PART 500

STRUCTURES

DRIVING PILES

501.1 DESCRIPTION:

Piles driven under this specification shall be accurately spaced and driven either vertically or to the prescribed batter, as indicated on the plans; no greater variation from the vertical or specified batter line than 1/4 of an inch per foot of length being permitted. Piles otherwise driven, and those seriously damaged in driving shall be removed, or cut off, and replaced with new piles. Should any pile be raised by the subsequent driving of others, it shall be redriven.

The pile tip elevations shown on the plans are approximate, and are to be used as a basis for establishing quantities for piling, including exploratory piles, for bidding purpose only.

When required in the special provisions one pile of the type selected or designated for the work shall be driven in each pier and abutment area as an exploratory pile. The location of these piles shall be determined by the Engineer.

The conditions under which the exploratory piles will be driven shall be as ordered by the Engineer. These exploratory piles shall be furnished and driven by the Contractor, and under normal circumstances shall be left in place and utilized as one of the specified piles.

Exploratory piles shall be driven with the same size and type hammer operating with the same effective energy and efficiency as that to be used in driving the remainder of the piles.

The purpose of driving the exploratory piles is to determine the length and penetration that will be required in the balance of the piles. Therefore, no piles other than the exploratory piles shall be driven at each pier or abutment area until such determination has been made by the Engineer, and has been reported to the Contractor.

The Engineer shall order the tip elevation to which the piling shall be driven for the particular pier or abutment. All piles shall be driven to the tip elevation as established by the Engineer or deeper if necessary to develop the prescribed bearing value as determined by the formula prescribed below.

Required excavations in the areas through which the piles are to be driven shall be made before any pile is driven. No excavation may be made below the bottom of the pile footing elevation, unless approved by the Engineer.

When piles are to be driven through bridge approach embankment and the depth of the embankment at the pile location is in excess of 5 feet, the pile shall be driven in a hole drilled through embankment. The hole shall have a diameter of not less than the butt diameter of the pile plus 6 inches. After driving the pile, the annular space around the pile shall be filled to ground surface with dry sand or pea gravel.

No piles shall be driven within 25 feet of any concrete that has not attained a minimum compressive strength of 2000 psi.

501.2 DRIVING EQUIPMENT:

Pile hammers, shall be an approved type that develop sufficient energy to drive the pile at a penetration rate of not less than 1/8 of an inch per blow at the required bearing value and shall develop an energy per blow at each full stroke of the piston of not less than one foot pound for each pound of weight driven.

Drop hammers may be used on timber pile only. Drop hammers shall weigh not less than 3,000 pounds and shall be equipped with proper leads and hoisting equipment to handle the work efficiently. The fall of the hammer shall not exceed 10 feet.

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. The boiler or compressor shall be equipped with an accurate pressure gauge at all times. The valve mechanism and other parts of steam or air hammers 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 can be obtained at the required bearing value. Steam or air hammers not meeting these specifications, shall be removed from the work.

Other types of pile driving equipment may be used under conditions approved by the Engineer.
When necessary to obtain the specified penetration and with the approval of the Engineer, the Contractor may supply and operate one or more water jets and pumps, furnish the necessary drilling apparatus and drill holes not greater than the diameter of the pile

to the proper depth and drive the piles as specified below.

If a pile is set in a drilled hole, it shall be driven sufficiently to fix the point firmly and secure full bearing. The use of jets at locations where the stability of embankments or other improvements would be endangered will not be permitted.

The cost of any jetting or drilling that may be required shall be included in the price bid for driving piles, or for other applicable items of work.

The use of followers, underwater hammers, or hammers not in leads will not be permitted unless authorized by the Engineer. When a follower or underwater hammer is used, one pile in each bent or footing shall be furnished sufficiently long to permit being driven without a follower or underwater hammer.

501.3 PREDRILLED HOLES:

When approved by the Engineer, piles may be driven in predrilled holes. The holes shall have a diameter not greater than the diameter of the pile at the ground surface. The depth of the predrilled hole shall be adjusted by the Contractor as directed by the Engineer as the work proceeds in order to maintain adequate bearing. Minimum penetration of the pile below the bottom of the predrilled hole shall be 5 feet unless otherwise authorized by the Engineer.

501.4 DRIVING:

During driving operations, the pile heads shall be protected and held in position by the use of a steel driving block or anvil. Timber piles shall be sound headed and square or shaped to closely fit the driving head. The heads of the piles may be protected by means of heavy steel or wrought iron rings. The heads of timber or concrete piles or casings shall be protected from direct impact of the hammer by a cushion head block. The cushion shall be maintained in good condition during the entire driving operation. This cushion driving block shall be so arranged that any reinforcing bars projecting above the piles will not be displaced or injured in driving. For driving steel H-beam piles, and shells without a mandrel for cast-in-place concrete piles, steel combination driving heads and pilots shall be used. The driving heads shall closely fit the top of the steel pile or shell and shall extend down the sides of the pile at least 4 inches. Piles materially out of lie as determined by the Engineer, shall be pulled and replaced.

501.5 BEARING VALUE:

Piles shall be driven to the penetration and bearing value shown on the plans as a minimum. Timber piles shall not be driven to a bearing value exceeding 20 tons. The bearing value shall be determined from the applicable formula in the following schedule.

(A) For piles driven with a drop hammer:

$$P = \frac{2WL}{s+1}$$

(B) For piles with a single acting steam or air hammer and open type diesel hammers:

$$P = \frac{2WL}{s+0.1} \quad \text{or} \quad P = \frac{2E}{s+0.1}$$

(C) For piles driven with a double acting steam or air hammer and closed type diesel hammer:

$$P = \frac{2L(W+ap)}{s+0.1} \quad \text{or} \quad P = \frac{2E}{s+0.1}$$

(D) For precast concrete piles:

$$P = \frac{2WL}{s + 0.1\frac{W^{-}}{W}}$$ for single acting steam or air hammer and open type diesel hammers

$$P = \frac{2L\,(W + ap)}{s + 0.1\frac{W^{-}}{W}} \quad or \quad P = \frac{2E}{s + 0.1\frac{W^{-}}{W}}$$ for double acting steam or air hammer or closed type diesel hammer

(E) For piles driven to a batter, the safe bearing value of the pile shall be taken as U times P, the value of U being determined as follows:

$$U = \frac{0.25(4 - m)}{\sqrt{1 + m^2}}$$ for drop hammers

$$U = \frac{0.1(10 - m)}{\sqrt{1 + m^2}}$$ for steam or air hammer and diesel hammers

U = a coefficient, less than unity.
P = safe bearing load developed by the pile in pounds.
W = weight of hammer in pounds.
L = length of stroke or height of fall of the hammer in feet.
s = penetration of the pile into the ground per blow in inches, taken as the average over the last 10 blows for drop hammers and 10 to 20 for steam hammers. Penetration shall be measured at a time when there is no appreciable rebound of the hammer and preceding blow was struck upon a sound pile head or driving block.
a = effective area of the piston in square inches.
p = mean effective steam pressure in the case of steam hammers or mean effective pressure in the case of air hammers, in pounds per square inch.
E = manufacturer's rating of energy developed by the hammer in foot-pounds.
W = weight of pile in pounds.
m = tangent at the angle of batter.

501.6 CUTOFF AND EXTENSION:

Timber piles which are to be capped shall be accurately cut off so that true bearing is obtained on every pile without the use of shims. Other timber piles shall be cut off on the square at the elevation designated. Piles inaccurately cut off shall be replaced. Splicing of timber piles will not be permitted, except upon written permission of the Engineer.

The tops of treated piles, after cutoff, except piles that are to be capped with concrete, shall be treated as specified in Section 779. Concrete piles shall be cut off at such elevation that they will extend into the cap or footing as indicated on the plans. Concrete piles may be cast the full length of the reinforcing bars, provided that the concrete is cut off to expose the steel as shown on the plans after the piles have been driven. 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 20 diameters. 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, or as shown on the plans.

When concrete piles are driven or cut off below the elevation of the bottom of the cap, the pile section shall be extended to the elevation of the bottom of the cap by means of a reinforced concrete extension constructed in accordance with the details shown on the plans.

Steel shells or concrete casings for cast-in-place concrete piles shall be cut off at the designated elevations. The work of cutting off precast concrete piles or concrete casings shall be performed in such a manner as to avoid spalling or damaging the pile below cut-off. In case of such damage the pile shall be replaced or repaired as required by the Engineer.

All cut off lengths of piling shall become the property of the Contractor and shall be disposed of outside the project area.

501.7 LOAD TESTING:

A loading test shall consist of the continuous application of a load of twice the design load to the pile being tested. 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 1/4 inch.

Unless otherwise permitted by the Engineer the loading tests shall be completed before the remaining piles are cast or driven.

Under normal circumstances, if load tests are required, they shall be performed on the exploratory piles. The loading shall not be applied until 48 hours after the pile is driven and, in the case of cast-in-place piles, the concrete has attained a minimum compressive strength of 2,000 psi.

In order to conduct the prescribed loading test, the Contractor shall provide proper and suitable facilities and equipment by means of which a prescribed test load may be transmitted vertically to each pile to be so tested. Provision for varying the applied load must also be made, and the loads applied must be truly determinate and truly axial with the pile. The loading equipment or device so provided must be so constructed and arranged that any marks, gauges, dials or other instruments required to determine or measure deflection or settlement of the pile may be conveniently installed and observed without endangering either the observer or the instruments so installed.

The test loads shall be applied under the direction of the Engineer and at such rate or in such increments as he may specify. When a load test of a pile is commenced, the test shall be continuous, and the Contractor shall furnish all facilities on a 24 hour, 7 day week basis until the test is completed. 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 rate or in such increments as the Engineer may direct. If the results of the above described operations indicate that excessive permanent settlement of the test pile has occurred the pile shall be driven to such additional depth as the Engineer may specify, and the above described test loading operations then repeated, if so directed by the Engineer. Each complete operation, which shall include loading and unloading as above prescribed, shall be considered as an individual test.

501.8 MEASUREMENT:

Furnishing piles will be measured by the linear foot of piles furnished in accordance with the lengths specified on the plans or ordered by the Engineer, except that no measurement for payment will be made for furnishing piles which are subsequently damaged in handling or driving to the extent that they are unusable.

No measurement for payment will be made for falsework piles.

Driving piles will be measured by the linear foot from the tip to the required cut-off point of all piles satisfactorily driven.

Splicing piles will be measured as a unit for each splice made, when splicing is required because of pile lengths driven in excess of those specified on the plans.

No measurement for payment will be made of splices made to obtain pile lengths in accordance with the plans.

Pile loading tests will be measured as a unit for each test made as specified or as directed.

501.9 PAYMENT:

The accepted quantities of piling, measured as provided above, will be paid for at the contract unit prices for furnishing piles, driving piles, splicing piles and pile loading tests.

When more than one type of piling is shown, each type will be scheduled and paid for separately.

When not otherwise provided, payment for splicing piles will be made at the contract unit price per splice arrived at by multiplying the contract unit price per linear foot for furnishing the pile by the factor five.

When test piles are specified on the plans, the bidding schedule will not contain specific items for furnishing, driving and splicing test piles. Test piles will be measured and paid for as in the case of other piles.

Municipality	Supplements
MC:	**502.1 Description:** **502.1.1 General:** The work under this Section shall include furnishing all materials and constructing reinforced concrete shafts formed within a drilled excavation. Each Drilled Shaft Foundation shall consist of a shaft section with or without casing left in place, as specified or requested, with or without a rock socket or bell footing. Each Drilled Shaft Foundation shall be constructed to conform to the details and dimensions shown on the Project Plans, and the requirements of these Specifications and the Special Provisions. **502.1.2 Installation Plan:** The Contractor shall submit to the Engineer, for review and approval, a detailed Installation Plan. The Installation Plan shall be based on available geotechnical information. To assist in plan evaluation and upon request by the Engineer, the Contractor shall provide copies to the Engineer of the geotechnical information used to develop the Installation Plan. The Installation Plan shall contain the following information: **(1) Equipment:** List of proposed equipment to be used including cranes, drills, augers, bailing buckets, final cleaning equipment, desanding equipment, slurry pumps, sampling equipment, tremies or concrete pumps, casing, and any other equipment essential to the successful installation of the proposed Drilled Shaft Foundations. Information provided on each proposed equipment unit shall be sufficient to identify the unit in the current edition of the Rental Rate Blue Book. **(2) Personnel:** List of all personnel to be committed to the installation of the Drilled Shaft Foundations on the project, and a summary of the relevant experience of each individual, including their involvement in the projects listed under (11). The On-Site Supervisor in charge of the installation of the Drilled Shaft Foundations shall have not less than five (5) years of comparable in-charge experience with drilled shaft installations similar in nature and magnitude to the foundation requirements for the specified project. The On-Site Supervisor shall be on or immediately available to the project during all foundation construction activities. At least one (1) Drill Operator, having not less than five (5) years of experience on the equipment that the Contractor proposes to use, working on drilled shaft foundation installations similar to those for the specified project, shall be on or available to the project during all foundation construction activities. **(3) Construction Sequence:** Details of the overall construction operation sequence, and the sequence of shaft installation in bents or groups. Supporting justification shall be provided for all variations between the Contractor's proposed sequence of shaft installation, and shaft sequence requirements called out on the Project Plans. **(4) Shaft Excavation:** Details of shaft excavation methods, including equipment and procedures for checking the location, alignment, and dimensions of each shaft excavation. **(5) Slurry:** When slurry is required, details of the method proposed to mix, circulate and desand the slurry, and methods proposed to comply with the requirements of Sections 502-3.4(A) and 502-3.7(C), including disposal of the slurry. **(6) Excavation Cleaning:** Details of methods to clean the shaft excavation.

(7) Steel Reinforcement: Details of reinforcement placement, including support and centering methods.

(8) Concrete Mixes: Details of concrete mix designs, and the mitigation of possible loss of slump during placement.

(9) Concrete Placement: Details of concrete placement.

(10) Casing: Details of casing dimensions, material, and splice details.

(11) Construction Experience: List of all drilled shaft construction experience by the Contractor on previous projects of a similar nature, from the present and covering the past 3 to 5 years, highlighting major features of the drilled shaft operations and installations, describing any complexities and/or problems, and their subsequent resolution.

(12) Additional Information: Other information shown on the plans or requested by the Engineer.

(13) Emergency Shaft Joints: Emergency horizontal construction joint method if unforeseen stoppage of work occurs.

(14) Safety Plan: List of safety equipment, and the Contractor's Safety Plan for the drilled shaft construction.

The detailed Installation Plan for the Drilled Shaft Foundations, complete with all required information relevant to the project, and any supplemental information the Contractor believes relevant, shall be submitted to the Engineer not less than four (4) weeks before the work on the drilled shafts is to begin. The Engineer will review the submittal package and return comments to the Contractor within ten (10) working days. No drilled shaft work shall be performed until the Contractor's final submittal has been approved by the Engineer. Such approval will not relieve the Contractor of responsibility for results obtained by use of the Installation Plan, or any other responsibilities under the Project Contract.

Based on the Contractor's experience, the project Contract Documents, and the Geotechnical and Foundation Report, including the Foundation Boring logs, if the Contractor reasonably concludes that slurry will not be required for shaft installation, information required under (5) Slurry may be omitted from the Installation Plan, subject to the approval of the Engineer. If it is subsequently determined that slurry will be required for shaft installation, the approval of the omission by the Engineer in no way relieves the Contractor of responsibility for constructing acceptable Drilled Shaft Foundations, in accordance with the requirements of Section 502.3.1(A).

The Contractor shall submit shop drawings in accordance with Section 105.2 for drilled shaft reinforcing steel, casings, and all other drilled shaft elements to remain in place and requiring prefabrication.

502.2 Materials

502.2.1 Concrete: Concrete shall conform to the requirements of Section 725 for the class and strength shown on the plans, with the following additions or modifications:

(A) Cement: Concrete placed in drilled shaft excavations containing slurry or water shall have a cement content between 660 and 750 lbs/C.Y.

(B) Aggregate: Maximum aggregate size shall be limited to 1/5 of minimum clear bar spacing (vertical and horizontal), not to exceed one inch.

502.2.2 Reinforcing Steel: Reinforcing steel shall conform to the requirements of Section 727. Welded splices will not be allowed, except as shown on the Project Plans.

502.2.3 Casing: The casing shall be steel, and may be of unit or sectional construction. The casing shall be of sufficient strength to withstand handling and driving stresses, to withstand the pressure of concrete and the surrounding earth, and to prevent seepage of water. Steel shall conform to the requirements of AASHTO M 270M/M 270 (ASTM A 709/A 709M), Grade 36 (Metric Grade 250), unless otherwise specified in the Special Provisions.

When telescoped casing is used, the Contractor shall not allow concrete to overfill any interior casing. Spillage shall be removed from the annulus, or the shaft shall be declared deficient.

Temporary casing shall be clean, inside and out, prior to placement in the excavation. All casing shall be handled so as to limit distortion to plus or minus two percent (2%) of the diameter. No side shear capacity will be allowed where an installed temporary casing becomes permanent. If conditions permit, and if approved by the Engineer, temporary casings may be corrugated and non-watertight.

The Contractor shall be responsible to compensate for loss of frictional capacity in the cased zone if temporary casing is abandoned in the shaft. Such modifications shall be at no additional cost to the County.

502.3 Construction Requirements:

502.3.1 General: The methods and equipment used shall be suitable for the intended purpose and materials encountered. Either the dry method, wet method, temporary casing method or permanent casing method, as defined by the current AASHTO Standard Specifications for Highway Bridges, Division II, Section 5, shall be used as necessary to produce sound, durable concrete foundation shafts free of defects, subject to approval of the Engineer. The permanent casing method shall be used only when required by the Project Plans and Special Provisions, or authorized by the Engineer.

(A) Installation Changes: If at any time during the construction of the drilled shafts, the Engineer determines that the equipment, materials, personnel, or procedures are such that defects in the work may occur, the Engineer may stop the work until appropriate changes are made by the Contractor. The Contractor shall also revise the Installation Plan, as approved by the Engineer. In no case shall the Contractor be relieved of responsibility for constructing acceptable Drilled Shaft Foundations.

(B) Adjacent Drilled Shafts: The successive installation of Adjacent Drilled Shafts shall not be allowed, to minimize any potential disturbance to newly cast drilled shafts. An Adjacent Drilled Shaft is defined as being any drilled shaft to be located within four (4) diameters of an installed shaft, measured center to center of shafts. Drilling for an Adjacent Drilled Shaft shall not be started within 48 hours of the completion of casting concrete for the installed drilled shaft, unless otherwise approved by the Engineer. The Contractor's sequence of shaft installation, detailed as required in Section 502.1.2(3), shall also conform to shaft sequence requirements called out on the Project Plans, unless otherwise approved by the Engineer in the Contractor's Installation Plan.

502.3.2 Confirmation Shafts: When called out on the Project Plans, or when required in the Contract Special Provisions, the Contractor shall construct a Confirmation Shaft. The Confirmation Shaft is constructed to determine the adequacy of the Contractor's equipment, materials, personnel, and procedures for completion of the Drilled Shaft Foundations, in accordance with the requirements of the Project Plans, these Specifications and the project Special Provisions, and the Installation Plan. The Confirmation Shaft normally will be the first production Drilled Shaft Foundation developed, subject to the approval of the Engineer.

