Accelerated and Innovative Bridge Construction In Washington State

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Summary

1. Recent ABC Projects
2. ABC Related Research Projects
3. New Wide Flange Deck Bulb Tee Girders with UHPC Closure
5. Standardization of Precast Culverts
6. R04 ABC Peer to Peer Exchange Q&A
Summit -1: P2P Exchange - PBES
Prefabricated Bridge Elements & Systems
Accelerated Bridge Construction
November 13-16, 2012
Seattle, Washington

Summit -2: Every Day Count – GRS-IBS
November 29-30, 2012
Portland, Oregon
WSDOT ABC

Implementation Activities:

- ABC Workshop:
  - 2008 and 2015
- Strategic Plan for ABC Implementation
- ABC Decision making Matrix
- ABC Domestic Scan
- Design and Construction Tools
## ABC Decision-Making Framework Matrix

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>Maybe</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>High traffic volume?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emergency replacement?</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Worker safety concerns?</td>
<td></td>
<td></td>
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<tr>
<td>High daily traffic control costs?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High traffic volume?</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emergency replacement?</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Evacuation route or over railroad or navigable channel?</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lane closures or detours?</td>
<td>✓</td>
<td></td>
<td></td>
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<tr>
<td>Critical path of project?</td>
<td>✓</td>
<td></td>
<td></td>
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<tr>
<td>Close during off-peak traffic?</td>
<td>✓</td>
<td></td>
<td></td>
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<tr>
<td>Rapid recovery/repair required?</td>
<td>✓</td>
<td></td>
<td></td>
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<tr>
<td>Adverse economic impact?</td>
<td>✓</td>
<td></td>
<td></td>
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<tr>
<td>Weather constraints?</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Worker safety concerns?</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmentally sensitive site?</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Natural or endangered species?</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Feasibility if historic bridge?</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multiple similar spans (segments)?</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Problem for ready-mix concrete?</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>High daily traffic control costs?</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delay-related user cost concern?</td>
<td>✓</td>
<td></td>
<td></td>
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<tr>
<td>Innovative contracting strategies?</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adequate owner staffing?</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group with other bridges?</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Future use?</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Totals:</td>
<td>15</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>
Innovative Bridge Construction

SR 167 over Puyallup River - Weekend closure to move an existing 350 feet long truss bridge using the ABC sliding technology - 2014

SR 101 Dosewalips River – Detour Bridge
WSDOT SPMT BRIDGE Replacement

LEWIS & CLARK BRIDGE
120 - 8 Hrs Night Closures
200 - Single Lane Closures

Hood Canal Bridge Transition Span – Tabular Steel Truss
Accelerated Bridge Construction Project

5 Span PS Girder Superstructure Replacement – Hood Canal Bridge
Innovative Bridge Construction

SR 405 - Bellevue Access NE 8th Street ABC – Weekend Closure

Steel I-Girder Bridges Replacement using Lateral Slide Technology
Spliced Girders: Manette Bridge
Record-Length Precast Girders
Alaskan Way Viaduct - 205 ft WF100G
Bridge Move Summary:
1. Temporary Span out (25 min.)
2. Permanent Span in (45 min.)
3. Deck Lowering (30 min.)

• Truss Collapse, I-5 near Mount Vernon on May 23
• Over height load struck critical steel supports.
• I-5 carries ADT = 71,000

Skagit River Bridge Switchover_mpeg2video.mpg
Skagit River Bridge collapse footage.mp4
Skagit River Bridge Replacement

Connection of Deck Beam Elements
Example of ABC Projects - Substructure
WSDOT - Precast Bent For Seismic Regions

Pier Elevation - Segmental Columns and Precast Bent Cap
Innovative Materials SMA-ECC for Bridge Bents
AWV South Approach - Innovative Materials UNR

Polyvinyl Alcohol Fiber
WSDOT Fish Passage Culverts Replacement

- WSDOT to correct 825 fish barriers by 2030.
- 30 to 40 culverts each year between 2015 – 2030.
- $310 million per biennium ($2.4+ billion Total).

Fish Passage Structures are Suitable For:
- ABC – Lateral Slide
- WF Deck Girders
- GRS-IBS
- Precast Culverts

<table>
<thead>
<tr>
<th>Total Fish Passages</th>
<th>825</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Bridge</td>
<td>40%</td>
</tr>
<tr>
<td>Total Bridge</td>
<td>330</td>
</tr>
<tr>
<td>Remaining Culverts</td>
<td>495</td>
</tr>
<tr>
<td>Culverts with span</td>
<td>50%</td>
</tr>
<tr>
<td>Total Culverts</td>
<td>248</td>
</tr>
<tr>
<td>Added to WSDOT</td>
<td>578</td>
</tr>
<tr>
<td>Added to WSDOT Bridge Inventory by No of Structures</td>
<td>16%</td>
</tr>
</tbody>
</table>
New Wide Flange Deck Girders

Efficiency of DBT Girders (4 ft wide Top Flange)

\[ \rho = \frac{r^2}{y_b y_t} \]

\[ r = \sqrt{\frac{l}{A}} \]

Girder Depth in.

Span Range of standard wide flange DBT concrete:

- Thin deck span up to 225 ft (250 ft LW Girders)
- Deck girders span up to 195 ft (230 ft LW Girders).

