Experimental Study of Drilled-Shaft Footings under Uniaxial Flexural Compression Designed with Different Column Reinforcement Anchorages

Yousun Yi, Hyunsu Kim, Ryan Boehm, Zachary Webb, Jongkwon Choi, Juan Murcia-Delso, Trevor Hrynyk, Oguzhan Bayrak

TEXAS
The University of Texas at Austin

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Research in Progress Session

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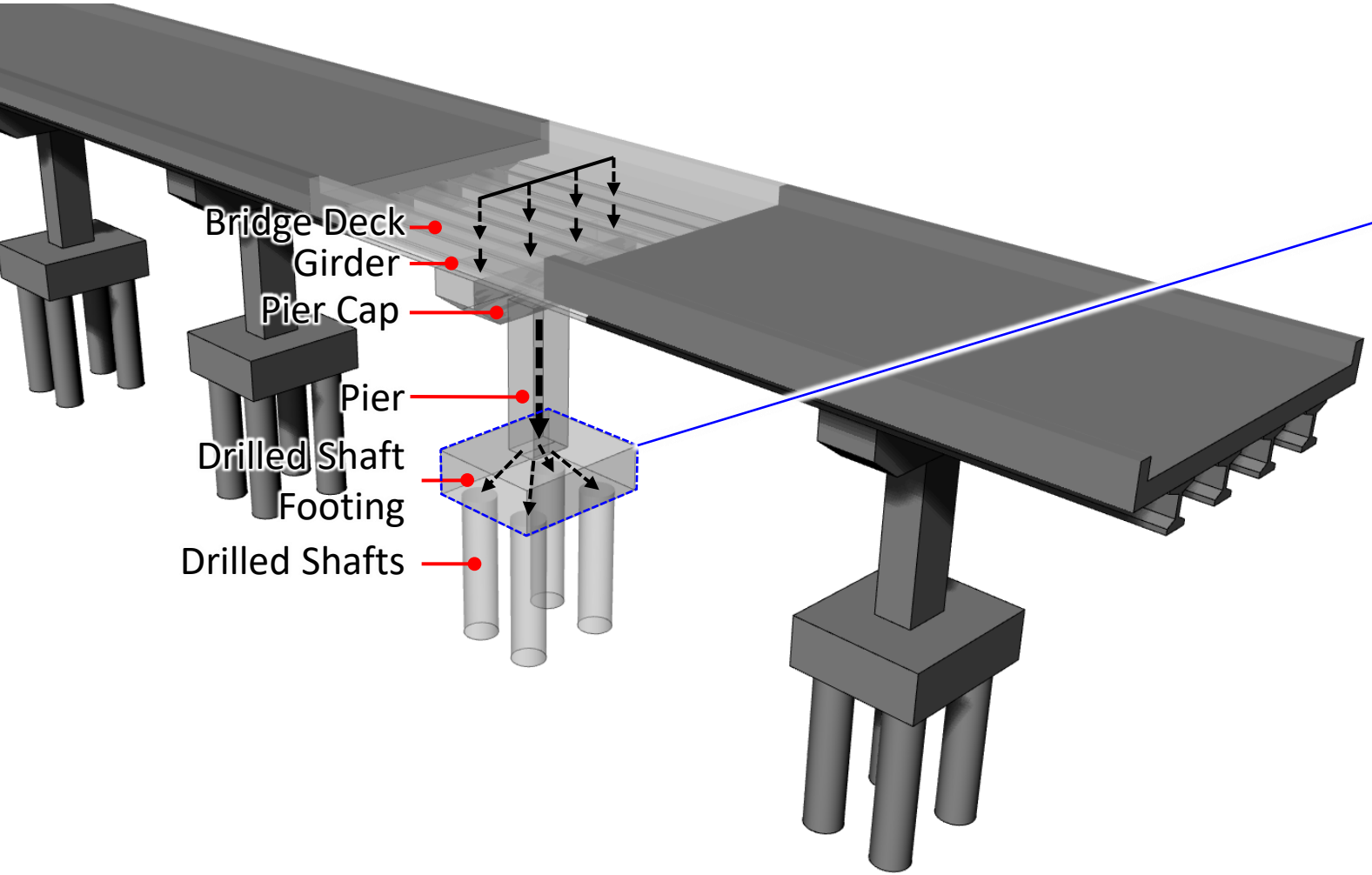
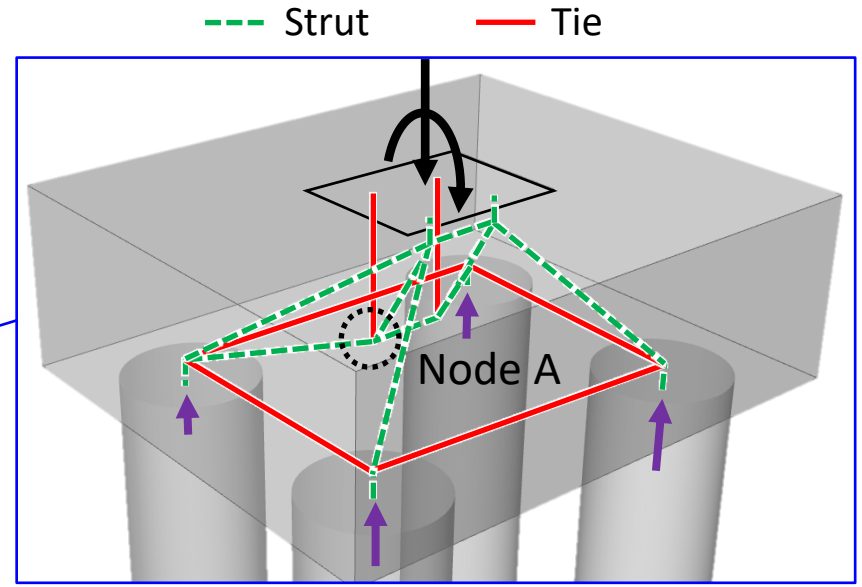
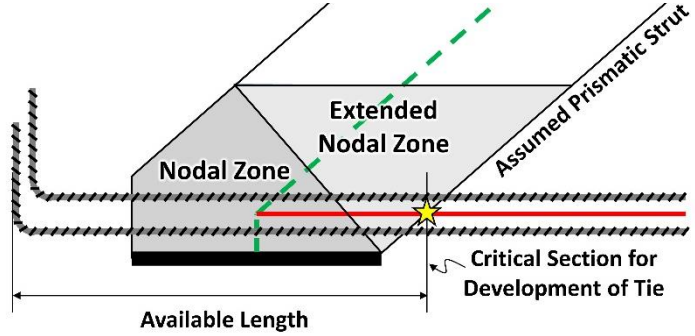
Introduction





