

TO: All Design Section Staff
FROM: Bijan Khaleghi
DATE: March 08, 2019
SUBJECT: Spliced Girder Bridges

This design memorandum provides revisions to the use of spliced girders for WSDOT bridges. BDM Section 5.6.3 “Fabrication and Handling” and Section 5.9 “Spliced Prestressed Concrete Girders” shall be revised as follows:

Delete the second paragraph of 5.6.3.D.3 for Weight Limitations

~~Long span prestressed concrete girders may bear increased costs due to difficulties encountered during fabrication, shipping, and erection. Generally, costs will be less if a girder can be shipped to the project site in one piece. However, providing an alternate spliced girder design to long span one piece pre-tensioned girders may reduce the cost through competitive bidding.~~

Replace 5.9 “Spliced Prestressed Concrete Girders” with the following:

5.9 Spliced Prestressed Concrete Girders

5.9.1 Definitions

The provisions herein apply to precast girders fabricated in segments that are spliced longitudinally to form the girders in the final structure. The cross-section for this type of bridge is typically composed of bulb tee girders or trapezoidal tub girders with a composite CIP deck. WSDOT standard drawings for spliced I-girders are as shown on the Bridge Standard Drawings website (www.wsdot.wa.gov/Bridge/Structures/StandardDrawings.htm). Span capabilities of spliced prestressed concrete girders are shown in Appendices 5.6-A1-8 for girders and 5.6-A1-9 for trapezoidal tub girders.

Prestressed concrete deck bulb tee girder bridges may also be fabricated in segments and spliced longitudinally. Splicing in this type of girder may be beneficial because the significant weight of the cross-section may exceed usual limits for handling and transportation. Spliced structures of this type, which have longitudinal joints in the deck between each deck girder, shall comply with the additional requirements of AASHTO LRFD Section 5.12.2.3.

Spliced prestressed concrete girder bridges may be distinguished from what is referred to as “segmental construction” in bridge specifications by several features which typically include:

- The lengths of some or all segments in a bridge are a significant fraction of the span length rather than having a number of segments in each span.

- Design of joints between girder segments at the service limit state does not typically govern the design for the entire length of the bridge for either construction or for the completed structure.
- Wet-cast closure joints are usually used to join girder segments rather than match-cast joints.
- The bridge cross-section is composed of precast girders with a full-depth CIP concrete deck or SIP deck panels composite deck rather than precasting the full width and depth of the superstructure as one piece. In some cases, the deck may be integrally cast with each girder. Connecting the girders across the longitudinal joints completes a bridge of this type.
- Girder sections are used, such as wide flange I-girders, deck bulb tee or tub girders, rather than closed cell boxes with wide monolithic flanges.
- Provisional ducts are required for segmental construction to provide for possible adjustment of prestress force during construction. Similar requirements are not given for spliced prestressed concrete girder bridges because of the redundancy provided by a greater number of webs and tendons, and typically lower friction losses because of fewer joint locations.
- The method of construction and any required temporary support is of paramount importance in the design of spliced prestressed concrete girder bridges. Such considerations often govern final conditions in the selection of section dimensions and reinforcing and/or prestressing.
- CIP concrete closures of minimum 2'-0" wide are required for connecting spliced-girder segments while segmental bridge segments are match cast and connected with epoxy joints.

All supports required prior to the splicing of the girder shall be shown on the contract documents, including elevations and reactions. The stage of construction during which the temporary supports are removed shall also be shown on the contract documents.

Stresses computations shall account for changes in the structural system, in particular the effects of the application of load to one structural system and its removal from a different structural system. Redistribution of such stresses by creep shall be taken into account and allowance shall be made for possible variations in the creep rate and magnitude.

Prestress losses in spliced prestressed concrete girder bridges shall be estimated using the provisions of Section 5.1.4. The effects of combined pretensioning and post-tensioning and staged post-tensioning shall be considered. When required, the effects of creep and shrinkage in spliced prestressed concrete girder bridges shall be estimated using the provisions of Section 5.1.1.

