



From UHPC Graduate Scholars to Technical Field Experts



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UHPC Research at the University of Alabama



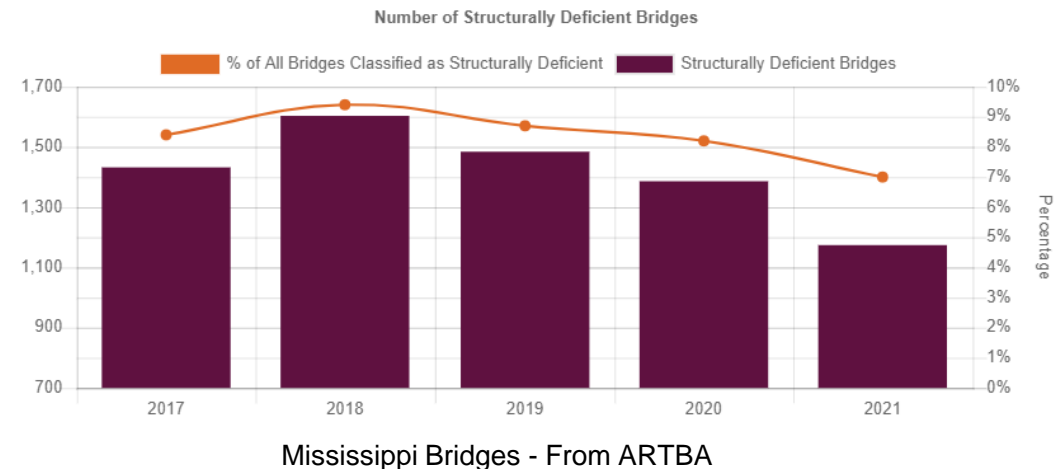
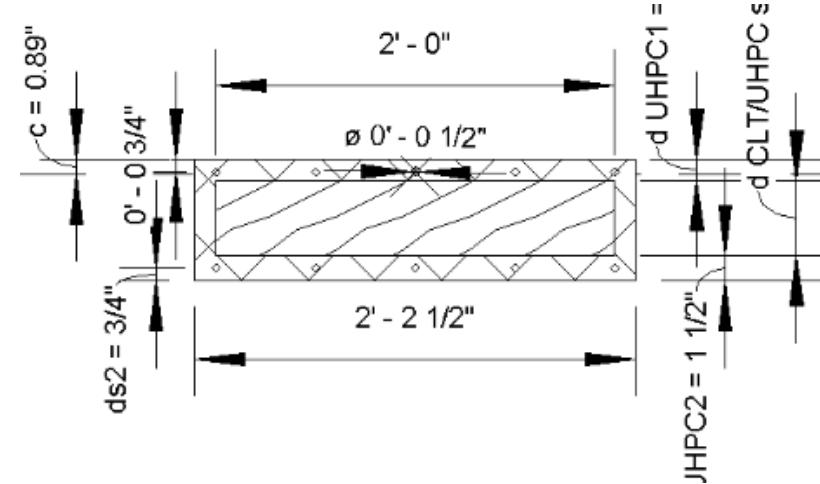
- Worked under Dr. Sriram Aaleti
 - Large scale structures lab
- UHPC for structural applications
 - Fiber distribution
 - Seismic footings and retrofits
 - Foundation elements
 - Composite action with other engineering materials
 - Impact response
 - Fire resistance



UHPC/CLT Composite Bridge Deck Panel

Introduction

- Over 1,600 Structurally Deficient Bridges in AL & MS – Rural, Local Roads
- Focus on Short-Span Bridge Deck Replacements
- Cross-Laminated Timber available locally in AL
- Increase Capacity of bridge while lowering weight.
- Goal is to research a solution for ALDOT and MDOT that is economically and environmentally sustainable.



