SECTION 601 ¾ CONCRETE

601.01 DESCRIPTION. Use concrete consisting of a mixture of cement, fine aggregate, coarse aggregate, and water, with admixtures as specified, combined in the proportions and mixed to the consistency specified, when forming or casting to dimensions specified in the Plans or as the Engineer directs. Provide the materials, material proportions, equipment, and construction methods necessary to ensure that the concrete produced conforms to the Contract. Structural concrete is concrete for structures such as bridges, culverts, and retaining walls. Non-structural concrete is concrete for non-structural items such as sidewalks, entrances, curb and gutter, and roadway median barrier.

601.02 MATERIALS AND EQUIPMENT.

601.02.01 Steel Reinforcement. Conform to Section 811.

601.02.02 Cement. Conform to Section 801. Use Type I cement. The Department will allow the use of Type IA, Type IP, Type IPA, Type IS, Type I(SM), Type II, Type IIA, and Type III when the Engineer approves. The Engineer will condition his approval upon satisfactory means of storage and handling to ensure the ready identification of these cements when used in portions of the work. If unsatisfactory test results are obtained using Types IA, IP, IPA, IS, I(SM), II, IIA, or III cement, complete the work using Type I cement. Do not intermix cement types in any structural unit.

601.02.03 Admixtures. Conform to Section 802. Use air-entraining and water reducing admixtures in all classes of concrete. Water reducing admixtures are not required when slip forming is used for concrete placement. Use other admixtures when the Engineer directs or approves.

601.02.04 Water. Conform to Section 803.

601.02.05 Fine Aggregate. Conform to Section 804.

601.02.06 Coarse Aggregate. Conform to Section 805.

601.02.07 Joint Materials. Conform to Section 807.

601.02.08 Structural Steel. Conform to Section 812.

601.02.09 Miscellaneous Metals. Conform to Section 813.

601.02.10 Concrete Curing Materials. Conform to Section 823.

601.02.11 Masonry Coating. Conform to Section 828.

601.02.12 Mineral Admixtures. Conform to Section 844.

601.02.13 Forms. Provide forms that are mortar tight, true to the dimensions, lines, and grades of the structure, and of sufficient strength to prevent appreciable deflection during placing concrete.

A) Form Panels. Form panels are continuous sections of form facing material unbroken by joint marks, against which concrete is placed. For exposed surfaces, use form panels of plywood conforming to U.S. Product Standard PS-1 for Exterior B-B (Concrete Form) Class I plywood or any material other than plywood that will produce an equivalent smooth uniform concrete surface.

B) Plywood Forms. Ensure that plywood forms are at least 3/4 inch thick.

C) Plastic Forms. Conform to the manufacturer's specifications.

D) Plastic Lined Forms. Conform to the manufacturer's specifications.

E) Metal Forms. Use metal forms of such thickness that the forms will remain true to shape. Do not use metal forms that do not present a smooth surface or line up properly.

F) Stay-In-Place Metal Forms. Conform to the following requirements:

1) Forms and Supports. Fabricate permanent steel bridge deck forms and supports from steel conforming to ASTM A 653, Grades A through E, and having a zinc coating class of G 165 according to ASTM A 924. Use forms having a minimum thickness of 22 gage.
2) Fastener Hardware. For miscellaneous fastener hardware (bolts, nuts, metal screws, and washers), provide common stock hardware items with a zinc coating equal to or better than that required by ASTM A 153.
3) Coarse Aggregate. Conform to the requirements of Section 805.04.01 for all coarse aggregate used in concrete for bridge decks and barrier walls when using permanent steel bridge deck forms.
4) Precast Beam Hardware. Provide all deck and overhang support hardware that is cast into precast beam tops with a zinc or epoxy coating of a commercial quality grade.
5) Anchor Legs. To anchor angle weld tabs, use straight anchor legs containing a hole having a 1 1/8-inch minimum diameter. If necessary, incline the anchor leg to vertical.

G) Plank Forms. Use plank forms having a minimum nominal thickness of 1 1/2 inches.

H) Form Oil. Provide a commercial quality form oil or other equivalent coating that allows ready release of the forms and does not discolor the concrete or is detrimental to masonry coating.

I) Form Fasteners. Use Engineer approved form fasteners.

J) Chamfer Strips. Only use chamfer strips that are no less than 3/4 by 3/4 inch.

601.02.14 Scales. For weighing water, aggregates, cement, and mineral admixtures, provide either beam, springless dial, or electronic load cell type scales, designed as an integral unit of the batching plant. When checked under static loads, maintain the accuracy of the scales to within 0.5 percent of the net load on the scales. The net load on the scales is the total weight of the actual test weights used in the accuracy determination. Use enough actual test weights to at least equal the weight necessary to check the cement scales to the net load required for a normal size batch. The Department will allow the use of aggregates in combination with test weights to obtain the accuracy determination of aggregate scales in the higher ranges.

Provide dial scales having a minimum of 1,000 graduations with a clear interval between graduation marks of 0.03 inch or more.

Provide beam scales having a graduation interval not greater than 0.1 percent of the scale capacity with a clear interval of 0.03 inch or more.

Provide scales that are sensitive enough to discern movement due to the addition to the scales of a weight equal to 0.1 percent of the scale capacity under load when the scales are not connected for automatic operation, or equal to 0.2 percent when the scales are connected for automatic operation.

Except for small batches of concrete for headwalls, box inlets, finishing up operations, etc., use a batch size that exceeds 30 percent of the capacity of the scales.

Equip each beam scale with an auxiliary dial or "telltale" that will indicate to the operator that the required load in the hopper is being approached. The device shall show a minimum of 4 percent of the net rated capacity of the largest beam for underweight and 3 percent for overweight. Ensure that the indicator registers any movement of the beam.

Provide dial scales with suitable markers capable of being set to indicate the correct position of the dial indicator for predetermined loads. Enclose the dial in a glass-faced case for protection against dust.

Ensure that all weighing and indicating devices are in full view of and readable by the operator while charging the hopper, and provide the operator with convenient access to all controls.

Have all scales inspected and certified before use and whenever the Engineer may deem necessary to confirm the accuracy of the scales. Ensure that an inspection of the scales has been made within the preceding 6 months at any time a plant is supplying concrete to a Department construction project. Have a representative of a commercial scales company certified by the Division of Weights and Measures inspect and certify the scales. After the inspection and certification, only make adjustments or changes in the weighing mechanism at the direction of the Engineer. Keep all exposed fulcrums, clevises, and similar working parts of the scales clean at all times.

Furnish all weights and other equipment necessary for testing and calibrating the scales.

601.02.15 Batching Plant Equipment. Ensure that the plant conforms to all safety, health, and sanitation requirements specified in Subsection 107.01.01. Supply the batching plant with bins, weighing hoppers, and scales for the fine aggregate, each size of coarse aggregate, bulk cement, and mineral admixtures. The Department will allow weighing of cementitous material cumulatively. For the bulk cement, provide scales separate and distinct from those used for aggregate. Install and maintain the batching plant in a manner to provide accurate operations at all times. Only use weatherproof equipment for unloading cement, and protect the storage, weighing, and batching equipment for cement from the weather at all times.

Provide bins with separate compartments of sufficient capacity for each size of fine and coarse aggregate, and for bulk cement. Design each compartment to discharge efficiently and freely into the weighing hopper.

Provide a means of control so that when the quantity desired is being approached, the material may be added slowly and shut off with precision.

Use freely suspended weighing hoppers that do not affect the free movement of the weighing mechanism. Enclose the cement weigh hopper to prevent the loss of cement during weighing, and provide it with an approved device to transfer the cement to the batch trucks or the mixer. Construct all hoppers to eliminate leakage and the accumulation of tare materials, and to discharge completely. Provide any hopper that does not discharge satisfactorily with a vibrator having the frequency and power necessary to effect complete discharge.

601.02.16 Mixers.

A) Batch Mixer. Furnish a batch mixer of an approved size and type specified to positively ensure uniform distribution of materials throughout the mass, and to ensure discharge of the entire batch without segregation. Do not use any mixers having a rated capacity of less than one bag batch. Equip the mixer with adequate water storage and a device for accurately measuring and automatically controlling water discharge into each batch. Provide a mechanical device to control time of mixing for each batch and to automatically prevent discharge of the mixture until materials have been mixed for the specified time. Equip the mixer with a mechanical means for preventing addition of aggregates after mixing has started.

B) Continuous Mixer. Furnish a continuous mixer of an approved size and type specified to ensure uniform distribution of materials throughout the mass and to ensure discharge of the entire batch without segregation. Equip continuous type mixers to fix the proportions of admixture, cement, and fine and coarse aggregates by calibration according to KM 64-312. Provide devices to indicate the proportions of all components being incorporated into the mixture. Equip the

water supply portion of the mixer with a readily accessible cumulative type meter which can be read to the nearest 0.1 gallon. Ensure that the meter is of sufficient size to allow for easy reading. Calibrate the continuous type mixer to the satisfaction of the Engineer before starting work. Recalibrate the mixer thereafter at least once during each 50 cubic yards of production when yield checks indicate recalibration is necessary, and at any other times the Engineer deems necessary.

C) Truck Mixer. Furnish a truck mixer of an approved revolving drum or revolving blade type, constructed to produce a thoroughly mixed concrete mass with a uniform distribution of materials throughout. Keep the interior of the mixer drums free from hardened concrete.

Equip the truck mixer with a discharge mechanism which will ensure discharging of the mixed concrete without segregation. When the Engineer deems it necessary, provide baffle plates in the chute to avoid segregation in the concrete placed in the work. Make satisfactory repairs to any truck mixers that will not discharge concrete within the specified slump and air content ranges before using them.

Attach to each truck mixer a metal plate stating the manufacturer's capacities in terms of volume of mixed concrete for the various uses the equipment is applicable and the manufacturer's recommended speeds of rotation for mixing and agitation. For the mixer drum, apply the rates of rotation used for mixing and agitation as designated on the metal plate by the manufacturer of the equipment.

Do not allow the mixer drum to lose any water or concrete during charging, mixing, and agitation, or during transportation.

Equip the truck mixer with an automatic revolution counter that allows reading of the count at the plant and at the destination. Do not use trucks equipped with defective revolution counters. Keep the interior of the mixer drums free from hardened concrete. Equip tanks containing mixing water on all trucks with a device for accurately determining the quantity of water added at the job site.

Conduct annual tests to evaluate capability of the truck mixer to produce a uniform mixture according to KM 64-311. The Department will perform random checks of the tests.

D) Central Mixer.

1) Drum Type Mixer. Equip each drum type mixer with a batch counter and an approved timing device that automatically locks the discharge mechanism during the mixing period.
2) Pan Type Mixer. Equip each pan type mixer with a batch counter and an approved timing device that automatically locks the discharge mechanism during the mixing period.

601.02.17 Concrete Transfer Equipment. To transfer concrete from truck mixers or agitators, only use equipment of adequate design and dimension to deposit concrete of the specified slump at the point of placement.

601.02.18 Vibrators. Use a type and design approved by the Engineer that is capable of transmitting vibration to the concrete at frequencies to adequately consolidate the concrete and, when applicable, not damage the epoxy coating on reinforcing steel.

601.02.19 Wooden Float. Use Department approved wooden floats.

601.02.20 Carborundum Brick. Use Department approved carborundum brick.

601.02.21 Tremies. Use tremies consisting of a tube having a diameter of 10 inches or more, constructed in sections having flanged couplings fitted with water tight gaskets.

601.02.22 Wire Brooms. Use Department approved wire brooms.

601.02.23 Slip Form Machine (Extrusion Machine). Use a self-propelled slip form machine designed to consolidate and finish the concrete in one pass without damaging or displacing any steel reinforcement, and that finishes the concrete to a smooth, uniformly textured surface conforming to the required cross section with a minimum of hand finishing.

601.02.24 Curing Compound Sprayer. To apply the membrane forming curing compound, use a sprayer consisting of a container having a capacity of no less than 10 gallons in which a constant pressure can be maintained by mechanical means or by a suitable pumping arrangement in order to maintain a constant pressure at the spray nozzle or nozzles, and to uniformly apply the membrane forming curing compound at the specified rate. Equip the spray unit with mechanical devices providing constant agitation of the membrane forming curing compound or continuous circulation of the compound within the container. Use nozzles designed to deliver a uniform, fine spray and that allow for easy cleaning. Provide a shield or apron to protect the spray from wind. Provide means for cleaning the nozzles as part of the spraying equipment.

601.03 CONSTRUCTION. Conduct a prepour meeting whenever the work will involve placing bridge slab concrete, concrete pumping, or trial batches. The Engineer will facilitate the meeting to discuss items such as timing of truck delivery, target air content and slump of delivered concrete, minimizing air content and slump loss through the pump, sampling location and procedures, and other items as appropriate. Attendance is required by the Contractor, concrete supplier, pump contractor (when pumping is involved), and jobsite inspector.

601.03.01 Care, Storage, and Handling of Aggregates, Cement, and Mineral Admixtures. Furnish, stock, and handle the fine and coarse aggregates at the job site or at the plant site to maintain uniformity of grading and free moisture contents at the time of batching. The Engineer may direct saturation to continue if necessary. Obtain the Engineer's permission prior to using materials stockpiled at areas remote from the plant site. The Engineer may revoke permission to use materials remote from the plant site any time it is apparent there is not uniformity of grading and free moisture content.

When storing in stockpiles, place each size aggregate in separate stockpiles sufficiently removed from each other to prevent the intermixing of material at edges of piles. Do not use materials which have become mixed with foreign matter, or fine and coarse aggregates which have become mixed with each other. Build stockpiles in layers not exceeding 3 feet in height. Complete each layer before beginning the next layer. Handle aggregates in a manner that ensures the uniformity of the moisture content for each pour. Do not batch directly from washing plants. When handling by hydraulic methods or when washing is involved, stockpile or use bins to drain all aggregates at least 12 hours before batching. Do not remove aggregates from stockpiles within one foot of the ground line until final cleanup of the work.

Protect stored cement from dampness at all times. For cement storage, use weatherproof buildings that have ample space for storing separate shipments readily identified and accessible for sampling. Remove the cement from storage in the order received, as practical, to avoid long storage periods.

Handle cement in a manner to prevent loss, wetting, or contamination.

When using bulk cement, maintain a clean and clear cement feed to the cement batching bin to maintain the correct batch weight at all times. Furnish to the Engineer daily records of the cement shipments to the job batch plant. The Engineer may not require daily records of cement shipments when using commercial concrete plants.

Do not allow the temperature of the cement at the time of its incorporation into the mixture to exceed 170 °F.

Store and handle fly ash and GGBF slag as specified for cement. Provide means, such as double wall separation, to prevent the intermixing of cement with fly ash or GGBF

slag.

601.03.02 Concrete Producer Responsibilities. Ensure that the concrete producer complies with the following when the quantity of concrete delivered to the project in a plastic condition is 100 cubic yards or more:

A) General. Design concrete mixtures, and perform quality control and process control testing as needed.

B) Certified Personnel. Employ concrete technicians responsible for the design of the concrete mixtures and for performing quality control and process control testing as necessary. Ensure that concrete technicians are certified as ACI Level I and KRMCA Level II as awarded by the KRMCA.

C) Quality Control. Take full responsibility for the batch weight calculations and quality control of concrete mixtures at the plant. Ensure that the Level II concrete technician is available when work is in progress. A Level II concrete technician is responsible for inspecting trucks, performing aggregate moisture tests, batch weight calculations, monitoring, batching, making mixture adjustments, performing the necessary slump and air content tests, and monitoring the concrete temperature, all to ensure that the concrete arrives at the project conforming to the specifications. A Level I concrete technician is responsible for testing production material for aggregate moisture, slump, entrained air, unit weight, and temperature of the mixture. A Level II concrete technician is responsible for supervising this testing.

Ensure that Level II concrete technicians cooperate with the Engineer in making minor adjustments to the mixture proportions within the limits of the specifications, that may be desirable due to conditions at the job site.

Ensure that a Level II concrete technician completes and furnishes to the Department a daily summary of batch quantities on a TC 64-305 form within 3 working days after each production day. Show the batch quantities for sand, stone, cement, water, and admixtures; the moisture content of the aggregates; and the air content, slump, and temperature of the mix. Ensure the technician performs all sampling and testing according to the appropriate Kentucky Methods.

D) Producer Testing. Have a Level I concrete technician perform a daily moisture content of coarse and fine aggregate. Perform air content, unit weight, slump, and temperature tests on the concrete mixture of the first unit and at least every 100 cubic yards thereafter, for each day's production. For concrete paving, subsequent testing will be every 500 cubic yards after the first unit.

E) Trip Tickets. Furnish a trip ticket form TC 63-9 or equivalent for each load of concrete. Include on the trip ticket a statement certifying that the data on the ticket is correct and that the mixture conforms to the approved mix design. The Inspector will insert the required job site information in the spaces provided. Ensure that the plant manager or a Level II concrete technician signs the ticket.

F) Records. Retain all concrete technician records and test results pertaining to concrete produced for a Department project for at least 3 years after formal acceptance of the project. Make records and test results available to the Engineer and the Contractor on the project for review upon request.

G) Mix Designs. Design the mixture for each class of concrete specified. Determine the proportions of materials to be used on an absolute volume basis. Establish quantities to yield as nearly practical, the design volume. Before producing any concrete for the project, submit a proposed mixture design to the Engineer and obtain the Engineer's approval.

Consider any load of concrete delivered to the job site that fails to conform to specification requirements to be subject to rejection. The Engineer may allow the addition of water and admixtures at the job site. When the Engineer allows the addition of water or admixtures at the job site, take responsibility for the quantity to be added. Do not allow the total water/cement ratio to exceed that

listed in the Ingredient Proportions and Requirements for Various Classes of Concrete table. The Engineer may test remixed loads having additional water added to the mix at the job site. The Engineer will retest all loads when admixtures are added.

1) New Mixture Designs. Base the proposed design on standard Department methods unless the Engineer approves otherwise. Include the following with the submitted design:

    a) The class of concrete and 28-day compressive strength.
    b) The source, specific gravity, percentage, and quantity of fine and coarse aggregate. The Engineer will provide an average value of the specific gravity and aggregate absorption.
    c) The cement producer, type, and pounds of cement per cubic yard.
    d) The mineral admixture supplier, type, class, percentage of cement reduction and replacement ratio, and total pounds per cubic yard.
    e) The source of water, predicted amount of total water per cubic yard, and the maximum allowable water per cubic yard.
    f) The brands and predicted dosages of admixtures per cubic yard.
    g) If the concrete mixture is a class that the producer has not previously furnished to a Department project, have the producer provide trial batches of at least 4 cubic yards to demonstrate that the mixture will conform to the requirements for slump, air content, water/cement ratio, and compressive strength. Have the producer make the trial batches using the ingredients, proportions, and equipment (including batching, mixing and delivery time) to be used on this project. Have the producer make at least 2 consecutive trial batches conforming to all specified requirements. Department personnel will observe all phases of the trial batches. Have the producer submit a report containing mix proportions and test results for slump, air content, water/cement ratio, and compressive strength for each trial batch for the Engineer's review and approval.

2) Approval. The Engineer will base approval of the mixture design on the following criteria:

    a) Provide concrete cylinders molded at the project site to verify that the specified compressive strength will be attained.
    b) The quantities of components given for a one cubic yard batch will, on the basis of absolute volumes, produce one cubic yard of concrete mix. Include the volume occupied by entrained air.
    c) The cement factor is at least the minimum specified in the Ingredient Proportions and Requirements for Various Classes of Concrete table in Subsection 601.03.03.
    d) The water/cement ratio does not exceed the maximum specified in the Ingredient Proportions and Requirements for Various Classes of Concrete table in Subsection 601.03.03.
    e) The aggregate sources, the cement supplier, the mineral admixture supplier or producer, and the admixture brands are on the Department's List of Approved Materials.
    f) The trial batches, when required, produce acceptable results.

3) Changes in Approved Mixture Designs. Do not change the source of supply of mixture ingredients without the Engineer's written permission. If it is necessary to change the source of aggregates, submit a new design reflecting the new source of aggregate to the Engineer. Upon the Engineer's written approval, the Department will allow the use of aggregate from the new

source.

601.03.03 Proportioning and Requirements.

A) Concrete.

INGREDIENT PROPORTIONS AND REQUIREMENTS FOR VARIOUS CLASSES OF CONCRETE

Class of Concrete	Approximate Percent Fine to Total Aggregate		Maximum Free Water by W/C Ratio (lb/lb)	28-Day Compressive Strength [1] (psi)	Slump [4] (inches)	Minimum Cement Factor (lb/yd^3)	Air Content (%)
	Gravel	Stone					
A[5]	36	40	0.49	3,500	2-4[7]	564	6 ± 2
A Mod	36	40	0.47	3,500	4-7	658	6 ± 2
AA[2]	36	40	0.42	4,000	2-4[13]	620	6 ± 2 [12]
AAA[9]	36	40	0.40	5,500	3-7	686	6 ± 2 [12]
B	40	44	0.66	2,500	3-5	451	6 ± 2
D[3]	35	39	0.44	4,000	3-5[6]	639	6 ± 2
D Mod[3]	35	39	0.42	5,000	3-5[6]	733	6 ± 2
M1[8] w/ Type 1 Cement	36	40	0.33	4,000[10]	7 max.	800	6 ± 2
M2[8] w/ Type III Cement	36	40	0.38	4,000[10]	7 max.	705	6 ± 2
P[5]	35	38	0.49	3,500	1 1/2-2[9]	564[11]	6 ± 2 [12]

[1] *The Department may direct non-payment, additional construction, or removal and replacement for concrete for which test cylinders indicate low compressive strength and follow-up investigations indicate inadequate strength. The Department may require some classes to attain the required compressive strength in less than 28 days.*

[2] *When the ambient air temperature while placing slab concrete is 71°F or more, add to the concrete a water-reducing and retarding admixture. The Engineer may require or allow, water-reducing and retarding admixture in slab concrete for ambient air temperatures of less than 71°F. Only use one type of admixture for concrete placed during any individual contiguous pour.*

[3] *For prestressed members, the Department will require a strength of 5,000 psi at or before 28 days.*

[4] *The Engineer will allow slumps less than the minimum provided concrete is workable.*

[5] *The Department will allow the use of JPC pavement mixture for non-structural construction.*

[6] *At the option of the prestressed product fabricator, the Department will allow the slump of Class D or Class D Modified concrete to be increased to a maximum of 8 inches for all items, except products with voids. Provide a high range water reducer (Type F or G) in an amount not to exceed the following water/cement ratios:*

Summer mix designs - 0.39
Spring & Fall mix designs - 0.3
Winter mix designs - 0.34

[7] *The precast fabricator may increase the slump of Class A concrete to a maximum of*

7 inches provided the fabricator uses a high range water reducer (Type F or G).

(8) *Use a high range water reducer (Type F or G)*

(9) *Slump. 2 inches maximum with a nominal slump of 11/2 inches. The Department will allow a maximum of 3 inches when hand finishing or truck mixing.*

(10) *Compressive Strength Testing, Opening to Traffic and Acceptance Requirements for Class M1 and Class M2. Test one set of cylinders at 24 ± 0.5 hours from the time of molding, and allow the resulting average strength to dictate one of the following actions:*

(a) *If the average compressive strength is 3,500 psi or above, open to traffic, and test the remaining set of cylinders at an age of 7 days or 28 days.*

(b) *If the average compressive strength is between 3,000 and 3,500 psi, open to traffic, and test the remaining set of cylinders at 48 ± one hour.*

(c) *If the average compressive strength is less than 3,000 psi, protect the item as directed or approved. Test the remaining set of cylinders at 48 ± one hour.*

If the average strength of the cylinders tested at 48 ± one hour is 3,500 psi or above, the Engineer will consider the concrete acceptable. If the average strength is below 3,500 psi, take 2 cores from the concrete and test at an age of 7 days. If the average strength of the cores tested at 7 days is 4,000 psi, the Engineer will consider the concrete acceptable.

When 2 consecutive first sets of cylinders or when 2 first sets out of any 4 first sets of cylinders do not reach 3,500 psi, compressive strength, the Engineer will suspend the work. Resume work when the Engineer approves the adjusted mix design.

Cast 2 sets of cylinders from the concrete used for each placement.

Cast the cylinders after tests verify that the concrete conforms to slump and air content requirements. Make and cure the cylinders according to the procedures outlined in KM 64-305. Department personnel will test the mixture and cast cylinders.

(11) *611 lb/yd^3 when using coarse aggregate sizes No. 8, 78, or 9-M.*

(12) *7 ± 2% when using coarse aggregate sizes No. 8, 78, or 9-M.*

(13) *The Department may allow the slump of AA concrete to be increased up to a 6-inch maximum, provided the w/c ratio does not exceed 0.40 and a high range water reducer (Type F or G) is used. Trial Batches will be required if producer has not previously supplied.*

B) Mortar, Grout, Flowable Fill, and Self-Consolidating Concrete. When required, ensure that the air content of mortar or grout is 8 percent ± 2 percent by volume. Do not allow the quantity of fly ash in mortar or grout to exceed 20 percent of the cement quantity.

1) Mortar. Proportion mortar mix with one part cement or cement with fly ash to 2 parts mortar sand, by volume. Add water in an amount not to exceed a water/cement ratio of 0.48.
2) Grout. Proportion grout with water and one part cement or cement with fly ash to 2 parts mortar sand, by volume. Adjust the water to produce a mixture of a consistency suitable for job conditions.
3) Non-Shrink Grout. Use the non-shrink grout on the Department's List of Approved Materials. Use an approved non-shrink, non-staining grout consisting of either a mixture of hydraulic cement, water, fine aggregate, and an approved non-ferrous expansive admixture, or a packaged commercial product. To be placed on the Department's List of Approved Materials, non-shrink, non-staining grout, must conform to the following requirements:

a) Use an initial set time of at least 45 minutes when tested according to ASTM C 191 or ASTM C 403. The Department will allow the use of a

set-retarding admixture compatible with the expansive admixture.

b) Ensure that the grout exhibits expansion of no less than 0.02 percent and no more than 1.50 percent upon setting, when tested according to ASTM C 1090 with the exception that the glass plate shall remain in place during the test period.

c) Use grout that has a minimum 7 day compressive strength of 4,500 psi when tested using applicable portions of ASTM C 109.

d) Use grout that has a minimum durability factor of 85 percent and a maximum expansion of 0.06 percent when tested according to KM 64-626.

e) Keep the water content of the grout as low as possible for proper grouting and do not exceed a water/cement ratio of 0.44. Do not exceed the manufacturer's recommendations for water added to commercial products.

f) Ensure that the grout does not contain chlorides or nitrates.

g) Cure grout mixtures by covering with 2 layers of wet burlap or other approved covering so as to keep the grout continuously moist for at least 3 calendar days, except cure commercial mixtures as recommended by the manufacturer.

h) Ensure that commercial products are non-ferrous and approximately match the color of hardened concrete.

i) When preparing non-commercial grout mixture, submit a proposed mix design and a sample of the expansive admixture to the Engineer for testing and approval before use.

j) When using packaged commercial grout, provide certified test results from the manufacturer showing the material conforms to Subsection 601.02. When the Engineer requests, provide samples of the grout mixture for testing and approval.

4) Latex Grout. Use latex and cement mixture of a paste consistency.

5) Flowable Fill. Use flowable fill consisting of a mixture of cement, sand, fly ash, water, and other materials the Engineer approves. Contrary to Section 844, do not allow the loss on ignition for Class F fly ash to exceed 12 percent. Ensure that the concrete producer certifies mix proportions for flowable fill as follows:

a) Flowable Fill for Pipe Backfill. Proportion as follows, per cubic yard batch:

Cement	30 pounds
Fly Ash, Class F	300 pounds
Natural Sand (S.S.D.)	3,000 pounds
Water (Maximum)	550 pounds

b) Flowable Fill for Bridge End Bent Backfill. Proportion as follows, per cubic yard batch:

Cement	100 pounds
Fly Ash, Class F or Class C	300 pounds
Natural or Crushed Sand (S.S.D.)	2,950 pounds
Water (Maximum)	550 pounds

Alternate Mixtures for Flowable Fill. The Department may approve other mixtures. The mixtures may include other proportions of the above materials, Class C fly ash, chemical admixtures, or aggregate not conforming to the Standard Specifications. When deviating from the above specified proportions and materials, make and test a trial batch of at least 4

cubic yards to ensure that the mix will have flow and density characteristics suited for the intended use. Use the ingredients, proportions, and equipment intended for the project, including batching, mixing, and delivery.

The Department will observe all phases of the trial batching for approval. Ensure the proposed mixture is proportioned to obtain a minimum flow of 8 inches when tested with a 3 by 6 inch open ended cylinder modified flow test and meets applicable strength requirements. Ensure additional requirements, as stated below, for time of bleeding and time to achieve firmness are met when appropriate for application. Submit the proposed mixture proportions and appropriate test results to the Engineer for review and approval. When the mixture is proprietary, comply with Subsection 107.05.

The Department will cast, cure, and break test cylinders from the flowable fill trial batch according to ASTM D 4832. Prior to completion of the 28 day curing period, transport the test cylinders to the MCL for compressive strength testing. Obtain an average compressive strength of 50 to 100 psi at 28 days for application as pipe backfill or minimum compressive strength of 250 psi at 28 days for application as bridge end bent backfill. For applications requiring early opening to traffic or placement of pavement as soon as possible, provide a mixture that conforms to the following general guidelines:

1) Mixture bleeds freely within 10 minutes.
2) Require the mixture to support a 150-pound person within 3 hours.

The Engineer will approve flowable fill, delivered to the project, based on certifications indicating proper proportions for the intended use.

6) Self Consolidating Concrete (SCC). Conform to KM 64-320 with application limited to precast plants.

C) Mixtures Using Type IP, IS, and I(SM) Cement or Mineral Admixtures. The Engineer will not consider any Contract time extension requests for delays due to additional time necessary to attain specified strengths. Seasonal limitations on the use of Type IP cement and fly ash in bridge decks are specified in Subsection 601.03.09 D).

1) Type IP, IS, I(SM), Cement. The Department will allow the use when substituted for Type I cement, pound for pound.

To produce the necessary workability, strength properties, and expected durability of the concrete, the Department will allow adjustment of the proportioning, air entraining agent, and finishing requirements; and acceptance procedures. Obtain the Engineer's approval for all such adjustments.

Conform to all strength requirements for loading structures or removing falsework before applying loads or removing falsework. If strength requirements are not met, increase the minimum times specified in the Required Time in Calendar Days Before Removing Forms and Falsework table in Subsection 601.03.14 and the Required Time in Calendar Days Before Applying Significant Loads on Concrete Structures table in Subsection 601.03.15 by 33 percent.

Ensure that the mixture contains the specified amount of entrained air.

2) Mineral Admixtures. The use of fly ash, Ground Granulated Blast Furnace (GGBF) slag, or microsilica in concrete is the Contractor's option. Reduction of the total cement content by a combination of any mineral admixtures will be allowed, up to a maximum of 30 percent.

When the ability to use GGBF slag or microsilica has not been demonstrated have the concrete producer provide trail batches in accordance

with Subsection 601.03.02 G) 1). Have the producer make the trail batches using the ingredients, proportions, and equipment (including batching, mixing and delivery time) to be used on the project. Furnish all required materials and samples at no cost to the Department.

a) Fly Ash. When added as a separate ingredient, the Department will allow the use of fly ash to reduce the quantity of cement, except do not use fly ash to reduce the quantity of Type IP cement. The Department will allow the use of Class F fly ash to reduce the quantity of cement up to a maximum of 20 percent of the minimum cement content. For each 1.0 pound of cement reduced, add at least 1.0 pound, but no more than 1.25 pounds, of Class F fly ash.

The Department will allow the use of Class C fly ash to reduce the quantity of cement up to a maximum of 30 percent of the minimum cement content. For each 1.0 pound of cement reduced, add 1.0 pound of Class C fly ash.

Incorporate and uniformly distribute the fly ash into the mixture using methods and equipment that the Engineer approves. The Department will allow weighing of fly ash cumulatively in the same weigh hopper with the cement, but weigh the cement first. Weigh fly ash within a tolerance of 1.0 percent of the specified weight.

Conform to all strength requirements for loading structures or removing falsework before applying loads or removing falsework. If strength requirements are not met, increase the required times specified in the Required Time in Calendar Days Before Removing Forms and Falsework table in Subsection 601.03.14 and the Required Time in Calendar Days Before Applying Significant Loads on Concrete Structures table in Subsection 601.03.15 by 33 percent.

To produce the necessary workability, strength properties, and expected durability of the concrete, the Department will allow adjustment of the proportioning, air entraining agent, finishing requirements, and acceptance procedures. Obtain the Engineer's approval for all such adjustments.

Calculate the maximum free water based on the total cementitious material including fly ash. Do not change any of the slump requirements.

Ensure that the mixture contains the specified amount of entrained air.

b) Ground Granulated Blast Furnace Slag (GGBF Slag). When added as a separate ingredient, use Grade 120 GGBF or 100 GGBF slag to reduce the quantity of cement, except do not use GGBF slag to reduce the quantity of Type IS or I(SM) cement. The Department will allow the use of GGBF slag to reduce the quantity of cement up to a maximum of 30 percent of the minimum cement content. For every 1.0 pound of cement reduced, add 1.0 pound of GGBF slag. The combined weight of the cement and GGBF slag will determine the minimum cement factor and water cement ratio. Due to the lower specific gravity of GGBF slag, the concrete volume will increase. Unless directed by the Engineer, adjust the increased volume by reducing an equal volume of the fine and coarse aggregate in the mixture.

Use Type I cement unless otherwise specified. Use Type IA and Type II cement only if requested and approved in writing. When additional cements are approved, store and handle the cement so intermixing does not occur. Work done with each cement shall be readily identifiable. If test results are unsatisfactory, complete the work using Type I cement. Use only one brand of cement for each structure unless otherwise permitted by the Engineer.

Weigh the cement first when weighing GGBF slag cumulatively in the same weigh hopper. GGBF slag shall be within a tolerance of 1.0 percent of its specified weight. Incorporate the GGBF slag into the mixture by methods and equipment that ensure uniform distribution throughout the mixture.

c) Microsilica. When added as a separate ingredient, replace cement with microsilica as a percentage by weight specified elsewhere in the contract. When not specified elsewhere, replace 7 percent. The Department will allow the use of microsilica to reduce the quantity of cement up to a maximum of 10 percent of the minimum cement content. The combined weight of the cement and microsilica will determine the minimum cement factor and water cement ratio.

Use a high range water reducer conforming to ASTM C 494, Type F or Type G. Incorporate into the microsilica slurry or add at the time of batching for dry microsilica.

Use Type I cement unless otherwise specified. Use Type IA, IS, I(SM) and Type II cement only if requested and approved in writing. When additional cement types are approved, store and handle the cement so intermixing does not occur. Work done with each cement shall be readily identifiable. If test results are unsatisfactory, complete the work using Type I cement. Use only on brand of cement for each structure unless otherwise permitted by the Engineer.

Weigh the cement first when weighing microsilica in the dry or pellet form cumulatively in the same hopper. When the microsilica is in a slurry form, verify the dispenser or other means of measurement to the Engineer's satisfaction. The percent of microsilica will be considered in the measurement determinations and in the proportioning calculations.

When the microsilica admixture is in a slurry form, continuously recirculate by pumping. Begin recirculation at least four hours before batching and continue until batching operations cease.

When using a truck mixer, limit the mixer charge to 3/4 of its rated capacity, unless the Engineer approves a larger size.

D) Department Tests. The Department will test the work at the minimum frequencies indicated in the Manual of Field Sampling and Testing Practices or as necessary to determine the quality. The Department will perform the tests according to procedures outlined by the applicable Kentucky Method. The Department will cast and test compressive strength specimens according to KM 64-305 and ASTM C 39, respectively. In cases of failures, the Department will evaluate cylinder results according to KM 64-314 to determine whether in-place investigation may be necessary.

E) Measuring.

1) Cement. Measure cement by weight, considering one bag equal to 94 pounds, or weigh it in bulk on scales. When the weight of an entire shipment of cement in bags varies more than 2 percent from 94 pounds per bag, weigh the cement in bulk on scales. Do not produce batches from fractional bags, unless the entire quantity of cement is batched by weight as required for handling bulk cement.
2) Aggregates. Measure fine and coarse aggregates by weight, making corrections for moisture content. When the fine and coarse aggregates used contain more than the maximum free water stipulated in the Ingredient Proportions and Requirements for Various Classes of Concrete table in Subsection 601.03.03, increase the cement content according to the concrete proportioning requirements, and ensure that the maximum water/cement ratio is not exceeded.

3) Water. Measure water either by weight or by volume. Use an approved visible measuring device for measuring water. Use only water meter systems and other approved volumetric systems that can accurately deliver into the mixer, to within ± 1.0 percent of the required amount of water per batch and are arranged to automatically stop flow of water when the required quantity has been delivered into the mixer. When the water measuring device fails to deliver the quantity of water discharged into the mixer within the limits specified, suspend operation of the mixer until making repairs and proper adjustments. Assume water weighs 8.34 pounds per gallon.

Each time the scales are checked, check, or obtain an approved scale company to check, water meter systems for accuracy in the presence of the Engineer. Ensure that all calculations are included in the scale company's report. Refer to the requirements of the Department's Concrete Manual for the procedure for checking scales.

Withhold a portion of the water until the last part of the batching process to wash any cement that is sticking to the sides of the mixer into the mix.

4) Measuring Admixtures. Introduce air-entraining admixtures into the concrete along with or as part of the mixing water by means of an approved mechanical dispenser. However, do not introduce air entraining admixtures into the water line when the water is being heated.

When used, introduce water-reducing or water-reducing and retarding admixtures into the concrete along with, or as part of, the mixing water by means of an approved mechanical dispenser separate from one that may be used for introduction of the air-entraining admixture. Add the air-entraining admixture and the water-reducing or water-reducing and retarding admixture to the batch separately. Use a dispenser for the water-reducing or water-reducing and retarding admixture that is equipped with a meter or gage that indicates the quantity of admixture dispensed.

Use a dispenser that is capable of being adjusted to deliver the quantity of admixture required to produce the desired air content at all times, and is capable of delivering quantities of the admixture consistently to successive batches at any setting it is adjusted with satisfactory accuracy.

The Department may allow admixtures to be added to the truck at the project site provided the Engineer's approval is obtained first.

601.03.04 Classes and Primary Uses. Use the following classes of concrete in the types of construction designated.

A) Class A. All reinforced concrete abutments below top of caps including pedestals, retaining walls, box culverts, pipe culvert headwalls, nonstructural concrete, and all items for which the concrete class is not specified.
B) Class A Modified. All concrete deposited under water.
C) Class AA. All reinforced concrete in bridge substructures and superstructures above the tops of caps, excluding pedestals.
D) Class AAA. Bridge decks and other high strength uses.
E) Class B. Gravity retaining walls, and all non-reinforced concrete deposited as fill for cavities or voids and mass footings.
F) Class D. Prestressed I beams, cast-in-place piles, and precast piles.
G) Class D Modified. Prestressed box, slab, and I-beams; and prestressed concrete piles.
H) Class M1. High early strength for bridge joint repair and full depth slab patching. (Type I cement)
I) Class M2. High early strength for bridge joint repair and full depth slab patching. (Type III cement)
J) Class P. JPC pavement.

