

Summary of Administrative Revisions to Standard Specifications

500 Series

Section	Description of Revision
ALL	<ul style="list-style-type: none"> • Formatting in accordance with CSI standards <ul style="list-style-type: none"> ○ All Paragraphs identified by a letter <ul style="list-style-type: none"> ▪ Sub-paragraphs identified by a number • Replace pronouns with appropriate noun references • Delete number word references and retain numeric number only • Modify grammar structure for clarity • Edit cross-references • Delete references to self (Uniform Standard Specifications) • Delete metric units • Delete references to design and procedural guidelines • Delete references to codes and standards that do not specifically relate to the section
502	<ul style="list-style-type: none"> • Subsection 502.04.01H – Referenced chart in Section 501 has been deleted. Added a best fit linear 28 day strength conversion to approximate chart.
504	<ul style="list-style-type: none"> • Subsection 504.04.01D – Referenced chart in Section 501 has been deleted. Added a best fit linear 28 day strength conversion to approximate chart.
506	<ul style="list-style-type: none"> • Subsection 506.03.01B.4 – Deleted paragraph about shop drawings being part of the contact. • Rivets are no longer used in steel structures. Deleted Subsections 506.03.06, 506.03.07, 506.03.07, and portions of 506.03.26 relating to rivets.

SECTION 502
CONCRETE STRUCTURES

~~04~~DESCRIPTION

502.01.01 GENERAL

- A. This work shall consist of furnishing and placing Portland cement concrete in bridges, culverts, headwalls, retaining walls, barrier rail, and all other types of concrete structures.
- B. The concrete structures shall be constructed to the lines and grades given by the Engineer and in accordance with the design shown on the plans.
- C. The concrete shall be of the class or classes of concrete ~~designated~~ specified in the ~~proposal on the plans~~ contract documents and shall conform to the requirements of Section 501, "Portland Cement Concrete," ~~unless~~ unless otherwise specified.

~~02~~MATERIALS

502.02.01 GENERAL

- A. The materials used shall be those prescribed for the several items which constitute the finished work and shall conform to the requirements for such materials in the following sections:

Materials	Section
Portland Cement Concrete	501
Concrete Curing Materials and Admixtures	702
Joint Materials	707
Reinforcement	713
Miscellaneous Metals	712
Elastomeric Bearing Pads	725

~~03~~CONSTRUCTION

502.03.01 DEPTH OF FOOTINGS

- A. The elevation of the bottoms of footings as shown on the plans, shall be considered as approximate only and the Engineer may order, in writing, such changes in dimensions or elevations of footings as may be necessary to secure a satisfactory foundation.

502.03.02 FORMS

- A. All forms shall be built mortar tight and of sufficient rigidity to prevent distortion due to the pressure of the concrete and other loads incidental to the construction operations.
1. Forms previously used shall be thoroughly cleaned of all dirt, mortar, and foreign matter before being reused.
 2. Before concrete is placed in forms, all inside surfaces of the forms shall be thoroughly coated with an approved coating or form oil.
 3. Coating or form oil shall leave no film on the surface of the form that can be absorbed by the concrete.

4. When required by the Engineer and immediately before placing concrete, the forms shall be thoroughly wetted with water.
- B. When requested by the Engineer, the Contractor shall submit detailed plans of form work for examination by the Engineer. If such plans are not satisfactory to the Engineer, the Contractor shall make such changes as may be required, but it is understood that the Engineer's concurrence in the use of the plans as submitted or corrected shall in no way relieve the Contractor of responsibility in obtaining satisfactory results.
- C. The forms shall be substantial and unyielding and shall be so designed that the finished concrete will conform to the proper dimensions and contours.
1. The design of the forms shall take into account the effect of vibration on the concrete as it is placed.
 2. Forms shall be filleted at all exposed corners unless corners are rounded as hereinafter provided.
 - a. Triangular molding used for fillets shall have ~~two (2)~~ equal sides.
 - b. In general, the width of the equal sides of moldings shall be ~~three-fourths (3/4)~~ inch ~~(2 centimeters)~~.
 - c. For massive work, such as heavy pier copings and columns, the width shall be ~~one and one-half (1 1/2)~~ to ~~two (2)~~ inches ~~(4 to 5 centimeters)~~.
 - d. Top edges of walls may be filleted or rounded as hereinafter provided for curbs.
 - e. Top edges of curbs and slabs shall be rounded with an edging tool to a radius of ~~one-half (1/2)~~ inch to ~~three-fourths (3/4)~~ inch ~~(1.25 to 2 centimeters)~~.
- D. When concrete is placed in excavation, forms shall be provided for all vertical surfaces unless otherwise permitted by the Engineer.
1. On thin walls, such as abutments, wing walls, and retaining walls, the forms on ~~one~~ 1 face may be built up as the concrete is poured, but only to such elevation as will permit proper placing and thorough spading, and in no case greater than the height which can be placed in ~~one~~ 1 day's run.
 2. Ports shall be provided in high, thin walls to permit thorough cleaning before placing concrete.
 3. If the forms develop any defects, such as bulging or sagging, after the concrete has been placed, that portion of the work shall be corrected in a manner satisfactory to the Engineer, without additional compensation to the Contractor.
 4. During the erection and after the completion of the forms, they ~~forms~~ forms shall be protected in such a manner as to preclude shrinkage, warping, curling, and distortion.
 5. Form lumber used a second time shall be free from bulge or warp and shall be thoroughly cleaned.
- E. Forms for concrete over or in the vicinity of operating railroads shall be so constructed and placed that standard clearances demanded by the railroad company will be maintained at all times.

- F. The falsework and forms supporting the bottom slab of the superstructure of box girder structures shall remain in place until the curing period of the deck of the superstructure has expired.
1. Unless otherwise permitted by the Engineer, forms for the webs of box girders shall be removed before the deck slab is poured.
 2. All interior forms in box girders, except those permitted to remain in place, shall be completely removed and the inside of the box girder cleared of all loose material and swept clean.

G. Side Forms:

1. Side forms for beams, girders, columns, railing, or other members of the structure wherein the forms do not resist dead load bending may be removed as specified in Subsection ~~502.03.4211(e)~~, "[Removal of Falsework Forms.](#)"
 2. The side forms ~~are for~~ arch rings, columns, and piers shall be removed before the members of the structure which they ~~forms~~ support are poured or placed, so that the quality of the concrete may be inspected.
 3. All such side forms shall be so constructed that they ~~forms~~ may be removed without disturbing other forms which resist direct load or bending stresses.
- H. The condition of the forms will have a direct bearing upon the amount of finishing required.

I. Form Requirements and Physical Design:

1. Full pieces of forms shall be used and shall extend from the bottom to the top of the wall or post.
2. Curved surfaces shall be formed to provide a smooth surface without visible breaks.
3. The forms shall be so constructed that portions, where finishing is required, may be removed without disturbing portions of forms to remain.
4. Forms shall be of sufficient strength to carry the dead weight of the concrete as a liquid without a deflection in excess of $L/270$, and if such deflection occurs, ~~it~~ [the deflection](#) shall be sufficient cause for rejection of the work.
5. Forms for girders and slabs shall be cambered in such amounts as may be required by the Engineer.
6. Approved form clamps or bolts shall be used to fasten forms. The use of ties consisting of twisted wire loops to hold forms in position during the placing of concrete will not be permitted.
7. Bolts or form clamps shall be positive in action and shall be of sufficient strength and number to prevent spreading of the forms.
 - a. They ~~clamps~~ shall be of such type that they ~~clamps~~ can be entirely removed or cut back sufficiently to allow finishing of the concrete.
 - b. All forms for the outside surfaces shall be constructed with stiff wales at right angles to the studs and all forms ~~s~~ clamps shall extend through and fasten such wales.
8. Plywood for forms shall be "exterior type" of the grade Concrete-Form Exterior, ~~conforming to the specifications of the U.S. Department of Transportation, National Bureau of Standards, Commercial Standards, latest edition.~~

- a. Plywood form panels shall be furnished and placed in ~~four (4)~~ foot ~~(1.22 meters)~~ widths and in uniform lengths of not less than ~~eight (8)~~ feet ~~(2.44 meters)~~, except where the dimensions of the member form are less than the specified panel dimensions.
 - b. Where form panels are attached directly to the studding of joints, the panel shall not be less than ~~five-eighths (5/8)~~ inch ~~(1.59 centimeters)~~ thick.
 - c. Form panels less than ~~five-eighths (5/8)~~ inch ~~(1.59 centimeters)~~ thick, otherwise conforming to the requirement herein specified, may be used with continuous backing of ~~one (1)~~ inch ~~(2.54 centimeters)~~ nominal thickness surfaced material.
 - d. All form panels shall be placed in a neat symmetrical pattern subject to the approval of the Engineer.
 - e. The panel shall be placed with the long dimensions perpendicular to the studs.
9. Plywood for left-in-place forms in box girders may be of any grade and thickness that will satisfy the other requirements of this S subsection.
 10. Fabricated stay-in-place metal forms may be used for concrete floor slabs at the Contractor's option when so noted on the plans.
 11. Metal forms to remain in place for concrete floor slabs shall be fabricated from steel conforming to ASTM ~~Designation~~ A-466 (Grades A through E) having a coating class of G-165 ~~according to ASTM Designation A 525~~.
 12. The following criteria shall govern the design of permanent stay-in-place steel bridge deck forms:
 - a. The steel forms shall be designed on the basis of dead load of form, reinforcement, and plastic concrete plus ~~fifty (50)~~ pounds per square foot ~~(244 kilograms per square meter)~~ for construction loads. The unit working stress in the steel sheet shall not be more than 0.725 of the specified minimum yield strength of the material furnished, but shall not ~~to~~ exceed 36,000 pounds per square inch ~~(248 MPa)~~.
 - b. Deflection under the weight of the forms, the plastic concrete and reinforcement shall not exceed L/180 of the form span or 1/2 inch ~~(1.27 centimeters)~~, whichever is less, but in no case shall this loading be less than 120 psf ~~(5.74 KPa)~~ total.
 - c. The permissible form camber shall be based on the actual dead load condition. Camber shall not be used to compensate for deflection in excess of foregoing limits.
 - d. The design span of the form sheets shall be the clear span of the form plus ~~two (2)~~ inches ~~(5 centimeters)~~ measured parallel to the form flutes.
 - e. Physical design properties shall be computed in accordance with requirements of the American Iron and Steel Institute Specification for the Design of Cold Formed Steel Structural Members, latest published edition.
 - f. All reinforcement shall have minimum concrete cover of ~~one (1)~~ inch ~~(2.54 centimeters)~~.
 - g. The plan dimensions of both layers of primary deck reinforcement from the top surface of the concrete deck shall be maintained.

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- h. Permanent steel bridge deck form shall not be considered as lateral bracing for compression flanges of supporting structural members.
 - i. Permanent steel bridge deck form shall not be used in panels where longitudinal deck construction joints are located between stringers.
 - j. Welding shall not be permitted to flanges in tension or to structural steel bridge elements fabricated from non-weldable grades of steel.
- J. Fabricator's shop and erection drawings shall be submitted to the Engineer for approval. These ~~plans~~ drawings shall indicate the material properties and grade of steel, the ~~physical and properties of geometric~~ sections properties for all permanent steel bridge deck form sheets, and all ~~clear indication of~~ locations where the forms are by in the vicinity of steel beam flanges subject to tensile stresses.

K. Form Supports:

1. Form sheets shall not be permitted to rest directly on the top of the stringer or floor beam flanges.
 2. Sheets shall be securely fastened to form supports and shall have a minimum bearing length of ~~one (1)~~ inch ~~(2.54 centimeters)~~ at each end.
 3. Form supports shall be placed in direct contact with the flange of stringer or floor beam.
 4. All attachments shall be made by permissible welds, bolts, clips, or other approved means.
 5. ~~However, w~~ Welding of form supports to flanges of steel not considered weldable and to portions of flange subject to tensile stresses shall not be permitted.
 6. Welding and welds shall be in accordance with the provisions of AWS ~~D-2.0~~ pertaining to fillet welds except that ~~1/8~~ inch ~~(0.32 centimeters)~~ fillet welds will be permitted.
- L. Any permanently exposed form metal where the galvanized coating has been damaged shall be thoroughly cleaned, wire brushed, and painted with ~~two~~ 2 coats of zinc oxide zinc dust primer, Federal Specification ~~TT-P-641D~~, Type ~~II~~, no color added, to the satisfaction of the Engineer. Minor heat discoloration in areas of welds need not be touched up.
- M. Transverse construction joints shall be located at the bottom of the flute and ~~1/4~~ inch ~~(0.64 centimeters)~~ weep holes shall be field drilled at not more than ~~12~~ inches ~~(30 centimeters)~~ on center along the line of the joint.
- N. Emphasis shall be placed on proper vibration of the concrete to avoid honeycomb and voids.
1. Pouring sequences, procedures, and mixes shall be approved by the Engineer.
 2. Calcium chloride or any other admixture containing chloride salts shall not be used in the concrete placed on permanent steel bridge deck forms.
- O. The Contractor's method of construction shall be carefully observed during all phases of the construction of the bridge deck slab.
1. These phases include installation of the metal forms; location and fastening of the reinforcement; composition of concrete items; mixing procedures, concrete placement, and vibration; and finishing of the bridge deck.

2. Should the Engineer determine that the procedures used during the placement of the concrete warrant inspection of the underside of the deck, the Contractor shall remove at least ~~one~~1 section of the forms at a location and time selected by the Engineer for each span in the contract.
 3. This should be done as soon after placing the concrete as practicable in order to provide visual evidence that the concrete mix and the Contractor's procedures are obtaining the desired results.
 4. An additional section shall be removed if the Engineer determines that there has been any change in the concrete mix or procedures warranting additional inspection.
- P. After the deck concrete has been in place for a minimum period of ~~two (2)~~ days, the concrete shall be tested for soundness and bonding of the forms by sounding with a hammer as directed by the Engineer.
1. If areas of doubtful soundness are disclosed by this procedure, the Contractor will be required to remove the forms from such areas for visual inspection after the pour has attained adequate strength.
 2. This removal of the permanent steel bridge deck forms shall be at no additional cost to the ~~project~~Contracting Agency.
 3. At locations where sections of the forms are removed, the Contractor will not be required to replace the forms, but the adjacent metal forms and supports shall be repaired to present a neat appearance and asensure their satisfactory retention.
 4. As soon as the form is removed, the concrete surfaces will be examined for cavities, honeycombing and other defects.
 5. If irregularities are found, and it is determined by the Engineer that these irregularities do not justify rejection of the work, the concrete shall be repaired as the Engineer may direct and shall be given an Ordinary Surface Finish.
 6. If the concrete where the form is removed is unsatisfactory, additional forms, as necessary, shall be removed to inspect and repair the slab, and the Contractor's methods of construction shall be modified as required to obtain satisfactory concrete in the slab.
 7. All unsatisfactory concrete shall be removed or repaired as directed by the Engineer.
- Q. The amount of sounding and form removal may be moderated, at the Engineer's discretion, after a substantial amount of slab has been constructed and inspected, if the Contractor's methods of construction and the results of the inspections as outlined above indicate that sound concrete is being obtained throughout the slabs.

502.03.03 FALSEWORK

- A. Detailed plans of the falsework or centering shall be furnished by the Contractor to the Engineer in accordance with Subsection 105.02, "Plans and Working Drawings," for any structures having a clear cast-in-place span of ~~twenty (20)~~ feet (~~6 meters~~) or over or any cast-in-place structure over traffic. If such plans are not satisfactory to the Engineer, the Contractor shall make such changes in the ~~m~~plans as may be required.

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- B. In addition to the detailed drawings of the falsework or centering which are to be furnished to the Engineer as specified herein, the Contractor shall also furnish the Engineer with a copy of falsework or centering design calculations.
- C. All falsework or centering shall be designed and constructed to provide the necessary rigidity and to support the loads.
1. Falsework for the support of superstructures for box girder spans shall be designed to support the loads that would be superimposed were the entire superstructure poured at ~~one~~ 1 time.
 2. For designing falsework and centering, a weight of ~~one hundred fifty (150)~~ pounds per cubic foot (~~2,400 kilograms per cubic meter~~) shall be assumed for green concrete (~~one hundred twenty (120)~~ pounds for lightweight concrete) (~~1,900 kilograms per cubic meter~~) and an allowance of not less than ~~twenty five (25)~~ pounds per cubic foot (~~400 kilograms per cubic meter~~) for forms, live load, and impact.
 3. Falsework or forms shall be constructed to produce in the finished structure the lines and grades indicated on the plans.
 4. Suitable screw jacks or wedges in pairs shall be used in connection with falsework or centering to set the forms to grade or cambered as shown on the plans, or to take up any settlement in the form work either before or during the placing of concrete.
 5. Excessive use of blocking and shims shall be cause for rejection of the falsework.
 6. Falsework failures shall become the sole responsibility of the Contractor.
- D. Immediately prior to placing bridge or slab concrete, the Contractor shall check all falsework and wedges or jacks and shall make all necessary adjustments.
1. Care shall be exercised to ~~insure~~ ensure that settlement and deflection due to the added weight of the deck or slab concrete will be ~~minimal~~ um.
 2. Suitable means such as telltales shall be provided by the Contractor to permit ready measurement of settlement and deflection as it occurs.
- E. Falsework or centering shall be founded on a solid footing safe from undermining and protected from softening. Falsework which cannot be founded on a satisfactory footing shall be supported on piling which will be spaced, driven, and removed in a manner approved by the Engineer.
- F. Arch span shall be removed uniformly and gradually beginning at the crown and working toward the spring, to permit the arch to take its load slowly and evenly. Centering for bridges having ~~two~~ 2 or more adjacent arch spans will be struck simultaneously.
- G. Falsework supporting the main carrying members of all continuous structures shall not be removed from any span until all spans between expansion joints are cured.
- H. Falsework and forms left in place in the cells of box girders shall not exceed ~~12~~ pounds per square foot (~~59 kilograms per square meter~~) of deck. All supports between the top and bottom slabs in the cells of box girders shall be water soaked for a period of not less than ~~forty eight (48)~~ hours.

502.03.04 REINFORCEMENT

- A. Reinforcing shall be furnished and placed as shown on the plans and in accordance with the applicable provisions of Section 505, "Reinforcing Steel," of these specifications.

502.03.05 COFFERDAMS AND CRIBS

- A. Cofferdams for foundation construction shall be carried well below the bottom of the footings and shall be well braced and as watertight as practical. The interior dimensions of cofferdams shall be such as to provide sufficient clearance for constructing forms and, when no seal is placed, to permit pumping outside the forms.
- B. The Contractor shall submit for approval, drawings showing proposed method of construction of cofferdams or cribs in accordance with Subsection 105.02, "Plans and Working Drawings."
 - 1. Approval of such drawings shall in no way relieve the Contractor of ~~his~~Contractor's responsibility under the contract for the successful completion of the improvement.
 - 2. Cofferdam construction shall not start before the submitted drawings are approved and returned.
- C. After the completion of the substructure, the cofferdams with all sheeting and bracing shall be removed to ~~one (1)~~foot (30 centimeters) below the stream bed, by the Contractor, and such removal shall be performed in such a manner as not to disturb or mar the finished concrete foundation. Removal of cofferdams, sheeting, and bracing shall be considered subsidiary to other pay items of work and no further payment will be made therefor.

502.03.06 PUMPING WATER

- A. Pumping from the interior of any foundation enclosure shall be done in such a manner as to preclude the possibility of the movement of water through any fresh concrete.
- B. No pumping will be permitted during the placing of concrete or for a period of at least ~~twenty-four (24)~~hours thereafter, unless it be done from a suitable pump separated from the concrete work by a watertight wall or other effective means.
- C. Pumping to ~~under~~water a sealed cofferdam shall not commence until the seal has set sufficiently to withstand the hydrostatic pressure.

502.03.07 MIXING CONCRETE

- A. All concrete shall be mixed and proportioned as specified in Section 501, "Portland Cement Concrete."

502.03.08 HANDLING AND PLACING CONCRETE

- A. ~~(a)~~**General.** In preparation for the placing of concrete, all sawdust, chips, and other construction debris and extraneous matter shall be removed from the interior of forms.
 - 1. Struts, stays, and braces, serving temporarily to hold the forms in correct shape and alignment, pending the placing of concrete at their locations, shall be removed when the concrete placing has reached an elevation rendering their service unnecessary.
 - 2. These temporary members shall be entirely removed from the forms and not buried in the concrete.
- B. No concrete shall be used which does not reach its final position in the forms within the time and temperature stipulated under Section 501, "Portland Cement Concrete."
- C. Surfaces on which concrete is to be placed shall be thoroughly moistened with water immediately before placing concrete.

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- D. Concrete shall be placed so as to avoid segregation of the material and the displacement of the reinforcement.
1. The use of long troughs, chutes, and pipes for conveying concrete from the mixer to the forms shall be permitted, only on written authorization of the Engineer.
 2. In case an inferior quality of concrete is produced by the use of such conveyors, the Engineer may order discontinuance of their use and the substitution of a satisfactory method of placing.
 3. Open troughs and chutes shall be of metal or metal lined; where steep slopes are required, the chutes shall be equipped with baffles or be in short lengths that reverse the direction of movement.
 4. All chutes, troughs, and pipes shall be kept clean and free from coatings of hardened concrete by thoroughly flushing with water after each run; water used for flushing shall be discharged clear of the structure.
- E. When placing operations would involve dropping the concrete more than ~~five (5)~~ feet (~~1.5 meters~~), ~~it~~ concrete shall be deposited through sheet metal or other approved pipes, except when placing concrete for thin vertical walls less than ~~fifteen (15)~~ inches (~~38 centimeters~~) thick, double belting may be used in lieu of adjustable pipes or elephant trunks.
1. As far as practicable, the pipes shall be kept full of concrete during placing and their lower ends of pipe shall be kept buried in the newly placed concrete.
 2. After initial set of the concrete, the forms shall not be jarred and no strain shall be placed on the projecting ends of reinforcement bars ~~which project~~.
- F. All concrete placed in concrete structures, except tremie seal concrete, shall be compacted by means of mechanical vibration subject to the following provisions:
1. ~~(1)~~ The number of vibrators employed shall be ample to consolidate incoming concrete to a proper degree within ~~fifteen (15)~~ minutes after concrete is deposited in the forms. In all cases, at least ~~two~~ 2 vibrators shall be available at the site of the structures in which more than ~~twenty-five (25)~~ cubic yards (~~19 cubic meters~~) is being placed.
 2. ~~(2)~~ The vibration shall be internal unless special authorization of other methods is given by the Engineer or as provided herein.
 3. ~~(3)~~ Vibrators shall be capable of transmitting vibration to the concrete at frequencies of not less than 4,500 impulses per minute.
 4. ~~(4)~~ The intensity of vibration shall be such as to visibly affect a mass of concrete of ~~one (1)~~ inch (~~2.54 centimeters~~) slump over a radius of at least ~~eighteen (18)~~ inches (~~46 centimeters~~).
 5. ~~(5)~~ Vibrators shall be manipulated to thoroughly work the concrete around the reinforcement and imbedded fixtures and into the corners and angles of the forms.
 6. Vibration shall be applied at the point of deposit and in the area of freshly deposited concrete. The vibrators shall be inserted and withdrawn out of the concrete slowly.
 7. The vibration shall be of sufficient duration and intensity to thoroughly compact the concrete, but shall not be continued at any ~~one~~ 1 point to the extent that localized areas of grout are formed.

8. Application of vibrators shall be at points uniformly spaced and not farther apart than twice the radius over which the vibration is visibly effective.
 9. Vibration shall not be applied directly 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.
 10. ~~#~~Vibration shall not be used to make concrete flow in the forms over distances so great as to cause segregation, and vibrators shall not be used to transport concrete in the forms.
 11. ~~(6)~~Vibration shall be supplemented by such spading as is necessary to ensure smooth surfaces and dense concrete, along form surfaces and in corners and locations impossible to reach with the vibrators.
 12. ~~(7)~~The provisions of this article shall apply to the filler concrete for steel grid floor except that the vibrator shall be applied to the steel.
- G. Immediately following the discontinuance of placing concrete, all accumulations of mortar splashed upon the reinforcement steel and the surface of forms shall be removed.
1. Dried mortar chips and dust shall not be puddled into the unset concrete.
 2. If the accumulations are not removed prior to the concrete becoming set, care shall be exercised not to injure or break the concrete-steel bond at and near the surface of the concrete while cleaning the reinforcement steel.
- H. ~~(b)~~ **Culverts.**
1. The base slab or footings of box culverts shall be placed and allowed to set before the remainder of the culvert is constructed. Suitable provisions shall be made for bonding the sidewalls to the culvert base.
 2. Walls and top slab shall not be constructed as a monolith on box culverts where the depth of pour below the bottom of the top slab exceeds ~~four (4)~~ feet (~~1.2 meters~~) unless approved in writing by the Engineer. When this method of construction is used, any necessary construction joints shall be vertical and at right angles to the axis of the culvert.
 3. When walls are poured separately, in non-rigid frame box culverts, the concrete in the walls shall be placed and allowed to set a minimum of ~~two (2)~~ hours before the top slab is placed.
 4. When walls are poured separately, in rigid frame box culverts, the concrete in the walls shall be placed and allowed to set a minimum of ~~twelve (12)~~ hours before the top slab is placed.
 5. Each wing wall shall be constructed, if possible, as a monolith. Construction joints, where unavoidable, shall be horizontal and so located that no joint will be visible in the exposed face of the wing wall above the ground line.
- I. ~~(c)~~ **Girders, Slabs, and Columns.**
1. When the height of a web in a "T" beam is more than ~~three (3)~~ feet (~~1 meter~~), the top slab shall be poured independently.
 2. When the distance from a construction joint to the top of the web in a box girder exceeds ~~three (3)~~ feet (~~1 meter~~), the top slab shall be poured independently.

