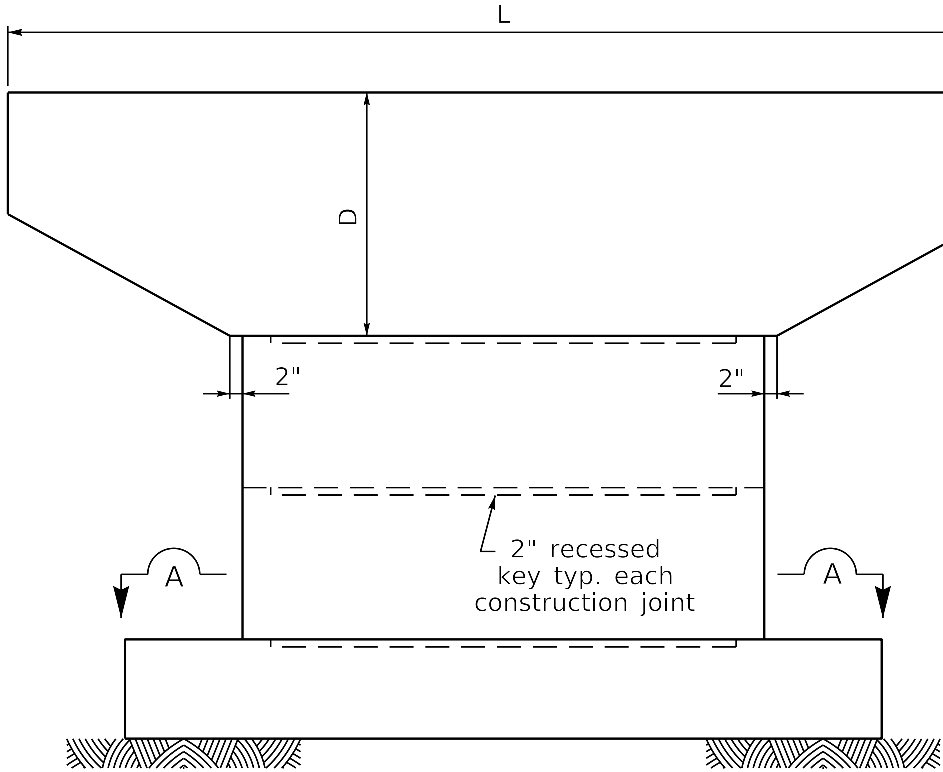
W varies between limits of 3' and 5'
D varies from W to W+12" but not more than 5'
T varies from D minus 6" to D but in no case less than W



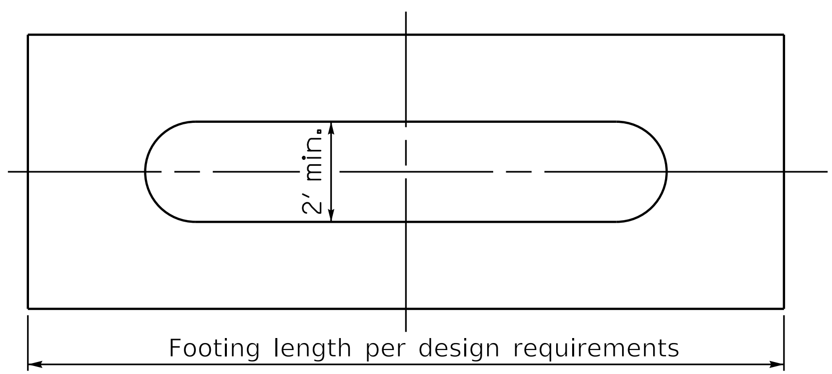
*Dimensions,details & Elevations as required by design engineer

FOR RECTANGULAR COLUMN PIERS

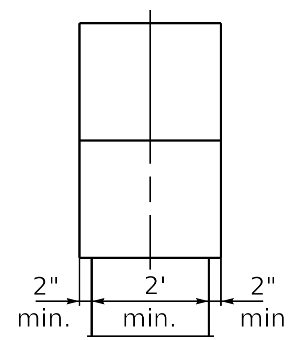
TYPE "C" PIER



ELEVATION TYPE "C1" PIER



SECTION "A-A"

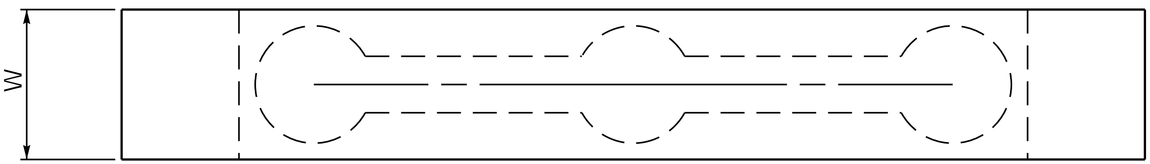


MINIMUM SHAFT
DETAIL

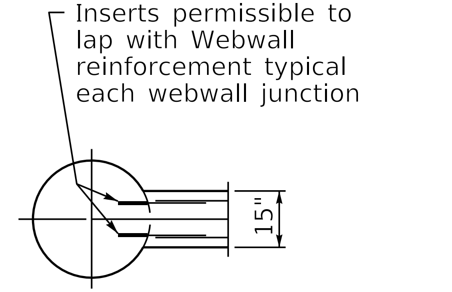
HAMMERHEAD PIER

TYPE "C1" PIER

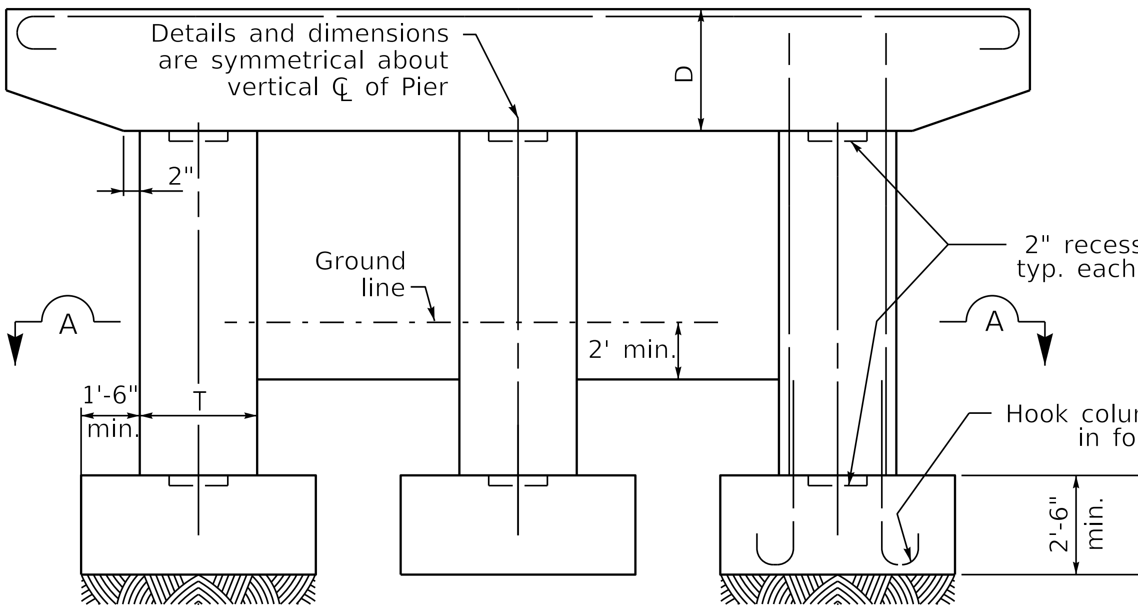
W varies between limits of 3' and 5'
D varies from W to W+12" but not more than 5'
T varies from D minus 6" to D but in no case less than W



