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## Material properties

**First trial assumption:** all materials are linear elastic


Concrete Brick Properties		
Modulus of Elasticity (E), GPa	Poisson's ratio ( $\nu$ )	Density (g/cm <sup>3</sup> )
19.70	0.25	2.44

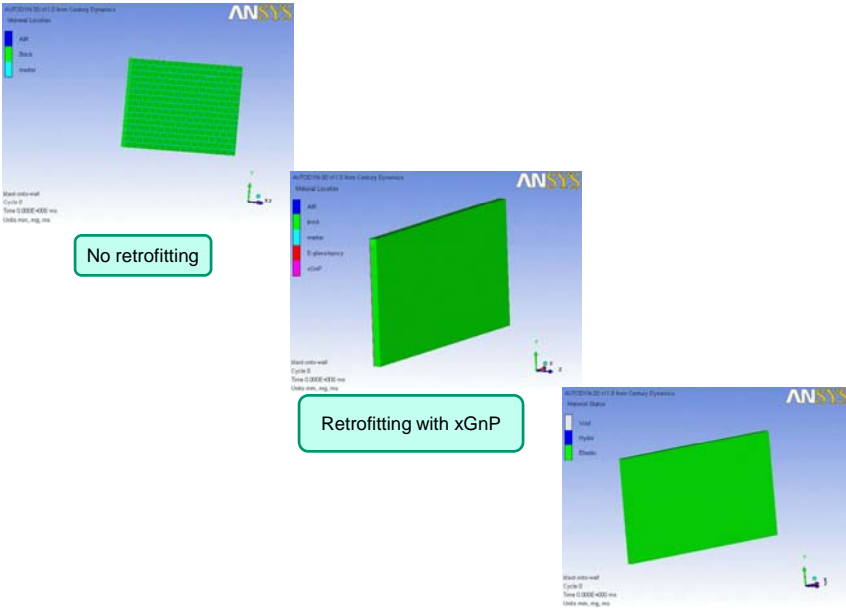
xGnP Properties		
Modulus of Elasticity (E), GPa	Poisson's ratio ( $\nu$ )	Density (g/cm <sup>3</sup> )
6.00	0.34	1.265

