Assessment of Coupled Numerical Models applied to semi-integral bridge

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Summary

In the general design process of structures the engineer needs to decide which models are suitable for simulating realistically and efficiently the physical processes determining the structural behaviour. The theoretical knowledge, but also the experience from prior design processes will influence the model selection decision. It is thus often a qualitative choice of different models. The goal of this paper is the quantitative evaluation for coupled numerical partial models to assess the Global Model Quality. The evaluation is applied to the simulation of a semi-integral prestressed concrete girder bridge. The material behaviour, the creep and the shrinkage both for the superstructure and piers, furthermore geometrical nonlinearities and temperature distributions are considered as partial models. The results show that the Global Model Quality is strongly dependent on the sensitivity and quality of each model class with its corresponding partial models.

Keywords: semi-integral concrete bridge; sensitivity analysis; model quality assessment.

1. Evaluation method for coupled numerical models

Global models (GM) for numerical simulation approaches utilise different model classes (M) with subordinate partial models (PM). Material descriptions, creep and/or shrinkage models are named here as possible M for concrete structures. Interactions and couplings of their PM are necessary for determining an appropriate structural behaviour. Therefore the following evaluation method enables to assess the Global Model Quality. For detailed information the author recommends Keitel et al. [1].

1.1 Sensitivity according a model class

The first step is to quantify whether the class has an influence on a certain target value. This is evaluated by using Sensitivity Analysis [2] which in general is the study of how the output of a model (Y) is related to the model input (X). By using discrete random variables for selecting the model class, the Sensitivity Study in this case is not an estimation of uncertainty, but a quantified value of the influence of the M class (X_i). The First Order Sensitivity Index is

$$S_i = \frac{V(E(Y|X_i))}{V(Y)} \tag{1}$$

This index S_i illustrates the exclusive influence of model X_i. According to interactions in complex engineering problems higher order Sensitivity Indices are needed. The Total Effect Index is defined as

$$S_{Ti} = 1 - \frac{V(E(Y|X_{\sim i}))}{V(Y)} \tag{2}$$

A finite number of possible model class combinations ncomb are necessary for the indices:

$$n_{comb} = 2^{n_M} \tag{3}$$

with n_M random variables (model classes). A measure of interaction between X_i and other model classes is the difference between S_i and S_{Ti}. High values of these Sensitivity Indices highlight a significant influence of this partial model class on the response of the global model. Models with

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