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A Numerical Study of Brace-Viscous Damper System of Fixed Offshore Jacket Platforms Under Extreme Environmental Loads

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Abstract: The Persian Gulf is one of the most common regions where offshore platforms exist due to the presence of oil and natural gas. Wind, current, and wave loading affect the dynamic response of offshore structures, increasing performance uncertainty and catastrophic failure probability. Thus, this study investigates energy dissipation systems, particularly viscous dampers, to solve design and rehabilitation problems of fixed offshore structures. Viscos dampers improve vibrational behaviour and reduce structural response to optimise platform performance. Thus, eliminating costly structural repairs and strengthening components under extreme environmental loads extends structure lifetime. Thus, different viscous damper system configurations are tested to reduce dynamic response under extreme environmental loads in the Persian Gulf. Diagonal and inverted V-shaped brace viscous dampers with nine different arrangements are compared to find the best configuration. The study found that the brace viscous dampers with only three applied dampers at the top three levels are most efficient at mitigating dynamic response. It reduced displacements from level 1 to level 5 by 52% to 64% and connection stresses by 38% to 54%. Finally, viscous dampers reduce structural vibration and provide uniform and constant structural dynamic response, so the oil and gas industry should use them for offshore structure design and rehabilitation.

Keywords: Offshore structure, viscous dampers, wind loads, Persian Gulf, Rassalat platform

1. Introduction

Steel is the primary material used in the construction of the offshore structure, which is comprised primarily of platforms for installing machinery related to oil or natural gas. The fixed offshore jacket platform is the type of offshore platform that is used the most frequently [1]. All varieties of jacket platforms are subject to severe environmental loads brought on by natural occurrences such as current, wave, wind, and earth movement. Seismic and ice loads may also be present in certain oceanic regions [2]. The continuously repeated forces that occur daily on offshore platforms several times lead to a greater dynamic response under stronger environmental loads, producing higher levels of uncertainty regarding the performance of the platforms and the probability of catastrophic failure [3]. In addition, failure due to fatigue will occur as a result of the transferred energy from the aforementioned loads causing various modes of vibrations and resulting stress concentrations. These stress concentrations have the potential to compromise the capacity of structures to withstand overload. The Persian Gulf water is one of the most common regions where the design experiences of fixed offshore platforms show that the Persian Gulf water had many marine structures that

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