DIVISION 500 – STRUCTURES

SECTION 501 - FOUNDATION PILES

501.01 Description This work shall consist of furnishing and driving piles, of the types and dimensions specified on the Contract Plans. Piles shall conform to and be installed, as detailed in these specifications, to the lines, grades, locations, and required resistance(s) shown on the Plans or as authorized by the Resident. Work under this item shall also consist of any pile testing specified by the project Contract Plans and described in these specifications.

501.02 Materials Materials shall meet the requirements of the following sections of Divisions 500, Structures, and 700, Materials:

Structural Concrete (Class A)	502.05
Reinforcing Steel	709.01
Welded Steel Wire Fabric	709.02
Steel Pipe Piles, Splices and Tips	711.01
H-Beam Piles, Splices and Tips	711.10

Steel casings shall conform to the material requirements of Section 711.01, Steel Pipe Piles, Splices and Tips.

Mill test reports will be required for Steel Pipe Piles and H-Beam Piles. Notch toughness tests will not be required.

501.03 Quality Control Plan The Contractor shall control the quality of the foundation piles through testing, inspection and practices which shall be described in the Quality Control Plan (QCP), sufficient to assure a product meeting the Contract requirements. The QCP shall meet the requirements of Section 106, Quality and this specification. The Department will use criteria established in the approved QCP to accept the work provided in this Section.

No work under this item shall proceed until the QCP, or amendments to the QCP, is submitted to and approved by the Resident.

The QCP shall address all elements that affect the quality of the foundation piles including but not limited to, the following:

A. Driving Equipment
B. Wave Equation Analysis
C. Static Load Testing Apparatus
D. Driving Procedures
E. Number of Pile Splices, Locations and Details
F. Tolerances
G. Pile and Driving Equipment Data Form

The Contractor's Schedule of Work shall allow time for the review of the QCP or amendments to the QCP, as noted in Section 106.4.1.B, Approval.

501.04 Construction Requirements

501.041 Ordering Piles The Contractor shall order all pilings from an itemized list of order lengths provided by the Resident. When additional lengths of piles are necessary, the additional lengths will be ordered by the Contractor from a written list provided by the Resident.

501.042 Equipment for Driving Piles

Hammers Piles shall be driven with approved power-actuated impact hammers powered with steam/air, diesel fuel, or hydraulics (hereinafter referred to as power hammers). Gravity drop hammers (hereinafter referred to as drop hammers), except as noted on the Plans, shall only be used to drive timber piles. When drop hammers are used to drive timber piles, the ram shall be between 2,000 and 3,500 pounds and the height of drop shall not exceed 13 feet. In no case shall the ram weight be less than the combined weight of the drive head and pile. All drop hammers shall be equipped with hammer guides to insure concentric impact on the drive head.

Air/steam hammers shall be operated and maintained within the manufacturer's specified ranges. The plant and equipment furnished for air/steam hammers shall have sufficient capacity to maintain, at the hammer under working conditions, the volume and pressure specified by the manufacturer. The plant and equipment shall be equipped with accurate pressure gauges that are easily accessible to the Resident. The weight of the striking parts of air and steam power hammers shall not be less than 1/3 the weight of drive head and pile being driven, and in no case shall the striking parts weigh less than 2,750 pounds.

Open-end (single acting) diesel hammers shall be equipped with a device such as rings on the ram or a scale (jump stick) extending above the ram cylinder, to permit the Resident to visually determine hammer stroke at all times during pile driving operations. The Contractor shall provide the Resident with a chart from the hammer manufacturer equating stroke and blows per minute to energy imparted for the open-end diesel hammer to be used.

Closed-end (double acting) diesel hammers shall be equipped with a bounce chamber pressure gauge, in good working order, mounted near ground level to be easily read by the Resident. The Contractor shall provide the Resident with a chart, calibrated within 90 days of use, of actual hammer performance, equating bounce chamber pressure to either equivalent energy or stroke for the closed-end diesel hammer to be used.

Double-acting hydraulic hammers shall have a power plant with sufficient capacity to maintain the volume and pressure specified by the manufacturer, under working conditions. The power plant and equipment shall be equipped with digital readouts, easily accessible to the Resident, showing pertinent system criteria, including but not limited to energy imparted to the pile, to enable the Resident to visually determine whether or not the refusal criteria has been

met. In addition, the Contractor shall provide the Resident with a chart, calibrated within 90 days of use, of actual hammer performance.

Approval of Pile Driving Equipment All pile driving equipment shall be sized such that the specified piles can be driven to the required resistance, without damage, as indicated on the Plans. Approval of the pile driving equipment by the Department will be based on the wave equation analysis and a completed Pile and Driving Equipment Data Form, as shown on Figure 1 of this Section.

The wave equation analysis prepared by the Contractor shall include a proposed stopping criterion, where the number of blows per inch, for a number of 1 inch driving intervals, at a specified hammer-stroke and fuel setting, is clearly defined. The criteria that the Department will use to evaluate the driving equipment will be based on the approved wave equation analysis utilizing the information provided in the completed Pile and Driving Equipment Data Form.

For the driving system to be acceptable, the number of hammer blows at the required resistance indicated by the wave equation analysis shall be between 3 and 15 blows per inch, and the driving stresses shall not exceed 90% of the specified yield stress of the pile material. For timber piles, the compressive driving stress shall not exceed 1.15 times the base resistance of the wood in compression parallel to the grain. The stopping criteria used for pile driving operations shall be approved by the Department.

If the wave equation analyses show that the driving system is unacceptable, the Contractor shall modify or replace the proposed driving equipment in an amendment to the QCP, at its expense, until subsequent wave equation analyses indicate the piles can be driven to the required resistance, without damage or excessive blows. Department review times of a revised wave equation analysis and Pile and Driving Equipment Data Form will be per Section 106.4.1.B.

During pile driving operations, the Contractor shall use the approved system. No variations in the driving system will be permitted without an amendment to the QCP and a revised wave equation analysis and Pile and Driving Equipment Data Form.

Acceptance of the pile driving equipment does not relieve the Contractor of the responsibility to properly install the piling. The hammer acceptance and driving criteria will be based on commonly accepted hammer efficiencies, component properties, and soil parameters. Local soil conditions and the actual driving system will affect the driving. If, in the opinion of the Resident, the accepted driving system fails to perform satisfactorily during actual driving, the Department reserves the right to revise the driving criteria.

Drive System Components and Accessories

Leads Pile driver leads shall be constructed in such a manner as to afford freedom of movement of the hammer while maintaining alignment of the hammer and the pile to insure concentric impact for each blow.

Followers Followers, when used, must be included in the QCP. In cases where a follower is permitted, the first pile in each group and every tenth pile driven thereafter shall be driven full length without a follower, to verify that adequate pile length is being attained to develop the required pile resistance. The follower and pile shall be held and maintained in equal and proper alignment during driving. The follower shall be of such material and dimensions to permit the piles to be driven to the length determined necessary from the driving of the full-length piles. The final position and alignment of the first two piles installed with followers in each substructure unit shall be verified in accordance with location tolerances.

Hammer Cushion All power pile driving equipment shall be equipped with a suitable thickness of hammer cushion material to prevent damage to the hammer and pile and to insure uniform driving behavior. Hammer cushions shall be made of durable, manufactured materials, provided in accordance with the hammer manufacturer's guidelines except that all wood, wire rope, and asbestos hammer cushions are specifically disallowed and shall not be used. A striker plate as recommended by the hammer manufacturer shall be placed on the hammer cushion to insure uniform compression of the cushion material. The hammer cushion shall be inspected in the presence of the Resident when beginning pile driving at each pile group or after each 100 hours of pile driving, whichever is less. Any hammer cushion thickness measuring less than 75% of the original thickness shall be replaced by the Contractor before driving is permitted to continue.

Helmet Piles driven with power hammers require an adequate drive head to distribute the hammer blow to the pile head. The helmet shall be axially aligned with the hammer and the pile. The helmet shall be guided by the leads and not be free-swinging. The helmet shall fit around the pile head in such a manner as to prevent transfer of torsional forces during driving while maintaining proper alignment of hammer and pile.

For special types of piles, appropriate driving heads, mandrels, or other devices shall be provided in accordance with the manufacturer's recommendations so that the piles may be driven without damage.

501.043 Driving Procedures and Tolerances The sequence of driving piles in any substructure unit shall be included in the QCP. The ground surface shall be brought to the bottom of the footing elevation before driving the piles. The Contractor shall furnish all assistance required to make any observations and measurements. Prior to placing any pile section in the leads, the Contractor shall make the pile section available for foot and inch marking by the Resident. When pile sections are placed in the leads prior to marking by the Resident, the Contractor shall mark the pile in foot and inch increments, or provide reasonable means of access to the pile for foot and inch marking. The order of placing individual piles in pile groups shall be either starting from the center of the group and proceeding outwards in both directions or starting at the outside row and proceeding progressively across the group.

When driving is interrupted before final penetration is reached, data for the bearing resistance of the pile shall not be taken until at least 12 inches of pile penetration is attained after driving has been resumed, or pile refusal has been attained.

The heads of all piles shall be plane and perpendicular to the longitudinal axis of the pile before the helmet is attached. Approval of the hammer relative to driving stress damage shall not relieve the Contractor of responsibility for piles damaged because of misalignment of the leads, failure of cushion materials, failure of splices, malfunction of the pile hammer, or improper construction methods. Piles damaged for such reasons shall be rejected and replaced at the Contractor's expense when the Resident determines that the damage impairs the strength of the pile.

Jetting Jetting shall be done only with the permission of the Resident and must be addressed in the Contractor's Soil Erosion and Water Pollution Control Plan (SEWPCP). When water jets are used, the number of jets and the volume and pressure of the water at the nozzles shall be sufficient to erode freely the material adjacent to the piles. The plant shall have sufficient capacity to deliver at all times at least 100 pounds per square inch pressure at two ¾ inch jet nozzles. Before the desired penetration is reached, the jets shall be withdrawn and the piles shall be driven with the hammer to the required penetration or bearing capacity.

Vibratory Hammers When approved, non-displacement piles may be initially driven with a power-actuated vibratory hammer powered with electricity or hydraulics (hereinafter referred to as vibratory hammers). Vibratory hammers shall not be used for precast concrete piles due to pile damage and bending stress considerations. Vibratory hammers shall not be used to set piles which develop resistance primarily from friction with the surrounding soils through the pile length.

Piles permitted to be initially driven using a vibratory hammer shall be subsequently driven to the required capacity in accordance with the approved stopping criteria and the QCP using a power hammer. Vibratory hammers, when permitted, may only be used to initially set a pile up to a distance of 20 feet above the expected tip elevation, at which point a power hammer shall be employed. Vibratory hammers will only be permitted to initially set production piles after the pile tip elevation is established by load testing and/or piles driven with an impact hammer and the ultimate pile resistance is verified. If the pile penetration rate is 12 inches or less per minute, the use of a vibratory hammer shall be discontinued and a power hammer employed. When a battered pile is initially set using a vibratory hammer, the hammer shall be mounted in a set of leads and/or kept in alignment using a driving frame/template.

Preaugering When necessary to clear obstructions or to obtain the specified pile penetration, as approved by the Resident, the Contractor may preauger. When specified in the Contract documents, the Contractor shall preauger holes at pile locations and to the depths shown on the Plans. Preaugered holes shall be of a size smaller than the diameter of the diagonal of the pile cross section. If subsurface obstructions, such as boulders or rock layers are encountered, the hole diameter may be increased to the least dimension needed for pile installation. Any void space remaining around any type pile after driving shall be completely filled with sand or other approved material. The use of spuds, which are driven and removed to make a hole for inserting a pile, shall not be permitted in lieu of preaugering.

Pre-excavation When necessary to clear subsurface obstructions, such as boulders or rock layers, or to obtain the specified pile penetration, the Contractor may pre-excavate, with the approval of the Resident.

Heaved Piles Piles that have heaved more than ¼ inch during the driving of other piles in a group shall be reseated to the required penetration or bearing capacity at the Contractor's expense.

Location and Alignment Tolerance The Contractor will be responsible to hold the piles in place to allowable tolerances. Piles shall be driven with a variation of not more than ¼ inch per foot from the vertical or from the batter shown on the Plans. For piles that cannot be inspected for axial alignment internally after installation, an alignment check shall be made before installing the last 5 feet of pile, or after installation is completed, provided the exposed portion of the piles is not less than 5 feet in length. The Resident may require that driving be stopped in order to check the pile alignment. Pulling laterally on piles to correct misalignment, or splicing a properly aligned section of a misaligned section shall not be permitted.

The cutoff elevation of piles for trestle bents and pile bent piers shall not be out of position by more than 2 inches from the dimensions shown on the Plans. The cutoff elevation of piles for integral abutments shall not be out of position from the dimensions shown on the Plans by more than 2 inches in any direction. The cutoff elevation of piles, other than for trestle bents and integral abutments, shall not be out of position by more than 6 inches. Actual embedment of the piles in the concrete shall be within 6 inches of that shown on the Plans. The as-driven centroid of load of any group at cutoff elevation shall be within 5 percent of the Plan location of the designated centroid of load. No pile shall be nearer than 4 inches from any edge of the pile cap. Any increase in size of the pile cap to meet this edge distance requirement shall be at the Contractor’s expense.

501.044 Special Requirements for Steel Pipe Piles and Steel Casings Pipe piles shall be driven closed ended, unless otherwise specified. When open-ended pipe piles are specified or when the ends are not completely closed ended when driven, the inside of the pile shall be thoroughly cleaned out, and the inside walls cleaned by jetting or other means approved by the Resident. The sediment control required for the cleaning operations shall be covered in the Contractor’s SEWPCP.

Pipe piles shall be inspected and approved by the Resident immediately before concrete is placed in them. They shall be free from rupture and undue deformation and shall be free from water unless the Resident determines that the concrete can be placed without damage to the pile and such that the discharged water will be contained. The Contractor shall provide lights and other equipment necessary to enable the Resident to inspect each pipe pile.

Portland cement concrete for filling the pipe piles shall be placed in one continuous operation to fill the pile completely without causing water contamination. An internal type vibrator shall be used in the top 25 feet. Pile heads shall be protected and cured in accordance with Section 502, Structural Concrete.

The placing of concrete and the driving of piles shall be scheduled so that fresh and setting concrete will not be injured by the pile driving.

Concrete shall not be placed in pipe piles until pile driving has progressed beyond a radius of 15 feet from the pile to be concreted. If pile heave is detected for pipe piles that have been filled with concrete, the piles shall be redriven to the original position after the concrete has attained sufficient strength and a proper hammer-pile cushion system, is in place and is satisfactory to the Resident.

When a reinforcing steel cage is specified, it shall be placed inside the piles to allow for a minimum of 2 inches of concrete cover and the piles shall be filled with concrete to the elevation shown on the Plans.

Full-length pipe piles and steel casings shall be used wherever practicable; however, splicing may be permitted when approved by the Resident. The method of splicing shall be as follows:

a. Steel pipe piles and steel casings shall be spliced by full penetration butt joint welds.

b. When the pipe piles and steel casings are to be spliced while in a vertical position, splicing shall be accomplished utilizing single-bevel groove welds with the use of back-up rings. When the pipe piles and steel casings are to be spliced while in a horizontal position, splicing shall be accomplished utilizing single-vee groove welds with the use of back-up rings.

c. Welded joints shall conform to the Standard Details. Welding, including welder qualifications, shall comply with the requirements of AWS D1.1, Structural Welding Code - Steel.

All welding and welder qualifications shall be in conformance with Section 501.047, parts (d) and (e).

501.045 Defective Piles and Corrective Measures Pile driving activities shall not result in damage to, or deformation of, the piles. Any pile damaged due to internal defects, improper driving, or driven below cutoff elevation, shall be considered defective and shall be corrected by and at the expense of the Contractor, by a method approved by the Resident.

501.046 Driven Pile Resistance, Pile Testing, and Acceptance Pile testing will be required as shown on the Plans. Pile testing will be required to confirm that piles attain the required resistance and that the stresses in the piles do not exceed allowable limits during driving.

A dynamic load test consists of mounting instruments on the pile and accurately recording the output during driving using dynamic pile load test equipment meeting the requirements of ASTM D4945. The stresses in steel piles during driving shall not exceed 90% of the yield stress, as determined by wave equation analyses or dynamic pile load testing. Piles which have

been overstressed, per wave equation or dynamic pile load testing, shall be replaced by the Contractor, at no additional cost to the Department.

A static load test consists of the application of a known load to the pile or group of piles and the accurate measurement of the resulting displacement. The Contractor shall furnish all labor and equipment for static load testing.

In the case of concrete filled steel pipe piles, no load shall be placed on the pile for at least 7 days after the concrete has been placed in the pile.

On completion of either static or dynamic load testing, any test or anchor piling, not a part of the finished structure, shall be removed or cut off at least 1 foot below either the bottom of the footing or the finished ground elevation, whichever is lower.

Driven Pile Capacity - Wave Equation The piles shall be driven to the required resistance using the approved stopping criteria. The pile acceptance will be based on obtaining the blow count and hammer stroke from the approved stopping criteria at the required resistance. When the wave equation is used in conjunction with dynamic or static pile load testing, the stopping criteria shall be amended based on correlation with the testing method results, as determined by the Resident. Adequate pile penetration shall be considered to be obtained when the specified wave equation resistance criteria (approved stopping criteria) is achieved within 5 feet of the pile toe elevation, based on Contract lengths. Piles not achieving the specified required resistance within these limits shall be driven to penetration established by the Resident.

The wave equation resistance criteria will not be considered valid under any of the following conditions:

a. The hammer or striking part does not have a free fall.
b. The head of the pile becomes broomed or crushed.
c. The penetration is not reasonably quick and uniform.
d. There is an appreciable bounce after a blow.
e. The hammer is operated outside the parameters recommended by the manufacturer.

Static Load Test When a static load test is specified in the Contract documents, load tests shall be performed by procedures set forth in ASTM D1143 using the quick load test method except that the test shall be taken to plunging failure or the capacity of the loading system. Testing equipment and measuring systems shall conform to ASTM D1143, except that the loading system shall be capable of applying 150% of the nominal pile resistance or 2,000 kips, whichever is less, and that a load cell and spherical bearing plate shall be used.

The Contractor shall submit in the QCP, detailed plans, prepared by a licensed Professional Engineer, of the proposed loading apparatus. The apparatus shall be constructed to allow the various increments of the load to be placed gradually without causing vibration to the test pile. When the approved method requires the use of tension (anchor) piles, such tension piles shall be of the same type and diameter as the production piles and shall be driven in the location of

permanent piles when feasible, except that timber or tapered piles installed in permanent locations shall not be used as tension piles.

The design load shall be defined as 50% of the failure load. The failure load for a pile shall be defined as follows:

For piles 24 inches or less in diameter or width, the failure load of a pile tested under axial compressive load is that load which produces a settlement at failure of the pile head equal to:

$$s_f = \Delta + (0.15 + 0.008b)$$

Where:

s_f = Settlement at failure in inches

b = Pile diameter or width in inches

Δ = Elastic deformation of total unsupported pile length in inches

For piles greater than 24 inches in diameter or width:

$$s_f = \Delta + b/30$$

The top elevation of the test pile shall be determined immediately after driving and again just before load testing to check for heave. Any pile that heaves more than ¼ inch shall be redriven or jacked to the original elevation before testing. Unless otherwise specified in the Contract, a minimum 3-day waiting period shall be observed between the driving of any anchor piles or the load test pile and the commencement of the load test.

Dynamic Pile Tests When dynamic load tests are specified in the Contract, dynamic measurements will be taken by the Contractor using procedures set forth in ASTM D4945. Dynamic testing shall be completed during the driving of piles designated on the Plans, or as designated by the Resident. Dynamic load tests will be performed for the full length of the test pile during initial drive. The Contractor's representative performing the dynamic tests shall be an experienced pile testing engineer and have attained the dynamic pile load test Signatory Advanced level on the Foundation QA High Strain Dynamic Pile Testing Examination, or equivalent level of certification or training, or be a licensed Professional Engineer. The same Contractor's representative conducting the wave equation analysis shall perform the dynamic load tests. Each test shall also include a numerical evaluation of static axial pile resistance using field dynamic measurements obtained per ASTM D4945 (also known as signal matching). The Contractor's representative shall be experienced in the use of dynamic pile load test equipment and its purpose related to pile capacity determinations. Dynamic measurements shall be reported to the Resident and include items specified in Section 7 of ASTM D4945.

Before placement of the pile in the leads, the Contractor shall make the designated pile available for obtaining wave speed measurements and for predrilling the required instrument attachment holes. The Contractor shall mark the designated pile in foot and inch markings. The

Contractor shall make provisions in ordered lengths of pile to account for an additional pile length, equal to three pile diameters or 5 feet, whichever is greater, for instrumentation attachment. Pre-driving wave speed measurements will not be required for steel piles. When wave speed measurements are made, the piling shall be in a horizontal position and not in contact with other piling. The Contractor will furnish the equipment, materials, and labor necessary for drilling holes in the piles for mounting the instruments. The instruments will be attached near the head of the pile with bolts placed through drilled holes on the steel piles or with wood screws for timber piles.

The Contractor shall provide the Contractor's dynamic testing technician with reasonable means of access to the pile for attaching instrumentation after the pile is placed in the leads. The Contractor shall furnish electric power for the dynamic test equipment. The power supply at the outlet shall be 10 amp, 115 volt, 55-60 cycle, A.C. only. Field generators used as the power source shall be equipped with functioning meters for monitoring voltage and frequency levels.

With the dynamic testing equipment attached, the Contractor shall drive the pile to the depth at which the dynamic test equipment indicates that the required nominal resistance has been achieved or to the minimum tip elevation, whichever results in the greatest depth, as called for on the Plans, or as directed otherwise by the Resident. The stresses in the piles will be monitored during driving with the dynamic test equipment to ensure that the values determined do not exceed the allowable values specified in this Section. If necessary, the Contractor shall reduce the driving energy transmitted to the pile by using additional cushions or reducing the energy output of the hammer in order to maintain stresses at or below the allowable values. If non-axial driving is indicated by dynamic test equipment measurements, the Contractor shall immediately realign the driving system.

When directed to restrike by the Resident, the Contractor shall wait a minimum of 24 hours, or as otherwise specified on the Contract Plans, and after the instruments are reattached, restrike the dynamic load test pile. A cold hammer shall not be used for the restrike. The hammer shall be warmed up before restrike begins by applying at least 20 blows to another pile. The maximum amount of penetration required during restrike shall be 6 inches, or the maximum total number of hammer blows required will be 50, whichever occurs first. After restriking, the Resident will either accept the re-driven pile or specify additional pile penetration and testing. The Contractor shall supply the Resident with a report of the test results of each dynamically tested pile, numerical evaluations of static axial pile resistance using dynamic field measurements (signal matching), and a driving criteria within 5 Working Days of the completion of testing. When directed by the Resident or required by the Contract Plans, numerical evaluations of static pile capacity using the field dynamic measurements and a driving criteria shall be supplied to the Resident within 24 hours of completing the testing.

Hammer Performance If at any time during pile driving operations or dynamic testing the performance or efficiency of the power hammer is not in accordance with the Pile and Driving Equipment Data Form, the wave equation analyses, or the dynamic/static testing results, as determined by the Resident, the Contractor shall repair or replace the driving system. This may include, but not be limited to, rebuilding the hammer, or replacing the hammer with another

hammer. All costs and time associated with replacing the driving system, including additional wave equation analyses and dynamic/static testing, as determined by the Department, shall be borne by the Contractor.

Required Pile Resistance Piles shall be driven by the Contractor to the penetration depth shown on the Plans or to a greater depth if necessary to obtain the required pile resistance. The required pile resistance shall be determined by the approved wave equation analysis or by the results of dynamic testing and numerical evaluations of static pile resistance using dynamic field measurements (signal matching).

Piles shall not be driven to the required nominal pile resistance with a vibratory hammer.

501.047 Splicing Piles Full-length piles shall always be used wherever practicable. When full-length piles cannot be used, the number of splices, locations, and details shall be noted in the QCP. Piles fabricated from multiple pieces will be acceptable only if they comply with the following:

H-Beam Piles [a]		**Pipe Piles [a,b]**	
Lengths	Maximum No. Field Splices	Lengths	Maximum No. Field Splices
Less than 20 ft.	0	Less than 20 ft.	0
Over 20 – 35 ft.	1	Over 20 – 40 ft.	1
Over 35 – 79 ft.	2	Over 40 – 60 ft.	2
Over 79 ft.	1 per 40 ft.	Over 60 – 80 ft.	3
		Over 80 ft.	1 per 20 ft.
[a] Pile lengths less than 10 feet will not be spliced, except as the final (top) section of the pile. [b] Where pipe piles are used for pile bent piers, no splices will be allowed in the length of pile from the cutoff elevation to 2 feet below the channel bottom.			

When pre-planned splicing is approved, the pile piece of lesser length shall be placed at the tip of the pile (the first part of the pile that enters the ground).

When splicing is approved, piles shall be spliced as follows:

a. Damaged material shall be removed from the end of the driven pile. Lifting holes in H-piles shall be repaired or trimmed off. Lifting holes in pipe piles shall be trimmed off. The ends of both pieces to be spliced shall be cut off square with the longitudinal axis of the pile and beveled per the Standard Details. Except for minor trimming, all cutting shall be done with the use of a mechanical guide.
b. The Contractor shall use an approved mechanical splicer or a full penetration butt weld for the entire cross section of the pile.
c. Evaluation of mechanical splicers will be based on the submission of data demonstrating the capability of transferring the full pile strength in compression and tension and developing the bending moment capacity of the pile in both the x-x and

y-y axes. The splicers shall be installed and welded as recommended by the manufacturer with the additional requirements in d. and e., below.

d. All welding shall comply with the requirements of Section 504, Structural Steel, except as modified hereinafter.

1. Welding shall not be done when the temperature in the immediate vicinity of the weld is below 0°F; when the surfaces are damp or exposed to rain, snow, or high wind; or when the welders or welding operators are exposed to inclement conditions.
2. The pile shall be preheated to and maintained at 150°F minimum within 6 inches from the weld during welding.
3. Written welding procedures do not need to be submitted.

e. Welders shall be prequalified in accordance with Section 504, Structural Steel.

501.048 Prefabricated Pile Tips Steel H-beam piles tips shall be attached to the pile with a 5/16 inch groove weld along each flange, or as specified by the manufacturer's product data sheet welding requirements. Welding shall be done using low-hydrogen electrodes and the base metal shall be preheated to 150°F, minimum.

Unless otherwise shown on the Plans, steel pipe piles shall have pointed cast steel pile tips. All welding and welder qualifications shall be in conformance with Section 501.047, parts (d) and (e).

Pile tips for both H-beam and pipe piles shall be approved by the Resident.

Pile tips may be welded to the piles either by the supplier of the piles or in the field by the Contractor, at its option.

501.05 Method of Measurement

a. Equipment Mobilization A lump sum price bid for mobilization shall include the cost of furnishing all labor, materials, and equipment necessary for the transporting, erecting, dismantling, and removing all pile driving equipment.

b. Piles Furnished The unit of measurement for furnishing H-piles, pipe piles and steel casings shall be the linear foot. The quantity to be paid for will be the sum of the lengths in feet of the piles, of the types and lengths ordered in writing by the Resident. No allowance will be made for the length of piles, including test piles furnished by the Contractor, to replace piles that were previously accepted by the Resident, but are subsequently damaged prior to completion of the Contract. When additional lengths of piles are necessary, the additional length ordered in writing by the Resident will be included in the length of piling furnished. All piles must be cutoff at the cutoff elevation shown on the Plans.

c. Piles in Place Initiation of pile installation by use of a vibratory hammer, preaugering, jetting or other methods used for facilitating pile driving procedures will not be measured and payment shall be considered included in the unit price bid for the Piles, In Place, pay item.

The quantity of H-beam, pipe pile or casings to be paid for will be the actual number of linear feet of H-pile, steel pipe piles or casings driven and left in place in the completed and accepted work. Measurements will be made from the tip of the H-beam pile, steel pipe pile or casing to the cutoff elevation as shown on the Plans.

Unused pile cutoffs 10 feet or more in length, except those required to accommodate the Contractor's construction method, as discussed herein, will remain the property of the Department and will be stored at a bridge maintenance yard nearest the project. Hauling and unloading of piles will be done by the Contractor or by the Department, depending upon availability of services.

When hauling and unloading is done by the Contractor, payment will be made under the provisions of Section 109, Changes. There will be no separate payment to load piles at the project site; loading will be considered an incidental cost to the item.

No separate measurement will be made for reinforcing steel, excavation, pre-excavation, drilling, cleaning of drilled holes, cleaning out of pipe piles, drilling fluids, sealing materials, concrete, required casing, and other items required to complete the Work.

d. Pile Tips Pile Tips will be measured by the number of tips authorized and satisfactorily installed.

e. Pile Splices Pile splices will be measured by the number of splices authorized and satisfactorily completed to drive the piles in excess of the ordered length furnished and approved by the Resident.

f. Static Load Tests Static load tests will be measured by the number of unit tests authorized and satisfactorily made.

g. Dynamic Load Tests Dynamic load tests will be measured by the number of dynamic pile tests authorized and satisfactorily made. One dynamic test includes all data collected on one pile during both the initial pile driving and a restrike done a minimum of 24 hours after the initial driving, and numerical evaluation of static axial pile resistance using dynamic field measurements (signal matching).

501.06 Basis of Payment The accepted quantities of piles and casings will be paid for at the Contract Unit Price per linear foot, delivered, and complete, in place. Such payment will include full compensation for any necessary excavation or backfilling required after driving, to bring the foundation area to the correct elevation.

Pile cutoffs and concrete for pipe piles and casings will not be paid for separately but will be considered as incidental to related Pay Items. Damaged pile lengths removed for pile splicing will be considered incidental to related Pay Items.

Payment for all Work related to the following will not be made directly, but will be considered incidental to related Pay Items: Jetting; preaugering; pre-excavation; providing special driving tips or heavier sections for steel piles, or other work necessary to obtain the specified penetration and bearing resistance of the piles; reseating of piles; excavating and cleaning within steel pipe piles and steel casings; furnishing and placing reinforcing steel and steel templates in steel pipe piles; disposing of material resulting from cleaning out pipe piles; all excavation and backfilling involved in installing piles; installation and removal of temporary falsework and driving frames; and development of an approved QCP and amendments, as required.

Wave equation analyses and any subsequent wave equation analyses re-submittals, required to demonstrate the appropriateness of the driving system, will be considered incidental to the related Pay Items.

Payment for pile tips and pile splices will be paid for at the Contract Unit Price each.

Payment for dynamic and static pile tests will be paid at the Contract Unit Price per pile tested. The price shall be full compensation for satisfactory completion of all Work associated with performing and collecting measurements from initial dynamic tests, restrike tests, numerical evaluations of static pile resistance using dynamic measurements (signal matching), all sensors and wiring, monitoring equipment, setup time, reaction piles and frame, load cells, jacking equipment, survey tie-in, monitoring personnel, as applicable, and costs associated with the Contractor's down time during regular working hours while setting up equipment, performing tests and taking measurements.

Payment will be made under:

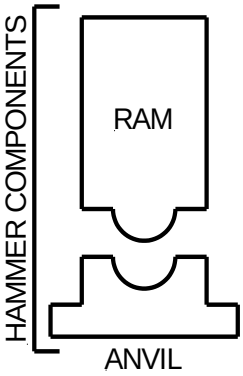
Pay Items		Pay Unit
501.230	Static Loading Test	Each
501.231	Dynamic Loading Test	Each
501.36	Steel H-beam Piles 36 lb/ft, delivered	Linear Foot
501.361	Steel H-beam Piles 36 lb/ft, in place	Linear Foot
501.38	Steel H-beam Piles 42 lb/ft, delivered	Linear Foot
501.381	Steel H-beam Piles 42 lb/ft, in place	Linear Foot
501.40	Steel H-beam Piles 53 lb/ft, delivered	Linear Foot
501.401	Steel H-beam Piles 53 lb/ft, in place	Linear Foot
501.42	Steel H-beam Piles 57 lb/ft, delivered	Linear Foot
501.421	Steel H-beam Piles 57 lb/ft, in place	Linear Foot
501.44	Steel H-beam Piles 63 lb/ft, delivered	Linear Foot
501.441	Steel H-beam Piles 63 lb/ft, in place	Linear Foot

501.46	Steel H-beam Piles 73 lb/ft, delivered	Linear Foot
501.461	Steel H-beam Piles 73 lb/ft, in place	Linear Foot
501.48	Steel H-beam Piles 74 lb/ft, delivered	Linear Foot
501.481	Steel H-beam Piles 74 lb/ft, in place	Linear Foot
501.50	Steel H-beam Piles 89 lb/ft, delivered	Linear Foot
501.501	Steel H-beam Piles 89 lb/ft, in place	Linear Foot
501.52	Steel H-beam Piles 102 lb/ft, delivered	Linear Foot
501.521	Steel H-beam Piles 102 lb/ft, in place	Linear Foot
501.54	Steel H-beam Piles 117 lb/ft, delivered	Linear Foot
501.541	Steel H-beam Piles 117 lb/ft, in place	Linear Foot
501.70	Steel Pipe Piles, delivered	Linear Foot
501.701	Steel Pipe Piles, in place	Linear Foot
501.72	Steel Casings, delivered	Linear Foot
501.721	Steel Casings, in place	Linear Foot
501.90	Pile Tips	Each
501.91	Pile Splices	Each
501.92	Pile Driving Equipment Mobilization	Lump Sum

*Project/Bridge:*_____ *Town:*_____

*WIN:*_____ *Fed. Proj. No:*_____ *Bridge No:*_____

*Contractor:*_____ *Pile Driving Sub:*_____



HAMMER

*Manufacturer:*_____ *Model:*_____

*Hammer Type:*_____ *Serial No:*_____

*Max Energy:*_____*(ft-lbs) @Stroke Length:*_____*(ft)*

*Ram Weight:*_____*(lbs)*

*Modifications:*_____

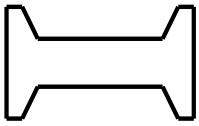
HAMMER CUSHION

*Material:*_____

*Thickness:*_____*(in.) Area:*_____*(in.^{2})*

*Modulus of Elasticity (E):*_____*(psi)*

*Coefficient of Restitution (e):*_____



DRIVE HEAD

Helmet
Bonnet
Anvil Block
Pile Cap

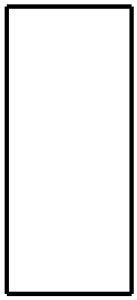
*Weight:*_____*(lbs)*

PILE CUSHION

*Material:*_____ *Thickness:*_____*(in.)*

*Modulus of Elasticity (E):*_____*(psi)*

*Coefficient of Restitution (e):*_____



PILE

*Pile Type:*_____

*Length (in Leads):*_____*(ft)*

*Weight/Length:*_____*(lbs/ft) Diameter:*_____*(in.)*

*Wall Thickness:*_____*(in.) X-Section Area:*_____*(in.^{2})*

*Maximum Factored Load:*_____*(kips)*

*Required Resistance:*_____*(kips)*

*Splice Description:*_____

*Pile Tip Description:*_____

*Submitted by:*_____ *Date:*_____

*Telephone #:*_____ *Fax #-*_____

Figure 1- Pile and Driving Equipment Data Form. Form can be found on MaineDOT Website

SECTION 502 - STRUCTURAL CONCRETE

502.01 Description This work shall consist of furnishing and placing Portland Cement Concrete for structures and incidental construction in accordance with these Specifications and in conformity with the lines, grades, and dimensions shown on the Plans or established, or for placing concrete fill for foundations where called for on the Plans. For Method A Statistical Acceptance, or Method B Statistical Acceptance, the work shall conform to the Contractor's approved Quality Control (QC) Plan and Quality Assurance (QA) provisions, in accordance with these Specifications and the requirements of Section 106 - Quality. For Method C, the work shall conform to the Contractor's Quality Control Plan (QCP), the requirements of this specification and Section 106- Quality.

502.02 Classification The Portland Cement Concrete shall be the class indicated on the Plans.

502.03 Materials Materials shall meet the requirements specified in the following Sections of Division 700, Materials:

Portland Cement and Portland Pozzolan Cement	701.01
Water	701.02
Air Entraining Admixtures	701.03
Water Reducing Admixtures	701.04
High Range, Water Reducing, Admixture	701.0401
Set Retarding Admixtures	701.05
Curing Materials	701.06
Water stops	701.07
Smooth Surfaced Asphalt Roll Roofing	701.08
Fly Ash	701.10
Calcium Nitrite Solution	701.11
Silica Fume	701.12
Ground Granulated Blast Furnace Slag	701.13
Fine Aggregate for Concrete	703.01
Coarse Aggregate for Concrete	703.02
Alkali Silica Reactive Aggregates	703.0201
Preformed Expansion Joint Filler	705.01
Bridge Drains	711.04

502.04 Shipping and Storage The cement shall be completely protected from rain and moisture. Any cement damaged by moisture or which fails to meet any of the specified requirements shall be rejected and removed from the site.

Fly ash and Slag shall be stored in weather tight silos. All silos shall be completely empty and clean before material is deposited therein, unless the silo already contains material of the same type and properties.

Fly ash or Slag remaining in bulk storage at the batch plant for a period greater than one year after completion of tests will be resampled and retested by the Department before use.

Handling, shipping and stockpiling of aggregates shall be done in such a way as to minimize segregation and breakage.

Fine aggregate and each size of coarse aggregate shall be stored in completely separate stockpiles on prepared bases constructed of the same material as that to be stockpiled, with a minimum thickness of 1 foot. The ground under the prepared bases shall be reasonably graded to drain away from the stockpile and shall be free of brush or other harmful vegetation. The base shall be left in place, undisturbed for the duration of the use of the stockpile. Prepared bases can be salvaged for reuse provided this material is reprocessed. Wood, metal or other approved hard surfaces shall be considered acceptable alternates for the prepared bases described above.

502.041 Testing Equipment The Contractor shall provide test equipment and materials as specified below for use by the Resident, or their representative, exclusively. The equipment shall be available and acceptable to the Resident one week prior to placing any concrete. All costs associated with providing and maintaining testing equipment shall be considered incidental to the Work and no additional payment will be made.

The Resident will maintain the test equipment in reasonable condition. However, the Contractor shall replace any equipment that becomes unusable due to normal wear and tear or which is stolen or damaged from other than the Resident's neglect or mistreatment. All such replacement costs shall be considered incidental to the work and no additional payment will be made.

A. Pressure Air Meter meeting requirements of AASHTO T152 (Type B) and all accessory items required for use with the particular design of apparatus. This shall include one 9 inch mason trowel, one metal scoop 9 inches long x 5 inches wide, one tamping rod conforming to AASHTO T119, one rubber mallet as described in AASHTO T152, one strike off bar (flat straight bar of steel). The air meter shall be functional and shall bear a current calibration certificate issued by a recognized testing laboratory. Current shall mean within the calendar year.

B. Two thermometers meeting the requirements of AASHTO T309.

C. "Contractors" rubber tired wheelbarrow.

D. Two D-handle square end shovels 9 ½ inches wide.

E. Two pair heavy duty, long cuff, rubber gloves.

F. Miscellaneous equipment: 16 ounce plastic squeeze bottle, 5 gallon bucket, scrub brush, paper towels, folding rule, and rubber syringe.

G. Small rod - one tamping rod conforming to AASHTO T277.

502.05 Composition and Proportioning Concrete shall be composed of a homogeneous mixture of Portland cement or Portland cement with Fly Ash, Silica Fume, or Ground Granulated Blast Furnace Slag, fine aggregate, coarse aggregate, water and admixtures proportioned according to these Specifications and shall conform to the requirements of Table 1. All material shall be approved by the Department prior to use.

TABLE 1

Concrete CLASS	Minimum Compressive Strength (PSI)	Maximum Permeability (COULOMBS)	Entrained Air (%)		Notes
			LSL	USL	
S	3,000	N/A	N/A	N/A	4,5
A	4,000	2,400	6.0	9.0	1,4,5
P	-----	-----	5.5	7.5	1,2,3,4
LP	5,000	2,000	6.0	9.0	1,4,5
Fill	3,000	N/A	6.0	9.0	4,5

NOTE # 1 Permeability testing for all concrete mixes, excluding those containing fly ash (at 20 percent or greater pozzolan cement replacement), will be done at 56 days. Permeability testing for concrete mixes containing fly ash, at 20 percent or greater pozzolan cement replacement, will be done at 120 days. Concrete expected to be exposed to deicing salts prior to the test date shall be sealed with a protective coating, in accordance with Standard Specification Section 711.05, Protective Coating for Concrete Surfaces, and per the manufacturer's recommendations, at no additional cost to the Department.

NOTE # 2 Calcium Nitrite shall be added at the rate of 3 gallons per cubic yard.

NOTE # 3 Strength and permeability requirements for precast concrete will be shown on the Plans. Permeability testing will only be done on precast concrete when the Plans include permeability requirements.

NOTE # 4 Compressive strength testing for all concrete mixes, excluding those containing fly ash (at 20 percent or greater pozzolan cement replacement), will be done at 28 days. Compressive strength testing for concrete mixes containing fly ash, at 20 percent or greater pozzolan cement replacement, will be done at 56 days.

NOTE #5 Coarse aggregate for concrete shall meet the requirements of Section 703.02 for Class "A" or "AA" or, with Department approval, SP1 or SP2 (refer to Standard Specification Section 518, Structural Concrete Repair).

Each concrete mix design shall be submitted by the Contractor to the Department for approval. No concrete shall be placed on a project until the concrete mix design is approved by the Department.

For the first time use of a concrete batch plant or a change in pozzolan source or type, the Contractor shall conduct a trial batch at the concrete plant utilizing transit mixers. The Contractor shall submit four clearly identified 4 inch diameter x 8 inch high cylinders to the Department, at least 15 days prior to the first placement, for permeability testing. Full documentation shall be submitted with the cylinders and must include actual batch weights and all concrete test properties. The cylinders shall be submitted between the ages of 2 and 7 days.

The mix design submitted by the Contractor shall include the following information:

A. Description of individual coarse aggregate stockpiles, original source, bulk specific gravity, absorption, gradation, and alkali silica reactivity test results. A combined coarse aggregate blended gradation shall be provided, including the percentage of each coarse aggregate used.

B. Description of fine aggregate, original source, bulk specific gravity, absorption, colorimetric, gradation, Fineness Modulus (F.M.), base F.M., alkali-silica reactivity and sand equivalent test.

C. Description and original source and amount of cement and pozzolanic material.

D. Target water cement ratio.

E. Target water content by volume.

F. Target strength.

G. Target air content, slump and concrete temperature.

H. Target concrete unit weight.

I. Type, manufacturer, and dosages of air entraining and chemical admixtures.

J. Target Coulomb Value.

Approval by the Department will be contingent upon the ability of the mix design proportions to meet concrete strength and permeability requirements and other factors that affect durability.

Concrete mix designs shall contain not more than 30 percent fly ash or 50 percent slag pozzolan cement replacement, by weight.

Cast-in-place concrete shall contain not more than 635 lbs/yd^3 of cement and not more than 660 lbs/yd^3 of cementitious material. Pozzolans are included as cementitious material.

Under water concrete shall contain a minimum of 635 lbs/ yd^3 of cementitious material.

All concrete mixes must be designed in accordance with the criteria of this Section. The design proportions with the fine aggregates designated as a percent of the total aggregate must be stated in terms of aggregates in a saturated, surface dry condition and the batch weights will be adjusted by the Contractor for the actual moisture of the aggregate at the time of use.

Self-consolidating concrete (SCC) may be used for Class A, LP or P mixes when approved by the Resident. SCC shall meet the requirements for strength, entrained air and permeability for the respective concrete Class. SCC shall be tested for slump flow in accordance with ASTM C1611; the visual stability index (VSI) shall be 0 or 1.

No change in the source, proportions or character of the mix ingredients may be made without notice to the Department and no new mix ingredients shall be used until the Department has approved such ingredients and new mix proportions, if they change. The Contractor shall notify the Resident of any changes to the coarse aggregate blend prior to supplying concrete to the project.

502.06 Batching Measuring and batching of materials for Structural Concrete shall be performed at an approved batching plant. The plant shall meet the requirements of AASHTO M-157. Batching plants will be inspected annually for approval by either the Department or by the National Ready Mixed Concrete Association.

The Contractor shall provide a Certificate of Compliance for each truckload of concrete to the Department at the time of the load placement. The Certificate of Compliance shall be a form acceptable to the Department and shall include:

Contract Name and Number
Bridge Name
Manufacturing Plant (Batching Facility)
Name of Contractor (Prime Contractor)

Date
Time Batched/Time Discharged
Truck Number
Quantity (Quantity Batched this Load)
Type of Concrete by Class and Department Mix Design Number
Cement Brand or Type, and Shipment Certification Number
Temperature of Concrete at Discharge
Target Weights per cubic yard and Actual Batched Weights for:

1. Cement
2. Pozzolanic Additives, including Fly Ash, Slag, and Silica Fume
3. Coarse Concrete Aggregate
4. Fine Concrete Aggregate
5. Water (including free moisture in aggregates, batch water held out at the plant and water added at the project)
6. Admixtures- Brand Names and Quantities (fluid ounces/cubic yard)

Placement Location

502.07 Mixing and Delivery

A. All transit mixers used in the production and delivery of Structural Concrete shall be inspected annually by the Department. Delivery and discharge of the concrete from the mixer shall be completed within a maximum of 90 minutes from the time the cement is added to the aggregate, except that in hot weather when the concrete mix temperature exceeds 70°F, or under other conditions contributing to quick stiffening of the concrete, delivery and discharge from the mixer shall be completed within 60 minutes. When approved by the Resident, the use of a retarding admixture (Type D) may be used for increasing the 60 minutes discharge time to 90 minutes, provided concrete temperatures are kept below 80ºF and conditions contributing to quick stiffening of the concrete are not present. With prior approval of the Resident, an approved hydration stabilizing admixture may be used to increase the discharge time. Use of hydration stabilizing admixtures will not be allowed for the sole purpose of increasing the discharge time limits.

B. Concrete, which has been rejected for any reason, shall be removed immediately from the job site and disposed of properly.

C. Concrete temperature, prior to discharge, shall not exceed 85°F.

502.08 Cold Weather Concrete Concrete shall not be placed against frozen surfaces.

All frost, ice, and snow shall be removed from all material that will be in contact with fresh concrete.

