



Agenda

- Incident and Site History
- Developing a Solution
- Evaluating Damage
- Temporary Roadway
- Traffic Impacts
- Permanent Bridge Replacement
- Summary

benesch



Incident

- Sunday, June 11, 2023, 6:17 am
- Philadelphia, PA
- PennDOT District 6-0

Photo 1




Photo 2


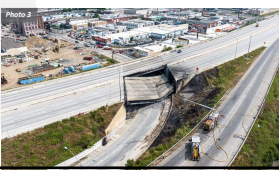


Photo 3



benesch

Benesch & I-95

- Cottman-Princeton Interchange (CPR)
- PennDOT District 6-0
- Interchange improvements
- Reconstruction of 1.4 miles of I-95
- 5 Contracts: CP1, CP2, CP3, ITF, ITB
- Total cost: \$340M



95 Revive.com

benesch

I-95 over Cottman Ave



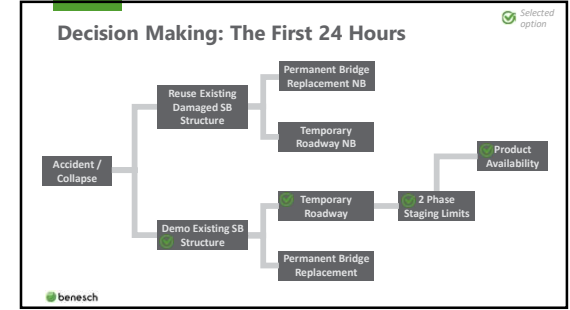
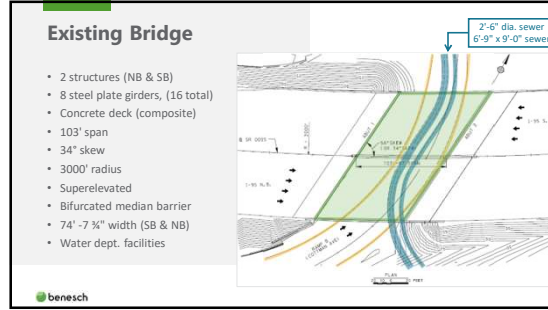


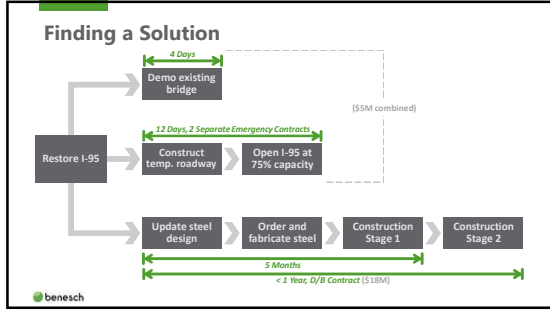
Photo from 2020



June 11, 2023

benesch





Temporary Roadway Solution

- Temporary retaining wire walls
- Lightweight fill
- Roadway with barrier
- Existing:
 - Four 12 ft lanes (each direction) with full inside/outside shoulders
- Temporary roadway:
 - Three 11 ft lanes (each direction)

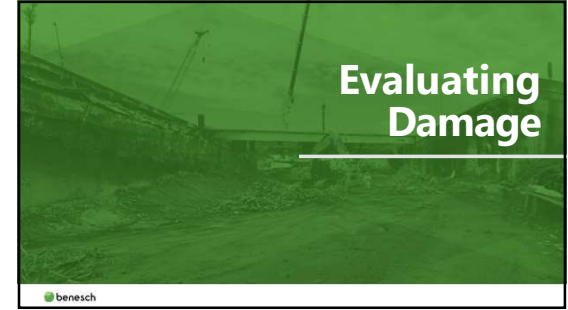
Temp roadway construction

Stage 1

Stage 2

Full restoration

benesch



Southbound Bridge Inspection

- June 11th
- Visual & hands-on
- Heavy soot staining limited visual inspection
- Could not inspect connections for displacement-induced cracking



