A DESIGN LIFE BASED APPROACH TO MULTI-HAZARD RISK ANALYSIS

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INTRODUCTION

Small craft harbors are important facets to many coastal communities providing a transition from land to ocean. Because of the damage resulting from the 2010 Chile and 2011 Japanese tele-tsunamis, the tsunami risk to the small craft harbors in California has become an important concern. However, tsunamis represent only one of many hazards a harbor is likely to see in California. Other natural hazards including wave attack, wind events, storm surge and sea level rise all can damage a harbor but are not typically addressed collectively in traditional risk studies.

Existing approaches to assess small craft harbor vulnerably typically look at single events assigning likely damage levels to each event. However, a harbor will likely experience damage from several different types of hazards over its service life with each event contributing proportionally to the total damage state. The approach presented here will consider the how the damage from many different natural phenomena is likely to be distributed during a harbors service life and how the cumulative effect of the events could contribute to failure potential of components within the harbor.

METHODOLOGY

A new, fully probabilistic risk method will be presented which considers the distribution of return period for various hazards over a harbor's service life (also called design life). The likelihood of failure is connected to each hazard via vulnerability curves. For small craft harbors, tsunamis pose a risk in both surface elevation and current speed. Keen et al. (2017) developed fragility curves for damage from tsunami currents which can be included in this framework. For surface elevation, the vulnerability is related to the floating docks floating off their piles during the event. In this case, failure would be binary.

Winter storms in California have the potential to increase the water level like tsunami events. Astronomical tides, seasonal water levels and period events all contribute to the total water level in a harbor and need to be addressed separately due to the difference in periodicity. Sea level rise will increase this likelihood of failure for harbors into the future and will be included in the analysis in a non-stationary manor.

By tabulating the expected damage levels from each event, the method provides a quantitative measure of a harbor's risk to various types of hazards as well as the likelihood of failure (i.e. cumulative risk) during the service life.

CONCLUSION

The analysis will be carried out for a few harbors in California. Each harbor is dynamically different and will be chosen to highlight the strengths and weaknesses of the method. Findings of each study will focus on assisting the stakeholders and decision makers to better understand the relative risk to each harbor with the goal of providing them with a tool to better plan for the future maritime environment.

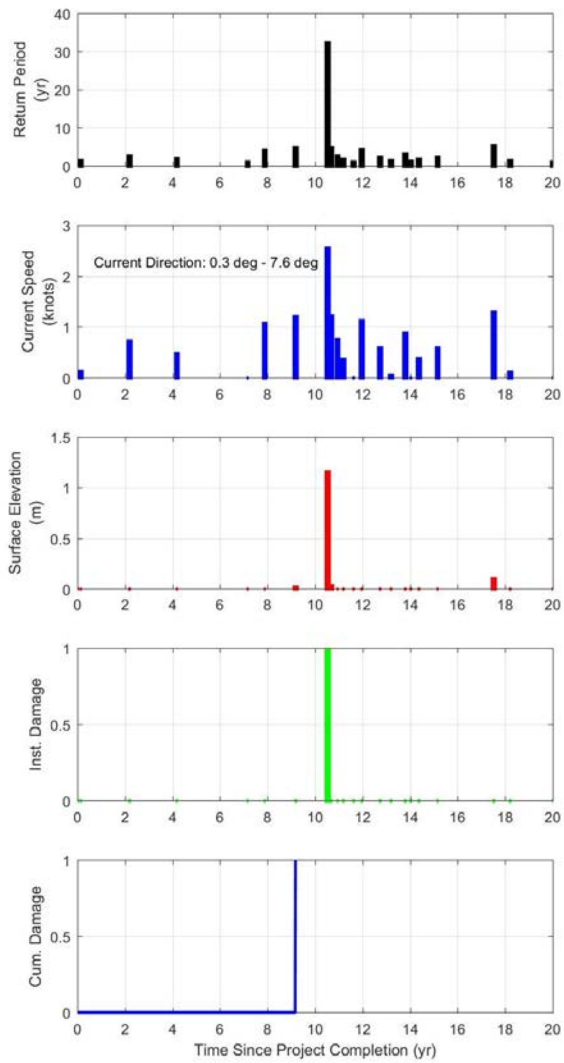

Figure 1 – Multi-hazard risk framework relates damage sources from individual hazards to a cumulative damage of cleats and pile guides within a harbor.

REFERENCES

Keen, Lynett, Eskijian, Ayca and Wilson (2017): Monte Carlo-Based Approach to Estimating Fragility Curves of Floating Docks for Small Craft Marinas, Journal of Waterway, Port, Coastal, and Ocean Engineering, vol. 143, pp. 04017004.