U.S. Department
of Transportation

Federal Highway
Administration

CRASH COURSE
GRS-IBS BRIDGES

EDC Web Site

www.fhwa.dot.gov/innovation/everydaycounts/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

Webinars/Videos

EDC Exchange *(02/12)*

EDC Exchange *(09/15)*

Construction Video

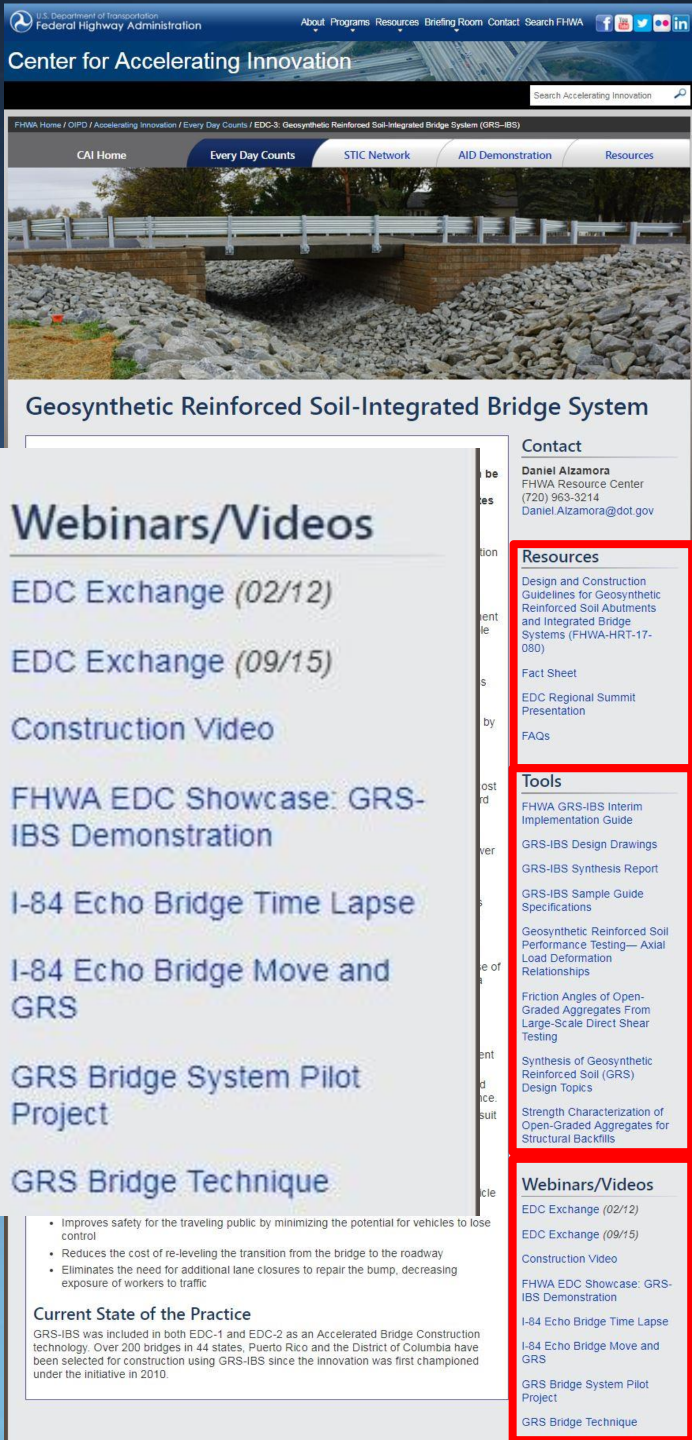
FHWA EDC Showcase: GRS-IBS Demonstration

I-84 Echo Bridge Time Lapse

I-84 Echo Bridge Move and GRS

GRS Bridge System Pilot Project

GRS Bridge Technique



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

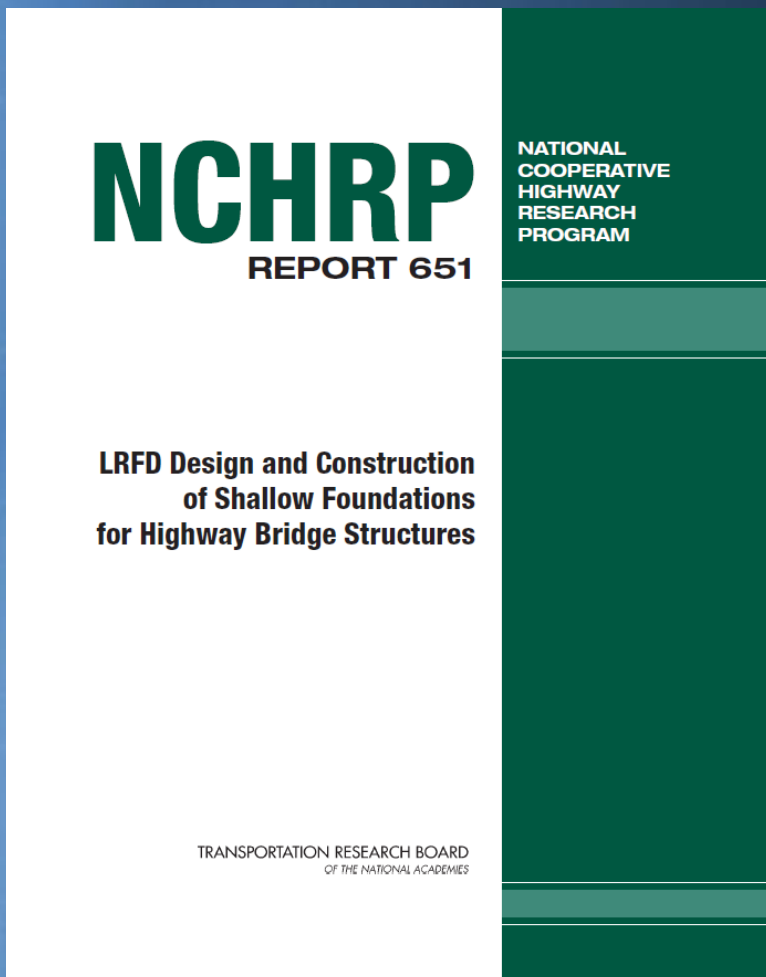
Easy field modifications for unforeseen conditions

