

Dynamic Inelastic Behavior of Fixed Offshore Platforms

Pile-Leg Interaction Numerical Modeling

Campaign 1 (Portal elements)

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Abstract

Increasingly offshore operators of steel jacket structures are requiring reappraisal of existing installations. This may be in the light of revised design recommendations based on a better knowledge of structural performance. Many jackets have foundation piles through each main leg which are welded to the structure at deck level. The annulus between the pile and leg might be filled with cement grout as a means of reducing horizontal deflections, inhibiting corrosion, and increasing energy absorption capacity.

This paper aims at discussing an approach which can be used to demonstrate enhanced structural performance due to both the presence and lack of grouted piles. In this study, nonlinear fiber element will be used. Therefore, different behavior of grouted and ungrouted jackets and the relative different pile-leg interaction is investigated. The experimental results of two frames of the same geometries filled with a standard offshore cement grout in their pile-leg gap under lateral deck displacement-controlled load, together with the two similar frames without any grout, are ongoing and will be presented in near future. However, this paper presents an important comparison between the general behaviors of grouted and un-grouted offshore frames in an area where there are many existing jacket-type platforms.

1- Introduction

Offshore platforms in seismically active areas should be designed to survive rare and unusually intense earthquake motions of ductility level, allowing for local damages, without global failure. The inelastic dynamic response of a structure subjected to severe seismic excitation can be studied, either analytically or experimentally, by applying real time history earthquake acceleration records scaled to produce the desired intensity of ground shaking. An alternative approach as was utilized in this investigation is to impose quasi-static load or deformation histories on the specimen to verify specific aspects of the models [5]. In this case, same displacement history is imposed on all specimens. This way the differences in behavior can be compared and related to differences in the specimens. In this study, nonlinear fiber element for “simulation of buckling, post-buckling and hysteretic responses of tubular struts and nonlinear behavior of portals, formulated in DRAIN-3DX [2]”, is introduced; Finally the different behavioral aspects of grouted and un-grouted jackets including different pile-leg interaction are investigated.

Under cyclic excitations, tubular members respond either as portals or as struts. Jacket legs act as portals with nearly constant axial forces but variable lateral displacements. However jacket braces behave as struts with more or less constant lateral forces, but variable axial displacements[3]. Two of most useful applicable numerical models, presented in recent years, for nonlinear dynamic analysis of offshore platforms elements and jacket frames can be summarized as:

I) In Kayvani and Barzegar efforts (1993), based on the engineering beam theory and appropriate provisions for plasticity and large displacements, typical tubular members are successfully modeled and analyzed using the general-purpose FE Program, ANSYS [3].