



**CONSTRUCTION SPECIFICATION FOR
FORMWORK AND FALSEWORK**

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This specification covers the design and construction requirements for formwork, falsework, and temporary supports used in the construction and rehabilitation of structures.

919.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Construction

OPSS 903	Deep Foundations
OPSS 904	Concrete Structures
OPSS 906	Structural Steel
OPSS 910	Stressing Systems for Post-Tensioning

Ontario Provincial Standard Specifications, Material

OPSS 1010	Aggregates - Base, Subbase, Selected Subgrade, and Backfill Material
OPSS 1350	Concrete - Materials and Production

Ontario Ministry of Transportation Publications

Guideline for Foundation Engineering Services

MTO Forms:

PH-CC-701	Request to Proceed
PH-CC-702	Notice to Proceed
PH-CC-822	Certificate of Conformance

CSA Standards

A23.3:19	Design of Concrete Structures
G40.20/G40.21-13 (R2018)	General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel
O86:19	Engineering Design in Wood
O121:17 (R2022)	Douglas Fir Plywood
O122-16 (R2021)	Structural Glued-Laminated Timber
O151:17 (R2022)	Canadian Softwood Plywood
O153:19	Poplar Plywood
S16:19	Design of Steel Structures
S157/S157.1-17 (R2022)	Strength Design in Aluminum/Commentary on CSA S157-17, Strength Design in Aluminum
S269.1-16 (R2021)	Falsework and Formwork

ASTM International

A123/A123M-17	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
D1037-12(2020)	Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials

National Research Council (NRC)

National Building Code of Canada-2020

919.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Architectural Concrete means concrete that is permanently exposed to view and is designated as architectural concrete in the Contract Documents, and therefore requires special care in selection of the concrete materials, forming, placing, and finishing to obtain the desired architectural appearance.

Bulkhead means the vertical form that supports the end width of a concrete deck pour.

Closure Strip means a temporary separation between two regions of slab, typically precast, that will be constructed of cast-in-place concrete separately.

Culvert means a structure with a span greater than 3.0 m that is typically embedded in fill, and is used to convey water, pedestrians, vehicles, cyclists, or animals.

Draft means a small angle or taper in the formwork for re-entrant formed surfaces that facilitates release when the form is stripped.

Exposed Surface means all external formed surfaces not to be covered by backfill material.

Falsework means any temporary structural support including supporting members, bracing, and hardware, used to support all or part of the formwork or of the structure during its construction or rehabilitation until it becomes self-supporting.

Formwork means the total system of support for freshly placed concrete, including the mould, sheathing or liner that contacts the freshly placed concrete, but excluding the falsework.

Foundation means the ground immediately below the mudsills that supports the falsework or that portion of ground supporting the falsework piles.

Grade means:

- a) For steel, the designation of the quality of the steel that can be determined by referring to the appropriate CSA standard or by specimen testing.
- b) For wood, the designation of the quality of a piece of wood that can be determined by referring to the appropriate CSA Standard.
- c) For aluminum, the designation of the quality of the aluminum that can be determined by referring to the appropriate CSA standard.

Hardwood means a wood species with an average Janka hardness, according to ASTM D1037, equal to or greater than 5700 N, such as hard maple, northern red oak, or American beech.

Joist means one of a series of parallel, horizontal members, usually loaded on its narrow face, by which form material is supported.

Ledger means a horizontal flexural member usually supporting joists and resting on vertical supports.

Liner means a multi-use lining material attached to the forms that imparts an architectural face design, texture, arrangement, or configuration on the finished concrete.

Mudsill means a plank, lumber, or timber assembly, or a small footing that bears on soil and is used as a base to support falsework, framed construction, or formwork.

Shoring means a system of vertical or inclined support members, or braced frames, for forms or structure components. Shoring may be wood, metal posts, sheets, scaffold-type frames, various patented members, or other system of falsework.

Stay-in-Place Forms means forms that are not removed.

Structure means any bridge, culvert, building, tunnel, retaining wall, wharf, dock, or guideway, or any part thereof, or other reinforced concrete component designed to carry loads, including high mast pole footings and sign support footings.

Stud means one of a series of usually vertical members used in framing to support the plywood or formwork fastened to it.

Timber means felled trees or logs suitable for conversion by sawing or otherwise, or a piece of lumber, 114 mm or more in its smaller dimension, with a larger dimension not more than 51 mm greater than the smaller dimension.

Tower means a composite vertical structure of frames, braces, and accessories.

Wood means lumber and timber.

919.04 DESIGN AND SUBMISSION REQUIREMENTS

919.04.01 Design Requirements

919.04.01.01 Formwork Design

Formwork design shall be according to CSA S269.1.

Deck formwork design for precast prestressed NU girder bridges shall not rely solely on the restraint provided by temporary bracing for girders.

919.04.01.02 Falsework Design

Falsework design shall be according to CSA S269.1 and:

- a) Wood components shall be designed according to CSA O86;
- b) Structural steel components shall be designed according to CSA S16;
- c) Aluminum components shall be designed according to CSA S157;
- d) Concrete components shall be designed according to CSA A23.3;
- e) Deflections shall be designed so the finished concrete surface meets the tolerances specified in Table 1 for the surface class specified in the Contract Documents. Where the surface class of a component is not specified, it shall be assumed to be class C.

The maximum effective deflection of beams shall be limited to $L/270$, where L is the length of span. The loading for deflection shall be the weight of concrete and formwork. When deflection of a beam is 10 mm or more, provision shall be made to compensate for deflection;

- f) Where scaffolding, fabricated shoring, or proprietary products are used, the design shall be according to the manufacturer's recommendations; and,
- g) Where another authority is involved, any additional requirements specified by the authority shall also be satisfied.

919.04.01.03 Vertical Loadings

The vertical loadings shall include the effects of environmental factors, such as rain, snow; wind load; weight of reinforced concrete; self-weight of equipment; live load due to workers; material loads; any additional construction loads; post-tensioning loads; and other pertinent factors.

Falsework shall be subject to the following vertical loads:

- a) The weight of the concrete being supported or 2.5 kN/m^2 on the horizontal projected area of the formwork, whichever is the greater;
- b) The weight of concrete as it is placed. The Engineer shall consider the concrete, as it is placed, as a liquid. Unless otherwise specified in the Contract Documents, the weight of normal concrete shall be taken as 24 kN/m^3 ;
- c) The weight of the formwork supported by the falsework or 0.5 kN/m^2 of the horizontal projected area, whichever is greater;
- d) The weight of workers, equipment, and tools that is to be supported during the concrete placing and finishing operations or 2.0 kN/m^2 of horizontal projected area of formwork whichever is greater. When motorized placing equipment is used this minimum load shall be increased to 3.1 kN/m^2 ;

- e) The load due to any special conditions of construction likely to occur, such as unsymmetrical placement of concrete, impact, uplift, concentrated loads, and the additional pressure due to placing concrete by pump;
- f) The loads for temporary supports as specified in the Contract Documents;
- g) The loads due to stored materials and equipment, alterations or repair of structures; and,
- h) The accumulative loads on the falsework due to construction methodology and sequencing such as when closure strips are specified on the Contract Documents.

When there is a post-tensioning operation, the loads on falsework due to post-tensioning shall be considered.

919.04.01.04 Horizontal Loading

The horizontal loadings shall include the effects of environmental factors, such as rain, snow; wind load; concrete pressure including the rate of placing of concrete; the temperature of the concrete; the effect of vibration of the concrete; the consistency of the mix; any additional construction loads; post-tensioning loads; and other pertinent factors.

Falsework shall be subject to the following horizontal loads:

- a) The greater of:
 - i. Calculated lateral wind forces based on 1/50 probability pressures not less than those recommended by the National Building Code of Canada, with a gust effect factor of 2 and a minimum wind pressure of 0.8 kPa. A reduction factor of 0.75 may be applied to the design values for falsework and formwork systems where the duration is less than 2 years;
 - ii. A minimum transverse and longitudinal force of 2% of the total vertical loads assumed to act at the centre of gravity of these applied loads, or 1.50 kN/m of deck edge applied at the mid-depth of the deck, whichever is greater;
 - iii. Any other loads due to environmental conditions. Other environmental loads such as, but not limited to, rain and snow shall be taken into account in the design, where applicable, at the falsework Engineer's discretion unless otherwise specified in the Contract Documents;
- b) Lateral force components that would develop from vertical loads specified in the Vertical Loadings clause if applied to sloping members requiring horizontal restraint; and,
- c) Any calculated or reasonably anticipated lateral forces that may be applied to the falsework such as cable tension, inclined supports or impact from concrete placing operations or moving equipment.

919.04.01.05 Tower Leg Loads

The vertical loads on the tower legs may be based on simple span assumptions. The loads supported by a tower leg may be assumed to be those loads applied to the area immediately above the tower leg that is bounded by lines located at the centreline between each of the bays adjacent to the tower leg being considered.

When locating towers, the following criteria shall apply:

- a) The maximum design load on one leg of a frame shall not exceed four times the design load on the other leg under full or partial loading conditions; and,
- b) The maximum design load on one of the two frames making up a tower shall not exceed four times the design load on the opposite frame under any loading condition.

919.04.01.06 Minimum Bracing Requirements

919.04.01.06.01 General

The minimum bracing requirements are according to the Minimum Bracing Requirements clauses.

919.04.01.06.02 Connections Between Joists and Ledgers

Every fourth joist shall be connected to a ledger.

Ledgers on top of frames shall be axially continuous across the shoring system to evenly distribute horizontal forces to individual scaffold towers below. Ledgers with a splice designed to take the axial load are considered axially continuous.

919.04.01.06.03 Bracing in the Transverse Direction

When the shoring height is composed of three frames, or the shoring height is more than three times the tower width, or the total shoring height is more than 5 m, one horizontal brace made continuous shall be installed on one face of each tower.

The brace shall be located at the mid-height of a two-frame tower and at the top of the second frame for a three-frame tower.

When shoring towers are adequately braced against transverse movement by tying to an adjacent structure or adjacent tower, the above height-to-width restriction applies only to the tower grouping.

When the shoring height is composed of more than three frames, at least one horizontal brace made continuous and one diagonal brace made continuous shall be attached to one transverse face of each tower for every three frames of shoring height. In addition, the maximum spacing of the horizontal brace shall be three times the tower width. The horizontal brace shall be located near the top of a frame. Diagonal braces on adjacent towers shall be installed in opposite directions.

When superelevation is 4% or greater, a horizontal transverse brace shall be attached to one tower face of the top frame in addition to the bracing required by the preceding paragraph.

When the shoring height is greater than 20 m, guy wires shall be installed. The spacing of the guy wires shall not be greater than 15 m horizontally.

919.04.01.06.04 Bracing in the Longitudinal Direction

When the shoring height is composed of three frames or the total height is more than 5 m, one horizontal brace made continuous shall be installed with a horizontal spacing no more than 6 m apart. The brace shall be located at the top of the first frame of a two-frame tower and the top of the second frame of a three-frame tower.

When the shoring height is composed of four frames or more, horizontal braces and diagonal braces made continuous shall be attached on a tower and spaced horizontally not more than 6 m apart. The lowest brace shall be located no higher than the third frame and additional braces shall be spaced vertically at the top of every third frame thereafter.

When the bridge is on a longitudinal grade of 4% or greater, braces parallel to the grade shall be attached to one tower face of the top frame and spaced not more than 6 m apart horizontally.

919.04.01.06.05 Tie Back Bracing - Falsework Opening Towers

The falsework opening towers shall be longitudinally braced to two rows of scaffold towers behind them according to the Bracing in the Longitudinal Direction clause requirements, regardless of the height, and shall be continuously braced transversely.

919.04.01.07 Mudsills

Mudsills shall be designed such that the settlement of mudsills shall not exceed 12 mm.

919.04.02 Submission Requirements

919.04.02.01 Working Drawings

919.04.02.01.01 General

The seals and signatures of a design Engineer and a design-checking Engineer shall be affixed on the Working Drawings, including any revisions, verifying that the drawings are consistent with the requirements of the Contract Documents and sound engineering practices. The Contractor's Engineer shall clearly indicate on the Working Drawings whether or not post tensioning effects are taken into consideration.

Where multi-discipline engineering work is depicted on the same Working Drawing and the design or design-checking Engineer or both are unable to seal and sign the Working Drawing for all aspects of the work, the drawing shall be sealed and signed by as many additional design and design-checking Engineers as necessary.

When other authorities are involved, one set of Working Drawings shall be submitted for each authority at least 5 weeks prior to the commencement of falsework construction.

The Contractor shall have a sealed and signed copy of the Working Drawings on the site at all times from assembly, erection, use and cycling, through to dismantling.

919.04.02.01.02 Falsework

Working Drawings shall be submitted for all falsework used in the construction or rehabilitation of structures, except for culverts less than 3.0 m in span.

Falsework Working Drawings shall be submitted to the Contract Administrator at least 1 Day prior to commencement of erection of falsework for each structure.

The Working Drawings for the falsework for each structure shall include all details of all falsework to be erected and shall include at least the following:

- a) Longitudinal, lateral, vertical, live, impact, and anticipated construction loads used in the design;
- b) A description of the subsurface conditions;
- c) Allowable bearing capacity of the soil beneath the mudsills. Reduction of the bearing capacity of existing ground or compacted fill, due to water or ice, shall be prevented by suitable drainage or protection;
- d) Details of foundation on sloping ground;
- e) Foundation preparation details;
- f) Foundation construction details;
- g) Maximum column loads;
- h) Deflection diagrams for beams having a deflection of 10 mm or more;
- i) The grade and actual size of all structural materials;
- j) Posts, connections, bracing and welding sufficiently detailed to demonstrate compliance with the structural analysis and erection requirements;
- k) Fully detailed frame shoring;
- l) Type and mass of moving or stationary equipment to be supported by the falsework;
- m) Sequence, method, and rate of concrete placement;

- n) All proprietary equipment sufficiently identified to demonstrate compliance with the structural analysis and erection requirements;
- o) Full details and locations of all splices;
- p) Method of maintaining rotational and lateral stability of structure members;
- q) Vertical stiffening details and lateral restraint for ledgers and subledgers;
- r) Lateral restraint details for falsework supporting beams spanning openings;
- s) Fluid concrete loads, assumed for design purposes;
- t) Location of screed rail supports and design load;
- u) Anticipated settlement of falsework, including settlement of mudsill.

919.04.02.01.03 Formwork

919.04.02.01.03.01 General

Working Drawings are required for the following formwork:

- a) Inside forms for internal voids in post-tensioned decks;
- b) Bulkheads in post-tensioned decks 2.0 m or greater in height;
- c) All columns and walls, 2.4 m or greater in height, of abutments, piers, and retaining walls;
- d) Architectural finishes except those for components in structural Standard Drawings.

Working Drawings for other formwork shall only be submitted when specified in the Contract Documents.

Formwork Working Drawings shall be submitted to the Contract Administrator at least 1 Day prior to commencement of erection of formwork.

The Working Drawings shall show all necessary design and construction details, including the grade and size of materials used, and the pressure diagrams used in the design.

919.04.02.01.03.02 Splices for Stay-In-Place Forms

Details of the method of joining stay-in-place forms shall be shown on the Working Drawings.

919.04.02.01.03.03 Architectural Finishes

Working Drawings for architectural concrete shall also include jointing of facing panels; locations and details of form ties, rustications, and recesses; and details of joints, anchorages, types of liner material and other accessories for formed surfaces designated as architectural concrete in the Contract Documents.

919.04.02.02 Falsework Foundation Design Report

The subsurface conditions shall be assessed at the site to determine if additional information is required to facilitate the design and construction of the falsework foundation. If additional subsurface information is required, a field investigation and laboratory analyses shall be conducted according to the most current version of the Guideline for Foundation Engineering Services.

A falsework foundation design report shall be submitted to the Contract Administrator at least 3 weeks prior to commencement of work under this item. The falsework foundation design report shall be signed and sealed by a foundation Engineer and foundation checking Engineer employed by a firm registered in RAQS - Geotechnical

(Structures and Embankments) - medium complexity.

The falsework foundation design report shall include:

- a) A description of the subsurface and groundwater conditions;
- b) Discussion and recommendations regarding the foundation options and vertical and horizontal bearing/axial resistances; and,
- c) Construction considerations including but not limited to site preparation details.

919.04.02.03 Permission to Use Other Structures

Formwork and falsework shall not be supported by, braced to, or come in contact with another structure unless written permission is received from the owner of the other structure. A request to receive written permission shall be submitted to the owner of the other structure including a copy of Working Drawings showing the support locations and imposed loads as they are applied to that structure, and certification that the structure can safely support all the imposed loads from the Contractor's method of construction.

919.04.02.04 Proprietary Shoring, Forms, and Accessories

When proprietary shoring, forms, and accessories are used, the manufacturers' documentation shall be submitted with the Working Drawings including but not limited to:

- a) Rated capacities indicating limit states or working stress method of all components and assemblies with supporting test data where applicable;
- b) Load and deflection charts for standard applications;
- c) Recommended use for intended applications;
- d) Method of erection and dismantling of equipment;
- e) Maintenance manuals and procedures, including items requiring special attention during formwork erection or dismantling; and,
- f) Safety factors, according to CSA S269.1, used to establish safe working loads for components and assemblies.

919.04.02.05 Revised Submissions

When falsework design considerations or field conditions necessitate amendments to the falsework, revisions shall be submitted to the Contract Administrator according to the Working Drawings clause.

919.05 MATERIALS

919.05.01 General

Forms and falsework shall be constructed of wood, metal, concrete, or foam.

Substitution of other materials is not permitted unless approval is received from the Contract Administrator.

919.05.02 Accessories

All accessories used shall comply with the details shown on the Working Drawings or with the recommendations of the manufacturer of the specified accessory.

Deck hangers and hardware left embedded in concrete shall be hot dip galvanized. Only bridge deck hangers shall be permitted to protrude from the concrete surface.

All form ties left in place in concrete barrier and concrete parapet walls shall be hot dip galvanized or non-corrodible.

Where stainless steel or glass fibre reinforced polymer (GFRP) reinforcement is used within a form, all form ties, hangers, and hardware left in place shall be stainless steel type 304.

The maximum diameter of plastic cones for form ties shall be 30 mm.

Hot dip galvanizing shall be according to ASTM A123/A123M.

919.05.03 Concrete

Concrete shall be according to OPSS 1350.

919.05.04 Foam

Foam shall be a closed cell solid such as expanded or extruded polystyrene.

919.05.05 Granular A

Granular A shall be according to OPSS 1010.

919.05.06 Liners

Form liners and flexible formwork shall not be fabric or textiles.

919.05.07 Metal

Structural steel shall be according to CSA G40.20/G40.21 and be of the grade shown on the Working Drawings.

Aluminum shall be according to CSA S157 and be of the alloy and temper shown on the Working Drawings.

Used metal shall be in good condition and examined prior to use. All previous fabrication, adversely affecting the required strength, or any obvious defects or signs of deterioration, deformation, or corrosion shall be corrected.

919.05.08 Plywood

Plywood for formwork shall be:

- a) Identified with a durable, legible marking from an accredited certification body, indicating the manufacturer, bond type, species, grade, and conformance to the appropriate CSA standard or approved equivalent; and,
- b) Douglas fir plywood according to CSA O121 with bond classified as exterior or exposure 1, and grade of veneer according to Table 1 for the class of concrete surface; or,
- c) Canadian softwood plywood according to CSA O151 with bond classified as exterior or exposure 1, and grade of veneer according to Table 1 for the class of concrete surface; or,
- d) Poplar plywood according to CSA O153 with bond classified as exterior or exposure 1, and grade of veneer according to Table 1 for the class of concrete surface.

Unless specified otherwise, the finish side of plywood forms for exposed surfaces are not required to meet veneer grade requirements in the following locations:

- a) The underside of a deck between girders;

- b) The ends of decks;
- c) The face of ballast walls; and,
- d) The internal faces of a culvert.

919.05.9 Proprietary Patching Materials

Proprietary patching materials shall be from the ministry's list of concrete patching materials.

919.05.10 Rustication and Reveal Strips

Materials used for forming rustications or reveals shall not be metallic.

919.05.11 Structural Glued-Laminated Timber

Structural glued-laminated timber shall be exterior grade according to CSA O122.

919.05.12 Void Tubes

919.05.12.01 Post-Tensioned Decks

Ducts for internal post-tensioning shall be according to OPSS 910.

919.05.12.02 Cross Sonic Logging (CSL) Access Tubes and Caps

Cross sonic logging (CSL) access tubes shall be according to the Contract Documents.

919.05.13 Wood

Wood shall be according to CSA O86.

919.07 CONSTRUCTION

919.07.01 Formwork

919.07.01.01 General

Forms shall be smooth; clean; free from warps, splits, holes, and bulges; and constructed and maintained to be mortar tight.

919.07.01.02 Exposed Surfaces

919.07.01.02.01 General

Forms for exposed surfaces shall be new, except that forms may be re-used for exposed surfaces providing their condition is such as to produce a surface equal to one that would be attained using new materials. Where possible, plywood used on exposed surfaces shall be in full sheets and, except when used to form the underside of deck slabs for slab-on-girder construction, shall be so arranged that the face grain is perpendicular to the studs or joists.

919.07.01.02.02 Architectural Exposed Surfaces

Forms for exposed surfaces identified as architectural concrete shall be as specified in the Contract Documents.

Contact surfaces of the formwork shall be carefully installed to produce neat and symmetrical joint patterns, unless otherwise specified. Joints shall be either vertical or horizontal and, where possible, shall be staggered to maintain structural continuity.

Panel area joints may be recessed into the concrete surface by applying rustication strips on the formed surfaces. Rustication strips may be used for construction joints on final faces only, as needed by the Contractor. Waterstops, keyways, and joint sealants may be included where required. Chamfer, rustication, or isolation strips may be placed so as to cover form joints.

Architecturally acceptable concrete surfaces shall be aesthetically compatible with minimal colour and texture variations and surface defects when viewed at a distance of 6 m or more, or as otherwise specified in the Contract Documents.

919.07.01.03 Rustication Strips

Formwork rustication strips shall have a draft of at least 15 degrees. Wooden strips shall have widths at least equal to their depths and shall be kerfed on the backside to prevent binding. All rustication strips or other inserts shall be installed continuously tight to the form contact surface. Rustication strips shall be uniform in dimensions, non-absorbent, and of sufficient stiffness to maintain alignment during concrete placement operations. Intersections of rustication strips shall be mitered or coped to fit snugly.

919.07.01.04 Studs, Joists, and Decking

Studs and joists shall be spaced not more than 400 mm on centres. Edges of abutting sheets shall be nailed to the same stud or joist with 50 mm nails at not more than 200 mm centres. When used to form the underside of deck slabs in post-tensioned slab and rigid frame bridges, the joints between sheets abutting over joists shall be staggered a minimum of 400 mm. When prefabricated form panels are used, adjacent panels shall be placed such that the joints are maintained flush.

919.07.01.05 Form Release Oil

Non-staining form release oil shall be applied to the faces of forms against which concrete is to be placed. The form release oil shall be applied before placing steel reinforcement.

919.07.01.06 Form Ties

When internal form ties are used, concrete cover to any metal left upon removal of the forms shall be 20 mm minimum.

All ties, securing stay-in-place forms in position and extending below the deck soffit shall be loosened before any stressing commences.

Holes left in the deck soffit after removal of hanger coil rods shall be left open. Holes left in concrete from the use of sleeved form ties shall be filled with a mortar from the ministry's list of proprietary patching material, after removal of formwork.

919.07.01.07 Exposed Corners

All exposed corners on concrete work and the edges of the box void slabs on the soffit of the structure shall be chamfered. The chamfer shall have a vertical and horizontal dimension of 20 mm, unless otherwise specified in the Contract Documents.

919.07.01.08 Stay-in-Place Forms

Stay-in-place forms shall only be used when specified in the Contract Documents or under the following conditions:

- a) Round void tubes in cast-in-place hollow prestressed concrete decks and in precast prestressed hollow slab deck units. Void tubes shall be formed with foam.
Where round voids are used, individual lengths shall be joined by an inner or outer sleeve or other method. Details of the method of joining shall be submitted to the Contract Administrator; or
- b) Box girder voids less than 1.2 m in depth, which shall be formed with foam.

919.07.02 Falsework

919.07.02.01 General

Sound, adjustable falsework shall be built such that the structure remains true to line and grade after anticipated settlement.

A set of falsework Working Drawings shall be on site prior to placement of mudsills.

Hangers or other attachments shall not be welded to structural steel, except that tack welds may be used on shear studs where it is not detrimental to the connection between the stud and the structural steel. All welding of structural steel shall be according to OPSS 906.

Temporary hangers or other attachments shall not be affixed to exposed surfaces of concrete girders. Drill holes or anchoring into the bridge deck fascia to support falsework, working platforms or scaffolding shall not be permitted.

919.07.02.02 Foundation Work

The falsework shall be supported on a foundation that satisfies the performance requirements of the Contract Documents. The foundation type shall be suitable for the applied loadings and the subsurface conditions.

Deep foundation alternatives shall be installed according to OPSS 903.

For traffic openings, a minimum horizontal space of 1.0 m shall be provided between the back face of the concrete barrier and the front edge of the mudsill.

Levelling pads shall be constructed according to the Working Drawings.

For foundations on sloping ground surfaces, the foundation shall be installed according to the Working Drawings.

919.07.02.03 Wooden Shoring

All wooden posts shall be solid, and not built up. Where splicing is necessary, the posts shall be cut square and the two pieces shall be in full contact over the splice. Scabbing shall be provided on all four faces of a post to be spliced. Each post shall be braced in two directions both above and below the splice immediately adjacent to the scabbing. Splices on adjacent posts shall be staggered.

Splicing of round posts shall not be permitted.

Bracing material shall be at least 38 mm x 89 mm lumber except for cross bracing for side forms where 19 mm x 138 mm lumber may be used. Bracing shall be nailed to each post with at least two 100 mm nails for 38 mm x 89 mm lumber and two 75 mm nails for 19 mm x 138 mm lumber. Splicing of bracing shall not be permitted.

Wedges used for purposes of falsework adjustment or to facilitate removal shall be hardwood.

919.07.02.04 Metal Shoring

Metal frame shoring shall be according to CSA S269.1.

The maximum extension of jacks shall not exceed the lesser of the manufacturer's recommendations or 600 mm.

Shims used for levelling mudsills shall be fir plywood or solid lumber.

Wedges used to provide full bearing in U-heads shall be hardwood.

919.07.03 Temporary Supports

The construction of temporary supports shall be as specified in the Contract Documents.

919.07.04 Screed Rail Supports in Slab on Girder Construction

In slab-on-girder construction, screed rail supports shall be positioned directly over the flange of the exterior girders within 100 mm of the centreline of the web.

919.07.05 Inspection after the Completion of the Construction of the Falsework and Formwork

A MTO form PH-CC-822, Certificate of Conformance and a MTO form PH-CC-701, Request to Proceed shall be submitted to the Contract Administrator:

- a) Upon completion of the falsework foundation; and
- b) Upon completion of the construction of the falsework and formwork for which Working Drawings are submitted.

The placement of concrete shall not proceed until the Contract Administrator has issued a MTO form PH-CC-702, Notice to Proceed.

919.07.06 Removal of Formwork, Falsework, and Temporary Supports

All formwork and falsework shall be removed, and removals shall not damage the concrete. If the top of a pile used for falsework is 1.2 m below the finished grade or ground level, or is at least 0.6 m below a streambed, a request may be made in writing to the Contract Administrator to leave it in place.

The method and sequence of removal of the formwork and falsework shall be such that it permits the concrete to take up the stresses gradually.

Falsework shall not be removed from post-tensioned structures until the post-tensioning is completed.

When a component is not post-tensioned, falsework may be removed after the concrete has attained a minimum strength of 20 MPa.

Formwork shall not be removed until the concrete has attained a minimum strength of 20 MPa, except for the following:

- a) Formwork for structure concrete barrier wall, concrete parapet wall, curb and sidewalk on the deck shall be removed within 24 hours after completion of the concrete placing operation, except during cold weather where the forms may be left in place for the duration of the curing period; and,
- b) Vertical formwork for approach slabs, deck fascia, and footings may be removed 24 hours or more after concrete placement.

Following the removal of formwork, curing must be applied and maintained according to the Contract Documents. Early loading of structural concrete must be as specified in the Contract Documents.

Where insulation is used, the side forms may be slackened off 24 hours after concrete placement to help control temperature.

Removal of temporary supports shall be as specified in the Contract Documents.

919.07.07 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

919.10 BASIS OF PAYMENT

919.10.01 Formwork and Falsework

The Contract price for the concrete tender item directly associated with formwork and falsework shall include full compensation for all labour, Equipment, and Material to do the work.

919.10.02 Temporary Support - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the Work.

**TABLE 1
Concrete Face and Plywood Properties**

Size of Permitted Abrupt or Gradual Irregularities in Formed Surfaces				
Class of Concrete Surface	A	B	C	D
Tolerance	3 mm	6 mm	13 mm	25 mm
Standard for Test	Tested according to the Surface Tolerance clause of OPSS 904 except that the length of measure for the straight edge shall be 1.5 m.			
Minimum Plywood Face Veneer Grade for Class of Formed Surface (Typical)				
Douglas Fir	B	C face	C face	C
Canadian Softwood	B	C face	C face	C
Poplar	B	Select	Select	C