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Damage detection on framed structures: from fundamental frequency to mode curvature variations based methods

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The application of vibration-based damage identification methods is rapidly expanding over the last few years. These techniques are based on the assumption that modal parameters (frequency, mode shape, equivalent viscous damping factor) are functions of the physical properties of the structure (mass, damping and stiffness). Therefore, changes in the physical properties can cause detectable variations in the modal properties.
In the last two decades several research projects have been funded to set-up new approaches and methodologies for the fast assessment of existing structures and infrastructures combining both direct and indirect information retrieved from materials, soil, ambient conditions, interaction with other structures and soil, dynamic properties. Indeed, damage in a structure can alter the structural integrity and therefore the physical properties like stiffness, mass and/or damping. The structural vibration based approaches generally allow for an easy interpretation of the measured responses, giving the possibility to assess structural damage for complex structures without destructive investigations and/or direct visual inspections.
In this work different methods for damage detection on framed structures during a moderate/destructive earthquake are tested on the responses of nonlinear numerical models of reinforced concrete framed structures and on a real structure.
First of all a damage detection method based on the mode curvature evolution over time is applied on nonlinear numerical models of reinforced concrete structures designed considering only gravity loads. This approach is based on the use of the Band-Variable Filter, able to evaluate the time evolution of the dynamic characteristics of a system, operating simultaneously in both time and frequency domain.
In the second part of the work the preliminary results obtained from a campaign of experimental measurements carried out on a strategic structure located in Spoleto (Central Italy), affected by the seismic sequence started on August 24, 2016 are shown. Particularly, the dynamic characterization of the monitored structure has been performed and preliminary analyses have been carried out in order to evaluate the stiffness variation during the seismic sequence (stiffness variation has been used as damage indicator).

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