

# Investigation of Compressive Membrane Action in Ultra High Performance Concrete Slab Strips

## Introduction and Objectives

To quantify the static and dynamic behavior of restrained UHPC slabs considering compressive membrane action through experimental and numerical analysis.

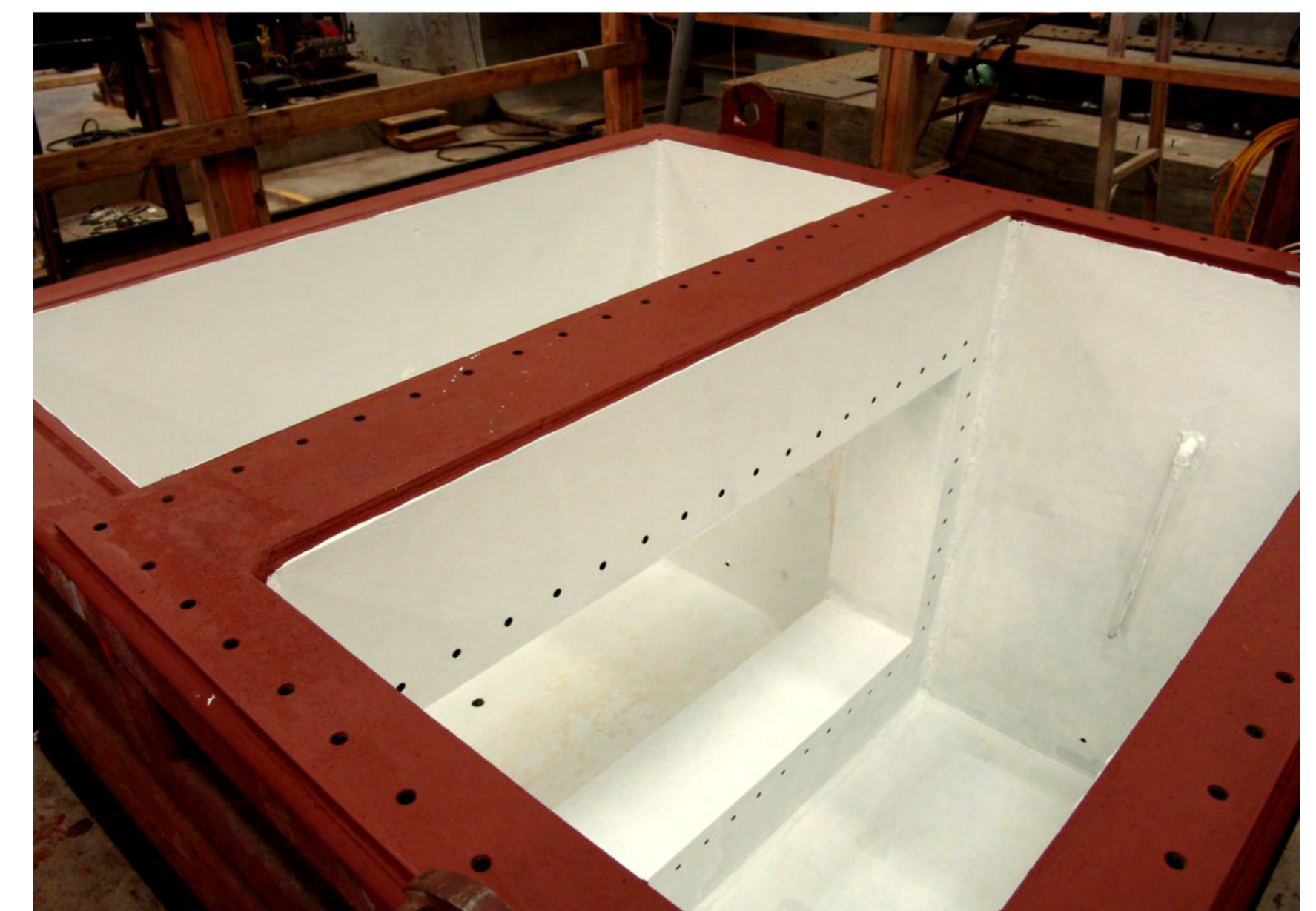
## Objectives

- Perform static and shock tube precision testing on NSC, Cor-Tuf1 and Cor-Tuf2 push-off one-way slab specimens
- Compare test data to previous theoretical and empirical models
- Propose changes to the models if required

