	April 2018 ABC-UTC Webinar Featured Presentation: Partial-Depth Precast Deck Panel Design and Construction in Texas	
#	Q&A Session: Questions	Responses
	Design	
	Use	
1	Is panel use permitted over negative moment regions of continuous spans?	Decks are currently placed continuously across simple spans, essentially creating a negative moment region. With additional reinforcement that detail works well. TxDOT is currently doing research on placing panels over the negative moment regions of continuous spans but with proper detailing believe that is a viable option.
2	On a deck that widens in a span, does it help to align as many girders as possible parallel to each other (for panel symmetry)?	Absolutely. Keeping the girders parallel helps in all aspects of the panel construction (design, fabrication, erection).
3	Is there a point (say, due to bridge length) at which the precast overhang panels become uneconomical?	TxDOT has allowed the use of overhang panels for several years but thus far they have not caught on. The only projects in which they have been used were the ones where we required them. So, unfortunately, the answer for now is that any span length makes them uneconomical in the eyes of the contractors. We are working on that.
4	At what point does a framing plan become too complex to allow for partial-depth precast panels?	We let economics and contractor preference decide. TxDOT does not require the partial-depth deck panels; rather, we allow them as an equal alternate to full-depth cast-in-place. Individual contractors decide on a case-by-case basis what would be too complex, but we see the panels used on the vast majority (> 90%) of our bridge construction.
5	How do you ensure composite behavior between the partial-depth precast deck panels and cast-in-place topping?	TxDOT researched this topic when the panels came into use in the 1970's. Because there is no composite steel protruding from the panels, we rely on the roughness of the top surface of the panels to help tie the cast-in-place portion of the deck to the panels. Prior to placement, the tops of the panels are cleaned and must achieve a saturated-surface-dry condition to help prevent debonding at the interface.The primary tie occurs at the tops of the girders, where composite steel extends from the tops of girders into the cast-in-place concrete. Additionally, there are specific requirements for the bedding that allows the cast-in-place concrete to flow under the edges of the panels. Together, these details help to ensure composite behavior of the deck. Anchorage steel is also added over the beam to engage the panel when haunch height exceeds 3".
6	Are the partial-depth deck panels also applicable for flared girders?	The panels are allowed to be placed over flared girders but much of the economy would be lost. We allow the panels, but we don't require them. Contractors decide what is most economical on a case-by-case basis.

7	Are the panels used over piers? Is the 1% of longitudinal steel for the negative flexure deck obtained with the top mat (6.10.1.7)?	Refer to the answer to Question #1. There is ongoing research into this topic.
8	Please explain how much overhang you would allow while still able to use a concrete placing machine.	The use of panels does not affect how screeds or other deck placement equipment is utilized. Though not used often, the overhang panels are connected to the girders to permit placement of screeds.
9	How do you detail to protect against reflective cracking over the deck joints?	Reflective cracking appears to be tied mostly to shrinkage of the cast-in-place concrete as it is restrained by the panels, so our primary focus is on the concrete mix designs (limiting shrinkage). It's also critical that the bedding strips be placed properly to allow proper bearing and prevent movement of the panels during or after placement of the concrete.
10	Limitations such as skews and curved decks?	The panels can be used for skews as high as 45 degrees if the panels are taken all the way to the joints. For curves, we attempt to align the girders as much as possible, but whether panels are used is determined on a case-by-case basis.
11	Is the deck panel applied to widening skewed decks also? If yes, is there any limitation?	The panels are used primarily for new bridge construction but could be utilized in widenings depending on the circumstances. This would be determined on a case-by-case basis.
12	On the basis of what aspect should I be guided to know the depth in the construction of prefabricated panels?	For our purposes, bridge deck depths stay consistent when precast panels are utilized. This helps to keep the decks economical and the construction fast. The panels are prestressed and 4 inches deep by 8 feet wide (length varies based on girder spacing). The cast-in-place portion of the deck is 4.5 inches with a single mat of reinforcing.
13	Although in the BDM it is indicated a bottom mat reinforcement in the deck, in Standard Drawing SIG-40 is not included. Why?	There are different details for the decks depending on which system is utilized. The Bridge Design Manual and our standards cover both full-depth cast-in-place deck placement and partial-depth precast panels with cast-in-place topping.
	General	
14	What further tools or guidance do you believe would be good to develop for the end users of these panels?	Come to Texas! We would be glad to demonstrate the excellent performance of the partial-depth panels after nearly 50 years of use. Much of the hesitation in states not utilizing the panels appears to be related to concerns over (1) composite action, and (2) reflective cracking. While those are both potential problems, we have seen great success from the use of this system and do not think they are show stoppers by any means.