Unless authorized by the Resident, the mixing and placing of concrete shall be discontinued when the atmospheric temperature is below 40°F in the shade and dropping and shall not be resumed until the atmospheric temperature is as high as 35°F in the shade and rising. If

authorization is granted for the mixing and placing of concrete under atmospheric conditions different from those specified above, the water shall be heated to a temperature not exceeding 180°F. When either the aggregate or water is heated to above 120°F, they are to be combined first in the mixer before the cement is added. If the atmospheric temperature is below 25°F, the aggregate shall also be heated. Materials containing frost or lumps of frozen material shall not be used. Stockpiled aggregates may be heated by the use of dry heat or steam. Aggregates shall not be heated directly by gas or oil flame or on sheet metal over a fire. When aggregates are heated in bins, steam coil or water coil heating or other methods that will not be detrimental to the aggregates may be used. The heating apparatus shall be capable of heating the mass uniformly and preventing the occurrence of spots of overheated material. The minimum temperature of the mixed concrete shall be in accordance with Table 2, when it is placed in the forms. Salt, other chlorides or other unapproved chemicals shall not be added to the concrete for any reason whatsoever.

TABLE 2
COLD WEATHER TEMPERATURE TABLE

MINIMUM FORM DIMENSION SIZE			
Less than 12 inch	12 to 36 inch	36 to 72 inch	Greater than 72 inch
60°F	55°F	45°F	40°F
MINIMUM CONCRETE TEMPERATURE AS PLACED			

When permitted by the Resident, footings may be protected by completely submerging them by admitting water inside the cofferdam. Until submersion takes place, the temperature of the concrete and its surface shall be controlled as specified above. Submersion shall proceed slowly and the temperature of the air or water shall be maintained sufficient to prevent ice from forming within the cofferdam for a period of 7 days after the placing of the concrete.

When depositing concrete under water, there shall be no ice inside the cofferdam.

Permission given to place concrete under the conditions mentioned above and as described in the Contractor's QCP shall not relieve the Contractor of its responsibility for obtaining satisfactory results. The Contractor shall be wholly responsible for the protection of concrete during cold weather operations and any concrete injured by frost action or overheating shall be removed and replaced at the Contractor's expense.

502.09 Forms and False work

A. Construction of Forms All forms shall be well built, substantial and unyielding, securely braced, strutted and tied to prevent motion and distortion while concrete is being placed in them. The forms shall be strong enough to safely support the weight of the concrete and all superimposed loads (such as runways, concrete buggy loads, workers, scaffolding, etc.) placed upon them.

Forms shall be built to conform to the dimensions, location, contours and details shown on the Plans. The faces of forms against which the concrete is to be placed shall be dressed smooth and uniform and shall be free from winds, twists, buckles and other irregularities.

Stay-in-place forms of any type will not be permitted for any part of slab structures, unless otherwise indicated on the Plans.

The placing of concrete in excavated pits and trenches without forms will not be permitted.

All corners within the forms shall be fitted with chamfer strips mitered at their intersections, except that chamfer strips will not be required as follows: (1) on corners of slab blocking of interior steel beams and the inside of exterior steel beams; (2) on corners constructed transversely at the underside of the slab of superstructures which consist of a concrete slab on steel beams; (3) on footings not exposed to view; and (4) on all structures when more than 2 feet below the final finished grade line.

Chamfer strips shall have a width across the diagonal face between ½ and ¾ inch. The size to be adopted for a given portion of the work shall depend upon the general dimensions. Except where special size chamfer strips are shown on the Plans, the size of chamfer strips shall be uniform on individual projects. Provision shall be made for the chamfering of the top edges of abutment bridge seats and wing walls, tops of piers and retaining walls, tops of through girders, roadway curbs, etc., by nailing chamfer strips inside the forms. Unless otherwise provided, all chamfer strips shall produce plain flat surfaces on the concrete.

The forms for beams, girders and spandrel arches shall be so constructed as to permit the sides to be removed without disturbing the supports.

All foreign matter within the forms shall be removed before depositing concrete in them.

In all cases where metal or composite anchorages or ties within or through the face forms are required to hold the forms in their correct position, such anchorages or ties shall be of ample strength and shall be so constructed that the metal/composite work can be removed to a depth of not less than 1 inch from the face and back surfaces of the concrete without damaging such surfaces.

Elevations will be taken on the top flanges of structural beams and girders for the purpose of determining the depth of blocking necessary for the construction of the forms for the concrete slab, after the following conditions have been satisfied:

1. The satisfactory erection of the superstructure structural beams or girders, including any required flooring beams, stringers and intermediate diaphragms, unless an alternative plan is submitted by the Contractor and approved by the Department.

2. All bolt tightening operations must be complete.

3. No foreign loads supported by the beams or girders are present.

The Contractor shall submit working drawings for approval of the proposed forms and false work supporting the overhanging portion of the superstructure slab in accordance with Section 105.7. The working drawings shall show the size and location of the supporting members, the proposed loads and the weight of concrete forms to be carried by the members.

In the construction of forms and false work for the portion of superstructure slabs overhanging the exterior members of beam and girder spans, forms and supporting devices resulting in point loadings on the exterior members shall not be used. Loads resulting from supporting devices shall be distributed directly to the flanges by means of brackets or braces.

All forms shall be inspected and approved by the Department before the placing of any concrete within them.

B. Surface Treatment of Forms The inside surfaces of forms shall be uniformly coated with form oil or other approved surface treatment. Form surfaces shall be treated before placing the reinforcing steel.

C. Construction of False work All false work used for supporting reinforced concrete superstructures shall be comprised of members having ample structural sections to resist all loads imposed upon them, with deformations less than: (Span Length) / 360.

When the vertical members of false work consist of piles or when framed or other false work is supported upon piles, the piles shall be driven to secure a safe load resistance.

When false work is supported upon mud sills, the foundation pressures resulting from the imposed loads upon the mud sills (false work, forms, fresh concrete, scaffolding, etc.) shall not exceed the capacity of the on-site soils.

All false work systems shall be designed to support all vertical loading and any differential settlement forces, all horizontal and longitudinal forces, and shall account for any temporary unbalanced loading due to the placement sequence of the concrete. Sufficient redundancy shall be designed into false work systems so that the failure of any member shall not cause a collapse. False work systems adjacent to and/or over traveled ways shall additionally be designed to resist any vibration forces due to traffic and shall incorporate sufficient protection against impact by errant vehicles.

False work shall be so constructed that the forms will have a camber, the amount of which will depend upon the deflection anticipated in the design. Forms supported upon false work shall be provided with a satisfactory means for their adjustment in the event of settlement or deformation of the false work due to overloading or other causes. Provisions shall be made for the gradual lowering of false work and rendering the supported structure self-supporting.

All false work system computations, plans, and working drawings shall be designed and sealed by the Contractor's Professional Engineer, who must be licensed in accordance with the laws of the State of Maine. Prior to concrete placement, the Contractor's Professional Engineer responsible for the design of the false work system shall, after false work inspection, provide a sealed certification that the system was erected in conformance with the Professional Engineer's plans and design details. This Professional Engineer may be directly employed, or otherwise retained, by the Contractor.

No concrete shall be placed until the sealed design computations, plans and working drawings package and the sealed certification of erection of the false work have been submitted to the Resident. The Department shall have no obligation to review or comment on any design, construction, maintenance or removal of false work. No review or comment by the Department, or any lack of review or comment by the Department, shall relieve the Contractor of its responsibility to properly design, construct, maintain in good condition, and remove false work in accordance with the Contract, or shall shift any responsibility to the Department. The Contractor shall be responsible for all damages resulting from the failure of false work.

The torsional effect of the false work on permanent structural members, which results from supporting cantilevered concrete sections, shall be analyzed by the Department. In the event that the Department finds that the torsional stresses imposed on any permanent structural member, due to the false work, is unacceptable, the Contractor shall redesign the false work in order to reduce the stresses to an acceptable level, at no additional cost to the Department.

D. Removal of Forms and False work

1. Location, weather conditions, cementitious materials used and the character of the structure involved shall be considered in determining the time for the removal of forms and false work. Forms and false work shall not be removed until concrete cylinders cured with the structure establish that the concrete has developed a minimum of 80 percent of design strength. The Contractor shall cast and break a sufficient number of cylinders to ensure that all concrete, associated with the forms and Falsework to be removed, has reached the minimum required strength; the test results from these cylinder breaks shall be furnished to the Resident before removal of the forms and false work.

When approved by the Resident, the vertical forms and false work of footings, walls, columns and sides of beams and slabs may be removed 48 hours after completion of placement of concrete, exclusive of the time the ambient air temperature is below 45°F and provided the following conditions are met:

Immediately after, or as otherwise allowed by the Resident, the forms are removed, defects in the concrete surface shall be repaired in accordance with Section 502.12 and the repaired area thoroughly dampened with water. The surfaces of exposed concrete shall be cured for the remainder of the 7-day curing period by the application of a curing compound listed on the Department's Qualified Products List. The curing compound shall be applied continuously by approved mechanical pressure spraying or distributing equipment at a rate necessary to obtain

an even, continuous membrane, meeting the manufacturer's recommendations but at a rate of not less than 1 gallon per 200 ft^2 of surface. At a minimum, two coats shall be applied using a pressurized sprayer, with the second coat being applied within 30 minutes and at right angles to the first. Hand-pump sprayers, rollers or brushes shall not be used.

2. Forms and false work, including blocks and bracing, shall not be removed without the consent of the Resident. The Resident's consent shall not relieve the Contractor of its responsibility for the safety of the Work. In no case shall any portion of wood forms be left in the concrete. As the forms are removed, all projecting metal or composite devices that have been used for holding the forms in place shall be removed in accordance with Section 502.09(A). The holes shall be filled as required in Section 502.12.

502.10 Placing Concrete

A. General Concrete shall not be placed until forms and reinforcing steel have been checked and approved by the Resident. The forms shall be clean of all debris. The method and sequence of placing the concrete shall be approved before any concrete is placed.

All concrete shall be placed before it has taken its initial set and, in any case, as specified in Section 502.07. Concrete shall be placed in horizontal layers in such a manner as to avoid separation and segregation. A sufficient number of workers for the proper handling, tamping and operation of vibrators shall be provided to compact each layer before the succeeding layer is placed and to prevent the formation of cold joints between layers. Concrete shall not be placed against any surface coated with curing compound unless the curing compound has been removed. Care shall be taken to prevent mortar from spattering on structural steel, reinforcing steel and forms. Any concrete or mortar that becomes dried on the structural steel, reinforcing steel or forms shall be thoroughly cleaned off before the final covering with concrete. Following the placing of the concrete, all exposed surfaces shall be thoroughly cleaned as required, with care not to injure any surfaces.

Concrete shall not come in direct contact with seawater during placing and for a period of 72 hours thereafter, except as follows:

1. Concrete seals that are located entirely below low tide.

2. Concrete footings constructed in the dry and located entirely below low tide or final ground elevation.

3. Concrete Fill placed under water.

Concrete in any section of a structure shall be placed in approximately horizontal layers of such thickness that the entire surface shall be covered by a succeeding layer before the underlying layer has taken its initial set. Layers shall not exceed 18 inches in thickness and be compacted to become an integral part of the layer below. Should the placement be unavoidably

delayed long enough to allow the underlying layer to take initial set or produce a so-called "cold joint", the following steps shall be taken:

An incomplete horizontal layer shall be bulk-headed off to produce a vertical joint.

Horizontal joints shall be treated as required in Section 502.10(F).

The concrete in superstructures shall be placed monolithically except when construction joints are shown on the Plans or are authorized in accordance with approved details submitted by the Contractor. If the concrete in the stems of T-beams is to be placed independent of the slab section, the construction joint shall be located at the underside of the slab and the bond between stem and slab shall be a mechanical one. The bond shall be produced by embedding 2 inch by 4 inch wooden blocks having a length approximately 4 inches less than the width of the stem and placed horizontally at right angles to the centerline of the beam in the top surface of the concrete immediately following the completion of the concrete placement. To provide for the uniform spacing of the blocks and their ready removal when the concrete has taken a set sufficient to hold its form, the blocks shall be firmly nailed upon a board at a distance of 1 foot center to center. The blocks shall be thoroughly oiled to facilitate their ready removal from the concrete.

In arch spans, the order of construction or sequence of the work, as shown on the Plans, shall be followed in the placing of concrete.

In no case shall the work on any section or layer be stopped or temporarily discontinued within 18 inches below the top of any face, unless the Plans provide for a coping having a thickness less than 18 inches, in which case, at the option of the Resident, the construction joint may be made at the underside of the coping. Concrete in columns shall be placed in one continuous operation, unless otherwise directed.

If SCC has been approved for use, it shall be placed from a single discharge point to build hydraulic head and allow the SCC to progressively flow forward until the form is filled. The discharge point shall be moved as the SCC reaches the full height being cast, while maintaining a hydraulic head as the cast progresses. If subsequent loads of SCC are placed on top of a previous layer, a minimal amount of internal vibrating must be introduced to ensure the top layer blends with the previous layer.

Fresh concrete threatened with rain damage shall be protected by approved means. Sufficient material for covering the work expected to be done in one day shall be on hand at all times for emergency use. The covering shall be supported above the surface of the concrete.

Concrete Fill shall be placed at least to the pay limits shown on the Plans. Forms may be omitted at the Contractor’s option. Vibration of concrete will not be required. The Contractor has the option of placing Concrete Fill under water or in the dry.

B. Chutes, Troughs, Pipes and Buckets Sectional drop chutes or short chutes, troughs, pipes and buckets, when used as aids in placing concrete, shall be arranged and used in such a manner that the ingredients of the concrete do not become separated or segregated. Wood and aluminum chutes, troughs, pipes or buckets shall not be used.

Dropping the concrete a distance of more than 6 feet, unless confined by closed chutes or pipe, will not be permitted. The concrete shall be deposited at, or as near as possible to, its final position.

C. Vibrating Mechanical, high frequency internal vibrators shall be used, operating within the concrete, for compacting the concrete in all structures and precast and cast-in-place piles, with the exception of concrete placed under water. The vibrators shall have a frequency of between 5,000 and 12,000 vibrations per minute and shall be visibly capable of properly consolidating the designed mixture. For each type of vibrator used, a spare vibrator shall be available on the project at all times during the placing of concrete.

Sufficient vibrators shall be used to consolidate the incoming concrete within 5 minutes after placing. Vibrators shall neither be held against forms or reinforcing steel, nor shall they be used for flowing the concrete or spreading it into place. Over-vibrating shall not be allowed.

D. Dewatering Forms All forms shall be dewatered before concrete is placed in them. Pumping will not be permitted from the inside of forms while concrete is being placed. Moving water shall not be permitted to be exposed to fresh concrete.

E. Depositing Concrete under Water No concrete shall be deposited under water except for cofferdam seals. Pumping will not be allowed within the cofferdam while concrete is being placed.

The concrete shall be placed carefully in a compact mass in its final position by means of a tremie or by other approved means and shall not be disturbed after being deposited. Bottom dump buckets will not be permitted. Special care must be exercised to maintain still water at the point of deposit. Concrete shall not be placed in running water. The method of depositing concrete shall be so regulated as to produce approximate horizontal surfaces. Each seal shall be placed in one continuous operation.

When a tremie is used, it shall consist of a tube not less than 10 inches in diameter. The means of supporting the tremie shall be such as to permit free movement of the discharge end over the entire seal and to permit its being lowered rapidly, when necessary to choke off or retard flow. The tremie shall be filled by a method that will prevent washing of the concrete. The discharge end shall be completely submerged in concrete at all times and the tremie tube shall be kept full to the bottom of the hopper. The flow shall be regulated by raising or lowering the tremie.

When the horizontal area of the tremie seal is large, several tremie hoppers shall be provided and positioned strategically to allow placement of concrete near the point where it is

needed, to avoid moving concrete horizontally through the water. The number of tremie hoppers and the work plan shall be approved by the Resident.

All laitance or other unsatisfactory material shall be removed from the surface of the seal before placing additional concrete. The surface shall be cleaned by scraping, chipping or other means that will not injure the concrete.

The placing and dewatering of seal concrete within cofferdams shall be in accordance with Section 511 - Cofferdams.

F. Construction Joints Construction joints shall be located where shown on the Plans or permitted by the Resident. When the concrete is in seawater, no horizontal construction joint will be permitted between extreme low tide and extreme high tide elevations, with the exception of concrete cores for stone masonry.

At horizontal construction joints, temporary gage strips, having a minimum thickness of 1-½ inches, shall be placed horizontally inside the forms along all exposed faces, to give the joints straight lines. The joint shall be so constructed that the surface of the concrete will not be less than ¼ inch above the bottom of the gage strip. Before placing fresh concrete, the temporary gage strip shall be removed, the surfaces of construction joints shall be thoroughly cleaned, drenched with water until saturated and kept saturated until the new concrete is placed. Immediately prior to placing new concrete, the forms shall be drawn tight against the concrete already in place. Concrete in substructures shall be placed in such a manner that all horizontal joints will be horizontal and, if possible, in locations such that they will not be exposed to view in the finished structure.

Where vertical construction joints are necessary, reinforcing bars shall extend across the joint in such a manner as to make the structure monolithic. Construction joints through paneled wing walls or other large surfaces which are to be treated architecturally will not be allowed except as shown on the Plans. All vertical construction joints in abutments and retaining walls shall contain water stops as shown on the Plans. The water stops shall be one continuous piece at each location.

All horizontal construction joints in abutments and retaining walls shall be constructed using a joint cover, as shown on the Plans.

Construction joints in the wearing surface shall be located where called for on the Plans. No other construction joints will be allowed.

All joints shall be formed in the manner detailed on the Plans. The forms shall not be treated with oil or any other bond breaking material that will adhere to the concrete.

Sealing slots shall be provided at all joints in the wearing surface that are located directly over a slab construction joint.

Construction joints in the wearing surface not receiving a sealing slot shall be brushed with a neat cement paste immediately prior to making the adjacent concrete placement.

After the concrete has been cured, sealing slots, when required, shall be sandblasted, or high-pressure (minimum of 8,000 psi) water cleaned, to remove all laitance and foreign material on the surfaces of the slots. The bottom of the sealing slots shall receive an approved bond breaker. The joint shall then be filled within ⅛ inch of the surface with an elastomeric concrete product listed on the Department's Qualified Products List, in accordance with the manufacturer's recommendations.

G. Bonding of Cast-In-Place Concrete Slabs Concrete wearing surface slabs placed on cast-in-place superstructure slabs, concrete wearing surface slabs placed on precast concrete superstructure elements, structural concrete slabs placed on precast concrete superstructure elements, or concrete leveling slabs placed on precast concrete superstructure elements shall be permanently bonded. Precast concrete superstructure elements include, but are not limited to, deck slabs, voided slabs, box beams, bulb tee girders and Northeast Extreme Tee (NEXT) beams.

The structure supporting the cast-in-place slab shall be cleaned to remove all laitance, dust, dirt, debris, oil, grease, bituminous material, paint, and other foreign matter. When the supporting structure is composed of cast-in-place concrete, the Contractor shall scabble the entire surface of the structure and then sandblast, or high pressure (minimum of 8,000 psi, typical) water clean, the entire supporting structure. When the supporting structure is comprised of precast elements, the Contractor shall sandblast, or high pressure water clean, the entire surface of the supporting surface elements. The final cleaning of the supporting structure shall be performed within the 24 hour period preceding the placement of the cast-in-place slab. All debris resulting from the cleaning operation shall be thoroughly removed using compressed dry air from the cleaned surfaces and adjacent areas. Air lines shall be equipped with effective oil traps. Prepared areas of the supporting structure that have not received the cast-in-place slab within 36 hours of being cleaned shall be recleaned. No surface preparation of a new supporting structure shall begin before completion of the specified curing period.

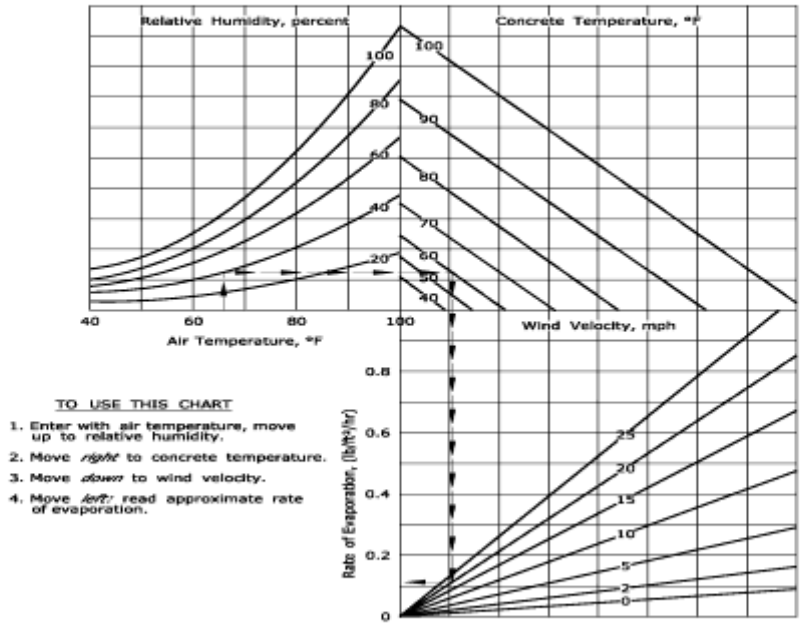
After cleaning of the structure supporting the cast-in-place slab has been satisfactorily completed, the supporting structure and all porous surfaces to be in contact with the new slab shall be thoroughly saturated with water for a minimum of 12 hours prior to placement of the slab. Remove all standing water immediately prior to placement with oil-free compressed air and protect the supporting structure from drying, so that the concrete remains in a saturated surface dry condition.

The following is further required when placing concrete wearing surface slabs: In addition to the cleaning prescribed above for the supporting structure, the faces of curb and barrier walls, or other median devices, up to a height of one inch above the top elevation of the wearing surface, shall be cleaned to remove all curing compound, laitance, dust, dirt, debris, oil, grease, bituminous material, paint and all other foreign matter. The cleaning shall be performed by dry sand blasting or high pressure water cleaning.

Bonding grout for wearing surface slabs. All horizontal surfaces in contact with the wearing surface shall receive a coating of bonding grout. The vertical faces in contact with the wearing surface shall be broomed up to the elevation of the top of the wearing surface with bonding grout. Stiff bristled street brooms shall be used to brush the grout onto the surface. The coating shall not exceed ⅛ inch in thickness. The rate of progress in applying grout shall be limited so that the grout does not become dry before it is covered with new concrete. During delays in the surfacing operations, should the surface of the grout indicate an extensive amount of drying, the grout shall be removed by methods approved by the Resident and the area shall be regrouted. The bonding grout shall have Portland cement and fine aggregate proportioned 3 to 1, respectively, by volume. The grout mix design shall be included in the QCP. The fine aggregate, from which the material larger than ⅛ inch has been removed, shall be the same source as used in the concrete. The cement and fine aggregate shall be measured separately in appropriately sized containers. The fine aggregate shall be deposited in an approved mechanical mortar mixer before adding cement. Water shall be added in sufficient quantity to allow flow of the grout without segregation of the grout ingredients. No water shall be added to the bonding grout after initial mixing. The grout shall not be allowed to separate before placement. The cement to water contact time of the grout shall not exceed 30 minutes before it is placed. Any grout that has dried or become unworkable before application, as determined by the Resident, shall not be incorporated into the work. The use of retarding admixtures for increasing the discharge time limits will be allowed. The Resident may approve the batching of bonding grout at an approved commercial concrete batch plant. In this case, mixing and delivery shall be in transit truck mixers.

H. Concrete Slab Surface Evaporation Limitations No placement of structural concrete slab structures, including, but not limited to, concrete deck slabs, wearing surfaces, simple slab spans, and slabs on precast superstructures, shall be commenced if the combination of ambient air temperature, relative humidity, wind speed, and plastic concrete temperature result in a surface moisture evaporation rate theoretically equal to, or greater than, 0.1 lb/ft²/hr of exposed surface (Refer to the Rate of Evaporation from Concrete Surface Chart). If the surface moisture evaporation rate rises to 0.15 lb/ft²/hr of exposed surface, the Contractor shall implement the remedial action described in the approved QCP. The temperature of the concrete shall not exceed 75°F at the time the concrete is placed in its final position. The maximum temperature of the surface on which concrete will be placed shall be 90°F. The Contractor shall provide all equipment and perform all measurements and calculations in the presence of the Resident to determine the rate of evaporation, the cost of which shall be incidental to related items.

RATE OF EVAPORATION FROM CONCRETE SURFACE CHART



502.11 Expansion and Contraction Joints Expansion and contraction joints shall be located and constructed as shown on the Plans. Water stops shall be one continuous piece at each location. Joint cover, as shown on the Plans, shall be applied to all joints where water stops cannot physically be installed, as determined by the Resident.

502.12 Repairing Defects and Filling Form Tie Holes in Concrete Surfaces After the forms are removed, all surface defects and holes left by the form ties shall be repaired.

All fins and irregular projections shall be removed from the following: Surfaces which are visible in the completed work; surfaces to be waterproofed; and the portion of vertical surfaces of substructure units which is below the final ground surface to a depth of 12 inches, not including underwater surfaces.

In patching surface defects, all coarse or fractured material shall be chipped away until a dense uniform surface, exposing solid coarse aggregate, is obtained. Feathered edges shall be saw cut away to form faces having a minimum depth of 1 inch perpendicular to the surface. All surfaces of the cavity shall be saturated thoroughly with water, after which a thin layer of neat cement paste shall be applied. The cavity shall then be filled with thick, reasonably stiff mortar, not more than 30 minutes old, composed of material of the same type and quality and of the same proportions as that used in the concrete being repaired. The surface of this mortar shall be

floated before initial set takes place and shall be neat in appearance. The patch shall be water cured for a period of five days.

The holes left by form ties shall be filled with a mortar similar to that described above, but with the addition of a non-shrink additive.

If the removal of defective concrete materially impairs the soundness or strength of the structure, as determined by the Resident, the affected unit shall be removed and replaced by the Contractor at its expense.

The holes left by form ties, on the portions of substructure concrete that are to be permanently covered in the finished work, may be filled with an acceptable grade of plastic roofing cement. Holes in the bottom of slabs caused by supporting hangers need not be filled.

502.13 Finishing Concrete Surfaces Neat cement paste, dry cement powder or the use of mortar for topping or plastering of concrete surfaces will not be permitted.

A. Float Finish A float finish for horizontal surfaces shall be achieved by placing an excess of concrete in the form and removing or striking off the excess with a template or screed, forcing the coarse aggregate below the surface. Creation of concave surfaces shall be avoided. After the concrete has been struck off, the surface shall be thoroughly floated to the finished grade with a suitable floating tool. Aluminum and steel floats are not allowed.

Float finish, unless otherwise required, shall be given to all horizontal surfaces except those intended to carry vehicular traffic and those of sidewalks.

B. Structural Concrete Slab Structures Structural concrete slab structures include, but are not limited to, structural concrete deck slabs, wearing surfaces, slabs on precast superstructures, top and bottom slabs of box culverts, approach slabs, rigid frame structures and simple slab spans, as applicable. Screed rails shall be set entirely above the finished surface of the concrete and shall be supported in a manner approved by the Resident. Where shear connector studs are available, welding to the studs will be permitted. No welding will be permitted directly on the stringer flanges to attach either screed rail supports or form supports of any type.

Screed rail supports set in the concrete shall be so designed that they may be removed to at least 2 inches below the surface of the concrete. Voids created by removal of the upper part of the screed rail supports shall be filled with mortar having the same proportions of sand and cement as that of the slab or wearing surface. The mortar shall contain an approved additive in sufficient proportions to produce non-shrink or slightly expansive characteristics.

The rate of placing concrete shall be limited to that which can be finished without undue delay and shall not be placed more than 10 feet ahead of strike-off.

The Contractor shall furnish a minimum of two work bridges behind the finishing operation, supported on the screed rails, each of which shall be capable of spanning the entire width of the deck and supporting at least a 500 pound load without deflection to the concrete surface. These work bridges shall be used by the Contractor for touch-up and curing cover application and shall be available for inspection purposes. When the overall length of the structure is 60 feet, or less, only one work bridge will be required.

An approved bridge deck finishing machine complying with the following requirements shall be used, except as otherwise specified, for finishing structural concrete slab structures. The finishing machine shall have the necessary adjustments, built in by the manufacturer, to produce the required cross section, line and grade. The supporting frame shall span the section being cast in a transverse direction without intermediate support. The finishing machine shall be self-propelled and capable of forward and reverse movement under positive control. Provisions shall be made for raising all screeds to clear the screeded surface for traveling in reverse. The screed device shall be provided with positive control of the vertical position.

The finishing machine shall be self-propelled with one, or more, oscillating screeds or one, or more, rotating cylinder screeds. An oscillating screed shall oscillate in a direction parallel to the centerline of the structure and travel in a transverse direction. A rotating cylinder screed shall rotate in a transverse direction while also traveling in the same direction. Either type of screed shall be operated transversely in overlapping strips in the longitudinal direction not to exceed 6 inches. One, or more, powered augers shall be operated in advance of the screed(s) and a drag (pan type) float shall follow the screed(s). For concrete placements less than 6 inches in depth, vibratory pan(s) having a minimum of 3,000 vibrations/minute shall be operated between the oscillating screed(s) or rotating cylinder screed(s) and the power auger(s). For concrete placed in excess of 3 ½ inches in depth, hand-operated spud vibrators shall be used in addition to the machine vibratory pan(s).

The transversely operated rotating cylinder(s) of the bridge deck finishing machine shall be rotated such that the direction of the rotation of the cylinder(s) at the surface of the concrete is in accordance with the manufacturer's recommendations.

Concrete immediately in front of the power auger(s) of a bridge deck finishing machine shall be placed or cut to a depth that is in close proximity to the center of the rotating auger(s). The advance auger(s) shall strike off the concrete to approximately ¼ inch above the final grade. The concrete shall then be consolidated with the vibrating pan(s) and then finished to final grade.

If the drag float does not seal the surface of the concrete, an additional float finish shall be applied immediately following strike-off.

A small handheld pan vibrator shall be required at edges and adjacent to joint bulkheads. In lieu of the handheld pan vibrator equipment, the Resident may approve small spud vibrator(s).

Lightweight, vibrating, screeds may be used on slab structures which are more than 12 inches below the roadway finish grade or have a length of 30 feet or less, or where concrete placements are specified to be less than 16 feet in width, and shall have the following features:

1. It shall be portable and easily moved, relocated, or adjusted.
2. The power unit shall be operable without disturbing the screeded concrete.
3. It shall be self-propelled with controls that will allow a uniform rate of travel and by which the rate of travel can be increased, decreased or stopped.
4. It shall have controlled, uniform, variable frequency vibration, end to end.
5. It shall be fully adjustable for flats, crowns, or valleys.
6. The screed length shall be adjustable to accommodate the available work area.

When a lightweight vibrating screed is utilized, the concrete shall be placed or cut to no more than ½ inch above the finished grade in front of the front screed. The screed shall be operated such that at least three feet of concrete is in position in front of the screed.

Supporting slabs for bituminous wearing surfaces shall be finished in accordance with the recommendations of the waterproofing membrane manufacturer.

On all concrete wearing surfaces, a one foot wide margin shall be finished adjacent to curbs and permanent barriers with a magnesium float.

Immediately after screeding and floating, the surface of the concrete shall be tested for trueness, by the Contractor, with a 10 foot straightedge and all irregularities corrected at once in order to provide a final surface within the tolerance required in Table 3. The surface shall be checked both transversely and longitudinally.

The straightedges shall be furnished and maintained by the Contractor. They shall be fitted with a handle and all parts shall be made of aluminum or other lightweight metal. The straightedges shall be made available for use by the Resident when requested.

In the event of a delay during a concrete placement, all concrete that cannot receive the final curing cover shall be covered with wet burlap.

No vehicles will be allowed, either directly or indirectly, on reinforcing steel before concrete placement.

C. Curb and Sidewalk Finish on Bridges Curbs and sidewalks shall receive a float finish. Sidewalks shall, additionally, receive a light broom finish, perpendicular to the sidewalk.

When a concrete curb is monolithic with a sidewalk, a 6 inch wide smooth margin shall be made along the top of the curb with a magnesium float.

Unless shown on the Plans, the sidewalk area shall not be divided into sections by transverse grooves.

At all transverse construction and expansion joints, except where steel expansion dams are used, the edges of the joints, on the surface of the sidewalk, shall be finished with a sidewalk edging tool, 2 inches in width, with a ¼ inch radius lip. Finishing shall be completed within 15 minutes of concrete placement.

D. Form Surface Finish The character of the materials used and the care with which forms are constructed and concrete placed shall be considered in determining the amount of rubbing required. If concrete surfaces are obtained that are satisfactory to the Resident, then the Contractor may be relieved, in part, from the requirement of rubbing.

1. Ordinary Finish An Ordinary Finish is defined as the finish left on a surface after the removal of the forms, the filling of all holes and the repairing of all defects. The surface shall be true and even, free from stone pockets and depressions or projections and of uniform texture. All formed concrete surfaces shall be given an ordinary finish unless otherwise specified.

Repaired areas that do not meet the above requirements or areas that cannot be satisfactorily repaired to meet the requirements for ordinary finish shall be given a rubbed finish. When a rubbed finish is required on any part of a surface, the entire surface shall be given a rubbed finish.

2. Rubbed Finish After removal of forms, the rubbing of concrete shall be started as soon as its condition will permit. Immediately before starting this work, the concrete shall be thoroughly saturated with water. Sufficient time shall have elapsed before wetting down to allow the mortar used in ordinary finish to become thoroughly set. Surfaces to be finished shall be rubbed with a medium coarse carborundum stone, using a small amount of mortar on its face. The mortar shall be composed of cement and fine sand mixed in proportions as used in the concrete being finished. Rubbing shall be continued until all form marks, projections and irregularities have been removed, all voids filled and a uniform surface has been obtained. A thin layer of paste produced by this rubbing shall be left on the surfaces.

After all concrete above the surface being treated has been cast, the final finish shall be obtained by a second rubbing with a fine carborundum stone using only water. This rubbing shall be continued until the entire surface is of a smooth texture and uniform color. The paste produced by this second rubbing shall be carefully spread with a moist whitewash brush to form a very thin uniform coating upon the surface of the concrete.

After the final rubbing is completed and the surface has dried, it shall be rubbed lightly with clean, dry, burlap to remove excess loose powder and shall be left free from all unsound patches, paste, powder and objectionable marks. This finish shall result in a surface of smooth texture and uniform color.

No surface finishing shall be done in freezing weather or when the concrete contains frost. In cold weather, the preliminary rubbing necessary to remove the inert sand and cement

materials and the surface irregularities may be done without the application of water to the concrete surfaces.

The following portions of concrete roadway grade separation structures shall be given a rubbed finish unless otherwise indicated in the Contract:

(a) Retaining walls and the breast and wing walls of abutments-face surfaces to 12 inches below the finished ground line.

(b) Piers-All vertical surfaces and the underside of overhanging portions of caps, except that for overpass structures, the piers beyond the outside limits of the roadway pavement, the vertical surfaces on the back which are not visible from the roadway or sidewalk will not require a rubbed finish.

If, in the opinion of the Resident, the general appearance of a concrete structure, due to the excellence of workmanship, cannot be improved by a rubbed finish, this requirement may be waived.

E. Surface Finish After the concrete has cured the surface shall be tested with a 10 foot straightedge or a lightweight profiler.

The straightedge shall be furnished and maintained by the Contractor. It shall be fitted with a handle and all parts shall be made of aluminum or other lightweight metal. The straightedges shall be made available for use by the Resident when requested. The lightweight profiler will be furnished by the Department.

Areas found to not comply with the tolerance of Table 3 shall be brought into conformity by methods proposed by the Contractor and approved by the Resident at no additional cost to the Department.

TABLE 3
SURFACE TOLERANCE LIMITS

Type of Surface	Maximum deviation of surface in inches below a 10 foot straightedge*
Concrete Wearing Surfaces, Curbs, Sidewalks, and Barriers	⅛ inch
Concrete Slab Surfaces to be Covered by Membrane Waterproofing or Concrete Wearing Surfaces	¼ inch
Concrete Slab Surfaces with Integral Concrete Wearing Surface	¼ inch
Concrete Slab Surfaces to be Covered By Earth or Gravel	⅜ inch
Concrete Surface of Box Culvert Bottom Slabs	⅜ inch
Concrete Surface of Abutments, Piers, Pier	⅜ inch

Shafts, Footings, and Walls	

*Allowance shall be made for crown, camber and vertical curve.

F. Transverse Saw Cut Grooving of Concrete Wearing Surfaces A transverse saw cut grooved finish shall be applied to concrete wearing surfaces. This work shall be performed using a multi-bladed diamond wet saw using circular saw blades. The Resident may allow the use of a single blade, circular saw tool, where it is determined that such equipment is necessary to complete the work, as required. The equipment the Contractor proposes to use will be subject to the approval of the Resident, prior to use.

Saw cutting may begin only after the specified curing period has elapsed. Transverse grooves shall be cut perpendicular to the centerline of the roadway using a single pass. Cut all grooves in a rectangular shape conforming to the following dimensions:

Width: 1/8 inch +/- 1/32 inch
Depth: 1/4 inch +/- 1/16 inch

Terminate grooves 12 inches away from the vertical face of curbs or parapets.

The grooves shall be randomly spaced. The random spacing shall range from 1-1/4 inches to 2 inches, with 50 percent of the spacings being less than, or equal to, 1-1/2inches. The Contractor shall submit a spacing pattern to the Resident for approval.

An example of an acceptable random pattern is 1-1/4, 1-1/2, 1-3/8, 1-1/4, 1-3/4, 1-1/2, 2, 2, 1-1/2, 1-1/4, 1-3/8, 2, 1-5/8, 1-1/4, 1-1/2, 1-1/2, 1-3/4, 2, and 1-5/8, with all spaces measured in inches. Spacings should not be based solely on multiples of 1/4 inch, because the result will not be truly random (e.g., do not use a pattern such as 1-1/4, 1-1/4, 1-3/4, 2, 1-1/2, 2, 2, etc.).

During the grooving operations, the Resident will verify, at random, that the minimum grooved depth is being achieved. If the Resident determines that the minimum groove depth is not being achieved, then the Contractor shall stop grooving operations and make all adjustments necessary, as well as any repairs, as required by the Resident.

The Contractor shall supply the Resident with two (2) accurate, easily readable, gauges with which to verify groove depth. Deliver the gauges and applicable manufacturer's instructions for use no later than 7 Days prior to the anticipated start of grooving operations.

Slurry, or debris, from the grooving operation will not be allowed to accumulate or harden and shall be prevented from flowing into drains, onto the roadway slopes or water bodies below or adjacent to the bridge. Residue shall be continuously removed. The slurry, or debris, shall be disposed of properly by the Contractor.

502.14 Curing Concrete All concrete surfaces shall be kept wet with clean, fresh, water for a curing period of at least 7 days after concrete placing, with the exception of vertical surfaces, as provided for in Section 502.09(D) - Removal of Forms and False work, and sidewalks, as

provided for in this section. For concrete wearing surfaces and all concrete containing fly ash or slag, the temperature of the concrete shall be kept above 50°F for the entire seven (7) day period. All other concrete and its surfaces shall be kept above 50°F for the first four (4) days of the curing period and above 32°F for the remainder of the period.

In the 24 hours following the end of the curing period, the temperature of the concrete shall be decreased on a gradual basis, not to exceed a total change of 40°F for moderate sections, such as abutments and pier bents, and 30°F for mass sections, such as massive piers.

All slabs and wearing surfaces shall be water cured and kept continuously wet for the entire curing period by covering with one of the following systems:

A. 2 layers of wet burlap,

B. 2 layers of wet cotton mats,

C. 1 layer of wet burlap and either a polyethylene sheet or a polyethylene coated burlap blanket,

D. 1 layer of wet cotton mats and either a polyethylene sheet or a polyethylene coated burlap blanket.

Except as otherwise specified, curing protection for slabs and wearing surfaces shall be applied within 15 minutes after the concrete is screeded and before the surface of the concrete has lost its surface "wetness" or "sheen" appearance. The burlap or the cotton mats shall be pre-soaked, prior to being applied. Polyethylene sheets shall not be placed directly on the concrete, but may be placed over the fabric cover to prevent drying.

The covering of concrete wearing surfaces, decks, curbs, and sidewalks shall be kept continuously wet for the entire curing period by the use of a continuous wetting system and shall be located to insure a completely wet concrete surface for the entire curing period, except as noted below.

The finished surfaces of sidewalks may be cured using a curing compound listed on the Department's Qualified Products List. The curing compound shall be applied continuously by approved mechanical pressure spraying or distributing equipment at a rate necessary to obtain an even, continuous membrane, meeting the manufacturer's recommendations, but at a rate of not less than 1 gallon per 200 ft^2 of surface. At a minimum, two coats shall be applied using a pressurized sprayer, with the first coat being applied within 15 minutes after finishing is complete, and the second coat being applied within 30 minutes of, and at right angles to, the first. Hand-pump sprayers, rollers or brushes shall not be used.

All other surfaces, if not protected by forms, shall be kept thoroughly wet either by sprinkling or by the use of wet burlap, cotton mats or other suitable fabric until the end of the curing period, except as provided for in Section 502.09(D) - Removal of Forms and False work.

Polyethylene sheets shall not be placed directly on the concrete, but may be placed over the fabric cover to prevent drying.

Use of evaporation retardants, finishing aids or water, to finish any concrete surfaces shall not be allowed.

502.15 Loading Structures and Opening to Traffic No superstructure concentrated loads such as structural steel beams, girders and trusses shall be placed upon finished concrete substructures until the concrete has reached its design strength.

No load or work will be permitted on concrete superstructure slabs or rigid frame structures until concrete cylinders cured with the slab establish that design strength has been reached. However, after a shorter period of time the Resident may permit handwork for form construction and setting stone bridge curb. No curbing or other materials shall be stored on the bridge during the 7 day curing period, except that if handwork is permitted, curb stones may be stored in a line near their final location until ready to be set.

Neither traffic nor fill material shall be allowed on superstructures of concrete bridges or culverts until concrete cylinders cured with the slab establish that design strength has been reached, dependent upon conditions as specified in Section 502.09 and with the approval of the Resident.

No traffic will be allowed on the cured concrete of a concrete wearing surface until 24 hours after the completion of the application of protective coating for concrete surfaces.

Concrete approach slabs at the end of structures may be opened to traffic or backfilled if buried, when the design strength has been reached.

Foundations for light bases, traffic signals and overhead signs must reach design strength prior to loading.

502.16 Bridge Drains and Incidental Drainage All drains shall be accurately placed at the locations shown on the Plans, or authorized, and adequate means provided for securely holding them in the required positions during the placing of concrete.

Bridge drains shall be galvanized in accordance with Section 711.04 - Bridge Drains. The Contractor shall furnish an insulator between surfaces of galvanized and weathering steels when erecting the bridge drain support assembly. Epoxy-coated washers shall be used when the support assembly attaches to weathering steel beam webs.

Drains or weep holes through abutments and retaining walls shall be pipe of the size and shape shown on the Plans and shall be of Schedule 40 PVC pipe.

For the purpose of providing drainage for any moisture that may collect between the deck slab and the hot mix asphalt roadway surface, approved one inch inside diameter plastic tube

drains shall be installed at the low points of the slab surface, adjacent to the end dam or dams. The exact location will be determined in the field by the Resident and the discharge from them shall be such as to clear the bridge seats and any other portion of the structure in their proximity. The tops of the drains shall be depressed ⅜ inch below the surface of the slab and the outlets shall project 2 inches below the underside of the slab. Care shall be exercised such that the drains are open after the installation of the membrane waterproofing, when it is installed.

502.1701 Quality Control, Method A and B The Contractor shall control the quality of the concrete through testing, inspection, and practices which shall be described in the QCP, sufficient to assure a product meeting the Contract requirements. The QCP shall meet the requirements of Section 106, Quality, and this specification. No work under this item shall proceed until the QCP is submitted to and approved by the Department.

The QCP shall address all elements that affect the quality of the structural concrete including, but not limited to, the following:

A. Mix Design(s)
B. Aggregate Production
C. Quality of Components
D. Stockpile Management
E. Proportioning, including Added Water
F. Mix and Transportation, including Time from Batching to Completion of Delivery
G. Initial and as-Delivered Mix Properties, including Temperature, Air Content, Consistency and Water/Cement Ratio
H. Process QC Testing
I. Placement and Consolidation
J. Permeability
K. Compressive Strength
L. Finishing and Curing
M. Hot and Cold Weather Concreting Procedures, including curing and form removal

The QCP shall include the names and specific qualifications of the individuals meeting these requirements and qualifications:

A. QCP Administrator meeting one of the following qualifications:

1. Professional Engineer licensed in the State of Maine with one year of concrete experience acceptable to the Department.

2. Engineer-in-Training certified by the State of Maine with two years of concrete experience acceptable to the Department.

3. An individual with three years concrete experience acceptable to the Department and with a Bachelor of Science Degree in Civil Engineering or a related Civil Engineering Technology discipline.

4. Certified Quality Assurance Technologist, certified by the NorthEast Transportation Training and Certification Program (NETTCP).

B. Process Control Technician(s) (PCT) shall utilize test results and other quality control practices to assure the quality of aggregates and other mix components and control proportioning to meet the mix design(s). The QCP shall detail the frequency of sampling and testing, corrective actions to be taken, and documentation. The PCT shall periodically inspect all equipment utilized in proportioning and mixing to assure it is operating properly and that proportioning and mixing conforms to the mix design(s) and other Contract requirements. The QCP shall detail how these duties and responsibilities are to be accomplished and documented and whether more than one PCT is required. The QCP shall include the criteria utilized by the PCT to correct or reject unsatisfactory materials. The PCT shall be a MCTCB certified Concrete Plant Technician or a NETTCP certified Concrete Technician.

C. Quality Control Technician(s) (QCT) shall perform quality control tests and inspection at the job site to assure that materials meet the requirements of the mix design(s) and specifications. The QCP shall detail frequency of sampling and testing, inspection procedures, corrective actions to be taken, and documentation. The QCP shall detail how these duties and responsibilities are to be accomplished and documented, and whether more than one QCT is required. The QCP shall include the criteria utilized by the QCT to reject unsatisfactory materials. The QCT shall be an ACI certified Concrete Field Testing Technician- Grade I or a NETTCP certified Concrete Technician.

D. The Plan shall detail the coordination of the activities of the QCP Administrator, the PCT and the QCT.

The Contractor shall maintain records of all QC tests and calculations. The gradation test data and results shall be reported to the Department before the placement they represent. The Contractor or supplier shall retain split samples of the most recent QC gradations for possible Verification testing by the Department. In addition, the Department will sample the aggregates at the plant on a monthly basis to determine specification compliance. If the Department's gradation tests determine that the aggregate does not meet the specified gradation limits, corrective action shall be required before additional concrete may be supplied to the project. The compressive strength test results shall be reported to the Department by 10:00 A.M. of the first working day following the test. All QC test data shall be signed by the person who performed the test. The Contractor shall record all onsite QC test data and calculations at the time of the placement and present this information, on a form acceptable to the Department, to the Department by 10:00 A.M. of the first working day following the concrete placement. All Method A and B QC testing shall meet the minimum requirements found in Table 4.

