Delivery of Accelerated Bridge Construction WSDOT Workshop Wednesday April 1st, 2015

New Development in Accelerated Bridge Design and Construction in WA

Washington State Department of Transportation Bridge and Structures Office Olympia Washington



## **Presentation Summary**

- 1. ABC Projects
- 2. ABC Related Research Projects
- 3. New Wide Flange Deck Bulb Tee Girders with UHPC Closure
- 4. Accelerated Bridge Construction Lateral Slide
- 5. Geosynthetic Reinforced Soils Integrated Bridge System GRS-IBS
- 6. Standardization of Precast Culverts















### 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



# Challenges in the implementation of PBES/ABC

- ✓ Lack of Education, Training, and experience
- ✓ Concerns about durability and quality
- ✓ Lack of defined decision process for PBES/ABC
- ✓ PBES/ABC process is not integrated into practices
- Lack of perceived need for speed

Lack of interest from the construction industry



## **Prefabricated Bridge Elements & Systems**

Superstructures



- ✓ Deck Panels: Partial & Fuii-Deptn
- Prefabricated Beams: Optimized for ABC
- ✓ Total Superstructure Systems:
- Substructures
  - ✓ Pier Caps, Columns, & Footings
  - ✓ Abutment Walls, Wing Walls, & Footings
- Totally Prefabricated Bridges



## **Example of ABC Related Bridge Projects in WA - Superstructure**



## **Example of ABC Related Bridge Projects in WA - Substructure**











## **ABC Research Projects in Washington State**

 Design of Precast Concrete Piers for Rapid Bridge Construction in Seismic Regions

University of Washington, August 2005

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

**Reinforced Concrete Filled Tubes for use in Bridge Foundations** 

Phase 2: Shear capacity of CFT

 Seismic Performance Of Square Nickel-titanium Reinforced ECC Columns With Headed Couplers

University of Nevada, Reno, July 2014

 Accelerated Bridge Construction (ABC) Decision Making and Economic Modeling Tool

Oregon State University, December 2011



# **Participation in ABC Webinars**

ABC Center at Florida International University - ABC-UTC

- October 2013 Washington State's Skagit River Bridge Emergency Slide - WSDOT
- September 2014 SR167 Puyallup River historic bridge lateral slide – Jcobs-WSDOT

### **NHI Innovation Web Conference**

- August 2011 Precast Bent System for Use in High Seismic Regions – ABAM-UW-WSDOT
- August 2013 Precast Bent System for Use in High Seismic Regions – ABAM-UW-WSDOT



# **ABC Folios and Tech Notes**

#### Bridge & Structures Office Accelerated Bridge Construction

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#### WSDOT ENHANCED MOBILITY

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#### **Highways for LIFE Projects**



#### From research to practice.

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**Skagit River Bridge** 

**Concrete Girders** 

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#### **Bridge & Structures Office Skagit River Bridge Emergency**



#### Bridge collapse insident

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View construction photos at: www.flickt.com/photos/wedgt/sets/

#### **Bridge & Structures Office** Excellence & Innovation in Design

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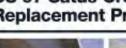
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# **NCHRP ABC Projects**

- *NCHRP 12-102:* Recommended AASHTO Guide Specification for ABC Design and Construction
- NCHRP 12-105: Proposed AASHTO Seismic Specifications for ABC Column Connections
- NCHRP 12-101: Seismic Design of Bridge Columns with Improved Energy Dissipating Mechanisms
- NCHRP 12-88: Synthesis on System Performance of Accelerated Bridge Construction Connections in Moderate-to-High Seismic Regions



# **PBES – Implementation**

From: Summit -1: P2P Exchange - PBES

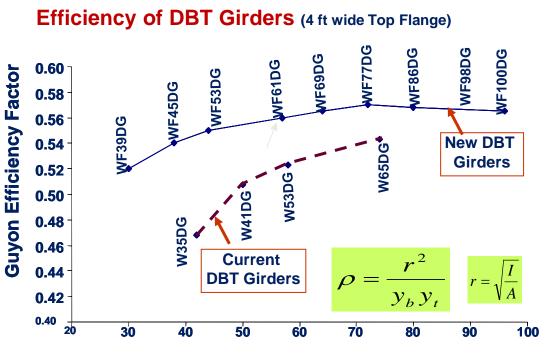
## **Beam Elements**

Prefabricated Deck Beam Elements include:

- ✓ Deck Bulb Tee Beams
- Precast Deck Elements
- Precast Box Beams
- Precast Slabs