UHPC/CLT Composite Bridge Deck Panel

Individual Study of Materials

- UHPC Compression & Flexural Tension
- CLT Mechanical Properties (by others)
- UHPC/CLT Shear Concepts
- Water Intrusion of UHPC (Durability)

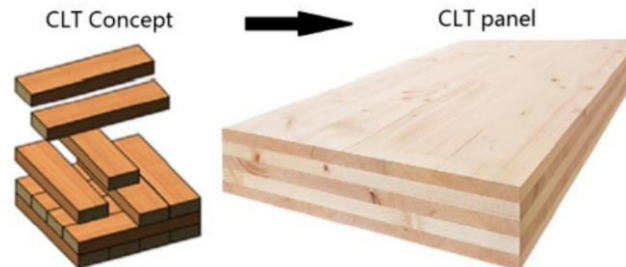
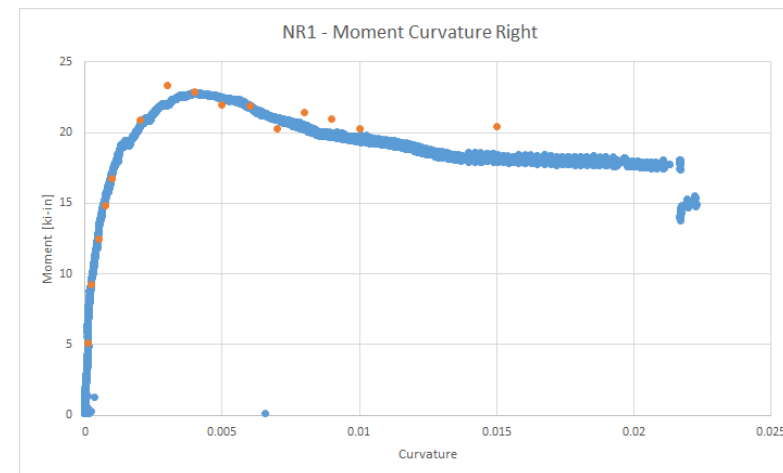
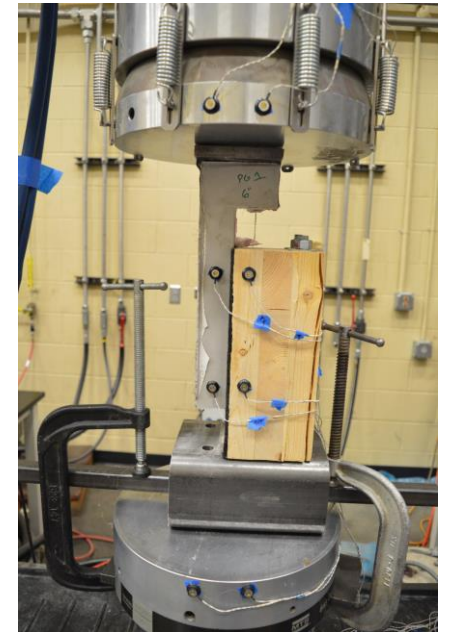
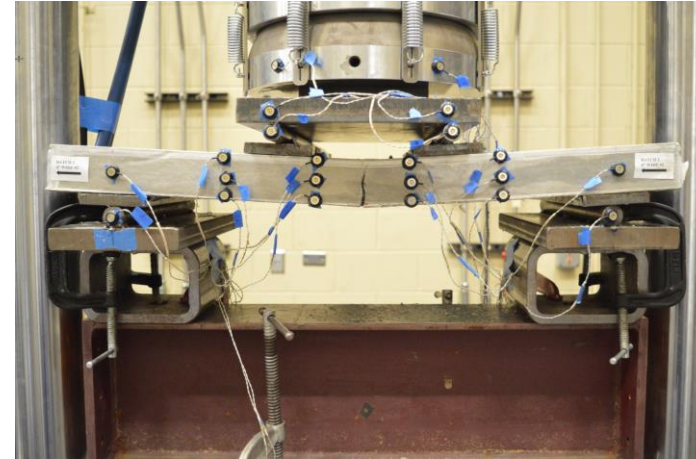