TABLE 4
METHOD A & B MINIMUM QUALITY CONTROL TESTING REQUIREMENTS

TEST	TEST METHOD	SAMPLING LOCATION	FREQUENCY
Gradation	AASHTO T-27 & T-11	Stockpile	One set per mix before production. One set every 100 yd^3 (Min. 1 set per month)
Organic Impurities	AASHTO T-21	Stockpile	One set per each FA gradation
% Absorption	AASHTO T-84 & T-85	Stockpile	Once per aggregate per 6 months
Specific Gravity	AASHTO T-84 & T-85	Stockpile	Once per aggregate per 6 months
Total Moisture in Agg.	AASHTO T-255	Stockpile	One set per day's production
Free Water and Agg. Wt.	N/A		One per day's production
% Entrained Air	AASHTO T-152	On Project	On first two loads and every third load thereafter provided consistent results are achieved
Compressive Strength	AASHTO T-22	On Project	One set per sublot
Compressive Strength	AASHTO T-22 @ 7days	On Project	One set per sublot

Additional QC testing will be required any time a process change occurs during a placement, including changes in type or dosage of admixture.

502.1702 Quality Control, Method C The Contractor shall submit a QCP listing the mix design(s) to be used, the name and location of the production facility, a brief description of the placement and curing process and the name and qualifications of any QCT to be used. A QCT will be required. The Contractor shall provide a Certificate of Compliance for each truckload of concrete to the Department at the time of the load placement.

502.1703 Acceptance Methods A and B The Department will determine the acceptability of the concrete through a quality assurance program.

The Department will take Acceptance samples a minimum of once per sublot on a statistically random basis. Samples will be taken at the discharge point, with pumped concrete sampling taken at the discharge end of the pump line. Acceptance tests will include compressive strength, air content and chloride permeability.

Lot Size A lot size shall consist of the total quantity represented by each class of concrete in the Contract. A lot shall consist of a minimum of 3 and a maximum of 10 sublots. If a lot is comprised of more than 10 sublots, sized in accordance with Table 5, then this quantity shall be divided equally into 2, or more, lots, such that there is a minimum of 3 and a maximum of 10 sublots per lot. If there is insufficient quantity in a lot to meet the recommended minimum sublot size, then the lot shall be divided into 3 equal sublots.

Sublot Size, General The size of each sublot shall be determined in accordance with Table 5. The Resident may vary sublot sizes based on placement sizes and sequence.

Sublot Size, Unit Price Items Sublot sizes will initially be determined from estimated quantities. When the actual final quantity of concrete is determined: If there is less than one-half the estimated sublot quantity in the remaining quantity, then this quantity shall be combined with the previous sublot, and no further Acceptance testing will be performed; if there is more than one-half the estimated sublot quantity in the remaining quantity, then this quantity shall constitute the last sublot and shall be represented by Acceptance test results. If it becomes apparent part way through a lot that, due to an underrun in quantity, there will be an insufficient quantity of concrete to comprise three sublots, then the Resident may adjust the sizes of the remaining sublots and select new sample locations based on the revised estimated quantity of concrete remaining in the lot.

Sublot Size, Lump Sum Items Each lot shall be divided into sublots of equal size, based on the estimated quantity of concrete.

TABLE 5

Quantity (CY)	Recommended Sublot Size (CY)
0-500	50
501-1000	75
1001-2000	100
2001 or greater	250

Determination of the concrete cover over reinforcing steel for structural concrete shall be made prior to concrete being placed in the forms. Bar supports, chairs, slab bolsters, and side form spacers shall meet the requirements of the Concrete Reinforcing Steel Institute (CRSI) Manual of Standard Practice, Chapter 3 Section 3.2.5 Class 1, Section 3.2.6 Class 1A, or Section 3.4, All-Plastic Bar Supports. All supports shall meet the requirements for type and spacing as stated in the CRSI Manual of Standard Practice, Chapter 3. Concrete will not be placed until the placing of the reinforcing steel and supports have been approved by the Resident. If the Contractor fails to secure Department approval prior to placement, the Contractor's failure shall

be cause for removal and replacement at the Contractor's expense. The Contractor shall notify the Resident, at least 48 hours prior to the placement, when the reinforcing steel will be ready for checking. Sufficient time must be allowed for the checking process and any needed repairs.

Compressive strength tests will be completed by the Department in accordance with AASHTO-T 22 and T 23 at ≥ 28 days, except that no slump will be taken. Two 4 inch x 8 inch cylinders will be cast per sublot placed. The average of two concrete cylinders per sublot will constitute a test result and this average will be used to determine the compressive strength for pay adjustment computations.

Testing for Entrained Air in concrete, at the rate of one test per sublot, shall be in accordance with AASHTO T152.

Rapid Chloride Permeability specimens will be tested by the Department in accordance with AASHTO T-277 at an age ≥ 56 days. Two 4 inch x 8 inch cylinders will be cast per sublot placed. The average of two concrete specimens per sublot will constitute a test result and this average will be used to determine the permeability for pay adjustment computations.

Surface Tolerance, Alignment and Trueness, Plumb and Batter, Finish The Resident will measure the properties of surface tolerance, alignment and trueness, plumb and batter and finish to ensure they conform to the following criteria. If the concrete fails to meet any of these requirements and the Contractor fails to repair or mitigate the identified defects, to the satisfaction of the Resident, then there shall be no positive Quality Assurance Acceptance incentive payments on the respective lots.

A. Surface Tolerance Surface tolerance of exposed horizontal and sloping portions of the substructure, superstructure slabs, wearing surface, sidewalks, barriers and wingwalls will be measured with a 10 foot straightedge. Surface tolerance limits are given in Table 3, Section 502.13(E). The Contractor shall furnish the 10 foot straightedge.

B. Alignment and Trueness Alignment and trueness will be measured longitudinally along any vertical surface of any portion of the structure and shall not exceed a deviation of ¼ inch in 3 feet for structures up to 30 feet in length. Structures in excess of 30 feet in length will be subject to a maximum tolerance of 2 inches.

C. Plumb and Batter Columns and other vertical surfaces that will remain exposed will be measured to determine actual batter and degree of verticality. Measurements will be taken subsequent to every placement. Vertical faces of columns will be measured at a minimum of two faces at right angles to each other. Other vertical surfaces will be measured once every 15 feet along the face of longitudinal walls. All measurements will be made on a per placement basis and will be subject to a tolerance of ¼ inch in 10 feet.

D. Finish Surface finish of concrete surfaces will be evaluated and repaired in accordance with Sections 502.09, 502.12, and 502.13, for each placement.

Rejection by Resident For material represented by an Acceptance test with test results failing to meet the criteria specified in Table 1, the Department will, at its sole discretion:

A. Require the Contractor to remove and replace the entire affected placement with concrete meeting the Contract requirements at no additional expense to the Department, or

B. Accept the material, at a reduced payment as determined by the appropriate Quality Level Analysis specification formula.

502.1704 Acceptance Method A A lot size shall consist of the total quantity represented by each class of concrete in the Contract. A lot shall consist of a minimum of 3 and a maximum of 10 sublots.

502.1705 Acceptance Method B A lot size shall consist of the total quantity represented by each class of concrete in the Contract. A lot shall consist of a minimum of 3 sublots.

502.1706 Acceptance Method C The Department will determine the acceptability of the concrete through Acceptance testing. The Department reserves the right to waive tests at times deemed appropriate by the Resident. Acceptance tests will include compressive strength, air content and permeability. Method C concrete not meeting the requirements listed in Table 1 shall be removed and replaced at no cost to the Department. At the Department's sole discretion, material not meeting requirements may be left in place and paid for at a reduced price as described in Section 502.195.

502.1707 Resolution of Disputed Acceptance Test Results The Contractor shall work cooperatively with the Resident in maintaining Control Charts, as outlined in Subsection 106.4.3, in order to identify potential issues with any test results and take appropriate actions to address these issues before they become disputed issues. In cases where the Department may determine that removal of the affected placement is warranted or that the material is marginally acceptable and may remain in place and paid for at a reduced rate, in accordance with Section 502.1703, Acceptance Methods A and B, this Subsection provides recourse for the Contractor to contest the Department's Acceptance test results as follows, at no additional cost to the Department:

A. Compressive Strength There may be cases where the Department's test results indicate that concrete must be removed and replaced, or that the material is maginally acceptable and my remain in place and paid for at a reduced rate. In these cases, and providing that the Contractor's QC test results from a NETTCP certified laboratory for the same load are more than 500 psi higher than that of the Department's test results, the following procedure concerning compressive strength may be undertaken by the Contractor and witnessed by the Department, within 36 days of the placement date (within 64 days of the placement date in the case where fly ash at 20%, or greater, pozzolan cement replacement is used in the concrete mix):

1. Drilled core specimens shall be retrieved from the concrete in question in accordance with the requirements of ASTM C42/C42M, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete. The core strength acceptance and evaluation criteria included in ACI 318 shall not apply.

2. Three drilled core specimens shall be taken from each sublot in question, from randomly selected locations to be representative of the entire volume of the sublot. The Resident and the Contractor's representative shall agree on the sample locations prior to drilling. The specimens shall have a minimum diameter of 4 inches and a minimum length of 8 inches.

3. The concrete cores shall be taken directly from the Project to the nearest MaineDOT laboratory for processing for testing. The cores shall be protected from drying during transport. The Contractor shall make arrangements with the appropriate MaineDOT laboratory for testing prior to beginning the coring process.

4. Core test results will be evaluated by the Department. The test results of the three cored cylinders shall be averaged and then divided by a factor of 0.85. The resulting compressive strength shall be used by the Department in the final determination of the acceptability of the material in question and shall replace the contested test result in computing pay adjustments for the Lot in question. If coring is not done within the 36-day time limit (or 64-day time limit, as applicable), the Department will not allow dispute testing of the sublot.

5. If the Department concludes that the strength of the structural element in question is adequate as a result of the above procedure, then the concrete shall remain in place and payment will be adjusted using the test results from the above procedure. If the Department concludes that the strength of the structural element in question is unsatisfactory as a result of the above procedure, the original acceptance test result will remain in the lot and, the Department will direct the Contractor to take appropriate actions, as determined by the Department, and at no additional cost to the Department.

B. Rapid Chloride Permeability In cases where the Department's test results indicate that the material is subject to removal and replacement according to section 502.192, the following procedure concerning permeability may be undertaken by the Contractor and witnessed by the Department, within four calendar days of the receipt of the results:

1. Drilled core specimens shall be retrieved from the concrete in question in accordance with the requirements of ASTM C42/C42M, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete. Specimens shall have a diameter of 4 inches and a minimum length of 8 inches.

2. Three drilled core specimens shall be taken from a location that would be from the same load as the original Department specimen for each sublot in question.

3. The concrete cores shall be taken directly from the Project to the nearest MaineDOT laboratory for processing for testing. The cores shall be protected from drying during transport. The Contractor shall make arrangements with the appropriate MaineDOT laboratory for testing prior to beginning the coring process.

4. The cored cylinders will be tested by the Department in accordance with AASHTO T-277. The resulting permeability value shall be used by the Department in the final determination of the acceptability of the material in question and shall replace the contested test result in computing pay adjustments for the Lot in question.

5. If the Department concludes that the permeability of the placement in question is adequate as a result of the above procedure, then the concrete shall remain in place and payment will be adjusted using the test results from the above procedure. If the Department concludes that the permeability of the affected placement in question is unsatisfactory as a result of the above procedure, the original acceptance test result will remain in the lot and the Department will direct the Contractor to take appropriate actions, as determined by the Department, and at no additional cost to the Department.

C. Entrained Air In order to dispute the Department's test results, the Contractor must test material from the same sample as the Department. If the difference between the Department's and the Contractor's air tests is equal to or greater than 0.6 percent, then the material shall be retested by both parties. If the difference between the retests is equal to or greater than 0.6 percent, the concrete placement will be suspended immediately. Both air meters will be checked for accuracy by either comparison to a third calibrated air meter or by use of an air meter calibration vessel. If either air meter is found to be out of calibration it shall be replaced immediately. Once it is demonstrated that the QC and Acceptance air meters are in agreement within 0.6 percent, the concrete placement may resume.

502.18 Method of Measurement

A. Structural concrete satisfactorily placed and accepted will be measured by the cubic yard, in accordance with the dimensions shown on the Plans or authorized changes in the Plans, or as one lump sum unit, as indicated in the Schedule of Items.

Structural Concrete for any irregular shapes may be measured by the cubic yard as determined from the theoretical yield of the design mix or in the case of transit mixed concrete, by delivery ticket, as directed by the Resident.

B. The limits to be used in determining the quantities of the aforementioned structural concrete items for arriving at a lump sum price will be as follows:

1. Structural Concrete Superstructure Slabs, Structural Concrete Roadway and Sidewalk Slabs on Steel Bridges, Structural Concrete Roadway and Sidewalk Slabs on Concrete Bridges and Structural Concrete Superstructure T-beam Type The limits will be the entire

concrete superstructure, outside to outside, both transversely and longitudinally, exclusive of concrete curbs, sidewalks, permanent concrete barrier and concrete transition barriers.

2. Structural Concrete Wearing Surfaces The limits will be the entire concrete wearing surface bounded transversely by the roadway curbs and longitudinally by the extreme ends.

3. Structural Concrete Box Culverts The limits will be the entire structure, meaning the bottom floor slab, abutments, wings, superstructure floor slab and headwalls or curbs.

4. Structural Concrete, Approach Slabs The limit will be the entire approach slab or slabs, as shown on the Plans.

5. Structural Concrete, Abutments and Retaining Walls, Structural Concrete, Abutments and Retaining Walls (placed under water), Structural Concrete Piers, and Structural Concrete Piers (placed under water) The limits will be the entire concrete substructure unit or units, from the bottom of the footing to the top of the unit, and outside to outside, both transversely and longitudinally, except for the portion to be placed under water, as indicated on the Plans, which will be the limits of the concrete unit or units, outside to outside, transversely, longitudinally, and vertically.

6. Structural Concrete Rigid Frame Structures The limits will be the entire concrete structure, meaning the frame walls and top slab. Included within the limits for payment, unless otherwise shown on the Plans, are bottom slab, wing walls and headwalls.

7. Structural Concrete Culvert End walls The limit will be the entire concrete end wall or end walls, as shown on the Plans.

8. Structural Concrete Curb and Sidewalks The limit will be the entire concrete curb or sidewalk, as shown on the Plans.

9. Concrete Fill Will be measured for payment by the number of cubic yards of concrete, in place, to the vertical pay limits shown on the Plans. If the Contractor elects to omit forms, then any excavation or concrete placed beyond the pay limits indicated on the Plans shall not be paid for, but shall be at the Contractor's expense.

C. No deduction will be made for the volume of concrete displaced by structural steel, reinforcing steel, pile heads, expansion joint material, drains, chamfers on corners, inset panels of 1 ½ inches or less in depth, pipes, weep holes and authorized openings for utilities of ¼ yd^3 or less in volume, when any of these items occur in structural concrete which is to be paid for on a cubic yard basis.

D. When the bottom of foundations for concrete structures is required to be at a definite elevation within rock excavation, as shown on the Plans or otherwise designated, the quantity to be measured will be the number of cubic yards of concrete actually and satisfactorily placed above a plane at one foot below the above specified plan elevation and within the neat lines of

the structure as shown on the Plans or on authorized changes in the Plans. If the ledge rock is excavated below the plane at one foot below the plan elevation, without authorization, then this space shall be replaced with concrete of the same composition as required for the structure foundation but will not be measured for payment.

E. For the purposes of making pay adjustments under Quality Level Analysis Method A or Method B, quantities of lots and sublots shall be determined as outlined under Section 502.1703 - Acceptance Methods A and B, and under Section 502.19 - Basis of Payment.

F. Transverse saw cut grooving of concrete wearing surfaces, complete and accepted, will be measured for payment as one lump sum.

502.19 Basis of Payment The accepted work done under structural concrete, of the classes and for the types of work required, will be paid for at the Contract unit price per cubic yard, or at the Contract lump sum price, for the respective Contract items involved. Payment for both the unit price and the lump sum price items will be full compensation for furnishing and installing bridge drains, pier nose armor, water stops, expansion joint filler, PVC or plastic tube drains, asphalt roll roofing (roofing felt), asphalt for painting or covering various type of joints, all required sandblasting, high-pressure water cleaning, bonding, curing and joint sealing and all incidentals necessary to complete the work satisfactorily. No direct payment will be made for concrete admixtures.

No price adjustments will be made to the lump sum bid for the respective items that are bid lump sum, except when quantity changes are directed by the Department. It will be the responsibility of the Contractor to verify the estimated quantities prior to submitting bid documents.

Transverse saw cut grooving of concrete wearing surfaces will be paid for at the Contract lump sum price, which shall be payment for furnishing all materials, labor and equipment, including depth gauges and all incidentals, to satisfactorily complete the work.

Payment for structural concrete culvert connection shall include drilling and grouting the dowels into the existing headwall and excavation. Reinforcing will be paid for under Pay Item 503.12, Reinforcing Steel, Fabricated and Delivered and Pay Item 503.13, Reinforcing Steel, Placing.

Reinforcing steel, railings, stone curbing and any material that may be required for bridge lighting systems, will be measured and paid for separately as provided in the appropriate sections.

Implementation of the QCP and costs associated with acceptance test sampling shall be incidental to related items.

All costs associated with obtaining, testing and evaluating drilled core specimens for dispute resolution will not be paid for directly, but will be considered incidental to related items.

Pay adjustments will be made only for cast-in-place concrete. Pay adjustments shall be computed on the actual final quantity for unit price items. Pay adjustments shall be computed on the estimated quantity for lump sum items, except when precast deck panels are used, or when quantity changes are directed by the Department. When precast deck panels are used, the precast deck panel quantity, as computed from the Working Drawings, shall be deducted from the estimated lump sum quantity to determine the new estimated quantity that will be used to compute pay adjustments. When Department-directed quantity changes are made, this quantity shall be added to, or subtracted from, the estimated lump sum quantity to determine the new estimated quantity that will be used to compute pay adjustments. When precast deck panels are used and Department-directed quantity changes are made under the same lump sum item, the combined quantity change shall be added to, or subtracted from, the estimated lump sum quantity to determine the new estimated lump sum quantity that will be used to compute pay adjustments. Pay adjustments will be made according to the formula in Section 502.194. P, the unit value for pay adjustment purposes, is specified in Special Provision Section 502, Structural Concrete (QC/QA Acceptance Methods). P values, as specified in Special Provision Section 502, reflect the price per cubic yard for all pay adjustment purposes.

502.191 Pay Adjustment for Compressive Strength, Methods A and B Pay factors (PF) for pay adjustments for compressive strength will be determined using the Quality Level Analysis as specified in Section 106.

502.192 Pay Adjustment for Chloride Permeability, Methods A and B Pay factors (PF) for pay adjustments for Chloride Permeability will be determined using the Quality Level Analysis as specified in Section 106.

Values greater than 3,400 coulombs for Class A concrete or 3,000 coulombs for Class LP concrete shall be subject to rejection and replacement, at no additional cost to the Department.

502.193 Pay Adjustment for Air Content, Methods A and B Pay factors (PF) for pay adjustments for air content will be determined using the Quality Level Analysis as specified in Section 106.

502.194 Pay Adjustments for Compressive Strength, Chloride Permeability and Air Content, Methods A and B The Composite Pay Factor (CPF) for each lot of concrete shall be computed as follows:

CPF = [(Compressive Strength PF-1)(0.20)] + [(Air Content PF-1)(0.40)]
+ [(Chloride Permeability PF-1)(0.40)]

The pay adjustment for each lot of concrete shall be computed as follows:

Lot Pay Adjustment = P x CPF x Lot Size

There will be no positive pay adjustments for Method B Concrete.

502.195 Pay Adjustment Method C When the Department determines that Method C concrete which does not meet the specified limits may remain in place, payment will be reduced in accordance with Table 6. The quantity to which the pay reduction shall apply will be determined by the Resident.

TABLE 6: METHOD C PAY REDUCTIONS *

Class LP	**Class A**	**Class S**	**Class Fill**
Compressive Strength {Strength Range in PSI and Pay Reduction per CY}			
4,750 to 4,999 ($25)	3,900 to 3,999 ($60)	2,900 to 2,999 ($10)	2,900 to 2,999 ($10)
4,500 to 4,749 ($40)	3,800 to 3,899 ($80)	2,800 to 2,899 ($20)	2,800 to 2,899 ($20)
4,250 to 4,499 ($55)	3,700 to 3,799 ($100)	2,700 to 2,799 ($30)	2,700 to 2,799 ($30)
4,000 to 4,249 ($70)	3,600 to 3,699 ($120)	2,600 to 2,699 ($40)	2,600 to 2,699 ($40)
< 4,000 (Removal)	< 3,600 (Removal)	2,500 to 2,599 ($50)	2,500 to 2,599 ($50)
		< 2,500 (Removal)	< 2,500 (Removal)
Chloride Permeability {Permeability Range in Coulombs and Pay Reduction per CY}			
2,001 to 2,250 ($50)	2,401 to 2,650 ($25)	N/A	N/A
2,251 to 2,500 ($75)	2,651 to 2,900 ($50)	N/A	N/A
2,501 to 2,750 ($100)	2,901 to 3,150 ($75)	N/A	N/A
2,751 to 3,000 ($125)	3,151 to 3,400 ($100)	N/A	N/A
> 3,000 (Removal)	> 3,400 (Removal)	N/A	N/A
Entrained Air {Air Range in Percent and Pay Reduction per CY}			
< 4.5 (Removal)	< 4.5 (Removal)	N/A	< 4.0 (Removal)
4.5 to 4.9 ($100)	4.5 to 4.9 ($100)	N/A	4.5 to 4.9 ($20)
5.0 to 5.4 ($75)	5.0 to 5.4 ($75)	N/A	5.0 to 5.4 ($15)
5.5 to 5.9 ($50) 6.0 to 9.0 Acceptable	5.5 to 5.9 ($50) 6.0 to 9.0 Acceptable	N/A	5.5 to 5.9 ($10) 6.0 to 9.0 Acceptable
9.1 to 9.5 ($25)	9.1 to 9.5 ($25)	N/A	9.1 to 9.5 ($10)
9.6 to 10.0 ($50)	9.6 to 10.0 ($50)	N/A	9.6 to 10.0 ($15)
10.1 to 10.5 ($75)	10.1 to 10.5 ($75)	N/A	10.1 to 10.5 ($20)
> 10.5 (Removal)	> 10.5 (Removal)	N/A	> 10.5 (Removal)

* All Ranges Are Inclusive

Payment will be made under:

Pay Item		Pay Unit
502.21	Structural Concrete, Abutments and Retaining Walls	Cubic Yard
502.219	Structural Concrete, Abutments and Retaining Walls	Lump Sum
502.22	Structural Concrete, Abutments and Retaining Walls (placed under water)	Cubic Yard
502.229	Structural Concrete, Abutments and Retaining Walls	Lump Sum

	(placed under water)	
502.23	Structural Concrete Piers	Cubic Yard
502.239	Structural Concrete Piers	Lump Sum
502.24	Structural Concrete Piers (placed under water)	Cubic Yard
502.249	Structural Concrete Piers (placed under water)	Lump Sum
502.25	Structural Concrete Superstructure Slab	Lump Sum
502.26	Structural Concrete Roadway and Sidewalk Slab on Steel Bridges	Lump Sum
502.261	Structural Concrete Roadway and Sidewalk Slab on Concrete Bridges	Lump Sum
502.27	Structural Concrete Superstructure T-beam Type	Lump Sum
502.28	Structural Concrete Rigid Frame Structures	Cubic Yard
502.289	Structural Concrete Rigid Frame Structures	Lump Sum
502.29	Structural Concrete Wearing Surface on Bridges	Lump Sum
502.291	Saw Cut Grooving	Lump Sum
502.30	Structural Concrete Box Culvert	Lump Sum
502.31	Structural Concrete Approach Slab	Lump Sum
502.32	Structural Concrete Culvert End wall	Cubic Yard
502.33	Structural Concrete Culvert End wall	Lump Sum
502.40	Structural Concrete Box Culvert	Cubic Yard
502.41	Structural Concrete Superstructure Slab	Cubic Yard
502.42	Structural Concrete Roadway and Sidewalk Slab on Steel Bridges	Cubic Yard
502.43	Structural Concrete Superstructure T-beam Type	Cubic Yard
502.44	Structural Concrete Wearing Surface on Bridges	Cubic Yard
502.45	Structural Concrete Approach Slab	Cubic Yard
502.46	Structural Concrete Culvert Connection	Cubic Yard
502.48	Low Permeability Concrete	Cubic Yard
502.49	Structural Concrete Curbs and Sidewalks	Lump Sum
502.565	Concrete Fill	Cubic Yard

SECTION 503 - REINFORCING STEEL

503.01 Description This work shall consist of furnishing and placing reinforcing steel bars (plain, galvanized, stainless, epoxy-coated, zinc and epoxy dual-coated, or low-carbon chromium), welded wire fabric and mechanical/welded reinforcing steel splices in accordance with these specifications and other applicable Contract Documents.

503.02 Materials Materials shall meet the requirements of the following Sections of Division 700, Materials:

Reinforcing Steel	709.01
Welded Steel Wire Fabric	709.02

503.03 Schedule of Material When the Department does not furnish reinforcing steel schedules, the Contractor shall submit order lists, bending diagrams and bar layout drawings to the Resident for approval. The reinforcing steel shall not be ordered until these lists and drawings are approved. Approval shall not relieve the Contractor of full responsibility for the satisfactory completion of this item. When the Department allows the use of precast concrete deck panels, or any other significant changes that affect the quantity of reinforcing steel, the Contractor shall be responsible for revising the reinforcing steel schedule; the revised schedule shall be submitted to the Resident for approval.

503.04 Protection of Material Reinforcement, either plain, galvanized, stainless, epoxy-coated, zinc and epoxy dual-coated, or low-carbon chromium, shall be stored on skids or other supports a minimum of 12 inches above the ground surface and protected at all times from damage and surface contamination. The storage supports shall be constructed of wood or other material that will not damage the surface of the reinforcement or epoxy coating. Bundles of bars shall be stored on supports in a single layer. Each bundle shall be placed on the supports out of contact with adjacent bundles. Coated and uncoated steel reinforcing bars should be stored separately.

Do not use carbon steel tools, chains, slings, etc. when fabricating or handling stainless steel reinforcing bars- use only nylon or polypropylene slings. Prior to shipping, ensure that all chains and steel bands will not come into direct contact with stainless steel reinforcing bars. Place wood or other soft materials (e.g., thick cardboard) under the tie-downs. Alternatively, use nylon or polypropylene straps to secure stainless steel reinforcing bars. When bundles of plain reinforcement steel and stainless steel reinforcing bars must be shipped one on top of the other, the stainless steel reinforcing bars should be loaded on top. Use wooden spacers to separate the two materials.

If it is expected that epoxy-coated or zinc and epoxy dual-coated bars will be required to be stored outdoors for a period in excess of two months, then they shall be protected from ultraviolet radiation.

503.05 Fabrication Bending of reinforcing bars and tolerances for bending of reinforcing bars shall be in conformance with the latest edition of the "Manual of Standard Practice of the Concrete Reinforcing Steel Institute" and the "Detailing Manual of the American Concrete Institute". Unless otherwise specifically authorized, bars shall be bent cold.

503.051 Epoxy Coating Reinforcing steel, specified on the design drawings to be epoxy coated or zinc and epoxy dual-coated, shall meet the requirements of AASHTO M284 (ASTM A775), Epoxy-Coated Steel Reinforcing Bars, or ASTM A1055, Zinc and Epoxy Dual-Coated Steel Reinforcing Bars as applicable and the following requirements:

a. The Contractor shall furnish a written certification that, at the point of application of the coating and at the reinforcing steel fabrication shop, the coating, the coated bars, and the handling and packaging of the coated bars, meet all the requirements specified in Section 5.2.1

and Section 15.1 of AASHTO M284 (ASTM A775), or 5.3.2 and 15.1 of ASTM A1055 as applicable, and Section 503.053 of these specifications.

b. Patching material as specified in Section 5.4 of AASHTO M284 (ASTM A775) shall be supplied for both shop and field patching of epoxy-coated and dual-coated reinforcing steel. The patching material shall be supplied as required, but at not less than the following rates:

#3 to #5 bars: 1 quart/15,000 ft. of bar, or fraction thereof
#6 to #9 bars: 1 quart/8,000 ft. of bar, or fraction thereof
#10 and up: 1 quart/6,000 ft. of bar, or fraction thereof

c. All testing shall be as specified in AASHTO M284 (ASTM A775) or ASTM A1055 as applicable, except that the frequency of testing for adhesion of the coating shall be two bars of each size out of all bars coated with each individual batch or lot of epoxy resin, or two bars of each size out of all bars coated in an eight hour period, whichever is greater.

d. If a reinforcing bar fabrication shop uses previously stockpiled bars to supply the requirements of this Contract, the fabrication shop shall furnish copies of all certificates required to be furnished by the coating applicator under a., above. The certificates furnished shall be directly traceable to the actual bars used through batch numbers, order numbers or similar information. If such certification is not available, the Department reserves the right to perform the tests specified under AASHTO M284 (ASTM A775) or ASTM A1055 as applicable, at the expense of the Contractor. For bars supplied from stock, the fabrication shop shall supply all patching material specified under b., above.

e. The Contractor shall notify the Resident at least one week prior to the start of any coating application, so that the Resident, or their designated representative, may be present at the beginning of the application of the coating.

503.052 Patching of Epoxy Coating Patching required at the point of application of the epoxy coating shall be done in conformance with the requirements of AASHTO M284 (ASTM A775). All patching related guidelines in ASTM A775 or A1055, Section X1, Guidelines for Job-Site Practices, shall be considered mandatory.

At the reinforcing steel fabrication shop and at the job site, all nicks, cuts, scratches, cracks, abrasions, sheared ends etc., visible to the naked eye, shall be repaired using patching material supplied as specified under Section 503.051 b. To the greatest extent possible, repairs to each day's production at the fabrication shop and each day's placement at the job site shall be done before the end of each working day. If damaged areas do become rusted or contaminated with foreign matter, then these areas shall be cleaned by sandblasting, or an equally effective method, such that all visible rust and/or foreign matter is removed prior to patching.

503.053 Zinc Coating Reinforcing steel, specified on the design drawings to be zinc-coated (galvanized) shall meet the requirements of ASTM A767, Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement. Bars shall have a Class 1 coating per ASTM A767 and shall be

galvanized after fabrication. Bending of galvanized bars in the field shall not be allowed unless approved by the Resident. Damage to the zinc coating as a result of field-bending shall be repaired in accordance with Section 9 of ASTM A767.

The Contractor shall furnish a written certification from the galvanizer that the material was manufactured and tested in accordance with ASTM A767, together with the report of the test results, at the time of shipment.

503.054 Packaging and Handling of Epoxy-Coated and Zinc-Coated (Galvanized) Bars All handling of epoxy-coated, dual-coated, and galvanized reinforcing bars by mechanical means shall be done by equipment having padded contact areas, or by the use of nylon webbing slings. The use of chains or wire rope slings shall not be allowed, even when used with padding. All bundles of coated bars shall be lifted with a strong-back, spreader bar, multiple supports or a platform bridge to prevent bar-to-bar abrasion from sags in the bundles. Support points during lifting or transporting of bundled coated bars shall be spaced at a maximum of 15 feet.

Bundled bars shall be strapped together with non-metallic or padded straps in a manner to prevent bar-to-bar abrasion due to relative movement between bars.

Bars loaded for transport shall be loaded and strapped down in a manner that will prevent damage from motion and vibration, to the greatest extent possible. Bundles of bent bars shall be transported strapped to wooden platforms or shall be crated. All individual bundles and layers of bundles shall be separated, and supported by dunnage.

Individual bars shall be handled in a manner that prevents damage to the coating due to abrasion or impact, and at no time shall any bar be moved by dragging over any surface, including other reinforcing bars. Sufficient personnel shall be assigned to assure that there is compliance with the above.

All packaging and handling related guidelines in ASTM A775, A1055, or A767, Section X1, Guidelines for Job-Site Practices, shall be considered mandatory where not already covered by this specification.

503.06 Placing and Fastening All steel reinforcement shall be accurately placed in the positions shown on the Plans and shall be firmly held there during the placing and setting of the concrete. Immediately before placing concrete, steel reinforcement shall be free from all foreign material, which could decrease the bond between the steel and concrete. Such foreign material shall include, but not be limited to, dirt, loose mill scale, excessive rust, paint, oil, bitumen and dried concrete mortar.

Bars shall be fastened together at all intersections except where spacing is less than 1 foot in either direction, in which case, fastening at alternate intersections of each bar with other bars will be permitted, providing this will hold all the bars securely in position. This fastening may be done using tightly twisted wire or by welding, when permitted by the Fabrication Engineer. All welding shall be done in accordance with this specification. Welders must be qualified by

passing qualification tests for the process and position to be used in accordance with AWS D1.4 Structural Welding Code – Reinforcing Steel. Welding shall only be done when performed in accordance with a welding procedure approved by the Fabrication Engineer. Weld area preheat shall comply with AWS D1.4. Weld areas shall be free of cracks, undercut or other deficiencies injurious to the reinforcing steel. Welds are not permitted within two bar diameters of a bend, if the bend radius is less than 16 bar diameters. Welds must comply with testing and sampling requirements in the Fabrication and Mechanical Properties sections of AASHTO M 54 (ASTM A184). Welds shall be able to withstand a static load of 150 pounds applied perpendicular to the reinforcing grid. Tension specimens must meet the material requirements of the type bar used when tested with a welded joint approximately at the center of the specimen. Frequency of testing shall be for every 75,000 square feet, or fraction thereof, of reinforcing grid fastened by welding. No welding for fastening or supporting reinforcing steel in areas of high tensile stresses will be permitted. Welding on epoxy-coated or dual-coated reinforcing steel will not be permitted under any condition.

In general, no welding will be permitted on the main reinforcing steel of superstructures.

Proper distances from the forms shall be maintained by means of chairs, stays, blocks, ties, hangers or other approved means. Chairs used for this purpose shall be plastic, plastic coated, epoxy coated or plastic tipped. Where stainless steel reinforcement is specified, the plastic tipped chairs shall be made of stainless steel conforming to the requirements of ASTM A493, Type 316 or 316L. Blocks used for this purpose shall be precast portland cement mortar blocks of approved shape and dimensions. Blocks shall not be used in cases where the blocks will be visible in the finished product. Layers of bars may be separated by precast portland cement mortar blocks or other approved devices. The use of pebbles, pieces of broken stone or brick, metal pipe or wooden blocks shall not be permitted. The placing of reinforcement as concrete placement progresses, without definite and secure means of holding the steel in its correct position, shall not be permitted except in the case of welded steel wire fabric or reinforcing bar grids.

Epoxy-coated, dual-coated, or galvanized reinforcing bars supported on formwork shall rest on coated wire bar supports, or on bar supports made of dielectric material or other acceptable materials. Wire bar supports shall be coated with dielectric material for a minimum distance of 2 inches from the point of contact with the reinforcing bars. Reinforcing bars used as support bars shall be epoxy-coated or zinc-coated as applicable. In walls, spreader bars shall be epoxy-coated or zinc-coated as applicable.

Tie wire for epoxy-coated, zinc and epoxy dual-coated, galvanized, stainless, or low-carbon chromium reinforcing steel shall be soft annealed wire that has been nylon, epoxy or plastic coated. Tie wire for stainless steel reinforcement may also be uncoated stainless steel conforming to the requirements of ASTM A493, Type 316 or 316L. 16 gauge (or heavier) black-annealed ferrous metal wire may also be used for low-carbon chromium or plain reinforcement.

Stainless steel reinforcement shall not be tied to any other type of reinforcement, galvanized attachments or conduits, or any other dissimilar metal including concrete formwork hardware.

Direct contact is not acceptable. When stainless steel reinforcing must be near other steel reinforcing, galvanized metals, or dissimilar metal formwork hardware, a minimum of one inch clearance between the two metals shall be maintained. Where insufficient space exists to maintain this minimum, the least significant metal, subject to the Resident's approval, may be sleeved with a continuous 1/8 inch minimum thickness polyethylene or nylon tube, extending at least one inch in each direction past the point of closest contact between the two dissimilar metals, and bound with nylon or polypropylene cable ties.

When formwork for casting concrete is made of uncoated steel or stainless steel, the use of galvanized steel reinforcing bars shall require an electrical isolation of the formwork from the galvanized reinforcement. The Contractor is referred to Section X2 of ASTM A767, Guidelines for Use of Galvanized Reinforcing Bars with Non-Galvanized Steel Formwork, for more information.

Field bending or cutting of epoxy-coated or dual-coated reinforcing bars will not be allowed, unless otherwise indicated on the Plans or permitted by the Resident. When field bending or cutting is allowed, all damaged coating areas shall be repaired in accordance with the patching requirements, Section 503.052. All placing and fastening related guidelines in ASTM A775 or A1055, Section X1, Guidelines for Job-Site Practices, shall be considered mandatory where not already covered by this specification.

Bars in bridge seats shall be placed so as to clear anchor bolts.

When specified on the Plans, reinforcing steel shall be anchored into drilled holes.

The anchoring material shall be one of the products listed on the Maine Department of Transportation's Qualified Products List, Type 3 Anchoring Materials. Installation shall be in accordance with the manufacturer's published recommendations.

At each anchor location, existing reinforcing shall be located to avoid drilling through existing bars. Where interferences are found to exist, location adjustments will be determined by the Resident.

Minimum embedment lengths of reinforcing bars shall comply with the manufacturer's published recommendations for the anchoring material selected. These embedment lengths shall be verified by the Resident before installation of the reinforcing bars. The reinforcing steel lengths indicated on the Plans may be reduced, at the Contractor's option, to the determined minimum embedment lengths.

Reinforcement shall be inspected and approved by the Resident before any concrete is placed.

503.07 Splicing Reinforcing bars shall be spliced in accordance with the requirements of this section, and in the locations shown on the Plans. No modifications of, or additions to, the splice arrangements shown on the Plans shall be made without the Resident's prior approval.

Any additional splices authorized shall be staggered as much as possible. All splices shall be made in a manner that will ensure that not less than 75 percent of the clear concrete cover and not less than 75 percent of the minimum clear distance to other bars will be maintained, as compared to the cover and clear distance requirements for the unspliced bar.

Lapped splices shall be made by placing the bars in contact and wiring them together. Splice laps shall be made in accordance with the following table, unless otherwise noted on the Plans:

US CUSTOMARY UNITS

Minimum Lap Splice Length (inches) [1]									
Bar Type/ Bar Size	#3	#4	#5	#6	#7	#8	#9	#10	#11
Plain or Galvanized	16	16	20	24	30	39	49	62	77
Epoxy or Dual-Coated	19	19	24	29	36	47	74	93	115
Low-carbon Chromium	20	26	33	39	49	65	82	104	127
Stainless	16	20	25	30	37	49	61	78	96

[1] Lap Splice lengths are based on the following parameters: Minimum center-to-center spacing between bars of 6 inches; nominal yield strength of the reinforcing steel equal to 60 ksi (100 ksi for low-carbon chromium reinforcement, 75 ksi for stainless steel reinforcement); minimum 28-day compressive strength of concrete equal to 4,000 psi; Class B tension lap splice. When any of the preceding parameters are altered, appropriate minimum lap splice lengths will be as shown on the Plans. When lap splices are placed horizontally in an element where the concrete depth below the splice will be 12 inches, or more, the indicated lap splice lengths shall be multiplied by a factor of 1.4.

Mechanical couplers may be used for splicing reinforcing bars, provided they are approved by the Resident and conform to the following requirements:

a. Tension Couplers Couplers shall be able to develop 1.25 times the theoretical yield strength of the spliced bar in tension. Bolted and wedge-lock type couplers will not be allowed.

b. Compression Couplers Couplers shall be capable of maintaining the spliced bars in alignment prior to and during concrete placement. For reinforcing bars designed to act in compression, the individual bar ends shall be within 1-½ degrees of being "square" to the final 12 inches of the bar. Additionally, abutting bar ends shall be in contact, and the angle of the gap between abutting bar ends shall be 3 degrees, or less.

c. Mechanical Couplers Any mechanical couplers using a threaded splicer and dowel in combination, requiring a lapped splice with the reinforcing bars, shall have a minimum lap splice length as required by this Section.

Welded splices may be made by the "Thermit" process or, with the approval of the Resident, by the shielded metal arc welding process or the self-shielded flux-core arc welding process. The latter two processes shall be used in strict conformance with the requirements of the latest edition of AWS D1.4 "Structural Welding Code - Welding Reinforcing Steel" and any applicable provisions of Section 504, Structural Steel. The Contractor shall submit complete details of their proposed method of making welded splices for the Resident's approval.

503.08 Lapping Sections of welded steel wire fabric shall be securely fastened to adjoining sections and overlapped. All laps for wire sizes D4 thru D20 shall be 14 inches.

Reinforcing bar grids shall be spliced as required for the individual bars, per the table in Section 503.07, Splicing.

503.09 Substitution Substitution of different size bars shall not be permitted except with the written authorization of the Resident.

503.10 Method of Measurement Reinforcing steel bars, either plain, galvanized, stainless, epoxy-coated, zinc and epoxy dual-coated, or low-carbon chromium, shall be measured by the computed number of pounds or by the lump sum, of steel reinforcement authorized, as indicated in the Contract. Welded steel wire fabric shall be measured by the computed number of pounds or by the lump sum of fabric authorized, as indicated in the Contract. Splices made using mechanical devices or by welding, as shown on the Plans or required by the specifications, will be measured as the number of splices of each kind satisfactorily made and accepted.

Weights will be computed in accordance with the following:

For steel bars, either plain, galvanized, stainless, epoxy-coated, zinc and epoxy dual-coated, or low-carbon chromium, weights will be computed in accordance with the following table:

US CUSTOMARY UNITS

Pounds per Foot									
Bar Size	#3	#4	#5	#6	#7	#8	#9	#10	#11
Weight	0.376	0.668	1.043	1.502	2.044	2.67	3.4	4.303	5.313

For welded steel wire fabric, weights will be computed in accordance with the following table:

US CUSTOMARY UNITS

Size in inches	6 by 6	3 by 6	4 by 4	6 by 6
Gauge	W1.4 by W1.4	W1.4 by W1.4	W1.4 by W1.4	W2.9 by W2.9
Weight (lbs./100 ft^2)	21	30	31	42

For other sizes of fabric, the commercially recognized weights will be used.

No addition to, or deduction from, the theoretical weight per foot of the uncoated bars will be made because of additional requirements for blast cleaning and epoxy, zinc, or dual-coating of the bars.

Lapped splices and splices made using mechanical devices or by welding, that are authorized at the Contractor's request, will not be measured for payment.

503.11 Basis of Payment The accepted quantity of reinforcing steel, either plain, stainless or low carbon chromium, will be paid for at the Contract unit price per pound or by the lump sum, for each item involved, complete, and accepted.

The accepted quantity of epoxy-coated, galvanized or zinc and epoxy dual-coated reinforcing steel will be paid for at the Contract unit price per pound or by the lump sum, for each item involved, complete and accepted, and all additional expenses that may be incurred by the Contractor or their suppliers as a result of the requirements in these specifications will be considered incidental to, and included in, the Contract unit price per pound or lump sum price.

When reinforcing steel schedules are required, they shall be considered incidental to the related Contract items. Payment for work associated with revisions to the reinforcing steel schedule, required when the Department allows the use of precast concrete deck panels, or any other significant changes that affect the quantity of reinforcing steel, shall be considered incidental to related Contract items.

The accepted quantity of welded steel wire fabric will be paid for at the Contract unit price per pound or by the lump sum, in place, complete and accepted.

The accepted quantity of mechanical and/or welded splices will be paid for at the Contract unit price each, complete and accepted, for each type specified.

Payment will not be made for any materials used to hold reinforcement in place or for extra weight due to substitutions and splices made for the Contractor's convenience.

When reinforcing steel is specified to be anchored into drilled holes, no additional payment will be made for drilling and anchoring reinforcing steel or cutting of reinforcing steel to embedment lengths.

Payment for additional material samples, as required for testing by the Department, shall be considered incidental to related Contract items.

Payment will be made under:

Pay Item		Pay Unit
503.12	Reinforcing Steel, Fabricated and Delivered	Pound
503.121	Reinforcing Steel, Fabricated and Delivered	Lump Sum

503.13	Reinforcing Steel, Placing	Pound
503.131	Reinforcing Steel, Placing	Lump Sum
503.14	Epoxy-Coated Reinforcing Steel, Fabricated and Delivered	Pound
503.141	Epoxy-Coated Reinforcing Steel, Fabricated and Delivered	Lump Sum
503.15	Epoxy-Coated Reinforcing Steel, Placing	Pound
503.151	Epoxy-Coated Reinforcing Steel, Placing	Lump Sum
503.16	Welded Steel Wire Fabric, Complete in place	Pound
503.161	Welded Steel Wire Fabric, Complete in place	Lump Sum
503.17	Mechanical/Welded Splice	Each
503.19	Low-Carbon Chromium Reinforcement, Fabricated and Delivered	Pound
503.191	Low-Carbon Chromium Reinforcement, Fabricated and Delivered	Lump Sum
503.20	Low-Carbon Chromium Reinforcement, Placing	Pound
503.201	Low-Carbon Chromium Reinforcement, Placing	Lump Sum
503.22	Zinc-Coated (Galvanized) Reinforcing Steel, Fabricated and Delivered	Pound
503.221	Zinc-Coated (Galvanized) Reinforcing Steel, Fabricated and Delivered	Lump Sum
503.23	Zinc-Coated (Galvanized) Reinforcing Steel, Placing	Pound
503.231	Zinc-Coated (Galvanized) Reinforcing Steel, Placing	Lump Sum
503.26	Stainless Steel Reinforcement, Fabricated and Delivered	Pound
503.261	Stainless Steel Reinforcement, Fabricated and Delivered	Lump Sum
503.27	Stainless Steel Reinforcement, Placing	Pound
503.271	Stainless Steel Reinforcement, Placing	Lump Sum
503.28	Zinc and Epoxy Dual-Coated Reinforcing Steel, Fabricated and Delivered	Pound
503.281	Zinc and Epoxy Dual-Coated Reinforcing Steel, Fabricated and Delivered	Lump Sum
503.29	Zinc and Epoxy Dual-Coated Reinforcing Steel, Placing	Pound
503.291	Zinc and Epoxy Dual-Coated Reinforcing Steel, Placing	Lump Sum

SECTION 504 STRUCTURAL STEEL

GENERAL REQUIREMENTS

504.01 Description This work shall consist of detailing, fabricating and erecting structural steel bridges, ancillary bridge products and other steel structures. Materials, workmanship, inspection and documentation not specifically addressed by this Specification shall done be in

accordance with the applicable sections of the AASHTO/AWS D1.5 Bridge Welding Code including Commentary (the D1.5 Code), the AASHTO Guide Specification For Highway Bridge Fabrication with HPS 70W (HPS 485W) STEEL (the Fab Guide) and other Standards and Specifications referenced herein.

