



U.S. Department of Transportation

Federal Highway Administration



Geosynthetic Reinforced Soil Integrated Bridge System (GRS IBS) - Update and Case History

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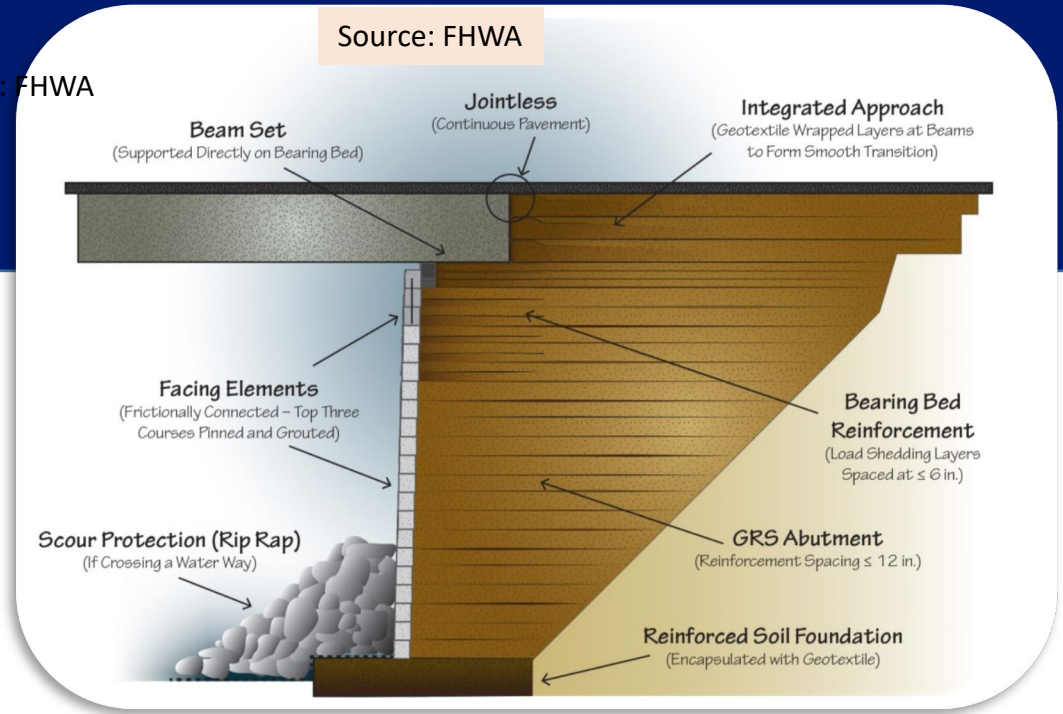
What is GRS IBS?

- Accelerated construction technique
- Utilizes compacted granular fill and geosynthetic reinforcement in alternating layers.



Source: Hamilton County, IN

Source: FHWA



Source: FHWA



Source: Hamilton County, IN



Design Process

- Updated Design and Construction Guidelines
- FHWA-HRT-17-080
- Revised for LRFD

Design and Construction Guidelines for Geosynthetic Reinforced Soil Abutments and Integrated Bridge Systems

PUBLICATION NO. FHWA-HRT-17-080

JUNE 2018



U.S. Department of Transportation
Federal Highway Administration

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



GRS-IBS Long-Term Monitoring Projects

- Tiffin River, OH (2009)
- St. Lawrence County, NY (2013)
- Sheffield, MA (2014)



Source: FHWA

Long-Term Performance Monitoring of GRS Mini-Piers and Mini-Abutments at TFHRC

- Secondary settlement
- Open- vs. well-graded backfill
- Reinforcement strength
- Thermal interaction



- Secondary settlement
- Plane strain conditions (L/b)
- Shape effect
- Lateral pressure distributions

