जामिया मिल्लिया इस्लामिया
(संसदीय अभिनियमानुसार 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
इंजीनियरिंग और प्रौद्योगिकी संकाय

Phone (Office) : 011-26985227
26981717 (Ex 2312)
Phone (Personal) : 9810984903
26981717 (Ex 2318)
Email : kmoin_ci@hotmail.com
kmoin@jmi.ac.in
Website : www.jmi.ac.in

Department of Civil Engineering
Faculty of Engineering & Technology

NO: 2020/3581 **Dated: 11.06.2020**

TO WHOMSOEVER IT MAY CONCERN

Following designs of Solar Module Mounting Structure submitted by M/S ***Ethos Power Pvt. Ltd***

S. No.	Structure Table Size	Drawing No.
01	6 Modules Mounting Structure	SEPL/VT/P02202021/M01
02	9 Modules Mounting Structure	SEPL/VT/P02202021/M02

have been checked & evaluated using STAAD Pro report for various parameters as per IS 875 : 2015, IS 800 : 2007 for a wind speed of 155kmph and hence it is approved.

The above designs have been compared with "Indicative MNRE Design" of the tender no. NIT/Bid Document No. EESL/06/2019-20/KUSUM/SWPS/Phase-01/Off Grid/192007012 dated 21-08-2019 (Section 4, Annexure - A) 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	Higher Wind Speed withstanding capacity	ALTERNATE Design can withstand a wind speed of 155kmph which is higher than the requirement of 150kmph by MNRE.	Withstanding Higher wind speed would result in a better reliability and longer life of the MMS.
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. (Refer Annexure 01)	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 pilling 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
Deptt. of Civil Engineering
F/O Engineering & Technology
Jamia Millia Islamia
New Delhi-110025

DESIGN BASIS REPORT

FOR

6 MODULE SOLAR PUMP

MOUNTING STEEL STRUCTURE TABLE

For

ETHOS POWER PVT LTD.

121-123, 1st Floor, NH – 8 DLF Star Tower, Sector 30, Gurugram, Haryana, India - 122001

Date:06thJUNE 2020

Approved :-

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

TABLE OF CONTENTS

1. GENERAL:

2.1SCOPE

This document covers the Analysis & Design of Fixed typeSolar PV Module mounting structure at an angle of **tilt 25 degree** for at **155kmph** wind speed.

2.2UNITS OF MEASUREMENTS

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

2.3CODES 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 (WSD)	Code of practice for general construction in steel of hot rolled
8	IS 801: 1975	Code of practice for cold formed steel
9	IS 811: 1987	Specifications for cold formed light gauge structural steel sections
10	IS: 2062	Hot rolled medium and high tensile structural steel

2.4MATERIAL PROPERTIES:

Material	Property	Value	Units
Concrete - M25	Density	25	kN/m^3
	Characteristic Strength	25	N/m^2
	Modulus of Elasticity	25000	N/m^2
High Strength Reinforcing Steel	Density	78.5	kN/m^3
	Characteristic Strength	500	N/m^2
	Modulus of Elasticity	200000	N/m^2
Structural Steel	Density	78.5	kN/m^3
	Characteristic Strength	350000	kN/m^2
	Modulus of Elasticity	250000	N/m^2

2.5PLANT INFORMATION:

Location of Site: India
Basic Wind Speed: 43 m/s (155kmph)

2.6 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

Approved -

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

2. LOADS:

2.1 Load Calculation:

Dead Load Calculation:-	UDL LOAD			
Module	=			
Solar module Dimension	=	Length (mm)	Width (mm)	Nos
		1964	986	6
Weight per module	=	22.5	Kg's/module	
Weight of 6 modules	=	135	Kg's	
Module Configuration	=	2X3	Portrait	
Including 10% extra Load per for connections	=	135	Kg's	
Purlin Length	=	3	m	
Total Legth of purlin	=	12	m	
Udl load at purlin	=	0.110	kN/m	
All dead loads have been applied as udl load by considering the modules are in constant touch with the purlin upper face.				

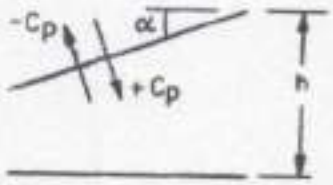
2.1.1 Wind Load:

Wind Pressure Calculation					
Basic Wind Speed	=	150.00	kmph		
Basic Wind Speed	=	42	m/sec		
Design Period	=	25	years	As per Tender Specification	
Type of MMS	=	Ground Based			
Terrain Category	=	2			
Class	=	A			
Module Clearance From NGL	=	0.85	m		
		Length	Width	Nos	
Solar module Dimension	=	1964	986	6	
Risk Co-efficient k1	=	0.91	**(As per Table-1, IS-875 part-3)**		
Terrain Factor, k2	=	1.00	**For Terrain Category 2**		
Topography factor k3	=	1.00	**(As per Table-2 of IS: 875 Part 3- 1987)**		
Importance factor k4	=	1.00	**(Refer IS-875,part-3 clause-6.3.4)**		
Design Wind Speed, Vz=k1*k2*k3*k4=	=	37.92	**m/sec**		
Design Wind pressure, Pz =0.6*[Vz]^2=	=	718.84	**N/sqm**		
As per Latest code IS : 875 (Part-3-2015)					
The design wind pressure pd can be obtained as as per clause 4.5.2[pd = Kd. Ka. Kc .Pz]					
Where,					
Wind directionality factor kd	=	0.90	**(Refer clause-7.2.1, In IS-875-part-3)**		
Area of solar panels	=	5.62	**<10**		
Area averaging factor, ka	=	0.95	**(if this area is >= 25 than Ka = 0.9)**		
Combination factor kc	=	1	**(Refer clause-7.3.3.10, In IS-875-part-3)**		
Design pressure shall be, pd = Kd. Ka. Kc . Pz=	=	**621.08**	**N/sqm**		

Approved

Dr. KHALID MOIN
Professor
Deptt. of Civil Engineering
FAO Engineering & Technology
Jamia Millia Islamia
New Delhi-110025

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, Part3 - 2015. The pressure coefficients for a mono-slope free roof of 05° tilt angle and solidity ratio of 0.

WINDLOAD SIDEWAYS (X & Z DIRECTION)								
MMS ELEMENTS		SECTIONS DETAIL						
		Web	Flange	Lip	Thk			
Column	=	127	127	0	4.5			
Rafter	=	100	60	15	3			
BRACING	=	33.7	33.7	0	2.6			
As per table 39, IS-875,part 3								
Design Wind speed Vd	=	37.92	m/sec					
Design Wind pressure Pd	=	421.68	N/mm2					
Section		Angle of Wind	Cfx	Wind facing width in mm(D) (X-direction)	Length of member in mm(l)	Dvd in m²/sec (X-direction)	l/b or l/D ratio (X-direction)	Reduction factor (K)
Column	=	0°	0.56	127	3117	3	8.89	0.82
Rafter	=	0°	2.05	100	6000	4	30.00	0.94
Section		Angle of Wind	Cfz	Wind facing width in mm(D) (Z-direction)	Length of member in mm(l)	Dvd in m²/sec (Z-direction)	l/b or l/D ratio (Z-direction)	Reduction factor (K)
Column	=	90°	0.16	127	3117	3	8.89	0.82
BRACING	=	80°	0.58	33.7	3175	1	34.72	0.61
Wind force at Column per metre F=pd*width*cfx*b=	=	0.0321	Kn/m	X-direction				
Wind force at Rafter per metre F=pd*width*cfx*b=	=	0.1069	Kn/m					
Wind force at Column per metre F=pd*width*cfz*b=	=	0.0323	Kn/m	Z-direction				
Wind force at Bracing per metre F=pd*width*cfz*b=	=	0.0366	Kn/m					

Approved

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

WINDLOAD UPWARD/DOWNWARD (+/- Y DIRECTION)					
Solar module Dimension	=	Length	Width	Nos	
		1964	980	6	
Tilt angle of MMS for mount	=	25	Degree		
Upward/Downward Wind Force,F=Cp*A*Pd					
Where					
Pressure Coefficient for Upward wind,cp	=	-1.6		(As per IS875 Part-3, Table-B)	
Surface Area of Structural element A=(1964*886*6)/(10^6)	=	11.62	sqm		
Design wind pressure,pd	=	621.08	N/sqm		
Upward Wind force,Fu=Cp*A*Pd	=	-11.55	Kn		
Pressure coefficient for Downward wind,cp	=	1.00		(As per IS875 Part-3, Table-B)	
Downward Wind force,Fd=Cp*A*Pd	=	7.22	Kn		
Here, we are considering aplied wind force of Solar panels shall be bear by Purlin					
No. of Purlin support	=	4	Nos		
Length of member	=	3	m		
Upward Wind force,F=Fu/(4*3)	=	-0.96	Kn/m		
Downward Wind force,F=Fd/(4*3)	=	0.601	Kn/m		

Where, Negative sign shows Upward direction of Wind

2.2 LOAD COMBINATION

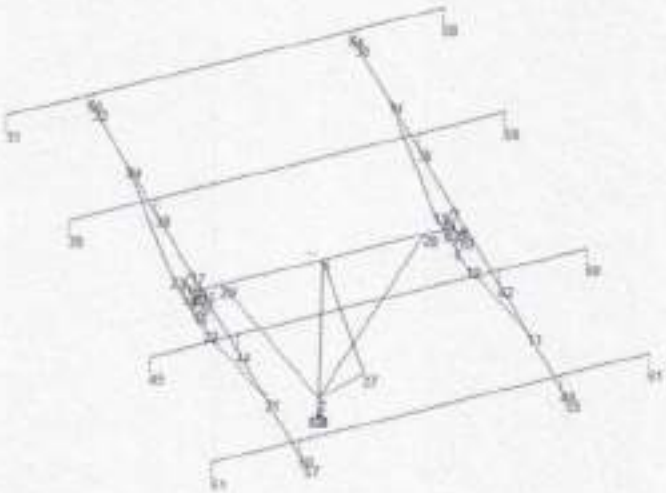
LOAD TYPE	L/C	LOAD NAME
Primary	1	DEAD LOAD STRUCTURE
Primary	2	WIND LOAD X+
Primary	3	WIND LOAD X-
Primary	4	WIND LOAD Z+ UPWARD
Primary	5	WIND LOAD Z- DOWNWARD
Combination	6	1 DEAD LOAD + 1 WIND LOAD X+
Combination	7	1 DEAD LOAD + 1 WIND LOAD X-
Combination	8	1 DEAD LOAD + 1 WIND LOAD Z+ UPWARAD
Combination	9	1 DEAD LOAD + 1 WIND LOAD Z- DOWNWARD
Combination	10	1 DEAD LOAD + 1 WIND LOAD X+ + 1 WIND LOAD Z+ UPWARD
Combination	11	1 DEAD LOAD + 1 WIND LOAD X+ + 1 WIND LOAD Z- DOWNWARD
Combination	12	1 DEAD LOAD + 1 WIND LOAD X- + 1 WIND LOAD Z+ UPWARD
Combination	13	1 DEAD LOAD + 1 WIND LOAD X- + 1 WIND LOAD Z- DOWNWARD

