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PART 00500 - BRIDGES

Section 00501 - Bridge Removal

Description

00501.00 Scope - This work consists of removing and disposing of existing bridges or portions of existing bridges as shown or specified.

Construction

00501.40 Removal and Disposal - Perform removal and disposal work according to Section 00290 and Section 00310.

Measurement

00501.80 Measurement - No measurement of quantities will be made for bridge removal work performed under this Section.

Payment

00501.90 Payment - The accepted quantities of bridge removal work will be paid for at the Contract lump sum amount for the item "Bridge Removal Work".

Payment will be payment in full for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

Section 00503 - Bridge Deck Cold Plane Pavement Removal

Description

00503.00 Scope - This work consists of removing existing pavement from bridge deck surfaces.

Equipment

00503.20 Equipment for Grinding on Bridge Decks - To remove pavement from bridge decks, use power-operated diamond grinders, micro-milling equipment, or hydroblast machines capable of uniformly removing the existing surface to the depths required.

(a) Diamond Grinders - Diamond grinders shall be power-driven self-propelled units with cutting heads made up of diamond cutting blades.

(b) Micro-milling - Micro-milling equipment shall consist of the following:

(1) Cold Plane or Rotomill Grinders - Cold plane or rotomill grinding machines using carbide cutting tools in a rotary drum. Provide equipment with a tooth spacing of not more than 1/4 inch, capable of leaving a smooth, uniform pattern of striations. Limit machines to a gross operational weight of no more than 35 tons and a forward speed to 2.5 feet per minute. Operate at a drum speed of at least 120 RPM.

(2) Shot-Blasters - Mono-directional or bi-directional electric-powered shot blast machines with single or multiple blast wheels.

Machines shall cover at least 2.5 feet per pass, and shall conform to EPA air pollution requirements by containing dust and steel abrasive media. If the equipment is not equipped for simultaneous bi-directional blasting, make separate passes in opposite directions to ensure equal cleaning on all sides of the exposed aggregate. Limit forward speed to 2.5 feet per minute.

(c) Hydroblasting - Hydroblasting equipment shall be capable of removing concrete at a rate and volume acceptable to the Engineer without leaving a striated surface. Remove the entire original deck surface to a minimum depth of 0.125 inch. Demonstrate the removal rate and accuracy of the equipment to the Engineer prior to commencing work.

Construction

00503.40 Pavement Removal on Bridges - Remove pavement from bridges according to the following:

(a) General:

- Before removing the wearing surfaces, do the following:
  - Determine the actual depth of pavement to be removed.
  - Block all deck drains and all catch basins. Do not allow any grinding, chipping, sweeping, flushing, or shot blasting material to enter them.
- Remove material that is within 12 inches of all joints in a manner acceptable to the Engineer. Do not damage any joints.
- Remove AC, laitance, and residual film by approved hand methods in areas that cannot be reached by grinding machines.
- Hydroblast all deck surfaces before placing high performance concrete.

- Repair all damage to abutting concrete surfaces or other surfaces that are damaged by the Contractor's operations at no additional cost to the Agency.

(b) AC Surfacing - Do not grind into the existing concrete bridge deck.

(c) PCC Surfacing - If diamond, cold plane, or rotomill grinders are used, clean the entire surface with a shot blaster after completion of the diamond grinding operation. Provide a final surface that is free of cement paste and sand and has a minimum 0.125 inch depth of exposed large aggregate.

(d) Scheduling - Schedule the work so the full width and length of travel lane pavement can be removed during the same shift. Remove the shoulder area within 24 hours after removing the travel lane pavement.

If the depth of the existing pavement to be removed is over 2 inches, then within the same day construct a wedge of asphalt concrete, at a slope of 1V:10H or flatter along each exposed longitudinal drop-off, and 1V:50H or flatter along each exposed transverse drop-off. Place wedges completely across the milled area at joints, deck drains, catch basins, and other structures. Maintain wedges as long as the area remains under traffic or until pavement is replaced. Remove and dispose of wedges before placing new surfacings.

00503.41 Surface Tolerance - Test with a 12 foot straightedge furnished and operated by the Contractor, as directed. The variation of the top of the ridges from the testing edge of the straightedge, between any two ridge contact points, shall not exceed 1/4 inch.

00503.42 Disposal of Materials - Materials removed under this Section that are not used on the Project become the property of the Contractor at the point of origin. Dispose of the material according to 00290.20 unless special sites are specified in the Special Provisions.

00503.43 Maintenance Under Traffic - If the cold planed pavement surface will be exposed to traffic, sweep and clean prior to allowing traffic to use the roadway.

Measurement

00503.80 Measurement - The quantities of bridge deck cold plane pavement removal will be measured on the area basis. The area will be determined by measuring the width and length of the bridge deck surface, measured to the nearest 0.1 foot, and calculated to the nearest square yard.

When the depth of pavement to be removed is variable, the depth is an estimate and will be considered approximate only. No guarantee is made that the actual depth will be the same as the estimated depth.

Payment

00503.90 Payment - The accepted quantities of bridge deck cold plane pavement removal will be paid for at the Contract unit price, per square yard, for the item "Bridge Deck Cold Plane Pavement Removal, _____ Deep".

The depth will be inserted in the blank. If the depth is variable, the depth range will be inserted in the blank.

Payment will be payment in full for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

No separate or additional payment will be made for removing asphalt concrete surfacing from bridge decks for the preparation of waterproofing membrane or for constructing, maintaining, and removing temporary wedges.

Section 00510 - Structure Excavation and Backfill

Description

00510.00 Scope - This work consists of excavating, backfilling and disposing of materials in connection with the construction of bridges, grade separation structures, rigid frame structures, and other major structures. Other major structures under this Section are retaining walls, reinforced concrete box culverts, headwalls, structural plate structures, and pipe culverts, sewers, siphons and irrigation pipes greater than 72 inches in diameter.

This work does not include any earthwork covered under any sections of Parts 00300 or 00400, or any earthwork that may be specifically included and provided for as incidental work for particular items or parts of the work. The construction, measurement, and payment of embankment at bridge ends and engineered fills will be according to Section 00330.

00510.01 Lines, Grades, and Cross Sections - Perform the work to the lines, grades and cross sections shown or as established.

00510.03 Cofferdam Plans, Calculations, and Construction Inspection - Submit stamped cofferdam plans and design calculations according to 00150.35 except as modified by this subsection.

Design cofferdams according to the ODOT Bridge Design and Drafting Manual.

Submit a Cofferdam Design Summary and complete a Cofferdam Design Checklist prepared by the cofferdam design engineer, to accompany the plans and calculations. Include the following in the summary:

- A list of cofferdam members with their capacities and design stresses
- Design loading assumptions for each member
- Design references

Complete the checklist included in the Special Provisions.

Submit five sets (nine sets if railroad approval is required) of the plans, and three copies (five copies if railroad approval is required) of the calculations, summary, and checklist.

The Engineer will provide a list of construction concerns at least two days prior to the cofferdam design engineer's inspection. Upon completion of the cofferdam construction and immediately after dewatering, the cofferdam design engineer of record, accompanied by the Engineer, shall inspect the cofferdam. Do not continue construction until:

- The cofferdam design engineer furnishes the Engineer a written statement that the cofferdam conforms to the design and will serve the intended purpose, and
- The Engineer agrees in writing that all construction concerns have been addressed and the cofferdam will serve the intended purpose.

00510.04 Shoring Plans, Calculations, and Construction Inspection - Submit stamped shoring plans and design calculations according to 00150.35 except as modified by this subsection.

Design shoring according to the ODOT Bridge Design and Drafting Manual.

Submit a Shoring Design Summary and complete a Shoring Design Checklist prepared by the shoring design engineer, to accompany the plans and calculations. Include the following in the summary:

- A list of shoring members with their capacities and design stresses
- Design loading assumptions for each member
- Design references

Complete the checklist included in the Special Provisions.

Submit five sets (nine sets if railroad approval is required) of the plans, and three copies (five copies if railroad approval is required) of the calculations, summary, and checklist.

The Engineer will provide a list of construction concerns at least two days prior to the shoring design engineer's inspection. Upon completion of the shoring construction, the shoring design engineer of record, accompanied by the Engineer, shall field inspect the shoring. Do not continue construction until:

- The shoring design engineer furnishes the Engineer a written statement that the shoring conforms to the design and will serve the intended purpose and;
- The Engineer agrees in writing that all construction concerns have been addressed and the shoring will serve the intended purpose.

Materials

00510.10 Selected General Backfill - Furnish soil selected from roadbed, ditch, trench, or structure excavations meeting the requirements of 00330.13.

00510.11 Selected Granular Backfill - Furnish granular material selected from roadbed, ditch, trench or structure excavations meeting the requirements of 00330.14.

00510.12 Granular Wall Backfill - Furnish granular wall backfill meeting the requirements of 02630.11.

00510.13 Granular Structure Backfill - Furnish granular structure backfill meeting the requirements of 02630.10.

00510.15 Quality Control - Provide quality control according to Section 00165.

Labor

00510.30 Quality Control Personnel - Provide certified technicians in the following fields:

- CEBT
- CDT

Construction

00510.40 Clearing, Grubbing, and Removal Work - In the absence of pay items under Section 00310 and Section 00320, the provisions of those sections apply when applicable. Perform such work as incidental work for which no separate payment will be made.

Clearing, grubbing, and removal limits shall be at least 10 feet outside of the entire structure, including the ends of the structure but within the right-of-way.

00510.41 Structure Excavation - Structure excavation includes:

- Removal of all material necessary for the construction of foundations and substructures as shown or specified.
- Placement of all backfill except granular wall backfill and granular structure backfill.
- Disposal of excavated material not required or suitable for backfill according to 00330.41(a-5).
- Correction, according to recognized practice, of conditions detrimental to the work, including removal of excess water.

Shore, brace, or use cofferdams to protect excavations unless open excavation would not be detrimental to adjacent structures, roadways, or waterways.

If the plans show concrete in footings placed against undisturbed material, make excavation for footings as nearly as possible to neat lines of the footings. Where such material will not stand vertically after excavation and the excavation does not exceed 1 foot outside the footing dimensions, fill all space between the footing and remaining undisturbed material to the top of the footing with footing concrete or granular structure backfill material, as directed. Compact the granular structure backfill to 97% of maximum density, according to 00330.43.

Concrete placed against steel sheet piles in cofferdams or cribs will be considered placed against undisturbed material, whether or not the steel sheets are later removed.

Where practical, excavate rock materials using pavement breakers, rippers, backhoes, other excavation equipment or non-explosive means that preclude breakage of rock materials below and outside of the structure excavation limits. If blasting is required, perform such work in a manner that avoids disturbing rock outside the structure excavation limits. Use controlled blasting techniques for all structure excavation requiring blasting according to Section 00335. Backfill and repair as directed, at no additional cost to the Agency, any excavation, shattered rock, void, fault, or unstable condition caused by the Contractor outside the limits of structure excavation. Backfill and repair of voids, faults or unstable condition not caused by the Contractor or covered elsewhere in the Specifications will be paid for according to Section 00196.

Consider the elevations of the bottoms of footings or foundations shown as approximate only. The Engineer may order, in writing, changes in elevations of footings necessary to secure a satisfactory foundation.

00510.42 Structure Excavation and Backfill Below Elevations Shown - Excavate soft, unstable or unsuitable material below footings or bases of structures, including bedding, if any, to elevations as directed.

Perform one of the following as directed:

- Increase the length of columns or walls until the bottom of the footing is at the new established elevation.
- Increase the thickness of footings until the bottom of the footing is at the new established elevation
- Backfill the subexcavated area to the plan elevation according to 00510.46(a).

00510.43 Preservation of Channel - Do not excavate outside of caissons, cribs, cofferdams, sheet piling or sheeting, or disturb the natural streambed unless specified or allowed. Where such excavation is allowed, comply with Section 00405. Do not sidecast any excavated material into the stream.

When allowed, the necessary excavation for placement of riprap outside the perimeter of the footing may be made without the use of cofferdams or cribs, and disposed of according to 00330.41(a-4).

00510.44 Cofferdams and Cribs - Design and construct cofferdams and cribs when shown, specified or determined by the Contractor to be necessary for performing the work in the dry inside them as follows:

- Prepare and submit plans, calculations, summary and checklist for cofferdams or crib designs according to 00510.03.
- Provide interior dimensions for cofferdams and cribs to give sufficient clearance for the inspection of forms.
- When weighted cribs are used to partially overcome the hydrostatic pressure acting against the bottom of the foundation seal, provide an appropriate special anchor system such as dowels or keys to transfer the entire weight of the crib into the foundation seal.
- Do not leave cofferdam or crib timber or bracing extending into the substructure concrete.
- Place and cure seal concrete according to 00540.48(e).
- Vent or port, at low water level, any cofferdam that is to remain in place.
- Unless otherwise directed, remove cofferdams or cribs, including all sheeting and bracing, after the completion of the substructure. Do not disturb or damage the finished concrete.

00510.45 Pumping - No pumping of water from the interior of any foundation enclosure will be allowed during the placing of concrete or for a period of at least 24 hours thereafter unless an effective means of eliminating moving water through fresh concrete is employed. Water may then be pumped, if approved.

Do not pump to dewater a sealed cofferdam until the seal concrete meets the requirements of 00540.48(e).

00510.46 Preparation of Foundations - Do not place concrete on prepared foundations without prior approval. Construct foundations as follows:

(a) Backfilled Foundations - Construct the top surface of the foundation fill at least 3 feet beyond the area to serve as a foundation unless otherwise shown or directed. Use selected granular backfill or granular structure backfill as directed. Place in 6 inch layers and compact to not less than 95% of maximum density according to 00330.43.

(b) Undisturbed Soil Foundations - Do not disturb the sides or bottoms of foundation excavations. Place concrete against undisturbed soil when shown. Concrete may be used as backfill, subject to 00540.45(a). If soil is disturbed, compact all disturbed material to 95% of maximum density according to 00330.43.

(c) Formed Foundations on Soil - Do not disturb the bottoms of foundation excavations. If soil is disturbed, compact all disturbed material to 95% of maximum density according to 00330.43.

(d) Rock Foundations - Before placing concrete:

- Clean all rock surfaces and remove loose material
- Clean seams and fractures according to 00510.41, and seal with grout
- Level, step or roughen the rock surface as shown or as directed

Construct formwork, if allowed or required, and place concrete as soon as practical following the removal of material, to the specified elevation.

00510.47 Embankment Construction at Bridge Ends - Construct embankments at bridge ends according to 00330.42(c-7) and, when shown, engineered fills according to 00330.42(c-8).

00510.48 Backfill:

(a) General - Prepare for, place and compact backfill according to 00330.42 and 00330.43, if it becomes a part of a roadway embankment or is to support a roadway, bridge approach end panel, rock slope protection or slope paving, and is not covered by 00510.41, 00510.42, 00510.46, or 00510.47.

Do not place backfill that will cause unbalanced loading on the concrete until the concrete has been in place seven calendar days and test cylinders show the concrete strength to be 100% of design strength according to 00540.17(c).

Do not place backfill against any other concrete until the concrete has been in place three calendar days, and test cylinders show the concrete strength to be 40% of design strength according to 00540.17(c).

Place backfill and riprap in a manner that will not damage the concrete footings, drain pipes, and other permanent work. Do not jet or puddle the backfill unless approved in writing. Prevent large lateral or wedging compaction forces from occurring directly against the concrete.

Dispose of excess materials according to 00330.41(a-4).

(b) Bridge Abutments and Retaining Walls - Backfill at abutments and retaining walls with granular wall backfill to the upper pay limits shown or as directed, and as follows:

- Do not place backfill until superstructure elements are set, pinned and tensioned.
- Place backfill required at the front face of retaining walls before backfilling behind the wall.
- For single span bridges with abutments, keep the backfill heights within 2 feet of each other.
- Place granular wall backfill at all weep holes.

(c) Pier and Column Footings - Backfill piers and columns as follows:

- Use either selected general backfill, selected granular backfill, riprap or other materials as shown or directed.
- Deposit backfill around piers and columns on all sides to approximately the same elevation at the same time.
- Place backfill up to the original ground surface, the upper limits of pay excavation, or as shown or directed.

(d) Reinforced Concrete Box Culverts, Structural Plate Structures and Pipe Culverts Over 72 Inches in Diameter - Provide bedding, if required, according to 00405.12. Use backfill materials conforming to 00510.12 or 00510.13 unless otherwise specified. Place and compact as shown and according to 00405.46. Place backfill up to the surrounding ground surface, to the top of trench, or the upper backfill pay limits shown or as directed.

Measurement

00510.80 Measurement - The quantities of work performed under this Section will be measured according to the following:

(a) Shoring, Cribbing and Cofferdams - No measurement of quantities will be made for shoring, cribbing, and cofferdams.

(b) Structure Excavation - Structure excavation will be measured according to the following:

(1) Lump Sum - Under this method, no measurement will be made. Estimated quantities of structure excavation will be listed in the Special Provisions.

(2) Volume - Under this method, structure excavation will be measured on the volume basis in original position (position before excavating).

Quantities will be limited to the neat lines shown, or if not shown, will be limited to the following:

a. Lower Limit - The lower limit will be the elevations shown for the bottoms of structure footings or bases, including bedding, if any.

b. Upper Limits - The upper limit will be determined as follows:

1. Within Embankments - The planes of the new embankment at the elevation specified or established.

2. Within Roadbed or Channel Change Excavations - The planes of the bottoms and side slopes of the excavations.

3. All Other Cases - The ground surface immediately before starting the excavation.

c. Horizontal Limits - The horizontal limits will be the vertical planes parallel to and 1 foot outside the neat lines of the footings or bases of all structures, except for structural plate structures and pipe culverts over 72 inches in diameter, which will be as shown.

When the Engineer approves or directs, structure excavations less than the specified horizontal limits, the measured limits will be the actual excavation made.

(c) Structure Excavation Below Elevations Shown - Structure excavation below elevations shown will be measured according to the following:

(1) Lump Sum - When structure excavation is lump sum basis and when the Engineer requires structure excavation below the elevations shown, measurement to extend the excavations will be made as follows:

- **0 to 3 Feet Below Elevations** - For excavation 0 to 3 feet below elevations shown, measurement will be determined according to 00190.10(f) and based on a theoretical unit price of the lump sum structure excavation item.

- **More than 3 Feet Below Elevations** - For excavation more than 3 feet below elevations shown, measurement will be determined according to Section 00196.

(2) Volume - When structure excavation is volume basis and when the Engineer requires structure excavation below the elevations shown, measurement to extend the excavations will be made on the volume basis.

Quantity limits will be from the bottom limit described in 00510.80(b-2-a) to the new lower limits of the excavation for the footing or base of the structure, including bedding, if any, established by the Engineer. The horizontal limits will be vertical extensions of the quantity limits established according to 00510.80(b-2-c).

(d) Granular Wall/Structure Backfill - Granular wall backfill and granular structure backfill will be measured on the volume basis, of material used in backfilling as determined by cross section measurement of the materials in place. The quantities will be limited to the quantities placed according to the plans and specifications or as directed. When backfilling excavated areas, the quantities will be limited to the pay limits of the excavation for the part of excavated areas backfilled with the specified granular backfill material.

Payment

00510.90 Payment - The accepted quantities of work performed under this Section will be paid for as follows:

(a) Shoring, Cribbing and Cofferdams - Shoring, cribbing, and cofferdams will be paid for at the Contract lump sum amount for the item "Shoring, Cribbing and Cofferdams".

No separate or additional payment will be made for maintaining and removing all materials.

No separate or additional payment will be made for clearing and grubbing, preparing foundations, pumping, and cleaning up.

If the Engineer orders excavations that extend below the elevation shown, the Contractor will be compensated to extend shoring, cribbing, and cofferdams as follows:

Footing Elevation Changes	Compensation
0 to 3 feet below	No extra payment
More than 3 feet below	Section 00196

When the Contract Schedule of Items does not indicate payment for shoring, cribbing and cofferdams, no separate or additional payment will be made. Payment will be included in payment made for the appropriate items under which this work is required.

(b) Structure Excavation - Structure excavation will be paid for at the Contract lump sum amount or the Contract unit price, per cubic yard, for the item "Structure Excavation".

Except for granular wall backfill, no separate or additional payment will be made for backfilling and compacting to the elevation specified.

(c) Structure Excavation Below Elevations Shown - Structure excavation below elevations shown will be paid for as follows:

(1) Lump Sum - For excavation 0 to 3 feet below elevations shown, payment will be determined and made according to 00190.10(f). For excavation more than 3 feet below elevations shown, payment will be determined and made according to Section 00196.

(2) Volume - For excavation 0 to 3 feet below elevations shown, payment will be made at the Contract unit price, per cubic yard, for the item "Structure Excavation".

For excavation more than 3 feet below elevations shown, payment will be made at the Contract unit price, per cubic yard, for the item "Structure Excavation Below Elevations Shown". If the Contract Schedule of Items does not indicate payment for this work, payment will be determined according to Section 00196.

(d) Granular Wall/Structure Backfill - Granular wall backfill and granular structure backfill will be paid for at the Contract unit price, per cubic yard, for the item "Granular Wall Backfill" or "Granular Structure Backfill", as applicable.

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

No separate or additional payment will be made for:

- removing material forced up between foundation piles during driving or of material used in backfilling around piles, should subsidence occur during driving
- bedding
- excavations made below the elevations established for the bottoms of the footings or bases, including bedding, if any, or for any other unauthorized excavations. Backfill, seal, or otherwise repair these unauthorized excavations with concrete or other material acceptable to the Engineer according to 00510.46 at no additional cost to the Agency.
- water removed from excavations and water used in compaction or other items of work

Section 00512 - Drilled Shafts

Description

00512.00 Scope - This work consists of excavating and constructing drilled, cast-in-place, reinforced concrete shafts, according to these Specifications and the plans.

00512.01 Definitions:

Drilled Shafts - Reinforced concrete sections, cast-in-place against in situ soil, rock, or a casing.

Permanent Casing - Casing designed as part of the drilled shaft and intended to remain in place after concrete placement is completed.

Temporary Casing - Casing installed to facilitate drilled shaft construction only and removed during or after concrete placement.

00512.02 Subsurface Investigation - The Soils and Geological Exploration Logs are available for review through the Engineer's office. The data shown for each test boring or test pit applies only to that particular boring or test pit. Subsurface conditions may vary between borings or test pits. Core samples and laboratory test results, if obtained and performed for the Project, are available for review by contacting the Engineer.

The Foundation Data shown in the plans is a compilation of pertinent information including, but not limited to, the Soils and Geological Exploration Logs.

Materials

00512.10 General - Furnish materials meeting the following requirements:

(a) Reinforcement - Use reinforcement complying with Sections 00530 and 02510.

(b) Concrete - Use Class 4000 structural concrete according to Section 02001, except as modified in this Section.

00512.12 Concrete Mix Design - Design the drilled shaft concrete mix for minimum segregation. Use a pre-approved mix design that meets the slump requirements of Section 02001.

Mix a trial batch and take test cylinders for one seven-day and two 28-day test breaks prior to placing concrete in the completed shaft excavations.

Water may be added at the Project Site only if allowed by the mix design and if approved. Accurately measure water added at the site by water meters, buckets or other approved devices and limit it to 1.0 gallon per cubic yard. Retarding or water-reducing agents may be used to maintain specified slump ranges and to facilitate temporary casing extraction. To allow for adequate concrete workability throughout the duration of concrete placement and prior to temporary casing extraction, provide a concrete mix having a slump loss characteristic such that a minimum slump of 4 inches is maintained for the entire duration of the pour. Admixtures may be used if tested and certified in the mix design and if approved.

00512.13 Steel Casing - Furnish temporary casing meeting the requirements of ASTM A 252 or ASTM A 36. Furnish permanent casing meeting the requirements of ASTM A 36 with the application of supplemental requirement S5. Test each heat of steel at 40 °F with a minimum absorbed energy requirement of 15 foot pounds. Do not use previously used casing for permanent casing. Use casing of sufficient strength to resist handling, transportation and installation stresses and the external stresses of

the subsurface materials. Ensure that the casing is clean and watertight prior to placement in the drilled shaft excavation. Use casing with an outside diameter not less than the specified drilled shaft diameter.

00512.14 Drilling Slurry - Furnish drilling slurry meeting one of the following requirements:

(a) Mineral Slurry - Use mineral slurry conforming to the following requirements:

Property	Test	Requirement
Density	Mud Density API * 13B-1, Section 1	64 - 75 lb./cu. ft.
Viscosity	Marsh Funnel and Cup API * 13B-1, Section 2.2	26 - 50 sec./qt.
pH	Glass Electrode, pH Meter, or pH Paper	8 - 11
Sand Content	Sand API * 13B-1, Section 5	4.0 % max.

Maintain slurry temperature at 40 °F or more during testing.

* American Petroleum Institute

(b) Synthetic Slurries - Select synthetic slurries from the QPL. Use synthetic slurries according to the manufacturer's recommendations and the Contractor's quality control plan. The sand content of synthetic slurry shall be less than 2.0 percent (API 13B-1, Section 5) prior to final cleaning and immediately prior to concrete placement.

(c) Water Slurry - Water may be used as slurry when casing is used for the entire length of the drilled shaft. Use of water slurry without full-length casing will only be allowed with the Engineer's approval. Use water slurry conforming to the following requirements:

Property	Test	Requirement (Maximum)
Density	Mud Weight (Density) API 13B-1, Section 1	70 lb./cu. ft.
Sand Content	Sand API 13B-1, Section 5	2.0 %

Do not use blended slurries.

00512.15 Crosshole Sonic Log (CSL) Access Tubes - Furnish steel crosshole sonic log (CSL) access tubes meeting the following requirements:

- Steel access tubes shall be at least 1 1/2 inch inside diameter Schedule 40 pipe conforming to ASTM A 53, Grade A or B, Type E, F, or S.
- Use access tubes having a round, regular inside diameter free of defects and obstructions, including all pipe joints, in order to permit the free, unobstructed passage of the source and receiver probes used for the testing. Ensure that access tubes are watertight, free from corrosion with clean internal and external faces to ensure good bonding between the drilled shaft concrete and the access tubes. Fit the access tubes with watertight caps on the top and bottom.
- Access tube acceptance will be based on manufacturer's certification that the furnished material meets the requirements of this Specification.

00512.18 Grout - Furnish portland cement grout meeting the requirements of Section 02080.

00512.19 Quality Control - Maintain and be responsible for quality control of the drilled shaft work throughout the construction operation. The Engineer will inspect all drilling operations and verify the suitability of all drilled shaft construction procedures. Provide lights, mirrors, weighted tape, weighted probe, personnel, and all assistance required for the Engineer to perform inspection during drilled shaft construction.

Labor

00512.30 Personnel Qualifications - Perform the drilled shaft construction work using a company and personnel experienced in drilled shaft construction work. Submit a list to the Engineer for approval identifying the on-site supervisors and drill rig operators assigned to the Project and the companies experience relevant to the Project. Experience shall be relevant to the anticipated subsurface materials, groundwater conditions, shaft size, depth and any special construction techniques required. Also provide the experience qualifications of the company performing the CSL testing. Before the preconstruction conference, provide the following information to verify the firm's experience and the qualifications of personnel scheduled to perform the drilled shaft construction and CSL testing:

- Submit a project reference list of at least three separate foundation projects, successfully completed in the last five years, with drilled shafts of diameters and depths equal to or larger than those shown in the plans and in ground conditions similar to those indicated. Include a brief description of each project and the owner's contact person's name and current phone number for each project listed.
- On-site supervisors shall have at least two years experience in supervising construction of drilled shaft foundations of similar size (diameter and depth) and scope to those shown in the plans and in similar geotechnical conditions to those described in the geotechnical report. Experience shall include the direct supervisory responsibility for the on-site construction operations.
- Drill operators shall have at least one year experience in the construction of drilled shaft foundations.
- Perform CSL testing using an independent testing organization retained by the Contractor and approved by the Agency. Furnish personnel experienced in operating the CSL testing equipment. Submit the CSL testing firm qualifications according to 00512.40(a). The CSL testing firm shall have successfully performed CSL testing on a minimum of five projects during the last three years. CSL testing personnel shall be trained in the operation of the CSL equipment and have at least one year of experience in operating CSL testing equipment on a minimum of 10 shafts.

The Engineer will respond within 21 calendar days after receipt of the submittal. Do not begin work on any drilled shafts until the qualifications have been approved. The Engineer may suspend the drilled shaft construction if the Contractor substitutes unapproved personnel during construction. Submit requests for substitution of either on-site supervisors, drill operators, or CSL testing personnel to the Engineer, who will have seven calendar days to respond to each request. Additional costs resulting from the suspension of work due to the changing of personnel is the Contractor's responsibility, and no adjustment in Contract Time resulting from the suspension of work will be allowed.

Construction

00512.40 Submittals - Provide the following submittals to the Agency for review and approval:

(a) Drilled Shaft Installation Plan - At least 21 calendar days before beginning shaft construction, submit the following:

- The sequence of drilled shaft construction as it relates to the overall construction plan.

- A review of equipment suitability based on the Contractor's understanding of the site subsurface conditions. Include a project history of the drilling equipment that demonstrates the successful use of the equipment for drilled shafts of equal or greater size in similar subsurface conditions.
- Details of shaft excavation methods, including proposed drilling methods and a disposal plan for excavated material. Include details of methods used to perform final cleaning of the excavation. Include details of the methods and materials used to fill or eliminate all voids between the plan shaft diameter and excavated shaft diameter, or between the casing and surrounding soil, if permanent casing is specified. Include a disposal plan for any water or contaminated concrete expelled from the top of the shaft (if applicable).
- Details of the proposed method(s) for ensuring drilled shaft stability during excavation and concrete placement.
- Details for the use of drilling slurry including mix design, slurry head requirements, mixing methods, maintaining, and disposing of the slurry (if applicable). Include a discussion of the suitability of the proposed drilling slurry in relation to the anticipated subsurface conditions.
- A plan for quality control of all drilling slurries, if their use is proposed. In the quality control plan, include property requirements, required tests and test methods to ensure the slurry performs as intended. Submit to the Engineer the name and current phone number of synthetic slurry manufacturer's representatives who will provide technical assistance during construction. Provide the name(s) of the Contractor's personnel assigned to the Project and trained by the synthetic slurry manufacturer in the proper use of synthetics slurries.
- Unstamped reinforcing steel shop drawings and details of reinforcement placement, including bracing, splicing, centering, and lifting methods and the method for supporting the reinforcement on the bottom of the shaft excavation according to 00150.35. Include details on the type, number, and placement of spacers and other devices for ensuring the reinforcing cage position is maintained during construction. Include details for attaching the CSL test access tubes to the reinforcing cage (if applicable).
- Evidence that the proposed materials and concrete mix design conform to all applicable Specifications.
- Details of concrete placement, including proposed operational procedures for pumping and tremie methods. Include details for grout placement in the crosshole sonic logging test access tubes after testing is completed (if applicable).
- Detailed procedures for permanent casing installation and temporary casing installation and removal. Include casing diameters, dimensions, and depths and the methods and equipment for casing installation and removal.
- CSL testing company performing the CSL testing work, including documentation demonstrating that the company, and company personnel, meets the required qualifications.
- Confinement methods required to contain drilling fluids, spoils, waste concrete and other products from contacting sensitive environmental areas according to Section 00290 and all applicable regulatory permits.
- Methods for protecting existing structures according to 00170.82.

The Engineer will approve or reject the drilled shaft installation plan within 21 calendar days after receipt of all submissions. Provide any additional information and submit a revised plan, if requested, for review and approval. All procedural approvals given by the Engineer will be subject to trial in the field and will not relieve the Contractor of the responsibility to satisfactorily complete the work. Submit requests for modification of adopted procedures to the Engineer. Allow 21 calendar days for approval of modifications. Do not begin drilled shaft construction work until all drilled shaft submittals have been approved.

(b) Drilled Shaft Repair Plans - For any shaft determined to be unacceptable, submit a repair plan to the Engineer for approval. Furnish all materials and work, including engineering analysis and design, needed to correct unacceptable drilled shafts, at no additional cost to the Agency. Do not begin repair operations before remedial procedures or designs are approved. Any modifications to the dimensions or material of the drilled shafts shown on the plans that are proposed in the repair plan will require stamped calculations and working drawings according to 00150.35.

(c) Drilled Shaft Inspection Reports - Provide the Engineer with a completed Drilled Shaft Inspection Report for each drilled shaft, detailing the actual location, alignment, elevations, dimensions, and quantities of the shafts.

Submit the report within 21 calendar days after the completion and acceptance of each shaft. A "Drilled Shaft Inspection Report" form is available from the Engineer.

(d) Concrete Placement Logs and Volume Curves - Measure and record all concrete placed into drilled shafts using standard ODOT forms designated for this purpose or other forms approved by the Engineer. Provide the Engineer with a completed Drilled Shaft Concrete Placement Log and Concrete Volume Curve Form for each drilled shaft within 24 hours after completion of shaft concrete placement.

00512.41 Drill Shaft Coordination Meeting - Hold a drilled shaft coordination meeting at least seven calendar days before beginning any shaft construction work at the site to discuss construction procedures, schedules, staging, personnel, equipment to be used, and other elements of the approved shaft installation plan as specified in 00512.40. If synthetic slurry is used to construct the shafts, the frequency of scheduled site visits to the project site by the synthetic slurry manufacturer's representative will be discussed. Those attending the meeting include:

- **Representing the Contractor** - The superintendent, on-site supervisors, and all supervisors in charge of excavating the shaft, placing the casing, mixing and installing slurry (as applicable), placing the steel reinforcing bars, and placing the concrete. If synthetic slurry is used to construct the shafts, the slurry manufacturer's representative and a Contractor's employee trained in the use of the synthetic slurry shall also attend.

- **Representing the Contracting Agency** - The Project Engineer, key inspection personnel, and designers of record or their appointed representatives.

If the Contractor's key personnel change, or if the Contractor proposes a significant revision of the approved shaft installation plan, hold an additional meeting before any additional shaft construction operations are performed.

00512.42 Construction Tolerances - Excavate drilled shafts as accurately as possible at the locations shown and within the specified tolerances listed below. Determine the drilled shaft dimensions and alignment with approved methods. The following construction tolerances apply to drilled shafts unless otherwise stated:

- **Horizontal Position (At the Plan Elevation of the Top of Shaft):**

  - **Shaft Diameter Less Than or Equal to 6 Feet** - 3 inch horizontal tolerance from the location shown.

  - **Shaft Diameter Greater Than 6 Feet** - 6 inch horizontal tolerance from the location shown.

- **Top Elevation of Shaft Concrete:**

  - **Top Elevation Above Water** - Minus 3 inches to plus 1 inch from the plan top of shaft elevation.

  - **Top Elevation Under Water** - Minus 3 inches to plus 6 inches from the plan top of shaft elevation.

- **Vertical Alignment in Soil** - May not vary from the plan alignment by more than 1.5% of the shaft length.

- **Vertical Alignment in Rock** - May not vary from the plan alignment by more than 2% of the shaft length.

- **Top of Steel Reinforcement** - Plus or minus 6 inches from the plan top of steel reinforcement elevation.

Frequently check the plumbness, alignment, and dimensions of the shaft during construction. Correct all out-of-tolerance shaft excavations and completed shafts to the satisfaction of the Engineer. Materials and work necessary to complete corrections for out-of-tolerance drilled shafts will be at the Contractor's expense, and no extension of the Project completion date will be granted. Materials and work necessary to complete corrections for out-of-tolerance drilled shafts resulting from the removal of unexpected drilled shaft obstructions will be paid for as Extra Work.

00512.43 Drilled Shaft Excavation - Perform drilled shaft excavation according to the following:

(a) General - Excavate drilled shafts to the dimensions and elevations shown or as directed. Provide and maintain stabilized drilled shaft sidewalls and bottoms for the full depth of the excavation, using approved materials, equipment and methods. If caving or other unstable conditions occur during any construction procedure, stop further construction, notify the Engineer, and stabilize the shaft excavation by approved methods and submit a revised installation plan which addresses the problem and prevents further instability. Do not continue with shaft construction until any damage which occurred has been repaired according to the Specifications and until receiving the Engineer's approval of the revised shaft installation plan.

If the Engineer has reason to believe that the drilled shaft excavation techniques or workmanship have been deficient, so that the integrity of any excavation is in question, work on that drilled shaft may be stopped. Drilled shaft excavation will not be allowed to resume until the deficient excavation techniques or workmanship have been changed to the Engineer's satisfaction.

Dispose of materials removed from the shaft excavations according to 00290.20.

Do not leave partially completed shaft excavations open overnight unless they are cased full depth or otherwise stabilized with approved methods. If approved by the Engineer, a partially excavated shaft may be left open overnight, provided that the excavation:

- Is stabilized at the bottom, sides and surface to prevent soil caving or swelling or a reduction of soil strength, and
- Is covered at the surface to protect the public.

Extend the drilled shaft excavation if the Engineer determines that the subsurface materials encountered are not capable of providing the required bearing resistance or differ from those anticipated in the design of the drilled shafts.

(b) Protection of Existing Structures - Control shaft construction operations to prevent damage to existing structures and utilities. Preventive measures include, but are not limited to, selecting construction methods and procedures that will prevent caving of the shaft excavation and monitoring and controlling the vibrations from construction activities such as the driving and vibrating of casing or sheeting, drilling of the shaft, or from blasting, if blasting is allowed. Repair all damage caused to existing structures, utilities or other facilities, resulting from drilled shaft construction activities, at no additional cost to the Agency.

(c) Temporary Casing - Provide temporary casing according to the approved installation plan and of sufficient quantities to meet the needs of the anticipated construction method.

Where the acceleration coefficient used for seismic design of the structure is less than or equal to 0.10, temporary telescoping casing may be used for the drilled shafts, subject to the following conditions:

- Submit the request to use temporary telescoping casing to the Engineer for approval. Specify the diameters and lengths of the temporary telescoping casing and the shafts where use is requested.
- The minimum diameter of the shaft shall be as shown on the plans.
- Backfill all voids between the temporary telescoping casing and the plan shaft dimensions with a material that approximates the geotechnical properties of the subsurface soils, or with concrete as approved.
- Use temporary telescoping casing material conforming to 00512.13.

(d) Unexpected Drilled Shaft Obstructions - Remove any natural or manmade object encountered that was not revealed by the Agency's site investigation, and that would cause a significant decrease in the rate of advancement if removed using the techniques and equipment used successfully to excavate the shaft. The Engineer will be the sole judge of the significance of any reduced rate of shaft advancement and the classification of any unexpected obstructions. Removal of unexpected obstructions from the shaft excavation will be paid as Extra Work.

(e) Lost Tools - Promptly remove drilling tools lost in the excavation. Lost tools will not be considered unexpected obstructions and shall be removed without additional compensation. Drilling tools lost during the course of removing unexpected drilled shaft obstructions will be paid as Extra Work.

(f) Drilling Slurry Installation - If synthetic drilling slurry is selected, provide a manufacturer's representative to provide technical assistance at the site prior to use of the slurry, who shall remain at the site during construction and completion of a minimum of one drilled shaft to adjust the slurry mix for the specific site subsurface conditions. After the manufacturer's representative is no longer at the site, provide the approved personnel trained in the use of the synthetic slurry for the remainder of the shaft slurry operations to supervise the proper slurry mix design and quality control procedures.

All in-hole drilling slurry shall meet the required slurry specifications during excavation and prior to concrete placement. Clean, recirculate, de-sand or replace the slurry to maintain the required slurry properties.

Unless otherwise approved, maintain the level of slurry in the excavation at not less than 5 feet above the groundwater level for mineral slurries or 10 feet above the groundwater level for synthetic or water slurries. Maintain the slurry level a sufficient distance above all unstable zones to prevent bottom heave, caving or sloughing.

Maintain the required slurry properties and levels at all times during shaft construction, including work stoppages, unless other approved stabilization methods are applied.

Feed slurry continuously into the shaft excavation as drilling progresses so that a stable excavation is maintained. Use a self-priming pump to reclaim the slurry. Keep a standby pump available during the drilling operation.

(g) Drilling Slurry Inspection and Testing - Mix and thoroughly hydrate all drilling slurries in an appropriate storage facility. Collect sample sets from the storage facility and perform tests to ensure the slurry conforms to the specified material properties before introduction into the drilled shaft excavation. A sample set shall be composed of samples taken at mid-depth and within 24 inches of the bottom of the storage facility.

Sample and test all slurry in the presence of the Engineer, unless otherwise directed. The sample sets of slurry within the excavation shall consist of samples taken at mid-depth of the excavation and within 24 inches of the bottom of the excavation. Collect and test sample sets during the drilling operation as necessary to ensure the specified properties of the slurry are maintained. Clean, recirculate, de-sand, or replace the slurry as necessary to maintain the specified slurry properties. Final cleaning of the excavation and placement of concrete will not be allowed until the test results indicate the slurry properties are as specified.

Perform a minimum of two sets of slurry tests per eight-hour work shift, the first test being done at the beginning of the shift. Field conditions may require more frequent testing to ensure acceptable slurry properties.

Make copies of all slurry test results available to the Engineer on request.

(h) Clean Out - Use appropriate means, such as a cleanout bucket, pump or air lift, to clean the bottom of the drilled shaft excavations. No more than 2 inches of loose or disturbed material will be allowed at the bottom of the excavation for end-bearing drilled shafts. No more than 6 inches of loose or disturbed material will be allowed at the bottom of the excavation for side friction drilled shafts. Assume end-bearing shafts unless otherwise shown or specified. Shaft cleanliness will be determined by the Engineer.

Notify the Engineer of completion of each drilled shaft excavation to permit inspection before proceeding with construction. Measure final shaft depths with a suitable weighted tape or other approved method after final cleaning to determine that the shaft bottom meets the requirements in the Contract. Do not proceed with shaft construction until the bottom cleanliness requirements have been met and the bottom (shaft tip) elevation is approved.

00512.45 Reinforcing Steel - Furnish and place reinforcing steel as shown and according to the following:

(a) Placement - Do not place reinforcing steel in the shaft excavation until the Engineer has approved the final elevation of the bottom of the shaft.

In each shaft, place reinforcing steel extending from 6 inches above the bottom of the shaft excavation to the elevation shown. The reinforcing cage may be supported on the bottom of the shaft excavation if approved. Support the reinforcing cage to prevent distortion or settlement during concrete placement. If concrete placement does not immediately follow cage placement, remove the reinforcing cage from the excavation and rectify the integrity of the excavation prior to reinstallation of the cage.

(b) Bracing - Rigidly brace the reinforcing cage to retain its shape for lifting. Lift the cage in a manner that does not cause permanent racking or distortion. Show bracing and any extra reinforcing steel required for fabrication of the cage on the submitted shop drawings. Remove cross bracing during cage placement unless otherwise approved.

(c) Splicing - Splice all drilled shaft reinforcement using approved mechanical splicer's unless otherwise shown or approved.

(d) Concrete Cover - Maintain the required concrete cover shown on the plans by placing concentric spacer bars or other approved devices around the reinforcing cage. Provide details of the proposed centering method on the shop drawings submitted according to 00512.40.

00512.46 Crosshole Sonic Log Test Access Tubes - Furnish and install access tubes for CSL testing as shown. Attach CSL access tubes securely to the interior of the reinforcement cage as near to parallel as possible in each drilled shaft and in the pattern shown. Extend the access tubes from the bottom of the reinforcement cage to at least 24 inches above the top of the shaft. Joints required to achieve full-length access tubes shall be watertight. Do not damage the access tubes during reinforcement cage installation and concrete placement. Fill the tubes with potable water, according to 02020.10(b), as soon as possible, but no more than one hour after concrete placement and reinstall the top watertight caps. Check water level and top off as needed.

Replace all access tubes that the test probe cannot pass through to the full depth of the shaft at no additional cost to the Agency. Replace all damaged access tubes with 1.5 inch to 2.0 inch diameter holes cored through the concrete for the entire length of the shaft. Unless otherwise directed, locate replacement core holes approximately 6 inches inside the reinforcement. Do not damage the shaft reinforcement during coring operations.

Fill the access tubes with grout only after all CSL testing has been completed and the shaft has been accepted.

00512.47 Concrete - Furnish and place concrete according to the following:

(a) Concrete Placement - Place concrete immediately after completion of the shaft excavation and with the approval of the Engineer. Prior to concrete placement, ensure the shaft clean-out requirements are met according to 00512.43(h) and the properties of the slurry (if used) conform to specifications. Shaft concrete may be placed without mechanical vibration in those areas of the drilled shaft that are not formed or are below the ground line or the water surface.

Place concrete continuously until concrete at the top of the shaft is free of water, soil, and debris, and uncontaminated concrete extends to the plan top-of-shaft elevation. Dispose of all contaminated concrete expelled from the top of the shaft in an approved manner. Remove waste concrete from the site. If a delay in concrete placement occurs because of a delay in concrete delivery or other factors, reduce the placement rate to maintain a flow of fresh concrete into the shaft excavation.

Unless otherwise approved by mix design, allow a maximum of 60 minutes between concrete placements and use no concrete older than 90 minutes from batch time. Use procedures for concrete placement which ensure that the concrete within the shaft becomes a monolithic, homogeneous unit.

Place concrete using hoses or pipes having watertight joints. For concrete placement by gravity tremie, use hose or pipe having an inside diameter of at least 8 inches. For placement by concrete pump, use hose with inside diameter of at least 4 inches. Provide an alternate delivery system that can be used in case of failure of the primary delivery system. Place concrete only against the bottom of the drilled shaft or into fresh concrete.

If caving occurs during concrete placement, the shaft may be rejected.

(b) Dry Shaft Concrete Placement - Concrete may be placed by free-fall if all of the following conditions are met:

- no more than 3 inches of water is present in the bottom of the excavation at the beginning of the pour
- groundwater seepage into the excavation is at a rate of no more than 12 inches per hour
- shaft diameter is greater than or equal to 3 feet

Under free-fall placement, deposit concrete through the center of the reinforcement cage by a method which prevents segregation of aggregates and splashing of concrete on the reinforcement cage. Place concrete so that the free-fall is vertical down the center of the shaft without hitting the sides, the steel reinforcing bars or steel cage bracing.

(c) Wet Shaft Concrete Placement - If the drilled shaft excavation does not meet the requirements for dry concrete placement, stabilize water inflow and place the concrete under water or slurry with a tremie pipe or pump hose according to 00540.48(e). Place concrete continuously from the bottom of the shaft to the top-of-shaft elevation shown. Use a plug in the tremie pipe or pump hose to force water or slurry ahead of the advancing flow of fresh concrete. Dispose of all displaced water, slurry, or waste concrete according to 00290.20. When groundwater, the drilling water or slurry in the shaft excavation is to be removed by pumping during concrete placement, have a standby pump available.

Place concrete in a continuous operation so that the concrete always flows upward within the shaft. Withdraw the delivery hose or pipe slowly as the elevation of the fresh concrete rises in the shaft. Keep the discharge end of the pipe or hose at least 5 feet below the surface of the concrete after the concrete has reached a depth of 5 feet. Maintain sufficient concrete inside the hose or pipe to prevent drilling fluid from entering. During concrete placement, provide and maintain markings on the tremie pipe or pump hose, or a sounding device or other appropriate method to determine the relative elevations of the fresh concrete surface and the bottom end of the pipe or hose. Raise the bottom end of the pipe or hose only when the pipe or hose has a sufficient head of fresh concrete to prevent the formation of a void at the bottom.

(d) Concrete Curing and Cleaning - Allow the exposed top of concrete to cure a minimum of seven calendar days by covering with wet burlap overlain with plastic sheets or by keeping top of concrete under water. Keep the burlap wet during the concrete cure.

Prior to placing any fresh concrete on top of a completed shaft, clean the upper surface of the concrete by removing all scum, laitance, loose gravel, and sediment and chip off any high spots on the upper surface that would prevent the steel reinforcing bar cage from being properly placed in the position shown on the plans. Remove all loose material and poor quality concrete at the top of the shaft down to sound concrete prior to performing any required CSL testing.

(e) Casing Removal - Remove all temporary casing during or after completion of concrete placement. Do not start temporary casing removal until the level of fresh concrete within the casing has reached a depth of at least 10 feet or the level necessary to adequately counteract the external hydrostatic pressure head. As the temporary casing is withdrawn, maintain a minimum 5 feet head of concrete above the bottom of the casing. A slight downward movement of the casing while exerting downward pressure, or hammering or vibrating the casing will be allowed to facilitate extraction. Extract the casing so that concrete is cast directly against the surrounding in-situ material. Check the elevation of the top of the reinforcing cage before and after temporary casing extraction for conformance with the construction tolerance criteria of 00512.42. Casing that cannot be extracted during, or immediately after, the concrete placement operation may be cause for rejection of the shaft.

Remove the tops of permanent casing to the top of the drilled shaft or the finished groundline, whichever is lower, unless otherwise shown or directed. Remove the tops of permanent casing for shafts constructed in a permanent body of water to the low water elevation, unless otherwise shown or directed.

00512.48 Drilled Shaft Testing and Acceptance - Acceptance of drilled shafts will be based on the Engineer's review of the results of CSL, or other, integrity testing (if conducted), field inspection reports and visual observations during drilled shaft construction. The Engineer has final authority on the approval of drilled shafts. For shafts that are integrity tested, the Engineer will determine final acceptance of each tested shaft, based on the integrity test results and inspection reports and will provide a response to the Contractor within five calendar days after receiving the CSL test report.

(a) Crosshole Sonic Log Testing - Provide crosshole sonic log testing equipment and perform crosshole sonic log testing and analysis on the first drilled shaft completed at each structure and subsequent shafts as specified or designated for testing by the Engineer. Provide CSL testing equipment conforming to the requirements of ASTM D 6760 and approved by the Engineer. Provide all necessary access and other support to the CSL testing firm necessary to do the CSL testing work.

Unless otherwise directed, perform one CSL test on each shaft designated for testing. A single CSL test consists of all ultrasonic profile combinations in a given shaft. Test completed drilled shaft foundations using Ultrasonic Crosshole Testing methods (Crosshole Sonic Log (CSL) Testing) according to ASTM D 6760. Inform the Engineer of scheduled CSL testing at least three calendar days prior to the testing. Perform all CSL testing using the Contractor's CSL technician in the presence of the Engineer.

Allow at least three calendar days of curing time before testing unless otherwise approved. Additional curing time beyond three calendar days may be required if the shaft concrete contains admixtures such as set retarding admixture or water reducing admixture. Additional CSL testing required due to the CSL testing being conducted on concrete that has not cured sufficiently is at no additional cost to the Agency. Additional curing time required due to concrete admixtures will not be grounds for additional compensation or time extensions.

