JETTY DESIGN USING DUAL LIFE-CYCLE AND PHYSICAL MODELING APPROACH – COOS BAY, OR

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The advantages of risk-based methodologies over traditional deterministic analyses have been well documented for the design of coastal projects. The consideration of probabilistic forcing allows for the application of a life-cycle approach that can be used to optimize structure design, including the quantification of uncertainty. Damage progression and functional performance can be assessed over the project's design life and can be considered in the design process. A life-cycle modeling approach was developed and applied, in conjunction with a 1:55 scale physical model, to the design of the North jetty major maintenance repair in Coos Bay, Oregon.

LIFE-CYCLE APPROACH

The Coastal Engineering Manual (USACE 2008) describes the life-cycle approach for risk-based analysis as better suited to most coastal applications when compared to frequency-based approaches. Nevertheless, coastal structure design methodologies are not described in this context. The time dependent jetty damage modeling approach used for Coos Bay allows for the assessment of jetty performance throughout a 50 year life-cycle for a wide range of forcing and design conditions. The armor stone damage model was based on Melby and Kobayashi (2011) with validation for the general model based on lab data. The 2D spectral wave model CMS-Wave was used to run 4320 synthetic storms to train a Gaussian process metamodel (Jia et al. 2016) for wave transformation of offshore USACE Wave Information Studies waves to the nearshore. The model was validated with 20 historical storms and was set to run concurrently within the life-cycle model. Two forcing scenarios were implemented for the life-cycle damage assessment: (1) Random sequencing of historical storms with random tides; (2) Synthetic storms sampled from a copula-based joint distribution of wave height, wave period, storm duration and water level. Figure 1 shows damage curves for four jetty regions and uncertainty for the jetty head in the form of confidence limits of one standard deviation.

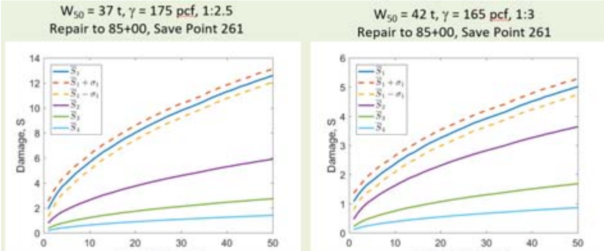

Figure 1 – Life-cycle analysis for two repair stone size design alternatives

PHYSICAL MODEL

A 1:55 scale physical model of the Coos Bay jetties and deep draft channel was constructed to perform jetty stability tests centered on the North Jetty head. A directional spectral wave generator (DSWG) was used to reproduce severe forcing conditions based on the most extreme storm events. Storm selection was informed by preliminary damage model results, as well as wave and water level forcing parameters. Three jetty head alternatives were run in the physical model, with validations of the numerical model performed after each one. The validated numerical model was used to inform the selection of the next alternative to be run in the physical model. Physical model is shown in Figure 2.

Figure 2 – Coos Bay jetties physical model

CONCLUSION

The life-cycle methodology presented herein provides an understanding of the project risks based on a high fidelity analysis with quantified uncertainties. The use of a physical model in the Coos Bay North Jetty Major Maintenance design study provided an invaluable opportunity to interactively assess and directly validate the numerical life-cycle model.

REFERENCES

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