FUZZY DISTRIBUTION OF INTERNAL FORCES IN DYNAMICALLY LOADED STRUCTURE

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In this paper, an approach to dynamic analysis based on the fuzzy set theory is presented. The dynamic analysis uses the response spectra method where the material parameters are considered fuzzy, which results in mode shapes and natural frequencies with fuzzy distribution. The internal forces are also in the form of fuzzy numbers and their fuzzy distribution i n the structural elements reflects the degree of uncertainty contained in the input material parameters. This approach is explained in an illustrative example.

Key words: *dynamic analysis, fuzzy numbers, internal forces*

1. Introduction

Material description of concrete always contains uncertainty about its composition, which is difficult to be eliminated completely, however, this uncertainty can be assessed by statistical, fuzzy, or other suitable tools. For design purposes, one may wish to conduct a statistical analysis, using the statistical characteristics of several measured events. In the case of earthquake, the measured data for each site of interest is not particularly dense, leaving the statistical characteristics with little relevance. On the other hand, the expected seismic load at a site can be alternatively expressed by the fuzzy sets, [1], which take into account the scarcity of seismic stations and the information about local sub-soil composition.

In this paper, an approach to dynamic analysis based on the fuzzy set theory is presented as a pre-step of the classical stochastic dynamic analysis. The material parameters of reinforced concrete are considered to be fuzzy quantities with a given distribution, i.e. fuzzy numbers with a desired shape of the membership function, [2]. The dynamic analysis is performed with help of the fuzzy arithmetic on the α-cuts, [3]. The result of such an analysis is in the form of fuzzy numbers which compared with the stochastic approach is less expensive in terms of computation time and still it provides the designer with an idea of distribution of the sought quantity, [4]. In order to further improve the computational efficiency, inspired by [5], the concept of a surface response function, [6, 7], is utilized. This approach is demonstrated in an illustrative example of a 2D frame where the effect of uncertain material parameters transpires in corresponding distributions of natural modal shapes and natural frequencies of an analyzed two-dimensional frame. The results of the natural vibration analysis are then used in the investigation of structural vibration by the response spectrum. The fuzzy distribution of internal forces were obtained for a design accelerogram.

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