(b) Contractor's CSL Test Reports - Provide a brief summary report of the data, with interpretation of the test results, to the Engineer at the completion of each test. Provide copies (either hardcopies or electronic files) of the raw test data as requested. Mark the test data files to identify, as a minimum, the structure, bent and shaft number, the date of CSL testing, depths of testing and any other pertinent information.

Submit three copies of a final CSL Test Report for each shaft tested according to ASTM D 6760. Provide electronic file copies of the raw CSL data measurements (compatible with the Cross Hole Ultrasonic Monitor (CHUM) program), if requested. The report shall summarize the CSL testing performed, data analysis, and interpretation of CSL data with special attention made to the identification and location of any anomalies or possible defects. Provide interpretation of the CSL test data in terms of overall shaft integrity and acceptance. Submit all reports to the Engineer within five calendar days of the performance of the tests.

(c) Additional Testing and Investigation - Conduct additional testing or investigation necessary to identify the location, extent and condition of possible shaft defects if requested by the Engineer. Additional testing and investigation may include, but is not limited to, additional CSL testing, excavation work or core drilling.

If requested by the Engineer, drill a core hole in any questionable quality shaft to explore the shaft condition. The number, location and depths of the core holes will be determined by the Engineer. Submit the method and equipment used to drill and remove cores from the shaft to the Engineer for review and approval prior to drilling. Use a coring method that provides complete core recovery and

minimizes abrasion and erosion of the core. If a defect is confirmed, as determined by the Engineer, all investigation costs associated with identifying the defect will be at no additional cost to the Agency and no extension of the Project completion date will be granted, regardless of whether the identified defect is repaired or not.

If no defect is identified in the investigation work, and the CSL tubes were satisfactorily installed according to ASTM D 6760 and accepted, the Agency will pay for all coring and excavation costs associated with the additional investigation and grant an appropriate time extension, if required, according to Section 00190 and Section 00195. If it is determined by the Engineer that the CSL tubes were not installed properly thus invalidating the CSL test results, all coring, excavation, and other investigation and evaluation costs will be at no additional cost to the Agency and no extension of the Project completion date will be granted.

Fill all core holes with grout only after the evaluation process is completed and the shaft is accepted and approved.

(d) Drilled Shaft Repair - Repair all defects and rejected shafts according to 00512.40(b). Perform additional CSL testing, or other investigation required, as directed by the Engineer, to confirm the quality of the completed shaft repair work at no additional cost to the Agency with no time extension granted.

For temporary casing not extracted from the shaft excavation, submit a repair plan or a structural evaluation to the Engineer for approval according to 00512.40. If caving occurs during concrete placement submit a repair plan to the Engineer for approval.

00512.49 Scheduling and Restrictions - Unless otherwise approved, do not proceed with construction of subsequent shafts until the CSL testing has been completed on the first drilled shaft and the results have been approved and accepted, in writing by the Engineer. Approval to proceed with the construction of subsequent shafts, before receiving approval of the first shaft will be based on the Engineer's observations of the Contractor's workmanship during construction of the first shaft and the Engineer's review and assessment of the following:

- The Contractor's conformance with the approved shaft installation plan.
- The Contractor's daily reports and inspector's daily logs of excavation, rebar, and concrete placement.
- The concrete placement logs and volume curves.

Written notification will be provided to the Contractor on whether or not to proceed with subsequent shaft construction within 24 hours after completion of the first shaft. If the Engineer determines the first shaft to be of questionable quality, discontinue all shaft construction until the CSL test results of the first shaft are received and reviewed and the shaft accepted, in writing, by the Engineer.

Denial of permission to proceed with subsequent shaft construction will not be cause for contract time extension.

Do not proceed with the third drilled shaft until the final CSL test results from the first drilled shaft has been received and reviewed and the shaft accepted, in writing, by the Engineer.

After the first drilled shaft on the Project has been accepted, make no significant changes in construction methods, equipment, or materials used to construct subsequent shafts, unless otherwise approved.

Measurement

00512.80 Measurement - The quantities of work performed under this Section will be measured according to the following:

(a) Furnish Drilling Equipment - No measurement of quantities will be made for furnishing drilling equipment.

(b) Permanent Casing - Permanent shaft casing will be measured on the length basis.

(c) Drilled Shaft Excavation - Drilled shaft excavation will be measured on the length basis by the vertical excavated length from the bottom of the shaft to the ground surface or to the mudline if under water. If the top of the shaft is located below the original ground surface, measurement will be made to the top of the shaft as shown or directed. If directed to excavate drilled shafts below the elevations shown, the drilled shaft excavation will be measured from the revised bottom of shaft.

(d) Drilled Shaft Concrete - No measurement of quantities will be made for drilled shaft concrete. Estimated quantities of concrete will be listed in the Special Provisions.

(e) Drilled Shaft Reinforcement - No measurement of quantities will be made for drilled shaft reinforcement. Estimated quantities of reinforcement will be listed in the Special Provisions.

(f) Crosshole Sonic Log Equipment Mobilization - CSL testing equipment and operating personnel mobilization will be measured on the unit basis for each time the Contractor mobilizes equipment and personnel to the Project for CSL testing as required by the Engineer.

(g) Crosshole Sonic Log Test Access Tubes - CSL access tubes will be measured on the length basis of the number of tubes installed in the shafts.

Grout used to fill the access tubes after the completion of CSL testing will not be measured.

(h) Crosshole Sonic Log Tests - CSL tests will be measured on the unit basis for each CSL test completed, reported, and accepted. No separate measurement will be made for CSL tests performed at the Contractor's option.

Payment

00512.90 Payment - The accepted quantities of work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

	Pay Item	Unit of Measurement
(a)	Furnish Drilling Equipment	Lump Sum
(b)	Permanent Shaft Casings	Foot
(c)	Drilled Shaft Excavation, ____ Diameter	Foot
(d)	Drilled Shaft Concrete	Lump Sum
(e)	Drilled Shaft Reinforcement	Lump Sum
(f)	CSL Equipment Mobilization	Each
(g)	CSL Test Access Tubes	Foot
(h)	CSL Tests	Each

Item (a) includes furnishing and moving the drilling equipment to the Project, setting up the equipment at the various locations on the Project and removing the equipment from the Project.

Partial payments for item (a) will be made as follows:

- When drilling equipment is on the job, assembled and ready to excavate the shafts 60%
- When all shafts have been excavated and shaft concrete has been placed and accepted ...40%

In item (c), the diameter of the shaft will be inserted in the blank. Item (c) includes excavating the shafts and disposing of the excavated material and for furnishing, placing, splicing, and removing temporary shaft casing and forms.

Item (e) includes all reinforcement within the drilled shaft plus the reinforcement shown which is to be embedded in the shaft and extends above the top of the drilled shaft including the continuous vertical and spiral reinforcement extending from the bottom of the shaft to the elevation shown. No separate or additional payment will be made for bracing, mechanical splices, centering devices, and support for the bottom of the reinforcement cage.

Item (f) includes each time the Contractor mobilizes all testing equipment and personnel onto the Project as required for CSL testing. Once CSL equipment and personnel are mobilized onto the Project, no separate or additional payment will be made for equipment mobilization required to access test shafts at different locations within the Project limits.

Item (g) includes filling the tubes with grout after completion of CSL testing.

Item (h) includes all testing, interpretation, analysis, electronic data, and final report for each tested and accepted shaft.

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

If the Contractor chooses to use a larger shaft diameter casing than the shaft diameter shown, no additional payment will be made for the larger casing, or for the additional excavation, concrete, and reinforcement.

Section 00520 - Driven Piles

Description

00520.00 Scope - This work consists of furnishing and driving piles of the type and dimensions shown or specified, including cutting off or building up piles when required.

Materials

00520.10 General - Furnish materials meeting the following requirements:

Preservative Treatment of Timber	02190
Prestressed Concrete Piles	02520.20
Reinforced Pile Tip	02520.10
Steel Piles	02520.10
Steel Reinforcement for Concrete	00530
Timber Piles	02120.20
Timber Pile Straps	02120.30

00520.11 Engineer's Estimated Length List - Furnish steel piles of sufficient length to attain the penetration and bearing resistance specified, and to extend into the cap or footing as shown. The Contractor may, at no additional cost to the Agency, drive test piles, make borings, and perform other investigations the Contractor considers necessary. The "Engineer's Estimated Length" of steel piles will be listed in the Special Provisions.

00520.12 Pile Order List - Furnish prestressed concrete and timber piles according to the pile order list in the Special Provisions, which will list the type, number, and length of piles. The pile order length includes an allowance for variation. The Contractor may increase the order lengths as necessary to suit pile driving operations at no additional cost to the Agency.

00520.13 Test Piles - Furnish test piles according to the test pile length list in the Special Provisions. When test piles are required, the production pile lengths shown or specified in the Special Provisions are estimated lengths only. The actual lengths to be furnished for production piles will be determined by the Engineer after the test piles have been driven. This applies for all pile types.

00520.14 Unused Piles - Acceptable full length piles furnished according to the estimated length list, order list, or revised pile order list, but not incorporated in the work, will be handled according to one of the following:

- Mark and identify piles for the Contractor's own use.
- Return piles to the supplier with the Agency paying transportation and restocking charges.
- The Agency will purchase from the Contractor piles that are stockpiled at a location on the Project selected by the Engineer according to 00195.80.

Equipment

00520.20 Equipment for Driving Piles - Provide pile driving equipment meeting the following requirements:

(a) Impact Pile Hammers - Provide a striking part of the hammer not less than one-third the weight of the helmet and pile being driven, but never less than 2,750 pounds.

(1) Air-Steam Hammers - Provide power plant and equipment for air-steam hammers with sufficient capacity under working conditions to maintain the volume and pressure at the hammer specified by the manufacturer and with accurate pressure gauges easily accessible to the Engineer.

(2) Open-End Diesel Hammers - Provide open-end (single-acting) diesel hammers equipped with a device which allows the Engineer to visually determine hammer stroke at all times during pile driving operations. Provide the Engineer with the hammer manufacturer's chart equating stroke and blows per minute.

(3) Closed-End Diesel Hammers - Provide closed-end (double-acting) diesel hammers equipped with a bounce chamber pressure gauge, mounted near ground level so the Engineer can easily read it. Before driving, provide the Engineer a chart calibrated within six months before first use on the Project to actual hammer performance, equating bounce chamber pressure to either equivalent energy or stroke.

(4) Gravity Hammers - Provide gravity hammers that have a ram weighing between 2,000 pounds and 5,000 pounds and a drop height of not more than 10 feet. The weight of gravity hammers shall not be less than the combined weight of helmet and pile.

(5) Hydraulic Hammers - Provide either single or double acting hydraulic hammers equipped with monitoring systems to measure impact velocity and determine equivalent energy and stroke. Locate monitoring systems for easy access by the Engineer.

(b) Vibratory Hammers - Control installation of production piles with vibratory hammers according to the power consumption, rate of penetration, specified tip elevation, or other acceptable means which assure the pile resistance equals or exceeds the required nominal pile bearing resistance. After driving piles with a vibratory hammer, verify pile resistance (see 00520.42) by driving them with an impact hammer of suitable energy. Do not use vibratory hammers to drive test piles or when preboring or jetting.

(c) Driving Components:

(1) Pile Cushion - Protect the heads of prestressed concrete piles with a pile cushion made of wood or other approved material.

The pile cushion shall be:

- Equal to or greater in cross-sectional contact area than the pile head
- In full contact with the pile head
- No less than 4 inches thick, before driving begins, if made of plywood

Provide a pile cushion for each pile. Replace the pile cushion if, during the driving, the cushion is either compressed to less than one-half the original thickness or begins to burn.

(2) Helmet - Equip piles driven with impact hammers with an adequate metal helmet. The helmet shall:

- Fit around the pile top
- Be axially aligned with the hammer and pile
- Distribute the hammer energy to the total cross section of the pile head
- Be guided by leads

(3) Hammer Cushion - Equip impact pile driving equipment with a suitable thickness of hammer cushion material to prevent damage to the hammer or pile and to ensure uniform driving performance. Provide hammer cushions of durable manufactured materials according to the hammer manufacturer's guidelines. Do not use wood, wire rope, or asbestos hammer cushions.

Place a striker plate, as recommended by the hammer manufacturer, on the hammer cushion to ensure uniform compression of the cushion material.

Inspect the hammer cushion in the presence of the Engineer at the beginning of pile driving at each structure or after each 100 hours of use during pile driving, whichever is less. Replace the hammer cushion when its thickness becomes less than 75% of its original thickness.

(4) Followers - Use a follower between the pile hammer and the pile to transmit energy when the pile head is below the reach of the hammer, if allowed by the Special Provisions or approved in writing. If a follower is allowed, drive the first pile in each bent, and every tenth pile driven after that, full length without a follower. Before additional piles are installed, verify that the first two piles installed with followers in each substructure unit meet the position and alignment criteria of 00520.41(f).

(5) Leads - Support piles in line and position while driving. Construct pile hammer leads to give the hammer freedom of movement while maintaining alignment of the hammer and the pile to ensure concentric impact for each blow. Leads shall be fixed unless the Engineer approves the use of swinging leads. Fit swinging leads, when used, with a pile gate at the bottom of the leads. To maintain alignment of batter piles, use horizontally braced swinging leads, adequately embedded in the ground, or rigidly attached to prevent movement during pile driving.

(d) Approval of Pile-Driving Equipment:

(1) General - Before beginning test pile or production pile driving, obtain approval in writing of pile driving equipment.

To obtain approval, complete and submit the Agency's "Pile and Driving Equipment Data" form at least 14 calendar days before pile driving begins. This form is available from the Engineer. Within 14 calendar days of receiving the form, the Engineer will notify the Contractor of approval or rejection of the pile-driving equipment.

During pile-driving operations, no changes to the approved equipment will be allowed without the Engineer's written permission. Submit a request for change on a "Pile and Driving Equipment Data" form. The Engineer will give notification of approval or rejection within seven calendar days of receiving the form. Time required for resubmission and review of a Contractor's equipment change request is not a basis for a Contract Time extension request unless the Engineer does not respond in seven calendar days.

(2) Standard Evaluation Method - The standard method of evaluating driving equipment requires that the field-measured hammer energy be within the range of energy levels given in Table 00520-1 corresponding to the nominal pile bearing resistance shown.

Table 00520-1 Pile Hammer Requirements [1]

Nominal Pile Bearing Resistance (kips)	Minimum Field Energy (foot-pounds)
≤ 180	6,500
> 180 and ≤ 280	11,000
> 280 and ≤ 420	20,000
> 420 and ≤ 600	35,000
over 600	Wave Equation required

[1] Using FHWA Gates equation (see 00520.42(b)), except all driving criteria for double acting and differential hammers both air, steam and diesel will be by the wave equation analysis.

If during the pile-driving operation, the Engineer determines the hammer is not operating properly and is unable to drive the piles to the required resistance, do not use the hammer until repaired to the Engineer's satisfaction.

The required number of hammer blows indicated by the FHWA Gates equation at the nominal pile bearing resistance shall be at a rate between 3 and 15 blows per inch.

(3) Wave Equation Method - Select a suitable hammer for driving piles and perform wave equation analyses. Use the 1987 or newer version of the Wave Equation Analysis Program (WEAP). Conduct the wave equation analyses using personnel qualified by training and experience to perform this type of work.

Submit the WEAP analysis concurrent with the Pile and Driving Equipment Data Form. The Engineer will approve or reject the pile driving equipment submittal after a review of the wave equation analysis conducted by the Contractor.

Provide pile hammers meeting the following requirements based on wave equation analysis:

- The energy of the submitted hammer shall produce a wave equation predicted blow count between 3 and 15 blows per inch for the nominal resistances, pile lengths and other conditions specified.
- The pile stresses indicated by the wave equation at the nominal resistance shall not be greater than the stress at the point of impending damage to the pile as follows:
    - **Steel Piles** - Tensile and compressive stresses in the pile of 90% of the pile material's yield strength for the grade of steel specified at any time during the pile installation.
    - **Prestressed Concrete Piles:**
        - A tensile stress of $(.095\sqrt{f'_c})$ + effective prestress
        - A compressive stress of $(0.85\ f'_c)$ - effective prestress

        Where: f'_c = concrete compressive strength (ksi)
    - **Timber Piles** - A compressive driving stress of three times the allowable static design stress.

Hammers not meeting these requirements will be rejected. Replace rejected hammers with suitable hammers.

Use input values for the wave equation analyses provided in the Special Provisions and according to the following:

Use the following settings and default values as input to the wave equation analysis program:

- Output option (IOUT) zero (normal option).
- R_N is the nominal pile bearing resistance.
- Smith damping.
- Do not use residual stress option.

- Default hammer efficiency values. Do not adjustment the hammer's efficiency outside of the wave equation program recommended (default) values without prior concurrence of both the pile hammer manufacturer and the Engineer.
- % skin is the percent skin friction.

A Pile Driving Analyzer (PDA) test may be required prior to approval of non-default wave equation input values.

At a minimum, provide the following information and documentation:

- A written summary of how the proposed hammer and associated equipment meets the specifications regarding blow count criteria and allowable pile stresses.
- Electronic and paper copies of the wave equation input and output files. Output files shall be in the standard WEAP output format.
- WEAP analysis demonstrating that for the required nominal bearing resistances and conditions provided, the hammer will produce pile stresses less than those described above for the range of hammer strokes expected in the field.
- The "Pile and Driving Equipment Data" form.
- WEAP hammer input files for hammers not in the wave equation default hammer files.

For Agency reviewing and approving of the wave equation analysis submittals, the following will be taken into consideration:

- The pile length for use in the WEAP analysis will be the total pile length at the end of driving, including all pile length above the ground surface. This length may be longer than the Engineers Estimated length depending on the site conditions, equipment used, pile hammer access limitations and other factors.
- The properties and thicknesses of the hammer and pile cushion materials.
- Various hammer types such as direct-drive diesel, standard diesel, air/steam or hydraulic hammers have major effects on predicted stresses and blow counts.
- Changes in pile type or size will affect the blow count rate and pile stresses.
- Battered piles may effect hammer energy transfer and blow counts.

Failure to address these issues may be cause for rejection of the proposed pile hammer.

The size of the pile hammer selected according to the above specification may have significant impacts on the size and capacity of associated equipment including the leads and crane. This equipment, in turn, may have significant impacts on the size and capacity of work bridges, shoring required for existing structures or other aspects and elements of construction.

Failure of a previously approved hammer to operate properly during construction will be cause for rejection.

Construction

00520.40 Preparation for Driving:

(a) Excavation - Unless otherwise provided or authorized, do not drive piles until after excavation is complete. Remove to the correct elevation any material forced up by pile driving before concrete for the foundation is placed, at no additional cost to the Agency.

(b) Embankments - Unless otherwise provided or authorized, do not drive piles until the roadway embankment at bridge ends is in place according to 00330.42. Drive piles completely through roadway embankments to the required penetration and bearing in the underlying material.

00520.41 Driving:

(a) General - Drive piles as specified with approved pile driving equipment to the required penetration depth and to the required nominal pile bearing resistance as shown or specified.

(b) Installation Sequence - Unless otherwise shown or specified, install individual piles in pile groups starting from the center of the group and proceeding outward in either direction, or as approved.

(c) Minimum Penetration - Unless otherwise specified or approved, drive piles at least 12 feet below the footing or pile cap, 12 feet below the groundline at trestle pile locations, and completely through embankments at bridge ends. When shown or specified drive piles to a greater minimum penetration. If the required penetration cannot be attained with a hammer complying with 00520.20(d), provide a larger hammer, prebore or jet holes, or use other approved methods as necessary to attain the required penetration.

(d) Preboring - Use augering, wet-rotary drilling or other methods of preboring only when specified or with written approval. When allowed, prebore holes at pile locations and to the depths shown or directed. Make prebored holes smaller than the diameter or diagonal of the pile cross section, but sufficient to allow penetration of the pile to the specified depth. If subsurface obstructions, such as cobbles, boulders or rock layers are encountered, the hole diameter may be increased to the least dimension which is adequate for pile installation. The use of a reinforced section (spud) to loosen the subsurface material at pile locations will not be allowed unless otherwise approved.

Perform preboring in a manner that will not impair the bearing or lateral capacity of the piles already in place or the safety of existing adjacent structures. When it is determined that preboring has disturbed the load bearing resistances of previously installed piles, restore those piles that have been disturbed to conditions meeting the requirements of this Specification by redriving or by other acceptable methods. The Contractor shall be responsible for the costs of any necessary remedial measures unless the preboring method was specifically included in the Contract Documents and properly executed by the Contractor.

(1) End-Bearing Piles - For end-bearing pile as classified by the Engineer, preboring may be carried to the surface of the end-bearing foundation material. Following that, drive pile with an approved impact pile hammer to the specified blow count.

(2) Other Piles - For other piles, extend preboring to the minimum pile penetration depth and then drive pile with an approved impact pile hammer to the specified blow count.

After completion of driving, fill any void space remaining around the pile with sand or other approved material.

(e) Jetting - Jetting may only be used when allowed in the Contract Documents or if approved in writing. When jetting is not required in the Contract Documents, but approved at the Contractor's request, determine and submit for review the number of jets and the volume and pressure of water at the jet nozzles necessary to freely erode the material adjacent to the pile without affecting the lateral stability of the final in-place pile. The Contractor shall be responsible for all damage caused by unapproved or improper jetting operations, unless the jetting method was specifically included in the Contract Documents and properly executed by the Contractor. Control, treat if necessary, and dispose of all jet water in a satisfactory manner. Drive all jetted pile with an approved impact hammer.

(f) Location and Alignment Tolerance - Place the tops of piles at plan cutoff elevation and horizontally within 6 inches of plan locations. No pile shall be nearer than 4 inches from any edge of the cap. Any increase in cap size to meet this edge distance requirement will be at no additional cost to the Agency.

Install piles so the axial alignment of the top 10 feet of the pile is within 5 inches of the specified alignment. For piles that cannot be inspected after installation, make an alignment check before installing the last 5 feet of pile. The Engineer may require that driving be stopped to check the pile alignment. Pulling laterally on piles to correct misalignment or splicing a properly aligned section onto a misaligned section will not be allowed.

If the specified location or alignment tolerances are exceeded, the effect of the pile misalignment on the substructure design will be investigated. If the Engineer determines corrective measures are necessary, implement suitable measures and pay all costs and delays associated with the corrective action.

(g) Heaved Piles - Make elevation readings on piles during pile driving operations to check on pile heave. Take elevation readings after each pile has been driven and again after piles within a radius of 15 feet have been driven. Redrive to the required penetration and resistance all piles that have risen more than 1/2 inch, at no additional cost to the Agency. Continue readings until the Engineer determines that such checking is no longer required. If pipe piles which have been filled with concrete subsequently heave, redrive them to original position, after the concrete has attained specified strength, with an approved hammer-pile cushion system.

(h) Test Piles - When specified, furnish and drive test piles at the locations and to the lengths directed. All test piles shall be of the kind and size specified for the permanent foundation piles unless otherwise directed. Drive all test piles with approved pile driving equipment. The specified length of test piles will be greater than the estimated length of production piles to provide for variation in soil conditions. Drive test piles using driving equipment identical to that which the Contractor proposes to use on the production piling. Excavate to the elevation of the bottom of the footing before driving test piles. (see Section 00510)

Drive test piles to or below the required minimum tip elevation and to a hammer blow count established by the Engineer. Allow test piles which do not attain the hammer blow count specified at the minimum tip elevation shown to "set up" for 24 hours, or less if directed, before being redriven. (see 00520.42(d)) If the tops of test piles reach plan grade without attaining the required pile bearing resistance, splice them and drive until the required bearing resistance is attained.

Remove test piles that are not to be incorporated in the completed structure to at least 2 feet below the surface of the ground and backfill the remaining hole with acceptable material.

Do not order piling to be used in the permanent structure until test pile data has been reviewed and the production pile order lengths are determined. The Engineer will provide the Engineer's estimated length list or pile order list within seven calendar days after completion of all test pile driving specified in the Contract.

00520.42 Nominal Pile Bearing Resistance:

(a) General - Drive piles with approved pile driving equipment to the lengths necessary to attain the required penetration and nominal pile bearing resistance. Adequate pile penetration will be considered reached when the piles are driven to or below the minimum penetration depth and the specified equation resistance value is achieved. If piles do not achieve the specified resistance when driven to order length or estimated length, splice and drive them to penetrations established by the Engineer. The pile blow count shall be at a rate of between 3 and 15 blows per inch at the required

nominal pile bearing resistance. The required number of hammer blows per inch at final penetration shall be maintained for 3 consecutive inches unless "refusal" driving is first obtained. "Refusal" driving is defined as 20 blows per 1 inch or as determined by the Engineer.

If water jets are used with the driving, the bearing value shall be determined by the specified equation from the results of driving after the jetting has been completed according to 00520.42(e).

(b) FHWA Gates Equation - Unless otherwise specified, the Engineer will determine nominal pile bearing resistance of the driven pile by the FHWA Gates equation:

$$R_n = 1.75 \left(\sqrt{E} \right) \log_{10}(10N) - 100$$

where:

R_n = Nominal Pile Bearing Resistance (kips)
E = W x H (Hammer energy (foot-pounds) at the ram stroke observed in the field)
W = Weight (pounds) of striking parts of hammer
H = Height of fall (feet) of the ram measured during pile driving in the field
$Log_{10}(10N)$ = Logarithm to the base 10 of the quantity 10 multiplied by N
N = Number of hammer blows per inch at final penetration to be sustained for 3 consecutive inches

$$N = 10^{\left[\frac{R_n + 100}{1.75 \sqrt{E}} - 1 \right]}$$

or N = 10 to the power in brackets

The FHWA Gates equation is applicable only if:

- The hammer is in good condition and operating in a satisfactory manner
- The hammer has a free fall
- A follower is not used
- The head of the pile is not broomed or crushed

If the Engineer determines that the hammer being used may not be attaining the specified bearing resistance when the above equation is applied, the Engineer may order the Contractor, at no additional cost to the Agency, to verify the bearing resistance values obtained by the use of a different hammer.

(c) Wave Equation Analysis - If specified, the Engineer will determine nominal pile bearing resistance based on wave equation analysis.

(d) Set Period and Redriving - If piles do not attain the required nominal bearing resistance when driven to the specified length, and if allowed or required, allow the piles to stand for a "set period" without driving. The "set period" shall be a minimum of 24 hours unless otherwise approved by the Engineer. After the set period, perform check driving on either two piles in each bent or on one pile in every 10 piles, whichever is more. The Engineer will designate the piles on which check driving is to be performed. Do not use a cold hammer for redriving. Warm up the hammer before redriving begins by applying at least 20 blows to another pile. Redriving shall consist of driving the pile to the required bearing resistance with a maximum of 15 blows. If the specified hammer blow count is not attained on redriving, the Engineer may direct the Contractor to drive all of the remaining pile length and repeat the set period and redriving procedure. Splice those piles driven to plan grade that do not

attain the hammer blow count required, and drive until the required bearing resistance is attained. If the required bearing resistance is attained for each pile that is redriven, then the remaining piles in that bent will be considered satisfactory when driven to at least the same penetration and resistance as the redriven piles.

(e) Jetted Piles - The nominal pile bearing resistance of jetted piles will be based on impact driving blow count after jetting has been completed. Jet pipes may be removed when the pile tip is at the required minimum pile tip elevation and before the pile is driven to the required bearing resistance. For piles that are jetted at the Contractor's request and do not attain the required nominal bearing resistance at the ordered length, splice, as required, and drive with a specified impact pile hammer until the required nominal bearing resistance is achieved according to appropriate criteria in 00520.42. Regardless of Agency approval, the Contractor shall pay all costs of splicing and driving piles beyond the order length if jetting is requested by the Contractor.

(f) Followers - The required nominal pile bearing resistance of piles driven with followers will only be considered acceptable when the follower-driven piles attain the same tip elevation as piles driven without followers. (see 00520.20(c-4))

(g) Vibratory Hammers - The nominal bearing resistance of piles driven with vibratory hammers will be based on impact driving blow count after the vibratory equipment has been removed. When vibratory installation of the piles is approved by the Engineer and the vibrated piles do not attain the required nominal bearing resistance at the specified length, splice them as required, at no additional cost to the Agency, and drive with a specified impact pile hammer until the required nominal bearing resistance is achieved, according to 00520.42.

(h) Load Tests:

(1) Static Load Test - Perform static load tests on foundation or test piles when specified or required. Conduct static load tests according to ASTM D 1143 using the quick load test method to plunging failure or the capacity of the loading system. Use testing equipment and measuring systems capable of applying 150% of the nominal pile bearing resistance or 1,000 tons, whichever is less.

(2) Dynamic Load Tests - Take dynamic load test measurements during the driving of piles designated as dynamic load test piles as specified. Perform dynamic testing according to ASTM D 4945.

Drive the pile to such depth that the dynamic load test equipment indicates that the nominal pile bearing resistance shown has been achieved, unless otherwise directed. Monitor the stresses in the piles during driving with the dynamic test equipment to ensure the values do not exceed the values in 00520.20(d-3). If necessary, reduce the driving energy by using additional cushions or reduce the energy output of the hammer to stay below the values in 00520.20(d-3). If non-axial driving is indicated by dynamic test equipment measurements, immediately realign the driving system.

00520.43 Steel Piles:

(a) General - Unless otherwise specified, furnish standard steel piles in the longest practical lengths.

(b) Storage and Handling - Store and handle steel piles in ways that protect them from damage. Bent or kinked piles will be rejected.

(c) End Treatment - Cut pile ends square.

(d) Reinforced Pile Tips - Install pile points, shoes, or other tip reinforcement according to the manufacturer's recommendations and Section 02520.

(e) Driving - During driving, protect the pile head with a fitted metal helmet.

(f) Splices - Where splices are unavoidable, submit for approval their number, location and details.

(1) Welded Splices - Make welded splices using a full penetration butt weld, as shown. Comply with the welding procedures of AWS D1.1.

(2) Mechanical Splices - Mechanical splices may be used if the splice transfers the full pile strength in compression, tension, and bending, according to unstamped working drawings submitted according to 00150.35 and approved by the Engineer.

(g) Welding - Weld pile splices, pile tips, pile anchors, and other welded attachments to steel piles according to AWS D1.1.

(1) Splices - Splice joints for round piles shall conform to Joint B-U4a or C-U4a-GF (Single-Bevel Groove Weld) in D1.1 Figure 3.4. Weld back-up rings with a full penetration groove weld.

Splice joints for H-piles shall conform to Joint B-U3b or B-U3-GF (Double V-Groove Weld) in D1.1 Figure 3.4 for both the web and flange sections. Joint B-U4a or C-U4a-GF may be substituted on the flange weld. Provide access holes at the ends of the web according to D1.1 Section 5.17.

(2) Submittals - Prior to welding, submit the following for approval:

- A Welding Procedure Specification (WPS) for all pile welds, conforming to the limitations of D1.1 Table 4.5. Both ASTM A 36 and ASTM A 252 Grade 1 and 2 may be treated as prequalified base metals under Group 1. ASTM A 252 Grade 3 will not be considered a prequalified base metal unless the steel has a Carbon Equivalent (CE) of 0.30% or less. Develop a Procedure Qualification Record (PQR) for all welding using Grade 3 steel or present proof that the chemistry of the steel meets the CE requirements.
- Qualification documents for each welder. Use welders qualified according to D1.1 Section 4 for the position, process and pile diameter used on the job.

Do not begin welding without approval.

Following completion of all welding, submit the following:

- An inspection report stating that the welding under the Contract was performed according to D1.1. The report shall include a review of the WPS, a review of welder qualifications and a report on visual inspection of the welds on the job site. The inspection shall be signed by a Certified Welding Inspector (CWI) holding QC1 certification as defined in D1.1 Section 6.
- If the plans or Specifications call for additional inspection other than visual, include reports in the submittal.

(3) Additional Testing - The Engineer may request additional nondestructive testing (NDT), such as radiography or ultrasonic testing of any or all welds. If the additional testing identifies defects warranting rejection, perform repair and additional inspection at no additional cost to the Agency. If the additional NDT does not identify defects warranting rejection, the Agency will pay the cost of the additional testing. Radiographic and ultrasonic defect indications will be evaluated according to the statically loaded criteria of D1.1.

(h) Cutoff Lengths - Cut off the tops of all permanent piles square and smooth at the elevation shown or as directed. All cut-off pile becomes the property of the Contractor. Dispose of according to 00290.20. With approval, undamaged cutoffs may be used as pile extensions or welded together to form full length piles. Steel pile cutoffs welded together, whether pile extensions or full length piles, shall not vary from a straight line more than 1/4 inch in 20 feet measured along any edge of the pile.

All acceptable cutoffs and unused pile lengths remaining at completion of pile driving will be marked for identification by the Engineer as acceptable for use on other or future Agency projects if requested by the Contractor.

(i) Capping - If required by the plans, cap steel piles with a steel plate of the size and shape shown. Connect this cap to the pile according to the details shown.

00520.44 Prestressed Concrete Piles:

(a) General - Furnish full-length prestressed concrete piles according to the Special Provisions and Section 00550.

(b) Lifting, Storing, and Transporting - Lift, store and transport prestressed concrete piles according to 00550.49.

(c) Strength Before Driving - Do not drive precast, prestressed concrete piles until the conditions of 00550.12(d) are met, and the Engineer gives consent to proceed.

(d) Extensions or "Build-ups" - If additional driving is required beyond the order length, splice on pile extensions or build-ups as specified and directed. Prestressed concrete pile cutoffs may be used as extensions if additional driving is not required. Do not use pile cutoffs as extensions exceeding 5 feet in length unless approved.

(1) Epoxy-Dowel Method - Make splices of prestressed concrete piles to prestressed concrete piles and poured-in-place extensions or build-ups with the epoxy-dowel method, as shown or approved.

(2) Mechanical Splices - Mechanical splices may be used subject to limitations of 00520.43(f).

(e) Cutoffs - Cut off permanent prestressed concrete piles at the elevations shown or directed. All cut-off lengths become the property of the Contractor. Dispose of according to 00290.20. Take care to prevent spalling of the concrete below the footing or pile cap. Repair damage to the piles at no additional cost to the Agency.

(f) Finishing - Finish all exposed prestressed concrete pile surfaces to 1 foot below ground surface according to 00550.47.

00520.45 Timber Piles:

(a) General - Furnish full length treated timber piles according to the Special Provisions and 02120.20. Cut the heads of piles back square to untreated wood before driving. Provide a length of pile above the elevation of cutoff sufficient to permit the complete removal of all pile damaged by driving. Splicing of timber piles will not be allowed.

(b) Storage and Handling - Store and handle piles to avoid damage. Avoid breaking the surface of treated piles. Do not use cant hooks, dogs or pike poles on portions of the piles remaining in the completed work. Give cuts or breaks in the surface of treated piles three brush coats of

pentachlorophenol, hot creosote oil or other preservative from the QPL. Pour pentachlorophenol, hot creosote oil or preservative from the QPL into all bolt holes. If the treatment is damaged so the integrity of the pile is in jeopardy, the pile will be rejected. Furnish a replacement pile at no additional cost to the Agency.

(c) Strapping - Strap timber piles with at least three straps as follows:

- One approximately 18 inches from the butt
- One approximately 24 inches from the butt
- One approximately 12 inches from the tip

Use straps manufactured according to 02120.30. Wrap the strap around the pile once and fasten with a clip so crimped that the joint will have a tensile strength of at least 4,100 pounds. Install the straps after pressure treating the pile.

(d) Reinforced Pile Tips - Provide metal tips and fasten securely to the pile when shown or specified. Carefully shape the pile tip to secure an even, uniform bearing on the pile tip reinforcement.

(e) Cutoffs - Saw timber piling to a plane parallel to the bottom of the structure at the elevation shown or as directed. All cut-off materials become the property of the Contractor. Dispose of according to 00290.20.

(f) Capping - Cover timber pile heads not encased in concrete with alternate layers of hot asphalt and loosely woven fabric, using four applications of asphalt and three layers of fabric. Make the cover at least 6 inches more in dimension than the diameter of the pile head. Neatly fold down over the pile and secure by binding with not less than seven complete turns of commercial corrosion resistant wire (13.5 gauge minimum diameter) held in place by large headed commercial corrosion resistant nails or staples. Hot-dipped galvanized or stainless steel straps and clips conforming to 02120.30 may be used instead of commercial corrosion resistant wire. Neatly trim the edges of the fabric projecting below the binding.

00520.46 Damaged or Defective Piles - In addition to other specified requirements:

- Approval of a pile hammer shall not relieve the Contractor of responsibility for piles damaged from misalignment of the leads, failure of capblock or cushion materials, failure of splices, malfunctioning of the pile hammer or other improper construction methods.
- Piles damaged during installation will be considered unsatisfactory unless the nominal bearing resistance is proved by load tests performed by the Contractor. If such tests indicate inadequate resistance, take corrective measures, such as the use of damaged piles at reduced resistance, installation of additional piles, strengthening of damaged piles, or replacement of damaged piles.
- A concrete pile will be considered defective if a visible crack appears around the entire periphery of the pile, or any other crack or defect is observed which is determined to affect the strength or performance of the pile.
- Do not place footing concrete until all piles within a footing are inspected by the Engineer.

Measurement

00520.80 Measurement - The quantities of work performed under this Section will be measured according to the following:

(a) Furnish Equipment for Driving Piles - No measurement of quantities will be made for furnishing equipment for driving piles.

(b) Furnish Piles - The quantities of furnishing steel, prestressed concrete, timber, and test piles will be measured on the length basis, to the nearest foot, as follows:

(1) Steel Piles - Steel piles will be the length of each pile remaining in the completed work, from the pile tip to the cutoff plane.

(2) Prestressed Concrete and Timber Piles - Prestressed concrete and timber piles will be the sum of the lengths of piles of the types and lengths ordered, furnished according to these Specifications, and stockpiled in good condition at the work site.

(3) Test Piles - Test piles, including test piles remaining in the completed work, will be measured according to (b-1) and (b-2) above as applicable.

No allowance will be made for that length of pieces furnished by the Contractor to replace piles previously accepted by the Engineer, but that are subsequently damaged before completion of the Project

(c) Drive Piles - The quantities of driving steel, prestressed concrete, timber, and test piles will be measured on the unit basis. Driving test piles includes test piles remaining in the completed work.

Preboring will be measured on the length basis, to the nearest foot.

Jetting will be measured on the unit basis, for each pile driven with the aid of jetting.

(d) Load Tests - Load tests to be will be measured on the unit basis, for the number of specified load tests completed and accepted. Load tests made at the option of the Contractor will not be measured.

(e) Reinforced Pile Tips - The quantities of reinforced pile tips will be measured on the unit basis.

(f) Pile Splices - Pile splices will be determined as follows:

(1) Steel Piles - Splices incorporated in the finished structure that were made to increase the length of the pile 5 feet or more for estimated pile lengths of 60 feet or less and 10 feet or more for estimated pile lengths of over 60 feet beyond the estimated pile length will be measured on the unit basis. Only one splice will be measured per pile.

No measurement will be made for splices to steel piles within the estimated lengths listed in 00520.11 of the Special Provisions.

(2) Prestressed Concrete Piles - No measurement of quantities will be made for prestress concrete pile splices shown or specified Additional splices required to complete the work will be done as Extra Work according to Section 00196.

Payment

00520.90 Payment - The accepted quantities of work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

	Pay Item	Unit of Measurement
(a)	Furnish Pile Driving Equipment	Lump Sum
(b)	Furnish _____ Piles	Foot
(c)	Furnish _____ Test Piles	Foot
(d)	Drive _____ Piles	Each
(e)	Drive Test Piles	Each
(f)	Preboring Piles	Foot
(g)	Jetting Piles	Each
(h)	Pile Load Test (static)	Each
(i)	Pile Load Test (dynamic)	Each
(j)	Reinforced Pile Tips	Each
(k)	_____ Steel Pile Splices	Each

Partial payments for Item (a) will be made as follows:

- When equipment for driving piles is furnished and is satisfactorily driving piles 75%
- When driving piles is complete and equipment has been removed from site.....25%

Item (a) includes:

- furnishing all materials, equipment, and labor necessary for transporting, erecting, maintaining, replacing any ordered equipment, dismantling and removing the entire pile driving equipment
- resubmittal of wave equation analysis data if original data is rejected
- replacing previously approved hammers if hammer operates improperly
- all considerations when selecting the pile hammer size

The cost of all materials and labor, including the manipulation of the pile driving equipment in connection with driving piles will be included in the unit price each for driven piles. Furnishing equipment for driving sheet piling is not included in this work.

In items (b),(c), (d) and (k) the type and size of pile will be inserted in the blank.

Item (d) includes cutting off piles, treating and capping pile heads, attaching anchor brackets, lugs or other attachments, and finishing concrete piles.

Items (d) and (e) include all expenses involved in driving piles which have not attained the required bearing resistance and are required to stand for a "set period".

Item (j) includes attaching the tips to the piles.

Item (k) includes steel pile splices required to increase pile length beyond the estimated length listed in 00520.11 of the Special Provisions. No payment will be made for splices to steel piles that are within the estimated lengths listed in 00520.11 of the Special Provisions.

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

No separate or additional payment will be made for work needed to drive piles to minimum tip elevation as shown or specified.

No separate or additional payment will be made for welding inspection performed according to 00520.43(g-2).

No separate or additional payment will be made for preboring and jetting of piles if not included in the Contract Schedule of Items but requested by the Contractor.

Preboring and jetting, if not included in the Contract Schedule of Items, larger hammers, and construction of concrete pile extensions, build-ups, and splices ordered by the Engineer, as a result of differing site conditions (see 00140.40) will be made on an Extra Work basis according to Section 00196.

Section 00530 - Steel Reinforcement for Concrete

Description

00530.00 Scope - This work consists of furnishing and placing steel reinforcement of the grade, type and size shown or specified.

Materials

00530.10 General - Furnish materials meeting the following requirements:

Deformed Bar Reinforcement	02510.10
Epoxy Coated Reinforcement	02510.11
Galvanized Coating	02510.30
Mechanical Splices	02510.20
Welded Wire Fabric	02510.40
Wire Reinforcement	02510.60

00530.11 Order Lists and Bending Diagrams - Before ordering material, submit all order lists according to 00150.37 and unstamped bending diagrams according to 00150.35 for approval. Do not order material until such lists and bending diagrams have been approved. The review of order lists and bending diagrams by the Engineer will in no way relieve the Contractor of responsibility for the correctness of such lists and diagrams. Revise lists and diagrams as required to make them comply with the design drawings at no additional cost to the Agency.

Order lists and bending diagrams for reinforcement affected by stressing system in prestressing beams or post-tensioning systems such as anchorage design and duct placement will not be reviewed before the stressing system is reviewed.

00530.12 Fabrication - Cold bend reinforcement bars to the shapes shown. Make bends, tag, mark and ship reinforcement bars according to the current edition of the CRSI "Manual of Standard Practice".

00530.13 Miscellaneous Metal - Minor metal parts such as drains, bolts, concrete anchors, spacer blocks, expansion and bearing devices, access hole covers and frames, anchor bolts, inserts and similar miscellaneous metal, unless otherwise provided, will be classified as reinforcement.

Pipe attached to or used in conjunction with bridge deck drains or catch basins will be classified as reinforcement.

00530.14 Concrete Inserts - Furnish hot-dip galvanized expanded coil concrete inserts with closed-back ferrule threaded to receive UNC threaded bolts or rods of the size shown. Provide concrete inserts with the following minimum lengths and capacities:

Bolt or Rod Diameter (Inches)	Minimum insert Length (Inches)	Minimum Safe Working Load in Shear or Tension (Pounds)
3/4	4 1/2	4,000
1	5 1/2	6,000
1 1/4	7 1/2	10,000
1 1/2	9 1/2	16,000

Labor

00530.30 Mechanical Splice Installers - Provide qualified mechanical splice installers to construct mechanical splices. To qualify an installer, provide the Engineer with three completed mechanical

splice samples of each type and size to be installed on the Project for each mechanical splice installer, at no additional cost to the Agency. Prepare the splice samples as follows:

- Make splice samples in the presence of the Engineer using the same materials, equipment, and procedures that will be used on the Project.
- Construct each splice sample according to the manufacturer's recommendations.
- Construct each splice sample with two equal lengths of straight reinforcing bar so the total length of the assembled splice sample is at least 48 inches.
- Mark each splice sample with the heat treatment lot number.

Provide splice samples that meet the requirements of 02510.20. Do not begin mechanical splice installation until the Engineer confirms, in writing, the qualification of each mechanical splice installer. The Engineer may suspend mechanical splice installation if the Contractor substitutes unapproved personnel during construction.

Construction

00530.40 Protection of Material - Store reinforcement above the surface of the ground on dunnage. Protect reinforcement from damage at all times. Ensure reinforcement is free of dirt, detrimental rust or scale, paint, oil and other foreign substances when placed in the work.

In addition to the requirements above, store epoxy coated bars with supports close enough to prevent sagging in the bundles. Provide protective padding when bundles are stacked or when supported on metal. Store bars as close as practical to where they will be placed in the structure. Cover bars with an opaque material during storage to protect them from exposure to sunlight and saline mist. Move bars to or from storage according to 02510.11(c) to minimize damage to the coating. Do not allow the total exposure time from bar delivery to concrete placement, while in storage or in place, to exceed two months.

00530.41 Placing and Fastening - Place all reinforcement within the tolerances recommended in the CRSI "Manual of Standard Practice" unless otherwise specified. Hold reinforcement firmly during the placing and setting of concrete.

(a) Fabric - If fabric reinforcement is shipped in rolls, straighten it into flat sheets before placing.

(b) Ties and Supports - Keep reinforcement properly positioned during placement of concrete according to the following:

- Tie bars in top mats of footings and deck slabs at all intersections. Where bar spacing is less than 6 inches, tie alternate intersections.
- Tie all other bars at all intersections except where spacing is less than 1 foot in each direction; in that case tie alternate intersections.
- When precast concrete blocks are used, provide blocks that have cast-in wire ties. Provide tie wires meeting the requirements of 02510.60.
- For bridge decks, support the top mat of reinforcing steel from the bottom mat with reinforcing bar supports according to Chapter 3 of the CRSI "Manual of Standard Practice" (SBU, BBU or CHCU) at 24 inch maximum centers.
- Where at least one of the bars to be tied or supported is epoxy coated, provide tie wires that are either plastic coated or epoxy coated. Where precast concrete blocks with cast-in wire ties are used to support bridge deck reinforcement, the wire ties need not be coated.

(c) Clearances:

- Provide the same surface clearance for ties and splices that is shown or specified for the reinforcement.
- Maintain distance from the forms with stays, precast concrete blocks, ties, hangers, or other approved supports.
- Separate layers of bars with precast concrete blocks or by other suitable devices.
- Use precast concrete blocks with approved shape and dimensions and with the same or greater compressive strength as the concrete to be placed.
- Do not use pebbles, pieces of broken stone or brick, metal pipe or wooden blocks as bar supports or to separate layers of bars.
- Use stainless steel metal chairs conforming to the requirements of ASTM A 493, Type 430 or plastic chairs from the QPL when the legs of the chair will be on an exposed surface.
- Turn up the legs of metal chairs a minimum of 1/8 inch.
- Remove all precast member lifting devices prior to placing concrete deck reinforcement.
- Ensure bridge deck clearances meet the requirements of 00540.48(g).

(d) Approval - After placing reinforcement in any member have it inspected and approved before placing concrete. Concrete placed in violation of this provision may be rejected and removal required.

00530.42 Splicing:

(a) General - Furnish full length reinforcing bars the specific length shown or the calculated length for those designated "full length".

If specific locations are designated for splices, make splices only at those locations, or use full-length bars.

In the absence of other directions, including bars designated "continuous," furnish reinforcing bars to provide the minimum practical number of bars.

Where splicing is allowed, unless shown otherwise:

- Splice No. 11 bars and smaller by lapping, or with an approved mechanical splice.
- Splice No. 14 bars and larger with an approved mechanical butt splice.

(b) Lapped Splices - In lapped splices, place the bars in contact and fasten together according to 00530.41 with at least three ties per splice.

Where coated reinforcement is spliced to uncoated reinforcement, provide the required splice lap for the coated reinforcement unless shown otherwise.

(c) Mechanical Splices:

(1) General - Construct mechanical splices according to 02510.20 and the manufacturer's recommended procedures. Use devices that join bars end-to-end if a butt splice is specified; otherwise bars may be lapped or joined end-to-end. All requirements for mechanical splices apply to mechanical butt splices.

Ensure mechanical butt-spliced reinforcing bars do not deviate from the layout line by more than 1/4 inch over a 3 foot length of bar.

When approved, dowels may be replaced by reinforcing bars with threaded sleeve mechanical splice couplers embedded in the portion of concrete placed first and threaded reinforcing bars inserted in the couplers after forms are removed. Construct assemblies that develop 135% of the specified minimum yield strength of the dowels shown or specified. Construct reinforcing bars that have effective splice or development lengths equal to the replaced dowels.

(2) Sampling and Testing:

a. General - Furnish labor, material and equipment for fabricating sample mechanical splices at no additional cost to the Agency. All sample splices will be tested by the Agency at no cost to the Contractor.

b. Samples - Provide all samples meeting the requirements of 02510.20 and this subsection.

c. Testing - Construct test splices in the presence of the Engineer. Construct test splices with two equal lengths of straight reinforcing bar so that the total length of the assembled sample is not less than 148 inches. Mark each splice sleeve with the heat treatment lot number.

d. Jobsite Quality Control - During the installation of mechanical splices:

- Submit one quality control sample for each 100 splices performed up to 500 splices then submit one sample for each 500 splices. This sequence of testing will be required for each heat treatment lot used.
- Make non-threaded mechanical splice quality control samples at the jobsite in a manner similar to that used for the production splices.
- Fabricate threaded sleeve mechanical splice quality control samples on a random basis during the cutting of threads on the reinforcing bars and deliver to the Engineer at the jobsite with the material they represent.
- Complete the splice according to the manufacturer's recommendations.
- Quality control samples will be tested according to this Section. If any sample fails to meet the test criteria, the lot which it represents will be rejected until the cause of failure has been determined. Materials from a rejected lot may be accepted if they are shown to be free of the condition which caused the failure.

(3) Installation - Install splices in the presence of the Engineer. Splices made without the Engineer present will be rejected.

Do not place stirrups and other reinforcing bars between a mechanical splice sleeve and the surface of the concrete where it would impair the specified clearance. Instead, place additional reinforcement as necessary at no additional cost to the Agency.

Coat mechanical splices of epoxy coated reinforcing bars after installation, according to AASHTO M 284 for patching damaged epoxy coatings.

Where pre-coating is required, pre-coat splices with an approved coating.