## **New Wide Flange Deck Girders**

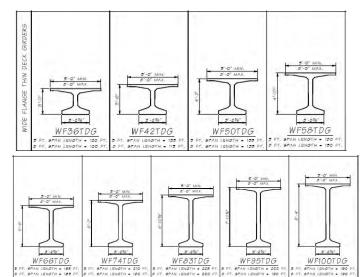


### Girder Depth in.

# Span Range of standard wide flange DBT concrete:

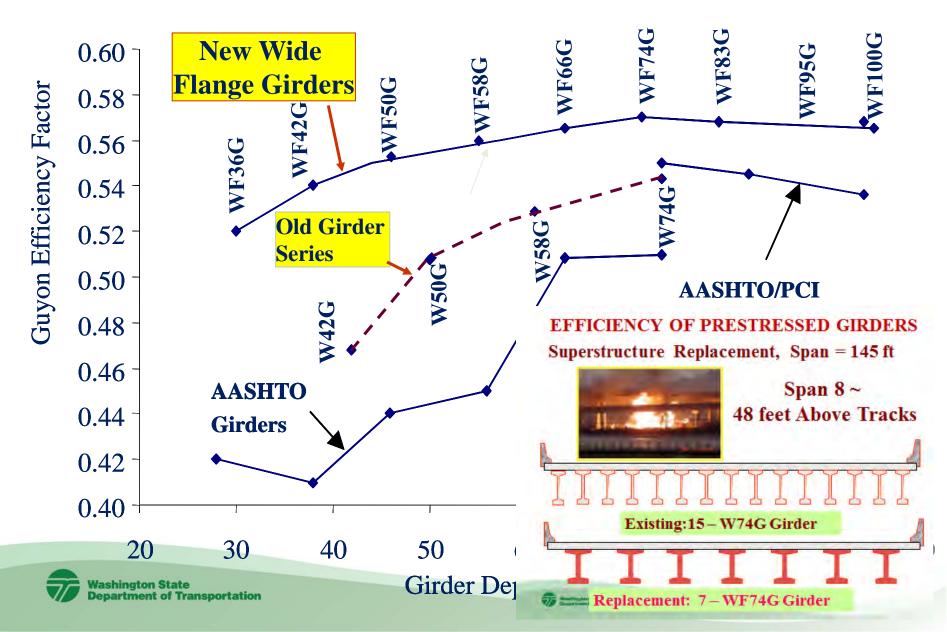
- Thin deck span up to 225 ft (250 ft LW Girders)
- Deck girders span up to 195 ft (230 ft LW Girders).







# **Efficiency Of Prestressed Girders**



### **December 2011 Concrete Products Article by Don Marsh**



#### DECEMBER 2011

 Nasentry check-off funding program on Capitol HIU, p. 4
 Baker Ready-HIX chief on regelatory accountability, p. 8
 Transmerica Pyramid aims for LEED Hottourn, p. 14
 2012 Marker Forecast, p. 23
 Software to predict compressive strength, p. 38
 Software ITrack update, p. 40
 Sofar-provered precast home, p.48

### TAKE IT TO THE LIMIT

Value engineering, design-build methods steer states' record-length girder specs



#### RECORD-LENGTH PRESTRESSED CONCRETE GIRDERS

State DOT, single-piece, road-delivered

1959-1999

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# Wide Flange Deck Bulb Tee Girders

- Girder Types:
  - Type 1: CIP Slab = 5" min. for WSDOT Projects

- Type 2: CIP concrete Overlay =  $1 \frac{1}{2}$ " for Low ADT

- Concrete Types: Normal weight, and LW
- Top flange width: 5.0 ft, 6.0 ft, 7.0 ft, 8.0 ft
- Closure Types:
  - ✓ CIP UHPC connection with lap spliced bars
  - Welded ties and grouted key connection for Low ADT Roads/Others



## Deck Girders: Skagit River Bridge Replacement - ABC and A+B+C











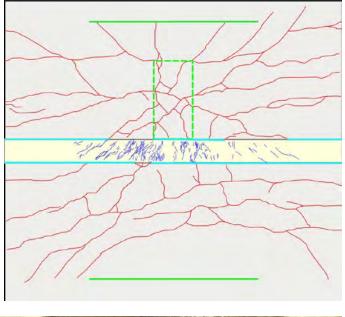


## **Research Pays off: New NCHRP Publication**

- NCHRP 18-15 High-Performance/High-Strength Lightweight Concrete for Bridge Girders and Decks
- FHWA HRDI-40- Lightweight Concrete for Bridge Girders: Contact: Ben Graybeal
- FHWA-HRT-13-060 Ultra-High Performance Concrete for Bridges, Ben Graybeal
- Nchrp 12-69 Guidelines for Design and Construction Of Decked Precast, Prestressed Concrete Girders
- NCHRP 173 Cast-in-Place Concrete Connections for Precast Deck Systems

