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Variation of displacement created by seismic load and wave load in a leg of offshore platform

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Abstract – The offshore platform usually rest on legs of platform on sea deep. The calculation of legs is complicated due to variation of loads with time. In this study analysis is the linear elastic of the structure based on stresses up to yield stress. The main objective of this study is to perform non linear analysis using nonlinear finite element software SAP 2000 and investigate behavior of offshore platforms legs for wave load and seismic load. Analysis is carried out for four legged steel template structure and perform wave analysis and seismic analysis. Analysis of platform is carried out for various depth of water to investigate behavior of the platforms legs for the varying depth of water.
Keywords – Offshore platform, Wave analysis, Seismic analysis, steel template, displacement.

I. INTRODUCTION

- **Offshore construction** is the installation of structures and facilities in a marine environment, usually for the production and transmission of electricity, oil, gas and other resources.
- **Offshore platform** is a large structure with facilities to drill wells, to extract and process oil and natural gas, or to temporarily store product until it can be brought to shore for refining and marketing.
- The offshore platform divided into following categories:
  1. **Fixed Platforms**
     a. Steel template Structures
     b. Concrete Gravity Structures
  2. **Compliant tower**
     a. Compliant Tower
     b. Guyed Tower
     c. Articulated Tower
     d. Tension Leg Platform
  3. **Floating Structures**
     a. Floating Production System
     b. Floating Production, Storage and Offloading System.

II. Loads on offshore platform

- Various environmental loads acting on the offshore platform is listed below.

1. **Gravity Loads**
   a. Structural Dead Loads
   b. Facility Dead Loads
   c. Fluid Loads
   d. Live Loads
   e. Drilling Loads

2. **Environmental Loads**
   a. Wind Loads
   b. Wave Loads
   c. Current Loads
   d. Buoyancy Loads
   e. Ice Loads
   f. Mud Loads

3. **Seismic Loads**

III. Description of structure

- Platform Overall dimensions: 18.2m X 24.15m
- Water Depth: 27m and 30m w.r.t. MSL
- Design life: 30 years
- Main Characteristics of topside of platform structure are:
  - Four leg decked structure of 18.2m x 24.15m overall dimensions. The topside consists of six level deck structure consists of ESDV deck at EL (+) 8.435, cellar deck at EL (+) 11.435, Mezzanine deck EL (+) 14.435, Main deck EL (+) 18.435 and Upper Main deck EL (+) 22.435.

IV. Methodology

- 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 17.2.0 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 unmodeled in terms were included in the analysis through super imposed dead loads. 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 mud line elevation.

