Title of Diploma Thesis

Effect of Climate Change on the Design of Breakwaters

Authors

Spyridoula Nata, Anthoula Charalampidou

Academic Year

2014-2015

ABSTRACT

Climate change refers to any change in the state of the climate. Therefore, climate change may be identified by an increase of the mean wind speed and by the sea level rise as a result of the increased ice flow and thermal expansion. The height of an incident wave, which is the main source of loading on a breakwater, is directly affected by the wind and the sea level. Therefore, coastal/port structures are directly affected by the climate change, since the change of the above mentioned parameters leads to the increase of the loads applied on them.

The objective of this diploma thesis is the investigation of the effect of the climate change on the design of coastal structures used for the protection against the incident waves (external coastal structures). For this purpose a breakwater of a port, which has been damaged, - is selected and- its redesign is examined. Initially, short-term (no effect of climate change) and long-term (effect of climate change) wave forecasting is implemented, using all necessary data, such as wind data and bathymetry of the corresponding coastal area, which are appropriately collected. Next, the characteristics of the wave in the coastal area, where the breakwater is installed, for both the short-term and the long-term wave forecasting (effect of climate change) are calculated using appropriate numerical models. After that, a typical cross section of the breakwater is proposed (initial cross section). The required crest height is calculated following the methodology described in the European Manual EurOtop. Moreover, at this stage the above calculations are compared with the corresponding methodology included in the Coastal Engineering Manual. Next, the aforementioned cross section of the breakwater is fully designed by using the methodology described above and the construction cost of this section is calculated. The applicability of the initial cross section of the breakwater considering functionality requirements (overtopping), is then examined for both present and future (effect of climate change) wave conditions. Since, the initial cross section does not satisfy functionality requirements in the case of future wave conditions, alternative solutions (alternative cross-sections) are proposed aiming to the enhancement of the functionality performance of the breakwater. The design of these alternative cross sections is then performed according to the methodology described in the EurOtop and the Coastal Engineering Manual. Moreover, the construction cost of these cross sections is calculated. Next, the slope stability and the safety of all the proposed cross sections (initial and alternative ones) against failure is assessed using an appropriate finite element numerical model (PLAXIS). Finally, comparison of the proposed solutions is implemented considering: functionality requirements (overtopping below specific limits), construction cost, slope stability and safety against failure and the best solution is proposed.

Keywords: Climate change, Coastal/port structures, Rubble mound breakwater, Overtopping, Slope stability, Cost.