Analysis of Buried Reinforced Concrete Box Structures Subjected to Buried High Explosive Detonations

Introduction
A numerical method for the dynamic analysis of the side walls of buried reinforced concrete box-type structures subjected to the ground shock loading from a buried high explosive detonation was developed. This method combines the box resistance functions present in DSAS with newly created load and thrust functions from buried HE charges.

Resistance Functions
- Flexure and direct shear response modes
- Flexural resistance enhanced by external thrust

Free-Field Ground Shock
- Derived from empirical equations dependent upon soil properties, charge weight, and range

Wave Reflections and Transmissions
- At material interfaces, including soil-air and soil-soil layers
- Use elastic wave propagation equations for analysis

Conversion to Surface Pressure
- Apply wave reflection on wall to derive surface pressures
- Use pressures integration on a square grid to find average load

Thrust Function Calculation
- Calculate thrust function resulting from ground shock traveling along around the buried box

Comparison with Experimental Data
- Using data from Kiger and Albritton (1980) tests

Summary of Results

<table>
<thead>
<tr>
<th>Test</th>
<th>Experiment Failure Mode</th>
<th>Measured Permanent Deflection (in)</th>
<th>Numerical Permanent Deflection (in)</th>
<th>Computed Permanent Deflection (in)</th>
<th>Failure Direct Shear St (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FH1</td>
<td>Flexure</td>
<td>0.44</td>
<td>0.90</td>
<td>1.14</td>
<td>0.20</td>
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<tr>
<td>FH2</td>
<td>Direct Shear</td>
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<td>Collapsed</td>
<td>Collapsed</td>
<td>1.00</td>
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<tr>
<td>FH3</td>
<td>Flexure</td>
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<td>6</td>
<td>5.9</td>
<td>0.98</td>
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<td>FH4</td>
<td>Flexure</td>
<td>3000</td>
<td>12.5</td>
<td>11.4</td>
<td>0.91</td>
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<td>Shear</td>
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<td>3.1</td>
<td>3.4</td>
<td>1.09</td>
</tr>
<tr>
<td>FH6</td>
<td>Direct Shear</td>
<td>8320</td>
<td>Collapsed</td>
<td>Collapsed</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Conclusions
- Program yields accurate wall response results if measured loads are applied
- Proposed load generation methodology does not yield accurate pressures for all cases
- Possible variations in site soil conditions from repeated explosive tests might be a contributing factor to observed inconsistencies in ground shock calculations
- Follow up research is needed to address such difficulties, and to identify possible approaches for their correction