SECTION 504 - PRESTRESSED CONCRETE MEMBERS

504.01 Description. This section describes prestressing precast or cast-in-place concrete by furnishing, placing, and tensioning of prestressing steel; and includes prestressing by either pretensioning or post-tensioning methods or combination of both methods.

The work shall include furnishing and installing prestressed concrete members complete in place, including concrete, prestressing steel, reinforcing steel; and appurtenant items necessary for the particular prestressing system to be used, including ducts, anchorage assemblies, and grout used for pressure grouting ducts.

When members are to be constructed with part of the reinforcement pretensioned and part post-tensioned, applicable requirements of these specifications shall apply to each method.

504.02 Materials.

(A) Portland Cement Concrete. Portland cement concrete shall conform to Section 601 - Structural Concrete, and the following:

Place concrete in prestressed concrete members with cement content of not less than 658 pounds nor more than 893 pounds of cement per cubic yard.

Unless otherwise indicated in the contract documents, for prestressed members, place concrete with minimum 28-day compressive strength of 6,000 pounds per square inch.

Use nominal size aggregate of 1 inch maximum.

Incorporate into the concrete mixture, water-reducing admixture conforming to Subsection 711.03(C) - Admixture Usage .

Use batch sizes that will enable initial concrete workability to be maintained throughout concrete placement. Concrete slump shall be the minimum necessary for satisfactory concrete placement, without honeycomb. Retempering will not be allowed.

(B) Other Materials.

Reinforcing Steel	709.01
Prestressing Steel	709.03
Admixtures	711.03
Water	712.01

504.03 Construction.

(A) General.

(1) Design. Design, fabricate, and erect prestressed members in accordance with *AASHTO LRFD Bridge Design Specifications*, including the latest interim revisions.

For girders, alternative design may be submitted using pretensioning or post-tensioning methods, or a combination of these methods. Do not make changes in prestressing force and prestressing force centroid unless accepted by the Engineer. Changes in cross section of girder will not be permitted. If design uses post-tensioning exclusively, use end block with minimum length equal to depth of girder, at each end of girder. If design uses combination of pretensioning and post-tensioning, end blocks may be required, subject to stress requirements.

Do not make changes in size, spacing, or shape of reinforcing steel. Increasing or rearranging reinforcing steel in ends of members may be accepted, as required by prestressing method .

Compute quantity of prestressing steel to be furnished for post-tensioning on basis that maximum tensile stress in prestressing steel at jacking end, regardless of actual jacking stress, shall not exceed 70 percent of specified minimum ultimate tensile strength of prestressing steel.

Working force and working stress are defined as the force and stress remaining in prestressing steel after losses. Losses include the following:

(a) Creep and shrinkage of concrete.

(b) Elastic compression of concrete.

(c) Steel relaxation.

(d) Losses in post-tensioned prestressing steel due to sequence of stressing, friction, and take up of anchorages.

(e) Other losses peculiar to method or system of prestressing.

For alternative design, submit the following: six copies of preliminary plans and engineering calculations not later than three weeks after contract award; and 10 copies of final plans and engineering calculations at least 20 working days before fabrication.

Alternative design plans and engineering calculations shall be stamped and signed by a Hawaii Licensed Structural Engineer. Prepare alternative plans on tracings 22-3/4 inches wide by 36 inches long, with 2-inch margin on left side and 1/2-inch margin on other sides. Place title block in lower-right corner, listing project and providing description of sheet contents. Convert alternative design plans into latest version of microstation electronic files that are compatible with the State format. Submit tracings with Engineer's stamp and signature, and electronic files after final acceptance. Tracings and electronic files, once submitted, become property of the State.

(2) Shop Drawings. Prior to casting prestressed members, submit 10 copies of shop drawings, including complete outline and details of the following: prestressing method; materials; pattern of prestressing steel; equipment proposed for use in prestressing operations; elongation calculations; sequence of stressing and releasing; complete specifications and details of prestressing steel and anchoring devices; anchoring stresses; type of enclosures; and other data for prestressing operation. Prestressing operation includes proposed arrangement of prestressing steel in members, pressure-grouting materials, and equipment. Obtain shop drawing acceptance prior to casting.

