

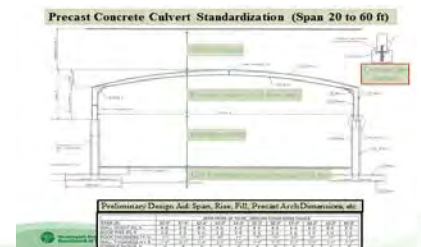
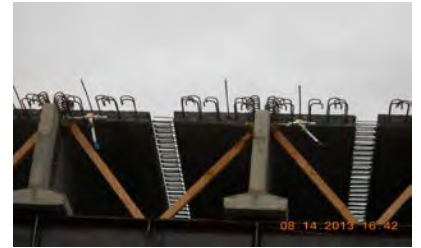
**Delivery of Accelerated Bridge  
Construction  
WSDOT Workshop  
Wednesday April 1st, 2015**

**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





Federal Highway Administration

**Every Day Counts**

Innovation Initiative



## ***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 & Full-Depth
- ✓ 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 – Jacobs-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



# 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
- Others

# PBES – Implementation

*From: Summit -1: P2P Exchange - **PBES***

## ***Beam Elements***

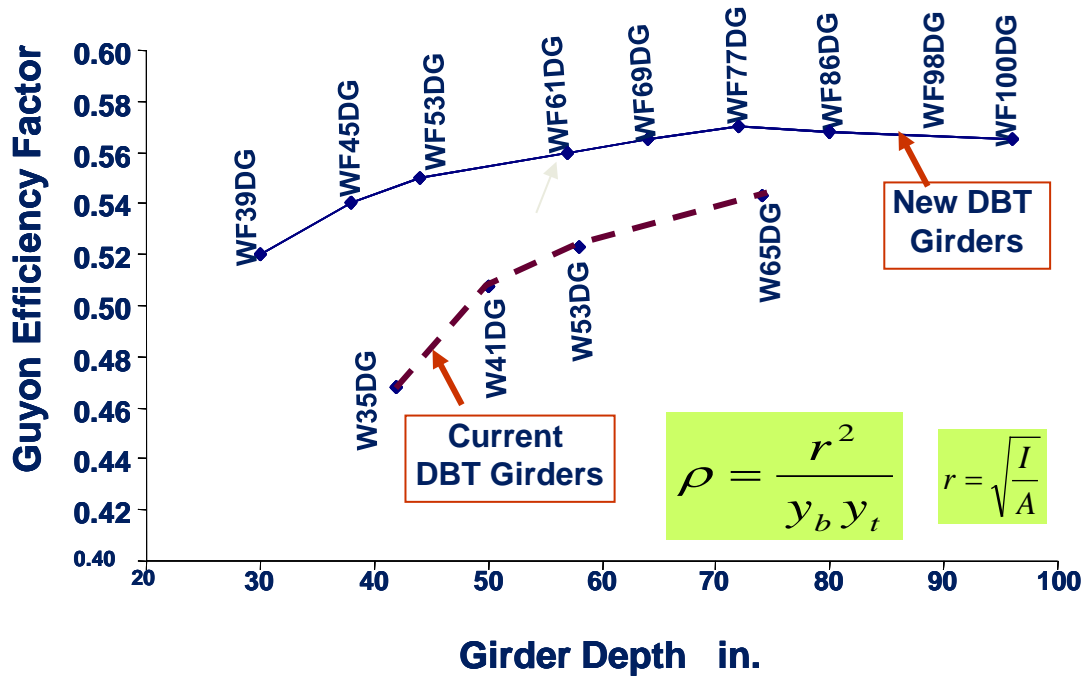
Prefabricated *Deck Beam Elements include:*