K) Class S. Bridge slabs or barrier walls when specified in the Contract.
L) Mortar. Concrete pipe joint seals, leveling drainage structure flowlines, and filling around inlets or outlets of drainage structures.
M) Flowable Fill. Backfill for pipe.
N) Grout. Patching, filling spalled areas, or other uses specified in the Contract.
O) Latex Grout. Bond coat between existing bridge surface and new overlays; and joint sealing for centerline and other construction joints and minor cracking on overlays.
P) Non-Shrink Grout. Bonding and sealing for post-tensioning, tie-back rods and bolts, and box beams.
Q) Self-Consolidating Concrete (SCC). Precast Units.

601.03.05 Admixtures. For all classes of concrete, add at least a water-reducing admixture. Water reducing admixtures are not required when slip forming is used for concrete placement. The Department will allow the use other admixtures when specified or approved by Engineer. The Department will allow admixtures according to the Ingredient Proportions and Requirements for Various Classes of Concrete table in Subsection 601.03.03. Follow the manufacturer's recommendations in determining the quantity of admixture to use.

Ensure that the concrete producer establishes the quantity of air-entraining admixture necessary to produce a mixture having the specified air content for the class of concrete being produced. Add air-entraining admixtures separately from other admixtures, and keep them separate until introducing them into the mixing water or concrete mixture. The Engineer will not require air-entraining of mortar or grouts, except when they are exposed to freeze-thaw conditions.

Ensure that any type of admixture is uniform in properties throughout its use in the work. Only dispense of admixtures in liquid form unless the Engineer approves prepackaged powdered water reducing admixtures. When using more than one admixture ensure that the admixtures are compatible. When using fly ash, ensure that the concrete producer uses fly ash compatible admixtures.

Clearly label admixture containers that indicate the exact brand name and type of admixture. Store products in containers with the correct label. Store admixtures in suitable areas to protect them from freezing temperatures or excessive heat.

When using water-reducing and retarding admixtures provide the Engineer with manufacturer's recommendations regarding the quantity of admixture used and expected retardation period for the job mixture and conditions.

601.03.06 Slump. The Department will measure the slump of the concrete as described in KM 64-302. Do not exceed the water/cement ratio, including the free water on the aggregates, according to the Ingredient Proportions and Requirements for Various Classes of Concrete table in Subsection 601.03.03. In general, use a mixture which contains the minimum quantity of water required by these specifications, and ensure that concrete mixtures are such that:

1) mortar clings to the coarse aggregate;
2) concrete is not sufficiently fluid to segregate when transported to the place of deposit;
3) mortar shows no free water when removed from the mixer;
4) concrete, when transported in metal chutes at an angle of 30 degrees with the horizontal, slides rather than flows into place; and
5) upper layers of the hardened concrete show a cement film on the surface but are free from laitance.

601.03.07 Delivery. Mix the concrete in the quantities required for immediate use. Except for prestressed box beams, do not allow an interval greater than 20 minutes between delivery of batches placed contiguously in the work. When using concrete with a water reducing and retarding admixture, the Engineer will allow a 30-minute intervals

between the delivery of batches, except for bridge deck slabs. For prestressed box beams, the Engineer will allow a 45-minute interval for delivery of batches between placement of the bottom slab and the remainder of the box beam when using concrete with a water reducing and retarding admixture.

After adding all water, cement, and aggregates to the mixer, deliver and place concrete in its final position within the time limits listed in the following table. Do not use concrete that has developed initial set, that has become segregated, or that has not been delivered within the time limits listed.

TIME OF DISCHARGE LIMITS [1] (minutes)					
Normal Concrete [2]			Retarded Concrete [3]		
Agitated [4]	Agitor [5]	Non-Agitated	Agitated [4]	Agitor [5]	Non-Agitated
60	45	30	90[6]	60	30

[1] *All times begin when cement first enters the mixer.*
[2] *Normal concrete is concrete without the addition of a water-reducing and retarding admixture.*
[3] *Retarded concrete is concrete to which a water-reducing and retarding admixture has been added at the Engineer's direction or approval.*
[4] *Agitated is defined as concrete that has been continuously agitated from the time of initial contact between cement and mixing water to the time of placement at the site of work.*
[5] *An agitor is a truck with paddles.*
[6] *120 minutes for Class B concrete placed in miscellaneous work such as fence post footings.*

601.03.08 Mixing Concrete.

A) General. The Department will allow mixing of concrete at the site of work or the use of ready-mixed methods. Ready-mixed concrete includes central-mixed and truck-mixed concrete. Site mixing includes batch mixing and continuous mixing. The Engineer may allow hand mixing.

B) Site Mixing. Thoroughly mix concrete in a batch mixer or continuous mixer.

Maintain the mixer, whether batch or continuous type, free of partially dried or hardened materials at all times. Consistently produce concrete to provide a uniform thoroughly blended mixture within the specified air content and slump limits.

1) Batch Mixing. Mix all concrete for a period of no less than 60 seconds after all materials, including water, are in the mixer. During the period of mixing, operate the drum at the manufacturer's recommended drum speed. When necessary, continue mixing until all aggregates are thoroughly coated with mortar.

   Remove the entire contents of the mixer from the drum before adding any materials for the succeeding batch. Deposit materials composing a batch simultaneously into the mixer. Do not operate any mixer above its rated capacity.

2) Continuous Mixing. The Department will allow the use of continuous type mixers for Class A or Class B concrete, except do not use them to place concrete in bridges or box culverts. Notify the Engineer of any proposed changes in the proportioning of any of the ingredients. Maintain the free-moisture content of the fine aggregate within the limits necessary to produce concrete conforming to these specifications.

   Perform slump tests on mixtures produced by continuous type mixers 4 to 5 minutes after depositing the concrete.

C) Ready-Mixed. When electing to use ready-mixed concrete, prevent delays in delivery and placing concrete. Provide a means of direct voice communication between the inspector at the job site and the inspector at the plant.

1) Truck Mixing. Accurately measure and control the entire quantity of mixing water to within ± 1.0 percent accuracy. Mix each batch no less than 70 revolutions at the plant site, at the rate of rotation the manufacturer specifies for a mixing speed. The Department will allow a reduction in mixing to 50 revolutions when the batch is charged so that all ingredients, including water, are uniformly blended during charging to produce a satisfactory mixture. In this case, mix the concrete an additional 10 revolutions at the specified mixing speed at the job site. When the Engineer allows additional water or admixtures at the job site, mix the concrete an additional 30 revolutions at the specified mixing speed after addition. Perform any additional mixing at a lower speed as the mixer manufacturer specifies for agitation, and continuously agitate until discharging the batch.

   Replace or repair any truck mixer that does not produce a uniform mixture.

2) Central Plant Mixing. When using a central-mixing plant, mix the concrete in an approved drum type mixer or pan type mixer. For drum type mixers having a rated capacity of 2 cubic yards or less, mix for a minimum of 60 seconds. For mixers having capacities greater than 2 cubic yards, mix for a minimum of 90 seconds. The Department will allow a reduction in the minimum mixing time for drum type mixers from 90 to 75 seconds when the concrete ingredients are uniformly blended during the charging of the mixer. In order to attain uniform blending, charge the batch so that the flows of water, coarse aggregate, fine aggregate, and cement are started, continued, and ended simultaneously or nearly simultaneously.

   For pan type mixers having a rated capacity of 3 cubic yards or less, mix for a minimum of 45 seconds. Increase the mixing time for pan type mixers having rated capacities greater than 3 cubic yards by 15 seconds for each 3 cubic yards, over that allowed for the 3-cubic yard mixer. Any fraction of 3 cubic yards is considered to be 3 cubic yards.

   The Engineer may increase the minimum mixing time for any type of mixer if the mixer does not produce the desirable quality with respect to uniformity of mixture, slump, and air content, or upon proof by tests that concrete of an undesirable quality with regard to compressive strength would be prevented by additional mixing. Measure the mixing time from the time all cement and aggregates are charged into the mixer until the mixer is ready for discharging.

   Deliver concrete for use at points other than the central plant site in approved truck mixers. Start agitating immediately after introducing the batch into the mixer and continue without interruption until discharging the batch. Completely discharge each batch before introducing the succeeding batch.

   The Department will allow the delivery of central-mixed concrete without agitation to a structural unit having a volume not exceeding 10 cubic yards, provided the time of delivery does not exceed the 30-minute limit listed in the Time of Discharge Limits table in Subsection 601.03.07 and the interval between delivery of batches does not exceed 20 minutes.

601.03.09 Placing Concrete.

A) General. Deliver concrete to its final position of placement within the time required for delivery after mixing and within the required time interval between delivery of batches as specified for the method of mixing and handling employed.

Moisten forms and reinforcement with water immediately before placing the concrete.

Ensure that all equipment used for handling or placing concrete accommodates concrete of the proportions and consistencies as specified. The Engineer will make no adjustments in mixture proportions to accommodate equipment incapable of handling concrete of specified proportions and consistencies.

Whenever possible, completely remove water from all foundation excavations before depositing concrete. When it is necessary to deposit concrete under water, place concrete according to the requirements specified.

Employ methods and manners of placing concrete that avoid segregation or separation of aggregates or displacement of reinforcement. The Department will allow the use of long chutes, troughs, belts, and pipes for conveying concrete from the mixing plant or point of delivery to the forms only with the Engineer's written permission. When the Engineer allows such conveyers and the quality of concrete or methods of placing or working it are not satisfactory, discontinue their use and re-equip his plant or conveyance to place concrete in a satisfactory manner. Arrange and use troughs, pipes, or chutes used as aids in placing concrete so that ingredients of the concrete are not separated. Where steep slopes are required, equip the chutes with baffle boards or provide the chutes in short lengths that change the direction of movement. Maintain all chutes, troughs, and pipes clean and free from coating of hardened concrete by thoroughly flushing with water after each run or when out of operation for more than 30 minutes. Discharge water used for flushing clear of in-place concrete. Use troughs, pipes, and chutes that are either metal or metal lined and extend as near as possible to the point of deposit. Do not use aluminum or aluminum alloy troughs, pipes, or chutes.

Do not drop concrete in excess of 5 feet without using pipe or tremies, and do not deposit a large quantity at any point and run or work it along the forms. When pumping, equip the delivery pipe with a nozzle, having a minimum of 2 right angles, at the discharge end. Maintain the discharge end of the pipe as close to the point of deposit as feasible. Place concrete to entirely fill but not bulge or distort the forms or to disturb their alignment. Fill each part of the forms by depositing concrete as near its final position as possible, to work the coarser aggregate back from the face, and to force concrete under and around reinforcing bars without displacing them. After concrete has taken its initial set, avoid jarring the forms or placing any strain on ends of projecting reinforcement.

Consolidate concrete in all bridges and box culverts with a mechanical vibrator operated within the mass of concrete. Consolidate concrete in all other concrete construction, exclusive of pavement, either by vibration as described herein or with approved spading tools. When vibrating concrete, the Engineer will require spading in addition to vibrating to prevent formation of honeycomb, voids, and air pockets against the forms, except for concrete placed in pavements, bridge slabs, footings, and culvert slabs.

Provide vibration of sufficient intensity and duration to cause flow or settlement of the concrete and complete consolidation, but ensure that vibration is not used to cause concrete to flow over long distances in the forms or is unduly prolonged to cause segregation or undesirable laitance at the surface of the lift being consolidated. Use plastic coated vibrators, when necessary, to prevent damage to the epoxy coating of the steel. Provide and use a sufficient number of mechanical vibrators to ensure that consolidation can be started immediately after concrete has been deposited in the forms. Do not attach the mechanical vibrator to the forms or reinforcing steel or apply to the surface of the concrete. Apply the vibrator to the concrete immediately after depositing the concrete and move it throughout the mass, thoroughly working the concrete around the reinforcement, embedded fixtures, and into angles and corners of the forms. Design forms to provide for requirements of vibration.

Place concrete in continuous horizontal layers not exceeding a thickness of one foot, unless otherwise specified for different types of structures. In any given layer, place and consolidate consecutive batches before the preceding batch has taken its initial set. Ensure that each layer of concrete retains a rough surface to secure efficient bonding with the next layer. Consolidate a succeeding layer placed before the underlying layer has set in a manner that will entirely break up and eliminate the tendency to produce a cold joint between layers.

Construct the bridge seats comprising the area of that portion of the pier or abutment tops receiving steel bridge bearings to an elevation of 1/8 inch greater than that specified in the Plans for an area in excess of the bearing area occupied by masonry bearing plates. Construct this excess material for the bearing area with mortar of the same proportions as that in the concrete and cast it monolithic with the pier or abutment. Prevent the coarse aggregate from being placed within 1/4 inch of finished elevation specified in the Plans. Immediately after depositing the mortar, strike the surface off by means of a wooden float. When the concrete has thoroughly hardened, finish it to the true, correct elevation specified in the Plans by tooling and polishing with a carborundum brick. Test the finished surface with a spirit level, and ensure that there is no variation in excess of 1/32 inch above or below a true level plane.

When temporarily discontinuing placing, clean the concrete, after it becomes firm enough to retain its form, of laitance and other objectionable material to a sufficient depth to expose sound concrete. To avoid visible joints as far as possible upon exposed faces, make construction joints according to Subsection 601.03.10.

Regulate the method and manner of placing concrete so as to place all construction joints across regions of low shearing stress and in locations that will be hidden from view the greatest possible extent. Use methods and sequences of placing concrete for various types of concrete bridge construction as specified for the particular type of construction involved.

Deposit and consolidate concrete to form a compact, dense, and impervious mass of uniform texture having smooth faces on exposed surfaces. When any section of concrete is defective, remove and satisfactorily replace or repair it as directed.

B) Placing Concrete Under Water. Do not expose concrete to the action of water before setting, or deposit it in water, except upon the Engineer's written permission. Mix all concrete deposited under water in proportions specified for Class A Modified. Place concrete deposited under water in its final position by means of a tremie or by other approved methods. Do not disturb it after depositing. Provide a sufficient number of tremies or other approved devices to ensure proper distribution of concrete to all portions of the seal. Maintain calm water at the point of deposit. Do not place any concrete in flowing water. Ensure that all form work, such as interlocking sheeting, designed to retain concrete under water is water-tight.

Regulate the consistency of the concrete to prevent segregation of materials. Maintain the surface of the concrete as nearly horizontal as practical at all times. To ensure thorough bonding, place each succeeding layer before the preceding layer has taken its initial set.

Close the discharge end at the start of work to prevent water from entering the tube. Induce the flow of concrete by slightly raising the tremie, but always keeping the discharge end in the deposited concrete. Stop the flow by lowering the tremie. Provide a continuous flow and, unless unavoidable, do not interrupt it until completing the work.

The Department will allow dewatering when the concrete is sufficiently strong to withstand hydrostatic pressure, but in no case in less than 3 calendar days after placing, or such additional length of time as the Engineer may direct. Remove all laitance or other unsatisfactory material from the exposed surfaces by scraping, chipping, or other means which will not injure the concrete surface, as

the Engineer directs.

When it is necessary to use a concrete seal in construction of a foundation, construct it as hereinafter described. A concrete seal in a foundation is that volume of concrete placed under water by means of a tremie or other approved means for sealing the entire bottom area of the excavated pit within the cofferdam against hydrostatic pressure, to dewater the excavation and construct the remainder of the foundation in dewatered forms. Use Class A Modified concrete for the seal, and in general make the thickness of the seal course 0.43 times the hydrostatic head exerting pressure on the bottom of the foundation, or of a thickness as specified in the Plans. Place the corners of the seal to an elevation lower than the remaining surface of the seal course for the purpose of dewatering. In such cases, do not exceed an elevation difference between the corners and the remaining surface of 6 inches.

C) Placing Flowable Fill. To place flowable fill requires a minimum trench width of 6 inches clearance on each side of the pipe. The Engineer will allow standing water to be in the trench when backfilling with flowable fill. Deep trenches may require bleeder trenches or placement in layers to drain excess water.

Because certain types of pipe may float, backfill in lifts or anchor the pipe when necessary. Backfilling in lifts is more applicable to long lines of pipe, allowing time for a substantial amount of the water to dissipate before applying the next lift. The Department will allow the use of adequately spaced anchors made of small lumber or metal straps to anchor the pipe. For larger diameter pipe, it may be possible to maintain a surge of flowable fill on top of the pipe to prevent floating. Floating usually does not occur after the level of the backfill is above the springline of the pipe. Ensure that the pipe remains in the correct horizontal position and elevation.

Place flowable fill by discharging directly from truck chutes into the trench or place by means of conveyors, buckets or pumps. When pumping, fill the voids adequately with solid particles to provide cohesion during the transport through the pump line under pressure to prevent segregation and line blockage. Maintain continuous flow through the pump line to prevent segregation and line blockage.

Place the flowable fill from the top of the compacted bedding to the bottom of the pavement structure. Unless the Engineer directs otherwise, allow a minimum of 2 hours before adding and compacting any material above the flowable fill.

To expedite settling and hardening in cool weather, drain or pump the bleed water from the surface or overfill the trench to allow bleed water to flow out. When overfilling, remove all excess material after hardening.

The flowable fill will bleed water within 5 to 10 minutes after placement. The release of water by bleeding causes the solid particles to realign and become firm. A delay in bleeding indicates there are too many fines in the mixture or insufficient water. If the maximum water was added, reduce the fly ash quantity in increments of 50 pounds until the mixture bleeds freely. Add approximately 60 pounds of sand to replace each 50-pound increment of fly ash to maintain the original yield. When 2 increment reductions, 100 pounds total, do not promote free bleeding of the mixture, evaluate other possible remedies. The flowable fill is too dry when cracks develop as it flows into place.

D) Weather Limitations and Protection. Maintain concrete at a minimum temperature of 45 °F for 3 calendar days after placement and at a minimum temperature of 40 °F for an additional 4 calendar days. When the Engineer requires, submit a written outline of the method to be used for protecting concrete. Designate an employee for the Engineer to contact in case of unexpected situations. The Department reserves the right to discontinue concrete placement when the means of protection or method of placement does not produce satisfactory results. Do not place concrete during times of the year that temperatures may be expected to drop below the 45 °F or 40 °F limits, unless there are adequate provisions at the job site for maintaining concrete at the

specified temperature. When performing cold weather concrete work, supply a maximum/minimum reading thermometer.

Maintain the temperature of the mixture at or below 90 °F during placement. Unless the Engineer determines that safety concerns or other considerations prohibit a shutdown, cease concrete production when the mixture exceeds 90 °F until adequate methods are in place to reduce or maintain the mixture temperature. Ensure that the temperature of the concrete mixture immediately before placing in bridges or box culverts is between 50 and 90 °F. When the ambient air temperature is above 90 °F, cool the temperature of the forms, reinforcing steel, steel beam flanges, and other surfaces that will come in contact with the mixture to below 90 °F by means of a water spray or other approved methods. Allow excess water to drain, or remove it from the forms before placing concrete. Do not place concrete in box culverts or bridges if the ambient temperature exceeds 100 °F. Do not place Class S concrete when the ambient daytime temperature exceeds 80 °F.

In cold weather, heat all water and/or aggregate so the temperature of the mixed concrete is no less than 50 °F or more than 90 °F at the time of placement. To avoid the possibility of flash set when water or aggregate is heated to above 100 °F, mix the water and aggregate before adding the cement, and do not exceed a temperature of 90 °F for the mixture of water and aggregate when adding the cement.

When using artificial heat, provide a means to maintain adequate moisture in the air within the enclosure. Maintain surfaces of all concrete in a moist condition as specified for curing during the entire curing period. When using artificial heat, do not exceed a temperature of 90 °F for concrete near the source of heat, and maintain the temperature of concrete remote from the source of heat higher than the designated 45 °F or 40 °F for the time of curing after placement. When using stoves or salamanders, make adequate provisions for fire protection.

Assume all risk connected with placing concrete under these conditions, and even with the Engineer's permission to do the work, take responsibility for proper results. Should concrete placed under such conditions prove unsatisfactory, remove and replace it with satisfactory concrete.

Do not use fly ash or Type 1P cement in bridge decks, JPC pavement, JPC base, or JPC shoulders between November 1 and March 1 if the item is to be opened to public traffic and exposed to deicing salts. If the item will remain closed to public traffic until the following spring or later, the Department will allow the use of fly ash or Type 1P cement during this period.

601.03.10 Construction Joints.

A) General Requirements for Structures. When work of placing concrete is delayed until the concrete attains its initial set, deem the point of stopping to be a construction joint. Locate construction joints in the structure as specified in the Contract for the different types of structures; but, when the volume of concrete is too great to be placed without the use of additional construction joints, locate and construct the additional construction joints without impairing the strength or appearance of the structure as the Engineer approves. Avoid construction joints through paneled wingwalls or other surfaces to be treated architecturally. To avoid visible joints as far as possible upon exposed faces, finish the top surface of concrete adjacent to the forms by smoothing with a mason's plastering trowel. Where a featheredge might be produced at a construction joint, as in the sloped top surface of a wingwall, use an inset form work to produce a blocked out portion in the preceding layer that produces an edge thickness of 6 inches or more in the succeeding layer. Do not stop or temporarily discontinue work on any section or layer within 18 inches below the top of any face unless details of the work provide for a coping having a thickness less than 18 inches. When the details provide for a coping having a thickness less than 18 inches, the Engineer

may allow placement of the construction joint at the underside of the coping.

Whenever construction joints are required and in the opinion of the Engineer an insufficient quantity of reinforcement is projecting to secure satisfactory bond, accomplish bonding as specified in B) below.

B) Bonding Construction Joints for Structures. In joining fresh concrete to concrete that has already set, or to preceding layers, thoroughly clean the surface of work already in place of all laitance, loose, and foreign material. Then, wash and scrub this surface with wire brooms and thoroughly drench with water until saturated. Keep the surface saturated until placing new concrete. Immediately before placing new concrete, draw all forms tight against concrete already in place.

After interrupting concrete placement and forming a construction joint, interlock with the succeeding concrete by forming suitable keys in the concrete. Form these keys by inserting and subsequently removing beveled wood strips. Thoroughly saturate the wood strips with water before inserting them. The Department may allow the use of steel dowels instead of keys. The Engineer will determine the size and placement of keys and dowels.

C) Non-Structural Concrete Items. When non-structural concrete items are constructed on top of rigid pavement, ensure that construction joints in the non-structural items coincide with the pavement joints. Install expansion joint material 1/2 inch thick and cut it to conform to the cross section of the non-structural item at all construction joints. When a construction joint is within 100 feet of a break in alignment or a drainage structure; treat the construction joint as a contraction joint.

601.03.11 Falsework. Design and construct falsework that provides the necessary rigidity, supports the loads imposed, and produces, in the finished structure, the lines and grades specified in the Plans. Have a Registered Professional Engineer design all falsework that is not a Department standard design for structures with clear span lengths of 20 feet or more and all falsework where traffic openings are specified.

Furnish the Engineer detailed working drawings in triplicate and design calculations for falsework. Do not begin any falsework construction until the Engineer has reviewed the falsework drawings. Take full responsibility for any falsework constructed prior to the Engineer's review of falsework drawings. Do not place any concrete until the Engineer has completed the review of the falsework drawings. Provide time for the Engineer to complete this review that is proportionate to the complexity of the falsework design; however always provide at least 3 weeks. For falsework over railroads or navigable streams, the Engineer’s review of the falsework drawings will be contingent upon the drawings being satisfactory to the railroad company involved, US Coast Guard, Army Corps of Engineers, or other agency having jurisdiction, as applicable.

The Department will allow the revision of falsework drawings at any time. When requesting a revision, allow sufficient time for the Engineer’s review before starting construction on the revised portion.

When using footing type falsework foundations, decide the bearing value of the soil, and show the values assumed in the design of the falsework on the falsework drawings. Show assumed values for both wet and dry soil conditions.

Construct slab forms between girders with no allowance for settlement relative to the girders.

Ensure that the design load for falsework consists of the sum of dead and live vertical loads. Include the weight of concrete, reinforcing steel, forms, and falsework in the dead loads. Assume the weight of concrete, reinforcing steel, and forms to be no less than 160 pounds per cubic foot of concrete. In addition to the full dead load, assume a live load of 50 pounds per square foot for horizontal surfaces and finishing machine weight, if necessary, in the design of falsework and centering.

Design the falsework so that horizontal loads are resisted in any direction by diagonal bracing, blocking, ties, or other means the Engineer approves, to be no less than 2 percent of the total dead load.

Design falsework footings to carry the load imposed upon them without exceeding the estimated soil bearing values and all anticipated settlements. When post-tensioning the concrete, design the falsework to support any increased or readjusted loads caused by the post-tensioning.

Ensure that the design of all plywood form panels and studs supporting them is as specified for forms. Design all joists supporting slabs and overhangs as falsework.

When falsework is over or adjacent to roadways or railways, install all details of the falsework system which contribute to horizontal stability and resistance to impact at the time each element of the falsework is erected and leave them in place until removing the falsework.

Construct falsework to reasonably conform to falsework drawings. Use materials in the falsework construction of the quality necessary to sustain stresses required by the falsework design. Use workmanship in falsework construction of such quality that the falsework will support the loads imposed without excessive settlement or deformation. Use suitable jacks or oak wedges in connection with falsework to set the forms to the required grade and to take up any excessive settlement in the falsework, either before or while placing concrete.

If unanticipated events occur, including undue settlements, which in the opinion of the Engineer would prevent obtaining a structure conforming to the Contract, discontinue placing concrete and provide corrective measures satisfactory to the Engineer. In the event satisfactory measures are not provided before initial set of the concrete in the affected area, discontinue placing concrete at a location the Engineer determines. Remove all unacceptable concrete.

Do not place temporary supports or shoring under prestressed concrete or structural steel girders when paving bridge slabs or when taking top of beam elevations.

When placing falsework installations over or adjacent to an open public road, include design considerations and protection to ensure that the falsework system is not disturbed by errant highway vehicles or from vibration forces caused by passing vehicles. Include provisions to protect traffic from falling objects.

601.03.12 Forming.

A) Forms for Structures. Clean the inside surfaces of forms of all dirt, mortar, and foreign material. Thoroughly coat forms which will later be removed with form oil before use.

Do not deposit concrete in forms until completing all work connected with constructing the forms, placing all materials required to be embedded in the concrete for the unit to be poured, and the Engineer has inspected forms and materials.

Control the rate of depositing concrete in forms to prevent over stressing the forms due to fluid pressure.

Provide forms for all concrete surfaces not completely enclosed or hidden below the permanent ground surface that conform to the requirements herein for forms for exposed surfaces. The Engineer will consider interior surfaces of underground drainage structures the same as to be completely enclosed surfaces.

Prior to using the forming system for exposed surfaces and when the Engineer requests, furnish the Engineer the form design and materials data so the Engineer may verify compliance with this section.

Design and construct forms for exposed concrete surfaces so the formed surfaces of concrete do not deflect excessively in any direction between studs, joists, form stiffeners, form fasteners, or wales. Place plywood with the face grain perpendicular to the studs or joists. If placement of the plywood with the grain parallel to the studs or joists is desired, furnish the Engineer calculations showing that excessive deflection or stresses will not occur. Provide a clear span between supporting studs or joists that is no more than 20 times the thickness of the form facing and that does not deflect more than 1/360 of the clear span. Should any form or forming system, even though previously reviewed before use,

produce a surface with excessive bulges, discontinue its use until making modifications satisfactory to the Engineer.

Form all exposed surfaces of each element in a concrete structure with the same forming material or with materials which produce similar surface textures, color, and appearance.

Face forms for exposed surfaces with form panels. Only use form panels in good condition free of defects, such as scars, dents, or delaminations, for exposed surfaces.

In general, furnish and place form panels for exposed surfaces in uniform widths of 3 feet or more and in uniform lengths of 5 feet or more, except where the dimensions of the member formed are less than these dimensions. Arrange panels in symmetrical patterns conforming to the general lines of the structure. Precisely align form panels on each side of the panel joint using supports or fasteners common to both panels, to obtain a continuous, unbroken concrete plane surface.

Construct forms for exposed surfaces with 3/4 inch chamfer strips attached to prevent mortar runs and to produce smooth, straight chamfers at all sharp edges of the concrete.

Use form fasteners consisting of form bolts, clamps, or other devices as necessary to prevent spreading of the forms during concrete placement. Do not use twisted wire loop ties to hold forms in position.

The Department will allow casting of anchor devices into the concrete for later use in supporting forms or for lifting precast members when the Engineer allows. Do not use driven types of anchorages for fastening forms or form supports to concrete on bridge decks.

Construct all forms to allow removal without damaging the concrete. Frame forms for copings, offsets, railings, and all ornamental work so there will be no damage to or marring of the concrete when removing the forms.

Leave openings in forms at intervals no greater than 10 feet vertically. Ensure that the openings are adequate to allow free access to the forms for the purpose of inspection, working, and vibrating the concrete.

Set and maintain all forms true to lines and grades designated until the concrete has hardened. After placing concrete, remove the forms according to Subsection 601.03.14.

For narrow walls where access to the bottom of forms is not readily attainable otherwise, leave the lower form boards loose so they may be removed to remove all chips, dirt, sawdust, or other extraneous material from inside the forms immediately before placing concrete.

Construct metal ties or anchorages within the forms to allow their removal to a depth of at least one inch from the face without injury to the concrete. Design all fittings or metal ties such that upon their removal the cavities that remain will be the smallest possible size. Regardless of their position in the completed construction, ram and fill cavities with mortar, and ensure that the surface is sound, smooth, even, and uniform in color.

When using ordinary tie wires within the forms for areas where concrete will be exposed and will receive surface finish, cut back all wires at least 1/4 inch from the face of the concrete with chisels or nippers. Fill the resulting cavities with mortar, and ensure that the surface is sound, smooth, even, and uniform in color. Use nippers for cutting wires in fresh concrete. Cut the wires that are not included within the areas where the concrete will receive surface finish flush with the concrete surface. The Engineer will not require grouting unless concrete is damaged in cutting wires.

Maintain forms that are intended for reuse in good condition to ensure accuracy of shape, strength, rigidity, watertightness, and surface smoothness. Do not use forms that are unsatisfactory in any respect in the opinion of the Engineer and remove them immediately from the job site.

Use forms for circular section concrete columns that are plastic, plastic

lined, metal, or other approved material in order to provide a smooth and true surface free from fins, joints, and other irregularities.

Apply the above wooden form specifications relative to design, mortar tightness, filleted corners, beveled projections, bracing, alignment, removal, reuse, and oiling to metal forms, also. Countersink all bolt heads. Design clamps, pins, or other connecting devices to hold the forms rigidly together and to allow removal without injury to the concrete. Keep metal forms free from rust, grease, or other foreign matter that may discolor the concrete.

B) Forms for Non-Structural Construction. Provide wood or metal side forms used for non-structural construction, free from warps, of sufficient strength to resist warping during construction, and of a height approximately equal to the depth of the section to be constructed. Thoroughly clean, oil well, and securely stake, brace, and hold forms to the required line and grade before depositing any concrete. Use approved flexible forms for construction of circular sections where the radius is 100 feet or less.

C) Slip Forming for Non-Structural Construction. The Department will allow the use of slip form or extruding machines for non-structural concrete items whose design is compatible with the slip form or extrusion process. For concrete placed by the slip form or extrusion process, the Engineer may waive the minimum slump requirements for the concrete being placed. Control the slump so that during each continuous run the maximum range of slump between the various batches or loads does not exceed one inch.

Produce items by the slip form or extrusion process that are comparable in quality to those produced by use of side form methods. When work is not satisfactory, the Engineer may require the use of side forms instead of the slip form or extrusion process, as well as corrective work.

D) Slip Forming for Bridge Barrier Wall. The Department will allow slip form construction of bridge barrier wall when the Engineer approves test sections. Core or slice the test section as the Engineer directs. The Engineer will review the cores or slices to ensure concrete consolidation around the horizontal steel reinforcement. When concrete is not consolidated around the steel or the quality is not comparable to the side form methods, the Engineer may require the use of side forms and corrective work. The Engineer may waive the minimum slump requirements. Control the slump so that during each continuous run, the maximum range of slump between the various batches of loads does not exceed one inch. Conform to the alignment tolerance requirements of Subsection 601.03.18. Construct joints and bevels according to the Plans. Construct barrier wall to the dimensions specified on the Plans.

601.03.13 Camber. Set falsework and forms to provide structural camber indicated or as directed.

601.03.14 Removal of Falsework and Forms. In determination of time for removal of falsework and forms, consider the location and character of the structure, weather, and other conditions influencing hardening of the concrete and materials used in the mixture.

Do not remove falsework centering and falsework supporting any concrete work or loosen any wedges without obtaining the Engineer's permission. Even with the Engineer's permission, take full responsibility for the safety of the work.

The Department will allow the removal of forms for ornamental work, railing, parapets, columns, and vertical surfaces that do not carry loads after 18 hours, unless otherwise directed or approved.

1) The Department will allow the removal of supporting forms and falsework for structural units subjected to bending stresses, 3 days after placing the last concrete in the unit upon conformance to the following conditions:

   a) Advise the Engineer in writing at least 24 hours in advance of placing

concrete that early removal is necessary or desirable, and request that additional cylinders for the required testing be made.

b) Submit, for approval, a written request for the intended use of any special procedures or modifications to the mixture such as increased cement content, use of Type III cement, use of high range water reducing admixture. If supplying a high range water reducing admixture, subject to the Engineer's approval, the Department will allow the use of a higher than specified slump.

c) Ensure that results of the compressive strength tests demonstrate a minimum of 80% the required 28-day compressive strength for the class of concrete specified. The Engineer will sample for compressive strength at the minimum frequencies indicated in the Manual of Field Sampling and Testing Practices. The Department will cast and test compressive strength cylinders according to KM 64-305 and ASTM C 39, respectively. Cure cylinders to be tested for early removal of forms and falsework as nearly as possible in the identical manner that the concrete in the structural unit is cured. The Engineer will allow early removal of forms and falsework when all of the cylinders achieve the specified minimum compressive strength.

Upon conforming to the above conditions, the Department will allow the removal of supporting forms and falsework for structural units subjected to bending stresses to begin 3 days after placing the last concrete in the unit.

2) If early release cylinders are not requested or have failed strength requirements, do not remove the falsework, centering, and forms supporting any girder, slab, beam, arch, or member subject to direct bending stress, or forms inside concrete barrels, until the minimum curing time has elapsed as shown in the following table. The Engineer will take air temperature readings at 7:00 AM and 3:00 PM each day during the curing period and determine the average temperature from those readings. The curing time will start after placing the last concrete in the member considered.

The Engineer will add one day to the following calendar days shown in the table for each day the average ambient air temperature falls below 40 °F.

REQUIRED TIME IN CALENDAR DAYS BEFORE REMOVING FORMS AND FALSEWORK[1]			
Item	Average Ambient Temperature During Curing Period		
	41 to 54 °F	55 to 69 °F	70 °F or more
Box Culverts, spans 10 feet or less	18	11	7
Box Culverts, spans 10 to 20 feet inclusive	18	12	8
Slab and Girder Spans, 10 feet or less, including Slab Spans between Steel Girders	18	11	7
Slab and Girder Spans, 10 to 20 feet inclusive, including Slab Spans between Steel Girders	18	12	8
Slab and Girder Spans, over 20 feet, including Slab Spans between Steel Girders	21	15	12
Caps of Concrete Pile Bents, Open Column Abutments, and Piers	18	11	7
Caps of Piers with Copings extending 3 feet or less beyond Web Walls	7	5	3
Curbs or Slabs Overhanging 2 feet or less, and Rails in Open Handrails	7	5	3
Falsework under Web Walls	7	5	3
Curbs or Slabs Overhanging more than 2 feet	18	11	7
Walls, Columns, and Vertical Sides of Beams and Girders	18 hours min. as the Engineer directs		

[1]*For mixtures using Type IP cement or fly ash, see Subsection 601.03.03*

3) Remove falsework and centering in such a manner and sequence that allows concrete to uniformly and gradually take the stresses due to its own weight.

   Remove forms without defacing the structure. Always remove forms from the sides of columns and piers before removing falsework or centering beneath girders, beams, or other members that they will support, so the Engineer may inspect the quality of concrete.

   The Engineer will not grant any extension of time to complete work due to falsework remaining in place during curing.

4) Box culvert top slab forms may be removed earlier than 3 days. Submit special mix design and early release cylinder plan to the Engineer for approval if removal of forms earlier than 3 days is desired.

601.03.15 Opening to Traffic. Conform to the following requirements for the time

of opening a completed structure to traffic or application of significant loads. The Engineer will consider construction equipment passing over a structure to be traffic.

1) The Engineer will allow early opening to traffic or application of significant loads under the same criteria as early removal for forms and falsework with the following additional requirements:

    a) Ensure that results of the compressive strength tests demonstrate a minimum of 100% the required 28 days compressive strength, for the class of concrete specified.
    b) When possible, continue to cure concrete for the time specified in the following table even when the specified strength requirements have been met.

2) If early release cylinders are not requested or have failed strength requirements, do not open the structure to traffic or subject it to significant loads until the minimum time has elapsed as specified in the Required Time in Calendar Days Before Removing Forms and Falsework table in Subsection 601.03.14 and the Required Time in Calendar Days Before Applying Significant Loads on Concrete Structures table in this subsection. The curing time will start after placing the last concrete in the structure, with the exception of handrails not designed as load supporting members. The Engineer will add one day to the following calendar days shown in the table for each day the average ambient air temperature falls below 40 °F.

    The Engineer will take air temperature readings at 7:00 AM and 3:00 PM each day during the curing period and will determine the average temperature from those readings.

REQUIRED TIME IN CALENDAR DAYS BEFORE APPLYING SIGNIFICANT LOADS ON CONCRETE STRUCTURES			
Item	Average Ambient Temperature During Curing Period		
	40 to 54 °F	55 to 69 °F	70 °F or more
Box Culverts, spans 10 feet or less	21	13	10
Box Culverts, 10 to 20 feet inclusive	22	14	11
Slab and Girder Spans, 10 feet or less, including Slab Spans between Steel Girders	21	13	10
Slab and Girder Spans, 10 to 20 feet inclusive, including Slab Spans Steel Girders	22	14	11
Slab and Girder Spans, over 20 feet, including Slab Spans between Steel Girders	23	18	14
Overhanging Slabs, age before barrier walls are placed[2][3]	23	18	14
Caps on Concrete Pile Bents, Open Column Abutments, and Piers			
Concentrated Loads, as produced by steel superstructures or precast concrete	18	11	7
Distributed Loads, as produced by poured-in-place concrete deck girder superstructures	3	2	1[2]
Class "D" Piles, Moved or Driven[1]	28	21	21
Class "D" (HES) Piles, Moved or Driven[1]	7	5	3
Class "D" Modified Piles, Moved or Driven[1]	14	10	7
Backfill against Abutments or Retaining Walls	14	10	7

[1] *See Subsection 604.03.*
[2] *No strength requirements apply.*
[3] *The Engineer will not apply time limits when falsework is designed to support barrier wall.*

601.03.16 Joints.

A) Expansion and Contraction Joints for Structures. Construct expansion joints to allow absolute freedom of movement. After completing all work, use a fine chisel to carefully remove all loose or thin shells or mortar likely to spall under movement from expansion joints.