15	Has TxDOT investigated the use of fiber-reinforced concrete to eliminate or reduce the amount of additional deck reinforcement?	TxDOT has looked at using micro and macro fibers in an attempt to reduce plastic shrinkage and drying shrinkage reflective cracking in the cast-in-place portions of the decks. We are currently researching the use of steel fibers in an attempt to eliminate or significantly reduce the amount of reinforcement required in the cast-in-place portion of the deck.
16	Do you use high-performance concrete (HPC) in deck joint closure pours?	Our primary focus is on partial-depth panels, not full depth, so we don't usually have closure pours. However, TxDOT utilizes HPC in many concrete elements (including decks).
17	Can we use this for bridge rehabilitation?	The partial-depth panels are utilized primarily for new bridge deck construction.
18	Do you have any experience with partial-depth precast deck slabs and railway bridges? Would there be any special concerns?	Since the girder spacing is typically much tighter for rail bridges you would lose much of the advantage in using the partial-depth panels.
19	BIM / BrIM use in Bridge Design for ABC projects - deliverables required? Bentley or AutoCAD?	Not sure I understand the question. Please feel free to contact us directly.
20	(1) Do you have any freeze-thaw areas that affect the partial-depth precast concrete deck panel design? (2) Did you have deck panels with irregular geometry?	We are fortunate in Texas to not have a significant freeze-thaw issue with our bridges. However, since the panels are completely encased by cast-in-place concrete, freeze-thaw should not be an issue even in colder environments.
21	Do panels develop full composite action with the cast-in-place deck and, if so, how?	Refer to the answer to Question 5.
22	Are these placed over existing decks? Mill existing then place panels? If so, discuss surface preparation?	No, the partial-depth panels are placed on girders. They would not be used on existing decks.
	Advantages	
23	What are the benefits of partial-depth precast concrete vs. stay-in-place steel forms?	We're fine either way, and have seen good performance from both.
	Seismic	
24	How does it work against earthquakes?	We are fortunate in Texas to not have significant seismic events so can't comment on how they perform during an earthquake.

25	How to improve the structural strength of masonry confers against even seismic evente, since Peru is a highly seismic zone.	Refer to the answer to Question 24.
	Construction	
26	Are there issues with the panels to lay properly on the beams that are not cambered exactly the same?	Fabricators and contractors work together to try and prevent differential camber, and it is not often an issue. However, when it does occur then a contractor can typically address it simply by adjusting bedding strip heights.
27	Explain how cracking on deck panels is evaluated for rejection/acceptance.	TxDOT's Standard Specification includes rejection criteria for defects in the precast panels: (1) any crack extending to the reinforcing plane and running parallel and within 1 inch of a strand for at least 1/3 of the embedded strand length, or (2) and transverse or diagonal crack, including corner cracks or breaks, intersecting at least two adjacent strands and extending to the reinforcing plane. Despite this rigid rejection criteria, there is an extremely low rejection rate for the panels, both in the fabrication yards and at the job sites.
28	Do you require diamond grinding for a smooth ride? Are you concerned about cold joints between closure pour and precast panel?	TxDOT's Standard Specification addresses deck finishing and ride quality, but that doesn't apply to the partial-depth panels since they are completely encased by cast-in-place concrete.
	Performance	
	Reflective Cracking	
29	What sort of performance has been seen with this system. Specifically, how prevalent is reflective cracking in the CIP concrete?	Refer to the answer to Question 9. Reflective cracking is not common, but it does occasionally occur. Even when reflective cracks do occur we have not seen evidence of increased deterioration or corrosion rates, and we're not aware of a single deck rehab project undertaken as a result of deterioration that occurred as a result of the reflective cracking. The cracks are typically less than 0.01" wide.
30	How can we ensure that no transverse cracking occurs in decks due to open joints between PCP?	The bridge standard limits the amount of space between panels to 1". Typically there is not a gap and adjacent panels are flush. Large gaps and steps between panels could lead to reflective cracking.
31	Transverse deck cracking mitigation (at panel joints). Long term durability of decks (achieving 100-year life span)?	Refer to the answer to Questions 9, 29, and 30. We have not seen long-term durability problems related to the reflective cracks but if they are excessive we will require that a contractor mitigate them, typically using methacrylate or some other gravity-fed material.

