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Influence of Ride Control Systems on the Motions Response and Passenger Comfort of High-Speed Catamarans in Irregular Waves

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Abstract : During the last decades, a growing interest in faster and more efficient waterborne transportation has led to the development of high-speed vessels for both commercial and military applications. To satisfy this global demand, a wide variety of arrangements of high-speed crafts have been proposed by designers. Among them, high-speed catamarans have proven themselves to be a suitable Roll-on/Roll-off configuration for carrying passengers and cargo due to widely spaced demi hulls, a wide deck zone, and a high ratio of deadweight to displacement. To improve passenger comfort and crew workability and enhance the operability and performance of high-speed catamarans, mitigating the severity of motions and structural loads using Ride Control Systems (RCS) is essential.In this paper, a set of towing tank tests was conducted on a 2.5 m scaled model of a 112 m Incat Tasmania high-speed catamaran in irregular head seas to investigate the effect of different ride control algorithms including linear and nonlinear versions of the heave control, pitch control, and local control on motion responses and passenger comfort of the full-scale ship. The RCS included a centre bow-fitted T-Foil and two transom-mounted stern tabs. All the experiments were conducted at the Australian Maritime College (AMC) towing tank at a model speed of 2.89 m/s (37 knots full scale), a modal period of 1.5 sec (10 sec full scale) and two significant wave heights of 60 mm and 90 mm, representing full-scale wave heights of 2.7 m and 4 m, respectively. Spectral analyses were performed using Welch's power spectral density method on the vertical motion time records of the catamaran model to calculate heave and pitch Response Amplitude Operators (RAOs). Then, noting that passenger discomfort arises from vertical accelerations and that the vertical accelerations vary at different longitudinal locations within the passenger cabin due to the variations in amplitude and relative phase of the pitch and heave motions, the vertical accelerations were calculated at three longitudinal locations (LCG, T-Foil, and stern tabs). Finally, frequency-weighted Root Mean Square (RMS) vertical accelerations were calculated to estimate Motion Sickness Dose Value (MSDV) of the ship based on ISO 2631-recommendations. It was demonstrated that in small seas, implementing a nonlinear pitch control algorithm reduces the peak pitch motions by 41%, the vertical accelerations at the forward location by 46%, and motion sickness at the forward position by around 20% which provides great potential for further improvement in passenger comfort, crew workability, and operability of high-speed catamarans.

Keywords : high-speed catamarans, ride control system, response amplitude operators, vertical accelerations, motion sickness, irregular waves, towing tank tests.
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