Following installation on projects within 25 aerial miles of the Pacific Ocean, coat exposed areas of bare steel with heat shrink tubing from section 2510.11 of the QPL. On all other projects, coat exposed areas of bare steel with heat shrink tubing or epoxy patching material from section 2510.11 of the QPL. Apply coating according to AASHTO M 284.

(d) Welded Splices - Perform welded splices of steel reinforcing according to AWS D1.4. Submit welder certification, Welding Procedure Specifications and Procedure Qualification Records to the Engineer for approval.

00530.43 Splicing Welded Wire Fabric - Overlap sheets of welded wire fabric as shown or provide edge and end laps not less than one mesh in width. Securely fasten sheets at the ends and edges according to 00530.41.

00530.44 Substitutions - Substitute different size bars only if approved.

00530.45 Inspection and Repair of Epoxy Coated Rebar - Inspect coated bars before placement for damage to coating. Patch all visual defects in the coating with a prequalified patching material according to AASHTO M 284 before installation. Clean areas to be patched to remove all surface contaminants and damaged coating. Promptly treat cleaned areas according to the resin manufacturer's recommendations and before detrimental oxidation occurs. Where rust is present, remove it by blast cleaning or power tool cleaning methods immediately before applying the patching material. Clean and roughen the metal before applying patching material. Feather the patching material 2 inches to 3 inches, or as recommended by the manufacturer, into undamaged coated areas. Apply patching material to a thickness greater than 8 mils.

Clean visual damage found after placement as specified above. Coating damage exceeding 2 percent of the surface area in any lineal foot section of a bar may be cause for rejection of that bar.

00530.46 Marine Environment - On projects within 3 aerial miles of the Pacific Ocean, clean bars with a high pressure washer (1,500 pounds per square inch minimum pressure, with a fan pattern, 4.5 gallons per minute capacity) just prior to placing concrete.

Measurement

00530.80 Measurement - The quantities of reinforcement will be measured by one of the following methods:

(a) Lump Sum - Under this method, no measurement will be made. Estimated quantities of reinforcement will be listed in the Special Provisions. The weight of reinforcement in prestressed beams, slabs, piles and other items where the reinforcement is included in those items will not be included in the listed estimated quantities.

(b) Weight - Under this method, reinforcement will be measured on the weight basis, of reinforcement incorporated into the concrete based on the total computed weight for the sizes and lengths of bars as shown or authorized.

The following assumed densities will be used as a basis for computing the theoretical weight of miscellaneous metal:

Steel	-	490 pounds/cubic foot
Copper	-	555 pounds/cubic foot
Cast Iron	-	450 pounds/cubic foot

The weight of mesh will be computed from the theoretical weight of plain wire. If the weight per square foot is shown, that weight will be used.

For the purpose of computing weight of reinforcement, weights published in the CRSI "Manual of Standard Practice" will be used.

The weight of reinforcement in prestressed beams, slabs, piles and other items where the reinforcement is included in those items will not be included in the listed quantities.

If bars are substituted at the Contractor's request, and as a result, more steel is used than specified, only the amount specified will be included in the pay quantities. When laps are made for splices for the convenience of the Contractor, the extra reinforcement will not be included in the pay quantities.

Payment

00530.90 Payment - The accepted quantities of reinforcement will be paid for at the Contract unit price, per unit of measurement, for the following items:

	Pay Item	Unit of Measurement
(a)	Reinforcement	Lump Sum or Pound
(b)	Coated Reinforcement	Lump Sum or Pound

Item (a) includes fabricating and placing uncoated reinforcement as specified.

Item (b) includes placing epoxy coated reinforcement as specified.

Payment for reinforcement will be made when the reinforcement is incorporated into the concrete.

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified,

No separate or additional payment will be made for clips, wire, separators, wire chairs, and other material used in fastening the reinforcement in place.

Section 00535 - Resin Bonded Anchor Systems

Description

00535.00 Scope - This work consists of drilling and preparing holes in hardened concrete and providing and installing anchor bolts and/or reinforcement using a resin bonded anchor system as shown.

Materials

00535.10 Materials - Furnish anchor bolts meeting the requirements of 02560.30 and reinforcing steel meeting the requirements of Section 02510 as shown. High-strength anchor bolts meeting the requirements of ASTM A 193, Grade B7 may be substituted in place of these specified in 02560.30(b).

Furnish a polyester, vinyl ester, or epoxy resin bonding system from the QPL that will sustain not less than the pullout forces shown. See Table 00535-1 when pullout forces are not shown. Provide the resin in proper proportions to be mixed easily.

TABLE 00535-1

Minimum Pullout Force					
	Anchor Bolts			Rebar	
	Grade 36	Grade 55	Grade 105	Grade 60	
Dia. (inch)	Force (Pounds)			Size	Force (Pounds)
1/2	7,400	9,700	15,300	3	7,900
5/8	11,700	16,900	24,300	4	14,400
3/4	17,300	22,500	36,000	5	22,300
7/8	24,000	31,200	49,900	6	31,700
1	31,700	40,900	65,400	7	43,800
				8	56,700

Unless shown otherwise, do not install anchors larger than 1 inch in diameter using a resin-bonded anchor system.

Unless shown otherwise, select a resin from the QPL as follows:

- For Grade 36 and Grade 55 anchors, use either low strength or high strength resin.
- For Grade 105 anchors and Grade 60 rebar, use high strength resin only.

Provide the Engineer with:

- Certification, according to 00165.35, that the anchor system meets all requirements for the Project.
- Mill test certificates verifying the strengths of material used in the manufacture of the anchors.
- Proposed embedment depths for approval, if not shown.

Unless shown otherwise, galvanize all anchors which have any portion of the anchor exposed. Galvanize according to AASHTO M 232 (ASTM A 153) or AASHTO M 298 (ASTM B 695), Class 50. When within 25 aerial miles of the Pacific Ocean, galvanize according to AASHTO M 232 (ASTM A 153) only. Unless otherwise shown, anchors that become completely encased in concrete will not require galvanizing.

Provide thread lengths as shown. If thread lengths are not shown and the anchor is not rebar, provide threads on the resin-bonded end of the anchor for at least 80% of the embedment depth shown.

Construction

00535.40 Construction - Install the anchor system according to the manufacturer's recommendations and to the embedment depths shown. Use epoxy resins only when the ambient air temperature is within the temperature range recommended by the manufacturer. Unless stated otherwise in the manufacturer's instructions, use a drill bit diameter 1/8 inch larger than the nominal anchor diameter for AASHTO M 314 anchors and 5/64 inch larger than the out-to-out diameter for rebar. Unless shown otherwise, drill holes for anchor bolts as follows:

- When the center of the hole is more than 6 inches from a concrete edge, use either a 9 pound air hammer weight, or a carbide bit rotary hammer with two cutting edges on the diameter.
- When the center of the hole is 6 inches or less from a concrete edge, use either a diamond bit core drill or a carbide bit rotary hammer with four cutting edges on the diameter.

Clean holes with a non-metallic brush, compressed air, and water. Remove excess water from the hole. The cleaned hole may be damp, but be free of concrete dust, foreign matter, and standing water.

When nuts are applied to anchor bolts, tighten to one quarter turn past snug-tight unless shown otherwise.

Measurement

00535.80 Measurement - No measurement of quantities will be made for resin bonded anchor systems.

Payment

00535.90 Payment - No separate or additional payment will be made for resin bonded anchor systems. This work is included in payment made for the applicable items in which the anchor system fastens.

Section 00540 - Structural Concrete

Description

00540.00 Scope - This work consists of furnishing, placing, and finishing portland cement concrete, throughout this Specification referred to as structural concrete or concrete, for bridges and other structures according to these Specifications and in close conformity to the lines, grades and dimensions shown or established.

00540.01 Abbreviations and Definitions:

ASTV - Actual Strength Test Value - See 02001.02 for definition.

Falsework - Structural system to support the vertical and horizontal loads from forms, reinforcing steel, plastic concrete, structural steel, loads from placement operations and other related loads.

Forms - Structural system to contain the horizontal pressures exerted by plastic concrete.

HPC - High Performance Concrete - See 02001.02 for definition.

Post-Tensioned - Tensioning of prestressing steel after concrete has reached specified strength.

Surrounding Temperature - The air temperature measured in the shade. When placement and curing of concrete is enclosed, it is the lowest temperature within the enclosure.

Tolerance:

- The permitted variation from a given dimension or quantity, or
- The range of variation permitted in maintaining a specified dimension, or
- A permitted variation from location or alignment.

00540.02 Deck Pre-Placement Conferences:

(a) Supervisory Personnel - Hold a pre-placement conference with all supervisory personnel who are to be involved in the concrete work at a mutually agreed time approximately three weeks in advance of placing concrete for bridge decks. Ensure the Engineer, concrete supplier, and any other subcontractor is represented. Present and discuss all phases of the concrete deck placement work.

(b) Placement Crew - Hold a second pre-placement conference with the Engineer and the entire concrete placement crew at the job site one-half hour before the first placement begins to discuss placement duties and procedures.

Materials

00540.10 General - Furnish materials meeting the following requirements:

Concrete	02001
Concrete Coating	02210.30
Curing Materials	02050
Epoxy and Non-Epoxy Bonding Agents	02070
Epoxy and Non-Epoxy Grouts	02080
Epoxy Cement	02060
Poured Joint Fillers	02440.30
Preformed Expansion Joint Filler	02440.10

00540.11 Classes of Concrete - Furnish concrete meeting the requirements of Section 02001 and the requirements of Table 02001-1 for the classes of concrete to be used in various structures and concrete paving mixtures. The plans or Special Provisions will show the class of concrete required for the component parts of the structure. Use the specified class of concrete, or a higher class. Where the class is not specified, use Class 3300.

00540.14 Concrete Mix Tolerances and Limits - Furnish a workable concrete mixture, uniform in composition and consistency and meeting the properties and limits requirements of 02001.20.

00540.15 Form Materials - Furnish wood, plywood, metal, or other suitable form material. For round concrete columns, provide either metal or other approved form material that produces a smooth and true surface free from fins, joints and other irregularities. Where plywood is used, provide a minimum nominal thickness of 5/8 inch.

00540.16 Quality Control - Provide quality control according to Section 00165 and the following:

- Sample and test according to the MFTP.
- For all structural concrete, provide personnel according to 00540.30 to sample and test the mix for temperature, air content, slump, water-cementitious ratio, density and yield, from the first load of each placement, whenever there is a visible change in the slump of the concrete, and when a set of cylinders is obtained.
- If the results of any test are outside of the specification limits, stop placement of the load. Correct the load or, if the load cannot be corrected, do not incorporate it into the work. Test subsequent loads before any further concrete placement. Correct subsequent loads if any of the tests are still outside the specification limits. Return to the specified test frequency when the test results from two consecutive loads are shown to meet the specification limits.

00540.17 Acceptance of Concrete - Acceptance of concrete will be according to Section 00165 and the following:

(a) Aggregate - Acceptance will be based on the Contractor's quality control testing, if verified, according to Section 00165. Blend aggregates only as allowed in 02001.20.

(1) Aggregate Gradation - A stockpile contains specification aggregate gradation when the quality level for each sieve size calculated according to 00165.40 is equal to or greater than the quality level indicated in Table 00165-2 for a PF of 1.00. Each required sample represents a sublot. When the quality level indicated in Table 00165-2 yields a PF of less than 1.00 for any constituent, the material is non-specification.

(2) Non-specification Aggregate Gradation - Stockpiled aggregates that contain non-specification aggregate gradation will be rejected by the Engineer unless non-specification material is removed from the stockpile. Do not add additional material to the stockpile until enough non-specification material is removed so that the quality level for each constituent is equal to or greater than the quality level in Table 00165-2 for a 1.00 PF.

(b) Plastic Concrete - Acceptance of plastic concrete will be based on tests performed by the Contractor's QCT, according to the tolerances and limits of 02001.20.

(c) Hardened Concrete - Cast and cure test specimens according to AASHTO T 23 in 6 inch x 12 inch or 14 inch x 8 inch, single-use plastic molds and test at 28 days according to AASHTO T 22.

(1) General - For all classes of concrete, acceptance of hardened concrete will be based on an analysis of compressive strength tests of cylinders cast by the QCT. Test cylinders at an Agency certified laboratory.

(2) Actual Strength Test Value (28-Day) - The ASTV is the average compressive strength of the three cylinders tested. If the compressive strength of a single test specimen varies by more than 10% from the average of the other two specimens, that compressive strength value will be discarded. The average compressive strength test of the two remaining specimens will be the ASTV.

(3) Acceptance - Hardened concrete with an ASTV meeting or exceeding the specified design strength, f'c will be accepted for strength. If the ASTV is less than f'c but at least 85% of f'c, the Engineer may review the results to determine if the concrete represented by the cylinders is suitable for the intended purpose. Remove concrete that has an ASTV less than 85% of f'c unless otherwise authorized, in writing, by the Engineer. If the concrete is removed, the cost of removal, replacement and all related work is the Contractor's responsibility. If the Engineer determines that the concrete is suitable for the intended purpose, the concrete may be allowed to remain in place, subject to a price adjustment according to 00150.25.

If an ASTV falls below f'c, the Contractor may submit a written plan within three days of the test for review by the Engineer. Provide a plan outlining a proposed alternate method of evaluating compressive strength. Provide evidence that a reasonable f'cr (over-design) was maintained and that there is credible evidence (besides low strength) which warrants consideration of this option. If the Engineer determines that the compressive strength test results are suspect from definable external factors, the Engineer may allow an alternate method of acceptance.

Equipment

00540.22 Concrete Conveying Equipment - Use clean, non-aluminum conveying equipment capable of supplying concrete to the point of placement without segregation.

(a) Concrete Pumping Equipment - Provide a discharge line for the pump made of steel or rubber pipe and having the following minimum size:

Nominal Maximum Size of Concrete Aggregate	Minimum Pipe Size, Inside Diameter
1 inch	4 inches
1 1/2 inches	5 inches

(b) Chutes - Use steel or steel-lined chutes. Where steep slopes are required, equip the chutes with baffles or provide short lengths that reverse the direction of movement.

(c) Pipes or Trunks - Other than tremie seal pipe, provide rubber or steel pipes, and plastic trunks.

(d) Tremie Seal Pipe - Provide a tremie seal pipe that:

- Is rigid pipe with minimum diameter of 10 inches and sufficient length to reach from the bottom of the excavation to above the waterline, with an attached receptacle or hopper for receiving concrete.
- If jointed, is the flange-and-gasket type and waterproof.
- Has means to close the discharge end.
- Is supported to permit free movement of the discharge end throughout the seal.
- Is equipped with a device to permit rapid lowering when necessary to retard or stop the flow of concrete.

00540.23 Vibrators - Provide vibrators that:

- Are an internal type unless other methods are approved by the Engineer.
- Are capable of transmitting vibration to the concrete at frequencies of not less than 4,500 impulses per minute.
- Are in working condition to meet manufacturer's rating.
- Are fitted with a manufactured rubber head to minimize damage to epoxy coated reinforcement.

00540.24 Deck Finishing Machine - Provide a deck finishing machine that is:

- Capable of finishing the entire roadway surface or the specified stage construction width.
- Self-propelled with positive control in both forward and reverse directions.
- Capable of raising rolls or screed to clear the screeded surface with positive control to the specified grade.
- Equipped with augers.
- Equipped with rollers or vibrating screeds.

(a) Deck Finishing Machine Support System - Furnish calculations and detailed drawings of the proposed deck finishing machine support system according to 00540.41.

(b) Other Deck Finishing Equipment - In narrow bridge widenings where a deck finishing machine is not practical, a mechanical vibrating screed may be used.

00540.25 Straightedge - Furnish a 12 foot metal straightedge for checking bridge deck roadway and sidewalk surface tolerances.

00540.26 Concrete Saws - Provide power-driven concrete saws for sawing joints and as required for surface texture.

00540.28 Power Washers - Provide power washers that produce a minimum 2,500 psi pressure at the nozzle, with a fan pattern, and a minimum 4.5 gallons per minute capacity. For bridge decks, provide at least one power washer for each side of the deck section to be placed. When using power washers to produce a fog spray for curing, match the flow rates and pressures of the power washers with the fogging nozzles to produce an average droplet size of 3 mils, according to the nozzle manufacturer’s recommendation.

00540.29 Work Bridges - Provide at least two transverse work bridges when placing concrete on a bridge deck. Use the transverse work bridges to facilitate placement of the cure.

Labor

00540.30 Quality Control Personnel - In addition to the certified technicians required in 02001.50 provide and designate an individual to be present at the placement site at all times during concrete placements for projects with more than 100 cubic yards of structural concrete and for all high performance concrete, and who is authorized and responsible for acceptance and rejection of materials.

Construction

00540.40 Tolerances - The following tolerances apply to cast-in-place structures:

(a) Foundation Footings:

(1) Lateral Alignment:

- Actual (as cast) location of the center of gravity: 0.02 times width of footing in the direction of misplacement, but not more than 2 inches
- Supporting masonry: 1/2 inch

(2) Level or Vertical Alignment:

- Top of footing supporting masonry: 1/2 inch
- Top of other footings: minus 2 inches to plus 1/2 inch

(3) Cross-Sectional Dimensions:

a. Horizontal dimension of formed members: minus 1/2 inch to plus 2 inches

b. Horizontal dimension of unformed members cast against soil:

- Less than and equal to 2 feet: minus 1/2 inch to plus 3 inches
- Over 2 foot and less than and equal to 6 feet: minus 1 1/2 inch to plus 6 inches
- Over 6 feet: minus 1/2 inch to plus 12 inches

c. Vertical dimension (thickness): 0 to plus 6 inches

(4) Relative Alignment - Footing side and top surfaces may slope with respect to the specified plane at a rate not to exceed 1 inch in 10 feet.

(b) All Other Structural Members:

(1) Vertical Alignment:

- Exposed surfaces: ± 3/4 inch
- Concealed surfaces: ± 1 1/2 inches
- Construction joints: 0 to minus 3 inches

(2) Lateral Alignment - Centerline alignment: 1 inch

(3) Level Alignment:

a. Profile grade: ± 1 inch

b. Top of other concrete surfaces and horizontal grooves:

- Exposed: ± 3/4 inch
- Concealed: ± 1 1/2 inches

c. On ramps, sidewalks and intersections, in any direction, the gap below a 12 foot unleveled straightedge resting on high spots shall not exceed 1/4 inch.

d. On bridge decks, in any direction the gap below a 12 foot unleveled straightedge does not vary from the testing edge by more than 1/8 inch.

(4) Cross-Sectional Dimensions:

- Bridge slabs and decks vertical dimension (thickness): minus 1/8 inch to plus 1/4 inch
- Members such as columns, beams, piers, walls and others (slab thickness only): minus 1/4 inch to plus 1/2 inch
- Openings through members: 1/2 inch

(5) Relative Alignment:

a. Location of openings through members: 1/2 inch

b. Formed surfaces may slope with respect to the specified plane at a rate not to exceed the following amounts in 10 feet:

- Watertight joints: 1/8 inch
- Other exposed surfaces: 1/2 inch
- Concealed surfaces: 1 inch

c. Unformed exposed surfaces, other than pavements and sidewalks, may slope with respect to the specified plane at a rate not to exceed the following amounts:

- In 10 feet: 1/4 inch
- In 20 feet: 3/8 inch

00540.41 Design of Falsework for Vertical Pressures:

(a) Submittal of Working Drawings and Calculations - Submit stamped falsework plans and design calculations according to 00150.35, except as modified below.

Ensure the falsework designer prepares a Falsework Design Summary and completes a Falsework Design Checklist to accompany the plans and calculations. Include in the summary a list of each falsework member with its:

- Assumed dead and live loads
- Allowable and design stresses
- Allowable and calculated deflections
- Design references and derivations for design formulas
- Documentation for computer generated calculations

The Falsework Design Checklist is included in the Special Provisions.

Submit five sets (nine sets if railroad approval is required) of the plans and three copies (five copies if railroad approval is required) of the calculations, summary, and checklist.

Design falsework according to the current edition of "AASHTO Guide Design Specifications for Bridge Temporary Works" except where in conflict with these Specifications.

(b) General Design Loads - Design and construct falsework to support the total applied loads and provide enough redundancy in the design to prevent a failure of the entire system.

Ensure design loads used are the maximum loadings. Ensure deflections used on manufactured devices and assemblies do not exceed the manufacturer's recommendations. Furnish catalog data that lists the manufacturer's recommendations.

(c) Falsework Foundation:

(1) On Soils - Consider anticipated construction and soil conditions in determining the soil's support capacity, including draining water away from the supports. For falsework supported on soils, show the following in the calculations:

- Assumptions and methods used to determine the soil's capacity to support the footing loads.
- Anticipated falsework footing settlement based on the allowable soil bearing values.

(2) On Piles - For falsework supported on piles, show on the working drawings the pile type, size and spacing. Accompany these drawings with calculations which show the assumptions and methods used to design the piles and the bearing values to which the piles need to be driven to support the calculated loads.

(d) Requirements at Highway and Railroad Traffic Openings - For falsework adjacent to or spanning a highway or railroad traffic opening, do the following:

- Design the posts using a minimum elastic section modulus, about each axis, of:
  - 12.2 cubic inches for structural steel
  - 244 cubic inches for timber
- Increase the vertical post load 150%. If the load on the falsework will be increased by load transfer due to prestressing, increase the vertical post load by the additional load due to prestressing or by 150%, whichever is greater.
- Provide mechanical connections for posts to supporting footing with capacity to resist a minimum lateral force of 2,000 pounds applied in any direction at the base of the post.
- Provide mechanical connections between top of posts and the cap or stringer capable of resisting a lateral force of 1,000 pounds from any direction.
- Tie down all beams or stringers spanning traffic so that each will resist a 500 pound force from any direction.
- Use 5/8 inch diameter or larger bolts at connections for timber bracing.
- Show temporary erection/removal bracing on the falsework plans.

(e) Additional Requirements at Railroad Traffic Openings - For falsework bents within 20 feet of the track centerline:

- Design bracing so that the bent will resist the required horizontal load or 500 pounds, whichever is greater.
- Provide solid sheathing of 5/8 inch thick plywood between 3 feet and 16 feet above the top of the rail, properly blocked at the edges.
- On falsework plans, show:
  - Collision posts if they are required
  - Soffit and deck overhang forming details

00540.42 Falsework Construction - Construct falsework according to the current edition of "AASHTO Construction Handbook for Bridge Temporary Works", except where in conflict with these Specifications. Assure that falsework is constructed according to the falsework design and on soils equal to or exceeding design assumptions. Within two days of notice of the falsework design engineer's pending inspection, the Engineer will provide a list of construction concerns. Do not place concrete until the falsework design engineer of record, accompanied by the Engineer, field inspects that portion of the falsework proposed for use. Do not place concrete until all construction concerns have been addressed, the falsework design engineer furnishes the Engineer a written statement that the falsework conforms to the design and will serve the intended use, and the Engineer agrees in writing that the falsework will serve the intended use.

Set falsework to give the finished structure the camber shown or specified.

Install telltales on falsework at locations as directed and use jacks, hardwood wedges or other methods approved, to take up settlement in the formwork.

When used, provide sand jacks consisting of a metal piston and metal frame filled with compacted, clean, dry sand. Ensure the annular space between the top bearing plate or piston and the frame does not exceed 1/4 inch.

Use temporary concrete barriers according to 00225.12(c) to protect falsework from damage from adjacent traffic. Make provisions to prevent damage by debris in streams.

Upon completion of the structure, remove all falsework to at least 24 inches below ground line or streambed.

Limit the height of timber blocking and wedging to 24 inches, or to less than one and one-half times the least horizontal dimension of the blocking or wedges, whichever is smaller. Limit post, shim pack and wedging assemblies supporting beams to six faying (interface or contact) surfaces. Ensure adjacent beam support assemblies do not have a difference of more than two faying surfaces. Ensure timber blocks loaded perpendicular to the grain are free of splits.

For post-tensioned structures, do not remove falsework until post-tensioning is complete.

00540.43 Joints - Construct joints in concrete bridges according to details shown or directed.

(a) Construction Joints - Make construction joints between concrete placements only where shown or specified unless otherwise approved.

Do not form construction joints in concrete exposed to salt water between levels of extreme low and high water. Where concrete may be exposed to the action of alkaline water or soil, place concrete continuous until completion of the section, or until the concrete is at least 18 inches above the ground or high water level.

Unless otherwise shown, provide construction joints with a roughened surface. Do not smooth or trowel aggregate into the cement paste. Provide a minimum deviation from a plane surface or 1/4 inch and a maximum deviation from a plane surface equal to the maximum size of aggregate in the specified class of concrete.

Within 24 hours after placing concrete, clean the joint surface by removing loosened particles of aggregate, damaged concrete, unconsolidated concrete and surface laitance with a high pressure washer conforming to 00540.28 to the extent that clean aggregate (free of cement film) on 50% of the surface is exposed. Clean the joint surface again immediately prior to the concrete placement to remove any subsequent deposits of dirt, debris or other foreign materials. Saturate the joint surface with potable water immediately before resuming concrete placement. Remove standing water in depressions or hollows of the joint surface.

(b) Open Joints - Locate open joints as shown. Construct the form so the form support system may be released as soon as the concrete takes its initial set. Do not chip or break the corners of the concrete when removing forms. Do not extend reinforcing bars across an open joint unless shown.

(c) Joints with Fillers - Construct joints with preformed expansion joint fillers or poured fillers as shown and according to the manufacturer's recommendations for the filler used.

(d) Bridge Deck Expansion Joints - Construct expansion joints for bridge decks as shown and according to Section 00585.

00540.44 Foundations - Place concrete foundations for structures on suitable soil or rock bearing surfaces, concrete seals or piles as shown. Excavate and backfill according to Section 00510.

00540.45 Construction of Forms - Construct forms that:

- Are mortar-tight and sufficiently rigid to conform to and maintain the specified dimensions and tolerances.
- Provide a 3/4 inch chamfer on all exposed concrete edges unless otherwise noted.
- Provide a smooth concrete surface unless otherwise specified.
- Are constructed so portions may be removed without disturbing forms that are to remain.
- Are treated with a release agent that is not detrimental to the concrete.
- Are cleaned of dirt, sawdust, excess water and other foreign material before placing concrete in the forms.
- Are saturated with water immediately before placing concrete and kept damp during placement.
- Are retightened before depositing new concrete on or against concrete which has hardened.

On structures 25 aerial miles from the Pacific Ocean, construct metal ties or anchorages within the forms so they can be removed to a depth of 2 inches from accessible surfaces. On all other structures, construct metal ties or anchorages within the forms so they can be removed to a depth of at least 1 inch from accessible surfaces.

Install embedded conduit 2 inches clear of the nearest face of concrete.

Secure in place expanded polystyrene forms and spacers between adjacent concrete placements to prevent floating or displacement during concrete placement. Carefully cut joints in expanded polystyrene and fill with a suitable filler or mastic to prevent intrusion of concrete mortar. After the concrete has hardened, completely remove expanded polystyrene unless otherwise stated.

Permanent stay-in-place bridge deck forms are not allowed unless shown otherwise.

(a) Footings - When footings are not founded in firm rock, concrete may be placed without forms if the excavation does not exceed the tolerances of 00540.40(a-3-b).

Do not form portions of footings founded in firm rock. Place concrete against undisturbed rock, filling the overbreak to the top of rock or top of footing.

(b) Accessible Box Girder Cells - Falsework and deck forms for accessible box girder cells may be supported by girder stems or bottom slab provided the bottom slab is fully supported and designed to take additional loading from deck forms and falsework, deck concrete, and concrete placement forces.

(c) Inaccessible Box Girder Cells - Falsework and deck forms for inaccessible box girder cells may be left in place provided:

- Falsework and deck forms left in place are not supported off the bottom slab. Falsework and deck forms supported by girder stems are allowed.
- 1/2 inch preformed expansion joint filler are placed between the end of deck forms and transverse beams and at 25 foot spacing in the deck forms.
- Box girder cells are cleared of materials and forms except as necessary to support the deck slab before the deck forming is complete.

(d) Form Maintenance - Set forms and maintain them true to designated line and grade until the concrete hardens. When forms appear to be unsatisfactory, either before or during the placing of concrete, the Engineer may order the work stopped until the defects have been corrected. Leave forms in place for periods specified in 00540.52.

00540.47 Delivering Concrete - Schedule delivery of concrete to ensure continuous delivery during placement. For all placements except seal and deck placements, ensure the interval between the end of one load and the start of the next load does not exceed 20 minutes. See 00540.48 for seal and deck placements.

If the requirements of the previous paragraph are not met, the Engineer will determine whether the concrete has taken its initial set and may order a bulkhead installed or removal of concrete in the affected placement.

00540.48 Handling and Placing Concrete:

(a) General - Do not place concrete under water or in flowing water unless specifically authorized. Place concrete:

- In the sequence shown or as approved.
- In its final position in the forms within one and one-half hours after the addition of the cement to the aggregate. A retarder may be used or required. Use a retarder from the QPL and furnish at no additional cost to the Agency.
- As close as possible to its final position and consolidated to:
  - Avoid segregation of the materials and displacement of the reinforcement
  - Produce a dense, homogeneous concrete, free of voids and rock pockets
- Through pumps, chutes or trunks conforming to 00540.22, when placement requires dropping concrete more than 5 feet. Place the bottom of pump hose, chutes, pipes or trunks as close to final placement position as practical.
- In layers not more than 18 inches thick, except for seal concrete placement, and unless shown otherwise. Place and consolidate each layer before the preceding layer has taken initial set to avoid surfaces of separation between the layers.

Do not place concrete prior to complete approval of:

- The excavation and the bearing material in a foundation
- Installed piling
- The falsework and forms
- Placed reinforcing steel

After initial set of the concrete, do not disturb the forms or place loads on the ends of reinforcing bars projecting from the concrete placement until allowed by 00540.52.

(b) Pumping Concrete - Pump concrete with pumping equipment conforming to 00540.22. Pump a cement-water slurry through the lines before starting the mix through the pump. Operate the pump in a manner that produces a continuous stream of concrete without air pockets or segregation. When a placement nears completion, if concrete remaining in the pipeline is to be used, remove it in a manner that will not cause contamination of the concrete already in place.

There will be no extra payment for additional cement or additives required to ensure a mix is pumpable.

(c) Vibrating Concrete - Except for seal concrete, thoroughly consolidate fresh concrete according to the following:

- Vibrate concrete internally using mechanical vibrating equipment.
- Provide an extra vibrator for emergency use.
- Re-vibration of concrete may be required as directed.

Apply vibration at the point of freshly deposited concrete. Apply vertically at points uniformly spaced not farther apart than 1 1/2 the radius over which the vibration is visibly effective. Penetrate into previously placed plastic layers.

Do not use vibrators to make concrete flow or to move concrete from one point to another in the forms. Do not apply directly on or through the reinforcement to sections or layers of concrete which have hardened to the degree that the concrete ceases to be plastic under vibration.

Supplement vibration by spading as necessary to ensure smooth surfaces and dense concrete along form surfaces and in corners or other locations impossible to reach with vibrators.

Continue vibration until the concrete is thoroughly consolidated. Discontinue vibration if segregation occurs or localized areas of grout form.

(d) Concrete Exposed to Salt Water, Alkaline Water, or Soil - For concrete exposed to salt water, see 00540.43(a) for location of construction joints, and 00540.53 for surface finish requirements.

Do not allow alkaline water or soil to contact the concrete during placement or for a period of at least 72 hours after placement. See 00540.43(a) for location of construction joints.

(e) Seal Concrete - Deposit seal concrete in still water near its final position, by means of a tremie seal pipe meeting the requirements of 00540.22(d) or a concrete pump with a rigidly held discharge line to prevent unwanted vertical movement. Place seal concrete continuously from start to finish, at a rate of at least 50 cubic yards per hour, keeping the surface of the concrete nearly horizontal at all times. Place each increase in height before the preceding concrete has taken its initial set.

Do not use vibrators.

At the start of the work and on any withdrawal of the pipe, close the discharge end to prevent water entering the pipe. During the progress of the work, keep the pipe full of concrete to the bottom of the hopper. When concrete is dumped into the hopper, start the flow of concrete by slightly raising the discharge end, always keeping it in the deposited concrete. Control the elevation of water inside the cofferdam to prevent any flow through the seal.

Dewatering may proceed when the concrete seal has achieved a compressive strength of 2,200 psi. Remove high spots, laitance and other unsatisfactory material from the exposed surface.

(f) Walls, Abutments, Bents, Piers, Columns, Beams, Girders, and Slabs - Place concrete following the sequences shown and the delay period specified in 00540.52.

Delay placement for the superstructure until the column forms have been stripped sufficiently to determine the character of the column concrete. Ensure superstructure loads are not carried by the bents or piers until the concrete has been in place and has attained the strength specified in 00540.52.

Stop placement for the bottom slab of box girder structures at the bottom of beam stems or bottom of stem fillets. Before placing concrete in the stems, wait for a period not less than that specified in 00540.52.

Stop placement for T-beams and box girder stems at the bottom of the deck fillet. Before placing deck concrete, wait for a period not less than that specified in 00540.52.

(g) Bridge Decks - Use deck finishing machines conforming to 00540.24 and set to run parallel to the skew of the bent lines. Place screed rails outside the finishing area. Extend screed rails beyond both ends of the scheduled placement length for a distance that allows the finishing machine to reach all of the concrete.

For bridges with continuous spans, ensure reinforcing steel is in place and tied in any adjacent span in the continuous bridge segment before placing concrete.

Before placing concrete, operate the finishing machine the length of the proposed placement, and check the deck thickness and clearance from the screed to the reinforcing steel in the presence of the Engineer, by an approved method. The permissible variation from the clearance indicated will be plus or minus 1/4 inch. Make necessary corrections before beginning the placement.

Furnish transverse work bridges according to 00540.29. Extend the screed rails beyond the start end to allow placement of all transverse work bridges on the screed rails before placement of concrete begins.

Do not place bridge deck concrete until the Engineer is satisfied that the Contractor:

- Meets the requirements of 00540.41, 00540.45 through 00540.49, and 00540.52.
- Has the finishing machine and transverse work bridges placed and ready on the screed rails.
- Is able to deliver concrete for decks so deck placement progresses at a rate of not less than 20 feet per hour.
- Proceeds up grade from the lowest deck elevation, unless otherwise shown.
- Is able to produce and place concrete at a rate sufficient to complete proposed placement and finishing operations within the specified time.
- Illuminates the work area during hours of darkness.
- Has experienced concrete finishers and necessary finishing tools and equipment at the work site.
- Provides wind breaks, fog spray, or other approved methods when the concrete surface is exposed to conditions which may cause premature drying during placement operations.

If delays occur lasting longer than 30 minutes, the Engineer may order construction of a bulkhead. If a bulkhead is constructed, do not begin further placement in that span or the adjacent falsework span, if any, for at least 24 hours. Construct bulkheads only where shown or when directed by the Engineer.

00540.49 Weather Conditions for Concreting:

(a) All Concrete Placement:

(1) Hot Weather - Maintain the concrete temperature during hot weather as specified. When concrete temperatures approach 80 °F, take appropriate action to lower concrete temperature.

Do not place concrete on or in forms if surface temperature of forms or reinforcing steel is 90 °F or above.

(2) Cold Weather:

a. General - Do not place concrete if the air temperature is, or is forecast to be, below 40 °F the day of placement or is forecast to be below 40 °F on any of the next seven calendar days after placement, unless a specified enclosure and heat are used or insulated forms are approved and used.

Keep the foundation, form surfaces and reinforcing steel free of frost and ice.

Ensure the temperature of the concrete is not less than 60 °F when placed in the forms. If air temperature is below 40 °F, heat mixing water to a temperature of at least 70 °F, but not more than 150 °F, or heat the aggregates with either steam or dry heat. Ensure the temperature of concrete produced with heated aggregate, heated water, or both does not exceed 80 °F before placing.

b. Enclosures - If enclosures are used, do the following:

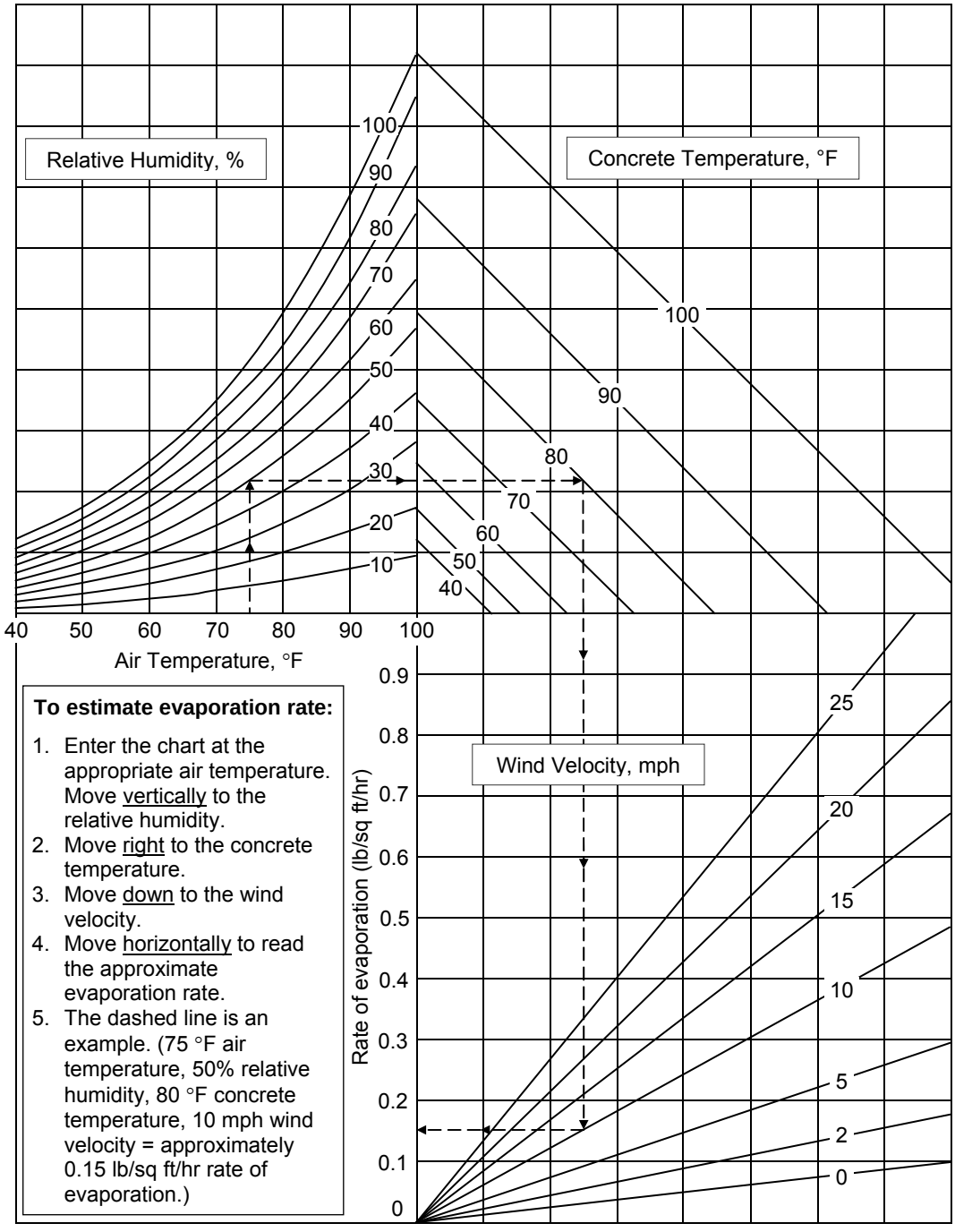
- Furnish and use a 24-hour high-low or continuous temperature recording thermometer to record air temperature within the enclosure.
- Supply heat and curing moisture.
- Maintain the air temperature in the enclosure between 60 °F and 80 °F for a period of seven days after placing concrete.

c. Insulated Forms - When approved by the Engineer, insulated forms, capable of maintaining the surface of the concrete at not less than 50 °F for a period of seven days, may be used instead of enclosures and heating. If forms are insulated, protect exposed horizontal surfaces with a similar layer of insulating material securely fastened in place. If the insulated forms do not maintain the proper temperature at the concrete surface, use auxiliary protection, and provide additional heat and thermometer, as described in (b) above.

(b) Bridge Deck Placement - Place concrete for bridge decks:

- Only if not raining and the combination of air temperature, relative humidity, concrete temperature and wind velocity produces an evaporation rate of less than 0.10 pounds per square foot of surface area per hour, according to Figure 00540-1, or
- Within an enclosure, according to 00540.49(a-2-b).

FIGURE 00540-1 SURFACE EVAPORATION FROM CONCRETE [1]



[1] Based on ACI 305 R, "Hot Weathering Concreting"

00540.50 Bridge Deck Roadway and Sidewalk Finish:

(a) General - After the bridge deck roadway and sidewalk concrete is placed and consolidated, strike it off to lines, grades and cross sections shown.

(b) Deck Roadway Finish - After the deck roadway concrete has been screeded with a finishing machine conforming to 00540.24, float, if necessary, to produce a uniform surface, according to 00540.55. If the work does not conform to the prescribed limits, stop the operation until revised methods, changes in equipment, or correction of procedures are approved for trial. Also stop the revised operation if it does not produce a specified surface.

(c) Deck Roadway Texturing - After correcting any non-specification surface tolerance according to 00540.55, texture the deck roadway surface with a saw that cuts grooves into the bridge deck as follows:

- Cut grooves 1/8 inch wide and 1/8 inch to 3/16 inches deep.
- Unequally space grooves from 3/4 inch to 1 1/2 inches apart with a minimum of 12 grooves for every foot of deck surface. Measure groove spacing parallel to the roadway centerline.
- Orient the grooves perpendicular to the roadway centerline and full width of the roadway except leave smooth strips 16 inches wide along each curb face. Do not overlap grooves.
- Continuously remove saw slurry and laitance from the sawing operation while cutting grooves.
- Cut grooves after the bridge deck has been checked for non-specification surface tolerances as required by 00540.55 and after the water cure is complete.
- Cut grooves no sooner than 14 days after the deck is cast. Cut grooves before opening the roadway to traffic. For structures constructed in stages, the roadway may be opened to traffic before cutting grooves provided the time period from opening to actual construction of grooves is between June 1 and October 1.

(d) Deck Sidewalk Finish - After the deck sidewalk surface has been struck off with a strike board, float it with a wooden or cork float. Use an edging tool on edges and at expansion joints. Remove edging tool marks prior to final finishing. Apply a light broom texture to the surface.

00540.51 Curing Concrete:

(a) General Requirements - Cure cast-in-place concrete with water. Begin curing as soon after placement as possible without damaging the freshly placed concrete. Continue curing for seven days after placement.

Keep surfaces not covered by waterproof forms damp by applying water with a fog nozzle until the surface has set sufficiently to allow sprinkling with water or covering with wet burlap or an approved wet or dry material.

Do not interrupt curing for more than one hour during the curing period.

If temperature falls below 35 °F during the seven-day cure period, the Engineer may require enclosures or insulated forms according to 00540.49(a-2).

(b) Curing Concrete Bridge Decks - In addition to requirements of 00540.49, cure cast-in-place concrete bridge deck surfaces by doing the following:

- Provide wind breaks or other approved methods when exposed to conditions which may cause premature drying during placement operations. Premature drying is defined as an evaporation

rate equal to or greater than 0.20 pounds per square foot per hour, as determined from Figure 00540-1, or as the loss of surface sheen when the evaporation rate at the surface exceeds the bleed rate.

- Provide high pressure washers, according to 00540.28, fitted with fog nozzles during all deck placements to prevent and control premature drying. Apply fog spray upwind of the concrete placement during finishing. The purpose of fogging is to maintain a layer of high humidity above the concrete surface in order to minimize water loss in the mix after placement and before application of cure. Do not allow larger water droplets that drip from nozzles to fall onto the freshly finished plastic concrete.
- Cover the concrete with a single layer of clean initial covering immediately after finishing. Apply initial covering no later than 20 minutes after final pass of the finishing machine and no greater than 20 feet from the back of the finishing machine. Provide an initial covering with a minimum length sufficient to cover the bridge deck from side to side of the concrete placement. Use one of the following:
  - Saturated wet burlap having a minimum dry weight of 10 ounces per yard for material 40 inches wide. Presoak the burlap by immersing it completely in water for 72 hours prior to the deck placement and presoak new burlap with a wetting agent. Overlap the edges at least 6 inches.
  - Non-woven, needle punched polypropylene fabric curing blanket from the QPL. Thoroughly wet fabric within 15 minutes of fabric placement. Overlap the edges at least 12 inches.
- Provide soaker hoses for additional soaking of the initial covering. Place over the full width of the concrete placement, at a maximum of 10 foot intervals. Do not allow initial wetting of burlap or fabric to dry before soaker hoses are in place and operational. Operate soaker hoses continuously to keep the initial covering saturated.
- Place a layer of 4 mil polyethylene film over the initial covering and soaker hoses. Provide clear or white polyethylene film if the air temperature is forecasted to be above 65 °F within 24 hours of the concrete placement, and black at other times, as determined by the Engineer. Overlap the edges of polyethylene film by 12 inches. Keep the film in place by taping and weighting the edges where they overlap or are vulnerable to movement by wind. Once a particular type of film has been placed, do not change it during the curing period.
- Maintain a continuous water cure of the concrete surface for 14 days.

(c) Additional Cure Time - If, during the cure time, the surrounding temperature falls below 45 °F, extend the cure for the number of hours the temperature is below 45 °F.

00540.52 Removal of Forms and Falsework, and Subsequent Loading - Do not remove forms and falsework or place subsequent loads without approval.

In determining when to remove forms and falsework, and when to place subsequent loads, the Engineer will consider the Contractor's proposed schedule, the location and character of the structure, the weather, and other conditions influencing the setting of the concrete. If appropriate, these operations will be controlled by compressive strength tests of cylinders cast by the Contractor and witnessed by the Engineer. Test the cylinders at a recognized testing laboratory at no additional cost to the Agency. Cure cylinders under conditions which are equivalent to the most unfavorable field conditions for the portions of the concrete which the cylinders represent.

Forms and falsework may be removed and subsequent loads may be placed when both conditions of Table 00540-1 are met.

Table 00540-1

Part 1:

Form and Falsework Removal for:	Percent of Specified Strength	Counting Days [1]
Side form for footings, walls, abutments, caps, traffic and pedestrian barriers, and any other side forms not supporting the concrete weight	–	1
Columns	–	3
Cantilevered bridge deck sidewalks	–	7
Bridge decks supported on steel beams or precast, prestressed concrete members; top slabs of concrete box culverts	80	7
Crossbeams, caps, box girders, T-beam girders, and flat slab superstructures [2]	80	7
Arches [2]	80	7

Part 2:

Subsequent Loading [3] of:	Percent of Specified Strength	Counting Days [1]
Footings for signal, luminaire and sign supports	100	7
Footings [4]	–	3
Walls, wall-type abutments, columns, vertical girder stems, and box culvert stems over 4 feet in height [4]	–	3
Bottom slabs of box girders	66	5
Members and falsework designed integrally to carry the additional loads	100	7
Pile caps, bents, and other members designed as moment-carrying members	100	7
All other members	100	7

[1] From the time of the last placement in the forms or falsework supports and excluding days when the surrounding temperature is below 40 °F for a total of four hours or more.

[2] Where continuous spans are involved, the time for all spans will be determined by the last concrete placed affecting any span.

[3] Except loads from forms and reinforcing steel of further concrete placements.

[4] Mass type or other type members where subsequent loading will not induce flexural bending and flexural stresses.

Early removal of forms does not eliminate the curing requirement of 00540.51.

Remove forms and falsework:

- With methods not likely to deface, damage, or cause overstressing of the concrete.
- In a manner that permits the concrete to uniformly and gradually take the stresses due to its own weight.
- From the interior of structural steel box girders.
- From accessible concrete box girder cells before any loading, post-tensioning or removal of the supporting falsework.
- From all decks after subsequent loading is authorized, except those necessary to support the deck slab in inaccessible cells.

Dispose of forms and falsework according to 00290.20(c).

00540.53 Surface Finish Other Than Bridge Decks - Provide concrete surfaces with a general surface finish unless otherwise shown or specified. See 00540.50 for bridge deck and sidewalk surface finishing. Leave concrete surfaces unfinished as they come from the forms when exposed to salt water between the levels of extreme low and high water, except for needed repairs.

If a Class 1 or Class 2 surface finish is required, it will not include the interior sides of girders and the underside of decks between girders. Finish Class 1 and Class 2 surfaces to a point 1 foot below finished ground line.

(a) General Surface Finish - Give all concrete surfaces a general surface finish prior to the higher class finish specified for a particular item of work. A general surface finish consists of the following:

(1) On All Surfaces:

- Remove form bolts and metal to a depth of 1 inch, 2 inches on structures within 25 aerial miles of the Pacific Ocean.
- Remove rock pockets and unsound concrete.
- Fill holes and depressions at least 1/2 inch in depth or diameter with an approved patching material.

(2) On All Exposed Surfaces:

- Correct bulges, fins, depressions, stains, discolorations and other imperfections.
- Slope formed surfaces with respect to the specified plane at a rate not to exceed the following amounts in 10 feet, if required:
  - Watertight joints: 1/8 inch
  - Other exposed surfaces: 1 1/2 inch
  - Concealed surfaces: 1 inch
- Slope unformed, exposed surfaces, other than pavements and sidewalks, with respect to the specified plane at a rate not to exceed the following, if required:
  - In 10 feet: 1/4 inch
  - In 20 feet: 3/8 inch

The Engineer will determine the extent of the required repairs.

(b) Class 1 Surface Finish (Ground and Coated) - After completion of the general surface finish, grind the surface with a power grinder or an equivalent method to remove laitance and surface film. Apply coating according to (d) below.

(c) Class 2 Surface Finish (Ground, Floated and Coated or Uncoated) - After completion of the general surface finish, grind the surface with a power grinder or an equivalent method to remove laitance and surface film. Float the surface with a rubber or sponge float, using a paste of fine mortar sand, cement, water, and bonding agent to fill air holes or voids and to bring the surface to a uniform texture. Keep the retextured surface damp a minimum of 12 hours or until the paste has set, whichever is longer. If dusting occurs after the retextured surface sets and is rubbed, refinish the surface.

After the paste has set for a minimum of 24 hours, apply coating according to (d) below.

(d) Concrete Coating - Apply either a concrete paint or a concrete stain or sealer as shown or specified. Where a Class 1 or Class 2 surface finish is shown, apply a concrete paint unless specified or shown otherwise.

