Examples of Accelerated and Innovative Bridge Construction

1. Lateral Sliding

I-5, Skagit River Bridge - Bridge Number 5/712
Mount Vernon and Burlington, Washington

Benefits and reasons for using Accelerated Bridge Construction:

After the Skagit River Bridge collapsed, shutting down all of I-5, rapid replacement of that span was necessary to restore the movement of goods from Canada to the rest of the United States. A temporary span was installed, and allowed traffic to flow at reduced speeds. A permanent span was constructed alongside the temporary span and then rolled into place.

- Reduced length of long and inconvenient detours were in place.
- Minimized the disruption to the regional economy by restoring the interstate quickly.
- Minimized the disruption to the local economy by minimizing time local streets along the detour were jammed with traffic.

Lessons Learned:

- Incentivizing the Contract resulted in reducing the duration of the full closure. This was an A + B bid and the selected contractor ended up getting the contract based on lowest cost for the structure and least amount of time needed to close I-5. The Contract was also structured to require any full closure be done after the busy tourist time.
- With an incentivized contract, you not only limit the high impact closure in duration, you can implement it at a more opportunistic time and insure very good public communication.
**Benefits and reasons for using Accelerated Bridge Construction:**

The Hood Canal Bridge is a vital link between the Kitsap and Olympic Peninsulas. It is also the longest floating bridge on sea water. Replacing the approach spans was done in one of a series of road closures to replace this span. This section of bridge was constructed adjacent to the existing span and slid into place.

- With a detour of over 130 miles, accelerated bridge construction dramatically reduced required Hood Canal bridge closure time.
- Conventional construction techniques would have required several months of closures.
- The 156-foot single span West Approach rollover was completed in 51 hours and the 601-foot 5-span East Approach was completed in 49 hours.

**Lessons Learned:**

- Distributing load evenly on bearings before sliding the structure can be difficult. Additional shims and jacks were required to redistribute the load prior to sliding the superstructure.
Benefits and reasons for using Accelerated Bridge Construction:
An existing truss was slid laterally and used as a detour structure to make room for a new bridge used to replace the truss.

- The original design required realignment of the highway, new approach roadway, retaining walls, signal replacement, major utility relocations and existing bridge modifications
- Existing truss provided the river crossing necessary for a detour.
- Moving the bridge was quick. It required only a weekend closure of the bridge.
- Utilizing the existing alignment saved construction time and money, eliminated a pier in the river, reduced environmental impacts and reduced inconvenience to the traveling public.

Lessons Learned:
- It would have been convenient to have a spare set of jacks.
- Larger stroke jacks would have further sped up the process.
- Caution should be exercised when designing SEW wall supported footings for temporary structures. Design of the SEW as a temporary bridge allowed lower design values that resulted in excessive settlement of one of the abutments.
- When reusing existing structures, especially ones in poor condition, plan for continued deterioration of critical structural members.
- Plan for the required NBIS bridge condition inspections before and after moving bridges, and state in the contract who is responsible for these inspections.
## 2. Precast Deck

| I-5, 38th Street - Bridge Number 5/430  
Tacoma, Washington |
|-------------------------------------------------|

### Benefits and reasons for using Accelerated Bridge Construction:

This bridge is a main point of entry for the Tacoma Mall and spans over I-5. Precast deck panels were selected to speed up deck construction and eliminate bridge construction staging.

- Stakeholders required existing bridge to be demolished and replaced with a new structure in one construction season.
- The staged construction alternative required three stages and three years. Precast deck panels eliminated the need for staging.
- Precast slab panels eliminated I-5 closures for soffit formwork installation and removal.
- Precast slab panels accelerated the bridge deck construction.
- Segmented precast, prestressed concrete tubs have no bottom flange to support a false deck for accessing the deck soffit between the girders. Stay-in-place deck panels eliminate the need for the false deck.

