GeoSynthetic Reinforced Soil Integrated Bridge System (GRS-IBS)

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Defiance County's GRS Experience

- What is GRS?
- How does it work?
- What are its advantages?
- Defiance County’s experience
- Lessons learned and advice

What is GRS?

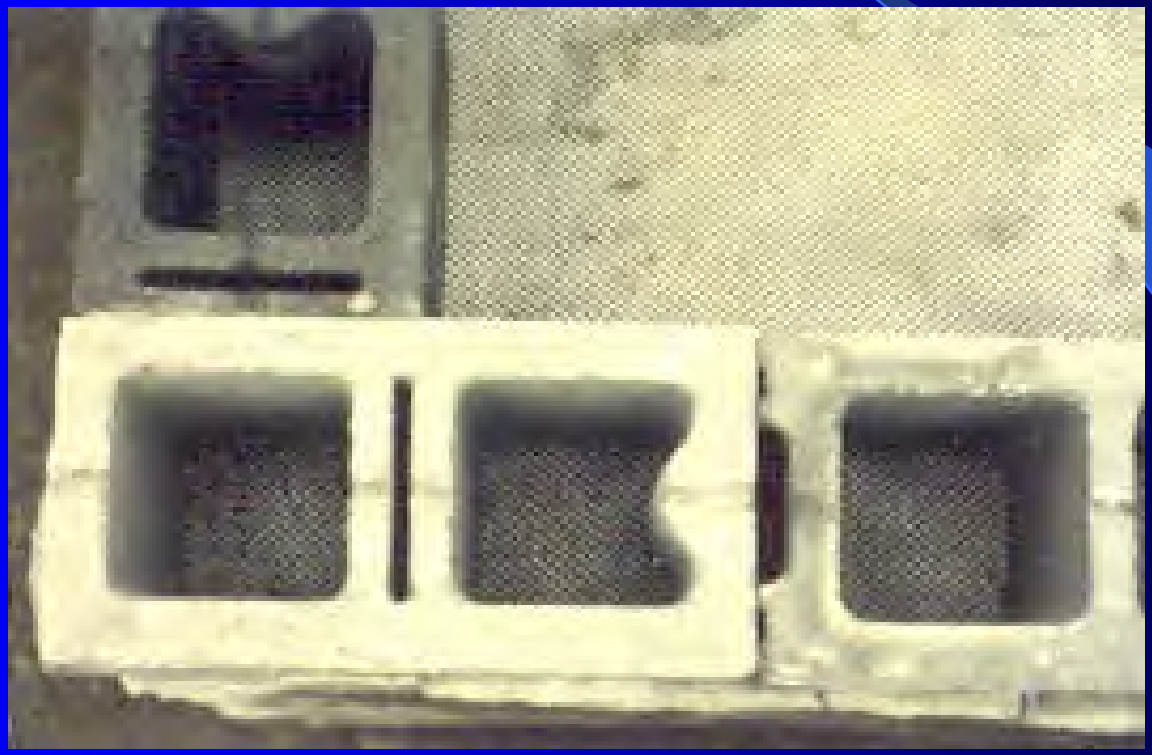
Geosynthetic Reinforced Soil

The combination of closely spaced (<12”) geosynthetic layers with compacted select granular material

Reinforcement Spacing Controls Performance

Cut away of GRS mass

A split faced CMU SRW Block

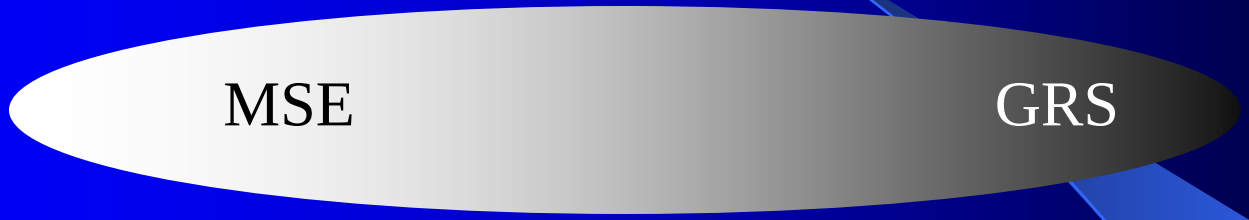


How does it work?

