SECTION 906

PRESTRESSED CONCRETE MEMBERS

INDEX

906.01 SCOPE

This section covers all prestressed components used in bridge structures and includes both pre-tensioning and post-tensioning methods.

The Contractor shall furnish all labour, materials, equipment, plant and services specified, indicated or required to manufacture, transport, store and install the prestressed concrete and/or prestressed steel components in accordance with the plans and specifications.

906.02 GENERAL

Post-tensioning in general, post-tensioning materials, grouting, preparations for post-tensioning, application and measurement of prestressing force shall conform to CSA A23.1 “Concrete Materials and Methods of Concrete Construction.”

Cast in place concrete or optionally precast at the site shall conform to CSA A23.1.

Precast concrete and pre-tensioning operations shall conform to CSA A23.4 “Precast Concrete – Materials and Construction.”

Welding will not be permitted within 3.0 metres of any tendon without adequate protection of the prestressing steel from welding sparks. Under no circumstances shall prestressing steel be used to ground welding equipment.

906.02.01 Design Submissions

For Department provided girder designs, Contractor shall provide shop drawings meeting the requirements of 906.02.03. Drawings shall clearly indicate any Contractor specified components such as, but not limited to, hold downs, hold ups, lifting anchors, etc.

For non-Department provided girder designs, or a design which, in the Department’s opinion, has been significantly modified by the Contractor, the Contractor shall provide calculations in accordance with Section 927. In addition, the following shall apply:

1. The Contractor is responsible for all costs associated with the design and implementation of the alternate girders. This includes but is not limited to: the design and implementation of any changes to the structure that are required to accommodate the Contractor’s design, bearing details, screed elevations, haunch elevations, and abutment modifications.
2. The design live load and design reactions for the girder will be clearly stated on the shop drawings. If requested by the Owner’s Representative, the reactions for different load cases shall be provided.

906.02.02 Approvals and Casting

The Contractor shall clearly indicate at the preconstruction meeting their intention to cast the concrete members on site or at an accepted plant. The method of prestressing to be used shall be either pre-tensioning or post-tensioning as detailed on the drawings unless otherwise accepted.

Prior to construction of pre-tensioned members, the Contractor shall submit to the Owner’s Representative for review the name of the plant from which it is intended to order the members. Only members supplied from a plant, accepted by the Owner’s Representative, will be accepted for payment.

906.02.03 Prestressing Method

Prior to casting any concrete to be prestressed, the Contractor shall submit to the Owner's Representative for review 1 Hard copy and one 1 Electronic copy of: 1 set of metric design calculations and a complete set of metric drawings. These details shall outline the method and sequence of stressing and shall include but is not limited to: complete specifications and details of the prestressing steel and anchoring devices, e.g. anchorage block out dimensions and angles, anchoring stresses, elongation calculations, type of enclosures, and all other data pertaining to the prestressing steel in the members, pressure grouting materials and equipment, size and spacing of diaphragm and end block reinforcement, where applicable.

The prestress supplier shall determine the prestress anchorage bearing plate/casting as well as the spiral steel directly behind and adjacent to the same.

906.02.04 Inspection and Testing

At all times the Owner's Representative and Engineer of Record shall have the right to inspect and accept all methods, plant and materials involved. This shall include the right to momentarily stop jacking in order to measure the elongation and jacking pressure from initial to final load on as many cables as deemed appropriate by the Owner's Representative and/or Engineer of Record.

906.02.05 Member Top Flanges

Members whose top flanges become the bottom form for the deck slab shall have the flange designed to safely accommodate all temporary construction loads.

The top surface of prestressed members, against which new concrete is to be placed, shall be intentionally roughened while it is sufficiently plastic so that the depth of the indentations is at least 5 millimetres and the spacing is not greater than 15 millimetres. All concrete surfaces against which new concrete is to be placed shall be clean, sound, and free from any loose particles and laitance.

906.02.06 False work

Sound, adjustable false work in accordance with Section 907 shall be required to compensate for any settlement such that the structure, particularly the soffit, is constructed true to line and grade. The prestressed concrete is not self supporting until stressing, anchoring, grouting and proper curing have been carried out. Except as noted on the contract drawings and as outlined in the Specifications, false work may be removed after these operations have been completed. The prestressing ducts, strands and anchorages must be accurately and rigidly fixed in position before any concrete is placed.

In addition to the requirements of Section 907, forms for prestressed members shall also meet the following requirements:

1. Forms shall be smooth, clean, free from warps, splits, holes and bulges and shall be constructed and maintained to be mortar tight and free from warps and open joints due to shrinking or other causes.

