DHS Summit, Washington DC, March 2009

Blast Mitigation

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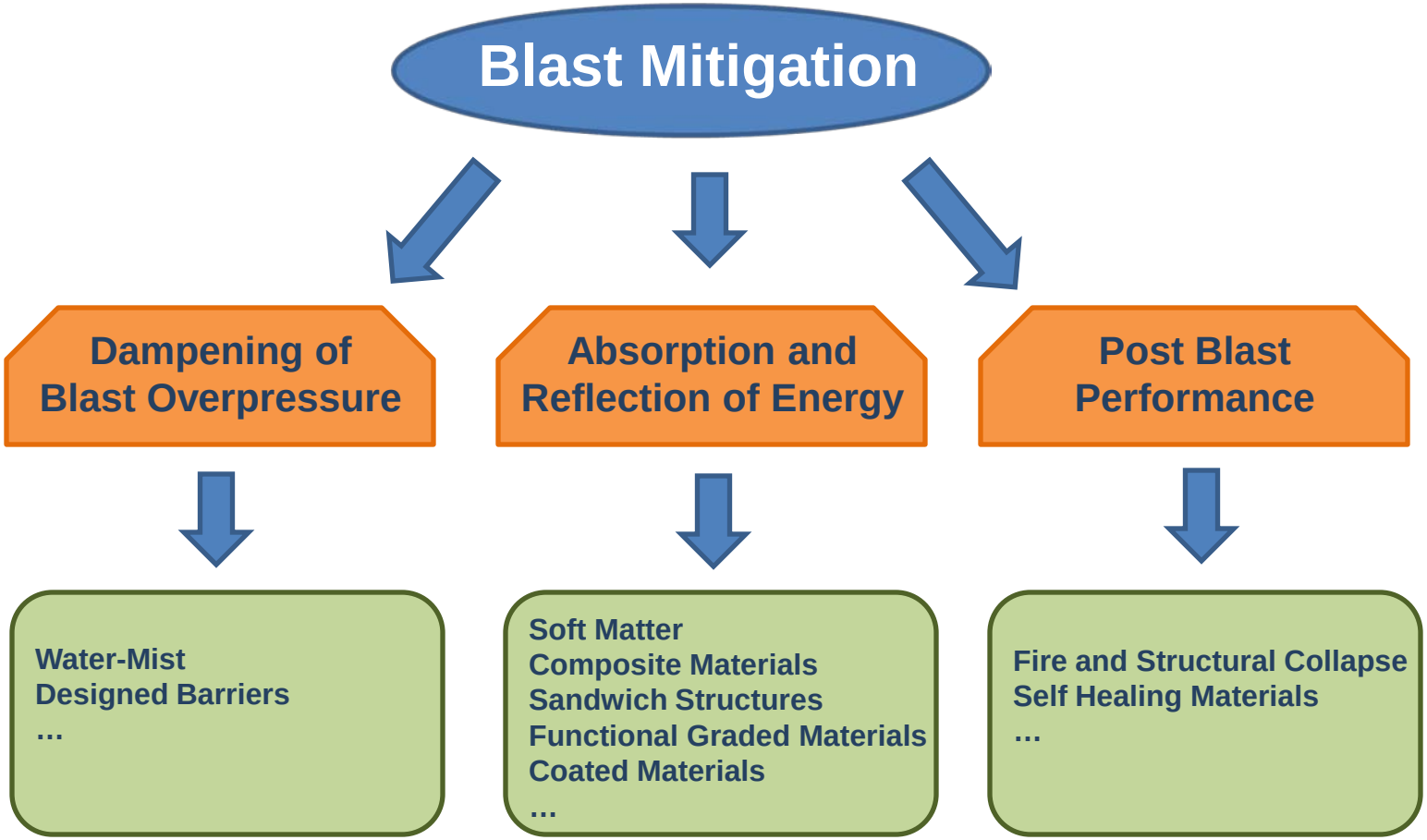
MITIGATION: Forestalling