32	Mitigation of deck cracking?	This is not a significant problem. There has been the occasion when we have sealed the cracks with a gravity-feed crack repair material (epoxy/methacrylate). Additionally, the standard specification requires the contractor to seal cracks attributed to their operations related to placement, finishing, and curing. Reflective cracks related to the panel edges are not the responsibility of the contractor.
33	Is reflective cracking an issue with these panels?	Refer to the answer to Question 29.
34	Are reflective cracks a recurring issue and what remedies have been successful?	Refer to the answer to Questions 9 and 29.
	Freeze-Thaw Concerns	
35	Freeze-thaw issues	None. The panels are encased by cast-in-place concrete.
	General Failure	
36	What are the failure modes?	No common failure modes associated with the use of partial-depth precast panels. The only known failure mode, which has been a very isolated issue, is not getting concrete bedding under the panel. This can result in panel settlement and signficant deck problems.
	Cost	
37	How does cost compare to conventional CIP construction?	TxDOT bids the panels and conventional CIP construction as equal alternatives, so we don't have direct costs for one vs. the other. However, contractors opt to use the panel system over 90% of the time.
38	What is the typical installed cost range per square foot?	The average bid cost for bridge decks on a typical structure (e.g., single-span prestressed girder construction) ranges from $15 to $20 per square foot. The average cost for the entire bridge is typically around $70 per square foot.
39	Unit price?	Refer to the answer to Question 38.
40	Please address costs and practical use for projects in the Midwest (Illinois).	Economics drives these decisions since we allow for either option (full-depth CIP or partial-depth panels with CIP topping) in the plans. Texas is a heavy user of precast concrete, and there are several large-scale panel production operations. Both systems work well. Our contractors are adamant that the more options we give them the lower our costs will be. Perhaps you could consider allowing both as equals in Illinois and see where the contractors lean.
	Other	

41	Sources of information	The TxDOT Bridge Standards and Standard Specification both include a great deal of information on the panels. We would also be glad to point you towards information if you have specific questions.
42	What are the advantage and disadvantage of these partial-depth precast deck panels?	Lots of advantages: safety, speed, economics. Potential disadvantages are defects associated with improper placement, but we very rarely have problems with this type of construction. The panels are used on over 90% of our routine bridge construction projects.
43	Runyang constructive method.	Please clarify.
44	Do you know why the precast deck panel system is not approved in Florida?	No.
45	ABC Foundation Topics	Please clarify.
46	Any comment on stay-in-place metal deck forms?	None, other than we have not seen common problems associated with that system. Our heavy use of the partial-depth precast panels is driven by economics rather than dissatisfaction with the PMDF or other deck placement methods.
47	More design examples	Please clarify.
	Questions during Webinar	
48	Was inspection conducted on decks? If so, was there delamination between the layers of the deck?	As our existing bridge infrastructure ages we are performing more evaluations of older decks. While delamination does occasionally occur, the vast majority of our inventory demonstrates excellent performance when the precast panels are utilized.
49	Have you observed reflective cracking (either longitudinal or transverse) with precast deck panel use? If so, can these be prevented? Have you addressed or mitigated these in any way (during design, in the field, or through specs)?	Refer to answers to Questions 9 and 29.
50	How do you address skewed panels, including design, specifications, construction, such as replacement of prestressing strands with rebar?	Our standards include limitations and special requirements for skewed panels. To prevent damage to the precast concrete, debonding is necessary for skewed panels in which there is not adequate development length.
51	Can you provide a list of references/links, including design, specifications (design and construction), and details.	TxDOT's Standard Specifications and Bridge Standards include a great deal of information on the panels.