Wall Type


External
Internal
Tieback
Soil Nails
MSE
GRS
Increased Reinforcement Frequency

From external to internal support



metallic geosynthetic

Strips Wire Grids 0.8m 0.6m 0.4m 0.2m

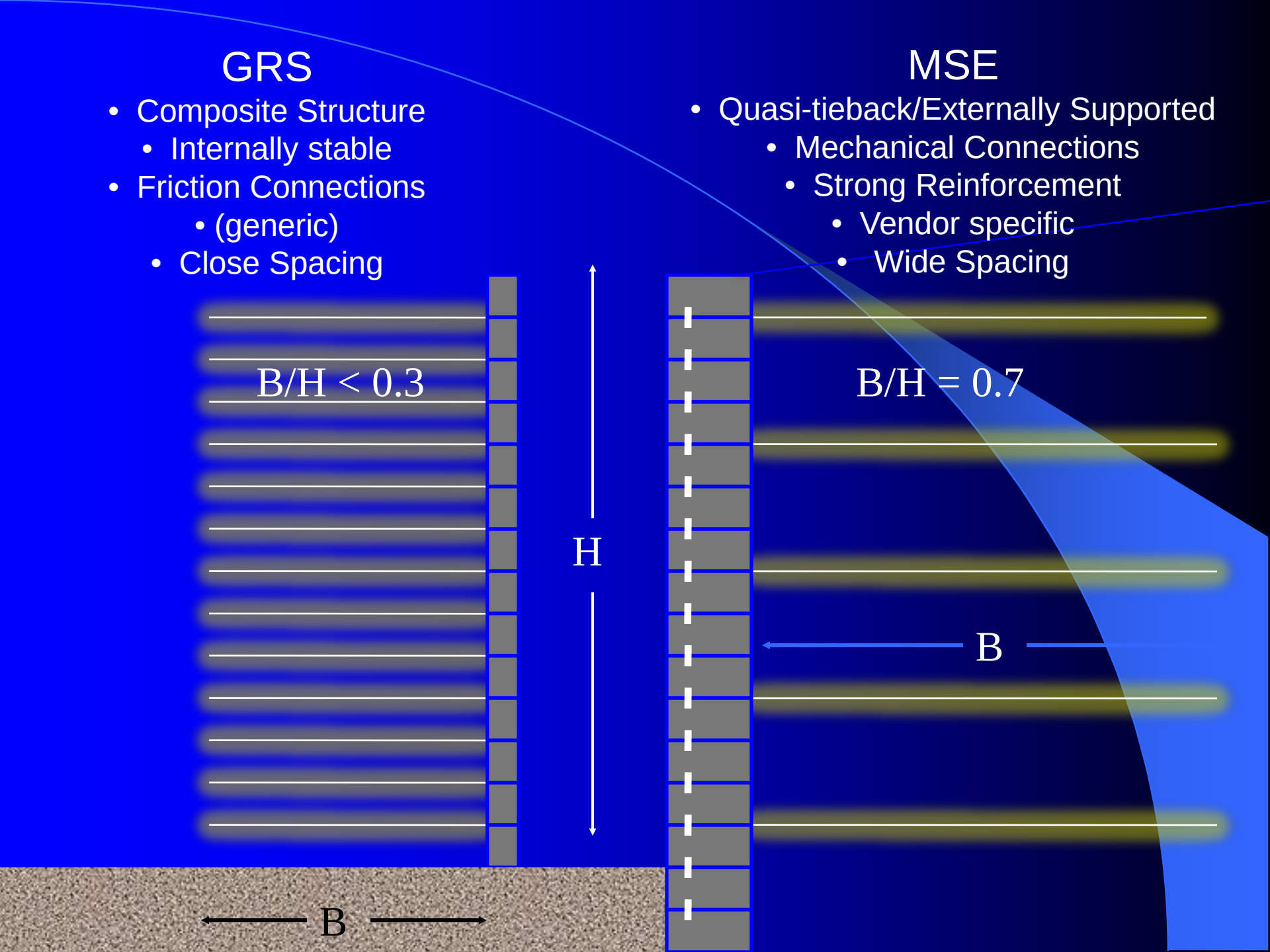
Reinforcement Frequency

GRS

- Composite Structure
  - Internally stable
- Friction Connections
  - (generic)
- Close Spacing

MSE

- Quasi-tieback/Externally Supported
  - Mechanical Connections
- Strong Reinforcement
  - Vendor specific
- Wide Spacing