Washington State Department of Transportation

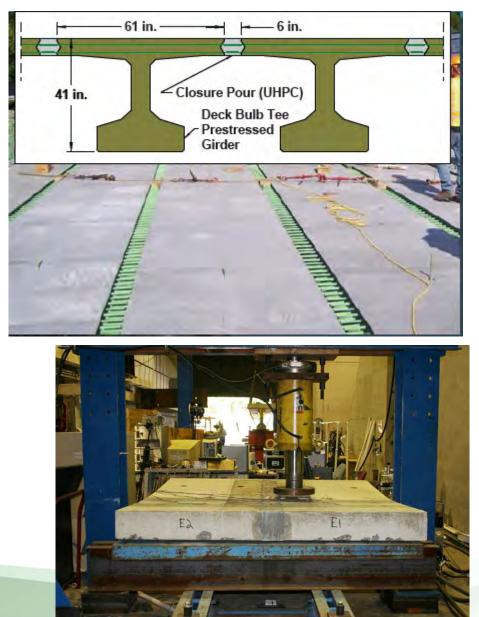
## **Connection of Deck Beam Elements**





SR 31 over Canandaigua Outlet Lyons, New York Ultra-High Performance Concrete (UHPC)





## **Past Performance of Deck Girder Bridges**

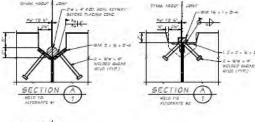


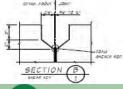
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## <u>2015 WSDOT Research Project</u> Use of UHPC For Decked Girder Connections Between Adjacent Units

### **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



WF53DTC

WE77DIG

WF103DT

### Summit -2: Every Day Count – GRS-IBS Geosynthetic Reinforced Soil Integrated Bridge System

- Eliminates approach slab
- Reduced construction time (complete in10 days)
- 25 60 % less cost depending on standard of construction
- Flexible design easily modified for unforeseen site conditions
- Built with common equipment and materials



### Every Day Counts

Geosynthetic Reinforced Soil Integrated Bridge System May 9<sup>th</sup>, 2013

> Location Washington State Department of Department of Transportation Bridge and Structures Office 7345 Linderson Way Southwest Tumwater, Washington 98501 Conference Room 1028

#### Geosynthetic Reinforced Soil Integrated Bridge System

Instead of conventional bridge support technology, Geosynthetic Reinforced Soil (GRS) Integrated Bridge System (IBS) technology uses alternating layers of compacted granular fill material and geosynthetic reinforcement to provide support for the bridge. GRS provides a smooth transition from the bridge onto the roadway, and alleviates the "bump at the bridge" problem caused by uneven settlement between the bridge and approaching roadway. To learn more about EDC, please refer to the following web site:

http://www.fhwa.dot.gov/everydaycounts/technology/grs ibs/index.cfm

Agenda:	
9:30AM	Introduction
9:40AM	GRS Fundamentals
10:00AM	Performance tests and monitoring
10:30AM	Construction of GRS-IBS and Video
11:30AM	Lunch
12:30PM	Design of GRS-IBS
1:30PM	User Perspective and example project
2:15PM	Status of implementation nationally
2:30PM	Adjourn

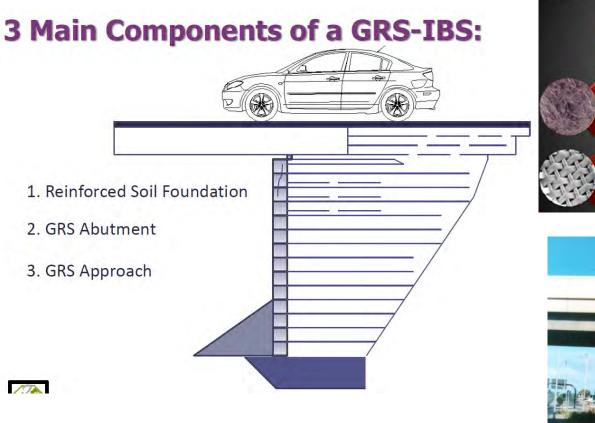
Presenter: Daniel Alzamora, P.E. Geotechnical Engineer Federal Highway Administration Office of Technical Services Resource Center 720-963-3214 daniel alzamora@dot.gov





