DR.B.C.ROY ENGINEERING COLLEGE, DURGAPUR

DR. B.C. ROY SOCIETY ENGINEERING

Laboratory..Design..of..Steel..Structure..Sessonal.....

REPORT

Title.....

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Department..Civil Engineering.....

Semester..6th.....Roll No..12001323035.....

Signature.....

Date of Experiment.....

Dr. B. C. ROY ENGINEERING COLLEGE, DURGAPUR

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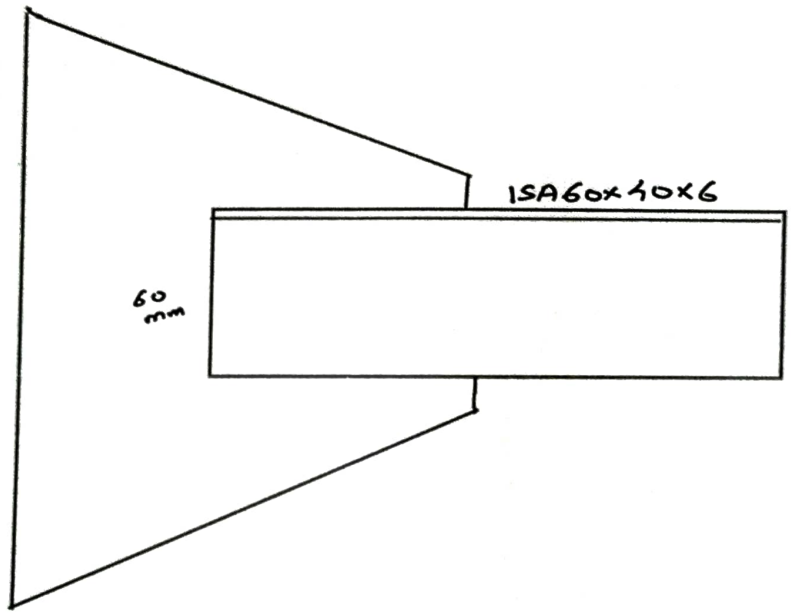
Roll No: 12001323035
SEMESTER : 6th.
SUBJECT : Steel Structure design Sessional.
SUBJECT CODE : CE (PC) 694

INDEX

SL. NO.	NAME OF EXPERIMENT	PAGE NO.	DATE OF EXP	DATE OF SUB	SIGNATURE	REMARKS
1	Design of tauss by bolted connection.		25.02.25	11.03.25		
2.	Design a fillet weld to join the gusset plate.		4.03.25	11.3.25		
3.	Design the shade (using staad Pro) DL.LL = 10 KN/m^2		22.04.25	23.325		
4.	Design & detailing of member of truss-3 with CAD		22.04.25	23.04.25		
5.	Design of industrial shade using staad pro with DL/LL&WL		29.04.25	18.5.25		
6.	connection design & detail of industrial shade with DL, LL, WL.		29.04.25	18.5.25		

Assignment – 1

Design a bolted connection of truss joint as shown in figure using M16 black bolts of 4.6 grade and steel having fu = 410 N/mm^2. Use 10mm gusset plate.



Problem-2

Design a welded connection to joint a 10mm thick gusset plate using 410 steel to join a two leage angle of size 60x40x6mm to resist a factored load of 150 KN. Consider site welding.

⇒ Given data,
Factored load (P) = 150 KN.
Steel grade = 410MPa (Fe 410)
Gusset plate thickness (t) = 10mm.
Angle section size = 60x40x6mm.
Site welding = Assume manual metal arc welding (MMAW) or shielded metal arc welding (SMAW).

Design strength of weld:-

The design strength of the weld is calculated based on the throat thickness & the allowable stress in the weld.

Throat thickness - For fillet welds, the throat thickness is given by -

$$t_w = K \cdot S.$$

where, S = size of the weld (leg length).
K = constant = 0.707 for equal leg fillet welds.

Assume a weld size of 6mm (minimum recommended size for a 10mm thick plate as per IS 800:2007).

$$t_w = 0.707 \times 6 = 4.242 \text{ mm}.$$

Design stress in weld - The design stress in the weld (f_w) is given by -

$$f_w = \frac{f_u}{\sqrt{3} \cdot \gamma_{mw}}.$$

where,
f_u = ultimate tensile strength of the weld metal = 410MPa (for Fe 410 steel)
γ_{mw} = Partial safety factor weld metal = 1.25 (as per IS 800:2007).

$$f_w = \frac{410}{\sqrt{3} \cdot 1.25} = 189.37 \text{ MPa}.$$

Design strength of weld per unit length -

The design strength of the weld per unit length (P_w) is -

$$P_w = t_w \cdot f_w.$$

$$P_w = 4.242 \cdot 189.37 = 803.5 \text{ N/mm}.$$

Total weld length required:-

The total weld length (L) required to resist the factored load of 150 KN is -

$$L = P/P_w.$$

$$L = \frac{150 \cdot 10^3}{803.5} = 186.7 \text{ mm}.$$

Since there are two angles, the total weld length is distributed equally between them. Therefore, the weld length for each angle is -

$$L_{\text{per angle}} = \frac{186.7}{2} = 93.35 \text{ mm}$$

Weld configuration:-

- Provided 6mm fillet welds along the edges of the angles.
- Distribute the weld length along the 60mm & 40 mm legs of the angle section.
- Ensure proper detailing to avoid stress connection.

Check for weld size.

As per IS 800:2007, the minimum weld size for a 10mm thick plate is 5mm & the maximum weld size is -

$$S_{max} = t - 1.5 = 10 - 1.5 = 8.5 \text{ mm}.$$

The assumed weld size of 6 mm is within the permissible range.

Summary of Design:-

- weld size : 6mm fillet weld.
- Total weld length required : 186.7 mm (distributed equally between the two angles).

- Weld configuration: Along the 60mm & 40mm legs of the angles
- Steel grade: Fe 410
- Gusset plate thickness: 10mm.

Drawing:-

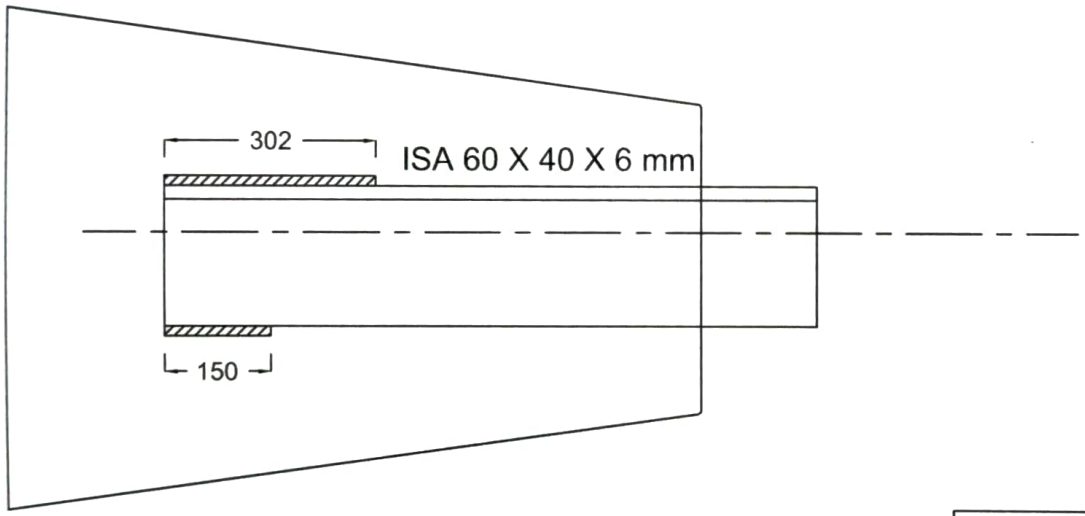
A detailed drawing should show:-

1/ The gusset plate (10mm thick) welded to the two angles. (60 x 40 x 6) mm.

2/ Fillet welds of 6mm size along the edges of the angles.

3/ Proper dimensions & weld symbols as per IS 800:2007.

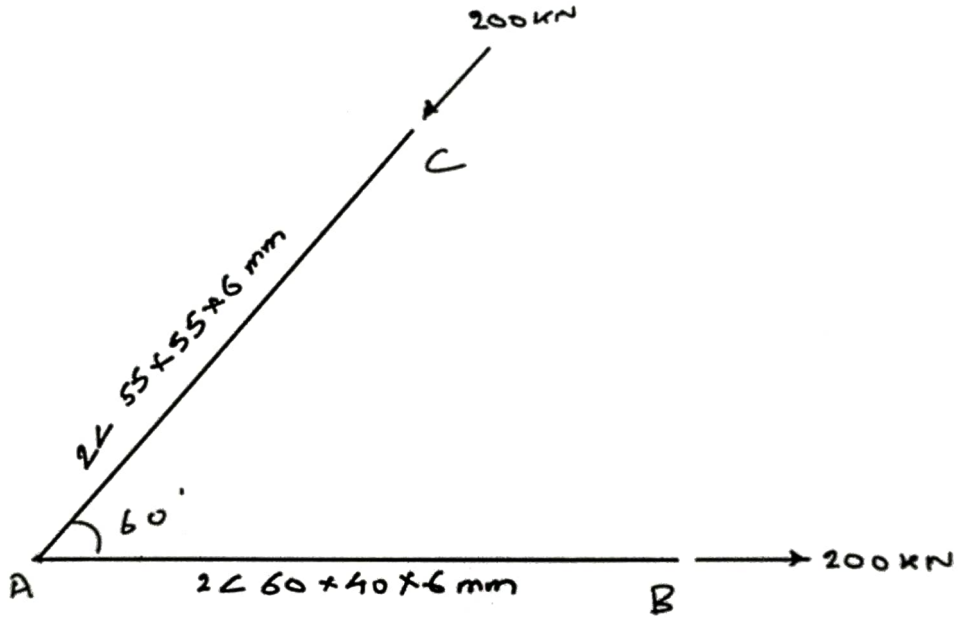
09



ARGHYA MUKHERJEE	DR. B. C. ROY ENGG. COLLEGE	
12001323035	SUBJECT :DESIGN OF STEEL STRUCTURE SESSIONAL	
DEPT.: CIVIL ENGINEERING	SUBJECT CODE: CE (PC) 694	
D.O.C.: 04/03/2025		
D.O.S.: 11/03/2025	SHEET:A4	SHEET NO: 1 OF 1
SCALE: 1:10	REV:R0	CHKD. BY:

Assignment – 2

Design a fillet weld to join a 8mm gusset plate with an angle of size ISA 60 x 40 x 6mm to resist a force of 60 KN. Use FE410 and welding at site.



Problem-1.

Design a bolted connection of a truss joint as shown in fig. using M16 block bolt of 4.6 grade & steel having $f_u = 410$ N/mm². Use 10 mm thick gusset plate.

⇒ Given data,

Dia of bolt M16, $d = 16$ mm.

Dia of hole, $(d_0) = (16+2) = 18$ mm.

Grade of bolt material 4.6.

Ultimate tensile strength of bolt material, $f_{ub} = 400 \text{ N/mm}^2$

Ultimate stress of steel material, $f_u = 410 \text{ N/mm}^2$

Yield strength, $f_y = 250 \text{ N/mm}^2$

Strength Calculation:-

(a) Design shear strength of one bolt in single shear -

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

where, γ_{mb} = Partial safety factor $= (1.25)$

$n_n = 1$, $n_s = 0$.

Net shear area of the bolt at threaded,

$A_{nb} = 0.78 \times \pi/4 \, d^2 = 0.78 \times \pi/4 \times 16^2 = 156.82 \text{ mm}^2$

A_{sb} = Nominal shank area of the bolt.

$$\therefore V_{dsb} = \frac{1}{1.25} \left[\frac{400}{\sqrt{3}} (1 \times 156.32) \right] = 28972.82 \text{ N} \Rightarrow 28.972 \text{ KN}.$$

∴ Strength of one bolt in double shear.

$= 2 \times 28.972 \text{ KN} = 57.594 \text{ KN}.$

(b) Strength of one bolt in bearing -

Design bearing strength of bolt,

$$V_{dpb} = \frac{1}{\gamma_{mb}} \cdot [2.5 K_b \, d \, t \, f_u].$$

where, K_b = Smaller of $\cdot \frac{e}{3d_0}, \frac{D}{3d_0} - 0.25, \frac{f_{ub}}{f_u}, 1.0$

Assuming,

$P = 2.5d = 2.5 \times 16 = 40$ mm.

$e = 1.7 d_0 = 1.7 \times 18 \approx 30$ mm.

$$\therefore \frac{e}{3d_0} = \frac{30}{3 \times 18} = 0.55.$$

$$\therefore \frac{P}{3d_0} - 0.25 = \frac{40}{3 \times 18} - 0.25 = 0.49.$$

$$\therefore \frac{f_{ub}}{f_u} = \frac{400}{410} = 0.975.$$

∴ and 1.0

∴ $\boxed{K_b = 0.49.}$

Thickness of angle section, $t = 6$mm.

For two angle, $t = 6 \times 2 = 12$ mm.

Thickness of gusset plate = 10mm.

∴ Consider, $t = 10$ mm.

$$\therefore V_{dpb} = \frac{1}{1.25} [25 \times 0.49 \times 16 \times 10 \times 10] = 64288.0 \text{ N} = 64.28 \text{ KN}.$$

No. of bolts for member AB & AC.

For member AB:- The member is composed of double angle section ISA, 60×90×6 & connected to 10 mm thick gusset plate, bolt will be in double shearing & bearing.

