UF | Center for Infrastructure Protection and Physical Security (CIPPS)
UNIVERSITY of FLORIDA

RC AND UHPC COLUMNS WITH PLASTIC HINGES UNDER IMPACT AND BLAST LOADS

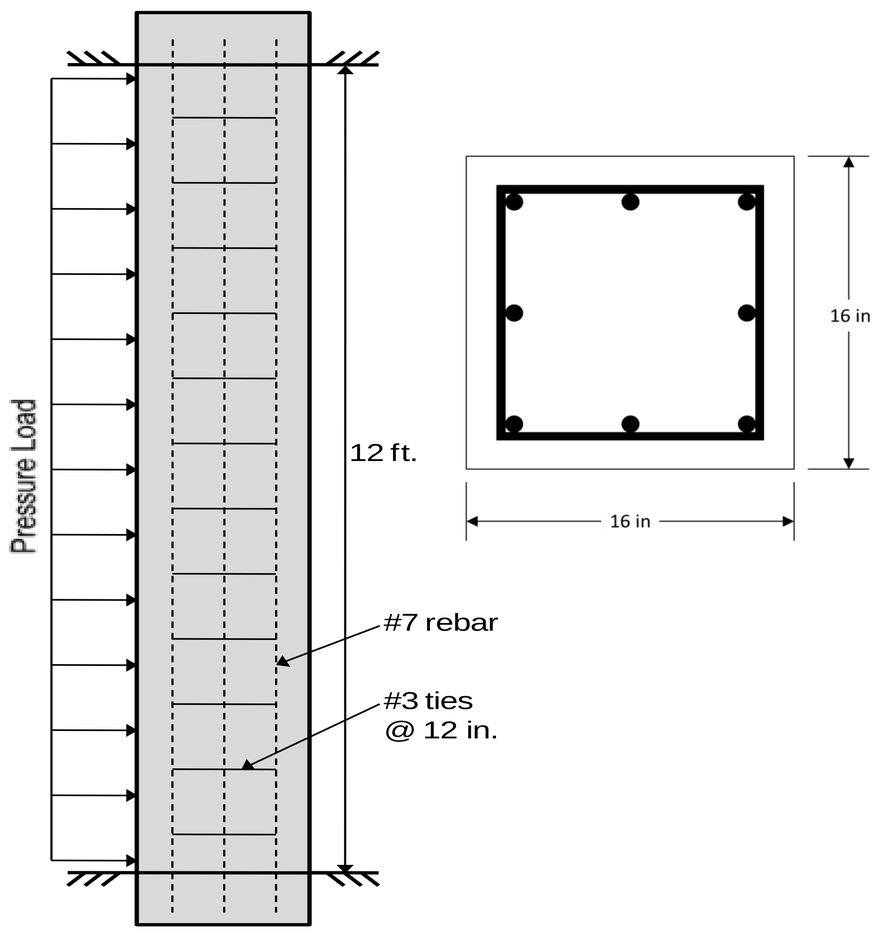
Objective

Develop a new computational capability that represents the development of plastic hinges in NSC and UHPC column undergoing large deformations, geometric instabilities, and the transition into a tension membrane behavior. Implement the approach into the computer code DSAS, and validate the numerical simulations with data obtained from ABAQUS/Explicit.

Research Significance

Enhance the computer program DSAS to represent plastic hinges in RC and UHPC columns, and perform more realistic analyses of column behavior up to failure. Validate the program against numerical simulations with ABAQUS/Explicit.