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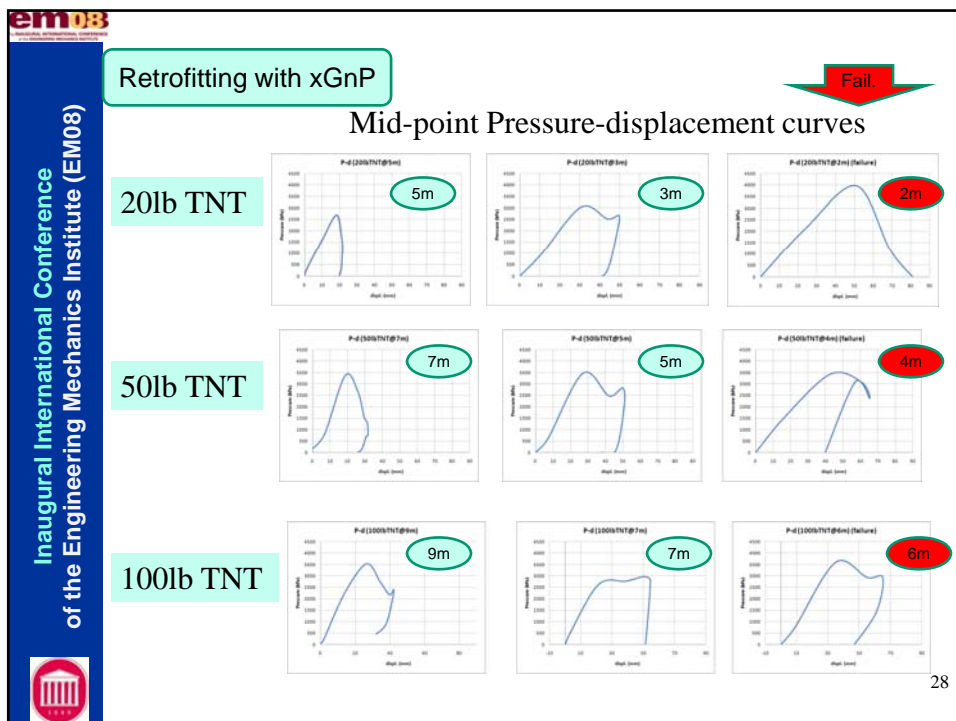
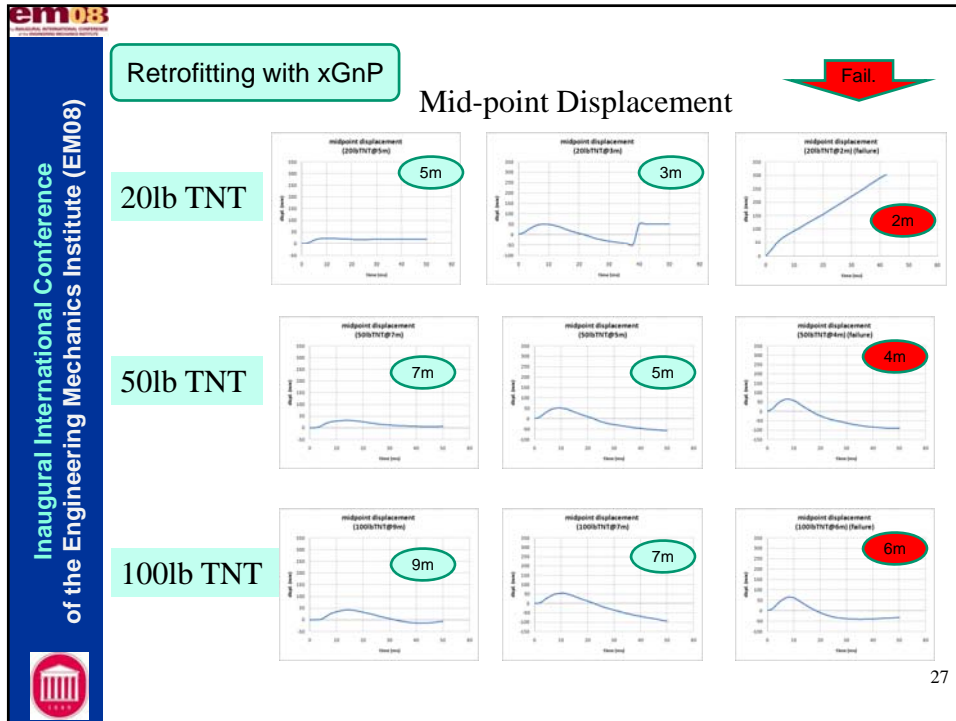


