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Proven technology viable for I-90 floating bridge rail joint

Summary

Studies by the Washington State Department of Transportation found that the Interstate 90 floating bridge can support the weight of a light rail system. Sound Transit studies confirm that a light rail track system can be designed to accommodate the movements of the floating bridge.

Background

Two high capacity transit modes are currently under consideration in the I-90 corridor between Seattle and Bellevue and east to Overlake and Redmond: light rail and rail convertible bus rapid transit. In July 2005, when the Sound Transit Board updated its Long-Range Plan, it directed the completion of additional analyses of the I-90 corridor. This work included a light rail simulation test across the I-90 bridge, completed by WSDOT in September 2005, which confirmed previous computer modeling work and structural analyses finding the bridge capable of carrying light rail. The study also provided information about the anticipated bridge movements with light rail.

Because I-90 would be the first known example of rail operation on a floating bridge, Sound Transit compared the anticipated movements on the I-90 bridge with the movements of modern passenger rail suspension bridges. This comparison demonstrates that it is feasible to design a light rail track system to accommodate the movements of the I-90 floating bridge.

Light rail feasibility on the I-90 floating bridge

Since 1985, many studies have assessed the feasibility of operating light rail on the I-90 floating bridge. These include an assessment of alternate loading scenarios, anticipated movement of the roadway structures, and consideration of the rail joint at the floating bridge and transition structure spans.

To assess how rail joints would operate on I-90 between the fixed and floating bridge spans, Sound Transit reviewed assumptions and assessments from prior rail joint studies. Additional review included rail joint design and operations, operational assumptions for light rail vehicle type, track configurations, associated transitional bridge movements, and potential mitigation measures.

The I-90 floating bridge includes land-based fixed spans attached to the floating mid-section of the bridge. Transition joints between the fixed and floating portions of the bridge allow for the bridge's movement. The light rail track system across the transition joint will need to be designed to accommodate the bridge's movement.

Comparison to existing similar rail bridges

Sound Transit has identified examples of modern rail bridges that have rail joints designed to accommodate similar movements to those expected for the I-90 floating

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bridge. Structural details follow for two of these bridges – the Tagus River Suspension Bridge in Lisbon, Portugal, and the SkyTrain Cable Stayed Bridge (SkyBridge) in Vancouver, B.C., Canada -- both of which have a successful history of passenger rail operation.

The following table compares these bridges with the I-90 floating bridge by two major movement types, longitudinal (along the length of the bridge) and vertical (up and down). Movements on the Tagus River Suspension Bridge exceed those expected on the I-90 floating bridge. Movements on the SkyBridge are slightly less than those expected on the I-90 floating bridge.

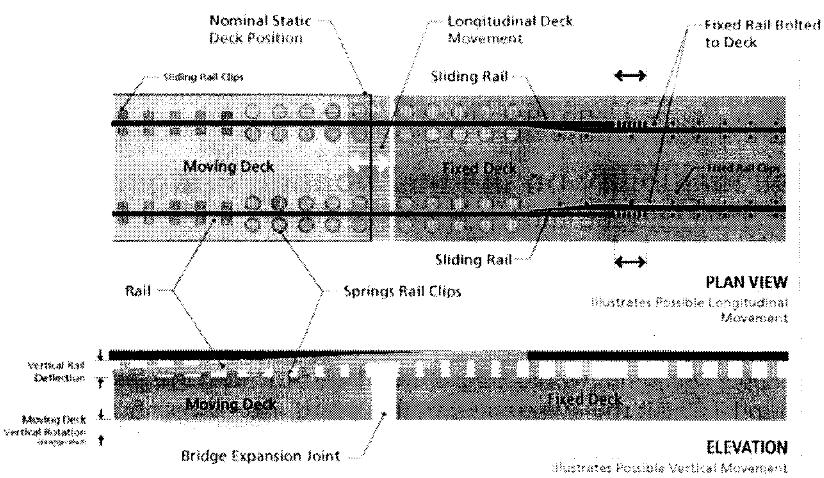
Summary of Bridge Movements

Movement	I-90 Bridge (modeled)	Tagus River Bridge Lisbon, Portugal	SkyBridge Vancouver, BC
Longitudinal Movement	+/-2'-0.5"	+/-5'-0	+/-1'-1.1"
Vertical Rotation*	2.2 degrees (downward)	+/-3.43 degrees	+/-0.75 degrees

**Rotation of transition span due to its vertical placement at floating bridge*

The I-90 floating bridge also experiences a horizontal rotation (side to side) of +/- 1.1 degrees as it shifts in the water. On the Tagus River Bridge and SkyBridge, similar horizontal rotation occurs due to changes in temperature and the effects of trains crossing the bridge. These horizontal rotations cause additional longitudinal movement and slight horizontal rotation across the transition rails. Engineering reviews conclude that the designs of the rail joints across the Tagus River Bridge and SkyTrain Bridge also could accommodate the I-90 floating bridge movement.

