

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.

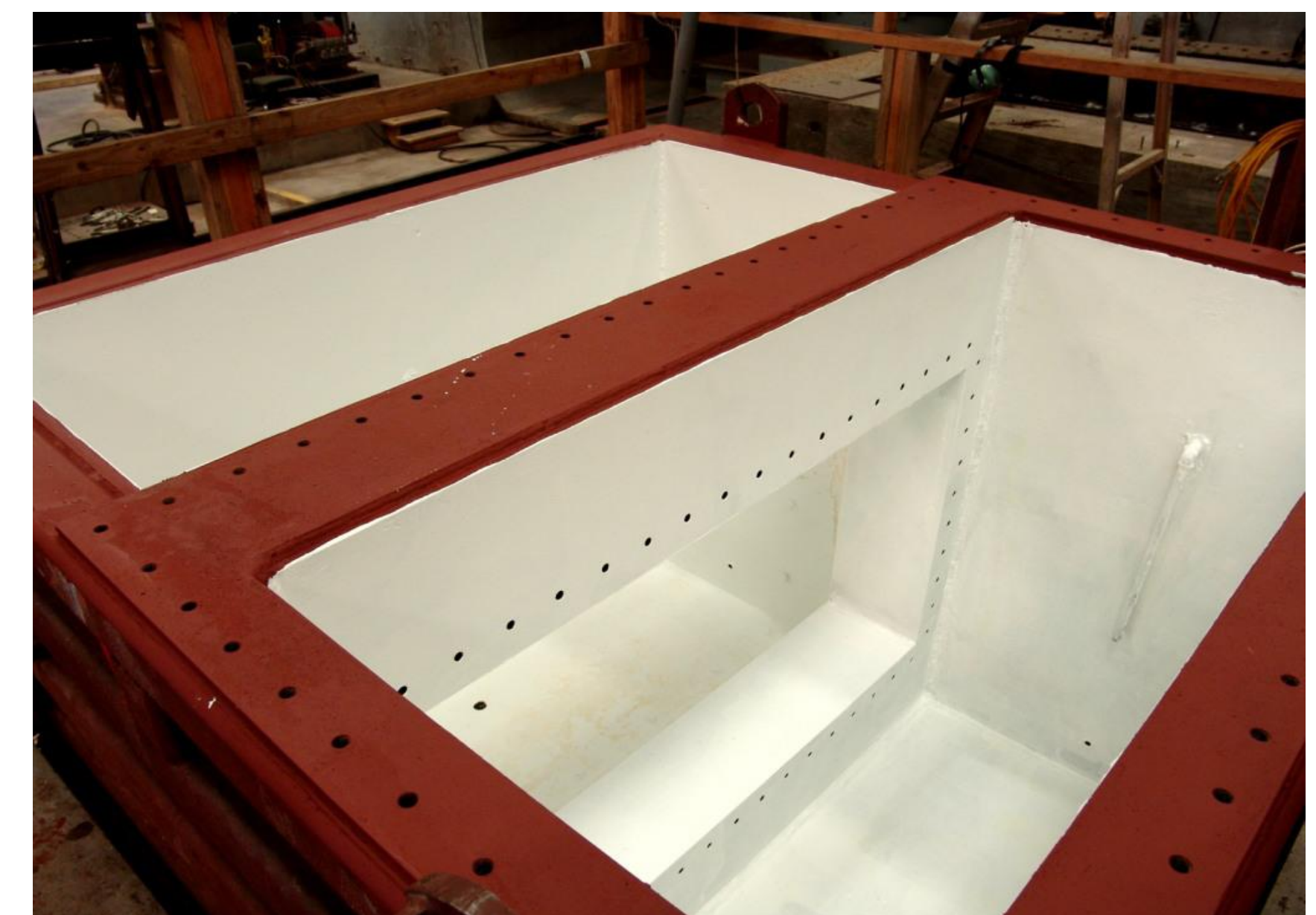
Objectives

- 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

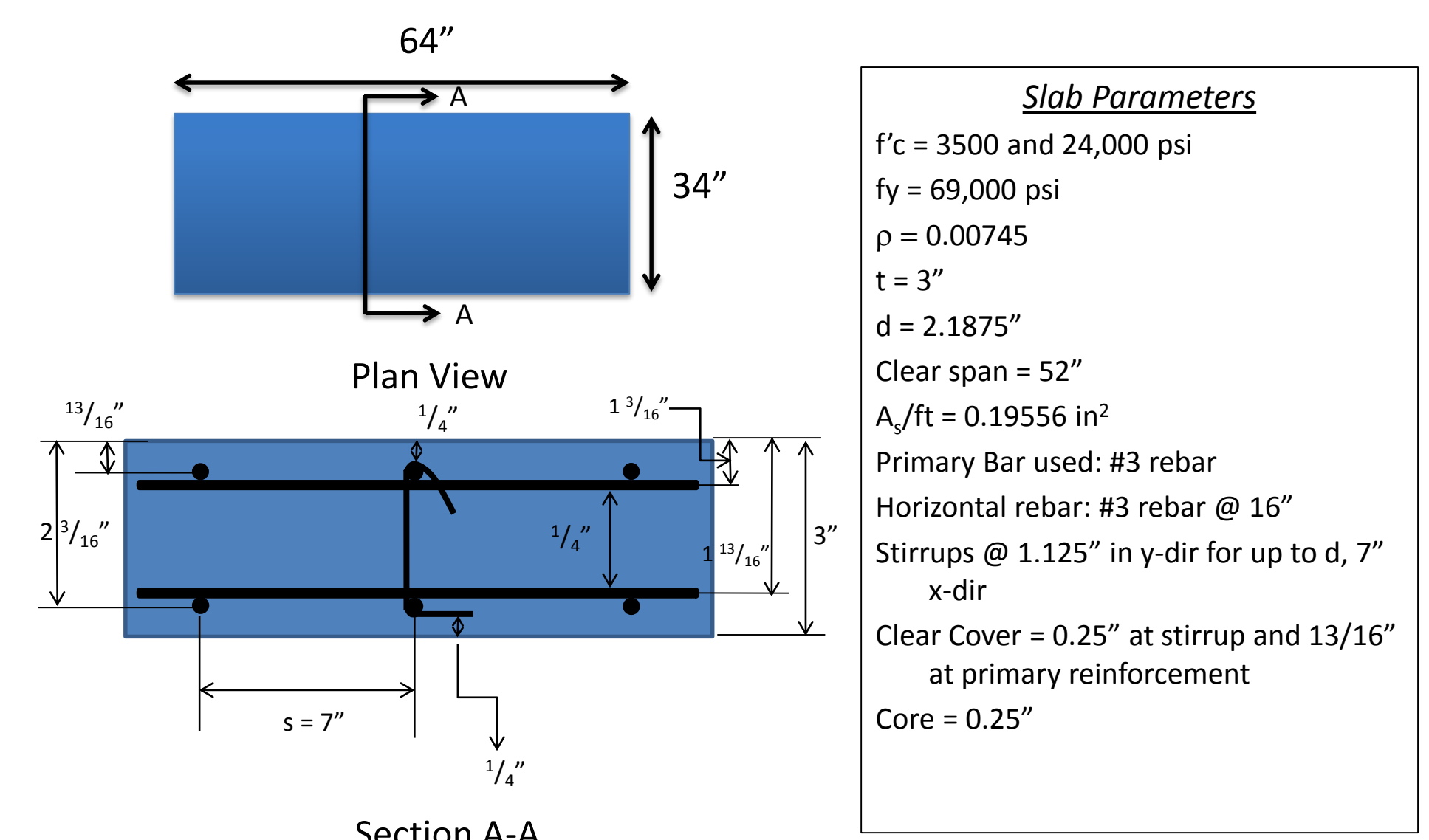
Static Tests



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
Total	9						30
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
Total	7						18
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
Total	6						18
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
Total	5						30
TOTAL SLABS	27						96



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_{uc} 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