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3. Concrete in slab spans shall be placed in ~~one~~1 continuous operation for each span unless otherwise specified.
4. Concrete in columns shall be placed in ~~one~~1 continuous operation, unless otherwise specified. The concrete shall be allowed to set at least ~~twelve (12)~~ hours before the succeeding pour is started.
5. Before pouring concrete for superstructure, the forms on base of columns shall be exposed sufficiently to determine the character of the concrete in the columns.

502.03.09 CONCRETE DEPOSITED UNDER WATER

- A. If conditions render it impossible or inadvisable, in the opinion of the Engineer, to dewater excavation before placing concrete, the Contractor shall deposit under water, by means of a tremie or underwater bottom dump bucket, a seal course of concrete of sufficient thickness to thoroughly seal the cofferdam.
 1. The concrete shall be carefully placed in a compact mass and shall not be disturbed after being deposited.
 2. Still water shall be maintained at the point of deposit.
- B. The use of an aluminum tremie for placing concrete is prohibited.
- C. A tremie shall consist of a watertight tube having a diameter of not less than ~~ten (10)~~ inches (~~25 centimeters~~) with a hopper at the top.
 1. The tube shall be equipped with a device that will prevent water from entering the tube while charging the tube with concrete.
 2. The tremie shall be supported so as to permit free movement of the discharge end over the entire top surface of the work and to permit rapid lowering when necessary to retard or stop the flow of concrete.
 3. The tremie shall be filled by a method that will prevent washing of the concrete.
 4. The discharge end shall be completely submerged in concrete at all times and the tremie tube shall contain sufficient concrete to prevent any water entry.
 5. When a batch is dumped into the hopper, the flow of concrete shall be induced by slightly raising the discharge end, always keeping it in the deposited concrete.
 6. The flow shall be continuous until the work is completed and the resulting concrete seal shall be monolithic and homogeneous.
- D. The underwater bucket shall have an open top and the bottom doors shall open freely and outward when tripped.
 1. The bucket shall be completely filled and slowly lowered to avoid backwash and shall not be dumped until it rests on the surface upon which the concrete is to be deposited.
 2. After discharge, the bucket shall be raised slowly until well above the concrete.
- E. Concrete deposited in water shall be in accordance with Section ~~501~~, ["Portland Cement Concrete,"](#) with ~~ten (10)~~ percent extra cement added.
 1. The exact thickness of the seal will depend upon the hydrostatic head, bond, and spacing of piles, size of cofferdam, and other related factors, but in no case shall the seal be less than ~~two (2)~~ feet (~~60 centimeters~~) in thickness, unless otherwise shown on the plans.

2. Before dewatering, the concrete in the seal shall be allowed to cure for not less than ~~five (5)~~ days after placing.
- F. If a seal which is to withstand hydrostatic pressure is placed in water having a temperature below ~~forty-five (45)~~ degrees ~~F. (7 degrees C.)~~, the curing time before dewatering shall be increased.
1. Periods of time during which the temperature of the water has been continuously below ~~thirty-eight (38)~~ degrees ~~F. (3 degrees C.)~~ shall not be considered as curing time.
 2. After sufficient time has elapsed to ~~i~~ensure adequate strength in the concrete seal, the cofferdam shall be dewatered and the top of the concrete cleaned of all scum, laitance, and sediment.
 3. Before fresh concrete is deposited, local high spots shall be removed as necessary to provide proper clearance for reinforcing steel.

502.03.10 CONSTRUCTION JOINTS

- A. Construction joints shall be made only where located on the plans or shown in the pouring schedule, unless otherwise approved by the Engineer.
- B. Construction joints where the placing of concrete is delayed until the concrete has taken its initial set and for which no expansion is provided, shall be planned in advance and shall be subject to approval by the Engineer.
1. The placing of concrete shall be continuous from joint to joint.
 2. These joints shall be perpendicular to the principal lines of stress and, in general, located at points of minimum shear.
 3. Only joints shown on the plans will be permitted in a cantilevered member.
 4. Horizontal joints at piers and abutments, except where specified, shall be avoided, and when used shall not be located within ~~two (2)~~ feet (~~60 centimeters~~) of the normal water level.
- C. Unless otherwise specified, construction joints shall be struck off but not troweled.
- D. When making a horizontal construction joint, care shall be taken to have the concrete as dry as possible, and any excess water or creamy material shall be drawn off before the concrete sets. On all exposed surfaces, the line of the proposed joint shall be made straight by placing a temporary straightedge on the inside of the form and pouring the concrete so that it will set flush with the edge as provided.
- E. To avoid visible joints as far as possible upon exposed faces, the top surfaces of the concrete adjacent to the forms shall be smoothed with a trowel. Where a "feather edge" might be produced at a construction joint, as in the slope top surface of a wing wall, an insert form block shall be used to produce a blocked out portion in the proceeding layer which shall produce an edge thickness of not less than ~~six (6)~~ inches (~~15 centimeters~~) in the succeeding layer.
- F. When the work is unexpectedly interrupted by breakdowns, storm, or other causes, and the concrete as placed would produce an improper construction joint, the Contractor shall either rearrange the freshly deposited concrete, or continue by hand mixing, if necessary, until a suitable arrangement is made for a construction joint. When such a joint occurs at a section on which there is shearing stress, the Contractor shall provide adequate

mechanical bond across the joint by inserting reinforcing steel, or by some other means satisfactory to the Engineer, which will prevent a plane of weakness.

- G. In resuming work, the surface of the concrete previously placed shall be thoroughly cleaned of dirt, scum, laitance, or other soft or porous materials by ~~one~~ 1 of the following methods:
1. ~~(a)~~ Concrete surface of fresh concrete (not more than ~~eight (8)~~ hours after placement) shall be cleaned with air and water jets in such a manner that the surface is thoroughly cleaned and the aggregate is not loosened.
 2. ~~(b)~~ Hardened concrete surface (more than ~~eight (8)~~ hours after placement) shall be cleaned by abrasive blast methods in such a manner that the aggregate is not loosened or the edges of the concrete shattered.
- H. The surface of the joint shall be thoroughly washed with clean water and the forms tightened to close contact with the previously placed work, after which the concreting may proceed. The surface of the joint shall be wet just prior to placing new concrete.

502.03.11 REMOVAL OF FALSEWORK AND FORMS

A. ~~(a)~~ **General.**

1. ~~(1)~~ Methods of form removal likely to cause overstressing of the concrete shall not be used.
 - a. Forms and their supports shall not be removed without the approval of the Engineer.
 - b. Supports shall be removed in such a manner as to permit the concrete to uniformly and gradually take the stresses due to its own weight.
2. ~~(2)~~ Compressive strengths will be determined by ~~Test Method No.~~ ASTM_C39 and ASTM_C31 and will be considered information tests only and not acceptance tests as described in Subsection_501.02.04, "Concrete Making Properties."
3. ~~(3)~~ ~~Attention is directed to~~ Comply with Subsection_501.03.09, "Curing."

B. ~~(b)~~ **Falsework.**

1. Where stresses will be placed on the concrete, in arch centers, centering under beams and girders, and in floor slabs, falsework shall not be removed until the concrete has reached an age of ~~ten (10)~~ days and it has reached ~~seventy-five (75)~~ percent of the required ~~twenty-eight (28)~~ day compressive strength.
2. In the event of cold weather, the ~~ten (10)~~ day time requirements shall be increased ~~one (1)~~ day for every day the curing time is increased as prescribed in Subsection_501.03.10 ~~(b)~~ B, "Cold Weather ~~--~~ General."
3. In case the concrete does not reach the desired strength within the time specified, the Engineer shall determine when the strength is adequate to allow removal of falsework.
4. Form removal and replacement with shoring will not be permitted.

C. ~~(c)~~ **Forms.**

1. Forms on parapets and curbs shall not be removed until concrete has set sufficiently to prevent distorting or cracking.

2. Forms for columns, walls, side of beams, girders and all other parts, ~~which~~that are not subjected to stress shall not be removed until the concrete has reached a minimum age of ~~forty (40)~~ hours unless authorized by the Engineer.
3. Forms ~~which~~that are subjected to stresses shall not be removed until the requirements of Subsection 502.03.11.B(b) ~~above~~ have been satisfied, unless otherwise approved by the Engineer.

502.03.12 EXPANSION AND FIXED JOINTS AND BEARINGS

- A. All joints shall be constructed according to details shown on the plans and ~~the following:~~as specified in this subsection.
- B. ~~(a)~~ **Open Joints.**
 1. Open joints shall be placed in the locations shown on the plans and shall be constructed by the insertion and subsequent removal of a wood strip, metal plate, or other approved material.
 2. The insertion and removal of the template shall be accomplished without chipping or breaking the corners of the concrete.
 3. Reinforcement shall not extend across an open joint unless so specified on the plans.
- C. ~~(b)~~ **Filled Joints.**
 1. Poured expansion joints shall be constructed similar to open joints.
 2. When premolded types are specified, the filler shall be placed in correct position before concrete is placed against the filler.
 3. Holes and joints in the filler shall be filled with mastic to prevent the passage of mortar or concrete from ~~one~~1 side of the joint to the other.
 4. The edges of the concrete at the joint shall be edger finished.
- D. ~~(c)~~ **Steel Joints.**
 1. The plates, angles, or other structural shapes shall be accurately shaped, at the shop, to conform to the section of the concrete floor.
 2. The fabrication and painting shall conform to the requirements of these specifications covering those items.
 3. When called for on the plans or in the Special Provisions, the materials shall be galvanized in lieu of painting.
 4. Care shall be taken to ~~insure~~ensure that the surface in the finished plane is true and free of warping.
 5. Positive methods shall be employed in placing the joints to keep them ~~m~~ joints in correct position during the placing of the concrete.
 6. The opening at expansion joints shall be that designated on the plans at normal temperature, and care shall be taken to avoid impairment of the clearance in any manner.
- E. ~~(d)~~ **Waterstops.**
 1. Waterstops shall be furnished and installed in accordance with the details shown on the plans.

2. The edge of the waterstop shall be supported in a manner satisfactory to the Engineer.
 3. Waterstops shall be manufactured from either natural rubber, synthetic rubber, or polyvinyl chloride (PVC) at the option of the Contractor.
 4. Waterstops shall be manufactured with an integral cross section which shall be uniform within $\pm 1/8$ -inch (~~0.32 centimeters~~) in width, and the web thickness or bulb diameter, within $+1/16$ -inch (~~0.16 centimeters~~) and $-1/32$ -inch (~~0.8 centimeters~~).
 - a. No splices will be permitted in straight strips.
 - b. Strips and special connection pieces shall be well cured in a manner such that any cross section shall be dense, homogeneous, and free from porosity.
 - c. Junctions in the special connection pieces shall be fully molded.
 - d. During the vulcanizing period, the joint shall be securely held by suitable clamps.
 - e. The material at the splices shall be dense and homogeneous throughout the cross section.
 5. Field splices for either natural or synthetic rubber waterstops shall be either vulcanized, mechanical, using stainless steel parts, or made with a rubber splicing union of the same stock as the waterstop, at the option of the Contractor. All finished splices shall have a full size tensile strength of 600x (width in inches) pounds (~~17.85 (width in centimeters) kilograms~~).
 6. Field splices for polyvinyl chloride waterstops shall be formed by heat sealing the adjacent surfaces in accordance with the manufacturer's recommendations.
 - a. A thermostatically controlled electric source of heat shall be used to make all splices.
 - b. The heat shall be sufficient to melt but not char the plastic.
 7. Waterstops, when being installed, shall be cut and spliced at changes in direction as may be necessary to avoid buckling or distortion of the web or flange.
- F. ~~(e)~~ **Bearing Devices.**
1. Bearing plates, bars, rockers, assemblies, and other expansion or fixed devices shall be constructed in accordance with the details shown on the plans and shall be hot-dip galvanized after fabrication in accordance with Section 715, "Galvanizing."
 2. Structural steel and cast steel shall conform to the provisions in Section 506, "Steel Structures," for those items.
 3. The bearing plates shall be set level and the rockers or other expansion devices shall be set to conform to the temperature at the time of erection or to the setting specified.
 4. When bearing assemblies or masonry plates are shown on the plans to be placed (not embedded) directly on concrete, the concreted bearing area shall be constructed slightly above grade and shall be finished by grinding or other approved means to a true level plane which shall not vary perceptibly from a straightedge placed in any direction across the area. The finished plane shall not vary more than ~~one-eighth (1/8)-inch (0.32 centimeters)~~ from the elevation shown on the plans.

5. When elastomeric bearing pads, elastic bearing pads, preformed fabric pads, or asbestos sheet packing are shown on the plans, the concrete surfaces on which pads or packing are to be placed shall be wood float finished to a level plane which shall not vary more than ~~one-sixteenth (1/16)~~ inch ~~(0.16 centimeters)~~ from a straightedge placed in any direction across the area. The finished plane shall not vary more than ~~one-eighth (1/8)~~ inch ~~(0.32 centimeters)~~ from the elevation shown on the plans.
 6. Where bearing assemblies or masonry plates are shown on the plans to be placed on grout pads, they shall be placed in accordance with the provisions in Subsection 506.03.258, "Bearing and Anchorage."
- G. ~~(f)~~ **Elastomeric Bearing Pads.**
1. Pads over ~~one (1)~~ inch ~~(2.54 centimeters)~~ in thickness shall be laminated.
 2. Laminated pads shall consist of alternate laminations of elastomer and metal or elastomer and fabric bonded together.
 3. All elastomeric bearing pads shall be ~~fifty (50)~~ durometer.
 4. Pads shall be installed where designated on the plans.

502.03.13 CURING

- A. Curing of formed concrete shall conform to the requirements of Subsection 501.03.09, "Curing," ~~and attention is directed thereto.~~

502.03.14 PATCHING

- A. After removal of forms, all metal ties except those to be used to aid future forming shall be cut back and patched.
1. Honeycomb shall be removed and patched.
 2. When honeycomb is determined by the Engineer to be excessive, the excessive honeycombing shall be sufficient cause for rejection of all or a part of the structure.
- B. Loose or broken material shall be chipped away until a dense, uniform surface exposing solid coarse aggregate is obtained.
1. Feather edges shall be cut away to form a face perpendicular to the surface being patched.
 2. All surfaces of the cavity shall be thoroughly saturated with water.
 3. Contact surfaces shall be coated with an approved bonding agent.
 4. Bonding agent may be mixed with mortar in lieu of coating the contact surfaces.
- C. Patching mortar shall consist of ~~one~~ 1 part cement and ~~three~~ 3 parts sand.
1. White cement or other approved tinting materials shall be used on all surfaces where an "ordinary finish" is final.
 2. For patching large or deep areas, coarse aggregate shall be added to the patching mortar.
- D. The patching mortar shall be thoroughly tamped into place.
1. Mortar may be placed pneumatically when approved by the Engineer.

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2. The surface of the mortar shall be floated with a wooden float before initial set takes place.
 3. The patch shall present a neat and workmanlike appearance.
- E. The patched surface shall be cured by ~~one~~1 of the methods described in Subsection 501.03.09, "Curing."
- F. Patching is the only treatment required for those portions of the structure below ground.

502.03.15 FINISH OF HORIZONTAL SURFACES

- A. Concrete bridge decks shall be struck off with a template immediately after pouring to provide the proper crown and shall be finished to a smooth even surface by means of both longitudinal and transverse wooden floats, or other suitable means.
1. When a transversely broomed finish is used, the allowable variations noted herein shall be independent of the depth of the broom marks.
 2. No variations will be permitted that will tend to prevent complete drainage on all parts of the deck.
 3. The surface shall be corrected by grinding off the high spots, or other approved method, as may be required ~~in order~~ to conform to these limits.
 4. An edging tool shall be used at expansion joints and deck edges not armored.
- B. Approach slabs to concrete bridges shall be finished to the tolerances specified for bridge decks.

~~FINISH OF BRIDGE CONCRETE ROADWAY DECKS~~C. Finishing Bridge Decks.

1. A smooth riding surface of uniform texture, true to the required grade and cross section, shall be obtained on all bridge roadway decks.
2. The Contractor may use hand tools, or finishing machines₁ or a combination of both, conforming to the requirements specified herein for finishing bridge roadway deck concrete.
3. Finishing of concrete placed in bridge decks shall consist of striking off the surface of the concrete as placed and floating with longitudinal floats the surface so struck off.
4. The placing of concrete in bridge roadway decks will not be permitted until the Engineer is satisfied that:
 - a. The rate of producing and placing concrete will be sufficient to complete the proposed placing and finishing operations within the scheduled time₁.
 - b. ~~that e~~ Experienced finishing machine operators and concrete finishers are employed to finish the deck₁.
 - c. ~~that f~~ Fogging equipment and all necessary finishing tools and equipment are on hand at the site of the work and in satisfactory condition for use.
5. Finishing machines shall be set up sufficiently in advance of use to permit inspection by the Engineer during the daylight hours before each pour.
6. The adjustment and operation of deck finishing machines shall be verified by moving the machine over the full length of the deck section to be placed and

- traversing the float completely across all end bulkheads before placement of concrete is begun.
7. Unless adequate lighting facilities are provided by the Contractor, the placing of concrete in bridge decks shall cease at such time that finishing operations can be completed during daylight hours.
 8. Rails for the support and operation of finishing machines and headers for hand-operated strike off devices shall be completely in place and firmly secured for the scheduled length for concrete placement before placing of concrete will be permitted.
 - a. Rails for finishing machines shall extend beyond both ends of the scheduled length for concrete placement a sufficient distance that will permit the float of the finishing machine to fully clear the concrete to be placed.
 - b. Rails or headers shall be adjustable for elevation and shall be set to elevations, with allowance for anticipated settlement, camber, and deflection of falsework, as required to obtain a bridge roadway deck true to the required grade and cross section.
 - c. Rails or headers shall be of a type and shall be so installed that no springing or deflection will occur under the weight of the finishing equipment, and shall be so located that finishing equipment may operate without interruption over the entire bridge roadway deck being finished.
 - d. Rails or headers shall be adjusted as necessary to correct for unanticipated settlement or deflection which may occur during finishing operations.
 9. Should settlement or other unanticipated events occur, which in the opinion of the Engineer would prevent obtaining a bridge deck conforming to the requirements of these specifications, placing of deck concrete shall be discontinued until corrective measures satisfactory to the Engineer are provided.
 - a. In the event satisfactory measures are not provided prior to initial set of the concrete in the affected area, the placing of concrete shall be discontinued and a bulkhead installed at the location determined by the Engineer.
 - b. All concrete in place ahead of the bulkhead shall be removed.
 10. Unless otherwise permitted by the Engineer, bridge deck concrete shall be placed in a uniform heading approximately parallel to the bridge pier or bent caps. The rate of placing concrete shall be limited to that which can be finished before the beginning of initial set, except that concrete for the deck surface shall not be placed more than ~~ten (10)~~ feet (~~3 meters~~) ahead of strike-off.
 11. After the concrete has been placed and consolidated, the surface of the concrete shall be carefully struck off by means of a hand-operated strike board operating on headers, or by a finishing machine operating on rails. A uniform deck surface true to the required grade and cross section shall be obtained.
 12. Following strike off, the surface of the concrete shall be floated longitudinally.
 - a. In the event strike off is performed by means of a hand-operated strike board, ~~two~~ 2 separate hand-operated float boards for longitudinal floating shall be provided.

- b. The first float shall be placed in operation as soon as the condition of the concrete will permit and the second float shall be operated as far back of the first float as the workability of the concrete will permit.
13. In the event the strike off is performed with a finishing machine, longitudinal floating of the concrete shall be performed by means of a hand-operated float board or a finishing machine equipped with a longitudinal wooden float.
 - a. The longitudinal wooden float on the finishing machine shall have a length of not less than ~~eight (8.)~~ feet (~~2.4 meters~~) nor more than ~~twelve (12.)~~ feet (~~3.7 meters~~).
 - b. When both strike off and longitudinal floating are to be performed by finishing machines, ~~one~~ 1 machine, with operator, shall be used for strike off and a second machine, with second operator, shall be used for longitudinal floating.
 - c. Longitudinal floating may be performed with the same finishing machine that is used for strike off provided that the length of deck unit being placed is not more than ~~thirty (30.)~~ feet (~~9 meters~~) and the strike off operation is completed for ~~said~~the deck unit before the condition of the concrete requires that longitudinal floating be started.
14. Finishing machines used for strike off having a wheel base ~~six (6.)~~ feet (~~1.8 meters~~) or less shall be followed by ~~two~~ 2 separate hand-operated float boards for longitudinal floating. All the provisions in this section pertaining to hand-operated float boards shall apply to the ~~two~~ 2 separate float boards for longitudinal floating.
15. Longitudinal floats, either hand-operated or machine-operated, shall be used with the long axis of the float parallel to the centerline of the bridge roadway.
 - a. The float shall be operated with a combined longitudinal and transverse motion planing off the high areas and floating the material removed into the low areas.
 - b. Each pass of the float shall lap the previous pass by ~~one-half~~ 1/2 the length of the float.
 - c. Floating shall be continued until a smooth riding surface is obtained.
- D. In advance of curing operations, the surface of the concrete shall be textured by brooming with a stiff bristled broom or by other suitable devices which will result in uniform scoring. Brooming shall be performed transversely from finishing bridges.
- E. Hand-operated float boards shall be from ~~twelve (12.)~~ feet (~~3.7 meters~~) to ~~sixteen (16.)~~ feet (~~4.9 meters~~) long, ribbed and trussed as necessary to provide a rigid float and shall be equipped with adjustable handles at each end.
 1. The float shall be wood, not less than ~~one (1.)~~ inch (~~2.54 centimeters~~) thick and from ~~four (4.)~~ inches (~~10 centimeters~~) to ~~eight (8.)~~ inches (~~20 centimeters~~) wide.
 2. Adjusting screws spaced at not to exceed ~~twenty-four (24.)~~ inches (~~60 centimeters~~) on centers shall be provided between the float and the rib.
 3. The float board shall be maintained true and free of twist.
- F. Hand-operated float boards shall be operated from transverse finishing bridges.
 1. The finishing bridges shall span completely the roadway area being floated and a sufficient number of finishing bridges shall be provided to permit operation of the floats without undue delay.

2. Not less than ~~two~~² transverse finishing bridges shall be provided when hand-operated float boards are used.
 3. When a finishing machine is used for longitudinal floating, ~~one~~¹ finishing bridge equivalent to the transverse finishing bridge specified herein shall be furnished for use by the Engineer.
- G. Finishing bridges shall be of rigid construction and shall be free of wobble and springing when used by the operators of longitudinal floats and shall be easily moved.
- H. Fogging equipment ~~to be~~ furnished shall be capable of applying water to the concrete in the form of a fine fog mist in sufficient quantity to curb the effects of rapid evaporation of mixing water from the concrete on the deck. The fog mist shall be applied at the time and in the manner approved by the Engineer.
- I. Immediately following completion of the deck finishing operations, the concrete in the deck shall be cured as specified in Subsection ~~501.03.09~~, "Curing."
- J. The finished surface of the concrete shall be tested by means of a straightedge ~~twelve (12)~~¹² feet ~~(3.7 meters)~~ long.
1. The surface shall not vary more than 0.01¹ foot ~~(0.30 centimeters)~~ from the lower edge of the straightedge.
 2. All high areas in the hardened surface in excess of 0.01¹ foot ~~(0.30 centimeters)~~ as indicated by testing shall be removed by abrasive means.
 3. After grinding by abrasive means has been performed, the surface of the concrete shall not be smooth or polished, but shall have a surface texture satisfactory to the Engineer.
 4. Ground areas shall be of uniform texture and shall present neat and approximately rectangular patterns.
- K. Where the concrete of the bridge deck is to be covered by bituminous surfacing, earth, or other cover, ~~one (1)~~¹ inch ~~(2.54 centimeters)~~ or more in thickness, the surface of the concrete shall not vary more than 0.03¹ feet ~~(0.91 centimeters)~~ from the lower edge of the ~~twelve (12)~~¹² foot ~~(3.7 meters)~~ straightedge.
- L. Bridge deck surfaces under the curbs, railings, and sidewalks shall be struck off to the same plane as the roadway and left undisturbed when future widening is shown on the plans.
- M. The top and face of the finished parapet and curb shall be true and straight, and the top surface shall be of uniform width, free from humps, sags, or other irregularities. When a straightedge ~~twelve (12)~~¹² feet ~~(3.7 meters)~~ long is laid on top of the face of the curb or on the face of the parapet, the surface shall not vary more than ~~one-eighth (1/8)~~^{1/8} inch ~~(0.3 centimeters)~~ from the theoretical grade or alignment in ~~twelve (12)~~¹² feet ~~(3.7 meters)~~, except that proper allowance shall be made for curves and camber.
- N. Manual methods, other than specified in this subsection, or other machine methods for finishing bridge deck concrete may be permitted in accordance with the provisions in Subsection ~~108.05~~, "Character of Workmen; Methods and Equipment."