Provide and place expansion joints at locations specified in the Plans and Standard Drawings as follows:

1) Friction or Sliding Joints. Friction or sliding joints may be either metal,

neoprene, rubber, or premolded filler type as specified.

2) Open Joints. Place at locations designated and form by insertion and subsequent removal of a template of timber, metal, or other suitable and approved material. Use a method of insertion and removal of joint templates that avoids the possibility of chipping or breaking the edges and construct the templates so removal is readily accomplished without injury to the work. Do not extend reinforcement across an open joint unless specified in the Plans. Carefully set structural steel angles, channels, plates, or other shapes used in connection with open joints to conform to the crown and grade of the bridge deck. Construct the joint with a uniform opening and to dimensions specified in the Plans.

3) Special Types. Use special types other than those listed when specified in the Plans or when the Engineer so orders in writing. Furnish special details for such joints.

B) Expansion Joints for Non-Structural Items. Install expansion joints at all breaks in alignment and at all locations where one concrete construction abuts another concrete or other type construction. Install expansion joints at each 1,000 feet of continuous construction. The Engineer will not require steel reinforcement in expansion joints.

When another concrete item crosses an expansion joint in JPC pavements, construct the expansion joint for the structural or non-structural concrete item one inch wide and construct all other expansion joints 1/2 inch wide. The Engineer will not require expansion joints in paved ditches except at locations where the paved ditch abuts another structure. Cut the one-inch thick expansion joint material to conform to the cross section of the concrete.

C) Contraction Joints for Non-Structural Concrete Items. Either form 1/8-inch wide contraction joints for non-structural concrete items or construct them according to requirements of this subsection at intervals not to exceed 30 feet, except when items are constructed on or adjacent to a rigid pavement or shoulder. For these exceptions, make the joint spacing coincide with that of the pavement or shoulder. Space contraction joints for sidewalks as specified in Section 505. The Engineer will not require the sealing of contraction joints in non-structural items.

The Engineer will not require contraction joints for paved ditches. Construct sawed contraction joints to a minimum depth of 2 inches, except that the Engineer will allow one inch of depth for header curbs and integral curbs.

601.03.17 Curing Concrete. Cure reinforced concrete bridge slabs according to Subsection 609.03. Wet cure all surfaces that are to receive a masonry coating finish, unless using combination material. When using combination material, cure as specified in B) below. Either wet cure all other concrete, except pipe culvert headwalls, as specified in A) below or cure it by application of membrane forming compound as specified in B) below. The Engineer will not require curing for cast-in-place pipe culvert headwalls.

At any time the Engineer determines concrete on the project is not being properly cured, the Engineer may suspend all or any concreting operations on the project.

At any time during the curing period when the atmospheric temperature is 45 °F or less, protect the concrete to satisfy the temperature requirements according to Subsection 601.03.09 D).

A) Wet Curing. Cure concrete for a period of at least 7 calendar days, beginning immediately after placement and finishing, by frequently applying water to all surfaces to keep them continuously damp during the full 7-calendar day curing period or until the required strength is attained. Protect exposed concrete surfaces from drying by application of a double thickness of wet burlap or similar approved material and keep the burlap or other approved material continuously wet for a period of 7 or more calendar days. Soak new burlap in water for at least

12 hours before the first use.

When the structure or any portion thereof is enclosed and artificial heat is provided for protection, the Engineer will not waive the moist curing requirement. When using steamlines for heating, leave the pipe loose so sufficient steam escapes into the housing to maintain a moist atmosphere at all times. When using stoves or salamanders, maintain vessels containing water on each stove or salamander to maintain a moist atmosphere at all times. The Department will allow the curing of flat horizontal surfaces with curing blankets.

B) Membrane Curing. Do not dilute or alter the membrane forming curing compound. Thoroughly agitate the compound immediately before using it. When the compound is too viscous to apply, warm it in a water bath to approximately 100 °F before applying.

Uniformly apply the compound to a surface by use of an approved pressure sprayer. The Department will allow the placement of curing compound in one application. When placing in one application, achieve uniform and satisfactory coverage. If the Engineer directs that 2 applications are required because one application is not satisfactory, then make each application at the rate of one gallon per 300 or less square feet. Start the first application as soon as practical after the final finish and as the Engineer directs, and start the second application after finishing the first application. Use a total actual application rate of at least one gallon per 150 square feet or less actual coverage.

Do not apply curing compound to construction joints, reinforcing steel, or surfaces to receive a masonry coating, except:

1) The Department will allow the use of materials conforming to the water retention requirements of AASHTO M 148 for liquid membrane forming curing compound, and also conforming to Section 828 for masonry coating, on areas designated to receive masonry coating.
2) When using combination materials, follow wet curing procedures until completing all patching or other surface corrections and applying the compound. Keep the surface covered with wet burlap or other approved material and alternately expose small sections for surface corrections, to avoid drying. Conform to surface preparation requirements for masonry coating in all respects.

   When inadvertently applying curing compound to surfaces upon which the compound is not allowed for use, remove it by sandblasting.

   Protect the curing compound and maintain it in an acceptable condition for a period of at least 7 calendar days. Moisten and respray curing compound on surfaces on which the curing compound is damaged before the end of the 7-calendar day curing period. Cover surfaces upon which curing compound has been applied and that will be used as work surfaces or otherwise subject to damage to the curing compound with planks, boards, or other protective material to protect the curing compound from damage.

C) Curing Blankets. Only use curing blankets for curing bridge deck slabs and other flat horizontal surfaces.

Keep the concrete continuously damp for the period of time specified for the item being constructed, beginning immediately after placing and finishing. As soon as possible, without damaging the concrete surface, moisten the concrete by applying water, and immediately cover the surface with the curing blankets.

Place the blankets so that adjoining blankets overlap at least 18 inches. Weight all laps and outside edges to prevent displacement of the blankets before completing curing. Ensure intimate contact between the blankets and the concrete surface.

If the blankets are disturbed before the curing time expires, immediately replace them. Apply water at any time drying of the concrete is evident.

Immediately repair torn places in the blankets by cementing an additional

thickness of the same material over the torn area. At the end of each curing period, inspect the blankets; repair all tears or holes before reusing the blankets.

601.03.18 Surface Finish. Apply the following surface finishes to various parts of concrete structures:

1) Ordinary Surface Finish,
2) Masonry Coating Finish, or
3) Floated Surface Finish.

Apply ordinary surface finish to all concrete surfaces not required to have masonry coating finish or a floated surface finish. Consider ordinary surface finish as a final finish on all surfaces not required to have masonry coating.

Ensure that exposed finished concrete surfaces do not vary more than 1/4 inch in 10 feet as measured from a straightedge.

A) Ordinary Surface Finish. Immediately following removal of forms, remove all fins and irregular projections from all surfaces except those not to be exposed in the completed work. On all surfaces, that have cavities and depressions resulting from removal of form ties, and all other holes, honeycomb spots, broken corners or edges, and other defects, thoroughly clean the defects, saturate them with water, and carefully point them. Use a mortar of the same cement and fine aggregates mixed in the same proportions as used in the class of concrete being finished. Do not use a mortar that is more than 30 minutes old, and cure the mortar patches as specified for the structures. After the mortar has thoroughly hardened, finish it with a carborundum brick to obtain a uniform and smooth surface that is the same color and texture as in the surrounding concrete. When required, chip out honeycomb areas before pointing. Carefully tool all open and filled contraction and expansion joints in the completed work and keep them free of all mortar and concrete. Expose the joint filler for its full length with clean true edges.

Obtain smooth and even surfaces of uniform color and texture without unsightly bulges, patched areas, depressions, and other imperfections.

The Engineer will consider individual surfaces satisfactory and in compliance with requirements for ordinary surface finish when the surfaces have been formed and finished as specified and the Engineer has approved the resultant surface as to uniformity, color, texture, and smoothness.

The Engineer will consider each face of a column, wing, girder, or parapet separately in determining if the finish is satisfactory.

Protect all exposed surfaces from subsequent construction operations and from drip and disfigurement. Clean and finish any surface disfigured as a result of construction or other operations as the Engineer may require to give a satisfactory surface finish.

B) Masonry Coating Finish. After the Engineer has inspected and accepted the concrete surfaces of bridges and median barriers as having a satisfactory ordinary surface finish, clean the concrete surfaces specified hereinafter of all dust, foreign matter, and form oil, and apply a Department approved masonry coating finish. Coat the following surfaces, including all beveled edges:

1) Bridge End Bents, Abutments, Retaining Walls, and Headwalls for box or long span underpasses - every exposed surface including wingwalls, above a point 6 inches below ground or fill line.
2) Bridge Pier Caps - the tops (including exposed surfaces of pads, pedestals, and keys), sides and ends. Do not apply the coating to bearing areas.
3) Bridge Superstructure - the tops, inside and outside faces, and ends of all barrier walls, parapets, curbs, and plinths that will be exposed. Do not apply the coating to the riding surface of the bridge deck.

4) Median Barriers - all exposed surfaces of concrete median barriers and concrete terminal sections appurtenant to the barriers.
5) Exposed Surfaces of Substructure and the Superstructure of Highway, Railway, and Pedestrian Bridges Over a Highway - all surfaces identified in 1), 2), and 3) above and the underneath surfaces of slab overhangs that are outside of exterior girders and the exterior side and bottom of exterior beams, girders and box beams and all exposed surfaces of piers, abutments and walls that are within 200 feet of a public road or street. Extend the masonry coating from a point 6 inches below ground line to the top of the exposed surface.

Thoroughly clean all surfaces to receive a masonry coating and keep them free of oil, form oil, grease, dust, dirt, mud, curing compound, release agents, loose patching mortar, or any other substance that may prevent bonding. Before applying the masonry coating material, fill all air holes flush with the surface with the masonry coating material or an approved mortar to provide a uniform surface.

Check all surfaces to receive a masonry coating for the presence of dust by wiping a dark cloth across the surface of the concrete. If a white powder can be seen on the dark cloth, clean the concrete by wire brushing, grinding, or water blasting and then allow it to thoroughly dry before applying the masonry coating. The Engineer will recheck the surface for the presence of dust after cleaning.

Check all surfaces to receive a masonry coating for the presence of oily conditions by sprinkling or fogging water on the surface of the concrete. If the water stands in droplets without spreading out immediately, this indicates the surface is contaminated with an oily substance, and the Engineer will require cleaning using a detergent and water followed by thorough rinsing with water. The Engineer will recheck the surface for the presence of oily conditions after cleaning.

Thoroughly dry all surfaces to receive a masonry coating before applying the coating, unless the coating manufacturer specifically recommends the surface to be wet. The Department's List of Approved Materials contains each manufacturer's recommendation. The Engineer will not consider surfaces to be dry unless an absorbent paper pressed tightly against the surface does not show any trace of moisture.

Suspend coating application any time the ambient temperature or the temperature of the concrete does not comply with the coating manufacturer's recommendations.

Prior to application of the materials, furnish the Engineer with copies of the coating material manufacturer's brochures or booklets. Apply masonry coating materials in strict conformity with the manufacturer's written instructions and apply the material at a uniform rate of at least 50 ± 10 square feet per gallon.

Satisfactorily repair or remove any portions of the coating that are not clean, uniform in color, texture, thickness, tightly bonded, or that are damaged before final acceptance of the project and replace them with an acceptable finish and coating.

Provide a neat uniform appearance, and prevent the coating from being dripped, sprayed, or otherwise deposited upon concrete or steel surfaces not designated to receive the coating. Remove any objectionable deposits or material and repair the surfaces to the Engineer's satisfaction.

C) Floated Surface Finish. Finish horizontal surfaces not subject to wear, and those that do not receive the Masonry Coating Finish, such as back walls, and headwalls, by placing an excess of materials in the form and removing or striking off such excess with a wooden template, forcing coarse aggregate below the mortar surface. Do not use mortar topping for surfaces falling under this classification. After striking-off the concrete as described, thoroughly work the surface and float it by hand with a wooden float leaving a fine grained, smooth-

sanded surface.

Finish concrete bridge floors as specified in Section 609.

Finish sidewalks on structures as specified in Section 505.

601.03.19 Construction Date and Identification. On all concrete bridges and box culverts, stencil the year the Contract was executed and the structure drawing number on the concrete at the locations designated. Make the figures on the stencil according to details specified in the Plans. For bridges having a clear span of 20 feet or more, stencil the year the Contract was executed and load capacity of the structure on the outside face of the plinth or barrier wall as shown on the Standard Drawing or as directed. On all box culverts, place stenciled figures giving the year in which the Contract is executed on the inlet end of the culvert on the outside face and center of the parapet or headwall. Do not use permanent plates or markers of any kind, other than those shown, on any structure. On all bridges, imprint the name(s) of the prime contractor, and the subcontractor when applicable, in the concrete at the location shown or designated. Furnish stencils, all equipment, tools, labor, materials, and other incidentals necessary.

601.04 MEASUREMENT.

601.04.01 Concrete. The Department will measure the quantity in cubic yards according to the dimensions specified in the Plans. The Department will not measure the volume of concrete displaced by pile heads (except when using concrete piles) for payment and will consider it incidental to this item of work. The Department will measure the volume of concrete displaced by concrete pile heads in cubic yards. The Department will not measure forming, including permanent steel forms, for payment and will consider it incidental to this item of work. The Department will measure the average core strength in psi by testing cores. The Department will not measure the average core strength as a separate pay unit, but will use it to calculate an adjusted Contract unit price for Concrete, Class M1 or M2.

601.04.02 Steel Reinforcement. The Department will measure the quantity according to Subsection 602.04.

601.04.03 Masonry Coating. The Department will measure the quantity in square yards.

601.04.04 Mass Concrete. The Department will measure the quantity in cubic yards actually placed.

601.05 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

Code	Pay Item	Pay Unit
8100, 8102-8106, 2555	Concrete, Class[(1)]	Cubic Yard
8150	Steel Reinforcement	See Subsection 602.05
2998	Masonry Coating	Square Yard
10040	Mass Concrete[(2)]	Cubic Yard

[(1)] *The Department will adjust the Contract unit price for Concrete, Class M1 and Concrete, Class M2 by the Schedule for Adjusted Payment for Strength Deficiency. The adjusted quantity is equal to the plan quantity of Concrete, Class M1 or Concrete, Class M2 multiplied by the Contract unit price for the Concrete, Class M1 or Concrete, Class M2 and the Price Adjustment. The Department will not make additional payment for average core strengths in excess of the specified strength.*

[(2)] *The Department will pay for Mass Concrete at a unit price of 2 times the*

delivered cost of the concrete. When mixing concrete on site, the Department will pay for Mass Concrete at one-half the contract unit price for that class concrete.

SCHEDULE FOR ADJUSTED PAYMENT FOR CLASS M STRENGTH DEFICIENCY	
Average Core Strength psi	Percent of Contract Unit Price
3,800 – 3,999	90
3,600 – 3,799	80
3,400 – 3,599	70
3,200 – 3,399	[1]
Below 3,200	[2]

[1] *Acceptable at no pay.*

[2] *Remove and replace these areas with concrete of the specified strength at no expense to the Department when directed by the Engineer.*

The Department will consider payment as full compensation for all work required under this section.

SECTION 602 ¾ STEEL REINFORCEMENT

602.01 DESCRIPTION. Furnish and place steel for reinforcement of concrete. Furnish bars, spirals, welded wire fabric, bar mat, or other specified reinforcement, of the quality, type, size, and quantity designated by the Contract.

602.02 MATERIALS.

602.02.01 Steel Reinforcement. Conform to Section 811.

602.02.02 Epoxy Coating Material. Conform to Section 811.

602.02.03 Welded Steel Wire Fabric (WWF). Conform to Section 811.

602.03 CONSTRUCTION.

602.03.01 Protection of Material. Handle and store steel reinforcement to prevent bending, excessive rusting, or contamination with objectionable substances.

602.03.02 Straightening. Before placing in the work, straighten reinforcement bent during shipment or handling without injuring the steel. Do not heat the steel, or use steel with sharp kinks.

602.03.03 Bending. Bend reinforcement cold to the dimensions and shapes specified in the Plans and to within tolerances designated in the CRSI Manual of Standard Practice. In bending, do not injure the steel. Bend bars in the shop before shipment, not in the field.

602.03.04 Placing and Fastening. Accurately place all steel reinforcement as shown, and firmly hold in position while placing and during hardening of concrete. Hold in position to within a tolerance of ± 1/2 inch, and place to within a tolerance of ± 1/4 inch of specified clearance from the face of concrete, except for bridge deck reinforcement steel. Place steel reinforcement for bridge slabs to within the tolerances specified in Subsection 609.03.03. Dimensions shown from the face of concrete to bars are clear distances. Bar spacings are from center to center of bars. Tie bars at all intersections, except where spacing is less than one foot in both directions, then tie alternate intersections. Always pass vertical stirrups around the main tension members and securely attach them to the members.

Use Engineer approved supports to maintain distances from forms. Use precast blocks composed of mortar or Engineer approved metal chairs as supports for holding reinforcement from contact with the forms. Ensure that the tips of metal chair supports in contact with the surface of the concrete are plastic coated steel. When using plastic coated steel supports, provide a minimum of 1/8 inch thickness of the plastic material between the metal tips and the exposed surface of the concrete. The Engineer will accept metal supports as specified for epoxy coated bars. Securely tie down the steel placed in reinforced concrete slabs to prevent any possibility of steel rising above the specified elevation during placing, vibrating, and finishing the concrete as required by Subsection 609.03. Ensure that metal supports have a shape that will be easily enveloped by the concrete.

Separate the top and bottom mats of bars with precast mortar blocks or by other equally suitable devices. Do not use pebbles, pieces of broken stone or brick, metal pipe, and wooden blocks as separators. Securely place reinforcement in any member, and then obtain the Engineer's approval before placing concrete. The Engineer may reject concrete placed in violation of this provision.

When using grout to install steel bars into existing concrete, conform to Section 511.

602.03.05 Special Requirements for the Installation of Epoxy Coated Bars. Either coat all tie wires, clips, chair and bar supports, and other metallic materials used for the installation of the epoxy coated reinforcing bars with fusion bonded epoxy resin or with an approved vinyl type material, or make them of an approved non-metallic material.

Use an epoxy material that provides a uniform continuous coating having a film thickness of 12 ± 7 mils. Use vinyl-type material that is pliable and provides a uniform continuous coating having a thickness of 30 ± 10 mils. Test installation devices coated with either material according to KM 64-106.

Allow the Engineer to check the installation devices for flaking, chipping, or any other defects during the pre-pour inspection of the epoxy coated reinforcing bars, and repair or replace the devices as the Engineer deems necessary.

Coat tie wires with a flexible plastic or vinyl material to a thickness of 12 ± 7 mils. The Engineer will test the coating according to KM 64-106.

Provide all systems for handling coated bars with padded contact areas for the bars whenever possible. Pad all bundling bands, and lift all bundles with a strong back, multiple supports, or a platform bridge so as to prevent bar-to-bar abrasion from sags in the bar bundle. Use nylon slings for direct epoxy bar contact. Use loading and unloading procedures and equipment that does not damage the coating.

Unload and store the epoxy coated steel bars on the project site in a manner to avoid damage or contamination. Avoid extended outdoor storage of coated bars of over 2 months. If expecting the outdoor storage to exceed 2 months, cover the bars for protection against the elements and to prevent condensation from forming on the bars. Install the bars in the bridge deck according to applicable requirements of Section 609, except as provided in this section and as the Engineer deems necessary in order to protect and preserve the epoxy coating.

Repair all cuts, nicks, and abrasions that exceed 0.25 percent of the surface area and the bar end with the epoxy repair material supplied by the powdered epoxy resin manufacturer. If the areas damaged during transportation, handling, and placing exceed 2 percent per foot of the coated area, remove and replace them with acceptable bars. Also, repair any damaged metallic accessories with a suitable material.

Make every reasonable effort to repair all damaged areas of the reinforcing steel and accessories before any rusting occurs. If infrequent and small damaged areas do rust, thoroughly remove the rust by sandblasting or other Engineer approved methods before repairing the areas. Ensure that the coated bars, when incorporated into the work, are reasonably free from dirt, paint, oil, grease, or other foreign substance, and, when deemed necessary, clean the bars to the satisfaction of the Engineer.

Place concrete in the deck using methods and equipment that will not damage the coated materials.

Since the epoxy coating is flammable, do not expose the coated bars to any fire or flame. Do not cut coated bars by burning.

602.03.06 Splicing. Do not splice any reinforcement that is not of the type and at the locations specified in the Plans without the Engineer's written permission. The Department will allow the use of lapped splices, welded splices, mechanical couplers, or other positive connection splices specified in the Plans or designated by Engineer. Do not weld rail steel bar reinforcement used for bridges, cast-in-place culverts, and cast-in-place walls.

Make all splices added in the field and not specified in the Plans as far from the point of maximum tensile stress in the member as practical, and stagger splice points 3 feet or more in adjacent bars, when possible. Do not use any splices which reduce the clear distance between the splice and the closest bar to less than the minimum clear distance required by the design specifications. Do not use mechanical couplers having a diameter of greater than 125 percent of the nominal diameter of the reinforcing bar in the top bars in beams, slabs, or girders in which the concrete under the top bars is 12 inches or more in depth.

Make all splices with clean, sound materials properly affixed to the members being spliced and free of any substances that would weaken or contaminate the splice or concrete

surrounding the splice.

Provide lapped splices that have a length no less than that specified in the Plans. When using lapped splices in areas not specified in the Plans, obtain the Engineer's approval. Splice bars by rigidly clamping or to otherwise wire together in a manner the Engineer approves. Make splices for spirals, where necessary, with a minimum lap of 1.5 turns of spiral.

When welding splices, conform to the AWS Reinforcing Steel Welding Code. Butt together and weld bars to develop, in tension, at least 125 percent of the specified yield strength of the bars. Do not use welded splices unless specified in the Plans or as the Engineer approves.

Use mechanical couplers primarily for bars required for compression only. Use only mechanical couplers or bars designed to carry critical tension or compression that are equivalent in strength to approved welded splices (125 percent of the specified bar yield strength).

When the Engineer allows welded splices or mechanical couplers, prepare 2 test specimens of the spliced reinforcement for submittal to the Division of Materials for testing before incorporating the splices into the work, and submit one additional test specimen for each 100 splices made. Ensure that only personnel who are qualified in conformance with the AWS Reinforcing Steel Welding Code make the welded splices.

602.03.07 Welded Steel Wire Fabric (WWF). Overlap sheets of WWF by 40 or more times the nominal diameter of the longitudinal wires to maintain a uniform strength, and securely fasten the sheets at the ends and edges.

602.04 MEASUREMENT.

602.04.01 Steel Reinforcement. The Department will measure the quantity, including bars used to replace test specimens, by the pound in the final work based on the theoretical number of pounds. The Department will not measure clips, wire, chairs, or other material used for fastening reinforcement in place for payment and will consider them incidental to this item of work. The Department will not measure welded splicing for payment and will consider it incidental to this item of work.

The Department will base quantities of materials furnished and placed on the calculated weights of the reinforcing steel actually placed. The Department will calculate the weights based upon the following table:

ASTM STANDARD REINFORCING BARS

Bar Size English and (metric)	Nominal Mass pounds per foot	Nominal Dimensions - Round Sections		
		Diameter inches	Cross Section Area, sq. inches	Perimeter inches
#3 (10)	0.376	0.375	0.11	1.178
#4 (13)	0.668	0.500	0.20	1.571
#5 (16)	1.043	0.625	0.31	1.963
#6 (19)	1.502	0.750	0.44	2.356
#7 (22)	2.044	0.875	0.60	2.749
#8 (25)	2.670	1.000	0.79	3.142
#9 (29)	3.400	1.128	1.00	3.544
#10 (32)	4.303	1.270	1.27	3.990
#11 (36)	5.313	1.410	1.56	4.430
#14 (43)	7.650	1.693	2.25	5.320
#18 (57)	13.600	2.257	4.00	7.090

602.04.02 Steel Reinforcement, Epoxy Coated. The Department will measure the quantity according to Subsection 602.04.01. The Department will not measure the epoxy coating or its application for payment and will consider it incidental to this item of work.

602.04.03 Mechanical Couplers. The Department will measure the quantity by each individual unit.

602.05 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

Code	Pay Item	Pay Unit
8150	Steel Reinforcement	Pound
8151	Steel Reinforcement, Epoxy Coated	Pound
73003, 7113 73023, 73033	Mechanical Reinforced Couplers, Size	Each

The Department will consider payment as full compensation for all work required under this section.

SECTION 603 ¾ FOUNDATION PREPARATION AND BACKFILL

603.01 DESCRIPTION. Excavate and backfill or dispose of all materials required for the construction of bridges, box culverts, and other structures for which excavation is not otherwise provided.

603.02 MATERIALS AND EQUIPMENT. Use fabric wrapped backfill drains conforming to Section 845.

603.03 CONSTRUCTION. Remove and dispose of all materials excavated for the construction of the foundations for all structures, including the removal of existing structures. Place backfill to the original ground level and perform final cleaning up.

603.03.01 Classification. Perform structure excavation necessary for all bridge foundations and culverts, except pipe culverts, as Structure Excavation Solid Rock or Structure Excavation Common. Perform structure excavation necessary in the construction of cribwalls and retaining walls as Structure Excavation Unclassified.

A. Structure Excavation Solid Rock. The Department considers all of the following Structure Excavation Solid Rock:

1) All rock in solid beds, detached masses, or ledge formations which cannot be removed without blasting or quarrying. Hoerams and jackhammers may be required for solid rock removal.
2) Detached rocks or boulders having a volume of 0.5 cubic yards or more each.
3) Shale, slate, or coal which cannot be removed without blasting or quarrying.
4) Rock layers interspersed with strata of earth, or all conglomerate boulder formations, when rock strata or boulders constitute 60 percent or more of the volume to be removed.

B. Structure Excavation Common. The Department considers Structure Excavation Common as all material not classified as Solid Rock Structure Excavation.

C. Structure Excavation Unclassified. The Department considers Structure Excavation Unclassified as all excavation regardless of the materials encountered.

603.03.02 Channel Preservation. When any excavation or dredging is done at the site of the structure, do not excavate outside of caissons, cofferdams, steel piling, or sheeting, and do not disturb the natural stream bed adjacent to the structure without the Engineer's written permission.

603.03.03 Footing Excavation. Notify the Engineer at least 48 hours in advance of beginning structure excavation.

Excavate the foundation pits to allow placing of the full width and length of footings specified in the Plans with full horizontal beds. Do not use rounded or undercut corners and edges of footings. Ensure that all rock and other hard foundation material is free from all loose material, cleaned, and cut to a firm surface, either level, stepped, or roughened, as directed. Clean all seams and fill with concrete, mortar, crushed stone, or sand. When masonry is to rest on an excavated surface other than durable rock or durable shale (SDI equal to or greater than 95 according to KM 64-513), do not disturb the bottom of the excavation, and do not make the final removal of the foundation material to grade until just before the masonry is to be placed. When unsuitable foundation material is encountered, excavate and replace with acceptable material as the Engineer directs. Maintain the

excavation free of standing water, insofar as is practical.

When the Plans require the foundation for a bridge or culvert to be solid rock or shale, drill into the foundation material to confirm its suitability. Drill according to the Division of Construction's Guidance Manual.

603.03.04 Backfilling. Use only approved materials that will provide a dense well-compacted backfill. Ensure that the backfill material is free of frozen lumps, vegetation, debris, and rock fragments larger than 4 inches in any dimension. Before starting backfill, clear the excavated pits of all form material and rubbish, and, when practical dewater the pits.

Place and compact backfill material in uniform horizontal lifts not exceeding one foot for stone and 6 inches for soil and rock/soil combination material. For backfill that will be beneath, or within a proposed embankment, backfill according to Subsection 206.03.03.

When backfilling piers constructed in a stream bed or flood plain, the Department will allow material removed from the excavation as backfill material provided no large rock or broken concrete fragments are placed in contact with the structure, and provided no logs, stumps or rubbish are used. Backfill below normal low water elevation will not require compaction.

Shape the backfilled areas lying outside the limits of roadway embankment to a uniform finish.

As a precaution against introducing unbalanced stresses in masonry walls or columns, place and compact the backfill to the same elevation on both sides of culverts, wingwalls, piers, and abutments before proceeding to the next layer.

For structures over which rock fills will be constructed, first cover the structures to a minimum depth of 2 feet with materials placed and compacted as required for backfill.

Obtain the Engineer's permission before backfilling against any concrete masonry structure.

603.03.05 Drainage. At locations where depth to weep hole flowline is 30 feet or less, drain backfill by installing a fabric-wrapped drain.

Center a fabric-wrapped drain over the inlet end of each weep hole with a wide side against the concrete, and glue the drain in place. Use a glue recommended by the drain manufacturer. Ensure that glue is not placed over the portion of the drain covering the weep hole. Place drains vertically at each weep hole.

Extend the drain from top of footing or from 6 inches below the inlet end of weep holes to 6 inches below subgrade elevation or, in the case of box culverts, to the top of the top slab. Avoid damaging or compressing the drain during backfilling.

When splices are required, provide a 6-inch lap of fabric to be glued to the adjacent piece so the spliced drain is completely covered by fabric.

Provide flaps or separate pieces of fabric to cover the top and bottom of the drain, and overlap the fabric on all sides of the drain at least 6 inches.

At the weep hole, if necessary, puncture the plastic core to provide free drainage from the drain to the weep hole. If puncturing of the core is necessary do not puncture the geotextile fabric on the outside face of the drain. Place a piece of plastic, at least 8 inches by 8 inches by 3/16 inches on the outside face of the drain over the weep hole, as reinforcement.

When depth to weep hole flow line is greater than 30 feet, cover the inlet ends of weep holes with at least 2 cubic feet of No. 57 coarse aggregate. Place the aggregate to allow free drainage but at the same time prevent the fill from washing. From approximately 6 inches below the bottom of the inlet ends of the weep holes, place a column of clean crushed stone or gravel, at least one square foot, up against the back of the wall to the upper limits of the backfill. At the time of placing the remainder of embankment adjacent to the structure, continue placing the column of stone up to subgrade elevation, or, in the case of box culverts, to the top of the top slab.

603.03.06 Cofferdams. For foundation construction, drive sheet piles for cofferdams to an elevation well below the bottom of the footings. Brace walls to ensure

against collapse. Provide interior dimensions that allow sufficient clearance for the construction of forms and the inspection of their exteriors, and to permit pumping outside the forms. Right, reset, or enlarge cofferdams that are tilted or moved laterally during the process of sinking to provide the necessary clearance. Construct cofferdams sufficiently watertight to prevent water from coming in contact with fresh concrete. Do not allow bracing to extend into the substructure masonry unless the Engineer permits in writing. Submit drawings prepared by a Registered Professional Engineer showing the design and construction methods of proposed cofferdams. Include in the drawings all necessary details and design calculations. The type and clearance of cofferdams, details that affect the character of the finished work and the safety of the installation are subject to Department approval. The Department will review design details of cofferdams, bracing, shoring, or other work.

Remove all cofferdams, including all sheeting and bracing, after completion of the substructure without disturbing or causing damage to the finished masonry.

603.03.07 Foundation Seals. When conditions are encountered which, in the judgement of the Engineer, render it impracticable to remove water from the cofferdam before placing masonry, the Engineer may require construction of a concrete foundation seal according to Subsection 601.03.09 B).

Do not dewater cofferdam until the concrete seal has set sufficiently to withstand the hydrostatic pressure and in no case less than 72 hours after placement.

The Engineer may require longer than 72 hours.

603.04 MEASUREMENT. The Department will not measure the removal of existing structures, or portions thereof, in structure excavation when listed in the Contract as a bid item.

The Department will measure removing masonry necessary in the building of extensions to or the rebuilding of an existing structure according to Section 203.

The Department will consider removal of existing pipe incidental to structure excavation and will deduct the interior volume of the pipe from the structure excavation quantity.

When the Plans require the foundation to be solid rock or shale, drilling to confirm suitability is incidental to the structure excavation.

603.04.01 All Structures. When it is necessary to backfill in excess of the material excavated, the Department will measure the quantity of the additional material necessary for such backfill in cubic yards in its original position under Borrow Excavation or Roadway Excavation, unless it is paid for as Extra Work.

The Department will not measure dewatering excavated pits and placing and compacting backfill for payment and will consider them incidental to the structure excavation bid items.

When not listed as a bid item, the Department will not measure furnishing and placing fabric wrapped drains or coarse aggregate at weep holes for payment and will consider them incidental to the structure excavation bid items.

When it is necessary to construct any footing more than 5 feet below the elevation specified in the Plans for structures, except pipe culverts, sewers, and underdrains, the Department will pay for all excavation below plan elevation as Extra Work.

The Department will not measure excavation or backfill in excess of the limits described in this section for payment.

603.04.02 Bridges, Culverts, and Retaining Walls. The Department will measure the quantity of all excavation in its original position as that actually excavated within the limits bounded by vertical planes 18 inches outside the footings and parallel thereto except as follows. The Department will measure between the original ground surface and the bottom of the excavated pit, except in cuts where the finished cross section will govern, and except when structures are removed, the bottom of the excavation for removal shall govern. The Department will not include in the quantity the volume of the waterway of

existing culverts and bridges, the volume of materials removed as Remove Existing Structure, nor materials removed as incidental. The Department will not measure structure excavation for pipe culverts and pipe culvert headwalls, sewer pipe, or combination sewer and storm pipe.

Where tie beams, struts, web walls, overhangs, or similar construction are required on the substructure above the bottom of the footings and extend beyond the area bounded by vertical planes 18 inches outside the footings, the Department will measure the excavation, except that the Department will measure the area bounded by vertical planes 18 inches outside the footings and 18 inches outside the neat lines of the tie beams, struts, web walls, and other similar construction. The Department will measure between the original ground surface and a plane 18 inches below the bottom of the tie beams, struts, web walls, and other similar construction.

The Department will not measure excavation necessary to construct concrete encasement for an individual steel pile for payment and will consider it incidental to the pile. The Department will not measure Structure Excavation in the construction of timber bents or backing planks, or for excavation incidental to splicing piling for payment.

603.04.03 Foundation Preparation. When listed as a bid item, the Department will measure all work performed as part of Foundation Preparation as a lump sum for each structure. The Department will not measure cofferdams, shoring, dewatering, common excavation, or backfill for payment, and will consider them incidental to this bid item. The Department will measure Structure Excavation Solid Rock and removal of unsuitable foundation material and refill separately for payment.

603.04.04 Structure Excavation Common. When Foundation Preparation is not listed as a bid item, the Department will measure the quantity, in cubic yards. The Department will not measure any material removed or excavated before the Engineer takes measurements.

603.04.05 Structure Excavation Solid Rock. The Department will measure the quantity in cubic yards. The Department will not measure any material removed or excavated before the Engineer takes measurements.

603.04.06 Structure Excavation Unclassified. The Department will measure the quantity in cubic yards. The Department will not measure any material removed or excavated before the Engineer takes measurements.

603.04.07 Foundation Undercut. When Foundation Preparation is not a bid item and the Engineer directs that unsuitable foundation material is be excavated and replaced, the Department will measure the quantity of excavation as Structure Excavation Common, Structure Excavation Solid Rock, or Structure Excavation Unclassified in cubic yards, as applicable, which will be complete compensation for all excavation, disposal, backfill, and all other incidentals necessary to prepare a suitable foundation.

When Foundation Preparation is a bid item, the Department will pay for Foundation Undercut as Extra Work.

603.04.08 Cofferdams. The Department will not measure the quantity unless it is listed as a separate bid item and will consider it incidental to the bid item Structure Excavation or Foundation Preparation.

603.04.09 Foundation Seals. The Department will not measure the quantity unless it is listed as a separate bid item or the work is directed by the Engineer.

603.05 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

Code	Pay Item	Pay Unit
8002	Structure Excavation Solid Rock	Cubic Yard
8001	Structure Excavation Common	Cubic Yard
2203	Structure Excavation Unclassified	Cubic Yard
2210	Borrow Excavation	See Section 205.05
2200	Roadway Excavation	See Section 204.05
8003	Foundation Preparation	Lump Sum

The Department will consider payment as full compensation for all work required under this section.

SECTION 604 ¾ BEARING PILES

604.01 DESCRIPTION. Furnish and drive prestressed concrete, precast concrete, cast-in-place concrete, or HP shape structural steel bearing piles.

604.02 MATERIALS AND EQUIPMENT.

604.02.01 Concrete. Conform to Subsection 601.02 and 601.03.

604.02.02 Structural Steel. Conform to Section 812.

604.02.03 Welded Steel Pipe Piles (Cast-In-Place Pile Shells). Conform to ASTM A 252, Grade 3.

604.02.04 Miscellaneous Metals. Conform to Section 813.

604.02.05 Polypropylene Sleeves. Conform to the manufacturer's recommendations.

604.02.06 Pile Points. Conform to AASHTO M 103, Grade 65/35 or ASTM A 148. Furnish pile points from a supplier on the Department's List of Approved Materials.

604.02.07 Equipment for Driving.

A) Hammers. Provide hammers for driving precast or prestressed concrete piles that develop a minimum energy per blow at each full stroke of the piston of more than one foot-pound per each pound weight of pile being driven. Use 150 pounds per cubic foot as the weight of concrete in the pile being driven. Use a hammer that develops a total energy of 12,000 or more foot-pounds per blow.

Provide hammers for driving steel piles or steel shells for cast-in-place piles that develop a minimum energy of 5,000 foot-pound for each ton of steel in the pile or shell being driven and in no case develop less than 10,000 foot-pounds of total energy.

Use diesel powered pile hammers with a ram weighing at least 2,000 pounds to drive steel piles, concrete piles, and steel shells for cast-in-place piles. For hammers that do not restrict the rebound of the ram use a ram 2,000 pounds or more.

If hammers with an enclosed ram are used, they will have a rated equivalent energy of no less than 250 foot-pounds per blow per ton of the required bearing. For driving concrete piles, use hammers that have a rated equivalent energy of 15,000 foot-pounds or more per blow. Equip hammers of this type with a gage and charts that will evaluate the equivalent energy actually produced under any driving conditions.

When the Engineer determines the size of the hammer to be unsatisfactory, correct or replace it to produce satisfactory results. Provide the Engineer with the manufacturer's specifications regarding hammers on request.

