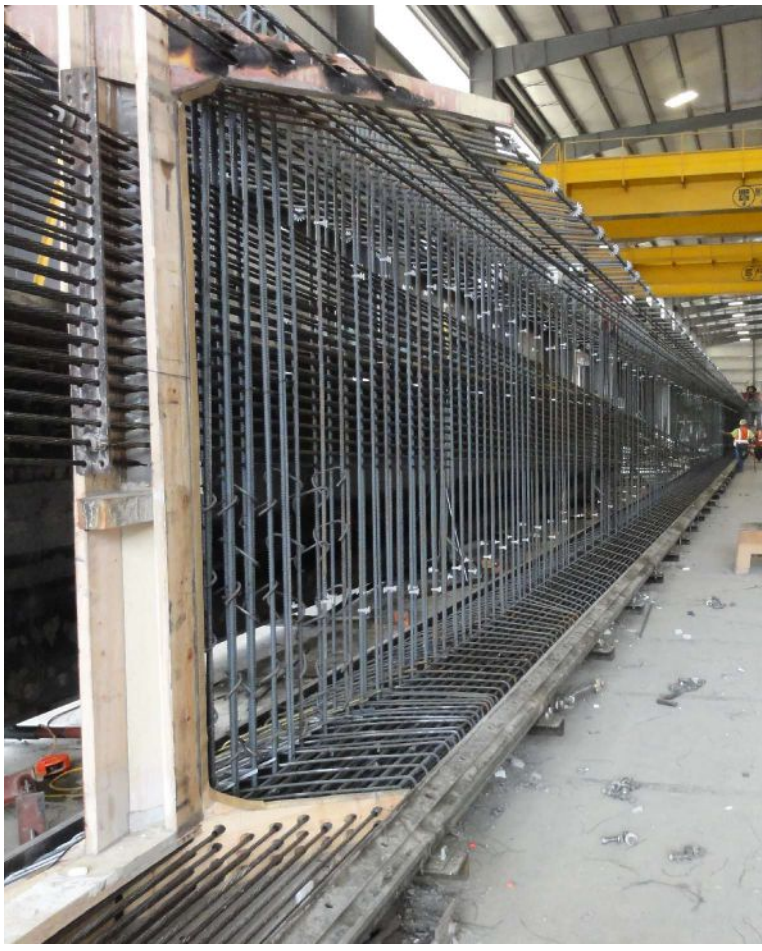
Prestressed Concrete Girders Achieve Record Lengths