### Lessons Learned:

- Project successfully completed within the required time frame.
- Girder stirrups are typically field bent with 135 degree hooks. However, after precast deck panel placement a full 135 degree bend was not feasible. Future details called for closed stirrups to eliminate this problem.
- The 4 inch cast-in-place deck did not allow for a full 2-1/2 inch cover over the deck rebar without the reinforcement resting directly on the deck panels.
- Experience from this project led to the development of precast deck panel standard plans.
Benefits and reasons for using Accelerated Bridge Construction:

The Hood Canal Bridge is a vital link between the Kitsap and Olympic Peninsulas. It is also the longest floating bridge on sea water. Replacing the approach spans was done in one in a series of road closures to replace this span. Precast stay-in-place deck panels were used to construct the deck.

- Stay-in-place forms eliminated the need for removing formwork below the deck.
- With such a long approach structure and such short spans, there was opportunity for savings in repetition.
- This design also eliminated intermediate diaphragms, and allowed precast approach slabs to further speed up construction.

Lessons Learned:

- The superstructure was a series of continuous spans, and the deck was rather thin for stay-in-place forms. The negative moment steel over the piers was a bit cramped and hard to install with some of the usual space consumed with the stay-in-place forms.
- Adjusting the forms for camber was originally designed with a mechanical adjustment system. The contractor chose to cut foam blocks to make adjustments. Those foam blocks would tend to crush.
- Using the foam shims saved the step of grouting underneath the mechanical adjustment brackets.
- Field bending of girder and diaphragm bars was sometimes interrupted by the panels.
- Cumulative tolerances among many small pieces often led to fit-up problems.
- Casting all of the panels at one time did not allow time for QA process improvements. Some panels were cracked or twisted, within spec, and the contractor used them anyways.
- During placement of the deck cast-in-place topping and overhangs, the girders rotated and damaged the end diaphragms. When intermediate diaphragms are eliminated, temporary bracing is often needed to provide girder stability during deck construction.
3. Precast Crossbeam

SR 16, Eastbound Nalley Valley - Bridge Number 16/6W-N
Tacoma, Washington

Benefits and reasons for using Accelerated Bridge Construction:

This is one of many bridges constructed in the rebuilt I-5 to SR 16 interchange. It was constructed with precast crossbeams and provided an option for precast columns.

• Took advantage of repetition of many similar precast pieces.
• Allowed crossbeam formwork on the ground, instead of 70 feet in the air.
• Provided a real world test case for precast crossbeams.
• This project allowed for an option to precast columns, to test the marketability of precast columns.

Lessons Learned:

• Precast crossbeams are often desirable. Precast columns were not desirable here.
• Contractors are still developing construction techniques for the grouted duct.
• Recesses in precast members can complicate construction.
• Holding the ducts in place can be a challenge.
• Ducts protruding partially through precast members can cause rebar congestion, and make it hard to stabilize the ducts in the forms.
• Providing an excellent seal between the duct and the concrete is critical.
Benefits and reasons for using Accelerated Bridge Construction:

The contractor installed precast crossbeams for some of the intermediate bridge piers.

- Allowed crossbeam formwork on the ground, instead of 50 feet in the air.
- Provided a real world test case for precast crossbeams.

Lessons Learned:

- Demonstrated that precast crossbeams are often desirable.
<table>
<thead>
<tr>
<th>Benefits and reasons for using Accelerated Bridge Construction:</th>
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<tbody>
<tr>
<td>This was a demonstration project used to test the real world constructability of precast piers, intermediate diaphragms, and to once again use deck bulb tee girders. This project was the recipient of a grant from FHWA specifically intended to test the viability of ABC.</td>
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<tr>
<td>• Verified this construction method works.</td>
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<td>• Taught WSDOT and the contractor many lessons about processes that worked and those that didn’t.</td>
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<td>• Confirmed what was tested in local universities.</td>
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<table>
<thead>
<tr>
<th>Lessons Learned:</th>
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<tr>
<td>• Pressure grouting column joints requires careful attention to tolerances near the sealing locations.</td>
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<td>• Tolerances at the ends of columns require special attention to be assured segments stack well.</td>
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<tr>
<td>• The end diaphragms were precast for a portion of them with the desire to use the precast portion as a form for the main body of the diaphragm. Not achieving required tolerances made these precast forms difficult to seal.</td>
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<tr>
<td>• The intermediate diaphragms had a precast joint at their centers. These half diaphragm sections were to be linked together with a mechanical device. Not achieving required tolerances made these devices difficult to install.</td>
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<tr>
<td>• Architectural details can be enhanced with ABC methods. In this project WSDOT provided a precast aesthetic pier end cap and well detailed column elements. The columns had strategically placed rustications that obscured the field joints between pieces.</td>
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SR 520, Floating Bridge & Landings – Bridge Number 520/7.5
Seattle, Washington

