Non Linear Analysis of Off Shore Structures

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Abstract- *Performance-based design for offshore requires consideration of environmental conditions at recurrence periods well beyond those of current practice, when structural damage is expected and connections are likely to behave in-elastically. Performance-based design considers both the occurrence and consequence of structural damage caused by extreme conditions and could improve the performance of offshore structures. This paper assesses the post-elastic behavior and ductility of common connection details for offshore jacket structures based on a survey of experiments and empirical joint models and on nonlinear finite element analyses. The assessment includes common connection details under tension, compression, and bending.*

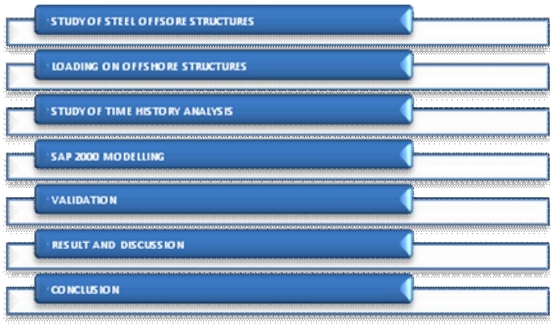
Keywords- Offshore structure ,time history analysis, SAP 2000

I. INTRODUCTION

The total number of offshore platform in various bays, gulf and oceans of the world is increasing year by year, most of which are of fixed jacket-type platforms located in 30 m to 200 m depth for oil and gas exploration purposes. Fixed offshore platforms are subjected to different environmental loads during their lifetime. These loads are imposed on platforms through natural phenomena such as wind, current, wave, earthquake, snow and earth movement. Among various types of environmental loading, wave forces loading is dominated loads. The results of these investigations highlight the importance of accurately simulating nonlinear effects in fixed offshore structures from the point of view of safe design and operation of such systems.

It is necessary to design an offshore structure such that it can respond to moderate environmental loads without damage and is capable of resisting severe environmental loads without seriously endangering the occupants. The standard design of the structure is carried out using the allowable stress method. However, it is important to clarify the effects on nonlinear responses for an offshore structure under the severe wave conditions. Offshore structures may be analyzed using static or dynamic analysis methods. Static analysis methods are sufficient for structures, which are rigid enough to neglect the dynamic forces associated with the motion under the time-dependent environmental loadings. On the other hand, structures which are flexible due to their particular form and which are to be used in deep sea must be checked for dynamic loads.

II. METHODOLOGY



2.1Ground Motions and Linear Time History Analysis:

Dynamic analysis using the time history analysis calculates the building responses at discrete time steps using discretized record of synthetic time history as base motion. If three or more time history analyses are performed, only the maximum responses of the parameter of interest are selected.

2.2 Response Spectrum Method:

Response spectrum analysis is a procedure for computing the statistical maximum response of a structure to a base excitation. Each of the vibration modes that are considered may be assumed to respond independently as a single-degree-of-freedom system. Spectra which determine the base acceleration applied to each mode according to its period (the number of seconds required for a cycle of vibration).

III. PROBLEM STATEMENT

The studied platform is a fixed Jacket-Type platform currently installed in the Suez gulf, Red sea, 1988 shown in Figure 3, The offshore structure is a four legs jacket platform, consists of a steel tubular-space frame. There are diagonal brace members in both vertical and horizontal planes in the units to enhance the structural stiffness. The Platform was originally designed as a 4-pile platform installed in 110 feet (110' =33.5 m) water depth.

- The Top side structure consists of Helideck 50'x50' at ELevation, EL. (+54') & Production deck 50'x50' at EL. (+26'); Top of jacket at EL (+12.5').
- The Jacket consists of 4 legs with 33 inch Outer Diameter (33" O.D.) & 1 inch Wall Thickness (1"W.T.) between EL. (+10') and EL. (-23') and (33" O.D. x 0.5" W.T.) between EL. (-23') and EL. (-110').
- In the splash zone area that is assumed to extend from EL. (-6') to EL. (+6') LAT. (Lowest Astronomical Tide).
- The jacket legs are horizontally braced with tubular members (8.625" O.D. x 0.322" W.T.) at elevations (+10'); (10.75" O.D. x 0.365" W.T.) at elevations (-23'); (12.75" O.D. x 0.375" W.T.) at elevations (-62') and (14" O.D. X 0.375" W.T.) at elevations (-110').
- In the vertical direction, the jacket is X-braced with tubular members (12.75" O.D. x 0.844" W.T.) from EL. (+10') to EL. (-23') and (12.75" O.D. x 0.375" W.T.) from EL. (-23') to EL. (-110'). The platform is supported by 4 piles (30" O.D. x 1.25" W.T.).)