Fig. 3 – CLT Concept and Panel



UHPC/CLT Composite Bridge Deck Panel

Final Sample Construction & Testing

- 2 Samples (3-Ply and 5-Ply CLT)
- 5-Ply Failed at 64 Kips; 3-Ply Failed at 38 Kips
- Nominal Strengths were 62 Kips and 31 Kips
 - Strain Compatibility Analysis



UHPC/CLT Composite Bridge Deck Panel

Conclusion

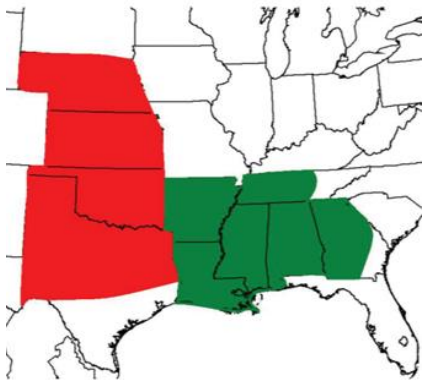
- Viable option for ABC
 - Precast Option
- Lightweight efficient Design
- Local AL & MS Materials



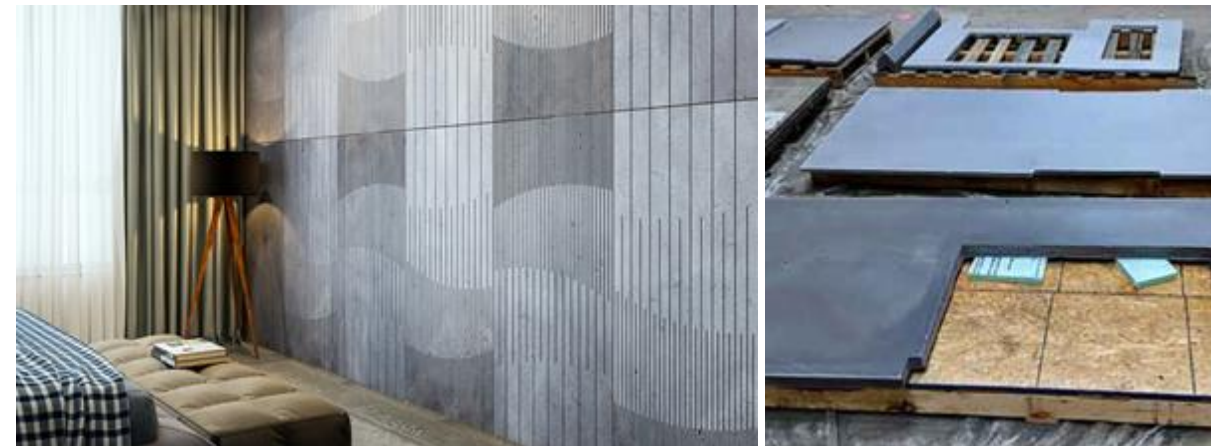
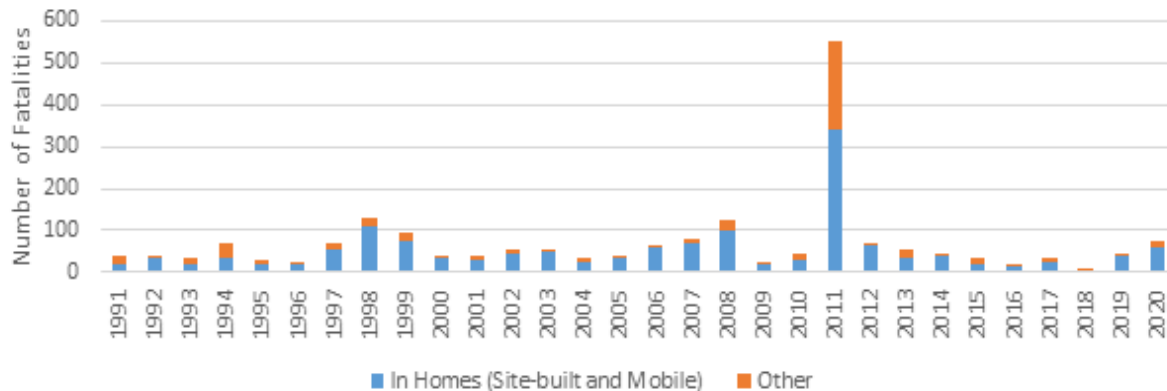
UHPC Panels under Tornado Impact Loads

