Technologies for Resiliency of Infrastructure

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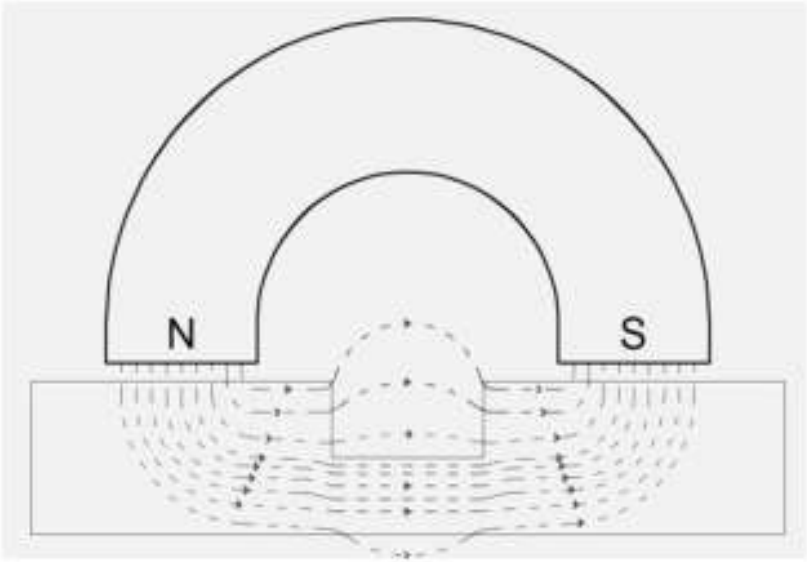
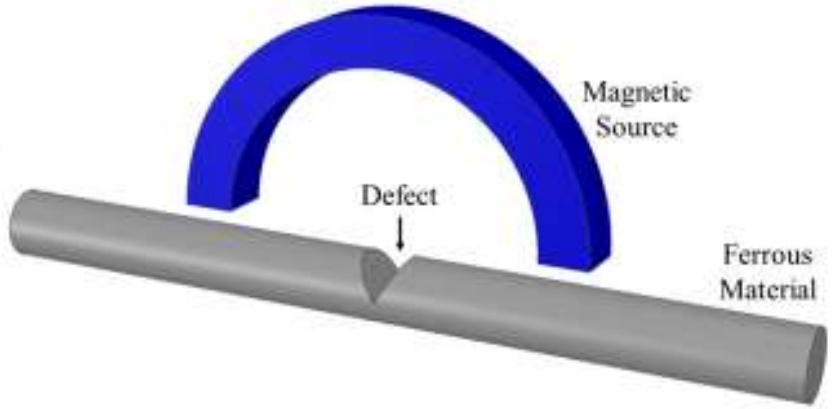
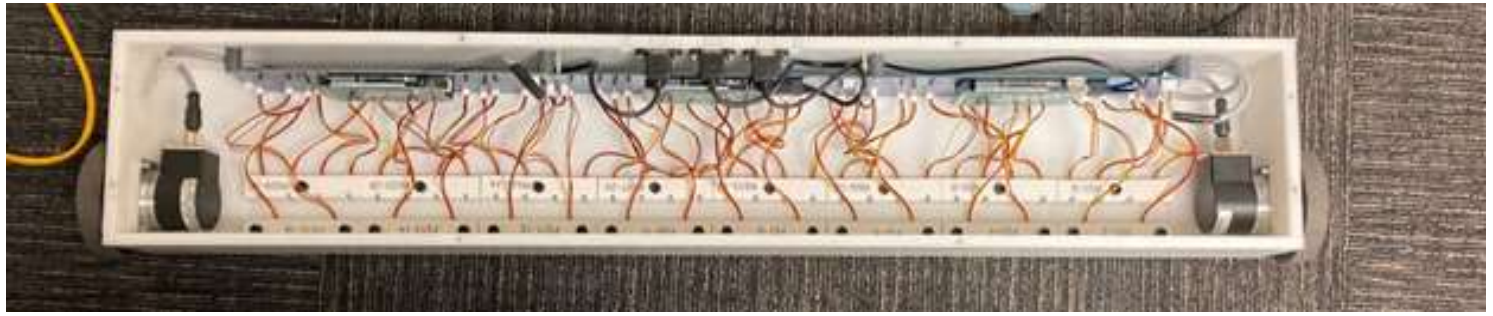
Technologies for Inspecting for Corrosion