ALL REQUIREMENTS IN THIS SPECIFICATION ARE THE RESPONSIBILITY OF THE CONTRACTOR UNLESS NOTED OTHERWISE.

504.02 Materials Materials shall meet the requirements of the following sections of Division 700-Materials:

Structural Steel	713.01
Heavy-Hex Structural Bolts, Washers, Nuts and DTI's	713.02
Pre-formed Pads	713.03
Bronze or Copper-Alloy Bearing and Expansion Plates	713.04
Cold-Finished Carbon Steel Shafting	713.05
Castings	713.06

Note: The Department maintains a list of pre-approved welding consumables that the Contractor may use without furnishing Certificates of Conformance from the electrode/consumable manufacturer. This list is available on the Department's Qualified Products List of Electrodes and Electrode/Flux Combinations.

504.03 Drawings Prepare shop detail, erection and other necessary drawings in accordance with Section 105.7–Working Drawings. Show nondestructive examination symbols on the Shop Drawings. Include a fastener assembly table showing the number, size, length location and number of all bolts. Procedure Qualification Records and Weld Procedure Specifications are part of the shop drawing submittal. Weld Procedure Specifications that have been previously reviewed by the Department and are in conformance with the D1.5 Code need not be re-submitted. The drawings will be reviewed in accordance with the applicable requirements of Section 105.7 of the Standard Specifications, the AASHTO/NSBA Shop Detail Drawing Review/Approval Guidelines, G1.1 and this Specification. Review times will be in accordance with Section 105.7.2 of the Standard Specifications.

504.04 Facility Requirements Fabricate steel in a facility holding a current AISC or MDOT shop certification as follows:

Type of Product	Type of Certification Required[1,2,3,4]
1. Welded Plate Girders 2. Spliced Rolled Beams 3. Complex Bridges and Movable Bridges 4. All Structures that include the use of High Performance Grade Steel (HPS)	AISC CBR

1. Unspliced Rolled Beam Bridges 2. Steel for Bridge Repair and Rehabilitation	AISC CBR or SBR
1. Ancillary Products (See Section 713.01) 2. Structural Supports (See Section 504.58)	Any AISC Fabrication Certification or MaineDOT

[1] Application of protective coatings requires a "P" endorsement or SSPC QP3 Certification.
[2] Fracture Critical fabrication requires an "F" endorsement.
[3] All materials fabricated in a non-certified shop will be rejected.
[4] Work shall not be subcontracted to a non-certified facility, except that machining operations may be performed in non-certified facilities, as approved by the Fabrication Engineer.

504.05 Notice of Beginning Work Give the Fabrication Engineer a minimum of two weeks notice for in-state work and three weeks notice for out-of-state work prior to beginning production. Provide the Fabrication Engineer with a copy of the production schedule. If the production schedule changes, notify the Fabrication Engineer no less than 3 working days prior to the initial start-up date. If work is suspended on a project, the Fabrication Engineer will require 72 hours notice prior to the resumption of work. Any work done without the Quality Assurance Inspector (QAI) present will be subject to rejection.

504.06 Inspection Quality Control (QC) is the responsibility of the Contractor. Inspect all aspects of the work and supervise all nondestructive examination (NDE). Record measurements and test results in a clear and legible manner. Reject materials and workmanship that do not meet contract requirements. The Contractor may perform NDE in addition to the minimum required. Make the results of all measurements and testing available to the QAI.

Quality Assurance (QA) is the prerogative of the Department. The QAI will ensure that the QC Department is performing properly, verify documentation, periodically inspect workmanship and witness NDE. The QAI will schedule testing deemed necessary by the Fabrication Engineer in addition to the minimum testing requirements in a manner that minimizes interference with the production schedule.

504.07 Inspector's Authority The QAI has the authority to reject material or workmanship that does not meet the contract requirements. The acceptance of material or workmanship by the QAI will not prevent subsequent rejection if the work or material is found unacceptable.

504.08 Rejections Correct or replace rejected material and/or workmanship. Generate a non-conformance report (NCR). Provide a copy to the QAI and forward a copy to the Fabrication Engineer for review and comments.

In the event that an item fabricated under this Specification does not meet the contract requirements but is deemed suitable for use by the Department, said item may be accepted in accordance with Section 100 of the Standard Specifications (see 106.8), Non-Conforming Work.

504.09 Facilities for Fabrication Inspection Provide a private office at the fabrication plant for QA personnel. The office shall be in close proximity to the work. The office shall be

climate controlled to maintain the temperature between 68° F and 75° F and have the exit(s) closed by a door(s) equipped with a lock and two keys which shall be furnished to the QAI (s).

The QAIs' office shall meet the following minimum requirements:

Description	Quantity
Office area (minimum ft^2)	100
Drafting Table Surface (ft^2)	35
Drafting stools-each	1
Office Desk	1
Ergonomic Swivel Chairs	1 per inspector
Folding Chairs	2
High-speed internet connection (ports) or wireless	1 per inspector
Fluorescent Lighting of 100 ft-candles minimum for all work areas	2
110 Volt 60 Cycle Electric Wall Outlets	3
Wall Closet	1
Waste Basket with trash bags	1
Water Cooler	1
Broom	1
Dustpan	1
Cleaning Materials-floor, surfaces, windows - duration of the project	

The Contractor is responsible for disposing of trash and supplying commercially bottled water for the water cooler.

The QAI will have the option to reject any furniture or supplies provided to the Inspector's Office based on general condition.

Provide parking spaces for QA personnel in close proximity to the QAIs' Office. Maintain the pathway between the parking area and the QAIs' office so that it is free of obstacles, debris, snow and ice.

The facilities and all furnishings shall remain the property of the Contractor upon completion of the work. Payment for the facilities, heating, lighting, telephone installation, internet connection, basic monthly telephone and internet charges and all furnishings shall be incidental to the Contract.

Failure to comply with the above requirements will be considered denial of access to work for the purpose of inspection. The Department will reject all work done when access for inspection is denied.

504.10 Mill Test Reports Provide legible Certified Mill Test Reports (CMTRs) for all steel and iron material. Provide the CMTRs prior to fabrication. If the Contractor begins fabrication,

including cutting material, before the QAI has verified the CMTRs and mill markings, the material will be rejected.

Furnish Certified Mill Test Reports for fasteners. The supplier shall perform a Rotational Capacity Test (RCT) for both plain and galvanized bolts in accordance with AASHTO M 164M/M 164 (ASTM A 325) for each combination of bolts, nuts and washers supplied. Each combination shall be assigned a unique Rotational Capacity (R-C) lot number.

504.11 Material Identification and Control Mark steel plates and shapes as specified in AASHTO M 160 (ASTM A 6). Only use material from stock if it can be positively identified, properly documented and the direction of rolling can be determined.

Store material and fabricated items off the ground. Protect the material and fabricated items from dirt, grease, other foreign materials and significant corrosion.

Store fasteners in a protected environment. Provide four fastener assemblies for each lot, length and combination to the Fabrication Engineer for testing. A fastener assembly consists of a bolt, washer, nut and direct tension indicator (when required). Provide the fastener samples to the Fabrication Engineer immediately upon delivery to the fabrication shop or job site.

Provide Certificates of Conformance for welding consumables that are not on the Department's pre-approved electrode list.

504.12 Protective Coatings If paint is specified, apply the coating in accordance with Section 506 of the Standard Specifications or Special Provision 506 as applicable.

When galvanizing is specified, clean the steel in accordance with SSPC-SP 6 prior to galvanizing. Galvanize in accordance with AASHTO M 111 (ASTM A 123). Galvanize fasteners in accordance with ASTM F 2329-05 or AASHTO M 198 Class 50 (ASTM B 695 Class 50). Galvanized nuts shall be lubricated with a water-soluble lubricant containing a dye that contrasts with the color of the galvanizing.

504.13 Unpainted Steel Clean all surfaces to a minimum SSPC-SP 6, Commercial Blast Cleaning. Steel may be abrasive-blast cleaned prior to fabrication. Clean steel that is abrasive-blast cleaned prior to fabrication in accordance with SSPC-SP 1 Solvent Cleaning after fabrication is complete. Disassemble bolted field splices and solvent clean all faying surfaces in accordance with SSPC-SP 1 Solvent Cleaning after drilling or reaming is complete. Inspect the splices prior to re-assembly.

HIGHWAY BRIDGE FABRICATION

504.14 Materials for Bridges The grade of steel is designated on the Plans. Do not substitute material without the approval of the Fabrication Engineer.

504.15 Handling Material Handle material in a manner that prevents nicks, gouges or other damage from chains, wire ropes or other handling devices during all phases of fabrication.

504.16 Plates for Fabricated Members Cut plates subject to calculated stress, including splice plates, so that the direction of rolling is parallel to the primary stresses. The direction of primary stresses for web and field splice material is parallel to the flanges unless otherwise shown. Transfer heat numbers to each primary member used in fabrication. Primary members include flanges, webs, splice plates, bearing stiffeners, connection plates and diaphragm material on curved bridges.

504.17 Correcting Materials Correct material by a method that does not damage the material. If heating of the steel is required, submit a written procedure to the Fabrication Engineer for review. Do not use external force in conjunction with heating unless authorized in the procedure. Following corrective work, inspect the steel with nondestructive testing methods acceptable to the Fabrication Engineer. The presence of cracks or fractures will be cause for rejection of the material.

504.18 Base Metal Repairs Make base metal repairs in accordance with the D1.5 Code. Submit an NCR to the Fabrication Engineer for review if the repair area exceeds the allowable limits for base metal repairs as specified in the D1.5 Code. Notify the QAI prior to beginning the repairs.

504.19 Thermal Cutting Thermal cut steel using automatic equipment or a mechanical guide. Adjust the rate of travel of the cutting equipment to prevent hardening the steel. Do not cut material freehand.

504.20 Edge Hardness Edge Hardness testing is not required.

504.21 Edge Planing Plane sheared edges of plates greater than 5/8 inch thick to a depth of 3/16 inch.

504.22 Bent Plates Cold-bend rolled steel plates in accordance with the AASHTO/NSBA S 2.1 Steel Bridge Fabrication Guide Specifications, Table 4.2 and the following:

(a) The bend line will be at right angles to the direction of rolling.

(b) The radius of bends shall be such that no cracking of the plate occurs. Measure the radii at the concave surface as follows:

MATERIAL		Radius in terms of plate thickness (inches)*		
ASTM Specification	Grade	T<1	1<t<2	2<t
ASTM A709	Gr. 36	1.5t	1.5t	2.0t
ASTM A709	Gr. 50, Gr.50W	1.5t	2.0t	2.5t
ASTM A709	Gr. 70W	1.5t	2.5t	3.0t

* A radius of 5t is required if the plate is subject to calculated stresses

(c) If a smaller radius is required, heat the bend line to a temperature between 1000º F and 1150º F before bending. Heat plates greater than 2 inches in thickness to a temperature of between 900º F and 1150º F before bending. Do not heat HPS70W without written approval of the Fabrication Engineer.

504.23 Die Stamping Die stamp primary members (including splice material, diaphragms and cross frames on curved bridges) in no-stress locations. No-stress locations include the ends of girders within the cross-sectional area, web splice plates in the middle third of the plate height and outside the outermost row of bolt holes and flange splice plate ends between the outermost row of holes and the edge. Use blunt-nose, low-stress dies.

504.24 Camber and Curvature When camber or curvature is required for stringers or girders, it will be specified on the Plans. Measure and record specified camber or curvature using the same ordinates shown on the reviewed shop drawings after all welding is complete. When no camber or curvature is specified, variations in straightness of rolled shapes, with and without cover plates, shall not exceed the tolerances of AASHTO M 160 (ASTM A 6).

504.25 Heat Cambering and Curving Minor correction of camber or sweep of welded plate girders is considered part of ordinary shop fabrication practice and does not require an approved procedure, however, use the following guidelines:

1. Notify the QAI prior to beginning heat correction
2. Do not use hammers
3. Have suitable temperature indicating crayons at the work station
4. Do not exceed 1150º F
5. Cool in still air to 600 º F. Below 600 º F compressed air may be used

All cambering and curving operations that are not corrective shall meet the following:

Use a camber/curving procedure reviewed by the Fabrication Engineer. The procedure shall include:

1. The heating pattern and sequencing of heating
2. Method of support of the member
3. Proposed minimum and maximum base metal temperature
4. Method of heating (fuel, nozzle size, etc.)

Clean structural steel to SSPC SP-6 prior to heating. Heat both the flanges and the web using two torches (one torch on either side of the plate). Do not use restraint or jacking devices unless approved by the Fabrication Engineer. Submit calculations showing that the nominal bending stress in the member does not exceed 0.60 F_y if restraint or jacking is proposed.

The target temperature for all ASTM A709 steel is 1100º F. Steel heated in excess of 1200° F will be subject to rejection. Measure the temperature of the steel with temperature indicating crayons applied to the heated area 10-15 seconds after the torch is removed or with a pyrometer that has been calibrated within the past year. Provide temperature-indicating crayons in increments of 50 º F between 1050º F and 1250º F to each torch operator. Stop the cambering/curving operation if a torch operator fails to demonstrate the proper skill and technique necessary to prevent potential damage to the steel.

Camber stringers and girders using a "V" pattern with a 10-15 degree included angle that extends the full web depth, less 2 inches at the apex. Heat the web first beginning at the apex of the triangle and proceeding toward the base. Begin heating the flange immediately after completion of the web.

The Contractor may curve stringers and girders using a combination of line heats applied to the edge of both flanges simultaneously with automatic track torches and "V" heats. "V" heats shall have an included angle of 15-30 degrees and a minimum height of 65% of the flange width. Apply heat to adjacent areas on both flanges simultaneously.

Perform all cambering and curving in the presence of the QAI. Heating a structural member without the QAI present shall be cause for rejection of the member. Measure and record camber and sweep after the steel has reached ambient temperature and all stiffeners and connection plates have been welded.

504.26 Welding Qualify welders and Weld Procedure Specifications in accordance with the most recent edition of the D1.5 Code. Provide a list of qualified welders including process and position to the QAI prior to beginning fabrication. Submit the Weld Procedure Specifications to the Fabrication Engineer for review prior to beginning work. Weld Procedure Specifications previously reviewed and still valid in accordance with the D1.5 Code are acceptable without re-submission.

The range of heat input for Complete Joint Penetration groove welds is between 40 kilojoules/inch (kj/in) and 90 kj/in for single-arc processes. Fillet welds joining primary members shall have a minimum heat input of 35 kj/in. Make runoff tabs in accordance with the D1.5 Code.

504.27 Welding Requirements Calibrate welding equipment at the intervals indicated in the D1.5 Code. Meters shall be accurate within 2% throughout the range of the WPS. Work done with equipment that is not properly calibrated will be rejected. Provide copies of the calibration records to the QAI. The QAI can require the Contractor to demonstrate the accuracy of the meters at any time.

Display a copy of the applicable Weld Procedure Specification at each welding station. Weld within the parameters of the Weld Procedure Specification. Failure to display a Weld Procedure Specification at the welding station will make all welding performed at that station subject to rejection.

Perform all preheat, welding and postheat in accordance with the D1.5 Code and this Specification.

Provide the appropriate temperature indicating crayons at each workstation to verify preheat. Calibrated digital thermometers may be used with the approval of the Fabrication Engineer instead of temperature indicating crayons.

Weld flange plate and web plate butt joints, web to flange welds, stiffener and connection plate to web welds, and cover plate to flange welds using an automatic weld process.

Make repairs with the same process used for the original welds, except that repairs less than 12 inches in length may be made with a different process using an approved Weld Procedure Specification. Do not blend repair welds by grinding unless the original weld requires grinding.

504.28 Welded Fabrication Each side of complete joint penetration welds, once begun, shall be welded to completion without interruption or a delay between passes except as necessary to maintain interpass temperature requirements. After backgouging, the groove and 3 inches on either side of the groove and through the thickness of the steel shall be preheated in accordance with the D1.5 Code immediately before the resumption of welding.

Single-pass fillet welds may be qualified by a Fillet Weld Soundness Test performed in accordance with the D1.5 Code as modified herein. Perform the "T" test by welding the smallest fillet weld to be used in production on one side and the largest fillet weld used in production on the other side of the "T". Macroetch the test specimens in accordance with the requirements of Clause 5, Method of Testing Specimens, of the D1.5 Code. Acceptance and re-testing, if required, shall be in accordance with Clause 5 Test Results Required and Retests, of the D1.5 Code.

The minimum heat input for single-pass fillet welds during testing and production shall be 35 kilojoules/in.

504.29 Welding ASTM A 709 HPS 70W Steel In addition to 504.28, use the most recent edition of the D1.5 Code and the Fab Guide as amended herein when welding ASTM A 709 Gr. HPS 70W. Use only consumables that produce weld metal with diffusible hydrogen of H_8or less. Handle and store consumables in accordance with the requirements of Clause 12 of the D1.5 Code. Preheat in accordance with Clause 4 of the D1.5 Code through the thickness of the steel and three inches in all directions from the weldment. Failure to properly preheat the steel will result in rejection of the weld metal. Remove and re-weld rejected weldments.

HPS 70W may be joined to Grade 50W steel using a Weld Procedure Specification qualified for Grade 50W steel if the diffusible hydrogen content of the deposited weld metal is H_8 or less. Use minimum preheat temperature for Gr. HPS 70W in accordance with the D1.5 Code.

Make weld runoff tabs for Gr. HPS 70W in accordance with the D1.5 Code except make them six (6) inches long. Remove runoff tabs and grind butt welds prior to nondestructive examination.

504.30 Nondestructive Testing Perform nondestructive testing in accordance with the D1.5 Code and these Specifications. The QAI will witness nondestructive testing. Give the QAI adequate notice to facilitate the QAI's presence. Failure to notify the QAI will result in re-testing with the QAI present. Document nondestructive testing on the appropriate forms from Annex III of the D1.5 Code, or an equivalent form.

504.31 Shop Assembly Assemble stringers and girders in accordance with the shop assembly drawings. Measure and record the bearing-to-bearing dimensions, the bearing-to-field-splice dimensions and the offset from the reference line dimensions as shown on the shop assembly drawings. Give the QAI the opportunity to verify the measurements prior to disassembly.

504.32 Tolerances Dimensional tolerances for welded plate girders are described in the D1.5 Code. Dimensional tolerances for rolled shapes are described in AASHTO M 160 (ASTM A6). The tolerance for the length of any primary bridge member is ±1/4 inch. The bearing-to-bearing tolerance is ±1/8 inch. The bearing elevation tolerance is ±1/8 inch. The offset tolerance for bolted field splices is ±3/4 inch.

504.33 Match marking Match mark drill assembled or ream assembled field splice material prior to disassembly. Preserve the match marking through field erection.

504.34 Holes for High Strength Bolts Oversize holes are not allowed unless noted on the Plans. Drill bolt holes full-size. Splice plates may be used as one-time templates to drill webs and flanges. The plates shall remain with the splice. Replace damaged plates used as a template. The Contractor may temporarily tack weld web splice plates to the web in the middle 1/3 of the web only. Completely remove tack welds by grinding and MT the tack areas. Do not tack weld flange splice plates to flanges.

Holes for cross frames, diaphragms and associated connection plates may be punched when the thickness of the plate is $\leq$ 3/8 inch. The diameter of the die shall not exceed the diameter of the punch by more than 1/16 inch. Holes shall be clean cut, without torn or ragged edges.

Make holes cylindrical and perpendicular to the member. Remove burrs from parts after drilling or reaming. Remove all visible drilling oil, lubricants and coolants, including water soluble lubricants and coolants from faying surfaces in accordance with SSPC-SP 1-Solvent Cleaning.

The Contractor may thermal cut holes in bearing base plates using an automatic process. Do not exceed a surface roughness of ANSI 1000 micro-inches.

504.35 Accuracy of Holes Following the completion of the drilling of holes in a contiguous group, with all plies of a connection in their proper position for assembly, all bolt holes shall

accept a pin 1/32 inch smaller in diameter than the nominal bolt hole diameter. Provide a pin of the applicable diameter for inspection purposes.

No finished bolt hole shall be located more than 1/8 inch from its theoretical location. The repair of mislocated holes shall be subject to the approval of the Fabrication Engineer.

504.36 Shop Bolts Install shop bolts in accordance with this Specification except that adequately lubricated fastener assemblies that have been Rotational Capacity (Ro Cap) tested by the supplier do not need to be Ro Cap tested prior to installation. As an alternative, Tension Control (TC) bolts meeting the requirements of ASTM F1852 may be used with the approval of the Fabrication Engineer. Submit a tensioning procedure for TC bolts to the Resident for review.

504.37 Bearings Finish bearings, base plates and other contact surfaces to the requirements of Section 523.

504.38 Marking and Delivery Mark each piece as shown on the Shop Drawings. Place erection marks, match marks and piece marks where they will not be exposed on the finished structure.

Notify the Fabrication Engineer after the girders and stringers have been loaded on trailers and prior to shipment. Furnish the Resident copies of shipping documents and erection diagrams.

Package bolts of each length and diameter, along with the required number of nuts and washers in waterproof containers. Attach a list of the fastener assemblies, including the identifying shipping lot number and Rotational-Capacity lot number in a waterproof envelope to the outside of the container.

504.39 Handling and Storing Materials Store beams and girders in an upright position on platforms, skids or other supports above the ground. Support material in a manner that will prevent damage due to excessive deflection and torsion. Do not use chains and wire rope slings in direct contact with fabricated members when being lifted or transported. Store bolts under sheltered conditions at all times.

BRIDGE STEEL ERECTION

504.40 Plans Provide the Resident with a steel erection plan for review prior to beginning steel erection. Schedule a pre-steel erection meeting at the jobsite prior to the delivery of the steel to discuss the erection plan, personnel qualifications, adequacy of tools and equipment and any other areas of concern to the Resident. If fabrication and erection of the Superstructure are done under separate contracts, the Department will furnish detailed Plans for the Bridge or Bridges to the Contractor.

504.41 Methods and Equipment Submit plans for any false work and/or modifications to an existing structure necessitated by construction loading to the Fabrication Engineer. The false

work and/or modifications shall be designed, constructed and maintained for the loads placed upon it. False work calculations and design shall be stamped by a licensed Professional Engineer. The review by the Fabrication Engineer shall not relieve the Contractor of the responsibility for the safety of the method, equipment or from carrying out the work in accordance with the plans and Specifications. Do not build or erect false work until the Fabrication Engineer has reviewed and returned the plan.

504.42 Bearings and Anchorages Finish bridge seats true to line and grade. Do not place bearings upon bridge seats that are improperly finished.

Cast anchor rods in place or set them in drilled holes. If the anchor rods are set in drilled holes, use an anchoring material from the MDOT Qualified Products List. Anchor rods shall be capable of developing unconfined pullout strength of 30 Kips and 70 Kips for 1 inch and 1½-inch anchor rods respectively.

The Department reserves the right to perform in-place pullout tests. Replace bolts failing to meet the pullout strength requirements.

Set bearings so that they are plumb or centered at 45 º F.

504.43 Assembling Steel Clean all faying surfaces before assembly. Use drift pins in both the web and flange connections to assure alignment of all holes. Use a minimum of eight drift pins in each flange and web connection. Install and tension a minimum of 50% of the bolts in each contiguous group before the member is released from the crane. Tension field splices within 72 hours of bolt installation. Protect splices from rain or other conditions that will, in the opinion of the Resident, degrade the lubrication on the bolts.

504.44 Connections Using High Strength Bolts Provide all necessary torque and power wrenches, calibration equipment, feeler gauges and labor required for the testing, calibration, installation and inspection of high strength bolts. Provide a tension-measuring device (Skidmore-Wilhelm or approved equal) and torque wrench, both of which have been calibrated within 12 months, and are in good condition. Provide calibration documentation. Both the tension-measuring device and the torque wrench shall remain at the job site during steel erection. The torque wrench shall have a maximum capacity that is approximately 100% greater than the anticipated job torque. Torque wrenches shall be equipped with a dial face gauge and a memory pointer that remains at the applied torque reading. Torque wrenches shall be graduated in increments not to exceed two percent of the maximum capacity of the wrench and shall be readable to one percent of the maximum capacity.

504.45 Bolts, Nuts, Washers and Direct Tension Indicators Protect fasteners from dirt and moisture. Take only as many fasteners as anticipated to be installed during a work shift from protected storage. Return unused fasteners to protected storage at the end of the workday. Clean and lubricate rusty and dirty fasteners prior to installation with a lubricant recommended by the bolt supplier or manufacturer. Tension Control (TC) fasteners shall only be re-lubricated by the manufacturer.

Surfaces in contact with the bolt head and nut shall not have a slope more than 1 to 20 with respect to a plane normal to the bolt axis. Where an outer face of the bolted parts has a slope of more than 1 to 20 with respect to a plane normal to the bolt axis, a hardened beveled washer shall be used. Bolted parts shall fit solidly together when assembled. All faying surfaces shall be free of mill scale, dirt, burrs, or other material that would prevent solid seating of the parts.

Install bolts with a hardened washer under the element turned in tightening. Hardened washers are required over slotted and oversize holes.

504.46 Fastener Assemblies for Testing Provide fastener assemblies (bolt, washer, nut and DTI, if required) to the Resident two weeks prior to beginning steel erection for testing. Randomly select and package four assemblies of each lot, length and diameter for independent verification testing. Identify each size fastener assembly separately with the lot numbers of the bolt/washer/nut/DTI combinations clearly marked. The cost of the assemblies is incidental to the appropriate contract items. Replace unacceptable fastener assembly lots.

504.47 Verification Perform a Rotational Capacity Test (RCT) for each Rotational Capacity (R-C) lot at the job site immediately prior to installation. Do not use fasteners assemblies that have been used to perform the RCT in the final assembly of the steel.

If DTI's are used, perform a DTI Verification Test for each production lot immediately prior to installation.

Give the Department adequate notification in order to witness both the RCT and DTI verification tests.

504.48 Rotational Capacity Test The RCT is intended to verify the effectiveness of the lubricant and the compatibility of the components of the fastener assembly. The test shall be conducted using a tension-measuring device (Skidmore-Wilhelm or equivalent) and a torque wrench. Select two fastener assemblies of each length and diameter from each R-C lot. Perform the RCT in the following manner:

1. Insert the fastener assembly in the tension-measuring device using enough hardened washers under the nut (a minimum of one) so that there is full nut engagement (threads flush with the end of the nut) and no more than 3 threads visible after the assembly is brought to a snug-tight condition with a hand wrench (approximately 10% of the Minimum Installation Tension from Table 1).

2. Mark the faceplate of the tension measuring device with a line at 0º, 120º, 180º, and 240º. Mark the torque wrench socket so that the total amount of nut rotation can be measured and recorded. Note: the lines are for measuring total rotation of the turned element and have nothing to do with minimum installation tension.

3. Bring the fastener assembly to *at least* the Minimum Installation Tension from Table 1 using the torque wrench.

4. At a point *after* the required Minimum Installation Tension has been achieved, measure and record the tension and the torque. Take the reading as close as possible to the Minimum Installation Tension from Table 1.

Table 1
Minimum Installation Tension Requirements and Turn Test Tension-U.S. Customary

Bolt Diameter (inches)	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8
Installation Tension (kips)	19	28	39	51	56	71	85
Turn Test Tension (kips)	22	32	45	59	64	82	98

5. Further tighten the fastener assembly to the total rotation (from snug tight) specified in Table 2 below:

Table 2
Total Fastener Rotation from Snug Tight

Bolt length up to and including 4 diameters	2/3 turn (240 degrees)
Bolt length over 4 diameters up to and including 8 diameters	1 turn (360 degrees)
Bolt length over 8 diameters and less than 12 diameters	1-1/6 (420 degrees)
12 diameters and greater	test not applicable

6. Measure and record the tension after total rotation of the nut. The measured tension must be equal to or greater than the Turn Test Tension value shown in Table 1 for the diameter bolt being tested. If the measured tension is less than the required Turn Test Tension, the fastener assembly has failed.

7. Upon completion of steps 1 through 6:

(a) The torque measured in step 4 shall not exceed the value obtained by the following equation:

Measured Torque $\leq 0.25PD$ Where:

P = *Measured* Bolt Tension -pounds (Step 4)
D = Nominal Bolt Diameter -feet
(bolt diameter in Inches divided by 12)

(b) If the torque measured in step 4 is greater than the torque calculated in step 7, the fastener has failed the test. Re-lubricate all fasteners in the lot and re-test.

(c) Disassemble each fastener assembly and run the nut down the full length of the threads excluding the grip length (the length between the bolt head and washer face of the nut). If evidence is found of torsional failure, shear failure or stripping of the threads, the assembly failed the test. Slight necking in the grip length is not a failure.

(d) If either bolt assembly fails the test, the R-C lot has failed. Re-lubricate all bolts from that lot and perform the test again. If either bolt fails the second test, the R-C lot shall be rejected.

8. Test bolts that are too short to fit in the tension-measuring device in a solid joint such as a bearing stiffener or connection plate. The hole in the joint may not be more than 1/16 inch greater in diameter than the bolt being tested. Randomly select two fastener assemblies from each R-C lot. Mark the nut relative to the steel joint in such a manner that rotation can be measured. Snug tighten the bolt with a spud wrench using approximately the same effort used to snug-tighten longer bolts in a tension measuring device. Restrain the bolt with a wrench to prevent rotation. Rotate the nut from snug tight to 1/3 turn with a torque wrench. Record the torque required to reach that rotation while the turned element is in motion. If the measured torque exceeds the maximum torque listed in Table 3 the fasteners have failed the test. If the fasteners fail the first test, re-lubricate all fasteners from that R-C lot, randomly select two samples and re-test. If there is no stripping or fracture the fasteners pass. If the either fastener fails the second test, the R-C lot is rejected.

Table 3
Maximum Allowable Torque

Bolt Diameter (inches)	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
Torque (ft-lbs)	500	820	1230	1500	2140	2810	3690

9. Discard bolts used for the Rotational Capacity Test.

504.49 DTI Verification Test Perform the DTI Verification Test for each production lot of DTIs in combination with each R-C lot of fasteners. If any of the three test assemblies fails, three additional samples from the same production lot shall be tested as the first. If any of the three samples fails the second test, the lot shall be rejected. Perform the test in TWO STEPS:

1. Step 1 is a test to determine that the DTI's are acceptable when the fastener is brought to the minimum allowable tension.

a) Randomly select three fastener assemblies from each R-C lot.

b) Install each bolt in the tension-measuring device with the bolt head bearing against the faceplate (the front of the tension-measuring device). Place the DTI under the bolt head with the protrusions bearing against the washer face of the bolt. This is

done so that the DTI is accessible for inspection with a feeler gauge. Install the nut and hardened washer using a filler sleeve between the bolt bushing (the back of the tension-measuring device) and the hardened washer under the nut. Two or more hardened washers may be used under the nut instead of a filler sleeve if the washers do not interfere with the proper operation of the tension-measuring device. When the bolt is brought to snug-tight condition, there should be 3 to 5 threads visible.

c) Using two wrenches, one to restrain the unturned element of the bolt assembly, tighten the nut to the Bolt Tension listed in Table 4. If an impact wrench is used, tighten the bolt to approximately 50% of the required tension and use a torque wrench to bring the fastener to the required tension.

TABLE 4- Minimum Installation Tension

U.S. Customary							
Bolt Diameter (inches)	5/8	3/4	7/8	1	1-1/8	1-1/4	1-1/2
Bolt Tension (kips)	20	29	41	54	59	75	108

d) Using a thickness gauge provided by the DTI manufacturer, record the number of spaces between the protrusions on the DTI that a 0.005 inch thickness gage is refused.

e) If the number of refusals exceeds the number in Table 5, the DTI has failed the DTI Verification Test for minimum tension. Reject the DTI lot.

TABLE 5

Bolt Diameter (inches)	¾, 7/8	1, 1-1/8	1-1/4, 1-3/8
Number of Spaces in DTI	5	6	7
Maximum Number of gaps in which gage is refused *	2	2	3

*If the test is a coated DTI, the maximum number of spaces the gage is refused is the number of spaces on the DTI minus one

2. Step 2 is to determine the maximum bolt tension allowable using a DTI.

a) After completing step 1, the bolt shall be further tightened to the smallest gap to be used during installation. Normally, this is defined as a condition where all gaps refuse a 0.005 inch gage but at least one visible gap remains.

b) Remove the bolt from the tension measuring device and turn the nut on the threads of the bolt by hand. If the nut can be run the length of the threads, excluding the thread run out, the DTI lot is acceptable. If the nut is unable to run the thread length at the smallest gap condition (defined in a) above), the test shall be performed again using a larger acceptance gap.

504.50 Installation and Tensioning High Strength Bolts Select one of the methods listed below for installing and tensioning high strength bolts. Do not use standard torque determined by the use of tables or formulas that attempt to relate torque to tension.

504.51 Installation Install a hardened washer under the turned element and a hardened washer on oversize holes. Install fasteners in all holes in a contiguous group, except for holes containing drift pins and bring them to a snug tight condition, progressing systematically from the most severely restrained location in a connection to the free edges. Do not remove the drift pins until a minimum of 50% of the fasteners have been tensioned. Do not force the bolts. If the bolts cannot be installed easily by hand, correct the hole alignment by installing more drift pins.

504.52 Tensioning Install and tension bolts by: (1) the Calibrated Wrench method, (2) the Turn of Nut method, (3) with Direct Tension Indicators or (4) Alternative Design Fasteners. Tension the fasteners systematically from the most rigid part of the joint to the free edges.

1. The Calibrated Wrench Method Adjustable pneumatic wrenches, adjustable hydraulic wrenches or torque wrenches may be used.

Calibrate the wrench used for tensioning bolts at least once each shift with fastener assemblies of each diameter, length and R-C lot to be installed. Calibrate pneumatic wrenches any time a section of hose has been added or eliminated. Calibrate pneumatic wrenches any time the compressor is changed.

Randomly select five fastener assemblies of each length and R-C lot for wrench calibration. Install each of the fastener assemblies in the tension measuring device and install enough washers so at least three but no more than five threads are showing. Install at least one hardened washer under the turned element. Snug the bolt using the same procedure to be used during installation.

If the wrench is an adjustable pneumatic wrench or an adjustable hydraulic wrench, set the adjustment so that each of the three assemblies is tensioned to no less than the Minimum Installation Tension specified in Table 4 above.

If a torque wrench is used, tension five randomly selected fastener assemblies to the minimum tension specified in Table 4. Record the torque readings. Discard the high and low torque reading. The job installation torque shall be the average of the three remaining torque values.

When bolts are too short to fit in the tension-measuring device, install five randomly selected fasteners in a solid joint with a hole diameter no greater than 1/16 inch the nominal bolt diameter. Rotate each assembly 1/3 turn and record the torque. Discard the high and low torque reading. The job installation torque shall be the average of the three remaining torque values.

Bolts used to calibrate wrenches may be re-used.

2. The "Turn of Nut" Method Perform the Turn of Nut calibration once, prior to fastener installation, for each diameter, length and R-C lot.

Select a random sample of no less than three fastener assemblies of each diameter, length and R-C lot. Install each assembly in a tension-measuring device. Bring the fastener assembly to snug tight (approximately 10% of the minimum installation tension from Table 4). Match mark the socket to reference points on the tension-measuring device in order to accurately determine nut rotation. Tighten the bolt to the required rotation specified in Table 6. Record the tensions for each diameter, length and R_C lot. The average of the three tension readings shall be no less than the Minimum Installation Tension specified in Table 4. If any of the three fastener assemblies does not achieve minimum installation tension at the specified rotation, select three more and re-test. Increase the minimum rotation if necessary.

Snug all the bolts in a contiguous group. Rotate the turned element the appropriate amount rotation specified in TABLE 6. The unturned element shall be held by a wrench to prevent rotation during tightening.

TABLE 6
Nut Rotation from Snug Tight [1, 2, 3]

Disposition of Outer Faces of Bolted Parts			
Bolt Length Measured from Underside of head to extreme of point	Both Faces Normal to Axis [3]	One Face Normal to Bolt Axis and Other Face Sloped Not More Than 1 to 20 (bevel washer not used) [3]	Both Faces Sloped Not More Than 1 to 20 from Normal to Axis (bevel washer not used) [3]
Up to and including 4 diameters	1/3 turn	½ turn	2/3 turn
Over 4 diameters but not exceeding 8 diameters	½ turn	2/3 turn	5/6 turn
Over 8 diameters but not exceeding 12 diameters [2]	2/3 turn	5/6 turn	1 turn

[1] Nut rotation is relative to bolt, regardless of the element (nut of bolt) being turned.
[2] For bolts tensioned with ½ turn or less, the tolerance shall be plus or minus 30 degree. For bolts tensioned with more than ½ turn, the tolerance shall be plus or minus 45 degrees.
[3] No research work has been performed by the Research Council on Riveted and Bolted Structural Joints to establish the turn-of-nut procedure when bolt lengths exceed 12 diameters, therefore, the required rotation must be determined by actual tests in a suitable tension-measuring device simulating the actual condition.

3. Tensioning Fastener Assemblies with DTI's Tension fasteners using DTI's so that a 0.005 inch feeler gage is refused in at least the number of gaps shown in Table 7 and a minimum of one visible gap remains. Tightening beyond crushing the DTI shall be cause for rejection of the fastener assembly.

TABLE 7

Inspection Criteria for DTI's						
Number of gaps in DTI	4	5	6	7	8	9
Minimum number of gap refusals	2	3	3	4	4	5

4. Alternate Design Fasteners Alternate design fasteners that are designed to indicate bolt tension indirectly or tension bolts automatically may be used only with the approval of the Fabrication Engineer. Alternate design fasteners shall meet the chemical and mechanical requirements of AASHTO M 164M / M 164 (ASTM A 325/ A 325M) and shall have the same body diameter of similar traditional fasteners and not less than the same bearing area under the head and nut as a similar heavy hex fastener.

Provide a detailed written installation procedure from the fastener manufacturer to the Fabrication Engineer for approval prior to beginning bolt installation. The Fabrication Engineer may modify or place restrictions on the installation procedure prior to approval.

Calibrate three random samples in a tension-measuring device. Each fastener shall achieve the Minimum Bolt Tension from Table 4 when installed and tensioned in accordance with the approved installation procedure. If any of the three fasteners fails to achieve 100% of the Minimum Bolt Tension, a retest of five fastener assemblies from the same lot may be performed. If any of the five fastener assemblies fails to achieve 100% of the Minimum Bolt Tension, the lot shall be rejected. The Resident may require re-calibration of the fasteners if the condition of the fasteners has significantly changed.

Tension alternate design fasteners immediately after installation. Alternate design fasteners are extremely dependent on proper lubrication and thread condition. Handle and store fasteners in accordance with the manufacturer's recommendations. Fasteners that have been improperly handled or stored shall be rejected.

504.53 Inspection Inspect all completed joints within 72 hours following completion of tensioning each joint or contiguous group of fasteners.

Use the following inspection procedure:

1. The Contractor, in the presence of the Resident shall use a calibrated torque wrench as an inspection tool.

2. At least once each day, tighten a representative sample of five bolts from each diameter, length and Ro-Cap lot used in the work in the tension-measuring device to the Minimum Bolt Tension specified in Table 6. Place a washer under the turned element of each bolt assembly. The job inspection torque shall be the average of three values after rejecting the high and low values.

3. Bolts represented by the sample in the preceding paragraph which have been tightened in the structure shall be inspected by applying, in the tightening direction, the inspection wrench and the job inspection torque to a minimum of 10% of the bolts, but not less than two bolts, selected at random, in each connection. If any nut or bolt is turned more than five degrees (approximately one inch at a twelve inch radius) by the application of the job inspection torque, all bolts in the connection shall be tested. Alternatively, the Contractor or Erector may re-tighten all the bolts in the connection before the specified inspection.

4. For joints using DTI's, inspection will consist of verifying that the DTI has the minimum number of refusals required from Table 9 and the minimum gap allowed in the work (from the DTI Verification Test) remains in at least one space.

5. At the Resident's option, if the Quality Assurance Inspector witnesses the initial and final tensioning of fasteners in a joint using the "Turn of Nut" method and finds it acceptable, no further inspection will be required.

504.54 Reuse of Bolts Reuse only black AASHTO M164M/M164 (ASTM A325/A325M) bolts. Do not reuse galvanized fasteners.

504.55 Field Welding Welders shall have in their possession a valid certification for the process and position to be used in production from the American Welding Society or other organization acceptable to the Resident.

Submit a written Weld Procedure Specification for each joint to the Fabrication Engineer for review. Provide the Weld Procedure Specification to the welder and Resident prior to beginning welding. Do not perform field welding without an approved Weld Procedure Specification. Power sources shall have meters indicating amperage/voltage that have been calibrated within 1 year.

Field welding and nondestructive examination of field welds shall be done in conformance with the requirements of the D 1.5 Code.

504.56 Misfits The correction of misfits involving minor reaming will be considered a legitimate part of steel erection. Errors in shop fabrication or deformation from handling and transportation that prevents the proper assembling and fit-up of parts by the use of drift pins or by reaming (not to exceed 10% of the holes in a contiguous array) shall be reported immediately to the Resident. Provide a written proposal for correction to the Fabrication Engineer. Do not make any field corrections that involve cutting or welding without the permission of the Resident.

ANCILLARY BRIDGE PRODUCTS and SUPPORT STRUCTURES

504.57 Ancillary Bridge Products Ancillary bridge products are defined in Subsection 713.01 of the Standard Specifications. Fabricate ancillary bridge products in accordance with

the D1.5 Code as applicable to ancillary bridge products and this Specification. Fabricate tubular products in accordance with the AWS D1.1 Structural Welding Code (the D1.1 Code).

504.58 Support Structures Weld support structures in accordance with the D1.1 Code. Support structures shall include, but not be limited to, non-vehicular bridges, high mast poles, light and signal poles, dual purpose poles, strain poles and sign supports; cantilever, bridge and butterfly support structures.

504.59 Materials Materials for ancillary bridge products will be specified in the Contract documents. When AASHTO M 270M/M 270 (ASTM A 709/A 709M) steel is specified for ancillary bridge products, equivalent ASTM grades of steel may be substituted. Provide Certified Mill Test Reports for all material.

504.60 Holes for Base Plates Holes in base plates may be drilled or thermal cut at the Contractor's option. The roughness shall not exceed the allowable tolerances in the D 1.1 Code. Do not deviate from specified dimension for thermal cut holes by more than 1/16 inch in any direction.

504.61 Bolted Connections Holes for bolted connections shall meet the requirements of Subsections 504.34 and 504.35. High strength bolts shall be installed, tensioned and inspected in accordance with Subsections 504.50 through 504.54.

504.62 Anchor Rods Anchor rods shall be as shown on the Plans or in the Standard Details. Anchor rods shall meet the material requirements of 720.07.

504.63 Support Structures Qualify Weld Procedure Specifications, welders and welding operators in accordance with the D1.1 Code.

Circumferential shop splices for poles shall be full penetration, butt welds. Welded longitudinal seams shall have 100 percent penetration for 6 inches on either side of a shop splice, and for the splice length plus 6 inches at the field splice end(s) of a shaft section. The remainder of the seam weld shall have a minimum effective weld throat of 60 percent of the wall thickness. Pole to base welds may be complete joint penetration welds or socket-type joints with two fillet welds.

Prior to erection, the assembled shaft or structure shall not exhibit a sweep in excess of 0.2 percent of the nominal pole height or length, as measured with the pole or structure in a horizontal position. Shafts that are to remain unpainted shall have the lower edge of all field slip connections sealed around the entire circumference with a sealant that will remain flexible and not degrade from exposure to ultraviolet light.

504.64 Non Destructive Testing-Ancillary Bridge Products and Support Structures
Unless otherwise specified, nondestructive testing shall be as follows:

1. Examine ten percent of each production lot using Magnetic Particle (MT) inspection. If any welds examined require a welded repair, an additional ten percent of the original lot number will

be examined using MT. If any welds in the second ten percent require a welded repair, test all welds in that production lot using MT.

2. For the purposes of this Specification, a production lot shall be defined as a day's production of small parts (e.g. post to base welds), each discrete segment of complex structures (e.g. overhead sign supports, mast arm poles, etc.) or other grouping or unit not to exceed one week's production at the discretion of the Fabrication Engineer.

3. Inspect one hundred percent of all circumferential welds and the full penetration sections of the longitudinal seam welds by radiographic examination (RT). Inspect one hundred percent of tube to plate welds: full penetration by RT, partial penetration and fillet by MT. Inspect twenty five percent of the partial penetration sections of the longitudinal seam welds (MT). Ultrasonic testing (UT) may be used on material ≥ (5/16 inch) thick and properly qualified UT may be used on thicknesses < 5/16 inch.

504.65 Method of Measurement Unless otherwise specified, structural steel will be measured as one lump sum complete and accepted, consisting of all metal and related materials in the fabricated and erected structure as shown on the Plans, excluding railings and drains. Related materials shall include, but not be limited to, preformed pads placed under the bearings and, when required, self-lubricating bronze or copper-alloy bearing and expansion plates.

504.66 Basis of Payment Structural steel will be paid for at the contract lump sum price for the respective contract items.

Payment will be made under:

	Pay Item	Pay Unit
504.70	Structural steel fabricated and delivered,	Lump Sum
504.701	Structural steel fabricated and delivered, rolled	Lump Sum
504.702	Structural steel fabricated and delivered, welded	Lump Sum
504.71	Structural steel erection	Lump Sum

SECTION 505 - STUD WELDED SHEAR CONNECTORS, ANCHORS, & FASTENERS

505.01 Description This work consists of furnishing and installing steel stud welded shear connectors, concrete anchors and threaded fasteners in accordance with the AASHTO/AWS D1.5 Bridge Welding Code (D1.5) and these Specifications.

505.02 Materials Materials shall meet the requirements of Section 711.06 - Stud Shear Connectors, Anchors, and Fasteners. The Contractor shall provide the stud manufacturer's certification that the studs meet the material requirements prior to beginning welding.

505.03 Quality of Work The studs shall be free from rust, scale, oil, and other contaminants that would adversely affect the welding operation.

Weld locations shall be free of scale, rust, oil and other deleterious material. The Contractor may clean the weld locations by any method that results in satisfactory welds.

The arc shields, or ferrules, shall be kept dry. Ferrules showing signs of moisture shall be oven dried at 250 degrees Fahrenheit for two hours prior to use.

