



U.S. Department
of Transportation
Federal Highway
Administration



CRASH COURSE GRS-IBS BRIDGES



EDC Web Site

www.fhwa.dot.gov/innovation/everdaycounts/edc-3/grs-ibs.cfm

Resources

Design and Construction Guidelines for Geosynthetic Reinforced Soil Abutments and Integrated Bridge Systems (FHWA-HRT-17-080)

Fact Sheet

EDC Regional Summit Presentation

FAQs

Tools

FHWA GRS-IBS Interim Implementation Guide

GRS-IBS Design Drawings

GRS-IBS Synthesis Report

GRS-IBS Sample Guide Specifications

Geosynthetic Reinforced Soil Performance Testing— Axial Load Deformation Relationships

Friction Angles of Open-Graded Aggregates From Large-Scale Direct Shear Testing

Synthesis of Geosynthetic Reinforced Soil (GRS) Design Topics

Strength Characterization of Open-Graded Aggregates for Structural Backfills

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AID Demonstration

Resources



Geosynthetic Reinforced Soil-Integrated Bridge System

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FHWA Resource Center
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Daniel.Alzamora@dot.gov

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Webinars/Videos

EDC Exchange (02/12)

EDC Exchange (09/15)

Construction Video

FHWA EDC Showcase: GRS-IBS Demonstration

I-84 Echo Bridge Time Lapse

I-84 Echo Bridge Move and GRS

GRS Bridge System Pilot Project

GRS Bridge Technique

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GRS Bridge System Pilot Project

GRS Bridge Technique

- Improves safety for the traveling public by minimizing the potential for vehicles to lose control
- Reduces the cost of re-leveling the transition from the bridge to the roadway
- Eliminates the need for additional lane closures to repair the bump, decreasing exposure of workers to traffic

Current State of the Practice

GRS-IBS was included in both EDC-1 and EDC-2 as an Accelerated Bridge Construction technology. Over 200 bridges in 44 states, Puerto Rico and the District of Columbia have been selected for construction using GRS-IBS since the innovation was first championed under the initiative in 2010.



Definitions

- **GRS - Geosynthetic Reinforced Soil**
 - An engineered fill of closely spaced ($< 12''$) compacted granular fill material and geosynthetic reinforcement
- **IBS - Integrated Bridge System**
 - A fast, cost-effective method of bridge support that blends the roadway into the superstructure using GRS technology



Benefits of GRS-IBS Bridges

Reduced Construction Time

Reduced Construction Cost Up to 40%

No bump at end of bridge

Construction is Less Dependent on Weather

Easy field modifications for unforeseen conditions

Easier to Maintain- Fewer bridge parts

No Specialized labor needed

Basic Equipment: Excavators, hand tools and compactors



Shallow Foundations

NCHRP REPORT 651

NATIONAL
COOPERATIVE
HIGHWAY
RESEARCH
PROGRAM

**LRFD Design and Construction
of Shallow Foundations
for Highway Bridge Structures**

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

SELECTION OF SPREAD FOOTINGS ON SOILS TO SUPPORT HIGHWAY BRIDGE STRUCTURES

Publication No. FHWA-RC/TD-10-001

February 2010



U.S. Department
of Transportation
**Federal Highway
Administration**



Facing Durability & Aesthetics

Durability of Segmental Retaining Wall Blocks: Final Report

PUBLICATION NO. FHWA-HRT-07-021

APRIL 2007



U.S. Department of Transportation
Federal Highway Administration

Research, Development, and Technology
Turner-Fairbank Highway Research Center
6300 Georgetown Pike
McLean, VA 22101-2296



GRS Design and Construction Guidance

Geosynthetic Reinforced Soil Integrated Bridge System Interim Implementation Guide

PUBLICATION NO. FHWA-HRT-11-026

JANUARY 2011



U.S. Department of Transportation
Federal Highway Administration
Research, Development, and Technology
Turner-Fairbank Highway Research Center
6300 Georgetown Pike
McLean, VA 22101-2296

Geosynthetic Reinforced Soil Integrated Bridge System Synthesis Report

PUBLICATION NO. FHWA-HRT-11-027

JANUARY 2011



U.S. Department of Transportation
Federal Highway Administration
Research, Development, and Technology
Turner-Fairbank Highway Research Center
6300 Georgetown Pike
McLean, VA 22101-2296

Sample Guide Specifications for Construction of Geosynthetic Reinforced Soil-Integrated Bridge System (GRS-IBS)

PUBLICATION NO. FHWA-HRT-12-051

AUGUST 2012



U.S. Department of Transportation
Federal Highway Administration

Research, Development, and Technology
Turner-Fairbank Highway Research Center
6300 Georgetown Pike
McLean, VA 22101-2296



GRS-IBS
DESIGN DRAWINGS
2011

INDEX TO SHEETS
A. COVER SHEET AND NOTES
B. QUANTITIES & DESIGN DIMENSIONS
C. PLAN AND ELEVATION FACING BLOCK SCHEDULE
D. GRS/RS ABUTMENT DETAILS

DEPARTMENT OF TRANSPORTATION
HIGHWAY ADMINISTRATION
FEDERAL LANDS HIGHWAY DIVISION

GRS-IBS

SIGN DIMENSION
QUANTITIES



Performance Test Report

FHWA-HRT-13-066

Geosynthetic Reinforced Soil

Performance Testing—

Axial Load Deformation Relationships

PUBLICATION NO. FHWA-HRT-13-066

AUGUST 2013



US Department of Transportation
Federal Highway Administration

Research, Development, and Technology
Turner-Fairbank Highway Research Center
6300 Georgetown Pike
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TECHBRIEF: FHWA-HRT-13-068

