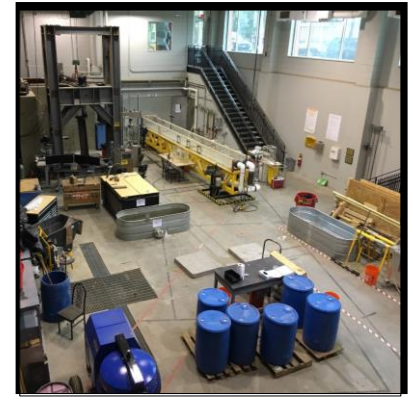


CORROSION PERFORMANCE OF ULTRA-HIGH-PERFORMANCE CONCRETE IN UNCRACKED AND CRACKED BEAMS: A STUDENT'S PERSPECTIVE



Seyed Masoud Shirkhorshidi, PhD Candidate

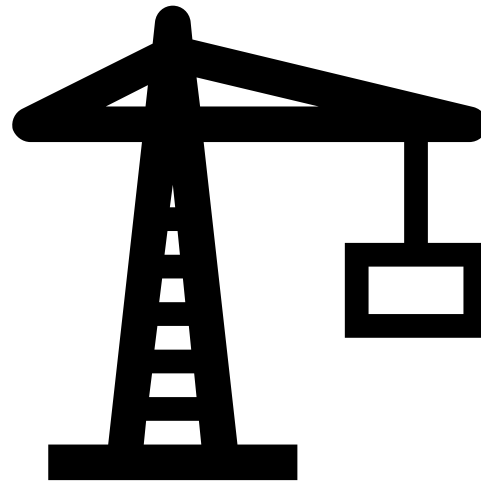
Matthew J. Bandelt, Assistant Professor

Matthew P. Adams, Assistant Professor

**J.A. Reif, Jr., Department of Civil and Environmental Engineering
New Jersey Institute of Technology**



INTRODUCTION AND BACKGROUND INFORMATION

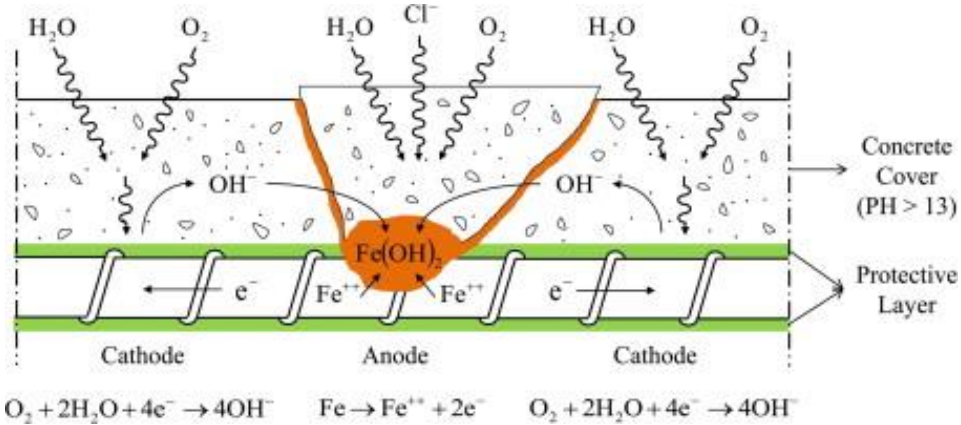


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CORROSION MECHANISM

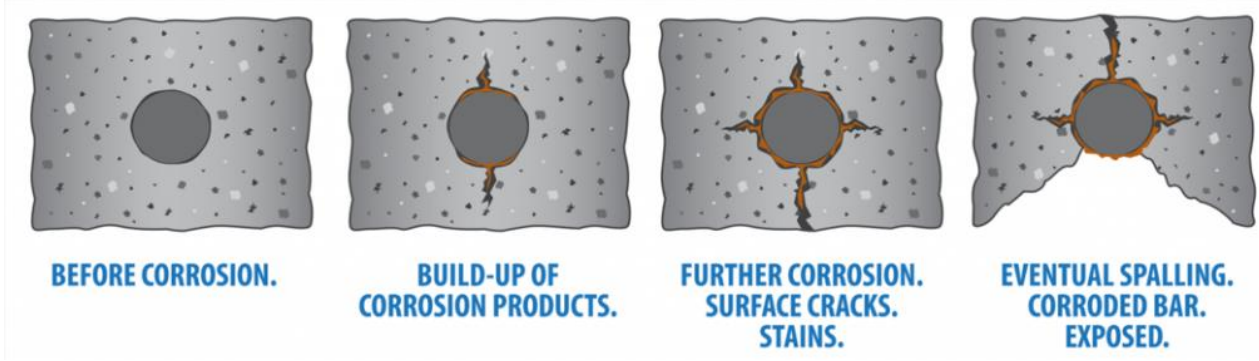
Chlorides can penetrate into concrete and break the protective layer on the rebar



