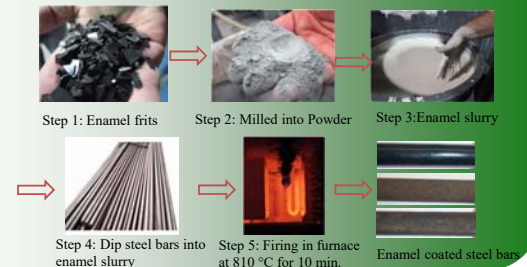




MECHANICAL AND ELECTROCHEMICAL BEHAVIOR OF ENAMEL-COATED STEEL BARS IN CONCRETE

Properties of Enamel Coating

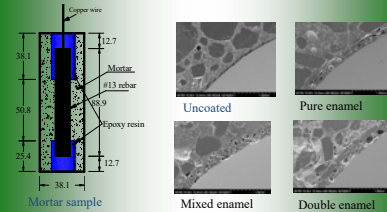
- Vitreous enamel, a material made by fusing powdered glass to a metal substrate by firing, usually between 750 and 850 °C. It has many advantages:
 - Chemically adhere with substrate steel,
 - Work as a barrier layer to prevent chloride diffusion,
 - Behave as physical and chemical inertia, and
 - Modify properties by addition of different oxides.



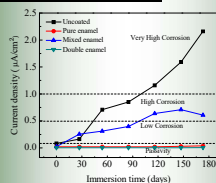
Corrosion Resistance

- To investigate long-term corrosion resistance of steel bars embedded in mortar cylinder and immersed in 3.5 wt.% NaCl solution.

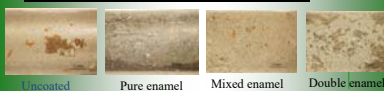
Specimen preparation



Evolution of corrosion current



Surface condition after 173 corrosion test



- Addition of CS particles changes the microstructure of enamel coating.
- Enamel coating increases the corrosion resistance of steel bars in long term.
- Pure enamel and double enamel coatings are better than mixed enamel coating.

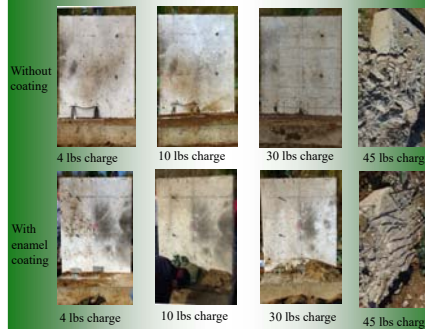
Blast Resistance

- To investigate how improved steel-concrete bond behavior can prevent concrete debris from becoming shrapnel during explosion events.

Specimen preparation



Blast damage under different charges

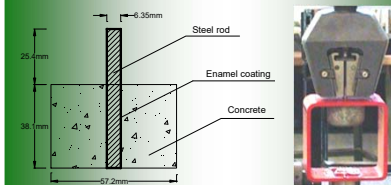


- Strong bond between enamel-coated steel rebar and concrete results in few cracks on the front and back faces.
- Strains measured on enamel-coated rebar are larger than those on uncoated rebar.
- Under 45-lb charge, the enamel-coated rebar remains to be anchored into the wall base while the uncoated rebar completely disappears.

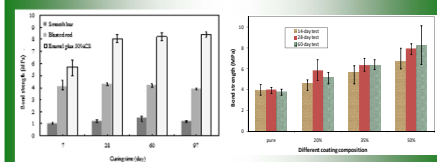
Bond Strength

- To optimize steel-concrete bond strength with various enamels and understand their interface behavior mechanically and chemically.

Specimen preparation



Bond strength comparison



Pull-out failure modes



- Enamel coating increases the bond strength of steel rods with surrounding concrete.
- The increased bond strength results from increased surface roughness and adhesive.
- The chemical bond changes the failure modes.

Potential Applications of Enamel Coating in Civil Infrastructure

- Building and bridges in marine environment or subjected to de-icing salt
- Barrier wall for car-bomb attack
- Transmission and distribution pipelines for oil, natural gas, or hazardous liquid transportation



Bridge piers subjected to corrosion



Barrier wall



Transmission pipeline

Sponsored by: Army Research Laboratory, National Science Foundation, Missouri Department of Transportation, and CTIS University Transportation Center.