A Comparative Study Of Off-Shore Platform Using Ansys.16

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Abstract- *Off shore structures design are very different from conventional structures.Hence there is need to perform structural analysis of off-shore platforms for staic as well as dynamic loading . Using the commercial F.E.A. program ANSYS(to model the Winkler and Brick-full bond models) and the stress matrix considering a dynamic load was superposed on the stiffness matrix of the structure. A time domain solution is recommended, using the generalized Morison's equation to construct a program to calculate the wave forces, and Airy's linear and Second Order Stake's wave theories are employed to describe the flow and the results are compared and discussed. Both free and forced vibration analyses are carried out for two case studies from literature review.*

I. INTRODUCTION

Fixed offshore platforms are unique structures since they extend to the ocean floor and their main function is to hold industrial equipment that services oil and gas production and drilling. Robust design of fixed offshore structures depends on accurate specification of the applied load and the strength of the construction materials used. Most loads that laterally affect the platform, such as wind and waves, are variable, so the location of the platform determines the metocean data. In general, the loads that act on the platform are:

- Wind loads
- Wave loads
- Current loads
- Earthquake loads
- Installation loads
- Other loads such as impact load from boats

II.LOADING ON OFFSHORE STRUCTURES ACCORDING TO ISO:

Gravity loads consist of the dead load and the live (imposed) load.

2.2.1 Dead Load

The dead load is the platform's own overall weight and, in addition, the weight ofthe equipment, such as piping, pumps, compressors, separators, and other mechanical equipment, used during operation of the platform. The overall weight of platform structure upper decks (topside) includes the piling, superstructure, jacket, stiffeners, piping and conductors, corrosion anodes, decking, railing, grout, and other appurtenances. Sealed tubular members are considered either buoyant or flooded, whichever produces the maximum stress in the structure analysis.

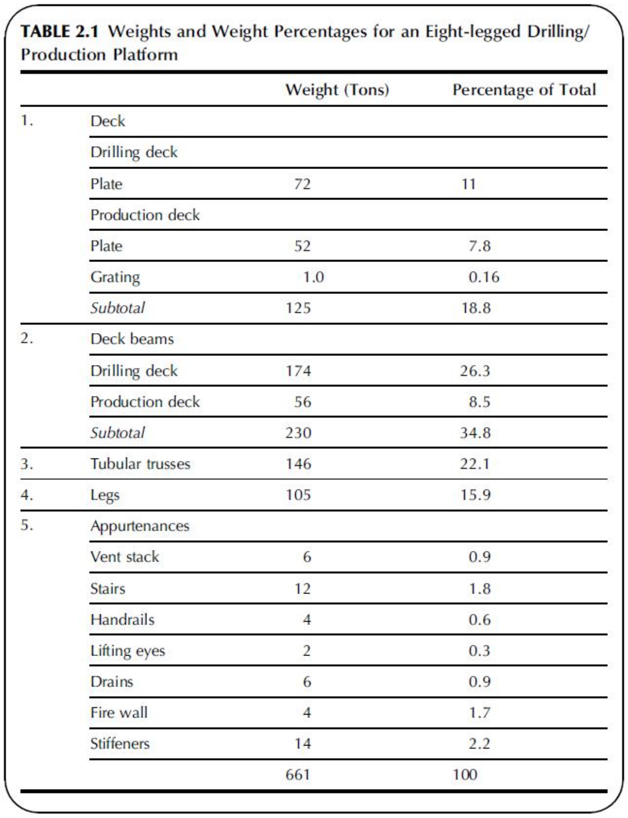


TABLE 2.1 Weights and Weight Percentages for an Eight-legged Drilling/ Production Platform

		Weight (Tons)	Percentage of Total
1.	Deck		
	Drilling deck		
	Plate	72	11
	Production deck		
	Plate	52	7.8
	Grating	1.0	0.16
	Subtotal	125	18.8
2.	Deck beams		
	Drilling deck	174	26.3
	Production deck	56	8.5
	Subtotal	230	34.8
3.	Tubular trusses	146	22.1
4.	Legs	105	15.9
5.	Appurtenances		
	Vent stack	6	0.9
	Stairs	12	1.8
	Handrails	4	0.6
	Lifting eyes	2	0.3
	Drains	6	0.9
	Fire wall	4	1.7
	Stiffeners	14	2.2
		661	100