(1) Concrete Paint - Thoroughly saturate the surface with water and coat it, while damp, with a coating material conforming to 02210.30(c). Apply a minimum of two coats of coating material. Apply coating according to the manufacturer's instructions. The second coat may be applied any time after the previous coat, when touched lightly, does not adhere to the finger. Additional coats may be required to provide uniformity in coverage and color. Mortar sand may be added to the coating material to help achieve a uniform surface.

(2) Penetrating Concrete Stain or Sealer - Select a penetrating concrete stain or sealer from the QPL. Apply stain or sealer to a dry concrete surface and according to the manufacturer's instructions. Ensure the concrete has cured sufficiently. Apply a minimum of two coats of stain or sealer. Additional coats may be required to provide uniformity in coverage and color.

00540.54 Crack Inspection and Deck Sealing - Immediately after the cure period, the Engineer will inspect the deck surface for cracks.

After correcting non-specification surface tolerance according to 00540.55 and after texturing the deck surface according to 00540.50(c), seal all visible cracks with a methacrylate sealer or epoxy sealer as directed by the Engineer. In areas where the cracks are numerous, the entire area may be flooded with a methacrylate or an epoxy sealer. Cover the sealer with a dry, washed sand, prior to the sealer setting. Use only QPL listed methacrylate or epoxy products approved for deck sealing applications.

Perform deck sealing work at no additional cost to the Agency. Complete all deck sealing work before opening to traffic, unless otherwise directed by the Engineer. If the bridge is opened to traffic at the Contractor's request prior to completion of deck sealing, perform all additional traffic control to complete deck sealing at no additional cost to the Agency.

00540.55 Final Acceptance of Bridge Deck Surface - Ensure the finished bridge deck roadway surface meets the tolerance specified in 00540.40(b-3-d) at every point. Furnish a 12 foot straightedge and use it under the Engineer's direction.

Correct non-specification surface tolerances by complete removal and replacement or with a diamond grinder. If the surface is ground, take care not to unnecessarily sacrifice concrete cover over the reinforcing bars. Restore transverse texture to specification tolerance. Perform correction work, including required traffic control, at no additional cost to the Agency.

Measurement

00540.80 Measurement - The quantities of work performed under this Section will be measured according to the following:

(a) Concrete - Concrete will be measured by one of the following methods:

(1) Lump Sum - Under this method, no measurement will be made. Estimated quantities of concrete will be listed in the Special Provisions.

Concrete quantities listed for cast-in-place deck is based on the nominal deck thickness shown.

Concrete quantities for prestressed, precast members, piling, bridge rail, slope paving, tremie seals and other similar items will not be included in the listed quantities.

(2) Volume - Under this method, concrete will be measured on the volume basis within the neat lines of the structure as shown.

No deductions will be made for the volume of pile heads, metal reinforcement, scoring, chamfer strips or structural steel embedded in the concrete.

(b) Saw Cut Texturing - The quantities of surface texturing will be measured on the area basis. The area will be determined by surface measurement of the width of bridge deck or end panel from curb face to curb face minus 16 inches on each side, and the full length of the bridge deck or end panel. The area will be calculated to the nearest square yard, for each bridge.

Payment

00540.90 Payment - The accepted quantities of work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

	Pay Item	Unit of Measurement
(a)	Foundation Concrete, Class _____	Lump Sum or Cubic Yard
(b)	Deck Concrete, Class _____	Lump Sum or Cubic Yard
(c)	General Structural Concrete, Class _____	Lump Sum or Cubic Yard
(d)	Saw Cut Texturing	Square Yard

In items (a), (b), and (c), the class of concrete will be inserted in the blank.

Item (a) includes footings, pile caps, and all other elements so designated.

Item (b) includes bridge decks and all other elements so designated.

Item (c) includes columns, crossbeams, diaphragms, wingwalls, backwalls, abutments, and all elements that are not designated as either (a) or (b) above.

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

Reinforcing steel, metal expansion joints, or other metal incorporated in the work will be paid for according to the appropriate Section in which the work is performed.

No separate or additional payment will be made for:

- surface finish, fogging, curing, joint filler, admixtures and other similar items, and for all other items required to complete the concrete work
- portland cement and fly ash used in excess of the minimum specified
- extra concrete required to fill footings cast directly against rock or soil or where forms are omitted
- additional concrete placed in deck buildups on top of beams to achieve the desired deck elevations

Section 00545 - Reinforced Concrete Bridge End Panels

Description

00545.00 Scope - This work consists of constructing reinforced portland cement concrete bridge end panels at the locations shown or as directed, and in close conformity to the lines, grades and dimensions shown or established.

Materials

00545.10 Materials - Furnish materials meeting the requirements of Section 00530 and Section 02001, modified as follows:

- Furnish Class HPC4000 concrete for end panels, unless shown otherwise.
- When pipe under end panels are shown, provide one of following types:
  - Class V reinforced concrete pipe meeting the requirements of 02410.20
  - Schedule 80 polyvinyl chloride (PVC) pipe meeting the requirements of ASTM D 1785
  - Type PSM polyvinyl chloride (PVC) sewer pipe meeting the requirements of ASTM D 3034 SDR 26
  - Grade A or B galvanized steel pipe, STD weight class minimum, meeting the requirements of ASTM A 53, hot-dip galvanized according to AASHTO M 111 (ASTM A 123)
- For pipe under end panels, provide pipe bedding, pipe zone material, and backfill meeting the requirements of 00405.12, 00405.13, and 00405.14.
- Provide granular structure backfill meeting the requirements of 00510.13.

00545.15 Quality Control - Provide quality control according to Section 00165.

Labor

00545.30 Quality Control Personnel - Provide certified technicians in the following fields:

- CEBT
- CDT
- CSTT

Construction

00545.40 General - Perform work according to Section 00530 and Section 00540 except as modified by this Section.

00545.41 Earthwork - Remove pavement and subgrade according to Section 00310 and Section 00330.

00545.42 Surface Finish - For end panels with an asphalt concrete wearing surface, a finishing machine and roadway texturing are not required. For end panels without an asphalt concrete wearing surface, texture the end panel roadway surface by saw cutting according to 00540.50(c). Perform saw cutting on end panels no sooner than 14 days after the end panels are cast.

00545.43 Curing - Cure concrete according to 00540.51(a).

00545.44 Expansion Joints - Construct expansion joints as shown, according to Section 00585, and as follows:

- Install armored corners for strip seal joints in preformed blockouts a minimum of 14 days after the bridge deck and end panels are cast. Set the joint opening as shown. Support the armored corners securely in position before placing concrete in the joint blockout.
- Place compression joint seals or poured sealant joint seals a minimum of 14 days after the bridge deck and end panels are cast.
- Place asphaltic plug joints a minimum of 14 days after the end panels are cast and after final paving is complete.

Saw cut the AC wearing course at the roadway end of end panels when detailed on the plans, as soon as practical but within 48 hours after paving. Use a saw cut width of 5/8 inch, plus or minus 1/8 inch, and 1/4 inch less than the thickness of the wearing course, to a maximum depth of 1 1/2 inch.

Flush the saw cut thoroughly with a high-pressure water stream immediately after the cut has been made. Before the cut dries out, blow it free of water and debris with compressed air. Fill the joint with a traffic loop sealant from the QPL.

00545.45 Pipes under End Panels - Install pipes under end panels for future utilities as shown and according to Section 00445.

00545.46 AC Paving - Compact AC abutting end panels according to 00745.62(b).

00545.47 Bridge Rails - Construct bridge rails on end panels as shown and according to Section 00587.

Measurement

00545.80 Measurement - The quantities of reinforced concrete bridge end panels will be measured on the area basis. The area will be determined by surface measurement of the width and length of each separately constructed end panel. The area will be calculated to the nearest square yard, for each bridge.

Surface texturing by saw cutting will be measured according to 00540.80.

Expansion joints at panel ends will be measured according to 00585.80.

Bridge rails on end panels will be measured according to 00587.80.

Payment

00545.90 Payment - The accepted quantities of reinforced concrete bridge end panels will be paid for at the Contract unit price, per square yard, for the item "Reinforced Concrete Bridge End Panels".

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals to complete the work as specified.

Surface texturing by saw cutting will be paid for according to 00540.90.

Expansion joints at panel ends will be paid for according to 00585.90

00545.90

Bridge rails on end panels will be paid for according to 00587.90.

No separate or additional payment will be made for:

- saw cutting and filling the joint in the wearing surface at the roadway end
- furnishing and placing pipe under the end panels for future utilities
- extra thickness of panels as shown at the panel ends
- required stage construction, including splices

Section 00550 - Precast Prestressed Concrete Members

Description

00550.00 Scope - This work consists of the manufacture, storage, transportation and installation of precast prestressed concrete girders, box girders, slabs or other concrete members. Precast prestressed concrete members in this Specification will be referred to as members.

00550.02 Design - Essential elements of design and section dimensions for members are as shown. Submit unstamped working drawings, stressing calculations, and detensioning sequence for all members for approval according to 00150.35.

00550.03 Alternate Designs - Agency design specifications will be furnished by the Agency upon request. The Contractor may propose another type of prestressing system or different member dimensions provided the following requirements are met:

- Before manufacturing the members, submit stamped design calculations, working drawings, and specifications for all modified members according to 00150.35.
- With the calculations, show that the member meets all applicable service and strength limit states used for the Agency design.
- Do not increase member dimensions by more than 1 inch, except that bulb width and overall depth may be increased up to 2 inches from the dimensions shown. Where overall depth is increased, verify that the required minimum vertical roadway clearance has been maintained.
- Do not incorporate alternate materials or members into the work until the proposal has been accepted by the Engineer.
- Make any structural changes required to accommodate an approved alternate prestressing system or section at no additional cost to the Agency.

00550.04 Member Tolerances:

(a) General - Fabricate members to the dimensional tolerances in the PCI "Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products" and as specified below. Acceptance or rejection of members outside these tolerances will depend on how the structure's strength, rideability and appearance are affected.

(b) Twist - Provide members with a relative twist of member bearing surfaces between member ends of less than or equal to 1/16 inch per foot of bearing width measured at right angles to the centerline of the member.

00550.05 Fabricator Certification and Qualification - Certification under the PCI Plant Certification Program is required for all plants producing precast prestressed concrete bridge members. Certification in Bridge Group B3 or Bridge Group B4 is mandatory for the fabrication of prestressed straight strand bridge members. Certification in Bridge Group B4 is mandatory for the fabrication of prestressed draped strand bridge members.

Materials

00550.11 Materials - Furnish materials meeting the following requirements:

Backer Rod	02440.14
Concrete Coating	02210.30
Concrete	02001
Deformed Bar Reinforcement	02510.10
Epoxy and Non-Epoxy Grouts	02080
Epoxy Coating	02510.11
Keyway Grout	02080.30
Poured Joint Filler	02440.30
Prestressing Reinforcement	02515
Tie Rods	02560.30

00550.12 Acceptance of Concrete - Acceptance of concrete will be according to Section 00165 and the following:

(a) Aggregate - Acceptance of aggregate will be based on the Contractor's quality control testing, if verified, according to Section 00165.

(b) Plastic Concrete - Acceptance of plastic concrete will be based on tests performed by the QCT, according to Section 02001.

(c) Hardened Concrete:

(1) General - Acceptance of hardened concrete will be based on analysis of compressive strength test results of cylinders cast and cured by the Contractor and tested according to AASHTO T 22 by a CSTT at an ODOT certified laboratory and verified according to Section 00165.

(2) Sampling and Testing - Obtain a sample from a delivery vehicle, selected at random, during placement in each bed. Test the sample for temperature, slump, density and air content and cast at least three cylinders for testing at 28 days. Cure the cylinders in a manner similar to the members they represent. Alternately, the cylinders may be cured in a curing chamber correlated in temperature with the concrete in the beds. Leave the cylinders in the bed with the member or in the curing chamber until the member is stripped. After the member is stripped, place the acceptance cylinders in storage in a moist condition according to AASHTO T 23.

(3) Acceptance - Concrete members with an ASTV meeting or exceeding the specified design strength, f'_c, will be acceptable for strength. If the compressive strength of a single test specimen varies by more than 10% from the average of the other specimens, that compressive strength value will be discarded. The average compressive strength test of the remaining specimens will be the ASTV.

If the ASTV is less than f'_c but at least 85% of f'_c, the Engineer may review the results to determine if the member is suitable for the intended purpose. If suitable, the concrete represented by an ASTV less than f'_c may be accepted subject to a price adjustment according to 00150.25.

Concrete that has an ASTV less than 85% of f'_c will not be accepted. All costs of removal, replacement, and all related work is the Contractor's responsibility.

Equipment

00550.20 Prestressing Equipment - Provide hydraulic jacks equipped with calibrated pressure gauges. Calibrate the jack and gauge combination and furnish a graph or table showing the calibration to the Engineer.

If other types of jacks are used, furnish calibrated proving rings or other devices that accurately indicate the jacking forces.

Recalibrate the jack and gauge combination annually or at any time the results are in question.

00550.25 Vibrators - Provide either internal or external vibrators in working condition meeting the manufacturer's rating.

When epoxy coated reinforcement is used, use internal vibrators fitted with a manufactured rubber head to minimize damage to the epoxy coating.

Construction

00550.40 Forming - Provide forms that are mortar-tight and sufficiently rigid to conform to the specified dimensions without appreciable distortion, warping or opening of joints.

Before placing concrete in the forms, remove all dirt, sawdust, excess water and other foreign material.

Tighten forms before depositing new concrete on or against hardened concrete.

00550.41 Placing Reinforcement - Place reinforcement according to the plans, Section 00530, and these Specifications.

00550.42 Pretensioning:

- Do not proceed with stressing prior to receiving the Engineer's approval of stressing calculations submitted according to 00550.02.
- Provide a person, skilled in the use of the system of prestressing to be used, to supervise the work and assist the Engineer.
- Hold the prestressing strands accurately in position and stress by jacks meeting the requirements of 00550.20.
- Determine the force induced in the strands by measurement of elongation and, independently, by direct measurement of force using a pressure gauge dynamometer and load cell. If the difference in force determination for the two methods exceeds 5%, determine the cause and correct it.
- Measure strand elongation on the first and last strands stressed, and on at least 10% of the other strands in the bed.
- Record the jacking forces and the elongations produced.
- In single straight strand tensioning, and in a completely open bed with no headers or other possible sources of friction, loads indicated by the gauging system may be used.

00550.43 Placing Concrete:

(a) General - Place concrete so that the finished members are uniform and monolithic, free from cold joints.

Do not deposit concrete in the forms until the Engineer has inspected and approved the placement of reinforcement, conduit, anchorages and prestressing steel.

In preparation for placing concrete, prepare forms according to 00550.40. Remove struts, stays and braces serving temporarily to hold the forms in correct shape and alignment before the placing of concrete when the concrete placing has reached an elevation rendering them unnecessary. Remove these temporary members entirely from the forms and do not bury them in the concrete.

Place concrete close to its final position, without segregation of materials or displacement of the reinforcement.

(b) Consolidation - Consolidate concrete, during and immediately after placing, by mechanical vibration as follows:

- Operate vibrators at frequencies that produce consolidated placements.
- Do not use vibration for shifting concrete to the extent of causing segregation.
- Vibrate at points uniformly spaced and not further than twice the radius over which vibration is visibly effective.
- Continue vibration until the concrete is thoroughly consolidated, but not until segregation occurs or localized areas of grout form.

00550.44 Hot or Cold Weather - Produce and place concrete within the temperature range specified in 02001.20(d). When the air temperature is, or is expected to be, below 40 °F or above 100 °F, observe the following precautions:

- Do not place concrete on forms, reinforcing steel or appurtenances when the temperature of these facilities is below 40 °F. Provide heat to maintain their temperature at 40 °F minimum.
- Do not place concrete when the form temperature is 100 °F or more.

00550.45 Curing - Cure members with low-pressure steam or radiant heat inside a suitable enclosure to contain the steam or heat, and minimize moisture and heat loss.

(a) Curing Temperature - Measure cure temperature by one of the two following methods:

(1) Measuring Enclosure Temperature:

- Equip the enclosure with 24-hour recording thermometers at each end of each casting bed. Record the temperature for each thermometer on a single chart for each 24-hour period.
- Do not allow the curing temperature within the enclosure to exceed 160 °F. During the initial application of live steam or radiant heat, do not allow the temperature within the enclosure to increase at a rate exceeding 40 °F per hour.

(2) Measuring Concrete Temperature:

- Embed a thermocouple 6 inches to 8 inches from the top or bottom of the member on its centerline and near its midpoint.
- Record the concrete temperature with a calibrated recorder that provides a continuous record of time and temperature throughout the curing cycle.
- Do not allow the concrete temperature to exceed 190 °F. During the initial application of steam or radiant heat, do not allow the concrete temperature to increase at a rate exceeding 80 °F per hour.

(b) Curing with Low-Pressure Steam:

- Make the initial application of steam after initial set of concrete as determined by AASHTO T 197 (ASTM C 403).
- Provide a steam supply line to the enclosure equipped with a motor-operated modulating steam control valve operated by a temperature-sensing element located in the enclosure.
- Provide steam at 100% relative humidity.
- Do not apply steam directly on the concrete, form surfaces or test cylinders.
- Distribute the steam within the enclosure through suitable ports located on each side of the units within the enclosure at not more than 30 foot centers to keep the units being cured completely and uniformly surrounded with steam.

(c) Curing with Radiant Heat - Radiant heat may be applied to beds by means of pipes circulating steam, hot oil or hot water, by electric blankets or heating elements adjacent to forms, or by circulating warm air under and around forms. Do not allow pipes, blankets or heating elements to be in contact with concrete, form surfaces, or test cylinders.

00550.46 Release of Prestress - Transfer bond stress to the concrete, or release end anchors, only when the concrete has attained the minimum compressive strength shown or specified for such transfer of load. Cut or release the elements according to the sequence shown on the reviewed working drawings so lateral eccentricity of prestress will be a minimum.

Determine the compressive strength of the concrete to establish time for detensioning by testing standard cylinders cast and cured identically with the member. Cast and test cylinders used to determine release time according to AASHTO T 22 and AASHTO T 23.

00550.47 Surface Finish - Apply the specified finish to each surface as shown or specified.

Where no finish is shown or specified, provide a Class 1 surface finish to all exposed concrete surfaces, except on the tops of members, unless shown otherwise. For concrete surfaces that are not exposed, provide a general surface finish except on the tops of members. For surfaces receiving a Class 1 surface finish (ground and coated), finish the surfaces when the member is in its final position and finish to a point 1 foot below the finished ground line.

Provide a roadway finish on the tops of members. After the concrete has been struck to grade and cross section, float it to produce a uniform surface. After the concrete has hardened sufficiently, texture it with a 1/8 inch wide steel-tined tool that will mark the finished concrete to a depth of 1/8 inch to 3/16 inch. Space the markings 3/4 inch on centers. Do not overlap the texturing. Produce the texture transverse to the roadway centerline and full member width.

(a) General Surface Finish - Apply a general surface finish as a final finish or preparatory to a higher class finish.

Remove strands in members, except members with ends to be embedded in concrete, to a depth of 1 inch from the face of the concrete and point up the resulting holes flush with the end of the member with an epoxy grout from the QPL.

Remove all metal form bolts, snap ties and any other metal to a depth of 1 inch below the finished concrete surface. Repair air pockets over 1/2 inch in depth, all form tie removals, rock pockets and unsound concrete, and fill resulting holes or depressions with concrete or a patching material from the QPL. On exposed surfaces, correct all bulges, fins, depressions, repairs, stains or discolorations to produce a smooth surface with uniform texture, lines, and appearance.

The Engineer will determine the extent of required repairs.

(b) Class 1 Surface Finish (Ground and Coated) - After completion of the general surface finish:

- Grind the surface with a power grinder or other equal method to remove all laitance and surface film.
- Thoroughly saturate the surface with water and coat while damp with a coating material conforming to 02210.30(c).
- Apply a minimum of two coats of coating material. The second coat may be applied at any time after the previous coat does not adhere to the finger. Apply additional coats as required to provide uniformity in coverage and color.
- Mortar sand may be added to the coating material to achieve a uniform surface.

00550.48 Exposed Reinforcement - After a member is removed from the casting bed, clean any projecting reinforcement of dirt, oil, grease, rust and corrosives and protect it from damage until concrete is cast around it.

00550.49 Lifting, Storing, Transporting, Erecting, and Bracing - Be responsible for the safety of precast members during all stages of construction. Include lifting and storage details on the working drawings for all precast members. Lifting, storage, transporting, erecting, and bracing details will not be reviewed by the Engineer. Lifting, storage, transporting, erecting and bracing of members is the sole responsibility of the Contractor subject to the following requirements:

(a) Lifting:

- Lift members so as to prevent damage.
- Lift members at the support points specified by the manufacturer.
- Lift members in a manner that does not cause damaging bending or torsional forces.
- Members will be rejected if not handled correctly as specified.

(b) Storing - Store members with support points that are level transversely.

(c) Transporting - Transport members from the casting yard not less than seven calendar days after casting, not less than seven days after all concrete patching and repairing is complete and after 28-day compressive strengths have been achieved.

- Temporary prestress strands may be added to precast concrete members for the purpose of controlling concrete stresses during transportation. Detension these strands after the members are set in the field and prior to establishing grades for the bottom of deck forms.
- Temporary strands may be either post-tensioned or pretensioned in the fabrication yard. Debond post-tensioned strands completely from end to end. Debond pretensioned strands completely from end to end except for a length at the end of the beam equal to the development length of the strand, but not more than 10 feet. Pretensioned strands may be used for simple span girders only.
- The stress from temporary strands may be transferred to the concrete member only after the stress from the permanent strands has been transferred to the concrete member. This requirement may be waived for pretensioned strands if calculations are submitted, and approved by the Engineer, that show acceptable stress levels in the member.
- For pretensioned temporary strands, form a hole in the girder at mid span or at each end of the debonded length, so the strand can be cut for detensioning. Ensure these holes are free draining and patched after detensioning. The detensioned strands may be left in place.

- Post-tensioned temporary strands may be placed in a conduit or debonded full length with direct contact sheathing. In either case, patch the holes formed by the conduit or sheathing to a depth of 1 1/2 inch, after the removal of the conduit or sheathing to this same depth. The detensioned strands may be left in place.
- Submit stamped calculations that predict the effect of temporary strands on initial and long term girder camber according to 00150.35.

Damaged members will be rejected. Replace damaged members, or if allowed by the Engineer, repair damaged members to the Engineer's satisfaction at no additional cost to the Agency.

(d) Erecting and Bracing - After a member has been erected and until it is secured to the structure, provide temporary bracing as necessary to resist wind or other loads. Provide the Engineer with an erection plan and bracing details at least 2 days prior to erecting girders. Bracing details are not necessary for side-by-side slab and box beam construction.

00550.50 Tie Rods - Furnish tie rods according to the Plans and Section 02560. Install as follows:

- Clean and lubricate tie rods and nuts before installation.
- Lubricate galvanized tie rods and nuts with a lubricant from the QPL containing dye that visibly contrasts with the color of galvanizing or coating.
- Install compressible washer type direct tension indicators under the non-turned nuts and tighten the nuts at the other end of the tie rods as recommended by the manufacturer until the gaps in the indicators are nil or as shown. A nil gap is defined as a gap when the number of spaces between the protrusions of a direct tension indicator in which the 0.005 inch feeler gauge is refused at each tie rod equals or exceeds 2, 3, 3, 4, or 4, when the number of spaces between protrusions in the direct tension indicator are 4, 5, 6, 7, or 8, respectively, and a visible gap exists in at least one space.

00550.51 Keyway Grouting for Slabs, Box Beams, and Integral Deck Members - After forms have been removed from slabs, box beams and integral deck bulb tees, sandblast all keyways to remove residual form oil and any other foreign material. After the members are in place and the tie rods are tensioned (for slabs and box beams) or welded connections are made (integral deck bulb tee girders), clean the keyways of all foreign material and keep moist for 24 hours before grouting. For slabs and box beams, after the tie rods are tensioned, seal the space remaining at the bottom of the keyways with a backer rod as shown before grouting.

Do not pour keyway grout unless the air temperature is above 45 °F and at or below the maximum air temperature recommended by the manufacturer. Water cure grout for the period of time indicated by the manufacturer.

00550.52 Poured Joint Filler for Integral Deck Members with AC Wearing Surface - After grout is poured to the level of the keyway shown for slabs and box beams, remove loose grout, and other foreign material from exposed keyway walls. After keyway grout is fully cured, dry surfaces to be sealed immediately before installing poured joint filler.

Install poured joint filler according to the manufacturer's directions. Cure the filler sufficiently to resist the pressures and temperatures of the paving operation before the wearing surface is placed.

00550.53 Differential Camber Correction for Integral Deck Members with No AC Wearing Surface - Correct differential camber between adjacent slabs, box beams or integral deck bulb tees in a span (measured in place at the site) if the variance between adjacent members or stages is 1/2 inch or more at any place along the top edge corners.

Equalize the camber differences by either patching with an epoxy or nonepoxy grout deck patching material from the QPL, or other approved method, at no additional cost to the Agency. Before patching, clean the area by sandblasting. Water cure the patch for the period of time indicated by the manufacturer. If patching is used, slope it away from the joint on a 1V:6H slope or flatter.

Measurement

00550.80 Measurement - The quantities of work performed under this Section will be measured on the length basis, and will be the sum of the horizontal lengths shown for each type and size of member. Field measurement of each member length will not be made. The quantities will be determined by calculating the theoretical horizontal length shown, added together for a total for each type and size, then rounded to the nearest foot.

Payment

00550.90 Payment - The accepted quantities of work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

Pay Item	Unit of Measurement
(a) _____ Precast Prestressed Girders	Foot
(b) _____ Precast Prestressed Slabs	Foot
(c) _____ Precast Prestressed Box Beams	Foot

In item (a), the girder type and depth will be inserted in the blank.

In item (b), the slab depth will be inserted in the blank.

In item (c), the box beam depth will be inserted in the blank.

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor and incidentals necessary to complete the work as specified.

No separate or additional payment will be made for:

- reinforcement, prestressing steel, enclosures for post-tensioning steel, anchorages, plates, nuts, and all other material contained within the member
- furnishing, transporting, and placing members
- furnishing and tensioning rods and pretensioning strands
- grouting keyways and installing poured joint filler
- furnishing and installing metal diaphragms for integral deck bulb tees
- furnishing and placing anchor bolts, dowels and diaphragm threaded rods where applicable
- furnishing and installing elastomeric bearing pads

00550.91 Fabrication Inspection Expense - If fabrication of members outside of the State of Oregon creates additional shop and plant inspection expenses for the Agency, the Contractor's payment for members will be reduced according to 00165.91.

Section 00555 - Post-Tensioning

Description

00555.00 Scope - This work consists of post-tensioning cast-in-place and precast concrete by furnishing, placing and tensioning stressing steel according to details shown and specified. This work also includes furnishing and installing any items necessary for the stressing system used including, but not limited to, anchorage assemblies, ducts and grout for pressure grouting. Concrete that is to be stressed by the post-tensioning method will be referred to as a member.

00555.03 Anchorage Devices - Secure all post-tensioned stressing steel at the ends by means of approved permanent type anchorage devices. Design anchorage devices according to the current AASHTO LRFD Bridge Design Specifications. Identify post-tensioning anchorage systems as either "Normal Anchorage Devices" or "Special Anchorage Devices" as defined in the AASHTO LRFD Bridge Design Specifications. Provide anchorage devices that meet all testing and construction requirements of the AASHTO LRFD Bridge Design Specifications and the AASHTO LRFD Bridge Construction Specifications.

For bearing plates, provide 7 inch minimum edge distance from the top of deck and 2 inch minimum edge distance from expansion joint blockouts and any other concrete edge.

Materials

00555.10 General - Furnish materials meeting the following requirements:

Anchorage Devices	02530 and 02540
Couplings	02515.60
Tendon Duct	02515.50

00555.11 Stressing Steel - Furnish stressing steel according to one of the following as the Contractor may elect, unless otherwise shown or specified:

Seven-Wire Strand	02515.10
High Strength Steel Bars	02515.30
Seven-wire strand epoxy coated reinforcement	02515.40

00555.12 Tendon Grout - For grouting post-tensioning ducts, furnish a commercial, pre-packaged, thixotropic tendon grout meeting the requirements of 02080.50. Label each grout bag with application, mixing and pumping instructions, lot number, date of manufacture and shelf life. A grout expiration date may be used in lieu of the date of manufacture and shelf life. Tendon grout will be rejected if the shelf life or expiration date has been exceeded.

Use water meeting the requirements of Section 02020.

At least 48 hours prior to the trial batch, submit a detailed written mix design showing the exact brand and batch quantities of pre-packaged grout and water including dosages proposed.

00555.13 Tendon Grout Trial Batch - Mix a trial batch of grout using the equipment, materials, and proportions proposed for use on the project at least 48 hours before the scheduled grouting. Grouting may proceed anytime after approval of the grout trial batch.

Perform the following tests:

(a) Flow Cone - Determine the efflux time at 0 quiescent time according to ASTM C 939 modified as follows:

- Fill the flow cone to the top of the cone.
- When thoroughly mixed, the efflux time of grout will be the time to fill a one quart container that is placed directly under the flow cone. Ensure the efflux time of the grout immediately after mixing is between 5 and 30 seconds.
- Let the grout stand for 30 minutes without agitation then retest as follows:
  - Remix for 30 seconds.
  - Ensure the efflux time of the grout immediately after remixing is 30 seconds or less.

(b) Bleeding - Determine wick induced bleeding according to ASTM C 940 as modified by the PTI "Guide Specification for Grouting of Post-Tensioned Structures" except limit the maximum allowable bleed to 0.0% at three hours.

(c) Mud Balance - Determine a wet density value for mud balance comparative testing during grouting operations according to API RP 13B-1 (American Petroleum Institute).

(d) Compressive Strength - Determine compressive strengths according to ASTM C 109. Provide 2 sets of 3 cubes, for informational purposes only, to the Engineer for 7 and 28-day testing.

If the proposed grout mix design does not produce acceptable trial batch results, revise the mix design and perform another trial batch. Results from previous projects will not be considered acceptable documentation. Seven and 28-day test results will be used for documentation purposes only.

Equipment

00555.20 Certified Calibrated Jacking Equipment - Equip each jack used to stress tendons with either:

- A pressure gauge with an accurate reading dial at least 6 inches in diameter and of such capacity that the final pressure reading is in the upper half of its range. Calibrate each jack and its gauge as a unit with the cylinder extension in the approximate position that it will be at final jacking force, and provide a certified calibration chart; or
- A certified, calibrated load cell with an indicator by which the stressing force in the tendon may be determined, and with a range such that the lower 10% of the manufacturer's rated capacity will not be used in determining the jacking stress.

Adjustment or repair of jacks, gauges, or load cell after certification will be cause for rejection.

The certified calibration charts for the hydraulic jacks, pressure gauges or load cells used for tensioning stressing steel may be checked before and during tensioning operations by Agency personnel with Agency-furnished load cells. Perform certified calibration of stressing system not more than 180 days before use.

00555.21 Grouting Equipment - Provide grouting equipment with:

- Separate motors or engines for the grout mixer and the grout pump, and a system for controlling each independent of the other.
- A high speed, high shear, colloidal mechanical grout mixer that will produce uniform and thoroughly mixed tendon grout.
- Equipment which will accurately measure solids and liquids to be batched.
- An easily accessible filter screen before the grout pump with clear openings of 1/8 inch maximum size.
- A grout pump capable of producing a minimum pressure of 75 psi, with a pressure gauge reading from 0 to 300 psi, and with a relief valve that will limit grouting pressures to less than 200 psi.
- Watertight grout hoses, valves and pipe fittings.

Provide standby water flushing equipment which:

- Is in addition to and separate from the grouting equipment
- Has a different power source than the grouting equipment
- Is capable of developing a pumping pressure of 250 psi and has sufficient capacity to flush out any partially grouted ducts or vents if necessary

Labor

00555.30 Personnel - Provide the following:

- **Post-Tensioning Supervisor** - A person, skilled in the use of the system of stressing to be used, to supervise the work.

- **Grouting Technician** - An American Segmental Bridge Institute (ASBI) certified grouting technician to supervise, inspect, and document the entire grouting operation.

Construction

00555.40 Required Submittals:

(a) Test Report - Submit a certified test report to the Engineer for review and acceptance for each size and type of anchorage device showing that the device meets the requirements of the AASHTO LRFD Bridge Design Specifications and the AASHTO LRFD Bridge Construction Specifications. With the certification, include a statement that the design, materials and manufacture of the anchorage devices have not changed since testing. Ensure the concrete strength, edge clearance dimensions and amount of reinforcing for the test block is not greater than that proposed for the Project.

(b) Working Drawings and Calculations - Submit stamped working drawings and calculations for post-tensioning systems to the Engineer for review according to 00150.35.

(c) Review of Methods - Submit for review complete details of the materials, equipment, method and sequence proposed for the stressing operations, including but not limited to:

- Additions or rearrangement of reinforcing steel or changes in member dimensions from that shown.

- For normal anchorage devices, bearing stress and resistance calculations satisfying Section 5.10.9.7.2 in the LRFD Bridge Design Specifications.
- Complete specifications and details of the ducts, stressing steel including arrangement and alignment, and the anchoring devices.
- Pressure grouting materials and equipment.

Furnish reinforcement working drawings that are compatible with the approved Post-Tensioning System working drawings.

Do not cast any member to be stressed before the working drawings have been reviewed according to 00150.35.

00555.41 Ducts - Provide ducts for post-tensioning tendons according to the following:

(a) General - Make ducts mortar-tight and place them accurately at the locations shown or as directed. Provide positive, metallic, mortar-tight connection joints between sections of rigid duct which do not permit angle changes at the joints. Use waterproof tape at connections.

(b) Vents - Provide vents in all ducts within plus or minus 3 feet of high and low points, and other locations shown. Make vents of 3/4-inch nominal diameter standard PVC, galvanized steel or copper pipe. Make connections to ducts with compatible structural fasteners. Make the vents mortar-tight, tape as necessary, and provide means for injecting grout through the vents and for sealing the vents. Securely fasten ducts and vents in place to prevent movement. After grouting, remove the ends of vents to provide 2 inches of cover to the nearest concrete surface.

(c) Repair - Before placing concrete, repair all holes or openings in the ducts. Holes less than 1/4 inch may be repaired by several wraps of waterproof tape. Repair holes larger than 1/4 inch with a split metal sleeve which overlaps itself by 3 inches, extends at least 3 inches on either side of the hole, is sealed with waterproof tape, and is secured to the duct. Cut out indentations which cannot be repaired and repair as above for holes larger than 1/4 inch.

(d) Maintenance - After installing ducts, keep the ends covered at all times in a manner that prevents entry of moisture or debris. If the surrounding temperature is below 32 °F, keep the ducts free of water to avoid damage due to freezing.

Before placing forms for the decks of box girder cells, demonstrate to the satisfaction of the Engineer that all ducts are unobstructed.

Clean all ducts and remove accumulated water at the time of placing stressing steel.

00555.42 Stressing:

(a) General - Do not make welds, or grounds for welding equipment, on the forms or on the steel in the member after any stressing steel has been installed.

Protect stressing steel against physical damage and rust or other corrosion at all times until grouted. A corrosion inhibitor may be used. Stressing steel that has sustained physical damage, detrimental rust, pitting or other results of corrosion at any time will be rejected. Stressing steel with only light rust is acceptable if rust spots can be removed by rubbing or scraping with the fingernail and only light streaks of rust remain.

Tension stressing steel by means of hydraulic jacks so that the force in the stressing steel is not less than the value shown.

(b) Duct Alignment - Provide a duct alignment according to the approved working drawings to the follow tolerances:

- **Horizontal Alignment** - ± 1/2 inch unless shown otherwise
- **Vertical Alignment** - ± 3/8 inch

(c) Timing - Do not stress members until at least 14 days, excluding days when the surrounding temperature is below 40 °F for a total of four hours or more, after the last concrete has been placed in the member and not until all the concrete has reached the specified compressive strength.

Subject to prior written approval, a portion of the total stressing force may be applied to a member when the concrete compressive strength in the member is less than the value shown. Approval of such partial stressing will in no way relieve the Contractor of full responsibility for successfully constructing the member.

(d) Procedures - Tension stressing steel by jacking at each end of the tendon unless otherwise noted.

(1) Continuous Span Members - Jacking of both ends need not be done simultaneously.

(2) Simple Span Members - When jacking from one end only is allowed, tension half of the stressing steel in each member from one end of the span and the other half from the opposite end, unless otherwise allowed in writing.

(3) Bent Cap Members - Subject to prior written approval, bent cap stressing steel may be tensioned by jacking from one end only.

(e) Measuring Prestressing Force - Conduct tensioning so the tension being applied and the elongation of the stressing steel may be measured at any time. Keep a record of gauge pressures, load cell reading and elongations. Furnish a copy of the record to the Engineer when requested.

Determine prestressing force by both of the following methods:

(1) Measurement of Strand Elongation - Determine required elongation from average load-elongation curves for prestressing strand used.

(2) Observation of Jacking Force - Observe jacking force on a calibrated gauge or load cell or by use of a calibrated dynamometer.

Ascertain the cause of any difference in force determination between (1) and (2) that exceeds 5% and correct the condition causing the discrepancy.

00555.43 Bonding and Grouting - Bond stressing steel to the concrete by filling the void space between the duct and the tendon with tendon grout consistent with the approved trial batch. Complete grouting each tendon within 14 calendar days after placing it. If projects are within 25 aerial miles of the Pacific Ocean, complete grouting each tendon within 7 calendar days after placing it. Test grout according to ASTM C 939, as modified in 00555.13(a) at least once daily at the start of grout production, and as requested by the Engineer, to verify that flow characteristics of the grout remain within the tolerances specified in 00555.13(a). Perform Mud Balance tests for each batch according

to 00555.13(c). Compare and document the wet density value with the value obtained during the trial batch. If the values differ by more than 3%, rerun ASTM C 939 as modified in 00555.13(a) for continued compliance.

(a) Pre-Grouting Procedure - Cut stressing steel 1 inch beyond wedges or anchor nuts after stressing operations. Coat stressing strand ends and bearing plates with an epoxy bonding agent from the QPL after post tensioning stressing operations and before post tensioning duct grouting. Do not coat wedges. Prepare post tensioning blockouts according to 00540.43(a) or as approved. Encase each anchorage with concrete after completion of all post tensioning operations.

(b) Grouting Operation - Provide a standby flushing system and demonstrate that it is readily accessible and operable should it become necessary to flush out a partially grouted tendon.

Do not retemper grout. Continuously agitate grout until it is pumped.

(c) Grouting Procedure - Make all ducts clean and free of deleterious materials. Blow out each duct thoroughly with oil-free air immediately before grouting. Ducts may be flushed with water immediately before grouting if approved.

Fit grout injection pipes with positive mechanical shutoff valves. Fit vent and ejection pipes with grout-tight caps, valves or other mechanical closing devices.

Grout from the low end of the structure.

Keep the temperature of the concrete surrounding the duct at 35 °F or higher at the time of grouting and until job-cured grout cubes reach 800 psi compressive strength.

Maintain grout temperatures between 50 °F and 90 °F during mixing and pumping. If necessary, cool the mixing water.

Open all vents when grouting starts. Allow grout to flow from the first vent until residual flushing water or entrapped air is removed, then close the vent. Close remaining vents in sequence in the same manner.

Whenever the grout pumping pressure exceeds 100 psi:

- Inject grout at any other vent which has been, or is ready to be, closed as long as a one-way flow of grout is maintained. If this procedure is used, fit the vent used for injection with a mechanical shutoff valve.
- If the one-way flow of grout cannot be maintained, immediately flush the grout out of the duct with water.

Pump grout through the duct and continuously waste it at the outlet vent until:

- No visible slugs of water or air are ejected.
- The afflux time of the grout at the mixer during the grouting process is not more than 5 seconds different from the efflux time at the mixer during the initial measurements of the flow cone test during the trial batch, and is between 5 and 30 seconds.
- The efflux time of the ejected grout is not more than 5 seconds different from the efflux time at the mixer.

Do not over-mix the grout.

Close the outlet vent and maintain the pumping pressure or 60 psi, whichever is greater, for at least 30 seconds; then close the valve at the injection pipe while maintaining this pressure. Do not open valves or vents until the grout sets.

Following grouting, fill all grouting and anchorage recesses with concrete and finish flush immediately after applying an epoxy bonding agent from the QPL.

Measurement

00555.80 Measurement - No measurement of quantities will be made for work performed under this Section. Estimated quantities of materials will be listed in the Special Provisions.

Payment

00555.90 Payment - The accepted quantities of work performed under this Section will be paid for at the Contract lump sum amount for the item "Post-Tensioning".

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

No separate or additional payment will be made for anchorage devices, ducts, tendons, prestressing steel, grout, and admixtures, or for preparation and testing of grout.

Section 00560 - Structural Steel Bridges

Description

00560.00 Scope - This work consists of furnishing, fabricating, and erecting steel structures as shown or specified. It also includes miscellaneous metal work on bridges and structures, such as access hole covers, frames, ladders, hangers, anchor bolts, scuppers, conduits, ducts, bearing devices, and structural steel shapes.

00560.02 Prefabrication Conference - Meet with the Steel Fabricator, the Engineer and the Agency's steel inspector for a conference at a time mutually agreed upon in advance of ordering steel materials for fabrication. At this conference, present and discuss all phases of the steel fabrication schedule and work. A prefabrication conference is not required for miscellaneous metal work, unless required by Special Provision.

00560.03 Working Drawings - Submit stamped copies of detailed working drawings according to 00150.35. Any work done before review of these drawings shall be at the Contractor's risk. When material is ordered in advance, obtain approval before placing the order.

Provide steel identification on the working drawings according to 00560.22(a).

(a) Reviews - The Engineer's review of the working drawings submitted will only cover "strength and detail" requirements. The Engineer assumes no responsibility for errors in dimensions.

(b) Revisions - Submit copies of any revisions to the detailed working drawings for review. Work done before review of these revisions shall be at the Contractor's risk.

Materials

00560.10 Materials - Furnish structural plates, shapes, bars, and miscellaneous metals meeting the requirements of Section 02530 and Section 02560.

Shop Fabrication

00560.20 Notice of Work - Give the Engineer at least 14 calendar days notice of the beginning of work at the mill, when directed, or at the shop, so inspection may be provided. The term "mill" means any rolling mill or foundry where material for the work is to be manufactured. Do not fabricate material, or perform work at the mill or shop, before the Engineer has been notified.

00560.21 Fabrication Inspection Expense - If fabrication of structural steel outside of the State of Oregon creates additional mill, shop, and plant inspection expenses for the Agency, the Contractor's payment for structural steel structures will be reduced according to 00165.91.

00560.22 Test Results Certificate and Steel Identification:

(a) Test Results Certificate and Initial Identification - Furnish test results certificates, showing chemical analysis and physical tests for each heat or plate of steel, for all members according to 00165.35 and Section 02530. Identify each piece of steel to be fabricated.

Identify on working drawings each piece to be made of steel other than AASHTO M 270 (ASTM A 709), Grade 36 steel. Give pieces made of different grades of steel different assembling or erecting marks, even though they are of identical dimensions and detail.

Provide a system of marking individual pieces made of steel, other than AASHTO M 270 (ASTM A 709), Grade 36, and issue cutting instructions to the shop (generally by cross-referencing

the assembly marks on the working drawings with the corresponding item on the mill purchase order) that maintain identity of the heat number.

Material that can be identified by heat number and mill test report may be furnished from stock.

Mark any unmarked excess material placed in stock for later use with the heat number and with its AASHTO M 160 (ASTM A 6) specification identification color code.

(b) Steel Identification during Fabrication - During fabrication, and until member assembly, each piece of steel, other than AASHTO M 270 (ASTM A 709), Grade 36 steel, shall show clearly and legibly its specification identification color code shown in AASHTO M 160 (ASTM A 6).

Individually marked pieces of steel used in furnished size, or reduced from furnished size, may be used only if end or edge trim does not disturb the heat number or color code. Any usable piece may be used without further color coding providing the heat number or color code remains legible.

Mark individual pieces, other than AASHTO M 270 (ASTM A 709), Grade 36, with the AASHTO M 160 (ASTM A 6) specification identification color code before cutting to a smaller size.

Mark individual pieces of steel, other than AASHTO M 270 (ASTM A 709), Grade 36 steel, which are furnished in tagged lifts or bundles with the AASHTO M 160 (ASTM A 6) specification identification color code immediately on being removed from the bundle or lift.

Pieces of steel, other than AASHTO M 270 (ASTM A 709), Grade 36 steel, which before assembling into members, will be subject to fabricating operations such as heating, blast cleaning, galvanizing or other coating that might obliterate paint color code marking, shall be marked for grade by steel die stamping or by a substantial tag firmly attached. Use only rounded characters when primary stress components are identified by steel die stamping. Impressions shall have a maximum allowable depth of 0.010 inch and shall be placed a minimum distance of 2 inches from edges of tension-stressed plate members. Characters shall be 1/4 inch to 3/8 inch high and shall have a minimum face radius of 0.015 inch.

(c) Check Samples - To verify the accuracy of test reports, obtain check samples from material furnished for fabrication. The plates, shapes or bars from which check samples are required will be as designated on the Plans, and shall be ordered from the mill with the extra size required for samples. The Engineer may take additional samples from drop-offs or scrap material as deemed necessary. No more than two samples will be required from any one plate according to AASHTO M 270 (ASTM A 709) Grade 36, 50, HPS 50W and HPS 70 W with QT processing, or from any one shape or bar. Remove material for check samples in the presence of the Engineer. The Engineer will select the locations where samples are to be taken. Check samples may be ordered cut from either end of the designated steel plate, according to AASHTO M 270 (ASTM A 709) Grade 36, 50, HPS 50W and HPS 70 W with QT processing, or shape or bar. To verify accuracy of test reports for HPS 50W and HPS 70W with thermo-mechanical control process, check samples of both ends of each plate is required.

Check samples in plates shall be rectangular, not less than 24 inches long in the required direction, depending on plate width, for the longitudinal axis of tensile specimens, and 5 inches wide. Bend specimens, where required, shall be not less than 24 inches long in the direction of rolling of the plate. Check samples in bars or shapes shall be the full section and at least 24 inches long. In removing the sample, take care not to damage it by overheating. The Agency will be responsible for the necessary machining of check test specimens and their testing. To expedite obtaining test results, the Contractor may, if approved, perform machining and testing of specimens, in the presence of the Engineer.

The normal basis of acceptance of material will be the mill report or other test report, and fabrication need not be held up pending results of check tests. If the check tests indicate material with properties failing to meet the minimum requirements of the material specification, the material may be rejected and the Contractor required to order new material at no additional cost to the Agency.

For purposes of determining compliance with these Specifications, if the results on an original tensile specimen are within 2,000 psi of the required tensile strength, within 1,000 psi of the required yield point, or within 2% of the required elongation, a retest will be allowed on two random specimens from the heat or lot. If the results from both of these retest specimens meet Specifications, the heat or lot will be accepted. The specimens shall be oriented with the final direction of rolling in the same manner as the original specimen, and may come from any location within the plate. The extra material from plates, shapes or bars that is not used for check testing shall become the property of the Contractor.

(d) Certification of Identification - Upon request, furnish an affidavit certifying that throughout the fabrication operation the identification of steel has been maintained according to this Specification.

00560.23 Shop Inspection and Testing:

(a) Facilities - Furnish facilities for the inspection of material and work in the mill and shop. Allow the Engineer free access to the material and work for inspection.

(b) Testing - Furnish samples for testing as specified according to Section 00165.

(c) Rejections - The Inspector's inspection at the mill or shop of any material, work or finished members will not prevent their subsequent rejection, if later found damaged or defective, nor relieve the Contractor of the responsibility to correct or replace the work at no additional cost to the Agency.

(d) Transport - Ship no member or piece of fabricated steel without the Inspectors' label or marking.

00560.24 Transporting to, Handling and Storage at Shop - In transporting, handling and storing the steel work at the shop, take care to avoid bending, scraping or overstressing the pieces. Reject pieces bent or otherwise damaged. In addition:

- Conduct the loading, transporting and unloading of pieces so the metal remains clean.
- Keep materials free from dirt, oil or other contaminants, and protect from corrosion.
- If pieces are shop-painted, handle with slings or other means that will not damage coating system.
- Handle and store girders and beams upright, and shore.
- Support and handle members so camber is maintained.
- Support long members, such as columns and chords, on skids placed near enough together to prevent damage from deflection.
- Store materials on platforms, skids or other supports above ground and high water elevations and slightly pitch all trough sections that might retain water to provide drainage.

00560.25 Plate Work:

(a) Straightening - Straighten bent or distorted plates, angles, and other shapes or built-up members according to paragraph 3.7.3 of AWS D 1.5, and as specified.

(b) Orientation of Plates - Unless otherwise shown, cut and fabricate steel plates for main members, and splice plates for flanges and main tension members, so the primary direction of rolling is parallel to the direction of the main tensile and/or compressive stresses.

(c) Plate Cut Edges:

(1) Edge Planing - Plane, mill, grind or thermal cut to a depth of 1/4 inch all sheared edges of plate more than 5/8 inch in thickness and carrying calculated stress.

(2) Flame Cutting - Flame cut structural steel according to paragraph 3.2.2 of AWS D1.5, and as specified.

(3) Visual Inspection and Repair - Visually inspect and repair plate cut edges according to paragraph 3.2.3 of AWS D1.5, and as specified.

(4) Re-entrant Corners - Fillet re-entrant corners to a radius of at least 3/4 inch before cutting.

(5) Corners and Edges - Round all corners and edges of steel members, or bevel 1/16 inch.

(d) Bent Plates - Unwelded, cold-bent, load-carrying, rolled-steel plates shall be:

- Rounded at the corners of the plate before bending, to a radius of 1/16 inch throughout the portion of the plate at which the bending is to occur.
- Bent at right angles to the direction of rolling, except that cold-bent ribs for orthotropic-deck structures may be bent in the direction of rolling if allowed.
- Bent so no cracking of the plate occurs. Minimum bend radii, measured to the concave face of the metal, are:

	Plate Thickness				
	Up to 1/2"	**Over 1/2" to 1"**	**Over 1" to 1 1/2"**	**Over 1 1/2" to 2 1/2"**	**Over 2 1/2" to 4"**
All grades of structural steel in this Specification	2 t	2.5 t	3 t	3.5 t	4 t

Where t = Plate thickness in inches

Low alloy steel in thicknesses over 1/2 inch may require hot bending for small radii

00560.26 Welding:

(a) Bridge Welding - Welding, welder qualifications, prequalification of weld details, and inspection of welds for bridge structures shall all conform to AWS D1.5.

