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Physical Model Testing of Storm-Driven Wave Impact Loads and Scour at a Beach Seawall

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Abstract : The Grande-Motte port and seafront development project on the French Mediterranean coastline entailed evaluating wave impact loads (pressures and forces) on the new beach seawall and comparing the resulting scour potential at the base of the existing and new seawall. A physical model was built at ARTELIA's hydraulics laboratory in Grenoble (France) to provide insight into the evolution of scouring overtime at the front of the wall, quasi-static and impulsive wave force intensity and distribution on the wall, and water and sand overtopping discharges over the wall. The beach was constituted of fine sand and approximately 50 m wide above mean sea level (MSL). Seabed slopes were in the range of 0.5% offshore to 1.5% closer to the beach. A smooth concrete structure will replace the existing concrete seawall with an elevated curved crown wall. Prior the start of breaking (at -7 m MSL contour), storm-driven maximum spectral significant wave heights of 2.8 m and 3.2 m were estimated for the benchmark historical storm event dated of 1997 and the 50-year return period storms respectively, resulting in 1 m high waves at the beach. For the wave load assessment, a tensor scale measured wave forces and moments and five piezo / piezo-resistive pressure sensors were placed on the wall. Light-weight sediment physical model and pressure and force measurements were performed with scale 1:18. The polyvinyl chloride light-weight particles used to model the prototype silty sand had a density of approximately 1 400 kg/m3 and a median diameter (d50) of 0.3 mm. Quantitative assessments of the seabed evolution were made using a measuring rod and also a laser scan survey. Testing demonstrated the occurrence of numerous impulsive wave impacts on the reflector (22%), induced not by direct wave breaking but mostly by wave run-up slamming on the top curved part of the wall. Wave forces of up to 264 kilonewtons and impulsive pressure spikes of up to 127 kilonewtons were measured. Maximum scour of -0.9 m was measured for the new seawall versus -0.6 m for the existing seawall, which is imputable to increased wave reflection (coefficient was 25.7 - 30.4% vs 23.4 - 28.6%). This paper presents a methodology for the setup and operation of a physical model in order to assess the hydrodynamic and morphodynamic processes at a beach seawall during storms events. It discusses the pros and cons of such methodology versus others, notably regarding structures peculiarities and model effects.

Keywords : beach, impacts, scour, seawall, waves
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