Cao et al., 2013

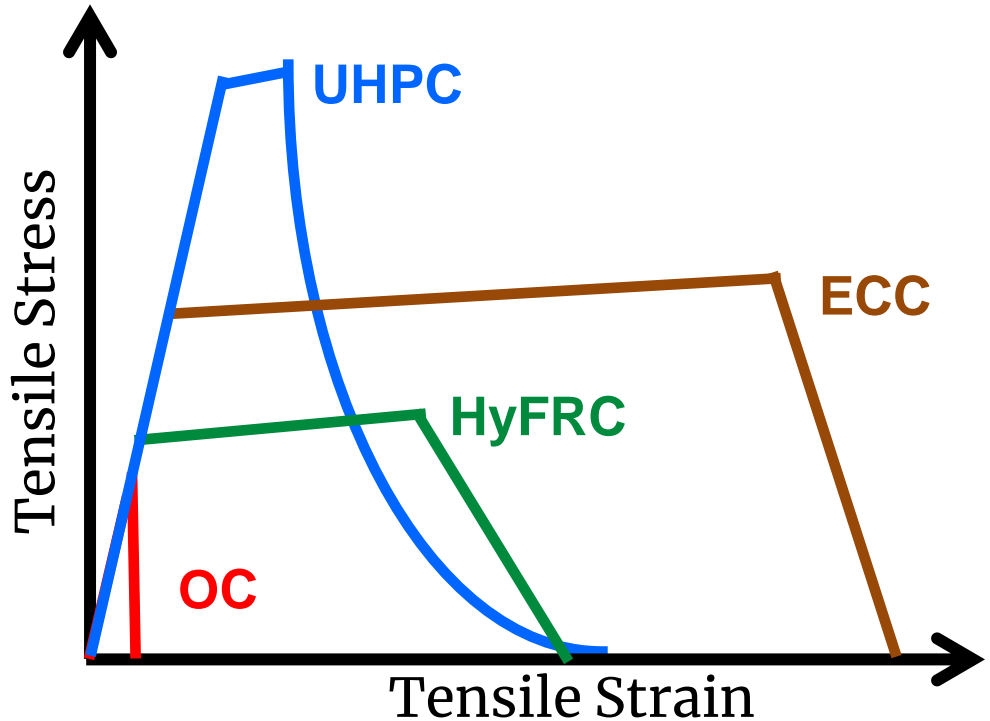
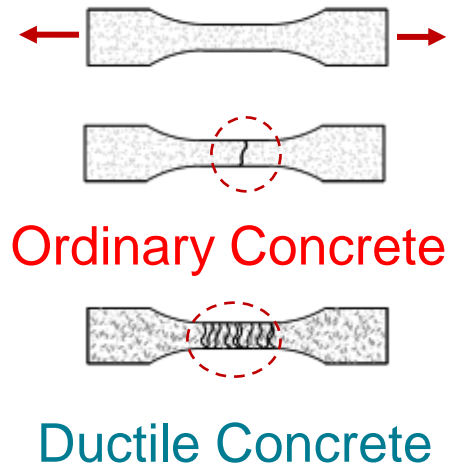
Corrosion products are expansive and impose stress on concrete

Imposed stress can cause cracking and spalling of concrete



<https://allthingsflooring.com>

DUCTILE CONCRETE MECHANICAL BEHAVIOR



UHPC – $f'_c = 20,000$ psi; $f_t = 1,100$ psi; $\epsilon_{tp} = 0.2\%$

ECC – $f'_c = 8,000$ psi; $f_t = 400$ psi; $\epsilon_{tp} = 1\%$

HyFRC – $f'_c = 6,500$ psi; $f_t = 275$ psi; $\epsilon_{tp} = 0.3\%$

Generally **do not spall** and retain **residual strength** in compression

DUCTILE CONCRETE MATERIALS



Binder
(Cement, Fly Ash, Silica Fume, Glass Quartz)



Fine Aggregate
(Sand)



Water and Admixtures

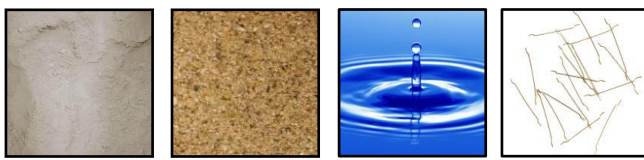


Coarse Aggregate
(Crushed Stone)

