

DESIGN OF SPICE CONNECTION FOR COLUMN MARKED A2, UPTO 29.40 M LVL

SECTION PROPERTIES OF COLUMN WEB

SECTION PROPERTIES OF COLUMN FLANGE

WEB PLATE

1800 X 28

Total Depth of Column
Web Thickness
Web Depth
Area of Web

D = 1800 mm
Tw = 28 mm
Dw = (D-2Xft) = 1700 mm
Aw = (Dw X Tw) = 47600 mm2

CALCULATION OF FORCES & MOMENT OF COLUMN WEB

Shear Force in the Web
Axial Force in the Web
Eccentricity

fy = 350 N/mm2
fy = 350 N/mm2
Ps = 666.4 Ton
Paw = 1000 Ton
e = (The distance of C.G. of Bolts from the Extreme Bolt) = 210 mm

FLANGE PLATE

740 X 50

Flange Thickness
Total Width of Flange
Area of Flange

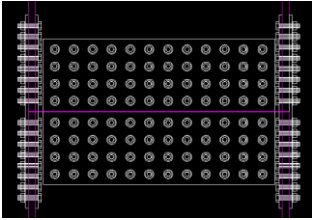
Tf = 50 mm
Fw = 740 mm
Af = (Tf X Fw) = 37000 mm2

CALCULATION OF FORCES & MOMENT OF COLUMN FLANGE

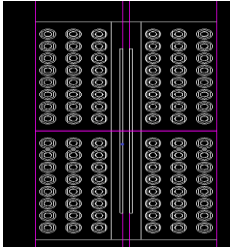
Axial Force in the Flange

Pafl = 777 Ton
fy = 350 N/mm2

WEB SPICE PROFILE



FLANGE SPICE PROFILE



CALCULATION OF SHEAR CAPACITY OF BOLT AND NUMBERS OF BOLT REQUIRED FOR WEB SPICE

Design Shear Force in the Web for Bolt Design(20%)
Design Axial Force in the Web for Bolt Design
Design Moment due to Eccentricity for Bolt Design

Ps = 133.28 Ton
Paw = 1000 Ton
Me = 0.2 X Ps X e (Consider 20% of Ps) = 28.0 T-m

Size of Bolt Selected
Nominal Diameter of Bolt, d
Shear Capacity(Double shear), Bv

= M36
= 36 mm
= Slip Factor X Number of effective interfaces X Minimum bolt Tension

Slip Factor
Number of effective interfaces
Minimum tension in bolt
Factor of Safety
Shear Capacity, Bv

= 0.3
= 2 Double Shear
= 49 T
= 1.4
= 21.00 Ton

Minimum Pitch Distance, (2.5"Dia of Bolt+3)
Pitch Distance Provided, P
Minimum Edge Distance,(1.5"Dia of Bolt)
Edge Distance Provided, E

= 97.5 mm
= 100 mm
= 54 mm
= 60 mm

No. of Vertical Row of Bolts, m
No. of Horizontal Row, n

= 14 (Assumed)
= 4 (Assumed)

Number of Bolts Provided, Nr

= 56 Nos.

r
Cosφ
Sinφ
Σx2
Σy2
z

= (Sqrt((m-1)2+(n-1)2 X P/2))
= 667.08 mm
= ((n-1)/2 X P)/r
= 0.22
= ((m-1)/2 X P)/r
= 0.97
= P2 X m X n X (m-1) X (n-1)/12
= 9100000.0 mm2
= P2 X m X n X (n-1) X (m-1)/12
= 700000.0 mm2
= (Σx2 + Σy2)/r
= 14.7 m
= 1.91 T
= 2.38 T
= 17.85 T

Shear Force on Extreme Bolt Due to Me, Fme
Shear Force on Extreme Bolt Due to Ps, FPs
Shear Force on Extreme Bolt Due to Paw, FPaw

= 1.91 T
= 2.38 T
= 17.85 T

Resultant Force, Fr

= Sqrt(((Fme)2+(FPs)2+(FPaw)2)+(2*Fme*FPs*cosφ)+(2*Fme*FPaw*sinφ))
= 19.91 T < 21.00 Safe

CALCULATION OF SHEAR CAPACITY OF BOLT AND NUMBERS OF BOLT REQUIRED FOR FLANGE SPICE

Design Force for Bolt

= Pafl = 777 Ton

Size of Bolt Selected
Nominal Diameter of Bolt
Shear Capacity(Double shear), Bv

= M36
= 36 mm
= Slip Factor X Number of effective interfaces X Minimum bolt Tension

Slip Factor
Number of effective interfaces
Minimum tension in bolt
Factor of Safety
Shear Capacity of Bolt, Bv

= 0.3
= 2 Double Shear
= 49 T
= 1.4
= 21.00 Ton

Minimum Pitch Distance, (2.5"Dia of Bolt+3)
Pitch Distance Provided, P
Minimum Edge Distance,(1.5"Dia of Bolt)
Edge Distance Provided, E

= 97.5 mm
= 100 mm
= 54 mm
= 60 mm

Number of Bolts required on one side, Nr

= Pafl/Bv Nos.
= 37 Nos.

Flange Top Splice Plate

No. of Vertical Row of Bolts, m1
No. of Horizontal Row, n1

= 6
= 7

Number of Bolts Provided

= 42 Nos. OK

Flange Bottom Splice Plate

No. of Vertical Row of Bolts, m2
No. of Horizontal Row, n2

= 3
= 7

Number of Bolts Provided

= 21 Nos.

CALCULATION SHEAR CAPACITY OF 8.8 GRADE HSFG BOLT

8.8 Grade Bolt, IS 4000:1992

Bolt	Nominal Dia(mm)	Shank Area(mm2)	Thread Area(mm2)	Slip Factor	Number of Effective Interfaces	Minimum Bolt Tension(T)	Factor of Safety	Shear Capacity of Bolt(T)
IS 4000:1992, Table-2								
M16	16	201	157	0.3	2	9.45	1.4	4.05
M20	20	314	245	0.3	2	14.70	1.4	6.30
M24	24	452	353	0.3	2	21.20	1.4	9.09
M30	30	706	561	0.3	2	33.70	1.4	14.44
M36	36	1017	817	0.3	2	49.00	1.4	21.00

CALCULATION SHEAR CAPACITY OF 8.8 GRADE HSFG BOLT

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M16	16	201	157	0.3	2	9.45	1.4	4.05
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M36	36	1017	817	0.3	2	49.00	1.4	21.00

DESIGN OF WEB SPICE PLATE

Depth of Web Splice Plate Required
Provided Depth of Web Splice Plate, Bws
Width of Web Splice Plate Required
Provided Width of Web Splice Plate, Dws
Thickness of Web Splice Plate Rgd.
Provided Thickness of Web Splice Plate, tws

= (Number of Horizontal rows of Bolt-1)*Pitch Distance + 2*Edge Distance
= ((n-1)*P+2E) X 2
= 840 mm OK
= (Number of Vertical rows of Bolt-1)*Pitch Distance + 2*Edge Distance
= ((m-1)*P+2E)
= 1420 mm OK
= (0.5 X thickness of Web X (Depth of Web)/3/(Depth of Web Splice Plate*3))
= (0.5 X Tw X Dw*3)/(Dw*3)
= 24.02 mm
= 28 mm OK

DESIGN OF FLANGE SPICE PLATE

Design Load for Splice Plate
Load on Top Splice Plate, F1
Load on Bottom Splice Plate, F2
Width of Flange Top Splice Plate, W1
Net Width of Flange Top Splice Plate, W1net
Thickness of Top Splice Plate Required
Thickness of Top Splice Plate Provided, T1
Width of Flange Bottom Splice Plate, W2
Net Width of Flange Bottom Splice Plate, W2net
Thickness of Bottom Splice Plate, T2
Length of Flange Top & Bottom Splice Plate, L