by Cameron West, Concrete Technology Corporation

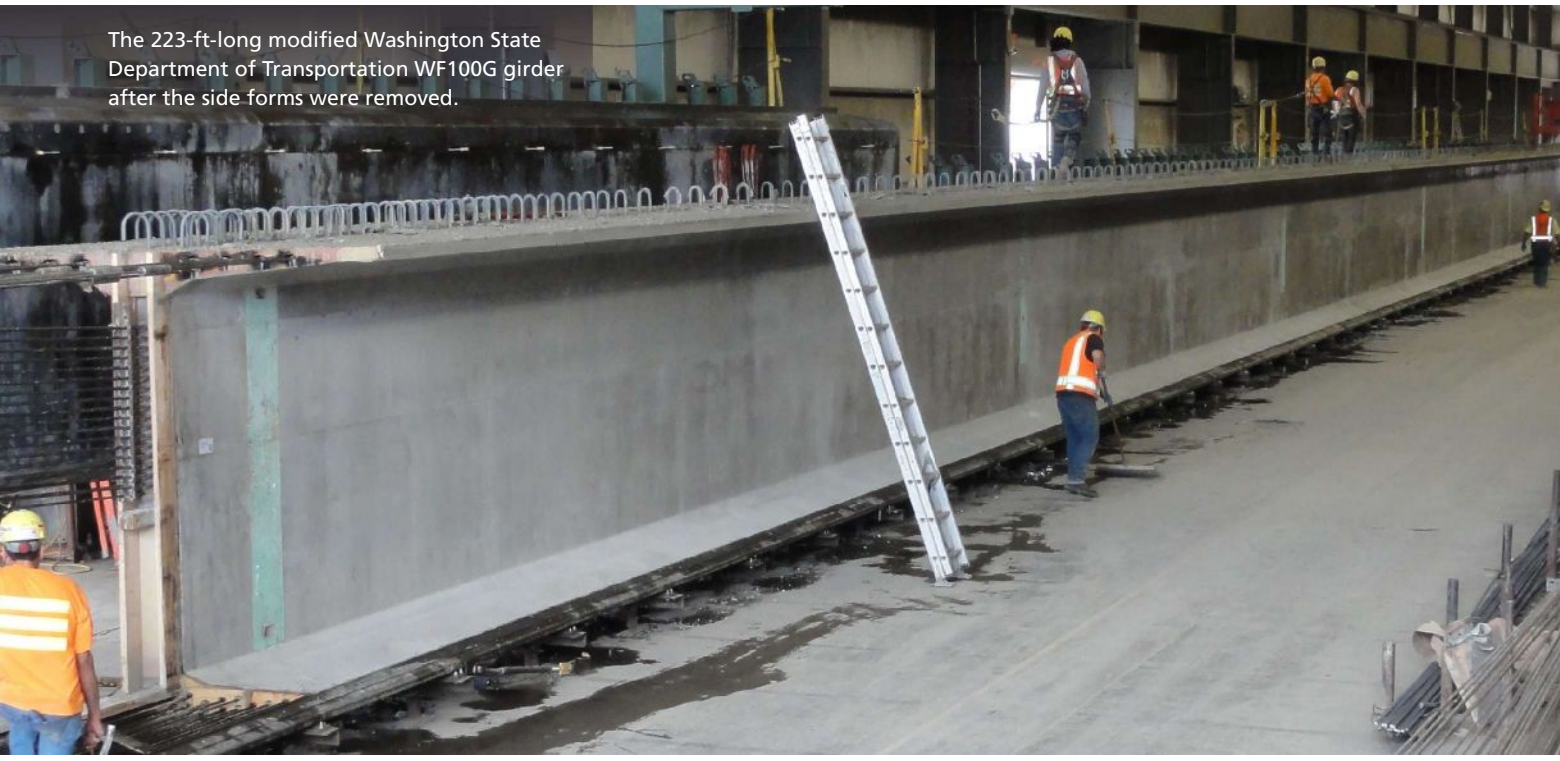


The 223-ft-long girder before side forms were set. All Photos: Concrete Technology Corporation.

Concrete Technology Corporation (CTC) and the design-build team of Atkinson Construction and Jacobs have partnered in Tacoma, Wash., on the Interstate 5 (I-5) Portland Avenue to Port of Tacoma Road southbound high-occupancy vehicle project, which is pushing the length limits of what is currently achievable with prestressed concrete girders. This bridge over the Puyallup River and multiple rail lines requires long span lengths and extreme skews. The longest girder, spanning five existing and future rail lines, has a plan length of 223 ft and approximately 55-degree end skews. This girder now holds the record as the longest single-piece prestressed concrete girder made in the U.S. Other important features of the project include the use of lightweight concrete to meet handling and shipping requirements and the use of a modified Washington State Department of Transportation (WSDOT) WF100G girder section with a widened top flange to improve stability.

Limiting Girder Weight

An early challenge in the project was reducing girder weight to ensure that it could be hauled to the jobsite by truck. Because available hauling



The 223-ft-long modified Washington State Department of Transportation WF100G girder after the side forms were removed.

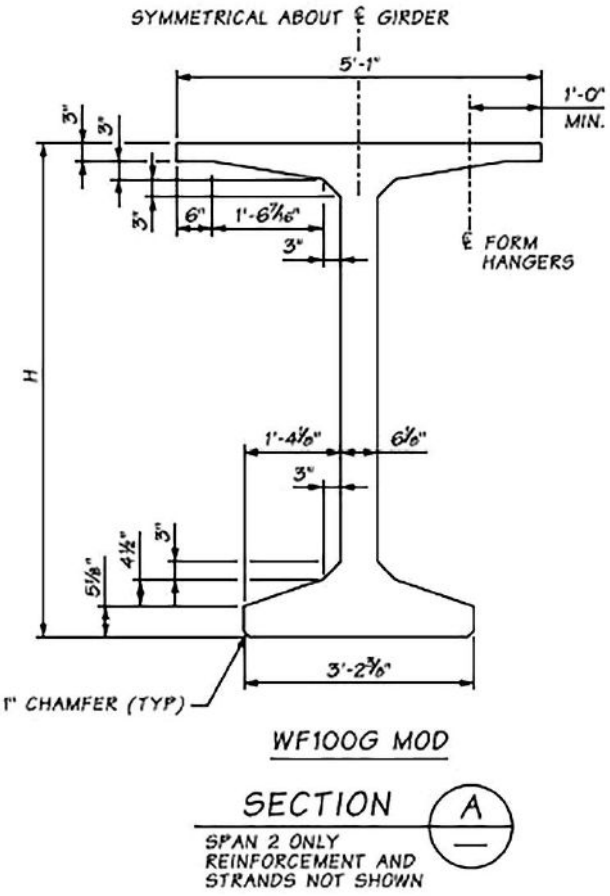
equipment in the region currently limits the maximum girder weight to 270 kip, lightweight concrete was chosen. On the I-5 Portland Avenue to Port of Tacoma Road project, the use of lightweight concrete with a fresh density of 0.125 kip/ft^3 and a reinforced density of 0.138 kip/ft^3 reduced the girder weight by 20%, to 247 kip. This concrete mixture met all project criteria and was able to reach a compressive strength of 8.4 ksi for transfer at 15 hours and 10.0 ksi at 28 days. CTC had previously used the same lightweight concrete mixture in several girder projects, including the I-5 Skagit River Bridge Replacement (see the Winter 2014 issue of *ASPIRE*® and the January–February 2015 issue of the *PCI Journal*) and State Route 162/6 Puyallup River Bridge (see the Summer 2016 issue of *ASPIRE*).