The longitudinal spacing of shear connectors shall vary no more than ±1 inch from that shown on the Plans. The minimum edge distance shall be 2 inches.

Arc shields or ferrules shall be removed from studs after welding.

505.04 Technique Studs shall be welded with automatically timed stud welding equipment connected to a suitable direct current, electrode negative (DCEN) power source.

If more than one stud-welding gun is operated from the same power source, they shall be interlocked so that only one gun can operate at one time.

Welding shall not be done when the base metal temperature is below zero degrees Fahrenheit or when the surface is wet or exposed to rain or snow.

Studs may be fillet welded using SMAW with the approval of the Resident.

505.05 Construction Requirements At the beginning of each day or shift and after any change in set-up, the first two studs welded shall be tested. The studs shall be visually inspected for a full 360 degrees weld flash. The studs shall be bent a minimum of 30 degrees from their original axis with a hammer, pipe or other hollow device. If either stud fails the visual or bend test, the Contractor shall correct the procedure and weld two more studs to separate material representative of the grade and thickness of the material being welded in production. This procedure shall continue on separate plates until the Contractor has successfully welded two consecutive studs.

While in operation, the welding gun shall be held in position without movement until the weld metal has solidified.

If an unacceptable stud has been removed from an area subject to tensile stresses or stress reversal, the weld area shall be ground flush. If base metal has been pulled out in the course of stud removal, the pocket shall be filled by welding in accordance with the field welding requirements of Section 504 - Structural Steel. The weld shall be ground flush. Base metal repairs in compression areas shall be the same as the repairs for tension areas except that if the depth of the pocket is less than ⅛ inch it shall be faired out by grinding. Replacement studs shall be welded no closer than 1 inch from the repair area.

505.051 Inspection Studs will be visually inspected for a full 360 degrees weld flash. Studs not having a full 360 degrees weld collar shall be bent 30 degrees from its original position in a direction away from the missing weld flash. Studs not developing a crack or tear will be considered acceptable. Failing studs shall be removed, replaced and weld areas repaired.

505.06 Method of Measurement Shear connectors shall be measured as one lump sum, consisting of all shear connectors required and acceptably installed. Stud welded anchors and fasteners will be considered incidental to the pay item for which they are required.

505.07 Basis of Payment The accepted quantity of shear connectors will be paid for at the lump sum price.

Payment will be made under:

Pay Item	Pay Unit
505.08 Shear Connectors	Lump Sum

SECTION 506- SHOP APPLIED PROTECTIVE COATING - STEEL

506.01 Description This work shall consist of applying protective coating to steel substrate in accordance with the Plans and this Specification. The protective coating system shall be as specified on the Plans.

ALL REQUIREMENTS IN THIS SPECIFICATION ARE THE RESPONSIBILITY OF THE CONTRACTOR UNLESS NOTED OTHERWISE.

506.02 Materials Materials shall comply with the requirements of the respective Subsections of this Specification.

506.03 Submittals Submit the following, as applicable:

A. The manufacturer's product data sheet for the specified protective coating system(s).
B. Material Safety Data Sheets.
C. Facility Certification, Endorsement or other Qualification(s)
D. Quality Control Plan
E. Quality Control Inspector (QCI) qualifications

506.04 General Specifications Specifications for the protective coating and/or protective coating systems are:

Zinc Rich Coating System	Subsections 506.10 through 506.19
Hot-Dip Galvanizing	Subsections 506.20 through 506.29

Thermal Spray Coating	Subsections 506.30 through 506.39
Fusion Bonded Epoxy Coating	Subsections 506.40 through 506.49

506.05 Inspection Quality Control (QC) is the responsibility of the Contractor. Inspect all aspects of the work and supervise all sampling, measurements and testing. Record measurements and test results in a clear and legible manner in a format acceptable to the Fabrication Engineer. Reject materials and workmanship that do not meet Contract requirements. The QCI may perform sampling, measurements and testing in addition to the minimum required. Make the results of all sampling, measurements and testing available to the Quality Assurance Inspector (QAI).

Training in surface preparation, coatings application, and inspection is required for QCI's. Acceptable training includes one or more of the following:

A. National Association of Corrosion Engineers (NACE) International: Coating Inspector Program Level 1 (minimum)
B. SSPC BCI Coatings Inspection Training and Certification for the Bridge Industry: (Level I without certification), or Level II
C. Other training that is acceptable to the Department.

Quality Assurance (QA) is the prerogative of the Department. The QAI's responsibility is to ensure that the QC personnel are performing acceptably, verify documentation, periodically inspect workmanship and witness sampling, measurements and testing. The QAI will schedule measurements and testing deemed necessary by the Resident in addition to the minimum requirements in a manner that minimizes interference with the production schedule.

The QAI has the authority to reject material or workmanship that does not meet the Contract requirements. The acceptance of material or workmanship by the QAI will not preclude subsequent rejection, if found unacceptable by the Department.

506.06 Non-Conforming Work Submit a non-conformance report to the Fabrication Engineer describing the deficiencies and proposed solution. Correct or replace rejected coatings as directed by the Fabrication Engineer.

506.07 Facilities for Inspection Provide a private office at the fabrication plant for the Department's inspection personnel, or QAI's. The office shall be in close proximity to the work. The office shall be climate controlled to maintain the temperature between 68° F and 75° F and have the exit(s) closed by a door(s) equipped with a lock and 2 keys which shall be furnished to the Inspector(s).

The QAI's office shall meet the following minimum requirements:

Description	Quantity
Office area (minimum ft^2)	100

Drafting Table Surface (ft^2)	35
Drafting stools-each	1
Office Desk	1
Ergonomic Swivel Chairs	1
Folding Chairs	2
High-speed internet connection (ports) or wireless	1
Fluorescent Lighting of 100 foot-candles minimum for all work areas	2
110 Volt 60 Cycle Electric Wall Outlets	3
Wall Closet	1
Waste Basket with trash bags	1
Broom	1
Dustpan	1
Water Cooler	1
Cleaning materials-floor, surfaces, windows- for duration of the project	

The Contractor will be responsible for disposing of trash and supplying commercially bottled water for the water cooler.

The QAI has the option to reject any furniture or supplies provided to the QAI's office, based on general poor condition.

Provide parking space for the QAI(s) in close proximity to the entrance to the QAI's office. Maintain the pathway between the parking area and the QAI's office so that it is free of obstacles, debris, snow and ice.

The facilities and all furnishings shall remain the property of the Contractor upon completion of the Work. Payment for the facilities, heating, lighting, telephone installation, internet connection, basic monthly telephone and internet charges and all furnishings shall be incidental to the Contract.

Failure to comply with the above requirements will be considered denial of access to the Work for the purpose of inspection. The Department will reject all Work done when access for inspection is denied.

506.08 Applicator Qualification Shop-applied paint systems shall be applied by applicators that hold a current AISC Sophisticated Paint Endorsement (SPE) or are qualified in accordance with SSPC-QP3, *Standard Procedure for Evaluating Qualifications of Shop Painting Applicators.* For specialty items, the Fabrication Engineer may accept other shop qualifications based on experience and/or an audit by the Department. Thermal Spray Coating (TSC), including sealers and top coating, fusion bonded coatings and hot-dip galvanizing shall be applied in facilities with a minimum of five years experience of satisfactory performance.

506.09 Inspection Measure and record the following, as applicable to the coating application, in a Job Control Record (JCR):

A. Surface preparation - cleanliness and anchor profile.
B. Environmental conditions – ambient temperature, surface temperature, relative humidity, dew point.
C. Coating batch and/or lot number, date of manufacture and shelf life.
D. Mixing/thinning.
E. Dry Film Thickness (DFT) for each coat.
F. Cure data-time/temperature/relative humidity.
G. Final inspection and acceptance by the QCI.

Submit the format for the JCR to the Fabrication Engineer for review prior to beginning application of protective coating.

Provide work area illumination as follows:

Work Area Illumination Requirements in Foot Candles		
Description of Work	Minimum	Recommended
General Work Area Illumination	10	20
Surface Preparation and Coating	20	50
Inspection	50	200

Provide a light meter that measures illumination in foot candles.

Use *SSPC-VIS 1, Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning or SSPC-VIS 3, Guide and Reference Photographs for Steel Surfaces Prepared by Hand and Power Tool Cleaning* as required in order to determine acceptable surface cleanliness.

Measure and record the environmental conditions during application and during the entire curing cycle. Failure to provide accurate and complete environmental data may result in rejection of the coating or an extended cure time as determined by the Fabrication Engineer.

Measure and record the DFT of each coat in accordance with *SSPC-PA 2, Measurement of Dry Coating Thickness with Magnetic Gages* (PA 2).

ZINC RICH COATING SYSTEM

506.10 Description This work shall consist of surface preparation and application of coating systems in accordance with the Plans and this Specification. The color shall be as specified on the Plans.

506.11 Materials Coatings systems shall be from the Northeast Protective Coating Committee (NEPCOAT) Qualified Products List (QPL), list A or B. The list may be found through NEPCOAT's Web page: http://www.nepcoat.org.

Provide the paint batch description, lot number, date of manufacture, shelf life and the manufacturer's storage requirements to the QAI. Provide the manufacturer's published data sheet for each coat of the coating system including equipment, surface cleanliness, anchor profile, mixing, thinning, application, and cure time for the entire range of allowable environmental conditions and the DFT.

506.12 Limits of Work Coat all surfaces exposed in the assembled product unless otherwise specified. Apply a mist coat, 0.5 to 1.0 mils, of primer only to surfaces to be embedded in concrete.

Apply primer to faying surfaces of bolted connections that develop a class B slip coefficient in accordance with the *"Specification for Structural Joints Using ASTM A325 or A490 Bolts" by the Research Council of Structural Connections* (RCSC). Provide documentation to demonstrate that the primer was tested and the requirements were met. Do not exceed the DFT applied for test purposes.

506.13 Surface Preparation Surface cleanliness shall be *SSPC-SP 10, Near-White Blast Cleaning* (SP 10) unless a higher standard of surface cleanliness is required by the manufacturer's published data sheet. Round all corners exposed in the assembled product to approximately a 3/32 inch radius, prior to abrasive blast cleaning. A series of tangents that approximate a radius may be considered as a rounded edge if there are no sharp breaks. Provide radius gauges to inspect corner preparation. The radius shall be the minimum specified above, but not greater than 3/16 inch.

The abrasive blast media shall meet the requirements of *SSPC-AB 1, Mineral and Slag Abrasives, AB 2, Cleanliness of Recycled Ferrous Metallic Abrasives and/or AB 3, Ferrous Metallic Abrasive*. The anchor profile shall be angular and meet the requirements of the coating manufacturer's published data sheet.

If compressed air is used for abrasive blast cleaning, perform a blotter test ASTM D4285 at the beginning of each shift and at any time requested by the QAI. Notify the QAI prior to performing the test.

Measure and record the anchor profile in accordance with ASTM D4417 Method C (replica tape). If the anchor profile fails to meet the minimum requirements, re-blast the substrate until the required anchor profile is achieved. If the anchor profile exceeds the maximum allowed, generate a Non-Conformance Report (NCR) describing the condition of the substrate and a proposed solution and submit it to the Fabrication Engineer for review.

Measure the anchor profile of the substrate on every plane of each beam or girder. If it has been established to the satisfaction of the QAI that the abrasive blast equipment is capable of providing uniform, acceptable anchor profile, a diminished degree of testing may be allowed at the discretion of the Fabrication Engineer.

The allowable time between abrasive blast cleaning and primer application shall not exceed the manufacturer's published recommendations or one work shift, whichever is less. Any evidence of rust bloom, flash rust or other surface conditions that cause the substrate cleanliness to fall outside the specified cleanliness standard will be rejected. Inspect all substrate immediately prior to coating application. Re-blast steel substrate that does not meet the surface cleanliness requirements.

506.14 Mixing and Application Record the batch and lot numbers of the coating, the type and amount of thinner used, the time and pot life of the coating.

Add thinner in accordance with the manufacturer's published data sheet. Measure thinner with a graduated cup, or other container, that clearly indicates the amount of thinner being added. Record the amount of thinner added. Mix the paint using the method, equipment and time recommended by the coating manufacturer. Mix each component separately and mix all components together for at least the minimum time recommended on the Manufacturer's Product Data Sheet but not less than two minutes.

Measure the environmental conditions in the immediate vicinity of the piece(s) being coated during the coating operation and during the entire cure period. Provide two data loggers capable of measuring ambient humidity and temperature. The data loggers shall come with software that can download the data onto a computer. Print out the data and provide a copy to the QAI for review prior to applying the subsequent coat of paint. Place the data loggers in the immediate vicinity of the coating operation during the entire application and curing cycle. The data will be used to determine that the cure/recoat time requirements for each coat have been met. Failure to comply will result in the coating being cured for the maximum time necessary to assure adequate cure, as determined by the Fabrication Engineer.

Stripe all corners, fasteners, welds and locations with poor access, in accordance with *SSPC-PA 1, Shop, Field and Maintenance Painting of Steel* (PA 1). Do not stripe using inorganic zinc primer (IOZ). Stripe the IOZ primer between the primer and intermediate coats using the intermediate coating.

Apply the coating using equipment recommended in the Manufacturer's Product Data Sheet, or equal. Apply the coating in a uniform manner without sags, runs or drips.

506.15 Dry Film Thickness Measure and record the DFT of each coat in accordance with PA 2. Record the following:

A. Gauge type/manufacturer/model
B. Serial number
C. Coat/shim used for calibration (e.g., Primer Coat or 5 mil shim)
D. Measurements/spot average/location
E. Cure time
F. Non-conforming areas and determination for correction

Each piece or area presented for acceptance, regardless of size, shall be considered a separate structure for purposes of determining the number of spot measurements to be taken, except that large quantities of small parts and/or secondary framing members coated at the same time may be measured at a lesser frequency, as directed by the Fabrication Engineer. When random DFT testing of a large quantity of small parts and/or secondary framing members results in unacceptable DFT's, the Contractor shall have the option of measuring and documenting the DFT of each piece or removing the coating and/or recoating all pieces represented in the production lot.

506.16 Touch-up and Repairs Touch-up is the repair of minor blemishes, including but not limited to, scratches and abrasions that to do not penetrate underlying layers of coating. Perform touch-up using the same coating and methods specified in the Manufacturer's Product Data Sheet. Cure the touch-up coating in the same manner as the original coating.

Repair coating damage that penetrates underlying layers in accordance with the Manufacturer's Product Data Sheet and this Specification. Prepare areas to be repaired in a manner that assures the proper adhesion of each coat. Feather back each damaged layer so that each repair coat is continuous with each corresponding existing coat. The topcoat shall be smooth and uniform in appearance. Repair damaged or unacceptable shop coating before the piece is removed from the paint area.

506.17 Handling and Storage Handle coated members in a manner that avoids damage to the coating. Lift and move members using non-metallic slings, padded chains and beam clamps, softeners or by other non-injurious methods. Store painted material in a manner that prevents damage to the coating.

Document damage to the coating that is discovered after the product is loaded for shipment to the job site. Minor damage as a result of handling shall be considered field repair unless, in the opinion of the Fabrication Engineer, the damage is the result of negligence or poor handling methods. Damage that is deemed to be the result of negligence or poor handling methods shall be repaired as directed by the Fabrication Engineer.

506.18 through 506.19- Reserved

HOT-DIP GALVANIZING

506.20 Description This work shall consist of surface preparation and application of hot-dip galvanizing in accordance with the Plans and this Specification. Hot-dip galvanizing shall meet the requirements of *AASHTO M111/ASTM A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel* (A123), including any applicable requirements listed in Section 2-Referenced Documents. The minimum average coating thickness grade shall conform to Table 1. The frequency of testing shall be in accordance with Section 6. The choice of the test method is the prerogative of the Contractor. Record the test results and provide them to the

Department. Provide certification of compliance and written test results to The Department in accordance with A123 -Section 10.

506.21 Surface Preparation Abrasive blast-clean the steel to a minimum of *SSPC-SP 6, Commercial Blast Cleaning* (SP6) prior to galvanizing. Grind all corners exposed in the assembled product to a 1/16 inch radius prior to galvanizing.

506.22 Repairs Repairs to galvanizing shall be in accordance with ASTM *A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings* (A 780), Annex A1 or A3. Zinc-rich paints for repairs may only be used with approval of the Fabrication Engineer.

506.23 Top-coating Galvanized Surfaces Areas of galvanized surfaces to be top-coated will be described on the Plans or in the Special Provisions.

Do not use chromate quenching or other types of quenching after galvanizing. Remove runs, sags, dross and other deleterious material from surfaces to be painted. Provide a smooth uniform surface, free of heavy build areas or other discontinuities that will project through the finish coat. Perform repairs to galvanizing in accordance with A 780. Remove visible surface contaminants in accordance with *SSPC-SP 1, Solvent Cleaning* (SP 1) prior to blast cleaning. Blast-clean surfaces to be coated in accordance with *SSPC-SP 7/NACE No.4-Brush-Off Blast-Cleaning* (SP 7). Measure the anchor profile in accordance with *ASTM D4417 Method C* (replica tape). Record the results in a manner acceptable to the Fabrication Engineer. Assure that the anchor profile corresponds with the anchor profile requirements on the Manufacturer's Product Data Sheet.

506.24 Materials Provide materials in accordance with 506.11.

506.25 Mixing and Application Mix and apply in accordance with 506.14.

506.26 Dry Film Thickness Measure and record the DFT in accordance with 506.15.

506.27 Touch-up and Repairs Perform touch-up and repairs in accordance with 506.16.

506.28 Handling and Storage Handle and store material in accordance with 506.17.

506.29- RESERVED

THERMAL SPRAY COATING

506.30 Description This work shall consist of surface preparation and application of Thermal Spray Coatings (TSC) in accordance with the Plans and this Specification. Application of TSC to steel substrate shall be done in accordance with requirements, recommendations and appendices of Joint Standard *NACE NO. 12/AWS C2.23M/SSPC-CS 23.00, Specification for the*

Application of Thermal Spray Coatings (Metallizing) of Aluminum, Zinc, and Their Alloys and Composites for the Corrosion Protection of Steel (The Standard) and this Specification.

The applicator shall have a minimum of five years experience and shall provide copies of application procedures, operator qualifications, QC Manuals and repair procedures.

506.31 Submittals Submit an application procedure and QC Plan for review by the Department prior to beginning work. Submit a certified analysis of the feedstock to the Department. Submit sample copies of QC records for review. Submit copies of applicator qualifications, job history, etc. Provide the name and qualifications of the QCI.

506.32 Surface Preparation Prior to abrasive blast cleaning, round all corners exposed in the assembled product to approximately a 3/32 inch radius. A series of tangents to the approximate radius will be considered acceptable. Abrasive blast clean all surfaces to be coated in accordance with the requirements of *SSPC-SP 5, White Metal Blast Cleaning* (SP 5). Use SSPC-VIS. 1 as a visual standard to determine acceptable cleanliness. Inspect the substrate immediately before spray application.

The anchor profile shall be 2.5-4.0 mils. Measure and record the anchor profile in accordance with *ASTM D4417 Method C (Replica Tape)* on each plane to be sprayed or at 120 ° intervals on pipe or tube. If the anchor profile fails to meet the minimum required profile, re-blast the substrate until the required anchor profile is achieved.

If compressed air is used for abrasive blast cleaning, perform a blotter test in accordance with *ASTM D4285* at the beginning of each shift. Empty moisture traps at the beginning of each shift and at any time thereafter when moisture appears to be present on the substrate. Notify the QAI prior to performing the test in order that the QAI can witness the blotter test.

506.33 TSC Requirements The coating thickness shall be between 14 mils and 17 mils. The DFT on faying surfaces shall not exceed the thickness tested for Class B slip coefficient rating. The TSC shall have a minimum tensile bond of 725 psi. Test the tensile bond in accordance with ASTM D4541. The frequency of testing shall be one test every 500 ft^2 or once per shift, whichever is less. The test location will be as directed by the QAI. The specified tensile force shall be applied to the TSC and removed. If the test does not reveal a failure of the TSC, the tensile bond shall be considered acceptable. Repair or recoat unacceptable work.

Perform a bend test as described The Standard, at the beginning of each shift. If the bend test fails, take corrective action and perform another test. After performing the bend test successfully a number of times, the Fabrication Engineer may reduce the frequency of testing. Document the results of the tensile bond test and bend test and provide the results to the Department.

The TSC shall have a uniform appearance, free from blistering, cracks, loose particles, or exposed steel substrate when examined with 10-X magnification.

506.34 TSC Application Record the batch and lot numbers of the consumables. Measure the environmental conditions in the immediate vicinity of the piece(s) being coated during the coating operation and during the entire cure period for intermediate and top coat. Provide two data loggers capable of measuring ambient humidity and temperature. The data loggers shall come with software that can download the data onto a computer. Print out the data and provide a copy to the QAI for review prior to applying the subsequent coat of paint. Place the data loggers in the immediate vicinity of the coating operation during the entire application and curing cycle. The data will be used to determine that the cure/recoat time requirements for each coat have been met. Failure to comply will result in the coating being cured for the maximum time necessary to assure adequate cure as determined by the Fabrication Engineer.

506.35 Seal Coat and Top Coat Application (Paint) Apply a wash primer and seal coat that contains pigmentation indicating uniformity of application. Top flanges of beams requiring shear connectors shall receive a flash/primer coat only. The seal coat shall be compatible with an epoxy intermediate coat and a polyurethane top coat from the NEPCOAT QPL. Provide certification of compatibility between the seal coat and intermediate coat from the intermediate coat/top coat manufacturer.

506.36 Materials Provide materials in accordance with 506.11.

506.37 Mixing and Application Mix and apply in accordance with 506.14.

506.38 Dry Film Thickness Measure and record the DFT in accordance with 506.15.

506.39 Touch-up and Repairs Repair damage to TSC by re-blasting the damaged area and re-applying TSC in accordance with this Specification. Perform touch-up and repairs to paint in accordance with 506.16.

FUSION BONDED EPOXY COATING

506.40 Description This work shall consist of surface preparation and application of Fusion-Bonded Epoxy (FBE) coating, in accordance with the Plans and this Specification, including measuring and documenting DFT and testing for holidays and other discontinuities in the epoxy coating. The FBE shall be applied to all surface areas indicated on the Plans.

Perform surface preparation and application of FBE in accordance with the following Specifications:

A. Steel pipe pile- *ASTM A972, Fusion Bonded Epoxy-Coated Pipe Pile*
B. H-pile and sheet pile- *ASTM A950, Fusion Bonded Epoxy-Coated Structural Steel H-Piles and Sheet Piling*
C. Reinforcing steel- *ASTM A775, Epoxy-Coated Steel Reinforcing Bars*

506.41 Materials The FBE coating shall meet all of the physical and testing requirements of the applicable Specifications above (including Annexes). Provide a certification that identifies

the coating, batch or lot number, date of manufacture and test results. Supply patching material from the same manufacturer.

506.42 Surface Preparation Prepare the surface(s) in accordance with applicable Specifications listed above. Grind all welds flush on spiral welded pipe pile prior to abrasive blast cleaning.

506.43 Inspection The DFT shall be between 12 mils and 20 mils, unless otherwise specified. Measure the DFT using a fixed-probe gauge in accordance with SSPC-PA 2. The testing procedure and reporting shall be in accordance with ASTM G12. The frequency of testing shall be each piece coated, unless a lesser frequency of testing is directed by the Fabrication Engineer.

After curing, the coating shall be checked for holidays (pinholes not visible to the unaided eye) using a 67½ Volt d-c, wet sponge, holiday, detector, in accordance with the requirements of ASTM G62, Test Methods for Holiday Detection in Pipeline Coatings. An average of more than five holidays per foot, in the coated length of a pile, will be cause for rejection of that pile.

506.44 through 506.59- RESERVED

506.60 Method of Measurement Protective coating shall be measured by the lump sum, complete and accepted. The coating limits shall be as shown or described in the Contract Documents.

506.61 Basis of Payment All work for Protective Coating will be paid for at the lump sum price for the respective item. Payment will be full compensation for all labor, materials and equipment required to complete the surface preparation and coating work, including, but not limited to, coating and cleaning materials, staging or accessing, testing, surface preparation, cleaning, application, curing and repairs.

Payment will be made under:

	Pay Items	Pay Unit
506.9102	Zinc Rich Coating System (Shop Applied)	Lump Sum
506.9103	Galvanizing	Lump Sum
506.9104	Thermal Spray Coating (Shop Applied)	Lump Sum
506.9106	Fusion Bonded Epoxy Coating	Lump Sum

SECTION 507 - RAILINGS

507.01 Description This work shall consist of furnishing all materials for, and construction of, bridge rail, handrail, and barrier mounted bridge rail in accordance with these specifications and the lines and grades shown on the Plans.

507.02 Materials Materials shall meet the requirements of the following Sections of Division 700 - Materials:

Steel Bridge Rail:	Structural Steel	713.01
	Preformed Pads	713.03
Aluminum Rail:	Preformed Pads	713.03
	Aluminum Railings	716.01

Pipe for Steel Pipe Hand Railing shall conform to the requirements of ASTM A53, Grade A or B.

507.03 Drawings The contractor shall prepare shop detail, erection, and other necessary Working Drawings in accordance with the requirements of Section 105.7, Working Drawings.

507.04 General Anchor bolts or anchor bolt sleeves shall be set with a template and shall be securely placed in their final position prior to the placement of the embedding concrete. Post anchor assemblies shall be installed to within $^{3}/_{16}$ inch of the theoretical horizontal and vertical location. No field drilling will be allowed to install anchor bolts without approval of the Resident. Post bearing areas shall be dressed smooth and true to grade. Prior to post erection, each rail post location shall be finished to the theoretical elevation determined from profile grade, cross slope and curb height and will not be acceptable until it is within $^{3}/_{16}$ inch of the theoretical elevation, as measured at the top of concrete. Preformed pads shall be used to adjust the rail posts for height and alignment. The number of preformed pads supplied shall be 10 percent more than the theoretical minimum number required. After erection of the railing, the Contractor shall clean the whole assembly, to present a neat and uniform appearance.

507.05 Steel Bridge Railing Steel railings shall be fabricated in accordance with the requirements of Section 504, Structural Steel. When called for on the Plans, railings shall be galvanized and/or coated in accordance with Section 506, Shop Applied Protective Coating-Steel.

Rail bars to be used on a radius of 1,000 feet, or less, shall be curved before the application of any galvanizing and/or coating. Bending tolerance from theoretical horizontal curvature shall be plus or minus ⅛ inch per yard, not to exceed ½ inch, total.

507.06 Steel Pipe Hand Railing Steel pipe hand railings shall be fabricated in accordance with the requirements of Section 504, Structural Steel. When called for on the Plans, railings shall be galvanized and/or coated in accordance with Section 506, Shop Applied Protective Coating- Steel.

507.07 Aluminum Bridge Railing Aluminum sections may be sheared, sawed, or milled. Cut edges shall be smooth and free of burrs.

Holes for rivets shall be drilled full size from the solid or sub punched and reamed.

Rivets shall be cold-driven in the "as-received" condition and the driven head shall be of the cone-point type.

Welding shall be done in conformance with the latest edition of AWS Structural Welding Code-Aluminum D1.2. No welding shall be performed before the approval of the appropriate weld procedures. No field welding is permitted.

To facilitate bending, aluminum extrusions of Alloy 6061-T6 or 6351-T5 may be heated to a maximum temperature of 400 degrees Fahrenheit for a period of not more than thirty minutes.

Threaded fasteners shall conform to the requirements of ANSI Standard B 1.1, Class 2A for external and Class 2B for internal threads.

507.08 Method of Measurement Railing will be measured as one lump sum unit, fabricated, delivered, erected, and accepted.

507.09 Basis of Payment Railing will be paid for at the contract lump sum price, complete in place. Payment for galvanizing and/or protective coating, when required, shall be included in the lump sum price.

Payment will be made under:

	Pay Item	Pay Unit
507.0811	Steel Bridge Railing, 2 Bar	Lump Sum
507.0821	Steel Bridge Railing, 3 Bar	Lump Sum
507.0831	Steel Bridge Railing, 4 Bar	Lump Sum
507.0841	Steel Pipe Hand Railing	Lump Sum
507.0846	Barrier Mounted Steel Bridge Rail: 1 Bar	Lump Sum
507.0848	Barrier Mounted Steel Bridge Rail: 2 Bar	Lump Sum
507.0951	Aluminum Bridge Railing, Pedestrians	Lump Sum
507.0961	Aluminum Bridge Railing, Pedestrian, with Pales	Lump Sum

SECTION 508 -WATERPROOFING MEMBRANE

508.01 Description This work shall consist of furnishing and applying an approved waterproofing membrane to concrete deck surfaces, or other concrete surfaces, with a barrier type membrane in accordance with this specification, other applicable Contract documents and the manufacturer's published recommendations, complete, in place and accepted. Waterproofing membrane shall be either peel and stick sheet waterproofing membrane (sheet

membrane) or torch or spray applied high performance waterproofing membrane (high performance membrane).

508.02 Materials Sheet membrane and high performance membrane shall include all materials, as recommended by the manufacturer, to produce a waterproof barrier on the specified concrete surface. In addition to the membrane, these materials may include primer, hot-applied rubberized asphalt sealer, mastic, flashing, aggregate scatter and tack coat. The list of acceptable sheet membrane products is included on the MaineDOT's Qualified Products List (QPL), under Waterproofing Membranes, under Prequalified Standard Systems. The list of acceptable high performance membrane products is included on the MaineDOT's QPL under Waterproofing Membranes, under Prequalified High-Performance Systems (Spray Applied and Torch Applied).

508.04 Construction- General The Contractor shall store and install the membrane and all associated components in accordance with the manufacturer's published recommendations.

Existing membrane waterproofing remaining on structures to be rehabilitated shall be completely removed to the primed surfaces. At the discretion of the Resident, tightly adhered membrane residue that cannot reasonably be removed by scraping using industry standard practices, may be left in place.

Prior to application of primer or installation of membrane: Concrete shall be cured in accordance with applicable Contract requirements; areas where rapid setting patching materials have been placed shall be cured for a minimum of 72 hours, or as recommended by the product manufacturer.

The entire surface of concrete structures specified to receive waterproofing membrane shall be shot blasted to achieve a surface which is clean and free of laitance, oil, grease and any foreign materials, as well as any sharp protrusions or sharp indentations. For superstructure decks, including, but not limited to, precast box beams, voided slabs, and NEXT beams, shot blasting shall be accomplished using self-contained, self-propelled equipment to achieve a consistent anchor profile; areas that are not accessible to self-propelled shot blasting equipment, as determined by the Resident, shall be blasted with appropriate equipment utilizing either mineral grit or steel grit and air pressure sufficient to achieve an acceptable surface profile. Surfaces of structures other than superstructure decks, such as box culverts or arches, that are to receive waterproofing membrane may be high-pressure (minimum of 8,000 psi) water blasted or sandblasted, in lieu of being shot blasted, as approved by the Resident. The Contractor shall have a copy of Technical Guideline No. 03732, published by the International Concrete Repair Institute. The final concrete surface profile shall range between a CSP 1 and a CSP 5, as defined by this Guideline, or as approved by the membrane manufacturer's representative. All surfaces shall then be cleaned to remove all loose dust and debris.

Priming and membraning shall only be done when the air and concrete temperatures are above 40 degrees Fahrenheit and the surfaces that are to receive the primer and membrane have a moisture content at, or below, 6 percent. Primer or membrane shall not be applied or installed

until the concrete has been in place for a minimum of 10 days. The Contractor shall supply a portable electronic moisture meter capable of measuring the moisture content of concrete surfaces in percent. The list of acceptable moisture meters is included on the MaineDOT's QPL under Waterproofing Membranes. The moisture meter shall be calibrated annually and a certificate of calibration from the moisture meter manufacturer shall accompany the meter. The Contractor shall perform moisture testing of the concrete substrate using the Contractor-provided moisture meter. Moisture tests shall be performed at locations determined by, and in the presence of, the Resident. Written test results shall be submitted to the Resident prior to beginning the priming and membraning operations.

Membrane shall be installed in a shingled pattern so that water is permitted to drain to the low areas of the structure without accumulating against seams, and pressed or rolled into place to assure bond with the primed surface and to eliminate air bubbles. Lap joints at the beginning and end of rolls shall be staggered with those of adjacent rolls. All overlapping joints shall be sealed in accordance with the manufacturer's recommendations.

Care shall be taken to ensure that the waterproofing membrane is properly sealed around the one inch diameter superstructure deck drains and that the drains are completely opened prior to paving over them. Any drainage slots in the bridge drains shall be opened both before and after placing the bituminous pavement.

Waterproofing membrane over which hot mix asphalt (HMA) pavement will be placed shall receive a bituminous tack coat, in accordance with Standard Specification Section 409, with a coverage rate of between 0.01 and 0.02 gallons per square yard. Alternately, if a membrane manufacturer recommends its own tack coat as part of its waterproofing system, then this tack material shall be applied in accordance with the manufacturer's recommendations. Prior to tacking, the membrane shall be clean and free from loose debris, moisture or other contaminants. Membrane surfaces that have been tacked shall be paved within 48 hours of application of the tack coat.

The required laydown temperature of HMA pavement placed on high performance membrane shall be within the tolerances included in the membrane manufacturer's written recommendations, with the target temperature to be at the high end of the given range, but not to exceed 330 degrees Fahrenheit, measured at the HMA pavement plant. Paving operations shall be done in a manner to permit water to drain to the low area of the deck without entrapment. No vehicles, other than the HMA paving equipment, will be permitted on the membrane prior to placing the HMA pavement. The first layer of HMA pavement placed on a superstructure deck shall be placed with an approved rubber mounted bituminous paver of such type and operated in such a manner that the waterproofing membrane will not be damaged in any way. Paving equipment wheels and tires shall be clean and free from stones or other material that could penetrate the membrane. The tack coat and HMA pavement may be applied immediately after the membrane is installed. For high performance membrane, the primer and membrane shall be applied by a manufacturer certified applicator. Applicators shall be individuals who have been thoroughly trained by the manufacturer, in all aspects of application of the membrane system. Although an individual may be certified as both an applicator and a representative, the

individual shall not serve in both capacities at the same time. Upon certification, the manufacturer shall issue a badge to the applicator that includes the manufacturer's name and logo, a current photograph of the applicator, the applicator's full name and the word "Applicator". The text of the badge shall be clearly printed in English. The applicator shall have the badge on and prominently displayed at all times, while installing the membrane system.

The Contractor shall arrange for a manufacturer's representative to be present at all times during the installation of high performance membrane, including application of the primer and tack coat. The representative shall also be present for placement of the HMA binder course over the membrane. The representative shall be readily identified by a photo identification badge, issued by the manufacturer, that includes the manufacturer's name and logo, a current photograph of the representative, the representative's full name and the word "Representative". The text of the badge shall be clearly printed in English. The representative shall have the badge on and prominently displayed at all times, while overseeing this work.

Overlap of side seams and end laps and application procedures not addressed by this specification shall be done in accordance with the membrane manufacturer's published recommendations. Torn or damaged membrane shall be repaired in accordance with manufacturer's recommendations. Blistering of membrane at any time prior to Final Acceptance shall be repaired in accordance with the manufacturer's recommendations. At least one week prior to installation of any waterproofing membrane, the Contractor shall submit the manufacturer's written requirements pertaining to overlapping of seams, application procedures, repairing of damaged membrane and treatment of blistering of the membrane, including treatment of blistering either before, during or after the first lift of HMA pavement is placed on the membrane, to the Resident.

508.05 Installation- Sheet Membrane All construction joints and all joints between precast concrete elements (e.g., box culverts, three-sided boxes, arches, box beams, voided slabs) shall be double covered with membrane by first applying a sheet with a minimum width of 12 inches, centered along the joint.

The perimeter of all membrane placed in a given day's operation shall receive a seal of mastic over the edge of the membrane. Areas around drains or protrusions shall be liberally coated with mastic at the edges. When the membrane is completed, the perimeter shall receive an additional seal of mastic along the edge of the membrane.

508.06 Installation- Torch Applied High Performance Membrane The waterproofing membrane shall be heat welded onto the prepared substrate. Care shall be taken to assure that the membrane is completely bonded to the primed surface. The Contractor shall be responsible for protection of adjacent areas. Machines used to apply membrane shall be fully functional, including thermostats.

When the surface area of a superstructure deck is greater than 8,000 square feet, the membrane shall be machine applied. The machine shall be capable of handling rolls of at least

100 square yards, shall be self-propelled and shall be capable of automatically following the edge of previously placed membrane.

Corner detail at edge of superstructure slab/vertical surfaces (e.g., curb or permanent barrier): Membrane material or special flashing shall be installed in corners, in accordance with the manufacturer's recommendations, to within ½ inch of the top of the HMA wearing surface. In the absence of a manufacturer's recommended flashing or if the manufacturer does not recommend bending membrane material to conform to this corner configuration, then the following procedure shall be used: The membrane shall be heat welded to the slab to within one inch of the vertical surface; the vertical surface shall be protected to prevent damage or permanent discoloring of the vertical surface; the remaining area between the edge of the membrane and the vertical surface shall be completely sealed with hot-applied rubberized asphalt material, meeting the requirements of the membrane manufacturer's recommendations; the hot-applied rubberized asphalt material shall be applied so as to form a complete seal between the membrane and the vertical surface and shall extend up the vertical surface to within ½ inch of the top of the HMA wearing surface.

Corner detail at end of superstructure slab/vertical surface (e.g., backwall): The waterproofing system shall be placed on vertical surfaces, at the ends of slabs, down the vertical face, a minimum of one foot, unless otherwise shown on the Plans.

All joints between buried precast concrete elements (e.g., box culverts, three-sided boxes, arches) shall be double covered with membrane by first applying a strip with a minimum width of 12 inches, centered along the joint.

For superstructure decks: Immediately prior to application of the tack coat, the entire surface of the membrane shall be rolled with a rubber tired roller and any blisters found in the membrane shall be repaired with guidance from the manufacturer's representative, as per the manufacturer's recommendations; similarly, if blisters appear during or after placement of the first lift of HMA pavement, the membrane shall be repaired with guidance from the manufacturer's representative, as per the manufacturer's recommendations.

508.07 Installation- Spray Applied High Performance Membrane Spray applied membrane shall be installed in accordance with the manufacturer's recommendations.

Corner detail at edge of superstructure slab/vertical surfaces (e.g., curb or permanent barrier): The waterproofing system shall be placed to within ½ inch of the top of the HMA wearing surface.

Corner detail at end of superstructure slab/vertical surface (e.g., backwall): The waterproofing system shall be placed on vertical surfaces, at the ends of slabs, down the vertical face, a minimum of one foot, unless otherwise shown on the Plans.

Aggregate scatter shall be applied to the final coat of membrane, in accordance with the manufacturer's recommendations. Materials for aggregate scatter shall be in accordance with the manufacturer's requirements.

508.08 Method of Measurement Waterproofing Membrane will be measured for payment as one lump sum.

508.09 Basis of Payment Waterproofing Membrane will be paid for at the Contract lump sum price, which shall be payment in full for furnishing all materials, labor and equipment, including cleaning of concrete surfaces and providing a moisture meter, and all incidentals necessary to provide a waterproof barrier on the specified concrete surface that is properly adhered to the concrete substrate. Tack coat provided as part of the waterproofing membrane manufacturer's system shall be included in the lump sum price for waterproofing membrane; bituminous tack coat provided in accordance with Standard Specification Section 409, Bituminous Tack Coat, shall be paid for under Item 409.15, Bituminous Tack Coat, Applied. Payment for repair of surfaces to which membrane is to be applied shall be paid for separately, when applicable repair items are included in the Contract. Damage to new concrete surfaces, resulting from the Contractor's placement or curing operations, or any damage caused by the Contractor's operations shall be repaired at no cost to the Department.

Payment will be made under:

Pay Item		Pay Unit
508.13	Sheet Waterproofing Membrane	Lump Sum
508.14	High Performance Waterproofing Membrane	Lump Sum

SECTION 509 -STRUCTURAL PLATE PIPES, PIPE ARCHES, ARCHES, AND METAL BOX CULVERTS

509.01 Description This work shall consist of furnishing and installing structural plate pipes, pipe arches, arches, and metal box culverts in accordance with these specifications and in reasonably close conformity with the lines and grades shown in the Contract Documents.

509.02 Materials Material shall meet the requirements of the following Sections of Division 700 - Materials:

Asphalt Filler for Structural Plate Arches	702.09
Steel Structural Plate Pipe, Pipe Arches, Arches, Box Culverts and Fasteners	707.09
Aluminum Alloy Structural Plate Pipe, Pipe Arches, Arches, Box Culverts and Fasteners	707.14

509.03 Fabrication Structural plate pipes shall be circular with a vertical elongation of approximately 5 percent, unless otherwise specified on the Plans.

Plates shall be formed to provide lap joints for bolted assembly. Joints shall be staggered so that no more than three plates come together at one point.

Bolt holes shall be made so that all plates having like dimension, curvature and the same number of bolts per foot of seam shall be interchangeable. Each plate shall be curved, before assembly, to the radius necessary to produce the final cross section called for.

End plates shall be neatly cut to the skew and slope shown on the Plans. Burnt edges shall be free of oxide and burrs, and shall be completely galvanized. Special plates and part plates shall be legibly marked to correspond to markings on an erection/assembly diagram, which shall be furnished by the Contractor. The Contractor shall prepare and submit Shop Drawings, erection/assembly diagrams, or other necessary Working Drawings in accordance with Section 105.7. These drawings will be reviewed and approved in accordance Section 105.7.

Bolt holes along those edges of the plates that will form longitudinal seams in the finished structure shall be staggered in 2 rows, 2 inches apart for steel structural plates and shall be in 2 rows, 1¾ inch apart for aluminum structural plates. Holes shall be in the valley and crest of the corrugations. Bolt holes along those edges of the plates that will form circumferential seams in the finished structure shall be no more than 12 inches apart. The distance from the center of a hole to the edge of the plate shall not be less than 2 times the diameter of the bolt. The nominal diameter of the bolt holes, not including corner holes in the longitudinal seam, shall be ⅛ inch greater that the diameter of the bolts.

509.04 General Excavation for the structure and for the bedding material shall be in conformance with Section 206 - Structural Excavation.

Structures shall be assembled in the sequence and manner recommended by the manufacturer and in such a way that no distortion of plates would occur. Bolts of the manufacturer's recommended length shall be used in all holes. Nuts shall be tightened to 200 foot-pounds, plus or minus 100 foot-pounds, of torque. Aluminum nuts, used with aluminum structural plate structures, shall be tightened to 125 foot-pounds, plus or minus 10 foot-pounds of torque. Any nuts loosened by subsequent procedures shall be retightened.

The Contractor shall provide the Resident with a calibrated torque wrench for use during construction. The Contractor shall provide proof to the Resident that the torque wrench has been calibrated within the past six months.

Steel plates or accessory materials, on which the zinc metallic coating has been burned by welding or has otherwise been damaged in fabrication or handling, shall be repaired in the field. The Resident shall determine if repairs are needed to the coating and will mark the areas to be repaired. The damaged areas shall be cleaned to bright metal by blast cleaning, power disk sanding, or wire brushing. The cleaned areas shall extend ½ inch into the undamaged section of the coating. The cleaned areas shall be coated within 24 hours of the cleaning using an

approved zinc-rich paint. The zinc-rich paint shall be applied to a dry film thickness of at least 0.005 inch over the damaged sections and surrounding cleaned areas.

The Contractor shall maintain a minimum cover of 3 feet over the top of the structure where construction equipment is used, or traffic is maintained.

509.05 Structural Plate Pipes and Pipe Arches The use of cofferdams and dewatering of the stream will not be a requirement for the installation of pipes and pipe arches unless otherwise specified in the Contract Documents. Prior to placing the structure or any plates, the bed shall be brought to the required line and grade and shaped to its required section, as much as practicable. When practicable, the pipe or pipe arch shall be moved back and forth longitudinally on the bedding material to shape and compact the bedding material prior to releasing the structure in its final position. The bedding material and structure shall not be placed at times of high water. The Contractor shall obtain approval before placing the bedding material and the structure.

The specified bedding material may be omitted if the existing material under the pipe is suitable.

When not otherwise specified in the Contract Documents, backfill shall be a selected material of a granular nature with a minimum of clay. It shall contain neither frozen material, vegetable matter nor anything that will not pass through a 3 inch square opening screen. The 3 inch size limitation shall not apply to areas 5 feet or more from the structure.

Fill material shall be deposited evenly on both sides of the structure in layers not exceeding 6 inches in depth, loose measure, until the three-quarter point is reached. It shall be thoroughly compacted under the pipe or pipe arch, on both sides of the structure. Above the three-quarter point, fill layers shall not exceed a depth of 8 inches, loose measure. Backfilling and compacting shall be done in the presence of the Resident.

509.06 Structural Plate Arches Structural plate arches shall be anchored to the concrete substructure by unbalanced channels, as shown on the Plans. When erection is complete and before any backfilling is done, the spaces between the structural plates and the legs of the unbalanced channels, on both sides, shall be completely filled with asphalt filler. Aluminum channels used with aluminum structural plate structures shall not be in direct contact with concrete. An appropriate material, approved by the Resident, shall be used between the aluminum channel and the concrete.

When backfilling arches before headwalls are built, a narrow ramp of backfill material shall be built up evenly at each side of the arch and midway between its ends until a minimum cover of 3 feet over the top of the arch is reached. The backfill material used in the ramps shall be thoroughly compacted as it is placed. The remainder of the backfill shall be deposited from the top of the ramp, both ways from the center toward the ends as evenly as possible on the sides of the arch.

If the headwalls are built before the arch is backfilled, the same procedure as above shall be followed, except that the backfill material shall first be placed in the form of a narrow ramp adjacent to one headwall. When the aforementioned height above the arch is reached, the backfill material shall be deposited from the top of the ramp toward the other headwall.

In all cases, the filling material shall be thoroughly, but not excessively, compacted. Compacting the backfill by means of flooding or ponding the material with water will not be permitted.

509.07 Structural Plate Box Culverts Box culverts shall be assembled in accordance with the Shop Drawings provided by the manufacturer and per the manufacturer's recommendations. The box culverts shall be installed in accordance with the Contract Documents and the manufacturer's recommendations. End treatments and the type of invert and/or foundation shall be as indicated on the Plans. The Contractor shall use caution during backfilling operations so that any anchor rods attached to the headwalls and wingwalls are not damaged.

Structural plate box culverts on concrete substructures shall be anchored to the substructure by unbalanced channels as shown on the Plans. When erection is complete and before any backfilling is done, the spaces between the structural plates and the legs of the unbalanced channels, on both sides, shall be completely filled with asphalt filler meeting the requirements of 702.09. Aluminum channels used with aluminum structural plate structures shall not be in direct contact with concrete. An appropriate material approved by the Resident shall be used between the aluminum channel and the concrete.