Friction Angles of Open-Graded Aggregates

TECHBRIEF



Friction Angles of Open-Graded Aggregates From Large-Scale Direct Shear Testing

FHWA Publication No.: FHWA-HRT-13-068
FHWA Contact: Jennifer Nicks, HRDI-40, (202) 493-3075,
jennifer.nicks@dot.gov

Introduction

State and local transportation agencies frequently use open-graded aggregates for wall and abutment applications. The primary advantages of these aggregates are their high in-place density than well-graded aggregates, their free-draining characteristics, and their assurance testing, using a large-scale direct shear test. The American Association of Highway Engineers (AAHE) and the American Association of State Highway Officials (AASHTO) classify aggregates according to the M43 gradation for processed aggregates.⁽¹⁾ For open-graded aggregates, their strength is frequently measured using a large-scale direct shear test. The most commonly used test is the large-scale direct shear (DS) test, with DS being the most conservative. Based on the American Association of State Highway Officials (ASTM) standards, the maximum aggregate size that can be tested is 1/10th and 1/6th of the test device, respectively. Standard DS devices are typically circular, with a 2.5-inch diameter. Therefore, the largest aggregates that can be tested are 0.25 or 0.4 inches, respectively. Similarly, standard TX devices are made for samples that are smaller than 2 inches in size; therefore, the maximum aggregate size that can be tested is about 0.3 inches. Because the AASHTO M43 aggregates are relatively large, with maximum aggregate sizes ranging from 0.375 to 4 inches, standard DS and TX devices are often not suitable.

Background

The most commonly used test for the strength of aggregates is the large-scale direct shear (DS) test, with DS being the most conservative. Based on the American Association of State Highway Officials (ASTM) standards, the maximum aggregate size that can be tested is 1/10th and 1/6th of the test device, respectively. Standard DS devices are typically circular, with a 2.5-inch diameter. Therefore, the largest aggregates that can be tested are 0.25 or 0.4 inches, respectively. Similarly, standard TX devices are made for samples that are smaller than 2 inches in size; therefore, the maximum aggregate size that can be tested is about 0.3 inches. Because the AASHTO M43 aggregates are relatively large, with maximum aggregate sizes ranging from 0.375 to 4 inches, standard DS and TX devices are often not suitable.

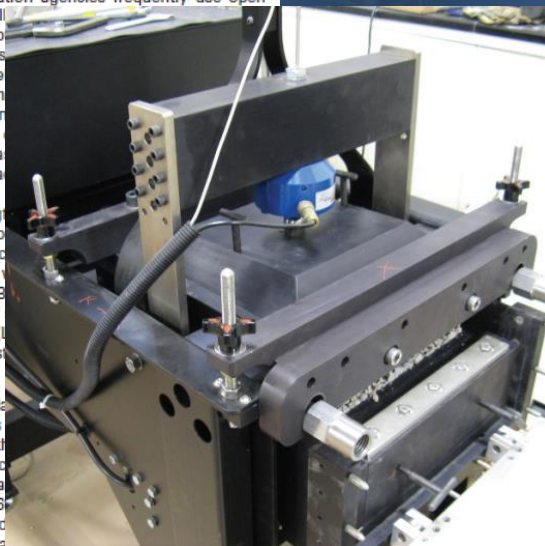


Table 2. Friction angle results using the linear MC envelope and ZDA approaches.

AASHTO Gradation	Friction Angle (°)			
	Mohr-Coulomb (MC)		Zero Dilation Angle (ZDA)	
	Dry	Saturated	Dry	Saturated
5	51	59	52	49
56	59	57	53	56
57	52	56	47	56
6	59	60	50	54
67	55	60	53	57
68	50	52	51	51
7	57	52	54	52
78	53	48	51	49
8A	54	50	52	50
8B	47	45	50	50
8C	43	43	50	48
8D	52	46	53	50
89	47	45	48	49
9	53	45	52	48
10	46	41	46	44



