Accounting for spatial variability in partial factor based design verifications

Wouter Botte, Robby Caspeele

Department of Structural Engineering and Building Materials, Ghent University, Ghent, Belgium

Contact: Wouter.Botte@UGent.be

Abstract

Traditional design and assessment approaches usually assume that e.g. material properties and environmental influences are uniform in space. However, it is well-known that such parameters can show considerable spatial variability. Furthermore, it has been shown that such spatial variability can significantly influence structural reliability. One way to account for spatial variability is by means of random fields. However, the use of such advanced calculations has not found its way to everyday engineering practice. Therefore, a methodology is developed in order to include spatial variability in the partial factor method in a way which is consistent with the current Eurocode format for design. This is done by introducing a separate partial factor which depends on the correlation length and the variability of the parameter under consideration. As such, an easy-to-use graph is generated, which can be applied in practice for the adjustment of partial factors to take into account spatial correlation. Finally, the proposed approach is validated by means of full-probabilistic calculations.

Keywords: Spatial variability; partial factor method; structural reliability.

1 Introduction

Traditional design and assessment approaches usually assume that e.g. material properties and environmental influences are uniform in space. However, it is well-known that such parameters can show considerable spatial variability. Furthermore, it has been shown that such spatial variability can significantly influence structural reliability [1–3]. One way to account for spatial variability is by means of random fields [4]. The latter can be characterized by a probability density function and an autocorrelation function which describes the correlation between different spatial locations. Subsequently, spatial variation can be taken into account in structural analysis through a discretized form of the random field. However, the use of such advanced calculations has not found its way to everyday engineering practice. This can be attributed to the fact that still several (fundamental) challenges exist which, nowadays, result in a simplistic treatment of spatial variability or even disregarding such variability completely. Therefore, in this contribution a methodology is developed for the inclusion of spatial variability of certain variables in the partial factor method. The proposed methodology is moreover consistent with the current Eurocode format for design. First, a general introduction is given regarding the formulation and properties of random fields. Next, in section 3, a partial factor is derived which enables to account for spatial variability. Finally, in section 4, the proposed partial factor approach is validated by means of full-probabilistic calculations.

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