The location of all Confirmation Shafts shall be as shown on the Project Plans, or as approved by the Engineer. All Confirmation Shaft holes and shaft installations shall be completed in the same manner as proposed for other similar production shafts. The Contractor shall revise drilled shaft installation methods and equipment, at any time during the installation of each Confirmation Shaft, as required. Such revisions may be made during the drilling of the Confirmation Shaft hole, and/or the placement of shaft reinforcement and concrete. Such revisions shall result in satisfactory installation of the Confirmation Shaft, COMPLETE IN PLACE, as approved by the Engineer.

When the Contractor fails to satisfactorily demonstrate the adequacy of his installation methods, procedures, or equipment; or when unforeseen conditions require revision, such as the need for slurry, the Installation Plan shall be revised. The next shaft to be constructed in accordance with the Contractor's approved installation sequence shall be designated as the Confirmation Shaft for the approved, revised Installation Plan, or the Confirmation Shaft shall be installed at a location approved by the Engineer.

When shown on the Project Plans, or when ordered by the Engineer in writing, the reaming of shaft bell footings or the development of shaft rock sockets at the specified Confirmation Shaft holes shall be required to establish installation feasibility in specific soil strata.

502.3.3 Excavation: The Contractor shall perform all excavation required for the shafts, rock sockets, and/or bell footings, through whatever materials encountered, to the dimensions and elevations shown on the Project Plans, or as approved by the Engineer. Unless otherwise shown on the Project Plans, the maximum deviation from plumb shall be not more than one and one-half percent (1 1/2%). The maximum permissible variation of the longitudinal center axis of both the shaft hole and reinforcing steel cage, from the Project Plan location at the top of the Drilled Shaft Foundation, shall be five percent (5%) of the Project Plan shaft diameter, not to exceed 3 inches. The Contractor shall determine shaft hole verticality by plumb lines in dry excavations, and by Kelly bar position readings at 10' intervals in wet excavations, or as approved by the Engineer. The Contractor shall provide the Engineer with these readings for each drilled shaft constructed, to verify verticality. When bell footings or rock sockets are required, they shall be excavated so as to form a bearing area of the size and shape shown on the Project Plans.

Temporary surface casings may be used to aid shaft location and alignment, and to prevent sloughing of the top of the shaft excavation, if approved by the Engineer.

If satisfactory foundation materials are not encountered when a shaft excavation has been advanced to the Bottom of Shaft Elevation shown on the Project Plans, the bottom of the drilled hole may be lowered, at the direction of the Engineer. Any lowering of the Bottom of Shaft Elevation will be based on the completed Drilled Shaft Foundation complying with foundation design requirements. Reinforcing steel and shaft concrete shall not be placed in the shaft excavation until the revised, final Bottom of Shaft Elevation has been established, and the shaft excavation completed. Similarly, the raising of any Bottom of Shaft Elevation, from the elevation shown on the Project Plans, shall require approval by the Engineer.

When a Drilled Shaft Foundation includes a Rock Socket, the actual Bottom of Shaft Elevation in the field will be established by the shaft excavation encountering competent bedrock stratum, as determined by the Engineer or a geotechnical specialist. The required Rock Socket length will be verified by the Engineer, based on foundation design requirements. Reinforcing steel and shaft concrete shall not be placed until the Rock Socket length has been verified, and the drilled/cored socket completed.

If caving conditions are encountered, no further drilling will be allowed until a method of construction is employed that prevents excessive caving, and which is acceptable to the Engineer. If casing is proposed, the shell shall be clean and shall extend to the top of the drilled shaft excavation. The inside diameter of the casing shall be not less than the dimensioned size of the shaft on the Project Plans, unless approved by the Engineer. The outside diameter of the shaft shall not exceed the Project Plan dimension by more than 6 inches, unless the use of telescoping casing or surface casing is allowed by the installation plan.

If the Engineer determines that the amount of excavation caving is within acceptable limits and the Contractor elects to drill under the same methods and procedures, the shaft excavation shall be filled with concrete at no additional cost to the County, regardless of the extent. Any excavation beyond the dimensions shown on the plans where casings are not used shall be filled with concrete at no additional cost to the County.

If the use of drilling slurry is to be employed, either with or without the use of casing, the Contractor shall use a method of construction that allows completion of the drilled shaft in a continuous manner without any mixing between the shaft concrete and the drilling slurry.

Material excavated from drilled shafts, bell footings, and rock sockets, that is not placed elsewhere on the project, shall be disposed of as approved by the Engineer.

When the Project Plans indicate that Drilled Shaft Foundations are to be constructed within embankments, the embankments shall be constructed prior to drilling, except when approved otherwise by the Engineer.

After the completion of the drilled shaft excavation, and prior to the placement of the reinforcing steel cage and shaft concrete, all loose material shall be machine cleaned from the shaft. A flight auger or other equipment, approved by the Engineer, shall be used for cleaning dry excavations where slurry or ground water is not present. Where slurry or ground water is present, the excavation shall be cleaned with a clean-out bucket or similar type of equipment, as approved by the Engineer.

Each open shaft excavation shall be covered in a manner approved by the Engineer, at all times when there is no hole excavation activity and/or shaft construction activity at that hole.

Drilled shaft excavation inspections shall be performed by the Contractor and will be reviewed by the Engineer. The Contractor shall provide suitable facilities, equipment, and associated safety measures for required excavation inspections that enable the Engineer to safely and completely evaluate drilled shaft excavations for correct location, alignment, and dimensions.

Reinforcing steel cages and shaft concrete shall not be placed in the drilled shaft excavation until the Engineer has made an evaluation and given approval.

502.3.4 Drilling Slurry:

(A) General Requirements: The Contractor shall provide a specialist experienced in the slurry drilling process to design and monitor the slurry. The specialist shall be present at all times when the slurry method is used, and shall supervise the slurry inspection and testing required in Section 502-3.4(B). Commercially prepared mineral slurries shall be employed when slurry is used in the drilling process. Commercially prepared synthetic slurry may be used only when specifically approved by the Engineer. The mineral slurry shall have both a mineral grain size that will remain in suspension and sufficient viscosity and gel characteristics to transport excavated material to a suitable screening system. The percentage and specific gravity of the material used to make the suspension shall be sufficient to maintain the stability of the excavation and to allow proper concrete placement. During construction, the level of the mineral slurry in the shaft excavation shall be maintained at a level not less than 4 feet above the highest expected piezometric pressure head along the depth of the shaft. In the event of a sudden significant loss of slurry to the hole, the construction of that foundation shall be stopped, until either a method to stop slurry loss or an alternative construction procedure has been approved by the Engineer.

The mineral slurry shall be premixed thoroughly with clean, fresh water. Adequate time, as prescribed by the mineral manufacturer, shall be allotted for hydration prior to the introduction of the mineral slurry into the shaft excavation. Slurry tanks of adequate capacity shall be required for slurry circulation, storage, and treatment. No excavated slurry pits shall be allowed in lieu of slurry tanks. No mixing of slurry shall be allowed in the drilled shaft excavation. Slurry shall not stand for more than four hours in the shaft excavation without agitation. If this is not possible, excavation sidewalls shall be cleaned to remove filter cake, and the slurry tested for compliance with Table 502-3.4(A). Slurry density shall be increased by adding barite only when sodium bentonite is the slurry mineral.

Desanding equipment shall be provided by the Contractor as necessary to control slurry sand content within the acceptable values shown in Table 502-3.4(A) at any point in the bore hole. Desanding will not be required for setting casing. The Contractor shall take all steps necessary to prevent the slurry from "setting up" in the shaft. Such methods may include agitation, circulation and/or adjusting the properties of the slurry. The Contractor shall dispose of all slurry off site at an approved disposal site.

TABLE 502-3.4(A):

TABLE 502-3.4(A)
(Sodium Bentonite or Attapulgite in Fresh Water)

Property, units	Range of Values*		Test Method
	At Time of Introduction of Slurry	In Hole at Time of Concreting	
Density, (pcf)	64.3 - 69.1	64.3 – 75.0**	Density Balance
Yield Point, psf Bentonite 0.026 – 0.21 Attapulgite 0.042 – 0.31 Or Viscosity, seconds/quart	 28 – 45	 28 - 45	 Rheometer Rheometer Marsh Cone
pH	8 – 11	8 – 11	pH Paper or pH Meter
Sand Content, % by volume	0 – 4	0 – 10	API Sand Content Kit

* Above 68 degrees F
** 85 pcf maximum when using Barite.

(B) Slurry Inspection and Testing: The Contractor shall have suitable inspection and testing apparatus available at the site, including a sampling tool capable of extracting slurry samples at any depth within the drilled shaft excavations. All equipment required for tests specified in this Section shall be provided by the Contractor, and the tests shall be performed by the Contractor, under the observation of the Engineer.

Control tests using suitable apparatus shall be carried out by the Contractor on the mineral slurry to determine density, viscosity or yield point, pH, and sand content. A range of values for those physical properties is shown in Table 502-3.4(A); but in all cases, no less than the minimum values necessary to achieve and maintain stability of the drilled shaft excavation shall be utilized.

The Contractor shall do tests during the shaft excavation, in the presence of the Engineer, to determine slurry density, viscosity or yield point, and pH value, to establish a consistent working pattern. A minimum of four sets of tests shall be made during the first eight hours of slurry use. When the results show consistent behavior, the testing frequency may be decreased to one set every four hours of slurry use.

The Contractor shall ensure that heavily contaminated slurry suspension, which could impair the free flow of shaft concrete, has not accumulated in the bottom of the completed shaft excavation. Prior to placing concrete in the completed shaft excavation, the Contractor shall take slurry samples in the shaft excavation, from the base of the shaft excavation, and 10’ (3.0m) above the base of the excavation. When any slurry samples are found to be unacceptable, the Contractor shall take whatever action is necessary to bring the mineral slurry within specification requirements. Shaft concrete shall not be placed until re-sampling and testing results produce acceptable values for density, viscosity or yield point, pH, and sand content.

Reports of all tests required above, signed by an authorized representative of the Contractor, shall be furnished to the Engineer on completion of each drilled shaft.

502.3.5 Integrity Testing:
All drilled shaft foundations shall be constructed to allow integrity testing by gamma ray density logging and by cross-hole sonic logging survey. Unless otherwise noted, the Contractor shall provide integrity testing using gamma ray density logging for all drilled shaft foundations. The gamma ray density logging shall be

conducted and results submitted for each drilled shaft no later than three days after placement of the drilled shaft concrete. In addition all drilled shafts 4' diameter and larger constructed in wet conditions shall be tested using cross-hole sonic logging. All tests using cross-hole sonic logging shall be conducted no later than six days after placement of the drilled shaft concrete. When inconclusive or bad results are obtained from the gamma ray density test, the Contractor shall conduct, at no additional cost to the County, cross-hole sonic logging within six days after placement of the drilled shaft concrete.

The Contractor shall furnish and install 2½", Schedule 80 PVC pipe for integrity testing. Each logging pipe shall be joined to provide a clean and unobstructed pipe opening from the top of the drilled shaft foundation to within one foot of each shaft tip or as shown on the Project Plans. All logging pipes shall be capped top and bottom. Logging pipes shall be tied to the inside of the reinforcing cages in a longitudinal straight line, located as detailed on the Project Plans. The logging pipes shall be securely fastened to the reinforcing steel cage, to ensure that the pipes remain straight after handling and shaft concrete placement, to permit the logging device to pass from top to bottom of pipe. PVC pipes shall be filled with water prior to concrete placement. The Contractor shall provide the testing equipment, perform the inspection, and furnish test results to the Engineer.

If the testing indicates the presence of voids, intrusions, or zones of unconsolidated concrete in the Drilled Shaft Foundation, or if the Engineer determines that construction defects may have occurred, or if testing cannot be performed because of blockage of the tubes, the Contractor shall core-drill or otherwise determine the extent of any defects in the concrete, as approved by the Engineer. The Contractor shall repair, replace, or supplement the defective work in a manner approved by the Engineer, at no additional cost to the County.

In case the above described testing methods provide inconclusive or deficient results and the situation is difficult or impossible to repair, the geotechnical engineer shall access the amount of loss to the drilled shaft safety factor. Any drilled shaft with a safety factor below 2.0 shall be replaced or repaired in a satisfactory manner at no additional cost to the County. Payment for drilled shafts with safety factor between 2 and 2.5 shall be reduced as indicated in Table 502-1.

Table 502-1 Payment Factors for Defective Drilled Shafts

Safety Factor	Percent of Payment
2.5 and above	100%
<2.5 to 2.4	95%
<2.4 to 2.3	90%
<2.3 to 2.2	85%
<2.2 to 2.1	80%
<2.1 to 2.0	75%
<2.0	Replacement Required

After all inspection and testing has been completed, all holes and test pipes in all Drilled Shaft Foundations shall be filled with a grout approved by the Engineer.

502.3.6 Reinforcing Steel, Cage Construction and Placement: The reinforcing steel cage for the drilled shaft, consisting of longitudinal bars and spiral reinforcement or lateral ties, shall be completely assembled and placed in the shaft excavation as a unit. The reinforcing steel cage shall not be installed in the shaft excavation until immediately before the placement of shaft concrete is to be started. The reinforcing steel cage shall be positioned in accordance with the details shown on the Project Plans.

All reinforcing cages shall be fabricated and supported to avoid damage during lifting and installing the cages. All temporary bracing and supports shall be removed from reinforcing cages prior to the final placement in the shaft excavation.

The reinforcing steel cage shall be adequately supported and anchored from the top, to prevent movement from the required location during the placement of shaft concrete, and for four hours after completion of concrete placement. The reinforcing cage shall not rest directly on the bottom of the excavation. Spacers

shall be at sufficient intervals along the shaft to ensure concentric location of the reinforcing cage for the entire length of shaft. Only spacers approved by the Engineer shall be allowed, but in no case shall "dobies" or other rectangular "blocks" tied to the reinforcing cage be allowed.

If the Bottom of Shaft Elevation of a Drilled Shaft Foundation, with or without a Rock Socket, is lowered in accordance with Section 502.3.3, and the Project Plans indicate full depth reinforcement, the Engineer shall be notified to determine if extension and/or modification of the reinforcing cage is required. The Engineer will provide details for changes in the shaft reinforcing cage, if required. Such changes in the shaft reinforcing steel cage will be paid for in accordance with Sections 109.4 and 109.5 of the Specifications.

If the Bottom of Shaft Elevation of the Drilled Shaft Foundation, with or without a Rock Socket, is raised in accordance with Section 502.3.3, the Engineer will determine if modification of the reinforcing steel cage is required. Such modification, other than shortening the reinforcing cage, will be paid for in accordance with Sections 109.4 and 109.5. If only shortening of the reinforcing cage is required, the Contractor shall shorten the cage at his expense, but will be paid for the full-length cage, as bid. All reinforcing cage cutoffs will become the property and responsibility of the Contractor.

The Contractor shall submit a written request to the Engineer for approval of any variation from the reinforcing steel splices specified in the contract documents.

502.3.7 Concrete Placement:

(A) General: The Contractor shall begin placement of shaft concrete within 24 hours after the completion of the drilled shaft excavation. All concrete shall be placed in accordance with Section 505 and as specified herein. If slurry-assisted excavation is used, concrete shall be placed the same day the excavation is completed.

Unless otherwise specified in the project Special Provisions, or as requested by the Engineer, the slump shall be between 5 and 6 inches for dry, uncased excavations. For all other shaft excavations, with water and/or using slurry and/or casing during excavation, the shaft concrete slump shall be 8 ± 1 inches at the time shaft concrete placement begins.

Prior to shaft concrete placement, the Contractor shall make all necessary arrangements to ensure the uninterrupted delivery of concrete, so that all Drilled Shaft Foundations will be constructed without cold joints. During shaft concrete placement, from start to finish, the rate of rise of the top of concrete in the drilled shaft shall be at least 40’ / hour.

Tremie downpipes and pump pipes shall be made of steel; no aluminum shall be allowed. The inside diameter of the tremie pipe shall be at least 10 inches. The inside diameter of the pump pipe shall be at least 5 inches.

(B) Placement in Dry Excavations: For placement in dry excavations, shaft concrete may be placed by free fall, except in cohesionless soils or where other caving conditions exist. The Contractor shall place the shaft concrete so that during free fall, the concrete does not strike the reinforcing cage or the excavation sidewalls. Where free fall cannot be used, concrete shall be placed through a suitable, clean downpipe.

Vibration of the shaft concrete for the full height of the shaft is not necessary to achieve proper consolidation of the concrete. However, the shaft concrete shall be vibrated in the top 10’ of the shaft.

For dry shafts, the maximum depth of water in the bottom of the drilled shaft excavation at the time of concrete placement shall be 3 inches.

(C) Wet Conditions, Placement under Slurry or Water: Shaft concrete placed under slurry or water shall be placed by tremie methods or by pumping. Care shall be taken to ensure that all the fluid and suspended solids are expelled from the shaft excavation during concrete placement.

Where shaft concrete is conveyed and placed by mechanically applied pressure, the equipment shall be of suitable type and shall have adequate capacity for the work. The concrete shall not flow over or through any piping, fittings or equipment which is fabricated of aluminum or aluminum alloys. The operation of the pump shall be such that a continuous stream of concrete without air pockets is produced. Excessive segregation due to high velocity discharge of the concrete will not be permitted. When pumping is completed, the concrete remaining in the pipeline, if it is to be used, shall be ejected in such a manner that there will be no contamination of the concrete or segregation of the ingredients. Standby equipment shall be readily available to replace initial pumping equipment should a breakdown occur.

The Contractor's Installation Plan shall demonstrate the procedures used to determine when the tremie pipe is to be raised during shaft concrete placement. The procedure shall ensure that the opening of the tremie pipe will be deeper than 5 feet below the surface of the concrete at all times, and that a void will not be created by lifting the tremie when there is an insufficient head of concrete. A rapid raising or lowering of the tremie will not be permitted.

To prevent contamination of the shaft concrete placed initially, the lower end of the pump or tremie pipe shall be provided with a valve, sealable cap, or plug ("pig"). The discharge end shall be placed at the bottom of the excavation prior to starting shaft concrete placement. If a plug is used, it shall be inserted at the top of the tremie pipe after the pipe has been set in place. Shaft concrete shall then be placed by pushing the plug ahead, with the plug separating the concrete from the drilling slurry/water. The bottom end of the tremie pipe shall not be lifted off the bottom of the shaft excavation until the pipe is completely filled with concrete. The first portion of the concrete flow that comes to the top of the shaft shall be displaced out of the shaft excavation until clean, fresh concrete is expelled.

Slurry ejected during shaft concrete placement may be reused provided that it is screened to remove gravel chips or other granular materials, and providing the slurry meets acceptance criteria. Slurry to be discarded shall be disposed of in a manner approved by the Engineer.

Concrete placed under slurry or water shall not be vibrated, except that the top 5 feet of the shaft shall be vibrated after the slurry or water and contaminated concrete have been totally expelled from the shaft. If temporary casing is used, the vibration shall occur after the casing has been removed.

502.3.8 Casing Removal: During removal of any casing, a sufficient head of not less than 5 feet of fluid concrete in the tremie pipe shall be maintained above the level of concrete in the shaft (outside the tremie pipe), except at the top of the shaft. All contaminated concrete shall be removed from the shaft. Temporary casings shall be removed while the concrete slump is not less than 4 inches. The Contractor shall maintain a minimum 5 foot head of concrete in the casing as it is being removed. Movement of the casing by exerting downward pressure and tapping to facilitate extraction, or extraction with a vibratory pile hammer will be permitted. Casing extraction shall be at a slow, uniform rate with the force in-line with the shaft axis.

