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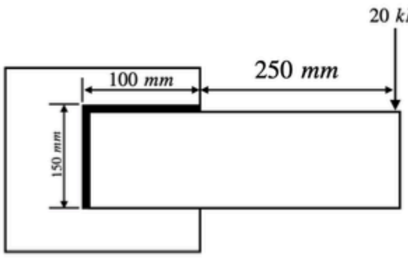
Internal Assessment Test 4 –Feb. 2022

Sub:	Design of Machine Elements - 1					Sub Code:	18ME52	Branch:	Mech
Date:	2.2.22	Duration:	90 min's	Max Marks:	50	Sem/Sec:	V/A&B		OBE

Answer All the Questions
Usage of Design data handbook is permitted

		MARKS	CO	RBT
1.	A shaft made up of C40 steel is subjected to a bending moment of 10 KN-m and a twisting moment of 8 kN-m. factor of safety used is 2.5. Determine the required diameter of the shaft according to: a) Maximum shear stress theory of failure. b) Maximum distortion energy of failure.	[10]	CO1 CO2	L2
2.	A round rod of diameter 1.2d has semi-circular groove of diameter 0.2d. The rod is subjected to a bending moment of 10 kN-m. The material of the rod is C30 steel (yield strength is 294 MPa). Determine the safe value of 'd', if the factor of safety is 2.	[10]	CO1 CO2	L3
3.	A plate of 80 mm wide and 15 mm thick is joined with another plate by means of a single transverse weld and double parallel weld. Determine the length of parallel fillet weld if the joint is subjected to both static and fatigue loading. Take $\sigma_t = 90$ MPa, $\tau = 55$ MPa as the allowable stresses and stress concentration factor as 1.5 for transverse and 2.7 for parallel weld.	[15]	CO5	L3
4.	A 16 mm thick plate is welded to a vertical support by two fillet welds as shown in figure. Determine the size of the weld, if the permissible shear stress for the weld material is 75 MPa. 	[15]	CO5	L3

Internal Assessment test - 4
18ME52 - Design of machine Elements - 1
Solutions key

Q.No	Solution
1	A shaft made up of C40 steel is subjected to a bending moment of 10 KN-m and a twisting moment of 8 kN-m. factor of safety used is 2.5. Determine the required diameter of the shaft according to: a) Maximum shear stress theory of failure. b) Maximum distortion energy of failure. C40 steel Yield stress = 328.6 MPa FOS = 2.5 design stress $= \sigma = \frac{328.6}{2.5} = 131.44$ MPa Bending moment M_b = 10kN-m = $10 \times 10^6\ N - mm$ Torque = $M_t = 8 \times 10^6\ N - mm$ $\therefore \sigma_b = \frac{32M_b}{\pi d^3} = \frac{101.85 \times 10^6}{d^3}$ MPa Shear stress $\tau = \frac{16M_t}{\pi d^3} = \frac{16 \times 8 \times 10^6}{\pi d^3} = \frac{40.74 \times 10^6}{d^3}$ MPa Max principal stress $\sigma_1 = \frac{127.82 \times 10^6}{d^3}$ Min Principal stress $\sigma_2 = \frac{-25.96 \times 10^6}{d^3}$ i) According to maximum shear stress theory, $\tau_{max} = Max\ [\lvert\frac{\sigma_1 - \sigma_2}{2}\rvert, \lvert\frac{\sigma_1}{2}\rvert, \lvert\frac{\sigma_2}{2}\rvert]$ Also, $\tau_{max} = \frac{\sigma_{yt}}{2 \times FOS}$ On substituting and simplifying, **d = 105.8 mm** ii) Distortion energy theory, For Bi-axial Stress state: $(\frac{\sigma_{yt}}{FOS})^2 = \sigma_1^2 + \sigma_2^2 - \sigma_1\sigma_2$ On substituting and simplifying, **d = 102.86 mm**

2	M_b = 10kNm = 10^7 N-mm D = 1.2 d ; r = $\frac{0.2d}{2} = 0.1d$ D/d = 1.2 and r/d = 0.1 From Fig 4.20 DDB, K_σ = 1.885 Also $\sigma_{max} = \frac{\sigma_y}{FOS} = 147$ MPa Now, $K_\sigma = \frac{\sigma_{max}}{\sigma_{nom}}$ 1.885 = $\frac{147}{\sigma_{nom}}$ $\sigma_{nom} = 77.894$ MPa For bending load, $\sigma_{nom} = \frac{32M_b}{\pi d^3}$ on simplifying, d = 109.3 ≈ 110 mm
3	(i) For static loading Allowable shear stress $\tau = \frac{P}{0.707wl}$ consider leg dimension = thickness of plate i.e w = h = 10 mm now, $50 = \frac{50 \times 10^3}{0.707 \times 10 \times l}$ $l = 141.44\ mm$ Adding 15 mm for starting and stopping, $l = 156\ mm$ (ii) For dynamic loading, for parallel fillet weld stress concentration $K_{-\sigma} = 2.7$ Permissible shear stress, $\tau = \frac{55}{2.7}$ = 20.32 MPa Permissible tensile stress = $\frac{90}{1.5}$ = 60 MPa P = 0.707 w $l_n\sigma$ + 0.707 w$l_p\tau$ On simplifying, l_p = 264.3mm

4	From 12.3 DDB, CG of weld is found as Step 1: $C_x = 45$ mm $C_y = 20$ mm Step 2: r = 91.79 mm cos ø = 0.8716 eccentricity e = 250+80 = 330 mm Step 3: $P_d = \frac{P}{l} = 80\ N/mm$ Step 4: $P_n = \frac{P.e.r}{J} = 710.98\ N/mm$ Step 5: $P_R = \sqrt{(P_d^2 + P_n^2 + 2.P_d.P_n.Cos\theta)} = 781.69\ N/mm$ Step 6: Allowable shear stress of weld, $\tau = \frac{P_R}{0.707w(1)}$ Substituting the values, $w = 14.74\ mm \approx 15\ mm$