

From

The Director General,
New & Renewable Energy Department Haryana & HAREDA
Akshay Urja Bhawan, Sector-17, Panchkula

To

M/s Himalayan Solar Pvt. Ltd.
237, HSIIDC, Industrial Area, Alipur, Barwala,
Panchkula-134118, Haryana.
agmsales@himalayansolar.co.in, majeet.singh@himalayansolar.co.in

Memo no. DNRE/Pumps-15/2021/ 10633 Dated: 21.09.2021

Subject:- Regarding acceptance of alternate MMS design.

In this regard, it is informed that the competent authority has considered the comparison made by the Jamia Millia Islamia, New Delhi for the alternate MMS design submitted by your firm vide your letter & email dated 17.09.2021 and has decided to allow your firm to supply these MMSs with a condition that your firm shall be solely responsible for these MMSs. It is also informed that the other specifications related to material, galvanisation and other technical features of MMS shall be followed as per MNRE specifications.


(Pradeep Nautiyal)
Chief Scientific Engineer,
for Director General, New & Renewable Energy
Deptt & HAREDA, Haryana, Panchkula
Email:-pradeep.nautiyal-hry@hry.gov.in,

CC:- Programmer, NRE to upload the new MMS design of said firm on website.

जामिया मिल्लिया इस्लामिया

(संसदीय अधिनियमानुसार 'केन्द्रीय विश्वविद्यालय')
मौलाना मोहम्मद अली जौहर मार्ग, नई दिल्ली-110025

JAMIA MILLIA ISLAMIA

NAAC Accredited 'A' Grade

(A Central University by an Act of Parliament)

Maulana Mohammad Ali Jauhar Marg, New Delhi-110025

सिविल इंजीनियरिंग विभाग

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Department of Civil Engineering

Faculty of Engineering & Technology

NO: 2021/3973

Dated: 03.03.2021

TO WHOMSOEVER IT MAY CONCERN

To,

Himalayan Solar Pvt. Ltd.
Plot No.-237, HSIIDC Industrial Estate, Alipur, Barwala
Panchkula, Haryana 134118

Subject: - Solar PV Module Mounting Structural Design Analysis and Certification

Document Reference specification: Structure design provided in MNRE's Technical Specification of Solar Water Pumping System- July 2019.

Dear Sir/Madam,

Following designs of Solar Module Mounting Structure submitted by M/s. Himalayan Solar Pvt. Ltd.

S. No.	Structure Table Size	Drawing No.
01	9 Modules Mounting Structure	SMP-SM-1216
02	10 Modules Mounting Structure	SMP-SM-1216
03	06 Modules Mounting Structure	SMP-SM-1216

have been checked & evaluated using STAAD Pro report for various parameters as per IS 875 : 2015, IS 800 : 2007 for a wind speed of 150 kmph and hence it is approved.

The above designs have been compared with "Indicative MNRE Design of July 2019 and had been found to be improved alternative over "Indicative MNRE Design" as shown below:

S.No.	Feature	Improvement in ALTERNATE Design	Advantage of Improvement
01	Wind Speed withstanding capacity	Design can withstand a wind speed of 150kmph.	
02	All parts per BIS standards	All the members used in ALTERNATE Design are as per IS 1161 where as several members of MNRE Design are not conforming IS 1161.	100% conformity to BIS would result in better quality
03	Suitability of Foundation for different soil types.	As per MNRE Annexure - A of the tender document, foundation is with base plate and direct piling design is used. The "ALTERNATE Design" has piling foundation and such type of foundation is better suited for all types of soils including soils having low bearing capacity.	- The proposed foundation is more suitable for sandy soils - Pile cap of 200mm will ensure that there is no damage to MMS due to water logging.

Certified By:

Prof. Khalid Moin
(Structural Engineer)
Professor

Dr. KHALID MOIN
Professor
Dept. of Civil Engineering
F/O Engineering & Technology
Jamia Millia Islamia
New Delhi-110025

For Himalayan Solar Pvt. Ltd.

Mangul
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6 MODULE MOUNTING STRUCTURE

Page No.-1

DESIGN BASIS REPORT
FOR
6 MODULE
SOLAR WATER PUMP
GROUND MOUNT SOLAR
MODULE MOUNTING STEEL STRUCTURE TABLE
KONARK ARCHITECT

Er.Neeraaj kumar Sharma
B.E.(CIVIL), A.I.I.A., M.I.E., F.I.V.
(CHARTERED ENGINEER)
MOB- 9412278819, 9953715238

CLIENT:-
HIMALAYAN SOLAR PRIVATE LIMITED
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Panchkula, Haryana- 134118

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1. GENERAL:

SCOPE

This document covers the Analysis & Design of Ground Mount Type Solar PV Module mounting structure at an angle of tilt 20 degree.

UNITS OF MEASUREMENTS

Units of measurements used in analysis shall be of SI Units.

CODES AND REFERENCE

Following have been referred for analysis and design of the MMS

Project Reference Drawings/Documents		
1	-----	Geo-Technical Investigation
2	-----	Plot Plan
3	-----	Module GA
Indian Standard Codes		
4	IS 456 - 2000	Plain and Reinforced Concrete - Code of Practice
5	IS 875: Part 1 & 2	Code of practice for the design loads for building and structures
6	IS 875: Part 3 - 2015	Code of practice for the design loads for building and structures - Wind Loads
7	IS 800: 2007 (LSD)	Code of practice for general construction in steel of hot rolled
8	IS 801: 1975	Code of practice for cold formed steel
9	IS 4923: 2017	Specifications for Hollow Steel Sections for Structural Use
10	IS 2062:2011	Hot rolled medium and high tensile structural steel- Specification
11	IS 4759:1996	Hot Dip Zinc Coating on Structural Steel and Allied Products -Specification

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MATERIAL PROPERTIES:

Material	Property	Value	Units
Concrete - M25	Density	23	kN/m ³
	Characteristic Strength	25	N/mm ²
	Modulus of Elasticity	25000	N/mm ²
High Strength Reinforcing Steel	Density	78.5	kN/m ³
	Characteristic Strength	500	N/mm ²
	Modulus of Elasticity	200000	N/mm ²
Structural Steel	Density	78.5	kN/m ³
	Characteristic Strength	210 & 250	N/mm ²
	Modulus of Elasticity	200000	N/mm ²

Section Properties

Sl. No.	Section	Area (cm ²)	I _{xx} (cm ⁴)	I _{yy} (cm ⁴)	J (cm ⁴)	Material
1	HPB 235	3.228	8.480	8.480	12.838	STEEL
2	HPB 235	2.540	3.080	3.080	8.168	STEEL
3	HPB 235	18.100	457.080	457.080	874.467	STEEL
4	70C 8.002	3.303	7.882	28.341	8.000	STEEL
5	TUB 80002 8	8.410	47.100	55.800	41.888	STEEL

PLANT INFORMATION:

Plant Location:

All Over India

Wind Speed:

41.6 m/s (150 kmph)

SOFTWARE USED:

Below listed software are used for the structural analysis and design;

S. No.	Software Name	Developed By	Uses
1	STAAD Pro	Research Engineers Inc., Berkeley, USA	Structural Analysis And Design
2	In-house developed MS-Excel Programs		Load Calculations

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2. LOADS:

Load Calculation:

Dead Load

Dead Load Calculations			
Module =		335	
Module Dimensions =	Length (mm)	Width (mm)	Nos.
	1998	1010	6
Module Orientation =	Portrait		
Tabel Configuration =	Horizontal Row	x	Vertical Column
	3	x	2
Module to Module Gap =	20	mm	
Module Tilt =	20	degree with horizontal	
Weight per module =	24	s	
Weight of 6 Modules =	144	kg	
Length of Purlin =	3200	mm	
Nos. of Purlins =	4		
Member load per unit length =	11.25	kg/m	
	0.1125	kN/m	
All dead load of module have been applied as member load by considering the modules are in constant touch with the purlin upper face.			

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Wind Load:

Wind Pressure Calculations			
Basic Wind Speed =	150	kmph	
Basic Wind Speed =	41.6	m/s	
Design Period =	25	years	
Type of Module Mounting Structure =	Ground Mount		
Terrain Category =	2		
Minimum Module Clearance From NGL =	1.0	m	
Height of Terrain/Building =	10	m	
Risk Coefficient Factor (k1) =	0.90	Table-1, IS-875, part-3-2015	
Terrain Factor (k2) =	1.00	Table-2, IS-875, part-3-2015	
Topography factor (k3) =	1.00	Clause-6.3.3.1 of IS: 875, part 3-2015	
Importance factor (k4) =	1.00	Clause-6.3.4 of IS-875, part-3-2015	
Design Wind Speed, $V_d = V_b \cdot k_1 \cdot k_2 \cdot k_3 \cdot k_4 =$	37.44	m/s	
Design Wind pressure, $P_z = 0.6 \cdot (V_d)^2 =$	841.0	N/sqm	
As per Latest code IS : 875 (Part-3-2015), the design wind pressure P_d can be obtained as as per clause 7.2; $P_d = K_d \cdot K_a \cdot K_c \cdot P_z$			
Where,	K_d = Wind directionality factor	0.9	Clause-7.2.1 of IS-875, part-3-2015
	K_a = Area averaging factor	1	Table-4 of IS: 875 part 3- 2015
	K_c = Combination factor	0.9	Clause-7.3.3.13 of IS: 875 part 3-2015
Hence, Design pressure = $P_d = K_d \cdot K_a \cdot K_c \cdot P_z =$		681.21	N/sqm

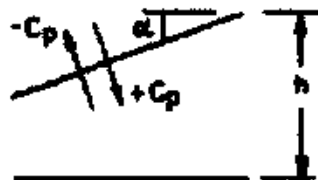
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Calculating pressure coefficient for mono-slope roof:



SIGN CONVENTION

+ TOWARDS THE STRUCTURE (SUCTION), - AWAY FROM THE STRUCTURE (UPLIFT)

For calculating the force on the panels from the pressure calculated above, we need pressure coefficient. The current structure falls under mono-slope free roofs. Pressure coefficient for mono-slope roof is found out referring section 7.3.3.2, Table 8, IS: 875, Part 3 - 2015. The pressure coefficients for a mono-slope free roof of 20° tilt angle and solidity ratio of 0.

WIND DATA (As per IS 875 Part 3 - 2015)		
Upward/Downward Wind Force, $F = C_p \cdot A \cdot P_d$		
Pressure Coefficient for Upward wind, $-C_p$	-1.3	(As per IS 875 Part-3, Table-7)
Pressure coefficient for Downward wind, $+C_p$	0.8	(As per IS 875 Part-3, Table-7)
Design wind pressure, P_d	581.21	N/sqm
Design wind pressure(Upward Direction) = $C_p \cdot P_d$	-885.57	N/sqm
Design wind pressure(Downward Direction) = $C_p \cdot P_d$	944.97	N/sqm
Surface Area of Structural element, $A = (1998 \times 1010 \times 6) / (10^6)$	12.11	sqm
Upward Wind force, $F_u = C_p \cdot A \cdot P_d$	-10.72	kN
Downward Wind force, $F_d = C_p \cdot A \cdot P_d$	6.59	kN
Here, we are considering applied wind force of Solar panels shall be bear by Purlin		
Upward Wind force per unit purlin length, $F_u / (4 \times 3.2)$	-0.84	kN/m
Downward Wind force per unit purlin length, $F_d / (4 \times 3.2)$	0.52	kN/m

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Note:- Negative sign shows Upward direction of Wind

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WINDLOAD SIDEWAYS (X & Z DIRECTION), X-being along the slope

MMS ELEMENT S	SECTION DETAILS			
	Length (mm)	Width (mm)	Up (mm)	Thickness (mm)
COLUMN	139.7(DIA)	0	0	4.5
RAFTER	80	40	0	2.9
PURLIN	70	40	15	2

As per table-29, IS-875, part-3 value of co-efficient & Reduction factor shall be referred

SECTION S	ANGLE OF WIND	C _{st}	Wind Facing Width (D) in mm (X-direction)	Length of member mm (l)	D*V ₁ (in m ² /s) - X-dir	I/D (X-Dir)	Reduction Factor (K)
COLUMN	90 degree	2.0	139.7	2000	5.2	14.0	0.70

SECTION S	ANGLE OF WIND	C _{st}	Wind Facing Width (D) in mm (Z-direction)	Length of member mm (l)	D*V ₂ (in m ² /s) - X-dir	I/D (X-Dir)	Reduction Factor (K)
COLUMN	0 degree	2.0	139.7	2000	5.2	14.0	0.70
RAFTER	0 degree	2.0	80	3100	3.0	62	0.78

SECTION S	WIND FORCE (Pd*width*CF K)	UNITS	DIRECTION
COLUMN	0.066	kN/m	X-Direction
COLUMN	0.066	kN/m	Z-Direction
RAFTER	0.10	kN/M	Z-Direction

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LOAD COMBINATION

LOAD TYPE	L/C	LOAD NAME
Primary	1	Dead Load + Module Weight (DL+MW)
Primary	2	WIND UP
Primary	3	WIND DOWN
Primary	4	WIND X
Primary	5	WIND Z
Combination	6	1.5 (DL+MW)
Combination	7	1.5 (DL+MW+WIND DOWN)
Combination	8	1.5 (DL+MW+WIND X)
Combination	9	1.5 (DL+MW+WIND Z)
Combination	10	1.2 (DL+MW+WIND UP)
Combination	11	1.2 (DL+MW+WIND DOWN)
Combination	12	1.2 (DL+MW+WIND X)
Combination	13	1.2 (DL+MW+WIND Z)
Combination	14	0.9 (DL+MW)+1.5WIND UP
Combination	15	0.9(DL+MW)+1.5 WIND DOWN
Combination	16	0.9 (DL+MW)+ 1.5 WIND X
Combination	17	0.9 (DL+MW)+1.5 WIND Z
Combination	18	1.5 (DL+MW)+ WIND UP

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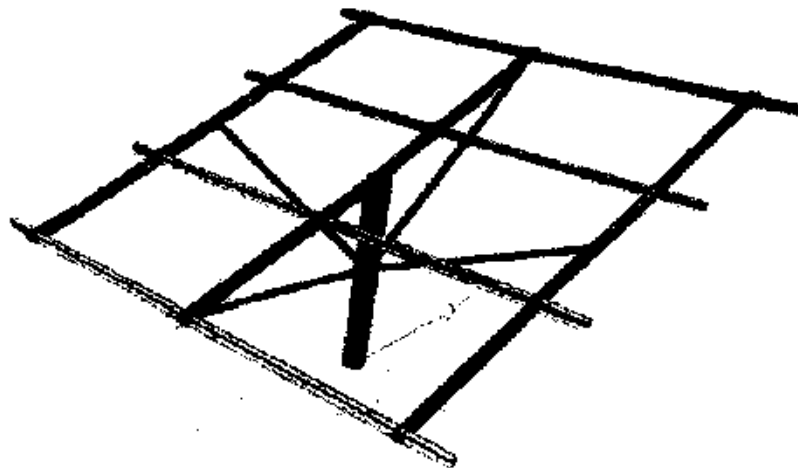
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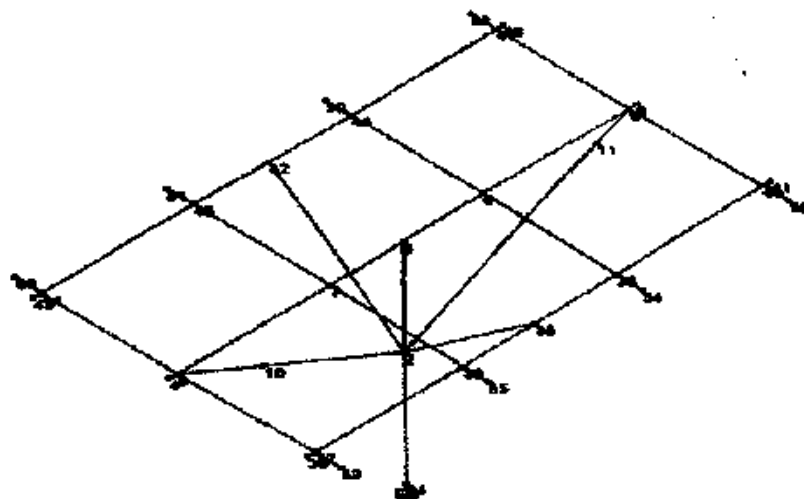
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3. STAAD MODEL:

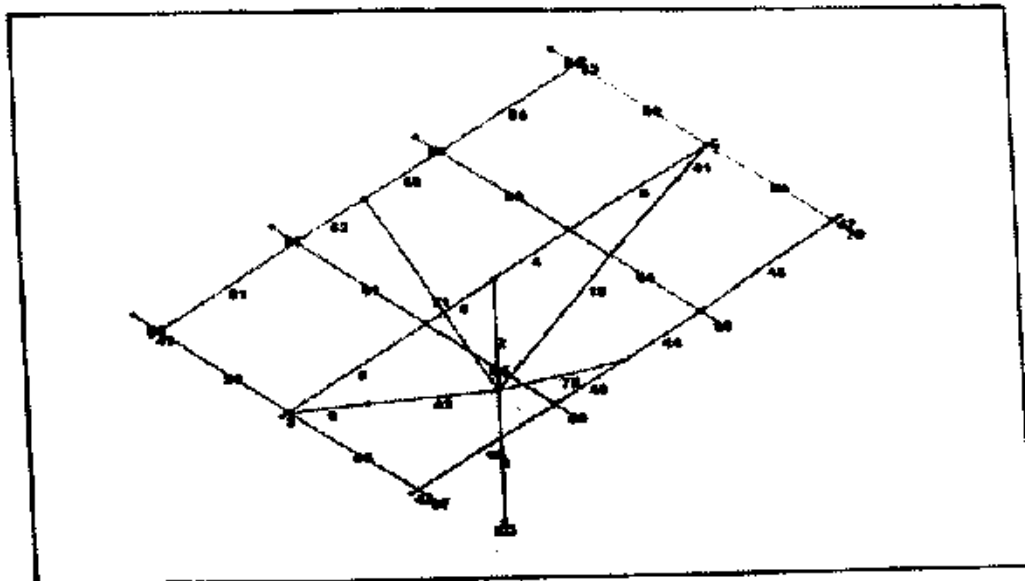


3D RENDERED VIEW



NODE NUMBER

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BEAM NUMBER

4. DEFLECTION CHECK:

As per IS 800:2007, following table can be referred for deflection check.

Table 4: Deflection Limits					
Type of loading	Deflection	Design Load	Member	Supporting	Maximum Deflection
(1)	(2)	(3)	(4)	(5)	(6)
Uniformly distributed load	Simply supported	Live load/Wind load	Perkins and Gable	Allowable deflection	Span/250
		Live load	Simple span	Basic deflection	Span/250
		Live load	Continuous span	Basic deflection	Span/250
		Live load	Continuous span	Basic deflection	Span/250
		Live load/Wind load	Roller supporting	Vertical Wave Bending	Span/250
	Fixed end	Crane load (fixed end)	Crane	Crane	Span/250
		Crane load (fixed end)	Crane	Crane	Span/250
		Crane load (fixed end)	Crane	Crane	Span/250
		Crane load (fixed end)	Crane	Crane	Span/250
		Crane load (fixed end)	Crane	Crane	Span/250
Point load	Simply supported	Crane + wind	Crane + wind	Crane + wind	Span/250
		Crane + wind	Crane + wind	Crane + wind	Span/250
		Crane + wind	Crane + wind	Crane + wind	Span/250
		Crane + wind	Crane + wind	Crane + wind	Span/250
		Crane + wind	Crane + wind	Crane + wind	Span/250
	Fixed end	Crane + wind	Crane + wind	Crane + wind	Span/250
		Crane + wind	Crane + wind	Crane + wind	Span/250
		Crane + wind	Crane + wind	Crane + wind	Span/250
		Crane + wind	Crane + wind	Crane + wind	Span/250
		Crane + wind	Crane + wind	Crane + wind	Span/250

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6 MODULE MOUNTING STRUCTURE

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電話: 4-453 5175

Max: 1.672 mm
2.000m

Permissible limit for deflection in Column = $2000 / 240 = 8.33 \text{ mm} > 4.453$, Hence OK

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1.000 16. Supplement
Displacement - 1000

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Maximum deflection in Rafter = 10.22 mm

Permissible limit for deflection in Rafter = $3100 / 180 = 17.22\text{mm} > 10.22$, Hence OK

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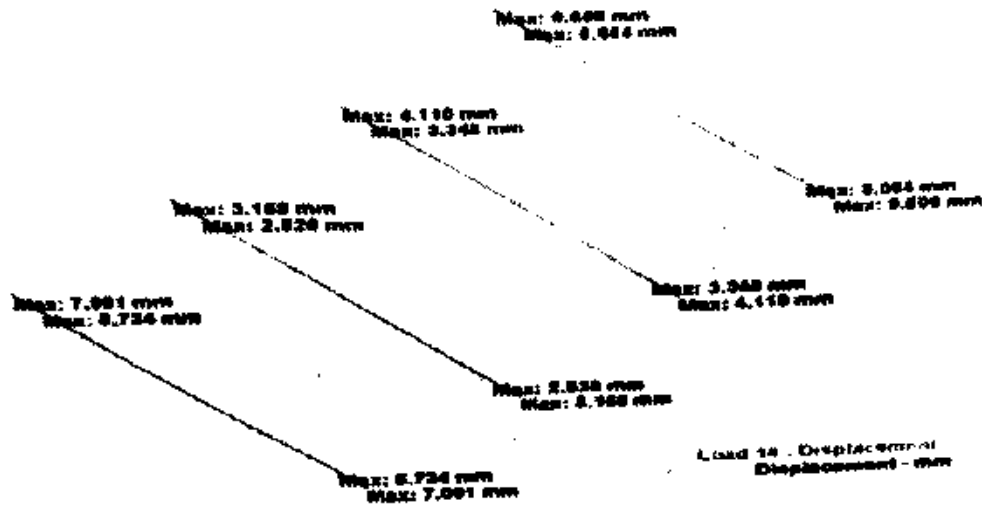
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Purlin deflection check:



Maximum deflection in Purlin = 9.506 mm

Permissible limit for deflection in Purlin = $3200 / 150 = 21.33 \text{ mm} > 9.506$, Hence OK

5. REACTION SUMMARY:

	Node	L/C	Horizontal	Vertical	Horizontal	Moment		
			PX (kg)	PY (kg)	PZ (kg)	MX (kgm)	MY (kgm)	MZ (kgm)
Max PX	1	0:1.5(DL+SWH)	0.000	4.017	-0.000	0.000	-0.000	-0.102
Min PX	1	3:WIND DOWN	-0.000	0.000	-0.000	0.000	0.000	0.140
Max FY	1	0:1.5(DL+SWH)	0.000	14.001	-0.000	0.000	0.000	0.314
Min FY	1	14:0.0(DL+SWH)	0.000	-13.718	0.000	-0.000	-0.000	-0.200
Max FZ	1	14:0.0(DL+SWH)	0.000	-13.718	0.000	-0.000	-0.000	-0.200
Min FZ	1	0:1.5(DL+SWH)	0.000	4.017	-1.000	-3.018	0.032	0.000
Max MX	1	0:1.5(DL+SWH)	0.000	14.001	-0.000	0.000	0.000	0.314
Min MX	1	0:1.5(DL+SWH)	0.000	4.017	-1.000	-3.018	0.032	0.000
Max MY	1	0:1.5(DL+SWH)	0.000	4.017	-1.000	-3.018	0.032	0.000
Min MY	1	14:0.0(DL+SWH)	0.000	-13.718	0.000	-0.000	-0.000	-0.200
Max MZ	1	0:1.5(DL+SWH)	0.000	14.001	-0.000	0.000	0.000	0.314
Min MZ	1	14:0.0(DL+SWH)	0.000	-13.718	0.000	-0.000	-0.000	-0.200

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6. UTILITY RATIO:



Beam	Analysis Property	Design Property	Actual Ratio	Allowable Ratio	Ratio (Act/Allow)	Clause	L/C	Az (cm ²)	Iz (cm ⁴)	Iy (cm ⁴)	Ix (cm ⁴)
1	PIP1307L	PIP1307L	0.102	1.000	0.102	Sec. 9.2.1.2	8	10.100	437.000	437.000	874.000
2	PIP1307L	PIP1307L	0.079	1.000	0.079	Sec. 9.2.1.2	8	10.100	437.000	437.000	874.000
3	TUB80402.9	TUB80402.9	0.800	1.000	0.800	Sec. 9.4	8	0.410	50.900	17.100	42.700
4	TUB80402.9	TUB80402.9	0.202	1.000	0.202	Sec. 9.3.2.2	14	0.410	50.900	17.100	42.700
5	TUB80402.9	TUB80402.9	0.090	1.000	0.090	Sec. 9.3.2.2	14	0.410	50.900	17.100	42.700
6	TUB80402.9	TUB80402.9	0.182	1.000	0.182	Sec. 9.3.2.2	14	0.410	50.900	17.100	42.700
7	TUB80402.9	TUB80402.9	0.800	1.000	0.800	Sec. 9.4	8	0.410	50.900	17.100	42.700
8	TUB80402.9	TUB80402.9	0.110	1.000	0.110	Sec. 9.3.2.2	14	0.410	50.900	17.100	42.700
9	PIP337L	PIP337L	0.104	1.000	0.104	Sec. 9.3.2.2	7	2.540	3.000	3.000	6.100
10	PIP424L	PIP424L	0.263	1.000	0.263	Sec. 9.3.2.2	7	3.250	8.400	8.400	12.920
11	PIP337L	PIP337L	0.153	1.000	0.153	Sec. 9.3.2.2	7	2.540	3.000	3.000	6.100
12	PIP424L	PIP424L	0.880	1.000	0.880	Sec. 9.3.2.2	7	3.250	8.400	8.400	12.920
13	TUB80402.9	TUB80402.9	0.800	1.000	0.800	Sec. 9.4	8	0.410	50.900	17.100	42.700
14	TUB80402.9	TUB80402.9	0.412	1.000	0.412	Sec. 9.3.2.2	7	0.410	50.900	17.100	42.700
15	TUB80402.9	TUB80402.9	0.104	1.000	0.104	Sec. 9.3.2.2	14	0.410	50.900	17.100	42.700
16	TUB80402.9	TUB80402.9	0.425	1.000	0.425	Sec. 9.3.2.2	14	0.410	50.900	17.100	42.700
17	TUB80402.9	TUB80402.9	0.090	1.000	0.090	Sec. 9.4	8	0.410	50.900	17.100	42.700
18	TUB80402.9	TUB80402.9	0.145	1.000	0.145	Sec. 9.3.2.2	7	0.410	50.900	17.100	42.700
19	TUB80402.9	TUB80402.9	0.800	1.000	0.800	Sec. 9.4	8	0.410	50.900	17.100	42.700
20	TUB80402.9	TUB80402.9	0.412	1.000	0.412	Sec. 9.3.2.2	7	0.410	50.900	17.100	42.700
21	TUB80402.9	TUB80402.9	0.104	1.000	0.104	Sec. 9.3.2.2	14	0.410	50.900	17.100	42.700
22	TUB80402.9	TUB80402.9	0.425	1.000	0.425	Sec. 9.3.2.2	14	0.410	50.900	17.100	42.700
23	TUB80402.9	TUB80402.9	0.090	1.000	0.090	Sec. 9.4	8	0.410	50.900	17.100	42.700
24	TUB80402.9	TUB80402.9	0.145	1.000	0.145	Sec. 9.3.2.2	7	0.410	50.900	17.100	42.700
25	TUB80402.9	TUB80402.9	0.800	1.000	0.800	Sec. 9.4	8	0.410	50.900	17.100	42.700
26	TUB80402.9	TUB80402.9	0.412	1.000	0.412	Sec. 9.3.2.2	7	0.410	50.900	17.100	42.700
27	TUB80402.9	TUB80402.9	0.104	1.000	0.104	Sec. 9.3.2.2	14	0.410	50.900	17.100	42.700
28	TUB80402.9	TUB80402.9	0.425	1.000	0.425	Sec. 9.3.2.2	14	0.410	50.900	17.100	42.700
29	TUB80402.9	TUB80402.9	0.090	1.000	0.090	Sec. 9.4	8	0.410	50.900	17.100	42.700
30	TUB80402.9	TUB80402.9	0.145	1.000	0.145	Sec. 9.3.2.2	7	0.410	50.900	17.100	42.700
31	TUB80402.9	TUB80402.9	0.800	1.000	0.800	Sec. 9.4	8	0.410	50.900	17.100	42.700
32	TUB80402.9	TUB80402.9	0.412	1.000	0.412	Sec. 9.3.2.2	7	0.410	50.900	17.100	42.700
33	TUB80402.9	TUB80402.9	0.104	1.000	0.104	Sec. 9.3.2.2	14	0.410	50.900	17.100	42.700
34	TUB80402.9	TUB80402.9	0.425	1.000	0.425	Sec. 9.3.2.2	14	0.410	50.900	17.100	42.700
35	TUB80402.9	TUB80402.9	0.090	1.000	0.090	Sec. 9.4	8	0.410	50.900	17.100	42.700
36	TUB80402.9	TUB80402.9	0.145	1.000	0.145	Sec. 9.3.2.2	7	0.410	50.900	17.100	42.700
37	TUB80402.9	TUB80402.9	0.800	1.000	0.800	Sec. 9.4	8	0.410	50.900	17.100	42.700
38	TUB80402.9	TUB80402.9	0.412	1.000	0.412	Sec. 9.3.2.2	7	0.410	50.900	17.100	42.700
39	TUB80402.9	TUB80402.9	0.104	1.000	0.104	Sec. 9.3.2.2	14	0.410	50.900	17.100	42.700
40	TUB80402.9	TUB80402.9	0.425	1.000	0.425	Sec. 9.3.2.2	14	0.410	50.900	17.100	42.700
41	TUB80402.9	TUB80402.9	0.090	1.000	0.090	Sec. 9.4	8	0.410	50.900	17.100	42.700
42	TUB80402.9	TUB80402.9	0.145	1.000	0.145	Sec. 9.3.2.2	7	0.410	50.900	17.100	42.700
43	TUB80402.9	TUB80402.9	0.800	1.000	0.800	Sec. 9.4	8	0.410	50.900	17.100	42.700
44	TUB80402.9	TUB80402.9	0.412	1.000	0.412	Sec. 9.3.2.2	7	0.410	50.900	17.100	42.700
45	TUB80402.9	TUB80402.9	0.104	1.000	0.104	Sec. 9.3.2.2	14	0.410	50.900	17.100	42.700
46	TUB80402.9	TUB80402.9	0.425	1.000	0.425	Sec. 9.3.2.2	14	0.410	50.900	17.100	42.700
47	TUB80402.9	TUB80402.9	0.090	1.000	0.090	Sec. 9.4	8	0.410	50.900	17.100	42.700
48	TUB80402.9	TUB80402.9	0.145	1.000	0.145	Sec. 9.3.2.2	7	0.410	50.900	17.100	42.700
49	TUB80402.9	TUB80402.9	0.800	1.000	0.800	Sec. 9.4	8	0.410	50.900	17.100	42.700
50	TUB80402.9	TUB80402.9	0.412	1.000	0.412	Sec. 9.3.2.2	7	0.410	50.900	17.100	42.700
51	TUB80402.9	TUB80402.9	0.104	1.000	0.104	Sec. 9.3.2.2	14	0.410	50.900	17.100	42.700
52	TUB80402.9	TUB80402.9	0.425	1.000	0.425	Sec. 9.3.2.2	14	0.410	50.900	17.100	42.700
53	TUB80402.9	TUB80402.9	0.090	1.000	0.090	Sec. 9.4	8	0.410	50.900	17.100	42.700
54	TUB80402.9	TUB80402.9	0.145	1.000	0.145	Sec. 9.3.2.2	7	0.410	50.900	17.100	42.700
55	TUB80402.9	TUB80402.9	0.800	1.000	0.800	Sec. 9.4	8	0.410	50.900	17.100	42.700
56	TUB80402.9	TUB80402.9	0.412	1.000	0.412	Sec. 9.3.2.2	7	0.410	50.900	17.100	42.700
57	TUB80402.9	TUB80402.9	0.104	1.000	0.104	Sec. 9.3.2.2	14	0.410	50.900	17.100	42.700
58	TUB80402.9	TUB80402.9	0.425	1.000	0.425	Sec. 9.3.2.2	14	0.410	50.900	17.100	42.700
59	TUB80402.9	TUB80402.9	0.090	1.000	0.090	Sec. 9.4	8	0.410	50.900	17.100	42.700
60	TUB80402.9	TUB80402.9	0.145	1.000	0.145	Sec. 9.3.2.2	7	0.410	50.900	17.100	42.700
61	TUB80402.9	TUB80402.9	0.800	1.000	0.800	Sec. 9.4	8	0.410	50.900	17.100	42.700
62	TUB80402.9	TUB80402.9	0.412	1.000	0.412	Sec. 9.3.2.2	7	0.410	50.900	17.100	42.700
63	TUB80402.9	TUB80402.9	0.104	1.000	0.104	Sec. 9.3.2.2	14	0.410	50.900	17.100	42.700
64	TUB80402.9	TUB80402.9	0.425	1.000	0.425	Sec. 9.3.2.2	14	0.410	50.900	17.100	42.700
65	TUB80402.9	TUB80402.9	0.090	1.000	0.090	Sec. 9.4	8	0.410	50.900	17.100	42.700
66	TUB80402.9	TUB80402.9	0.145	1.000	0.145	Sec. 9.3.2.2	7	0.410	50.900	17.100	42.700
67	TUB80402.9	TUB80402.9	0.800	1.000	0.800	Sec. 9.4	8	0.410	50.900	17.100	42.700
68	TUB80402.9	TUB80402.9	0.412	1.000	0.412	Sec. 9.3.2.2	7	0.410	50.900	17.100	42.700
69	TUB80402.9	TUB80402.9	0.104	1.000	0.104	Sec. 9.3.2.2	14	0.410	50.900	17.100	42.700
70	TUB80402.9	TUB80402.9	0.425	1.000	0.425	Sec. 9.3.2.2	14	0.410	50.900	17.100	42.700
71	TUB80402.9	TUB80402.9	0.090	1.000	0.090	Sec. 9.4	8	0.410	50.900	17.100	42.700
72	TUB80402.9	TUB80402.9	0.145	1.000	0.145	Sec. 9.3.2.2	7	0.410	50.900	17.100	42.700

