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Pushover Analysis of Fixed Offshore Structures

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***Abstract*—In the Present study the linear elastic analysis of the structural member is based on stresses upto the yield stress. Material is considered as perfectly elastic before yielding.**

The main purpose of study is to perform non linear analysis using commercial non linear finite element software SAP 2000 and to investigate the failure behavior of offshore platform for the lateral loads . The Non linear analysis static analysis is carried out for the general loading on four legged steel platform and lateral loads(wave, current, wind and seismic) are applied to perform pushover analysis at specified displacement. The various pushover curve, load deformation curve are presented.

***Keywords*—Push Over Analysis, Offshore Structure, Hinges**

I. INTRODUCTION

This template, Ease of Use a traditional offshore structures shown consists of welded steel tubular frame work or jacket to support the topside facilitates also called as deck and the arrangements is referred to a fixed steel structure. Topside facilitates will vary depending on the weather. It is an oil and gas producing installation but they will include hydro carbon process equipment power generation Helideck and accommodation services design to cater to the needs of the personal employed in the operation maintenance of installation. There are several phases in the live cycle of an offshore installation. (1) Fabrication (2) Load out (3) Operations like drilling productions etc.

A 3 dimensional model which includes sall lateral forces resisting elements is first created and gravity loads are applied initially, this process is continued until a control displacement at the top of the structure reaches a certail level of deformation or structure becomes unstable. The topside displacement is [plottes with base shear to get the global capacity curve

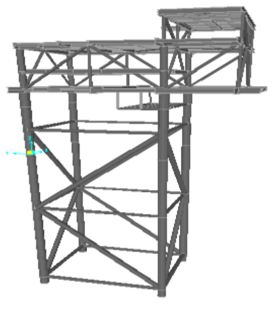

Figure.1. 3D view of SAP Model

II. DESCRIPTION OF THE STRUCTURE

Main characteristics of the current structure are given below.

Platform North Orientation	:	135^0 w.r.t Grid North
Overall Dimension	:	18.2mx 24.15m
Water depth	:	27.0 m w.r.t MSL
Design Life	:	30 years

Main characteristics of Topsides are:

Four legged Deck structure of 18.2m X 24.15m overall dimensions. The topside consists of six level deck structure namely ESDV deck at EL (+)8.435m, Cellar deck at EL(+) 11.435m, Mezzanine deck EL(+) 14.435m and Main deck EL(+)18.43m, Upper Main deck EL(+)22.435m

Main characteristic of the sub structures are:

The four legged non-grouted jacket structure with plan dimension of 12m X 15m at working point elevation at EL (+) 6.5m. the jackets legs are straight from work point elevation to mud line without any batter.

The jacket structure has three horizontal framing levels, EL (+) 4.5, EL (-) 10.5m and mud mat framing at EL (-) 25.5m

III. METHODOLOGY

A. Analysis and design methodology

Structure has to be designed to maintain its integrity for the duration of field life. The structural analysis was carried out using the SAP 2000 structural analysis program version 14.2.4, which performs linear elastic analysis based on the stiffness method.

SAP structural model consists of primary members was developed based on the structural drawings. Self weights unmodelled in terms were included in the analysis through super imposed deadloads. But their stiffness was ignored in the analysis. Piping, mechanical equipments, electrical, instrumentation and safety weights were included in the analysis model through machinery load. Live load was considered as separate load case in the analysis model. In addition to the above topside loads, wave, wind and seismic loads were applied through appropriate load paths, the boundary condition has been considered as fixed at the mudline elevation

B. Program generated Hinge

The hinge properties generated by program are used in the analysis. These hinges can be viewed but they cannot be modified. The main difference between define properties(both auto and user defined) and program generated properties is that typically the hinge properties or section dependent. Thus it is necessary to define a different set of hinge properties for each frame section type in the model. This results in defining a very large number of hinge properties.

The non-linear properties of beams and columns have been evaluated using the section designer and have been assigned to the computer model in SAP 2000. The flexural default hinges (M3) and share hinges (V2) were assigned to the beams at two ends. The interacting (P-M2-M3) frame hinges type a coupled hinge property was also assigned for all the columns at upper and lower ends.