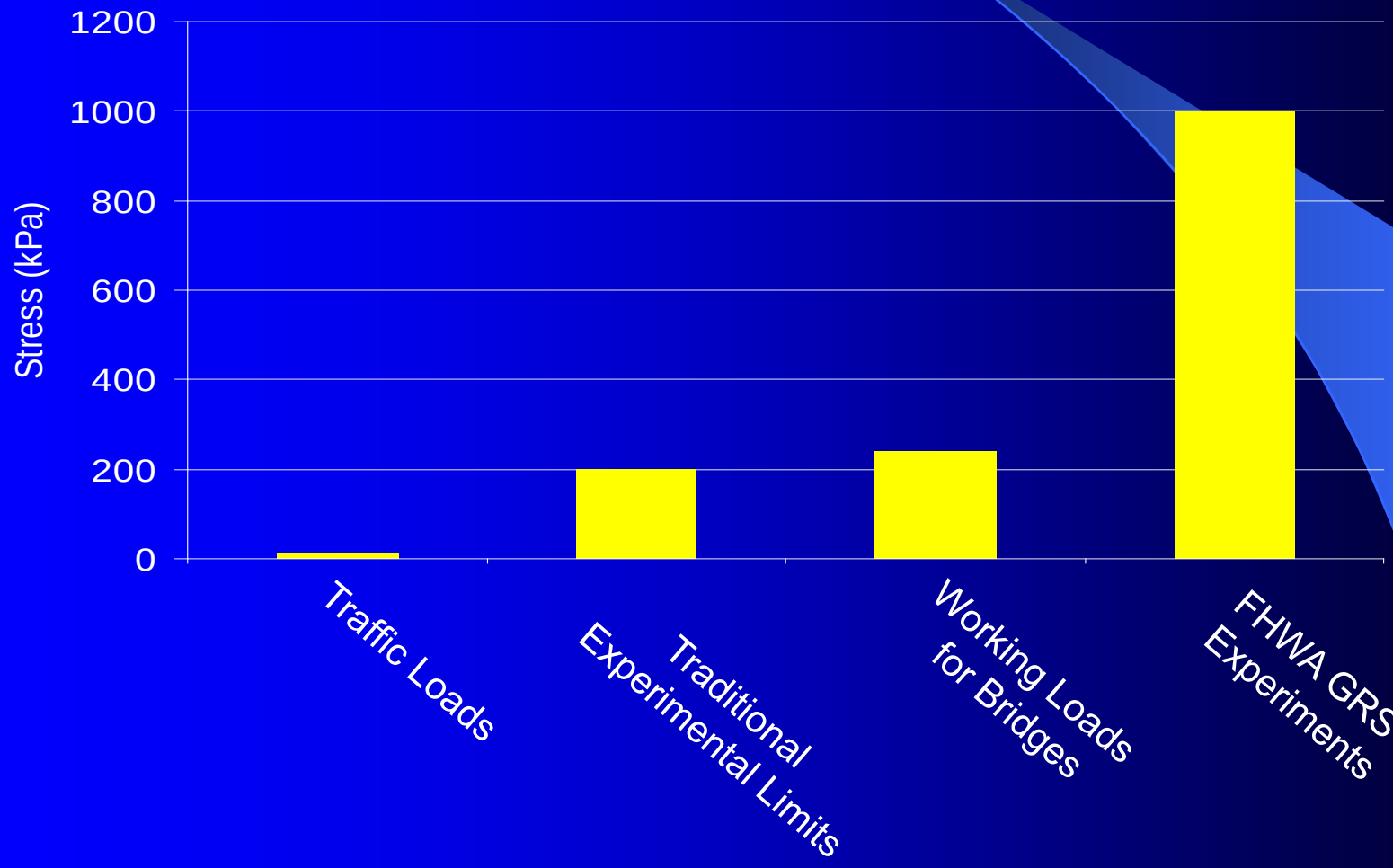


2 Factors for Internal Stability

- Good compaction with quality fill
- Close reinforcement spacing

Generalized Comparison