Benefits and reasons for using Accelerated Bridge Construction:

Much of the 520 Floating Bridge replacement does not float, and it is in isolated locations in sensitive natural areas. The Pier 36 crossbeam was constructed as precast.

• Having access to a large body of water, moving heavy pieces was easy. The contractor was already mobilized to do this type of work.
• The piers were only accessible by water. A precast crossbeam saved the effort of bringing a crew and wet concrete to the crossbeam in an isolated location.
• Eliminated crossbeam forming in an isolated location.
• L&I insurance rate is higher for workers that travel by boat to access the worksite. Precasting portions of the crossbeam on land saved cost.
• Geometry control of the crossbeam was easier to maintain.

Lessons Learned:

• This was a method chosen by the contractor. Seeing this type of work being done by the contractor’s own initiative demonstrated that precast crossbeams have their place in bridge construction.
• Sloped the tops of the column dowels to help with alignment of the crossbeam when placed worked well.
• A template of column dowel locations to ensure alignment of the ducts in the crossbeam worked well.
4. Precast Column

SR 520, 36th Street Bridge - Bridge Number 520/36.5
Redmond, Washington

Benefits and reasons for using Accelerated Bridge Construction:

The contractor had a tight spot in their schedule revolving around the column construction time. This bridge has many identical columns in the median of a very busy freeway. Casting them offsite overlapped their construction with other construction activities, and they were able to place them quickly in a few night time closures of the lanes adjacent to the median.

- Repetition made precasting cost effective.
- Time was saved on site.
- Lane closures were minimal.

Lessons Learned:

- The plan worked!
Benefits and reasons for using Accelerated Bridge Construction:

Bridge piers were prefabricated and installed as individual precast columns and crossbeam sections.

- Assured consistent quality among many similar piers.
- Took advantage of the repetition in fabricating the piers.
- Required less time on site, in a very busy corridor.

Lessons Learned:

- Precast piers demonstrated they have a legitimate place in the methods available for construction.
- When multiple elements of similar geometry are being constructed, ABC methods become more attractive.
Benefits and reasons for using Accelerated Bridge Construction:

Widening these bridges required the new portion of the bridge be constructed in the same fashion as the original bridge, which required inclined columns. The columns were decided to be precast.

- Simplified formwork. The columns are slanted and forming them in the slanted position would have been difficult.

Lessons Learned:

- It worked.
5. Adjacent deck bulb tee beams

Benefits and reasons for using Accelerated Bridge Construction:

After the Skagit River Bridge collapsed, shutting down all of I-5, rapid replacement of that span was necessary to restore the movement of goods from Canada to the rest of the United States. A temporary span was installed, and allowed traffic to flow at reduced speeds. The girders selected utilized the top flanges of the girders as the deck and lightweight concrete.

- Allowed for 95% completion of the superstructure while traffic flowed on a temporary span.
- Building this new bridge adjacent to the roadway required a shorter amount of time the bridge was closed. While the temporary bridge required reduced speeds on the bridge, staging the work allowed for opening of the bridge sooner.
- Using an extra wide girder flange, with high strength concrete closure pours between flanges, reduced the time required to construct the deck, by making the top flange the structural portion of the deck.
- Using lightweight concrete allowed the existing substructure to be used to support the new span by maintaining the original structure weight.