Himalayan Solar Pvt. Ltd.

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CONCLUSION:

The structure is found to be safe and the maximum utility ratio observed is 0.746.

The IS Code referred during analysis is IS800-2007 & IS 801- Code of practice for use of cold- formed light gauge steel structural members in general building construction, IS 875- Part 3 : Wind Loads and IS 875-Part 1: Dead Loads.

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For Himalayan Solar Pvt. Ltd.

Maryam
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7. STAAD INPUT DATA:

STAAD SPACE

START JOB INFORMATION

ENGINEER DATE 03-Nov-20

END JOB INFORMATION

INPUT WIDTH 79

UNIT METER KN

JOINT COORDINATES

1 0 0 0; 2 0 1.1 0; 3 0 2 0; 4 -1.35 1.3 0; 5 -1.30561 1.32302 0;
6 0.478755 2.25832 0; 7 -0.431174 1.77643 0; 8 1.34562 2.72605 0;
9 1.39 2.75 0; 10 -0.812749 1.23863 0; 11 1.14758 2.48674 0; 34 0 0 0;
35 0 2 1.34; 36 -1.35 1.3 1.34; 37 -1.30561 1.32302 1.34;
38 0.478755 2.25832 1.34; 39 -0.431174 1.77643 1.34; 40 1.34562 2.72605 1.34;
41 1.39 2.75 1.34; 42 0 2 -1.34; 43 -1.35 1.3 -1.34; 44 -1.30561 1.32302 -1.34;
45 0.478755 2.25832 -1.34; 46 -0.431174 1.77643 -1.34;
47 1.34562 2.72605 -1.34; 48 1.39 2.75 -1.34; 49 -1.30561 1.32302 -1.6;
50 0.478755 2.25832 -1.6; 51 -0.431174 1.77643 -1.6; 52 1.34562 2.72605 -1.6;
53 -1.30561 1.32302 1.6; 54 0.478755 2.25832 1.6; 55 -0.431174 1.77643 1.6;
56 1.34562 2.72605 1.6;

MEMBER INCIDENCES

1 1 2; 2 2 3; 3 4 5; 4 3 6; 5 5 7; 6 7 3; 7 8 9; 8 6 8; 9 9 10; 10 2 11;
41 11 8; 42 10 2; 43 36 37; 44 35 38; 45 37 39; 46 39 35; 47 40 41; 48 38 40;
49 43 44; 50 42 45; 51 44 46; 52 46 42; 53 47 48; 54 45 47; 55 44 49; 56 45 50;
57 46 51; 58 47 52; 59 44 5; 60 45 6; 61 46 7; 62 47 8; 63 5 37; 64 6 38;
65 7 39; 66 8 40; 67 37 53; 68 38 54; 69 39 55; 70 40 56; 71 42 2; 72 2 35;

DEFINE MATERIAL START

ISOTROPIC STEEL

E 2.05e+008

POISSON 0.3

DENSITY 76.8195

ALPHA 1.2e-005

DAMP 0.03

TYPE STEEL

STRENGTH FY 253200 FU 487800 RY 1.5 RT 1.2

END DEFINE MATERIAL

CONSTANTS

MATERIAL STEEL ALL

MEMBER PROPERTY INDIAN

10 42 71 72 TABLE ST PIP424L

9 41 TABLE ST PIP337L

1 3 TABLE ST PIP1397L

MEMBER PROPERTY COLOFORMED INDIAN

55 TO 70 TABLE ST 7BCS48X2

MEMBER PROPERTY INDIAN

3 TO 8 43 TO 54 TABLE ST TUB80002.9

SUPPORTS

1 FIXED

LOAD 1 LOADTYPE Dead TITLE DL+WM

SELFWEIGHT Y -1

MEMBER LOAD

55 TO 70 UNI GY -0.1125

LOAD 2 LOADTYPE Live REDUCIBLE TITLE WIND UP

MEMBER LOAD

55 TO 70 UNI GY 0.84

LOAD 3 LOADTYPE Live REDUCIBLE TITLE WIND DOWN

Dr.

Pr.

De.

F/O

Jamla Mata

New Delhi-110025

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MEMBER LOAD
55 TO 70 UNI GY -0.52
LOAD 4 LOADTYPE Live REDUCIBLE TITLE WIND Z
MEMBER LOAD
1 2 UNI GZ 0.066
3 TO 8 43 TO 54 UNI GZ 0.1
LOAD 7 LOADTYPE Live REDUCIBLE TITLE WIND X
MEMBER LOAD
3 2 UNI GX -0.066
LOAD COMB 5 1.5(DL+MW)
1 1.5
LOAD COMB 6 1.5(DL+MW+ WIND DOWN)
1 1.5 3 1.5
LOAD COMB 8 15(DL+MW+ WIND Z)
1 1.5 4 1.5
LOAD COMB 9 1.5(DL+MW+WIND X)
1 1.5 7 1.5
LOAD COMB 10 1.2(DL+MW+WIND UP)
1 1.2 2 1.2
LOAD COMB 11 1.2(DL+MW+WIND DOWN)
1 1.2 3 1.2
LOAD COMB 12 1.2(DL+MW+WIND Z)
1 1.2 4 1.2
LOAD COMB 13 1.2(DL+MW+WIND X)
1 1.2 7 1.2
LOAD COMB 14 0.9(DL+MW)+1.5 WIND UP
1 0.9 2 1.5
LOAD COMB 15 0.9(DL+MW)+1.5 WIND DOWN
1 0.9 3 1.5
LOAD COMB 16 0.9(DL+MW)+1.5 WIND Z
1 0.9 4 1.5
LOAD COMB 17 0.9(DL+MW)+1.5 WIND X
1 0.9 7 1.5
LOAD COMB 18 1.5(DL+MW)+WIND UP
1 1.5 2 1.0
PERFORM ANALYSIS
PARAMETER 1
CODE IS800 LSD
FYLD 210000 MEMB 1 TO 10 41 TO 54 71 72
CHECK CODE MEMB 1 TO 10 41 TO 54 71 72
PARAMETER 2
CODE IS801
FYLD 250000 MEMB 55 TO 70
CHECK CODE MEMB 55 TO 70
FINISH

For Himalayan Solar Pvt. Ltd.

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Signature
New Delhi-110025



8. STAAD OUTPUT:

STAAD.PRO CODE CHECKING-IS-800-2007-
LSD(V2.0)

Member Number:	1					
Member Section:	ST	PI1397L	(INDIAN SECTIONS)			
Status: PASS Ratio:	0.192	Critical Load Case:	9	Location:	0.00	
Critical Condition:	Sec. 9.2.1.2					
Member Number:	2					
Member Section:	ST	PI1397L	(INDIAN SECTIONS)			
Status: PASS Ratio:	0.079	Critical Load Case:	9	Location:	0.00	
Critical Condition:	Sec. 9.2.1.2					
Member Number:	3					
Member Section:	ST	TUB80402.9	(INDIAN SECTIONS)			
Status: PASS Ratio:	0.000	Critical Load Case:	9	Location:	0.05	
Critical Condition:	Sec. 9.4					
Member Number:	4					
Member Section:	ST	TUB80402.9	(INDIAN SECTIONS)			
Status: PASS Ratio:	0.202	Critical Load Case:	14	Location:	0.00	
Critical Condition:	Sec. 9.3.2.2					
Member Number:	5					
Member Section:	ST	TUB80402.9	(INDIAN SECTIONS)			
Status: PASS Ratio:	0.098	Critical Load Case:	14	Location:	0.99	
Critical Condition:	Sec. 9.3.2.2					
Member Number:	6					
Member Section:	ST	TUB80402.9	(INDIAN SECTIONS)			
Status: PASS Ratio:	0.182	Critical Load Case:	14	Location:	0.49	
Critical Condition:	Sec. 9.3.2.2					
Member Number:	7					
Member Section:	ST	TUB80402.9	(INDIAN SECTIONS)			
Status: PASS Ratio:	0.000	Critical Load Case:	8	Location:		
Critical Condition:	Sec. 9.4					
Member Number:	8					
Member Section:	ST	TUB80402.9	(INDIAN SECTIONS)			
Status: PASS Ratio:	0.116	Critical Load Case:	14	Location:	0.00	
Critical Condition:	Sec. 9.3.2.2					

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For Himalayan Solar Pvt. Ltd.

0.00
M. M. M.
Auth. Signature



```

1 Member Number:      9
2 Member Section:    ST  PIP337L      (INDIAN SECTIONS)
3 Status: PASS Ratio: 0.104 Critical Load Case: 7 Location: 0.21
4 Critical Condition: Sec. 9.3.2.2

```

STAAD.PRO CODE CHECKING - IS-800-2007-LSD (V2.0)

```

| Member Number:      10
| Member Section:    ST   PIP424L      (INDIAN SECTIONS)
| Status: PASS Ratio: 0.263 Critical Load Case: 7 Location: 0.00
| Critical Condition: Sec. 9.3.2.2

```

```

| Member Number: 41
| Member Section: ST P10337L (INDIAN SECTIONS)
| Status: PASS Ratio: 0.153 Critical Load Case: 7 Location: 0.00
| Critical Condition: Sec. 9.3.2.2

```

```

| Member Number:      42
| Member Section:    ST  PIP424L      (INDLAM SECTIONS)
| Status: PASS      Ratio:  0.090  Critical Load Case:  7  Location:  0.82
| Critical Condition: Sec. 9.3.2.2

```

Member Number: 43
Member Section: ST TUB#0402.9 (INDIAN SECTIONS)
Status: PASS Ratio: 0.000 Critical Load Case: 8 Location: 0.05
Critical Condition: Sec. 8.4

STAAD.PRO CODE CHECKING - IS-800-2007-LSD (V2.0)

Member Number: 44
Member Section: ST TUB80402.9 (INDIAN SECTIONS)
Status: PASS Ratio: 0.412 Critical Load Case: 7 Location: 0.00
Critical Condition: Sec. 9.3.2.2

```

| Member Number:      45
| Member Section:    ST   TUB00402.9      (INDIAN SECTIONS)
| Status: PASS Ratio: 0.164 Critical Load Case: 14 Location:
| Critical Condition: Sec. 9.3.2.2

```

Member Number: 46
Member Section: ST TUBS0402.9 (INDIAN SECTIONS)
Status: PASS Ratio: 0.425 Critical Load Case: 14 Location:
Critical Condition: Sec. 9.3.2.2

Dr. J. P. D. F. O. 96
James M. D. 110025
New Deft-110025

14 Location: P.O. Box 49, Solar Pvt. Ltd.

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Member Number: 47
Member Section: ST TUB80402.9 (INDIAN SECTIONS)
Status: PASS Ratio: 0.000 Critical Load Case: 8 Location: 0.00
Critical Condition: Sec. 8.4

STAAD.PRO CODE CHECKING - IS-800-2007-LSD (V2.0)

Member Number: 48
Member Section: ST TUB80402.9 (INDIAN SECTIONS)
Status: PASS Ratio: 0.145 Critical Load Case: 7 Location: 0.00
Critical Condition: Sec. 9.3.2.2

Member Number: 49
Member Section: ST TUB80402.9 (INDIAN SECTIONS)
Status: PASS Ratio: 0.000 Critical Load Case: 8 Location: 0.05
Critical Condition: Sec. 8.4

Member Number: 50
Member Section: ST TUB80402.9 (INDIAN SECTIONS)
Status: PASS Ratio: 0.412 Critical Load Case: 7 Location: 0.00
Critical Condition: Sec. 9.3.2.2

Member Number: 51
Member Section: ST TUB80402.9 (INDIAN SECTIONS)
Status: PASS Ratio: 0.164 Critical Load Case: 14 Location: 0.98
Critical Condition: Sec. 9.3.2.2

Member Number: 52
Member Section: ST TUB80402.9 (INDIAN SECTIONS)
Status: PASS Ratio: 0.425 Critical Load Case: 14 Location: 0.49
Critical Condition: Sec. 9.3.2.2

Member Number: 53
Member Section: ST TUB80402.9 (INDIAN SECTIONS)
Status: PASS Ratio: 0.000 Critical Load Case: 8 Location: 0.00
Critical Condition: Sec. 8.4

Member Number: 54
Member Section: ST TUB80402.9 (INDIAN SECTIONS)

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Status: PASS Ratio: 0.143 Critical Load Case: 7 Location: 0.00
Critical Condition: Sec. 9.3.2.2

Member Number: 71
Member Section: ST PIP424L (INDIAN SECTIONS)
Status: PASS Ratio: 0.176 Critical Load Case: 7 Location: 1.61
Critical Condition: Sec. 9.3.2.2

Member Number: 72
Member Section: ST PIP424L (INDIAN SECTIONS)
Status: PASS Ratio: 0.176 Critical Load Case: 7 Location: 0.00
Critical Condition: Sec. 9.3.2.2

- 94. PARAMETER 2
- 95. CODE ISB01
- 96. FYLD 250000 MEMB 55 TO 70
- 97. CHECK CODE MEMB 55 TO 70

STAAD.Pro CODE CHECKING - (I801)

UNITS: MM, KN, KNM, MPA |
MEMBER# 55 SECTION: 70CS40X2 LEN: 260.00 GOV.LOC: 0.00 |
STATUS: PASS RATIO = 0.043 GOV.MODE: Bend Z + Shear GOV.LOAD: 14 |

UNITS: MM, KN, KNM, MPA |
MEMBER# 56 SECTION: 70CS40X2 LEN: 260.00 GOV.LOC: 0.00 |
STATUS: PASS RATIO = 0.043 GOV.MODE: Bend Z + Shear GOV.LOAD: 14 |

UNITS: MM, KN, KNM, MPA |
MEMBER# 57 SECTION: 70CS40X2 LEN: 260.00 GOV.LOC: 0.00 |
STATUS: PASS RATIO = 0.043 GOV.MODE: Bend Z + Shear GOV.LOAD: 14 |

UNITS: MM, KN, KNM, MPA |
MEMBER# 58 SECTION: 70CS40X2 LEN: 260.00 GOV.LOC: 0.00 |

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6 MODULE MOUNTING STRUCTURE

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STATUS: PASS RATIO = 0.043 GOV.MODE: Bend Z + Shear GOV.LOAD: 14 |

UNITS: MM, KN, KNM, MPA |

MEMBER# 59 SECTION: 70CS40X2 LEN: 1340.00 GOV.LOC: 1340.00 |
STATUS: PASS RATIO = 0.740 GOV.MODE: Bending Z GOV.LOAD: 14 |

UNITS: MM, KN, KNM, MPA |

MEMBER# 60 SECTION: 70CS40X2 LEN: 1340.00 GOV.LOC: 1340.00 |
STATUS: PASS RATIO = 0.463 GOV.MODE: Bend + Compress GOV.LOAD: 14 |

UNITS: MM, KN, KNM, MPA |

MEMBER# 61 SECTION: 70CS40X2 LEN: 1340.00 GOV.LOC: 1340.00 |
STATUS: PASS RATIO = 0.390 GOV.MODE: Bend + Compress GOV.LOAD: 14 |

UNITS: MM, KN, KNM, MPA |

MEMBER# 62 SECTION: 70CS40X2 LEN: 1340.00 GOV.LOC: 1340.00 |
STATUS: PASS RATIO = 0.746 GOV.MODE: Bending Z GOV.LOAD: 6 |

UNITS: MM, KN, KNM, MPA |

MEMBER# 63 SECTION: 70CS40X2 LEN: 1340.00 GOV.LOC: 0.00 |
STATUS: PASS RATIO = 0.740 GOV.MODE: Bending Z GOV.LOAD: 14 |

UNITS: MM, KN, KNM, MPA |

MEMBER# 64 SECTION: 70CS40X2 LEN: 1340.00 GOV.LOC: 0.00 |
STATUS: PASS RATIO = 0.463 GOV.MODE: Bend + Compress GOV.LOAD: 14 |

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SECTION: Cover
sheet

6 MODULE MOUNTING STRUCTURE

Page No.-25

MEMBER# 65 SECTION: 70CS40X2 LEN: 1340.00 GOV.LOC: 0.00
STATUS: PASS RATIO = 0.390 GOV.MODE: Bend + Compress GOV.LOAD: 14

UNITS : MM, KN, KNM, MPA

MEMBER# 66 SECTION: 70CS40X2 LEN: 1340.00 GOV.LOC: 0.00
STATUS: PASS RATIO = 0.746 GOV.MODE: Bending 2 GOV.LOAD: 6

UNITS : MM, KN, KNM, MPA

MEMBER# 67 SECTION: 70CS40X2 LEN: 260.00 GOV.LOC: 0.00
STATUS: PASS RATIO = 0.043 GOV.MODE: Bend Z + Shear GOV.LOAD: 14

UNITS : MM, KN, KNM, MPA

MEMBER# 68 SECTION: 70CS40X2 LEN: 260.00 GOV.LOC: 0.00
STATUS: PASS RATIO = 0.043 GOV.MODE: Bend Z + Shear GOV.LOAD: 14

UNITS : MM, KN, KNM, MPA

MEMBER# 69 SECTION: 70CS40X2 LEN: 260.00 GOV.LOC: 0.00
STATUS: PASS RATIO = 0.043 GOV.MODE: Bend Z + Shear GOV.LOAD: 14

UNITS : MM, KN, KNM, MPA

MEMBER# 70 SECTION: 70CS40X2 LEN: 260.00 GOV.LOC: 0.00
STATUS: PASS RATIO = 0.043 GOV.MODE: Bend Z + Shear GOV.LOAD: 14

94. FINISH

***** END OF THE STAAD.Pro RUN *****

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9. FOUNDATION

Breadth of Pedestal	$B = 0.35$	m	
Length of Pedestal	$L = 0.35$	m	
Density of Water	$\gamma_w = 10$	KN/m ³	
Density of Soil	$\gamma_s = 20.0$	KN/m ³	
Factor of Safety	FOS = 1.5		
Unit weight of Pedestal material	$\gamma_p = 23.0$	KN/m ³	
Grade of Concrete	= 25.0	N/mm ²	
Soil Bearing Capacity	SBC = 70.0	KN/m ²	
Bearing capacity Factor, N_y Capacity factor	$N_y = 0.6$	IS 6403:1981 Table-1' Bearing	
Bearing capacity Factor, N_q	$N_q = 1.75$		
Bearing capacity Factor, N_c	$N_c = 8.86$		
Downward Pressure from Super structure(P)	$Q_v(+) = 14.01$	KN	
Uplift from Super structure	$Q_v(-) = 13.72$	KN	From STAAD Result
Lateral force from Super structure	$Q_H = 1.593$	KN	
Moment from Super structure(P)	$M = 3.015$	KN-m	
Unsupported length of pedestal Above ground	$e = 0.1$	m	

DESIGN

VERTICAL CAPACITY OF FOOTING

AREA OF FOOTING:

Assume Selfweight of footing	$w = 1.401$	KN	$w = 0.1P$
Total Weight	$W = 1.401 + 14.01$	KN	$W = 0.1P + P$
	= 15.411	KN	
Area of Footing	$A = 15.411 / 70$	KN	$A = W / SBC$
	$A = 0.220$	m ²	

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6 MODULE MOUNTING STRUCTURE

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Size of footing

$$L=B= \sqrt{0.220} \quad \text{m}$$

$$=0.469 \quad \text{m}$$

Therefore

Provide 0.6 m x 0.6 m Square Footing.

So

Total area Required

$$=0.36 \quad \text{m}^2$$

Length of Footing

$$=0.60 \quad \text{m}$$

Breadth of Footing

$$=0.60 \quad \text{m}$$

PRESSURE ACTS ON FOOTING:

Pressure

$$P = P_u/A \quad \text{KN/m}^2$$

$$P = 1.5 \times 15.411 / 0.36 \quad \text{KN/m}^2$$

Pressure

$$P = 64.212 \quad \text{KN/m}^2$$

FACTORED BENDING MOMENT per 'm':

Factored Bending Moment

$$M_u = P \times L \times ((B-D)/2)^2 / 2 \quad \text{KN-m}$$

$$M_u = 64.212 \times 0.6 \times ((0.6-0.35)/2)^2 / 2 \quad \text{KN-m}$$

$$M_u = 0.300 \quad \text{KN-m}$$

Where

B= Length of Footing

D= Length of Pedestal

P= Pressure on Footing

L= B

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EFFECTIVE DEPTH:



$$d_{\text{required}} = \sqrt{Mu/0.133x f_{ck}xb} \quad \text{mm}$$

$$d_{\text{required}} = \sqrt{0.0758 \times 10^6 / 0.133 \times 25 \times 800} \quad \text{mm}$$

$$d_{\text{required}} = 150.87 \quad \text{mm}$$

we provide
mm

$$d = 150.0$$

For considerations, increase depth 1.75 to 2 times more than the calculated value

$$d = 150.0 \times 2$$

Effective depth $d = 300 \quad \text{mm}$

Overall depth $D = 350 \quad \text{mm}$

Footing cover $= 60 \quad \text{mm}$

Where

Mu= Factored Moment

f_{ck} = Characteristic Compressive strength

b= Breadth of Footing

AREA OF TENSION REINFORCEMENT:

$$\text{Moment of Resistance } Mu = 0.87 F_y Ast d (1 - Ast F_y / bd F_{ck}) \quad \text{mm}^2$$

$$0.0758 \times 10^6 = 0.87 \times 500 Ast \times 300 (1 - Ast \times 500 / 500 \times 500 \times 20) \quad \text{mm}^2$$

$$0.30 \times 10^6 = 0.87 \times 500 Ast \times 300 (1 - Ast \times 500 / 500 \times 500 \times 20) \quad \text{mm}^2$$

$$Ast = 1032 \quad \text{mm}^2$$

Where

Mu= Factored Moment

f_{ck} = Characteristic Compressive strength

b= effective depth

d= Breadth of Footing

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AREA OF STEEL per m:

$$\begin{aligned} &= A_{st}/s_{pen} \\ &= 1032/0.6 \\ &= 1720 \quad \text{mm}^2 \end{aligned}$$

AREA OF ONE BAR:

$$\begin{aligned} a_{st} &= \pi d^2/4 \\ &= 3.14 \times 16^2/4 \\ &= 200.96 \quad \text{mm}^2 \end{aligned}$$

Assume 16 mm dia bar,

SPACING OF REINFORCEMENT:

$$\begin{aligned} &= (\text{Area of one bar}/\text{area}/\text{m}) \times 1000 \\ &= (a_{st}/A_{st}) \times 1000 \\ &= (200.96/1442) \times 1000 \quad \text{mm} \\ &= 116.83 \quad \text{mm} \end{aligned}$$

Provide 16 mm dia bars at 100 mm c/c spacing.

