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Internal Assessment Test 2 – May 2023

Sub :	Design of Steel Structural Elements				SubCode:	18CV61	Branch:	Civil
Date:	22.05.2023	Duration:	90 mins	Max Marks: 50	Sem/Sec:	VI		OBE

<u>Provide neat sketches wherever necessary</u>

		MARKS	CO	RBT
1a	What are the advantages and disadvantages of bolted connection?	[05]	CO3	L1
1b	What are the common defects in welding? Explain with neat sketch.	[05]	CO3	L1
2	Determine the design compressive strength of ISHB300@576.8N/m, length of column is 3.5m and both ends are pinned.	[10]	CO4	L2
3	Find the efficiency of a butt joint shown in Figure 1, black bolts of M20 and 4.6 grade and the plates are made of grade Fe410 are provided.	[10]	CO3	L1
4	Determine the safe load P that can be carried by the bracket. The bracket plate is 10mm thick M20 bolt of grade 5.6 are used. Refer Figure 2	[10]	CO3	L2
5	Determine the design load carrying capacity of a single angle (discontinuous) ISA 50x50x5 mm used as a compression member in a roof truss connected to a 10mm gusset by two bolts. The centre to centre distance between end connections is 1.5m. Assume fy = 250MPa.	[10]	CO4	L2

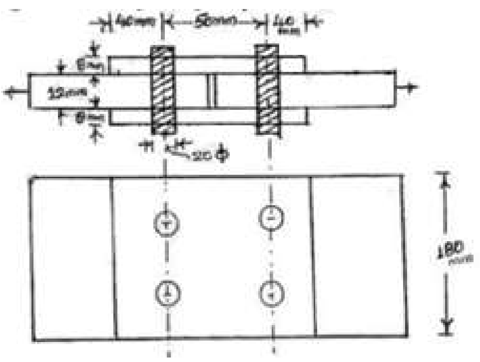


Figure 1

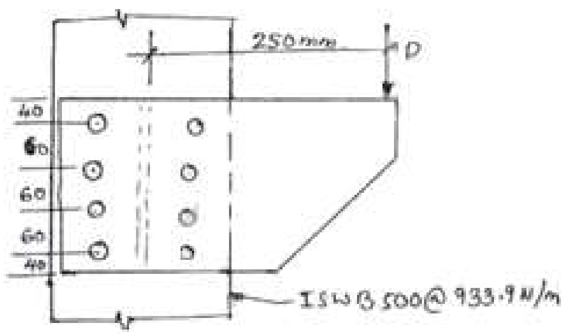


Figure 2

Q1 a

The advantages of bolted connections are:

1. Use of unskilled workers.
2. Noiseless fabrication.
3. Fast progress of work.
4. Immediate resistance of bolts after placement.
5. No specialized equipments required.
6. Less area required at work place.
7. Minor discrepancies in dimensions get eliminated.
8. Easy to dismantle and reuse the materials.
9. Alterations can be done easily.

Disadvantages of bolted connections are:

1. When subjected to vibrations or shocks bolts may get loose.
2. Tensile strength is reduced considerably due to stress concentrations and reduction of area at the root of the threads.
3. Rigidity of joints is reduced due to loose fit, resulting into excessive deflections.
4. Cost of the material is high.

Q 1b

Welding is highly specialised technique of jointing, and it should be done carefully so that no defects or imperfections are left. The most important defects arising from the welding technique are as follows :

1. Undercutting
2. Overlap
3. Incomplete penetration
4. Lack of fusion
5. Slag inclusion
6. Porosity and gas inclusion
7. Edge melting