X

the Inevitable

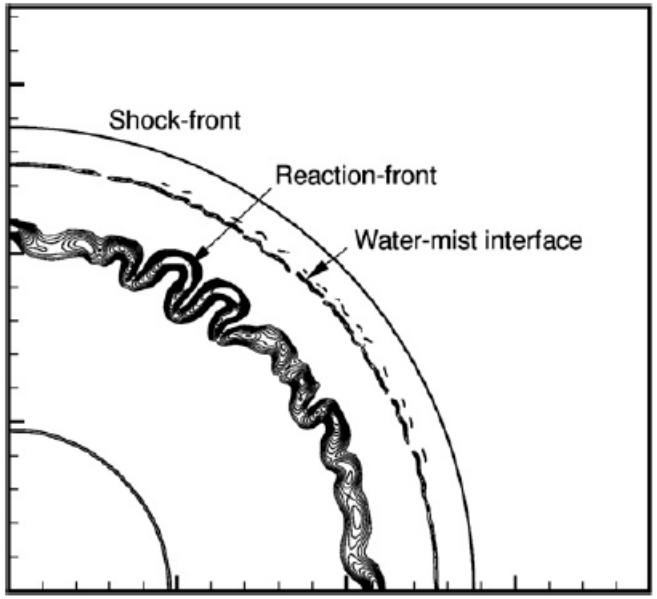
•http://www.fyfeasia.com/

Introduction

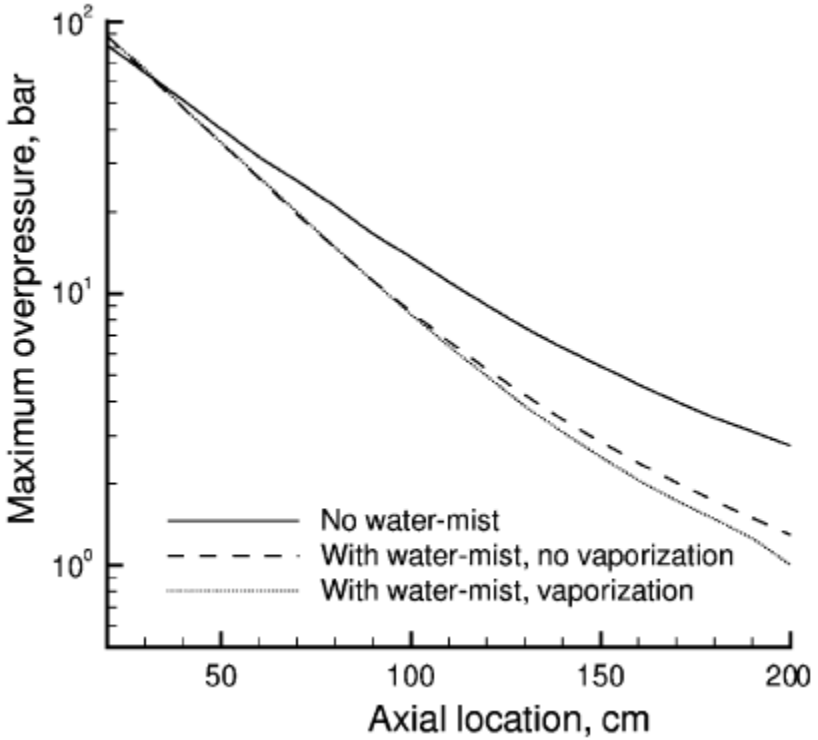


Dampening of Blast Overpressure

Water-Mist:



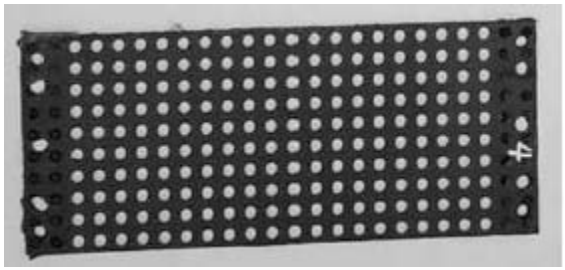
A blast of 2.12 kg TNT, 1 ms after detonation

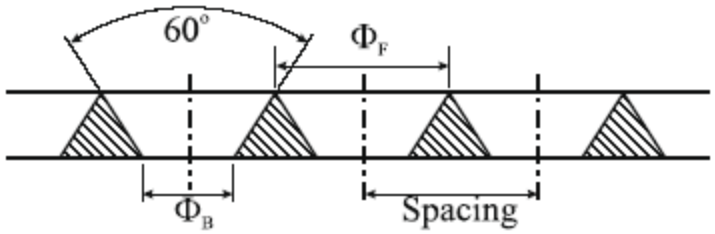


Douglas A. Schwer, K. Kailasanath, Proceedings of the Combustion Institute 31 (2007) 2361–2369

