The Evolving Metropolis
2019 IABSE Congress
New York City

IABSE 90 YEARS

# Pre-posterior analysis of inspections incorporating degradation of concrete structures

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## 1 Abstract

The framework of pre-posterior decision analysis has a large potential as a decision support tool in structural engineering. It seems ideally suited to tackle problems related to determining the value of Structural Health Monitoring and is commonly applied in inspection and maintenance planning. However, the application of this methodology for integrated life-cycle cost decision making related to monitoring of time-dependent and spatial degradation phenomena in concrete structures, needs further investigation. In this work, the time-dependent and spatial degradation phenomena will be coupled to the pre-posterior decision making approach and applied on concrete beams under bending, subjected to corrosion of the reinforcement. A framework is set up to determine the value of information of inspections enabling adequate decision-making. The methodology incorporates Bayesian updating based on the uncertain inspection outcomes. The framework will be illustrated by application on a simply supported reinforced concrete beam.

**Keywords:** Concrete, degradation, Bayesian updating, pre-posterior analysis, decision making, inspection

## 2 Introduction

Deterioration processes such as reinforcement corrosion are subjected to large uncertainties, reducing the reliability of reinforced concrete structures. Measuring the structure's condition state can reduce this uncertainty. Since inspections and maintenance represent a significant part of the total life cycle cost of a structure, pre-posterior analyses should be conducted to determine their cost-effectiveness, by quantification of the value of information (VoI) of an inspection strategy [1]. The fundamental decision whether to consider additional, however inherently uncertain and a priori unknown, information is expressed by this VoI, as given by equation (1) [2].

$$VoI = C_{prior} - \left[\int_{Y} f_{Y}(\boldsymbol{y}) \min_{a} \left[\sum_{i=1}^{m} c_{E_i}(a) \Pr(E_i|\boldsymbol{Y}=\boldsymbol{y})\right] d\boldsymbol{y}\right] \quad (1)$$

Here, $C_{prior}$ is the prior expected cost, $f_Y(\boldsymbol{y})$ the joint PDF of the monitoring outcomes $\boldsymbol{Y}$, $c_{Ei}(a)$ the expected cost of an action $a$ and $Pr(E_i|\boldsymbol{Y}=\boldsymbol{y})$ the probability of an event or damage state $E_i$, given the inspection outcomes $\boldsymbol{Y}=\boldsymbol{y}$.

https://doi.org/10.2749/newyork.2019.2435
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