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Damage Identification in Reinforced Concrete Beams Using Modal Parameters and Their Formulation

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Abstract : The identification of damage in reinforced concrete structures subjected to incremental cracking performance exploiting vibration data is recognized as a challenging topic in the published and heavily cited literature. Therefore, this paper attempts to shine light on the extent of dynamic methods when applied to reinforced concrete beams simulated with various scenarios of defects. For this purpose, three different reinforced concrete beams are tested through the course of the study. The three beams are loaded statically to failure in incremental successive load cycles and later rehabilitated. After each static load stage, the beams are tested under free-free support condition using experimental modal analysis. The beams were all of the same length and cross-sectional area (2.0x0.14x0.09)m, but they were different in concrete compressive strength and the type of damage presented. The experimental modal parameters as damage identification parameters were showed computationally expensive, time consuming and require substantial inputs and considerable expertise. Nonetheless, they were proved plausible for the condition monitoring of the current case study as well as structural changes in the course of progressive loads. It was accentuated that a satisfactory localization and quantification for structural changes (Level 2 and Level 3 of damage identification problem) can only be achieved reasonably through considering frequencies and mode shapes of a system in a proper analytical model. A convenient post analysis process for various datasets of vibration measurements for the three beams is conducted in order to extract, check and correlate the basic modal parameters; namely, natural frequency, modal damping and mode shapes. The results of the extracted modal parameters and their combination are utilized and discussed in this research as quantification parameters.

Keywords : experimental modal analysis, damage identification, structural health monitoring, reinforced concrete beam
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