502.03.16 FORMED SURFACES REQUIRING FINISHING

- A. Structures requiring a "fine surface finish (F.S.F.)" will be noted on the plans.
- B. All structures not requiring a fine surface finish shall be given an ordinary surface finish.

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- C. Only exposed surfaces of structures will require finishing (ordinary or fine).
- D. Exposed surfaces are defined as follows:
1. ~~(a)~~ Exterior vertical faces of slab spans, rigid frames, arches, and box ~~gir~~riders.
 2. ~~(b)~~ The underside of overhanging slabs to point of junction of the supporting beams.
 3. ~~(c)~~ Vertical surfaces of piers, columns, bent caps, abutments, wing walls, and retaining walls which are exposed to view after all backfill and embankment is placed. Exposed surfaces in this case are considered to extend to ~~one (1) foot (30 centimeters)~~ below finished grade.
 4. ~~(d)~~ The inside of culvert barrels over ~~four (4) feet (1.2 meters)~~ in height for the same distance as the height of the opening when seen from a traveled way.
 5. ~~(e)~~ The underside of superstructures in urban areas.

502.03.17 ORDINARY SURFACE FINISH

- A. The surface shall have all holes left by form ties and all other holes ~~one-fourth (1/4) inch (0.6 centimeters)~~ or more in largest diameter repaired in accordance with Subsection ~~502.03.15~~ 14, "Patching." The surface shall be true and even, free from stone pockets, depressions, or projections beyond the surface.
- B. All fins and projections shall be knocked off or ground flush. Offsets greater than ~~one-eighth (1/8) inch (0.3 centimeters)~~ shall be filled or tapered back to present a smooth appearance. A uniform color and appearance shall be obtained on all patched surfaces.

502.03.18 FINE SURFACE FINISH

- A. Where it is indicated on the plans that a fine surface finish is required, the finish shall conform to the requirements for "Bonded Grout Finish" as ~~hereinafter set forth~~ specified below.
1. Before the finish is applied, the surface shall be true and even and free from stone pockets, depressions, or projections beyond the surface.
 2. All fins and projections shall be knocked off or ground flush.
 3. Offsets greater than ~~one-eighth (1/8) inch (0.3 centimeters)~~ shall be filled or tapered back to present a smooth appearance.
 4. All holes ~~one-fourth (1/4) inch (0.6 centimeters)~~ or more in largest diameter shall be patched in accordance with Subsection ~~502.03.15~~ 14, "Patching."
- B. **Bonded Grout Finish.**
1. This finish shall be an application of grout consisting of sand and other pigments and mineral fillers combined with a suitable binder.
 - a. The sand shall pass a No. ~~30~~ sieve.
 - b. The binder shall be either an epoxy, acrylic, vinyl, or phenolic resin.
 - c. This mixture may be thinned by not more than ~~twenty-five (25) percent~~ water by volume.
 2. The finish shall be of such consistency and composition that it will provide a uniform appearance in color and texture when applied as specified below, and shall meet the requirements set forth in Section ~~727~~, "Concrete Surface Finishing Material."

3. At least ~~thirty (30)~~ days in advance of placing bonded grout finish, the Contractor shall furnish the Engineer a quart ~~(1-liter)~~ sample or larger, of the complete mixture for testing.
 - a. The Contractor shall also furnish ~~two~~² certificates, issued by the manufacturer, certifying that the product complies with the specifications.
 - b. ~~Said-The~~ certificates shall be delivered to the Engineer at least ~~thirty (30)~~ days in advance of placing the material.
4. The grout shall be applied by spray, using conventional spray equipment with a ~~one-fourth (1/4)~~-inch ~~(0.6 centimeters)~~ round spray head.
 - a. Material ~~is~~^{shall be} supplied by either a surge pump with a 12-~~to~~-1 ratio or an auger type pump, with air pressure sufficient to achieve uniform texture.
 - b. Worn spray heads shall be replaced as required to achieve a uniform finish.
5. Application shall be at the rate of 25-40 ~~square~~ feet per gallon ~~(0.6-1.0 square meters per liter)~~.
6. The finish surface shall present a uniform appearance.
7. Color of fine surface finish to be applied will be shown on the plans. Where the color of the fine surface finish that is to be applied is not indicated on the plans, it shall conform to Federal Color No. ~~37875~~ as shown in Table ~~I~~ of Federal Standard No. ~~595~~.
8. Surfaces of concrete shall be thoroughly cleaned just before applying fine surface finish. This may be accomplished by:
 - a. ~~(1)~~ Application of a ~~ten (10)~~ percent solution of muriatic acid or a ~~twenty-five (25)~~ percent zinc sulfate solution, which shall be applied ~~as~~ to completely remove ~~any~~ oily film and to lightly etch the surface, or
 - b. ~~(2)~~ Thorough cleaning by an approved abrasive as required to remove all oily film.
9. Following cleaning, the surface shall be thoroughly rinsed with clean water. Surface to be finished need not be completely dry, but may be damp, prior to application of finish.
10. **CAUTION:** Do not apply finish unless temperature is at least 40 ~~degrees~~ ~~F~~ ~~(4 degrees C)~~ and is rising. Application shall be stopped if temperature is 40 ~~degrees~~ ~~F~~ ~~(4 degrees C)~~ and is dropping.

502.03.19 LIVE LOADS

- A. Live loads such as traffic or superimposed earth loads shall not be allowed on the structure until concrete has reached an age of ~~fourteen (14)~~ days and ~~it~~ has reached the ~~twenty-eight (28)~~ day compressive strength required.
- B. Live loads may be allowed on the structure, with the approval of the Engineer, when the concrete has reached an age of ~~eight (8)~~ days and/or the ~~twenty-eight (28)~~ day compressive strength required in cases where Type ~~III~~ (high-early strength) cement is used.
- C. Approach slabs shall be treated as concrete paving under Section ~~409~~, "Portland Cement Concrete Pavement."

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- D. In the event of cold weather, the above specified time requirement shall be increased ~~one (1)~~ day for every day the curing time is increased as prescribed in the Subsection 501.03.10 ~~B(b)~~, "Cold Weather ~~---~~ General."
- E. In case the concrete does not reach the desired strength within the time specified, the Engineer shall determine when the strength is adequate to carry live loads.

04 METHOD OF MEASUREMENT

502.04.01 MEASUREMENT

- A. The estimated quantity shown on the plans, plus or minus quantities covered by approved changes will be the quantity used for payment.
1. The Contractor may, however, request a final measurement and calculation.
 2. The Contractor's request for final measurement and calculation shall be in writing.
 3. Final measurement will be made according to the dimensions shown on the plans plus or minus approved changes and quantities derived therefrom will be the quantity used for payment.
 4. Each class of concrete will be considered separately.
 5. Furthermore, when the Contractor requests final measurement and calculations and the quantities thus determined are the same or less than the planned quantities plus authorized changes, the Contractor shall reimburse the Contracting Agency for the ~~a~~ Agency's expenses incurred by such final measurements and calculations.
- B. ~~Such b~~ Box culverts, bridges, and ~~such~~ other miscellaneous concrete structures that are identified on the plans or in the Special Provisions as major structures will be paid for at the contract unit price bid for "Class _____ Concrete (Major)," or "Class _____ Concrete Modified (Major)" as the case may be.
- C. ~~Such p~~ Pipe headwalls, endwalls, drop inlets, and ~~such~~ other miscellaneous concrete structures that are identified on the plans or in the Special Provisions as minor structures will be paid for at the contract unit price bid for "Class _____ Concrete (Minor)."
- D. In the event any class of Portland cement concrete is placed and is shown by test to be below any specified ~~twenty-eight (28)~~ day compressive strength, a determination shall be made by the Engineer as to whether the concrete shall be removed and replaced or allowed to remain in place.
- E. This determination shall be based on an evaluation of the durability and other qualities of the concrete necessary to the integrity of the structure.
1. If the concrete is allowed to remain in place, it is agreed by the parties to the contract that the Contracting Agency will deduct from money due, or to become due the Contractor from the Contracting Agency, a percentage of the contract unit bid price.
 2. This deduction shall be considered to be liquidated damages and shall be at a rate of ~~five (5)~~ percent of the contract unit bid price for each ~~fifty (50)~~ P.S.I. ~~psi (345 kilopascals)~~ or portion thereof below the specified minimum compressive strength, to a maximum of ~~fifty (50)~~ percent, as set forth in the following example for the class of concrete shown:

Specified 28 -Day Compressive Strength P.S.I. psi	Liquidated Damages (Per Unit Bid Price) Percent
3000	0
2999-2950	5
2949-2900	10
2899-2850	15
2849-2800	20
2799-2750	25
2749-2700	30
2699-2650	35
2649-2600	40
2599-2550	45
2549-2500	50
Below 2500	Remove

- F. The reduced price shall apply to all concrete represented by the strength tests below the specified minimum compressive strength.
- G. When a compressive strength test falls below the specified ~~twenty-eight (28)~~-day compressive strength, the Contracting Agency may determine that an alternate strength test is required or the Contractor may request such a test.
1. When the Contracting Agency determines an alternate strength test is required, the Contractor will not be liable for the cost of such test.
 2. In case the Contracting Agency has not determined that an alternate strength test is necessary and the Contractor elects to have an alternate strength test made, the Contracting Agency will then make such a test; however, should this test indicate that the ~~twenty-eight (28)~~-day compressive strength requirement has not been met, the cost thereof shall be deducted from any money due or to become due the Contractor from the Contracting Agency.
 3. The cost of all other alternate strength tests made at the Contractor's request shall be borne by the Contractor.
 4. The alternate strength test shall consist of obtaining and testing ~~three~~ 3 drilled core samples in accordance with ~~Test Method~~ ASTM C-42.
 5. The test specimens will be taken at a single location approved by the Engineer, and shall be from the same area represented by the original strength test.
 6. The cores shall be obtained and the test performed by the Contracting Agency.
 7. The test shall be accomplished as soon as possible after the ~~twenty-eight (28)~~-day compressive strength test.
- H. The average compressive strength of the ~~three~~ 3 drilled core samples at the age tested shall be converted to a ~~twenty-eight (28)~~-day compressive strength ~~as shown by Chart No. 1 in Section 504~~ by subtracting 8 psi from the average for each day beyond 28 days, with a maximum conversion adjustment of 200 psi.
1. This calculation value shall be termed the "result of the core test." When the result of the core test validates the original ~~twenty-eight (28)~~-day strength test, the quality of the concrete shall be assessed on the basis of the original test.

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2. When the core test does not validate the ~~twenty-eight (28.)~~ day strength, then the result of the core test shall be used to assess the quality of the concrete.
- I. Concrete removed will not be paid for and the removal thereof will be at ~~the Contractor's expense~~ no additional cost to the Contracting Agency.
- J. No measurement or other allowances will be made for work, materials for forms, falsework, cofferdam, pumping, bracing, ~~etc~~ and so forth.
- K. The quantity of concrete involved in fillets, scorings, and chamfers ~~two (2.)~~ square inches ~~(13 square centimeters)~~ or less in cross-sectional area shall be neglected.
 1. No deduction shall be made for the volume of concrete displaced by reinforcing steel, expansion joint material, drainage, and weep holes.
 2. The volume of concrete displaced by pipes, conduits, ducts, and forms for voids embedded in concrete that are in excess of ~~two (2.)~~ square inches ~~(13 square centimeters)~~ in cross-sectional area shall be deducted.
 3. Deductions shall also be made for the volume of timber piles, concrete piles, and cast-in-place piles embedded in the concrete.
- L. Each class of concrete will be considered separately.
- M. Tremie seal concrete will be measured on the basis of batched volume placed.
- N. The quantity of concrete ~~hand~~ rail to be measured for payment will be the number of linear feet ~~(meters)~~ complete and in place.
- O. All measurements will be made in accordance with Subsection 109.01, "Measurement of Quantities."

05 BASIS OF PAYMENT

502.05.01 PAYMENT

- A. The accepted quantity of concrete measured as provided in Subsection 502.04.01, "Measurement," will be paid for at the contract unit price bid per cubic yard ~~(cubic meter)~~ for the Class or Type specified.
 1. Reinforcing steel will be paid for as provided in Section 505, "Reinforcing Steel."
 2. All metal parts, fabrics, pads, joint fillers, drains, and ~~any~~ other materials not specifically mentioned for payment herein, will be considered subsidiary to the other pay items of the work and no further compensation will be allowed therefor.
- B. The accepted quantity of concrete rail measured as provided in Subsection 502.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot ~~(meter)~~.
- C. All payments will be made in accordance with Subsection 109.02, "Scope of Payment."
- D. Payment will be made under:

PAY ITEM

PAY UNIT

Class _____ Concrete (Major).....	Cubic Yard (Cubic Meter)
Class _____ Concrete (Minor).....	Cubic Yard (Cubic Meter)
Concrete Rail.....	Linear Foot (Meter)
Tremie Seal Concrete.....	Cubic Yard (Cubic Meter)
Class _____ Concrete, Modified (Major).....	Cubic Yard (Cubic Meter)

SECTION 503**PRECAST PRESTRESSED CONCRETE MEMBERS****04DESCRIPTION****503.01.01 GENERAL**

- A. This work shall consist of furnishing and placing precast prestressed concrete members as specified in these specifications and the contract documents.
- B. This work shall include the manufacture, transportation, and storage of girders, slabs, piling, and other structural members of precast prestressed concrete and shall also include the placing of all precast prestressed concrete members, except piling which shall be placed as provided in Section 508, "Piling."
- C. The members shall be furnished complete including all concrete, prestressing steel, bar reinforcing steel, and incidental materials in connection therewith.

02MATERIALS**503.02.01 GENERAL**

- A. Concrete shall conform to the applicable requirements of Section 501, "Portland Cement Concrete" and Section 502, "Concrete Structures."
- B. Prestressing steel shall conform to the applicable requirements of Section 713, "Reinforcing."
- C. If lightweight concrete is used, this concrete shall conform to the applicable requirements of Section 504, "Lightweight Concrete for Structures."

03CONSTRUCTION**503.03.01 PRESTRESSING METHODS**

- A. Prestressing shall be performed by either pretensioning or post-tensioning methods. The method of prestressing to be used shall be optional with the Contractor, subject to the requirements specified in these specifications.
- B. Prior to casting the precast members, the Contractor shall submit working drawings to the Engineer for approval, giving complete details of the methods, materials, and equipment the Contractor proposes to use in the prestressing and construction and erection operations.
 - 1. ~~Such~~ Details shall outline the method of prestressing, and shall include:
 - a. ~~The~~ arrangement of the prestressing steel and mild steel reinforcement in the members.
 - b. ~~a~~ Anchoring stresses.
 - c. ~~s~~ Sequence of stressing post-tensioned prestressing steel.
 - d. ~~, and the s~~ Sequence of cutting or releasing pretensioned prestressing steel.
 - e. ~~t~~ Type of post-tensioning enclosures.

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- f. ~~, and s~~ Specifications and details of anchoring devices and distribution plates or assemblies, if required, for post-tensioning and pressure grouting materials and equipment.
 - g. ~~, together with e~~ Complete drawings of the forms proposed for casting the precast members. ~~Such~~ These drawings shall show complete details of the type of forms proposed for providing the ducts and proposed method of supporting and anchoring ~~such~~ the forms.
2. Working drawings shall be in accordance with Subsection ~~105.02~~, "Plans and Working Drawings."

503.03.02 FORMS

- A. Concrete shall not be deposited in the forms until the Engineer has inspected the placing of the reinforcement, enclosure, anchorages, and prestressing steel.
- B. The concrete shall be vibrated internally or externally, or both, as required to consolidate the concrete. The vibrating shall be done with care and in such a manner that displacement of reinforcement, enclosures, and prestressing steel will be avoided.
- C. Holes for anchor bars; and for diaphragm dowels which pass through the member openings for connection rods, recesses for grout, and holes for railing bolts shall be provided in the members in accordance with the details shown on the plans. Where diaphragm dowels do not pass through the member, the dowels may be anchored in the member by embedment in the concrete or by means of an approved threaded insert.
- D. Forms for interior cells or holes in the members shall be constructed of a material that will resist breakage or deformation during the placing of concrete and will not materially increase the weight of the member.
- E. Lifting anchors may be installed in members to be placed in bridge decks provided that all of the anchor above the concrete is removed after the member is placed.
- F. Side forms for prestressed members may be removed the next day after placing concrete therein, provided arrangements satisfactory to the Engineer are made for curing and protecting the concrete.

503.03.03 ANCHORAGES AND DISTRIBUTION

- A. Anchorages and distribution shall be constructed as specified in Subsection ~~495.03.02~~, "Anchorages s and Distribution."

503.03.04 ENCLOSURES

- A. Enclosures for prestressing steel shall be ferrous metal, mortar-tight, and accurately placed at the locations shown on the plans or approved by the Engineer.
- B. In lieu of metallic enclosures, openings for prestressing steel may be formed by means of cores or ducts composed of rubber or other suitable materials which are removed prior to installing prestressing steel.
- C. All enclosures or openings of anchorage assemblies shall be provided with pipes or other suitable connections for the injection of grout after prestressing.

503.03.05 PRESTRESSING

- A. All prestressing steel shall be tensioned by means of hydraulic jacks ~~—~~.

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1. Each jack shall be equipped with either a pressure ~~gage~~gauge or a load cell for determining the jacking stress, at the option of the Contractor~~---~~.
 2. The pressure ~~gage~~gauge, if used, shall have an accurate reading dial at least ~~six (6)~~ inches (~~15 centimeters~~) in diameter~~---~~.
 3. Each jack and its ~~gage~~gauge shall be calibrated as a unit with the cylinder extension in the approximate position that it will be at final jacking force, and shall be accompanied by a certified calibration chart~~---~~.
 4. The load cell, if used, shall be calibrated and shall be provided with an indicator by means of which the prestressing force in the tendon may be determined~~---~~.
 5. The range of the load cell shall be such that the lower ~~ten (10)~~ percent of the manufacturer's rated capacity will not be used in determining the jacking stress.
- B. The tensioning of prestressing steel in any post-tensioned member and the cutting or releasing of prestressing steel in any pretensioned member shall not be performed until tests on concrete cylinders made of the same concrete and cured under conditions identical to the member has~~ve~~ attained the minimum compressive strength value specified for detensioning or stressing of the steel.
- C. When ordered by the Engineer, prestressing steel tendons in pretensioned members, if tensioned individually, shall be checked by the Contractor for loss of prestress not more than ~~three (3)~~ hours prior to placing concrete for the members.
1. The method and equipment for checking the loss of prestress shall be subject to approval by the Engineer.
 2. All tendons which show a loss of prestress in excess of ~~three (3)~~ percent shall be retensioned to the original computed jacking stress.
- D. When prestressing steel in pretensioned members is tensioned at a temperature appreciably lower than the estimated temperature of the concrete and the prestressing steel at the time of initial set of the concrete, the calculated elongation of the prestressing steel shall be increased to compensate for the loss in stress, but in no case shall the jacking stress exceed ~~seventy-five (75)~~ percent of the specified minimum ultimate tensile strength of the prestressing steel.
- E. Subject to prior approval by the Engineer, a portion of the total prestressing force may be applied to a member when the strength of the concrete in the member is less than the value shown on the plans and the member may then be moved. Approval by the Engineer of such partial prestressing and moving shall in no way relieve the Contractor of full responsibility for successfully constructing the members.
- F. The cutting and releasing of prestressing steel in pretensioned members shall be performed in such an order that lateral eccentricity of prestress will be a minimum. The prestressing steel shall be cut off flush with the end of the member and the exposed ends of the prestressing steel shall be heavily coated with roofing asphalt or coal tar enamel.
- G. Post-tensioning will not be permitted until it is demonstrated to the satisfaction of the Engineer that the prestressing steel is free and unbonded in the enclosure.
- H. The tensioned process as applied to post-tensioned members shall be so conducted that tension being applied and the elongation of the prestressing steel may be measured at all times. A record shall be kept of ~~gage~~gauge pressures and elongations at all times and shall be submitted to the Engineer for approval.

- I. Prestressing steel in post-tensioned members shall be tensioned by simultaneously jacking at each end of the assembly, except as provided in the following:
1. ~~(a)~~ Jacking from 1 ~~one~~ end of the assembly will be permitted on simple span members under ~~sixty-five (65)~~ feet ~~(20-meters)~~ in length, provided the calculations show that the maximum temporary tensile stress at the center of the span will not be more than ~~seventy (70)~~ percent of the specified minimum ultimate tensile strength of the prestressing steel.
 2. ~~(b)~~ For simple span members ~~sixty-five (65)~~ feet ~~(20-meters)~~ and over in length, jacking from ~~one~~ 1 end will be permitted, provided the calculations and also field tests demonstrate that the maximum temporary tensile stress at the center of the span will not be more than ~~seventy (70)~~ percent of the specified minimum ultimate tensile strength of the prestressing steel.
- J. Unless otherwise permitted by the Engineer, half of the prestressing steel in each member shall be stressed from ~~one~~ 1 end of the span and the other half from the opposite end.
- K. Determination of the jacking stresses shall be supported by calculations, or by calculations and field tests when so specified, prepared by the Contractor.
1. The Contractor shall submit ~~hi~~ Contractor's calculations to the Engineer for approval.
 2. ~~;~~ ~~and~~ ~~p~~ Prior to making field tests, the Contractor shall submit to the Engineer for approval details of ~~hi~~ Contractor's proposed ~~gage~~ gauges and load devices for determining the jacking load at each end of the test ~~prestressing unit to the Engineer for approval.~~
 3. Unless otherwise permitted by the Engineer, a load cell shall be used at the end opposite the jacking end.
 4. Measurement of elongation and stress shall agree within ~~three (3)~~ percent.
 5. The stress at the center will be calculated from the average of the end test loads.
 6. Jacking stresses within ~~two (2)~~ percent of the calculated required jacking stresses will be considered satisfactory.
- L. The following friction coefficients shall be used in calculating friction losses. "K" represents the wobble of the ducts, and "U" represents the curvature in draped cables:

Type of Steel	Type of Duct	K	U
Bright metal wire or strand	Bright Metal	0.0020	0.30
	Galvanized	0.0015	0.25
Bright metal bars	Bright Metal	0.0003	0.20
	Galvanized	0.0002	0.15

- M. The maximum temporary tensile stress (jacking stress) in prestressing steel shall not exceed ~~seventy-five (75)~~ percent of the specified minimum ultimate tensile strength of the prestressing steel. The prestressing steel shall be anchored at stresses (initial stress) that will result in the ultimate retention of working forces of not less than those shown on the plans, but in no case shall the initial stress exceed ~~seventy (70)~~ percent of the specified minimum ultimate tensile strength of the prestressing steel.
- N. The loss of stress in post-tensioned or pretensioned prestressing steel due to creep and shrinkage of concrete, creep of steel, and sequence of stressing; shall be as indicated on the plans.

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- O. Longitudinal prestressing steel in pretensioned members shall not be cut or released until tests on concrete cylinders indicate that the concrete in the member has attained a compressive strength of not less than the value shown on the plans or the following values, whichever is the greater.

Diameter of Strand	Compressive Strength
Inches	psi
3/8	3,500
7/16	4,000
1/2	4,000

- P. The working force in the prestressing steel shall be not less than the value shown on the plans. Unless otherwise specified or shown on the plans, the average working stress in the prestressing steel shall not exceed ~~sixty (60)~~ percent of the specified minimum ultimate tensile strength of the prestressing steel.
- Q. Working force and working stress will be considered as the force and stress remaining in the prestressing steel after all losses, including creep and shrinkage of concrete, elastic compression of concrete, creep of steel, losses of post-tensioned prestressing steel due to sequence of stressing, friction and take up of anchorages, and all other losses peculiar to the method or system of prestressing have taken place or have been provided for.

503.03.06 CURING

- A. Curing shall conform to the applicable provisions of Subsection ~~501.03.09~~, "Curing," and, in addition, the following steam curing requirements shall apply.
- B. Any steam curing operation which deviates from the procedure listed below, shall be subject to the approval of the Engineer.
- C. Steam curing shall be done under a suitable enclosure to contain the live steam in order to minimize moisture and heat losses.
1. The initial application of the steam shall be from ~~two (2)~~ to ~~four (4)~~ hours after the final placement of concrete to allow the initial set of the concrete to take place.
 2. If retarders are used, the waiting period before application of the steam shall be from ~~four (4)~~ to ~~six (6)~~ hours.
 3. The steam shall be at ~~one hundred (100)~~ percent relative humidity to prevent loss of moisture and to provide excess moisture for proper hydration of the cement.
 4. Application of the steam shall not be directly on the concrete.
 5. During application of the steam, the ambient air temperatures shall increase at a rate not to exceed ~~forty (40)~~ degrees ~~F. (22 degrees C.)~~ per hour until a maximum temperature of from ~~one hundred forty (140)~~ degrees ~~F. (60 to 71 degrees C.)~~ is reached.
 6. The maximum temperature shall be held until the concrete has reached the desired strength.
 7. In discontinuing the steam, the ambient air temperature shall decrease at a rate not to exceed ~~forty (40)~~ degrees ~~F. (22 degrees C.)~~ per hour until a temperature has been reached about ~~twenty (20)~~ degrees ~~F. (11 degrees C.)~~ above the temperature of the air to which the concrete will be exposed.