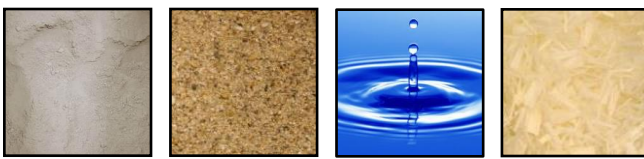


Fibers
(Polymeric, steel)

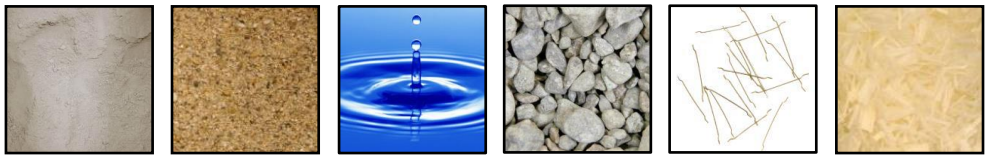
UHPC - Ultra high performance concrete



ECC - Engineered cementitious composite

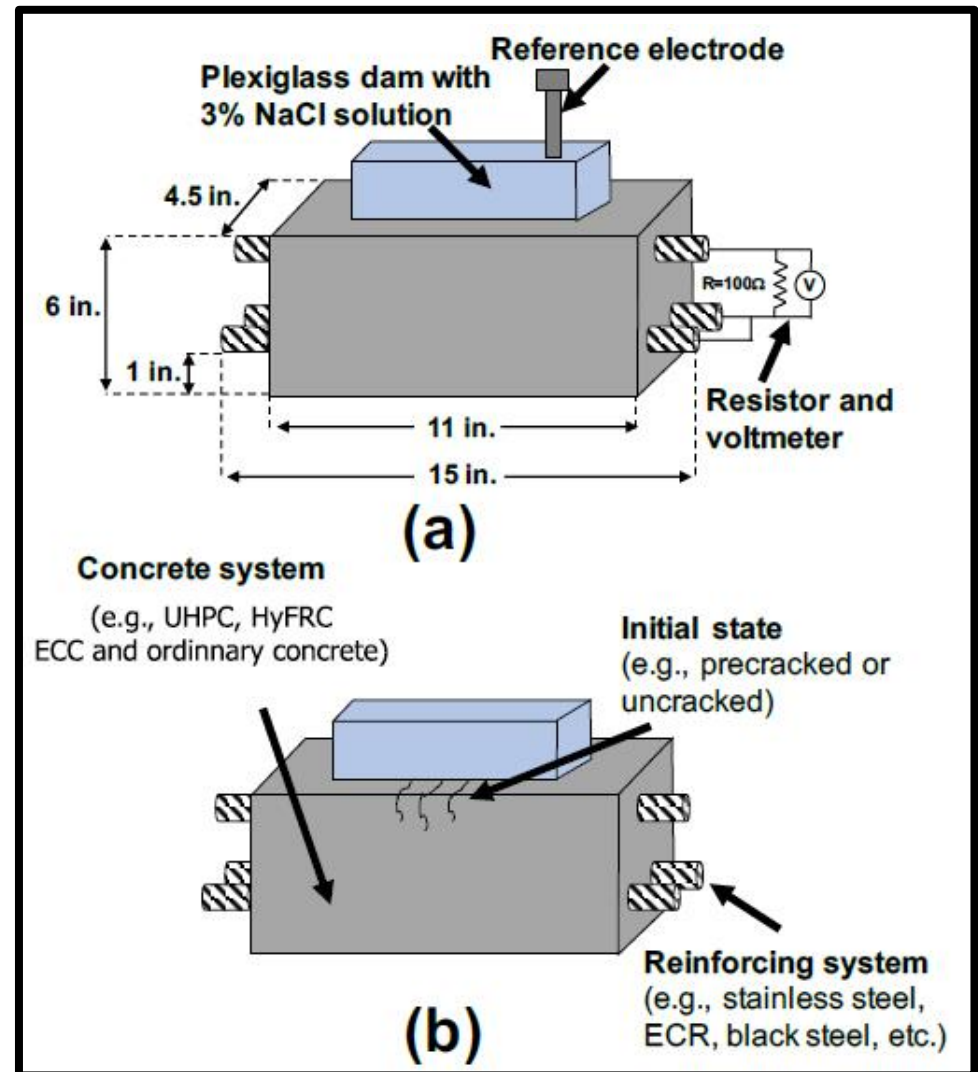


HyFRC - Hybrid fiber-reinforced concrete



ASTM G109 TEST METHOD

- Accelerated corrosion test
- Considering the effect of preloading and cracks with loading specimens up to 80 percent capacity
- Measuring corrosion current and corrosion potential

