

A SWING CONTROL MODULE FOR LARGE OFF-SHORE HOOK STRUCTURES: DESIGN AND VALIDATION USING A WIRELESS INCLINATION MEASUREMENT SYSTEM

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ABSTRACT. In order to reduce the vibration under intense wind and wave load to meet the demand on sea work and further increase the working efficiency for Lager Scale Heavy Derrick Lay Barge, an innovative Tuned Mass Damper (TMD) based swing control module for the hook is designed and validated. The vibration model of Lanjiang Hook is developed and a TMD control module for Lanjiang hook is provided. Based on the vibration model, the control module and actual application, a new gear-pendulum-type TMD control system including pendulum and inverted pendulum is presented so as to realize the control of the structure that has a long period, especially when there is a strict space requirement for the size of the control device to be small such as the application of control device on Lanjiang hook. The analysis of the proposed control system's parameters shows the suitable ones for the whole control system work effectively. Finally, the validation experiment for the presented control system using a wireless inclination measurement system is conducted. Experimental results show that, the wireless inclination measurement system can be used more conveniently in swing monitoring for the hook control of Lager Scale Heavy Derrick Lay Barge. Furthermore, the control effect of the developed TMD system is at least 33 percent which also validates the effectiveness and feasibility of the proposed control system for improving the swing movement of large hook model.

Keywords: Reducing swing control, Structural health monitoring, Tuned mass damper (TMD), Wireless inclination measurement system, Hook

1. Introduction. Structural health monitoring and vibration control techniques have been widely used in civil engineering, mechanical engineering, aerospace engineering, automotive industry, etc., with the developing history of more than one hundred years [1-3]. Frahm (1909) and Den Hartog (1928), etc. first conducted the studies on Dynamic Vibration Absorber (DVA) for resonance suppression and control of mechanical systems. Thereafter, Den Hartog (1956) systematically developed the theory of tuning vibration control for structures. So far, tuning vibration control has been widely and successfully applied in engineering practices up to date [4-6]. From the beginning of 1970s, DVA (Later called Tuned Mass Damper, TMD) has been used in the wind-induced vibration control of structures. In 1976, John Hancock building (60-storey high) was implemented with two TMD systems (300 tons each) on the 58th floor. From then on, hundreds of high-rising buildings and towers as well as some chimney and mast structures were implemented with TMD control systems for suppressing the wind-induced vibrations. Most