= Pafl
= 777.00 T
= 388.50 T
= 194.25 T
= Width of Flange Plate of Column
= 740 mm
= (Total Width of Splice Plate)-(m1 X (Nominal dia of Bolt + 3))
= 506 mm
= (1.05 X (Load on Top Splice Plate)/(0.6 X fy X Net Width of Splice Plate))
fy = 350 N/mm2
= 38.39 mm (Minimum Thickness Shall be 6 mm)
= 40 mm OK
= ((Width of Flange Splice Plate -Thickness of web-Edge Distance)/2)
= 296 mm OK
= (Width of Bottom Flange Splice Plate)-(m2 X Nominal dia of Bolt + 3)
= 213 mm
= (1.05 X (Load on Bottom Splice Plate)/(0.6 X fy X Net Width of Splice Plate))
fy = 350 N/mm2
= 45.60 mm (Minimum Thickness Shall be 6 mm)
= 50 mm OK
= ((2 X E) + (n1-1) X P) X 2
= 1440 mm OK

SUMMARY OF BOLT AND SPICE PLATE FOR WEB PLATE

Total No. of Bolt
Bolt Size
Total Width of Web Splice Plate
Total Depth of Splice Plate
Thickness of Web Plate

= 112 Nos.
= M36
= 1420 mm
= 840 mm
= 28 mm

Both Side of Wed Plate
Both Side of Wed Plate

SUMMARY OF BOLT AND SPICE PLATE FOR FLANGE PLATE

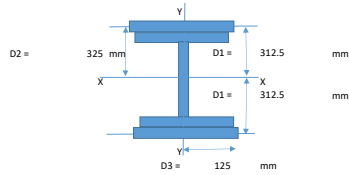
Total No. of Bolt
Bolt Size
Total Width of Top Flange Splice Plate
Total Width of Bottom Flange Splice Plate
Total Length of Flange Top Splice Plate
Total Length of Flange Bottom Splice Plate
Thickness of Flange Top Splice Plate
Thickness of Flange Bottom Splice Plate

= 84 Nos.
= M36
= 740 mm
= 330 mm (Two Nos.)
= 1440 mm
= 1440 mm
= 40 mm
= 50 mm

CALCULATION OF SPLICE PLATE & BOLT FOR NPB BEAM SECTION CONNECTED TO A2 COLUMN CONNECTED AT +8.75, +14.175, & +17.775 LVL

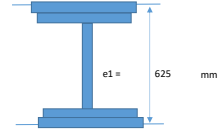
SECTION PROPERTIES OF BEAM

SECTION NPB 600X220X122.45				
WEB PLATE	600	X	12	
TOP FLANGE PLATE	220	X	19	
BOTTOM FLANGE PLATE	220	X	19	
Total Depth of Web		D	=	650 mm
Web Thickness		t _w	=	12 mm
Clear Depth of Web		D _w	=	600 mm
Area of Web		A _w	=	(D X t _w) = 7200 mm ²



SECTION PROPERTIES OF ADDITIONAL PLATE AT TOP AND BOTTOM


PLATE 250X25					
PLATE ABOVE TOP FLANGE PLAT	250	X	25		
PLATE BELOW BOTTOM FLANGE	250	X	25		
Thickness of Plate above Top Flange	t _{f1}	=	25	mm	
Width of Plate above Top Flange	b _{f1}	=	250	mm	
Area of Plate above Top Flange	A _{f1}	=	(T _{f1} X b _{f1})		
			= 6250	mm ²	
Thickness of Plate below Bottom Flange	t _{f2}	=	25	mm	
Width of Plate below Bottom Flange	b _{f2}	=	250	mm	
Area of Plate below Bottom Flange	A _{f2}	=	(T _{f2} X b _{f2})		
			= 6250	mm ²	



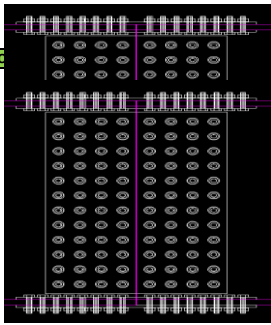
NPB6062D20X127.45			PLATE 250K25 (T & B)		
IxoNPB	=	920834000 mm4	IxoPlate	=	(Bf1 X f1*3)/12 + (Af1 X D1*2) + 1212354167 mm4
ZxoNPB	=	3069450 mm3	ZxoPlate	=	Ixo/D2 3758013 mm3
IyyNPB	=	33873400 mm4	IyyPlate	=	(Bf1*3 X f1)/12 + (Bf2*3 X f2)/12 65104167 mm4
ZyyNPB	=	307940 mm3	ZyyPlate	=	Iyy/D3 520833 mm4

[NPB600C2(20X122.45) + PLATE 250X25 (T & B)]	
Ixx, (IxxNPB+IxxPlate) =	2142188167 mm4
Zxx, (ZxxNPB+ZxxPlate) =	6827463 mm4
Iyy, (IyyNPB+IyyPlate) =	98977567 mm4
Zyy, (ZyyNPB+ZyyPlate) =	828773 mm4

CALCULATION OF FORCES & MOMENT OF BEAM WEB

Shear Force in the Web	$f_y \approx 250$	N/mm ²	$P_s \approx 0.4 f_y A_w$	≈ 72	Ton
Eccentricity			\approx (The distance of C.G. of Bolts From the Extreme Bolt) $\approx ((n-1)XP/2 + e)$ ≈ 110 mm		

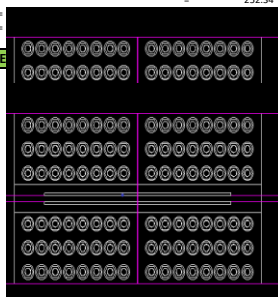
WEB SPLICE PRO



CALCULATION OF FORCES & MOMENT OF BEAM FLANGE

Maximum Moment	M	=	(0.66*fy) X Zxx	
fy = 350 N/mm2		=	157.71	T-m
Maximum Force Induced in Each Flange	F	=	M/e1	
		=	252.34	T
fy =				
fy =				

FLANGE SPLICE PROFILE



CALCULATION OF SHEAR CAPACITY OF BOLT AND NUMBERS OF BOLT REQUIRED FOR WEB SPLICE

Design Shear Force in the Web for Bolt Design(80%)		0.8 X Ps	=	57.6	Ton
Design Moment due to Eccentricity for Bolt Design		Me	=	0.8 X Ps X e	(Consider 20% of Ps) T-m
No. of Bolt Selected	=	M36		6.3	
Nominal Diameter of Bolt, d	=	36			mm
Shear Capacity(Double shear), Bv	=	Slip Factor X Number of effective interfaces X Minimum bolt Tension			
	=				Factor of Safety
Slip Factor	=	0.3			
Number of effective interfaces	=	2		Double Shear	
Minimum tension in bolt	=	49		T	
Factor of Safety	=	1.4			
Shear Capacity, Bv	=	21.00		Ton	
Minimum Pitch Distance, (2.5*Dia of Hole+3)	=	97.5		mm	
Pitch Distance Provided, P	=	100		mm	
Minimum Edge Distance,(1.5*Dia of Bolt)	=	54.0		mm	
Edge Distance Provided, E	=	60		mm	
No. of Vertical Row of Bolts, m	=	2		(Assumed)	
No. of Horizontal Row, n	=	3		(Assumed)	
Number of Bolts Provided, Nr	=	6		Nos.	
r	=	$(\sqrt{m-1})^2 + (n-1)^2 \times P / 2$			
Cosø	=	111.80		mm	
	=	$((m-1)/2 \times P)/r$			
	=	0.447			
$\sum x^2$	=	$P^2 \times m \times n \times (m-1) \times (m+1)/12$			
	=	15000.0		mm ²	
$\sum y^2$	=	$P^2 \times m \times n \times (n-1) \times (n+1)/12$			
	=	40000.0		mm ²	
z	=	$(\sum x^2 + \sum y^2)/r$			
	=	0.49		m	
Shear Force on Extreme Bolt Due to Me, Fme	=	12.88		T	
Shear Force on Extreme Bolt Due to Ps, FPs	=	9.60		T	
Resultant Force, Fr	=	$\sqrt{Fme^2 + FPs^2 + 2 \times Fme \times FPs \times \cosø}$			
	=	19.21		T	
	=				21.00

