

SUPERSTRUCTURE INSTALLATION, SPMT

Description

This work shall include the installation of the superstructure onto the permanent substructure units in accordance with 105.03. The superstructure shall be built in a temporary location and moved into its permanent position using a Self-Propelled Modular Transporter in accordance with these specifications.

Definitions

1. Self Propelled Modular Transporter (SPMT): Specialized equipment used to move bridge superstructures, consisting of motorized load bearing multi-axle platforms with each axle having its own hydraulic lifting system to equalize loading pressures and maintain a level system and with turning capabilities that are linked and controlled through a computer.
2. Bridge Staging Area (BSA): The location of the temporary bridge supports where the bridge superstructure is constructed prior to transport to its final location.
3. Travel Path (TP): The route along which the SPMT carries the new bridge superstructures from the Bridge Staging Area to the final bridge location.
4. Temporary Supports: Any structure used to provide temporary support to a bridge or bridge superstructure which will be removed after the structure is removed.
5. Temporary Sheeting and Shoring: Any temporary system to support either a structural component or soil slope.
6. Monitoring: The act of measuring, recording and quantifying changes in the geometry and condition of bridge superstructures as a result of temporary support conditions and moving operations.
7. Heavy Lifter: The firm employed by the Contractor to provide heavy lift equipment and operations including SPMTs and related shoring, bracing, and engineering.
8. Superstructure: Bridge elements above the bearings including but not limited to girders, deck, and barriers.
9. Twist: The condition where a corner of a superstructure deflects up or down relative to the plane defined by the other three corners of the supported bridge span.
10. Deflection Change: The relative vertical movement of the ends of the bridge while the superstructure is supported at the temporary support points, either during superstructure installation or in the BSA. It shall be the average of the three measurements along each centerline of bearing compared to the average of the three measurements along the temporary Support Line and the three measurements along the midspan of the structure.

Design Data

Any temporary supports, falsework, sheeting or shoring required to perform the work listed in this provision shall be in accordance with the following specifications:

1. AASHTO Guide Design Specifications for Bridge Temporary Works
2. AASHTO LRFD Bridge Construction Specifications
3. AASHTO LRFD Bridge Design Specifications

Qualifications

The Heavy Lifter shall have a minimum of five years of experience as a Heavy Lifter using SPMTs and shall have successfully completed a bridge installation using SPMTs within the United States in the past ten years.

The Heavy Lifter's supervisor in charge of this work shall have a minimum of five years of experience as a Heavy Lifter, which includes previous SPMT bridge installation experience.

The Heavy Lifter's SPMT operator shall have a minimum of five years of experience as a Heavy Lifter operator.

Submit the following information and data for approval with the working drawings:

1. Proof that the Heavy Lifter qualifications have been met including a list of similar projects completed within the last ten years with names and phone numbers of owner's representatives who can verify the Heavy Lifter's participation in those projects.
2. Name and experience record of the Heavy Lifter supervisor in charge of the bridge installation.
3. Name and experience record of the Heavy Lifter SPMT operator.

Submittals

Detailed Working Drawings of all equipment and material used for transporting and/or lowering the bridge superstructure for approval. The Working Drawings shall include the following:

1. Details of the heavy lift system, components, mechanical devices, jacks, temporary blocking, and operational techniques, including the capacity of the lift system.
 - a. Include locations of all equipment during the superstructure installation.
 - b. Include calculated superstructure weight for installation based on actual, known dimensions of components and known densities of materials.
 - c. Include weight capacities of the heavy lift system and limitations necessary for stability during all jacking, raising or lowering, and moving operations.
 - d. Include QC/QA procedures to be followed during the superstructure installation.
 - e. Include operational details for the control of the movement (including turning radius), lifting, and transportation. Include a system of check off items for the Operators and for safety purposes.
2. Details of the Contingency Plan
 - a. Discussion of potential equipment problems such as insufficient equipment or equipment breakdowns.
 - b. Discussion of potential problems with inclement weather.
 - c. Identification of individuals involved in the superstructure installation and their risks and responsibilities.
 - d. Identification of the use of manual overrides of electronic or hydraulic equipment.
 - e. Identification of additional equipment to have on hand such as SPMT controllers, spare tires and/or repair items for tires, demolition equipment, hydraulic jacks, blocking, columns or towers, stabilizing devices, strong-backs, and cross-frames and ties, shipping-containers, grillages, cribbing, shims and any

