SOLUTION T1 TOTAL [30]

ROTARY

1. (a) Two main classes of joints are :-

(i) Permanent joints (1)

e.g. Riveted, Welded, Brazed, Soldered, Glued and Interference fits.

(ANY 2) @ 0.5 // (1)

(ii) Temporary (Detachable) joints (1)

e.g. Threaded (Bolt, Nut, Screw), Pinned, Keyed, Splined etc. (ANY 2) @ 0.5 // (1)

(b) Strong joints — LAP JOINTS (1)

Strong and tight joints — BUTT JOINTS (1)

(c) Materials used for rivets are:

— Mild Steel

— Aluminium @ 0.5 // (2)

— Copper

— Brass

(d) (i) Advantages of riveted joints over welded joints are :-

— Can withstand vibration loads.

— Can be used where heat is prohibited. @ 1 // (2)

(ii) Disadvantages are :-

— Joining plate becomes weak due to holes.

— Weight of the structure increases.

— Costly. (ANY 2) @ 1 // (2)

Total (12)

2. $d = 16\,mm$; $t = 8\,mm$; $b = 15\,cm$;
$\tau_{all} = 90\ N/mm^2$; $\sigma_t = 120\ N/mm^2$
and $\sigma_c = 160\ N/mm^2$; $N = 5$ rivets.

(a) Strength of the joint

Shear

$F_s = \tau_{all} \times A_s$; $A_s = 2 \times \frac{\pi d^2}{4} \times N$

Double shear

$\therefore F_s = 90 \times 2 \times \pi \frac{(16)^2}{4} \times 5 = 180,955\ N$ (1)

Bearing / Crushing

$F_c = \sigma_c \times A_c$; $A_c = d \times t \times N$

$\therefore F_c = 160 \times 16 \times 8 \times 5 = 102,400\ N$ (1)

Tensile

$F_t = \sigma_t \times A_t$; $A_t = (b - nd) \times t$

n = rivets in weakest row

$\therefore F_t = 120 \times (150 - 3 \times 16) \times 8 = 97,920\ N$ (1)

$\therefore$ The strength of the joint is $F_t = 97,920\ N$ Ans. (2)

(b) Efficiency of the joint

$\eta = \frac{\text{Strength of the joint}}{\text{Tensile strength of unriveted plate}}$

$F = \sigma_t \times A_t$; $A_t = b \times t$

$\therefore F = 120 \times 150 \times 8 = 144,000\ N$ (1)

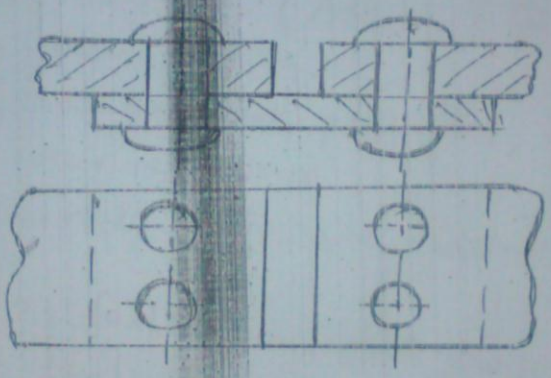
$\therefore \eta = \frac{77,920}{114,000} \times 100\% = 68\%$

$\therefore$ Efficiency of the joint is 68% Ans. (2)

Total (08)

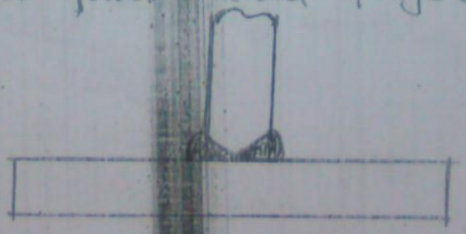
3. (a) Two types of Welding processes are:-
(i) FUSION WELDING
(ii) PRESSURE WELDING @ ½ (2)

(b) Single riveted one strapped butt joint



(2)

(c) Double fillet welded T-joint with K-seam.



(2)

(d) $P = \bar{\tau}_{all} \times A_s$ (1)

$P = 120$ kN, $\bar{\tau}_{all} = 100\ N/mm^2$

$A_s = t \times L$, $L = 300$ mm

$t = 0.7 \times s$

$\therefore 120000 = 100 \times 0.7 s (300)$ (1)

$\therefore s = \frac{12}{3 \times 0.7} = \frac{4}{0.7} = 5.71 \text{ mm} \approx 6 \text{ mm}$

$\therefore$ The size of the weld joint is 6 mm Ans. (2)

Total (10)

(1) — (3) ROTARY

SOLUTION T2 TOTAL 20

1. (a) A spindle is a short rotating shaft. (2)

(b) An axle is a shaft which is not subjected to torsion. (2)

(c) Properties of materials for shafts are:-
(i) High strength. (ANY 4) @ 1 ½
(ii) Good machinability.
(iii) Good heat treatment properties. (4)
(iv) High wear resistance.
(v) Low notch sensitivity factor.

(d) Two types of failure in shafts are:-
(i) Surface failure (1)
— Is due to wear of working surfaces.
(ii) Fatigue failure (1)
— Is due to cracks and pits caused cyclic loading. (1)

Total (12)

2. Solid circular shaft
$T = 2\ kNm$; $\tau_{all} = 60\ MPa$;
$\theta_{all} = 1^\circ = \frac{\pi}{180} \times 1$ rad ; $l = 1\ m$;
$G = 80\ GPa$.

(T – 2)

Strength

$$\tau_{max} = \frac{16T}{\pi d^3} = \tau_{all} \qquad (2)$$

$$\therefore d = \sqrt[3]{\frac{16T}{\pi \tau_{all}}}$$

$$= \sqrt[3]{\frac{16 \times 2 \times 10^6}{\pi \times 60}} \text{ mm}$$

$$= 55.37 \text{ mm} \simeq 56 \text{ mm} \qquad (1)$$

Rigidity

$$\frac{T}{J} = \frac{G\theta}{l}$$

$$\therefore \theta_{max} = \frac{Tl}{GJ} = \theta_{all} \qquad (1)$$

$$\frac{32Tl}{G.\pi d^4} = \theta_{all}$$

$$\therefore d = \sqrt[4]{\frac{32TL}{\pi G.\theta_{all}}} \qquad (1)$$

$$= \sqrt[4]{\frac{32 \times 2 \times 10^6 \times 10^3}{\pi \times 80 \times 10^3 \times \frac{\pi}{180}}} \text{ mm}$$

$$= 61.8 \text{ mm} \simeq 62 \text{ mm} \qquad (1)$$