Due care shall be exercised to prevent upward movement of the shaft concrete and reinforcing steel during casing extraction. Upward movement beyond one inch, excluding movement due solely to tension on the top anchoring system, may indicate serious concrete separation or necking problems at the bottom of the casing. The Contractor shall be responsible for corrective action which may include leaving the casing in place and compensating for the loss of frictional capacity in the resulting cased zone.

502.4 Method of Measurement: Drilled Shafts and accepted Confirmation Shafts will be measured to the nearest linear foot, from the top elevation of each completed Drilled Shaft Foundation to:

(A) The elevation of the surface of the rock stratum, when Rock Sockets are used, or
(B) The Bottom of Shaft Elevation shown on the Project Plans, or
(C) The elevation of the shaft-bell juncture, when Bell Footings are used,

or as determined in the field by the Engineer or a geotechnical specialist.

The length of Rock Sockets will be measured to the nearest linear 0.1 foot from the actual surface

	elevation of the rock socket bedrock stratum to the actual Bottom of Shaft Elevation, as shown on the Project Plans, or as determined in the field by the Engineer or a geotechnical specialist. Bell Footings will be measured by the unit each, for each configuration of Bell Footing constructed. **502.5 Basis of Payment:** The accepted quantities of Confirmation/Drilled Shafts and Rock Sockets, measured as provided above, will be paid for at the contract unit price per linear unit for each diameter designated in the Project Bidding Schedule, COMPLETE IN PLACE for placement in Dry Excavations. The contract unit price shall include all excavation; drilling; metal casing; steel reinforcing; Portland cement concrete; any needed forming, curing and finishing; exposing in-place shaft concrete and the subsequent repair of shaft foundations; furnishing all materials, equipment, and labor for splicing of reinforcing steel; conduit for integrity testing and integrity testing. No additional payment will be made for metal casing that is to remain in place, or for temporary casing left in place. No supplemental payment will be made for Confirmation Shafts; the cost of the confirmation process is considered as included in the overall cost of constructing production Drilled Shaft Foundations, including all Confirmation Shafts. Bell Footings will be paid for at the contract unit price per each, for each configuration of Bell Footing constructed and accepted. Payment for Obstructions will be made in accordance with the provisions of Section 109.4. Obstructions are defined as either material or objects of excessive dimensions that could not be reasonably inferred from the Geotechnical and Foundation Report, including the Foundation Boring Logs. Drilling tools lost in shaft excavations will not be considered Obstructions. Drilled Shaft Wet Conditions Extra Cost (Contingency Item) is an additional payment made for each drilled shaft installed under wet conditions. This contingency payment will only be made with the approval of the Engineer when warranted by ground water intrusion into the drilled hole, which requires application of special wet drilling methods such as those that use slurry. This payment will be in addition to the base bid for Drilled Shafts and shall be full compensation for all additional work and materials required for installation of drilled shafts under wet conditions.

CONCRETE STRUCTURES

505.1 DESCRIPTION:

Concrete bridges, culverts, catch basins, manholes, retaining walls, abutments, piers, footings, foundations and similar structures shall be constructed in conformity with the plans and specifications. Concrete for use in work constructed under this specification and testing thereof shall conform to the requirements of Section 725. Reinforcing shall conform to the requirements of Section 727.

Safe and suitable ladders shall be provided to permit access to all portions of the work.

Municipality	Supplements
MC:	**505.1 DESCRIPTION:** **505.1.1 MINOR STRUCTURES:** Concrete structures such as cattle guards, catch basins, median barriers, headwalls, and other small miscellaneous structures of sizes that can readily be precast as units, and furnished and installed in place, are hereby defined as Minor Structures. Such Minor Structures, at the option of the Contractor, may be either constructed of cast-in-place concrete, or furnished as precast units. Precast units shall be fabricated in accordance with shop drawings submitted by the Contractor and approved by the Engineer, in accordance with the requirements of Section 105.2

505.2 SUBGRADE FOR CONCRETE STRUCTURES:

Each subgrade upon which concrete is placed shall be firm and free from water. Ground water shall be kept several inches below subgrade until the concrete has set. When the subgrade is in dry earth, it shall be moistened with water from a spray nozzle immediately before concrete is placed.

When the design details for the project provide for the construction of filter or drain material consisting of gravel or combination of gravel and sand, which material becomes subgrade for concrete, the placing of steel reinforcement and pouring of concrete shall follow the placing of the filter or drain material as closely as practical. The filter or drain material shall be kept dewatered to the extent necessary to prevent any portion of concrete materials being carried away before the concrete has attained its final set. No payment will be made for the work required to keep such materials dewatered, other than such costs as may be included in the prices bid for various items of work or amount bid for dewatering when the schedule provides an item for same.

When concrete is to rest on rock, the rock shall be fully uncovered. The surface of the rock shall be removed to a depth sufficient to expose sound rock. Bedrock shall be roughly leveled off or cut to approximately horizontal and vertical steps. Seams in the rock shall be grouted as directed by the Engineer and the base for structures shall be slush grouted or otherwise treated as the Engineer may direct.

Municipality	Supplements
MC:	**505.2 SUBGRADE FOR CONCRETE STRUCTURES:** Precast Concrete Minor Structures shall be founded in accordance with the requirements of Section 206.4.5.

505.3 FORMS:

Forms shall be of suitable material and of type, size, shape, quality, and strength to enable construction as designed. The forms shall be true to line and grade, mortar tight, and sufficiently rigid to resist any appreciable amount of springing out of shape during placing of the concrete. The responsibility for their adequacy shall rest with the Contractor. All dirt, chips, sawdust, nails, and other foreign matter shall be completely removed from forms before any concrete is deposited. The surfaces of forms shall be smooth and free from irregularities, dents, sags and holes that would appreciably deface the finished surface. Forms previously used shall be thoroughly cleaned of all dirt, mortar and foreign matter before being reused, and the reuse of forms shall be subject

to the approval of the Engineer. Before concrete is placed in forms, all inside surfaces of the forms shall be thoroughly treated with an approved releasing agent that will leave no objectionable film on the surface of the forms that can be absorbed by the concrete. Care shall be exercised that no releasing agent is deposited on previously placed concrete.

Forms for all surfaces that will not be completely enclosed or hidden below the permanent surface of the ground shall be made of surfaced lumber, or material which will provide a surface at least equally satisfactory. Any lumber or material which becomes badly checked or warped prior to placing concrete may be rejected.

Forms for all exposed surfaces of bridges, viaducts, overcrossings and similar structures shall be constructed of plywood or an approved equal. Plywood for forms shall be exterior type, of the grade Concrete-Form Exterior, conforming to the specifications of the NBS, Commercial Standards latest edition. Plywood shall be furnished and placed in 48 inches widths and in uniform lengths of not less than 96 inches, except where the dimension of the member formed is less than the specified panel dimension. Plywood shall be placed with the grain of the outer plies in the direction of the span. Where plywood is attached directly to the studding or joints, the panels shall be not less than 5/8 inch thick, and the studdings or joints shall be spaced not more than 12 inches, center to center. Plywood less than 5/8 inch thick, otherwise conforming to the requirements specified, may be used with a continuous backing of 5/8 inch sheathing. All form panels shall be placed in a neat, symmetrical pattern with the horizontal joints level and continuous.

Wood forms for copings and curbs shall have a thickness of not less than 15/8 inches and a width of not less than the full depth of coping or curb.

Unless otherwise shown on the plans, all sharp edges shall be chamfered with 3/4 inch triangular fillets. Forms for curved surfaces shall be so constructed and placed that the finished surface will not deviate appreciably from the arc of the curve.

Forms shall be so constructed that portions, where finishing is required, may be removed without disturbing portion of forms to remain.

Forms for girders and slabs shall be cambered as may be required by the Engineer.

Forms shall, as far as practicable, be so constructed that the form marks will conform to the general lines of the structure.

Form clamps or bolts, approved by the Engineer, shall be used to fasten forms. The use of twisted wire loop ties to hold forms in position will not be permitted, nor shall wooden spreaders be used unless authorized by the Engineer. Clamps or bolts shall be of sufficient strength and number to prevent spreading of the forms. They shall be of such type that they can be entirely removed or cut back 1 inch below the finished surface of the concrete. Forms for outside surfaces shall be constructed with stiff wales at right angles to the studs and all form clamps shall extend through and fasten such wales, all based on the rate of concrete pour.

The Contractor may at his own option, pour such portions of the concrete for the structure directly against the side of the excavation or sheathing without the use of outside forms, provided that the following conditions are met.

(A) If concrete is poured directly against the sides of the excavation, the faces of the excavation must be firm and compact, and be able to stand without sloughing off and be at all points outside the concrete lines shown on the plans.

(B) If concrete is poured against sheathing, such sheathing shall be closely fitted and shall be outside of the concrete lines shown on the plans. Those surfaces against which the concrete is to be poured shall be faced with building paper. Except as otherwise specified all sheathing shall be removed, but not until either at least 7 days after placing concrete or until the concrete has attained a strength in compression of not less than 2,000 psi. Care should be used in pulling sheathing so as to avoid damaging the concrete. Voids left by the removal of sheathing, piles and/or similar sheathing supports shall be backfilled with material having a sand equivalent of not less than 30 and consolidated by jetting as directed by the Engineer. When, in the opinion of the Engineer, field conditions or the type of sheathing or methods of construction used by the Contractor are such as to make the removal of sheathing impracticable, that portion of the sheathing against which concrete has been poured may be left in place.

Regardless of the method used in pouring concrete without outside forms the following stipulations shall hold:

(A) The reinforcing steel shall be accurately set and held firmly in place, to the satisfaction of the Engineer.

(B) No direct payment will be made for building paper, sheeting, gunite or concrete placed outside of concrete lines shown on the

plans. The cost thereof shall be absorbed in the prices bid for the various items of work.

(C) The Contractor shall assume all risks of damage to the work or to existing improvements due to any reason whatsoever that may be attributable to the method of construction outlined above.

Municipality	Supplements
MC:	**505.3 FORMS:** Forming plans for cast-in-place bridge decks and cast-in-place bridge superstructures shall be prepared in accordance with the requirements of Section 105.2.

505.3.1 Removal of Forms: The falsework supporting any span of a continuous or rigid frame structure subject to bending stress shall not be released until after the last concrete placed in the span and in the adjoining spans, excluding concrete above the deck slab, has attained a compressive strength of not less than twice the design unit stress, or 21 days after the concrete is placed, whichever occurs first.

Stairway riser forms shall be removed and the finish of the steps completed on the day the concrete is placed. Metal stairway treads, if required by the plans, shall be installed immediately after the steps have been placed.

Side forms for beams, girders, columns, railings, or other members wherein the forms do not resist dead load bending shall be removed not more than 24 hours after placing concrete, where finishing is required, unless otherwise directed by the Engineer, provided that satisfactory arrangements are made to cure and protect the concrete thus exposed.

Side forms for arch rings, columns, and piers shall be removed before the members of the structure which they support are poured or placed so that the quality of the concrete may be inspected. Such forms shall be so constructed that they may be removed without disturbing other forms which resist direct load or bending stress.

Forms and shoring for box and arch sections of sewers and storm drains may be removed as follows:

(A) Forms for open channel walls — 16 hours.

(B) Outside forms of box sections and inside wall forms of box sections which do not support the slab forms — 16 hours.

(C) Arch sections in open cut — 12 hours.

(D) Slab forms for box sections:

(1) Type II Cement — 48 hours or 6 hours per foot of span between supports, whichever is greater.

(2) Type III Cement — 24 hours or 3 hours per foot of span between supports, whichever is greater.

(3) Type V Cement — 56 hours or 7 hours per foot of span between supports, whichever is greater.

The periods of time at which the Contractor may remove forms, as set forth above, are permissive only and subject to the Contractor's assuming all risks that may be involved in such removals. At his option, except for surfaces to be finished, the Contractor may leave the forms in place for such longer periods as are, in his opinion, required.

505.4 FALSEWORK:

All falsework shall be designed and constructed to provide the necessary rigidity and to support the loads. Falsework for the support of a superstructure shall be designed to support the loads that would be imposed if the entire superstructure were poured at one time.

All falsework, staging, walkways, forms, ladders, cofferdams, and similar accessories shall equal or exceed the minimum applicable safety requirements of Section 107. Compliance with such requirements shall not relieve the Contractor from full responsibility for the adequacy and safety of said items.

Falsework shall be founded upon a solid footing safe against undermining and protected from softening. When the falsework is supported on timber piles, the piles shall be driven to a bearing value as determined by the formula specified in Section 501, equal to the total calculated pile loading. The maximum calculated pile loading shall not exceed 20 tons.

Falsework and forms shall be so constructed as to produce in the finished structure the lines and grades indicated on the plans. Suitable jacks or wedges shall be used in connection with the falsework to set the forms to grade or camber shown on the plans, or to take up any settlement in the form work either before or during the placement of concrete. Single wedges for this purpose will not be permitted; it being required that all such wedges be in pairs to insure uniform bearing. Dead load deflection in stringers and joints will be compensated for by varying depths of the joists or by using varying depth nailing strips.

Arch centering shall be removed uniformly and gradually, beginning at the crown and working toward the springing, to permit the arch to take its load slowly and evenly. Centering for adjacent arch spans shall be struck simultaneously.

Falsework under any continuous unit or rigid frame shall be struck simultaneously; the supporting supports being released gradually and uniformly, starting at the center and working both ways towards the supports.

Municipality	Supplements
MC:	**505.4 FALSEWORK:** Falsework construction and erection shall not commence until the Contractor has received written approval of the sealed final falsework shop drawings

505.4.1 Falsework Design: Falsework shall be designed by the Contractor to carry all loads and pressures which may be applied to it. The construction loads to be applied are as follows:

Tunnel centering - 100 percent of the concrete load where concrete is placed by pumping. Forms shall be so constructed to provide adequate relief for excessive pump pressure.

All other structures - a live load of 30 pounds per square foot of horizontal area.

Transverse and longitudinal bracing - a horizontal force equal to 2 percent of the vertical load.

The unit stresses for wood falsework shall be those recommended in the West Coast Lumbermen's Association's standard grading and dressing rules increased 25 percent for short time loading.

Falsework may be bolted or spiked at the option of the Contractor, but the use of bolts and spikes shall not be combined in the same connection. The allowable spacings and connection values of bolts and spikes shall be in accordance with the national design specifications for stress-grade lumber and its fastenings as recommended by National Lumber Manufacturers Association except that an additional allowance of 25 percent for temporary use shall be added to the connection values for bolts and spikes.

Ends of columns bearing on wedges shall be tied in both direction by girts.

Unit stresses for steel falsework shall be in accordance with the requirements of the specifications for design, fabrication and erection of structural steel for buildings of the AISC.

Municipality	Supplements
MC:	**505.4.1 Falsework Design:** Falsework design shall be in accordance with the requirements of Section 105.2.

505.5 PLACING REINFORCEMENT:

Reinforcing bars shall be accurately placed as shown on the plans and shall be firmly and securely held in position by wiring at intersections with wire not smaller than No. 16 gage and by using concrete or metal chairs, spacers, metal hangers, supporting wires and other approved devices of sufficient strength to resist crushing under full load. Wooden supports shall not be used.

Placing bars on layers of fresh concrete as the work progresses and adjusting bars during the placing of concrete will not be permitted. Before placing in the forms, all reinforcing steel shall be thoroughly cleaned of mortar, oil, dirt, loose mill scale, loose

or thick rust and coatings of any character that would destroy or reduce the bond. No concrete shall be deposited until the placing of the reinforcing steel has been inspected and approved.

Bundle bars shall be tied together at not more than 6 foot centers.

Municipality	Supplements
MC:	**505.5 PLACING REINFORCING** The Contractor will be allowed the following tolerances when placing, tying and supporting reinforcing steel: (1) In slabs and beams, horizontal bars shall be within ¼ inch measured vertically, of the position indicated on the plans. (2) In vertical walls, columns, wings, and similar members, clearance from the forms shall be within ¼ inch of the clearance shown on the plans. (3) In slabs or walls, long runs of bars may vary up to 2 inches in spacing; however, the specified number of bars shall be placed.

505.5.1 Splicing: Splices of bars shall be made only where shown on the plans or as approved by the Engineer. Where bars are spliced they shall be lapped at least 30 diameters, unless otherwise shown on the plans.

Welding of reinforcing steel will not be permitted unless specifically authorized by the Engineer.

505.5.2 Bending Reinforcement: Bends and hooks in bars shall be made in the manner prescribed in the ACI, Manual of Standard Practice.

Bars shall not be bent nor straightened in a manner that will injure the material. Bars with kinks or unspecified bends shall not be used.

Municipality	Supplements
MC:	**505.5.2 Bending Reinforcement:** Revise section 505.5.2 to read: Bending of reinforcing steel shall conform to the requirements of the current edition of the AASHTO Standard Specifications for Highway Bridges, Division I, Article 8.2.3 – HOOKS AND BENDS. Bars shall not be bent nor straightened in a manner that will injure the material. Bars with kinks or unspecified bends shall not be used.

505.5.3 Welded Wire Fabric: Welded wire fabric shall be held firmly in place and spliced not less than 2 meshes.

Municipality	Supplements
MC:	**505.5.4 Dowels** **505.5.4.1 Dowel Placement:** Dowel placement shall consist of drilling or coring dowel holes in concrete, furnishing and placing anchoring materials, and placing reinforcing steel dowels in accordance with the details shown on the Project Plans, and the requirements of the project Special provisions and these Specifications. Dowel holes shall be cored where dowels are to be placed: (A) in bridge decks and other thin concrete sections, and the depth of the dowel hole shown on the project

plans projects to 3 inches or less from the opposite face of the concrete section, or

(B) within 4 inches from an existing concrete edge.

Cored holes shall be intentionally roughened after coring.

All holes shall be blown clean with compressed air, prior to applying the anchoring material.

The diameter of the holes for the dowels shall be 1/8“ larger than the diameter of the dowels to be placed. The depth of the holes for the dowels shall be as shown on the Project Plans.

The anchoring materials for the dowels shall be an epoxy adhesive conforming to the requirements of Section 505.5.4.2, unless otherwise specified on the Project Plans and/or the project Special Provisions, or as approved by the Engineer.

505.5.4.2 Anchoring Materials: Epoxy materials shall be used for anchoring dowels. The Contractor shall submit Certificates of Compliance or Analysis, complete with supporting documentation, to the Engineer for all epoxy materials to be used for anchoring dowels on a specific project, in accordance with the requirements of Section 106.2. The epoxy materials shall be provided by the Contractor in general conformance with the requirements of Section 1015.1 – General Requirements of Section 1015 – EPOXY MATERIALS of the current Arizona Department of Transportation (ADOT) Standard Specifications for Road and Bridge Construction, amended to date.

Epoxy resin base anchoring adhesive shall be used for anchoring dowels in concrete. High viscosity, or non-sag epoxies in the form of a gel, shall be used for horizontal or near-horizontal applications, where flow out of the anchoring hole is a problem. Low and medium viscosity epoxies may be used in vertical anchoring holes that open upward. The anchoring product shall specifically be designed for the designated application, according to the manufacturer’s product literature.

Epoxy resin base anchoring adhesive shall provide the specified minimum tensile pullout resistance, when tested in accordance with Arizona Test Method 725, as modified in accordance with Section 505.5.4.3 of these specifications. The pot life of the anchoring material shall be determined in accordance with AASHTO T 237, Part I. The determined pot life shall be within 25 percent or 10 minutes of the pot life specified by the manufacturer, whichever is greater.