CALCULATION SHEAR CAPACITY OF 8.8 GRADE HSFG BOLT

8.8 Grade Bolt, IS 4000:1992								
Bolt	Nominal Dia(mm)	Shank Area(mm ²)	Thread Area(mm ²)	Slip Factor	Number of Effective Interfaces	Minimum Bolt Tension(T)	Factor of Safety	Shear Capacity of Bolt(T)
IS 4000:1992, Table-2								
				IS 4000:1992, Annex-C	For Double Shear	IS 4000:1992, Table-2	IS 4000:1992, Table-2	IS 4000:1992, Table-2
M16	16	201	157	0.3	2	9.45	5.4	4.05
M20	20	314	245	0.3	2	14.70	1.4	6.30
M24	24	452	353	0.3	2	21.20	1.4	9.09
M30	30	706	561	0.3	2	33.70	1.4	14.44
M36	36	1017	817	0.3	2	49.00	1.4	21.00

CALCULATION OF SHEAR CAPACITY OF BOLT AND NUMBERS OF BOLT REQUIRED FOR FLANGE SPLICE

Design Force for Bolt	=	F	
	=	252	T
Size of Bolt Selected	=	M36	
Nominal Diameter of Bolt	=	36	mm
Shear Capacity(Double shear), Bv	=	Slip Factor X Number of effective interfaces	Factor
Slip Factor	=	0.3	
Number of effective interfaces	=	2	Double Shear
Minimum tension in bolt	=	49	T
Factor of Safety	=	1.4	
Shear Capacity of Bolt, Bv	=	21.00	Ton
Minimum Pitch Distance, (2.5*Dia of Hole+3)	=	97.5	mm
Pitch Distance Provided, P	=	100	mm
Minimum Edge Distance, (1.5*Dia of Bolt)	=	54.0	mm
Edge Distance Provided, E	=	54	mm
Number of Bolts required on one side, Nr	=	Paf/Bv	Nos.
	=	12	Nos.
Flange Top Splice Plate			
No. of Row of Bolts along beam, m1	=	6	
No. of Row of Bolt across Beam, n1	=	2	
Number of Bolts Provided	=	12	Nos. OK
Flange Bottom Splice Plate			
No. of Row of Bolts along beam, m2	=	6	
No. of Row of Bolt across Beam, n2	=	1	
Number of Bolts Provided	=	6	Nos.

CALCULATION SHEAR CAPACITY OF 8.8 GRADE HSFG BOLT

S.S Grade Bolt, ISO 4002										
Bolt	Nominal Dia(mm)	Shank Area(mm ²)	Thread Area(mm ²)	Slip Factor	Number of Effective Interfaces	Minimum Bolt Tension(T)	Factor of Safety		Shear Capacity of Bolt(T)	
							IS 4000:1992, Table-2			IS 4000:1992, Sd.2
							IS 4000:1992, Annex C	IS 4000:1992, Table-3		
					For Single Shear					
M16	16	201	157	0.3	2	8.45	1.4	4.30		
M20	20	314	245	0.3	2	14.70	1.4	6.30		
M24	24	452	353	0.3	2	21.20	1.4	9.09		
M30	30	706	563	0.3	2	35.20	1.4	14.44		
M36	36	1017	817	0.3	2	49.00	1.4	21.00		

DESIGN OF WEB SPLICE PLATE				DESIGN OF FLANGE SPLICE PLATE			
Depth of Web Splice Plate Required	=	(Number of Horizontal rows of Bolt-1)*Pitch Distance + 2*Edge Distance)		Design Load for Splice Plate	=	F	
	=	((n-1)*P+2*E)			=	252.34	T
Provided Depth of Web Splice Plate, Dws	=	320	mm	Load on Top Splice Plate, F1	=	126.17	T
	=	450	mm				
			OK				
Width of Web Splice Plate Required	=	(Number of Vertical rows of Bolt-1)*Pitch Distance + 2*Edge Distance)		Load on Bottom Splice Plate, F2	=	63.09	T
	=	((m-1)*P+2*E)/2					
Provided Width of Web Splice Plate, Bws	=	440	mm	Width of Flange Top Splice Plate, W1	=	bf1	
	=	440	mm		=	250	mm
			OK				
Thickness of Web Splice Plate Rqd.	=	(0.5 X thickness of Web X (Depth of Web)^3/(Depth of Web Splice Plate)^3)		Net Width of Flange Top Splice Plate, W1net	=	((Total Width of Splice Plate)-(n1 X (Nominal dia of Bolt + 3))	
	=	(0.5 X tw X Dw^3)/(Dws^3)			=	172	
	=	14.22		Thickness of Top Splice Plate Required	=	(1.05 X (Load on Top Splice Plate)/(0.6 X fy X Net Width of Splice Plate))	
	=	14.22		fy =	=	350	
Provided Thickness of Web Splice Plate, tws	=	20	mm	Thickness of Top Splice Plate Provided, T1	=	40	mm
			OK				OK
				Width of Top Flange Bottom Splice Plate, W2	=	((Width of Flange Splice Plate -Thickness of web-2*Edge Distance)/2	
					=	65	mm
					=	100	mm
							OK
				Net Width of Top Flange Bottom Splice Plate, W2net	=	(Width of Bottom Flange Splice Plate)-(n2 X Nominal dia of Bolt + 3)	
					=	61	
				Thickness of Top Flange Bottom Splice Plate, T2	=	(1.05 X (Load on Bottom Splice Plate)/(0.6 X fy X Net Width of Splice Plate))	
				fy =	=	51.71	mm
					=	56	mm
							OK
				Length of Top Flange Top & Bottom Splice Plate, L	=	(((2 X E) + (m1-1) X P)) X 2	
					=	1216	mm
					=	1220	mm
							OK
SUMMARY OF BOLT AND SPLICE PLATE FOR WEB PLATE				SUMMARY OF BOLT AND SPLICE PLATE FOR FLANGE PLATE			
Total No. of Bolt	=	12	Nos.	Total No. of Bolt	=	24	Nos.
Bolt Size	=	M36		Bolt Size	=	M36	
Total Width of Web Splice Plate	=	440	mm	Total Width of Top Flange Splice Plate	=	250	mm
Total Depth of Splice Plate	=	450	mm	Total Width of Bottom Flange Splice Plate	=	100	mm
Thickness of Web Plate	=	20	mm	Total Length of Flange Top Splice Plate	=	1220	mm
			Both Side of Wed Plate	Total Length of Flange Bottom Splice Plate	=	1220	mm
			Both Side of Wed Plate	Thickness of Flange Top Splice Plate	=	40	mm
				Thickness of Flange Bottom Splice Plate	=	56	mm

DESIGN OF SHEAR CONNCTION OF BEAM GIRDER WITH COLUMN MKD. A2, AT + 8.75 M LVL

BUILT-UP BEAM	WEB	750	X	25	FLANGE	250	X	32	
Total Depth	=			750	mm				
Web Thickness	=			25	mm				
Flange Thickness	=			32	mm				
Area of Web	=			18750	Sqmm				
Shear Area of Bolt	=			551.3	Sqmm				
Shear capacity of web (0.4*fy*A)	=			262.50	T	fy =	250	N/mm2	Pl. thk. <= 20mm
Considering 80% of Load Capacity	=			210.00	T	fy =	350	N/mm2	Pl. thk. > 20mm

CALCULATION FOR NUMBERS OF BOLTS

Size of Bolt	=		M30	
Diameter of Bolt	=		30	mm
Slip Factor	=		0.3	
Number of effective interfaces	=		2	Double Shear
Minimum tension in bolt	=		33.7	T
Factor of Safety	=		1.4	
Shear Capacity(Double shear)	=		Slip Factor X Number of effective interfaces X Minimum bolt Tension	
	=		Factor of Safety	
			14.4	T
Number of Bolts required(Double Shear)			15.0	Nos.
Number of Bolts Provided(Double Shear)			16.0	Nos. OK

8.8 Grade Bolt, IS 4000:1992

Bolt	Nominal Dia(mm)	Shank Area(mm2)	Thread Area(mm2)	Slip Factor	Number of Effective Interfaces	Minimum Bolt Tension(T)	Factor of Safety	Shear Capacity of Bolt(T)
IS 4000:1992, Table-2				IS 4000:1992, Annex-C	For Double Shear	IS 4000:1992, Table-3	IS 4000:1992, 5.4.2	IS 4000:1992, 5.4.2
M16	16	201	157	0.3	2	9.45	1.4	4.05
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M24	24	452	353	0.3	2	21.2	1.4	9.09
M30	30	706	561	0.3	2	33.7	1.4	14.44
M36	36	1017	817	0.3	2	49.0	1.4	21.00

