What's next for the Skagit River Bridge?

Raising the Portal and Sway Frames

Successful as the replacement of the collapsed bridge was (the number of closed days totaled only 28), there was little rest for the designers and contractors. With the permanent replacement span in place, attention turned to the remaining entrance portal, the sway-frame truss sections and their vertical clearances.

A portal frame is the end most lateral bracing frame at the end of each independent span. Sway frames are the frames between the portal frames within a span. Constructability demanded some innovation.

Raising a portal and sway frame isn't as simply as merely moving portions of the bridge up. The way this is done is to partially dismantle the bridge and reconstruct it in the new configuration. While the bridge is partially dismantled, its structural integrity is compromised until the portal or sway frame is reconstructed. So managing the volume of work performed at one time was essential in ensuring the repair didn't create another collapse. The restoration was successful.

Conclusion

While truckers are responsible for their over-height loads, states are prudent to examine over-height hits and apply mitigation if possible. In this case that means removing and replacing the lowest height elements of the trusses, increasing the vertical clearance across the two outside lanes, helping to extend the already long-life of the I-5 Skagit River Bridge.

Skagit River Bridge facts

- 71,000 vehicles were detoured through the city streets of Burlington and Mount Vernon.
- The lightweight girder concrete compressive strength was 9,500 pounds per square inch.
- A 500 ton and a 200 ton crane were used in unison to move girders.
- Concrete girders had 48 high strength steel pretension strands.
- A row of pilings and bents were built to support the rails for superstructure sliding.

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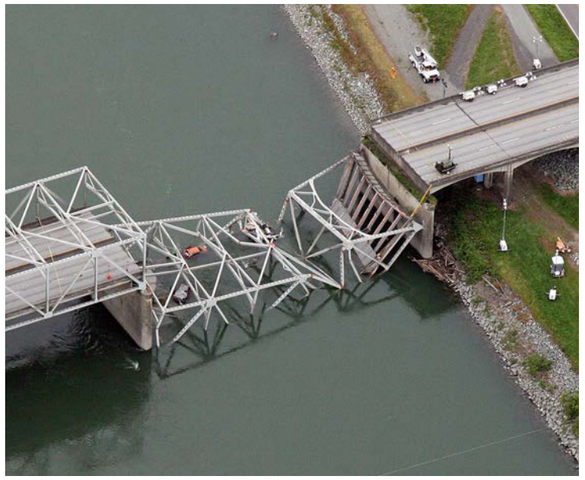
Skagit River Bridge Emergency



Bridge collapse incident

On May 23, 2013 the evening commute was just ending along a four-lane stretch of the Interstate 5 corridor, which lies between the Canadian Border and Seattle. At roughly 7 p.m., a semitruck heading southbound and carrying a permitted oversized-load struck the first portal and several subsequent sway members along the steel truss section of the bridge. The northern truss span of the bridge collapsed into the Skagit River.

While the semi-truck made it across hitting several more sway frames along the way, several vehicles didn't and the occupants had to be rescued. No one was killed in the collapse.

The Washington State Patrol (WSP), the Washington State Department of Transportation (WSDOT) and local agencies responded immediately, setting up and manning detour routes both east and west around the bridge.

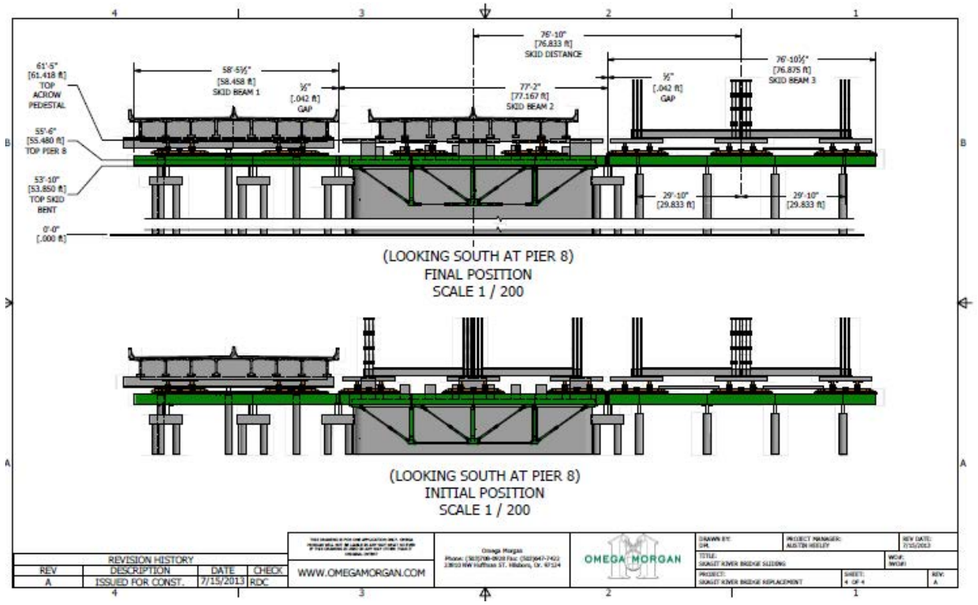
WSDOT bridge engineers assessed the damage and began plans for both emergency and permanent repairs, while communication staff responded to the media, sent out updates and Freight Alerts region-wide. Traffic engineers worked through the night to refine the detour routes for the roughly 71,000 vehicles that were detoured through the city streets of Burlington and Mount Vernon.

Within 24 hours a contractor was hired under an emergency contract to remove the collapsed span, and began working with WSDOT engineers to install a temporary span to get the Interstate back open. As the work was being done to temporarily restore I-5 traffic, WSDOT engineers began assembling contract documents for a permanent span repair.