2. Forms shall be designed and constructed strong enough to withstand the effect of placing and vibrating of concrete without movement or leakage and to permit the unrestrained shrinkage or elastic shortening of the concrete so that the forms remain true to line and grade.

3. Forms used for prestressed members shall be inspected by the Owner's Representative prior to use. Formwork which is damaged, deformed or is otherwise deemed unacceptable by the Owner's Representative shall be replaced at the Contractor's expense. Examples of unacceptable formwork includes, but is not limited to, the following:

    1. Formwork which has gaps between formwork connections or is otherwise not mortar tight.

    2. Formwork surfaces or connections that have one or more forming surface deformations or inconsistencies that result in a deviation from a perfectly flat surface by more than 10mm.

The use of expanding foam, caulking or another product to create mortar tight joints between formwork sections will not be considered acceptable.

906.03 MATERIALS

906.03.01 Concrete

All concrete work shall conform to the requirements of the Section 904, unless otherwise stated herein.

The minimum ultimate compressive strength of the concrete shall be as shown on the plans and at the time of tensioning shall be verified by the Owner's Representative from the results of the field cured test cylinders.

Care shall be taken to ensure that the test cylinders are compacted and cured under conditions similar to the conditions acting on the concrete in place. At least 3 specimens

shall be tested from each batch prior to tensioning the cables and at least 3 specimens at 28 days.

No concrete shall be deposited in the forms until the placing of reinforcing steel, enclosures, anchorages and prestressing steel has been inspected and accepted by the Owner's Representative.

An inspection and testing company may be appointed by the Owner's Representative to inspect and control quality of materials. If so, separate payment will be arranged for by the Department. The Contractor shall provide, without charge, all materials required for test purposes and give all necessary cooperation.

906.03.02 Reinforcing Steel

If the steel used in the deck is black steel reinforcement or galvanized steel reinforcement, the reinforcing steel in prestressed members shall meet the requirements of "Galvanized Steel Reinforcement" in Section 905 unless noted otherwise in the contract documents.

If the steel used in the deck is stainless steel reinforcement, the reinforcing steel in the prestressed members shall meet the requirements of "Stainless Steel Reinforcement" in Section 905 unless noted otherwise in the contract documents.

906.03.03 Prestressing Steel

All prestressing steel shall be protected against damage, rust and other corrosion and shall be free of all dirt, oil, grease and other deleterious substances when finally grouted in the deck. Splicing of prestressing steel bars only shall be permitted to manufacturers' specifications. Splicing of strands or wire is not permitted.

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

The Contractor shall furnish one sample, 1500 mm long from each manufactured reel of wire, strand or mill heat of bar prestressing steel for testing purposes. The Owner's Representative will select the samples of prestressing steel from the job site and all materials for testing shall be furnished by the Contractor at their own expense.

The Contractor shall have no claim for additional compensation in the event their work is delayed awaiting review of the materials.

The approval of any material by the Owner's Representative shall not preclude subsequent rejection if the material is damaged in transit or later damaged or found to be defective.

Prestressing steel shall be high tensile strength 7-wire strand or bar as shown on the contract drawings, fabricated, sampled and tested in accordance with the requirements of ASTM A 416/A 416M "Specification for Steel Strand, Uncoated, Seven Wire for Prestressed Concrete" and ASTM A 421/A 421M "Standard Specification for Uncoated Stress Relieved Steel Wire for Prestressed Concrete" and to the satisfaction of the Owner's Representative. Storage of prestress steel and components shall be in accordance with ASTM A 416/A 416M and ASTM A 421/A 421M and the environment shall not be wet, humid or subject to the accumulation of moisture.

2 copies of the mill certificate and 2 copies of the stress-strain curves representative of the actual lots to be used shall be submitted to the Owner's Representative with samples.

Prestressing steel shall be high tensile strength 7-wire strand or bar as shown on the contract drawings, fabricated, sampled and tested in accordance with the requirements of 416/A 416M and A 421/A 421M.

Tendons shall consist of parallel wires or strands composed of the required number of high tensile, cold-drawn, low-relaxation (stabilized) strands. Positive end anchorage shall be provided on each end of the tendon after threading through the terminal hardware. The tendon shall be enclosed in mortar-tight flexible metal conduit.

The pre-assembled connection between the conduit and the end bearing assemblies shall be adequate to ensure a mortar tight enclosure from terminal to terminal. The anchor shall provide for grout passage into the tendon. The supplier of the tendons shall furnish grout fittings for attachment to the terminal hardware.