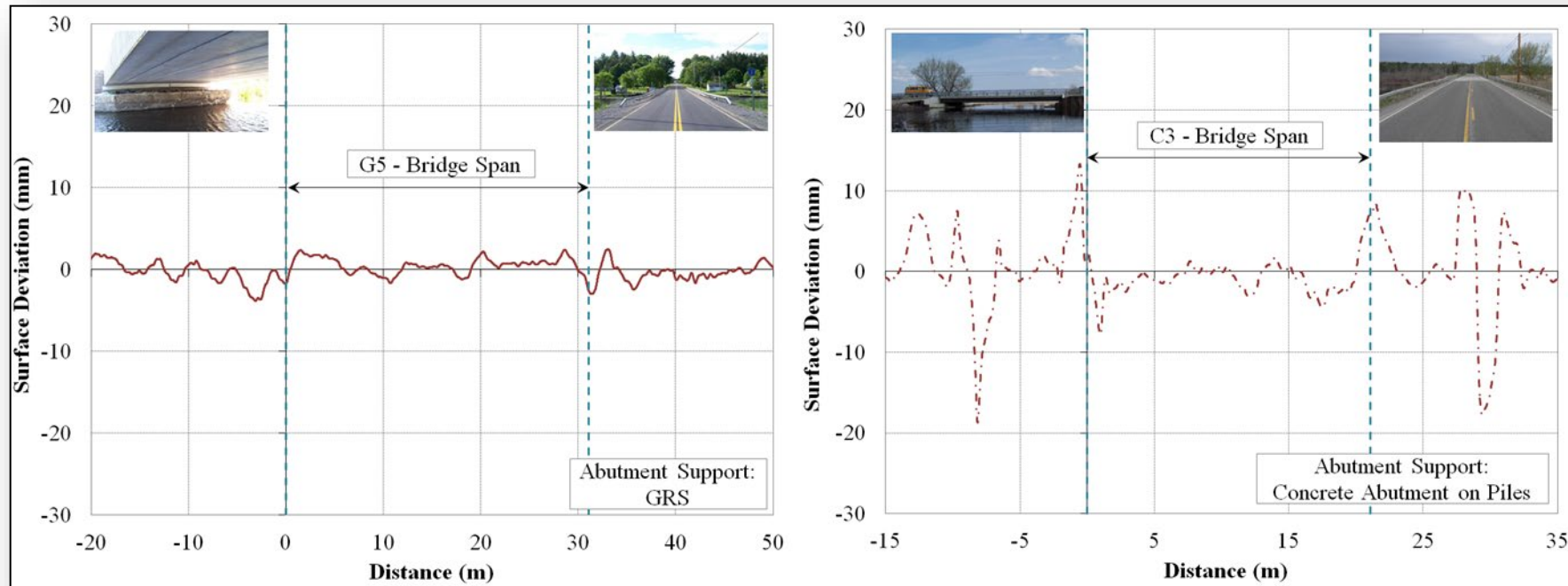


Source: FHWA



Bridge Approach Profiles

Comparison between GRS and conventional abutment



Source: FHWA



PR 2 (2013) - January 2020 Earthquake

Source: Imagery © 2023 CNES/Airbus, Maxar Technologies, US Geologic Survey, Map Data © 2023



Source: Google Street View (May 2016)



