Faculty of Maritime Engineering and Marine Sciences

Ship's Structure

Quiz #4 – Plate bending & Hull structure analysis **August, 29th, 2023**

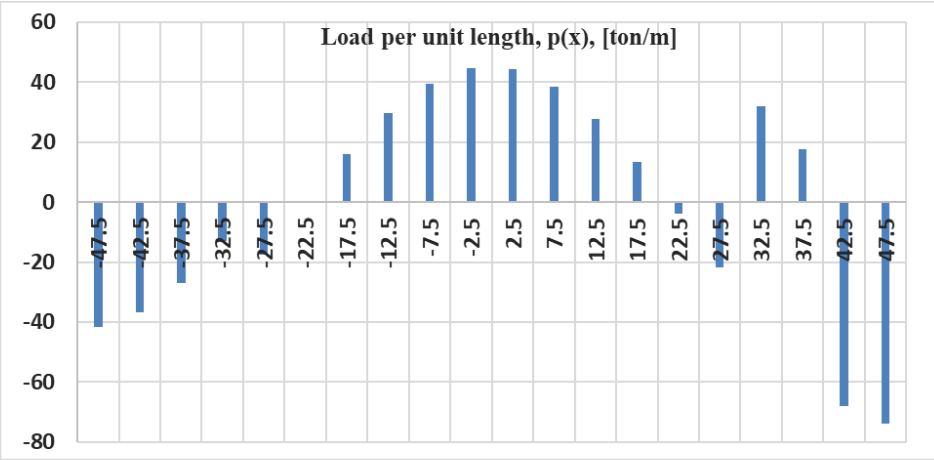
Student: …………………………………………………………………. ID: ……………………………………

Part 1. Closed books

1.- Equilibrium of a differential element of a plate with uniform thickness *t* is established by taking summatory of forces and moments. Resulting differential equation from summatory of moments in the *y*-direction is: (10)

$\frac{\partial M_{yx}}{\partial y}+\frac{\partial M_x}{\partial x}-Q_x=0$	$\frac{\partial M_{xy}}{\partial x}+\frac{\partial M_y}{\partial y}+Q_y=0$	$\frac{\partial M_{xy}}{\partial x}-\frac{\partial M_y}{\partial y}+Q_y=0$	$-\frac{\partial M_{xy}}{\partial x}+\frac{\partial M_y}{\partial y}+Q_y=0$

2.- In the following figure, it is shown the loading on a barge hull (L: 100 m, B: 18 m, D: 9 m, Δ: 9000 tons, LCG: -0.694 m), considered as a beam. Calculate the extreme value of the shear force in the region aft from midships of the hull. (10)



580 tons	-750 tons	680 tons	-825 tons

3.- For the design of Side structures of a ship, DNV rules in Section 6, proposes the following equation for the section modulus requirement of stiffeners, in cm^3:

$$Z = \frac{C\, l^2\, s\, p}{\sigma} \quad (\text{cm}^3)$$

where: l is the stiffener span in m, s is the stiffener spacing in m, p is the pressure acting on the panel in kN/m^2, and σ is the allowable stress in MPa. Assuming that the stiffeners are much smaller than the girders, what would be an adequate value for C applying concepts from our course Ship's Structure? (10)

C=15.8	C=83	C=5	C=32.0

4.- Suppose you have a rectangular plate, simply supported on all its edges, while supports a pressure of 10 kN/m^2. After doing calculations, the required thickness is 8 mm so the allowable maximum stress is reached. What would be the recommended thickness if the pressure acting on the plate is now 12500 N/m^2? (10)

10.02 mm	8.94 mm	8.53 mm	9.32 mm

Ship's Structure

Quiz 4 – Ship hull stress analysis **August 29th, 2023**

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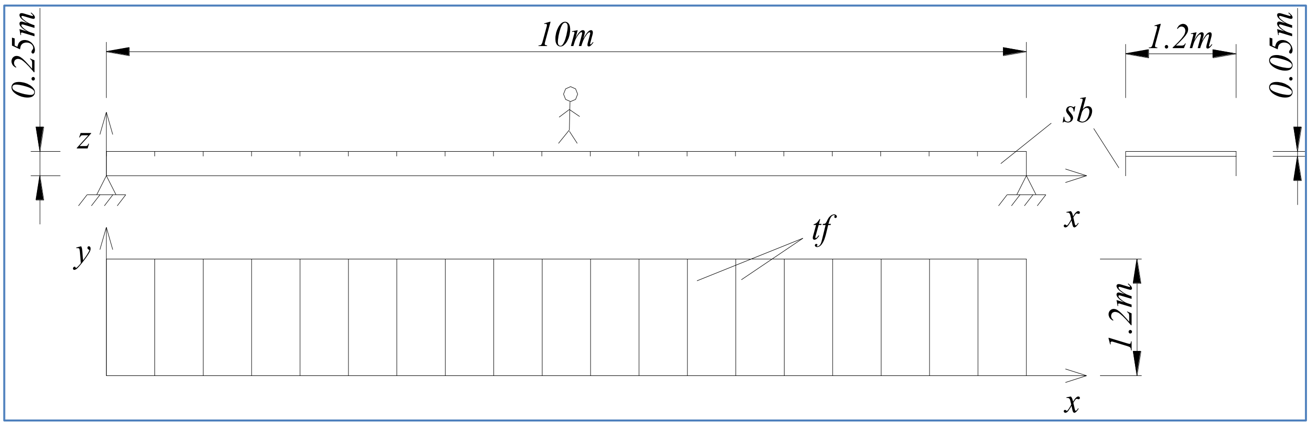
Part 2. Closed books