Magnetic Flux Leakage (MFL) Method



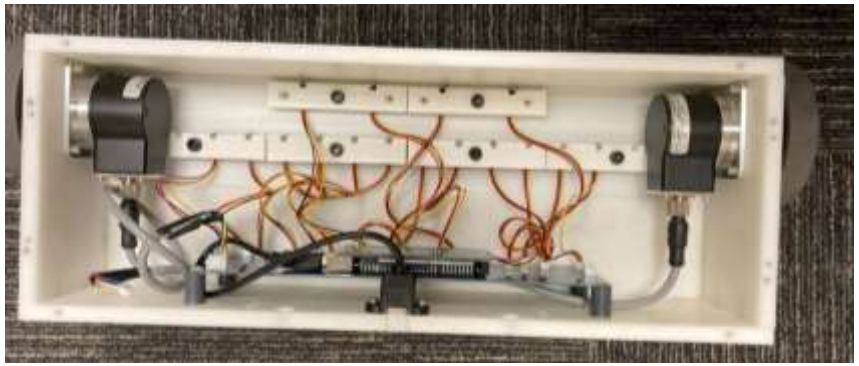


Final MFL System

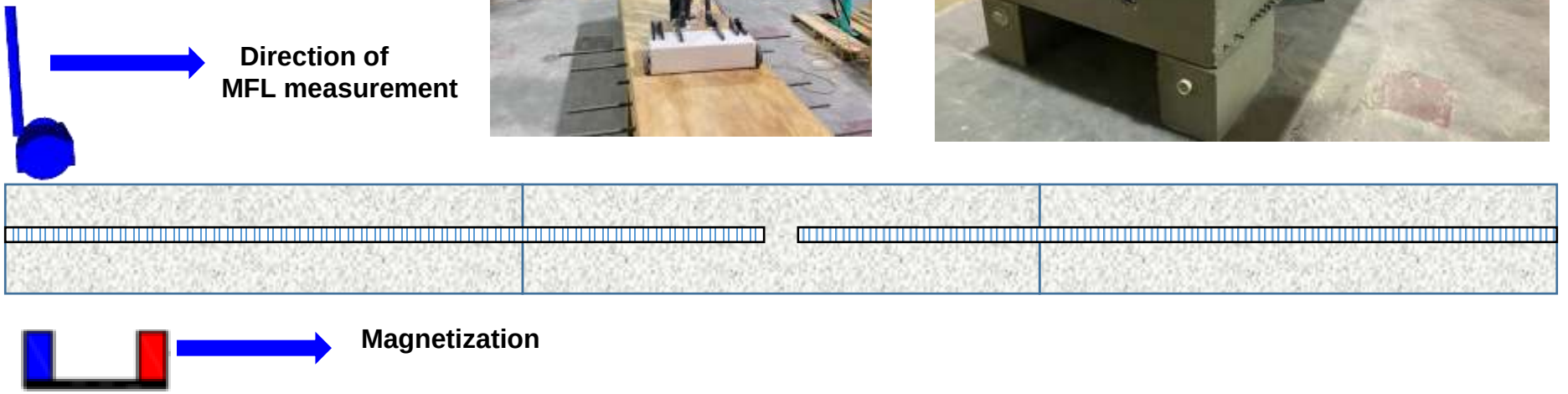


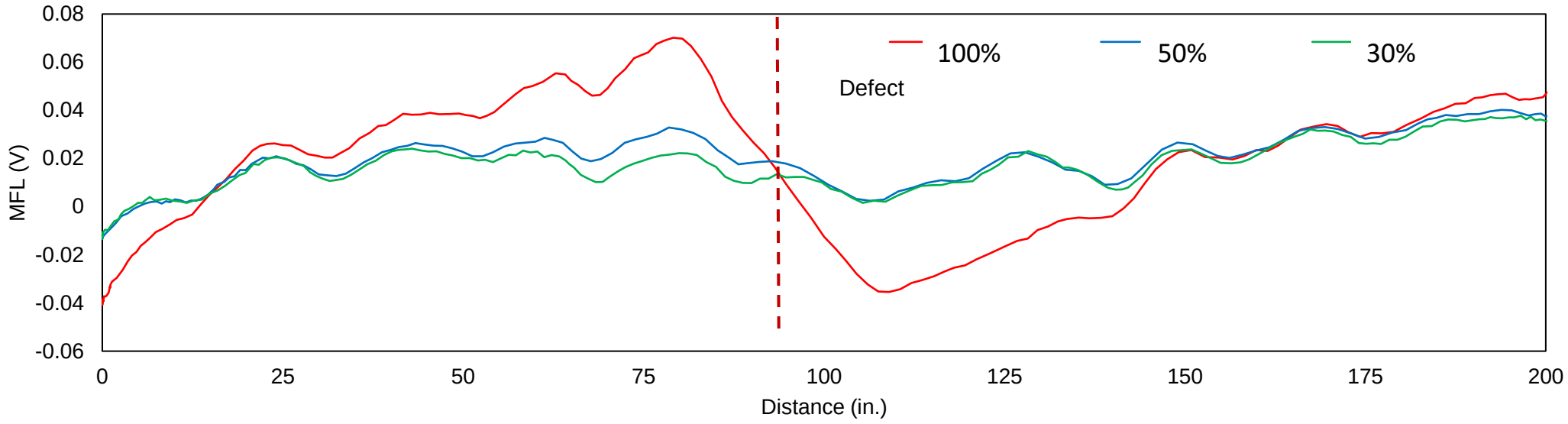
32 inch wide Measurement Unit

Final MFL System

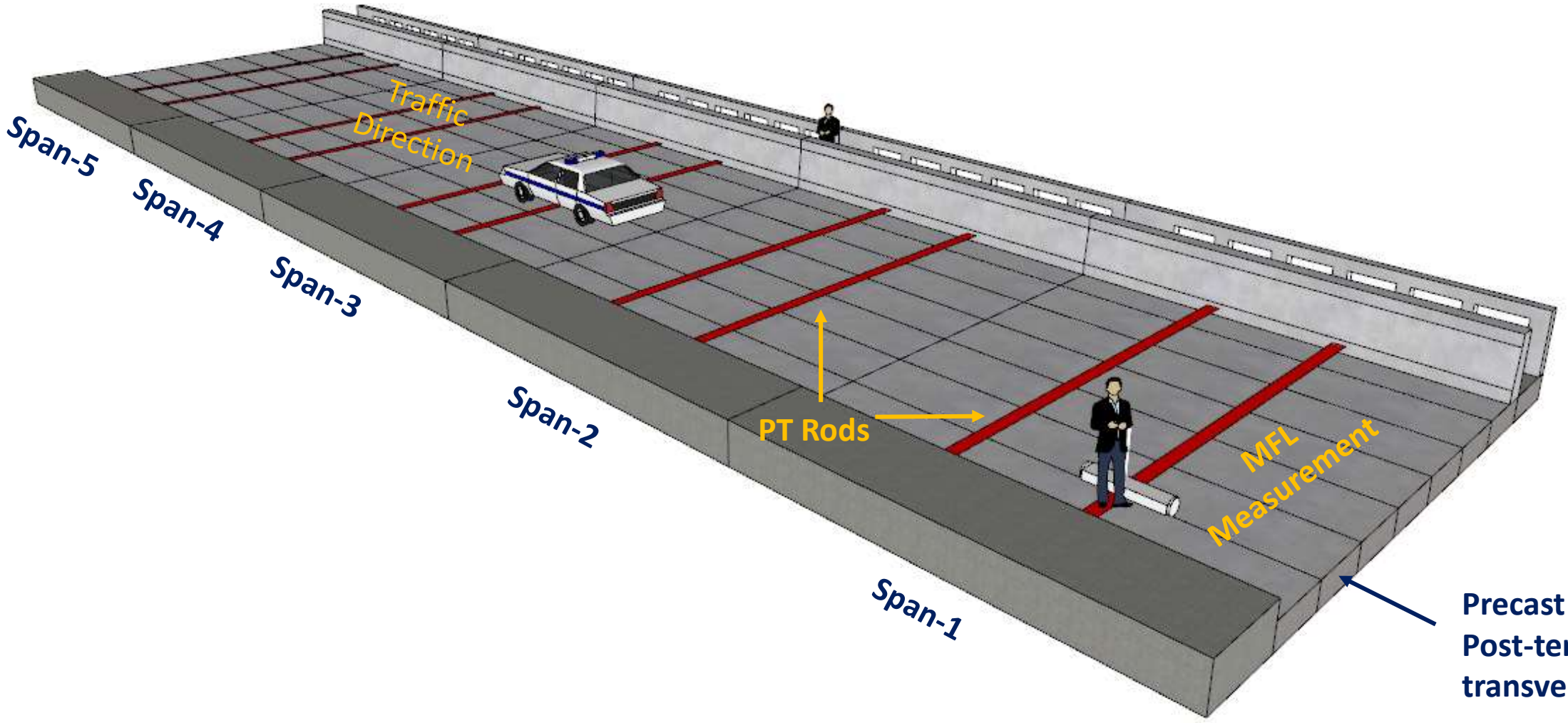


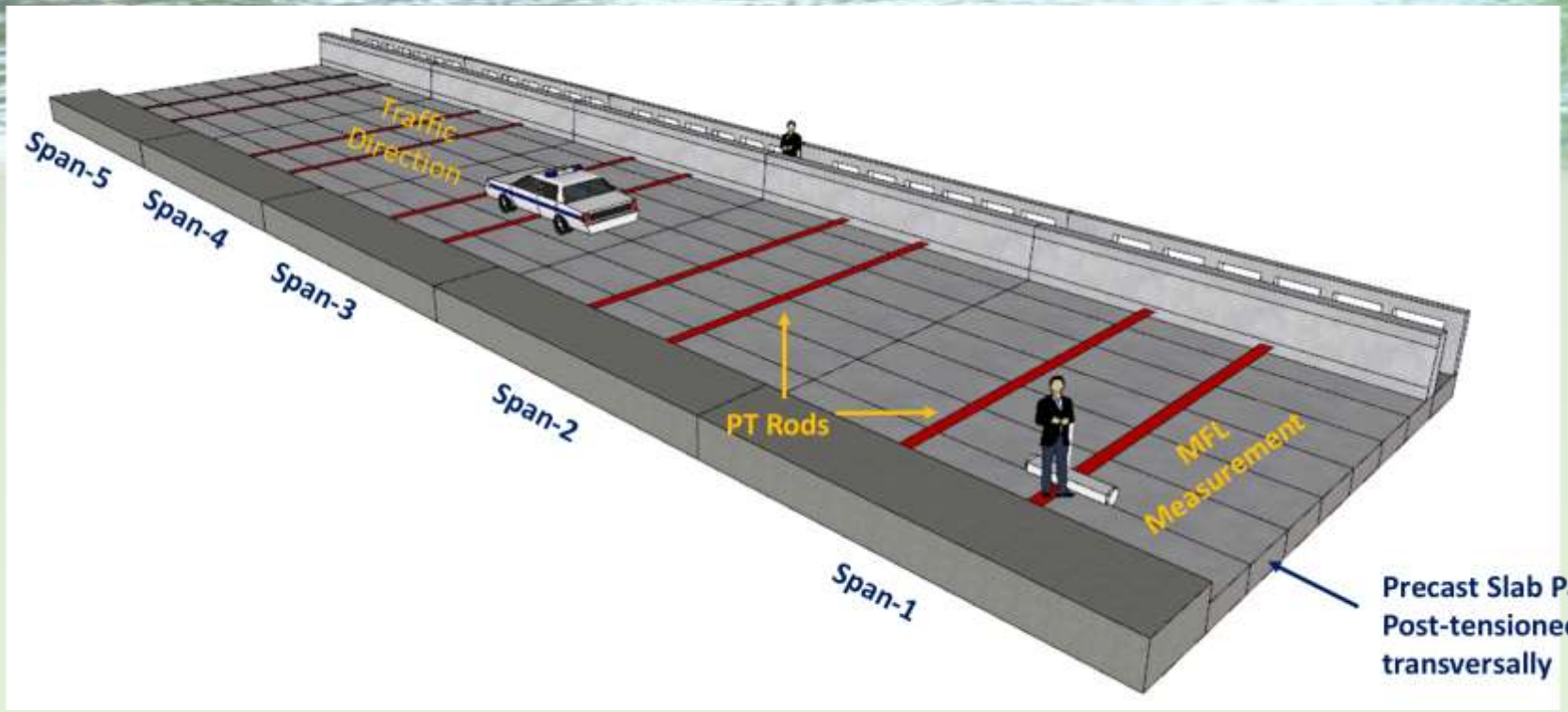
16 inch wide Measurement Unit


Direction of
MFL measurement
Magnetization

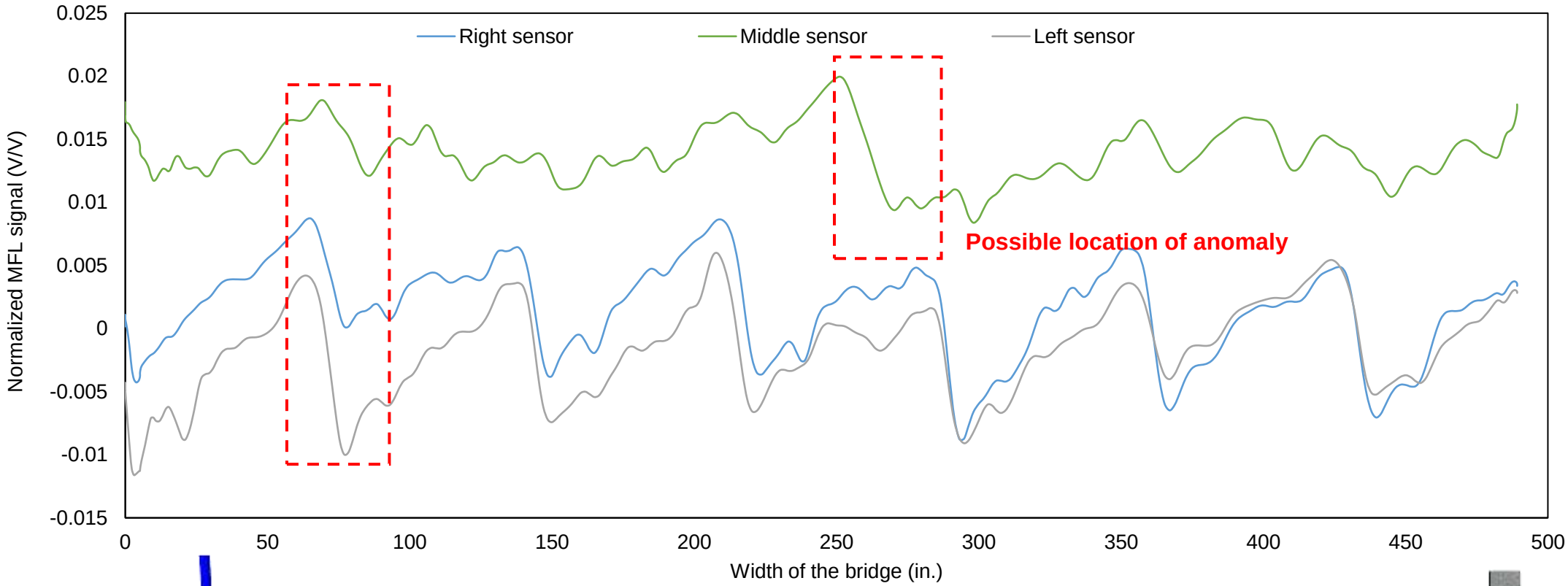

0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
MFL (V)
0
25
50
75
100
125
150
175
200
Distance (in.)
100%
50%
30%
Defect