PR 2 (2013) - January 2020 Earthquake



Source: PRHTA



January 2020 Earthquake

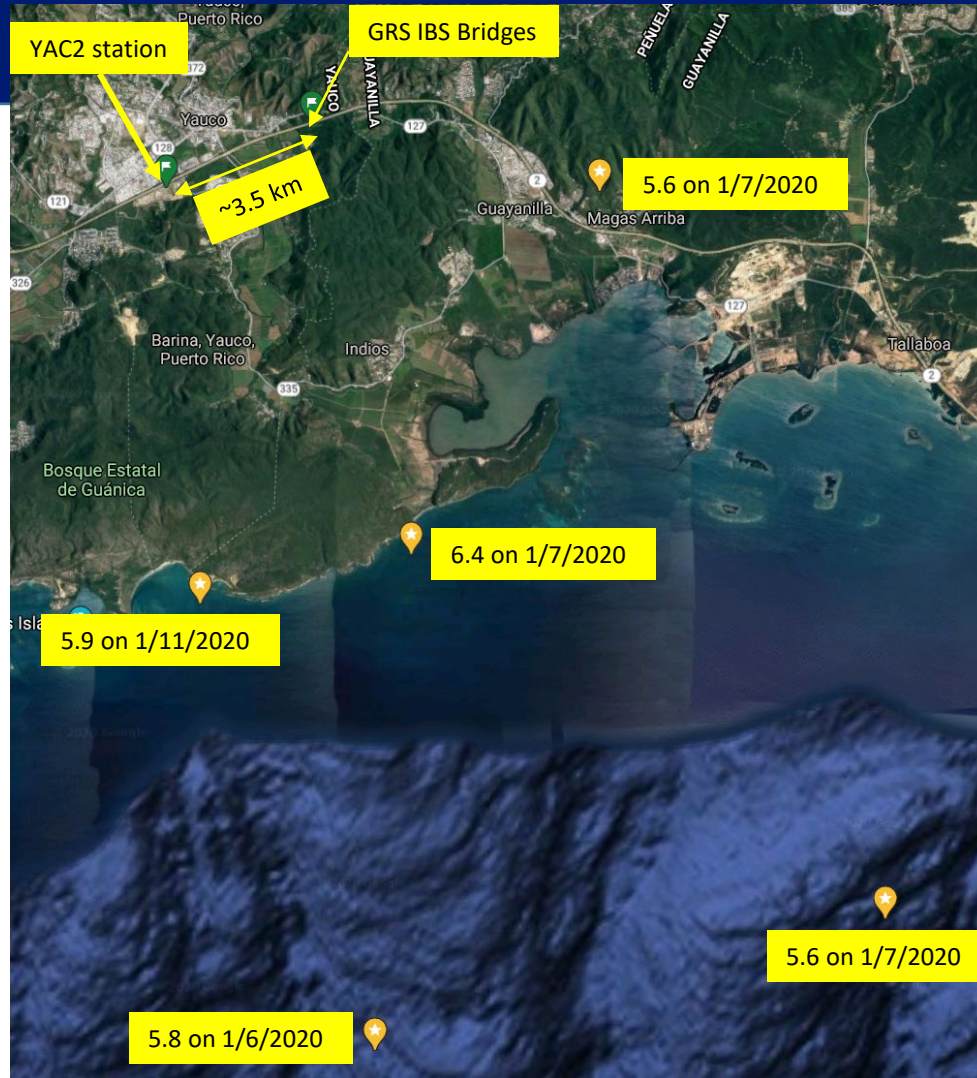


Table 1: Summary of events greater than M 4.5 in the seismic sequence

Magnitude	Date (m/d/y)	Lat (N)	Lon (W)	Depth (km)
4.7	12/28/2019	17.9371	66.8661	6
4.7	1/3/2020	17.9006	66.8261	2
4.9	1/6/2020	17.9075	66.799	6
5.8	1/6/2020	17.8675	66.8193	6
4.6	1/7/2020	17.9645	66.8256	8
4.7	1/7/2020	17.9315	66.927	8
5.6	1/7/2020	18.0223	66.776	9
4.7	1/7/2020	17.9128	66.6898	10
5	1/7/2020	17.9418	66.6754	10
5.6	1/7/2020	17.8919	66.7217	10
4.6	1/7/2020	17.9206	66.767	10
5	1/7/2020	17.8685	66.7029	10
6.4	1/7/2020	17.9578	66.8113	6
4.7	1/8/2020	17.915	66.7035	6
5.2	1/10/2020	17.935	66.883	9
4.6	1/11/2020	17.9423	66.8395	8
5.2	1/11/2020	17.8238	66.7941	10
5.9	1/11/2020	17.949	66.8508	5
4.8	1/11/2020	17.9923	66.7946	4

Data from the Puerto Rico seismic network and USGS

Source: GEER Report





Geotechnical Reconnaissance of the January 7, 2020 M6.4 Southwest Puerto Rico Earthquake and Associated Seismic Sequence

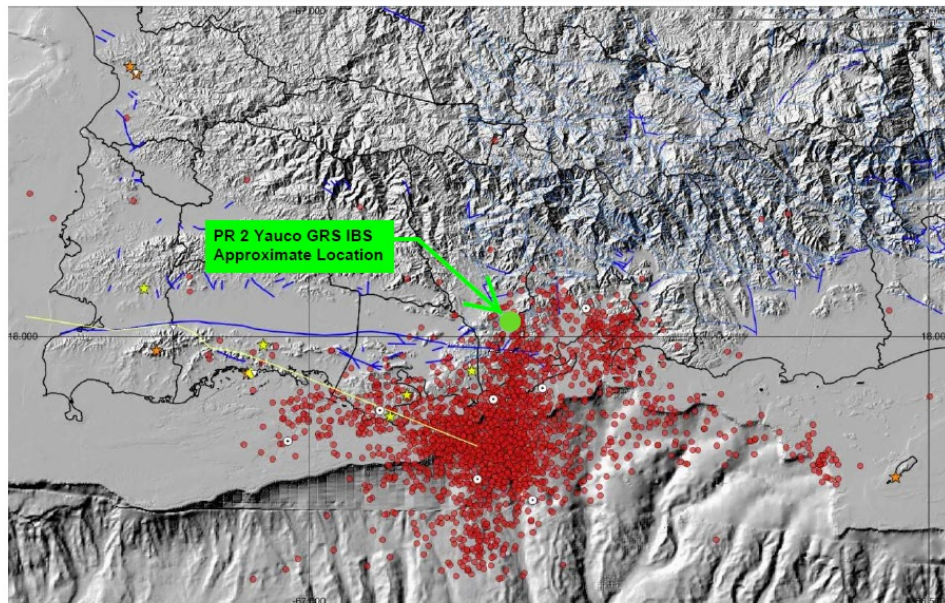


Figure 6: Shaded relief of the southwestern region of Puerto Rico. Yellow line is the left lateral strike slip Punta Montalva fault. More than 2,000 red dots are seismic events between 28-Dec-2019 and 22-Jan-2020. White dots are the events larger than M5.0. Blue lines are the same faults as seen in Figure 4. Map from López et al., 2020b.