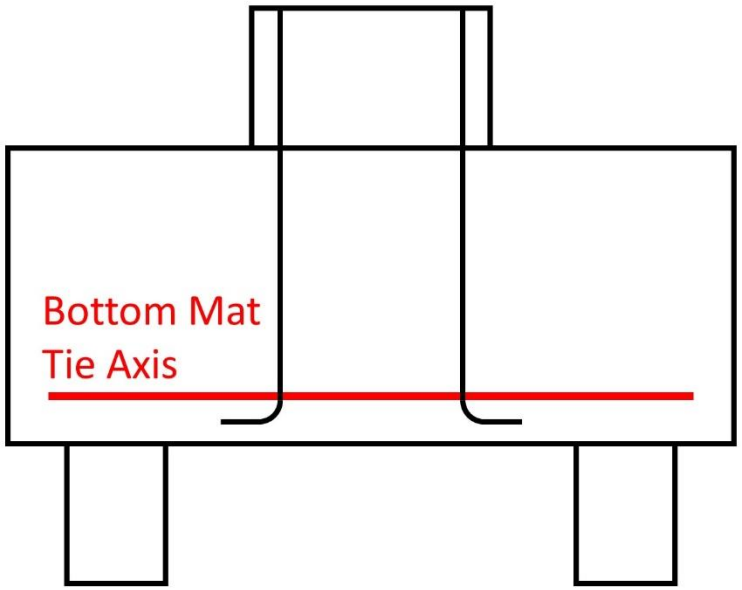
Axial compression combined with uniaxial moderate flexure



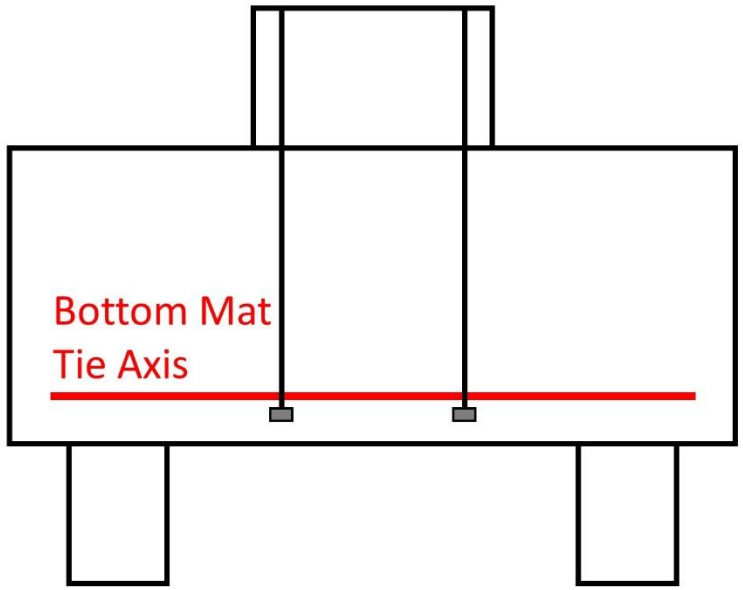
Extended Nodal Zone (adapted from AASHTO LRFD, 2020)

Anchorage Detail of Column Reinforcement

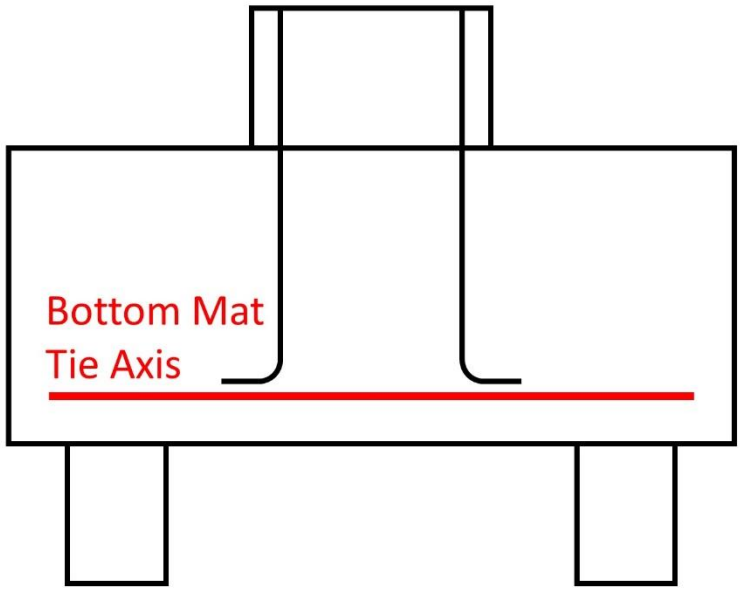
In previously published design examples



Klein (2002)



Widianto and Bayrak (2011)



Williams et al. (2012)

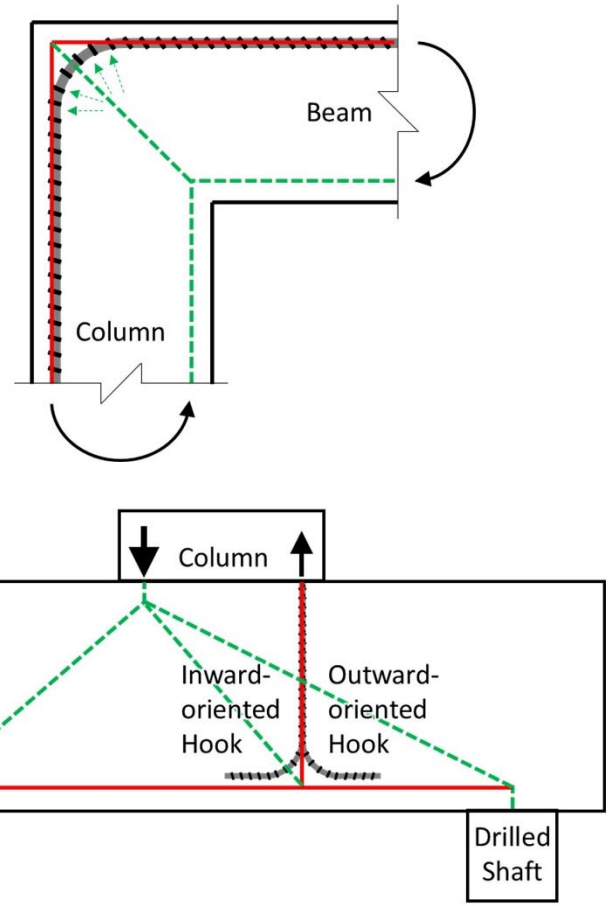
Commonly accepted detail for in-practice drilled shaft footings