Washington State Department of Transportation
Connection of Deck Beam Elements

[Images and diagrams related to connection details of deck beam elements]
2015 WSDOT Research Project
Use of UHPC For Decked Girder Connections

Research Objective: WSU and UW

- Develop UHPC mix design
- Performance of longitudinal joints using UHPC
- Distribution of live load between adjacent units
- Continuity for live load
- Lap splice length using UHPC
Precast Concrete Culvert Standardization

Precast Arch = 4 to 8 ft Rise

CIP Stem Wall

CIP Foundation (Spread Footing, Pile or Shaft)

Fill 2 to 50 ft

Complete PS&E Package and Contract Plans
**Summit -2: Every Day Count – GRS-IBS**

Geosynthetic Reinforced Soil Integrated Bridge System

- Eliminates approach slab
- Reduced construction time (complete in 10 days)
- 25 - 60% less cost depending on standard of construction

**The Choice of Geotextile or Geogrid**

*Depends on the type of backfill soil to be used*

- Geotextiles
  - Non woven geotextiles are porous and have high in-plane drainage capacity, but poor tensile capacity
- Geogrids
  - Provides high tensile strength, but poor in-plane drainage capacity
  - Woven geotextile elements added to a non-woven base will increase tensile capacity

**3 Main Components of a GRS-IBS:**

1. Reinforced Soil Foundation
2. GRS Abutment
3. GRS Approach

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**EDC: GRS - IBS**

 Presenter:
Daniel Alzamora, P.E.
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Resource Center
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ABC Research Projects in Washington State

- **Use of UHPC for Wide Flange Decked Girder Connections**
  University of Washington and Washington State University - 2015

- **Seismic Performance Of Nickel-titanium Reinforced ECC Columns With Headed Couplers**
  University of Nevada, Reno, July 2014

- **Highways for LIFE Precast Bent System for High Seismic Regions**
  BergerABAM and University of Washington, March 2013

- **Reinforced Concrete Filled Tubes for use in Bridge Foundations**
  University of Washington, June 2012 & 2014

- **Accelerated Bridge Construction (ABC) Decision Making and Economic Modeling Tool**
  Oregon State University, December 2011

- **Anchorage Of Large-diameter Reinforcing Bars Grouted Into Ducts**
  University of Washington, November 2007

- **Design of Precast Concrete Piers for Rapid Bridge Construction in Seismic Regions**
  University of Washington, August 2005
BDM Chapter for Accelerated and Innovative Bridge Design & Construction

• The Audience
  – WSDOT Engineers
  – Consultant Engineers
  – Contractors

• Provide a broad perspective.

• Provide technical guidance on Precast Bents.
  – DBB and DB.

• Be a resource for Regions and Bridge Engineers.
Who kicked off the ABC discussion in your agency? (Or is holding it back potentially?)
- ABC is not officially acknowledged. It is considered on a case-by-case basis per project

From an ABC standpoint, what has worked well and what has been more of a struggle?
- Superstructure: Lateral Sliding, SPMT worked well
- Substructure: Slowly but positively

Have your local consultants and/or contractors bought into ABC? Why or why not?
- Same as above
R04 ABC Peer to Peer Exchange Q&A

• Have you let the public know about your ABC projects and what they can expect?
  – Public involvement is not generally considered except for some joint replacement projects High ADT

• Is your agency working on a program wide implementation plan for ABC?
  – Not yet but it may change with the Fish passage program

• Has cost estimating been an issue? For let jobs did the estimate reflect the bid?
  – Yes - Cost estimating is usually based on direct cost
R04 ABC Peer to Peer Exchange Q&A

• Lessons learned from past projects? Things you would do again? Not?
  – Yes: All past ABC experiences were positive in WA.

• Were ABC designs/specifications problematic for your agency?
  – No – Design Specs were provided

• What issues came up during acquisitions and construction?
  – Potential for construction risks

• Would you do ABC construction again?
  – Yes – ABC has been successful in WA.
Accelerated Bridge Construction Resources (ABC)

Reports

- WSDOT ABC Strategic Plan (pdf, 161kb)
- FHWA Seismic ABC Workshop Report (pdf, 998kb)
- ABC Seismic Connections - TRB Research Proposal (pdf, 5.2mb)
- Design of Precast Concrete Piers for Rapid Bridge Construction in Seismic Regions (pdf, 2.78mb)
- A Precast Concrete Bridge Bent Designed to Re-center after an Earthquake (pdf, 2.82mb)
- Rapidly Constructible Large-Bar Precast Bridge-Bent Seismic Connection (pdf, 8.4mb)
- Anchorage of Large-Diameter Reinforcing Bars Grouted into Ducts (pdf, 1.9mb)
- Fully Precast Bridge Bents for Use in Seismic Regions (pdf, 356kb)

Presentations

- 2015 ABC Workshop (pdf, 16mb)
- Presentations from WSDOT ABC Workshop (September 30, 2008) (500mb)
- Presentations from WSDOT-CalTrans TRB 2009 Seismic ABC Collaboration (612mb)
- Lewis and Clark Bridge Deck Replacement (pdf, 11mb)
- Rapid Replacement of the Hood Canal Bridge Approach Spans (pdf, 9.07mb)
- ABC Pooled Fund Meeting (pdf, 960kb)
- HFL Testing Briefing (pdf, 5.3mb)
- A precast Concrete Bridge Bent for Seismic Regions: Achieving both Performance and Constructability (pdf, 9.6mb)
- Unbonded pre-stressed connections (pdf, 1.1mb)
- Concrete Filled Steel Tubes for Bridge Foundations and Substructures (pdf, 9.4mb)

Links

- Highways for Life