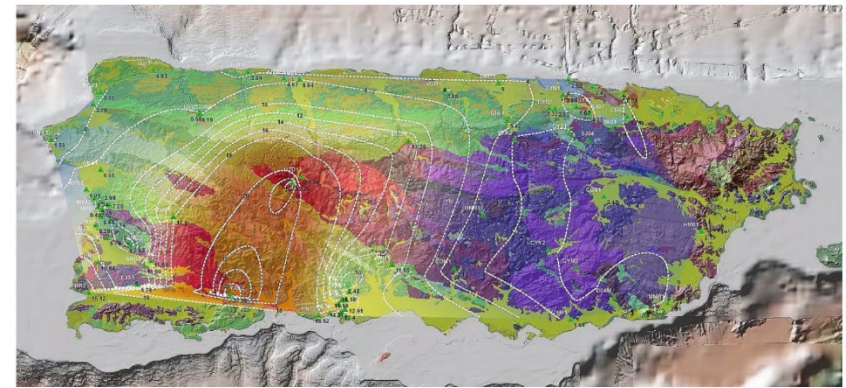


Figure 12: Intensity map showing isolines of PGA overlain on the generalized geologic map of the island. Values shown in the map are the accelerations in percentage of g and are the resultant of the maximum accelerations in the E-W and N-S directions. Image courtesy of Dr. C. Huertas of the UPRM-PRSMF.

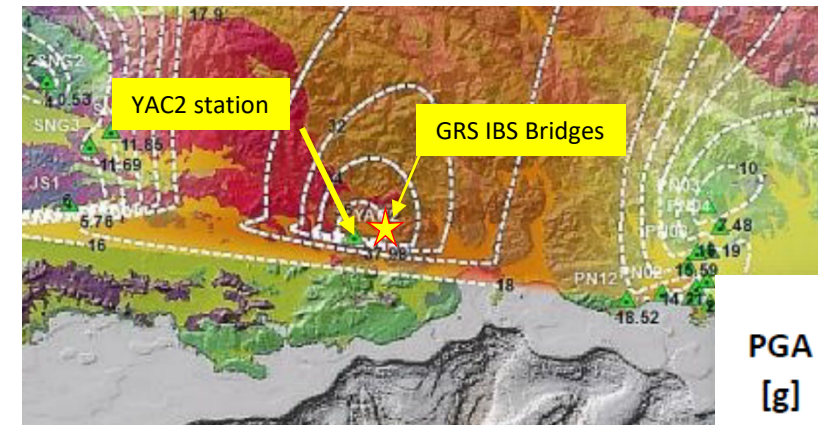
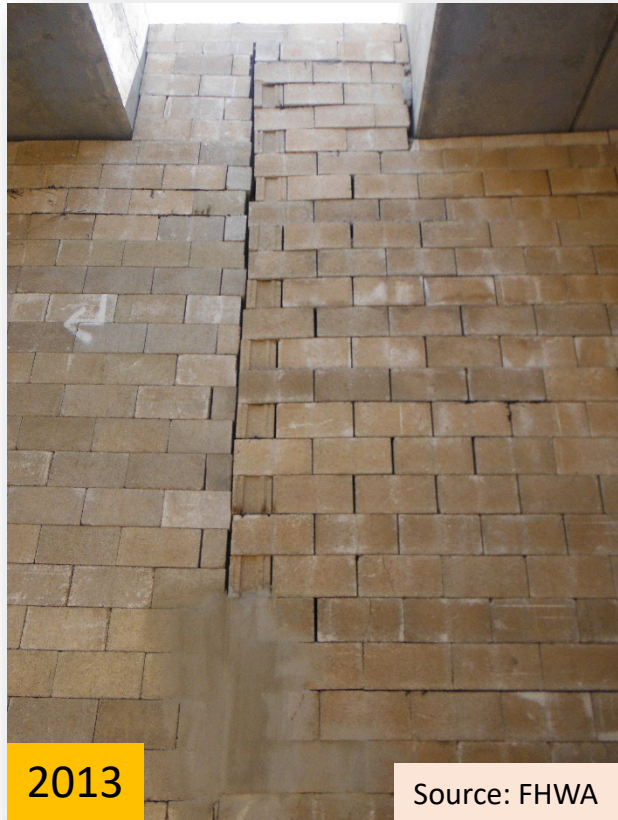


Table 2: Summary of Peak Ground Accelerations and Velocities near epicenter							PGA [g]	PGV [cm/s]
Station	Latitude (N)	Longitude (E)	Municipality	Station Name	Dist. from Epicenter [km]	Sensor Direction	PGA [g]	PGV [cm/s]
YAC2	18.023	-66.857	Yauco	Yauco Fire station	8.7	N-S	0.398	27.78
						E-W	0.362	26.57

Source: GEER Report



PR 2 – 2013 vs 2020



PR 2 – 2013 vs 2020



PR 2 – 2013 vs 2020



Source: PRHTA



Recent Projects



WY – Sand Creek Rd (2016)



Image source: FHWA

RI – East Shore Expressway Bridge No 475 & McCormick Quarry Bridge No 476 (2016)



Image source: FHWA



CT – Project #100-178, North Haven, CT (2017)



Image source: CT DOT



AZ - I-40 over Meteor City Rd (2019)



Image source: FHWA



VT – Depot Rd over I-91, Hartland, VT (2020)



