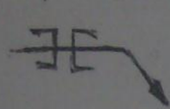
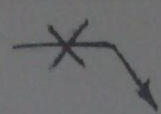
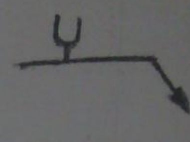
WELDS Questions and Solutions

Q.1.

(a) Define the following weld joint symbols and also give sketches for their joint preparation.

(i)  (ii)  (iii) 

(b) Fig. below is a joint of two pipes subjected to a torsional moment M_t resulting from force F_t. The allowable shear stress of the weld is $112\ N/mm^2$ and $d = 6\ cm$. Calculate the maximum permissible force F_t.

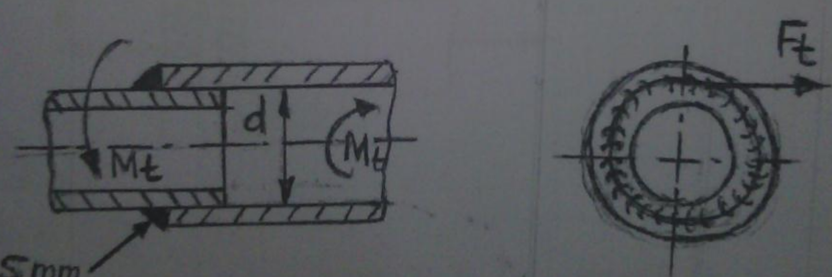


Fig:

Q.2.

An adhesive fluid of dry yield shear strength of $20\ N/mm^2$ is applied to make a lap joint of two sheet metals. (Fig. below).
If the factor of safety acceptable is 2; what is the maximum permissible force F?

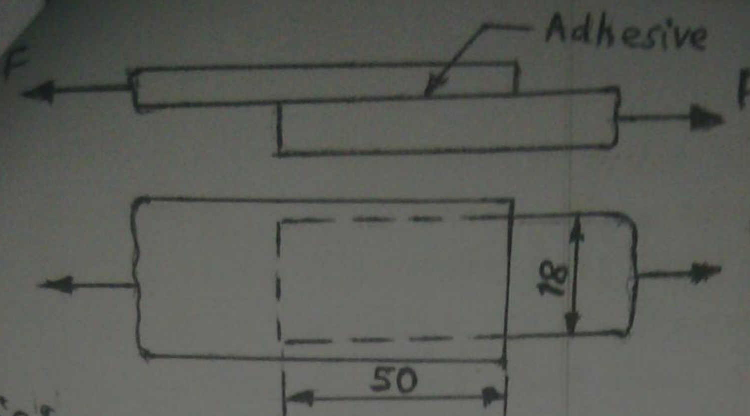


Fig:

Q.3.

A tie bar is welded to a plate as shown in fig. below. Find the strength of the weld. Take the size of the fillet as 6 mm and working stress of the fillet weld as $102.5\ N/mm^2$.

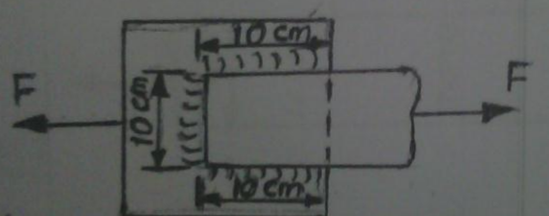


Fig:

Q.4.

A 100 x 10 mm plate is to be welded to another plate 150 x 10 mm by fillet weld of 6 mm size on three sides as shown in fig. below. Determine the necessary overlap of the plate. Take allowable stress in the plate as $142\ N/mm^2$, and in the weld as $102.5\ N/mm^2$.

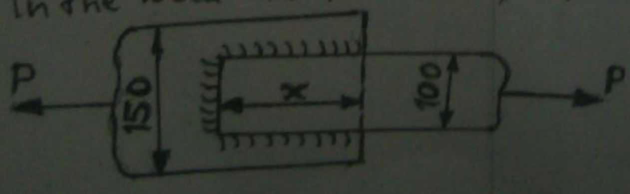


Fig:

Q.5.

Fig. below shows a transverse fillet weld in which $P = 62.8$ kN; $L = 150$ mm, $\sigma_t = 180$ N/mm^2

(a) What is the size of the fillet weld in this joint?

(b) Calculate the value of the throat.