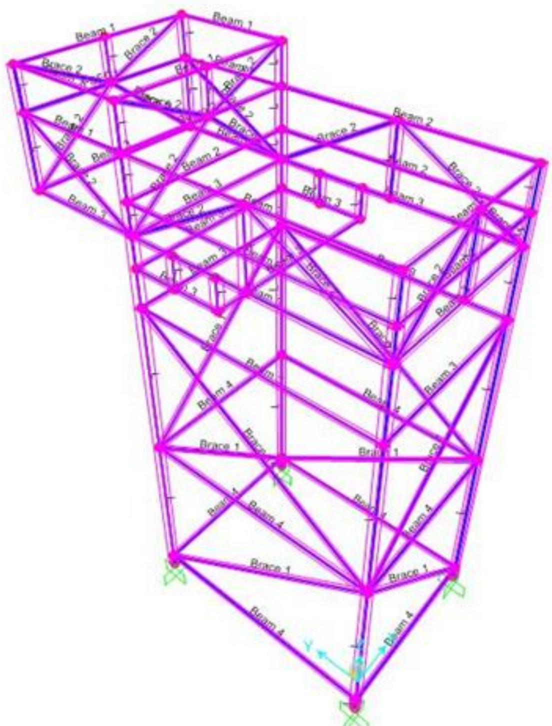

Figure 1 A 3D view of Platform's SAP2000 model

V. Analysis and Results

- Wave analysis
  - Displacement due to wave load for depth of water is 27m

Table 1 Displacement due to wave load for Water depth 27 m

Level (Height) of structure	Displacement
22.435	57.24
18.435	55.83
14.435	55.17

11.435	53.28
8.435	46.77
4.5	34.39
-10.5	18.25
-25.5	0.3
-27	0

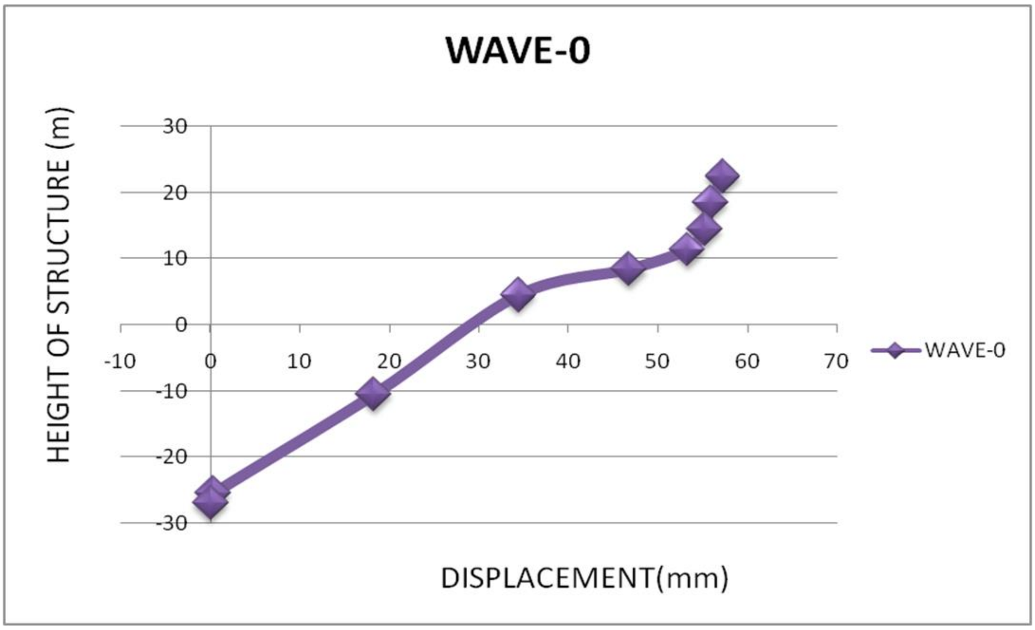

Figure 2 Displacement Graph for Wave Load for water depth 27m

- Displacement due to wave load for depth of water is 30m

Table 2 Displacement due to wave load for Water depth 30 m

Level (Height) of structure	**Displacement**
22.435	59.63
18.435	58.18
14.435	57.336
11.435	54.71
8.435	48.61
4.5	35.62
-12	18.68
-28.5	0.53
-30	0

