

# **Deterioration Prediction Model of Multi-Layer Coating Material and its Reference Service Life Evaluation in Terms of Carbonation Control Effect**

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## **1 Introduction**

Carbonation of concrete is one of the factors that determines the service life expectancy of reinforced concrete buildings. It is well known that paint exterior finishes on a reinforced concrete building suppress the concrete carbonation and prolonging service life of building.

As exterior finishes deteriorate and the protection function against the underlying concrete decreases with the passage of time, predicting the service life of the exterior finishes is a serious issue. Degradation of the exterior finish progresses for many reasons such as the type of material, the external force of deterioration, the site to be used, the construction level, the level of maintenance and maintenance, and therefore it is difficult to predict deterioration of the exterior finish.

Furthermore, the service life of the exterior finish is individual depending on the state of consideration of lifetime. Regarding the method of estimating the service life of the reinforced concrete exterior in “Principal guide for service life planning of buildings” edited by the Architectural Institute of Japan, the life time is defined as the condition that the coating cannot be recovered by normal repair. On the other hand, since protective performance against carbonation of reinforced concrete is required for exterior finish materials, it can also be considered that the life would be the time when the carbonation inhibiting effect becomes smaller than a certain value. However, the relationship between the deterioration of the exterior finish material and the decrease in carbonation inhibiting effect is not clear in many cases.

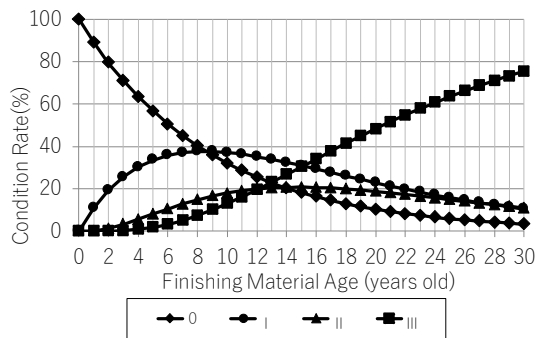
In this study, authors performed field survey of existing buildings, and based on the results, proposed the deterioration prediction method of exterior materials using Markov chain model which is one of probability theory. Authors have proposed a method for evaluating the service life of exterior finish to minimize the progress of neutralization of building concrete considering the carbonation inhibiting effect of the exterior finish suppress the progress of carbonation to reinforcing bars up to the number of years required by the owner of the building.

First, authors investigated the cracks of exterior finish painted on real buildings (table 1) and predicted crack deterioration progress by using Markov chain model in Chapter 2. The prediction results are shown in Fig. 1. Next, based on previous literature showing the relationship between permeability and carbonation, authors examined the relationship

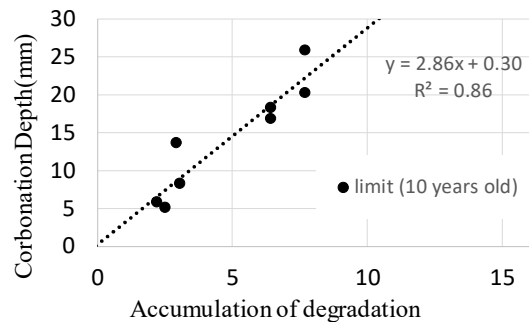
between the cracks of the exterior finish and the carbonation of the concrete in Chapter 3. As a result, authors showed a possibility that there is a tentative correlation between the cracks of the overcoat layer of the exterior finish and the surface permeability. In addition, authors proposed a method to evaluate the progress of carbonation from the cracks of the finish paint and the neutralization condition of concrete of real buildings (Fig 2). Finally, authors proposed the service life of exterior multi-layer finish to minimize the progress of carbonation of building concrete by using survey results on carbonation of actual buildings and prediction of crack deterioration in Chapter 4.

**Table 1.** Surveyed Buildings.

	Survey Buildings			
	A	B	C	D
Construction	reinforced concrete construction			
Stories	4	4	4	12
Design Strength	18 N/mm <sup>2</sup>	18 N/mm <sup>2</sup>	21 N/mm <sup>2</sup>	21 N/mm <sup>2</sup>
Year of construction	1978	1977	1977	1977
Year of Repaint	2010	2008	2001	1997
Age from Repaint	6 old	8 old	15 old	19 old
Finishing Material (construction)	Multi-layer Finish Material (E Type)			
Finishing Material (repaint)	Synthetic Resin Emulsion Paint			
Color of finish	white			



**Figure 1.** Prediction of Cracking.



**Figure 2.** Relation of Accumulation of degradation and Carbonation depth.

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