(c) Taking into account that there are two welds, is the strength of the welds adequate? Take $\tau_{all} = 108$ N/mm^2.

(d) Check the strength of the plates in tension.

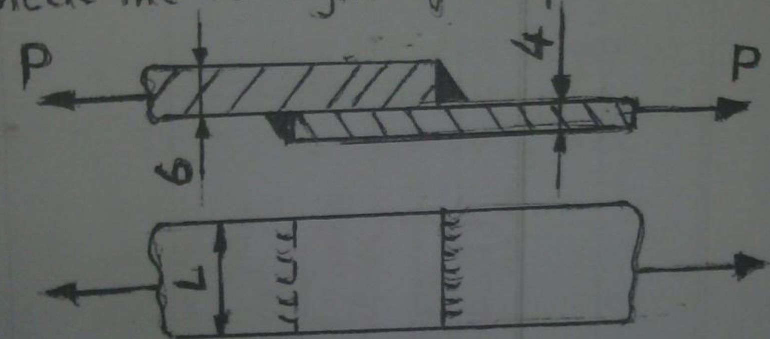


Fig:

Q.6.

A tie-bar in a truss consisting of a double angle section 100 x 65 x 10 mm is subjected to a load of 250 kN and is welded to a gusset plate as shown in fig. below. Design the joint with 8 mm fillet weld, if the permissible stress in the weld is 102.5 N/mm^2. Take the distances between the neutral axis and edges of the section as 33.7 mm and 66.3 mm respectively.

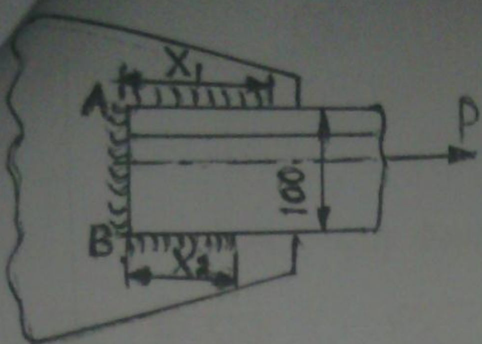


Fig:

Q.7.

(a) Two plates are welded together as in fig. below. Calculate the length L_1, if $\sigma = 10\ kN/cm^2$. $L = 100$ mm.

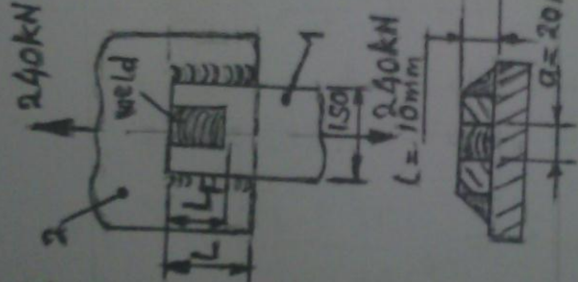


Fig:

(b) In fig. below, a special glue is used to join a drilling tool head. Calculate the torsional moment that can be transmitted. $D = 30$ mm, $L = 6$ mm and the gluing material has $\sigma_a = 5.3\ kN/cm^2$.

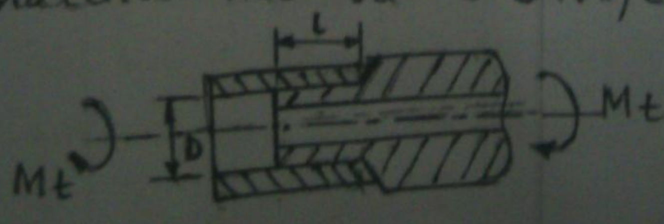


Fig:

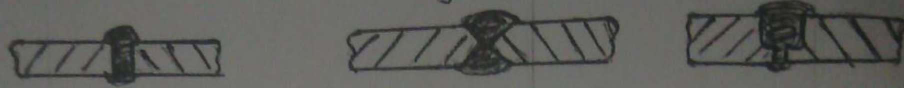
(3)

SOLUTIONS

Q.1.

(a)

(i) Square butt (ii) Double V or X butt groove (iii) Single U-groove butt



(b) Resultant load at centre is torque $M_t = F_t \cdot d/2$ and a direct shear load F_t.

