

MULTI-CRITERIA RATINGS METHODOLOGY FOR SUITABILITY EVALUATION OF OPEN PIER SITES

Ismael Aragorn D. Inocencio, AMH Philippines Inc, aragorn.inocencio@amhphil.com

Eric C. Cruz, AMH Philippines Inc.; University of the Philippines - Diliman, ecacruz@up.edu.ph

Edgardo P. Kasilag II, AMH Philippines Inc, epkasilag@amhphil.com

INTRODUCTION

Due to its archipelagic coastlines, the Philippines has more than 2,400 ports. Causeway piers are the most common docking structure in these ports. In interior coastlines, open piers are usually considered. Where the port is not sheltered by breakwaters, however, open piers are exposed to the hazards of the waves, tides, currents, and sediments. Thus, when planning the site for a proposed open pier, it is important to quantify these hazards and account for them in both the engineering design and the economic costing of the pier structure.

Along a long project coastline, the optimal selection of an open pier site is based on the criterion of minimum wave agitation under prevailing wave conditions (Cruz and Kasilag, 2009). Where multiple sites are being considered, it becomes imperative to carry out a ratings approach where the possible sites are assessed based on a ratings scale with objective weighting coefficients (Cruz, et al 2010). While the ratings scale approach is effective in selecting the optimal site among several alternatives, it does not provide an economic costing rating of the sites.

This paper discusses a methodology applied to a multiple pier site feasibility study of a proposed cargo pier along a relatively sheltered coastline of Batangas, Philippines. In order to select the optimal site based on both technical and operational considerations, a multi-criteria ratings approach was applied.

METHODOLOGY

Each of the sites was bathymetrically surveyed and the data consolidated with the secondary local bathymetry. The ship's bathymetric siting was then undertaken based on the geometric and draft requirements of the design cargo vessel. In order to determine the optimal horizontal siting of the pier in each site, a wind wave model was used to quantify the prevailing wave climate for various wind approaches under the country's two seasons.

To characterize the coastal aspects of the site, Mike21 by DHI was used to determine key coastal parameters for the entire coastline. This included the simulation of the prevailing wave scenario to show how the wave climate of the entire coastline is on a typical day and the wave approach. The nearshore wave climate was computed considering variable tide conditions corresponding to these seasons. Based on the simulated wave and current fields, the optimal location and layout of the main pier and connecting trestle was synthesized. For some sites, an economic layout was also obtained which does not coincide with the optimal

layout. Results of annual longshore sediment transport analysis are considered to identify possible long-term accretion or erosion zones around each site.

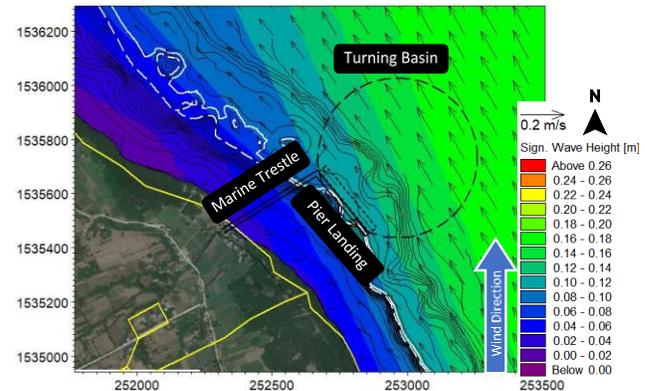


Fig. 1 Prevailing wave and current fields for Site 3

The hazard loadings of typhoons are also rated by simulating the storm tides and storm waves caused by typhoons. Several typhoons pass the project coasts, just like the rest of the country, so a methodology was applied to identify the potentially critical typhoons (PCT). For each site, the historical storm surges and typhoon wave heights generated by each PCT were simulated, then synthesized to determine the required minimum soffit elevation (MSE) of the open pier for non-overtopping condition at that site. The result then leads to the following additional economic costing indicators: lengths of trestle and pier piles, and the design water levels and wave conditions.

RESULTS

Among a total of 5 contemplated pier sites, 2 with alternative pier layouts, 2 sites came out with very close ratings based on technical considerations, including marine trestle length, MSE, design wave height, dredging requirement and landing alignment. Subsequently, port operational considerations, i.e. port development area, backshore topography, and proximity to existing roads, were also quantified into a multi-criteria matrix. Based on operational criteria, 2 preferred sites emerged. Overall, the multi-criteria ratings with generally objective weighting factors identified a clear optimal pier site based on both technical and operation considerations. Economic cost indicators are also obtained, which are useful in both the project procession decision and in the preliminary engineering of the trestle and pier structures.

The application of such a multi-criteria decision matrix may be applied to future shorelines to ensure the most technically feasible (and potentially economically viable) location for pier development be chosen. As it is a multi-criteria approach, criteria may be added/removed as needed, depending on the characteristics of the site and requirements of the proponent.

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REFERENCES

- Cruz, Santos, Kasilag (2010): Analysis and accounting of coastal hazards in the planning and siting of port structures. Proceedings, CECAR5 and ASEC
- Cruz, Kasilag (2009) Hydraulic analysis for seaport siting and engineering design. Proceedings, PICE
- Cruz, Luna (2014): A methodology for rational vertical siting of marine infrastructures - application to the preliminary engineering of a power plant along a typhoon-tracked seacoast. Proceedings, PICE
- Department of Public Works and Highways. (2015): Design Guidelines, Criteria, and Standards - III
- USACE (2011): Coastal Engineering Manual Part VI-5.
- RSMC Tokyo-Typhoon Center (2018): Best Track Data, Japan Meteorological Agency