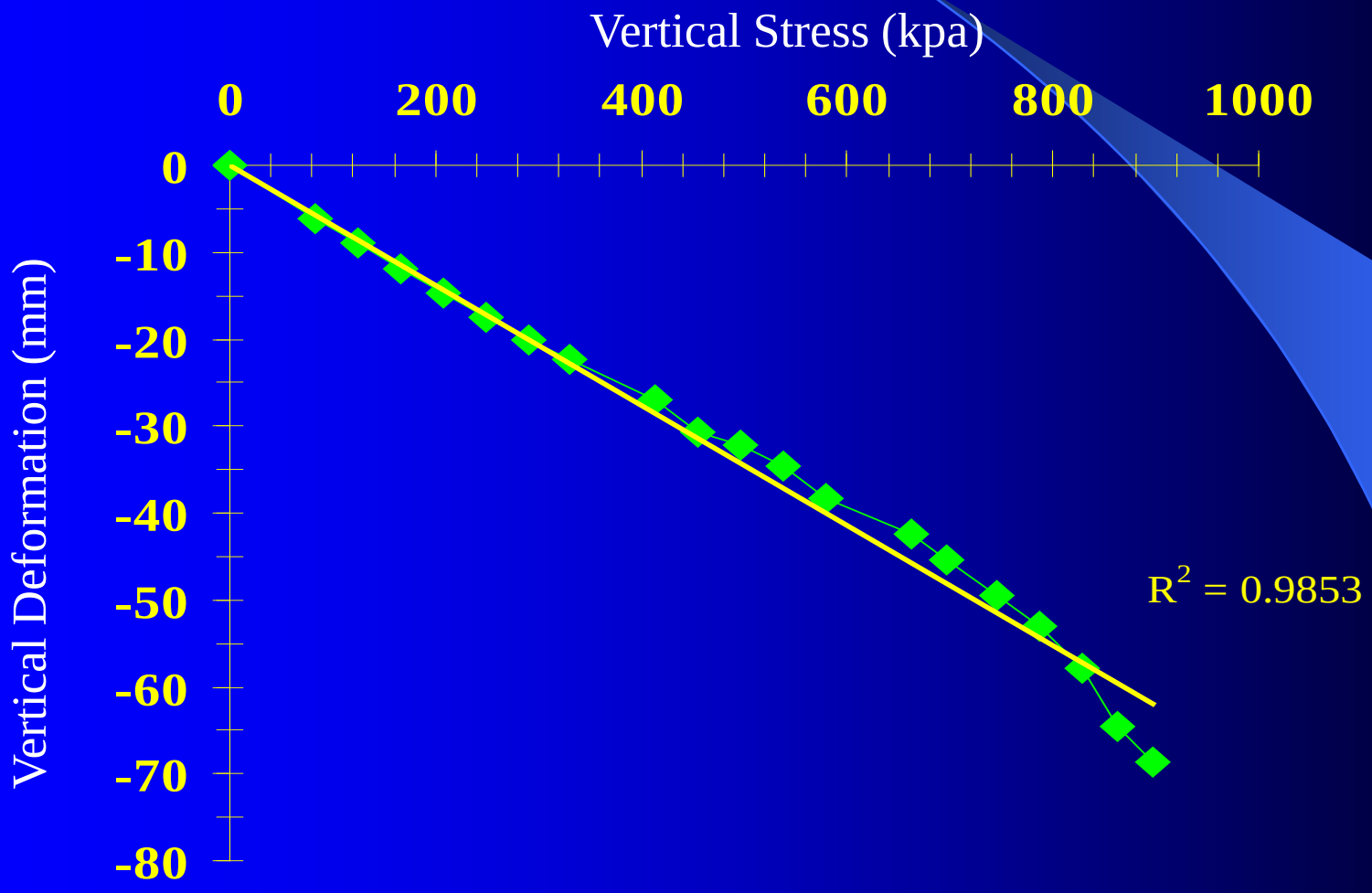
Surcharges on MSE/GRS walls



FHWA GRS Pier

FHWA GRS Pier

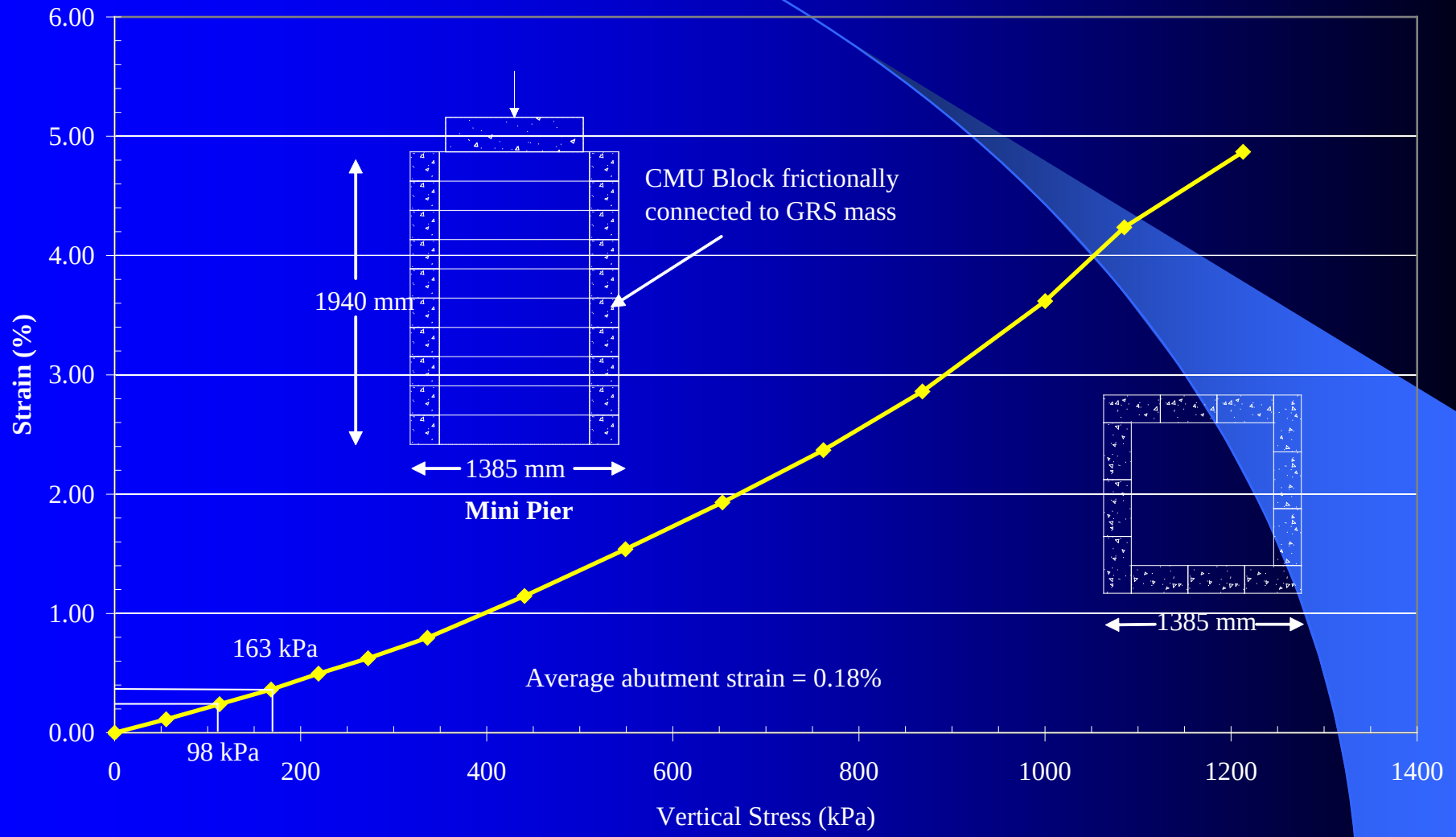
(Vertical Stress vs Vertical Deformation)