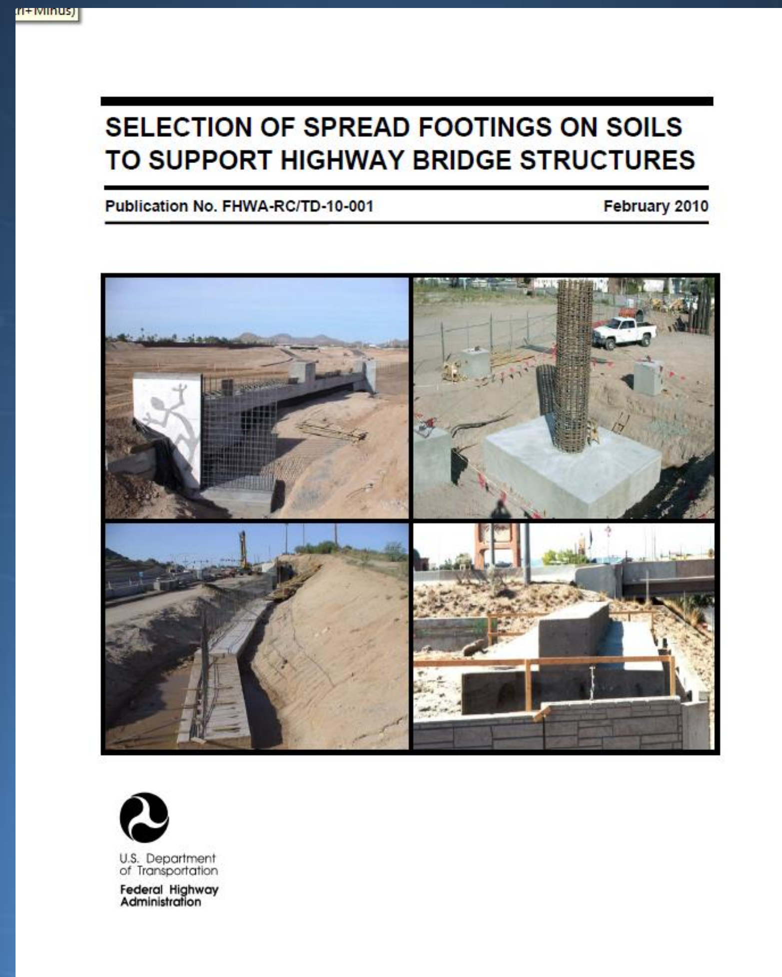
Easier to Maintain- Fewer bridge parts

No Specialized labor needed

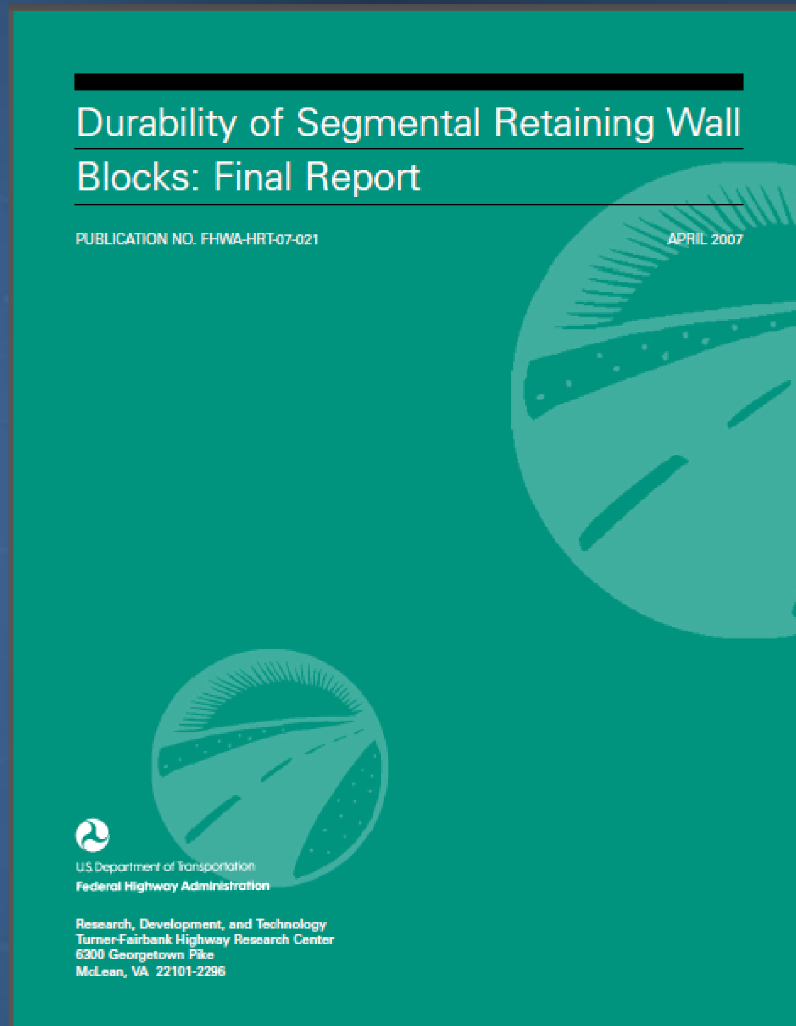
Basic Equipment: Excavators, hand tools and compactors