Approved :-

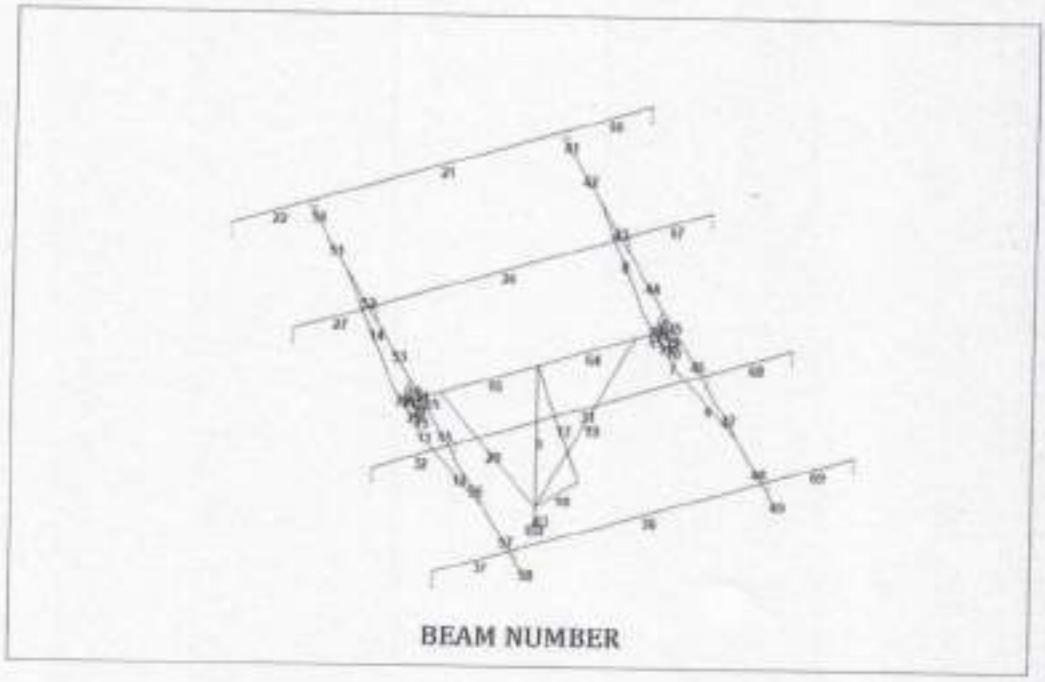
Dr. KHALID MOIN
Professor
Deptt. of Civil Engineering
FAO Engineering & Technology
Jamia Millia Islamia
New Delhi-110025

3. STAAD MODEL:

STAAD 3D Rendered View



NODE NUMBER



BEAM NUMBER

4. DEFLECTION CHECK:

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

Table 6 Deflection Limits

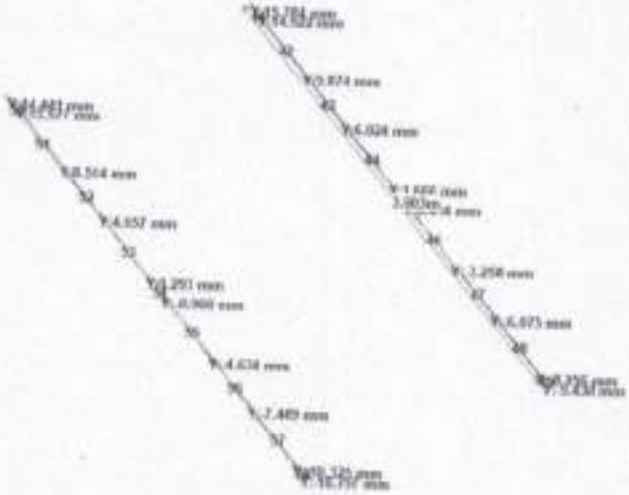
Type of Building	Deflection	Design Load	Member	Supporting	Maximum Deflection
(1)	(2)	(3)	(4)	(5)	(6)
Industrial Buildings	Vertical	Live load/ Wind load	Purlins and Girts	Elastic cladding	Span/150
				Brittle cladding	Span/180
		Live load	Simple span	Elastic cladding	Span/240
				Brittle cladding	Span/300
		Live load	Cantilever span	Elastic cladding	Span/120
				Brittle cladding	Span/150
		Live load/ Wind load	Rafter supporting	Profiled Metal Sheeting	Span/180
				Pressed Steeling	Span/240
		Crane load (Manual operation)	Gantry	Crane	Span/500
		Crane load (Electric operation up to 50 t)	Gantry	Crane	Span/750
		Crane load (Electric operation over 50 t)	Gantry	Crane	Span/1 000
	Lateral	Wind load	Column	Elastic cladding	Height/150
				Masonry/Brittle cladding	Height/240
		Crane + wind	Gantry (lateral)	Crane (shoulder)	Span/600
				Relative displacement between rails supporting crane	10 mm
		Crane+ wind	Column/Frame	Gantry (Elastic cladding: pendent operated)	Height/240
				Gantry (Brittle cladding: cab operated)	Height/400
Other Buildings	Vertical	Live load	Floor and Roof	Elements not susceptible to cracking	Span/300
				Elements susceptible to cracking	Span/360
		Live load	Cantilever	Elements not susceptible to cracking	Span/150
				Elements susceptible to cracking	Span/180
	Lateral	Wind	Building	Elastic cladding	Height/300
				Brittle cladding	Height/300
		Wind	Inter storey drift	—	Storey height/300

Column deflection check:

Maximum deflection in Column = 3.592 mm

Permissible limit for deflection in Column =1117/ 240 = 4.65 mm >3.592, **Hence OK**

Rafter deflection check:



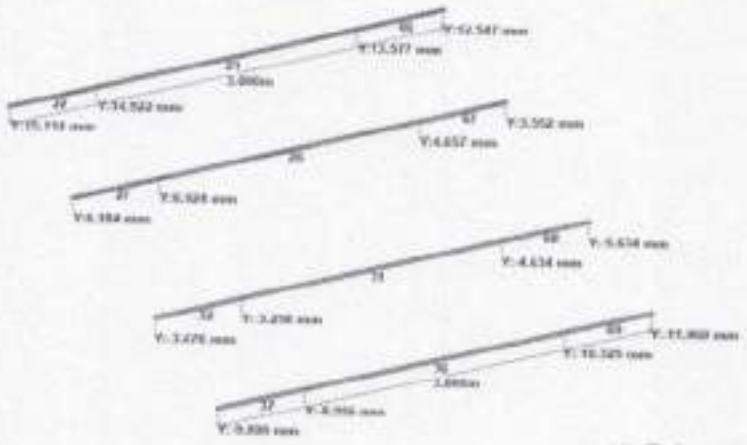
Maximum deflection in Rafter = 15.784 mm

Permissible limit for deflection in Rafter =3003/ 180 = 16.683mm >15.784, **Hence OK**

Approved :-

Dr. KHALID MOIN
Professor
Deptt. of Civil Engineering
FIO Engineering & Technology
Jamia Millia Islamia
New Delhi-110025

Purlin deflection check:



Maximum deflection in Purlin =14.922 mm

Permissible limit for deflection in Purlin =3000/ 180 = 16.66mm >14.922, **Hence OK**

5. REACTION SUMMARY:

		Horizontal	Vertical	Horizontal	Moment		
Node	L/C	Fx kN	Fy kN	Fz kN	Mx kN-m	My kN-m	Mz kN-m
3	1 DEAD LOA	-0.000	2.274	-0.000	-0.105	0.000	-0.000
	2 WIND LOA	-1.201	0.000	0.000	0.000	-0.028	1.378
	3 WIND LOA	1.201	-0.000	-0.000	-0.000	0.028	-1.378
	4 WIND LOA	-0.000	-10.441	-4.926	-5.965	0.000	-0.000
	5 WIND LOA	0.000	6.536	3.105	3.747	-0.000	0.000
	6 1 DEAD LO	-1.201	2.274	-0.000	-0.105	-0.028	1.378
	7 1 DEAD LO	1.201	2.274	-0.000	-0.105	0.028	-1.378
	8 1 DEAD LO	-0.000	-8.167	-4.926	-6.070	0.000	-0.000
	9 1 DEAD LO	0.000	8.810	3.105	3.642	-0.000	0.000
	10 1 DEAD L	-1.201	-8.167	-4.926	-6.070	-0.028	1.378
	11 1 DEAD L	-1.201	8.810	3.105	3.642	-0.028	1.378
	12 1 DEAD L	1.201	-8.167	-4.926	-6.070	0.028	-1.378
	13 1 DEAD L	1.201	8.810	3.105	3.642	0.028	-1.378