509.08 Method of Measurement Structural plate pipe, pipe arches, arches and plate box culverts will be measured as one lump sum.

509.09 Basis of Payment The accepted structure will be paid for at the respective Contract lump sum price, which price shall be full compensation for: Preparation of the bed for pipes and pipe arches; the asphalt filler and unbalanced channel for arches and metal box culverts; the horizontal end reinforcing ribs for aluminum alloy structural plate pipe and pipe arches; the headwalls, wingwalls, toewalls, full metal invert and/or footing pads for metal box culverts; anchor bolts embedded in concrete; the receiving channels for metal box culverts on concrete substructures; and all incidental items required to complete the work, including, but not limited to, the calibrated torque wrench for use by the Resident.

Reinforced concrete headwalls and wingwalls are not included for payment under this item.

Whenever the minimum cover material extends above the subgrade line, the removal of the material which is necessary to complete the work in accordance with the Plans will be measured and paid for as Common Excavation as provided in Section 203 - Excavation and Embankment.

Payment will be made under:

	Pay Item	Pay Unit
509.11	Steel Structural Plate Pipe	Lump Sum
509.12	Steel Structural Plate Pipe Arch	Lump Sum
509.13	Steel Structural Plate Arch	Lump Sum
509.141	Steel Structural Plate Box Culvert	Lump Sum
509.18	Aluminum Alloy Structural Plate Pipe	Lump Sum
509.19	Aluminum Alloy Structural Plate Pipe Arch	Lump Sum
509.20	Aluminum Alloy Structural Plate Arch	Lump Sum
509.411	Aluminum Structural Plate Box Culvert	Lump Sum

SECTION 510 - SPECIAL DETOURS

510.01 Description This work shall consist of the design, construction, maintenance in good condition and removal of temporary structures and approaches required for the satisfactory maintenance of vehicular and pedestrian traffic.

Easements or right-of-way for the Special Detour will be furnished by the Department and will be shown on the Contract Plans. If the Contractor proposes an alternative location for the Special Detour, and the alternative location is approved by Department, that easement may only be acquired by the Department. All additional costs associated with the acquisition, including, but not limited to, obtaining easements, environmental mitigation, restoration and Department time, shall be borne by the Contractor.

510.02 Materials Materials used for the Special Detour structure and approaches shall conform to the detailed plans and specifications submitted by the Contractor.

510.03 Vehicular and Pedestrian Traffic Not Separated The Special Detour shall be located as close as practicable to the new Work, or as shown on the Plans.

The Special Detour, including the temporary structure and approaches, shall be designed and sealed by a Professional Engineer, licensed in accordance with the laws of the State of Maine. The Contractor shall submit the design computations and detailed plans of the temporary structure and approaches that will serve as the temporary detour to the Resident prior to beginning construction of the Special Detour.

If the Department requires changes to Temporary Detour plans or computations, based on Contract requirements, then the Contractor shall implement the changes at no additional cost to the Department.

The Department shall have no obligation to review or comment on any design, construction, maintenance or removal of Temporary Detours. No review or comment by the Department, or any lack of review or comment by the Department, shall relieve the Contractor of its responsibility to properly design, construct, maintain in good condition, and remove Temporary Detours in accordance with the Contract, or shall shift any responsibility to the Department. The Contractor shall be responsible for all damages resulting from the failure of temporary structures or approaches.

The Special Detour shall not be opened to traffic until the Contractor's Professional Engineer inspects the temporary structure and provides the Department with a signed and sealed document certifying that the structure was built in accordance with the previously submitted sealed plans and design details of the structure and approaches.

510.031 Structure Design Temporary structures shall be designed in accordance with the AASHTO Standard Specifications for Highway Bridges, 17th Edition, 2002, or the current edition of AASHTO LRFD Bridge Design Specifications, except as noted herein, to meet live load requirements of HS25 for ASD and LFD, or HL-93, Maine Modified, for LRFD designs.

a. Deflections Primary structural members shall be designed so that deflection due to live load plus impact shall not exceed 1/300 of the span.

b. Fatigue Stresses Fatigue stresses for steel need not be considered if the steel is judged by the Contractor's Professional Engineer to be in sound structural condition.

c. Bridge Railing Loads Bridge railing shall be designed in accordance with AASHTO Standard Specifications, 17th Edition, 2002 or the current edition of AASHTO LRFD Bridge Specifications, except that the Standard Specification design load "P", specified as 10 kips, may be decreased to 5 kips. However, allowable design stresses for material used in bridge rails and posts shall not be increased above those allowed by AASHTO Standard Specifications.

d. Waterway Opening The minimum waterway opening of the temporary structure shall be designed to pass the Design Discharge indicated in the Contract Specifications, without any overtopping of the roadway.

e. Foundations Temporary foundations, embankment foundations and earth retaining structures shall be designed in accordance with the AASHTO Standard Specifications, 17th Edition, or the current edition of the AASHTO LRFD Bridge Design Specifications and AASHTO LFRD Bridge Construction Specifications, except as noted herein. The Contractor is responsible for determining the ultimate load carrying capacity of the foundation materials and foundation elements for the Special Detour. The determination of the ultimate load carrying capacity may require characterization of the subsurface conditions by the Contractor by means of subsurface investigation.

The applied loads on foundations shall consider both dead and live loads and all other applicable loads and forces. The Contractor is responsible for choosing an applicable factor of safety for foundations on soil and rock and an appropriate design load group. The factor of safety and maximum applied load, or LRFD factored applied loads and factored geotechnical resistances, used for each foundation design shall be clearly stated on the submitted calculations.

510.032 Geometric and Approach Design The geometric design of the Special Detour, except as otherwise shown on the Plans or as noted herein, shall be designed in accordance with the current AASHTO Specification "A Policy on Geometric Design of Highways and Streets".

a. Horizontal Alignment Horizontal curve radius shall not be less than 200 feet at the centerline of roadway, except as otherwise shown on the Plans.

Roadway width as indicated in the Contract shall be the minimum clear travel width between faces of bridge curbs, bridge rails or approach rails, whichever is less. The approach roadway shall have 2 feet wide shoulders, minimum, to the roadway berms, where guardrail is not required, in addition to the roadway width indicated in the Contract.

The roadway width shall be increased on curved portions of the Special Detour to account for the off tracking characteristics of a WB-62 vehicle in accordance with Exhibit 3-49, Case I or Case III, of the AASHTO Standard Specifications.

b. Vertical Alignment Grades shall not exceed 10 percent and any change in grade shall accommodate all legal highway vehicle components or attached loads.

c. Approach Road Guardrail The Special Detour approaches shall have guardrail where side slopes are steeper than three horizontal to one vertical. Approach guardrail shall be attached to the bridge rail in a manner that develops the approach guardrail in tension. Approach guardrail shall consist of Type 3 guardrail or an approved equal, unless other rail or barriers are specified.

The termination of approach guardrail and the end treatment of the rail shall be in accordance with the current AASHTO Roadside Design Guide.

d. Approach embankments The earth material used for approach embankments shall have sufficient strength under the placement method specified in the Contractor’s plans to maintain stability throughout the duration of the Special Detour.

e. Approach Road Base Drainage The approach road base structure shall consist of a 1 foot thick layer, minimum, of aggregate subbase course gravel, Type D or E. This layer shall be designed to support legal loads during the use of the detour. Drainage shall be designed to drain the approach area.

f. Approach Road Surface The approach road surface, including the shoulders, shall be paved with a 3 inch, minimum, thickness hot bituminous pavement layer, except when specified to be a gravel surface. When a gravel surface is specified, it shall consist of an approved gravel.

g. Design Speed The design speed of the Special Detour shall be not less than the construction area posted speed limit, or the advisory speed limit, as applicable, unless otherwise indicated in the Contract.

510.04 Pedestrian Traffic Only The provisions of Section 510.03 - Vehicular and Pedestrian Traffic Not Separated, shall apply to this Section with the following modifications:

a. Structures shall be designed for a live load of 85 lb/ft^2.
b. The Special Detour shall have a minimum clear width of 5 feet or as specified in the Contract.
c. Vertical alignment and ramps shall be ADA compliant.
d. Deflections due to live load shall not exceed 1/300 of the span.

510.05 Vehicular and Pedestrian Traffic Separated The provisions of both Section 510.03 - Vehicular and Pedestrian Traffic Not Separated, and Section 510.04- Pedestrian Traffic Only, shall apply to this Section. If vehicles and pedestrians are carried on the same structure, each shall have its own lane as specified. The pedestrian lane shall be protected from vehicular traffic by being at least 9 inches above the roadway surface or suitably protected by means of an adequate curb at least 9 inches in height above the roadway surface. No bridge rail will be required between vehicle traffic and pedestrian traffic, unless otherwise specified, but shall be located at the exterior side of the sidewalk.

510.06 Special Detour Construction The Special Detour, including temporary structures and approaches, shall be constructed in accordance with the plans submitted by the Contractor. Barricades, warning signs, lights and other traffic control devices shall be provided in accordance with the Contract and the approved Traffic Control Plan.

The temporary structure's deck and floor members shall be fastened or anchored so that all contact surfaces with adjacent supporting members bear continuously. If timber plank decking is used, it shall be secured into timber nailer strips with screw-type nails, or securely fastened by an alternate method that will prevent the decking from loosening. Immediate corrective action shall be taken by the Contractor to remedy any condition in the structure that results in objectionable or distractive noise levels, or results in the decking becoming loose, when subject to traffic loads.

Screw-type nails will not be required to anchor timber plank decking for pedestrian traffic use.

The approach road surface, including shoulders, whether paved or graveled, shall be maintained in a compacted and smooth condition. The temporary structure travel surface shall

be constructed and maintained in an acceptably smooth condition, as determined by the Resident. Immediate corrective action shall be taken by the Contractor to remedy objectionable roughness of the Special Detour riding surface.

Provisions shall be made for a skid resistant wearing surface throughout the period of time the temporary structure is open to public travel for vehicular and pedestrian traffic. A steel grid floor may be used for vehicular traffic if installed in accordance with the design plans and these specifications.

Erosion control shall be accomplished in accordance with Section 656 - Temporary Soil Erosion and Water Pollution Control.

When the Project has been opened to traffic, the temporary structure and approaches shall be removed to, or below, the streambed, finish ground line or original ground line, as applicable. The approaches shall be obliterated and the disturbed areas shall be stabilized to original, or better than original, conditions. The provisions of Section 104 - General Rights and Responsibilities, shall apply.

510.07 Contractor's Responsibility The Contractor shall be responsible for removal of snow from areas provided for pedestrian traffic as well as vehicular traffic in accordance with Section 105, General Scope of Work. In addition to normal maintenance, should any part, or all, of the Special Detour be damaged or destroyed by high water, or any other cause, prior to, or after, opening the Special Detour to traffic, it shall be repaired or replaced by the Contractor without additional compensation.

510.08 Method of Measurement Special Detours will be paid by the lump sum.

510.09 Basis of Payment The accepted Special Detour will be paid for at the Contract lump sum price which price shall be full compensation for the respective items, as called for in the Contract, including design, construction, maintenance, complete removal, rehabilitation and permanent stabilization including loaming, seeding and mulching. All gravel or borrow material and excavation needed to accommodate changes in elevation between temporary structures and existing roadways shall be incidental to this item. The lump sum price shall also include the cost of furnishing and revising, as necessary, all plans, computations and certifications, as called for in the Contract. Payment will be made as follows: 60 percent of the lump sum price will be paid when the Special Detour is acceptable and open to traffic; another 20 percent of the lump sum price will be paid when the Special Detour is no longer needed and is closed to traffic; the final 20 percent of the lump sum price will be paid when the Special Detour is removed and the area encompassing the Special Detour is acceptably restored.

Traffic control devices, temporary erosion control, pavement, and dust control will be paid for in accordance with the applicable Contract items.

Payment will be made under:

	Pay Item	Pay Unit
510.10	Special Detour, ___ foot Roadway Width Vehicular and Pedestrian Traffic Not Separated	Lump Sum
510.11	Special Detour, Pedestrian Traffic Only	Lump Sum
510.12	Special Detour, ___ foot Roadway Width Vehicular and Pedestrian Traffic Separated	Lump Sum

SECTION 511- COFFERDAMS

511.01 Description This work shall consist of the complete design, construction, maintenance and removal of cofferdams and other related work, including dewatering and inspection, required to allow for the excavation of foundation units, to permit and protect the construction of bridge or other structural units and to protect adjacent Roadways, embankments or other structural units, in accordance with the Contract.

511.02 Materials As specified in the cofferdam Working Drawings.

511.03 Cofferdam Construction

A. Working Drawings. The Contractor shall submit Working Drawings, showing the materials to be used and the proposed method of construction of cofferdams to the Department. Construction shall not start on cofferdams until such Working Drawings have been submitted. Any review of or comment on, or any lack of review of or comment on, these Working Drawings by the Department shall not result in any liability upon the Department and it shall not relieve the Contractor of the responsibility for the satisfactory functioning of the cofferdam.

B. Construction. Construct cofferdams in conformance with the submitted Working Drawings. Cofferdams shall, in general, be carried below the elevation of the bottom of footings to adequate depths to ensure stability and adequate heights to seal off water. Cofferdams shall be braced to withstand pressure without buckling, secured in place to prevent tipping or movement and be as watertight as necessary for the safe and proper construction of the substructure Work inside them. With the exception of construction of a concrete foundation seal placed under water, the interior dimensions of cofferdams shall provide sufficient clearance for the construction and inspection of forms and to permit pumping outside of forms. The Contractor shall be responsible for the righting and resetting of cofferdams that have tilted or moved laterally, as required for construction.

During the placing and curing of seal concrete, maintain the water level inside the cofferdam at the same level as the water outside the cofferdam, to prevent flow through the concrete.

No timber or bracing shall be used in cofferdams in such a way as to remain in the substructure Work.

Cofferdams shall be constructed to protect fresh concrete against damage from the sudden rising of the water body, to prevent damage by erosion and to prevent damage to adjacent Roadways, embankments or other structural units.

Unless otherwise noted, cofferdams, including all sheeting and bracing involved, shall be removed after the completion of the substructure work in a manner that prevents disturbance or injury to the finished Work.

Cofferdams shall be constructed, dewatered and removed in accordance with the requirements of Section 656 - Temporary Soil Erosion and Water Pollution Control and related Special Provisions.

C. Inspection of Seal Cofferdams. Seal cofferdam excavations shall initially be inspected and approved by the Contractor.

For each seal cofferdam excavation, the Contractor shall submit a written procedure to the Resident for sediment/overburden removal and excavation inspection. For cofferdams where seal concrete is to be placed on bedrock, the inspection procedure shall describe the Contractor's final cleaning and inspection process for attaining cleanliness of each cofferdam excavation. For cofferdams where seal concrete is not excavated to bedrock, the procedure shall describe the Contractor's final cleaning and inspection process for attaining the bottom of seal elevation shown on the Plans.

The Contractor shall notify the Resident at least 48 hours prior to when each seal cofferdam excavation will be ready for final inspection by the Department. The Contractor shall allow adequate time for each occurrence of cofferdam excavation inspection by the Department. The Contractor shall provide and maintain access and equipment, such as steel probes, for the Resident and/or the Department's Dive Team to independently inspect each cofferdam excavation.

No seal concrete placement shall begin until the Department has approved the cofferdam excavation.

511.04 Pumping Pumping from the interior of any cofferdam shall be done in such a manner as to prevent any current of water that would carry away or segregate the concrete.

Pumping to dewater a sealed cofferdam shall not commence until the seal concrete has set sufficiently to withstand the hydrostatic pressure and meets the following minimum curing time, after the completion of the installation of the seal concrete:

1. When the temperature of the water body outside the cofferdam is greater than 40 degrees Fahrenheit, a minimum of 5 days.

2. When the temperature of the water body outside the cofferdam is less than 40 degrees Fahrenheit, a minimum of 7 days.

Procedures for the removal of all water and materials from cofferdams shall be described in the Soil Erosion and Water Pollution Control Plan as required in Section 656 Temporary Soil Erosion and Water Pollution Control and related Special Provisions.

511.05 Method of Measurement Cofferdams will be measured as one lump sum unit, as indicated on the Plans or called for in the Contract.

511.06 Basis of Payment The accepted quantity of cofferdam will be paid for at the Contract lump sum price for the respective cofferdam items, which price shall be full compensation for design, construction, maintenance, inspection and removal.

When required, the elevation of the bottom of the footing of any substructure unit may be lowered, without change in the price to be paid for cofferdams. However, if the average elevation of more than 25 percent of the area of the excavation is more than three feet below the elevation shown on the Plans, and if requested by the Contractor, then the additional costs incurred that are included in the cofferdam Pay Item will be paid for in accordance with Section 109.7, Equitable Adjustments to Compensation and Time. The Contractor shall immediately notify the Department when these additional costs commence. Failure of the Contractor to provide this notification will result in undocumented additional work that will be non-reimbursable. The Department will evaluate this additional work to determine an appropriate time extension, if warranted.

All costs for sedimentation control practices, including, but not limited to, constructing, maintaining, and removing sedimentation control structures, and pumping or transporting water and other materials for sedimentation control will not be paid for directly, but will be considered incidental to the cofferdam Pay Item(s).

All costs for related temporary soil erosion and water pollution controls, including inspection and maintenance, will not be paid for directly, but will be considered incidental to the cofferdam Pay Item(s).

All costs associated with preparation of Working Drawings, design calculations, written procedure for sediment/overburden removal and excavation inspection, and the inspection of the seal cofferdam excavation shall be considered incidental to the cofferdam Pay Item(s). There shall be no additional payment for repeated inspection by the Department of the same cofferdam excavation.

All costs for cofferdams and related temporary soil erosion and water pollution controls, including inspection and maintenance, will be considered incidental to related Pay Items, when a specific Pay Item for cofferdams is not included in the Contract.

Seal concrete will be evaluated under Section 502.

Payment will be made under:

Pay Item	Pay Unit
511.07 Cofferdam	Lump Sum

SECTION 512 - FRENCH DRAINS

512.01 Description This work shall consist of furnishing, placing and compacting stone and gravel and furnishing and placing erosion control geotextile for French drains in accordance with these specifications and in reasonably close conformity with the lines and grades shown in the Contract.

512.02 Materials. Materials shall meet the requirements of the following Sections of Division 700, Materials.

Aggregate for Subbase	703.06(b)
Gravel Borrow	703.20
Stone for French Drains	703.24
Erosion Control Geotextile	722.03 (Class 1)

Gravel for French drains shall meet the requirements of either Aggregate for Subbase, Type D, or Gravel Borrow, at the Contractor's option.

512.03 Drains Stone shall be placed behind and against the structures with the bottom of the stone at the elevation of the flow line of the weeper drains. The stone shall form a box section, 2 feet wide and 2 feet high, for the entire length of the structure. Erosion control geotextile shall be installed to separate the stone box section from the surrounding gravel. Installation of the erosion control geotextile shall be in accordance with Section 620, Geotextiles. Gravel shall be placed to form a box section around the stone, to the limits of 2 feet above the stone, 2 feet behind the stone and 2 feet below the stone, but not to be placed below the top of the footing.

Gravel for French drains shall be compacted to the same requirements as the adjacent embankment.

512.04 Method of Measurement French drains will be measured as one lump sum unit, satisfactorily placed and accepted.

Excavation for French drains will be measured for payment in accordance with Section 206, Structural Excavation.

512.05 Basis of Payment French drains will be paid for at the Contract lump sum price, complete in place.

Payment will be made under:

Pay Item		Pay Unit
512.081	French Drains	Lump Sum

SECTION 513 - SLOPE PROTECTION

513.01 Description This work shall consist of excavating for, and placing of, a protective covering on designated slopes in accordance with these specifications and in reasonably close conformity with the lines, grades and thickness as shown in the Contract.

513.02 Materials Materials shall meet the requirements of the following Sections of Division - 700 Materials.

Crushed Stone	703.31
Reinforcing Steel	709.01

Portland cement concrete for slope protection shall be Class "A" and shall meet the requirements of Section 502 - Structural Concrete.

513.03 Portland Cement Concrete The slope on which the reinforced concrete for slope protection is to be placed shall be free of frost and frozen material and shall be well compacted. If additional fill material is required to bring the slope to the proper grade, it shall be of the same type material as that required for the slope protection foundation. Immediately prior to placing the concrete, the area to be covered shall be thoroughly dampened.

The Portland cement concrete shall be placed in alternate sections. Each individual section shall be placed by starting at the lowest extremity of the section and progressing upward on the slope. The reinforcement shall not extend through the construction joints and the bond between sections shall be broken by the application of approved asphalt cement on the edges of the previously placed slabs.

The surface of the concrete shall be float finished in accordance with the requirements of Section 502 - Structural Concrete and textured by applying a uniform light broom finish using an approved broom. An edging tool shall be used on the surface edges of each section and a groover at the transverse centerline of each section. The exterior surface from the edging or grooving shall be finished to match the interior surface.

Construction procedures shall be in accordance with Section 502 - Structural Concrete.

513.04 Crushed Stone Crushed stone shall be placed on granular material as shown on the Plans. The finished slope shall be worked to present a smooth and uniform surface.

513.05 Drains or Weep Holes Drains or weep holes through the slope protection shall be pipe of the size and shape shown on the Plans and shall be constructed of approved cast iron, tile, fiber or other material that will maintain its shape and alignment during placement of the concrete. Care shall be taken not to cover the drains when installed, or when concrete is placed.

513.06 Method of Measurement Slope protection will be measured by the number of square yards of surface area acceptably covered in accordance with the Contract.

513.07 Basis of Payment The accepted quantity of slope protection will be paid for at the Contract unit price per square yard. Payment will be full compensation for excavating, shaping and compacting the slope prior to placing bedding and slope protection and shall also include the bedding material. Excavating from original ground to the face of the slope protection will be paid under the appropriate Contract item.

Payment for Portland cement concrete slope protection shall be full compensation for furnishing and placing all material, including reinforcement, and for all labor and other incidentals, including drains and weep holes, necessary to complete the work.

Payment will be made under:

	Pay Item	Pay Unit
513.09	Slope Protection-Portland Cement Concrete	Square Yard
513.22	Crushed Stone Slope Protection	Square Yard

SECTION 514 - CURING BOX FOR CONCRETE CYLINDERS

514.01 Description This item shall consist of furnishing, installing, operating, and maintaining an approved thermostatically controlled curing box for concrete test cylinders, with the equipment as herein specified.

514.02 General The curing box shall be for the sole use of the Resident for the duration of the Contract. The Contractor shall relocate the curing box to a new location, as directed, whenever considered necessary during the progress of the Work. The Contractor shall furnish and maintain the electrical power and all utility connections necessary for the operation of the curing box. The Contractor shall monitor and maintain the internal temperature and water level of the box. The Resident shall be provided with two locks, each with two keys, to be used with the two securing latches. A lock for the switch box, with two keys shall be furnished, as well.

514.03 Construction Details The curing box shall be constructed with double walls separated by two inches of rigid foam insulation and shall have minimum internal dimensions of 42 inches long by 18 inches wide by 18 inches deep. The top of the curing box shall be an insulated lid hinged at the back with at least two securing latches on the front, suitable for sealing and locking the curing box. A moisture-proof seal shall be provided between the lid and

the body of the curing box. Handles shall be provided at the ends of the box for use in moving the box.

The curing box shall be constructed so that the required temperature and humidity within the box can be maintained using an immersible heating element (minimum of 1,000 watts), when the heating element is immersed in water, approximately 4 inches in depth, at the bottom of the box. The heating element shall be located to provide free access for cleaning and for adequate circulation of the surrounding water. The cylinders shall be supported so that they will not come in direct contact with the pool of water and that there will be free circulation of air above the water and around the cylinders. A drain shall be provided at the base of the box to allow draining of the water from the box. The electrical utility connection to the source of power shall be made in a lockable switch box that is securely attached to one end of the curing box.

All electrical connections from the curing box to the utility connection shall conform to the latest requirements of the NEC. When the curing box is outside and exposed to the weather, all wiring and fittings shall be of the weatherproof type. The curing box shall be effectively grounded.

An approved bimetallic thermometer shall be installed that will measure the internal temperature of the curing box and that can be read from the outside without having to open the box.

The curing box shall be suitable for maintaining an internal temperature of 70 degrees Fahrenheit, plus or minus 5 degrees Fahrenheit.

514.04 Method of Measurement Curing box for concrete cylinders will be measured by each unit, furnished and satisfactorily maintained.

514.05 Basis of Payment The accepted quantity of curing box for concrete cylinders will be paid for at the Contract unit price each, which payment shall be full compensation for furnishing and maintaining, for all materials, labor, tools, equipment, electrical power, temporary utility changes and adjustments, and all necessary incidentals. At the completion of the Contract, the curing box shall remain the property of the Contractor.

Payment will be made under:

	Pay Item	Pay Unit
514.06	Curing Box for Concrete Cylinders	Each

SECTION 515 - PROTECTIVE COATING FOR CONCRETE SURFACES

515.01 Description This work shall consist of furnishing and applying a protective coating on concrete surfaces as called for on the Plans or as designated by the Resident in accordance with these specifications and the manufacturer's published recommendations.

515.02 Materials Materials shall meet the requirements of Type 1c penetrating silane concrete sealers, from the MaineDOT Qualified Products List (QPL).

515.03 Surface Preparation On surfaces to be treated, all voids shall be filled with mortar and the entire surface shall be dressed by dry rubbing to remove form marks and blemishes to present a neat appearance. The concrete shall remain dry for at least 48 hours before treatment and shall be free of laitance, oil, grease, dirt, dust, curing compound or any other deleterious materials. All traces of dust shall be removed immediately before applying the silane sealer.

The treatment shall not be done until at least 14 days after casting the concrete, or in accordance with the manufacturer's published recommendations, and completed at least 24 hours before the treated portion is opened to traffic.

515.04 Application The application rate and method of application shall be in accordance with the manufacturer's published recommendations.

When practical, treatment of the concrete surfaces shall be completed before exposure to deicing salts. The temperature of the concrete to be treated shall be above 40 degrees Fahrenheit at the time of application, or per the manufacturer's published recommendations.

515.05 Method of Measurement Protective coating for concrete surfaces will be measured for payment by the square yard or lump sum unit as specified, satisfactorily applied and accepted.

515.06 Basis of Payment Protective coating for concrete surfaces will be paid for at the contract unit price per square yard or lump sum, as specified.

Payment will be made under:

	Pay Item	Pay Unit
515.20	Protective Coating for Concrete Surfaces	Square Yard
515.21	Protective Coating for Concrete Surfaces	Lump Sum

SECTION 516 - STYRENE-BUTADIENNE LATEX MODIFIED PORTLAND CEMENT MORTAR AND CONCRETE

Reserved

SECTION 517 - SHOTCRETE

Reserved

SECTION 518 - STRUCTURAL CONCRETE REPAIR

518.01 Description This work shall consist of repairing existing structural concrete as shown on the Plans and/or as directed by the Resident. Repairing structural concrete shall include removal and disposal of deteriorated concrete, cleaning exposed reinforcing steel, cleaning of concrete surfaces in repair areas, application of bonding agent and placing and curing repair material. All work shall be in conformance with applicable provisions of Sections 202, 502, and 503.

Upward Facing Surfaces are defined as any concrete surfaces where the slope is less than or equal to 15 percent from the horizontal. Overhead Surfaces are defined as any concrete surfaces where the slope is overhanging more than 15 percent from plumb. All other surfaces shall be defined as Vertical Surfaces.

518.02 Repair Materials A material from the Department's Qualified Products List (QPL) of concrete patching materials may be used instead of concrete for any depth of placement, at the Contractor's option, providing that all requirements of the manufacturer's published recommendations are met. All materials used for repair of concrete or reinforcing steel shall meet the applicable requirements of Division 700 as specified in Standard Specification Sections 502 and 503, respectively. When concrete is used as the repair material, it shall conform to the requirements of Table 1 of Section 502.05 for Class A Concrete.

Where the depth of placement is less than 1 inch, the repair material used shall be one of the products listed on the Department's QPL of concrete patching materials.

Where the depth of placement is equal to or greater than 1 inch, the Contractor may use concrete as the repair material. When concrete is used, the coarse aggregate shall conform to the requirements of the following tables.

	Thickness of Placement		
Coarse Aggregate Gradation Designation	1 to 3 inches	3 to 6 inches	> 6 inches
SP-1-7	x		
SP-1-78	x		
SP-2-8	x		
SP-2-89	x		
Class AA		x	
Class A or AA		x	x

Coarse Aggregate Gradation Designation	Sieve Designation Percent By Weight Passing a Square Mesh Sieve							
	¾ in	½ in	⅜ in	No. 4	No. 8	No. 16	No. 50	No.200
SP-1-7	100	90-100	40-70	0-15	0-5	-	-	0-1.5

SP-1-78	100	90-100	40-75	5-25	0-10	0-5	-	0-1.5
SP-2-8		100	85-100	10-30	0-10	0-5	-	0-1.5
SP-2-89		100	90-100	20-55	5-30	0-10	0-5	0-1.5

A bonding material shall be used for bonding fresh concrete or patching material to existing hardened concrete. The bonding material shall consist of the following, except that, in the case where patching materials from the QPL are used in the repair areas, the manufacturer's published recommendations regarding application and use of bonding materials shall take precedence:

a) For repair of Upward Facing Surfaces, the bonding grout shall have Portland cement and fine aggregate proportioned 3 to 1, respectively, by volume. The fine aggregate shall be from the same source as that used in the repair concrete. All material greater than ⅛ inch shall be removed from the fine aggregate. The sand and cement shall be measured separately in equal sized containers. The sand shall be added prior to the cement. Water shall be added during the mixing process a little at a time until sufficient water has been added to result in a workable consistency. A workable consistency is defined as the minimum water necessary to allow flow of most of the grout without segregation of the grout ingredients. Alternately, the Contractor may use a product from the Department's QPL of concrete bonding agents, in accordance with the manufacturer's published recommendations.

b) For repair of Vertical and Overhead Surfaces, the Contractor shall use a product from the Department's QPL of concrete bonding agents, in accordance with the manufacturer's published recommendations.

518.03 Removal of Unsound Concrete Removal of existing concrete shall be accomplished without damage to the portion of the structure that is to remain. The deteriorated or delaminated concrete shall first be removed from areas designated by the Resident. The initial classification of an area as sound concrete does not prevent its subsequent reclassification upon further inspection. After the initial removal of unsound concrete, the Resident shall inspect the area again to determine whether additional areas of unsound concrete were revealed by removal operations and if additional concrete removal is required in the areas to be repaired. This process shall continue until additional areas of unsound concrete are not revealed. After the Resident has determined that the deteriorated concrete has been completely and satisfactorily removed, the perimeter of each cavity created by the removal of concrete shall be saw cut to a minimum depth of ⅝ inch, unless a lesser depth is required to avoid reinforcing steel. The saw cut shall be approximately perpendicular to the original surface. Edges of the cavity shall not be feathered.

Unless otherwise approved by the Resident, the equipment used for removal of unsound concrete shall be chipping hammers weighing a maximum of 35 pounds and only chisel point bits will be allowed.

The surface area and depth of removal for concrete repairs shall be subject to the approval of the Resident.

Deteriorated concrete shall be removed to one of the following depths, whichever is greatest:

a) Sound substrate.

b) To the minimum depth required per the manufacturer's recommendations, when a material from the Department's QPL for concrete patching materials is used.

c) To the minimum depth indicated in the Thickness of Placement Table, when concrete is used, depending on the coarse aggregate gradation.

d) When reinforcing steel is exposed or encountered, the minimum depth shall be 1 inch behind reinforcing steel for Upward Facing Surfaces and 1-½ inches behind reinforcing steel for Vertical and Overhead Surfaces.

518.04 Reinforcing Steel All existing reinforcing steel exposed by concrete removal, which is to remain in the structure , shall be cleaned of all loose rust by sand blasting, wire brushing, machine wire brushing or other methods approved by the Resident. Where reinforcing steel is to remain in the structure, care shall be taken to prevent damage to the reinforcing steel or its bond to the surrounding concrete.

All existing main reinforcing steel which is broken, or has lost 25 percent, or more, of its original cross sectional area, shall be supplemented with new reinforcing steel. The total area of supplemental bars plus existing bars with section loss shall have the same total area as the original bar. Supplementary reinforcing steel shall be lap spliced a minimum length of 30 bar diameters for bars with section loss of up to 75 percent of the original bar area, and per Section 503, Reinforcing Steel, for all other bars. Reinforcing steel shall be wired to the existing steel or, where designated by the Resident, the existing reinforcing steel shall be cut and supplementary reinforcing steel spliced in with tension couplers.

518.05 Surface Preparation The surfaces to receive repair material shall be free of oil, solvent, grease, dirt, loose particles and foreign matter. Cleaning of repair areas shall be performed by sandblasting or other methods approved by the Resident. All surfaces receiving new material are to be sandblasted not more than 36 hours ahead of the placement of the repair material, or as per the bonding agent manufacturer's recommendations. Any sandblasted areas that have been rained on, exposed to high humidity or fog, or contaminated in any other manner shall be sandblasted again before the repair material is applied. All debris from the cleaning operations shall be thoroughly removed from the cleaned surfaces and adjacent areas using compressed, dry, air, prior to the application of repair materials. All air compressor lines used for cleaning of repair areas shall be equipped with effective oil traps.

518.06 Application of Bonding Agent When bonding grout is used on repair of upward facing surfaces the following shall apply, except that, in the case where concrete patching

materials from the Department's QPL are used in the repair areas, the manufacturer's published recommendations regarding application and use of bonding materials shall take precedence. Once a workable consistency has been reached, additional water shall not be added. The grout must be used or discarded within 30 minutes of the time water is added to the mix. The grout shall be applied no greater than ⅛ inch thick with stiff bristled, nylon, street brooms. The Contractor shall prevent the grout from drying by beginning the grout application immediately prior to the concrete placement and limiting the area of grout application ahead of concrete placement. If the grout begins to dry prior to concrete placement, additional grout may be brushed on the area as directed by the Resident. Should the grout become thoroughly dry it shall be removed by sand blasting or other methods as approved by the Resident.

When a bonding agent from the Department's QPL is used, the product shall be applied in accordance with the manufacturer's published recommendations.

518.07 Placing Repair Materials When concrete is used as the repair material the provisions of Section 502 shall apply. Additionally, concrete shall not be placed when either the ambient air temperature or the existing concrete temperature is below 45 degrees Fahrenheit. When a patching material is used, the Contractor shall follow the manufacturer's published recommendations for mixing and placing the material.

Forms shall be erected to the neat lines of the existing structure and the new concrete placed. For overhead and vertical repair areas, sufficient concrete shall be removed to ensure that air within the area to be patched can effectively escape during the placement of the repair material.

518.08 Curing Curing of concrete shall conform to the requirements of Section 502. For Overhead and Vertical Surfaces, curing compounds may be used, in accordance with the manufacturer's requirements. Patching materials shall be cured in accordance with the manufacturer's published recommendations.

518.09 Inspection The Contractor shall make provisions to allow safe access to the work for the Resident in order to inspect the work, facilitate ongoing inspection of the work and to measure the work for payment purposes.

518.10 Method of Measurement Repair of structural concrete is divided into repair areas less than 8 inches in depth and repair areas 8 inches in depth or greater. The repair depth shall be considered the average thickness of an individual repair area. The Resident shall make the final determination as to whether the average depth of repair is less than 8 inches, or 8 inches or greater.

Concrete repair will be measured for payment by the square foot of all surfaces repaired where the average depth of repair is less than 8 inches, complete and accepted.

Concrete repair will be measured for payment by the cubic yard for all repairs where the average depth of repair is 8 inches or greater, complete and accepted. The quantity will be

determined from the theoretical yield of the design mix, or in the case of transit mixed concrete, by delivery ticket, as directed by the Resident.

Supplementary reinforcing steel will be measured for payment by the pounds of steel provided and installed and paid for under Item 503.12, Reinforcing Steel, Fabricated and Delivered, and Item 503.13 Reinforcing Steel, Placing, respectively, except that Reinforcing Steel, Placing, will be measured for payment as 1.5 times the actual number of pounds placed. Reinforcing steel required to supplement reinforcing steel damaged by the Contractor shall be supplied and installed at the Contractor's expense.

Tension couplers will be measured for payment as the number of splices satisfactorily installed and accepted. Payment will be made under Item 503.17, Mechanical/Welded Splices. Couplers required to repair reinforcing steel damaged by the Contractor shall be provided and installed at the Contractor's expense.

Temporary support beams or girders required to repair bridge seats or pier caps will be paid for separately, as approved by the Resident.

518.11 Basis of Payment The repair of structural concrete will be paid for at the contract unit price as indicated in the Schedule of Items for the respective Contract item involved.

The following will be included in the unit price for the respective concrete items, complete and accepted: Removal of existing concrete; cleaning of existing reinforcing steel to remain in the structure; cleaning of existing concrete surfaces in repair areas; furnishing and installing bonding materials; providing, installing and removal of all formwork; furnishing and placing new concrete or other approved concrete patching materials in areas where existing concrete is removed; curing of concrete or patching materials; disposal of all demolition material and debris.

Payment for any staging, platforms or lifts required by the Contractor to gain access to the work in order to perform the work, or to provide access to the Resident in order to inspect or measure the work, shall be considered incidental to related Contract items unless the Contract provisions specify separate payment for such access devices.

Fabrication, delivery and placing of reinforcing steel, and mechanical couplers if required, will be paid for under separate Contract items.

The payment for each Contract item will also be full compensation for furnishing all materials, labor, equipment, and all other incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
518.50 Repair of Upward Facing Surfaces- to Reinforcing Steel	Square Foot

	< 8 inches	
518.51	Repair of Upward Facing Surfaces- below Reinforcing Steel < 8 inches	Square Foot
518.52	Repair of Upward Facing Surfaces ≥ 8 inches	Cubic Yard
518.60	Repair of Vertical Surfaces < 8 inches	Square Foot
518.61	Repair of Vertical Surfaces ≥ 8 inches	Cubic Yard
518.70	Repair of Overhead Surfaces < 8 inches	Square Foot
518.71	Repair of Overhead Surfaces ≥ 8 inches	Cubic Yard

SECTION 519 - VACANT

SECTION 520 - EXPANSION DEVICES - NON-MODULAR

520.01 Description This work shall consist of furnishing and installing expansion devices including the seals, anchorage system and curb, sidewalk expansion dams and barrier sliding plates, where required, as shown on the Plans, in accordance with these specifications and per the seal manufacturer's published recommendations.

Seals for expansion devices shall be either gland seals or compression seals as specified on the Plans.

520.02 Materials Materials shall meet the requirements specified in the following Sections of Division 700 - Materials:

Expansion Device - Gland Seal	
Stud Shear Connectors, Anchors and Fasteners	711.06
Structural Steel	713.01
High Strength Bolts	713.02
Steel Extrusions	713.08
Elastomer for Seal Elements	714.01
Lubricant Adhesive	714.03
Gland Type Seals	714.06

Expansion Device - Compression Seal	
Stud Shear Connectors, Anchors and Fasteners	711.06
Structural Steel	713.01
High Strength Bolts	713.02
Elastomer for Seal Elements	714.01
Lubricant Adhesive	714.03
Sealant	714.04
Compression Seals	714.05

Gland and compression seals shall be of the general configuration as shown on the Contract documents and shall be one of the seals listed on the Department's Qualified Products List.

520.03 Fabrication All work shall conform to the applicable provisions of Section 504-Structural Steel.

The Contractor shall submit Working Drawings in accordance with Section 105.7, Working Drawings.

Seals shall be furnished and installed in one continuous length and splices will not be allowed, except as specified hereafter.

As received from the supplier of the seal, seals may contain one splice for each continuous length of 50 feet or greater. Sections under 50 feet long shall not have any splices. Splices at abrupt angular changes in horizontal alignment will be allowed. Splices in gland type seals shall be shop vulcanized by the seal supplier. Splices in compression seals may be either vulcanized or adhesive bonded. At abrupt angular changes in vertical alignment, the lower 75 percent of the depth of compression seals may be cut to allow short radius bends.

520.04 Protective Coating The expansion device, including the curb and sidewalk expansion dams and barrier sliding plates, shall be galvanized in accordance with the requirements for Protective Coatings in Section 504, Structural Steel. The galvanizing on the metal surfaces in direct contact with neoprene seals shall be lightly sandblasted to a dull gray appearance in order to promote a high strength bond between the seal and mating surface, and for smoothness for installation purposes. Alternately, this galvanized surface may be prepared to the manufacturer's published recommendations for installation and bonding of seals.

When specified on the Contract Plans, reinforcing steel shall be anchored into drilled holes.

520.05 Delivery Unless otherwise specified on the Plans, expansion devices shall be shipped fully assembled and shall be installed as a unit. The unit shall be equipped with shipping and temperature adjustment devices approved by the Fabrication Engineer, and shall be preadjusted, in the fabrication facility, to the opening required at 45 degrees Fahrenheit.

520.06 Installation Expansion Devices shall be erected following placement of the structural deck slab. The devices shall be lowered into the blocked-out area of the deck slab, adjusted for the temperature in accordance with the Plans and Working Drawings, set to the proper height and fastened in place, in accordance with the Standard Details. Once the expansion devices are set in their final positions, all shipping and temperature adjustment apparatuses shall be removed and the concrete for the slab and abutment backwall blocked-out area shall be placed immediately.

Seal elements shall be installed in accordance with the manufacturer's recommendations, using equipment manufactured specifically for the purpose of installing the seal elements. The equipment shall not cause structural damage to either the seal or the joint armor and shall not

twist, distort or cause other malformations in the installed seal element. Any perforation or tearing of a seal element due to installation procedures or construction activities will be cause for rejection of the installed seal element, requiring replacement by the Contractor at no cost to the Department.

Immediately prior to the installation of the seal element, the metal contact surfaces of the joint armor shall be clean, dry, and free of oil, rust, paint, or foreign material. Unless otherwise recommended by the seal manufacturer, the contact surfaces of the seal element shall be cleaned with normal butyl-acetate, using clean rags or mops, immediately prior to application of the lubricant-adhesive or sealant. The lubricant adhesive or sealant shall be applied to the seal element and joint armor contact surfaces at the rate recommended by the manufacturer of the seal.

The exposed ends of compression seals shall be sealed with appropriately shaped pieces of foam rubber, bonded in place with sealant as described in Section 714.04, Sealant, or a bonding agent approved by the Resident.

520.07 Method of Measurement Expansion devices will be measured by each unit, complete in place and accepted. Each unit shall consist of one pair of matching elements, including anchorage system, seal, shipping and temperature adjustment devices, curb and sidewalk expansion dams and barrier sliding plates, as required.

520.08 Basis of Payment The accepted quantity of expansion devices will be paid for at the Contract unit price each, which shall be full compensation for all materials including anchorage system, protective coating, equipment, labor and incidentals necessary for furnishing and installing the expansion devices and, if required, curb and sidewalk expansion dams and barrier sliding plates.

Payment will be made under:

Pay Item		Pay Unit
520.21	Expansion Device - Gland Seal	Each
520.22	Expansion Device - Compression Seal	Each

SECTION 521 - FINGER JOINT AND FABRIC TROUGH/FABRIC CURTAIN

521.01 Description This work shall consist of fabricating and installing finger joint expansion devices and fabric troughs or fabric curtains when required, including the anchorage system, curb and sidewalk expansion dams, barrier sliding plates as required, support components for fabric troughs or curtains when required, and any metal downspout(s) and/or chute(s) used to guide the discharge from the trough(s) when required, and all necessary

materials and equipment required to complete the work as shown on the Plans and in accordance with these specifications.

521.02 Materials - Finger Joints Plates requiring a non-skid surface shall conform to the requirements of ASTM A786 or ASTM A36. Other plates shall conform to the requirements of ASTM A36 or ASTM A572. Shapes shall conform to the requirements of ASTM A500, Grades A and B, or ASTM A992. Other weldable steels may be used with approval of the Fabrication Engineer. Anchor studs shall conform to the requirements of Section 711.06, Stud Shear Connectors, Anchor and Fasteners. Bolts shall conform to the requirements of AASHTO M169 (ASTM A325).

521.03 General All work shall conform to the applicable provisions of Section 504, Structural Steel. Completed expansion devices and any required support components for troughs or curtains, expansion dams, barrier sliding plates, downspouts and chutes shall be hot dipped galvanized to the requirements of AASHTO M111 (ASTM A123). Anchorage parts encased in concrete may be supplied in the ungalvanized condition.

Each expansion device shall be shipped fully assembled, shall be installed as a unit, and shall be equipped with shipping and temperature adjustment devices approved by the Resident. When a project is built in stages, and if desired by the Contractor, the expansion device may be shipped in two or more sections, as approved by the Fabrication Engineer, with appropriate provisions for field splicing.

521.04 Materials- Fabric Trough or Curtain The fabric for the trough or curtain shall be ⅛ to $^{3}/_{16}$ inch in thickness and shall consist of a single layer of 14.6 ounce woven nylon fabric, or the equivalent in multiple layers of woven nylon fabric, laminated between two or more layers of neoprene rubber. The neoprene shall conform to the following requirements:

Physical Properties:

Grade (Duro)	60
Original Physical Properties	60 +/- 5
Hardness ASTM D2240	
Tensile Strength, Minimum	850 psi
ASTM D412	
Elongation at Break, Minimum Accelerated	300%
Test to Determine Long Term Aging Characteristics	
Oven Aged - 70 Hours/212ºF, ASTM D573	
Hardness, Points Change, Maximum	+15
Tensile Strength, Change, Maximum	-15%
Elongation at Break, Change, Maximum	-40%
Ozone - 1 PPM in Air by Volume 20% Strain	No cracks
100 +/- 2ºF - ASTM D1149*	100 hours

(*Samples shall be solvent wiped before test to remove any traces of surface impurities.)	
Compression Set - 22 Hours/ /212ºF	
ASTM D395 - Method B, 0/0 Maximum	35%
ASTM D746 - Procedure B	-40ºF
Brittleness at No Failure	
Fluid Resistance - ASTM D471	
70 Hours/212ºF in ASTM Oil No. 3	
Change in volume, Maximum	+120%
Change in tensile strength, Maximum	-70%
Change in ultimate elongation, Maximum	-55%

The finished fabric shall have a minimum breaking strength of 700 pounds/inch when tested by ASTM Test Method D5034. The minimum breaking strength shall be determined on a sample taken transverse to the centerline of the trough, or a random sample taken from the curtain.

When delivered to the job site, each separate length, roll or container shall be clearly tagged or marked with the manufacturer's name, trade mark and lot number. A lot is defined as that amount of fabric manufactured at one time from one batch of elastomer. A batch is defined as that amount of elastomer prepared and compounded at one time.

