Design of damage indicators for vibration-based Structural Health Monitoring (SHM) Systems

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Abstract Nowadays, the investments for maintenance of existing structures are not negligible in comparison to the construction costs. Hence, a fully automated structural health monitoring system to reduce maintenance costs is requested by many operators. Such structural health monitoring systems typically rely on the observation of certain features or damage indicators extracted from measured data. The overall aim is, therefore, to design indicators, which are most sensitive to damage, but insensitive to confounding effects, like environmental or operational influences and noise. The quality of such an indicator depends on many aspects, for example, the choice of measured quantity, the choice of sensor, the data acquisition including pre- and postprocessing and the feature extraction method, as well as, the feature itself.

The vibration research group of BATir at the Université Libre de Bruxelles follows an integrated approach, by considering as many influencing aspect as possible. The main subjects are (a) the design and manufacturing of a new embedded PZT sensor type, (b) the design of a new type of vibration-based damage indicators using modal filters and dynamic strains, and (c) the virtual testing assuming random vibrations for realistic damage patterns.

Even though all subjects are introduced shortly, the main focus of this presentation will be on virtual testing, that is the basis for the assessment of existing and the dedicated design of new damage indicators. The motivation for this research field is of course to replace expensive and time consuming laboratory experiments, as much as possible, by numerical realistic simulations. The process of creating a suitable numerical simulation for a plain concrete beam will be demonstrated in this presentation. This covers issues, such as the model updating of the implicit gradient damage law by experimental load-deflection-curves and the efficient dynamic simulation of the damaged structure under random vibration.