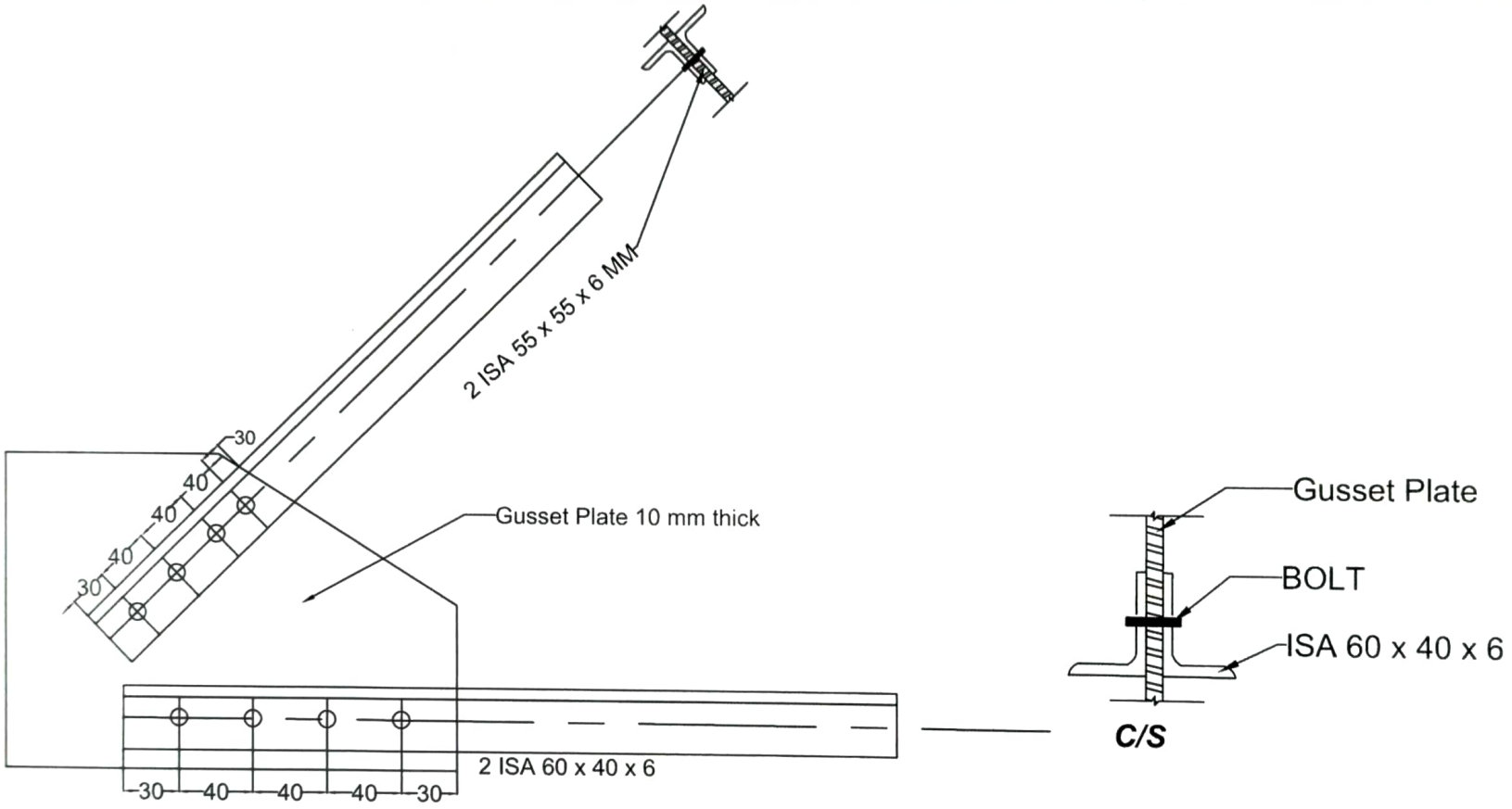
Bolt value = 57.944 KN.

∴ No. of bolts required = $\frac{200}{57.944} = 3.45 \approx 4$ nos.

For member AC:-

The member is composed of double angle section ISA, 55x55x6 & connected to 10mm thick gusset plate, bolt will be in double shearing & bearing.

Bolt value = 57.944 KN.



ELEVATION SHOWING JOINT DETAILS

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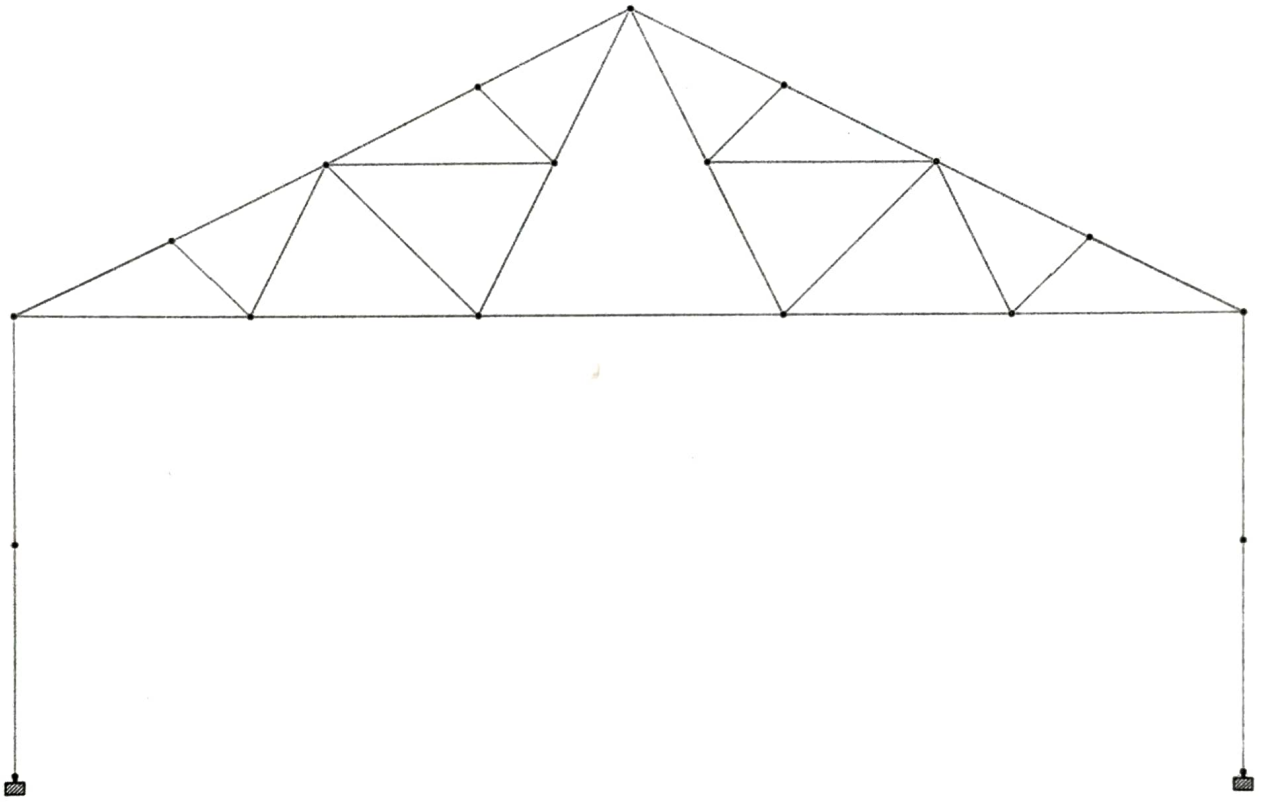
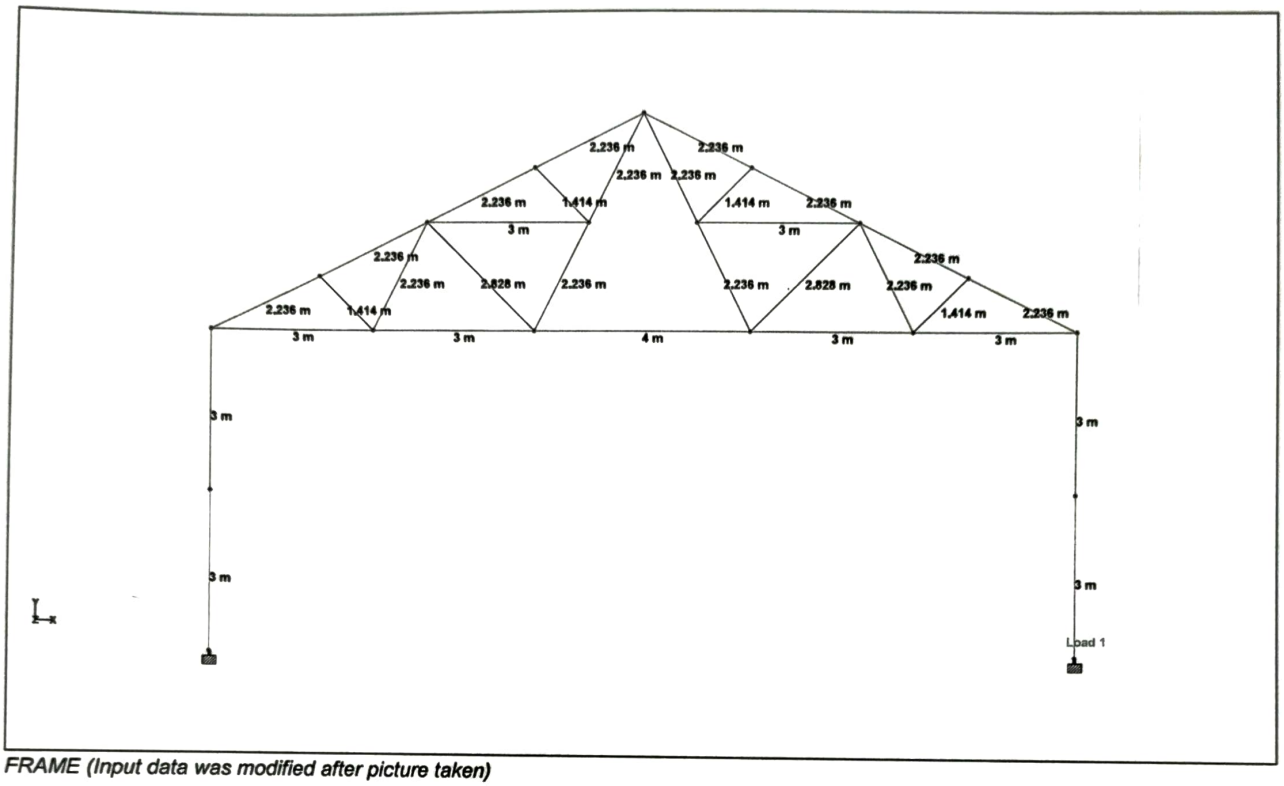
SCALE: 1:10	REV:R0	CHKD. BY:

Assignment – 3

Design of industrial shade using StaadPro with dead load, live load.



Software licensed to STAAD.Pro CONNECTED User: Not signed in	Job No 3	Sheet No 1	Rev
	Part		
Job Title INDUSTRIAL SHADE DL & LL	Ref		
	By	Date 15-Mar-25	Chd
Client BCREC	File industrial shade.STD	Date/Time 23-Apr-2025 22:11	



FRAME (Input data was modified after picture taken)

Job Information

	Engineer	Checked	Approved
Name:			
Date:	15-Mar-25		

Project ID	
Project Name	

Structure Type	SPACE FRAME

Number of Nodes	149	Highest Node	149
Number of Elements	469	Highest Beam	604
Number of Plates	2	Highest Plate	606

Number of Basic Load Cases	2
Number of Combination Load Cases	1

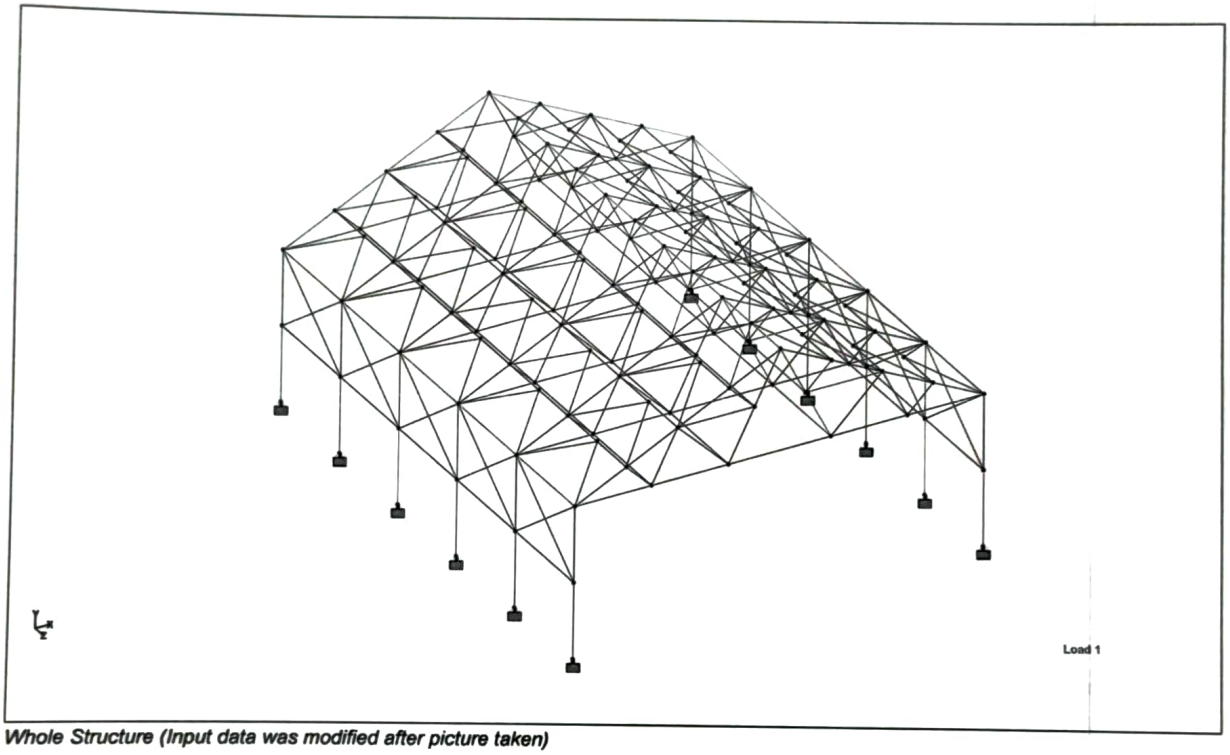
Included in this printout are data for:

All	The Whole Structure

Job Information Cont...

