PREDICTION OF CORE STONE DAMAGE THROUGH THINNED ARMOR LAYER

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EXPERIMENT

The stability of rock armor layers has been investigated extensively, but the stability of underlayer and core stones underneath the damaged and thinned armor layer has not been measured experimentally. Strazzella and Kobayashi (2022) conducted an experiment in a wave flume to measure the remaining capacity of low-crested rubble mounds damaged by breaking waves in the surf zone. A mound of a double armor layer on smaller core stones was exposed to irregular wave action lasting 22.2 hours. The core stone was visible through the thinned armor layer but remained in place. The mound with a single armor layer was damaged progressively because of core stone removal after 7.8 hours. These long-duration tests are useful for understanding the core stone damage process. A numerical model is developed to predict the progression of the armor layer damage and core stone removal.

NUMERICAL MODEL

The numerical model CSHORE (Kobayashi, 2016) has been extended to predict the progression of the armor layer damage and core stone removal under breaking irregular waves. Using the experiment by Strazzella and Kobayashi (2022), the critical stability number of armor stones is calibrated to reproduce the deformation of the armor layer surface. The resistance parameter of the core stones against erosional work by breaking waves is introduced in CSHORE to predict the core stone surface erosion underneath the thinned armor layer. CSHORE includes a combined wave and current model based on time-averaged equations of continuity, momentum, wave action, and roller energy, a sediment transport model consisting of bed load and suspended load in conjunction with the continuity equation of bottom cohesionless sediment (sand or stone), a permeable layer model to account for porous flow inside a rubble mound, and a probabilistic swash model on permeable (stone) bottom above the still water level.

The core stone erosion model added in this study is derived from the consolidated cohesive sediment erosion model by Kobayashi and Zhu (2020). The expanded CSHORE has been compared with irregular wave shoaling, breaking and transmission measured in the double and single armor layer tests. CSHORE predicts the mean and standard deviation of the free surface elevation and fluid velocity within errors of 20%. The measured and computed changes of the armor and core stone surface elevations from the measured initial profiles are compared for each test where the armor surface elevation was measured every one hour or so. The critical stability number of armor stones and the resistance parameter of core stones have been calibrated to obtain reasonable agreements. Figure 1 compares the measured and computed final profiles of the armor and core profiles for the double armor layer test. The agreement is similar for the single armor layer test.

REFERENCES

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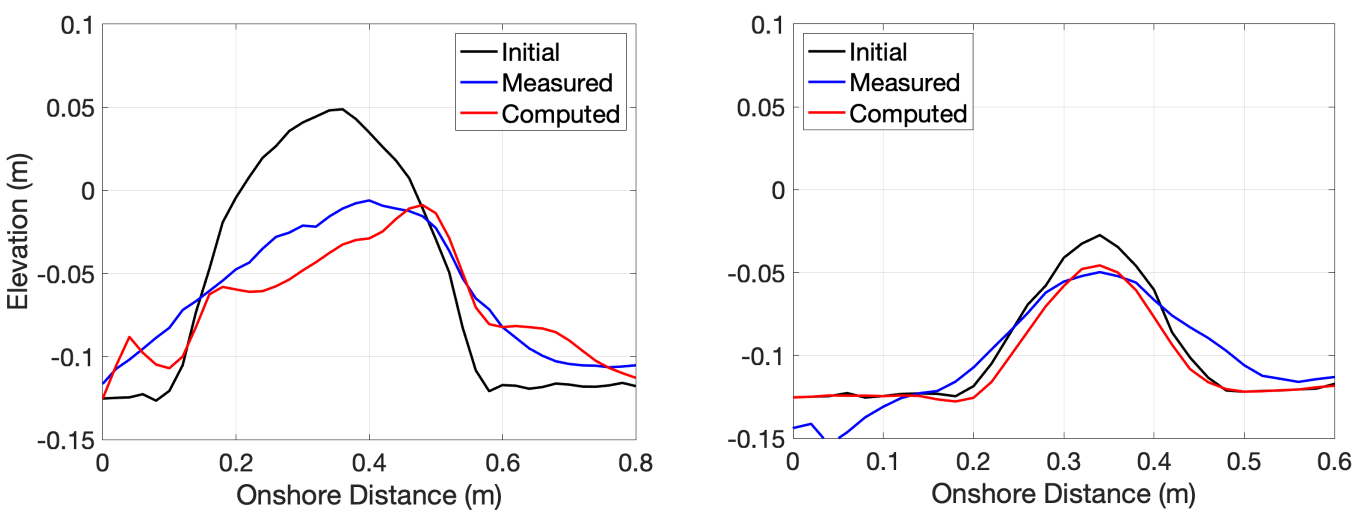

Figure 1. Armor profile evolution (left) and core profile change (right) for the double armor layer test lasting 22.2 hours.