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8. The concrete shall not be exposed to temperatures below freezing for ~~six (6)~~ days after casting.

503.03.07 SHIPPING

- A. For prefabricated tendons, the Contractor shall give the Engineer at least ~~ten (10)~~ days' notice before commencing the installation of end fittings or the heading of wires. The Engineer will inspect end fitting installation and wire headings while such fabrication is in progress at the plant and will arrange for the required testing of the material to be shipped to the site.
- B. No prefabricated tendon shall be shipped to the site without first having been released by the Engineer.
1. ~~and e~~ Each tendon shall be tagged before shipment for identification purposes at the site.
 2. All unidentified tendons received at the site will be rejected.
- C. The release of any material by the Engineer shall not preclude subsequent rejection if the material is damaged in transit or later damaged or found to be defective.

503.03.08 HANDLING

- A. Care shall be exercised in handling, storing, moving, and erecting precast prestressed concrete members to avoid twisting, racking, or other distortion that would result in cracking or damage to the members.
- B. Precast prestressed members shall be handled, transported, and erected in an upright position, and the points of support and direction of the reactions with respect to the member shall be approximately the same during transportation and storage as when the member is in its final position.

503.03.09 TOLERANCES

- A. Prestressed concrete members shall be fabricated to plan dimensions within the tolerances listed herein (tolerances are not to be considered accumulative). Members having dimensions outside the tolerance limits shall be subject to rejection.
1. **(a) Precast Prestressed Concrete I-Beams.**

<u>Dimension</u>	<u>Tolerance</u>
Depth (flanges, web, and fillets)	\pm 1/4 inch (0.635 centimeters)
Depth (overall)	+ 1/2 inch (1.27 centimeters) to - 1/4 inch (0.635 centimeters)
Width (flanges and fillets)	+ 3/8 inch (0.95 centimeters) to - 1/4 inch (0.635 centimeters)
Width (web)	+ 3/8 inch (0.95 centimeters) to - 1/4 inch (0.635 centimeters)
Length of Beam	\pm 1/8 inch (0.32 centimeters) per 10 feet (3.05 meters) or 1/2 inch (1.27 centimeters) whichever is greater

<u>Dimension</u>	<u>Tolerance</u>
Exposed Beam Ends Deviation from square or designated skew	Horizontal $\pm 1/4$ inch (0.635 centimeters) Vertical $\pm 1/8$ inch (0.32 centimeters) per 10 feet (3.05 meters) of beam height
Side inserts (spacing between centers of inserts and from the centers of inserts to the ends of the beams)	$\pm 1/2$ inch (1.27 centimeters)
Bearing Plates (spacing between the centers of bearing plates)	$\pm 1/8$ inch (0.32 centimeters) per 10 feet (3.05 meters) or $1/2$ inch (1.27 centimeters) whichever is greater
Bearing Plates (spacing from the centers of bearing plates to the ends of the beams)	$\pm 1/2$ inch (1.27 centimeters)
Bearing Plate or Bearing Area deviation from plane	$\pm 1/16$ inch (0.16 centimeters)
Stirrup Bars – Projection above top of beam	$\pm 3/4$ inch (1.91 centimeters)
Stirrup Bars – Longitudinal Spacing	± 1 inch (2.54 centimeters)
End Stirrup Bars --- not more than 2 inches from the end of the beam	<u>not more than 2 inches from the end of the beam</u>
Horizontal Alignment (deviation from a straight line parallel to the centerline of beam)	$1/8$ inch (0.32 centimeters) per 10 feet (3.05 meters)
Camber differential between to adjacent beams	$1/8$ inch (0.32 centimeters) per 10 feet (3.05 meters) of span to maximum of 1 inch (2.54 centimeters)
Center of gravity of strand group	$\pm 1/4$ inch (0.635 centimeters)
Center of gravity of depressed strand group at end of beam	$\pm 1/2$ inch (1.27 centimeters)
Position of post-tensioning duct	$\pm 1/4$ inch (0.635 centimeters)
Position of hold-down points for depressed strands	± 6 inches (15 centimeters)
Position of handling devices	± 6 inches (15 centimeters)

2. **(b) Precast Prestressed Concrete Box Beams and Flat Slabs.**

<u>Dimension</u>	<u>Tolerance</u>
Depth (top slab)	$\pm 1/2$ inch (1.27 centimeters)
Depth (bottom slab)	$+ 2$ inches (5.1 centimeters)
Depth (overall)	$\pm 1/4$ inch (0.635 centimeters)
Width (web)	$\pm 3/8$ inch (0.95 centimeters)
Width (overall)	$\pm 1/4$ inch (0.635 centimeters)
Length	$\pm 1/8$ inch (0.32 centimeters) per 10 feet (3.05 meters) or $1/2$ inch (1.27 centimeters) whichever is greater $\pm 1/2$ inch (1.27 centimeters) from end of void to center tie hole
Void Position	± 1 inch (2.54 centimeters) adjacent to end block
Square Ends (deviation from square)	$\pm 1/4$ inch (0.635 centimeters)
Skew Ends (deviation from designated skew)	

<u>Dimension</u>	<u>Tolerance</u>
Skew angle equal to or less than 30 degrees	±1/4 inch
Skew angle greater than 30 degrees	±1/2 inch (1.27 centimeters)
Beam Seat Bearing Area (variation from plane surface when tested with a straight edge) through middle half of member	±1/16 inch (0.16 centimeters)
Horizontal Alignment (deviation from a straight line parallel to the centerline of member)	1/4 inch (0.635 centimeters) under 40-foot (12.2 meters) lengths; 3/8 inch (0.95 centimeters) from 40- to 60-foot (12.2 to 18.3 meters) lengths; 1/2 inch (1.27 centimeters) over 60-foot (18.3 meters) lengths
Dowel Tubes (spacing between the centers of tubes and from the centers of tubes to the ends and sides of member)	±1/2 inch (1.27 centimeters)
Tie Rod Tubes (spacing between the centers of tubes and from the centers of tubes to the ends of member)	+1/4 inch (0.635 centimeters)
Total Width of Deck	Theoretical width +1/2 inch (1.27 centimeters) per joint
Camber differential between adjacent units	1/2 inch (1.27 centimeters) maximum
Camber differential between high and low members in same span	1 inch (2.54 centimeters) maximum
Side Inserts Positioning	Same as for I-Beams
Stirrup Bar Positioning	Same as for I-Beams
Tendon Positioning	Same as for I-Beams
Handling Device Positioning	Same as for I-Beams

3. ~~(c)~~ Precast Prestressed Concrete Piling.

<u>Dimension</u>	<u>Tolerance</u>
Width or Diameter	-1/4 inch (0.635 centimeters) to + 3/8 inch (0.95 centimeters)
Head out of square	1/16 inch (0.16 centimeters) per 12 inches (30 centimeters) of width
Length of Pile	±1-1/2 inch (3.81 centimeters)
Horizontal Alignment (deviation from a straight line parallel to the centerline of the pile)	1/8 inch (0.32 centimeters) per 10 feet (3.05 meters)
Void location	±1/2 inch (1.27 centimeters)
Stirrup Bars or Spiral Positioning	Same as for I-Beams
Tendon Positioning	Same as for I-Beams
Handling Device Positioning	Same as for I-Beams

04 METHOD OF MEASUREMENT

503.04.01 MEASUREMENT

- A. PayThe quantity of the various sizes and types for furnishing and erecting precast prestressed concrete members to be measured for payment will be the number of per

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each ~~of the various sizes and types for furnishing and erecting precast prestressed concrete members~~ complete and in place.

- B. The length of the members shown in the estimate of quantities and/or in the proposal are nominal. For exact length see the drawing of the members shown on the plans.
- C. All measurements will be made in accordance with Subsection -109.01, "Measurement of Quantities."

~~05~~BASIS OF PAYMENT

503.05.01 PAYMENT

- A. The accepted quantities of precast prestressed concrete members measured as provided in Subsection -503.04.01, "Measurement," will be paid for at the contract unit price bid for furnishing and erecting precast prestressed concrete members. Payment therefor will be full compensation for all labor and for furnishing all items involved in the finished members.
- B. All payments will be made in accordance with Subsection -109.02, "Scope of Payment."
- C. Payment will be made under:

PAY ITEM

PAY UNIT

(Size) Precast Concrete Members Each

SECTION 504**LIGHTWEIGHT CONCRETE FOR STRUCTURES****04DESCRIPTION****504.01.01 GENERAL**

- A. This work shall consist of furnishing and placing lightweight Portland cement concrete in bridges, culverts, and other types of concrete structures.
- B. The construction of conventionally reinforced lightweight concrete structures shall conform to the requirements of Sections 501, "Portland Cement Concrete, and Section 502, "Concrete Structures."

02MATERIALS**504.02.01 GENERAL**

- A. The materials used shall be those prescribed for the several items which constitute the finished work and shall conform to the requirements for such materials in the following sections:

Materials	Section
Portland Cement Concrete	501
Concrete Structures	502
Aggregate for Portland Cement Products	706

- B. Lightweight concrete shall be composed of an intimate mixture of Portland cement, water, and lightweight aggregates, with or without natural sand of normal specific gravity, and an air-entraining admixture proportioned and mixed as hereinafter provided.

504.02.02 ADMIXTURES

- A. Admixtures shall conform to the applicable requirements of Subsection 501.02.03, "Admixtures."

504.02.03 CONCRETE MAKING PROPERTIES

- A. Lightweight concrete shall be subject to the following requirements and test methods:

Test	Test Designation	Requirements
Making Test Specimens (laboratory)	ASTM C192	----
Making Test Specimens (field)	ASTM C31	----
Compressive Strength	ASTM C39	Table 1 H
Unit Weight & Cement Factor (wet)	ASTM C138	Table 1 H
Tests for Popouts	ASTM C330	No surface popouts
Freezing & Thawing	ASTM C666	----
Air Content	ASTM C173	Table 1 H
Slump	ASTM C143	Table 1 H
Air Dried Weight	ASTM C567	Table 1 H
Coring Concrete	ASTM C42	Subsection 504.04.01

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- B. The compressive strength requirements of Portland cement concrete shall be based on the strength test, which is defined as the average of the breaking strength of ~~three (3)~~ standard cylinders at ~~twenty-eight (28)~~ days. The cylinder strengths shall be determined in accordance with ASTM C39.
- C. A test, as defined above, will be required for each ~~fifty (50)~~-cubic yards, ~~(38 cubic meters)~~ or portion thereof, placed each day.
1. For large, continuous pours, ~~one (1)~~-test near the beginning of the pour, and ~~one (1)~~-test near the end of the pour may be substituted for the ~~fifty (50)~~-cubic yards ~~(38 cubic meters)~~-requirement.
 2. In any case, there shall be at least ~~one~~1 strength test made each day that concrete is placed, regardless of the volume placed.
 3. Other cylinders may be made and broken for information purposes.

~~03~~CONSTRUCTION**504.03.01 GENERAL**

- A. Mixing water, storage of cement, measurement of materials, weighing and measuring equipment, condition of equipment, mixing conditions, and mixing equipment shall conform to the requirements of Section 501, "Portland Cement Concrete," and Section 502, "Concrete Structures."
- B. The Contractor shall notify the Engineer not less than ~~thirty-two (32)~~-calendar days in advance of use of the proposed sources of materials and shall make arrangements for the Engineer to obtain samples as required for testing purposes.
1. Samples will not exceed ~~five hundred (500)~~-pounds ~~(227 kilograms)~~ for each separate grading.
 2. The Contractor shall furnish a written statement (job mix) giving the cement factor in sacks per cubic yard ~~(kilograms per cubic meter)~~, the proportions of cement and each size of aggregate in a saturated surface dry condition, the slump, and the percentage of air in the concrete proposed for use in the work.
 3. If the Contractor proposes to use an admixture other than air-entraining agent, the Contractor shall state its complete brand name and the quantity proposed to be used per sack of cement.
 4. The Engineer, after making such tests as the Engineer deems advisable, will either accept the proposed materials and proportions or suggest modifications needed for acceptance.
- C. After acceptance by the Engineer of batch proportions and materials, they proportions and materials shall not be altered during the course of the work except as found necessary to maintain yield, cement factor, and unit weight within specification requirements.
- D. In no case shall revised batch proportions result in concrete that contains an amount of total water per cubic yard greater than ~~one hundred five (105)~~-percent of that contained in concrete of the accepted proportions.

504.03.02 STORAGE OF AGGREGATES

- A. Storage of aggregates shall conform to the pertinent requirements of Subsection 501.03.03, "Storage of Aggregates," except as noted below.

- B. Lightweight aggregate shall be stockpiled on the job or at a central batching plant for a minimum time of ~~twenty-four (24)~~ hours prior to its use in the project.
- C. Fine and coarse aggregates shall be stockpiled separately.

504.03.03 CLASSIFICATION AND PROPORTIONS

- A. Lightweight concrete shall be proportioned by weight, using the lightweight aggregates, such that the requirements in ~~Table II~~ Table 1 will be satisfied.
- B. The Contractor shall give the Engineer advance notice in writing when any changes are to be made in the batch proportions.
- C. Batches of lightweight concrete placed on the work shall not vary more than 3_ pounds per cubic foot (~~50 kilograms per cubic meter~~) in unit weight from the design mix.
- D. The cement factor of any individual batch placed in the work shall not be more than 0.15_ sacks per cubic yard (~~8.3 kilograms per cubic meter~~) less nor more than 0.25_ sacks per cubic yard (~~13.9 kilograms per cubic meter~~) greater than the designated factor (sacks of cement per cubic yard) (~~kilograms per cubic meter~~).
- E. At the option of the Contractor, natural fine aggregate may be substituted for lightweight fine aggregate provided such substitution does not result in producing concrete having a weight in excess of maximum weight specified for lightweight concrete.

504.03.04 MIXING

- A. Lightweight aggregates in combination with natural sand, if used, shall be of such character that workable concrete of the properties specified herein will be obtained. Should premoistening be required, it shall be done uniformly at least ~~twenty-four (24)~~ hours in advance of batching.
- B. Mixing methods shall be as specified in Subsection 501.03.06, "Machine Mixing," except that the batch shall be so charged that ~~3/4~~ three-fourths of the total mixing water, and admixtures be introduced in the mixer in advance of the aggregates.
 1. The aggregates shall then be introduced and mixed for a minimum of ~~forty-five (45)~~ seconds.
 2. The amount of absorption by the aggregate will be the determining factor in mixing time.
 3. The cement and final water shall be added and mixing completed.
 4. The total mixing time for stationary mixers shall not be less than ~~three (3)~~ minutes.
 5. Minimum mixing for concrete mixed in trucks shall be ~~one hundred (100)~~ revolutions of the drum.
- C. The drum on truck mixers shall be operated at high speed while charging it with aggregate.
 1. Cement shall be introduced into the mixing drum while it is rotating at slow speed.
 2. Immediately prior to discharge of the concrete, the drum shall be rotated at high speed for at least ~~sixty (60)~~ seconds.

TABLE 1 - LIGHTWEIGHT CONCRETE MIX REQUIREMENTS								
Class	Sacks Cement Per Cubic Yard		Maximum Water Gallons Per Sack of Cement*	Minimum Compressive Strength 28-Day	Slump Range	Entrained Air Range	Unit Weight Variation	Air Dried Weight, Maximum
	Min.	Max.		psi	Inches	Percent	Pounds	Pounds per Cubic Foot
LA	6.0	7.0	6.0	3,000	1 - 4	0	±3	115
LAA	6.0	7.0	5.5	3,000	1 - 4	4-7	±3	115
Modified LA or LAA	6.0	8.0	6.0	Specified on plans	1 - 4	4-7	±3	115

* Based on aggregate in a saturated surface - dry condition

Class	Sacks Cement Per Cubic Yard		Kilograms Per Cubic Meter		Maximum Water Gallons Per Sack of Cement*	Liters Per Kilograms of Cement*
	Minimum	Maximum	Minimum	Maximum	Cement*	Cement*
LA	6	7	334	391	6	0.53
LAA	6	7	334	391	5.5	0.49
MODIFIED LA or LAA	6	8	334	446	6	0.53
Class	Minimum Compressive Strength (28) Day		Slump Range		Entrained Air Range	
	P.S.I.	MPa	Inches	Centimeters	Percent	
LA	3,000	20.68	1—4	2.5—10	0	
LAA	3,000	20.68	1—4	2.5—10	4-7	
MODIFIED LA or LAA	Specified on plans		1—4	2.5—10	4-7	
Class	Unit Weight Variation		Air Dried Weight, Maximum Pounds Per Cubic Foot		Kilograms Per Cubic Meter	
	Pounds	Kilograms	Foot			
LA	±3	1.4	115	1842		
LAA	±3	1.4	115	1842		
MODIFIED LA or LAA	±3	1.4	115	1842		

*Based on aggregate in a saturated surface—dry condition.

04METHOD OF MEASUREMENT

504.04.01 MEASUREMENT

- A. The quantity of lightweight concrete to be measured for payment will be the number of cubic yards ~~(meters)~~ complete and in place. The estimated quantity shown on the plans, plus or minus quantities covered by change orders, will be the quantity used for payment.
1. The Contractor, may, however, request a final measurement.
 2. The Contractor's request for final measurement shall be in writing.
 3. Final measurement will be made according to the dimensions shown on the plans plus or minus approved changes and quantities derived therefrom will be the quantities used for payment.
 4. Each class of lightweight concrete will be considered separately.
 5. Furthermore, when the Contractor requests final measurement and calculations and the quantities thus determined are the same or less than the planned quantities plus authorized changes, the Contractor shall reimburse the Contracting Agency for the ~~a~~Agency's expenses incurred by such final measurements and calculations.
 6. Only those quantities complete and in place will be measured for payment.
- B. In the event any class of Portland cement concrete is placed and is shown by test to be below the specified ~~twenty-eight (28)~~ day compressive strength, a determination shall be made by the Engineer as to whether the concrete shall be removed and replaced or allowed to remain in place.
1. This determination shall be based on an evaluation of the durability and other qualities of the concrete necessary to the integrity of the structure.
 2. If the concrete is allowed to remain in place, it is agreed by the parties to the contract that the Contracting Agency will deduct from money due, or to become due, the Contractor from the Contracting Agency, a percentage of the contract unit bid price.
 3. This deduction shall be considered to be liquidated damages and shall be at a rate of ~~five (5)~~ percent of the contract unit price bid for each ~~fifty (50)~~ psi ~~(345 kilopascals)~~ or portion thereof below the specified minimum compressive strength, to a maximum of ~~fifty (50)~~ percent, as set forth in the example for the class of concrete shown in the table in Subsection 502.04.01, "Measurement."
 4. The reduced price shall apply to all concrete represented by the strength tests below the specified minimum compressive strength.
 5. Concrete removed will not be paid for, and the removal thereof will be at ~~the Contractor's expense~~ no additional cost to the Contracting Agency.
- C. When a compressive strength test falls below the specified ~~twenty-eight (28)~~ day compressive strength, the Contracting Agency may determine that an alternate strength test is required or the Contractor may request such a test.
1. When the Contracting Agency determines that an alternate strength test is required, the Contractor will be liable for the cost of such test.
 2. In case the Contracting Agency has not determined that an alternate strength test is necessary and the Contractor elects to have an alternate strength test made, the Contracting Agency will then make a test; however, should this test fail to indicate

- that the ~~twenty-eight (28-)~~ day compressive strength requirements have been met, the cost thereof shall be deducted from any money due or to become due the Contractor from the Contracting Agency.
3. The cost of all other alternate strength tests made at the Contractor's request shall be borne by the Contractor.
 4. The alternate strength test shall consist of obtaining and testing ~~three~~3-drilled core samples in accordance with ~~Test Method~~ ASTM C42.
 5. The test specimens will be taken at a single location approved by the Engineer, and shall be from the same area represented by the original strength test.
 6. The cores shall be obtained and the test performed by the Contracting Agency.
 7. The test shall be accomplished as soon as possible after the ~~twenty-eight (28-)~~ day curing period.
- D. The average compressive strength of the ~~three~~3-drilled core samples at the age tested shall be converted to a ~~twenty-eight (28-)~~ day compressive strength by subtracting 8 psi from the average for each day beyond 28 days, with a maximum conversion adjustment of 200 psias shown by Chart No. 1 in Section 501 of these specifications. This calculated value shall be termed the "Result of the Core Test."
1. When the results of the core test validates the original ~~twenty-eight (28-)~~ day strength test, the quality of the concrete shall be assessed on the basis of the original test.
 2. When the core test does not validate the ~~twenty-eight (28-)~~ day strength test, then the result of the core test shall be used to assess the quality of the concrete.
- E. No measurement or other allowance will be made for work, material for forms, falsework, cofferdams, pumping, bracing, ~~etc~~and so forth.
- F. The quality of concrete involved in fillets, scorings, and chamfers ~~two (2-)~~ square inches (~~12.9 square centimeters~~) or less in cross-sectional area shall be neglected.
- G. No deduction shall be made for the volume of concrete displaced by reinforcing steel, expansion joint material, drainage and weep holes, pipes, conduits, and ducts embedded in concrete. Deduction shall be made for the volume of timber piles, concrete piles, and cast-in-place piles embedded in the concrete.
- H. All measurements will be made in accordance with Subsection 109.01, "Measurement of Quantities."

~~05~~ BASIS OF PAYMENT

504.05.01 PAYMENT

- A. The accepted quantity of concrete measured as provided in Subsection 504.04.01, "Measurement," will be paid for at the contract unit price bid per cubic yard (~~cubic meter~~) for the class of lightweight concrete specified.
- B. Reinforcing steel will be paid for as provided in Section 505, "Reinforcing Steel."
- C. All metal parts, fabrics, pads, joint fillers, drains, and any other materials not specifically mentioned for payment herein, will be considered subsidiary to the other pay items of the work and no further compensation will be allowed therefor.
- D. All payments will be made in accordance with Subsection 109.02, "Scope of Payment."

LIGHTWEIGHT CONCRETE FOR STRUCTURES

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E. Payment will be made under:

PAY ITEM	PAY UNIT
Class _____ Lightweight Concrete.....	Cubic Yard (Cubic Meter)

SECTION 505**REINFORCING STEEL****04DESCRIPTION****505.01.01 GENERAL**

- A. This work shall consist of furnishing and placing reinforcing steel and mesh reinforcing in accordance with ACI 318 Chapter 7 and ACI 315 with the additions or exceptions listed below.

02MATERIALS**505.02.01 GENERAL**

- A. Materials shall conform to the requirements specified in the following subsections:

Materials	Subsection
Fabricated Steel Bar or Rod Mats Reinforcement	713.03.02
Bar Steel Reinforcement	713.03.01
Welded Steel Wire Fabric Reinforcement	713.03.03

- B. Bar steel reinforcement ~~may shall~~ be ~~either Grade 300 (40) or Grade 420 (60)~~ bar steel reinforcement unless otherwise specified on the plans.
- C. Spiral Reinforcement may be either Bar Steel Reinforcement or Steel Wire, of the equivalent size of the bar steel.
- D. Epoxy coatings for steel reinforcing bars shall conform to ASTM ~~D2912-D3963~~ Annex. Epoxy coatings listed in the NDOT QPL, ~~latest edition, found on the web at http://www.nevadadot.com/reports_pubs/qpl/pdfs/QPL.pdf~~, shall be used.
- E. Tie wire shall be commercial quality ~~1.5 mm diameter (16 gage)~~ minimum, black annealed soft iron wire, unless otherwise approved. Tie wires used on epoxy coated reinforcing steel shall be coated with plastic or an equal type coating as approved.

505.02.02 SAMPLES

- A. One extra bar of each diameter shall be furnished for each ~~one hundred (100) tons (90 metric tons)~~ or fraction thereof.
1. This bar shall be selected from the longest bar of each size so that the bar, or a portion of it, can be used to replace any bar of that diameter ~~which~~ that is selected to be used as a field sample.
 2. Supplied field sample shall be of sufficient length to provide two ~~(2) thirty, (30-) inch (750 millimeters)~~ samples of each diameter.
 3. The extra bars shall be indicated on the fabricator's details.

505.02.03 SPECIFICATIONS FOR COATING REINFORCING STEEL

- A. Coating of reinforcing steel shall conform to AASHTO M284.

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1. The coating fabricator for epoxy coated reinforcing steel shall be certified by the Concrete Reinforcing Steel Institute's Certification Program for Fusion Bonded Epoxy Coating Applicator Plants.
 2. A copy of the Epoxy Coating Certification along with notification starting date of coating application shall be submitted.
- B. Notification shall be given of the date and location of the coating operation, in writing, at least 10 days before the planned date for beginning the coating operation.
1. The Engineer shall be allowed free access to plant of the coating applicator for inspection.
 2. If the representative so elects, preparation ~~of the bars~~, coating, and curing of the bars shall be performed in the representative's presence.
- C. Patching or repair material [that is in compliance with AASHTO M284](#) shall be made available from the coating manufacturer, ~~which is in compliance with AASHTO M284~~.