Defiance County Mini Pier

Strength of Material Test

Defiance County Mini Pier Test
Average Vertical Strain vs. Applied Stress

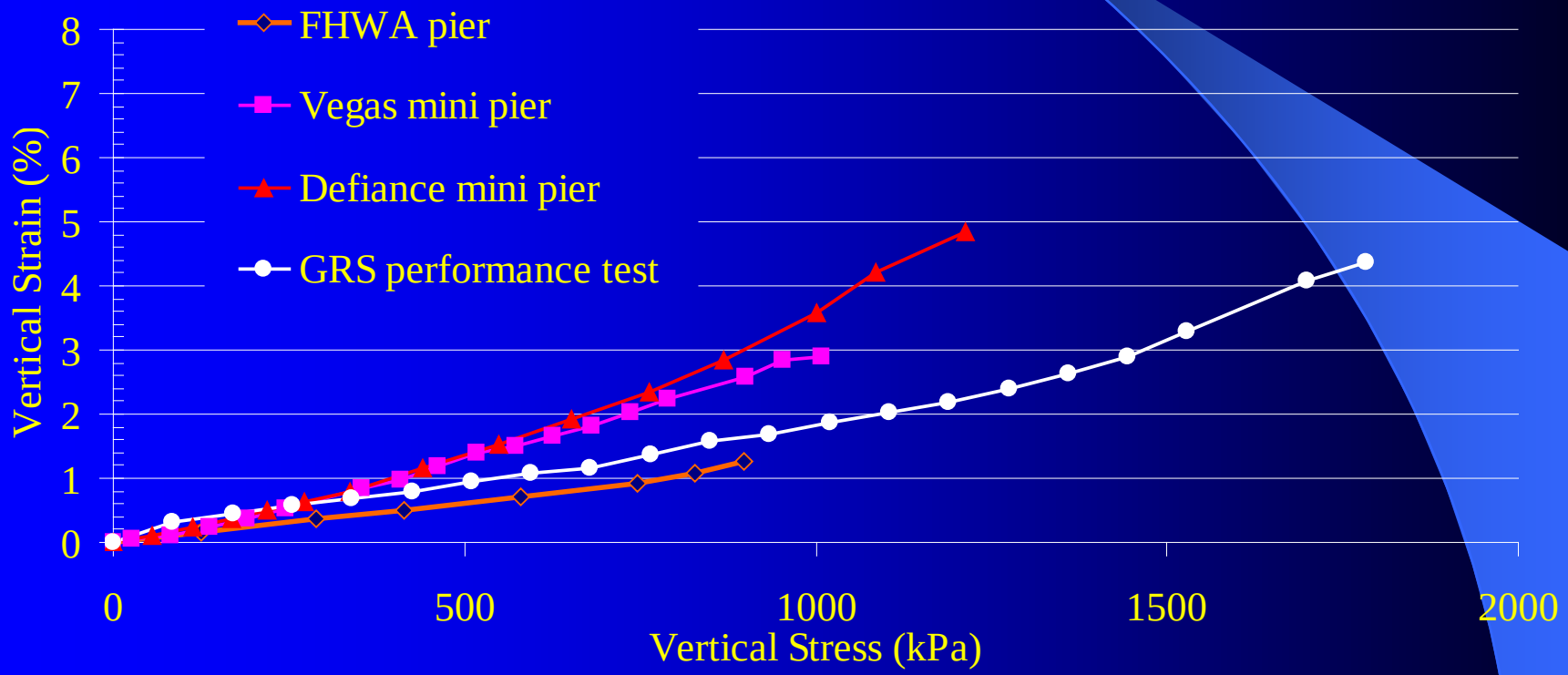


GRS Material Assumption

GRS has material properties different from that of soil with predicable behavior.

Applied Vertical Stress vs. Average Vertical Strain

(with 70kN/m at 8 in. spacing)