(3) Prestressing Operations Personnel. In lieu of a PCI-certified plant, obtain services of qualified equipment manufacturer's representative to train and guide project personnel in the use of prestressing equipment and materials installation, as necessary to attain required results. Provide a skilled technician, trained and certified by the qualified equipment manufacturer's representative, to supervise prestressing operations. Submit certification of prestressing operations supervisor.

(4) Electric Welding. When performing electric welding on or near members containing prestressing steel, attach welding ground directly to steel. Protect prestressing steel from temporary exposure to excessive temperatures produced by torches, welding equipment, sparks, or arcing.

(5) Tolerances. Fabricate prestressed concrete members to plan dimensions, within tolerances, in accordance with Product Dimension Tolerances, PCI MNL-116, *Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products*. Actual acceptance or rejection of members having dimensions outside tolerance limits will depend on how the Engineer believes those dimensional defects would affect structure's strength or appearance.

Modify and schedule fabrication of prestressed concrete members such that any increase in camber due to time, creep or other factors shall not cause total camber to exceed maximum camber immediately prior to erection of girders as indicated in the contract documents. Any prestressed concrete member that exceeds maximum camber specified in the contract documents will be rejected.

(6) Form Fabrication. Tool form fabrication facilities to provide for form construction at sufficient level of accuracy to produce product within required tolerances.

Store forms in manner that provides protection from dimensional, surface, and structural damage.

After stringing and tensioning, inspect strands for accuracy of alignment and contamination by form release agent or other surface coatings. If contaminated, clean strands using method accepted by the Engineer.

For fabrication of precast or prestressed structural products, or both, a Hawaii Licensed Structural Engineer shall design self-stressing forms, bed abutments, and anchorages. Submit information on capacity of each bed and self-stressing form, in terms of allowable prestress force and corresponding center-of-gravity above form base.

(B) Prestressing Equipment. Tension prestressing steel by hydraulic jacks or other means acceptable to the Engineer. Equip each jack used to stress tendons with either pressure gage or load cell, for determining jacking force. Submit accepted calibration chart for each jack. A qualified laboratory shall calibrate jack and gage as one unit, with cylinder extension in approximate position so that jack will be at final jacking force in accordance with ASTM E 4. If used, calibrate load cell and equip with indicator to determine prestressing force in tendon. Load cell range shall be such that lower 10 percent of manufacturer's rated capacity will not be used in determining jacking force.

Submit information as specified in ASTM E 4 at least two weeks before using each jack. Limit variation of calibration curve to ±5 percent within loading range of jacking unit. Calibrate jacking equipment after each repair and at intervals not exceeding two years for load cell and one year for gage and jack. The Engineer may require recalibration at any time if accuracy of jacking unit is in doubt.

The Engineer may verify prestressing force with State-furnished load cell. Provide sufficient labor, equipment, and material to install, support, and protect load cell at prestressing tendons and to remove load cell after verification is complete, as ordered by the Engineer.

Use pressure gages with indicating dials at least 6 inches in diameter and accuracy in reading of 1 percent or better.

Use identical tensioning equipment on each end of the prestressed member when performing non-simultaneous post tensioning at both ends.

Seat anchorage cones with hydraulically operated pistons.

Take safety measures to prevent accidents due to possible breaking of prestressing steel or slipping of grips during tensioning process. Submit safety plans.

(C) Prestressing Steel. Protect prestressing steel from physical damage and rust or other corrosion, from time of manufacture until encased in grout or concrete. Prestressing steel that has sustained physical damage or exhibits surface pitting, etching, or other results of corrosion, other than rust stains, will be rejected.

Package prestressing steel in containers or shipping forms to protect steel from physical damage and corrosion during shipping and storage. Place corrosion inhibitor that prevents rust or other results of corrosion in package or forms; or incorporate in corrosion inhibitor carrier-type packaging material. Immediately replace or restore to original conditions, any damaged packaging or forms. When permitted by the Engineer, corrosion inhibitor may be applied directly to steel.

Inhibitor shall have no deleterious effect on steel or concrete or bond strength of steel to concrete. Immediately replace or restore damaged packaging or forms to original conditions.

