SEISMIC VULNERABILITY ASSESSMENT OF CORRODED PILE-SUPPORTED WHARVES

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High temperature, high humidity, high amounts of chloride and sulfate ions make Persian Gulf one of the most sever exposure conditions that threaten the durability of concrete structures and unfortunately impose hundreds of million dollars in repair every year. Durability of reinforced concrete structures located in marine environments depends on several factors. However, abundant investigations demonstrate that corrosion of embedded steel bars within concrete structures mainly due to the chloride attack is the major cause of concrete deterioration in marine environments.

Seaports are the main factor of accelerating the development of national and regional economy and major part of maritime transportation that are taken into account as national assets in all over the world. Pile-supported wharves are one of the most common types of wharf structures that exposed to aggressive marine environment and may degrade due to chloride attack along its service life. In this respect, this paper investigate the effect of lifetime exposure to chlorides from Persian Gulf marine environment on the seismic vulnerability of a typical pile-supported wharf. Seismic vulnerability assessment of the pile-supported wharf has been performed by seismic fragility analysis.

To demostrate the precedure for seismic vulnerability assessment, three dimensional numerical models including the initial (t=0 years) and the corroded (t=50, t=75 years) RC pile-supported wharf are developed using finite element software. In order to obtain the capacity curve of the models and establish quantitative criteria for bound of damage states, pushover analysis is performed. A nonlinear static analysis called capacity spectrum method (CSM) proposed by ATC-40 (1996) is done to evaluate the response of models. Then, based on response values and damage criteria, seismic fragility analysis are performed to investigate the vulnerability of the initial and corroded wharf. The impact of aging on the wharf vulnerability can be evaluated through comparing their fragility curves.

In this study, corrosion of steel reinforcements in RC piles due to chloride attack, proposed by Enright and Frangopol (1998), is considered. This corrosion leads to decrease in diameter of the corroded reinforcement bars and consequently decrement in strength capacity of wharf piles.

Three dimensional numerical models of selected pile-supported wharf is made to evaluate the seismic response of the desirable pile-supported. The deck of the wharf is modelled by shell elements and piles have circular section and modelled by frame elements which are rigidly connected to the wharf. The soil is modelled by p-y and t-z spring elements with nonlinear load-displacement relationships to model normal and shear behaviour, respectively.

Displacement ductility factor (μ_d) is chosen as an engineering demand parameter (EDP) based on the quantitative bounds of damage states proposed by Heidary-Torkamani et al. (2013). Based on the bounds of damage state and seismic response values (resulted from CSM), the seismic fragility curves are obtained through simple statistical analysis. Figure 2 shows the derived fragility curves of the initial (t=0) and corroded (t=50, 75 years) pile-supported wharf.

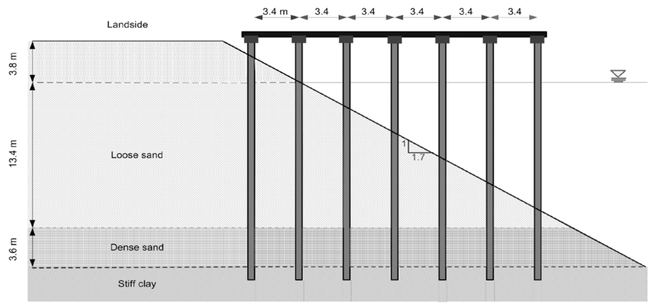

Figure 1. Cross section profile of the selected wharf

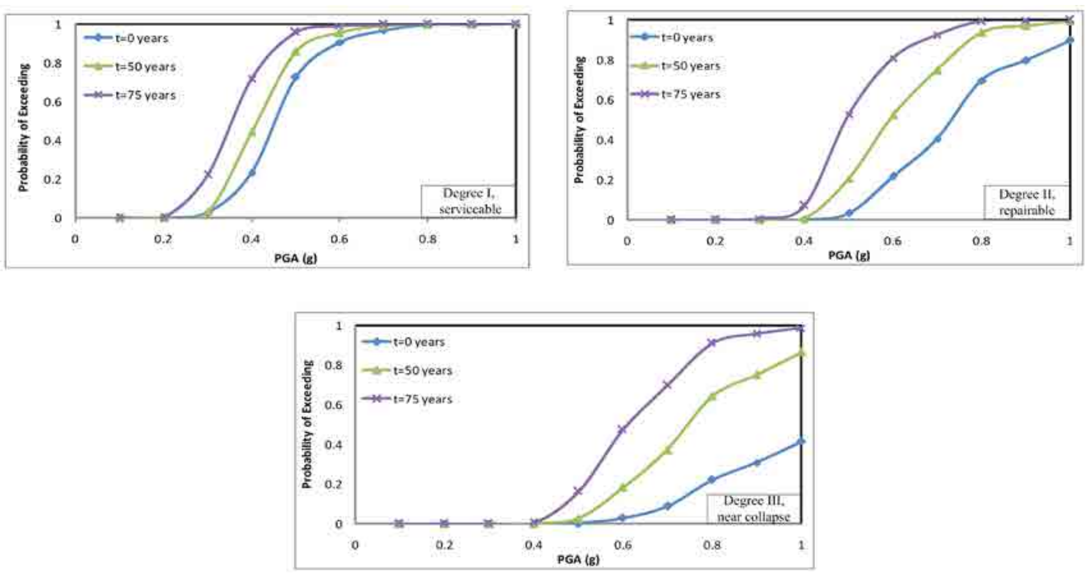

Figure 2. Fragility curves for the initial (t=o years) and corroded (t=50, 75 years) wharf

Fragility curves for each damage state reveal a significant increment in the seismic vulnerability of the pile-supported wharf over time due to corrosion. Furthermore, the effect of corrosion is more significant for more severe damage states. Therefore, it is important to taking into account the severity of the environmental exposure on the seismic vulnerability assessment of pile-supported wharves.

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