3.1 Description of loading:

Density of various materials considered for design,
Concrete – 25kN/m3
Insulation – 1kN/m3
Structural steel – 78.5kN/m3
Live load – 5kN/m3
Wind load:
The following wind parameters are followed in accessing the wind loads on the structure
Basic wind speed – 55m/s
Terrain category -2
Class of structure – c
Risk coefficient k1 – 1
Topography factor k3– 1
K2 factor taken from Draft Code CED 38(7892):2013 (third revision of IS 4998(part 1):1992)
Earthquake force data:
Earthquake load for the chimney has been calculated as per IS 1893(par 4) : 2005
Zone factor – 0.16
Seismic zone – III
Importance factor (I) – 1.5
Reduction factor (R) – 3

Idealization of above problem statement is modeled in finite element analysis tool SAP 2000.Following models are prepared for comparative analysis of offshore steel structures

Table no: 1

MODEL NO. 1	OFFSHORE PLATFOREM WITH SINGLE BRACING 0 DEGREE
MODEL NO. 2	OFFSHORE PLATFOREM WITH DOUBLE BRACING 0 DEGREE
MODEL NO. 3	OFFSHORE PLATFOREM WITH KNEE BRACING 0 DEGREE
MODEL NO. 4	OFFSHORE PLATFOREM WITH SINGLE BRACING 20 DEGREE
MODEL NO. 5	OFFSHORE PLATFOREM WITH DOUBLE BRACING 20 DEGREE
MODEL NO. 6	OFFSHORE PLATFOREM WITH KNEE BRACING 20 DEGREE
MODEL NO. 7	OFFSHORE PLATFOREM WITH SINGLE BRACING 30 DEGREE
MODEL NO. 8	OFFSHORE PLATFOREM WITH DOUBLE BRACING 30 DEGREE
MODEL NO. 9	OFFSHORE PLATFOREM WITH KNEE BRACING 30 DEGREE

