Investigation and Development of a Post Tensioned Pile Splice for Prestressed Piles

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Civil & Environmental Engineering

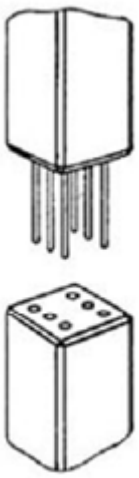
Splice Requirements

- **Capacity –** Spliced section should match both the axial and flexural strength of an un-spliced pile (incl. driving stresses).
- **Ductility –** Failure should occur in a ductile manner, not brittle.
- **Durability –** Splice components should be corrosion resistant to a level that would not hinder performance throughout the life of the structure.
- **Installation –** Installation should not be overly labor intensive, time consuming, or costly.

Current Practices

Epoxy Doweled Splice

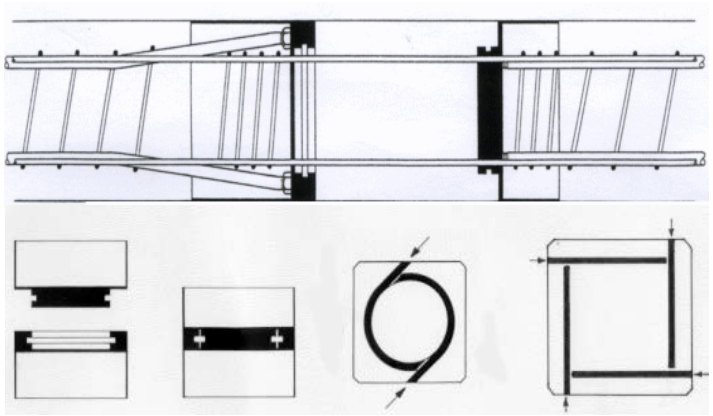
- Predominant method in FL.
- Low material cost.
- Long epoxy cure time.
- Limited flexural and tensile capacity.

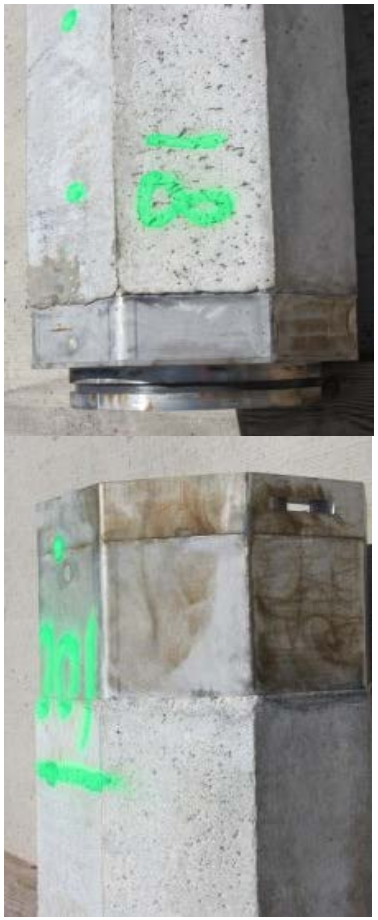


Current Practices

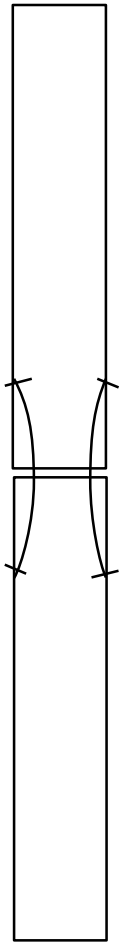
Kie-Lock Splice (formerly Sure-Lock)

- Most common mechanical splice.
- Good capacity.
- Some cracking from stress concentrations.
- No prestress adjacent to splice / most common break region
- Does not conform to Buy America provisions.

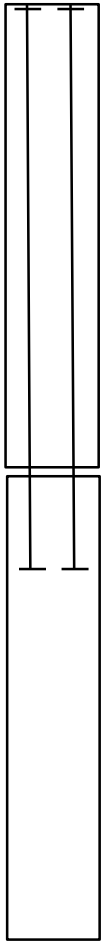




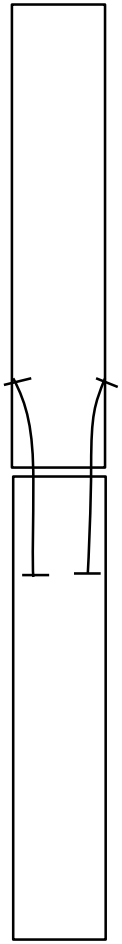
Proposed Concepts



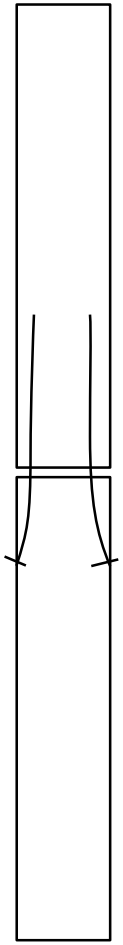
Intermediate anchorages
(Concept 1)



Embedded anchorages w/
full length post tensioning
(Concept 2)

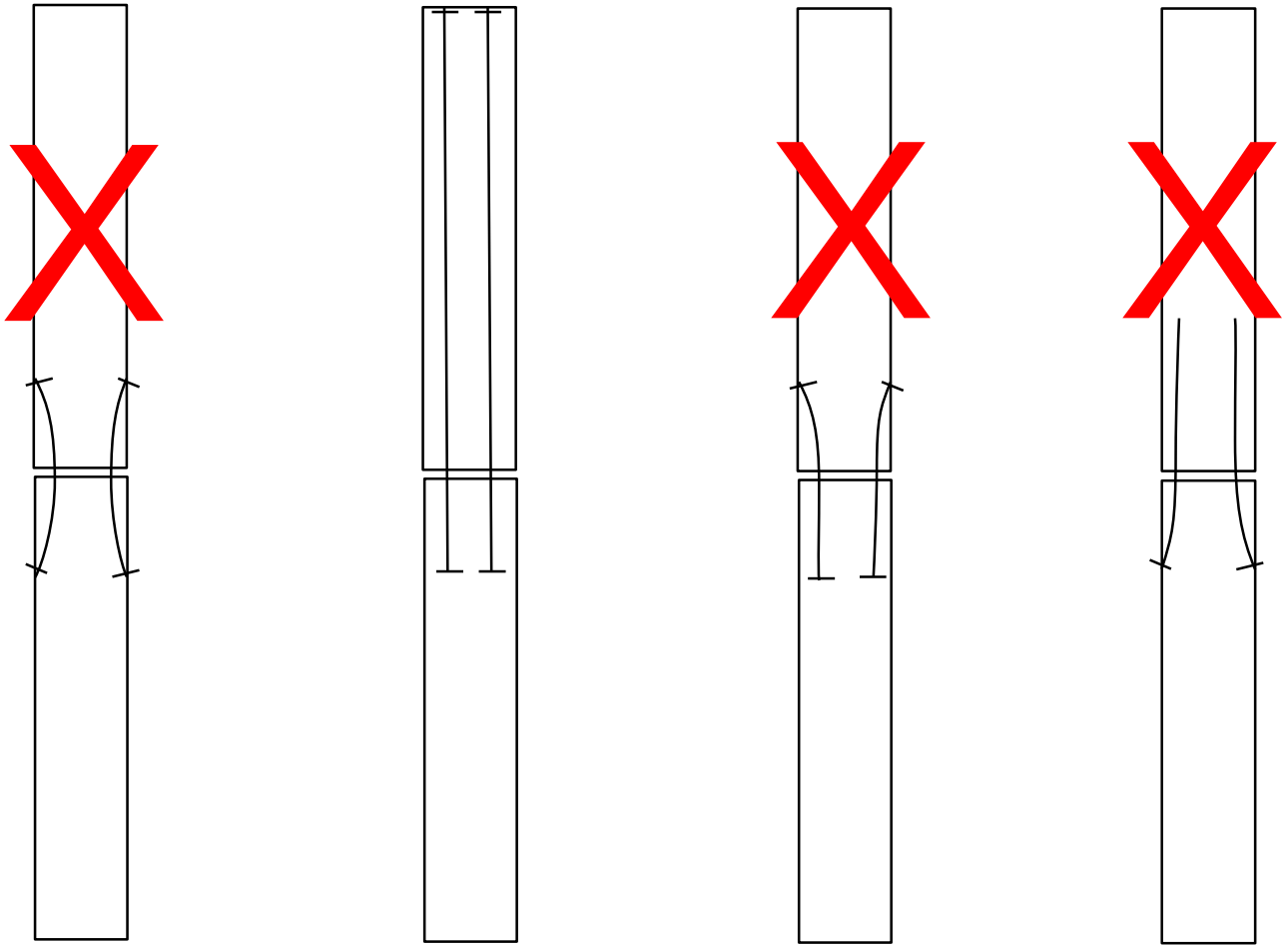


Combination of
Intermediate/Embedded
(Concept 3)