IV. RESULTS AND CONCLUSTION

A. Ntural Period and mode shapes of the structure

Every structures will have its own time period and frequency depends upon inherent features such as mass, stiffness and damping, for the presence study of structure the following loads are considered for mass participation such as deadload, liveload, sidl and machinery loads, and the values of mode shapes natural period , time period and the mass participation factor.

It has been found that mode shape 1 and mode shape 2has been predicted in x and y direction and corresponding mass participation factor was 82% and 89%.

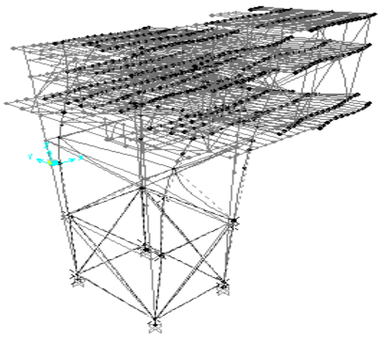

Figure.2.Mode Shape 1 in X direction(t=1.505sec, f=0.664Hz)

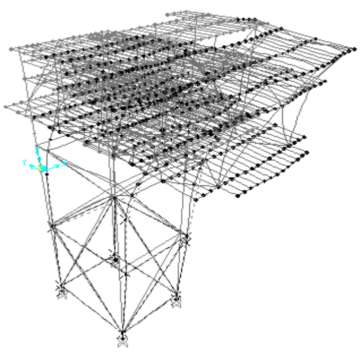

Figure.3. Mode Shape 2 in Y direction(t=1.255sec, f=0.7964Hz)

B. Sesimic analysis

The seismic analysis was performed using response spectrum method and parameters considered in the analysis. In order to predict the accurate base shear more the 90% of mass contribution has been taken into an account by considering 25 mode shapes.

The first and 3rd mode shapes are contributed 82% and 6.6% of mass participation factors and also 0.490 and 0.740m/s^2 for acceleration respectively are used for calculation of base shear.

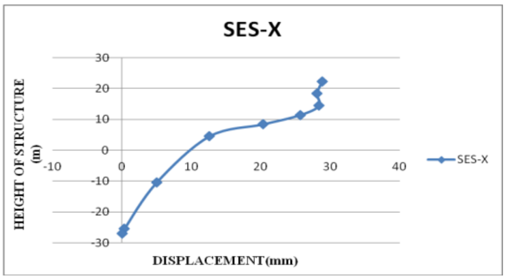

Figure.4. Displacement in sesimic X direction

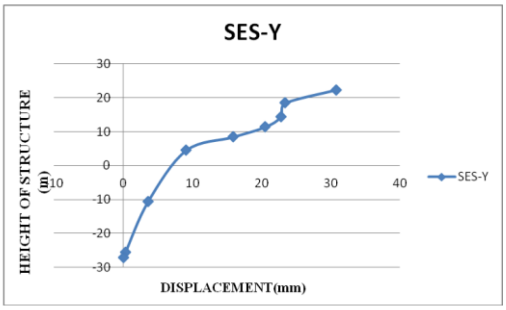

Figure.5. Displacement in sesimic Y direction

C. Wave analysis

The displacement pattern is similar to seismic and maximum displacement are almost same that is 30mm in both seismic and wave but the displacement at the water level is 20mm for wave load and 10mm for seismic loads, the displacement is more above water level for seismic load compared to wave load.

