Title:

**Damage detection for Offshore Structures using responses recorded during extreme events**

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Abstract:

Offshore platforms, located in the North Sea, can be subjected during their lifetime to excessive wave loads that, in turn, may compromise their functionality and structural integrity. Especially, the latter can be of high relevance for structures that have been designed and built decades ago, and hence, a gradual deterioration of the materials and the structural elements has been accumulated due to the aggressive marine environment and the external (wind and wave-induced) loads. Under these circumstances, a Structural Health Monitoring (SHM) campaign should be pursued in order to reliably monitor and then, assess the structural integrity of those energy-related infrastructure systems even in the direct aftermath of an extreme event. An essential part of a SHM campaign is oftentimes a Damage Detection (DD) scheme, which aims to identify the structural damage that adversely affects the structural performance. Plenty of DD methods have been developed for onshore structures (e.g., buildings and bridges); however, their application to offshore platforms can be seriously challenged by several peculiarities related to the remoteness of those structures and the underwater installation of a considerable portion of the load-bearing structural system. In this context, the current study focuses on detection of the presence of the structural damage as well as its localization and quantification. Extreme wave conditions are considered herein to trigger the structural damage of offshore platforms. By taking advantage of the design details (i.e., material, geometry of the structure and cross-sections), a finite element model of the offshore structure is developed reflecting the identified modal properties. The only additional information available is considered herein to be structural responses recorded by limited amount of sensors placed in the topside (above the water level) of the platform. The detection of the presence of the structural damage, which can be seen as flag to raise for deeper investigation, is made possible by screening the large response, the permanent deformation as well as the short increase of the natural period during yielding. Furthermore, the deeper investigation of the structural damage, namely its localization and quantification, is facilitated in the current study via the development of an input-state estimation method that can be applied in nonlinear systems. Especially, a Kalman Filter is used for the estimation of the input and the state while a nonlinear Finite Element model is used to account for the structural damage. The proposed DD scheme was tested on an offshore structure subjected to wave loads.