03 CONSTRUCTION**505.03.01 REINFORCING STEEL LIST**

- A. In accordance with ACI 315, before placing reinforcing steel, the Contractor shall submit shop drawing details and furnish ~~two~~2 copies of a list of all reinforcing steel showing sizes, lengths, and numbers of pieces and bends required to the Engineer at the site ~~of~~for ~~the~~the Engineer's use in administering the contract.
1. Furnishing such lists to the Engineer shall not be construed to mean that the lists will be reviewed for accuracy.
 2. The Contractor shall be wholly and completely responsible for the accuracy of the lists and for furnishing and placing all bar reinforcing steel in accordance with the details shown on the plans and as specified.

505.03.02 PROTECTION OF MATERIALS

- A. Reinforcing steel shall be protected at all times from damage.
- B. When placed in the work, the reinforcing steel shall be free from dirt, detrimental scale, paint, oil, or other foreign substance.
- C. However, when steel has on its surface loose mill scale or dust ~~which~~that is easily removable, it may be cleaned by a satisfactory method, if approved by the Engineer.

505.03.03 BENDING

- A. Bent bar reinforcement shall be cold bent to the shape shown on the plans, ~~and~~
- B. ~~u~~U Unless otherwise provided on the plans or by authorization, bends shall be made in accordance with the ACI Manual of Standard Practice for Detailing Reinforced Concrete Structures.

505.03.04 PLACING AND FASTENING

- A. In accordance with ACI 315, all bar reinforcement shall be accurately placed in the positions shown on the plans and firmly held during the placing and setting of concrete.

- B. When the spacing of bars exceeds ~~one (1) foot (30 centimeters)~~ in either direction, all intersections shall be tied.
- C. Distances from the vertical and horizontal forms shall be maintained by means of stays, blocks, ties, hangers, or other approved supports.
 - 1. Blocks used for holding reinforcing bars from contact with the forms or between layers of bars, shall be precast mortar blocks of approved shape and dimensions and shall have a compressive strength of not less than 3,000 psi ~~(20.68 MPa)~~.
 - 2. Metal chairs ~~which~~ that are in contact with the exterior surface of the concrete shall be fabricated of ~~either~~ galvanized steel, or have the steel tips plastic coated to at least 3/4 inch ~~(1.91 centimeters)~~ into the concrete, or be of stainless steel conforming to the requirements of ASTM A-493, Type 430.
 - 3. The use of pebbles, pieces of ~~f~~ broken stone or brick, metal pipe, and wooden blocks will not be permitted.
- D. Reinforcement in any member shall be placed, and then inspected and approved by the Engineer, before the placing of concrete begins. Concrete placed in violation of this provision may be rejected and its removal required.
- E. If mesh reinforcement is shipped in rolls, it shall be straightened into flat sheets before being placed.

505.03.05 SPLICING

- A. In accordance with ACI 315, all reinforcement bars shall be furnished in the full lengths indicated on the plans.
- B. Splicing of bars, except where shown on the plans, will not be permitted without the written approval of the Engineer.
 - 1. Splices shall be staggered as far as possible.
 - 2. Unless otherwise shown on the plans, bars near the top of beams and girders having more than ~~twelve (12) inches (30 centimeters)~~ of concrete under the bar shall be lapped ~~thirty-five (35) diameters~~ and all other bars shall be lapped ~~twenty (20) diameters~~ to make the splice.
 - 3. In lapped splices, the bars shall be placed in contact and wired together.
- C. Welding of reinforcing steel shall be done only if detailed on the plans or authorized by the Engineer in writing. Welding shall conform to the specifications for Welded Highway and Railway Bridges of the American Welding Society.
- D. Lapped splices in reinforcement shall not be used for sizes larger than No. 11, ~~(3.49 centimeters)~~.
- E. Tensile reinforcement shall preferably not be spliced at points of maximum stress. The length of lap for deformed bars shall not be less than 24 and 36 bar diameters for Grade 40 and Grade 60, respectively, nor less than 12 inches ~~(30 centimeters)~~.
- F. Where lapped splices are used in reinforcement in which the critical design stress is compressive and with concrete having a strength of 3,000 psi ~~(20.68 MPa)~~ or more, the length of lap for deformed bars shall be 20 bar and 24 bar diameters for Grade 40 and Grade 60, respectively, but not less than ~~twelve (12) inches (30 centimeters)~~. When the specified concrete strengths are less than 3,000 psi ~~(20.68 MPa)~~, the amount of lap shall be 1/3 greater than the values given above.

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- G. Splices in spiral steel shall be made by welding or a lap of ~~one and one-half (1-1/2)~~ turns.
- H. Sheets of mesh reinforcement shall overlap each other sufficiently to maintain a uniform strength and shall be securely fastened at the ends and edges. The edge lap shall not be less than ~~one (1)~~ mesh in width.

505.03.06 SUBSTITUTIONS

- A. Substitution of different size bars will be permitted only with specific authorization by the Engineer.
- B. The bars substituted shall have an area equivalent to the design area or larger.

~~04~~METHOD OF MEASUREMENT**505.04.01 MEASUREMENT**

- A. The calculated quantity of reinforcing steel shown on the plans, plus or minus quantities covered by approved changes, will be the quantity used for payment.
1. The Contractor may request final measurement if a possible error is suspected in the quantities shown on the plans.
 2. The Contractor's request for final measurement shall be in writing.
 3. Final measurement will be made according to the dimensions shown on the plans plus or minus approved changes and quantities derived therefrom will be the quantity used for payment.
 4. Furthermore, when the Contractor requests final measurement and calculations and the quantities thus determined are the same or less than the planned quantities plus authorized changes, the Contractor shall reimburse the Contracting Agency for the agency's expenses incurred by such final measurements and calculations.

~~B. The quantity of reinforcing steel measured for payment will be the number of pounds complete and in place.~~

- B. The calculated weights of the plain and deformed bars shall be based on the following table:

Size Number	Nominal Diameter	Weight Per Foot in
	Inches	Pounds
2	0.250	0.167
3	0.375	0.376
4	0.500	0.668
5	0.625	1.043
6	0.750	1.502
7	0.875	2.044
8	1.000	2.670
9	1.128	3.400
10	1.270	4.303
11	1.410	5.313
14	1.692	7.650
18	2.256	13.600

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- C. The ~~quality~~ quantity of mesh reinforcement to be measured for payment will be the number of square yards ~~(square meters)~~ complete and in place measured along the plane of placement. No allowance will be made for laps.
- D. All measurements will be made in accordance with Subsection 109.01, "Measurement of Quantities."

~~05~~ BASIS OF PAYMENT

505.05.01 PAYMENT

- A. The accepted quantity of reinforcing steel measured as provided in Subsection 505.04.01, "Measurement," will be paid for at the contract unit price bid per pound ~~(kilogram)~~.
- B. The accepted quantity of mesh reinforcement measured as provided in Subsection 505.04.01, "Measurement," will be paid for at the contract unit price bid per square yard ~~(square meter)~~.
- C. All payments will be made in accordance with Subsection 109.02, "Scope of Payment."
- D. Payment will be made under:

PAY ITEM

PAY UNIT

Reinforcing Steel	Pound (Kilogram)
Mesh Reinforcing	Square Yard (Square Meter)

SECTION 506**STEEL STRUCTURES**~~04~~DESCRIPTION**506.01.01 GENERAL**

- A. This ~~item~~work shall consist of furnishing, fabricating, casting, machining, or otherwise preparing, transporting, erecting, and painting structural steel, rivet and eye bar steel, steel forgings, casting, and any other metal of the type, shape, dimensions, and quality, required by these specifications or as shown on the plans.

~~02~~MATERIALS**506.02.01 GENERAL**

- A. Materials shall meet the pertinent requirements of the following sections:

Materials	Section
Structural and Eyebar Steel	710
Aluminum for Bridge Rail	711
Miscellaneous Metals	712
Paint <u>and Pavement Markings</u>	714
Galvanizing	715
Elastomeric Bearing Pads	725

- B. Turned bolts shall meet the material specifications set forth for Structural Rivet Steel. Anchor bolts, nuts, and washers shall be of structural steel, galvanized in accordance with ASTM ~~Designation~~-A-153. Bolts for fastening tubes to the rail posts sockets shall be stainless steel.
- C. Steel bridge and pedestrian railing shall be primed and painted in accordance with Subsection 714.03.01, "Iron and Steel Use Items Classifications."~~Subparagraph (a).~~
- D. Bridge or pedestrian rail and posts made of aluminum shall not be painted.
- E. Shims shall be either aluminum alloy or asbestos sheet packing, at the Contractor's option.
1. Aluminum Alloy Shims shall conform to ASTM ~~Designation~~-B209, Alloy 1100-0.
 2. Asbestos sheet packing shall be composed essentially of asbestos fibers bonded together with a cementing medium rendering it tough and pliable.
 3. The deformation of the packing under a load of 10,000 pounds per square inch (~~69 MPa~~) shall be less than 16 percent of the thickness and the loss on ignition shall not be more than 25 percent.
- F. Insulating material for insulating the base of aluminum rail posts from concrete and from steel anchor bolts shall be an aluminum impregnated light colored caulking compound of the consistency of putty.
- G. Shims for steel railing shall be galvanized steel plates.
- H. All bolts, nuts, and washers shall be either steel galvanized in accordance with ASTM ~~Designation~~-A153; stainless steel conforming to ASTM ~~Designation~~-A276; or steel cadmium plated in accordance with ASTM ~~Designation~~-A165 B766, Type TS.

03 CONSTRUCTION

506.03.01 SHOP DRAWINGS

- A. Shop drawings shall consist of shop detail, erection, and other working ~~plan~~ drawings showing dimensions, size of material, details, and other information necessary for the complete fabrication and erection of the metal work.
1. The drawings shall be prepared on sheets ~~twenty-four (24)~~ inches wide by ~~thirty-six (36)~~ inches ~~(60 by 90 centimeters)~~.
 2. ~~The original drawings may be made either on paper or on cloth, but the details~~ must ~~shall~~ be drawn so that the prints will be clear and legible.
- B. Unless otherwise requested, the Contractor shall submit to the Engineer, for approval, ~~two (2)~~ sets of ~~checked~~ drawings.
1. The Engineer reserves the right to refuse prints of shop drawings which are not clear and legible.
 2. Upon approval, the Contractor shall furnish the Engineer with the number of sets of shop drawings requested ~~and the original tracings or Van Dyke negatives thereof.~~
 3. All shop plans shall be submitted for approval at least ~~fifteen (15)~~ days before fabrication is started and no material shall be fabricated until the plans have been finally approved by the Engineer.
 4. ~~The shop drawings as approved by the Engineer shall become a part of the contract; provided, however, that any substitution of sections contemplated by the shop drawings different from sections shown on the plans shall be made only when approved by the Engineer and in such case, additional costs resulting from such substitution shall be borne by the Contractor.~~
- C. After approval, there shall be no deviation from the shop drawings or changes made thereon without the prior approval of the Engineer.
- D. Approval of shop drawings shall be understood to be an acceptance of the character and sufficiency of the details and not a check of any dimensions. Checking shop drawings is intended as a means of facilitating the work and avoiding errors, but it is expressly understood that it will not relieve the Contractor from the responsibility ~~in regard to~~ for errors or omissions on ~~said~~ the shop drawings.
- E. The contract price shall include the cost of furnishing all shop drawings and the Contractor will be allowed no extra compensation for ~~such~~ shop drawings.

506.03.02 NOTICE OF BEGINNING WORK

- A. The Contractor shall give the Engineer ample notice of manufacturing of material at the mill so that inspection may be provided. "Mill" means any rolling mill or foundry where material for the work is to be manufactured.
- B. No material shall be manufactured or fabrication begun without authorization by the Engineer.
- C. The Engineer may inspect the material, as provided for in ASTM ~~Designation~~ A6, at his Engineer's option.

STEEL STRUCTURES

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- D. Material not inspected at the place of manufacture shall be subject to inspection as provided for in Subsection 506.03.03, "Inspection and Testing." ~~"Mill" means any rolling mill or foundry where material for the work is to be manufactured.~~
- E. Prior to the beginning of fabrication, a ~~fifteen (15)~~-day written notice shall be provided by the Contractor to the Engineer.
- F. Any purchase of material prior to inspection at the mill or fabrication of any work without authorization from the Engineer shall be at the Contractor's risk.

506.03.03 INSPECTION AND TESTING

- A. The Engineer will examine and test as necessary all material before fabrication.
 - 1. Adequate facilities and free access to the necessary work areas will be provided to the Engineer by the manufacturer and fabricator.
 - 2. Required test samples will be furnished free of charge.
 - 3. Material not inspected at the place of manufacture shall be subject to all chemical, physical, and workmanship requirements established for the material supplied.
 - 4. Materials or workmanship not in conformity with the specified product may be rejected.
- B. The Engineer may inspect and test all material by any visual, destructive, or non-destructive method to evaluate the material for its specified properties.
 - 1. Mill orders and certificates, showing test values obtained, ~~must~~shall be furnished in triplicate to the Engineer.
 - 2. All certified test values ~~must~~shall include physical and chemical results and steel making process used.
 - 3. Test samples will be obtained from all steel not identified by mill heat numbers.
 - 4. Acceptance of any material at the mill or fabrication shop prior to incorporation shall not prevent the rejection of the material or finished member if defects are discovered during the fabrication process.
- C. Inspection in the fabrication shop is intended as a means of facilitating the work and avoiding errors as far as possible.
 - 1. It is expressly understood that shop inspection does not relieve the Contractor from responsibility for material or fabrication defects or errors and the necessity for replacement or correction of rejected materials and workmanship.
- D. Shop inspection of rail pipe and tubes will, in most cases, be waived and the Contractor permitted to ship subject to inspection at the project site.
 - 1. The field inspection will cover the general appearance, size, thickness, etc., of the pipe and tubing.
 - 2. Conformance of chemical and mechanical properties to requirements of the specifications will also be considered before the material is approved.
 - 3. Shop inspection of rail posts will be made on the first few rail post castings furnished for each project in order to establish a satisfactory class of finish and workmanship.
 - 4. When shop inspection is waived on a portion of the handrail posts for a project, a careful inspection will be made in the field to determine the acceptability of these

posts on the basis of the finish and workmanship as compared to that of the other posts previously inspected and approved.

- E. Fabrication of aluminum alloy material shall, in general, conform to or be equivalent to fabrication methods and practices recommended in the handbook of the major producers of aluminum materials and specifically the following requirements:
1. ~~(a)~~ Material shall be sawed, routed, or milled.
 2. ~~(b)~~ Flame cutting is not permissible.
 3. ~~(c)~~ Tubing may be heated to a temperature not exceeding ~~four hundred (400)~~ degrees F. ~~(204 degrees C.)~~ for a period not exceeding ~~fifteen (15)~~ minutes to facilitate bending.
 4. ~~(d)~~ Holes in pipe tubing shall be drilled. Holes in castings shall be cored and reamed, or drilled from the solid. Seats for pipe shall be finished smooth.
- F. The fabrication and handling of aluminum materials in the shop and field shall be performed in a manner to prevent scoring or marring of the surfaces.
1. An objectionable appearance resulting from such scoring or marring shall be cause for rejection of the material.
 2. Sleeves and rails shall be fabricated in lengths indicated on the plans.
- G. The finishing of rail posts shall be performed after fabrication is completed. All fins, pipes, and other casting irregularities and all drilling, reaming, and other fabrication marks shall be removed.

506.03.04 STORAGE

- A. The loading, transporting, unloading, storing, and handling of structural steel shall be conducted so that the metal will be kept clean and free from injury.
1. When unloaded, the material shall be placed on skids above the ground.
 2. All material for the project shall be stored separate from "in stock" materials.
 3. Girders and beams shall be placed upright and shored.
 4. Long members, such as columns and chords, shall be supported on skids placed near enough together to prevent injury from deflections.
- B. Different grades and classifications of material shall be color coded, as provided for in ASTM ~~Designation~~ A6. This color code ~~must~~ shall be transferred throughout fabrication.
- C. If the contract covering the erection of the steel does not include the fabrication, the Contractor shall check the material received by ~~him~~ Contractor and report promptly, in writing to the Engineer, any shortage or injury discovered.

506.03.05 STRAIGHTENING

- A. Rolled material before being laid out or worked shall be straight. Subassemblies and completed members shall be straight before being incorporated into the work.
- B. If straightening is necessary, it shall be done by methods acceptable to the Engineer. Details of methods proposed for straightening shall be submitted in writing to the Engineer prior to their use.

- C. After straightening, evidence of fracture or other damage will be cause for rejection of the material.
- D. Dimensional tolerances and repairs of surface irregularities, described in ASTM ~~Designation~~ A6, shall govern for the acceptance of repaired material.

506.03.06 RIVET HOLES

A.

- ~~1. Rivet holes in carbon steel which is more than three-fourths (3/4) inch (1.91 centimeters) in thickness shall be subpunched and reamed, subdrilled and reamed, or drilled full size from the solid.~~
- ~~2. Unless otherwise specified, all rivet holes in such material which is three-fourths (3/4) inch (1.91 centimeters) or less in thickness may be punched full size except where such holes match holes in thicker adjacent material.~~
- ~~3. In such cases the holes in the thinner material shall be subpunched (or subdrilled) and reamed while the parts are assembled or drilled full size from the solid while the parts are assembled.~~

B.

- ~~1. Rivet holes in material of alloy steels which is more than five-eighths (5/8) inch (1.59 centimeters) in thickness shall be subpunched and reamed, subdrilled and reamed or drilled to full size from the solid.~~
- ~~2. Unless otherwise specified, all rivet holes in such material which is five-eighths (5/8) inch (1.59 centimeters) or less in thickness may be punched full size except where such holes match holes in thicker adjacent material.~~
- ~~3. In such case the holes in the thinner material shall be subpunched (or subdrilled) and reamed while the parts are assembled or drilled full size from the solid while the parts are assembled.~~

~~C. Where there are five or more thicknesses of metal, all holes regardless of the thickness of the separate pieces shall be subpunched (or subdrilled) and reamed while the parts are assembled or drilled full size from the solid while the parts are assembled.~~

~~D. Full sized punched holes shall be one-sixteenth (1/16) inch (0.16 centimeters) larger than the nominal diameter of the rivet.~~

- ~~1. The diameter of the die shall not exceed the diameter of the punch by more than one-sixteenth (1/16) inch (0.16 centimeters).~~
- ~~2. If any holes must be enlarged to admit the rivets, they shall be reamed.~~
- ~~3. Holes must be clean cut, without torn or ragged edges.~~
- ~~4. Poor matching or mispunched holes will be cause for rejection.~~

~~E. Subpunched (or subdrilled) and reamed holes shall be punched or drilled at least three-sixteenth (3/16) inch (0.48 centimeters) smaller than the nominal diameter of the rivet.~~

- ~~1. After punching or drilling, the holes shall be reamed to a diameter of one-sixteenth (1/16) inch (0.16 centimeters) larger than the nominal diameter of the rivet.~~
- ~~2. The punch and die shall have the same relative sizes as specified for full sized punched holes.~~

- ~~3.Reamed holes shall be cylindrical and perpendicular to the member.~~
- ~~4.Where practicable, reamers shall be directed by mechanical means.~~
- ~~5.Burrs on the outside surfaces shall be removed.~~
- ~~6.Poor matching of holes will be cause for rejection.~~
- ~~7.Reaming of rivet holes shall be done with twist drills or with short taper reamers.~~
- ~~F.Full size drill holes shall be one-sixteenth (1/16) inch (0.16 centimeters) larger than the nominal diameter of rivet. Burrs on the outside surfaces shall be removed.~~
- ~~G.All holes punched full size, subpunched or subdrilled shall be so accurately punched after assembly (before any reaming is done) a cylindrical pin one-eighth (1/8) inch (0.32 centimeters) smaller in diameter than the nominal size in the punched hole may be entered perpendicular to the face of the member, without drifting, in at least seventy-five (75) percent of the contiguous holes in the same plane. If the requirement is not fulfilled, the badly punched pieces shall be rejected.~~
- ~~H.When holes are reamed or drilled, eighty-five (85) percent of the holes in any contiguous group shall, after reaming or drilling, show no offset greater than one thirty-second (1/32) inch (0.08 centimeters) between adjacent thicknesses of metal.~~

506.03.07RIVETS

- ~~A.Size of rivets called for on the plans shall be the size before heating.~~
 - ~~a.Rivet heads shall be of standard shape unless otherwise specified, and of uniform size for the diameter of rivet.~~
 - ~~b.They shall be full, neatly made, concentric with rivet holes, and in full contact with the surface of the member.~~

506.03.08SHOP RIVETING

- ~~A.Rivets shall be heated uniformly to a "light cherry red color" and shall be driven while hot.~~
 - ~~1.Any rivet whose point is heated more than the remainder shall not be driven.~~
 - ~~2.When a rivet is ready for driving, it shall be free from slag, scale, or other adhering matter.~~
 - ~~3.Any rivet which, in the opinion of the Engineer, is scaled excessively, shall be rejected.~~
- ~~B.All rivets that are loose, burned, badly formed, or otherwise defective shall be removed and replaced with satisfactory rivets.~~
 - ~~1.Any rivet whose head is deficient in size or whose head is driven off center will be considered defective and shall be removed.~~
 - ~~2.Stitch rivets that are loosened by the driving of adjacent rivets shall be removed and replaced with satisfactory rivets.~~
 - ~~3.Caulking or recupping of rivet heads will not be permitted.~~
- ~~C.Shop rivets shall be driven by direct-acting rivet machines where practicable.~~
- ~~D.Approved beveled rivet sets shall be used for forming rivet heads on sloping surfaces.~~
 - ~~1.When the use of a direct-acting rivet machine is not practicable, pneumatic hammers of approved size shall be used.~~

~~2. Pneumatic bucking tools will be required, when in the opinion of the Engineer, the size and length of the rivets warrant their use.~~

~~E. Rivets may be driven cold provided their diameter is not over three eighths (3/8) inch (0.95 centimeters).~~

506.03.06 SUBPUNCHING, DRILLING, AND REAMING

- A. Unless otherwise specified, rivet holes and connections and splices (shop and field) of main truss or arch members, continuous beams, plate girders and rigid frames and rivet holes in plate girder flanges, and stiffeners, intermediate stiffeners intended as supports for concentrated loads, and web splices shall either be subpunched (or subdrilled) and reamed while shop assembled or drilled to full size from the solid while assembled at the shop.
- B. The assembly, including camber, alignment, accuracy of holes and mill joints, shall be approved by the Engineer before reaming is commenced.
- C. Unless otherwise specified, each individual (full length) truss, arch, continuous beam, or girder shall be assembled at the shop before reaming or drilling is commenced. During shop assembly, all members shall be supported at such intervals and in such manner as is necessary to avoid undesirable deflections.
- D. All holes for floor beams and stringer field end connections shall be subpunched and reamed to a steel template.

506.03.07 BOLTS AND BOLTED CONNECTIONS:

- A. ~~(a) General.~~ **Bolted Connections:**
 - 1. Bolted connections shall not be used unless called for in the contract documents.
 - 2. Where bolted connections are permitted, the bolts furnished shall be as hereinafter specified.
 - a. Ribbed high-tensile strength bolts or high-tensile strength bolts may be substituted for field rivets in locations where, in the opinion of the Engineer, it is impractical to drive rivets.
 - b. Bolts shall be of such length that they will extend entirely through the nut, but not more than ~~three eighths (3/8) inch (0.95 centimeters)~~ beyond.
 - c. The Contractor shall furnish sufficient bolts of each type for each size and length to bolt such connections as called for with an ample surplus to replace ~~these bolts~~ lost or rejected.
 - 3. The holes, except holes in end diaphragms, shall be truly cylindrical.
 - a. Holes shall be at right angles to the surface of the metal so that both head and nut will bear squarely against the metal.
 - b. Bolts shall be driven accurately into the holes without damaging the thread.
 - c. A snap shall be used to prevent damaging the heads.
 - 4. Bolt holes in end diaphragms shall be slotted ~~one-half (1/2) inch (1.27 centimeters)~~ in addition to the dimensions shown on the plans, in the direction to facilitate erection. At all locations where such slotted bolt holes are required, circular washers shall be placed on each side of the bolted connection, and the necessary bolt length adjusted accordingly.

5. Bolts in end diaphragms to girder connections shall not be tightened until the deck pour has been completed.
 6. All bolted connections shall be fastened with high-tensile strength bolts or ribbed high-tensile strength bolts. The use of unfinished bolts or plain ribbed bolts will not be permitted.
- B. ~~(b)~~ **High-Tensile Strength Bolts.** The use of high strength bolts in structural connections shall comply with Article 2.10.20, "Construction Using High Strength Bolts," of the current AASHTO Standard Specifications for Highway Bridges.