CALCULATION FOR WELDING LENGTH

Size of Weld(Assumed)	=	16	mm	Minimum Weld Size for Various Cleat Connection				
Total Weld Length Required	=	(80% of Shear Capacity*10000/(0.707*Size of Weld*110)) / 2			Thickness of Cleat		Minimum Size of Weld	
	=	844			8		6	
					10		6	
					12		8	
					16		10	
					20		10	
					25		12	
					28		16	
					32		16	
					36		20	
					40		20	
					45		25	
					50		25	
Total Weld Length Provided, (685+200+200)	=	1085	mm	OK				

DESIGN OF SHEAR CONNECTION OF BEAM GIRDER WITH COLUMN MKD. A2, AT + 17.75 M LVL									
BUILT-UP BEAM		WEB	750	X	20	FLANGE	350	X	25
Total Depth		=			750	mm			
Web Thickness		=			20	mm			
Flange Thickness		=			25	mm			
Area of Web		=			15000	Sqmm			
Shear Area of Bolt		=			793.9	Sqmm			
Shear capacity of web (0.4*fy*A)		=			150.00	T	fy =	250	N/mm2 Pl. thk. <= 20mm
Considering 80% of Load Capacity		=			120.00	T	fy =	350	N/mm2 Pl. thk. > 20mm
CALCULATION FOR NUMBERS OF BOLTS									
Size of Bolt		=			M36				
Diameter of Bolt		=			36	mm			
Slip Factor		=			0.3				
Number of effective interfaces		=			2	Double Shear			
Minimum tension in bolt		=			49	T			
Factor of Safety		=			1.4				
Shear Capacity(Double shear)		=			Slip Factor X Number of effective interfaces X Minimum bolt Tension				
					Factor of Safety				
		=			21.0	T			
Number of Bolts required(Double Shear)					6.0	Nos.			
Number of Bolts Provided(Double Shear)					6.0	Nos.			OK
8.8 Grade Bolt, IS 4000:1992									
Bolt	Nominal Dia(mm)	Shank Area(mm2)	Thread Area(mm2)	Slip Factor	Number of Effective Interfaces	Minimum Bolt Tension(T)	Factor of Safety	Shear Capacity of Bolt(T)	
IS 4000:1992, Table-2				IS 4000:1992, Annex-C	For Double Shear	IS 4000:1992, Table-3	IS 4000:1992, 5.4.2	IS 4000:1992, 5.4.2	
M16	16	201	157	0.3	2	9.45	1.4	4.05	
M20	20	314	245	0.3	2	14.7	1.4	6.30	
M24	24	452	353	0.3	2	21.2	1.4	9.09	
M30	30	706	561	0.3	2	33.7	1.4	14.44	
M36	36	1017	817	0.3	2	49.0	1.4	21.00	
CALCULATION FOR WELDING LENGTH									
Size of Weld(Assumed)		=			10	mm	Minimum Weld Size for Various Cleat Connection		
Total Weld Length Required		=			(80% of Shear Capacity*10000/((0.707*Size of Weld*110)) / 2				
		=			772 mm				
Total Weld Length Provided, (650+150+150)		=			950	mm			OK

DESIGN CALCULATION FOR BOLT AND GUSSET PLATE IN BRACING CONNECTION OF BOX MC250 CONNECTED TO A2 COLUMN

CALCULATION OF SECTIONAL AREA & LOAD CAPACITY

Section	BOX	ISMC	250
Web Depth, D	=	250	mm
Web Thk., t	=	7.2	mm
Flange Width, B	=	80	mm
Flange Thk., T	=	14.1	mm
Stional Area, a	=	3900	mm ² (IS: 808)
Stional Area for Box (ISMC, 2 X a)	=	7800	mm ²
Load capacity (0.6*fy*A), P	=	117.00	Mton

fy = 250 N/mm2 l. thk. <= 20mm
fy = 350 N/mm2 l. thk. > 20mm

Standard Table, IS 800					
Section	D	T	a	T	a
BOX ISMC	75	75	4.8	40	7.5
BOX ISMC	100	100	5.0	50	7.7
BOX ISMC	125	125	5.3	65	8.2
BOX ISMC	150	150	5.7	75	9.0
BOX ISMC	175	175	6.0	75	10.2
BOX ISMC	200	200	6.2	75	11.4
BOX ISMC	225	225	6.5	80	12.4
BOX ISMC	250	250	7.2	80	14.1
BOX ISMC	300	300	7.8	90	13.6
BOX ISMC	350	350	8.3	100	13.5
BOX ISMC	400	400	8.8	100	15.3

CALCULATION FOR NUMBER OF BOLTS

Size of Bolt	=	M36
Diameter of Bolt, d	=	36 mm
Slip Factor	=	0.3
Number of effective interfaces	=	1
Minimum tension in bolt	=	49
Factor of Safety	=	1.4
Shear Capacity(single shear) =	$\frac{\text{Slip Factor} \times \text{Number of effective interfaces} \times \text{Minimum bolt Tension}}{\text{Factor of Safety}}$	
Shear Capacity(single shear)	=	10.50 Mton
Number of Bolts required	=	12 Nos.
Number of Bolts Provided along direction of force, n	=	2 Nos.
Number of Bolts Provided across direction of force, m	=	6 Nos.
Number of bolts provided, N	=	12 Nos.

8.8 Grade Bolt, IS 4000:1992							
Bolt	Nominal Dia(mm)	Shank Area(mm ²)	Thread Area(mm ²)	Slip Factor	Number of Effective interfaces	Minimum Bolt Tension(T)	Factor of Safety
IS 4000:1992, Table-2				IS 4000:1992, Annex-2	IS 4000:1992, Table-3	IS 4000:1992, 5.4.2	IS 4000:1992, 5.4.2
M16	16	201	157	0.3	1	9.45	1.4
M20	20	314	245	0.3	1	14.7	1.4
M24	24	452	353	0.3	1	21.3	1.4
M30	30	706	561	0.3	1	33.7	1.4
M36	36	1017	817	0.3	1	49	1.4

DESIGN OF GUSSET PLATE

THICKNESS OF GUSSET PLATE

Gusset Plate Thickness Required , T _{req}	=	Max{(P*10000)/(N*1.2*fy*(d+3)), 1.4*P*10000/(N*40*fy)}	
fy = 250 N/mm ²	=	13.65	mm
Gusset Plate Thickness Provided , T	=	20.00	mm

(Clause 5.3.4 of IS 4000:1992)

(Minimum Thickness of Gusset Plate Shall be 8 mm for Truss/Bracing Member with Member Thickness shall be 8 mm or Less)
(Minimum Thickness of Gusset Plate Shall be 12 mm for Truss/Bracing Member with Member Thickness shall be 10 mm or Less)

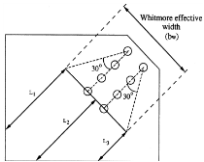
(Clause 5.3.4 of IS 8000:1992)

(Minimum Thickness of Gusset Plate shall be 8 mm for Truss/Bracing Member with Member Thickness shall be 8 mm or Less)
(Minimum Thickness of Gusset Plate shall be 12 mm for Truss/Bracing Member with Member Thickness shall be 10 mm or Less)

WIDTH OF GUSSET PLATE

Minimum width of Gusset Plate Required,bw1	=	$P/[0.6*fy*(T)*10000]$	
fy = 250 N/mm2	=	390.00	mm
Minimum whltmore width of Gusset Plate Required,bw2	=	$[(2*{s-1}*2.5*d*TAN(30°PHI/180)]+(m-1)*2.5*d]$	
	=	554.00	mm
Provided width of Gusset Plate, bw	=	650	mm
Effective width of Gusset Plate, bew	=	$bw-(m*(d+3))$	
	=	416	mm

fy = 250 N/mm2 (If Memb. Thick <= 20 mm)
fy = 350 N/mm2 (If Memb. Thick > 20 mm)