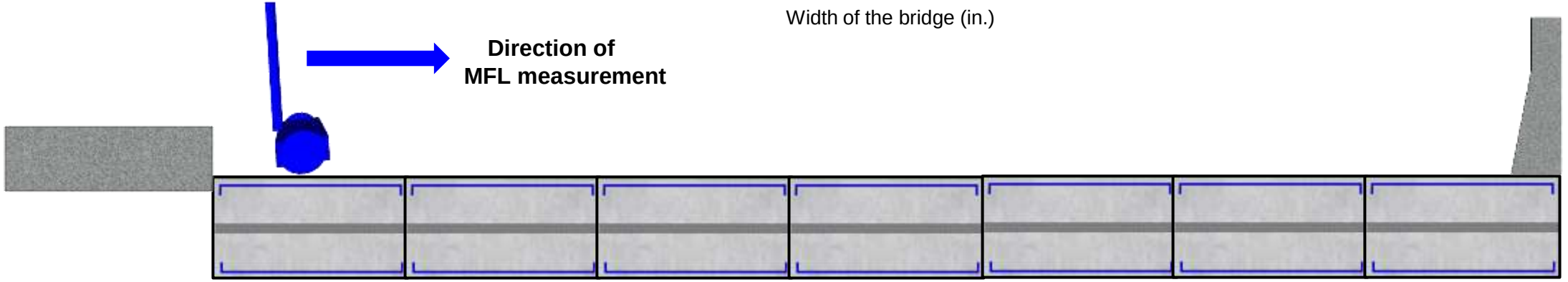
Bridge Detail



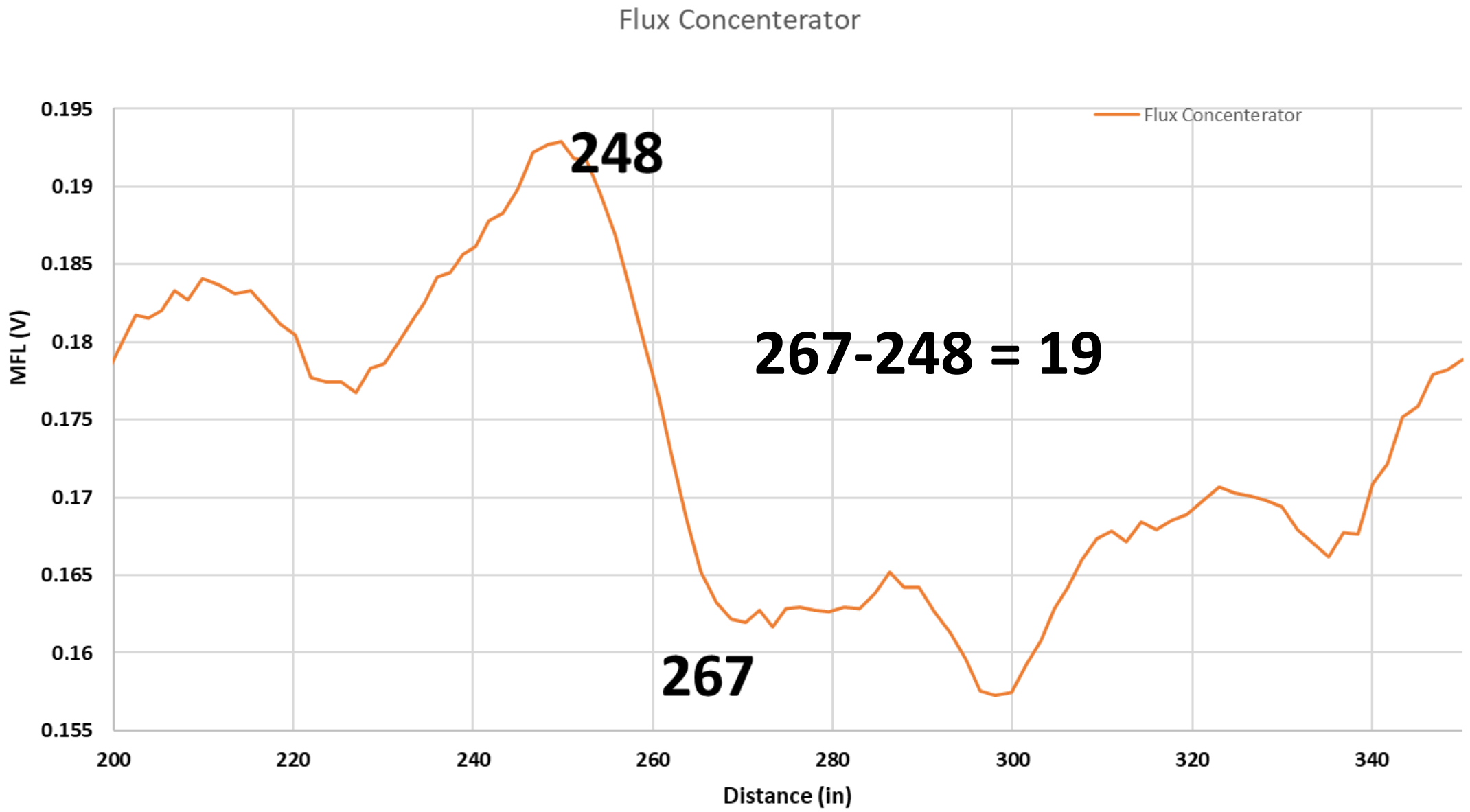

Span-5
Span-4
Span-3
Span-2
Span-1
Traffic Direction
PT Rods
MFL Measurement
Precast Slab Panels
Post-tensioned
transversally

Span 4, PT Rod-2 (Anomalous Signal)





Span 4, PT Rod-2 (Anomalous Signal)



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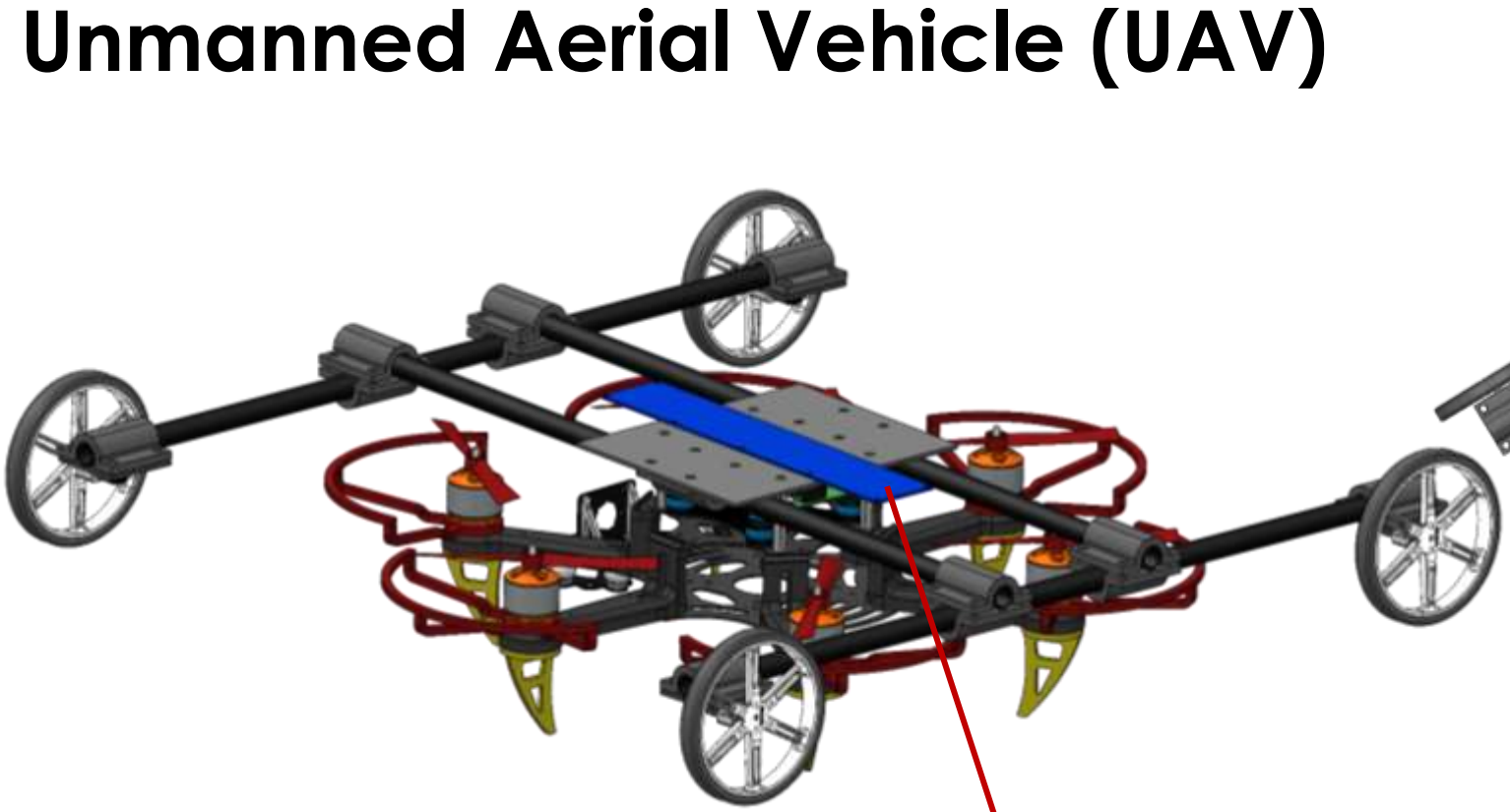
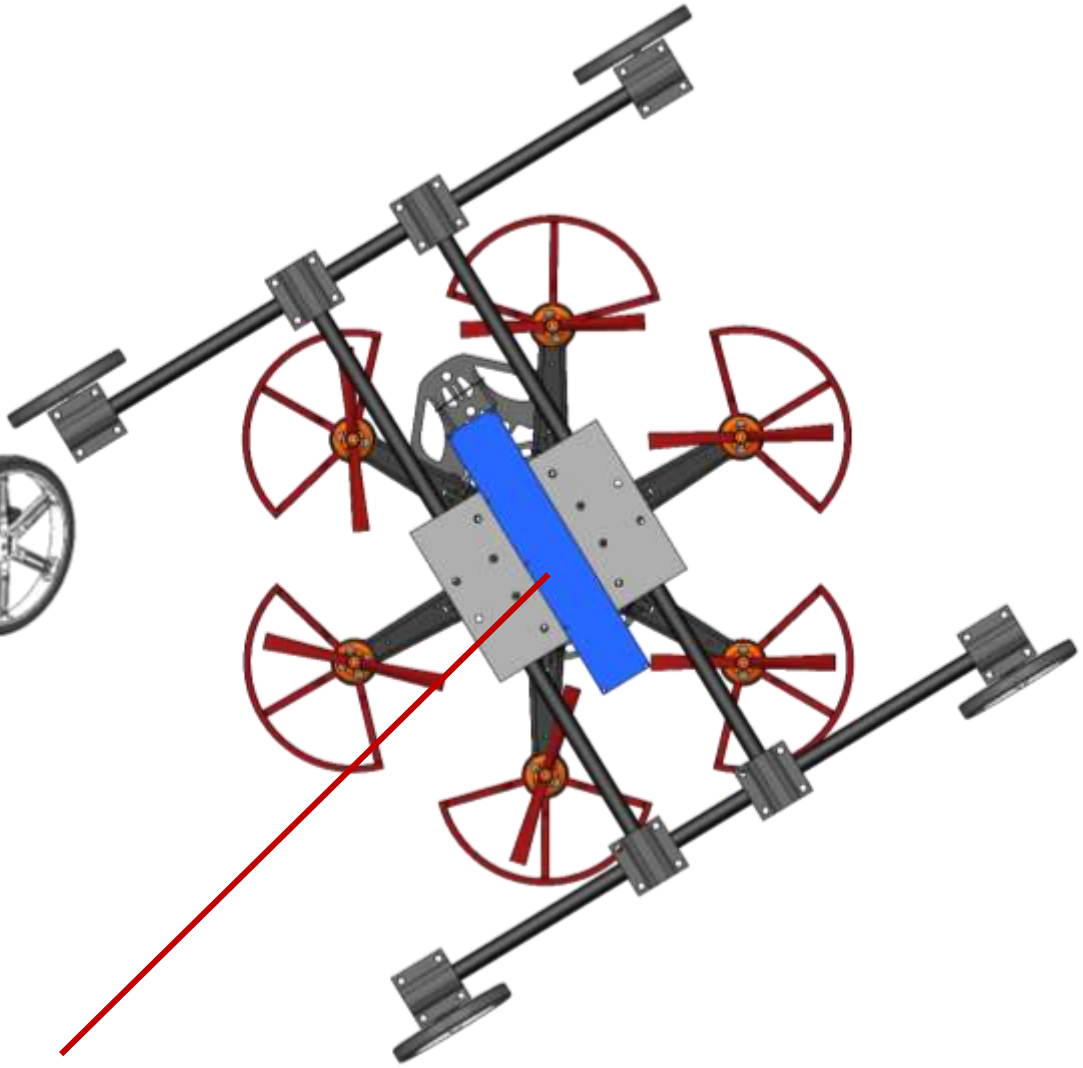
Unmanned Aerial Vehicle (UAV)



Hybrid Driving-Flying
Delivery Platform



Sensor Package

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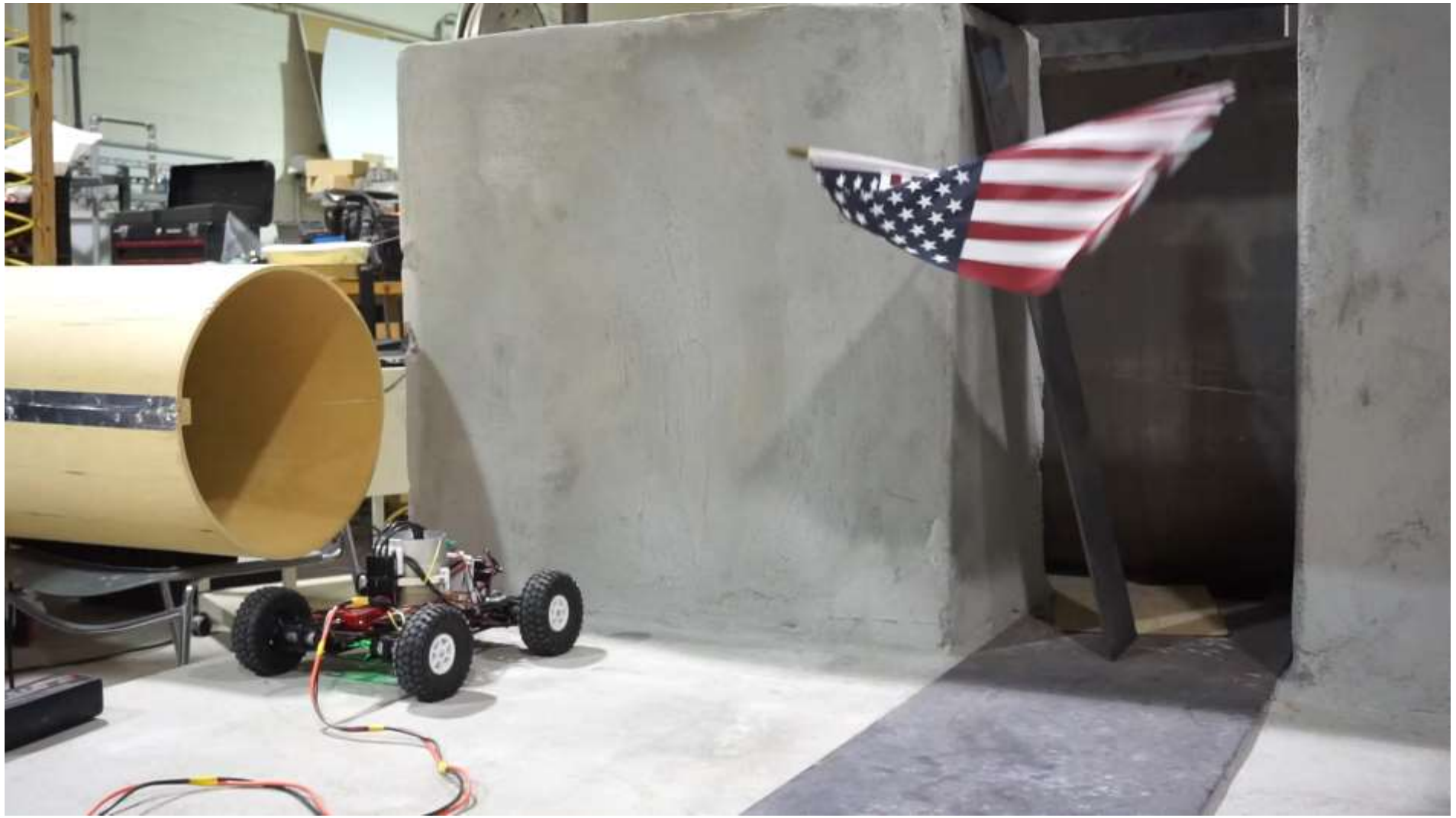
Wall Crawler