Included in this printout are results for load cases:

Type	L/C	Name
Primary	1	DL
Primary	2	LL
Combination	3	COMBINATION LOAD CASE 3



Whole Structure (Input data was modified after picture taken)

Software licensed to STAAD.Pro CONNECTED User: Not signed in	Job No 3	Sheet No 3	Rev
	Part		
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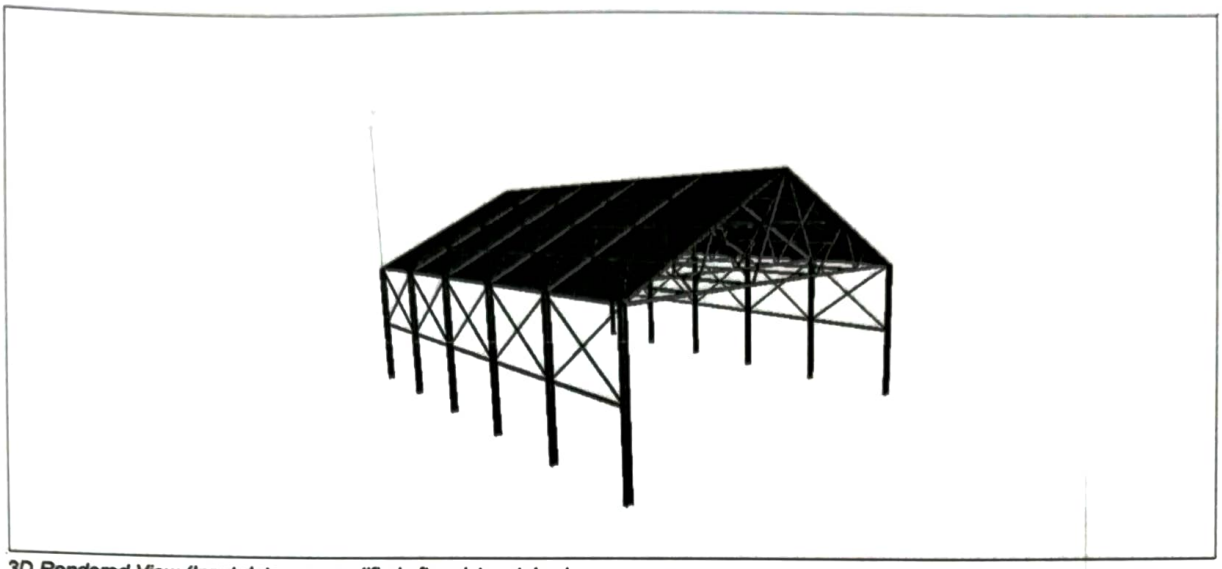
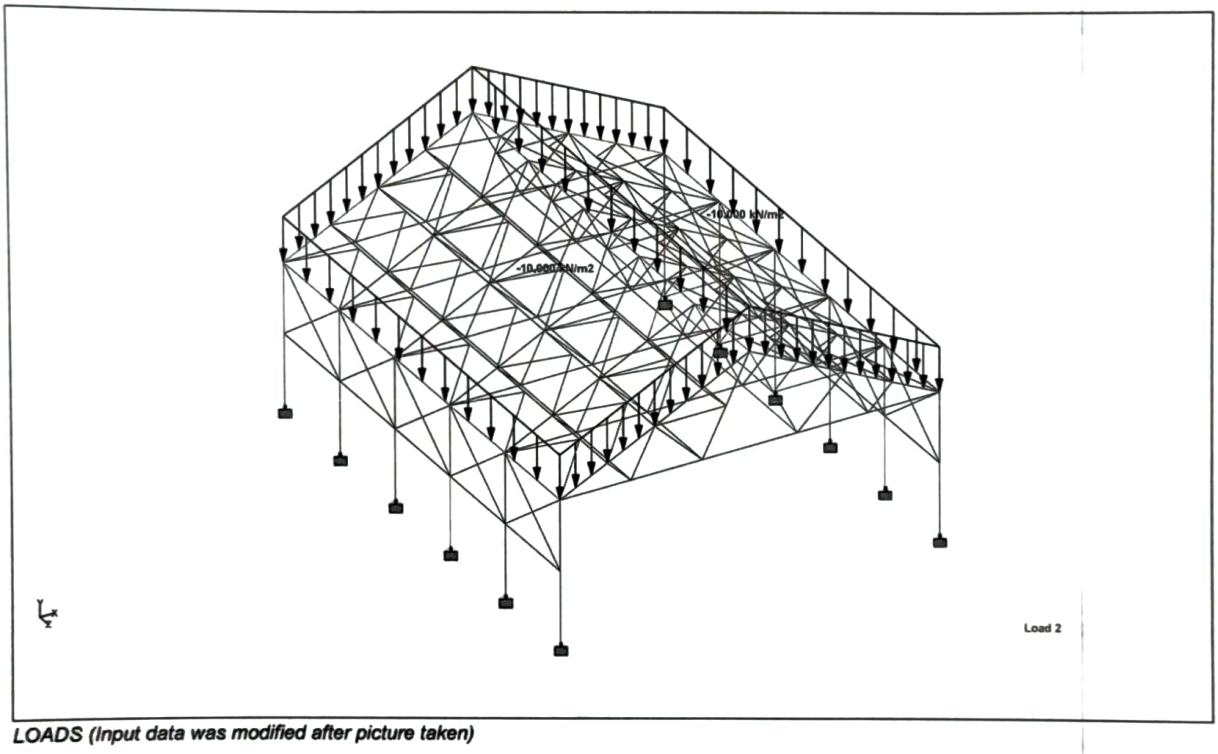
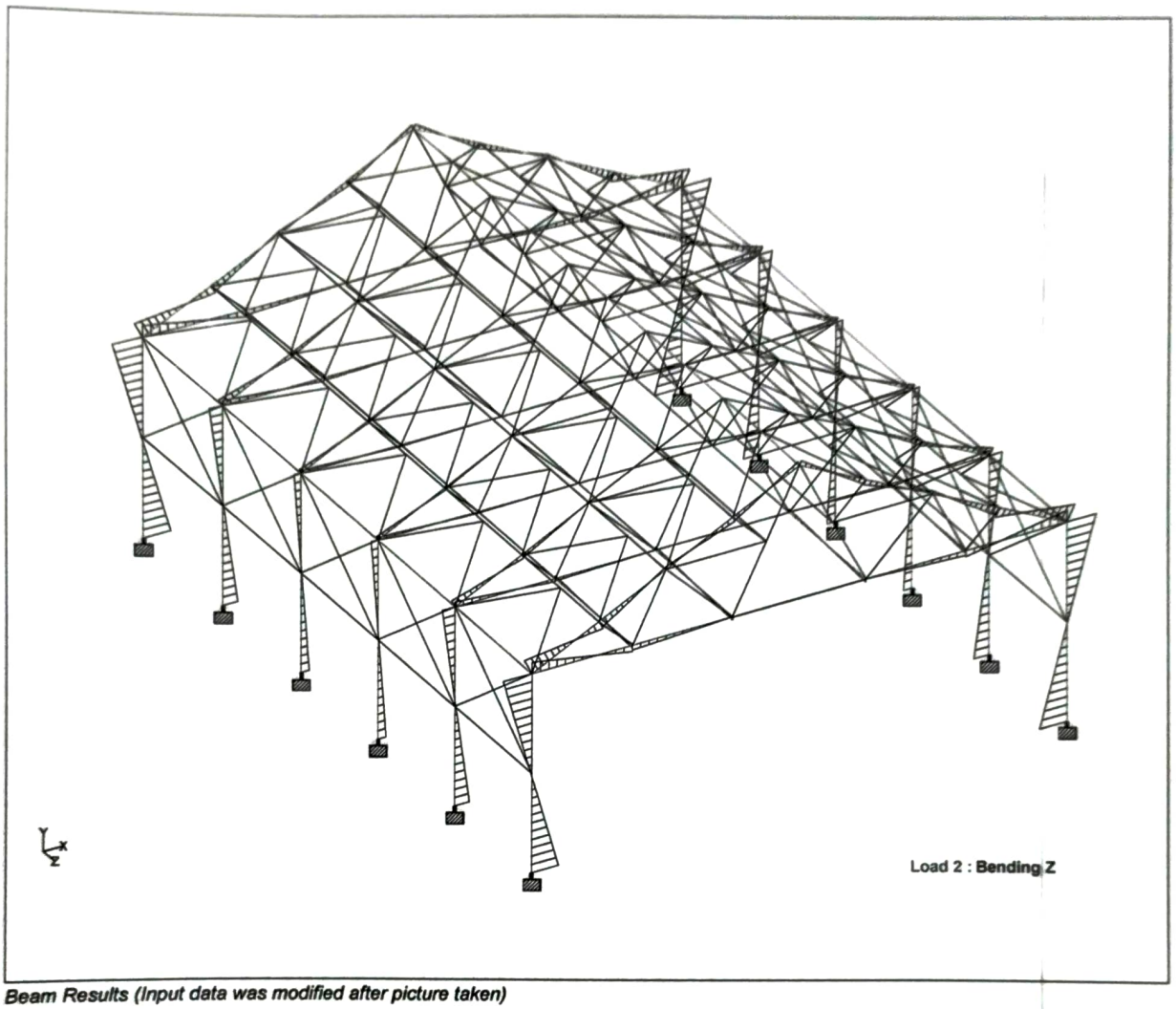


3D Rendered View (Input data was modified after picture taken)



LOADS (Input data was modified after picture taken)



Beam Results (Input data was modified after picture taken)

Section Properties

Prop	Section	Area (in^2)	I_{yy} (in^4)	I_{zz} (in^4)	J (in^4)	Material
2	ISMB250	7.378	8.048	123.297	0.601	STEEL
3	ISMC100	1.891	0.634	4.613	0.053576	STEEL
4	ISA65X65X8	1.513	1.460	0.379	0.052	STEEL

Plate Thickness

Prop	Node A (in)	Node B (in)	Node C (in)	Node D (in)	Material
1	0.059055	0.059055	0.059055	0.059055	STEEL

Materials

Mat	Name	E (kip/in^2)	ν	Density (kip/in^3)	α (/°F)
1	CONCRETE	3.15E+3	0.170	8.68e-05	5.5E -6
2	ALUMINUM	10E+3	0.330	9.8e-05	12.8E -6
3	STEEL_50_KSI	29E+3	0.300	0.000283	6.5E -6
4	STAINLESSSTEEL	28E+3	0.300	0.000283	9.9E -6
5	STEEL_36_KSI	29E+3	0.300	0.000283	6.5E -6
6	STEEL_275_NMM2	29.7E+3	0.300	0.000	6.67E -6
7	STEEL	29E+3	0.300	0.000283	6.5E -6
8	STEEL_355_NMM2	29.7E+3	0.300	0.000	6.67E -6

Supports

Node	X (kip/in)	Y (kip/in)	Z (kip/in)	rX (kip-ft/deg)	rY (kip-ft/deg)	rZ (kip-ft/deg)
16	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
17	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
33	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
34	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
61	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
62	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
87	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
88	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
113	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
114	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
139	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
140	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed

Primary Load Cases

Number	Name	Type
1	DL	Dead
2	LL	Live

Combination Load Cases

Comb.	Combination L/C Name	Primary	Primary L/C Name	Factor
3	COMBINATION LOAD CASE 3	1	DL	1.50
		2	LL	1.50

Beam Displacement Detail Summary

Displacements shown in italic indicate the presence of an offset

	Beam	L/C	d (m)	X (in)	Y (in)	Z (in)	Resultant (in)
Max X	580	3:COMBINATI(	4.000	**0.925**	-0.281	0.172	0.982
Min X	576	3:COMBINATI(	4.000	**-0.925**	-0.281	0.172	0.982
Max Y	28	1:DL	0	0	**0**	0	0
Min Y	562	3:COMBINATI(	0.224	-0.576	**-5.729**	-0.012	5.758
Max Z	495	3:COMBINATI(	4.000	0	-3.106	**0.447**	3.138
Min Z	32	3:COMBINATI(	2.000	0	-3.107	**-0.447**	3.139
Max Rst	562	3:COMBINATI(	0.224	-0.576	-5.729	-0.012	**5.758**

Beam Maximum Relative Displacements

Distances to maxima are given from beam end A.

Beam	Node A	Length (m)	L/C	y (in)	d (m)	z (in)	d (m)	Resultant (in)	d (m)	Span / Max z
1	2	2.236	1:DL	0.009	0.745	-0.001	0.559	0.009	0.745	> 10000
			2:LL	0.278	0.745	-0.041	1.118	0.280	0.745	317
			3:COMBINATI(	0.430	0.745	-0.061	0.932	0.434	0.745	205
2	3	2.236	1:DL	-0.001	1.677	-0.002	1.304	0.003	1.491	> 10000
			2:LL	-0.039	1.677	-0.021	0.745	0.040	1.677	2249
			3:COMBINATI(	-0.061	1.677	-0.035	0.745	0.063	1.677	1453
3	1	3.000	1:DL	0.009	0.750	-0.003	1.750	0.009	0.750	> 10000
			2:LL	0.332	1.000	0.090	1.500	0.342	1.000	356
			3:COMBINATI(	0.511	1.000	0.132	1.500	0.524	1.000	231
4	4	3.000	1:DL	-0.009	1.250	0.002	0.750	0.009	1.250	> 10000
			2:LL	-0.252	1.250	-0.033	1.000	0.254	1.250	469
			3:COMBINATI(	-0.392	1.250	-0.047	1.000	0.394	1.250	302
5	5	4.000	1:DL	-0.009	2.000	0.007	2.000	0.011	2.000	> 10000
			2:LL	-0.089	2.000	-0.013	2.000	0.090	2.000	1767
			3:COMBINATI(	-0.147	2.000	-0.010	2.000	0.148	2.000	1070
6	6	3.000	1:DL	-0.009	1.750	0.002	2.250	0.009	1.750	> 10000
			2:LL	-0.252	1.750	-0.033	2.000	0.254	1.750	469
			3:COMBINATI(	-0.392	1.750	-0.047	2.000	0.394	1.750	302
7	7	3.000	1:DL	0.009	2.250	-0.003	1.250	0.009	2.250	> 10000
			2:LL	0.332	2.000	0.090	1.500	0.342	2.000	356
			3:COMBINATI(	0.511	2.000	0.132	1.500	0.524	2.000	231
8	6	2.236	1:DL	-0.007	1.304	-0.001	0.559	0.007	1.491	> 10000
			2:LL	-0.038	1.677	0.135	0.745	0.138	0.745	2315

Beam Maximum Moments

Distances to maxima are given from beam end A.