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



# New Wide Flange Deck Girders

## Efficiency of DBT Girders (4 ft wide Top Flange)

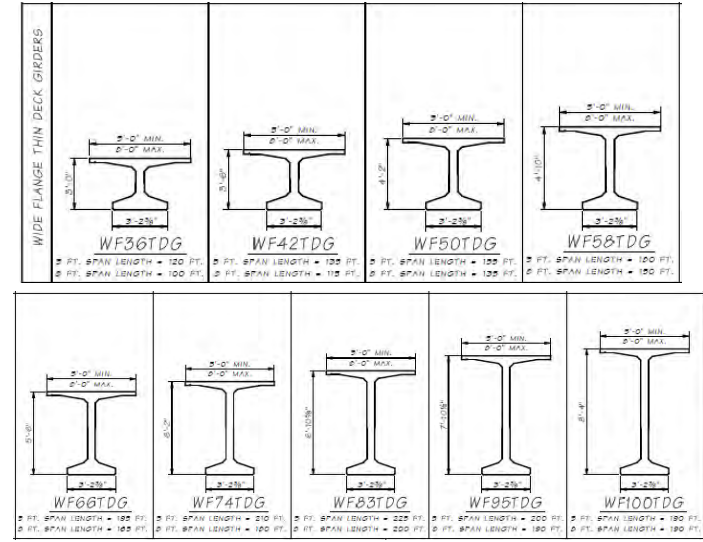


Current DBT Girders

New DBT Girders

$$\rho = \frac{r^2}{y_b y_t}$$

$$r = \sqrt{\frac{I}{A}}$$

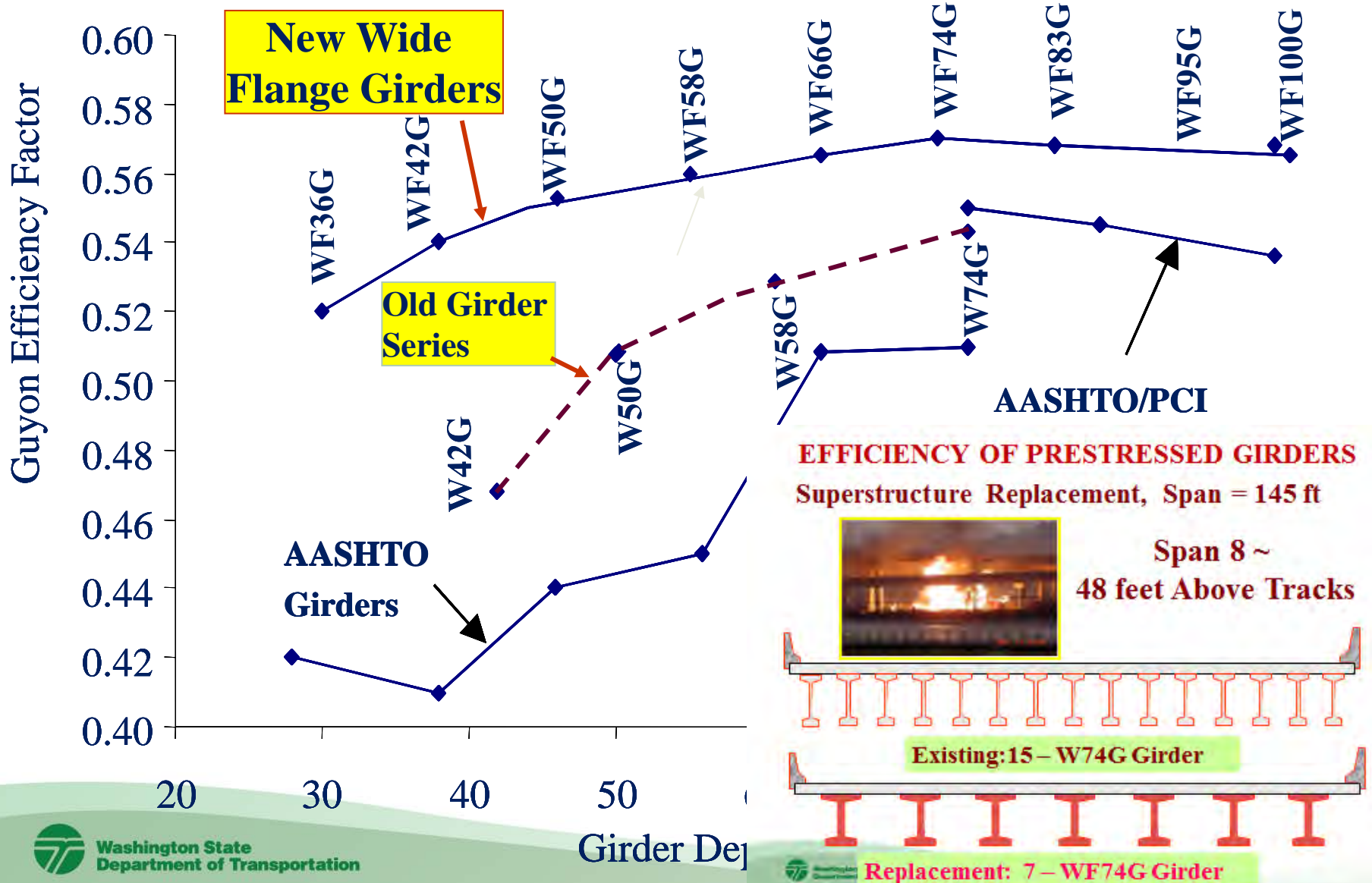


## Span Range of standard wide flange DBT concrete:

- 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

OPERATIONS • MARKET DEVELOPMENT • PRACTICE

# Concrete

PRODUCTS

CONCRETEPRODUCTS.COM

DECEMBER 2011

- Masonry check-off funding program on Capitol Hill, p. 4
- Baker Ready-Mix chief on regulatory accountability, p. 8
- Transamerica Pyramid aims for LEED Platinum, p. 14
- 2012 Market Forecast, p. 23
- Software to predict compressive strength, p. 38
- Cat Vocational Truck update, p. 40
- Solar-powered 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

### 2000-2011

Bridge	Length	Year	Producer
Devlin Trail at Bow River Calgary	211 ft	2011	Can-Tec Structures Canada
S.R. 26/Reagan Hwy. 400 at 14th Avenue, South	205 ft	2011	Concrete Technology Corp. Tacoma, Wash.
Hwy 47/84 at Golden Pass, Lake County	202.5 ft	2001	Can-Tec Structures