20 miles per hour crosswind!

MFL can easily be used to inspect Balconies

Ultra High-Performance Concrete (UHPC) Can be Used to Protect Buildings against Corrosion

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What is Ultra High-Performance Concrete (UHPC)?

Ultra High Performance Concrete

NSC
5 ksi

UHPC
18-28 ksi

Common Ingredients that makes UHPC

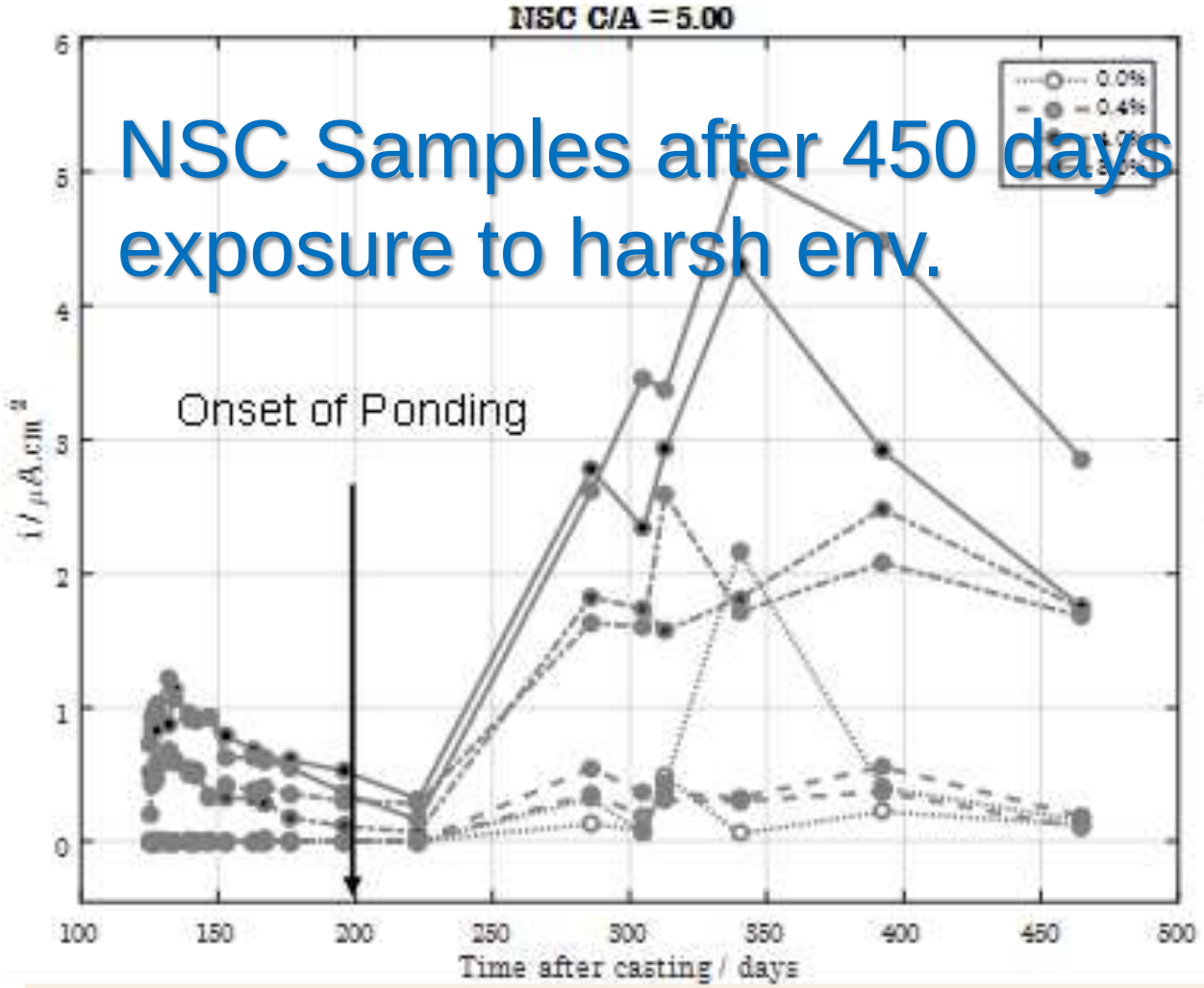
Material	Quantity	Specific Gravity	Supplier
Type I Cement, lb/yd^3	1179.6	3.15	Ash Grove Chanute, Kansas
Slag, lb/yd^3	589.8	2.97	Holcim, South Chicago
Silica Fume, lb/yd^3	196.6	2.22	Norchem Ohio
w/cm	0.2	NA	NA
Fine Masonry Sand, lb/yd^3	1966	2.63	Metro Materials Norman, OK
Steel Fibers, lb/yd^3	255.2	7.85	Bekaert (Dramix® OL 13/0.2)
Steel Fibers, %	2.0		
Superplasticizer, oz./cwt	18	1.07	BASF (Glenium 7920)

Figure 12. Photo. ASTM C1856 (C1437 mod.) flow test on UHPC.[25,9]

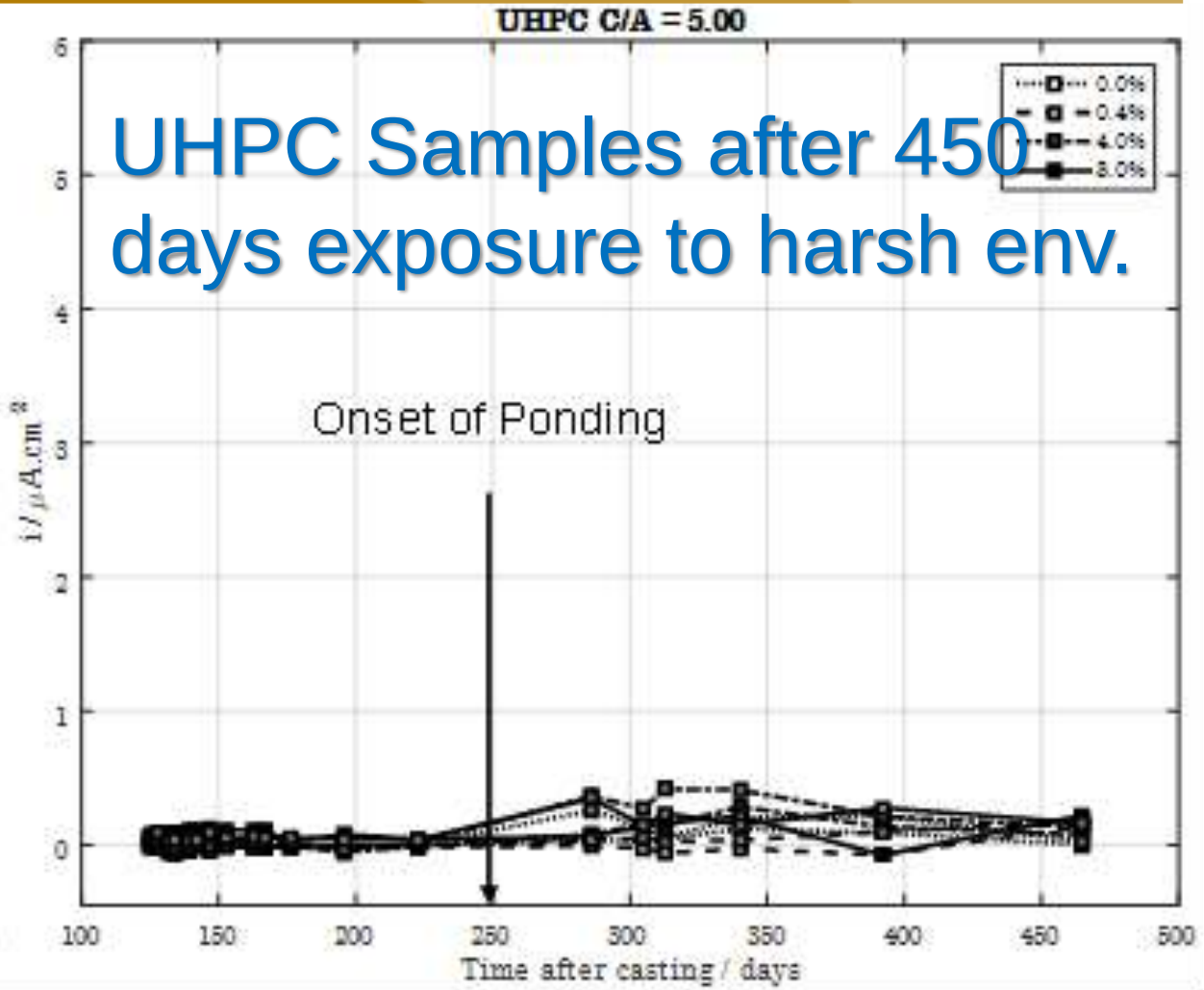
Source: FHWA.

Durability of UHPC

HOW DURABLE IS UHPC



NSC Samples after 450 days exposure to harsh env.



UHPC Samples after 450 days exposure to harsh env.