Introduction

- Tornadoes inflict tragedy across the United States each year
- Most fatalities occur inside the home
- Many shelter options exist, but they are often intrusive, clunky, and expensive
- Literature shows UHPC has exceptional impact resistance and extremely versatile casting options

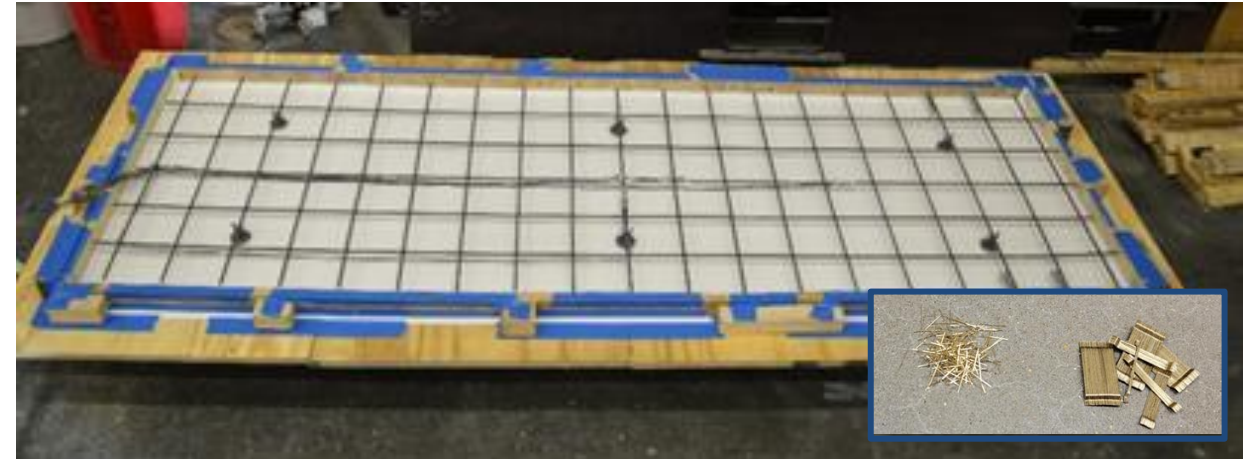


Tornado Deaths by Year in the United States, 1991-2020



UHPC Panels under Tornado Impact Loads

Experimental Design

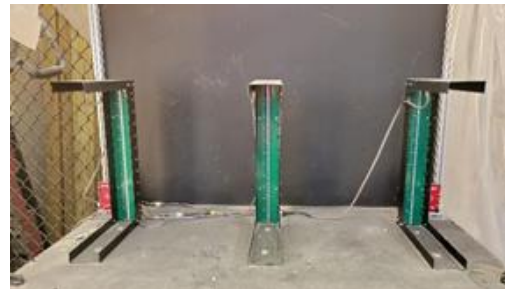
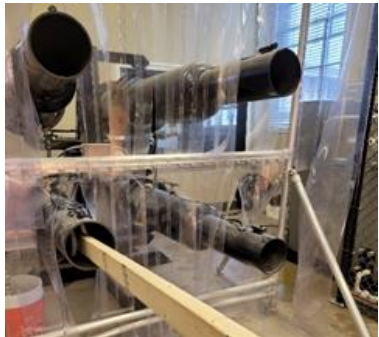
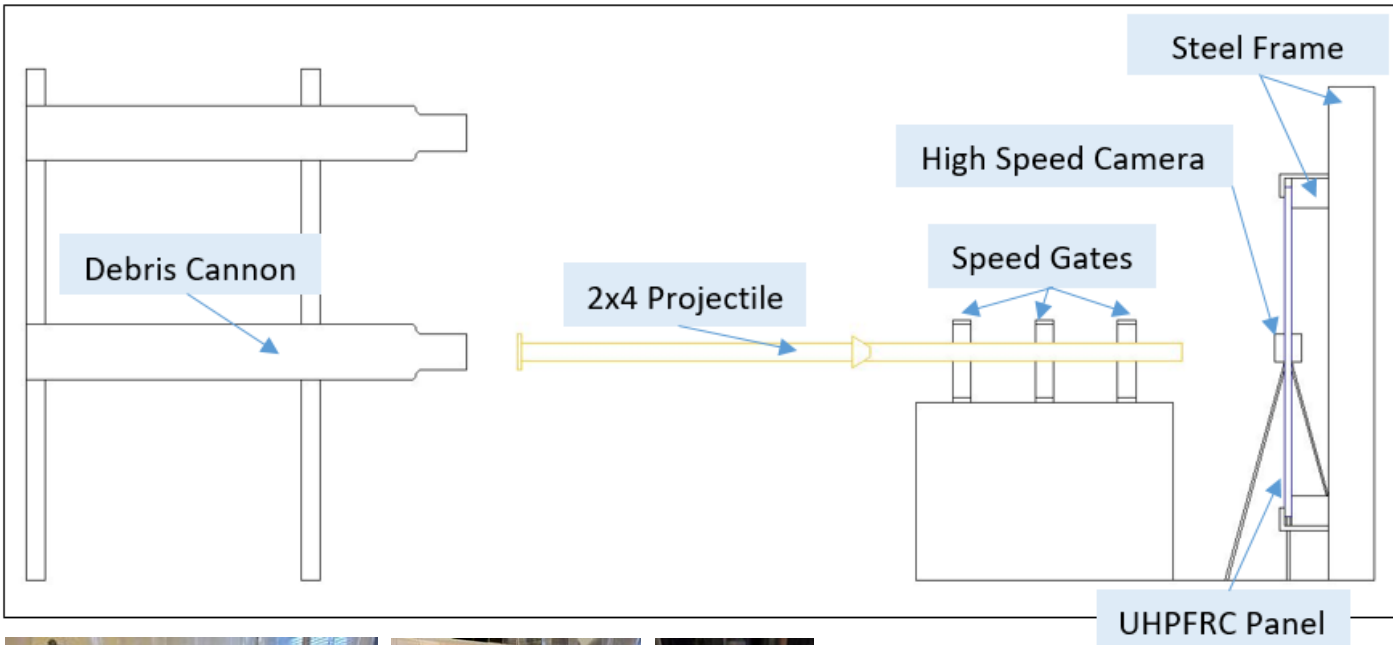


- ICC / NSSA 500 design guidelines
 - 15lb wood projectile at 100 mph
 - No spalling, 3-inch max deflection
- Suggestions from the literature
 - 1.25-inch and 1.625-inch thickness
 - Kinetic energy transfer, energy-mass-fiber relationship
 - 2% steel fibers, comparing shapes, mesh reinforcement

Specimen Name	Missile Length (in)	Missile Weight (lbf)	Target/Actual Missile Speed (mph)	Impact Energy (lbf-ft)	Impact Energy per Mass of Panel (lbf-ft/lbm)
AS_1.25x12	132	15.0	50 / 53	1407	14.1
AS_1.625x12	144	14.7	75 / 75	2762	21.2
AS_1.25x24	144	15.2	75 / 73	2706	13.5
AS_1.625x24	129	15.1	100 / 100	5044	19.4
SS_1.25x12	144	15.2	50 / 56	1592	15.9
SB_1.25x12	144	15.2	50 / 56	1592	15.9
Full_1.25	162	15.0	100	5010	12.5
Full_1.625	162	15.0	100	5010	9.6