CAPACITY OF GUSSET PLATE IN TENSION

Load capacity of plate in tension	=	(0.6*fy*bew*T)/10000		(Clause 4.1.1 of IS 800-1984)
fy = 250 N/mm2	=	124.80	MT	> 117.00
				OK

(Clause 4.1.1 of IS 800-1984)
117.00

CAPACITY OF GUSSET PLATE IN COMPRESSION

Buckling length of gusset assumed	=	100	mm	
Radius of gyration of gusset plate r	=	Thickness of Gusset Plate, T / SQRT(12)		
	=	5.8	mm	
Slenderness λ	=	1.2*Buckling Length of Gusset/Radius of gyration		
	=	20.78		
Elastic critical stress in compression, fcc	=	4569.26	N/mm2	
Permissible stress in axial compression, σc	=	0.6*(fcc*fy)/(fcc*1.4*fy*1.4*(1/1.2, 4))		(Clause 5.1 of IS 800-1984)
fy = 250 N/mm2	=	148.2	N/mm2	
Load carrying capacity of gusset	=	(σac) X bw X T/10000		
	=	192.7	Mton	> 117.00 OK

(Clause 5.1 of IS 800-1984)
117.00

CALCULATION FOR WELDING LENGTH

Minimum Size of Weld as per Table	=	10	mm
Size of Weld Provided	=	10	mm
Total Weld Length Required	=	1504	mm
(100% of Shear Capacity*10000)/(0.707*Size of Weld*110)	=	1520	mm
Total Weld Length Provided, (380+380+380)	=	1140	mm

Minimum Weld Size for Various Gusset Plate	
Gusset Plate Size	Minimum Size of Weld
8 mm	8 mm
10 mm	8 mm
12 mm	8 mm
16 mm	10 mm
20 mm	10 mm
25 mm	12 mm
28 mm	16 mm
32 mm	16 mm
36 mm	20 mm
40 mm	20 mm
45 mm	25 mm
50 mm	25 mm

ESIGN CALCULATION FOR BOLT AND GUSSET PLATE IN BRACING CONNECTION OF BOX MC300 CONNECTED TO A2 COLUMN

CALCULATION OF SECTIONAL AREA & LOAD CAPACITY

Section	BOX	ISMC	300
Web Depth, D	=		300 mm
Web Thk., t	=		7.8 mm
Flange Width, B	=		90 mm
Flange Thk., T	=		13.6 mm
Stional Area, a	=		4630 mm ² (IS 808)
Stional Area for Box ISMC, (2 X a)	=		9260 mm ²
Load capacity (0.6*Y*Al) P	=		138.90 Mton

fy = 250 N/mm2 l. thk. <= 20mm
fy = 350 N/mm2 l. thk. > 20mm

Standard Table, IS 800						
Section	D	t	B	T	a	
BOX ISMC	75	7.5	4.8	40	7.5	910
BOX ISMC	100	10.0	5	50	7.7	1220
BOX ISMC	125	12.5	5.3	65	8.2	1670
BOX ISMC	150	15.0	5.7	75	9	2130
BOX ISMC	175	17.5	6	75	10.2	2490
BOX ISMC	200	20.0	6.2	75	11.4	2850
BOX ISMC	225	22.5	6.5	80	12.4	3330
BOX ISMC	250	25.0	7.2	80	14.1	3900
BOX ISMC	300	30.0	7.8	90	15.6	4630
BOX ISMC	350	35.0	8.3	100	15.5	5440
BOX ISMC	400	40.0	8.8	100	15.3	6380

CALCULATION FOR NUMBER OF BOLTS

Size of Bolt	=	M36
Diameter of Bolt, d	=	36 mm
Slip Factor	=	0.3
Number of effective interfaces	=	1
Minimum tension in bolt	=	49
Factor of Safety	=	1.4
Shear Capacity(single shear) =	Slip Factor X Number of effective interfaces X Minimum bolt Tension	
Factor of Safety	=	10.50 Mton
Number of Bolts required	=	14 Nos.
Number of Bolts Provided along direction of force, n	=	2 Nos.
Number of Bolts Provided across direction of force, m	=	7 Nos.
Number of bolts provided, N	=	14 Nos.

S.8 Grade Bolt, IS 4000:1992						
Bolt	Nominal Dia(mm)	Shank Area(mm ²)	Thread Area(mm ²)	Slip Factor	Number of Effective interfaces	Minimum Bolt Tension(T)
IS 4000:1992, Table-2				IS 4000:1992, Annex-2	IS 4000:1992, Table-3	IS 4000:1992, 5.4.2
M16	16	201	157	0.3	1	9.45
M20	20	314	245	0.3	1	14.7
M24	24	452	353	0.3	1	21.3
M30	30	706	561	0.3	1	33.7
M36	36	1017	817	0.3	1	49

DESIGN OF GUSSET PLATE

THICKNESS OF GUSSET PLATE

Gusset Plate Thickness Required , Treq	=	Max(P*10000/(N*1.2*fy*(d+3)), 1.4*P*10000/(N*40*fy))
fy = 350 N/mm2	=	9.92 mm
Gusset Plate Thickness Provided , T	=	12 mm

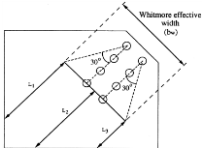
(Clause 5.3.4 of IS 800-1984)

(Minimum Thickness of Gusset Plate shall be 8 mm for Truss/Bracing Member with Member Thickness shall be 8 mm or Less)
(Minimum Thickness of Gusset Plate shall be 12 mm for Truss/Bracing Member with Member Thickness shall be 10 mm or Less)

WIDTH OF GUSSET PLATE

Minimum width of Gusset Plate Required,bw1	=	P/(0.6*fy*T)*10000
fy = 350 N/mm2	=	264.57 mm
Minimum whitmore width of Gusset Plate Required,bw2	=	((2*fy*(1+fy*2*FAN(30*PI/180)))/(m-1)*2.5*d))
	=	644.00 mm
Provided width of Gusset Plate, bw	=	730 mm
Effective width of Gusset Plate, bew	=	bw-(m*(d+3))
	=	447 mm

fy = 250 N/mm2 mb. Thick <= 20 mm
fy = 350 N/mm2 mb. Thick > 20 mm



CAPACITY OF GUSSET PLATE IN TENSION

Load capacity of plate in tension	=	(0.6*fy*bew*T)/10000
fy = 350 N/mm2	=	234.68 MT

(Clause 4.1.1 of IS 800-1984)

138.90 OK

CAPACITY OF GUSSET PLATE IN COMPRESSION

Buckling length of gusset assumed	=	100 mm
Radius of gyration of gusset plate, r	=	Thickness of Gusset Plate, T / SQRT(12)
	=	7.2 mm
Slenderness, λ	=	1.2*Buckling length of Gusset/Radius of gyration
	=	16.63
Elastic critical stress in compression, fcc	=	7139.47 N/mm2
Permissible stress in axial compression, ac	=	0.6*fy*(1+fy/fcc)*1.4*fy*(1.4*fy*(1/12, 4))
fy = 350 N/mm2	=	207.8 N/mm2
Load carrying capacity of gusset	=	(Fac) X bw X T /10000
	=	274.1 Mton

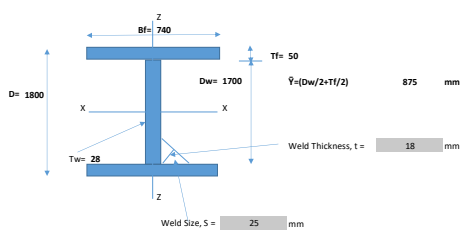
(Clause 5.1 of IS 800-1984)

138.90 OK

CALCULATION FOR WELDING LENGTH

Minimum Size of Weld as per Table	=	12 mm
Size of Weld Provided	=	12 mm
Total Weld Length Required	=	1488 mm
(100% of Shear Capacity*10000/(0.707*Size of Weld*110))	=	
Total Weld Length Provided, (375+375+375+375)	=	1500 mm

