July 2020 ABC-UTC Webinar Featured Presentation: Deck Replacement of Vermont's I-89 Bridges with Weekend Closures		
#	**Questions**	**Responses**
	Design	
1	Are the deck details standardized or designed on a case-by-case basis?	VTrans is moving towards standardized precast deck details, but they have been case-by-case to date.
2	Can lightweight concrete be used for the panels?	Yes, VTrans would consider lightweight concrete if there is a design or constructibility need to do so.
3	Since you only replaced the slab, did you check the fatigue details of the existing steel girders for the remaining design life?	Fatigue stresses and details were checked based on infinite fatigue life.
4	Were there any significant changes in deck weight between the old and new decks?	The new concrete barriers are heavier than the existing curb-mounted steel railings.
5	What were your major challenges on the design of the precast deck panels? What codes did you use for the steel repairs?	Shear connector pocket size and spacing with the associated reinforcing congestion was a challenge. AASHTO LRFD shear connector requirements for continuous bridges with relatively short spans are demanding. Steel repairs consisted of a web plate repair at the end of one beam, and flange plate repairs at the end of two beams. AASHTO LRFD was the design code for these repairs.
6	Was the new precast deck system intended to be composite with the girders? If so, how was this achieved, and how was performance verified?	The composite action is achieved by shear studs within the shear pockets, which is designed according to AASHTO LRFD.
7	What were the design challenges that specifically related to constructability issues on this project?	Shear stud pocket size, transportation and installation loadings, design and detailing of backwalls for phased construction.
	Construction	
8	Was this a Design-Bid-Build project? Did the DOT work with any contractors during preconstruction to vet the construction methods?	This was a Construction Manager / General Contractor (CMGC) project. Contractor involvement included constructibility, plan and specification review at each step of project development including a construction schedule and cost estimating.

9	How many of these types of bridge decks has the Vermont Agency of Transportation and the contractor built? Was this the first time? Was there a learning curve?	VTrans has used precast deck panels (post-tensioning) on several projects. This project was the first time that the AccelBridge system was used in Vermont. Yes, there was a learning curve, mostly about material specifications, cure times, and constructibility during the weekend closures.
10	Can you discuss the maintenance-of-traffic requirements and the solutions implemented to maintain traffic flow?	Traffic analysis indicated significant backup/delays on I-89 if lane reductions were used during peak traffic hours and direction. Contract requirements were to maintain two lanes of traffic during peak traffic (Southbound morning commute and Northbound evening commute). One lane in each direction on one barrel of interstate, via crossovers, was used on weekdays between peak traffic times and over the entire weekend.
11	What did you do for traffic control during weekend closures?	Traffic on I-89 was maintained via crossovers with one lane in each direction on one barrel of the interstate. Bay Road under I-89 was closed during the weekend, and traffic was maintained via short signed detours.
12	What tended to be the critical path during each weekend? Is it possible to limit the closures to a single (if not long) weekend?	Curing times for concrete closure pours and grouting haunches and shear pockets were frequently on the critical path.
13	Can the use of match-cast joints be used in any other situation?	Match-cast joints have been used in situations other than deck panel joints.
14	How was the girder haunch incorporated into the precast panels?	The haunch support height (shim pack between panel and girder) for each panel is adjusted based on an as-built survey of the girder top flange.
15	Can you comment on how fabrication and erection tolerances are accommodated in construction?	Using the long-line match-cast method, the geometry tolerance is minimum for precast work. During erection, placing the starting panel with accurate orientation is most critical. Surveys are provided as panel erection progresses. If the survey result indicates a need for geometry correction, the shimming of joint method used for segmental construction can be used.
16	Were there any phased-construction design considerations and construction challenges for the project?	Due to traffic volumes and phasing, the contractor was able to remove approximately half the width of the deck and prepare the exposed beams prior to closing the bridge to traffic.
17	What type of concrete was used on the project, and what were the lessons learned when working with it?	Standard 5000 psi precast concrete was used for the precast components. An accelerated rapid set concrete was used for the center closure pour. A lesson learned is that the rapid set concrete mix should be designed and tested thoroughly prior to use.