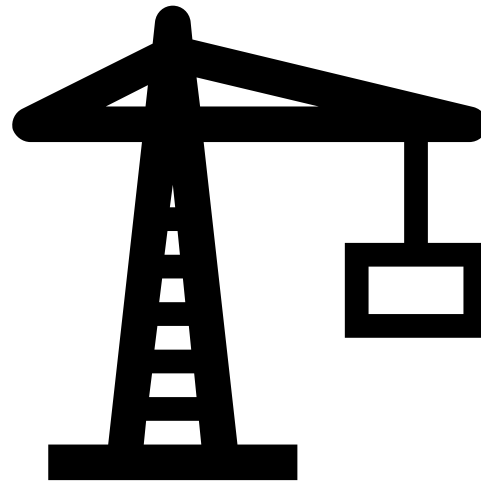


CORROSION TESTING PLAN

<i>Concrete</i> <i>Rebar</i>	NJ DOT HPC	NJ DOT SCC P	UHPC	HyFRC	ECC
Black	✓✓	✓	✓✓	✓✓	✓✓
ECR	✓✓	✓	✓✓	✓✓	✓
ECR- Damaged	✓✓	✓	✓	✓	✓
MMFX	✓	✓	✓✓	✓✓	-
Galvanized	✓	✓	-	-	-
Stainless Steel	✓	✓	-	-	-

✓: Uncracked ✓: Cracked

UHPC MIXING AND CASTING