B) Leads. Use pile driver leads that allow freedom of movement to the hammer and ensure proper distribution of hammer blows on the head of piles. Hold leads in position with guys, stiff braces, templates, or other Engineer approved means for supporting the pile during driving.

C) Followers. Avoid driving piles with followers if possible. Use followers only with the Engineer's written permission or when driving piles through water. If using followers, drive one long pile from every group of 10 without a follower, and use this pile to determine the average bearing power of the group.

D) Water Jets. The Department will allow the use of water jets alone or in combination with a hammer. Provide sufficient water volume and pressure at the

jet nozzles and number of jets to freely erode materials adjacent to the pile. When using water jets and a hammer for driving, withdraw external jets or stop jetting, and drive the piles with the hammer to secure final penetration. Consider the difficulties encountered in driving when determining the time of withdrawal of jets. Vary this procedure until obtaining the desired results.

604.03 CONSTRUCTION.

604.03.01 General.

A) Precast and Prestressed Concrete Piles. Construct according to Section 605.

B) Cast-In-Place Piles. Construct according to Section 601. Use Class D or D Modified concrete, according to the Contract. Use welded steel pipe pile shells of the design and dimensions specified in the Plans. Select a wall thickness for steel shells that is sufficient to withstand driving without injury and to resist harmful distortion and buckling due to soil pressure after driving. Use only watertight shells to exclude water during the placement of the concrete. For pile shells with a fluted or corrugated section, measure the diameter of the shells from crest to crest of flutes or corrugations. Use only shells equipped with heavy steel ends and with welded joints.

C) Steel Piles. Use HP shape piles.

604.03.02 Limitations of Use. Penetrate 10 feet or more into original ground and 10 feet or more below stream bed, or to rock. In all cases, develop the required bearing value with the pile penetration.

For foundation work, do not penetrate a very soft upper stratum overlying a hard stratum unless the piles penetrate the hard material a sufficient distance to rigidly fix the ends.

The Department will allow the driving of precast concrete piles and prestressed concrete piles 3 calendar days after casting or any time thereafter provided that samples of concrete taken from the respective mixture indicate a compressive strength of at least 4,000 psi for Class D concrete or 5,000 psi for Class D Modified concrete.

604.03.03 Storage and Handling. Store and handle piles in a manner that avoids injury to the piles.

604.03.04 Preparation for Driving.

A) Excavation. Do not drive piles until after completing excavation, except for test piles and for piles that extend above the ground in the completed structure. Sufficiently excavate the area in the vicinity of the test piles before driving them to ensure that the test piles are driven only through material that will not be excavated later in constructing the footing. Ensure that the Department allows driving test piles before excavating for the entire footing. Remove all material forced up between the piles to the correct elevation before placing concrete for the foundation.

B) Caps. Protect the heads of all precast concrete piles and prestressed concrete piles with caps of approved design having suitable cushion next to the pile head and fitting into a casting which in turn supports a timber shock block.

Cut the heads of steel piles squarely. Provide a driving cap or head that has been properly grooved or made in some manner to fit and hold firmly the head of the pile being driven so that the axis of the pile is in line with the axis of the hammer.

Protect tops of steel shells for cast-in-place piles with driving heads, mandrels, or other devices properly sized for the hammer according to the hammer manufacturer's recommendations to properly distribute the hammer blow and to prevent damage to the shell during driving.

C) Pointing. For steel piles, provide cast steel points when specified or directed in order to obtain penetration. Use pile points of the type specified in the Contract or by the Engineer. Weld pile points to the pile with a minimum 5/16 inch groove weld along the full outside width of each flange on the pile. Install pile points in the shop or in the field. Furnish a mill test report according to Subsection 607.03.13 C). Furnish the Engineer with the manufacturer's specifications.

D) Extensions, Build-Ups, and Splices. The Engineer may allow extensions, splices, or build ups when necessary as follows:

1) Precast and Prestressed Concrete Piles. Perform extension or build-ups according to the Standard Drawings. If alternate methods for extensions or build-up is desired submit proposal to the Engineer for consideration.
2) Cast-in-Place Piles. Make extensions, splices, or build-ups on steel shells as specified in the Plans or as directed.
3) Steel Piles. Make extensions or splices according to the standard drawings or the Division of Construction's Guidance Manual. Weld according to Subsection 607.03.07.

604.03.05 Methods of Driving and Placing. With the Engineer's written permission, water jet or core holes for prestressed, precast, or cast-in-place concrete piles, and then place piles in the holes and drive them to secure the last few feet of their penetration. Do not jet or core holes for steel piles unless the Engineer directs. Unless otherwise specified in the Plans or directed, prepare jetted or cored holes in compacted fills as necessary to secure the required penetration. Core holes to a maximum diameter equal to the least cross sectional dimension of the piles driven. Fill all voids that occur around a driven pile with free flowing sand.

Do not drive piles in the vicinity of recently placed concrete until the concrete is sufficiently cured to prevent damage, in the judgment of the Engineer.

For cast-in-place piles, drive the shells using steel heads having a projecting ring fitting inside the shell. Provide a 1/4 inch clearance between the ring and the shell. The Department will allow the use of other types of driving heads if the Engineer approves. The Department will not require painting the steel shells. Provide an inspection light before and during the shell filling operation. Remove and replace improperly driven, broken, or otherwise defective shells, or otherwise correct them to the Engineer's satisfaction by driving an additional pile. The Engineer will inspect all driven shells. When the Engineer approves the driven shells, cut them off to a horizontal plane at the required elevation.

Before placing concrete, remove all water or debris from the shell. Place concrete in an approved manner that will ensure against segregation. Do not place concrete until completely driving all piles within a radius of 16 feet of the shell to be filled or until completely driving all the shells for any one bent or foundation. Continuously place the concrete in each pile, and exercise proper care to fill every part of the shell and to ensure a dense, homogeneous mixture.

The Engineer will not require steel reinforcement in cast-in-place piles unless specified in the Plans. When specified, use the type and design of reinforcement specified in the Plans.

Ensure that the finished tops of piles are at the elevation specified in the Contract or directed by the Engineer and that they project no less than 6 inches into pier footings and no less than 3 feet into end bents.

604.03.06 Test Piles. Drive test piles of a length and at the location designated on the plans or determined by the Engineer. These piles shall be of greater length than the length assumed in the design in order to provide for any variation in soil conditions.

Test Piles are for the Engineer's use in determining capability of the Contractor's equipment and adequacy of design. The Engineer will determine when an adequate bearing value has been obtained. The Contractor shall be responsible for determining pile

lengths that may be necessary to obtain the required bearing values. No claim shall be made against the Department for costs of construction delays, or any materials, labor, or equipment, that may be necessary due to the Contractor's failure to furnish piles of a length sufficient to obtain the required bearing values, or for variations in length due to subsurface conditions that may be encountered.

The same model and size pile hammer shall be used to drive the remaining piles in the structure as the one used to drive the test pile. The same type of piles shall be used in the remainder of the group as the type tested for the group.

Soundings, boring logs, soil profiles, or other subsurface data included in the Contract documents are used by the Department for making preliminary estimates of quantities and should not be used for determining equipment, materials, or labor necessary for driving piles as required by the contract. All test piles shall be accurately located so they may be used in the finished structure.

604.03.07 Determination of Bearing Values. The Engineer will determine when each pile in the structure has obtained an adequate bearing value. Determine the pile lengths necessary to obtain the required bearing values. The Department will determine bearing values by the specified formulas. When specified in the Contract or directed by the Engineer, the Department will determine the bearing values by static load test. Drive piles to develop a bearing value of no less than that specified in the Plans, directed by the Engineer, or determined by static load testing. When using water jets or cored holes in connection with driving, withdraw the jets or drive the piles in the cored holes, then the Department will determine the bearing value.

A) Static Load Tests. When specified in the Contract or required by the Engineer, the Department will determine the size, number, and bearing value of piles by actual loading tests. Perform load test according to plans or proposal notes.

B) Formula. In the absence of load tests, the Department will determine the allowable bearing values for piles by the following formulas:

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

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

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

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

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

Where:

P = allowable bearing capacity in pounds;
W = weight in pounds, of striking parts of hammer;
H = height of fall in feet;
S = the penetration in inches per blow for the last 5 to 10 blows for gravity hammers and the last 10 to 20 blows for steam, air, or diesel hammers; and
E = 90 percent of the average equivalent energy in foot-pounds as determined by gage attached to pile hammer and recorded during the period when the penetration per blow is being observed.

The Department will use the preceding formulas only when:

1) the hammer has a free fall,
2) the head of the pile is not broomed or crushed,
3) the penetration is reasonably quick and uniform, and
4) there is no observed appreciable bounce after the blow.

604.03.08 Allowable Variation in Driving. Use templates when specified or directed.

A) Exposed Piles. The Engineer will not accept exposed piles in the finished structure when:

1) during driving, the pile varies more than 1/4 inch per foot from vertical or the batter position specified in the Plans;
2) the driven pile varies more than 4 inches from plan position at the pile cut-off elevation; or
3) the driven pile varies more than 2 inches from a stringline stretched between exterior piles in the exposed portion of the pile bent or group.

B) Unexposed Piles. The Engineer will not accept unexposed piles in the finished structure when:

1) during driving, the pile varies more than 1/4 inch per foot from vertical or the batter position specified in the Plans; or
2) the driven pile varies more than 6 inches from plan position at the pile cut-off elevation.

For either case, the Engineer will reference the plan position of the pile cut-off elevation to determine the variation of 1/4 inch per foot. For all piling that is unacceptable because of variations, remove and replace or redrive them in an acceptable position or correct them in a manner the Engineer directs. Furnish and place all additional concrete and steel reinforcement required to meet plan clearance and dimensions in footings, caps, or bridge seats due to variations in driving, even when variations are within allowable tolerances.

604.03.09 Design Modifications. When it is not possible to obtain the capacity required by the Plans, the Department will redesign the structure based on the actual bearings obtained by test piles or pile load tests.

604.03.10 Ordering Piles. Order piles of the number and lengths necessary to complete the work.

604.03.11 Pile Protection. When specified in the Contract, provide protection from negative skin friction as the Contract specifies.

604.03.12 Unused Pile Lengths. Take ownership of unused lengths of piles and pile cutoffs, and remove such lengths and cutoffs from the project.

604.04 MEASUREMENT.

604.04.01 Piles. The Department will measure the quantity in linear feet for the total lengths of the various types and sizes. Splices are incidental to this item of work.

For precast or prestressed concrete piles having concrete removed in order to expose the reinforcing steel, the Department will consider the end of the exposed reinforcing steel as the pile end for purposes of measurement.

The Department will not measure unused lengths of piles or pile cutoffs for payment.

The Department will not measure corrective work or redriven piles.

The Department will not measure any additional concrete or steel reinforcement required to meet plan clearance and dimensions in footings, caps, or bridge seats due to variations in driving, even when variations are within allowable tolerances.

604.04.02 Pile Points. When included as a bid item, the Department will measure the quantity by each individual unit.

604.04.03 Test Piles. For test piles actually used as a pile in the structure, the Department will measure the quantity according to Subsection 604.04.01 except that the minimum measured length for test piles will be the length specified in the Plans or directed by the Engineer. The Department will not measure unsatisfactory test piles that are not used as a pile in the structure.

Length of test piles specified in the Plans are approximate only. The Department will not measure necessary splices for payment and will consider them incidental to this item of work.

604.04.04 Loading Tests. The Department will measure the quantity by each individual unit. The Department will not measure for payment load tests made at the option of the Contractor.

604.05 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

Code	Pay Item	Pay Unit
8080, 8082, 8086, 8096	Piles, Prestressed Concrete, Size	Linear Foot
8072	Piles, Cast-in-Place, Size	Linear Foot
8042-8056	Piles Steel, Size	Linear Foot
8093-8095	Pile Points	Each
8033	Test Piles	Linear Foot
8040	Loading Tests	Each
8060-8066	Piles-Precast Concrete, Size	Linear Foot

The Department will consider payment as full compensation for all work required under this section.

SECTION 605 ¾ PRESTRESSED AND PRECAST CONCRETE PRODUCTS

605.01 DESCRIPTION. Construct precast prestressed concrete members.

Provide complete members, including all steel and other materials. Members include I-beams, box beams, barrier walls, deck units (box beams and slab), box culverts, and piling and other structural items.

Fabricate according to the Department's Precast and Prestressed Concrete Products Inspector's Manual.

605.02 MATERIALS AND EQUIPMENT.

605.02.01 Concrete. Conform to Subsection 601.02 and 601.03.

605.02.02 Steel Reinforcement. Conform to Section 811.

605.02.03 Prestressing Strands. Conform to Section 811.

605.02.04 Non-Shrink Grout. Conform to Subsection 601.03.

605.02.05 Forms. Conform to Subsection 601.02. Only use metal forms for prestressed sections, except that wooden bulkheads are acceptable. Ensure that all forms are accessible for vibrating, tamping, and consolidating the concrete. Only use non-petroleum based form release compounds.

605.02.06 Styrofoam. Use material the Engineer approves.

605.02.07 Cardboard. Use material the Engineer approves.

605.02.08 Batching Plant Equipment. Conform to Subsection 601.02.

605.02.09 Plant Certification. Ensure that all prestressed and precast concrete products supplied to Department of Highways' projects are manufactured in a Certified Plant.

A) Requirements. For a plant to become a Certified Plant, ensure that the producer has the following:

1) A production facility and other necessary equipment that conform to the Contract requirements.
2) A quality control program conforming to Division 100 of the Department's Precast and Prestressed Concrete Products Inspectors Manual.
3) An acceptable record of production of quality products.
4) Concrete technicians responsible for design of the concrete mixture and for performing quality control and process control testing, as required in Subsection 605.02.09 and Division 300 of the Department's Precast and Prestressed Concrete Products Inspectors Manual. Ensure that the concrete technicians are certified as ACI Level I and KRMCA Level II as awarded by the KRMCA.

   A Level I concrete technician is responsible for quality control tests such as air content, slump, and molding cylinders. A Level II concrete technician is responsible for supervising this testing.

   The Engineer may require retesting or re-certification as deemed necessary.

B) Application for Certification. Each year, ensure that the plant submits a

written application for plant certification before January 1 to the Division of Materials. Ensure that the plant submits an application for re-certification when transferring plant ownership.

Ensure that the plant includes the following items with the application:

1) Company name, plant address, the principle officers of the company, plant manager, production superintendent, and quality control supervisor.
2) The names and certification levels of the concrete technicians responsible for design of the concrete mixture and for performing the required quality control and process control testing.

The Department will place any plant that has not previously manufactured products for the Department on a one-year probationary period before qualifying it as a Certified Plant.

C) Additional Prestressed Concrete Certification. Ensure that all prestressed concrete members supplied to the Department are manufactured in a plant that is certified under the appropriate Prestressed Concrete Institute quality control program and is designated as a PCI Certified Plant.

605.02.10 Concrete Production. During production of concrete products, ensure that the producer conforms to all requirements of the Contract, and ensure that the concrete technicians perform all quality control and process control testing required by the Precast and Prestressed Concrete Products Inspectors Manual.

The Inspector will perform the inspection duties established by the Department for the item being produced, including but not limited to the duties in the Department's Precast and Prestressed Concrete Products Inspectors Manual. If, at any time, the producer is not abiding by the certification requirements, the Inspector will reject or accept those products not manufactured according to the Contract requirements as specified in Subsection 105.04. If a plant consistently produces products not conforming to the requirements as set forth in this agreement, the Department will revoke its certification, and the plant may not longer produce products for Department projects until the plant corrects all deficiencies and regains certification.

605.03 CONSTRUCTION. For prestressed concrete deck units, use Class D Modified concrete of either Type I or Type III cement, except do not allow the cement factor to exceed 800 pounds per cubic yard. Construct prestressed members other than concrete deck units of Class D concrete that uses either Type I or Type III cement, except do not allow the cement content to exceed 800 pounds per cubic yard.

When the ambient temperature is 71 °F or higher, add a water reducing and retarding admixture to the concrete mixture for prestressed concrete products. The Engineer may direct or allow the use of water reducing and retarding or water-reducing admixture.

605.03.01 Mixing and Batching. Conform to Subsection 601.03.

605.03.02 Forming. Construct formwork according to Subsection 601.03.

When the ambient temperature is above 80 °F, fog spray forms exposed to direct sunlight with water in order to cool the forms before placing the concrete mixture. When the ambient temperature is below 41 °F, heat forms left unprotected from the weather with steam or other Engineer approved methods, unless the temperature of the concrete mixture to be placed is maintained at 60 °F or greater.

Fabricate voids of styrofoam or from cardboard that has been treated with a waterproofing agent. Glue and band all voids made by stacking more than one piece of material to prevent separation during concreting operations. The Engineer will regard any evidence of separation as cause for rejection.

605.03.03 Casting. Cast all members in the horizontal position. Accurately place all steel, when required, as shown or directed. Dimensions shown from the face of

concrete to steel are clear distances. Spacings are from center to center of steel. Place and securely tie all steel reinforcement before placing concrete, unless the Engineer requires or allows otherwise.

For concrete batching equipment and procedures, conform to Section 601. Do not begin concreting operations when the wind chill factor at the site is consistently 0 °F or less.

Place concrete continuously in each section, vibrating internally or externally or both to consolidate the concrete. Overfill the forms, screed off the surplus concrete, and finish the top surfaces to a uniform, even texture comparable to the finish produced by the forms.

Give the top surfaces to be bonded to other concrete a rough finish. Initially, float finish the surfaces. Perform further finishing before the concrete takes its initial set, by scoring the tops of the members transversely at approximately 3-inch centers with a pointed tool. Remove any laitance present during the finishing operations.

Vibrate in a manner that avoids displacement of any steel or enclosures and segregation of the concrete. Properly embed steel and enclosures in the concrete.

The Department will allow casting of members at the job site or at any location away from the job site. The Engineer will inspect members at the site of the casting, but will make final acceptance according to Subsection 105.12.

Determine the compressive strength of the concrete from cylinders cast from concrete placed in the members and cured in the same manner as the concrete represented by the cylinders. Cast and test cylinders according to KM 64-305 and ASTM C 39, respectively.

Imprint the name or trademark of the fabricator of I beams, box beams, or deck units in the concrete near the abutment end of the right fascia beam or deck unit, on the beginning end of each bridge. Cast the name or trademark into the concrete according to Subsection 601.03.19 for the plate used to imprint the construction date.

The Department will inspect, sample, and test precast units to determine their acceptability. The fabricator is responsible for providing quality control personnel as necessary to ensure the work performed complies with all requirements of the Contract.

Ensure that fabricators of prestressed concrete members furnish, as part of their quality control equipment, a pachometer for determining the depth of concrete cover over steel reinforcement. Furnish a meter that is acceptable to the Engineer. Make the pachometer available for use by both the fabricator's quality control personnel and by the Inspectors. Instead of tying, the Department will allow tack welding steel reinforcement in prestressed or precast concrete members, except for prestressing steel.

605.03.04 Tack Welding. If tack welding steel reinforcement, conform to the following conditions.

1) Indicate any proposed tack welding of steel reinforcement in prestressed members on the shop drawings.
2) Do not tack weld on the portion of hairpin stirrups in the web area of I beams, or on any steel reinforcement located in the top 5 1/2 inches of box beams.
3) Tack weld only at intersections of bars. Do not splice bars by tack welding. Although there are no numerical strength requirements for the completed tack welds, ensure that they adequately hold the crossing bars in their true position while placing concrete. Use as low a current as possible to preclude notching or undercutting and still provide a weld of the intended strength. The Department will reject notched or undercut damaged bars. Replace rejected bars as the Engineer directs.
4) Tack weld either by the shielded metal-arc process using only electrodes with low hydrogen classifications E7015, E7016, E7018, E7028, E9015, E9016, E9018, or E9028 according to AWS A5.1 or A5.5 as applicable; or by the gas metal arc process using electrode classification ER70S according to AWS A5.18. Only tack weld when the base metal temperature is above 35 °F. Either purchase electrodes having low hydrogen coverings in hermetically sealed containers or dry them for at least 2 hours at a temperature between 450 and 500 °F before using them. For those that conform to AWS A5.5, dry for at least one hour at

temperatures between 700 and 800 °F before using them. Immediately after drying, store electrodes in a storage oven held at a temperature of at least 250 °F. Before using, re-dry any E70 electrodes that are not used within 4 hours or E90 electrodes not used within one hour after removal from sealed storage or drying oven. Do not use any electrodes that have been wet.

5) Only use tack welding procedures and employ tack welders that are qualified biennially by the Division of Materials by tests as prescribed below. Use the same bar stock and type of tack welding equipment that is required for fabrication of the steel in qualifying tack welding procedures and tack welders. To qualify tack welding procedures, prepare and test 2 sample tack welds of the following sequence: #3 to #6T, #6 to #3T, #4 Epoxy to #5T, and #5 Epoxy #4T, to where T is the short bar of the welded intersection. Subject each sample to a tensile test across the point of the tack weld. Each sample must meet the minimum requirement for tensile and yield strength of the bar stock.

6) To qualify tack welders, prepare and test samples in the same manner as specified above for qualification of tack welding procedures. Prepare tack welds for qualifying procedures and tack welders in the presence of the Engineer. Request that the Engineer conduct such inspection at least 5 days in advance of welding the bar reinforcement with the welders being qualified. Assemble all necessary equipment, personnel, and materials, and perform any experimental work to qualify tack welders and tack welding procedures in a reasonably short and continuous period of time. The Department will not disqualify the tack welding procedure or the tack welder for failure to conform to the percentage of elongation specified for the steel bars used.

7) Tack weld hair-pin stirrups and longitudinal bars according to ANSI/AWS D1.4, Table 5.2 as follows:

MINIMUM PREHEAT AND INTERPASS TEMPERATURE [(1),(2)]

Carbon Equivalent[(3),(4)] Range, %	Size of Reinforcing Bar	Shielded Metal Arc Welding with Low Hydrogen Electrodes, Gas Metal Arc Welding, or Flux Cored Arc Welding Minimum Temperature °F
Up to 0.40	Up to 11 Inclusive	none[(5)]
	14, 18	50
Over 0.40 to 0.45 Inclusive	Up to 11 Inclusive	none[(5)]
	14, 18	100
Over 0.45 to 0.55 Inclusive	Up to 6 Inclusive	none[(5)]
	7 to 11 Inclusive	50
	14, 18	200
Over 0.55 to 0.65 Inclusive	Up to 6 Inclusive	100
	7 to 11 Inclusive	200
	14, 18	300
Over 0.65 to 0.75	Up to 6 Inclusive	300
	7 to 18 Inclusive	400
Over 0.75	7 to 18 Inclusive	500

[(1)] When reinforcing steel is to be welded to main structural steel, conform to ANSI/AASHTO/AWS D1.5-88, Table 4.4, "Minimum Preheat and Interpass Temperature" for preheat requirements of the structural steel. Conform to the higher minimum preheat requirement of the 2 tables. Exercise extreme caution when welding reinforcing steel to quenched and tempered steels,

satisfy the preheat requirements for both. If not possible, do not use welding to join the two base metals.

(2) Do not weld when the ambient temperature is lower than 0 °F. When the base metal is below the temperature listed for the welding process being used and the size and carbon equivalent range of the bar being welded, preheat so the cross section of the bar for not less than 6 inches on each side of the joint is at or above the specified minimum temperature. Ensure preheat and interpass temperatures are sufficient to prevent crack formation.

(3) After welding is complete, allow bars to cool naturally to ambient temperature. Do not accelerate cooling.

(4) Determine the carbon equivalent of as follows:

(a) Where it is impractical to obtain chemical analysis, assume the carbon equivalent to be above 0.75%. Ensure certified prestressed plant furnishes on the mill test report, the carbon equivalent for each heat of reinforcing steel intended to be tack welded.

(b) For all steel bars, except those designated as ASTM A706, calculate the carbon equivalent using the chemical composition, as reported in the mill test report, using the following formula:

$$C.E. = \%C + \%Mn/6 \qquad \text{(Eq. 1)}$$

(c) For steel bars designated ASTM A706, calculate the carbon equivalent using the following formula:

$$C.E. = \%C + \%Mn/6 + \%Cu/40 + \%Ni/20 + \%Cr/10 - \%Mo/50 - \%V/10 \qquad \text{(Eq. 2)}$$

Ensure the carbon equivalent does not exceed 0.55% (for ASTM A706 bars only).

(d) When the base metal is below 32 °F, preheat it to at least 68 °F and maintain at this temperature during welding.

605.03.05 Special Requirements for Prestress Plants.

A) Hot Weather Production. In addition to the requirements of Subsection 605.03, ensure that the producer applies the following requirements to outdoor prestress operations:

1) When the ambient temperature is above 80 °F sprinkle or fog spray coarse aggregates.
2) Discontinue concreting operations when ambient temperatures are between 90 and 100 °F if the producer cannot effectively maintain form and concrete temperatures below 90 °F.
3) Discontinue concreting operations when ambient temperatures are above 100 °F.

B) Drawings. Have the producer submit drawings conforming to applicable requirements of Subsection 607.03 for prestressed girders. Include with the shop drawings a detailed drawing, including the total number of stirrups, for each different mark number and a diagram of the detensioning procedure. The Department will not require reproducible drawings. Obtain the Department's completed drawing review prior to releasing fabrication.

C) Safety Measures. Ensure that the producer takes effective safety measures to prevent injuries to personnel due to the breakage of strands or failure of anchorage devices during the tensioning operations. Ensure that the producer

provides adequate protection that allows the Inspector to perform his normal duties. The Inspector will report any safety precautions deemed inadequate to the Division of Materials. The Inspector will abide by the safety rules established by the producer, provided that they do not interfere with his normal duties.

D) Prestressing. Ensure that the producer performs prestressing by pretensioning and provides a skilled technician knowledgeable of the pretensioning system used.

Ensure that the producer conforms to the following:

1) Uses approved jacking equipment to perform prestressing.
2) When using hydraulic jacks, equips them with calibrated pressure gages. Calibrates the combination of jack and gage to an accuracy of ± 2 percent, and furnishes a graph or table showing the calibration to the Engineer. If using other types of jacks, furnishes calibrated proving rings or other devices to accurately determine jacking forces.
3) Accurately holds prestressing elements in position to stress by jacks.
4) Applies an initial force to each strand in beams or girders such as to develop a stress of 189,000 psi or such other stress as specified in the Plans.
5) Maintains a record of the jacking force and elongations produced thereby.
6) If desired, cast several units for precast sections in one continuous line, but stress them one at a time.
7) Does not transfer prestressing forces to any member or release end anchors before the concrete has attained a minimum compressive strength of 4,000 psi, as determined by tests of standard cylinders cured identically as the member. The Department may require a higher strength.
8) Removes forms and detensions prestressed members immediately after discontinuing steam curing or heat curing while the concrete is still warm and moist, when using either of these methods for curing.
9) Cuts or releases the elements in an order that minimizes the lateral eccentricity of the prestressing.
10) The Engineer will reject beams or girders having honeycomb of such extent to affect their strength or resistance to deterioration.
11) Makes an allowance of 0.0005 times the length for shortening of beams and girders as a result of shrinkage and elastic change.

E) Curing. Cure according to Subsection 605.03.06 except the producer may discontinue curing after the concrete reaches the detensioning strength.

F) Removal From Forms. The producer may remove and store precast, prestressed members from the casting beds after the prestress force has been applied, provided the Engineer approves arrangements for curing and protecting. Ensure that the producer conforms to the following:

1) Fills all air voids in the inclined surfaces of all I beams with grout.
2) Ensures that strand hold-down devices that remain in place are either a minimum of 1/2 inch from the surface of the concrete or are galvanized.
3) Patches all cavities.
4) The producer may use other type devices when the Engineer approves them. Complete all finishing operations on prestressed bridge beams within 48 hours of detensioning, except masonry coating, curbs, and damage repair as the Engineer directs.

605.03.06 Curing. Cure members either by water curing according to Subsection 601.03.17 or by rapid curing with low pressure steam or radiant heat.

Perform low pressure steam curing or radiant heat curing under an enclosure capable of adequately containing the live steam or radiant heat. Use enclosures that allow free circulation of steam or heat about the sides, ends, and tops of members and are constructed to contain the live steam with a minimum moisture loss. The Department will allow the

use of tarpaulins or similar flexible covers that remain in good repair. Secure the tarpaulins in a manner that prevents the loss of significant steam and moisture. Allow concrete to attain its initial set before applying the steam or heat. After placing the concrete, allow an initial set period of not less than 2 hours before applying the steam or heat. When using water reducing and retarding admixtures, increase the initial set period to 4 hours. The Department will allow determination of the time of initial set using ASTM C 403 and waive the time limits specified herein when the initial set has been reached as determined by the referenced test. Prevent surface drying during the period between placing the concrete and applying the steam or heat by covering the members after casting or by keeping the exposed surfaces wet with a fog spray or a double layer of wet burlap. During the waiting period, do not allow the temperature within the curing chamber to fall below 50 °F. Use live steam or radiant heat to maintain the curing chamber at the proper minimum temperature.

During the initial application of live steam or radiant heat, allow the ambient temperature within the curing enclosure to increase at an average rate not exceeding 40 °F per hour until reaching the curing temperature within the enclosure. Do not allow the maximum curing temperature within the enclosure to exceed 160 °F.

Apply live steam on the concrete forms in a manner that does not cause localized high temperatures.

Apply radiant heat using pipes circulating steam, hot oil, or hot water. Perform radiant heat curing under a suitable enclosure to contain the heat, and minimize moisture loss by covering all exposed concrete surfaces with a plastic sheeting. Provide a method of maintaining moisture satisfactory to the Engineer.

Water cure precast, non-prestressed, non-post-tensioned items for 3 days or rapid cure them with steam or heat overnight. The Department will allow curing to cease when the acceptance strength is reached as shown by test cylinders.

605.03.07 Removal of Forms and Surface Finish. The Department will allow the removal of side forms at any time when no distortion, slump, or misalignment of the concrete will result. Ensure that all surfaces are free from rough, open, or honeycombed areas, and appreciable depressions or projections. Finish or chamfer edges as directed. When removing the forms, avoid spalling or otherwise damaging the concrete. Finish members that will be exposed in the finished work according to Subsection 601.03.18. Repair vents opened to relieve air pressure in box beams during curing using non-shrink grout.

605.03.08 Dimensional Tolerances. Ensure that the producer furnishes members within the tolerances of the following tables. The Engineer will condition final acceptance upon satisfactory placement of the units in the structure.

I-BEAMS, BOX BEAMS WITH CAST-IN-PLACE SLAB, AND PRECAST BARRIER UNITS	
Depth (flanges, web, and fillets)	± 1/4 inch
Depth (overall)	+ 1/2 inch to – 1/4 inch
Width (flanges and fillets)	+ 3/8 inch to – 1/4 inch
Width (web)	+ 3/8 inch to – 1/4 inch
Length of Beam	± 1/8 inch per 10 feet or 3/4 inch, whichever is greater
Exposed Beam Ends (deviation from square or designated skew)	Horizontal ± 1/4 inch; Vertical ± 1/8 inch per foot of beam height
Side Inserts (spacing between centers of inserts and from the centers of inserts to the ends of the beams)	± 1/2 inch
Bearing Plate (spacing between the centers of bearing plates)	± 1/8 inch per 10 feet or 1/2 inch, whichever is greater
Bearing Plate (spacing from the centers of bearing plates to the ends of the beams)	± 1/4 inch
Bearing Plate or Bearing Area (deviation from a level plane)	± 1/8 inch
Stirrup Bars (projection above top of beam when design projection is more than 3 inches)	± 3/4 inch
Stirrup Bars (projection above top of beam when design projection is 3 inches or less)	± 1/2 inch
Stirrup Bars (long, spacing, anchorage zone)	± 1/2 inch
Stirrup Bars (long, spacing)	± 1 inch
End Stirrup Bars	Not more than 2 inches from the end of the beam
Horizontal Alignment (deviation from a straight line parallel to the centerline of beam)	1/8 inch per 10 feet
Camber of precast barrier units	± 1/4 inch per 10 feet
Camber differential between adjacent beams	1/8 inch per 10 feet of span to 1 inch max.
Center of gravity of strand group	± 1/4 inch
Strand positioning	± 1/4 inch
Center of gravity of depressed stand group at the end of beam	± 1/2 inch
Position of hold-down points for depressed stands-longitudinal	± 6 inches
Position of handling devices-longitudinal	± 6 inches
Position of material for debonding of strands	± 1 inch

DECK UNITS (Box Beams and Slabs)	
Depth (top slab, box beam)	± 1/2 inch
Depth (bottom slab, box beam)	± 1/2 inch
Depth (overall)	± 1/4 inch
Width (web, box beam)	± 3/8 inch
Width (overall)	± 1/4 inch
Length	± 1/8 inch per 10 feet or 3/4 inch, whichever is greater
Void position-longitudinal (flat slab)	± 1/2 inch from end of void to center tie hole; ± 1 inch adjacent to end block
Void position-transverse and vertical (flat slab)	± 1/2 inch
Square ends (deviation from square)	± 1/4 inch
Skew ends (deviation from designated skew) Skew angle equal to or less than 30° Skew angle greater than 30°	± 1/2 inch
Bearing plate or bearing area plane (deviation from level plane) (Bearing plate or bearing area plane must be an evenly distributed 80 percent of true plane, when tested with a straightedge.)	± 1/8 inch
Horizontal alignment (deviation from a line parallel to the centerline of member)	1/4 inch, up to 40 feet length; 3/8 inch, over 40 feet and up to 60 feet in length; 1/2 inch, over 60 feet in length
Dowel tubes (spacing between the centers of tubes and from the centers of tubes to the ends and sides of the member)	± 1/2 inch
Tie rod tubes (spacing between the centers of tubes and from the centers of tubes to the ends of the member)	± 1/2 inch
Tie rod tubes (spacing between the centers of tubes to the bottom of the beam)	± 1/2 inch
Total width of deck	Theoretical width + 1/2 inch per joint
Camber differential between adjacent units	± 1/4 inch per 10 feet, 3/4 inch max.
Camber differential between high and low members in the same span	1 inch max.
Side inserts positioning	± 1/2 inch
Stirrup bar positioning	± 1 inch
Stirrup bar (long, spacing, anchorage zone)	± 1/2 inch
Strand positioning	± 1/4 inch
Handling device positioning	± 6 inches
Center of gravity of stand group	± 1/4 inch
Curbs placed separately on prestressed box beams (Applies to any portion 10 feet in length over the entire length of the beam)	± 1/4 inch per 10 feet
Position of material for debonding of strands	± 1 inch

PILING	
Width or diameter	- 1/4 + 3/8 inch
Head out of square	1/8 inch per 12 inches of width
Length of pile	± 1 1/2 inch
Horizontal alignment (deviation from a straight line parallel to the centerline of the pile)	1/8 inch per 10 feet
Void position-longitudinal	± 2 inches
Void position-transverse	± 1/2 inch
Void position-vertical	± 1/2 inch
Stirrup bars or spiral position	± 1 inch
Tendon positioning	± 1/4 inch
Center of gravity of strand group	± 1/4 inch
Handling device positioning	± 6 inches

605.03.09 Transportation, Storage, Handling, and Erection. Transport precast girders in an upright position, and keep the points of support and directions of the reactions with respect to the girder approximately the same during transportation and storage as when the girder is in its final position.

Prevent cracking or damage during storage, hoisting, and handling of precast units. Replace units damaged by improper storing or handling. Do not ship precast units to the Project prior to attaining the specified acceptance strength.

During erection of members, keep the bridge seats and tops of bearing devices free of foreign materials. While shifting members, lift members completely away from bearings.

Temporarily brace and tie each prestressed concrete I-beam, after erection, in a manner that will prevent sliding, tipping, or other movement that may result from high winds, creeping down grade, or other causes, until casting the diaphragms. Erect and brace at least 2 adjacent members in any one span before suspending operations for any one day.

Begin erecting deck units at the location designated or approved by the Engineer and proceed, one member at a time, across the roadway. After placing and fastening the units by transverse tie assemblies, fill longitudinal keys between the units with non-shrink grout and seal as specified in the Plans. Cure the non-shrink grout keys with 2 layers of wet burlap, or other approved covering, placed on the slab. Keep the non-shrink grout continuously moist for 3 or more calendar days, except cure commercial mixtures according to the manufacturer's instructions.

Do not place equipment used to lift deck units into place on a portion of the bridge which has been erected without obtaining the Engineer's approval.

605.04 MEASUREMENT. The Department will not measure the work required to qualify the tack welders and tack welding procedures for payment and will consider it incidental to the pay item for prestressed or precast members, except the Department will test the specimens at no expense to the fabricator.

605.04.01 Precast I-Beams. The Department will measure the quantity in linear feet. The Department will not measure bearing devices for payment and will consider them incidental to this item of work.

605.04.02 Precast Panels. The Department will measure the quantity according to Subsection 613.04.

605.04.03 Precast Box Beams. The Department will measure the quantity in linear

feet. The Department will not measure bearing devices for payment and will consider them incidental to this item of work.

605.04.04 Precast Concrete Median Barrier. The Department will measure the quantity according to Subsection 508.04.

605.04.05 Precast Piles. The Department will measure the quantity according to Subsection 604.04.

605.04.06 Prestressed Piles. The Department will measure the quantity according to Subsection 604.04.

605.04.07 Masonry Coating. The Department will measure the quantity according to Subsection 601.04.

605.05 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

Code	Pay Item	Pay Unit
8631-8634, 8639	Precast PC I-Beam, Type	Linear Foot
8635-8638	Precast PC I-Beam Modified, Size	Linear Foot
8628	Precast PC Panels	See Subsection 613.05
8651-8672	Precast PC Box Beam, Designation	Linear Foot
1953,1955, 1967, 1988, 1989, 1992,1999	Concrete Median Barrier, Type	Linear Foot
8060-8066	Piles-Precast Concrete, Size	See Subsection 604.05
8080, 8082, 8086, 8096	Piles-Prestressed Concrete, Size	See Subsection 604.05
2998	Masonry Coating	See Subsection 601.05

The Department will consider payment as full compensation for all work required under this section.

SECTION 606 ¾ BRIDGE RESTORATION AND WATERPROOFING WITH CONCRETE OVERLAYS

606.01 DESCRIPTION. This work shall consist of bridge deck restoration and waterproofing with latex concrete or low slump concrete overlays.

606.02 MATERIALS AND EQUIPMENT.

606.02.01 Concrete. Conform to Subsection 601.02 and 601.03.

606.02.02 Latex Admixture. Conform to Subsection 841.

606.02.03 Epoxy for Epoxy-Sand Slurry. Conform to Section 826.

606.02.04 Sand for Epoxy-Sand Slurry. Conform to Subsection 804.

606.02.05 Mortar Sand. Conform to Subsection 804 (for Grout-Bond Coat).

606.02.06 Latex Grout. Conform to Section 601.02.

606.02.07 Joint Materials. Conform to Section 807.

A) Filler. Use preformed expansion joint filler, Type II (cork).
B) Sealers. Use rapid cure silicone with closed-cell polyethylene foam back-up rod compatible with silicone sealant.