Washburn Road at Beck Dr. Salt Lake City	180 ft	2011	Hyman Structural Precast S.R. Lake City
Palmer Parkway Bridge, Clark County, Wash.	165 ft	2000	Concrete Technology Corp.
Interstate Bridge, Bristol, Va.	163 ft	2008	Concrete Structures America, Baltimore, Md.
South Orange Bridge, Bristol, Va.	152 ft	2008	Concrete Structures America, Lynchburg, Va.
U.S. Highway 17, Anne Arundel	150 ft	2008	Concrete Precast Products Co. Spotsylvania, Va.
Atwood River Bridge, Orangeburg County, N.C.	177 ft	2001	Concrete Technology Corp.
S.R. 180 at Interstate 275, Pasaden County, Fla.	175 ft	2011	Concrete Structures America, Tampa, Fla.
U.S. 91 at Mt. Zion Road, Hastings, Minn.	174 ft	2011	Green Concrete Products, Maple Lake, Minn.
Interstate 29 at 1st Street, New York, Louisiana	170 ft (187 ft)	2007	Procast Engineering Corp., Portchar, La.; Prestressed Services LLC, Longview, La.
Hwy. 300 at 14th St., Galien County, Pa.	168 ft	2010	Verstead Precast/Products LLC, Crossville, Pa.
IRB Concrete (S.A. 114 & 121 Hwy.), Texas	164 ft	2011	Shelco Concrete Works LLC, San Antonio, Texas
S.R. 12045 & C.R. 107, Coahuila, Texas	163 ft	2011	Hydrotech Structures, San Marcos, Texas

110 & 900 GIRDERS PRECAST, Atlantic Marine, Inc. Haverhill, Mass./Structural Precast