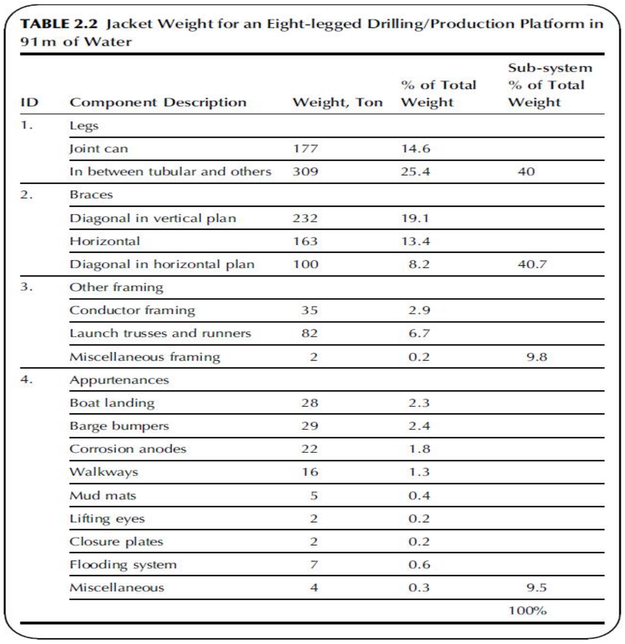


TABLE 2.2 Jacket Weight for an Eight-legged Drilling/Production Platform in 91 m of Water

ID	Component Description	Weight, Ton	% of Total Weight	Sub-system % of Total Weight
1.	Legs			
	Joint can	177	14.6	
	In between tubular and others	309	25.4	40
2.	Braces			
	Diagonal in vertical plan	232	19.1	
	Horizontal	163	13.4	
	Diagonal in horizontal plan	100	8.2	40.7
3.	Other framing			
	Conductor framing	35	2.9	
	Launch trusses and runners	82	6.7	
	Miscellaneous framing	2	0.2	9.8
4.	Appurtenances			
	Boat landing	28	2.3	
	Barge bumpers	29	2.4	
	Corrosion anodes	22	1.8	
	Walkways	16	1.3	
	Mud mats	5	0.4	
	Lifting eyes	2	0.2	
	Closure plates	2	0.2	
	Flooding system	7	0.6	
	Miscellaneous	4	0.3	9.5
				100%

Virtually all the decisions about the design of a platform depend on the number of jacket legs. Soil conditions and foundation requirements often con-trol the leg size. The function of the jacket is to surround the piles and to hold the pile extensions in position all the way from the mud line to the deck sub-structure. Moreover, the jacket legs provide support for boat landings, mooring Offshore Structure Loads and Strength bits, barge bumpers, corrosion protection systems and many other platform components. The golden rule in design is to minimize the projected area of the structure member near the water surface in high wave zones in order to minimize the load on the structure and to reduce the foundation requirements.

2.2.2 Live Load

Live load is the load imposed on the platform during its use; live loads change from one mode of operation to another. They include:

- The weight of drilling and production equipment.
- The weight of living quarters, heliport and other life-support equipment.
- The weight of liquid in storage tanks.
- The forces due to deck crane usage.

The live load depends on the owner's requirements, and normally it is included in the statement of requirements (SOR) or basis of design (BOD) documents. See Table 2.3 for guidelines on live loads. For general deck area loading, the topside deck structure should be designed for the specified imposed loads (outlined in Table 2.4) applied to open areas of the deck, where the equipment load intensity is less than the values shown.

DNV (2008) states that the variable functional loads on deck areas of the topside structure should be based on the values in Table 2.5. These values are considered guidelines, so they should be defined in the design criteria,which will be approved by the owner. If the owner needs to increase the load more than is noted in the code, it should be stated in the BOD and the detailed drawings should include the load on the deck. In Table 2.5, the loads that are identified for the local design are used for the design of the plates, stiffeners, beams and brackets. The loads for the primary design should be used in the design of girders and columns. The loads for the global design should be used for the design of the deck main structure and substructure.