18	Can you comment on the joint detailing, connections, and materials used on the project?	Joint detailing is the same as used for segmental bridges. The epoxy for jointing is ASTM C881, Type VI Grade 3. Connection between deck and girder is typically welded shear studs.
19	Can you comment on the effect of choice of materials (e.g., concrete, rebars etc.) on the construction procedures for the project?	Epoxy-coated reinforcing was used for the deck. Typically a new bridge deck in Vermont would have solid stainless steel or galvanized reinforcing; however, a full 75 or 100-year design life is not intended for these bridges. With epoxy-coated reinforcing, and the deck protected with a membrane and pavement, a long life is still expected.
20	Was this project successful in reducing construction time?	Yes, this is the first time VTrans has replaced four interstate bridge decks, backwalls and approach slabs in 6 weekend closures.
21	What were some things that you did not anticipate during design that happened during construction, and how did you address them?	Obtaining grout strength in expected durations was a challenge. Looked for concurrent work to perform and considered reduced grout strength for certain temporary activities.
22	Can you describe aspects of this project that you would have changed in hindsight?	New concept for putting panels in compression without the center span closure pour. See presentation slides.
	Maintenance	
23	Are there any maintenance issues of match-cast joints and repair techniques for these types of decks?	As a new technology, AccelBridge does not have a long track record of performance at this time. The match-cast joint in AccelBridge is expected to behave the same as in segmental bridges, which has performed well for over 40 years. With no post-tensioning or rebar at the joint, joint corrosion is not an issue.
	Cost	
24	Can you comment on the cost comparison of decks formed with precast panels to decks cast with regular forming techniques?	Information is provided in the presentation slides. Precast is typically more expensive, but there are cost savings in reducing the duration of construction work and impacts to traffic (user costs).
25	How does the cost compare with traditional methods of construction?	See reponse to question #24.
	Questions during Webinar	

26	What are some of the intangibles - cost to the motoring public, long-term durability of the construction details, etc.?	Traffic impact/user costs were the primary motivator to move to precast deck panels with weekend closures. Life-cycle costs were in favor of replacing the deck and repairing the steel and substructures versus complete replacement.
27	Is the use of epoxy-coated reinforcement in bridges still allowed? I understood that some jurisdictions in the states banned its use, promoting FRP and other more reliable corrosion-resistant rebars.	See response to question #19.
28	Do epoxy joints and jacking of panels mean that girder segments over the piers can be treated as composite members?	The girders were considered composite in positive moment regions and non-composite in negative moment regions. This is how continuous bridges are typically designed in Vermont and consistent with the fact that reinforcing doesn't extend through the joints.
29	For steel girder construction, are shear studs post-installed, and is UHPC used in the pockets?	Shear studs are installed after the deck panels are in place. Non-shrink grout is used to fill the haunch and shear pockets.
30	Is the location of the jacking gap "engineered," say where the deck in-service compressive forces are maximized or tension loads are minimized?	Since the jacking force loss due to friction is a very small amount (a few percent of the jacking force), the location of the jacking gap is not an important consideration of effective deck compression force. The layout of the jacking gap for the project is based on crane access.
31	Was the use of the AccelBridge system decided during the design phase? Were any additional beam analyses required due to the jacking?	The Accelbridge System was decided upon during the design phase with the contractor's input. An additional check was performed for the jacking force.
32	Why was grout used between deck panels and girders, rather than self-consolidating concrete?	The material for the haunch filling needs to meet three requirements: is able to flow through a haunch gap of 1/2 inch, has high early strength, and has non-shrink properties. The commercial pre-pack non-shrink grout seems most suitable to meet these requirements.
33	Was there any segregation of the grout at the shear pocket due to increased height at the shear pocket?	None was observed.

