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Analysis of the Statistical Characterization of Significant Wave Data Exceedances for Designing Offshore Structures

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Abstract : The statistical theory of extreme events is progressively a topic of growing interest in all the fields of science and engineering. The changes currently experienced by the world, economic and environmental, emphasized the importance of dealing with extreme occurrences with improved accuracy. When it comes to the design of offshore structures, particularly offshore wind turbines, the importance of efficiently characterizing extreme events is of major relevance. Extreme events are commonly characterized by extreme values theory. As an alternative, the accurate modeling of the tails of statistical distributions and the characterization of the low occurrence events can be achieved with the application of the Peak-Over-Threshold (POT) methodology. The POT methodology allows for a more refined fit of the statistical distribution by truncating the data with a minimum value of a predefined threshold u. For mathematically approximating the tail of the empirical statistical distribution the Generalised Pareto is widely used. Although, in the case of the exceedances of significant wave data (H_s) the 2 parameters Weibull and the Exponential distribution, which is a specific case of the Generalised Pareto distribution, are frequently used as an alternative. The Generalized Pareto, despite the existence of practical cases where it is applied, is not completely recognized as the adequate solution to model exceedances over a certain threshold u. References that set the Generalised Pareto distribution as a secondary solution in the case of significant wave data can be identified in the literature. In this framework, the current study intends to tackle the discussion of the application of statistical models to characterize exceedances of wave data. Comparison of the application of the Generalised Pareto, the 2 parameters Weibull and the Exponential distribution are presented for different values of the threshold u. Real wave data obtained in four buoys along the Irish coast was used in the comparative analysis. Results show that the application of the statistical distributions to characterize significant wave data needs to be addressed carefully and in each particular case one of the statistical models mentioned fits better the data than the others. Depending on the value of the threshold u different results are obtained. Other variables of the fit, as the number of points and the estimation of the model parameters, are analyzed and the respective conclusions were drawn. Some guidelines on the application of the POT method are presented. Modeling the tail of the distributions shows to be, for the present case, a highly non-linear task and, due to its growing importance, should be addressed carefully for an efficient estimation of very low occurrence events.

Keywords : extreme events, offshore structures, peak-over-threshold, significant wave data
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