Beam	Node A	Length (m)	L/C		d (m)	Max My (kN-m)	d (m)	Max Mz (kN-m)
1	2	2.236	1:DL	Max +ve	0	0.008	0	0.519
				Max -ve	2.236	-0.007	2.236	-0.214
			2:LL	Max +ve	0	0.128	0	15.209
				Max -ve			2.236	-8.036
			3:COMBINATIC	Max +ve	0	0.204	0	23.592
				Max -ve			2.236	-12.375
2	3	2.236	1:DL	Max +ve	2.236	0.011	0	0.147
				Max -ve	0	-0.002	2.236	-0.078
			2:LL	Max +ve	0	0.139	0	3.757
				Max -ve	2.236	-0.057	2.236	-4.080
			3:COMBINATIC	Max +ve	0	0.206	0	5.855
				Max -ve	2.236	-0.069	2.236	-6.236
3	1	3.000	1:DL	Max +ve	3.000	0.009	0	0.405
				Max -ve	0	-0.002	3.000	-0.130
			2:LL	Max +ve			0	10.341
				Max -ve	0	-0.116	3.000	-5.641
			3:COMBINATIC	Max +ve			0	16.118
				Max -ve	0	-0.178	3.000	-8.656
4	4	3.000	1:DL	Max +ve	3.000	0.017	3.000	0.108
				Max -ve	0	-0.018	0.750	-0.120
			2:LL	Max +ve	0	0.151	3.000	0.098
				Max -ve	3.000	-0.089	0	-4.339
			3:COMBINATIC	Max +ve	0	0.200	3.000	0.308
				Max -ve	3.000	-0.108	0	-6.645
5	5	4.000	1:DL	Max +ve			0	0.111
				Max -ve	4.000	-0.004	2.000	-0.076
			2:LL	Max +ve	4.000	0.009		
				Max -ve			4.000	-0.434
			3:COMBINATIC	Max +ve	4.000	0.006		
				Max -ve			2.000	-0.766
6	6	3.000	1:DL	Max +ve	0	0.017358	0	0.108
				Max -ve	3.000	-0.018	2.250	-0.120
			2:LL	Max +ve	3.000	0.151	0	0.098
				Max -ve	0	-0.089	3.000	-4.339
			3:COMBINATIC	Max +ve	3.000	0.200	0	0.308
				Max -ve	0	-0.108	3.000	-6.645
7	7	3.000	1:DL	Max +ve	0	0.009	3.000	0.405
				Max -ve	3.000	-0.002	0	-0.130
			2:LL	Max +ve			3.000	10.341
				Max -ve	3.000	-0.116	0	-5.641
			3:COMBINATIC	Max +ve			3.000	16.118
				Max -ve	3.000	-0.178	0	-8.656
8	6	2.236	1:DL	Max +ve	0	0.037	0	0.031
				Max -ve	2.236	-0.036	1.677	-0.017

Beam Maximum Moments Cont...

Beam	Node A	Length (m)	L/C		d (m)	Max My (kN-m)	d (m)	Max Mz (kN-m)
				Max -ve	3.000	-0.797	3.000	-0.539
601	109	3.000	1:DL	Max +ve	0	0.056	0	0.107
				Max -ve	3.000	-0.041	2.000	-0.036
			2:LL	Max +ve	0	0.156	0	0.259
				Max -ve	3.000	-0.213		
			3:COMBINATI(	Max +ve	0	0.317	0	0.549
				Max -ve	3.000	-0.381	3.000	-0.001
602	147	3.000	1:DL	Max +ve	3.000	0.027	3.000	0.073
				Max -ve	0	-0.052	1.250	-0.029
			2:LL	Max +ve	0	0.207		
				Max -ve	3.000	-0.265	3.000	-0.331
			3:COMBINATI(	Max +ve	0	0.233	0	0.043
				Max -ve	3.000	-0.356	2.750	-0.387
603	110	3.000	1:DL	Max +ve	3.000	0.024	3.000	0.053
				Max -ve	0	-0.017	1.500	-0.029
			2:LL	Max +ve			3.000	0.094
				Max -ve	3.000	-0.236		
			3:COMBINATI(	Max +ve			3.000	0.221
				Max -ve	3.000	-0.317		
604	146	3.000	1:DL	Max +ve	0	0.007	0	0.085
				Max -ve	3.000	-0.019	1.750	-0.034
			2:LL	Max +ve	0	0.936	0	0.362
				Max -ve	3.000	-0.747	3.000	-0.491
			3:COMBINATI(	Max +ve	0	1.416	0	0.670
				Max -ve	3.000	-1.149	3.000	-0.716

Beam Maximum Shear Forces

Distances to maxima are given from beam end A.

Beam	Node A	Length (m)	L/C		d (m)	Max Fz (kN)	d (m)	Max Fy (kN)
1	2	2.236	1:DL	Max +ve			0	0.422
				Max -ve	0	-0.006		
			2:LL	Max +ve			0	10.395
				Max -ve	0	-0.037		
			3:COMBINATI(	Max +ve			0	16.226
				Max -ve	0	-0.065		
2	3	2.236	1:DL	Max +ve	0	0.006	0	0.194
				Max -ve				
			2:LL	Max +ve			0	3.504
				Max -ve	0	-0.088		
			3:COMBINATI(	Max +ve			0	5.548
				Max -ve	0	-0.123		
3	1	3.000	1:DL	Max +ve	0	0.004	0	0.319

Beam Maximum Shear Forces Cont...

Beam	Node A	Length (m)	L/C		d (m)	Max Fz (kN)	d (m)	Max Fy (kN)
				Max -ve			3.000	-0.108
			2:LL	Max +ve				
				Max -ve	0	-0.066	0	-0.016
			3:COMBINATIC	Max +ve			0	0.132
				Max -ve	0	-0.079	3.000	-0.186
604	146	3.000	1:DL	Max +ve			0	0.130
				Max -ve	0	-0.009	3.000	-0.082
			2:LL	Max +ve			0	0.284
				Max -ve	0	-0.561		
			3:COMBINATIC	Max +ve			0	0.621
				Max -ve	0	-0.855		

Beam Maximum Axial Forces

Distances to maxima are given from beam end A.

Beam	Node A	Length (m)	L/C		d (m)	Max Fx (kN)
1	2	2.236	1:DL	Max +ve	0	17.888
				Max -ve		
			2:LL	Max +ve	0	513.237
				Max -ve		
			3:COMBINATIC	Max +ve	0	796.687
				Max -ve		
2	3	2.236	1:DL	Max +ve	2.236	16.950
				Max -ve		
			2:LL	Max +ve	0	909.623
				Max -ve		
			3:COMBINATIC	Max +ve	2.236	1.39E+3
				Max -ve		
3	1	3.000	1:DL	Max +ve		
				Max -ve	0	-16.122
			2:LL	Max +ve		
				Max -ve	0	-396.291
			3:COMBINATIC	Max +ve		
				Max -ve	0	-618.619
4	4	3.000	1:DL	Max +ve		
				Max -ve	0	-15.785
			2:LL	Max +ve		
				Max -ve	0	-418.427
			3:COMBINATIC	Max +ve		
				Max -ve	0	-651.319
5	5	4.000	1:DL	Max +ve		
				Max -ve	0	-13.306
			2:LL	Max +ve		

Reaction Summary

	Node	L/C	Horizontal FX (kN)	Vertical FY (kN)	Horizontal FZ (kN)	Moment MX (kN-m)	Moment MY (kN-m)	Moment MZ (kN-m)
Max FX	139	3:COMBINATIC	**12.979**	1.01E+3	0.475	0.558	0.008	-37.614
Min FX	140	3:COMBINATIC	**-12.979**	1.01E+3	0.475	0.558	-0.008	37.614
Max FY	140	3:COMBINATIC	-12.979	**1.01E+3**	0.475	0.558	-0.008	37.614
Min FY	87	1:DL	0.322	**12.666**	-0.002	-0.003	0.000	-0.894
Max FZ	139	3:COMBINATIC	12.979	1.01E+3	**0.475**	0.558	0.008	-37.614
Min FZ	16	3:COMBINATIC	12.979	1.01E+3	**-0.475**	-0.557	-0.008	-37.614
Max MX	139	3:COMBINATIC	12.979	1.01E+3	0.475	**0.558**	0.008	-37.614
Min MX	16	3:COMBINATIC	12.979	1.01E+3	-0.475	**-0.557**	-0.008	-37.614
Max MY	113	3:COMBINATIC	6.801	240.880	0.118	0.166	**0.016**	-21.489
Min MY	114	3:COMBINATIC	-6.801	240.880	0.118	0.166	**-0.016**	21.489
Max MZ	140	3:COMBINATIC	-12.979	1.01E+3	0.475	0.558	-0.008	**37.614**
Min MZ	139	3:COMBINATIC	12.979	1.01E+3	0.475	0.558	0.008	**-37.614**

Failed Members

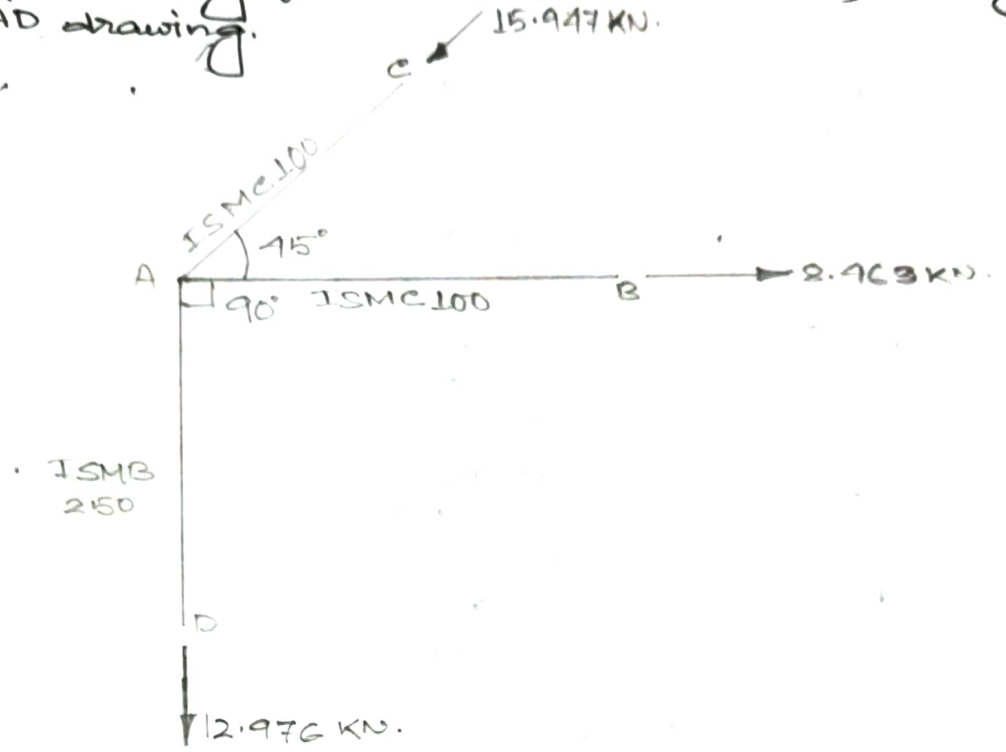
There is no data of this type.

Assignment – 4

Connection design and details :

(design of industrial shade using StaadPro with dead load, live load).

8. Design & Detailing of member of shade (truss) of assign-3. with CAD drawing.



⇒ Let assume.

- $f_u = 410 N/mm^2$; $\gamma_{mb} = 1.25$ [IS 800-2007, Table-5].
- 4.6 grade bolt, $f_{ub} = 400 N/mm^2$; $f_{yb} = 240 N/mm^2$.
- ISMC 100 :- thickness (t) = 4.7 mm. [Steel table].
- Dia. of bolt (d) = $6.01\sqrt{t}$ [Unwin's formula].
  $= 6.01\sqrt{4.7} = 13.029$.
  $\therefore$ $d \approx 16$ mm.

$d_o = 16 + 2 = 18$ mm [IS 800:2007 - table-19].

- Assume thickness of gusset plate = 10 mm.
- A_{sb} = Net shear area of bolt at thread.
  = 78% of net area $= 0.7 \times \pi/4 \times (16)^2 = 156.82 mm^2$
- $A_{sb} = \pi/4 \times (16)^2 = 201.06 mm^2$
- n_n = No. of shear plane with thread intercepting.
- n_s = No. of shear plane without thread intercepting.

Shear capacity of bolt:-

Single shear; $n_n = 1$, $n_s = 0$ [Consider shear plane occur at thread]

$$V_{dsb} = \frac{f_{ub}\cdot[A_{nb} n_n + A_{sb} n_s]}{\sqrt{3}\,\gamma_{mb}} = \frac{400[156.82 \times 1 + 0]}{\sqrt{3} \times 1.25} = \boxed{28.978 \text{ KN.}}$$

Bearing capacity of bolt:-

$$K_b = \text{least of } \left\{ \frac{e}{3d_o}, \left(\frac{p}{3d_o} - 0.25\right), \frac{f_{ub}}{f_u}, 1 \right\}$$

Edge distance (e):- [IS 800:2007, Pg-74] [Cl-10.2.4.2]

Min. $e = 1.5\, d_o = 1.5 \times 18 = 27$ mm.

Max $e = 40 + 4t = 40 + 4 \times 1.7 = 58.8$ mm

$\therefore$ Provide, $e = 50$ mm.

• Pitch distance (P) → [IS 800:2007, Pg-74]

Min, P = 2.5 d = 2.5 × 16 = 40 mm.

Max, P = 32t or 300 mm, = 32 × 4.7 or = 300 = 150.4 or 300 mm.

∴ Provide, P = 70 mm.

K_b = least of $\left\{ \frac{50}{3\times18}, \left(\frac{70}{3\times18} - 0.25\right), \frac{400}{410}, 1 \right\}$.

= least $\{0.92, 1.04, 0.975, 1\}$.

∴ $K_b = 0.92$.

Is single portion of 4.7 mm which is less than 10 mm gusset plate. So, taking, bearing capacity of bolt w.r.t to 4.7 mm.

∴ t = 4.7 mm.

$$V_{dpb} = \frac{2.5 K_b d t f_u}{\gamma_{mb}} = \frac{2.5 \times 0.92 \times 16 \times 4.7 \times 410}{1.25} = 56.730 \text{ KN.}$$

Hence, V_{dsb} = 28.972 KN.

V_{dpb} = 56.730 KN. } min.

∴ Strength of bolt = 28.972 KN.

Now, Member AB.

Factored load = 8.469 KN.

No. of bolts required = $\frac{8.469}{28.972}$ = 0.292.

Hence, Provide Min. of 2 bolts on member AB.

Member AC.

Factored load = 15.947 KN.

No. of bolt required = $\frac{15.947}{28.972}$ = 0.55.

Hence, Provide Min. of 2 bolt on member AC.

Member AD.

• ISMB 250 = thickness (t) = 6.9 mm.

• Dia of bolt = $6.01\sqrt{t}$. [by Unwin's formula, IS:800-2007].

= $6.01\sqrt{6.9}$ = 15.78.

d ≈ 16 mm.

d_0 = 16 + 2 = 18 mm.

• $A_{nb} = 0.78 \pi/4 (16)^2 = 156.82 \text{ mm}^2$

• $A_{sb} = \pi/4 (16)^2 = 201.06 \text{ mm}^2$

• $\gamma_{mb} = 1.25$.