Underside of the southbound structure, looking back. Note the heavy soot staining

benesch

Southbound Bridge Inspection Findings



Web distortion up to 2.5"



Severe cross frame distortion



Bottom flange lateral and vertical distortion

benesch

Southbound Bridge Inspection Findings

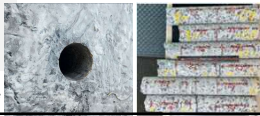
- Social media image of SB
- During fire: midspan sag ~9"
- During inspection: no sag



benesch

Assessing Substructure Damage

- Concrete cores
- Microcracks
- Assess capacity
- Microscopic, petrographic & fluorescent (UV) light examinations
- Fire spalled up to 6" to 7" of concrete
- Repair / replace depths = 1" to 4" with overall removal up to 9" from original face
- Compressive strength = 4700 psi to 6610 psi
- Estimated temperature in concrete
 - 300°F to 500°F



3" diameter core

benesch

Drainage Pipe Damage

PHILADELPHIA, PA
5099 COTTMAN AVE
INRB22 ← INRB23
Circular 36inch



Plastic Pipe Damage

benesch



Normal Concrete Pipe



Damaged Concrete Pipe

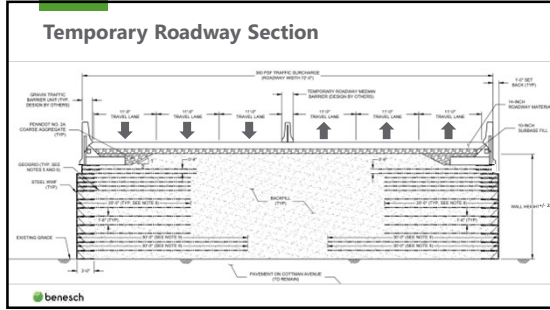


Reinforced Concrete Pipe



Temporary Roadway

benesch



Ultra-Lightweight Foamed Glass Aggregate

- 20 lbs/ft³, $\Phi = 40^\circ$
- 8,000 CY produced from 8 million recycled glass bottles
- Ship by truck (100 CY) or even plane
- Non-toxic, non-flammable, non-porous, insulated
- Pennsylvania-made
- Available
- In use at adjacent/nearby sites

The top photograph shows a close-up of the ultra-lightweight foamed glass aggregate, which consists of irregular, porous glass fragments. The bottom photograph shows a worker in a high-visibility vest operating a machine to compact the aggregate on a construction site.

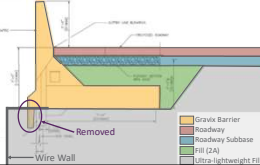

Retaining Walls

- Welded wire form
 - Filled with lightweight fill
- Geogrid
- ~22 feet high

The top photograph shows a worker in a high-visibility vest laying out a large sheet of geogrid on a construction site. The bottom photograph shows a completed retaining wall made of concrete blocks, with a worker standing next to it for scale.

Gravix Barriers

- Precast units available (sitting in yard)
- MASH TL-4
- Bottom 4" of unit backfilled roadway subbase 2A to load integral moment slab
- Units were not cut, so additional diaphragm, backwall, and approach slab removal required



Removed

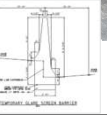

Wire Wall

- Gravix Barrier
- Roadway
- Roadway Subbase
- FBI (2A)
- Drive Lightweight 2A

benesch

Median Barrier

- Bifurcated 4.75"
- Cast with existing formwork
 - Only two forms available
- Turnaround time
 - 5 days 24/7, including weekend
- Strength (shipping) = 3,000 psi
 - 1-hour core breaks to accelerate segment delivery
- Strength (28 day) = 4,500 psi