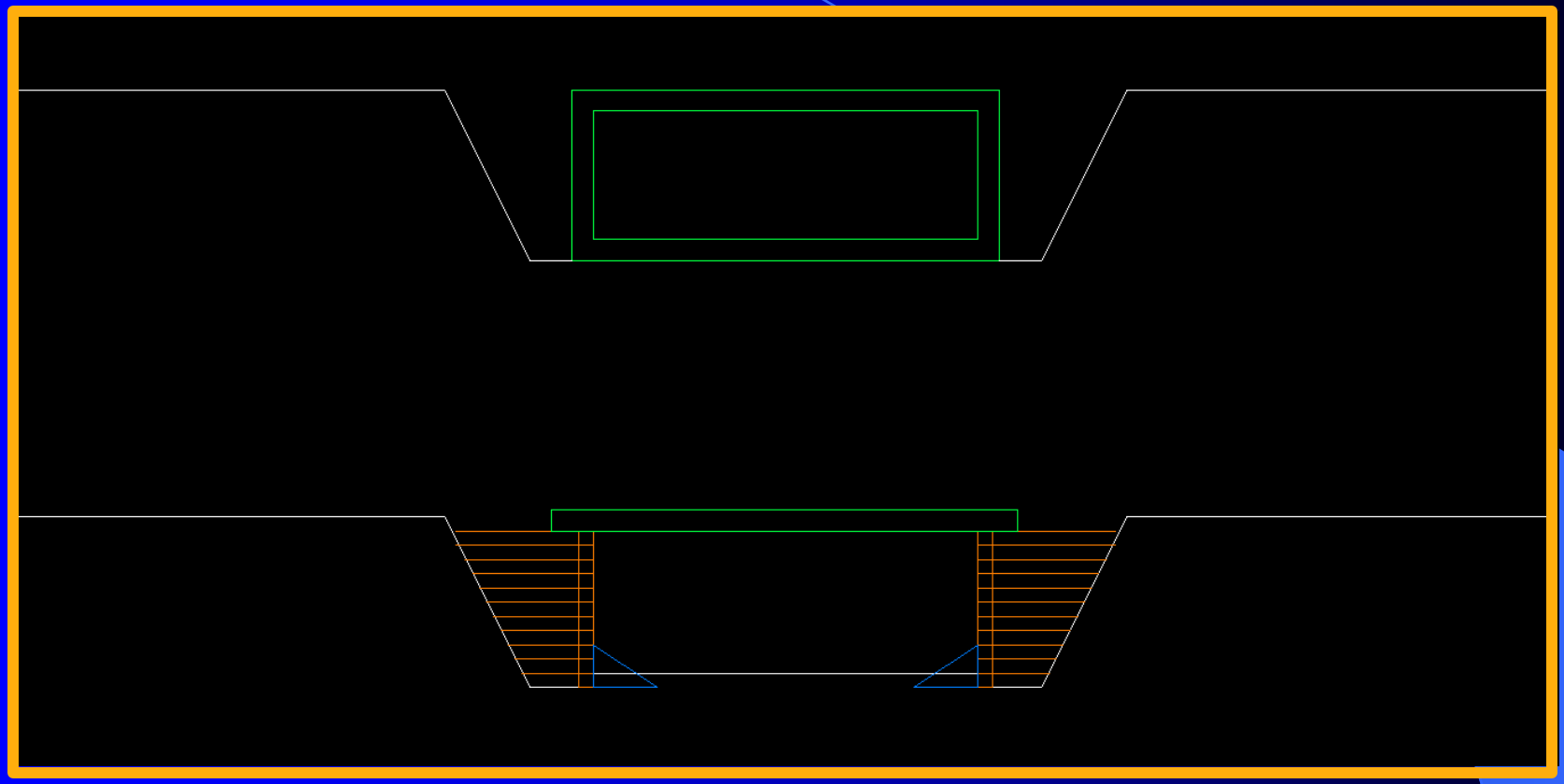


What are its advantages?

Advantages

- Low Cost Materials
- Non-Proprietary Materials and System
- Simple Design and Details
- Simple Construction
- Nearly All Weather Construction
- Very Flexible and Modular

Construction Advantages

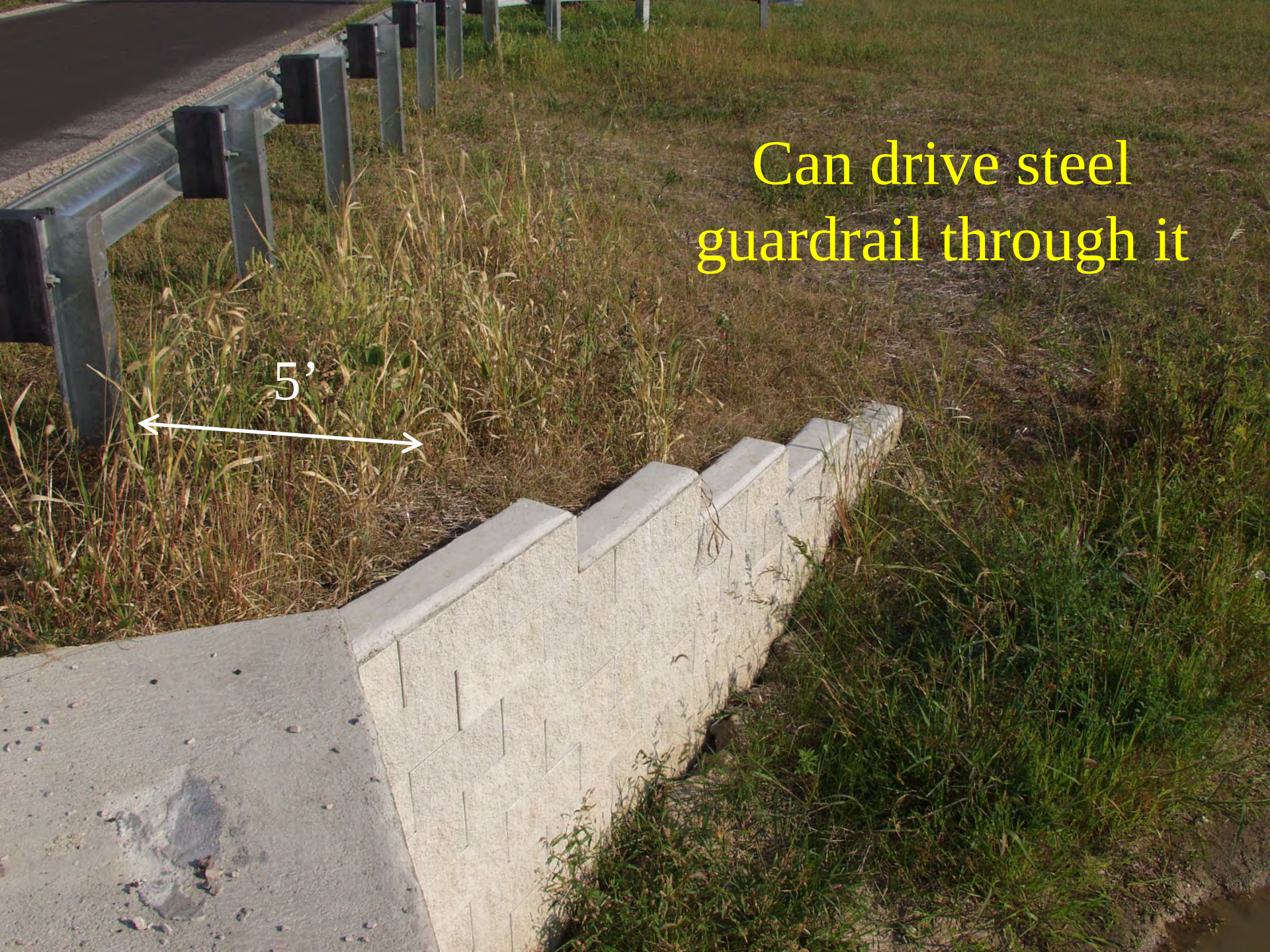


- Same excavation, less expensive materials, lighter weight components and less weather sensitive construction