Approved :-

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

6. UTILITY RATIO:

Beam	Analysis Property	Design Property	Actual Ratio	Allowable Ratio	Normalized Ratio (Actual/Allowable)	Clause	L/C	Az cm2	Iz cm4	Iy cm4	Ix cm4
1	PIP1270M	PIP1270M	0.812	1	0.812	IS-7.1.1(A)	10	18.4	344	344	688
3	BA50X50X3	BA50X50X3	0.278	1	0.278	IS-7.1.1(A)	10	4.79	4.561	17.939	0.399
4	BA50X50X3	BA50X50X3	0.147	1	0.147	IS-7.1.1(A)	12	4.79	4.561	17.939	0.399
5	BA50X50X3	BA50X50X3	0.784	1	0.784	IS-7.1.1(A)	12	4.79	4.561	17.939	0.399
6	70CS25X1.6	70CS25X1.6	0.313	1	0.313	Bend + Compr	12	2.07	14.569	1.887	0.017
7	70CS25X1.6	70CS25X1.6	0.404	1	0.404	Bend + Compr	12	2.07	14.569	1.887	0.017
8	70CS25X1.6	70CS25X1.6	0.331	1	0.331	Bend + Compr	12	2.07	14.569	1.887	0.017
9	BA50X50X3	BA50X50X3	0.278	1	0.278	IS-7.1.1(A)	12	4.79	4.561	17.939	0.399
10	BA50X50X3	BA50X50X3	0.147	1	0.147	IS-7.1.1(A)	12	4.79	4.561	17.939	0.399
11	BA50X50X3	BA50X50X3	0.784	1	0.784	IS-7.1.1(A)	12	4.79	4.561	17.939	0.399
12	70CS25X1.6	70CS25X1.6	0.313	1	0.313	Bend + Compr	11	2.07	14.569	1.887	0.017
13	70CS25X1.6	70CS25X1.6	0.404	1	0.404	Bend + Compr	11	2.07	14.569	1.887	0.017
14	70CS25X1.6	70CS25X1.6	0.331	1	0.331	Bend + Compr	11	2.07	14.569	1.887	0.017
15	TUB40401.6	TUB40401.6	0.58	1	0.58	IS-7.1.2	4	8.22	47.3	47.3	77.6
16	TUB40401.6	TUB40401.6	0.896	1	0.896	IS-7.1.1(A)	10	8.22	47.3	47.3	77.6
17	80X40X2.3RHS	80X40X2.3RHS	0.27	1	0.27	IS-7.1.1(A)	10	7.31	24.84	18.41	46.03
18	40X40X2.3RHS	40X40X2.3RHS	0.408	1	0.408	IS-7.1.1(A)	10	3.72	8.45	8.45	13.45
19	PIP33.7L	PIP33.7L	0.533	1	0.533	IS-7.1.1(A)	12	2.54	3.09	3.09	6.18
20	PIP33.7L	PIP33.7L	0.553	1	0.553	IS-7.1.1(A)	13	2.54	3.09	3.09	6.18
21	80CS40X1.6	80CS40X1.6	0.244	1	0.244	Bending Z	8	2.89	27.47	5.815	0.023
22	80CS40X1.6	80CS40X1.6	0.122	1	0.122	Bend Z + She	4	2.89	27.47	5.815	0.023
23	80CS40X1.6	80CS40X1.6	0.342	1	0.342	Bending Z	4	2.89	27.47	5.815	0.023
27	80CS40X1.6	80CS40X1.6	0.125	1	0.125	Bend Z + She	4	2.89	27.47	5.815	0.023
31	80CS40X1.6	80CS40X1.6	0.285	1	0.285	Bending Z	10	2.89	27.47	5.815	0.023
32	80CS40X1.6	80CS40X1.6	0.127	1	0.127	Bend Z + She	4	2.89	27.47	5.815	0.023
33	80CS40X1.6	80CS40X1.6	0.342	1	0.342	Bending Z	2	2.89	27.47	5.815	0.023
37	80CS40X1.6	80CS40X1.6	0.127	1	0.127	Bend Z + She	2	2.89	27.47	5.815	0.023
41	100CS40X2	100CS40X2	0	1	0	Bend Y + She	2	4.703	77.883	22.864	0.063
42	100CS40X2	100CS40X2	0.231	1	0.231	Bend Z + She	4	4.703	77.883	22.864	0.063
43	100CS40X2	100CS40X2	0.408	1	0.408	Bend + Compr	4	4.703	77.883	22.864	0.063
44	100CS40X2	100CS40X2	0.408	1	0.408	Bend + Compr	4	4.703	77.883	22.864	0.063
45	100CS40X2	100CS40X2	0.412	1	0.412	Bend + Compr	4	4.703	77.883	22.864	0.063
46	100CS40X2	100CS40X2	0.38	1	0.38	Bend + Compr	4	4.703	77.883	22.864	0.063
47	100CS40X2	100CS40X2	0.327	1	0.327	Bend + Compr	4	4.703	77.883	22.864	0.063
48	100CS40X2	100CS40X2	0.193	1	0.193	Bend Z + She	4	4.703	77.883	22.864	0.063
49	100CS40X2	100CS40X2	0	1	0	Bend Y + She	2	4.703	77.883	22.864	0.063
50	100CS40X2	100CS40X2	0	1	0	Bend Y + She	2	4.703	77.883	22.864	0.063
51	100CS40X2	100CS40X2	0.231	1	0.231	Bend Z + She	4	4.703	77.883	22.864	0.063
52	100CS40X2	100CS40X2	0.408	1	0.408	Bend + Compr	4	4.703	77.883	22.864	0.063
53	100CS40X2	100CS40X2	0.408	1	0.408	Bend + Compr	4	4.703	77.883	22.864	0.063
54	100CS40X2	100CS40X2	0.412	1	0.412	Bend + Compr	4	4.703	77.883	22.864	0.063
55	100CS40X2	100CS40X2	0.38	1	0.38	Bend + Compr	4	4.703	77.883	22.864	0.063
56	100CS40X2	100CS40X2	0.327	1	0.327	Bend + Compr	4	4.703	77.883	22.864	0.063
57	100CS40X2	100CS40X2	0.193	1	0.193	Bend Z + She	4	4.703	77.883	22.864	0.063
57	100CS40X2	100CS40X2	0.193	1	0.193	Bend Z + She	4	4.703	77.883	22.864	0.063
58	100CS40X2	100CS40X2	0	1	0	Bend Y + She	2	4.703	77.883	22.864	0.063
60	PIP1270M	PIP1270M	0.726	1	0.726	IS-7.1.2	10	18.4	344	344	688
61	TUB40401.6	TUB40401.6	0.894	1	0.894	IS-7.1.1(A)	12	8.22	47.3	47.3	77.6
62	TUB40401.6	TUB40401.6	0.567	1	0.567	IS-7.1.2	4	8.22	47.3	47.3	77.6
66	80CS40X1.6	80CS40X1.6	0.123	1	0.123	Bend Z + She	4	2.89	27.47	5.815	0.023
67	80CS40X1.6	80CS40X1.6	0.125	1	0.125	Bend Z + She	4	2.89	27.47	5.815	0.023
68	80CS40X1.6	80CS40X1.6	0.123	1	0.123	Bend Z + She	4	2.89	27.47	5.815	0.023
69	80CS40X1.6	80CS40X1.6	0.125	1	0.125	Bend Z + She	4	2.89	27.47	5.815	0.023
70	BA50X50X3	BA50X50X3	0.282	1	0.282	IS-7.1.1(A)	4	4.79	4.561	17.939	0.399
71	BA50X50X3	BA50X50X3	0.214	1	0.214	IS-7.1.1(A)	4	4.79	4.561	17.939	0.399
72	BA50X50X3	BA50X50X3	0.771	1	0.771	IS-7.1.2	4	4.79	4.561	17.939	0.399
73	70CS25X1.6	70CS25X1.6	0.42	1	0.42	Bend + Compr	11	2.07	14.569	1.887	0.017
74	70CS25X1.6	70CS25X1.6	0.403	1	0.403	Bend + Compr	11	2.07	14.569	1.887	0.017
75	BA50X50X3	BA50X50X3	0.282	1	0.282	IS-7.1.1(A)	4	4.79	4.561	17.939	0.399
76	BA50X50X3	BA50X50X3	0.214	1	0.214	IS-7.1.1(A)	4	4.79	4.561	17.939	0.399
77	BA50X50X3	BA50X50X3	0.771	1	0.771	IS-7.1.2	4	4.79	4.561	17.939	0.399
78	70CS25X1.6	70CS25X1.6	0.42	1	0.42	Bend + Compr	11	2.07	14.569	1.887	0.017
79	70CS25X1.6	70CS25X1.6	0.403	1	0.403	Bend + Compr	11	2.07	14.569	1.887	0.017

7. CONCLUSION:

The structure is found to be safe and the maximum utility ratio observed is 0.896. The IS Code referred during analysis is 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.

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

8. STAAD INPUT DATA:

```
STAAD SPACE DXF IMPORT OF PUMP-1BMODULE.DXF
START JOB INFORMATION
ENGINEER DATE 01-Jun-20
END JOB INFORMATION
INPUT WIDTH 79
UNIT METER KN
JOINT COORDINATES
1 0 -672.828 -2852.76; 2 0 -673.84 -2852.76; 3 0 -673.949 -2852.79;
5 0.9 -672.758 -2852.64; 6 0.9 -672.964 -2852.74; 7 0.9 -672.695 -2852.78;
8 0.9 -672.901 -2852.87; 9 0.9 -672.797 -2852.83; 10 0.9 -672.86 -2852.69;
11 0.9 -673.13 -2851.84; 12 0.9 -673.018 -2852.6; 13 0.9 -672.837 -2853.01;
14 0.9 -672.519 -2853.98; 15 -0.9 -672.758 -2852.64; 16 -0.9 -672.964 -2852.74;
17 -0.9 -672.695 -2852.78; 18 -0.9 -672.901 -2852.87;
19 -0.9 -672.797 -2852.83; 20 -0.9 -672.86 -2852.69; 21 -0.9 -673.13 -2851.84;
22 -0.9 -673.018 -2852.6; 23 -0.9 -672.837 -2853.01; 24 -0.9 -672.519 -2853.98;
25 0.9 -672.828 -2852.76; 26 -0.9 -672.828 -2852.76; 27 0 -673.391 -2852.23;
28 0.7 -672.828 -2852.76; 29 -0.7 -672.828 -2852.76; 30 0.9 -672.122 -2854;
32 -0.9 -672.122 -2854; 33 -1.5 -672.122 -2854; 36 0.9 -672.486 -2853.22;
38 -0.9 -672.486 -2853.22; 39 -1.5 -672.486 -2853.22; 42 0.9 -672.963 -2852.2;
44 -0.9 -672.963 -2852.2; 45 -1.5 -672.963 -2852.2; 48 0.9 -673.327 -2851.42;
50 -0.9 -673.327 -2851.42; 51 -1.5 -673.327 -2851.42; 54 0.9 -672.868 -2854.87;
55 0.9 -673.561 -2851.35; 56 -0.9 -672.088 -2854.87; 57 -0.9 -673.561 -2851.35;
58 1.5 -672.122 -2854; 59 1.5 -672.486 -2853.22; 60 1.5 -672.963 -2852.2;
61 1.5 -673.327 -2851.42;
MEMBER INCIDENCES
1 1 2; 3 5 10; 4 7 9; 5 9 25; 6 11 12; 7 13 6; 8 13 14; 9 15 28; 10 17 19;
11 19 26; 12 21 22; 13 22 15; 14 23 24; 15 25 28; 16 1 29; 17 1 27; 18 2 27;
19 2 28; 20 2 29; 21 30 32; 22 32 33; 23 36 38; 27 38 39; 31 42 44; 32 44 45;
36 48 50; 37 50 51; 41 54 56; 42 56 14; 43 14 56; 44 56 7; 45 7 5; 46 5 42;
47 42 11; 48 11 42; 49 43 55; 50 56 32; 51 32 24; 52 24 55; 53 58 17; 54 17 15;
55 15 44; 56 44 21; 57 21 59; 58 59 57; 63 2 7; 64 28 1; 65 29 26; 66 58 30;
67 59 36; 68 60 42; 69 61 48; 70 10 6; 71 9 8; 72 25 10; 73 8 13; 74 6 8;
75 28 16; 76 19 18; 77 26 29; 78 18 23; 79 16 18;
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 407888 RY 1.5 RT 1.2
END DEFINE MATERIAL
MEMBER PROPERTY INDIAN
```