High tensile strength steel shall be from steel made by the open hearth, electric furnace or basic oxygen process to produce the desired high tensile strength. Strand shall have a nominal diameter of 15.24 millimetres, minimum ultimate tensile strength of 260.6 kN and a nominal end area of 140.0 square millimetres per strand, or as otherwise indicated on the contract drawings.

Steel grade shall be 1860 MPa unless otherwise specified on the contract drawings.

Oil tempered steel shall not be employed for use in prestressed concrete construction.

The complete stress-strain curve for the steel shall be obtained for each heat or lot of steel used in the entire project and shall be used as data for stressing of the steel of that particular heat or lot. Steel shall be clearly identified during transportation and storage.

The Contractor shall furnish one entire tendon complete with anchorages, one complete coupling device and all hardware for testing and evaluation purposes unless waived by the Department. If the tendon and/or associated hardware has not been previously used in Newfoundland and Labrador, the Contractor shall supply a sample for evaluation and testing purposes. Any components which in the opinion of the Owner's Representative, fall below the quality of the sample provided shall not be used in the works.

906.03.04 Ducts

Ducts for prestressing steel shall be made of accepted galvanized rigid or semi-rigid corrugated steel tubing with mechanical joint connections of the diameter as shown on the drawings. Rigid ducts shall have a minimum wall thickness of 0.60 millimetres and be capable of being bent to a minimum inside radius of 9 metres without distress. Semi-rigid ducts shall have a minimum wall thickness of 0.25 millimetres and be capable of being bent to a minimum inside radius of 3.5 metres without distress. The wobble friction coefficient (k) shall not exceed 0.0023 per metre and 0.0033 per metre for rigid and semi-rigid ducts respectively. The curvature friction coefficient (μ) shall not exceed 0.20 for both duct types. Rigid ducts shall be used for longitudinal tendons and semi-rigid ducts used for transverse tendons unless otherwise specified in the contract documents.

Ducts shall be watertight and of sufficient strength to withstand all forces imposed upon them during placing of concrete without denting, sagging or leaking. All ducts and anchorage assemblies shall be provided with any necessary air vents and pipes for the injection of grout after prestressing. Grouting ducts and vents shall be located at all high points and at both ends of all longitudinal tendons. For transverse tendons, grouting ducts and vents shall be located at both ends of all tendons and at all high points when the vertical distance between the lowest and highest point in the duct exceeds 400 millimetres.

906.03.05 Anchorage Assemblies

The anchorages shall be of an accepted type as indicated on the contract drawings for the size of tendons shown on the drawings complete with all required spiral reinforcement.

Anchoring hardware shall meet the minimum requirements set forth in CSA A23.1. Moreover, the anchorage components, i.e. the bearing plate, wedges, anchor head and/or casting to develop at least 100% of the ultimate tendon capacity but the prestressing steel as anchored is permitted to fail at 95% of the ultimate tendon capacity.

All reinforcement, duct work, cones and/or anchorages shall be fastened firmly so that no movement can occur when concrete is placed. Anchorages shall be held tight to the end forms so that no laitance can leak down the face of the cone or bearing plates. Enclosures shall be protected against the entrance of foreign matter prior to grouting particularly in cold weather.

The anchorages shall be placed in the position shown on the contract drawings. The axis of the anchorage must coincide with the axis of the cable passing through it. Details of end anchorages, i.e. block out dimensions and angles shall be determined by the prestress supplier in coordination with the Owner's Representative.

906.03.06 Round Void Forms

When required the type of round void form used shall be in accordance with the following table:

OUTSIDE DIAMETER OF VOID	TYPE OF ROUND VOID FORM
OVER 930 MM	1.2 MM GALVANIZED CORRUGATED METAL PIPE
630 MM - 930 MM	1.0 MM GALVANIZED CORRUGATED METAL PIPE
UNDER 630 MM	1.0 MM GALVANIZED CORRUGATED METAL PIPE OR SONOVOID TUBES, TYPE D, 100% DUROBOARD OR ACCEPTED EQUAL

Metal void forms shall have outside diameter (top of corrugations to top of corrugation) equal to the diameter of the voids shown on the drawings.

Void tubes made of fibrous material shall be protected against damage during storage and handling and shall be protected from moisture and water at all times. Adequate ventilation shall be provided to prevent damage due to humidity. The void tubes shall not be stored on the site for more than seven days before installation.