Shear capacity of bolt:-

Single shear; $n_n = 1$, $n_s = 0$ [consider shear plane occurd thread].

$$V_{dsb} = \frac{f_{ub}[A_{nb} n_n + A_{sb} n_s]}{\sqrt{3}\,\gamma_{mb}} = \frac{400[156.82 \times 1 + 0]}{\sqrt{3} \times 1.25} = 28.972 \text{ KN.}$$

Bearing capacity of bolt:-

K_b = less of $\left\{ \frac{e}{3d_0}, \left(\frac{p}{3d_0} - 0.25\right), \frac{f_{ub}}{f_u}, 1 \right\}$

Edge distance (e) = Min (e) = 1.5 d_0 = 1.5 × 18 = 27 mm.

Max (e) = 40 + 4t = 40 + 4 × 6.9 = 67.6 mm.

Provide e = 50 mm.

Pitch Distance:-

Min P = 2.5 d = 2.5 × 16 = 40 mm.

Max P = 32 t or 300 mm.

= 32 × 6.9 or 300 mm = 220 or 300 mm.

Provide P = 70 mm.

k_b = least of $\left\{ \frac{50}{3\times18}, \left(\frac{70}{3\times18} - 0.25\right), \frac{400}{410}, 1 \right\}$.

$= \{0.92, 1.04, 0.975, 1\}$.

$k_b = 0.92$

$\therefore t = 6.9$ mm.

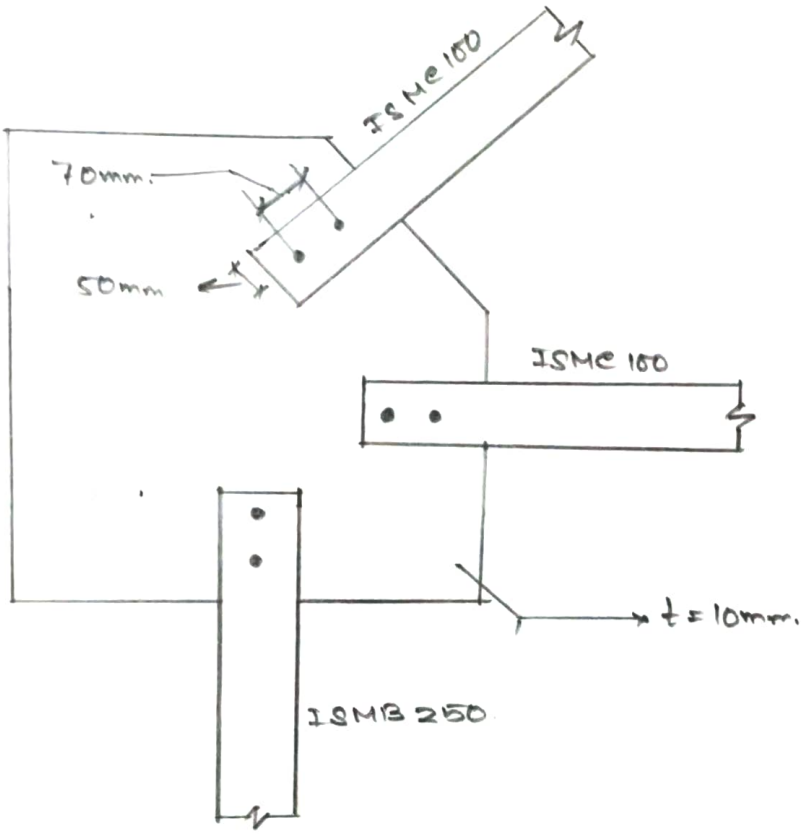
$V_{apb} = \frac{2.5 \times k_b \times d \times t \times f_y}{V_{mb}} = \frac{2.5 \times 0.92 \times 16 \times 6.3 \times 410}{2.25} = 83.23$ KN.

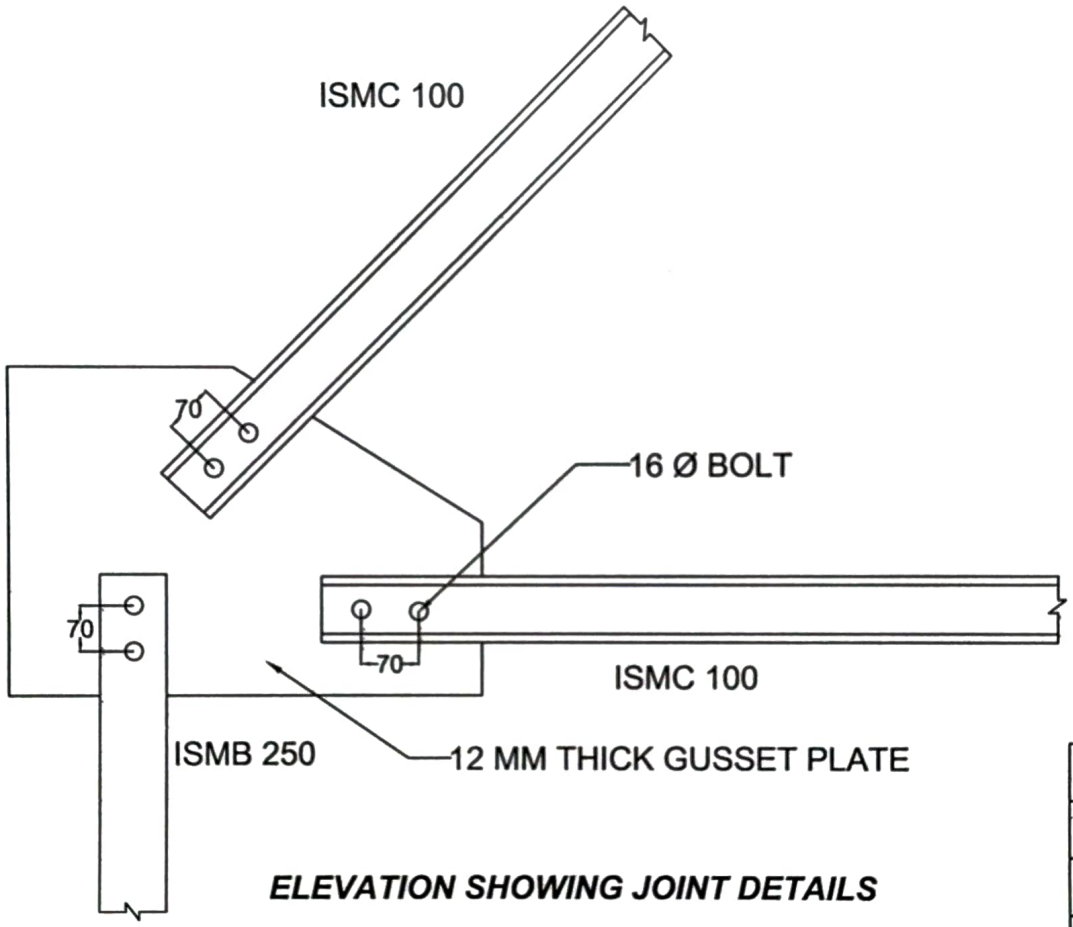
Hence, Strength of bolt = 28.972 KN.

Factored load = 12.972 KN.

No. of bolts req. = $\frac{12.976}{28.972} = 0.44$.

$\therefore$ Provide min. 2 bolts on member AD.



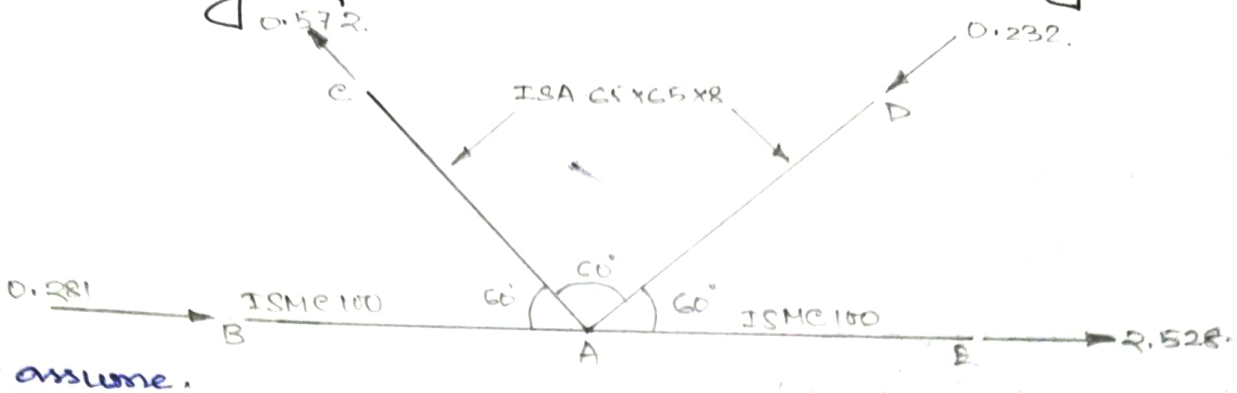


ELEVATION SHOWING JOINT DETAILS

ALL DIMENSIONS IN MM

ARGHYA MUKHERJEE	DR. B. C. ROY ENGG. COLLEGE	
12001323035	SUBJECT :DESIGN OF STEEL STRUCTURE SESSIONAL	
DEPT.: CIVIL ENGINEERING	SUBJECT CODE: CE (PC) 694	
D.O.C.: 22/04/2025		
D.O.S.: 29/04/2025	SHEET:A4	SHEET NO: 1 OF 1
SCALE: 1:10	REV:R0	CHKD. BY:

Q. Design & Detailing of member of shade (truss) of assign. 3 with. CAD drawing.



⇒ Let assume.

- $f_u = 410\ N/mm^2$; $\gamma_{mb} = 1.25$ [IS800-2007, Table-5].
- 4.6 grade bolt, $f_{ub} = 400\ N/mm^2$, $f_{yb} = 240\ N/mm^2$
- Given section – ISMC100 :- thickness (t) = 4.7 mm. [Steel Table].
- Dia of bolt (d) = $6.01\sqrt{t}$ [Unwin's formula]
  $= 6.01\sqrt{4.7} = 13.029$ mm. ≈ 16 mm.
  $d_0 = 16 + 2 = 18$ mm [IS800-2007-Table-19].
- Assume thickness of gusset plate = 10 mm.
- A_{nb} = Net shear area of bolt at thread.
  = 78% of net area $= 0.78 \times \pi/4 \times (16)^2 = 156.82\ mm^2$
- $A_{sb} = \pi/4\,(16)^2 = 201.06\ mm^2$
- n_n = No. of shear plane with thread intercepting
- n_s = No. of shear plane without thread intercepting.

Shear capacity of bolt:-

Single shear = $n_n = 1$, $n_s = 0$ [Consider shear plane occur at thread].

$$V_{dsb} = \frac{f_{ub}[A_{nb} n_n + A_{sb} n_s]}{\sqrt{3}\,\gamma_{mb}} = \frac{400[156.82 \times 1 + 0]}{\sqrt{3} \times 1.25} = 28.972\ KN.$$

Bearing capacity of bolt:-

$$K_b = \text{least of } \left\{ \frac{e}{3d_0}, \left(\frac{P}{3d_0} - 0.25\right), \frac{f_{ub}}{f_u}, 1 \right\}$$

Edge distance:- [IS 800:2007; Pg-74] [cl-10.2.4.2].

Min. $e = 1.5 d_0 = 1.5 \times 18 = 27$ mm.

Max. $e = 40 + 4t = 40 + 4 \times 4.7 = 58.8$ mm. ⇒ $e = 50$ mm.

Pitch distance (P) – [IS 800-2007, Pg-74].

Min. $P = 2.5\,d = 2.5 \times 16 = 40$ mm.

Max. $P = 32t$ or 300 mm.
$= 32 \times 4.7$ or 300 $= 150.4$ or 300 mm ⇒ $P = 70$ mm.

$$K_b = \text{least of } \left\{ \frac{50}{3 \times 18}, \left(\frac{70}{3 \times 18} - 0.25\right), \frac{400}{410}, 1 \right\}$$

$= \text{least } \{0.92, 1.04, 0.975, 1\}$ ⇒ $K_b = 0.92$.

$t = 4.7$ mm.

$$V_{dpb} = \frac{2.5 \times K_b \times d \times t \times f_u}{\gamma_{mb}} = \frac{2.5 \times 0.92 \times 16 \times 4.7 \times 410}{1.25} \Rightarrow V_{dpb} = 56.730\ KN.$$

Hence, $V_{dsb} = 28.972\ KN.$, $V_{dpb} = 56.730\ KN.$ } min.

∴ **Strength of bolt = 28.972 KN.**

Now,

 # Member AB

Factored load = 0.281 KN.

No. of bolt $= \frac{0.281}{28.972} = 0.0096$ ⇒ **Provide min. 2 bolts on AB.**

– Anghya Mukherjee 12007323035.

#Member AB

Factored load = 2.528 KN.

No. of bolt = $\frac{2.528}{28.972} = 0.087$ ⇒ Provide min = 2 bolts on AB.

ISA 65×65×8.

thickness = 8mm.

• Dia of bolt = $6.0\sqrt{t}$ [Unwin's formula, IS 800-2007].

$= 6.0\sqrt{8} = 16.9$ mm.

∴ $d \approx 20$mm.

$d_0 = 20 + 2 = 22$ mm

• $A_{nb} = 0.78 \times \pi/4 \times (20)^2 = 245.16$ mm²

• $A_{sb} = \pi/4 (20)^2 = 314.15$ mm²

• $\gamma_{mb} = 1.25$.

Shear capacity of Bolt:-

Single shear.

$n_n = 1$ $n_s = 0$.

$V_{dsb} = \frac{f_{ub}[A_{nb} n_n + A_{sb} n_s]}{\sqrt{3}\,\gamma_{mb}} = \frac{400[245.16 \times 1 + 0]}{\sqrt{3} \times 1.25}$ ⇒ $V_{dsb} = 45.29$ KN

Bearing capacity of bolt:-

K_b = least of $\left\{\frac{e}{3d_0}, \left(\frac{p}{3d_0} - 0.25\right), \frac{f_{ub}}{f_u}, 1\right\}$.

Edge distance (e)

Min. $e = 1.5 d_0 = 1.5 \times 22 = 33$ mm.

Max $e = 40 + 4t = 72$ mm.

∴ Provide, $e = 50$ mm.

Pitch distance (P):-

Min $P = 2.5 d = 2.5 \times 20 = 50$ mm.

Max $P = 32t$ on 300mm = 256 on 300mm. ∴ Provide P = 70mm.

K_b = least of $\left\{\frac{50}{3\times22}, \frac{70}{3\times22} - 0.25, \frac{400}{410}, 1\right\}$.

$= \{0.75, 0.81, 0.97, 1\}$ ⇒ $K_b = 0.75$.

∴ $t = 8$mm.