506.03.08 SHOP ASSEMBLY

- A. Shop assembly of trusses, arches, continuous beams, continuous plate girders, plate girders, and rigid frames shall be according to Subsection 506.03.069, "Subpunching, Drilling, and Reaming." All members shall be match marked before being disassembled.
- B. Complete shop assembly of an entire structure, including floor system, which may be necessary in the case of complicated design or of skewed or super-elevated structure shall be done only if required by the Special Provisions.
 1. The several component parts of a built-up member shall be straight and close fitting.
 2. Surfaces of metal in contact shall be cleaned before assembling.
 3. The parts of a member shall be assembled, well pinned, and firmly drawn together with bolts before drilling, reaming, or riveting is commenced.
 4. Assembled pieces shall be taken apart, if necessary, for the removal of burrs and shavings produced by the operations.
 5. The member shall be free from twists, bends, and other deformations.
 6. End connections, angles, stiffener angles, and similar parts shall be carefully adjusted to correct positions and bolted, clamped, or otherwise firmly held in place until riveted.
- C. The drifting done during assembling shall be such as to bring the parts into position, and not sufficient to enlarge the holes or distort the metal. If any holes must be enlarged to admit the rivets, they shall be reamed.
- D. Parts not completely riveted in the shop shall be secured by bolts insofar as practicable to prevent damage in shipment and handling.
- E. Connecting parts assembled in the shop for the purpose of reaming holes in field connections shall be match marked, and a diagram showing such marks shall be furnished to the Engineer.

506.03.09 EDGE PLANING

- A. Sheared edges of plates more than ~~five-eighths (5/8)~~ inch (~~1.59 centimeters~~) in thickness and carrying calculated stress shall be planed to a depth of ~~one-fourth (1/4)~~ inch (~~0.635 centimeters~~).
- B. Re-entrant cuts shall be filleted to a radius of ~~three-fourths (3/4)~~ inch (~~1.91 centimeters~~).

506.03.10 FACING OF BEARING SURFACES

- A. 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 meet the American Standards Association

surface roughness requirements as defined in ASA B46.1-55, Surface Roughness, Waviness and Lay, Part 1:

Steel Slabs	ASA 2,000
Heavy Plates in Contact in Shoes to be Welded	ASA 1,000
Milled Ends of Compression Members, Stiffeners, and Fillers	ASA 500
Bridge Rollers and Rockers	ASA 250
Pins and Pin Holes	ASA 125
Sliding Bearings	ASA 125

- B. Surfaces of bronze bearing plates intended for sliding contact shall be planed parallel to the movement of the spans and polished.

506.03.11 ABUTTING JOINTS

- A. Abutting joints in compression members of trusses and in columns shall be milled.
- B. Opening and abutting joints in tension members shall not exceed ~~one-fourth (1/4)~~-inch ~~(0.635 centimeters)~~.
- C. Abutting joints of continuous I-beam spans shall be square and tight-fitting.
- D. Abutting joints in top and bottom flanges of plate girders shall be square and tight-fitting.

506.03.12 FLAME CUTTING

- A. Preparation of material for flame cutting. ~~This work~~ shall be in accordance with the provisions of AWS D2.0, Paragraph 302.

506.03.13 END CONNECTION ANGLES

- A. Floor beams, stringers, and girders having end connection angles shall be built to exact length shown on the plans measured between the heels of the connection angles, with a permissible tolerance of minus ~~one-sixteenth (1/16)~~-inch ~~(0.16 centimeters)~~.
- B. Where continuity is ~~to be~~ required, end connections shall be faced.
- C. The thickness of the connection angles shall not be less than ~~three-eighths (3/8)~~-inch ~~(0.95 centimeters)~~, nor less than that shown on the detail drawings.

506.03.14 LACING BARS

- A. The ends of lacing bars shall be neatly rounded unless another form is required d.

506.03.15 WEB PLATES

- A. In girders having no cover plates and not to be encased in concrete, the top edge of the web plate shall not extend above the backs of the flange angles and shall not be more than ~~one-eighth (1/8)~~-inch ~~(0.32 centimeters)~~ below at any point.
1. Any portion of the plate projecting beyond the angles shall be chipped flush with the backs of the angles.
 2. Web plates or girders having cover plates may be ~~one-half (1/2)~~-inch ~~(1.27 centimeters)~~ less in width than the distance back to back of flange angles.
- B. Splices in webs of girders without cover plates shall be sealed on top by welding.

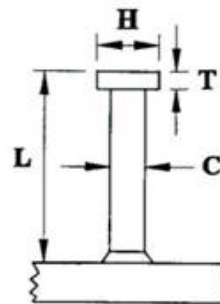
- C. At web splices, the clearance between the ends of the web plates shall not exceed ~~three-eighths (3/8) inch (0.95 centimeters)~~. The clearance at the top and bottom ends of web splice plates shall not exceed ~~one-fourth (1/4) inch (0.635 centimeters)~~.

506.03.16 STUD SHEAR CONNECTORS

- A. ~~(a)~~—Stud shear connectors shall be of a design suitable for end welding and shall be end welded to steel beams, girders, or plates with automatically timed stud welding equipment.
1. The type, size or diameter, placement pattern, and length of stud shall be as specified in the contract documents. (See Figure No. ~~1~~, below, for allowable tolerances or dimensions).
 2. A maximum variation of ~~one (1) inch (2.54 centimeters)~~ from the location shown will be accepted provided the adjacent studs are not closer than ~~two and one-half (2-1/2) inches (6.35 centimeters)~~ center to center.
 3. The clear distance between the edge of a girder flange and the edge of the shear connectors shall be not less than ~~one (1) inch (2.54 centimeters)~~.
 4. Fillet welds varying in size from ~~three-sixteenths (3/16) inch to five-sixteenths (5/16) inch (0.48 to 0.79 centimeters)~~ are satisfactory provided the studs pass all other tests required.
 5. Adequate provision shall be made in fabrication of structural members to compensate for loss of camber due to welding of the shear connectors.
- B. ~~(b)~~—Studs shall not be painted or galvanized.
1. The studs shall be free from rust, scale, rust pits, and oil at the time of welding and immediately before the concrete is placed.
 2. The beam surface to which the studs are welded shall be free from excessive mill scale, rust, dirt, paint, grease, or any other material which might impair the quality of the weld.
 3. When necessary to obtain satisfactory welds, the areas on the beam, girder, or plate to which the studs are to be welded shall be wire-brushed, peened, prick-punched, or ground free of scale or rust.
- C. ~~(c)~~—The Contractor shall submit to the Engineer for approval before installation, information on the studs to be furnished as follows:
1. ~~1~~—The name of the manufacturer.
 2. ~~2~~—A detailed description of the stud and arc shield.
 3. ~~3~~—A certification from the manufacturer that the stud is qualified as specified in AWS D2.0. The certification must also indicate the heat from which the studs were manufactured.

D. Welding specifications and procedure requirements shall conform to AWS D2.0.

STEEL STRUCTURES



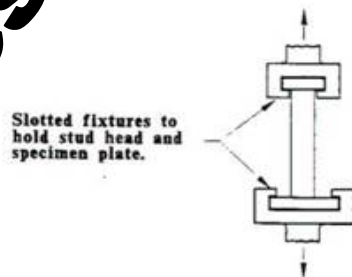
STANDARD DIMENSIONS

C	L*	H	T
3/4" + .000" - .010"	4" + .062" - .125"	1-1/4" + .004" - .004"	3/8" minimum
7/8" + .000" - .010"	4" + .062" - .125"	1-3/8" ± 1/6"	3/8" minimum

*NOTE: 4" length is standard. Other lengths may be obtained on special order.

DIMENSIONS AND TOLERANCES

Figure 1



TYPICAL TENSILE TEST FIXTURE

Figure 2

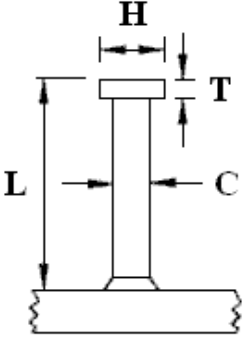
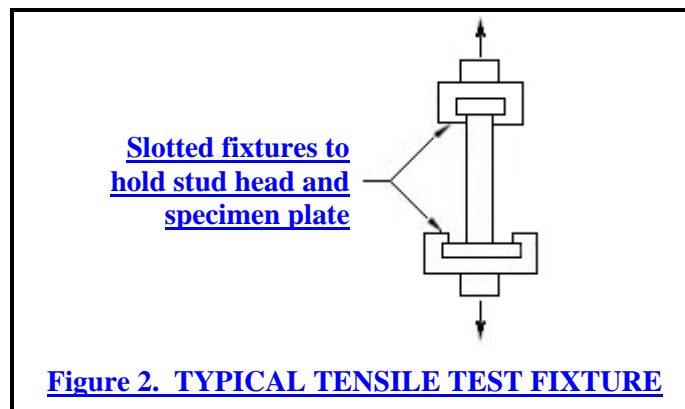
STEEL STRUCTURES	STANDARD DIMENSIONS			
	<u>C</u>	<u>L*</u>	<u>H</u>	<u>T</u>
	$\frac{3}{4}'' +0.000''$ $-0.010''$	$4'' +0.062''$ $-0.125''$	$1-1/4'' \pm 1/64''$	$3/8''$ minimum
	$7/8'' +0.000''$ $-0.010''$	$4'' +0.062''$ $-0.125''$	$1-3/8'' \pm 1/64''$	$3/8''$ minimum
<p>*NOTE: 4" length is standard. Other lengths may be obtained by special order.</p>				

Figure 1. DIMENSIONS AND TOLERANCES



506.03.17 WELDING

- A. Welding of steel structures when authorized in accordance with the provisions contained herein, called for in the contract documents, or upon written permission from the Engineer shall conform to ~~the requirements of the~~ most recent edition of the 1969 Edition of the American Welding Society's Standard Specifications for Welded Highway and Railway Bridges Bridge Welding Code, except as modified in this ~~S~~ subsection.
- B. All welding shall be performed in the fabrication shop, except as otherwise noted on the plans or permitted by the Engineer.
- C. **Inspection and Testing of Shop Welds:**
1. ~~(1)~~ **Radiographic Inspection:-**
 - a. The procedure, techniques, and standards of acceptance shall be in conformance with the current AWS D2.0 Specifications.
 - b. The Engineer will make all final interpretations of weld defects and film quality.
 - c. All radiographs will be the property of the Contracting Agency during and after completion of the project.
 2. ~~(2)~~ **Ultrasonic Inspection.** The procedure, techniques, and standards of acceptance shall be in conformance with the current AWS D2.0 Specifications except as modified in this ~~S~~ subsection.

3. ~~(3)~~ **Magnetic Particle Inspection.** This procedure and technique shall be in conformance with ~~the current~~ ASTM E4709, "[Standard Guide for Magnetic Particle Testing](#)~~Dry Powder Magnetic Particle Inspection.~~"
- D. **Inspection and Testing of Field Welds:**
1. The Contracting Agency will make ~~either~~ magnetic particle inspections, ultrasonic inspections, or radiographic inspections of field welds when so required by the plans or the Special Provisions, ~~and~~
 2. ~~†~~The acceptability of welds will be judged in accordance with the Inspection and Testing of Shop Welds for the type of inspection employed.
- E. Welds shall be painted according to the applicable provisions of Section 614, "Painting."
- F. All groove welds on primary members shall be finished smooth and flush with the base metal on all surfaces by grinding in the direction of applied stress, leaving surfaces free from depressions. Chipping may be used provided it is followed by such grinding.

506.03.18 FIT OF STIFFENERS

- A. End stiffeners of girders and stiffeners intended as supports for concentrated loads shall be milled or ground to secure an even bearing against the flange.
1. Intermediate stiffeners shall fit sufficiently tight to exclude water after being painted.
 2. Fillers under stiffeners shall fit within ~~one-fourth (1/4)~~ inch ~~(0.635 centimeters)~~ at each end.
- B. Welding will be permitted in lieu of milling or grinding if noted in the contract documents. Where stiffeners are required on ~~one~~ side of the web only, they shall be welded to the compression flange.

506.03.19 ANNEALING AND STRESS RELIEVING

- A. Members such as bridges shoes, pedestals, or other parts which are built up by welding sections of plate together, and stress relieving is called for in the contract documents, stress relieving shall be in accordance with the provisions of the American Welding Society.

506.03.20 PINS AND PIN HOLES

- A. Rollers shall be of structural carbon steel, and pins shall be carbon steel forgings meeting the requirements of Subsection 710.03.08, "Pins and Rollers."
1. Pins and rollers shall be accurately turned to the dimensions shown on the drawings and shall be straight, smooth, and free from flaws.
 2. Final surface shall be produced by a finishing cut.
- B. In pins larger than ~~nine (9)~~ inches ~~(23 centimeters)~~ in diameter, a hole not less than ~~two (2)~~ inches ~~(5 centimeters)~~ in diameter shall be bored full length along the axis after the forging has been cooled to a temperature below the critical range under suitable conditions to prevent injury by too rapid cooling, and before being annealed.
- C. Pin holes shall be bored true to the specified diameter, smooth and straight, at right angles with the axis of the member, and parallel with each other unless otherwise specified.
- D. The distance outside to outside of holes in tension members and inside to inside of holes in compression members shall not vary from that specified more than ~~one thirty-second~~

- ~~(1/32_)inch (0.08 centimeters)~~. Boring of holes in built-up members shall be done after the riveting assembly is completed.
- E. The diameter of the pin hole shall not exceed that of the pin by more than ~~one-fiftieth (1/50_)inch (0.05 centimeters)~~ for pins ~~five (5_)inches (12.7 centimeters)~~ or less in diameter, or more than ~~one thirty-second (1/32_)inch (0.08 centimeters)~~ for larger pins.
- F. Screw threads for all bolts and pins for structural steel construction shall conform to the American National Coarse Thread Series, Class 2, free fit, except that pin ends having a diameter of ~~one and three eighths (1-3/8_)inches (3.49 centimeters)~~ or more shall be threaded ~~six (6_)threads to the inch (2.54 centimeters)~~.
- G. Pilot and driving nuts shall be used in driving pins.
1. They shall be furnished by the Contractor without charge.
 2. Two pilot nuts and ~~two~~2-driving nuts for each size of pin shall be furnished, unless otherwise specified.
 3. Pins shall be so driven that the members will take full bearing ~~on them~~.
 4. Pin nuts shall be screwed up tight and the threads burred at the face of the nut with a pointed tool.

506.03.21 SHOP PAINTING

- A. Unless otherwise provided, the application of shop paints shall conform to the requirements of Section 614, "Painting."
- B. Surfaces to be in contact after shop riveting is completed shall be cleaned but shall not be painted.

506.03.22 MARKING AND SHIPPING

- A. Each member shall be painted or marked with an erection mark for identification and an erection diagram shall be furnished with erection marks shown thereon.
- B. Members weighing more than ~~three (3_)tons (2.75 metric tons)~~ shall have the weight marked thereon.
- C. Structural members shall be loaded on trucks or cars in such a manner that they may be transported and unloaded at their destination without being excessively stressed, deformed, or otherwise damaged.
- D. All girders ~~must~~shall be shipped with the web vertical, which position shall be maintained in subsequent operations.

506.03.23 ERECTION METHODS AND EQUIPMENT

- A. Before starting work, the Contractor shall inform the Engineer fully as to the method of erection ~~the Contractor~~ proposes to follow and as to the amount and character of the equipment ~~the Contractor~~ proposes to use, the adequacy of which shall be subject to the approval of the Engineer.
1. The approval of the Engineer shall not be considered as relieving the Contractor of the responsibility for the safety and adequacy of ~~hi~~Contractor's methods or equipment or from carrying out the work in full accordance with the plans and specifications.
 2. No work shall be done without the sanction of the Engineer.

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- B. Spot welding for the purpose of eliminating field erection bolts or for holding steel parts together while ~~riveting~~ fastening will not be permitted.
- C. All work of erection shall be subject to inspection. ~~and~~
 - 1. ~~The~~ Contractor shall furnish facilities for ~~such~~ inspection of material and workmanship.
 - 2. Material and workmanship not previously inspected shall be inspected after ~~its~~ delivery to the site of the work.
- D. The Contractor shall provide the falsework and all tools, machinery, and appliances, including drift pins and fitting ~~up~~ bolts necessary for the expeditious handling of the work.
- E. Anchor bolts for rail posts shall be galvanized high-strength bolts set with suitable templates in exact position and securely fixed to prevent displacement during the concreting operations.
 - 1. The areas of concrete upon which posts are to be set shall be dressed by grinding or rubbing to a true plane for the proper seating of the posts.
 - 2. All surfaces of aluminum alloy posts and adjustment shims to be in contact with concrete or with the steel anchor bolts nuts and washers shall be coated with aluminum insulating compound.
- F. Rail posts shall be erected in sections.
 - 1. Erection of sections of rails and posts shall continue successively until all or an approved portion of the required rail is erected.
 - 2. The rail shall then be aligned and the nuts on the anchor bolts tightened.
 - 3. In final adjustment, no posts shall deviate more than ~~one-eighth (1/8)~~ inch ~~(0.32 centimeters)~~ from true alignment and there shall be no abrupt break in alignment of any location.
 - 4. Aluminum shims may be slotted for ease in placing if approved by the Engineer.

506.03.24 FALSEWORK

- A. The falsework shall be ~~properly~~ designed and substantially constructed and maintained for the vertical and lateral loads ~~which will come upon it~~ that will be applied to the structure.
 - 1. The Contractor shall prepare and submit to the Engineer, for approval, plans for falsework or for changes in an existing structure necessary for maintaining traffic.
 - 2. Approval of the Contractor's plans shall not be considered as relieving the Contractor of any responsibility.
- B. Upon completion of the erection and before final acceptance, the Contractor shall remove all falsework, excavated or useless materials, rubbish and temporary buildings, replace or renew any fences damaged, restore in an acceptable manner all property, both public and private, which may have been damaged during the prosecution of the work, and leave the structure site and adjacent highway in a neat and presentable condition satisfactory to the Engineer.
- C. All excavated material or falsework placed in the stream channel before construction shall be removed by the Contractor before final acceptance.

506.03.25 BEARING AND ANCHORAGE

- A. Masonry bearing plates shall not be placed upon bridge seat bearing areas which are improperly finished, deformed, or irregular.
1. Bearing plates shall be set level in exact position and shall have a full and even bearing upon the masonry.
 2. Unless otherwise directed by the Engineer, the bearing plates shall be placed on a layer of canvas and red lead applied as follows:
 - a. Thoroughly swab the bridge seat bearing area with red lead paint and place upon it ~~three~~³ layers of ~~twelve (12-ounce)~~ to ~~fourteen (14-)~~ ounce ~~(340 to 397 grams)~~ duck, each layer being thoroughly swabbed on its top surface with red lead paint.
 - b. Place the superstructure shoes or pedestals in position while the paint is plastic.
 - c. As an alternate to canvas and red lead, sheet lead may be used if called for on the plans.
- B. The milled and finished surfaces of castings or bearing plates shall have the shop coat of tallow, white lead, or oil removed immediately prior to placing in the structure. Surfaces designed for sliding movement, one upon the other, shall be given a field coat of graphite grease when placed in the structure.
- C. The Contractor shall drill the holes and set the anchor bolts, except where the holes are formed or the bolts are built into the masonry.
1. The bolts shall be set accurately and fixed with Portland cement grout, completely filling the holes.
 2. The location of the anchor bolts in relation to the slotted holes in the expansion shoes shall correspond with the temperature at the time of erection.
 3. The nuts on anchor bolts at the expansion ends of spans shall be adjusted to permit free movement of the span.
- D. Elastomeric bearing pads shall conform to ~~the requirements specified in~~ Subsection 502.03.~~12~~¹³, "Expansion and Fixed Joints and Bearings."

506.03.26 FIELD ASSEMBLING ~~AND RIVETING~~

- A. The parts shall be accurately assembled as shown on the plans and match-marks shall be followed.
1. The material shall be carefully handled so that no part will be bent, broken, or otherwise damaged.
 2. Hammering which will injure or distort the members shall not be done.
 3. Bearing surfaces and surfaces to be in permanent contact shall be cleaned before the members are assembled.
 4. Unless erected by the cantilever method, truss spans shall be erected on blocking so placed as to give the trusses proper camber.
 5. The blocking shall be left in place until the tension chord splices are fully ~~riveted~~ fastened and all other truss connections pinned and bolted.

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6. Splices of ~~riveted~~ butt joints of compression members, in railings, and in other field splice connections shall have ~~one-half (1/2)~~ of the connection holes filled with bolts and cylindrical erection pins (half bolts and half pins) before ~~riveting~~fastening.
 7. Splices and connections carrying traffic during erection shall have ~~three-fourths~~3/4 of the holes so filled.
- B. ~~Fitting-up bolts shall be the same nominal diameter as the rivets, and c~~Cylindrical erection pins shall be ~~one-thirty-second (1/32)~~-inch (0.08 centimeters)-larger than the fitting up bolts.

~~C. Pneumatic hammers shall be used for field riveting.~~

- ~~1. Cup-faced dollies fitting the head closely to insure good bearing shall be used.~~
- ~~2. Connections shall be accurately and securely fitted up before the rivets are driven.~~
- ~~3. Driftings shall be only such as to draw the parts into position and not sufficient to enlarge the holes or distort the metal.~~
- ~~4. Unclear holes shall be reamed or drilled.~~
- ~~5. Rivets shall be heated uniformly to a light "cherry-red" color and shall be driven while hot.~~
- ~~6. They Rivets shall not be overheated or burned.~~
- ~~7. Rivet heads shall be full and symmetrical concentric with the shank and shall have full bearing all around.~~
- ~~8. They Rivets shall not be smaller than the heads of the shop rivets.~~
- ~~9. Rivets shall be tight and shall grip the connected parts securely together.~~
- ~~10. Caulking or recupping will not be permitted.~~
- ~~11. In removing rivets, the surrounding metal shall not be injured; if necessary, they rivets shall be drilled out.~~

~~D. Field-driven rivets shall be inspected and accepted before being painted.~~

506.03.27 MISFITS

- A. The correction of minor misfits involving nonharmful amounts of reaming, cutting, and chipping shall be considered a legitimate part of the erection.
- B. However, any error in the shop fabrication, or deformation resulting from handling and transportation, which prevents the proper assembling and fitting up of the parts by the moderate use of drift pins or by a moderate amount of reaming and slight chipping or cutting, shall be reported immediately to the Engineer and ~~hi~~Engineer's approval of the method of correction obtained.
- C. The correction shall be made in the Engineer's presence.
- D. The Contractor shall be responsible for all misfits, errors, and injuries and shall make the necessary corrections and replacements.

506.03.28 FIELD PAINTING

- A. Structural steel, unless otherwise specified, shall be painted as specified in Section 614, "Painting."

~~04~~METHOD OF MEASUREMENT**506.04.01 MEASUREMENT**

- A. Measurement of structural steel will be either by the pound or lump sum.
1. The calculated poundage shown on the plans, plus or minus quantities covered by approved changes, will be the poundage used for payment. The Engineer or the Contractor may request final measurement if a possible error is suspected in the quantities shown on the plans.
 2. Furthermore, when the Contractor requests a final measurement and calculation and the quantities thus determined are the same or less than the planned quantities adjusted for authorized changes, the Contractor shall reimburse the Contracting Agency for the Agency's expenses incurred by ~~such~~the final measurements and calculations.
 3. The Contractor's request for final measurement shall be in writing.
 4. Final measurement will be made according to the dimensions shown on the plans, plus or minus approved changes, and quantities derived therefrom will be the quantities used for payment.
- B. The calculated weights shall be based on the following assumptions: ~~(a) Unit — weights, pound per cubic foot (kilograms per cubic meter):~~

<u>Unit Weight</u>	<u>Pounds per Cubic Foot</u>
Iron, malleable	470.0 (7529)
Iron, wrought	487.0 (7801)
Steel, rolled, cast, copper bearing, silicon, nickel, and stainless	490.0 (7849)

1. The quantity of structural steel measured for payment will be the number of pounds ~~(kilograms)~~ complete and in place, except that additional weight of substitutions made at the Contractor's request will not be included.
2. ~~(b)~~ The weight of shop rivets will be computed on the basis of reasonable average lengths, in accordance with the following table:

Rivet Diameter	Per 100 Rivets
Inches	Pounds
1/2	20
5/8	30
3/4	50
7/8	100
1	150
1-1/8	250
1-1/4	325

3. The weight of bolts, cap screws, anchor bolts, nuts, washers and anchor pipe sleeves remaining in the finished structure will be computed on the basis of their nominal weight and dimensions.
4. ~~(c)~~ The weight of paint will not be included in the computed weight of metals.

5. ~~(e)~~ The weight of weld metal will be computed on the basis of the theoretical volume of the dimensions of the welds with no allowance for overrun.
- C. Lump Sum Basis:-
1. When specified, structural steel acceptably completed in the structure as shown on the plans will be measured for payment by the lump sum plus or minus approved changes. There will be no change in measurement due to substitutions made at the Contractor's request.
 2. If the proposal ~~ed~~ contains such an item, bridge rail shall be measured in linear feet ~~(meters)~~ between concrete posts in the completed work.
 3. Measurement will be made to the nearest foot ~~(0.3 meters)~~ of rail for each structure measured along the top of the parapet from concrete ends posts to concrete end posts.
 4. Pedestrian rail shall be measured by the linear foot ~~(meters)~~ of rail installed, complete and in place.
- D. All measurements will be made in accordance with Subsection 109.01, "Measurement of Quantities."