The void tubes shall be designed to withstand the forces imposed on them during concreting and until the concrete has set up, without deformation such as bulging, sagging or collapse.

Damaged tubes shall not be used.

All void tubes must be accurately placed and rigidly fixed in position before any concrete is placed. The Contractor shall pay particular attention to the buoyancy of the voids and adequate measures shall be taken to counteract the same. No concrete shall be placed until the installation of the tubes has been inspected and accepted by the Owner's Representative.

906.03.07 Other Components

Other components, including but not limited to, dowels, hold-downs, or other inserts shall be hot dipped galvanized, with the exception of threaded dowel inserts, which shall be hot dipped galvanized or painted with a zinc rich metallic paint.

906.04 DIMENSIONAL TOLERANCES

The following dimensional tolerances will be allowed:

LENGTH	= ± 10 MM
CROSS SECTION	= ± 3 MM FROM EACH DIM. (NOT CUMULATIVE)
TENDON POSITIONING	= ± 3 MM FROM EACH DIM. (NOT CUMULATIVE)
CONCRETE COVER	= ± 3 MM FROM EACH DIM. (NOT CUMULATIVE)
ALIGNMENT	= ± 3 MM MAX. IN ANY 3 M LENGTH
CAMBER DIFERENTIAL BETWEEEN ADJACENT PRESTRESSED MEMBERS	= 20 MM MAX.

In addition, camber in the prestressed members immediately after stressing or de-tensioning shall not vary more than 50% of the calculated value. Camber due to member dead load only, at the time of placing the deck slab, shall not be more than 20 millimetres greater than the initial camber without review by the Owner's Representative and Engineer of Record.

Deck slab surface under full dead load shall be to the grades indicated on the drawings. The deck slab thickness shall be constant between the top flanges of adjacent members. In order to meet these criteria the Contractor shall haunch the deck slab over the member or protrude the member a maximum of 20 millimetres into the deck slab or both, as indicated on the drawings.

For prestressed slab superstructures the deck slab surface and soffit shall be to the grades indicated on the drawings immediately after stressing, unless otherwise indicated in the contract documents.

906.05 PLACING CONCRETE, STRESSING AND GROUTING TENDONS

The minimum concrete strength at stressing shall be 30 MPa unless otherwise specified on the contract drawings.

906.05.01 Placing

Concrete must not be deposited in the forms until the Owner's Representative has inspected the placing of the reinforcement, ducts, anchorages, prestressing steel and has given their acceptance thereof.

Bar reinforcing steel and prestressing steel shall be placed accurately at the locations shown on the drawings or accepted by the Engineer of Record. The distance from the forms shall be maintained by plastic bar chairs, spacers, hangers or hold down devices. Within a 5.0 metre longitudinal distance from support locations i.e. piers and abutments, a tolerance of ± 6 millimetres will be permitted in the placing of prestressing ducts. At all other locations a tolerance of ± 12 millimetres will be permitted.

Post-tensioning ducts must be held securely at intervals of 500 millimetres or less against vertical or horizontal displacement from true alignment during the placing of concrete.

Holes shall be provided for anchor dowels and for diaphragm dowels which pass through the member, openings for connection rods, recesses for grout and holes for railing bolts in the members shall be provided in accordance with the details shown on the drawings.

Where diaphragm dowels do not pass through the member, the dowels shall be anchored in the member by embedment in the concrete or by means of accepted threaded inserts.

Where openings for diaphragm dowels are provided, these dowels shall be grouted in place after the installation of the member in the structure.

Where continuous prestressed concrete slab type construction is required, the deck shall be cast in one continuous concrete placing operation commencing at the lower end of the structure.

The concrete must be vibrated externally and can be vibrated internally as required to consolidate the concrete. The vibrating shall be done with care and in such a manner

that reinforcing steel, ducts and prestressing steel will not be displaced. Vibrators shall operate at a minimum frequency of 160 Hz for the internal type and 60 Hz for the external type.

All curing methods shall be subject to the Owner's Representative's review. Curing shall be in accordance with Section 904.05.

906.05.02 Prestressing Technician

The Contractor shall provide at their own expense a technician familiar with the type of prestressing involved, accepted by the Owner's Representative, to supervise all prestressing work. This technician shall be present at the completion of the steel installation and just prior to concreting operations, at stressing and grouting operations.

The prestressing supplier shall formally certify in writing that the stressing technician being employed on the works has sufficient knowledge and experience to undertake and successfully complete the prestressing, grouting and associated work.