<u>But not experimentally verified detail</u>

Experimental Program

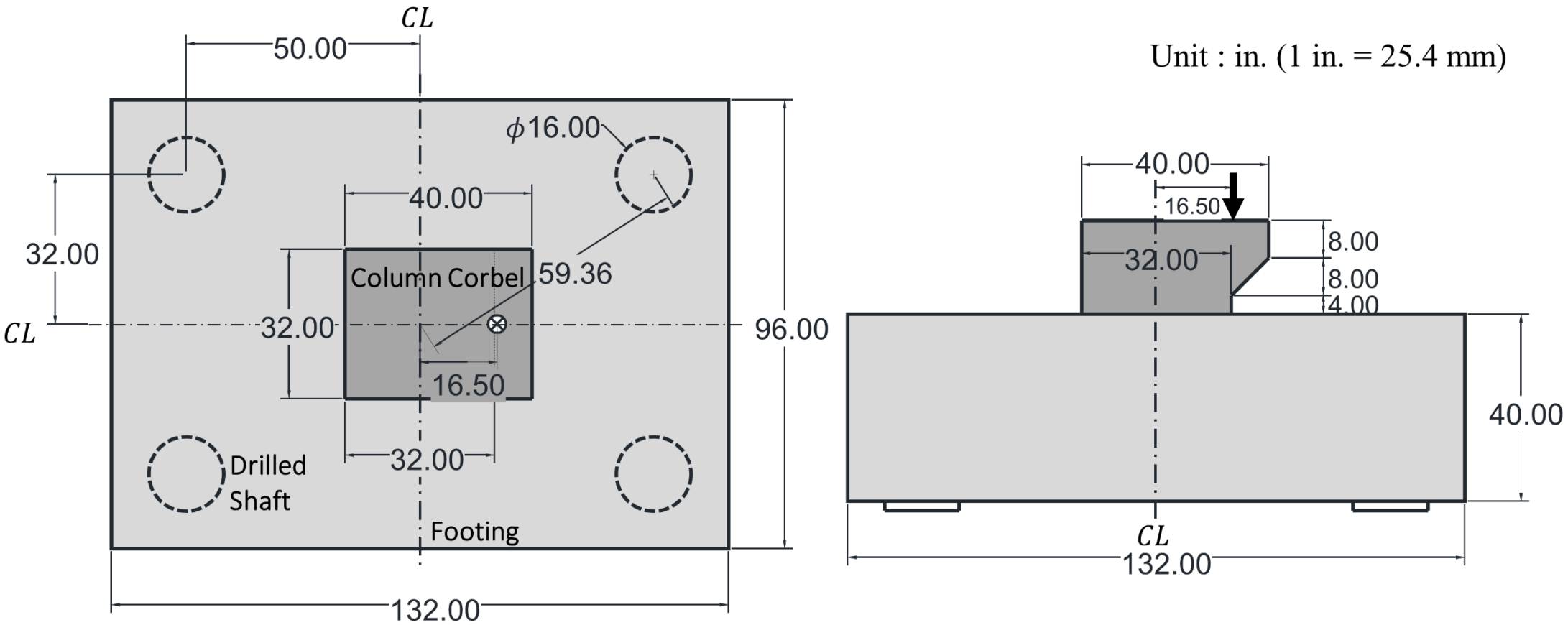
Test variable

Specimen ID	Top/Bottom mat of reinforcement		Load eccentricity [in.]	Column Reinforcement Anchorage
	Layout	Anchorage		
VI–ST	Grid	Straight (Top Mat) & Hooked (Bottom Mat)	16.5	Straight
VI–HD				Headed
VI–HKO				Hooked (Orientation: Outward)
VI–HKI				Hooked (Orientation: Inward)



Experimental Program

Specimen details (Geometry)

