

# EFFECT OF SHORT-DURATION-HIGH-IMPULSE AXIAL AND TRANSVERSE LOADS ON REINFORCED CONCRETE COLUMNS

## Introduction

A numerical model for the analysis of a reinforced concrete column subjected to dynamic axial and transverse loads induced by blast loads has been developed.

## Typical Column Model with ABAQUS/Explicit

## Objective

To determine the actual effect of dynamic axial and transverse loads on a reinforced concrete column with both single-degree-of-freedom (DSAS) and advanced computer codes (ABAQUS/Explicit).

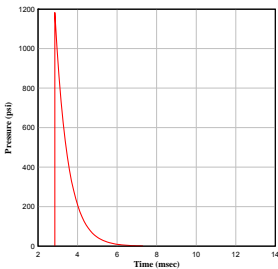
## Column Descriptions

Column	Bars	Stirrups	$\rho$	$s', \text{ in}$	$M_{max}, \text{ kip-ft}$	$P_{max}, \text{ kips}$
1	8 #7	#3	1.88	12	323.7	1720
2	8 #10	#3	4.88	12	450.7	2140
3	12 #11	#4	7.31	12	598.8	2820
4	4 #14	#4	3.52	12	474.5	2050

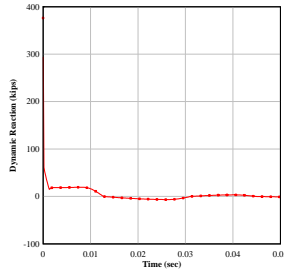
## Static Axial Loads due to Gravity

Column	$P_{top}, \text{ kips}$	$P_{1/2}, \text{ kips}$	$P_{2/3}, \text{ kips}$	$P_{3/4}, \text{ kips}$	$P_{bot}, \text{ kips}$
1	560	0	250	560	1000
2	560	0	250	560	1000
3	570	0	250	570	1500
4	530	0	250	530	1000

## Transverse Loads due to 500 lb TNT @ 20'



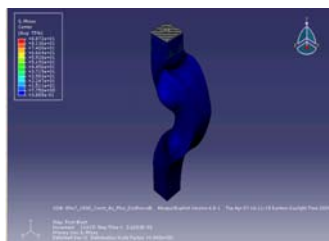
## Additional Dynamic Axial Loads due to 500 lb TNT @ 20'



## Comparisons on Displacements Induced by Transverse, Static and Dynamic Axial Loads

Load	P2	P2 + P <sub>var</sub>	% Increase	P3	P3 + P <sub>var</sub>	% Increase	P4	P4 + P <sub>var</sub>	% Increase
Column 1	2.40	2.62	8.68	2.28	4.90	53.37	2.66	24.57	89.15
Column 2	1.73	1.82	4.61	1.88	2.19	14.30	1.81	23.08	92.14
Column 3	2.48	2.54	2.28	2.3	3.32	30.77	24.61	4.46	-451.89'
Column 4	1.74	1.78	2.54	1.59	2.14	25.62	1.78	18.78	90.50

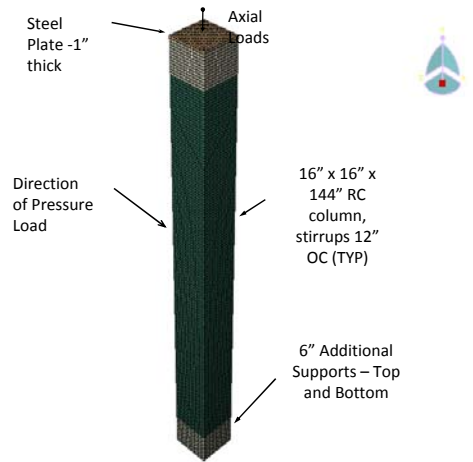
\* Column failed at 4.46 in



## ABAQUS/Explicit Simulation

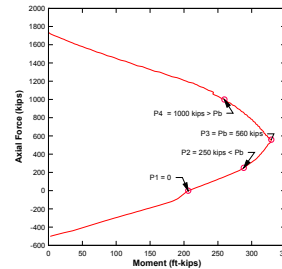
## Conclusions

Under the influence of short-duration-high-impulse transverse loads, the column fails as the magnitude of the static axial load exceed the balanced load of the column for low and normal ductility conditions. For column with high ductility, the column lasts longer even when its balanced load capacity is surpassed to a load magnitude where column failure occurs. Under the influence of short-duration-high-impulse dynamic axial and transverse loads, the magnitude of deformation is much larger, compared to that for the same static axial load.

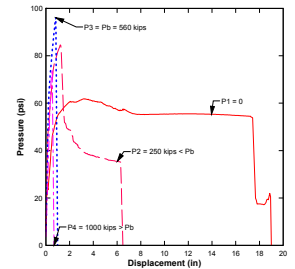


## Column Behavior Under the Effects of Transverse and Constant Axial Loads – Column 1 - DSAS

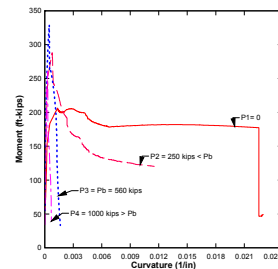
### Axial – Moment Diagram



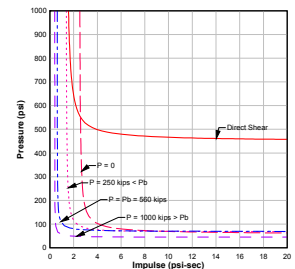
### Load Resistance Diagram



### Moment Curvature Diagram



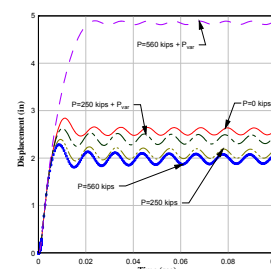
### Pressure Impulse Diagram



## Column Behavior Under the Effects of Transverse, Static and Dynamic Axial Loads – ABAQUS/Explicit

### Displacement Time History Diagram

$P \leq P_{bal}$



$P > P_{bal}$