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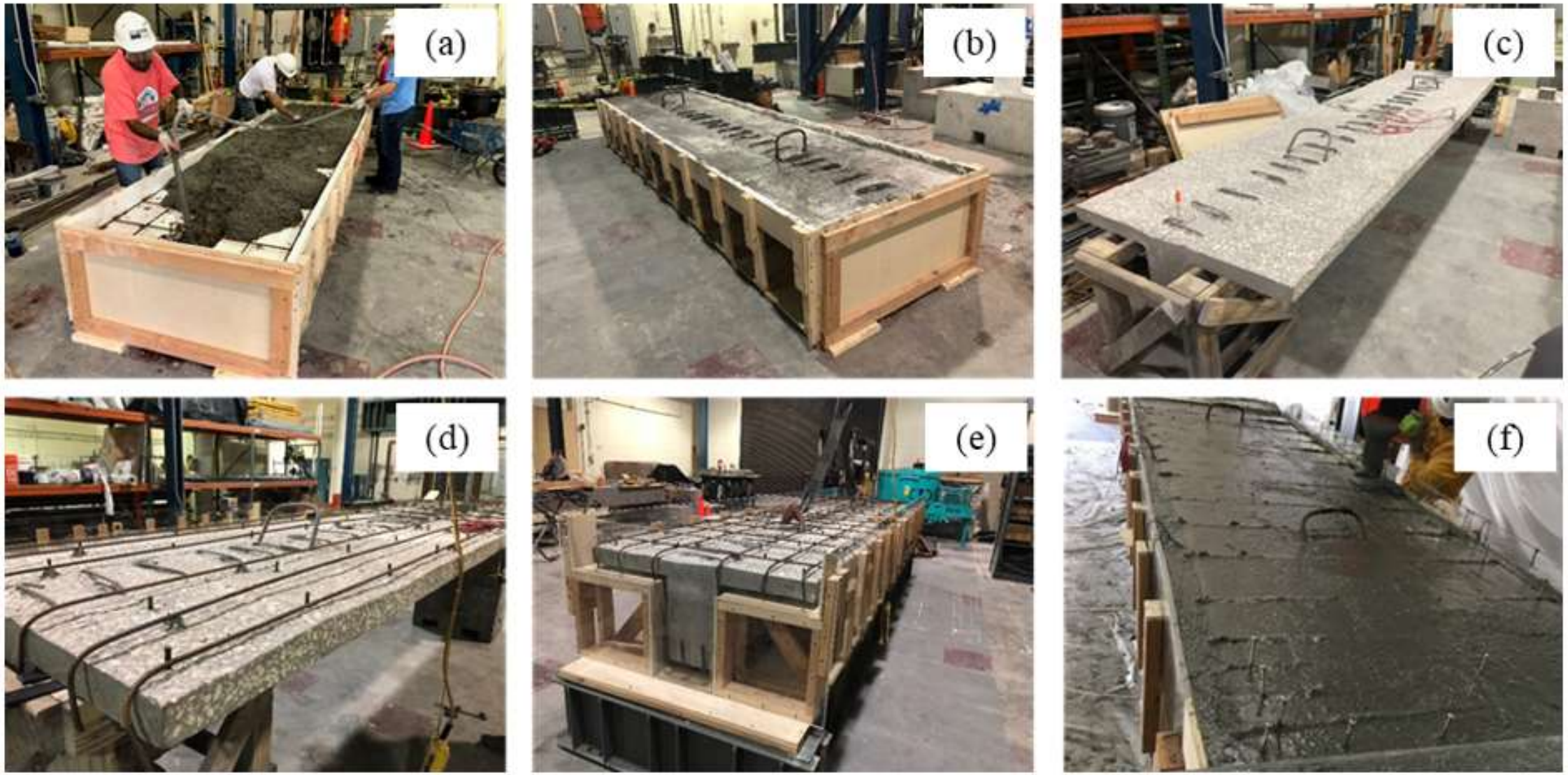
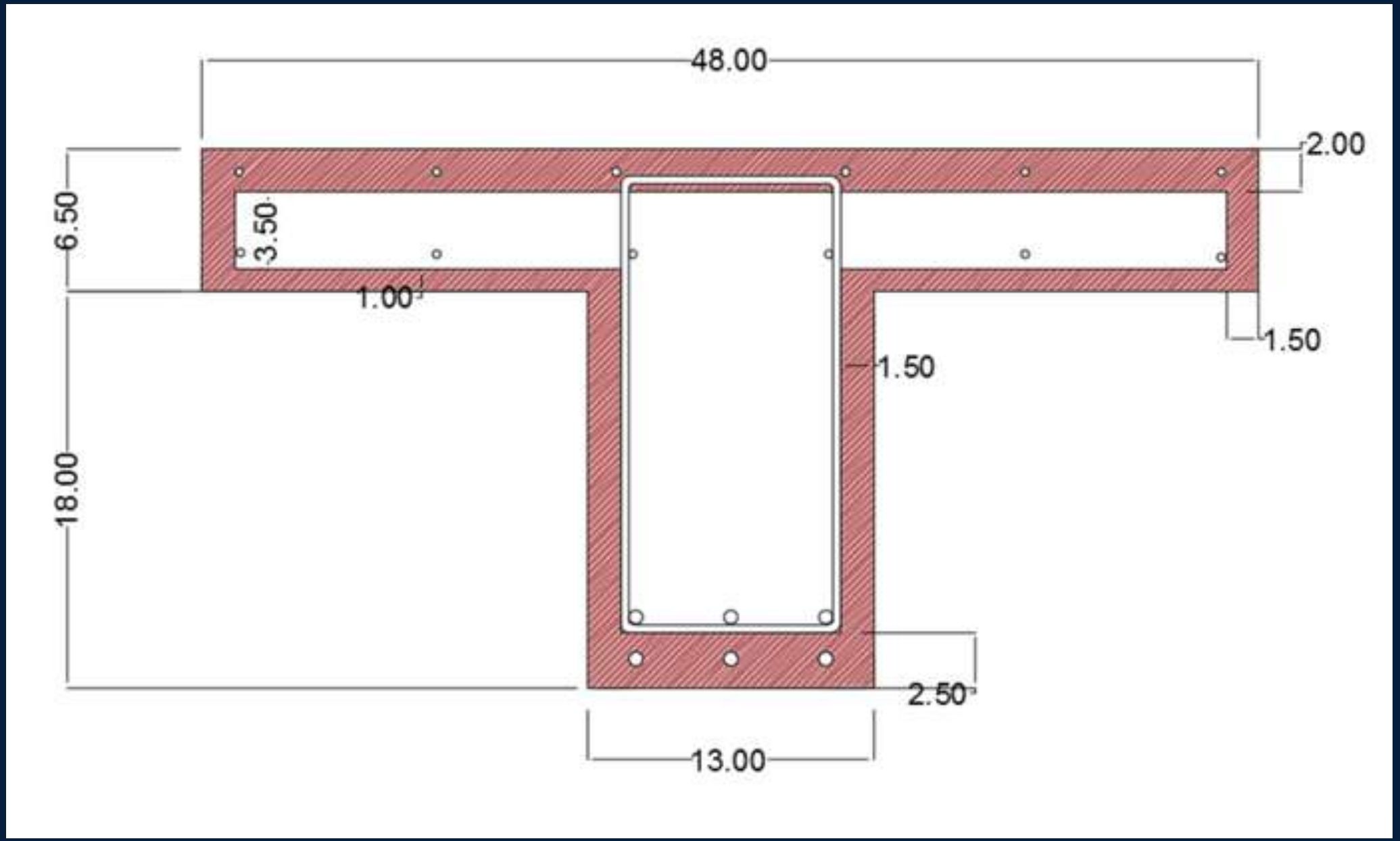
CYLINDER ON LEFT IS UHPC. ON RIGHT IS CONVENTIONAL CONCRETE. CONDITION AFTER SIMULATING BEING 400 FT., BELOW OCEAN WATER

10 MINUTES – NSC
30 MINUTES - UHPC

UHPC for Repair

Best use of UHPC perhaps is in retrofit and upgrading existing deficient structural members


(a)
(b)
(c)
(d)
(e)
(f)



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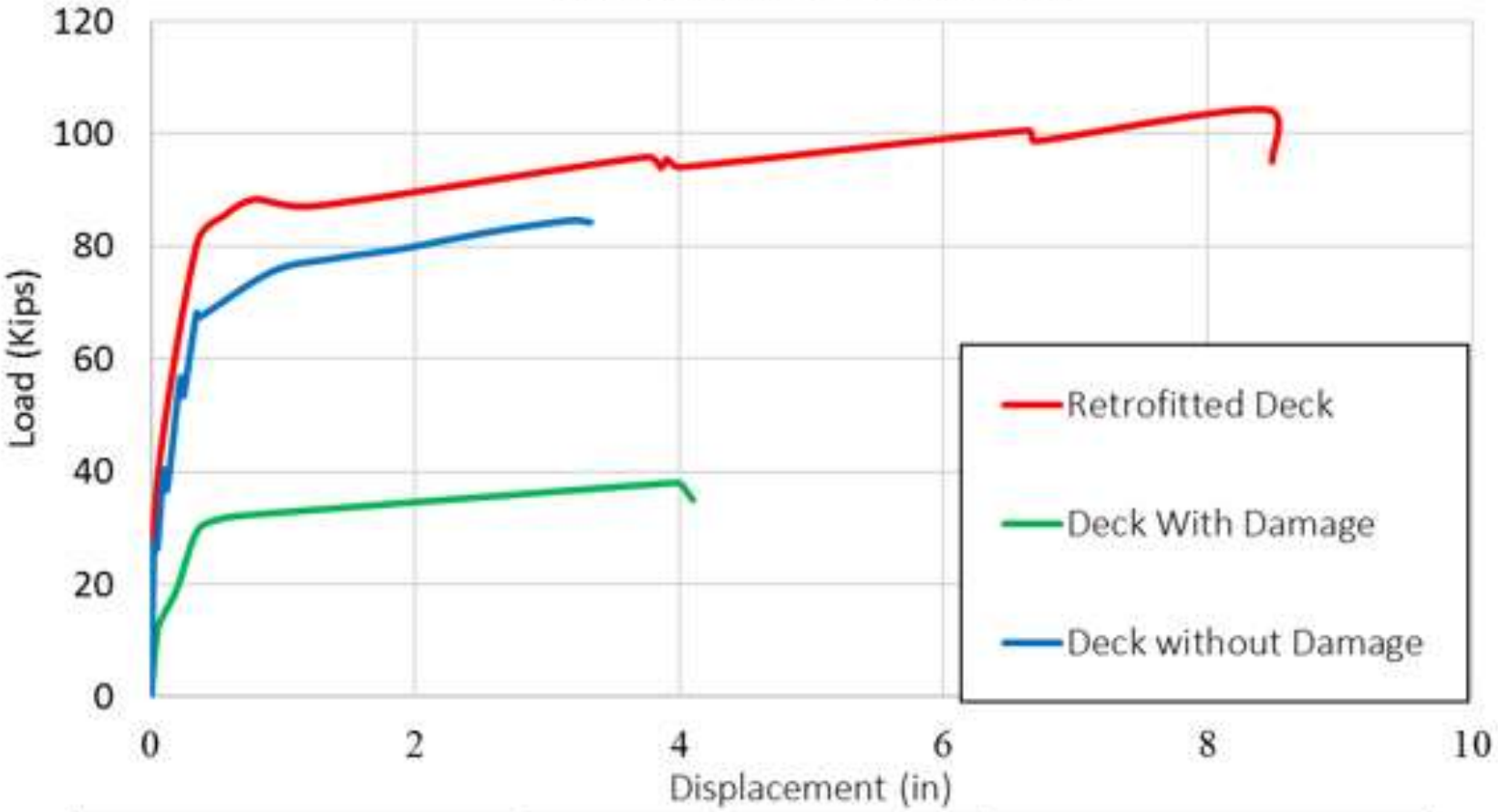

Specimen	Maximum load based on Moment-Curvature analysis (kips)	Maximum Load based on Finite Element Model (Kips)
Deck Without Damage	85	85
Deck With Damage	37.7	38