IV. SAP MODEL SOFTWARE

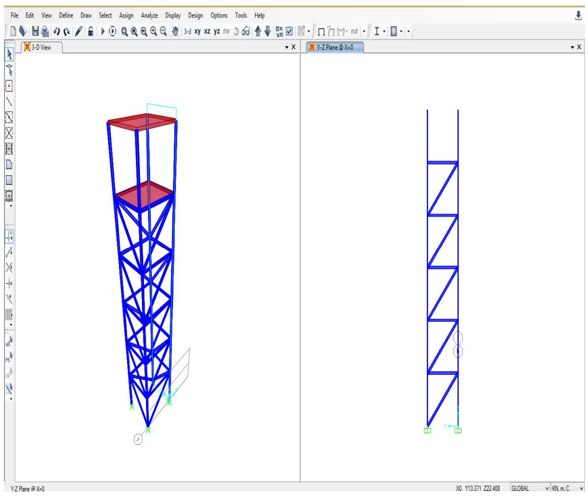


Fig4.1: Single bracing 0 degree

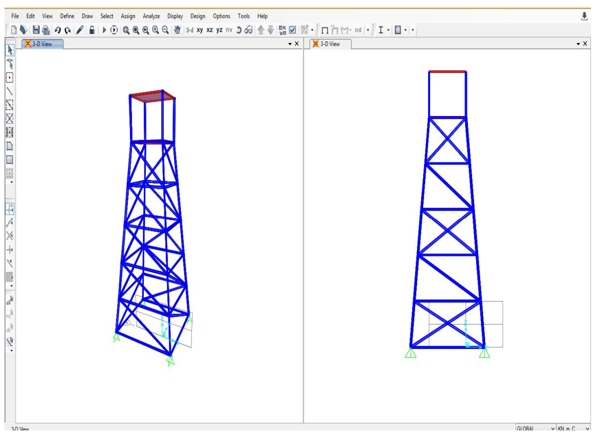


Fig4.2: single bracing 20 degree

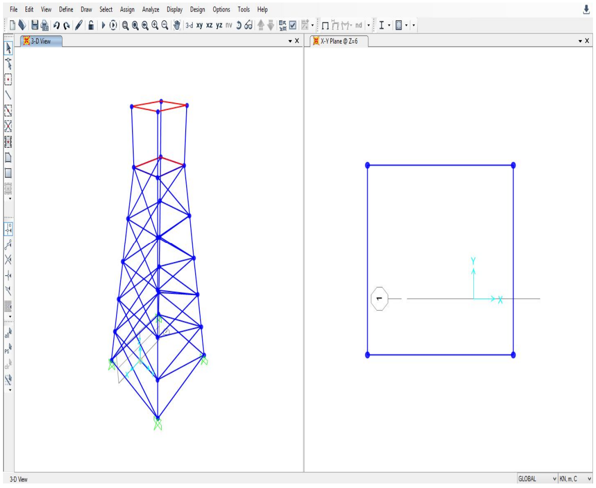


Fig4.3: single bracing 30 degree

V. RESULT AND DISCUSSION

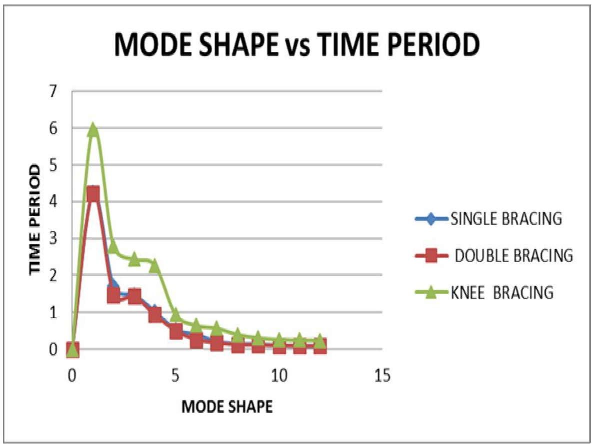


Fig 5.1: mode shear vs time period

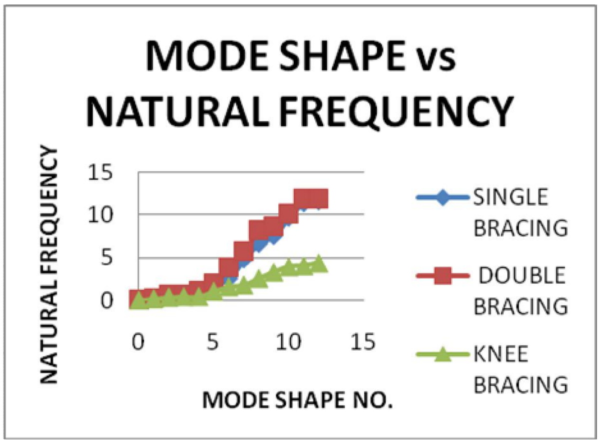


Fig 5.2: mode shear vs natural frequency

Fig 5.3:deformation-x20 degree

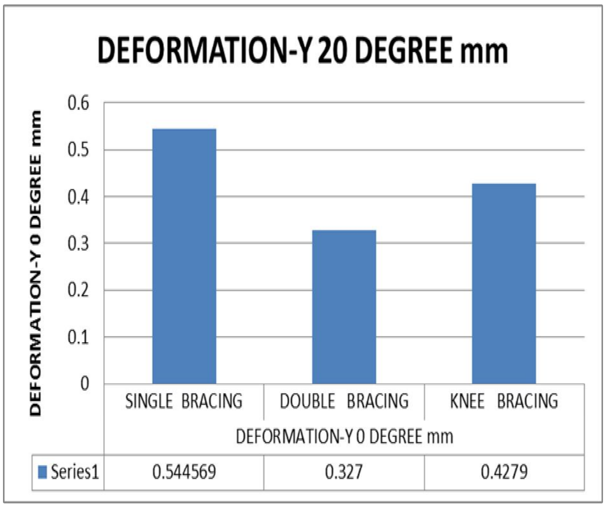


Fig 5.10:deformation-y20 degree

VI. CONCLUSION

From time history analysis of el centro data and Bhuj in SAP 2000 following conclusions are made

1. In fig 5.1 knee bracing is 25 % more than single and double bracing.
2. In fig 5.2 double bracing is 5% more than single bracing and 35% more than knee bracing.
3. In fig 5.3 knee bracing is 20% maximum than single and double bracing.
4. In fig 5.4 single bracing is 25% maximum than knee and double bracing

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