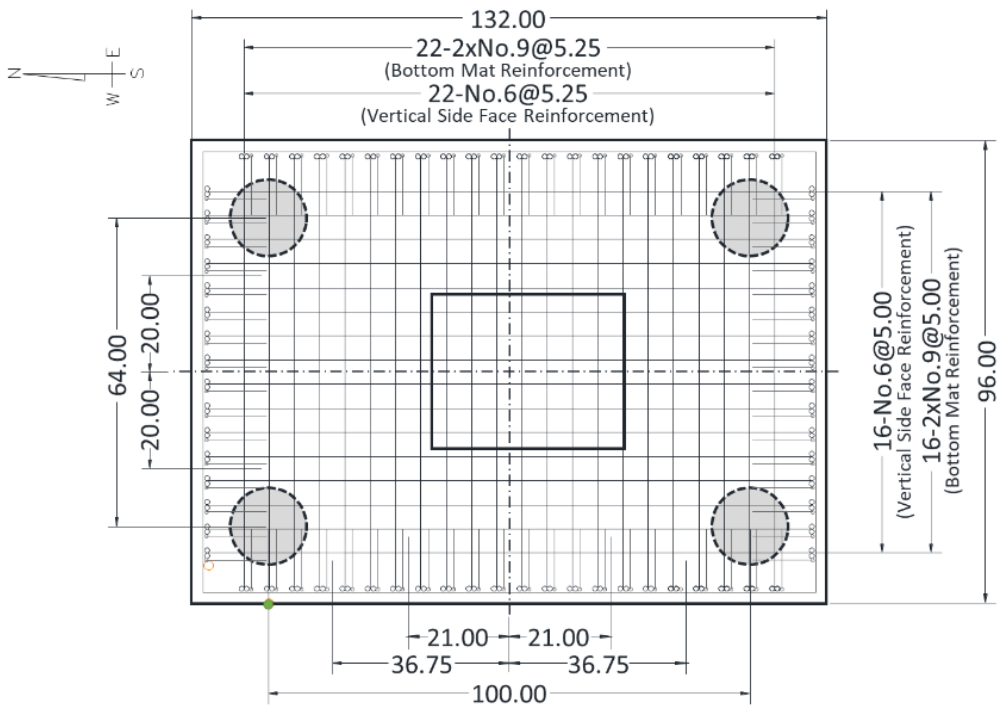


⊗ : Applied Loading Point

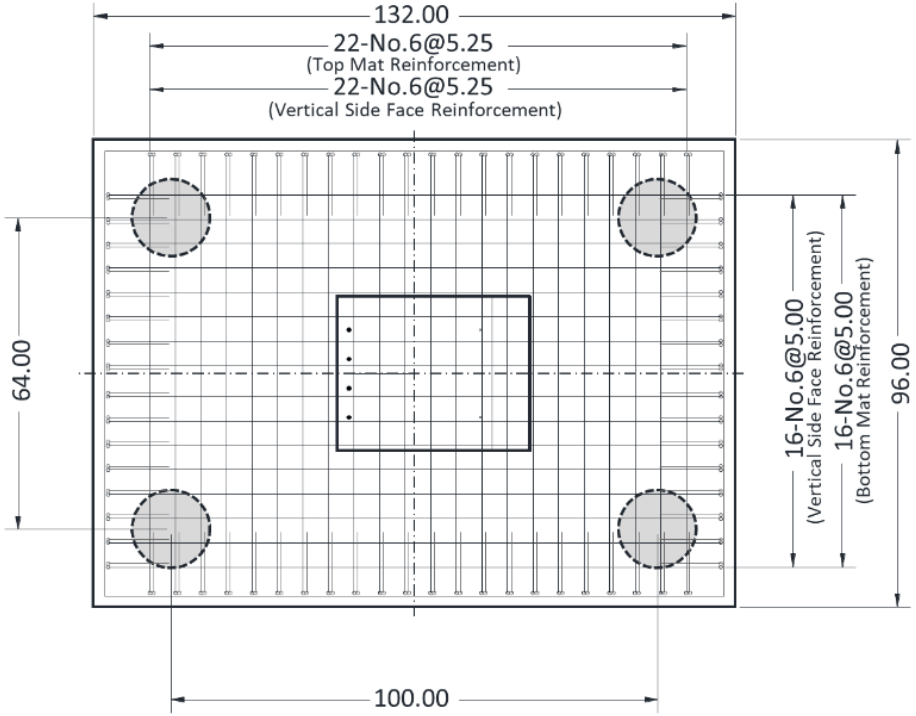
Experimental Program

Specimen details (Reinforcement details)

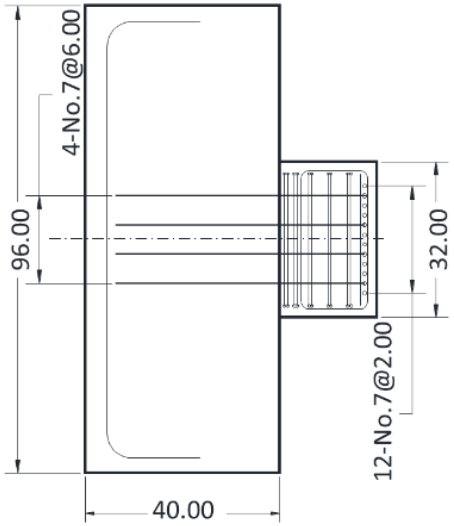
PLAN VIEW (BOTTOM MAT)



PLAN VIEW (TOP MAT)

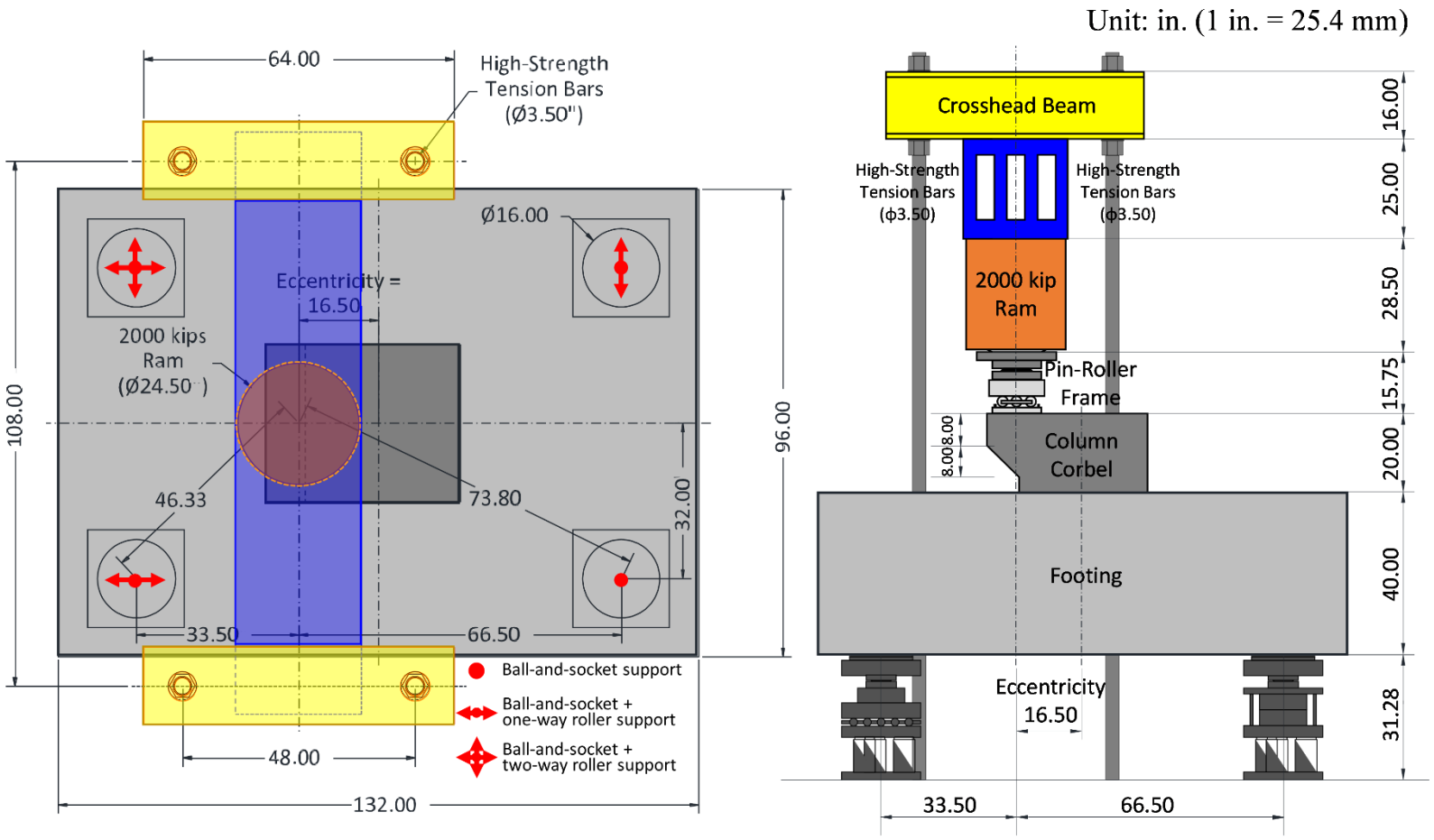


ELEVATION (N-S DIRECTION)



