**Research Project**: Nano particle reinforced composites for critical infrastructure protection

**Research Topic**: Structural Component level

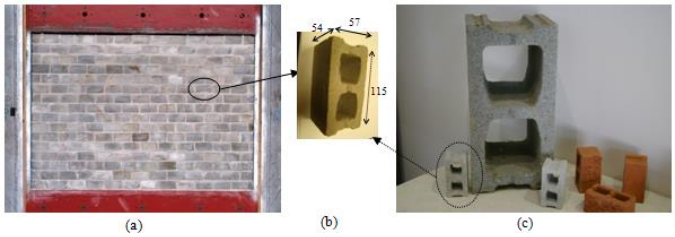
**Problem**

This part of the workplan includes the evaluation of structural components made of normal strength concrete, nanoparticle reinforced concrete, retrofitted concrete using FRP, retrofitted concrete using polyurea, and the new generation of carbon and clay nano-reinforced polymers.

**Approach**

The research focuses on performing computational simulations of components and subsystems with and without retrofit using models and parameters appropriate to the conventional or nano-composite material and the severe loading environment. Different models will be evaluated which includes Lagrange, Lagrange-Euler coupling, Lagrange-SPH models.

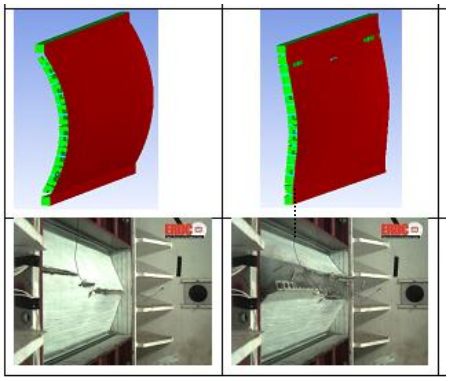
AUTODYN hydrocode that is capable of computing strains, stresses, velocities and propagation of shock wave as a function of time and position is used. In the hydrocode simulation, the response of continuum subjected to dynamic loading is governed by conservation of mass, momentum and energy, and also Equation of State EOS and constitutive relation. The EOS takes into account the effect of compressibility of the continuum.



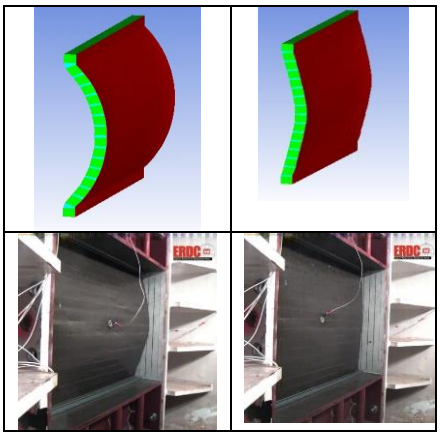

The UM project team will work closely with the ERDC Survivability and Protective Structures Branch in the Geotechnical and Structures Laboratory (GSL) to take advantage of their considerable experience with both computational simulation and physical model testing of reinforced concrete, concrete masonry, and a variety of retrofit options for components and subsystems subject to severe blast loading.

**Findings**

1. Results from blast experiments showed increase in ultimate flexural resistance achieved by both unreinforced and nano reinforced polyurea retrofit systems applied to infill masonry walls. Whereas nano reinforcing polyurea with POSS nano material improved the performance of the elastomeric retrofit for blast loading, xGnP addition show very little improvement.



***Numerical and experimental results for CMU wall retrofitted with polyuria***



***Numerical and experimental results for CMU wall retrofitted with POSS® enhanced polyurea***

2. The computational model could replicate with reasonable accuracy the masonry wall failure mechanisms, midpoint deflection and debris velocity of retrofitted CMU walls subjected to blast loads.
3. It was observed that a thin elastomeric coating on the interior face of the CMU walls could be effective at minimizing the fragmentation resulting from blast.

**Impact**

Outcome of this research will help identifying blast and severe natural hazards database of structure components

**Researcher**: Dr. Ahmed Al-Ostaz is an Associate Professors of Civil Engineering. Mohammad Irshidat is a Postdoctoral Research Associate in the Department of Civil Engineering at University of Mississippi

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Contact: Dr. Alex Cheng acheng@olemiss.edu