Not less than thirty days prior to the installation of the trough, a sample length of each lot of fabric, not less than 3 feet long, shall be submitted to the Resident for testing. All samples shall be taken from the lot(s) to be furnished, shall be tagged for identification purposes and shall be furnished to the Resident, at no additional cost to the Department. Approval of the material must be obtained before the material is incorporated in the work.

521.05 Fabrication The Contractor shall submit Working Drawings in accordance with Section 105.7, Working Drawings. These drawings shall include, but not be limited to, the following information: The complete details of the method, materials and equipment proposed to be used in the installation operation. Such details shall give complete specifications and details of the elastomeric trough or curtain, and other data pertaining to the installation operation.

Installation holes shall be cut round and cleanly with a sharp tool. Holes having jagged or roughly cut edges will be cause for rejection of the trough or curtain unit.

521.06 Construction of Fabric Trough Where a splice is required for staged construction, the upper section of the trough shall be fitted inside the lower section of the trough in such a manner that any water spillage through the splice shall be eliminated.

521.07 Method of Measurement Expansion Device - Finger Joint will be measured by each unit, complete in place and accepted. Each unit shall consist of one pair of matching devices

including anchorage system, curb and sidewalk expansion dams, barrier sliding plates as required, and, if shown on the Plans, trough or curtain components, downspouts and chutes.

Fabric Trough or Fabric Curtain for Finger Joint will be measured for payment by each unit complete in place and accepted.

521.08 Basis of Payment The accepted quantity of Expansion Device - Finger Joint will be paid for at the Contract unit price each, which payment shall be full compensation for all materials including anchorage system, curb and sidewalk expansion dams, barrier sliding plates, trough or curtain support systems, downspouts and chutes, galvanizing, equipment, labor and incidentals necessary for furnishing and installing the expansion devices and expansion dams. The accepted quantity of Fabric Trough or Fabric Curtain for Finger Joint will be paid for at the Contract price each, complete in place and accepted, which price shall include all materials, equipment, tools, labor and incidentals necessary for furnishing and installing the trough or curtain.

Payment will be made under:

Pay Item		Pay Unit
521.23	Expansion Device - Finger Joint	Each
521.32	Fabric Trough for Finger Joint	Each
521.33	Fabric Curtain for Finger Joint	Each

SECTION 522 - EXPANSION DEVICES - MODULAR

522.011 Description This work shall consist of furnishing and installing shop fabricated modular expansion devices. This shall include, but not be limited to, neoprene seal elements, steel transverse dividers and end channels, support bars and bearings, anchorages, sidewalk, median and curb expansion dams and barrier slide plates, all as specified herein or specified in the Contract documents.

522.012 Materials Materials shall meet the requirements specified in the following Sections of Division 700 - Materials:

Stud Shear Connectors, Anchor and Fasteners	711.06
Structural Steel	713.01
High Strength Bolts	713.02
Steel Extrusions	713.08
Lubricant Adhesive	714.03
Gland Type Seals	714.06

All steel divider bars, end channels and support bars shall conform to the requirements of ASTM A572 Grade 50 Steel. Other steel plates shall conform to the requirements of ASTM

A36 or ASTM A572. Shapes shall conform to the requirements of ASTM A500, Grades A and B, or ASTM A992. Other weldable steels may be used with the approval of the Fabrication Engineer. The entire assembly, unless otherwise indicated on the Contract Plans, shall be hot dip galvanized in conformance with AASHTO M111 (ASTM A123). All miscellaneous materials such as stainless steel sliding surfaces, bearings, etc. shall be as recommended by the manufacturer, and as approved by the Fabrication Engineer. The manufacturer shall submit full information on material specifications and dimensional data for approval.

522.013 Design The modular expansion devices shall incorporate divider bars, end channels, divider bar supports, seals, a system to maintain the seals at a substantially equal spacing at all times, and joint armor incorporating a support system for the divider bar supports and an anchoring system for fixing the expansion device to the supporting concrete. The expansion devices shall be capable of accommodating the movements specified in the Contract Documents.

The system maintaining the seal spacing shall be subject to prior approval by the Fabrication Engineer and shall be a design that does not employ a rigid scissor-type mechanical system. The seal spacing system shall at all times exert a positive control force, and shall have a certain amount of flexibility to absorb shock loads such as snowplow impacts.

The sealing elements shall be gland type seals, and shall be fabricated with lugs or other protrusions designed to have a positive interlocking action with the divider bars. Sealing elements that are continuous over the full width of the joint, and require a clamping element to fix the sealing element to the top surface of the divider bar(s), will not be accepted. The minimum joint opening between adjacent divider bars shall be ½ inch, and the maximum joint opening shall be 3-½ inches.

The divider bars and end channels shall be extruded or rolled shapes, designed to positively interlock with the sealing elements, and capable of sustaining all vertical and horizontal loads imposed by the traffic.

The divider bar supports shall be supported on the joint armor in a manner incorporating sufficient flexibility to absorb vertical shock loads.

The divider bars, divider bar supports and associated bearings, hardware, etc. shall be designed in accordance with the AASHTO LRFD Bridge Design Specifications. The manufacturer shall submit computations and data to verify appropriate load carrying capacity and said computations shall show conformance to all applicable requirements, including fatigue criteria, of the AASHTO LRFD Bridge Construction Specifications.

522.014 Fabrication The expansion joints shall be shop assembled in accordance with the manufacturer's recommendations and in conformance with the details shown in the Contract Documents and in these specifications.

All work shall be in accordance with the applicable provisions of Section 504, Structural Steel. Twenty-five percent of full penetration welds shall be inspected by ultrasonic (UT) or radiographic (RT) examination. Twenty-five percent of fillet welds and partial penetration welds shall be inspected by magnetic particle method (MT). Acceptance criteria shall be in accordance with the AWS D1.5 Bridge Welding Code. All shop welding shall be completed to the greatest extent possible before the steel is galvanized. Any welds to be made after the steel is galvanized shall be identified on the Shop Drawings. Steel surfaces welded subsequent to galvanizing shall be repaired to the requirements of ASTM A780 and Annexes A1, A2 or A3. The dry film thickness shall be within the range of 3 mils to 5 mils. Damaged areas of the galvanizing shall be similarly treated.

The galvanizing on the metal surfaces in direct contact with the neoprene seals shall be lightly sandblasted to a dull gray appearance to provide a high strength bond between the seal and mating metal surfaces, and to provide an appropriate surface smoothness for installation. Alternately, this galvanized surface may be prepared per the manufacturer's published recommendations for installation and bonding of the seals.

Seal elements shall be furnished and shop installed in one continuous length. Splices in seals will be permitted at abrupt changes in horizontal alignment. Abutting surfaces of splices shall be shop-vulcanized together.

The Contractor shall submit computations, Shop Drawings, erection drawings, and other Working Drawings in accordance with Section 105.7, Working Drawings.

The fabricated expansion device shall be preset by the manufacturer, before shipment, to the dimensions for 45 degrees Fahrenheit. Hardware for leveling, shipping and adjusting the device shall be supplied as part of the assembled expansion device. Final width adjustments of the prefabricated expansion device shall be made in the field, immediately prior to the final concrete placement.

522.015 Delivery Modular expansion devices shall be delivered to the job site in one unit, fully assembled. No field joints will be allowed, unless shown on the Contract Documents, or approved by the Fabrication Engineer before shop fabrication.

522.016 Installation Following completion of the structural deck slab, the expansion devices shall be installed in the blocked out portion of the slab and abutment backwall. Following final adjustment, the device shall be permanently fixed in place, all shipping and adjustment devices shall be removed, surfaces shall be repaired as specified in Section 522.014, Fabrication, and concrete shall be placed to complete the deck slab and backwall to the lines and grades shown on the Contract Documents.

522.017 Method of Measurement Modular Expansion Devices will be measured by each unit, complete in place and accepted. Each unit shall consist of a modular expansion device, including anchorage system, seals, shipping and temperature adjustment devices, curb, sidewalk and median expansion dams and barrier sliding plates, as required.

522.018 Basis of Payment The accepted quantity of Modular Expansion Devices will be paid for at the Contract unit price each, which payment shall be full compensation for all materials, equipment, labor and incidentals necessary for furnishing and installing the expansion devices, curb, sidewalk and median expansion dams and barrier sliding plates, as required.

Payment will be made under:

	Pay Item	Pay Unit
522.06	Modular Expansion Devices	Each

SECTION 523 - BEARINGS

523.01 Description This work shall consist of designing, furnishing, testing and installing bearings in accordance with this specification and in conformance with the details shown on the Plans.

523.02 Materials

Elastomer	711.11
Stainless Steel	711.12
Polytetrafluoroethylene (PTFE)	711.13
Structural Steel	713.01
Preformed Pads	713.03
Bronze or Copper-Alloy Bearing and Expansion Plates	713.04
Anchor Rods	720.07

Miscellaneous materials, caulking or lubricant shall be as recommended by the manufacturer of the bearings.

523.03 Submittals The Contractor shall prepare shop detail, erection and other necessary Working Drawings in accordance with Section 105.7, Working Drawings. The drawings will be reviewed in accordance with the applicable requirements of Section 105.7. Changes and revisions to the reviewed Working Drawings shall require further review by the Fabrication Engineer.

523.04 General Requirements Requirements for the type of bearing furnished are as follows:

Steel Bearings	Sections 523.10 thru 523.19
Elastomeric Bearings	Sections 523.20 thru 523.29
Pot or Disc Bearings	Sections 523.30 thru 523.39
Spherical Bearings	Sections 523.40 thru 523.49

Design of bearings shall be in accordance with AASHTO LRFD Bridge Design Specifications and AASHTO/NSBA Steel Bridge Collaboration G9.1 Steel Bridge Bearing and Design Guidelines.

523.05 Fabrication Steel fabrication work, for all types of bearings, shall comply with Section 504, Structural Steel.

523.051 Protective Coating Steel parts of bearings shall have protective coating applied to the areas described within this section in accordance with Section 506, Shop Applied Protective Coating- Steel.

Masonry plates shall, at the Contractor's option, be galvanized or metalized. The masonry plates shall be top coated to match the coating of the superstructure beams when beams are coated.

Portions of bearings between the masonry plate and sole plate that will be exposed after installation shall, at the Contractor's option, be galvanized or metalized. Steel between the masonry and sole plates shall be top coated to match the color of the superstructure beams when the adjacent superstructure beams are coated. Stainless steel and /or machined surfaces with a roughness height of 125 micro-inches or smoother shall not be coated. Machined surface finishes with a roughness height of 125 micro-inches or smoother, except stainless steel, shall be lubricated with a non-corrosive, waterproof, high pressure lubricant having a temperature range of -30 ^{o}F to 150 ^{o}F, National Lubrication and Grease Institute number not lower than 2 and an OK load of not less than 20 lbs., as measured by the requirements of ASTM D2509. Metal surfaces designed for sliding in contact with Teflon (TFE) coated surfaces shall not be lubricated.

Sole plates shall have the same finish as the adjacent structural steel. When adjacent structural steel is coated, the sole plate shall be galvanized/or metalized, at the option of the contractor. Sole plates shall be top coated to match the color of the superstructure beams. When the adjacent structural steel is bare and uncoated, the sole plate shall be bare and uncoated. When the adjacent beams are concrete, the sole plates shall be galvanized. Areas to be field welded shall not be coated prior to welding; they shall be touched up after welding.

Anchor rods shall be galvanized. When anchor rods are designated to secure bare unpainted steel, a dielectric coating (epoxy or bituminous type coatings are acceptable) shall be applied to the anchor rod and/or adjacent steel to prevent contact between galvanized surfaces and bare unpainted steel. When bearings, or portions of bearings, are painted to match adjacent structural steel, the anchor rods shall also be painted.

523.06 Fabrication Tolerances Fabrication tolerances for all bearings shall comply with Section 18.1 of AASHTO, LRFD Bridge Construction Specifications (Table 18.1.4.2-1) unless otherwise noted on the Plans or in this Section 523, Bearings.

523.061 Material Friction Test The coefficient of friction ('cof') between the two mating surfaces shall be measured. Tests shall be made either on samples taken from the same batch of materials as those used in the prototype bearings or the tests may, at the manufacturer's option, be conducted on finished bearings. Only new materials shall be used; material that has been previously tested shall not be used.

The surfaces shall be thoroughly cleaned with a degreasing solvent. No lubrication, other than that specified for the prototype bearings, shall be used. The mating surfaces for the test pieces shall have a common area no less than the smaller of the bearing area or 7.0 square inches.

The test piece shall be loaded in compression to a stress corresponding to their maximum service dead load plus live load, which shall be held for one hour prior to, and throughout the duration of, the sliding test. At least 100 cycles of sliding, each consisting of at least 1.0 inch of movement, shall then be applied at a temperature of 68 ^{o}F ± 2 ^{o}F. The uniform sliding speed shall be 2.5 inches per minute.

The breakaway 'cof' shall be computed for each direction of each cycle and its mean and standard deviation shall be computed for the sixth through twelfth cycles. The initial static breakaway 'cof' for the first cycle shall not exceed twice the design 'cof'. The maximum 'cof' for all subsequent cycles shall not exceed the design 'cof'. Failure of a single sample shall result in rejection of the entire lot.

Following the 100 cycles of testing, the breakaway 'cof' shall be determined again and shall not exceed the initial value. The bearing or specimen shall show no appreciable sign of wear, bond failure, or other defects.

523.07 Inspection The Contractor shall notify the Fabrication Engineer at least 10 days in advance of the start of fabrication so that inspection of the work can be provided by the Department. All work will be subject to inspection by the Fabrication Engineer.

Quality Control (QC) is the responsibility of the Contractor. The Quality Control Inspector (QCI) shall inspect all aspects of the work and shall supervise all testing. The QCI shall record measurements and test results in a Job Control Record (JCR). The QCI shall reject materials and workmanship that do not meet contract requirements. The Contractor may perform testing in addition to the minimum required. The results of all measurements and testing shall be made available to the Quality Assurance Inspector (QAI).

Quality Assurance (QA) is the prerogative of the Fabrication Engineer. The QAI will ensure that the Contractor's QC is performing properly, verify documentation, periodically inspect workmanship and witness testing. QA testing deemed necessary by the Fabrication Engineer in addition to the minimum testing requirements shall be scheduled to minimize interference with the production schedule.

523.08 Certification The Contractor shall furnish a materials certification letter in accordance with Division 700.

523.09 Installation of Bearings Bearings shall be placed upon bridge seats that are properly finished. Bridge seat elevations shall be within ± ¼ inch of the elevation shown on the Plans and the differential elevation between any two adjacent bearing areas shall not exceed ± ⅜ inch.

When the bearings are to be set directly on the concrete bridge seats, as indicated on the Plans, the bridge seats shall be dressed 1 inch larger all around than the bottom member of the bearing and to the exact elevations shown on the Plans or as determined by the Resident. If dressed areas are lower than the surface of the surrounding bridge seat, a channel 2 inches wide and with a minimum slope of 4 percent, shall be cut to the edge of the bridge seat for drainage.

Masonry plates shall be set level in their exact position and shall have a full and even bearing upon the masonry. They shall be placed on a preformed pad, the same size and shape as the masonry plate with holes to match the masonry plate.

523.091 Anchor Rods The contractor shall drill the holes and set the anchor rods with a chemical or cementitious Anchoring Material from the MaineDOT Qualified Products List. The Anchoring Material shall completely fill the holes. In place anchor rods shall be capable of developing unconfined pullout strength of 30 kips and 70 kips for M24 and M36, 1 inch and 1-½ inch anchor bolts, respectively.

523.092 Grout Pads When the bearings are to be set on a grout pad, the grout shall be a non-shrink cementitious grout from the Grout Materials list of the MaineDOT Qualified Products List. The grout shall have a minimum design compressive strength of 6,000 psi.

The grout shall be well bonded to the adjacent concrete and shall be placed under pressure to ensure that all anchor holes and the entire area under the masonry plate is free of voids.

523.093 Sliding Surfaces The sliding surfaces of bearings shall be installed level. Special care shall be exercised at all times to ensure protection of the stainless steel and the PTFE surfaces from coming in contact with any foreign matter.

At no time shall any forms, debris, or other material interfere with the free action of the bearing assemblies.

When bronze or copper-alloy bearing and expansion plates are used, the sliding surfaces or the steel in contact with the bearing and expansion plates shall be recoated immediately prior to installation with a lubricant recommended by the manufacturer of the bronze or copper-alloy plates.

523.094 Final Adjustment Bearings shall not be connected in place until the deck is in place. Final adjustment of the bearings for temperature shall be made after the deck is in place. Connecting of the bearing sole plate to the girder flange shall be done only after all adjustments have been made.

Sliding expansion bearings shall be set so that slotted holes in the sole plate will be centered on the anchor bolts, and rocker bearing assemblies shall be set so as to be plumb at 45 ºF. When determining temperature adjustments for bearings, the difference between the steel temperature (not the ambient temperature) and 45 ºF shall be used.

Nuts on anchor rods shall be brought in contact with the masonry plate or sole plate as shown on the Plans. Threads on anchor rods shall be upset with a punch to prevent easy removal of the nuts. When anchor rods extend through slotted holes in a sole plate, the lower of double nuts shall be left loose, bring to contact and loosen approximately ¼ turn, to allow movement of the sole plate.

STEEL BEARINGS

523.10 Steel Bearings Structural steel bearings- rocker type and sliding plate type- shall be fabricated in accordance with the dimensions and finishes shown on the Plans, Standard Details and the requirements of Section 504, Structural Steel.

Bearings, base plates and other contact surfaces shall be finished to the following tolerances:

Surface Roughness Requirements

Steel slabs	ANSI 2000 micro-inches
Bearing sole plates	ANSI 1000 micro-inches
Milled ends to compression members, milled or ground ends of stiffeners or rockers	ANSI 500 micro inches
Bridge rockers and rollers	ANSI 250 micro-inches
Sliding bearings	ANSI 125 micro-inches
Pins and pin holes	ANSI 125 micro-inches

Bearing mating surfaces (including steel to steel, or steel to bronze and steel to elastomeric material) shall have a minimum of 90% contact area. Flatness (the permissible variation from a true plane) shall be a maximum of 1/32 inch.

523.11 Materials Materials shall conform to Section 523.02, Materials.

ELASTOMERIC BEARINGS

523.20 Description Two types of bearings are applicable for the following Sections: Laminated Elastomeric Bearings, which shall consist of layers of elastomer laminated to steel plates; and Plain Elastomeric Bearings, which shall consist of a single layer of elastomer.

523.21 Materials Materials shall conform to Section 523.02, Materials.

If the elastomer material is specified by its shear modulus on the Plans, the measured shear modulus value shall lie within the specified range. When the elastomer material is specified by shear modulus, the Contractor shall supply a consistent value of hardness for the purposes of defining limits for the tests of Table A and B in Section 711.11.

Laminated Elastomeric bearings shall have a Shore A Durometer hardness of 50 or 60. Plain Elastomeric bearings shall have a Shore A Durometer hardness of between 50 and 70.

Shear modulus tests shall be carried out using the apparatus and procedure described in Annex A of the ASTM D4014 specifications.

523.22 Fabrication All components of Laminated Elastomeric Bearings shall be molded as an integral unit. Plain Elastomeric Bearings may be molded individually, cut from previously molded slabs, or extruded and cut to length. Cut edges shall have an ANSI 250 mils finish. Steel laminates shall be abrasive blast cleaned to an SSPC SP-6 and protected from contamination.

523.23 Testing The following testing shall be performed prior to delivery of the bearings:

1. Ambient Temperature Tests on the Elastomer (This test is required for each elastomer formulation)

The bond to the reinforcement shall develop a minimum peel strength of 40 pounds/inch. Peel strength tests shall be performed in accordance with ASTM D429, Method B.

2. Low-Temperature Test on the Elastomer (This test is required for each elastomer formulation)

Low-temperature tests shall be performed in accordance with the requirements of Section 711.11; the compound shall satisfy all criteria for its grade. The manufacturer may choose to provide certificates from low-temperature crystallization tests performed on identical material, within the last year, for Grade 3 to Grade 5 material.

3. Visual Inspection of the Finished Bearing Each laminated bearing shall be inspected for compliance with dimensional tolerances and for overall quality of manufacture. In steel reinforced bearings, the edges of the steel shall be protected everywhere from corrosion.

4. Short-Duration Compression Tests on Bearings Each laminated bearing shall be loaded in compression to 150% of the Bearing Design Load. The load shall be maintained for 5 minutes and released. The same load shall be reapplied and maintained for a second period of 5 minutes. The bearing shall be examined visually during the second loading. If the load drops below the required value during either application, the test shall be performed again.

The bearing shall be rejected if:

The bulging pattern suggests laminate parallelism outside of the specified tolerance,
A layer thickness is outside the specified tolerances,
A poor laminate bond exists, or
Three or more separate surface cracks greater than 0.08 inch wide and 0.08 inch deep exists.

5. Long-Duration Compression Tests on Bearings (This test is required on 10% of each type and size of laminated bearing furnished)

The long-term compression test shall be performed as specified in item 4 above, "Short-Duration Compression Tests on Bearings", except that the second load shall be maintained for 15 hours. The bearing shall be visually examined at the end of the tests while still under the load. If any patterns or cracks specified in section 4, above, occur, all bearings from that lot shall be rejected, unless the manufacture elects to test each bearing of the lot. If the additional testing does not reveal any rejectable defects as noted in item 4, above, the bearings will be accepted.

6. Shear Modulus Tests on Material from Bearings (This test is required for each elastomer formulation)

The shear modulus of the elastomer in the finished bearing shall be evaluated by testing a specimen cut from it using the apparatus and procedure described in Annex A of the ASTM D4014 specifications, amended where necessary in Tables A or B; or at the discretion of the Fabrication Engineer, a comparable nondestructive stiffness test may be conducted on a pair of finished bearings. The shear modulus shall fall within the specified range. If the test is conducted on the finished bearings, the material shear modulus shall be computed from the measured shear stiffness of the bearings, taking due account of the influence on shear stiffness of bearing geometry and compressive load.

Shear modulus tests performed on a sample of the same material as was used to fabricate the bearings will be acceptable. Shear modulus testing shall be performed using the apparatus and procedure described in ASTM D4014, Annex A.

POT or DISC BEARINGS

523.30 Design Pot or Disc bearings shall be designed for the loads and movements given on the Plans. Configurations and dimensions shall conform to AASHTO/NSBA G 9.1, Steel Bridge Bearing Design and Detailing Guidelines. Configurations and dimensions other than those given on the Plans or AASHTO/NSBA G 9.1 may be accepted subject to the approval of the Fabrication Engineer. Design calculations to substantiate all the requirements stated in this specification shall be submitted as part of the Working Drawings and shall be stamped and signed by a Professional Engineer licensed in the State of Maine.

Except where indicated on the Plans, the design shall also include the connections between the bearings and the superstructure, and the bearings and the substructure, along with adequate provisions for hold-downs equal to the tensile strength of the anchor rods.

The bearings shall be designed to accommodate a rotation of not less than 0.015 radians.

The static coefficient of friction between the PTFE and the stainless steel surface, for each size and type of bearing, shall not exceed 0.20 at the average unit bearing pressure for the minimum vertical load indicated on the Plans.

The bearings shall be designed for a horizontal force at least equal to 10% of the vertical capacity of the bearing.

No more than two bearings, with guide bars, per bearing line, shall be considered to be carrying the total maximum lateral horizontal load as indicated on the Plans.

Bearing friction shall not be considered when the horizontal load capacity of guided or fixed bearings is calculated.

The PTFE sliding surface for pot or disc bearings shall be designed to meet the following:

1. The average unit pressure shall be 3,500 psi, -5%, +0%, for the maximum vertical load indicated on the Plans.

2. Unfilled PTFE shall have a minimum thickness of ⅛ inch with half of its thickness recessed into the piston.

3. Filled PTFE shall be a minimum of $^{1}/_{16}$ inch thick and shall be bonded to the surface of the piston and to the guide bar.

4. The maximum thickness of the PTFE, filled or unfilled, shall be $^{3}/_{32}$ inch, except, if recessed it shall be $^{3}/_{16}$ inch.

The stainless steel sliding surface shall be designed to meet the following:

1. The stainless steel shall cover the PTFE in all operating positions such that the stainless steel will have a minimum of 1 inch edge clearance beyond the PTFE.

2. The thickness shall be not less than 0.040 inch or greater than 0.090 inch.

3. When a center guided key is utilized, a recess shall be machined in the sole plate and the vertical sliding surfaces of the recess shall be covered with stainless steel.

The guide bars shall be designed to meet the following:

1. The guide bars shall be designed for the maximum horizontal load, as indicated on the Plans, but not less than 10% of the vertical capacity of the bearing.

2. The guided member shall be within the guide bars at all operating positions.

3. The overall width of the guide bar and the PTFE sliding surfaces shall be ⅛ inch less than the clear width of the keyway in the guided member.

4. A PTFE sheet, $^{1}/_{16}$ inch minimum thickness, shall be bonded to the sliding contact surfaces of the guide bars. The sheets shall be filled PTFE.

Pot Bearings:

A. The elastomeric discs shall be designed to meet the following:

1. The average unit pressure shall be 3,500 psi, -0%, +10%, for the maximum vertical load indicated on the Plans.

2. The average unit pressure shall not be less than 700 psi for the minimum vertical load.

3. When utilizing flat brass sealing rings, the upper edge of the discs shall be recessed to receive the brass rings.

4. A PTFE sheet, filled or unfilled, $^{1}/_{16}$ inch minimum thickness and the same diameter as the design diameter of the disc, shall be placed below the discs.

The pot shall be designed to meet the following:

1. The depth of the cavity shall be equal to or greater than: Twice the design rotation plus 0.1 inch plus the thickness of the elastomeric disc and the PTFE sheet.

2. The inside diameter shall be the same as the design diameter of the elastomeric disc.

3. The pot shall be mounted, to provide a tight fit, in a ⅛ inch minimum depth recess in the steel masonry plate or distribution plate and shall be capable of being removed for inspection and repairs.

B. The piston shall be designed to meet the following:

1. The outside diameter shall be 0.03 inch less than the inside diameter of the pot.

2. The minimum thickness shall be not less than 0.08 times the design diameter.

3. When utilizing round brass sealing rings, the lower outside edge shall be beveled to accept and retain the brass ring and to permit full design rotation.

4. Laterally restrained pot bearings shall have a keyway in the sole plate. The top surface of the piston shall have a keyway slot and a cold finished steel guide bar press fitted into it and welded at the ends.

5. A PTFE sheet, filled or unfilled, $^{1}/_{16}$ inch minimum thickness and the same diameter as the bottom surface of the piston, shall be bonded to the bottom surface of the piston.

C. The elastomer sealing rings shall be brass and shall be designed to meet the following:

1. Flat brass sealing rings, if utilized, shall:

a. Have a width of ⅜ inch minimum, with bearings up to a 1,000 kip capacity and a ½ inch width, with bearings over a 1,000 kip capacity.

b. Have a minimum thickness of 0.050 inch.

c. Have two rings with a bearing capacity up to 1,000 kip, three rings with a bearing capacity over 1,000 kip, but less than 3,000 kip, and four rings with a bearing capacity of over 3,000 kip.

d. Have the ends cut at 45° with a minimum gap in the installed position of 0.050 inch and shall fit the inside diameter of the pot snugly.

e. Have the ring gaps staggered 180° apart.

2. Round brass sealing rings, if utilized, shall:

a. Be of one piece with the ends brazed to make a solid ring.

b. Have the outside of the ring fit snug in the inside diameter of the pot.

Disc Bearings:

A. The elastomeric discs shall be made from a compound based of polyether urethane using only virgin materials. The hardness shall be between 45 and 65 on the Shore D scale.

B. The disc shall be designed such that:

1. Its instantaneous deflection under total load does not exceed 10% of the thickness of the unstressed disc and the additional deflection due to creep does not exceed 8% of the unstressed disc.

2. The components of the bearing do not lift off each other at any location.

3. The average compressive stress on the disc does not exceed 5.0 ksi. If the outer surface of the disc is not vertical, the smallest plan area shall be used for computing stress.

523.31 Materials Materials shall conform to Section 523.02, Materials, and the following:

Sealing rings shall be brass. Flat rings shall conform to the requirements of ASTM B36, half hard. Round sealing rings shall conform to the requirements of Federal Specification QQB626, Composition 22, half hard.

Elastomeric Disc hardness shall be:

Shore A Durometer scale, between 50 and 60, for Pot Bearings
Shore D Durometer scale, between 45 and 65, for Disc Bearings

523.32 Fabrication Bonding of PTFE sheets to the piston shall be under factory-controlled conditions and in accordance with written instructions of the manufacturer of the adhesive. After completion of the bonding operation, the PTFE surface shall be smooth and free from bubbles. PTFE surfaces shall not be polished, but shall be wiped clean using a solvent appropriate for the material.

The stainless steel sliding surfaces shall be seal welded around the entire perimeter. The surfaces shall be smooth and flat and the back of the stainless steel shall remain in intimate contact with the sole plate.

Pots shall be machined from a solid plate or fabricated by welding a cut shape to a plate. Fabricated pots shall be 100% ultrasonically tested at the inside weld and magnetic particle tested at the exterior weld.

The elastomeric discs in pot bearings shall be manufactured from no more than three pieces.

Each bearing shall be assembled at the plant and, following assembly, shall be sealed at the joint between the piston and the pot with a continuous ¼ inch, minimum, bead of a flexible silicone rubber sealing compound approved by the Fabrication Engineer.

Each bearing shall have permanent match marks to indicate the neutral 45 °F position of the bearing. Each bearing shall also be marked for identification by die stamping on all steel parts (edge of sole plate, piston, masonry plate, and top edge of pot).

Each bearing shall be shipped and stored in moisture-proof and dust-proof covers until they are to be erected.

523.33 Fabrication Tolerances Tolerances shall comply with Section 523.06, Fabrication Tolerances, and as noted below.

Brass sealing rings shall have finished surfaces of less than 63 mils (ANSI B 46.1).

523.34 Testing and Certification The manufacturer of the pot or disc bearings shall furnish test facilities for testing and inspection of the completed bearings. The Fabrication Engineer, or an authorized representative, shall be allowed free access to the manufacturer's plant and test facility. The Fabrication Engineer will select two completed bearings for testing. The test shall be arranged so that the static coefficient of friction on the first movement can be determined. The test shall first be conducted at an average bearing pressure of 3,500 psi on the PTFE surface with the test load applied continuously for not less than 12 hours nor more than 14 hours prior to measuring the friction. The first movement static coefficient of friction shall then be determined. The above test shall then be repeated for the minimum vertical load indicated on the Plans for the bearings selected. The results shall not exceed that specified for the design.

A proof load test shall also be performed on each test bearing by applying a load equal to 150% of the maximum vertical load indicated on the Plans for the bearings selected for a period of one hour. The test bearings shall show no sign of failure or other defects while under load or subsequently upon disassembly and inspection.

Before testing, the testing equipment and procedure shall be submitted to the Fabrication Engineer for review.

523.40 thru 523.49 Reserved - Spherical Bearings

523.50 Method of Measurement Bearings will be measured for payment by each unit, tested and accepted. Bearing installation will be measured for payment by each unit in place and accepted.

523.51 Basis of Payment Bearings will be paid for at the contract unit price each, which price shall be full compensation for the design, fabrication, testing, and delivery. Bearing installation will be paid for at the contract unit price each which price shall be full compensation for installation, including all materials, equipment, labor and incidentals necessary for installing the bearings in accordance with the Plans and this specification. Removal of the existing bearings, if present, including all materials, equipment, labor and incidentals necessary for jacking the superstructure, removal of the existing bearings and preparation of the bridge seat in accordance with the Plans and this Specification, shall be considered incidental to bearing installation.

Payment will be made under:

	Pay Item	Pay Unit
523.52	Bearing Installation	Each
523.5301	Steel Bearings, Fixed, Sliding Plate	Each
523.5302	Steel Bearings, Expansion, Sliding Plate	Each
523.5303	Steel Bearings, Fixed, Rocker	Each

523.5304	Steel Bearings, Expansion, Rocker	Each
523.5401	Laminated Elastomeric Bearings, Fixed	Each
523.5402	Laminated Elastomeric Bearings, Expansion	Each
523.5403	Plain Elastomeric Bearings	Each
523.5551	Pot or Disc Bearings, Fixed	Each
523.5552	Pot or Disc Bearings, Expansion	Each
523.5601	Spherical Bearings	Each

SECTION 524 - TEMPORARY STRUCTURAL SUPPORTS

524.01 Description This work shall consist of the designing, fabricating, erecting, maintaining, and dismantling of temporary structural support(s) as called for on the Contract Plans, all in conformity with these specifications. Temporary structural supports proposed by the Contractor to facilitate the work shall also conform to these specifications.

524.02 Materials Materials used may be either sawn timber or steel, or a combination of both, at the Contractor's option, and, whether new or used, shall be sound and of adequate cross section for the intended loads. Blocking needed below the temporary supports to accommodate differences in elevation, and/or pads required to distribute loads to the soil may additionally incorporate plain and reinforced concrete.

524.03 Design Temporary structural support(s) shall be designed to support all vertical loading including live load and impact, differential settlement forces, horizontal and longitudinal forces, and shall account for any temporary unbalanced loading due to jacking forces and other loading during load transfer. Sufficient redundancy shall be designed into the support structure so that failure of one member will not cause the collapse of the entire system and the supported structure. Temporary support(s) shall be designed by a licensed Professional Engineer and all plans, computations, and working drawings shall be signed by that Engineer, and shall be submitted to the Resident for approval.

Temporary supports which are adjacent to traveled ways or which support structures carrying traffic, shall additionally be designed to resist any vibration or impact forces due to traffic and shall incorporate sufficient protection against impact by errant vehicles.

524.04 Erection and Removal The erection of temporary support(s) shall be in strict conformance with the approved design and details and shall use only the materials approved for use. No loads shall be placed on the temporary support(s) until the Contractor’s Professional Engineer has provided written certification to the Resident that the system was erected in conformance with the approved plans and design details.

The consent of the Department regarding design, construction or use of temporary supports shall not be construed, in any way, as relieving the Contractor of its responsibility to provide supports that are adequately designed and constructed to carry the loads that will be placed upon them. The work shall be entirely at the Contractor's risk.

Upon completing the work requiring the use of the temporary structural supports, the temporary support structures shall be removed and the area under and around them shall be restored to its original condition.

524.05 Method of Measurement Temporary structural supports will be measured as the number of individual units called for on the Plans, satisfactorily designed, erected, and dismantled. Temporary supports used by the Contractor for their convenience will not be measured for payment. The work associated with removal and reinstallation of existing highway appurtenances (e.g. guardrails, sign supports, etc.) to facilitate the erection of temporary supports will not be measured for payment, but will be considered incidental to the Temporary Structural Support Pay Item.

524.06 Basis of Payment Temporary structural supports will be paid for at the contract unit price each, which price shall be full compensation for all materials, equipment, labor and incidentals necessary for the design, erection, maintenance, and dismantling of such supports in accordance with these specifications.

Payment will be made under:

	Pay Item	Pay Unit
524.30	Temporary Structural Support	Each

SECTION 525 - GRANITE MASONRY

525.01 Description This work shall consist of furnishing and placing granite pier facing in accordance with these specifications and as shown on the Plans.

525.02 Materials The granite shall be obtained from a quarry approved by the Department and be free from materials which, by weathering, would cause discoloration or deterioration. The granite for the entire Project shall be uniform in color and free from seams, cracks and other structural defects.

Caulking of joints shall be accomplished with a two-component, epoxy-resin system designed for the intended use. A quartzite aggregate shall be added in accordance with the manufacturer's recommendations. The material shall be moisture insensitive, of low modulus of elasticity, and of a gel-like non-sag viscosity. Color shall be gray. The materials shall be subject to the approval of the Resident.

Anchors shall be of either ASTM A36 steel, galvanized in accordance with AASHTO M111 (ASTM A123), or ASTM A276 Type 304 stainless steel, ¾ inch diameter, as indicated on the Plans. Other types of anchors may be used with prior approval of the Resident.

Joint mortar shall comply with Section 705.02, Joint Mortar, except that it shall contain an additive to insure water-tightness. The additive shall not contain a retarding agent or hydrated lime and shall be approved by the Resident.

525.03 General Granite masonry shall have all stones dressed and cut to exact dimensions and laid up in joint mortar, with joints 1-½ inch +/- ⅛ inch in thickness.

A complete setting plan shall be submitted to the Department for approval, before ordering any stone.

The arrangement and the length of the stones shall be approved by the Department.

525.04 Stones The finish on exposed surfaces of the stones shall be free from tool marks. Irregular projections shall be limited to a maximum of 3 inches for any one stone measured from the pitch line. Irregular depressions shall be limited to a maximum of 1 inch for any one stone measured from the pitch line.

Stones shall have their edges pitched to a true line with tops and bottom parallel and cut to lie on their natural beds. The top and bottom beds shall be the full size of the stone, and hollow beds shall not be permitted. The beds of stone shall be sawn or fine finished, full depth. The vertical face joints shall be sawn or fine finished for a depth of not less than 4 inches, with the balance not to fall away more than 4 inches.

The top layer of granite shall have a 1-½ inch wide chisel draft line along the top face adjacent to concrete.

All stones shall be so finished that no holes or portions of holes shall show on surfaces that will be exposed in the finished work.

The depth of the stone shall be not less than 8 inches and not more than 12 inches, measured from the back face of the stone to the pitch line. The Contractor shall use extreme care when placing the concrete within the boundaries of the stone facing to avoid causing air pockets due to overhanging stones. Stone heights shall be a minimum of 15 inches.

525.05 Anchors Holes for anchors shall be drilled in the stones before they are placed.

There shall be a minimum of 2 anchors at a maximum spacing of 48 inches in the top and bottom beds of each piece and grooves shall be cut from the anchor holes to the back of the stones.

Stones greater than 48 inches in height shall have additional anchors located in the back face of the pieces such that there will be a maximum spacing, both vertical and horizontal, of 48 inches between anchors.

Anchors in the top and bottom beds of each stone shall be located such that an anchor will be not greater than 18 inches from each end of the piece. Anchors in the back face of each stone shall be located such that an anchor will be not greater than 18 inches from each end of the piece.

525.06 Mortar Joint mortar shall be machine mixed for not less than 1-½ minutes after all ingredients are in the mixer. Mortar shall be used within 30 minutes after mixing and the retempering of mortar will not be permitted. The mixing and placing of mortar shall be discontinued when the atmospheric temperature is below 40 degrees Fahrenheit in the shade, and dropping, and shall not be resumed until the atmospheric temperature is as high as 35 degrees Fahrenheit in the shade, and rising, unless otherwise authorized by the Resident.

525.07 Setting Stones Stones shall be thoroughly cleaned before being set and the bed to receive the stones shall be well cleaned. The thickness of all joints and beds shall be uniform throughout. Spalls shall not be used as pinners in mortar beds or joints. When any stone is disturbed or mortar joint broken, the stone shall be taken up, and after all mortar has been cleaned from the stone, bed and joints, the stone shall be reset in fresh mortar. All stones shall be well bedded with the face joints properly raked before the mortar has set.

The masonry shall be kept wet during the pointing, and in hot or dry weather shall be protected from the sun and kept wet for a period of 3 days after completion of setting, unless otherwise permitted or directed. Face surfaces of stone shall not be smeared with mortar and after pointing has been completed and set, the masonry shall be thoroughly cleaned to the satisfaction of the Resident. Stones shall not be set when the stones contain frost or during freezing weather, unless otherwise permitted.

Concrete backing shall be of the class shown on the Plans. The concrete shall be so worked and compacted that all spaces around stones are completely filled and an adequate bond with the stone is secured. Construction joints in the concrete, required by intermittent placing, shall be located not less than 6 inches below the top bed of any course of the stone facing. The stones shall be secured and the concrete so placed, as approved by the Resident, to prevent movement of the stones during placement of the concrete.

525.08 Joints All joints shall be raked 1-½ inches deep and caulked with an approved two-component epoxy-resin system. All caulking shall be done in such a manner as to produce a tight, durable and impervious seal at all joints. All caulking shall be accomplished as soon as possible to avoid exposure at joints to salt water.

The two-component epoxy-resin system shall be proportioned, mixed, and applied in accordance with the manufacturer's recommendations.

The joint below the bottom layer of granite shall be 1 inch ±½ inch in thickness.

525.09 Method of Measurement Granite masonry will be measured for payment by the number of square feet of exposed granite masonry, including joints, in the completed work and measured from the pitch lines as shown on the plans.

525.10 Basis of Payment Granite masonry will be paid for at the contract unit price per square foot complete in place and accepted. This price shall include all materials, equipment, labor and incidentals necessary to complete the work. The cost of the anchors, completed and in place, shall be included in the Contract unit price of this item.

Payment will be made under:

	Pay Item	Pay Unit
525.30	Granite Masonry	Square Foot

SECTION 526 - CONCRETE BARRIER

526.01 Description This work shall consist of the furnishing, constructing, erecting, setting, resetting, and removal of concrete barrier and associated elements in accordance with these specifications, the Standard Details and the lines and grades shown on the Plans or established by the Resident.

The types of concrete barrier are designated as follows:

Temporary Concrete Barrier Type I Double faced removable concrete barrier of the shape shown on the Plans.

Permanent Concrete Barrier Type II Double face barrier of a shape shown on the Plans.

Permanent Concrete Barrier Type IIIa Single face barrier 32 inches high of a shape shown on the Plans.

Permanent Concrete Barrier Type IIIb Single face barrier 42 inches high of a shape shown on the Plans.

Permanent Concrete Transition Barrier Barrier of various heights joining steel bridge rail to steel guardrail.

Permanent Texas Classic Rail Barrier, either traffic rail or sidewalk rail, as shown on the Plans.

526.02 Materials

a. Concrete Concrete shall meet the provisions of Section 502, Structural Concrete, and Portland cement shall conform to the requirements of AASHTO M85, Type I, II, or III.

Concrete for permanent barriers shall be Class LP, in accordance with Section 502.05, Composition and Proportioning.

Concrete for temporary barriers shall be Portland cement concrete with a minimum compressive strength of 2,500 psi. The Department reserves the right to take test core samples from the barriers in accordance with ASTM C42. Average compressive test strengths below 2,500 psi will result in rejection of the barriers.

b. Reinforcing Steel Reinforcing steel shall meet the requirements of Section 503, Reinforcing Steel.

c. Structural Steel Plate steel shall meet the requirements specified in Section 713.01, Structural Steel. Hot dipped galvanizing of plate steel shall be in accordance with AASHTO M111 (ASTM A123).

d. Bolts Bolts shall meet the requirements specified in Section 713.02, High Strength Bolts.

e. Connecting Pin for Temporary Concrete Barrier For all projects on the NHS, including the Interstate System, temporary concrete barriers must be connected using a 1-⅛ inch diameter rod with a washer and cotter pin on the bottom, per Standard Detail 526(02), The Contractor has the option to use a hex nut and washer connection at the top of the rod, as shown on the Standard Detail, or the top of the rod may be hooked over the top connector. The connecting pin must be smooth, not deformed, i.e., reinforcing bar may not be used, and shall meet the strength requirements of ASTM A36 steel, minimum.

For projects not on the NHS, temporary concrete barriers must be connected in accordance with Standard Detail 526(02), except that the top of the rod may be hooked over the top connector, instead of using a hex nut and washer. The connecting pin shall meet the strength requirements of ASTM A36 steel, minimum.

526.03 Construction Requirements Permanent Concrete barrier shall be constructed in accordance with the provisions of Standard Specification Section 502.05, Composition and Proportioning, through Section 502.14, Curing Concrete, inclusive, with the following additions:

a. Permanent concrete barrier may be formed by cast-in-place or slip forming methods.

b. Concrete finish shall be equal to a steel form finish.

c. Liquid membrane-forming compounds may be used for curing concrete barriers, if approved by the Resident. If a membrane-forming compound that contains fugitive dye or other agents which will discolor the concrete is used, the curing compound shall be removed to the satisfaction of the Resident prior to Final Acceptance.

When the slip forming method is used, a dissipating curing compound shall be applied to the concrete during placement, and then wet curing shall proceed in accordance with Section 502.

In addition to the foregoing methods of curing concrete, barrier may be cured by an accelerated curing method using low-pressure steam or radiant heat in a moist environment. Other methods of curing may be used if approved by the Resident.

If called for, protective coating shall be applied in accordance with Standard Specification Section 515, Protective Coating for Concrete Surfaces.

Temporary concrete barrier shall be generally free from fins and porous areas and shall present a neat and uniform appearance.

Permissible dimensional tolerances for all concrete barriers shall be as follows:

a. Cross-sectional dimensions shall not vary from design dimensions by more than ¼ inch. The vertical centerline shall not be out of plumb by more than ¼ inch.

b. Longitudinal dimensions shall not vary from the design dimensions by more than ¼ inch per 10 feet of barrier section and shall not exceed ¾ inches per section.

c. Location of anchoring holes shall not vary by more than ½ inch from the dimensions shown in the concrete barrier details on the Plans.

d. Surface straightness shall not vary more than ¼ inch under a 10 foot straightedge.

e. The barrier shall have no significant cracking. Significant cracking is defined as fractures or cracks passing through the section, or any continuous crack extending for a length of 12 inches or more, regardless of position in the section.

526.04 Method of Measurement Concrete Barrier Type II, IIIa, IIIb, and Texas Classic Rail will be measured for payment by lump sum, complete in place.

Temporary concrete barrier will be measured for payment by the lump sum. Lump sum measurement will include verification of the installation and removal of all concrete barrier required by the plans for the Contractor's operations.

The Contractor shall replace sections of temporary concrete barrier damaged by the traveling public when directed by the Resident. Replacement sections will be measured for payment.

Transition barrier will be measured by each barrier connecting bridge rail to guardrail, complete in place.

526.05 Basis of Payment The accepted quantities of Texas Classic Rail, Type II, IIIa, and IIIb concrete barrier will be paid for at the Contract lump sum price for the type specified, complete in place.

The accepted quantities of Temporary Concrete Barrier Type I will be paid for at the Contract lump sum price. Such payment shall be full compensation for furnishing all materials, assembling, moving, resetting, transporting, temporarily storing, and removing barrier, furnishing new parts as necessary, and all incidentals necessary to complete the work.

Temporary barrier shall become the property of the Contractor upon completion of the use of the barrier on the project, and shall be removed from the project site by the Contractor.

Transition barrier will be paid for at the Contract price each, complete in place.

The accepted quantity of all types of concrete barrier, whether temporary or permanent, will be paid for at the lump sum or per each price, as applicable, which payment shall be full compensation for all materials, including reinforcing steel, steel plates and hardware, equipment, labor and incidentals required, as necessary, to complete the work.