PLAN OF CAP

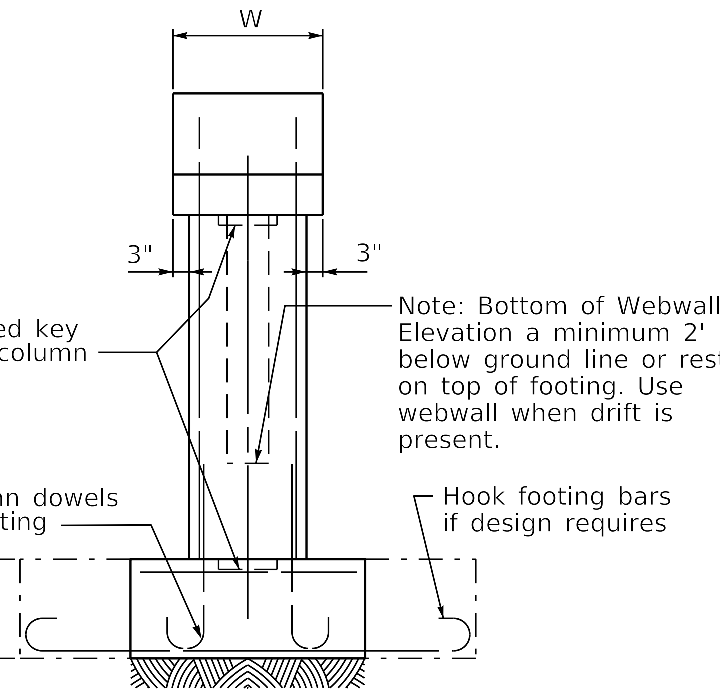


SHAFT-WEBWALL INSERT DETAIL



T= 3' minimum with 6" increments

ELEVATION

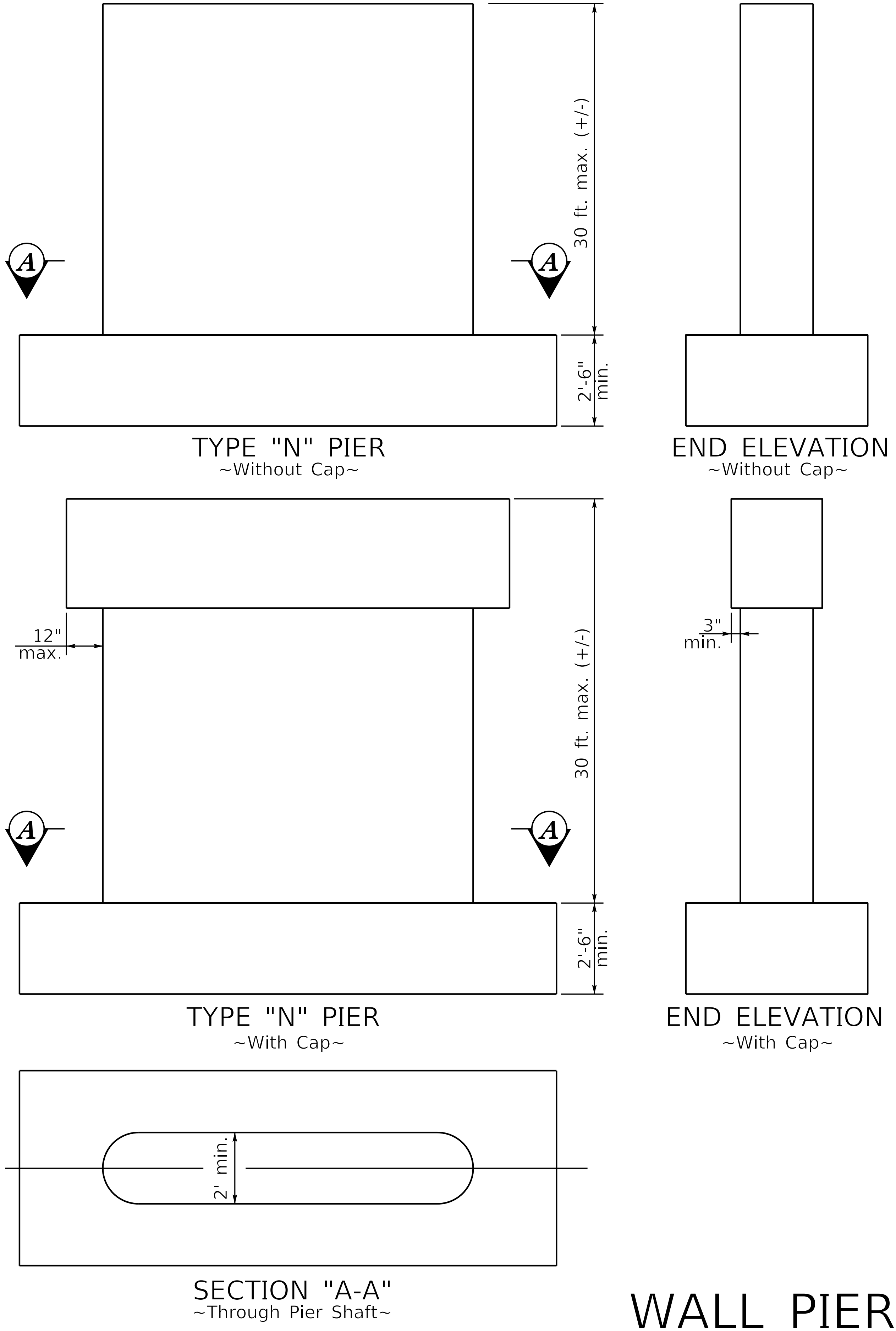


END ELEVATION

FOR CIRCULAR COLUMN PIERS

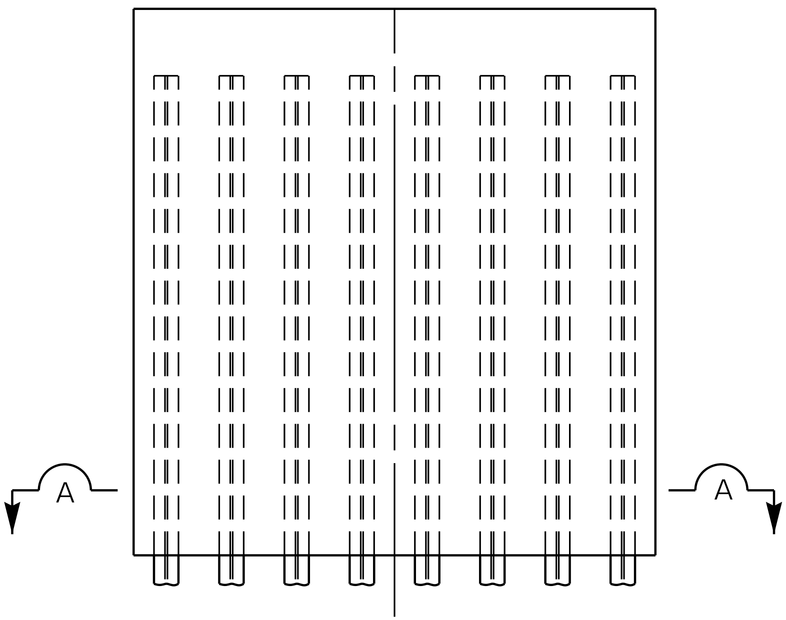
TYPE "L" PIER

EXHIBIT 610

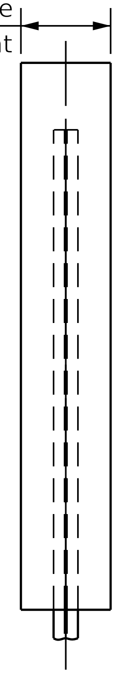


WALL PIER

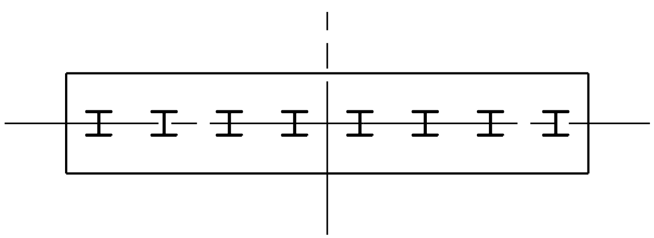
TYPE "N" PIER



ELEVATION



END ELEVATION



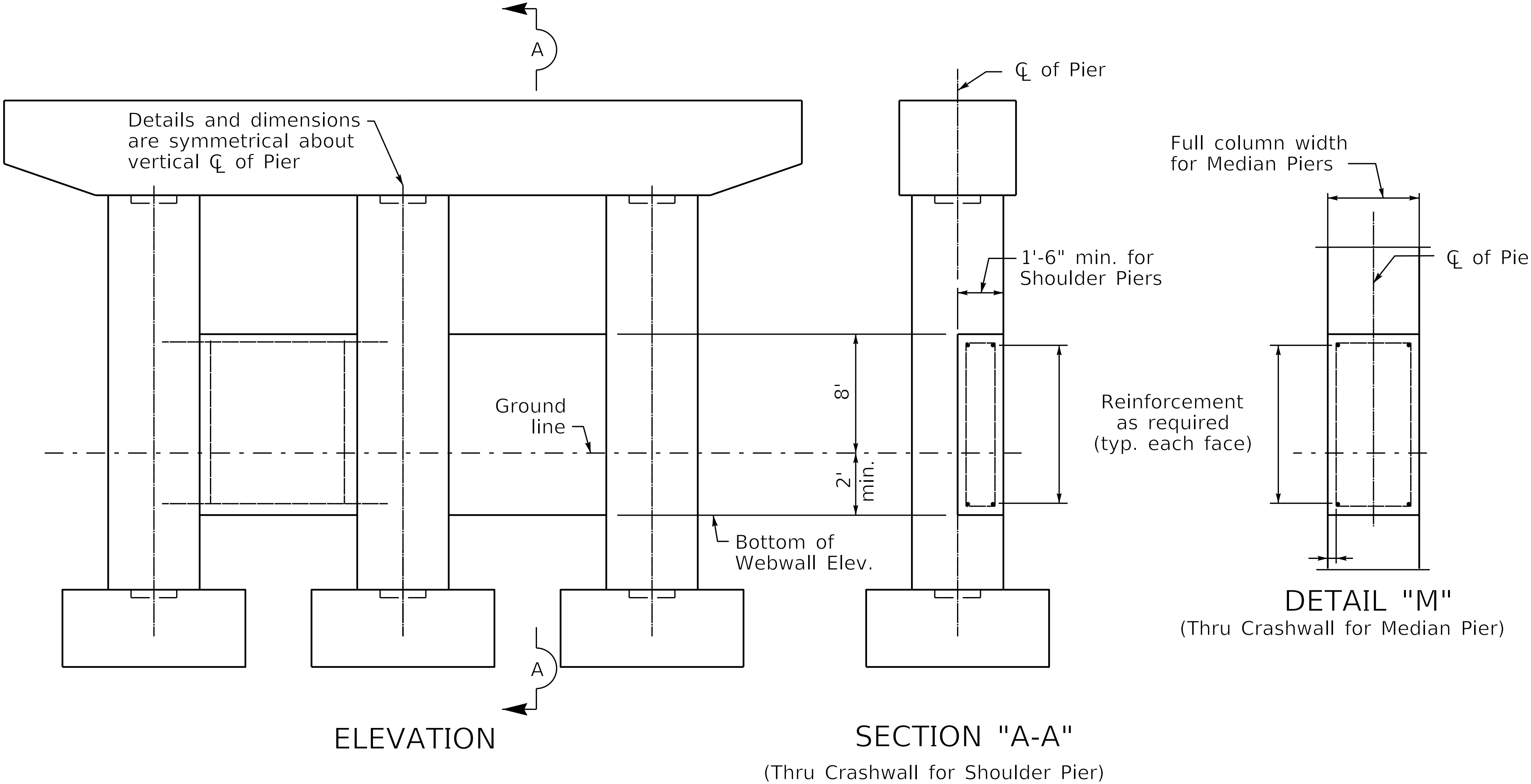
SECTION "A-A"

NOTE: Piles shown are for illustration only.
Use piles of type, spacing, and orientation
as required for design.

Use only with approval from
the Division of Structural Design.

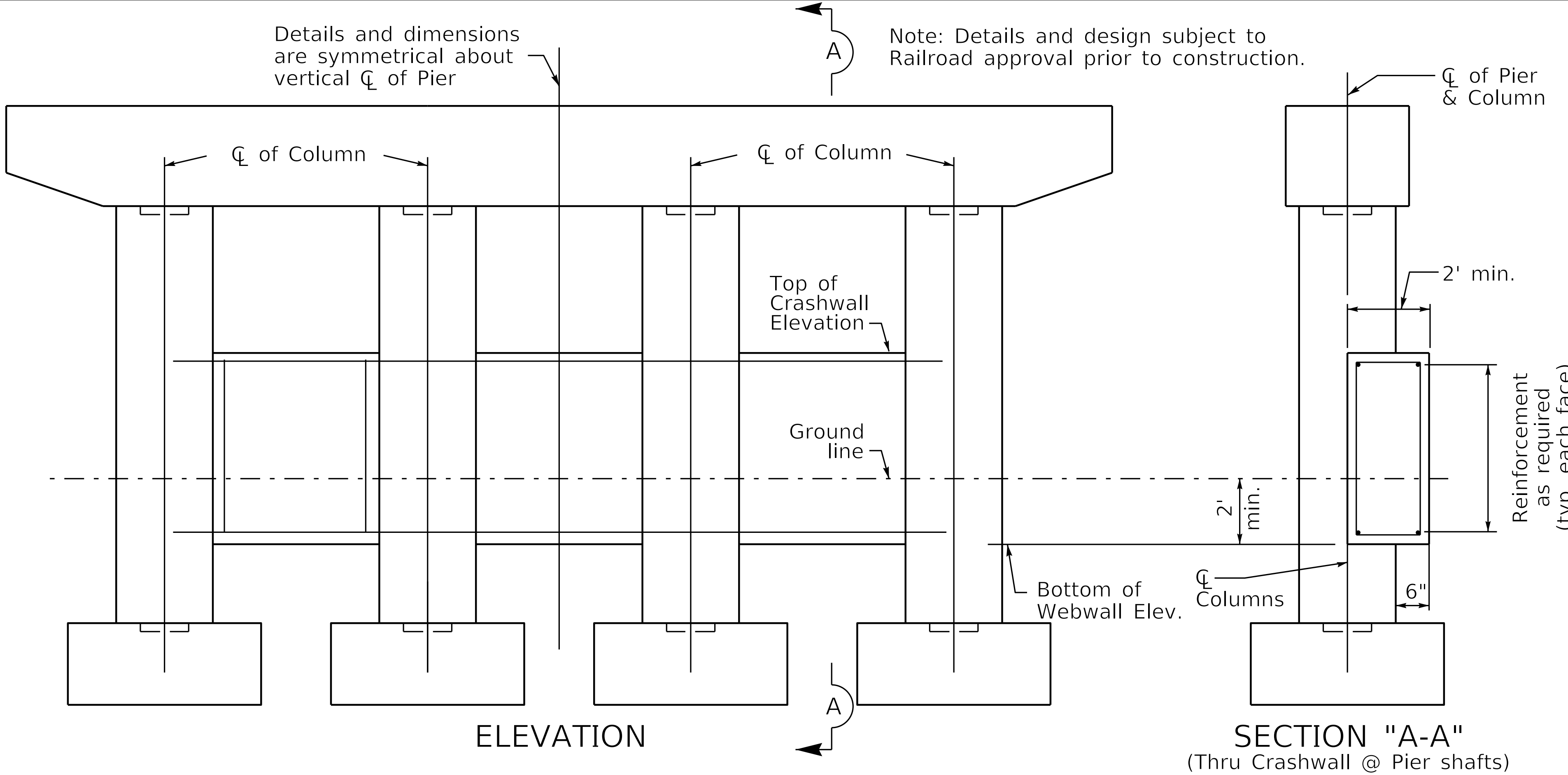
INTERMEDIATE PILE BENT

TYPE "W" PIER



Note: Bottom of Webwall Elevation a minimum 2' below ground line or rest on top of footing.

PIER CRASHWALL - HIGHWAY



Note: Bottom of Webwall Elevation a minimum 2' below ground line or rest on top of footing.

AREMA MANUAL FOR RAILWAY ENGINEERING

2.1.5 PIER PROTECTION

Piers supporting bridges over railways and located within 25' of the centerline of a railroad track shall be of heavy construction or shall be protected by a reinforced concrete crash wall extending to not less than 6' above top of rail. When two or more light columns compose a pier, a wall at least 2' thick shall connect the columns. When a pier consists of a single column, it shall be protected by a crash wall parallel to track. The wall shall be at least 2'-6" thick and extend for a distance of at least 6' from both sides of column. The face of crash walls shall extend a distance of at least 6" beyond the face of column on the side adjacent to the track and shall be anchored to the columns and footings with adequate reinforcement.