NUMBER OF BARS:

$$\begin{aligned} &= (A_{st}/a_{st}) \\ &= (1720/200.96) \\ &= 9 \text{ nos of bar} \end{aligned}$$

CHECK FOR ONE WAY SHEAR:

(a) SHEAR FORCE PER 'm':

$$\begin{aligned} V_u &= P \times B \times ((L-D)/2-d) \\ &= 64.212 \times 1 \times ((0.6-0.35)/2-0.6) \end{aligned}$$

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$$= 11.47$$

KN

(b) NOMINAL SHEAR STRESS:

$$T_v = V_u / b d$$

$$= 11.47 \times 10^3 / 1000 \times 350$$

$$= 0.032 \quad \text{N/mm}^2$$

(c) percentage of steel:

$$= 100 \times A_{st} / b d$$

$$= 100 \times 1032 / 600 \times 350$$

$$= 0.49$$

Now, Refer Table No.19 Page No. 73 of IS456:2000

$$T_c = 0.47 \quad \text{N/mm}^2$$

Therefore,

$$T_v < T_c$$

$$0.032 \text{ N/mm}^2 < 0.47 \text{ N/mm}^2$$

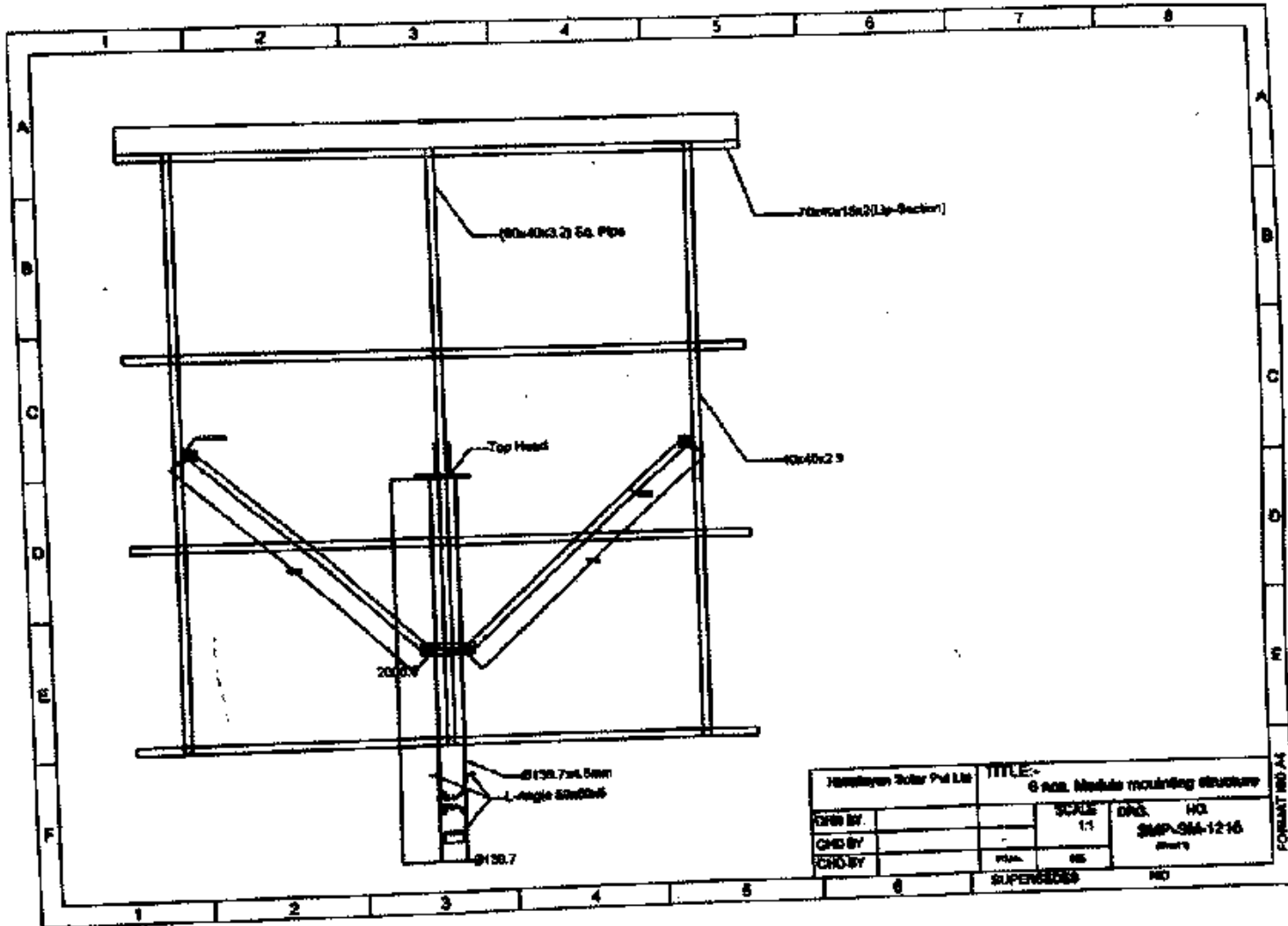
HENCE, Design is safe against one way shear.

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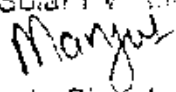
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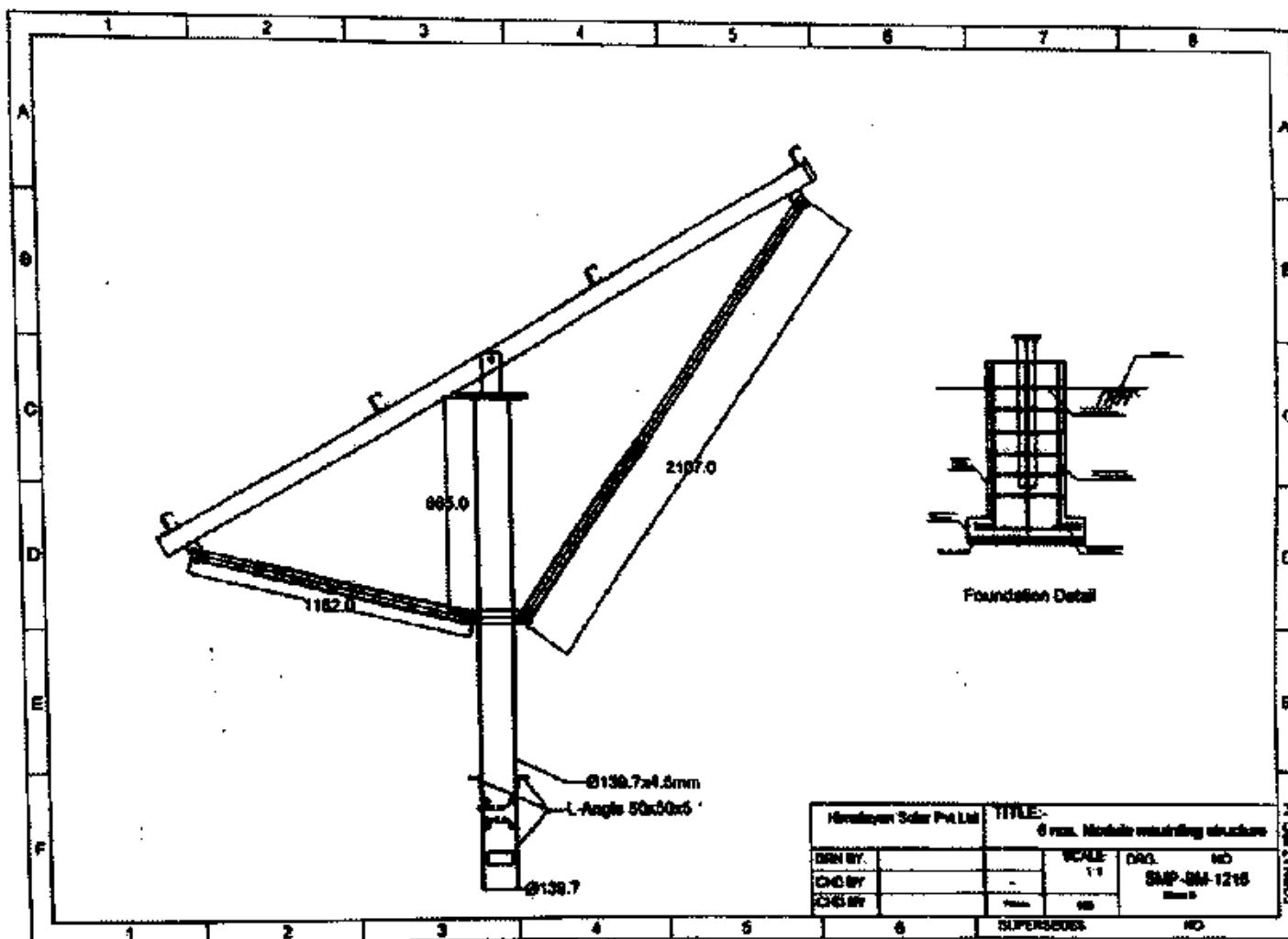
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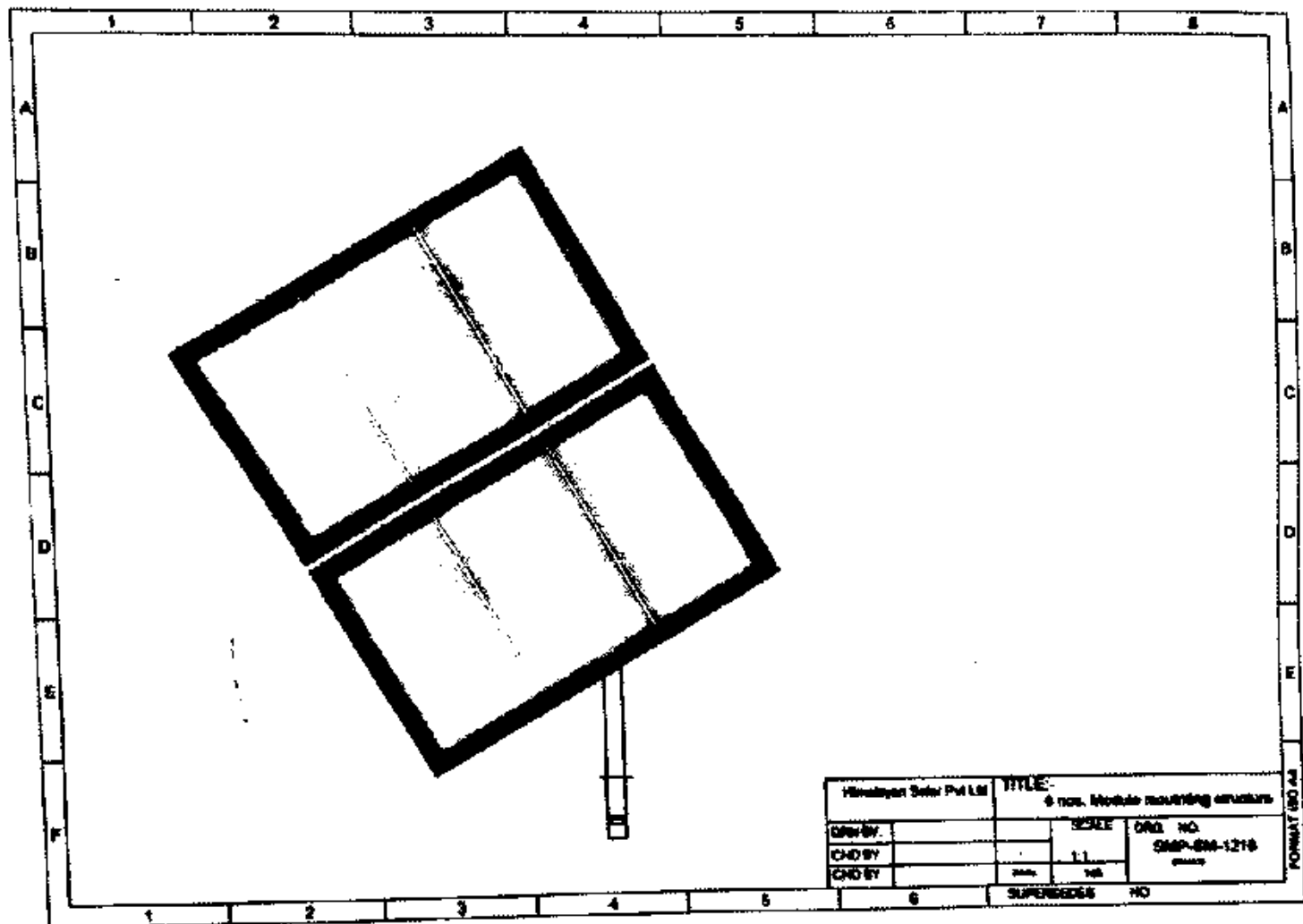


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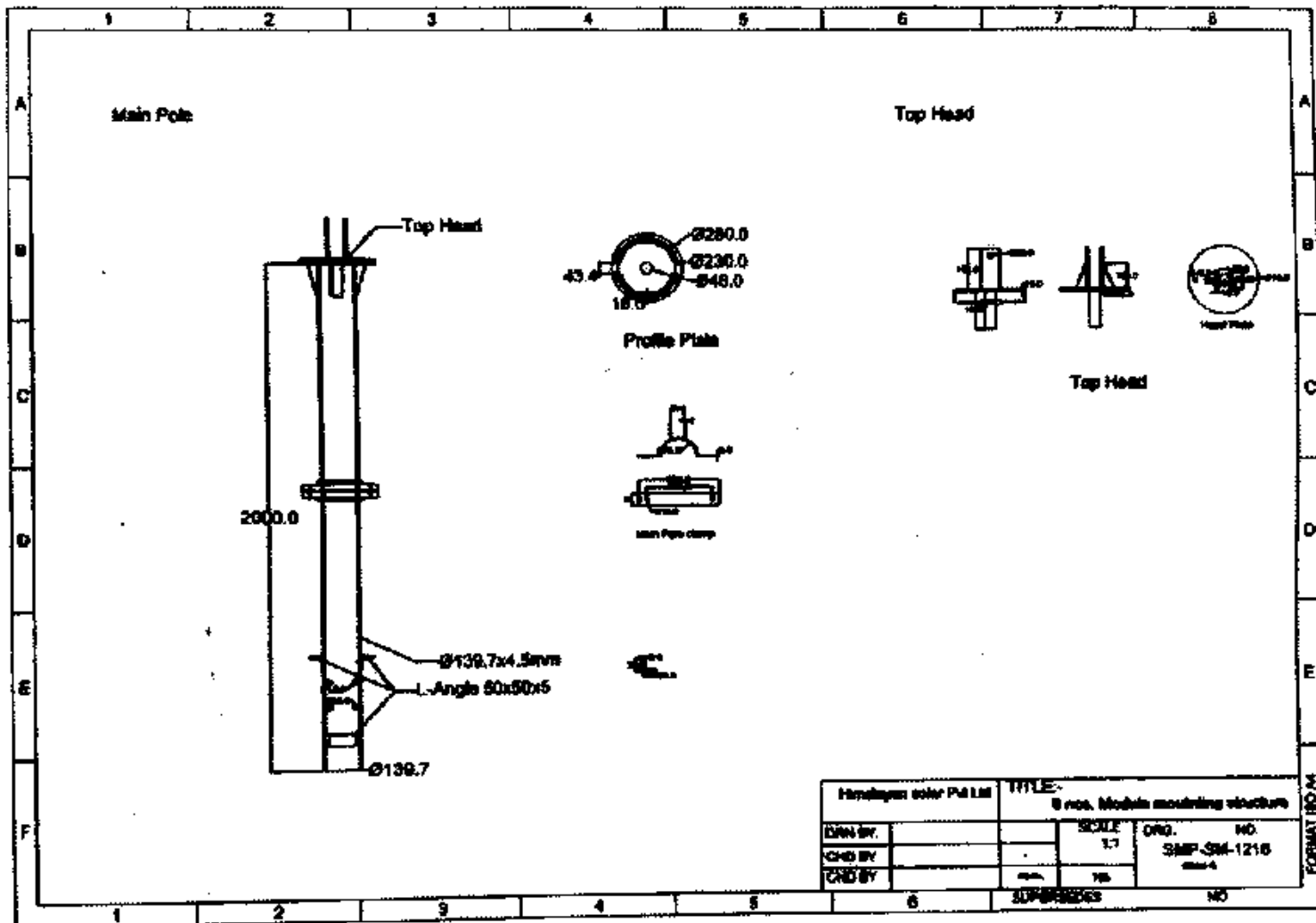
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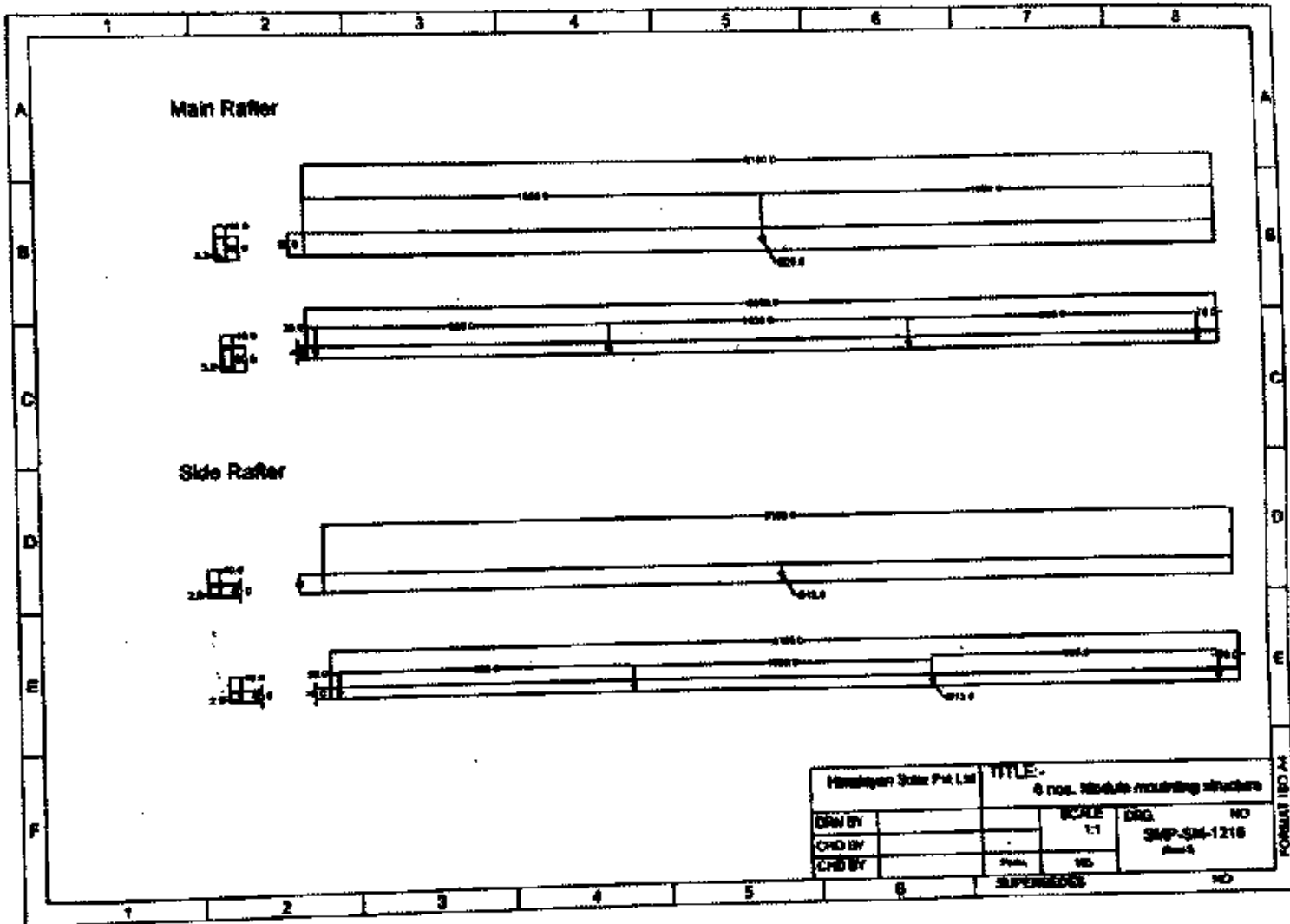
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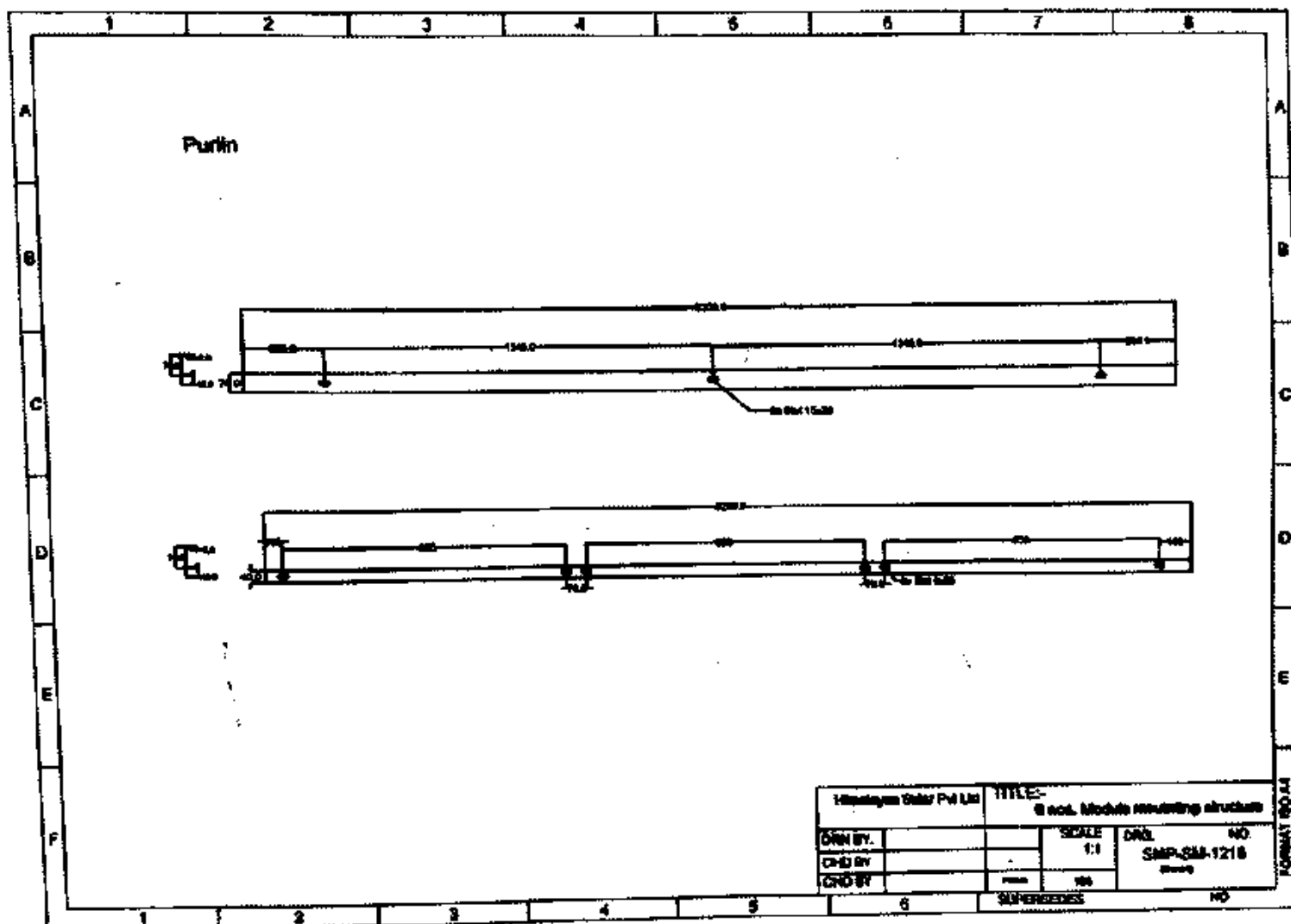


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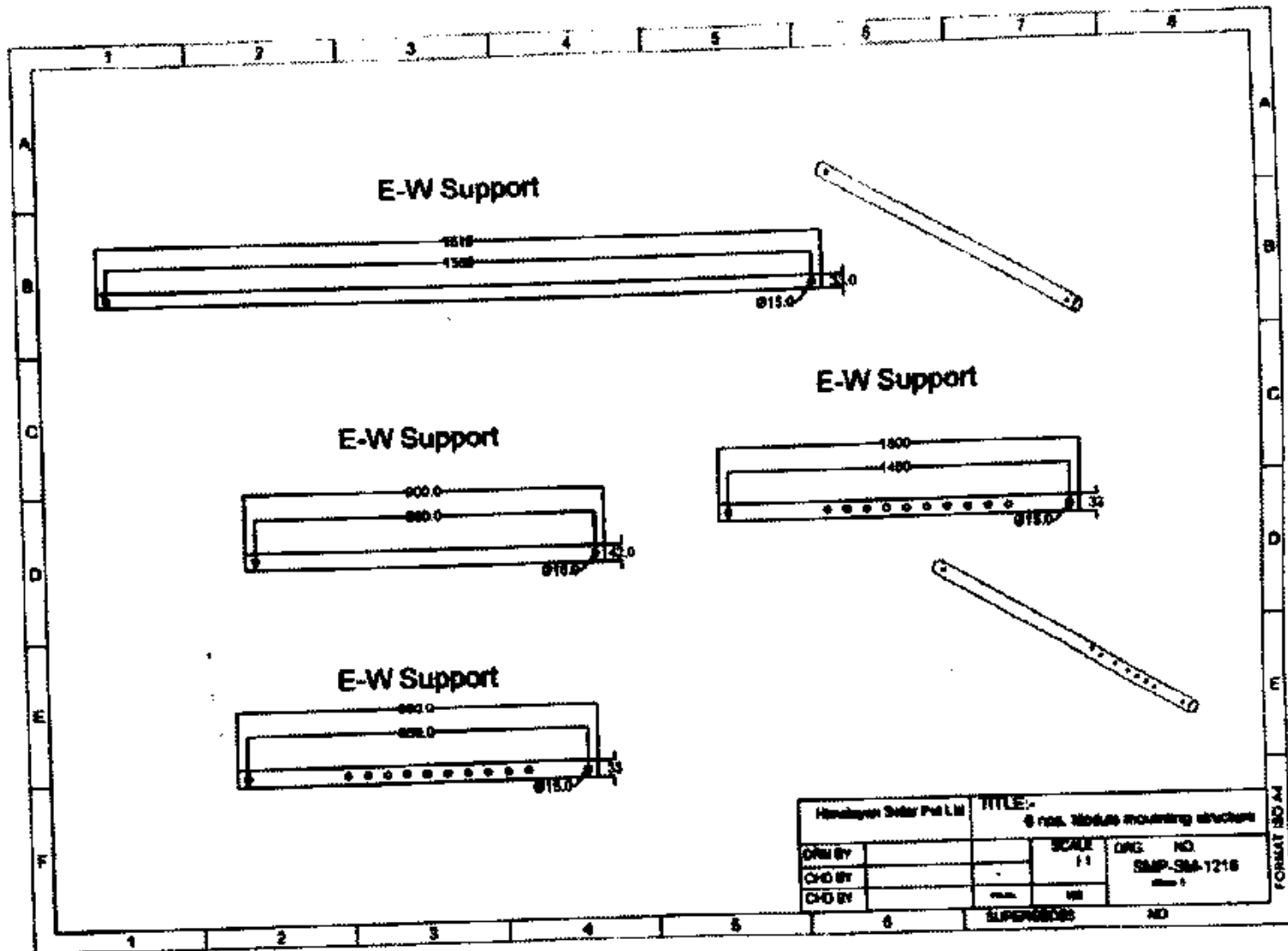
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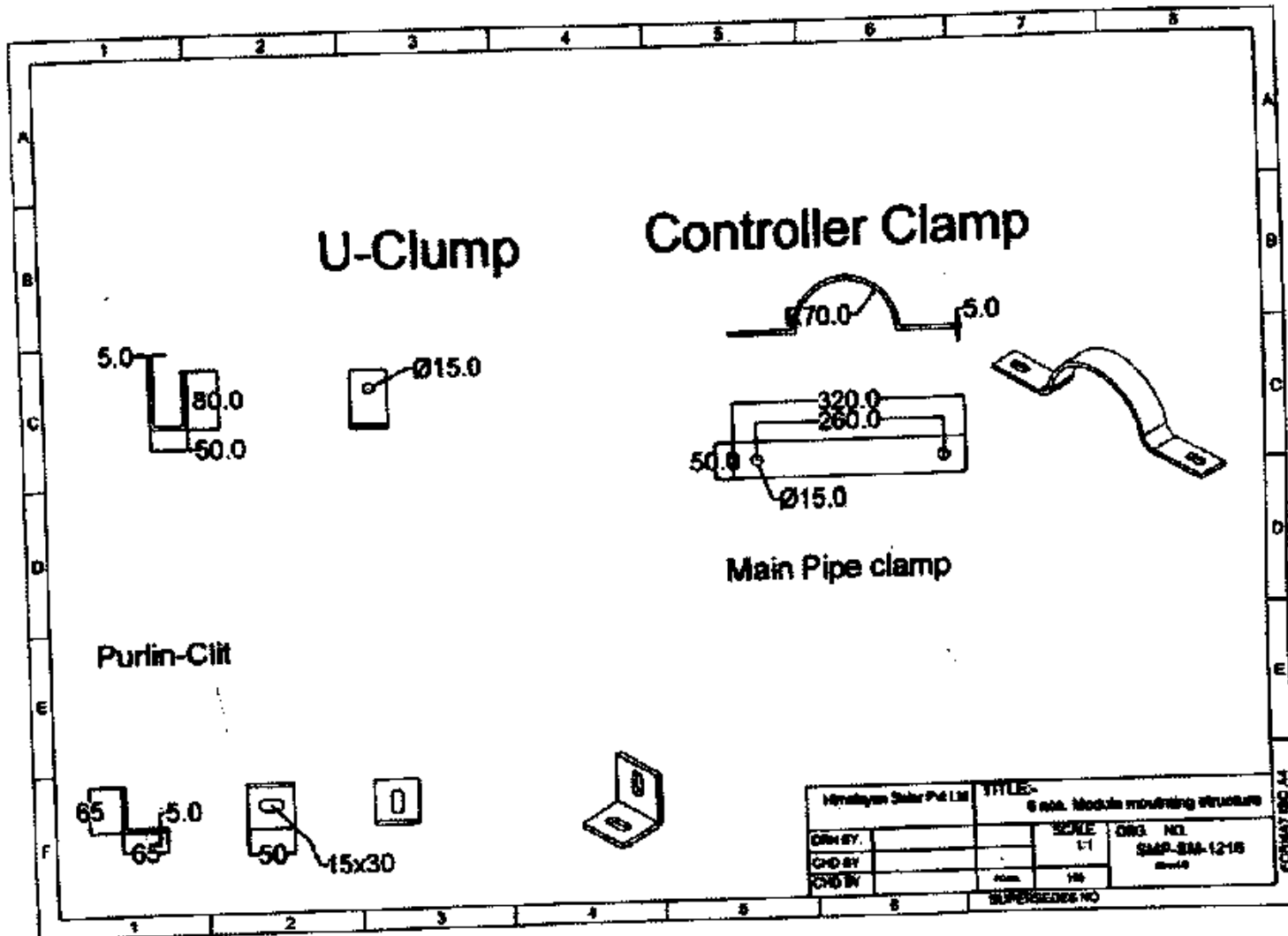
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SECTION: Cover sheet

9 MODULE MOUNTING STRUCTURE

Page No.-1

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DESIGN BASIS REPORT
FOR
9 MODULES SOLAR WATERPUMP
GROUND MOUNT SOLAR
MODULE MOUNTING STEEL STRUCTURE TABLE

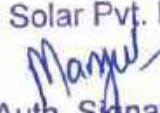
KONARK ARCHITECT

Er. Neeraj kumar Sharma
B.E.(CIVIL), A.I.A., M.I.E, F.I.V.
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MOB- 9412278819, 9953715238

CLIENT: -

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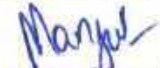
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Amr

1. GENERAL:

SCOPE

This document covers the Analysis & Design of Fixed type Solar PV Module mounting structure at an angle of tilt 20 degree.