- other incidental components needed to support the superstructure atop the SPMT platforms.
- f. Public notice of extended delays.
 - g. Identification of a detour route for extended closures.
 - h. Traffic shall not be allowed to pass beneath the superstructure supported by SPMTs until the source of the problem is found and corrected.
 - i. Corrective actions if problems occur.
3. Details of the Safety Plan
 - a. Ensures the protection of public, spectators, and workers.
 - b. Protects property during the movement of the superstructure.
 - c. Addresses nighttime operations including lighting.
 - d. Addresses OSHA requirements.
 4. Details of the Temporary Substructures and other Temporary Works
 - a. Include detailed plans for items such as temporary support structures, falsework, cofferdams, shoring, and temporary bridges.
 - b. Show temporary supports for the superstructure.
 - c. Include bents or ground beams and temporary piling.
 - d. Show elevations and dimensions of temporary bearings, as necessary, to match the relative positions of the final permanent bearings at the bridge site.
 - e. Include design calculations and supporting data.
 - f. Design temporary works according to the current edition of the documents in the Design Data.
 - g. Place basis of design criteria for all assumed loads, including wind and impact effects, limits for stability against overturning, combined stresses, deflection, and buckling on the working drawings.
 5. Details of any temporary sheeting or shoring required to install or complete the installation of the superstructure. This includes any sheeting or shoring required to open the roadway to traffic prior to other permanent earth retaining being installed.
 6. Details of the bridge staging area (BSA) and travel path.
 - a. Provide details of the BSA and travel path location, general layout surface grading, surfacing material, drainage, environmental protection, material storage area, concrete delivery methods, shelters, heavy lift travel path(s), accesses, fences, gates, barriers, offices, and workshops.
 - b. Include foundations and details of temporary bents or abutment seats to support the span under construction, including piling, spread footings, or other foundations.
 - c. Include clearances, utilities, details of construction, and intended access under the completed superstructure.
 7. Calculations for the temporary supports, bridge staging area, heavy lift system, and bridge travel path, including but not limited to:
 - a. Verify that the BSA and travel path have suitable foundations for all proposed construction operations.
 - b. Include the means of mitigating unacceptably high or concentrated loads.
 - c. Include calculations for actual and allowable bearing pressures along the travel path.
 8. Geometry Control Plan
 - a. The geometry control plan can be submitted in the form of working drawings or a manual.
 - b. Include measuring equipment, procedures and locations of geometry control reference points on the superstructure and in the BSA.

- c. Establish longitudinal and lateral location reference points on the superstructure that correspond to, or can be referenced to, appropriate longitudinal and lateral reference points at the erection site, such as station and offsets.
 - d. Include locations and values of permanent benchmarks and reference points in the BSA and at the bridge site.
 - e. Include a geometry control procedure for monitoring deflection change and twist before, during installation, and after setting the superstructure span in the permanent position.
 - f. Establish and maintain a record of key vertical elevations along the main longitudinal elements at the ends, proposed lifting supports, and midspan.
 - g. Maintain records in good condition so that they may be used for reference during erection and installation.
 - h. Include a monitoring plan for deflections and twist distortion during installation.
9. Provide repair methodology and supporting calculations for procedures for repairing damage and injecting and sealing cracks.
 10. Other items not covered above to be submitted for approval.
 - a. Provide Overall schedule of the timing and sequence of superstructure fabrication, erection, and installation. Submit an hour by hour schedule of the bridge installation 21 calendar days prior to the scheduled installation date for review.
 - b. Provide Step-by-Step Lift, Transport, and Place Superstructure procedures for lifting, transporting, and placing the superstructure span.