### 1959-1999

Bridge	Length	Year	Producer
Rockaway, New York City	190 ft	1963	Ray Sherr, Concrete Products Corp., May, N.J.
U.S. 23/Walton Blvd. West Lafayette, Ind.	175 ft	1966	Hesco Concrete, Lafayette, Ind.
Tom Mason, Ft. Worth, Texas	167.5 ft	1968	Quartz to Concrete, Inc., Dallas, Texas
Harwood Blvd., Berkeley, Calif.	167 ft	1970	Concrete Technology Corp.
16 Woodway Highway, Lawrence County, Pa.	92 ft	1980	Schubert Products
Washington State Bridge, Douglas County, Wis.	141 ft	1980	Marty Smith, Precastors, Tappan, Wis.
Waini Lane, Redwood City, Calif.	136 ft	1980	Schubert Products, Redwood City, Calif.
TH 169 at Millerville, River Falls, Wis.	131 ft	1995	Center Concrete Products, River Falls, Wis.
West Stanton, Atlantic County, Wash.	155 ft	1978	Concrete Precast Products, Pasaden, Wash.
U.S. 47 at Combs River, San Angelo, Texas	124 ft	1927	Traco Concrete
Don Diego, Sycamore, San Diego	151 ft	1968	Baykon Corp.
U.S. 90/Grand Canyon, Grand, Minn.	150 ft	1955	Concrete Works Concrete, Grand, Minn.
Coastal Gateway, Rockledge, Fla.	150 ft	1991	U.S. Concrete, Rockledge, Fla.
U.S. 90/Grand Canyon, Reno, Nev.	150 ft	1954	Quartz to Concrete, Inc., Reno, Nev.
Red Deer, Bay, Northern Alberta	149 ft	2002	Can-Tec Structures Canada

\* Large dimension \*\* See sidebar

Compiled by Concrete Products



# Wide Flange Deck Bulb Tee Girders

- **Girder Types:**

- Type 1: CIP Slab = 5" min. for WSDOT Projects
- Type 2: CIP concrete Overlay = 1 ½" 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



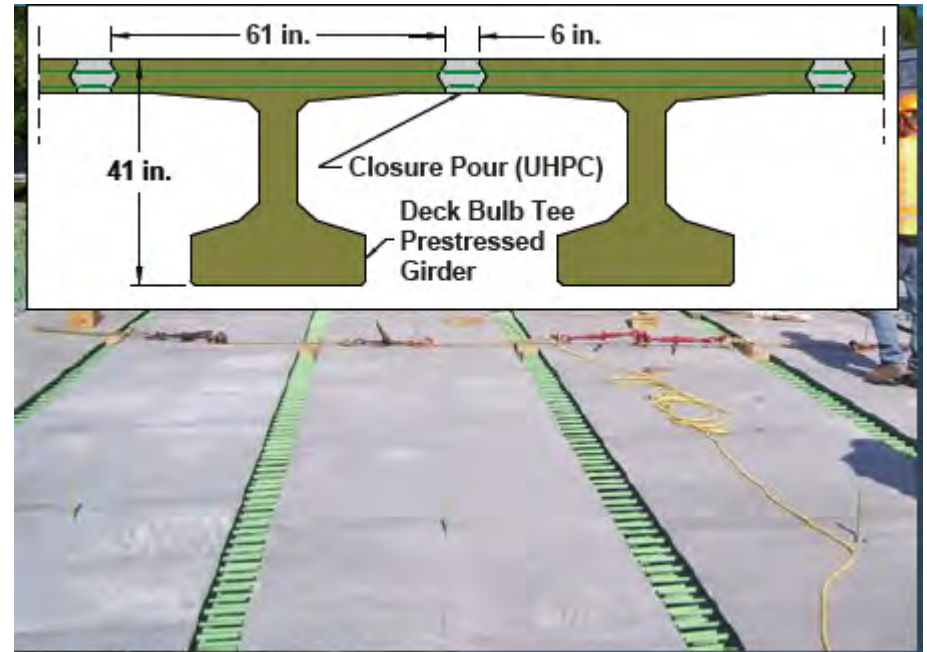
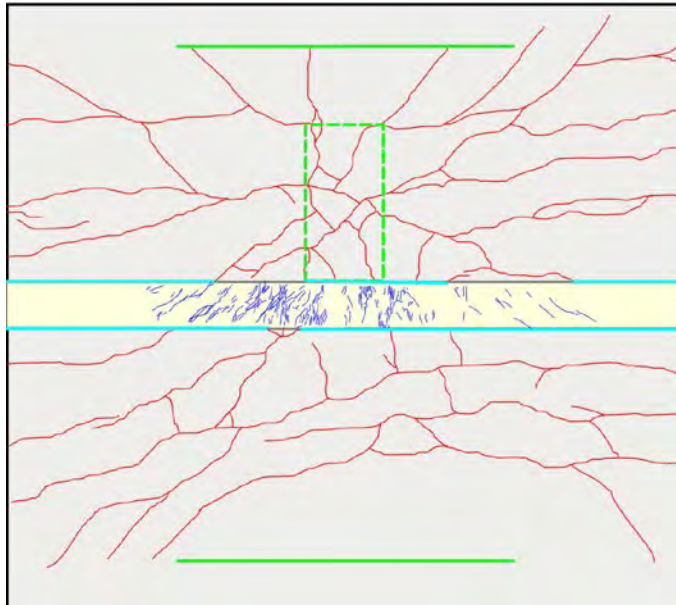
## Connection of Deck Beam Elements