UHPC Panels under Tornado Impact Loads

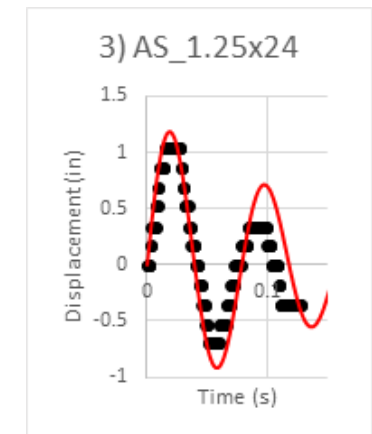
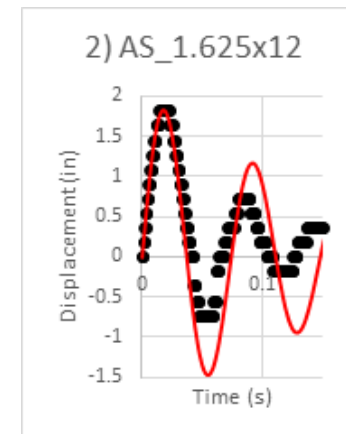
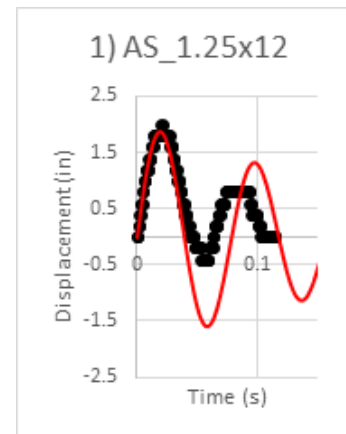
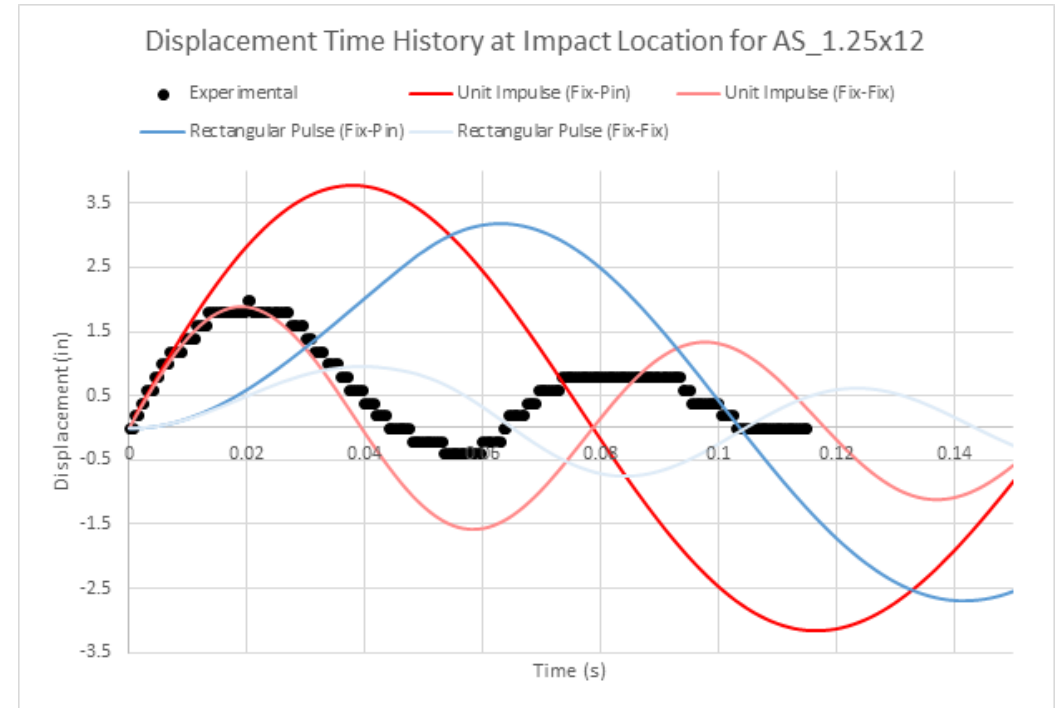
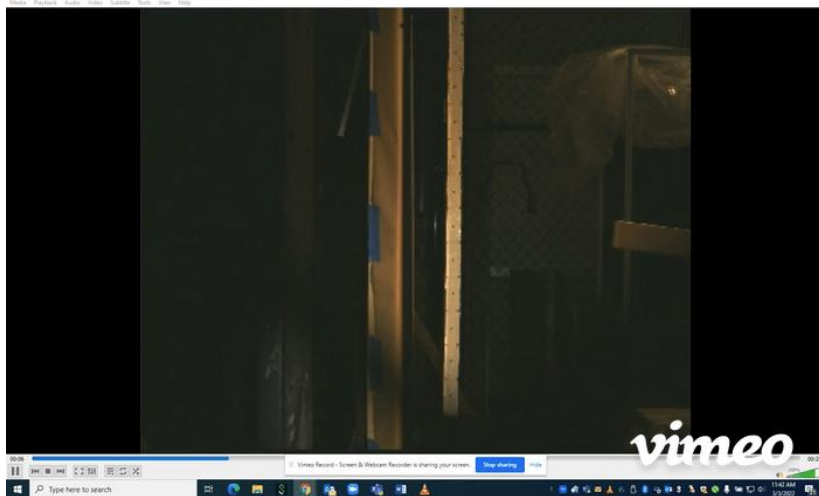
Experimental Design