(b) Non-Bridge Structures - Welding, welder qualifications, prequalification of weld details and inspection of welds for non-bridge structures shall all conform to AWS D1.1. Non-bridge structures include bridge railing posts, railing splices, deck expansion joints, earthquake restraints and similar structures. Submit all welding procedure specifications to the Engineer for approval.

Test earthquake restraint welds radiographically or ultrasonically. Testing will be witnessed by the Engineer. Additional inspection for earthquake restraint welds shall include:

- Ultrasonic inspection of 100% of the complete penetration welds using a straight beam transducer. A weld will be acceptable if it has no indications of cracks and no indications of lack of fusion between adjacent layers of weld metal and between weld metal and base metal.
- Magnetic particle inspection of 10% of the fillet welds.

00560.27 Bolt Holes:

(a) Punched Holes - Use a die with a diameter not exceeding the diameter of the punch by more than 1/16 inch. Ream any holes that are required to be enlarged to admit the bolts. Make clean cut holes without torn or ragged edges. Poor matching of holes will be cause for rejection.

(b) Drilled or Reamed Holes - Assemble and securely hold connecting parts requiring drilled or reamed holes. Match-mark connecting parts before disassembling.

Where practical, direct reamers by mechanical means.

Perform drilling and reaming with twist drills. Make drilled or reamed holes cylindrical, perpendicular to the member, and complying with the size requirements of these Specifications. Remove burrs on the outside surfaces. If required, take apart assembled parts for removal of burrs caused by drilling.

Poor matching of holes will be cause for rejection.

(c) Accuracy of Punched and Drilled Holes - Locate all holes punched full size, subpunched, or subdrilled so accurately that after assembling (before any reaming is done) a cylindrical pin 1/8 inch smaller in diameter than the nominal size of the punched hole may be entered perpendicular to the face of the member, without drifting, in at least 75% of the connecting holes in the same plane. Non-conforming pieces will be rejected. If any hole will not pass a pin 3/16 inch smaller than the nominal size of the hole, the non-conforming pieces will be rejected.

(d) Accuracy of Drilled and Reamed Holes - When holes are drilled or reamed, 85% of the holes in any connecting group shall, after drilling or reaming, show no offset greater than 1/32 inch between adjacent thicknesses of metal.

Provide steel templates with hardened steel bushings in holes and accurately dimensioned from centerlines of the connections inscribed on the template. Use the centerlines in accurately locating the template from the milled or scribed ends of the members. When steel templates 1 inch or greater in thickness are used six or fewer times in drilling members, hardened steel bushings are not required.

(e) Fitting for Bolting - Clean surfaces of metal in contact before assembling. Assemble, well pin, and firmly draw together the parts of a member before drilling, reaming, or bolting is commenced. Take apart assembled pieces, if necessary, for the removal of burrs and shavings produced by the operation. Construct the member free from twists, bends, and other deformation.

Perform drift pinning during assembling only to bring the parts into position and not sufficient to enlarge the holes or distort the metal.

(f) Holes for High-Strength Bolts and Unfinished Bolts - Punch or drill all holes for high-strength bolts and unfinished bolts. When there are not more than five thicknesses of material in a member, and the material is not thicker than 3/4 inch for structural steel or 5/8 inch for high-strength steel, the metal may be punched 1/16 inch larger than the nominal diameter of the bolts unless subpunching and reaming are required by these specifications.

When there are more than five material thicknesses in a member, or when any material is thicker than 3/4 inch for structural steel or 5/8 inch for high-strength steel, either sub drill holes or drill full size.

When required by 00560.27(g), subpunch or sub drill all holes 3/16 inch smaller and, after assembling, ream 1/16 inch larger or drill full size to 1/16 inch larger than the nominal diameter of the bolts. Sub drill if thickness limitation governs.

Holes not more than 1/32 inch larger than the nominal diameter resulting from a drill or reamer of the nominal diameter are considered acceptable. The slightly conical hole from punching operations is considered acceptable.

(g) Holes for Ribbed Bolts, Turned Bolts, and Others - Make holes with a driving fit as specified for ribbed bolts, turned bolts, or other approved bearing-type bolts by one of these methods:

- Subpunch or sub drill 3/16 inch smaller than the nominal diameter of the bolt and ream, while assembled,
- Drill to a steel template, or
- Drill from the solid after assembling.

(h) Holes for Field Connections:

(1) Subpunching and Reaming Field Connections - Unless otherwise specified, subpunch (or sub drill if subdrilling is required according to 00560.27(f) or 00560.27(g)) and subsequently ream holes in all field connections and field splices of main members of trusses, arches, continuous beam spans, bents, towers (each face), plate girders, and rigid frames while assembled on a steel template, as required by 00560.43. Holes for field splices of rolled beam stringers continuous over floor beams or crossframes may be drilled full size unassembled to a steel template.

Subpunch and ream all holes for floor beam and stringer field end connections to a steel template or ream while assembled. Drill or ream full size field connection holes through a steel template after the template has been carefully located as to position and angle and firmly bolted in place. Make templates used for reaming matching members, or the opposite faces of a single member, exact duplicates. Locate templates used for connections on like parts or members so accurately that the parts or members are duplicates and require no match-marking.

For any field connection, instead of subpunching and reaming or subdrilling and reaming, the Contractor may drill holes full size with all thicknesses of material assembled in proper position.

Use templates as described above, or do not interchange splice plates.

(2) Numerically Controlled Punched or Drilled Field Connections - Alternately, for any connection or splice designated in 00560.27(f), instead of subpunching and reaming field connections according to 00560.27(h), the Contractor may punch or drill bolt holes full-size in unassembled pieces and connections, including templates, for use with matching subsized and reamed holes by means of suitable numerically controlled punching or drilling equipment subject to this Section. Punch or drill full-size holes according to 00560.27(c).

Submit for review a detailed outline of the procedures proposed for accomplishing the work from initial punching or drilling through check assembly, if required. Include the specific members of the structure that may be numerically controlled punched or drilled, the sizes of the holes, the location of common index and other reference points, composition of check assemblies, and all other pertinent information. Do not begin until written approval is received.

Punch or drill holes by numerically controlled equipment to appropriate size through individual pieces, or drill through any combination of pieces held tightly together. Use each splice plate only once as a template and do not interchange after assembly drilling is complete.

If numerically controlled punching or drilling equipment is used, the Engineer may require the Contractor, by means of check assemblies, to demonstrate that this punching or drilling procedure consistently produces holes and connections conforming to 00560.27(g) and 00560.43.

00560.28 Carbon Steel Bolt Connections - Unless otherwise shown or specified, make connections with unfinished carbon steel bolts nuts and washers conforming to Section 02560. Use holes conforming to 00560.27.

(a) Turned Bolts - Provide and install turned bolts as follows:

- The body surface shall have a surface roughness of 125 microinches, or less, according to ANSI B46.1.
- The unthreaded body shall equal total thickness of connected parts.
- The outer thread diameter shall equal the nominal diameter of the bolt specified.
- Heads and nuts shall be hexagonal with standard dimensions for bolts of the nominal size specified or the next larger nominal size.
- Install bolts in carefully reamed holes with a tight driving fit.

(b) Ribbed Bolts - Provide and install ribbed bolts as follows:

- The body shall have an approved form with continuous longitudinal ribs.
- The diameter of the body, measured on a circle through the points of the ribs, shall be 5/64 inch greater than the nominal bolt diameter specified.
- Round heads shall conform to ANSI B 18.5.2.1M unless otherwise specified.
- Ribbed bolts shall make a driving fit with the holes.
- The hardness of the ribs shall be such that the ribs do not permit the bolts to turn in the holes during tightening.
- If for any reason the bolt twists before drawing tight, ream the hole and use an oversized bolt as a replacement.
- Nuts shall be hexagonal, with standard dimensions for bolts of nominal size specified or the next larger nominal size.

(c) Washers - Use hardened washers of suitable thickness under the turning element (nut or bolthead) in tightening.

Use beveled washers where bearing faces have a slope of more than 1:20 with respect to a plane normal to the bolt axis.

(d) Nuts - Use single self-locking nuts or double nuts unless otherwise shown or specified. The finished side shall be against the washer or plate.

00560.29 High-Strength Bolt Connections:

(a) General - When shown or specified, assemble structural joint connections with high-strength bolts conforming to AASHTO M 164 (ASTM A 325) or equivalent fastener using bolts, nuts, and washers conforming to Section 02560 and in holes conforming to 00560.27.

Fit-up bolted connections as follows:

- Provide all steel material within the grip of high-strength bolts (no compressible material such as gaskets or insulation).
- Remove burrs that would prevent solid seating.
- So that parts fit solidly together after bolts are tightened.

- Make slope of surfaces in contact with the bolt head or nut less than 1:20 with respect to a plane normal to the bolt axis.
- Install all bolts, unless otherwise shown, to expose the heads on the exterior surface of the structure.

(b) Surface Conditions - Make all joint surfaces including surfaces adjacent to the bolt head and nut free of scale, oil, grease, dirt, foreign material, and unless otherwise shown or specified, free of paint, lacquer, rust inhibitor, galvanizing or other coating.

(1) Coated Members - Prepare and coat steel-to-steel contact surfaces within slip-critical bolted joints for coated steel according to Section 00594. Prior to assembly, prepare the contact surfaces with approved methods not harmful to the primer.

Coat fasteners visible to the public, as determined by the Engineer, according to Section 00594 (except the primer coat) after installation. All direct tension indicators shall be mechanically galvanized according to 02560.40(b).

a. Non-Coastal Projects - On projects more than 25 aerial miles, of the Pacific Ocean, all high-strength fasteners shall be either black or galvanized as the Contractor elects. The fasteners shall meet the following requirements:

1. Black Fasteners - Clean black fasteners, including hardened washers, and the surrounding areas stained by the black fasteners, after installation, using an approved method. Coat according to Section 00594.

2. Galvanized Fasteners - Clean and prepare fasteners as approved, in areas visible to the public, as determined by the Engineer, and coat according to Section 00594 after installation.

b. Coastal Projects - On projects within 25 aerial miles of the Pacific Ocean, all high-strength fasteners, including hardened flat washers, shall be galvanized according to 02560.40 prior to installation. In areas visible to the public, as determined by the Engineer, clean and prepare fasteners as approved, and coat according to Section 00594.

(2) Non-Coated Weathering Steel Members - Blast clean steel-to-steel contact surfaces within slip-critical bolted joints for non-coated weathering steel according to SSPC-SP 10 "Near-White Blast Cleaning". The appearance of the blast-cleaned surface shall closely approximate Pictorial Standard Sa 2-1/2 of SSPC-Vis 1.

All fasteners shall be black. Do not use direct tension indicators for non-coated weathering steel connections.

(3) Galvanized Members - After galvanizing, roughen surfaces of galvanized slip critical connections by means of hand wire brushing. Power wire brushing is not allowed.

(c) Installation and Tightening:

(1) General - Fasteners shall be assigned lot numbers (including rotational capacity lot numbers) prior to shipping, and components shall be assembled when installed. Protect fasteners from dirt and moisture at the Project Site. Take from protected storage only as many fasteners as anticipated to be installed and tightened during a work shift. Return fasteners not used to protected storage at the end of the shift. Do not remove lubricant present in as-delivered condition. Clean and lubricate fasteners, if necessary, and retest before installation. Use lubricant according to 02560.70. Do not relubricate tension control fasteners designed to automatically provide the tension without consulting with the manufacturer.

Provide a tension measuring device at the Project Site if high-strength bolts are being installed and tightened. The device shall have capacity for the bolt being installed. Confirm the accuracy of the tension-measuring device through calibration by an approved testing agency at the start of work and at least annually. Use the tension-measuring device to calibrate wrenches if applicable, to assist the bolting crew in understanding and proper use of the method to be used, and to confirm the ability of the complete fastener assembly to be used in the work, including lubrication, if required, to satisfy the requirements of Table 00560-1.

Install fasteners with washers of specified size and quality, located as described below, in properly aligned holes, and tighten according to 00560.29(c-3) unless otherwise specified. Tighten to at least the tension specified in Table 00560-1 when all the fasteners are tight. Tightening may be done by turning the bolt while the nut is prevented from rotating when it is impractical to turn the nut. Impact wrenches, if used, shall be of adequate capacity and sufficiently supplied with air to tighten each bolt in 10 seconds.

Non-galvanized fasteners may be reused, if approved, but not more than once. Retightening previously tightened fasteners loosened by the tightening of adjacent fasteners will not be considered a reuse. Do not reuse galvanized fasteners.

Use bolt, nut and washer combinations from the same rotational-capacity lot.

Verify correct lengths of all AASHTO M 164 (ASTM A 325) bolts. In the tightened connection, the unthreaded portion of the bolt shall not jam against the internal threads of the nut. The bolt shall have full nut engagement with a positive stick-through. The space between the nut and the bolt head (the grip) shall include a threaded length of bolt at least three threads in length.

In these Specifications, "snug" is defined as having all plies of the connection in firm contact. Snugging shall progress systematically from the most rigid part of the connection to the free edges. The snugging sequence shall be repeated until the full connection is in a snug condition.

TABLE 00560-1

Required Fastener Tension in Bolts

Nominal Bolt Size (inch)	Minimum Tension (kips)
1/2	12
5/8	19
3/4	28
7/8	39
1	51
1 1/8	56
1 1/4	71
1 3/8	85
1 1/2	103

(2) Washer Requirements:

- Where the outer surface of the bolted parts has a slope greater than 1:20 with respect to a plane normal to the bolt axis, use a hardened, beveled washer to compensate for the lack of parallelism.
- Use a hardened washer under the element of the fastener (nut or bolt head) turned in tightening.
- Where AASHTO M 164 (ASTM A 325) bolts of any diameter are to be installed in an oversize or short slotted hole in an outer ply, use a hardened washer conforming to ASTM F 436.

- Where AASHTO M 164 (ASTM A 325) bolts of any diameter are to be installed in a long slotted hole in an outer ply, use plate washers or continuous bars of at least 5/16 inch thickness with standard holes. These washers or bars shall have sufficient size to completely cover the slot after installation. Make the plate washer from structural grade steel.
- Oversize and slotted holes shall be as defined by Manual of Steel Construction Load and Resistance Factor Design (AISC).

(3) Direct Tension Indicators (DTI's):

a. General - When direct tension indicators (DTI's) are used to indicate bolt tension, they shall be subjected to verification testing as described below and installed according to the method specified below. Unless otherwise directed, the DTI's shall be installed under the head of the bolt and the nut turned to tension the bolt. See 00560.29(c-2) for washer requirements. Follow the manufacturer's recommendations for the proper orientation of the DTI and additional washers, if any, required for the correct use of the DTI. The surface contacting the protrusions of a direct tension indicator shall not turn during the tightening operation. All direct tension indicators shall be new and unused and shall be mechanically galvanized according to 02560.40(b). Where tapered holes are found in washers that are in contact with the protrusions of DTI washers, the face with the smallest hole shall be placed against the DTI.

b. Verification Testing - Perform verification in a calibrated bolt tension-measuring device. Use a special flat insert in place of the normal bolt head holding insert. Three verification tests are required for each combination of fastener assembly rotational-capacity lot, DTI lot, and DTI position relative to the turned element (bolt head or nut) to be used on the Project. Install the fastener assembly in the tension-measuring device with the DTI located in the same position as in the work. The element not turned (bolt or nut) shall be restrained from rotation. The purpose of verification testing is to ensure that the fastener will be at or above the desired installation tension when the requisite number of spaces between the protrusions have a gap of 0.005 inches or less, and that the bolt will not have excessive plastic deformation at the minimum gap allowed on the Project.

Conduct verification tests in two stages. The bolt, nut, and DTI assembly shall be installed in such a manner that at least three, and preferably not more than five, threads are located between the bearing face of the nut and the bolt head. Tension the bolt first to the load equal to that listed in Table 00560-2 under Verification Tension for the grade and diameter of bolt. If an impact wrench is used, the tension developed using the impact wrench shall be no more than two-thirds the required tension. Subsequently, use a manual wrench to attain the required tension. Record the number of refusals of a 0.005 inch tapered feeler gauge in the spaces between the protrusions. The number of refusals for galvanized DTI's under the stationary element shall not exceed the number listed under Maximum Verification refusals in Table 00560-2 for the grade and diameter of bolt used. The maximum number of verification refusals for galvanized DTI's when used under the turned element shall be no more than the number of spaces on the DTI less one. The galvanized DTI lot will be rejected if the gauge is refused in all spaces.

After the number of refusals is recorded at the verification load, further tension the bolt until the 0.005 inch feeler gauge is refused at all spaces and a visible gap exists in at least one space. Record the load at this condition and remove the bolt from the tension-measuring device. The nut shall be able to be run down by hand for the complete thread length of the bolt, excluding the thread runout. If the nut cannot be run down for this thread length, the DTI lot shall be rejected unless the load recorded is less than 95 percent of the average load measured in the rotational capacity test for the fastener lot.

If the bolt is too short to be tested in the calibration device, verify the DTI lot on a long bolt in a calibrator to determine the number of refusals at the Verification Tension listed in Table 00560-2. The number of refusals shall not exceed the values listed under Maximum Verification Refusals in Table 00560-2. Another DTI from the same lot shall then be verified with the short bolt in a convenient hole in the work. Tension the bolt until the 0.005 inch feeler gauge is refused in all spaces and a visible gap exists in at least one space. Remove the bolt from the tension-measuring device. The nut shall be able to be run down by hand for the complete thread length of the bolt excluding the thread runout. Reject the DTI lot if the nut cannot be run down for this thread length.

c. Installation - Install fastener assemblies using DTI's in two stages. Hold the stationary element against rotation during each stage of the installation. First snug the connection with bolts installed in all holes of the connection and tensioned sufficiently to bring all the plies of the connection into firm contact. The number of spaces in which a 0.005 inch feeler gauge is refused in the DTI after snugging shall not exceed those listed under Maximum Verification refusals in Table 00560-2. If the number exceeds the values in the table, remove the fastener assembly and install and snug another DTI.

For galvanized DTI's under the stationary element, further tension the bolts until the number of refusals of the 0.005 inch feeler gauge is equal to or greater than the number listed under Minimum Installation Refusals in Table 00560-2. If the bolt is tensioned so that no visible gap in any space remains, remove the bolt and DTI, and replaced with a new properly tensioned bolt and DTI.

For galvanized DTI's under the turned element, the feeler gauge shall be refused in all spaces.

Table 00560-2

Direct Tension Indicators

Bolt Diameter (inch)	Verification Tension (Kips)	Maximum Verification Refusals	DTI Spaces	Minimum Installation Refusals
1/2	13	1	4	2
5/8	20	1	4	2
3/4	29	2	5	3
7/8	41	2	5	3
1	54	2	6	3
1 1/8	59	2	6	3
1 1/4	75	3	7	4
1 3/8	89	3	7	4
1 1/2	108	3	8	4

Table 00560-2 Notes:

Maximum Verification Refusals are for galvanized DTI's under a stationary element. The maximum number if Verification Refusals for galvanized DTI's under a turned element shall be no more than the number of spaces on the DTI less one.

Minimum Installation Refusals are for galvanized DTI's under a stationary element. The gauge shall be refused in all spaces when galvanized DTI's are used under a turned element.

(4) Tension Control Fasteners Tightening - When fasteners automatically provide the tension required by Table 00560-1 and have been qualified according to Section 02560 are to be installed, check a representative sample of not less than five bolts of each diameter, length and grade at the

Project Site in a device capable of indicating bolt tension. Include flat hardened washers in the test assembly, if required in the actual connection, arranged as in the actual connections to be tensioned. Demonstrate that each bolt develops a tension not less than 5% greater than required by Table 00560-1. Follow manufacturer's installation procedure for installation of bolts in the calibrating device and in all connections.

When using tension control fasteners which automatically provide the tension, install fasteners in all holes of the connection and initially tighten sufficiently to bring all plies of the joint into firm contact, but without yielding or fracturing the control or indicator element of the fasteners. Then further tighten all fasteners in sequence, progressing from the most rigid part of the connection to the free edges in a manner that minimizes relaxation of previously tightened fasteners. Proper tensioning of the fasteners may require more than a single cycle of partial tightening (snug-tightening) before final tightening of individual fasteners.

(5) Turn-of-Nut Tightening - Perform verification testing using a representative sample of not less than three bolt and nut assemblies of each diameter, length and grade used at the start of work in a device capable of indicating bolt tension. Demonstrate that the method for estimating the snug-tight condition and controlling the turns from snug-tight to be used by the bolting crew develops a tension not less than 5% greater than the tension required by Table 00560-1.

Install bolts in all holes of the connection and bring to a snug-tight condition. Sequence snug-tightening from the most rigid part of the connection to the free edges, and then retighten the bolts of the connection in a similar manner until all bolts are simultaneously snug-tight and the connection is fully compacted. Then tighten all bolts in the connection further by the amount of rotation specified in Table 00560-3. During the tightening operation prevent rotation of the part not turned by the wrench. Sequence tightening from the most rigid part of the joint to its free edges.

TABLE 00560-3

Nut Rotation from Snug-Tight Condition [1]

	Disposition of Outer Faces of Bolted Parts		
Bolt Length (underside of head to end of bolt)	**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 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]	2/3 turn	5/6 turn	1 turn

[1] Nut rotation is relative to bolt, regardless of the element (nut or bolt) being turned. For bolts installed by one-half turn and less, the tolerance shall be plus or minus 30°; for bolts installed by two-thirds turn and more, the tolerance shall be plus or minus 45°.

[2] No research has been performed by the Research Council on Structural Connections to establish the turn-of-nut procedure for bolt lengths exceeding 12 diameters. Therefore, the required rotation shall be determined by actual test in a suitable tension measuring device according to 00560.29(c-5).

(6) Lock-Pin and Collar Fastener Tightening - Install lock-pin and collar fasteners by methods and procedures as recommended by the manufacturer and approved.

When using lock-pin and collar fasteners, install lock-pins in all holes of the connection and initially snug-tighten sufficiently to bring all plies of the joint into firm contact, progressing systematically from the most rigid part of the connection to the free edges in a manner that minimizes relaxation of previously tightened fasteners. After all fasteners in the connection are snug-tight, fully tighten the fasteners, progressing systematically from the center most rigid part of the connection to its free edges. Ping the fasteners with a hammer for soundness. Remove and replace loose or relaxed fasteners with new fasteners to the satisfaction of the Engineer.

(d) Inspection - Before installing fasteners in the work, the Engineer will check the marking, surface condition and storage of bolts, nuts, and washers, and DTI's if used, and the faying surfaces of joints for compliance with 00560.29(c-1). The Engineer will observe calibration and/or testing procedures required in 00560.29(c-2) through 00560.29(c-5), as applicable, and will monitor the installation of fasteners in the work to confirm that the procedure is properly used and that, when so used with the fastener assemblies supplied, the tensions specified in Table 00560-1 are provided.

The Engineer will monitor the installation of fasteners in the work to assure that the selected installation method, as demonstrated in the initial testing to develop the specified tension, is routinely followed.

Either the Engineer or the Contractor, in the presence of the Engineer and with the Engineer's approval, shall inspect the tensioned bolts using an inspection torque wrench, unless alternate fasteners or direct tension indicators are used, allowing verification by other methods. Conduct inspection tests in a timely manner prior to prevent possible loss of lubrication, and before corrosion influences torque.

Place three fastener assembly lots, in the same conditions as those under inspection, individually in a device calibrated to measure bolt tension. Perform this calibration operation at least once each inspection day. There shall be a washer under the turned element in tensioning each bolt if washers are used on the structure. If washers are not used on the structure, the material used in the tension-measuring device that abuts the part turned shall be of the same specification as that used on the structure. In the calibrated device, each bolt shall be tensioned by any convenient means to the specified tension. Apply the inspecting wrench to the tensioned bolt to determine the torque required to turn the nut or head 5 degrees (approximately 1 inch at a 12 inch radius) in the tensioning direction. Take the average of the torque required for all three bolts as the job inspection torque.

Select at random ten percent (at least two) of the tensioned bolts on the structure represented by the test bolts in each connection. Apply the job inspection torque to each with the inspecting wrench turned in the tensioning direction. If this torque turns no bolt head or nut, the bolts in the connection will be considered to be properly tensioned. However, if the torque turns one or more bolt heads or nuts, apply the job inspection torque to all bolts in the connection. Retension and reinspect any bolt whose head or nut turns at this stage. The Contractor may, however, retension all the bolts in the connection and resubmit it for inspection, provided DTIs are not over-tensioned or fasteners assemblies are not damaged.

Labor

00560.30 Fabricators - Structural steel bridge fabricators shall have an American Institute of Steel Construction (AISC) Major Steel Bridges (Cbr) certification. For fracture critical structures, the fabricator shall also have an AISC Fracture Critical Endorsement (F). All fabricators of earthquake restraints shall have either a current AISC Cbr certification or a Simple Steel Bridge Structures (Sbr) certification.

Construction

00560.40 Members Work:

(a) General - Fabricate members true to line and free from twists, bends and open joints.

(b) End Connection Angles - Fabricate floor beams, stringers and girders having end connection angles to exact length shown, as measured between the heels of the connection angles, with a permissible tolerance of plus 0 to -1/16 inch. Where continuity is required, face end connections. Provide connection angles with a thickness of not less than 3/8 inch, nor less than shown after facing.

(c) Stiffeners - Fabricate end stiffeners of girders and stiffeners intended as supports for concentrated loads to have full bearing (either milled, ground, or on weldable steel in compression areas of flanges, welded as specified) on the flanges to which they transmit load or from which they receive load. Fabricate stiffeners not intended to support concentrated loads, according to paragraph 3.5.1.10 of AWS D1.5, unless specified otherwise.

(d) Abutting Members - Mill, saw-cut or flame cut abutting members carrying compression at joints in trusses, columns and girder flanges, to give a square joint and uniform bearing. At joints not required to be faced, the opening shall not exceed 1/4 inch.

(e) Annealing and Stress Relieving - Perform finished machining, boring and straightening on structural members which are specified to be annealed or normalized subsequent to heat treatment. Normalize and anneal (full annealing) according to ASTM A 941. Maintain the temperatures uniformly throughout the furnace during the heating and cooling so the temperature at no two points on the member will differ by more than 100 °F at any one time.

Make a record identifying the pieces in each furnace charge and show the temperatures and schedule actually used. Provide proper instruments, including recording pyrometers, for determining at any time the temperatures of members in the furnace. Provide the records of the treatment operation to the Engineer.

Stress relieve members, such as bridge shoes, pedestals or other parts that are built up by welding sections of plate together according to paragraph 4.4 of AWS D1.5, when specified.

(f) Facing of Bearing Surfaces - The surface finish of bearing and base plates and other bearing surfaces that are to come in contact with each other or with concrete shall conform to ANSI surface roughness requirements according to ANSI B46.1, Surface Roughness, Waviness and Lay, Part I, and the following table:

Member	Maximum Surface Roughness
Steel slabs	2,000 microinch
Heavy plates in contact with shoes to be welded	1,000 microinch
Milled ends of compression members, milled or ground ends of stiffeners and fillers	500 microinch
Bridge rollers and rockers	250 microinch
Pins and pin holes	125 microinch
Sliding bearings	125 microinch

(g) Pins and Rollers - Turn pins and rollers to the dimensions shown. Make them straight, smooth and free from flaws. Pins and rollers more than 9 inches in diameter shall be forged and annealed carbon-steel shafting. Pins and rollers 9 inches or less in diameter may be cold-finished or forged and annealed carbon-steel shafting.

In pins larger than 9 inches in diameter, bore a hole not less than 2 inches in diameter full length along the axis after the forging has cooled to a temperature below the critical range, under conditions that prevent injury by too rapid cooling, and before annealing.

Provide threads for all bolts and pins for structural steel construction according to ASME B1.1, Unified Inch Screw Threads, Class 2A for external threads and Class 2B for internal threads, except for pin ends having a diameter of 1 3/8 inch, or more, use a thread pitch of 6 threads per inch.

(h) Pin Holes - Bore pin holes true to the specified diameter, smooth and straight, at right angles to the axis of the member and parallel with each other unless otherwise specified. Produce the final surface by a finishing cut.

The diameter of the pin hole shall not exceed that of the pin by more than 0.02 inch for pins 5 inches or less in diameter, or by 0.03 inch for larger pins.

The distance outside-to-outside of end holes in tension members and inside-to-inside of end holes in compression members shall not vary from that specified more than 1/32 inch. Bore holes in built-up members after the fabrication is completed.

(i) Shear Connectors - Fabricate shear connector studs with material, welding and inspection according to Section 7 of AWS D1.5.

00560.41 Repair of Defects - Do not begin the repair of defects in the fabricated material until the proposed corrective procedure has been approved.

00560.42 Cambering - Provide a smooth, unbroken curve or camber over the full length of the member when shown.

Camber roll beams in the fabricating shop by use of heat or hydraulic jacks. The temperature of the heated area shall not exceed 1,200 °F as controlled by pyrometric stick (temperature crayon) or thermometers. Do not quench to accelerate cooling.

Trim web plates of cambered plate girders before assembly.

Camber truss spans according to 00560.46.

00560.43 Shop Assembling:

(a) General - Assemble in the shop the field connections of main members of trusses, arches, continuous beam spans, bents, towers (each face), plate girders and rigid frames with milled ends of compression members in full bearing, and then ream their subsize holes to specified size while the connections are assembled. Use full truss or girder assembly, unless progressive truss or girder assembly, full chord assembly, progressive chord assembly, or complete structure assembly is specified.

Make check assemblies with numerically controlled punched or drilled field connections and template drilled field connections of rolled beam stringers continuous over floor beams or cross frames according to 00560.43(g).

Obtain approval for each assembly, including camber, alignment, accuracy of holes and fit of milled joints before reaming is commenced or before a numerically controlled drilled check assembly is dismantled.

Furnish a camber diagram, prepared by the fabricator, showing the camber at each panel point in the cases of trusses or arch ribs, and at the location of field splices and fractions of span length (quarter

points minimum, tenth points maximum) in the cases of continuous beam and girders or rigid frames. When the shop assembly is Full Truss or Girder Assembly or Complete Structure Assembly, show the camber measured in assembly. When any of the other methods of shop assembly is used, show calculated camber.

(b) Full Truss or Girder Assembly - Assemble all members of each truss, arch rib, bent, tower face, continuous beam line, plate girder or rigid frame at one time.

(c) Progressive Truss or Girder Assembly - Assemble, initially for each truss, bent, tower face or rigid frame, all members in at least three connecting panels, but not less than the number of panels in three connecting chord lengths.

Assemble, initially for each arch rib, continuous beam line or plate girder, at least three connecting shop sections.

Make successive assemblies with at least one panel or section of the previous assembly (repositioned if necessary and adequately pinned to assure accurate alignment) plus two or more panels or sections added at the advancing end.

In the case of structures longer than 150 feet, make each assembly not less than 150 feet long regardless of the length of individual continuous panels or sections.

The sequence of assembly may start from any location in the structure and proceed in one or both directions, so long as the preceding requirements are satisfied.

Obtain approval for assemblies consisting of less than three panels or shop sections.

(d) Full Chord Assembly - Assemble, with geometric angles at the joints, the full length of each chord of each truss or open spandrel arch, or each leg of each bent or tower, then ream their field connection holes while the members are assembled, and ream the web member connections to steel templates set at geometric (not cambered) angular relation to the chord lines. Mill at least one end of each web member or scribe normal to the longitudinal axis of the member and accurately locate the templates at both ends of the member from one of the milled ends or scribed lines.

(e) Progressive Chord Assembly - Assemble connecting chord members in the manner specified for Full Chord Assembly and in the number and length specified for Progressive Truss or Girder Assembly.

(f) Complete Structure Assembly - Assemble the entire structure, including the floor system.

(g) Check Assemblies with Numerically Controlled Punched and Drilled Field Connections - A check assembly consists of at least three connecting shop sections, or in a truss, all members in at least three connecting panels, but not less than the number of panels in three connecting chord lengths; that is, the length between field splices. Check assemblies shall be based on the proposed order of erection, joints in bearings, special complex points such as the portals of skewed trusses, and similar considerations, as directed. Check assemblies shall be the first such sections of each major structural type to be fabricated.

Use geometric angles (giving theoretically zero secondary stresses under dead-load conditions after erection) or cambered angles (giving theoretically zero secondary stresses under no-load conditions) as shown or specified.

No match-marking and no shop assemblies other than the check assemblies are required.

If the check assembly fails to demonstrate that the required accuracy is being obtained, further check assemblies may be required at no additional cost to the Agency. Acceptance of the check assembly does not relieve the Contractor of the responsibility for assuring accurate fit-up during erection.

(h) Match-Marking - Match-mark connecting parts assembled in the shop for the purpose of reaming holes in field connections, and furnish a diagram showing such marks to the Engineer.

00560.44 Coatings:

(a) Galvanizing - Galvanize as shown or specified according to 02530.70.

(b) Other Coatings - Unless otherwise shown or specified, prepare and coat all steel surfaces according to Section 00594.

00560.45 Marking and Transporting to Site - Handle members and transport to the Project Site according to 00560.24 and the following:

- Mark each member with an erection mark for identification and furnish an erection diagram showing the erection marks.
- Mark the weight of members weighing more than 6,000 pounds on the member.
- Load structural members on trucks or cars so they may be transported and unloaded without being excessively stressed, deformed or otherwise damaged.
- Ship fasteners (bolts, nuts, and washers) according to 02560.60(a-3).
- Do not allow welding to be done on the steel members for the purpose of transporting anchorage.
- List and describe the contained material plainly on the outside of each shipping container.
- Furnish as many copies of material orders, shipping statements and erection diagrams as directed and show the weights of the individual members on the statements.
- Brace the girders properly and adequately, so as to eliminate cyclic out-of-plane bending stresses in the web gap between the end of stiffener on the web and the girder flange due to cyclic swaying motion in transit. Take care to minimize dynamic loads transmitted to girder support points during transit.
- Furnish the Engineer stamped detail plans of loading, unloading, supporting and bracing of the steel plate girders on trucks or cars for shipment to the Project Site, according to 00150.35. The review will not relieve the Contractor of responsibility for safe transportation of steel members.

00560.46 Erecting:

(a) General - Erect the metalwork, remove temporary construction and do all work required to complete the structure(s), including the removal of the old structure(s) according to Section 00501, if specified.

(b) Methods and Equipment - Before starting the erection work, the erection method proposed and the amount and character of equipment to be used will be reviewed. This review will not relieve the Contractor of the responsibility for the safety of the method or equipment, or from carrying out the work in full according to the plans and specifications. Do not perform work until approval has been obtained.

(c) Falsework - Design, construct, maintain and remove falsework according to 00540.41, 00540.42, and 00540.52. Review of the Contractor's plans will not relieve the Contractor of any responsibility.

(d) Field Inspecting and Testing - All erecting work is subject to the Engineer's inspection. Provide all facilities required for a thorough inspection of the work. Material not previously inspected, as well as previously inspected material, will be inspected after delivery to the construction Site.

(e) Handling and Storing Materials - Handle and store materials at the erection site according to 00560.24 and 00560.45.

(f) Bearings and Anchorages - Test, furnish and place structure bearings according to Section 00582. Construct rockers, hangers and other anchorages made entirely of structural steel according to the following:

- Drill holes for anchor bolts and set them in portland cement grout, or preset them as specified.
- Locate anchors and set rockers or rollers considering variation from mean temperature at the time of setting, and anticipated lengthening of bottom chord or bottom flange due to dead load after setting. As nearly as practical, at mean temperature and under dead load, the rockers and rollers shall stand vertically and anchor bolts at expansion bearings shall center their slots.
- Provide full and free movement of the superstructure at moveable bearings. Make sure it is not restricted by improper setting or adjustment of bearings or anchor bolts and nuts.

(g) Assembling Steel - Handle the material carefully so no parts will be bent, broken or otherwise damaged.

Do not perform hammering which will injure or distort the members.

Prepare bearing surfaces and surfaces to be in permanent contact before the members are assembled.

Assemble the parts accurately as shown, following any match-marks.

Unless erecting by the cantilever method, erect truss spans on blocking that gives the trusses proper camber. Leave the blocking in place until the tension chord splices are completed and all other truss connections are pinned and bolted.

Use fitting-up bolts of the same nominal diameter as the high-strength bolts, and cylindrical erection pins 1/32 inch larger.

Fill 50% of the holes in splices and field connections with equal numbers of fitting-up bolts and cylindrical erection pins before bolting with high-strength bolts. Fill 75% of the holes in splices and connections carrying added construction loads during erection with equal numbers of fitting up bolts and erection pins.

Tighten permanent bolts in butt-jointed splices of compression members and in railings after the span, if movable, has been swung.

Perform all field welding according to AWS D1.5 and all interim specifications.

(h) Pin Connection - Use pilot and driving nuts when driving pins. Drive pins so the members take full bearing on them. Screw pin nuts up tight and burr the threads at the face of the nut with a pointed tool.

(i) Misfits - The correction of minor misfits involving small amounts of reaming, cutting, and chipping will be considered a legitimate part of the erection. However, immediately report to the Engineer any error in the shop fabrication or deformation resulting from handling, storage and transportation which prevents the proper assembling and fitting up of parts by the moderate use of drift pins, or by a

moderate amount of reaming and slight chipping or cutting. Have the correction method approved. Make the correction in the Engineer's presence. The Contractor shall be responsible for all misfits, errors and injuries. Make the necessary corrections and replacements as approved by the Engineer.

Finishing and Cleaning Up

00560.70 Finish (Non-Coated Weathering Steel Only) - Sandblast all exposed surfaces of AASHTO M 270 (ASTM A 709), Grade 50W non-coated weathering steel, according to SSPC-SP6, Commercial Blast Cleaning, SSPC's Steel Structures Painting Manual. The appearance of the blast-cleaned surface shall approximate Pictorial Standard Sa 2 of SSPC-VIS 1, Pictorial Surface Preparation Standards for Painting Steel Surfaces, except no mill scale particles will be allowed; only rust or mill scale stains down in the profile will be allowed. The use of acids to remove scale and stains in the field is not allowed.

Promptly clean exposed surfaces of steel contaminated with stains, oil or foreign material after the above sand blasting cleaning process, as directed, to preserve conditions for uniform weathering of steel.

Measurement

00560.80 Measurement - No measurement of quantities will be made for work performed under this Section. Estimated quantities of structural steel will be listed in the Special Provisions.

00560.81 Miscellaneous Metal - Minor metal parts such as access hole covers, frames, ladders, hangers, anchor bolts, scuppers, conduits, ducts, bearing devices and other structural steel shapes, unless otherwise provided, will be classified as structural steel.

The weight of miscellaneous metal will be included in the estimated quantity of structural steel specified.

Payment

00560.90 Payment - The accepted quantities of structural steel will be paid for at the Contract lump sum amount for the item "Structural Steel".

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

No separate or additional payment will be made for:

- bolts, studs or bearing devices made entirely of structural steel (such as rockers and hinges)
- fabricating, transporting and erecting the structure(s)
- furnishing, erecting, and removing falsework
- preparing and coating

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Section 00570 - Timber Structures

Description

00570.00 Scope - This work consists of furnishing and installing timber and glue-laminated timber in bridges and other timber structures as shown or directed. Timber and lumber will be identified as timber in this Section.

The terms "hardware" and "fastenings" include nails, spikes, bolts, washers and nuts, dowels, lag screws, timber connectors, truss rods and shoes, and all other metal used in timber construction.

Materials

00570.10 Materials - Furnish materials meeting the following requirements:

Coatings for Steel	00594
Coatings for Timber	02210
Connectors and Fasteners	02150
Driven Piles	00520
Galvanizing	02530.70
Glued Laminated Timber	02140
Preservative Treatment	02190
Timber	02130

When preservative treatment of timber is required, the plans or Special Provisions will indicate the type and kind of treatment.

00570.11 Metal Parts - Hot-dip galvanize all hardware and all other metal parts after fabrication according to 02530.70 or coat all hardware and all other metal parts after fabrication according to Section 00594.

00570.12 Timber Fabrication:

- Use either split ring or shear plate timber connectors as specified. Install in precut grooves of dimensions as recommended by the manufacturer.
- Fabricate all members including holes, grooves, and special cuts, requiring timber connectors before treatment.
- When prefabricating from templates or shop details, bore bolt holes not more than 1/16 inch from specified location and perpendicular to the face of the timber. Bore bolt holes according to 00570.41.
- Submit unstamped working drawings for review, according to 00150.35, for prefabricated material before fabrication.

00570.13 Timber Storage - Store timber on the site in orderly piles or stacks. Provide protection from the weather or direct sun by a suitable covering.

Open-stack untreated timber on supports at least 12 inches above the ground surface and sticker to permit air circulation between the tiers and courses. Provide 1/2 inch thick by 1 1/2 inch wide stickers. Place stickers with the wide face bearing against the timber and at a spacing that provides adequate support for the members for their full length. Align stickers vertically to prevent uneven support and warp during storage.

Store timber after fabrication in a manner that prevents alignment changes of the members before assembly.

Store, protect, and handle glue-laminated timber according to the American Institute of Timber Construction AITC 111 "Recommended Practice for Protection of Structural Glued Laminated Timber during Transit, Storage, and Erection".

Construction

00570.40 Treated Timber - Handle treated timber that prevents dropping, breaking of outer fibers, bruising, or penetrating the surface with tools. Use nylon slings to handle treated timber. Do not use cant hooks, peaveys, pikes or hooks.

When treated timbers are to be placed in a marine or brackish environments, field treated and untreated cuts, borings and other joint framings will not be allowed below high-water elevation.

Do not cut, frame, or bore treated timber after treatment unless necessary. If untreated wood is exposed by cutting, planing, sanding, or any other means, trim all cuts and abrasions in timber, and cover with two applications of a field preservative according to 02190.30.

Pour field preservative into all holes bored after treatment, or treat the holes with field preservative with an approved pressure hole treater. Treat all unfilled holes with field preservative and plug with treated plugs. Field treat according to 02190.30 and the recommendations of the manufacturer.

When forms or temporary braces are attached to treated timber with nails or spikes, fill the resulting holes by driving larger size galvanized nails or spikes flush with the surface, or plug holes as required for unfilled bolt holes.

00570.41 Fasteners:

- Bore holes for drift pins, drift bolts, and dowels either 1/32 inch smaller than or the same size of the actual pin diameter.
- Bore holes for bolts 1/32 inch to 1/16 inch larger than the bolt diameter. Accurately align holes in main members and side plates. Do not force drive bolts.
- Bore holes for truss rods with a bit 1/16 inch larger than the rod.
- Drive nails and spikes with sufficient force to set the heads flush with the surface of the wood. Deep hammer marks in wood surfaces are evidence of poor work and sufficient cause for removal of damaged material.
- Bore holes for lag screws in two parts as follows:
  - Bore the lead hole for the shank the same diameter as the shank and the same depth as the length of the unthreaded shank.
  - Bore the lead hole for the threaded portion a diameter equal to approximately two-thirds of the shank diameter.
- Use a malleable iron washer of the size and type designated under all bolt heads and nuts in contact with wood except under button-head bolt heads.
- Lock all nuts after final tightening with a second nut or use self-locking nuts.
- Countersink where smooth faces are required. Coat recesses formed for countersinking with field preservative according to 02190.30 and the manufacturer's directions. After the bolt or screw is in place, fill horizontal recesses with asphalt roofing cement.
- Install all fasteners and connections according to the manufacturer’s recommendations.

00570.42 Framing - Cut and frame all timber to a close fit so that the joints have even bearing over the entire contact surfaces. Shimming will not be allowed.

(a) Pile Bents - Drive piles according to Section 00520. No shimming on tops of piles will be allowed.

Select the piles for any one bent as to size, to avoid undue bending or distortion of the sway bracing.

Distribute the piles of varying sizes to secure uniform strength and rigidity in the bents of any given structure.

(b) Framed Bents - Provide true and even bearing of sills on pedestals or piles. Finish concrete pedestals so the sills or posts support framed bents with even bearing.

Fasten posts to sills as shown. Remove all earth from contact with all timber so there will be free air circulation around them.

(c) Caps - Place timber caps to obtain an even and uniform bearing over the tops of the supporting posts or piles.

(d) Bracing - Bolt or lag screw intermediate intersections of bracing.

00570.43 Stringers - Place stringers according to the following:

- Knots near edges will be in the top portions of the stringers.
- Outside stringers may have butt joints, but lap interior stringers to take bearing over the full width of the floor beam or cap at each end. Do not extend the stringer end more than 6 inches beyond the floor beam or cap.
- Separate the lapped ends of untreated stringers at least 1/2 inch and securely fasten where shown or specified.
- Stagger joints when stringers are two spans in length.
- Frame cross-bridging between stringers as shown, with full bearing at each end against the sides of stringers, and securely toe-nail with at least two nails in each end.

00570.44 Decking - Unless otherwise shown or specified, construct decking with 4 inch x 12 inch planking and covering materials.

(a) Planking - Provide planking that is surfaced on four sides (S4S).

Place planking heart side down with 1/4 inch opening between planks for seasoned material and with tight joints for unseasoned material. Spike planks securely to each stringer with a minimum of one 3/8 inch x 8 inch spike placed 3 inches in from each edge.

(b) Covering Materials - Cover the planking with one of the following:

- 2 inch x 2 inch timber strips, placed transverse to the planking and nailed with 16d galvanized common nails at 12 inch centers. Cover deck with a warranted waterproofing membrane according to Section 00591 and a Level 2, 1/2 inch Dense HMAC wearing surface according to Section 00745; or

- 1 inch thick tongue and groove structural CD exterior grade plywood. Nail the plywood with face grain parallel to stringers using 10d galvanized or zinc coated ring shank nails. Place nails at 6 inch centers along all edges and 12 inch maximum centers intermediate. Fasten expanded metal grillage with a minimum opening of 1/4 inch and a minimum thickness of 1/8 inch to the top of the plywood for the entire roadway area. Minimum fastening shall be at 12 inch centers each direction using 8d galvanized common nails. Cover deck with a warranted waterproofing membrane according to Section 00591 and a Level 2, 1/2 inch Dense HMAC wearing surface according to Section 00745.

00570.45 Wheel Guards and Railings - Frame wheel guards and railing as shown, and erect true to line and grade.

Unless otherwise specified, provide wheel guards, rails, and rail posts that are surfaced on four sides (S4S).

Lay wheel guards in sections not less then 12 feet long unless otherwise shown.

For trusses, build railings after the removal of the falsework and the adjustment of the trusses to correct alignment and camber.

00570.46 Trusses - Finished trusses shall show no irregularities of line. Chords shall be straight and true from end to end in horizontal projection and show a smooth curve through panel points conforming to the correct camber. Fit all bearing surfaces accurately. Uneven or rough cuts at the points of bearing will be cause for rejection of the piece containing the defect.

00570.47 Coating - When specified, coat timber bridges according to the manufacturer's recommendations.

Measurement

00570.80 Measurement - The quantities of all timber, except piling and glue-laminated timber, incorporated into the permanent, finished structure, will be measured on the volume basis, based on the nominal dimensions of the members and the actual dimensioned length. No allowance will be made for waste.

The quantities of glue-laminated timber members will be measured on the volume basis, based on the net dimensions of the members.

Driven piles will be measured according to 00520.80.

Warranted waterproofing membrane will be measured according to 00591.80.

Asphalt concrete wearing surface will be measured according to 00745.80.

Payment

00570.90 Payment - The accepted quantities of work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

	Pay Item	Unit of Measurement
(a)	Timber and Lumber	MFBM
(b)	Glued Laminated Timber	MFBM

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

Driven piles will be paid for according to 00520.90.

Warranted waterproofing membrane will be pair for according to 00591.90.

Asphalt concrete wearing surface will be paid for according to 00745.90.

No separate or additional payment will be made for hardware, fastenings, preservative treatment, and coatings.

Section 00581 - Bridge Drainage Systems

Description

00581.00 Scope - This work consists of furnishing and installing metal deck drains, drain pipe and appurtenances for bridges as shown, specified or directed.

Materials

00581.10 Materials - Furnish steel pipe of standard weight meeting the requirements of ASTM A 53 and galvanized after fabrication according to AASHTO M 111 (ASTM A 123).

Furnish deck drains, hangers, clamps, and other incidentals meeting the requirements of Section 02530 and Section 02560.

Construction

00581.40 General - To prevent movement during concrete placement, support the pipe and deck drains by ties and other approved devices according to 00530.41.

00581.42 Appurtenances - Provide a watertight connection to the deck drains in the bridge deck as shown or directed.

00581.50 Test Bridge Drainage Systems - Test bridge deck drains and pipe connections to the storm drain system according to Section 00445 to ensure that the drains and drain pipe are water tight and free of obstructions.

Measurement

00581.80 Measurement - The quantities of bridge deck drains will be measured on the unit basis of each deck drain installed.

Payment

00581.90 Payment - The accepted quantities of work performed under this Section will be paid for at the Contract unit price, per each, for the item "Bridge Drains".

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

No separate or additional payment will be made for drain pipe connected to bridge drains or for water used in testing the drain systems.

Section 00582 - Bridge Bearings

Description

00582.00 Scope - This work consists of the following:

(a) Composite Bearings - Design, fabricate, test and install composite bearings according to the latest AASHTO LRFD Design Specifications and Section 02570. The bearing fixity (fixed bearing, guided bearing, nonguided bearing) and restrictions about type of bearing (disc, fabric pad, pot, spherical) will be shown or specified.

(b) Elastomeric Bearings - Furnish, test, and install elastomeric bearings according to the AASHTO LRFD Construction Specifications and Section 02571.

(c) Rockers and Hangers - Furnish and install bearings, such as rockers and hangers, which consist entirely of structural steel, according to Section 00560.

00582.02 Definitions:

Composite Bearing - Bearing having a rotational element between an upper and a lower unit. This includes disc bearings, fabric pad bearings, pot bearings and spherical bearings.

Disc Bearing - Composite bearing whose rotational element is comprised of a polyether urethane disc with an upper and lower unit.

Elastomeric Bearing - Bearing consisting of a single layer of elastomer (plain) or of several layers of elastomer alternated with steel plates (reinforced).

Fabric Pad Bearing - Composite bearing whose rotational element is a preformed fabric pad.

Fixed - Restrained against all horizontal structural movement.

Guide Bars - The elements that restrain the lateral movement of a sliding bearing.

Guided - Able to accommodate structural movement in a specified horizontal direction.

Nonguided - Able to accommodate structural movement in all horizontal directions.

Pot Bearing - Composite bearing whose rotational element is a piston supported on an elastomeric disc, totally confined within a base pot cylinder.