Mark shipping package or form clearly to indicate the following:

(1) Package contains high-strength prestressing steel.

(2) Package needs to be handled with care.

(3) Type, kind, and amount of corrosion inhibitor used, including date when placed, safety orders, and instructions for use.

When placed in the work before stressing, clean prestressing steel free of oil, dirt, corrosion, scale, and other foreign matter.

Continuously protect prestressing steel installed in ducts against rust or other corrosion by means of corrosion inhibitor placed in ducts or applied to prestressing steel in ducts, unless ducts are grouted within 10 days after installation of prestressing steel. Use corrosion inhibitor conforming to specified requirements.

Tension prestressing steel by using hydraulic jacks with calibrated pressure gage or load cell, so that force in prestressing steel is not less than value specified on shop drawings accepted by the Engineer. Verify gage or load cell readings with measured elongations.

Apply preliminary force to tendons to eliminate take-up in tensioning system before elongation readings are started. Preliminary force shall be between 5 and 25 percent of final jacking force. Mark each strand prior to final stressing to permit measurement of elongation and to ensure that anchor wedges set properly.

Consider force in prestressing steel as the smaller of two values determined by measured elongation and gage or load cell reading. If difference in stress, as obtained by measured elongation and gage or load cell reading, exceeds 5 percent of required prestressing force, terminate stressing operation. Submit data indicating cause of stress difference and proposed corrective action. Suspend tensioning operations until the Engineer has accepted the corrective action.

Submit daily record of gage pressures, jacking forces, seating losses, and elongations.

(D) Placing Steel. Straighten wires, strands, wire groups, parallel-lay cables, and other prestressing elements to ensure proper positioning in enclosures for prestressed reinforcement.

Use suitable horizontal and vertical bar supports or spacers to hold wires or strands in true position in enclosures. Do not use all-plastic bar supports or spacers.

(E) Pretensioning Method. Hold prestressing elements accurately in position while jacking. Keep record of jacking force and elongations produced. Several units may be cast in one continuous line and stressed at one time. Use of completed units in line as part of anchorage system will not be allowed. Leave sufficient space between ends of units to permit access for cutting after concrete has attained the required strength.

When prestressing by multi-strand jacking method, apply uniform, preliminary force to strands in accordance with requirements of Subsection 504.03(C) - Prestressing Steel, before fully pretensioning. Measure initial tension of each strand by dynamometer, gage, load cell, or other means accepted by the Engineer. After initial tensioning, continue to stress strands until elongation and jacking force indicated in the contract documents have been attained.

If deflecting pretensioned strands, elongate strands first to a straight line; then deflect strands to final position in a manner that provides initial pretension in deflected strands, as indicated in the contract documents. Use other methods of tensioning deflected strands only with acceptance of the Engineer.

Use low-friction devices at points of change in strand trajectory slope at time of tensioning of draped pretensioned strands.

When creating friction on or against strands during post tensioning, perform friction test in accordance with post-tension method.

Transfer pretension force to concrete when concrete attains compressive strength of at least 4,000 pounds per square inch, unless larger value is specified in the contract documents. For prestressed piles, pretension force may be transferred to concrete when concrete attains compressive strength of 3,500 pounds per square inch, as indicated by tests on cylinders made at time of concrete placement and cured in same manner as pile.

Before transferring pretension force to members, obtain pattern acceptance and strand-releasing schedule from the Engineer. Strip or loosen forms that restrict horizontal or vertical movement of member. Do not release strands until all strands in member have been stressed and accepted by the Engineer.

Release hold-down anchors for deflected strands in sequence shown on shop drawings accepted by the Engineer.

Transfer prestress by either multiple strand release method or by single strand release method.

When using multiple strand release method, release symmetrical group of strands or all strands gradually and simultaneously. Transfer strand load to jacking system, then gradually release jack(s) to relax strand loads.

When using single strand release method, release strands by slow-heat cutting, using low oxygen flame. Do not cut strands quickly. Following sequence of pattern and schedule of strand release, slowly heat each strand by moving low oxygen flame back and forth within a distance of 6 inches along strand, until necking down of strand wire occurs. Allow each strand to pull itself apart.