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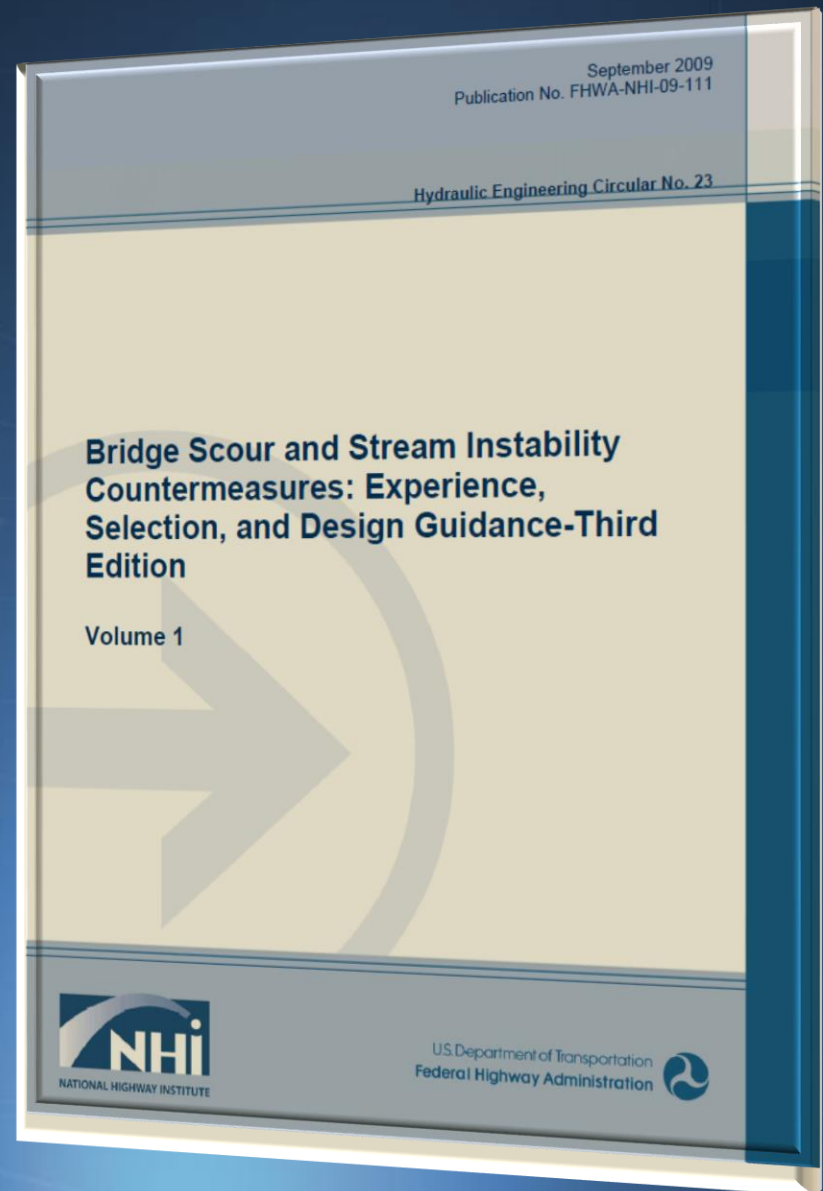
Hydraulic Engineering Guidelines

- HEC-18
 - Evaluating Scour at Bridges
- HEC-20
 - Stream Stability at Highway Structures
- HEC-23
 - Countermeasure Design

PDF version can be downloaded from the FHWA Hydraulics Web Page:

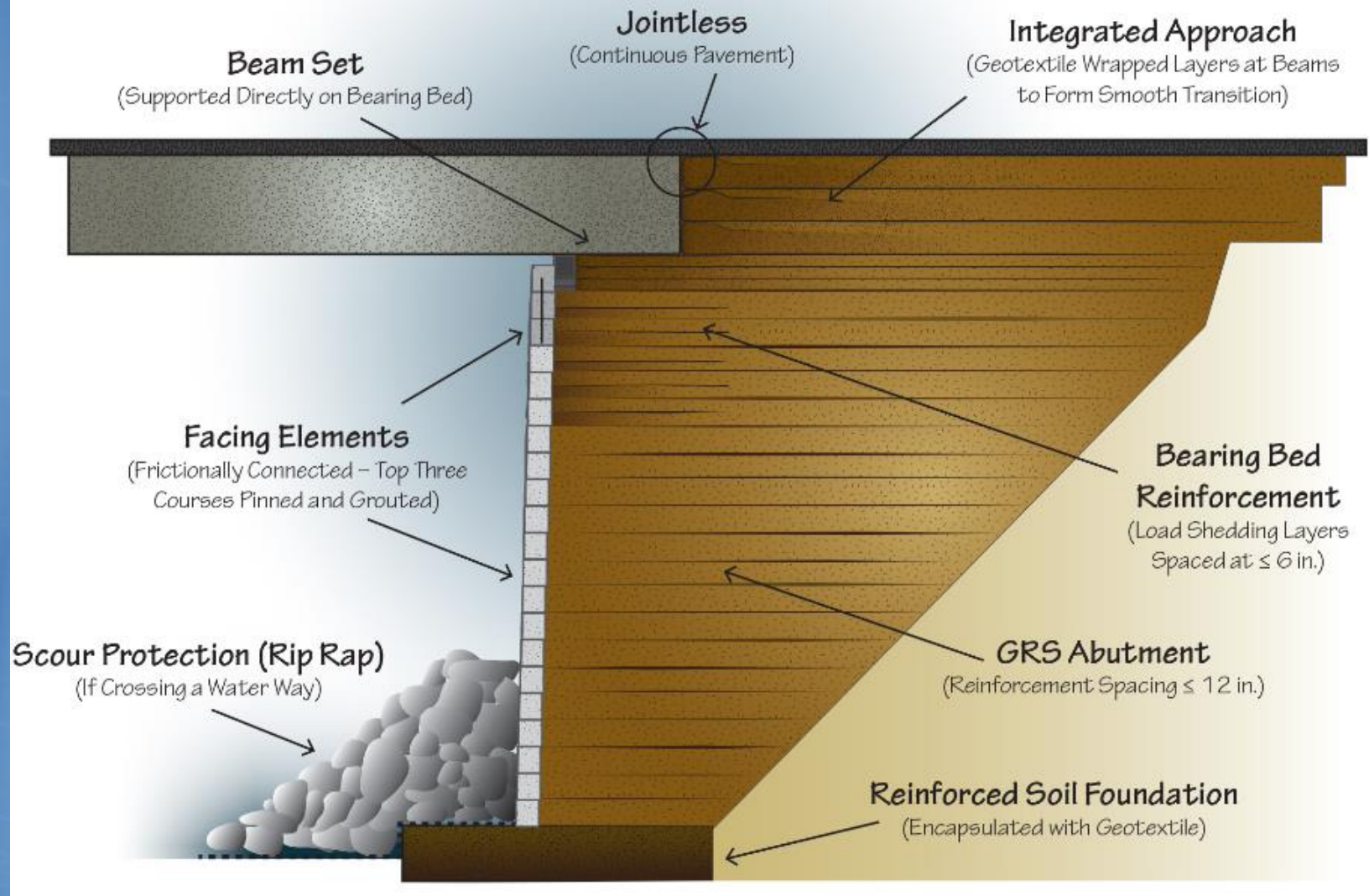
<http://www.fhwa.dot.gov/engineering/hydraulics/>

Under the publications section.