52	How does Texas' partial-depth precast deck panel design compare to a cast-in-place deck design in terms of deck rebar at negative moment section over interior girder and exterior girder?	Refer to the answer to Question 1. There is ongoing research into this topic.
53	Do you have a prescriptive strand spacing in design?	Yes. The prescriptive spacing allows for uniform design and fabrication of the panels.
54	What limit state/ loading condition governs in strand spacing? What is the condition that governs a significant number of cases for the design?	The panels are designed for construction loads for Service I, final loads for Service I, Service III and Strength I, as well as minimum reinforcement and elastic deformations.
55	Do you have the situation where the strand spacing changes slightly if the girder span is below 9 ft or 10 ft, and decrease rapidly if the girder span is greater than 10 ft?	Strand spacing stays the same regardless of girder spacing, with maximum spacing spelled out in the Bridge Standards.
56	I noticed the reinforcing mat above the panels was black steel not epoxy coated? Is that because you do not salt your bridge decks?	TxDOT uses epoxy-coated reinforcement in the cast-in-place portions of the deck in the northern Districts where deicing salts are applied.
57	Does the panel work as part of slab for live load? There is no shear connection between panel and slab!?	The decks act compositely. Refer to the answer to Question 5.
58	What advantages of partial-depth panels make it preferable to full-depth panels?	Full-depth panels have their place, but the partial-depth panels are much easier to fabricate, erect, and finish. The partial-depth panels are mass-produced and do not require the level of precision (especially for grading) necessary for full-depth panels.
59	What range of maximum coarse aggregate is acceptable for 1/2-inch vertical bedding to get concrete to flow in? Have you ever had any issues with flow of concrete underneath? Has venting of air ever been an issue?	TxDOT's Standard Specification includes requirements for coarse aggregate gradation in the concrete utilized for bridge decks. Proper flow of concrete under the edges of the panels is absolutely critical to the performance of the system so it is something that we emphasize in the Spec, the Standards, and during inspection. Air vents are required in the bedding strip and these locations are also used as inspection points to verify grout/concrete reaching there as visible by slight leakage.

60	It is great to see that UT researcher recommendations (led by Dr. Klingner) from 2012 have been implement in the PCP construction https://library.ctr.utexas.edu/ctr-publications/0-6348-2.pdf	Thanks for your comment.
61	In the precast deck panels, do the prestressing strands run parallel to the bridge girder orientation, or perpendicular?	Perpendicular.
62	Have you had any issues with using epoxy-coated strand (with grit) in panels (e.g., splitting cracks)?	TxDOT does not utilize epoxy-coated strand in the panels. However, we do require epoxy-coated mild reinforcement in the cast-in-place portions of the deck for northern Districts where deicing salts are frequently applied.
63	Are there shear connectors between the panel and the CIP concrete slab?	Refer to the answer to Question 5.
64	Half an inch would not allow the concrete to penetrate in the gap. Only fine particles will go underneath which may have lower strength. Is there any project were you have used high-strength grout?	Concrete does penetrate the gap. Utilizing grout would take much of the economy out of utilizing this system since it would require a completely separate operation.
65	What size aggregate is being used in the concrete mix after panels are in place?	Refer to Item 421 of our Standard Specification. Gradation requirements are spelled out for all structural classes of concrete, including bridge decks.
66	It is normal to use PCP continuous panels in the overhang regions? I believe that this is common in other countries and could avoid a formwork in the overhang area.	We have an overhang panel option in our standards but they have not caught on and contractors aren't using them, preferring instead to use the traditional bracket forming systems.
67	How do you handle bedding strips when dealiing with large cross slopes?	Bedding strips are typically low enough that this is not an issue, but we do have special detailing requirements for tall haunches.
68	Are there issues with reflective cracking ?	Refer to the answers to Questions 9 and 29.
69	How is that working on cantilever part of slab under parapet?	Refer to the answer to Question 3.

70	Partial-depth panels are likely to have reflective cracking in the cast-in-place concrete over the joints between panels. Please comment on your experiences as related to durability and long-term performance.	Refer to the answers to Questions 9 and 29.
71	What kind of joint do you use between panels placed next to each other in each bay? Are the panels connected in any way or are they just placed next to each other as closely as possible?	The panels are placed adjacent to one another, and there is no special joint material utilized.
72	Bedding material is noted on the TXDOT standard to be 4" maximum in height. Can this be thicker for larger haunch depth?	Yes. We have details available when taller haunches are required.
73	What roughness "coefficient" is required?	We do not require a specific roughness coefficient but the specification has finishing requirements to ensure adequate roughness of the panels.
74	Slide 41 - how did you achieve rail-to-deck attachment in locations where there is no rebar protruding from deck?	TxDOT's overhang panel standard includes provisions for rail attachments.
75	Are the panels designed only for vertical loads, or do you consider a combination of vertical and diaphragm shear loads?	The panels are designed for the self-weight of the panel, the weight of the cast-in-place slab, and the weight of any potential overlay and live load.
76	Any special surface preparation for the panels before placing the CIP portion of deck?	Clean, saturated-surface dry. This is a very important aspect. Dry panels can lead to debonding, and excessive ponding can lead to a weak layer of concrete at the interface.
77	What options do we have for the bedding strip and what are the main options?	Extruded polystyrene foam - ASTM C578 - Type IV (40 psi minimum) glued down.
78	For a continuous beam, are there any restrictions on partial-depth precast panel use in the negative moment region?	Refer to the answer to Question 1.