Shallow Foundations





Facing Durability & Aesthetics



Durability of Segmental Retaining Wall Blocks: Final Report

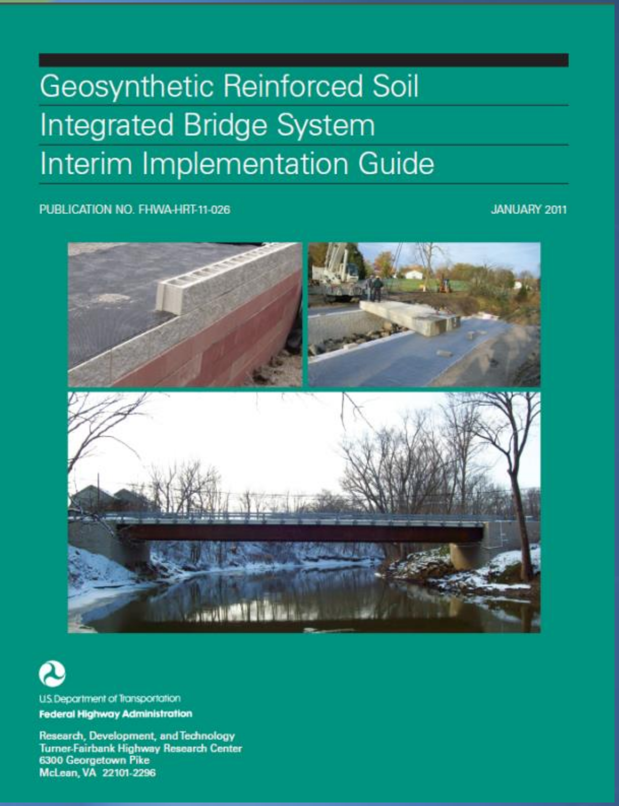
PUBLICATION NO. FHWA-HRT-07-021

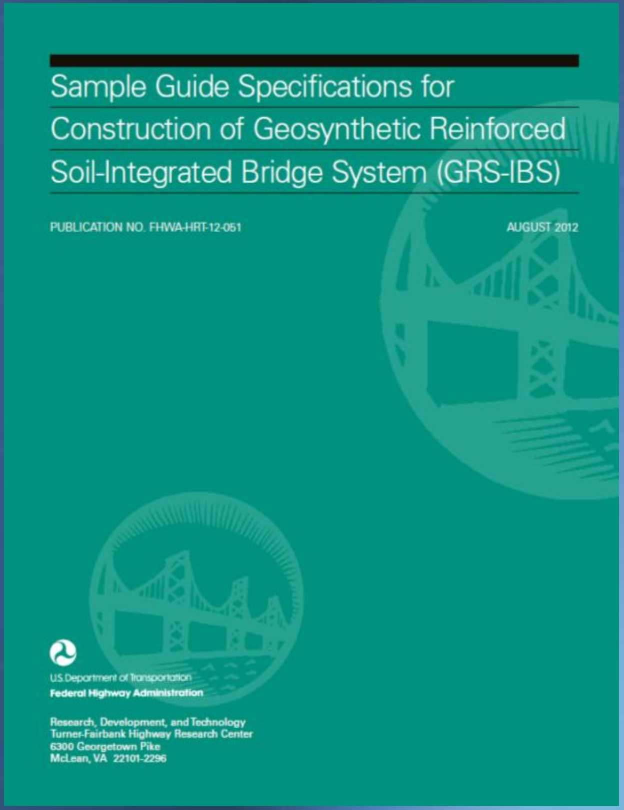
APRIL 2007

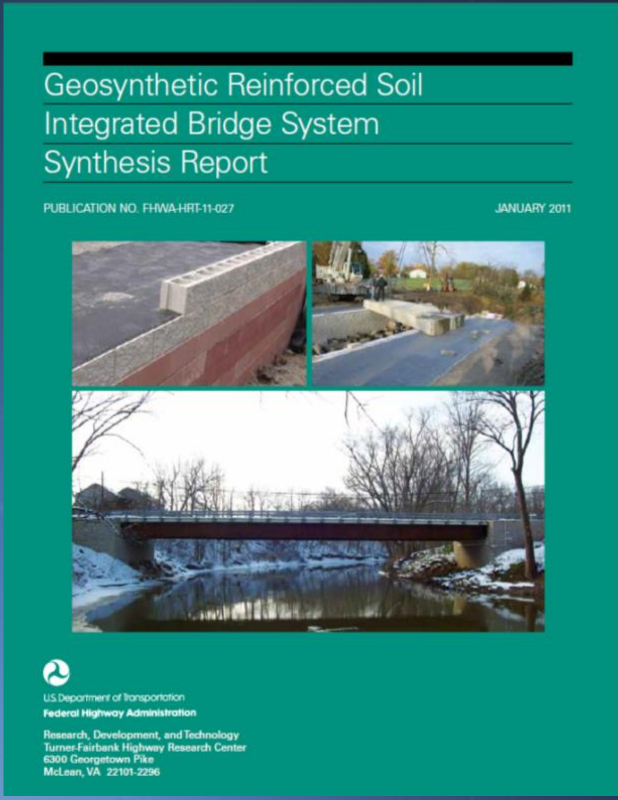
U.S. Department of Transportation
Federal Highway Administration