~~05~~ BASIS OF PAYMENT

506.05.01 PAYMENT

- A. The accepted quantity of structural steel measured as provided in Subsection 506.04.01, "Measurement," shall be paid for at the contract unit price bid per pound ~~(kilograms)~~ or lump sum price for structural steel as set forth for the bid item in the proposal.
- B. The additional steel in substitutions made at the Contractor's request will not be paid for.
- C. The price per pound ~~(kilograms)~~ or lump sum shall constitute full compensation for doing all the work involved in furnishing, fabricating, delivering, erecting, and painting the steel work in accordance with the details shown on the plans and as herein specified, including furnishing of mill tests and test specimens, except the specimens for full size tests.
 1. This price shall also include full compensation for furnishing and calibrating torque wrenches and/or power wrenches and all necessary equipment as required for testing high-strength bolt connections.
 2. Unless otherwise specified and provided for in the proposal, the lump sum price shall include all specified and approved metal in the finished structure.
- D. Bridge rail or pedestrian rail shall be paid for at the contract unit price bid per linear foot ~~(meter)~~ for the type specified, whether ~~it be~~ constructed of steel or aluminum, which ~~payment~~ shall be full compensation for furnishing, fabricating, delivering, erecting, and painting; ~~and~~ for all labor, material, tools, supplies, equipment and incidentals necessary to complete the item; ~~and~~ for furnishing ~~of~~ mill test reports and test specimens.
- E. Full compensation for conforming to the welder qualification requirements of this section shall be considered as included in the contract price paid per pound ~~(kilogram)~~ or lump sum price for structural steel and no separate payment will be made therefore.
- F. All payments will be made in accordance with Subsection 109.02, "Scope of Payment."
- G. Payment will be made under:

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PAY ITEM	PAY UNIT
Structural Steel	Pound Or-Lump Sum (Kilogram or Lump Sum)
Bridge Rail (type)	Linear Foot (Meter)
Pedestrian Rail (type)	Linear Foot (Meter)

SECTION 507**TIMBER STRUCTURES****04DESCRIPTION****507.01.01 GENERAL**

- A. This ~~item~~work shall consist of furnishing, framing, and installing timber of the kind, sizes, and dimensions and in accordance with the lines, grades, and sections shown on the plans.

02MATERIALS**507.02.01 GENERAL**

- A. Materials shall meet the requirements of the following sections:

Materials	Section
Structural and Eyebar Steel	710
Paint <u>and Pavement Markings</u>	714
Miscellaneous Metals	712
Hardware	723
Timber	718
Timber Preservatives	719

- B. If material lists or order lists are sent by the Contractor to the Engineer for checking or approval, such checking or approval by the Engineer shall in no way relieve the Contractor of responsibility for the correctness of ~~such~~the lists. ~~Any expenses incident to~~ ~~the~~ revision of materials furnished in accordance with ~~such~~revised lists to make the materials comply with the design drawings shall be ~~done by the Contractor~~at no additional cost to the Contracting Agency.
- C. All framing lumber and structural timber, unless otherwise specified or shown on the plans, shall be Douglas Fir or West Coast Hemlock or Larch.

03CONSTRUCTION**507.03.01 STORAGE OF MATERIALS**

- A. Lumber and timber on the site of the work shall be stored in piles.
- B. Untreated material shall be open-stacked at least ~~twelve (12)~~ inches ~~(30 centimeters)~~ above the ground surface and piled to shed water and prevent warping. When required by the Engineer, ~~the~~ material shall be protected from the weather by suitable covering.
- C. Treated timber and piling shall be close-stacked and piled to prevent warping.
- D. The ground underneath and in the vicinity of all material piles shall be cleared of all weeds and rubbish.

507.03.02 WORKMANSHIP

- A. None but competent bridge carpenters shall be employed, and all framing shall be true and exact.

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1. Unless otherwise specified, nails and spikes shall be driven with just sufficient force to set the heads flush with the surface of the wood.
 2. Deep hammer marks in wood surfaces shall be considered evidence of poor workmanship and sufficient cause for removal -of the workman causing them.
- B. The workmanship on all metal parts shall conform to ~~the requirements specified in~~ Section 506, "Steel Structures."

507.03.03 TREATED TIMBER

- A. Treated timber and piling shall be carefully handled without sudden dropping, breaking of the outer fibers, bruising, or penetrating the surface with tools.
1. ~~#~~Timber and piling shall be handled with rope sling.
 2. Cant hooks, peaveys, pikes, or hooks shall not be used.
- B. All cutting, framing, and boring of treated timbers shall be done before treatment insofar as is practicable.
- C. All cuts in treated piles or timbers, and all abrasions, after being carefully trimmed, shall be covered with ~~two~~2-applications of a mixture of ~~sixty~~(60)-percent creosote oil and ~~forty~~(40)-percent roofing pitch, or brush coated with at least ~~two~~2-applications of hot creosote oil and covered with hot roofing pitch.
- D. All bolt holes bored after treatment, shall be treated with creosote oil by means of an approved pressure bolt hole treater. Unfilled holes, after being treated with creosote oil, shall be plugged with creosote plugs.
- E. Whenever, with the approval of the Engineer, forms or temporary braces are attached to treated timber with nails or spikes, the hole shall be filled by driving galvanized nails or spikes flush with the surface or plugging holes as required for bolt holes.

507.03.04 UNTREATED TIMBER

- A. In structures of untreated timber the following surfaces shall be thoroughly coated with ~~two~~(2)-coats of hot creosote oil before assembling: ends, tops, and all contact surfaces of sills, caps, floors, and stringers; and all ends joints and all contact surfaces of bracing and truss members.
- B. The back faces of bulkheads and all other timber which is to be in contact with earth, metal, or other timber shall be similarly treated.
- C. Unless untreated timber is to be used in the construction within ~~three~~(3)-days after date of delivery, ~~it~~the timber shall be painted on each end with a prime coat at time of delivery.

507.03.05 HOLES FOR BOLTS, DOWELS, RODS, AND LAG SCREWS

- A. Holes for round driftholes and dowels shall be bored with a bit ~~one-sixteenth~~(1/16)-inch ~~(0.16 centimeters)~~ less in diameter than the bolt or dowel to be used.
- B. The diameter of holes for square drift-bolts or dowels shall be equal to the least dimension of the bolt or dowel.
- C. Holes for machine bolts shall be bored with a bit of the same diameter as the bolt.
- D. Holes for rods shall be bored with a bit ~~one-sixteenth~~(1/16)-inch ~~(0.16 centimeters)~~ greater in diameter than the rod.

- E. Holes for lag screws shall be bored with a bit not larger than the body of the screw at the base of the thread.

507.03.06 BOLTS AND WASHERS

- A. A washer of the size and type specified shall be used under all bolts and nuts which would otherwise come in contact with wood.
- B. The nuts of all bolts shall be effectively locked after they have been finally tightened.
- C. Countersinking shall be done whenever smooth faces are required. Recesses formed for countersinking shall be painted with hot creosote oil, and, after the bolts are screwed in place, shall be filled with hot pitch.

507.03.07 FRAMING

- A. All lumber and timber shall be accurately cut and framed to a close fit in such manner that the joints will have even bearing over the entire contact surface.
1. Mortises shall be true to size for their full depth and tenons shall fit snugly.
 2. No shimming will be permitted in making joints nor will open joints be accepted.
- B. Mud sills shall be firmly and evenly bedded to solid bearing and tamped in place.
- C. Concrete pedestals for the support of framed bents shall be carefully finished so the sills or posts will take even bearing on them. Dowels of not less than ~~three-fourths (3/4)-inch (1.91 centimeters)~~ diameter, used for anchoring the sills or posts and projecting at least ~~six (6)-inches (15 centimeters)~~ above the tops of the pedestals, shall be set in the ~~m pedestals~~ when the y pedestals are cast, ~~for anchoring the sills or posts~~.
- D. Sills shall have true and even bearing on mud sills, piles, or pedestals.
1. ~~They~~Sills shall be drift-bolted to mud sills or piles with bolts of not less than ~~three-fourths (3/4)-inch (1.91 centimeters)~~ diameter and extending into the mud sills or piles at least ~~six (6)-inches (15 centimeters)~~.
 2. When possible, all earth shall be removed from contact with sills so that there will be free air circulation around them.
- E. Posts shall be fastened to pedestals with dowels of not less than ~~three-fourths (3/4)-inch (1.91 centimeters)~~ diameter, extending at least ~~six (6)-inches (15 centimeters)~~ into the posts.
- F. Posts shall be fastened to sills by one of the following methods, as indicated on the plans:
1. ~~(a)~~By dowels of not less than ~~three-fourths (3/4)-inch (1.91 centimeters)~~ diameter, extending at least ~~six (6)-inches (15 centimeters)~~ into posts and sills.
 2. ~~(b)~~By drift-bolts of not less than ~~three-fourths (3/4)-inch (1.91 centimeters)~~ diameter driven diagonally through the base of the post and extending at least ~~nine (9)-inches (23 centimeters)~~ into the sill.

507.03.08 CAPS

- A. Timber caps shall be placed to secure an even and uniform bearing over the tops of the supporting posts or piles and to secure an even alignment of their ends.
- B. All caps shall be secured by drift-bolts, as indicated on the plans, extending at least ~~nine (9)-inches (23 centimeters)~~ into the posts or piles.

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C. Drift-bolts shall be approximately in the center of the post or pile.

507.03.09 BRACING

- A. The ends of bracing shall be bolted through the pile, post, or cap with a bolt of not less than ~~five-eighths (5/8)~~ inch ~~(1.59 centimeters)~~ diameter.
- B. Intermediate intersections shall be bolted, and spiked with wire or boat spikes, as indicated on the plans. In all cases, spikes shall be used in addition to the bolts.

507.03.10 STRINGERS

- A. Stringers shall be sized at bearings and shall be placed in position so that knots near edges will be in the top portions of the stringers.
- B. Outside stringers may have butt joints with the ends cut on a taper, but interior stringers shall be lapped to take bearing over the full width of the floor beam or cap at each end.
1. The lapped ends of untreated stringers shall be separated at least ~~one-half (1/2)~~ inch ~~(1.27 centimeters)~~ for the circulation of air and shall be securely fastened by drift-bolts where specified.
 2. When stringers are ~~two~~ 2 panels in length, the joints shall be staggered.
- C. Cross-bridging between stringers, shall be neatly and accurately framed and securely toe-nailed with at least ~~two~~ 2 nails at each end.
1. All cross-bridging members shall have full bearing at each end against the sides of stringers.
 2. Unless otherwise specified in the contract, cross-bridging shall be placed at the center of each span.

507.03.11 PLANK FLOORS

- A. Unless otherwise specified, flooring plank shall be surfaced ~~one~~ 1 side and ~~one~~ 1 edge.
1. Single plank floors shall consist of a single thickness of plank supported by stringers or joists.
 2. The plank shall be laid heart side down with ~~one-fourth (1/4)~~ inch ~~(0.64 centimeters)~~ openings between them for locally seasoned material and with tight joints for unseasoned material.
 3. Each plank shall be securely spiked to each joist.
 4. The plank shall be carefully graded as to thickness and so laid that not ~~two~~ 2 adjacent planks will vary in thickness more than ~~one-sixteenth (1/16)~~ inch ~~(0.16 centimeters)~~.
- B. Two-ply timber plank floors shall consist of ~~two~~ (2) layers of flooring supported on stringers or joist.
1. The lower course shall be pressure-treated with a creosote oil.
 2. The top course may be laid either diagonally or parallel to the centerline of the roadways, as specified, and each floor piece shall be securely fastened to the lower course.
 3. Joints shall be staggered at least ~~three~~ (3) feet ~~(1 meter)~~.

4. If the top flooring is placed parallel to the centerline of the roadway, special care shall be taken to securely fasten the ends of the flooring.
5. At each end of the bridge, these members shall be beveled.

507.03.12 LAMINATED FLOORS

- A. Laminated floors shall be composed of ~~three (3-inch)~~ by ~~six (6-inch)~~ (~~7.62 x 15.25 centimeters~~) or ~~two (2-inch)~~ by ~~six (6-inch)~~ (~~5.08 x 15.25 centimeters~~) timbers, as indicated on the plans, laid on edge at right angles to the centerline of the roadbed, unless otherwise shown on the plans.
- B. The flooring may be of random length and multiples of the stringer spacing with no single piece less than ~~six (6)~~-feet (~~2 meters~~) along. All splices shall be made on the centerline of a stringer and shall not occur more often than once in ~~six (6)~~-inches (~~15 centimeters~~) on any 1 one-stringer.
- C. Laminations shall be laid with a finished edge down.
 1. Before laying, the tops of stringers shall be checked with a straightedge and adjacent stringers which vary more than ~~one-eighth (1/8)~~-inch (~~0.32 centimeters~~) from a true plane, except treated stringers, shall be surfaced to meet this requirement.
 2. Treated stringers which do not meet the requirements may be rejected but shall not be framed or adzed after treatment.
 3. Each piece of flooring shall be fastened to the preceding strip at each end and at approximately ~~eighteen (18)~~-inch (~~0.5 meters~~) intervals with spikes or nails driven alternately near the top and bottom edges.
 4. Spikes or nails shall be of sufficient length to pass through ~~two 2~~ strips and at least halfway through the third strip.
 5. If timber supports are used, each piece shall be toenailed to every other support with 20d or 30d nails.
 6. Care shall be taken to have each strip vertical and tight against the preceding ~~one~~strip, and bearing evenly on all supports.

507.03.13 TRUSSES

- A. Trusses, when completed, shall show no irregularities of line.
 1. Chords shall be straight and true from end to end in horizontal projection, and in vertical projection, shall show a smooth curve through panel points conforming to the correct camber.
 2. All bearing surfaces shall fit accurately.
 3. Uneven or rough cuts at the points of bearing shall be cause for rejection of the piece containing the defect.
- B. Unless otherwise directed by the Engineer, housings and railings shall be built after the removal of the falsework and the adjustment of the trusses to correct alignment and camber.

507.03.14 PAINTING

- A. Outside stringers, wheel guards, rails, rail posts, ~~and~~ exposed surfaces of scupper blocks, filler blocks, and flooring of untreated timber; ~~or~~ and timber treated with preservative salts; shall be painted as specified in Section 614, "Painting."
- B. Ends of all pieces of untreated timber not otherwise painted shall be painted with ~~one~~ 1 prime coat.
- C. Metal parts, except hardware, shall be painted as specified in Section 614, "Painting," and given the number of coats specified in Subsection 714.03.01 ~~(b)~~, "~~Miscellaneous-Iron~~ and Steel Use Items Classifications."

~~04~~ METHOD OF MEASUREMENT

507.04.01 MEASUREMENT

- A. The quantity of timber and lumber to be measured for payment will be the number of thousand feet board measure (Mfbm) ~~(cubic meters)~~ conforming to all the requirements in the completed work.
- B. All measurements will be in accordance with Subsection 109.01, "Measurement of Quantities."

~~05~~ BASIS OF PAYMENT

507.05.01 PAYMENT

- A. The accepted quantity of materials measured as provided in Subsection 507.04.01, "Measurement," will be paid for at the contract unit price bid per thousand feet board measure (Mfbm) ~~(2.36 cubic meters)~~.
- B. The above prices shall be full compensation for furnishing all materials, including hardware, treating, erecting, and for all incidentals necessary for doing all the work involved, as shown on the plans or established by the Engineer, all in accordance with Subsection 109.02, "Scope of Payment."
- C. Payment will be made under:

PAY ITEM

PAY UNIT

Type Lumber.....	Mfbm <u>Thousand Feet Board Measure</u> (2.36 cubic meters)
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SECTION 508**PILING****04DESCRIPTION****508.01.01 GENERAL**

- A. This work shall consist of furnishing and driving bearing piles of the kind, shape, and size called for in the contract documents.
- B. ~~It~~Work includes timber piles, precast or cast-in-place concrete piles, sheet piling, and steel piles as described herein and is also applicable to other types of bearing piles if called for in the contract documents.

02MATERIALS**508.02.01 GENERAL**

- A. Materials shall conform to the requirements of the following sections and subsections:

Materials	Section/Subsection
Steel Shell for Piles	712.03.08
Steel Piles ("H" piles, sheet piling)	712.03.07
Reinforcement	713
Timber Piles	717
<u>Concrete</u>	<u>501</u>

~~Materials for concrete shall conform to the requirements of Section 501, "Portland Cement Concrete."~~

- B. The Contractor shall furnish the Engineer with copies of mill test reports on the steel shells and steel piles.

03CONSTRUCTION**508.03.01 DETERMINATION OF LENGTH**

- A. Bearing piles of any material shall be of ~~such~~the length ~~as is~~ required to develop the specified bearing value, to obtain the specified penetration, and to extend into the cap or footing block as indicated on the plans, after ~~cutting~~cutting off ~~of~~ any damaged portion.
- B. The Contractor shall be responsible for furnishing piling of sufficient length to obtain the penetration and bearing value required. For the purpose of determining the lengths of the piles required, the Contractor, at ~~his expense~~no additional cost to the Contracting Agency, may drive test piles, make borings, or make ~~such~~ other investigations as ~~may be~~ necessary.

508.03.02 TEST PILES

- A. Test piles furnished and driven by the Contractor for ~~hi~~Contractor's use in determining the lengths of piles to be furnished may be so located that they ~~test piles~~ may be cut off and become a part of the completed structure, provided that ~~such~~the test piles conform to the requirements for piling as specified ~~in these specifications~~.

- B. Test piles ~~which are~~ designated in the contract documents shall conform to the requirements for piling as specified ~~in these specifications~~ and shall be so located that they test piles may be cut off and become a part of the completed structure.
- C. Test piles that are to become a part of the completed structure shall be driven with the same type of equipment ~~that is~~ to be used for driving foundation piles.
- D. Test piles ~~which that~~ are not to be incorporated in the completed structure shall be removed to at least ~~two (2)~~-feet (~~0.6 meters~~) below the surface of the ground and the remaining hole shall be backfilled with earth or other suitable material.
- E. When piles are shown on the plans or specified in the special provisions to be load tested, such piles shall be load tested in accordance with the provisions in Subsection 508.03.07, "Load Testing."

508.03.03 EQUIPMENT

- A. The driving equipment shall be in good operating condition.
- B. The size of hammer shall be selected to suit the conditions that will be encountered~~—~~.
 - 1. ~~#The hammer~~ shall neither be so small that its energy will be largely dissipated in lost energy during driving nor so great that it will cause too rapid penetration and damage to the pile.
 - 2. If the size of the hammer used is found to be unsatisfactory, ~~#the hammer~~ shall be replaced with a larger or smaller hammer or other corrective measures shall be used as required to produce satisfactory results.
- C. All piles shall be driven with either single~~—~~ or double~~—~~ acting steam, air~~—~~ or diesel hammers.
- D. Precast concrete piles shall be driven with a steam, air~~—~~ or diesel hammer which shall develop an energy per blow at each full stroke of the piston of not less than ~~one (1)~~ foot-pound for each pound (~~3 joules per kilogram~~) of weight driven.
- E. For cast-in-place concrete piles where a mandrel is used in driving the shell, the total weight of the mandrel and the shell shall be considered as the weight of the pile and the hammer shall meet the same requirements as for precast concrete piles.
- F. Hammers for driving H-bearing steel piles and steel shells for cast-in-place concrete piles, which are driven without mandrel, shall be steam, air, or diesel hammers of sufficient capacity to drive the pile or shell to the required penetration and bearing value without appreciable distortion or distress to the pile or shell.
- G. Steam or air hammers shall be furnished with boiler or air capacity at least equal to that specified by the manufacturers of the hammers to be used.
 - 1. The boiler or compressor shall be equipped with an accurate pressure ~~gage~~gauge at all times.
 - 2. The valve mechanism and other parts of the steam or air hammer shall be maintained in first-class condition so that the length of stroke and number of blows per minute for which the hammer is designed will be obtained.
 - 3. Inefficient steam or air hammers shall be removed from the work.
 - 4. When necessary to obtain the required penetration, the Contractor shall supply and operate~~—~~ at ~~his own expense~~ no additional cost to the Contracting Agency, single or double water jets and pumps or furnish the necessary drilling apparatus and drill

- holes, not greater than the diameter of the pile, to the proper depth and drive the piles therein.
5. If a pile is set in a drilled hole, it shall be driven sufficiently to fix the point firmly and secure full bearing.
 6. Except as described in Subsection 508.03.04, "Driving of Piles," jets or drills may be used only when so specified or ordered in writing by the Engineer.
- H. Diesel-powered hammers may be used provided the required energy per blow, as specified for steam hammers, is delivered for the type of piling to be driven.
- I. Driving leads shall be used, ~~and shall be constructed in such a manner as~~ to afford freedom of movement of the hammer, and ~~they shall be~~ held in position by guys or stiff braces to ensure support to the piles during driving. Except where piles are driven through water, the leads shall be of sufficient length so that the use of a follower will not be necessary.

508.03.04 DRIVING OF PILES

- A. Unless otherwise permitted by the Engineer, piles shall not be driven until after the excavation is completed. Any material forced up between the piles shall be removed to correct elevation before masonry for the foundation is placed.
- B. Care shall be exercised to prevent damage to the piles due to overdriving.
- C. Piles shall be driven battered (sloped) if called for on the plans.
- D. Piles, other than sheet piles, shall not be driven until the approach fills are compacted and in place to an elevation of ~~one and one-half (1-1/2) feet (0.46 meters)~~ above the bottom of the concrete abutment, as indicated on the plans.
 1. When piles are to be driven through embankment and the depth of the embankment at the pile location is in excess of ~~five (5) feet (1.5 meters)~~, the pile (other than sheet pile) shall be driven in a hole drilled through the embankment.
 2. The hole shall have a diameter large enough to allow a minimum of ~~two (2) inches of (5 centimeters)~~ clearance around the pile.
 3. After driving the pile, the space around the pile shall be filled to ground surface with dry sand or crushed rock.
- E. When an abutment area is to be surcharged, piles shall not be driven therein until the surcharge has been in place the required period of time.
- F. All piles raised during the process of driving adjacent piles shall be driven down again.
- G. Unless otherwise ordered, inclined leads shall be used in driving battered piles.
- H. An adequate cushion cap shall be used in driving precast concrete piles. When driving timber piles, a cushion cap shall be used and not less than ~~two (2)~~ separate steel straps shall be placed within ~~two (2)~~ feet of the butt of each pile.
 1. Steel strapping shall conform to ~~the requirements of~~ A.W.P. ~~1A.~~ specifications, except that the straps shall encircle the pile only once per strap.
 2. The top of the pile and the cap shall be so shaped that the blow of the hammer will be uniformly distributed to the entire top surface of the pile.

- I. When load tests are required, no other piling shall be driven until test loading has been completed, except in case of service piles driven to serve as anchor piles for the test loading.
- J. If the top of a pile becomes broomed, split, or crushed during the driving, the driving shall be stopped until the pile has been repaired or replaced by a new one.
- K. The driving heads shall closely fit the top of the steel pile or shell and shall extend down over the sides of the pile at least ~~four (4) inches (10 centimeters)~~.
- L. Piles shall be driven to the position and line indicated on the plans.
 - 1. Piles out of position and line more than the diameter of the pile shall be pulled and replaced unless otherwise approved by the Engineer.
 - 2. When the tops of foundation piles are incorporated in a concrete footing, the distance from the side of any pile to the nearest edge of the footing shall not be less than ~~nine (9) inches (23 centimeters)~~.
 - 3. Any additional materials required because of out-of-line piles that are allowed to remain in place will be at ~~the expense of the Contractor~~ no additional cost to the Contracting Agency.

508.03.05 BEARING VALUE AND PENETRATION

- A. Piles shall be driven to a bearing value of not less than the design loading shown on the plans, ~~and in addition~~
- B. Unless a lesser penetration is permitted in writing by the Engineer, piles shall penetrate ~~at least to:~~
 - 1. ~~The specified tip elevation shown on the plans, at any location where a specified tip elevation is shown~~
 - C.2. ~~, unless otherwise permitted in writing by the Engineer; or shall penetrate a~~ At least ten (10) feet (3 meters) into the natural ground when a tip elevation is not specified or shown on the plans specified, unless a lesser penetration is approved by the Engineer.
 - D.3. ~~Natural ground shall be defined as the bottom of the highway embankment.~~
- C. When the pile design loading is omitted from the plans, timber, steel, and concrete piles shall be driven to bearing values equal to the Maximum Design Loads for Piles, specified in the AASHTO Standard Specifications for Highway Bridges ~~of the AASHTO~~.
 - 1. The bearing values for driven piles shall be determined from the following formula:
 - ~~P = Safe bearing value in pounds (.45359 P = Safe bearing value in kilograms)~~
 - ~~E = The energy of the hammer blow in foot-pounds~~
 - ~~For drop hammers and single acting steam hammers, E = WH, where W is the weight of the striking parts of the hammer in pounds and H is the height of fall of the striking parts in feet.~~
 - ~~For double acting or differential steam hammers, E = The manufacturer's rated energy in foot-pounds.~~
 - ~~For diesel hammers, E will be determined by the Engineer.~~
 - ~~S = The average penetration in inches per blow for the last five to ten blows.~~

$$P = \frac{2E}{S + 0.1}$$

P = Safe bearing value in pounds

E = The energy of the hammer blow in foot-pounds

For drop hammers and single acting steam hammers:

E = WH, where W is the weight of the striking parts of the hammer in pounds and H is the height of fall of the striking parts in feet.