# 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

# Connection of Deck Beam Elements

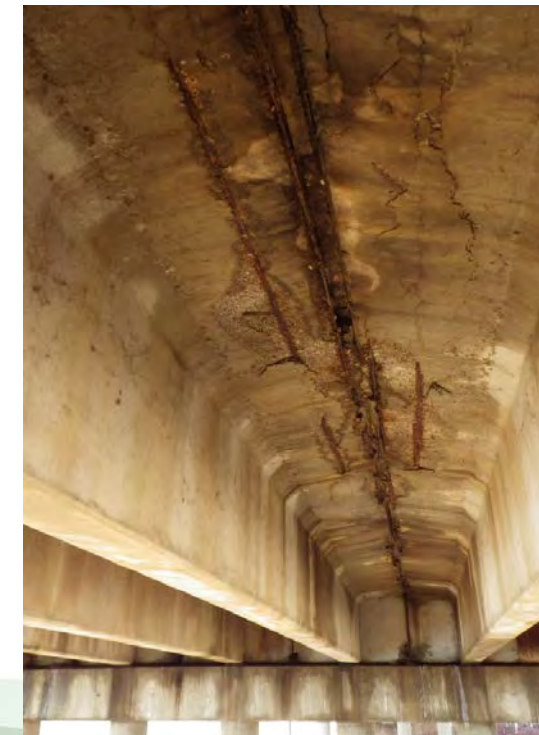
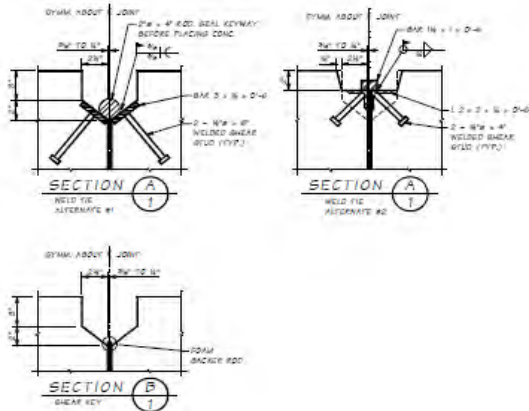
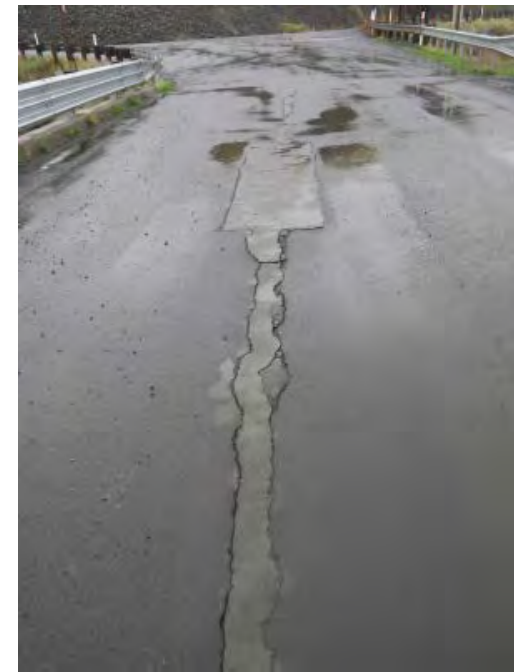