5.9.2 WSDOT Criteria for Use of Spliced Girders

See Section 5.6.3.D.3 for criteria on providing an alternate spliced-girder design for long span one-piece pre-tensioned girders.

5.9.3 Girder Segment Design

A. Design Considerations

Stress limits for temporary concrete stresses in girder segments specified in Section 5.2.1C shall apply at each stage of pretensioning or posttensioning. The concrete strength at release and initial lifting shall be f'_{ci} and at the time the post-tensioning is applied shall be f'_c in the stress limits.

Stress limits for final concrete stresses at the service load in girder segments as specified in Section 5.2.1C shall apply for intermediate load stages with the concrete strength at the time of loading shall be f'_c in the stress limits.

The designer shall consider requirements for bracing of the girder segments once they have been erected on the substructure. Any requirements for temporary or permanent bracing during subsequent stages of construction, along with the contractor's responsibilities for designing and placing them, shall be specified in the contract documents.

Effects of curved tendons shall be considered in accordance with Section 5.8.1.F.

B. Post-tensioning

Longitudinal post-tensioning may be applied with the following considerations:

1. Post-tensioning precast segments at the final position before deck casting. This option is recommended by WSDOT for all spliced girder bridges. This option may require higher concrete compressive stress at CIP closure. This option is more suitable for future deck repairs and deck replacements since deck is not prestressed.
2. Post-tensioning before deck casting away from the bridge locations. Handling and shipping of spliced girders with segments post-tensioned away from the pier location may be challenging and risky. This option may be used in some cases where use of temporary support at the bridge site is not feasible.
3. Post-tensioning after deck casting. This option require lower concrete compressive stress at CIP closure. This option may be challenging for future deck repairs and deck replacements since deck is prestressed along with girders.
4. Two stage post-tensioning where girders are post-tensioned separately for dead load in the first stage, followed by post-tensioning the entire superstructure using continuity tendons in the second stage.

Designers shall investigate the required concrete compressive strength at the CIP closures. Achieving high strength concrete for CIP closures may be challenging in some locations.

Ducts for longitudinal post-tensioning shall be kept below the bridge deck.

All post-tensioning tendons shall be fully grouted after stressing. Prior to grouting of post-tensioning ducts, cross-section properties shall be reduced by deducting the area of ducts and void areas around tendon couplers.

Where some or all post-tensioning is applied after the bridge deck concrete is placed, fewer post-tensioning tendons and a lower concrete strength in the closure joint may be required. However, deck replacement, if necessary, is difficult to accommodate with this construction sequence. Where all of the post-tensioning is applied before the deck concrete is placed, a greater number of

post-tensioning tendons and a higher concrete strength in the closure joint may be required. However, in this case, the deck can be replaced if necessary.

15.5.4 Superstructures

18. Spliced Prestressed Concrete Girders

Closure joints shall be CIP concrete with a minimum length of 2'-0". The sequence of placing concrete for the closure joints and deck shall be specified in the plans.

Concrete cover to web stirrups at the CIP closure at pier diaphragms shall not be less than 2½". If intermediate diaphragm locations coincide with CIP closures between precast segments, then the concrete cover at the CIP closures shall not be less than 2½".

Longitudinal post-tensioning may be applied as follows:

1. Post-tensioning precast segments at the final position before deck casting. This option is recommended by WSDOT for all spliced girder bridges. This option may require higher concrete compressive stress at CIP closure. This option is more suitable for future deck repairs and deck replacements since deck is not prestressed.
2. Post-tensioning before deck casting away from the bridge locations. Handling and shipping of spliced girders with segments post-tensioned away from the pier location may be challenging and risky. This option may be used in some cases where use of temporary support at the bridge site is not feasible.

Ducts for longitudinal post-tensioning shall be kept below the bridge deck.

Background:

If you have any questions regarding this policy memorandum, please contact
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