### EDC: GRS - IBS

## Geosynthetic Reinforced Soil-Integrated Bridge Systems (GRS-IBS)









### Geosynthetic Integrated Bridge System

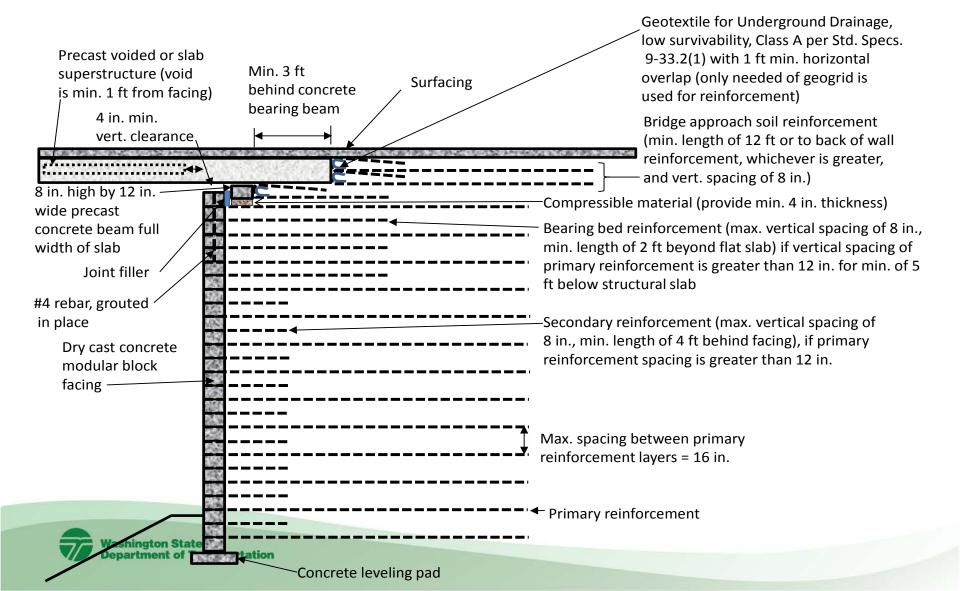






## **MSE wall supported abutments**

GRS supported abutment – flat slab superstructure with no footing and dry-cast modular block wall facing



# 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
- ✓ Deck Girders
- ✓ GRS-IBS
- Precast Culverts

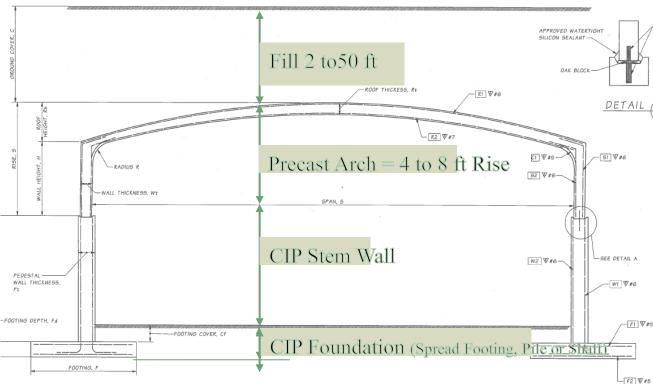


### Scope of Work: Fish Passage Projects Bridges and Culverts

Total Fish Passages	825		
% Bridge	40%		
Total Bridge	330		
Remaining Culverts and Stream Realignment	495		
Culverts with span over 20 ft			
Total Culverts	248		
Added to WSDOT Bridge Inventory by No of Structures	578		
Added to WSDOT Bridge Inventory by %	16%		



### **Precast Concrete Culvert Standardization**



## Preliminary Design Aid: Span, Rise, Fill, Precast Arch Dimensions, etc.

	SPAN FROM 50' TO 60', GROUND COVER MORE THAN 8'										
SPAN (S)	50'-0"	51'-0"	52'-0*	53'-0"	54'-0"	55'-0"	56'-0"	57'-0"	58'-0*	59'-0"	60'-0"
WALL HEIGHT (H), ft.	8-0	8-0	8-0	8-0	8-0	8-0	8-0	8-0	0-8	8-0	8-0
ROOP RISE (R), ft.	2.0	2 -0	2-0	2 -0	2 -0	2-0	2-0	2-0	2-0	2 -0	2 -0
ROOF THICKNESS T1, in.	11"	11"	11"	11"	11*	11"	11"	11*	11*	11*	11"
WALL THICKNESS W1, ft.	1'-1"	1'-1"	151"	1'-1"	1'-1"	1'-1"	11-17	1'-1"	1'-1*	151*	11-17
CORNER RADIUS, ft.	2'	2	2"	2'	2	2'	2"	2	2	2'	2"
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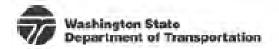




# **Standard Precast Concrete Culvert**

- Design Criteria & Design Specifications
- Preliminary Design Aids
- Span Capability Charts
- Design Tools and Software
- Bridge Design Manual & Standard Details
- Standard Drawings for Arch Structures
- Improved Joint Details between Segments
- Complete PS&E Package and Contract Plans





# **WSDOT ABC Website**

### 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

- 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, 1.1m)
- Concrete Filled Steel Tubes for Bridge Foundat

#### Links

Highways for Life



### ✓ ABC Website – Rick Brice

- ✓ **ABC BDM Chapter** Patrick Gallagher
- Folios and Tech Memos Paul Kinderman
- New Deck Girders Rick Brice Scott Sargent – Brian Aldrich
- ✓ **Culverts** Lou Tran Mark Szewcik

# Thank You!