05/02/2005


05/02/2005


05/02/2005


Can drive steel guardrail through it
5’


Poured Concrete in voids to tie top courses together


07/11/2005
Fits many shapes

Simple tools & Materials


This is the same
as 2 legally
loaded semis
STACKED.
160 kips


Open to Traffic - 47 days


Span half of
spill
throughs


HIDDEN BROOK

Defiance County Mini Pier

Strength of Material Test

Pioneer Lessons

- In hindsight, the most important lesson was a willingness to try it with an open mind
- The initial cost savings is in rapid, flexible construction, reduced superstructure cost and improved approach performance. Cost saving follows
- GRS-IBS design is about getting comfortable that it acts as a composite material

Pioneer Lessons

- Take advantage of others' experiences
- We have structures that have had the wrong type of guardrail used, experienced flood overtopping, etc.
- There is a growing community of GRS-IBS bridge owners that can share their experience

Scalable

- This structure has a 130’ opening, 25’ from deck to water
- “Semi Integral” abutments with excellent performance. No bump, no crack, 3 years old
- 4 ksf dead load like the smaller structures

Superstructure types

- Adjacent Prestressed Box Beams with waterproofing and overlay
- Adjacent and Spread Prestressed Box Beams with composite concrete deck
- Steel Beams with composite concrete deck
- Cast in place slab
- Fiberglass box beams

Adjacent Box Beams

28’x20’-$68,000 - 2008


36’x20’-$71,000 - 2010

Spread Box Beams

28’x32’-$85,000 - 2010

Construction Methods

- 17 built entirely by county crew
- 7 structures with abutments built by county and superstructure by contractor
- 5 structures built entirely by contractor (4 different contractors so far)

“Contractor” Conclusions

- We keep a large quantity of fabric on hand, other materials are readily available on very short notice
- We replenish our fabric supply in truckload intervals and have a number of suppliers
- We are replacing bridges at around half our previous costs and in substantially less time
- Our crew can install without engineering in many non abutment applications

“Contractor” Conclusions-2

- Able to work in many weather conditions including cold and rain
- Smaller superstructure requires smaller crane
- Abutments serve as permanent, engineered crane pads
- Has fit every superstructure type we have considered

Efficiency Gains

- For both our crew and the 4 contractors, the initial projects were similar in cost to traditional deep foundation cost but much faster
- We are at least twice a fast now over initial with a corresponding savings in cost
- 3 days for standard abutment