505.5.4.3 Dowel Strength Requirements: The epoxy resin base anchoring adhesive shall provide the following minimum pullout resistances:

#4 dowels:	12.0 Kips
#5 dowels:	18.6 Kips
#6 dowels:	26.4 Kips
#7 dowels:	36.0 Kips

Arizona Test Method (ATM) 725 is a Tensile Proof Dowel Test, developed by ADOT to specifically test #6 reinforcing steel dowels anchored in Portland cement concrete with an epoxy adhesive. When testing reinforcing steel dowel sizes for County projects, the anchoring hole (ATM 725: PREPARATION – 4.(a)) shall be modified as follows; the rotary hammer drill bit size (ATM 725: APPARATUS – 2.(a)) shall be modified accordingly:

#4 dowels:	5/8“ diameter x 8” long
#5 dowels:	3/4” diameter x 10” long
#6 dowels:	7/8” diameter x 12” long
#7 dowels:	1” diameter x 14” long

The Contractor may opt to conduct pullout tests with hole lengths other than those required above, based on the adhesive manufacturer’s product literature and recommendations; however, test results shall demonstrate that the tested system provides the required pullout resistances.

505.6 PLACING CONCRETE:

Where a schedule for placing concrete is shown on the plans, no deviation will be permitted therefrom unless approved in writing by the Engineer.

The placing of concrete for a given pour shall start at the low point and shall proceed upgrade, unless otherwise permitted by the Engineer.

With the exception of concrete placed in slope paving and aprons, and concrete placed under water, all concrete shall be compacted by means of high frequency internal vibrators of a type, size and number approved by the Engineer. The number of vibrators employed shall be ample to consolidate the incoming concrete to a proper degree within 15 minutes after it is deposited in the forms. In all cases, at least 2 vibrators shall be available at the site of the structure in which more than 25 cubic yards of concrete is to be placed. The vibrators shall not be attached to or held against the forms or the reinforcing steel. The locations, manner and duration of the application of the vibrators shall be such as to secure maximum consolidation of the concrete without causing segregation of the mortar and coarse aggregate, and without causing water or cement paste to flush to the surface. Fresh concrete shall be spread in horizontal layers insofar as practicable and the thickness of the layers shall not be greater than can be satisfactorily consolidated with the vibrators. If additional concrete is to be placed, care shall be taken to remove all laitance and to roughen the surfaces of the concrete to insure that fresh concrete is deposited upon sound concrete surfaces. Layers of concrete shall not be tapered off in wedge-shaped slopes, but shall be built with square ends and level tops.

Mixed concrete, after being deposited, shall be consolidated until all voids are filled and free mortar appears on the surface. The concrete shall be placed as nearly as possible in its final position and the use of vibrators for extensive shifting of the mass of fresh concrete will not be permitted.

Fresh concrete shall not be permitted to fall from a height greater than 6 feet without the use of adjustable length pipes or elephant trunks.

The use of approved external vibrators for compacting concrete will be permitted when the concrete is inaccessible for adequate compaction provided the forms are constructed sufficiently rigid to resist displacement or damage from external vibration.

During the placing of concrete, care shall be taken that methods of compaction used will result in a surface of even texture free from voids, water or air pockets, and that the coarse aggregate is forced away from the forms in order to leave a mortar surface. Spades or broad-tined forks shall be provided and used to produce the desired results if required by the Engineer.

The use of chutes in conveying or depositing concrete will be allowed only at the discretion of the Engineer, and wherever they are used they shall be laid at such inclination as will permit the flow of concrete of such consistency as is required. The use of additional water in mixing the concrete to promote free flow in chutes of low inclination will not be allowed. Where necessary in order to prevent segregation, chutes shall be provided with baffle boards or a reversed section at the outlet.

Columns shall be poured preferably through pipes of adjustable length and not less than 6 inches in diameter.

Horizontal members or sections shall not be placed until the concrete in the supporting vertical members or sections has been consolidated and a minimum 2 hour period has elapsed to permit shrinkage to occur.

Walkways shall be provided along each side and for the full length of bridge structures outside the deck area. These walkways shall be of sufficient width, and so constructed as to provide for the support of the bridges from which the longitudinal floats specified are to be operated. Inspection walkways and access thereto shall be provided under the deck forms between each pair of girders and outside of each outside girder for the full length of the bridge structure. The walkways shall be not more than 8 feet below the concrete to be inspected.

505.6.1 Joints: The work shall be so prosecuted that construction joints will occur at designated places shown on plans unless specifically permitted otherwise by the Engineer. The Contractor shall complete, by continuous depositing of concrete, section for the work comprised between such joints. The joints shall be kept moist until adjacent concrete is placed.

All construction joints at the bottom of walls or arches, at the top of walls, and all longitudinal construction joints having a keyed, stepped or roughened surface shall be cleaned by sandblasting prior to pouring the adjacent concrete. Any quality of sand may be used which will accomplish the desired results.

The sandblasting operations shall be continued until all unsatisfactory concrete, and all laitance, coatings, stains, debris, and other foreign materials are removed. The surface of the concrete shall be washed thoroughly to remove all loose material. The method used in disposing of waste water employed in washing the concrete surfaces shall be such that the waste water will not stain, discolor, or affect exposed surfaces of the structures. The method of disposal will be subject to the approval of the Engineer.

All horizontal construction joints or those on slight slopes, shall be covered with Class D mortar as specified in Section 776. Expansion and contraction joints in the concrete structures shall be formed where shown on the plans and as directed. In general, such joints shall have smooth abutting surfaces, painted or separated and sealed as detailed on the plans. No reinforcement shall be extended through the joints, except where specifically noted or detailed on the plans. Concrete or mortar shall not be permitted to lap these joints in such a manner as to effect a tie or bond that would later promote spalling.

Asphalt paint or premolded asphalt filler used in joints shall be as specified in Section 729.

No direct payment will be made for furnishing and placing asphaltic paint, premolded asphaltic filler or other types of joint separators; their costs shall be included in the price bid for the item of work of which they are a part.

505.6.2 ADVERSE WEATHER CONCRETING:

(A) Hot Weather Concreting: Hot weather is defined as any combination of high ambient temperature, low relative humidity, and wind velocity which would tend to impair the quality of fresh concrete. These effects become more pronounced as wind velocity increases. Since last minute improvisations are rarely successful, preplanning and coordination of all phases of the work are required to minimize these adverse effects.

As an absolute minimum, the Contractor shall insure that the following measures are taken:

(1) An ample supply of water, hoses, and fog nozzles are available at the site.

(2) Spare vibrators are on hand in the ratio of one spare vibrator for each three in use.

(3) Preplanning has been accomplished to insure prompt placement, consolidation, finishing, and curing of the concrete.

(4) Concrete temperature on arrival should be approximately 60°F. and in any event shall not exceed 90°F. The use of cold water and ice is recommended.

(5) The subgrade is moist, but free of standing water.

(6) Fog spray is utilized to cool the forms and steel.

Under extreme conditions of high ambient temperature, exposure to the direct rays of the sun, low relative humidity, and wind, even strict adherence to these measures may not produce the quality desired and it may be necessary to restrict concrete placement to early morning only. If this decision is made, then particular attention must be directed to the curing process since the concrete will be exposed to severe thermal stresses due to temperature variation; heat of hydration plus midday sun radiation versus nighttime cooling.

(B) Cold Weather Concreting: Concrete shall not be placed on frozen ground, nor shall it be placed when the ambient temperature is below 40°F. unless adequate means are used to heat the aggregate and/or water and satisfactory means have been taken for protecting and heating the concrete during the curing period.

(C) Wet Weather Concreting: Placing of concrete shall be discontinued when the quantity of rainfall is such as to cause a flow or wash to the surface. Any concrete already placed and partially cured shall be covered to prevent dimpling. A construction joint will be installed prior to shut down.

(D) Replacement of Damaged or Defective Concrete: Upon written notice from the Engineer, all concrete which has been damaged or is defective, shall be replaced by the Contractor at no cost to the Contracting Agency.

(E) Recommended Reference:
(1) ACI-305 Hot Weather Concreting

(2) ACI-306 Cold Weather Concreting

(3) ACI-308 Recommended Practices for Curing Concrete

Municipality	Supplements
MC:	**505.6 PLACING CONCRETE** No concrete shall be placed in any forms supported by falsework until the Contractor's Professional Engineer has inspected the completed falsework, and has issued a properly sealed and signed certificate that the falsework has been constructed according to the approved falsework drawings. **505.6.1 Joints:** is revised to read **505.6.1 Construction Joints in Major Structures**. **505.6.3 Bridge Deck Joint Assemblies** **505.6.3.1 Description:** This work shall consist of furnishing and installing expansion devices including the seals, anchorage system, and hardware in accordance with the project plans and these specifications. **505.6.3.2 Materials:** Elastomer Seals shall be of the Compression Seal or Strip Seal type, and shall conform to the requirements of the Arizona Department of Transportation Standard Specifications for Road and Bridge Construction Section 1011-5. Steel shapes and plates shall conform to the requirements of ASTM A36, or ASTM A588. **505.6.3.3 Construction Requirements:** (1) General: Deck joint assemblies shall consist of elastomer and steel assemblies which are anchored to the concrete at the deck joint. The seal armor shall be cast in the concrete. The completed assembly shall be properly installed in the planned position, shall satisfactorily resist the intrusion of foreign material and water, and shall provide bump-free passage of traffic. For each size of seal on a project, one piece of the seal material supplied shall be at least 18 inches longer than required by the project Plans. The additional length will be removed by the Engineer and used for materials testing. Certificates of Compliance conforming to the requirements of Section 106.2 shall also be submitted by the Contractor. (2) Shop Drawings: Prior to fabrication, the Contractor shall submit shop drawings to the Engineer for approval, in accordance with the requirements of Section 105.2. The shop drawings shall show complete details of the method of installation to be followed, including a temperature correction chart for adjusting the dimensions of the joint according to the ambient temperature, and any additions or rearrangements of the reinforcing steel from that shown on the project plans. Deck joint assemblies for pretensioned and post-tensioned prestressed concrete superstructures shall be installed at the narrowest joint opening possible to allow for long-term superstructure shortening. (3) Elastomer Seals: Seals shall conform to the requirements specified. (4) Welding: All welding and inspection of welding for structural steel, except for tubular structures, shall be performed in accordance with the requirements of the ANSI/AASHTO/AWS D1.5-88 Bridge Welding Code. All other references to the American Welding Society (AWS) Structural Welding Code AWS D1.1-80 and the AASHTO Standard Specifications for the Welding of Structural Steel Highway Bridges are deleted. The use of electro-slag welding process on structural steel will not be permitted. (5) Armor: All steel for cast-in-place deck joint assemblies shall conform to the requirements specified. (6) Galvanizing: All steel parts of strip seal assemblies shall be galvanized after fabrication, in accordance with the requirements of ASTM A123 and A153, unless ASTM A588 steel is used. Bolts shall be high

	strength, conforming to the requirements of ASTM A325M, with a protective coating of cadmium or zinc, followed by a chromate and baked organic coating conforming to the requirements of ASTM F1135, Grade 3, 5, 6, 7, or 8 and Color Code A. Steel parts of compression seal assemblies do not require galvanizing, plating, or painting. (7) Joint Preparation and Installation: At all joint locations, the Contractor shall cast the bridge decks and abutment backwalls with a formed blockout, sized to accommodate the pre-assembled joint assembly. The joint assembly will be anchored in the concrete to be placed with the secondary pour in the blockout. Prior to the secondary pour, the surface of the existing concrete in the blockout shall be coated with an approved adhesive specifically formulated for bonding new concrete to old concrete. Installed armor assemblies shall be covered or otherwise protected at all times prior to installing the elastomer portion of the joint assembly. The elastomer shall be installed at such time and in such manner that it will not be damaged by construction operations. The seal element shall be installed subject to these specifications and approval of the Engineer. Immediately prior to the installation of the seal element, the steel contact surfaces of the joint armor shall be clean, dry, and free of oil, rust, paint, or foreign material. Any perforation or tearing of the seal element due to installation procedures or construction activities will be cause for rejection of the installed seal element. During the installation of all proprietary deck joint assemblies, the manufacturer's representative shall be present. As a minimum, the representative shall be present during the placement of the joint assembly in the deck blockout, prior to the secondary concrete pour, and shall also be present during the installation of the seal element. **505.6.4 Water Stops** Water stops of rubber or plastic, shall be placed in accordance with the details shown on the project plans. Where movement at the joint is provided for, the water stops shall be of the type permitting such movement without damage. Water stops shall be mechanically spliced, vulcanized, or heat-sealed to form continuous watertight joints, in accordance with the manufacturer's recommendations, and as approved by the Engineer. **505.6.5 Longitudinal Joints between Precast Bridge Deck Units** After erection of the units and at the time requested by the Engineer, the longitudinal shear key joints between units shall be thoroughly packed with a pre-packaged non-shrink grout or a sand-cement grout with an expansion agent approved by the Engineer. The Contractor shall then transversely connect the deck units with the connection rods, stressing and anchoring them as shown on the project plans.

505.7 CONCRETE DEPOSITED UNDER WATER:

When 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 layer of concrete of sufficient thickness to thoroughly seal the cofferdam. To prevent segregation the concrete shall be carefully placed in a compact mass and shall not be disturbed after being deposited. Water shall be maintained in a still condition at the point of deposit.

A tremie shall consist of a water tight tube having a diameter of not less than 10 inches with a hopper at the top. The tube shall be equipped with a device that will close the discharge end and prevent water from entering the tube while charging the tube with concrete. 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. The discharge end

shall be closed at the start of the work to prevent water entering the tube and shall be entirely sealed at all times, except when concrete is being placed. The tremie tube shall be kept full of concrete. 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. The flow shall be continuous until the work is completed and the resulting concrete seal shall be monolithic and homogeneous.

The underwater bucket shall have an open top and the bottom doors shall open freely and outward when tripped. The bucket shall be completely filled and slowly lowered to avoid back wash and shall not be dumped until it rests on the surface upon which the concrete is to be deposited. After discharge, the bucket shall be raised slowly until well above the concrete.

Concrete deposited in water shall have 10 percent extra cement added.

505.8 CURING:

As soon after the completion of the specified finishing operations as the condition of the concrete will permit without danger of consequent damage thereto, all exposed surface shall either be sprinkled with water, covered with earth, sand or burlap; sprayed with a curing compound or sealed with a material conforming with Section 726. All concrete for bridge structures shall be water cured unless otherwise permitted by the Engineer.

Concrete that is water cured must be kept continuously wet for at least 10 days after being placed; preferably being covered, if possible, with at least 2 layers of not lighter than 7 ounce burlap, except that handrail, baserail, railing posts, tops of walls, and similar parts of the structure, if water cured, must be covered with burlap as above prescribed, immediately following the finishing treatment specified therefor, and such covering shall not be removed in less than 4 days. Roadway areas, floors, slabs, curbs, walks, and the like, that are water cured may be covered with sand to a depth of at least 2 inches, in lieu of the burlap as specified above, as soon as the condition of the concrete will properly permit, and such covering must remain wet and in place until the concrete so covered is at least 10 days old unless otherwise directed by the Engineer or provided by special provisions.

When a sprayed impervious membrane is used, it shall be applied under pressure through a spray nozzle in such manner and quantity as to entirely cover and seal all exposed surfaces of the concrete with a uniform film. To insure complete coverage, membrane shall be applied in two applications for a total coverage of 150 square feet per gallon. The membrane, however, shall not be applied to any surface until all of the finishing operations have been completed; such surfaces being kept damp, until the membrane is applied. All surfaces on which a bond is required, such as construction joints, shear planes, reinforcing steel, and the like, shall be adequately covered and protected before starting the application of the sealing medium in order to prevent any of the membrane from being deposited thereon; and any such surface with which the seal may have come in contact shall immediately thereafter be cleaned. Care shall be exercised to avoid and prevent any damage to the membrane seal during the curing period. Should the seal be broken or damaged before the expiration of 10 days after the placing of the concrete, the break shall be immediately repaired by the application of additional impervious membrane over the damaged area.

Should any forms be removed sooner than 10 days after the placing of the concrete, the surface so exposed shall either be immediately sprayed with a coating of the membrane seal, or kept continuously wet by the use of burlap or other suitable means until such concrete has cured for at least 10 days.

When tops of walls are cured by the membrane sealing method the side forms, except metal forms, must be kept continuously wet for the 10 days following the placing of the concrete.

If due to weather conditions, materials used, or for any other reason, there is any likelihood of the fresh concrete checking or cracking prior to the commencement of the curing operations, it shall be kept damp, but not wet, by means of an indirect fine spray of water until all danger of such checking or cracking is past, or until the curing operations are started in the particular area affected.

Since hot weather leads to more rapid drying of concrete, protection and curing are far more critical than in cool weather. Water curing should be used wherever it is practical and should be continuous to avoid volume changes due to alternation of wetting and drying. The need for adequate continuous curing is greatest during the first few hours after placement of concrete in hot weather.

Municipality	**Supplements**
MC:	**505.8 CURING** The Contractor shall use the wet burlap method for the water cure of all concrete in bridge decks and approach slabs, unless otherwise authorized by the Engineer.

505.9 FINISHING CONCRETE:

Immediately after the removal of forms as provided above, all concrete surfaces shall be finished in accordance with the requirements specified below.

All surfaces scheduled to be covered with backfill shall be finished so as to be free of open and rough spaces.

All surfaces that will remain exposed in the completed work shall be finished so as to be free of open and rough spaces, depressions or projections. All angles and fillets shall be sharp and true and the finished surface shall present a pleasing appearance of uniform color.

All top surfaces of walls, abutments, piers, etc., shall be finished to a smooth surface and shall be cured by an approved method.

If rock pockets or honeycomb are of such an extent and character as to affect materially the strength of the structure and to endanger the steel reinforcement the Engineer may declare the concrete defective and require the removal and replacement of that portion of the structure affected by the Contractor at no additional cost to the Contracting Agency.

If finishing operations are not carried out as set forth below, all placing of concrete shall stop until satisfactory arrangements are made by the Contractor to promptly correct defective finishing work and to carry out finishing operations as specified.

One of the classes of finish as specified shall be applied to the various surfaces as set forth under applicability of finishes.

No finishing or patching shall be permitted until the surface has been inspected by the Engineer.

505.9.1 Finishing Fresh Concrete in Bridge Decks: Upon placing the deck to a uniform and true surface, screed supports shall promptly be removed from the surface and any necessary hand finishing shall be promptly accomplished in the areas where the screed supports have been removed.

After final floating of the plastic concrete, bridge decks subject to vehicular traffic shall be textured transversely. Apparatus producing textured grooved shall be mechanically operated from an independent self-propelled bridge. Grooves shall be 1/16 to 1/8 inch in width and 3/32 to 6/32 in depth. Center to center spacing of the grooves shall be as follows: 7/8 inch, 3/4 inch, 1 inch, 3/4 inch, 1-1/8 inch and then repeated, or other measurements as approved by the Engineer. Texturing shall be completed before surface of concrete is torn or unduly roughened by texturing operation. Grooves that close following texturing will not be permitted and will have to be retextured. Hand tine brooms shall be available on the job site, at all times during texturing operation, to repair faulty texturing grooves.