606.02.08 Concrete Curing Material. Conform to Section 823.

606.02.09 Structural Steel. Conform to Subsection 812 (for expansion dams and joint build up).

606.02.10 Equipment. Conform to Subsection 601.02 with the following exceptions and additions:

A) Mechanical Scarifiers or Grinders. Furnish mechanical scarifiers or grinders designed specifically for scarifying bridge decks that the Engineer approves. Ensure that the scarifier or grinder is capable of producing a surface matching the existing slab cross section and that each pass of the machine matches the previous pass in elevation.
B) Hammers. Provide hammers weighing 40 pounds or less.
C) Mixers. In addition to the requirements of Subsection 601.02, furnish continuous mixers having a latex admixture supply portion equipped with a cumulative-type meter that can be read to the nearest 0.1 gallon. Furnish continuous mixers having a water supply portion equipped with a flow meter or other suitable device for calibrating the water supply, and a cumulative type water meter that can be read to the nearest 0.1 gallon. Ensure that the latex and water meters are readily accessible, accurate to within ± one percent, and legible.
D) Hand Tools. In addition to the requirements of Subsection 601.02, furnish sufficient hand tools for placement of stiff, plastic concrete capable of working the concrete down to approximately the correct elevation for striking off with a screed.
E) Finishing Machine.

1) Low Slump Concrete Overlays. Ensure that the design of the finishing machine and the appurtenant equipment is capable of positive machine screeding of the plastic concrete to within one inch of the face of the existing

curbs, is of sufficient length to extend at least 6 inches beyond an intended longitudinal joint, and is of sufficient length to extend at least 6 inches beyond the longitudinal edge of a previously placed overlay. Furnish a finishing machine that is capable of forward and reverse motion under positive control. Furnish a machine capable of raising the screeds to clear the screeded surface when traveling in reverse.

a) Support Rails. Furnish a finishing machine having support rails upon which the machine travels that is capable of being placed outside the area to be surfaced and capable of extending beyond each end of the bridge.
b) Strike off. Furnish a finishing machine equipped with a strike off to provide a uniform thickness of concrete in front of the screeds and with 2 oscillating screeds to provide the specified crown.
c) Anchorage. Furnish anchorage for the supporting rails that is substantial enough to provide for rigid horizontal and vertical stability of the rails.
d) Screeds. Ensure that the front oscillating screed is designed to thoroughly consolidate the concrete by vibration to the required density. Install identical vibrators along the length of the front oscillating screed at 5 feet intervals. Furnish a front oscillating screed with a bottom width of at least 5 inches and a turned up or rounded leading edge to minimize tearing of the surface of the plastic concrete. Furnish screeds with an effective weight of at least 75 pounds for each square foot of bottom surface area. Provide each screed with positive control of the vertical position, the angle of tilt, and the slope of the crown. Ensure that the final screed oscillates and finishes without vibration.

2) Latex Concrete Overlays. Furnish a Department approved machine.

F) Brooms. Furnish brooms having bristles of sufficient stiffness to treat the surface after finishing.

G) Air Compressors. Furnish air compressors equipped with separators and traps.

605.02.11 Coarse Aggregate. Conform to Section 805, size 9-M.

606.03 CONSTRUCTION.

606.03.01 Scheduling. Notify the Engineer at least 12 hours before placing concrete for the overlay. The Department will not grant a time extension for delay in placing concrete resulting from the Engineer receiving less than the 12-hour notice.

606.03.02 Weather Limitations. Construct the overlay during the night time hours when the ambient temperature will remain below 85 °F, the wind velocity is low, and hot conditions or rain are not expected. During hot weather, place the concrete when the ambient temperature falls to 85 °F or below. Complete placement of concrete before the ambient air temperature reaches 85 °F. Do not place concrete when the ambient temperature away from artificial heat is less that 45 °F and falling, except when using Type III cement. Keep all concrete at a temperature above 45 °F for at least 96 hours after placing. Make provisions for the uniform distribution of heat, and do not allow any area of the concrete surface to be heated to a temperature above 85 °F. To accomplish uniform distribution of heat during cold weather, provide housing, heating, or insulation methods that the Engineer approves. Do not place concrete during rain or drizzle. If it begins to rain or drizzle during placement, cease placement and finish and protect the material already in place.

606.03.03 Removal of Concrete, Restoration of Reinforcement and Cleaning.

Treat the entire area of the deck between the curbs (roadway) and the ends of the structure (100 percent of the deck area) by machine preparation consisting of removal of concrete to a depth of at least 1/4 inch below the existing concrete surface. Machine prepare with mechanical scarifiers or grinders. If satisfactory results are not achieved, the Engineer may direct that the work be performed with other equipment. The Department will not require machine preparation on endwalls.

Remove epoxy, asphalt, foreign surfaces, and unsound patches in a manner approved by the Engineer. Sound concrete patches are to be left in place as determined by the Engineer. Do not use equipment that may cause damage to the underlying concrete.

Remove all other concrete that the Engineer deems unsound. Remove concrete within areas where the depth of removal exceeds 1/4 inch with hammers or other small equipment. Do not damage any steel reinforcement. Remove concrete to a depth of 3/4 inch below any reinforcing bar which is more than 50 percent exposed or that appears not to be bonded to the existing concrete. Protect any underlying sound concrete and steel reinforcement. Ensure that the periphery of routed areas is as nearly vertical as possible. If the removal of unsound concrete extends through two thirds of the concrete slab or more, remove and replace the remaining sound concrete for full depth patching. Ensure that all exposed steel reinforcement is tied according to Subsection 602.03.04.

Remove all inferior concrete in the deteriorated and spalled areas near joints and all joint filler. Reform the joints to exact width and true alignment according to Subsection 609.03.04 for open joints except when a timber template is used, cover it with polyethylene sheeting.

Blast clean all exposed steel reinforcement and structural steel according to Subsection 606.03.04 to remove scale, rust, grease, oil and other material that would prevent adhesion of the concrete. Before placing concrete, replace or supplement deteriorated or damaged reinforcement as the Engineer directs. Remove all dust and chips of asphalt materials, concrete, or other debris and clean the entire area with compressed air. Ensure that the compressed air is free of detrimental quantities of water, oil, grease, or any other injurious substances. Do not allow leakage of oil, grease, gasoline, or other substances from the compressor or other equipment on the deck. Suspend protective sheeting such as plastic or tarpaulins under all equipment that leaks.

Remove all spalled or deteriorated concrete in curbs, sidewalks, and plinths to a minimum depth of one inch. Blast clean, coat with a grout-bond coat, and restore to the original section with overlay material. Seal with epoxy-sand slurry.

Partial and/or full depth removal of concrete may be accomplished using hydrodemolition. Calibrate the hydrodemolition machine to remove only unsound concrete. Test the machine on an area of concrete as directed by the Engineer. Use potable water with a rust inhibitor. Collect and strain all waste water from the hydrodemolition operation. After hydrodemolition operation, sound deck to ensure that all unsound concrete has been removed. Protect all traffic under or adjacent to work area. Protect structural steel paint. Prior to any hydrodemolition operation, submit a hydrodemolition plan, in writing, for approval by the Engineer. In the hydrodemolition plan state type of machine, water pressure settings and methods to collect and strain waste water and protect traffic and structural steel.

606.03.04 Blast Cleaning. Blast clean the entire area of the deck surface and vertical faces of curbs, barrier walls, and plinths up to a height of one inch above the top elevation of the overlay, and areas to receive epoxy-sand slurry to a bright, clean appearance that is free from curing compound, laitance, dust, dirt, oil, grease, asphalt material, paint, and all foreign matter. Perform blast cleaning of an area of the deck within the 24-hour period preceding placement of the overlay on the area. If the project is done under traffic, perform all blast cleaning within 12 hours prior to placement of the overlay. Perform blast cleaning according to the regulations specified in Subsection 107.01.04.

Protect the blast cleaned areas with white plastic before placement of the overlay. Blast clean contaminated areas and areas exposed more than 24 hours (12 hours when under traffic) again as the Engineer directs. Remove or roll the white plastic between the mixer truck rear wheels and the overlay placement.

Hydro blasting may be used in lieu blast cleaning. Use hand held high pressure wands with potable water. Water blast the entire area of the deck. Prevent steel reinforcement from rusting.

606.03.05 Full Depth Patching. Fill full depth holes with Class M1 or M2 Concrete. Immediately before placing concrete, dampen and surface dry the contact surface. Then apply a grout-bond coat by vigorously scrubbing or brushing into the vertical surface of full depth routed areas. Proportion the grout mixture according to Subsection 601.03 using Type I cement. Carefully place the Class M1 or M2 concrete and tamp or vibrate into place. Rough-finish the full depth patched areas to an elevation corresponding to the scarified grade and cure for a period of no less than 7 calendar days, or until the overlay is placed, by means of a double layer of wetted burlap or similar material. If the full depth patch area is encompassed by an area of partial depth patching, finish the full depth concrete patch to an elevation corresponding to the bottom of the partial depth routed areas instead of the elevation of the scarified deck.

After the concrete has hardened sufficiently to maintain the proper shape, remove all joint templates. Avoid chipping or breaking down the edges of the repaired joint. Remove all forming material before completion of the project.

Provide temporary support for existing concrete handrails while removing and replacing full depth concrete. Submit the proposed method of supporting the handrails to the Engineer for approval before beginning work.

Blast clean the surfaces of all patched areas and remove sand before constructing the overlay. Complete all full depth patching in each lane before beginning overlay operations on that lane.

Place latex concrete overlays only when full depth patches have been placed for 24 hours or longer. Place low slump concrete overlays only after the full depth patches attain a compressive strength of 3,000 psi. Do not allow construction equipment on the full depth patches until they have attained a compressive strength of 4,000 psi.

606.03.06 Partial-Depth Patching. Fill areas in where concrete is routed to partial depths to the level of reinforcement or below with overlay material and prefill when a low slump concrete overlay is being used. Cure these areas as the overlay is cured until such time as the overlay is placed over the patch or the cure time expires. When latex concrete is used for the overlay, the Department may allow monolithic placement of the partial depth patches with the overlay.

606.03.07 Prohibited Field Welding. Do not perform welding on load carrying members of the bridge without the Engineer's written consent, and then only in the manner and at the locations designated.

606.03.08 Mixing and Placing. Mix concrete at the site by either batch or continuous mixers as the Engineer approves. Do not use truck mixers on low slump concrete overlays. Mix and deliver according to Subsections 601.03.07 and 601.03.08 except discharge within 20 minutes.

Submit to the Engineer for approval proposed methods for anchoring the finishing machine supporting rails to the deck.

Hold the formation of longitudinal joints and transverse joints to a minimum. When constructing longitudinal or transverse joints, thoroughly blast clean and coat with grout-bond coat material before placing plastic concrete against the hardened sides of the joints. Form longitudinal joints using a longitudinal header secured to the deck, 1/4 inch less in thickness than the overlay. Locate longitudinal joints along lane lines. After removal of the header, saw the overlay longitudinally 3 inches or more inside the formed edge and remove the portion of the overlay outside the saw cut before placing the adjacent portion of the overlay. The Department may allow alternate methods of constructing joints on latex overlays.

Produce the mixture at a uniform rate and perform finishing immediately after mixing.

606.03.09 Brooming. Immediately after finishing, broom the surface of the overlay transversely across the bridge deck from curb to curb. Texture the surface according to Subsection 609.03.10 immediately after finishing on new structure overlays, when specified in the Contract, and on Federal Aid projects.

606.03.10 Epoxy-Sand Slurry. After the overlay has been completed and cured, apply a thin coat (approximately 1/16 inch) of an epoxy-sand slurry to the 12 inches of the overlay adjacent to the curbs, concrete barrier walls, or other vertical walls. Extend the epoxy-sand slurry up the faces of the curbs and walls or other vertical walls and extend the epoxy-sand slurry up the faces and tops of the curbs and plinth according to the Standard Drawings. Thoroughly blast clean to a bright appearance and dry the areas to receive the epoxy-sand slurry before applying the slurry. Apply the slurry only after the deck has been dry for 24 hours. Place strips of masking tape along the joints to prevent the slurry from entering the joints and to ensure a straight line of slurry. Proportion the slurry as follows:

One Gallon of Component A
One Gallon of Component B
2 Gallons of dry, silica sand

The Engineer may allow minor adjustments in the quantity of sand in order to produce a more workable mixture. Thoroughly mix the ingredient materials for 3 to 5 minutes. Then spread the slurry and use a squeegee to completely fill the blast cleaned pitted areas, cracks, and rough surfaces. Finish the slurry to a thickness of no more than 1/16 inch. Sprinkle silica sand very lightly over the slurry to provide skid resistance.

The Department will allow placement of thoroughly mixed neat epoxy according to Subsection 510.03.

606.03.11 Cleaning and Sealing Joints. Rework each joint according to the Standard Drawings and as follows:

A) Joint Preparation. Remove any old sealant and joint filler. Use tools and techniques as approved by the Engineer.

When joint is dry, sandblast to remove all contaminants. Sandblast each joint a minimum of 2 passes, one for each face, with nozzle held at an angle to the joint face and within 1 to 2 inches of the pavement. After sandblasting, air blast each joint to remove sand and other contaminants. Air blast in only one direction to prevent recontamination of the joint. Compressed air used for air blasting will be at a pressure of at least 90 psi. The air compressor used will be equipped with traps capable of removing moisture, and oil from the air. Apply primer as recommended by the sealant's manufacturer.

B) Sealant Filler and Installation. Seal joints on same day that preparation occurs. When joints are prepared, but not sealed on the same day, sandblasting, removal of sand and debris, and primer application will be repeated as directed by the Engineer. Also any joint that has become contaminated will be recleaned as directed by the Engineer.

Prior to installation of sealant, each joint will be inspected by the Engineer for proper depth, width, alignment, and cleanliness. Install sealant at a minimum of 1/2 inch below the pavement face and in accordance with the manufacturers' recommendations.

606.03.12 Bridge End Transitions. Overlay the end sections of the bridge and finish as follows:

A) Rigid Approach. Set the finishing machine rails to provide a 50-foot transition on the ends of the bridge to match the finished grade of the overlay with the existing grade of the adjacent pavement. Remove the existing concrete as necessary to maintain the minimum specified thickness of the overlay.

B) Non-Rigid Approach or a Rigid Approach with Asphalt Overlay. The Department will not require a transition.

606.03.13 Expansion Dam Treatment. Treat the existing expansion dams according to the Standard Drawings. The Department will not require painting of structural steel.

606.03.14 Material Hauling. Haul all material for latex concrete or low slump concrete overlays with vehicles which do not exceed the regulation for either the legal axle weights or axle spacing contained in 603 KAR 5-066. Prior to doing any overlay work on a structure, furnish to the Engineer a certified statement listing the empty weight of each hauling vehicle, axle weights when empty, axle weights when fully loaded, gross weight of each vehicle when loaded with a specific number of cubic yards, and the spacing of axles. The Engineer will use this information for the purpose of determining the allowable quantity of materials to be hauled. The Engineer will determine the allowable quantity of materials to be hauled based on the capacity and condition of the bridge after the removal of unsound concrete and prior to the placement of the overlay. Under no circumstances will the Department allow loads which exceed legal gross or axle load limits.

606.03.15 Damage to Structures. Take responsibility for all damage to the structure during construction until all work is completed, including the replacement of entire spans that fail as a result of this construction.

606.03.16 Unacceptable Work. When the Engineer deems necessary, the Department will core any areas of the overlay that display extensive cracking or other characteristics indicating the waterproofing effectiveness or expected life of the overlay may be reduced, or that the overlay may not be intimately bonded to the underlying deck. Remove and replace with acceptable concrete all areas shown by the cores to either have cracks exceeding a depth of 1/4 inch or to not be intimately bonded to the underlying deck The Engineer may require removal and replacement without coring when significant cracking or lack of bond are apparent. Seal all cracks that are not significant enough to require removal of the overlay with a latex grout as the Engineer directs.

Correct all individual areas of hardened grooved concrete of 25 square feet or larger in which the texture is unsatisfactory using methods the Engineer approves.

606.03.17 Special Requirements for Latex Concrete Overlays.

A) Existing Bridges and New Structures.

1) Prewetting and Grout-Bond Coat. Thoroughly and continuously wet the blast cleaned areas to receive the overlay with water at least one hour before placing the overlay is started. Keep the areas wet and cooled with water until placing the overlay.

   Disperse or remove all accumulations of water before applying the grout-bond coat. Immediately ahead of placing the overlay mixture, thoroughly brush and scrub a thin coating of the latex concrete mixture to be used for the overlay onto the wetted surface as a grout-bond coat. Do not allow accumulations of coarser particles of the mixture which cannot be scrubbed into intimate contact with the surface.

   Apply the grout-bond coat only for a short distance in advance of placing the overlay. Do not allow the grout-bond coat to show any signs of drying before placing the overlay. Thoroughly recoat all areas showing signs of drying with fresh grout.

2) Proportioning and Requirements. Proportion as follows:

   When adjusting, ensure the mixture contains no less than 658 pounds per cubic yard of cement nor less than 24.5 gallons per cubic yard of latex admixture.

Material	Quantity
Type I or Type III Cement	94 lbs
Latex Admixture	3.5 gal
Fine Aggregate	215 to 245 lbs[1]
Coarse Aggregate	165 to 195 lbs[1]
Water[2]	22 lbs[1]

[1] *Determine actual quantities and submit to the Engineer for approval.*
[2] *Includes free moisture on the fine and coarse aggregates.*

Furnish latex concrete with the following properties:

Property	Value
Slump[1]	4 – 6 in (KM 64-302)
Maximum Air Content	7% (KM 64-603)
Maximum W/C ratio[2]	0.40
7 - day compressive strength[3]	3,000 psi

[1] *The Department will perform the slump test 4 to 5 minutes after discharging from continuous type mixers.*
[2] *Consider all the non-solids in the latex admixture as part of the total water.*
[3] *Attain a 28-day compressive strength of 4,000 psi when compressive strength is tested at 28 days or later due to unusual circumstances.*

3) Placing, Consolidating, and Finishing the Overlay. Place the latex concrete overlay on the blast cleaned and prewetted deck immediately after applying the grout-bond coat. The Department will require a minimum latex concrete overlay thickness of one inch except on textured finishes. On textured finishes, the Department will require a minimum latex concrete overlay thickness of 1 1/4 inches. Ensure that the surface of the overlay conforms to the existing deck section while maintaining the minimum thickness. The Engineer will determine the deck section in the field, including the cross slope or crown. Pass the finishing machine over the existing deck prior to placing the overlay so that the Engineer can make measurements to ensure the proper cross slope and thickness.

Construct a transverse construction joint whenever placing is interrupted for any reason for 20 minutes or longer.

Ensure that the top surface of the overlay is uniform, smooth, and even-textured after finishing with a finishing machine. Thoroughly consolidate the concrete by vibration during the finishing operations. Ensure that the finished surface does not vary more than 1/8 inch in 10 feet as measured from a straightedge.

4) Curing. Immediately following the brooming operation or texturing, when texturing is required, cover the overlay with a thoroughly wetted layer of burlap immediately followed by a layer of polyethylene film 4 mils or more in thickness. Place sections or strips of burlap transversely, so that the overlay can be covered immediately after finishing or texturing. Leave the burlap and polyethylene film in place for at least 24 hours, and rewet the burlap if any signs of drying appear. Soak new burlap in water for at least 12 hours before the first use.

After the 24-hour period has ended, remove the burlap and polyethylene and allow the overlay to air-cure. Continue the air-cure for an additional 48

hours when using Type I cement or an additional 24 hours when using Type III cement at an ambient air temperature of 50 °F or more.

When the overlay has cured, give the tops of all longitudinal and transverse construction joints a thorough coating of grout of the same proportions as the latex concrete mixture used for the grout-bond coat material. Neatly and uniformly apply a 2-inch wide or wider coating to seal any minute cracks at these locations. Do not use epoxy-sand slurry to seal construction joints in lieu of grout.

The Department will allow the overlay to be opened to traffic as soon as curing is completed, all full depth patches are at least 7 days old or have attained a compressive strength of 4,000 psi, all construction joints are sealed, and gutterline and curb slurry is applied.

B) Special Requirements for New Structures. Construct according to A) above with the following exceptions and additions:

1) The Department will not require machine preparation of the top 1/4 inch of the deck.
2) Construct an overlay having a thickness of 1 1/2 inch.
3) Texture the overlay surface according to Subsection 609.03.10.
4) Perform operations in the following sequence: blast clean the existing deck; apply the grout-bond coat; mix, place, and consolidate the overlay mixture; finish; texture; cure; seal joints and cracks; then apply the epoxy-sand slurry.
5) Do not overlay the deck until it is at least 14 calendar days old.
6) When longitudinal construction joints are necessary, completely cure each section of the overlay before placing the adjacent section of the overlay.

606.03.18 Special Requirements for Low Slump Concrete Overlays.

A) Existing Bridges and New Structures.

1) Grout-Bond Coat. After the concrete surface has been blast cleaned and immediately before placing the concrete overlay mixture on the deck, vigorously scrub a thin coating of bonding grout into the dry, clean surface areas. Do no wet the surface areas before applying the grout. When the bridge deck is exposed to rain before the application of grout, delay the application until the bridge deck has dried a minimum of 4 hours and to the satisfaction of the Engineer. Proportion the grout with water and one part cement to one part mortar sand. Adjust the water to produce a wet slurry mixture to a consistency that is suitable to apply with a stiff brush or broom in a thin, even coating that will not run or puddle in low spots. Ensure that all areas of the blast cleaned deck receive a thorough, even coat of grout and that no excess grout collects in any areas. Apply the grout-bond coat only for a short distance in advance of placing the overlay. Do not allow the grout-bond coat to show any signs of drying before placing the overlay. Thoroughly recoat all areas showing signs of drying with fresh grout.
2) Proportioning and Requirements. Proportion low slump concrete to contain 8.75 bags of cement and no more than 35 gallons per cubic yard of water, including free moisture on the aggregates. Use enough water to maintain the required slump except do no use more than 35 gallons per cubic yard. Attain a 7-day compressive strength of 5,000 psi.

   Use an approximate percent fine to total aggregate of 50 as the Engineer approves. Incorporate the aggregate into the mixture as the Engineer directs.

   Add water-reducing admixture according to the manufacturer's recommendations.

   Use the amount of air-entraining admixture necessary to achieve 5.5 ±

1.5 percent as determined according to KM 64-302.

Maintain a slump as determined according to KM 64-302 of 3/4 inch. The Department will perform the slump test 4 to 5 minutes after discharge from the mixer. The Department may allow a slump tolerance of ± 1/4 inch. The Department will not accept concrete having a slump of more than 1 inch. The Department may accept concrete having a slump less than 1/2 inch when the finishing machine can finish and consolidate the concrete according to the requirements of this section. Meet slump requirements at both the site of mixing and at the time of placing.

3) Placing, Consolidating, and Finishing the Overlay. Construct a low slump overlay having a minimum thickness of 1 1/2 inch. For overlays requiring texturing, construct an overlay having a minimum thickness of 1 3/4 inch. The Engineer will determine the deck section in the field, including the cross slope or crown. Pass the finishing machine over the existing deck before placing the overlay so that the Engineer can make measurements to ensure the proper cross slope and thickness.

Promptly after applying the grout-bond coat, deposit the concrete on the deck. Then strike off and consolidated with the finishing machine.

The Department may require consolidation using hand-held vibrators when placing the mixture around steel reinforcement or structural steel members. Construct a transverse construction joint whenever placing is interrupted for 20 minutes or longer, for any reason.

First strike off the concrete at 1/4 inch or more above the specified final thickness, and then consolidated by vigorous mechanical vibration. The Department will determine the in-place density of the consolidated mixture by nuclear gages immediately following the screeding operation; the Department will adjust the determined in-place density using the following formula:

$$\text{Adjusted Density} = \frac{\text{in-place density} \times 0.945}{1.00 - \text{actual air content}^{(1)}}$$

$^{(1)}$ Express actual air content as a decimal.

Provide concrete with an adjusted density equal to or exceeding the target density of 99 percent of the maximum theoretical density calculated assuming an entrained air content of 5.5 percent. Immediately correct areas of concrete of deficient density by additional passes of the finishing machine. When any concrete cannot be consolidated to the specified density, remove it and replace with acceptable concrete. The Engineer may require hand finishing of the consolidated concrete with a float in order to produce a tight uniform surface.

4) Curing. Cure the overlay immediately after texturing or brooming. Cure with a double layer of wetted burlap. Place sections or strips of burlap transversely so that the overlay can be covered immediately after texturing. Continuously and thoroughly wet the burlap by automatic fogging or sprinkling equipment for at least 96 hours after the curing is started. Soak new burlap in water for at least 12 hours before the first use. Do not use membrane curing compound.

When the overlay has cured, give the tops of all longitudinal and transverse construction joints a thorough coating of grout of the same proportion and consistency as the grout-bond coat material. Neatly and uniformly apply a minimum 2-inch wide or wider coating to seal any minute cracks at these locations. Do not use epoxy-sand slurry to seal construction joints in lieu of grout. The Department will allow the overlay to be opened to traffic as soon as the curing is complete.

B) Special Requirements for New Structures. Construct according to Subsection A) above except for the following exceptions and additions:

1) The Department will not require machine preparation of the top 1/4 inch of the deck.
2) Construct an overlay of Contract specified thickness.
3) Texture the overlay surface according to Subsection 609.03.10.
4) Perform operations in the following sequence: blast clean the existing deck; apply the grout-bond coat; mix, place, and consolidate the overlay mixture; finish; texture; cure; seal joints and cracks; then apply the epoxy-sand slurry.
5) Do not overlay the deck until it is at least 14 calendar days old.
6) When longitudinal construction joints are necessary, completely cure each section of the overlay before placing the adjacent section of the overlay.

606.04 MEASUREMENT.

606.04.01 Removal of Epoxy, Asphalt, and Foreign Overlay. When listed as a bid item, the Department will measure the quantity in square yards.

606.04.02 Machine Preparation of Existing Slab. The Department will measure the quantity in square yards. The Department will not deduct parts of the deck that are not concrete such as deck drains, castings, expansion dams, and patches of foreign material for payment.

606.04.03 Concrete, Class M for Full-Depth Patching. The Department will measure the quantity in cubic yards. The Department will not measure removal of epoxy, asphalt, or foreign overlays for payment, unless listed as a bid item, and will consider it incidental to this item of work.

606.04.04 Structural Steel. The Department will measure the quantity according to Subsection 607.04.

606.04.05 Blast Cleaning. The Department will measure the quantity in square yards. Before placement of the overlay the Department will measure the area of the deck and the vertical part of the curb which will be in direct contact with the overlay (distance equal to the thickness of the overlay) plus one inch for payment. After placement of the overlay and before placement of the epoxy-sand slurry, the Department will measure the 12-inch width of the overlay and the sides and tops of curbs that are to receive the epoxy-sand slurry for payment. The Department will not measure any repeated blast cleaning for payment and will consider it incidental to this item of work.

606.04.06 Latex Concrete Overlay or Low Slump Concrete Overlay. The Department will measure the quantity in cubic yards as metered from an accurately calibrated mixing unit. The Department will measure the overlay partial depth patches and material used to patch spalled or deteriorated sections of curbs, sidewalks or plinths for payment. The Department will not measure the volume of material wasted or not incorporated in the work; grout used for the bond coat; crack sealing; or sand blast cleaning of reinforcing steel, longitudinal or transverse construction joints, areas of curbs, sidewalks, plinths, and other areas to be patched; or temporary supports for existing concrete handrails while removing and replacing full depth concrete for payment and will consider them incidental to this item of work.

606.04.07 Epoxy-Sand Slurry. The Department will measure the quantity in square yards. The Department will measure the entire area covered, including the 12-inch width of the overlay and the sides and tops of curbs, barrier walls, and plinths for payment.

606.04.08 Joint Sealing. The Department will measure the quantity in linear feet.

606.04.09 Hydrodemolition. When listed as a bid item, the Department will measure the quantity in square yards. Otherwise, the Department will not measure Hyrodemolition for payment and will consider it incidental to the overlay.

606.05 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

Code	Pay Item	Pay Unit
8510	Removal of Epoxy, Asphalt, or Foreign Overlay	Square Yard
8551	Machine Preparation of Slab	Square Yard
8526	Concrete, Class M for Full Depth Patching[(1)(3)]	Cubic Yard
8160	Structural Steel	See Subsection 607.05
8549	Blast Cleaning	Square Yard
8534	Concrete Overlay, Latex[(1)(2)(3)]	Cubic Yard
8535	Concrete Overlay, Low Slump[(1)(2)(3)]	Cubic Yard
8504	Epoxy-Sand Slurry	Square Yard
8540	Joint Sealing	Linear Foot
8550	Hydrodemolition	Square Yard

(1) The Department will establish an adjusted unit price according to the supplemental formulas established for excessive overruns and underruns in Subsection 104.02.02 when this pay item is a major item and either an overrun or an underrun of more than 25 percent occurs.

(2) The Department will adjust the Contract unit price of overlays on new structures by the Schedule for Adjusted Payment for Thickness Deficiency. The adjusted quantity is equal to the measured quantity of the pay item multiplied by the Contract unit price for the pay item and the Price Adjustment. As an option, remove and replace overlays with an average defiency in thickness of no more than 1/2 inch with an overlay of the specified thickness at no cost to the Department. The Department will not make additional payment for average thicknesses of overlay in excess of the specified thickness.

Schedule for Adjusted Payment for Thickness Deficiency

Average Thickness Deficiency (inches)	Price Adjustment (Percent of Contract Unit Bid Price)
0	100.0
1/16	95.0
1/8	90.0
3/16	80.0
1/4	70.0
5/16	57.5
3/8	45.0
7/16	25.0
1/2	0.0
Greater than 1/2	[(a)]

[(a)] Remove and replace with an overlay of the specified thickness at no expense to the Department.

(3) When placing concrete on overlays is not begun within 2 hours after the scheduled time, the Department will deduct all engineering costs from the scheduled time until the time placing begins or is canceled from the Contract amount. The Department will not deduct engineering costs for uncontrollable circumstances such as inclement weather or equipment failure after placing begins.

The Department will consider payment as full compensation for all work required under this section.

SECTION 607 ¾ STRUCTURAL STEEL BRIDGES

607.01 DESCRIPTION. Build steel bridges, and perform other structural steel and miscellaneous metal construction.

The dimensions specified in the Plans are for a normal temperature of 60° F with dead load on the structure.

607.02 MATERIALS AND EQUIPMENT.

607.02.01 Paint. Conform to Section 821.

607.02.02 Structural Steels. Conform to Section 812.

607.02.03 Miscellaneous Metals. Conform to Section 813 for pins and rollers; bearing and expansion plates (rockers and expansion dams); aluminum; high-strength steel bolts, nuts, and washers; and welding. Use flat and smooth circular washers and square or rectangular beveled washers.

Ensure that bolt dimensions conform to the heavy hexagon structural bolt requirements of ANSI B18.2.1 and Section 813.

Ensure that nut dimensions conform to the heavy hexagon nut requirements of ANSI B18.2.2 and Section 813.

Identify heavy hexagonal structural bolts, manufactured according to ASTM A 325, on the top of the head by 3 radial lines, the legend "A 325", and the manufacturer's mark.

Identify Grade 2H nuts on at least one face by the marking "2H" or "2HB", and Grade DH by the marking "DH". Ensure that all nuts bear the manufacturer's identification mark.

Heavy hexagonal structural bolts have shorter thread lengths than other standard bolts. Depending on the amount of bolt length added to adjust for incremental stock lengths, the full thread may extend into the grip as much as 3/8 inch for the following bolt sizes; 1/2 inch, 5/8 inch, 3/4 inch, 7/8 inch, 1 1/4 inch and 1 1/2 inch, and as much as 1/2 inch for the following bolt sizes; one inch, 1 1/8 inch, and 1 3/8 inch. The fabricator may include some of the thread run-out into the plane of the shear. When the thickness of an outside part adjacent to the nut is less than these values, the fabricator may use the next increment of bolt length together with a sufficient number of flat circular washers to ensure full seating of the nut.

607.02.04 Wrenches. Use manual or power torque wrenches. Use power wrenches of adequate capacity and of sufficient air supply to perform the required tightening of bolts in approximately 10 seconds.

607.02.05 Direct Tension Indicators. When specified on the plans, use direct tension indicators consisting of a hardened washer with protrusions on one face that flatten under bolt tension. Determine correct bolt tension by examining the gap between the washer and bolt head remaining after tightening.

Include with each shipment of direct tension indicators, reports of actual tests showing the bolt tension achieved when the indicators are loaded. Ensure that the bolt tension is ± 20 percent greater than the tension specified in the Bolt Tension table in Subsection 607.03.05. Furnish test reports for representative samples of each lot or heat and each size tension indicator in the shipment, and provide packaging that easily identifies individual lots or heats. The Department may perform any additional sampling or testing the Engineer deems necessary.

Mark the tension indicators with the correct grade (A 325 or A 490) to ensure ready verification on the job.

607.02.06 Tapes. Use only tapes that are correctly calibrated with NIST to ensure correct fit of the work.

607.03 CONSTRUCTION.

607.03.01 Shop Drawings and Welding Procedures. Submit to the Division of Bridge Design detailed shop drawings and welding procedures. The Department will furnish plans showing sufficient details to prepare detailed shop drawings. Include welding procedures and details, when required, as part of the shop drawings. The Department will not consider the shop drawing review process to be complete without the submittal of welding procedures. Make all drawings on sheets of 0.003 inch minimum thickness mylar film, 22 inches or 24 inches wide by 36 inches in length. Ensure that final drawings provide clear, sharp lines on prints. If applicable, use photo reproductions on photo sensitive film. Submit to the Division of Bridge Design 3 full or half size sets (6 for railroad bridges) of prints of the detailed shop drawings and welding procedures. The Division of Bridge Design will return one set of reviewed shop drawings with all required corrections noted. When corrections are necessary, submit 3 full or half size sets of prints of the corrected drawings. After final review, furnish to the Division of Bridge Design 10 full or half size sets of correct shop drawing prints. After fabrication is complete and the Engineer has approved the structural steel for shipment, furnish to the Engineer one full-size set of the reviewed shop drawings, including the welding procedures, which will produce clear prints and microfilms.

Do not make any changes to any drawing after the Engineer has reviewed it without the Engineer's written approval or written direction.

Only make substitutions of sections different from those shown on the drawings when the Engineer approves in writing.

Although the drawings may have been reviewed, take responsibility for the correctness of the drawings and for shop fits and field connections.

Take responsibility for any material ordered or work done before the Engineer reviews the drawings and welding procedures.

When design drawings differ from the shop drawings, the design drawings govern. When the requirements of this section differs from the shop drawings, the requirements of this section govern.

When the design drawings differ from the requirements of this section, the design drawings govern.

607.03.02 Workmanship.

A) Quality of Workmanship. Ensure that workmanship and finish are equal to the AISC best general practices in modern bridge shops.

B) Storage of Materials. Store structural material, either plain or fabricated, at the fabricating shop above ground upon platforms, skids, or other supports. Keep it free from dirt, grease, and other foreign matter and protect it from corrosion.

C) Straightening Materials. Before measuring or working rolled material, ensure that it is straight. When straightening is necessary, use methods that will not injure the metal. If sharp kinks and bends are evident, the Engineer will reject the material.

D) Finish. Provide a neat finish to the work. Shear, flame cut, grind, and chip carefully and accurately. Remove all burrs resulting from reaming or drilling.

607.03.03 Bolt Holes. Either punch or drill all holes for connections.

A) Punched Work. Punch all holes full-size except:

1) When there are more than 5 thicknesses, or when any of the main material is thicker than 3/4 inch in structural carbon steel, 5/8 inch in high-strength low alloy steel, or 1/2 inch in quenched and tempered alloy steel, sub-punch all holes, and ream them after assembling according to the requirements of C) below.

2) When the metal is thicker than the size of the bolts, drill the holes according to the requirements of D) below.
3) Sub-punch and ream punched holes for stringer and floor beam field connections according to the requirements C) below, or sub-punch and ream to a metal template no less than one inch thick, without assembling.
4) Sub-punch and ream punched holes in field connections of main truss or arch members, skew portals, skew portal bracing plate, girder spans, continuous I-beam spans and rigid frames. Punch holes in connection plates or other parts of such members according to the requirements of C) below. Main truss members are the top and bottom chords, end posts, and web members forming the truss.

B) Punched Holes. Punch full-size holes 1/16 inch larger than the nominal diameter of the bolt. Do not allow the diameter of the die to exceed the diameter of the punch by more than 3/32 inch. Ensure that holes are cut cleanly without torn or ragged edges.

Punch holes so that, after assembling the component parts of a member and before reaming, a cylindrical pin 1/8 inch smaller than the nominal diameter of the punched hole may be passed through at least 75 of any group of 100 contiguous holes, or in like proportion for any smaller group of holes. When 10 percent or more of any group of 100 or fewer holes will not pass a pin 3/16 inch smaller than the nominal diameter of the punched hole, the Engineer will reject the mispunched pieces. Ream any holes that must be enlarged to admit bolts.

C) Sub-Punched and Reamed Holes. Punch sub-punched and reamed holes for bolts 3/16 inch smaller than the nominal diameter of the bolts. Ensure that the punch and die have the same relative sizes as specified for full size punched holes.

After assembling, ream sub-punched holes to a diameter of 1/16 inch larger than the nominal diameter of the bolt.

After assembling and firmly bolting pieces forming a built member perform reaming. Do not interchange reamed parts.

Ream holes with twist drills or with short taper reamers. Do not direct reamers by hand unless the Engineer approves. Use solvents, detergents, or other Engineer approved means before cleaning and painting, to thoroughly remove any oil or grease used as a reaming lubricant.

D) Drilled Holes. Ensure that drilled holes are 1/16 inch larger than the nominal diameter of the bolt. However, do not allow drilled holes for turned bolts to be more than 1/32 inch larger than the diameter of the finished bolt. Hold parts securely together while drilling assembled members.

Do not use numerical tape or electronic computer controlled drills unless the fabricator can provide a history showing defect free work of this type. This means that previous work was free of misdrilled holes caused by human errors or machine errors.

Drill holes according to the requirements of E) below. Submit to the Engineer for review with the shop drawings, the proposed procedure for drilling holes and assuring correct fit of members. When using numerical tape or electronic computer controlled drills, the Department will require shop assembly of at least 25 percent of the splices and at least 10 percent of floor beam and bracket main member connections as proof of accurate fit. In the event holes do not match as prescribed for the assembled pieces, assemble and ream all splices to fit and use metal templates to ream all other floor beam connections.

E) Accuracy of Reamed and Drilled Holes. Ensure that reamed or drilled holes are cylindrical and perpendicular to the member. After reaming or drilling, do not allow 85 of any group of 100 contiguous holes, or in like proportion for any smaller group of holes, to show an offset greater than 1/32 inch between adjacent thicknesses of metal.

