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Damage Identification of Concrete Beams using a Hybrid Approach of Element Modal Strain Energy and Data Fusion with Reconstructed Modal Rotations

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Damage identification of structures is always attractive to researchers because it plays an important role in the health monitoring in many civil engineering structures. When carrying out a health monitoring, sensors are usually laid on a concrete beam to record acceleration signals, in which the modes of the beam can be extracted to construct indicators for detecting damages of the investigated beam. It should be noted that it is difficult to measure rotational signals of the beam at a position where sensors are laid, thus only the modal translations can be available. Although the pure modal translations can still be used to construct indicators and often it is the case, an indicator taking into account modal rotations is suggested in application to consider the effect of signal noise on the accuracy of measurement. In this paper, modal rotations were reconstructed by modal translations using the principle of static condensation. Then both modal translations and rotations were used to build an indicator based on an idea regarding element modal strain energy together with the theory of data fusion. The modal translations were extracted from accelerations recorded on a concrete beam using stochastic subspace identification (SSI). Studies were carried out on choosing values of two parameters in SSI in order to eliminate the effect of noise as nearly as possible. The simulation given by a FEM model and analyses of real accelerations recorded on a reinforced concrete beam show that this proposed hybrid approach with elimination of noise effects is certainly able to determine the location of the damages in the investigated concrete beams.