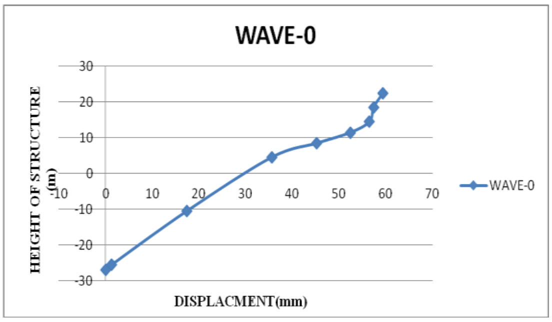

Figure.6. Displacement in wave X direction

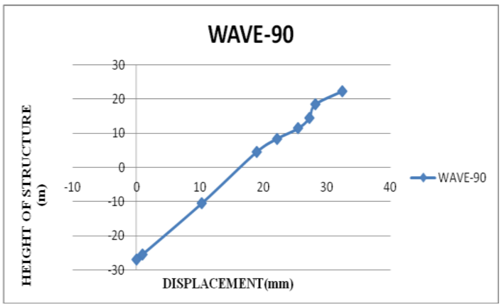

Figure.7. Displacement in wave Y direction

D. Comparision of sesimic and wave behavious

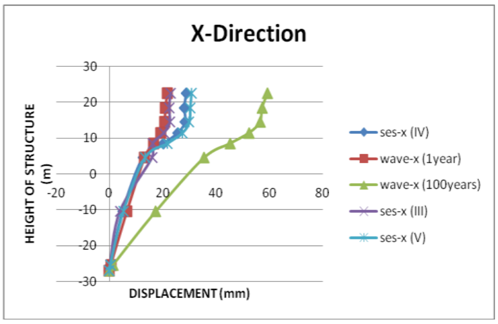

Figure.8. Displacement comparison in X direction

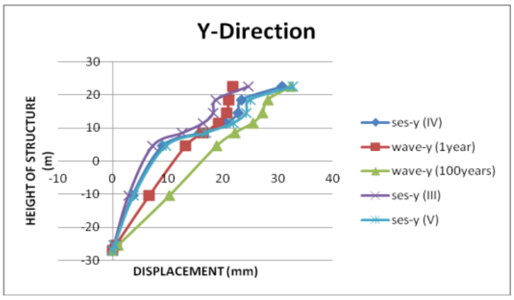

Figure.9. Displacement comparison in Y direction

From the figure 8 and 9 has been found that displacement pattern is linear upto yield point and takes almost parabolic after the yield point. Also it has been noted that displacement pattern under seismic and wave load almost in line with modal analysis

E. Pushover analysis

Table 5.9 Displacements for pushover analysis

Height of structure (m)	Joints	PUSH-X (mm)	PUSH-Y (mm)
22.435	588	601.620	628.420
18.435	328	587.850	429.490
14.4.35	246	607.140	412.470
11.435	648	541.600	370.280
8.435	430	399.130	283.550
4.500	397	237.120	159.430
-10.500	245	103.180	61.030
-25.500	239	9.270	8.390
-27.000	58	0.000	0.000

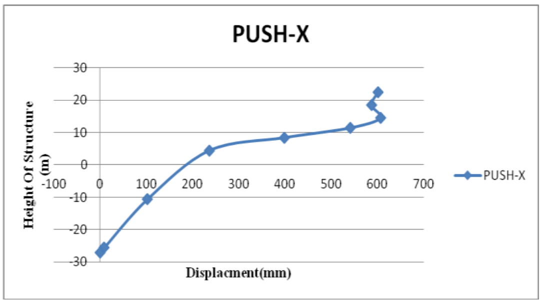

Figure.10. Displacement pattern- push in X direction

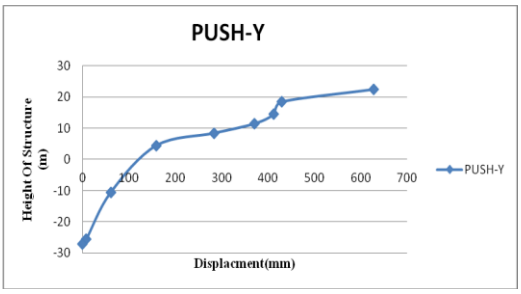

Figure.11. Displacement pattern- push in Y direction

F. Conclusion

1. From pushover analysis, it is observed that structure can withstand two times the wave base shear.
2. It has been found that wave loading is predominant compared to seismic loading.
3. From the pushover analysis stagewise failure of the members were observed, which can be used during retrofitting of structure for later loads.

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