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DETERMINATION OF DESIGN WAVE IMPACT LOADING ON A PEDESTRIAN WALKWAY ON TOP OF A BREAKWATER

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INTRODUCTION

At the city of Oostende, Belgium, a plan is being designed to build a pedestrian walkway on top of a low-crested breakwater.

The crest of the breakwater is situated only ca. 2 m above design storm water level. Design storm conditions at the toe of the structure are a significant wave height H_s of 3.6 m and a peak period T_p of 11 s. Important wave loading can be expected on the pedestrian walkway.

The pedestrian walkway is conceived as a construction in stainless steel elements: a deck with a width of 8 m situated 2 m higher than the breakwater crest, two rows of supporting piles and a balustrade with a height of ca.1 m.

The seaward slope of the breakwater has a smooth surface towards the landside end and a rough rubble mound surface towards the seaside end.

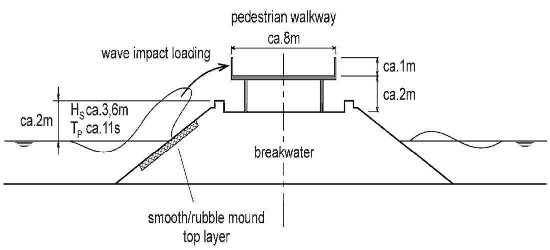

Figure 1 : cross section.

DETERMINATION OF DESIGN WAVE LOADING

The wave loading on the pedestrian walkway is an impact loading with high forces acting for short times. The impact loading is depending on the characteristics of the overtopping waves and on the dynamic characteristics of the pedestrian walkway.

In order to assess the impact effect of the overtopping waves tests are run on a physical model (scale 1/20) built in the large wave flume ($L \times W \times D$ = 71m $\times$ 4m $\times$ 1.5m) of Flanders Hydraulics Research (Antwerp, Belgium). Each run generates a series of app. 1000 waves in the flume running up the breakwater with the pedestrian walkway situated on top of it.

The model walkway cannot represent all the relevant material properties like mass and elasticity, consequently the forces in the (flexible) connections between walkway and breakwater cannot be derived accurately for the prototype design. Therefore the model is solely used to assess the integral wave impact loading on the walkway, whose boundary conditions in the model have been adapted for measuring time series of horizontal and vertical reaction forces with load cells.

These time series are converted to actual wave loading on the model by using a numerical model for the dynamic response of the scale model, thus taking into account the dynamic characteristics of the scale model. Doing so a numerical filter is derived to eliminate possible natural frequencies due to the characteristics of the model set-up. Measured time series of the reaction forces are used as input for the numerical model. Eventually the design values for the wave impact loading in prototype are derived using Froude scaling (1/8000 = 1/20^3).

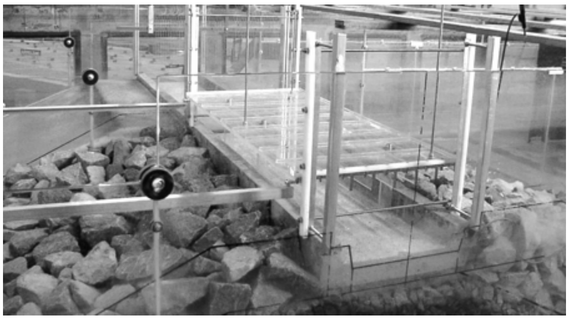

Figure 2 : scale model set-up (1/20).

CONCLUSIONS

Using this instrumentarium of physical and numerical models several configurations are tested and analysed statistically taking into account the exceedance probability of individual wave heights.

Adopting the numerical filtering procedure, reliable design values are estimated from time series of reaction forces measured in the physical scale model.

An important conclusion is the fact that a relatively modest heightening of the deck level of the pedestrian walkway of 0.5 m would significantly decrease the wave impact loading.