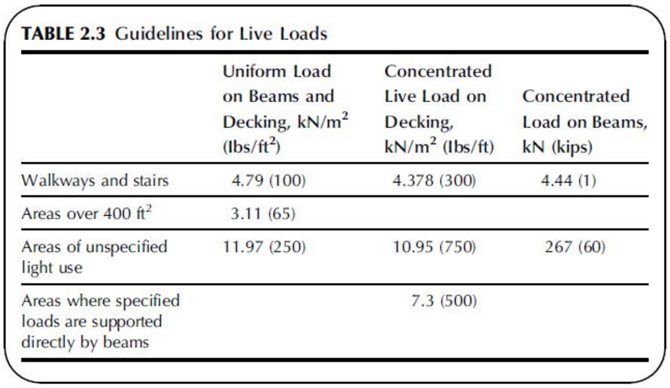


TABLE 2.3 Guidelines for Live Loads

	Uniform Load on Beams and Decking, kN/m^2 (lbs/ft^2)	Concentrated Live Load on Decking, kN/m^2 (lbs/ft)	Concentrated Load on Beams, kN (kips)
Walkways and stairs	4.79 (100)	4.378 (300)	4.44 (1)
Areas over 400 ft^2	3.11 (65)		
Areas of unspecified light use	11.97 (250)	10.95 (750)	267 (60)
Areas where specified loads are supported directly by beams		7.3 (500)	

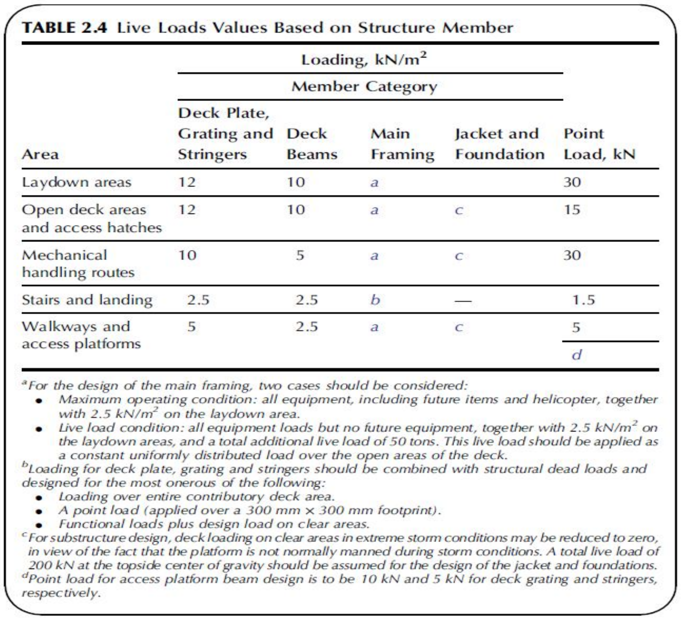


TABLE 2.4 Live Loads Values Based on Structure Member

	Loading, kN/m^2				
	Member Category				
Area	Deck Plate, Grating and Stringers	Deck Beams	Main Framing	Jacket and Foundation	Point Load, kN
Laydown areas	12	10	*a*		30
Open deck areas and access hatches	12	10	*a*	*c*	15
Mechanical handling routes	10	5	*a*	*c*	30
Stairs and landing	2.5	2.5	*b*	—	1.5
Walkways and access platforms	5	2.5	*a*	*c*	5 *d*

[a] *For the design of the main framing, two cases should be considered:*

- *Maximum operating condition: all equipment, including future items and helicopter, together with 2.5 kN/m^2 on the laydown area.*
- *Live load condition: all equipment loads but no future equipment, together with 2.5 kN/m^2 on the laydown areas, and a total additional live load of 50 tons. This live load should be applied as a constant uniformly distributed load over the open areas of the deck.*

[b] *Loading for deck plate, grating and stringers should be combined with structural dead loads and designed for the most onerous of the following:*

- *Loading over entire contributory deck area.*
- *A point load (applied over a 300 mm × 300 mm footprint).*
- *Functional loads plus design load on clear areas.*

[c] *For substructure design, deck loading on clear areas in extreme storm conditions may be reduced to zero, in view of the fact that the platform is not normally manned during storm conditions. A total live load of 200 kN at the topside center of gravity should be assumed for the design of the jacket and foundations.*

[d] *Point load for access platform beam design is to be 10 kN and 5 kN for deck grating and stringers, respectively.*

From Table 2.5, the wheel loads should be added to distributed loads where relevant. (Wheel loads can be considered as acting on an area of 300 × 300 mm.) Point loads, which should be applied on an area 100 × 100 mm, and at the most severe position, should not be added to wheel loads or distributed loads.