When member ends are not continuous, cut off exposed ends of prestressing steel not embedded in concrete, flush with member ends. Heavily coat cut-off exposed ends of prestressing steel with roofing asphalt or coal tar.

When member ends are continuous, extend prestressing steel embedded in concrete beyond member ends, as ordered by the Engineer.

(F) Placing Concrete. Submit production schedule at least seven days prior to casting. Place items to be encased in concrete accurately in position and secure them in a manner that prevents displacement during placing and setting of concrete.

Vibrate precast or cast-in-place unit concrete internally or externally, or use both methods. Apply internal vibration to concrete for time intervals of approximately 10 seconds and distance intervals of not more than 30 inches apart. Do not use vibrators to move concrete horizontally in form. Avoid displacement of reinforcement, prestressing strands, sheaths, shoes, and inserts.

Place concrete for each precast or cast-in-place unit in minimum of two continuous lifts. Do not exceed 30 minutes between placing continuous lifts of concrete. For I-beam sections, ensure that thickness of first layer is such that top of concrete is slightly above top of bottom fillet. Modify casting procedure if concrete sets before next lift is placed.

Make concrete test cylinders for each day's production, test, and cure them in accordance with Subsection 601.03(B) – Design and Designation of Concrete. Furnish number of cylinders and methods of test, as ordered by the Engineer. Perform testing for concrete compressive strength at location where prestressed concrete members are manufactured.

(G) Curing. Steam cure under suitable enclosure that contains live steam and minimizes moisture and heat losses. Provide initial application of steam at 2 to 4 hours after final concrete placement. If retarders are used, increase waiting period before application of steam to 4 to 6 hours. Use steam at 100 percent relative humidity. Do not apply steam directly on concrete or on forms in a manner that would cause localized high temperatures. During application of steam, increase ambient air temperature within curing enclosure at rate not to exceed 40 degrees F per hour, until the maximum temperature between 140 to 160 degrees F is reached. Maintain this temperature until desired strength of concrete is attained. In discontinuing steaming, limit rate of decrease in ambient air temperature within curing enclosure to maximum of 40 degrees F per hour, until temperature of approximately 20 degrees F above air temperature to which concrete will be exposed to has been reached. Then, expose concrete. Keep exposed surfaces wet with fog spray, wet blankets, or other methods accepted by the Engineer. Submit steam curing temperature charts.

Water curing will be allowed in lieu of steam curing for prestressed members. Maintain water curing for at least 7 days after placing concrete.

If required steam or water curing is completed and time lapses before prestress is applied to units under fabrication, keep units continuously wet until units are prestressed. Submit method of continued curing.

(H) Post-tensioning Method.

(1) Ducts. Use bonded-type, post-tensioned prestressed members. Install tensioned steel in holes, zinc-coated metal ducts cast in concrete. Bond tensioned steel to surrounding concrete by filling tubes or ducts with grout. Completely fill void spaces with grout, removing entrapped air and water. Grout ducts within 3 days after tensioning prestressing steel. Allow grout to set for not less than 3 days before handling, inducing loading, or stressing members.

To provide holes for placement of post-tensioned, bonded tendons, use rigid, zinc-coated ferrous metal ducts that are mortar tight, conforming to requirements of AASHTO LRFD Bridge Construction Specifications Subsection 10.8 - Ducts.

Fabricate metal ducts with either welded or interlocked seams. Zinc coating of welded seam will not be required. Use ducts with sufficient strength to maintain correct alignment during concrete placement. Use positive metallic connections that do not result in angle changes at joints between duct sections. Waterproof joints with tape, sheet metal, or other materials acceptable to the Engineer. Bend ducts without crimping or flattening. Zinc coating of metal transition couplings that connect ducts to anchoring devices will not be required.

Make duct alignment a smooth, parabolic curve with no visible kinks or abrupt changes in direction. Submit shop drawings to locate and align ducts. Place duct accurately, at locations shown on shop drawings.

