Faculty of Maritime Engineering and Marine Sciences

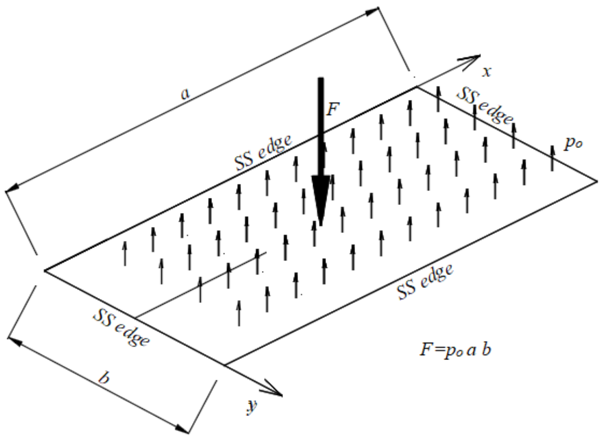
Ship's Structure

Quiz #4 – Plate bending & Hull structure analysis **August, 27th, 2024**

Student: ………………………………………………. ID: ……………… Time of completion: ,,,,,,,,,,

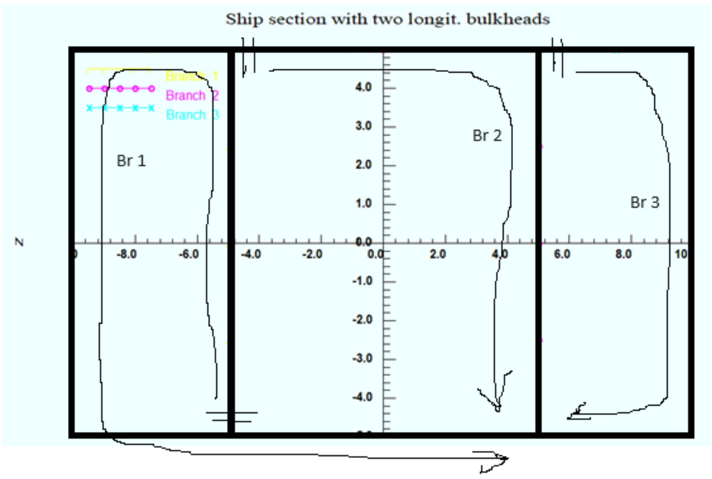
Part 1. Closed books

1.- On a simply supported plate, *a* x *b* two loadings are applied simultaneously, one uniformly distributed, p_o, and a concentrated forced $F=p_o\,a\,b$, at the center of the plate, see figure. Calculate the amplitude of the term p_{33} that represents this combination of load. (10)



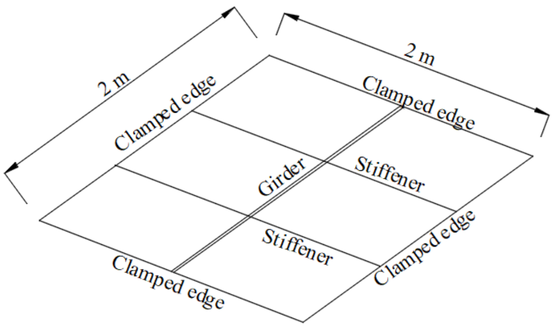
$p_{33}=4p_o\left(1-\frac{4}{\pi^2}\right)$	$p_{33}=4p_o\left(1-\frac{4}{9\pi^2}\right)$	$p_{33}=p_o\left(1-\frac{16}{9\pi^2}\right)$	$p_{33}=16p_o\left(1-\frac{1}{\pi^2}\right)$

2.- In a steel ship section (*B*: 20, *D*:10 m) with two longitudinal bulkheads, the shear flow has been estimated as 156.3 kN/m at the connection of the deck and side, for a shear force of 10 MN. Thickness is uniform in the whole section, 10 mm, and sectional inertia is 13.33 m^4. Calculate maximum shear stress on the section's side. (10)



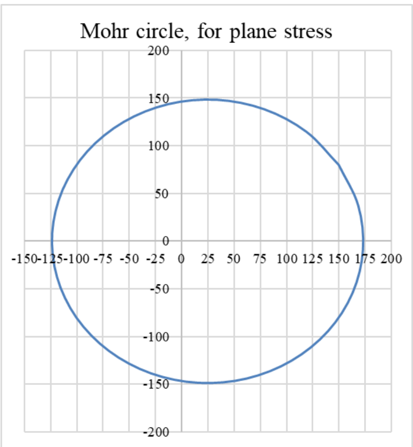
235 MPa tons	25 MPa	110 MPa	50 MPa

3. A reinforced steel plate panel is formed by one girder and two stiffeners, as can be seen in the figure. The effective inertia of stiffeners is 70 cm^4 and the ratio between inertia of girder and stiffeners is 7.14:1. Pressure on the panel is uniform and has a value of 20 kN/m^2. Considering the flexibility of the girder, the contact force between girder and stiffeners is calculated as 11436N, what are the reactions on the stiffeners' ends? (10)