Spherical Bearing - Composite bearing whose rotational element consists of an upper plate with a spherical concave bottom surface and a lower plate with a spherical convex top surface.

Materials

00582.10 Materials - Furnish materials from the QPL and meeting the requirements of Section 02570 and Section 02571, as applicable.

00582.20 Composite Bearings - Unless otherwise shown, use only one type of composite bearing per bridge, subject to the following requirements:

- Make composite bearings, including all plates except distribution plates and masonry plates, removable and replaceable.

- Provide rotational elements between upper and lower units to meet the following:

  - **Upper Unit** - The upper unit shall consist of a distribution plate that is permanently attached to the superstructure and a sole plate attached to the distribution plate with cap screws. For a guided or nonguided bearing, a stainless steel sheet shall be welded to the bottom surface of the sole plate.

  - **Lower Unit** - The lower unit shall consist of a masonry plate permanently anchored to the structural support and a base plate attached to the masonry plate with cap screws. A separate masonry plate and base plate are not necessary for fabric pad bearings fabricated as outlined in 00582.27, third paragraph.

  - **Bearing-to-Base Connection:**

    - The base pot of a pot bearing, the lower bearing plate of a disc bearing, or the convex plate of a spherical bearing shall be welded to the base plate.
    - For guided or nonguided bearings, a polytetrafluoroethylene (PTFE) sheet shall be recessed into and bonded to the top surface of the piston of a pot bearing, the upper bearing plate of a disc bearing, the top surface of the concave plate of a spherical bearing, or a steel backing plate bonded to the top surface of a fabric pad forming a sliding surface with the stainless steel surface of the sole plate.
    - For fixed bearings, the piston of a pot bearing, the upper bearing plate of a disc bearing, or the concave plate of a spherical bearing shall be welded to the sole plate.

  Provide bearings that accommodate the loads, movements, and rotations as shown.

  Use schematic drawings, and/or details of bearings shown, to describe the attachment of the upper unit to the superstructure, and the attachment of the lower unit to the substructure.

00582.21 Disc Bearings - Design disc bearings according to the following:

- The shear restriction mechanism shall allow free rotation but prevent any shear being applied to the rotational element.
- Each guided bearing shall resist the total horizontal load at the bent or hinge where it is located.

00582.25 Composite Bearings with Polytetrafluoroethylene (PTFE) Sliding Surface:

(a) PTFE Sliding Surfaces - Recess PTFE 1/16 inch into the material it is bonded to for all composite bearings.

Bond PTFE to the steel substrate sufficiently to develop a horizontal force as shown and not less than 10% of the vertical design capacity shown, in addition to the shear force developed as a result of the natural bearing friction shear force.

(b) PTFE Rotational Surface for Spherical Bearings - Use only woven PTFE having a minimum thickness of 1/8 inch. The PTFE shall be recessed 1/16 inch into the spherical element.

PTFE fabric minimum thickness shall be 1/16 inch when measured according to ASTM D 1777.

(c) Stainless Steel Sliding Surfaces - Provide a flat stainless steel sliding surface which completely covers the PTFE surface in all operating positions, plus at least 2 inches more in every direction of possible movement.

Provide a spherical stainless steel rotational surface attached to the convex surface of the spherical convex plate of each spherical bearing so that it completely covers the convex surface of the plate.

00582.26 Guide Bars for Composite Bearings - Provide a sliding surface between the guide bars and the guide element made of polished stainless steel against virgin PTFE. The virgin PTFE shall be bonded and mechanically fastened to the guide bars. Provide guide bars that:

- Resist the horizontal design forces on the bearing, but not less than 10% of the vertical design load of the bearing.
- Resist the total horizontal load at the bent or hinge where it is located. Do not include the resistance due to bearing friction as part of the horizontal load capacity of guided bearings and fixed bearings.
- Are Integral and machined from a solid plate, or attached by welding or with cap screws, or fabricated from a single steel plate.
- Have a space equal to 3/16 inch plus or minus 1/16 inch to the guided member.
- Allow the guided member to be always within the guides at all points of translation and rotation of the bearing. Avoid guiding the member off the fixed base or any extension of it where transverse rotation is anticipated.

00582.27 Sole, Base, Distribution, and Masonry Plates for Composite Bearings - Make the bottom surface of sole plates flat and level. Make the top surface flat, and sloped as required to mate with the bottom surface of the distribution plate.

Use 3/4 inch minimum plates, except sole plates may taper to 5/8 inch at the thinnest edge.

For fabric pad bearings, keeper bars at least 1/4 inch thick shall be fastened to the top surface of the base plate, around the perimeter of the fabric pad, with high-strength cap screws. Provide a gap at all bar ends to allow drainage.

Provide studded anchors or threaded bolts, as shown or specified, to anchor the masonry plates to the supported and supporting members. Locate anchoring devices to avoid conflict with metal reinforcement and prestressing systems.

00582.30 Fabrication - Fabricate bearings according to the reviewed working drawings and these Specifications.

(a) Working Drawings - Submit unstamped working drawings according to 00150.35 for both composite bearings and elastomeric bearings.

(1) Composite Bearings - For composite bearings, include:

- Complete details of the anchor layout
- Plan and elevation of the bearing showing dimensions and tolerances
- Complete details of all components with sections showing all materials incorporated into the bearing
- All ASTM or other material designations
- Vertical and horizontal force capacity
- Compressive stresses on all sliding surfaces, and on elastomeric polyether urethane and cotton duck surfaces, at maximum and minimum design loads
- Rotational capacity

- Translation capacity for guided and nonguided bearings
- Instructions for installation of the bearing

(2) Elastomeric Bearings - For elastomeric bearings, include:

- The overall dimensions of the bearings
- The durometer hardness of the elastomer and the ASTM designation of reinforcing materials, if any
- The thicknesses of the components of reinforced bearings and the cover over edges of reinforcements

(b) Minimum Requirements for Composite Bearings:

(1) Edges - Grind edges of all parts of the bearing so that sharp edges are eliminated.

(2) Welding - Perform all welding and inspection of welding for structural steel according to 00560.26.

(c) Special Requirements for Horizontal Capacity of Composite Bearings - Submit stamped calculations supporting the design for horizontal force capacity, according to 00150.35. Calculations are not required when the design horizontal capacity is less than, or equal to, 10% of the design vertical capacity. A horizontal proof load test report may be submitted instead of engineer's calculations. See 002570.20(b) for test requirements.

00582.31 Disc Bearings - Fabricate upper and lower bearing plates as follows:

- Connect the lower bearing plate to base plate by means of a fillet weld around entire perimeter of the lower bearing plate.
- For a fixed bearing, connect upper bearing plate to the sole plate by means of a fillet weld around the entire perimeter of upper bearing plate.

00582.32 Fabric Pad Bearings - Fabricate fabric pad bearings according to the following:

(a) Steel Backing Plate - Minimum thickness of the steel backing plate shall be 3/8 inch.

Bond the backing plate to the top surface of the fabric pad under controlled conditions and according to the written instructions of the manufacturer of the adhesive system specified by the fabric pad manufacturer.

Finish the surface of steel recess to a surface roughness of 250 microinches or better, and to Class A flatness:

(b) Fabric Pad - Maximum allowable bearing pad thickness is 4 inches. For pads over 2 inches thick, place an 11 gauge steel shim at mid-depth.

00582.33 Pot Bearings - Fabricate pot bearings according to the following:

(a) Pot - Fabricate the pot from one solid plate by machining.

Finish the top and bottom surfaces of the pot cylinder to Class A flatness.

Connect the pot cylinder to the base plate by means of a fillet weld around the entire perimeter of the pot cylinder.

(b) Piston - Fabricate the piston from one solid plate by machining.

Finish the top surface to Class A flatness.

Finish the bottom surface to Class C flatness.

For a fixed bearing connect the piston to the sole plate by means of a fillet weld around the entire perimeter of the piston.

(c) Elastomeric Disc - Make the disc in one piece.

Recess the upper edge of the elastomeric disc to accommodate the flat brass sealing rings.

Lubricate the disc with a material compatible with the elastomer.

00582.34 Spherical Bearings - Fabricate spherical bearings according to the following:

(a) Spherical Concave Plate:

Finish top surface to a roughness of 125 microinches or better, and Class A flatness.

Fabricate the concave radius of the bottom surface to have a positive tolerance not to exceed 0.010 inch according to ANSI Y14.5.

For a fixed bearing, connect to the sole plate by means of a fillet weld around the entire perimeter of top surface of spherical concave plate.

(b) Spherical Convex Plate - Fabricate the top convex stainless surface from one of the following:

- Solid stainless steel ASTM A 240, Type 304 or 304L
- Stainless steel weld overlay a minimum of 3/32 inch thick

Fabricate convex radius of the top surface to have a negative tolerance not to exceed 0.010 inch according to ANSI Y14.5.

Finish the top surface to a roughness of 20 microinches or better, and other surfaces to a roughness of 250 microinches or better.

Finish the bottom surface to Class B flatness.

Connect to base plate by means of a fillet weld around entire perimeter of bottom surface of spherical convex plate.

00582.35 Composite Bearings with Polytetrafluoroethylene (PTFE) Sliding Surfaces:

(a) PTFE Sliding Surfaces - Bond PTFE to steel substrate under controlled conditions and according to the written instructions of the manufacturer of the adhesive system specified by the PTFE manufacturer.

After completion of the bonding operation, the PTFE surface shall be smooth and free of bubbles.

(b) Stainless Steel Sliding Surfaces - Attach stainless steel to steel substrate by a seal weld around entire perimeter of stainless steel sheet. Clamp stainless steel sheet down to have full contact with the steel substrate during welding. Fabricate so welds do not protrude beyond the sliding surface of the stainless steel.

00582.36 Guide Bars for Composite Bearings - Construct guide bars parallel to the surface on which they bear and to other guide bars to within a tolerance of plus or minus 1/32 inch for the full length of the bar.

The tolerance for section dimensions is plus or minus 1/16 inch.

If guide bars are welded to the sole plate, weld before attaching the stainless steel surface.

00582.38 Coatings for Steel Bearings - Coat all exposed steel surfaces, except stainless steel, according to Section 00594.

00582.39 Elastomeric Bearings - Fabricate elastomeric bearings according to the following:

(a) Pads - Pads 1/2 inch and less in thickness shall be made entirely of elastomer. Pads over 1/2 inch in thickness shall consist of alternate laminations of elastomer and metal.

(b) Pad Sizing - Mold pads individually to the sizes required. No shearing to size or drilling of holes will be allowed except pads 1/2 inch and less in thickness may be sheared.

(c) Tolerances and Finishes - Tolerances and finishes shall be according to 002571.20(d).

00582.40 Shipping and Handling - Protect all bearings from damage during shipment, and keep them dust-free. Protect composite bearings as follows:

- Fully assemble each bearing at the manufacturing plant and deliver to the construction site as a complete unit ready for installation.
- Mark centerlines on the sole plate and base plate for checking alignment in the field.
- Hold bearings together with removable restraints so the sliding surfaces are not damaged.
- Ship and store bearings in lightproof, moisture-proof and dustproof packages.

Construction

00582.50 Installation - Use only one type of bearing on any one bridge unless shown, specified or directed otherwise.

(a) Composite Bearings - Install composite bearings as follows:

- Obtain approval of the bearing assembly proposed for use before constructing the upper portions of the supporting structure so bearing elevations may be properly determined.
- Before constructing bridge bearing seats, inform the Engineer in writing, of the total bearing thickness.
- Do not place bridge bearings on concrete bearing areas that are irregular or improperly prepared.
- Install bearings level and according to the manufacturer's recommendations, subject to these Specifications.
- Install bearings in exact positions, and with full and even bearing.
- Protect the sliding surfaces of PTFE bearings from contact with concrete or other foreign matter.
- To prevent gouging and contamination, install bearing with the stainless steel surface on top of the PTFE interface.

(b) Elastomeric Bearings - Construct bearing seats for elastomeric bearings parallel to the bottom surfaces of the members which will bear on them. Install as follows:

- Set elastomeric bearing pads directly on the concrete pad surface.
- Provide for a uniform bearing over the entire area of the bearing seat and over the entire area of the superstructure member in contact with the bearing pad.
- Keep pads in correct position during erection of superstructure members.

(c) Cleanup - Remove all forms and debris that interfere with the free action of the bearing assemblies.

Measurement

00582.80 Measurement - The quantities of work performed under this Section will be measured according to the following:

(a) Composite Bearings - Composite bearings will be measured on the unit basis, of bearing devices in place which includes all components from the bearing seat attachment through the superstructure attachment.

(b) Elastomeric Bearing Pads - Elastomeric bearing pads will not be measured.

Payment

00582.90 Payment - The accepted quantities of bridge bearings will be paid for at the Contract unit price, per each, for the item "Bearing Devices, Bent ___".

The bent number will be inserted in the blank.

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary for complete the work as specified.

No separate or additional payment will be made for designing, fabricating, and testing composite bearings.

(b) Elastomeric Bearing Pads - No separate payment will be made for elastomeric bearing pads. This item is included in one or more of the listed items.

Section 00583 - Electrical Conduit In Structures

Description

00583.00 Scope - This work consists of furnishing and installing electrical conduit in structures as shown or as directed.

Materials

00583.10 Materials - Furnish galvanized rigid metal or intermediate metal conduit meeting the requirements of 02920.10, and nonmetallic schedule 40 conduit meeting the requirements of 02920.11. Furnish other materials meeting the requirements of Section 00960 and Section 02920.

Construction

00583.40 General - Install conduit as shown and specified, according to the applicable portions of 00530.41 and Section 00960.

Install galvanized steel conduit on all runs externally attached to structures, and all runs stubbing out of the structure or entering conduit expansion devices. Where nonmetallic conduit is installed elsewhere in the run, the conduit segment stubbing out or entering the expansion device shall have a minimum length of 5 feet of galvanized rigid metal embedded within the concrete.

Install embedded conduit in concrete members with 2 inch clearance from the nearest face of concrete.

Measurement

00583.80 Measurement - The quantities of electrical conduit in structures will be measured on the length basis, including the stub-outs if shown.

Payment

00583.90 Payment - The accepted quantities of electrical conduit in structures will be paid for at the Contract unit price, per foot, for the item " ____ inch Electrical Conduit".

The size of the conduit will be inserted in the blank.

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

No separate or additional payment will be made for junction boxes, cabinets, expansion joints, fittings, or fasteners.

Section 00584 - Elastomeric Concrete Nosing

Description

00584.00 Scope - This work consists of furnishing and placing elastomeric concrete nosing to form a bulkhead at bridge ends or at expansion joints, including cleaning and preparing the concrete or steel surfaces as shown and specified.

Materials

00584.10 Materials - Furnish elastomeric concrete nosing using materials from the QPL and the following:

Provide materials delivered in their original, undamaged containers bearing the manufacturer's label with the following information:

- Product name
- Component part
- Name and address of manufacturer
- Date of manufacture
- Use-by date
- Batch number
- Mixing ratio

Provide sufficient materials in storage at the site prior to beginning construction to complete the entire elastomeric concrete nosing as detailed on the plans or as directed. Store the materials to prevent damage by the elements and to ensure the materials maintain their original quality.

Store the materials so that the storage space is dry and maintains a temperature as recommended by the manufacturer. Use only stored materials that meet these requirements at the time of use.

If used, the promoter/initiator for the methacrylate resin may consist of a metal drier and peroxide. Do not mix the metal drier directly with the peroxide. Store the containers so that no leakage from one material contacts the containers of the other materials.

Equipment

00584.20 Equipment - Use equipment recommended by the product manufacturer and approved by the Engineer.

Labor

00584.30 Manufacturer's Representative - Provide a manufacturer’s representative on-site during the installation of the elastomeric concrete nosing. The manufacturer’s representative shall be either someone independent of the Contractor’s work force or a member of the Contractor's work force that possesses certification from the manufacture that the Contractor's representative has the knowledge, skills, and training to install the elastomeric concrete nosing. Discuss the work to be done with the manufacturer's representative to review the methods of installation and the equipment needed before beginning the work.

The representative shall advise both the Engineer and the Contractor on proper installation procedures to assure correct installation of the elastomeric concrete nosing.

Mix, place, and cure the elastomeric concrete nosing according to the recommendations of the manufacturer's representative.

Construction

00584.40 General - Construct elastomeric concrete nosing according to the following:

(a) Training - Use installers trained in application methods and in the health and safety requirements specific to the materials used.

(b) Safety - Make available to workers any manufacturer's safety precautions for hazardous chemicals. Ensure that all workers wear appropriate impermeable protective clothing when using hazardous chemicals.

(c) Weather Conditions at Time of Installation - Do not proceed with installation until the weather conditions meet the requirements of the manufacturer's representative.

00584.41 Surface Preparation - Ensure that all surfaces to receive elastomeric concrete nosing material are sound, dry, clean, frost free, and sand blasted at the time of nosing installation. Sandblast steel contact surfaces to SSPC-10, "Near-White Blast Cleaning", immediately before constructing the nosing. Prepare the deck surface according to these Specifications and the material manufacturer's recommendations.

00584.43 Elastomeric Concrete Placement - When an asphaltic concrete overlay is to be used as the wearing surface, place a bond breaker on the area where the concrete nosings are to be constructed before placing the asphaltic concrete overlay over the bridge deck joints. After the overlay is placed, sawcut the overlay to the width shown on the plans, remove the overlay material in the joint area and construct the elastomeric concrete nosing.

Prepare the elastomeric concrete nosing material by mixing the aggregate at the recommended temperature with the mixed binder. Clean and dry the bonding surfaces and prepare joint surfaces according to the manufacturer's recommendations. Place the properly mixed elastomeric concrete into the prepared area on each side of the expansion joint. Compact and trowel the elastomeric concrete to the required shape.

Form and cast the elastomeric concrete nosing to smoothly match the surface of the finished roadway. Finish the surface to a moderately rough texture such as that produced by a wood float.

Protect the elastomeric concrete nosing material from damage, and allow the nosing to cure properly prior to opening the work area to traffic. Do not open up to traffic without the approval of the manufacturer's representative.

00584.75 Warranty - Provide a manufacturer's warranty that the elastomeric concrete will not delaminate, debond, rut, or otherwise fail to perform for two years. Acts of god, or failures adjacent to the installation would not be included. The manufacturer will replace or repair the installation using specification materials.

The Warranty period will start on the date the Engineer accepts the work and authorizes final payment.

The Warranty shall recite that the manufacturer is required to repair or replace, at the discretion of the Engineer, all elastomeric joint nosings that fail during the warranty period at no additional cost to the Agency. The repairs shall be made within six months of the Agency's written request to do so.

Perform Warranty repair work when weather permits. At the discretion of the Engineer, temporary repairs may be required at the manufacturer's expense to protect traffic until permanent repairs can be made.

Measurement

00584.80 Measurement - The quantities of elastomeric concrete nosing will be measured on the length basis, from face of curb to face of curb taken along the centerline of the joint, between the outer limits of the installed material. Only one measurement will be taken along each installed joint, regardless of the number of recesses, openings, or voids filled with the elastomeric concrete nosing material.

The estimated quantities of elastomeric concrete nosing is based on a nominal depth of 2 inches.

The quantities of elastomeric concrete nosing deeper than 2 inches will be measured on the volume basis to the nearest 0.05 cubic yard.

Joint seal material will be measured according to 00585.80.

Payment

00584.90 Payment - The accepted quantities of work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

	Pay Item	Unit of Measurement
(a)	Elastomeric Concrete Nosing	Foot
(b)	Elastomeric Concrete Nosing Material	Cubic Yard

Item (a) includes elastomeric concrete nosing installed to a nominal depth of 2 inches.

Item (b) includes materials only for concrete nosing depths greater than 2 inches.

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

Payment for the elastomeric concrete nosing will be limited to 75% of the amount due until the Agency has received the signed warranty.

Joint seal material will be paid for according to 00585.90.

No separate or additional payment will be made for providing the manufacturer's representative or for furnishing the warranty.

Section 00585 - Expansion Joints

Description

00585.00 Scope - This work consists of the fabrication, joint preparation, and installation of expansion joints as shown or specified.

00585.01 Definitions:

Armored Corner - Steel armoring to protect the vertical edges of a joint opening. The armor may be steel angles or steel shapes.

Asphaltic Plug Joint - A closed expansion and contraction joint system composed of aggregate and flexible binder material placed over a steel bridging plate.

Closed Expansion Joint - A joint in which a seal material is placed to prevent water or debris from entering the joint. This includes poured joint seals, preformed compression joint seals, asphaltic plug joints, performed strip seal systems, and modular expansion joint systems.

Filled Joint - A joint using a preformed filler, poured joint filler, traffic loop sealant, or a combination of these materials.

Modular Expansion Joint System - A closed expansion and contraction joint using a series of continuous preformed polychloroprene strip seals inserted into steel shapes to seal the joint.

Poured Joint Seals - A closed expansion and contraction joint sealed with a rapid-cure poured joint sealant.

Preformed Compression Joint Seal - A closed expansion and contraction joint sealed with a continuous preformed polychloroprene elastomeric compression gland.

Preformed Strip Seal System - A closed expansion and contraction joint using a continuous preformed polychloroprene elastomeric gland (strip seal) inserted into an extruded or formed steel retainer bar with steel anchors.

Materials

00585.10 Materials - Furnish expansion joints using materials from the QPL and meeting the following requirements:

Asphaltic Plug Joint Binder	as specified or as recommended by the manufacturer
Asphaltic Plug Joints	02440.19
Backer Rod	02440.14
Elastomer	02570.10
Hot Poured Joint Filler	02440.30
Lubricant/Adhesive	02440.15
Polytetrafluoroethylene (TFE)	02570.10
Poured Joint Sealant	02440.11
Preformed Joint Filler for Concrete	02440.10
Preformed Joint Seals	02440.20
Stainless Steel Sliding Surfaces	02570.10
Structural Steel	02530
Traffic Loop Sealant	00990

00585.11 Approval of Materials - Submit QPL listed products to the Engineer for Project specific approval.

Equipment

00585.20 Equipment - Use approved equipment as recommended by the product manufacturer.

Labor

00585.30 Closed Expansion Joint Installers - Use installers trained by the manufacturer in application methods of materials and health and safety to install closed expansion joints as detailed.

00585.31 Closed Expansion Joint Manufacturer's Representative - Provide a manufacturer's representative on-site during the installation of closed expansion joints. The manufacturer's representative shall be either someone independent of the Contractor's work force or a member of the Contractor's work force that possesses certification from the manufacturer that the Contractor's representative has the knowledge, skills, and training to install the expansion joints.

The representative shall advise both the Engineer and the Contractor on proper installation procedures to assure correct installation of expansion joints.

Construction

00585.40 Filled Joints - Unless otherwise specified, form filled joints with preformed joint filler by placing concrete directly against the preformed joint filler material. Provide formwork behind the preformed joint filler material firm enough to prevent deflection of the joint material when placing the concrete, or place preformed joint filler against formed concrete. If shown or specified, place traffic loop sealant or pour joint filler at the top of the joint.

00585.41 Closed Expansion Joints - The following requirements apply to all closed expansion joints:

(a) Submittals - Submit stamped working drawings according to 00150.35 for each expansion joint at least 21 calendar days before beginning work.

(1) Design - Joints shall be designed to:

- Prevent the entrance of water and incompressible materials into the joint.
- Produce no appreciable elevation changes in the deck surface plane with the expansion and contraction movements of the structure.
- Accommodate the required structure movements shown on the plans.
- Support a wheel load (plus impact) corresponding to the design load shown on the plans.

(2) Shop Drawings - Submit shop drawings including, but not limited to:

- Plan, elevation and section of the joint system with dimensions and tolerances.
- Complete details of all joint materials with all ASTM, AASHTO or other material designations.
- Method of installation including sequence and installation details at traffic barriers, roadway surfaces, curbs and sidewalks.

(3) Additional Submittals for Modular Joints - See 00585.47(b) for submittals for modular joints.

(4) Notification - Notify the Engineer in writing at least seven calendar days prior to installation of the joint. Include the Contract number, bridge number, joint seal material, product name and the approximate date of installation.

(5) Certificate of Compliance - Provide the Engineer with a certificate of compliance 21 calendar days before beginning work, including the manufacturer's name, prior to joint installation, verifying that the materials as furnished will meet the requirements of these Specifications.

(b) Safety - 21 calendar days before beginning work, provide safety precautions from the manufacturer for hazardous chemicals. Wear appropriate impermeable protective clothing when using hazardous chemicals.

(c) Joint Preparation - Prepare the joint surfaces as directed in this Section and the material manufacturer's recommendations. Ensure that all joint surfaces to receive a seal are sound, dry, clean and frost-free at the time of joint installation. Remove expansion joint material from existing joints and construct the required joints as detailed. Repair existing joints of spalled, cracked or deteriorated concrete as shown or as directed to provide a uniform and smooth surface along the joint.

(d) Weather Conditions at Time of Installation - Install joint seals when the joint is dry and meets the manufacturer's technical representative's approval.

(e) Leakage Check - Check joints for leakage after rainfall has occurred or by flooding the joint with water. If leakage is observed, repair the joints at no additional cost to the Agency and according to the manufacturer’s recommendations.

00585.42 Armored Corners - Provide joint corner armoring and anchors as shown or specified, and according to the following:

(a) Tolerance - Install armored corners that are straight and do not deviate from a true line by more than 1/4 inch horizontal and 1/8 inch vertical over the length of the joint, nor more than 1/16 inch in either direction from a 12 foot straight edge.

Maintain a minimum cross sectional thickness of 3/8 inch when measuring the vertical backwall and the flanges of the steel retainers that act as the locking edge rails for strip seal joints. The steel retainer rails may be manufactured from rolled shapes and plates or may be hot-rolled steel with the gland groove milled after rolling.

(b) Installation - Furnish armored corners in the longest practical length as controlled by transportation and installation.

Fabricate steel according to Section 00560. Sandblast steel shapes just prior to installation. Use welding procedures conforming to AWS D1.1.

For new construction, install armored corners in preformed blockouts a minimum of 14 days after the deck is cast with the joint opening as shown. Support the armored corners securely in position before placing concrete or elastomeric concrete in the joint blockout. Install the preformed seal a minimum of seven days after the concrete blockouts have been cast and after the deck concrete reaches 3,000 psi. For elastomeric concrete installations, install the preformed seal a minimum of 24 hours after placing the strip rails in the elastomeric concrete.

00585.43 Asphaltic Plug Joints - Furnish and install asphaltic plug joints according to the following:

(a) General - Provide a plane surface on which to place the steel bridging plate. Use elastomeric concrete as needed to repair the deck surface of new or existing concrete.

(b) Installation Procedures - Install asphaltic plug joints according to the binder manufacturer's recommendations.

Place poured joint sealant in curbs and sidewalks.

00585.44 Poured Joint Seals - Install poured joint seals according to the manufacturer's recommendations.

00585.45 Preformed Compression Joint Seals - Install preformed compression joint seals according to the manufacturer's recommendations and the following:

- In one continuous strip that extends across the full roadway width and into the curbs without splices.
- So they remain in compression throughout the design movement range. Provide for maximum and minimum compressive pressures according to AASHTO M 297 (ASTM D 3542).

Base the compression joint seal nominal size on the design movement of the joint and the seal's anticipated compression set.

00585.46 Preformed Strip Seal Systems - Install preformed strip seal systems according to the manufacturer's recommendations and the following:

(a) General - Use steel retainers acting as the locking edge rails that have a minimum cross sectional thickness of 3/8 inch for the vertical backwall and flanges. The steel retainers may be manufactured from extruded or hot-rolled steel.

Furnish steel extrusions in the longest practical length as controlled by transportation and installation. Make steel extrusion splices with an approved weld according to AWS D1.1.

Field weld rail segments that are too long to ship in one piece according to AWS D1.1.

Base the joint opening between retainer bars on structure temperature at the time of joint placement and the designed temperature movement rating.

(b) Installation Procedure - Install seals in one continuous strip, extending across the full roadway width and into the curbs without splices.

Remove all lubricant/adhesive from the top of the installed seal before the adhesive sets.

00585.47 Modular Expansion Joint Systems - Design, fabricate, install, inspect, and water test modular expansion joint systems according to the manufacturer's recommendations and the following:

(a) General - Furnish factory-fabricated modular expansion joints of multi-cell assemblies preset by the manufacturer before shipment, according to the approved working drawings.

Use expansion joint seals of one continuous strip extending across the full roadway width and into the curbs as shown.

Field weld rail segments that are too long to ship in one piece.

(b) Submittals - In addition to the requirements of 00585.41(a), submit the following to the Engineer for review or approval at least 21 calendar days before beginning work:

(1) Manufacturer's Experience - Written certification that the joint manufacturer has at least three years experience in designing and manufacturing modular expansion joints. Include the following:

- Bridge locations
- Names of owning agencies or other entities
- Names, addresses and telephone numbers of the owners' representatives

(2) Shop Drawings and Calculations - In addition to the requirements of 00585.41(a-1) and 00585.41(a-2), stamped drawings and calculations according to 00150.35, including the following:

- Design calculations for all structural elements including springs and bearings, including fatigue design for all structural elements, connections and splices. Show all details for welded splices on the shop drawings.
- Requirements for storage of the joint and details of temporary support of the joint for shipping, handling and job site storage.
- Installation procedures.
- Allowance for replacement of parts subject to wear in the design. Submit a written maintenance and part replacement plan prepared by the joint manufacturer to the Engineer for approval. Include a list of parts and instructions for maintenance inspection, acceptable wear tolerances, methods for determining wear, procedures for replacing worn parts and procedures for replacing the watertight seals.
- Modification of blockout reinforcing to accommodate the expansion joint unit.
- Tables showing the total anticipated movements for each joint and the required setting width of the joint assemblies at various structure temperatures.

(3) Certificates of Compliance - The following certifications:

- A manufacturer's certificate of compliance with the AISC Quality Certification Program, Simple Steel Bridges.
- A manufacturer's certificate of compliance verifying that the materials as furnished will meet the requirements of these Specifications.
- Manufacturer's certification that all polytetrafluoroethylene (PTFE) sheeting, PTFE fabric and elastomer meet the requirements of Section 18 of the AASHTO LRFD Bridge Construction Specifications. Do not use reprocessed material.
- Certification that welding inspection personnel are qualified and certified as welding inspectors under AWS QC1, Standard for Qualification and Certification of Welding Inspectors.
- Certification that personnel performing nondestructive testing (NDT) are qualified and certified as NDT Level II under the American Society for Nondestructive Testing (ASNT) Recommended Practice SNT-TC-1a.
- Mill test reports for all steel and stainless steel in the joint assemblies with shop drawings and calculations.

(4) Quality Assurance Inspection Program - Arrange for an independent inspection agency to provide quality assurance inspection. Submit the forms to be used by the independent inspection agency and the proposed Quality Assurance Inspection Program to the Engineer for approval prior

to the start of fabrication. Quality assurance inspection is not required to be full-time inspection, but shall cover each phase of the manufacturing process. Include the frequency of inspection in the Quality Assurance Inspection Program.

(c) Shipping and Handling - Deliver the expansion joint units to the job site and store according to the manufacturer's written recommendations and as approved by the Engineer.

Do not weld lifting mechanisms, temperature setting devices and construction adjustment devices to the centerbeams or edgebeams.

Damage to the joint unit during shipping and handling will be cause for rejection of the joint.

(d) Design Requirements:

(1) General - Design and fabricate modular expansion joints from steel components so:

- Individual components conform to the applicable portions of 00585.46.
- Metal to metal contact surfaces meet the requirements of Section 00560 and welded according to AWS D 1.5.
- That joint openings of all individual cells remain equal throughout the full movement range of the joint.
- Sliding surfaces of internal joint components are made of stainless steel and polytetrafluoroethylene (PTFE).
- The expansion joint seals do not protrude above the top of the extrusions. Split extrusions may be used at curb upturns.

Design the elastomeric or urethane springs and bearings so that they are removable and replaceable. Provide for the removal and reinstallation of the strip seal from above the joint by using a 1 1/4 inch minimum joint gap width.

Account for the effects of vertical and horizontal rotations and longitudinal movements of the superstructure.

(2) Limit States Fatigue Wheel Loads - Design the centering beams or transverse seal separation beams, including edge beams, support bars, bearings and other structural elements for the simultaneous application of the vertical and horizontal limit states fatigue wheel load ranges shown below:

Limit States Fatigue Vertical Wheel Load Range (Normal to the roadway surface)	**Limit States Fatigue Horizontal Wheel Load Range (Parallel to the roadway surface)**
26,000 pounds/wheel	8,100 pounds/wheel

These limit states fatigue wheel loading ranges include impact. Increase the limit states fatigue wheel loading range for the effect of roadway grades when the grade exceeds 4%. For roadway grades 4% or less, the loads shown can be used without modification.

Alternate wheel load ranges may be used, providing that the absolute magnitude of the wheel load ranges (i.e., sum of positive and negative loads along the same axis) is not less that the total wheel load ranges shown above.

(3) Application of Limit States Fatigue Wheel Load Ranges - For the design of the center beams and edge beams, apply simultaneously the two vertical and horizontal load ranges

described above, spaced 6 feet apart, at the roadway surface as a rectangular patch loading. Use a rectangular patch 9 inches in length in the direction of traffic and 20 inches in width perpendicular to the direction of traffic. When the roadway grade exceeds 4%, add the additional horizontal component due to grade to the horizontal limit states fatigue wheel range described previously.

As shown below, the percentage of the load applied to the center beams and edge beams is based on the midrange position of the seals and the width of the top flange of the center beams.

Width of Top Flange of Center Beams or Edge Beams	Percentage
2 1/2 inches	40
3 inches	50
4 inches	60

(4) Fatigue Limit States Design - Design the expansion joint structural steel members, connections both welded and bolted, and steel components to remain free of cracks after 100 million cycles, which represents the endurance limit. Perform fatigue testing to satisfy the fatigue limit states equation shown below for all expansion joint steel structural members, connections both welded and bolted, and steel components.

$$(0.5)f_{sr\ calc} \leq F_{sr\ test}$$ Fatigue Limits States Equation

where:

$f_{sr\ calc}$ = calculated stress range based on the simultaneous application of two sets of vertical and horizontal limit states fatigue wheel ranges at 6 feet spacing.

$F_{sr\ test}$ = allowable limit states fatigue stress range at the endurance limit of 100 million cycles.

(5) Fatigue Testing - Perform constant amplitude fatigue testing to determine $F_{sr\ test}$, for all structural members, connections both welded and bolted, and components.

Base the allowable limit states fatigue stress range at 100 million cycles with a survival probability of 95%.

Apply the test loadings so that the vertical and horizontal loadings are applied simultaneously. Perform testing so that the horizontal load is 20% of the vertical load.

Use an independent testing laboratory for the fatigue testing. Contact the Engineer for information on facilities capable of performing fatigue testing.

(e) Fabrication - Fabricate the modular joint seals according to the dimensions, shapes, designs and details shown in the approved shop drawings. All modular joint seals for the Project shall be fabricated by the same manufacturer. Weld seal retainer clips continuously on the top and bottom, if welded to the seal separation or edge beams.

(1) PTFE Sliding Surface - Bond the PTFE under controlled conditions and according to written instructions provided by the manufacturer of the PTFE. Complete the bonding operation so that the PTFE surface is smooth and free from bubbles.

(2) Stainless Steel Sliding Surface - Finish the stainless steel sliding surface to a finish of 8 microinches (RMS) or less.

Weld the stainless steel sheet all around to the steel backing plate by a tungsten-arc welding process according to the current AWS specifications. Clamp the stainless steel sheet so that it has full contact with the steel backing plate during welding. Stop the welds so that they do not protrude beyond the sliding surface of the stainless steel.

(f) Installation - Install the joint assembly according to the shop drawings submitted under 00585.47(b-2), and as follows:

- Install so that the joint matches the roadway profile and grade.
- Fill the blockout opening with the same class of concrete that is used in the deck. Place concrete after the modular expansion joint has been set to final line and grade.
- Construct the bottom inside edge of the outside extrusions so that the concrete-steel interface below the joint is at the same elevation and distance from the centerline of the joint, full length of the joint.
- Place modular expansion joint seal units only in preformed blockouts. Coordinate the shop drawings with Agency-furnished details to provide a proper fit. Protect the joint unit and the blockout from damage prior to installation and after installation. Submit to the Engineer for approval details for bridging the joint for construction loads. Do not subject the joint to construction loads for a minimum of seven days after placing the blockout concrete.
- Set the modular expansion joint unit to the proper width for the structure temperature at the time of installation. Record the temperature of the underside of the concrete deck slab on both sides of the expansion joint. Take the average of the readings to adjust the joint width for the ambient temperature setting. In lieu of surface readings, internal slab temperature readings may be taken by drilling a 1/4 inch diameter hole 3 inches deep into the deck slab; filling the hole with water and inserting a probe thermometer. Read the probe thermometer after 30 minutes. See the plans for change in joint opening per change in structure temperature from ambient temperature.
- Remove all forms and debris that interfere with the free action of the expansion joint unit after casting the joint blockouts.
- Any mechanical devices supplied by the manufacturer to set the joint unit to the proper joint width shall remain the property of the fabricator.

(g) Inspection and Acceptance - Expansion joint units will be accepted after satisfying the following three levels of inspection. The manufacturer shall provide for both Quality Control inspection and Quality Assurance inspection. A description of the three levels of inspection follows:

(1) Quality Control Inspection - During the fabrication of major components, the manufacturer shall provide full-time quality control inspection to ensure that the materials and workmanship meet or exceed the requirements of the Contract.

(2) Quality Assurance Inspection - Provide quality assurance inspection according to the plan submitted under 00585.47(b-4).

No kinks or bends are allowed in the expansion joint units, except those necessary to match the roadway grades. Remove any expansion joint unit exhibiting bends or kinks, other than those shown on the approved shop drawings from the Project Site.

Replace polychloroprene strip seals not fully bonded to the steel extrusions with fully bonded seals at no additional cost to the Agency.

Perform fatigue testing of all structural members, splices, connections and components according to 00585.47(d-5). Retest any revised details of material substitutions developed after the initial fatigue testing.

(3) Field Inspection - The manufacturer's representative shall provide full-time quality control inspection to ensure that workmanship meets these specifications.

(4) Acceptance - Expansion joint units shall satisfy each of the three levels of inspection described above prior to acceptance. Replace or repair expansion joint units that fail any one of the three levels of inspection at no additional cost to the Agency.

Submit any proposed corrective procedures to the Engineer for approval before undertaking corrective work.

00585.48 Hot-Dip Galvanizing - Hot-dip galvanize steel expansion joint surfaces, except stainless steel, according to AASHTO M 111 (ASTM A 123).

The contact surfaces at all galvanized slip critical structural bolted connections shall meet Class C (slip coefficient 0.33) surface preparation requirements.

00585.75 Manufacturer's Warranty - Furnish a Manufacturer's Warranty according to 00170.85(c-1), for a Warranty period of two years.

For purposes of the Warranty, expansion joints will be deemed to have failed when:

- Leakage is detected
- Delamination is detected
- Debonding is detected
- Rutting that is greater than the surrounding pavement surfaces is detected

The Warranty shall recite that, upon written notification by the Agency, that the expansion joint, or portions of the expansion joint, used according to the manufacturer's recommendations, have failed, the manufacturer will replace expansion joint or portions of the expansion joint, within 6 months of the Agency's written notification.

The Warranty shall also recite that if the manufacturer fails to replace the expansion joint of portions of expansion joints within the given 6 month period after written notification, the Agency at it's discretion, will replace the expansion joints or portions of the expansion joint, or have the expansion joints or portions of the expansion joint replaced by an independent contractor, with the total cost of replacement, including all materials, equipment, labor, associated mobilization, and traffic control costs will be paid for by the manufacturer.

Provide materials and use procedures to replace failed expansion joints that meet the specifications in effect at the time of original installation, or if no longer available, use current expansion specifications.

Measurement

00585.80 Measurement - No measurement of quantities will be made for closed expansion joints. Estimated quantities of closed expansion joints will be listed in the Special Provisions.

The estimated quantities of asphaltic plug joints is based on a nominal depth of 2 1/4 inches.

The quantities of asphaltic plug joint material for joints deeper than 2 1/4 inches will be measured on the volume basis.

No measurement will be made for elastomeric concrete used to provide a plane surface on which to place the steel bridging plate.

Payment

00585.90 Payment - The accepted quantities for work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

	Pay Item	Unit of Measurement
(a)	Asphaltic Plug Joint Seals	Lump Sum
(b)	Asphaltic Plug Joint Seal Material	Cubic Yard
(c)	Poured Joint Seals	Lump Sum
(d)	Type _____ Preformed Polychloroprene Compression Joint Seals	Lump Sum
(e)	Performed Elastomeric Strip Seals	Lump Sum
(f)	Type _____ Modular Expansion Joint Seals	Lump Sum

Item (a) includes sawcutting, steel bridging plate, and installation of the asphaltic plug joint to a nominal depth of 2 1/4 inches.

Item (b) includes materials only for asphaltic plug joint depths greater than 2 1/4 inches.

In items (d) and (f), the type of joint seal will be inserted in the blank.

Payment will not be made before joints have passed the leakage test of 00585.41(e). No payment will be made for any material installed as replacement material for that removed, unless the Engineer determines that the reason for the removal was beyond the Contractor's control, or that the plans specifically required the removal.

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

Payment for work under this Section will be limited to 75% of the amount due until the Agency has received the signed warranty.

No separate or additional payment will be made for:

- preformed expansion joint filler, poured joint filler, traffic loop sealant, or sawcutting
- providing the manufacturer's representative or for furnishing the warranty

Section 00587 - Bridge Rails

Description

00587.00 Scope - This work consists of constructing bridge rails of the material or combination of materials shown or specified.

Bridge rails will be classified as concrete or steel according to the predominant material used in the rail.

Materials

00587.10 Materials - Furnish materials meeting the following requirements:

Cast Steel Posts	02810.40
Concrete	02001
Concrete Coating	02210.30
Galvanizing	02530.70
Grout	02080.30
Reinforcement	00530
Structural Steel	02530
Structural Steel Tubing	02810.20
Thrie Beam Rail	02810.50
Tube	02810.30

Construction

00587.40 General - Construct bridge rails:

- True to line, grade and dimensions shown or established, with a smooth, even top rail without following any unevenness in the superstructure.
- Vertical, rather than normal to the deck, whether the deck is superelevated or not, unless shown otherwise.
- After falsework has been removed, so that the span is self-supporting.

00587.42 Concrete Rails:

(a) General - Construct concrete rails according to Section 00540 and the following:

- Cast-in-place rails may be slipformed as the Contractor elects subject to paragraph (c) of this subsection.
- Construct expansion joints which permit freedom of movement. After all other work is completed, use a sharp chisel to remove all loose or thin shells of concrete likely to spall under movement at expansion joints.

(b) Fixed Forms - Forms shall be smooth and tight fitting, rigidly held in line and grade, and removed without damage to the concrete. Make form joints in vertical planes. Construct all moldings, panel work, and bevel strips as shown. Make corners in the finished work true, sharp and free from cracks, spalls or other defects.

(c) Slipformed - Concrete rails may be slipformed if the plans contain details for slipforming. Before slipforming any permanent rail, the Contractor shall meet one or both of the following requirements (1) and (2) as directed:

(1) Cast a test section at least 20 feet long as follows:

- Place the test section off the structure.
- Use the same section and reinforcement as detailed for use on the structure.
- Include one typical contraction or open joint.
- Remove at no additional cost to the Agency.

(2) Identify, for the purposes of evaluating work quality, at least two recent slipformed rail projects completed by the Contractor.

The Engineer will make the final decision about the use of slipforming on the Project based on work quality. If slipforming is used, conform to the following:

- Provide concrete with a slump of 1 inch $\pm$ 1/2 inch.
- Keep the top and faces of the finished rail free from sags, humps, and other irregularities.
- Maintain contraction joints, open joints, and expansion joints to the dimensions shown until the concrete sets.
- Use slipforming only for sections of rail with constant dimensions. Use fixed forms where dimensions vary, as at luminaire or signal supports and at rail end transitions.
- Brush-finish exposed rail surfaces with vertical strokes. Do not grind brush-finished surfaces that are to receive a Class 1 finish.
- Remove and replace any unsatisfactory work at no additional cost to the Agency.

(d) Surface Finish - Give all exposed concrete surfaces a general surface finish followed by a Class 1 surface finish (ground and coated) according to 00540.53 except as provided in 00587.42(c).

(e) Latex Paint Cure for PCC - As an option to curing cast-in-place or slipformed bridge rails, according to the Specifications, the following procedure may be used:

- Allow free moisture to flash off, but only until the concrete surface does not glisten, and never for more than one hour.
- Apply the first coat of a latex paint approved for bridge use and meeting the requirements of 02210.30(c) at an application rate of 150 square feet per gallon.
- Allow the first coat to air-dry for one hour.
- Apply the second coat of latex paint at the same rate as above, with application direction transverse to the direction of the first coat.

00587.43 Metal Rails:

(a) Construction - Provide structural steel tubing, tube or metal thrie beam rail as shown or specified. Fabricate and erect metal rails according to Section 00560. Adjust metal rails before fixing in place to ensure proper matching at abutting joints and correct alignment and camber throughout their length.

(b) Coating - Unless otherwise specified, galvanize steel portions of the railing. Galvanize after fabrication of the rail according to 02530.70. If galvanized portions of the rail are to be coated, coat according to Section 00594.

Measurement

00587.80 Measurement - No measurement of quantities will be made for work performed under this Section. Estimated quantities of bridge rails will be listed in the Special Provisions.

Payment

00587.90 Payment - The accepted quantities of bridge rails will be paid for at the Contract lump sum amount for the appropriate bridge rail items listed in the Contract Schedule of Items.

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

No separate or additional payment will be made for anchor bolts and anchorage devices, except those cast in precast concrete members.

Payment for anchor bolt and anchorage devices in cast-in-place concrete members and for reinforcement extending from a precast unit, cast-in-place deck, wall or bridge end panel into the rail will be included in payment made for the precast unit, cast-in-place deck, wall or end panel, as appropriate.

Payment for guardrail terminal connectors, connection plates, spacer blocks and other connection hardware will be included in the payment for the guardrail transition item according to 00810.90.

Section 00591 - Waterproofing Membrane

Description

00591.00 Scope - This work consists of furnishing and placing bridge deck waterproofing membrane on the decks of bridges as shown.

Materials

00591.10 Materials - Furnish a warranted waterproofing membrane system from the QPL that complies with the maximum profile grades and superelevations shown. Profile grade and superelevation limitations for products are listed in the QPL and are available from the manufacturer.

(a) Concrete Patching Material - If concrete repairs are required, furnish a PCC patching material from the QPL that is compatible with the membrane.

(b) Tack Coat - Furnish hot asphalt tack coat meeting the requirements of 00745.11(a), or a primer coat as recommended by the membrane manufacturer. An emulsified tack will not be allowed.

Labor

00591.30 Manufacturer's Representative - Provide the services of a manufacturer's representative authorized to sign a warranty on behalf of the manufacturer to observe the installation of each membrane system, including the wearing course. The manufacturer's representative may be an employee of the Contractor if written documentation from the manufacturer is provided stating that the Contractor is certified to install warranted materials and the identified employee is certified to serve as the manufacturer's representative. Follow the recommendations of the manufacturer's representative in all matters pertaining to proper installation of the membrane system. Instruct the manufacturer's representative to immediately alert the Contractor and the Engineer of anything that could affect the performance of the waterproofing membrane or the warranty.

Construction

00591.40 General - Do not begin membrane installation until all materials and equipment necessary to perform the installation and any required repairs are at the job site.

(a) Weather and Other Restrictions - Place tack coats, surface patching, and waterproofing membrane when the deck is dry, the air temperature is between 40 °F and 90 °F, and the surface temperature of the deck is below 120 °F.

(b) Handling Materials - Load and unload waterproofing membrane and primer without damage to the materials. Store membrane indoors at a temperature between 60 °F and 120 °F until it is placed on the bridge deck. Do not allow the membrane to sit in direct sunlight longer than necessary.

(c) Pre-Placement Meeting - Hold a pre-placement meeting with the Engineer at least ten days prior to application of each membrane. For each membrane proposed for use, submit for the Engineer's approval a manufacturer approved procedure for preparing the deck surface, applying the membrane, and placing an asphalt concrete protective course if one is required. Include details such as the number of persons required, equipment, installation sequence, traffic control, and the estimated time schedule for installing the membrane and opening the bridge to traffic. For bridges with curbs or concrete rails, submit unstamped manufacturer shop drawings according to 00150.35, detailing membrane placement at the curbs or rail. Do not proceed with the work until the proposed procedure, and shop drawing if applicable, have been approved by the Engineer.

(d) Area of Application - On bridges without curbs, apply the waterproofing membrane from outside edge to outside edge of the deck, or within the limits of the AC wearing course.

Protect adjacent surfaces not to be covered with the membrane from spatter or coating.

00591.42 Preparing Existing Bridge Decks:

(a) Surface Removal - Unless otherwise specified, remove the existing asphalt concrete wearing surface from the deck, according to Section 00503, before placing the waterproofing membrane. Ensure that the deck is smooth and free of obstructions. Small areas of asphalt and asphalt stain need not be removed if smooth and tightly bonded to the deck, as determined by the Engineer. The nominal thickness of the wearing surface on the bridge(s) will be identified in the plans.

Completely remove any existing paint and pavement markers.

Remove any spalled or loose surface concrete to sound concrete. Prepare the deck surface so that it is smooth and free of voids, sharp projections, form release agents, concrete curing agents and other contaminants.

Prior to placing the membrane, verify that the deck is free from loose rocks, or other debris. Clean the deck with compressed air immediately prior to placing the membrane.

Dispose of all removed materials according to 00290.20.

(b) Surface Patching - Leave the final surface smooth enough to allow placing the waterproofing membrane directly on the deck, yet rough enough to provide good adhesion.

Use hand-placed grout or other approved material to smooth or fill all gaps, breaks, or edges that are more than 1/4 inch deep, including the offset in adjacent slabs with different camber, vertical edges adjacent to different milling passes or striations left by milling machine teeth. If a water-based grout is used, allow for proper cure time as recommended by the membrane manufacturer, prior to applying the membrane.

00591.43 Tack Coat - Place a hot tack coat, or primer as applicable, on a dry deck only.

00591.45 Installation - Construct waterproofing membrane according to the manufacturer's recommendations and as approved.

Release bubbles or pockets of trapped air or vapor and repair in a manner satisfactory to the Engineer.

00591.46 Protection During Construction:

(a) General - Do not use the waterproofing membrane as a temporary wearing surface or haul road. Until the membrane is protected by pavement, keep Contractor traffic on the membrane to a minimum. Allow Contractor traffic only with the approval of the Engineer and the membrane manufacturer.