The finished surface will be tested with a 10 foot straightedge furnished by the Contractor. The testing will be accomplished by holding the straightedge in contact with the deck surface and parallel to the centerline. The surface shall not vary more than 1/8 inch from the lower edge of the straightedge. Areas showing high spots of more than 1/8 inch shall be corrected by cutting or planing. The cutting or planing machine shall be a rotary type, equipped with an adjustable cutter and having a minimum wheel base of 10 feet. Areas showing low spots of more than 1/8 inch shall be filled with an approved mixture of sand, cement and epoxy. The mixture shall firmly adhere to the surface and shall match the surrounding concrete. All areas corrected shall not show deviations in excess of 1/8 inch when tested with a 10 foot straightedge.

505.9.2 Finishing Fresh Concrete in Sidewalks and Bridge Sidewalks: After the concrete has been placed and spread between the forms, it shall be thoroughly worked until all the coarse aggregate is below the surface and the mortar comes to the top. Concrete may be consolidated by means of mechanical vibrators approved by the Engineer.

The surface shall then be struck off and worked to grade and cross section with a wood float.

A mechanical finishing machine that will consolidate the concrete and strike off and finish the surface may be used if permitted by the Engineer, provided that the machine produces a sidewalk equal to or better in all respects than that produced by the methods specified herein.

The surface shall be sweat finished by means of a steel trowel followed by a light broom finish.

The sidewalks shall be marked and edged with the proper tools to form the joints, marking and edges shown on the plans.

505.9.3 Finishing Green Concrete: Class I Finish — All bolts, wires and rods shall be clipped and recessed. All holes, honeycomb, rock pockets and other surface imperfections shall be cleaned out, thoroughly moistened and carefully patched with mortar. Mortar shall be composed of 1 part of cement and 2 parts of fine sand. A portion of the required cement for mortar shall be white as required to match the color of the surrounding concrete.

Class II Finish — The surface shall be patched and pointed as specified above for Class I Finish and then promptly covered with polyethylene film, wet burlap or wet cotton mats. If polyethylene film is used, the film shall be held securely to the surface by means of weights, adhesive or other suitable means. Only white polyethylene film for covering will be acceptable.

When the mortar used in patching and pointing has set sufficiently, the surface shall be uncovered and thoroughly rubbed with either a float or a carborundum stone until the surface is covered with a lather. Cork, wood or rubber floats shall be used only on surfaces sufficiently green to work up such lather, otherwise a carborundum stone shall be used. During the rubbing process, a thin grout composed of 1 part cement and 1 part of fine sand may be used to facilitate producing a satisfactory lather; however, this grout shall not be used in quantities sufficient to cause a plaster coating to be left on the finished surface. A portion of the required cement for grout shall be white as required to match the color of the surrounding concrete. Rubbing shall continue until irregularities are removed and there is no excess material. At the time a light dust appears, the surface shall be brushed or sacked. Brushing or sacking shall be carried in one direction so as to produce a uniform texture.

Class III Finish — The surface shall be treated as specified above under Class II Finish except that after brushing, the surface shall again be securely covered with polyethylene film, wet burlap or wet cotton mats. In not less than 1 day nor more than 4 days, the surface shall be uncovered and rubbed with a carborundum stone. This rubbing shall continue until the entire surface is of a smooth texture and uniform color. During the process, the use of a thin mixture of equal parts of sand and cement with water will be permitted. At the time a light dust appears, the surface shall be brushed or sacked, care being taken to carry this brushing in one direction so as to produce a uniform texture.

505.9.4 Finish Hardened Concrete: If for reasons either beyond the control of the Contractor or with the approval of the Engineer, more than 6 days have elapsed between the time of placing concrete and the time of the removal of forms, the concrete shall be considered as hardened. Prior to finishing hardened concrete, the surface shall be covered with burlap or cotton mats and kept thoroughly wet for a period of at least 1 hour. Finishing shall be identical to the respective requirements for Class I, Class II and Class III Finish for green concrete, except that the use of a mechanically operated carborundum stone will be required for Class II and Class III Finishes.

505.9.5 Applicability of Finishes: Surfaces requiring Class I Finish — All formed structures that are to be covered by backfill and those surfaces that are normally not in view of either vehicular or pedestrian traffic such as the surfaces on the inside of barrels of culverts, the under surfaces of decks, surfaces of concrete girders, piers and abutment walls.

Surfaces requiring Class II Finish — All exposed surfaces of headwalls, wingwalls, deck edges on culverts, end of piers on bridges and culverts, retaining walls and those vertical surfaces under highway grade separation structures that are exposed to view of the traveling public, including piers and pier caps, the outside face of outside girders, and other similar surfaces.

When surfaces of uniform texture and pleasing appearance are obtained through the use of first class metal forms, paper tubing or the use of special form coatings and the use of special care, such surfaces may, upon approval of the Engineer, be excluded from the surfaces requiring Class II Finish.
Surfaces requiring Class III Finish for bridge structures — All formed or finished surfaces above the surface of the deck on the roadway side of the handrail and the outside vertical surfaces from the top of handrail and dado to the lower edge of the chamfer at the bottom of the deck.

505.10 PAYMENT:

Payment for portland cement concrete structures will be made in conformity with the terms of the contract and will be based on unit prices and/or lump sums as set forth in the proposal. Such payment shall include full compensation for furnishing all labor, materials, tools and equipment, preparation of subgrade for placing of concrete and doing all work required to construct the structures in conformity with the plans and specifications.

Where concrete is scheduled for payment on the basis of cubic yards, the calculation of the quantity of concrete for payment will be made only to the neat lines of the structures as shown on the plans and on the basis of the concrete having the specified lengths, breadths, and thicknesses. However, all concrete shall be placed to line and grade within such tolerances as, in the opinion of the Engineer, are reasonable and acceptable for the type of work involved. The quantity of such concrete will be calculated

considering the mortar used to cover construction joints as being concrete and no deductions will be made for rounded or beveled edges, space occupied by reinforcing steel, metal inserts, or openings 5 square feet or less in area. The cost of cement used in mortar for covering construction joints, patching, or other uses in the structure being constructed, in excess of that required for the design mix of the adjacent concrete, shall be absorbed in the item of work of which said mortar is a part.

Municipality	Supplements
MC:	**505.10 DIMENSIONAL TOLERANCES:** The maximum allowable tolerances or deviations from dimensions shown on the project plans or the approved shop drawings shall be as follows: **505.10.1 Cast-in-Place Concrete** (A) Variation from plumb in the lines and surfaces of columns, piers, abutment and girder walls: In any 10 foot or less length: 0.4 inches Maximum for the entire length: 1 inch (B) Variation in cross-sectional dimensions of columns, piers, girders, and in the thickness of slabs and walls: + 1/4 inch - 1/8 inch (C) Girders alignment (deviation from straight line parallel to center line of girder measured between diaphragms): 1/8 inch per every 10 feet in length (D) Variation in footing cross sectional dimensions in project plans: + 2 inches - ½ inch (E) Variation in footing thickness: Greater than specified - No Limit Less than specified - 5 percent of specified thickness up to a maximum of 1 inch (F) Subgrade Tolerances: Slab poured on subgrade excepting footing thickness: + ¼ inch - ¾ inch (G) Girder Bearing Seats: Deviation from plane surface (flatness): ± 1/8 inch in 10 feet. Deviation from required elevation: + 1/4 inch - 1/8 inch (H) Cast-in-Place concrete box girder superstructures: Deviation in overall depth: + 1/4 inch - 1/8 inch Deviation in slab and wall thickness: + 1/4 inch - 1/8 inch Deviation of post-tensioning ducts: ± ¼ inch

	505.10.2 Minor Precast Concrete Structures: Precast units that do not comply with the dimensional tolerances specified herein will be rejected. Precast units that show evidence of cracks, pop outs, voids or other evidence of structural inadequacy, or imperfections that will reduce the aesthetics of the unit after final placement, will be rejected. The maximum allowable tolerances or deviations from the dimensions shown on the drawings shall be as follows: (A) Over-all dimensions of member: ± ¼ inch per 10 feet, maximum of ± ¾ inch. (B) Cross-sectional dimensions: Sections 6 inches or less ± 1/8 inch Sections 18 inches or less and over 6 inches ± ¼ inch Sections 39 inches or less and over 18 inches ± ¼ inch (C) Deviations from straight line: Not more than ¼ inch per 10 feet All exposed, sharp corners of the concrete shall be filleted ¾ inches with a maximum allowable deviation of ± 1/8 inch.

Municipality	**Supplements**
MC:	**505.11 MEASUREMENT:** **505.11.1 Reinforcing Steel:** Reinforcing steel will be measured in pounds, based on the total computed weight for the size and length of bars, or for the area of welded wire fabric, as shown on the Project Plans or as approved by the Engineer. Unit bar weights for deformed and plain billet-steel bars will be the nominal unit weights specified in AASHTO M 31 (ASTM A 615). Area unit weights for steel welded wire fabric will be calculated based on specified wire spacings and unit weights for specified wire types and sizes. Unit weights for plain wire shall be based on the nominal areas specified for Wire Size Numbers in AASHTO M 32 (ASTM A 82). Unit weights for deformed wire shall be the nominal unit weights specified for Deformed Wire Size Numbers in AASHTO M 225 (ASTM A 496). If the area unit weights for steel welded wire fabric are specified on the Project Plans or in the Special Provisions, both the Contractor and the Engineer shall independently calculate the area unit weight, using specified wire spacings, types and sizes, and the criteria in the preceding paragraph. Any apparent discrepancy between the specified and calculated area unit weights shall be resolved by the Engineer prior to the Contractor placing the order for the steel welded wire fabric. Lap splices made for the convenience of the Contractor will not be included in the measurement for payment. Reinforcing steel for Minor Structures, as defined in Section 505.1.1, will not be measured, but will be included in the items unit price or specified method of payment, unless otherwise called out on the Project Plans or in the Special Provisions. Dowel Placement will be measured by the unit each.

	505.11.2 Concrete: When concrete is scheduled for payment on the basis of cubic yards, the calculation of the quantity of concrete for payment will be made only to the neat lines of the structures as shown on the plans. The quantity will be based on the concrete having the specified plan lengths, widths/depths, and thicknesses. However, all concrete shall be placed to line and grade within the tolerances specified in Section 505.10, or as approved by the Engineer as being reasonable and acceptable for the type of work involved. No volumetric deductions will be made for rounded or beveled edges, space occupied by reinforcing steel, metal inserts, or openings 0.5 square yard or less in area. The quantity of concrete will be calculated considering any mortar used to cover construction joints as being concrete. The cost of cement used in any mortar for covering construction joints, patching, or other uses in the structure being constructed, in excess of that required for the design mix of the adjacent concrete, shall be absorbed in the cost of the item of work of which said mortar is a part. **505.11.3 Deck Joint Assemblies:** Deck joint assemblies will be measured to the nearest tenth of a foot. Measurement will be made along the centerline of the joint, at the surface of the roadway, from face-to-face of curb or barrier. No measurement will be made for that portion of the deck joint assembly required by plan details to extend through the barrier face or curb; that portion of the joint assembly will be considered incidental to the sealing of the joint. **505.11.4 Bridge Railing, Curbs, Barriers, and Approach Slabs** Bridge Pedestrian Fence and Curb, Bridge Pedestrian Fence and Parapet, and Bridge Fence and Parapet will be measured to the nearest tenth of a foot, from end post to end post. Bridge Traffic and Pedestrian Rail will be measured to the nearest foot, determined from the outside dimensions of the rail. Bridge Concrete Barrier will be measured to the nearest tenth of a foot. Barrier Concrete Barrier Transition will be measured as a unit for each constructed. Reinforced Concrete Approach Slab will be measured to the nearest square yard.

Municipality	**Supplements**
MC:	**505.12 PAYMENT** **505.12.1 Reinforcing Steel:** The accepted quantities of reinforcing steel, of the type indicated on the Project Plans or specified in the Special Provisions, and measured in conformance with Section 505.11.1 will be paid for at the contract unit price per pound, complete in place. The accepted quantity of dowels placed will be paid for at the contract unit price for Dowel Placement, which shall be full compensation for the work, complete in place. Steel reinforcement furnished for the dowels will be measured and paid for under the pay item Reinforcing Steel. No measurement or direct payment will be made for dowels which are required to replace existing reinforcing steel that is damaged as a result of the Contractor's operations; the Contractor shall furnish and place such dowels at his own expense. **505.12.2 Concrete:** Payment for Portland cement concrete structures will be made in conformity with the terms of the contract and will be based on unit prices and/or lump sums as set forth in the proposal. Such payment shall include full compensation for furnishing all labor, materials, tools and equipment, preparation of subgrade for placing of concrete, and doing all work required to construct the structures in

conformity with the plans and specifications.

An adjustment in the contract unit price, to the nearest cent, will be made for the quantity of concrete represented by the results of cylinder strength tests that are less than the specified 28-day compressive strength. Strength tests will be conducted in accordance with Section 725.10 of the Uniform Standard Specifications. The adjustment in contract unit price, if the concrete is accepted, will be based on the schedule in Section 725.11.

The contract unit price for structural concrete shall include full compensation for all items incidental to providing a concrete structure complete in place, including waterstops, roadway drains, scuppers, metal inserts, and bearing pads.

505.12.3 Minor Concrete Structures and Accessories:

The accepted quantities of:

Minor Structures	Each
Deck Joint Assemblies	0.1 Foot
Bridge Pedestrian Fence and Curb	0.1 Foot
Bridge Pedestrian Fence and Parapet	0.1 Foot
Bridge Fence and Parapet	0.1 Foot
Bridge Traffic and Pedestrian Rail	Foot
Bridge Concrete Barrier	0.1 Foot
Bridge Concrete Barrier Transition	Each
Reinforced Concrete Approach Slab	Square Yard

will be paid for at the unit price and/or lump sums as set forth in the proposal. The contract unit price shall include full compensation for all labor, materials, tools and equipment necessary to provide the concrete structure or accessory complete in place, including all concrete, reinforcing steel, and items embedded in the concrete, such as anchor bolts, grates and frames, metal inserts, etc.

PRECAST PRESTRESSED CONCRETE MEMBERS

506.1 DESCRIPTION:

This work shall consist of furnishing and placing precast prestressed concrete members in accordance with the details shown on the plans, and as provided in these specifications and special provisions.

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 for concrete piling.

The members shall be furnished complete including all concrete, prestressing steel, bar reinforcing steel, and incidental materials in connection therewith.

Prestressing may be performed by either pretensioning or posttensioning methods. The method of prestressing to be used shall be optional with the Contractor, subject to the requirements provided in these specifications.

Prior to casting any members to be prestressed, the Contractor shall submit to the Engineer for review complete details of the method, materials and equipment he proposes to use in the prestressing operations, including any additions or rearrangement of reinforcing steel from that shown on the plans. Such details shall outline the method and sequence of stressing and shall include complete specifications and details of the prestressing steel and anchoring devices, anchoring stresses, type of enclosures, and all other data of the prestressing steel in the members, pressure grouting materials and equipment. For any rearrangement of prestressing tendons the stress calculations shall be submitted for approval by the Engineer.

Municipality	Supplements
MC:	**506.1 DESCRIPTION:** Elastomeric Bearing Pads shall conform to the requirements of the current edition of the AASHTO Standard Specifications for Highway Bridges, Division II – Construction, Article 18.4.5, and shall be Grade 3, 60 durometer elastomer, unless otherwise specified in the Special Provisions. Prestressing of all precast concrete I-girder, box beam, voided and solid slab bridge members shall be by the pretensioning method only. Prior to initiating girder fabrication, shop drawings for the proposed precast concrete members shall be submitted in accordance with Section 105.2, and approved by the Engineer.

506.2 CONCRETE:

Concrete construction shall conform to the provisions in Section 505.

The Contractor shall be responsible for furnishing concrete for prestressed members which contains not less than 611 nor more than 752 lbs., of cement per cubic yard of concrete, which is workable and which conforms to the strength requirements specified. Batch proportions shall be determined by the Contractor.

The compressive strength of the concrete will be determined from concrete test cylinders cured under conditions similar to those affecting the member.

The use of admixtures for the purpose of producing high strength at an early date shall be subject to the approval of the Engineer. In no case shall calcium chloride or any additive containing calcium chloride be used in concrete for prestressed construction.

Concrete shall not be deposited in the forms until the Engineer has inspected the placing of the reinforcement, enclosures, anchorages, and prestressing steel.

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.

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.

Forms for interior cells or voids 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.

Forms may be removed when permitted by the Engineer provided that the concrete is not damaged in so doing and that adequate curing is provided. The members shall be properly supported to prevent dead load bending at all times prior to initial tensioning. After prestressing, the members shall be handled or supported at or near the final bearing points for storage.

The members shall be supported in transporting in a manner that will allow reasonable conformity to the proper bearing points with consideration for limitations of adequate hauling equipment. At all times members shall be handled or supported securely in an upright position, avoiding tipping or racking.

Lifting devices shall not project above the surface of the member after erection unless they will be imbedded in a subsequent concrete pour, have a minimum concrete cover of 2 inches and do not interfere with the placement of reinforcing steel or concrete.

The steam curing method or other approved methods may be used for curing precast prestressed concrete members in lieu of water curing. Steam curing, if elected by the Contractor, shall conform to the following provisions:

(A) After placement of the concrete, members shall be held for a minimum 2-hour presteaming period. The initial application of the steam shall be from 2 to 4 hours after the final placement of concrete to allow the initial set of the concrete to take place.

(B) All exposed surfaces of the members shall be kept wet continuously during the holding and curing period.

(C) The steam shall be saturated below pressure and shall be distributed uniformly over all exposed surfaces of the member and shall not impinge on the exposed concrete surfaces.

(D) The steam hood shall be equipped with temperature recording devices that will furnish an accurate continuous permanent record of the temperatures under the hood during the curing period. The position of the temperature devices shall be approved by the Engineer.

(E) During application of the steam the ambient air temperature shall increase at a rate not to exceed 40°F. per hour until a maximum temperature of from 140°F. to 160°F. is reached. The maximum temperature shall be held until the concrete has reached the desired strength.

<table>
<tr><th>Municipality</th><th>Supplements</th></tr>
<tr><td>MC:</td><td>
506.2 CONCRETE:

506.2.1 Reinforcing Steel: Non-prestressed reinforcement shall conform to the provisions of Section 727; placement shall conform to the provisions of Section 505.5.

506.2.2 Dimensional Tolerances: Precast Prestressed Concrete Bridge Members that do not comply with the dimensional tolerances specified herein will be rejected. Precast members that show evidence of cracks, pop-outs, voids or other evidence of structural inadequacy, or imperfections that will reduce the aesthetics of the member after final placement, will be rejected.

