An Adaptive NDT Inspection Strategy to Assess the Spatial Variability of Concrete Structures

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Abstract

Spatial variability is an essential key in modeling material properties, loading or the deterioration process in structural engineering degradation. Non-destructive Testing (NDT) technique is a crucial tool to characterize this spatial variability. In this paper, we propose an original approach that enables to characterize the spatial variability of structure through discrete and limited measurements in efficient and accurate way. An adaptive approach based on two indicators errors is performed to model the quantities of interest. Firstly, an error indicator is run to estimate an accurate parameter of fluctuations using Maximum Likelihood Estimate (MLE) from a set of measurements. Secondly, the accuracy of the estimated moments of the field from the current number of measures is revised by analyzing the behavior of the second indicator. The advantage of this approach is that the spatial correlation is not neglected between measurements and the range of the correlation is given in good way within a desirable threshold. The potential of the presented approach is demonstrated through numerical examples with synthetic and experimental data.

Keywords: Spatial variability, Non-Destructive Testing, Scale of fluctuations, Gaussian random field, Maximum Likelihood Estimate.

1 Introduction

Structural serviceability and safety are impacted by various sources of uncertainty involved during their whole lifetime: material properties, loading, modelling, degradation process, etc. The spatial variability of concrete is the key in modeling such properties, it qualifies the non-homogeneity of mechanical and physical properties of structural components. Assessing the spatial variability of concrete structures is of major interest for either locating potential damaged areas in an existing structure, or reliability analysis. On the other hand, it has been shown that spatial variability of existing infrastructures cannot be simplified to a random variable or to a stochastic white noise. Because there is a considerable correlation between spatial locations. For instance, recent studies have shown that this spatial correlation has an important impact on the level of structural reliability [1, 2]. Therefore, recent research [2, 3, 4, 5] have focused on spatial variability of inspected parameters. However, to the best of our knowledge, none of them has focused on sampling optimization for optimal assessment of the correlation length, which governs the spatial

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