Immediately repair and damage to the membrane caused by the paving operation. Make repairs before resuming paving.

(b) Protective Course and Tack Coat - If the wearing course will be 3/4 inch open-graded HMAC, place a protective course of 3/8 inch dense-graded HMAC conforming to Section 00744, at least 3/4 inch thick, over the membrane. Treat the top surface of the membrane with a hot asphalt

tack coat according to the membrane manufacturer's recommendations prior to placing the protective course, or prior to placing a 3/4 inch or 1/2 inch dense-graded HMAC wearing course, if applicable. The mix may be Level 3 or Level 4 as directed.

00591.47 Leakage Test - As soon as the deck is ready for traffic, flood the deck with water to test the membrane for leakage. No water leakage will be allowed. Make appropriate repairs and re-test, at no additional cost to the Agency, until no leakage is detected.

00591.75 Manufacturer's Warranty - Furnish a warranty, for a warranty period of two years, from the manufacturer and signed by a manufacturer's representative, against failure of the product or the installation, conforming to the following requirements:

(a) Warranty Period - The warranty period will begin on the date the Engineer authorizes final payment for the Work under this Section.

When the Agency makes written request to the manufacturer for repair or replacement, the Warranty period will stop until the requested repair(s) or replacement(s) are made and accepted.

(b) Failure - For purposes of the warranty, failure is defined as:

- Leakage of the membrane, or
- Delamination of the membrane from the underlying or overlying pavement.

(c) Remedy - Upon notification by the Engineer of a failure as defined above, provide the following remedy:

- Repair failures within 60 days at no additional cost to the Agency.
- Use materials and procedures meeting these Specifications.
- Match repairs to finished grade.
- Coordinate timing of repair work with the Engineer.

(d) Traffic Control; Agency's Right to Make Repairs - If, in the opinion of the Engineer, a failure of the membrane causes a traffic hazard, the failure may be temporarily corrected by Agency or other forces at the manufacturer's expense. Replace temporary repairs with permanent repairs at the manufacturer's expense and according to these Specifications.

Measurement

00591.80 Measurement - The quantities of waterproofing membrane will be measured on the area basis, and will be the sealed surface area, excluding curb and rail faces, and will be limited to the neat lines and dimensions shown.

Payment

00591.90 Payment - The accepted quantities of waterproofing membrane will be paid for at the Contract unit price, per square foot, for the item "Warranted Waterproofing Membrane".

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals required to complete the work as specified.

Payment for work done under this Section will be limited to 75% of the amount due until the Agency has received the signed warranty.

00591.90

No separate or additional payment will be made for:

- overlaps
- removing the existing asphalt concrete wearing surface and pavement markings, preparing the surface, surface patching, asphalt used as a protective course, and for providing tack coat, and primer
- providing the manufacturer's representative, furnishing the warranty

Section 00593 - Powder Coating Metal Structures

Description

00593.00 Scope - This work consists of preparing and powder coating new and existing metal structures and features, including all steel, galvanized, aluminum, and other specified surfaces.

00593.01 Abbreviations, Definitions, and References:

(a) Abbreviations:

AAMA - American Architectural Manufacturers Association

(b) Definitions:

Apparent Magnetic Surface - The magnetic surface that a magnetic gauge senses, somewhere between the peaks and valleys of the profile, after the steel is roughened by abrasive cleaning.

Cleaning - Removing detrimental material in preparation for coating.

Coat - Apply powder to a substrate to form a single uniform layer. A coat is comprised of as many applications as necessary to achieve the specified coat thickness.

Coating - Protective material after it is applied to a structure.

Coating System - All specified coats applied separately in a predetermined order.

Hold Point - A time at which the Contractor is required to stop a particular activity until a phase of work is inspected or tested. If the Engineer finds this phase conforms to the Specifications, the subsequent phase of work may proceed.

Manufacturer's Recommendation - The written specifications and instructions provided by a manufacturer of a coating material concerning the handling, mixing, and application of the coating material.

Phase - An activity or step of the preparation and coating procedures to be inspected or tested. The transition from one phase to another represents a hold point.

Preparation - Measures taken to provide a suitable surface ready to coat.

Substrate - A surface to which a coating is to be applied. This may be the prepared surface of the metal structure or a previous coating.

Surface Profile - Roughness of a cleaned steel surface. The height of the profile is measured from the bottom of the valleys to the top of the peaks in mils.

00593.03 Precoating Conference - Before beginning work, the Contractor's supervisory personnel, together with any subcontractors and their supervisory personnel who are to be involved in the preparation and coating work, and a representative from the coating manufacturer shall meet with the Engineer for a precoating conference at a time mutually agreed upon. Submit the following 14 calendar days before the precoating conference:

- The name, location, and contact information (mail address, phone, and e-mail) for the firm performing the powder coating operation.

- Quality assurance and quality control (QA/QC) programs established and followed by the firm performing the powder coating operation.
- A product data sheet and material safety data sheet of each type of coating material to be used, including the products to be used for field repair of damaged areas.
- Project specific powder coating plan, including a specific cleaning, surface preparation, pre-heating, application, curing, shop and field coating repair, handling, and storage processes to be taken for the assemblies being coated for the Project.
- Letter from galvanizer that neither water quenching nor a chromate conversion coating will be used on the surfaces that are to be powder coated.

00593.04 Notice - Notify the Engineer, in writing, at least seven calendar days in advance of the date that preparation and coating operations are to begin.

Materials

00593.10 Materials - Furnish material meeting the requirements of this Section and the Special Provisions.

(a) Coating Systems:

(1) Steel Substrates - Provide a two coat system for steel substrates consisting of a zinc-rich epoxy primer and a polyester topcoat.

(2) Galvanized and Other Non-Steel Metallic Substrates - Provide a two coat system for galvanized and non-steel metallic substrates consisting of an epoxy primer and polyester topcoat.

(b) Specifications - Furnish an epoxy powder primer meeting the following requirements:

Test	Zinc-rich Epoxy	Epoxy
Adhesion (ASTM D 3359, Method B)	B5 (no failure)	B5 (no failure)
Flexibility (ASTM D 522, Method B)	Pass 1/4" Mandrel Bend	Pass 1/8" Mandrel Bend
Pencil Hardness (ASTM D 3363)	H Plus	H Plus
Specific Gravity (ASTM D 792)	2.30 minimum	1.25 minimum
Zinc in Dry Film (calculated weight)	50% minimum	–

Furnish a polyester topcoat meeting the requirements of the American Architectural Manufacturers Association (AAMA) Specification 2605.

Before notice required by 00593.04, submit a manufacturer's certification stating that each coating material in the coating system:

- Meet the requirements of this Section.
- Meet the specifications of the manufacturer's data sheets.
- Are compatible, including coating repair materials.

The color of the topcoat will be specified in the Special Provisions. Obtain approval of the Engineer before applying any coating.

00593.12 Caulking - Furnish structural steel caulking from the QPL and approved for use by the coating manufacturer. The caulking color shall be clear or match the color of the top coating.

Furnish industrial grade polystyrene or polyurethane backing material of sufficient diameter to fill the crevices or gaps as required.

Obtain the Engineer's approval of the caulking and backing material before using.

Construction

00593.40 General - Structures to be prepared and powder coated include new and existing steel, galvanized, and non-steel metallic substrates.

00593.41 Special Fabrication, Preparation, and Coating:

(a) Inaccessible Surfaces - Coating inside of rolled sections, such as poles and rail tubes, is not required unless otherwise specified.

(b) Fabrication Areas - Schedule fabrication, preparation, and coating so that the coating system is not damaged by the welding or fabricating process.

Neutralize weld areas and remove smoke stain and spills according to SSPC-SP 1. Remove weld slag and spatter by mechanical means before blast-cleaning. Supplement blast-cleaning by other treatment as recommended by the manufacturer of the coating system and as required in 00593.42.

Do not apply coatings within 4 inches of the weld before finishing the welding operation.

00593.42 Preparation of Surfaces:

(a) Steel Substrates - Clean new and existing steel surfaces to be coated according to SSPC-SP 10, "Near-White Blast Cleaning". The appearance of the final blast-cleaned surface shall closely approximate Pictorial Standard SP 10 of SSPC-Vis 1 and have a 1.0 to 2.5 mil profile finish.

Apply a phosphate conversion coating as a surface treatment immediately after blasting. Use heat to dry the phosphate coating immediately after it is applied.

(b) Galvanized Substrates - Clean and prepare galvanized surfaces to be coated according to ASTM D 6386, the approved project specific powder coating plan, and the following:

- **Newly Galvanized Steel** - Smooth and clean surfaces according to ASTM D 6386, Section 5 and prepare surfaces according to ASTM D 6386, Section 5.4.1.

- **Partially Weathered Galvanized Steel** - Check and prepared according to ASTM D 6386, Section 6, then smooth and clean surfaces according to ASTM D 6386, Section 5, then prepare surfaces according to ASTM D 6386, Section 5.4.1.

- **Weathered Galvanized Steel** - Prepare according to ASTM D 6386, Section 7.

(c) Other Non-Steel Metallic Substrates - Solvent clean non-steel metallic substrate surfaces according to SSPC-SP 1 then either light brush blast, according to SSPC-SP 7, with a non-ferrous blasting media or hand sand. The prepared surface shall have a 1.0 to 2.5 mil profile finish.

(d) All Substrates - Remove fins, tears, slivers, and sharp edges, plus hardened or damaged edges resulting from flame cutting, shearing, or similar operations.

00593.43 Coating Metal Structures:

(a) Description - When not in conflict with this Section and the Special Provisions, perform powder coating application according to the following:

- The recommendations of the coating manufacturer.
- The best practices of the trade.

(b) Application of Coating - Apply the powder coating system according to the following requirements:

(1) Surface Condition - Ensure that the surface to be coated is free of moisture, dust, grease, rust, or other substance which would prevent the bond of succeeding applications. Prepare contaminated surfaces to the Engineer's satisfaction before applying the coating.

(2) Application Methods - After surface preparation, apply the two coat system according to the powder coating manufacturer's recommendations, the approved Project specific powder coating plan and the following:

- Pre-heat surface.
- Apply the epoxy primer coat, followed by a partial cure.
- Apply the polyester finish coat, followed by the finish cure.

Apply each coat in a uniform layer, completely covering the preceding coat. Finish each individual coat by the manufacturer in a sufficiently different shade so that skips and holidays can be easily detected. Correct skips or other deficiencies before application of succeeding coats.

(c) Coating Requirements:

(1) Minimum Dry Film Thickness - Apply all coats to the following minimum thicknesses:

- **Primer:** 2.5 mils
- **Topcoat:** 2.5 mils

(2) Coating Thickness and Coverage Requirements - Each coat shall consist of as many applications as necessary to cover the work and achieve the minimum thickness specified. Apply each coat in sufficient thickness to achieve uniform and complete coverage and appearance. If all thickness measurements are not within the specified minimum dry film thickness, or if the visual inspection does not satisfy the Engineer, make additional applications, as necessary, to meet the thickness and coverage required. Film thickness will be measured above the peaks of the profile of the anchor pattern in the steel substrate.

The dry film thickness will be measured for acceptance using a Type 2 gauge according to SSPC-PA 2. If a question arises about an individual coat thickness or coverage, it will be verified using a Tooke gauge, according to ASTM D 4138. If the Tooke gauge shows a prime coat to be less than the specified minimum thickness the total coating system will be rejected even if the thickness of the total system equals or exceeds the total specified thickness.

(3) Additional Top Coat Requirements - Even if the total thickness of prime coat exceeds the prime coat specified thickness, apply the top coat to at least the minimum required topcoat thickness, as well as provide uniform and complete coverage and appearance.

(d) Time of Application - Apply the prime coat within 4 hours of the final cleaning and before any visible indication of rust forms.

(e) Caulking - Apply the caulk after complete application of the top coat. Fill and seal crevices and gaps between structural shapes and plates, around bolt heads or nuts, and similar areas that would retain moisture with the following:

- Caulk, if the crevice or gap cannot be filled with coating materials.
- Backing material and caulk to fill the crevices and gaps that exceed 1/4 inch. Apply caulk over the backing material to form a watertight seal.

00593.44 Inspecting and Testing - The powder coating firm shall conduct or make arrangements for powder coating tests required in the approved Project specific powder coating plan. Tests include the following:

Test	Test Method
Cleanness of Abrasive Material	ODOT TM 616
Cleanness of Compressed Air	ASTM D 4285
Pictorial Surface Preparation Standards	SSPC-VIS 1
Surface Profile by Replica Tape	ASTM D 4417
Hardness	AAMA 2605 and ASTM D 3363
Dry Film Thickness by Magnetic Gauge	SSPC-PA 2
Dry Film Thickness by Tooke Gauge	ASTM D 4138
Pull-off Strength of Coating [min. 400 psi] (Test Method B)	ASTM D 4541

Provide access to the Engineer, at the powder coating facility, to visually inspect the assemblies for the presence of coating holidays and other unacceptable surface imperfections, and to witness the coating thickness testing, the hardness testing, and the adhesion testing.

Provide documentation of the QA/QC testing to the Engineer.

Assemblies failing these tests will be rejected. Repair and recoat the rejected assemblies as directed.

Do not ship assemblies to the Project site without Engineer's approval.

00593.45 Protecting Against Damage:

(a) Contaminated Surfaces - If the prepared surface becomes contaminated by material other than rust, clean the surface in a manner satisfactory to the Engineer before making the succeeding application. If the prepared surface becomes contaminated by rust, prepare the contaminated area again according to 00593.42 and recoat with all specified coats. Clean, reprepare and recoat at no additional cost to the Agency.

(b) Surfaces Not to Be Coated - Protect surfaces that are not to be coated from blast-cleaning, overspray, and drippings. Remove or repair unintended coatings or other damage on these surfaces to the Engineer's satisfaction at no additional cost to the Agency.

(c) Handling, Shipping, or Surface Damage - After curing and acceptance, individually wrap the coated assemblies with multiple layers of bubble wrap, or other protective wrapping materials specified in the approved Project specific powder coating plan.

During storage and shipping, separate each wrapped assembly with expanded polystyrene spacers and other spacing materials specified in the approved plan.

After erection, repair marred and damaged coated surfaces due to the Contractor's shipping, storage, handling, and erection operations according to 00593.60.

00593.60 Repair of Damaged and Unacceptable Coatings - Repair damaged surfaces as follows:

(a) Surface Preparation - Prepare the surface according to SSPC-SP 1, SSPC-SP 2, and SSPC-SP 3. Use a solvent that is acceptable to the paint manufacturer or approved by the Engineer. Extend the prepared area at least 2 inches into adjacent, tightly adhering, intact coating.

(b) Feathering of Repair Areas - Feather the existing coating system surrounding each repair location. Feather the repair area for a distance of 1 inch to 2 inches to provide a smooth, tapered transition into the existing intact coating.

(c) Coating Application in Repair Areas - When steel substrate is exposed in the repair area, apply a coat of zinc rich primer before applying the topcoat.

When the damage does not extend to the bare substrate, apply only the affected coats.

Measurement

00593.80 Measurement - No measurement of quantities will be made for work performed under this Section.

Payment

00593.90 Payment:

(a) New Metal Structures - No separate payment will be made for preparing and powder coating new metal work. Payment for this work, including correction of damages, will be included in payment made for furnishing and placing the new metal structures.

(b) Existing Metal Structures - The accepted quantities for preparing and powder coating existing metal structures will be paid for at the Contract lump sum amount for the item "Prepare and Powder Coat Existing Structures".

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

No separate or additional payment will be made for correction of damages described in 00593.44.

Section 00594 - Preparing and Coating Metal Structures

Description

00594.00 Scope - This work consists of preparing and coating new metal structures and features in the shop and in the field, and preparing and coating existing metal structures. This includes all:

- Interior and exterior steel surfaces
- Steel railings, bridge bearings, and bridge expansion joint assemblies
- Other miscellaneous steel
- Galvanized and aluminum surfaces

00594.01 Abbreviations, Definitions, and References:

(a) Abbreviations:

AAMA - American Architectural Manufacturers Association
DFT - Dry Film Thickness
FTMS - Federal Test Method Standard

(b) Definitions:

Apparent Magnetic Surface - The magnetic surface that a magnetic gauge senses, somewhere between the peaks and valleys of the profile, after the steel is roughened by abrasive cleaning.

Cleaning - Removing detrimental material in preparation for coating.

Coat - Apply paint or other protective material to a substrate to form a single uniform layer. A coat is comprised of as many applications as necessary to achieve the specified coat thickness.

Coating - Protective material after it is applied to a structure.

Coating Material - Protective material in the liquid state before application.

Coating System - All specified coats applied separately in a predetermined order.

Field Coating - The on-site coating of new or existing metal structures before or after erection.

Hold Point - A time at which the Contractor is required to stop a particular activity until a phase of work is inspected or tested. If the Engineer finds this phase conforms to the Specifications, the subsequent phase of work may proceed.

Maintenance Coating - The coating of existing steel structures that have been previously coated and need recoating.

Manufacturer's Recommendation - The written specifications and instructions provided by a manufacturer of a coating material concerning the handling, mixing, and application of the coating material.

Paint - A pigmented liquid, applied as a thin layer, which is converted to a solid colored film after curing. This film provides a decorative and protective coating to the substrate. The binder is a resin that may or may not be modified with natural vegetable oils, fish oils, or other ingredients.

Phase - An activity or step of the preparation and coating procedures to be inspected or tested. The transition from one phase to another represents a hold point.

Preparation - Measures taken to provide a suitable surface ready to coat.

Shop Coating - The coating of steel surfaces in the fabrication shop before the metal is transported to the erection site.

Skin - A solid or semi-solid membrane that forms on paint in a container.

Skimming - The process in which a film forms over a liquid coating, either during storage or after application.

Stripe Coat - Separate, independent coating that is applied to complex details and irregular surfaces before the application of the full coat. Complex details and irregular surfaces include but are not limited to edges, seams, corners, gaps, crevices, weld lines, pitted surfaces, holes, nuts, bolts, rivets, and threads. Brushes are used to push the coating around and into complex details and irregular surfaces. Each stripe coat is a different color than the preceding and subsequent full coat, extends a minimum of 1 inch from the irregular surface, and completely hide the substrate.

Solvent - Liquid used to solvate or put materials into solution or to clean equipment and tools.

Substrate - A surface to which a coating is to be applied. This may be the prepared surface of the metal structure or a previous coating.

Surface Profile - Roughness of a cleaned metal surface. The height of the profile is measured from the bottom of the valleys to the top of the peaks in mils.

Thinner - Volatile liquids used to thin compatible coating materials. Thinners may be a blend of solvents.

(c) References - In this Section, references such as SSPC-SP 1 and SSPC-PA 1 refer to Volume 2, "Systems and Specifications", of SSPC's "Painting Manual".

In these Specifications, references are made to FTMS 141, "Paint, Varnish, Lacquers, and Related Materials: Methods of Inspection, Sampling and Testing", which is distributed by the U.S. General Services Administration.

00594.03 Precoating Conference - Before beginning work, the Contractor's supervisory personnel, together with any subcontractors and their supervisory personnel who are to be involved in the preparation and coating work and a representative from the coating manufacturer, shall meet with the Engineer for a precoating conference at a time mutually agreed upon. 14 calendar days before the precoating conference, submit a plan for accomplishing all phases of the preparation and coating work including but not limited to the following:

- ventilation
- containment
- surface preparation
- painting
- coating materials
- quality control plan
- waste handling and disposal

00594.04 Notice - Notify the Engineer, in writing, at least seven calendar days in advance of the date that preparation and coating operations are to begin.

00594.05 Access and Containment For Field Preparation and Coating - Contain work debris that is generated from dry blast cleaning operations according to the Class 1A requirements of SSPC-Guide 6, with the following parameters:

- Type A1 rigid containment material with Type C1 rigid support structure in locations adjacent to traffic.
- Type A1 rigid containment floor decking.
- Type A2 flexible containment materials may be used where rigid containment materials are not specified. Provide flexible containment materials that are air impenetrable and have tear strength of at least 200 pounds per foot and tensile strength of at least 300 pounds per foot.
- Type H1 instrument verification of air pressure in rigid containment
- Type H2 visual verification of air pressure in flexible containment
- Type I1 minimum specified air movement 50 feet per minute cross draft. Use portable fans as needed to provide air movement in stagnant areas.
- Type J1 exhaust air filtration 99% cleaning efficiency for particulate diameters above 39 microinches and less than 2 grains of particulate per thousand cubic feet of exhaust air (or air recycled to work area).
- Operate dust collection, air flow, and air movement equipment during blowdown to prevent settling of dust on the structure or within the containment.

Contain work debris that is generated from water jet cleaning operations according to the Class 2W requirements of SSPC-Guide 6, with the following parameters:

- Type A1 rigid containment material with Type C1 rigid support structure in locations adjacent to traffic.
- Type A1 rigid containment floor decking.
- Type A2 flexible containment materials may be used where rigid containment materials are not specified. Provide flexible containment materials that are water impenetrable and have tear strength of at least 200 pounds per foot and tensile strength of at least 300 pounds per foot.
- Ceiling not required.
- Wall height shall effectively prevent loss of contaminated water.

Contain work debris that is generated from hand tool cleaning or power tool cleaning operations according to the Class 1P requirements of SSPC-Guide 6. For hand tool cleaning or vacuum shrouded power tool cleaning, ground covers or free-hanging tarpaulins are an acceptable alternate means of containment provided the debris is captured and controlled to the same degree as Class 1P. Provide Type A1 rigid flood decking work access platforms regardless of containment methods.

Emission from various containment systems will be assessed visually. Address any visible emissions immediately.

Maintain all traffic clearances shown. Do not allow the containment and cables, hoses, supplies and equipment to encroach on the indicated traffic clearances at any time.

For containment using forced air ventilation, submit a sketch showing the size (length x width x height) and location of each containment that will be used, and identifying the air moving equipment (manufacturer, model, and capacity in cubic feet per minute) for each containment, to the Engineer for review 21 calendar days prior to precoating conference.

Structural design requirements include:

- Dead load, live load, and wind load when designing loads for containment structures and work platforms. Dead load is the self-weight of the containment and work platforms, live load is all personnel, equipment, and materials, including collected debris, required for normal operations, and wind load is a basic wind speed of 90 mph applied in the most critical direction.
- Design a factor of safety of least 6 for wire ropes and connecting hardware and at least 4 for all other components for containment structure and work platform components. Factor of safety is the ultimate failure load of the component divided by the maximum working load combination applied to the component.
- Verify structural adequacy of bridge with added loading from containment structures and work platforms using either AASHTO Standard Specifications for Highway Bridges, Group II, III, V, and VI load combinations, or AASHTO LRFD Bridge Design Specifications, Strength III loading combination.
- Submit for review at least 21 calendar days before the precoating conference the containment structure plans, specifications, shop drawings, welding procedures, and design calculations assuring that the containment system, work platforms, and the structural members of the bridge can safely resist the combined effects of dead loads, live loads, and wind loads. The plans, specifications, and calculations shall be prepared and stamped by a civil or structural engineer licensed to practice in the State of Oregon, who has designed at least one bridge painting containment structure.

Comply with Section 00290 for spill response, spill containment and cleanup of spills, and contamination.

Comply with all applicable requirements of the Occupational Safety and Health Administration, including but not limited to applicable portions of 29 CFR Ch. XVII, Sections 1926.55 through 1926.57, 1926.62, 1926.65, 1926.450 through 1926.454, and 1926.500 through 1926.503.

00594.06 Waste Handling and Disposal - Dispose of waste material according to 00290.20, and the requirements of SSPC Guide 7 that do not conflict with 00290.20.

Materials

00594.10 Materials - Furnish materials meeting the requirements of this Section, the Special Provisions, and the applicable portions of SSPC-PA 1, "Shop, Field and Maintenance Painting", when not in conflict with either this Section or the Special Provisions.

00594.11 Coating Materials:

(a) Coating System - Furnish coating materials from the QPL and the following:

- Shop coating of steel or iron surfaces, 3 coat system with inorganic zinc primer.
- Shop coating or maintenance coating of steel or iron surfaces, 3 coat system with organic zinc primer.
- Field rehabilitation of coated steel or iron surfaces, 3 coat system with surface tolerant organic zinc primer.
- Shop coating or maintenance coating of non-ferrous surfaces, 2 coat system.

Application of coating materials will not be allowed until certifications required by 00165.35(a) and 00165.35(b) have been provided and the materials are accepted for use by Agency check testing.

(b) Manufacturing - Furnish coating material meeting the following requirements:

- Be prepared at the factory ready for application or mixing of multi-component coatings. Proportion multi-component coating materials by the manufacturer with each component in its correct proportion and furnished in separate containers ready for field mixing. No field mixing will be allowed for moisture-cured urethane coating system components unless approved by the Engineer.
- Be homogeneous, free of contamination, and of a consistency suitable for the specified use.
- Include additives for control of sagging, pigment settling, leveling, drying, dryer absorption, skimming, and other qualities and properties that affect its application and curing.
- Not require a pretreatment chemical or material prior to application of the prime coat except as stipulated in these Specifications.
- Include required tinting and coloring materials at the time of manufacture. Do not use gray for the first prime coat. To provide contrast between coats, when successive coats are specified, use a different color for each coat of the system. Use tinting material that is compatible with the coating material and is not detrimental to performance.
- Unless otherwise specified, conform to the following colors:
  - Federal Standard 595B color #24272 for ODOT Green top coat
  - Federal Standard 595B color #30059 for weathering steel top coat
  - Federal Standard 595B color #26357 for miscellaneous metal on concrete bridges
- Not vary in composition without prior notice by the manufacturer and approval of the Engineer. No reformulation will be allowed.
- Be applied before expiration of manufacturer's recommended shelf life.

(c) Packaging - Furnish each container meeting the following requirements:

- Be the manufacturer's original unopened container.
- Be new steel or plastic of not more than 6 gallon capacity.
- Meet U.S. Department of Transportation's Hazardous Material Shipping Regulations.
- Be lined, if necessary, to prevent attack by the coating material. The lining shall not delaminate from the container wall so as to contaminate the coating.
- Be labeled with a quality compliance certificate according to 00165.35, showing the following:
  - Manufacturer's name
  - Exact title of coating material
  - Manufacturer's batch number
  - Date of manufacturer
  - Identification of all toxic substances
  - Handling and application precautions

(d) Sampling and Testing - Have the coating material manufacturer furnish the following to the Agency's Materials and Research Section:

- One unopened 1 quart container of each coating material, each component of multi-component coating material, and each thinner, from each batch of each coat. The Agency may, at its discretion, place an inspector at the site of manufacture and obtain check samples at the jobsite.

- Test results certification according to 00165.35 for each batch of each coat, and if the coating material is specified for use on steel-to-steel contact surfaces, certification that the coating material meets the requirements of 00594.11(e).
- A product data sheet for each type of coating material and thinner.
- A material safety data sheet with the initial sample of each type of coating material and thinner.

Agency testing will include the following tests necessary to ensure that the coating materials conform to Specifications, manufacturer's product data sheet, and other testing as the Agency deems appropriate.

Test	Test Method
Density of Liquid Coatings, Inks, and Related Products	ASTM D 1475
Determination of Zinc in Dry Films of Paints and Coatings	ODOT TM 614
Coarse Particles in Pigments, Pastes, and Paints	ASTM D 185
Consistency of Paints Using the Stormer Viscometer	ASTM D 562
Fineness of Dispersion of Pigment-Vehicle System	ASTM D 1210
Drying, Curing, or Film Formation of Organic Coatings at Room Temperatures	ASTM D 1640
Volatile Content of Paints	ASTM D 2369
Pigment Content of Solvent-type Paints	ASTM D 2371
Volume Nonvolatile Matter in Clear or Pigmented Coatings	ASTM D 2697
Vehicle Solids (Ordinary Centrifuge)	FTMS 141, Method 4051
Nonvolatile vehicle Content	FTMS 141, Method 4053

Agency testing is not to be construed as determining or predicting the performance or compatibility of the individual coating material or the total coating system.

(e) Specifications - The coatings on steel-to-steel contact surfaces at all slip-critical structural bolted connections using high strength bolts shall meet Class B (slip coefficient of 0.5) coating requirements according to "Test Method to Determine the Slip Coefficient for Coatings Used in Bolted Joints", as adopted by the Research Council on Structural Connections.

00594.12 Caulking - Furnish structural steel caulking from the QPL and approved for use by the coating manufacturer. The caulking color shall be clear, approximate the color of the top coating, or be over coated.

Furnish industrial grade polystyrene or polyurethane backing material of sufficient diameter to fill the crevices or gaps as required.

Obtain the Engineer’s approval of the caulking and backing material before using.

Construction

00594.40 General:

(a) New Steel Structures - Prepare and coat new steel structures and features erected at locations shown. Except as provided in these Specifications, perform all required preparation and coating at the fabrication shop after completion of fabrication and before transporting to the Project Site.

(b) Existing Steel Structures - Prepare and coat the existing steel structures described in the Special Provisions.

(c) Rehabilitating Coated Steel Structures - Prepare and coat new steel members and existing steel structures impacted by erection. This includes all existing steel surfaces uncovered by the removal of existing steel, wood, and concrete members, except top flanges. Impacted areas include, but are not limited to areas, where rivets or bolts are removed, and existing steel surfaces damaged during erection or other Contractor operations. Except as provided in these Specifications, perform all required preparation and coating of new steel members at the fabrication shop after completion of fabrication and before transporting to the Project Site. Perform preparation and coating of existing steel structures impacted by erection in the field.

(d) Non-Steel Metallic Substrates - Prepare and coat new non-steel substrates and features erected at locations shown. Except as provided in these Specifications, perform all required preparation and coating at the fabrication shop after completion of fabrication and before transporting to the Project Site. Prepare and coat existing non-steel substrates described in the Special Provisions.

00594.41 Special Fabrication, Preparation and Coating:

(a) Inaccessible Surfaces - Before fabrication, prepare and coat with all coats steel surfaces inaccessible to preparation and coating after fabrication.

Prepare and coat contact surfaces within slip-critical joints, constructed as part of the work under Section 00560, according to 00594.42 and 00594.43(d-1).

(b) Welded Areas - Schedule fabrication, preparation, and coating so that the coating system is not damaged by the welding or fabricating process.

Neutralize weld areas and remove smoke stain and spills according to SSPC-SP 1. Remove weld slag and spatter by mechanical means before blast-cleaning. Supplement blast-cleaning by other treatment as recommended by the manufacturer of the coating system and as required in 00594.42.

Do not apply coatings within 4 inches of the weld before finishing the welding operation.

00594.42 Preparation of Surfaces:

(a) New Steel Structures - Clean new steel structure surfaces to be coated according to SSPC-SP 10, "Near-White Blast Cleaning", except as modified by this Section. The appearance of the final blast-cleaned surface shall closely approximate Pictorial Standard SP 10 of SSPC-Vis 1.

(b) Existing Steel Structures - Blast-clean existing steel structure surfaces to be coated according to SSPC-SP 10, "Near White Blast Cleaning" with the appearance of the blast-cleaned surface to closely approximate Pictorial Standard SP 10 of SSPC-Vis 1 or clean to SSPC-SP 12, "High and Ultrahigh Pressure Water Jetting", cleaned to visual condition WJ-2.

(c) Rehabilitating Existing Coated Steel Structures - Clean all existing steel surfaces to be coated according to SSPC-SP 15, "Commercial Grade Power Tool Cleaning". The cleaned surface shall have a minimum surface profile of 1 mil.

The areas to be prepared shall include all areas of existing coated surfaces exposed by the removal of the existing components involved in the rehabilitation, all areas in which rivets, bolts, or plates are to be removed, and areas damaged by erection or other Contractor operations. Completely clean all existing lead-based coatings exposed by the removal of any structural or miscellaneous member to SSPC-SP 15 "Commercial Grade Power Tool Cleaning" requirements. Extend all prepared areas at least 2 inches into tightly adhering, intact paint. Overlap the subsequent coating and the still intact coating by a minimum of 2 inches. Lightly sand the overlap area of the intact coating to provide a profile for the subsequent repair coating to adhere to.

(d) Non-Steel Metallic Substrates:

(1) Galvanized Surfaces - Prepare surfaces to be coated according to ASTM D 6386.

(2) Aluminum - Solvent clean surfaces to be coated according to SSPC-SP 1 then follow by a light brush blast according to SSPC-SP 7, with a minimum nozzle pressure of 75 psi, or hand sand the surface to create a minimum 1 mil profile, or clean the surface according to the manufacturer's recommendation.

(e) All Metal Structures - Remove fins, tears, slivers, and sharp edges, plus hardened or damaged edges resulting from flame cutting, shearing, or similar operations.

Clean all surfaces of material detrimental to the application of the coating system as follows:

(1) Cleaning Methods - Blast-clean surfaces using one or more of the following methods to discharge the abrasive:

- A stream of high-pressure air
- A rotating centrifugal paddlewheel
- A stream of high-pressure water

Surfaces shall be dry before cleaning unless a wet blast cleaning method is used. Use methods specified in SSPC-SP 1, "Solvent Cleaning", SSPC-SP 2, "Hand Tool Cleaning", SSPC-SP 3, "Power Tool Cleaning", and SSPC-SP 15 "Commercial Grade Power Tool Clean", as necessary to augment blast-cleaning.

(2) Abrasives - Perform blast-cleaning using an abrasive of a size which will continually produce a surface profile of at least 1 mil, but not more than 4 mils, as measured by ASTM D 4417 using replica tape on the prepared surface. The blast-cleaning shall result in a roughened steel surface comparable to a Keane-Tator Surface Profile Comparator for sand or grit using ASTM D 4417.

If a centrifugal wheel with a grit mixer is used for blast-cleaning, inspect each member and for those members not meeting the comparator or profile requirements, perform a final blast-cleaning with high-pressure air with an abrasive to obtain the specified profile.

Provide abrasives that have no corrosion products, water, oil, or any other material detrimental to the application and adherence of the coatings. Provide abrasives that conform to SSPC-AB 1 or SSPC-AB 3. Cleanliness will be tested according to ODOT TM 616 and ASTM D 4940. The conductivity results from ASTM D 4940 shall not exceed 100 microsiemen/cm. Wet abrasives are allowed if wet sandblasting methods are used.

(3) Air - The high-pressure air used for blast-cleaning or blowing down shall be free of water, oil or any other material detrimental to the coating system. Provide adequate separators and traps. Compressed air cleanliness will be tested according to ASTM D 4285 by the Engineer.

(4) Rust Inhibitor - If a rust inhibitor is not used with wet surface preparation methods, brush-blast any rust bloom on the surface before applying the coating. If an effective rust inhibitor is used, it shall be compatible with the coating system and be applied to the freshly cleaned surface or contained in the liquid used in cleaning. Use a rust inhibitor from the QPL, or prepare a test panel at least 14 calendar days before beginning work to show that the rust inhibitor does not cause loss of bond between the prepared steel substrate and the primer. If bond failure occurs, no further use of the rust inhibitor will be allowed.

(5) Cleaning Procedures - Perform blast-cleaning operations without damaging partially or entirely completed portions of the work. Do not blast-clean adjacent to areas being coated.

The blast-cleaned surface will be examined for any traces of corrosion, water, oil, grease, and other material deposited during the cleaning operations. If present, remove any detrimental material by solvent cleaning and reblast the surface.

(6) Final Preparation - Before coating, the prepared surface shall be:

- Blown down using high pressure air, within the fully enclosed containment with the specified ventilation operating and supplemented by brushing if required.
- Free of all residue.
- Repair any damaged galvanizing according to ASTM A 780.
- Acceptable to the Engineer.

00594.43 Coating Metal Structures:

(a) Description - When not in conflict with this Section and the Special Provisions, perform coating application according to the following:

- The applicable portions of SSPC-PA 1.
- The recommendations of the coating manufacturer.
- The best practices of the trade.

(b) Application Site Mixing, Thinning, and Storage of Coating Materials:

(1) Rejection - The container contents will be rejected, and not be used if:

- The material arrives at the application site in other than original, unopened containers.
- The container has a break in the lid seal or a puncture.
- The coating materials have begun to polymerize, solidify, gel or deteriorate in any other manner.
- The recommended shelf life, as stated in the manufacturer's product data sheets, has expired.
- A skin forms on the surface of the material or on the sides of the container and the volume of the skin exceeds 2% of the material. If there is not more than 2% skin, remove and discard only the skin.

(2) Mixing - Thoroughly mix coating materials by mechanical means to ensure a uniform composition. Do not mix coating materials by means of air stream bubbling or boxing. Mix in the original container and continue until all pigment or metallic powder is in suspension. Ensure that all solid coating material that may have settled to the bottom of the container is thoroughly dispersed. After mixing, inspect the coating materials for uniformity and to ensure that no unmixed pigment or lumps are present.

Add separately packaged catalysts, curing agents, hardeners, initiators or dry metallic powders to the base coating material only after the base coating material is thoroughly mixed to achieve a uniform mixture with all particles wetted. Add the proper volume of curing agent to the correct volume of base with constant agitation. Use the mixture within the pot life specified by the manufacturer. Discard unused portions at the end of each workday.

(3) Thinning - Do not add additional thinner at the application site unless approved. The amount and type of thinner, if allowed, shall conform to the manufacturer's specifications.

(4) Straining - Strain all coating materials after mixing to remove undesirable matter, but not pigment or metallic powder.

(5) Agitation - Constantly agitate coating materials as recommended by the manufacturer, and all inorganic zinc primers during application, using paint pots equipped with mechanical agitators.

(6) Storage - Store the coating material and solvents in original containers. Store the containers in a weather-tight space where the temperature is maintained between 40 °F and 100 °F or according to the manufacturer recommendations, whichever is more restrictive.

(c) Application of Coating:

(1) Surface Condition - Ensure that the surface to be coated is free of moisture, dust, grease or other substance which would prevent the bond of succeeding applications. Protect freshly coated surfaces from contamination by abrasives, dust or foreign materials from any source. Prepare contaminated surfaces to the Engineer's satisfaction before applying succeeding coats.

(2) Application Methods - Apply coating materials by air or airless spray, brush, roller, any combination of these methods, or as recommended by the coating material manufacturer unless otherwise specified. Regardless of which application method is used to apply the coating, push the coating into complex details, crevices, gaps, difficult to access areas and areas with brushes where spraying does not adequately cover or penetrate. All application techniques shall conform to Section 7, SSPC-PA 1.

Apply each coat in a uniform layer, completely covering the preceding coat. Each individual coat shall be furnished by the manufacturer in a sufficiently different shade so that skips and holidays can be easily detected. Do not tint the coating material in the field unless approved. Correct runs, sags, skips or other deficiencies before application of succeeding coats. Corrective work may require recleaning, application of additional coating, or other measures as directed, at no additional compensation.

(d) Coating Requirements:

(1) Number of Coats and Film Thickness - Apply all coats to the minimum thickness specified in the manufacturer's product date sheet for the coatings.

Apply the coating system in the number of coats specified in the QPL, with each coat consisting of as many applications as necessary to cover the work and achieve the minimum thickness specified for the coat.

Apply only a coating of zinc primer to all steel-to-steel and steel-to-concrete, except top flanges, contact surfaces, whether in the shop or field. The dry film thickness shall not be less than 3 mils nor more than the manufacturer's class "B" certification allows.

Do not assemble coated joints before the coatings have cured for at least the time used in the qualifying test, or as recommended by the manufacturer.

On steel-to-wood contact surfaces, apply all coatings specified.

(2) Stripe Coats - On maintenance coating projects apply a prime stripe coat before applying the full prime coat and apply an intermediate stripe coat before applying the full intermediate coat.

The stripe coat shall be a different color and be approximately 3 mils thick. Each stripe coat will have its own hold point and shall not be used to correct deficiencies in the preceding or subsequent coats.

The full prime coat may be applied prior to the prime stripe coat to prevent flash rusting of the cleaned steel surfaces if approved. In either case, the first application of prime coat shall be accomplished by the use of brushes as described in the definition of "Stripe Coat" in 00594.01(b).

(3) Coating Thickness and Coverage Requirements - Coating thickness measurements will be made by the Engineer after the application of each coat and before application of the succeeding coat. In addition to coating thickness measurements, a visual inspection for complete coverage will be made by the Engineer after each coat. Apply each coat in sufficient thickness to achieve uniform and complete coverage and appearance. If all thickness measurements are not within the specified minimum dry film thickness, or if the visual inspection does not satisfy the Engineer, make additional applications, as necessary, to meet the thickness and coverage required. Film thickness will be measured above the peaks of the profile of the anchor pattern in the metal substrate.

The dry film thickness will be measured for acceptance using a Type 2 gauge according to SSPC-PA 2. The frequency of measurements will be based on the following:

- A single gauge reading will be taken for each 10 square feet of surface area.
- A spot measurement is only taken at locations where a gauge reading is less than 100% of the Project specified minimum DFT.
- All spot measurements shall meet 100% of the project specified minimum DFT.
- Additional readings may be required to identify the limits of the non-compliant areas.

If a question arises about an individual coat thickness or coverage, it will be verified using a Tooke gauge, according to ASTM D 4138. If the Tooke gauge shows a prime coat to be less than the specified minimum thickness, or reveals a missing intermediate coat, the total coating system will be rejected even if the thickness of the total system equals or exceeds total specified thickness.

In areas where dry film thickness measurements are impractical, wet film thickness measurements will be made according to ASTM D 4414.

(4) Additional Top Coat Requirements - Even if the total thickness of prime and intermediate coats exceed the prime and intermediate coats specified thicknesses, apply the top coat to at least the minimum required topcoat thickness, as well as provide uniform and complete coverage and appearance.

(e) Time of Application - Within 3 aerial miles of the Pacific Ocean, prime existing steel structure surfaces on the same day they are cleaned, apply an approved rust inhibitor to the entire surface on the same day as cleaning, and prime within 48 hours after inhibitor application, or reblast all surfaces prior to coating.

Beyond 3 aerial miles of the Pacific Ocean, prime existing steel surfaces as soon as possible within 3 calendar days of cleaning.

All surfaces shall be free of flash rust and dry before priming.

Apply each coat over the preceding coat as soon as possible, allowing for drying time of the preceding coat, weather, temperature, and similar factors, as well as the manufacturer's recommendation.

Each coat shall be dry before recoating, and sufficiently cured so the succeeding or additional coat can be applied without delamination, blistering, wrinkling, or loss of adhesion or cohesion. Recoat times shall conform to the manufacturer's recommendations unless they conflict with this Section or any coating problems develop. Revision of recoat times requires approval of the Engineer before recoating.

(f) Caulking - Apply the caulk after complete application of the top coat. Fill and seal crevices and gaps between structural shapes and plates, around bolt heads or nuts, and similar areas that would retain moisture with the following:

- Caulk, if the crevice or gap cannot be filled with coating materials.
- Backing material and caulk to fill the crevices and gaps that exceed 1/4 inch.

Apply caulk over the backing material to form a watertight seal.

In areas that collect or channel water, apply caulk even if coating fills the gap.

(g) Adhesion - Minimum adhesion shall be 350 psi within one week of application of each coat to its substrate. The Engineer will perform adhesion tests according to ASTM D 4541, using test method "B".

(h) Environmental Conditions - Apply coating materials only during periods when, according to testing by ASTM E 337, the:

- Air temperature is above 45 °F
- Steel surface temperature is:
  - Greater than 45 °F
  - Less than 115 °F
  - At least 5 °F above the dew point
- Relative humidity is within the manufacturer's recommended range

Application of coating materials will not be allowed if the Engineer determines that conditions are not favorable for proper application and performance of the coating.

If fresh coatings are damaged by the elements, replace or repair at no additional cost to the Agency.

If a coating system allows application in environmental conditions different from those specified, submit a letter from the manufacturer stating the conditions under which the coatings can be applied. Application under conditions other than specified will not be allowed without the Engineer's written approval.

Cover and protect the metal if coating is to be applied in adverse weather conditions. Heat the metal and surrounding air to the temperature specified in this subsection. Continue protecting the newly coated steel until the coating achieves proper cure.

(i) Stenciling - Stencil the month and year of application and the type of coating used in block letters 2 inches high at a location on each end of each span on the structure being coated. The exact location of stenciling will be determined by the Engineer. Use flat black color stenciling unless otherwise directed.

00594.44 Inspecting - The Engineer will inspect each phase of preparation and coating. Do not proceed with succeeding phases until approved. Provide the inspector timely access to areas where work is being performed. Allow adequate time for inspection at each hold point. Hold points are the following:

- Before cleaning operations begin
- After cleaning operations are completed and before application of any coating materials
- After each stripe coat
- After each full coat
- After cleaning in conjunction with coating repairs
- After application of each coat in coating repairs
- After application of last coat, before moving work platforms and containment structures

Repair coating system damages resulting from Agency inspection and testing at no additional cost to the Agency.

Aspects of the preparation and coating process to be inspected and tested include, but are not limited to:

Test	Test Method
Environmental Conditions for Coating	ASTM E 337
Cleanness of Abrasive Material	ODOT TM 616
Ionic Contamination of Abrasive Material	ASTM D 4940
Cleanness of Compressed Air	ASTM D 4285
Pictorial Surface Preparation Standards	SSPC-VIS 1, 3, 4, and 5
Surface Profile by Keane -Tator Comparator	ASTM D 4417
Surface Profile by Replica Tape	ASTM D 4417
Wet Film Thickness	ASTM D 4414
Dry Film Thickness by Magnetic Gauge	SSPC-PA2 (modified)
Dry Film Thickness by Tooke Gauge	ASTM D 4138
Pull-off Strength of Coating	ASTM D 4541 (Method B)

00594.45 Protecting Against Damage:

(a) Contaminated Surfaces - If the prepared surface becomes contaminated by material other than rust, clean the surface in a manner satisfactory to the Engineer before making the succeeding application. If the prepared surface becomes contaminated by rust, prepare the contaminated area again according to 00594.42 and recoat with all specified coats. Clean, reprepare, and recoat at no additional cost to the Agency.

(b) Surfaces Not to Be Coated - Protect surfaces that are not to be coated from blast-cleaning, overspray and drippings. Remove or repair unintended coatings or other damage on these surfaces to the Engineer's satisfaction at no additional cost to the Agency.

Do not clean or coat galvanized steel members such as ladders, safety rails and stanchions unless otherwise directed in the Special Provisions. Protect them from damage during preparation and application operations. Repair damaged galvanizing at no additional cost to the Agency.

Protect navigation lights and conduits. If navigation lights or lenses are damaged by the preparation or coating operations, immediately repair or replace at no additional cost to the Agency. Keep navigation lights operating and visible during the hours of darkness.

(c) Handling, Shipping, or Surface Damage - Exercise care in moving or handling steel in the shop, during shipping and during erection. Do not move or handle coated metal until the coating has cured.

Repair marred or damaged coated surfaces at no additional cost to the Agency, with the same materials and to the same condition as specified. At the completion of all work, the coating shall be complete and the surfaces undamaged and clean.

(d) Other Damage - Prevent, at no additional cost to the Agency, damage resulting from preparation and coating work, including:

- Damage to marine or vehicular traffic or harm to pedestrians in the vicinity of the work.
- Abrasive material or debris falling into an area which would create a traffic hazard.
- Damage to the bridge substructure, superstructure or motorized equipment.
- Damage to other property as a result of the Contractor's operations.

00594.60 Repair of Damaged and Unacceptable Coatings - Repair damaged surfaces and surfaces not in compliance with requirements of 00594.43 as follows:

(a) Surface Preparation - Repair localized damage, corrosion, and unacceptable coatings.

Prepare areas exhibiting coating defects down to the metal substrate, whether exhibiting visible corrosion or not, according to SSPC-SP 10.

If approved, prepare small areas according to SSPC-SP 15 so it does not damage adjacent areas. Extend the prepared area at least 2 inches into adjacent tightly adhering, intact coating.

In areas exhibiting coating defects which do not extend down to the metal substrate remove all loose, delaminating, non-intact, non-sound coating, or otherwise defective coating down to sound, still performing coating. Extend the prepared areas at least 2 inches into adjacent tightly adhering, intact coating.

(b) Feathering of Repair Areas - Feather the existing coating system surrounding each repair location. Feather for a distance of 1 inch to 2 inches to provide a smooth, tapered transition into the existing intact coating.

Verify that the edges of coating around the periphery of the repair areas are tight and intact by probing with a putty knife according to SSPC-SP 3. Roughen the existing coating in the feathered area to ensure proper adhesion of the repair coats overlap the intact, still sound surfaces at least 2 inches.

(c) Coating Application in Repair Areas - When the bare metal substrate is exposed in the repair area, apply all coats of the system to the specified thicknesses.

When the damage does not extend to the bare metal substrate, apply only the affected coats.

Maintain the thickness of the system in overlap areas within the specified total thickness tolerances and overlap the intact, sound existing coating at least 2 inches.

Measurement

00594.80 Measurement - No measurement of quantities will be made for work performed under this Section.

Payment

00594.90 Payment:

(a) New Metal Structures - No separate payment will be made for preparing and coating new metal work. Payment for this work, including correction of damages, will be included in payment made for structural steel according to 00560.90 and metal sign supports according to 00930.90 as appropriate.

(b) Existing Metal Structures - The accepted quantities for preparing and coating existing metal structures will be paid for at the Contract unit price, per unit of measurement, for the following items:

	Pay Item	Unit of Measurement
(a)	Containment	Lump Sum
(b)	Moving Bridge Containment System	Lump Sum
(c)	Surface Preparation	Lump Sum
(d)	Coating Application	Lump Sum
(e)	Coating Materials	Lump Sum

Item (a) includes designing, erecting, and securing access platforms and containment structure, and containment worker protection requirements.

Item (b) includes moving and removing the access platforms and containment structure.

Item (c) includes preparing existing metal surfaces.

Item (d) includes coating existing metal surfaces.

Item (e) includes the coating material.

Partial payments of items (c), (d), and (e) will be made only for portions of the structure that have been prepared and coated with all coats specified. The partial payment will represent an estimate of the work completed as a percentage of the total coating system work to be done.

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

No separate or additional payment will be made for correction of damages described in 00594.45.

Section 00595 - Reinforced Concrete Box Culverts

Description

00595.00 Scope - This work consists of constructing cast-in-place reinforced concrete box culverts (RCBC) and precast reinforced concrete boxes to the lines, grades, and dimensions shown or directed.

Materials

00595.10 Cast-in-Place Materials - For cast-in-place RCBC, cast-in-place ends, and cast-in-place wingwalls and aprons, furnish materials meeting the following requirements:

Reinforcement.....00530
Concrete 00540

Unless otherwise shown, provide Class 3300 - 1 1/2" or 3/4" portland cement concrete.