Lessons Learned:

- Lightweight concrete was not as easy to accomplish as hoped. There’s great variability in aggregate weights and moisture absorption percentages. There ought to be a lot of attention given to moisture absorption in the mix.
- The closure pour designed used in this bridge had not been tested by NCHRP in service. The durability of this connection detail is yet to be determined.
Benefits and reasons for using Accelerated Bridge Construction:

This bridge is one of the few access points to the town of Easton, high in the Cascade Mountains. A span was significantly damaged by a high load hit. This project was a demonstration project used to discover how fast WSDOT could replace a span. As a benefit, it helped the local economy by restoring this route quicker. Deck bulb tees were selected for the girders.

- Sped up construction.
- Minimized traffic impacts.
- Deck bulb tees allowed for an immediate riding surface that would allow traffic to cross the bridge in the winter, until an overlay would have been installed the following spring.
- Allowed the repairs to be done before winter.
- Took advantage of girder designs WSDOT already has available.

Lessons Learned:

- Excellent relationships with precasters makes coordination easy, ultimately saving time. It also makes scheduling girder fabrication easy.
- Seasons have a profound effect on schedule. Some of the diaphragm concrete had to be wrapped in tarps and heated as winter closed in.
- Don’t toss out bearings and grout pads in demolition. For the span replacement, those items likely could have been reused, saving more time.
6. Self-Propelled Modular Transporter (SPMT)

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<tr>
<th>SR 104, Hood Canal Bridge - Bridge Number 104/4 and 104/5</th>
<th>East and West Approaches - Port Gamble, Washington</th>
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Benefits and reasons for using Accelerated Bridge Construction:

The Hood Canal Bridge is a vital link between the Kitsap and Olympic Peninsulas. It is also the longest floating bridge on sea water. Replacing the approach spans was done in one in a series of road closures to replace this span. The approach truss was prefabricated and shipped to the site.

- Fabricating an entire structure in one piece and installing it as one piece saved time on the job site.
- Fabricating an entire truss in the shop assured excellent quality welding and no bolting, improving the durability of the structure. Without an ABC approach, bolting would have been required.
- Water access was easy to obtain, allowing heavy lifts to be done with ease.
- Allowed the full three-coat paint system to be applied in the controlled environment of the fabrication facility. Eliminated costs and environmental risks associated with painting in the field.

Lessons Learned:

- The plan worked.
Benefits and reasons for using Accelerated Bridge Construction:

This bridge is a narrow, but heavily traveled roadway, and a vital link for transporting goods across the Columbia River. Lengthy road closures for deck replacement were not an option. The deck was installed in a series of full width precast deck panels.

- Precast deck panels allowed the bridge to be replaced in sections, with nightly closures. Entire sections of road would be replaced over night as the new deck marched across the bridge.
- The similarity of the deck panels made for easy repetition, making precast a more viable option.
- During the nightly closures in the vicinity of the deck section being replaced, other work could be performed elsewhere on the bridge, allowing improvement activities to overlap.

Lessons Learned:

- It worked.
7. Other Precast Elements

**SR 303, Manette Bridge - Bridge Number 303/4A**
Bremerton, Washington

Benefits and reasons for using Accelerated Bridge Construction:

The Manette Bridge spans between two high banks along the Puget Sound. It has tall columns and deep foundations installed in a tidal zone. The shaft cap was constructed using a portion of the shaft cap as a coffer dam.

- This eliminated the need for a traditional coffer dam by simply incorporating the coffer dam into the final product.
- With proximity to water, moving a heavy precast concrete coffer dam was easy.
- Mobilization costs were already covered. Many other portions of the project were large precast pieces, so the contractor took advantage of the heavy equipment already on site by using it for more precast pieces.

Lessons Learned:

- It worked.
### 8. Other ABC Non-WSDOT Project Examples

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<th>Full-Depth Precast Deck Panels with and without Longitudinal Post-Tensioning</th>
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<td>Lightweight Precast Deck Panels</td>
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<td>Lightweight Precast Deck Panels</td>
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<td><strong>Adjacent Inverted Tee Beams with Overlay</strong></td>
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<td>Arch Span Without Deck</td>
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<td>Providence, Rhode Island</td>
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<th>Prefabricated Caps for Caisson or Pile Foundations</th>
<th>![Image of Prefabricated Caps for Caisson or Pile Foundations]</th>
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