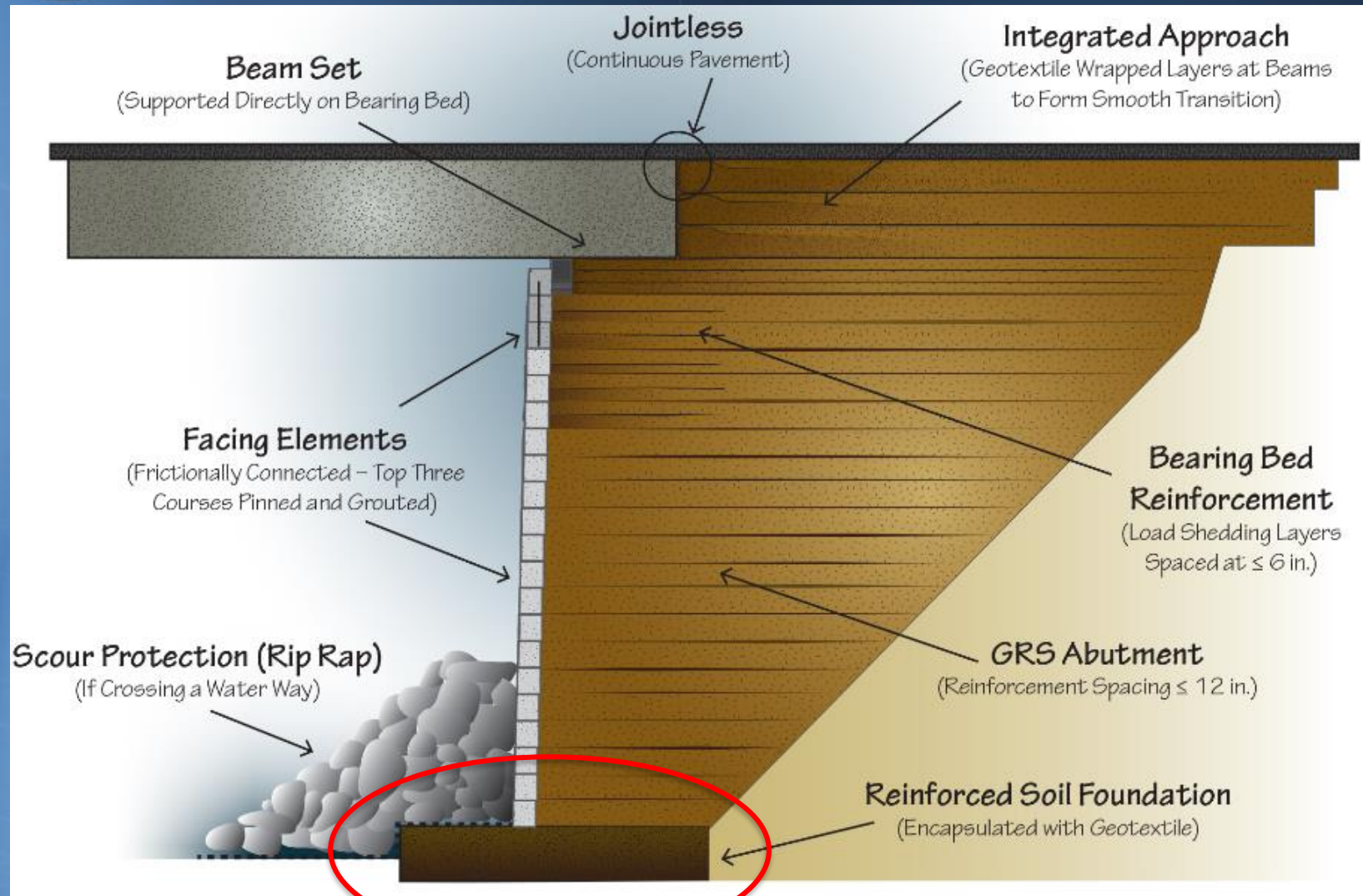


GRS-IBS Cross-Section





Reinforced Soil Foundation (RSF)