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

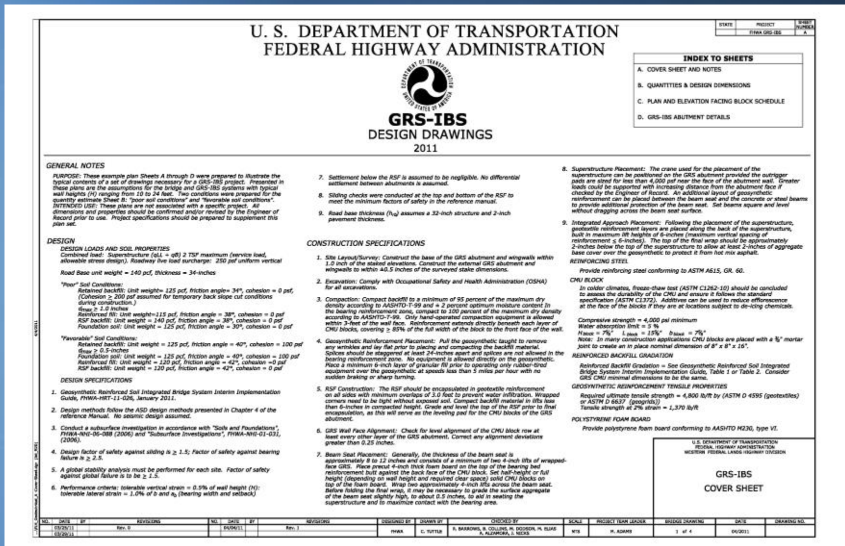
GRS Design and Construction Guidance

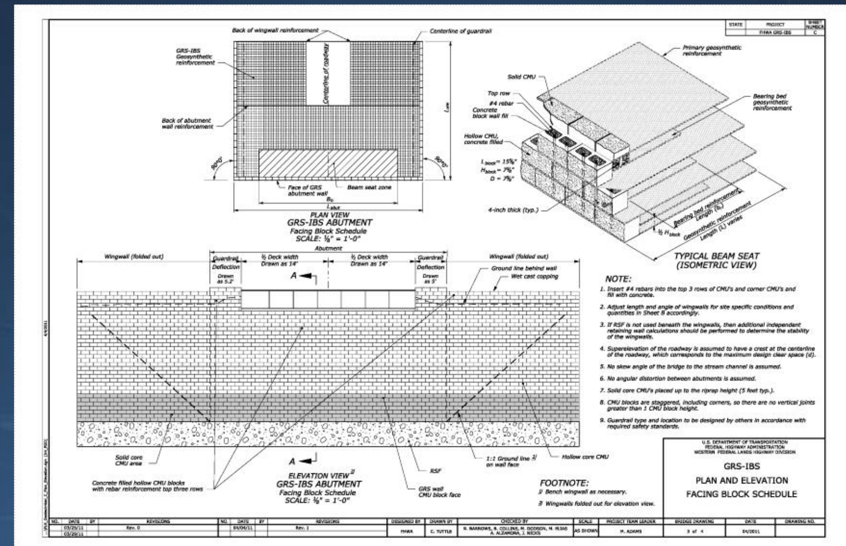


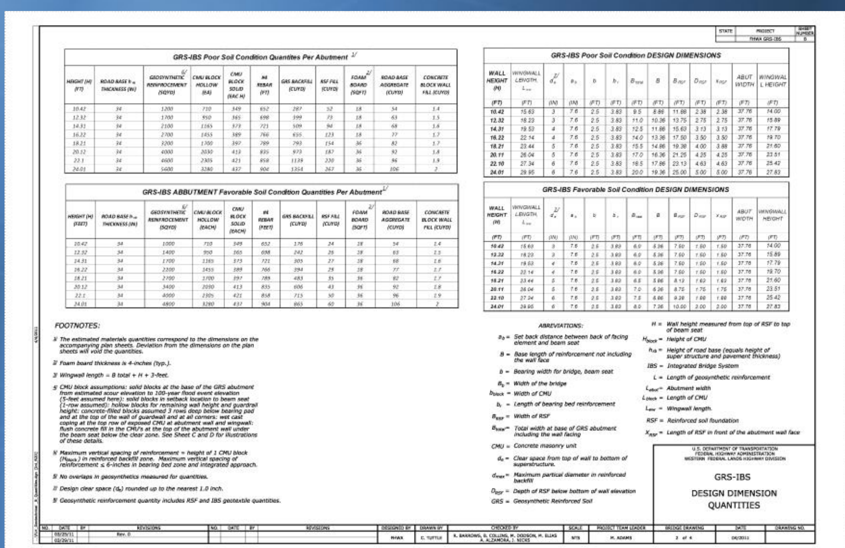


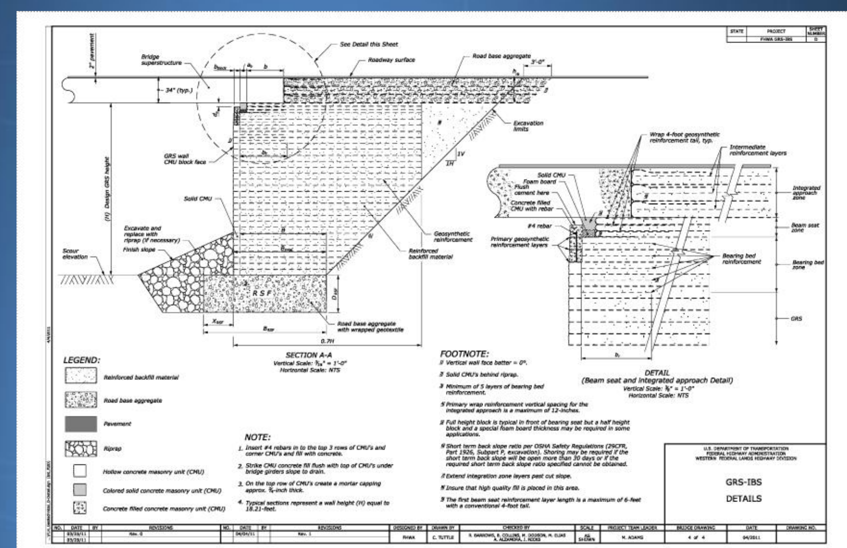


Standard Plans









Performance Test Report

FHWA-HRT-13-066

Geosynthetic Reinforced Soil Performance Testing— Axial Load Deformation Relationships

PUBLICATION NO. FHWA-HRT-13-066 AUGUST 2013

U.S. Department of Transportation
Federal Highway Administration

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

TECHBRIEF: FHWA-HRT-13-068
Friction Angles of Open-Graded Aggregates

TECHBRIEF

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

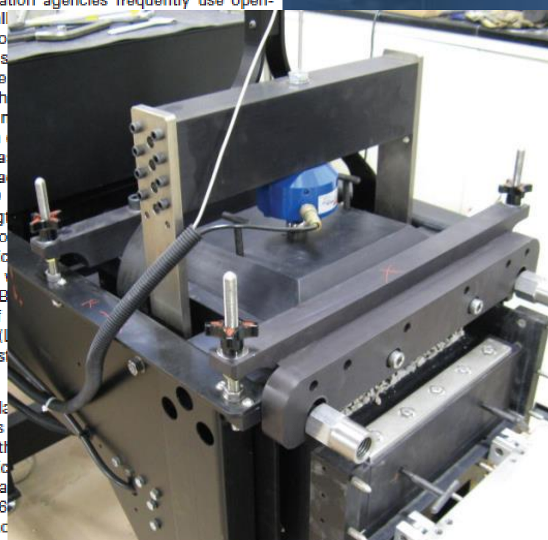
FHWA Publication No.: FHWA-HRT-13-068
FHWA Contact: Jennifer Nicks, HRDI-40, (202) 493-3075, jennifer.nicks@dot.gov

Introduction

State and local transportation agencies frequently use open-graded aggregates for wall
The primary advantages o
and abutment applications
in-place density than we
content, free-draining ch
assurance testing, using a r
The American Association
Officials (AASHTO) cla
according to the M43 gra
processed aggregates.[1]
aggregates, their streng
systematically measured o
frequently use a default fric
conservatism in retaining
mary purpose of this TechB
the strength properties of
a large-scale direct shear (
practice for the design of s

Background

The most commonly used la
the strength of aggregates
(TX) tests, with DS being t
test. Based on the Americ
(ASTM) standards, the ma
testing are 1/10th and 1/6
device, respectively. Stand
circular, with a 2.5-inch dia
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.



U.S. Department of Transportation
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www.fhwa.dot.gov/research

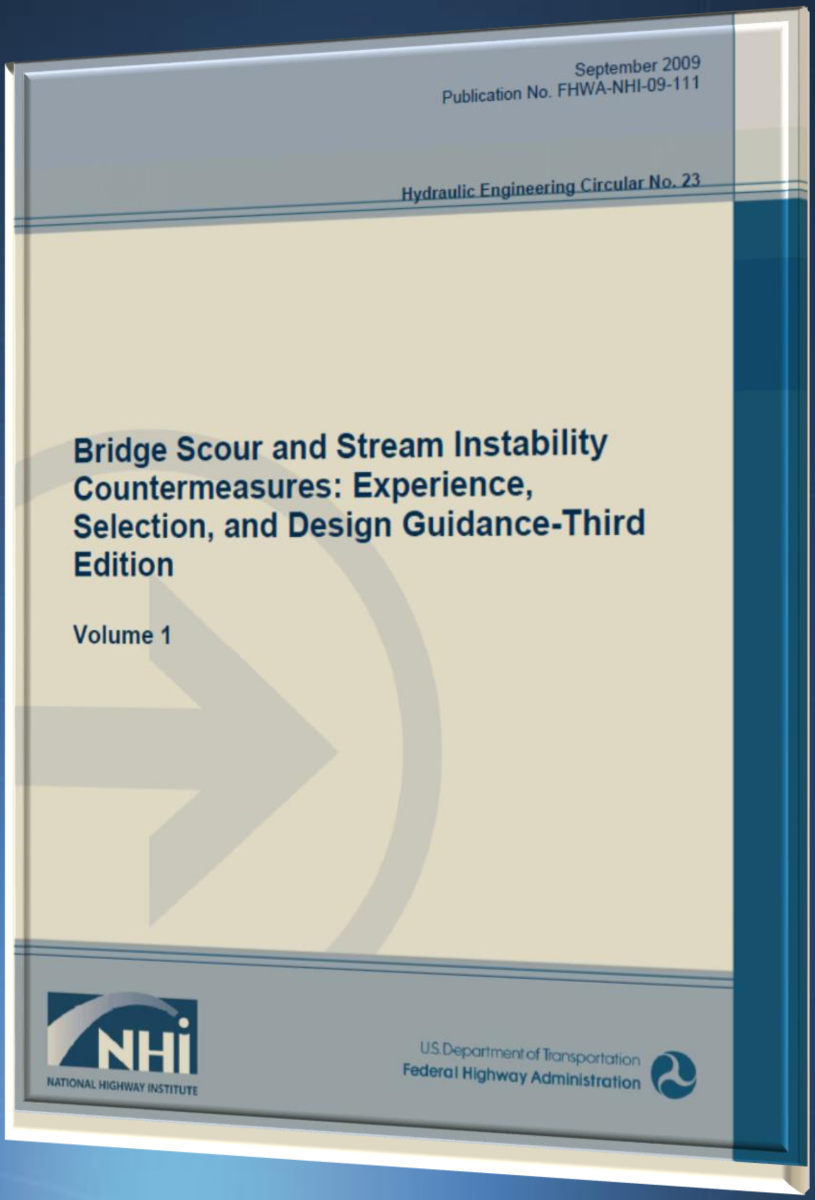
Table 2. Friction angle results using the linear MC envelope and ZDA approaches.