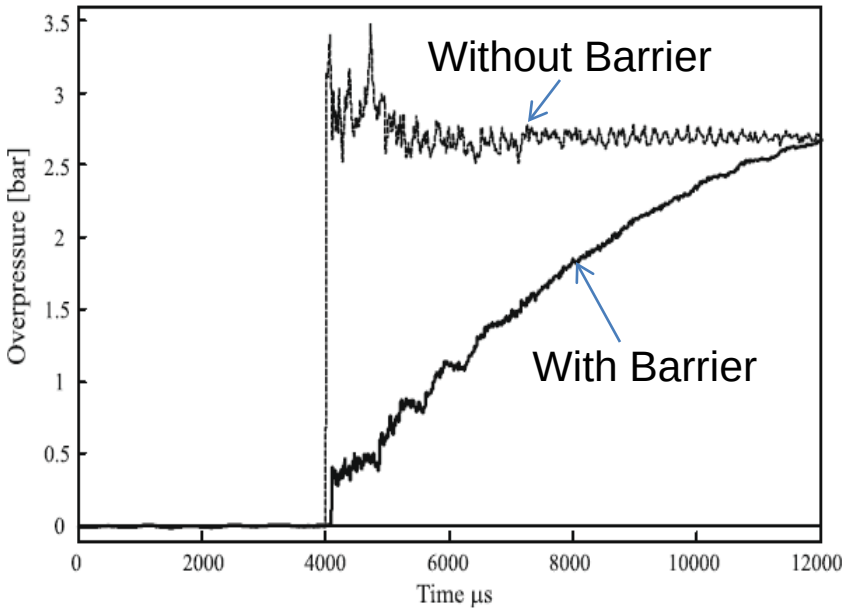
Dampening of Blast Overpressure

Designed Hard Barrier:





Barrier with tapered holes

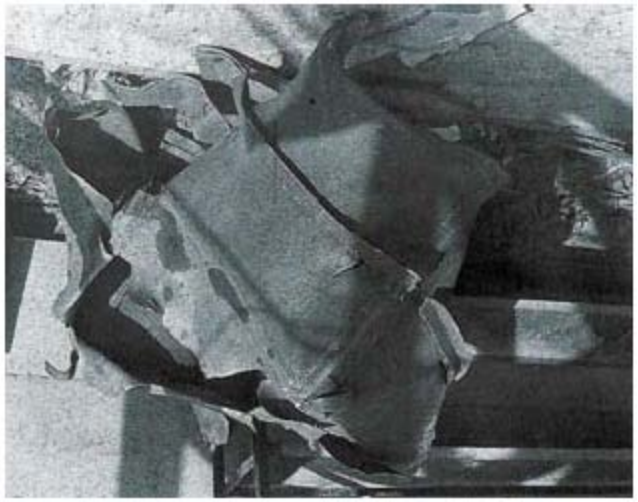


Sumil Seeraj, Beric W. Skews, Experimental Thermal and Fluid Science 33 (2009) 503–516

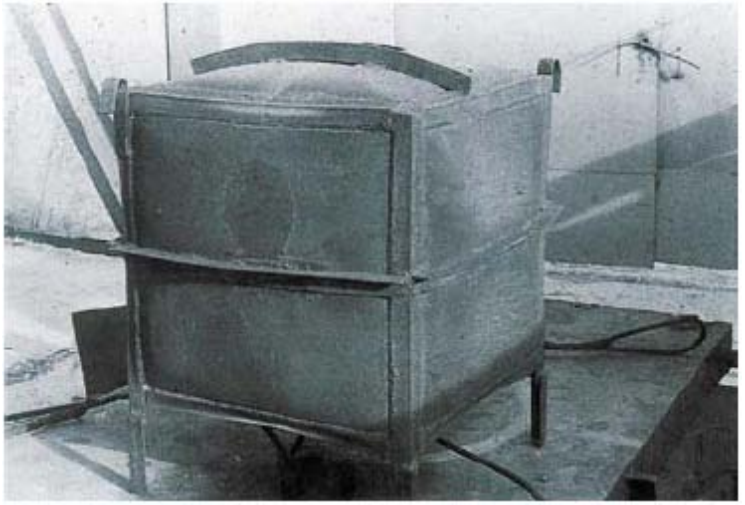
Absorption and Reflection of Energy

Soft-Matter:

Granular, porous materials, foams



Catastrophical failure of steel structure after inside explosion in air



Confined explosion in the same structure filled with sawdust

Explosive (RDX) mass was 0.5 kg in both cases, wall thickness of containers 3 mm, side 0.7 m, sawdust density 100 kg/m^3

V.F. Nesterenko, Dynamics of Heterogeneous Materials, Springer-Verlag, New York, 2001

Absorption and Reflection of Energy

Composite Materials:

Unretrofitted column

Retrofitted column

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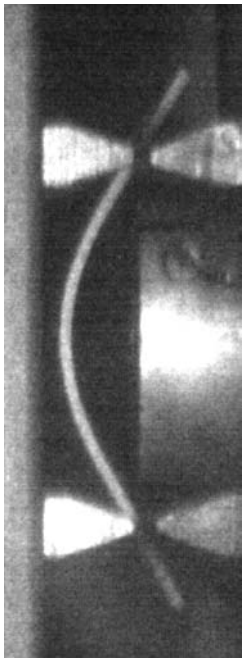
Absorption and Reflection of Energy

Sandwich Structures:

Blast Overpressure

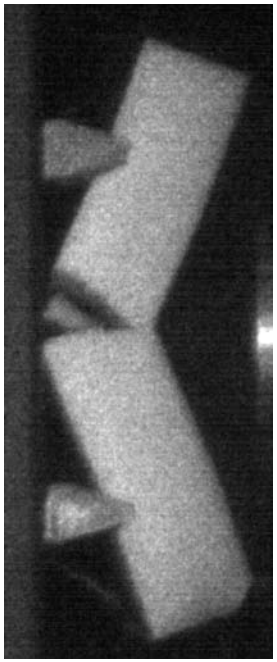
0.35 MPa



Face Sheet

Total Collapse

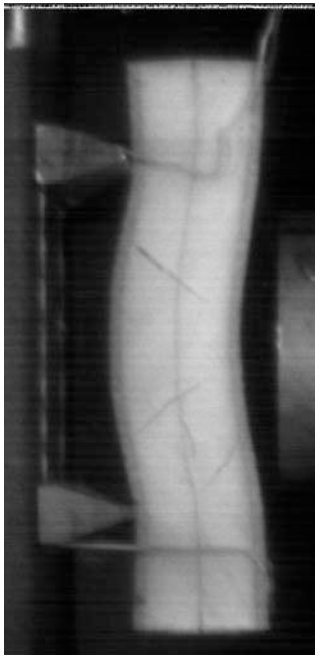
0.35 MPa



Foam Core

Total Collapse

2 MPa



Sandwich Structure

Can withstand more intensive blast loading

The sandwich structure can stand much higher blast loading than that components can.

Shukla et.al. URI, 2009

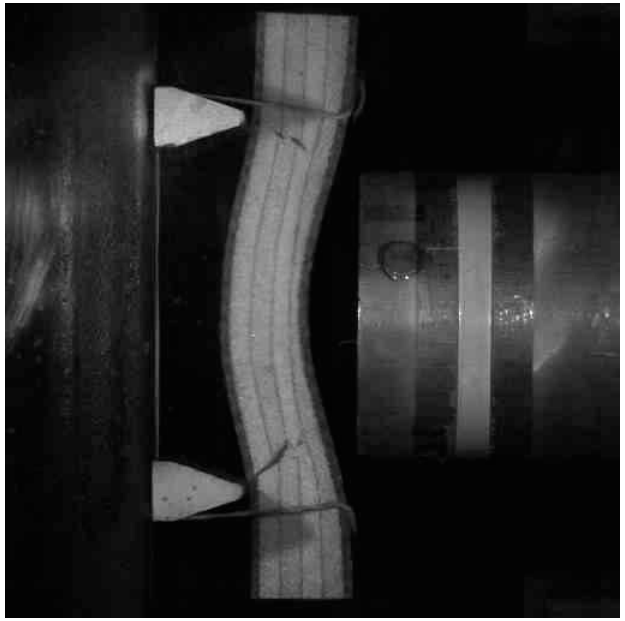
Absorption and Reflection of Energy

Sandwich Structures:

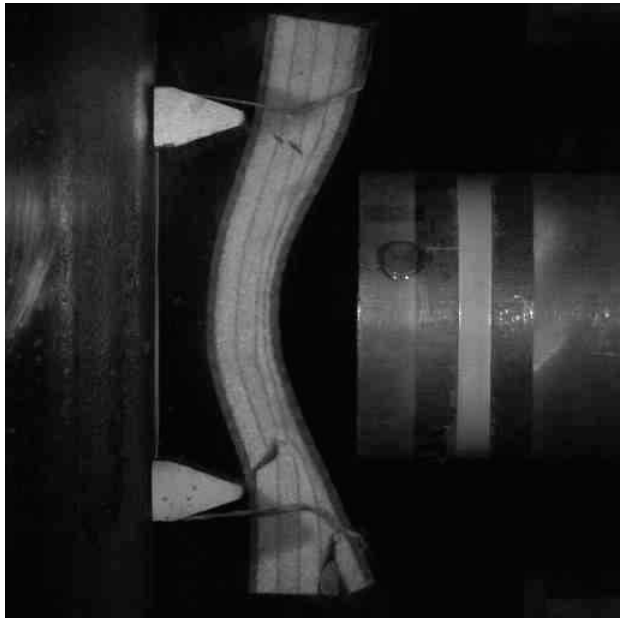
Shukla et.al. URI, 2009

Absorption and Reflection of Energy

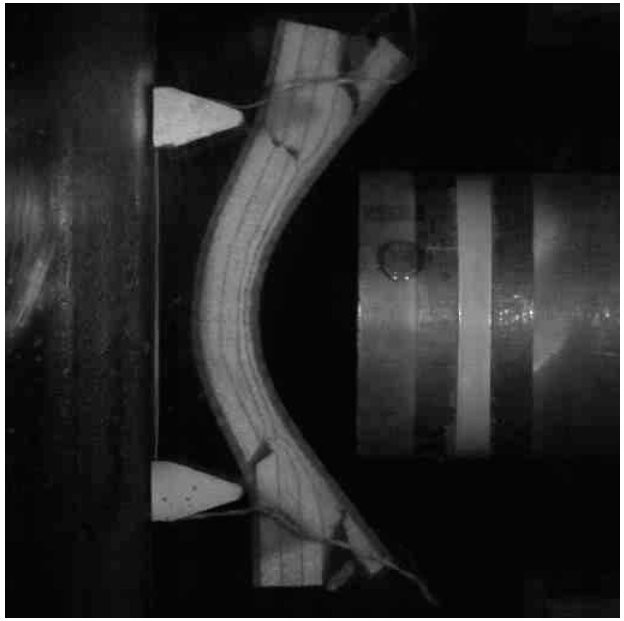
Functionally Graded Materials:



1st Layer Compression



2nd Layer Compression

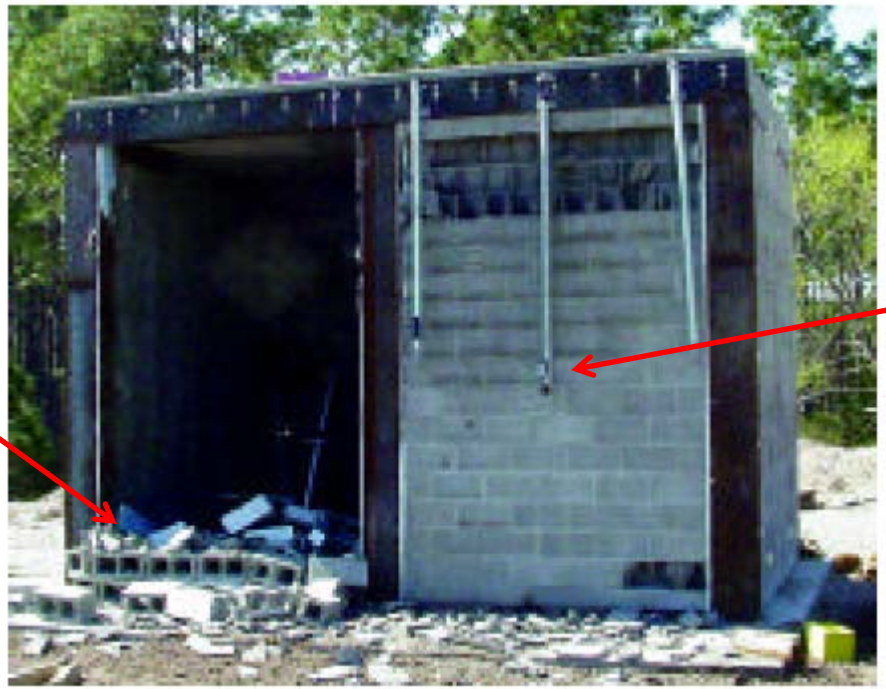


3rd Layer Compression

Shukla et.al. URI, 2009

Absorption and Reflection of Energy

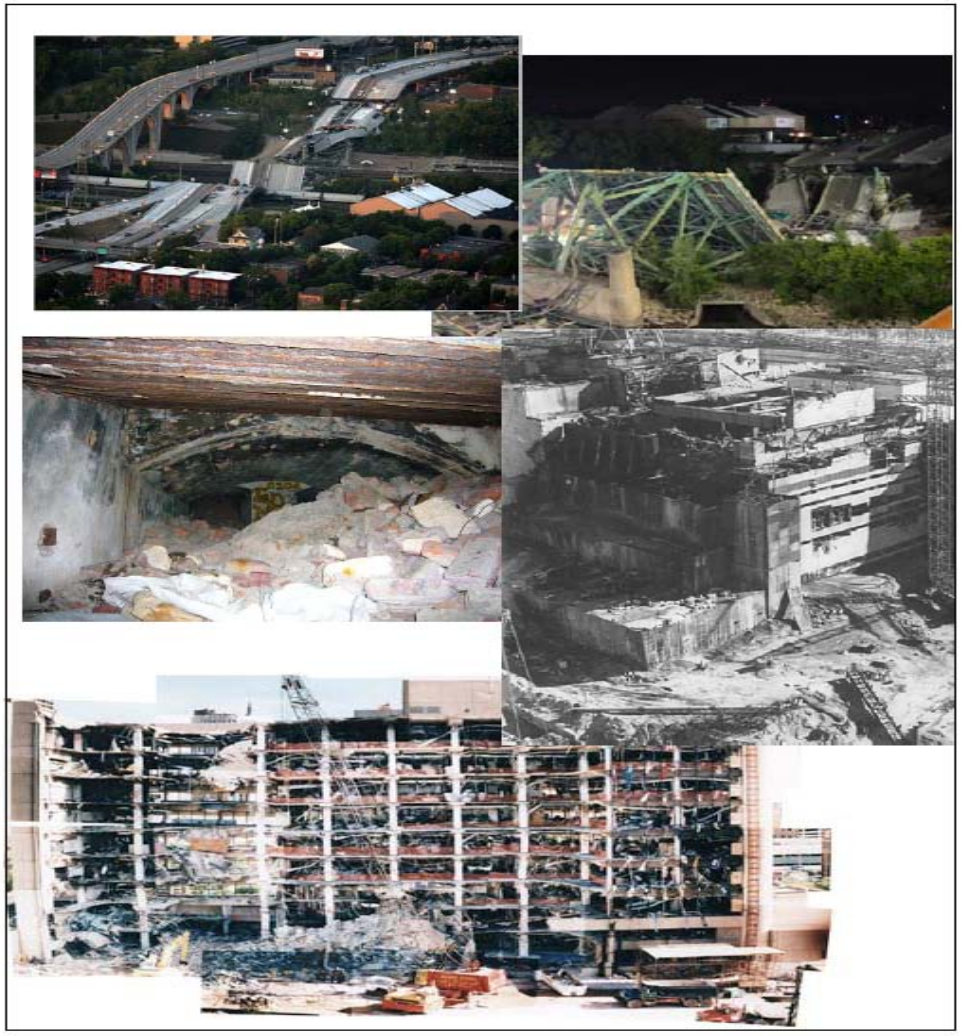
Coated Materials:



A series of explosive performance tests on CMU (concrete masonry unit) walls were conducted at Tyndall Air Force Base and in Israel. In general, post-test observations indicated that the exterior faces of the CMU were shattered at least half way through the CMU, with the interior faces of the CMU remaining adhered to the polymer liner.

AMPTIAC Quarterly Volume 6 Number 4

Mitigation of Fire and Structural Collapse



•http://www.fyfeasia.com/

Mitigation of Fire and Structural Collapse

Without polypropylene fibers

With polypropylene fibers

Hydrocarbon Fires differ from conventional fires because their heat gain is very rapid. The temperature of the moisture vapor entrapped in the concrete rises rapidly and turns to steam at 100 C. Unable to dissipate quickly through the microstructure of the concrete the pressure builds up causing an explosive spalling or "pop-corn cracking" of the concrete.

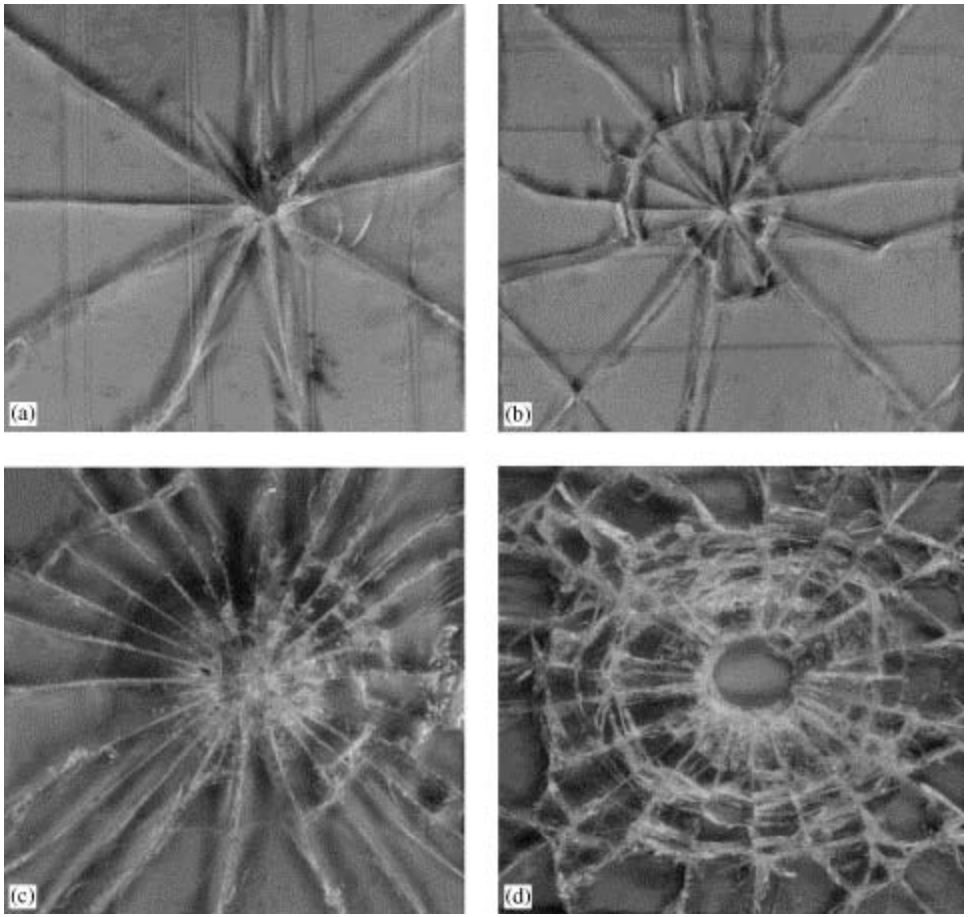
Experiment: 5kg/m^3 of polypropylene fibers were added within the concrete mix.