Minimum Weld Size for Various Gusset Plate	
Gusset Plate Size	Minimum Size of Weld
8 mm	8 mm
10 mm	8 mm
12 mm	8 mm
16 mm	10 mm
20 mm	10 mm
25 mm	12 mm
28 mm	16 mm
32 mm	16 mm
36 mm	20 mm
40 mm	20 mm
45 mm	25 mm
50 mm	25 mm

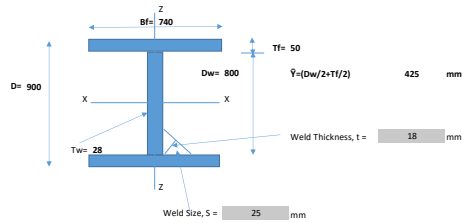
DESIGN CALCULATION OF WELD SIZE FOR A2 COLUMN WEB TO FLANGE CONNECTION UP TO 29.4M LVL																																			
SECTION PROPERTIES OF PLATE					SECTION PROFILE																														
WEB PLATE		1800	X	28																															
FLANGE PLATE		740	X	50																															
Total Depth of Column	D	=	1800	mm																															
Web Thickness	Tw	=	28	mm																															
Web Depth	Dw	=	(D-2Xf)																																
		=	1700	mm																															
Width of Flange	Bf	=	740	mm																															
Thickness of Flange	Tf	=	50	mm																															
Area of Web	Aw	=	(D X Tw)																																
		=	50400	mm2																															
Area of Flange	Af	=	(Bf X Tf)																																
		=	37000	mm2																															
Moment of Area	Aȳ	=	32375000	mm3																															
Moment of Inertia, Ixx =	$((Bf \times Tf^3/12) + (Af \times Y^2) + (Tw \times Dw^3/12) + (Bf \times Tf^3/12) + (Af \times Y^2))$																																		
	Ixx	=	68135333333	mm4																															
CALCULATION OF WELD THICKNESS					MINIMUM WELD SIZE REQUIRED OF VARIOUS WEB PLATE																														
Shear Force in the Web		Ps	=	(0.4*fy*Aw)	<table><tr><th>Plate Size</th><th>Size of Weld</th></tr><tr><td>8 mm</td><td>6 mm</td></tr><tr><td>10 mm</td><td>6 mm</td></tr><tr><td>12 mm</td><td>8 mm</td></tr><tr><td>16 mm</td><td>10 mm</td></tr><tr><td>20 mm</td><td>10 mm</td></tr><tr><td>25 mm</td><td>12 mm</td></tr><tr><td>28 mm</td><td>16 mm</td></tr><tr><td>32 mm</td><td>16 mm</td></tr><tr><td>36 mm</td><td>20 mm</td></tr><tr><td>40 mm</td><td>20 mm</td></tr><tr><td>45 mm</td><td>25 mm</td></tr><tr><td>50 mm</td><td>25 mm</td></tr></table>					Plate Size	Size of Weld	8 mm	6 mm	10 mm	6 mm	12 mm	8 mm	16 mm	10 mm	20 mm	10 mm	25 mm	12 mm	28 mm	16 mm	32 mm	16 mm	36 mm	20 mm	40 mm	20 mm	45 mm	25 mm	50 mm	25 mm
Plate Size	Size of Weld																																		
8 mm	6 mm																																		
10 mm	6 mm																																		
12 mm	8 mm																																		
16 mm	10 mm																																		
20 mm	10 mm																																		
25 mm	12 mm																																		
28 mm	16 mm																																		
32 mm	16 mm																																		
36 mm	20 mm																																		
40 mm	20 mm																																		
45 mm	25 mm																																		
50 mm	25 mm																																		
	fy =	350	N/mm2																																
			=	705.6	Ton																														
Minimum Size of Weld Required, (Refer Table)			=	16	mm																														
Size of Weld Provided,	S		=	25	mm																														
Effective Thickness of Weld,	t		=	(0.7 x S)																															
			=	17.5	mm																														
Effective Thickness of Weld for both side of Plate,	2 * t		=	35	mm																														
Shear Stress	Tvf, cal		=	(Ps X Aȳ) / (Ixx X 2 X t)																															
			=	96	N/mm2																														
Allowable Shear Stress,	Tvf, all		=	110	N/mm2																														

DESIGN CALCULATION OF WELD SIZE FOR A2 COLUMN WEB TO FLANGE CONNECTION ABOVE 29.4M LVL

SECTION PROPERTIES OF PLATE

WEB PLATE	900	X	28
FLANGE PLATE	740	X	50
Total Depth of Column	D	=	900 mm
Web Thickness	Tw	=	28 mm
Web Depth	Dw	=	(D-2Xf) mm
Width of Flange	Bf	=	800 mm
Thickness of Flange	Tf	=	740 mm
Area of Web	Aw	=	(D X Tw) mm2
Area of Flange	Al	=	(Bf X Tf) mm2
Moment of Area	A \bar{Y}	=	15725000 mm3
Moment of Inertia, Ixx =	((Bf X Tf^3/12) + (Al X Y^2) + (Tw*Dw^3/12) + (Bf X Tf^3/12) + (Al X Y^2))		
	Ixx	=	1457633333 mm4

SECTION PROFILE

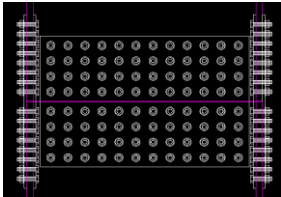
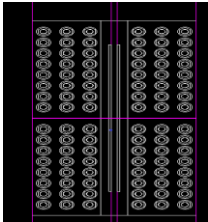


CALCULATION OF WELD THICKNESS

Shear Force in the Web	fy =	350	N/mm2	Ps =	(0.4*fy*Aw)	=	352.8	Ton
Minimum Size of Weld Required, (Refer Table)						=	16	mm
Size of Weld Provided,	S	=	25	mm				OK
Effective Thickness of Weld,	t	=	(0.7 x S)			=	17.5	mm
Effective Thickness of Weld for both side of Plate,	2 * t	=	35	mm				
Shear Stress	Tvf, cal	=	(Ps X A \bar{Y}) / (Ixx X 2 X t)			=	109	N/mm2
Allowable Shear Stress,	Tvf, all	=	110	N/mm2				OK

MINIMUM WELD SIZE REQUIRED OF VARIOUS WEB PLATE

Plate Size	Size of Weld
8 mm	6 mm
10 mm	6 mm
12 mm	8 mm
16 mm	10 mm
20 mm	10 mm
25 mm	12 mm
28 mm	16 mm
32 mm	16 mm
36 mm	20 mm
40 mm	20 mm
45 mm	25 mm
50 mm	25 mm

DESIGN OF SPLICE CONNECTION FOR COLUMN MARKED A2, ABOVE 29.40 M LVL									
SECTION PROPERTIES OF COLUMN WEB					SECTION PROPERTIES OF COLUMN FLANGE				
WEB PLATE 900 X 28					FLANGE PLATE 740 X 50				
Total Depth of Column D = 900 mm					Flange Thickness Tf = 50 mm				
Web Thickness Tw = 28 mm					Total Width of Flange Fw = 740 mm				
Web Depth Dw = (D-2Tw) = 800 mm					Area of Flange Af = (TF X Fw) = 37000 mm ²				
Area of Web Aw = (Dw X Tw) = 22400 mm ²									
CALCULATION OF FORCES & MOMENT OF COLUMN WEB					CALCULATION OF FORCES & MOMENT OF COLUMN FLANGE				
Shear Force in the Web fy = 350 N/mm ² Ps = (0.4*fy*Aw) = 313.6 Ton					Axial Force in the Flange Paf = 350 N/mm ² = (0.6*fy X Af) = 777 Ton				
Axial Force in the Web fy = 350 N/mm ² Paw = (0.6*fy X Af) = 470 Ton									
Eccentricity fy = 350 N/mm ² e = (The distance of C.G. of Bolts from the Extreme Bolt) = ((n-1)P/2 + e) = 260 mm									
WEB SPLICE PROFILE					FLANGE SPLICE PROFILE				
									