UNITS OF MEASUREMENTS

Units of measurements used in analysis shall be of SI Units.

CODES AND REFERENCE

Following have been referred for analysis and design of the MMS

Project Reference Drawings/Documents		
1	_____	Geo-Technical Investigation
2	_____	Plot Plan
3	_____	Module GA
Indian Standard Codes		
4	IS 456 - 2000	Plain and Reinforced Concrete - Code of Practice
5	IS 875: Part 1 & 2	Code of practice for the design loads for building and structures
6	IS 875: Part 3 - 2015	Code of practice for the design loads for building and structures - Wind Loads
7	IS 800: 2007 (LSD)	Code of practice for general construction in steel of hot rolled
8	IS 801: 1975	Code of practice for cold formed steel
9	IS 4923: 2017	Specifications for Hollow Steel Sections for Structural Use
10	IS 2062: 2011	Hot rolled medium and high tensile structural steel- Specification
11	IS 4759: 1996	Hot Dip Zinc Coating on Structural Steel Products - Specification

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**MATERIAL PROPERTIES:**

Material	Property	Value	Units
Concrete - M20	Density	23	kN/m ³
	Characteristic Strength	20	N/mm ²
	Modulus of Elasticity	250000	N/mm ²
High Strength Reinforcing Steel	Density	78.5	kN/m ³
	Characteristic Strength	500	N/mm ²
	Modulus of Elasticity	200000	N/mm ²
Structural Steel	Density	78.5	kN/m ³
	Characteristic Strength	210 & 250	N/mm ²
	Modulus of Elasticity	200000	N/mm ²

Section Properties

Prop	Section	Area (cm ²)	I _{xx} (cm ⁴)	I _{yy} (cm ⁴)	J (cm ⁴)	Material
1	PIP1397L	19.100	437.000	437.000	874.407	STEEL
2	70CS40X2	3.303	7.532	25.341	0.000	STEEL
4	TUB66482.8	8.018	31.980	95.810	73.890	STEEL
5	PIP424L	3.250	8.480	8.480	12.829	STEEL
6	PIP337L	2.540	3.080	3.080	6.185	STEEL

PLANT INFORMATION:

Plant Location:

Rajasthan/Haryana/Madhya Pradesh, India Wind

Speed:

41.6m/s (150kmph)

SOFTWARE USED:

Below listed software are used for the structural analysis and design;

S. No.	Software Name	Developed By	Usages
1	STAAD Pro	Research Engineers Inc., Berkely, USA	Structural Analysis And Design
2	In-house developed MS-Excel Programs		Load Calculations

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	9 MODULE MOUNTING STRUCTURE	

2. LOADS:

Load Calculation:

Dead Load

Dead Load Calculations			
Module =	-	335	-
Module Dimensions =	Length (mm)	Width (mm)	Nos.
	1998	1010	8+1=9
Module Orientation =	Portrait		
Tabel Configuration =	Horizontal Row	x	Vertical Column
	4	x	2
Module to Module Gap =	20	mm	
Module Tilt =	30	degree with horizontal	
Weight per module =	24	s	
Weight of 10 Modules =	240	kg	
Length of Purlin =	5300	mm	
Nos. of Purlins =	4		
Member load per unit length =	11.32	kg/m	
	0.1132	kN/m	
All dead load of module have been applied as member load by considering the modules are in constant touch with the purlin upper face.			

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	9 MODULE MOUNTING STRUCTURE	

Wind Load:

Wind Pressure Calculations			
Basic Wind Speed =	150	kmph	
Basic Wind Speed =	41.6	m/s	
Design Period =	25	years	
Type of Module Mounting Structure =	Ground mount		
Terrain Category =	2		
Minimum Module Clearance From NGL =	1.0	m	
Height of Terrain/Building =	10	m	
Risk Coefficient Factor (k1) =	0.90		Table-1, IS-875, part-3-2015
Terrain Factor (k2) =	1.00		Table-2, IS-875, part-3-2015
Topography factor (k3) =	1.00		Clause-6.3.3.1 of IS: 875, part 3-2015
Importance factor (k4) =	1.00		Clause-6.3.4 of IS-875, part-3-2015
Design Wind Speed, $V_z = V_b \cdot k_1 \cdot k_2 \cdot k_3 \cdot k_4 =$	37.44	m/s	
Design Wind pressure, $P_z = 0.6 \cdot (V_z)^2 =$	841.0	N/sqm	
As per Latest code IS: 875 (Part-3-2015), the design wind pressure P_d can be obtained as as per clause 7.2; $P_d = K_d \cdot K_a \cdot K_c \cdot P_z$			
Where,	K_d = Wind directionality factor	0.9	Clause-7.2.1 of IS-875, part-3-2015
	K_a = Area averaging factor	1	Table-4 of IS: 875 part 3- 2015
	K_c = Combination factor	0.9	Clause-7.3.3.13 of IS: 875 part 3-2015
Hence, Design pressure = $P_d = K_d \cdot K_a \cdot K_c \cdot P_z =$		681.21	N/sqm

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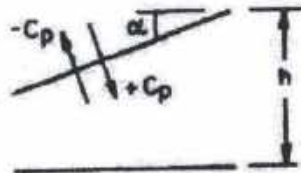
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Himadhar

Calculating pressure coefficient for mono-slope roof;



SIGN CONVENTION

- + TOWARDSTHESTRUCTURE(SUCTION), -AWAYFROMTHESTRUCTURE(UPLIFT)

For calculating the force on the panels from the pressure calculated above, we need pressure coefficient. The current structure falls under mono-slope free roofs. Pressure coefficient for mono-slope roof is found out referring section 7.3.3.2, Table 8, IS: 875, Part3 - 2015. The pressure coefficients for a mono-slope free roof of 20° tilt angle and solidity ratio of 0.

WINDLOAD UPWARD/DOWNWARD (+/-Y DIRECTION)		
Upward/Downward Wind Force, $F = C_p \cdot A \cdot P_d$		
Pressure Coefficient for Upward wind, $-C_p$	-1.3	(As per IS875 Part-3, Table-7)
Pressure coefficient for Downward wind, $+C_p$	0.8	(As per IS875 Part-3, Table-7)
Design wind pressure, P_d	681.21	N/sqm
Design wind pressure(Upward Direction) = $C_p \cdot P_d$	-885.57	N/sqm
Design wind pressure(Downward Direction) = $C_p \cdot P_d$	544.97	N/sqm
Surface Area of Structural element, $A = (1998 \times 1010 \times 9) / (10^6)$	18.17	sqm
Upward Wind force, $F_u = C_p \cdot A \cdot P_d =$	-16.09	kN
Downward Wind force, $F_d = C_p \cdot A \cdot P_d =$	9.9	kN
Here, we are considering applied wind force of Solar panels shall be bear by Purlin		
Upward Wind force per unit purlin length, $F = F_u / (4 \times 5.3)$	-0.76	kN/m
Downward Wind force per unit purlin length, $F = F_d / (4 \times 5.3)$	0.47	kN/m
Note:- Negative sign shows Upward direction of Wind		

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SECTION: Cover sheet

9 MODULE MOUNTING STRUCTURE

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WINDLOAD SIDEWAYS (X & Z DIRECTION), X-being along the slope							
MMS ELEMENT S	SECTION DETAILS						
	Lentgh (mm)	Width (mm)	Lip (mm)	Thickness (mm)			
COLUMN	139.7(DIA)	0	0	4.5			
RAFTER	96	48	0	2.9			
PURLIN	70	40	15	2			
As per table-29, IS-875,part-3 value of co-efficient & Reduction factor shall be referred							
SECTION S	ANGLE OF WIND	Cft	Wind Facing Width (D) in mm (X-direction)	Length of member mm (l)	D*Vz (in m2/s)-X-dir	I/D (X-Dir)	Reductio n Factor (K)
COLUMN	90 degree	2.0	139.7	2000	5.2	14.0	0.70

SECTION S	ANGLE OF WIND	Cfn	Wind Facing Width (D) in mm (Z-direction)	Length of member mm (l)	D*Vz (in m2/s)-X-dir	I/D (X-Dir)	Reducti o n Factor (K)
COLUMN	0 degree	2.0	139.7	2000	5.2	14.0	0.70
RAFTER	0 degree	2.0	96	3100	3.5	32	0.78

SECTION S	WIND FORCE (Pd*width*C _f K)	UNITS	DIRECTION
COLUMN	0.066	kN/m	X-Direction
COLUMN	0.066	kN/m	Z-Direction
RAFTER	0.10	KN/M	Z-Direction

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	9 MODULE MOUNTING STRUCTURE	

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LOAD COMBINATION

LOAD TYPE	L/C	LOAD NAME
Primary	1	Dead Load + Module Weight (DL+MW)
Primary	2	WIND UP
Primary	3	WIND DOWN
Primary	4	WIND X
Primary	5	WIND Z
Combination	6	1.5 (DL+MW)
Combination	7	1.5 (DL+MW+WIND DOWN)
Combination	8	1.5 (DL+MW+WINDX)
Combination	9	1.5 (DL+MW+WINDZ)
Combination	10	1.2 (DL+MW+WIND UP)
Combination	11	1.2 (DL+MW+WIND DOWN)
Combination	12	1.2 (DL+MW+WIND X)
Combination	13	1.2 (DL+MW+WIND Z)
Combination	14	0.9 (DL+MW)+1.5WIND UP
Combination	15	0.9(DL+MW)+1.5 WINDDOWN
Combination	16	0.9 (DL+MW)+ 1.5 WIND X
Combination	17	0.9 (DL+MW)+1.5 WIND Z
Combination	18	1.5 (DL+MW)+ WIND UP

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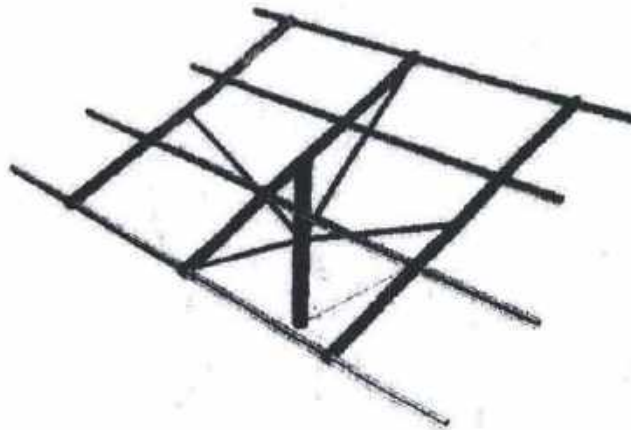
SECTION: Cover sheet

9 MODULE MOUNTING STRUCTURE

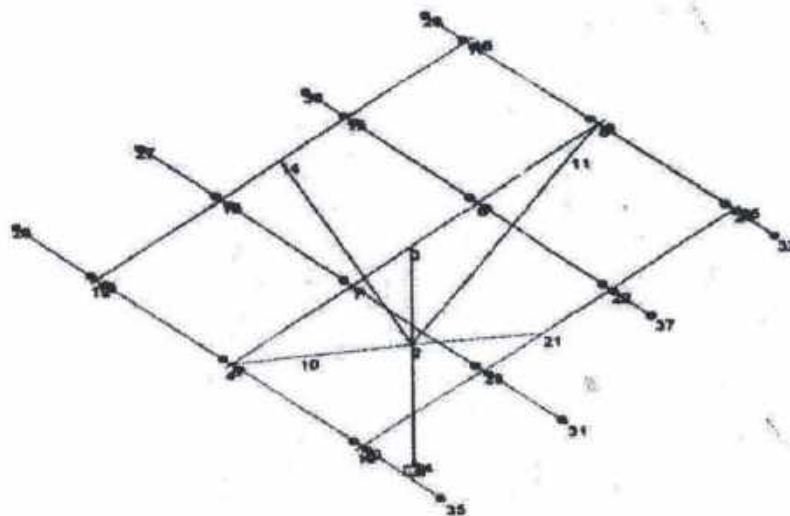
Page No.-10

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3. STAAD MODEL:



3D RENDERED VIEW

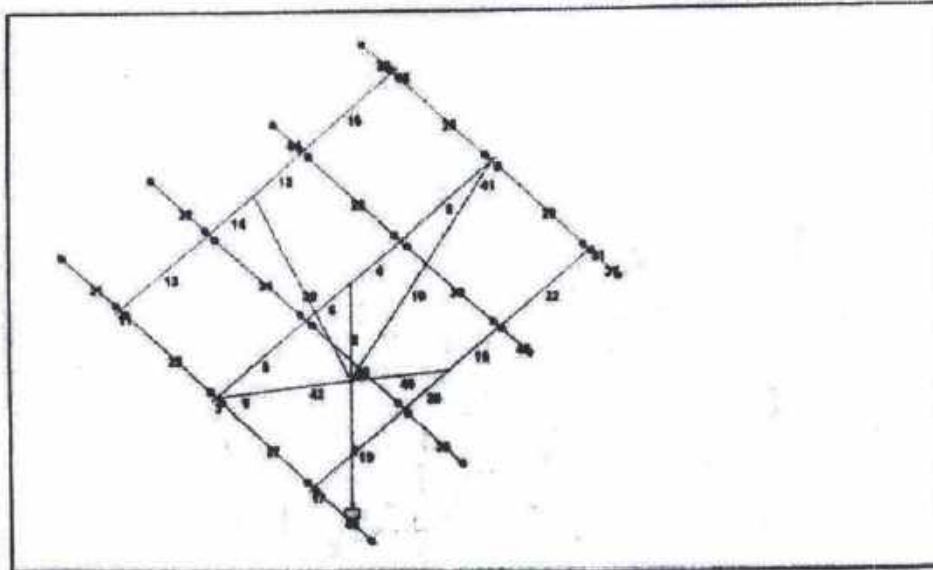


NODE NUMBER

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BEAM NUMBER

4. DEFLECTION CHECK:

As per IS 800:2007, following table can be referred for deflection check.

Table 4 Deflection Limits					
Type of building	Deflection	Design Load	Member	Supporting	Maximum Deflection
(1)	(2)	(3)	(4)	(5)	(6)
Industrial Buildings	Vertical	Live load/Wind load	Roof and Gable	Stress checking Stress checking	Span/120 Span/120
		Live load	Roof or open	Stress checking	Span/140
		Live load	Roof or open	Stress checking	Span/120
		Live load/Wind load	Roof supporting	Stress checking Roof/Wind Sheeting	Span/120 Span/120
		Crane load (lateral movement)	Crane	Crane	Span/200
		Crane load (lateral movement up to 30 t)	Crane	Crane	Span/120
		Crane load (lateral movement over 30 t)	Crane	Crane	Span/100
		No crane	Column	Stress checking Masonry/brickwork	Height/150 Height/140
		Crane + wind	Crane (lateral)	Crane (lateral)	Span/100
		Crane + wind	Column/beam	Relative displacement between both supporting crane	10 mm
Other Buildings	Vertical	Live load	Floor and Roof	Stresses not susceptible to cracking Stresses susceptible to cracking	Span/200 Span/200
		Live load	Roof or open	Stresses not susceptible to cracking Stresses susceptible to cracking	Span/150 Span/140
		Wind	Roofing	Stress checking	Height/100
	Lateral	Wind	Roofing	Stress checking	Height/100
		Wind	Roof or open	Stress checking	Span/100
	Lateral	Wind	Roofing	Stress checking	Height/100

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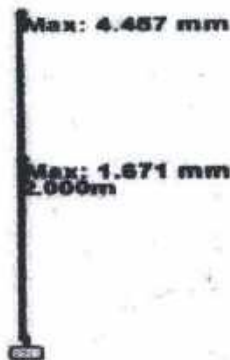
SECTION: Cover sheet

9 MODULE MOUNTING STRUCTURE

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P. Prasad

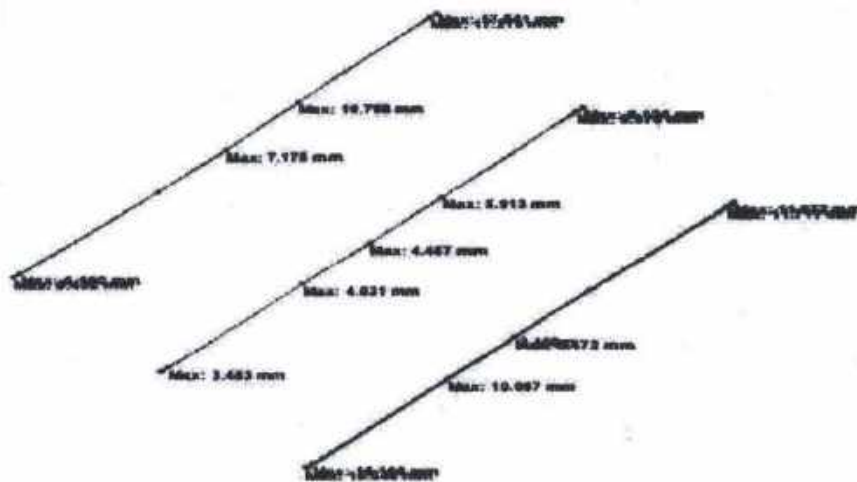
Column deflection check:



Maximum deflection in Column = 4.457 mm

Permissible limit for deflection in Column = $2000 / 240 = 8.33 \text{ mm} > 4.457$, Hence OK

Rafter deflection check:



Maximum deflection in Rafter = 17.219 mm

Permissible limit for deflection in Rafter = $3100 / 180 = 17.22 \text{ mm} > 17.219$, Hence OK

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Purlin deflection check:



Maximum deflection in Purlin = 7.007 mm

Permissible limit for deflection in Purlin = $5300/150 = 35.33 \text{ mm} > 7.007$, Hence OK

5. RACTION SUMMARY:

	Node	L/C	Horizontal	Vertical	Horizontal	Moment		
			FX (kN)	FY (kN)	FZ (kN)	MX (kNm)	MY (kNm)	MZ (kNm)
Max FX	1	9:1.5(DL+MW+)	6.198	4.902	0.000	0.000	-0.000	-0.288
Min FX	1	8:1.5(DL+MW+)	-8.898	17.445	0.000	0.000	-0.000	-0.490
Max FY	1	8:1.5(DL+MW+)	-0.000	17.445	0.000	0.000	-0.000	-0.490
Min FY	1	14:0.9(DL+MW)	-0.000	-17.344	-0.000	-0.000	0.000	0.637
Max FZ	1	8:1.5(DL+MW+)	-0.000	17.445	0.000	0.000	-0.000	-0.490
Min FZ	1	8:15(DL+MW+)	-0.000	4.902	-1.593	-3.015	0.032	-0.070
Max MX	1	8:1.5(DL+MW+)	-0.000	17.445	0.000	0.000	-0.000	-0.490
Min MX	1	8:15(DL+MW+)	-0.000	4.902	-1.593	-3.015	0.032	-0.070
Max MY	1	8:15(DL+MW+)	-0.000	4.902	-1.593	-3.015	0.032	-0.070
Min MY	1	8:1.5(DL+MW+)	-0.000	17.445	0.000	0.000	-0.000	-0.490
Max MZ	1	14:0.9(DL+MW)	-0.000	-17.344	-0.000	-0.000	0.000	0.637
Min MZ	1	8:1.5(DL+MW+)	-0.000	17.445	0.000	0.000	-0.000	-0.490

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6. UTILITY RATIO:

Beam	Analysis Property	Design Property	Actual Ratio	Allowable Ratio	Ratio (Act/Allow.)	Clause	L/C	Ax (cm ²)	Iz (cm ⁴)	Iy (cm ⁴)	Ix (cm ⁴)
1	PIP1397L	PIP1397L	0.192	1.000	0.192	Sec. 8.2.1.2	8	19.100	437.000	437.000	874.000
2	PIP1397L	PIP1397L	0.080	1.000	0.080	Sec. 8.2.1.2	8	19.100	437.000	437.000	874.000
3	TUB96482.9	TUB96482.9	0.000	1.000	0.000	Sec. 8.4	8	8.016	95.810	31.980	80.100
4	TUB96482.9	TUB96482.9	0.093	1.000	0.093	Sec. 8.2.1.2	8	8.016	95.810	31.980	80.100
5	TUB96482.9	TUB96482.9	0.046	1.000	0.046	Sec. 9.3.2.2	14	8.016	95.810	31.980	80.100
6	TUB96482.9	TUB96482.9	0.091	1.000	0.091	Sec. 9.3.2.2	14	8.016	95.810	31.980	80.100
7	TUB96482.9	TUB96482.9	0.000	1.000	0.000	Sec. 8.4	8	8.016	95.810	31.980	80.100
8	TUB96482.9	TUB96482.9	0.049	1.000	0.049	Sec. 9.3.2.2	14	8.016	95.810	31.980	80.100
9	PIP337L	PIP337L	0.064	1.000	0.064	Sec. 9.3.2.2	7	2.540	3.090	3.090	6.180
10	PIP424L	PIP424L	0.163	1.000	0.163	Sec. 9.3.2.2	7	3.250	6.460	6.460	12.920
11	TUB96482.9	TUB96482.9	0.000	1.000	0.000	Sec. 8.4	8	8.016	95.810	31.980	80.100
12	TUB96482.9	TUB96482.9	0.516	1.000	0.516	Sec. 9.3.2.2	7	8.016	95.810	31.980	80.100
13	TUB96482.9	TUB96482.9	0.279	1.000	0.279	Sec. 9.3.2.2	14	8.016	95.810	31.980	80.100
14	TUB96482.9	TUB96482.9	0.581	1.000	0.581	Sec. 9.3.2.2	14	8.016	95.810	31.980	80.100
15	TUB96482.9	TUB96482.9	0.000	1.000	0.000	Sec. 8.4	8	8.016	95.810	31.980	80.100
16	TUB96482.9	TUB96482.9	0.233	1.000	0.233	Sec. 9.3.2.2	7	8.016	95.810	31.980	80.100
17	TUB96482.9	TUB96482.9	0.000	1.000	0.000	Sec. 8.4	8	8.016	95.810	31.980	80.100
18	TUB96482.9	TUB96482.9	0.516	1.000	0.516	Sec. 9.3.2.2	7	8.016	95.810	31.980	80.100
19	TUB96482.9	TUB96482.9	0.279	1.000	0.279	Sec. 9.3.2.2	14	8.016	95.810	31.980	80.100
20	TUB96482.9	TUB96482.9	0.581	1.000	0.581	Sec. 9.3.2.2	14	8.016	95.810	31.980	80.100
21	TUB96482.9	TUB96482.9	0.000	1.000	0.000	Sec. 8.4	8	8.016	95.810	31.980	80.100
22	TUB96482.9	TUB96482.9	0.233	1.000	0.233	Sec. 9.3.2.2	7	8.016	95.810	31.980	80.100
23	70CS40X2	70CS40X2	0.315	1.000	0.315	Bending Z	14	3.303	25.341	7.532	0.044
24	70CS40X2	70CS40X2	0.471	1.000	0.471	Bend + Comp	14	3.303	25.341	7.532	0.044
25	70CS40X2	70CS40X2	0.315	1.000	0.315	Bending Z	14	3.303	25.341	7.532	0.044
26	70CS40X2	70CS40X2	0.450	1.000	0.450	Bend + Comp	14	3.303	25.341	7.532	0.044

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Beam	Analysis Property	Design Property	Actual Allowable Ratio		Ratio (Act/Allow.)	Clause	L/C	Ax (cm ²)	Iz (cm ⁴)	Iy (cm ⁴)	Ix (cm ⁴)
27	70CS40X2	70CS40X2	0.315	1.000	0.315	Bending Z	14	3.303	25.341	7.532	0.044
28	70CS40X2	70CS40X2	0.471	1.000	0.471	Bend + Comp	14	3.303	25.341	7.532	0.044
29	70CS40X2	70CS40X2	0.315	1.000	0.315	Bending Z	14	3.303	25.341	7.532	0.044
30	70CS40X2	70CS40X2	0.450	1.000	0.450	Bend + Comp	14	3.303	25.341	7.532	0.044
31	70CS40X2	70CS40X2	0.124	1.000	0.124	Bending Z	14	3.303	25.341	7.532	0.044
32	70CS40X2	70CS40X2	0.124	1.000	0.124	Bending Z	14	3.303	25.341	7.532	0.044
33	70CS40X2	70CS40X2	0.033	1.000	0.033	Bending Z	14	3.303	25.341	7.532	0.044
36	70CS40X2	70CS40X2	0.124	1.000	0.124	Bending Z	14	3.303	25.341	7.532	0.044
37	70CS40X2	70CS40X2	0.033	1.000	0.033	Bending Z	14	3.303	25.341	7.532	0.044
39	PIP424L	PIP424L	0.597	1.000	0.597	Sec. 9.3.2.2	7	3.250	6.460	6.460	12.920
40	PIP424L	PIP424L	0.597	1.000	0.597	Sec. 9.3.2.2	7	3.250	6.460	6.460	12.920
41	PIP337L	PIP337L	0.091	1.000	0.091	Sec. 9.3.2.2	7	2.540	3.090	3.090	6.180
42	PIP424L	PIP424L	0.058	1.000	0.058	Sec. 9.3.2.2	7	3.250	6.460	6.460	12.920
43	70CS40X2	70CS40X2	0.124	1.000	0.124	Bending Z	14	3.303	25.341	7.532	0.044
44	70CS40X2	70CS40X2	0.033	1.000	0.033	Bending Z	14	3.303	25.341	7.532	0.044
45	70CS40X2	70CS40X2	0.033	1.000	0.033	Bending Z	14	3.303	25.341	7.532	0.044

CONCLUSION:

The structure is found to be safe and the maximum utility ratio observed is 0.597. The IS Code referred during analysis is IS800-2007 & IS 801- Code of practice for use of cold- formed light gauge steel structural members in general building construction, IS875-Part3: Wind Loads and IS875-Part1: Dead Loads.