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MIXING PROCEDURE



Dry Mixing



Wet Addition



Fiber Addition



Discharge

UHPC POWDER MIXING



UHPC TURNING POINT



UHPC PASTE



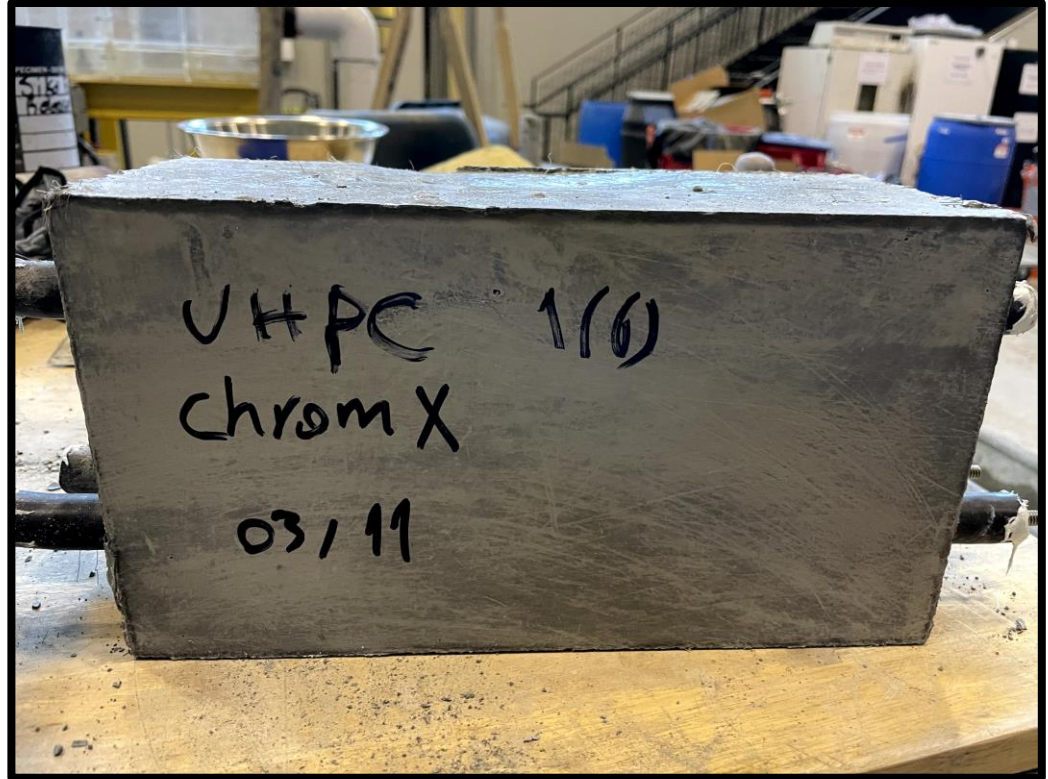
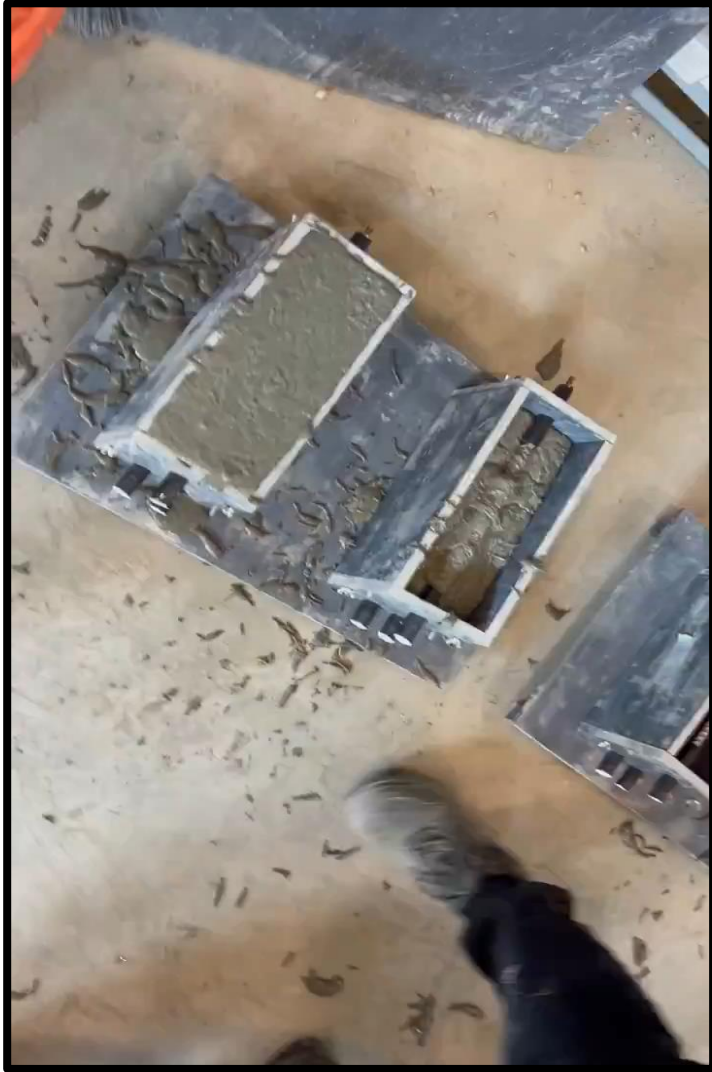
FLOW TEST OF UHPC