Neglecting transverse shear load F_t, the torsional shear stress τ is given by

$$\tau_{max} = \frac{M_t \cdot r}{J} = \tau_{all} \; ; \; r = \frac{d}{2} = \frac{60}{2} = 30 \text{ mm}$$

$J = J_u \cdot t$, $t = k.s$, $s = 5\text{mm}$, $k = 0.7$

$\therefore t = 0.7(5) = 3.5\text{mm}$, $J_u = 2\pi r^3$, $\tau_{all} = 112 \frac{N}{mm^2}$

$$\therefore \tau = \frac{(F_t \cdot r)r}{3.5(2\pi r^3)} = \tau_{all} = 112 \, N/mm^2$$

$$\therefore F_{t_{max}} = 112(7\pi)(30) \, N = 73.89 \text{ kN}$$

$\therefore$ Max. force $F_t = 73.89$ kN Ans.

Q.2.

$S_{sy} = 20 \, N/mm^2$, $n = 2$

$$\therefore \tau_{all} = \frac{S_{sy}}{n} = \frac{20}{2} = 10 \, N/mm^2$$

Adhesive area $A = 50 \times 18 \; mm^2$

$$\tau_{max} = \frac{F}{A} = \tau_{all}$$

$$\therefore F_{max} = \tau_{all} \cdot A = 10(50 \times 18) N$$

$\therefore \underline{\underline{F_{max} = 9\ kN\ Ans}}$

Q.3.

$s = 6\ mm$, $\therefore t = k.s$, $k = 0.7$

$\therefore t = 0.7\,(6) = \underline{4.2\ mm}$

$\tau_{all} = 102.5\ N/mm^2$

Length of weld $l = 10 + 10 + 10\ cm = \underline{300\ mm}$

Strength of the weld $F = \tau_{all} . A$

$A = l.t$

$\therefore F = 102.5\ (300)(4.2)\ N = \underline{129.05\ kN}$

$\therefore$ Strength of the weld $\underline{\underline{F = 129.05\ kN\ Ans.}}$

Q.4.

X-sectional areas of plates

Larger plate $A = 150 \times 10 = 1500\ mm^2$

Smaller plate $A = 100 \times 10 = 1000\ mm^2$

$\sigma_a = 142\ N/mm^2$ for plates.

$\therefore$ Strength of plate $P = \sigma_a . A$, $A =$ of small plate.

$\therefore P = 142\,(1000)\,N = \underline{142\ kN}$

If this is the maximum force to be applied.

For weld $s = 6\ mm$, $k = 0.7$, $\therefore t = k.s$

$\therefore t = 0.7(6) = \underline{4.2\ mm}$

Length of weld $l = (2x + 100)\ mm$

where $x =$ overlap required

$\tau_{all} = 102.5\ N/mm^2$ for weld.

$\therefore P = \tau_{all} . A_w$; $A_w = l.t$

$\therefore 142{,}000 = (102.5)(2x + 100)\,4.2$

$\therefore$ $x = 114.9$ mm Ans.

Q.5. $P = 62.8kN$, $L = 150$ mm, $\sigma_t = 180\ N/mm^2$
$\tau_{all} = 108\ N/mm^2$.

(a) The size of the fillet weld is $s = 4$ mm Ans.
(minimum plate thickness)

(b) Value of throat, t
$t = k.s$, $k = 0.7$
$\therefore t = 0.7(4) = 2.8$ mm Ans.

(c) Consider plate of 4 mm.
$\therefore P_1 = lt_1 . \tau_{all}$, $t_1 = 2.8$ mm
$= 150(2.8) \times 108$ N
$\therefore P_1 = 45360$ N

Consider plate of 6 mm
$t_2 = K.S_2 = 0.7(6) = 4.2$
$\therefore P_2 = lt_2 . \tau_{all}$
$= 150(4.2)(108) = 68040$ N

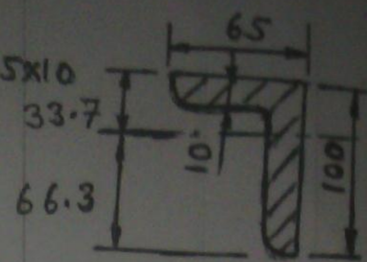
$\therefore$ Total force of resistance $P = P_1 + P_2 = 113.4$ kN

Note If $t = 2.8$ mm
Total resistance $= 2 \times 45360 = 90.720$ kN
$\therefore$ Strength of weld is adequate Ans.