For injection of grout after prestressing, provide ducts or anchorage assemblies with pipes or other suitable connections. When bars are used, furnish prestressing steel ducts with minimum inside diameter 3/8 inch larger than bar diameter. Fasten prestressing steel ducts securely in place to prevent movement. After installation in forms, cover ends of ducts as necessary to prevent entry of water or debris. If prestressing steel is installed after concrete placement, demonstrate to the Engineer that ducts are free of water and debris.

Before placing forms for top slabs of box girder cells, show that either prestressing steel is free and unbonded in duct; or prestressing steel has not yet been in place, and that ducts are unobstructed.

Before post-tensioning members, show that prestressing steel is free and unbonded in duct.

Immediately before grouting, flush ducts thoroughly with clean water and use compressed air to remove surplus water.

Use water containing either quick lime (calcium oxide) or slaked lime (calcium hydroxide), in amount of 0.1 pound per gallon, for flushing ducts. Use oil-free, compressed air to blow out ducts.

For long or continuous members with draped strands of 400 feet maximum lengths, open taps will be required at high or low points of duct, or both.

(2) Anchorages. Secure post-tensioned prestressing steel at ends by permanent-type, positive anchoring devices. Loop tendon anchorages will not be allowed.

Anchorages shall develop at least 96 percent of actual ultimate strength of prestressing steel, when tested in an unbonded state, without exceeding anticipated set.

Distribute load from anchoring device to concrete by devices that shall effectively distribute load to concrete. Anchoring devices shall conform to the following requirements:

(a) Final unit compressive stress on concrete directly beneath plate or assembly shall not exceed 3,000 pounds per square inch.

(b) Bending stresses in plates or assemblies induced by pull of prestressing shall not exceed yield point of material or cause visible distortion in anchorage plate when applying 95 percent of specified ultimate tensile strength of tendons.

Steel distribution plates or assemblies may be omitted if anchoring devices furnished are used in conjunction with steel grillage embedded in concrete and adequately sized to distribute compressive stresses to concrete.

After completion of duct grouting, clean concrete surfaces by abrasive blasting and expose clean aggregate.

When end of post-tensioned assembly will not be covered by concrete, recess anchoring devices so that ends of prestressing steel and all parts of anchoring devices are at least 2 inches inside end surface of members. Following post-tensioning, fill recesses with grout and finish flush.

(3) Friction Tests. Prior to final tensioning of prestressing steel, first submit test procedures, then conduct friction tests to verify friction losses used in calculating working force. Conduct at least two friction tests for each different tendon or duct length and profile. Submit test results at completion of testing. Consider testing costs to be incidental to prestressing operation. The Engineer will not pay for conducting tests and submitting test procedures and results separately.

(4) Tensioning Process. Strands in each tendon, except for those in flat ducts with not more than four strands, shall be stressed simultaneously with a multi-strand jack. Unless otherwise indicated in the contract documents or shop drawings accepted by the Engineer, tendons in continuous post-tensioned members shall be tensioned by jacking at each end of tendon. For straight tendons and when one-end stressing is indicated in the contract documents, tensioning may be performed by jacking from one end or both ends of tendon, at the Contractor's option.

Conduct tensioning process to allow tension and elongation to be measured. Do not apply loads to concrete until strength specified for pretensioning method is attained. Apply loads no sooner than 10 days after last concrete placement. Stressing sequence shall be such that temporary, lateral eccentricity is minimized.

(5) Grouting. Prepackage grouts in moisture proof containers. Indicate application, date of manufacture, lot number and mixing instructions in grout bags. Any change of materials or material sources requires new testing and certification of the conformance of the grout with this Specification. Furnish to the Engineer and the Contractor a copy of the Quality Control Date Sheet for each lot number and shipment sent to the job site. Test materials with a total time from manufacture to usage in excess of six months and certify that the product conforms to the QC Control Specifications before use. Remove and replace materials if test does not conform to QC Control Specifications.

Mix grout material in accordance with the manufacturer's recommendations.

Grout shall not contain aluminum powder or components, which produce hydrogen, carbon dioxide or oxygen gas.

Use the following standard and modified ASTM test methods conducted at normal laboratory temperature (65 to 78 degrees F) and conditions in Table 504.03-1 – Grout Properties to determine grout to be in compliance with requirements.

