MODELING BLAST DAMAGE OF COMPOSITE STRUCTURES
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RESEARCH MOTIVATION

- Blast Affects a Multitude of People and Structures Causing Irreparable Loss to Life and Damage to Structures Worth Millions
- Blast is a Challenge Not Only to Structures, Both Civilian and Military, but Also to Scientists Who Are Trying To Model It and Come Up With a Viable Blast Resistant Solution
- In Order to Minimize the Effects of Blast Loading on Structures We Need to Understand the Way Structures Respond to Blast Loading
- Finite Element Analysis Can Provide Fundamental Understanding of the Interactions between the Structure and the Blast Loading

RESEARCH GOALS

- Understanding the response of structures under BLAST Loading
- Idealize the "Blast Load" as a Pressure Load on Structures of Finite Duration
- Study the Dynamics of Blast Damage
  - Energy Dissipation
  - Momentum Transfer
  - Blast Resistance Force
  - Dynamic Deflection
  - Acceleration
- Study the Effect of Geometry and Architecture
  - Flat Plate and Cylinders
  - Plates and Sandwich

FINITE ELEMENT MODELING

- BLAST Loading was Applied with the "LOAD_BLAST Option"
- Blast on Plates: 1 KG TNT Equivalent, 610 mm
- BLAST on Cylinders: 10-kg TNT Equivalent at the Center
  - Aluminum only
  - Composite
  - Sandwich

RESULTS - PLATES

- Total Energy
- Momentum
- Displacement

LS-DYNA FINITE ELEMENT MODELING

- Plates with FIXED Boundary Conditions: Dimension = 610 mm x 610 mm, AD = 10 psf (48.8 kg/m²), 100 x 100 elements along the X and Y directions
- Cylinder with NON-Reflecting Boundary Conditions: 100 elements along the radial direction and 80 elements along the length, D = 1000 mm, H = 2000 mm

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Plate and Cylinder Geometries showed similar Acceleration for Cylinders (10 kg TNT) and 200+ kgGee’s for Plates (1 kg TNT) and 200+ kgGee’s for Cylinders (10 kg TNT).

Sandwich Structures showed Higher Energy Dissipation and Momentum Transfer.

Blasting Rotational Axis (Y), a, kGee’s.

Sandwich and Monoliths were Different, the Momentum/Resistance Forces are Similar.

The Initial Accelerations were Found High, i.e., 30–50 kGee’s for Plates (1 kg TNT) and 200+ kGee’s for Cylinders (10 kg TNT).

What Do We Understand by BLAST Mitigation?
- Reduce Acceleration and Dynamic Deflection?
- Prevent Catastrophic Failure of the Structure?
- What are the Competing Role of Energy Dissipation and Momentum Transfer?

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