$V_{dpb} = \frac{2.5 \times K_b \times d \times t \times f_u}{\gamma_{mb}} = \frac{2.5 \times 0.75 \times 22 \times 8 \times 410}{1.25}$

∴ $V_{dpb} = 98.4$KN.

Strength of bolt = 45.29 KN.

Member AC

Factored load = 0.572 KN.

No. of bolt = $\frac{0.572}{45.29} = 0.012$

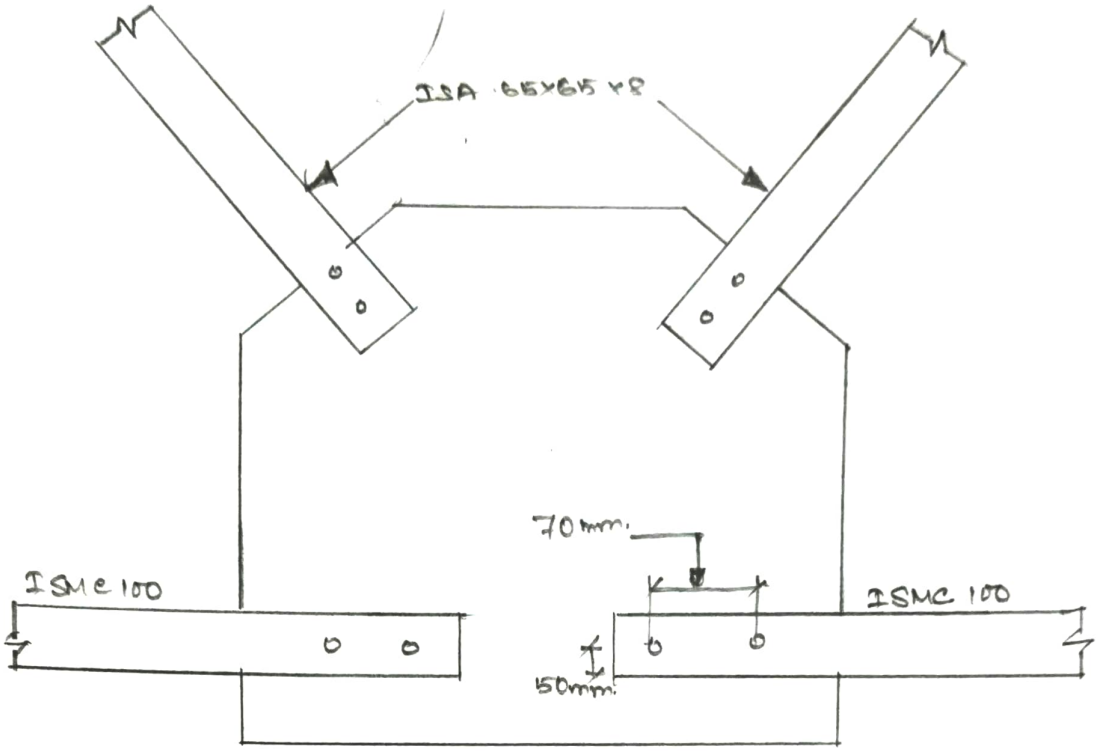
∴ Providing Min of 2 bolt in member AC.

Member AD

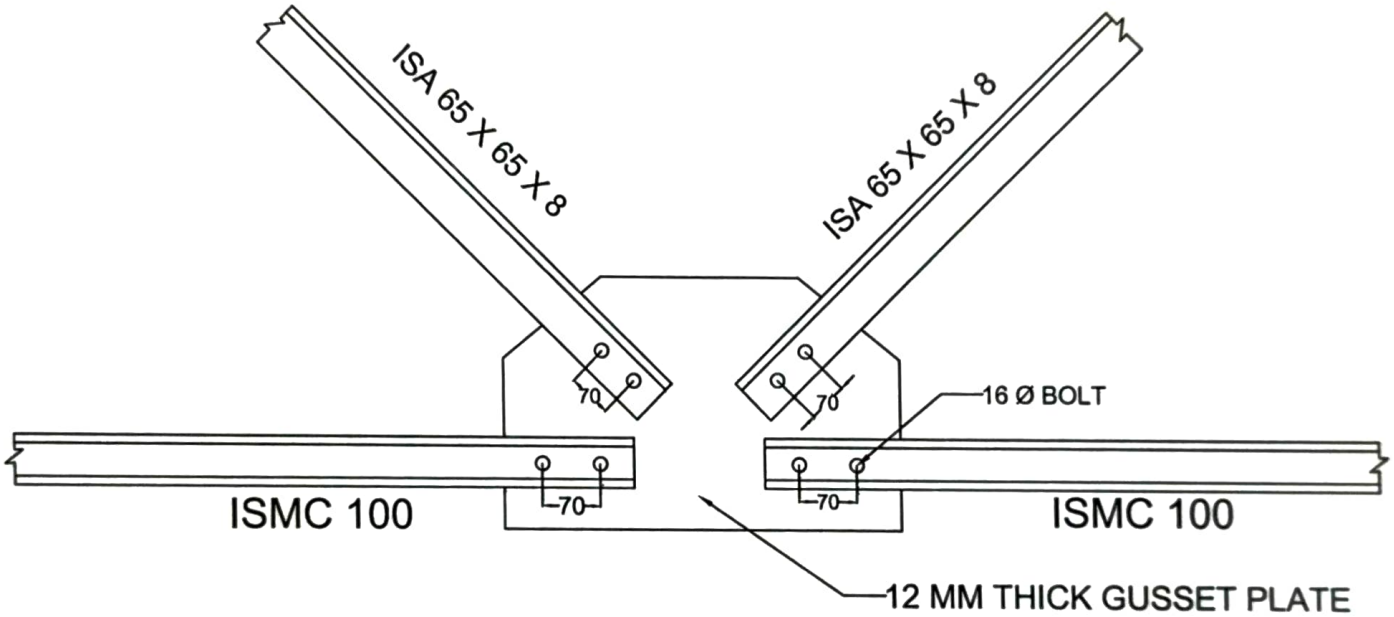
Factored load = 0.232 KN.

No. of bolt = $\frac{0.232}{45.29} = 0.005$.

∴ Hence, provide Min. 2 nos of bolts in member AD.



Elevation showing Joint Details.



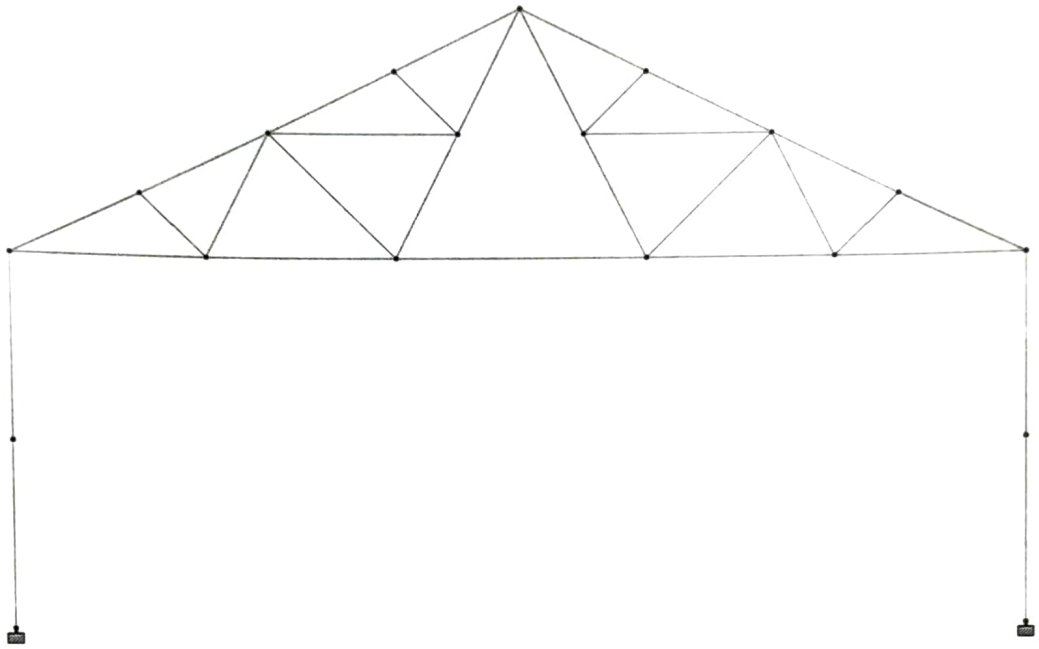
ELEVATION SHOWING JOINT DETAILS

ALL DIMENSIONS IN MM

ARGHYA MUKHERJEE	DR. B. C. ROY ENGG. COLLEGE	
12001323035	SUBJECT :DESIGN OF STEEL STRUCTURE SESSIONAL	
DEPT.: CIVIL ENGINEERING	SUBJECT CODE: CE (PC) 694	
D.O.C.: 22/04/2025		
D.O.S.: 29/04/2025	SHEET:A4	SHEET NO: 1 OF 1
SCALE: 1:10	REV:R0	CHKD. BY:

Assignment – 5

Design of industrial shade using StaadPro with dead load, live load and wind load.



31

Plate Thickness

Prop	Node A (in)	Node B (in)	Node C (in)	Node D (in)	Material
1	0.059055	0.059055	0.059055	0.059055	STEEL

Materials

Mat	Name	E (kip/in^2)	ν	Density (kip/in^3)	α (/°F)
1	CONCRETE	3.15E+3	0.170	8.68e-05	5.5E -6
2	ALUMINUM	10E+3	0.330	9.8e-05	12.8E -6
3	STEEL_50_KSI	29E+3	0.300	0.000283	6.5E -6
4	STAINLESSSTEEL	28E+3	0.300	0.000283	9.9E -6
5	STEEL_36_KSI	29E+3	0.300	0.000283	6.5E -6
6	STEEL_275_NMM2	29.7E+3	0.300	0.000	6.67E -6
7	STEEL	29E+3	0.300	0.000283	6.5E -6
8	STEEL_355_NMM2	29.7E+3	0.300	0.000	6.67E -6

Supports

Node	X (kip/in)	Y (kip/in)	Z (kip/in)	rX (kip-ft/deg)	rY (kip-ft/deg)	rZ (kip-ft/deg)
16	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
17	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
33	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
34	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
61	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
62	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
87	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
88	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
113	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
114	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
139	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
140	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed

Primary Load Cases

Number	Name	Type
4	WX+	Wind
5	WX-	Wind
6	WY+	Wind
7	WY-	Wind
1	DL	Dead
2	LL	Live

Combination Load Cases

Comb.	Combination L/C Name	Primary	Primary L/C Name	Factor
8	ULC, 1.5 DEAD + 1.5 LIVE	1	DL	1.50
		2	LL	1.50
9	ULC, 1.2 DEAD + 1.2 LIVE + 1.2 WIND (1	1	DL	1.20
		2	LL	1.20
		4	WX+	1.20
10	ULC, 1.2 DEAD + 1.2 LIVE + 1.2 WIND (2	1	DL	1.20
		2	LL	1.20
		5	WX-	1.20
11	ULC, 1.2 DEAD + 1.2 LIVE + 1.2 WIND (3	1	DL	1.20
		2	LL	1.20
		6	WY+	1.20
12	ULC, 1.2 DEAD + 1.2 LIVE + 1.2 WIND (4	1	DL	1.20
		2	LL	1.20
		7	WY-	1.20
13	ULC, 1.2 DEAD + 1.2 LIVE + -1.2 WIND (1	1	DL	1.20
		2	LL	1.20
		4	WX+	-1.20
14	ULC, 1.2 DEAD + 1.2 LIVE + -1.2 WIND (2	1	DL	1.20
		2	LL	1.20
		5	WX-	-1.20
15	ULC, 1.2 DEAD + 1.2 LIVE + -1.2 WIND (3	1	DL	1.20
		2	LL	1.20
		6	WY+	-1.20
16	ULC, 1.2 DEAD + 1.2 LIVE + -1.2 WIND (4	1	DL	1.20
		2	LL	1.20
		7	WY-	-1.20
17	ULC, 1.2 DEAD + 1.2 LIVE	1	DL	1.20
		2	LL	1.20
18	ULC, 1.5 DEAD + 1.5 WIND (1)	1	DL	1.50
		4	WX+	1.50
19	ULC, 1.5 DEAD + 1.5 WIND (2)	1	DL	1.50
		5	WX-	1.50
20	ULC, 1.5 DEAD + 1.5 WIND (3)	1	DL	1.50
		6	WY+	1.50
21	ULC, 1.5 DEAD + 1.5 WIND (4)	1	DL	1.50
		7	WY-	1.50
22	ULC, 1.5 DEAD + -1.5 WIND (1)	1	DL	1.50
		4	WX+	-1.50
23	ULC, 1.5 DEAD + -1.5 WIND (2)	1	DL	1.50
		5	WX-	-1.50
24	ULC, 1.5 DEAD + -1.5 WIND (3)	1	DL	1.50
		6	WY+	-1.50
25	ULC, 1.5 DEAD + -1.5 WIND (4)	1	DL	1.50
		7	WY-	-1.50
26	ULC, 1.5 DEAD	1	DL	1.50

Combination Load Cases Cont...

Comb.	Combination L/C Name	Primary	Primary L/C Name	Factor
27	ULC, 0.9 DEAD + 1.5 WIND (1)	1	DL	0.90
		4	WX+	1.50
28	ULC, 0.9 DEAD + 1.5 WIND (2)	1	DL	0.90
		5	WX-	1.50
29	ULC, 0.9 DEAD + 1.5 WIND (3)	1	DL	0.90
		6	WY+	1.50
30	ULC, 0.9 DEAD + 1.5 WIND (4)	1	DL	0.90
		7	WY-	1.50
31	ULC, 0.9 DEAD + -1.5 WIND (1)	1	DL	0.90
		4	WX+	-1.50
32	ULC, 0.9 DEAD + -1.5 WIND (2)	1	DL	0.90
		5	WX-	-1.50
33	ULC, 0.9 DEAD + -1.5 WIND (3)	1	DL	0.90
		6	WY+	-1.50
34	ULC, 0.9 DEAD + -1.5 WIND (4)	1	DL	0.90
		7	WY-	-1.50
35	ULC, 0.9 DEAD	1	DL	0.90

Beam Displacement Detail Summary

Displacements shown in italic indicate the presence of an offset

	Beam	L/C	d (m)	X (in)	Y (in)	Z (in)	Resultant (in)
Max X	474	10:ULC, 1.2 DE	3.200	**2.647**	-0.188	0.051	2.654
Min X	473	14:ULC, 1.2 DE	3.200	**-2.634**	-0.188	0.050	2.641
Max Y	413	32:ULC, 0.9 DE	1.200	-2.369	**0.236**	-0.048	2.381
Min Y	562	8:ULC, 1.5 DE/	0.224	-0.576	**-5.729**	-0.012	5.758
Max Z	5	20:ULC, 1.5 DE	2.000	0.000	-0.161	**1.207**	1.218
Min Z	547	25:ULC, 1.5 DE	2.000	0.000	-0.161	**-1.209**	1.219
Max Rst	562	8:ULC, 1.5 DE/	0.224	-0.576	-5.729	-0.012	**5.758**

Beam Maximum Relative Displacements

Distances to maxima are given from beam end A.

