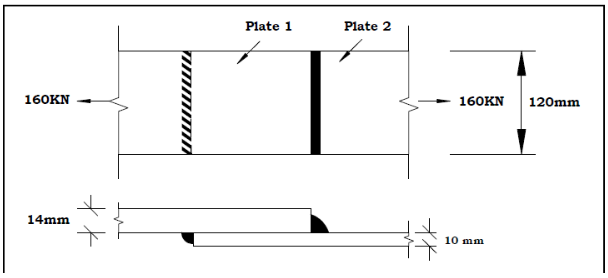
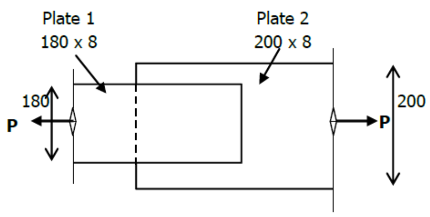
USN | | | | | | | | | | |

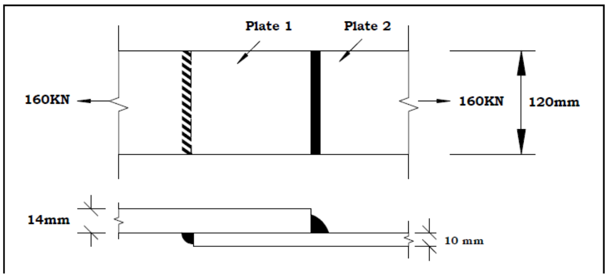
Scheme and solution of Internal Assessment Test 2 – June 2022

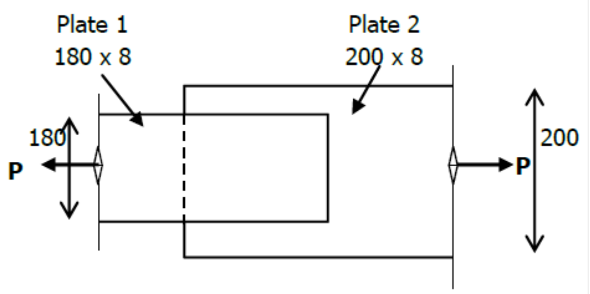
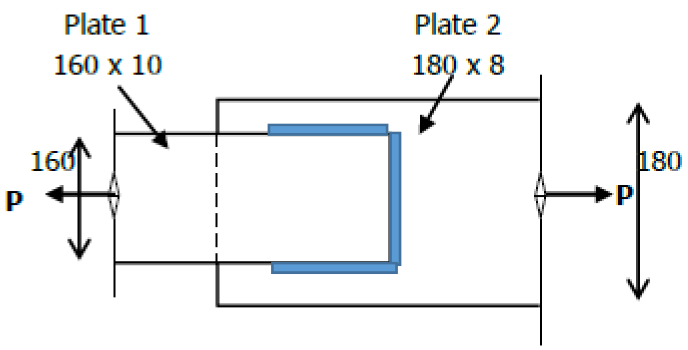
Sub:	Design of steel structures			Sub Code:	18CV61	Branch:	Civil
Date:	9/06/2022	Duration:	90 min’s	Max Marks: 50	Sem / Sec:	6	OBE

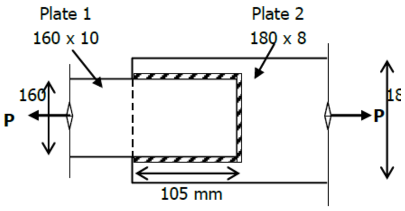
Answer any ALL Questions

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

		MARKS	CO	RBT
1 (a)	Design a suitable fillet weld to connect a tie bar 60mm X 8mm to a 12mm thick gusset plate. Assume shop welds. Use Fe 410 steel.	[05	CO1	L2
1 (b)	A tie bar of 120 mm x 10 mm(p2) is to be connected to other of size 120 mm x 14 mm(p1). if the tie bars are to be loaded by a pull of 160 KN, find out the size of end fillets such that the stresses in both the end fillets are same. Take f_u=410 N/mm^2, Assume shop welding. 8marks 	[10]	CO1	L4
1 (c)	Design the fillet welded joint between two plates of size 180 mm x 8 mm and 200 mm x 8 mm to develop the full strength of the smaller plate in tension. Assuming field welding. 	[10]		
2(a)	A bracket plate 12mm thick is to be bolted to the flange of column ISHB 350@710.2 N.m by means of close tolerance and turned bolts. M20 bolts of grade 4.6 are arranged in two vertical row 100mm apart at a pitch of 70mm. Design a bracket connection if the bracket plate carries a load of 120kN at a lever arm of 250mm	[20]		
2(b)	Calculate the strength of 20mm dia bolt of grade 4.6 for the following cases. The main plates to be joined are 12mm thick. Lap joint	[5]		

	Marks
1(b). A tie bar of 120 mm x 10 mm(p2) is to be connected to other of size 120 mm x 14 mm(p1). if the tie bars are to be loaded by a pull of 160 KN, find out the size of end fillets such that the stresses in both the end fillets are same. Take f_u=410 N/mm^2, Assume shop welding.	10
	
Let D1 and D2 be the size of the weld of Plate (1) and Plate (2) $\frac{D_1}{D_2} = \frac{14}{10}$	1
$D_1 = 1.4D_2$ Length of the weld in each case = 120mm	
Strength of the weld of Plate 1 = $0.707D_1 * l * f_{wd}$ $= 0.707 * 1.4D_2 * l * \frac{410}{\sqrt{3} * 1.25}$ $= 22492.72D_2$ N	1
Strength of the weld of Plate 2 = $0.707D_2 * l * f_{wd}$ $= 0.707 * D_2 * l * \frac{410}{\sqrt{3} * 1.25}$ $= 16066.23\ D_2$ N	1
Load carried by the tie bars= 160 kN Since there are two sizes of the weld I,e D1 and D2 P= P1+P2	
$160 * 10^3 = 22492.72D_2 + 16066.23\ D_2$	1
D_2= 4.15mm say 5mm (minimum size of the weld= 3mm, maximum size of weld=10-1.5=8.5mm)	1
$D_1 = 1.4D_2$ = 1.4*5= 7mm (minimum size of the weld= 5mm, maximum size of weld=14-1.5=12.5mm)	1
Overlap length: it is the maximum of following 4*t= 4*10= 40mm and 40mm Width of plate (120 mm)	2

Length of longitudinal weld given = 120 mm **Provide 7 mm size weld for plate (1) and 5 mm size weld for plate (2) to a length of 120mm.**	2
1(c) Design the fillet welded joint between two plates of size 180 mm x 8 mm and 200 mm x 8 mm to develop the full strength of the smaller plate in tension. Assuming field welding.   	10
Tension capacity of the member 1 = $T_{dg} = \frac{A_g \times f_y}{\lambda_{mo}} = \frac{160 \times 10 \times 250}{1.1 * 1000}$ = 363.64N	1
Tension capacity of the member 2 = $T_{dg} = \frac{A_g \times f_y}{\lambda_{mo}} = \frac{180 \times 8 \times 250}{1.1 * 1000}$ = 327.30N	1
Strength of joint= full strength of thinner plate= 327.30kN	
Strength of weld = 0.707D*l*f_{wd} = 0.707*8*l*$\frac{410}{\sqrt{3}*1.5}$ = 892.60* L N	1
By condition equilibrium = total strength of joint= strength of weld =327.03*10^3= 892.60* L Total length of the weld= *L= 327.30*1000/892.60* *= 366.65mm*	1
*B= 160mm, 16*t=16*8=128mm,* *since b is greater than 16*t, end fillet weld of length 160mm has to be provided*	1

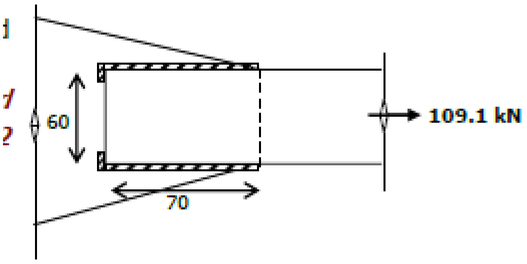
along with longitudinal side fillet weld	1
$$length\ of\ longitudinal\ weld\ on\ each\ side = \frac{366.65 - 160}{2} = 103.32mm$$ $$= 105mm$$	1
	1
Length of longitudinal weld required: It is the maximum of the following 1. Overlap length a) 4 x 8 = 32 mm b) 40 mm 2. Length of longitudinal weld calculated = 105 mm.	2
1(a). Design a suitable fillet weld to connect a tie bar 60mm X 8mm to a 12mm thick gusset plate. Assume shop welds. Use Fe 410 steel. **Solution:**	5
Effective length=*l*=	1
Tension capacity of the plate = T_{dg}= $A_g f_y / \lambda_{m0}$ = 60*8* 250/1.1 = 109.09kN	
Strength of the weld= 0.707D****l****$\frac{f_u}{\sqrt{3}\lambda_{mw}}$ =*0.707*6** ***l**** $\frac{410}{\sqrt{3}*1.25}$ =*803.31* ***l*** *N/mm*	1
On applying the equilibrium condition **109.09*10^3= 803.31* *l***	1
L= 109.09*10^3/808.31 = 135.80mm= 140mm is the total length of weld ***Therefore, for each side 140/2= 70mm***	1
D= size of the weld = minimum size of weld = 5mm = maximum size of the weld = 8-1.5= 6.5mm = 6mm	1
Length of longitudinal weld required: It is the maximum of the following 1. Overlap length a) 4 x 8 = 32 mm b) 40 mm	

2. Width of plate (60 mm)

3. Length of longitudinal weld calculated = 70 mm

The overall length of weld provided with end return of (2 x D) = 2 x 70 +2 x 6+2x 6 = 164 mm 1

Note:
If b < 16t= 128, ------ only longitudinal weld can be provided = 16*8= 128
If b > 16t, along with longitudinal weld End weld also should be provided

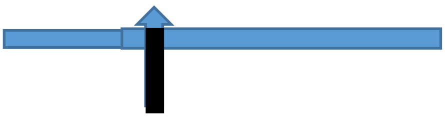


2(b) calculate the strength of 20mm dia bolt of grade 4.6 for the following cases. The main plates to be joined are 12mm thick.

a) Lap joint

Solution:

a) Lap joint



Strength of bolt in single shear: (assume fully threaded bolt)

$$V_{dsb} = \frac{f_{ub}}{\sqrt{3}}(n_n A_{nb} + n_s A_{sb})\ /\gamma_{mb}$$ 2

$$= \frac{400}{\sqrt{3}}(1 * 0.78 * pi * 20 * 20/4 + 0)\ /1.25 = 56.58\text{kN}$$

Bolts in Bearing = V_{dpb} = $(2.5 K_b\, d\, t\, f_u)/\gamma_{mb}$

K_b is least of $e/3d_o$, $p/3d_o - 0.25$, fub/fu , 1 from the IS 800:2007 pg no 75 2

Assumed e=40mm, p= 50mm, d_o= 20+2=22mm

40/ 3*22= 0.60

50/3*22-0.25= 0.50

400/410= 0.97

1 1

V_{dpb} = (2.5*0.50*20*12*410)/ 1.25 = 98.40kN

Therefore, the strength of bolt in lap joint is 56.58kN

2(a) A bracket plate 12mm thick is to be bolted to the flange of column ISHB 350@710.2 N.m by means of close tolerance and turned bolts. M20 bolts of grade 4.6 are arranged in two vertical row 100mm apart at a pitch of 70mm. Design a bracket connection if the bracket plate carries a load of 120kN at a lever arm of 250mm

From SP-6 Properties of ISHB 350= Weight=72.4 kg C/S area= 92.21cm^2 depth of section= 350mm = width of web Width of flange = 250mm Thickness of flange = 11.6 mm	2
No. of bolts calculation No. of bolts for regular connection = Load/ bolt value (B_v)	1
Bolt value is the least of Shear and Bearing strength No. of bolts for bracket connection= $\sqrt{\frac{6M}{p\ m\ B_v}}$	1
Assume dia of bolt as 20mm **1. Design shear strength of the bolt:** a. $V_{dsb} = V_{nsb}/ \gamma_{mf}$ b. $V_{dsb} = \frac{f_{ub}}{\sqrt{3}}(n_n A_{nb} + n_s A_{sb}) /\gamma_{mb} = \frac{400}{\sqrt{3}}$(1*0.78*pi*20*20/4)/1.25 = 45.26kN As given in IS 800:2007, Pg no 75	3
2. Design bearing strength of plate $V_{dpb} = (2.5K_b\ d\ t\ f_u)/ \gamma_{mb}$ K_b *is least of* e/3d$_o$, p/3d$_o$- 0.25, fub/fu, 1 from the IS 800:2007 pg no 75	2
Assumed e=1.7*d$_0$= 1.7*22= 37.5mm= 40mm, p= 70mm, d$_o$= 20+2=22mm 40/ 3*22=0.61 70/3*22-0.25= 0.81 800/410= 1.95 1 V_{dpb} = (2.5*0.61*20*11.6*410*10^{-3})/ 1.25 =116.04kN	2
B_v= bolt value = 45.26 kN No of bolting rows given in question= m= 2 M= ultimate moment = Ultimate load * eccentricity = (1.5*120)*250 = 45000kN-m	4
1. No of bolts for bracket connection= $\sqrt{\frac{6M}{p\ m\ B_v}} = \sqrt{\frac{6*45000}{70*2*45.26}}$ = 6.85= 7no's 250mm $\sum r^2 = r_1^2 + r_2^2 + r_3^2$...............	2

$\sum r^2$ =4(50^2+210^2) + 4(50^2+140^2) +4(50^2+70^2) + 2(50^2+0^2) = 309400mm^2 Force on the extreme bolts F= Magnitude of Resultant force = $\sqrt{F_1^2 + F_2^2 + 2F_1F_2cos\theta}$ = $\sqrt{25.71^2 + 31.39^2 + 2 * 25.71 * 39.24cos76.6}$ = should be always less than bolt value = 44.95kN hence safe Direction of the force on the extreme bolt = θ= $\tan^{-1}\frac{210}{50} = 76.6$ F_1= force due to direct load = $\frac{180}{7} = 25.71kN$ F_2= force due to Moment acting =$\frac{M*r_n}{\sum r^2}$ = $\frac{45000*215.87}{309400}$ = 31.39kN $r_n = distance\ between\ cg\ of\ the\ section\ to\ the\ center\ of\ the\ extreme\ bolt$ $r_n = \sqrt{50^2 + 210^2}$ = 215.87mm	4 4