PIER CRASHWALL - RAILROAD

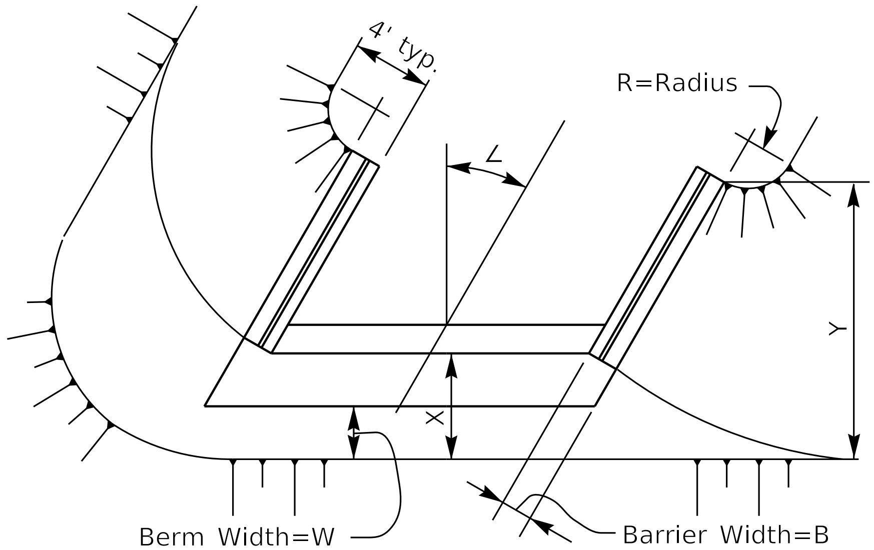


FIGURE 3

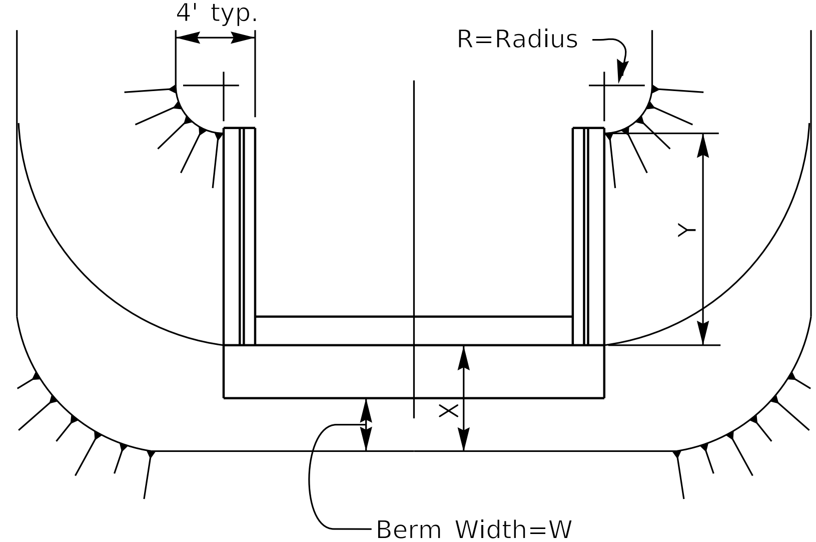


FIGURE 2

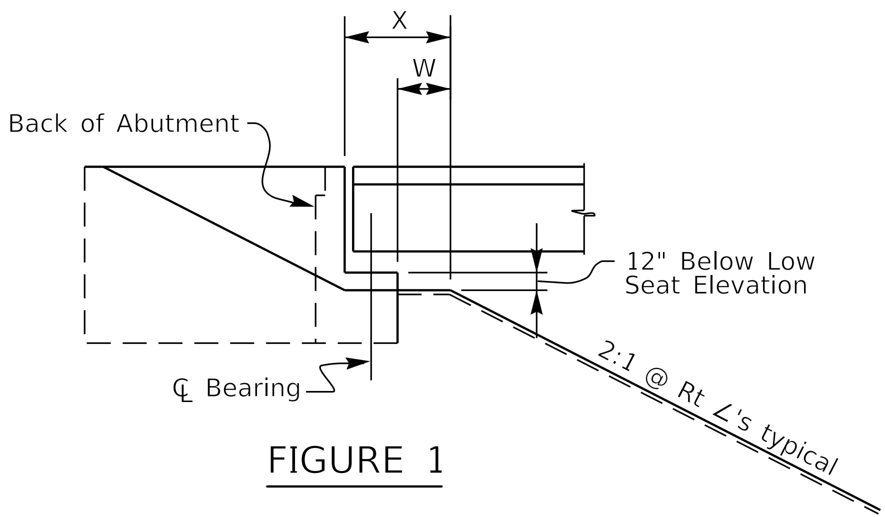
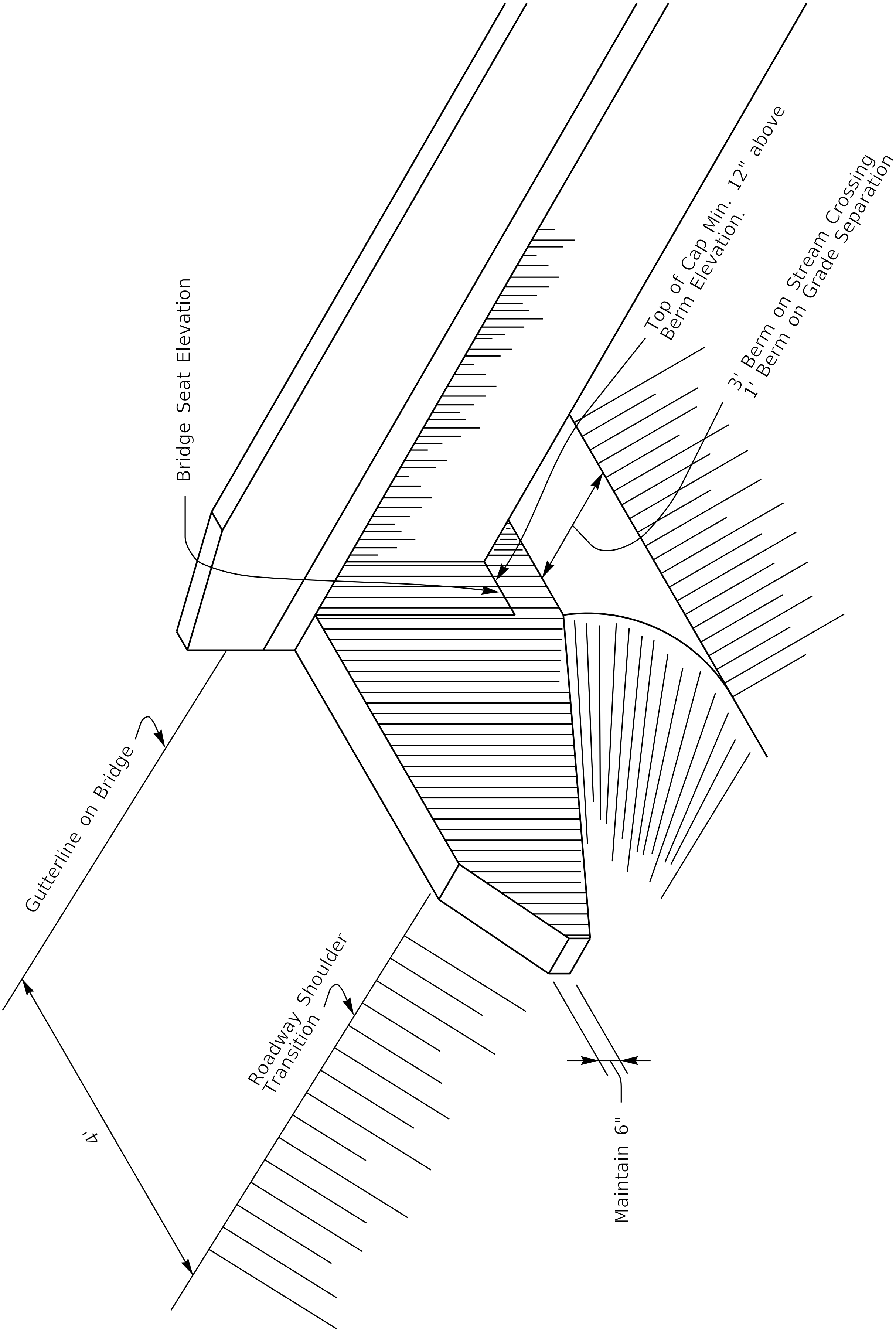


