August 2019 ABC-UTC Webinar Featured Presentation: WSDOT's Alaskan Way Viaduct Replacement Project: SR-99 Seattle Tunnel Precast Deck		
#	**Questions**	**Responses**
	Design	
1	Please comment on the precast deck connection design and tolerance.	Global tunnel centerline tolerance was a bullseye +/- 6" on the liner location. This tolerance is achieved during the two concrete corbel placements for the SB walls and deck. Having placed the corbels to line and grade, vertical tolerances are available in grout pad and in the concrete overlay thickness for the NB prestressed panels. Horizontal curvature of the rectangular panel is made up in the grouted keyway widths. The grouted keyway widths are nominally 1/2" but vary from 1/4" to 3/4" depending on curvature. The horizontal radius of curvature for the tunnel is 6,000 ft.
2	Could you discuss innovations that were considered but not utilized and why?	Good question but nothing comes to mind regarding the Lower NB deck.
3	Discuss the load rating of the precast slabs, if possible.	Bridge load rating, LRFR, was completed for Inventory and Operating for HL-93, AASHTO 1-2-3, NRL, EV2, EV3, OL1 and OL2. Ratings were completed prior to tunnel opening and included both Strength and Service Limit States for the prestressed NB slabs.
4	How did the precast deck system account for alignment variations between the design and the as-constructed tunnel?	See response to #1.
5	Please comment on the seismic connection details for an underground structure.	The NB slab modules are pinned with threaded rods at central location to the portals. This maintains module location and allows thermal expansion/contraction, PT shortening and seismic shear.
6	It's my understanding that the tunnel crosses through a soil slip plane as it dives down and then comes back up. How was this designed?	The Seattle Fault location is south of the tunnel near the mouth of the Duwamish Waterway.
7	Was UHPC used at the closure pours?	No, conventional WSDOT 4000D concrete was used.

8	When is it advisable to use prefabricated full-depth slabs?	This system of transversely pre-tensioned and longitudinally post-tensioned concrete slab with a concrete overlay was advantageous for us to meet the loading requirements, deflection limitations and shallow enough to meet vertical clearance requirements.
	Construction/Maintenance	
9	How did you coordinate your precast deck elements and the hauling route, and did the hauling route impact your design?	The hauling weight of the precast panels is 22 tons. STP utilized the same trailers required for the delivery of the liner segments as a legal load. Overload permits were not required. The haul route was not a determining factor to the design.
10	What are the shipping contraints for the precast deck panels, e.g., size, weight or other limitations? Also, what are the QA/QC differences of precast versus CIP decks?	The trailer configuration used was a legal load. This is a Design-Build Contract and both STP and Concrete Technology implemented QC/QA Programs with a QA Manager. Procedures are similar and STP incorporated QA staff for the full 9 months of precast slab fabrication at the Concrete Technology plant.
11	What were your construction challenges, e.g., pouring closure joints on a longitudinal slope?	Maximum slope is +/- 4%. Closure joint grouting was a messy operation but was cleaned and shotblasting prior to placing the overlay.
12	Please comment on waterproofing of the tunnel and the maintenance aspect of the precast deck.	The Bored Tunnel portion of the project is waterproofed utilizing fully gasketed tunnel liner panels under high compression from hydrostatic and earth pressure forces. The pre-tensioned and post-tensioned concrete slab is designed for zero tension, and the concrete overlay system will protect the panels from water intrusion.
	Cost	
13	What were the cost and time savings realized from the use of precast decks?	We believe the time savings approximated 8 months from a cast-in-place slab alternative. The cost difference between the precast panels and a cast-in-place slab is unknown to the Owner.
14	What is the cost of the project?	The Deep Bored Tunnel contract to Seattle Tunnel Partner, STP, is $1.4B. The Alaskan Way Viaduct Replacement Program cost is $3.2B.
	General	

15	Can you comment on reported "bouncing" that some drivers have reportedly experienced when driving through the tunnel?	This is personal preference with varying opinions from users. Both the SB and NB directions experience a similar ride. WSDOT believes the use of an air-powered screed contributed to the ride as conventional bridge deck paving equipment could not be used in many circumstances. The tunnel environment required the use of diesel-powered screed equipment, and the availability is limited.
16	What do you believe was the most important tool that gave support to the project?	Common goal to complete the tunnel after the TBM delay. It made sense to construct with precast concrete to speed completion within the tunnel.
17	How is the tunnel performing?	The tunnel is performing very well.
18	What went well and what might be some of the lessons learned that would help improve the future implementations?	Precast slab delivery, erection, duct splicing and post-tensioning went extremely well. Preparation of the deck for the overlay could have been improved by texturing when cast.
	Questions during Webinar	
19	Did you include shear connectors between panels from module to module?	There is an expansion joint between modules. There are no shear connectors near the expansion joint. The rigidity of the slab acting as a horizontal diaphragm supported vertically on bearings ensures no loss of the gapping near the module ends.
20	How is the geometry of precast deck panels at the curves? Any adjustment in longitudinal post-tensioning at the curves?	See Response to #1. There was no adjustment required to the PT in the curves. The slab geometry was controlled by wood shimming through the PT effort.
21	What was the horizontal curvature R?	6,000 ft.
22	What concrete mix was used for the overlay?	WSDOT Modified Concrete Overlay (Flyash)
23	What type of grout mix was used for the shear keys?	4,000 psi Non-Shrink Grout

24	As I understand it, a prestressed deck is more difficult to repair or retrofit compared to plain reinforced concrete. Is there any difference in design, either WSDOT standard or project specific, concerning the longevity or life-cycle repair for a prestressed versus plain deck? Have in situ repairs to prestressed decks changed the way we design and install them?	WSDOT expects very good performance with this slab system as the design eliminates tensile stress. Any rehabilitation will likely be in the overlay or the overlay interface. This repair would unlikely affect the pre-tensioned, post-tensioned slab panels.
25	How deep is the tunnel buried?	The low point of the tunnel is 150' below the water table elevation. The highest soil surcharge depth is 270'.
26	Why did the utilities have to go through the slab? Why not all under the slab or to the side?	Utilities do not go through the slab; they were supported beneath the slab through hanger rods from the inserts. Most of the electrical utilities are supported directly on the corbels. The utilidor lighting and drainage is supported beneath the slabs.
27	What is the width of grouted joints?	See response to #1.
28	What is the design life of the tunnel?	100 years
29	From a Bridge Management System (BMS) standpoint, is the deck treated as all precast or are the slivers of plain reinforced concrete captured with a small square amount?	The cast-in-place portions are defined as precast.
30	Are there any monitoring sensors placed in the project to collect data and compare precast slabs versus cast in place?	There is no structural instrumentation.
31	Was any FRP reinforcement used?	Not in the NB roadway slab. FRP was utilized for the soft-eye tunnelling portal walls.