Approved :-

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

```
MEMBER PROPERTY INDIAN
 1 63 TABLE ST PIPE127BH
MEMBER PROPERTY COLDFORMED INDIAN
 41 TO 58 TABLE ST 100CS98X2
 21 22 26 27 31 32 36 37 66 TO 69 TABLE ST 80CS48X1.6
MEMBER PROPERTY TATASTRUCTURA
 17 TABLE ST 80X40X3.0RHS
 18 TABLE ST 40X40X2.6SHS
MEMBER PROPERTY COLDFORMED INDIAN
 6 TO 8 12 TO 14 72 74 76 79 TABLE ST 70CS32X1.6
MEMBER PROPERTY INDIAN
 19 20 TABLE ST PIPE89L
 5 TO 9 TO 11 70 TO 72 75 TO 77 TABLE ST ISA50X50X5
 15 16 64 65 TABLE ST TUB60X3.6
CONSTANTS
 BETA 180 MEMB 41 TO 58
 BETA 335 MEMB 21 22 26 27 31 32 36 37 66 TO 69
 MATERIAL STEEL ALL
MEMBER OFFSET
 21 22 26 27 31 32 36 37 66 TO 69 START 0 0.185 0
 21 22 26 27 31 32 36 37 66 TO 69 END 0 0.185 0
SUPPORTS
 2 FIXED
LOAD 1 LOADTYPE Dead  TITLE DEAD LOAD STRUCTURE
 SELFWEIGHT Y -1
MEMBER LOAD
 21 22 26 27 31 32 36 37 66 TO 69 UNI GY -0.11
LOAD 2 LOADTYPE Wind  TITLE WIND LOAD X+
MEMBER LOAD
 1 63 UNI GX 0.0313
 3 4 6 TO 10 12 TO 14 41 TO 58 70 71 73 TO 76 78 79 UNI GX 0.1869
LOAD 3 LOADTYPE Wind  TITLE WIND LOAD X-
MEMBER LOAD
 1 63 UNI GX -0.0313
 3 4 6 TO 10 12 TO 14 41 TO 58 70 71 73 TO 76 78 79 UNI GX -0.1869
LOAD 4 LOADTYPE Wind  TITLE WIND LOAD Z+ UPWARD
MEMBER LOAD
 1 63 UNI GZ 0.0313
 19 20 UNI GZ 0.0066
 21 22 26 27 31 32 36 37 66 TO 69 UNI Y 0.98
LOAD 5 LOADTYPE Wind  TITLE WIND LOAD Z- DOWNWARD
MEMBER LOAD
 1 63 UNI GZ -0.0313
 19 20 UNI GZ -0.0066
 21 22 26 27 31 32 36 37 66 TO 69 UNI Y -0.681
LOAD COMB 6 1 DEAD LOAD + 2 WIND LOAD X+
 1 1.0 2 1.0
```

Approved :-

Dr. KHALID MOIN
Professor
Deptt. of Civil Engineering
F/O Engineering & Technology
Jamia Hamdard
New Delhi-110025

```
1 1.0 2 1.0
LOAD COMB 7 1 DEAD LOAD + 1 WIND LOAD X-
 1 1.0 3 1.0
LOAD COMB 8 1 DEAD LOAD + 1 WIND LOAD Z+ UPWARD
 1 1.0 4 1.0
LOAD COMB 9 1 DEAD LOAD + 1 WIND LOAD Z- DOWNWARD
 1 1.0 5 1.0
LOAD COMB 10 1 DEAD LOAD + 1 WIND LOAD X+ + 1 WIND LOAD Z+ UPWARD
 1 1.0 2 1.0 4 1.0
LOAD COMB 11 1 DEAD LOAD + 1 WIND LOAD X+ + 1 WIND LOAD Z- DOWNWARD
 1 1.0 2 1.0 5 1.0
LOAD COMB 12 1 DEAD LOAD + 1 WIND LOAD X- + 1 WIND LOAD Z+ UPWARD
 3 1.0 4 1.0 1 1.0
LOAD COMB 13 1 DEAD LOAD + 1 WIND LOAD X- + 1 WIND LOAD Z- DOWNWARD
 1 1.0 3 1.0 5 1.0
 PERFORM ANALYSIS PRINT ALL
PARAMETER 1
 CODE INDIAN
 FYLD 250000 MEMB 1 3 TO 5 9 TO 11 15 TO 28 45 54 63 TO 65 70 TO 72 75 TO 77
 RATIO 1 MEMB 1 3 TO 5 9 TO 11 15 TO 28 45 54 63 TO 65 70 TO 72 75 TO 77
 TRACK 1 MEMB 1 3 TO 5 9 TO 11 15 TO 28 45 54 63 TO 65 70 TO 72 75 TO 77
 CHECK CODE MEMB 1 3 TO 5 9 TO 11 15 TO 28 45 54 63 TO 65 70 TO 72 75 TO 77
PARAMETER 2
 CODE IS801
 FU 450000 MEMB 6 TO 8 12 TO 14 21 22 26 27 31 32 36 37 41 TO 58 66 TO 69 71 -
 74 78 79
 FYLD 350000 MEMB 6 TO 8 12 TO 14 21 22 26 27 31 32 36 37 41 TO 58 66 TO 69 -
 73 74 78 79
 RATIO 1 MEMB 6 TO 8 12 TO 14 21 22 26 27 31 32 36 37 41 TO 58 66 TO 69 71 -
 74 78 79
 TRACK 1 MEMB 6 TO 8 12 TO 14 21 22 26 27 31 32 36 37 41 TO 58 66 TO 69 71 -
 74 78 79
 CHECK CODE MEMB 6 TO 8 12 TO 14 21 22 26 27 31 32 36 37 41 TO 58 66 TO 69 -
 73 74 78 79
PARAMETER 3
 CODE IS801
 STEEL MEMBER TAKE OFF ALL
 FINISH
```

Approved :-

Dr. ISHAQ MOIN
Professor
Deptt. of Civil Engineering
FIO Engineering & Technology
Jamia Millia Islamia
New Delhi-110025

9. STAAD OUTPUT:

```
STAAD.Pro CODE CHECKING - (IS-800:1984)   v1.1
                        ************************


ALL UNITS ARE - KN   METE (UNLESS OTHERWISE Noted)

MEMBER     TABLE        RESULT/      CRITICAL COND/     RATIO/     LOADING/
                          FX             MY               MZ       LOCATION
=============================================================================


     1 ST   PIP127OM                  (INDIAN SECTIONS)
                         PASS      IS-7.1.1(A)          0.613          10
                       2.42 C          0.00              5.35          1.01
|-----------------------------------------------------------------------|
| ALLOWABLE STRESSES FOR MEMB      1     UNIT - MPA                     |
| FCZ=163.58  FTZ=165.00  FCY=165.00  FTY=165.00  FA=147.49  FV=100.0 |
|-----------------------------------------------------------------------|
     3 ST   ISA50X50X5                (INDIAN SECTIONS)
                         PASS      IS-7.1.1(A)          0.276          10
                       0.37 C          0.11              0.06          0.12
|-----------------------------------------------------------------------|
| ALLOWABLE STRESSES FOR MEMB      3     UNIT - MPA                     |
| FCZ=144.59  FTZ=165.00  FCY=165.00  FTY=165.00  FA=149.61  FV=100.0 |
|-----------------------------------------------------------------------|
     4 ST   ISA50X50X5                (INDIAN SECTIONS)
                         PASS      IS-7.1.1(A)          0.147          11
                       0.77 C          0.05              0.03          0.12
|-----------------------------------------------------------------------|
| ALLOWABLE STRESSES FOR MEMB      4     UNIT - MPA                     |
| FCZ=144.59  FTZ=165.00  FCY=165.00  FTY=165.00  FA=149.61  FV=100.0 |
|-----------------------------------------------------------------------|
     5 ST   ISA50X50X5                (INDIAN SECTIONS)
                         PASS      IS-7.1.1(A)          0.784          10
                       0.44 C          0.05             -0.26          0.08
|-----------------------------------------------------------------------|
| ALLOWABLE STRESSES FOR MEMB      5     UNIT - MPA                     |
| FCZ=144.82  FTZ=165.00  FCY=165.00  FTY=165.00  FA=149.87  FV=100.0 |
|-----------------------------------------------------------------------|
     9 ST   ISA50X50X5                (INDIAN SECTIONS)
                         PASS      IS-7.1.1(A)          0.276          12
                       0.37 C         -0.11              0.06          0.12
|-----------------------------------------------------------------------|
| ALLOWABLE STRESSES FOR MEMB      9     UNIT - MPA                     |
| FCZ=144.59  FTZ=165.00  FCY=165.00  FTY=165.00  FA=149.61  FV=100.0 |
|-----------------------------------------------------------------------|
  DXF IMPORT OF PUMP-10MODULE.DXP                        -- PAGE NO.   18
```

Approved :-

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

ALL UNITS ARE - KN METE (UNLESS OTHERWISE Noted)

MEMBER	TABLE	RESULT/ FX	CRITICAL COND/ MY	RATIO/ MZ	LOADING/ LOCATION
10 ST	ISA50X50X5		(INDIAN SECTIONS)		
	PASS	IS-7.1.1(A)	0.147		13
	0.77 C	-0.05	0.03		0.12
ALLOWABLE STRESSES FOR MEMB 10 UNIT - MPA					
FCZ=144.59 FTZ=165.00 FCY=165.00 FTY=165.00 FA=149.61 FV=100.0					
11 ST	ISA50X50X5		(INDIAN SECTIONS)		
	PASS	IS-7.1.1(A)	0.784		12
	0.44 C	-0.05	-0.26		0.08
ALLOWABLE STRESSES FOR MEMB 11 UNIT - MPA					
FCZ=144.92 FTZ=165.00 FCY=165.00 FTY=165.00 FA=149.87 FV=100.0					
15 ST	TUB63633.6		(INDIAN SECTIONS)		
	PASS	IS-7.1.2	0.567		4
	0.35 T	-0.32	-1.08		0.20
ALLOWABLE STRESSES FOR MEMB 15 UNIT - MPA					
FCZ=164.89 FTZ=165.00 FCY=165.00 FTY=165.00 FA=150.00 FV=100.0					
16 ST	TUB63633.6		(INDIAN SECTIONS)		
	PASS	IS-7.1.1(A)	0.994		10
	4.46 C	-2.00	0.37		0.00
ALLOWABLE STRESSES FOR MEMB 16 UNIT - MPA					
FCZ=162.57 FTZ=165.00 FCY=165.00 FTY=165.00 FA=145.42 FV=100.0					
17 ST	80X40X3.2RHS		(TATA STRUCTURA SECTIONS)		
	PASS	IS-7.1.1(A)	0.270		10
	0.51 C	0.00	-0.56		0.00
ALLOWABLE STRESSES FOR MEMB 17 UNIT - MPA					
FCZ=156.15 FTZ=165.00 FCY=165.00 FTY=165.00 FA=133.65 FV=100.0					

ALL UNITS ARE - KN METE (UNLESS OTHERWISE Noted)