**SR 31 over Canandaigua  
Outlet Lyons, New York  
Ultra-High Performance  
Concrete (UHPC)**





# Past Performance of Deck Girder Bridges



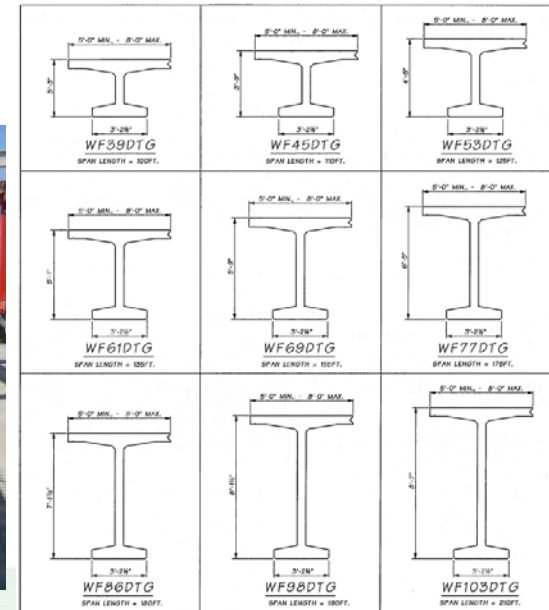


# 2015 WSDOT Research Project

## 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
- Lap splice length using UHPC



# 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
- Flexible design – easily modified for unforeseen site conditions
- Built with common equipment and materials

U.S. Department of Transportation  
Federal Highway Administration

*Every Day Counts*

### Geosynthetic Reinforced Soil Integrated Bridge System

May 9<sup>th</sup>, 2013

Location

Washington State 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](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:

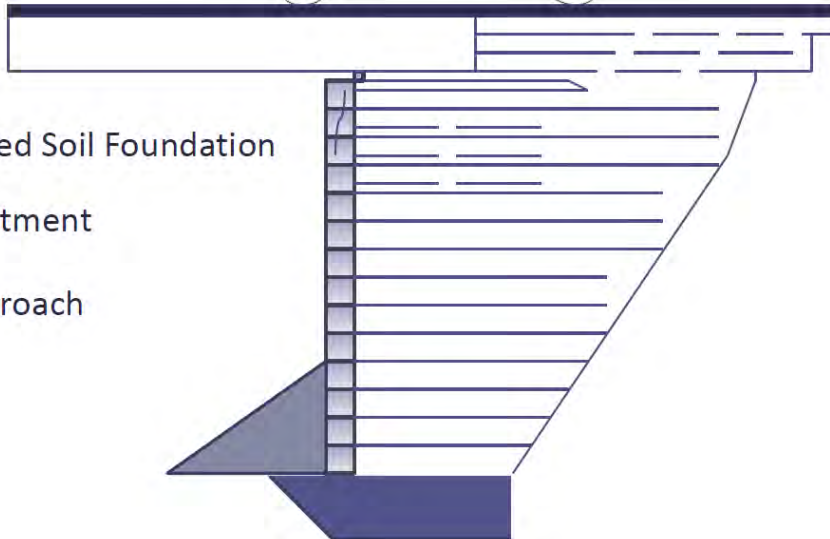
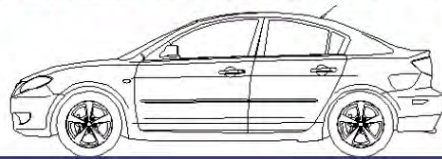
Daniel Alzamora, P.E.  
Geotechnical Engineer  
Federal Highway Administration  
Office of Technical Services  
Resource Center  
720-963-3214  
[daniel.alzamora@dot.gov](mailto:daniel.alzamora@dot.gov)



*EDC: GRS - IBS*

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

## 3 Main Components of a GRS-IBS:



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



## 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



Woven geotextile elements added to a non-woven base will increase tensile capacity