00595.11 Precast Materials - For precast boxes, furnish materials meeting the requirements of AASHTO M 259 or AASHTO M 273. Furnish joint seals meeting the requirements of 02440.40.

Unless otherwise shown, provide Class 5000 - 1 1/2" or 3/4" portland cement concrete.

Construction

00595.40 Cast-in-Place - Construct cast-in-place RCBC, cast-in-place ends, and cast-in-place wingwalls and aprons according to the following:

(a) Reinforcement - Place reinforcing steel according to Section 00530.

(b) Portland Cement Concrete - Place portland cement concrete according to Section 00540 and the following:

(1) Placing Concrete - Allow base slabs or box culvert footings to set at least 12 hours before constructing the remainder of the box culvert.

When constructing box culverts 4 feet or less in height, the sidewalls and top slab may be constructed as a monolith, with sidewalls constructed full height. If this method is used, place construction joints vertical and at right angles to the axis of the culvert.

When constructing box culverts more than 4 feet in height, place concrete in the walls to at least the bottom elevation of the top slab. Allow three days before placing the top slab according to 00595.40(b-2).

Construct each wingwall as a monolith.

(2) Removal of Forms and Falsework and Subsequent Loading - Do not remove forms and falsework or place subsequent loads until the following conditions are met:

Form and Falsework Removal	**Counting Days** [1]
Stems and walls	1
Top Slabs	10

Subsequent Loading [2]	**Counting Days** [1]
Stems and walls over 4 feet in height	3

[1] From the time of the last placement of concrete in the forms or falsework supports and excluding days when the surrounding temperature is below 40 °F for eight hours or more.

[2] Except loads from form work and reinforcing steel for further concrete placements.

(3) Concrete Finish - Finish all exposed concrete surfaces with a general finish according to 00540.53(a).

00595.41 Precast - Construct precast boxes according to AASHTO M 259 except as shown. A production run will be considered continuous if it is not interrupted for more than three calendar days.

Place a continuous flexible watertight seal in the joint, on the sides and top, between each precast reinforced concrete box section.

Measurement

00595.80 Measurement - The quantities of reinforced concrete box culverts will be measured on the length basis, along the centerline of the box culvert, from end to end of the cast-in-place ends.

No measurement of quantities will be made for wingwalls and aprons.

No separate measurement will be made for concrete and reinforcement used in the box culverts. Estimated quantities of concrete and reinforcement will be listed in the Special Provisions.

Payment

00595.90 Payment - The accepted quantities of work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

(a) Reinforced Concrete Box Culverts ..... Foot
(b) Wingwalls and Aprons ..... Lump Sum

Item (a) includes cast-in-place ends regardless of the type of box culvert constructed.

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

Section 00596 - Retaining Walls

Description

00596.00 Scope - This work consists of furnishing and constructing retaining walls as shown or specified, and in close conformity to the lines, grades, and dimensions shown or established.

The Special Provisions will list the types and locations of walls to be constructed.

00596.02 Definitions - Geosynthetic terms not defined in this subsection are identified in ASTM D 123, ASTM D 4439, or 00350.01. If there is a conflict, definitions in this subsection take precedence.

Alternate Fasteners - Spiral binders or high tensile locking spring steel clip or clamp-on ring type fasteners specified as an alternate to tie wire for assembling and joining gabions.

Bin Walls - Concrete or metal gravity retaining structures filled with granular backfill material. Bin walls consist of interlocking, prefabricated modules or bolted lightweight steel members constructed like building blocks.

Company - In the case of a proprietary retaining wall, the firm or other entity that identifies lawful claim to the retaining wall or design of the retaining wall. In the case of non-proprietary retaining wall, the firm or other entity that produces, provides, or designs the retaining wall.

Conventional Segmental Retaining Walls:

- A basic gravity retaining wall type, and
- Retaining walls composed of segmental retaining wall units only (i.e., no soil reinforcements).

Crib Walls - Prefabricated, interlocking reinforced or unreinforced gravity retaining structures backfilled with granular backfill material. Crib walls consist of alternating transverse and longitudinal beams.

Extensible Tensile Reinforcements - Reinforcements in which the deformation at failure is comparable to or greater than the deformability of the reinforced backfill (e.g., geotextile and polymeric materials).

Gabion Retaining Walls:

- A basic gravity retaining wall type, and
- Retaining walls composed of assembled wire baskets, connected together, filled with specified rock, and placed with a riprap geotextile between the back face of the basket and the backfill material.

Geogrid - See 00350.01 for geogrid definition.

Geosynthetic - See 00350.01 for geosynthetic definition.

Geotextile - See 00350.01 for geotextile definition.

Inextensible Tensile Reinforcements - Reinforcements in which the deformation at failure is significantly less than the deformability of the reinforced backfill (for example, metallic materials).

Internal Connecting Wires - Internal wires used to prevent gabions from bulging.

Mechanically Stabilized Earth (MSE) Retaining Walls:

- A basic gravity retaining wall type, and
- Retaining walls composed of granular backfill and either extensible or inextensible tensile reinforcements in the granular backfill mass. Examples of facing include precast concrete panels, cast-in-place facades, and segmental retaining wall units.

Prefabricated Modular Block Retaining Walls - Unreinforced, prefabricated concrete block gravity (non-MSE) retaining walls composed of concrete blocks greater than 3 cubic feet.

Proprietary Retaining Walls:

- Retaining walls in which a private company identifies lawful claim to the product or design of the product,
- Retaining wall products typically associated with a trade name or name brand, or
- Retaining walls designed by someone other than the retaining wall Contract Documents engineer of record.

Retaining Wall or Retaining Structure - A group of interrelated components designed to resist earth pressures.

Rigid Gravity Retaining Walls - A basic gravity retaining wall type that includes cast-in-place concrete gravity retaining walls.

Segmental Retaining Wall Unit - A machine-formed solid or hollow modular concrete block less than 3 cubic feet.

Semi-Gravity Retaining Walls - A basic gravity retaining wall type that includes cast-in-place concrete cantilever or counterfort retaining walls.

Tie Wire - Wire used to assemble and join gabion units.

00596.03 Variables - The amount and type of work required to construct a proprietary retaining wall varies according to the wall selected. The Contractor is responsible for making a careful study of the work required for each wall and for determining the quantities.

Variables could involve shoring, excavation, backfilling, excess material, staging work, corrosion protection, utilities and drainage systems adjustments and other details of the work.

00596.04 Proprietary Retaining Wall Submittals - Submit stamped working drawings and design calculations, and field construction manuals and product brochures prepared by the manufacturer of the proprietary retaining wall selected, as necessary, according to 00150.35. Submit this information at least 30 calendar days before beginning retaining wall fabrication or construction. Obtain the Engineer's written approval before fabricating retaining walls.

(a) Working Drawings - Provide working drawings that include at least the following information:

(1) General:

- **General Notes** - Necessary information on design and construction of the retaining wall.

- **Materials and Quantity Summary List** - Show all items of each wall.

- **Plan View** - Show the construction centerline and related horizontal curve data, the offset from the construction centerline to the face of the wall at all changes in horizontal alignment, and the centerline of any utility or drainage structure or pipe that is behind or passes under or through the wall.

- **Elevation View** - Show the elevation at the top of the wall at all horizontal and vertical break points, and at least every 65 feet along the wall; vertical curve data; the location of the original and final ground line at both the heel and face of the wall; elevations at the base of the wall (for example, top of cast-in-place footings and leveling pads); the distance along the face of the wall to all steps in the wall base; and the applied bearing pressures.

- **Typical Sections** - Show wall construction and limits of backfill.

- **Structural and Geometric Details** - The following minimum structural and geometric details:

  - Loading conditions
  - Footing and/or leveling pad details
  - Final front face batter
  - Reinforcing bar bend details
  - Details for appurtenances not detailed in the plans, including connections to concrete barriers, coping, parapets, soundwalls, fences, and attached lighting
  - Construction around utility and drainage facilities, overhead sign support footings, abutment piles, or other structures

(2) MSE Retaining Walls:

- **Plan View** - Show soil reinforcement limits.

- **Elevation View** - Show the type and size of facing components; the length, size and number of soil reinforcements; and the distance along the face of the wall to where changes in the length of the soil reinforcement occur.

- **Typical Section** - Show soil reinforcement limits.

- **Facing Components** - Show all dimensions, including thickness; all details necessary to construct the facing components; all reinforcing steel in the component; and the location of tensile soil reinforcement attachment devices embedded in the facing. Show the type of concrete finish.

- **Soil Reinforcements** - Show all dimensions and details necessary to construct the soil reinforcements.

(b) Design Calculations - The design calculations shall include but not be limited to:

(1) General:

- **Design Input** - Show wall geometry; soil parameters; and both permanent and temporary design loads, including applied loads from pedestrian rails, fencing, guard rail, concrete barrier, soundwalls, sign supports, or luminaire supports.

- **External Stability Calculations** - Indicate factors of safety against sliding and overturning.

- **Foundation Bearing Pressure Calculations** - Indicate the factor of safety against foundation bearing failure.

- **Appurtenances** - Show calculations for the design of pedestrian rails, fencing, guard rail, concrete barrier, soundwalls, sign supports or luminaires when not fully detailed on the plans. Design concrete barriers according to AASHTO Standard Specifications for Highway Bridges, and Interim Revisions, to withstand a horizontal force of 10,000 pounds per 5 feet applied at the top of the barrier and conforming to the National Cooperative Highway Research Program (NCHRP) Report 350, unless otherwise indicated.

(2) MSE Retaining Walls:

- **Internal Stability** - Indicate reduction factors and factors of safety against soil reinforcement rupture, pullout, and facing connection strength.

- **Local Stability** - Indicate factors of safety against sliding and bulging of segmental retaining wall facing units.

(c) Field Construction Manual - Provide a field construction manual, prepared by the manufacturer of the proprietary retaining wall selected, including step-by-step directions for constructing the retaining wall.

Materials

00596.10 Materials - Furnish materials meeting the following requirements:

(a) Agency Approval - Use only retaining wall materials, products or systems that have met the requirements of the Agency Retaining Structures Program and have an "Approved" status according to the Agency Retaining Structures Program prior to the Project Bid Opening. Information regarding approval or any other aspect of the Agency Retaining Structures Program may be obtained from the Agency Retaining Structures Coordinator in Salem.

(b) Agency-Furnished Designs - For retaining wall designs shown (i.e., non-proprietary retaining walls), either provide specified materials according to these applicable material Specifications or provide products from the QPL also according to these applicable material Specifications. Obtain like materials for the retaining wall from the same company.

(c) Proprietary Retaining Wall Systems - For proprietary retaining walls, provide products from the selected company according to the company's specifications and these applicable material Specifications. If there is a conflict between the company's specifications and the Agency's Specifications the Agency's Specifications will take precedence. Obtain all materials for the selected proprietary retaining wall from the same company. Use only one proprietary retaining wall on the Project unless different proprietary retaining walls are specified.

Do not use materials from unlisted sources without written approval. Acceptance will be based on manufacturer's test results and certificates of compliance according to 00165.35, visual inspection and other criteria in this Section.

(d) Quality Control - Provide quality control according to Section 00165.

00596.11 Backfill - Furnish backfill meeting the requirements of Section 00510 and the following:

(a) Granular Drain Backfill Material - Provide granular drain backfill material according to 00430.11. Provide a Type 1 drainage geotextile according to Section 02320.

(b) Special Filter Material - Provide special filter material according to Section 02610.

(c) Gabion Retaining Walls - Provide a well-graded 4 inch to 10 inch rock fill material inside the gabion baskets meeting the requirements of 00390.11(b).

Provide granular wall backfill material behind the gabion baskets according to 00510.12.

(d) Metal Bin Retaining Walls - Provide granular structure backfill material for the interior cell of the metal bin retaining wall units according to 00510.13.

Provide granular wall backfill material behind the metal bin retaining wall units according to 00510.12.

(e) Leveling Pads - Provide granular structure backfill material for gravel leveling pads according to 00510.13.

(f) Segmental Retaining Wall Units - Provide granular structure backfill material for the interior cell of hollow segmental retaining wall units according to 00510.13.

Provide backfill material behind the segmental retaining wall units as specified.

(g) MSE Granular Backfill - Provide MSE granular backfill material meeting the following requirements:

(1) Gradation - Gradation shall meet all requirements in Section 02630 and Table 02630-1. Use either 1" - 0 or 3/4" - 0 base aggregate conforming to the requirements of 02630.10(a) through 02630.10(c). Test the MSE granular backfill at the frequency specified in the ODOT Manual of Field Testing Procedures (MFTP) for aggregate base material. Additionally, MSE granular backfill placed in the spread footing foundation support zone shall have between 90 to 100 percent passing the 3/4 inch Sieve for all "Separated Sizes" as determined by AASHTO T27.

(2) Other Requirements:

a. Material Passing No. 200 Sieve - The percent, by weight, passing the No. 200 sieve shall not exceed 15% when tested according to AASHTO T 27 and AASHTO T 11.

b. Plasticity Index - The plasticity index of the material passing the No. 40 sieve shall not exceed 6 when tested according to AASHTO T 90.

c. Electrochemical Properties - The electrochemical properties of the material shall meet the following requirements:

Property	Limits	Test Procedures
pH	5.0 - 10.0	AASHTO T 289
Resistivity	5,000 Ω-cm (min.)	AASHTO T 288

MSE granular backfill material with resistivities of less than 5,000 Ω-cm but greater than 3,000 Ω-cm and meeting all other requirements may be accepted if they meet the following additional requirements:

Property	Limits	Test Procedures
Chlorides	100 PPM (max.)	AASHTO T 291
Sulfates	200 PPM (max.)	AASHTO T 290

d. Organic Content - The organic content shall meet one of the following conditions:

- Organic content as computed according to AASHTO T 267 for material finer than the No. 10 sieve does not exceed 1.0%.
- The ratio (expressed as a percentage) of the weight of organic material (as determined by AASHTO T 267) to the weight of the total sample does not exceed 0.75%.

00596.12 Gabion Baskets - Furnish gabion baskets meeting the requirements of Section 02340.

00596.13 Concrete:

(a) ODOT Standard Cast-in-Place Concrete Gravity Retaining Wall - Provide commercial grade concrete according to Section 00440.

(b) ODOT Standard Cast-in-Place Concrete Cantilever Retaining Wall - Provide structural concrete according to Section 00540.

(c) Leveling Pads - Provide commercial grade concrete according to Section 00440.

(d) MSE Retaining Wall Cast-in-Place Concrete Facades - Provide commercial grade concrete according to Section 00440.

(e) MSE Retaining Wall Precast Concrete Facing Panels - Provide commercial grade concrete according to Section 00440 and the following:

(1) Portland Cement Concrete - Use the class of concrete listed in the Special Provisions.

(2) Casting - Set soil reinforcement connection devices on the rear face of the precast panel and secure to prevent displacement during concrete placement and consolidation. Do not allow devices used to connect soil reinforcements to facing panels (e.g., loop embeds tie strips, etc.) to contact the face panel reinforcement steel. Place concrete in each panel without interruption and consolidate with an approved vibrator.

Use clear form oil throughout the casting operation.

(3) Curing - Follow the curing procedure given in the Special Provisions.

(4) Finish - Give the front face a general surface finish according to 00540.53(a), unless otherwise specified. Screed the back face to eliminate surface distortions and open pockets of aggregate.

(5) Tolerance - Manufacture all units within the following tolerances:

a. Panel Dimensions - Do not exceed a difference of 1/2 inch between diagonals. All other dimensions are not to exceed a difference of 3/16 inch. Angular distortion, with regard to the height of the panel, is not to exceed 1/8 inch in 3 feet.

b. Soil Reinforcement Connection Devices:

1. Tie Strips - Locate tie strip connection devices within 1 inch of the plan location.

2. Loop Embeds - Locate loop embeds within 3/16 inch of the plan location.

3. Retention Slots - Locate retention slots within 1 inch of the plan location. Slot openings are not to exceed 1/8 inch. Check the slot opening with the supplied "feeler" gauge according to the company's recommendations. Reject panels from which the "feeler" gauge is pulled from the slot.

c. Panel Face - Smooth formed surfaces are not to vary over 3/32 inch when measured over a length of 3 feet. Textured-finished surfaces are not to vary over 3/16 inch when measured over a length of 3 feet.

d. Rear Face - Eliminate surface distortions in excess of 1/4 inch.

(6) Acceptance of Panels - Acceptance will be according to 00540.17 except as follows:

- Acceptance of precast panels will be determined based on production sublots. A production sublot will be represented by a single compressive strength sample and will consist of either 40 panels or a single day's production, whichever is less. Cast one set of cylinders for each production sublot.
- Acceptability of the precast panel will be determined based on conditional compressive strength tests results, check tests, and visual inspection. Panels may be placed in the wall if 7-day initial strength exceeds 85% of the 28-day requirements. Final acceptance will be based on the 28-day test results.

(7) Marking - Clearly scribe on the rear face of each panel the date of manufacture, the production sublot number, and the piecemark.

(8) Handling, Storage, and Shipping - Handle, store, and ship all units in a manner that eliminates chipping, discoloration, cracks, fractures and connecting device damage. Support stored panels on firm blocking.

(9) Rejection - Any of the following defects will be cause for rejection:

- Imperfect molding
- Honeycombed or open texture concrete
- Exposed reinforcing steel
- Improperly installed soil reinforcement connection devices
- Broken or chipped concrete
- Excessive color variation on front face of panel
- Nonspecification strength
- Cross-sectional thickness of the wall facing component less than the minimum thickness indicated on the plans or working drawings

(f) Segmental Retaining Wall Units - Provide a minimum compressive strength after 28 days of 4,000 psi and a maximum absorption rate of 5% by weight.

(1) Portland Cement - Use portland cement meeting the requirements of 02010.10.

(2) Blended Cement - Use blended cement meeting the requirements of 02010.20.

(3) Aggregate - Use aggregate meeting the requirements of ASTM C 33.

(4) Tolerance - Molded dimensions are not to differ more than 1/8 inch from the manufacturer's published dimensions, except height, which is not to differ more than 3/16 inch.

(5) Color - Provide gray units unless specified otherwise.

(6) Finish - Provide split-face units unless specified otherwise.

Provide units that are sound and free of cracks or other defects that would interfere with the proper placement of the unit or significantly impair the strength or permanence of the construction.

Provide units that are free of chips, cracks or other imperfections when viewed from a distance of 10 feet under diffused light.

(7) Acceptance of Units - Acceptability will be determined based on compressive strength, moisture absorption, and dimension tests according to ASTM C 140 and visual inspection. Segmental retaining wall units may be placed in the wall if 7-day initial strength exceeds 85% of the 28-day requirements. Final acceptance will be based on the 28-day test results.

(8) Marking - Indicate the date of manufacture and the production lot number on each lot of segmental retaining wall units.

(9) Handling, Storage, and Shipping - Handle, store, and ship all units in a manner that eliminates chipping, discoloration, cracks and fractures.

(10) Rejection - Any one of the following defects will be cause for rejection:

- Imperfect molding
- Honeycombed or open texture concrete
- Broken, cracked or chipped units
- Extreme color variation on front face of unit
- Nonspecification strength
- Absorption

(g) Prefabricated Modular Concrete Blocks:

(1) Concrete - Provide concrete suitable for common structural applications. Concrete tests are not required.

(2) Grade - Provide Standard Grade blocks.

(3) Color - Provide gray blocks unless specified otherwise.

(4) Finish - Provide smooth face blocks unless specified otherwise.

Provide blocks that are sound and free of cracks or other defects that would interfere with the proper placement of the block or significantly impair construction of the wall.

Provide blocks that are free of chips, cracks or other imperfections when viewed from a distance of 10 feet under diffused light.

(5) Tolerance - Molded dimensions are not to differ more than 1/4 inch from the manufacturer's published dimensions, except height, which is not to differ more than 5/32 inch.

(6) Handling, Storing, and Shipping - Handle, store, and ship all blocks in a manner that eliminates chipping, discoloration, cracks and fractures.

(7) Acceptance of Blocks - Acceptability will be determined based on tolerances specified in (5) of this subsection and visual inspection.

(8) Rejection - Any one of the following defects will be cause for rejection:

- Concrete not suitable for common structural applications
- Imperfect molding
- Honeycombed or open texture concrete
- Broken, cracked or chipped blocks
- Extreme color variation on front face of block

00596.14 Steel Reinforcement for Concrete - Furnish steel reinforcement for concrete meeting the requirements of Section 00530.

00596.15 Steel - Furnish structural steel meeting the requirements of Section 00560 and the following:

(a) Metal Bin Retaining Walls - Provide metal bin retaining walls according to Section 02350.

(b) Inextensible Soil Reinforcements, Facing Components and Attachment Hardware - Shop-fabricate true size and defect-free soil reinforcements, facing components and attachment hardware as follows:

Galvanize soil reinforcements, facing components and attachment hardware according to 02530.70, except where noted. If specified, epoxy coat according to AASHTO M 284 (ASTM A 775), except where noted.

(1) Reinforcing Strips - Use steel reinforcing strips of the required shape and dimensions conforming to ASTM A 36 or equal. Provide a minimum 2.0 ounce per square foot galvanized coating. If specified, provide a minimum 18 mils epoxy coating.

(2) Reinforcing Mesh - Furnish welded wire reinforcement according to 02510.40 supplemented and modified as follows:

a. Galvanized Reinforcement - Provide a minimum 2.0 ounce per square foot galvanized coating for welded wire embedded in either concrete or soil according to ASTM A 641.

b. Epoxy Coated Reinforcement - When specified, provide a Class A coating for welded wire reinforcement embedded in concrete and a Class B coating for welded wire fabric embedded in soil according to ASTM A 884.

(3) Tie Strips - Provide tie strips of steel conforming to the requirements of ASTM A 1011, Grade 50, or equivalent.

(4) Loop Embeds - Fabricate 1 inch loop embeds from cold drawn steel wire conforming to AASHTO M 32 (ASTM A 82). Weld loop embeds according to AASHTO M 55 (ASTM A 185). Galvanize loop embeds according to ASTM B 633 or equal.

(5) Fasteners - Use galvanized high-strength bolts according to 02560.20.

(6) Connectors - Fabricate connectors from cold drawn steel wire according to AASHTO M 32 (ASTM A 82).

00596.16 Geosynthetics - Furnish geosynthetics meeting the following requirements:

(a) Gabion Wall Filter - Provide Type 2 riprap geotextile according to Section 02320.

(b) Precast Concrete Facing Panel Joint Cover - Provide Type 1 drainage geotextile according to Section 02320.

(c) Extensible Soil Reinforcements:

(1) Geotextile - Provide geotextile according to the Special Provisions.

(2) Geogrid - Provide geogrid according to the Special Provisions.

00596.17 Elastomeric Bearing Pads for Precast Concrete Facing Panels - In horizontal joints between precast concrete panels, furnish either preformed ethylene propylene diene monomer (EPDM) rubber pads meeting the requirements of ASTM D 2000, M2AA 810 A13B33C12F17 having a durometer hardness of 80 $\pm$ 5, or neoprene elastomeric pads having a durometer hardness of 55 $\pm$ 5, or other bearing material as recommended by the supplier, certified by the manufacturer and approved by the Engineer.

00596.18 Timber - Furnish timber meeting the requirements of Section 00570.

00596.19 Piles - Furnish piling meeting the requirements of Section 00520.

Labor

00596.30 Quality Control Personnel - Provide certified technicians in the following fields:

- CAgT
- CDT
- CEBT

Construction

00596.40 General:

(a) Proprietary Retaining Walls - Provide for a field representative from the selected proprietary retaining wall company to be present at the start of retaining wall construction. Supervisory personnel of the Contractor, the company field representative, and any subcontractors who are to be involved in the construction of the proprietary retaining wall shall meet with the Engineer for a retaining wall preconstruction conference. At this conference, discuss methods of accomplishing all phases of the work required to construct the proprietary retaining wall. If all representatives are not in attendance, the retaining wall preconstruction conference and start of retaining wall construction shall be rescheduled.

In addition to the retaining wall preconstruction conference, the company field representative shall be available as needed during the erection of the proprietary retaining wall to provide instructions and recommendations, and to assist the Contractor or Engineer. Follow instructions and recommendations of the representative if approved by the Engineer.

(b) All Retaining Walls - All retaining walls, regardless of design, shall conform to the applicable top of wall profile shown. Retaining walls detailed in the Agency-provided plans shall conform to the applicable bottom of wall elevations shown for walls without footings, the applicable top of footing elevations for walls with footings, or the applicable top of leveling pad elevations for walls with leveling pads. Verify existing ground elevations and bottom of wall elevations for proprietary retaining walls prior to final design.

00596.41 Excavation, Backfill, and Compaction Requirements:

(a) General - Perform structure excavation and backfill for all retaining walls according to Section 00510 to the limits and stages shown.

Construct all retaining walls on suitable foundation materials. Excavate any unsuitable foundation materials below elevations shown and backfill with suitable material as directed. Grade the foundation for the structure level for a width equal to the width of the footing or the bottom soil reinforcement and facing component thickness, or as shown. Do not reinforce overexcavated foundations with geosynthetic or similar materials without prior approval.

Do not construct backfill when the backfill, the foundation, or the embankment on which it would be placed is frozen, unstable, or not compacted, unless otherwise directed. Place backfill material in nearly horizontal layers not more than 8 inches thick or to the top of the facing component if the height of the facing component is less than or equal to 8 inches.

Unless otherwise specified, compact the entire surface of each layer in place with a minimum of three coverages, using equipment made specifically for compaction. Select compaction equipment based on the type of material being compacted and the layer thickness. Normal compaction equipment consists of sheepsfoot rollers, tamping foot rollers, grid rollers, pneumatic tired rollers, and vibratory rollers. Routing of hauling and grading equipment will not be accepted as adequate to achieve compaction.

Compact backfill material within 3 feet of the backface of the retaining wall using a low weight mechanical tamper, roller or vibratory system.

Avoid any damage or misalignment of retaining wall components as the backfill is placed. Remove any wall materials that become damaged during backfill placement and replace at no additional cost to the Agency. As directed, correct misaligned units not meeting the limits specified due to backfill placement at no additional cost to the Agency.

(b) Testing - Except for backfill material within 3 feet of the back face of the retaining wall, test for compaction as follows:

- **Moisture and Density** - Determine according to AASHTO T 310.
- **Optimum Moisture and Maximum Density** - Determine as required by AASHTO T 99 Standard Proctor Method D, with coarse particle correction according to AASHTO T 224.

Meet each of the following moisture content, density and deflection requirements:

- **Moisture Content** - Prepare material to within -4% to +2% of optimum moisture content at the time of compacting. Add water to material that does not contain sufficient moisture and thoroughly mix as directed. Remove excess moisture by manipulation, aeration, drainage, or other means before compacting.

- **Density:**
  - Compact MSE granular backfill to 100% of relative maximum density as determined by AASHTO T 99 Standard Proctor Method D, with coarse particle correction according to AASHTO T 224.
  - Where spread footings for bridges or other structures are founded behind free standing retaining walls, including in or on MSE granular backfill material, compact the spread footing foundation zone to 100% of relative maximum density as determined by AASHTO T 99 Standard Proctor Method D, with coarse particle correction according to AASHTO T 224. The spread footing foundation zone depth is twice the footing width or 6 feet, whichever is greater, and extends a horizontal distance equal to the footing width beyond the outside bottom edge of the footing in all directions. Begin compaction of the backfill material at the backface of the wall or the wall facing component.

- **Deflection Requirement** - In addition to moisture-density testing, each compacted layer will be observed for deflection or reaction under moving loaded equipment according to ODOT TM 158 to verify that no soft or pumping areas remain in any layer or foundation soil. Correct all such areas at no additional cost to the Agency.

00596.42 Cast-in-Place Concrete Retaining Walls:

(a) Wall Drainage Systems - Construct the retaining wall drainage system according to the applicable sections of 00430 and as shown. A drainage geotextile is required when using granular drain backfill material.

(b) ODOT Standard Cast-in-Place Concrete Gravity Retaining Wall - Construct cast-in-place concrete gravity retaining walls according to Sections 00440 and 00530.

(c) ODOT Standard Cast-in-Place Semi-Gravity (Cantilever) Retaining Wall - Construct cast-in-place concrete semi-gravity retaining walls according to Sections 00530 and 00540.

00596.43 Gabion Retaining Walls - Erect gabion retaining walls according to the Agency-provided plans and approved working drawings, if applicable, and the company's field construction manual as approved, supplemented and modified as follows:

(a) General - Select and use the same style of mesh for the gabion panel bases, ends, sides, diaphragms, and lids; the same method of joining the edges of a single gabion unit; and the same method of tying successive gabion units together throughout each structure.

If the height of the constructed gabion wall is less than 95% of the design height, add additional gabion baskets as directed to attain the design height, at no additional cost to the Agency.

Place riprap geotextile according to Section 00350 and the following:

- Minimum overlap shall be 12 inches.
- Against the back of the gabion wall before placing backfill material.

(b) Assembly - Assemble each style of gabion by rotating the panels into position and joining the vertical edges with tie wire or alternate fasteners.

If twisted wire panels are tied with tie wire, join the selvage vertical edges with alternating single and double loops at 4 inch nominal spacing.

If welded wire panels are tied with tie wire, pass the tie wire through each mesh opening along the vertical edges joint and secure with a half hitch locked loop.

Leave no openings greater than 4 3/4 inches (line dimension) along the edges or at corners of tied or spiral bound gabions of either mesh style. Crimp the edges of spiral binding wire to secure the spiral in place.

If high tensile fasteners are used in lieu of tie wire, install one fastener in each mesh opening according to the manufacturer's recommendations.

(c) Placement - Set the empty gabions in place and connect each gabion to the adjacent gabion along the top and vertical edges with tie wire or spiral binders. Connect each layer of gabions to the underlying layer along the front, back and sides with tie wire or spiral binders in the same manner as specified for assembly of baskets. Common wall construction will not be allowed.

Before filling each gabion with rock, remove all kinks and folds in the wire fabric and properly align all baskets. Remove all temporary clips and fasteners. The assembled gabion baskets may be placed in tension before filling.

(d) Filling - Place the rock by hand or machine to ensure proper alignment, avoiding bulges and assuring a minimum of voids. All exposed rock surfaces shall have a smooth, neat appearance with no sharp edges projecting through the wire mesh.

Place the rock in layers to allow placement of internal connecting wires in each outside cell of the structure or when directed by the Engineer at the following intervals:

- None required for 1 foot high baskets
- At the 1/2 point for 1 1/2 foot high baskets
- At 1/3 points for 3 foot high baskets

Completely fill the basket so the lid will bear on the rock when it is closed. Secure the lid to the sides, ends, and diaphragms with tie wire or spiral binders in the same manner as specified for assembly of baskets.

(e) Repairs - During construction, repair and secure any breakage of the wire mesh that results in mesh or joint openings larger than 4 3/4 inches (line dimension). Make repairs using 13 1/2 gauge galvanized tie wire as directed.

Repair any damage to PVC wire coating in a manner that provides the same degree of corrosion resistance as the undamaged wire, according to the manufacturer's recommended repair procedures and as approved.

00596.44 Prefabricated Modular Retaining Walls - Erect retaining wall components according to the Agency-provided plans and approved working drawings, if applicable, and the company's field construction manual as approved , supplemented and modified as follows:

(a) Metal Bin Retaining Walls - Concurrently with the assembly of the bins, backfill within and around the bins of the assembled wall to the limits shown. Keep the backfill around the outside approximately level with the inside fill. Exercise care to completely fill the depressions of stringers and spacers, and compact without displacing them from line and batter.

(b) Prefabricated Modular Concrete Blocks:

(1) Leveling Pad - Construct a gravel leveling pad at each foundation level as shown. Compact gravel leveling pads according to 00596.41(b).

(2) Block Installation and Backfill Placement - Place blocks as shown. Blocks should typically be placed in a running bond pattern unless placed perpendicular to the face of the wall. Place blocks so the final position is battered as shown. Place the first course of blocks on top of and in full contact with the prepared leveling pad surface. Closely follow erection of each course of blocks with placement of Granular Wall Backfill material. Remove excess backfill from the top of the blocks prior to installing the next course of blocks.

(3) Construction Tolerances - During construction of the wall and placement of blocks maintain a vertical tolerance and tangent horizontal alignment tolerance not in excess of 1 1/4 inch when measured with a 10 foot straightedge. Check the plumbness and tolerances of each course of blocks before erecting the next course.

00596.45 Conventional Segmental Retaining Walls - Erect retaining wall components according to the Agency-provided plans and approved working drawings, if applicable, and the company's field construction manual as approved, supplemented and modified as follows:

(a) Leveling Pad - Construct a gravel or unreinforced cast-in-place concrete leveling pad at each foundation level as shown. Compact gravel leveling pads according to 00596.41(b). Cure cast-in-place leveling pads for a minimum of 12 hours before placing the segmental retaining wall units.

(b) Segmental Unit Installation and Backfill Placement - Place segmental retaining wall units so the final position is battered as shown. Place the first course of segmental units on top of and in full contact with the prepared leveling pad surface. If applicable, install shear connectors and place unit fill. Closely follow erection of each course of segmental units with placement of granular wall backfill material. Remove excess backfill from the top of the segmental units prior to installing the next course of units. Glue the uppermost row of segmental units or caps to underlying units with an adhesive recommended by the manufacturer. For walls in which the manufacturer does not provide an adhesive for this purpose use an epoxy adhesive from the QPL. Clean the completed wall face of foreign material deposits on exposed horizontal portions of the segmental units.

(c) Construction Tolerances - During construction of the wall and placement of segmental retaining wall units maintain a vertical tolerance and tangent horizontal alignment tolerance not in excess of 1 1/4 inch when measured with a 10 foot straightedge. Check the plumbness and tolerances of each course of segmental retaining wall units before erecting the next course.

00596.46 MSE Retaining Walls - Erect retaining wall components according to the Agency-provided plans and approved working drawings, if applicable, and the company's field construction manual as approved, supplemented and modified as follows:

(a) Leveling Pad:

(1) Precast Concrete Facing Panels - Provide a precast concrete leveling pad, or construct an unreinforced cast-in-place concrete leveling pad at each facing panel foundation level as shown. Place precast concrete leveling pads in full contact with the foundation. Cure cast-in-place leveling pads for a minimum of 12 hours before placing the wall facing panels.

(2) Segmental Retaining Wall Units - Construct a gravel or unreinforced cast-in-place concrete leveling pad at each facing unit foundation level as shown. Compact gravel leveling pads

according to 00596.41(b). Cure cast-in-place leveling pads for a minimum of 12 hours before placing the segmental retaining wall units.

(b) Facing Components - Place facing components so the final position is vertical or battered as shown. Place the first course of facing components on top of and in full contact with the prepared leveling pad surface. As backfill placement proceeds place the facing components and applicable hardware in successive horizontal courses in the sequence shown.

(1) Precast Concrete Facing Panels - Erect precast panels using the lifting devices connected to the upper edge of the panel. Attach geotextile joint cover as shown to the rear of the facing panels with an approved adhesive recommended by the company. Use a minimum 12 inch wide geotextile with a minimum overlap of 4 inches. Maintain the panels in position by means of temporary wedges or bracing according to the company's recommendations.

(2) Wire Facing Components - Attach soil retention material as shown to the rear of the facing component as recommended by the company and as approved.

(3) Segmental Retaining Wall Units - If applicable, install shear connectors and place unit fill. Remove excess backfill from the top of the segmental retaining wall units prior to installing the next course of units and/or soil reinforcements. Glue the uppermost row of segmental retaining wall units or caps to underlying units with an adhesive recommended by the company. On walls for which the company does not provide an adhesive for this purpose, use an epoxy adhesive from the QPL. Clean the completed wall face of foreign material deposits on exposed horizontal portions of the segmental units.

(c) Soil Reinforcement Components - Before placing the soil reinforcement components, compact the foundation according to 00596.41. If skewing of the soil reinforcements is required due to obstructions in the reinforced volume, submit design computations to the Engineer justifying the effect of skewing on the performance of the soil reinforcements.

(1) Inextensible Soil Reinforcement Components - Place the soil reinforcement components normal to the face of the wall unless otherwise shown or directed. Repair damaged galvanized or epoxy-coated components before placing backfill material, to provide a coating comparable to that provided by 02530.70 or AASHTO M 284 (ASTM A 775), respectively.

(2) Extensible Soil Reinforcement Components - Orient geosynthetic reinforcements with the highest strength axis normal to the face of the wall unless otherwise shown or directed. Prior to placing backfill, pull geosynthetic reinforcements taut, and anchor them. Geosynthetic reinforcements shall be continuous throughout their embedment lengths. Spliced connections will not be allowed.

a. Non-Proprietary Geosynthetic Wrapped-Face Retaining Walls - Construct geosynthetic wrapped-face retaining walls according to 00350.20, 00350.40 and 00350.41 supplemented as follows:

1. General - Begin wall construction at the lowest portion of the excavation and place each layer horizontally as shown. Complete each layer in its entirety before the next layer is started. Seams will be allowed only at the wall face. Either overlap geotextile sheets 24 inches minimum and perpendicular to the wall face, or sew seams parallel to the wall face according to 00350.41(a-3). Stretch the geotextile in a direction perpendicular to the wall face to eliminate slack before backfilling.

2. Wall Forming - Use a temporary form system at the wall face during construction. A typical temporary form system and a sequence of wall construction required will be shown.

Use pegs, pins, or the manufacturer's recommended method as approved, in combination with the forming system, to hold the geotextile in place until the cover material is placed.

(d) Backfill Placement - Closely follow erection of each course of facing components with placement of MSE granular backfill material. Construct adjacent general embankment layers at the same time the MSE layers are constructed.

Do not operate tracked or rubber tired construction equipment directly upon geosynthetic reinforcement. A minimum fill thickness of 6 inches is required prior to operation of tracked vehicles over geosynthetic reinforcement. Avoid sudden braking and sharp turning movements.

At the end of each day, if rain is anticipated, slope the MSE granular backfill away from the MSE retaining wall face to direct surface runoff away from the wall. Do not allow surface runoff from adjacent areas to enter the MSE retaining wall construction site.

(e) Construction Tolerances - During construction of walls and placement of facing components, maintain the following tolerances:

(1) Precast Concrete Facing Panels:

- Vertical tolerances and tangent horizontal alignment tolerances along the wall line shall not exceed 3/4 inch when measured with a 10 foot straightedge.
- Maximum allowable offset in any facing component joint shall be 3/4 inch.
- Horizontal, vertical and sloped joint openings between components shall be uniform, no larger than 1 1/4 inch, and no smaller than 5/8 inch.

(2) Wire Facing Components:

- Vertical tolerances and tangent horizontal alignment tolerances along the wall line shall not exceed 2 inches when measured with a 10 foot straightedge.

(3) Cast-in-Place Concrete Facades:

- Vertical tolerances and tangent horizontal alignment tolerances along the wall line shall not exceed 3/4 inch when measured with a 10 foot straightedge.

(4) Segmental Retaining Wall Units:

- Vertical tolerance and tangent horizontal alignment tolerance shall not exceed 1 1/4 inch when measured with a 10 foot straightedge.

Check the plumbness and tolerances of each course of facing components before erecting the next course.

Measurement

00596.80 Measurement - The quantities of retaining walls will be measured on the area basis, and will be the area shown, in a vertical plane, for each retaining wall. Field measurement of each retaining wall area will not be made. The quantity will be the theoretical area of each retaining wall unless changes are ordered in writing by the Engineer. If changes are ordered, an adjustment will be made only for the quantity difference involved in the ordered plan changes.

The estimated quantities of excavation, shoring, footings, leveling pads, and specified backfill will be listed in the Special Provisions.

The quantities of type "F" coping will be measured on the length basis, from end to end of coping.

The quantities of sidewalk coping will be measured on the area basis, from end to end and from top of curb to exterior edge of coping.

Excavation below elevations shown will be measured according to 00510.80(b).

Payment

00596.90 Payment - The accepted quantities of work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

	Pay Item	**Unit of Measurement**
(a)	Retaining Wall, Cast-In-Place Concrete	Square Foot
(b)	Retaining Wall, Gabion	Square Foot
(c)	Retaining Wall, Prefabricated Modular	Square Foot
(d)	Retaining Wall, Conventional Segmental	Square Foot
(e)	Retaining Wall, MSE	Square Foot
(f)	Retaining Wall, Contractor's Option	Square Foot
(g)	Type "F" Coping	Foot
(h)	Sidewalk Coping	Square Foot

Item (f) consists of two or more wall type options that would generally be paid for as individual walls under items (a) through (e). These options will be listed in the Special Provisions.

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

Excavation below elevations shown and backfill will be paid for according to 00510.90(c).

No separate or additional payment will be made for reinforcing steel and concrete in type "F" coping and sidewalk coping.

No separate or additional payment will be made for technical representatives, excavation, shoring, footings, leveling pads, specified backfill, or for wall drainage and filter systems, including perforated pipe, drain material, geotextile, and drain pipe, cast-in-place or precast standard coping, including coping reinforcing steel and concrete, and other appurtenances.

Section 00597 - Sound Walls

Description

00597.00 Scope - This work consists of furnishing and constructing sound walls at the locations shown or as directed.

Use one of the following sound wall types:

- Concrete block walls
- Precast concrete panel walls
- Concrete panel fence walls

00597.01 Variables - The amount and kind of work required to construct a sound wall varies according to the type of wall selected. Be responsible for determining the work required for each wall type and for the variables in quantities, including shoring, excavation, backfilling, excess material, staging work and other details of the work.

Materials

00597.10 Materials - Obtain all manufactured materials for the selected sound wall type from the same company. Only one type of wall will be allowed on the Project unless otherwise specified.

Store concrete masonry units and cementitious materials at the jobsite in a manner which will protect the materials from contact with soil and weather. Store mortar and grout materials in original unbroken packages.

00597.11 Concrete Block Sound Walls:

(a) Concrete Blocks - Furnish concrete blocks meeting the following requirements:

- Hollow, load-bearing blocks, graded N-1, f'm = 1,300 psi with 2,000 psi 28-day strength on net cross sectional area, according to ASTM C 90
- Kiln dried to 33% total absorption
- Split ribbed (York) pattern on exposed areas
- Standard block on unexposed areas
- Nominal 8 inch x 8 inch x 16 inch size

Do not tint concrete blocks. Use uniform colored blocks along the length of individual walls.

(b) Concrete Caps - Construct concrete caps meeting the following requirements:

- Nominal 4 inch x 8 inch x 16 inch size
- Same color as concrete blocks

(c) Reinforcement - Furnish reinforcement meeting the requirements of Section 00530.

(d) Concrete - For pile footings, furnish concrete according to Section 00440. For all other components, including spread footings, furnish concrete according to Section 00540.

(e) Mortar and Grout - Furnish mortar meeting the requirements of ASTM C 270 that attains an ultimate compressive strength of at least 2,500 psi at 28 days. Furnish coarse grout meeting the requirements of ASTM C 476 with a suitable consistency for pouring without segregation of materials.

(f) Preformed Expansion Joint Filler - Furnish expansion joint filler meeting the requirements of 02440.10.

(g) Fillers, Sealers and Damp-proofing - Furnish fillers, sealers, and damp-proofing materials from the QPL.

00597.12 Precast Concrete Panel Sound Walls:

(a) Reinforcement - Furnish reinforcement meeting the requirements of Section 00530.

(b) Concrete - For footings, furnish commercial grade concrete meeting the requirements of Section 00440. For all other components, furnish concrete meeting the requirements of Section 00540.

00597.13 Concrete Panel Lock Fence Sound Walls:

(a) General - Furnish concrete panel lock fence material and necessary components. Provide the manufacturer's test results and certificate of compliance according to 00165.35.

(b) Reinforcement - Furnish reinforcement meeting the requirements of Section 00530.

(c) Concrete - For footings, furnish commercial grade concrete meeting the requirements of Section 00440. For all other components, furnish concrete meeting the requirements of Section 00540.

Construction

00597.40 General - Perform structure excavation according to Section 00510 to the limits and stages shown. All sound walls, regardless of type, shall conform to the top of wall profile shown. Provide footings as shown or approved.

00597.41 Concrete Block Sound Walls:

(a) General - Construct all masonry walls plumb, level and true. Build walls in running bond pattern. Place masonry according to accepted standards of good practice and work in masonry construction and as shown.

If work is discontinued, protect the top of the wall with a well-secured waterproof cover.

Do not perform masonry work when the surrounding temperature is less than 35 °F unless provisions are made for heating and drying materials and for protecting the work.

Do not backfill walls until at least 24 hours after damp-proofing is applied.

Use clean, dry, ice-free, and frost-free masonry units. Do not dampen units before or during laying unless approved.

Place the first course of masonry on the footing in a full mortar bed. Mortar joints between units shall be 3/8 inch thick with full mortar coverage on vertical and horizontal face shells only. Vertical joints shall be shoved tight.

Discard mortar when:

- Not used within two hours of initial mixing
- Stiffened due to hydration past initial set
- Stiffened due to evaporation
- Allowed to stand one hour without mixing

Grout all cells containing reinforcing bars. Walls and crosswebs forming cells to be filled shall be full-bedded in mortar to prevent leakage of grout. Grout may stop in cells containing bars where, and if, the reinforcement stops. Position vertical steel in the center of the cell and securely tie in place at intervals of not more than 5 feet. Use grout that is sufficiently fluid to flow into all grout spaces, leaving no voids. Perform grouting according to either "low-lift grouting" or "high-lift grouting" as follows:

(1) Low-Lift Grouting - When the wall is grouted as the wall is laid up, do the following:

- Do not exceed 4 feet high wall construction before placing grout.
- Construct vertical cores or cells of a clear, unobstructed size measuring not less than 2 inches by 3 inches.
- Rod or vibrate grout when placed.
- Position reinforcing steel and tie in place.
- Do not proceed with constructing the wall above a bond beam course until the vertical cells below the bond beam course and the bond beam course itself have been filled with grout.
- When the time interval between lifts will exceed one hour, stop the lifts 1 1/2 inches below the top of the course.

(2) High-Lift Grouting - When the wall is to be grouted full height or if the height to be grouted will exceed 4 feet, do the following:

- Leave cleanouts, with a minimum opening of 3 inches by 4 inches as shown, in the bottom course of the placement at each vertical cell. Keep cleanouts open until all mortar droppings have been removed and vertical reinforcing steel has been placed and inspected.
- Remove excess mortar from vertical cores and expose an unobstructed vertical hole with a dimension of at least 2 inches and a cross-sectional area of at least 10 square inches.
- Do not start grout work until 24 hours after the portion of the wall to be grouted has been constructed.
- Do not place grout in lifts greater than 4 feet in height. Rod or vibrate grout not later than 10 minutes after placing and before the preceding lift takes its permanent set. Extend rodding or vibrating 12 inches to 18 inches into the preceding lift.
- Do not begin grouting successive lifts until at least 30 minutes have elapsed after rodding or vibrating the preceding lift.
- If the time interval between lifts will exceed one hour, stop the lifts 1 1/2 inch below the top of the course.
- Place wire screen, small mesh, expanded metal lath or other approved material in mortar joints under each bond beam course to prevent filling vertical cells not intended to be filled.

(b) Waterproofing - Treat all masonry wall cap surfaces with a waterproofing application of a high-build filler and rubber sealer. Treat at least 14 calendar days after the wall is completed. Apply filler by spraying or rolling according to the manufacturer’s recommendations. Apply two coats of sealer to a minimum thickness of 10 mils. The finished product shall be the color "Summer Gray".

(c) Damp-Proofing - After the cap is waterproofed, damp-proof the vertical surfaces of the masonry walls. Apply damp-proofing at least 14 calendar days after the walls are completed and according to the manufacturer's recommendations.

00597.42 Precast Concrete Panel Sound Walls - Construct precast concrete panel sound walls plumb, level and true. Panels shall be free of major cracks. Cracks in panels will be measured after the panel is placed and walls have been backfilled. Cracks greater than 0.02 inch may require repairs or panel replacement, at the discretion of the Engineer.

00597.43 Concrete Panel Lock Fence Sound Walls - Construct concrete panel lock fence walls according to the manufacturer's recommendations.

Measurement

00597.80 Measurement - The quantities of sound walls will be measured on the area basis, to the nearest square foot, of the wall face area projected onto a vertical plane along one side of the wall.

Payment

00597.90 Payment - The accepted quantities of sound walls will be paid for at the Contract unit price, per square foot, for the item "Sound Walls".

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

No separate or additional payment will be made for excavation, backfill, footings, concrete, reinforcement, waterproofing, and damp-proofing.

Section 00599 - Concrete Slope Paving

Description

00599.00 Scope - This work consists of constructing concrete slope paving on bridge end slopes as shown, specified, or directed.

Materials

00599.10 Materials - Furnish materials meeting the following requirements:

Commercial Grade Concrete 00440
Grout 02080.40
Reinforcement 00530

Construction

00599.40 Slope Preparation - Grade the slopes for slope and berm paving, and curbs to the lines and grades established. Finish the area to a smooth, firm, compacted condition.

Dispose of excess materials according to 00330.41(a-4).

If slopes constructed under a separate contract require additional materials to prepare slopes to the established lines and grades, furnish such materials as Extra Work according to Section 00196.

00599.42 Slope Paving - Pave slopes with pre-cast or cast-in-place blocks as the Contractor elects. Give the tops of blocks a wood float and brush finish parallel with the long dimension of the block.

(a) Pre-cast Blocks - Manufacture pre-cast blocks according to the plans and Section 00440.

(b) Cast-in-place Blocks - Place concrete for cast-in-place blocks according to Section 00440.

00599.43 Berm Paving - Construct berm paving according to the plans and Section 00440, except finish the berm paving to a neat, smooth surface.

00599.44 Slope Paving Curbs - Construct slope paving curbs according to the plans and to Section 00440 and Section 00530.

Measurement

00599.80 Measurement - The quantities of work performed under this Section will be measured according to the following:

(a) Slope Paving - Concrete slope paving will be measured on the area basis, to the nearest square foot, on the slope paving surface for each bridge end slope.

(b) Berm Paving - Berm paving will be measured on the area basis, to the nearest square foot, on the berm paving surface for each berm.

(c) Slope Paving Curbs - Slope paving curbs will be measured on the length basis, to the nearest foot.

Payment

00599.90 Payment - The accepted quantities of work performed under this Section will be paid for at the Contract unit price, per unit of measurement, for the following items:

	Pay Item	Unit of Measurement
(a)	Concrete Slope Paving	Square Foot
(b)	Berm Paving	Square Foot
(c)	Slope Paving Curbs	Foot

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

Payment for furnishing additional embankment materials required for slope preparation constructed under a separate contract will be made as Extra Work.