REINFORCED SOIL FOUNDATION



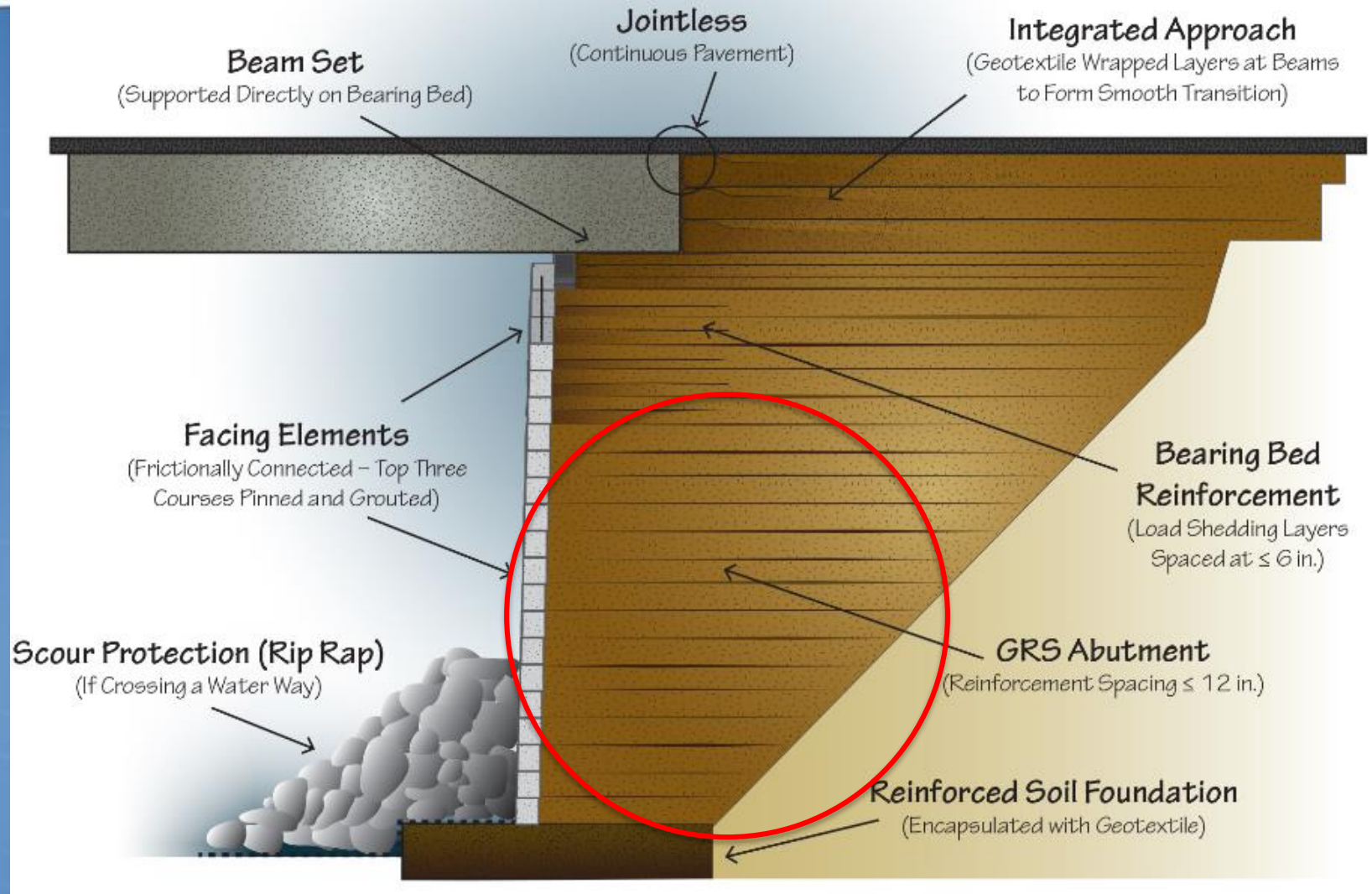
1. Excavate foundation level base and fill voids.
2. Place reinforcement with 3 ft for overlap on both wings and face.



3. Reinforcement @ 1.5-ft lifts, compact every 6 in.
4. Encapsulate fill by wrapping with reinforcement.



PRIMARY GRS ABUTMENT





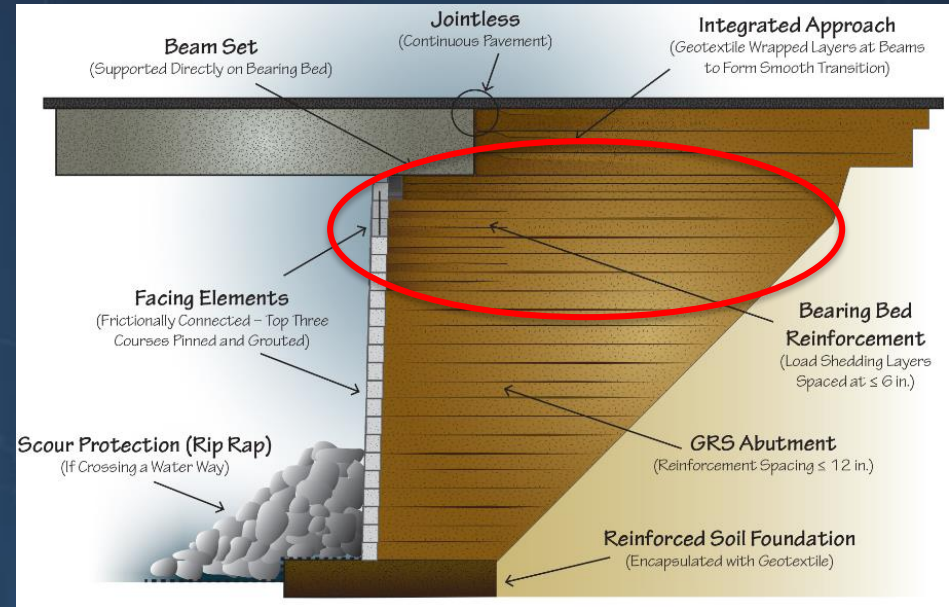
PRIMARY GRS ABUTMENT



1. Place reinforcement, CMU blocks, fill and compact
2. Construct each layer entirely before beginning next layer.
3. Place blocks tightly against each other to prevent gaps
4. Offset blocks in consecutive rows.
5. Check vertical and horizontal alignment every other layer, and correct any deviations