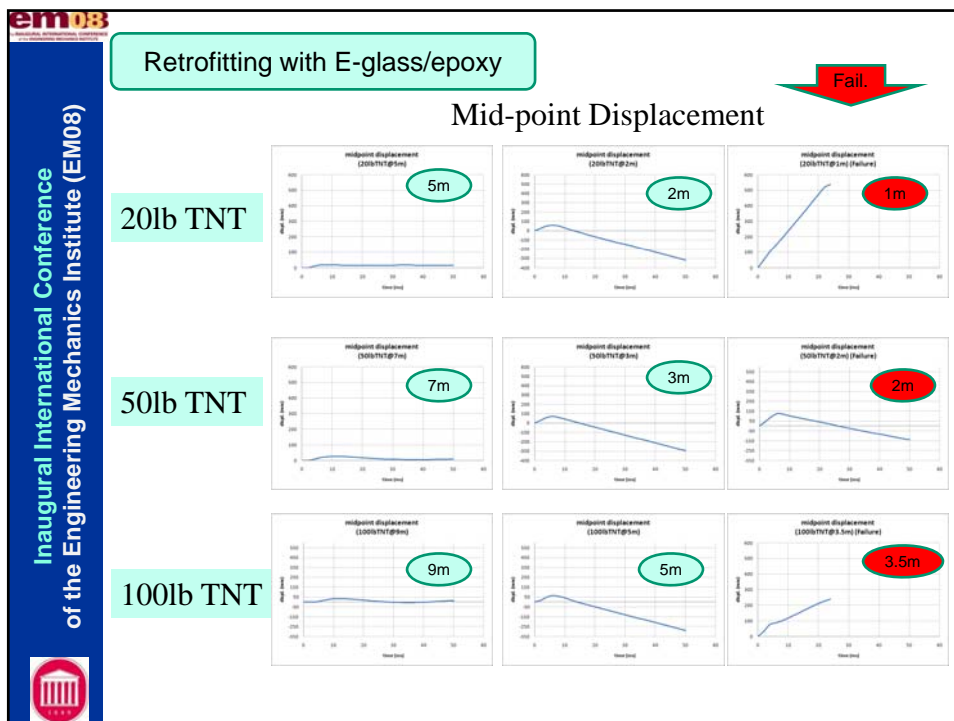
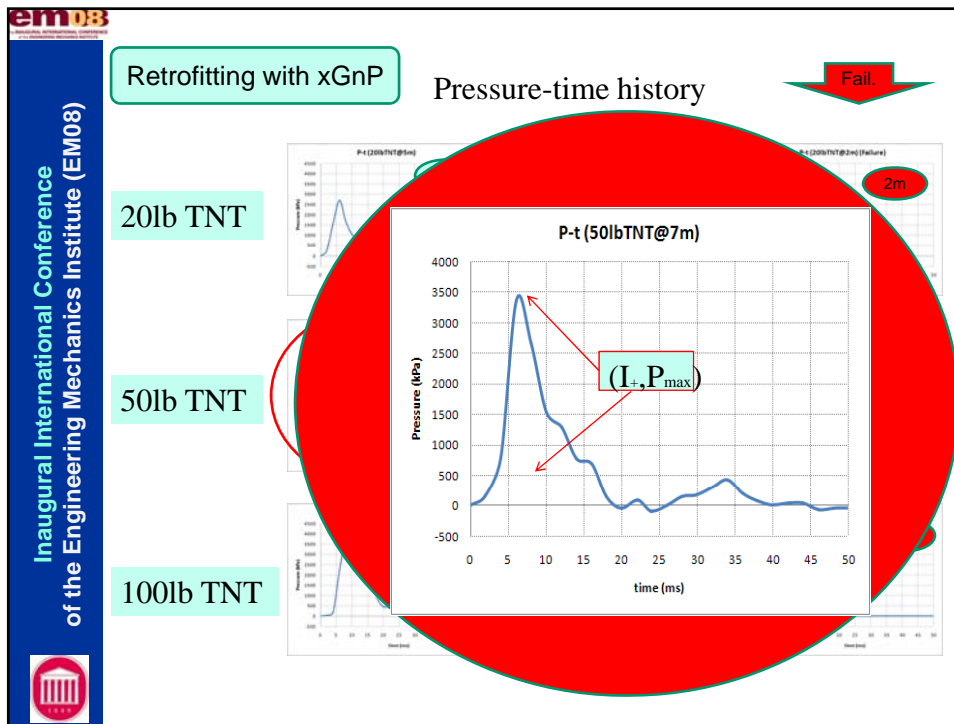
No retrofitting

