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Static and dynamic behavior of concrete slabs reinforced with chemically reactive enamel-coated steel bars and fibers

Key words: Chemically reactive enamel coating, Blast load, Fracture pattern, Steel fibers

BACKGROUND

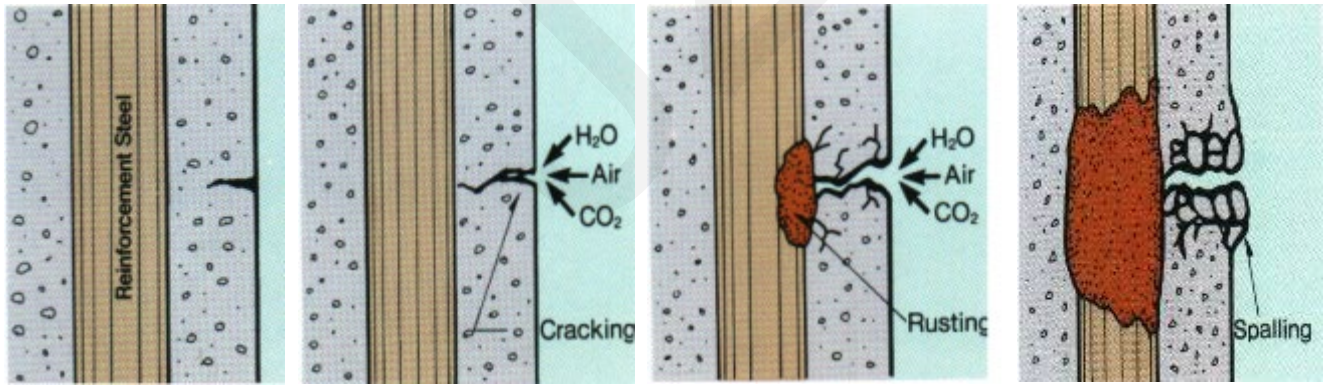
- The corrosion of steel bars in reinforced concrete (RC) structures has been a main concern in civil engineering for many decades. Today, the long-lasting concern becomes ever more serious as more civil infrastructure has been built in modern society.



- Corrosion-resistant coating has been regarded as one of the direct, efficient and cost-effective ways to prevent or delay the corrosion process of rebar in concrete structures.

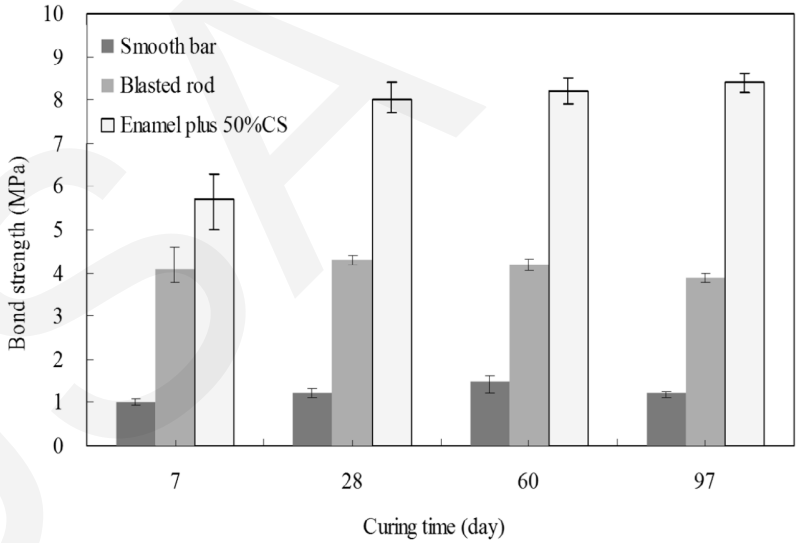
- Epoxy coating could accelerate the corrosion process of steel bar since moisture can be trapped between the coating and steel bar, while chemically reactive enamel (CRE) coatings have been shown to significantly improve the corrosion resistance of steel bar

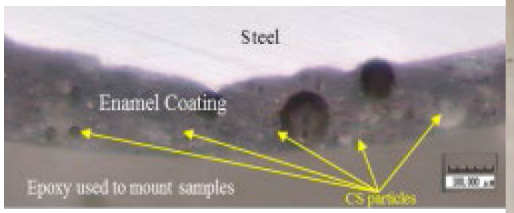




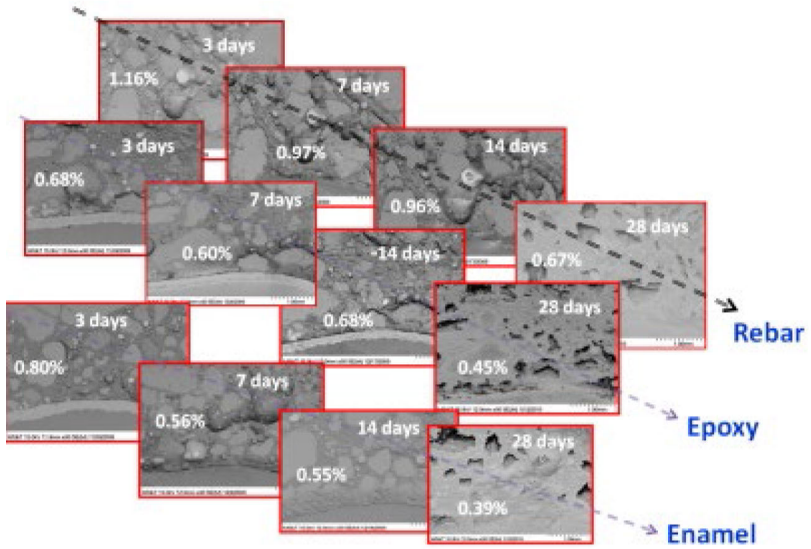
CRE COATING

- CRE coating, particularly when mixed with calcium silicate, provided an excellent transition medium between the steel and concrete and minimized the so-called interfacial transition zone in RC structures through chemical reactions with both steel and concrete.
- CRE coatings have been shown to significantly improve the corrosion resistance of steel bar
- In the present work, we investigate the effect of CRE coating on the overall behavior of concrete slabs reinforced with steel bars and fibers under static or dynamic loading.





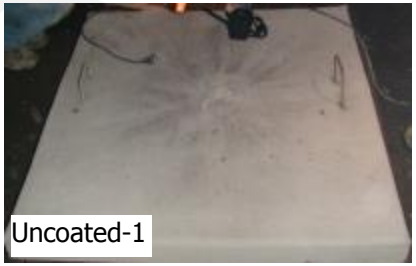




BLAST TEST





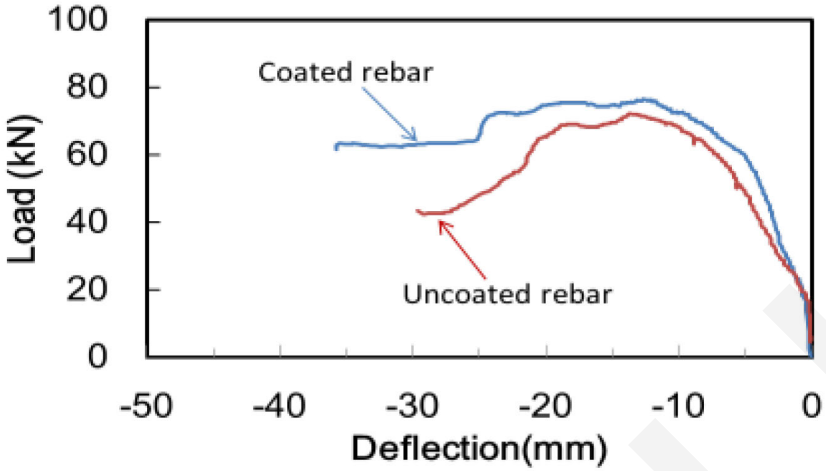




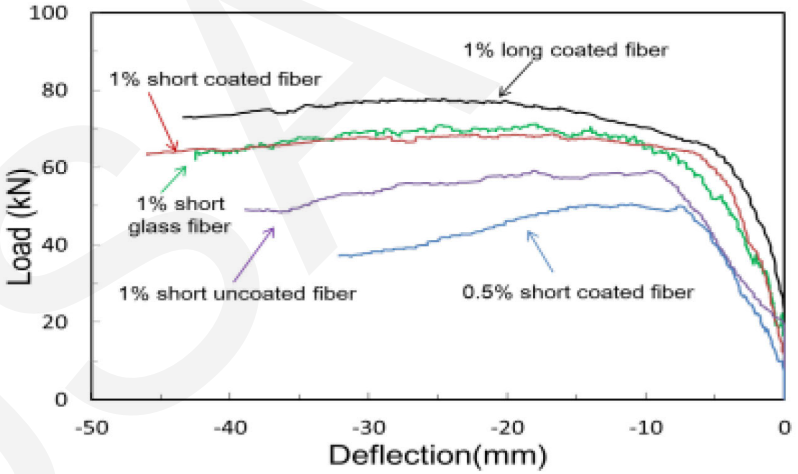


Slab	Step	Charge Weight (kg)	Standoff Distance (cm)
Uncoated-1,CRE Coated-1	1	0.45	91.4
	2	1.14	30.5
	3	1.73	20.3
Uncoated-2,CRE Coated-2	1	1.14	30.5
Uncoated-3,CRE Coated-3	1	1.73	20.3

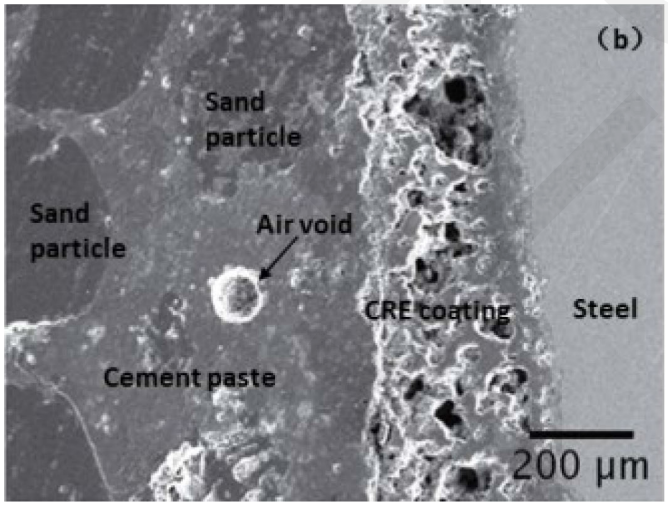
STATIC TEST RESULTS



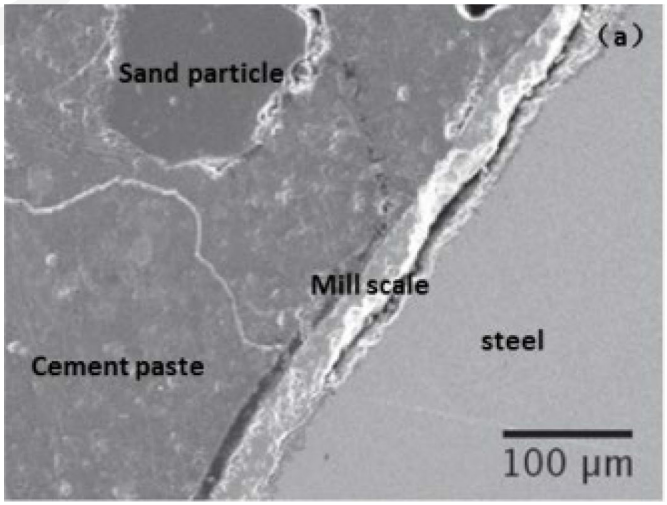
Load-deflection curves of two slabs under a point load



Load-deflection curves of slabs with coated steel bars



uncoated steel bar



CRE-coated steel bar

RESULTS AND CONLUSIONS

- CRE coating can reduce the crater area of RC slabs under a single charge by up to 25%. Multiple charges from low to high explosives in blast tests can generate an over 30% smaller crater than a single charge of the same high explosive only. This is because the crater induced at low explosives allows the release of air pressure at the time of high explosives

- In comparison with slabs with uncoated bars, the load-deflection curves of slabs reinforced with CRE-coated bars under both static and blast loads have a relatively broader plateau and a less degradation of strength, indicating a more ductile behavior as a result of more distributed minor cracks accumulated in concrete.

- Compared to uncoated fibers, CRE-coated fibers can increase the ultimate strength of slabs by up to 17% under static loading. Long fibers (59 mm) in concrete allow the development of yield strength of fibers, prevent concrete cracks from widening, and thus increase the ultimate strength of RC slabs more significantly than short fibers.

- Although developed for reinforcing steel bars, the ACI development length equation appears applicable to steel fibers with a coating factor of $0.57<\beta<1.0$. The debonding behavior of short fibers and the fracture behavior of long fibers used in the tested slabs agree well with the predictions by the ACI equation. The required development length of the short and long steel fibers can be used to consistently explain the strength and ductility of load-deflection curves.

- Future studies are directed to the determination of a coating factor of steel fibers in the ACI development length equation in tension and the evaluation on the compressive strength of concrete reinforced with uncoated and CRE-coated steel fibers.