Allow the Engineer 14 calendar days to review and approve working drawings and supporting calculations. The Engineer may grant an increase in the number of working days for the project when that time is exceeded. This review period applies each time the drawings and calculations are submitted.

Do not deviate from the approved drawings unless authorized in writing by the Engineer of Record. Assume the responsibility for costs incurred due to faulty detailing or fabrication.

Costs incurred due to faulty design or detailing are the Contractor's responsibility.

Within the Working Drawings, include revisions to the concepts and to the detailed descriptions of materials, components, erection methods, and sequencing indicated on the Contract Plans. This includes, but is not limited to, changes to locations of permanent support conditions, cross section component sizes or connectivity, construction joints in any plane, and splice location, sizes, or types as required.

Construction Requirements

(a) General Requirements

Use methods and procedures to provide adequate safety to the general public from all construction activities, superstructure installation, and erection using heavy lift equipment and falsework placed over or adjacent to traveled roadways or any existing commercial, industrial or other facilities.

(b) Meetings

The following meetings shall be held between the Contractor, Heavy Lifter, Engineer and other representatives of the Owner.

(c) Superstructure Installation Meeting

The meeting shall be held a minimum of two weeks prior to the Superstructure Installation. This meeting shall discuss pertinent items of the working drawings, including the Contingency Plan and Safety Plan.

(d) Final Walk through Pre-installation Meeting

Immediately prior to installing the bridge, conduct a final walk through pre-installation meeting at the bridge site for the bridge installation. Verify that all items identified in the Working Drawings have been completed. Walk the travel path to verify surfaces have been prepared adequately, all utility protection is in place, slopes have been adequately supported, and verify all work has been completed for the installation.

(e) BSA

The Contractor shall be responsible for all work items and materials necessary to prepare the bridge staging area including clearing and grubbing, excavation, drainage, drainage structures, fill, grades, and the soil support for all equipment, SPMTs, materials, and temporary supports. Prior to substantial completion of the project, all equipment and material, including components of the temporary substructure, shall be removed from the BSA. The BSA shall be regraded and seeded to closely match the ground surface prior to construction.

(f) SPMT Lifting System

Use a SPMT lifting system capable of lifting a bridge superstructure off the temporary supports, carrying it to its final location, and setting it down at its final location. The assembly shall function as one unit using one controller with capability to move forward, backward, transversely, at any angle, and pivot 360 degrees in a carousel motion. The SPMT axles shall provide a minimum of a 24-inch vertical hydraulic stroke. Limit SPMT axle loads to 25 tons per axle, per single wide SPMT unit.

The SPMT lifting system shall include the SPMTs, their blocking which provides the interface between the SPMT platform and the bridge superstructure, and any other devices or apparatus used to tie the SPMTs together and to move the bridge superstructures.

Design the SPMT lifting system to lift the superstructures at the support points shown on the plans. Any variation in support point locations from the locations shown on the plans shall require approval by the Engineer of Record.

(g) Temporary Supports

1. Design all temporary works according to the applicable specifications listed in the Design Data
2. Verify that temporary support structures are built according to approved working drawings.
3. Verify that support surfaces are built to required elevations and tolerances with sufficient clearances to accommodate the heavy lift system and that the latter are independently verified by the heavy lift firm.
4. The railings shall be constructed prior to transporting the superstructure from the BSA to the final location unless clearance under the westbound bridge restricts clearance.
5. Provide weekly elevation control surveys, including top of footing if exposed and temporary bearing seat elevations, to monitor settlement.

(h) Age at Installation

1. Do not lift or attempt to install the superstructure until it has attained a minimum age of 28 days since the last casting operation, unless otherwise approved by the Engineer or the requirements of 702.24 are met. For the purpose of this provision, installation of the structure shall be considered a "traffic load".