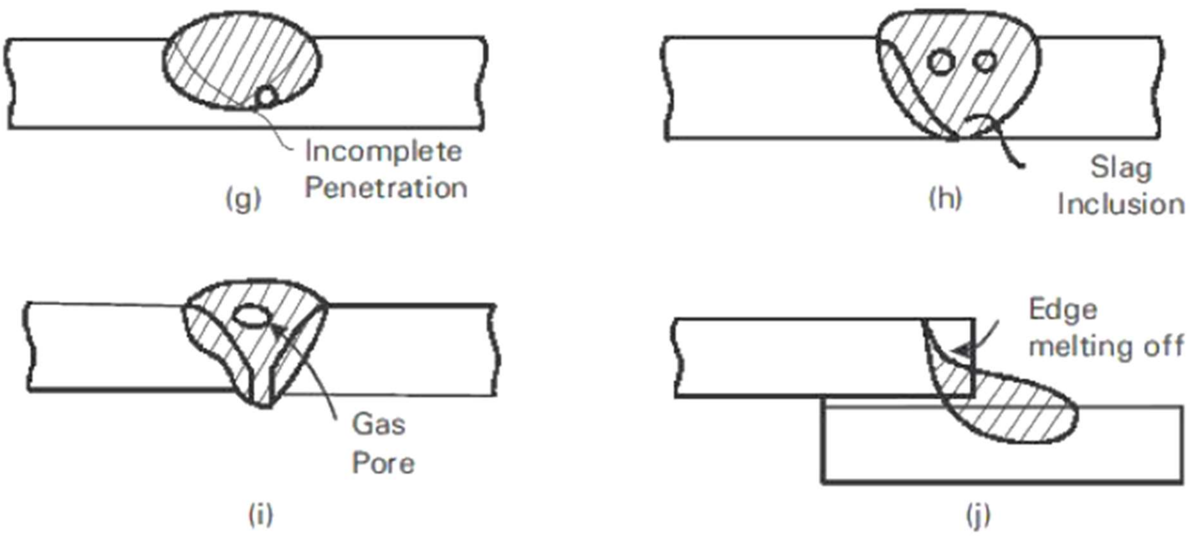
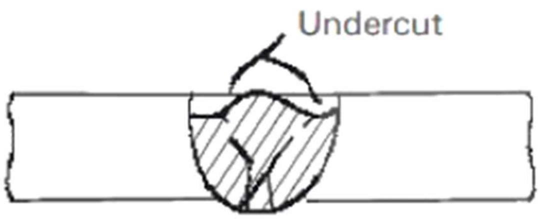


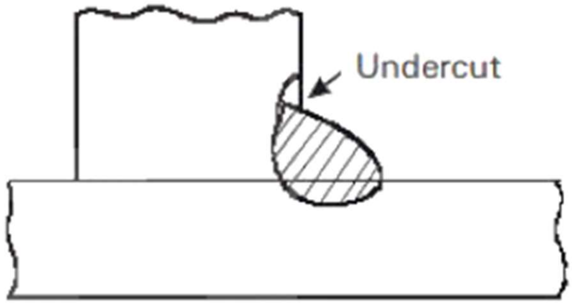
Fig. 2.56 : Important weld defects

These defects have been shown diagrammatically in Fig. 2.56.

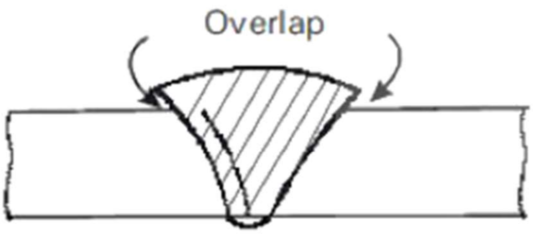
- **Under cutting** (Fig. 2.56 a,b) takes **place due to excessive current** and excessive length of arc, resulting in the formation of a groove in the base metal.
- When the weld metal overflows the groove, but doesnot fuse with base metal, and **Overlap** is formed (Fig. 2.56 c)
- **Incomplete penetration** takes place when the weld metal does not penetrate up to the root of the joint because of faulty groove penetration (Fig. 2.56 f,g) or because of faulty technique used during welding.
- **Lack of fushion** (Fig. 2.56 d,e) takes place when the parent metal is coated with some foreign matter and when the groove is not clean. Due to this, there will be lack of union between two runs of weld metal.
- **Slag inclusion** (Fig. 2.56 h) takes place because of formation of oxides due to chemical reaction among the base metal, air and electrode coating, during welding.
- A group of gas pores may get entrapped in the weld as shown in (Fig. 2.56 i), such a defect of gas inclusion is also called **porosity**.
- **Edge melting off** occurs in fillet welds (Fig. 2.56 j) because of careless welding.