Source: Google Street View (September 2022)



AZ - I-40 A-1 Mountain Bridge (2022)



Source: Google Street View (April 2023)



Source: AZ DOT

OK – Grant County (2022)



Image source: OK DOT



MI – M-63 over I-196 (2019)



No skew

Source: Google Street View (July 2023)



October 2021



September 2023

Image source: MI DOT



MI - I-75 under Newport Road (2022)

15 deg skew



Source: Google Street View (April 2023)



MI - I-75 under Nadeau Road (2022)

33 deg skew



Source: Google Street View (August 2023)



MI - US-10 under Mackinaw Road (planned for 2024)

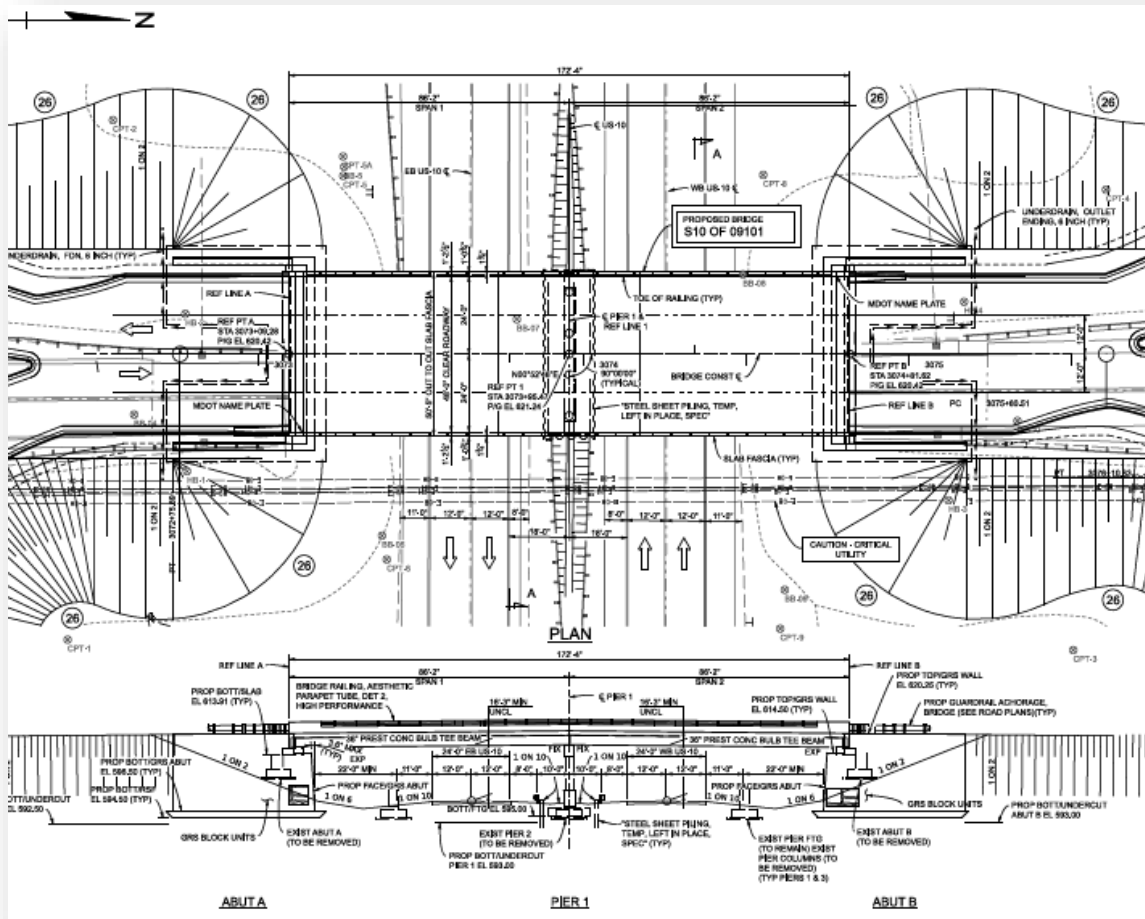


Image source: MI DOT

- MDOT has Successfully Completed Three 2-Span GRS-IBS Bridges
- We Continue to Improve the Design and Construction Process
 - Updates to Plans
 - Modify GRS Special Provisions
- Additional Wrapped Section Appears to Address the Issues
- Incorporated All Lessons Learned Into the Next Project
- Always Looking for Next GRS-IBS
- Midland County Road Commission has Built More Than 12 GRS-IBS Single Span



WV – Stanaford Road (2022/23)

