Title of Diploma Thesis

Effect of Zoning Corrosion on the Life-Time Structural Reliability of a Jacket Offshore Structure

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ABSTRACT

Offshore oil platforms operate in highly corrosive marine environments. Therefore, during the platforms' construction stage, protective measures (e.g. protective coatings and cathodic protection) are applied to prevent corrosion. Nevertheless, the service life of the protection measures is usually less than the structure's operational life, while, often, the structural components suffer lack of appropriate maintenance due to economical reasons. In the case of poor maintenance, corrosion takes place leading to material loss of the platform's components. Consequently, the quantification of the risk associated with the structural degradation due to corrosion can be considered of great importance for the economical optimization of the platform's maintenance scheme.

In this thesis, the effect of zoning corrosion on the life-time structural reliability of an existing 4-legged jacket platform located in the northern Aegean Sea is investigated. The platform is modeled and analyzed using a finite element time domain numerical model. The time dependent probability of failure of the platform's main tubular members and joints is assessed considering the effect of corrosion. Based on local water characteristics, contemporary long-term corrosion models are used for the prediction of the corrosion process in terms of uniform loss of thickness across the circumference of the tubular members. The structure is divided into different exposure zones (submerged, transition, splash and atmospheric). The evolution of the corrosion loss is estimated for each zone resulting to a progressive corrosion profile with period of exposure. Also, due to high nutrient concentration in the structure's location, the effect of accelerated low water corrosion is also considered in the corrosion profile.

For quantifying the failure probability, a Monte Carlo simulation approach is used. The platform is analyzed for different periods of exposure to corrosion, considering two different loading scenarios. In the first scenario, extreme environmental conditions (wave, wind and current) are considered with stochasticity included in drag and inertia coefficients, yield strength and modulus of elasticity of the steel. The second loading scenario corresponds to earthquake excitation with stochastic parameters being: damping ratio, foundation stiffness, yield strength and modulus of elasticity of steel. For evaluating the platform's response, linear time domain dynamic analysis and linear dynamic spectral analysis are implemented for the first and the second loading scenario respectively. For each corrosion exposure time period and for both loading scenarios, the strength of the structural components is assessed using appropriate guidelines; while the time-dependent probability of failure is calculated for every structural component. Furthermore, the effect of corrosion is assessed in terms of the mean displacement of specified joints.

The results illustrate the increase of the probability of failure at specific structural components for specific corrosion exposure time periods. The effect of the existence of different corrosion zones and of the different loading scenarios on the probability of failure is also demonstrated.

Keywords: Reliability analysis, Offshore structures, Corrosion, Structural degradation.