MEMBER	TABLE	RESULT/ FX	CRITICAL COND/ MY	RATIO/ MZ	LOADING/ LOCATION
18 ST	40X40X2.6SHS		(TATA STRUCTURA SECTIONS)		
		PASS	IS-7.1.1(A)	0.436	10
		0.92 C	-0.02	0.26	0.00
ALLOWABLE STRESSES FOR MEMB 18 UNIT - MPA					
FCB=157.94 FTZ=165.00 FCY=165.00 FTY=165.00 FA=134.99 FV=100.0					
19 ST	PIP337L		(INDIAN SECTIONS)		
		PASS	IS-7.1.1(A)	0.533	11
		7.29 C	0.00	0.04	0.00
ALLOWABLE STRESSES FOR MEMB 19 UNIT - MPA					
FCB=134.71 FTZ=165.00 FCY=165.00 FTY=165.00 FA= 70.26 FV=100.0					
20 ST	PIP337L		(INDIAN SECTIONS)		
		PASS	IS-7.1.1(A)	0.533	13
		7.29 C	0.00	0.04	0.00
ALLOWABLE STRESSES FOR MEMB 20 UNIT - MPA					
FCB=134.71 FTZ=165.00 FCY=165.00 FTY=165.00 FA= 70.26 FV=100.0					
45 ST	100CS60X2		(IS COLDFORMED SECTIONS)		
		PASS	IS-7.1.1(A)	0.423	10
		7.69 C	0.18	0.33	0.15
ALLOWABLE STRESSES FOR MEMB 45 UNIT - MPA					
FCB=164.92 FTZ=165.00 FCY=165.00 FTY=165.00 FA=149.91 FV=100.0					
54 ST	100CS60X2		(IS COLDFORMED SECTIONS)		
		PASS	IS-7.1.1(A)	0.423	12
		7.69 C	-0.18	0.33	0.15
ALLOWABLE STRESSES FOR MEMB 54 UNIT - MPA					
FCB=164.92 FTZ=165.00 FCY=165.00 FTY=165.00 FA=149.91 FV=100.0					

ALL UNITS ARE - KN METE (UNLESS OTHERWISE Noted)

MEMBER	TABLE	RESULT/ FX	CRITICAL COND/ MY	RATIO/ MZ	LOADING/ LOCATION
63 ST	PIP127GM		(INDIAN SECTIONS)		

	PASS	IS-7.1.2	0.726	10
	8.17 T	0.00	8.22	0.10

ALLOWABLE STRESSES FOR MEMB 63 UNIT - MPA
FCZ=164.96 FTZ=165.00 FCY=165.00 FTY=165.00 FA=150.00 FV=100.0

64 ST TUB63633.6 (INDIAN SECTIONS)

PASS	IS-7.1.1(A)	0.994	12
4.46 C	-2.00	0.37	0.70

ALLOWABLE STRESSES FOR MEMB 64 UNIT - MPA
FCZ=162.57 FTZ=165.00 FCY=165.00 FTY=165.00 FA=145.42 FV=100.0

65 ST TUB63633.6 (INDIAN SECTIONS)

PASS	IS-7.1.2	0.567	4
0.35 T	-0.32	-1.08	0.00

ALLOWABLE STRESSES FOR MEMB 65 UNIT - MPA
FCZ=164.89 FTZ=165.00 FCY=165.00 FTY=165.00 FA=150.00 FV=100.0

70 ST ISA50X50X5 (INDIAN SECTIONS)

PASS	IS-7.1.1(A)	0.262	4
1.66 C	-0.00	0.10	0.12

ALLOWABLE STRESSES FOR MEMB 70 UNIT - MPA
FCZ=144.59 FTZ=165.00 FCY=165.00 FTY=165.00 FA=149.61 FV=100.0

71 ST ISA50X50X5 (INDIAN SECTIONS)

PASS	IS-7.1.1(A)	0.234	4
2.73 C	0.00	-0.07	0.11

ALLOWABLE STRESSES FOR MEMB 71 UNIT - MPA
FCZ=144.62 FTZ=165.00 FCY=165.00 FTY=165.00 FA=149.65 FV=100.0

DXF INPORT OF PUMP-10MODULE.DXF -- PAGE NO. 21

ALL UNITS ARE - KN METE (UNLESS OTHERWISE Noted)

MEMBER	TABLE	RESULT/ FX	CRITICAL COND/ MY	RATIO/ MZ	LOADING/ LOCATION

72 ST ISA50X50X5 (INDIAN SECTIONS)

PASS	IS-7.1.2	0.271	8
0.05 T	-0.00	0.10	0.08

ALLOWABLE STRESSES FOR MEMB 72 UNIT - MPA
FCZ=144.82 FTZ=165.00 FCY=165.00 FTY=165.00 FA=150.00 FV=100.0

Approved :-
DR KHALID MOIN
Professor
Deptt. of Civil Engineering
F/O Engineering & Technology
Jamia Millia Islamia
New Delhi-110025

```
    75 ST   ISA50X50X5                (INDIAN SECTIONS)
                        PASS      IS-7.1.1(A)        0.262          4
                     1.66 C         0.00             0.10          0.12
|-------------------------------------------------------------------------|
| ALLOWABLE STRESSES FOR MEMB     75     UNIT - MPA                       |
| FCE=144.59  FTE=165.00  FCY=165.00  FTY=165.00  FA=149.61  FV=100.0      |
|-------------------------------------------------------------------------|
    76 ST   ISA50X50X5                (INDIAN SECTIONS)
                        PASS      IS-7.1.1(A)        0.234          4
                     2.73 C         -0.00            -0.07          0.11
|-------------------------------------------------------------------------|
| ALLOWABLE STRESSES FOR MEMB     76     UNIT - MPA                       |
| FCE=144.62  FTE=165.00  FCY=165.00  FTY=165.00  FA=149.65  FV=100.0      |
|-------------------------------------------------------------------------|
    77 ST   ISA50X50X5                (INDIAN SECTIONS)
                        PASS      IS-7.1.2           0.271          8
                     0.05 T         0.00             0.10          0.08
|-------------------------------------------------------------------------|
| ALLOWABLE STRESSES FOR MEMB     77     UNIT - MPA                       |
| FCE=144.82  FTE=165.00  FCY=165.00  FTY=165.00  FA=150.00  FV=100.0      |
|-------------------------------------------------------------------------|

 ************** END OF TABULATED RESULT OF DESIGN **************

 112. PARAMETER 2
 113. CODE IS801
  DXF IMPORT OF PUMP-10MODULE.DXF                        -- PAGE NO.   22

 114. FU 450000 MEMB 6 TO 8 12 TO 14 21 22 26 27 31 32 36 37 41 TO 58 66 TO 69 73 -
 115. 74 78 79
 116. FYLD 350000 MEMB 6 TO 8 12 TO 14 21 22 26 27 31 32 36 37 41 TO 58 66 TO 69 -
 117. 73 74 78 79
 118. RATIO 1 MEMB 6 TO 8 12 TO 14 21 22 26 27 31 32 36 37 41 TO 58 66 TO 69 73 -
 119. 74 78 79
 120. TRACK 1 MEMB 6 TO 8 12 TO 14 21 22 26 27 31 32 36 37 41 TO 58 66 TO 69 73 -
 121. 74 78 79
 122. CHECK CODE MEMB 6 TO 8 12 TO 14 21 22 26 27 31 32 36 37 41 TO 58 66 TO 69 -
 123. 73 74 78 79
  DXF IMPORT OF PUMP-10MODULE.DXF                        -- PAGE NO.   23


STAAD.Pro CODE CHECKING - (IS-800:1984)   v1.1
                          ***********************

|-------------------------------------------------------------------------|
|                        UNITS : MM, KN, KNM, MPA                         |
|                                                                         |
| MEMBERS     6  SECTION: 70CS25X1.6        LEN:   766.83  GOV.LOC:   0.00 |
```

Approved :-

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

STATUS: PASS RATIO = 0.315 GOV.MODE: Bend + Compress GOV.LOAD: 13
RESISTANCES: AX.TENS: 0.00 COMPRESS: 31.32
BEND. Z: 0.94 BEND. Y: 0.00 SHEAR Z: 7.62 SHEAR Y: 13.89

UNITS : MM, KN, KNM, MPA
MEMBER# 7 SECTION: 70CS25X1.6 LEN: 154.02 GOV.LOC: 154.02
STATUS: PASS RATIO = 0.404 GOV.MODE: Bend + Compress GOV.LOAD: 13
RESISTANCES: AX.TENS: 0.00 COMPRESS: 35.22
BEND. Z: 0.87 BEND. Y: 0.00 SHEAR Z: 7.62 SHEAR Y: 13.89

UNITS : MM, KN, KNM, MPA
MEMBER# 9 SECTION: 70CS25X1.6 LEN: 770.31 GOV.LOC: 770.31
STATUS: PASS RATIO = 0.351 GOV.MODE: Bend + Compress GOV.LOAD: 13
RESISTANCES: AX.TENS: 0.00 COMPRESS: 31.29
BEND. Z: 0.69 BEND. Y: 0.00 SHEAR Z: 7.62 SHEAR Y: 13.89

UNITS : MM, KN, KNM, MPA
MEMBER# 12 SECTION: 70CS25X1.6 LEN: 766.83 GOV.LOC: 0.00
STATUS: PASS RATIO = 0.315 GOV.MODE: Bend + Compress GOV.LOAD: 11
RESISTANCES: AX.TENS: 0.00 COMPRESS: 31.32
BEND. Z: 0.70 BEND. Y: 0.00 SHEAR Z: 7.62 SHEAR Y: 13.89

UNITS : MM, KN, KNM, MPA
MEMBER# 13 SECTION: 70CS25X1.6 LEN: 154.02 GOV.LOC: 154.02
STATUS: PASS RATIO = 0.404 GOV.MODE: Bend + Compress GOV.LOAD: 11
RESISTANCES: AX.TENS: 0.00 COMPRESS: 35.22
BEND. Z: 0.87 BEND. Y: 0.00 SHEAR Z: 7.62 SHEAR Y: 13.89

```
|-------------------------------------------------------------------------|
|                        UNITS : MM, KN, KNM, MPA                         |
|                                                                         |
| MEMBER#    14  SECTION: 70CS25X1.6        LEN:   770.31  GOV.LOC:  770.31 |
| STATUS: PASS   RATIO =  0.351  GOV.MODE: Bend + Compress  GOV.LOAD:   11 |
|                                                                         |
| RESISTANCES:       AX.TENS:     0.00                    COMPRESS:  31.29 |
| BEND. Z:    0.84   BEND. Y:     0.00  SHEAR Z:    7.62  SHEAR Y:  13.89 |
|-------------------------------------------------------------------------|
```

```
|-------------------------------------------------------------------------|
|                        UNITS : MM, KN, KNM, MPA                         |
|                                                                         |
| MEMBER#    21  SECTION: 80CS40X1.6        LEN:  1800.00  GOV.LOC:    0.00 |
| STATUS: PASS   RATIO =  0.244  GOV.MODE: Bending Z        GOV.LOAD:    8 |
|                                                                         |
| RESISTANCES:       AX.TENS:    56.48                    COMPRESS:   0.00 |
| BEND. Z:    0.63   BEND. Y:     0.00  SHEAR Z:   14.34  SHEAR Y:  16.13 |
|-------------------------------------------------------------------------|
```

```
|-------------------------------------------------------------------------|
|                        UNITS : MM, KN, KNM, MPA                         |
|                                                                         |
| MEMBER#    22  SECTION: 80CS40X1.6        LEN:   600.00  GOV.LOC:    0.00 |
| STATUS: PASS   RATIO =  0.125  GOV.MODE: Bend Z + Shear   GOV.LOAD:    4 |
|                                                                         |
| RESISTANCES:       AX.TENS:     0.00                    COMPRESS:   0.00 |
| BEND. Z:    1.44   BEND. Y:     0.00  SHEAR Z:   14.34  SHEAR Y:  16.13 |
|-------------------------------------------------------------------------|
```

```
|-------------------------------------------------------------------------|
|                        UNITS : MM, KN, KNM, MPA                         |
|                                                                         |
| MEMBER#    26  SECTION: 80CS40X1.6        LEN:  1800.00  GOV.LOC:  900.00 |
| STATUS: PASS   RATIO =  0.343  GOV.MODE: Bending Z        GOV.LOAD:    4 |
|                                                                         |
| RESISTANCES:       AX.TENS:     0.00                    COMPRESS:  26.00 |
| BEND. Z:    0.63   BEND. Y:     0.00  SHEAR Z:    0.00  SHEAR Y:   0.00 |
  DXF IMPORT OF PUMP-10MODULE.DXF                          -- PAGE NO.   25

|-------------------------------------------------------------------------|
```

```
|-------------------------------------------------------------------------|
|                        UNITS : MM, KN, KNM, MPA                         |
|                                                                         |
| MEMBER#    27  SECTION: 80CS40X1.6        LEN:   600.00  GOV.LOC:    0.00 |
| STATUS: PASS   RATIO =  0.125  GOV.MODE: Bend Z + Shear   GOV.LOAD:    4 |
|                                                                         |
| RESISTANCES:       AX.TENS:     0.00                    COMPRESS:   0.00 |
```