F) Edge Distance of Bolts. Maintain a minimum distance from the center of any

bolt to a sheared or flame cut edge of:
For one inch diameters, 1 3/4 inch.
For 7/8 inch diameters, 1 1/2 inch.
For 3/4 inch diameters, 1 1/4 inch.
For 5/8 inch diameters, 1 1/8 inch.

Ensure that the minimum distance from a rolled or planed edge, except in flanges of beams and channels, is:

For one inch diameters, 1 1/2 inch.
For 7/8 inch diameters, 1 1/4 inch.
For 3/4 inch diameters, 11/8 inch.
For 5/8 inch diameters, one inch.

In the flanges of beams and channels, ensure that the distance is:

For one inch fasteners, 1 1/4 inch.
For 7/8 inch fasteners, 1 1/8 inch.
For 3/4 inch fasteners, one inch.
For 5/8 inch fasteners, 7/8 inch.

Ensure that the maximum distance from any edge is 8 times the thickness of the thinnest outside plate, but does not exceed 5 inches. If the design drawings or the Engineer approves in writing, the Department will allow the use of oversize, short-slotted, and long-slotted holes according to the applicable structural steel design sections of the AASHTO Standard Specifications for Highway Bridges.

607.03.04 Shop Assembly and Material Traceability. Conform to the requirements of A) through D) below when not using numerical tape or electronic controlled drills; conform to E) below for all structural steel fabrication.

A) Assembling Trusses and Other Supports. Assemble trusses, arches, skew portals, skew portal bracing, girder spans, continuous I-beam spans, and rigid frames in the shop, and adjust the parts to line, camber, and fit for drilling or reaming of field connections.

B) Assembling Members. Thoroughly clean surfaces of metal in contact before assembly. Before reaming, assemble, well pin, and firmly draw together the parts of a member with bolts. When necessary, take apart assembled pieces to remove burrs and shavings produced by the reaming operation. Ensure that members are free from twists, bends, and other deformation.

Progressively shop assemble each longitudinal girder unit in no less than 3 contiguous sections adjusted to line, elevation, camber, and fit for drilling or reaming. Add at least one section at the rear end of the assembly when removing any section from the advancing end to ensure that the assembled portion of the structure is never less than 3 contiguous sections.

With connected parts assembled, either drill or ream other major bolted connections to the longitudinal girders in the shop or drill or ream to a metal template without assembly. Keep girder sections assembled until match marked and the Engineer has inspected and approved them.

Do not apply the assembly requirement for drilling or punching to connections for cross frames, diaphragms, lateral bracing, expansion dams, and other minor members.

C) Drifting of Holes. Only allow drifting during assembly to the extent that it brings the parts into position, but does not enlarge holes or distort the metal. Ream all holes that must be enlarged. Do not allow reaming to exceed the allowable tolerances.

D) Match Marking and Identification. Match mark connecting parts assembled in the shop for the purpose of reaming holes in field connections, according to the diagram shown on reviewed shop drawings. Match mark with 3/8 inch steel, low stress riser dies. Indicate the location of match marks with a circle of paint around them. Use paint for indicating the location of match marks of a different color than that specified for shop paint.

E) Material Traceability. Ensure that the fabricator can demonstrate by a written procedure and by actual practice a method of material application and traceability, visible at least through the "fit up" operation, of all elements of a shipping piece. Ensure that the traceability method is capable of verifying proper material application as it relates to material specification designation; heat number and manufacturer; and material test reports for special requirements where required.

In addition, upon completion of fabrication, furnish the Department with a list of each component of each major load-carrying member and the heat number and manufacturer applicable to the material used for each, including sketches or diagrams when necessary. Provide this list on drafting film which will produce clear prints and microfilms, and submit it as part of the final shop drawings.

607.03.05 Bolted Connections Using High-Strength Steel Bolts.

A) General. Use friction type joint for all connections made with high-strength steel bolts.

To determine the required bolt length, add the grip, the adjustment for bolt size specified in the following table, 3/16 inch for each hardened flat washer, and 5/16 inch for each beveled washer. Grip is the total thickness of all connected materials, exclusive of washers. Then round up to the next 1/4 inch length.

BOLT SIZE ADJUSTMENT	
Nominal Bolt Size (inch)	Adjustment for Bolt Size (inch)
1/2	11/16
5/8	7/8
3/4	1
7/8	1 1/8
1	1 1/4
1 1/8	1 1/2
1 1/4	1 5/8
1 3/8	1 3/4
1 1/2	1 7/8

The adjustment in the above table allows for manufacturing tolerances and for the use of a heavy hexagon nut, and provides adequate "stick through" at the end of the bolt.

Provide adequate bolt length to allow for the exposure of at least 2 complete threads beyond the face of the nut after tightening.

Where necessary, clip washers on one side and no closer than 0.875 of the bolt diameter from the center of the washer.

Install bolts with a hardened washer under the nut or bolt head, whichever is the element turned in tightening. The Department will allow the use of a flat washer when the abutting surface adjacent to the bolt head or nut does not have a slope of more than 1:20 with respect to a plane normal to the bolt axis. Where outer faces of the bolted parts have a slope of more than 1:20 with respect to a

plane normal to the bolt axis, use a smooth beveled washer to compensate for lack of parallelism.

Ensure that bolted parts fit solidly together when assembled and are not separated by gaskets or any other interposed compressible material. Keep all joint surfaces free of dirt, burrs, and other defects that would prevent solid seating of the parts. Maintain contact surfaces free of oil, excess primer, and any other foreign matter.

Tighten all bolts, with properly calibrated wrenches, to provide at least the required minimum bolt tension values shown in the following table on completion of the joint.

BOLT TENSION		
Nominal Bolt Size (inch)	Minimum Bolt Tension ASTM A 325 Bolts (KIPS)	ASTM A 490 Bolts (KIPS)
1/2	12	15
5/8	19	24
3/4	28	35
7/8	39	49
1	51	64
1 1/8	56	80
1 1/4	71	102
1 3/8	85	121
1 1/2	103	148

Set the calibrated wrenches used to provide the bolt tension specified in the table above so as to induce a bolt tension at least 5 percent in excess of this value.

Calibrate the wrenches twice daily by tightening, in a device capable of indicating actual bolt tension, no less than 3 typical bolts from the lot to be installed. Adjust power wrenches to stall or cut-out at the selected tension. When using manual torque wrenches, note the torque indication corresponding to the calibrating tension and use it in the installation of all bolts of the tested lot. When measuring torque, keep nuts in tightening motion. For short-grip bolts, the Department will allow calibration of wrenches by using direct-tension indicating washers with solid plates in a manner acceptable to the Engineer.

When using calibrated wrenches to install several bolts in a single joint, use the wrench to "touch up" bolts previously tightened, which may have been loosened by tightening of the subsequent bolts, until all are tightened to the prescribed amount.

When required, because of bolt entering and wrench operation clearances, tighten by turning the bolt while preventing the nut from rotating.

Furnish all tension machines and torque wrenches.

The Engineer will approve the procedure for calibration of wrenches.

Operate a manual torque wrench as the Engineer spot inspects installed bolts by observing the indicated torque. Use a torque wrench that has been calibrated as previously described in this subsection. When the Engineer is inspecting bolts, apply the inspecting wrench and its required torque to 10 percent of the bolts, but not less than 2 bolts, selected at random in a connection. The Engineer will accept the connection as properly tightened if the nut or bolt head does not turn when applying the required torque. When applying the required torque and a nut or bolt turns, the Engineer will test all bolts in the connection. Tighten all bolts whose nut or bolt head is turned by the required

torque. The Engineer will reinspect all connections whose nut or bolt head is turned by the required torque. Alternatively, the Department will allow retightening of all of the bolts in the connection and then resubmit the connection for the Engineer to inspect.

Store bolts and nuts in a dry location until use to protect them from contamination by foreign substances and the formation of rust. Only open shipping containers when needed for the work or for inspection purposes. Properly cover and store partially used containers to avoid contamination or exposure to moisture. Only install bolts and nuts that are clean and free of excessive rust. Do not consider a thin, tightly adhering rust as cause to require cleaning; however, apply a dry lubricant to the threads and bearing surface of all nuts to be used when either bolts or nuts show evidence of rust on the threads.

In lieu of using calibrated wrenches, the Department will allow the use of the turn-of-nut method to install bolts. During installation, regardless of the tightening method used, install bolts in all holes of the connection and bring them to a "snug tight" condition. Snug tight is the tightness that exists when the plies of the joint are in firm contact. Attain this condition either by a few impacts of an impact wrench or by the full effort of an ordinary spud wrench. When snug tightening, progress systematically from the most rigid part of the connection to the free edges, and then retighten the bolts of the connection in a similar systematic manner as necessary until all bolts are simultaneously snug tight and the connection is fully connected.

When using turn-of-nut tightening: Check a representative sample of not less than three bolt and nut assemblies of each diameter, length, and grade at the start of work in a device capable of indicating bolt tension. Use the test to demonstrate that the method for estimating the snug tight condition and controlling the turns from snug tight to be used by the bolting crew to develop a tension not less than 5 percent greater than the required tension specified in table above. After bringing to a "snug tight" condition, further tighten all bolts in the connection by the applicable amount of rotation specified in the following table. During the tightening operation, do not allow any rotation of the part not turned by the wrench. When tightening, progress systematically from the most rigid part of the joint to its free edges.

NUT ROTATION FROM SNUG TIGHT CONDITIONS[(1),(2),(3)]

Bolt Length (Under side of head to end of bolt.)	Disposition of Outer Faces of Bolted Parts		
	Both faces normal to bolt axis	One face normal to bolt axis and other sloped not more than 1:20 (beveled washer not used)	Both faces sloped not more than 1:20 from normal to the bolt axis (beveled washer not used)
Up to and including 4 diameters	1/3 turn	1/2 turn	2/3 turn
Over 4 diameters but not exceeding 8 diameters	1/2 turn	2/3 turn	5/6 turn
Over 8 diameters but not exceeding 12 diameters	2/3 turn	5/6 turn	1 turn

[(1)] *Nut rotation is relative to bolt, regardless whether turning the element (nut or bolt). For installing bolts by half turn and less, the tolerance is ± 30°; for installing bolts by two-thirds turn and more, the tolerance is ± 45°.*

(2) Applicable only to connections in which all material within the turn grip of the bolt is steel.

(3) There is no research available to establish the turn-of-nut procedure for bolt lengths exceeding 12 diameters. Therefore, determine the required rotation by actual test in a suitable tension measuring device that simulates conditions of solidly fitted steel.

Perform the rotational-capacity test described in Section 813 on each rotational-capacity lot prior to the start of bolt installation. Use hardened steel washers for the test even if they are not required in the actual installation procedures.

Verify that a visible lubricant is on the threads of galvanized nuts. Ensure that black bolts are oily to the touch when delivered and installed.

Before installing, clean and relubricate weathered or rusted bolts or nuts not conforming to the requirements of the rotational-capacity test. Retreat recleaned or relubricated nut and washer assemblies to conform to rotational-capacity test requirements before installing.

Use bolt, nut and washer (when required) combinations from the same lot used for the rotational-capacity test.

B) Direct Tension Indicators. When specified in the Plans, the Department will allow tightening all high-strength bolts in diameters of 1/2 inch through 1 1/4 inch inclusive, using direct tension indicators.

Before work begins, furnish the Engineer with the manufacturer's written installation instructions. Install direct tension indicators, and tighten the bolts according to these instructions.

Under normal conditions, install the tension indicator under the non-turned element of the fastening system. Obtain the Engineer's permission before installing tension indicators under the turned element. If the Engineer determines that it is necessary to install the tension indicator under the turned element, install additional hardened washers according to the manufacturer's instructions. Use bolt lengths sufficient to accommodate the tension indicators and any additional washers required.

Do not reuse tension indicators. If it becomes necessary to loosen a previously tensioned bolt, discard and replace the tension indicator. The fastener assembly may also need to be replaced.

Furnish a device capable of measuring actual bolt tension. Before work begins, tighten at least 3 typical bolts and direct tension indicators in the device to the correct bolt tension. Keep the tension device available thereafter for additional checks when the Engineer deems necessary.

The Engineer will inspect bolt installation by inserting a feeler gage into the opening between adjacent flattened protrusions. The Engineer will examine at least 10 percent, but no less than 2, of the bolts in each connection. The Engineer will consider the installation acceptable if the gage will not enter the opening. The Engineer will not consider a zero gap as cause for rejection. If the gap is not uniform around the bolt, the Engineer will base acceptance on the average gap. That is, the Engineer will check the gap at several points around the bolt and if the gage will not enter the gap on at least half the tries, the installation will be acceptable.

Seal the gap behind the indicator completely with paint. If necessary, use moisture cure aluminum polyurethane intermediate coat at that location.

Furnish tension indicators in addition to washers when specified in the Contract.

607.03.06 Reuse of ASTM A 325 Bolts. The Department will allow the use of ASTM A 325 high-strength bolts one additional time after initially tightening them to specification tension, provided a close visual inspection indicates no distress in the bolt. This allows ASTM A 325 bolts to remain installed when tightened to specification tension

twice, one time at original installation and one time at reuse. Do not consider touching up or retightening previously tightened bolts, which may have been loosened by the tightening of adjacent bolts, as reuse, providing the snugging up continues from the initial position. When removing and loosening a bolt after it has been tightened to specification tension twice, discard the bolt and substitute a new bolt.

607.03.07 Welds. Perform all welding, when authorized, according to requirements specified in ANSI/AASHTO/AWS D1.5. Do not field weld, except as specified in the Plans, without the Engineer's written permission.

Ensure that in all cases, welders, welding operators, and tackers have been qualified by testing according to KM 64-110 within the previous 24 months of the time of actual weld performance.

607.03.08 Planing and Finishing.

A) Edge Planing. Plane to a depth of 1/4 inch all sheared edges of plates that are more than 5/8 inch thick and carry calculated stress. The Department will allow fillet re-entranting cuts before cutting.

B) Flame Cutting. Obtain a smooth surface free from cracks and notches, and an accurate profile using a mechanical guide and the Department will allow flame cutting of steel. Only perform flame cutting by hand where the Engineer approves. Smooth the surface by planing, chipping, or grinding. Adjust and manipulate the cutting flame to avoid cutting beyond the prescribed lines. Fillet re-entrant cuts to a radius of no less than 3/4 inch. Do not allow the surface roughness value of oxygen cut surfaces to be greater than that specified in ANSI/ASME B46.1, as follows:

Material Thickness	Surface Roughness Value
Less than 4 inch[1]	1,000 MU inch
4 to 8 inches	2,000 MU inch

[1] *for ends of members not subject to calculated stress at the ends, conform to the surface roughness value of 2,000 MU inches.*

Remove roughness exceeding these values and occasional notches or gouges no more than 3/16 inch deep, on otherwise satisfactory surfaces, by machining or grinding. Leave cut surfaces and edges free of slag. Remove irregularity or unevenness from defects to the oxygen cut surfaces with a slope not exceeding one in 10. Do not repair defects in oxygen-cut edges by welding except with the Engineer's approval. Perform such weld repairs by suitably preparing the defect, welding with low-hydrogen electrodes not exceeding 3/16 inch in diameter and grinding the completed weld smooth and flush with the adjacent surface to produce a workmanlike finish.

Preheat members in the area to be cut to a minimum temperature of 200 °F to prevent edge cracks. Allow sufficient additional width to permit planing, chipping, or grinding to remove rough, burned, cracked, or otherwise defective edges. Grind corners at flame cut edges to a radius of at least 1/16 inch, and remove any evidence of edge cracking by planing, chipping, or grinding to a depth not exceeding 1/4 inch.

C) Heat Curving. The fabricator may either fabricate welded girders by flame cutting the flanges to the required curvature from rectangular plates before fitting and welding to the web, or fabricate welded girders or rolled beams by fabricating straight units and then, through the application of heat to the flange edges, induce the required curvature. Do not perform heat curving in beams or girders fabricated from steels that are manufactured to a specified minimum yield point greater than 50,000 psi or in beams or girders having a radius shorter than the minimum radius of curvature as determined by the procedures outlined in the

AASHTO Standard Specifications for Highway Bridges.

When the Contract requires heat curving rolled beams or welded girders, ensure that the work conforms to the following requirements.

Curve beams and girders by either continuous or V-type heating. For the continuous method, simultaneously heat a strip along the edge of the top and bottom flanges. Ensure that the strip is of sufficient width and temperature to obtain the required curvature. For the V-type heating, heat the top and bottom flanges in truncated triangular areas having their bases along the flange edge and spaced at regular intervals along each flange. Determine the spacing and temperature of the areas necessary to obtain the specified curvature. Apply heat along the top and bottom flanges at approximately the same rate.

For V-type heating, terminate the apex of each truncated triangular area applied to the inside of a flange surface just before reaching the juncture of the web and the flange. To avoid unnecessary web distortion, carefully heat the inside flange surfaces (the surfaces that intersect the web) to avoid applying heat directly to the web. When the radius of curvature is 1,000 feet or more, extend the apex of each truncated triangular heating area applied to the outside of a flange surface to the juncture of the flange and web. When the radius of curvature is less than 1,000 feet, extend the apex of each truncated triangular heating area applied to the outside of a flange surface past the web for a distance equal to 1/8 of the flange width or 3 inches, whichever is less. Ensure that each truncated triangular area has an included angle of approximately 15 to 30 degrees; however, do not allow the length of the base of each triangle to exceed 10 inches. Obtain the Engineer's approval before making any variation in the patterns as prescribed in this subsection.

For both types of heating, heat the flange areas that will be on the inside of the horizontal curve. Concurrently heat both surfaces of flanges when the flange thickness is 1 1/4 inch or greater. Space the heating patterns uniformly along the full length of each flange to produce a uniform arc of a circular curve in the member. When heating causes a chording effect that the Engineer judges not aesthetically pleasing, ensure that the fabricator reheats the member using additional heating patterns as required to obtain the desired results.

Conduct the heat-curving operation so that temperature of the steel does not exceed 1,150 °F. Confine heating to the patterns or areas specified in this section, and apply heat to bring the steel within the patterns or areas to the required temperature as rapidly as possible without overheating the steel. Consider any heating procedure which causes a portion of the steel to be heated to a temperature greater than 1,150 °F as destructive heating and as a possible cause for rejection of the steel. The fabricator may propose to the Engineer various means to reaccept, repair, or replace the steel rejected for overheating. The Engineer will review the fabricator's proposal. Do not artificially cool the steel until it has cooled naturally to 600 °F. Never quench the steel with water or water and air. When appropriate, cool the steel with dry compressed air only after it has cooled to 600 °F. The fabricator shall maintain temperature controls using temperature indicating crayons or other suitable means during heating and cooling of the steel.

The Department will allow heat curving of beams and girders with the web in either a vertical or horizontal position. When heat curving beams and girders in the vertical position, brace or support them in such a manner that the tendency to deflect laterally during the heat-curving process will not cause them to overturn.

When heat curving beams and girders in the horizontal position, support them near the ends and at intermediate points, as required, to obtain a uniform curvature. Do not allow the bending stress in the flanges due to the dead weight of a beam or girder to exceed 20,000 psi. When a beam or girder is positioned horizontally for heating, maintain intermediate safety catch blocks at the midlength within 2 inches of the flanges at all times during the heating process to

guard against a sudden sag due to plastic flange buckling.

Heat curve beams and girders in the fabrication shop before painting. The Department will allow performing of the heat-curving operation either before or after completing all required welding of transverse intermediate stiffeners. However, unless provisions are made for girder shrinkage, locate and attach all connection plates and bearing stiffeners after heat curving. When the Engineer requires longitudinal stiffeners heat curve or flame cut them to the required radius and then weld them to the curved girder. When attaching cover plates to rolled beams, attach them before heat curving when the total thickness of one flange and cover plates is less than 2 1/2 inches and the radius of curvature is greater than 1,000 feet. For other rolled beams with cover plates, heat curve the beams before attaching the cover plates; either heat curve or oxygen cut cover plates separately and then weld them to the curved beams.

Camber girders before heat curving. Obtain camber for rolled beams by heat-cambering methods approved by the Engineer. For girders, cut the web to the prescribed camber with suitable allowance for shrinkage due to cutting, welding, and heat curving. The curving process may tend to change the existing vertical camber. This change will be most pronounced when the top and bottom flanges are of unequal widths on a given transverse cross section. However, subject to approval of the Engineer, correct moderate deviations from the specified camber by a carefully supervised application of heat.

The Engineer will not measure horizontal curvature and vertical camber for final acceptance until after the fabricator has completed all welding and heating operations and the flanges have cooled to a uniform temperature. The Engineer will check the horizontal curvature in each edge of each flange with the beam or girder in the vertical position by measuring offsets from a stringline or wire or by using other suitable means. The Engineer will check camber by similar means.

D) Facing of Bearing Surfaces. Ensure that the surface finish of bearing and base plates and other bearing surfaces that are to come in contact with each other or with concrete conforms to the surface roughness requirements as defined in ANSI/ASME B46.1, Part I:

Steel Slabs	ANSI 2000
Heavy plates in contact in shoes to be welded	ANSI 1000
Milled ends of compression members, stiffeners, and fillers	ANSI 500
Bridge rollers and rockers	ANSI 250
Pins and pin holes	ANSI 125
Sliding bearings	ANSI 125

With the exception of abutting joints and base plates, coat machine-finished surfaces with waterproof grease or other approved coating, as soon as practical after the Engineer has accepted the structural steel and before removing it from the shop. Apply one coat of an approved rust inhibiting primer compatible with the finished coat instead of zinc rich primer to machine finished surfaces that are to be painted.

E) Abutting Joints. Face abutting ends of compression members and girder flanges accurately to secure an even bearing when assembled in the structure. Rough finish ends of tension members at splices to secure close and neat but not contact fitting joints. Where joints are not faced, do not allow the opening to exceed 1/4 inch.

F) End Connection Angles. Build floor beams, stringers, and girders having end connection angles to the exact length specified in the Plans measured between the heels of the connection angles, with a permissible tolerance of + 0 to - 1/16 inch. Where the Contract requires continuity, face end connections. Do not allow the thickness of the connection angles to be less than 3/8 inch, or less than that shown on the detailed drawings.

G) Finished Members. Ensure that finished members are true to line and free from

twists, bends, and open joints.

H) Web Plates. Cut web plates to provide for camber of the girder. At bolted web splices, do not allow clearance between ends of web plates to exceed 3/8 inch.

I) Fit of Stiffeners. Mill or grind bearing stiffeners of girders and stiffeners intended as supports for concentrated loads to secure an even bearing against the flanges. Ensure that intermediate stiffeners fit sufficiently tight to exclude water after being painted. Ensure that clearance between the ends of horizontal stiffeners and the sides of vertical stiffeners is one inch. Place bearing stiffeners plumb. Place intermediate stiffeners perpendicular to flanges.

J) Bent Plates. Ensure that unwelded, cold-bent, load-carrying, rolled-steel plates conform to the following:

1) Take them from stock plates so the bend line will be at right angles to the direction of rolling.
2) The radius of bends, measured to the concave face shall not be less and preferably shall be greater than shown as follows where "T" is the thickness of the plate:

Angle of Bend	Minimum Radius
61° to 90°	1.0T
91° to 120°	1.5T
121° to 150°	2.0T

When a shorter radius is essential, bend the plates while hot at a temperature not to exceed 1,150 °F; except for ASTM A 514 or ASTM A 517 steel, in which case bend at a temperature not to exceed 1,125 °F and requench and temper them. Ensure that hot-bent plates conform to the requirements of 1) above.

3) Before bending, round corners of the plate to a radius of 1/16 inch through that portion of the plate where bending is to occur.

607.03.09 Pins and Rollers.

A) General. Accurately turn pins and rollers to the dimensions shown on the drawings. Furnish pins and rollers that are straight, smooth, and free from flaws. Produce the final surface by a finishing cut, and provide a smooth finished surface with an ANSI 125 standard finish.

Forge and anneal pins and rollers more than 7 inches in diameter.

In pins larger than 7 inches in diameter, bore a hole 2 inches or more in diameter full length along the axis after the forging has cooled to a temperature below the critical range. Bore under suitable conditions to prevent injury by too rapid cooling and before being annealed.

Furnish 2 pilot nuts and 2 driving nuts for each size of pin.

B) Boring Pin Holes. Bore pin holes true to the specified diameter, smooth and straight, at right angles with the axis of the member and parallel with each other. Produce the final surface by a finishing cut, and leave the finished surface smooth and polished.

Do not allow the outside-to-outside distance of holes in tension members and inside-to-inside distance of holes in compression members to vary from that specified by more than 1/32 inch. Bore holes in built-up members after completing connections.

C) Pin Clearances. Do not allow the diameter of the pin hole to exceed that of the pin by more than 1/64 inch for pins 5 inches or less in diameter, or 1/32 inch for larger pins.

607.03.10 Threads for Bolts and Pins. Furnish threads for bolts and pins that conform to the United States Standard Series UNC-ANSI B1.1, Class 2A for external

threads and Class 2B for internal threads, except that pin ends having a diameter of 1 3/8 inches or more shall be threaded 6 threads to the one inch, and except as required for high-strength steel bolts.

607.03.11 Annealing and Stress Relieving. For structural members indicated in the Contract to be annealed or normalized, finish machining, boring, and straightening after heat treatment. Normalize and anneal (full annealing) as specified in ASTM E 44. Maintain temperatures uniformly throughout the furnace during heating and cooling so that temperatures at points on the members will not differ by more than 100 °F at any one time.

Maintain a record of each furnace charge that identifies pieces in the charge and lists temperatures and schedule actually used. Provide proper instruments, including recording pyrometers, for determining temperatures of members in the furnace at any time. Make records of the treatment operation available to the Engineer.

Stress relieve members, such as bridge shoes, pedestals, or other parts built up by welding sections of plates together according to the requirements of AWS D1.5 when required by the Contract.

607.03.12 Forgings. Furnish forgings that are free from internal and external cracks and other harmful defects. The Engineer will determine the method of inspection.

607.03.13 Mill and Shop Inspection and Shipping.

A) Notice of Beginning Work. Designate to the Engineer within 30 days subsequent to the award of the Contract the locations of fabricating shops and estimated quantities of steel to be fabricated at each.

The Department will not allow structural steel to be fabricated in more than 2 fabricating locations (a location will be considered all shops within one city) unless approved in writing by the Engineer.

The Engineer will not allow any work to be done in the shop before granting authorization to proceed. Furnish the Department copies of mill tests and analyses reports of such structural shapes bearing the manufacturer's name and heat number. When such identification does not exist, the Engineer may require samples for test purposes be cut from the materials. When mill tests and analyses, or subsequent tests of samples, indicate material does not comply with this section, the Engineer will reject such materials. When the Engineer rejects materials, furnish suitable material.

B) Facilities for Inspection. Furnish all facilities for inspection of material and workmanship in the mill and shop, and allow the Inspector free access to necessary parts of the premises. Notify the Engineer when material is ready for shop inspection.

Furnish power and utilities for operating inspection equipment, provide shop space for inspection work, handle material as necessary, and enforce required safety precautions for radioactive exposure.

C) Mill Orders, Change Orders, Shipping Statements, Mill Test Reports, and Shop Bills. Furnish 3 copies of mill orders, change orders, mill shipping statements, mill test reports, fabricator's shop bills (when not attached to drawings), and shipping statements to the Engineer for all structural steel materials. Ensure that mill test reports show that all materials conform to this section and are signed by a responsible representative of the company. Include the weights of individual members on shipping statements.

D) Facilities for Testing. Furnish test specimens, and all labor, testing machines, and tools necessary to prepare specimens and make full size tests.

E) Rejections. The Inspector's initial acceptance of any material or finished members will not prevent the Engineer from subsequently rejecting material or finished members when he determines that they do not conform to the Contract.

F) Weighing of Members. When the Contract specifies that the Department will

pay for any part of the material by weight, weigh the finished work in the presence of the Inspector. Supply accurate scales and perform all work involved in handling and weighing various parts.

G) Marking and Shipping. Paint or mark each member with an erection mark for identification and furnish an erection diagram with erection marks shown thereon.

Mark the weights of members weighing more than 3 tons on the member. Load structural members on trucks or cars so that they may be transported and unloaded at their destination without being excessively stressed, deformed, or otherwise damaged. Ship girders and store them with the web vertical, unless the Engineer allows in writing.

Pack bolts of one length and diameter and loose nuts and washers of each size separately. Mark a list and description of contents on the outside of each container.

H) Handling Material. Conduct loading, transporting, unloading, and storing of structural material to maintain it clean and free from injury.

607.03.14 Field Inspection. When the substructure is constructed under a separate contract, establish lines and elevations for setting steel from the completed substructure. Obtain the Engineer's approval of the existing lines and elevations prior to submitting shop details for review. The Engineer's approval of the established lines and elevations does not relieve the substructure contractor from the responsibility for constructing the substructure to the lines and elevations shown.

Provide inspection facilities to inspect erection of structural steel. When the Contract does not require shop inspection of the structural steel, the Engineer will inspect the material and workmanship upon site delivery.

607.03.15 Field Storing and Handling Materials. Place material to be stored on blocking above ground. Maintain it clean and properly drained. Place uniform depth girders and beams upright. Support long members, such as columns and chords, on skids placed to prevent injury from deflection.

Use extreme care in handling the steel at all times to prevent damage of any parts. Insulate the steel from binding chains with approved softeners. Pad the hooks and slings used to hoist steel. Place the steel so that rubbing will not occur during shipment. Store the steel at the job site on pallets, or other means approved by the Engineer, so that it does not rest on the ground and so that its components do not fall or rest on each other.

607.03.16 Falsework, Erection Methods, and Equipment. Ensure falsework is properly designed by a Registered Professional Engineer. Construct and maintain falsework for the loads that will be placed thereon. When required, prepare and submit for review plans for falsework or for changes in an existing structure necessary for maintaining traffic. Although the Engineer has reviewed these plans, take responsibility for the falsework design.

Before starting work present for the Engineer's review, the proposed method of erection, and the proposed amount and character of equipment to use for erection. Although the Engineer has reviewed this method, take responsibility for safety and erection.

Provide the Engineer with a certification by a Registered Professional Engineer that falsework towers have been assembled according to the approved falsework drawings before placing loads on the falsework.

When placing falsework installations adjacent to an open public road, design and protect the falsework system from errant highway vehicles or from vibration forces caused by passing vehicles.

607.03.17 Bearings and Anchorages. Set all bearing assemblies level and to the elevations specified in the Plans. Make adjustments in the horizontal positions of bearing assemblies for temperature as the Engineer directs. Obtain full bearing on the concrete

under bearing assemblies regardless of tolerances.

Set masonry plates and the bearing plates of bearing assemblies on ground concrete surfaces, or elastomeric bearing pads, or on lead plates in conformance with the details specified in the Plans.

Immediately before setting bearing assemblies or masonry plates, thoroughly clean the surfaces of concrete and metal to be in contact.

Drill the anchor bolt holes to the depth and dimensions specified in the Plans, after properly setting the base plates. Keep the holes dry during freezing weather. Do not lead or grout anchor bolts until after assembly of each continuous unit or span. After placing the anchor bolts, pour molten lead into the holes and pack them so the holes will be completely filled flush to the top of the base plates. Heat anchor bolts prior to pouring the lead to ensure the lead reaches the bottom and to prevent premature cooling.

Ensure that the final adjustment and setting of expansion rockers, rollers, and anchor bolts take into consideration dead load elongation in the span and temperature at the time of setting. Normal temperature is considered 60 °F. Set rockers so as to be vertical at 60 °F, after applying all dead load. Adjust nuts on anchor bolts at the expansion ends of spans to allow free movement of the span.

When expansion devices such as rockers and expansion dams have been rigidly fixed to hold them in correct alignment, release them immediately upon completing concrete placement in the portion of the structure they are installed.

607.03.18 Straightening Bent Material. Straighten bent plates and angles or other shapes by methods that will not produce fracture or other injury. Do not heat the metal unless the Engineer allows, in which case do not heat to a higher temperature than 1,150 °F as determined by a temperature stick or crayon. After heating and straightening, cool the metal as slowly as possible. Following straightening, carefully inspect the surface of the metal for evidence of fracture. The Department will reject metal with sharp kinks and bends. Do not straighten material by direct hammering.

607.03.19 Field Assembling. Assemble parts accurately as shown, and follow all match marks. Handle material so no part will be bent, broken, or otherwise damaged. Do not injure or distort the members by hammering them. Clean bearing surfaces and surfaces to be in permanent contact before assembling the members. Unless erected by the cantilever method, erect truss spans on blocking that is placed to provide proper camber. Leave blocking in place until tension chord splices and all other truss connections are pinned and bolted, and then release it sufficiently from the falsework to bring compression chord joints into full bearing.

607.03.20 Pin Connections. Use pilot and driving nuts in driving pins. Drive pins so that members will take full bearing. Screw pin nuts tight and burr the threads at the face of the nut with a pointed tool.

607.03.21 Misfits. The Engineer will allow the correction of minor misfits using small amounts of reaming, cutting, and chipping. However, immediately report to the Engineer any error in shop fabrication or deformation resulting from handling and transportation that prevents proper assembly and fitting of parts by moderate use of drift pins or by a moderate amount of reaming and slight chipping or cutting. Obtain the Engineer's approval of the proposed method for correction. Make the correction in the Engineer's presence.

For beams or girders that do not conform to the plan camber and grade in the erected position, either adjust the depth of the concrete slab haunch over the steel supporting members or rework the girder camber to meet the plan grade and slab thickness. Do not allow shear connectors to penetrate the slab less than 2 inches.

607.03.22 Removal of Falsework. Upon completion of erection and before final acceptance, remove all falsework, excavated or useless materials, rubbish, and temporary buildings. Replace or renew any fences damaged and restore in an acceptable manner all

property, both public and private, which may have been damaged during prosecution of work. Leave the bridge site and adjacent highway in a neat and presentable condition satisfactory to the Engineer. Remove all excavated material or falsework placed in the stream channel during construction before final acceptance.

607.03.23 Cleaning and Painting.

A) General. Furnish a paint system consisting of one shop coat of zinc rich primer, one field coat of moisture cure aluminum polyurethane intermediate coat, and one field application of urethane finish coat. Furnish a paint system in which all coats are produced by the same manufacturer. Use tie coats and thinners only when specified or recommended in writing by the manufacturer or the Engineer. When using thinners and tie coats, mix according to the manufacturer's written recommendation.

Furnish copies of the manufacturer's technical data sheets, written safety instructions, and written application instructions to the Engineer for review and approval before beginning painting.

Submit written procedures for compliance with this subsection for cleaning and painting in both the shop and the field to the Engineer for approval before beginning work. Include at least the following:

1) Cleaning Methods and Equipment. Operating pressure ranges for blast cleaning and water wash equipment.
2) Painting Methods and Equipment. Methods of access for field painting, safety precautions, and traffic control. Address responsibility for damage due to overspray.
3) Storage and Handling. Methods and equipment for handling and storing painted truss members and other pieces to prevent coating damage to painted parts.
4) Paint Manufacturer's Special Instructions. Recommendations for cleaning primer coated surfaces. Address the possible need for a tie coat before application of the aluminum polyurethane intermediate coating. Recommendations for the preparation of aluminum polyurethane surfaces to ensure adequate bond of subsequent application of urethane finish coat considering chalking, catalytic blush, surface hard curing, and recoat window.
5) Quality Control Plan. Outline a plan for controlling the quality of the completed paint system. Include the following:

    a) Name and qualifications of painting supervisors.
    b) Assurance of authority and responsibility for painting supervisors to halt operations and make corrections upon discovery of non-conforming work.
    c) Methods of informing painting personnel of the written approved painting procedures and their responsibility to comply.

Apply paint only after it has been approved by the Department. The Department may sample and test the paint before delivery or after it is delivered to the project. When the paint is tested and approved before delivery, the Department will label the product containers to indicate approval for use. When the paint is tested and approved after delivery, it must be available for sampling and testing at least 10 calendar days prior to use. Store the paint according to Section 821. The Department will reject the paint when test results indicate that the material does not conform to the requirements of this section. Remove all rejected paint from the job before beginning any painting.

Mix coatings with a high shear mixer, such as Jiffy Mixer, or according to the manufacturer's instructions to obtain a smooth, lump-free consistency. Do

not use paddle mixers or paint shakers unless recommended by the paint manufacturer. Mix in the original containers unless otherwise approved by the Engineer. Continue mixing until all of the metallic powder or pigment is in suspension. Ensure that all of the solids that may have settled to the bottom of the container are thoroughly dispersed. When specified by the manufacturer's product data sheet or application instructions, continuously agitate the mixed primer until applying it.

Spread the paint coatings smoothly and uniformly allowing no excess paint to collect at any point. Paint the contacting surfaces of joints or connections.

When deemed unsatisfactory by the Engineer, remove, clean, and prepare again all paint work at any stage of its completion.

When necessary or requested by the Engineer, furnish a technical representative from the paint manufacturer to observe the initial application of all coatings used, to advise as to proper application techniques, and to determine that proper results are being obtained. Ensure that the technical representative is also available to visit the project at all times during the work if the Engineer requests or deems a visit is necessary.

Keep painted material under cover until the paint is dry or until weather conditions permit exposure. Apply paint only when the weather is cool enough so that blistering or formation of a porous film does not occur.

Apply paint coatings using spray nozzles and pressures recommended by the producer of the coating system to attain the specified dry film thickness.

Provide adequate separators and traps to remove all water and oil from compressed air. Perform blotter tests daily in the presence of the Inspector. Paint only when there is no evidence of moisture or oil in the air lines.

All mil thickness measurements are dry film thickness. Determine dry film thicknesses with a magnetic dry film thickness gage. Calibrate the dry film thickness gage on the blasted steel with plastic shims approximately the same thickness as the minimum dry film thickness or with NIST calibration blocks. Use a Tooke film thickness gage to verify the coating thickness on all coats applied after the primer. The Engineer will reject the total coating system when the Tooke gage shows the primer coat to be less than the specified minimum thickness even when the total dry film thickness exceeds the total of the minimum for all coats.

If the application of the coating at the required thickness in one coat produces runs, bubbles, or sags, apply the coating in multiple passes of the spray gun. Separate the passes by several minutes. Where excessive coating thickness produces mud-cracking of the zinc rich prime in small areas, scrape back to soundly bonded coating and recoat the area to the required thickness. For large areas, re-clean and re-prime the surface.

Provide access for proper inspection of the cleaning and painting at both the fabrication plant and the construction site during all phases of work and for a period of at least 10 working days after completing each painting section. Furnish, erect, and move scaffolding or appropriate equipment approved by the Engineer, to allow the Inspector to closely inspect all surfaces. Use rubber rollers or other protective devices on scaffold fasteners. Do not use metal rollers or other types of fasteners that may mar or damage the freshly coated surfaces.

Comply with all Federal, State, and local regulations relative to environmental contamination, safety, and protection of persons and property.