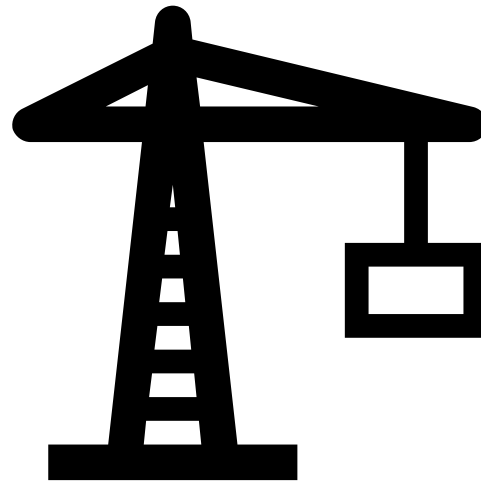
FLOW TEST RESULT



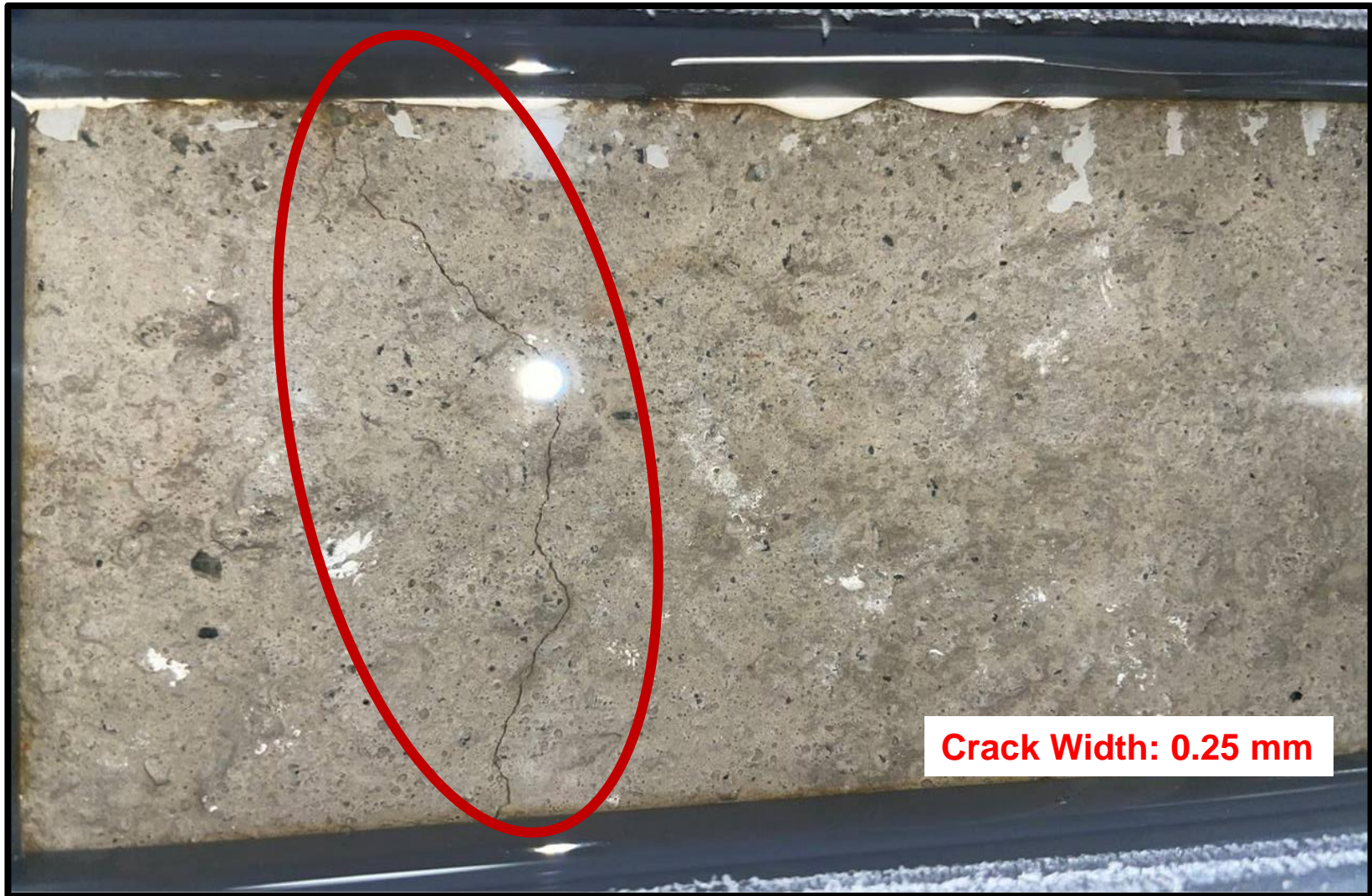
CASTING BEAMS



OBSERVATIONS AND RESULTS



HPC SPECIMEN WITH GALVANIZED BARS



Crack Width: 0.25 mm

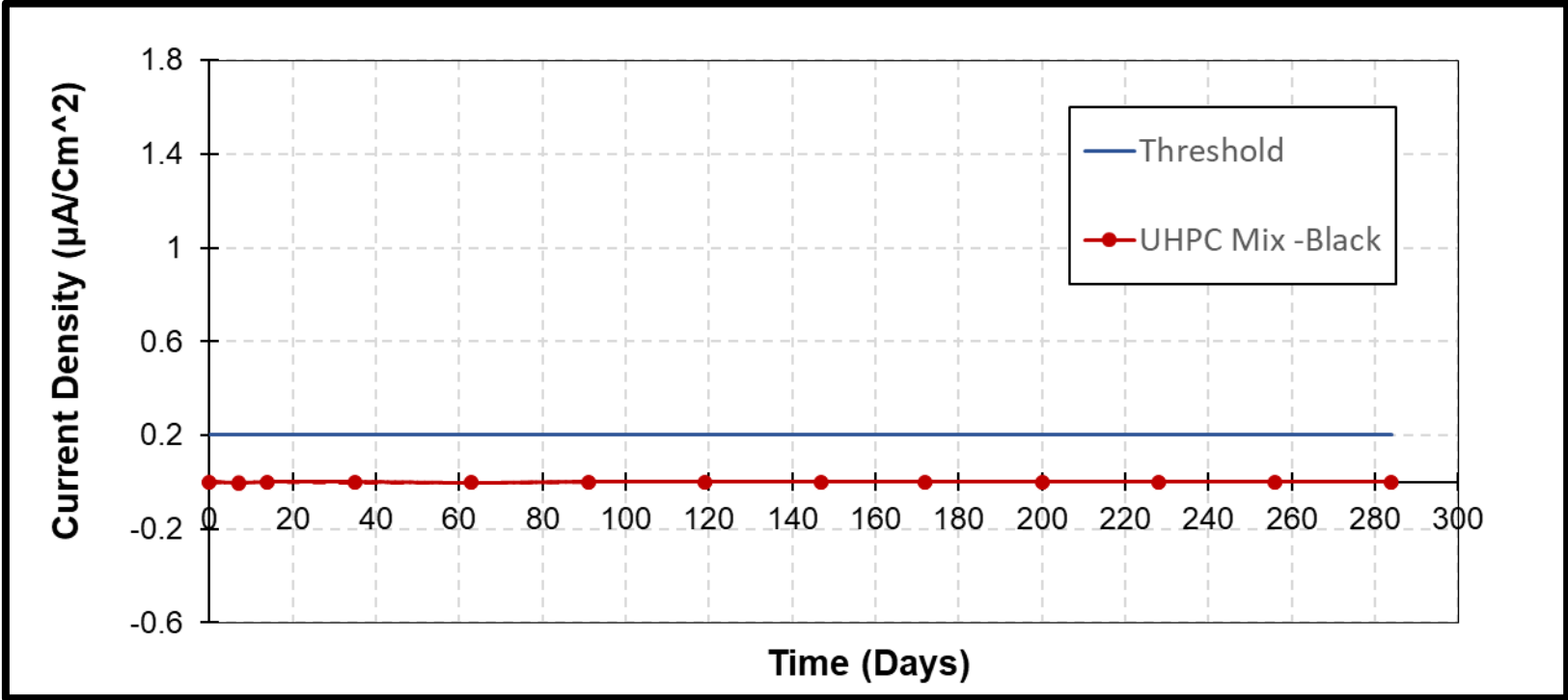
UHPC MICROCRACKS



