ITEM 598.00000411 - CABLE STAYED MAIN SPAN ERECTION ENGINEERING

DESCRIPTION

The Contractor shall be responsible for the construction of the cable stayed main span. The Contractor and his Engineer are responsible for developing the erection sequence, calculations, drawings, temporary supports, any additional wind tunnel testing, a monitoring program and Erection Manual that are needed for the construction of the cable stayed main span. In addition, the Contractor and his Engineer are responsible for Geometric Controls and Loads throughout construction and updates to the Erection Manual as needed.

SUBMITTALS

All plans and calculations submitted to the Department for review shall be prepared, signed, and sealed by the Contractor’s Engineer, who shall be a Professional Engineer registered in the State of New York and who is experienced in the design and construction of cable stayed bridges and is qualified to be responsible for all aspects of the erection analysis including an Erection Manual. The Engineer must meet the Key Personnel requirements outlined in the Design-Bid-Build Best Value Special Note. Calculations shall be submitted in a neat organized manner that is easy to follow.

Stay cable design shall conform to the Post Tensioning Institute PTI DC45.1-12 Recommendations for Stay Cable Design, Testing and Installation (PTI Recommendations) as modified by these Special Provisions. The erection of the structure shall be in accordance with the best practice and shall conform to the specifications.

At the start of the development of the erection sequence, the Contractor shall meet with the Department to discuss the proposed erection procedure, erection design criteria, and structure capabilities to support the proposed erection scheme. The Department will review the preliminary erection procedure proposal.

The Contractor shall submit the erection sequence, checked design calculations, drawings, any additional wind tunnel testing, temporary supports, detailed shop drawings, monitoring program and Erection Manual to the Department for review. The Contractor shall submit each of these submittals at least 90 days in advance of the start of construction of the Main Span superstructure.

The review by the Department of the Contractor’s submittals, calculations and plans shall not relieve the Contractor from his responsibility for performing the work required by the Contract.

No Work shall be performed on the cable stayed structure until the Contractor’s erection sequence, all associated calculations and shop drawings have been reviewed and accepted by the Department and the Engineer of Record, including the following:

- Complete detailed erection sequence drawings and calculations. Erection and erection wind stresses in permanent and temporary members including temporary piers and falsework reactions shall be determined for each stage. Moments, shears, axial loads and other forces and cambers shall be computed and tabulated for all pertinent members at a
sufficient number of points to demonstrate that the load demand will not exceed the capacity and allowable stresses for erection. Details of contemplated elevations, cable lengths, adjustments and shims required shall also be shown for each stage. Final cable adjustment shall be performed after all dead loads including overlay are in place.

- A complete description and stress calculations of the proposed process and sequence of erection including positions and weights of equipment at each position and weights of equipment at each stage in sufficient details to allow review of the effects of the erection procedure on the structure.
- Detailed design of all erection equipment, temporary bracing, falsework and other items as required for erection.
- Detailed design and layouts of any tie down assembly including all connections, foundation elements, and material properties required to ensure the intermediate static and dynamic stability of the structure for the various stages of the construction. To fulfill this requirement, the Contractor may have to construct temporary support bents or install auxiliary cables to stabilize the bridge. Temporary cable ties may be required to provide damping of wake galloping in the stay cables until final stabilizing cables are installed.
- Design of any temporary supports and/or falsework required to erect the structure. Falsework shall be properly designed by the Contractor’s Engineer for all anticipated loads in accordance with the AASHTO as modified by the New York State Blue Pages and the AASHTO Guide Design Specifications for Bridge Temporary Works. The Contractor shall submit detailed plans for all falsework to be used showing all loadings assumed by the Contractor’s design.
- An analysis of winds and wind forces during erection. The Contractor may use the construction wind loads provided by RWDI dated 11/7/2016, if they are consistent with his proposed erection sequence. The Contractor shall be responsible for the cost of any additional wind tunnel testing associated with his erection sequence.
- Detailed shop and erection drawings.
- Fully developed details for side span and central span closures, including placement of tiedown units as required, jacking, and counterweighing and stay cable adjustments shall be included in the Contractor's erection scheme.
- Based on the Contractor’s construction equipment and procedures, the Contractor shall compute and prepare tables of anticipated cable tensions in each cable at corresponding stages of erection including, but not limited to the stages of:

  - Structural steel erection
  - Placement of precast panels
  - After full dead load including concrete parapets and overlay

If cable forces exceed the design forces as shown in the plans, the Contractor shall investigate adequacy of all cable components and anchorages. Cost for all and any additional material required shall be borne by the Contractor.

- A Monitoring Program to verify that the profile, stay cable forces and edge girder stresses in the as built structure are as predicted by the erection analysis. The baseline monitoring shall include:
  - the baseline profile survey of the edge girders and deck;
the baseline position and elevation of the towers; and

- the baseline load in each stay cable based on the vibration method as listed in Section 7.4 of the PTI Recommendations for Stay Cable Design, Testing and Installation.

**DURING CONSTRUCTION**

The Contractor will be responsible for determination of and monitoring of forces, and deflections in the permanent structure at all erection stages as are caused by his proposed erection process. The Contractor shall increase members as required by his erection sequence.