Embedded Strands w/
Intermediate Anchorages
(Concept 4)

Durability / Corrosion



Intermediate anchorages
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Combination of
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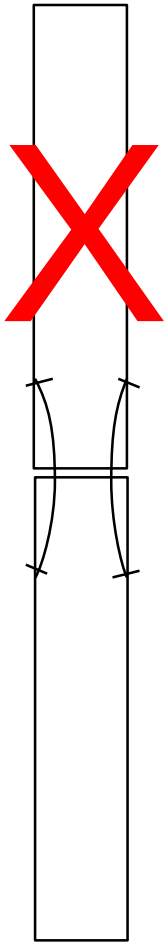
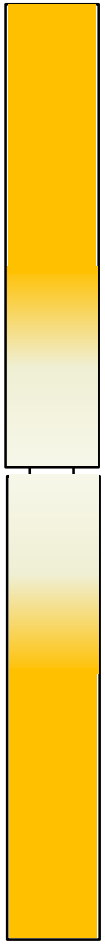
(Concept 3)

Embedded Strands w/
Intermediate Anchorages
(Concept 4)

Before Stressing



Intermediate anchorages
(Concept 1)



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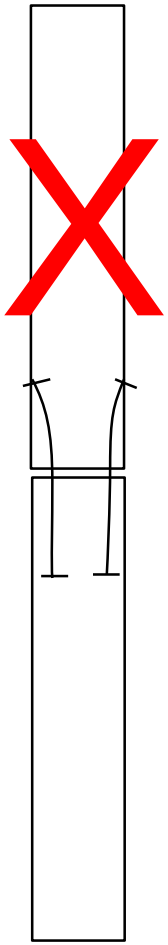

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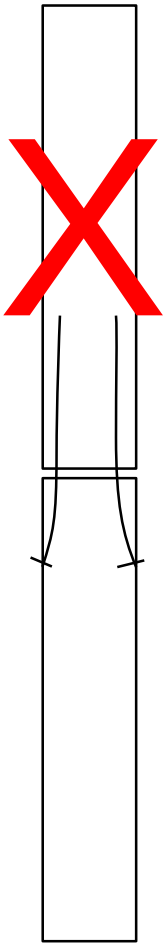
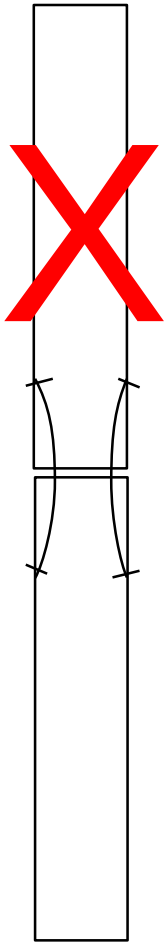


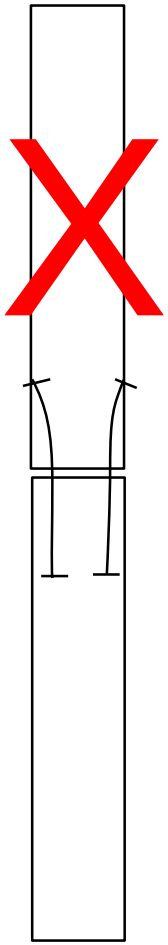
Embedded Strands w/
Intermediate Anchorages
(Concept 4)

Over-Stress Upper Segment



Intermediate anchorages
(Concept 1)

Embedded anchorages w/
full length post tensioning
(Concept 2)



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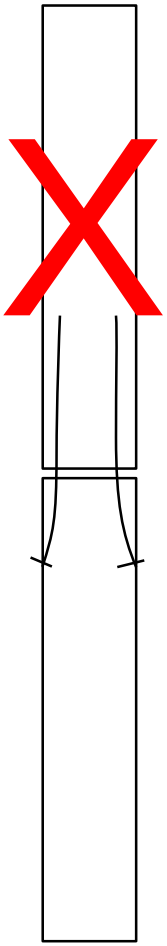
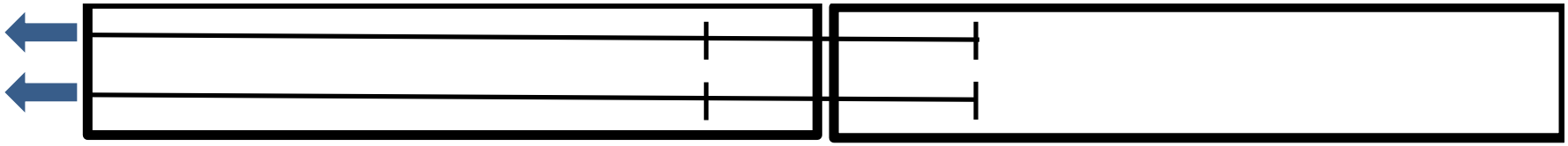


Embedded Strands w/
Intermediate Anchorages
(Concept 4)

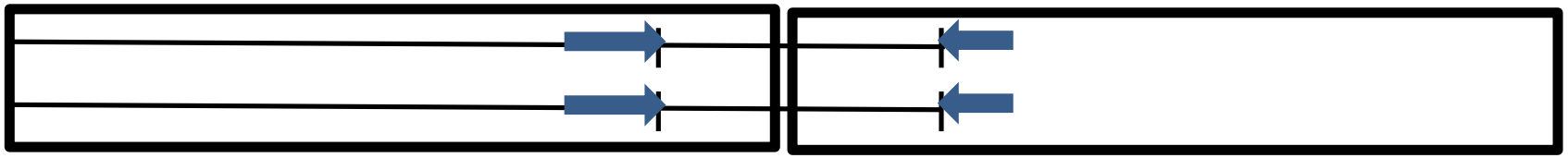
Modified Concept

Move anchors from top to splice zone

Initial Jacking Forces



Final Splicing Strand Forces



Splice Header Plate

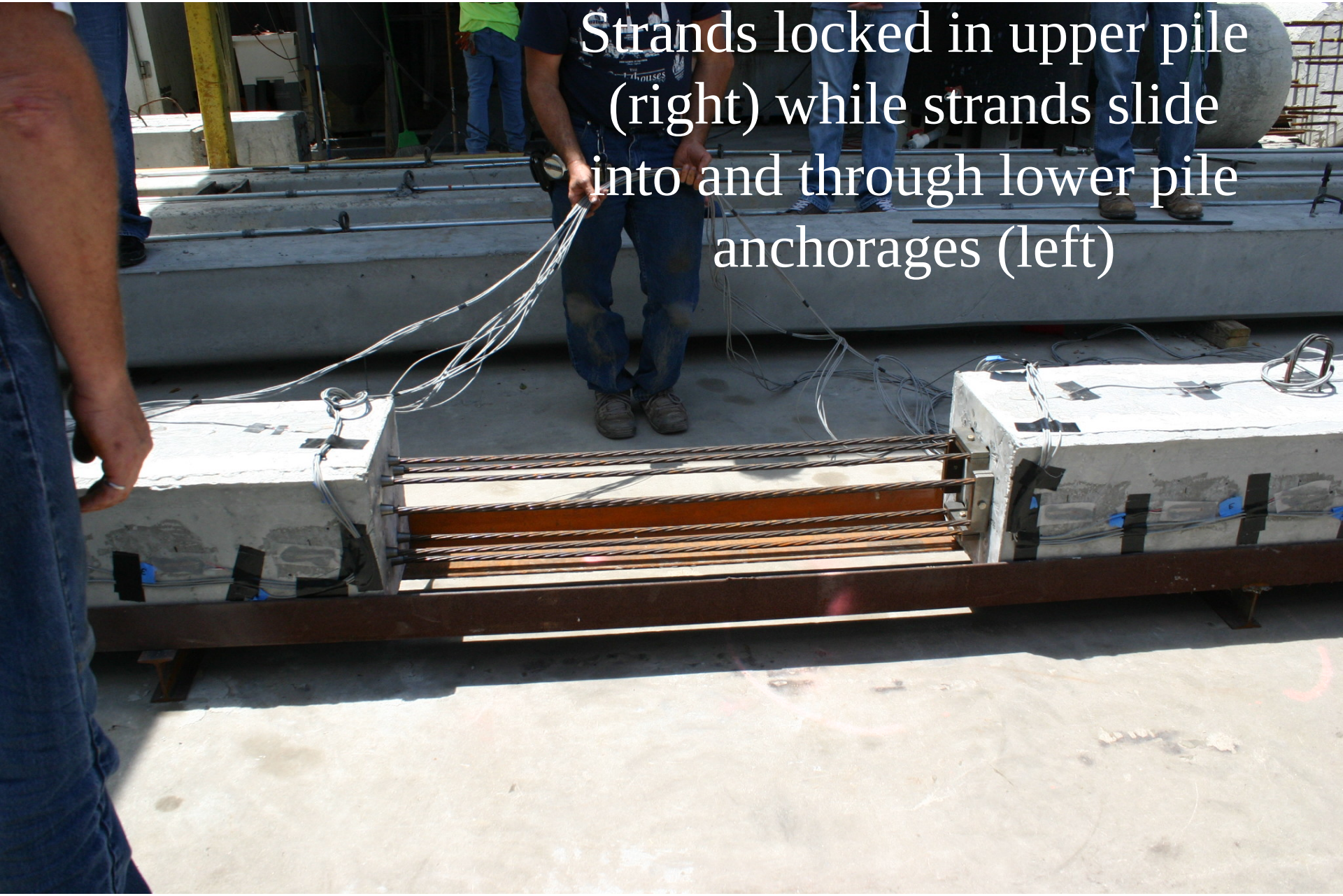
Precision drilled and faced for perfectly mated pile ends