B) Preparation for Shop Coating. After fabrication and immediately before painting, remove all areas of oil and grease with a solvent and blast clean all exposed surfaces of the metal, except where galvanized or metalized, according to SSPC-SP 10. The Engineer will base acceptance of the surface condition on photographic standards. Acceptance after blast cleaning and immediately before painting, will be according to Pictorial Standards A SP 10, B SP 10, or C SP 10, of SSPC Vis. 1. Ensure that the depth of the anchor texture of the blast-cleaned

steel is 1.5 to 3 mils. Do not use a wash primer. Apply zinc coating within 24 hours after blast cleaning.

Remove all fins, tears, slivers, and burred or sharp edges that are present on steel members, and that appear during the blasting operation, by grinding and reblasting the area to achieve a 1.5 to 3 mils surface profile.

When removing scale, do not allow the hammers to scar the metal.

Use clean dry sand, steel shot, mineral grit, or manufactured grit for a blast cleaning abrasive. Remove all abrasive and coating residue from the steel surfaces with a good commercial grade vacuum cleaner equipped with a brush-type cleaning tool, or by double blowing. When using double blowing, vacuum the top surfaces of all structural steel, including flanges, longitudinal stiffeners, splice plates, hangers, and all other surfaces after completing the double blowing operations. Blow the steel clean with an air line that has an in-line water trap, and ensure that the air is free of oil and water as it leaves the air line.

Apply paint only after the Engineer inspects and approves the surfaces.

Defer painting of galvanized surfaces as long as possible in order that the surfaces may weather. Before painting galvanized surfaces, treat according to ASTM D 2092 or treat with a solution composed of 2 fluid ounces of commercial muriatic acid added to 2 ounces each of copper chloride, copper nitrate, and sal ammoniac dissolved in one gallon of water. Prepare the solution in an earthen or glass vessel, never in a metal receptacle. Apply the solution with a wide flat brush. The galvanized surface will assume a very dark color, drying to a grayish film.

C) Application of Shop Coating. Apply one coat of zinc rich primer to all metal surfaces prior to shipping steel from the plant. Include surfaces that are to be field bolted in contact.

Apply paint only when the air temperature at the shop is 40 °F or greater, the surface temperature of the steel members to be painted is at least 5 °F above the dew point temperature, and the relative humidity at the site is between 30 and 85 percent. Do not apply paint to damp or frosted surfaces, nor when the air is misty.

Ensure that the dry film thickness of the prime coat is 3 mils with a tolerance of –0.5 mil and + 2.0 mils on all surfaces except those that are to be field bolted in contact or that will be in contact with concrete. Ensure that the dry film thickness on surfaces to be field bolted in contact or surfaces that will be in contact with concrete is 1.5 mils ± 0.5 mil except when the slip coefficient is based on a coating thickness of 5.0 mils. When the slip coefficient is based on a 5.0-mil thickness, if desired, apply the prime coat to the full specified thickness of 3.0 mils with a tolerance of –0.5 and + 2.0 mils.

If the prime coat is deficient in thickness, thoroughly clean with power washing equipment, then wire brush, vacuum and recoat according to B) above.

Protect freshly coated primed surfaces from subsequent blast cleaning operations. When damage occurs, thoroughly wire brush or if visible rust occurs, reblast to a near-white condition. Vacuum and reprime these surfaces by spraying.

Do not apply subsequent coats of paint over the primer until at least 72 hours have elapsed or until the film is dry throughout. Apply a shop coat of zinc rich primer to all steel surfaces that will be in contact with concrete and to surfaces that will be inaccessible after field assembly. Apply the aluminum polyurethane intermediate coating and urethane finish coat in the shop before assembly or erection in areas that will be inaccessible when assembled in the field. Apply the shop primer to interior surfaces of box sections that are to be sealed by welding. When shear connectors are to be installed in the shop, install them before painting the top surfaces of girders. After installing the shear connectors in the shop, repair all heat damage to the shop paint on the bottom surface of the top flange. The Engineer will not require the repair of heat damage to the top of the flange in contact with concrete. The Engineer will not require

painting the shear connectors. If the shear connectors are painted, the Engineer will not require cleaning the overspray. When installing shear connectors in the field, shop paint the top surface of the girder.

Paint structural steel that is to be welded only after completing welding. When welding the steel in the shop and subsequently erected by bolting, apply one coat of primer after finishing the shop welding and blast cleaning.

Paint surfaces of iron and steel castings only when directed according to Subsection 607.03.08 D).

Transfer or preserve field identification erection marks and weight marks. Load the steel for shipment only after the shop coating has cured at least 72 hours and the Engineer has inspected it.

D) Preparation for Field Coatings. Clean by sections, bays, or other readily identifiable parts of work. Apply paint only after the Engineer has inspected and accepted each section, bay, or part.

After erection, including all bolting and remedial work, prepare the shop applied zinc coating for field applied intermediate coating as follows. Remove all grease, oil or other lubricants from all surfaces to be painted including lubricant or residuals from the surfaces of all galvanized nuts, bolts and washers by solvent cleaning according to SSPC SP 1. When dry overspray from the shop applied zinc coating exists, remove by sanding. High pressure water wash all structural steel at 4,500 to 5,000 psi. using clean potable water. As needed, use a non-sudsing, bio-degrable detergent to remove all surface contaminants not removed by high pressure water washing. Rinse all areas where a detergent and/or solvent was applied by pressure washing with clean potable water. Blast clean all surfaces sustaining damage to the shop applied zinc coating to the pictorial standards described in subsection B. Apply a field coat of approved zinc rich coating to all areas not possessing an acceptable shop applied zinc coating. Completely remove all rust, scale and other foreign material before applying the intermediate coating.

When application of the finish coat exceeds the recoat window of the intermediate coat, abrade the surface of the intermediate coat according to the coating manufacturer's recommendations before applying the finish coat.

E) Application of Field Coatings. Paint between April 1 and November 15. The Department may allow painting at other times when the Engineer approves in writing.

Apply paint only to clean and dry surfaces when the ambient air temperature is 40 °F or greater, the surface temperature of the steel members to be painted is at least 5 °F above the dew point, and the relative humidity is less than 90 percent. Do not apply paint to damp or frosted surfaces, nor during any period of rainfall.

Protect pedestrian, vehicular, and other traffic on or underneath the bridge and all portions of the bridge superstructure and substructure against damage or disfigurement by spatters, splashes, and smirches of paint or paint materials. Take responsibility for all damages resulting from paint operations. Submit a detailed written outline to the Engineer for approval before field painting. Include sketches, if necessary, of methods to prevent overspray drift. Include protection of vehicular traffic, boats, and marinas beneath the bridge, and buildings or other property in the vicinity of the bridge.

Apply field coatings only after satisfactorily completing field cleaning and ensuring that the paint applied for retouching the shop coat is thoroughly dry. Do not apply succeeding coats until the previous coats have dried throughout the full thickness of the paint film.

Paint from the top of the structure toward the bottom, and proceed by sections, bays, or parts of the work, unless the Contract or Engineer directs otherwise.

Apply field coats only at levels greater than 10 feet above the bridge slab until completing concrete work, including final rubbing or application of the masonry coating.

Mitigate dust produced by traffic for the necessary distance on each side of the bridge. Prevent dust and dirt from coming in contact with freshly painted surfaces or other surfaces before applying paint when the Engineer directs.

Apply the intermediate coat to all exposed surfaces of the completed structure. Ensure that the dry film thickness of the intermediate coating is 2 to 4 mils.

Apply urethane finish coat to all exposed surfaces of the completed structure. Ensure that the dry film thickness of the urethane finish coat is 3.0 ± 1.0 mils.

Stencil the completion date of painting, including the year and month, on the structure as the Engineer directs.

F) Repair of Shop and Field Coatings. Repair according to the manufacturer's recommendations and as otherwise specified in this section.

When using blast cleaning to field repair coatings, use an approved low-dust abrasive. Apply coating systems for repair as follows:

1) Rusted Areas. Zinc rich primer, aluminum polyurethane intermediate coat, and urethane finish coat.
2) Non-rusted Areas. Organic zinc rich primer only in areas where dry film thickness of primer coating is less than specified, aluminum polyurethane intermediate coat, and urethane protective coat.
3) Galvanized Components. Aluminum polyurethane intermediate coat, and urethane protective coat.

When spot repair will not produce a uniform and durable coating, repaint the entire member as the Engineer directs.

Repair surfaces before erection that will be inaccessible after erection.

607.03.24 Name Plates. When shown, furnish and install name plates including fastening devices.

607.04 MEASUREMENT. The Department will measure the quantity by the lump sum. The Department will not measure miscellaneous metals, shop inspections, inspection facilities and equipment, material samples for mill authorization, enforcement of required safety precaution for radioactive exposure, furnishing of technical representatives for paint, extra paint required when bolting, nameplates, or direct tension indicators for payment and will consider them incidental to this item of work.

607.05 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

Code	Pay Item	Pay Unit
8160	Structural Steel	Lump Sum

The Department will adjust the Contract unit price for Structural Steel by the following formula when the Engineer makes plan changes that result in an increase of the estimated plan weight of steel:

$$\text{Adjusted Contract Unit Price} = \text{Original Contract Unit Price} \times \frac{\text{(Revised Estimated Plan Weight)}}{\text{(Original Estimated Plan Weight)}}$$

Bear all shop inspection costs incurred at locations other than the 2 original designated locations. The Department will initially pay for the inspection cost. Reimburse the Department subsequently.

The Department will consider payment as full compensation for all work required under this section.

The Department will make partial payment for structural steel plate stored at the fabrication shop when requested. This applies to structural steel quantities of 1,000,000 pounds or more.

SECTION 608 ¾ CONCRETE BRIDGES

608.01 DESCRIPTION. Construct concrete bridges and parts of other bridges that are concrete.

608.02 MATERIALS.

608.02.01 Concrete. Conform to Subsection 601.02 and 601.03.

608.02.02 Steel Reinforcement. Conform to Section 811.

608.02.03 Bearing and Expansion Plates. Conform to Section 813. When the Contract requires self-lubricating plates, furnish machine surfaces with trepanned recesses.

608.02.04 Rockers. Conform to Section 812.

608.02.05 Elastomeric Bearing Pads. Conform to Section 822.

608.02.06 Preformed Cork Expansion Joint Filler (Type II). Conform to Section 807. Use with bearing pads.

608.02.07 Forms. Conform to Subsection 601.02.

608.02.08 Structural Steel. Conform to Section 812.

608.02.09 Masonry Coating. Conform to Section 828.

608.02.10 Anchor Bolts. Conform to Section 813.

608.02.11 Precast and Prestressed Members. Conform to Subsection 605.

608.02.12 Concrete Curing Materials. Conform to Section 823.

608.03 CONSTRUCTION.

608.03.01 Foundation. Begin work after structure excavation, sheet piling, and all bearing piles have been prepared according to Sections 603 and 604.

608.03.02 Falsework and Forms. Construct all falsework and forms according to Subsections 601.03.11 and 601.03.12.

608.03.03 Classes of Concrete for Substructure. Use Class AA concrete in portions of the substructure above the top of caps except pedestals. Use Class A concrete in portions of the substructure below the top of caps and in pedestals. When placing concrete under water, use Class A Modified concrete.

608.03.04 Placing Steel Reinforcement in Substructure. Place steel reinforcement according to Subsection 602.03.

608.03.05 Placing Concrete in Substructure. Proportion, mix, and place concrete according to Subsection 601.03. Construct construction joints according to Subsection 601.03.10. Place concrete for footings to the full depth in one continuous operation, and allow them to set at least 12 hours before placing forms thereon for other parts of the substructure unit. Place concrete in columns in one continuous operation between construction joints. Allow concrete in columns to set at least 12 hours before placing forms for caps. Place concrete for bridge seats according to Subsection 601.03.09.

Finish all exposed surfaces according to Subsection 601.03.18. Bevel all exposed edges 3/4 inch.

Cure according to Subsection 601.03.17.

608.03.06 Placing Anchor Bolts. Place anchor bolts in piers and abutments according to Subsection 607.03.17.

608.03.07 Setting Expansion Devices. Install bearing and expansion plates, bearing pads, rockers**,** and other expansion devices, except friction or sliding type, according to Subsection 607.03.17.

For friction or sliding expansion devices furnish either structural steel plates, elastomeric bearing pads, or preformed cork. Firmly anchor expansion devices in correct position as specified in the Plans. Thoroughly coat all sliding surfaces of expansion devices with graphite lubricant just before placing them in position. Do not place concrete in a manner that will interfere with free movement of the expansion devices.

When preformed cork expansion devices are specified for sliding joints, furnish preformed cork material that is the full width and depth of each contact surface and is not built up with several pieces or strips.

608.03.08 Protection. Protect the structure during construction. Protect concrete parapet walls of abutments and end bents or ends of concrete spans from damage by equipment or traffic by methods specified in the Plans or as directed. Do not allow any traffic over the structure from the time it is completed until the pavement is completed, without protecting the ends of the bridge.

608.03.09 Placing Superstructure. Do not place any superstructure on finished piers or abutments until attaining the required concrete strength or the table in Subsection 601.03.15 for applying significant loads. With the exception of rigid frame structures, do not start the erecting or placing of the superstructure until removing the forms and determining the character of concrete in the substructure.

Construct the concrete deck according to Subsection 609.03. Construct the concrete beams according to Subsection 605.03.

608.03.10 Concrete Pile Piers, Steel Pile Piers, and Abutments. Construct all precast or cast-in-place concrete pile piers and abutments, and steel pile piers and abutments according to the lines, grades, dimensions, and design specified in the Plans and according to Sections 601, 602, and 604. Remove falsework under pier caps according to Subsection 601.03.14.

608.03.11 Construction Date and Identification. Stencil the construction date and identification according to Subsection 601.03.19.

608.03.12 Inspection Facilities. Provide facilities for inspection of work as it progresses and for final inspection of completed work. Provide ladders, or other satisfactory means, to enable the Engineer to examine and inspect pier and abutment caps and bearings. Remove them after final inspection and the Engineer's approval of work.

608.03.13 General Requirements for Superstructure. Give all exposed surfaces a finish according to Subsection 601.03.18. Construct bridge slabs according to Subsection 609.03. Construct precast and prestressed beams according to Subsection 605.03.

608.03.14 Steel Reinforcement for Superstructures. Place all steel according to Subsection 602.03.

608.03.15 Concrete Bridge Layout. Dimensions specified in the Plans are for a normal temperature of 60 °F. Layout dimensions are horizontal measurements.

608.03.16 Permissible Finish Variations. Do not allow lines of the finished concrete, except bridge slabs and precast piles, to vary more than 1/4 inch per 10 feet or vary from plan lines more than 0.1 percent of the distance between extremities of the unit considered.

The Engineer will decide whether any variations in excess of those stated are cause either for removal and replacement of the work according to Subsection 105.01.04 or for a reduction in payment.

608.03.17 Forms and Steel Reinforcement Quality Control. Perform quality control according to Section 113. Submit a written plan. Describe inspection procedures. Identify jobsite quality control personnel. Provide qualified QC personnel. Locate their personnel in the management diagram.

Perform a thorough dimensional, grade, and location check of all work prior to each concrete placement. Notify the engineer when the inspection is complete and all corrective actions are taken.

The Engineer will perform the Department quality assurance inspection of forms and steel reinforcement. Perform corrective work as direct by the Engineer.

608.04 MEASUREMENT.

608.04.01 Concrete. The Department will measure the quantity according to Subsection 601.04.

The Department will not measure furnishing inspection facilities or stenciling for payment and will consider them incidental to this item of work.

608.04.02 Steel Reinforcement. The Department will measure the quantity according to Subsection 602.04.

608.04.03 Structural Steel. The Department will measure the quantity according to Subsection 607.04.

608.04.04 Masonry Coating. The Department will measure the quantity according to Subsection 601.04.

608.04.05 Quality Control. Measure and pay according to Section 113.

608.05 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

Code	Pay Item	Pay Unit
8100-8105, 2555	Concrete, Class	See Subsection 601.05[1]
8150	Steel Reinforcement	See Subsection 602.05
8160	Structural Steel	See Subsection 607.05
2998	Masonry Coating	See Subsection 601.05

[1] *When the variation is not within the permissible limits and the Engineer does not require removal and replacement, the Department will deduct from the total Contract price the product of the volume of Concrete not within the permissible limits multiplied by the Contract unit price for the Concrete.*

The Department will consider payment as full compensation for all work required under this section.

SECTION 609 ¾ REINFORCED CONCRETE BRIDGE SLABS

609.01 DESCRIPTION. Construct reinforced concrete slabs on bridges.

609.02 MATERIALS AND EQUIPMENT.

609.02.01 Steel Reinforcement. Conform to Section 811.

609.02.02 Concrete. Conform to Subsection 601.02 and 601.03.

609.02.03 Joint Materials. Conform to Section 807.

609.02.04 Structural Steel Joints. Conform to Section 812.

609.02.05 Forms. Conform to Subsection 601.02.13.

609.02.06 Concrete Curing Materials. Conform to Section 823.

609.02.07 Welded and Seamless Steel Pipe for Bridge Floor Drains. Conform to Section 810.

609.02.08 Zinc Oxide-Zinc Dust Primer. Conform to Federal Specification TT-P-641, Type II.

609.02.09 Finishing Machines. Provide each finishing machine with at least 2 movable footbridges from which to perform finishing and curing.

Furnish a self-propelled finishing machine equipped with:

1) one or more augers or other equally effective device to move and position the concrete,
2) a cylinder to compact and finish the concrete, and
3) a pan float.

Provide a machine that is readily adjustable so all its devices may be easily operated to satisfactorily position, consolidate, and finish the concrete.

Use machines that span the full width of the bridge, are adjustable to grades paralleling the roadway crown, and are of rigid construction to ensure a surface finish true to the lines, grades, and cross sections specified in the Plans or established by the Engineer. Give consideration to setting finishing machine on skew if angle exceeds 15 degrees.

Support the machine by rails or tracks of sufficient section modulus to withstand the imposed loads and deflect no more than 1/16 inch between the rail supports. Provide rails or track that are sufficiently rigid to prevent the machine from riding up when finishing concrete of the specified slump. Install the rails outside the limits of the roadway slab, set and maintain them true to grades paralleling the bridge grade, throughout the entire finishing operation.

609.02.10 Hand Operated Internal Vibrators. Conform to Subsection 601.02.

609.03 CONSTRUCTION.

609.03.01 Swinging the Spans. Before placing concrete slabs on steel spans or precast concrete release the temporary erection supports under the bridge and swing the span free on its supports.

609.03.02 Forming. Form according to Subsection 601.03.12. Construct falsework

according to Subsection 601.03.11. Construct falsework and forms for multiple slab spans to provide the camber required in the finished structure.

Department will allow the use of permanent steel bridge deck forms as follows:

A) Design. Conform to the following criteria for designing permanent steel bridge deck forms:

1) Design the steel forms on the basis of dead load of form, reinforcement, and plastic concrete plus 50 pounds per square foot for construction loads. Do not allow the unit working stress in the steel sheet to exceed 0.725 of the specified minimum yield strength of the furnished material, or to exceed 36,000 psi.
2) Do not allow deflection under the weight of the forms, the plastic concrete, and reinforcement to exceed 1/180 of the form span or 1/2 inch whichever is less, and do not base this deflection on a total loading of less than 120 pounds per square foot.

   Base the permissible form camber on the actual dead load condition. Do not use camber to compensate for deflection in excess of the forgoing limits.
3) Use the design span of the form sheets as the clear span between edges of support angles plus 2 inches measured parallel to the form flutes. Do not use a fabricated panel length that is less than the distance between edges of beam flanges minus 2 inches.
4) Compute physical design properties according to AISI Specification for the Design of Cold-Formed Steel Structural Members.
5) Maintain the plan dimensions of both layers of primary deck reinforcement from each surface of the concrete deck.
6) Do not consider permanent steel bridge deck forms as lateral bracing for compression flanges of supporting structural members.
7) Except when permitted by the Engineer, do not use permanent steel bridge deck forms in panels where longitudinal deck construction joints are located between stringers.
8) Do not weld to any steel girder, stringer, or floor beam; to reinforcement bars in concrete beams; or to form supports fabricated from nonweldable grades of steel. Protect flanges from damage during erection of forms.
9) Submit fabrication, shop, and erection drawings, with design calculations, to the Engineer for review. Clearly indicate on these plans the grade of steel, the physical and section properties for all permanent steel bridge deck form sheets, and the locations where the forms are supported.
10) Adjust the steel forms to grade, from the plan construction elevations, to provide the plan slab thickness with no additional dead load other than that of the steel forms.
11) Fasten laps between sheets to ensure mortar tightness. Consider direction of concrete placement to determine lap orientation.

B) Installation. Install all forms according to approved fabrication and erection plans.

On steel members, do not rest form sheets directly on the top of the girder, stringer, or floor beam flanges. Securely fasten sheets to form supports with a minimum bearing length of one inch at each end. Place form supports in direct contact with the flange of girder, stringer or floor beam. Make all attachments by permissible welds, screws, bolts, clips or other approved means. However, do not weld form supports to flanges of steel. Ensure that welding and welds are according to the provisions of AWS D 1.5 pertaining to fillet welds, except that the Engineer will allow 1/8 inch fillet welds. Welder certification is not required.

Securely fasten all forms to supports while placing them.

On concrete beams, show all support hardware that is to be cast into the beam, on the shop drawings. Make attachments to the form supports or to the auxiliary components by permissible welds, screws, bolts, clips, or other approved means.

Protect the concrete beam from damage.

Clean all form welds of slag and wire brush just before placing the deck concrete.

Thoroughly clean, wire brush, and paint any form metal where the galvanized coating has been damaged or where white rust has formed on the metal with 2 coats of zinc oxide-zinc dust primer with no color added, to the satisfaction of the Engineer. It is not necessary to touch up minor heat discoloration in areas of welds.

Locate transverse construction joints in the concrete deck slab at the bottom of a flute and field drill 1/4 inch weep holes at not less than one foot on center along the line of the joint. Locate the joint and weep holes at the lowest portion of the concrete soffit.

C) Inspection. The Engineer will carefully observe placement of the bridge deck slab. If the Engineer determines that an event such as a delay that may have caused a cold joint or insufficient vibration of concrete during the placement of the concrete warrants inspection of the underside of the deck, remove at least one section of the forms at a location and time selected by the Engineer to provide visual evidence that the concrete mixture and construction procedures are obtaining the desired results.

When forms are removed for inspection, do not replace the forms, but repair the adjacent metal forms and supports to present a neat appearance and ensure their satisfactory retention. Upon removal of the forms, the Engineer will examine the concrete surfaces for cavities, honeycombing and other defects. If the Engineer finds irregularities, and determines that these irregularities do not justify rejection of the work, repair the concrete and give it an ordinary surface finish. If the Engineer determines that the concrete where the form was removed is unsatisfactory, remove additional forms, as necessary, for the Engineer to inspect. Modify methods of construction as the Engineer requires to obtain satisfactory concrete in the slab. Remove or repair all unsatisfactory concrete.

Provide all facilities reasonably required for the safe and convenient conduct of the Engineer's inspection procedures.

609.03.03 Placing and Fastening Reinforcement. Place all steel reinforcement to within ± 1/4 inch vertically and horizontally of the position shown and according to applicable requirements of Subsection 602.03. When concrete overlays are included in the original bridge construction, construct according to the tolerance requirements for a new slab. Tie down reinforcing mats securely with wire 0.148 inch or greater in diameter at intervals of no greater than 8 feet in both the longitudinal and transverse directions to prevent upward movement of reinforcement during construction operations. When tied to the forms, extend the ties through the forms.

Do not deposit any concrete until the reinforcement is in place and the Engineer has inspected and approved it, and observed a complete and thorough "dry run" with the finishing machine over the entire slab area to be placed to ensure accurate placement of steel top clearance and proper slab depth.

The Engineer may allow splicing the reinforcement according to Subsection 602.03.

609.03.04 Expansion and Fixed Joints. Place all joints according to the details specified in the Plans or as directed. Correct improperly placed joints to the satisfaction of the Engineer even when the correction requires removal and replacement.

A) Open Joints. Place open joints in the locations specified in the Plans and construct them by the insertion and subsequent removal of a template of approved material. Accomplish the insertion and removal of the template

without chipping or breaking the corners of the concrete. Do not extend reinforcement across an open joint.

B) Steel Joints. Accurately shape the plates, angles, or other structural shapes at the shop, to conform to the configuration of the concrete slab. Ensure that the surface in the finished plane is true and free of warping. Employ methods in placing the joints to keep them in correct position during placement of the concrete. Set the opening at expansion joints to the temperature adjustment specified in the Plans. Avoid impairment of the clearance. When placing concrete, make adjustments in the joint widths to accommodate temperature changes.

C) Cold-Applied or Hot-Applied Sealing Compound. Ensure that all joints to be sealed are free of cracked or spalled areas. Chip cracked areas back to sound concrete.

Ensure that the faces of all joints to be sealed are free of all foreign matter, curing compound, oils, greases, paint, dirt, free water, and laitance. Thoroughly clean all joint faces by sandblasting or by means of a mechanical rotary wire brush.

Immediately before sealing, blow out the joint with air from an air compressor equipped with an oil and water trap. Use an air compressor of such capacity as will maintain 90-psi pressure when air is delivered to the joint through a nozzle no more than 1/4 inch in diameter.

When any sealing compound has not bonded to the joint wall or face, remove it and clean and reseal the joint.

Place all cold-applied sealing compound with a manufacturer recommended applicator, and follow the manufacturer's mixing and placing instructions. Provide a copy of these instructions and the specifications for the applicator to the Division of Materials.

D) Preformed Neoprene Joint Seals. Ensure that all joints are true to alignment and have vertical faces. Ensure that each joint is uniform in width throughout its length. Reform, reconstruct, and resaw or otherwise modify improperly constructed joints to the satisfaction of Engineer.

Construct expansion joints to be sealed by this method according to the details shown on the Standard Drawings or specified in the Plans.

When a joint, as constructed, has a width larger or smaller than the specified width, provide a seal for that joint that is the correct size for the as-built width.

Ensure that all joints to be sealed are free of cracked or spalled concrete.

Chip damaged areas back to sound concrete and repair them with an approved epoxy resin compound or other materials approved by the Department.

Install the seals in the properly prepared joints by a tool designed specifically for installing joint seals. Remove and replace any seal that is damaged during installation. Remove any seal that is improperly positioned in the joint and reinstall it at the proper elevation. Use hand methods to install seals only in areas that are inaccessible to the machine, or obtain the Engineer's written permission to install seals by hand methods.

The Engineer will measure seals before and after installation as a check against stretch. Remove any installed seal that shows more than 5 percent stretch and correctly reinstall it or replace it. Install the seals in structures immediately after expiration of the curing period. Install all seals securely and ensure that they are free from any objectionable curling or twisting in the joint groove. Use a lubricant adhesive that covers both sides of the seal over the full area in contact with the sides of the joint. Apply the lubricant adhesive either to the faces of the joint or to the seal, or to both. Install all seals in a highly compressed state so that the top of the seals is $3/8 \pm 1/8$ inch below the level of the roadway surface. Install the seals in one piece, without field splicing, for the full length of each of the transverse joints. The Engineer will allow one factory splice per transverse joint. Obtain the Engineer's approval for any field splices required by partial width construction.

When specified for longitudinal joints in structures, install the seals in practical lengths, without field splicing.

E) Neoprene Expansion Joints. Furnish neoprene expansion joint consisting of any one of the manufactured joint seals specified in the Plans. Determine which of the specified joint seals will be used and obtain written approval of joint details, prior to placing the deck concrete.

Submit shop drawings for approval according to Subsection 607.03.01. Ensure that these drawings, along with joint details, include a layout plan of the joint units to be used. Also include procedures for setting expansion joint width, so the opening will be the specified width at 60 °F. The Engineer will approve of details of installation and his decision will be final.

Include the details and material specifications for the manufactured neoprene expansion joints and incidental accessories, sealants, and adhesives with the shop drawings for approval.

Before beginning work on the joint, furnish the manufacturer's written installation instructions.

Comply with the manufacturer's installation instructions, apply sealants and adhesives, and install joint units as shown on the approved shop drawings and as specified in this section.

When the Engineer requests, obtain technical assistance from the supplier of the joint. Failure of the joint supplier to provide adequate technical assistance may be cause for removal of the joint seal from the Department's List of Approved Materials.

Remove all forms and debris from the joint opening. Ensure that concrete or metal surfaces where the neoprene expansion joints are to be set are dry; clean and free from dirt, grease, and contaminants; level; and sound with no broken or spalled concrete. Ensure that adjacent joint seats are on a straight plane with each other.

Furnish and install the neoprene strip sealing element in one continuous unbroken length for the entire joint length. For the strip seal type joint, ensure that the locking groove in the metal extrusion is clean and free of any dirt or corrosion before installing the neoprene strip seal element. Bond the strip seal in place with the manufacturer's recommended adhesive which meets the Engineer's approval.

Where longitudinal joints cross transverse joint seals, provide a seal by flattening and extending the longitudinal joint neoprene seal element under the transverse joint pad. When this procedure is not practical, use a separate neoprene apron, bonded to the longitudinal seal element.

Ensure that the finished joint presents a smooth, neat appearance. Wipe or scrape away excess sealant before it becomes hard. Upon completion of an entire joint, grind any uneven concrete or armored edge.

609.03.05 Drainage. Install deck drains at the locations shown or as directed and place them before placing the bridge deck slab. Paint all drain pipes according to Subsection 607.03.23. Provide transverse drainage of the roadway surface by means of a suitable crown or cross slope in the floor slab. Effectively drain gutters using weep holes or drain scuppers constructed at locations and in the manner specified in the Plans. Install drain scuppers to prevent drainage water from staining exposed surfaces of girders and abutment walls. In general, extend drain pipes through the concrete slab to a distance of no less than one inch below the slab or underlying beam. Provide the under surface of cantilever brackets and overlapping slabs with a V groove (drip strip) 1/2 inch in depth at a point no more than 6 inches from the outside face of the overhang for the purpose of arresting flow of moisture to prevent staining.

609.03.06 Weather Limitations and Placing Concrete. Do not place any concrete within deck slabs during the months of January or February, except for barriers, plinths, curbs, walks, etc. Place all deck concrete according to Subsection 601.03.09. Any time

the ambient temperature is anticipated to be 85 °F or higher, place concrete in the deck slab during evening hours after ambient temperatures cool to below 85 °F and cease placement before temperatures rise above 85 °F. Cool forms and beams tops by water spray if their temperature exceeds 85 °F.

Always protect deck placement from rain water being introduced into the concrete and from rainwater surface damage. Cease deck placement immediately or cover it for complete protection when rain occurs.

609.03.07 Depositing, Consolidating, and Striking Off Slab Concrete. Wet the reinforcing steel and forms with water prior to placing concrete. Deposit the concrete between the curbs or between the longitudinal joints when specified in the Plans to the full depth of the slab, and consolidate it. Consolidate by means of hand-operated internal vibrators according to Subsection 601.03.09. Use a spade in addition to vibrating, if required, to ensure that no honeycomb, voids, or air pockets exist against the forms. Continue consolidating the concrete until there is complete contact between the reinforcing steel and the concrete, and until mortar flushes to the top surface.

When using permanent steel bridge deck forms, place emphasis on proper vibration of the concrete to avoid honeycombing and voids, especially at construction joints, expansion joints, and valleys and ends of form sheets. Obtain the Engineer's approval of pouring sequences, procedures, and mixtures.

Continuously place concrete in any slab between expansion joints or between construction joints as specified in the Plans.

Prevent displacement of reinforcement during placing of concrete. Place concrete in the sequence as specified in the Plans and in the absence of such designation, place as directed. Obtain written approval to change the pouring sequence. Provide sufficient work capacity to place concrete at a minimum rate of 25 cubic yards per hour.

When, in case of an emergency, it becomes necessary to introduce a construction joint, form it by means of a vertical bulkhead constructed to produce a keyed joint and located as approved by the Engineer.

In placing concrete around steel shapes, place it only on one side of the shape until it flushes up over the bottom flange of the shape on the opposite side, after which place it on both sides to completion.

Do not place concrete railings monolithic with the slab.

On continuous, composite design structures, keep concrete in slabs plastic for a sufficient length of time to allow the structure to deflect to the natural deflected shape.

Place the concrete in each integral unit of the superstructure continuously. Do not begin placing concrete without sufficient approved material on hand nor without sufficient forces and equipment to complete that unit without interruption. Avoid joints in the concrete due to work stoppage. Form construction joints, when necessary, according to Subsection 601.03.10.

Place concrete in slab spans in one continuous operation for each span. Place concrete in transverse strips the entire width of the bridge. Place concrete for the full depth and ensure that the width of strips is such that concrete in any one strip does not take its initial set before placing the adjacent strip.

When expansion devices such as rockers, expansion dams, and similar fixtures have been rigidly fixed to hold them in correct alignment, immediately release them upon completion of concrete placement in the portion of the structure in which they are installed.

Immediately following consolidation of the concrete, strike off the surface to crown and cross section with the finishing machine. Move the machine in the direction that work is progressing. Maintain a slight excess of concrete at all times so no low spots are left in front of the finishing machine. Prevent the excess concrete from tearing the surface. After finishing, do not work, walk on, or disturb the concrete in place except as described in this section.

In general, do not add water to the surface of the concrete to assist in finishing operations. If the Engineer allows the application of water to the surface, apply it as a fog spray using approved spray equipment.

609.03.08 Working the Surface. Following the striking off or screeding, randomly check the surface for irregularities and mortar ridges, at least every 50 feet of bridge length, with an approved 10-foot straightedge operated parallel to the centerline of the bridge and slab surface. Eliminate all variations greater than 1/8 inch.

After the concrete slab has cured, the Engineer will again check the slab for variations exceeding 1/8 inch. Perform any corrective action that the Engineer deems necessary.

After completing the finishing operation, ensure that the surface of the concrete presents a uniform appearance; conforms to the required grade and cross section; and is free from surplus water, rough and porous spots, irregularities, depressions, and other objectionable surface features resulting from improper finishing.

609.03.09 Finish with Burlap Drag. If the Contract does not require texturing, finish the slab using a burlap drag. Use a burlap drag of double thickness, at least 3 feet wide, and long enough to span between curb faces. Lay the burlap on the slab surface and drag it in the direction the slab is being placed, keeping approximately 2 feet of its width in contact with the slab surface. Keep the burlap drag damp, clean, and free from hardened concrete.

609.03.10 Texturing. Texture the surface by forming transverse grooves. Form the transverse grooves by approved manual tools such as rakes with spring steel tines. Form the grooves in the concrete at an appropriate time during concrete set, so that in the hardened concrete, the grooves will be between 0.09 to 0.13 inch in width, between 0.12 and 0.19 inch in depth, and be spaced at random intervals between 0.3 and 1.0 inch. Terminate the grooves approximately 18 inches from faces of the curbs, concrete barrier walls, or other vertical walls.

Regardless of the method used to form the grooves, ensure that the grooves are relatively smooth and uniform, are formed without tearing the surface or without bringing pieces of the coarse aggregate to the top of the surface, and are formed to drain transversely.

Correct any individual areas of hardened grooved concrete that do not conform to these requirements by the cutting of acceptable grooves in the hardened surface with an approved cutting machine or by other approved methods.

609.03.11 Waterproofing Membranes and Surface Courses for Slabs. When a waterproofing membrane overlay or special surface course is specified in the Contract, prepare the slab surface according to the procedures designated in the Contract. Do not texture the surface and do not apply a liquid membrane forming curing compound when the slab is to be waterproofed or receive a surface course.

609.03.12 Curing. Immediately after finishing and while the surface is slightly damp, apply Type II (white pigmented) membrane-forming curing compound to the slab between the curb lines. Do not dilute or alter the compound, but thoroughly agitate it immediately before applying it. When the compound is too viscous to apply, warm it in a water bath to approximately 100 °F before applying it. Apply the compound uniformly using an approved pressure sprayer at a rate of one gallon per 120 square feet. If the Engineer deems the application is not uniform as it progresses, apply the compound in 2 applications, each at a minimum rate of one gallon per 240 or less square feet. Start the second application after completing the first application. The Engineer will determine the total quantity of compound actually applied to the slab and compute the actual rate of application. When the Engineer determines the total actual application rate is less than one gallon per 120 square feet actual coverage, apply additional compound immediately and uniformly over the entire surface at a rate the Engineer directs.

When the Contract does not require texturing, reduce the total rate of application to one gallon per 150 square feet. If the Engineer deems the application is not uniform as it progresses, apply the compound in 2 applications, each at a minimum rate of one gallon per 300 square feet. Start the second application after completing the first application. When the Engineer determines the total actual application rate is less than one gallon per

150 square feet actual coverage, apply additional compound immediately and uniformly over the entire surface at a rate the Engineer directs.

Prevent the compound from being applied to reinforcing steel, concrete surfaces to be bonded to other concrete, or any other surfaces not specifically designated to receive the compound. When having inadvertently applied the compound to areas or surfaces not designated, remove by sandblasting or other approved methods.

After applying the compound, and as soon as possible without damaging the surface texture, cover the slab between the curb lines with curing blankets or a double thickness of burlap and keep the slab continuously wet until the required compressive strength is attained as determined by testing field cured cylinders. If other operations are not delayed, the Engineer may require 7 days wet cure regardless of cylinder strengths. If using curing blankets, place and maintain blankets and apply water as specified in Subsection 601.03.17.

When using Class S concrete, wet cure according to Subsection 601.03.17.

609.03.13 Surface Finish. Finish exposed areas of curbs, railings, and plinths, as specified in Subsection 601.03.18.

609.04 MEASUREMENT.

609.04.01 Concrete. The Department will measure the quantity in cubic yards according to the Record Plans. The Department will base the final quantity on the design quantity. When there is an error or omission in the design quantity in excess of 2 percent, the Department will adjust the design quantity accordingly. The Department will adjust quantities resulting from authorized dimension changes. The Department will not subject these quantities to the 2 percent limitation.

The Department may measure the depth of concrete cover above the top mat of steel reinforcement in inches according to KM 64-313. The Department will not measure the depth of concrete cover above the top mat of steel reinforcement as a separate pay unit, but will use it to calculate an adjusted Contract quantity for Concrete.

The Department will not measure furnishing inspection facilities, joint construction, or stenciling for payment and will consider them incidental to this item of work.

609.04.02 Steel Reinforcement. The Department will measure the quantity according to Subsection 602.04.

609.04.03 Drain Pipe. If this item is a separate pay item, the Department will measure the quantity in linear feet. If this item is not a separate pay item, the Department will not measure the quantity for payment and will consider it incidental to Structural Steel.

609.04.04 Structural Steel. The Department will measure the quantity, including drainage systems and structural steel expansion joint systems, according to Subsection 607.04. The Department will not measure paint, fittings, and connections for payment and will consider them incidental to this item of work.

