October 2019 Research Seminar: Performance Comparison of In-Service, Full-Depth Precast Concrete Deck Panels to Cast-in-Place Decks		
	Questions	**Responses**
	General	
1	How often are full-depth precast panels used? Are they acceptable by most states?	See slide 26 for recent usage and slide 23 for states that allow their use. FDPC panels are being used much more frequently in the past 10 years. Of the states that we surveyed, 72% currently allow their use.
2	Do the speakers have data on the percentage of concrete bridge construction using full-depth precast panels versus partial-depth precast panels versus cast in place decks?	Currently, 62,826 of 616,096 bridges (10.1%) have a "Deck Structure Type (107)" of "2 - Concrete Precast Panels" in the NBI. This precast panels category includes both full and partial depth panels. We found through our survey about 300 bridges with full-depth precast panels (0.05% of all bridges).
3	How many years have you been collecting data? How have you accounted for the variations in precast manufacturing?	The oldest inspection data in the database is from 1983. We have not done anything to account for variations in precast manufacturing
	Joints	
4	Please address issues and challenges of dealing with maintenance of the joints between precast panels.	The only specific issue we encountered was when cracking occurred at the joint interface resulting in water leaking through the joint.
5	Can you comment on the materials and effectiveness of joints in precast panel decks?	See slide 56. The most common joint combinations all performed well. There has also been a significant amount of recent research by numerous universities and FHWA on CC and UHPC joints to improve their behavior.
6	What type of concrete was used in the closure joints?	Conventional concrete and high-performance concrete can be used for joints. Shrinkage reducing admixtures and proper curing of the joint can be used to reduce the likelihood of cracking in larger volume closure pours.

7	Assuming joints are filled with UHPC, do you have any recommendations for any subsequent cracking in the deck?	We did no receive any feedback and could not find any informaiton on specific cracking in the deck for bridges with UHPC joints.
	Overlays	
8	Are overlays required with full-depth precast slabs?	Overlays are not required with full-depth precast slabs.
9	Are overlay material types (asphalt, epoxy overlay, etc.) an important variable in the performance of FDPC panel decks?	We found no difference in performance between the overlay types. We don't have any information regarding the maintenance of the overlays, which will have a large effect on their performance. Local repairs can be made to extend their service life.
10	What is the difference in performance of the different precast concrete panel overlays?	We found no difference in performance between the overlay types. We don't have any information regarding the maintenance of the overlays, which will have a large effect on their performance. Local repairs can be made to extend their service life.
	Performance	
11	Did the research investigate the performance of deck panels in a cold environment and with high chloride loading?	See slide 49, bridges in cold climates were found to have the highest deterioration rates and shortest estimated service life.
12	What factors are necessary to calculate the rate of deterioration and the useful life for bridges?	For this project, we used the NBI inspection data to find deterioration rates and estimated service lives. This has been done in other research efforts using NBI data. A better idea of service life could be obtained using non-destructive testing (NDT) techniques. This was one of the objectives of the LTBP Program.
13	What is the effective life of precast concrete deck panels in years?	Using the NBI data, we found the estimated service life to be more than 33 years for bridges with FDPC deck panels.

14	Can you give a comparison of both types of decks as well as the use of UHPC for the closure pour? Please comment on the durability and future maintenance.	We found similar performance between bridges with FDPC deck panels and CIP decks. There has been recent research to improve the design of joints and there is more contractor experience today, so we would expect the future performance of bridges with FDPC deck panels to improve.
15	Did the survey also cover the performance of UHPC field-cast connections for full-depth precast deck panels?	Yes; see slide 20 for information on UHPC joints considered in survey.
16	Can you comment on the cases with FDPC deck panels in multispan continuous bridges including the type of longitudinal connection?	See slide 52. The NBI differentiates between single-span and continuous steel and concrete bridges. We saw similar performance between the two types of structures.
17	Were problems associated with deck weld plates considered when evaluating the differences between precast decks and CIP decks?	See slide 17. The deck weld plates were found to have the most durability-related issues.
	Cost	
18	Were cost and time savings evaluated, or was this research strictly a performance comparison only?	We did collect information on initial cost (slide 29), but did not do anything related to life-cycle cost. Time savings have been reported in the PCI State-of-the-Art report as 50-75%, but this was not directly studied in this project.
19	Are the use of FDPC deck panels an efficient and cost effective choice for bridges with irregular framing?	This question was not directly addressed in this research, but there are creative panel layouts that can account for irregular framing (e.g. longitudinally oriented panels, skewed panels, offset panels). Some of these are discussed in the ABC-UTC Guide to FDPC Deck Panels.
20	How expensive are the full-depth precast panel decks compared to cast-in-place decks?	See slide 29 for a cost comparison.
21	Instead of UHPC, what is the benefit-cost of post-tensioning joints transversely, longitudinally, and transversely and longitudinally?	This question was not directly addressed in this research. We only saw FDPC deck panels longitudinally post-tensioned. We do not have information on the cost between the two types of systems.