Simulated RC and UHPC Column Dimensions



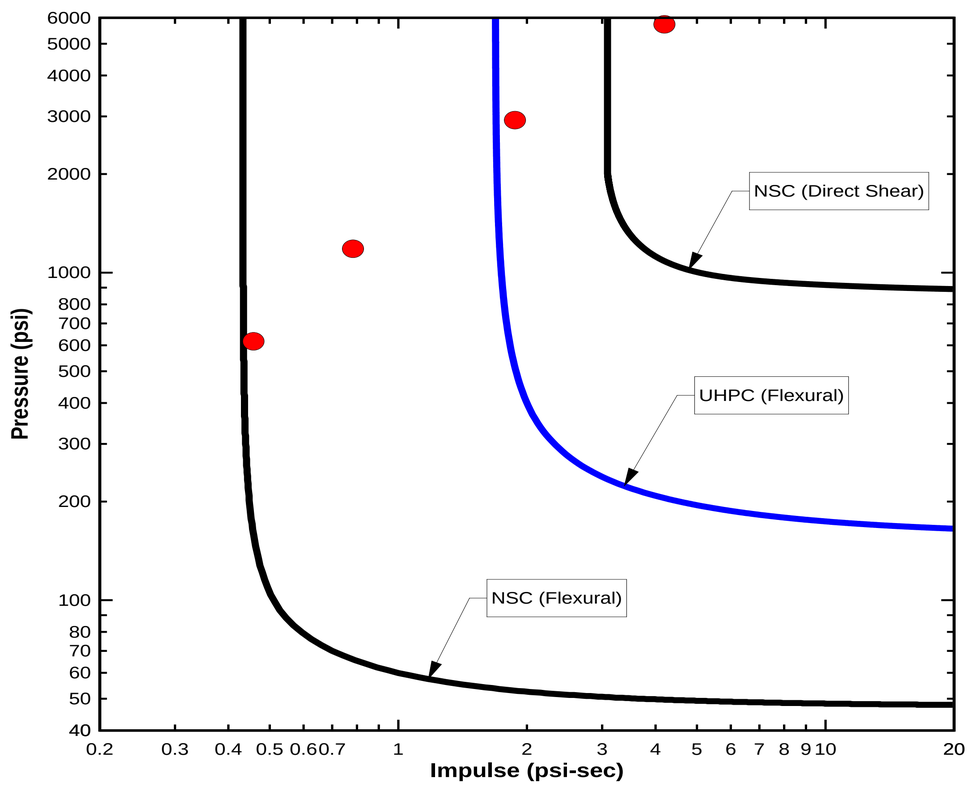
Axial Load Parameters

Description	ϕM_n (in-kips)	ϕP_n (kips)
Maximum capacity	933	640
100% f'_c	2031	259
$0.1f'_cA_g$	1706	102
Zero axial load	1602	0

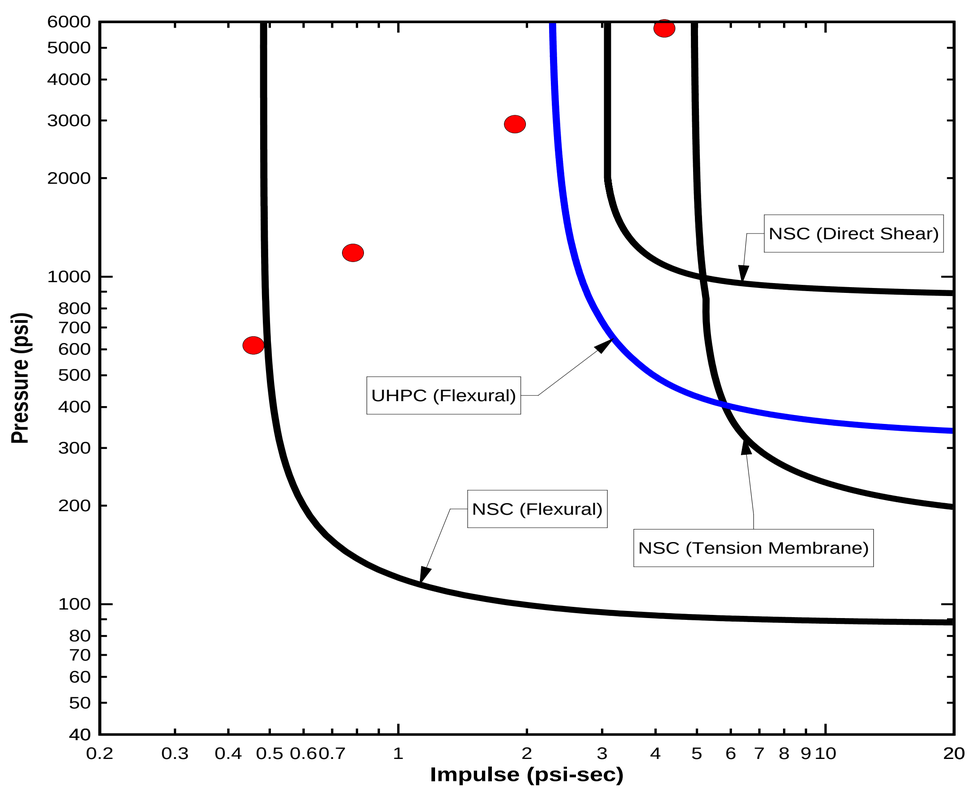
Blast Load Parameters

Blast Case	Reflected pressure (psi)	Reflected impulse (psi-sec)	Duration (ms)
1	617	0.458	1.485
2	1183	0.783	1.324
3	2922	1.875	1.283
4	5732	4.196	1.464

Selected Results



Load-impulse diagram, simply supported NSC and UHPC columns, 640 kips axial load



Load-impulse diagram, fixed NSC and UHPC columns, 640 kips axial load

Conclusions

- The results obtained from DSAS and ABAQUS were reasonably close.
  - For the simply supported columns, the average differences were about 8% for NSC, and 15% for UHPC.
  - For the fixed columns, the average differences were about 22% for NSC, and about 24% for UHPC.
- A typical run time of a column time-history analysis with DSAS was under 10 seconds on a desktop computer.
- The analysis of the same column with ABAQUS on a 12-core node in a high performance computing cluster required 30 minutes using reduced integration (single-point quadrature), or up to a day using fully integrated elements.
- The study highlighted the significant contribution of hinge formation to the structural response.
- The ability of UHPC columns to resist impulse was four times higher than that of NSC columns.