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An Integrated Framework for Wind-Wave Study in Lakes

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Abstract : The wave analysis is an integral part of the hydrotechnical assessment carried out during the permitting and design phases for coastal structures, such as marinas. This analysis aims in quantifying: i) the Suitability of the coastal structure design against Small Craft Harbour wave tranquility safety criterion; ii) Potential environmental impacts of the structure (e.g., effect on wave, flow, and sediment transport); iii) Mooring and dock design and iv) Requirements set by regulatory agency's (e.g., WSA section 11 application). While a complex three-dimensional hydrodynamic modelling approach can be applied on large-scale projects, the need for an efficient and reliable wave analysis method suitable for smaller scale marina projects was identified. As a result, Tetra Tech has developed and applied an integrated analysis framework (hereafter TT approach), which takes the advantage of the state-of-the-art numerical models while preserving the level of simplicity that fits smaller scale projects. The present paper aims to describe the TT approach and highlight the key advantages of using this integrated framework in lake marina projects. The core of this methodology is made by integrating wind, water level, bathymetry, and structure geometry data. To respond to the needs of specific projects, several add-on modules have been added to the core of the TT approach. The main advantages of this method over the simplified analytical approaches are i) Accounting for the proper physics of the lake through the modelling of the entire lake (capturing real lake geometry) instead of a simplified fetch approach; ii) Providing a more realistic representation of the waves by modelling random waves instead of monochromatic waves; iii) Modelling wave-structure interaction (e.g. wave transmission/reflection application for floating structures and piles amongst others); iv) Accounting for wave interaction with the lakebed (e.g. bottom friction, refraction, and breaking); v) Providing the inputs for flow and sediment transport assessment at the project site; vi) Taking in consideration historical and geographical variations of the wind field; and vii) Independence of the scale of the reservoir under study. Overall, in comparison with simplified analytical approaches, this integrated framework provides a more realistic and reliable estimation of wave parameters (and its spatial distribution) in lake marinas, leading to a realistic hydrotechnical assessment accessible to any project size, from the development of a new marina to marina expansion and pile replacement. Tetra Tech has successfully utilized this approach since many years in the Okanagan area.

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