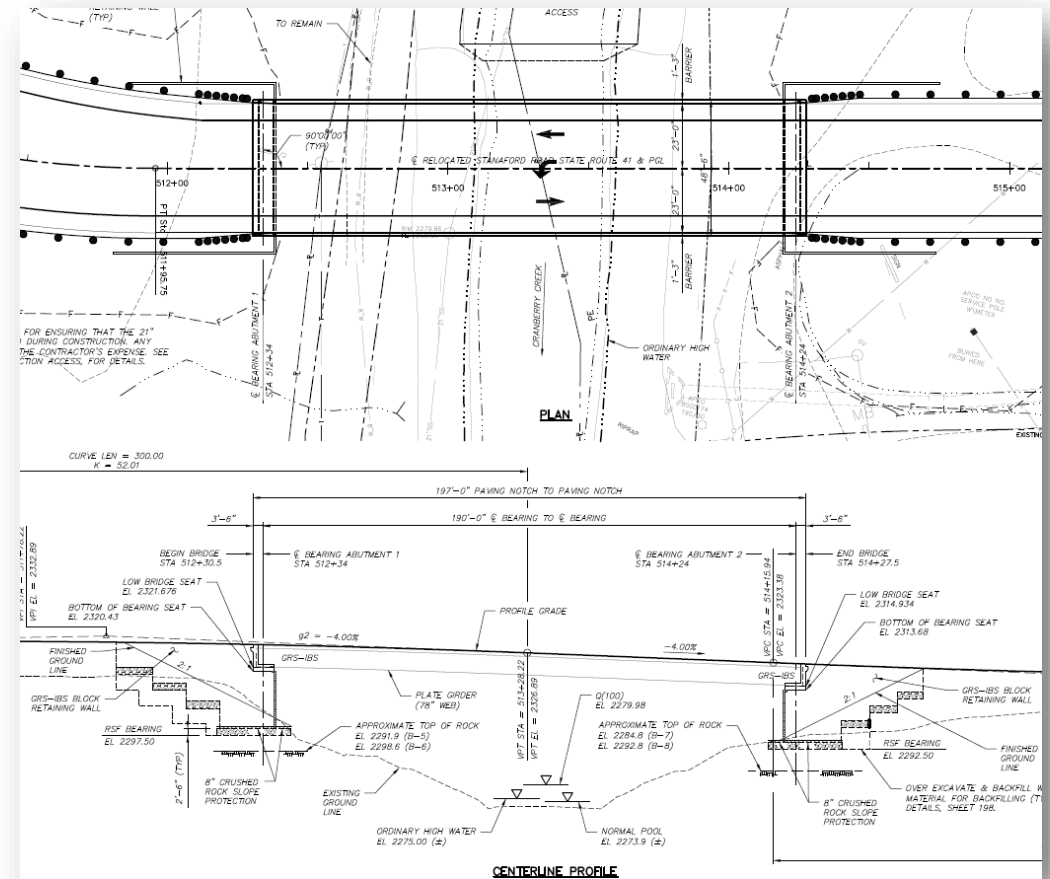
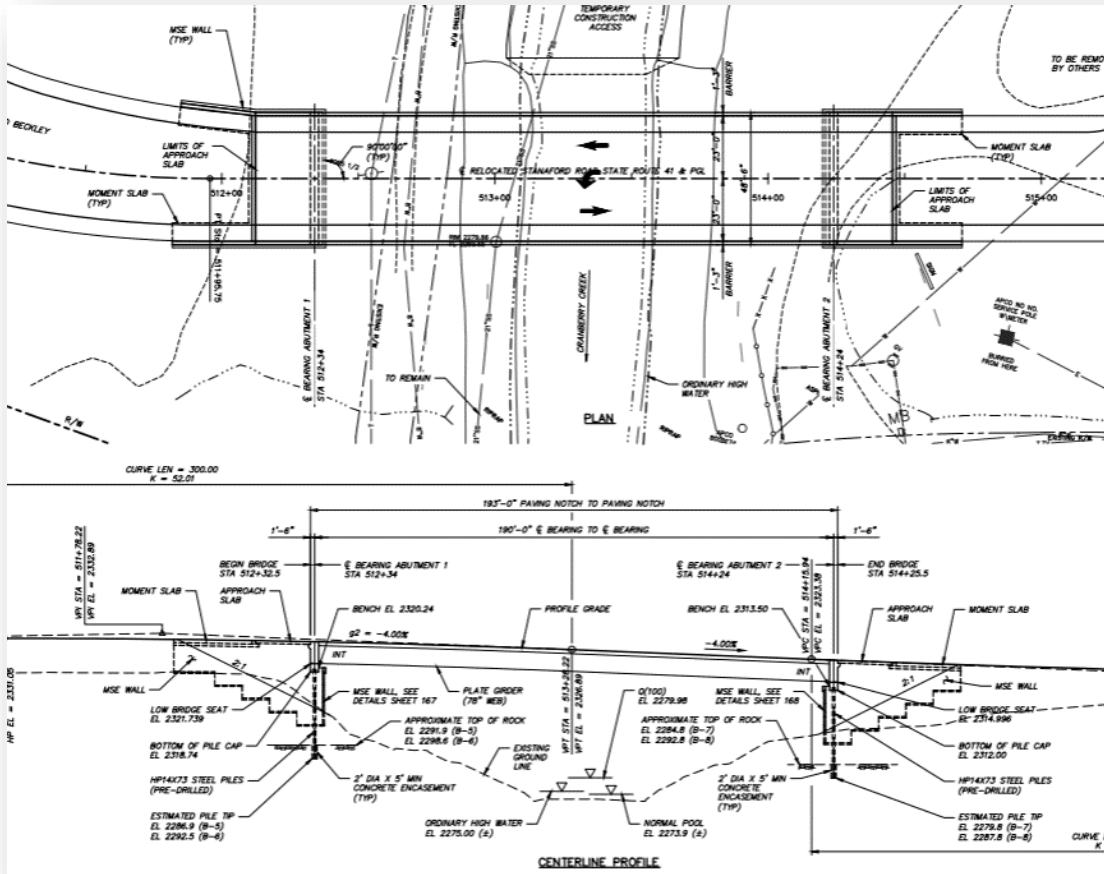