Table 504.03-1 – Grout Properties

Property	Test Value	Test Method
Total Chloride Ions	Max. 0.08 percent by weight of cementitious material	ASTM C 1152
Fine Aggregate (if utilized)	99 percent passing No. 50 Sieve (300 micron)	ASTM C 136*
Hardened Height Change @ 24 hours and 28 days	0.0 percent to 1.0 +0.2 percent	ASTM C 1090**
Expansion	2.0 percent for up to three hours	ASTM C 940
Compressive Strength 28 days (Average of 3 cubes)	7,000 psi	ASTM C 942
Initial Set of Grout	Min. three hours Max. 12 hours	ASTM C 953

Table 504.03-1 – Grout Properties (Continued)

Property	Test Value	Test Method
Fluidity Test *** Efflux Time from Flow Cone		
(a) Immediately after mixing	Min. 20 Second. Max. 30 Second.	ASTM C 939
	Or Min. nine Second. Max. 20 Second.	ASTM C 939****
(b) 30 minutes after mixing with remixing for 30 second.	Max. 30 Second.	ASTM C 939
	Or Max. 30 Second.	ASTM C 939****
Bleeding @ three hours	Max. 0.0 percent	ASTM C 940*****
Permeability @ 28 days	Max. 2500 coulombs At 30 V for six hours	ASTM C 1202

* Use ASTM C 117 procedure modified to use No. 50 sieve. Determine percent passing No. 50 sieve after washing sieve.
** Modify ASTM C 1090 to include verification at both 24 hours and 28 days.
*** Achieve adjustments to flow rates by strict compliance with manufacturer’s recommendations.
**** Grout fluidity shall meet with standard ASTM C939 flow cone test or modified test described herein. Modify ASTM C939 test by filling cone to top instead of to standard level. Efflux time is time to fill one liter container placed directly under flow cone.

Table 504.03-1 – Grout Properties (Continued)
***** Modify ASTM C940 to conform with wick induced bleed test as follows: (a) Use wick made of 20 inch length of ASTM A 416 seven wire 0.5 inch diameter strand. Wrap strand with 2 inch wide duct or electrical tape at each end prior to cutting to avoid splaying of wires when cut. Degrease (with acetone or hexane solvent) and wire brush to remove any surface rust on strand before temperature conditioning. (b) Condition dry ingredients, mixing water, prestressing strand and test apparatus overnight at 65 to 75 degrees F. (c) Mix conditioned dry ingredients with conditioned mixing water and place 800 milliliters of resulting grout into 1,000 milliliters graduate cylinder. Measure and record level of top of grout. (d) Completely insert strand into graduate cylinder. Center and fasten strand so it remains essentially parallel to vertical axis of cylinder. Measure and record level of top of grout. (e) Store mixed grout at temperature range listed above in (b). (f) Measure level of bleed water every 15 minutes for first hour and hourly for two successive readings thereafter. (g) Calculate bleed water, if any, at end of three hour test period and resulting expansion per procedures outlined in ASTM C940, with quantity of bleed water expressed as percent of initial grout volume. Note if bleed water remains above or below top of original grout height. Note if any bleed water is absorbed into specimen during test.

Perform a conditioned laboratory high temperature grout fluidity test as described below using production grouting equipment utilizing both mixing and storage tanks. Grouts must conform to requirements for grout physical properties including initial fluidity test. For test to be successful, grout must have an efflux time of not greater than 30 seconds at end of one hour test period. Efflux time may be determined by either ASTM C939 or the modified ASTM C939 described herein.

(a) Perform test in temperature conditioned laboratory. Condition room, grout, water, duct, pump, mixer and all other equipment to be used to temperature of 90 degrees F for minimum of 12 hours prior to test.

(b) Use 400 feet (± 10 feet) of duct (tube) for test. Use duct with a nominal inside diameter of 1 inch.

(c) Mix grout to specified water content. Pump grout through duct until grout discharges from outlet end of duct and is returned to pump.

(d) Start one hour test period after duct is completely filled with grout. Record time to circulate grout through duct. Constantly pump and recirculate grout into commercial grout mixer storage tank.

(e) Pump and recirculate grout for a minimum of one hour.