View construction photos at:
www.flickr.com/photos/wsdot/sets/72157634573080718/

Immediate response project delivery

Hours after the collapse, discussions were underway at WSDOT about how best to replace the collapsed span, and how to restore traffic as quickly as possible. Time requirements, vertical clearance requirements, and superstructure dead load limitations quickly became the primary guiding factors in designing the span replacement.



Minimizing traffic disruptions dictated the installation of temporary side-by-side dual lane modular truss bridge spans (supplied by ACROW, and subsequently replaced with the permanent span). Demolition of the collapsed span and installation of the two temporary spans was completed by Guy F. Atkinson Construction of Renton, Washington. For navigational purposes, vertical clearance to the river below had to be equal to or greater than that provided by the original truss span. And, importantly, to minimize any additional seismic inertial loads to the existing bridge substructure, the dead load of the replacement span could not exceed the dead load of the original truss span by more than 5 percent.

The Design-Build method was chosen for the permanent span replacement with the goal of rapid construction. Three options were investigated; a steel through-truss (a near duplicate of the original span), a steel plate girder span with concrete deck, and a prestressed concrete girder span with concrete deck. The steel through-truss, though light in weight and aesthetically consistent with the original bridge, was thought to be too time-consuming to fabricate and erect. The project was advertised for Proposal with the assumption that the most-likely structure types were going to be the steel or concrete girder options.

Four design-build teams submitted proposals for the permanent span replacement. Two of the proposals included steel girder replacement spans, and the remaining two proposals included prestressed concrete girder span options. WSDOT selected the best-value proposal, submitted by Max J. Kuney Company (MJK) of Spokane Washington, which utilized a prestressed concrete girder deck bulb-tee replacement span.

Lightweight concrete was specified for the girders, diaphragms and barriers, to stay within the stipulated span dead load limitations. The concrete girder proposal chosen offered competitive initial costs, low overall life-cycle costs, the shortest girder procurement time, and the minimum closure time required to replace the temporary span with the permanent span.

Timeline

MAY 23rd — SPAN COLLAPSES AND TRAFFIC IS DETOURED

24th — EMERGENCY CONTRACT TO REMOVE COLLAPSED SPAN

June 14th — CONTRACT AWARDED FOR PERMANENT SPAN

19th — TEMPORARY REPLACEMENET BRIDGE OPEN

JULY 9th — FABRICATION OF PRE-STRESSED GIRDER REPLACEMENT SPAN

12th — OVERALL CONSTRUCTION BEGINS

SEPT. 14th — PERMANENT SPAN ROLLED INTO PLACE

15th — PERMANENT SPAN OPEN TO TRAFFIC

NOV. 19th — FINISH PORTAL RAISING AND SWAY BRACE REPAIR

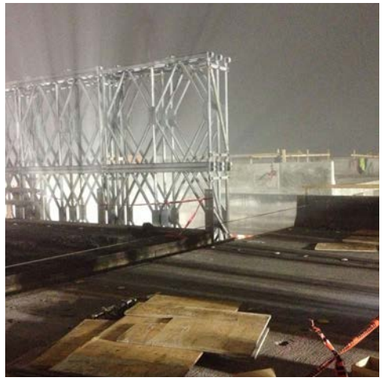
I-5 Closed to traffic — 27 days

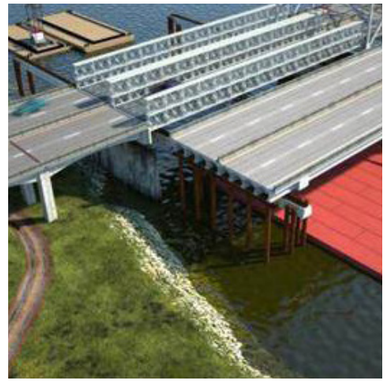
I-5 open with temporary replacement bridge — 208 days

Temporary closure — 1 day

I-5 permanently open — 66 days

Complete





Bridge builders innovate

The WSDOT plan to reconstruct the bridge consisted of constructing the permanent replacement span using accelerated construction techniques. The permanent replacement span, composed of deck bulb-tee girders made of lightweight aggregate with concrete overlay, was built adjacent to the bridge and its temporary spans.

The WSDOT Bridge and Structures Office provided over-the-shoulder reviews of Parsons Brinckerhoff's design, shop drawings, and construction submittals.

MJK received notice to proceed on June 19 and fabrication of the eight bulb-tee girders began July 9.

In order to limit the weight of superstructure, the 7'-6" girder spacing was considered to keep the replacement structure as light as possible. The total weight of new superstructure including the lightweight concrete traffic barriers and concrete overlay was 915 tons.

The permanent superstructure was constructed on a steel piling and bents, just downstream of the temporary spans. The crane work required 19 specific moves, including passing the end of the girder from the dike to the barge crane, tucking the girder under the boom of the barge crane - while re-ballasting the barge system - and finally re-ballasting the barge as the girder was placed on the temporary bent.

A vertical and horizontal jacking system was concurrently installed using rails supported by temporary piling and bents. To complete the installation of the new span, first the temporary spans were lifted off the existing substructure and slid off onto the temporary bents upstream of the bridge.

BRIDGE INNOVATION FOR THE PROJECT

1. Emergency installation of temporary side-by-side dual lane modular truss
2. Accelerated bridge construction with horizontal jacking of permanent span
3. Lightweight concrete girders

A time lapse series of the entire girder setting operation can be found at: www.youtube.com/watch?v=-IdUap4 IvY

Washington State Department of Transportation • Bridge and Structures Office • Tumwater, Washington