Image source: WV DOT



WV – Stanaford Road (2022/23)

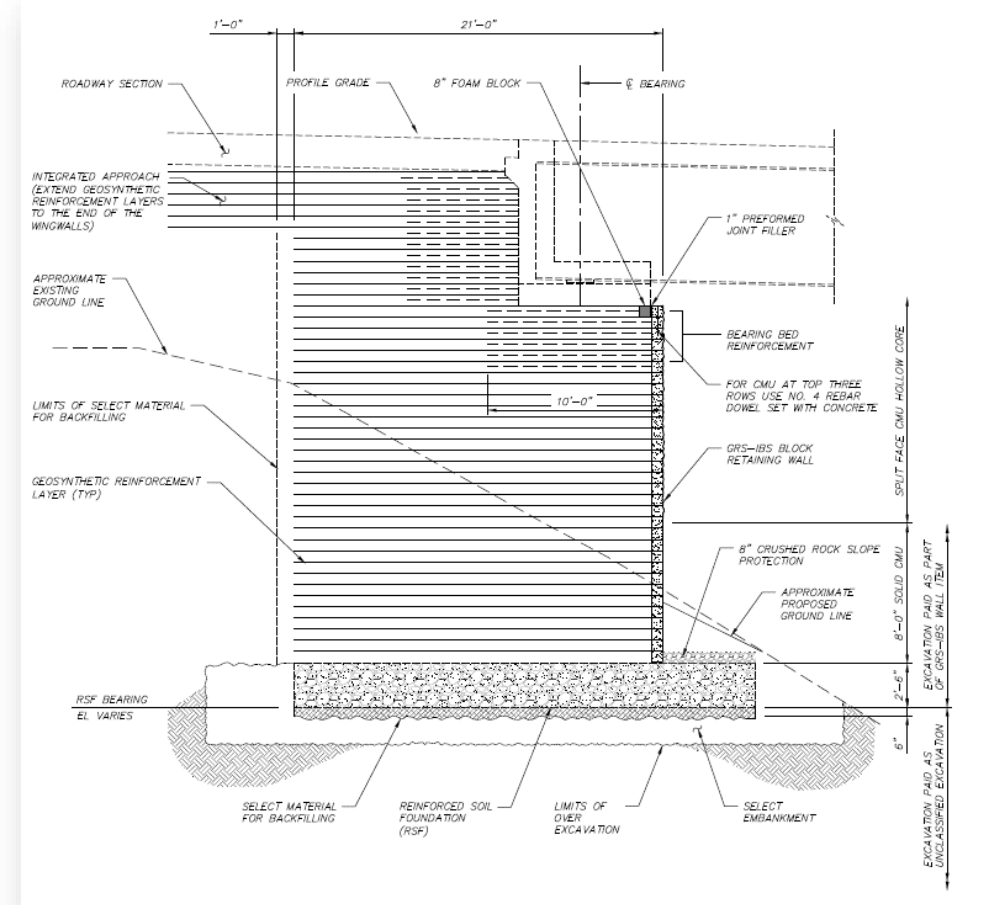
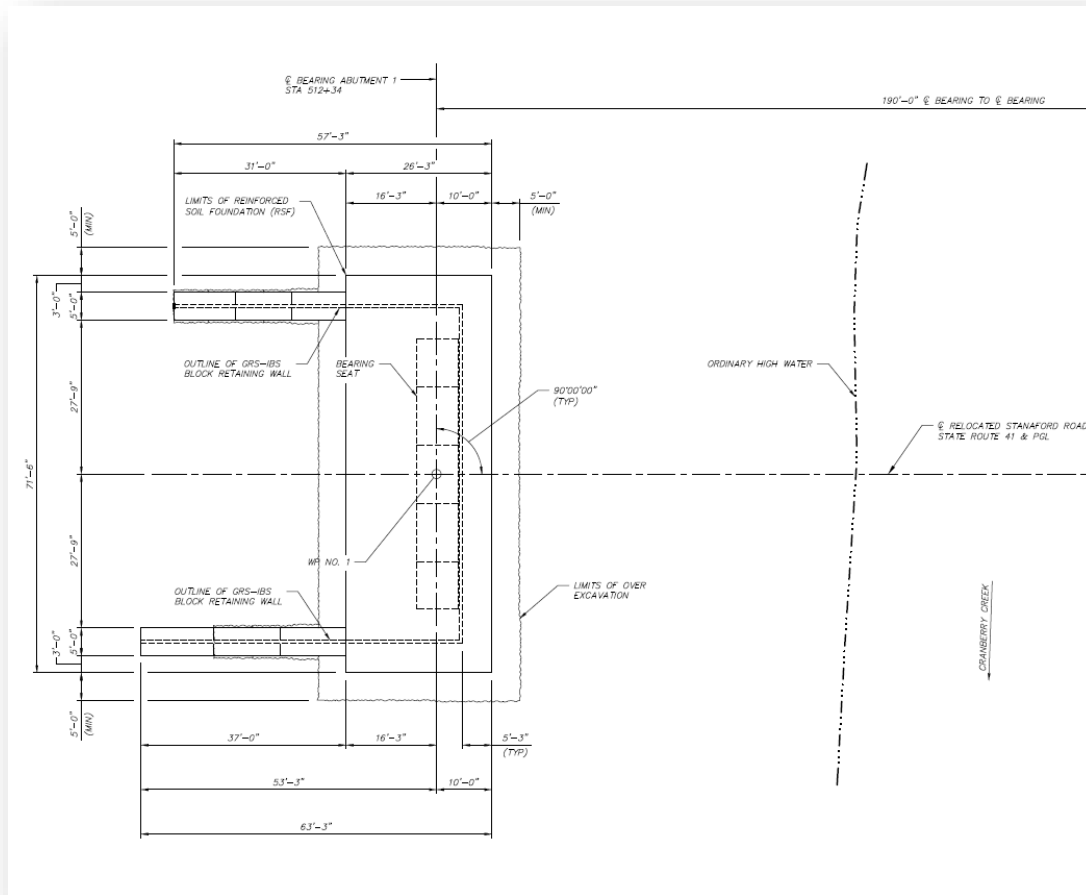