Beam	Node A	Length (m)	L/C	y (in)	d (m)	z (in)	d (m)	Resultant (in)	d (m)	Span Max z
1	2	2.236	4:WX+	0.113	0.932	0.001	1.491	0.113	0.932	777
			5:WX-	0.112	0.932	0.002	1.491	0.112	0.932	789
			6:WY+	-0.000	0.745	0.005	0.745	0.005	0.745	> 10000
			7:WY-	-0.000	0.745	0.005	0.745	0.005	0.745	> 10000
			1:DL	0.009	0.745	-0.001	0.559	0.009	0.745	> 10000
			2:LL	0.278	0.745	-0.041	1.118	0.280	0.745	317
			8:ULC, 1.5 DE/	0.430	0.745	-0.061	0.932	0.434	0.745	205
			9:ULC, 1.2 DE/	0.479	0.745	-0.048	0.932	0.481	0.745	184
			10:ULC, 1.2 DE	0.477	0.745	-0.047	0.932	0.479	0.745	184
			11:ULC, 1.2 DE	0.343	0.745	-0.044	1.118	0.346	0.745	256
			12:ULC, 1.2 DE	0.343	0.745	-0.044	1.118	0.346	0.745	256
			13:ULC, 1.2 DE	0.208	0.745	-0.050	1.118	0.214	0.745	422
			14:ULC, 1.2 DE	0.210	0.745	-0.051	1.118	0.216	0.745	418
			15:ULC, 1.2 DE	0.344	0.745	-0.055	0.932	0.348	0.745	256
			16:ULC, 1.2 DE	0.344	0.745	-0.055	0.932	0.348	0.745	256
			17:ULC, 1.2 DE	0.344	0.745	-0.049	0.932	0.347	0.745	256
			18:ULC, 1.5 DE	0.182	0.745	0.002	1.677	0.182	0.745	483
			19:ULC, 1.5 DE	0.180	0.745	0.004	1.677	0.180	0.745	490
			20:ULC, 1.5 DE	0.012	0.745	0.007	0.745	0.014	0.745	7093
			21:ULC, 1.5 DE	0.012	0.745	0.007	0.745	0.014	0.745	7077
			22:ULC, 1.5 DE	-0.158	0.932	-0.002	1.118	0.158	0.932	558
			23:ULC, 1.5 DE	-0.155	0.932	-0.003	1.304	0.155	0.932	567
			24:ULC, 1.5 DE	0.013	0.745	-0.008	0.745	0.016	0.745	6585
			25:ULC, 1.5 DE	0.013	0.745	-0.008	0.745	0.015704	0.745	6604
			26:ULC, 1.5 DE	0.013	0.745	-0.001	0.559	0.013	0.745	6837
			27:ULC, 0.9 DE	0.177	0.932	0.002	1.677	0.177	0.932	497
			28:ULC, 0.9 DE	0.175	0.932	0.004	1.491	0.175	0.932	504
			29:ULC, 0.9 DE	0.007	0.745	0.007	0.745	0.010	0.745	> 10000
			30:ULC, 0.9 DE	0.007	0.745	0.007	0.745	0.010	0.745	> 10000
			31:ULC, 0.9 DE	-0.163	0.932	-0.001	1.304	0.163	0.932	541
			32:ULC, 0.9 DE	-0.160	0.932	-0.003	1.491	0.160	0.932	550
			33:ULC, 0.9 DE	0.008	0.745	-0.008	0.745	0.011	0.745	> 10000
			34:ULC, 0.9 DE	0.008	0.745	-0.008	0.745	0.011	0.745	> 10000
			35:ULC, 0.9 DE	0.008	0.745	-0.001	0.559	0.008	0.745	> 10000
2	3	2.236	4:WX+	0.002	1.118	0.001	1.491	0.002	1.304	> 10000
			5:WX-	0.002	1.304	-0.000	0.559	0.002	1.304	> 10000
			6:WY+	-0.000	1.677	-0.004	0.559	0.004	0.559	> 10000
			7:WY-	-0.000	1.677	-0.004	0.559	0.004	0.559	> 10000
			1:DL	-0.001	1.677	-0.002	1.304	0.003	1.491	> 10000
			2:LL	-0.039	1.677	-0.021	0.745	0.040	1.677	2249
			8:ULC, 1.5 DE/	-0.061	1.677	-0.035	0.745	0.063	1.677	1453
			9:ULC, 1.2 DE/	-0.047	1.677	-0.027	0.745	0.048	1.677	1883
			10:ULC, 1.2 DE	-0.047	1.677	-0.028	0.745	0.048	1.677	1881
			11:ULC, 1.2 DE	-0.049	1.677	-0.032	0.745	0.050	1.677	1803

Beam Maximum Relative Displacements Cont...

Beam	Node A	Length (m)	L/C	y (in)	d (m)	z (in)	d (m)	Resultant (in)	d (m)	Span / Max z
			19:ULC, 1.5 DE	-0.033	1.750	-0.001	2.000	0.033251	1.750	3553
			20:ULC, 1.5 DE	-0.077	1.750	0.008	2.000	0.077	1.750	1534
			21:ULC, 1.5 DE	-0.078	1.750	0.008	2.000	0.079	1.750	1510
			22:ULC, 1.5 DE	-0.037	1.750	0.003	1.750	0.038	1.750	3161
			23:ULC, 1.5 DE	-0.043	1.750	0.008	2.000	0.043834	1.750	2736
			24:ULC, 1.5 DE	0.008	0.500	0.002	0.750	0.008	0.500	> 10000
			25:ULC, 1.5 DE	0.008	0.500	0.002	0.750	0.008	0.500	> 10000
			26:ULC, 1.5 DE	-0.038	1.750	0.003	2.000	0.038	1.750	3091
			27:ULC, 0.9 DE	-0.024	1.750	0.002	2.000	0.023884	1.750	4967
			28:ULC, 0.9 DE	-0.018	1.750	-0.002	2.000	0.018	1.750	6574
			29:ULC, 0.9 DE	-0.062	1.750	0.007	2.000	0.062	1.750	1914
			30:ULC, 0.9 DE	-0.063	1.750	0.007	2.250	0.063	1.750	1878
			31:ULC, 0.9 DE	-0.022	1.750	0.002	1.750	0.022	1.750	5350
			32:ULC, 0.9 DE	-0.028	1.750	0.006	2.000	0.029	1.750	4233
			33:ULC, 0.9 DE	0.017	2.250	-0.003	2.250	0.017319	2.250	6923
			34:ULC, 0.9 DE	0.018	2.250	-0.003	2.250	0.018	2.250	6484
			35:ULC, 0.9 DE	-0.023	1.750	0.002	2.000	0.023	1.750	5151

Beam Maximum Moments

Distances to maxima are given from beam end A.

Beam	Node A	Length (m)	L/C		d (m)	Max My (kN-m)	d (m)	Max Mz (kN-m)
1	2	2.236	4:WX+	Max +ve	0	0.004	0	4.574
				Max -ve	2.236	-0.008	2.236	-1.262
			5:WX-	Max +ve	0	0.010	0	4.530
				Max -ve	2.236	-0.018	2.236	-1.273
			6:WY+	Max +ve	2.236	0.028	2.236	0.010
				Max -ve	0	-0.044	0	-0.018
			7:WY-	Max +ve	2.236	0.027	2.236	0.009
				Max -ve	0	-0.043	0	-0.017
			1:DL	Max +ve	0	0.008	0	0.519
				Max -ve	2.236	-0.007	2.236	-0.214
			2:LL	Max +ve	0	0.128	0	15.209
				Max -ve			2.236	-8.036
			8:ULC, 1.5 DE/	Max +ve	0	0.204	0	23.592
				Max -ve			2.236	-12.375
			9:ULC, 1.2 DE/	Max +ve	0	0.169	0	24.362
				Max -ve			2.236	-11.414
			10:ULC, 1.2 DE	Max +ve	0	0.175	0	24.310
				Max -ve			2.236	-11.428
			11:ULC, 1.2 DE	Max +ve	0	0.110	0	18.852
				Max -ve			2.236	-9.888
			12:ULC, 1.2 DE	Max +ve	0	0.111	0	18.854

Beam Maximum Moments Cont...

Beam	Node A	Length (m)	L/C		d (m)	Max My (kN-m)	d (m)	Max Mz (kN-m)
				Max -ve	3.000	-0.085	2.250	-0.077
			31:ULC, 0.9 DE	Max +ve			0	0.070
				Max -ve	3.000	-0.010	1.750	-0.029
			32:ULC, 0.9 DE	Max +ve	0	0.024	0	0.082
				Max -ve	3.000	-0.055	2.000	-0.036
			33:ULC, 0.9 DE	Max +ve	3.000	0.049	3.000	0.086
				Max -ve	0	-0.042	1.250	-0.003
			34:ULC, 0.9 DE	Max +ve	3.000	0.051	3.000	0.089
				Max -ve	0	-0.044	1.250	-0.002
			35:ULC, 0.9 DE	Max +ve	0	0.007	0	0.076
				Max -ve	3.000	-0.017	1.750	-0.031

Beam Maximum Shear Forces

Distances to maxima are given from beam end A.

Beam	Node A	Length (m)	L/C		d (m)	Max Fz (kN)	d (m)	Max Fy (kN)
1	2	2.236	4:WX+	Max +ve			0	2.610
				Max -ve	0	-0.006		
			5:WX-	Max +ve			0	2.595
				Max -ve	0	-0.012		
			6:WY+	Max +ve	0	0.032		
				Max -ve			0	-0.013
			7:WY-	Max +ve	0	0.031		
				Max -ve			0	-0.01153
			1:DL	Max +ve			0	0.422
				Max -ve	0	-0.006		
			2:LL	Max +ve			0	10.395
				Max -ve	0	-0.037		
			8:ULC, 1.5 DE/	Max +ve			0	16.226
				Max -ve	0	-0.065		
			9:ULC, 1.2 DE/	Max +ve			0	16.112
				Max -ve	0	-0.059		
			10:ULC, 1.2 DE	Max +ve			0	16.095
				Max -ve	0	-0.067		
			11:ULC, 1.2 DE	Max +ve			0	12.965
				Max -ve	0	-0.014		
			12:ULC, 1.2 DE	Max +ve			0	12.967
				Max -ve	0	-0.014		
			13:ULC, 1.2 DE	Max +ve			0	9.849
				Max -ve	0	-0.045		
			14:ULC, 1.2 DE	Max +ve			0	9.866
				Max -ve	0	-0.037		
			15:ULC, 1.2 DE	Max +ve			0	12.996

Beam Maximum Shear Forces Cont...

Beam	Node A	Length (m)	L/C		d (m)	Max Fz (kN)	d (m)	Max Fy (kN)
				Max -ve			3.000	-0.107
			34:ULC, 0.9 DE	Max +ve	0	0.031	0	0.08307
				Max -ve			3.000	-0.108
			35:ULC, 0.9 DE	Max +ve			0	0.117
				Max -ve	0	-0.008	3.000	-0.074

Beam Maximum Axial Forces

Distances to maxima are given from beam end A.

Beam	Node A	Length (m)	L/C		d (m)	Max Fx (kN)
1	2	2.236	4:WX+	Max +ve		
				Max -ve	0	-2.831
			5:WX-	Max +ve		
				Max -ve	0	-2.048
			6:WY+	Max +ve		
				Max -ve	0	-0.408
			7:WY-	Max +ve		
				Max -ve	0	-0.277
			1:DL	Max +ve	0	17.888
				Max -ve		
			2:LL	Max +ve	0	513.237
				Max -ve		
			8:ULC, 1.5 DE/	Max +ve	0	796.687
				Max -ve		
			9:ULC, 1.2 DE/	Max +ve	0	633.952
				Max -ve		
			10:ULC, 1.2 DE	Max +ve	0	634.892
				Max -ve		
			11:ULC, 1.2 DE	Max +ve	0	636.860
				Max -ve		
			12:ULC, 1.2 DE	Max +ve	0	637.018
				Max -ve		
			13:ULC, 1.2 DE	Max +ve	0	640.747
				Max -ve		
			14:ULC, 1.2 DE	Max +ve	0	639.807
				Max -ve		
			15:ULC, 1.2 DE	Max +ve	0	637.839
				Max -ve		
			16:ULC, 1.2 DE	Max +ve	0	637.682
				Max -ve		
			17:ULC, 1.2 DE	Max +ve	0	637.350
				Max -ve		
			18:ULC, 1.5 DE	Max +ve	0	22.585

Reaction Summary

	Node	L/C	Horizontal	Vertical	Horizontal	Moment		
			FX (kN)	FY (kN)	FZ (kN)	MX (kN m)	MY (kN m)	MZ (kN m)
Max FX	139	13 ULC, 1.2 DE	22.176	813.814	0.568	0.761	0.002	-79.105
Min FX	17	10 ULC, 1.2 DE	-23.233	814.261	-0.151	-0.043	0.002	80.116
Max FY	140	8 ULC, 1.5 DE/	-12.979	1.01E+3	0.475	0.558	-0.008	37.614
Min FY	16	4 WX+	-9.450	-4.120	-0.142	-0.252	-0.004	39.029
Max FZ	34	24 ULC, 1.5 DE	-0.521	18.959	3.348	5.517	0.000	1.460
Min FZ	114	21 ULC, 1.5 DE	-0.523	18.951	-3.348	-5.517	-0.000	1.463
Max MX	34	24 ULC, 1.5 DE	-0.521	18.959	3.348	5.517	0.000	1.460
Min MX	114	21 ULC, 1.5 DE	-0.523	18.951	-3.348	-5.517	-0.000	1.463
Max MY	113	8 ULC, 1.5 DE/	6.801	240.880	0.118	0.166	0.016	-21.489
Min MY	114	8 ULC, 1.5 DE/	-6.801	240.880	0.118	0.166	-0.016	21.489
Max MZ	140	10 ULC, 1.2 DE	-22.544	813.854	0.630	0.866	-0.002	80.888
Min MZ	139	13 ULC, 1.2 DE	22.176	813.814	0.568	0.761	0.002	-79.105