The Contractor shall prepare and submit a Proforma to the Department prior to each round of cable stay stressing. The Proforma shall include the latest geometry control information, deck survey information, current cable stay stresses, and proposed additional cable stay forces and cable length adjustments.

**Geometric Controls and Loads**

The Contractor shall be responsible for geometric control of construction so that the completed structure will conform to the lines, grades, and dimensions and cable stresses on the plans. The Contractor shall furnish competent engineering and surveying personnel and equipment to establish and verify elevations and alignment of the structure and cable stays at every stage of construction. The Contractor shall be responsible to determine the need for the amount of shimming that may be required in the erection stages. The Department shall review each such use of shims.

The structure shall have a geometric configuration at 68 °F normal temperature in general conformance with the dimensions shown on the plans for the dead load conditions. The Contractor shall provide sufficient computation and analysis, for the structure to reasonably assure that final adjustments can be made to obtain the dead load cable stress and deck elevations with the following tolerances:

- Absolute tolerance in deck elevation at the centerline of bridge at center span shall be ± 5.5", provided that the deck elevation at cable attachment points shall follow, within a tolerance of 1" (unless a tighter tolerance is required to satisfy drainage) from the elevation based on the bridge cross-slope. A smooth parabolic curve shall pass through the final deck elevation at the centerline of the bridge and the deck elevation at the end of the cable stayed span.

- Cables shall be adjusted for the dead load condition such that each individual cable shall not exceed values of ± five percent (5%) of the cable dead load computed from approved working Drawings. It is possible that one individual cable may have to be adjusted to lesser tolerances to prevent stress in other cables from exceeding the ± five percent (5%) tolerance.

- Final fabrication lengths for the stay cables shall be calculated by the Contractor after erection loads and methods are known and detailed erection stress calculations have been
The tolerance in the fabrication length of the cable in the unstressed condition shall be as follows:

<table>
<thead>
<tr>
<th>Length between bearing faces (ft)</th>
<th>Permissible tolerance (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>plus 1.0, minus 0.0</td>
</tr>
<tr>
<td>300</td>
<td>plus 1.5, minus 0.0</td>
</tr>
<tr>
<td>500 and over</td>
<td>plus 2.0, minus 0.0</td>
</tr>
</tbody>
</table>

Intermediate values may be interpolated. Differences between the actual and planned fabricated length shall be compensated for by shims at either anchorage.

- At some intermediate stage of superstructure erection, which the Department will designate depending on the approved sequence and method of erection, the tension in each cable shall be checked again to ensure that it is within the anticipated range. Any cable requiring adjustment at this stage shall be properly jacked and shimmed.
- Each pair of cables anchoring at the same segment of deck shall be installed and stressed simultaneously. The difference in force in the two cables shall not exceed five percent (5%) of the corresponding designed cable forces.
- Promptly after erection of each cable, the tension in the cable shall be checked to ascertain that it is within the range of anticipated tension for the corresponding stage of superstructure erection. Maximum cable tension during construction shall not exceed fifty-six percent (56%) of the cable's guaranteed ultimate tensile strength.
- The live (stressing) end anchorage of the cable is at the tower anchorage and the live end anchorage shall be detailed to provide for future cable replacement. The stay cable anchorage shall allow for future force adjustments (increase or decrease) of 2.5% of the guaranteed ultimate strength of the stay cable. The Contractor shall include in the cable installation plan fully developed details and procedures for removing/detensioning strands and re-installing strands.

**Closure Pours**

- To make up the closure pours the suspended ends of the bridge shall be brought into vertical and horizontal alignment by jacking, counterweighing or adjusting selected cables. This shall be included in the Contractor’s erection scheme submitted to the Department for review and evaluation.
- After the closure concrete has attained the required strength, certain selected cables shall be adjusted to produce the required stresses in the structure.
- Upon completion of placing and post-tensioning the closure concrete and the placement of the concrete parapets and overlay, the cables shall be adjusted as required to their planned tension by jacking and shimming.

The Contractor shall prepare as-built plans that shall indicate the final erection forces so that future analysis, rating or modification of the structure can properly account for these forces.
METHOD OF MEASUREMENT

This work shall be measured as a lump sum.

BASIS OF PAYMENT

The price shall include all costs to complete the erection engineering and analysis described herein to the satisfaction of the Department and the Engineer of Record.

Progress payments will be paid for Cable Stayed Main Span Erection Engineering as described below

Thirty percent (30%) of the total lump sum amount will be paid once the Contractor’s Erection Procedure Manual has been accepted by the Department. This manual will include each of the following items: the erection sequence including positions and weights of equipment; a complete description and stress calculations of the proposed erection process; detailed design of all erection equipment, temporary bracing, falsework and other items as required for erection; details and layouts of any tie down assembly including all connections, foundation elements and material properties; and an analysis of winds and wind forces during erection.

Fifty-six percent (56%) of the lump sum price will be paid in 2% increments per stay as the second stage of stressing has been completed and accepted for each stay. Note that this second stage is identified as “perform adjustments” in the suggested erection sequence in the Contract Plans.

Four percent (4%) of the total lump sum amount will be paid after cable stay adjustments have been completed just prior to the overlay installation.

Ten percent (10%) of the total lump sum amount will be paid once all cable stay work has been completed and accepted.