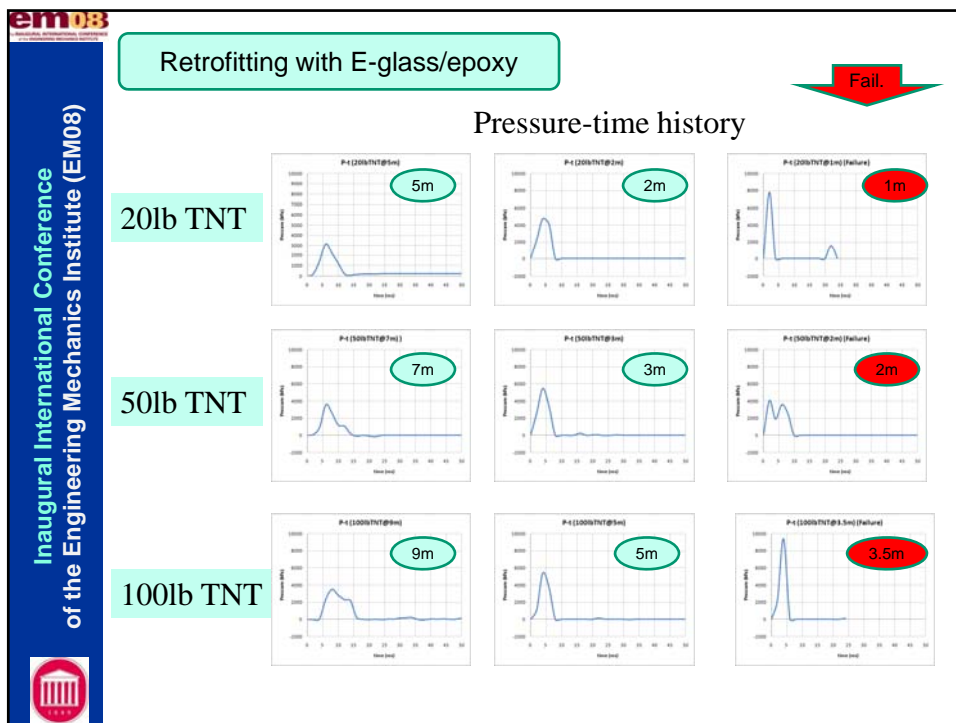
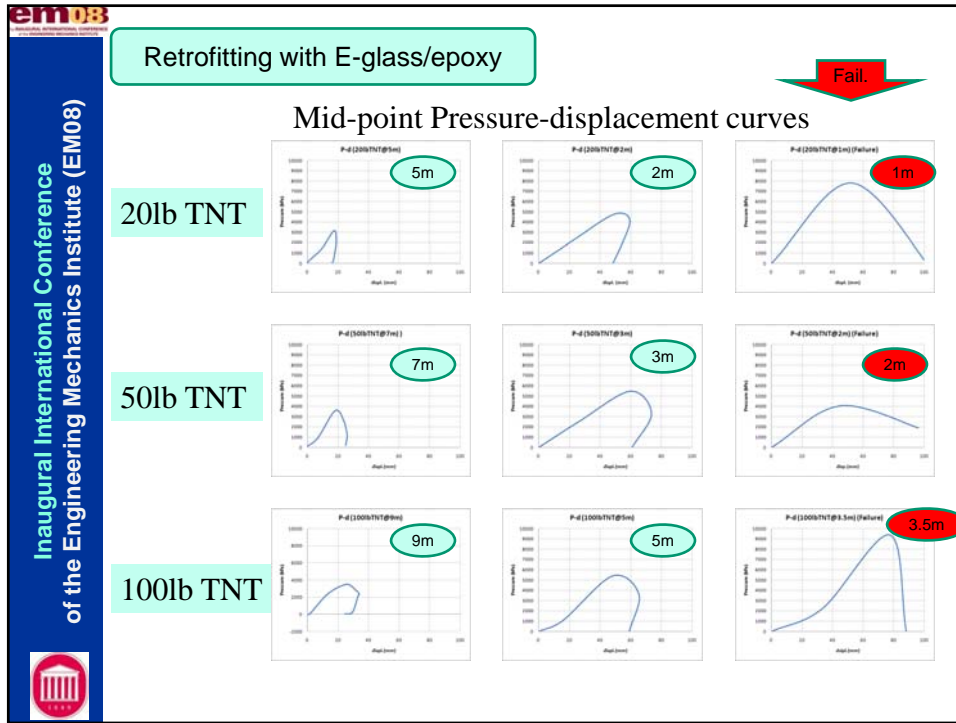
Retrofitting with xGnP