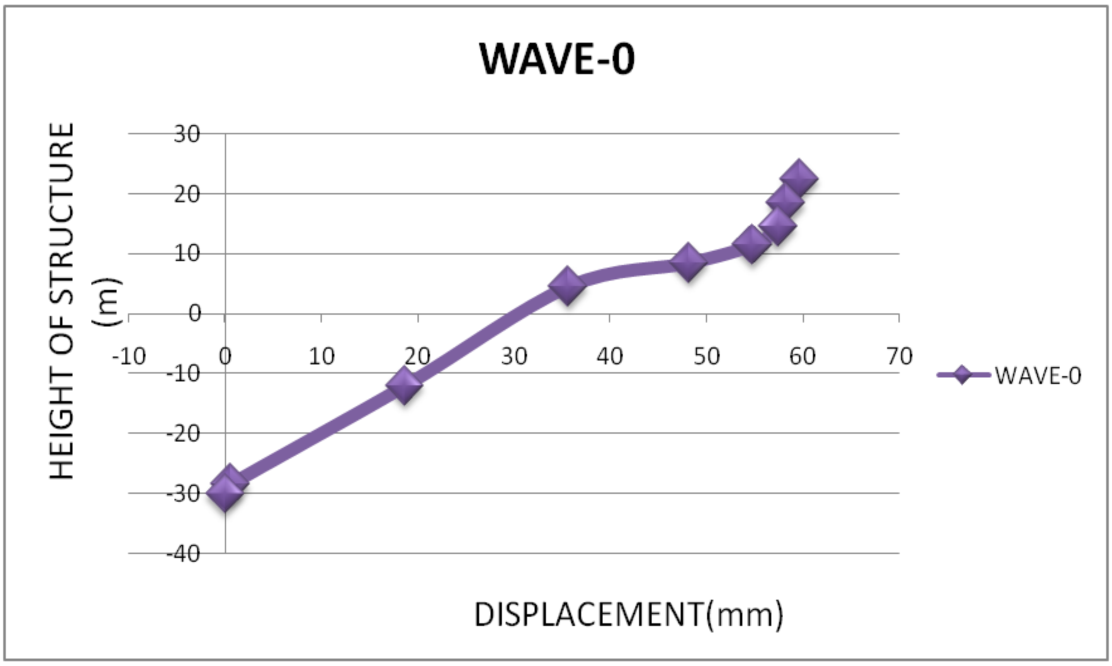

Figure 3 Displacement Graph for Wave Load for water depth 30m

- Seismic Analysis

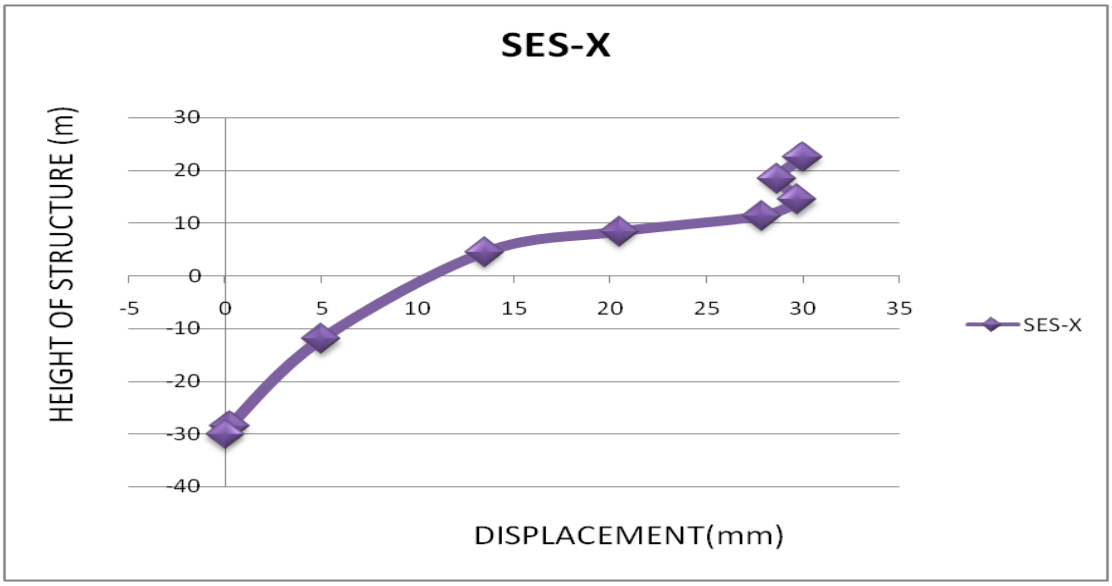

Fig 4 Displacement Graph for Seismic X load for water depth 27m

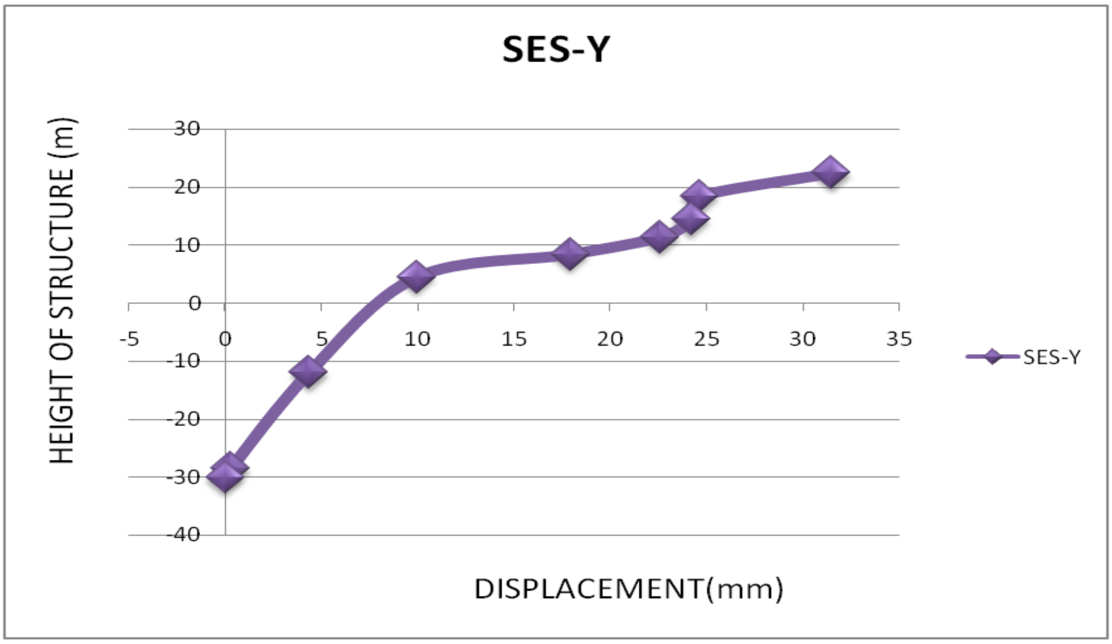

Fig 5 Displacement Graph for Seismic Y load for water depth 27m

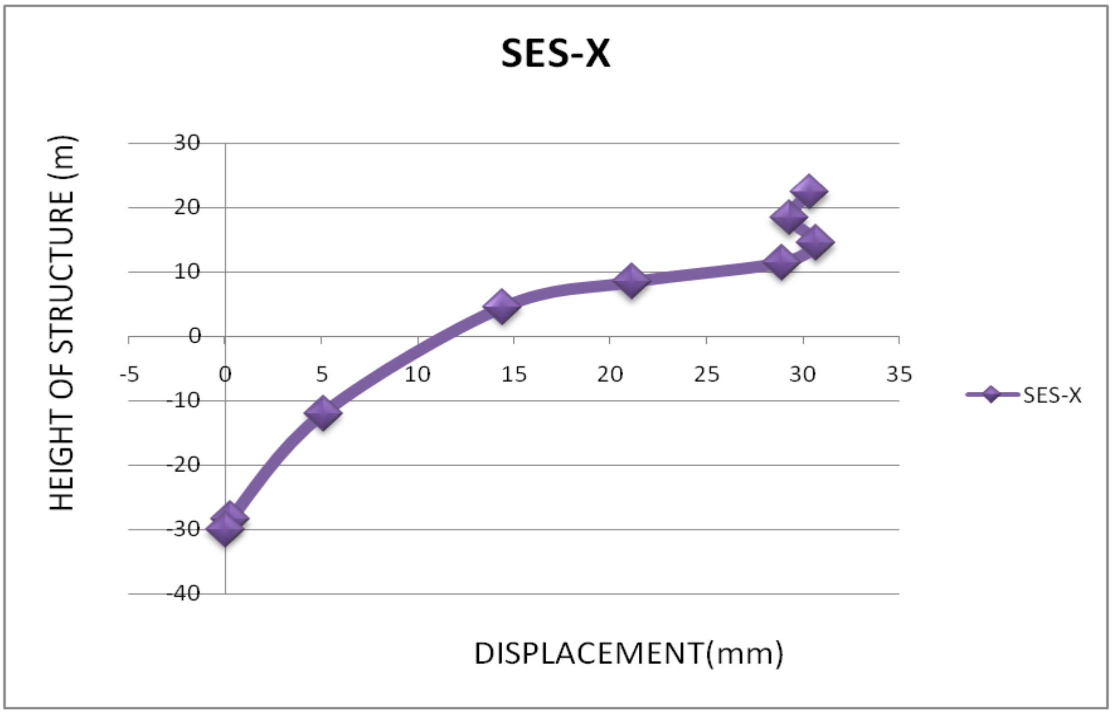