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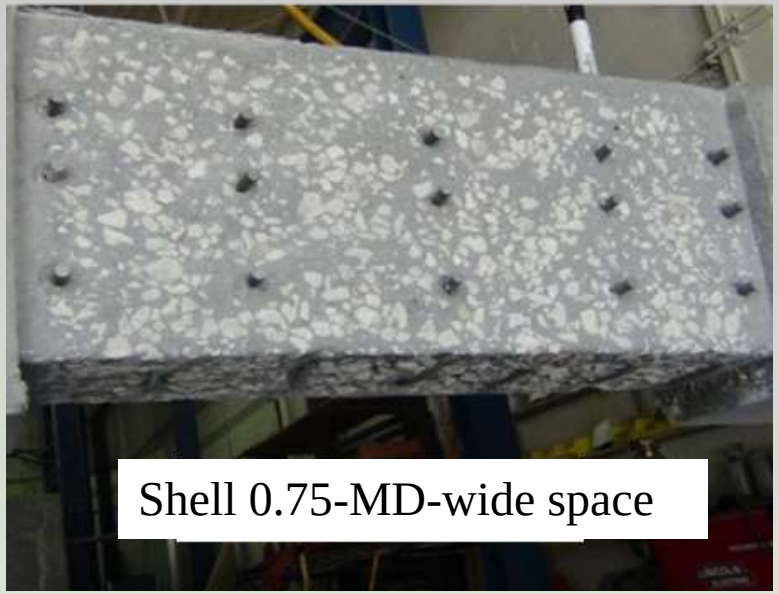
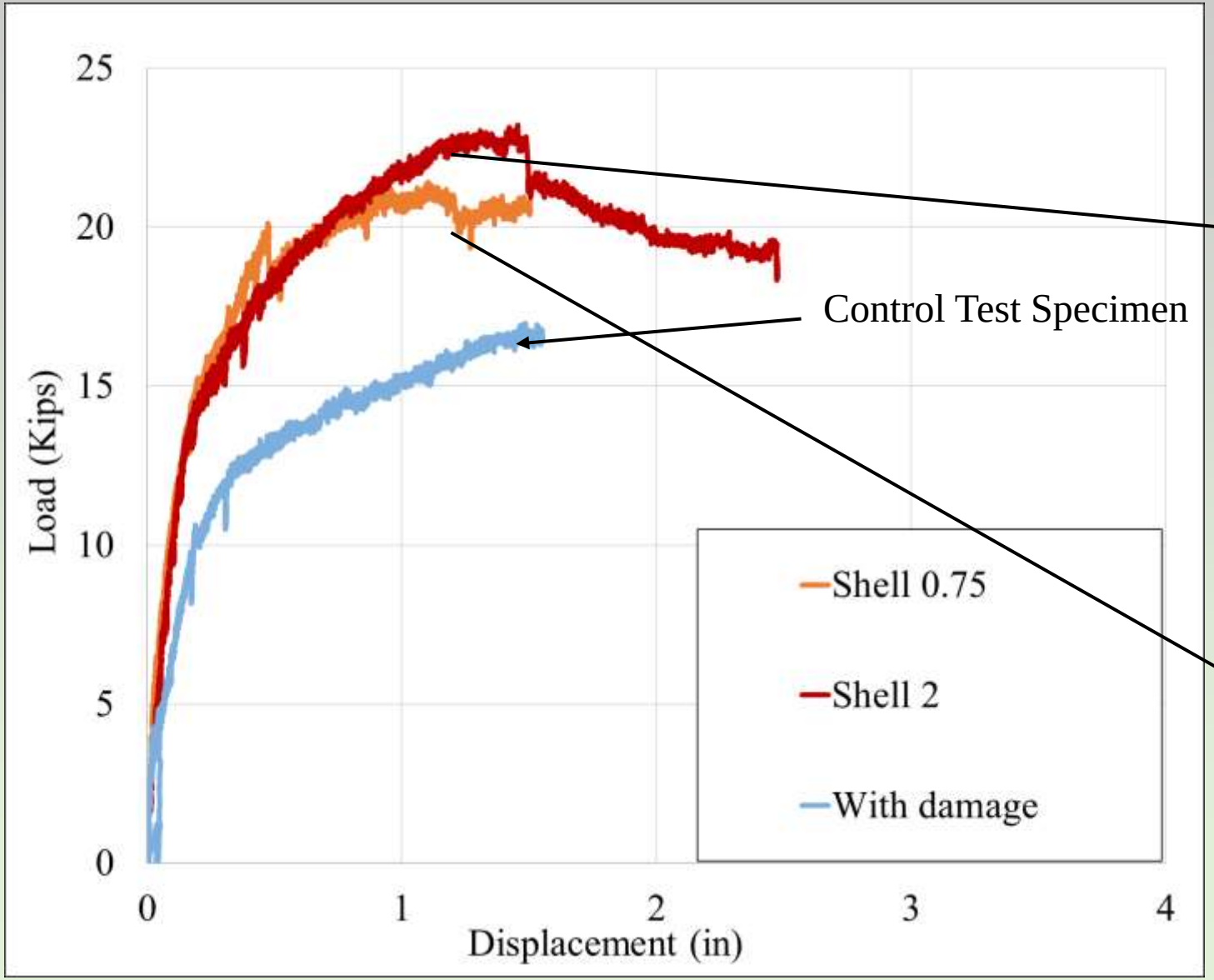
Test Specimens – Surface Condition after Surface Preparation



TEST RESULTS



Control Test Specimen

Retrofitting Columns Using UHPC

TYPICAL DAMAGE OF COLUMNS DUE TO CORROSION IN MIAMI




REPAIR PROCESS

- Surface preparation

- Batching repair

DISCUSSION ON EXPERIMENTS

UNIT 10: Column & footing repair (UHPC 2% fiber) Symmetric repair

UNIT 11: Column & footing repair (UHPC 4% fiber) Symmetric repair

Use of Robotics for Constructing Ultra High Performance Concrete Shell

Shotcrete Using UHPC

Spray Demonstration #2

Use of UHPC in Conjunction with Pneumatic Spray Application and Robotic for Repair and Strengthening of Culverts- Phase I

3D Printing Using UHPC

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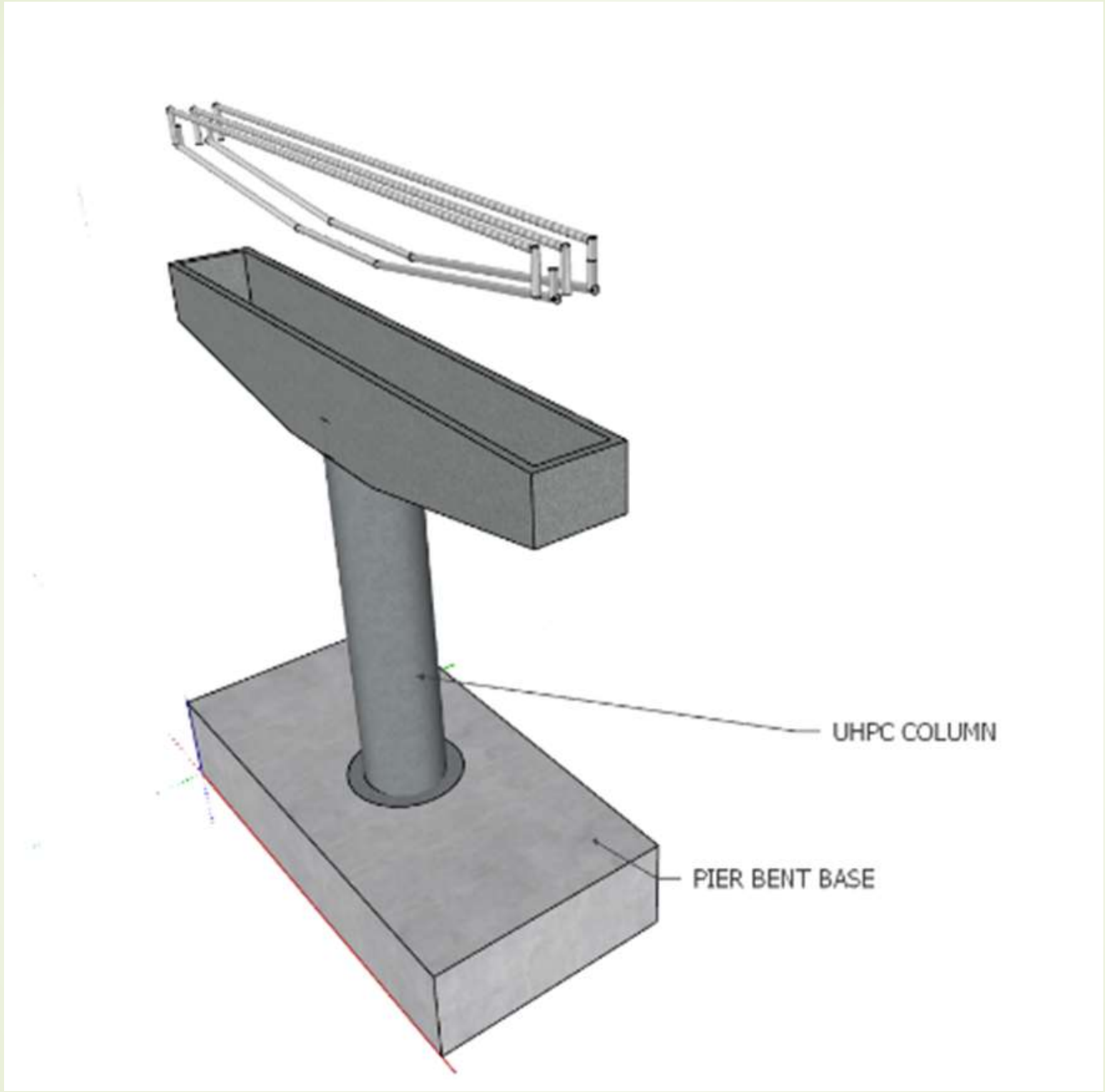
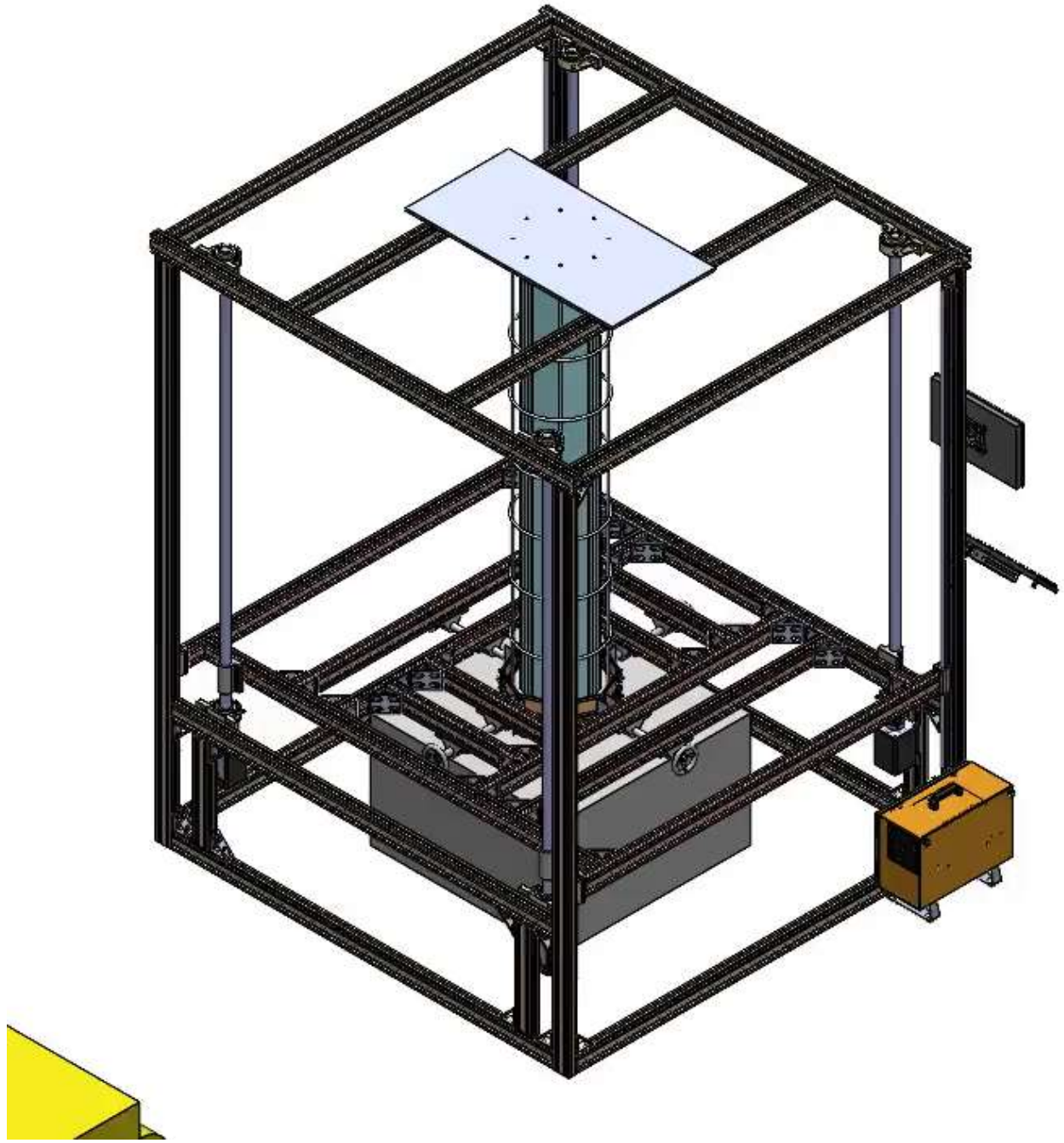
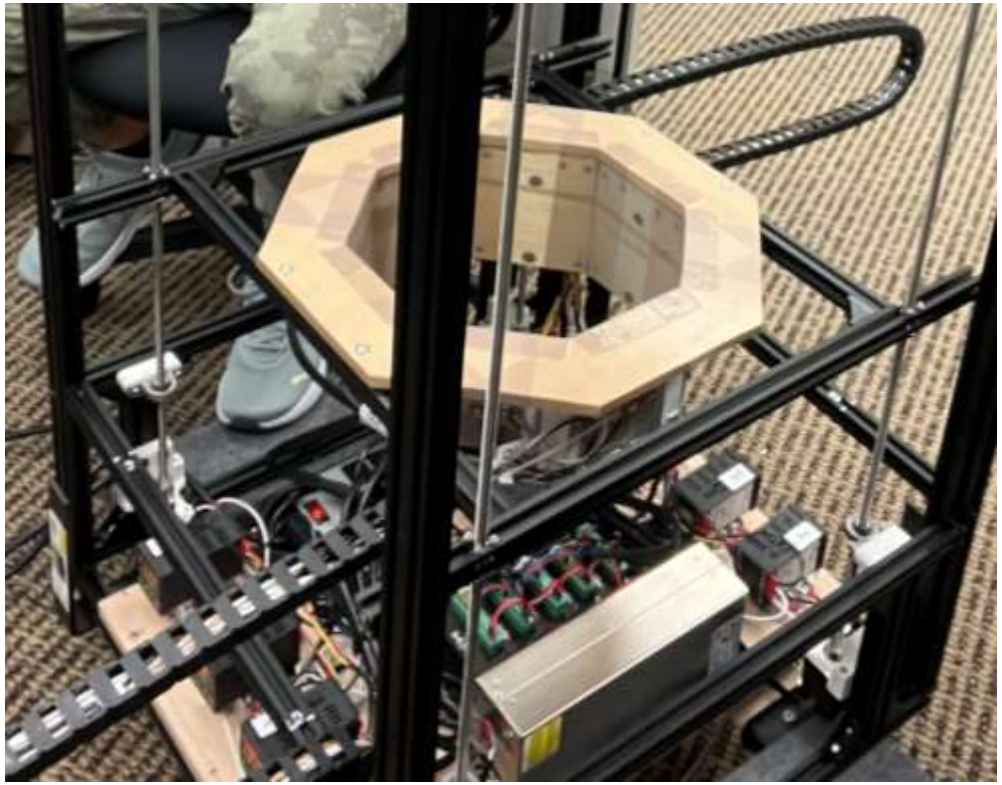

UHPC COLUMN
PIER BENT BASE



Section 3D-Printing System for UHPC Column Shell

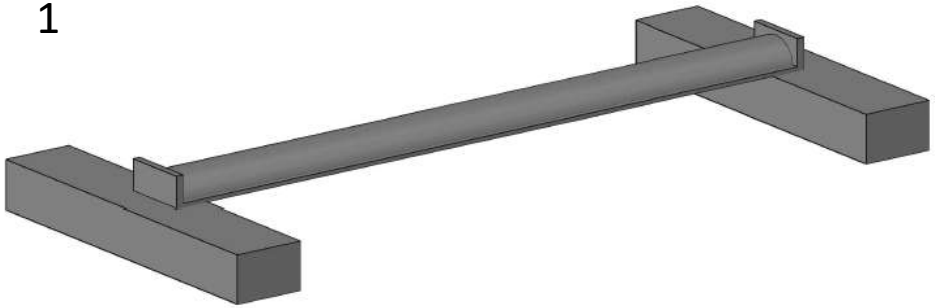


Nozzle Head

Column Shell Printer

Modular Short Span Bridge Construction

1



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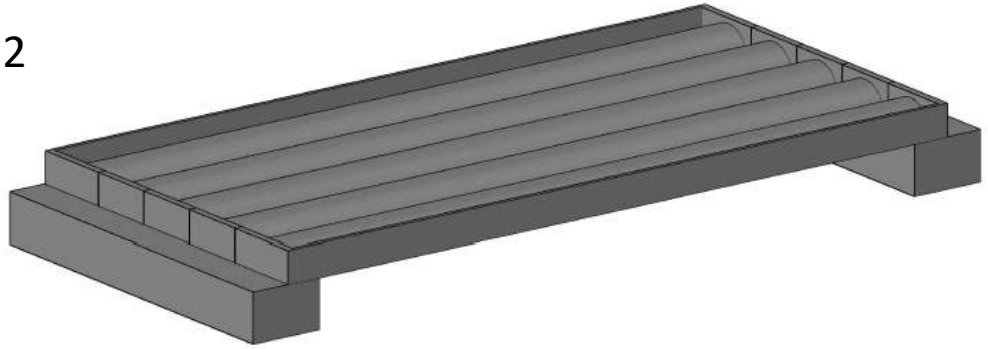

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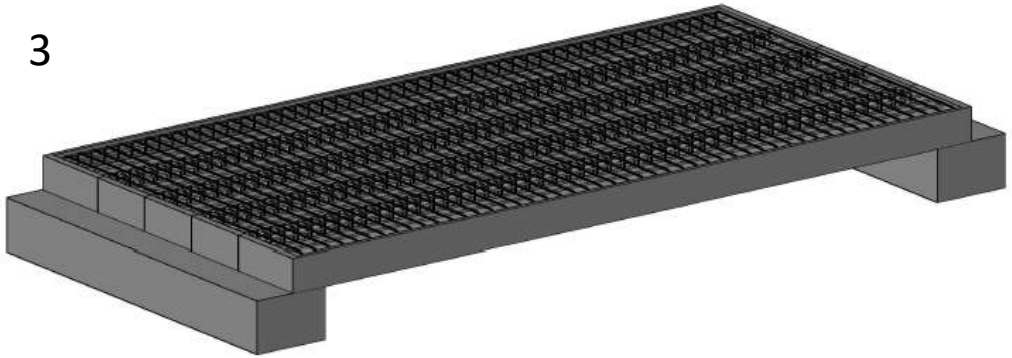

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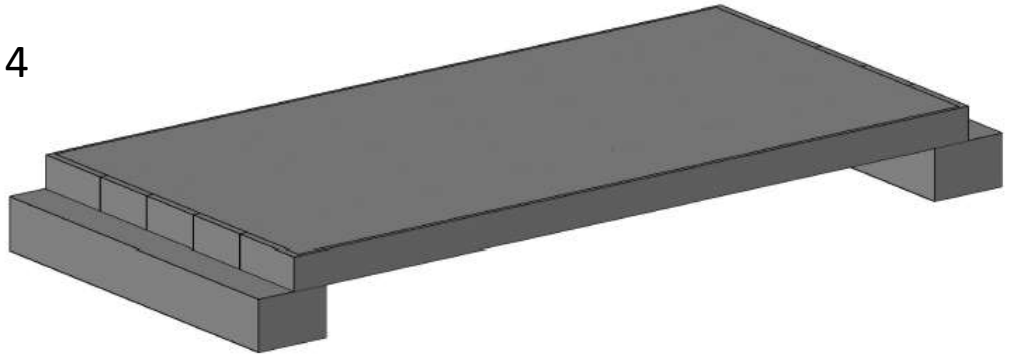


SPECIMEN CONSTRUCTION

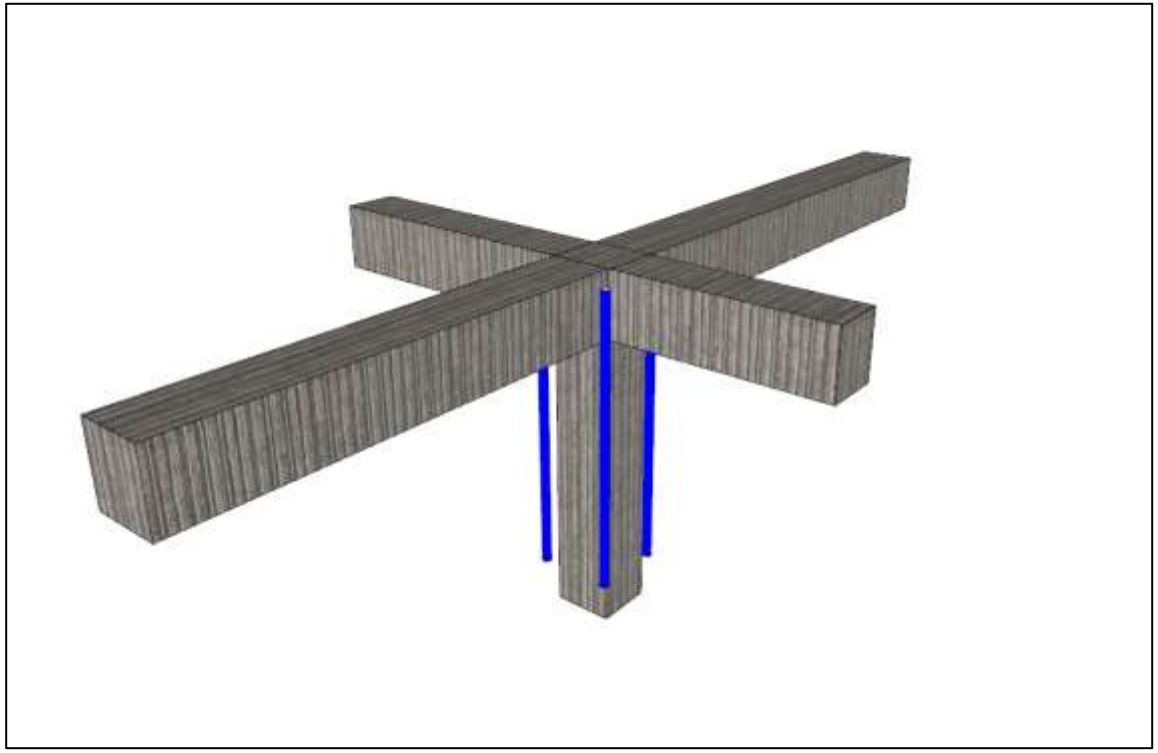
SPECIMEN CONSTRUCTION-CHECKING ALLIGNMENTS