The value of q in Table 2.5 is to be evaluated for each case. Laydown areas should not be designed for less than 15 kN/m2. The value of f in Table 2.5 is obtained from:

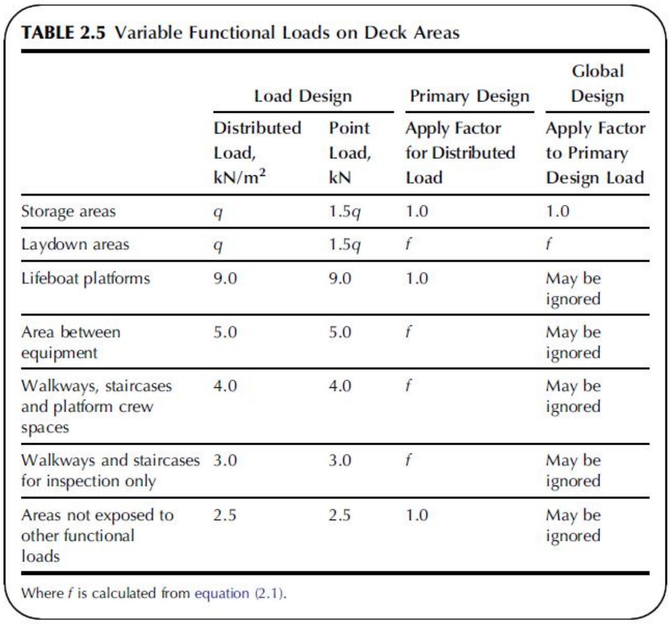


TABLE 2.5 Variable Functional Loads on Deck Areas

	Load Design		Primary Design	Global Design
	Distributed Load, kN/m^2	Point Load, kN	Apply Factor for Distributed Load	Apply Factor to Primary Design Load
Storage areas	*q*	1.5*q*	1.0	1.0
Laydown areas	*q*	1.5*q*	*f*	*f*
Lifeboat platforms	9.0	9.0	1.0	May be ignored
Area between equipment	5.0	5.0	*f*	May be ignored
Walkways, staircases and platform crew spaces	4.0	4.0	*f*	May be ignored
Walkways and staircases for inspection only	3.0	3.0	*f*	May be ignored
Areas not exposed to other functional loads	2.5	2.5	1.0	May be ignored

Where *f* is calculated from equation (2.1).

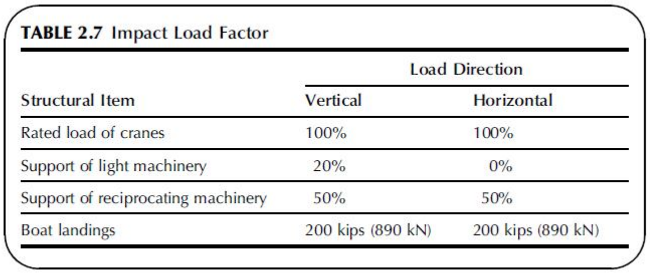


TABLE 2.7 Impact Load Factor

	Load Direction	
Structural Item	Vertical	Horizontal
Rated load of cranes	100%	100%
Support of light machinery	20%	0%
Support of reciprocating machinery	50%	50%
Boat landings	200 kips (890 kN)	200 kips (890 kN)

2.2.3 Impact Load

For structural components carrying live loads that could face impact, the live load must be increased to account for the impact effect, as shown in Table 2.7.

2.2.4 Design for Serviceability Limit State

The serviceability of the topside structures can be affected by excessive relative displacement or vibration in vertical or horizontal directions. Limits for either can be dictated by the following:

- Discomfort to personnel.
- Integrity and operability of equipment or connected pipework.
- Limits to control deflection of supported structures, such as flare structures.
- Damage to architectural finishes.
- Operational requirements for drainage (free surface or piped fluids).
- Unless stricter limits are established by the platform owner's company or regulator, the limits of deflection (presented in "Deflections" below) should apply.

