SEISMIC RELIABILITY ASSESSMENT OF A CORRODED RC BRIDGE PIER IN MARINE ENVIRONMENT USING INSPECTION DATA

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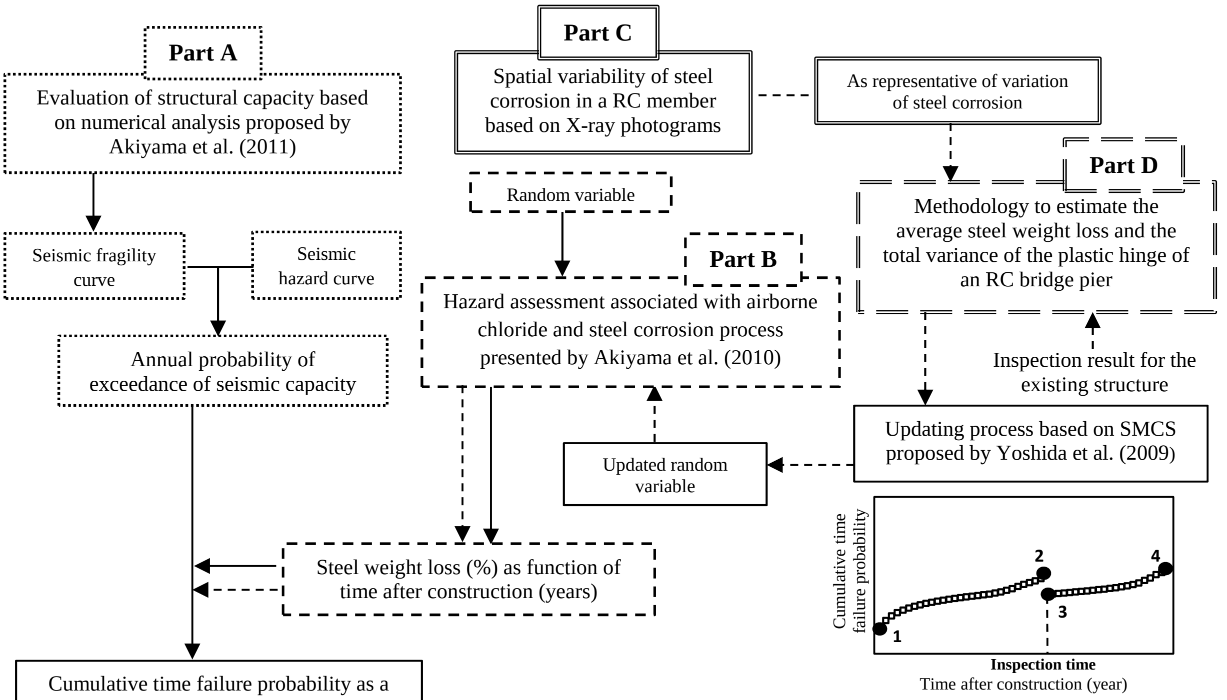
1. INTRODUCTION

Although there are several precise models for estimating the seismic performance of a corroded reinforced concrete (RC) bridge structure, seismic reliability assessment models considering the effect of steel corrosion are currently very scarce in the literature. Therefore, it is very difficult to evaluate the seismic safety of a deteriorated RC structure and to determine how long the structure would have a safety level higher than the threshold. For an existing RC bridge, inspection results could be used to estimate the current level of material deterioration. It is important to evaluate the effect of steel corrosion in the plastic hinge of the bridge pier on the deterioration of the seismic ductility capacity.

In this study, the methodology to estimate the average steel weight loss and variance of the local average (hereafter, total variance) in plastic hinge of an existing RC bridge pier is presented based on previous experimental results of corroded RC members acquired by X-ray technology. A procedure for estimating the seismic reliability of an existing RC bridge pier in a marine environment is established based on the inspection data considering the spatial distribution of steel corrosion. The mean and total variance of the steel weight loss will be used to resolve the epistemic uncertainties associated with the prediction of steel weight loss using Sequential Monte Carlo Simulation (SMCS). Finally, the updated cumulative time failure probability of the RC bridge pier is presented in an illustrative example.

2. PROCEDURE FOR ESTIMATING THE LIFE-CYCLE SEISMIC RELIABILITY OF A CORRODED RC BRIDGE PIER IN A MARINE ENVIRONMENT



- **Point1 to Point2** can be obtained by using Part A and Part B (no updating).
- **Point2 to Point3** is the effect of updating the process by using SMCS
- **Point2 to Point4** can be calculated by using the updated random variable based on Part C and Part D

Fig. 1 Framework for estimating the life-cycle seismic reliability of an RC bridge structure in a marine environment

As shown in Fig. 1, in Part A, the annual probability of the exceedance of the seismic capacity can be obtained. In Part B, the steel weight losses at time *t* after construction are calculated. The combination of the results of Part A and Part B derives the cumulative time failure probability for new RC structure (Akiyama et al. 2011). Since the inspection results are provided for an existing structure, the model uncertainties associated with the prediction of steel corrosion represented by the multiple random variables could be updated by SMCS, even if the relationship between these random

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variables and the inspection results are nonlinear, and non-Gaussian variables are involved (Akiyama et al. 2010,Yoshida 2009). Based on the updated random variables, the structural failure probability can be obtained after inspection.