You have to analyze a 10-m long steel pedestrian bridge, all of it built from steel plating, 3 mm thick. The structure has a width of 1.2 m, and is designed to support 22 "standard Ecuadorian" pedestrians plus its own structural weight (γ_{steel}: 76440 N/m^3). The structure has two longitudinal side beams, *sb*, and 18 transversal frames, *tf*, strengthening the walking surface. The longitudinal on the sides and the transverse frames are 25 and 5 cm in height, respectively. Keep the directional system shown in the figure.



For this simplified analysis, load may be assumed as uniformly distributed on the bridge.

i. Analyze the "girders" located on the sides of the bridge. In a simplified way, take the plate as a flange, with 60% of effectivity. (20)

ii. Analyze the "stiffeners", aligned in the transverse *y*-direction. (15)

iii. Analyze the plating between reinforcements, considering the combination of stresses acting on it. Use von Mises equivalent stress: $\sigma_{eq} = \sqrt{\sigma_x{}^2 + \sigma_y{}^2 - \sigma_x\sigma_y + 3\tau_{xy}{}^2}$. (25)

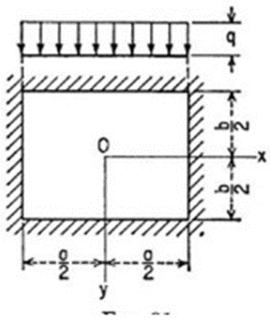


TABLE 35. DEFLECTIONS AND BENDING MOMENTS IN A UNIFORMLY LOADED RECTANGULAR PLATE WITH BUILT-IN EDGES (FIG. 91)

$\nu = 0.3$

b/a	$(w)_{x=0,y=0}$	$(M_x)_{x=a/2,y=0}$	$(M_y)_{x=0,y=b/2}$	$(M_x)_{x=0,y=0}$	$(M_y)_{x=0,y=0}$
1.0	$0.00126qa^4/D$	$-0.0513qa^2$	$-0.0513qa^2$	$0.0231qa^2$	$0.0231qa^2$
1.1	$0.00150qa^4/D$	$-0.0581qa^2$	$-0.0538qa^2$	$0.0264qa^2$	$0.0231qa^2$
1.2	$0.00172qa^4/D$	$-0.0639qa^2$	$-0.0554qa^2$	$0.0299qa^2$	$0.0228qa^2$
1.3	$0.00191qa^4/D$	$-0.0687qa^2$	$-0.0563qa^2$	$0.0327qa^2$	$0.0222qa^2$
1.4	$0.00207qa^4/D$	$-0.0726qa^2$	$-0.0568qa^2$	$0.0349qa^2$	$0.0212qa^2$
1.5	$0.00220qa^4/D$	$-0.0757qa^2$	$-0.0570qa^2$	$0.0368qa^2$	$0.0203qa^2$
1.6	$0.00230qa^4/D$	$-0.0780qa^2$	$-0.0571qa^2$	$0.0381qa^2$	$0.0193qa^2$
1.7	$0.00238qa^4/D$	$-0.0799qa^2$	$-0.0571qa^2$	$0.0392qa^2$	$0.0182qa^2$
1.8	$0.00245qa^4/D$	$-0.0812qa^2$	$-0.0571qa^2$	$0.0401qa^2$	$0.0174qa^2$
1.9	$0.00249qa^4/D$	$-0.0822qa^2$	$-0.0571qa^2$	$0.0407qa^2$	$0.0165qa^2$
2.0	$0.00254qa^4/D$	$-0.0829qa^2$	$-0.0571qa^2$	$0.0412qa^2$	$0.0158qa^2$
∞	$0.00260qa^4/D$	$-0.0833qa^2$	$-0.0571qa^2$	$0.0417qa^2$	$0.0125qa^2$