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A considerable number of existing offshore platforms in the North Sea can be subjected during their lifetime to excessive wave loads, which may compromise their functionality and structural integrity. Especially, this issue can be of high relevance for structures that were built decades ago, and hence, have already undergonea slow deterioration of their materials and structural elements 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 carried in order to reliably monitor and assess the structural integrity of those energy-related infrastructure systems even directly after an extreme event. An essential part of an SHM campaign is oftentimes a Damage Detection (DD) scheme, which aims to identify the structural damage thatadversely affect 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 the localization and quantification of the structural damage that an offshore platform can experience due to extreme wave conditions. Apart from the design details (material, geometry of the structure and cross-sections), the only additional information available is considered herein to be structural responses recorded by sensors placed in few locations above the water level. The DD problem is approachedherein as an input-state estimation problem for nonlinear systems. A Kalman Filter is used for the estimationof 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 a 2D steel jacket structure subjected to various wave loads.