609.04.05 Neoprene Expansion Dams. The Department will measure the quantity in linear feet.

609.04.06 Joint Sealing. The Department will measure the quantity according to Subsection 601.04.

609.05 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

Code	Pay Item	Pay Unit
8100-8105, 2555	Concrete, Class[(1)]	See Subsection 601.05
8150	Steel Reinforcement	See Subsection 602.05
8160	Structural Steel	See Subsection 607.05
2998	Masonry Coating	See Subsection 601.05
8820, 8821	Drain Pipe, Size	Linear Foot
8469-8472	Neoprene Expansion Dam, Size	Linear Foot
8540	Joint Sealing	See Subsection 601.05

[(1)] *The Department will adjust the Contract quantity for Concrete by the Schedule for Adjusted Quantity for Depth of Cover Deficiency. The adjusted quantity is equal to the theoretical slab volume of concrete times the ratio of the area in square feet, which is not within the specified tolerance to the plan slab area in square feet, times the factor listed in the Schedule for Adjusted Quantity for Depth of Cover Deficiency. The Department will not make additional payment for depth of cover in excess of the specified thickness.*

Schedule for Adjusted Quantity for Depth of Cover Deficiency

Depth of Cover Deficiency (inches)	Quantity Adjustment Factor
0.00 to -0.50	0.00
-0.51 to -0.63	0.12
-0.64 to -0.75	0.25
-0.76 to -0.88	0.50
-0.89 to -1.50	[(1)]
-1.51 or greater	[(2)]
0.00 to +0.50	0.00
+0.51 to +0.63	0.12
+0.64 to +0.75	0.25
+0.76 to +0.88	0.37
+0.89 to +1.00	0.50
+1.01 or greater	[(3)]

[(1)] *Construct a concrete overlay at no expense to the Department. The Department may apply a factor of 1.00 to small isolated areas in lieu of a concrete overlay.*

[(2)] *Remove and replace these areas with concrete of the specified thickness at no expense to the Department.*

[(3)] *Perform corrective work at no expense to the Department. The Department may require removal of any excess concrete or removal and replacement of the entire slab. The Department may apply a factor of 1.00 to small isolated areas in lieu of corrective work.*

The Department will consider payment as full compensation for all work required under this section.

SECTION 610 — CONCRETE BOX CULVERTS AND CONCRETE HEADWALLS

610.01 DESCRIPTION. Build all concrete box culverts and concrete headwalls according to the Contract.

For box culverts constructed using precast sections, conform to Section 611. For precast headwalls, conform to Section 710.

610.02 MATERIALS.

610.02.01 Concrete. Conform to Subsection 601.02 and 601.03.

610.02.02 Steel Reinforcement. Conform to Section 811.

610.02.03 Concrete Pipe. Conform to Section 810.

610.02.04 Joint Materials. Conform to Section 807.

610.02.05 Masonry Coating. Conform to Section 828.

610.02.06 Concrete Curing Materials. Conform to Section 823.

610.03 CONSTRUCTION. Conform to Subsection 601.03 for all concrete construction.

610.03.01 Footings. Construct footings to the elevation specified in the Plans, and increase the depth when the Engineer determines that it is necessary to provide sufficient bearing or to prevent undermining. Only raise footing elevations when encountering solid rock at elevations above those specified in the Plans and with the approval of the Engineer.

Form the outside face of all footings of concrete headwalls for pipe, box, or arch culverts to the full depth of the footing. Do not place any concrete in the foundation until the Engineer has inspected and approved the depth of excavation and character of the foundation material.

Whenever the natural foundation material is not sufficiently stable to support the structure or whenever it is anticipated that high water may cause excessive erosion around the footings, the Engineer may order Extra Work to provide the structure with adequate support or protection according to Subsection 109.04.

When the condition of excavation for footings is otherwise satisfactory but is such that concrete cannot be placed without mud becoming mixed with the concrete, remove the entire mass of mud and replace it with stable material or prevent infiltration of mud by methods such as a layer of coarse aggregate and geotextile fabric or a layer of plastic material. Perform work by methods other than removing and replacing the entire mass of mud according to Subsection 109.04.

610.03.02 Apron Walls and Headwalls.

A) Apron Walls. The Engineer may require additional depth than that specified in the Plans if necessary to prevent undermining. Form the outside faces of all concrete apron walls for the full depth. When necessary to form the back face or the end of apron walls due to the lack of solid material, do not exceed the excavation limits specified for footing structure excavation.

Pave the space between wings when the Engineer directs. In this event, relocate the apron walls so that they are in a straight line between the ends of the wings, or at locations to provide the best protection.

B) Headwalls. Construct headwalls according to the Standard Drawings for Headwall Supplement. When headwalls for pipe culverts are located at the

shoulder, construct the top of the headwalls parallel to the shoulder line for both line and grade.

610.03.03 Drainage. Place weep holes consisting of 4-inch pipe or formed to 4 inches in diameter at intervals not to exceed 25 feet in retaining walls, nor exceeding 10 feet in box culverts. Place the outlet invert elevation of weep holes in box culverts 4 inches above the flowline of the culvert. Raise box culvert weep holes to accommodate significant silting when the Engineer directs. Make adequate provisions for thorough drainage of backfill and embankment according to Subsection 603.03.

610.03.04 Placing Concrete. Place concrete according to Subsection 601.03.09.

Place the base slab or footings, and allow them to cure before constructing the remainder of the structure. Construct base slabs, footings, and apron walls as monolithic units when practical. When construction joints are necessary, place them at right angles to the culvert barrel.

Bond construction joints, according to Subsection 601.03.10.

In constructing all box culverts having a clear height of 5 feet or more, place concrete in the side walls, and allow it to set before placing the top slab.

For culverts having a clear height of less than 5 feet, if desired, pour the culvert top slab monolithically with the side walls. When using this method of construction, make all necessary construction joints vertical and at right angles to the axis of the culverts.

Construct each wingwall as a monolithic unit. Place construction joints, where unavoidable and when not specified in the Plans, horizontal or vertical as appropriate.

610.03.05 Removing Forms. Remove forms according to Subsection 601.03.14..

610.03.06 Surface Finish and Placing Fill. Finish surfaces according to Subsection 601.03.18. Texture top slabs of box culverts to be used as the wearing surface for traffic according to Subsection 609.03.10, and conform to the roadway rideability requirements of Subsection 501.03.19.

Place backfill or embankment as allowed by concrete strength.

Backfill according to Subsection 603.03. Construct embankment according to Subsection 206.03.

610.03.07 Extensions to Existing Culverts. Construct extensions according to the lines and grades established and to dimensions specified in the Plans.

Remove portions of the existing structure designated to be removed according to Subsection 203.03. Remove portions of the existing structure designated to be removed in a manner that provides a neat junction with the extension, and leave undamaged that portion of the existing structure that is to remain in service. For exposed joints in the finish work, the Engineer may require sawing of the existing concrete to a depth sufficient to ensure a neat joint. Repair all damage to the existing structure due to his activities. Remove and dispose of all silt or other debris that may have collected within the barrel of the existing structure. The Engineer will only require this silt and debris removal once, unless erosion control measures were not adequate.

610.04 MEASUREMENT.

610.04.01 Concrete. The Department will measure the quantity according to Subsection 601.04.

610.04.02 Steel Reinforcement. The Department will measure the quantity according to Subsection 602.04.

610.04.03 Structure Excavation. The Department will measure the quantity according to Subsection 603.04. The Department will measure the removal and replacement of unstable material in footing excavation as Structure Excavation.

610.04.04 Removal of Existing Structure. The Department will measure the quantity according to Subsection 203.04. The Department will not measure repair of damage to, removal of silt and debris from, and providing a neat cut for the joint on the portion of the structure designated to remain for payment and will consider them incidental to this item of work.

610.05 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

Code	Pay Item	Pay Unit
8100, 8102-8105, 2555	Concrete	See Subsection 601.05
8150	Steel Reinforcement	See Subsection 602.05
----	Structure Excavation	See Subsection 603.05
2731	Remove Structure	See Subsection 203.05

The Department will consider payment as full compensation for all work required under this section.

SECTION 611 ¾ PRECAST REINFORCED CONCRETE BOX CULVERT SECTIONS

611.01 DESCRIPTION. Install precast reinforced concrete box sections used as culverts, storm drains, and sewers.

611.02 MATERIALS.

611.02.01 Concrete. Conform to ASTM C 1433.

611.02.02 Steel Reinforcement. Conform to Section 811.

611.02.03 Backfill Material. Conform to Subsection 206.03.01.

611.02.04 Free Draining Backfill Material. Conform to Section 805.

611.02.05 Grout. Conform to Subsection 601.02.

611.02.06 Sand. Conform to Section 804.

611.02.07 Sand for Pipe Bedding. Conform to Section 804.

611.02.08 Crushed Aggregate for Bedding. Conform to Section 805.

611.02.09 Joint Sealer for Rigid Pipe. Conform to Section 807.

611.02.10 Geotextile Fabric. Conform to Section 843.

611.03 CONSTRUCTION.

611.03.01 Transportation and Handling. Handle and store the precast units so that flexural stresses are not induced until the concrete age is 7 days or attains a compressive strength of 3,000 psi.

Remove and replace all sections that are not in true alignment and grade or that show undue settlement after laying, or are otherwise damaged.

611.03.02 Precast Unit Construction. Construct units according to AASHTO C 1433 and Section 605 with the following exceptions and additions:

1) A water meters is not required if using dry-cast methods.
2) Make all markings by indentation, except the Department will allow the use of waterproof paint to indicate the month and day of casting. Place indented markings on the inside top of each section, in letters at least 1 inch high. When a manufacturer has more than one plant, mark the plant letter that the Division of Materials assigns on the inside of the culvert. Paint the month and day of casting on the outside of the sections
3) Furnish precast sections at least 4 feet long.
4) Contrary to ASTM C 1433 Section 10.3, ensure the compressive strength of the cores tested are equal to or greater than the design strength.

611.03.03 Shop Drawings. Submit shop drawings for review according to Subsection 105.02, except do not include original tracings. Include on the shop drawings details of joint configuration, the size of rubber gaskets or butyl rubber sealants when used, the area of steel reinforcement, lift holes, and the size and location of reinforcement.

611.03.04 Excavation. Perform structure excavation according to Section 603,

except as modified in this subsection.

611.03.05 Bedding. Perform bedding as specified in the Plans or Standard Drawings. Level the compacted bedding with a template or straightedge to ensure uniform support throughout the entire width and length of the structure.

When desired, substitute crushed aggregate up to 3/4 inch maximum size for sand as bedding material. Do not use DGA or gravel base for this substitution. Substitute measure for measure.

The Engineer will require a vertical trench from the bottom of the excavation to the top of the culvert or original ground, whichever is lower, as specified in the Plans or Standard Drawings.

611.03.06 Laying Sections. Do not lay any unit until the Engineer approves the proposed location. Take soundings for foundation design at the inlet and outlet of each culvert and at intervals no greater than 20 feet along the grade line of the bottom of the culvert, to a depth of 3 feet. Perform soundings on the centerline and at each edge of the culvert. Where ledge rock, gravel, hardpan, or other unyielding material is encountered or known to exist within the limits stated, prepare the foundation as specified in the Plans or Standard Drawings.

Camber the box culvert sections as the Engineer directs. Begin placing sections at the outlet end of the pipe with the bell or groove end being laid upgrade. Fully extend successive spigot ends into each adjoining hub. Provide a "come-along" or other mechanical device to pull each section firmly into the previously placed section, tightly meshing the joints. Do not push sections together with a tractor-mounted blade. After installing the sections, seal lift holes by inserting a tapered precast concrete plug and coating the top of the joint around the plug with asphalt mastic material.

When the Plans require the volume between side-by-side installations to be filled with grout, use grout consisting of one part cement to 6 parts mortar sand or concrete sand, with sufficient water to provide a consistency suitable for job conditions.

Provide drainage with 4-inch weepholes as specified in Subsections 610.03.03 and 603.03.05 respectively, except that for side-by-side installations separated by grout, place weepholes in the extreme outside walls only.

Grout formed openings between the precast sections and any side entry of pipes or top entry of manholes to form a watertight joint. When manholes are to be placed directly on the top slab of the precast sections, provide sufficient additional steel reinforcement in the top slab to compensate for the section removed.

611.03.07 Joints. Use either rubber gaskets, butyl rubber sealants, or asphalt mastic joint sealing compound in joints between the precast box sections. Use the same material throughout each individual structure.

A) Rubber Gaskets. Use a cement and lubricant to facilitate joining the sections that is recommended by the manufacturer of the rubber gaskets. Install the rubber gaskets in a manner to snugly fit in the beveled surface of the tongue and groove ends of the section to form a flexible water-tight seal under all conditions of service.

B) Butyl Rubber Sealants. Use a primer; rate and method of primer application; and width and method of application of the butyl rubber sealant recommended by the manufacturer. Provide the Engineer with the manufacturer's literature for installation procedures.

C) Asphalt Mastic Joints. Prime and seal asphalt mastic joints according to Subsection 701.03.05.

D) Joint Fit. Regardless of the type of sealant to be used, ensure proper meshing of the joints.

Do not allow sand or foreign materials to intrude into joints. If sand or foreign material is present within the joint upon joining the sections, thoroughly clean until no

sand or foreign material is present, and reseal the joint.

If the joint is not entirely filled with sealant after connecting the culvert sections fill all exposed unsealed areas, both inside and outside the culvert, with asphalt mastic or other approved material. If using plastic gaskets, use an additional sealant compatible with the plastic and recommended by the gasket manufacturer.

Fill the exterior joint gap on the top of precast reinforced concrete boxes with mortar. Cover the exterior joint with a minimum of a 15-inch double layer geotextile fabric joint wrap. Before applying the wrap, ensure that the surface is free from dirt and foreign substance. Use one continuous roll of double layered joint wrap to cover the joint on the top of the box and to extend completely down the sides to the bottom of the box. During backfilling, keep the joint wrap in the proper location over the joint. Apply the joint wrap to all joint sections.

611.03.08 Backfilling. Backfill according to Subsection 603.03, the Plans, and the Standard Drawings. Place free draining backfill between side-by-side installations when required by the Plans. Compact the backfill as the Engineer directs.

611.03.09 Headwalls. Construct headwalls as specified in the Plans or Standard Drawings.

611.04 MEASUREMENT.

611.04.01 Structure Excavation. The Department will measure the quantity according to Subsection 603.04. For necessary side-by-side installations, the Department will measure the entire excavated volume between sections when the Plans or the Engineer require excavation of this volume. The Department will measure embankment placed and subsequently excavated according to the plan requirements for bedding as structure excavation. The Department will not measure free draining backfill or grout between side-by-side installations for payment and will consider them incidental to this item of work.

611.04.02 Precast Reinforced Concrete Box Sections. The Department will measure the quantity in linear feet according to the length dimensions specified in the Plans. The Department will not measure joint materials (including the geotextile fabric wrap), shear connectors required for joining sections, and any required acceptance coring for payment and will consider them incidental to this item of work.

The Department will not measure repair of sections not in true alignment and grade or that show undue settlement after laying, or otherwise damaged.

611.04.03 Headwalls. The Department will measure the quantity of concrete and steel reinforcement in headwalls according to Subsections 601.04 and 602.04 respectively.

611.05 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

Code	Pay Item	Pay Unit
----	Structure Excavation	See Subsection 603.05
3010-3038	Precast Concrete Box Sections, Size	Linear Foot
8100-8105, 2555	Concrete, Class	See Subsection 601.05
8150	Steel Reinforcement	See Subsection 602.05

The Department will consider payment as full compensation for all work required under this section.

SECTION 612 ¾ STRUCTURAL PLATE SOIL INTERACTION STRUCTURES

612.01 DESCRIPTION. Furnish and install corrugated metal multi-plate soil interaction structures where an equivalent inner diameter of greater than 10 feet and less than or equal to 20 feet is required for drainage or other openings. Corrugated metal multi plate soil interaction structures include pipe, pipe arches, and arches.

612.02 MATERIALS.

612.02.01 Pipe. Conform to Section 809 for the following:

1) Corrugated Aluminum Alloy Structural Plate Pipe, Pipe Arches, and Arches.
2) Corrugate Steel Structural Plate Pipe, Pipe Arches, and Arches.

612.02.02 Concrete. Conform to Subsection 601.02 and 601.03.

612.02.03 Asphalt Material for Coating and Paving. Conform to Section 806.

612.02.04 Bedding and Backfill Materials.

A) Fine Aggregate. Conform to Section 804, Sand for Pipe Bedding.
B) Coarse Aggregate. Conform to Section 805, Structural Granular Backfill.
C) Flowable Fill. Conform to Section 601.02 and 601.03.

612.02.05 Joint Materials. Conform to Subsection 701.02.

612.03 CONSTRUCTION.

612.03.01 Composition. Provide structures that consist of prefabricated sections ready to be assembled and erected at the site. Furnish prefabricated sections consisting of asphalt coated galvanized (zinc coated) corrugated steel or aluminum alloy plates that have been factory shaped and punched. The Department will allow the use of a factory assembled structure when units are available that conform to the requirements of the Contract for opening size, material, corrugation dimensions, metal thickness, and coating. Ensure that factory assembled steel units are asphalt coated. The Department will not extend the Contract time to accommodate the use of factory assembled pipe or pipe arches. Ensure that field and factory assembled steel pipe and pipe arch units are asphalt coated and paved.

612.03.02 Transportation and Handling. Transport and handle according to Subsection 701.03.04.

612.03.03 Erections Plans. Submit 3 full sets of erection plans for each unit to the Engineer. Include with each submitted set of erection plans a natural scale plan, an elevation view of the structure, and the design calculations. In lieu of design calculations, the Department will accept a manufacturer's certification that the proposed structure conforms to all of the Department's structural design requirements. The Department will return one set after review with needed corrections noted. Each time the Department requires corrections, submit 3 full sets of the erection plans. The Department will have 20 calendar days to review each submission.

After the Department has approved the erection drawings, submit one full set of the approved drawings. Submit final drawings on 22 inches wide by 36 inches long and 0.003 inch thick mylar film or equivalent capable of producing clear prints and microfilms.

612.03.04 Shop Drawings. Before fabricating any parts of the structure, submit

shop drawings according to Subsection 607.03.01.

612.03.05 Soundings for Foundation. Take the soundings for foundation design for pipe, and pipe arches according to Subsection 701.03. Where rock foundations are encountered or known to exist within the limits specified, excavate the foundation to a depth below the proposed outside bottom of the structure of 1/2 inch per foot of fill to a subgrade elevation above the proposed outside top of the structure. Excavate no less than one foot and no more than 0.75 times the height of the structure. Replace with material conforming to Subsection 612.02.04. Rock foundations include ledge rock, gravel, hardpan, or other unyielding material. Camber the pipe or pipe arch whenever directed. Do not lay the pipe in cuts until completing the rough grading.

When an unstable foundation is encountered at the grade established, remove the unstable material and replace it with material conforming to Subsection 612.02.04 to a width and depth that will provide a uniform and firm foundation.

612.03.06 Installation. Install steel pipe, pipe arches, and arches according to ASTM A 807. Install aluminum alloy pipe, pipe arches, and arches according to ASTM B 789. Provide the type and method of bedding according to ASTM A 807 and B 789.

Compact backfill according to Subsection 206.03.03. Construct in lifts of not exceeding 8 inches in thickness. Exercise care to avoid displacement of the true line of the arch. Backfill with flowable fill when the Engineer directs. Proportion flowable fill according to Subsection 601.03.

Conform to the elongation tolerance in Appendix A, Tabulation of Construction Tolerances.

612.03.07 Paving. After erecting steel structures and constructing the embankments, pave the inverts throughout their length and to a minimum width of 25 percent of the circumference for circular pipes or to a minimum of 38 percent of the circumference for pipe arches. Pave with wire reinforced asphalt paving mixture or similarly reinforced concrete.

A) Asphalt Paving. Place wire mesh of a diameter of 0.1 inch or more, having openings 6 by 6-inch or less, in the invert, and securely fasten it to bolts of the structure with wire or suitable clips. Provide reinforcing mesh in widths that are one foot less than the finished width of the pavement. Provide an asphalt paving mixture that consists of 70 percent mortar sand and 30 percent mineral filler combined with sufficient bituminous material (9 to 12 percent by weight) to provide a workable plastic mixture. Provide an asphalt material that consists of a PG 58-22 asphalt binder. Heat the aggregate and asphalt binder separately to 300 ± 60 °F, then combine and thoroughly mix them. Ensure that the invert of the culvert is clean and dry while spreading and compacting the mixture. Spread and shape the mixture by means of a template. Compact the mixture to a minimum depth of one ± 0.2 inch over the crest of the corrugations. While the compacted paving material is still warm, apply a 0.1 inch coating of heated asphalt cement throughout its width and length by spraying or other suitable means.

During the paving operation take precautions against asphyxiation, heat, or the accumulation of inflammable vapors in culverts. The Department recommends using forced ventilation.

B) Concrete Paving. Place wire mesh of a diameter of 0.1 inch or more, having openings 6 by 6-inch or less, in the invert, and securely fasten it to bolts of the structure with wire or suitable clips. Spread and shape Class D Concrete having 3/4 inch maximum size coarse aggregate throughout the required width and length of the invert to provide a uniform thickness of 1.5 ± 0.5 inch over the crest of corrugations. Shape and smooth the concrete pavement by means of a template to conform to the approximate contours of the invert. Float finish the concrete. After initial set, cure the concrete for 3 calendar days using a double

layer of wet burlap.

612.03.08 End Structures. Construct end structures according to the Contract.

612.04 MEASUREMENT.

612.04.01 Structural Plate Pipes, Pipe Arches, and Arches. The Department will measure the quantity in linear feet along the bottom centerline. The Department will not measure paving, bedding, backfilling, bolts and other hardware, erection plans and shop drawings for payment and will consider them incidental to this item of work.

612.04.02 Embankment-In-Place. The Department will measure the quantity according to Subsection 701.04.10.

612.04.03 Roadway Excavation. The Department will measure the quantity according to Subsection 701.04.11.

612.04.04 Pipe Undercut. The Department will measure the quantity according to Subsection 701.04.12.

612.04.05 Structure Excavation Unclassified. The Department will measure the quantity according to Subsection 701.04.13.

612.05 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

Code	Pay Item	Pay Unit
----	Aluminum Alloy Structural Plate Pipe, Size	Linear Foot
----	Aluminum Alloy Structural Plate Pipe Arch, Size	Linear Foot
----	Aluminum Alloy Structural Plate Arch, Size	Linear Foot
----	Steel Structural Plate Pipe, Size	Linear Foot
----	Steel Structural Plate Pipe Arch, Size	Linear Foot
----	Steel Structural Plate Arch, Size	Linear Foot
2230	Embankment-In-Place	See Subsection 701.05
2200	Roadway Excavation	See Subsection 701.05
2219	Pipe Undercut	See Subsection 701.05
2203	Structure Classification, Unclassified	See Subsection 701.05

The Department will consider payment as full compensation for all work required under this section.

SECTION 613 ¾ RETAINING WALLS

613.01 DESCRIPTION. Construct a standard gravity, cast-in-place reinforced concrete (CIP), or gabion retaining wall as specified in the Contract.

613.02 MATERIALS. Use the same material throughout all individual walls, and at both ends of all individual structures. Use only approved systems and materials.

613.02.01 Concrete. Conform to Section 601.02 and 601.03.

613.02.02 Reinforcing Steel. Conform to Section 811**.**

613.02.03 Joint Materials. For CIP walls conform to Section 807.

613.02.04 Geotextile Fabric. Conform to Section 843, Table I. Use fabric sheets with a minimum width and lap of 18 inches for vertical joints, one foot for horizontal joints, and 4 inches for all laps in fabric.

613.02.05 Granular Embankment. Conform to Section 805.

613.02.06 Gabion Baskets. Conform to Section 813.

613.02.07 Gabion Fill Material. Conform to Section 805.

613.02.08 Grout. Conform to Subsection 601.02.

613.03 CONSTRUCTION.

613.03.01 Design. When the plans do not include a complete design for the retaining wall, provide all design calculations, shop drawings, and construction plans required.

Comply with Subsection 107.05, covering the use of patented devices, materials, and processes.

1) Design the wall through a Registered Professional Engineer.
2) Design the wall in conformance with the AASHTO Standard Specifications for Highway Bridges, current edition and all published interims, and all other AASHTO or Industry specifications required by the plans.
3) Require a minimum top wall thickness of 10 inches for standard gravity walls and a 9 inches minimum for all other CIP walls.
4) No materials are to be furnished and no fabrication or work done before the Department's review of the proposed design, drawings, and instructions.

613.03.02 Foundation. Excavate the foundation bed for the retaining wall as required. Before wall construction, compact the foundation to 95 percent of the maximum density as determined by KM 64-511. Remove and replace all foundation soils found unsuitable. If shown on the plans or directed by the Engineer, place structure granular backfill to the dimensions required under the footings or bottom units. Obtain approval by the Engineer before erection is started.

613.03.03 Standard Gravity Wall. Construct according to Standard Drawing No. RGX-002. Construct walls, footings, leveling pads, copings, and all other cast-in-place appurtenances using Class B concrete according to Subsection 601.03. When the wall will be surcharged, special drawings are required.

Ensure the base width is half the vertical height of the wall and the top width is one

foot. Place transverse expansion joints 1/2 inch in width at minimum intervals of 30 feet throughout the length of retaining walls and fill with expansion joint material. All exposed edges shall be beveled 3/4 inch.

When it is not practical to pour the wall to full height in one operation, ensure construction joints are truly horizontal and provide a bond between the sections with keys formed by beveled timbers. Where necessary to provide construction joints in the length of the wall, ensure joints are truly vertical and provide a bond between the sections with shear keys formed by beveled timbers.

Grout around and behind all pipes in the wall face. Proportion grout according to Subsection 601.03.

At the end of each day's operation slope the last level of the backfill away from the wall facing to direct runoff away from the wall face. Do not allow surface runoff from adjacent areas to enter the wall construction site.

When shown on the Plans or directed by the Engineer, backfill with structure granular backfill.

613.03.04 CIP Walls. Construct according to the structure plans.

613.03.05 Joints. Provide contraction joints at 30-foot intervals and 1/2-inch expansion joints at 100-foot intervals in all standard gravity and CIP walls. Provide 1/2-inch joint material in all expansion joints. Place 24-inch long, 1/2-inch diameter, commercial grade steel dowels and 12-inch long, 5/8-inch inside diameter, commercial grade steel dowel sleeves across the joint. Provide caps on one end of the sleeves. Grease one end of the dowel and insert into the sleeve. Space dowels and sleeves at 12-inch intervals along the centerline of the wall stem. Do not pass reinforcing steel through either joint. Seal joints from top to bottom with waterstops.

613.03.06 Drainage. Provide 4-inch weep hole drains at 8-foot intervals through standard gravity and CIP walls. Place fabric wrapped backfill drains at each weep hole according to Subsection 603.03.05. Place weep hole inverts 6 inches above finish grade at the front face.

613.03.07 Gabion Walls. Construct according to Standard Drawings and the Contract. Place the basket flat on the ground, flatten any kinks or bends, and erect the sides, ends and diaphragms. Ensure all creases are in the correct position and the tops of all sides level. Lace the 4 corners of the basket together with alternating single and double loops at 5-inch intervals. Secure both ends of the lacing wire by looping and twisting. Install and lace internal diaphragms in the same manner. Place the individual assembled baskets in their proper location. Connect all adjoining baskets using individual tie wires looped and twisted at approximately 3-inch intervals along the entire perimeter of their contact surfaces.

Partially fill the first basket in line for anchorage and stretch the connected gabions to proper alignment using a come-along or other means of at least one ton capacity. Keep the baskets in tension while filling. Control joints to avoid any unravelling. Filled in one-foot layers, in a manner that will minimize voids. Place 2 connecting wires in each direction between each layer in all cells by looping lacing wire around 2 mesh openings in the front and back face, and in the ends and diaphragms. Securely fasten the ends of the connecting wires to prevent their loosening under tension. Fill cells in each course of in stages. Do not allow any cell at any time to be filled to a depth exceeding one foot more than the adjoining cell. Level the last layer of stone with the top of the basket to allow proper closing of the lid and provide an even surface for the next course. Stretch the lids tightly over the stone fill using crowbars or similar methods, until the lid meets the edges of the front and ends. Tie the lids along all edges, ends, and diaphragms in the same manner as required for connecting adjoining baskets. Place and connect succeeding courses or tiers as specified for the first course. Offset vertical joints for succeeding courses at least 18 inches from course to course. Place baskets as headers or stretchers in accordance with the Contract. Tie each course of baskets to the lower course after stretching but before filling,

with individual tie wires looped and twisted at approximately 3-inch spacing along all edges and diaphragms. Reinforce vertical edges at each end of the wall that are not connected to an adjoining basket by looping and twisting individual tie wires at approximately 3 inches spacing the full length of such edges.

Ensure the stone fill is firmly in place, bulging or distortion of the filled baskets is minimal, and all lacing and tying is thoroughly wound, looped and twisted to preclude loosening in service.

613.04 MEASUREMENT. The Department will measure items such as concrete barriers that are not a part of normal retaining wall construction as the wall area. When barriers are constructed on retaining walls, the plans will show the top of the wall for payment purposes.

The Department will consider all joint material, design calculations, shop drawings, and construction plans with required corrections, manufacturer supplied technical assistance incidental to the retaining wall.

613.04.01 Standard Gravity and CIP Walls. The Department will measure concrete, steel reinforcement, and structure excavation according to Subsections 601.04, 602.04, and 603.04, respectively. The Department will consider backfill, foundation preparation, portions of the footings for cast-in-place walls outside of the approved gross area, structure granular backfill, and geotextile fabric required incidental. The Engineer may include portions or all of the footings for cast-in-place walls in the gross area as shown on the plans. The Department will include the WWF dowel and dowel sleeves in the weight of steel reinforcement.

613.04.02 Gabion Walls. Unless the Contract provides for payment based on field measurements, the Department will not measure gabion walls but will make final payment at the Contract unit price for the design quantity, increased or decreased by authorized adjustments.

The Department will measure structure excavation according to Subsection 603.04.

613.05 PAYMENT. The Department will make payment for the completed and accepted quantities under the following:

Code	Pay Item	Pay Unit
8100-8105, 2555	Concrete	See Subsection 601.05
8150	Steel Reinforcement	See Subsection 602.05
2203	Structure Excavation Unclassified	See Subsection 603.05
2223	Granular Embankment	Cubic Yard
2610	Retaining Wall, Gabion	Cubic Yard

The Department will consider payment as full compensation for all work required under this section.

SECTION 614 ¾ MAINTENANCE CLEANING AND PAINTING STEEL BRIDGES

614.01 DESCRIPTION. Clean and prepare all surfaces to be painted; furnish and apply all paint; maintain, protect, and control all pedestrian and vehicular traffic; and protect the structure and all other property against damage that may result from this work. The surfaces to be painted include all structural steel surfaces and other exposed metal surfaces that may exist within the limits of the project, such as handrails, guardrails, cables, wire fence, light fixtures, metal flooring, and other metal appurtenances, except items specifically deleted in the Contract.

614.02 MATERIALS AND EQUIPMENT.

614.02.01 Paint. Conform to Section 821 or as the Contract designates. Furnish a paint system in which all coats are produced by the same manufacturer and use the same system throughout the entire project.

614.02.02 Brushes. Use brushes not exceeding 4 inches in width. Maintain brushes in a usable and acceptable condition at all times.

614.02.03 Spraying Equipment. Conform to the paint manufacturer's recommendations. Use equipment that applies the paint in a fine, even spray without adding thinner. Provide adequate separators and traps in the air spraying equipment to remove all water and oil from the compressed air.

614.03 CONSTRUCTION.

614.03.01 Responsibility for Damage. Protect all pedestrian, vehicular, and other traffic upon or beneath the bridge; all adjacent property; and all portions of the bridge superstructure and substructure against damage or disfigurement by paint or paint materials.

When performing work in urban areas, or when developed areas exist in the close vicinity of the work, submit for the Engineer's review a detailed written outline, including sketches, if necessary, of the proposed methods to prevent damage to these areas from the work. Include specific information for protecting vehicular traffic on or beneath the bridge, boats and marinas beneath the bridge, and buildings or other property in the vicinity of the bridge. Do not begin work until the Engineer reviews and accepts the protection methods.

Take sole responsibility for all damage resulting from painting operations, even if the Engineer reviewed and accepted the protection methods.

614.03.02 Seasonal and Weather Limitations. Do not paint between November 15 and April 1 unless the Engineer provides written permission. Apply paint only when the temperature measured at the area of the bridge to be painted is 40 °F or greater; the surface temperature of the steel members to be painted is at least 5 °F above the dew point temperature; and the relative humidity measured at the site is 90 percent or less. Do not apply paint when the surfaces are hot enough to cause the paint to blister or produce a porous film; when the air is misty; when there is moisture or frost on the surfaces; or when other weather conditions, in the judgment of the Engineer, are unsatisfactory for work.

614.03.03 Prosecution of the Work. Upon beginning the operation of cleaning and painting, proceed with the operation on all working days, without stoppage, until completion. When specified in the Contract, submit a schedule proposing the sequence and time needed to clean and paint all structures included in the Contract.

Clean and paint all areas in strict conformance with the Contract, unless the Engineer approves alternate methods in writing.

614.03.04 Maintaining Traffic. Maintain all pedestrian, highway, railway, and waterway traffic while working. Do not leave cleaning or painting equipment on the roadways or sidewalks of any structure overnight.

Furnish and erect all necessary warning signs and other traffic control devices as directed to ensure public safety and convenience.

614.03.05 Surface Preparation. Before applying any paint, thoroughly clean and properly prepare all surfaces to be coated, including drains, expansion dam troughs, and other areas subject to build up of rust and debris, to the satisfaction of the Engineer. Expect that surface conditions may vary throughout the structure, requiring different cleaning methods to prepare the surfaces for painting. Remove all contaminants that might prevent paint from adhering tightly to the underlying surface.

Pressure wash and tool clean all steel surfaces to be overcoated to requirements specified in the Contract. Obtain the minimum acceptable surface quality immediately before painting that corresponds to the Contract requirements. Do not apply paint until the Engineer inspects and accepts the cleaned surfaces.

Remove and clean all trash, debris, and other foreign substances from pockets and crevices and from around expansion dams, bearing plates, shoes, etc. Clean the entire surface of the bridge seat on each unit of the structure. Cut and remove all tree limbs or other growth overhanging or fouling the structure.

Proceed with cleaning by sections, bays, or other readily identifiable parts of work. Completely clean each section, bay, or part, and have it inspected and accepted by the Engineer before applying any paint. Provide safe access to the work to allow the Engineer to properly inspect the cleaning and painting.

When traffic or any other source produces an objectionable amount of dust, prevent dust and dirt from coming in contact with the cleaned or freshly painted surfaces.

614.03.06 Paint Application. Before beginning painting, provide the Engineer with the manufacturer's technical data sheets, safety instructions, material safety data sheets, and application instructions for the paint to be used.

When necessary or requested by the Engineer, furnish a technical representative from the paint manufacturer to observe the initial application of all coatings used, to advise as to proper application techniques, and to determine that proper results are being obtained. Ensure that the technical representative is also available to visit the project at all times during the work if the Engineer requests or deems a visit is necessary.

Spread the paint smoothly and uniformly, and work it into all corners and crevices without allowing excess paint to collect at any point. When the Engineer determines that work done by spraying or rolling is not satisfactory, the Engineer may require hand brushing or removing and repainting. Apply paint with sheepskin daubers on surfaces inaccessible to brushes. When applying paint with spray equipment, immediately brush the area sprayed as necessary to secure uniform coverage and to eliminate wrinkling, blistering, and air holes.

Paint from the top of the structure toward the bottom, and proceed by sections, bays, or parts of the work, unless the Contract or Engineer directs otherwise. Finish painting each coat on each section, bay, or part of work before applying a succeeding coat to any portion of that section, bay or part. Ensure that each coat is thoroughly dry throughout the full thickness of the coat before applying another coat.

Conform to the tolerance requirements of Appendix A, Tabulation of Construction tolerances or as the Contract specifies.

A) Thinning. Do not thin paint unless the Engineer gives written permission. Add only thinners specified or recommended in writing by the manufacturer according to the written recommendations of the manufacturer. Provide the Engineer with the manufacturer's technical data sheets and application instructions for the thinner and its use with the paint.

B) Mixing. Thoroughly mix the paint in the original containers. Use a mechanical mixer to mix the paint so the pigment is in uniform suspension. Frequently stir the paint to keep it thoroughly mixed while being applied to keep the pigments in suspension, according to the paint manufacturer's written instructions or as directed.

C) Marking. Stencil the Maintenance Project Number, the month and year of the painting completion date, and any existing panel numbering system or any panel numbering system set forth in the Contract on the structure at approved locations. Make the legend in letters and numerals 2 inches high, and use a paint color that contrasts with the background.

614.03.07 Unsatisfactory Work. Remove paint, at any stage of its completion, that the Engineer finds unsatisfactory, and clean, prepare again, and repaint the surface at no expense to the Department and to the satisfaction of the Engineer. Unsatisfactory work includes but is not be limited to:

1) failure to properly clean and prepare the surface;
2) poor workmanship in application of the paint;
3) painting with impure, improperly mixed, thinned, or unauthorized paint; and
4) failure of the paint to adhere to the metal or to previously applied paint coat.

614.04 MEASUREMENT. The Department will measure the quantity as a lump sum unit. The Department will not measure necessary cleaning and painting; and furnishing all materials, equipment, tools, tackles, and scaffolding for separate payment but will consider them incidental to this item of work. The Department will consider having the manufacturer's technical representative present incidental to this item of work.

614.05 PAYMENT. The Department will pay for this work at the lump sum Contract price for Clean and Paint Structural Steel, or a designated section of a structure. The Department will base partial payments on Department estimates per section as the work progresses. When the structure is not divided into sections, the Department will consider the entire structure as one section for pay purposes. For purposes of partial payments, the Department will allocate percentages of the lump sum Contract price to the various phases of the work as set out below depending on the number of paint coats specified.

The Department will make payment for the completed and accepted quantity under the following:

Code	Pay Item	Pay Unit
8434	Clean and Paint Structural Steel	Lump Sum[(1)]

[(1)] *Two-Coat System. When the specified number of paint coats consists of a prime coat and finish coat, the Department will allocate 40 percent to the satisfactory cleaning and acceptable spot painting (if applicable), 30 percent to the acceptable application of the prime coat of paint, and the remaining 30 percent to the acceptable application of the finish coat of paint.*

Three-Coat System. When the specified number of paint coats consists of a prime coat, an intermediate coat, and a finish coat, the Department will allocate 10 percent to the satisfactory cleaning and spot painting (if applicable), 40 percent to the acceptable application of the prime coat, 25 percent to the acceptable application of the intermediate coat, and the remaining 25 percent to the acceptable application of the finish coat.

The Department will consider payment as full compensation for all work required under this section.