An IGA-BEM solver for fully nonlinear wave kinematics and associated loads on offshore wind turbine towers

Wave loads have been widely investigated to provide design standards for fixed-bottom offshore structures. Such systems are generally installed in shallow to intermediate water, where waves are steeper and may induce resonant amplifications, such as ringing [1], and violent impulsive actions on the structure. Typically, numerical wave-loading models relying on linear or weakly nonlinear wave kinematics are not able to capture such nonlinear forcing phenomena [2-5], leading to the underprediction of both extreme loads and accumulated fatigue damage. Within this context, this contribution investigates the effects of nonlinear wave kinematics on the dynamic forces exerted on the bottom-mounted foundations supporting Offshore Wind Turbines (OWTs).

A fully nonlinear IGA-BEM (IsoGeometric Analysis-Boundary Element Method) is developed to solve fully nonlinear potential flow problems on the fluid domain. IGA-BEM methods employ higher order piecewise shape functions, B-spline or NURBS, to discretize the geometry and to solve the Boundary Value Problem (BVP), reducing significantly the computational cost and ensuring higher-order accuracy. In order to estimates the fully nonlinear wave-induced forces on the structure, different force models, such as Morison, Rainey and FNV (Faltinsen–Newman–Vinje) [4-5], will be compared.

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