Vibrations

All sources of vibration should be considered in the design of the structure. At a minimum, the following should be reviewed for their effect on the structure:

- Operating mechanical equipment, including that used in drilling operations.
- Vibrations from variations of fluid flow in piping systems, in particular slugging.
- Oscillations from vortex shedding on slender tubular structures.
- Global motions from the effect of environmental actions on the total platform structure.
- Vibrations due to earthquake and accidental events.

Design limits for vibration should be established from operational limits set by equipment suppliers and from the requirements for personnel comfort, health and safety.
It is important to note that large cantilevers, whether they are simple beams or trusses forming an integral part of the topside platforms, but excluding masts or booms, normally should be proportioned to have a natural period of less than 1 second in the operating condition.

Deflections

The final deflected shape, Δmax, of any element or structure has three components:

$$\Delta max = \Delta 1 + \Delta 2 - \Delta 0 \quad (2.2)$$

where Δ0 is any precamber of a beam or element in the unloaded state if it exists, Δ1 is the deflection from the permanent loads (actions) immediately after loading and Δ2 is the deflection from the variable loading and any time-dependent defor-mations from permanent loads.

The maximum values for vertical deflections, based on ISO 9001, are given in Table 2.8.

The limiting values for vertical deflection based on a load and resistance factor design (LRFD) are given in Table 2.9.

Lower limits may be necessary to limit ponding of surface fluids and to ensure that drainage systems function correctly.

Horizontal deflections generally should be limited to 0.3% of the height between floors. For multifloor structures, the total horizontal deflection should not exceed 0.2% of the total height of the topside structure. Limits can be defined to limit pipe stresses and to avoid riser or conductor overstress or failure. Some designers allow higher deflections for structural elements where serviceability is not compromised by deflection.

III. GRAVITY LOADS

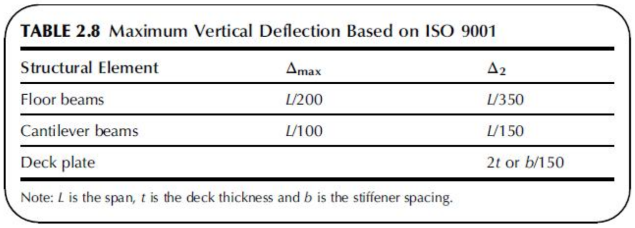


TABLE 2.8 Maximum Vertical Deflection Based on ISO 9001

Structural Element	Δ_{max}	Δ_2
Floor beams	$L/200$	$L/350$
Cantilever beams	$L/100$	$L/150$
Deck plate		$2t$ or $b/150$

Note: L is the span, t is the deck thickness and b is the stiffener spacing.

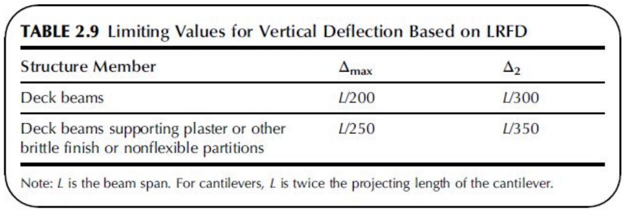


TABLE 2.9 Limiting Values for Vertical Deflection Based on LRFD

Structure Member	Δ_{max}	Δ_2
Deck beams	$L/200$	$L/300$
Deck beams supporting plaster or other brittle finish or nonflexible partitions	$L/250$	$L/350$

Note: L is the beam span. For cantilevers, L is twice the projecting length of the cantilever.

IV. LITERATURE REVIEW

Buckling Analysis Of Underwater Cylindrical Shells Subjected To External Pressure

International Journal of Innovative Research in Advanced Engineering (IJIRAE) ISSN: 2349-2163Volume 1 Issue 10 (November 2014)

Rinu Cherian Iin

In the field of structural mechanics the word shell refers to a spatial, curved structural member. In shells, the external loads are carried by both membrane and bending response. The effect of such responses needs careful observation. This project fulfills the need on study of behavior of shell structures by both mathematical and numerical methods. In the present development, the Donnell's relation forms the basis of stability equation for circular cylindrical shells. The effect of stiffeners on cylindrical structures has been studied, by varying the geometry and orientation of stiffeners. The paper aims to analyze the cylindrical section of an underwater pressure hull, using finite element analysis and strengthen it accordingly. The project considers the finite element method for static structural and deflection analysis of underwater cylindrical structure by using ANSYS 15software