906.05.03 Stressing

All prestressing steel shall be stressed by means of hydraulic jacks which shall be equipped with accurately calibrated hydraulic pressure gauges, damped from vibration, with a dial not less than 150 millimetres in diameter, to permit the stress to be computed at any time. A certified calibration curve shall accompany each jack, showing the relationship between gauge readings and stress in the ram for both ascending and descending movements of the ram. In general monostrand jacks shall not be used for stressing multi-strand tendons unless specifically accepted by the Designer. A monostrand jack shall be present on site during stressing operations or be available to the Contractor within a 48 hour delivery period should the need arise

A load cell attached to the jack will be accepted, as an alternative to the above, as a means of obtaining the force in the tendon provided the accuracy of the load cell is attested to by an authority acceptable to the Owner's Representative.

The stressing operation shall be conducted in a manner recommended by the manufacturer of prestressing material and only in the presence of the Owner's Representative or designated representative.

The supervisor in charge of the tensioning shall be provided with the required extension of the tendons and the jack pressure. The extension shall be carried out at an even rate, jack pressure and extension shall coincide with the required extension and pressure at the time of anchoring, due allowance being made for anchorage slippage at both ends of

the tendons. The permissible variation in specified prestress shall not be more than 95% to 100% of the theoretical jacking force or pressure for both longitudinal and transverse tendons. Moreover, the permissible variation in specified elongation shall not be more than ± 5% of the theoretical elongation for longitudinal tendons. For transverse tendons the permissible variation in specified elongation shall not be more than ± 5% of the theoretical elongation or ± 10 mm whichever is greater.

The stress in the tendons shall be measured by means of the extension of the tendons and shall be continuously checked by means of the pressure gauge on the jack. The accuracy of the jack pressure gauge shall be checked periodically. The zero error in the jack pressure shall be determined by plotting a few straight pressure readings against jack extension and extending the straight line back to determine the zero intercept.

The stressing shall be carried out as shown on the contract drawings. The tensioning shall not be commenced until the tests on the concrete cylinders, manufactured and cured under the same conditions as the prestressed member, indicate that the concrete of the member has attained the required compressive strength as shown on the contract drawings.

After the concrete is placed, no tensioning will be permitted until it is demonstrated, to the satisfaction of the Owner's Representative, that the prestressing steel is free and unbounded in the enclosure.

Any tendon in which the accuracy of the extension is doubted shall be de-stressed and restressed in the presence of the Owner's Representative.

Records of elongation, calibrated jack force readings and slip shall be kept by the Owner's Representative. Until such acceptance is obtained in writing, no tendons shall be grouted.

The prestressed steel shall be anchored at a stress that will result in the ultimate retention of working forces or stresses of not less than those shown on the plans, but in no case shall the steel be tensioned above 80% of the ultimate strength. Losses in stress due to creep, plastic flow, elastic flow and shrinkage of concrete plus creep of steel and sequence stressing, shall be computed in accordance with CSA S6 "Canadian Highway Bridge Design Code."

Prestressed strands which have been stressed and meet project criteria shall be cut off with a saw; a torch is not acceptable. The Contractor shall leave 25-50 millimetres of strand protruding beyond the visible end of the wedge.

906.05.04 Bonding And Grouting

906.05.04.01 General

The Contractor shall sandblast all concrete surfaces in anchorage boxout areas and fill the boxout with concrete of a quality similar to that used in the member. For anchorages without the tendon end cap, anchorage recesses or boxouts are to be sandblasted and filled with concrete before grouting operations commence.

All post-tensioned prestressing steel shall be bonded to the concrete by pressure grouting the ducts or openings. All stressing shall be completed before grouting begins. All areas around post-tensioned cables, strands, tendons or rods shall be completely filled with high early strength non-shrink grout.

The grouting procedure shall be reviewed by the Owner's Representative.

Generally this work shall be done as soon as the prestressing steel has been stressed and accepted and in no case shall any tensioned prestressing steel be left ungrouted for more than 7 days after prestressing.

In the case of post-tensioned slabs which contain both longitudinal and transverse prestressing steel, the maximum time permitted between the beginning of the stressing sequence and the grouting of the last cable shall not exceed two weeks.

Stressing and grouting sequences of longitudinal and transverse tendons shall be as outlined in the contract documents. The maximum time permitted between the beginning of stressing and grouting of the last cable shall not exceed two weeks.