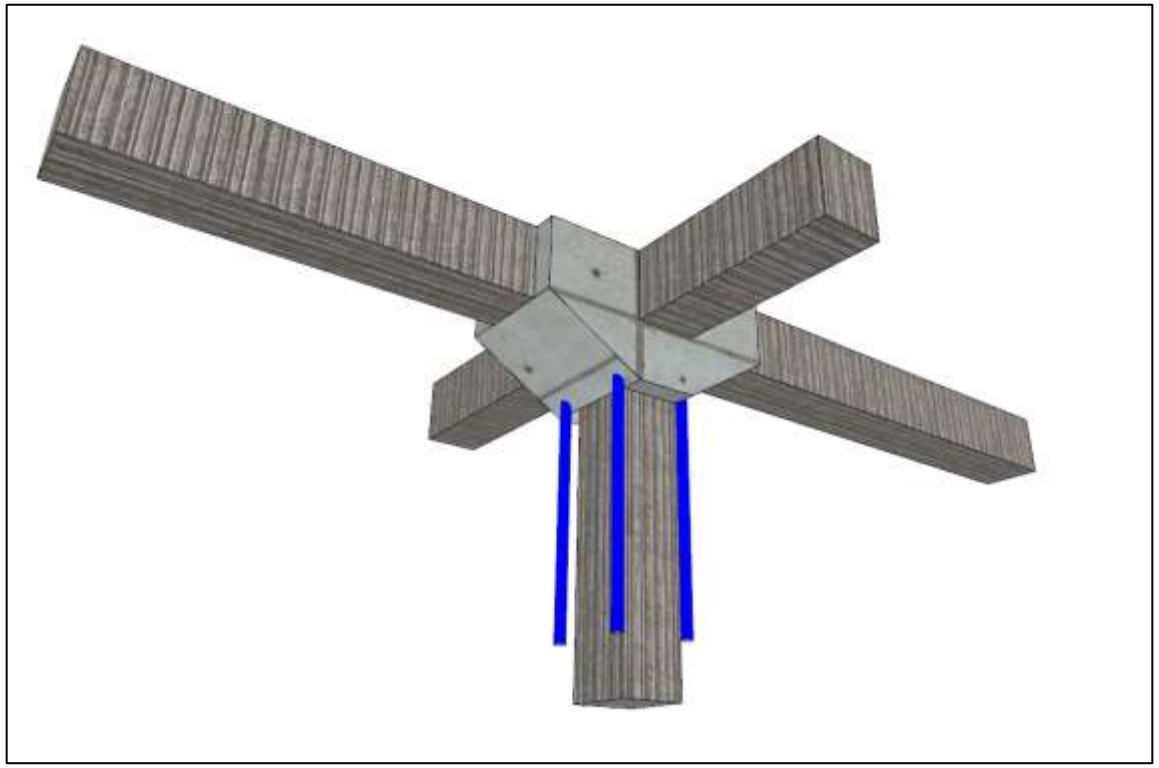
CONNECTED AND SEALED BY EPOXY

REBAR CAGE INSTALLATION

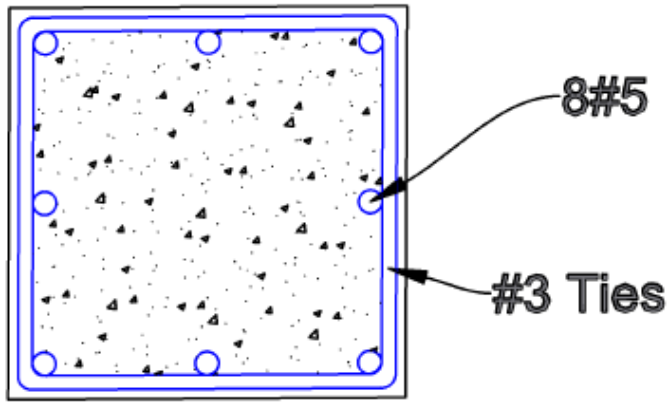
Building Column Retrofit

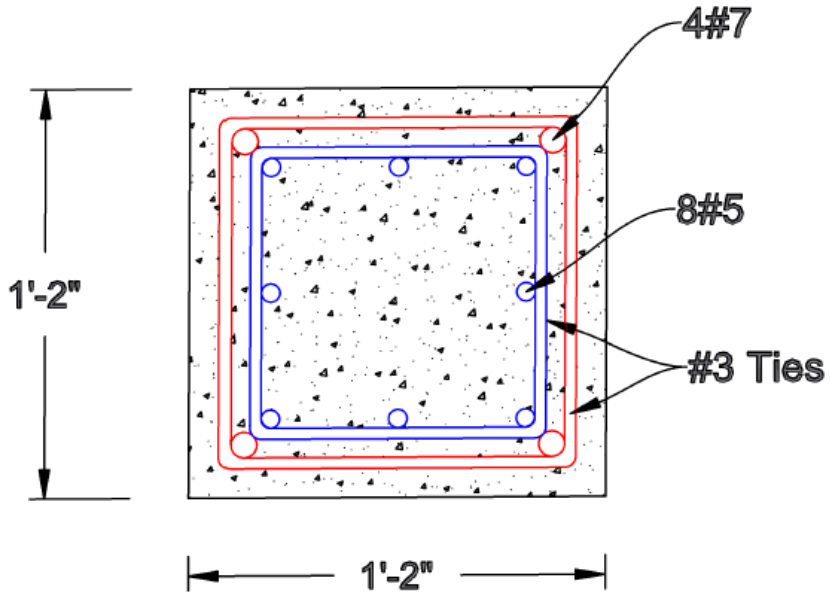
Proposed Retrofitting Method

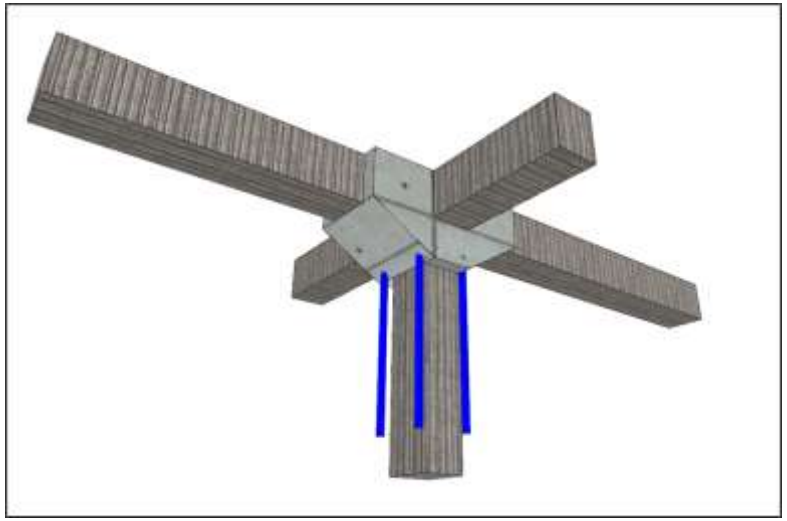


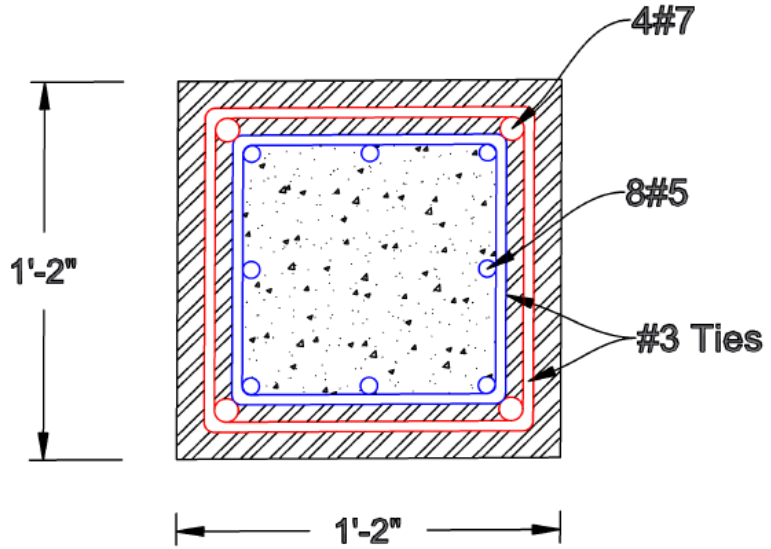


Test Specimens

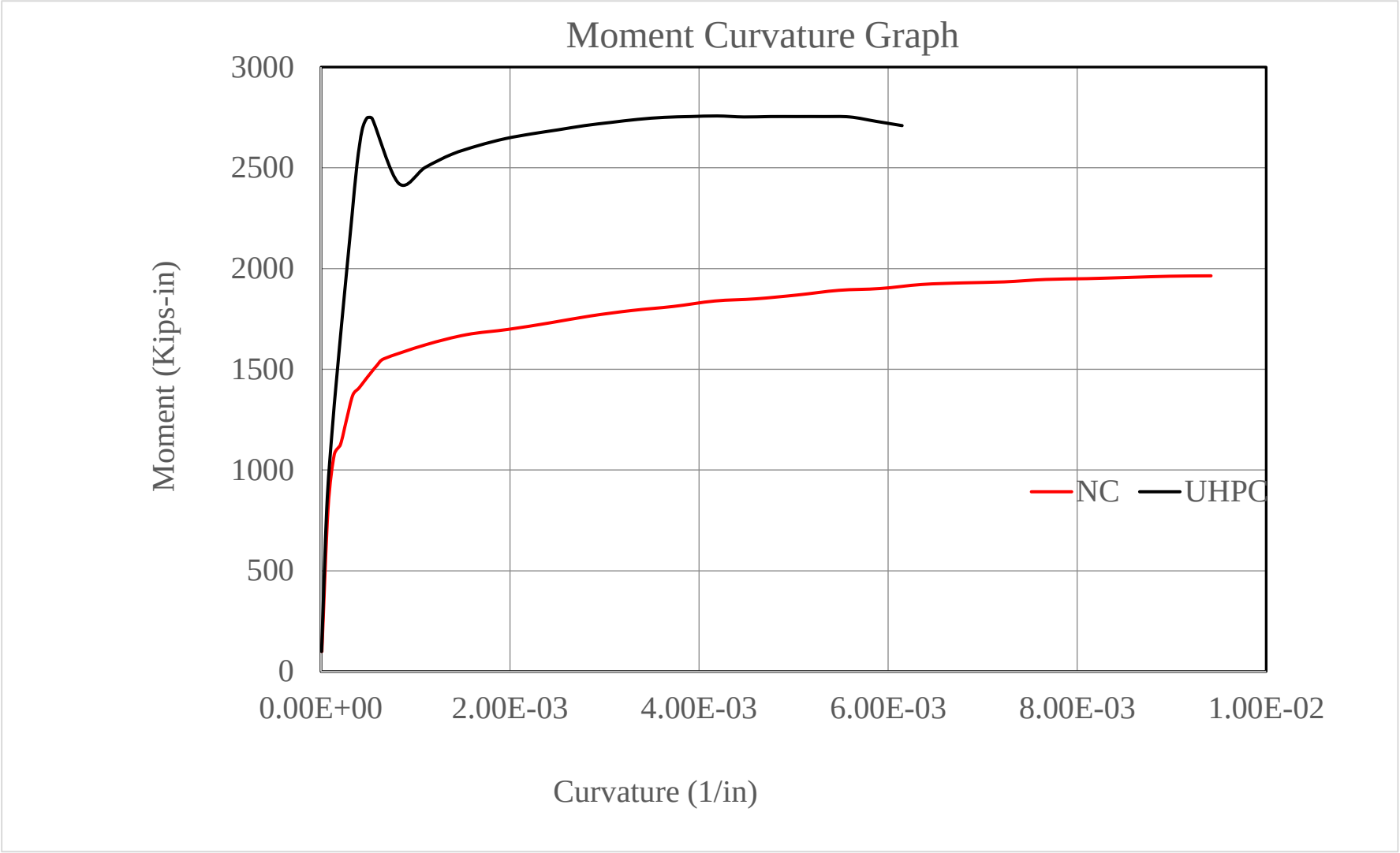

8#5
#3 Ties


4#7
8#5
#3 Ties
1'-2"
1'-2"




4#7
8#5
#3 Ties
1'-2"
1'-2"

Moment Curvature

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