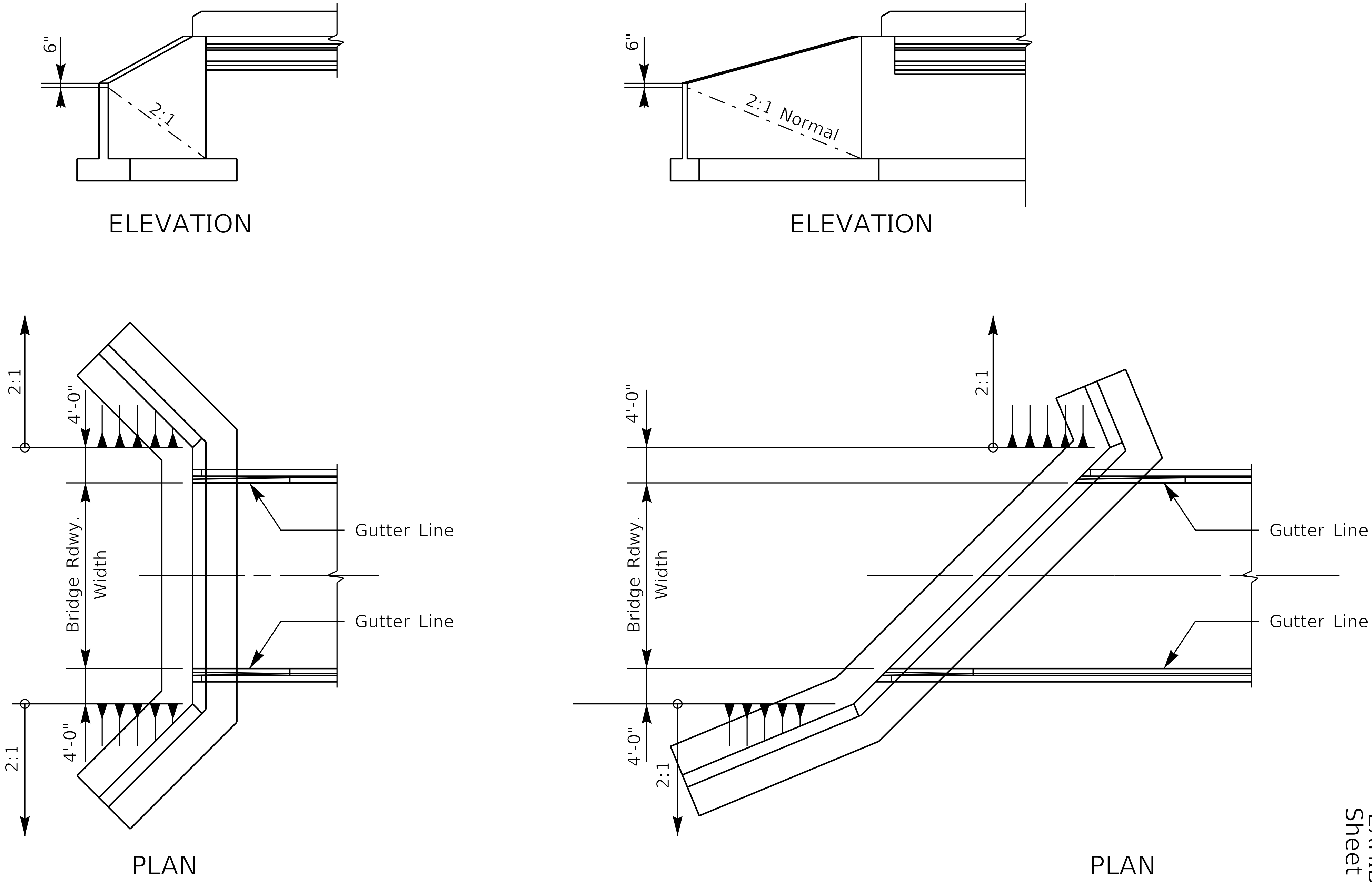
FIGURE 1

X = W + width of Bridge Seat
Y = 2*[Difference between Shoulder Elevation and Berm Elevation] (for 2:1 slope)
W = 3'on Stream Crossing Structures
W = 1'on Grade Separation Structures