### Geogrids



Provides high tensile strength, but poor in-plane drainage capacity





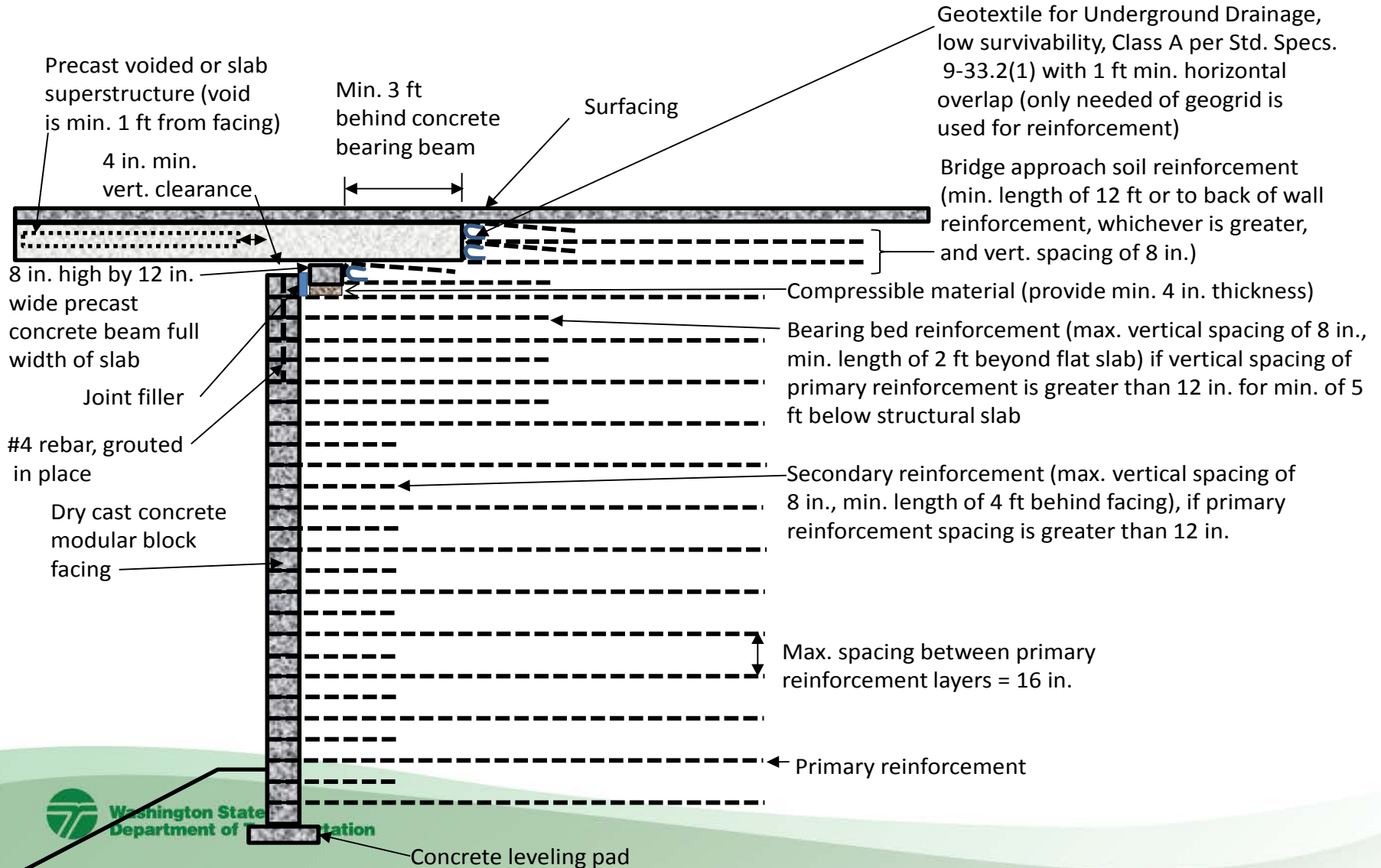
# Geosynthetic Integrated Bridge System





# MSE wall supported abutments

GRS supported abutment – flat slab superstructure with no footing and dry-cast concrete 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