UHPC Panels under Tornado Impact Loads

Results – Dynamic Modeling



UHPC Panels under Tornado Impact Loads

Results – Design Recommendations

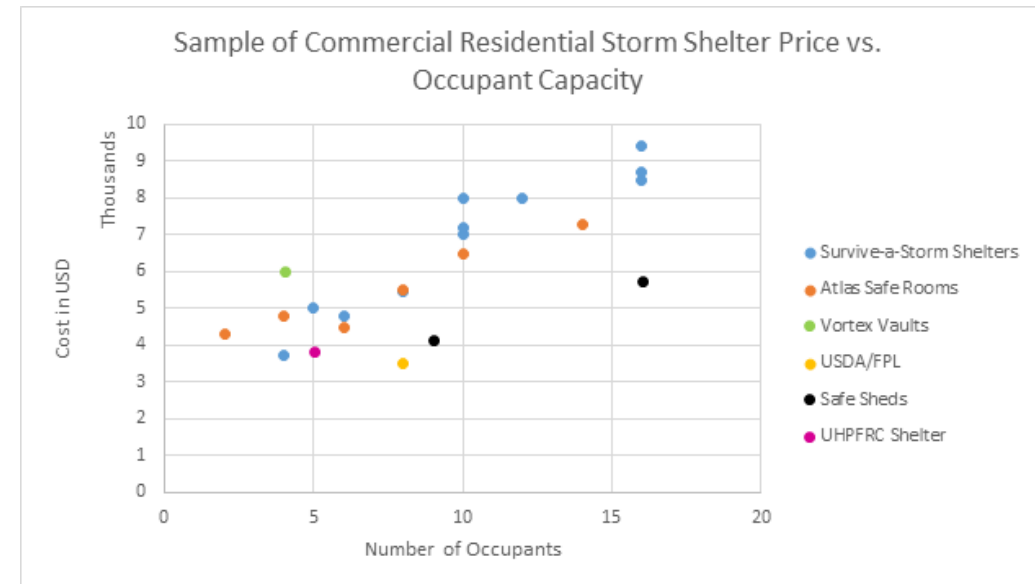


Successful Panel – 1.25-inch thick



Failed Panel – 1.625-inch thick

- Encourage panels to fail via flexure instead of punching shear
 - Utilize high ductility of UHPC
 - 1.625-inch thickness is too stiff
- Cost competitive for 4' x 4' x 6' shelter (5-person occupancy)
 - Traditional stand-alone design
 - Retrofit closet
 - Entire structure?