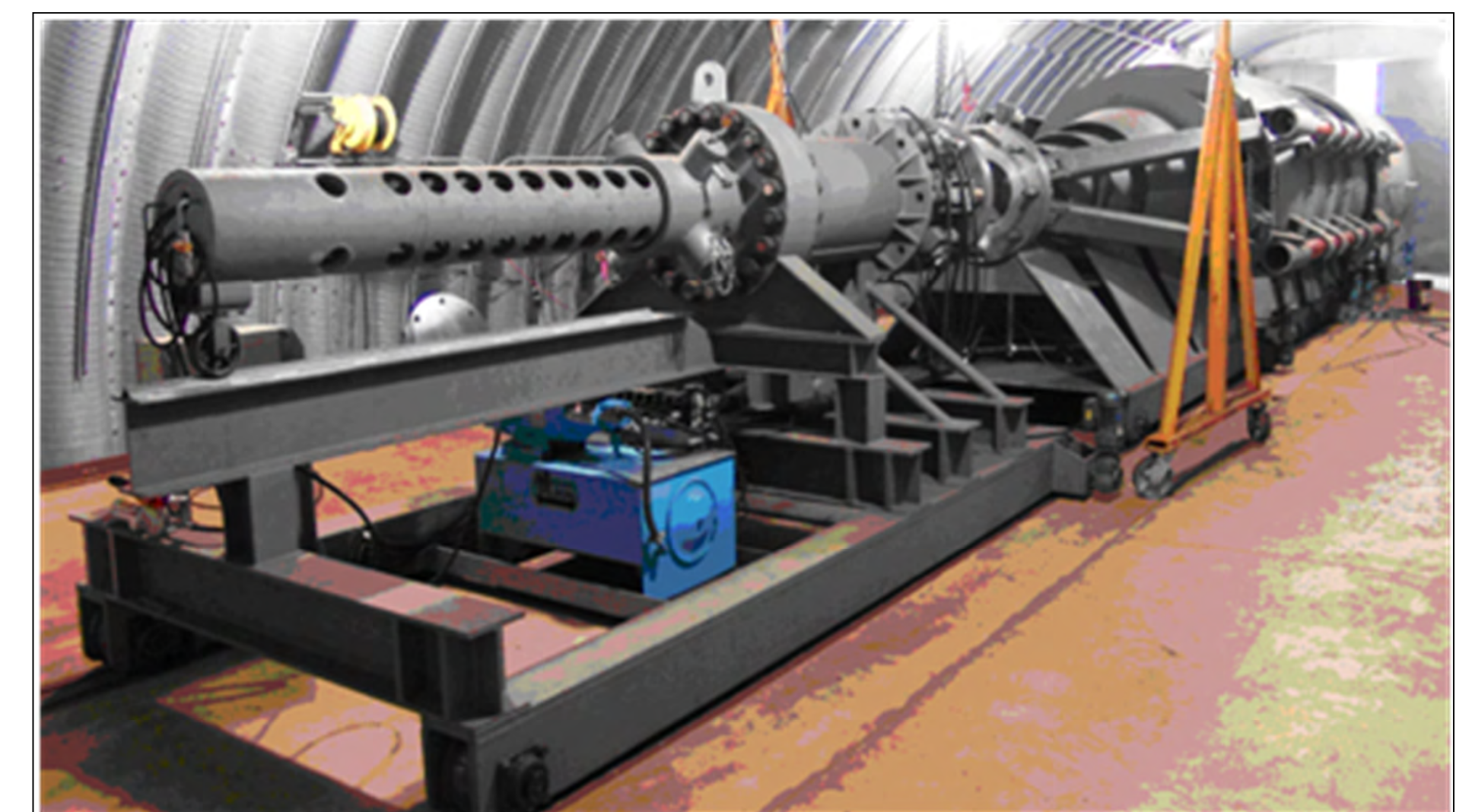
## Research Approach

- 27 reinforced concrete slabs constructed and tested
  - 11 quasi-static tests (5 SS and 6 RR)
  - 16 dynamic tests (9 SS and 7 RR)
- Compare experimental data to existing compressive membrane theory predictions
- Conduct SDOF analysis with existing fast running engineering codes to compare response predictions
- Modify resistance function to resemble experimental data
- Conduct finite element analysis to assess current material model's capability to capture response of UHPC