For double acting or differential steam hammers:

E = The manufacturer's rated energy in foot-pounds

For diesel hammers:

E will be determined by the Engineer

S = The average penetration in inches per blow for the last 5 to 10 blows

2. The above formula is applicable only when:
 - a. The hammer has a free fall.
 - b. The head of pile is not damaged.
 - c. The penetration is reasonably quick and uniform.
 - d. A follower is not used.
- D. Twice the height of bounce shall be deducted from H to determine its value in the formula.
- E. If the weight of the pile and the driving cap and all parts driven is greater than the weight of the striking parts of the hammer, the formula shall be multiplied by the following factor, where P is the weight of the pile and cap:

$$\frac{2W}{W + P}$$
- F. In case jets are permitted in connection with the driving, the bearing value shall be determined by the above formula from results after the jets have been withdrawn.

508.03.06 CUT OFF AND EXTENSIONS

- A. Timber piles ~~which~~that are to be capped shall be accurately cut off so that true bearing is obtained on every pile without use of shims.
 1. Other timber piles shall be cut off on the square at the elevation designated.
 2. Piles inaccurately cut off shall be replaced.
 3. Splicing of timber piles will not be permitted except upon the written permission of the Engineer.
- B. Concrete piles shall be cut off at such elevation that they ~~y~~ piles will extend into the cap or footing as indicated on the plans.
 1. Concrete piles may be cast the full length of the reinforcing bars, providing that the concrete is cut off to expose the steel as shown on the plans after the piles have been driven.
 2. When it is necessary, after driving, to increase the length of precast concrete piles, concrete shall be removed to expose sufficient reinforcing steel to permit a lap of at least forty diameters.

3. The added length shall be sufficient to reach the elevation of the bottom of the cap and shall be of the same section and the same reinforcement as the pile itself.
- C. When the cut off elevation for precast concrete pile is below the elevation of the bottom of the cap, the pile shall be built up from the butt of the pile to the elevation of the bottom of the cap by means of a reinforced concrete extension constructed as shown on the plans.
- D. The work of cutting off precast concrete piles shall be performed ~~in such a manner~~ so as to avoid spalling or damaging the pile below the cut off. ~~In case of s~~ Such damage to the pile shall be replaced or repaired as required by the Engineer.
- E. All cut-off lengths of piling shall remain the property of the Contractor and shall be disposed of outside the right-of-way in accordance with the provisions of Subsection 107.14, "Disposal of Material Outside Project Right-of-Way."

508.03.07 LOAD TESTING

- A. If load tests are required, the ~~y~~ tests shall be performed on the test piles as specified in Subsection 508.03.02, "Test Piles." The loading shall not be applied until ~~forty-eight (48)~~ hours after the pile is driven; or, in the case of cast-in-place piles, the concrete has attained a minimum compressive strength of 2,000 ~~psi - pounds per square inch (141 kilograms per square centimeter)~~.
- B. A loading test shall consist of the continuous application of a load of twice the design load to the pile being tested.
 1. The pile shall be considered to have a bearing value equal to the design load if the permanent settlement produced by such test loading is not greater than ~~one-fourth (1/4)~~ inch ~~(0.64 centimeters)~~.
 2. Unless otherwise permitted by the Engineer, the loading tests shall be completed before the remaining piles are cast or driven.
- C. When a loading test is required, the Contractor shall provide suitable facilities and equipment ~~by means of which a~~ to transmit the prescribed test load ~~can be transmitted~~ vertically to each pile to be tested.
 1. Provisions for varying the applied load shall be made, and the loads must be in known and measurable increments, applied axially to the pile.
 2. The marks, ~~gage~~ gauges, dials, or other instruments of ~~any~~ loading equipment required to determine settlement of the pile, shall be arranged ~~for so as to provide~~ convenient observation ~~thereof~~ without danger to the observer or the equipment.
 3. All test equipment shall be accurately calibrated and shall be approved by the Engineer.
- D. The test loads shall be applied under the direction of the Engineer, and at such rate or in such increments as the Engineer may specify.
 1. When a load test of a pile is commenced, the test shall be continuous, and the Contractor shall furnish all facilities on a ~~twenty-four (24)~~ hour, ~~seven~~ 7-day week basis until the test is completed.
 2. Forty-eight hours after all deflection and settlement has ceased, or sooner if directed by the Engineer, the test load shall be removed at ~~such~~ the rate or in ~~such~~ increments as the Engineer may direct.

3. If the results of the above prescribed operations indicate that excessive permanent settlement of the test pile has occurred, the pile shall be driven to such additional depths as the Engineer may specify, and the above described test loading operations repeated.
4. Each complete operation, which shall include loading and unloading as above prescribed, shall be considered as an individual test.

508.03.08 TIMBER PILES

- A. The species of timber used for timber piles shall be either Douglas Fir, Southern Yellow Pine, Larch, or Cedar as shown in the contract documents.
- B. When treated piles are required, they piles shall be given a preservative treatment of creosote by pressure processes to retain at least ~~ten (10)~~ pounds ~~(4.5 kilograms)~~ of creosote per cubic foot ~~(0.25 cubic meters)~~.
- C. Timber piles shall conform to the requirements of Section 717, "Timber Piles," and shall be inspected as therein provided.
- D. Commercially treated piles from stock may be used for test piles when required. Where commercially treated piles are permitted, stamping the piles by the inspector before treatment will not be required.
- E. Treated timber piles shall be carefully handled during and after loading from cars.
 1. They piles shall not be dragged across the ground at any time and shall be handled only with rope slings or with wooden equipment.
 2. Sharp tools shall be permitted only when used for necessary field cutting and trimming.
 3. All places where the surface of creosoted piling is broken by cutting, boring, or otherwise, shall be thoroughly coated with at least ~~three~~ 3 applications of hot creosote oil.
 4. Each application shall be allowed to become reasonably dry before the succeeding one is applied.
- F. The piles in any one bent shall be carefully selected as to size, to avoid undue bending or distortion of the sway bracing. However, care shall be exercised in the distribution of piles of varying sizes to secure uniform strength and rigidity in the bents of any given structure.
- G. Heads of piles, when the nature of the driving is such as to unduly injure them, shall be protected by caps of approved design.
 1. When timber caps are specified, a coat of hot creosote oil shall be first applied to the head of the pile and a protective cap shall be built up by applying alternate layers of loosely woven fabric in a hot asphalt or tar using ~~three~~ 3 layers of asphalt or tar and ~~two~~ 2 layers of fabric.
 2. The fabric shall measure at least ~~six (6)~~ inches ~~(15 centimeters)~~ more in each direction than the diameter of the pile and shall be turned over the pile and the edges secured by binding with ~~two~~ 2 turns of No. 10 galvanized wire.
 3. The fabric shall be wired in advance of the application of the final coat of asphalt or tar which shall extend down over the wiring.
- H. In lieu of the above method of treatment, the sawed surface may be covered with ~~three~~ 3 applications of a hot mixture of ~~sixty (60)~~ percent creosote oil and ~~forty (40)~~ percent

roofing pitch, or thoroughly brush coated with ~~three~~ 3 applications of hot creosote oil and covered with hot roofing pitch. A covering of galvanized sheet iron shall be placed over the pitch coating and bent down over the sides of the pile to shed water.

- I. The method to be used shall be at the option of the Contractor unless otherwise provided on the plans or in the ~~s~~Special ~~p~~Provisions.

508.03.09 PRECAST CONCRETE PILES

- A. Precast concrete piles shall be constructed of Portland cement concrete proportioned and mixed in accordance with ~~the requirements of~~ Section 501, "Portland Cement Concrete," and placed in accordance with Section 502, "Concrete Structures," ~~of these specifications.~~ Reinforcing steel shall conform to ~~the requirements of~~ Section 505, "Reinforcing Steel," ~~of these specifications.~~
- B. Concrete for precast concrete piles shall be poured in smooth, watertight forms, ~~so~~ supported ~~as~~ to prevent appreciable deformation or settlement during pouring or curing. When removed from the form, the piles shall present true, smooth, even surfaces free from honeycombs and voids and shall be such that a line stretched from butt to tip on any face will not be more than ~~one (1.)~~ inch (~~2.54 centimeters~~) from the face of the pile at any point.
- C. Concrete piles shall be kept continuously wet for at least ~~ten (10.)~~ days after pouring and shall be allowed to harden for at least ~~thirty (30.)~~ days before being lifted or driven, except that this ~~thirty (30.)~~ day requirement may be decreased if the specimen of concrete from which the piles were poured develops a strength of ~~three thousand (3,000 psi)~~ pounds or more ~~per square inch (20.7 MPa)~~ of compression.
- D. When raising or transporting precast concrete piles, the Contractor shall provide slings or other equipment to avoid any appreciable bending of the pile or cracking of the concrete.
 1. Piles materially damaged in handling or driving shall be replaced.
 2. Concrete piles shall be so handled at all times as to avoid breaking or chipping of the edges.

508.03.10 CAST-IN-PLACE CONCRETE PILES

- A. Concrete filling for cast-in-place concrete piles shall be Portland cement concrete conforming to ~~the requirements of~~ Section 501, "Portland Cement Concrete," ~~of these specifications.~~
 1. Reinforcement shall conform with the details shown on the plans and with the ~~requirements of~~ Section 505, "Reinforcing Steel."
 2. Cast-in-place concrete piles shall consist of one of the following:
 - a. Steel shells driven permanently to the required bearing value and filled with concrete.
 - b. Drilled holes filled with concrete.
- B. ~~(a)~~ **Steel Shells.**
 1. Steel shells shall be of sufficient strength and rigidity to permit their driving and to prevent distortion caused by soil pressures or the driving of adjacent piles until filled with concrete.
 2. The shells shall also be sufficiently watertight to exclude water during the placing of concrete.

3. The shells may be cylindrical or tapered, step tapered, or a combination of either with cylindrical sections.
 4. The tip diameter shall not be less than ~~eight (8)~~ inches ~~(20 centimeters)~~ and the butt diameter shall not be less than shown on the plans.
 5. Shells to be driven without a mandrel shall be equipped with heavy steel driving ends and all joints in the shell shall be welded or adequately lock seamed.
 6. After being driven and prior to placing concrete and reinforcing steel therein, the steel shells or casings shall be examined for collapse or reduced diameter at any point.
 - a. Any shell or casing that is improperly driven or broken or shows partial collapse to such an extent as to materially decrease its bearing value will not be accepted and shall be replaced by the Contractor at ~~his own expense~~ no additional cost to the Contracting Agency.
 - b. Driven shells or casings shall be clean and free from water before concrete and reinforcing steel are placed.
 - c. The Contractor shall have available at all times a suitable light for the inspection of the shells, throughout the entire length, before they shells are filled with concrete and reinforcing steel.
 7. Concrete shall be placed in steel shells so that it is dense and homogeneous. ~~Concrete placed in~~ the upper portion of the shell shall be vibrated to a depth of not less than ~~one-third (1/3)~~ the length of the pile or ~~ten (10)~~ feet ~~(3 meters)~~, whichever is ~~the~~ greater.
 8. The length of steel shell to be ordered shall be determined by the Contractor. Should the Contractor elect to order piling in short lengths, all splices necessary to build up these shorter lengths to the length required, other than those splices for payment in Subsection 508.04.01, ~~"Measurement," of these specifications,~~ shall be at ~~the Contractor's expense~~ no additional cost to the Contracting Agency.
- C. ~~(b)~~ **Drilled Holes.**
1. Each pile excavation shall be drilled to the minimum specified diameter and depth as shown on the plans.
 - a. The bottom of each drilled excavation shall be reasonably free of loose soil and ~~er~~ mud at the completion of drilling and prior to the placement of concrete.
 - b. Existing groundwater may remain in the excavation and need not be pumped out.
 - c. Holes shall be examined for straightness and any hole which on visual inspection from the top shows less than ~~one-half (1/2)~~ the diameter of the hole at the bottom of the holes shall be rejected.
 - d. Suitable casing shall be furnished and placed when required to prevent caving of the hole before concrete is placed therein.
 2. All loose material existing at the bottom of the hole after drilling operations have been completed shall be removed or recompact to the satisfaction of the Engineer before placing concrete in the hole.
 3. Materials resulting from drilling holes shall be disposed of as provided in the last paragraph of Subsection 206.03.01, "General."

4. Casing, if used in drilling operations, shall be removed from the hole as concrete is placed therein.
 - a. The bottom of the casing shall be maintained not more than ~~five (5)~~ feet nor less than ~~one (1)~~ foot (~~1.5 meters~~ ~~0.3 meters~~) below the top of the concrete during withdrawal and placing operations unless otherwise permitted by the Engineer.
 - b. The casing shall be hammered or the concrete vibrated during withdrawal of the casing.
 5. Care shall be exercised to ensure that the concrete in the hole is dense and homogeneous. Vibration of the concrete during placing will be required. The concrete in the hole for the length of the reinforcing cage (bottom of spiral wire) shall be vibrated.
 6. The reinforcing cage shall be placed and secured symmetrically about the axis of the pile and shall be securely blocked to clear the sides of the hole.
- D. For either ~~(a) steel shells~~ or ~~(b) drilled holes~~, the bottom of each shell casing or hole shall be filled with mortar to a depth of not less than ~~two (2)~~ feet (~~0.60 meters~~) immediately before placing the concrete filling materials. The mortar shall be as specified in Subsection 501.03.412, "Mortar," Class C.
- E. Drilled pile excavations which encounter caving or sloughing conditions shall be deepened at the direction of the Engineer. The additional depth to be drilled shall equal the height of caving or sloughing encountered in the pile excavation.
- F. Concrete placement in the pile excavation shall be accomplished with a concrete pump and steel pipe tremie.
 1. The concrete pump shall have sufficient capacity to fill the pile excavation by displacing the water and mud out of the top of the drilled hole.
 2. A minimum ~~ten-10-foot (3 meters)~~ head of concrete shall be maintained above the bottom of the steel tremie pipe at all times.
- G. ~~It shall be the Contractor's responsibility to~~ shall drill the pile excavations and ~~to~~ pour the concrete in such a manner as to ensure the structural integrity of the concrete pile.
 1. All phases of pile drilling, steel reinforcement installation, and concrete placement shall be inspected by the Engineer.
 2. Inspection by the Engineer does not, however, relieve the Contractor in any way of the responsibility ~~of~~ for constructing piles that meet the requirements of the plans and specifications.
- H. The Contractor shall test all completed drilled shaft foundations with ~~a~~ the nondestructive testing (NDT) method called Crosshole Sonic Logging (CSL) after at least ~~one (1)~~ day of curing time.
 1. Final approval for the first drilled shaft constructed will be given after the CSL tests have been performed on the shaft and the results have been analyzed.
 2. Concrete placement in subsequent shaft excavations will not be allowed until the first shaft has been approved.
- I. The consultant who will conduct the Crosshole Sonic Logging (CSL) tests shall submit evidence of qualification to the ~~e~~ Engineer for approval. Such evidence of qualification shall include the following:

1. Written evidence of successful completion of CSL tests, brief descriptions and references for ~~four~~ 4 recent CSL projects, and a list of tested shafts with a minimum of 75 shafts tested in the past ~~five~~ 5 years.;
 2. Personnel qualifications.;
 3. Equipment description and test procedure.;
 4. Example reports.
- J. For the purposes of CSL tests, tubes shall be installed in each pile to permit access for the CSL test probes.
1. The tubes shall be ASTM A53, Grade B Schedule 40 steel pipe or Schedule 40 PVC.
 2. The maximum number of days from placing concrete to completing CSL testing is ~~forty-five (45)~~ calendar days for ~~s~~Schedule 40 steel access tubes and ~~ten (10)~~ calendar days for ~~s~~Schedule 40 PVC access tubes.
 3. The tubes shall be 1.5_-inches (~~38.1 millimeters~~) to 2_-inches (~~50.8 millimeters~~) in inside diameter and shall have a round, regular inside diameter free of defects or obstructions, including obstructions at any pipe joints, ~~in order~~ to permit the free, unobstructed passage of 1.35_-inch (~~34.3 millimeters~~) diameter source and receiver probes used for the CSL tests.
 4. The tubes shall be watertight, and free from corrosion with clean internal and external faces to ensure good bond between the concrete and the tubes.
 5. The tubes shall be fitted with a watertight cap on the bottom and the top.
- K. The design drawings for each foundation may specify the number of tubes and the tube spacing angles. Otherwise, the CSL testing firm shall be consulted for the proper number of tubes, which shall be spaced evenly around the perimeter of the reinforcing cage.
- L. Prior to placing the pile reinforcement cage into the shaft, the tubes shall be securely attached to the interior of the reinforcement cage.
1. Use a regular, fairly symmetrical pattern in which each tube is spaced the maximum distance possible from adjacent tubes.
 2. The number and spacing of tubes around the perimeter of the cage ~~must~~shall correspond to the design drawings.
 3. Position tubes so that, after reinforcement operations, they tubes will be as near to vertical and as parallel as possible.
 4. Fit access tubes with a watertight shoe on the bottom and a removable cap on the top.
 5. Any joints added to make full-length tubes must be watertight.
 6. Wire-tie tubes to the interior of the cage every ~~three (3)~~ feet (~~0.9 meters~~), or otherwise secure so tubes remain in place for remaining operations.
- M. The tubes shall extend from the bottom of the reinforcement cage to at least ~~three (3)~~ feet (~~0.9 meters~~) above the top of the shaft.
1. If the shaft top is below ground elevation, extend tubes at least ~~three (2)~~ feet (~~0.6 meters~~) above the ground surface.

2. Under no circumstance shall ~~ould~~ the tubes be allowed to rest on the bottom of the drilled excavation.
 3. Care shall be taken to prevent damaging the tubes during reinforcement cage installation operations in the drilled shaft excavation.
 4. The tubes shall be filled with potable water prior to or as soon as possible after concrete placement (but no later than 4 hours) and the tube tops shall be capped.
- N. The ~~e~~Contractor is responsible for good care and workmanship in installing testing tubes ~~souch~~ that the testing equipment will pass through the entire length of the tube.
1. If the inspection equipment cannot pass through the full length of the inspection tube, a ~~two (2.)~~ inch ~~(51 millimeter)~~ diameter hole shall be cored through the concrete the full length of the pole, at no additional cost to the Contracting Agency, to replace the defective tube.
 - ~~2. The cost for all work related to coring this hole, should it be necessary, shall be the sole responsibility of the Contractor.~~
 - 3.2. Core holes shall be located ~~at a location~~ determined by the Engineer and approximately ~~nine (9.)~~ inches ~~(229 millimeters)~~ inside the drilled shaft reinforcement.
- O. The final acceptance of each drilled shaft shall be determined by the Engineer and will be based on the CSL test results.
1. If any shaft is determined to be unacceptable, the Contractor ~~must~~shall submit a plan for remedial action to the Engineer for approval.
 2. Any modifications to the dimensions of the drilled shafts shown on the contract plans caused by remedial action will require calculations and working drawings stamped by a Nevada licensed professional engineer ~~registered to practice in Nevada~~.
 3. The Engineer, prior to repair operations, shall approve any remedial correction procedures or designs.
- P. At the Engineer's direction, a core hole shall be drilled in any questionable quality shaft (as determined from the CSL test results or by observation of the Engineer) to explore the shaft condition.
1. A coring method that provides complete core recovery and minimizes abrasion and erosion of the core (i.e., double or triple core barrels) shall be used.
 2. If a defect is confirmed, the Contractor shall pay for all coring costs.
 3. If no defect is encountered, the Contracting Agency will pay for all coring costs, and compensation for the delay will be granted by an appropriate time extension and payment.
 4. Materials and work necessary, including engineering analysis and redesign, to effect corrections for the shaft defects shall be furnished to the Engineer's satisfaction with no additional compensation.
- Q. After completion of the CSL testing and acceptance of the pile, testing tubes shall be cut off flush with the top of the drilled shaft, and all core holes and testing tubes shall be filled with grout from the bottom up.

508.03.11 COVERING HOLES

- A. To eliminate hazard to life and to preclude dirt or debris from falling or being thrown into them, the tops of driven pile shells or drilled holes shall be securely covered immediately upon withdrawal of the material or drilling equipment.

508.03.12 STEEL PILES

- A. Steel piles shall be H-bearing of the section shown on the plans.
- B. The length of steel pile may be built up in sections either before or during the driving operations.
1. The sections, unless otherwise shown on the plans, shall be identical in cross section.
 2. The connections shall be made by welding the entire cross section in conformance with ~~the requirements of~~ Subsection 506.03.20, "Welding."
 3. Care shall be taken to properly align the sections connected so that axis of the pile will be straight.
 4. The number of welded connections in the length of a pile shall be as few as practicable.
 5. If a welded splice is made during the driving operation, it shall be done when the top of the lower portion is at least ~~three (3)~~-feet ~~(1 meter)~~ above the ground to permit observation of the welded connection during several feet of driving.
- C. Piling built up from structural steel plates welded together may be substituted for the rolled steel piling shown on the plans provided that the depth, width, average mean thicknesses, and moments of inertia of the built-up sections are at least equal to those of the rolled section, and the flanges are welded to the web with continuous fillet welds on each side of the web, and the welding conforms to Section 506, "Steel Structures."

04 METHOD OF MEASUREMENT**508.04.01 MEASUREMENT**

- A. The quantity of ~~"Furnish and Drive (Type) Piles"~~ to be measured for payment will be the number of linear feet ~~(meters)~~ of (type) pile complete and in place measured from the tip of the pile to the plane of pile cutoff.
- B. If the Contractor casts concrete piles full length of the reinforcement bars to facilitate driving, no measurement will be made for that portion where concrete must be removed in order that bars may project as shown on the plans.
- C. Load tests will be measured per each and the number used in the work will be the number paid for.
- D. The quantity of splices to be measured for payment will be limited to the number required to splice the pile if it becomes necessary to drive beyond ~~"Design Pile Tip Penetration."~~
1. Length of extensions will be determined by the Engineer.
 2. All splices necessary to drive to ~~"Design Pile Tip Penetration"~~ and for extensions made of shorter lengths than ordered by the Engineer will be at ~~the Contractor's expense~~ no additional cost to the Contracting Agency.

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- E. Metal pile shells driven with a removable core or mandrel shall be spliced according to the manufacturer's specifications. No splices will be measured and paid for when thin shell piles are used that do not require complete circumferential welding performed in the field.
- F. All measurements will be made in accordance with Subsection 109.01, "Measurement of Quantities."

05BASIS OF PAYMENT

508.05.01 PAYMENT

- A. The accepted quantity of "Finish and Drive (Type) Piles," measured as provided in Subsection 508.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot ~~(meter)~~, which ~~price~~ shall be full compensation for furnishing all materials including Portland cement concrete, steel shells and reinforcing steel, placing filling materials, and disposing of all unused material; ~~and which price shall be full compensation~~ for doing all the work involved in driving, drilling holes, cutting off piles, excavation, and backfill; and for filling the space remaining around the pile with sand or crushed rock; all to the required bearing and penetration as shown on the plans or ordered by the Engineer.
- B. Test piles that become a part of the completed structure will be paid for at the contract prices for the type of piling used.
- C. No payment will be made for piles driven out of place or for imperfect piles, or for piles which are damaged in handling or driving.
- D. When, in addition to the requirements of the plans and specifications, brackets or plates are required on steel piles, or special driving shoes are required on timber piles, the Contractor shall furnish and place such devices, and the cost thereof will be paid for as extra work as provided in Subsection 104.03, "Extra Work."
- E. The accepted quantity of load tests measured as provided in Subsection 508.04.01, "Measurement," will be paid for at the contract unit price bid per each for load tests, which ~~price~~ shall be full compensation for all material, equipment, tools, and labor incidental to make the tests and to construct the loading platform, procuring and placing the loading material, and removing and disposing of platform material in a satisfactory manner.
- F. The accepted quantity of splices measured as provided in Subsection 508.04.01, "Measurement," will be paid for at the contract unit price bid per each for the splice, which ~~price~~ shall be full compensation for all material, equipment, tools, and labor incidental to make the splice.
- G. Where piling built up from structural steel plates is substituted for the piling specified on the plans, the Contractor shall be entitled to no extra compensation for any excess thickness of steel furnished or for any extra work, materials, equipment, handling, or treatment required to construct such piling.
- H. The accepted quantity of "~~Furnish~~ Cast ~~in~~ ~~Place~~ Drilled Hole Concrete Piles," measured as provided in Subsection 508.04.01, "Measurement," will be paid for at the contract unit price bid per linear foot, which ~~price~~ shall be full compensation for drilling holes for piling and disposing of material resulting therefrom; and for furnishing and placing all materials including Portland cement concrete and reinforcing steel; and for doing all the work necessary to install the piling complete and in place as shown on the plans and as directed by the Engineer.

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- I. All payments will be made in accordance with Subsection 109.02, "Scope of Payment."
- J. Payment will be made under:

PAY ITEM	PAY UNIT
Furnish and Drive (Type) Piles	Linear Foot (Meter)
Load Test	Each
Splices	Each
<u>Cast-in-Place Drilled Hole Concrete Piles</u>	<u>Linear Foot</u>