

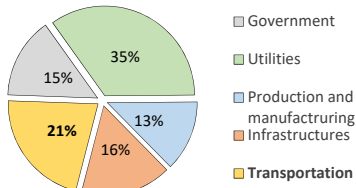
Using Ductile Concrete Covers to Improve Corrosion Resistance of Reinforced Concrete Bridge Piers

Hamidreza Fakhri (hfakhri@buffalo.edu)

Advisor: Ravi Ranade, PhD, PE (ranade@buffalo.edu)

Motivation

Direct annual cost of corrosion in the US is about **\$300 Billion**



Estimated cost of corrosion (Koch et al. 2002)

About **\$10 billion** is needed each year to repair the corrosion related damage in RC bridges.

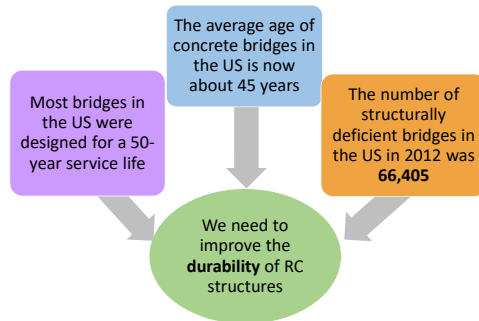
Objective

To reduce corrosion-related deteriorations of RC bridges by eliminating the brittleness of concrete cover.

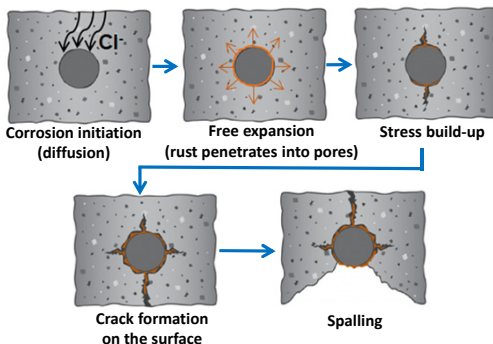
Relevance to transportation infrastructure



Route 438 overpass over the NYS Thruway, available at: <https://riversonghousewright.wordpress.com>



Corrosion-deterioration mechanism

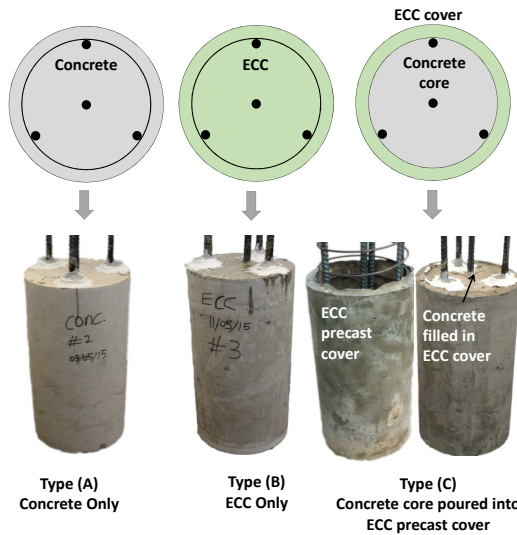


Source: "From Rome to Portland - The Story of Concrete", available at: <https://riversonghousewright.wordpress.com>

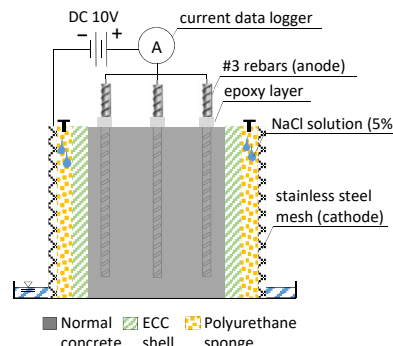
Approach

- Replace only the brittle concrete cover with a precast cover made by ductile concrete (ECC, known as Engineered Cementitious Composite (ECC))
- Ductile ECC cover accommodates the expansion of rebars during corrosion without formation of large cracks, thereby preventing the penetration of chloride ions, water, and air
- Corrosion propagation period is prolonged, which significantly increases the service life of the structure

Specimen types

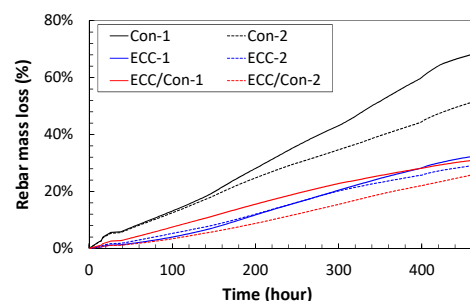


Accelerated corrosion test (ACT)

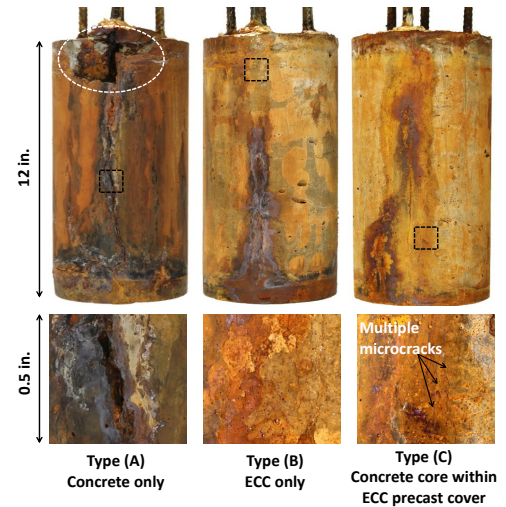


Results so far ...

Rebar mass loss history



Observed damage patterns

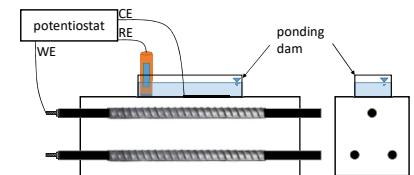


Conclusions

- Using ECC covers significantly reduces the rate of rebar corrosion in type (B) and type (C) cylinders compared to type (A).
- Using ECC only in the cover is sufficient for corrosion mitigation in RC elements as the mass loss of rebars is comparable in type (B) and type (C) cylinders.
- Precast ECC covers can be used as permanent formworks to accelerate constructions and improve durability.

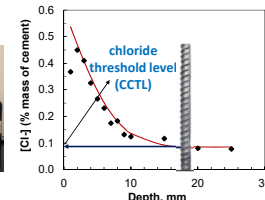
Future work

- Determining the time-to-corrosion initiation



Electrochemical measurements

- Linear Polarization Resistance (LPR)
- Half-cell potential
- Macro-cell current
- Tafel test



Titration analysis to determine [Cl⁻]

Determining chloride corrosion threshold values and diffusion coefficients

- Determining the bond between ECC layer and concrete using slant shear and pull-out tests
- Developing analytical and numerical models to link the corrosion initiation, corrosion propagation and evaluate the service-life of the RC structure

References

- Fakhri, H., Han, Y., & Ranade, R. (2017). In Proc. of 4th International RILEM Conference on SHCC, Dresden, Germany.
- Ranade, R., Fakhri, H., & Ragalwar, K. (2016). In Proc. of 9th RILEM International Conference on Fiber Reinforced Concrete (BEFIB-9), Vancouver, Canada.