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	49	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

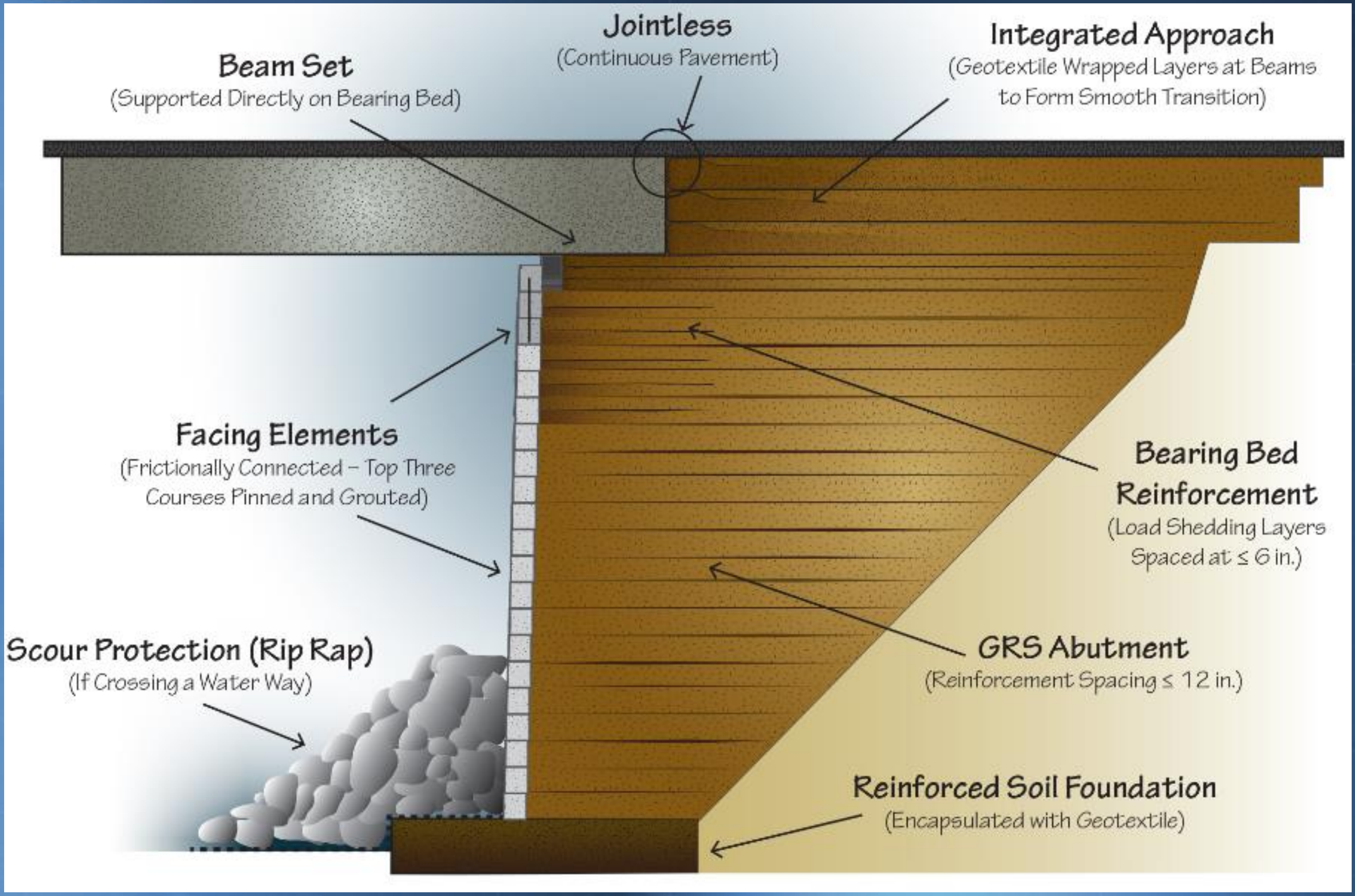
Hydraulic Engineering Guidelines

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

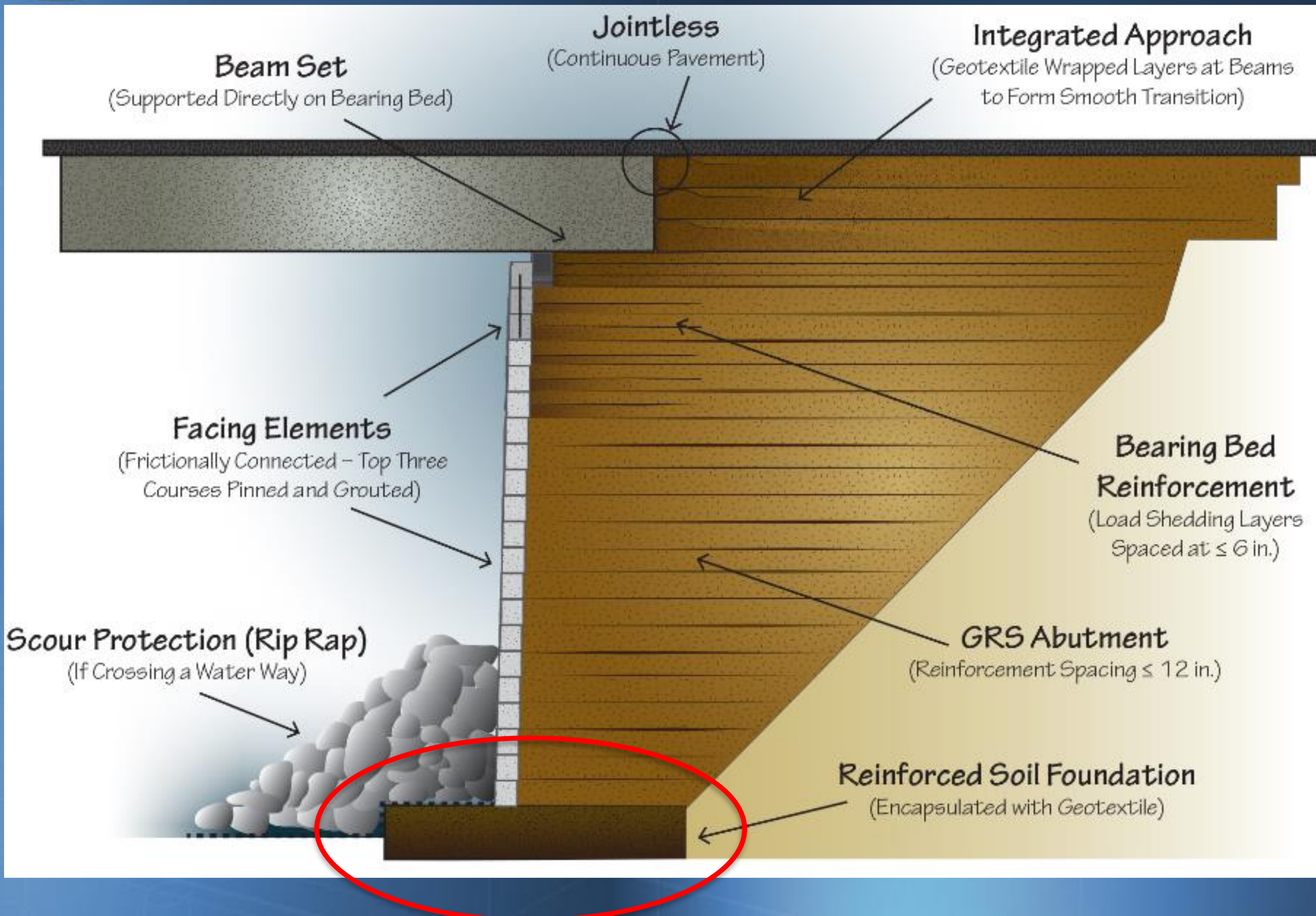
PDF version can be downloaded from the FHWA Hydraulics Web Page:
http://www.fhwa.dot.gov/engineering/hydraulics/
Under the publications section.



GRS-IBS Cross-Section



Reinforced Soil Foundation (RSF)



REINFORCED SOIL FOUNDATION

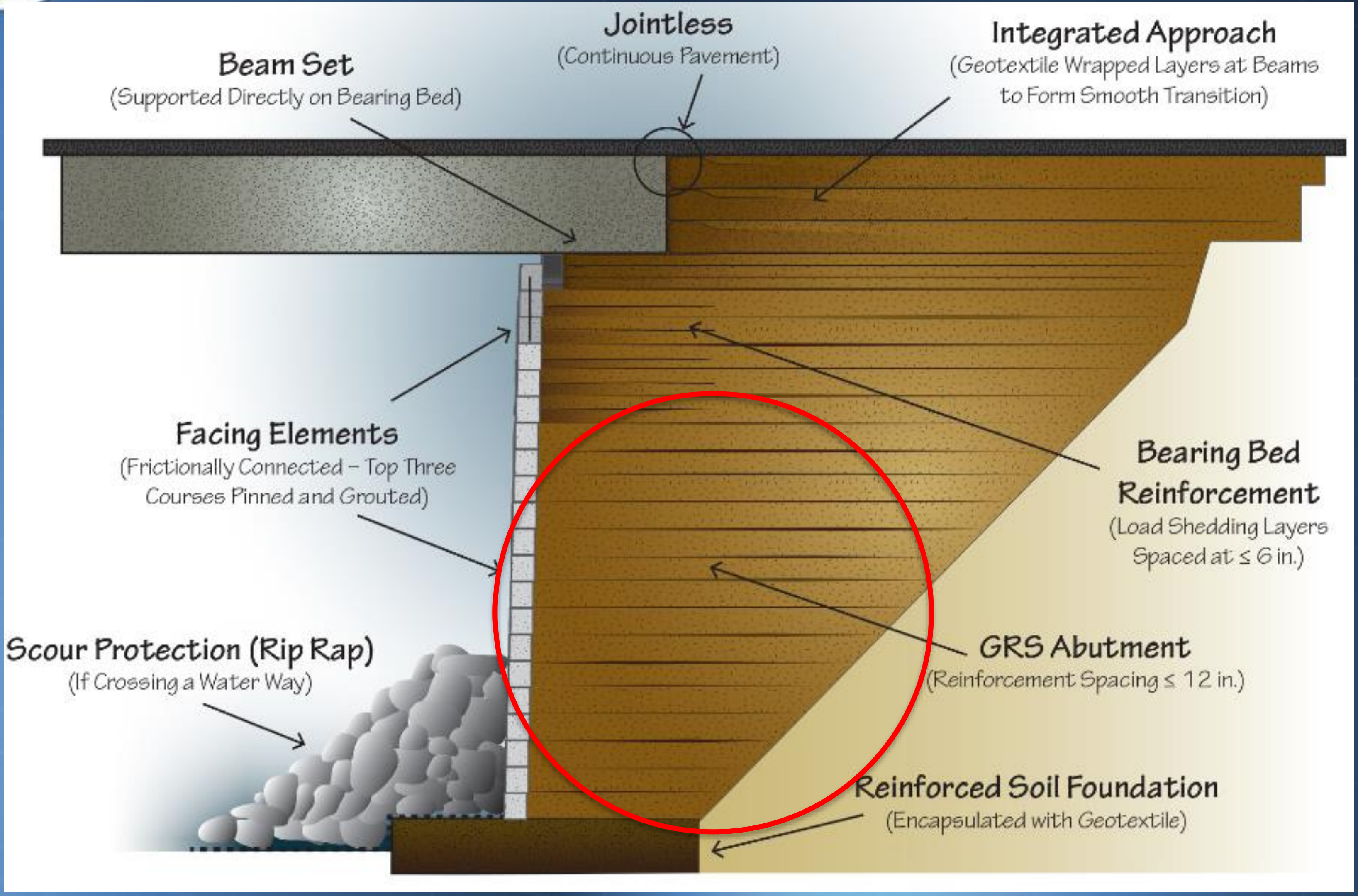
1. Excavate foundation level base and fill voids.

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.

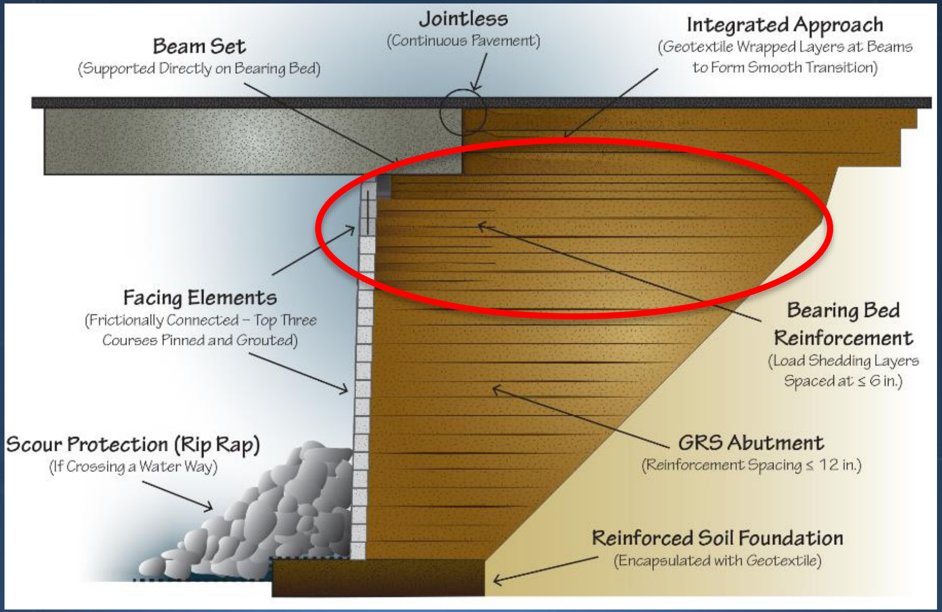
PRIMARY GRS ABUTMENT



PRIMARY GRS ABUTMENT

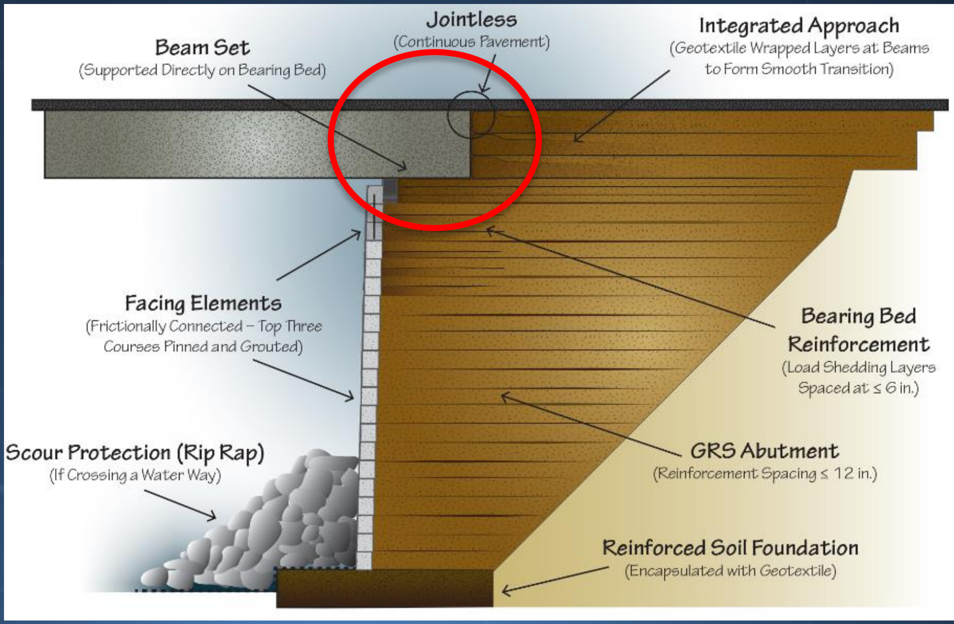
1. Place reinforcement, CMU blocks, fill and compact
2. Construct each layer entirely before beginning next layer.
3. Place blocks tightly against each other to prevent gaps
4. Offset blocks in consecutive rows.
5. Check vertical and horizontal alignment every other layer, and correct any deviations

BEARING BED REINFORCEMENT



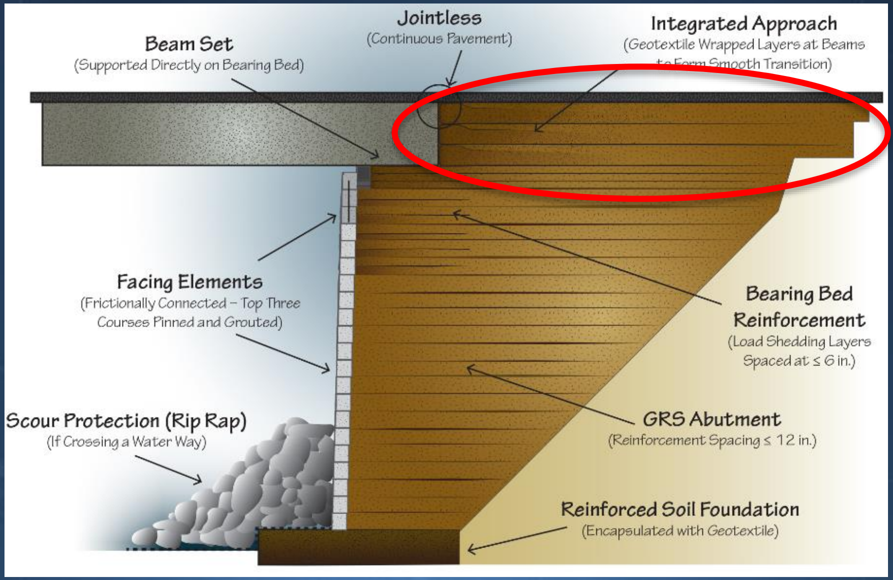
1. Place bearing bed reinforcement every 4 inches, fill, compact
2. Extend the layers to full width of excavation.

BRIDGE SEAT



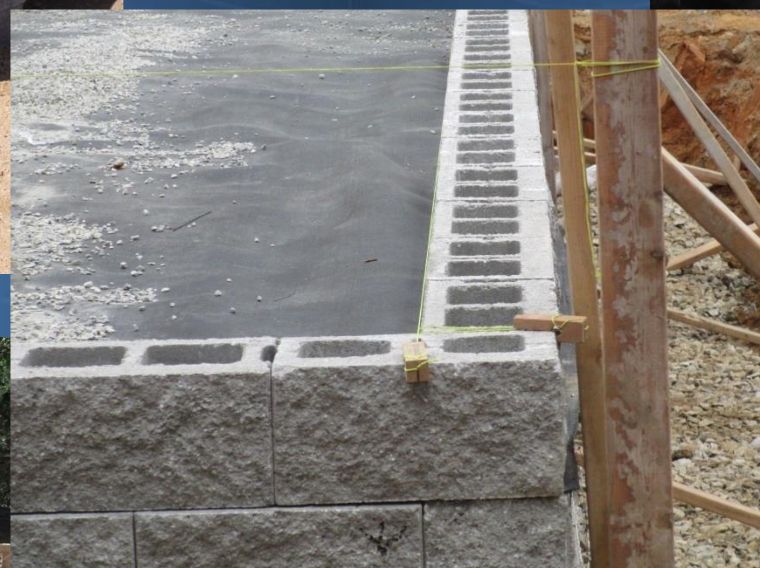
1. Two inch thick foam board with a 4” x 8” block on top of the last reinforcement layer.
2. Fill behind it and compact.
3. Place bridge beams on GRS abutment.

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	$\varepsilon_{v,tol}$	0.5	%
5	Tolerable Lateral Strain	$\varepsilon_{h,tol}$	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_{wf}	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_b	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	$S_{v,s}$	6	in
30				
31	**SOIL AND REINFORCEMENT CONDITIONS**			
32	Retained Soil Unit Weight	γ_b	125	lb/ft^3
33	Retained Soil Undrained Shear Strength	c_b	500	lb/ft^2
34	Retained Soil Effective Cohesion	c'_b	500	lb/ft^2
35	Retained Soil Friction Angle	ϕ_b	28	deg
36	Active Earth Pressure Coefficient - Backfill	K_{ab}	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	

Disclaimer | ASD | Required Reinf Strength - ASD | **LRFD** | Required Reinf Strength - LRFD

1	**ASD**			
2				**Input**
3	**PERFORMANCE CRITERIA**			
4	Tolerable Vertical Strain	$\varepsilon_{v,tol}$	0.5	%
5	Tolerable Lateral Strain	$\varepsilon_{h,tol}$	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_b	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	$S_{v,s}$	3.8125	in
30				
31	**SOIL AND REINFORCEMENT CONDITIONS**			
32	Retained Soil Unit Weight	γ_b	125	lb/ft^3
33	Retained Soil Undrained Shear Strength	c_b	500	lb/ft^2
34	Retained Soil Effective Cohesion	c'_b	0	lb/ft^2
35	Retained Soil Friction Angle	ϕ_b	28	deg
36	Active Earth Pressure Coefficient - Backfill	K_{ab}	0.36	
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41	Reinforced Fill Friction Angle	ϕ_r	48	deg
42	Active Earth Pressure Coefficient - Reinforced Fill	K_{ar}	0.15	

Disclaimer | **ASD** | Required Reinf Strength - ASD | LRFD | Required Reinf Strength - LRFD

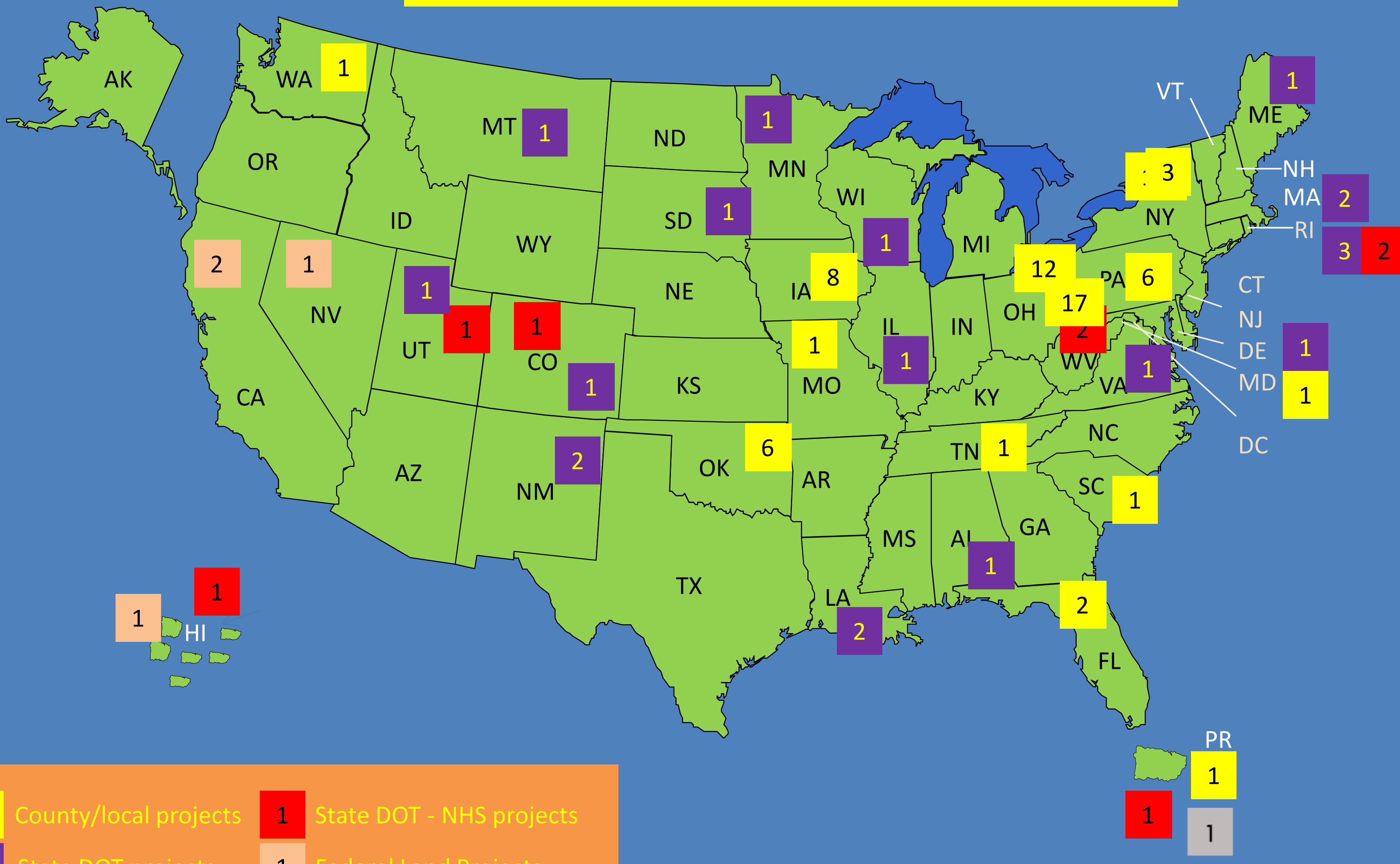
Prior to EDC Initiative

GRS IBS Projects

<u>October 2010 thru September 2012</u>

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 - NHS projects
1 State DOT 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

Upcoming Showcase: Sept 11, 2018 Missoula, MT

Folded Steel Plate Girder (FSPG)™ Innovation Showcase

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:

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