BERM WIDTH DETAILS



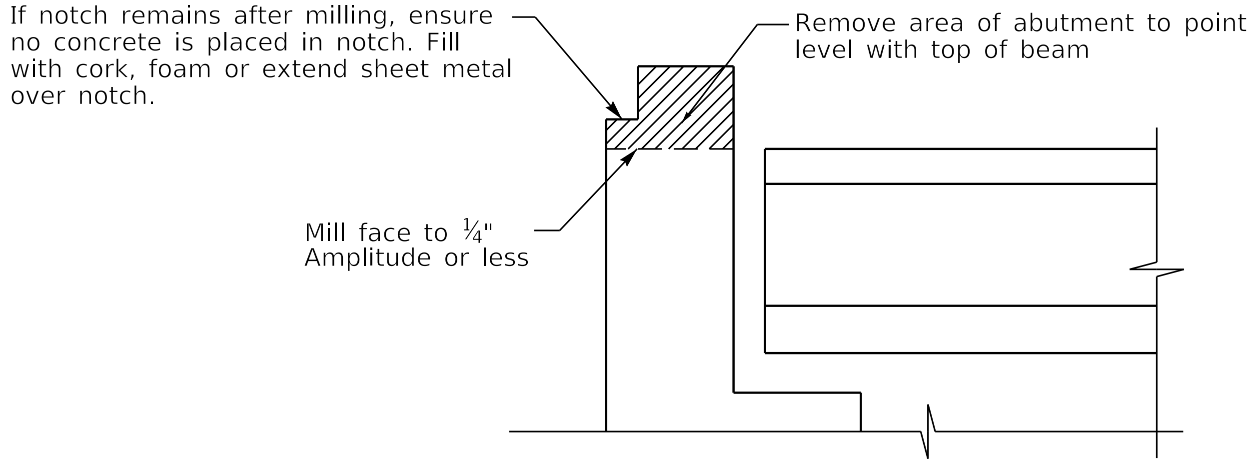
BERM WIDTH DETAILS



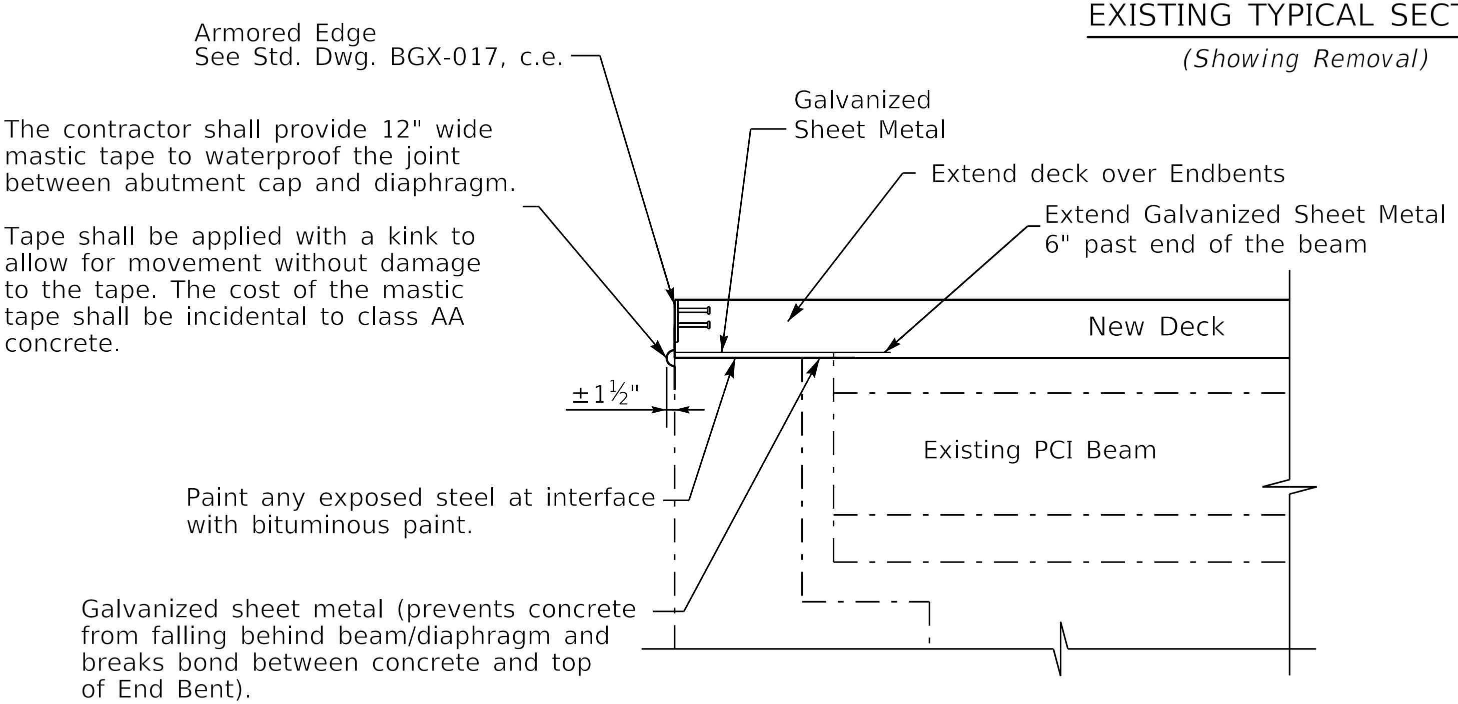
BERM WIDTH DETAILS

JOINT ELIMINATION AT ENDS OF BRIDGE

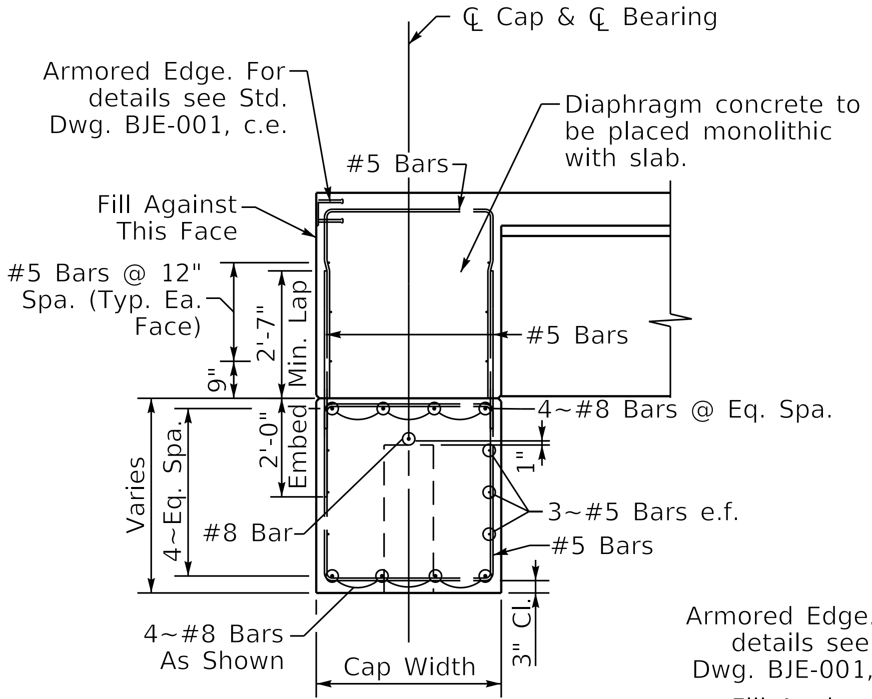
Note:
Ensure that gap between diaphragm and back wall is free of any debris.



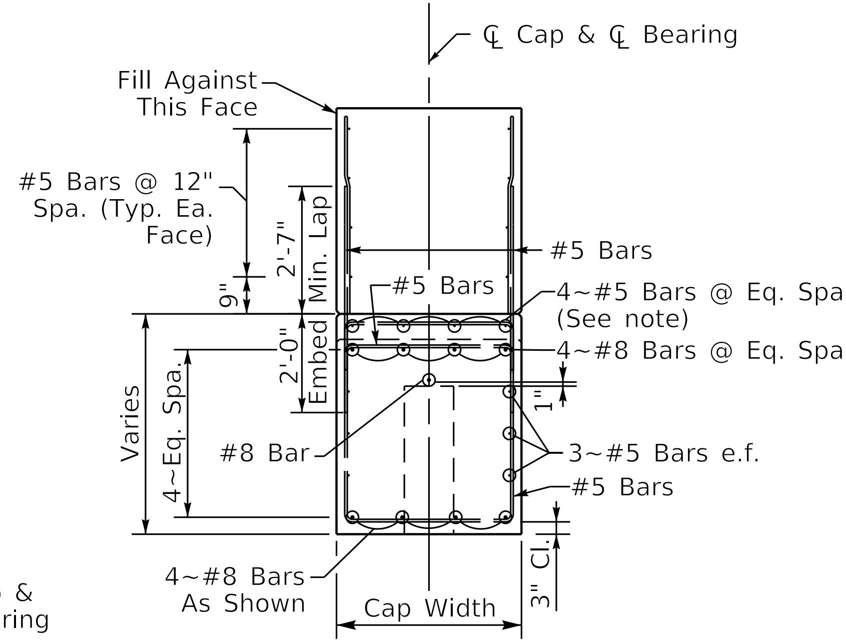
EXISTING TYPICAL SECTION
(Showing Removal)



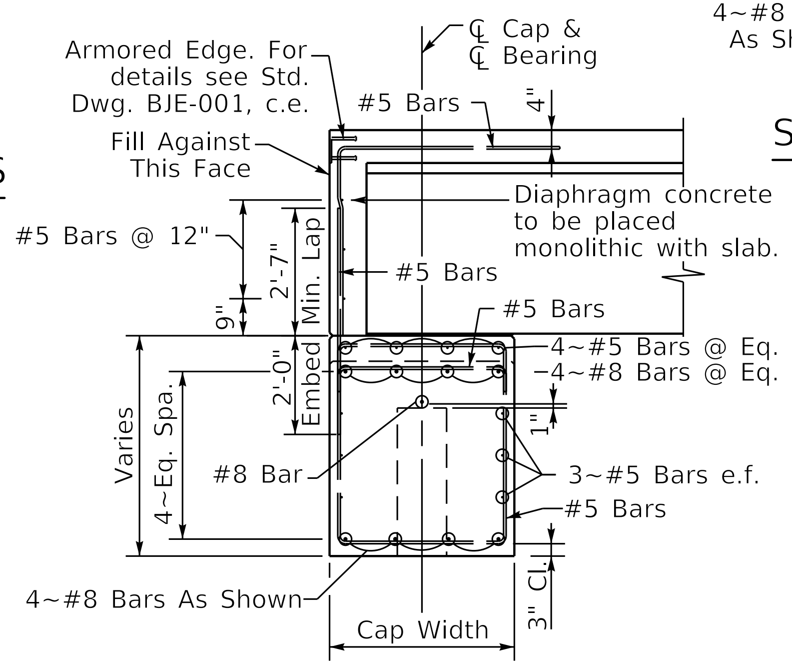
PROPOSED TYPICAL SECTION
(Showing Proposed)