34	What is the long-term performance of this bridge deck system? How do you make sure that the jacking forces are preserved given the actual dynamic loading of trucks?	As a new technology, AccelBridge does not have a long track record of performance at this time. The match-cast joint in AccelBridge is expected to behave the same as that in segmental bridges, which has performed well for over 40 years. With no post-tensioning or rebar at the joint, joint corrosion problem is not an issue. Regarding preserving the jacking force, it is expected that the joint can hold up well since any joint opening has to overcome the tension of the supporting girder, which is rather robust.
35	What strength was used for the grout mix for the haunch? Also, what type of curing method was used for the haunch grout?	5000 psi grout strength. Wet burlap curing.
36	During the deck demolition, were there any issues with the tops of the existing girders being hit by the concrete saws used to cut the existing bridge deck? If so, how were those issues handled?	No significant issues were noted.
37	With the parapets integral to the deck, is there anything special done to the joints above the deck?	Nothing special was done to the joints above the deck. Typical score marks in the barrier were used to control cracking.
38	What was the amount of compressive stress applied to the deck? Did you considered only the minimum of 250 psi recommended by AASHTO? Any consideration for time-dependent losses?	The jacking stress provided is 390 psi. We did not do an in-depth time dependent analysis. The loss was estimated based on experience.
39	How do you control tolerance in this system?	The most critical geometry tolerance is offset in the transverse direction of the bridge, which is limited to 1/2". A survey is conducted after each panel is placed. Joint shimming is applied if the engineer feels the need for geometry adjustment. Only one joint was shimmed out of the four bridges.
40	What was the final bridge wearing surface?	Membrane and pavement.
41	Is there a length limit for effective jacking of the bridge?	There is not a set limit for jacking length. The longest jacking unit we have used is 240 ft. The loss of jacking force due to friction is small (less than 10 psi per 100 ft). The factors in determining the length of jacking are mostly from panel delivery, equipment accessibility, schedule, and construction tolerance.

42	If the panels were grouted "after" the jacking force was introduced, how was camber put into the steel girders? It appears the panels were jacked, but no steel was engaged during the jacking phase. The girders themselves appear to be flat by the time they are grouted.	The camber due to jacking is small (typically in the same magnitude as deadload deflection); therefore, it is not noticeable to the naked eye. The haunch height (supporting shims) does consider the camber due to jacking.
43	Could you comment on why VTrans' projects did not include precast concrete match-cast barriers along with the deck?	The barrier has to be TL-5. At this time, a match-cast barrier has not been tested.
44	Is there a technical reason why transverse prestressing in the deck panel could not be used in this type of system? Some feel that transverse prestress is needed for handling.	The system can accommodate transverse prestressing. However, based on our precast experience, panels up to 40 ft without prestressing can be handled without concern of cracking. The precaster does provide a specially designed 3-point supporting frame for panel transportation to avoid cracking due to twisting of truck bed.
45	What is the size of the concrete keyway?	The typical shear key is 6"x4"x1".
46	How much prestress is typically applied across the joints?	The jacking stress is provided to meet the 250 psi minimum and zero tension under service condition.
47	Is there a minimum recommended deck thickness to safely jack the sections?	We recommend a minimum of 8 inches. Most of the time, the thickness is controlled by transverse design.
48	Was the decision to cast in place the barriers because of crane weight size requirements?	The deck system can work with precast barrier. Since the match-cast precast barrier is not tested for TL-5, cast-in-place barrier was used for the project.
49	Could you comment on the measured ride quality of the completed deck structure for the VTrans project?	There is a membrane wearing surface on Vtrans' projects; therefore, the ride quality is not controlled by the deck panel finishing. AccelBridge does have other projects without overlays (grinding after completion). The riding quality of such systems is satisfactory. The contruction method and result are the same as a grind finish on a segmental bridge.
50	Was the existing bridge on a crest or sag? How was the vertical geometry re-established? Is there a limitation to the shear stud spacing blockouts?	The bridge profile is tangent in the project. The vertical geometry can be established by varying the shim support height (haunch height). The maximum spacing of shear studs is limited to 4 feet (AASHTO requirement).

51	Guidance on full-depth panels of the past had suggested match-casting was risky due to imperfect fit. What has changed or done differently that has overcome these issues of the past?	We do not know the specific causes of previous recommendations regarding imperfect fit. Our experience is very positive. We have completed 7 bridges with match-cast decks at this time. Only a few joints in the first project had a misfit problem, all because the precaster repaired the match-cast joint incorrectly. When the precaster correctly follows the established match-cast specification (same as segmental), no imperfect fit occurs. Our observations from completed projects are that the fitting of match-cast deck panels is much easier than segmental, evidenced by the fact that it takes less than 10 psi to close panel joints during assembly. We think the better fit of deck panels is from two reasons: 1) simpler and more uniform geometry, and 2) the checkerboard casting pattern eliminates the "bowing effect" which is a main contributor of misfit in segmental construction. The checkerboard casting pattern does not result in a temperature gradient which causes the bowing effect.
52	Are the spans on this bridge designed to be simple or continuous? If they are continuous, how is the negative moment steel included given no rebar crossover between match-cast pieces?	The girders were considered composite in the positive moment regions and non-composite in the negative moment regions. This is how continuous bridges are typically designed in Vermont and is consistent with the fact that reinforcing does not extend through the joints.
53	Is $120/sq ft the total cost of the deck? If not, what was the total cost/sq ft (Eng, Constr, CM, Constr Engineering)?	$120/sq ft is based on the bid cost. VTrans construction oversight was not included.
54	These panels were full width of the bridge. Is there a width limit where a joint will be required longitudinally?	We typically limit the width of deck panels to 45 feet due to shipping and handling stresses.
55	Did transportation of the wide deck section result in any significant cracking in the deck concrete?	Nothing significant was noted. The panels were checked for cracking as part of the erection plan, and a special support system was used for transportation.
56	Did you experience any significant differences in the jacking process when dealing with the skewed bridge (although it is 19 degree)?	The skew angle does not cause any difference in the jacking. The shear keys do need to be sized to resist the transverse force component due to jacking when assuming zero friction at the joint and the epoxy acts as a perfect lubricant.
57	Are skew and/or horizontal curvature limiting factors in the use of this deck system?	The deck system can be applied for skews up to 30 degrees. There are conceptual designs on curved bridges, but we do not have completed projects on curved bridges yet.