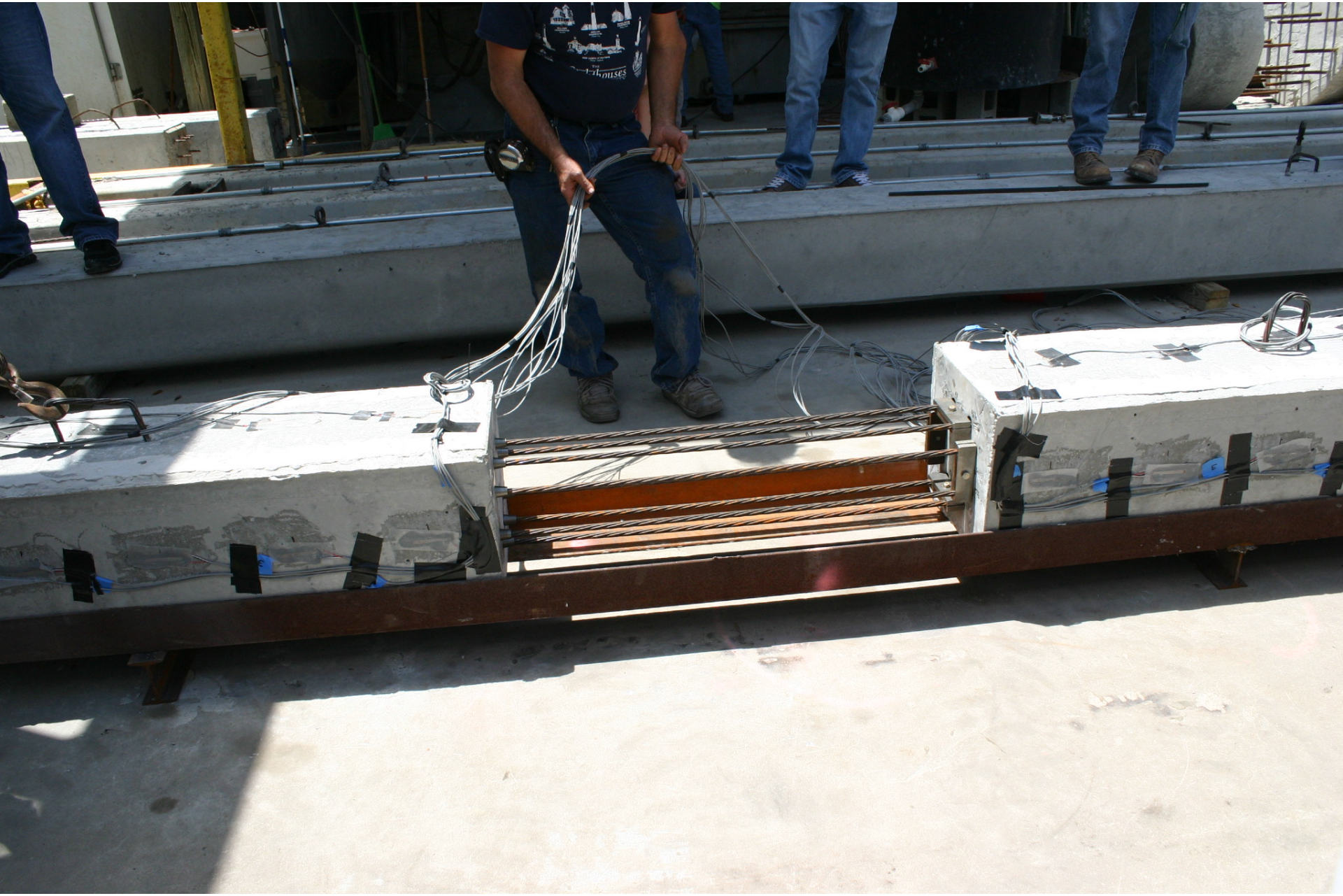
Embedded Anchorages

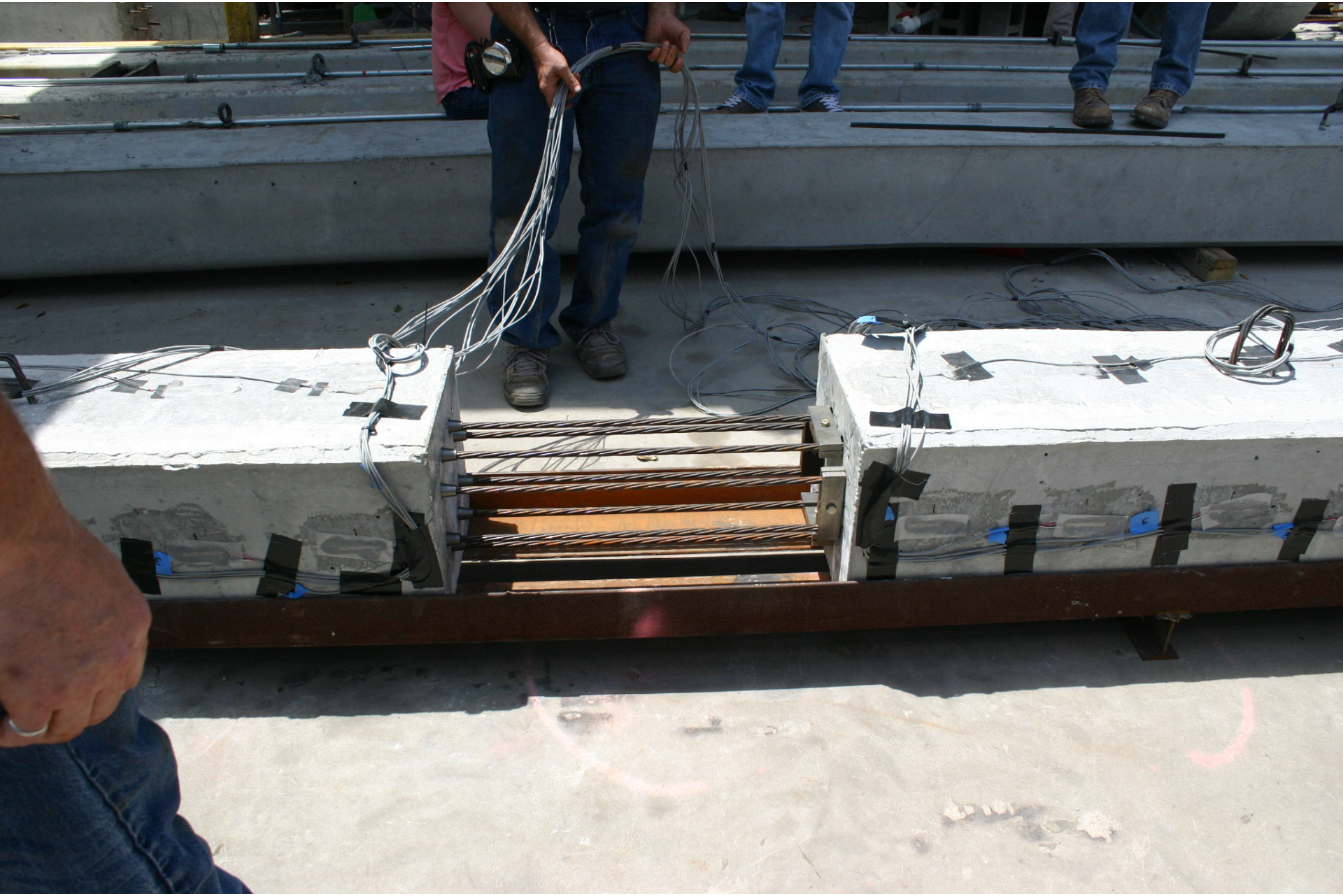
- OTS prestressing chucks
- 2.5”x3”x½” plate, full weld
- Washer inserts to reduce seating losses