In the event of a fire, these fibers tend to melt, increasing the porosity of the concrete and thereby dissipating the pressure build-up, which would otherwise occur.

Fire Induced Progressive Collapse, David Scott, Barbara Lane, Craig Gibbons, ARUP Consulting NY

Post Blast Performance

Safety Glasses:



Glass samples subjected to different loading modes.

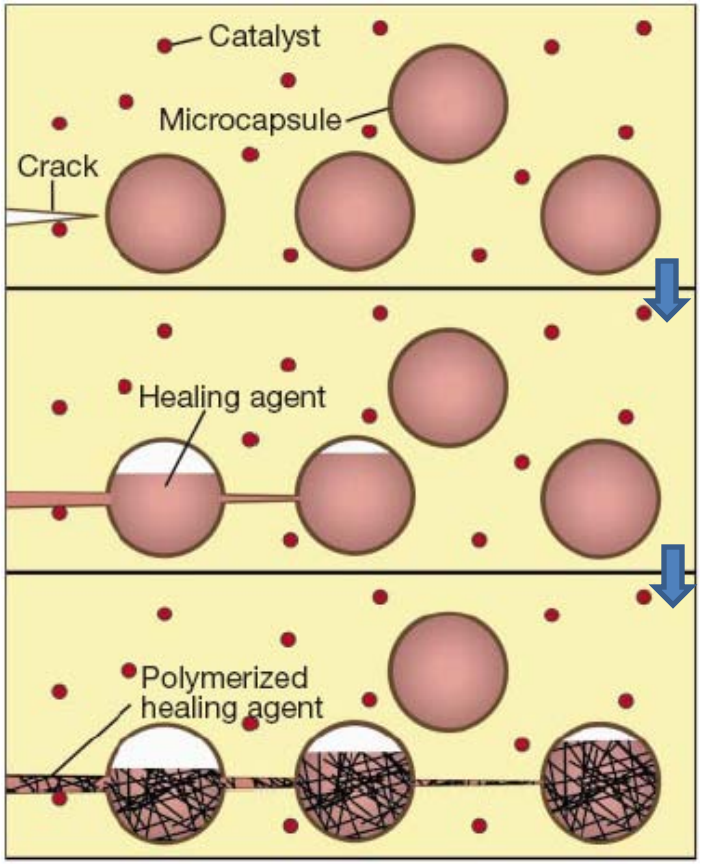
(a, b): test by drop ball (low loading rates)

(c, d): test by Hopkinson bars (high loading rates).

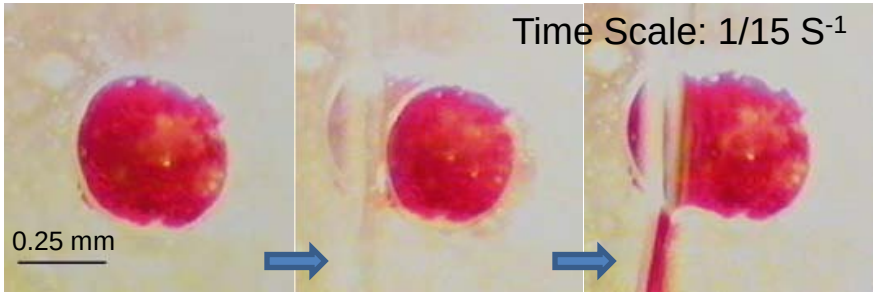
S. Bouzid et al, International Journal of Impact Engineering, 25 (2001): 831-845

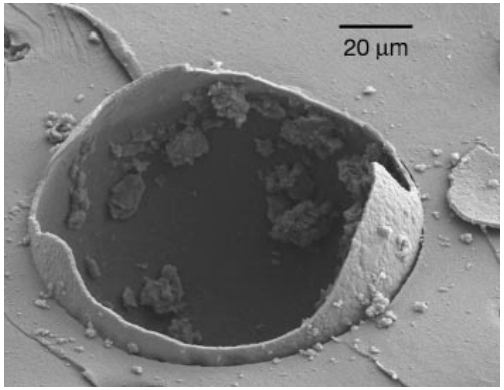
Post Blast Performance

Self-Healing Materials:



Real Process

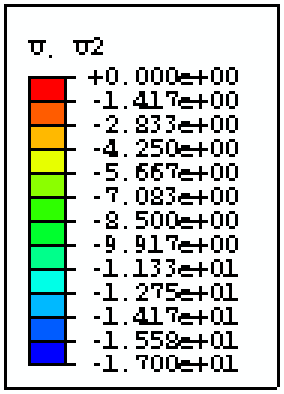


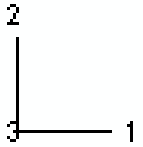


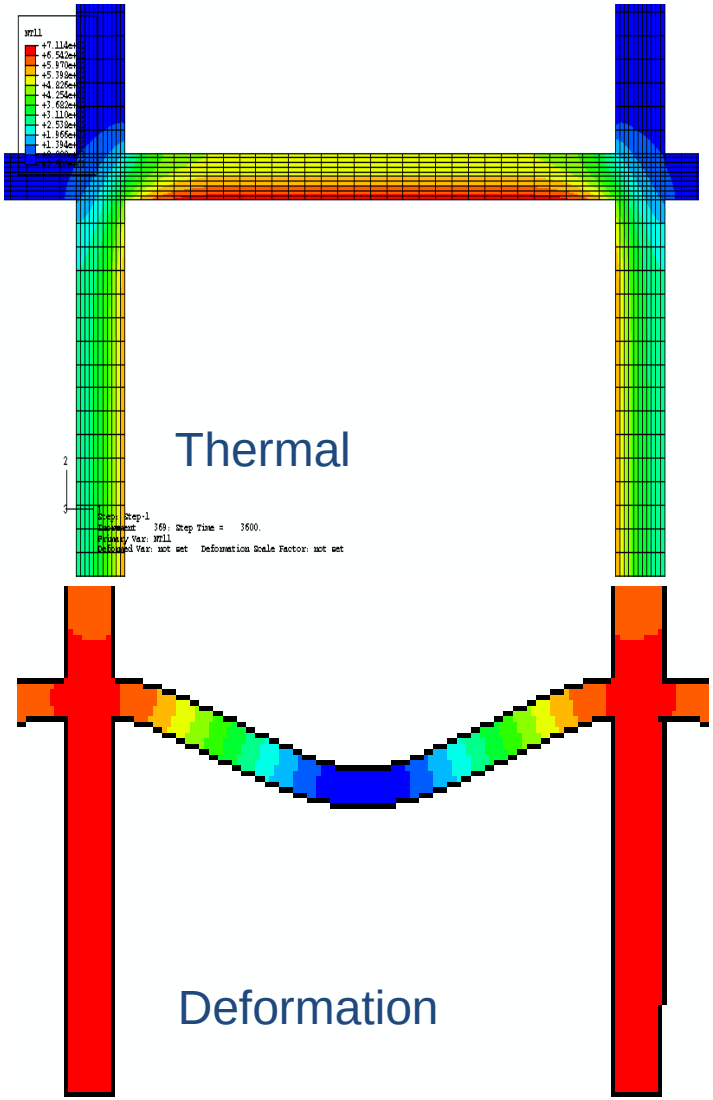
a ruptured urea formaldehyde microcapsule in a thermosetting matrix.

White, S.R., Sottos, N.R et al. Autonomic healing of polymer composites, Nature, 409 (2001), 794-797

Thermal and Strain Distributions in Reinforced Structure







Ghonem/Gregory, URI 2009

Blast Mitigation Workshop, April 30, 2009
The University of Rhode Island

Organizers: Arun Shukla (shuklaa@egr.uri.edu), Carl-Ernst Rousseau (rousseau@egr.uri.edu) and Jimmie Oxley (joxley@chm.uri.edu)

Focus Area: Blast/Fragment/Structure/Interaction and Blast/Pressure/Mitigation

Tentative Program

8:30 - 8:40	Arun Shukla : INTRODUCTION
8:40 - 9-10	**Mary-Ellen Hynes (DHS): PLENARY LECTURE**
9:10 - 9:25	Hamouda Ghonem & Otto Gregory
9:25 - 9:40	Carl-Ernst Rousseau
9:40 - 9:55	Arun Shukla
9:55 - 10:10	**Break**
10:10– 10:40	**Bruce LaMattina (ARO): PLENARY LECTURE**
10:40 - 10:55	Joseph Shepherd
10:55 - 11:10	Choong Shik Yoo & Yogi Gupta
11:10- 11:25	Jason Baird & John Meyers
11:25 - 12:15	*OPEN DISCUSSION*
12:15 - 1:15	**LUNCH**
1:15 - 1:45	**Kailas Kailasanath (NRL): PLENARY LECTURE**
1:45 - 2:00	Nancy Sottos/Arijit Bose
2:00 - 2:15	Mehrdad Sasani
2:15 - 2:30	Tim Harrigan
2:30 - 2:45	Ted Krauthammer
2:45 - 3:00	**BREAK**
3:00 - 3:15	Steven F. Son
3:15 - 3:30	Stephen W. Smith
3:30-3:45	William Fourney
3:45 - 4:30	*OPEN DISCUSSION*
4:30 - 5:00	Closing Remarks: Where do we go from here?
6:00	**DINNER**