Fig 6 Displacement Graph for Seismic X load for water depth 30m

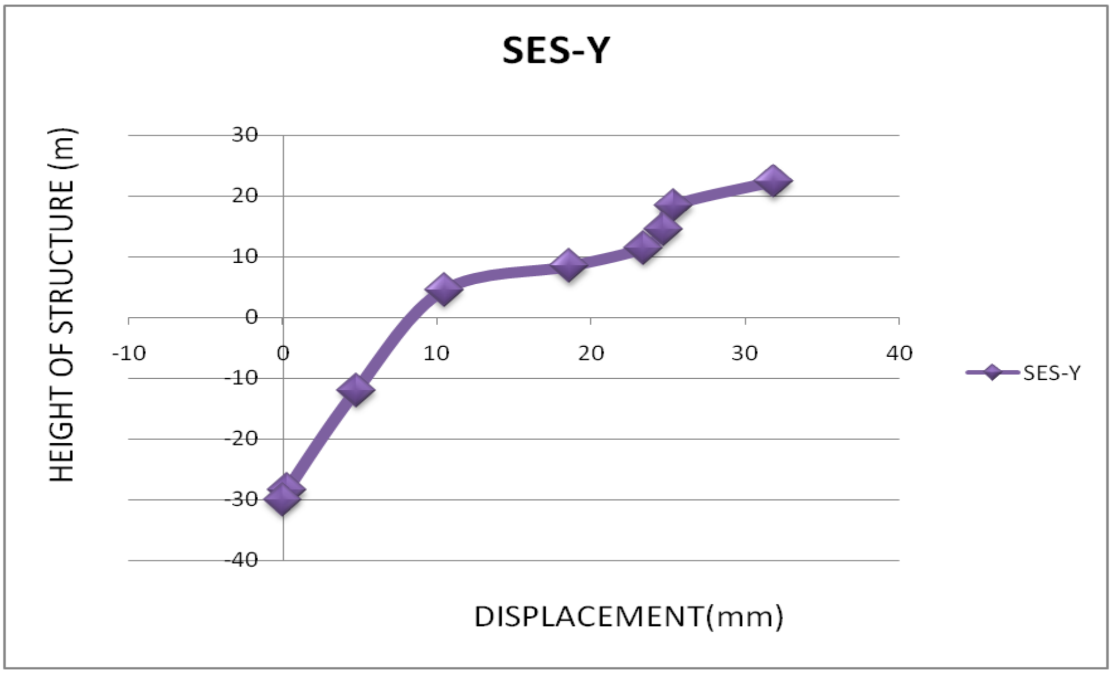

Fig 7 Displacement Graph for Seismic Y load for water depth 30m

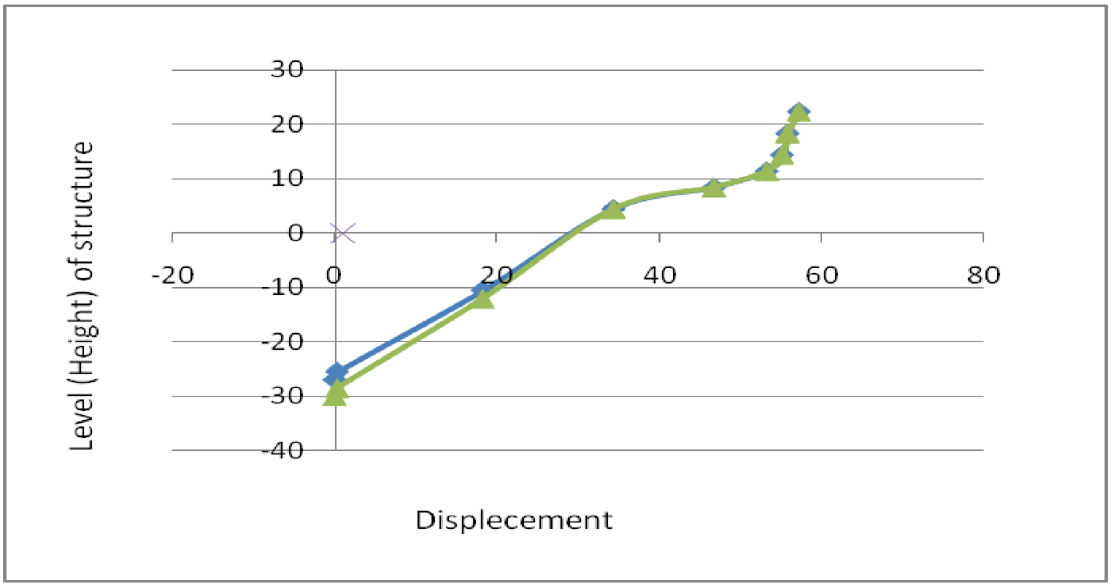

Fig 8 Comparison of model depth 27m and 30m.

VI. CONCLUSION

- It has been found that wave loading is predominant compared to seismic loading.
- From the wave analysis stage wise failure of the members were observed, which can be used during retrofitting of structure for later loads.
- It has been found that wave load have a major influence on the displacements which appear in structure leg of an offshore platform. From this we can conclude that it necessary to consider that influence on the dimensioning of such structures.

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