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UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2017

Program: M. Tech. (Structural Engineering)		**Semester –**	**I**
Subject (Course): Design and Construction of Offshore Structures		**Max. Marks**	**: 100**
Course Code	**:CIVL 7007**	**Duration**	**: 3 Hrs**
No. of page/s:		**Paper I**	

Note: Attempt All Questions. Assume suitably any data not given and state clearly.

	Section A		
1.	**Sketch the configuration of a fixed bottom offshore platform and a complaint structure platform, and explain why is the time period of vibration of a complaint structure higher than a fixed bottom structure.**	**[4]**	**CO1**
2.	**In sea studies, it has been noticed that the energy of sea waves depends on their time period. Sketch the wave energy vs wave time period diagram, showing the time period interval during which the energy content of sea waves is maximum. Also show how the fixed bottom and complaint structures are placed in this diagram.**	**[4]**	**CO2**
3.	**During the construction of legs of jacket of offshore platforms, residual stresses are induced. Explain how these are induced, and how these can be minimized.**	**[4]**	**CO3**
4.	**During construction of joints in jacket members of offshore platform, sometimes 'ovalization' phenomena is noticed. Explain what happens during ovalization, and which joint most and least liable to be ovalized.**	**[4]**	**CO4**
5.	**What are the problems related to fixed offshore platforms, that led to the development of jack up rigs. What are the main areas where jack up rigs have been deployed successfully.**	**[4]**	**CO5**
	SECTION B		
6.	**A fixed offshore platform is installed in sea at a depth of 110m from MSL. The jacket of the platform carries a hull of size 55x55m. The jacket projects to a height of 25m above MSL . Assuming the slope of jacket legs as 1:10, and estimated mass as 3000 t, sketch the configuration of the jacket and check if it can safely withstand the resonance caused by the sea waves.**	**[10]**	**CO1**

	Also Check if it can carry a deck weighing 2000 t safely for carrying out the drilling operations without any resonance due to sea waves.		
7.	**The jacket of an offshore platform projects 20m above MSL and carries a three layered deck with the height of 10m each for lower decks and 5m height for the top layer deck. The wind velocity has been recorded as 55m/s at a height of 10m above MSL for 3 second gust.** **(a) Plot the variation of wind velocity for each layer of deck of offshore platform.** **or** **(b) Sketch the variation of wind velocity for the projecting portion of the jacket above MSL. Assume one hour averaging period.**	**[10]**	**CO2**
8.	**The brace of unequal size when joined to the chord can sometimes punch through the chord or create notch at the joint resulting in large stress variations. Explain through sketches the conditions when this can happen.**	**[10]**	**CO3**
9.	**The joints in legs of offshore structures are often strengthened by providing an additional collar of CHS sections. Explain through figure how it is done and why it is necessary to do it.**	**[10]**	**CO5**
	SECTION C		
10.	**A T joint is made up of a brace of size 500x16mm connected to a chord of 800x20mm . The loading on the brace is as follows:** **Axial load tensile = 1200KN** **In plane moment = 200 KNm** **Out plane moment = 150KNm** **Check if the joint made in the existing chord is safe and redesign the joint if necessary. Assume 345 grade steel.**	**[20]**	**CO4**
11.	**The leg of an offshore jacket structure is made up of panels 12m long.As a result of external loading of the member the following loads have been calculated as acting on one of the leg of the jacket panel:** **Axial load = 800 kN** **Inplane moment = 800 kNm**	**[20]**	**CO4**

Outplane moment = 600 kNm.

Assuming the yield strength of steel as 345 MPa, design the leg member of the panel, such that it can carry the above loads safely.

Or

A brace member of a fixed offshore platform is 12m long, made up of CHS section of size 800x12mm. The member has been designed for the following loads acting on it:

Axial load = 800 kN

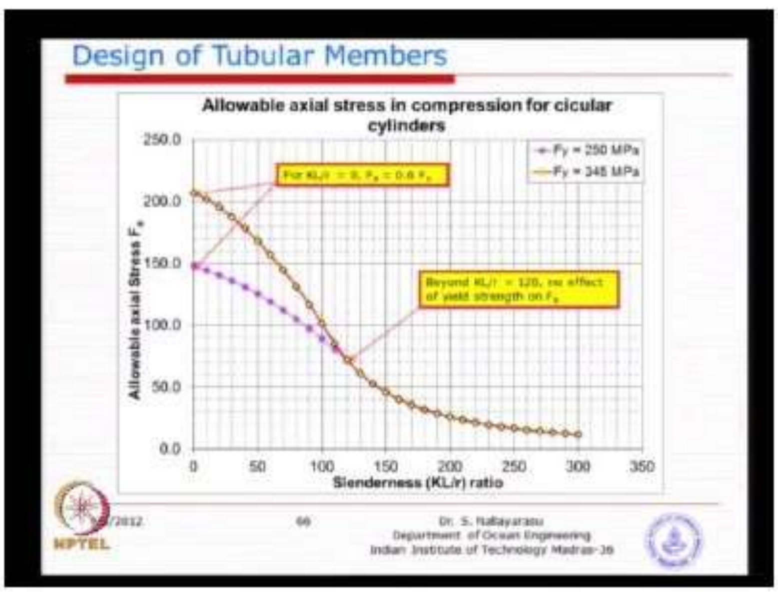
Inplane moment = 800 kNm

Outplane moment = 600 kNm.

However, during bending of steel plates for fabrication of the member, a strain of 10×10^{-5} was produced. Check if the brace can still carry the above loads safely. Assume the jacket to be fabricated using steel having f_y = 345 MPa.

Following data may be used.

$F_b = [0.84 – 1.74(f_y D)/(Et)]f_y$



Qu the joint geometry factor is given as:

<u>For Calculation of allowable axial load (P_a) in chord</u>

<u>For T and Y joints</u>

Brace in axial tension

$Q_u = 30\ \beta$ (6 < Qu < 30)

Brace in axial compression

$Q_u = 2.8 + (20 + 0.8\ \gamma)\ \beta^{1.6}$ (0 < Qu < 36)

But not exceeding

$2.8 + 36\ \beta^{1.6}$

<u>For balanced K joints</u>

$Q_u = (16 + 1.2\ \gamma)\ \beta^{1.2}\ Q_g$

But not exceeding $40\ \beta^{1.2}\ Q_g$

Where Q_g **is gap factor given as:**

$Q_g = 1 + 0.2\ (1 - 2.8\ (g/D))^3$ **for g/D not less than 0.05**

But not less than 0.05

<u>For Calculation of allowable in plane moment in chord (M_{ai})</u>

$Q_u = (5 + 0.7\ \gamma)\ \beta^{1.2}$

<u>For Calculation of allowable out plane moment in chord (M_{ao})</u>

$Q_u = 2.5 + (4.5 + 0.2\ \gamma)\ \beta^{2.6}$

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Program	:	**M. Tech. (Structural Engineering)**					
Semester	:	**I**					
Name of the Subject (Course)	:	**Design and Construction of Offshore Structures**					
Course Code	:	**CIVL7007**					
Name of Question Paper Setter	:	**Dr. Vijay Raj**					
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No. of page/s:	**Paper : II**

Note: Attempt All Questions. Assume suitably any data not given and state clearly.

	Section A		
1.	**The configuration of fixed bottom offshore platforms and complaint platforms is so arranged that their natural time period are below 4 sec and above 20 sec respectively. Explain with the help of a sea wave energy vs wave time period diagram, why such configurations are decided, and also show the location of these platforms in this diagram.**	**[4]**	**CO1**
2.	**The wave force as calculated by the Morison equation, consists of two components, the drag force and the inertia force. Explain through a diagram the variation of these forces as the wave progresses. Also explain how the variation of total force can be represented in this diagram.**	**[4]**	**CO2**
3.	**Circular hollow sections(CHS) are considered to be most suitable sections for construction of legs of jacket of a fixed offshore platform. Explain why. Give any four reasons.**	**[4]**	**CO3**
4.	**In case of axially loaded joints, the axial stress can be estimated uniformly as P/A. But in case of axially loaded CHS sections in offshore structures unequal stress distribution occurs. Explain with examples why this happens.** .	**[4]**	**CO4**
5.	**The legs of jack up rig can be made either truss type or tubular type. Which type are preferred. Give reasons.**	**[4]**	**CO5**
	Section B		
6.	**A fixed offshore platform consisting of a steel jacket is installed in sea at a depth of 90m from MSL, with the projection of jacket above MSL being 30m. A hull of size 60x60m weighing 3000 t is proposed to be mounted on the jacket. Assuming the slope of jacket legs as 1:10, suggest a suitable configuration for the jacket and calculate its natural time period assuming the preliminary mass of jacket as 2500 t.** **Check if the proposed deck can be safely mounted on the jacket for carrying out the drilling operations without resonance due to sea waves.**	**[10]**	**CO1**

