

Towards Reliable Seismic Design Approaches for Offshore Structures

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Abstract. Offshore structures are increasingly being constructed in seismically active regions, where intricate geohazard conditions and severe ground motions pose significant hazards to the structural integrity and operational continuity of the structures. In the current study, an extensive review of the latest seismic design concepts of offshore structures, with a focus on performance-based concepts guided by standards, is presented. This study begins by defining fundamental seismic hazard and risk vocabulary and continues to outline deterministic and probabilistic hazard assessments, such as the PSHA process, the generation of hazard curves, and uniform hazard spectrum (UHS) preparation. The influence of ground motion parameters such as peak acceleration, velocity, displacement, frequency content, and duration on offshore structure behavior was investigated. Specific focus is given to seismic instability- critical nonlinear instability phenomena, such as the P-Δ effect, which can result in the toppling of structures. Combined hazard and dynamic response analyses underlining the site-specific soil response and its translation of bedrock-level ground motion to mudline responses are presented. Advances in structural control devices, structural health monitoring (SHM), and seismic retrofitting methods are also discussed. This study identifies a new tendency towards combined PSHA-DSRA approaches, providing enhanced seismic demand estimates at the structure level and enabling safer, performance-based offshore design approaches. Study presents a comprehensive state-of-the-art review of contemporary seismic design methodologies for offshore structures.

Keywords: Offshore structures; seismic hazard; PSHA; ground motion uniform hazard spectrum (UHS); P-Δ effect structure toppling; site response analysis; performance-based design; structural control; seismic retrofit; dynamic soil-structure interaction.

DOI: <https://doi.org/10.15157/tultechbook.3.c13>

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