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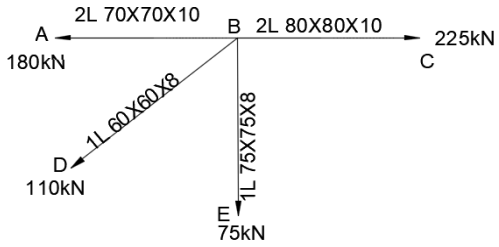
Internal Assessment Test 1 – May. 2021

Sub:	Design of steel structures					Sub Code:	18CV61	Branch:	Civil
Date:	19/05/2021	Duration:	90 min's	Max Marks:	50	Sem / Sec:	6 A, 6B, 6C		OBE

Answer any TWO FULL Questions

Note: Use of IS 800:2007 is permitted and Assume missing data.

		MARKS	CO	RBT
1 (a)	What are the advantages and disadvantage of using steel structures?	[08]	CO1	L2
(b)	Two flats (Fe 410 grade steel), each 210mm8mm, are to be jointed using 20mm dia, 4.6 grade bolts, to form a lap joint is supposed to transfer a factored load of 250kN. Design the joint and determine suitable pitch for bolts.	[17]	CO1	L4
2 (a)	Explain the various modes of failure of bolted connection with neat sketch.	[08]	CO1	L2
(b)	Design joint B of a roof truss as shown in Fig. the members are connected with 16mm dia, bolt of grade 4.6 to the gusset plate of 12mm thick.	[17]	CO1	L4



3 (a)	State the limit state design principle. Mention the limit states	[08]	CO1	L2
(b)	Design a bolted connection for lap joint of plate thickness of 10mm and 12mm to carry a service load of 100kN. Use M16 4.6 grade bolt. Give the details with neat sketch.	[17]	CO1	L4

01 a) What are the advantages and disadvantage of using Steel Structures?

Advantages

→ High Strength

→ The high ratio of Strength to weight (the Strength per Unit Weight)

→ Exellent ductility and Seismic resistance

→ With Stand Extensive deformation without failure Even Under high tensile Stress

→ Elasticity, Uniformity of material

→ Predictability of properties, close to design assumption

→ Ease of fabrication and Speed of Erection

→ The properties of Steel mostly do not chang with time

Disadvantages

- Susceptibility to corrosion
- Maintenance costs/ thin-Welled Structure
- Loss of Strength at Elevated temperature
- Fireproofing costs
- Susceptibility to bucking
- Fatigue and brittle fracture
- Steel Structure need fire proof treatment which increases the cast
- At the places of Stress concentration in Steel Section Under Section conditions the Steel may losses its durability

4 marks

4Marks

1) (b) Two flats (Fe 410 grade Steel), Each 210mm 8mm, are to be jointed using 20mm dia, 4.6 grade bolts. to from a lap joint is Supposed to transfer a factored load of 250kN. Design the joint and determine Suitable pitch for bolts

$f_u = 400 MPa$

$f_{ub} = 400 MPa$

$d = 20mm$

$d_0 = 20 + 2 = 22mm$

$A_{nb} = 245mm$

$\gamma_{mb} = 1.25$

The bolt will be in Single Shear

design Shear Strength : V_{dsb}

$$V_{dsb} = \frac{f_{ub}}{\sqrt{3}} (n_n A_{nb} + n_s A_{ns}) / \gamma_{mb}$$

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

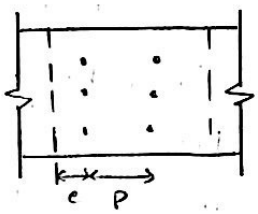
$$\boxed{V_{dsb} = 45.26 kN}$$

2 Marks

$\therefore$ For this Shear force

$$\text{No of bolts} = \frac{250}{45.26} = 5.52 \simeq 6 \text{ no}$$

$\therefore$ Arrange the bolts in three lines as



5 Marks

Now Strength of joint per pitch length on the basis of Shear on bolts

$= 2 * 45.26 = 90.52 kN$

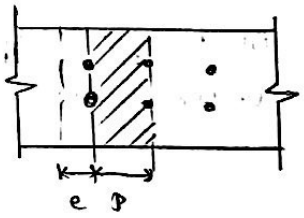
Equating this Strength to the net Tensile Strength of plate / pitch length

$$T_{dn} = 0.9 \frac{f_u (P - d_0) * t}{\gamma_{mb}}$$

$$90.52 \times 10^3 = \frac{0.9 \times 410 (P - 22) \times 8}{1.25}$$

$$P = 60.32mm$$

$$4 = 65mm \geq 2.5 \times 20 (i.e. = 50mm)$$



5 Marks

Now Edge distance available $= \frac{1}{2}(210 - 2\times65) = 40mm$

$K_b = \frac{e}{3d_o} ; \frac{p}{3d_o} - 0.25 ; \frac{f_{ub}}{f_u} ; 1$ — 3 Marks

$= \frac{40}{3\times22} ; \frac{50}{3\times22} - 0.25 ; \frac{400}{410} ; 1$

$= 0.6 ; 0.75 ; 0.975 ; 1$

Least value : $K_b = 0.6$

∴ ~~Shear~~ Strength of bolt in bearing

$V_{dpb} = 2.5 K_b d t f_u / f_{mb}$ — 2 Marks

$= 2.5 \times 0.6 \times 20 \times 8 \times 400 \times 10^{-3} / 1.25$

$= 78.72kN >$ Design Shear Strength $= 45.26kN$

Hence the design needs no revision.

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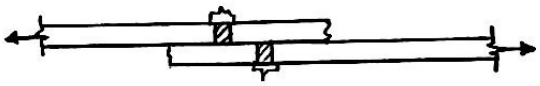
02. Explain the various ~~metho~~ modes of failure of bolted connection with Neat Sketch

01. Shear failure of bolt
02 Shear failure of plate — 2 Marks
03 ~~Shear~~ Bearing failure of bolt
04 Bearing failure of plate
05 Tensile failure of bolt
06 Tensile failure of plate

01 Shear failure of bolt

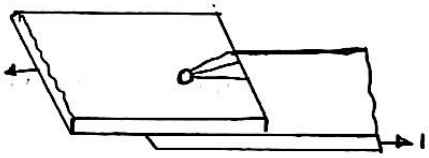
The plates bolted together and subjected to tensile loads may results in the shear of the bolts. the bolts are sheared across their cross Sectional areas.



Single shear occurring in a lap joint has been show in fig

02 Shear failure of plates:

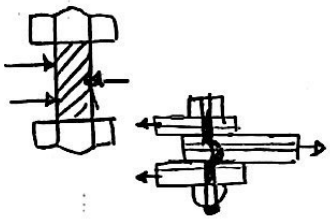
A plate may fail in shear along two lines as shown in fig. this may occur when minimum proper edge distance is not provided



03) Bearing failure of bolt

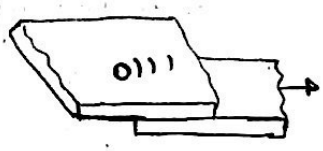
The bearing failure of a bolt occurs when the bolt is crushed by the plate as shown.

The bearing, shearing and splitting failure of plates may be avoided by providing adequate edge distance.



04) Bearing failure at plate

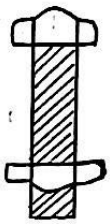
The bearing failure of a plate may occur becouse of insufficient edge distance in the bolted joint. the crushing of plate against the bearing of bolt as show takes a plate in such failure



4 Marks

05 **Tensile failure of bolt:**

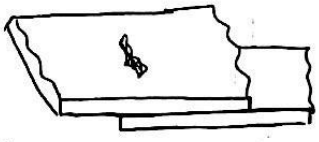
The tensile failure of a plate may occure because of insufficent Edge distance in the bolted joint the Splitting of plate bolt



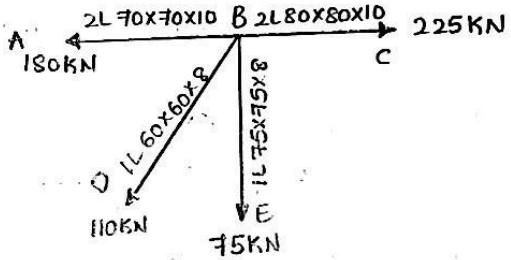
2 Marks

06) **Tensile failure of plate:**

When plates bolted together are carrying tensile load. tearing of bolts plates may When Strength of the plate of less than that of the bolts. the tearing failure occurs at Net



02) (b) Design joint B of a roof truss as Shown in fig. The members are connected with 16mm dia. bolt of grade 4.6 to the gusset plate of 12mm thick



$f_u = 410 MPa$

$f_{ub} = 400 mpa$

$A_{nb} = 0.78 \times \frac{\pi}{4} \times d^2 = 0.78 \times \frac{\pi}{4} \times (16)^2$

$= 157$

$D_0 = 16 + 2 = 18mm$

$\gamma_{mb} = 1.25$

Strength of the bolt in Single Shear (assume fully threaded bolts) for member BD and BE

$$V_{nsb} = \frac{f_{ub}}{\sqrt{3}} (n_n A_{nb} + n_s A_{sb}) / \gamma_{mb}$$

$$= \frac{400}{\sqrt{3}} (1 * 157 + 0) / 1.25$$

$$V_{nsb} = 29.0 KN$$

5 Marks

Strength of the bolt in double shear (Assume fully threaded) for members AB and BC

$= \frac{400}{\sqrt{3}} (2*157+0)/1.25 = 58.0\ KN$

5 Marks

Bolts in Bearing = $V_{dpb} = \frac{2.5 K_b d t f_u}{\gamma_{mb}}$

K_b is least of

$\frac{e}{3d_0}$; $\frac{p}{3d_0} - 0.25$; $\frac{f_{ub}}{f_u}$; 1

$\frac{40}{3X18}$; $\frac{50}{3*18} - 0.25$; $\frac{400}{410}$; 1

0.74 ; 0.67 ; 0.97 ; 1

3 Marks

Strength of 16mm dia bolt in bearing for different thickness of bolt

t=8mm $= (0.25 \times 0.67 \times 16 \times 8 \times 410)/1.25 = 70.32$

t = 10mm = $0.25 \times 0.67 \times 16 \times 10 \times 410/1.25 = 87.9$

t = 12mm = $0.25 \times 0.67 \times 16 \times 12 \times 410)/1.25 = 105.48$

- Member AB = 180KN, 58.0KN in Shear and 105.48KN in bearing

No of bolts = $\frac{\text{load}}{\text{bolt value}} = \frac{180}{58} = 3.10 = 4$ No

- Member BC = 225KN, 58.0KN in Shear and 105.48KN in bearing

No of bolts = load/ bolt value = 225/58 = 4no

4 Marks

- Member of BD = 110KN, 29.0KN in Shear and 70.32KN in bearing

No of bolts = load/ bolt value = 110/29 = 4no

- Member BE = 75KN, 29 KN in Shear and 70.32KN in bearing

No of bolts = load/ bolt value = 75/29 = 3No