UF Center for Infrastructure Protection and Physical Security (CIPPS)
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ERDC
US Army Engineer Research and Development Center

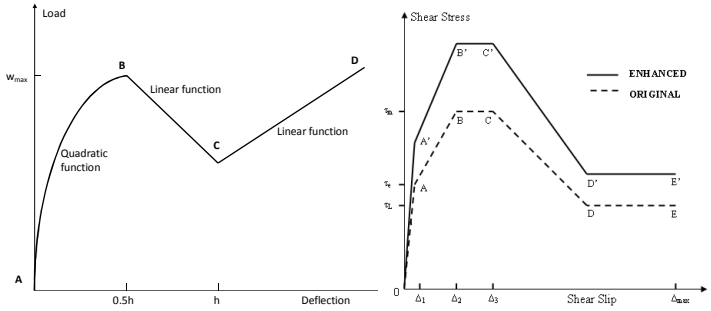
Analysis of Buried Reinforced Concrete Box Structures Subjected to Buried High Explosive Detonations

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

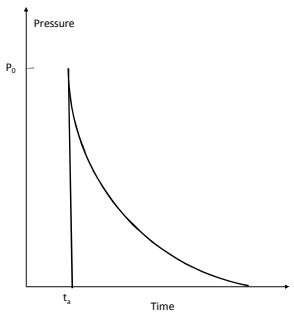
- Derived from empirical equations dependent upon soil properties, charge weight, and range

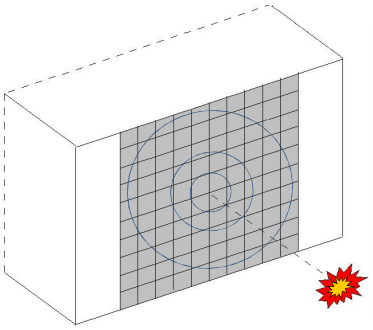
Wave Reflections and Transmissions

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

Conversion to Surface Pressure

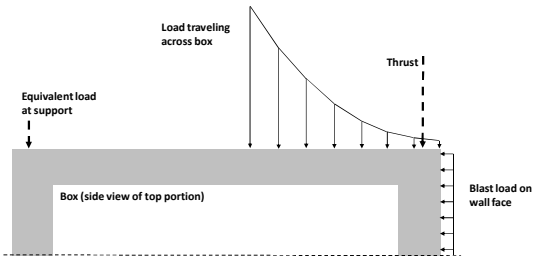
- Apply wave reflection on wall to derive surface pressures
- Use pressures integration on a square grid to find average load





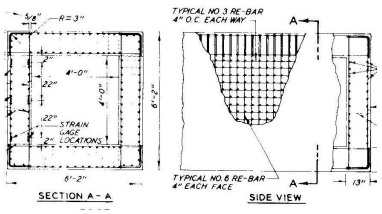
Thrust Function Calculation

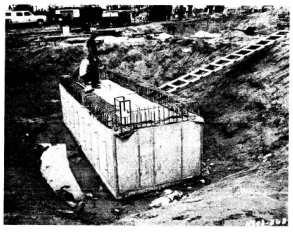
- Calculate thrust function resulting from ground shock traveling along around the buried box

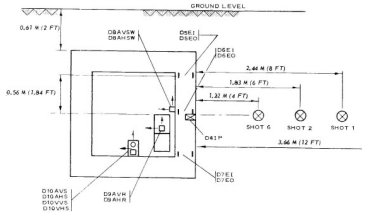


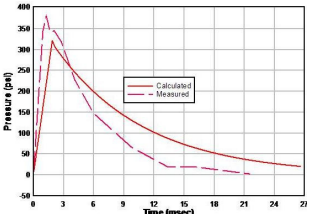
Comparison with Experimental Data

- Using data from Kiger and Albritton (1980) tests









Summary of Results

Test No.	Experiment Structural Behaviour / Failure Mode	Average Peak Pressure (psi)	Measured Permanent Deflection (in) Δ_1	Numerical Structural Behavior / Failure Mode	Computed Permanent Deflection (in) Δ_2	$\frac{\Delta_2}{\Delta_1}$	Failure Direct Shear Slip (in)	Time of Failure (msec)
FH1	Flexure	2400	0.44	Flexure	0.50	1.14	--	--
FH2	Direct Shear	5200	Collapsed	Direct Shear	Collapsed	1.00	0.20	1.1
FH3	Flexure	2650	6	Flexure	5.9	0.98	--	--
FH4	Flexure	3000	12.5	Flexure	11.4	0.91	--	--
FH5	Shear	18000	3.1	Flexure / Shear	3.4	1.09	--	--
FH6	Direct Shear	8320	Collapsed	Direct Shear	Collapsed	1.00	0.23	1.2

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