SECTION BETWEEN BEAMS



SECTION THRU WING



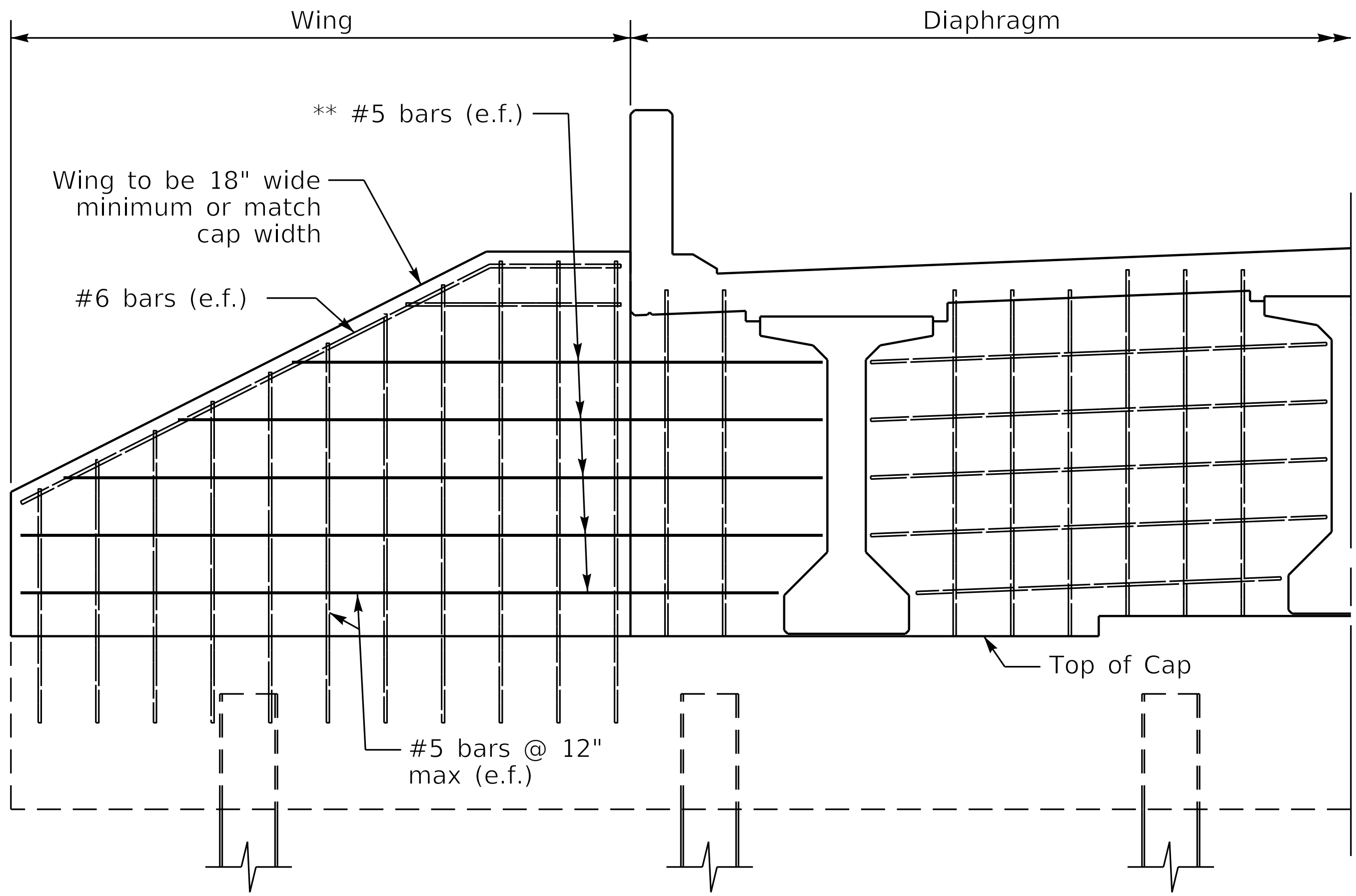
SECTION THRU BEAM

NOTE:
When beam seat elevations are 6"or greater a reinforced cap step is required. Place #5 bars below each reinforced step as shown.

NOTE:
Minimum steel shown for 3' wide cap. Increase number of bars, sizes, etc. for actual design. Maintain 12" maximum spacing for all steel. The Department reserves the right to require changes as necessary to meet current policy. Obtain current policy before beginning design.

INTEGRAL END BENT SECTIONS

** These bars along the front face should protrude into the diaphragm as shown. Bars along the back face should extend behind the beams across the full length of the diaphragm and wings.



INTEGRAL END BENT ELEVATION

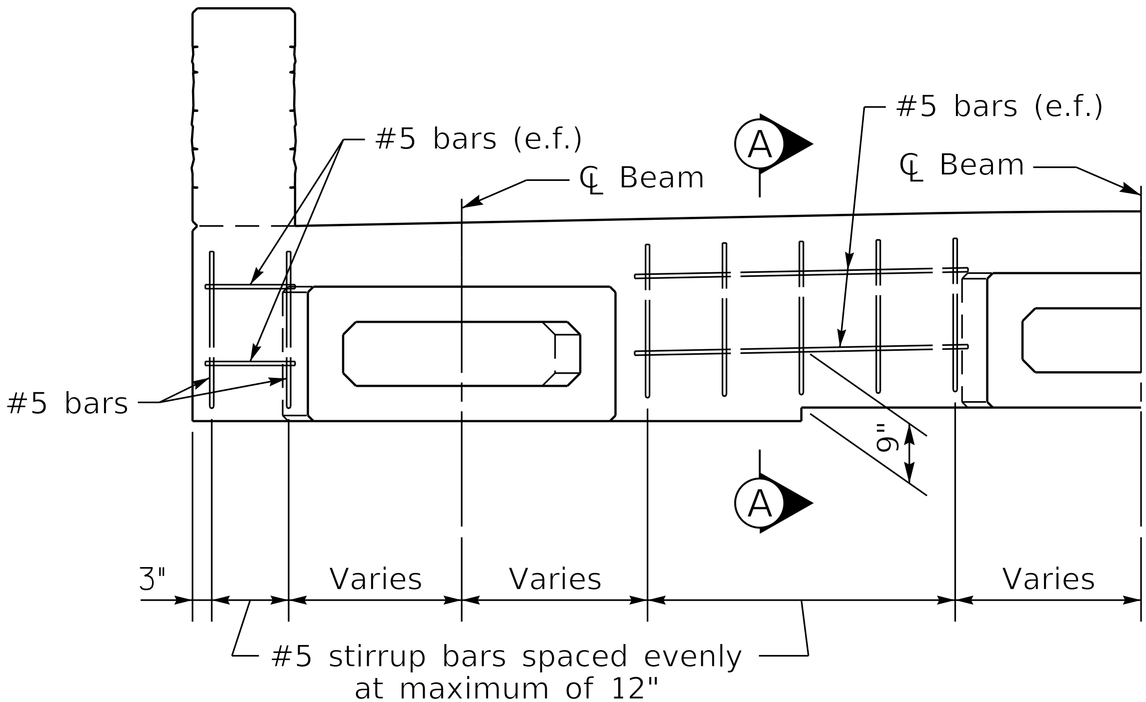
ABUTMENT DIAPHRAGMS

NOTES:

1.) Diaphragm stirrups are to project into the slab regardless of slab forming method.

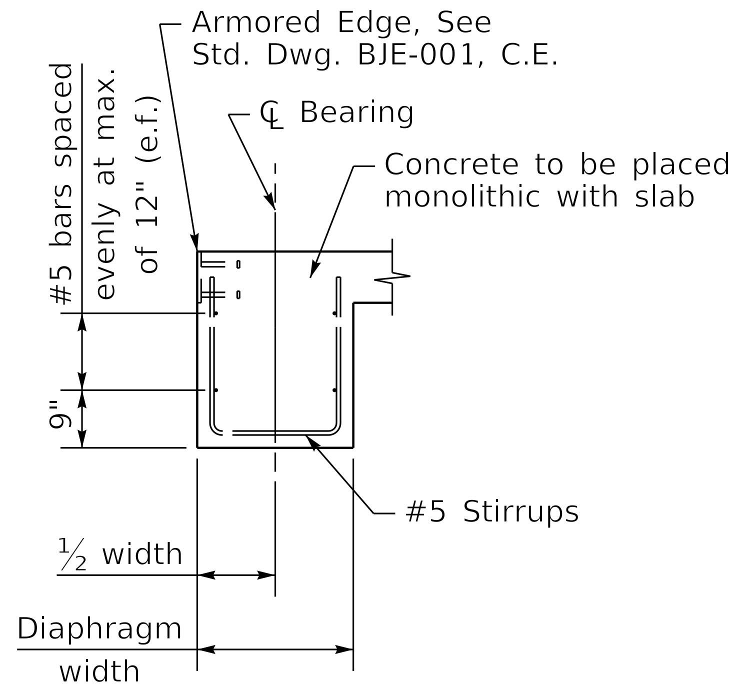
2.) Place stirrup bars parallel to face of beams.

3.) #5 bars in backface should be a single bar the full length of the diaphragm.