79	What is the application for continous steel plate girder units (straight) with highly skewed support? 60 degrees and above.	Current practice does not allow panels skewed more than 45 degrees. Careful consideration would need to be given to the differential movement between the girders.
80	Is it possible to cut the precast panels after fabrication?	Perhaps, but that never happens. The panels are mass produced. It would be much easier to discard and fabricate a new panel than it would be to cut an existing one.
81	Do you have any issue with precast deck panels on curved or skewed bridges ?	Refer to answer to Question 10.
82	Has TxDOT site cast any of the partial-depth panels?	Yes. Our Standard Specification allows for panels to be cast in dedicated fabrication yards or in project-specific applications, though the approval process for either scenario is strenuous in order to ensure high levels of quality.
83	Do you allow any negative moment deck rebar to be placed directly on panels?	Yes.
84	Has UHPC been gaining use for pouring the shear keys? Or is the cost too much or is UHPC not needed?	Closure pours and shear keys are not utilized for partial-depth panels. Rather, they are encased in conventional concrete.
85	What kind of surface prep (e.g. wetting for 24 hrs.) is required before pouring finished deck?	Clean, saturated-surface dry. We are not overly prescriptive in how the contractor achieves that but do check closely to ensure that it happens because surface prep is a critical component of making this system work.
86	What is the maximum height to require additional bar over the haunch?	Maximum of 3" before additional steel required.
87	Please address reflective cracking issue.	Refer to answers to Questions 9 and 29.
88	How much tolerence is permissible in placing panels?	A maximum 1" gap between panels.
89	Is TXDOT still using LFD FOR NEW BRIDGES?	LRFD.
90	Do panel joints reflect as cracks on the surface?	Refer to answer to Question 9.
91	The reinforcement I noticed was not epoxy coated. Is there a reason why not?	TxDOT uses epoxy-coated reinforcement in the cast-in-place portions of the deck in the northern Districts where deicing salts are applied.

92	What edition of AASHTO has been adopted?	LRFD 7th Edition with current interims.
93	Do you have standard repair procedures for cracked panels?	Generally not. The criteria is for rejection. These panels are mass produced so it is easier to discard and utilize a new panel than to repair a damaged one. However, minor defects (e.g. small corner spalls) can be repaired in accordance with TxDOT's Concrete Repair Manual.
94	About the joints between the precast panel and the cast-in-place concrete, is there any specific material for that work that it can be used in any country, for example here in Perú?	If this is a question about closure pours, then those are not necessary with this type of construction. Nor do we install joint material between panels and CIP.
95	What is the estimated service life of these structures, precast panels and composite section?	Good question. Since we only have 50 years of demonstrated service life we can't say how long they will last, but so far so good. I have no reason to think that properly constructed partial-depth panel bridge decks will not last the intended service life.
96	Is there a cost savings with the panels vs. conventional formwork between girders?	Yes. TxDOT allows either option, but since contractors choose to go with the panels on over 90% of the bridges, it seems cost savings are associated with using the panel system.
97	With regard to overhang panels..... what about long-term use with regard to a future, more stringent rail standard where a future rail retrofit is needed with doweling and expansion/epoxy anchors into the top of the overhang panel? Any thoughts with regard to future problems? Possibly clashing with panel prestressing?	We expect future rail retrofits to be handled similarly to how we currently handle them. Consideration will need to be given with respect to the edge of the panels and the epoxy anchors.
98	Is there a minimum beam spacing for the use of partial-deck panels	No, but mild steel reinforcing is required for panel widths less than 3.5 ft.
99	If a panel delaminates and a large portion spalls off from the underside of the deck, how is that repair handled?	This has never happened as far as I know.
100	Quality wise, which one is better comparing precast vs normal?	TxDOT allows either option, but given the stringent fabrication criteria associated with precast fabrication (including rejection criteria for damaged panels), TxDOT is a big believer in precast concrete for panels and many other aspects of bridge construction.