22	What is the life cost comparison between FDPC and CIP decks?	We did not do a life-cycle cost analysis for this project.
	Design	
23	How can this concept be applied to deck replacements on existing bridges?	We found that there were numerous deck replacements done using FDPC deck panels. The old deck would need to first be removed, shear studs or shear interface reinforcement replaced, and then FDPC deck panels installed. This can be done for the entire deck or segments of the deck at a time.
24	How do we make them plug-n-play (easier to replace)?	This question was not addressed in this research, but has been the focus of some recent research efforts. The University of Nevada - Reno recently completed research on "deconstructable and robuse bridges."
25	Please describe any correlation between design criteria used for allowable tension and the long-term performance of the deck.	This question was not addressed in this research.
26	Were any comparisons made between precast and CIP decks with both isotropic and traditionally designed reinforcement (4-way compression)?	This data was not collected in this research.
27	Were there differences in the FDPC and CIP decks' steel reinforcement, and if so, how did you account for those differences?	Details on the type of steel used in the deck was not collected in this research.
28	Please comment on the pros and cons and detailing considerations or examples of precast deck panels with glass fiber-reinforced polymer (GFRP).	Information on GFRP reinforcement was not collected in this research.
29	Can you comment on precast decks with additional accessory mounting, like a walkway, overhead caternary poles, direct fixation track, etc.?	This data was not collected in this research.

	Construction	
30	Are there any problems with fit-up and deck elevations with the panel during construction?	Some problems related to fit-up have been reported (e.g. joint rebar interference between adjacent panels, slight misalignment of PT ducts), but these issues could be taken care of with field modifications (e.g. bending joint rebar) and prevented with reasonable tolerances and quality control. Some contractors have also done trial runs of construction procedure offsite or to the side for more accelerated projects. Differential camber was also a reported concern by DOTs, but this can typically be handled in the haunch.
31	Can you cover the details involved in the support of the slabs off of the bridge girders and the interface between slabs?	This was not specifically covered in this research, but lifting and storing the panels panels before construction can be the critical load case and should be designed for.
32	What is the length of time for precast panels to be manufactured? What is the best material to join precast panels?	The length of time for precast panels to be manufactured was not covered in this project. Different materials can be used to join the panels with the appropriate detail. The three joints that we found to be the most common and offer good performance are UHPC with straight bars, CC with hooped bars, and grouted with PT.
33	Do you see fewer bidding contractors on projects with precast decks, as opposed to conventional cast-in-place decks?	This was an issue that was reported by states. The recent trend of more projects with FDPC deck panels will hopefully increase the number of experienced contractors and increase the number bidding on these projects.
	Future Research	

