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Streamlining Coastal Defense: Investigating the Impact of Seawall Geometry on Wave Loads

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Abstract : Seawall geometry plays a crucial role in mitigating wave impacts, though detailed exploration of its manipulation is limited. This study delves into the effects of varying cross-shore seawall geometry on the dynamics of wave impacts, with a particular focus on vertical seawalls. Inspired by foundational insights linking seawall shape to hydraulic efficiency, this investigation centres on how alterations in seawall geometry can influence wave energy dissipation and subsequent wave impacts. The study investigates the 2D interaction of regular waves with a period of 2.1s with a vertical seawall and berm featuring small-scale cross-shore protrusions and recesses. Utilising OpenFOAM® simulations and a k-ω SST turbulence model, this investigation compares results to a base case simulation, which is partially calibrated with experimental data from a flume study. The analysis evaluates various geometric modifications, specifically interchanged protrusions and recesses at different heights and orientations along the seawall. Findings suggest that specific configurations, such as interchanged protrusions and recesses, can mitigate initial impact forces, while certain arrangements may intensify subsequent impacts. Key insights include the identification of geometry configurations that can effectively reduce the force impulse of slamming waves on coastal structures and potentially decrease the frequency and cost of seawall maintenance. This research contributes to the field by advancing the understanding of how seawall geometry influences wave forces and by providing actionable insights for the design of more resilient seawall structures. Further exploration of seawall geometry variation is recommended, advocating additional case studies to optimise designs tailored to specific coastal environments.

Keywords : seawall geometry, wave impact loads, numerical simulation, coastal engineering, wave-structure interaction
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