benesch

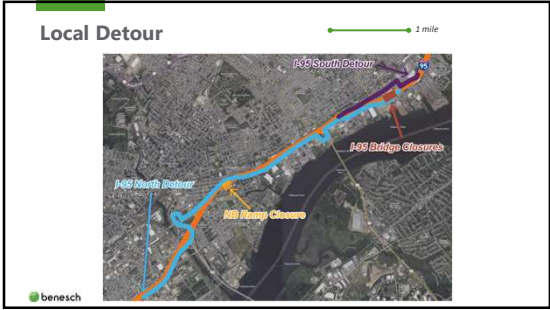
From Rendering to Reality

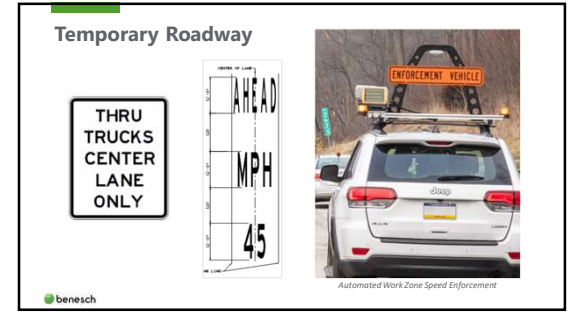
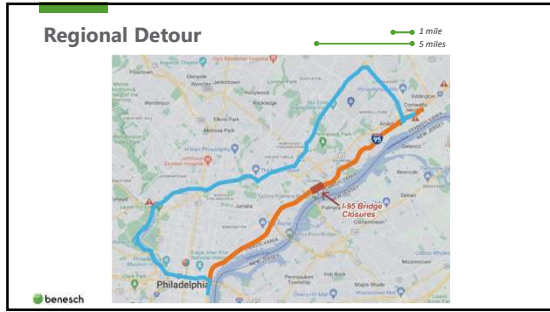


June 15, 2023

June 23, 2023

benesch







Existing Structure

- 8 beam lines
- SB: 9'-11 1/2"
- NB: 9'-9 3/4"

benesch

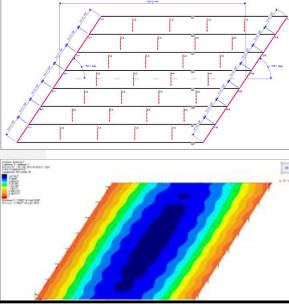
Design Updates

- AASHTO LRFD
 - 3rd Ed. to 8th Ed.
- MASH barrier update
 - Height changed from 42" to 45"
- Design truck update
 - P2016-13 PennDOT Design Truck
- Relocated stage construction joint

benesch

Steel Analysis Considerations

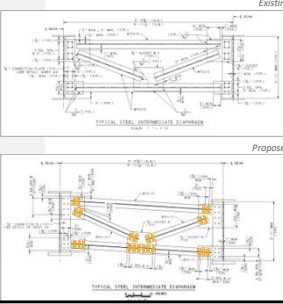
- Skew = 34°
- Line girder analysis for beam design
- Refined analysis
- Cross frame design
- Uplift
- Bearing rotations
- Bottom flange lateral forces



benesch

Cross Frames

- Welded connections
 - Fatigue analysis failed
- Updated to bolted connection
- Final stiffener connections to be field drilled

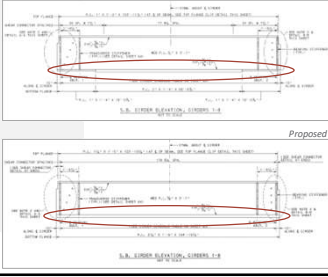


benesch

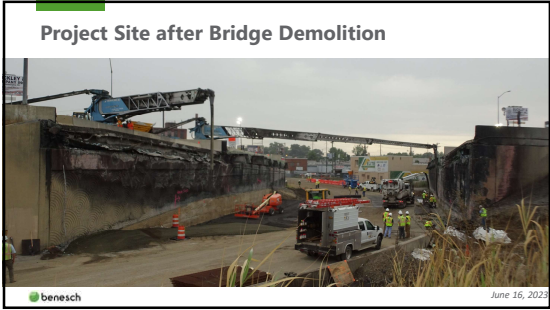
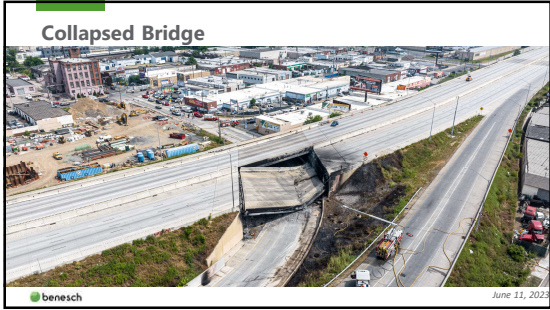
Beam Design