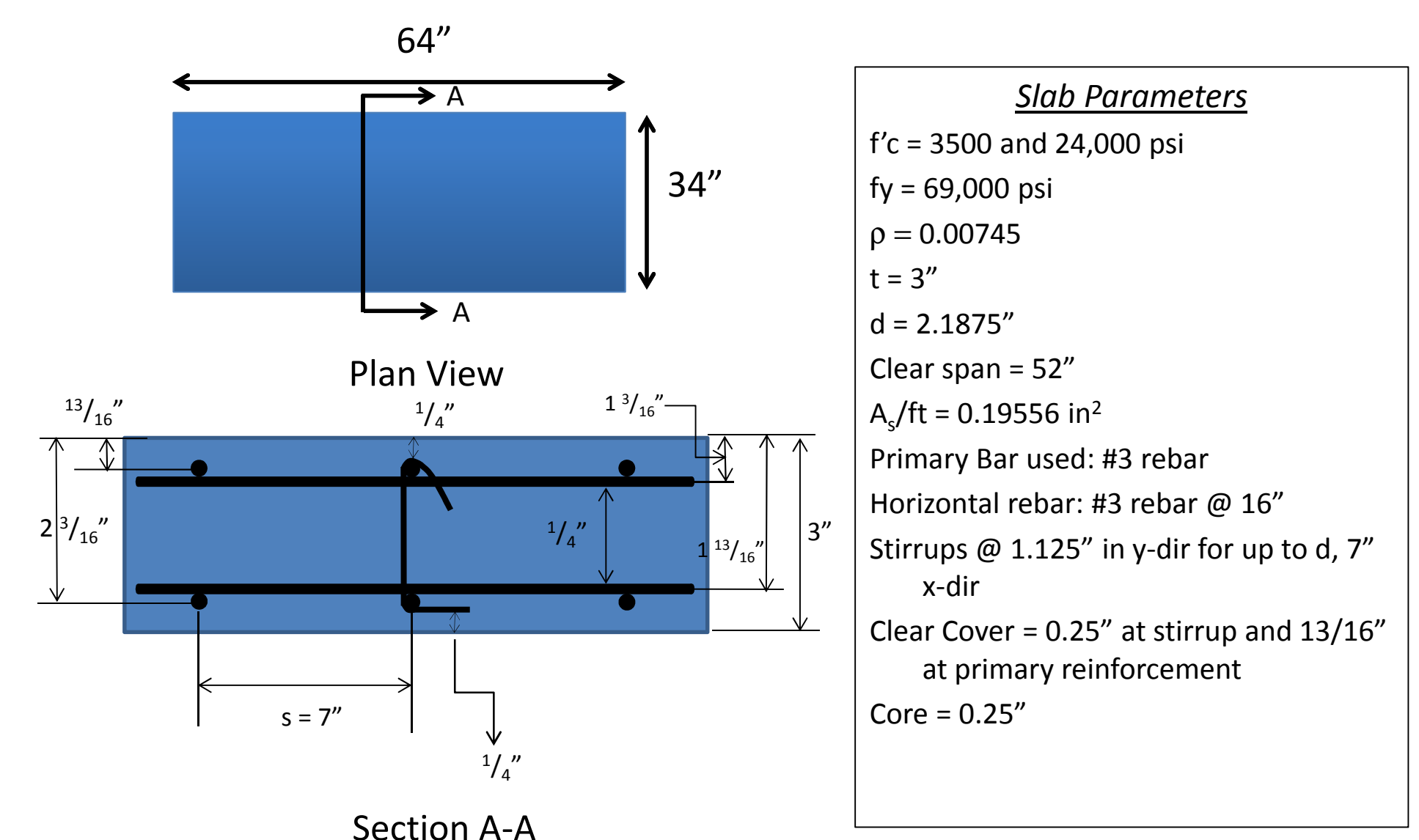
## Static Tests



## Shock Tube Tests



Parameters							
Slab Dimensions	Number of slabs	Primary reinforcement ratio at midspan	Concrete type	Shear reinforcement	Loading	Boundary conditions	# strain gages (min)
64" x 33 3/4" x 3"	4	0.70%	NSC (4000 psi)	Yes, see drawing for details	Dynamic BLS	simply supported	6
64" x 33 3/4" x 3"	3	0.70%	CorTuf w/o fibers	Yes, see drawing for details	Dynamic BLS	simply supported	12
64" x 33 3/4" x 3"	2	0.70%	CorTuf w/ fibers	Yes, see drawing for details	Dynamic BLS	simply supported	12
<b>Total</b>	<b>9</b>						<b>30</b>
65 3/8" x 33 3/4" x 3"	4	0.70%	NSC (4000 psi)	Yes, see drawing for details	Dynamic BLS	laterally restrained & clamped	6
65 3/8" x 33 3/4" x 3"	3	0.70%	CorTuf w/o fibers	Yes, see drawing for details	Dynamic BLS	laterally restrained & clamped	12
<b>Total</b>	<b>7</b>						<b>18</b>
58" x 33 3/4" x 3"	4	0.70%	NSC (4000 psi)	Yes, see drawing for details	Static	laterally restrained & clamped	6
58" x 33 3/4" x 3"	2	0.70%	CorTuf w/o fibers	Yes, see drawing for details	Static	laterally restrained & clamped	12
<b>Total</b>	<b>6</b>						<b>18</b>
60" x 33 3/4" x 3"	2	0.70%	NSC (4000psi)	Yes, see drawing for details	Static	simply supported	6
60" x 33 3/4" x 3"	2	0.70%	CorTuf w/o fibers	Yes, see drawing for details	Static	simply supported	12
60" x 33 3/4" x 3"	1	0.70%	CorTuf w/ fibers	Yes, see drawing for details	Static	simply supported	12
<b>Total</b>	<b>5</b>						<b>30</b>
<b>TOTAL SLABS</b>	<b>27</b>						<b>96</b>



## Conclusions

- For UHPC slabs whose compressive strength is in excess of 20 ksi, length to depth ratio is 10 < L/h < 20, a good rule of thumb estimate for Δ<sub>uc</sub> is 0.5h.
- An alternate approach of determining the deflection that occurs at ultimate capacity was developed based on Keenan's[10] strain-deformation approach:

$$\delta = \frac{x\epsilon_u(x+t)}{3.5c_m} = \frac{x\phi_m(x+t)}{3.5}$$

- Once the deflection at ultimate capacity has been determined from the above equation, either Park's equation or Equations 10-38 and 10-39 found in Army TM 5-855-1 may be used to determine the value of ultimate resistance and beyond to snap-through point