7.	**The Arabian sea in India is subjected to tidal currants regularly. Assume the velocity of tidal currants at the surface of sea as 2m/s and depth of sea as 100m, sketch the variation of tidal current velocity with depth at intervals of 10m. Also indicate the point where the velocity will be zero.** **Or** **Strong wind driven currants are regularly noticed in Gulf of Mexico. Assume the velocity of wind driven currants at the surface of sea as 3m/s and depth of sea as 120m, sketch the variation of wind driven currant velocity with depth at intervals of 10m. Also indicate the point where the velocity will be zero.**	**[10]**	**CO2**
8	**The leg of jacket of an offshore platform 12m long, having 1.2m nominal diameter and 25 mm thickness is being fabricated in factory. Due to construction imperfections the thickness of plate as measured varies at two points. The thickness is less by 2mm at first point and more by 3mm at second point. Calculate the eccentricity produced .** **Further the leg is observed to deviate by 10 mm out of straightness. Calculate the total eccentricity produced and check if it is acceptable.**	**[10]**	**CO3**
9	**Two braces I and II are connected to the chord at 45^0 and 30^0 respectively. The permissible stresses in chord in which brace will be higher and why. Give reasons.**		**CO5**
	SECTION C		
10.	**A Y joint is made up of a brace of size 400x12mm connected to a chord of 800x20mm at an angle of 30^0. The loading on the brace is as follows:** **Axial load tensile = 1300KN** **In plane moment = 250 KNm** **Out plane moment = 150 KNm** **Check if the joint made in the existing chord is safe. If not design the joint.**	**[20]**	**CO4**
11.	**The brace of an offshore jacket structure fitted in one of the panels is 12m long. Following loads have been calculated as acting on brace due to external loadings:** **Axial load = 800 kN** **Inplane moment = 800 kNm** **Outplane moment = 600 kNm.** **Assuming the yield strength of steel as 345 MPa, design the brace of the panel.**	**[20]**	**CO4**

Or

An offshore jacket structure is constructed in sea having a brace member 10m long made up of CHS section of size 600x16mm. The brace has been designed for the following loads acting on the brace member:

Axial load = 800 kN

Inplane moment = 800 kNm

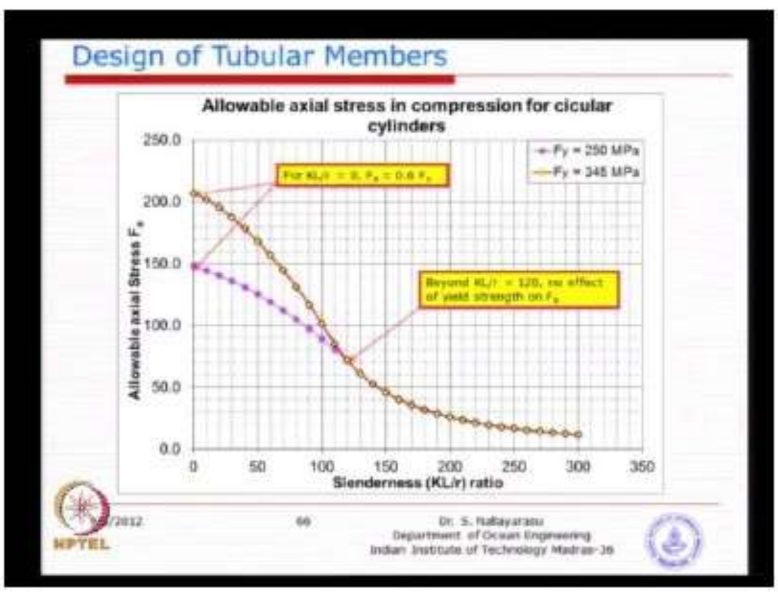
Outplane moment = 600 kNm.

Following residual stresses were estimated in the member during the fabrication process:

a. **While bending of the steel plates : 10MPa**
b. **Due to seam welding : 5 MPa**
c. **Due to butt welding : 8 MPa**

Check if the brace is still safe to carry the above loads. Assume the yield strength of steel as 345 MPa.

Following data may be used



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