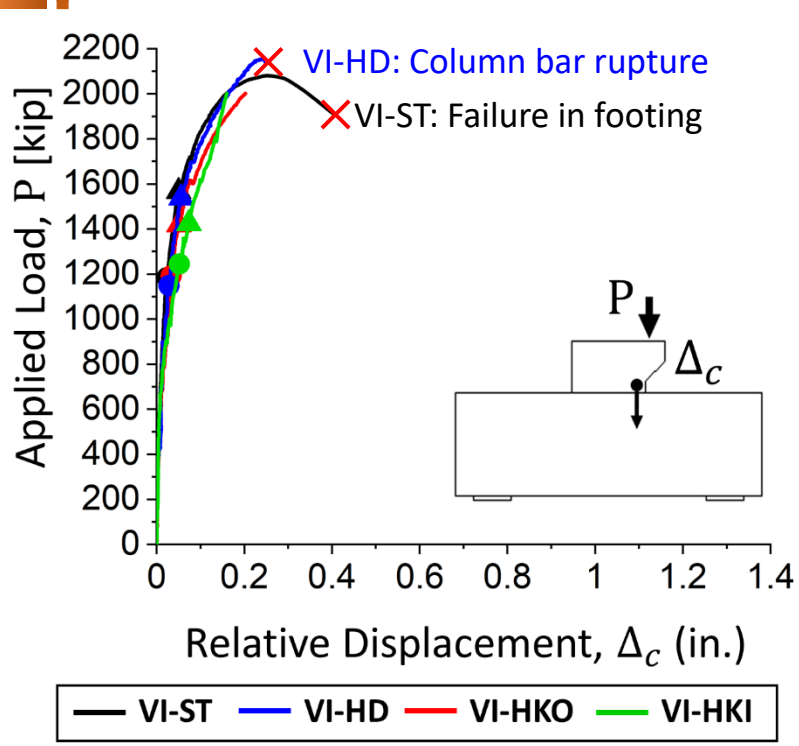
Experimental Program

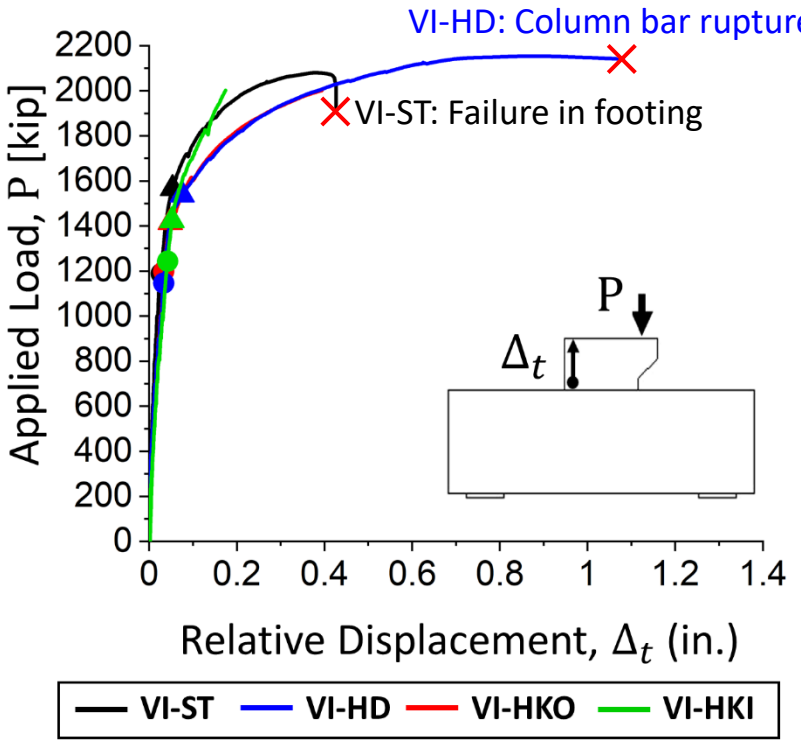
Test setup

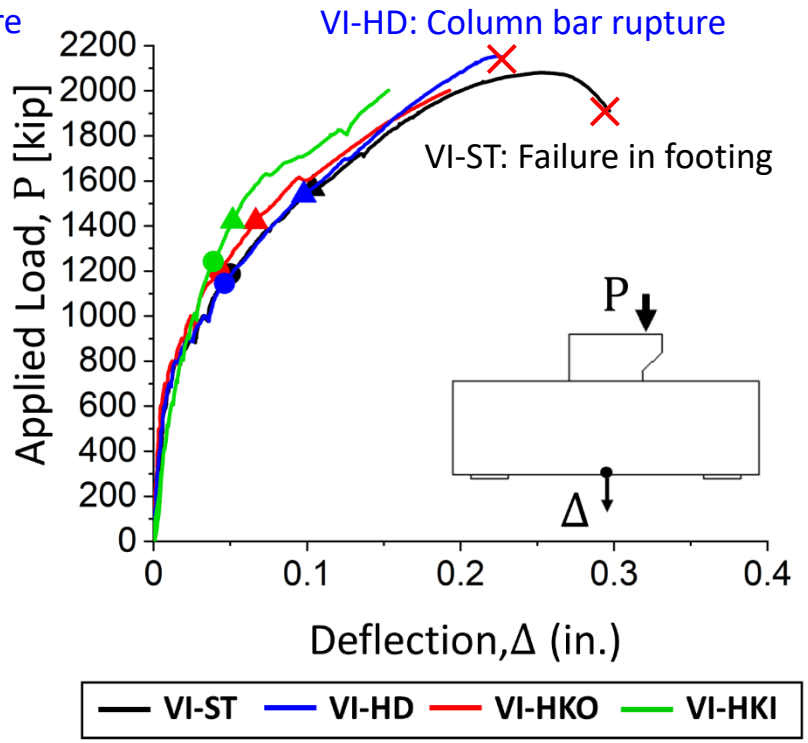


Experimental Program

Test results – Overall response





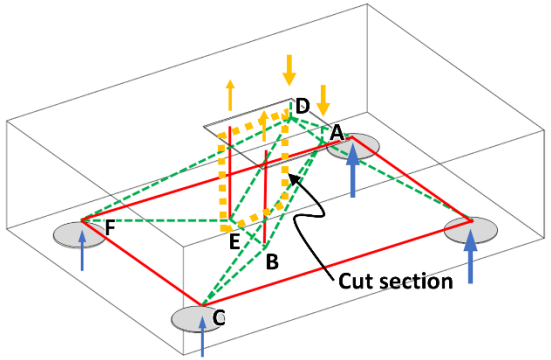


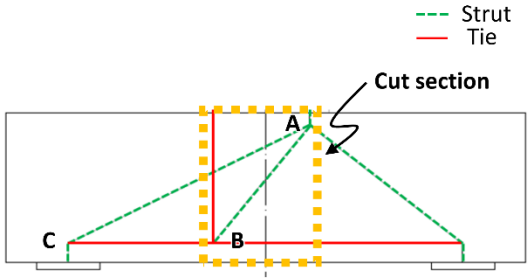
● First yielding of column reinforcement ▲ Yielding of all column reinforcement

	VI-ST	***VI-HD***	***VI-HKO***	***VI-HKI***
f_c' (Footing) [ksi]	4.62	5.01	5.00	5.25
f_y (Column rebar) [ksi]	70.3	72.1	70.3	76.8

Experimental Program

Test results – Visual observation





*Side view of the 3D STM

VI-ST (Straight Bar)

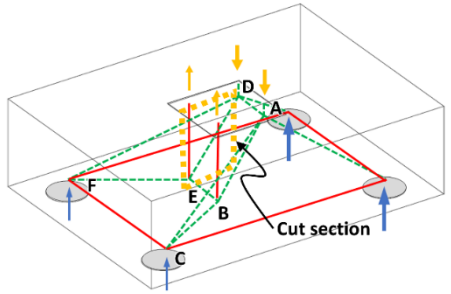
VI-HD (Headed Bar)

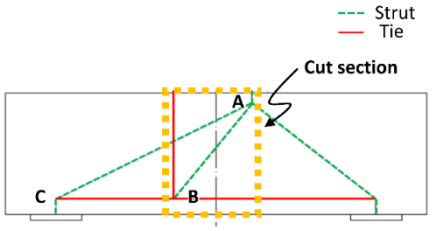
VI-HKO (Hooked Bar) (Outer-oriented)

VI-HKI (Hooked Bar) (Inner-oriented)