| BEND. Z: 1.44 BEND. Y: 0.00 SHEAR Z: 14.34 SHEAR Y: 16.13 |

UNITS : MM, KN, KNM, MPA

| MEMBER# 31 SECTION: 80CS40X1.6 LEN: 1800.00 GOV.LOC: 1200.00 |
| STATUS: PASS RATIO = 0.295 GOV.MODE: Bending Z GOV.LOAD: 10 |
| RESISTANCES: AX.TENS: 0.00 COMPRESS: 26.00 |
| BEND. Z: 0.63 BEND. Y: 0.00 SHEAR Z: 14.34 SHEAR Y: 16.13 |

UNITS : MM, KN, KNM, MPA

| MEMBER# 32 SECTION: 80CS40X1.6 LEN: 600.00 GOV.LOC: 0.00 |
| STATUS: PASS RATIO = 0.125 GOV.MODE: Bend Z + Shear GOV.LOAD: 4 |
| RESISTANCES: AX.TENS: 0.00 COMPRESS: 0.00 |
| BEND. Z: 1.44 BEND. Y: 0.00 SHEAR Z: 14.34 SHEAR Y: 16.13 |

UNITS : MM, KN, KNM, MPA

| MEMBER# 36 SECTION: 80CS40X1.6 LEN: 1800.00 GOV.LOC: 960.00 |
| STATUS: PASS RATIO = 0.341 GOV.MODE: Bending Z GOV.LOAD: 4 |
| RESISTANCES: AX.TENS: 56.48 COMPRESS: 0.00 |
| BEND. Z: 0.63 BEND. Y: 0.00 SHEAR Z: 0.00 SHEAR Y: 0.00 |

UNITS : MM, KN, KNM, MPA

| MEMBER# 37 SECTION: 80CS40X1.6 LEN: 600.00 GOV.LOC: 0.00 |
| STATUS: PASS RATIO = 0.125 GOV.MODE: Bend Z + Shear GOV.LOAD: 4 |
| RESISTANCES: AX.TENS: 0.00 COMPRESS: 0.00 |
| BEND. Z: 1.44 BEND. Y: 0.00 SHEAR Z: 14.34 SHEAR Y: 16.13 |

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UNITS : MM, KN, KNM, MPA

MEMBER# 41 SECTION: 100CS60X2 LEN: 77.86 GOV.LOC: 77.86
STATUS: PASS RATIO = 0.000 GOV.MODE: Bend Y + Shear GOV.LOAD: 3
RESISTANCES: AX.TENS: 0.00 COMPRESS: 0.00
BEND. Z: 0.00 BEND. Y: 0.00 SHEAR Z: 28.00 SHEAR Y: 25.20

UNITS : MM, KN, KNM, MPA
MEMBER# 42 SECTION: 100CS60X2 LEN: 463.81 GOV.LOC: 463.81
STATUS: PASS RATIO = 0.231 GOV.MODE: Bend Z + Shear GOV.LOAD: 4
RESISTANCES: AX.TENS: 98.76 COMPRESS: 0.00
BEND. Z: 3.28 BEND. Y: 0.00 SHEAR Z: 28.00 SHEAR Y: 25.20

UNITS : MM, KN, KNM, MPA
MEMBER# 43 SECTION: 100CS60X2 LEN: 396.81 GOV.LOC: 0.00
STATUS: PASS RATIO = 0.408 GOV.MODE: Bend + Compress GOV.LOAD: 4
RESISTANCES: AX.TENS: 0.00 COMPRESS: 35.97
BEND. Z: 3.28 BEND. Y: 0.00 SHEAR Z: 28.00 SHEAR Y: 25.20

UNITS : MM, KN, KNM, MPA
MEMBER# 44 SECTION: 100CS60X2 LEN: 486.39 GOV.LOC: 486.39
STATUS: PASS RATIO = 0.408 GOV.MODE: Bend + Compress GOV.LOAD: 4
RESISTANCES: AX.TENS: 0.00 COMPRESS: 35.91
BEND. Z: 3.28 BEND. Y: 0.00 SHEAR Z: 28.00 SHEAR Y: 25.20

DXF IMPORT OF PUMP-10MODULE.DXF -- PAGE NO. 27

UNITS : MM, KN, KNM, MPA
MEMBER# 45 SECTION: 100CS60X2 LEN: 153.43 GOV.LOC: 0.00
STATUS: PASS RATIO = 0.412 GOV.MODE: Bend + Compress GOV.LOAD: 4
RESISTANCES: AX.TENS: 0.00 COMPRESS: 36.06
BEND. Z: 3.28 BEND. Y: 0.00 SHEAR Z: 28.00 SHEAR Y: 25.20

```
|-------------------------------------------------------------------------------|
|                        UNITS : MM, KN, KNM, MPA                               |
|                                                                               |
| MEMBER#    46  SECTION: 100CS60X2          LEN:   486.39  GOV.LOC:     0.00  |
| STATUS: PASS   RATIO =  0.360  GOV.MODE: Bend + Compress   GOV.LOAD:      4  |
|                                                                               |
| RESISTANCES:       AX.TENS:     0.00                      COMPRESS:   35.91  |
| BEND. Z:     3.28  BEND. Y:     0.00  SHEAR Z:    28.00  SHEAR Y:   25.20  |
|-------------------------------------------------------------------------------|

|-------------------------------------------------------------------------------|
|                        UNITS : MM, KN, KNM, MPA                               |
|                                                                               |
| MEMBER#    47  SECTION: 100CS60X2          LEN:   396.81  GOV.LOC:   396.81  |
| STATUS: PASS   RATIO =  0.357  GOV.MODE: Bend + Compress   GOV.LOAD:      4  |
|                                                                               |
| RESISTANCES:       AX.TENS:     0.00                      COMPRESS:   35.97  |
| BEND. Z:     3.28  BEND. Y:     0.00  SHEAR Z:    28.00  SHEAR Y:   25.20  |
|-------------------------------------------------------------------------------|

|-------------------------------------------------------------------------------|
|                        UNITS : MM, KN, KNM, MPA                               |
|                                                                               |
| MEMBER#    48  SECTION: 100CS60X2          LEN:   463.81  GOV.LOC:     0.00  |
| STATUS: PASS   RATIO =  0.193  GOV.MODE: Bend Z + Shear    GOV.LOAD:      4  |
|                                                                               |
| RESISTANCES:       AX.TENS:     0.00                      COMPRESS:   35.93  |
| BEND. Z:     3.28  BEND. Y:     0.00  SHEAR Z:    28.00  SHEAR Y:   25.20  |
|-------------------------------------------------------------------------------|

|-------------------------------------------------------------------------------|
  DXF IMPORT OF PUMP-10MODULE.DXF                          -- PAGE NO.   28

|                        UNITS : MM, KN, KNM, MPA                               |
|                                                                               |
| MEMBER#    49  SECTION: 100CS60X2          LEN:    77.96  GOV.LOC:     0.00  |
| STATUS: PASS   RATIO =  0.000  GOV.MODE: Bend Y + Shear    GOV.LOAD:      3  |
|                                                                               |
| RESISTANCES:       AX.TENS:     0.00                      COMPRESS:    0.00  |
| BEND. Z:     0.00  BEND. Y:     0.00  SHEAR Z:    28.00  SHEAR Y:   25.20  |
|-------------------------------------------------------------------------------|

|-------------------------------------------------------------------------------|
|                        UNITS : MM, KN, KNM, MPA                               |
|                                                                               |
| MEMBER#    50  SECTION: 100CS60X2          LEN:    77.96  GOV.LOC:    77.96  |
| STATUS: PASS   RATIO =  0.000  GOV.MODE: Bend Y + Shear    GOV.LOAD:      3  |
|                                                                               |
```

| RESISTANCES: AX.TENS: 0.00 COMPRESS: 0.00 |
| BEND. Z: 0.00 BEND. Y: 0.00 SHEAR Z: 28.00 SHEAR Y: 25.20 |

UNITS : MM, KN, KNM, MPA

| MEMBER# 51 SECTION: 100CS60X2 LEN: 463.81 GOV.LOC: 463.81 |
| STATUS: PASS RATIO = 0.231 GOV.MODE: Bend Z + Shear GOV.LOAD: 4 |
| RESISTANCES: AX.TENS: 98.76 COMPRESS: 0.00 |
| BEND. Z: 3.28 BEND. Y: 0.00 SHEAR Z: 28.00 SHEAR Y: 25.20 |

UNITS : MM, KN, KNM, MPA

| MEMBER# 52 SECTION: 100CS60X2 LEN: 396.81 GOV.LOC: 0.00 |
| STATUS: PASS RATIO = 0.408 GOV.MODE: Bend + Compress GOV.LOAD: 4 |
| RESISTANCES: AX.TENS: 0.00 COMPRESS: 35.97 |
| BEND. Z: 3.28 BEND. Y: 0.00 SHEAR Z: 28.00 SHEAR Y: 25.20 |

UNITS : MM, KN, KNM, MPA

| MEMBER# 53 SECTION: 100CS60X2 LEN: 486.39 GOV.LOC: 486.39 |
| STATUS: PASS RATIO = 0.408 GOV.MODE: Bend + Compress GOV.LOAD: 4 |
| RESISTANCES: AX.TENS: 0.00 COMPRESS: 35.91 |
| BEND. Z: 3.28 BEND. Y: 0.00 SHEAR Z: 28.00 SHEAR Y: 25.20 |

UNITS : MM, KN, KNM, MPA

| MEMBER# 54 SECTION: 100CS60X2 LEN: 153.43 GOV.LOC: 0.00 |
| STATUS: PASS RATIO = 0.412 GOV.MODE: Bend + Compress GOV.LOAD: 4 |
| RESISTANCES: AX.TENS: 0.00 COMPRESS: 36.06 |
| BEND. Z: 3.28 BEND. Y: 0.00 SHEAR Z: 28.00 SHEAR Y: 25.20 |