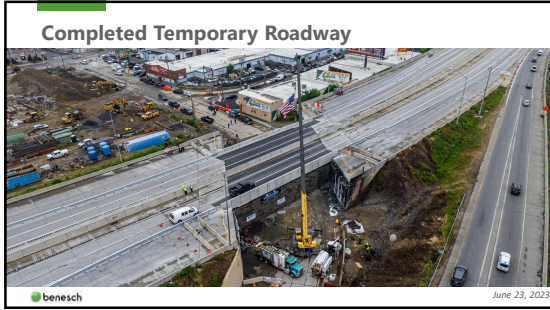
	Existing	Proposed
Top Flange	1" x 14"	1 3/4" x 17"
Web	3/8" x 43"	3/4" x 43"
Bottom Flange	1" x 14"	2 3/4" x 17"
	1" x 14"	1" x 14"

- Minor updates to beam clips, bearings, and anchor rods



benesch







Team Acknowledgements

Owner: pennsylvania DEPARTMENT OF TRANSPORTATION

Contractor: B&C CONTRACTORS

Designer: benesch

Subcontractors:

- AERO AGGREGATES:** Ultra-lightweight fill supplier
- A.D. MARBLE:** environmental cultural engineering; Environmental clearance documentation
- Faddis:** Bilateral Median Barrier fabrication
- C. Ableson Contractors Inc.:** Bridge demolition
- AECOM:** Initial damage inspection
- Jacobs:** Immediate MPD (closure) plans
- J. HIGH STEEL STRUCTURES:** Steel beam fabrication
- JMT:** Construction inspection
- HILL International:** Construction management
- AEG:** Settlement assessment; for temporary roadway loading
- Schnabel:** Wire-ropeless wall system design (for bridge buckles & bearing capacity)

benesch



The I-95 solution was a true testament to collaboration, expertise, and resilience.

*"That's all due to the incredible coordination with our local, state, and federal partners."
- PA Governor Josh Shapiro*

AWARD RECOGNITION

- WTS 2023 Innovative Transportation Solution Award
- APC 2023 Remarkable Achievement Award
- ACEC/PA 2024 Grand Conceptor Diamond Award for Engineering Excellence
2024 Best Panel Design Award
- NSPE-PA 2024 Outstanding Project Award
- ESWIP 2023 Emergency Response Project of the Year
- ACEC 2024 National Recognition Award
- ASME 2023 Project of the Year "Special Project" Award

benesch

Pressure from Political Interest


- PA Governor, PA & US Transportation Secretaries, US President

benesch

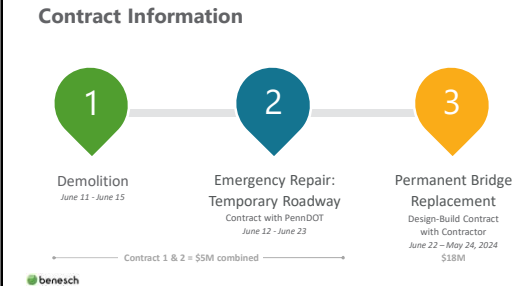
Construction Livestream

benesch

Undoing Detours



Contract Information



1 Demolition
June 11 - June 15

2 Emergency Repair:
Temporary Roadway
Contract with PennDOT
June 12 - June 23

3 Permanent Bridge
Replacement
Design-Build Contract
with Contractor
June 22 - May 24, 2024
\$18M

Contract 1 & 2 = \$5M combined