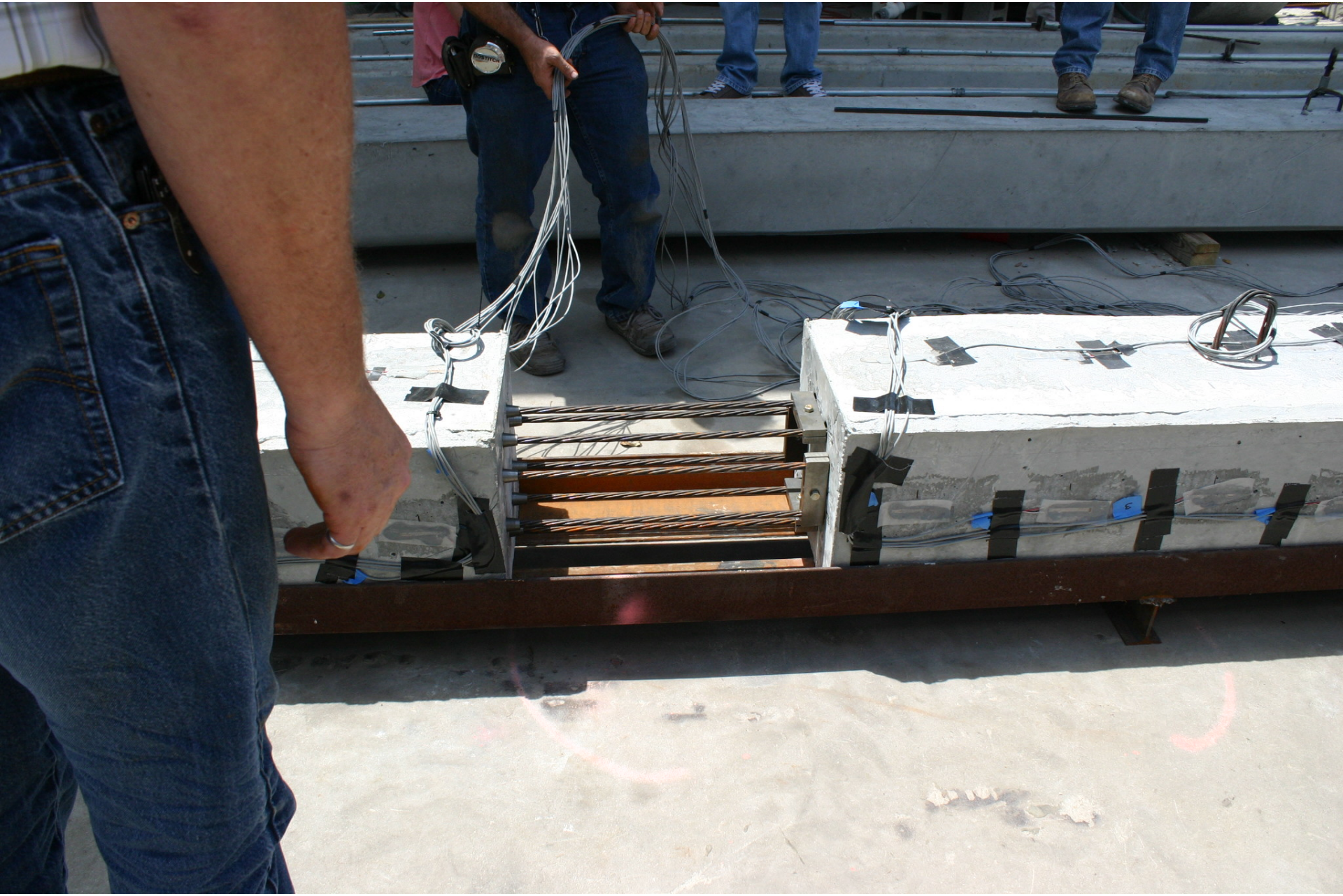
Splicing

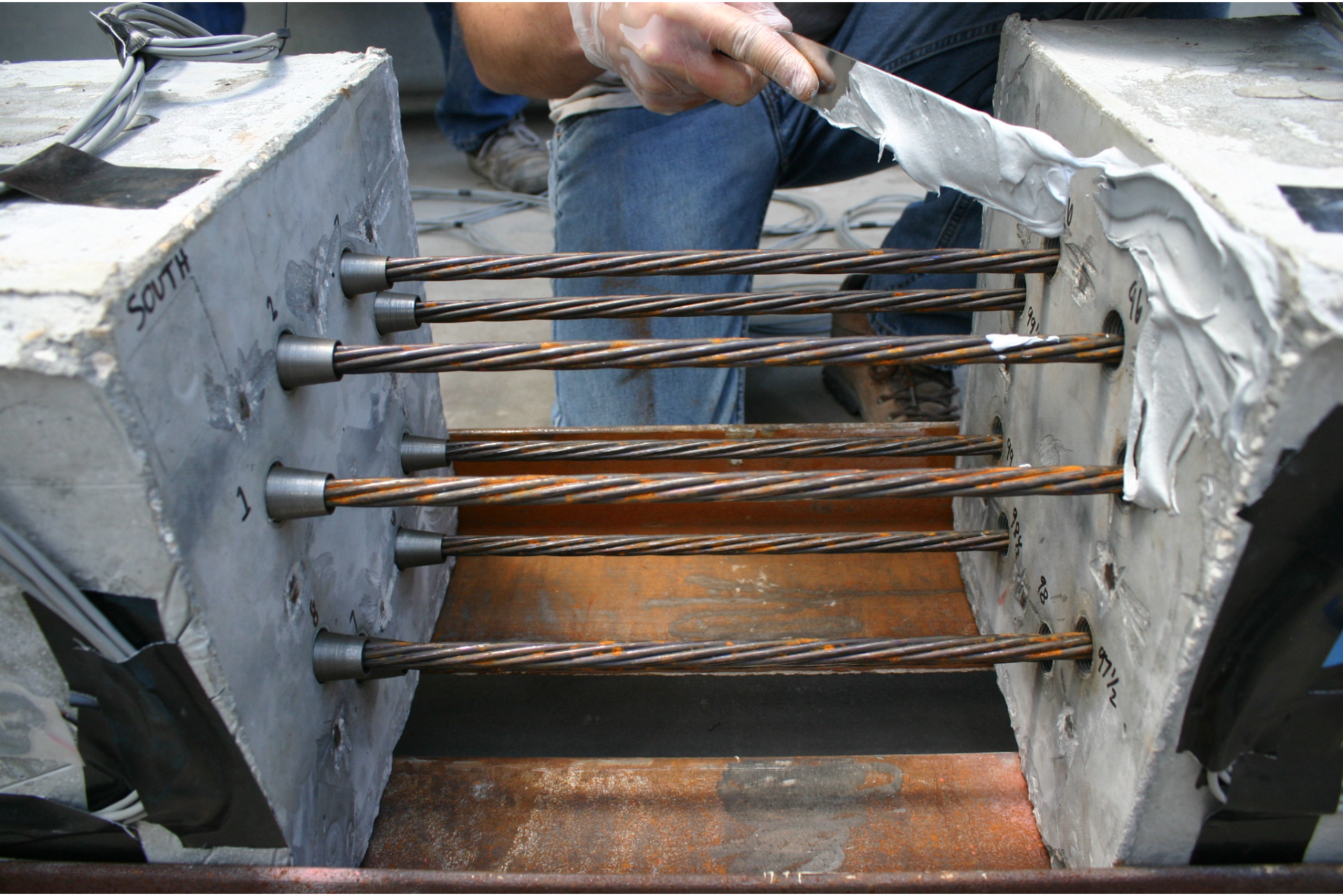

Each strand staggered
to ease alignment


Strands locked in upper pile
(right) while strands slide
into and through lower pile
anchorages (left)