UNITS : MM, KN, KNM, MPA

Approved :-

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

MEMBER# 55 SECTION: 100CS60X2 LEN: 486.39 GOV.LOC: 0.00
STATUS: PASS RATIO = 0.360 GOV.MODE: Bend + Compress GOV.LOAD: 4
RESISTANCES: AX.TENS: 0.00 COMPRESS: 35.91
BEND. Z: 3.28 BEND. Y: 0.00 SHEAR Z: 28.00 SHEAR Y: 25.20

UNITS : MM, KN, KNM, MPA

MEMBER# 56 SECTION: 100CS60X2 LEN: 396.81 GOV.LOC: 396.81
STATUS: PASS RATIO = 0.357 GOV.MODE: Bend + Compress GOV.LOAD: 4
RESISTANCES: AX.TENS: 0.00 COMPRESS: 35.97
BEND. Z: 3.28 BEND. Y: 0.00 SHEAR Z: 28.00 SHEAR Y: 25.20

UNITS : MM, KN, KNM, MPA

MEMBER# 57 SECTION: 100CS60X2 LEN: 463.81 GOV.LOC: 0.00
STATUS: PASS RATIO = 0.193 GOV.MODE: Bend Z + Shear GOV.LOAD: 4
RESISTANCES: AX.TENS: 0.00 COMPRESS: 35.93
BEND. Z: 3.28 BEND. Y: 0.00 SHEAR Z: 28.00 SHEAR Y: 25.20

UNITS : MM, KN, KNM, MPA

MEMBER# 58 SECTION: 100CS60X2 LEN: 77.86 GOV.LOC: 0.00
STATUS: PASS RATIO = 0.000 GOV.MODE: Bend Y + Shear GOV.LOAD: 3
RESISTANCES: AX.TENS: 0.00 COMPRESS: 0.00
BEND. Z: 0.00 BEND. Y: 0.00 SHEAR Z: 28.00 SHEAR Y: 25.20

UNITS : MM, KN, KNM, MPA

MEMBER# 66 SECTION: 80CS40X1.6 LEN: 600.00 GOV.LOC: 600.00
STATUS: PASS RATIO = 0.125 GOV.MODE: Bend Z + Shear GOV.LOAD: 4
RESISTANCES: AX.TENS: 0.00 COMPRESS: 0.00
BEND. Z: 1.44 BEND. Y: 0.00 SHEAR Z: 14.34 SHEAR Y: 16.13

```
|-------------------------------------------------------------------------|
|                        UNITS : MM, KN, KNM, MPA                         |
|                                                                         |
| MEMBER#    67  SECTION: 80CS40X1.6        LEN:   600.00  GOV.LOC:  600.00 |
| STATUS: PASS   RATIO =  0.125  GOV.MODE: Bend Z + Shear   GOV.LOAD:    4 |
|                                                                         |
| RESISTANCES:       AX.TENS:     0.00                  COMPRESS:    0.00 |
| BEND. Z:    1.44  BEND. Y:     0.00  SHEAR Z:   14.34  SHEAR Y:   16.13 |
|-------------------------------------------------------------------------|


|-------------------------------------------------------------------------|
|                        UNITS : MM, KN, KNM, MPA                         |
|                                                                         |
| MEMBER#    68  SECTION: 80CS40X1.6        LEN:   600.00  GOV.LOC:  600.00 |
| STATUS: PASS   RATIO =  0.125  GOV.MODE: Bend Z + Shear   GOV.LOAD:    4 |
|                                                                         |
| RESISTANCES:       AX.TENS:     0.00                  COMPRESS:    0.00 |
| BEND. Z:    1.44  BEND. Y:     0.00  SHEAR Z:   14.34  SHEAR Y:   16.13 |
|-------------------------------------------------------------------------|


|-------------------------------------------------------------------------|
|                        UNITS : MM, KN, KNM, MPA                         |
|                                                                         |
| MEMBER#    69  SECTION: 80CS40X1.6        LEN:   600.00  GOV.LOC:  600.00 |
| STATUS: PASS   RATIO =  0.125  GOV.MODE: Bend Z + Shear   GOV.LOAD:    4 |
|                                                                         |
| RESISTANCES:       AX.TENS:     0.00                  COMPRESS:    0.00 |
| BEND. Z:    1.44  BEND. Y:     0.00  SHEAR Z:   14.34  SHEAR Y:   16.13 |
  DXF IMPORT OF PUMP-10MODULE.DXF                        -- PAGE NO.   31
|-------------------------------------------------------------------------|


|-------------------------------------------------------------------------|
|                        UNITS : MM, KN, KNM, MPA                         |
|                                                                         |
| MEMBER#    73  SECTION: 70CS25X1.6        LEN:   153.84  GOV.LOC:    0.00 |
| STATUS: PASS   RATIO =  0.450  GOV.MODE: Bend + Compress  GOV.LOAD:   13 |
|                                                                         |
| RESISTANCES:       AX.TENS:     0.00                  COMPRESS:   35.22 |
| BEND. Z:    0.87  BEND. Y:     0.00  SHEAR Z:    7.62  SHEAR Y:   13.89 |
|-------------------------------------------------------------------------|


|-------------------------------------------------------------------------|
|                        UNITS : MM, KN, KNM, MPA                         |
|                                                                         |
| MEMBER#    74  SECTION: 70CS25X1.6        LEN:   144.44  GOV.LOC:  144.44 |
| STATUS: PASS   RATIO =  0.403  GOV.MODE: Bend + Compress  GOV.LOAD:   13 |
```

Approved by
(Dr. JAVED MOIN)
Professor, Civil Engineering
F/O Engineering & Technology
Jamia Millia Islamia
New Delhi-110025

RESISTANCES:	AX.TENS:	0.00			COMPRESS:	35.24
BEND. Z:	0.87	BEND. Y:	0.00	SHEAR Z:	7.62	SHEAR Y:	13.89

UNITS : MM, KN, KNM, MPA

MEMBER#	78	SECTION:	70CS25X1.6	LEN:	153.84	GOV.LOC:	0.00
STATUS: PASS	RATIO =	0.450	GOV.MODE:	Bend + Compress		GOV.LOAD:	11

RESISTANCES:	AX.TENS:	0.00			COMPRESS:	35.22
BEND. Z:	0.87	BEND. Y:	0.00	SHEAR Z:	7.62	SHEAR Y:	13.89

UNITS : MM, KN, KNM, MPA

MEMBER#	79	SECTION:	70CS25X1.6	LEN:	144.44	GOV.LOC:	144.44
STATUS: PASS	RATIO =	0.403	GOV.MODE:	Bend + Compress		GOV.LOAD:	11

RESISTANCES:	AX.TENS:	0.00			COMPRESS:	35.24
BEND. Z:	0.87	BEND. Y:	0.00	SHEAR Z:	7.62	SHEAR Y:	13.89

124. PARAMETER 3
125. CODE IS801
126. STEEL MEMBER TAKE OFF ALL

STEEL TAKE-OFF

	PROFILE	LENGTH(METR)	WEIGHT(KN)
ST	PIP127SM	1.12	0.158
ST	ISA50X50X5	1.22	0.045
ST	70CS25X1.6	3.98	0.063
ST	TUB63633.6	1.80	0.114
ST	80X40X3.2RHS	0.77	0.042
ST	40X40X2.6SHS	0.69	0.020
ST	PIP337L	2.46	0.048
ST	80CS40X1.6	12.00	0.248
ST	100CS60X2	6.01	0.217
	TOTAL =		0.954

Approved :-

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

MEMBER	PROFILE	LENGTH (METE)	WEIGHT (KN)
1	ST PIP1270M	1.01	0.143
3	ST ISA50X50X5	0.12	0.004
4	ST ISA50X50X5	0.12	0.004
5	ST ISA50X50X5	0.08	0.003
6	ST 70CS25X1.6	0.77	0.012
7	ST 70CS25X1.6	0.15	0.002
8	ST 70CS25X1.6	0.77	0.012
9	ST ISA50X50X5	0.12	0.004
10	ST ISA50X50X5	0.12	0.004
11	ST ISA50X50X5	0.08	0.003
12	ST 70CS25X1.6	0.77	0.012
13	ST 70CS25X1.6	0.15	0.002
14	ST 70CS25X1.6	0.77	0.012
15	ST TUB63633.6	0.20	0.013
16	ST TUB63633.6	0.70	0.044
17	ST 80X40X3.2RHS	0.77	0.042
18	ST 40X40X2.6HHS	0.69	0.020
19	ST PIP337L	1.23	0.024
20	ST PIP337L	1.23	0.024
21	ST 80CS40X1.6	1.80	0.037
22	ST 80CS40X1.6	0.60	0.012
26	ST 80CS40X1.6	1.80	0.037
27	ST 80CS40X1.6	0.60	0.012
31	ST 80CS40X1.6	1.80	0.037
32	ST 80CS40X1.6	0.60	0.012
36	ST 80CS40X1.6	1.80	0.037
37	ST 80CS40X1.6	0.60	0.012
41	ST 100CS60X2	0.08	0.003
42	ST 100CS60X2	0.46	0.017
43	ST 100CS60X2	0.40	0.014
44	ST 100CS60X2	0.49	0.018
45	ST 100CS60X2	0.15	0.006

DXF IMPORT OF PUMP-1UMODULE.DXF -- PAGE NO. 34

46	ST 100CS60X2	0.49	0.018
47	ST 100CS60X2	0.40	0.014
48	ST 100CS60X2	0.46	0.017
49	ST 100CS60X2	0.08	0.003
50	ST 100CS60X2	0.08	0.003
51	ST 100CS60X2	0.46	0.017
52	ST 100CS60X2	0.40	0.014
53	ST 100CS60X2	0.49	0.018
54	ST 100CS60X2	0.15	0.006
55	ST 100CS60X2	0.49	0.018
56	ST 100CS60X2	0.40	0.014
57	ST 100CS60X2	0.46	0.017
58	ST 100CS60X2	0.08	0.003
63	ST PIP1270M	0.10	0.015

Approved :-

Dr. KHALID MOIN
Professor
Deptt. of Civil Engineering
FO Engineering & Techn.
Jamia Millia Islamia
New Delhi-110025

64	ST	TUB63633.6	0.70	0.044
65	ST	TUB63633.6	0.20	0.013
66	ST	80CS40X1.6	0.60	0.012
67	ST	80CS40X1.6	0.60	0.012
68	ST	80CS40X1.6	0.60	0.012
69	ST	80CS40X1.6	0.60	0.012
70	ST	ISA50X50X5	0.12	0.004
71	ST	ISA50X50X5	0.11	0.004
72	ST	ISA50X50X5	0.08	0.003
73	ST	70CS25X1.6	0.15	0.002
74	ST	70CS25X1.6	0.14	0.002
75	ST	ISA50X50X5	0.12	0.004
76	ST	ISA50X50X5	0.11	0.004
77	ST	ISA50X50X5	0.08	0.003
78	ST	70CS25X1.6	0.15	0.002
79	ST	70CS25X1.6	0.14	0.002
			TOTAL =	0.954

********** END OF DATA FROM INTERNAL STORAGE **********

127. FINISH

Approved :-

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

Approved :-

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

DESIGN BASIS REPORT

FOR

9 MODULE SOLAR PUMP

MOUNTING STEEL STRUCTURE TABLE

For

ETHOS POWER PVT LTD.

