CMS4SI Structural Identification Approach for Interpreting Measurements

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Summary

The ageing of existing structures and new innovative designs are increasing the necessity for a greater understanding of structural behaviour. A better understanding would improve effectiveness of activities such as assessing reserve capacity, evaluating load increases and replacement decision making. Identification methodologies are needed to indicate the right behaviour using indirect measurements and behaviour models.

This paper proposes a methodology that is able to accommodate multiple explanations while overcoming limitations of other SI approaches. The algorithm is called Candidate Model Search for System Identification (**CMS*4*SI**). Metrology guidelines are extended for use in the field of system identification while systematically including uncertainties and their correlations. The **CMS*4*SI** approach provides the necessary robustness and simplicity to support decisions related to the identification and understanding of structural behaviour. The approach is evaluated by full scale-testing of the Langensand Bridge. A critical aspect for meaningful identification is the uncertainty associated with model simplifications. The adaptation of clustering techniques and the use of radar plots allow for a convenient visualisation of results involving several parameters. Finally, models that are identified can be used to perform predictions of unmeasured behaviour, thereby supporting infrastructure management.

Keywords: CMS4SI, Structural identification (SI), Performance assessment, Uncertainty, Correlation, Radar plot

1. Introduction

Finding models that correctly predict structural behaviour is not feasible using advanced models alone. Even when using a refined, task-adapted numerical model, there are too many unknowns. Without structural measurements, values for parameters such as material properties, interface conditions (ex: composite interaction, connection stiffness, etc…), and cannot be assessed. Resources are always limited, and therefore sensors cannot be placed everywhere in every direction to measure all important phenomena on civil structures. Therefore, identification methodologies are needed to indicate the right behaviour using indirect measurements and behaviour models.

Model-based system identification (SI) is an active research area in many engineering fields. Several approaches of varying complexity are available.

1.1 Multiple-Model Methods

Multiple-model approaches have been introduced by Raphael and Smith [2]. The starting point for the method was to be compatible with the presence of errors in inverse engineering tasks. Therefore, more than one model should be retained for the evaluation of observed behaviour. Over the years, the concept evolved to propose sampling through model composition [3, 4] based on stochastic search [5].

Previous work has proposed thresholds to represent uncertainties that separate potential and rejected models. However, uncertainty combination was not developed into a robust and systematic

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