(f) Record at 15 minute intervals throughout test period, pumping pressure at inlet, grout temperature, and fluidity at discharge outlet.

Perform ACTM as outlined in Appendix B of "Specification for Grouting of Post-Tensioning Structures" published by the Post-Tensioning Institute. Report time to corrosion for both grout being tested and control sample using a 0.45 water-cement ratio neat grout. Grout shows a longer average time to corrosion in ACTM than control sample and time to corrosion exceed 1,000 hours is considered satisfactory.

Use grouting equipment capable of grouting at pressure of at least 100 pounds per square inch; and equipped with pressure gage having full-scale reading of not more than 300 pounds per square inch.

Use standby flushing equipment capable of developing pumping pressure of 250 pounds per square inch and flushing partially grouted ducts.

Clean ducts and remove water and deleterious materials that would impair bonding of grout or interfere with grouting procedures.

Use grout that will pass through screen with 0.07087-inch maximum clear openings prior to being introduced into grout pump.

Fit grout injection pipes, vents, and ejection pipes with positive mechanical shutoff valves that can withstand pumping pressures. Do not remove or open valves and caps until grout has set. Prevent leakage of grout through anchorage assembly by positive mechanical means.

Pump grout through duct and continuously waste grout at outlet until no visible slugs of water or air are ejected; and efflux time of ejected grout is not less than 11 seconds.

Close outlet and allow pumping pressure to build to a minimum of 75 pounds per square inch before inlet valve is closed.

Grout shall not be above 90 degrees F during mixing or pumping. If necessary, cool mixing water.

(I) Handling, Storage, and Transportation. Precast pretensioned members may be handled immediately after transferring prestressing forces to concrete. Post-tensioned members may be handled three days after grout in hole or duct has set. For members with combination of both pretensioning and post-tensioning, the Engineer will determine time of handling.

If stressing of prestressed members is not performed in a continuous operation, do not handle or disturb prestressed members until they are stressed to sustain all forces and bending moments due to handling.

Maintain beams and girders in upright position. Pick up and support beams and girders at points near their ends. Pick up piles at pick-up points indicated in the contract documents. Support piles at pick-up points. Piles may be supported at other locations when accepted by the Engineer in writing.

Stabilize storage areas and provide suitable foundations for precast prestressed members.

Separate and support stacked members by battens placed across full width of each bearing location. Arrange battens in same vertical planes and at support locations as described in this subsection. Stack members so that lifting devices are accessible and undamaged. Do not use upper members of stacked tier as storage areas for shorter members or heavy equipment.

During transportation, make provisions for supporting members as described in this subsection, with adequate bracing to maintain vertical position and dampen vibrations. Provide adequate padding material between tie chains or cables to prevent chipping of concrete.

Take measures to prevent precast units from cracking or damage during storage, hoisting, and handling. Replace units damaged by improper storing or handling at no increase in contract price or contract time.

Submit working drawings for proper member support at each stage of handling, storage, transportation and placing prior to concrete placement of diaphragms. Member support shall minimize warping, bowing and the possibility of loss of support or bearing.

Do not store member on road travelway or shoulder.

Do not place member when wind velocity could cause member to swing beyond control of crane operator or other placing personnel. During operation, do not allow member to swing, cross over, or be above lanes carrying public traffic. Do not allow member, crane, or any lifting machine to be on or above air space of private property near construction site.

(J) Placing. Place precast, prestressed concrete members in structure, as indicated in the contract documents. Avoid unbalanced loading on supports. Provide temporary bracing of girders to ensure accurate positioning and stability during construction.

504.04 Measurement. Prestressed concrete members will be paid on a lump sum basis. Measurement for payment will not apply.

504.05 Payment. The Engineer will pay for the accepted prestressed concrete members on a contract lump sum basis. Payment will be full compensation for the work prescribed in this section and the contract documents.

The Engineer will pay for the following pay item when included in the proposal schedule:

Pay Item	**Pay Unit**
Type ____ Prestressed Concrete ____	Lump Sum

The Engineer will pay for prestressed concrete piling in accordance with and under Section 505 - Piling.

END OF SECTION 504