(i) Preparation for Installation of Superstructure

1. Verify that the permanent substructure bridge seat elevations match the relative elevations of the bridge seats in the BSA. Any discrepancy shall be identified prior to transporting the structure. Proposed mitigation measures shall be submitted to the Engineer for approval.
2. Verify that adequate horizontal and vertical clearances exist to safely move the bridge.
3. Carefully jack-up and /or jack-down the superstructure in an incremental or differential fashion using the insertion or removal of incremental cribbing, purpose-made steel grillages, blocks, prefabricated falsework sections or similar devices to facilitate raising or lowering of the superstructure span by the amount necessary to installation the bridge to the required elevation.
4. Operate heavy lift system with care and within anticipated height change limitations (stroke limits) of the jacking systems. Follow limitations on Working Drawings or Manuals for all incremental and differential jacking with due regard to corresponding stability conditions for the heavy lift system and falsework.
5. Proper considerations should be made to ensure that the support of the superstructure will not damage the superstructure beams.
6. Implement checking (QC/QA) procedures prior to a transportation operation in order to ensure satisfactory completion.
7. Implement contingency plans in the event of a major breakdown or equipment malfunction.

(j) Lift, Transportation and Placement of Superstructure

1. The intent during lifting, transportation and placement is to ensure that the structure is delivered to the Owner, in its final location, with no damage or adverse loss of strength, loss of performance or loss of long term durability. To this end, it is necessary to place certain limitations upon characteristics that can be quantified and observed or checked by careful observations or by using suitable detection methods during these operations.
2. Exercise care and precaution when placing the span into its final location on the bridge bearings and use observations to monitor and record conditions just before and just after setting the span in place.
3. Deflection and Twist Control During Installation
 - a. The Contractor is responsible for ensuring the superstructure span does not deflect or twist beyond the allowable tolerances and is responsible for ensuring the superstructure is not damaged during lifting, transporting and setting.
 - b. Maintain twist distortion of superstructure within maximum allowable tolerance at all times during movement.
 - c. Immediately prior to setting span down in final bridge location, check that twist distortion of the superstructure span is less than that allowed described herein.
 - d. Immediately after setting span in final location on permanent bearings, check that elevations and twist distortion of the

superstructure span are satisfactory. Allowable permanent twist distortion is zero.

- e. In the event of breakdown during installation, perform deflection and twist check as soon as possible after bringing operations to a halt. Perform intermediate checks during the period of the breakdown and again prior to moving.
4. Deflection and Twist Control Monitoring During Installation
 - a. A minimum of 15 points shall be monitored during lifting and transportation. Transverse to the centerline of the bridge, a measurement point shall be recorded at the face of each rail and one at the centerline of the structure. Parallel to the centerline of the bridge, a measurement point shall be placed at each centerline of bearing, each centerline of temporary support and at midspan.
 - b. Using measurements of elevations, determine the Deflection Change of the ends of the span relative to mid-span and Temporary Support Line as a result of the first lifting of the span along both railings and the centerline of the bridge. During installation, use elevation measurements or devices to monitor twist distortion (Twist) of the span itself.
 - c. Monitor the global rotations of the span itself longitudinally and transversely in a manner independent of any self-leveling devices and monitoring systems of the heavy lift system itself.
 - d. By means of taking elevation readings or by using other methods approved by the Engineer, take responsibility for taking the above observations or implementing monitoring methods accordingly. As a minimum, observe, report and act upon the following to avoid exceeding these limits and tolerances:
 - i. Deflection Change
 - ii. Twist
 - e. Halt operations immediately if deflection or twist exceeds the allowable limits shown on the plans. Return the superstructure to temporary supports if necessary, and consult with the Engineer.

(k) Tolerances

1. Plan Alignment: Location and Clearances
 - a. For the final condition of the span after placement of the superstructure the maximum deviation from alignment in both primary plan directions at each end of the span being set shall not exceed 1/2 inch or that required for the accommodation of manufactured bearings, whichever is the less.
2. Bridge Bearings: Elevation and Location
 - a. Keep the elevation of individual bridge bearings for superstructure within plus or minus 1/8 inch of required elevations, unless tighter tolerances are required according to the bearing manufacturer or as specified on the Working Drawings.
 - b. Keep the plan location of bridge bearings within 1/8 inch and the alignment within plus or minus 1/8 inch across the bearing, unless tighter tolerances are required according to the bearing manufacturer or as specified on the Working Drawings.
 - c. If tolerances are not met, submit for approval of Engineer, means to adjust elevations or to correct for or accommodate errors or unintended deviations from required tolerances. Submit proposals for approval by the Engineer for the use of shims, injection of high strength grout or other methods to accommodate differences from required tolerance.
3. During Lifting, Transportation and Placement (Installation)