Dynamic Behavior of Jacket Type Offshore Structure

Jordan Journal of Civil Engineering, Volume 6, No. 4, Anis A. Mohamad Ali, Ahmed Al-Kadhimi and Majed Shaker

Unlike structures in the air, the vibration analysis of a submerged or floating structure such as offshore structures is possible only when the fluid-structures is understood, as the whole or part of the structure is in contact with water. Using the commercial F.E.A.

program ANSYS (v.12.0) (to model the Winkler and Brick-full bond models) and program ABAQUS(v.6.9) (to model the Brickinterfacemodel), the stress matrix considering a dynamic load was superposed on the stiffness matrix of the structure. A time domain solution is recommended, using the generalized Morison’s equation by FORTRAN90 program to construct a program to calculate the wave forces, and Airy's linear and Second Order Stoke's wave theories are employed to describe the flow characteristics by usingMAPLE13 program (to solve and apply the boundary conditions of the problems on Laplace's equation), and the results are compared and discussed. Both free and forced vibration analyses are carried out for two case studies

Nonlinear Analysis of Offshore Structures under Wave Loadings

WCEE

Shehata E. Abdel Raheem

Taibah University, Madinah, KSA. (On leave; Assiut University, Egypt)

The structural design requirements of an offshore platform subjected wave induced forces and moments in the jacket can play a major role in the design of the offshore structures. For an economic and reliable design; good estimation of wave loadings are essential. A nonlinear response analysis of a fixed offshore platform under wave loading is presented, the structure is discretized using the finite element method, wave force is determined according to linearized Morison equation. Hydrodynamic loading on horizontal and vertical tubular member sand the dynamic response of fixed offshore structure together with the distribution of displacement, axial force and bending moment along the leg are investigated for regular and extreme conditions, where the structure should keep production capability in conditions of the one year return period wave and must be able to survive the 100 year return period storm conditions. The result of the study shows that the nonlinear response investigation is quite crucial for safe design and operation of offshore platform.

V. PROBLEM STATEMENT

The following 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 plat form installed in 110 feet (110' =33.5 m) water depth.

- The Top side structure consists of Helipad 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

FEA MODELING IN ANSYS

Three comparative model of offshore jacket platform for 40m height considering self weight and hydrostatic pressure is modeled in ansys using SOLID 186 element.

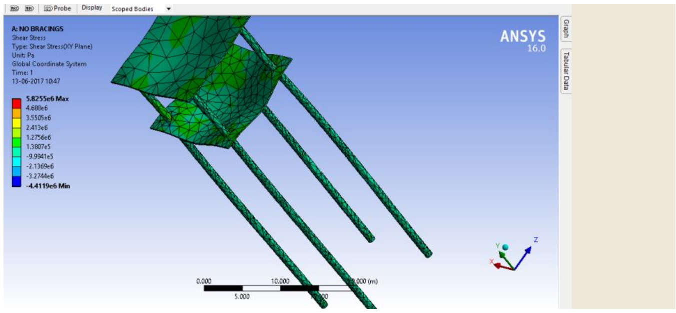


Fig.No.3 Horizontal Bracings

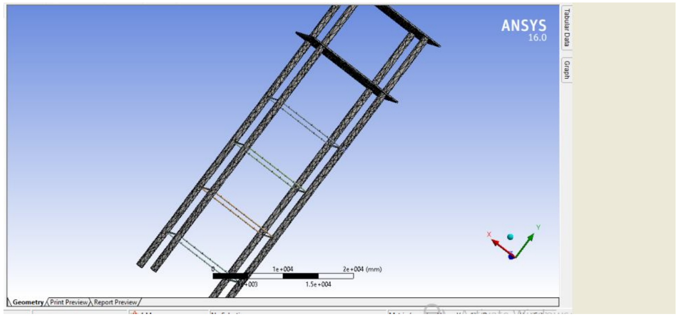
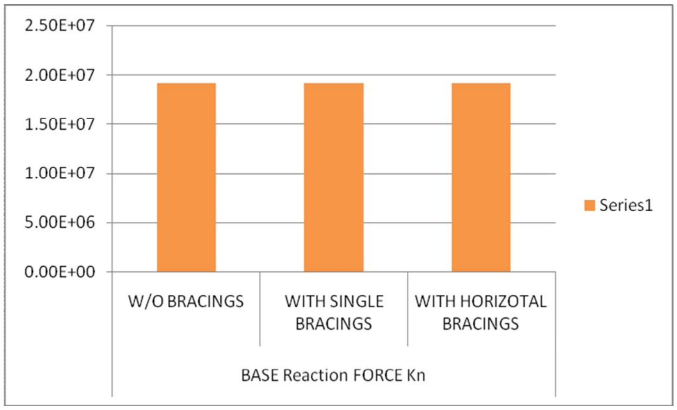