ABUTMENT DIAPHRAGM

~Measured along face of diaphragm~



SECTION A-A

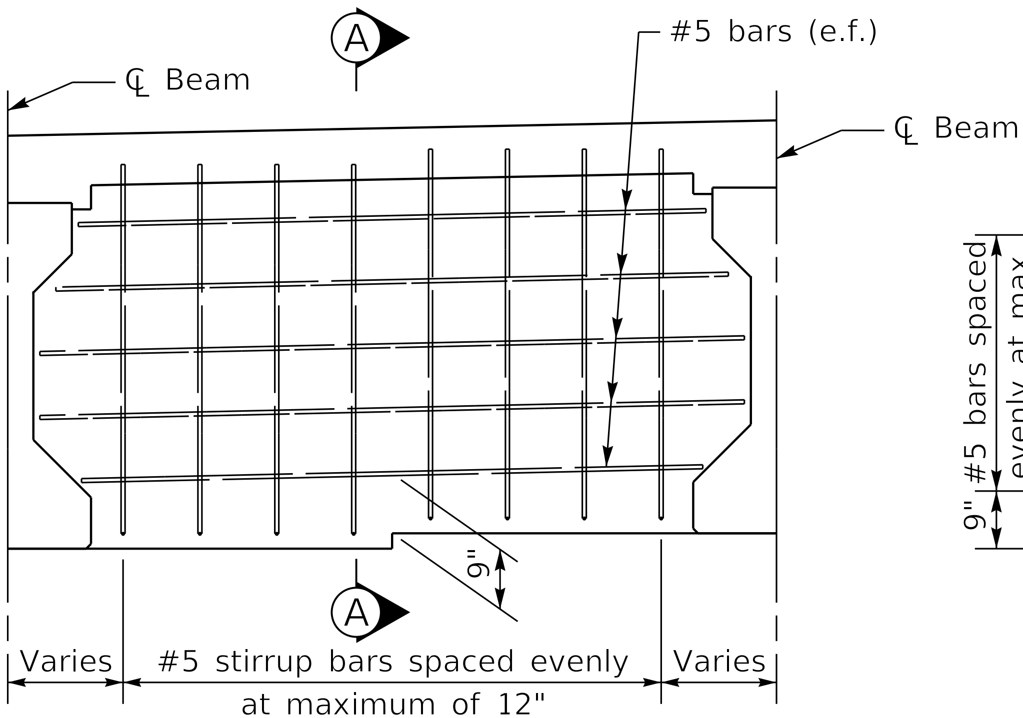
~Measured parallel to beams~

PIER DIAPHRAGMS

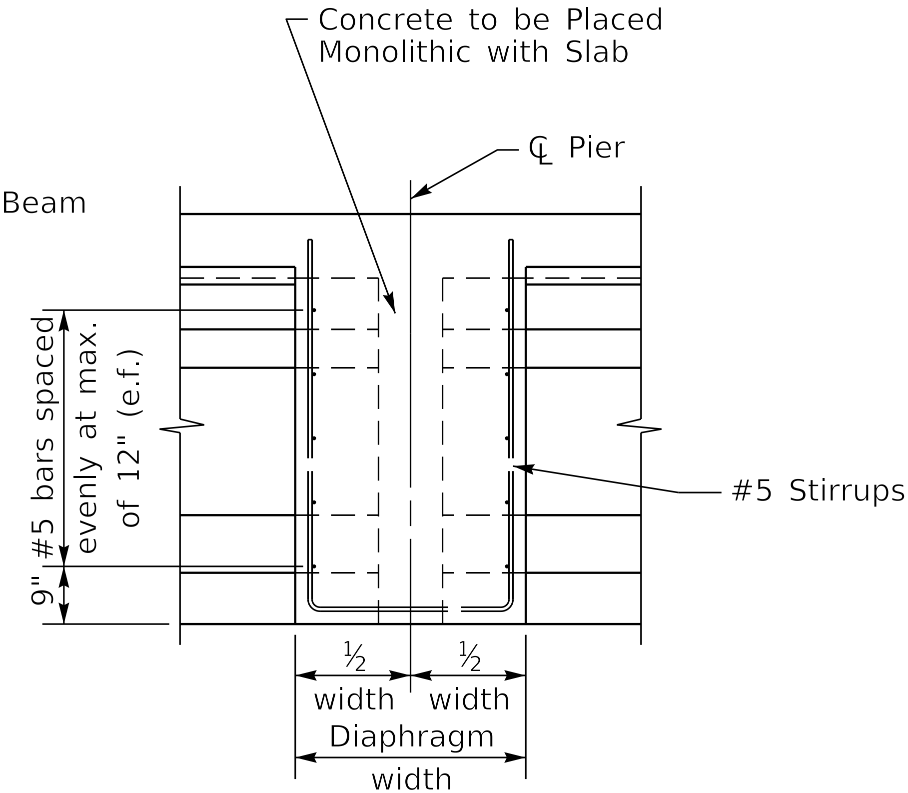
NOTES:

1.) Diaphragm stirrups are to project into the slab regardless of slab forming method.

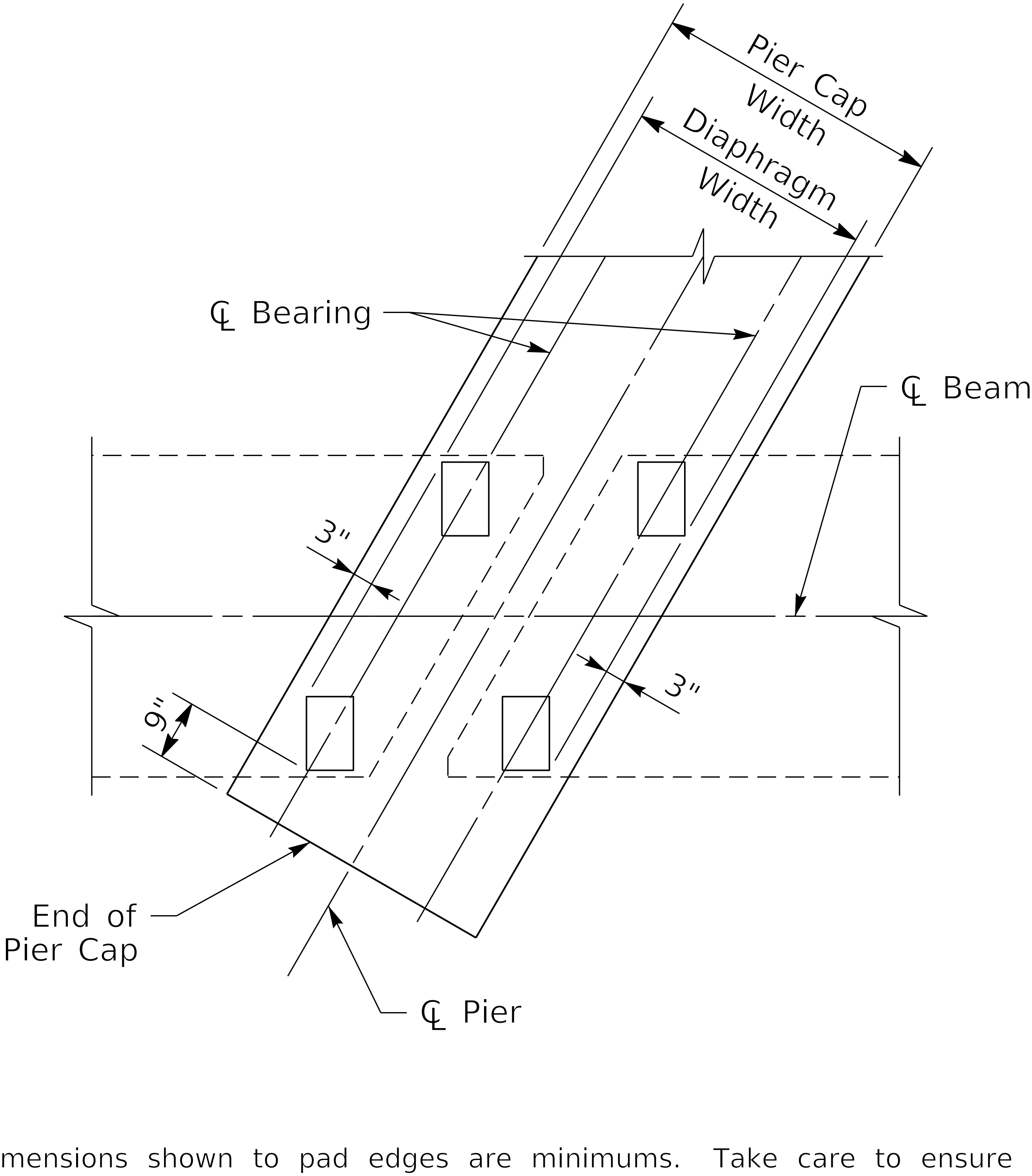
2.) Place stirrup bars parallel to face of beams.



PIER DIAPHRAGM DETAIL



SECTION A-A



Dimensions shown to pad edges are minimums. Take care to ensure beams are not overhanging pier caps excessively when single pads are used under beams with large bottom flange widths. The Division of Structural Design reserves the right to require larger dimensions than those shown

BEARING TO FACE MINIMUMS