11436 N	13333 N	7615 N	26666 N

4.- After calculation of primary, secondary and tertiary stresses in a steel ship, the following results are obtained: σ_x: 150 MPa, τ_{xy}: 80 MPa, while the value of σ_y is unknown. With this information, the following Mohr circle is prepared. Which of the following proposals is correct? (10)



Von Mises stress is defined as:

$$\sigma_{VM} = \sqrt{\sigma_1{}^2 + \sigma_2{}^2 - \sigma_1\sigma_2}$$

σ_1 =25, σ_2 =150 MPa System is safe	σ_1 =175, σ_2 =-125 MPa System fails	σ_1 =235, σ_2 =110 MPa System is safe	σ_1 =175, σ_2 =-125 MPa System is safe

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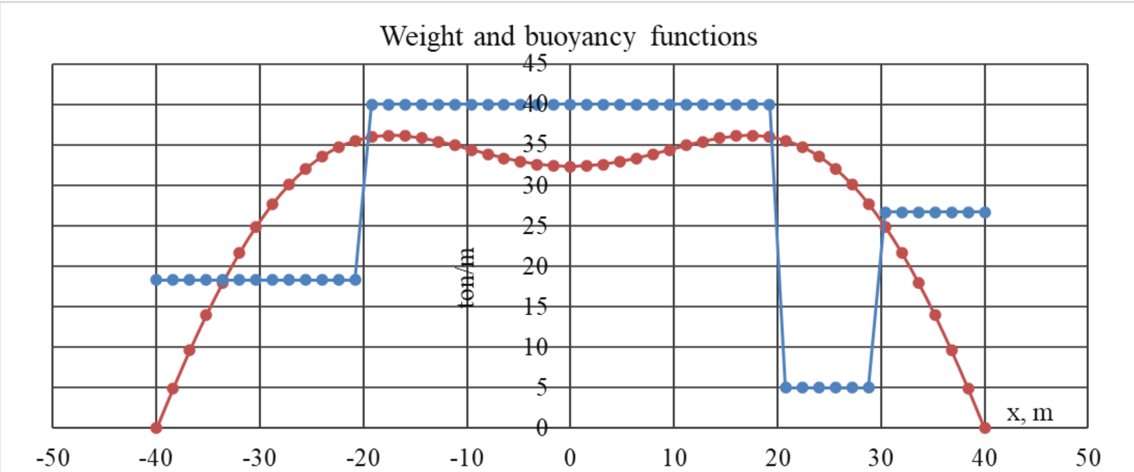
Part 2. Closed books

1.- The primary behavior of a steel cargo ship with a simplified form is to be analyzed (L: 80 m, B: 10 m, T: 4.656m). She has quadratic distribution of beam along the length of the ship, $B(x) = B_o(1 - (2x/L)^2)$, $-L/2<x<L/2$, and sides are vertical. The weight distribution includes four items, all uniformly distributed: hull with 800 tons, cargo in the central region: 1000 tons, propulsion machinery abaft of vessel: 266 tons, and forward anchoring machinery: 230 tons. Waves are acting on the ship, in sagging condition with amplitude of 1.5 m.

After equilibrating the ship in the wave, the following distributions of weight and buoyancy are obtained. Considering an allowable stress of 175 MPa, calculate the minimum section modulus that the ship hull structure must have in the midship area. (30)



2.- You are asked to design at preliminary level the structure of deck of a ship (L: 48 m, B: 9 m, D: 5 m), with a transversely framing system, which has one central longitudinal bulkhead. You have to concentrate in a panel between two transverse bulkheads which are separated 8 meters. Loading on the deck has been estimated as 15 kN/m^2 uniformly distributed on the surface. Prepare a simple sketch of your design. Select the thickness of the plate considering an allowable stress of 100 MPa. Then, if the stiffeners which will be welded to the plate are flat bars, 12x0.8 cm, are they adequate for your design, considering an allowable stress of 160 MPa? (30)

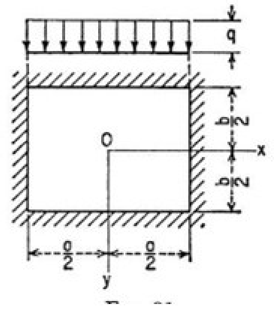


TABLE 35. DEFLECTIONS AND BENDING MOMENTS IN A UNIFORMLY LOADED RECTANGULAR PLATE WITH BUILT-IN EDGES (FIG. 91)

$\nu = 0.3$

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	$0.00254qa^4/D$	$-0.0829qa^2$	$-0.0571qa^2$	$0.0412qa^2$	$0.0158qa^2$
∞	$0.00260qa^4/D$	$-0.0833qa^2$	$-0.0571qa^2$	$0.0417qa^2$	$0.0125qa^2$

Von Mises equivalent stress: $\sigma_{eq} = \sqrt{\sigma_x{}^2 + \sigma_y{}^2 - \sigma_x\sigma_y + 3\tau_{xy}{}^2}$

Jrml/2024