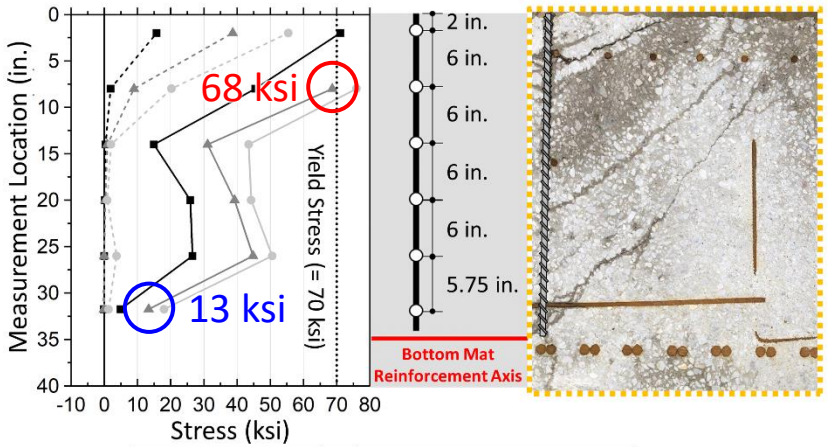
Experimental Program

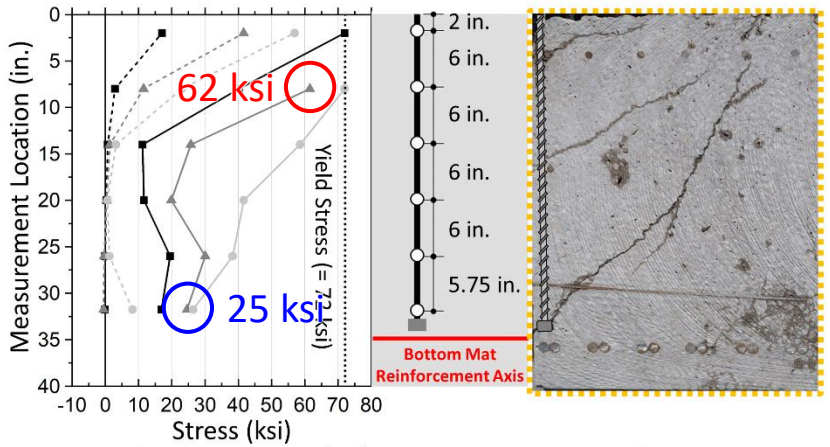
Test results – Stress Profile

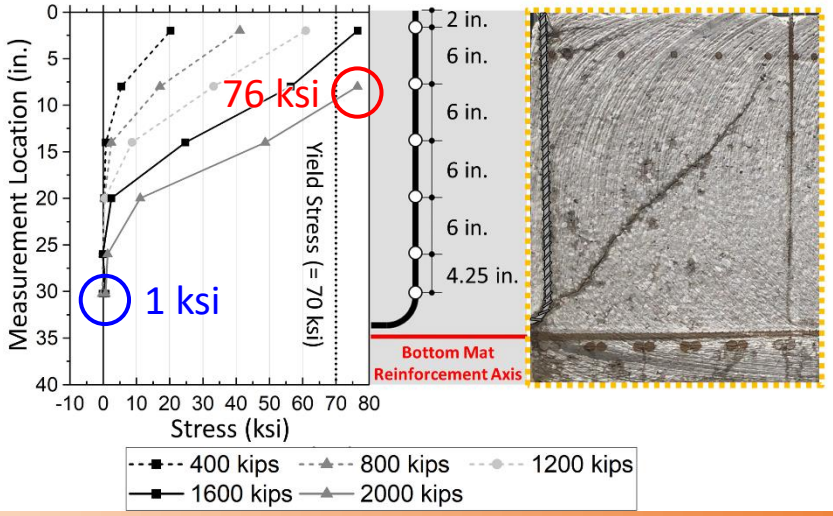


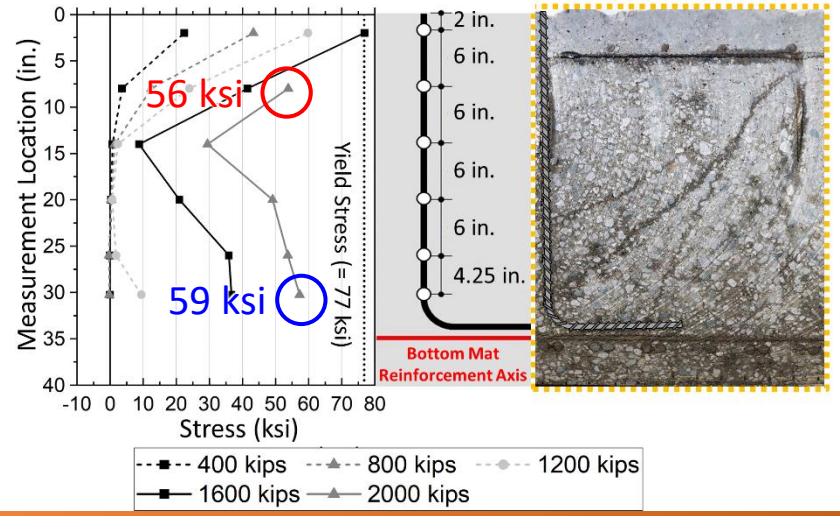


*Side view of the 3D STM



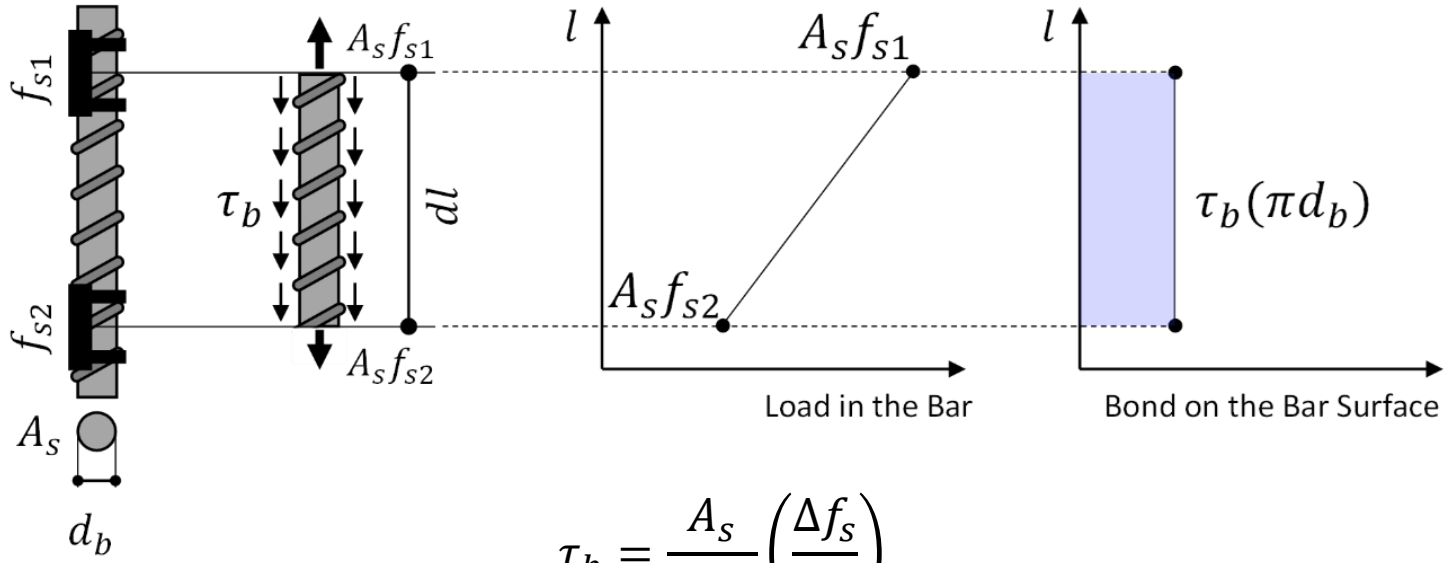






Experimental Program

Test results – Bond Stress Profile

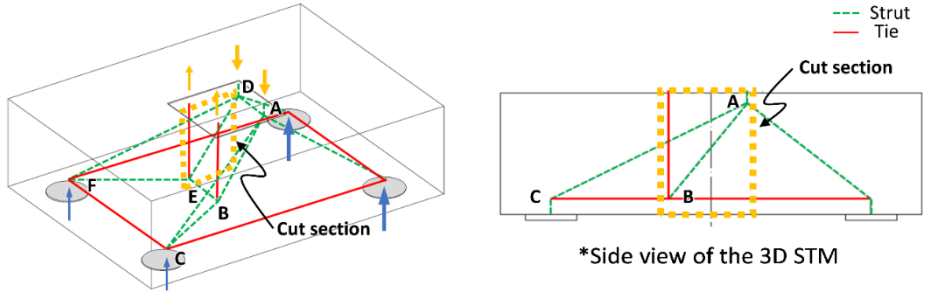


$$\tau_b = \frac{A_s}{d_b \pi}\left(\frac{\Delta f_s}{\Delta l}\right)$$

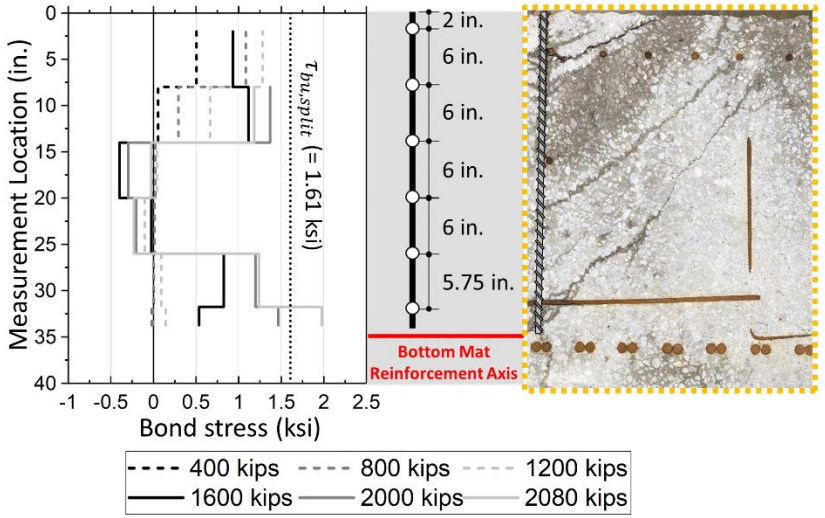
τ_b	= average bond stress between two consecutive gauges [ksi]
A_s	= cross-sectional area of reinforcement to be anchored [in.^{2}]
d_b	= diameter of reinforcement to be anchored [in.]
Δf_s	= change in stress between two consecutive gauges [ksi]