BEARING BED REINFORCEMENT



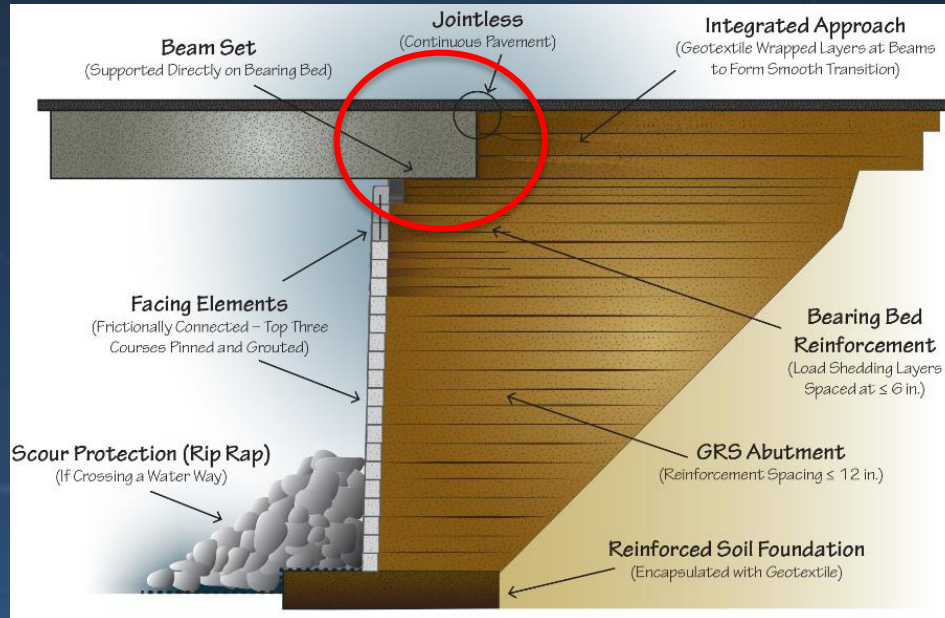
1. Place bearing bed reinforcement every 4 inches, fill, compact

2. Extend the layers to full width of excavation.





BRIDGE SEAT

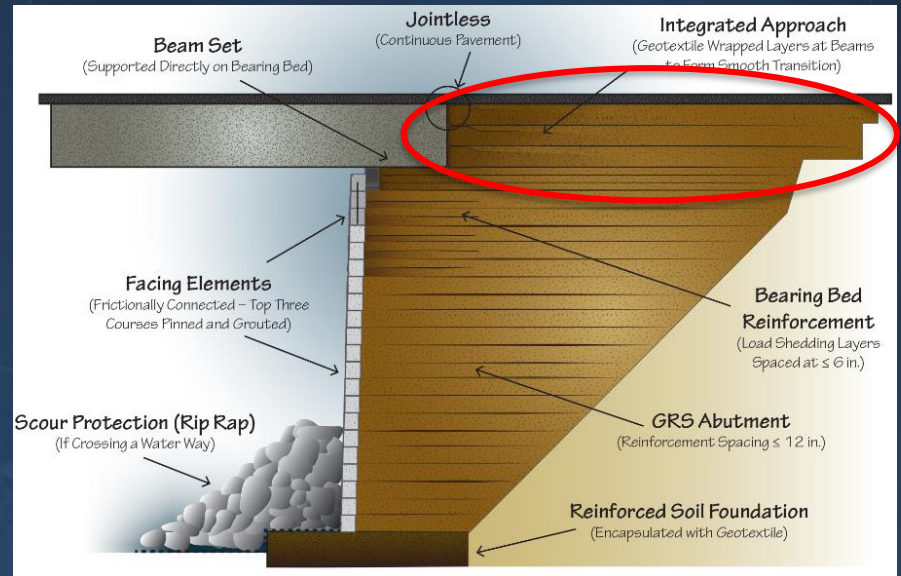


1. Two inch thick foam board with a 4" x 8" block on top of the last reinforcement layer.
2. Fill behind it and compact.
3. Place bridge beams on GRS abutment.





Integrated Approaches



1. Reinforcement every 12 inches
2. Extend the layers to full width of excavation.
3. Extend the reinforced fill to a minimum of 8 ft from the bridge beams.



Facing Types

Durability & Aesthetics





Design Spread Sheet

1	LRFD			
2				Inputs
3	PERFORMANCE CRITERIA			
4	Tolerable Vertical Strain	$E_{v, \text{tol}}$	0.5 %	
5	Tolerable Lateral Strain	$E_{h, \text{tol}}$	1 %	
6				
7	LAYOUT			
8	Span Length	L_{span}	78 ft	
9	Wall Height	H	15.25 ft	
10	Width of wall facing	b_{block}	0.64 ft	
11	Length of Individual Wall Facing Element	L_{block}	1.30 ft	
12	Height of Individual Wall Facing Element	H_{block}	0.64 ft	
13	Weight of Individual Facing Element	W_{block}	44 lb	
14	Number of Facing Elements in a Single Column	N_{block}	24	
15				
16	Base Width of Wall (including wall facing)	B_{tot}	6 ft	
17	Base Width of Wall (not including wall facing)	B	5.36 ft	
18	Check Base to Height Ratio ≥ 0.3	B/H	0.35 OK	
19				
20	Set Back (Section 4.3.4, FHWA-HRT-11-026)	a_0	12 in	
21	Clear Space (Section 4.3.4, FHWA-HRT-11-026)	d_e	4 in	
22				
23	Minimum Base Width of Reinforced Soil Foundation (Section 4.3.4, FHWA-HRT-11-026)	B_{RSF}	7.50 ft	
24	Minimum Depth of Reinforced Soil Foundation (Section 4.3.4, FHWA-HRT-11-026)	D_{RSF}	1.5 ft	
25	Minimum Distance of RSF in front of Abutment (Section 4.3.4, FHWA-HRT-11-026)	X_{RSF}	1.50 ft	
26				
27	Reinforcement Spacing	S_v	8 in	
28	Number of Reinforcement Layers	N_{SV}	23	
29	Secondary Reinforcement Spacing	$S_{v,2}$	6 in	
30				
31	SOIL AND REINFORCEMENT CONDITIONS			
32	Retained Soil Unit Weight	γ_0	125 lb/ft ³	
33	Retained Soil Undrained Shear Strength	c_0	500 lb/ft ²	
34	Retained Soil Effective Cohesion	c'_0	500 lb/ft ²	
35	Retained Soil Friction Angle	ϕ_0	28 deg	
36	Active Earth Pressure Coefficient - Backfill	K_{a0}	0.36	
37				
38	Reinforced Fill Unit Weight	γ_r	110 lb/ft ³	
39	Maximum Diameter of Reinforced Fill	d_{max}	0.5 in	
40	Reinforced Fill Cohesion	c_r	0 lb/ft ²	
41	Reinforced Fill Friction Angle	ϕ_r	48 deg	
42	Active Earth Pressure Coefficient - Reinforced Fill	K_{aR}	0.15	

