Probabilistic approach to the modeling of reinforced concrete elements using Gaussian random fields

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Abstract:

Finite element models require quite some parameters to perform a full non linear analysis of concrete structures. Some of these parameters, e.g. the Young modulus, concrete compressive and tensile strength and reinforcement yield strength, can be estimated by standard laboratory tests. Other parameters are not so easily determined if they can be determined incontestably at all. It is then the task of the modeler to provide estimated values for these parameters based on experience and best practice. Sometimes these undetermined parameters are fitted to the results of one or two tests. It is disputable if this method provides reliable estimates that can be used to predict future test results. Furthermore traditional calculation procedures consider concrete as a homogeneous isotropic material, whereas the concrete quality can differ significantly from location to location in real concrete elements.

A probabilistic approach to model concrete structures can solve some of the issues mentioned before. Both concrete and steel properties are stochastic values and the reliability of the laboratory tests is reflected in the material property's standard deviation. The spatial variability of concrete strength and stiffness can also be taken into account by using Gaussian random fields to generate the material properties of individual elements in the model.

A two span reinforced concrete beam was used to demonstrate that the probabilistic modeling scheme only needs a limited amount of random samples to generate a confidence interval for the large scale laboratory tests.