CALCULATION OF SHEAR CAPACITY OF BOLT AND NUMBERS OF BOLT REQUIRED FOR WEB SPLICE					CALCULATION OF SHEAR CAPACITY OF BOLT AND NUMBERS OF BOLT REQUIRED FOR FLANGE SPLICE				
Design Shear Force in the Web for Bolt Design(20%) Ps = 62.72 Ton					Design Force for Bolt = Paf = 777 Ton				
Design Axial Force in the Web for Bolt Design Paw = 470 Ton									
Design Moment due to Eccentricity for Bolt Design Me = 0.2 X Ps X e = 16.3 T-m									
Size of Bolt Selected = M36					Size of Bolt Selected = M36				
Nominal Diameter of Bolt, d = 36 mm					Nominal Diameter of Bolt = 36 mm				
Shear Capacity(Double shear), Bv = Slip Factor X Number of effective interfaces X Minimum bolt Tension					Shear Capacity(Double shear), Bv = Slip Factor X Number of effective interfaces X Minimum bolt Tension				
Slip Factor = 0.3					Slip Factor = 0.3				
Number of effective interfaces = 2 Double Shear					Number of effective interfaces = 2 Double Shear				
Minimum tension in bolt = 48 T					Minimum tension in bolt = 48 T				
Factor of Safety = 1.4					Factor of Safety = 1.4				
Shear Capacity, Bv = 21.00 Ton					Shear Capacity of Bolt, Bv = 21.00 Ton				
Minimum Pitch Distance, (2.5*Dia of Bolt+3) = 97.5 mm					Minimum Pitch Distance, (2.5*Dia of Bolt+3) = 97.5 mm				
Pitch Distance Provided, P = 100 mm					Pitch Distance Provided, P = 100 mm				
Minimum Edge Distance,(1.5*Dia of Bolt) = 54 mm					Minimum Edge Distance,(1.5*Dia of Bolt) = 54 mm				
Edge Distance Provided, E = 60 mm					Edge Distance Provided, E = 60 mm				
No. of Vertical Row of Bolts, m = 6 (Assumed)					Number of Bolts required on one side, Nr = Paf/Bv = 37 Nos.				
No. of Horizontal Row, n = 5 (Assumed)									
Number of Bolts Provided, Nr = 30 Nos.					Flange Top Splice Plate				
r = (Sqrt((m-1)/2+(n-1)/2 X P/2) = 320.16 mm					No. of Vertical Row of Bolts, m1 = 6				
Cosθ = ((n-1)/2 X P)/r = 0.62					No. of Horizontal Row, n1 = 7				
Sinθ = ((m-1)/2 X P)/r = 0.78					Number of Bolts Provided = 42 Nos. OK				
Σx ² = P ² X m X n X (m-1) X (n+1)/12 = 875000.0 mm ²					Flange Bottom Splice Plate				
Σy ² = P ² X m X n X (n-1) X (n+1)/12 = 600000.0 mm ²					No. of Vertical Row of Bolts, m2 = 3				
z = (Σx ² + Σy ²)/r = 4.6 m					No. of Horizontal Row, n2 = 7				
Shear Force on Extreme Bolt Due to Me, Fme = 3.54 T					Number of Bolts Provided = 21 Nos.				
Shear Force on Extreme Bolt Due to P _y , FPy = 2.09 T									
Shear Force on Extreme Bolt Due to P _{aw} , Fpaw = 15.68 T									
Resultant Force, Fr = SQRT((Fme+2*FPy+2*Fpaw) ² +(2*FMe*FPy*Cosθ)+(2*FMe*Fpaw*Sinθ)) = 18.94 T < 21.00 Safe									
CALCULATION SHEAR CAPACITY OF 8.8 GRADE HSGF BOLT					CALCULATION SHEAR CAPACITY OF 8.8 GRADE HSGF BOLT				
8.8 Grade Bolt, IS 4000:1992					8.8 Grade Bolt, IS 4000:1992				
Bolt	Nominal Dia(mm)	Shank Area(mm ²)	Thread Area(mm ²)	Slip Factor	Number of Effective Interfaces For Double Shear	Minimum Bolt Tension(T)	Factor of Safety	Shear Capacity of Bolt(T)	
IS 4000:1992, Table-2					IS 4000:1992, Annex-C				
M16	16	201	157	0.3	2	9.45	1.4	4.05	
M20	20	314	245	0.3	2	14.70	1.4	6.30	
M24	24	452	353	0.3	2	21.20	1.4	9.09	
M30	30	706	561	0.3	2	33.70	1.4	14.44	
M36	36	1017	817	0.3	2	49.00	1.4	21.00	
DESIGN OF WEB SPLICE PLATE					DESIGN OF FLANGE SPLICE PLATE				
Depth of Web Splice Plate Required = (Number of Horizontal rows of Bolt-1)*Pitch Distance + 2*Edge Distance = ((n-1)*P+2*E) X 2 = 1040 mm OK					Design Load for Splice Plate = Paf = 777.00 T				
Provided Depth of Web Splice Plate, Bws = 1040 mm OK					Load on Top Splice Plate, F1 = 388.50 T				
Width of Web Splice Plate Required = (Number of Vertical rows of Bolt-1)*Pitch Distance + 2*Edge Distance = ((m-1)*P+2*E) = 620 mm					Load on Bottom Splice Plate, F2 = 194.25 T				
Provided Width of Web Splice Plate, Dws = 640 mm OK					Width of Flange Top Splice Plate, W1 = Width of Flange Plate of Column = 740 mm				
Thickness of Web Splice Plate Rqd. = (0.5 X thickness of Web X (Depth of Web/3))/(Depth of Web Splice Plate/3) = 27.34 mm					Net Width of Flange Top Splice Plate, W1net = (Total Width of Splice Plate)-(m-1 X (Nominal dia of Bolt + 3)) = 506 mm				
Provided Thickness of Web Splice Plate, tws = 28 mm OK					Thickness of Top Splice Plate Required fy = 350 N/mm ² = (1.05 X (Load on Top Splice Plate)/(0.6 X fy X Net Width of Splice Plate)) = 38.39 mm				
					Thickness of Top Splice Plate Provided, T1 = 40 mm OK				
					Width of Flange Bottom Splice Plate, W2 = ((Width of Flange Splice Plate - Thickness of web-Edge Distance)/2) = 296 mm				
					Net Width of Flange Bottom Splice Plate, W2net = (Width of Bottom Flange Splice Plate)-(m-2 X Nominal dia of Bolt + 3) = 213 mm				
					Thickness of Bottom Splice Plate, T2 = (1.05 X (Load on Bottom Splice Plate)/(0.6 X fy X Net Width of Splice Plate)) = 45.60 mm				
					fy = 350 N/mm ² = 96 mm (Minimum Thickness Shall be 6 mm) OK				
					Length of Flange Top & Bottom Splice Plate, L = ((2 X E) + ((n-1) X P)) X 2 = 1440 mm OK				
SUMMARY OF BOLT AND SPLICE PLATE FOR WEB PLATE					SUMMARY OF BOLT AND SPLICE PLATE FOR FLANGE PLATE				
Total No. of Bolt = 60 Nos.					Total No. of Bolt = 84 Nos.				
Bolt Size = M36					Bolt Size = M36				
Total Width of Web Splice Plate = 640 mm					Total Width of Top Flange Splice Plate = 740 mm				
Total Depth of Splice Plate = 1040 mm					Total Width of Bottom Flange Splice Plate = 330 mm (Two Nos.)				
Thickness of Web Plate = 28 mm					Total Length of Flange Top Splice Plate = 1440 mm				
					Total Length of Flange Bottom Splice Plate = 1440 mm				
					Thickness of Flange Top Splice Plate = 40 mm				
					Thickness of Flange Bottom Splice Plate = 50 mm				

[illegible]

(Minimum Thickness of Gusset Plate Shall be 12 mm for Truss/Bracing Member with Member Thickness shall be 10 mm or Less)

[illegible]