Δl	= center-to-center distance between two consecutive gauges [in.]

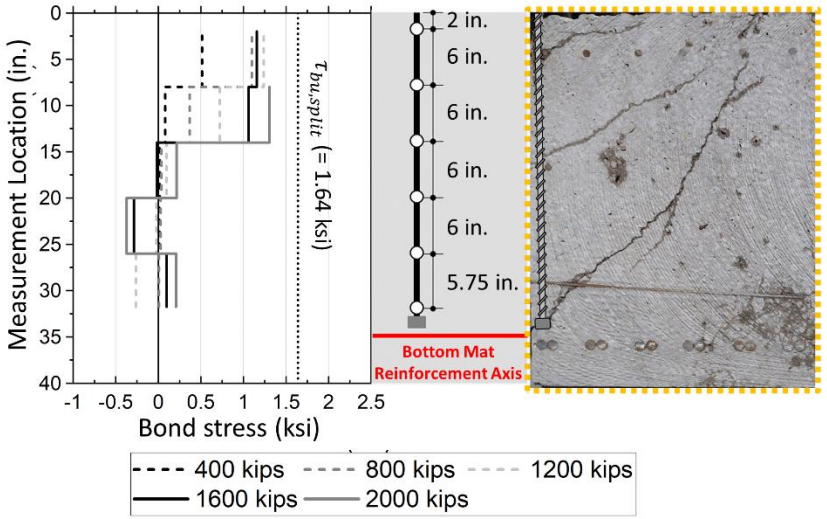
Experimental Program

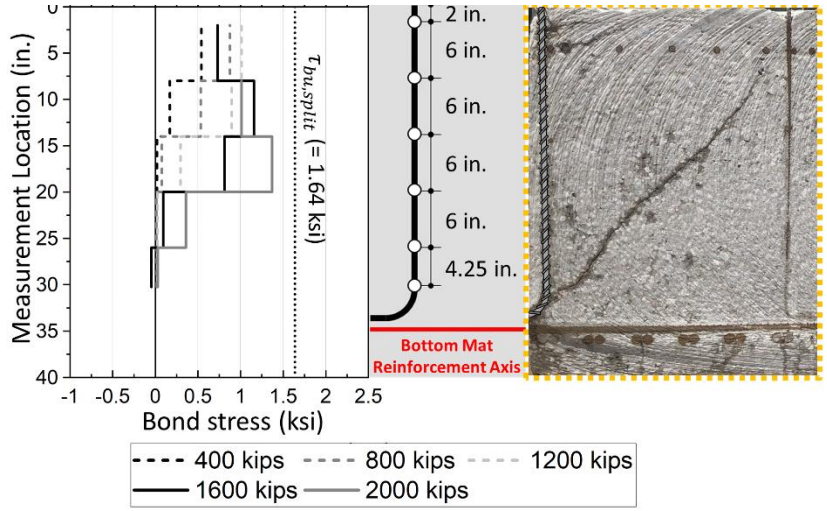
Test results – Bond Stress Profile

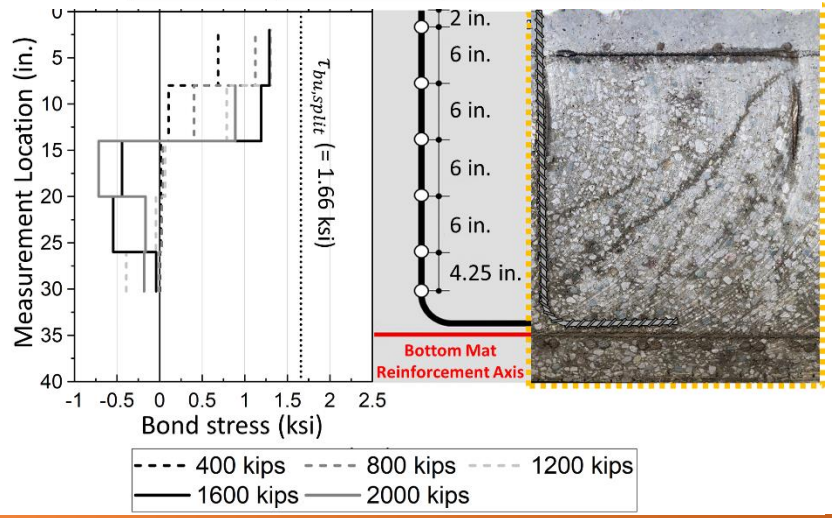


*Side view of the 3D STM









Conclusions

- All column bars could yield regardless of the anchorage type.
- Different column reinforcement transfer actions were found depending on the anchorage detail.
- **Diagonal struts flowing down to the drilled shaft and the bottom end of the column reinforcement induce significant tensile stresses in the vicinity of the bottom end of the column reinforcement** except for the outer-oriented hooked anchor, which are commonly employed anchorage details for drilled shaft footings.
- The inner-oriented hooked bars and headed bars relied on the bearing action of the hook or head to develop tensile yield capacity.
- The outer-oriented hooked bar could not activate its bearing action in the hook, since no stresses were developed near the hook end. **This resulted in a relatively high-stress level developing in the central and upper portions of the embedment region.**

Acknowledgements

Any Questions?

ysyi89@utexas.edu

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The University of Texas at Austin

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Experimental Program

Test results – Visual observation

VI-ST (Straight Bar)

Side View (West)

Compression-side

Tension-side

VI-HD (Headed Bar)

Side View (West)

Compression-side

Tension-side