Payment will be made under:

	Pay Item	Pay Unit
526.301	Temporary Concrete Barrier, Type I	Lump Sum
526.312	Permanent Concrete Barrier Type II	Lump Sum
526.321	Permanent Concrete Barrier Type IIIa	Lump Sum
526.323	Texas Classic Rail	Lump Sum
526.331	Permanent Concrete Barrier Type IIIb	Lump Sum
526.34	Permanent Concrete Transition Barrier	Each

SECTION 527 - ENERGY ABSORBING UNIT
(Work Zone Crash Cushion)

527.01 Description The Contractor shall furnish and install Work Zone Crash Cushions as specified in Special Provision 652 or as directed by the Resident.

527.02 Materials Work Zone Crash Cushions must comply with NCHRP Report 350. Work Zone Crash Cushions meeting NCHRP 350 include, but are not limited to, the following: The N-E-A-T from Energy Absorption Systems of Chicago, Illinois, Adiem-II from Syro Inc. of Dallas, Texas, Clusters of the Energite III sand barrels from Energy Absorption Systems of Chicago, Illinois, or an approved equal.

527.03 Construction Requirements Work Zone Crash Cushions shall be provided and installed in accordance with the manufacturer's recommendations for the specific application and the posted speed limit.

Work Zone Crash Cushions, which are damaged or destroyed, shall be repaired or replaced promptly. The Contractor shall have on hand one complete set of replacements.

527.04 Method of Measurement The Department will measure Work Zone Crash Cushions by the Unit, complete in place and accepted. A cluster of Portable Crash Barrels or a cluster of Energite III sand barrels is considered a Unit. Each N-E-A-T or Adiem II is considered a Unit.

527.05 Basis of Payment The Department will pay for the accepted quantity of Work Zone Crash Cushions at the Contract unit price for each Unit, which price shall be full compensation for furnishing and placing the Work Zone Crash Cushion, including all incidentals and for resetting as many times as required.

Replacements for the Work Zone Crash Cushions damaged beyond functionability by collisions will be paid for as new Work Zone Crash Cushions, and the removal of the impacted devices and debris will be considered incidental to the replacement units. Replacement Work Zone Crash Cushions on hand, but unused, will not be paid for directly.

Payment will be made under:

	Pay Item	Pay Unit
527.34	Work Zone Crash Cushions	Unit

SECTION 528 - STRUCTURAL TIMBER
Reserved

SECTION 529 - NAVIGATIONAL AIDS
Reserved

SECTIONS 531 to 533 – VACANT

SECTION 534 - PRECAST STRUCTURAL CONCRETE

534.01 Description The Contractor shall design, manufacture, furnish, and install precast structural concrete arches, box culverts or three sided frames and associated wingwalls, headwalls, toe walls, cut-off walls and appurtenances, in accordance with the Contract Documents.

534.02 Materials Structural precast elements for the arch, box culvert, or three sided frame and associated precast elements shall meet the requirements of the following Standard Specification Subsection, except as noted otherwise in this specification:

Structural Precast Concrete Units	712.061

New concrete mix designs and mix designs not previously approved by the Fabrication Engineer shall be qualified by trial batches prepared in accordance with AASHTO T 126 (ASTM C192). The test results shall demonstrate that the concrete meets the requirements of the Contract Documents.

Bedding and backfill material shall conform to the requirements of Standard Specification 703.19, Granular Borrow, Material for Underwater Backfill, with the additional requirement that the maximum particle size shall be limited to 4 inches, or as shown on the Plans.

534.03 Drawings Prepare shop detail, erection and other necessary Working Drawings in accordance with Standard Specification Section 105.7, Working Drawings. The Department will review the drawings in accordance with the applicable requirements of Section 105.7, Working Drawings. Changes and revisions to the reviewed Working Drawings shall require further review by the Fabrication Engineer. Working Drawings shall include the following minimum details:

1. Fully dimensioned views showing the geometry of the units, including all projections, recesses, notches, openings, block outs, keyways and chamfers.
2. Details and bending schedules of reinforcing steel including the size, spacing, and location. Reinforcing provided under lifting devices shall be shown in detail.
3. Details and locations of all items to be embedded.
4. Total weight of each unit.

Concrete mix designs shall be part of the Working Drawing submittal. Include aggregate specific gravity, absorption, percent fracture, fineness modulus and gradation as part of the mix design. Provide the mix design calculations demonstrating how the batch weights, water-cement ratio and admixture dosage rate were determined.

534.04 Design Requirements The Contractor shall design the precast structural concrete structure in accordance with the AASHTO LRFD Bridge Design Specifications, latest edition. The HL-93 live load specified in the AASHTO LRFD Bridge Design Specifications shall be used for all limit states, except for Strength I. The live load used for the Strength I limit state shall be the Maine Modified live load, which consists of the standard HL-93 Live Load with a 25 percent increase in the Design Truck only. (Wheel loads based on the Design Truck shall be increased 25 percent). Additionally, if the governing load rating factor based on the HL-93 live load is equal to or less than 1.10 and the span is 14 feet, or greater, then a load rating based on the Maine legal truck (Configuration #6) shall also be checked to insure the rating factor is equal to, or greater than, 1.0.

The live load deflection check, per AASHTO LRFD Bridge Design Specifications, for the top slab of box culverts and frames with clear spans of 15 feet, or greater, and cover depths of 4 feet, or less, is mandatory. The live load deflection check shall be documented in the design computations submittal.

Design calculations that consist of computer program generated output shall be supplemented with at least one hand calculation and graphics demonstrating the design methodology used. The hand calculation shall document, at a minimum, the Strength I load case flexural design check of the top slab positive moment reinforcing steel. Design calculations shall provide thorough documentation of the sources of equations used and material properties.

The design shall be load rated in accordance with the AASHTO Manual for Bridge Evaluation, latest edition, by the LRFR method and in accordance with the MaineDOT Load Rating Guide.

The Contractor shall submit design calculations and load rating, if applicable, for the precast structure to the Department for review. A Professional Engineer, licensed in accordance with State of Maine laws, shall sign and seal all design calculations and drawings.

The Contractor shall submit the following items for review by the Department, at least forty-five Working Days prior to production:

A. The name and location of the manufacturer
B. Method of manufacture and material certificates
C. Description of method of handling, storing, transporting, and erecting the units
D. Design computations (bound and indexed)
E. Load rating computations and completed load rating form (bound and indexed)

534.05 Facilities for Inspection Provide a private office at the fabrication plant for the Department's inspection personnel, or Quality Assurance Inspectors (QAI's), in accordance with Section 535.05, Facilities for Inspection.

Failure to comply with the above requirements will be considered denial of access to the Work for the purpose of inspection. The Department will reject all Work done when access for inspection is denied.

534.06 Notice of Beginning Work Refer to Section 712.061.

534.07 Quality Control Quality Control (QC) is the responsibility of the Contractor.

Provide a copy of the Quality System Manual (QSM) to the Fabrication Engineer, if requested.

Inspect all aspects of the Work in accordance with the Contractor's QSM. Reject materials and workmanship that do not meet Contract requirements.

Record measurements and test results on the appropriate forms from APPENDIX E of Precast/Prestressed Concrete Institute Manual for Quality Control for Plants and Production of Structural Precast Concrete Products (MNL 116), or an equivalent form prepared by the user. Provide copies of measurements and test results to the QAI as follows:

Type of Report	When Provided to QAI*
Aggregate gradations-fine aggregate and coarse aggregate	Prior to beginning work and at least once a week thereafter
Material certifications /calibration certifications	Prior to beginning work (anticipate adequate time for review by QAI)
Pre-placement inspection report	Prior to the concrete placement
Concrete batch slips	The morning of the next work day
Results of concrete testing	The morning of the next work day
Concrete temperature records	Provide with compressive strength testing
Nonconformance reports/repair procedures	Within 24 hours of discovery
Results of compressive strength testing (for design strength)	Prior to stopping curing / Prior to final acceptance
Post-placement inspection report	Prior to final acceptance

* The Contractor and QAI may, by mutual agreement, modify any part of the schedule; however, failure to provide the documentation when required by the Fabrication Engineer will result in the product being deemed unacceptable. The Contractor may perform testing in addition to the minimum required. The results of all testing shall be made available to the Department.

534.08 Quality Assurance Quality Assurance (QA) is the prerogative of the Department. Refer to Section 712.061.

534.09 Nonconforming Work Refer to Section 712.061.

534.10 Forms Construct forms in accordance with the Working Drawings. The forms shall be well constructed, carefully aligned and sufficiently tight to prevent leakage of mortar. Reject forms that do not maintain the dimensions shown on the Working Drawings.

Seal wooden forms to prevent absorption of water. Apply and cure the sealer in accordance with the manufacturer's product data sheet.

Remove all paint, adherent material, foreign matter and debris prior to placing concrete.

Apply a non-staining bond-breaking compound to the forms in accordance with the manufacturer's product data sheet. Solvent clean reinforcing steel and welded steel wire fabric contaminated with the bond-breaking compound.

534.11 Reinforcing Steel and Welded Steel Wire Fabric Refer to Sections 712.061 and 503 for fabrication, packaging, handling, storing, placing, splicing and repair of reinforcing steel, welded steel wire fabric and mechanical/welded reinforcing steel splices.

The concrete cover over the outside circumferential reinforcement shall be 2 inches, minimum, and the concrete cover over the inside reinforcement shall be 1-½ inches, minimum. The clear distance of the end of circumferential wires shall not be less than 1 inch or more than 2 inches from the end of the units. Use sufficient supports and spacers to maintain the minimum concrete cover. The supports and spacers shall be made of a dielectric material or other material approved by the Fabrication Engineer.

Welded steel wire fabric shall meet the spacing requirements and contain sufficient longitudinal wires extending through the unit to maintain the shape and position of the reinforcement. Longitudinal distribution reinforcement may be welded steel wire fabric or deformed steel bars which meet the spacing requirements. The ends of the longitudinal distribution reinforcement shall not be more than 3 inches from the ends of the units.

Do not use more than three layers of reinforcing to form a single mat. If reinforcing steel is cut to install lifting devices, install additional reinforcing adjacent to the cut steel, as shown on the Working Drawings.

Tension splices in the reinforcement will not be permitted. For splices other than tension splices, the overlap shall be a minimum of 12 inches for welded steel wire fabric and as specified in Standard Specification Section 503 for deformed steel bars. The center-to-center wire spacing in wire fabric sheets shall not be less than 2 inches, or more than 4 inches, for the circumferential wires, and shall not be more than eight inches for the longitudinal wires. The center-to-center spacing of the longitudinal distribution steel for either line of reinforcing in the top slab shall not be more than 15 inches.

534.12 Inserts Refer to Section 712.061.

534.13 Concrete Placement Do not batch or place concrete until all the form(s) for any continuous placement have been inspected and accepted by the Quality Control Inspector (QCI), and the QAI concurs.

Test concrete in accordance with the Standards included in Section 712.061.

Test the first two loads of concrete for temperature, air entrainment and slump flow for Self-Consolidating Concrete (SCC). If the first load is unacceptable, test the second load as the first. Continue this process until two consecutive loads are acceptable. After two consecutive loads are acceptable, the frequency of testing shall be at the discretion of the QAI.

If there is a change in the dosage rate of any admixture or a change of more than 5° F in mix temperature, then test the concrete for temperature, air entrainment and slump flow for SCC.

Test every load of 1 cubic yard, or less, from a stationary mixer or 2 cubic yards, or less, from a transit mixer for temperature, air entrainment and slump flow for SCC, prior to placing the concrete in the forms.

Perform all testing in the presence of the QAI. The QAI will designate the loads to be tested. Make cylinders used to determine stripping strength during the last 1/3 of the placement.

Place the concrete as nearly as possible to its final location. Control the depth of each lift in order to minimize entrapped air voids. The maximum depth of an unconsolidated lift shall be 18 inches. Vibrate the concrete with internal or internal and external vibrators. Do not use external vibrators, only. Insert internal vibrators vertically and penetrate the lower layer of concrete by at least 4 inches. Insert the vibrators in the concrete to assure that the radii of action of the vibrators overlap. Hold the vibrators in position from 5 to 15 seconds; vibration time shall be reduced by 50 percent when placing SCC. Do not use vibrators to move concrete horizontally. Each lift of concrete shall have sufficient plasticity to be consolidated with subsequent lifts.

Do not re-temper the concrete with water after discharging has begun. The Contractor may add High Range, Water Reducing, admixture to the concrete after batching if that practice conforms to the manufacturer's product data sheet. Discard concrete that becomes unworkable.

Do not use water or water-based products to aid in finishing fresh concrete.

After the concrete has been placed and finished and before the forms are covered, remove all concrete from projecting reinforcing steel.

534.14 Process Control Test Cylinders Refer to Section 712.061.

534.15 Manufacture of Precast Units The units shall be free of fractures. The ends of the units shall be normal to the walls and centerline of the unit, within the limits of variation provided, except where beveled ends are specified. The surfaces of the units shall be a smooth steel form or troweled surface finish, unless a form liner is specified. The ends and interior of the assembled structure shall make a continuous line of units with a smooth interior surface.

Defects which may cause rejection of precast units include, but are not limited to, the following:

A. Any discontinuity (crack, rock pocket, etc.) of the concrete which could allow moisture to reach the reinforcing steel.
B. Rock pockets or honeycomb over 6 square inches in area or over 1 inch deep.
C. Edge or corner breakage exceeding 12 inches in length or 1 inch in depth.
D. Any other defect that clearly and substantially impacts the quality, durability, or maintainability of the structure, as determined by the Fabrication Engineer.

The manufacturer of the units shall sequentially number and shop fit each adjacent unit to ensure that they fit together in the field. This fit up shall be witnessed by the QAI. Any non-fitting units shall be corrected or replaced at no cost to the Department.

The manufacturer of the units shall keep accurate records of aggregate gradations, concrete batching, testing, curing, and inspection activities to verify that forms, reinforcing and unit dimensions conform to these requirements. Copies of reports shall be furnished to the Resident when requested.

534.16 Tolerances Dimensional tolerances shall be in conformance with the following:

A. The internal dimensions shall not vary by more than 1 percent from the design dimensions or 1-½ inches, whichever is less, with the exception of the cross diagonal dimension which shall not vary by more than one-half inch from the design dimension.
B. The haunch dimensions shall not vary by more than three-quarters inch from the design dimension.
C. The dimension of the legs shall not vary by more than one-quarter inch from the dimension shown on the reviewed Working Drawings.
D. The slab and wall thickness shall not be less than the design thickness by more than one-quarter inch. A thickness greater than the design thickness shall not be cause for rejection.
E. Variations in laying lengths of two opposite surfaces shall not be more than five-eights inch in any unit, except where beveled ends for laying of curves are specified.
F. The under-run in length of any unit shall not be more than one-half inch.

534.17 Finishing Concrete Products shall be finished to meet the ordinary finish requirements of Standard Specification Section 502. Units, or portions of units, that will be exposed to view in their final location shall receive a rubbed finish, per Section 502. The Contractor may use alternative methods of achieving an acceptable finish on exposed units if approved by the Fabrication Engineer.

Marking: The date of manufacture, the production lot number, and the type of unit shall be clearly and indelibly scribed on a rear, unexposed portion of each unit.

534.18 Repairing Defects Defects requiring repair will be considered either non-structural or structural.

Non-Structural Defects: Exposed surfaces shall be of uniform appearance; only minor repairs to remove and blend fins, patch minor spalls and to repair small, entrapped air pockets, shall be permitted. Repair honeycombing, ragged or irregular edges and other non-structural or cosmetic defects using a patching material from the MaineDOT Qualified Products List (QPL). The repair, including preparation of the repair area, mixing and application and curing of the patching material, shall be in accordance with the manufacturer's product data sheet. Corners not exposed in the final product may be ground smooth with no further repair necessary, if the depth of the defect does not exceed one-half inch. Remove form ties and other hardware to a

depth of not less than one inch from the face of the concrete and patch the holes using a patching material from the MaineDOT QPL.

Structural Defects: Repair structural defects only with the approval of the Fabrication Engineer. Submit a nonconformance report (NCR) to the Fabrication Engineer with a proposed repair procedure. Do not perform structural repairs without an NCR that has been reviewed by the Fabrication Engineer. Structural defects include, but are not be limited to, exposed reinforcing steel, cracks in bearing areas, through cracks and cracks 0.013 inch in width that extend more than 12 inches in length in any direction. Give the QAI adequate notice prior to beginning any structural repairs.

534.19 Handling, Storage and Transportation Handle, store and transport units in a manner as to eliminate the danger of chipping, cracks, fracture, and excessive bending stresses. Any units found damaged upon delivery, or damaged after delivery, shall be subject to rejection.

Do not place precast units in an upright position until a compressive strength of at least 4,000 psi is attained. Precast units may be handled and moved, but not transported, until the 28 day design strength has been attained.

Support stored precast units above the ground on dunnage in a manner to prevent twisting or distortion. Protect the units from discoloration and damage.

Set precast units on one-half inch thick neoprene pads during shipment to prevent damage to the unit legs. The Contractor shall repair any damage to precast units resulting from shipping or handling; this shall be accomplished by saw cutting a minimum of one-half inch deep around the perimeter of the damaged area, removing any loose concrete out to the saw cut perimeter and installing a polymer-modified cementitious patching material, from the Department's QPL, per the manufacturer's product data sheet.

534.20 Installation of Precast Units When footings are required, install the precast units on concrete footings that have reached a compressive strength of at least 3,000 psi. Construct the completed footing surface to the lines and grades shown on the Plans. When checked with a 10 foot straightedge, the surface shall not vary more than one-quarter inch in 10 feet. The footing keyway shall be filled with a Department-approved non-shrink flowable cementitious grout with a design compressive strength of at least 5,000 psi.

Three sided frame and box culvert joints shall be sealed with a Department-approved flexible joint sealant in accordance AASHTO M 198 (ASTM C990). Joints shall be closed tight. Culvert units shall be equipped with joint closure mechanisms to draw units together and close joints to the required opening.

Completely fill the exterior face of joints between precast units with a material from the MaineDOT QPL and cover with a minimum 12 inch wide joint wrap. Additionally, for box culverts and three sided frames, cover the entire top surface with waterproofing membrane; waterproofing membrane shall extend one foot from the top down the sides of the units. The

surfaces shall be free of dirt and deleterious materials before applying the filler material and joint wrap. Install the external wrap in one continuous piece over each unit joint, taking care to keep the joint wrap in place during backfilling.

Seal the back of joints between the end unit and attached elements with a non-woven geotextile. Install and tighten the bolts fastening the connection plate(s) between the elements that are designed to be fastened together as designated by the manufacturer.

Fill holes that were cast in the units for handling with either Portland cement mortar or with precast plugs secured with Portland cement mortar or other approved adhesive.

Place and compact the bedding material as shown on the Plans prior to lifting and setting the culvert units. Backfilling of the structure shall be done in accordance with the manufacturer's instructions and the Contract Documents. Uniformly distribute backfill material in layers of not more than 8 inches in depth, loose measure, and thoroughly compact each layer using approved compactors before successive layers are placed. Compact the Granular Borrow bedding and backfill in accordance with Section 203.12, Construction of Earth Embankment with Moisture and Density Control, except that the minimum required compaction shall be 92 percent of maximum density, as determined by AASHTO T-180, Method C or D. Place and compact the backfill without disturbance or displacement of the structure, keeping the fill at approximately the same elevation on both sides of the structure. Whenever a compaction test fails, the Contractor shall not place additional backfill over the area until the lift is re-compacted and a passing test achieved.

Use hand-operated compactors within five feet of the precast structure as well as over the top until it is covered with at least 12 inches of backfill. Take appropriate precautions to protect the top of the culvert from damage during backfilling and/or paving operations. Any damage to the top of the precast structure shall be repaired, or units replaced, at no cost to the Department.

534.21 Method of Measurement Precast Structural Concrete Arches, including three-sided frames, and Precast Concrete Box Culverts will be measured as one lump sum, complete, in place and accepted.

534.22 Basis of Payment The accepted Precast Structural Concrete Arches, including three-sided frames, or Precast Concrete Box Culverts will be paid for at the respective Contract lump sum price. The lump sum price shall include associated wingwalls, headwalls, toe walls, cut-off walls and appurtenances, and shall be full compensation for all labor, equipment, materials, professional services, and incidentals necessary for designing, manufacturing, furnishing and installing the precast concrete elements and accessories. Falsework, reinforcing steel, welded steel wire fabric, joint wrap, geotextile, repair material, grout, cast-in-place concrete fill or grout fill for anchorage of precast wings and/or other appurtenances will not be measured and paid for separately, but will be incidental to the lump sum pay item. Cast-in-place concrete, reinforcing steel in cast-in-place elements and waterproofing membrane will be measured and paid for separately, under the provided Contract Pay Items. Pay adjustments for quality level will not be made for precast concrete.

Excavation for precast structural concrete structures, including excavation below culverts for bedding and backfilling, will be measured and paid for as provide in Section 206, Structural Excavation.

When the minimum cover material extends above the subgrade line, the removal of the cover material necessary to complete the work will not be paid for directly, but shall be considered incidental to the precast structural concrete lump sum pay item.

Payment will be made under:

Pay Item		Pay Unit
534.70	Precast Structural Concrete Arch	Lump Sum
534.71	Precast Concrete Box Culvert	Lump Sum

SECTION 535 - PRECAST, PRESTRESSED CONCRETE SUPERSTRUCTURE

535.01 Description This work shall consist of casting and erecting precast/prestressed concrete products and related material. Materials, work, inspection and documentation not specifically addressed by this Specification shall be done in accordance with the applicable sections of the Precast/Prestressed Concrete Institute (PCI), Manual for Quality Control for Plants and Production of Structural Precast Concrete Products (MNL 116), including Commentary.

ALL REQUIREMENTS IN THIS SPECIFICATION ARE THE RESPONSIBILITY OF THE CONTRACTOR, UNLESS NOTED OTHERWISE.

535.02 Materials Materials for precast/prestressed concrete products shall meet the requirements of the following Subsections of the Standard Specifications:

Portland Cement and Portland Pozzolan Cement	701.01
Water	701.02
Air-Entraining Admixtures	701.03
Water Reducing Admixtures	701.04
High Range, Water Reducing, Admixture (HRWR)	701.0401
Set-Retarding Admixtures	701.05
Fly Ash	701.10
Calcium Nitrite Solution	701.11
Silica Fume	701.12
Ground Granulated Blast Furnace Slag	701.13
Fine Aggregate for Concrete	703.01
Coarse Aggregate for Concrete (Class A, AA or Latex)	703.02
Reinforcing Steel	709.01

Welded Steel Wire Fabric	709.02
Steel Strand	709.03

Portland cement shall conform to AASHTO M85 (ASTM C150), Type I, Type II, or Type III or AASHTO M 240. Supply the Department with copies of Certified Mill Test Reports for the cement.

Provide a Materials Certification from the manufacturer of the prestressing strand. The certification shall include a representative load elongation curve for each coil. The manufacturer shall identify each coil of strand. Do not remove the identification from the coil. Partial coils may be used with the approval of the Fabrication Engineer. Failure to maintain traceability of a coil will be cause for rejection. Provide Certified Mill Test Reports for the reinforcing steel, welded wire fabric and fusion bonded epoxy coating.

535.03 Working Drawings Prepare shop detail, erection and other necessary Working Drawings in accordance with Section 105.7, Working Drawings. The Department will review the drawings in accordance with the applicable requirements of Section 105.7, Working Drawings. Changes and revisions to the reviewed Working Drawings will require further review by the Fabrication Engineer.

Concrete mix designs shall be part of the Working Drawing submittal. Include aggregate specific gravity, absorption, percent fracture, fineness modulus and gradation as part of the mix design. Provide the mix design calculations demonstrating how the batch weights, water-cement ratio and admixture dosage rate were determined.

535.04 Plant The plant shall be a PCI Certified facility.

535.05 Facilities for Inspection Provide a private office at the fabrication plant for the Department's inspection personnel, or Quality Assurance Inspectors (QAI's). The office shall be in close proximity to the Work. The office shall be climate controlled to maintain the temperature between 68° F and 75° F and have the exit(s) closed by a door(s) equipped with a lock and 2 keys which shall be furnished to the QAI's.

The QAI's office shall meet the following minimum requirements:

Description	Quantity
Office area (minimum ft^2)	100
Drafting table surface (ft^2)	35
Drafting stools-each	1
Office desk	1
Ergonomic swivel chairs	1
Folding chairs	2
High-speed internet connection (ports) or wireless	1

Fluorescent lighting of 100 ft-candles minimum for all work areas	2
110 Volt 60 cycle electric wall outlets	3
Wall closet	1
Waste basket with trash bags	1
Broom	1
Dustpan	1
Water cooler	1
Cleaning materials-floor, surfaces, windows, for duration of the project	

The Contractor will be responsible for disposing of trash and supplying commercially bottled water for the water cooler.

The QAI will have the option to reject any furniture or supplies provided to the QAI's office, based on general poor condition.

Provide parking space for the QAI(s) in close proximity to the entrance to the QAI's office. Maintain the pathway between the parking area and the QAI's office so that it is free of obstacles, debris, snow and ice.

The facilities and all furnishings shall remain the property of the Contractor upon completion of the Work. Payment for the facilities, heating, lighting, internet connection and monthly internet charges and all furnishings shall be incidental to the Contract.

Failure to comply with the above requirements will be considered denial of access to the Work for the purpose of inspection. The Department will reject all Work done when access for inspection is denied.

535.06 Notice of Beginning Work Give the Department a minimum of two weeks notice for in-Maine work and three weeks notice for out-of-Maine work, prior to beginning production. If the production schedule changes, notify the Fabrication Engineer no less than 3 working days prior to the initial start-up date. Any Work done without the QAI present will be rejected. Advise the Fabrication Engineer of the production schedule and any changes to it. If Work is suspended on a project, the Fabrication Engineer will require 72 hours notice prior to the resumption of Work.

535.07 Quality Control Quality Control (QC) is the responsibility of the Contractor.

Provide a copy of the Quality System Manual (QSM) to the Fabrication Engineer, if requested.

Calibrate all production equipment in accordance with MNL 116, except that stressing jacks shall be calibrated every 6 months. Provide calibration certifications to the QAI prior to beginning fabrication. Calibrate scales, admixture dispensers and water gauges at the frequency specified in MNL 116. Use proving rings, load cells and solid standard weights, as applicable. The calibration shall be performed by a testing laboratory acceptable to the Department using

calibration equipment the accuracy of which is traceable to a National Institute of Standards and Technology (NIST) standard.

Quality Control Inspectors (QCI's) shall have a valid PCI Quality Control Certification Level I, Level II or Level III. Personnel performing concrete testing shall hold a current ACI Field Testing Technician Grade I Certification, or equivalent.

Inspect all aspects of the Work in accordance with the Contractor's QSM. Reject materials and workmanship that do not meet Contract requirements.

Record measurements and test results on the appropriate forms from APPENDIX E of MNL 116, or an equivalent form prepared by the user. Provide copies of measurements and test results to the QAI as follows:

Type of Report	When Provided to QAI*
Aggregate gradations-fine aggregate and coarse aggregate	Prior to beginning work and at least once a week thereafter
Material certifications / stressing calculations / calibration certifications	Prior to beginning work (anticipate adequate time for review by QAI)
Tensioning report	The same work day
Pre-placement inspection report	Prior to the concrete placement
Concrete batch slips	The morning of the next work day
Results of concrete testing	The morning of the next work day
Results of compressive strength testing (for release)	The same work day
Concrete temperature records	Provide with compressive strength testing (for release)
Nonconformance reports/repair procedures	Within 24 hours of discovery
Results of compressive strength testing (for design strength)	Prior to stopping curing
Post-placement inspection report	Within 48 hours of achieving design strength

* The Contractor and QAI may, by mutual agreement, modify any part of the schedule; however, failure to provide the documentation when required by the Fabrication Engineer will result in the product being deemed unacceptable. The Contractor may perform testing in addition to the minimum required. The results of all testing shall be made available to the Department.

535.08 Quality Assurance Quality Assurance (QA) is the prerogative of the Department.

The QAI will witness or review documentation, workmanship and testing to assure the Work is being performed in accordance with the Contract Documents.

The QAI has the authority to reject materials and products that do not meet the Contract requirements, including Work rejected due to denial of access or the lack of adequate notice of the beginning of production. The acceptance of material or workmanship by the QAI will not preclude subsequent rejection, if found unacceptable by the Department, at a later date.

535.09 Nonconforming Work Correct or replace nonconforming material and/or workmanship. Generate a nonconformance report (NCR) describing the nonconformance and the proposed corrective action; provide a copy to the QAI and forward a copy to the Fabrication Engineer for review.

In the event that an item does not meet the Contract requirements but is deemed suitable for use by the Department, said item may be accepted in accordance with Section 106.8, Non-Conforming Work, of the Standard Specifications.

535.10 Forms and Casting Beds Construct forms in accordance with the Working Drawings. The forms shall be well constructed, carefully aligned and sufficiently tight to prevent leakage of mortar. Reject forms that do not maintain the dimensions shown on the Working Drawings. Inspect the bulkheads after each cast and repair or replace worn or damaged pieces.

Seal wooden forms to prevent absorption of water. Apply and cure the sealer in accordance with the manufacturer's product data sheet.

Remove all paint, adherent material, foreign matter and debris prior to placing concrete.

Apply a non-staining bond-breaking compound to the forms in accordance with the manufacturer's product data sheet. Solvent clean reinforcing steel and strand contaminated with the bond-breaking compound.

535.11 Reinforcing Steel Fabricate, package, handle, store, place, splice and repair reinforcing steel in accordance with Section 503 of the Standard Specifications.

Accurately locate and securely anchor the reinforcing steel to prevent displacement during concrete placement. Install and secure all reinforcing steel prior to beginning the concrete placement.

The concrete cover shown on the reviewed Working Drawings shall be the minimum allowable cover. Use sufficient bar supports and spacers to maintain the minimum concrete cover. The bar supports and spacers shall be made of a dielectric material or other material approved by the Fabrication Engineer.

535.12 Voids and Inserts Voids shall be non-absorbent. The out-to-out dimensions of the voids shall be within 2 percent of Plan dimensions. Repair damaged voids in a manner acceptable to the Fabrication Engineer. Store, handle and place voids in a manner that prevents damage.

Accurately locate and securely anchor, securely cap and vent the voids in the form. Any portion of a void that is displaced beyond the allowable dimensional tolerances shall be cause for rejection of the slab or beam.

Open the void drains immediately upon removing the product from the form.

Recess inserts 1 inch, unless noted otherwise on the Plans.

The Department is not responsible for verifying the location of inserts or other hardware installed for the convenience of the Contractor.

535.13 Concrete New concrete mix designs and mix designs not previously approved by the Fabrication Engineer shall be qualified by trial batches prepared in accordance with AASHTO T 126 (ASTM C192). The test results shall demonstrate that the concrete meets the requirements of the Plans and this Specification. If accelerated curing is to be used in production, the test specimens shall be similarly cured.

The concrete mix design shall meet the following requirements:

Minimum cement content	658 lbs./cubic yard
Water-cement ratio *	0.40 (maximum)
Air entrainment	5-½ % to 7-½ %
Allowable Slump Flow for Self-Consolidating Concrete (SCC)	20 inches to 30 inches
Visual Stability Index(VSI) for SCC	VSI of 0 or 1, per ASTM C1611. If a mortar paste halo is present, it shall not exceed 0.25 inch.
Corrosion inhibitor **	3 gal. /c.y. (unless otherwise specified)
Silica Fume (when used)	5% to 10% of cement content by weight
Fly Ash (when used)	40% of cementitious material (maximum)
Slag (when used)	50% of cementitious material (maximum)

* For the purpose of calculating water cement ratios, one U.S. gallon of water shall be considered to weigh 8.34 pounds.
** The water in the corrosion inhibitor solution shall be included when calculating the water-cement ratio.

The concrete mix design shall be proportioned so that the concrete achieves transfer strength within twenty four hours of the completion of the placement if the release strength is 6,000 psi,

or less. If two consecutive placements fail to meet the above requirements, no further placements shall take place until corrective action is taken by the Contractor.

535.14 Concrete Placement Do not batch or place concrete until all the form(s) for any continuous placement have been inspected and accepted by the QCI, and the QAI concurs.

Test concrete in accordance with the following Standards:

AASHTO T 22 (ASTM C39) Test Method for Compressive Strength of Cylindrical Concrete Specimens
AASHTO T23 (ASTM C31) Practice for Making and Curing Concrete Test Specimens in the Field
AASHTO T141 (ASTM C172) Practice for Sampling Freshly Mixed Concrete
AASHTO T152 (ASTM C231) Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
AASHTO T196 (ASTM C173) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C1064 Test Method for Temperature of Freshly mixed Portland Cement Concrete
ASTM C1611 Standard Test Method for Slump Flow of Self-Consolidating Concrete

Test the first two loads of concrete for temperature, air entrainment and slump flow for SCC. If the first load is unacceptable, test the second load as the first. Continue this process until two consecutive loads are acceptable. After two consecutive loads are acceptable, the frequency of testing shall be at the discretion of the QAI.

If there is a change in the dosage rate of any admixture or a change of more than 5° F in mix temperature, then test the concrete for temperature, air entrainment and slump flow for SCC.

Test every load of 1 cubic yard, or less, from a stationary mixer or 2 cubic yards, or less, from a transit mixer for temperature, air entrainment and slump flow for SCC, prior to placing the concrete in the forms.

Perform all testing in the presence of the QAI. The QAI will designate the loads to be tested. Make cylinders used to determine release strength during the last one-third of the placement.

Place the concrete as nearly as possible to its final location. Control the depth of each lift in order to minimize entrapped air voids. The maximum depth of an unconsolidated lift shall be 18 inches. Vibrate the concrete with internal or internal and external vibrators. Do not use external vibrators, only. Insert internal vibrators vertically and penetrate the lower layer of concrete by at least 4 inches. Insert the vibrators in the concrete to assure that the radii of action of the vibrators overlaps. Hold the vibrators in position from 5 to 15 seconds; vibration time shall be reduced by 50 percent when placing SCC. Do not use vibrators to move concrete horizontally. Each lift of concrete shall have sufficient plasticity to be consolidated with subsequent lifts.

Do not re-temper the concrete with water after discharging has begun. The Contractor may add HRWR to the concrete after batching, if that practice conforms to the manufacturer's product data sheet. Discard concrete that becomes unworkable.

Do not use water or water-based products to aid in finishing fresh concrete.

After the concrete has been placed and finished, and before the forms are covered, remove all concrete from projecting reinforcing steel.

Measure and record the concrete cover at each void location after void hold-downs have been removed. The QAI will indicate the number and location of the measurements.

535.15 Process Control Test Cylinders Make concrete test cylinders for each day's cast and each form bed used. Cylinders tested to determine strand release strength and design strength shall be field cured in accordance with AASHTO T23 (ASTM C31). 28 day cylinders shall be standard cured. Record unit identification, entrained air content, water-cement ratio, slump flow and temperature of the sampled concrete at the time of cylinder casting. At least once per week, the Contractor shall make 2 concrete cylinders (6 cylinders when the Contract includes permeability requirements) for use by the Department; cylinders shall be standard cured in accordance with AASHTO T23 (ASTM C31).

If the Contractor fails to make enough cylinders to demonstrate that the product meets the Contract requirements, the product will be considered nonconforming work.

The compressive strength of the concrete will be determined by averaging the compressive strength of two test cylinders made from the same sample. For the purpose of detensioning prestressed products, neither of the test cylinders shall have a compressive strength less than the minimum required transfer strength. For the purpose of determining design strength, the average of two cylinders shall meet or exceed the design strength, and the difference in strength between the two shall be no more than 10 percent of the higher strength cylinder.

Perform compressive strength testing to determine transfer and design strength in the presence of the QAI. Cylinder tests not witnessed by the QAI will not be acceptable.

535.16 Curing by Moisture Retention Cure the concrete in accordance with MNL 116, Section 4.20. Moist cure the concrete until it has reached design strength.

Do not use membrane- forming curing compounds without the approval of the Fabrication Engineer. If membrane-forming curing compounds are authorized, follow the requirements of MNL 116 and the curing compound manufacturer's published recommendations.

535.17 Accelerated Curing of Concrete (Optional) Cure the concrete in accordance with MNL 116, Section 4.19, except as modified herein.

After initial set, the temperature gain of the concrete shall not exceed 40°F per hour. Initial set shall be determined in accordance with ASTM C403, Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance; a strength gain of 500 psi indicates initial set. The maximum allowable concrete temperature shall be 160°F. Concrete temperature shall be measured near each end of the casting bed and at intervals not to exceed 100 feet. In order to qualify for accelerated cure, the concrete temperature shall attain a minimum temperature of 120°F; that temperature shall be maintained for a minimum of 8 hours and the concrete shall achieve a minimum of 80 percent of design strength.

Detension precast/prestressed products immediately after the completion of the curing cycle while the products are warm and moist. The accelerated curing cycle shall be considered complete when the method of supplying heat is stopped and/or the concrete temperature drops below 120°F. Two cylinders shall be tested immediately upon completion of the accelerated cure cycle. Products that have not achieved all of the above criteria shall be moist cured until the concrete has achieved design strength.

If the precast/prestressed concrete products have achieved 80 percent of design strength during the accelerated curing cycle, no further curing will be required.

535.18 Prestressing Tension the strands in accordance with MNL 116 and this Specification.

Provide stressing calculations to the QAI prior to tensioning strands. Do not tension the strands until the QAI has reviewed the calculations. Apply initial force and final force to the strands in the presence of the QAI. The QCI shall be present to monitor and document the application of initial force, final force and the elongation of the strands.

Tension strands in an orderly sequence to avoid snags and entanglements. When strands from two, or more, coils are used, identify the locations of the different strand lots. Calculate the elongation and adjusted gauge pressure readings for each modulus of elasticity and cross sectional area of the strands.

Prior to tensioning, cycle the hydraulic jacking devices until the hydraulic fluid reaches normal operating temperature.

After initial tensioning, establish a permanent and clearly visible reference mark on the strand to determine strand elongation after final tensioning. Measure the strand elongation to the nearest 1/16 inch.

If the strands have been tensioned for more than 48 hours without concrete being placed in the forms, test a minimum of 10 percent of the strands, but not less than two strands in each row and not less than two strands in draped strand arrays, by applying the theoretical force used during the final tensioning to each of the strands. If additional elongation is gained, subtract the amount gained from the theoretical elongation. If the result of the theoretical elongation minus the gain in elongation is less than the minimum allowable elongation for any of the strands

tested, apply the final force to all strands. Do not measure total elongation from the original reference mark. Accept properly tensioned strand based on the force applied to the strands.

Measure and record the chuck-to-chuck distance on self-stressing beds after tensioning the first set-up and at any time the number of strands or strand array changes. Confirm that the measurement used in the stressing calculations is the same as the field measurement.

535.19 Detensioning Detension the strands in accordance with MNL 116 and this Specification. Use a carburizing flame. Heat a minimum length of 6 inches of the strand slowly so that only one wire is released at a time. Cut both ends and any intermediate points simultaneously. Failure to maintain symmetry of cutting or causing sudden shock to the product will make it subject to rejection. Detension the strands in the presence of the QAI and QCI.

Measure any strand slippage on all precast/prestressed concrete products. Mark all strands prior to detensioning. Measure a minimum of four strands per row. The QAI will choose the strands to be measured.

535.20 Finishing Concrete and Repairing Defects Precast/prestressed concrete products fabricated under this Section shall meet Standard Grade finish requirements as defined in MNL 116, except that the Contractor shall rub fascia units in accordance with Section 502 of the Standard Specifications. Abrasive blast fascia surfaces prior to finishing. The Contractor may use alternative methods of achieving an acceptable finish on fascia units, if approved by the Fabrication Engineer.

Repair honeycombing, ragged or irregular edges and other non-structural or cosmetic defects using a patching material from the MaineDOT Qualified Products List (QPL). The repair, including preparation of the repair area, mixing and application and curing of the patching material, shall be in accordance with the manufacturer's product data sheet. Corners that are not exposed in the final product may be ground smooth with no further repair necessary if the depth of the defect does not exceed 1/2 inch. Remove form ties and other hardware to a depth of not less than 1 inch from the face of the concrete and patch the holes using a patching material from the MaineDOT QPL.

Repair structural defects only with the approval of the Fabrication Engineer. Submit a nonconformance report (NCR) to the Fabrication Engineer with a proposed repair procedure. Do not perform structural repairs without an NCR that has been reviewed by the Fabrication Engineer. Structural defects include, but are not be limited to, exposed reinforcing steel or strand, cracks in bearing areas, through cracks and cracks 0.013 inch in width that extend more than 12 inches in length in any direction. Give the QAI adequate notice prior to beginning any structural repairs.

Make chamfers and drip notches smooth and uniform. Sandblast keyways to remove mortar paste prior to shipping. Recess strand ends 1 inch and patch the holes with a patching material from the MaineDOT QPL. Coat the entire ends of the precast/prestressed concrete units with a

bituminous protective coating unless otherwise specified on the Plans or as directed by the Fabrication Engineer.

535.21 Precast/prestressed Deck Panels Produce precast/prestressed deck panels in accordance with the Plans and Specifications. Cure the deck panels in accordance with Sections 535.16 or 535.17.

535.22 Tolerances Product dimensional tolerances shall be in conformance with the latest edition of MNL 116, Appendix B, as applicable to the particular product (e.g., slab, I-girder. box beam), the Plans and this Specification. Use Box Beam fabrication tolerances for voided slabs and use Double T tolerances for NEXT beams. In case of dispute, the Fabrication Engineer shall determine the allowable tolerance.

535.23 Transportation and Storage Handle and store material using lifting devices. Handle and transport precast/prestressed units so that the reactions with respect to the unit shall be approximately the same during transportation and storage as in its final position. Do not transport units until the 28 day design strength has been attained.

Support stored precast/prestressed units above the ground on dunnage in a manner to prevent twisting or distortion. Protect the units from discoloration and damage.

Repair or replace precast/prestressed concrete units damaged by improper storing, hoisting or handling.

535.24 Installation of Slabs, Beams and Girders Finish bearing areas to the elevations shown on the Plans and in accordance with Section 523, Bearings, as applicable.

Lift the units using the lifting devices cast into them. Support I-Girders at the abutments and piers to prevent overturning. Place beams and slabs in their final location in a manner that assures that the keyways are spaced properly and the post-tensioning ducts are in alignment. Use compressible gaskets around duct openings within keyways to prevent blocking of the duct with grout.

Prior to grouting, initially post-tension slabs or beams to 5,000 lbs. force, per strand. Make a permanent and clearly visible reference mark on each strand after it has been initially post-tensioned in order to determine strand elongation after final post-tensioning.

Immediately prior to grouting, clean the keyways between slab or box units and soak the keyways with water in order to prevent absorption of water from the grout. Seal the bottom of the keyways to prevent the loss of grout.

Fill longitudinal keyways between slabs or beams with a non-shrink, flowable, cementitious grout with a minimum design compressive strength of 6,000 psi at 28 days. The grout shall be a material for keyways from the MaineDOT QPL. Mix, place and cure the grout in accordance with the manufacturer's product data sheet. The Contractor may propose the use of an alternate

grout material supplied from a MaineDOT approved ready mixed concrete batch plant. Ready mixed grout shall achieve a design compressive strength of 6,000 psi at 28 days, have an entrained air content of between 6.0 and 9.0 percent, be non-shrink, flowable, and contain a non-shrink additive listed on the MaineDOT QPL for expansive cements. The proposed grout mix design shall be submitted to the Department for approval.

Do not perform final post-tensioning of slabs or beams less than 24 hours after completion of the grouting operation. Final post-tension precast/prestressed concrete slabs or beams to 41,000 lbs. force per strand, unless otherwise specified on the Plans. Provide a jacking device that has been calibrated in accordance with MNL 116. Provide calibration documentation, a calibration curve and stressing calculations to the Resident, allowing adequate time for review. Do not post-tension slabs or beams until the documentation has been reviewed by the Department. Post-tension the slabs or beams in the presence of the Resident. No vehicular traffic, including the Contractor's equipment, shall be allowed on the bridge until post-tensioning is complete.

Saw cut or abrasive cut the post-tensioning strand of slabs or beams no closer than 1-¼ inches from the wedges after tensioning is complete. Coat the strand ends and wedges with a corrosion inhibiting grease and cap the ends with a watertight cover.

Pack and neatly finish the post-tensioning recesses of slabs or beams with a grout made of the same brand and type of cement used to cast the slabs or beams. Clean the post-tensioning recesses prior to packing the grout.

535.25 Installation of Precast/Prestressed Deck Panels Erect deck panels as shown on the Plans or reviewed Working Drawings, as applicable. Adjust the bottom-of-slab elevation using threaded jacking devices cast into the panels, or by other means approved by the Resident.

Fill the voids between the top of the beam and the bottom of the panels, as shown on the Plans, reviewed Working Drawings or Standard Details, as applicable, with a non-shrink, flowable, cementitious grout with a minimum design compressive strength of 6,000 psi at 28 days. The grout shall be a material for keyways from the MaineDOT QPL. Mix, place and cure the grout in accordance with the manufacturer's published product data sheet. Provide vent holes at 3-foot intervals to avoid air locks. The Contractor may propose the use of an alternate grout material supplied from a MaineDOT approved ready mixed concrete batch plant. Ready mixed grout shall achieve a design compressive strength of 6,000 psi at 28 days, have an entrained air content of between 6.0 and 9.0 percent, be non shrink, flowable, and contain a non shrink additive listed on the MaineDOT QPL for expansive cements. The proposed grout mix design shall be submitted to the Department for approval.

Prevent concrete leakage between the deck panels using caulking, backer rod or other methods approved by the Resident.

Remove all visible contaminants from the deck panels and protruding reinforcing steel by abrasive blast cleaning or high pressure (minimum of 8,000 psi) water cleaning, prior to placing the deck concrete.

535.26 Method of Measurement Prestressed structural concrete items will be measured by the lump sum, except that precast deck panels will be measured as part of the structural concrete slab Pay Item(s).

535.27 Basis of Payment Acceptable work done under Precast, Prestressed Concrete Superstructure will be paid for at the Contract lump sum price for the respective Pay Item; all work associated with precast deck panels will be considered incidental to the structural concrete slab Pay Item(s). Payment will be full compensation for furnishing all materials, labor and equipment in the precast/prestressed work, including concrete, strand, reinforcing steel, anchor dowels and related items. Related items will include, but not be limited to: Working Drawings, preformed pads, transportation, erecting the units, drilling and grouting of anchor dowels, grouting of keyways, panels and ducts, tensioning and post-tensioning operations, and required concrete admixtures.

Payment will be made under:

Pay Item		Pay Unit
535.60	Prestressed Structural Concrete Slab	Lump Sum
535.61	Prestressed Structural Concrete I-Girders	Lump Sum
535.62	Prestressed Structural Concrete Box Beams	Lump Sum
535.622	Prestressed Structural Concrete NEXT Beam	Lump Sum