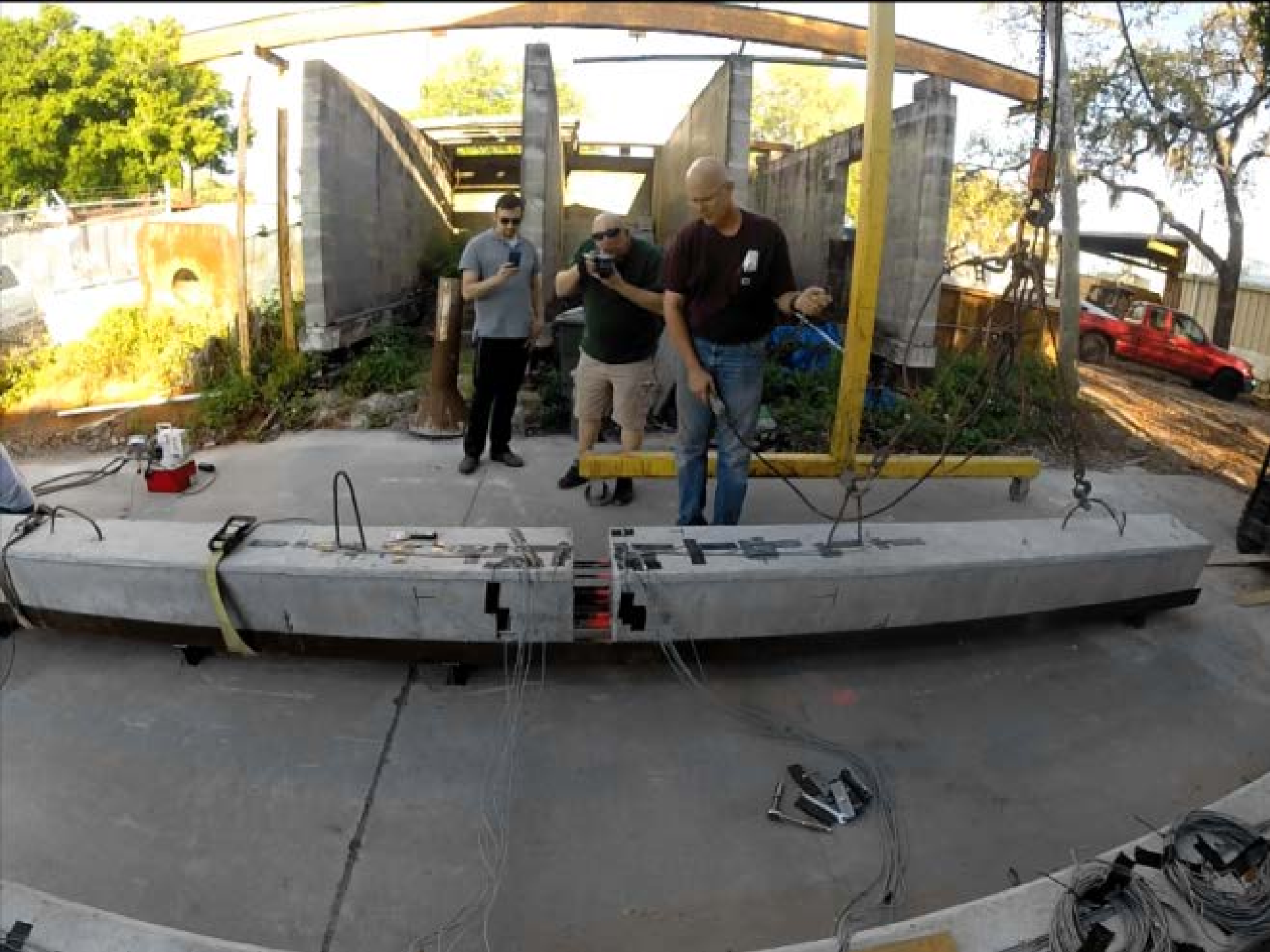


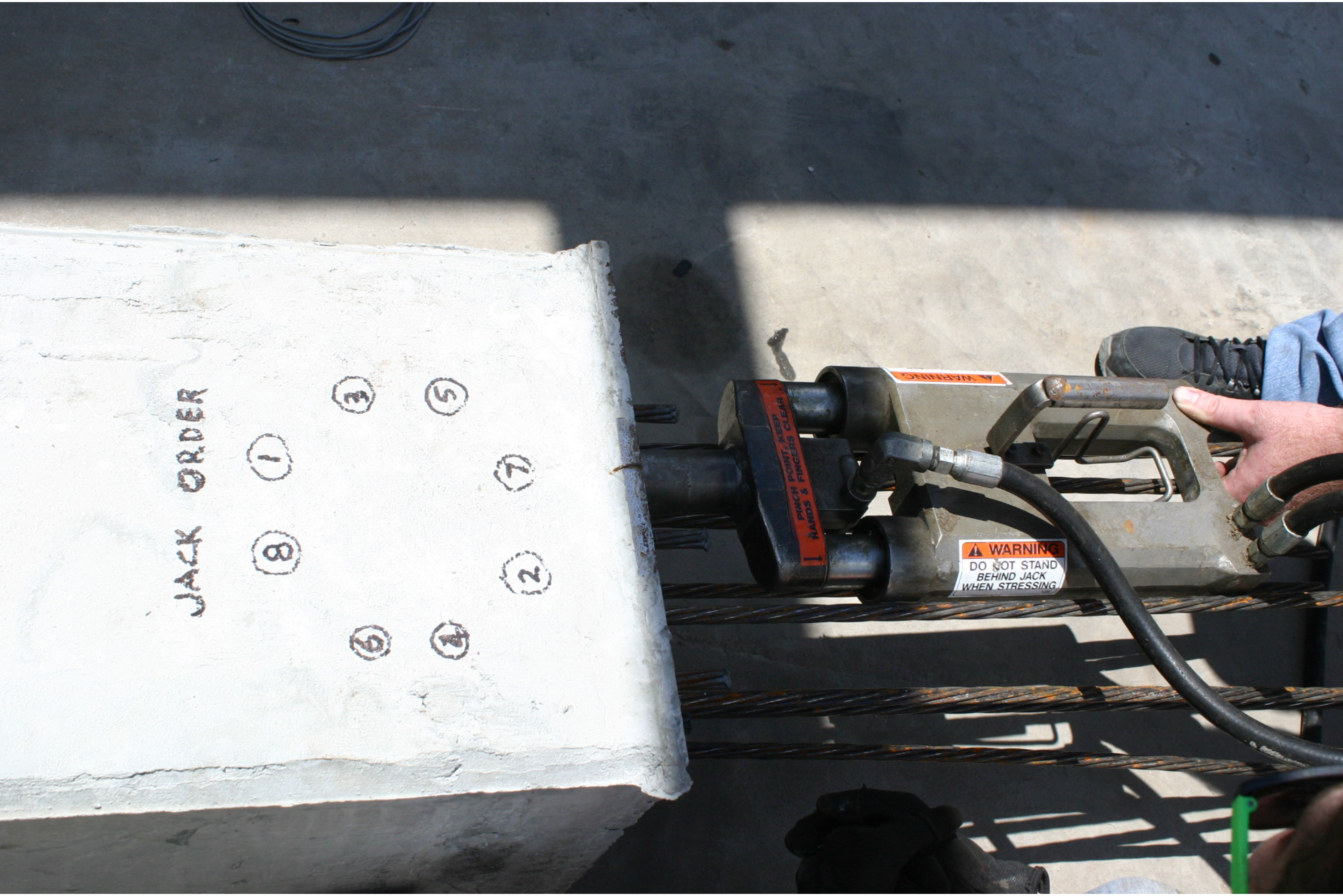





SOUTH


go to fullscreen, ctrl+click to snap to video size



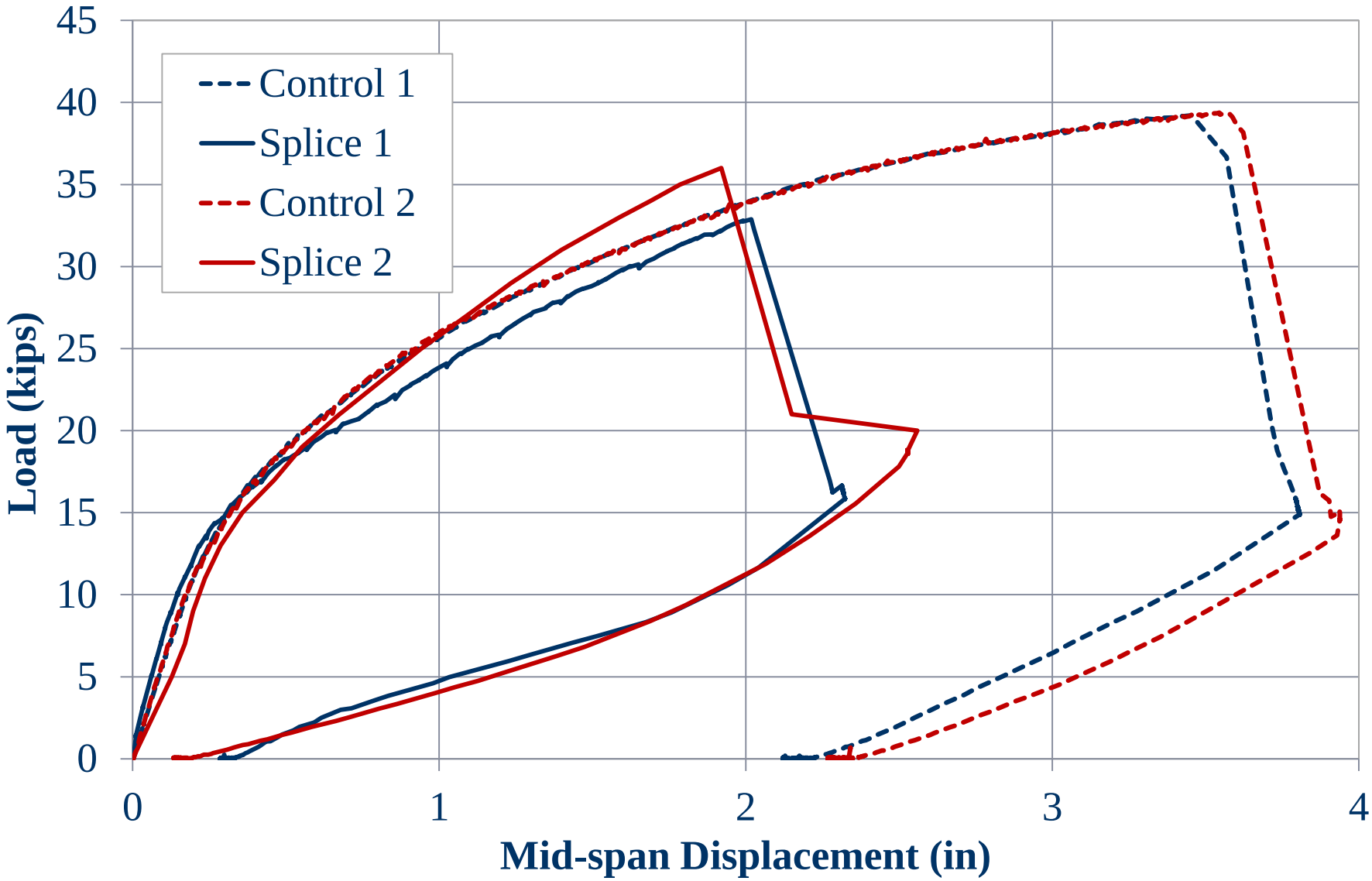

JACK ORDER
1
2
3
4
5
6
7
8
PINCH POINT, KEEP HANDS & FINGERS CLEAR
WARNING
DO NOT STAND BEHIND JACK WHEN STRESSING


