Wave Vibration Control of Offshore Structures using Improved Tuned Liquid Column Damper

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1. INTRODUCTION & OBJECTIVE

The offshore platforms are widely used as operation stations for offshore exploitation, floating breakwater, offshore fish-farming platforms and a combination of entertainment facilities. These structures are subjected to forces such as waves, wind, currents, earthquakes and tsunamis which may result in tremendous vibration and instability. Several vibration mitigation methods are utilized to mitigate the vibration of such structure, like tuned mass dampers (TMDs)[1], multiple TMDs (MTMD)[2]etc. The present study focuses on passive vibration control of offshore structures subjected to wave-induced vibration. Especially, the performance of passive vibration mitigating by Tuned Liquid Column Damper (TLCD) and Improved Tuned Liquid Column Damper (ITLCD) is studied for its applicability to control of wave vibration response of an offshore structure. To do so, the vibration response study is performed considering the stochastic wave model. The wave force acting on the structure is modelled using the Morison equation and the JONSWAP wave height spectrum is used to generate random wave time history. To explore the effectiveness of the ITLCD systems in mitigating wave-induced vibration of SDOF system, a jacket offshore platform with and without damper is modelled and the performance of the ITLCD is studied under different loading criteria.

2. RESULTS & HIGHLIGHTS OF IMPORTANT POINTS

To demonstrate the usefulness of ITLCD in controlling wave-induced vibration, a jacket platform, idealized as an SDOF system, having a height of 14.93m and a period of 2.5s with a total weight of 12000 kg is considered first.

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Figure 1 presents the RMSD values for both the unprotected and protected structures under different load cases, revealing a substantial reduction in peak responses in the frequency domain.

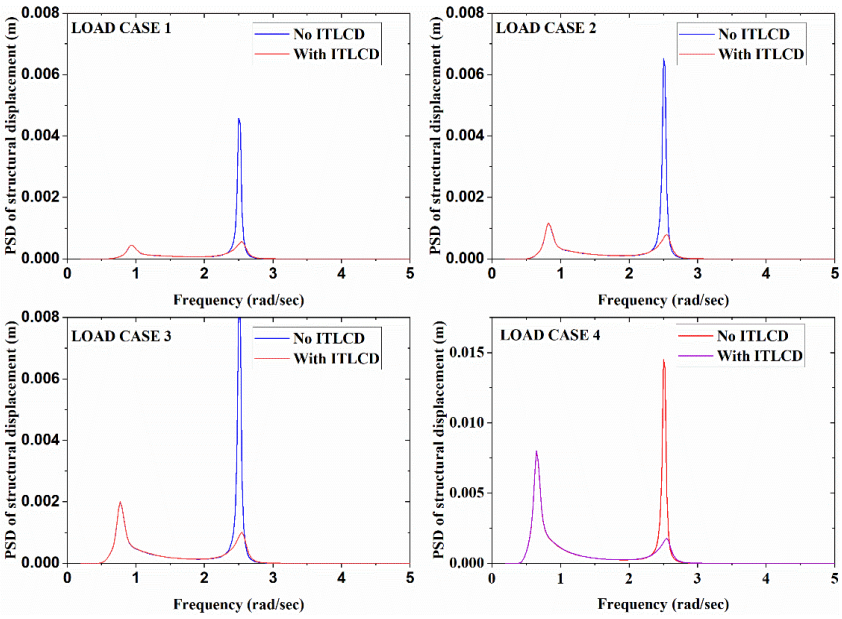

Fig.1 The PSD of structural displacement with and without TLCD

A comparison analysis is done against reduction in RMSD with individual TLCD and ITLCD and the results are shown in Figure 2 for different load cases. Various optimum parameters of TLCD and ITLCD were obtained first for different load cases used for this comparative study. It can be found from Figure 2 that the ITLCD system plays a crucial role in substantially decreasing the RMSD of the structure. The implementation of the ITLCD system exhibits a noteworthy impact on minimizing the RMSD of the SDOF system with the same mass ratio, showcasing its effectiveness in enhancing structural stability.

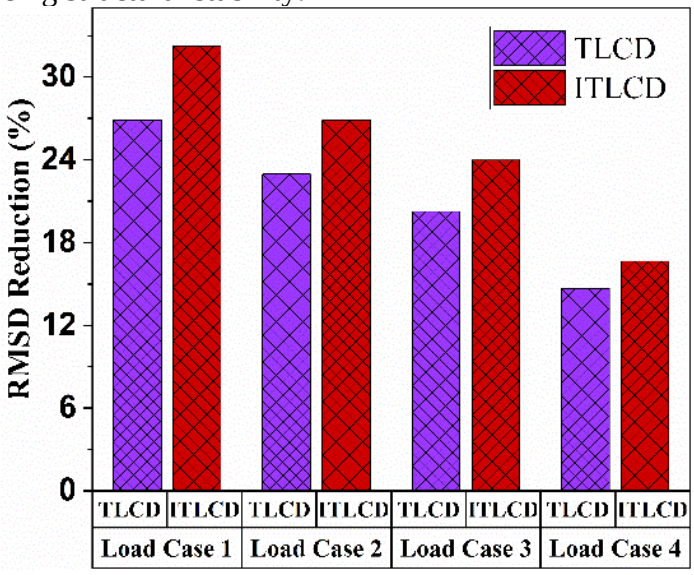

Fig.2 Performance of TLCD and ITLCD with SDOF system

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