Retrofitting with E-glass/epoxy

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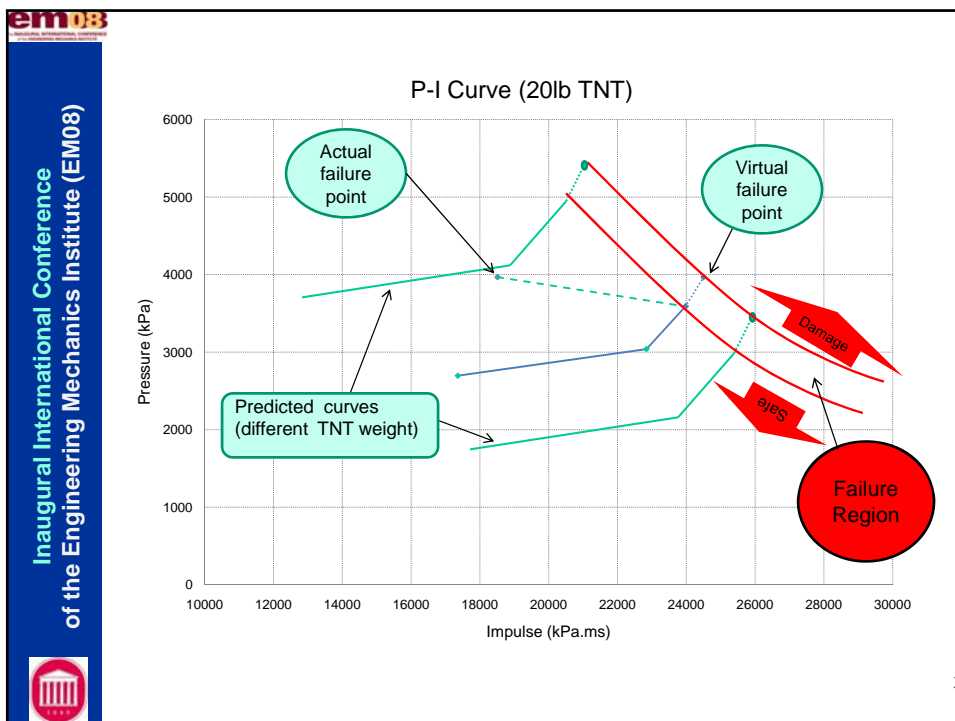


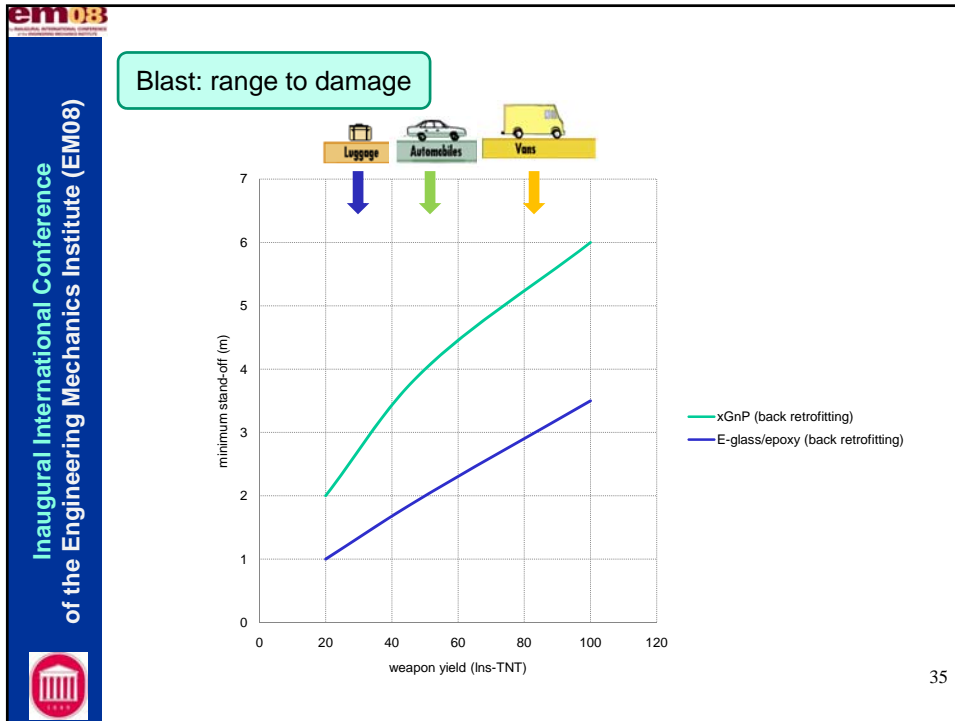


**Post-failure Analysis**

1. Damage (P-I) curve
2. Minimum stand off distance

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**Results comparison**

Detonation of 20lb TNT @3m								
Midpoint displacement (mm)			Reaction forces (N)					
xGnP	E-glass/epoxy			xGnP			E-glass/epoxy	
				bottom	top		bottom	top
49.76	42.17		Fx (N)	65.5333	393.7439		165.4223	672.8111
			Fy (N)	126.4871	4461.285		334.3672	5596.003
			Fz (N)	298.631	2136.085		1746.201	1915.167

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## Remarks/Conclusions

- It is important to develop physics-based models to better understand and engineer nano structured materials for desired properties.
- Successful retrofit not necessarily always mean protecting the member.
- Hybrid rigid-soft or in some cases functionally graded materials may be a choice.

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# THANK YOU

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