All ducts or openings shall be clean and free of all foreign materials that would impair bonding of the grout. Each duct or opening shall be thoroughly blown out with compressed air immediately prior to grouting. Where it is found necessary, in the opinion of the Owner's Representative, the duct or opening shall be flushed out with water, prior to use of compressed air. The concrete shall have a temperature of at least 5 degrees Celsius at the time of grouting and shall be maintained at this temperature or higher for a period of at least 48 hours. If necessary this may include preheating the structure and maintaining protection for a period of three days after the grout is placed. The temperature of the grout at the time of injection shall be not less than 16 degrees Celsius nor more than 27 degrees Celsius.

906.05.04.02 Grout Materials and Grouting

Cementing materials shall consist of Type GU Portland cement and silica fume. The cement shall be according to OPSS.MUNI 1301 “Cementing Materials” and certified to be free from early stiffening tendency when tested according to CSA A3000 “Cementitious Materials Compendium.” Silica fume shall be according to CSA A3000 and in an uncompacted form. Silica fume shall constitute a 6% replacement by mass of cement in the dry grout mixture.

Superplasticizer shall be a non-retarding naphthalene sulphonate in powdered form. Superplasticizer shall constitute 1.5% by mass of cementing materials in the dry grout mixture.

Aluminum powder shall be according to ASTM D 962 “Standard Specification for Aluminum Powder and Paste Pigments for Paints” Type 1, Class C, and coated with 2.5 to 3.0% stearic acid. Aluminum powder shall be used in a quantity sufficient to provide the expansion specified herein.

Water for testing grout mixture shall be according to OPSS.MUNI 1302 “Water”.

The grout shall not bleed or segregate when allowed to stand for 1 hour immediately after mixing.

The grout shall expand by 6% ± 2% of its original volume when measured at 1 hour after mixing.

The time for the grout to flow through the flow cone shall be between 11 and 25 seconds when the measurements are performed immediately after the grout is removed from the mixer and shall remain between 11 and 25 seconds, when measured 30 minutes after mixing.

Cubes made from the grout shall have a minimum specified 28-Day compressive strength of 60 MPa.

Grout shall have a maximum water: cement ratio of not more than 0.36, not contain any trace amounts of chlorides, contain at least 6% of silica fume by weight, contain an accepted superplasticizer and an accepted expansive agent. Masterflow 1205 High Performance Duct Grout manufactured by Master Builders Inc. and MS Cable manufactured by King are two grouts which are accepted by the Department. Accepted equivalent grouts as determined by the Owner’s Representative may also be utilized.

The grout mix design and representative samples shall be submitted for review at least 14 days in advance of anticipated use. The mix design must be accepted by the Owner's Representative prior to grouting. The grout shall be mixed and placed as per the manufacturer's instructions and under the supervision of the Owner's Representative. The compressive strength of the grout shall be at least 40 MPa in 4 days. Strength tests shall be performed on 50 millimetre cubes, stored and tested in accordance with ASTM C109 "Standard Test Method for Compressive Strength of Hydraulic Cement Mortars."

The Contractor shall be responsible for all mix design and quality control of grout production and placing. Quality control and assurance of the grout from a testing viewpoint shall be provided by the Department.

When allowed to stand for 15 minutes, the grout shall not bleed or segregate. At the time of initial set, the grout shall exhibit an expansion of 6% (± 2%) of its original volume.

Grouting equipment shall be capable of grouting to a pressure of at least 1.5 MPa with a 19 millimetre minimum inside diameter grout hose, maximum pressure 1.7 MPa.

Alternatively, the grouting equipment shall be specifically designed for the job and accepted by the Owner's Representative.

Grout shall be mixed in an accepted mechanical mixer, that provides for straining and re-agitating the grout before it is used. Time between mixing and pumping the grout shall not exceed 40 minutes.

Retempering the grout will be prohibited.

The grout shall completely fill the duct or opening and shall be allowed to flow continuously and freely for 5 seconds at the outlet end of the duct or opening. In case the continuity of grouting is interrupted, the duct or opening shall be immediately cleaned out. A dependable high pressure air and water supply shall be on hand during grouting.

After grout has set, all exposed vents and hoses, in finished concrete surfaces are to be removed 50 millimetres from the finished surface. The resulting void or cavity must have all debris removed and be thoroughly cleaned. The void or cavity should be filled with SET 45, manufactured by Master Builders or an accepted equal. The Contractor shall follow the Manufacturer's recommendations and specifications in the mixing and placing of SET 45.

906.05.05 Concrete Finishing

Top flanges or surfaces which concrete will be poured against shall be finished as per 906.02.05.