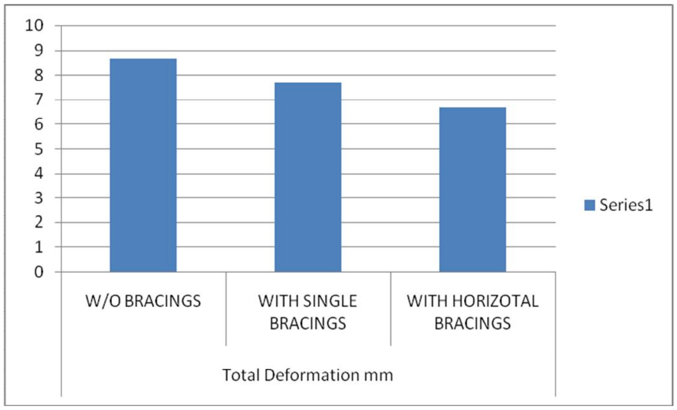
Fig.No.4 Horizontal Bracings

Model1: Without horizontal and diagonal bracings
Model2: With diagonal bracings
Model3: With horizontal bracings

VI. RESULT AND DISCUSSION



Graph No.1



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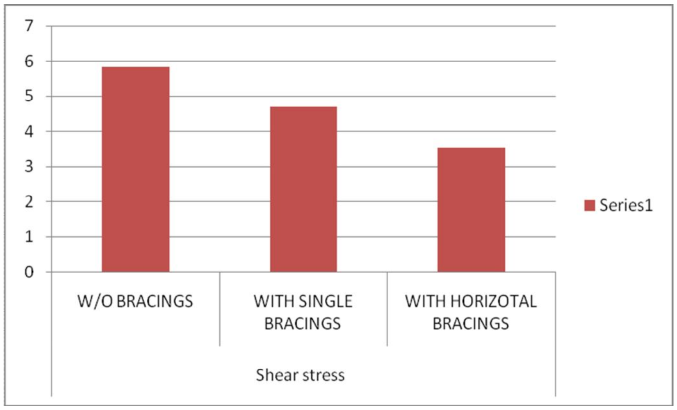

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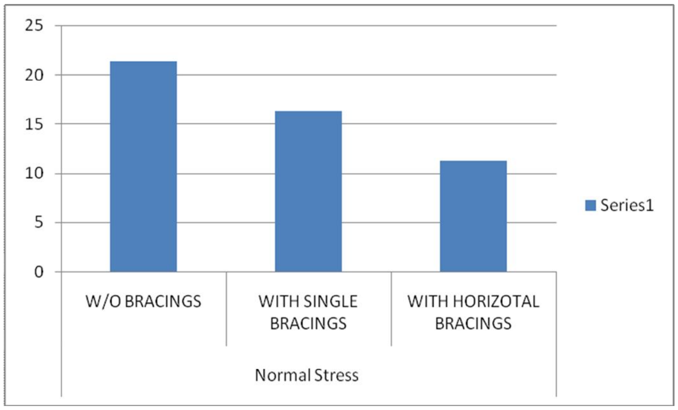

VII. CONCLUSION

In this paper finite element analysis of off shore platform is done using FEA tool ANSYS workbench,3 midels are compared for wave loading and following conclusions are obtained

1. The base reaction observed same in all models
2. The normal stresses and shear stresses observed 15% less in offshore platform with horizontal bracings
3. The maximum absolute displacement is obsrved 25% less in horizotal bracings than single bracing model and without bracing model

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