SkyBridge rail joint example



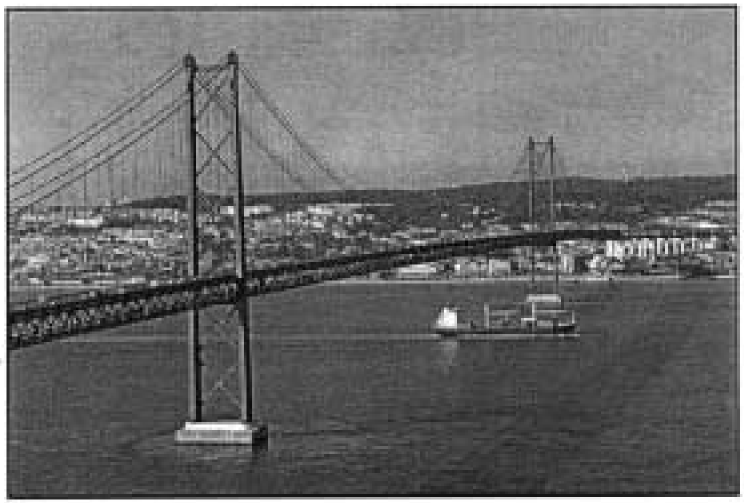
SkyTrain SkyBridge Rail Extension Joint
Vancouver, B.C. *Not to scale*

The SkyBridge joint allows movement due to temperature, wind and movement of the SkyTrain vehicles. The rail joint undergoes vertical and horizontal angular changes and longitudinal movement. The rail joint consists of two parts: a pair of sliding sections that allow for longitudal movement (top), and another section with spring devices that allow for vertical angular change (bottom).

What's next?

If light rail is identified by the Sound Transit Board as the preferred technology for cross-lake high capacity transit in the I-90 corridor, Sound Transit will work closely with the State Department of Transportation in project-level analysis to design a light rail joint for the bridge's expansion joints. Such design would be informed by all the previous design work on the I-90 bridge and by other transit systems operating rail across bridges.

Passenger rail bridges with similar movements to I-90



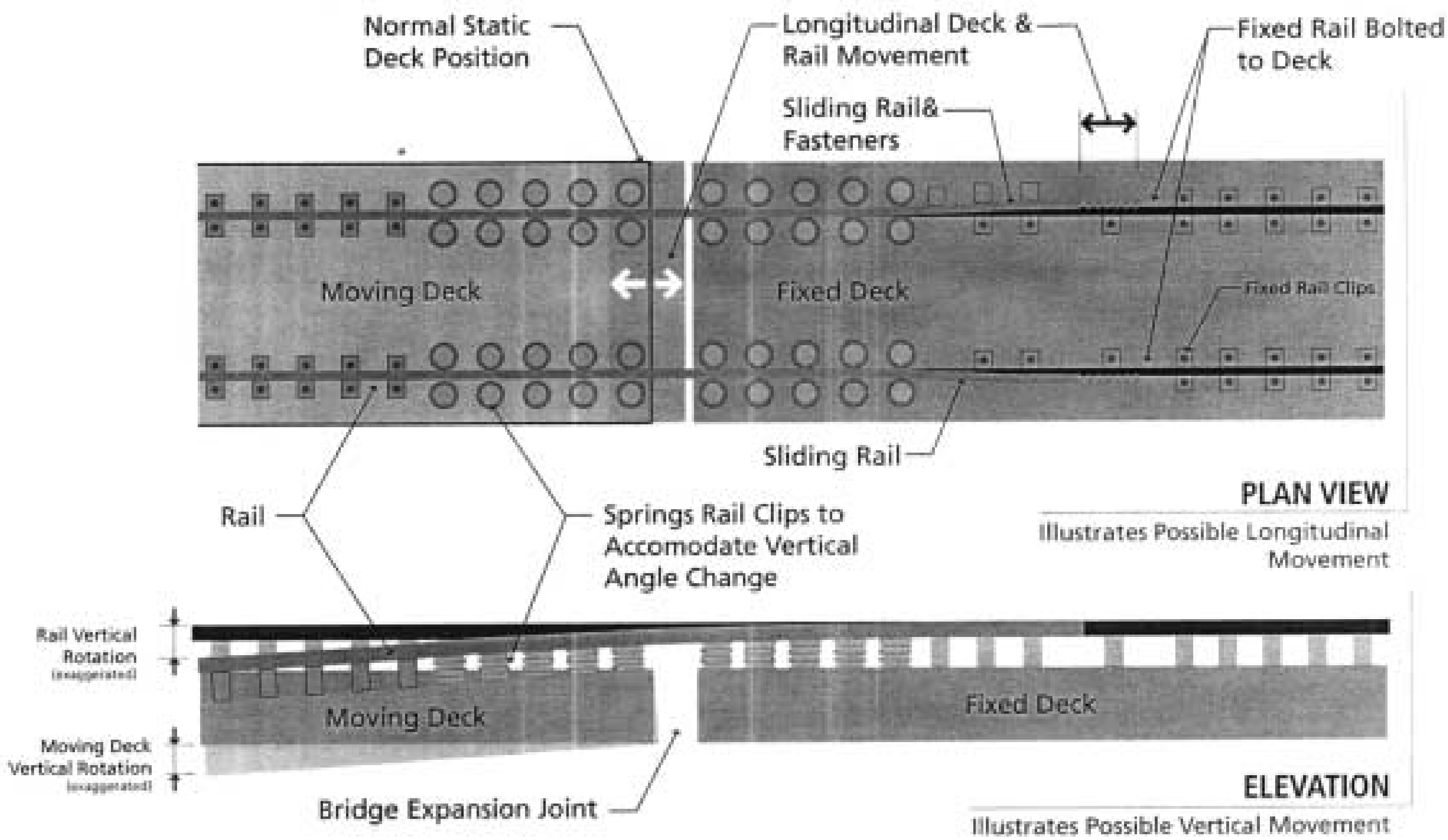
Tagus River Bridge

- Lisbon, Portugal
- Suspension bridge
- Autos on upper deck
- Rail on lower deck

SkyTrain Bridge

- Vancouver, British Columbia
- Cable stay bridge
- Rapid rail bridge

SkyTrain rail expansion joint



SkyTrain Skybridge Rail Expansion Joint

Vancouver, B.C., Canada

Not to Scale