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	9 MODULE MOUNTING STRUCTURE	

7. STAAD INPUT DATA:

```

STAAD SPACE
START JOB INFORMATION
ENGINEER DATE 03-Nov-20
END JOB INFORMATION
INPUT WIDTH 79
UNIT METER KN
JOINT COORDINATES
1 0 0 0; 2 0 1.1 0; 3 0 2 0; 4 -1.35 1.3 0; 5 -1.30561 1.32302 0;
6 0.478755 2.25832 0; 7 -0.431174 1.77643 0; 8 1.34562 2.72605 0;
9 1.39 2.75 0; 10 -0.812749 1.23883 0; 11 1.14758 2.48674 0;
12 -1.35 1.3 -1.62; 13 -1.30561 1.32302 -1.62; 14 0 2 -1.62;
15 0.478755 2.25832 -1.62; 16 -0.431174 1.77643 -1.62;
17 1.34562 2.72605 -1.62; 18 1.39 2.75 -1.62; 19 -1.35 1.3 1.62;
20 -1.30561 1.32302 1.62; 21 0 2 1.62; 22 0.478755 2.25832 1.62;
23 -0.431174 1.77643 1.62; 24 1.34562 2.72605 1.62; 25 1.39 2.75 1.62;
26 -1.30561 1.32302 -2.65; 27 -0.431174 1.77643 -2.65;
28 1.34562 2.72605 -2.15; 31 -0.431174 1.77643 2.65; 32 1.34562 2.72605 2.15;
34 0 0 0; 35 -1.30561 1.32302 2.65; 36 0.478755 2.25832 -2.15;
37 0.478755 2.25832 2.15;
MEMBER INCIDENCES
1 1 2; 2 2 3; 3 4 5; 4 3 6; 5 5 7; 6 7 3; 7 8 9; 8 6 8; 9 5 10; 10 2 11;
11 12 13; 12 14 15; 13 13 16; 14 16 14; 15 17 18; 16 15 17; 17 19 20; 18 21 22;
19 20 23; 20 23 21; 21 24 25; 22 22 24; 23 5 13; 24 7 16; 25 8 17; 26 6 15;
27 5 20; 28 7 23; 29 8 24; 30 6 22; 31 13 26; 32 16 27; 33 17 28; 36 23 31;
37 24 32; 39 14 2; 40 2 21; 41 11 8; 42 10 2; 43 20 35; 44 15 36; 45 22 37;
DEFINE MATERIAL START
ISOTROPIC STEEL
E 2.05e+008
POISSON 0.3
DENSITY 76.8195
ALPHA 1.2e-005
DAMP 0.03
TYPE STEEL
STRENGTH FY 253200 FU 407800 RY 1.5 RT 1.2
END DEFINE MATERIAL
CONSTANTS
MATERIAL STEEL ALL
MEMBER PROPERTY INDIAN
1 2 TABLE ST PIP1397L
10 39 40 42 TABLE ST PIP424L
9 41 TABLE ST PIP337L
3 TO 8 11 TO 22 TABLE ST TU896482.9
MEMBER PROPERTY COLDFORMED INDIAN
23 TO 33 36 37 43 TO 45 TABLE ST 70CS40X2
SUPPORTS
1 FIXED
MEMBER RELEASE
23 TO 33 36 37 43 TO 45 START MX MY MZ
23 TO 33 36 37 43 TO 45 END MX MY MZ
LOAD 1 LOADTYPE Dead TITLE DL+MW

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SECTION: Cover sheet

9 MODULE MOUNTING STRUCTURE

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SELFWEIGHT Y -1
MEMBER LOAD
23 TO 33 36 37 43 TO 45 UNI GY -0.1132
LOAD 2 LOADTYPE Live REDUCIBLE TITLE WIND UP
MEMBER LOAD
23 TO 33 36 37 43 TO 45 UNI GY 0.76
LOAD 3 LOADTYPE Live REDUCIBLE TITLE WIND DOWN
MEMBER LOAD
23 TO 33 36 37 43 TO 45 UNI GY -0.47
LOAD 4 LOADTYPE Live REDUCIBLE TITLE WIND Z
MEMBER LOAD
1 2 UNI GZ 0.066
3 TO 8 11 TO 22 UNI GZ 0.1
LOAD 7 LOADTYPE Live REDUCIBLE TITLE WIND X
MEMBER LOAD
1 2 UNI GX -0.066
LOAD COMB 5 1.5(DL+MW)
1 1.5
LOAD COMB 6 1.5(DL+MW+ WIND DOWN)
1 1.5 3 1.5
LOAD COMB 8 1.5(DL+MW+ WIND Z)
1 1.5 4 1.5
LOAD COMB 9 1.5(DL+MW+WIND X)
1 1.5 7 1.5
LOAD COMB 10 1.2(DL+MW+WIND UP)
1 1.2 2 1.2
LOAD COMB 11 1.2(DL+MW+WIND DOWN)
1 1.2 3 1.2
LOAD COMB 12 1.2(DL+MW+WIND Z)
1 1.2 4 1.2
LOAD COMB 13 1.2(DL+MW+WIND X)
1 1.2 7 1.2
LOAD COMB 14 0.9(DL+MW)+1.5 WIND UP
1 0.9 2 1.5
LOAD COMB 15 0.9(DL+MW)+1.5 WIND DOWN
1 0.9 3 1.5
LOAD COMB 16 0.9(DL+MW)+1.5 WIND Z
1 0.9 4 1.5
LOAD COMB 17 0.9(DL+MW)+1.5 WIND X
1 0.9 7 1.5
LOAD COMB 18 1.5(DL+MW)+WIND UP
1 1.5 2 1.0
PERFORM ANALYSIS
PARAMETER 1
CODE IS800 LSD
FYLD 210000 MEMB 1 TO 22 39 TO 42
CHECK CODE MEMB 1 TO 22 39 TO 42
PARAMETER 2
CODE IS801
FYLD 250000 MEMB 23 TO 33 36 37 43 TO 45
CHECK CODE MEMB 23 TO 33 36 37 43 TO 45
FINISH

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	9 MODULE MOUNTING STRUCTURE	

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8. STAAD OUTPUT:

MemberNumber: 1		
MemberSection: ST PIP1397L (INDIANSECTIONS)		
Status: PASSRatio: 0.161	CriticalLoadCase: 8	Location: 0.00
CriticalCondition: Sec.8.2.1.2		
MemberNumber: 2		
MemberSection: ST PIP1397L (INDIANSECTIONS)		
Status: PASSRatio: 0.068	CriticalLoadCase: 8	Location: 0.00
CriticalCondition: Sec.8.2.1.2		
MemberNumber: 3		
MemberSection: ST TUB96482.9 (INDIANSECTIONS)		
Status: PASSRatio: 0.000	CriticalLoadCase: 8	Location: 0.05
CriticalCondition: Sec.8.4		
MemberNumber: 4		
MemberSection: ST TUB96482.9 (INDIANSECTIONS)		
Status: PASSRatio: 0.087	CriticalLoadCase: 14	Location: 0.00
CriticalCondition: Sec.9.3.2.2		
STAAD.PROCODECHECKING-IS-800-2007-LSD(V2.0)		

MemberNumber: 5		
MemberSection: ST TUB96482.9 (INDIANSECTIONS)		
Status: PASSRatio: 0.044	CriticalLoadCase: 14	Location: 0.98
CriticalCondition: Sec.9.3.2.2		
MemberNumber: 6		
MemberSection: ST TUB96482.9 (INDIANSECTIONS)		
Status: PASSRatio: 0.086	CriticalLoadCase: 14	Location: 0.49
CriticalCondition: Sec.9.3.2.2		
MemberNumber: 7		
MemberSection: ST TUB96482.9 (INDIANSECTIONS)		
Status: PASSRatio: 0.000	CriticalLoadCase: 8	Location: 0.00
CriticalCondition: Sec.8.4		
MemberNumber: 8		
MemberSection: ST TUB96482.9 (INDIANSECTIONS)		
Status: PASSRatio: 0.046	CriticalLoadCase: 14	Location: 0.00
CriticalCondition: Sec.9.3.2.2		

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Model per

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MemberNumber: 9			
MemberSection: ST PIP337L	(INDIANSECTIONS)		
Status: PASSRatio: 0.058	CriticalLoadCase: 7	Location: 0.42	
CriticalCondition: Sec.9.3.2.2			

MemberNumber: 10			
MemberSection: ST PIP424L	(INDIANSECTIONS)		
Status: PASSRatio: 0.166	CriticalLoadCase: 7	Location: 0.00	
CriticalCondition: Sec.9.3.2.2			

MemberNumber: 11			
MemberSection: ST TUB96482.9	(INDIANSECTIONS)		
Status: PASSRatio: 0.000	CriticalLoadCase: 8	Location: 0.05	
CriticalCondition: Sec.8.4			

MemberNumber: 12			
MemberSection: ST TUB96482.9	(INDIANSECTIONS)		
Status: PASSRatio: 0.467	CriticalLoadCase: 7	Location: 0.00	
CriticalCondition: Sec.9.3.2.2			
STAAD.PROCODECHECKING-IS-800-2007-LSD(V2.0)			

MemberNumber: 13			
MemberSection: ST TUB96482.9	(INDIANSECTIONS)		
Status: PASSRatio: 0.263	CriticalLoadCase: 14	Location: 0.98	
CriticalCondition: Sec.9.3.2.2			

MemberNumber: 14			
MemberSection: ST TUB96482.9	(INDIANSECTIONS)		
Status: PASSRatio: 0.549	CriticalLoadCase: 14	Location: 0.49	
CriticalCondition: Sec.9.3.2.2			

MemberNumber: 15			
MemberSection: ST TUB96482.9	(INDIANSECTIONS)		
Status: PASSRatio: 0.000	CriticalLoadCase: 8	Location: 0.00	
CriticalCondition: Sec.8.4			

MemberNumber: 16			
MemberSection: ST TUB96482.9	(INDIANSECTIONS)		
Status: PASSRatio: 0.211	CriticalLoadCase: 7	Location: 0.00	

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Handed over

| CriticalCondition:Sec.9.3.2.2
 | STAAD.PROCODECHECKING-IS-800-2007-LSD(V2.0)
 | *****

| MemberNumber: 17
 | MemberSection: ST TUB96482.9 (INDIANSECTIONS)
 | Status:PASSRatio: 0.000CriticalLoadCase: 8Location: 0.05
 | CriticalCondition:Sec.8.4

| MemberNumber: 18
 | MemberSection: ST TUB96482.9 (INDIANSECTIONS)
 | Status:PASSRatio: 0.467CriticalLoadCase: 7Location: 0.00
 | CriticalCondition:Sec.9.3.2.2

| MemberNumber: 19
 | MemberSection: ST TUB96482.9 (INDIANSECTIONS)
 | Status:PASSRatio: 0.263CriticalLoadCase: 14Location: 0.98
 | CriticalCondition:Sec.9.3.2.2

| MemberNumber: 20
 | MemberSection: ST TUB96482.9 (INDIANSECTIONS)
 | Status:PASSRatio: 0.549CriticalLoadCase: 14Location: 0.49
 | CriticalCondition:Sec.9.3.2.2

STAAD.PROCODECHECKING-IS-800-2007-LSD(V2.0)

| MemberNumber: 21
 | MemberSection: ST TUB96482.9 (INDIANSECTIONS)
 | Status:PASSRatio: 0.000CriticalLoadCase: 8Location: 0.00
 | CriticalCondition:Sec.8.4

| MemberNumber: 22
 | MemberSection: ST TUB96482.9 (INDIANSECTIONS)
 | Status:PASSRatio: 0.211CriticalLoadCase: 7Location: 0.00
 | CriticalCondition:Sec.9.3.2.2

| MemberNumber: 39
 | MemberSection: ST PIP424L (INDIANSECTIONS)
 | Status:PASSRatio: 0.590CriticalLoadCase: 7Location: 1.85
 | CriticalCondition:Sec.9.3.2.2

| MemberNumber: 40

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	9 MODULE MOUNTING STRUCTURE	

M. K. Singh

MemberSection: ST PIP424L (INDIANSECTIONS)
 Status: PASS Ratio: 0.590 Critical Load Case: 7 Location: 0.00
 Critical Condition: Sec. 9.3.2.2
 STAAD.Pro CODE CHECKING-IS-800-2007-LSD(V2.0)

MemberNumber: 41
 MemberSection: ST PIP337L (INDIANSECTIONS)
 Status: PASS Ratio: 0.083 Critical Load Case: 7 Location: 0.00
 Critical Condition: Sec. 9.3.2.2

MemberNumber: 42
 MemberSection: ST PIP424L (INDIANSECTIONS)
 Status: PASS Ratio: 0.053 Critical Load Case: 7 Location: 0.02
 Critical Condition: Sec. 9.3.2.2
 STAAD.Pro CODE CHECKING-(I801)

UNITS: MM,KN,KNM,MPA
 MEMBER#23 SECTION: 70CS40X2 LEN:
 1620.00 GOV.LOC: 810.00
 STATUS: PASS RATIO= 0.267 GOV.MODE: Bending 2 GOV.LOAD: 14

UNITS: MM,KN,KNM,MPA
 MEMBER#24 SECTION: 70CS40X2 LEN:
 1620.00 GOV.LOC: 810.00
 STATUS: PASS RATIO= 0.398
 GOV.MODE: Bend + Compress GOV.LOAD: 14

UNITS: MM,KN,KNM,MPA
 MEMBER#25 SECTION: 70CS40X2 LEN:
 1620.00 GOV.LOC: 810.00
 STATUS: PASS RATIO= 0.267 GOV.MODE: Bending 2 GOV.LOAD: 14

UNITS: MM,KN,KNM,MPA

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Member

MEMBER#26 SECTION:70CS40X2 LEN:
1620.00 GOV.LOC:810.00 |
|STATUS:PASSRATIO= 0.379
GOV.MODE:Bend+CompressGOV.LOAD:14 |

UNITS:MM,KN,KNM,MPA

MEMBER#27 SECTION:70CS40X2 LEN:
1620.00 GOV.LOC:810.00 |
|STATUS:PASSRATIO= 0.267
GOV.MODE:BendingZGOV.LOAD:14 |

UNITS:MM,KN,KNM,MPA

MEMBER#28 SECTION:70CS40X2 LEN:
1620.00 GOV.LOC:810.00 |
|STATUS:PASSRATIO= 0.398
GOV.MODE:Bend+CompressGOV.LOAD:14 |

UNITS:MM,KN,KNM,MPA

MEMBER#29 SECTION:70CS40X2 LEN:
1620.00 GOV.LOC:810.00 |
|STATUS:PASSRATIO= 0.267
GOV.MODE:BendingZGOV.LOAD:14 |

UNITS:MM,KN,KNM,MPA

MEMBER#30 SECTION:70CS40X2 LEN:
1620.00 GOV.LOC:810.00 |
|STATUS:PASSRATIO= 0.379
GOV.MODE:Bend+CompressGOV.LOAD:14 |

UNITS:MM,KN,KNM,MPA

MEMBER#31 SECTION:70CS40X2 LEN:
1030.00 GOV.LOC:515.00 |
|STATUS:PASSRATIO= 0.099
GOV.MODE:BendingZGOV.LOAD:14 |

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UNITS:MM,KN,KNM,MPA

MEMBER#32 SECTION:70CS40X2 LEN:
1030.00 GOV.LOC:515.00 |
STATUS:PASS RATIO= 0.099
GOV.MODE:BendingZGOV.LOAD:14 |

UNITS:MM,KN,KNM,MPA

MEMBER#33 SECTION:70CS40X2
LEN:530.00 GOV.LOC:265.00 |
STATUS:PASS RATIO= 0.026
GOV.MODE:BendingZGOV.LOAD:14 |

UNITS:MM,KN,KNM,MPA

MEMBER#36 SECTION:70CS40X2 LEN:
1030.00 GOV.LOC: 515.00 |
STATUS:PASS RATIO= 0.099
GOV.MODE:BendingZGOV.LOAD:14 |

UNITS:MM,KN,KNM,MPA

MEMBER#37 SECTION:70CS40X2 LEN:
530.00 GOV.LOC: 265.00 |
STATUS:PASS RATIO= 0.026
GOV.MODE:BendingZGOV.LOAD:14 |

UNITS:MM,KN,KNM,MPA

MEMBER#43 SECTION:70CS40X2 LEN:
1030.00 GOV.LOC:515.00 |
STATUS:PASS RATIO= 0.099
GOV.MODE:BendingZGOV.LOAD:14 |

UNITS:MM,KN,KNM,MPA

MEMBER#44 SECTION:70CS40X2 LEN:

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530.00 GOV.LOC:265.00 |
|STATUS:PASSRATIO= 0.026
GOV.MODE:BendingZGOV.LOAD:14 |

|UNITS:MM,KN,KNM,MPA |

|MEMBER#45 SECTION:70CS40X2 LEN: 530.00GOV.LOC: 265.00 |
|STATUS:PASSRATIO= 0.026
GOV.MODE:BendingZGOV.LOAD:14 |

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Model No.

8. FOUNDATION

Breadth of Pedestal	B	=	0.40	m	
Length of the Pedestal	L	=	0.40	m	
Unit weight of water	Yw	=	10.00	kN/m ³	
Unit weight of soil	Ys	=	20.00	kN/m ³	
Factor of Safety	FOS	=	1.5		
Unit Weight of Pedestal Material	Yp	=	23.00	kN/m ³	
Grade of Concrete		=	20.00	N/mm ²	
Grade of Steel	Fy	=	500	N/mm ²	
Soil Bearing Capacity		=	80.00	kN/m ²	
Bearing Capacity factor, Ny	Ny	=	0.60		
Bearing Capacity factor, Nq	Nq	=	1.75		IS:6403:1981 Table:1 Bearing Capacity Factors
Bearing Capacity factor, Nc	Nc	=	6.86		
Downward force from superstructure(P)	Qv(+)	=	17.34	kN	
Uplift from superstructure	Qv(-)	=	17.45	kN	
Lateral force from superstructure	QH	=	5.80	kN	
Moment from Superstructure	M	=	3.02	kN-m	
Unsupported length of the Pedestal above ground	e	=	0.10	m	

From STAAD Result

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DESIGN**VERTICAL CAPACITY OF FOOTING****AREA OF FOOTING:**

Assume self weight of footing	w	=	0.1x17.34	KN	w=0.1P
Total Weight	W	=	1.734+17.34	kN	W=0.1P+P
	W	=	19.074	kN	
Area of Footing	A	=	19.074/80	kN	A= W/SBC
Size of Footing,		=	$\sqrt{0.238}$	m	
		=	0.487	m	

Therefore

Provide 0.5 m x 0.5 m Square Footing,

So

Total area Required	=0.25	m ²
Length of Footing	=0.25	m
Breadth of Footing	=0.25	m

PRESSURE ACTS ON FOOTING:

Pressure	P = Pu/A	KN/m ²
	P = 1.5x19.074/0.25	KN/m ²
Pressure	P = 114.42	KN/m ²

FACTORED BENDING MOMENT per 'm':

Factored Bending Moment	Mu = PxLX((B-D)/2) ² /2	KN-m
	Mu = 114.42x0.5X((0.5-0.4)/2) ² /2	KN-m