1	ASD			
2				Inputs
3	PERFORMANCE CRITERIA			
4	Tolerable Vertical Strain	$E_{v, \text{tol}}$	0.5 %	
5	Tolerable Lateral Strain	$E_{h, \text{tol}}$	1 %	
6				
7	LAYOUT			
8	Span Length	L_{span}	78 ft	
9	Wall Height	H	15.25 ft	
10	Width of Wall Facing Element	b_{block}	0.64 ft	
11	Length of Individual Wall Facing Element	L_{block}	1.30 ft	
12	Height of Individual Wall Facing Element	H_{block}	0.64 ft	
13	Weight of Individual Facing Element	W_{block}	44 lb	
14	Number of Facing Elements in a Single Column	N_{block}	24	
15				
16	Base Width of Wall (including wall facing)	B_{total}	6 ft	
17	Base Width of Wall (not including wall facing)	B	5.36 ft	
18	Check Base to Height Ratio ≥ 0.3	B/H	0.35 OK	
19				
20	Set Back (Section 4.3.4, FHWA-HRT-11-026)	a_0	12 in	
21	Clear Space (Section 4.3.4, FHWA-HRT-11-026)	d_e	4 in	
22				
23	Minimum Base Width of Reinforced Soil Foundation (Section 4.3.4, FHWA-HRT-11-026)	B_{RSF}	7.50 ft	
24	Minimum Depth of Reinforced Soil Foundation (Section 4.3.4, FHWA-HRT-11-026)	D_{RSF}	1.5 ft	
25	Minimum Distance of RSF in front of Abutment (Section 4.3.4, FHWA-HRT-11-026)	X_{RSF}	1.50 ft	
26				
27	Reinforcement Spacing	S_v	7.625 in	
28	Number of Reinforcement Layers	N_{SV}	24	
29	Secondary Reinforcement Spacing	$S_{v,2}$	3.8125 in	
30				
31	SOIL AND REINFORCEMENT CONDITIONS			
32	Retained Soil Unit Weight	γ_0	125 lb/ft ³	
33	Retained Soil Undrained Shear Strength	c_0	500 lb/ft ²	
34	Retained Soil Effective Cohesion	c'_0	0 lb/ft ²	
35	Retained Soil Friction Angle	ϕ_0	28 deg	
36	Active Earth Pressure Coefficient - Backfill	K_{a0}	0.36	
37				
38	Reinforced Fill Unit Weight	γ_r	110 lb/ft ³	
39	Maximum Diameter of Reinforced Fill	d_{max}	0.5 in	
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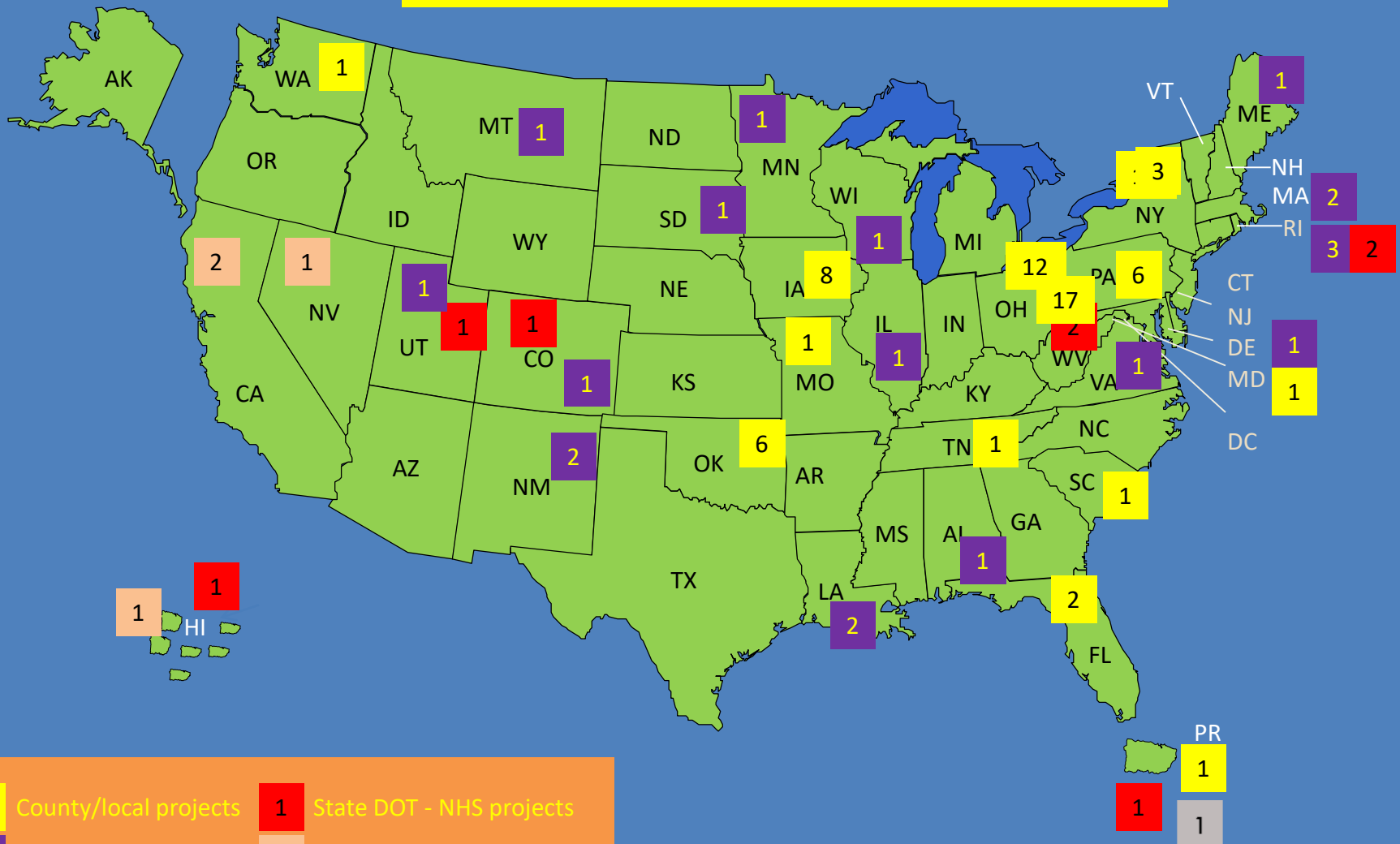
Prior to EDC Initiative

GRS IBS Projects

October 2010 thru September 2012

Bridges on the NHS – 8 bridges in 6 states

Bridges not on the NHS - 75 bridges in 30 states and FLD



1 County/local projects
1 State DOT projects
1 State DOT - NHS projects
1 Federal Land Projects



PR, PR 2 Yauco





Training and Technical Assistance

- Training as needed
- Peer exchanges
- Demonstration showcases
- Technical assistance for design and construction
- Support of state and local agencies
- Instrumentation and monitoring of new structures
- Development of references and design aids



YouTube Construction Video

The video player shows a blue background with the title 'Geosynthetic Reinforced Soil' in large white and blue text, followed by 'Integrated Bridge System' in smaller blue text. A circular logo with 'Every Day Counts' and the words 'innovation', 'ingenuity', 'invention', and 'imagination' is on the left. Below it is the 'HIGHWAYS FOR LIFE' logo with the tagline 'Accelerating Innovation for the American Driving Experience'. On the right is the U.S. Department of Transportation Federal Highway Administration logo. The video progress bar shows 00:06 / 19:54. Below the video, the title 'Geosynthetic Reinforced Soil-Integrated Bridge System (GRS-IBS)' is displayed. The channel name 'USDOTFHWA' is shown with a subscriber count of 128 videos. A red 'Subscribe' button is visible with a count of 341. The video has 12,713 views, 11 likes, and 0 dislikes.

Geosynthetic Reinforced Soil
Integrated Bridge System

Every Day Counts
innovation ingenuity invention imagination

HIGHWAYS FOR LIFE
Accelerating Innovation for the American Driving Experience

U.S. Department of Transportation
Federal Highway Administration

00:06 / 19:54

Geosynthetic Reinforced Soil-Integrated Bridge System (GRS-IBS)

USDOTFHWA · 128 videos

Subscribe 341

12,713

11 0



Upcoming Showcase: Sept 11, 2018 Missoula, MT

WHEN: September 11, 2018

TIME: 8:30 AM to 4:00 PM

SHOWCASE LOCATION:
USDA Forest Service (USDA FS)
Missoula Technology and
Development Training Center
5785 Hwy 10 W
Missoula, Montana 59808

Why use FSPG™ for simple span bridges?

- ✓ Simpler to build
- ✓ Cost savings
- ✓ Cuts construction time
- ✓ Easier to maintain
- ✓ Longer service life
- ✓ Lowers environmental impact

Why Attend:

Folded Steel Plate Girder (FSPG)™ Innovation Showcase

The Confederated Salish and Kootenai Tribes (CSKT) and the Federal Highway Administration (FHWA) invite you to attend this free FSPG™ Showcase.

The CSKT are replacing the North Valley Creek Bridge with a FSPG™ Geosynthetic Reinforced Soil - Integrated Bridge System (GRS-IBS).

By prefabricating the FSPG™ superstructure offsite, the onsite assembly time is shortened for the replacement of the bridge.

This Showcase is geared for practitioners including tribal, state, local and federal employees, academia, consultants, contractors and manufacturers.

AGENDA

Park at the USDA FS and catch the 8:30 AM bus

Travel to the bridge site: 36 miles north

Observe the FSPG™ Installation

Return and Lunch

Afternoon classroom session speakers

Roger Surdahl, FHWA, GRS-IBS

Mike Jensen, DJ&A, Designing Innovation

Bob Elliott, CDR Bridges, FSPG™ Technology

<https://www.eventbrite.com/o/federal-highway-administration-centerfor-local-aid-support-14578522274>