Grout pumped through lower
ducts and out all other ducts

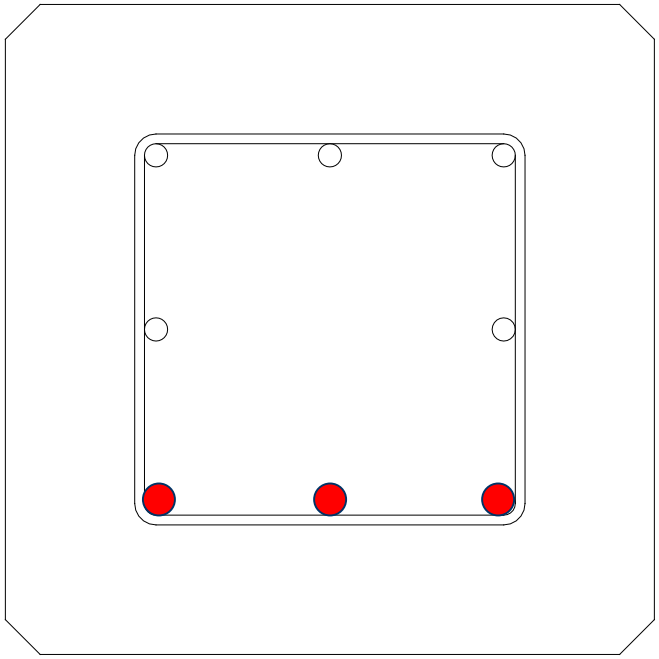
4-Point Bending

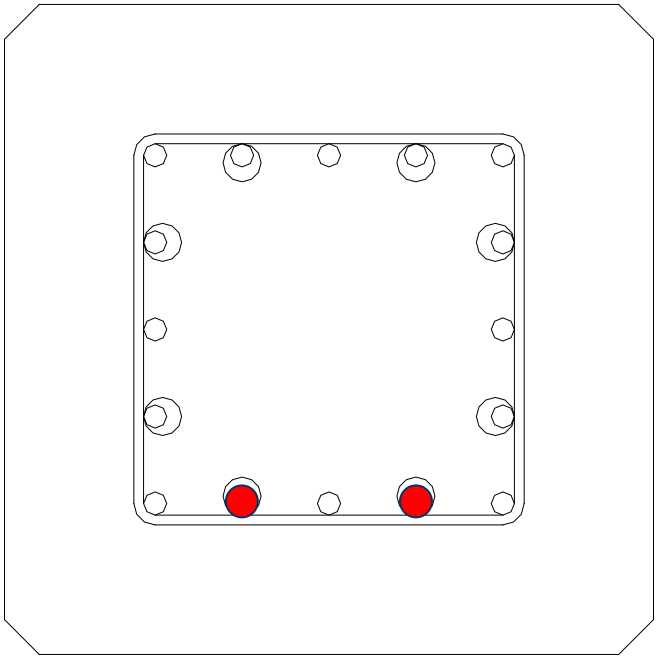
Load – Deflection

Control 2 vs. Splice 2



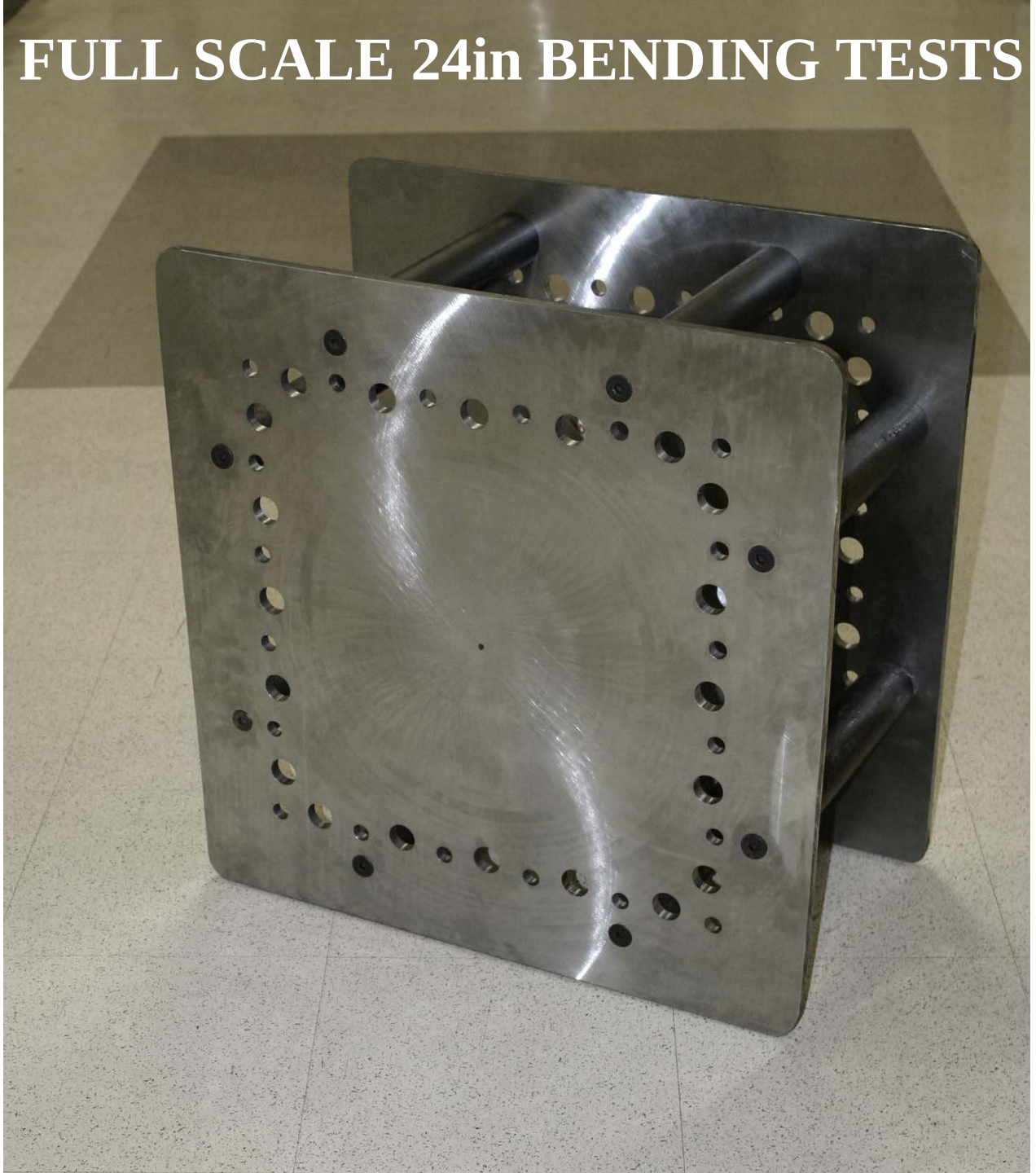
Effective prestress same; Cracking load same; Ultimate moment16.3% less



