Significance of the Research

• Bolted joint is a common type of fastener used in many vehicles and vessels.
• These structures may be subjected to various kinds of shock loads like mine blast and projectile impact.
• Shock response of the structure depends on the dynamics of the bolted joints.
• Understanding the transient behavior of structures with bolted joints when subjected to medium and high shock or impact loads can be challenging due to their nonlinear response, which is induced by the complex interactions between the bolts and the structure.
• While few researchers have considered shock transmission through bolted joints at low impact loading, there are little literature on shock transmission through bolted joints under high loading conditions.

Factors Affecting the Bolted Joints

• Preload (bolt tightening),
• Intensity of the impact,
• Damping within the joint,
• Strain rate effects on the material characteristics

Objectives

• Develop test fixture for medium impact study on bolted joints
• Create FEA model that can replicate the experiment
• Develop test fixture for high impact loading
• Create FEA model and select material properties that can produce results that closely match experiments.
• Compare different modeling techniques for high impact loading

PART I – Medium Impact Drop Tower Experiment

• Replicates a flange and lid system of vessels like blast containment vessel
• Subject the bolts to plastic deformation and failure at high strain rate
• Study the effect of bolt failure by measuring experimental parameters like force and acceleration.
• Study the effect of tightening torque on failure.
• Develop FE model to simulate the experiments.

PART II – High Impact Gas Gun Experiment

• Subject the bolt to high shock waves, where the shock speed is higher than the elastic wave speed.
• Understand how shock waves are transmitted through joints.
• Create a FE model to simulate the experiment
• Study the material parameters and experiment parameters to simulate material failure and shock transmission through bolts.
• Study different methods for simulating high impact study.

Initial Results – 2” drop – Impact Energy - 2.25 J

Initial Results: Impact on PMMA plate at 6.2 Km/s

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Experiment</th>
<th>FEA</th>
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<tbody>
<tr>
<td>Hole radius (mm)</td>
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<tr>
<td>Impact side crater radius (mm)</td>
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<td>Impact side crater depth (mm)</td>
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<td>Rear side crater radius (mm)</td>
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<tr>
<td>Rear side crater depth (mm)</td>
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<td>1.55</td>
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