Failed Members

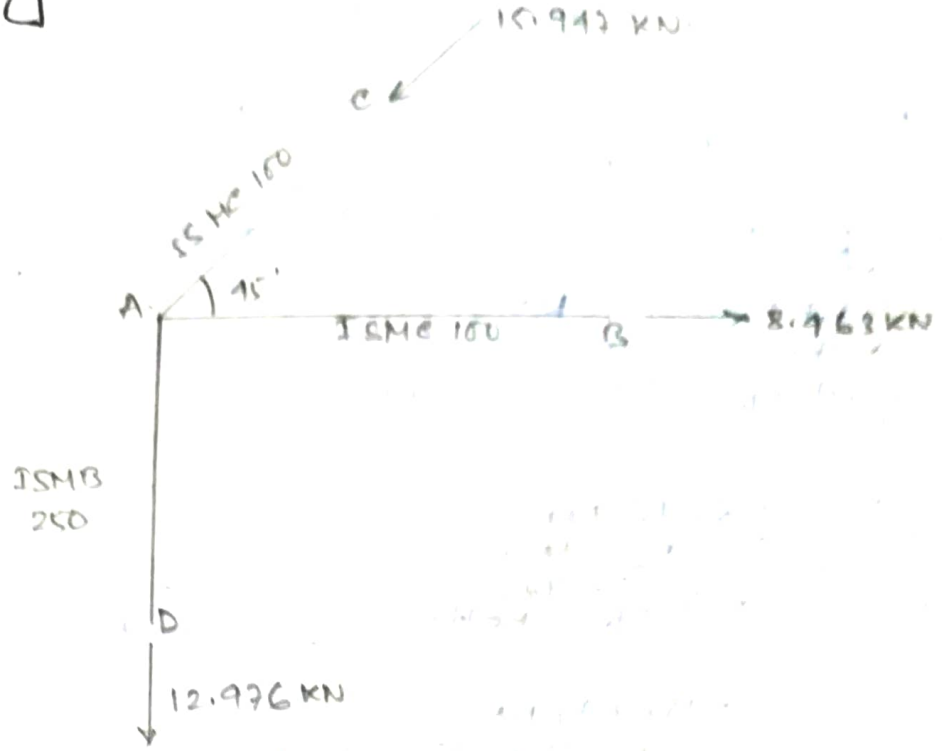
There is no data of this type.

Assignment – 6

Connection design and details :

(design of industrial shade using StaadPro with dead load, live load, wind load).

8) Design & detailing of member of shade (truss) of assign-3 with CAD drawing.



⇒ Let Assume:-

- $f_u = 410 N/mm^2$; $\gamma_{mb} = 1.25$ [IS 800-2007, Table-5].
- 4.6 grade bolt, $f_{ub} = 400 N/mm^2$, $f_{yb} = 240 N/mm^2$
- ISMC 100:- thickness (t) = 4.7 mm [Steel Table].
- Dia of bolt (d) = $6.01\sqrt{t}$ [Unwin's formula].
  $= 6.01\sqrt{4.7} = 13.023$. ≈ 16 mm.

$d_0 = 16 + 2 = 18$ mm [IS 800:2007 - table-13].

- Assume thickness of gusset plate = 10 mm.
- A_{nb} = Net shear area of bolt at thread.
  = 78% of net area $= 0.78 \times \pi/4 \times (16)^2 = 156.82 mm^2$
- $A_{sb} = \pi/4 \times (16)^2 = 201.06 mm^2$
- n_n = No. of shear plane with thread intercepting.
- n_s = No. of shear plane without thread intercepting.

Shear capacity of bolt:-

Single shear; $n_n = 1$, $n_s = 0$ [Consider shear plane occur at thread]

$V_{dsb} = \frac{f_{ub}[A_{nb} n_n + A_{sb} n_s]}{\sqrt{3}\,\gamma_{mb}} = \frac{400[156.82 \times 1 + 0]}{\sqrt{3} \times 1.25}$ ⇒ $V_{dsb} = 28.972$ KN.

Bearing capacity of bolt:-

K_b = least of $\left\{\frac{e}{3d_0}, \left(\frac{p}{3d_0} - 0.25\right), \frac{f_{ub}}{f_u}, 1\right\}$.

Edge distance (e):- [IS 800:2007, Pg-74] [Cl-10.2.4.2].

Min. $e = 1.5 d_0 = 1.5 \times 18 = 27$ mm.

Max. $e = 40 + 4t = 40 + 4 \times 4.7 = 58.8$ mm.

∴ Provide, e = 50 mm

Pitch distance (P):- [IS 800:2007, Pg-74].

Min, $P = 2.5d = 2.5 \times 16 = 40$ mm.

Max, $P = 32t$ or 300 mm $= 32 \times 4.2$ or $300 = 150.4$ or 300 mm.

∴ Provide P = 70 mm

K_b = least of $\left\{\frac{80}{3\times18}, \left(\frac{70}{3\times18}-0.25\right), \frac{400}{410}, 1\right\}$.

= least of $\{0.92, 1.04, 0.975, 1\}$.

$\therefore K_b = 0.92$

As single portion of 4.7mm which is less than 10mm gusset plate. So, taking bearing capacity of bolt w.r.t to 4.7 mm.

$\therefore t = 4.7$ mm.

$V_{dpb} = \frac{2.5 K_b \cdot d \cdot t \cdot f_u}{\gamma_{mb}} = \frac{2.5\times0.92\times16\times4.7\times410}{1.25}$ $\therefore V_{dpb} = 56.730$ KN.

Hence, $V_{dsb} = 28.972$ KN. } min.
$V_{dpb} = 56.730$ KN. }

$\therefore$ Strength of bolt = 28.972 KN.

Now,

Member AB.

factored load = 8.469 KN.

No of bolt required = $\frac{8.469}{28.972} = 0.292$.

Hence, provide min of 2 bolts on member AB.

Member AC.

factored load = 15.947 KN.

No. of bolt required = $\frac{15.947}{28.972} = 0.55$.

Hence, provide min of 2 bolts on member AC.

Member AD.

- ISMB 250 = thickness (t) = 6.9 mm.
- Dia of bolt = $6.01\sqrt{t}$ [by unwin's formula IS 800:2007].
  $= 6.01\sqrt{6.9} = 15.78 \Rightarrow d \approx 16$ mm.
  $d_0 = 16 + 2 = 18$ mm.
- $A_{nb} = 0.78 \cdot \pi/4 (16)^2 = 156.82$ mm^2
- $A_{sb} = \pi/4 (16)^2 = 201.06$ mm^2
- $\gamma_{mb} = 1.25$.

Shear capacity of bolt:-

Single shear, $n_n = 1$ $n_s = 0$ [consider shear plane occur at thread].

$V_{dsb} = \frac{f_{ub}[A_{nb} n_n + A_{sb} n_s]}{\sqrt{3}\,\gamma_{mb}} = \frac{400[156.82\times1+0]}{\sqrt{3}\times1.25} \Rightarrow V_{dsb} = 28.972$ KN.

Bearing capacity of bolt:-

K_b = least of $\left\{\frac{e}{3d_0}, \left(\frac{P}{3d_0}-0.25\right), \frac{f_{ub}}{f_u}, 1\right\}$.

Edge distance (e)

Min (e) = $1.5 d_0 = 1.5\times18 = 27$ mm.

Max (e) = $40 + 4t = 40 + 4\times6.9 = 67.6$ mm

$\therefore$ Provide (e) = 50 mm.

Pitch Distance:-

Min (P) = $2.5 d = 2.5\times16 = 40$ mm.

Max (P) = $32t$ or 300 mm.

$= 32\times6.9$ or 300 mm.

$= 220$ or 300 mm

$\therefore$ Provide P = 70 mm.

k_b = least of $\left\{\frac{50}{3\times18}, \left(\frac{70}{3\times18} - 0.25\right), \frac{400}{410}, 1\right\}$

$= \{0.92, 1.04, 0.975, 1\}$ $\therefore$ $k_b = 0.92$

$\therefore$ $t = 6.9$ mm.

$V_{apb} = \frac{2.5 k_b t d f_u}{\gamma_{mb}} = \frac{2.5 \times 0.92 \times 16 \times 6.9 \times 410}{1.25}$.

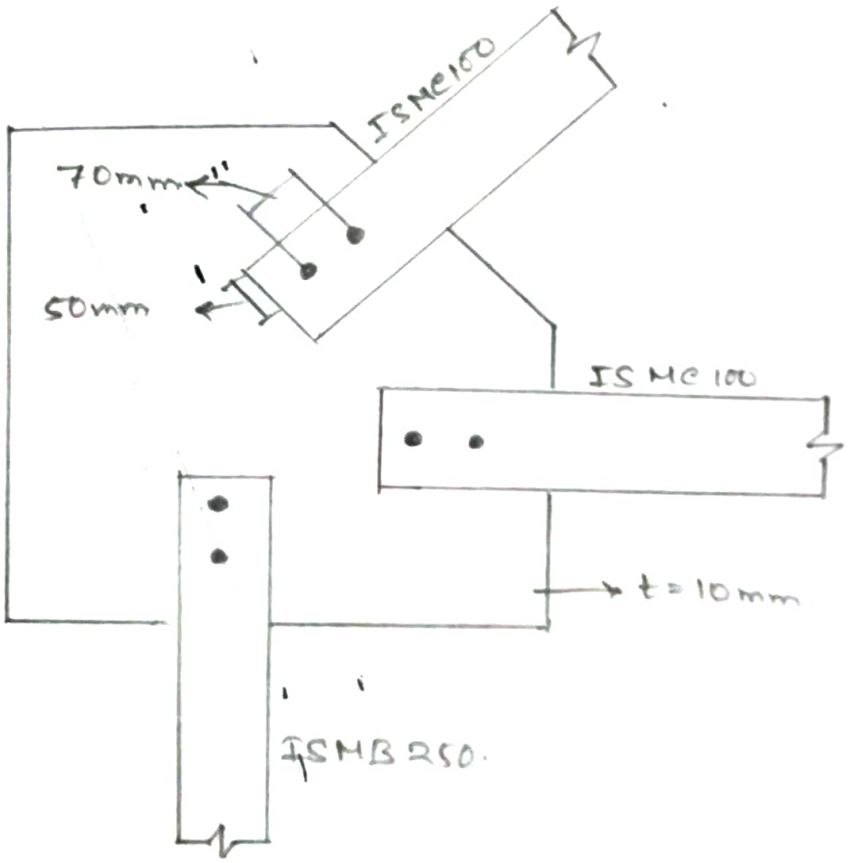
$\therefore$ $V_{apb} = 83.23$ KN

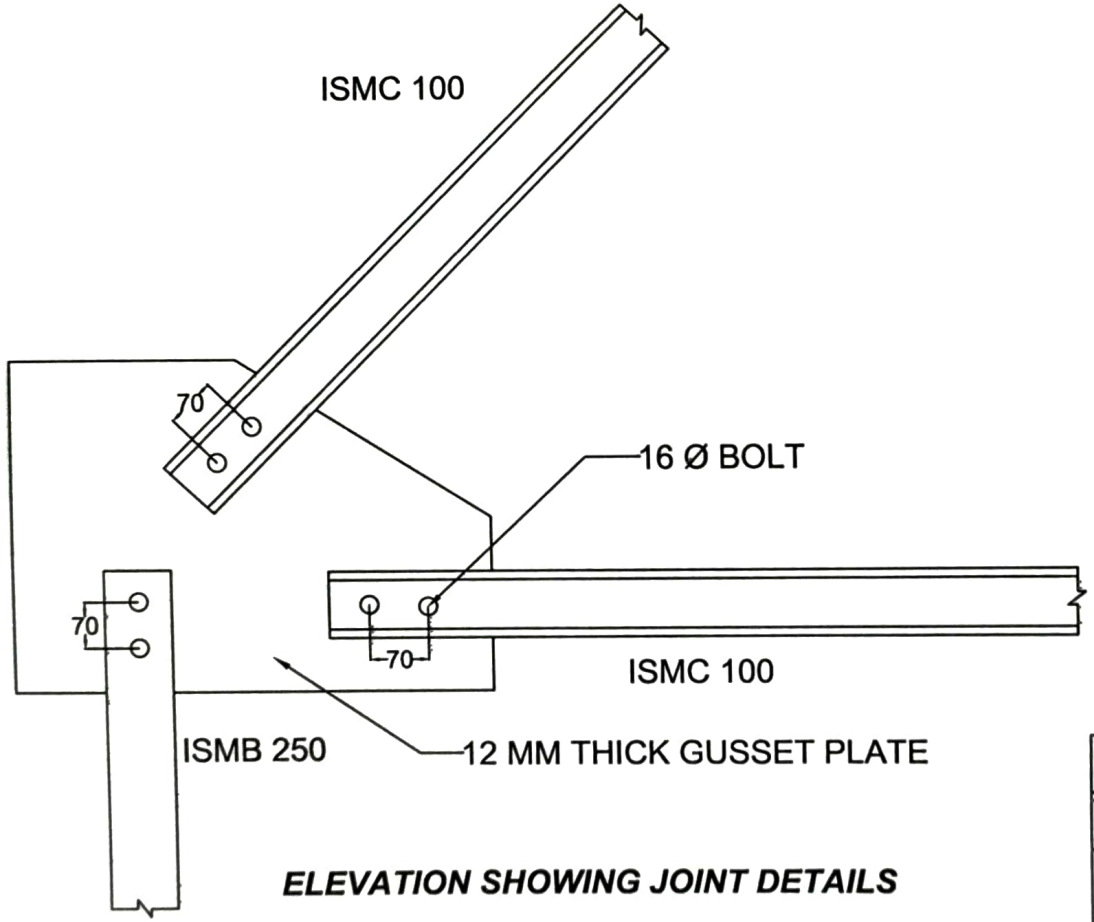
Hence, Strength of bolt = 28.972 KN.

factored load = 12.976 KN.

No. of bolts req^n. $= \frac{12.976}{28.972} = 0.44$.

$\therefore$ Provide Min. 2 bolts on member AD.





ELEVATION SHOWING JOINT DETAILS

ALL DIMENSIONS IN MM

ARGHYA MUKHERJEE	DR. B. C. ROY ENGG. COLLEGE	
12001323035	SUBJECT :DESIGN OF STEEL STRUCTURE SESSIONAL	
DEPT.: CIVIL ENGINEERING	SUBJECT CODE: CE (PC) 694	
D.O.C.: 22/04/2025		
D.O.S.: 29/04/2025	SHEET:A4	SHEET NO: 1 OF 1
SCALE: 1:10	REV:R0	CHKD. BY: