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Long-term Performance of Repairs to Reinforced Concrete Exposed to Coastal Conditions

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1 Introduction

The present study models an RC structure located near the coast, at risk of salt damage from ambient chloride (Sato. K *et.al.* 2002) Specimens were initially treated using a selection of surface coating and/or patch repair methods and materials, left exposed, and then evaluated in terms of several physical characteristics to characterize the durability afforded by each combination. Exposure tests were performed in a coastal region of Hokkaido, the cold, northernmost prefecture of the long Japanese archipelago. Evaluation data from 25-year-old specimens were additionally compared with those of similar specimens exposed for 4.8 and 8 years.

2 Experimental Overview

Table 1 shows the types of materials used in the repairs. Concrete was chipped away from a designated area of the RC slab, which had two reinforcing steel bars ("rebar") embedded in it. Next, this area was patched and its surface coated using a specific combination of materials.

Concrete was removed to two different depths ("chipping depth"), defined relative to the embedded rebar: (A) chipping extended below the bar, allowing it to be completely covered with mortar, or (B) chipping reached the same depth as the rebar axis, meaning only half of it was covered with mortar.

Table 1. Repair materials.

Process	Symbol	Type
Patch repair	N	None
	CM	Cement mortar
	PS	SBR* polymer cement mortar
	PI	SBR* polymer cement mortar with anti-rust additive
	LE	Lightweight epoxy mortar
Surface coating	N	None
	L	Thin textured coat
	S	Multi-layer textured coat

*SBR: styrene–butadiene rubber

These specimens were left at the exposure test site for predetermined lengths of time (43.025N, 140.53E, ~40 m from coastline). At each timepoint, several specimens were broken apart and the rebar inside removed to measure the surface area affected by corrosion and the weight lost due to corrosion. Carbonation depth and chloride penetration were measured in the broken concrete in parallel.

3 Results and Discussion

Figure 1 depicts correlations of rebar corrosion speed in the unrepaired versus border and repaired sections. Corrosion was effectively prevented by the repair techniques utilized, by and large proceeding at slower speeds in repaired than unrepaired rebar. Corrosion speed was quite high in the border region after eight years of exposure following repair with the rust-resistant SBR polymer cement (PI). This behavior could be attributable to a macrocell formed by a major differential in corrosion potential between the repaired and unrepaired parts due to the anti-rust additive in the mortar. However, the same tendency was not apparent in the 25-year-old specimens repaired using the same material, suggesting this variation likely originated in individual differences between specimens. In any case, the results showed that multi-layer textured coating is most effective to prevent corrosion.

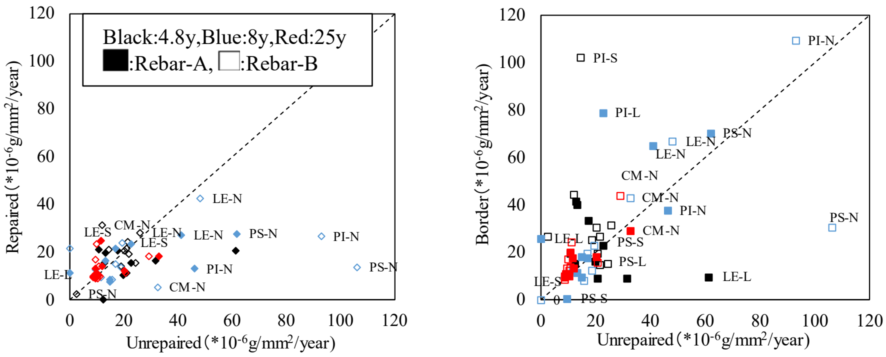

Figure1. Rebar corrosion speed.

4 Conclusion

- Corrosion protection was greater when concrete chipping extended below the rebar than merely to the same depth.
- Rebar corrosion, as with carbonation, was most effectively prevented by the multi-layer textured coating material.
- Rebar was more resistant to corrosion following patch repair with SBR polymer cements than with lightweight epoxy.

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References

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