Concrete surfaces which are to be exposed to weather, such as the outside faces of exterior girders, or as otherwise indicated in the contract documents shall be sealed as per Section 924.

906.05.06 Treatment at Ends of Members

The prestressing tendons at ends of members that are to be encased in concrete shall be cut flush with the ends of the beams.

Pretensioning tendons at the end of members that are not to be encased in concrete shall be cut back to recess the cable 25 millimetres from the end of member. The recess shall be cleaned and filled with a suitable patching material.

Concrete surfaces at the ends of the members that are not to be encased in concrete shall be coated with elastomeric coating.

906.06 HANDLING AND INSTALLATION OF PRESTRESSED MEMBERS

At least 7 days before starting work, the Owner's Representative shall be fully informed as to the method of handling, installation and the amount and kind of equipment proposed for use. The Contractor shall comply with the provisions of the Highway Traffic Act and make all necessary arrangements with the authorities for permission to transport.

The Contractor shall exercise extreme care in handling, storing, moving and erecting precast prestressed concrete members to avoid twisting, racking or other distortion that would result in cracking or damage to the members. The Contractor shall handle, transport and erect precast prestressed members in an upright position and keep the points of support during lifting, storing, transportation and erection within 600 mm of the points of support in the final structure. The Contractor shall not permit the reactions of the lifting devices to be inclined to the vertical at an angle greater than thirty degrees. Holes provided for lifting shall be filled with mortar when members have been placed.

The Contractor must decide upon the method by which they plan to lift the prestressed girders and submit design calculations signed and stamped by a Professional Engineer licensed to practice in the Province of Newfoundland and Labrador.

Prestressed concrete girders shall not be moved or transported until the grout has attained 30 MPa. False work shall not be removed from continuous prestressed concrete structures until the grout has attained 30 MPa. Loads in addition to member self-weight shall not be placed on the prestressed concrete members until the grout has attained 30 MPa. Grout samples shall be taken, field cured and tested to establish the appropriate time to move or transport girders, remove false work or apply loads to prestressed concrete structures. Grout samples shall also be obtained and tested for acceptance purposes.

906.06.01 Temporary Bracing

The Contractor is responsible for the stability of the prestressed girders during placing and until the diaphragms are in place.

Temporary bracing for members shall be designed according to CSA S6 using a wind load specific for the location and having a minimum return period of 10 years if the members are to be fabricated and permanently connected within the same construction season. Temporary bracing shall be designed by a Professional Engineer licensed to practice in Newfoundland and Labrador.

The supply and installation of the bracing, including all cast-inserts and fixings, at external girder ends shall be considered incidental to the work

It is the responsibility of the Contractor to ensure that girder stability is maintained at all times including during and after stressing, and under the weight of the wet slab, until the slab is cured. The brace, inserts, and plates as detailed on the contract plans to provide stability to the exterior girders during deck construction will be considered incidental to the supply and installation of the girders.

906.07 STORAGE OF PRESTRESSED MEMBERS

The period between stressing of a concrete member and the application of permanent dead loads shall not be greater than 6 months without the approval of the Engineer of Record. The Contractor shall be responsible for the monitoring of member(s) in storage including the monitoring of any cambers or other relevant dimensions as directed by the Engineer of Record and/or the Department.

No payment will be made until prestressed members are delivered to the installation site and accepted by the Owner’s Representative.

906.08 MEASUREMENT FOR PAYMENT

906.08.01 Prestressed Concrete Members Other than Post-Tensioned Slabs

The quantity of prestressed members supplied and erected for which payment shall be made shall be the total number of members required as shown on the plans.

906.08.01.01 Supply of Prestressing Steel and Accessories

Prestressing tendons including anchorages will be considered incidental to the cost of supplying any prestressed members other than post-tensioned slabs.

906.08.02 Prestressed Concrete In Post- Tensioned Slabs

906.08.02.01 Concrete

Measurement for payment will be by cubic metres of concrete placed based on neat lines shown on the plans. No deductions will be made from the volume of concrete for reinforcing or prestressing steel, anchorages or inserts. Deductions for any design voids will be made. The quantity shall include the volume of concrete in curbs, sidewalks, medians, parapets, including those on the wingwalls or as otherwise shown on the plans.

906.08.02.02 Supply of Prestressing Steel and Accessories

The quantity of prestressing tendons including anchorages for which payment shall be made shall be the total number of tendons required as shown on the plans. This will be considered incidental to the cost of the prestressed concrete in post tensioned slab structures.