34	What is next for research on this topic?	There are no immediate next phases planned at this point. Information on the database is provided in the Appendix of the report and can be requested from us. A more detailed inspection of the bridges (e.g. using NDT methods) would be a better was to evaluate the performance of bridges with FDPC deck panels and comparison bridges with CIP decks. This project could also be revisited every 5-10 years as more bridges with FDPC deck panels are constructed and current bridges age. We are willing to collaborate with any interested parties to expand this work and improve the understanding of the performance of these bridges.
	Questions during Research Seminar	
35	The table on slide 8 or 9 describes the San Francisco-Oakland Bay Bridge work in 1961 as occurring on a cable-stayed bridge. It is a suspension bridge with stiffening truss and a supporting through truss.	Thank you for the clarification.
36	Slide 29: The average cost for FDPC, did you notice any difference between the costs of the top three connection choices?	We did not collect cost data for each type of connection.
37	Slide 41: How did you come to an estimated service life of 40 years?	This was decided on after a discussion with our Research Advisory Panel.
38	Slide 43: ADTT is dynamic, i.e., it changes from year to year. How did you come to a single figure for this variable for the life of a bridge?	ADT and ADTT were taken from 2018 NBI data.
39	Bridges in hot humid coastal environments were not mentioned. Any comments?	There was sufficient inspection information for only 1 bridge in hot humid climate and 2 bridges in marine environments.
40	Was there any distinction between different types of deck reinforcement and how that affects deck service life?	We did not gather information on deck reinforcement type in this project.

41	I did not see full-depth deck panels prestressed transversely and post-tensioned longitudinally compared with using none. Any comments?	We did not gather information on if the deck panels were transversley prestressed in this project.
42	NBI data is fairly vague for early age evaluation. Did you look at element-level data for deck or wearing course cracking in the service life evaluation?	We did not look at element-level data in this project. NBE data is only available for about 1/3 of all bridges. This is something that could be looked at in future phases of this research though.
43	Which are the most common signs of deterioration? Surface defects? Joints? Bottom of deck spalling due to corrosion? Uneven bearing of next panels?	The most common sign reported was cracking or reflective cracking at the joint locations.
44	Do you know if there is waterproof membrane under the asphalt overlay?	We did not gather this information in this project.
45	Did you find any preparation of the precast concrete surface that improved the bond of asphalt concrete with the precast panels?	We did not gather this information in this project.
46	Were you consistent with the definition of FDPC during data mining?	The closest NBI classification for "Deck Structure Type (107)" is "2 - Concrete Precast Panels," which includes both full and partial depth panels. Because of this, we had to rely on the state survey results to determine bridges with FDPC deck panels. Through the survey we found about 300 bridges with full-depth precast panels and used their NBI numbers to collect additional data to what we found through the survey.
47	Can FDPC panels be used on major busy Interstate highways?	FDPC deck panels have been used on several major interstates (30 projects on bridges with ADT greater than 30,000). These projects are performing reasonably well with an average estimated service life of over 30 years.
48	Does the reinforcement type affect the service life? For instance, epoxy versus MMFX?	Information on reinforcement type was not gathered in this project.
49	Did the survey study the cost of maintenance of each type?	This study did not collect information on maintenance cost.

50	It appears to me that the Utah and Alaska inventory is skewing the results. Do you agree?	New York had the most projects in the database (125) followed by Alaska (40) and Utah (37). We agree that Alaska skewed the data, with their bridges in very cold climates and typically on lower-volume roads. We tried to highlight throughout the presentation where the Alaska bridges were skewing the data.
51	Was the frequency of the bridge or girder considered in the evaluation of the joint detail?	The frequency of the bridge or girder was not considered in this study.
52	What are some next phases to this research? Would a thin layer of UHPC overlay improve the performance?	Thin UHPC overlays have been used on some projects in the US and in Europe. Research is also being conducted at several universities, including FIU and the ABC-UTC. Thin UHPC overlays are not specific to decks with FDPC deck panels though.
53	Were any stainless steel rebars used in the service life estimate?	Information on reinforcement type was not gathered in this project.
54	Were the rates of deterioration only done by deck thickness measurements?	The rate of deterioration was determined using the NBI deck ratings (see slide 40).
55	Were the reported costs for the deck only or the entire project?	The requested reported cost was for the deck only (including the wearing surface). A few states reported costs per square foot for the entire project. These are highlighted in the final report for this project (Table 3.2).
56	What is the relative environmental impact of constructing a FDPC panel deck versus a cast-in-place concrete deck? Which is better for the environment and why?	This was not specifically investigated in this research. However the FDPC deck panels would likely have a smaller environmental impact as they will reduce construction time impacting traffic and thus decrease traffic delays. They can also be designed to use less concrete.