Undercut

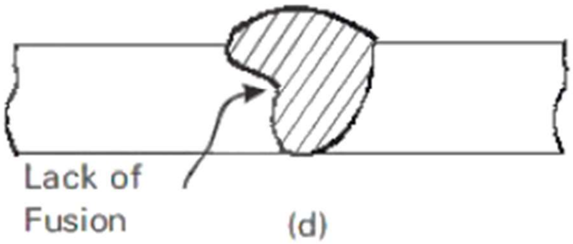
(a)


Undercut

(b)


Overlap

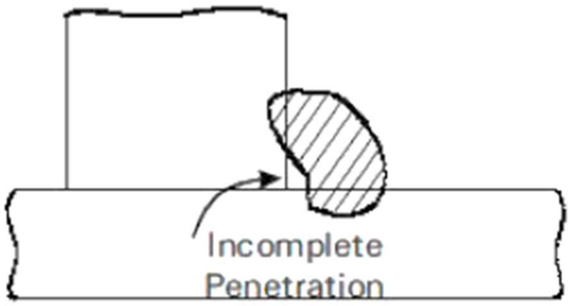
(c)


Lack of
Fusion

(d)


Lack of
fusion

(e)


Incomplete
Penetration

(f)

2. Given

ISHB 300 @ 576.8 N/m

$A = 7485\ mm^2$ → using steel table

$h = 300\ mm$

assume $f_y = 250\ MPa$.

$b = 250\ mm$

$t_f = 10.6\ mm$

$t_w = 7.6\ mm$

$r_x = 129.5\ mm$

$r_y = 54.1\ mm$

Length $(l) = 3.5\ m = 3500\ mm$

Step 1:- Buckling class of Rolled - I - section

$$\frac{h}{b_f} = \frac{300}{250} = 1.2 \leq 1.2 \qquad z\text{-}z \rightarrow \text{class 'b'}$$

$$t_f \leq 100\ mm \Rightarrow 10.6 \leq 100\ mm \qquad y\text{-}y \quad \text{class 'c'}$$

Step 2:- ~~Slendrness~~ Slenderness ratio:-

$$\frac{Kl}{r_{min}} = \frac{1 \times 3500}{54.1} \qquad \therefore K = 1$$

because both the ends are pinned.

$$= 64.69$$

See table '9-c' in IS-800

f_{cd}

60	168	Interpolation
70	152	$\longrightarrow$ using calc.

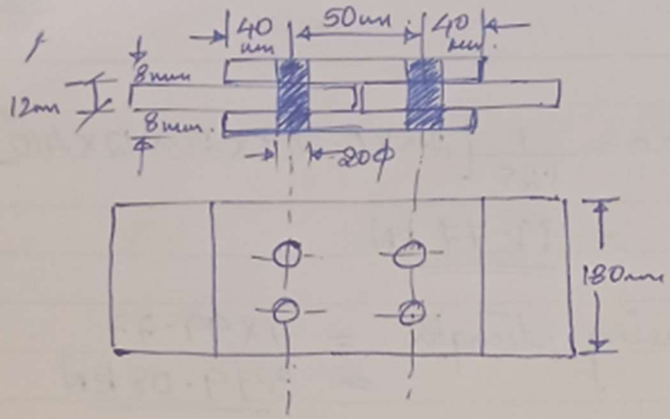
$f_{cd} = 160.496$

$P_d = A_e \times f_{cd}$.

