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Subsea free span pipeline damage detection based on wavelet transform under environmental load.

[*Sajad . Shahverdi* سجاد شاهوردی]
[*Mohammad Ali . Lotfollahi-Yaghin* محمد علی لطف الهی یقین]

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Abstract

During their service life, marine pipelines continually accumulate damage as a result of the action of various environmental forces. Clearly the development of robust techniques for early damage detection is very important to avoid the possible occurrence of a disastrous structural failure. Most of vibration-based damage detection methods require the modal properties that are obtained from measured signals through the system identification techniques. However, the modal properties such as natural frequencies and mode shapes are not such a good sensitive indication of structural damage. In this paper, structural damage is identified based on a new method called Detail Signal Energy Rate Index (DSERI). Damage localization of offshore pipeline is then based on Continuous Wavelet Transform (CWT) and Discrete Wavelet Transform (DWT). For modeling the damage, the stiffness of 1 and 2 elements are reduced in three models and the dynamic signals are measured by finite element analysis. The dynamic signals are analyzed by applying discrete and continuous wavelet transforms. Then by using Daubechies wavelet, a peak is clearly evident and the exact damage location is identified by the peak with the maximum absolute value in the plots of the detail signal calculated with the DWT and CWT. To eliminate the effects of the boundary conditions on the wavelet-based damage, the authors proposed a new method: DSERI. Component energies are then calculated and used for damage assessment. The results show that the DSERI are good candidate indices that are sensitive to structural damage. These component energies can be used for damage assessment including identifying damage occurrence and location of damage. Wavelet coefficient is a good candidate for structural damage identification when damage occurs at the middle of pipeline but not sensitive for damaged elements near to supports.

Introduction

Onshore and offshore pipes are of great importance for the transportation of natural gas and oil. In these structures, regular checks are necessary because damages are accumulated during the life time of offshore-pipeline as a result of the effect of various environmental forces. For example: fatigue, buckling, bending, corrosion, collision, overloading during heavy storms and falling objects from ships. Numerous methods for damage inspection and system monitoring have been developed, (magnetic leakage detection, ultrasonic inspection, eddy current testing, acoustic emission testing, electronic video testing, video detection, X-ray, MRI, dye penetration and visual inspection). These methods are generally slow and costly, often requiring the exposure of pipeline for detecting local damage.

Poor visibility results in the concealment of damage caused by marine growth. It is clear that the development of robust methods for detecting early damage is very important and inspection of