Current Involvement with UHPC

Smart-Up Technical Service Engineer

- Material supplier
- Technical expertise
 - Project planning phase
 - On job sites
- Outreach



Thouare Bridge, France (2017)



SH-15 in Lipscomb County, Texas (2021)



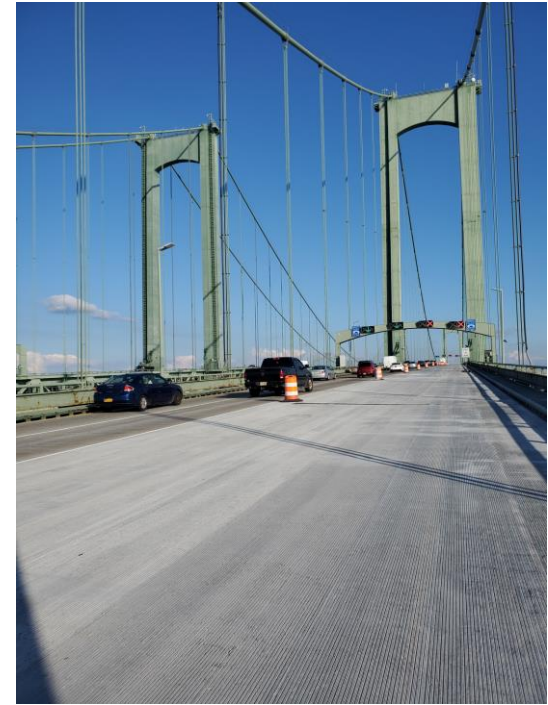
Chillon Viaduct, Switzerland (2015)



Current Involvement with UHPC

WALO Project Engineer

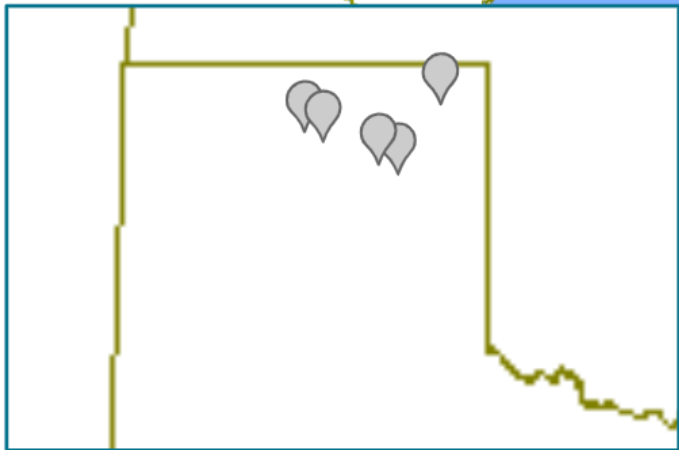
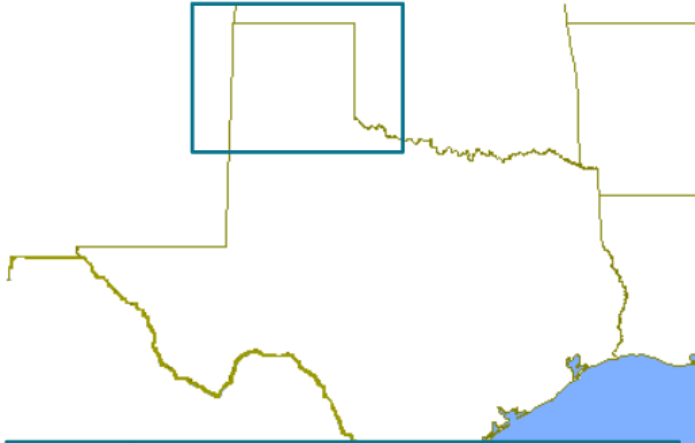
- Works Closely With **UHPC**SOLUTIONS
 - Material Expertise
 - Project Execution
- Hydro-Demolition Surface Preparation
 - Overlays
 - Joint Removal





Current Involvement with UHPC

North Texas Five Bridges Project





Current Involvement with UHPC

North Texas Five Bridges Project





Thank you!



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