	Mu = 0.0715	KN-m

Where

B= Length of Footing

D= Length of Pedestal

P= Pressure on Footing

L= B

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EFFECTIVE DEPTH:

$$d_{\text{required}} = \sqrt{M_u / 0.133 \times f_{ck} \times b} \quad \text{mm}$$

$$d_{\text{required}} = \sqrt{0.0715 \times 10^6 / 0.133 \times 20 \times 500} \quad \text{mm}$$

$$d_{\text{required}} = 8.0 \quad \text{mm}$$

we provide

$$d_{\text{required}} = 150.0 \quad \text{mm}$$

For considerations, increase depth 1.75 to 2 times more than the calculated value

$$d_{\text{required}} = 150.0 \times 2$$

Effective depth

$$d_{\text{required}} = 300 \quad \text{mm}$$

Overall depth

$$D = 350 \quad \text{mm}$$

Footing cover

$$= 50 \quad \text{mm}$$

Where

M_u = Factored Moment

f_{ck} = Characteristic Compressive strength

b = Breadth of Footing

AREA OF TENSION REINFORCEMENT:

Moment of Resistance

$$M_u = 0.87 F_y A_{st} d (1 - A_{st} F_y / b d F_{ck}) \quad \text{mm}^2$$

$$0.0715 = 0.87 \times 500 A_{st} \times 300 (1 - A_{st} \times 500 / 500 \times 500 \times 20) \quad \text{mm}^2$$

$$0.0715 = 0.87 \times 500 A_{st} \times 300 (1 - A_{st} \times 500 / 500 \times 500 \times 20) \quad \text{mm}^2$$

$$A_{st} = 671 \quad \text{mm}^2$$

Where

M_u = Factored Moment

f_{ck} = Characteristic Compressive strength

b = effective depth

d = Breadth of Footing

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AREA OF STEEL per m:

$$= A_{st}/\text{span}$$

$$= 671/0.5$$

$$= 1342 \quad \text{mm}^2$$

AREA OF ONE BAR:

Assume 16 mm dia bar,

$$a_{st} = \pi d^2/4$$

$$= 3.14 \times 16^2/4$$

$$= 200.96 \quad \text{mm}^2$$

SPACING OF REINFORCEMENT:

$$= (\text{Area of one bar}/\text{area}/\text{m}) \times 1000$$

$$= (a_{st}/A_{st}) \times 1000$$

$$= (200.96/1342) \times 1000 \quad \text{mm}$$

$$= 149.746$$

mm

Provide 16 mm dia bars at 150 mm c/c spacing.

NUMBER OF BARS:

$$= (A_{st}/a_{st})$$

$$= (1342/200.96)$$

$$= 7 \text{ nos of bar}$$

CHECK FOR ONE WAY SHEAR:
(a) SHEAR FORCE PER 'm':

$$V_u = P \times B \times ((L-D)/2-d)$$

$$= 114.42 \times 1 \times (((0.5-0.4)/2-0.5)$$

$$= 51.49$$

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(b) NOMINALSHEAR STRESS:

$$\begin{aligned}T_v &= V_u / b d \\&= 51.49 \times 10^3 / 1000 \times 300 \\&= 0.172 \quad \text{N/mm}^2\end{aligned}$$

(c) percentage of steel:

$$\begin{aligned}&= 100 \times A_{st} / b d \\&= 100 \times 671 / 500 \times 300 \\&= 0.447\end{aligned}$$

Now, Refer Table No.19 Page No. 73 of IS456:2000

$$T_c = 0.46 \quad \text{N/mm}^2$$

Therefore,

$$\begin{aligned}T_v &< T_c \\0.172 \text{ N/mm}^2 &< 0.46 \text{ N/mm}^2\end{aligned}$$

HENCE, Design is safe against one way shear.

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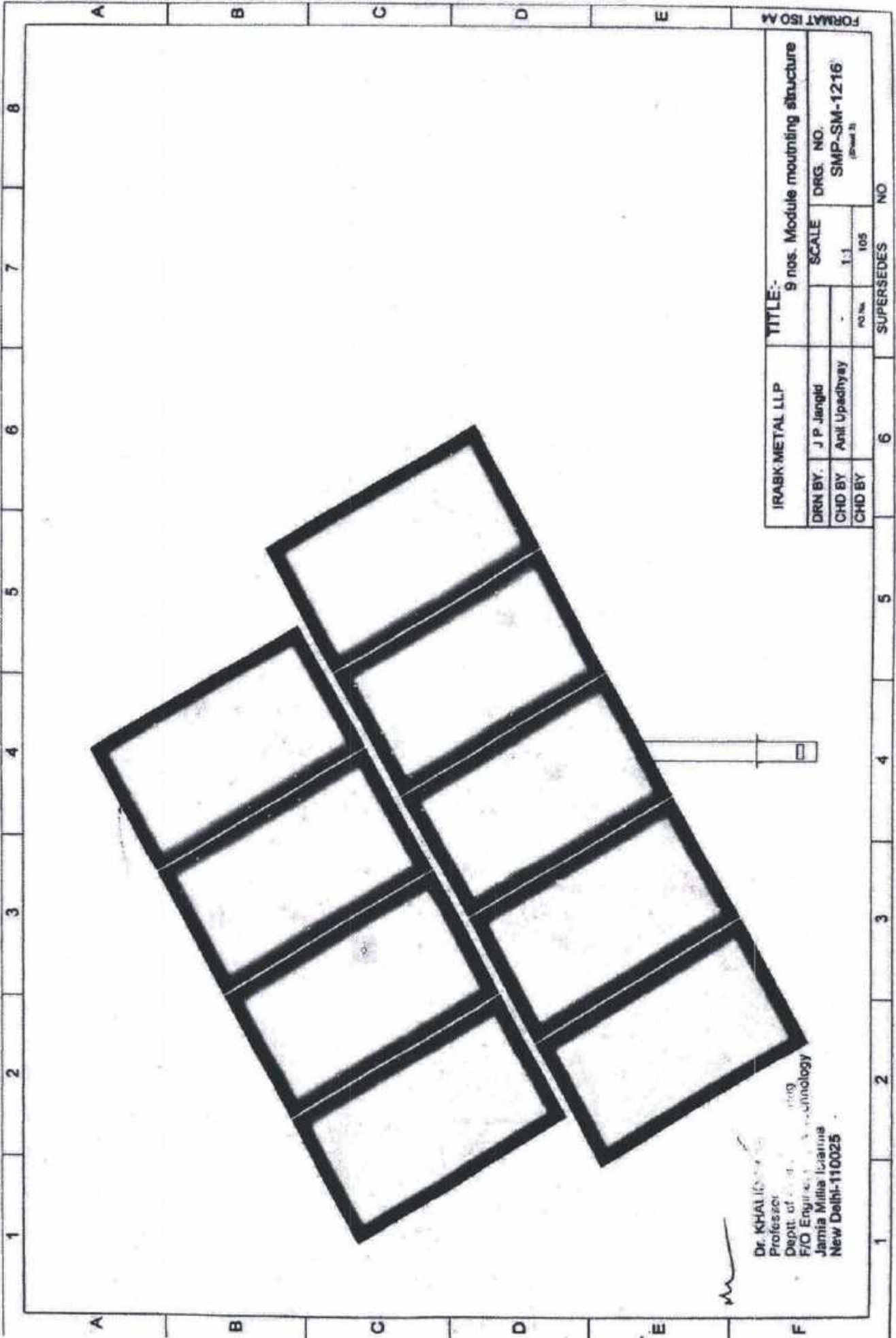
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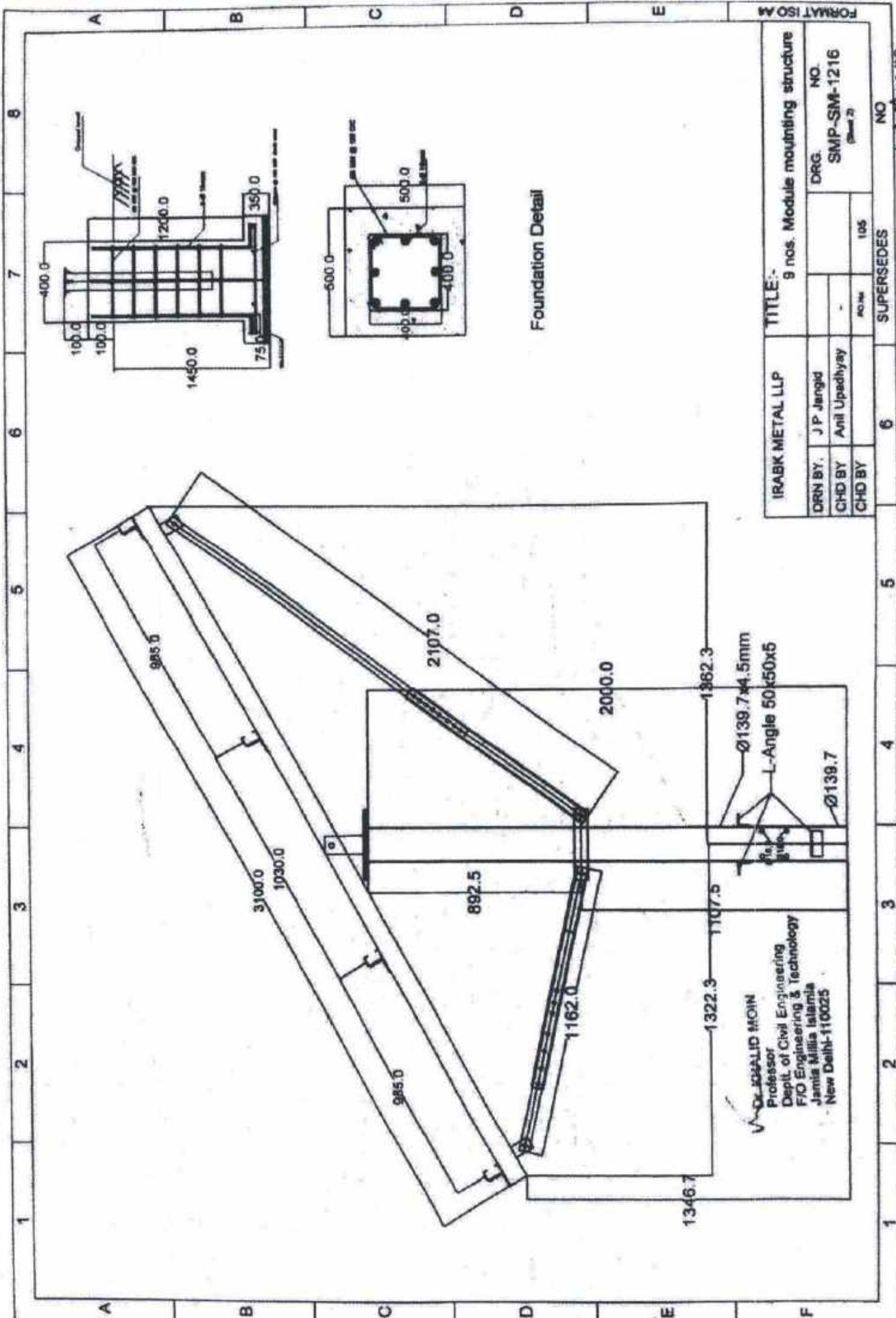
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IRASK METAL LLP		TITLE:-		9 nos. Module mounting structure	
DRN BY.	J P Jangid	SCALE	1:1	DRG. NO.	SMP-SM-1216
CHD BY	Anil Upadhyay	PO No.	105		(Sheet 2)
CHD BY				SUPERSEDES	NO

Approved



Foundation Detail

IRABK METAL LLP		TITLE:-		9 nos. Module mounting structure	
DRN BY.	J P Jangid			DRG.	NO.
CHD BY	Anil Upadhyay	-			SMP-SM-1216
CHD BY					(Sheet 2)
	</				

NO

SUPERSEDES

6

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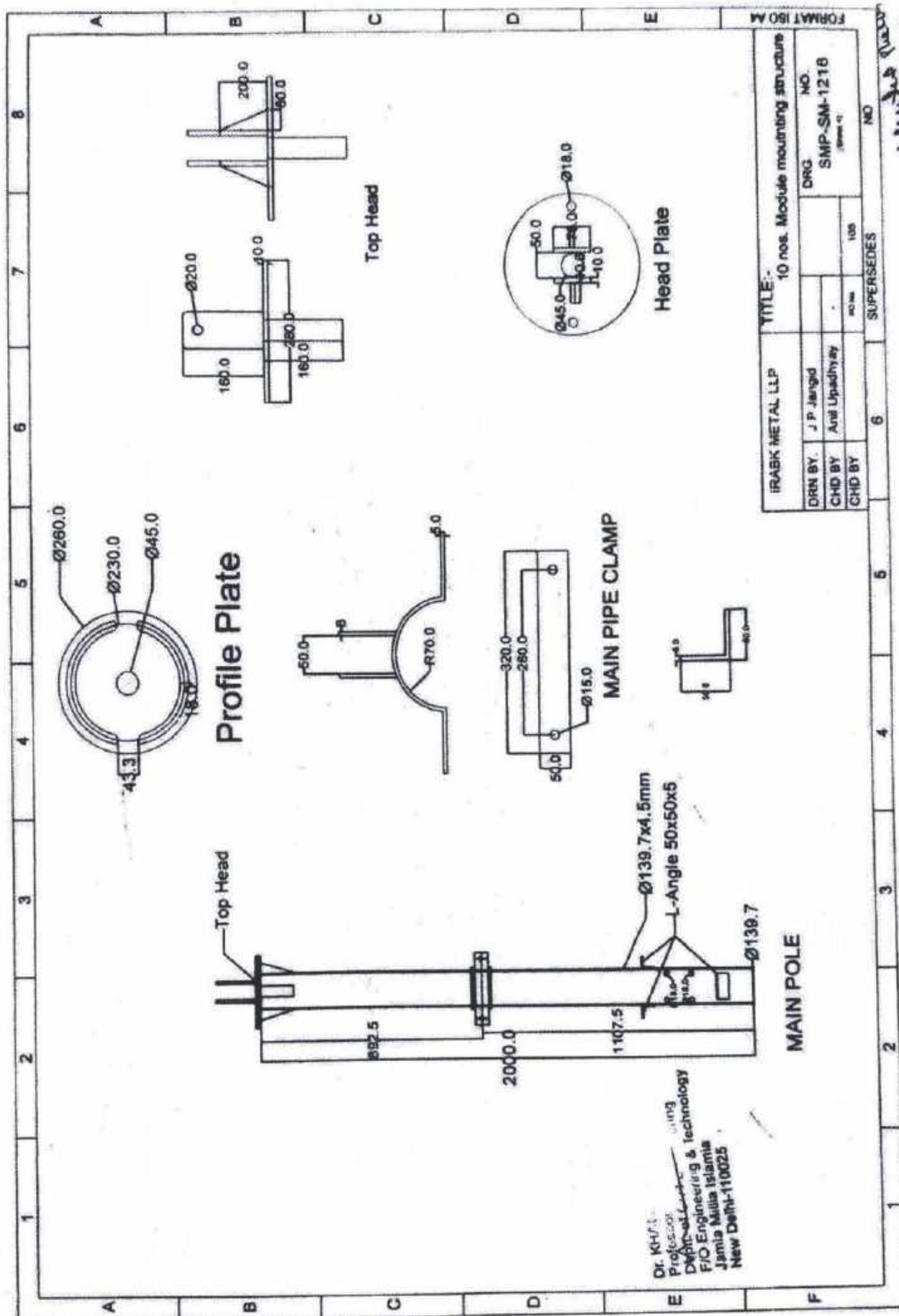
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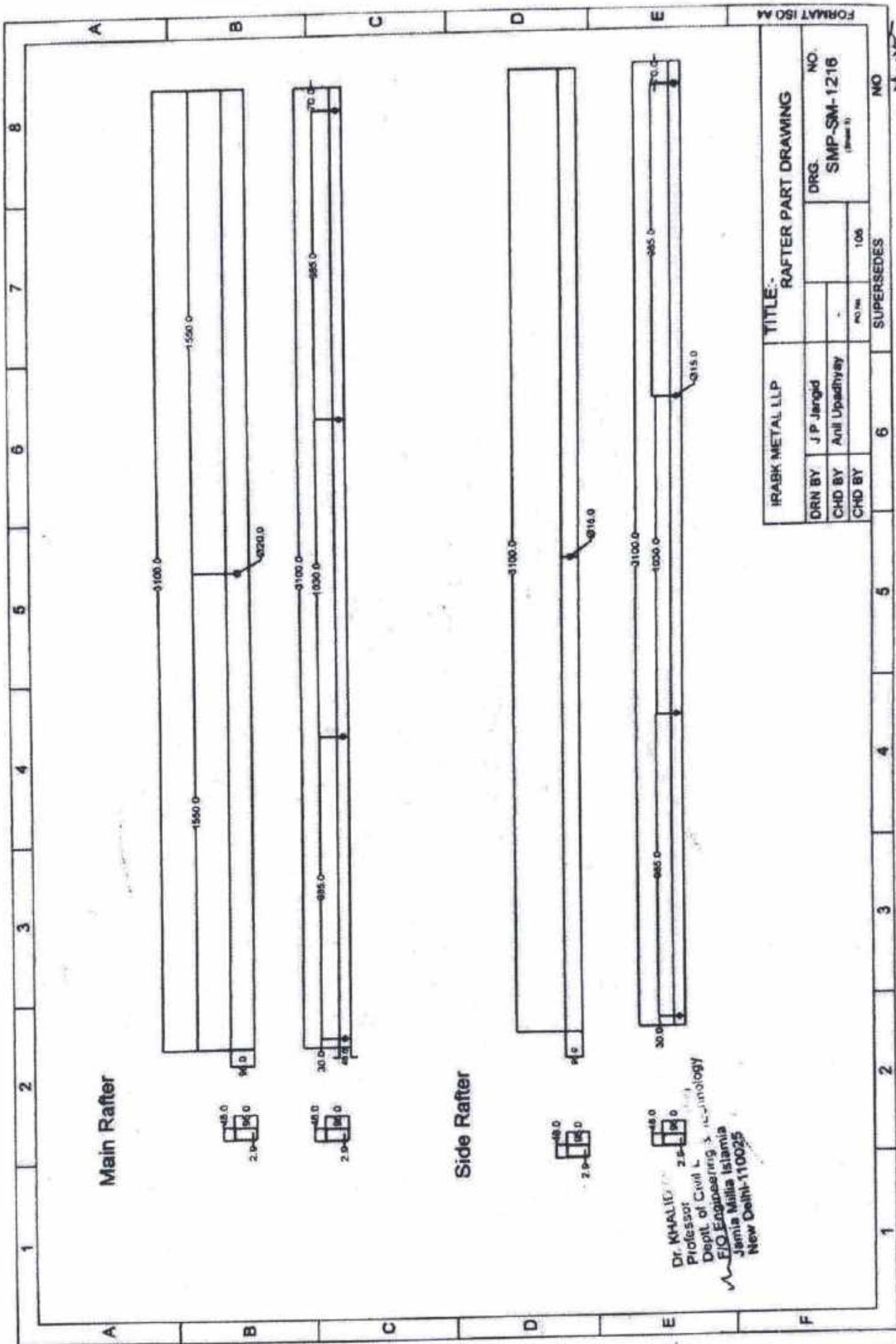
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Main Rafter

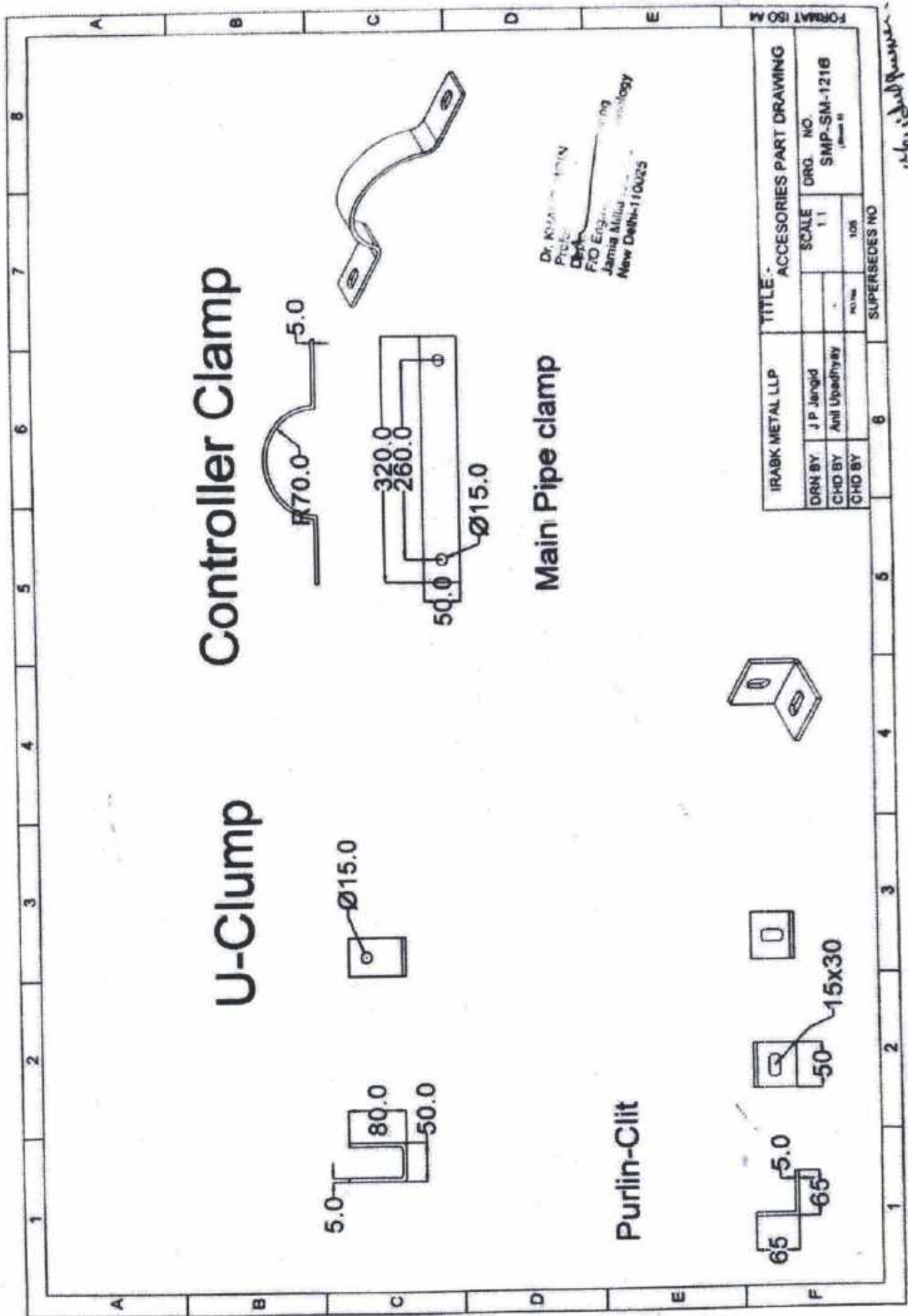
Side Rafter

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IRABK METAL LLP				TITLE:-			
DRN BY	J P Jangid	DRG.	SMP-SM-1216	NO.			
CHD BY	Anil Upadhyay			(Sheet No.)			
CHD BY		PC No.	106	SUPERSEDES			

NO. *Handwritten signature*

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DESIGN BASIS REPORT
FOR
10 MODULE SOLAR WATER PUMP
GROUND MOUNT SOLAR
MODULE MOUNTING STEEL STRUCTURE TABLE

KONARK ARCHITECT

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B.E.(CIVIL), A.I.A., M.I.E, F.I.V.
(CHARTERED ENGINEER)
MOB- 9412278819, 9953715238

CLIENT:-
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3	STAAD MODEL
4	DEFLECTION CHECK
5	REACTION SUMMARY
6	UTILITY RATIO
7	STAAD INPUT DATA
8	STAAD OUTPUT DATA
9	CALCULATION FOR FOUNDATION

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1. GENERAL:

SCOPE

This document covers the Analysis & Design of Fixed type Solar PV Module mounting structure at an angle of tilt 20 degree.

UNITS OF MEASUREMENTS

Units of measurements used in analysis shall be of SI Units.

CODES AND REFERENCE

Following have been referred for analysis and design of the MMS

Project Reference Drawings/Documents		
1	-----	Geo-Technical Investigation
2	-----	Plot Plan
3	-----	Module GA
Indian Standard Codes		
4	IS 456 - 2000	Plain and Reinforced Concrete - Code of Practice
5	IS 875: Part 1 & 2	Code of practice for the design loads for building and structures
6	IS 875: Part 3-2015	Code of practice for the design loads for building and structures - Wind Loads
7	IS 800: 2007 (LSD)	Code of practice for general construction in steel of hot rolled
8	IS 801: 1975	Code of practice for cold formed steel
9	IS 4923:2017	Specifications for Hollow Steel Sections for Structural Use
10	IS 2062:2011	Hot rolled medium and high tensile structural steel Specification
11	IS 4759:1996	Hot Dip Zinc Coating on Structural Steel and Allied Products -Specification

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MATERIAL PROPERTIES:

Material	Property	Value	Units
Concrete - M25	Density	23	kN/m ³
	Characteristic Strength	20	N/mm ²
	Modulus of Elasticity	25000	N/mm ²
High Strength Reinforcing Steel	Density	78.5	kN/m ³
	Characteristic Strength	500	N/mm ²
	Modulus of Elasticity	205000	N mm ² /
Structural Steel	Density	78.5	kN/m ³
	Characteristic Strength	210 & 250	N/mm ²
	Modulus of Elasticity	205000	N/mm ²

Section Properties

Prop	Section	Area (cm ²)	I _{yy} (cm ⁴)	I _{xx} (cm ⁴)	J (cm ⁴)	Material
1	PI1397L	19.100	437.000	437.000	874.407	STEEL
3	70CS40X2	3.303	7.532	25.341	0.000	STEEL
4	TUB96462.9	8.018	31.990	95.810	73.990	STEEL
5	PI1424L	3.250	6.480	6.480	12.920	STEEL
6	PI1337L	2.540	3.090	3.090	6.185	STEEL

PLANT INFORMATION:

Plant Location:

Rajasthan/Haryana/Madhya Pradesh, India

Wind Speed:

41.6 m/s (150 kmph)

SOFTWARE USED:

Below listed software are used for the structural analysis and design:

S. No.	Software Name	Developed By	Usages
1	STAAD Pro	Research Engineers Inc., Berkely, USA	Structural Analysis And Design
2	In-house developed MS -Excel Programs		Load Calculations

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2. LOADS:

Load Calculation:

Dead Load

Dead Load Calculations			
Module =	-	335	-
Module Dimensions =	Length (mm)	Width (mm)	Nos.
	1998	1010	10
Module Orientation =	Portrait		
Tabel Configuration =	Horizontal Row	x	Vertical Column
	5	x	2
Module to Module Gap =	20	mm	
Module Tilt =	20	degree with horizontal	
Weight per module =	24	s	
Weight of 10 Modules =	240	kg	
Length of Purlin =	5300	mm	
Nos. of Purlins =	4		
Member load per unit length =	11.32	kg/m	
	0.1132	kN/m	
All dead load of module have been applied as member load by considering the modules are in constant touch with the purlin upper face.			

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Wind Load:

Wind Pressure Calculations			
Basic Wind Speed =	150	kmph	
Basic Wind Speed =	41.6	m/s	
Design Period =	25	years	
Type of Module Mounting Structure =	RoofTop		
Terrain Category =	2		
Minimum Module Clearance From NGL =	1.0	m	
Height of Terrain/Building =	10	m	
Risk Coefficient Factor (k1) =	0.90	Table-1, IS-875, part-3-2015	
Terrian Factor (k2) =	1.00	Table-2, IS-875, part-3-2015	
Topography factor (k3) =	1.00	Clause-6.3.3.1 of IS: 875, part3-2015	
Importance factor (k4) =	1.00	Clause-6.3.4 of IS-875, part-3-2015	
Design Wind Speed, $V_z = V_b * k_1 * k_2 * k_3 * k_4 =$	37.44	m/s	
Design Wind pressure, $P_z = 0.6 * (V_z)^2 =$	841.0	N/sqm	
As per Latest code IS: 875 (Part-3-2015), the design wind pressure P_d can be obtained as as per clause 7.2; $P_d = K_d . K_a . K_c . P_z$			
Where,	Kd = Wind directionality factor	0.9	Clause-7.2.1 of IS-875, part-3-2015
	Ka = Area averaging factor	1	Table-4 of IS: 875 part 3- 2015
	Kc = Combination factor	0.9	Clause-7.3.3.13 of IS: 875 part3-2015
Hence, Design pressure = $P_d = K_d . K_a . K_c . P_z =$		681.21	N/sqm

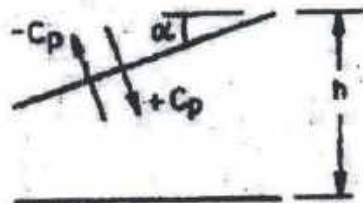
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Calculating pressure coefficient for mono-slope roof;



SIGN CONVENTION

+ TOWARDSTHESTRUCTURE(SUCTION),-AWAYFROMTHESTRUCTURE(UPLIFT)

For calculating the force on the panels from the pressure calculated above, we need pressure coefficient. The current structure falls under mono-slope free roofs. Pressure coefficient for mono-slope roof is found out referring section 7.3.3.2, Table 8, IS: 875, Part3 - 2015. The pressure coefficients for a mono-slope free roof of 20° tilt angle and solidity ratio of 0.

WINDLOAD UPWARD/DOWNWARD (+/-) DIRECTION)		
Upward/Downward Wind Force, $F = C_p \cdot A \cdot P_d$		
Pressure Coefficient for Upward wind, $-C_p$	-1.3	(As per IS875 Part-3, Table-7)
Pressure coefficient for Downward wind, $+C_p$	0.8	(As per IS875 Part-3, Table-7)
Design wind pressure, P_d	681.21	N/sqm
Design wind pressure(Upward Direction) = $C_p \cdot P_d$	-885.57	N/sqm
Design wind pressure(Downward Direction) = $C_p \cdot P_d$	544.97	N/sqm
Surface Area of Structural element, $A = (1998 \cdot 1010 \cdot 10) / (10^6)$	20.18	sqm
Upward Wind force, $F_u = C_p \cdot A \cdot P_d =$	-17.87	kN
Downward Wind force, $F_d = C_p \cdot A \cdot P_d =$	10.99	kN
Here, we are considering applied wind force of Solar panels shall be bear by Purlin		
Upward Wind force per unit purlin length, $F = F_u / (4 \cdot 5.3)$	-0.84	kN/m
Downward Wind force per unit purlin length, $F = F_d / (4 \cdot 5.3)$	0.52	kN/m

Note:- Negative sign shows Upward direction of Wind

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WINDLOAD SIDEWAYS (X & Z DIRECTION), X-being along the slope

MMS ELEMENT S	SECTION DETAILS			
	Lentgh (mm)	Width (mm)	Lip (mm)	Thickness (mm)
COLUMN	139.7(DIA)	0	0	4.5
RAFTER	96	48	0	2.9
PURLIN	70	40	15	2

As per table-29, IS-875, part-3 value of co-efficient & Reduction factor shall be referred

SECTION S	ANGLE OF WIND	C _{ft}	Wind Facing Width (D) in mm (X-direction)	Length of member mm (l)	D*V _z (in m ² /s) -X-dir	VD (X-Dir)	Reduction Factor (K)
COLUMN	90 degree	2.0	139.7	2000	5.2	14.0	0.70

SECTION S	ANGLE OF WIND	C _{fm}	Wind Facing Width (D) in mm (Z-direction)	Length of member mm (l)	D*V _z (in m ² /s) -X-dir	VD (X-Dir)	Reduction Factor (K)
COLUMN	0 degree	2.0	139.7	2000	5.2	14.0	0.70
RAFTER	0 degree	2.0	96	3100	3.5	32	0.78

SECTION S	WIND FORCE (Pd*width*C _f K)	UNITS	DIRECTION
COLUMN	0.066	kN/m	X-Direction
COLUMN	0.066	kN/m	Z-Direction
RAFTER	0.10	KN/M	Z-Direction

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LOAD COMBINATION

LOAD TYPE	L/C	LOAD NAME
Primary	1	Dead Load + Module Weight (DL+MW)
Primary	2	WIND UP
Primary	3	WIND DOWN
Primary	4	WIND X
Primary	5	WIND Z
Combination	6	1.5 (DL+MW)
Combination	7	1.5 (DL+MW+WINDDOWN)
Combination	8	1.5 (DL+MW+WINDX)
Combination	9	1.5 (DL+MW+WINDZ)
Combination	10	1.2 (DL+MW+WIND UP)
Combination	11	1.2 (DL+MW+WINDDOWN)
Combination	12	1.2 (DL+MW+WINDX)
Combination	13	1.2 (DL+MW+WINDZ)
Combination	14	0.9 (DL+MW)+1.5WIND UP
Combination	15	0.9(DL+MW)+1.5 WINDDOWN
Combination	16	0.9 (DL+MW)+ 1.5 WIND X
Combination	17	0.9 (DL+MW)+1.5 WIND Z
Combination	18	1.5 (DL+MW)+ WIND UP

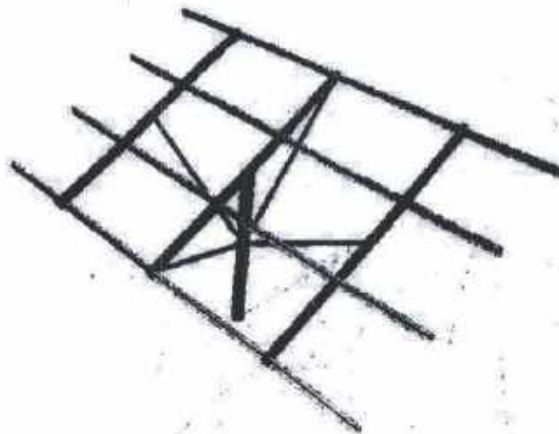
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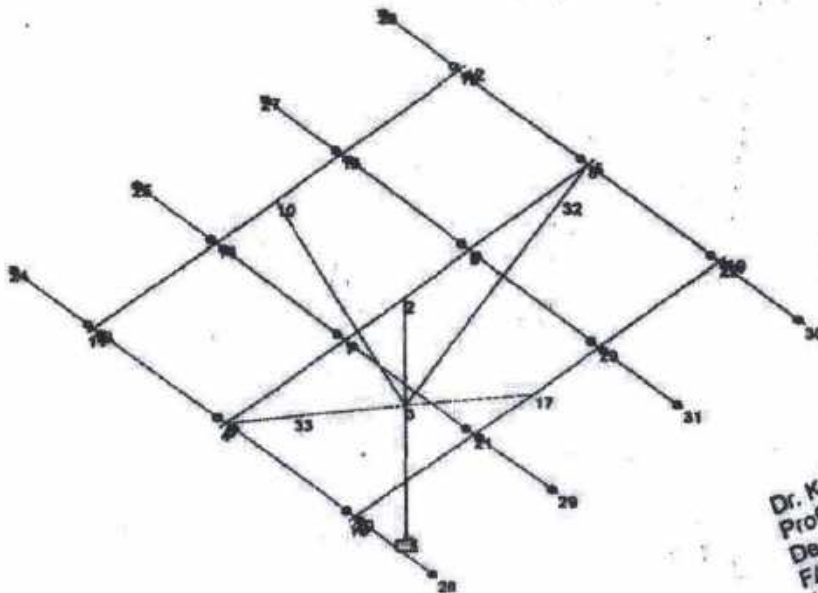
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3. STAAD MODEL:



3D RENDERED VIEW

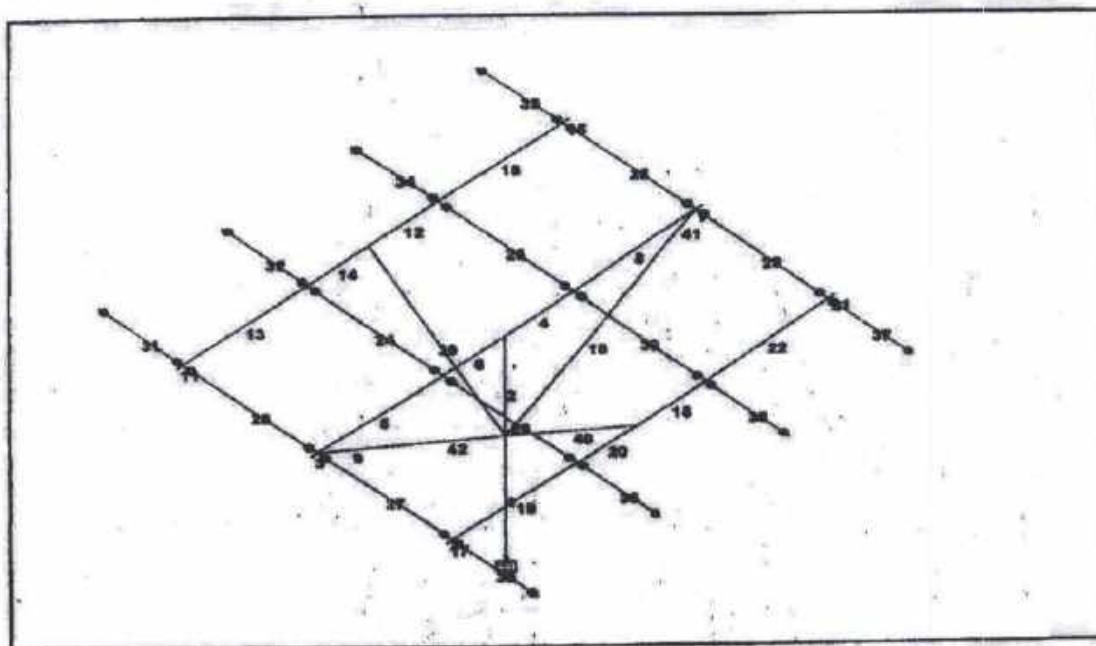


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BEAM NUMBER

4. DEFLECTION CHECK:

As per IS 800:2007, following table can be referred for deflection check.

Table 6 Deflection Limits					
