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Study of the stochastic response of an offshore pile to a combined Morison force induced by current and turbulence

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Abstract: A set of relationships is derived allowing the characterization of the stochastic response of an offshore pile subject to the combined Morison force arising from a gaussian unidirectional stationary velocity flow and its acceleration. This equation contains a nonlinear term on the velocity and a linear term on the acceleration. The input stochastic processes, that is, the velocity and acceleration arise from a turbulent marine medium with current.

The set of relationships are established using polynomial transformations of the stochastic processes in the Morison equation and represent a link between the known statistical moments and power spectral density of the velocity and acceleration process and those of the response. The expressions allow the consideration of bending moment and shear force as responses in a straightforward fashion.

The information provided by these relationships is then applied to further study the characteristics of the response. The statistical moments are used to obtain the maximum entropy estimation of the probability density function of the response. Some connections between the asymmetry of the response and the statistical properties of the inputs can be established, with the main advantage of not requiring the time-consuming Monte-Carlo approach. The present analysis is restricted to up to the fourth moment but can be easily expanded.

Finally, the transformations of the covariance function allow the calculation of the power spectral density of the response. This information is used to estimate the extreme value distribution of the response by means of the theory of translated Gaussian processes.

Keywords: non-gaussian process, extreme value distribution, random field, maximum entropy distribution, translated gaussian process