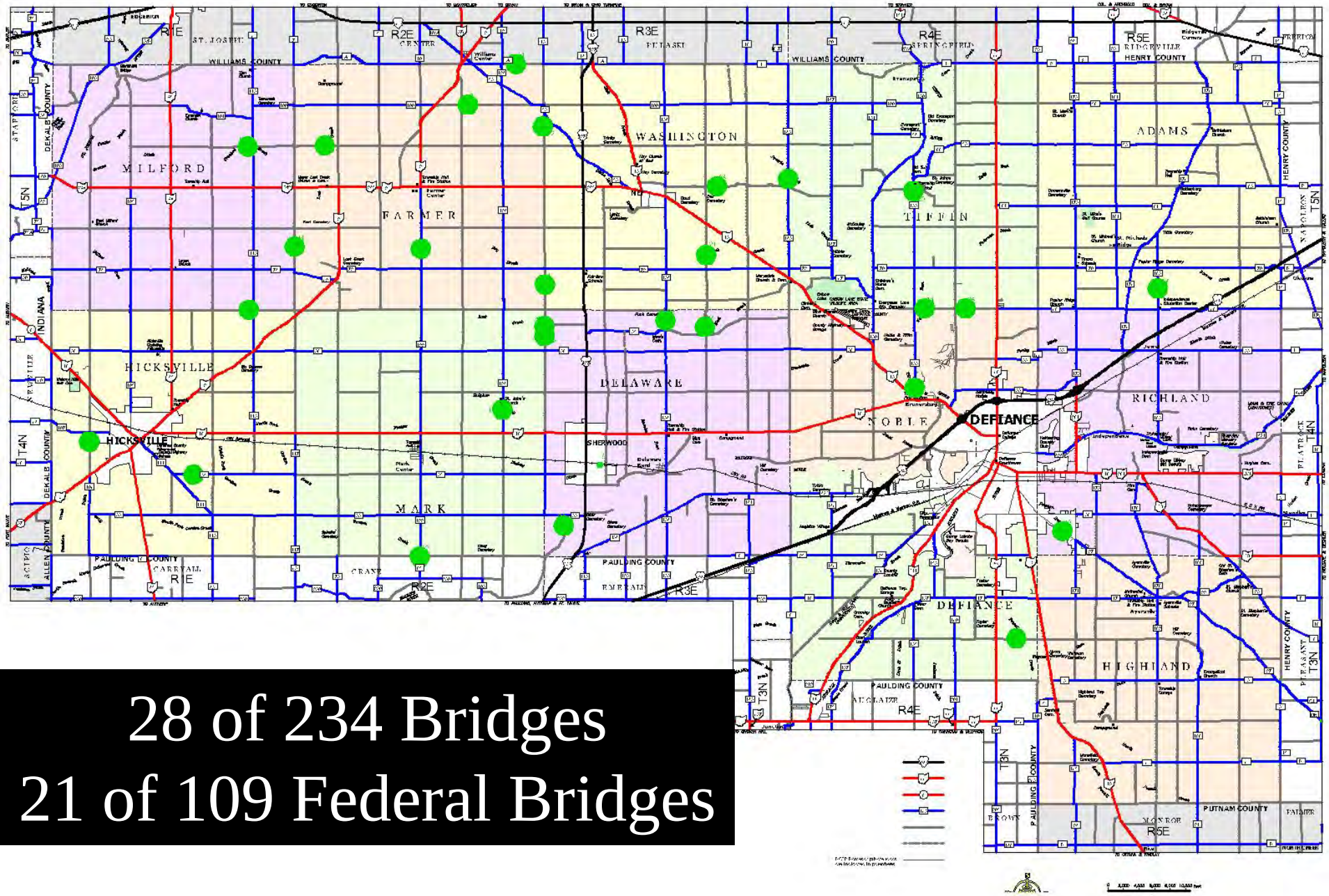
“Owner” Conclusions

- Easy to design. Gravity abutment with engineered composite material
- Easy change orders. Unit prices
- Easy to inspect construction. 1-2-3
- Easy to maintain. No bump, masonry repairs to cosmetic face if needed
- Easy to inspect.

Financial Impact

- In the 6 years 2000-2005 we replaced 11 structures over 20’ span. 8 with federal funds and 3 with local funds.
- In the 6 years 2006-2011 we replaced 18 structures over 20’ span. 4 with federal funds and 14 with local funds.

Year	Road	Construction by	ADT	Width	Opening	Superstructure	Cost
2005	Bowman Rd	Defiance Co\Zachrich	345	34	74	NAPBB	$272,000
2006	Glenberg Rd	Defiance Co\Ft. Defiance	240	28	45	NAPBB	$187,000
2006	Fountain St	Defiance Co\Ft. Defiance	320	28	30	NAPBB	$122,000
2006	Behnfeldt Rd	Defiance Co\Ft. Defiance	125	28	47	NAPBB	$141,000
2006	Farmer Mark Rd	Defiance Co	430	32	25	NARBB	$95,000
2006	Vine St	Defiance Co	590	28	25	NARBB	$102,000
2007	Scott Rd	Defiance Co	50	28	17	NARBB	$75,000
2007	Huber Rd	Defiance Co\Ft. Defiance	100	28	23	NAPBB	$156,000
2007	Casebeer Miller Rd	Zachrich Const	450	32	20	Fiberglass Beams	$200,484
2007	Beerbower Rd	Defiance Co	100	28	17	NARBB	$60,000
2008	Williams Co Line	Defiance Co	150	28	14	NARBB	$74,000
2008	Beerbower Rd	Defiance Co	100	28	20	NARBB	$74,000
2008	Defiance Ayersville	Defiance Co	2500	40	20	NARBB	$105,000
2008	Flory	Stable Construction	130	28	20	NAPBB	$180,000
2009	Stever Rd	Defiance Co\Zachrich	845	36	130	Steel Beams	$616,000
2009	Behnfeldt Rd	Defiance Co	100	28	19	NARBB	$88,000
2010	Independence	Defiance Co	150	32	10	NARBB	$51,000
2010	Openlander Rd	Defiance Co	350	32	17	NARBB	$70,000
2010	Stever Rd	Defiance Co	700	32	20	NARBB	$71,000
2010	Mulligans Bluff	Defiance Co	150	28	20	NARBB	$65,000
2010	Behnfeldt Rd	Defiance Co	90	28	31	SPBB	$85,000
2010	Paulding Co Line	Nagel Constr	175	28	53	NAPBB	$300,000
2011	Flory Rd	Defiance Co	600	28	11	Slab	$45,000
2011	Behnfeldt Rd	Defiance Co\Zachrich	100	28	59	CAPBB	$193,000
2011	Rosedale Rd	Defiance Co	75	28	32	SPBB	$86,000
2011	Bostater Rd	Defiance Co	15	20	76	Steel Beams	$89,000
2012	Mulligans Bluff	Zachrich Const	83	28	60	CAPBB	$250,000
2012	The Bend Rd	Miller Brothers	845	36	52	CAPBB	$270,000
2012	Platter Creek	Defiance Co	70	20	60	Steel Beams	In Progress



28 of 234 Bridges
21 of 109 Federal Bridges

Implementation Advice

- This is new, change takes effort
- Our initial cost was much higher than today
- Contractors like consistency, worry about risk
- Its often easier to identify threats and risks than opportunities

Implementation Advice

- Good education ahead of bid is vital
- FHWA video, prebid meeting
- Initial costs will be high, but will drop with familiarity and experience
- We saw consistent bids from very large to very small contractors
- Use unit price bids to encourage thought and lower contractor risk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