58	Regarding the proposed system where the transverse jacking pours are eliminated, does the jacking operation result in a gap? If so, how is it accommodated?	In the proposed system, there is no gap between any deck panels. The longitudinal movement due to jacking will be reflected by the change of gap width between the last deck panel and the abutment. If you are interested in getting more details, please contact info@accelbridge.com.
59	For the waterway bridge, were cranes for panel setting positioned on the approach embankments or on work barges in the waterway?	Cranes were set on causeways between the Northbound and Southbound interstate barrels and were accessed via the I-89 median.
60	Some perceive that the construction joints of shear pockets are not desirable at the top surface. FHWA and others have done hidden pockets or longitudinal partial-depth full-length leaveouts. Has that been used with this system?	The system has not worked with your mentioned details but will be able to accommodate them. There will be relative movement between deck panel and girder due to deck jacking, which has to be considered in the stud positioning. The other alternative is to have open pockets with typical grout for the lower part and UHPC for the top 4 inches of the pocket. We are developing such a detail in an upcoming project.
61	Do you advise having a pavement layer on the panels?	Pavement and membrane aid in a smooth riding surface and prevent salt-laden water from potentially penetrating the deck surface.
62	Was the assumption that the full jacking force was transferred into the deck panels and not lost through friction between the panels and the top of girders? Was or has this ever been confirmed with strain-gauged panels during construction?	We did consider the friction loss (less than 10 psi loss per 100 ft). In our first AccelBridge project, strain-gauges were installed in panels and girders to validate the friction loss.
63	Were any shims needed to maintain alignment from the bridge ends to the closure pour location?	Shimming at the joint can be used to correct the lateral geometry if needed. One joint shimming was used for such purpose out of all four bridges in the project.
64	What was the effect of concrete shrinkage, taking into consideration that there was no reinforcement across the joints?	Shrinkage will result in some loss of compression force. To minimize the effect of shrinkage, the panel has a minimum 60-day age before installation. The shrinkage is not a concern for the joint with no reinforcement across it; this has been a proven detail in segmental bridges.
65	Was the deck propped prior to the grouting of the shear pockets?	Deck panels are supported vertically by shim packs between deck and girder top flange during panel installation (before grouting).

66	The existing structure is a 3-span continuous structure. How did you allow for tension stresses at the interior supports?	The lock in-deck compression can compensate for the tensile stress due to live load. There is no tension in the joint under service condition.
67	What is the magnitude of the compressive force put into the deck panels?	1400 kips across the section.
68	Were any considerations to future deck replacement given, specifically related to how to handle the post-tensioning force during demolition?	The future deck can be jacked longitudinally, just as done now.
69	Is there a skew limitation to this deck system?	The deck system can be applied to skews up to 30 degrees. Highly skewed bridges will need to be investigated case by case.
70	Were the shear studs installed before or after the jacking process?	The studs can be installed before or after jacking. If installed before jacking, one needs to provide room to allow for relative movement between the girder and deck.
71	Any used for recycling on the old deck?	No.
72	The original bridge deck was non-composite. Could the system have been installed without jacking?	Without jacking (or compression across the panel match-cast joint), we would not be comfortable with the joint's integrity when subjected to wheel loads.
73	Are expansion joints needed on these bridges?	There were expansion joints between the approach slab and sleeper slab at the expansion end of the bridges.