3. METHODOLOGY TO ESTIMATE THE AVERAGE STEEL WEIGHT LOSS AND THE TOTAL VARIANCE OF A PLASTIC HINGE OF AN EXISTING RC BRIDGE PIER (PART D)

The steel weight loss in the plastic hinge of an RC bridge pier can be estimated based on discretely distributed measurements of steel weight loss over the entire RC bridge pier. The parameters to reproduce the spatial random field of steel corrosion in spatial statistics are determined based on the experimental results of corroded RC members taken by X-rays. By semi-variogram calculation, Kriging interpolation, and the statistical error estimation proposed by Honjo and Otake (2013), the mean and total variance of the steel weight loss in the plastic hinge of the RC bridge pier could be estimated depending on the inspection results and the number of inspection points. The limited number of inspection points increases the total variance and decreases the seismic reliability of the corroded RC bridge pier analyzed.

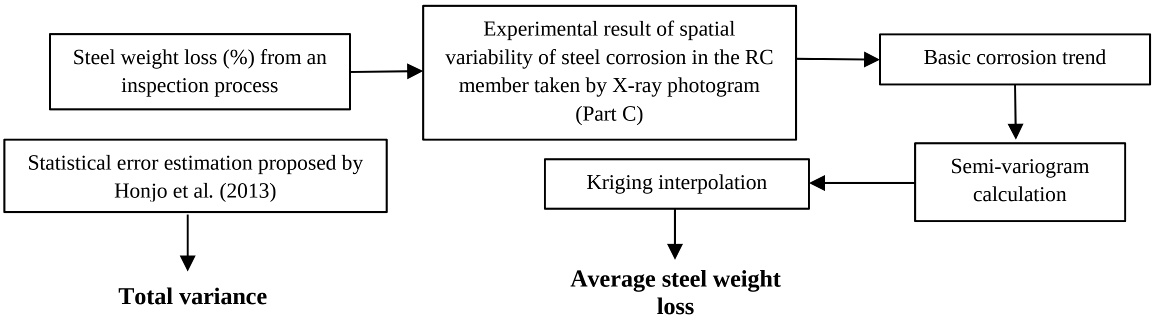

Fig. 2 Methodology of the integration of the spatial variability of corrosion into the obtained inspection result

As a case study, Fig. 3 shows the results of the updated steel weight loss and cumulative time failure probability of an existing bridge pier in which the estimated mean and total variance of the steel weight loss in the plastic hinge are 3.07% and 0.21, respectively. It is assumed that the inspection results are provided at 30 years after construction, and the bridge is located in Niigata city. The cumulative time failure probability at 30 years after construction is much smaller than that before updating since the epistemic uncertainties are decreased by SMCS to be consistent with the inspection results.

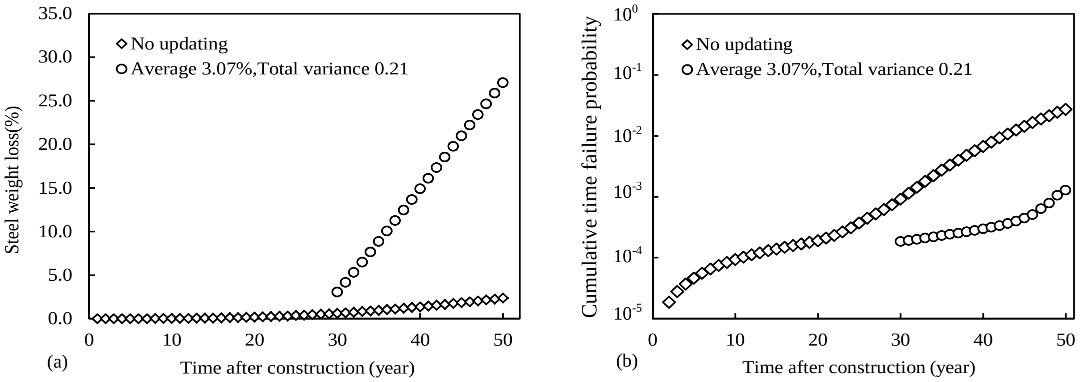

Fig. 3 Relationship between (a) steel weight loss (%) and (b) cumulative time failure probability and time after construction (year) based on the inspection results

4. CONCLUSIONS

A novel procedure to estimate the life-cycle seismic reliability of an existing RC bridge pier in marine environment by considering a spatial steel corrosion distribution is presented. A more accurate reliability assessment could be performed since parameters associated with the prediction of steel corrosion are updated to be consistent with inspection results.

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