Proceedings of the 9th International Conference on Civil Structural and Transportation Engineering (ICCSTE 2024)
Chestnut Conference Centre - University of Toronto, Toronto, Canada – June 13-15, 2024
Paper No. 188
DOI: 10.11159/iccste24.188

Multiple Tmds On Motion Reduction Of Floating Offshore Wind Turbines

Wei-Ren Chen[1], Shing-Na Wu[1] and Bang-Fuh Chen[1,2]*
1 Department of Marine Environment and Engineering, National Sun Yat-sen University, Kaohsiung, Taiwan
2 Center of Excellence for Ocean Engineering, National Taiwan Ocean University, Keelung, Taiwan
*chenbf@g-mail.nsysu.edu.tw

Abstract

This study explores the damping effects of the Tuned Mass Damper (TMD) on a floating offshore wind turbine (FOWT). The environmental conditions refer to the IEC-61400-3 Design Load Case. The DLC 1.2 and DLC 6.2 were used in the study. Turbulent wind field simulation was performed by TurbSim, and the load of wind waves on structures was generated by FAST which was developed by NREL. The TMD is located at the proper places of the supported tower to see the motion reduction effects. The best mass ratio and damping ratio were tested. Various TMDs have different motion reduction effect of FOWT when it is under wind, wave and seismic load separately. The TMD motion reduction effect of FOWT under coupled wind and wave loads were also studied.

In a DLC 6.2 environmental loads, the offshore wind turbines stopped operating due to extreme environmental conditions. The average extreme wind speed in the 10-minute 50-year regression period was 54.16 m / s, and the significant wave height and period in the 50-year regression period were 8.24 m and 12.01 s. Figure 25 shows the fore-aft response of FOWT without TMD, with one TMD and three TMDs. It can be seen that the motion reduction is more significant that that of FOWT under DLC 1.2 loads. Simliar results can be seen in Figure 26. As before, there are no clear improvement when the number of TMD is increase to 3. The best motion reduction occurred at the second beating response. In the first beating, the motion response of FOWT with 1 TMD is even worse than that of FOWT without TMD, whereas the problem may be solved to some extent when 3-TMDs is installed.

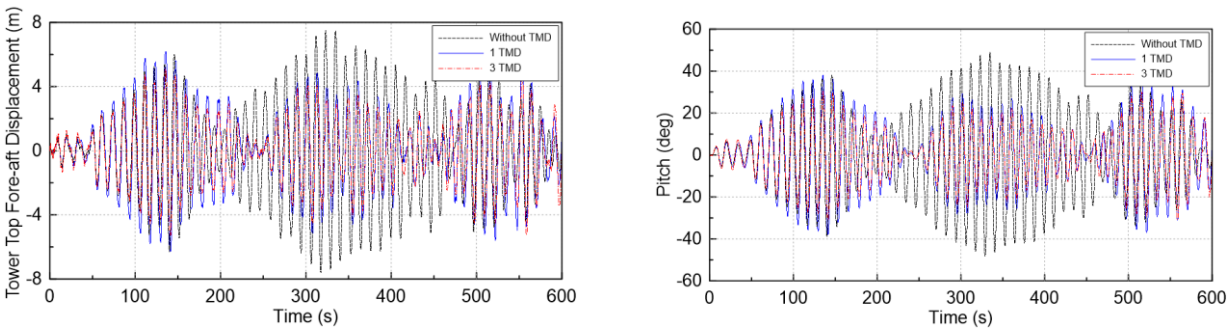

Figure 1 The comparison of the displacements of FOWT under DLC 6.2 loads; with and without TMD installed.

The present study has come to following conclusions:

[1] Although the effect of three TMDs is the best, the motion reduction is insignificant since the dynamic repsonse of FOWT under DLC 1.2 loads is small. While, there are no clear improvement for the motion reduction effect of TMD on pitch motion when the number of TMD is increase from 1 TMD to 3 TMDs.
[2] The effects of TMD on motion reduction of FOWT under DLC 1.2 loads also can be found in fore-aft, side-

side, roll and ptich resposnes. Besides, the bending moment at the tower base may reduced by 2.7 % and 9.0% respectively when 1 TMD and 3 TMDs were installed.

[3] The results shown in this study confidently demonstrate the installation of TMD and 3-TMDs on FOWT may reduce the motions of FOWT in many degree of freedoms. Multiple TMDs might be applied on the structural motion control of FOWT in the near future.