(1) Precast Prestressed Concrete I-girders: The maximum allowable tolerances or deviations from dimensions and details shown on the project plans and shop drawings shall be as follows:

<table>
<tr><td>Girder Length</td><td>± 3/4”</td></tr>
<tr><td>Width (flanges and fillets)</td><td>+ 3/8”, -1/4”</td></tr>
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Girder Depth (overall)	+1/2", -1/4"
Width (web)	+ 3/8", -1/4"
Depth (flanges and fillets)	± 1/4"
Bearing plates (center to center)	±1/8" per 10 feet but not greater than ±3/4"
Horizontal alignment (deviation from straight line parallel to centerline of girder)	1/8" per every 10 feet in length
Stirrup bars (deviation from top of girder)	+ 1/4", - 3/4"
Position of strands	± 1/4" for strands and center of gravity of strand group
Longitudinal position of deflection points for deflected strands	± 10"
Position of handling devices	± 6"
Bearing plates (center to end of girder)	± 1/4"
Side inserts (center to center and center to end of girder)	± 1/2"
Girder ends (deviation from square or designated skew)	Horz. ± 1/4" Vert. ± 1/8" per 12 foot of beam depth
Bearing area deviation from plane	± 1/8"
Stirrup bars (longitudinal spacing)	± 1"
Position of weld plates	± 1"

(2) Precast Prestressed Concrete Box Beams, Voided Slabs, and Flat Slabs: The maximum allowable tolerances or deviations from dimensions and details shown on the project plans and shop drawings shall be:

Member Length	± 3/4"
Member Width (overall)	± 1/4"
Member Depth (overall)	± 1/4"
Width (web)	± 3/8"
Depth (top slab)	± 1/4"
Depth (bottom slab)	+ 1/4", -1/8"
Horizontal alignment (deviation from straight line parallel to centerline of member)	1/8" per every 10 feet in length
Camber differential between adjacent members	Not greater than 3/4"
Position of strands	± 1/4" for center of gravity for strand group
Stirrup bars (longitudinal spacing)	± 1"
Position of handling devices	± 6"
Member void position	± 1/2" from end of void to center of tie hole, + 1" adjacent to end block.
Member ends (deviation from square and/or designated skew)	± 1/2"
Bearing area deviation from plane (straight edge through middle half)	± 1/8"
Dowel tubes (spacing between centers of tubes, and centers of tubes to the ends and sides of members)	± 1/2"
Tie rod tubes (spacing between centers of tubes, and centers of tubes to ends of members)	± 1/2"
Tie rod tubes (spacing from centers of tubes to bottom of member)	± 3/8"
Position of side inserts	± 1/2"

506.3 PRESTRESSING STEEL:

Prestressing steel shall be high-tensile wire conforming to ASTM A-421, high-tensile wire strand confirming to ASTM A-416, or high-tensile strength alloy bars conforming to the following requirements:

High-tensile strength alloy bars shall be thermal stress relieved to produce suitable metallurgical structure and shall be individually proof-tested during the process of manufacturing to a minimum of 90 percent of the manufacturer's minimum guaranteed ultimate strength. The mechanical properties of the completed bars shall be as follows:

	Regular Grade	**Special Grade**
Ultimate tensile strength psi. min.	145,000	160,000
Yield strength, measured by the 0.7 percent extension under load method, psi. min.	130,000	140.000
Elongation in 20 bar diameters after rupture, percent, minimum	4.0	4.0
Reduction of area, percent, min.	25.0	20.0
Modulus of elasticity at 70 percent of the manufacturer's minimum guaranteed ultimate strength psi.min.	25×10^6	25×10^6

Diameter tolerances shall conform to ASTM A-29

Bars of different ultimate strength shall not be used interchangeably in the same member, unless otherwise permitted by the Engineer.

In handling and shipping bars, every care shall be taken to avoid bending, injury from deflection, scraping or overstressing of the bars. All damaged bars will be rejected.
All wire and strand to be post-tensioned shall be:

(A) Protected from corrosion during shipping by a factory treatment or processing.

(B) Protected against abrasion during shipment and handling.

Wires shall be arranged to produce equal stress in all wire of wire groups or parallel lay cables that are to be stressed simultaneously or when necessary to insure proper positioning in the enclosures.

Where wires are to be button-headed, the buttons shall be cold formed symmetrically about the axes of the wires, and shall develop the full strength of the wire. No cold forming process shall be used that causes indentations in the wire.

When the button-headed wire assembly is tested as a unit in tension at least 90 percent of the failures at or above the minimum guaranteed ultimate strength of the wire shall occur in the wire and not in the buttons.

All prestressing steel shall be protected against rust and other corrosion and damage and shall be free of all dirt, scale and pits due to rust, oil, grease and other deleterious substances when finally encased in concrete or grouted in the member.

Municipality	**Supplements**
MC:	**506.3 PRESTRESSING STEEL**: Prestressing Steel Strand for precast concrete bridge members shall conform to the requirements of AASHTO Specification M 203 (ASTM A 416) for Steel Strand, Uncoated Seven-Wire for Concrete Reinforcement, and shall be Low-Relaxation Strand, Grade 270.

506.4 ANCHORAGES AND DISTRIBUTION:

All post tensioned prestressing steel shall be secured at the ends by means of approved anchoring devices. The anchors shall be of such nature that they will not kink, neckdown or otherwise damage the prestressing steel.

The load from the anchoring device shall be distributed to the concrete by means of approved devices that will effectively distribute the load to the concrete.

Anchoring devices for all post-tensioned prestressing steel shall be of the permanent type.

Where the end of a post-tensioned assembly will not be covered by concrete, the anchoring devices shall be recessed so that the ends of the prestressing steel and all parts except tendons of the anchoring devices will be at least 2 inches inside of the end surface of the members, unless a greater embedment is shown on the plans. Following post-tensioning, the recesses shall be filled with grout, and finished flush.

When headed wires are used, the outside edge of any hold for prestressing wire through a stressing washer or through an unthreaded bearing ring or plate shall not be less than 1/4 inch from the root of the thread of the washer or from the edge of the ring or plate.

Distribution plates or assemblies shall conform to the following requirements:

(A) The final unit compressive stress on the concrete directly underneath the plate or assembly shall not exceed 3,000 psi, and a suitable grillage of reinforcing steel shall be used in the stressed area.

(B) Bending stresses in the plates or assemblies induced by the pull of the prestressing steel shall not exceed design working stress, as determined by the Engineer, in the anchorage plate when 100 percent of the ultimate load is applied.

(C) Materials and workmanship shall conform to the requirements in Section 515.

Should the Contractor elect to furnish anchoring devices of a type which are sufficiently large and which are used in conjunction with a steel grillage imbedded in the concrete that effectively distributes the compressive stresses to the concrete and steel distribution plates or assemblies may be omitted.

506.5 ENCLOSURES:

Enclosures for prestressing steel shall be metallic and mortar-tight and shall be accurately placed at the locations shown on the plans or approved by the Engineer.

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 that can be removed prior to installing prestressing steel.

All enclosures or openings or anchorage assemblies shall be provided with pipes or other suitable connections for the injection of grout after prestressing.

506.6 PRESTRESSING:

All prestressing tendons shall be tensioned by the use of equipment allowing actual elongation to be measured directly and using a hydraulic ram equipped with an accurate method of determining the tensioning force applied using one of the following methods; a gauge measuring the internal hydraulic pressure of the ram, or force exerted by the ram; a spring-type dynamometer used with the tensioning force applied directly; an electronic load cell used with the tensioning force applied directly. Readings taken from any one of these gauges shall be converted to actual tensioning forces through the use of calibrated values taken from a certified chart from a recent calibration. All gauges shall be of sufficient size and adequately made to allow accurate readings to be made of load increments of 1 percent of the total capacity of the ram used, not to exceed 2 percent of the tensioning force used.

The force in each tendon as obtained from the calibrated value shall be compared with the tensioning force obtained from calculation using the modulus of elasticity, cross-sectional area and length of tendon for the actual net elongation measured

directly. When there is a difference between the values in excess of 5 percent final anchorage of the tendon shall be delayed until the reason for the discrepancy is found and appropriate correction is made to reduce the difference to 5 percent or less. Within the allowable difference, final anchorage shall be made when the required tensioning force is obtained according to the elongation used in pretensioning and according to the corrected gauge reading in post-tensioning.

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 indicate that the concrete in the member has attained a compressive strength of not less than the value shown on the plans for transfer strength.

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.

The cutting and releasing of prestressed 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.

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.

The tensioning 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 gauge pressures and elongations at all times and shall be submitted to the Engineer for approval.

Draped prestressing steel in post-tensioned members shall be tensioned by simultaneous jacking at each end of the assembly, except where low frictional forces permit tensioning from one and as determined by the Engineer.

Determination of the jacking stresses shall be supported by calculations, or both calculations and field tests when specified, prepared by the Contractor. The Contractor shall submit his calculations to the Engineer for approval, and prior to making field tests shall submit details of his proposed gauges and load devices for determining the jacking load at each end of the test prestressing unit to the Engineer for approval. The stress at the center will be calculated from the average of the end test loads, when tests are required. Jacking stresses within 2 percent of the specified values will be considered satisfactory.

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	0.002	0.30
	Galvanized	0.0015	0.25
Bright metal bars	Bright metal	0.0003	0.20
	Galvanized	0.0002	0.15

The maximum temporary tensile stress (jacking stress) in prestressing steel shall not exceed 75 percent of the 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 70 percent of the ultimate tensile strength of the prestressing steel.

Municipality	**Supplements**
MC:	**506.6 PRESTRESSING:** Unless otherwise shown on the project plans, the stresses in the prestressing strands shall not exceed those specified in the current edition of the AASHTO Standard Specifications for Highway Bridges, Division I – Design, Section 9.15.1.

	When concrete has not been placed within 72 hours of the tensioning of the prestressing strands, all strands shall be re-tensioned prior to placing concrete. Prestressing steel at the end of the members shall be cut and bent in accordance with details on the project plans. Exposed strand ends shall not be coated, but shall be clean and free of all rust, corrosion, dirt, scale, oil, grease, and other deleterious substances, in accordance with Sections 506.3 and 506.7 of these Specifications, before encasement in the cast-in-place concrete pier and abutment diaphragms of the superstructure.

506.7 BONDING AND GROUTING:

Post-tensioned prestressing steel shall be bonded to the concrete by pressure grouting the enclosures or openings.

All prestressing steel to be bonded to the concrete shall be free of scale and pits due to rust, dirt, oil, grease and other deleterious substances.

Grouting equipment shall be capable of grouting to a pressure of at least 100 psi. The grouting shall consist of neat cement and water conforming to the provisions in Section 725. The grout shall completely fill the enclosure or opening.

All enclosures or openings shall be clean and free of all foreign materials that would impair bonding of the grout. Each enclosure or opening shall be thoroughly flushed out with water and blown out with air or cleaned by other approved methods immediately prior to grouting.

After post-tensioned prestressing steel has been pressure grouted, the member shall not be moved or otherwise disturbed until at least 24 hours have elapsed.

506.8 SAMPLES FOR TESTING:

Sampling and testing shall conform to the specifications or ASTM A-416 and A-421 as provided in this specification.

Samples from each size and each lot of prestressing steel wires and bars, from each manufactured reel of prestressing steel strand, and from each lot of anchorage assemblies and bar couplers to be used shall be furnished for testing.

All wire or bars of each size from each mill lot and all strand from each manufactured reel to be shipped to the site shall be assigned an individual lot number and shall be tagged in such a manner that each such lot can be accurately identified at the job site. Each lot of anchorage assemblies and bar couplers to be installed at the site shall be likewise identified. All unidentified prestressing steel, anchorage assemblies or bar couplers received at the site will be rejected.

The following samples of material and tendons, selected by the Engineer from the prestressing steel at the plant or job site, shall be furnished by the Contractor to the Engineer well in advance of anticipated use:

(A) For wire or strand one 7 foot long sample shall be furnished for each heat or reel and for bars one 6 foot long sample shall be furnished for each heat.

(B) If the prestressing tendon is to be prefabricated, one completely fabricated prestressing tendon 5 feet in length for each size of tendon shall be furnished, including anchorage assemblies. If the prestressing tendon is to be assembled at the job site, sufficient wire or strand and end fittings to make up one complete prestressing tendon 5 feet in length for each size of tendon shall be furnished, including anchorage assemblies.

(C) If the prestressing tendon is a bar, one 6 foot length complete with one end anchorage shall be furnished and in addition if couplers are to be used with the bars two 3 foot lengths of bar equipped with one coupler and fabricated to fit the coupler shall be furnished.

Prestressing systems previously tested and approved need not be furnished as complete tendon samples, provided there is no change whatsoever in the material, design or details previously approved. Shop drawings shall contain an identification of the project on which approval was obtained, otherwise sampling will be necessary.

For prefabricated tendons, the Contractor shall give the Engineer at least 10 days notice before commencing the installation of end fittings or the heading of wires. The Engineer will inspect all end fitting installations and wire headings while such fabrication is in progress at the plant and will arrange for all required testing of the material to be shipped to the site.

No prefabrication tendon shall be shipped to the site without first having been released by the Engineer, and each tendon shall be tagged before shipment for identification purposes at the site. All unidentified tendons received at the site will be rejected.

Job site or site as referred to herein shall be considered to mean the location where the members are to be manufactured whether at the project site or a removed casting yard.

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.

Municipality	Supplements
MC:	**506.8 SAMPLES FOR TESTING**: Sampling and testing of prestressing strand for bridge members shall conform to the specifications of AASHTO M 203.

506.9 HANDLING:

Extreme 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. Precast prestressed members shall be handled, transported and erected in an upright position and the points of support and directions of the reactions with respect to the members shall be approximately the same during transportation and storage as when the member is in its final position.

Precast prestressed concrete members shall be placed in the structure in the conformity with the plans and special provisions for the structure to be constructed.

Precast prestressed concrete piling shall be placed in accordance with the provisions for concrete piling.

Municipality	Supplements
MC:	**506.9 HANDLING:** Precast prestressed concrete bridge members shall not be transported from the fabricating yard to the bridge site until attaining full design compressive strength, and not less than seven (7) days after the total transfer of prestressing force.

506.10 PAYMENT:

Precast prestressed concrete members, except piling, will be paid for at the contract price or prices for furnishing and erecting precast prestressed concrete members of the various types and lengths set forth in the proposal.

The contract price paid for furnishing the member shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all work involved in constructing and furnishing the member at the site of the work complete in place as shown on the plans, and as specified.

Partial payment will be allowed for members which are in the stockpile at the manufacturer's plant.

Municipality	Supplements
MC:	**506.10 PAYMENT:** A partial payment of one-half the contract unit price, administered in accordance with the provisions of Section 109.7(A), will be allowed for stockpiled precast prestressed concrete bridge members that have been approved by the Engineer for conformance with the project plans and these specifications. An adjustment in the contract unit price, to the nearest cent, will be made for precast prestressed concrete bridge members having cylinder strength test results less than the specified 28-day compressive strength. Strength tests will be conducted in accordance with Section 725.10 of the Uniform Standard Specifications. The adjustment in contract unit price, if the precast prestressed concrete bridge member is accepted, will be based on the schedule in Section 725.11.

Municipality	Supplements
MC:	**507.1 Description:** The work under this Section shall consist of furnishing a water-repellent penetration stain and other materials, and staining the following exposed concrete surfaces: 1) All concrete surfaces of bridge superstructures, including: • For Cast-in-place Post-tensioned Box Girders: Complete bottom(s) and sides, from parapet to parapet. • For Precast I-Girders: Fascia girders and overhangs, from top of inside face of bottom girder flange to deck parapet; bottom flanges of interior girders, including flange sides; faces of pier and abutment diaphragms; and bottoms of interior diaphragms. Excluded from staining are all vertical faces and fillets of interior girders and diaphragms, and the bottom of the deck slab; nominal overspray above the areas to be stained will be acceptable. • For Precast Box Beams/Voided Slab & Slab Units: Complete bottom(s) and sides, from parapet to parapet. • For Steel Girders: Overhangs from edge of steel girder top flange to parapet; faces of cast-in-place abutment diaphragms. 2) All surfaces of bridge piers, columns, exposed concrete pile bents, abutments, and parapet walls; concrete retaining walls; Mechanically Stabilized Earth (MSE) with precast concrete fascia panels; and Sound Walls; to at least one foot below finished grade. 3) All surfaces of bridge barriers and the sides and tops of permanent barriers not adjacent to the traveled way; and 4) Excluded from staining are the • Top side of decks, from barrier-to-barrier or curb-to-curb. • Sidewalks • Inside of curbs • Downdrains in accordance with this Section, unless called out otherwise on the Project Plans or specified otherwise in the Special Provisions. The work shall include the preparation of the surfaces to be stained, the protection and drying of the stain coatings, and the protection of pedestrian, vehicular, and other traffic under and near the work from stain spatter and disfigurement.

Municipality	Supplements
MC:	**507.2 Materials** **507.2.1 General Requirements:** Prior to application of the penetrating stain, the Contractor shall furnish the Engineer with independent laboratory test reports, which certify compliance of the stain with each of the specified physical, chemical, and performance requirements. Stain will be sampled and tested on a lot basis. At least one sample, not less than one quart in size, will be taken and tested. Random samples may be taken at the discretion of the Engineer. The water-repellent penetrating stain shall be ready-mixed at the manufacturer's plant. Water-repellent stain shall be furnished in new, unopened, air-tight containers which are clearly labeled with the exact title of the stain, Federal Specification number (when applicable), name and address of manufacturer, date of stain manufacture, and the lot or batch number. The containers shall conform to U.S. Department of Transportation Hazardous Material Shipping Regulations. Precautions concerning the handling and the application of the stain shall be shown on the label of stain containers. **507.2.2 Physical And Chemical Requirements:** The water-repellent penetrating stain shall be a semi-opaque colored toner, containing methyl methacrylate-ethyl acrylate copolymer resins or isobutyl methacrylate resin, inorganic oxide toning pigments suspended in solution at all times by a chemical suspension agent and solvent, and shall conform to the following:

Property	**Requirement**	**Test Method**
Resin:	Methyl methacrylate - ethyl acrylate copolymer resin or isobutyl methacrylate resin	ASTM D 2621
Solvent:	Xylene or other hydrocarbon base compatible with the type of resin utilized.	ASTM D 3271
Viscosity:	55(±5) Krebs Units for methyl methacrylate-ethyl acrylate copolymer resin stains or 67(±8) Krebs Units for isobutyl methacrylate resin stain products.	ASTM D 562
Solids:	By weight - Total Composition 32.0 - 45.0%	ASTM D 2369
Gloss:	Angular reflectance shall not exceed 10 at 60 degrees	ASTM D 523
Grind:	7 = scatter back to 6	ASTM D 1210
Pigment to Resin Ratio:	Not more than 1.2:1.0, or less than 0.7:1.0, as determined by combined evaporation/solvent extraction procedures.	ASTM D 4451 ASTM D 2369 ASTM D 2698
Water Content:	Not more than 1.00 percent by volume	ASTM D 4017
Drying Time:	Dry to Touch - Max. 2 Hrs. Dry to Recoat - Max. 5 Hrs.	ASTM D 1640
Density:	8.2 lbs/US Gal. minimum	ASTM D 1475

The stain shall exhibit no settling or color variation. The use of vegetable or marine oils, paraffin materials, stearates, or organic pigments in any part of the stain formulation will not be permitted.

The Contractor shall provide a maximum of three samples of each color to be considered for the specified concrete structures and surfaces. The colors of each stain shall approximate that of the Paint Numbers as specified by Federal Standard 595a, when applied to 1) a concrete test specimen and to 2) the surface of the structures to be stained. Specific Paint Numbers required will be called out on the Project Plans or in the Special Provisions. The Contractor shall prepare test samples as specified in Section 507.3 for each color, after which time the Engineer will select one sample for each color for use with all applicable concrete structures and surfaces.

507.2.3 Performance Requirements:

(A) Resistance to Accelerated Weathering: The stain shall show no appreciable change in color or appearance after 2500 hours, when tested in accordance with ASTM G 53.

(B) Resistance to Sulfide Staining: The stain shall show no discoloration after 15 minutes immersion in saturated hydrogen sulfide solution when tested in accordance with ASTM D 1712. The test specimen shall be treated cement asbestos board or an approved equal.

(C) Resistance to Peeling and Flaking: When penetrating stain is applied to concrete test specimens or to final concrete surfaces, and subjected to the following cross-cut tests within 12 to 24 hours after application, removal of the stain shall be limited to small flakes of coating detached at the cross-cut intersections, such that less than 5% of the test area is affected.