Girder Stability and Prestressing

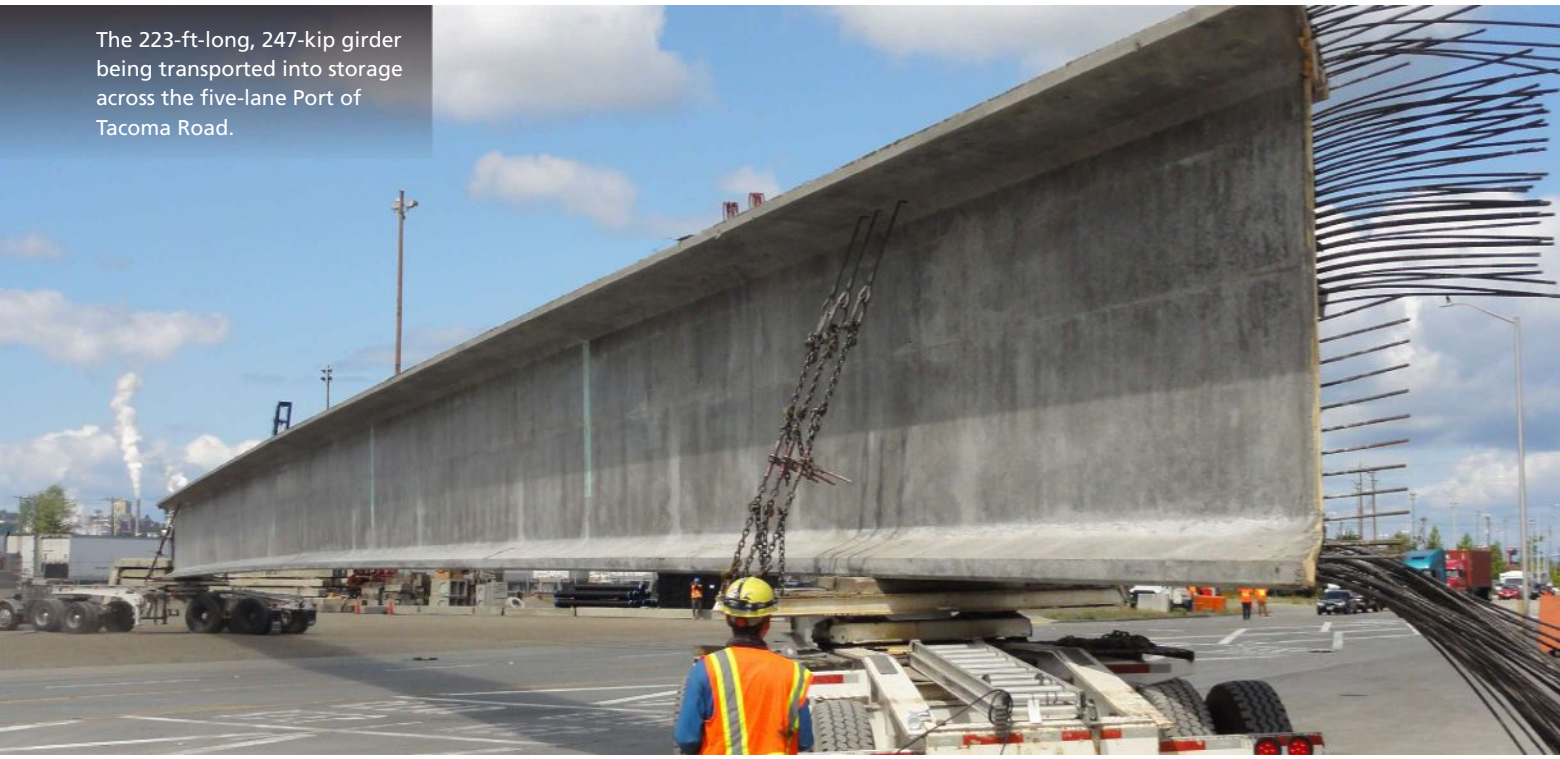
Special consideration was given to girder stability and stresses during plant handling, hauling, and erection. This analysis resulted in the selection of a modified WSDOT WF100G girder cross section, where the top flange was widened from 4 ft 1 in. to 5 ft 1 in. for this project to increase the weak-axis stiffness. The modified girder cross section was only used for one span with the longest girders; other spans used standard girder cross sections. To meet handling and hauling criteria, the design also required the use of ten 0.6-in.-diameter pretensioned temporary top strands, pick points at 26 ft from each end, and hauling bunk points at 25 ft from each end.

In addition to the record-setting length, this girder has a very high amount of prestress. The design specified 46 straight, 35 harped, and 10 temporary top 0.6-in.-diameter strands, which results in an initial tensioning force of nearly 4 million lb. This force, when combined with the girder length and lifting locations, required a concrete compressive strength of 8.4 ksi at transfer. The prestressing force in combination with the severe skew required strand debonding and supplemental mild reinforcement in the acute corner of the bottom flange to minimize cracking.

Cameron West is the chief engineer with Concrete Technology Corporation in Tacoma, Wash.



Modified girder cross section. Figure: Washington State Department of Transportation.



The 223-ft-long, 247-kip girder being transported into storage across the five-lane Port of Tacoma Road.