906.08.02.03 Concrete Surface Finish

Payment for concrete surface finish on prestressed members shall be incidental to the supply of the member.

906.08.03 Concrete Sealing

Payment for concrete sealing shall be incidental to “Installation” for the concrete member.

906.09 BASIS OF PAYMENT

906.09.01 Prestressed Concrete Members Other than Post-Tensioned Slabs

Payment at the contract price for ”Prestressed Concrete Members Other than Post-Tensioned Slabs” in the Unit Price Table shall be full compensation for all materials, labour, equipment, plant and services necessary to complete the prestressed concrete work in accordance with the plans and as described herein.

In particular, no separate payment will be made for:

a) Supply of cement, aggregates and other materials, plant or equipment for producing the concrete.
b) Supply and placement of grout.
c) Form work and false work.
d) Supply and installation of void tubes including all drain tubes, air vents, bracing, non-corrosive chair supports, splices and end closures.
e) Sandblasting the construction joints.
f) Supply and apply accepted bonding adhesive.
g) Supply and installation for reinforcing steel except that in post-tensioned slabs.
h) Transporting and storing prestressed concrete members.
i) Any post construction jacking of the superstructure.
j) Supply of prestressing steel and accessories

Payment for prestressed concrete members, such as AASHTO or CPCI Girders and double tees, will be under "Prestressed Girders" “Supplied” and “Installed” as appropriate.

Payment for the supply of all materials, equipment, and labour to construct and transport these prestressed members shall be on a per unit basis as per bid under item “Supplied” under “Prestressed Girders”.

No payment will be made until prestressed members are delivered to the installation site and accepted by the Owner’s Representative.

Payment for the supply of all materials, equipment, cranes, and labour required to place the pre-stressed members and install temporary bracing shall be on a per unit basis as per bid under item “Installed” under “Prestressed Girders.”

Payment for “Installed” shall be made once the girders have been properly placed, without damage, into their final position and required temporary bracing has been installed.

906.09.02 Post-Tensioned Slabs

Payment for concrete in post-tensioned slabs will be as per “Superstructure Concrete” in Section 904, "Concrete Structures".

Payment at the contract price shall be full compensation for all materials, labour, equipment, plant and services necessary to complete the prestressed concrete work in accordance with the plans and as described herein.

In particular, no separate payment will be made for:

a) Supply of cement, aggregates and other materials, plant or equipment for producing the concrete.
b) Supply and placement of grout.
c) Form work and false work.
d) Supply and installation of void tubes including all drain tubes, air vents, bracing, non-corrosive chair supports, splices and end closures.
e) Sandblasting the construction joints.
f) Supply and apply accepted bonding adhesive.
h) Transporting and storing concrete members.
i) Any post construction jacking of the superstructure.

Payment for reinforcing steel in post-tensioned slabs shall be as detailed for the appropriate bid item in Section 905.

Payment for prestressing steel and accessories in post-tensioned slabs shall be as per 906.09.03.

906.09.03 Supply of Prestressing Steel and Accessories

When provided in the Contract Documents, payment at the contract price for "Supply Of Prestressing Steel And Accessories" in the Unit Price Table shall be full compensation for all materials, labour, services, plant and equipment necessary for the supply, delivery, installation and stressing of the tendons including all anchorages, bursting and spalling or end block steel and grouting as required in accordance with the contract drawings and this specification.

For post-tensioned slab structures, the materials, fabrication and placing, cost of bursting and spalling or end block steel shall be paid for under Section 905.

906.09.04 Concrete Surface Finish

Payment for concrete surface finish on all prestressed members shall be incidental to the cost of the member.

906.09.05 Concrete Sealing

Payment for concrete sealing shall be incidental to “Installation” for prestressed concrete members other than post-tensioned slabs.

Payment for concrete sealing shall be incidental to the cost of concrete for post-tensioned slabs.

906.09.06 Rejection

Honeycombing, distortion, warping, cracking, improper grouting or other evidence of inferior workmanship or failure to meet the requirements of these specifications shall be cause for rejection of any member.

Minor surface cavities or irregularities which are satisfactorily repaired shall not constitute cause for rejection. Repairs shall not be made until the Owner's Representative has inspected the extent of the irregularities and has determined whether or not the concrete member will be rejected.

Final acceptance of members will not be made until they have been installed in the structure. Members that have been tentatively accepted at the manufacturing plant but are damaged in transit shall be replaced by the Contractor at their own expense.

Erection by a non-accepted method may be cause for rejection.