- a. Deflection Change
 - (1) Relative to the local tangent to the vertical profile grade at mid-span, keep the anticipated downward deflection of ends of superstructure when lifted at heavy lift support locations within plus or minus 20% of that given on the Plans or approved Working Drawings.
- b. Twist
 - (2) Twist is not allowed to exceed the lesser of $W/200$ or 0.25 feet when the four monitored points are over the centerlines of the permanent span support bearings. Twist is not allowed to exceed the lesser of $W/300$ or 0.16 feet when the four monitored points are over the centerlines of the temporary supports during installation. W is defined as the perpendicular width in feet between the face of rails (clear roadway width).
 - (3) Twist must remain within the above allowable limits or as otherwise predetermined and provided in the approved Working Drawings in order to incur no damage (i.e. cracks), even if cracks close after setting the bridge span in place.
- c. Change in Longitudinal Gradient (along the railing and Centerline Bridge)
 - (4) The heavy lift firm is required to provide the maximum allowable change in longitudinal gradient.
 - (5) The change in longitudinal gradient is defined as the change in slope experienced along the railing or Centerline Bridge from conditions just before first lifting to any time during installation.
 - (6) The longitudinal gradient may be calculated from differences in elevations taken just before lifting to elevations taken at any time during installation.
- d. Change in Transverse Gradient (across the beams of span)
 - (7) The heavy lift firm is required to provide the maximum allowable change in transverse gradient.
 - (8) The change in transverse gradient is defined as the change in slope experienced along the end diaphragms from conditions just before first lifting to any time during installation.
 - (9) The change in transverse gradient may be calculated from differences in elevations taken just before lifting to elevations taken at any time during installation.

(l) Superstructure Requirements

- 1. Provide uniform support for all girder lines and ensure that the temporary supports do not damage the superstructure.
- 2. Shims may be used, if required, to correct discrepancies in the seat elevations at the substructures.
- 3. Non-shrink grout in accordance with 707.09 may be used, if required, to correct discrepancies in the seat elevations at the substructures.

(m) Corrections and Repairs

- 4. After the installation of the structure, the structure shall be inspected for cracking. Any cracks shall be repaired as follows:
 - a. Crack width less than 0.012 inches - Sealed with an epoxy penetrating sealer followed by an application of an approved sand. The sealing and sand application shall be repeated as needed to ensure that the voids remain completely filled.

- b. Crack width greater than 0.025 - Epoxy Injection in accordance with 727.

Method of Measurement

No measurement of the work described in this provision will be made.

Basis of Payment

This work shall be paid for at the contract lump sum price for the work as outlined below.

Payment will be under:

Pay Item	Pay Unit Symbol
Superstructure Installation, SPMT, Engineering	LS
Superstructure Installation, SPMT, Temporary Substructure	LS
Superstructure Installation, SPMT	LS

The cost of all material, labor and incidentals related to the preparation of the Working Drawings, including any geotechnical analysis required for the TP and BSA, designing of the temporary supports shall be included in the lump sum unit price for Superstructure Installation, SPMT, Engineering.

The cost of all material, labor and incidentals related to the preparation and restoration of the BSA and construction and removal of the temporary supports shall be included in the lump sum unit price for Superstructure Installation, SPMT, Temporary Substructure.

The cost of all other material, labor and incidentals required to perform the work described herein, including superstructure monitoring, preparation and restoration of the travel path, meetings, temporary sheeting and shoring, and superstructure repairs due to the installation shall be included in the cost of Superstructure Installation, SPMT.

A maximum payment of 50% of the Contract Unit Price per item shall be made after the first Superstructure Installation. The remaining amount shall be made after the second Superstructure Installation.