$= 7485 \times 160.496$

$$\boxed{P_d = 1201.312\ KN}$$

3)



Sol^n :-

$b = 180\,mm$

$t = 8 + 8 = 16\,mm$ OR $12\,mm$ } least $\therefore t = 12\,mm.$

$N = 4$ bolts

M20 $\rightarrow d = 20\,mm$ $\quad d_0 = 20 + 2 = 22\,mm$

$f_{ub} = 400\,N/mm^2$

$p = 50\,mm, \quad e = 40\,mm, \quad g = 180 - 40 - 40 = 100\,mm.$

a) Rupture Strength of plate

$$T_{dn} = 0.9\,A_n \frac{f_u}{\gamma_{m1}}$$

$$A_n = [180 - 2 \times 22] \times 12 = 1632\,mm^2$$

$$T_{dn} = 0.9 \times 1632 \times \frac{410}{1.25} = 481766.4$$

$$= \underline{481.76\,kN}$$

CMR

Design yield strength

$$T_{dg} = A_g \frac{f_y}{\gamma_{mo}}$$

$$T_{dg} = 180 \times 12 \times \frac{\cancel{410}\ 250}{1.0} = \underline{805.1}\ \text{kN} \quad 490.9$$

Solid Strength of plate

$$T_d = 0.9 A_g \frac{f_u}{\gamma_{m1}}$$

$$= 0.9 \times 180 \times 12 \times \frac{410}{1.25} = \underline{637.63\ \text{kN}}$$

Shear strength of Bolt

$$V_{dsb} = \frac{1}{\gamma_{mb}}\left[\frac{f_{ub}}{\sqrt{3}}\left(n_n A_{nb} + n_s A_{sb}\right)\right] \quad 0$$

$$= \frac{1}{1.25}\left[\frac{400}{\sqrt{3}}\left(2 \times 0.78 \times \pi/4 \times 20^2\right)\right]$$

$$= \cancel{[illegible]}\ \cancel{45.27}\ 90.54\ \text{kN}$$

Total shear strength $= 4 \times \cancel{[illegible]}\ \cancel{45.27}\ 90.54 = \cancel{181.08}\ 362.16$ kN

Bearing capacity of Bolt

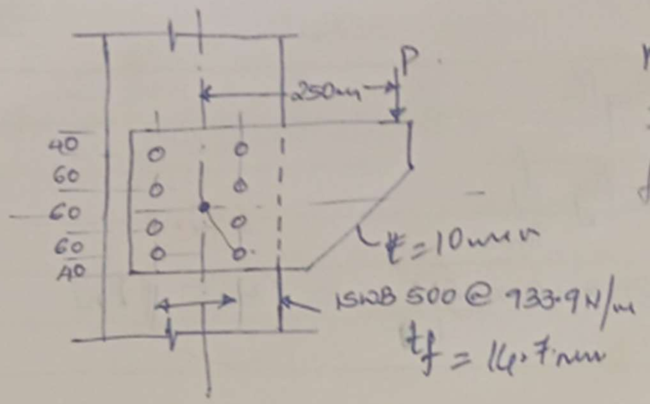
$$V_{dpb} = \frac{1}{\gamma_{mb}}\left[2.5 k_b d t f_u\right]$$

$$k_b = \frac{e}{3d_0} = \frac{40}{3 \times 22} = 0.606$$

$$= \frac{p}{3d_0} - 0.25 = \frac{50}{3 \times 22} - 0.25 = 0.507$$

$$= \frac{f_{ub}}{f_u} = \frac{400}{410} = 0.976$$

$k_b = 0.507$



M20 bolt
5.6 grade
$f_{ub} = 500\ N/mm^2$

a) Bolt value (Strength of single bolt)

M20 → $d = 20$ $\quad d_0 = d_h = 20 + 2 = 22mm$

plate → Fe 410 $\quad f_u = 410\ N/mm^2$

'p' = pitch = 60mm. $\quad$ Gauge = 140mm ⇒ 'g'

$e = 40mm$.

