Differential Evolution Applied to Mooring Optimization of Offshore Floating Systems Based on an Integrated Design Methodology

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ABSTRACT

The offshore oil production industry is currently expanding its activities in even deeper waters, using moored floating platforms submitted to operational and extreme environmental conditions. Therefore, the design of mooring systems to keep the position of such platforms is of vital importance to assure safety and economical feasibility for offshore activities. Moreover, recently an integrated methodology for the design of mooring systems and risers of floating production platforms has been proposed [1], indicating that the design of the mooring system should consider the riser integrity, by generating a diagram with the safe operational zone (SAFOP) for the risers (comprising an envelope of horizontal excursions of the platform where no design criteria for the risers is violated), to be superimposed to a diagram with the offsets of the floating platform. Therefore, a safe operation is assured when this offset diagram (generated performing global analysis under extreme environmental condition of wave, current and wind for each direction) are within the SAFOP diagram.

In this context, this work presents an optimization procedure to determine the mooring configuration leading to the minimum offsets under environmental loads, taking radius, azimuth, pre-tension and material of the mooring lines as design variables. In previous works, the authors have presented such an optimization tool based on evolutionary algorithms for the synthesis and optimization of mooring system; however, the case studies were relatively simple. Now, this paper presents an implementation of a different algorithm - the Differential Evolution method (DE), which is applied to optimize the mooring system of a real-case scenario for an offshore floating platform.

Considering that such optimization procedure requires high computational costs, due to the need of nonlinear static and dynamic analyses with Finite Element models for each candidate solution, it is very suitable to consider the possibility to apply an algorithm which allows smaller populations, therefore significantly reducing computational time. Differential Evolution, a population-based evolutionary algorithm (EA) has these advantages and has been implemented for this process. This algorithm is a practical approach to global numerical optimization where the number of control parameters in DE is very few; three operators are used including mutation, crossover and selection.

Results of the application for real-case systems are presented, which indicate that the method is effective.

REFERENCES

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