All inspection testing of applied stain finishes on concrete test specimens and final concrete surfaces will be performed by the Engineer, using the following apparatus and procedures. The Contractor is to have the stain manufacturer's representative observe cross-cut testing, as deemed appropriate:

Test Apparatus and Materials: The Engineer will use 1) a sharp utility razor knife, 2) a single-edge razor blade scraper, and 3) two-inch wide, transparent pressure-sensitive tape (No. 3750-G Scotch Brand Tape by 3M Corp. is suitable for this purpose) to perform all tests.

Cross-Cut Tape Test: Vertical and horizontal cross-cuts will be made, through the stain film to the substrate, with the utility razor knife. Cuts shall be approximately two inches in length and 1/4 inch apart in both directions, forming a lattice pattern covering an area approximately two inches square. Before applying the pressure-sensitive tape, the cross-cut area will be inspected for any flaking and peeling of the stain film from the substrate, resulting from cutting the lattice pattern.

One end of a six-inch length of pressure-sensitive tape will be placed to cover the cross-cut area. The tape will be smoothed in the area of the cross-cuts, and then rubbed firmly with the blunt end of the razor knife, to attain maximum adhesion. Within 90 seconds (+ 30 seconds) of application, the tape will be removed by gripping the free end and pulling it off rapidly (not jerking), back upon itself, as close to an angle of 180 degrees as possible. The cross-cut area will then be inspected again for any flaking and peeling of the stain film from the substrate, this time resulting from the adhesion of the tape to the stain film.

Cross-Cut Scrape Test: Vertical and horizontal cross-cuts will be made, through the stain film to the substrate, with the utility razor knife. Cuts shall be approximately two inches in length and 1/4 inch apart in both directions, forming a lattice pattern covering an area approximately two inches square. Before scraping the cross-cut area, the area will be inspected for any flaking and peeling of the stain film from the substrate, resulting from cutting the lattice pattern.

The cross-cut area will then be scraped with the razor blade scraper, and the area inspected again for any separation and flaking and peeling of the stain film from the substrate, resulting from the scraping.

Municipality	Supplements
MC:	**507.3 Construction/Application Requirements:** All water-repellent penetrating stain shall be applied by an Arizona Licensed Painting Contractor, acceptable to both the manufacturer and the Engineer. The method of application, the rate of application, the number of coats of application, and the surface temperature range of application shall all be in accordance with the manufacturer's written recommendations. A copy of these recommendations shall be furnished to the Engineer, prior to application of the stain. The Contractor shall furnish a maximum of three samples of concrete, each with one of the specified penetrating stains applied. Each sample shall measure 2 feet by 2 feet and shall have a surface similar in pattern and texture to that to be used on the work. When new concrete is to be stained, the samples shall be cast at the same time as the new concrete. The stain(s) shall be applied to the samples, using the same methods that will be used to stain the work. The samples shall be placed at the project site, and left for two weeks for observation. At this time, the Engineer will select one color for use with all applicable concrete structures and surfaces. All inspection testing of the stain finishes on the samples will be performed by the Engineer. Such testing will consist of the same cross-cut tests specified herein under Section 507.2.3(C) – Resistance to Peeling and Flaking, to verify penetration and adhesion of the stain finish. No stain shall be applied on the project until the final sample stain finish has been approved by the Engineer in writing. All new concrete shall be finished and cured in accordance with the requirements of the Specifications, the MCDOT Supplement, and the Special Provisions, prior to the application of the stain. Before the stain is applied, all concrete surfaces to be stained shall be sandblasted, and then cleaned in accordance with the stain manufacturer's written recommendations, to remove all dirt, dust, curing agents, form release agents, efflorescence, scale, and other foreign substances which could be detrimental to the stain penetration or color. All sandblasting shall be performed in strict compliance with regulations of local and governing authorities. All concrete surfaces to be stained shall be clean, completely dry, and free of frost and other foreign substances at the time of the application of stain. The Contractor shall provide such protection as is necessary to prevent damage to the work, property, and persons, as a result of the cleaning and staining operations. After the structure has been prepared for the application of stain, and prior to stain application, the Contractor and the stain manufacturer’s representative shall inspect the surfaces to be stained. The manufacturer’s representative shall notify the Engineer in writing that the surfaces are satisfactory for the stain to be applied. The Contractor shall not start applying the stain without specific approval from the Engineer. All random inspection testing of the completed stain finish will be performed by the Engineer. Such testing shall consist of the same cross-cut tests specified herein under Section 507.2.3(C) – Resistance to Peeling and Flaking, to verify penetration and adhesion of the stain finish. Any stained areas that show evidence of peeling or flaking shall be sandblasted and cleaned as previously specified, and refinished to match the stain finish of the surrounding concrete surfaces. The Contractor shall restain all damaged test inspection areas. **507.4 Measurement:** Measurement for Concrete Stain will be by the lump sum, as a single, complete unit of work, unless otherwise specified in the Special Provisions and contract documents. **507.4 Payment:** Payment for the accepted area of Concrete Stain, as specified in this Section, the Project Plans, and the Special Provisions, will be made at the contract lump sum price. The contract lump sum payment will include the costs of all independent laboratory tests and reports; supplying samples; sandblasting and cleaning surfaces; furnishing and applying water-repellent penetrating stain; restaining damaged test inspection areas; sandblasting, cleaning, and refinishing previously rejected areas of applied stain; providing a manufacturer's representative as specified herein; and protecting all traffic under and near the work from stain spatter and disfigurement.

CONCRETE BLOCK MASONRY

510.1 DESCRIPTION:

All materials for concrete block masonry shall conform to the requirements of Sections 775 and 776.

510.2 CONSTRUCTION:

Proper masonry units shall be used to provide for all windows, doors, bond beams, lintels, pilasters, etc. with a minimum of unit cutting. Where masonry unit cutting is necessary, all cuts shall be neat and regular and edges exposed in the finished work shall be cut with a power driven abrasive saw.

Where no bond pattern is shown, the wall shall be laid up in straight uniform course with regular running bond with alternate header joints in vertical alignment.

Intersecting masonry walls and partitions shall be bonded by staggering the joints to form a masonry bond and the use of 1/4 inch minimum diameter ties at 24 inches o.c. maximum.

Where stack bond is indicated on the plans, approved metal ties shall be provided horizontally at 24 inches o.c. maximum.

Where masonry facing is a part of wall construction metal, ties shall be furnished and installed as directed by the Engineer.

Mortar joints shall be straight, clean and uniform in thickness. Unless otherwise specified or detailed on the plans, horizontal and vertical joints shall be approximately 3/8 inch thick with full mortar coverage on the face shells; shall have vertical joints buttered well for a thickness equal to the face shell of the block and these joints shall be shoved tightly, so that the mortar bonds to both blocks. No slushing or grouting of a joint will be permitted, nor shall a joint be made by working in mortar after the units have been laid.

Exposed walls shall have joints tooled with a round bar or V-shaped bar to produce a dense, slightly concave surface well bonded to the block at the edges. Tooling shall be done when the mortar is partially set but still sufficiently plastic to bond. All tooling shall be done with a tool which compacts the mortar, pressing the excess mortar out of the joint rather than dragging it out.

If it is necessary to move a block so as to open a joint the block shall be removed from the wall, cleaned and set in fresh mortar.

510.3 PLACING REINFORCING STEEL:

Reinforcing steel shall be placed as indicated on the plans. Splices shall be lapped a minimum of 40 diameters, except that dowels other than column dowels need to be lapped only 30 diameters. Column dowels shall lap 50 diameters.

Outside horizontal steel shall lap around corners 40 diameters, and be carried through columns unless otherwise shown on the plans. Inside horizontal steel shall extend as far as possible and bend into corner core. A dowel shall be provided in the foundation for each vertical bar. Bending of dowels to fit openings will not be permitted and, where required, new dowels shall be installed by drilling and grouting. All lap joints shall be wired.

Vertical cores containing steel shall be filled solid with grout, and thoroughly rodded.

Where knockout blocks are used, steel shall be erected and wired in place before 3 courses have been laid. Vertical cores at steel locations shall be filled as construction progresses.

Where knockout blocks are not used, vertical cores at steel locations shall be filled in lifts of not more than 4 feet. The maximum height of pour shall be 8 feet. Cores shall be cleaned of debris and mortar and shall have reinforcing steel held straight in place. If ordered by the Engineer, inspection and cleanout holes shall be provided at the bottom of each core to be filled.

Reinforcing steel shall be inspected prior to placing grout.

510.4 CURING:

Newly constructed masonry shall be kept damp for at least 5 days with a nozzle regulated fog spray sufficient only to moisten faces of the masonry but not of such quantity as to cause water to flow down over the masonry.

510.5 MORTAR AND GROUT:

Mortar and grout used for concrete block masonry shall conform to Section 776.

510.6 PAYMENT:

Payment for concrete block masonry will be included in the lump sum price for the structure of which the masonry is a part, unless another basis for payment is included in the proposal.

BRICK MASONRY

511.1 MATERIALS:

Unless otherwise specified, brick masonry shall be constructed of brick conforming to Section 775 and cement mortar as described in Section 776.

511.2 BRICKLAYING:

The amount of wetting will depend on the rate of absorption of the brick at the time of laying. When being laid, the brick shall have suction sufficient to hold the mortar and to delete the excess water from grout, and shall be sufficiently damp so that the mortar will remain plastic enough to permit the brick to be leveled and plumbed after being laid without breaking the mortar bond.

Brick work shall be plumb, level, straight and true to dimensions shown on the plans. Such work shall start, where feasible, at a least important corner of wall and the masonry contractor shall request an early inspection of the work by the Engineer. All pattern work, bonds or special details indicated on the plans shall be accurately and uniformly executed. Face bonding shall be as shown on the plans, but if not shown, shall be running bond for standard size brick and approximately _ bond for oversize brick and approximately 1/4 bond for modular brick unless otherwise designated by the Engineer. All bed and head joints shall be solidly filled with mortar at the time of laying.

Unless otherwise shown or detailed on the plans the thickness of mortar joints shall be uniformly 1/2 inch.

Face bricks shown to be laid in stack bond shall have the center lines of vertical joints plumb and the brick laid equidistant from the center line with not more than 1/8 inch variation in the width of these joints. The brick in each separate stack shall not vary more than 1/8 inch in length, but the separate stacks may vary in width of stacks.

When mortar has slightly stiffened, solidly fill with mortar all interstices between bricks and between bricks and other materials and also fill all line pin holes. Jointing and tooling shall be done before mortar has stiffened.

Masonry to be plastered shall have all mortar joints trowel cut flush.

Masonry to be painted and not shown to be tooled or raked, shall have all joints carefully and evenly struck with a trowel.

Masonry to be left exposed without paint or plaster, shall have all mortar joints carefully and evenly tooled with a metal jointing tool of a type as approved by the Engineer. Masonry shown or indicated to have raked joints shall have the joints raked out 3/8 inch deep, then tooled with a flat jointing tool, then brushed with a stiff non-metallic brush. Sack-rubbing or wiping finished masonry with rags will not be permitted.

511.3 PROTECTION:

Protect all sills, ledges, offsets, other materials, etc., from droppings of mortar during construction. Protect the tops of all unfinished masonry from rain by using water-repellant covering such as roofing felt or tar paper.

Protect the surfaces of wall, piers, etc., from mortar droppings, or splashes at scaffold heights.

511.4 CURING:

Finished masonry shall not be wetted, except when exposed to extreme hot weather or hot wind, and then only by using a nozzle regulated fog spray sufficient only to dampen the face but not of such quantity to cause water to flow down over the masonry.

511.5 REINFORCED GROUTED BRICK MASONRY:

Mortar in all bed joints shall be held back 1/4 inch from edges of brick adjacent to grout space, or shall be beveled back and upward from grout space. The thickness of head and bed joints shall be as hereinbefore specified or shown. Head joints specified or shown to be less than 5/8 inch thick shall be solidly filled with mortar as brick are laid. Head joints 5/8 inch or more in thickness may have mortar sufficient only to form dams to retain the grout. Bed joints shall not be deeply furrowed with the trowel. All brick shall be shoved at least 1/2 inch into place. One outer tier shall be not more than 12 inches before grouting, but the other tier shall be not more than 4 inches high before placing the grout. Grout shall be thoroughly agitated and mixed to eliminate segregation before being placed. All interior grout spaces shall be filled with grout and immediately puddled or swished with a stick or rod (not a trowel) sufficiently to cause the grout to flow into all interstices between the bricks and to fully encase the reinforcing steel. Wherever possible, grouting shall be done from the inside face of exterior masonry. If any grout contacts the finished masonry, it shall be immediately removed, and the surface cleaned.

In masonry which is more then 2 tiers in thickness, including pilasters and columns, the interior shall be of whole or half bricks placed into grout with not less than 3/4 inch of grout surrounding each brick or half brick. Except at the finish course, all grout shall be stopped 1 1/2 inches below the top of both outer tiers. Where necessary to stop off a longitudinal run of masonry, it shall be done only by racking back 1/2 brick length in each course and stopping grout 2 inches back of the rack. Toothing will not be permitted unless special approval is given by the Engineer.

Reinforcing steel shall be accurately placed in strict accordance with the plans and notes thereon. Vertical steel shall be held firmly in proper position. Where necessary this shall be done by means of frames or other suitable devices. Horizontal steel may be placed as the work progresses.

511.6 PAYMENT:

Payment for brick masonry will be included in the lump sum price for the structure of which the masonry is a part unless another basis for payment is included in the proposal.

STEEL STRUCTURES

515.1 DESCRIPTION:

515.1.1 Shop Drawings: The Contractor shall prepare and submit to the Engineer for approval, complete shop drawings which shall show details, dimensions, sizes of materials, and all information and data necessary for the metal work, including full details of the match markings. Any materials fabricated by the Contractor prior to the approval of the drawings will be at his risk. The Contractor shall be responsible for the correctness of the drawings and for shop fits and field corrections, even though the drawings may have been approved by the Engineer.

515.1.2 False work: The Contractor shall be fully responsible for designing and providing false work capable of supporting all loads which are applied.

515.1.3 As Built Plans: When required by the special provisions, the Contractor shall furnish to the Engineer before formal acceptance of the work detailed plans of the structure as built. Inasmuch as the plans will be retained by the Contracting Agency as permanent records, they must be in the form of printable transparencies of quality satisfactory to the Engineer.

515.1.4 Methods and Equipment: When requested by the Engineer, before starting erection of any structural members, the Contractor shall inform the Engineer fully as to the methods he proposes to follow and the amount and character of equipment he proposes to use. The use of such methods and equipment shall be subject to the approval of the Engineer. Approval by the Engineer shall not be considered as relieving the Contractor of the responsibility for the safety of his methods or equipment or for carrying out the work in full accordance with the plans and specifications.

An inspector or other authorized representative of the Engineer may examine the metals and metal items to be fabricated before they are worked in the shop and may exercise constant surveillance over the work during its progress, with full power to reject materials or workmanship not conforming to the plans and specifications.

The Contractor shall give the Engineer sufficient advance notice to permit ample time for the inspection of materials before commencement of the fabricating operations.

The Engineer shall be furnished complete copies in triplicate of all mill reports. The Contractor shall furnish ample means and assistance for sampling all materials. Arrangements shall be made for the Engineer to have free access at all times to any portion of the shops where work is being done.

No fabricating, machining, cutting, welding, assembling, or painting shall be done except with the knowledge of the Engineer. Any work done otherwise will be subject to rejection.

The acceptance of any material or finished member by the Engineer shall not be a bar to subsequent rejection if it is later found to be defective. Rejected material and workmanship shall be promptly replaced.

Samples of materials, except castings, shall be cut from stock designated by the Engineer or will be selected from items furnished. Gray iron, steel, and bronze castings shall be cast with test coupons.

515.2 STEEL BUILDING AND MISCELLANEOUS STEEL STRUCTURES:

Details of design, fabrication and erection of such buildings and structures shall conform to the specifications for the design, fabrication and erection of structural steel for buildings of the AISC except as modified by the special provisions for any conflicts with the applicable building code which may exist.

The design, fabrication and erection of structural steel and all similar work incidental or appurtenant to steel construction for highway bridges shall be performed in accordance with the latest standard specifications for highway bridges adopted by AASHTO. The plans or special provisions will designate the members to be galvanized.

515.2.1 Miscellaneous Metal Fabrication: The provisions of this subsection shall apply to items not intended primarily for structural purposes and which are fabricated from metals.
If straightening of any materials is necessary, the straightening shall be done by methods which will restore the material to its

original shape or surface without residual blemish. Sharp kinks or bends will be considered a cause for rejection of the materials.

The finish of miscellaneous metal items shall not be less in quality and workmanship than that standard considered to be the commercial standard for the kind of member being furnished. Punched and drilled holes shall be burred and, unless otherwise specified, sheared and machined edges shall be finished by grinding to an appropriate radius. Riser, sprue, or vent marks on castings shall be ground flush with the adjacent surface. Blow holes in castings shall not be repaired by any method except as authorized in advance by the Engineer. Exposed edges of sheet metal shall be dressed with a stone or file to remove the sharp edges or corners. Drilled or punched holes which are improperly located or misaligned shall be cause for rejection and may not be corrected without the prior approval of the Engineer. All parts of assemblies shall be fabricated so that they may be assembled without forcing or drifting.

Welders proposed to be used on miscellaneous metal fabrication will be subject to qualifications.

515.3 WORKMANSHIP:

Workmanship and finish shall be equal to the best general practice in modern bridge shops.

Rolled material before being laid off or worked shall be straight. If straightening is necessary, it shall be done by methods approved by the Engineer. Kinks and bends may be cause for rejection of the material.

If straightening is necessary in the field only methods approved by the Engineer shall be used.

Following the straightening of a bend or buckle, the surface of the metal shall be carefully inspected for evidence of fracture.

Portions of the work exposed to view shall be finished neatly. Shearing, flame cutting and chipping shall be done carefully and accurately. Undercut gusset plates will not be accepted. All sharp corners and edges, and edges that are marred, cut or roughened in handling or erection, shall be slightly rounded by grinding or other suitable means.

515.4 COMPUTED WEIGHT:

The computed weight shall be obtained by the use of the following rules and assumptions:

(A) The weight of structural and cast steel shall be assumed at 0.2833 pound per cubic inch. The weight of cast iron shall be assumed at 0.2604 pound per cubic inch. The weight of wrought iron shall be assumed at 0.2776 pound per cubic inch.

(B) The weights of rolled shapes and of structural plates, shall be computed on the basis of their nominal weights and dimensions, as shown on the shop drawings, deducting for copes, cuts, and open holes, exclusive of rivet or bolt holes.

(C) Rivets, bolts, and welds shall be considered as incidentals and their price shall be included in the price of steel shapes and plates.

(D) The weight of castings and fillets shall be computed from the dimensions shown on the shop drawings, deducting for all openings or cuts in the finished casting.

(E) The weight of pins and rollers shall be computed from the dimensions shown on the shop drawings, deducting for all holes, openings, pockets, and metal removed by machine finishing.

Pilot nuts and driving nuts for each size of pin shall be furnished for erection work and the weights of such nuts will not be included in the weight of structural steel to be paid for.

(F) If computed weights are used to determine the pay quantities of galvanized metal, the weight to be added to the calculated weight of base metal for the galvanizing shall be determined from the table of weights of zinc coatings specified by the ASTM A-153.

515.5 PAINTING:

With the exception of items which are to be galvanized, structural steel members and miscellaneous metal items shall have a shop prime coat of approved rust-inhibitive paint. Application shall be as specified in Section 530. The thickness of the prime coat shall be not less than one mill.