Shear strength of bolt

$$V_{dsb} = \frac{f_{ub}}{\sqrt{3}\gamma_{mb}}\left[n_n A_{nb} + \cancel{n_s A_{sb}}^{\,0}\right]$$

$$= \frac{500}{\sqrt{3} \times 1.25}\left[1 \times 0.78 \times \frac{\pi}{4} \times 20^2\right]$$

$$= 56.59\ kN.$$

Bearing Strength

$$\left.\begin{aligned} k_b &= \frac{e}{3d_0} = \frac{40}{3 \times 22} = 0.606 \\ &= \frac{p}{3d_0} - 0.25 = \frac{60}{3 \times 22} - 0.25 = 0.66 \\ &= \frac{f_{ub}}{f_u} = \frac{500}{410} = 1.22 \end{aligned}\right\} k_b = 0.606$$

$$V_{dpb} = \frac{2.5\, k_b\, d\, t\, f_u}{\gamma_{mb}}$$

$$= \frac{2.5 \times 0.606 \times 20 \times 10 \times 410}{1.25}$$

$$= \underline{\underline{99.38\ kN}}$$

$\therefore$ Bolt value $= \underline{\underline{56.59\ kN}}$

$$r = \sqrt{70^2 + 90^2} = \underline{114.0175\ mm}$$

$$\theta = \tan^{-1}\left(\frac{90}{70}\right) = 52.125$$

$$\Sigma r^2 = 4(70^2 + 90^2) + 4(70^2 + 30^2)$$

$$= 75200$$

Moment $= Pe = 250P$.

$$\therefore F_1 = \frac{P}{N} = \frac{P}{8} = 0.125P$$

$$F_2 = \frac{M \cdot r}{\Sigma r^2} = \frac{250P \times 114.017}{75200} = 0.379P$$

$$F_R = \sqrt{F_1^2 + F_2^2 + 2F_1F_2\cos\theta} = 56.59 \times 10^3$$

$$0.217P^2 = 3202.43$$

$$\boxed{P = 121.5\ kN}$$

5) ISA 50×50×5

$A = 479\ mm^2$
$r_{vv} = 0.97 = 9.7\ mm$ } Steel table (SP6).

$$\lambda_e = \sqrt{k_1 + k_2 \lambda_{vv}^2 + k_3 \lambda_\phi^2}$$

$k_1 = 0.2,\ k_2 = 0.35\ \&\ k_3 = 20$ (Assuming fixed end)

$\because \epsilon = \sqrt{\frac{250}{f_y}} = 1 \qquad E = 2\times10^5\ N/mm^2$

$$\lambda_{vv} = \frac{l/r_{vv}}{\epsilon\sqrt{\frac{\pi^2 E}{250}}} = \frac{\frac{1500}{9.7}}{1\sqrt{\frac{\pi^2 \times 2\times10^5}{250}}} = \frac{154.64}{88.86}$$

$= 1.74.$

$$\lambda_\phi = \frac{\frac{b_1+b_2}{2t}}{\epsilon\sqrt{\frac{\pi^2 E}{250}}} = \frac{\frac{50+50}{2\times(5)}}{1\times\sqrt{\frac{\pi^2\times2\times10^5}{250}}} = \frac{10}{88.86}$$

$= 0.112.$

$$\lambda_e = \sqrt{0.2 + 0.35(1.74^2) + 20\times(0.112)^2}$$

$= 1.248$

$$f_{cd} = \frac{f_y/\gamma_{m0}}{\phi + (\phi^2 - \lambda_e^2)^{0.5}}$$

$$\phi = 0.5\left[1 + \alpha(\lambda_e - 0.2) + \lambda_e^2\right]$$

$\alpha = 0.49$ (Table 7)

$$\phi = 0.5\left[1 + 0.49(1.248 - 0.2) + 1.248^2\right]$$

$$= 1.535$$

$$f_{cd} = \frac{250/1.1}{1.535 + \left[1.535^2 - 1.248^2\right]^{0.5}}$$

$$= \frac{227.27}{2.428} = 93.6 \text{ N/mm}^2.$$

Design Compressive Strength $= A_e f_{cd}$

$$= 479 \times 93.6$$

$$= \underline{\underline{44.834 \text{ kN}}}.$$