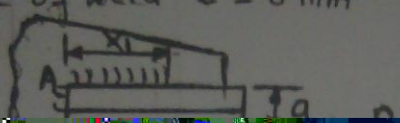
(d) To check the strength of the plates in tension
Consider smaller plate
X-sectional area $A_p = 4 \times 150\ mm^2$
$\therefore P_p = \sigma_t . A = 180 \times 600 = 108$ kN
$\therefore$ Adequate $P_p > P$

Q.6.

Double angle section 100×65×10



Size of weld $s = 8$ mm



$\therefore \quad P_{2_1} = \frac{b}{(a+b)} P_2 \quad$ and $\quad P_{22} = \frac{a}{(a+b)} P_2$

$P_{21} = \tau_{all} \cdot t \cdot x_1 \quad , \quad P_{22} = \tau_{all} \cdot t \cdot x_2$

$$\therefore \quad x_1 = \frac{P_2 \cdot b}{t \cdot \tau (a+b)} = \frac{67,600 (66.3)}{5.6 (102.5) 100} = \underline{78.1 \text{ mm}}$$

For a good design add $2S = 16$ mm

$\therefore \quad X_1 = 78.1 + 16 = 94$ mm. Ans

$$\text{and} \quad x_2 = \frac{P_2 \cdot a}{t \cdot \tau (a+b)} = \frac{67,600 (33.7)}{5.6 (102.5) 100} = \underline{39.7 \text{ mm}}$$

Also add $2S$ i.e. 16 mm

$\therefore \quad X_2 = 39.7 + 16 = 56$ mm Ans

Q.7

(a) $\tau_{all} = 10 \text{ kN/cm}^2 = 100 \text{ N/mm}^2$

$P = 240$ kN

$L = 100$ mm — side weld length

$l = 10$ mm — size of side weld

$a = 20$ mm — plug weld

$L_1 = ?$ — plug weld length

Total area of shear of weld $A = A_S + A_P$

A_S = Area of side weld (fillet)

A_P = Area of plug weld

$A_S = 2L (K \cdot l)$, $K = 0.7$ 2 welds

$\therefore \quad A_S = 2(100)(0.7 \times 10) = 1400 \text{ mm}^2$

$A_p = L_1 . a = 20 L_1$ mm

$\therefore A = 1400 + 20L_1$

Now $\tau_{max} = \frac{P}{A} = \tau_{all}$

$\therefore A_{min} = \frac{P}{\tau_{all}} = \frac{240,000}{100}$ mm^2

$= 2400$ mm^2

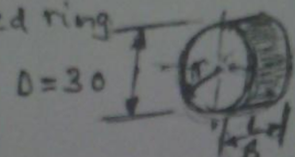
$\therefore A_p = 2400 - 1400 = 1000$ mm^2

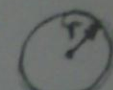
$\therefore L_1 = \frac{1000}{20} = \underline{\underline{50 \text{ mm}}}$ **Ans.**

(b) $\tau_{all} = 5.3$ kN/cm^2 $= 53$ N/mm^2

$D = 30$ mm, $t = 6$ mm

Consider Glued ring





Unit polar moment of inertia J_u is

$J_u = 2\pi r^3$

$\therefore$ with t = thickness of glue

$\therefore J = 2\pi r^3 t$ polar moment of inertia

Now $\tau_{max} = \frac{Tr}{J} = \tau_{all}$

$\therefore T_{max} = \frac{\tau_{all} . J}{r} = \tau_{all} . \frac{2\pi r^3 t}{r} = \tau_{all} . 2\pi r^2 t$

$r = D/2 = 15$ mm

~~subst~~

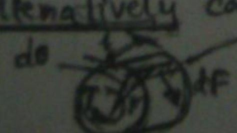
subst $\therefore M_{t_{max}} = 53(2\pi)(15)^2(6)$ Nmm

$= \underline{449.5 \text{ Nm}}$ or 449 Nm

$\therefore$ The torsional moment that can be transmitted is

$\underline{\underline{449 \text{ Nm}}}$ **Ans**

<u>Alternatively</u> consider $dA = t r d\theta$, $dF = \tau . dA$



$\therefore dF = \tau . t r d\theta$, $dT = r dF$

$\therefore T = \int dT = \int \tau . t r^2 d\theta = \tau t r^2 \int_0^{2\pi} d\theta$

$\therefore T = \underline{\underline{2\pi r^2 t . \tau}}$ same as above.