After erection of structural steel uncoated surfaces at connections, surfaces where the shop coat has been abraded or otherwise damaged shall be touched up. Match marks and identification marks shall be properly cleaned off and painted over. The paint shall be identical to that used for the shop prime coat.

515.6 MEASUREMENT:

Steel structures will be paid for at a lump sum price or at a price per pound for structural steel, and at prices per pound for cast steel and cast iron. The pay quantities will be determined by computed weights or, by scale weights obtained as provided in this specification. Only material actually used in the completed structure will be paid for.

The pay quantities will be determined by computed weights for rolled sections and scaled weights for castings except as otherwise specified.

Computed weights will be used to determine pay quantities of alloy and carbon steel when members contain both alloy and carbon steel.

The weight of erection bolts, paint, boxes, crates, and other containers used for packing and the materials used for supporting members during transportation will not be included in the weights of material to be paid for.

The weight of structural steel to be paid for will not exceed the computed weight by more than 1 1/2 percent. The weight of cast steel or cast iron to be paid for will not exceed the computed weights by more than 7 1/2 percent. If the scale weight of any member is less than 99 1/2 percent of the computed weight of that member, the member will be rejected and will not be paid for.

If computed weights are used, the weight to be paid for will be the calculated weight as established by the Engineer and no allowance will be made for weight in excess thereof.

515.7 PAYMENT:

Unless otherwise provided in the proposal, the basis of payment for steel structures shall be as follows:

The price paid per pound for structural steel including full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for doing all the work involved in furnishing, fabricating, delivering, erecting and prime coating the steel work, complete in place, as shown on the plans, and as specified in these specifications and the special provisions, and as directed by the Engineer.

The prices paid per pound for cast steel, cast bronze and cast iron shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in furnishing and placing the materials, complete in place, as shown on the plans, and as specified in these specifications and the special provisions, and as directed by the Engineer.

Full compensation for furnishing and placing sheet packing, performed fabric pads, elastomeric or elastic bearing pads, and red lead paste, and for grouting masonry or bearing plates as shown on the plans shall be considered as included in the price paid for structural steel and no separate payment will be made therefore. Where the specifications or plans require metal to be galvanized, the price paid per pound for the metal, including the weight of zinc coating, shall be considered as full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in furnishing the galvanized metal complete in place, as shown on the plans, and as specified in the specifications and the special provisions, and as directed by the Engineer.

STEEL AND ALUMINUM HANDRAILS

520.1 DESCRIPTION:

Metal handrail shall consist of furnishing all materials and constructing handrail of steel or aluminum, including railing, posts, fittings and anchorages. Metal handrail shall be fabricated, installed and painted, when required, in accordance with the details shown on the plans and these specifications.

520.2 FABRICATION:

Prior to beginning any work on the fabrication of the railing, the Contractor shall submit shop drawings for approval, showing complete railing details.

Materials furnished for metal handrail shall conform to the requirements specified on the plans.

The Engineer shall be furnished complete, copies in triplicate of all mill reports on steel and aluminum materials furnished.

Railings shall be fabricated from welded or seamless members of the size and thickness shown on the plans. Steel members shall conform to the requirements of ASTM A-53. Grade B structural steel conforming to ASTM A-36, or tubular sections of hot rolled mild steel, as shown.

Welding shall be performed by the electric arc process and shall be done in conformance with Specifications for Welded Highway and Railway Bridges of the AWS. All butt welds on exposed surfaces shall be ground flush with adjacent surfaces.

Railing panels shall be straight and true to dimensions.

For structures on curves, either horizontal or vertical, the railing shall conform closely to the curvature of the structure.

The completed steel railing units shall be galvanized in accordance with the requirements of Section 771 unless otherwise specified.

Municipality	Supplements
PH:	**20.2 Fabrication:** Aluminum railings or members shall be Aluminum Alloy 6063-T6 as per the Aluminum Alloy Association Standards for Handrails.

520.3 ERECTION:

The railing shall be carefully erected, true to line and grade. Posts and balusters shall be vertical and parallel with the deviation from the vertical for the full height of the panel not exceeding 5/8 inch. After erecting the railing, any abrasions or exposed steel shall be repaired in accordance with Section 771 or Section 530.

520.4 MEASUREMENT:

The various types of railing will be measured by the linear foot from end to end along the face of the railing including terminal sections.

520.5 PAYMENT:

The price paid per linear foot for handrailing shall include full compensation for furnishing all labor, materials, tools, and equipment and doing all work involved in constructing the railing complete in place as shown on the plans and specified herein.

PNEUMATICALLY PLACED MORTAR

525.1 DESCRIPTION:

The work under this section shall consist of furnishing all material and pneumatically placing, by means of suitable equipment and competent operators, either premixed portland cement and fine aggregate (dry mix process) or premixed concrete (wet mix process).

525.2 DRY MIX PROCESS:

The dry mix process shall consist of thoroughly mixing a proportional combination of fine aggregate and portland cement and conveying this mixture through a delivery hose to a special nozzle where water is added and combined with the dry ingredients prior to discharge. The nozzle water ring shall be cleaned daily.

The fine aggregate shall be material sand, conforming to ASTM C-33, with Gradation No. 1 as shown in Table 525-1 and with not less than 3 percent or more than 7 percent moisture by weight.

Portland cement and mixing water shall conform to the requirements of Section 725.

The dry mix shall consist of 1 part portland cement and 4.5 parts of fine aggregate by weight. Machine mixing will be required. This operation of proportioning and mixing shall be subject to the approval of the Engineer.

525.3 WET PROCESS:

The wet process shall consist of premixing by mechanical methods a proportional combination of portland cement, aggregate and water required to produce mortar or concrete and conveying this mortar or concrete through the delivery hose to the special nozzle where additional compressed air is added prior to discharge. The air ports in the nozzle shall be cleaned daily.

The portland cement concrete used for the Wet Mix Process shall conform to Section 725 and shall be Class A (3000 psi) unless otherwise specified. In no event shall a slump greater than 4 inches be used. As the work approaches the vertical, the maximum slump shall not exceed 1 inch.

The fine and coarse aggregate shall conform to ASTM C-33 using one of the three graduations shown in Table 525-1. Unless otherwise specified, Gradation No. 1 will be used.

TABLE 525-1

PNEUMATICALLY PLACED MORTAR GRADATION (A.C.I. TABLE 2.2.1)

Sieve size	Percent by weight passing individual sieves		
	Gradation No. 1	Gradation No. 2	Gradation No. 3*
3/4 in.	—	—	100
1/2 in.	—	100	80-95
3/8 in.	100	90-100	70-90
No. 4	95-100	70-85	50-70
No. 8	80-100	50-70	35-55
No. 16	50-85	35-55	20-40
No. 30	25-60	20-35	10-30
No. 50	10-30	8-20	5-17
No. 100	2-10	2-10	2-10

*Batch fine and coarse aggregates separately to avoid segregation.

525.4 REINFORCING STEEL:

Reinforcing steel bars or welded-wire fabric shall conform to Section 727 and shall be 6 x 6 - W 1.4 x 1.4 welded wire fabric unless otherwise specified. Reinforcement shall be placed as closely as possible to the center of the mortar.

525.5 EQUIPMENT:

Prior to the start of construction, the Contractor shall demonstrate that his equipment, materials and operators are capable of providing a finished structure in accordance with the specifications. For this demonstration, the Contractor shall provide test panels, 30 inches by 30 inches, with a depth the same as the structure, but not less than 4 inches. A separate panel shall be provided for each shooting position to be used (overhead, slope and/or slab) and one half of each panel shall contain reinforcement as used in the structure. Cores will be taken for visual inspection and compressive strength tests. The Engineer has the authority to accept or reject equipment, materials and/or operators based on his evaluation and his decision will be final.

If the Contractor can present valid, factual documentation to the satisfaction of the Engineer that his equipment, materials and operators have produced satisfactory results on similar work within the past six months, the Engineer may eliminate the test panel procedure.

525.6 SURFACE PREPARATION:

The surface on which the mortar is to be placed shall be compacted and true to line and grade as required by the plans and specifications. The surface shall be uniformly moistened so that water will not be drawn from the freshly-placed mortar. Placement of the mix shall not start until the temperature is 35°F and rising and shall stop when the temperature is 40°F and falling.

525.7 FORMS AND GROUND WIRES:

Forms shall be plywood or some other suitable material, true to line and grade, sufficiently rigid to resist deflection during mortar placement.

Ground or gauging wires shall be installed where necessary to establish the thickness and finish lines of the structure.

525.8 JOINTS:

Construction joints shall be tapered to a shallow edge from not more than one inch thick over a width of approximately one foot except where the joint will be subjected to compressive stress. In this case, square joints shall be constructed. Joints shall be thoroughly cleaned and wetted prior to any additional application.

Install control joints in accordance with the plans. Reinforcement will not extend across control joints.

525.9 FINISHING:

Unless otherwise specified, the natural gun finish will be provided.

525.10 CURING:

Curing shall be accomplished using Type 2 compound as specified in Section 726. Application rate shall be not less than one tenth of a gallon per square yard. Subsection 505.6.2 Adverse Weather Concreting is applicable.

525.11 TESTING:

Tests to determine the quality of the mortar will be performed by the Engineer periodically during the course of work. Test panels shall be prepared by the Contractor.

Test panels shall be at least 12 inches square and as deep as the structure, but not less than 4 inches. Cores shall be taken from the panel for visual and compressive strength tests. The minimum compressive strength at the end of 28 days shall be 3000 psi.

The Engineer may allow the use of 6 inches by 12 inches hardware cloth cylinders for testing in lieu of the test panels. These cylinders will be furnished by the Contractor.

All rebound pockets and any mortar, defective in the compressive strength test, shall be cut out and replaced.

525.12 PAYMENT:

Payment for pneumatically-placed mortar will be made at the unit price per square yard or the lump sum as set forth in the proposal. Such payment shall be full compensation for furnishing all labor, tools, equipment and accomplishing all work in conformity with the plans and specifications.

PAINTING

530.1 DESCRIPTION:

This work shall consist of furnishing paint and other necessary materials and painting metal, wood or other surfaces in accordance with the details shown on the plans and these specifications.

530.2 MATERIALS:

Materials used in paint for painting shall conform to the requirements of Section 790.

530.3 WEATHER CONDITIONS:

Paint shall be applied only on thoroughly dry surfaces and during periods of favorable weather. Except as provided below, painting will not be permitted when weather conditions during application are such that the atmospheric temperature will drop below 35°F. during the drying period. If fresh paint is damaged by the elements, it shall be replaced by the Contractor at no additional cost to the Contracting Agency.

Subject to the approval of the Engineer, the Contractor may provide suitable enclosures to permit painting during inclement weather. Provisions must be made to control atmospheric conditions artificially inside the enclosures within limits suitable for painting throughout the painting operation. The cost of providing and maintaining such enclosures shall be considered as included in the prices paid for the various contract items of work and no additional payment will be made therefore.

530.4 APPLICATION:

Painting shall be done in a neat and workmanlike manner. Unless otherwise specified paint shall be applied either by brush, roller, or spray methods.

If brushes are used, they shall have sufficient body and length of bristle to spread the paint in a uniform coat. In general, the primary movement of the brush shall be such as to fill thoroughly all irregularities in the surface, after which the coating shall be smoothed by a series of parallel strokes. Paint shall be evenly spread and thoroughly brushed out. If a considerable amount of brush marks appear, it will be considered that the paint has been improperly applied. If rollers are used, they shall be of a type that do not leave a stippled texture in the paint file.

On all surfaces which are inaccessible for brushing, the paint shall be applied by spray or by sheepskin daubers especially constructed for the purpose, or by other means approved by the Engineer.

If spray methods are used, the operator shall be thoroughly experienced. Runs, sags, thin areas in the paint coat, or skips and holidays shall be considered as evidence the work is unsatisfactory and the Contractor may be required to apply the remainder of the paint by brush.

A water trap acceptable to the Engineer shall be furnished and installed on all equipment used in spray painting.

Mechanical mixers shall be used to mix the paint. The paint shall be mixed a sufficient length of time, prior to use, to thoroughly mix the pigment and vehicle together. Paint shall be kept thoroughly mixed while being applied.

530.5 THINNING PAINT:

Paints specified are formulated ready for application and no thinning will be allowed. If the paint becomes thick in cool weather, it shall be heated in the container immersed in hot water.

530.6 PROTECTION OF WORK:

The Contractor shall protect all parts of the structure against disfigurement by spatters, splashes, and smirches of paint or of paint materials. The Contractor shall be responsible for any damage caused by his operations to vehicles, persons, or property, and shall provide protective means to guard against such damage at his expense.

Paint stains which might result in an unsightly appearance shall be removed or obliterated by the Contractor.

When ordered by the Engineer, if traffic causes an objectionable amount of dust, the Contractor shall sprinkle the adjacent roadbed and shoulders with water for a distance on each side of the location where painting is being done sufficient to abate the dust nuisance. The Contractor shall furnish and post at his own expense DRIVE SLOWLY signs and take other necessary precautions to prevent dust and dirt from accumulating on freshly painting surfaces.

530.7 SAFETY PRECAUTIONS:

The following safety precautions shall be observed in addition to those prescribed by law in Section 107.

The applicable sections of NACE, A Manual for Painter Safety.

530.8 SURFACE PREPARATION FOR PAINTING:

530.8.1 Steel: Surface preparation for painting of the steel shall conform to the surface preparation specifications of the Steel Structures Painting Council.

Unless otherwise specified, the commercial blast method shall be used.

After erection and riveting or welding, all surfaces of structural steel which will be exposed to air in the completed structure and the repainting of existing steel structures where partial painting is required, the method of cleaning will be as directed by the Engineer or as specified in the special provisions.

530.8.2 Galvanized Surfaces:

(A) Hand Cleaning: Concrete spatter, heavy grease, and other foreign matter shall be removed from galvanized surfaces by hand scraping or wire brushing.

(B) Solvent Cleaning: After hand cleaning, all galvanized surfaces shall be cleaned by the solvent cleaning procedures prescribed in Section 530.8.1 above to remove oil, grease and other detrimental foreign matter.

(C) Pretreatment: After hand and solvent cleaning, the cleaned areas shall then be painted by brushing on at least 1 full coat of paint No. 1. Unless otherwise directed by the Engineer, the second coat shall be applied within 24 hours after the primer is applied.

530.8.3 Wood Surface: Wood surfaces shall be prepared for painting by removing all cracked or peeled paint, loose chalky paint, dirt, and other foreign matter by wire brushing, scraping, sanding, or other approved means immediately prior to painting. All surfaces shall be wiped or dry brushed to remove any dust or chalky residue that may result from cleaning operations. All wood designated to be painted shall be thoroughly dry before paint is applied.

530.9 PAINTING:

530.9.1 Structural Steel:

(A) Paint: Unless otherwise required on the plans or in the special provisions, the paints to be applied to structural steel surfaces shall consist of a shop prime coat, as specified in Section 515, a second coat, and a finish coat. The total dry film thickness of the prime and second coat shall be not less than 3 mills. The dry thickness of the paint will be measured in place with a calibrated magnetic film thickness gauge.

Excessively thick coats of paint will not be permitted. The thickness of each coat shall be limited to that which will result in uniform drying throughout the paint film.

Unless specified otherwise on the plans or in the special provisions, the paint coats shall be as specified for general use on structural steel in Section 790. Succeeding coats of paint, not otherwise materially different in color, shall have carbon black mixed into the paint in accordance with Section 790 to produce a perceptible color difference between the paint coat being applied and the preceding coat.

Any damage to sound paint on areas not designated for treatment, resulting from the Contractor's operations, shall be repaired as directed by the Engineer.

(B) Application of Paint: Painting of structural steel, except for shop applied prime coats and sections which will be inaccessible after erection as described below, shall be done after erection unless otherwise specified in the special provisions. Requests to do any additional painting prior to erection shall be submitted by the Contractor and approved by the Engineer in writing before such work is started. Painting prior to erection will be limited to a prime coat of paint, except that surfaces exposed to the atmosphere which would be inaccessible for painting after erection shall be painted the full number of coats prior to erection. Any deficiencies in the prime coat of paint, or any second coat shall be corrected to the satisfaction of the Engineer prior to the application of the finish coat of paint.

The surface of the paint coat being covered shall be free from moisture, dust, grease, or any other deleterious material which would prevent the bond of the succeeding coat. In spot painting, any old paint which lifts after application of the touch-up coat, shall be removed by scraping and the area repainted before application of the next coat.

The finish coat shall not be applied until the required total film thickness of the undercoats of paint, as described above is obtained.

Open seams at contact surfaces of built-up members which would retain moisture shall be caulked with red lead paste before applying the second coat of paint.

Except for anchor bolt assemblies, steel embedded in concrete need not be painted. Anchor bolt assemblies shall be painted or dipped with 1 coat of paint prior to installation.

With the exception of abutting chord and column splices and column and truss shoe bases, machine finished surfaces shall be coated with a rust inhibitor which can be easily removed. Surfaces of iron and steel castings which have been machine finished shall be painted with a coat of shop paint.

530.9.2 Machinery: Prior to installation, all surfaces of machinery exposed to the atmosphere which are subject to corrosion and are normally painted, shall be painted with 2 coats of paint. Unless otherwise specified, after installation of the machinery, such surfaces shall be painted with a finish coat. All coats shall be as specified for structural steel.

530.9.3 Galvanized Surfaces: Unless otherwise provided on the plans or in the special provisions, galvanized surfaces shall be left unpainted. Areas of galvanized coating damaged due to welding after fabrication or handling shall be prepared as specified above and then painted with 1 full coat of paint No. 15.

530.9.4 Metal Guard Rails: Metal guard rails when required to be painted shall be painted with 2 coats of paint No. 11.

530.9.5 Wood Surfaces:

(A) Paint: The surface shall be prepared as specified above and painted with paint No. 6 or 7. The number of coats of paint will be specified in the special provisions.

(B) Application of Paint: When permitted in writing by the Engineer, the prime coat of paint may be applied prior to erection. After the prime coat has dried and the timber is in place, all cracks, checks, nail holes, etc., shall be puttied flush with the surface and allowed to dry before the second coat is applied.

Skips, holidays, and thin areas or other deficiencies in any 1 coat of paint shall be corrected to the satisfaction of the Engineer before the succeeding coat is applied.

The surface of the paint coat being covered shall be free of any deleterious material before any additional paint is applied.

530.10 TESTING:

Paint and paint materials shall be sampled and tested prior to use. Tests shall be conducted in accordance with methods specified by ASTM or by methods set forth in Federal Standard 141. In the absence of any such methods, other suitable methods may be designed and utilized by the Engineer. Lots or batches of paint of proprietary brand, as defined in Section 790, which have been previously sampled and tested by the Contracting Agency, and approved, may be used without further testing, if permitted by the Engineer.

530.11 PAYMENT:

Payment for the preparation of surfaces, shop prime coat and field touch-up coats on structural steel and miscellaneous metal items shall be considered as included in the prices for the structural steel and miscellaneous metal items. Payment for second and finish coats on structural steel or miscellaneous metal items shall be considered as included in payments for the structures, except that payment for cleaning all painting on miscellaneous metal items shall be considered as included in the price for the item when a separate price therefore is included in the proposal.

Full compensation for preparing surfaces and for painting machinery, galvanized metal, guard rails and wood shall be considered as included in the various prices paid for the contract items or work and no separate payment for such work will be made.