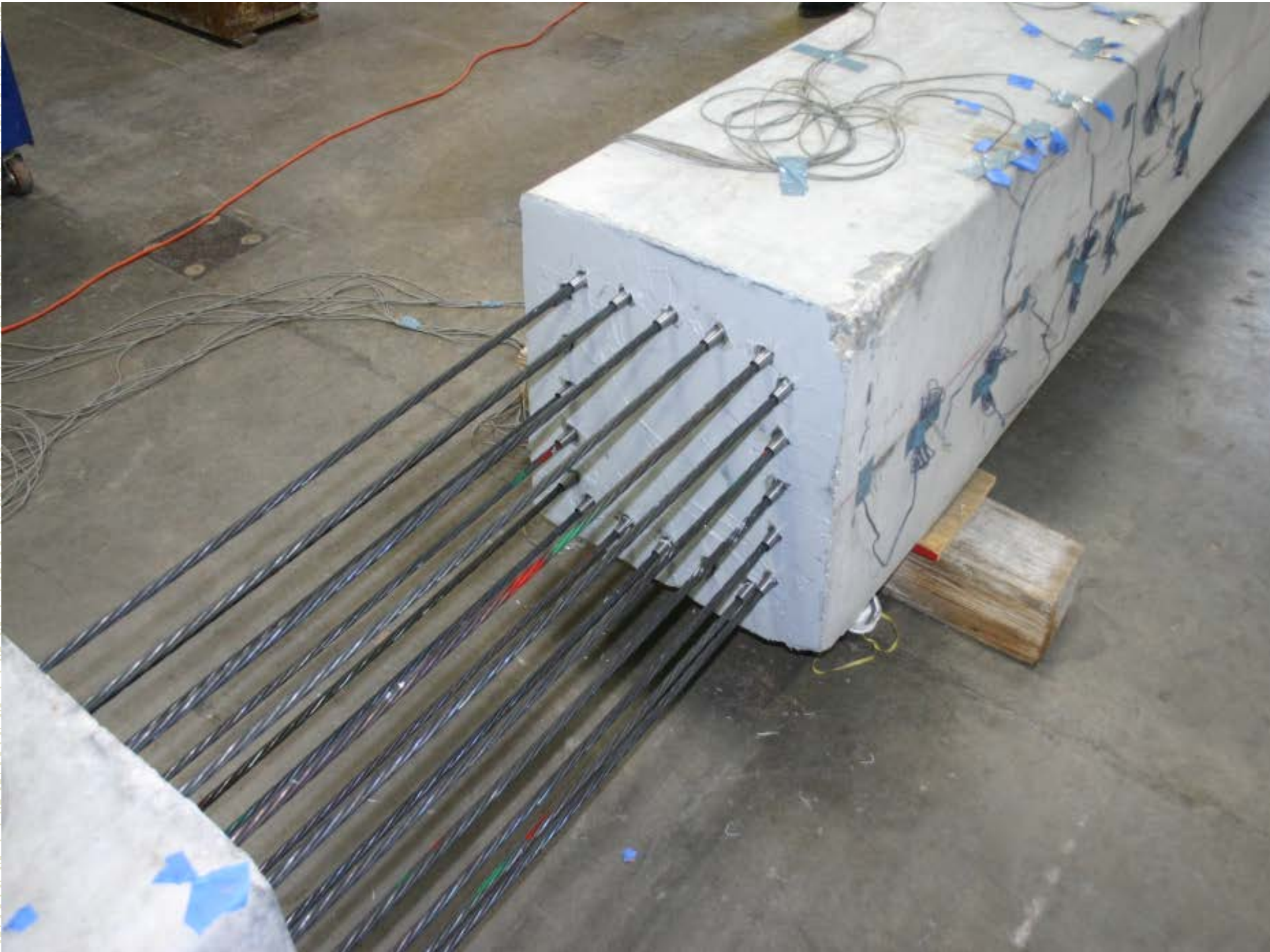


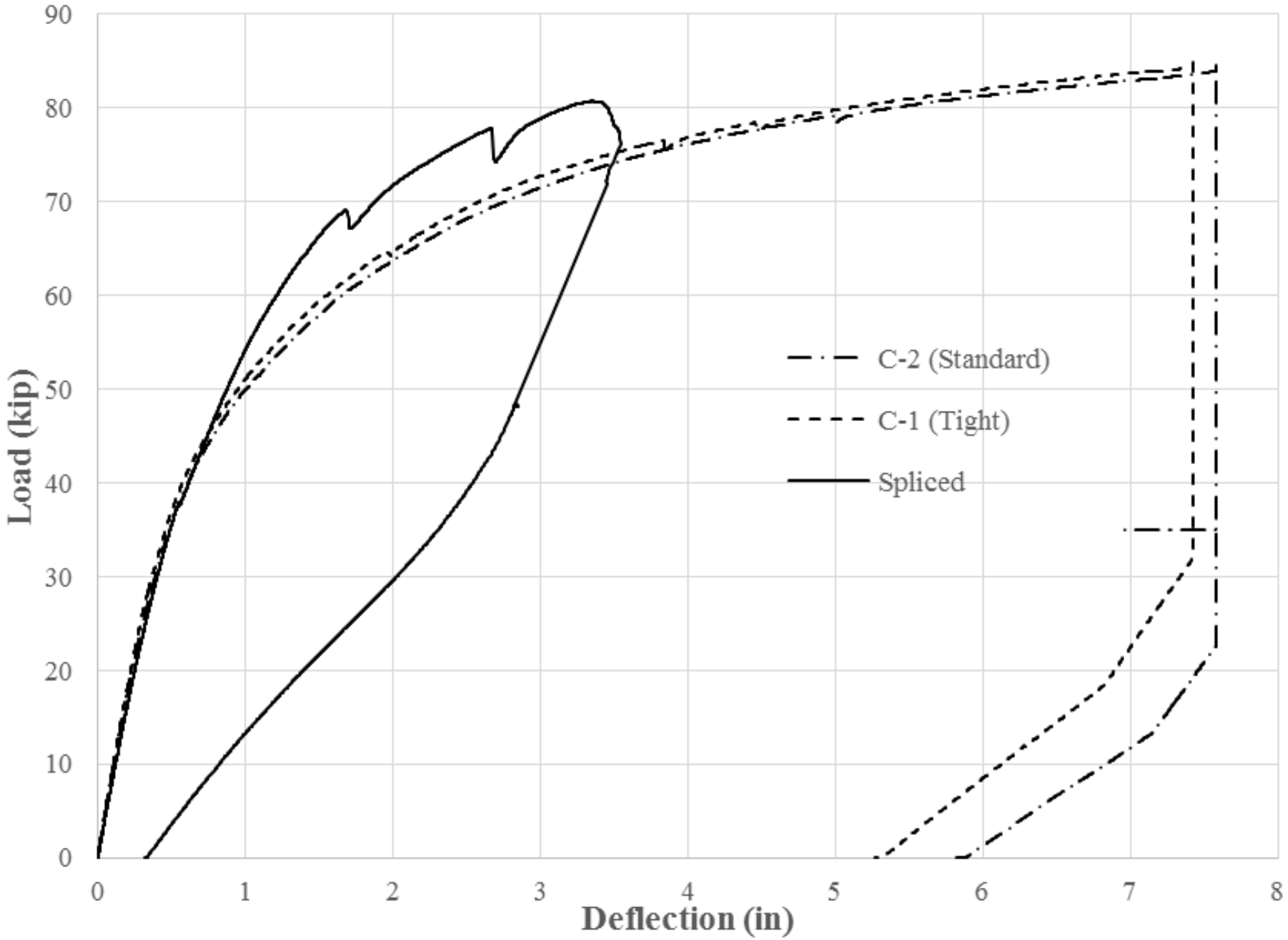
Pile Size (in)	No Strands	Strand Size (in)	Strand Group Moment of Inertia (in^4)		Loss (%)
			Prestressing	Splicing	
14	8	0.5 standard	11.26	9.37	16.8
24	20	0.5 special	173.9	168.8	2.9

FULL SCALE 24in BENDING TESTS




Acetone




90
80
70
60
50
40
30
20
10
0
Load (kip)
0
1
2
3
4
5
6
7
8
Deflection (in)
C-2 (Standard)
C-1 (Tight)
Spliced


Splice Pile
One-Piece Pile


Splice Pile
One-Piece Pile

Pile Driving Demonstration

- 24in, 100ft pile
- Spliced with 30ft upper segment (70ft lower)
- Driven along I-4 in Deland area
- Test pile from project used as control comparison