Type of Building	Deflection	Design Load	Member	Supporting	Maximum Deflection
(1)	(2)	(3)	(4)	(5)	(6)
Industrial Buildings	Vertical	Live load/ Wind load	Roof and Girts	Elastic strutting Brick strutting	Span/150 Span/100
		Live load	Single span	Elastic strutting Brick strutting	Span/240 Span/200
		Live load	Continuous span	Elastic strutting Brick strutting	Span/130 Span/120
		Live load/ Wind load	Roof supporting	Profiled Metal Sheeting Flat metal Sheeting	Span/100 Span/240
		Crane load (Elastic operation)	Gantry	Crane	Span/200
		Crane load (Electric operation up to 50 t)	Gantry	Crane	Span/220
		Crane load (Electric operation over 50 t)	Gantry	Crane	Span/1 000
	Lateral	No crane	Column	Elastic strutting Masonry/Brick strutting Crane (absent)	Height/150 Height/240 Span/400
		Crane + wind	Gantry (lateral)	Relative displacement between rails supporting crane	10 mm
		Crane + wind	Column/frame	Gantry (Elastic strutting; product operated) Gantry (Brick strutting; cab operated)	Height/200 Height/400
Other Buildings	Vertical	Live load	Floor and Roof	Elements not susceptible to cracking	Span/300
				Elements susceptible to cracking	Span/360
				Elements not susceptible to cracking	Span/130
	Lateral	Live load	Continuous	Elements susceptible to cracking	Span/180
		Wind	Building	Elastic strutting Brick strutting	Height/200 Height/240
		Wind	Four storey drift	—	Storey height/200

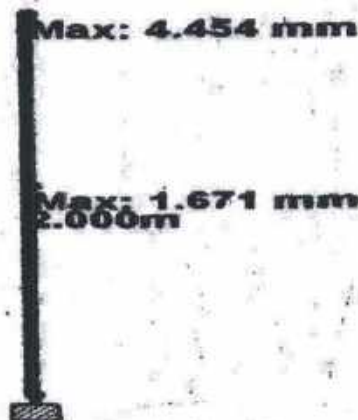
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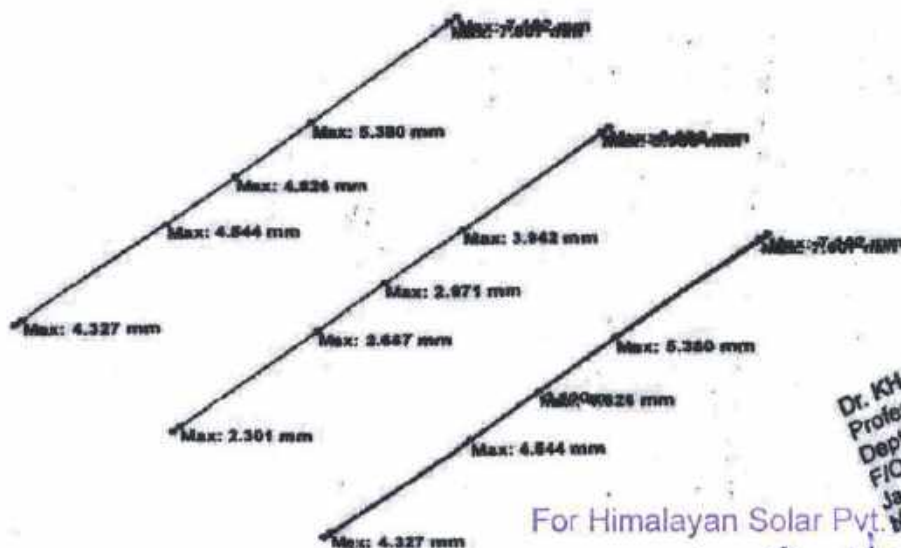
Column deflection check:



Maximum deflection in Column = 4.454 mm

Permissible limit for deflection in Column = $2000 / 240 = 8.33 \text{ mm} > 4.454$, Hence OK

Rafter deflection check:



Maximum deflection in Rafter = 7.607 mm

Permissible limit for deflection in Rafter = $3100 / 180 = 17.22 \text{ mm} > 7.607$, Hence OK

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Purlin deflection check:



Maximum deflection in Purlin = 15.589 mm

Permissible limit for deflection in Purlin = $5300/150 = 35.33 \text{ mm} > 15.589$, Hence OK

5. RACTION SUMMARY:

	Node	L/C	Horizontal	Vertical	Horizontal	Moment		
			FX (kN)	FY (kN)	FZ (kN)	MX (kNm)	MY (kNm)	MZ (kNm)
Max FX	1	9:1.5(DL+MW+)	0.198	5.070	0.000	0.000	0.000	-0.077
Min FX	1	6:1.5(DL+MW+)	-0.000	18.393	0.000	0.000	0.000	0.412
Max FY	1	6:1.5(DL+MW+)	-0.000	18.393	0.000	0.000	0.000	0.412
Min FY	1	14:0.9(DL+MW)	-0.000	-18.504	-0.000	-0.000	-0.000	-0.399
Max FZ	1	9:1.5(DL+MW+)	0.198	5.070	0.000	0.000	0.000	-0.077
Min FZ	1	8:15(DL+MW+)	-0.000	5.070	-1.593	-3.015	0.032	0.121
Max MX	1	6:1.5(DL+MW+)	-0.000	18.393	0.000	0.000	0.000	0.412
Min MX	1	8:15(DL+MW+)	-0.000	5.070	-1.593	-3.015	0.032	0.121
Max MY	1	8:15(DL+MW+)	-0.000	5.070	-1.593	-3.015	0.032	0.121
Min MY	1	14:0.9(DL+MW)	-0.000	-18.504	-0.000	-0.000	-0.000	-0.399
Max MZ	1	6:1.5(DL+MW+)	-0.000	18.393	0.000	0.000	0.000	0.412
Min MZ	1	14:0.9(DL+MW)	-0.000	-18.504	-0.000	-0.000	-0.000	-0.399

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6. UTILITY RATIO:

Beam	Analysis Property	Design Property	Actual Ratio	Allowable Ratio	Ratio (Act./Allow.)	Clause	L/C	Ax (cm ²)	Iz (cm ⁴)	Iy (cm ⁴)	Ix (cm ⁴)
1	PIP1397L	PIP1397L	0.192	1.000	0.192	Sec. 8.2.1.2	8	19.100	437.000	437.000	874.000
2	PIP1397L	PIP1397L	0.080	1.000	0.080	Sec. 8.2.1.2	8	19.100	437.000	437.000	874.000
3	TUB96482.9	TUB96482.9	0.000	1.000	0.000	Sec. 8.4	8	8.016	95.810	31.980	80.100
4	TUB96482.9	TUB96482.9	0.104	1.000	0.104	Sec. 9.3.2.2	14	8.016	95.810	31.980	80.100
5	TUB96482.9	TUB96482.9	0.052	1.000	0.052	Sec. 9.3.2.2	14	8.016	95.810	31.980	80.100
6	TUB96482.9	TUB96482.9	0.102	1.000	0.102	Sec. 9.3.2.2	14	8.016	95.810	31.980	80.100
7	TUB96482.9	TUB96482.9	0.000	1.000	0.000	Sec. 8.4	8	8.016	95.810	31.980	80.100
8	TUB96482.9	TUB96482.9	0.055	1.000	0.055	Sec. 9.3.2.2	14	8.016	95.810	31.980	80.100
9	PIP337L	PIP337L	0.069	1.000	0.069	Sec. 9.3.2.2	7	2.540	3.080	3.080	6.180
10	PIP424L	PIP424L	0.174	1.000	0.174	Sec. 9.3.2.2	7	3.250	6.460	6.460	12.920
11	TUB96482.9	TUB96482.9	0.000	1.000	0.000	Sec. 8.4	8	8.016	95.810	31.980	80.100
12	TUB96482.9	TUB96482.9	0.654	1.000	0.654	Sec. 9.3.2.2	7	8.016	95.810	31.980	80.100
13	TUB96482.9	TUB96482.9	0.323	1.000	0.323	Sec. 9.3.2.2	14	8.016	95.810	31.980	80.100
14	TUB96482.9	TUB96482.9	0.673	1.000	0.673	Sec. 9.3.2.2	14	8.016	95.810	31.980	80.100
15	TUB96482.9	TUB96482.9	0.000	1.000	0.000	Sec. 8.4	8	8.016	95.810	31.980	80.100
16	TUB96482.9	TUB96482.9	0.295	1.000	0.295	Sec. 9.3.2.2	7	8.016	95.810	31.980	80.100
17	TUB96482.9	TUB96482.9	0.000	1.000	0.000	Sec. 8.4	8	8.016	95.810	31.980	80.100
18	TUB96482.9	TUB96482.9	0.654	1.000	0.654	Sec. 9.3.2.2	7	8.016	95.810	31.980	80.100
19	TUB96482.9	TUB96482.9	0.323	1.000	0.323	Sec. 9.3.2.2	14	8.016	95.810	31.980	80.100
20	TUB96482.9	TUB96482.9	0.673	1.000	0.673	Sec. 9.3.2.2	14	8.016	95.810	31.980	80.100
21	TUB96482.9	TUB96482.9	0.000	1.000	0.000	Sec. 8.4	8	8.016	95.810	31.980	80.100
22	TUB96482.9	TUB96482.9	0.295	1.000	0.295	Sec. 9.3.2.2	7	8.016	95.810	31.980	80.100
23	70CS40X2	70CS40X2	0.353	1.000	0.353	Bending Z	14	3.303	25.341	7.532	0.044
24	70CS40X2	70CS40X2	0.544	1.000	0.544	Bend + Comp	14	3.303	25.341	7.532	0.044
25	70CS40X2	70CS40X2	0.353	1.000	0.353	Bending Z	14	3.303	25.341	7.532	0.044
26	70CS40X2	70CS40X2	0.524	1.000	0.524	Bend + Comp	14	3.303	25.341	7.532	0.044

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Beam	Analysis Property	Design Property	Actual Ratio	Allowable Ratio	Ratio (Act/Allow.)	Clause	L/C	Ax (cm ²)	Ix (cm ⁴)	Iy (cm ⁴)	Iz (cm ⁴)
27	70CS40X2	70CS40X2	0.353	1.000	0.353	Bending Z	14	3.303	25.341	7.532	0.044
28	70CS40X2	70CS40X2	0.544	1.000	0.544	Bend + Comp	14	3.303	25.341	7.532	0.044
29	70CS40X2	70CS40X2	0.353	1.000	0.353	Bending Z	14	3.303	25.341	7.532	0.044
30	70CS40X2	70CS40X2	0.524	1.000	0.524	Bend + Comp	14	3.303	25.341	7.532	0.044
31	70CS40X2	70CS40X2	0.139	1.000	0.139	Bending Z	14	3.303	25.341	7.532	0.044
32	70CS40X2	70CS40X2	0.139	1.000	0.139	Bending Z	14	3.303	25.341	7.532	0.044
33	70CS40X2	70CS40X2	0.139	1.000	0.139	Bending Z	14	3.303	25.341	7.532	0.044
34	70CS40X2	70CS40X2	0.139	1.000	0.139	Bending Z	14	3.303	25.341	7.532	0.044
35	70CS40X2	70CS40X2	0.139	1.000	0.139	Bending Z	14	3.303	25.341	7.532	0.044
36	70CS40X2	70CS40X2	0.139	1.000	0.139	Bending Z	14	3.303	25.341	7.532	0.044
37	70CS40X2	70CS40X2	0.139	1.000	0.139	Bending Z	14	3.303	25.341	7.532	0.044
38	70CS40X2	70CS40X2	0.139	1.000	0.139	Bending Z	14	3.303	25.341	7.532	0.044
39	PIP424L	PIP424L	0.615	1.000	0.615	Sec. 9.3.2.2	7	3.250	6.480	6.460	12.920
40	PIP424L	PIP424L	0.615	1.000	0.615	Sec. 9.3.2.2	7	3.250	6.480	6.460	12.920
41	PIP337L	PIP337L	0.098	1.000	0.098	Sec. 6.2	14	2.540	3.090	3.090	6.180
42	PIP424L	PIP424L	0.056	1.000	0.056	Sec. 9.3.2.2	7	3.250	6.480	6.460	12.920

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CONCLUSION:

The structure is found to be safe and the maximum utility ratio observed is 0.673. The IS Code referred during analysis is IS800-2007 & IS 801- Code of practice for use of cold- formed light gauge steel structural members in general building construction, IS 875- Part3: Wind Loads and IS875- Part1: Dead Loads.



7. STAAD INPUT DATA:

STAAD SPACE
START JOB INFORMATION
ENGINEER DATE 03-Nov-20
END JOB INFORMATION
INPUT WIDTH 79
UNIT METER KN
JOINT COORDINATES
1 0 0 0; 2 0 2 0; 3 0 1.1 0; 4 -1.35 1.3 0; 5 1.39 2.75 0;
6 -1.30561 1.32302 0; 7 -0.431174 1.77643 0; 8 1.34562 2.72605 0;
9 0.478755 2.25832 0; 10 0 2 -1.62; 11 -1.35 1.3 -1.62; 12 1.39 2.75 -1.62;
13 -1.30561 1.32302 -1.62; 14 -0.431174 1.77643 -1.62;
15 1.34562 2.72605 -1.62; 16 0.478755 2.25832 -1.62; 17 0 2 1.62;
18 -1.35 1.3 1.62; 19 1.39 2.75 1.62; 20 -1.30561 1.32302 1.62;
21 -0.431174 1.77643 1.62; 22 1.34562 2.72605 1.62; 23 0.478755 2.25832 1.62;
24 -1.30561 1.32302 -2.65; 25 -0.431174 1.77643 -2.65;
26 1.34562 2.72605 -2.65; 27 0.478755 2.25832 -2.65; 28 -1.30561 1.32302 2.65;
29 -0.431174 1.77643 2.65; 30 1.34562 2.72605 2.65; 31 0.478755 2.25832 2.65;
32 1.14758 2.48674 0; 33 -0.812749 1.23883 0;
MEMBER INCIDENCES
1 1 3; 2 3 2; 3 4 6; 4 2 9; 5 6 7; 6 7 2; 7 8 5; 8 9 8; 9 6 33; 10 3 32;
11 11 13; 12 10 16; 13 13 14; 14 14 10; 15 15 12; 16 16 15; 17 18 20; 18 17 23;
19 20 21; 20 21 17; 21 22 19; 22 23 22; 23 6 13; 24 7 14; 25 8 15; 26 9 16;
27 6 20; 28 7 21; 29 8 22; 30 9 23; 31 13 24; 32 14 25; 33 15 26; 34 16 27;
35 20 28; 36 21 29; 37 22 30; 38 23 31; 39 10 3; 40 3 17; 41 32 8; 42 33 3;
DEFINE MATERIAL START
ISOTROPIC STEEL
E 2.05e+008
POISSON 0.3
DENSITY 76.8195
ALPHA 1.2e-005
DAMP 0.03
TYPE STEEL
STRENGTH FY 253200 FU 407800 RY 1.5 RT 1.2
END DEFINE MATERIAL
MEMBER PROPERTY INDIAN
1 2 TABLE ST PIP1397L
MEMBER PROPERTY COLDFORMED INDIAN
23 TO 38 TABLE ST 70CS40X2
MEMBER PROPERTY INDIAN
3 TO 8 11 TO 22 TABLE ST TUB96482.9
10 39 40 42 TABLE ST PIP424L
9 41 TABLE ST PIP337L
CONSTANTS
MATERIAL STEEL ALL
SUPPORTS
1 FIXED
MEMBER RELEASE
23 TO 38 START MX MY MZ
23 TO 38 END MX MY MZ
LOAD 1 LOADTYPE Dead TITLE DL+MW

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SELFWEIGHT Y -1 LIST 1 TO 40
MEMBER LOAD
23 TO 38 UNI GY -0.1132
LOAD 2 LOADTYPE Live REDUCIBLE TITLE WIND UP
MEMBER LOAD
23 TO 38 UNI GY 0.841
LOAD 3 LOADTYPE Live REDUCIBLE TITLE WIND DOWN
MEMBER LOAD
23 TO 38 UNI GY -0.52
LOAD 4 LOADTYPE Live REDUCIBLE TITLE WIND Z
MEMBER LOAD
1 2 UNI GZ 0.066
3 TO 8 11 TO 22 UNI GZ 0.1
LOAD 7 LOADTYPE Live REDUCIBLE TITLE WIND X
MEMBER LOAD
1 2 UNI GX -0.066
LOAD COMB 5 1.5(DL+MW)
1 1.5
LOAD COMB 6 1.5(DL+MW+ WIND DOWN)
1 1.5 3 1.5
LOAD COMB 8 1.5(DL+MW+ WIND Z)
1 1.5 4 1.5
LOAD COMB 9 1.5(DL+MW+WIND X)
1 1.5 7 1.5
LOAD COMB 10 1.2(DL+MW+WIND UP)
1 1.2 2 1.2
LOAD COMB 11 1.2(DL+MW+WIND DOWN)
1 1.2 3 1.2
LOAD COMB 12 1.2(DL+MW+WIND Z)
1 1.2 4 1.2
LOAD COMB 13 1.2(DL+MW+WIND X)
1 1.2 7 1.2
LOAD COMB 14 0.9(DL+MW)+1.5 WIND UP
1 0.9 2 1.5
LOAD COMB 15 0.9(DL+MW)+1.5 WIND DOWN
1 0.9 3 1.5
LOAD COMB 16 0.9(DL+MW)+1.5 WIND Z
1 0.9 4 1.5
LOAD COMB 17 0.9(DL+MW)+1.5 WIND X
1 0.9 7 1.5
LOAD COMB 18 1.5(DL+MW)+WIND UP
1 1.5 2 1.0
PERFORM ANALYSIS
PARAMETER 1
CODE IS800 LSD
FYLD 210000 MEMB 1 TO 22 39 TO 42
CHECK CODE MEMB 1 TO 22 39 TO 42
PARAMETER 2
CODE IS801
FYLD 250000 MEMB 23 TO 38
CHECK CODE MEMB 23 TO 38
FINISH

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8. STAAD OUTPUT:

STAAD.PROCODECHECKING-IS-800-2007- LSD(V2.0)

MemberNumber:1	
MemberSection:STPIP1397L(INDIANSECTIONS)	
Status:PASSRatio:0.161 CriticalLoadCase:8 Location:0.00	
CriticalCondition:Sec.8.2.1.2	

MemberNumber:2	
MemberSection:STPIP1397L(INDIANSECTIONS)	
Status:PASSRatio:0.068CriticalLoadCase:8Location:0.00	
CriticalCondition:Sec.8.2.1.2	

MemberNumber:3	
MemberSection:STTUB96482.9(INDIANSECTIONS)	
Status:PASSRatio:0.000CriticalLoadCase:8Location:0.05	
CriticalCondition:Sec.8.4	

MemberNumber:4	
MemberSection:STTUB96482.9(INDIANSECTIONS)	
Status:PASSRatio:0.087CriticalLoadCase:14Location:0.00	
CriticalCondition:Sec.9.3.2.2	

MemberNumber: 5	
MemberSection:STTUB96482.9 (INDIANSECTIONS)	
Status:PASSRatio: 0.044 CriticalLoadCase: 14 Location:	0.98
CriticalCondition:Sec.9.3.2.2	

MemberNumber: 6	
MemberSection:ST TUB96482.9 (INDIANSECTIONS)	
Status:PASSRatio: 0.086 CriticalLoadCase: 14 Location:	0.49
CriticalCondition:Sec.9.3.2.2	

MemberNumber: 7	
MemberSection:ST TUB96482.9 (INDIANSECTIONS)	
Status:PASSRatio: 0.000CriticalLoadCase: 8Location:	0.00
CriticalCondition:Sec.8.4	

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SECTION: Cover sheet

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Page No.-20

MemberNumber: 8

MemberSection: ST TUB96482.9 (INDIANSECTIONS)

Status: PASS Ratio: 0.046 Critical Load Case: 14 Location:

0.00

Critical Condition: Sec.9.3.2.2

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Page No.-21

MemberNumber: 9
MemberSection: STPIP337L (INDIANSECTIONS)
Status: PASSRatio: 0.058CriticalLoadCase: 7Location: 0.17
CriticalCondition: Sec.9.3.2.2

MemberNumber: 10
MemberSection: STPIP424L (INDIANSECTIONS)
Status: PASSRatio: 0.166CriticalLoadCase: 7Location: 0.00
CriticalCondition: Sec.9.3.2.2

MemberNumber: 11
MemberSection: STTUB96482.9 (INDIANSECTIONS)
Status: PASSRatio: 0.000CriticalLoadCase: 8Location: 0.05