Image source: WV DOT



WV – Stanaford Road (2022/23)

Proposal	Call Order	Counties	Bidder ID	Bidder Name	Bid Amount	
1734099	1	RALEIGH	27-2000626	TRITON CONSTRUCTION, INC.	6,716,500.00	GRS IBS
1734099	1	RALEIGH	83-0989025	ALL CONCRETE, INC.	7,385,527.72	GRS IBS +10%
1734099	1	RALEIGH	55-0481221	MOUNTAINEER CONTRACTORS, INC.	8,109,719.58	MSE/piles +21%
1734099	1	RALEIGH	55-0345840	VECELLIO & GROGAN, INC.	8,233,296.45	GRS IBS +23%
1734099	1	RALEIGH	81-0626623	CLEARWATER CONSTRUCTION, INC.	8,392,000.00	MSE/piles +25%
1734099	1	RALEIGH	55-0487806	ORDERS CONSTRUCTION COMPANY, INC.	8,919,984.67	MSE/piles +33%

The unit price shall include in place the following: solid, hollow core, corner, and cap blocks, Reinforced Soil Foundation, geotextiles, coping, flashing, joint filler, foam blocks, spacer blocks, rebar dowels, concrete infill, and other similar items that are an incidental part of wall construction.

The unit price shall also include in place the items shown within the pay limits in the Plans as follows: granular backfill, excavation, embankment, sand leveling pads and fabric for separation. No separate measurement of these items shall be made.

626.9 – PAY ITEMS:

ADD THE FOLLOWING TO THE TABLE:

ITEM NUMBER	DESCRIPTION	UNIT
626005-*	GRS-IBS MODULAR BLOCK RETAINING WALL	SF



WV – Stanaford Road (2022/23)

Triton Construction, GRS IBS option:

Total project cost	\$6,716,500
Total GRS IBS alternative	\$3,145,000
GRS IBS Bid portion	\$1,094,150
GRS IBS face quantity	15,050 sf
Unit price	\$72.70/sf

Average of 2 lowest Bids:	GRS IBS	MSE/Piles	Delta	
Total project cost	\$7,051,000	\$8,251,000	+\$1,200,000	+17%
Average costs (walls and piles)	\$1,081,000	\$1,261,965	+\$180,965	+17%
Total alternative costs	\$3,177,000	\$4,209,400	+\$1,032,400	+32%



WV – Stanaford Road (2022/23)



Image source: FHWA



WV – Stanaford Road (2022/23)



Image source: WV DOT

WV – Stanaford Road (2022/23)



Image source: WV DOT

WV – Stanaford Road (2022/23)



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