20 Splice Strands
(bending tests)


16 Splice Strands
(driving demo)

SCC Pile Mix

Lower Pile Honeycombing

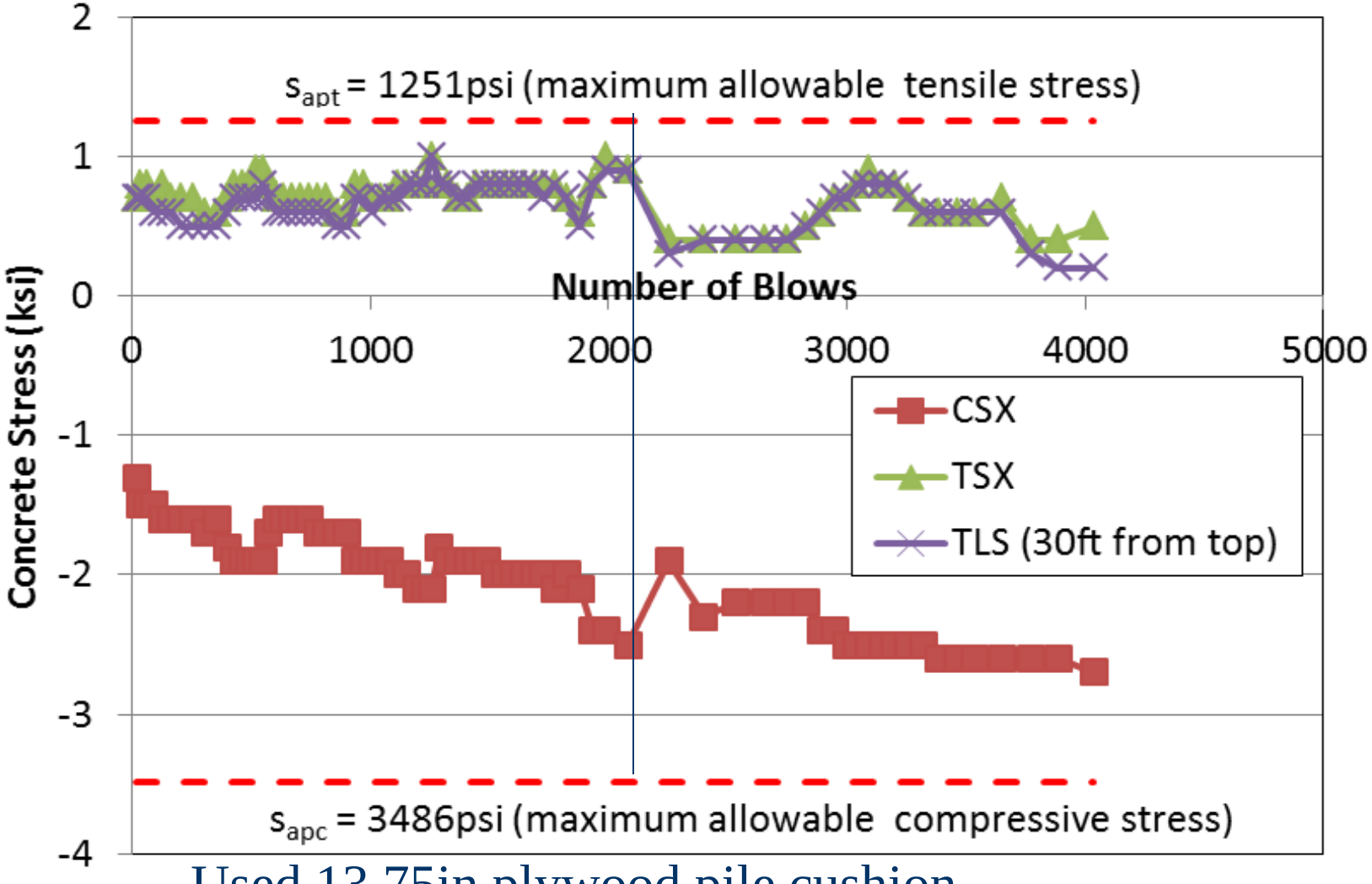
Upper Pile Damaged

As-Received On-site

Initial State Prior to Driving

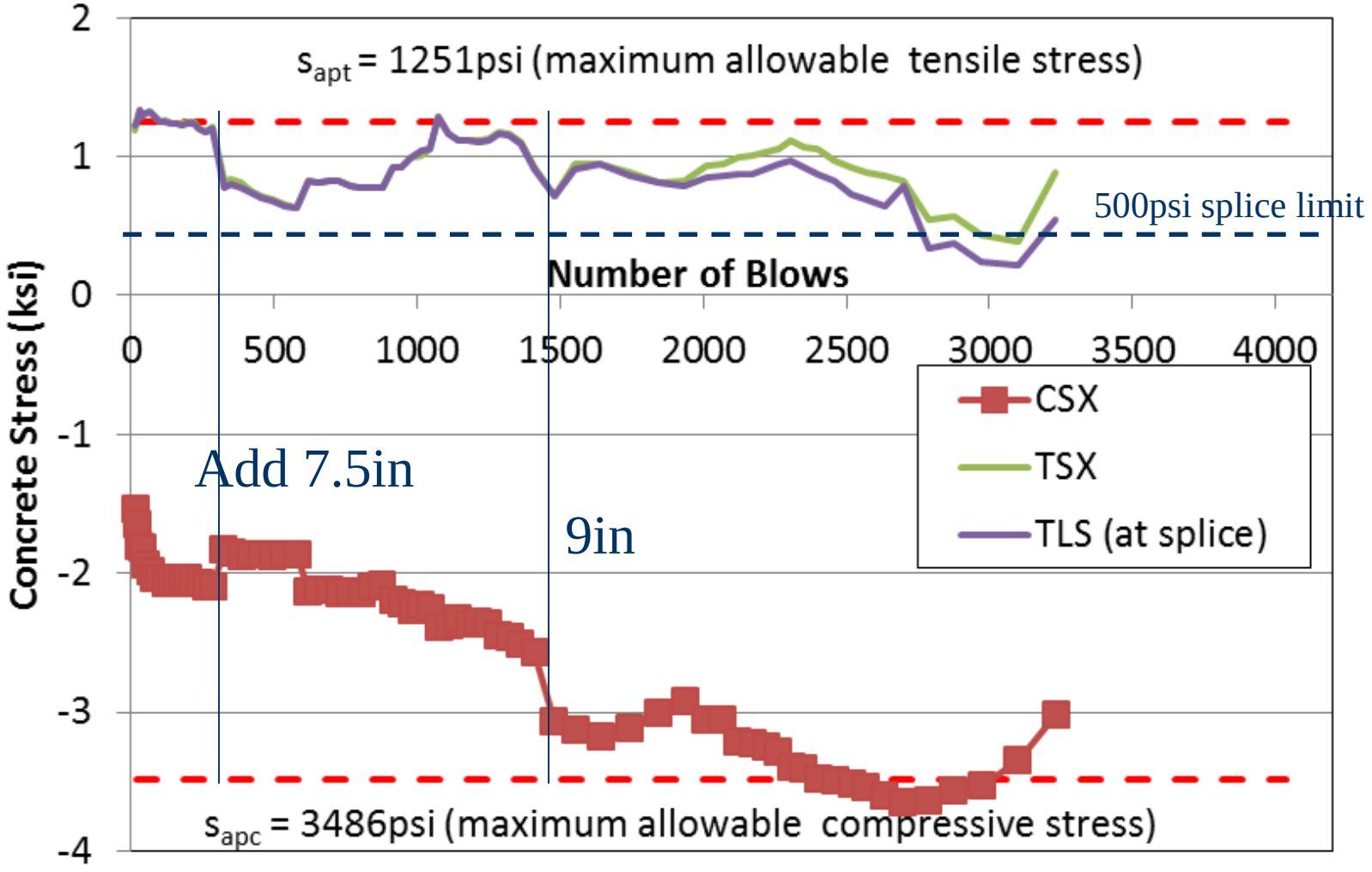
No change after 1200 blows (70ft embedment)

Test Pile 1 (control)



Used 13.75in plywood pile cushion

Test Pile 1-1 (spliced)



Started with 11.75in cushion

At End of Drive

Test Pile

- 115ft long; 99.8ft driven
- 13.75in cushion; 1 change
- 4035 blows
- 150 blows/ft
- 9.9ft stroke
- 1400kip capacity

Splice Pile

- 100ft; 99.4ft driven
- 11.75in cushion; 2 changes
- 3231 blows
- 314 blows/ft
- 9.8ft stroke
- 1660kip capacity

Conclusions

- Post tensioned pile splice was successfully designed that satisfied both bending and driving requirements of an unspliced, one-piece pile
- No splice related stress limits needed
- Original splice concept was adapted to eliminate corrosion susceptibility
- Design is applicable to all FDOT pile sizes


Questions?