CriticalCondition: Sec.8.4

MemberNumber: 12
MemberSection: STTUB96482.9 (INDIANSECTIONS)
Status: PASSRatio: 0.550CriticalLoadCase: 7Location: 0.00
CriticalCondition: Sec.9.3.2.2

MemberNumber: 13
MemberSection: STTUB96482.9 (INDIANSECTIONS)
Status: PASSRatio: 0.272CriticalLoadCase: 14Location: 0.98
CriticalCondition: Sec.9.3.2.2

MemberNumber: 14
MemberSection: STTUB96482.9 (INDIANSECTIONS)
Status: PASSRatio: 0.565CriticalLoadCase: 14Location: 0.49
CriticalCondition: Sec.9.3.2.2

MemberNumber: 15
MemberSection: STTUB96482.9 (INDIANSECTIONS)
Status: PASSRatio: 0.000CriticalLoadCase: 8Location: 0.00
CriticalCondition: Sec.8.4

MemberNumber: 16
MemberSection: STTUB96482.9 (INDIANSECTIONS)
Status: PASSRatio: 0.248CriticalLoadCase: 7Location: 0.00
CriticalCondition: Sec.9.3.2

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MemberNumber: 17

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Page No.-22

MemberSection:ST TUB96482.9 (INDIANSECTIONS)

Status:PASS Ratio: 0.000 CriticalLoadCase: 8 Location: 0.05

CriticalCondition:Sec.8.4

MemberNumber:18

MemberSection:ST TUB96482.9 (INDIANSECTIONS)

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Page No.-23

| Status:PASSRatio: 0.550CriticalLoadCase: 7Location: 0.00 |
| CriticalCondition:Sec.9.3.2.2 |

| MemberNumber:19 |
| MemberSection: ST TUB96482.9 (INDIANSECTIONS) |
| Status:PASSRatio: 0.272CriticalLoadCase: 14Location: 0.98 |
| CriticalCondition:Sec.9.3.2.2 |

| MemberNumber:20 |
| MemberSection: ST TUB96482.9 (INDIANSECTIONS) |
| Status:PASSRatio: 0.565CriticalLoadCase: 14Location: 0.49 |
| CriticalCondition:Sec.9.3.2.2 |

STAAD.PROCODECHECKING-IS-800-2007-LSD(V2.0)

| MemberNumber:21 |
| MemberSection:ST TUB96482.9 (INDIANSECTIONS) |
| Status:PASSRatio: 0.000CriticalLoadCase: 8Location: 0.00 |
| CriticalCondition:Sec.8.4 |

| MemberNumber:22 |
| MemberSection:ST TUB96482.9 (INDIANSECTIONS) |
| Status:PASSRatio: 0.248CriticalLoadCase: 7Location: 0.00 |
| CriticalCondition:Sec.9.3.2.2 |

| MemberNumber:39 |
| MemberSection:STPIP424L (INDIANSECTIONS) |
| Status:PASSRatio: 0.567CriticalLoadCase: 7Location: 1.85 |
| CriticalCondition:Sec.9.3.2.2 |

| MemberNumber:40 |
| MemberSection:STPIP424L (INDIANSECTIONS) |
| Status:PASSRatio: 0.567CriticalLoadCase: 7Location: 0.00 |
| CriticalCondition:Sec.9.3.2.2 |

STAAD.PROCODECHECKING-IS-800-2007-LSD(V2.0)

| MemberNumber:41 |
| MemberSection:STPIP337L (INDIANSECTIONS) |
| Status:PASSRatio: 0.083 CriticalLoadCase: 14Location: 0.00 |
| CriticalCondition:Sec.6.2 |

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Page No.-24

MemberNumber: 42
MemberSection: ST PIP424L (INDIANSECTIONS)
Status: PASS Ratio: 0.048 CriticalLoadCase: 7 Location: 0.82
CriticalCondition: Sec.9.3.2.2

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Page No.-25

STAAD.ProCODECHECKING-(1801)

UNITS:MM,KN,KNM,MPA

MEMBER#23 SECTION:70CS40X2

LEN:

1620.00 GOV.LOC:810.00 |

STATUS:PASSRATIO= 0.267 GOV.MODE:BendingZGOV.LOAD:14 |

UNITS:MM,KN,KNM,MPA

MEMBER#24 SECTION:70CS40X2 LEN:

1620.00GOV.LOC:810.00|

STATUS:PASSRATIO= 0.411

GOV.MODE:Bend+CompressGOV.LOAD:14 |

UNITS:MM,KN,KNM,MPA

MEMBER#25 SECTION:70CS40X2

LEN:

1620.00 GOV.LOC:810.00 |

STATUS:PASSRATIO= 0.267 GOV.MODE:BendingZGOV.LOAD:14 |

UNITS:MM,KN,KNM,MPA

MEMBER#26 SECTION:70CS40X2LEN:

1620.00 GOV.LOC:810.00 |

STATUS:PASSRATIO= 0.395

GOV.MODE:Bend+CompressGOV.LOAD:

14 |

UNITS:MM,KN,KNM,MPA

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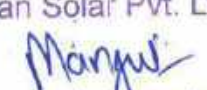
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1620.00GOV.LOC810.00|

|STATUS:PASSRATIO= 0.267 GOV.MODE:BendingZGOV.LOAD:14 |


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UNITS:MM,KN,KNM,MPA

MEMBER#28 SECTION:70CS40X2

LEN:

1620.00 GOV.LOC:810.00 |

STATUS:PASSRATIO= 0.411

GOV.MODE:Bend+CompressGOV.LOAD:14 |

UNITS:MM,KN,KNM,MPA

MEMBER#29 SECTION:70CS40X2

LEN:

1620.00 GOV.LOC:810.00 |

STATUS:PASSRATIO= 0.267 GOV.MODE:BendingZGOV.LOAD:14 |

UNITS:MM,KN,KNM,MPA

MEMBER#30 SECTION:70CS40X2LEN:

1620.00 GOV.LOC:810.00 |

STATUS:PASSRATIO= 0.395

GOV.MODE:Bend+CompressGOV.LOAD:14 |

UNITS:MM,KN,KNM,MPA

MEMBER#31 SECTION:70CS40X2

LEN:

1030.00 GOV.LOC:515.00 |

STATUS:PASSRATIO= 0.099 GOV.MODE:BendingZGOV.LOAD:14 |

UNITS:MM,KN,KNM,MPA

MEMBER#32 SECTION:70CS40X2

LEN:

1030.00 GOV.LOC:515.00 |

STATUS:PASSRATIO= 0.099 GOV.MODE:BendingZGOV.LOAD:14 |

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UNITS:MM,KN,KNM,MPA

MEMBER#33 SECTION:70CS40X LEN: 1030.00
GOV.LOC:515,00

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|STATUS:PASSRATIO= 0.099
GOV.MODE:BendingZGOV.LOAD:14 |

|UNITS:MM,KN,KNM,MPA

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|STATUS:PASSRATIO= 0.099 GOV.MODE:BendingZGOV.LOAD:14 |

|UNITS:MM,KN,KNM,MPA

|MEMBER#35 SECTION:70CS40X2 LEN:
1030.00GOV.LOC:515.00 |

|STATUS:PASSRATIO= 0.099 GOV.MODE:BendingZGOV.LOAD:14 |

|UNITS:MM,KN,KNM,MPA

|MEMBER#36 SECTION:70CS40X2 LEN:
1030.00GOV.LOC:515.00 |

|STATUS:PASSRATIO= 0.099 GOV.MODE:BendingZGOV.LOAD:14 |

|UNITS:MM,KN,KNM,MPA

|MEMBER#37 SECTION:70CS40X2 LEN: 1030.00
GOV.LOC:515.00 |

|STATUS:PASSRATIO= 0.099 GOV.MODE:BendingZGOV.LOAD:14 |

|UNITS:MM,KN,KNM,MPA

|MEMBER#38 SECTION:70CS40X2 LEN:
1030.00 GOV.LOC:515.00 |

|STATUS:PASSRATIO= 0.099 GOV.MODE:BendingZGOV.LOAD:14 |

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9. FOUNDATION

Breadth of Pedestal	$B = 0.4$	m	
Length of Pedestal	$L = 0.4$	m	
Density of Water	$\gamma_w = 10$	KN/m ³	
Density of Soil	$\gamma_s = 20.0$	KN/m ³	
Factor of safety	$FOS = 1.5$		
Unit of Pedestal material	$\gamma_p = 23.0$	Kn/m ³	
Grade of Concrete	$= 23.0$	N/mm ²	
Grade of Steel	$F_y = 500$	N/mm ²	
Soil Bearing Capacity	$SBC = 80.0$	Kn/m ²	
Bearing capacity Factor, N_y	$N_y = 0.6$	IS 6403:1981 Table-1' Bearing Capacity factor	
Bearing capacity Factor, N_q	$N_q = 1.75$		
Bearing capacity Factor, N_c	$N_c = 6.86$		
Downward Pressure from Super structure(P)	$Q_v(+) = 18.39$	KN	
Uplift from Super structure	$Q_v(-) = 18.50$	KN	From STAAD Result
Lateral force from Super structure	$Q_H = 1.593$	KN	
Moment from Super structure(P)	$M = 3.015$	KN-m	
Unsupported length of pedestal	$e = 0.1$	m	
Above ground			

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DESIGN

VERTICAL CAPACITY OF FOOTING

AREA OF FOOTING:

Assume Selfweight of footing

$$w = 1.839 \text{ KN}$$

$$w = 0.1P$$

Total Weight

$$W = 1.839 + 18.39 \text{ KN}$$

$$W = 0.1P + P$$

$$= 20.229 \text{ KN}$$

Area of Footing

$$A = 20.229 / 80 \text{ KN}$$

$$A = W / \text{SBC}$$

$$A = 0.253 \text{ m}^2$$

Size of footing

$$L = B = \sqrt{0.253} \text{ m}$$

$$= 0.5029 \text{ m}$$

Therefore

Provide 0.5 m x 0.5 m Square Footing,

So

Total area Required

$$= 0.25$$

$$\text{m}^2$$

Length of Footing

$$= 0.50$$

$$\text{m}$$

Breadth of Footing

$$= 0.50$$

$$\text{m}$$

PRESSURE ACTS ON FOOTING:

Pressure

$$P = Pu / A \text{ KN/m}^2$$

$$P = 1.5 \times 20.229 / 0.25 \text{ KN/m}^2$$

Pressure

$$P = 121.37 \text{ KN/m}^2$$

FACTORED BENDING MOMENT per 'm':

Factored Bending Moment

$$Mu = PxLX((B-D)/2)^2/2 \text{ KN-m}$$

$$Mu = 121.37 \times 0.5 \times ((0.5 - 0.4)/2)^2/2 \text{ KN-m}$$

$$Mu = 0.0758 \text{ KN-m}$$

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Where

B= Length of Footing

D= Length of Pedestal

P= Pressure on Footing

L= B

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EFFECTIVE DEPTH:

$$d_{\text{required}} = \sqrt{Mu/0.133 \times f_{ck} \times b} \quad \text{mm}$$

$$d_{\text{required}} = \sqrt{0.0758 \times 10^6 / 0.133 \times 20 \times 500} \quad \text{mm}$$

$$d_{\text{required}} = 56.99 \quad \text{mm}$$

we provide

$$d = 150.0 \quad \text{mm}$$

For considerations, increase depth 1.75 to 2 times more than the calculated value

$$d = 150.0 \times 2$$

Effective depth

$$d = 300 \quad \text{mm}$$

Overall depth

$$D = 350 \quad \text{mm}$$

Footing cover

$$= 50 \quad \text{mm}$$

Where

Mu= Factored Moment

f_{ck} = Characteristic Compressive strength

b= Breadth of Footing

AREA OF TENSION REINFORCEMENT:

Moment of Resistance

$$Mu = 0.87 F_y A_{st} d (1 - A_{st} F_y / b d F_{ck}) \quad \text{mm}^2$$

$$0.0758 \times 10^6 = 0.87 \times 500 A_{st} \times 300 (1 - A_{st} \times 500 / 500 \times 500 \times 20) \quad \text{mm}^2$$

$$0.0758 \times 10^6 = 0.87 \times 500 A_{st} \times 300 (1 - A_{st} \times 500 / 500 \times 500 \times 20) \quad \text{mm}^2$$

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$$A_{st} = 721 \quad \text{mm}^2$$

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Where

M_u = Factored Moment

f_{ck} = Characteristic Compressive strength

b = effective depth

d = Breadth of Footing

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AREA OF STEEL per m:

$$= A_{st}/\text{span}$$

$$= 721/0.5$$

$$= 1442$$

mm^2

AREA OF ONE BAR:

$$a_{st} = \pi d^2/4$$

Assume 16 mm dia bar,

$$= 3.14 \times 16^2/4$$

$$= 200.96$$

mm^2

SPACING OF REINFORCEMENT:

$$= (\text{Area of one bar}/\text{area}/\text{m}) \times 1000$$

$$= (a_{st}/A_{st}) \times 1000$$

$$= (200.96/1442) \times 1000$$

$$= 139.36$$

mm

mm

Provide 16 mm dia bars at 150 mm c/c spacing.

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NUMBER OF BARS:

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$$= (A_{st}/a_{st})$$

$$= (1442/200.96)$$

$$= 8 \text{ nos of bar}$$



CHECK FOR ONE WAY SHEAR:

(a) SHEAR FORCE PER 'm':

$$\begin{aligned} V_u &= P \times B \times ((L-D)/2-d) \\ &= 121.37 \times 1 \times ((0.5-0.4)/2-0.5) \\ &= 54.62 \quad \text{KN} \end{aligned}$$

(b) NOMINAL SHEAR STRESS:

$$\begin{aligned} T_v &= V_u / bd \\ &= 54.62 \times 10^3 / 1000 \times 300 \\ &= 0.182 \quad \text{N/mm}^2 \end{aligned}$$

(c) percentage of steel:

$$\begin{aligned} &= 100 \times A_{st} / bd \\ &= 100 \times 721 / 500 \times 300 \\ &= 0.48 \end{aligned}$$

Now, Refer Table No.19 Page No. 73 of IS456:2000

$$T_c = 0.47 \quad \text{N/mm}^2$$

Therefore,

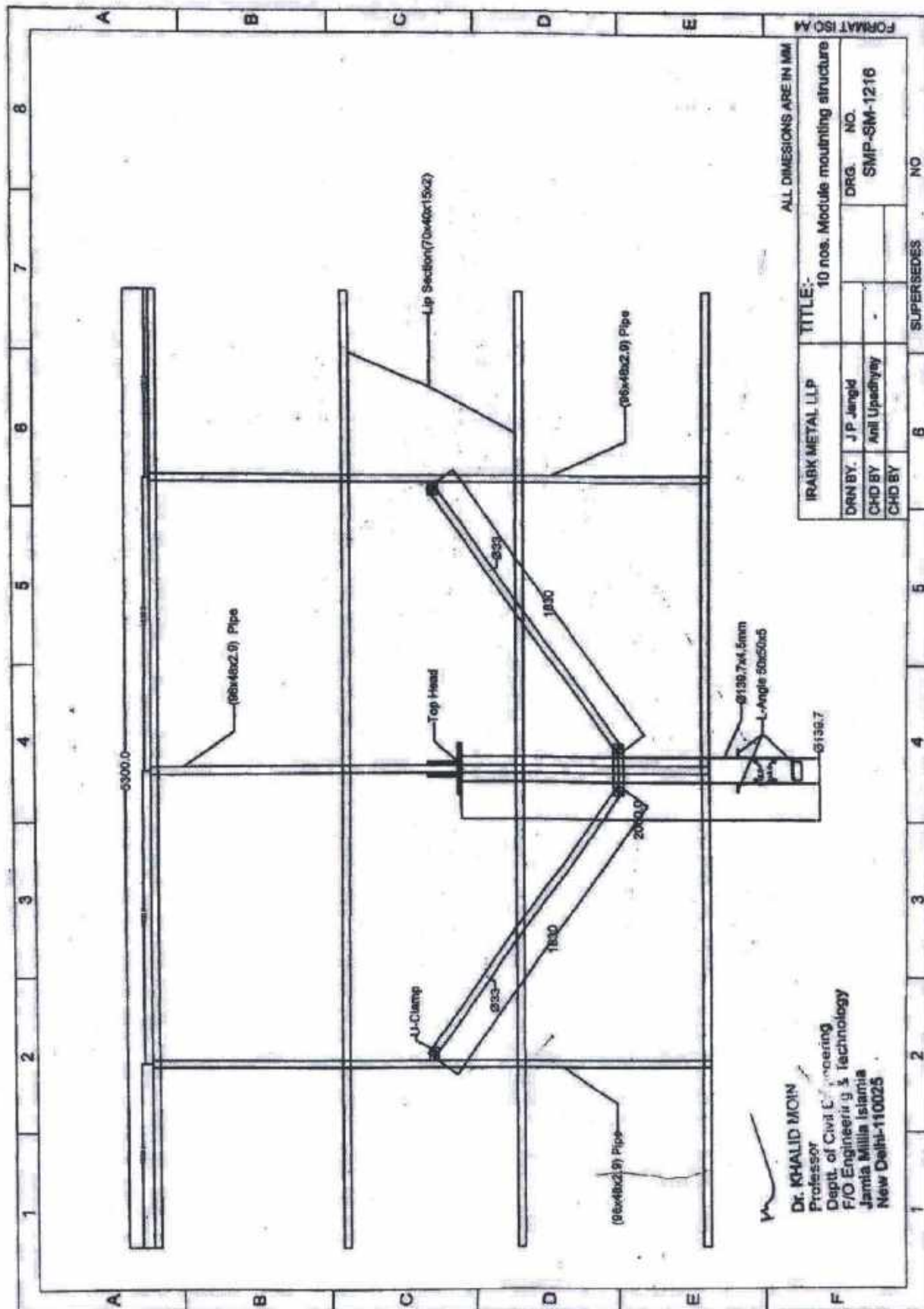
$$\begin{aligned} T_v &< T_c \\ 0.172 \text{ N/mm}^2 &< 0.47 \text{ N/mm}^2 \end{aligned}$$

HENCE, Design is safe against one way shear.

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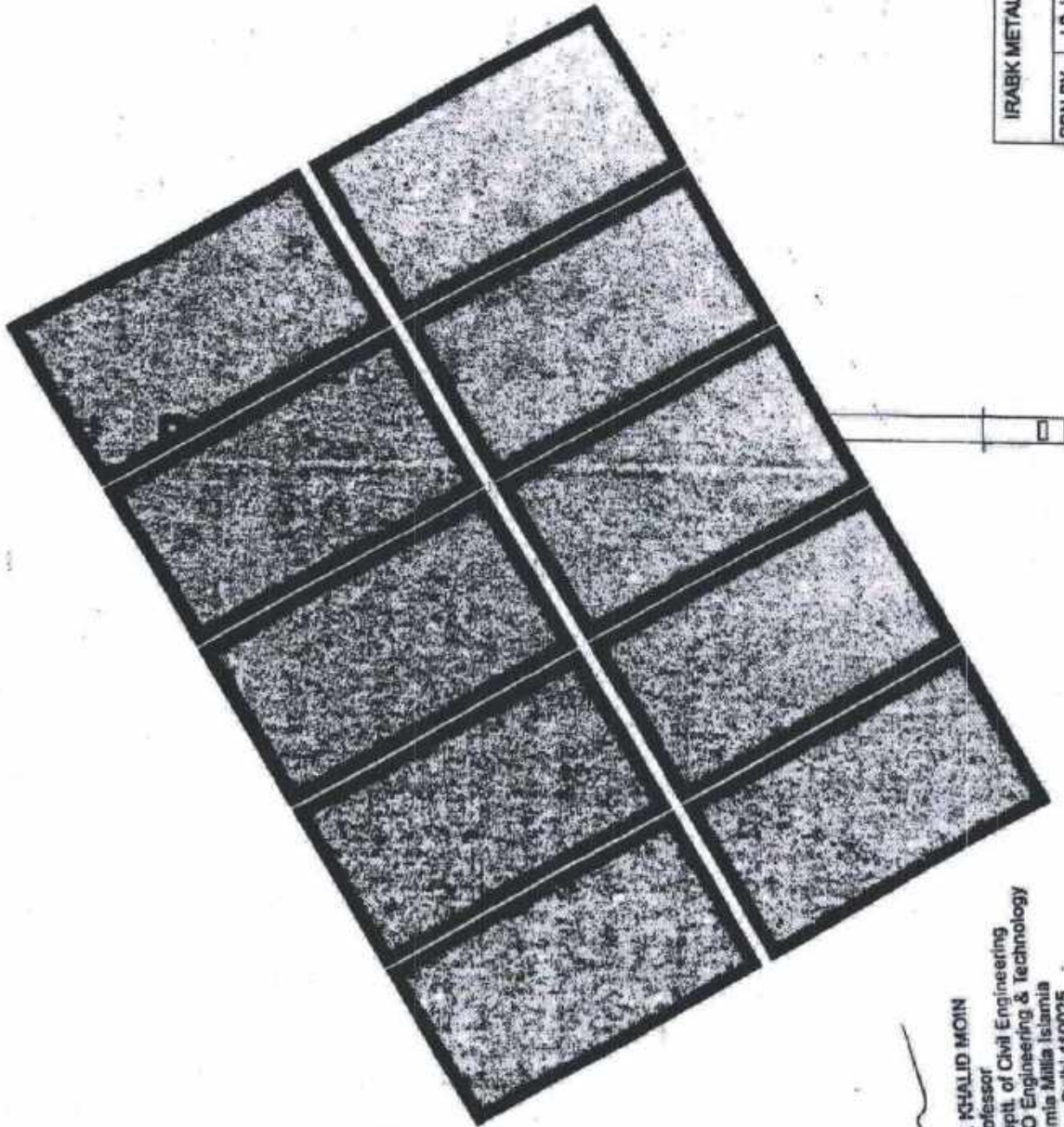
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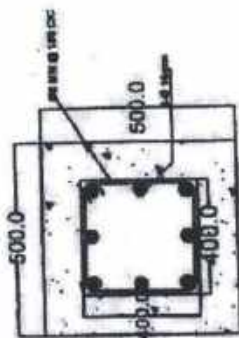
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DRN BY.	J P Jangid	SCALE	DRG. NO.	SMP-SM-1216	
CHD BY	Anil Upadhyay	1:1	105	(Sheet 3)	
CHD BY					
SUPERSEDES			NO		



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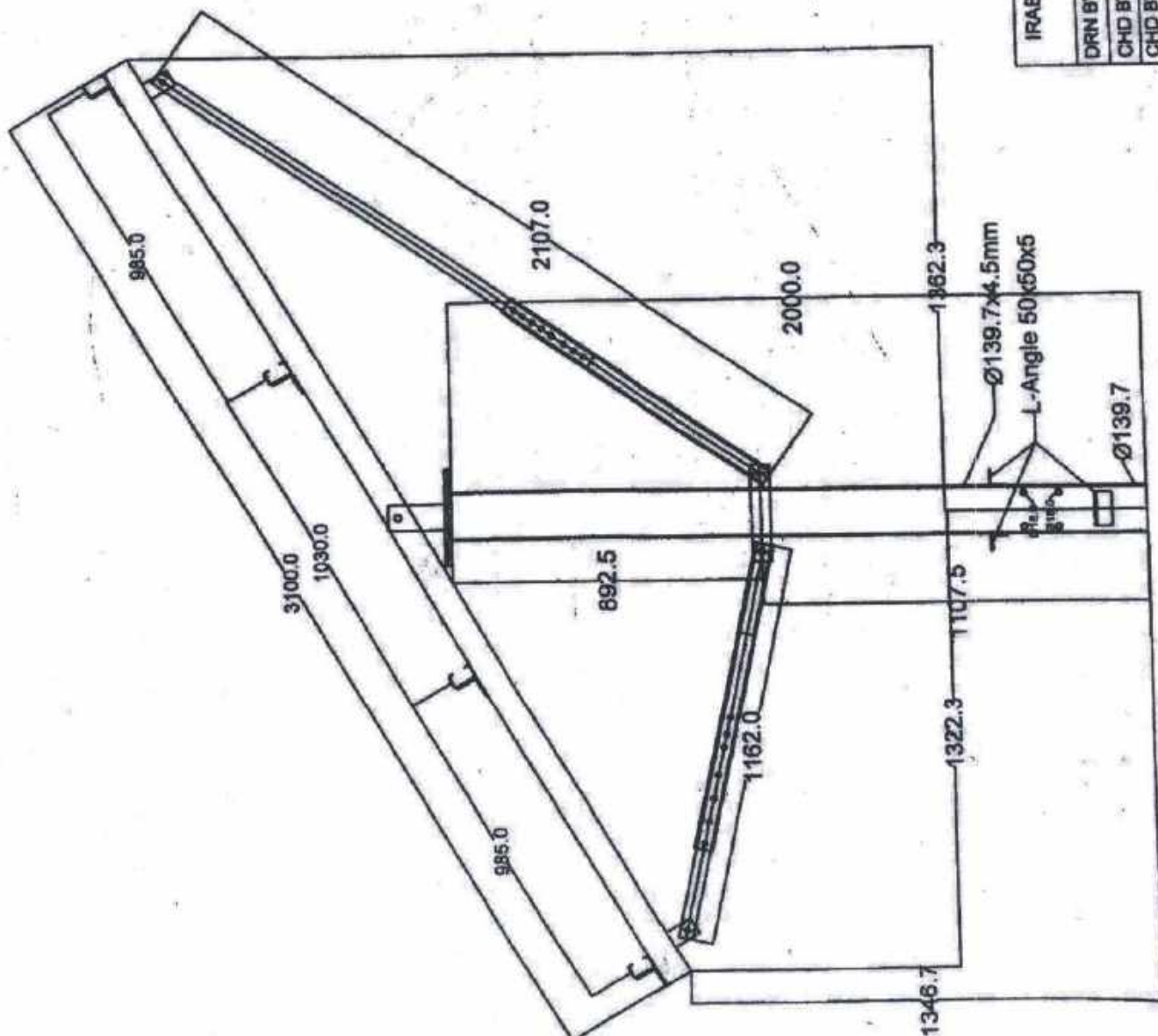
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DRN BY.	J P Jangid	DRG. NO. SMP-SM-1216 (Sheet 2)	NO
CHD BY	Anil Upadhyay		
CHD BY			
		PO. No.	105
		SUPERSEDES	

NO	CLIPPERSEDES
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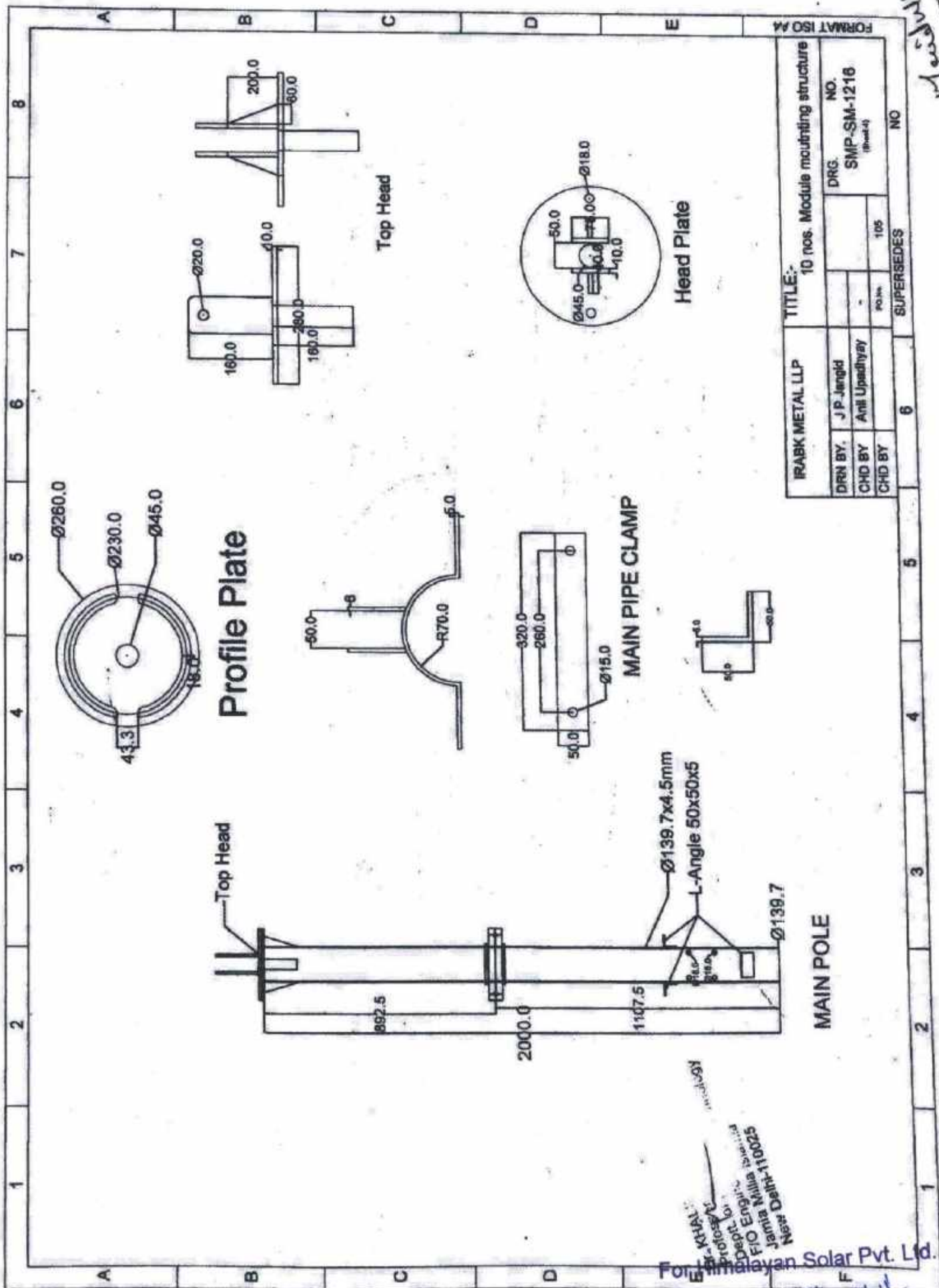
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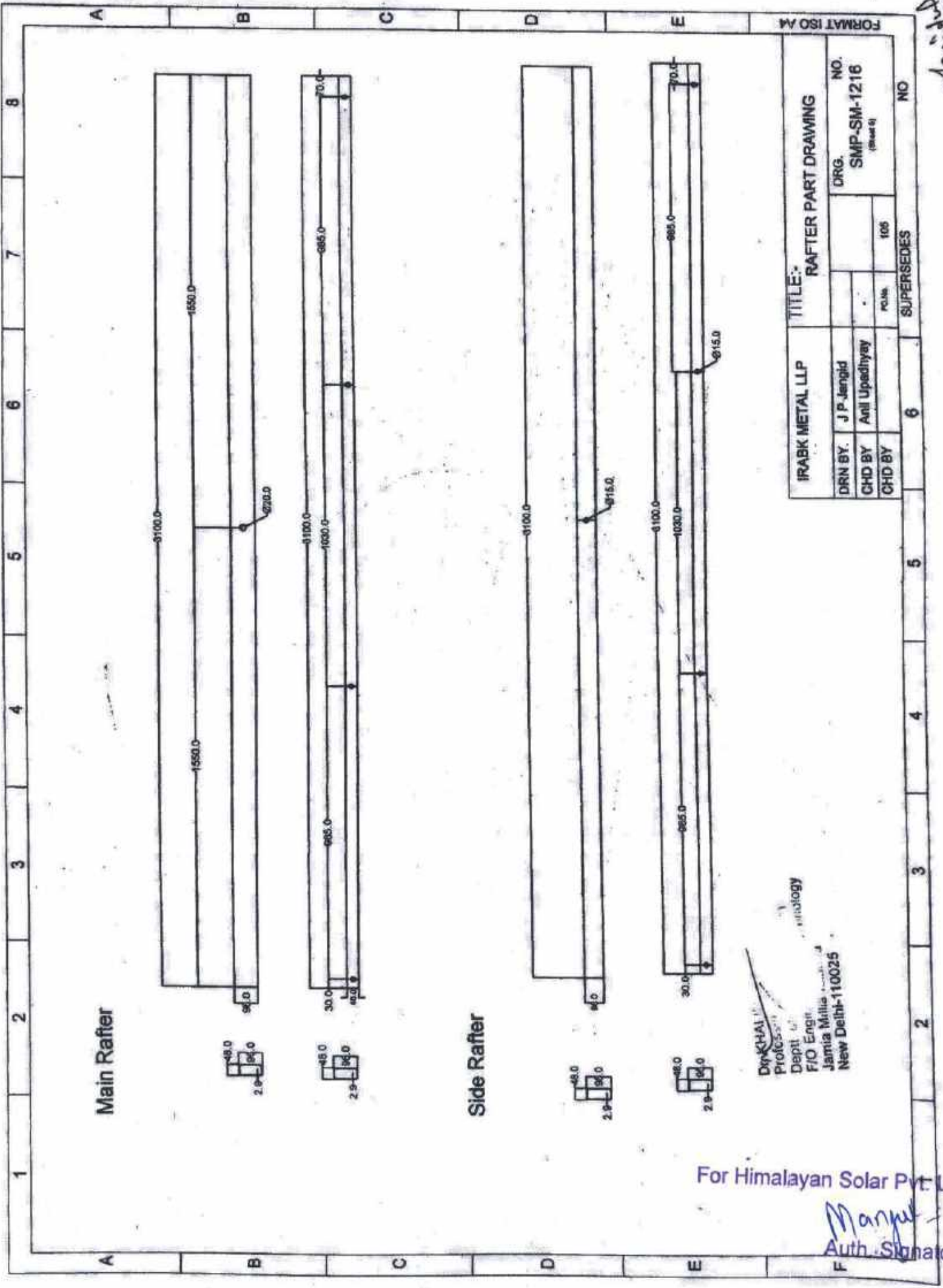
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1

1. Amphipoda





FORMAT ISO A4

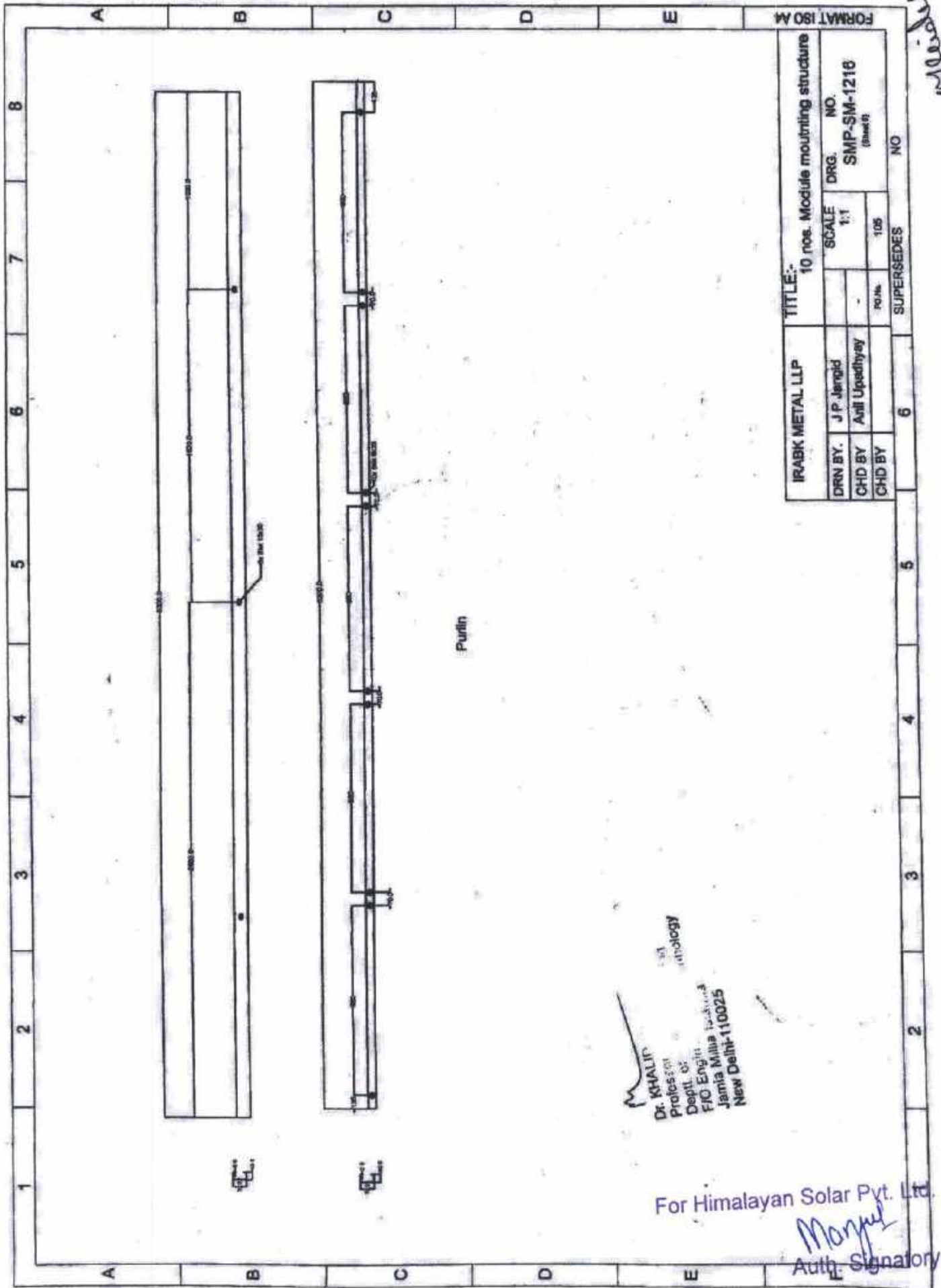
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DRN BY. J P Jangid				DRG. SMP-SM-1216	
CHD BY Anil Upadhyay				(Sheet 6)	
CHD BY		PC/M	105	NO	
			SUPERSEDES		
			6		

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DRN BY.	J.P. Jangid	SCALE	1:1	DRG. NO.	SMP-SM-1216		(Sheet 1)
CHD BY	Anil Upadhyay	PO No.	105	SUPERSEDES	NO		
CHD BY							

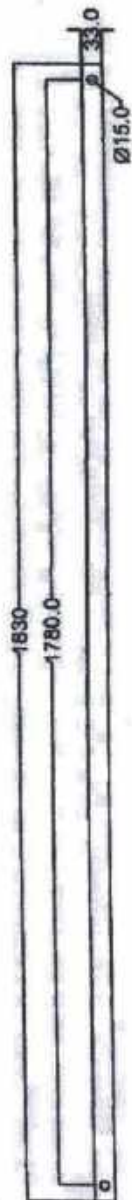
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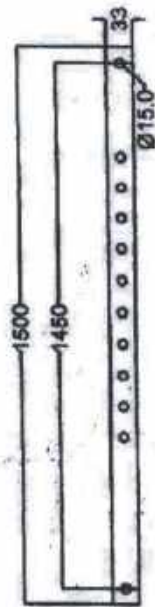
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E-W Support



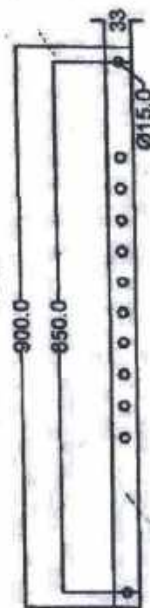
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CHD BY		SCALE	

NO. 6

SUPERSEDES

6

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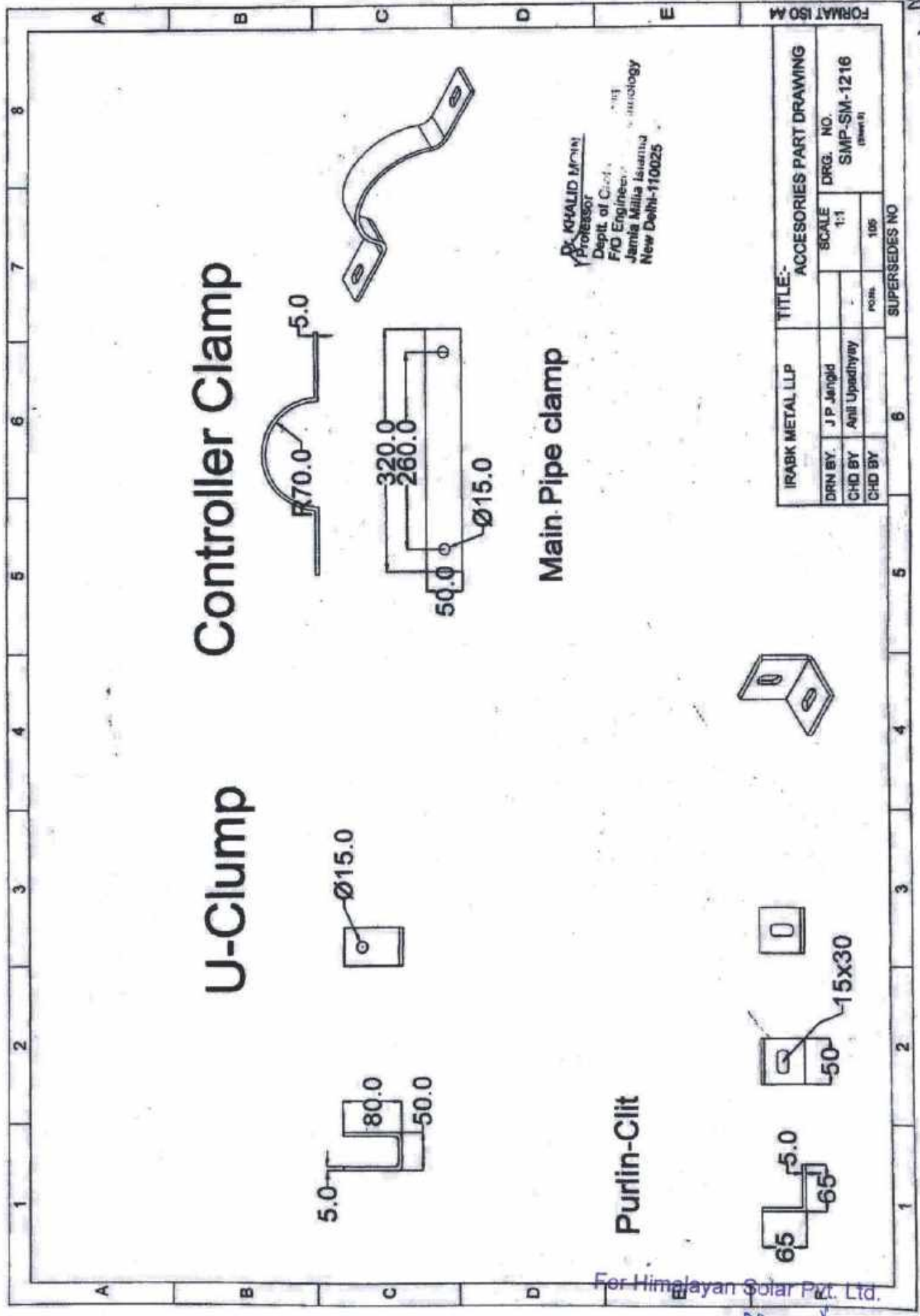
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IRABK METAL LLP				TITLE:-	
DRN BY.	J P Jangid	SCALE	1:1	ACCESSORIES PART DRAWING	
CHD BY	Anil Upadhyay	DRG. NO.	SMP-SM-1216	(sheet 1)	
CHD BY		POIN.	105	SUPERSEDES NO	

For Himalayan Solar Pvt. Ltd.

Manjiv
Auth. Signatory