	30 mm	23 mm	
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DESIGN OF SHEAR CONNECTION OF BEAM GIRDER WITH COLUMN MKD. A2, AT + 26.10 M LVL FOR VENTILATION DUCT SUPPORT									
BUILT-UP BEAM		WEB	600	X	12	FLANGE	250	X	20
Total Depth		=			600	mm			
Web Thickness		=			12	mm			
Flange Thickness		=			20	mm			
Area of Web		=			7200	Sqmm			
Shear Area of Bolt		=			551.3	Sqmm			
Shear capacity of web (0.4*fy*A)		=			72.00	T	fy = 250	N/mm2	Pl. thk. <= 20mm
Considering 80% of Load Capacity		=			57.60	T	fy = 350	N/mm2	Pl. thk. > 20mm
CALCULATION FOR NUMBERS OF BOLTS									
Size of Bolt		=			M30				
Diameter of Bolt		=			30	mm			
Slip Factor		=			0.3				
Number of effective interfaces		=			2	Double Shear			
Minimum tension in bolt		=			33.7	T			
Factor of Safety		=			1.4				
Shear Capacity(Double shear)		=			Slip Factor X Number of effective interfaces X Minimum bolt Tension				
					Factor of Safety				
		=			14.4	T			
Number of Bolts required(Double Shear)					4.0	Nos.			
Number of Bolts Provided(Double Shear)					4.0	Nos.			OK
8.8 Grade Bolt, IS 4000:1992									
Bolt	Nominal Dia(mm)	Shank Area(mm2)	Thread Area(mm2)	Slip Factor	Number of Effective Interfaces	Minimum Bolt Tension(T)	Factor of Safety	Shear Capacity of Bolt(T)	
IS 4000:1992, Table-2				IS 4000:1992, Annex-C	For Double Shear	IS 4000:1992, Table-3	IS 4000:1992, 5.4.2	IS 4000:1992, 5.4.2	
M16	16	201	157	0.3	2	9.45	1.4	4.05	
M20	20	314	245	0.3	2	14.7	1.4	6.30	
M24	24	452	353	0.3	2	21.2	1.4	9.09	
M30	30	706	561	0.3	2	33.7	1.4	14.44	
M36	36	1017	817	0.3	2	49.0	1.4	21.00	
CALCULATION FOR WELDING LENGTH									
Size of Weld(Assumed)		=			10	mm		Minimum Weld Size for Various Cleat Connection	
Total Weld Length Required		=			(80% of Shear Capacity*10000/(0.707*Size of Weld*110)) / 2				
		=			370	mm		Thickness of Cleat	
								Minimum Size of Weld	
								8	6
								10	6
								12	8
								16	10
								20	10
								25	12
								28	16
								32	16
								36	20
								40	20
								45	25
								50	25
Total Weld Length Provided, (420+100+100)		=			620	mm		OK	

DESIGN OF 2XISA 75X75X8 BACK TO BACK BRACING CONNECTED TO A2 COLUMN FOR VENTILATION DUCT SUPPORT BRACKET AT +23.40M LVL

CALCULATION OF SECTIONAL AREA & LOAD CAPACITY

Section =	2XISA	75X75X8
Width, b =		75
Thickness, t =		8.0
Sectional area, a	=	1140 mm ² (Refer IS: 808)
Sectional area for double angle, 2*a	=	2280 mm ²
Size of Bolt used	=	M24
Nominal Diameter of Bolt, d	=	24 mm
Dia of hole for corresponding nominal dia 'd' of bolt = (d+2)	=	26 mm
C/S area of hole for corresponding nominal dia 'd' of bolt, Ad=(d+2)*t	=	208 mm ²
Number of Bolts Provided across direction of force, m	=	4 Nos.
Net Stional Area for double angle, Anet	=	(2*a)-(2*Ad)*m
	=	1864 mm ²
Load capacity (0.6*fy*An), P	=	27.96 Mton

CALCULATION FOR NUMBER OF BOLTS

Size of Bolt	=	M24
Nominal diameter of Bolt, d	=	24 mm
Slip Factor	=	0.3
Number of effective interfaces	=	2
Minimum tension in bolt	=	21.2
Factor of Safety	=	1.4
Shear Capacity(single shear) =	Slip Factor X Number of effective interfaces X Minimum bolt Tension	
Factor of Safety	=	9.09 Mton
Number of Bolts required	=	4 Nos.
Number of Bolts Provided along direction of force, n	=	4 Nos.
Number of Bolts Provided across direction of force, m	=	2 Nos.
Number of bolts provided, N	=	4 Nos. OK

8.8 Grade Bolt, IS 4000:1992						
Bolt	Nominal Dia(mm)	Shank Area(mm ²)	Thread Area(mm ²)	Slip Factor	Number of Effective Interfaces	Minimum Bolt Tension(T)
IS 4000:1992, Table-2				IS 4000:1992, Annex-C	For Single Shear	IS 4000:1992, Table-3
						IS 4000:1992, S.4.2
						IS 4000:1992, S.4.2
M16	16	201	157	0.3	2	9.45
M20	20	314	245	0.3	2	14.7
M24	24	452	353	0.3	2	21.2
M30	30	706	561	0.3	2	33.7
M36	36	1017	817	0.3	2	49

DESIGN OF GUSSET PLATE

THICKNESS OF GUSSET PLATE

Gusset Plate Thickness Required , Treq	=	Max(P*10000/(N*1.2*fy*(d+2)), 1.4*P*10000/(N*40*fy)
fy = 250 N/mm2	=	9.73 mm
Gusset Plate Thickness Provided , T	=	12.00 mm OK (Clause 5.3.4 of IS 4000:1992)
(Minimum Thickness of Gusset Plate Shall be 8 mm for Truss/Bracing Member with Member Thickness shall be 8 mm or Less)		
(Minimum Thickness of Gusset Plate Shall be 12 mm for Truss/Bracing Member with Member Thickness shall be 10 mm or Less)		

WIDTH OF GUSSET PLATE

Minimum width of Gusset Plate Required,bw1	=	P/(0.6*fy*TT)*10000
fy = 250 N/mm2	=	155.33 mm
fy = 350 N/mm2	=	111.11 mm (If Memb. Thick <= 20 mm)
fy = 350 N/mm2	=	111.11 mm (If Memb. Thick > 20 mm)

Minimum whitmore width of Gusset Plate Required,bw2	=	(I2*(n-1)*2.5*d*TAN(30*PI/180))+(m-1)*2.5*d
	=	208.00 mm

Provided width of Gusset Plate, bw	=	250 mm OK
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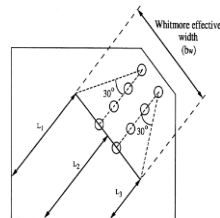
Effective width of Gusset Plate, bew	=	bw*m*(d+3)
	=	223 mm

CAPACITY OF GUSSET PLATE IN TENSION

Load capacity of plate in tension	=	(0.6*fy*bew*TT)/10000
fy = 250 N/mm2	=	40.14 MT
	=	27.96 OK (Clause 4.1.1 of IS 800:1984)

CAPACITY OF GUSSET PLATE IN COMPRESSION

Buckling length of guesset assumed	=	100 mm
Radius of gyration of guesset plate, r	=	Thickness of Gusset Plate, T / SQRT(12)
	=	3.5 mm
Slenderness, λ	=	1.2*Buckling Length of Gusset/Radius of gyration
	=	34.64
elastic critical stress in compression, fcc	=	1644.93 N/mm2
permissible stress in axial compression, σd	=	0.6*(fcc*fy)/(fcc*1.4+fy*1.4)*(1/1.4)
fy = 250 N/mm2	=	142.8 N/mm2 (Clause 5.1 of IS 800:1984)
load carrying capacity of guesset	=	(GAc) X bw X T/10000
	=	42.8 Mton
	=	27.96 OK



CALCULATION FOR WELDING LENGTH

Minimum Size of Weld as per Table	=	8 mm
Size of Weld Provided	=	8 mm OK
Total Weld Length Required	=	440 mm
(100% of Shear Capacity*10000)/(0.707*Size of Weld*110)	=	500 mm OK
Total Weld Length Provided, (250+250)	=	500 mm
Minimum Weld Size for Various Gusset Plate		
Gusset Plate Size		Minimum Size of Weld
8 mm		6 mm
10 mm		6 mm
12 mm		8 mm
16 mm		10 mm
20 mm		10 mm
25 mm		12 mm
28 mm		16 mm
32 mm		16 mm
36 mm		20 mm
40 mm		20 mm
45 mm		23 mm
50 mm		25 mm