CONSTRUCTION SPECIFICATION FOR JACKING OF BRIDGE SUPERSTRUCTURE

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921.01 SCOPE

This specification covers the requirements for raising and lowering a bridge superstructure by using hydraulic jacks.

921.02 REFERENCES

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

Ontario Provincial Standard Specifications, Construction

OPSS 906 Structural Steel for Bridges
OPSS 919 Formwork and Falsework
OPSS 922 Installation of Bearings

Ontario Ministry of Transportation Publications

Designated Sources for Materials (DSM)

ASTM International

A563M-15 Standard Specification for Carbon and Alloy Steel Nuts
F3125M-15a Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 830MPa and 1040MPa Minimum Tensile Strength [Metric]
F436M-16 Standard Specification for Hardened Steel Washers

921.03 DEFINITIONS

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

Jacking Design Engineer means the Engineer retained by the Contractor who performs the design of the jacking system and related work.

Jacking Design Checking Engineer means the Engineer retained by the Contractor who performs the design check of the jacking design Engineer's work.

Jacking System means all components required to perform the lifting and temporary support of the bridge superstructure. This includes but is not limited to; jacks, hydraulic hoses and fluid, valves, sensors, jacking systems, shims, temporary support systems, and all related appurtenances.

Survey means precise and detailed measurements and elevations taken, recorded, documented and certified by an Ontario Land Surveyor or an Engineer.

921.04 DESIGN AND SUBMISSION REQUIREMENTS

921.04.01 Design Requirements

921.04.01.01 General

A detailed jacking system shall be designed and provided to do the work by a jacking design Engineer and checked by a jacking design checking Engineer, unless a detailed jacking system is provided in the Contract Documents. The jacking design Engineer and jacking design checking Engineer shall have knowledge in the design of bridge jacking systems, and proven experience in recent projects of similar complexity. Both Engineers shall be capable of certifying that the provided jacking equipment and jacking methodologies will facilitate the jacking and lowering of the bridge shall be according to the Contract Documents.

When specific requirements for the jacking system are provided in the Contract Documents, they shall be incorporated into the design of the jacking system.

When jacking locations are provided in the Contract Documents, they shall be incorporated into the design of the Contractor's proposed jacking system and shall not be changed.

Where the replacement of bearings is specified in the Contract Documents, the design shall consider the possible difference in bearings size between the new and the original and ensure that the placement of the temporary supports does not interfere with the proper placing of bearings.

The design shall account for the structural work and condition of the structure at the time of jacking, and the stages that may interfere with temporary supports or jacking locations. It shall consider any deterioration and/or removals prior to and during the duration of the jacking and remedial work. The design of temporary supports shall account for articulation of the superstructure including thermal movements, as well as any potential slip in supports. Jack and support locations shall account for conflicts between structural work and temporary works designed by the contractor.

The amount of pre-loading to be applied to the jacks prior to the start of displacement controlled jacking shall be specified. The pre-loading amount shall be no less than 15% of the specified jacking load and shall be sufficient to account for decompression of bearings, gaps between shims (if used) and any other geometric imperfections in the proposed jacking system.

Temporary supports, including shims and blocking, used to support the jacks shall be designed for no less than 150% of the jacking loads specified on the Contract Drawings.

921.04.01.02 Jacking Corbels

The design of temporary jacking corbels anchored into substructure elements shall consider the non-uniform distribution of load between anchors when the system is not pre-tensioned and relies on tension or the combined bearing and shear resistance of the anchors.

921.04.01.02 Temporary Supports

Temporary Supports shall be designed according to OPSS 919 and the requirements of this specification.

921.04.02 Submission Requirements

921.04.02.01 Jacking Drawings and Calculations

Three sets of the jacking drawings and calculations and a digital PDF format copy shall be submitted to the Contract Administrator seven Days prior to the commencement of the jacking operations, for information purposes only. Submissions shall bear the seals and signatures of the jacking design Engineer and the jacking design checking Engineer.

The jacking drawings and calculations shall include the following:

a) Jacking methodology and sequence.

b) Location, number, type and capacity of the jacks to be used.

c) Description of the control system, complete with all design, schematics and equipment to be used.

d) Location and material to be used for temporary blocking and shimming.

e) Proposed pre-loading to be applied to jacks.

f) Schematic showing the configuration of all jacks, stop valves, gauges, manifolds and hydraulic pumps.

g) Calibration certificates for all jacks, gauges, and lifting/lowering controller, issued within 12 months from when the equipment is to be used.

h) Full details of the temporary support system including forces to be transmitted and method of transferring the loads to the substructure or founding strata, including considerations for thermal expansion and contraction.

i) Restrictions on traffic and construction traffic.

A copy of the signed and sealed jacking drawings shall be kept at the site during jacking setup and operations.

921.04.02.02 Revised Submissions

When jacking design considerations or field conditions necessitate amendments to the jacking drawings, revised jacking drawings shall be submitted according to the Jacking Drawings and Calculations clause.

921.05 MATERIALS

921.05.01 General

Temporary supports shall be structural steel or concrete according to OPSS 919.

When jacks with locking collars are used as temporary supports, they shall be unmodified and as supplied by the manufacturer.

921.05.02 Mechanical and/or Adhesive Anchors

Mechanical and/or adhesive anchors shall be suitable for dynamic loads and shall be installed according to the manufacturer's recommendations.

921.05.03 Grout

Grout used for the jacking system that will remain as part of the permanent structure shall be cement based, non-shrink, non-staining, and shall be supplied from a source named on the ministry's DSM. Grout shall have a minimum 7-day compressive strength of 35 MPa.

921.06 EQUIPMENT

921.06.01 Synchronized Jacking System

A synchronized jacking system shall consist of either a Programmable Logic Controller (PLC) controlled system or a volumetric controlled system. The system shall be capable of adjusting pressures and hydraulic volumes in order to achieve a uniform lift and/or lowering to a tolerance of less than or equal to 1.5 mm from the leading to lagging cylinders.

921.06.01.01 Programmable Logic Controlled Jacking System

A PLC controlled system shall include a central unit which continuously monitors the relative and absolute position of each individual jacking point.

921.06.01.02 Volumetric Controlled Jacking System

A volumetric controlled jacking system shall be fully calibrated and designed to precisely deliver the same volume of hydraulic oil to each individual jack at the same time. The same make and model of jacks shall be used at all locations.

921.06.02 Displacement Sensors

The synchronized jacking system shall display real-time data for each jack location showing vertical displacement and hydraulic pressure for monitoring purposes during the jacking operation. The data shall be automatically recorded at one second intervals during active lifting and lowering operations in a data log file for the entire duration of the jacking/lowering operation(s) and only shall cease after the bridge is firmly on the temporary supports or permanent bearings. The data interval may be increased to 10 seconds when the bridge is resting on the pressurized hydraulic component of the system, and not being actively lifted or lowered.

Digital displacement sensors or linear transducers shall be installed at all locations where a jack is placed. Multiple jacks may be represented by a single displacement sensor when all of the following conditions are met:

a) All jack centrelines are within 1000 mm of each other.

b) Each jack in the group is in contact with the same structural element.

c) The structural element is continuous between all jacks within a group, and not separated by any structural discontinuities or abrupt changes in stiffness (such as a bolted connection).

d) All jacks within a group receive an equal pressure for programmable logic controlled jacking systems, or the same amount of hydraulic fluid for volumetric controlled jacking systems.

Digital displacement sensors or linear transducers shall be accurate to 0.1 mm to monitor displacements. The displacement sensors can be either integrated into the jacking system or independently monitored such that displacement sensors, stroke sensors or calibrated volumetric control system is capable of achieving the relative lift/lowering tolerances specified in the Contract Documents. For jacks supported on temporary fixtures (such as jacking corbels), independent displacement sensors shall be used, and measurements shall be made relative to a fixed location on the adjacent bearing seat.

A data log file shall be submitted to the Contract Administrator within seven days of any jacking operation in Microsoft Excel format (or approved equivalent). Data log file format is to be in a table with individual columns representing each displacement sensor reading in millimetres, hydraulic pressure applied to the jack (or group of jacks), and applied force at each jack (or group of jacks). Data for applied force may be provided using applied pressure to each jack and the area of the jack's piston. Individual rows shall represent the time in Hr:Min:Sec format.

921.07 CONSTRUCTION

921.07.01 Pre-Condition Surveys

Prior to the start of any work related to the jacking operation, field measurements shall be taken of all components of the existing structure that might impact the installation of the jacking system. The jacking design Engineer and the jacking design checking Engineer shall determine whether any adjustments to the jacking system based on the field measurements. When adjustments to the jacking drawings and calculations are required, the jacking drawings and calculations shall be resubmitted to the Contract Administrator along with a request for approval.

Measurements of the underside of deck or girders at bearing locations prior to jacking the structure shall be made taken relative to an adjacent fixed point on the substructure which will not move during construction. This shall include a minimum of one local fixed marking on the abutment or pier immediately adjacent to each lift point and bearing location. This marking must be located such that it will not be moved or compromised by the Work. Measurements to the underside of each girder and lifting point shall be made relative to the corresponding fixed marking, which shall be recorded accurate to 1 mm.

Measurements shall be submitted to the Contract Administrator prior to jacking.

921.07.01.01 Detailed Survey

A detailed, geodetic survey of the deck top is not required prior to jacking, unless specified in the Contract Documents.

921.07.02 Structural Steel

All structural steel fabrication, delivery and erection shall be according to OPSS 906.

921.07.03 Formwork and Falsework

All formwork and falsework shall be according to OPSS 919.

921.07.04 Installation of Bearings

When jacking is required for the installation, replacement or adjustment of bearings, the requirements shall be according to OPSS 922.

921.07.05 Jacking

921.07.05.01 General

All end components of the bridge deck, such as expansion joints and railing systems, shall be free to move vertically prior to jacking. Bolts securing the handrail posts to the parapet walls, if present, shall be loosened to permit jacking without damaging the handrails.

Upon completion of the fabrication and installation of the components of the temporary works and prior to jacking, the jacking design Engineer or jacking design checking Engineer shall conduct an inspection to verify that the fabrication and installation of the temporary works has been carried out according to the jacking drawings.

Traffic shall not be permitted on or below the bridge during the jacking operation, unless specified in the Contract Documents.

921.07.05.02 Jacking Points and Loads

Jacks shall only be placed at the jacking points specified in the Contract Documents. Jacks with a rated capacity of no less than 150% of the jacking loads specified on the Contract Drawings shall be used.

At no point shall the applied jacking loads exceed 200% of the jacking loads specified on the Contract Drawings.

921.07.05.03 Inspection Prior to the Commencement of the Jacking Operation

A Certificate of Conformance shall be submitted to the Contract Administrator prior to commencing each jacking operation.

921.07.05.04 Jacking Operations

The Contract Administrator shall be informed in writing at least three Days prior to the commencement of the jacking operations.

The lifting or lowering of the entire width of the structure shall be carried out in one uniform and synchronized operation using a synchronized jacking system. At no time during the lifting or lowering of the structure, except during pre-loading of the system, shall the elevation difference between any displacement sensor exceed 1.5 mm.

Jacking operations shall be carried out under the direct supervision of the jacking design Engineer or the jacking design checking Engineer. Prior to the commencement of jacking operations, the accuracy of all transducer read-outs, relative to manual measurements shall be demonstrated to the Contract Administrator.

The lift and/or lowering at each jacking point shall be monitored continuously during the jacking operation from a centralized location by remote sensors or calibrated jacking system. The maximum lift for all jacking points shall be as specified in the Contract Documents. The minimum lift shall be 3 mm above the bearings once decompressed.

921.07.05.05 Temporary Supports

The bridge superstructure shall not be supported on pressurized hydraulic jacks for a period longer than permitted on the jacking drawings and shall never exceed 12 hours.

When the required lift for all jacking points has been achieved and the bearings have been released, temporary supports (such as blocking and shimming) shall be placed to support the bridge. The jacks shall then be lowered in one synchronized operation while maintaining the maximum allowable difference between any two jacking points of 1.5 mm.

The jacking loads shall be transferred to temporary supports prior to bearing removal, bearing seat reconstruction, or other related bearing replacement work.

Temporary supports shall be located at the jacking points or as specified in the Contract Documents.

The superstructure shall not be left on temporary supports for more than 30 Days or as specified in the Contract Documents.

921.07.05.05.01 Post-Jacking Survey

Immediately after the structure has been placed on temporary supports and prior to the bearing seats being reconstructed (if applicable), the underside of the superstructure that will be in contact with the new bearings shall be surveyed. The survey shall include the four corners in contact with the bearings and at least one point in the middle of the bearing area. Data from the survey shall be forwarded to the Contract Administrator to determine if adjustments to the design are required.

921.07.05.06 Lowering of the Superstructure

Where jacking of the superstructure is accompanied by rehabilitation of bearing seats, the superstructure may be jacked again for the removal of the temporary supports only after the concrete in the bearing seats has reached 75% of its design strength. The jacks shall then be lowered in one synchronized operation, while maintaining the maximum allowable difference between any two jacking points of 1.5 mm, and the superstructure shall be placed onto the bearings.

921.07.05.06.01 Bearing Contact

The bearings shall have uniform and full contact at top and bottom. The requirements for bearing full contact shall be according to OPSS 922. The jacking system shall remain in place until full contact of bearings is achieved.

921.07.05.07 Reinstatement of Structure and Components

The bridge deck and girders shall be reinstated to the original elevations unless new elevations are specified in the Contract Documents or as otherwise directed by the Contract Administrator.

When bearings are replaced, a final continuous and smooth riding surface across all joints, approaches, and adjacent spans shall be provided with a tolerance of 3 mm across each joint. The Contract Administrator shall be notified when existing conditions, information in the Contract Documents, or specific components will affect the ability to meet this requirement for further clarification or instruction.

Anchor holes shall be filled with non-shrink grout finished flush with the surrounding concrete. No metal components of the jacking system shall be embedded permanently in concrete with less than 40 mm of cover.

All expansion joint and handrail components removed or loosened to facilitate jacking shall be reinstated.

921.07.06 Inspection After Completion of the Jacking Operation

A Certificate of Conformance shall be submitted to the Contract Administrator upon completion of each jacking operation.

921.07.07 Management of Excess Material

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

921.10 BASIS OF PAYMENT

921.10.01 Jacking of Superstructure - Item

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