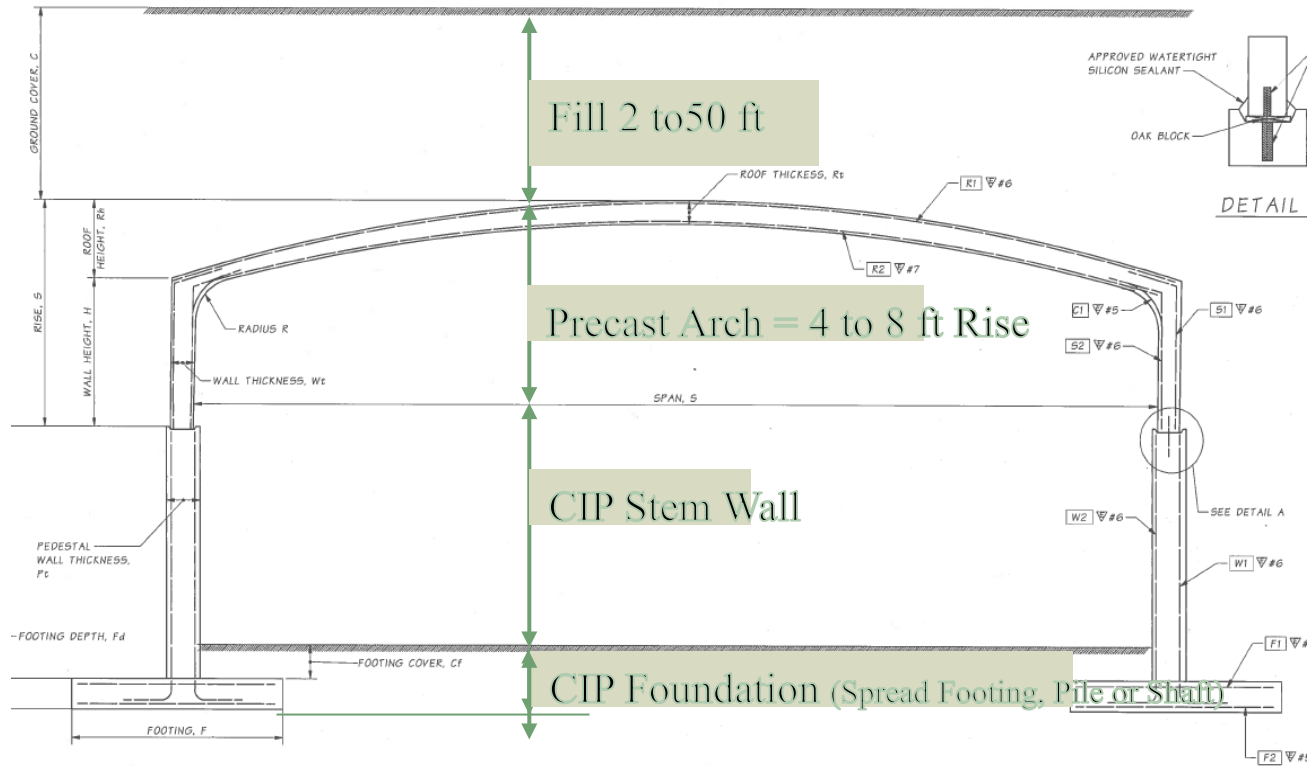
# Scope of Work: Fish Passage Projects

## Bridges and Culverts

<b>Total Fish Passages</b>	<b>825</b>
% Bridge	40%
<b>Total Bridge</b>	<b>330</b>
Remaining Culverts and Stream Realignment	495
Culverts with span over 20 ft	50%
<b>Total Culverts</b>	<b>248</b>
<b>Added to WSDOT Bridge Inventory by No of Structures</b>	<b>578</b>
<b>Added to WSDOT Bridge Inventory by %</b>	<b>16%</b>



# 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	8-0	8-0	8-0
ROOF 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"	1'-1"	1'-1"	1'-1"	1'-1"	1'-1"	1'-1"	1'-1"	1'-1"	1'-1"
CORNER RADIUS, ft.	2'	2'	2'	2'	2'	2'	2'	2'	2'	2'	2'

# 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

## 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, 1.1mb)
- Concrete Filled Steel Tubes for Bridge Foundat

### Links

- Highways for Life

**Thank You!**

- ✓ **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