Crack Widths < 0.1 mm

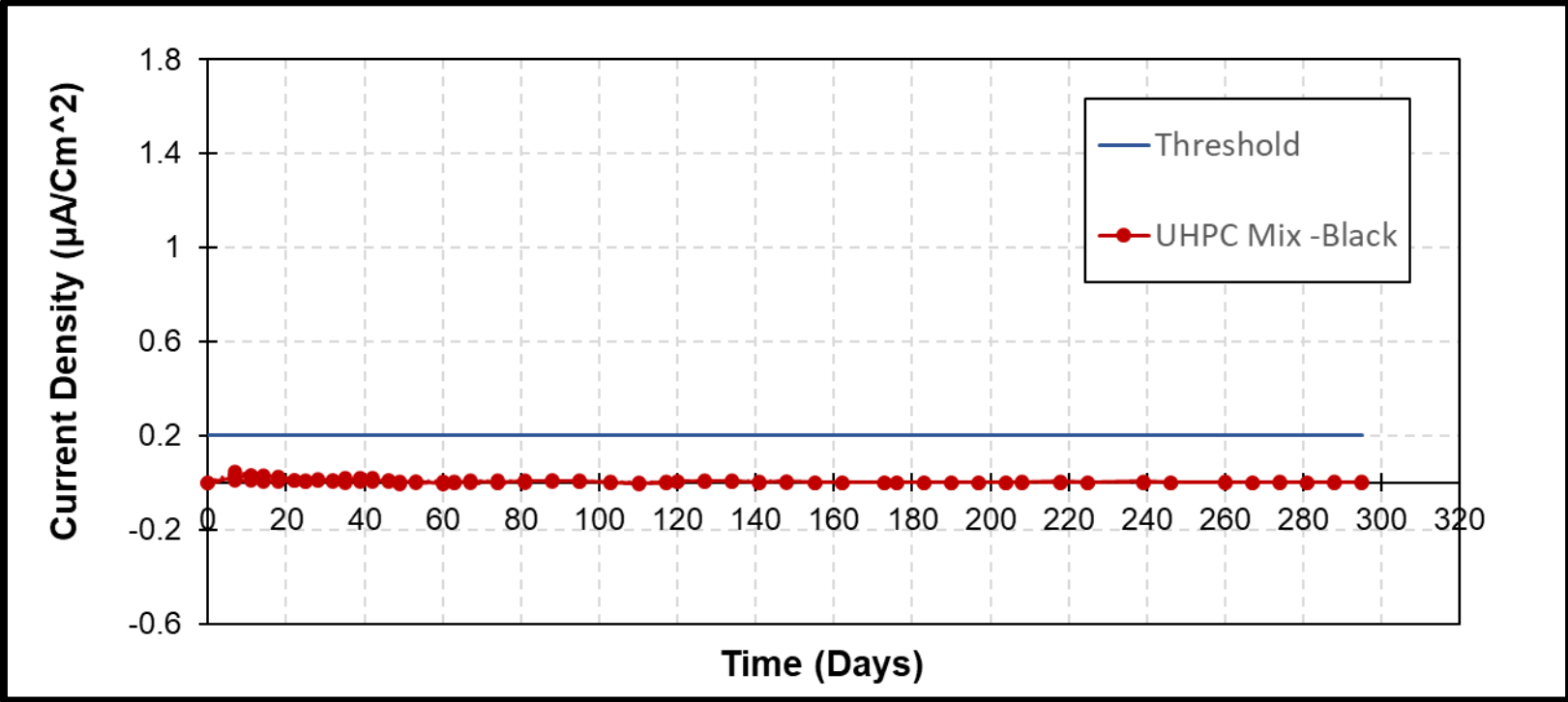
UHPC Mix - UNCRACKED CORROSION RESULTS

- Black Bars

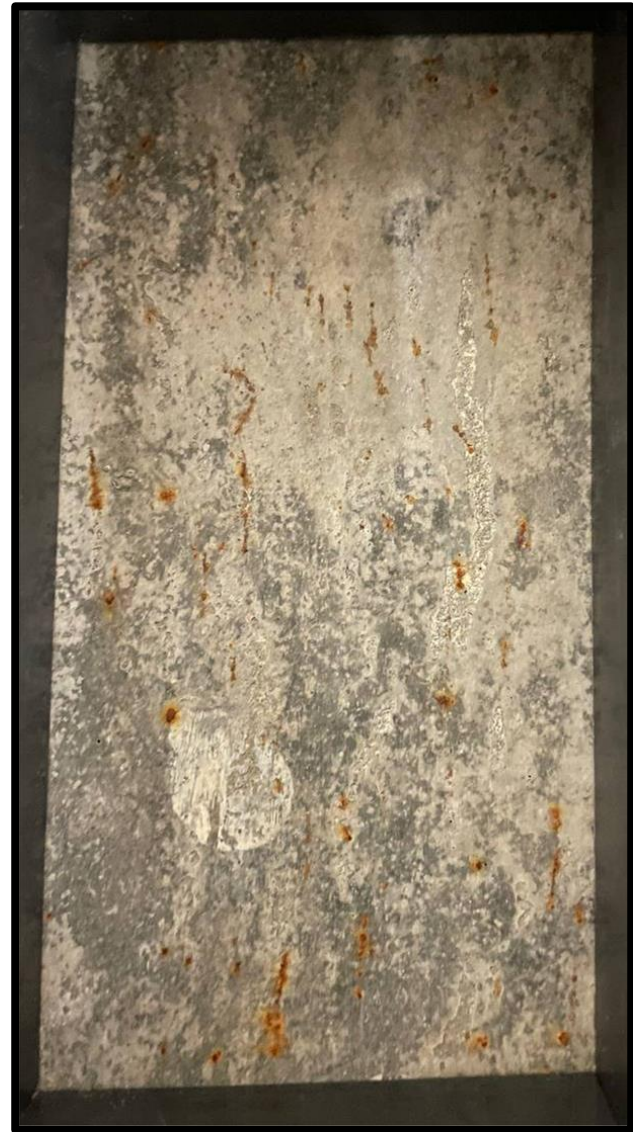


UHPC MIX - CRACKED CORROSION RESULTS

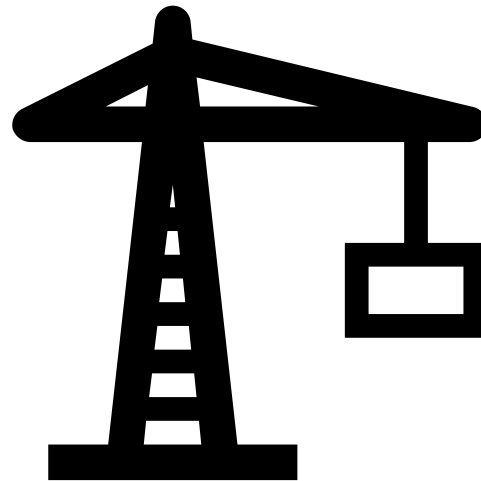
- Black Bars



UHPC UNCRACKED SPECIMENS



FUTURE WORK



FUTURE WORK

- Continue measuring response throughout wetting and drying cycles
- Chloride profiling of specimens
- Durability testing of ductile concrete systems



**THANK YOU FOR YOUR
ATTENTION!**

ANY QUESTIONS ...