121-123, 1st Floor, NH – 8 DLF Star Tower, Sector 30, Gurugram, Haryana, India - 122001

Date:06thJUNE 2020

TABLE OF CONTENTS

Approved :-

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

1. GENERAL:

2.1SCOPE

This document covers the Analysis & Design of Fixed typeSolar PV Module mounting structure at an angle of **tilt 25 degree** for at **155kmph** wind speed.

2.2UNITS OF MEASUREMENTS

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

2.3CODES 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 (WSD)	Code of practice for general construction in steel of hot rolled
8	IS 801: 1975	Code of practice for cold formed steel
9	IS 811: 1987	Specifications for cold formed light gauge structural steel sections
10	IS: 2062	Hot rolled medium and high tensile structural steel

2.4MATERIAL PROPERTIES:

Material	Property	Value	Units
Concrete - M25	Density	25	kN/m^3
	Characteristic Strength	25	N/m^2
	Modulus of Elasticity	25000	N/m^2
High Strength Reinforcing Steel	Density	78.5	kN/m^3
	Characteristic Strength	500	N/m^2
	Modulus of Elasticity	200000	N/m^2
Structural Steel	Density	78.5	kN/m^3
	Characteristic Strength	350000	kN/m^2
	Modulus of Elasticity	250000	N/m^2

2.5PLANT INFORMATION:

Location of Site: India
Basic Wind Speed: 43 m/s (155kmph)

2.6 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

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

2. LOADS:

2.1 Load Calculation:

Dead Load Calculation:-	UDL LOAD			
Module	=			
Solar module Dimension	=	Length (mm)	Width (mm)	Nos
		1964	986	9
Weight per module	=	22.5	Kg's/module	
Weight of 9 modules	=	202.5	Kg's	
Module Configuration	=	5X2	Portrait	
Including 10% extra Load per for connections	=	202.5	Kg's	
Purlin Length	=	9.02	m	
Total Legth of purlin	=	18.04	m	
Udl load at purlin	=	0.110	kN/m	
All dead loads have been applied as udl load by considering the modules are in constant touch with the purlin upper face.				

2.1.1 Wind Load:

Wind Pressure Calculation					
Basic Wind Speed	=	155.00	kmph		
Basic Wind Speed	=	43	m/sec		
Design Period	=	25	years	As per Tender Specification	
Type of Mounting	=	Ground Based			
Terrain Category	=	2			
Class	=	A			
Module Clearance From NGL	=	0.85	m		
		Length	Width	Nos	
Solar module Dimension	=	1964	986	9	
Risk Co-efficient k1	=	0.91	(As per Table-1, IS-875,part-3)		
Terrain Factor, k2	=	1.00	For Terrain Category 2		
Topography factor k3	=	1.00	(As per Table-2 of IS: 875 Part 3- 1987)		
Importance factor k4	=	1.00	(Refer IS-875,part-3 clause-6.3.4)		
Design Wind Speed, Vz=k1*k2*k3*k4=	=	39.18	m/sec		
Design Wind pressure, Pz =0.6*(Vz)^2=	=	767.56	N/sqm		
As per Latest code IS : 875 (Part-3-2015)					
The design wind pressure pd can be obtained as as per clause 4.5.2(pd = Kd. Ka. Kc .Pz)					
Where,					
Wind directionality factor kd	=	0.90	(Refer clause-7.2.1, In IS-875-part-3)		
Area of solar panels	=	17.41	<50		
Area averaging factor, ka	=	0.90	(if this area is >= 25 then Ka = 0.9)		
Combination factor kc	=	1	(Refer clause-7.3.3.13, In IS-875-part-3)		
Design pressure shall be, pd = Kd. Ka. Kc . Pz=	=	663.17	N/sqm		

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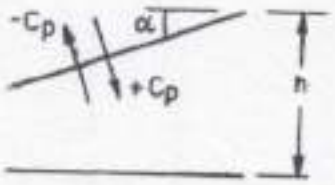
Calculating pressure coefficient for mono-slope roof;



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, Part3 - 2015. The pressure coefficients for a mono-slope free roof of 05° tilt angle and solidity ratio of 0.

WINDLOAD UPWARD/DOWNWARD (+/- Y DIRECTION)

Solar module Dimension	=	Length	Width	Nos
		1984	984	9

Tilt angle of MMS for mount	=	15	Degree	
Upward/Downward Wind Force,F=Cp*A*Pd				
Where,				
Pressure Coefficient for Upward wind,cp	=	-1.0		(As per IS875 Part-3, Table-8)
Surface Area of Structural element, A=(1964*984*9)/(10^6)	=	17.43	sqm	
Design wind pressure,pd	=	665.17	N/sqm	
Upward Wind force,Fu=Cp*A*Pd	=	18.49	Kn	
Pressure coefficient for Downward wind,cp	=	1.00		(As per IS875 Part-3, Table-8)
Downward Wind force,Fd=Cp*A*Pd	=	11.56	Kn	
Here, we are considering uplied wind force of Solar panels shall be bear by Purlin				
No. of Purlin support	=	2	Nos	
Length of member	=	9.02	m	
Upward Wind force,F=Fu/(2*9.02)	=	-1.03	Kn/m	
Downward Wind force,F=Fd/(2*9.02)	=	0.641	Kn/m	

Where, Negative sign shows Upward direction of Wind

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FAO Engineering & Technology
Jamia Millia Islamia
New Delhi-110025

WINDLOAD SIDEWAYS (X & Z DIRECTION)									
MWS ELEMENTs				SECTIONS DETAIL					
		Web	Flange	Lip	Thk				
Column	=	139.7	139.7	0	5.4				
Rafter	=	120	60	20	3.15				
BRACING	=	42	42	0	3.2				
As per table-28, IS-875,part-3									
Design Wind speed,Vd	=	39.18	m/sec						
Design Wind pressure,Pd	=	603.37	N/sqm						
Sections		Angle of Wind	Cfx	Wind facing width in mm(D) (X-direction)	Length of member in mm(l)	Dvd in m/sec (X-direction)	l/b or l/D ratio (X-direction)	Reduction factor (k)	
Column	=	0°	0.50	139.7	3650	5	11.42	0.82	
Rafter	=	0°	2.00	120	3100	5	25.83	0.84	
Sections		Angle of Wind	Cfz	Wind facing width in mm(B) (Z-direction)	Length of member in mm(l)	Dvd in m/sec (Z-direction)	l/b or l/D ratio (Z-direction)	Reduction factor (k)	
Column	=	90°	0.36	139.7	3600	5	11.42	0.82	
BRACING	=	90°	0.36	42	4010	5	95.48	0.82	
Wind force at Column per metre F=pd*width*cfx*k=	=	0.0386	Kn/m	X-direction					
Wind force at Rafter per metre F=pd*width*cfx*k=	=	0.1370	Kn/m						
Wind force at Column per metre F=pd*width*cfz*k=	=	0.0388	Kn/m	Z-direction					
Wind force at Bracing per metre F=pd*width*cfz*k=	=	0.0114	Kn/m						

2.2 LOAD COMBINATION

LOAD TYPE	L/C	LOAD NAME
Primary	1	DEAD LOAD STRUCTURE
Primary	2	WIND LOAD X+
Primary	3	WIND LOAD X-
Primary	4	WIND LOAD Z+ UPWARD
Primary	5	WIND LOAD Z- DOWNWARD
Combination	6	1 DEAD LOAD + 1 WIND LOAD X+
Combination	7	1 DEAD LOAD + 1 WIND LOAD X-
Combination	8	1 DEAD LOAD + 1 WIND LOAD Z+ UPWARAD
Combination	9	1 DEAD LOAD + 1 WIND LOAD Z- DOWNWARD
Combination	10	1 DEAD LOAD + 1 WIND LOAD X+ + 1 WIND LOAD Z+ UPWARD
Combination	11	1 DEAD LOAD + 1 WIND LOAD X+ + 1 WIND LOAD Z- DOWNWARD
Combination	12	1 DEAD LOAD + 1 WIND LOAD X- + 1 WIND LOAD Z+ UPWARD
Combination	13	1 DEAD LOAD + 1 WIND LOAD X- + 1 WIND LOAD Z- DOWNWARD

Approved :-

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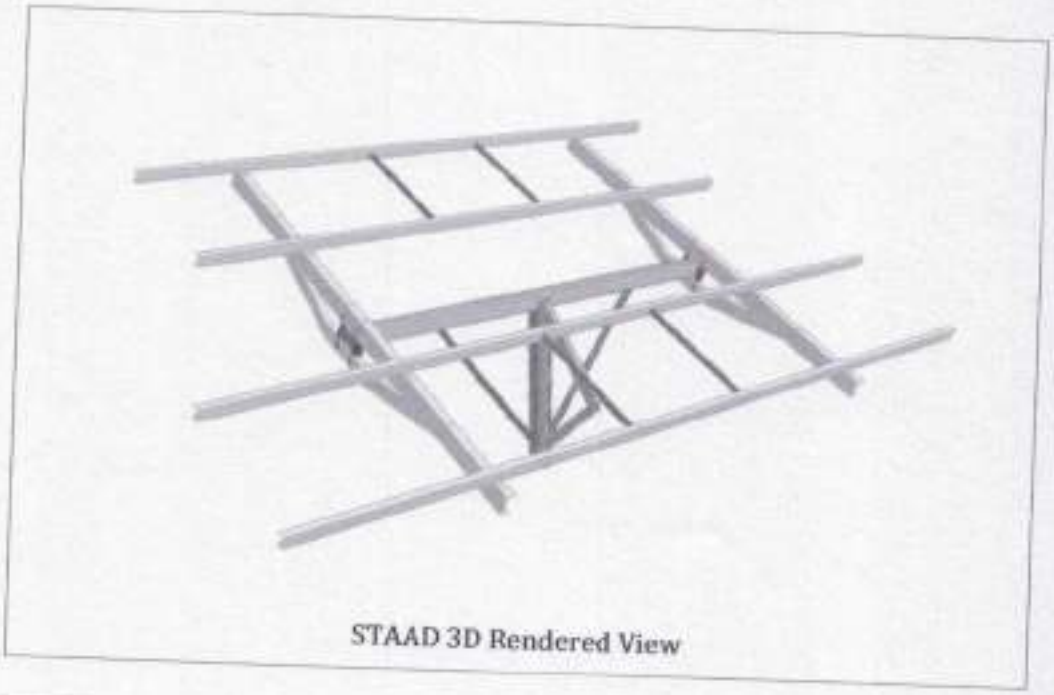
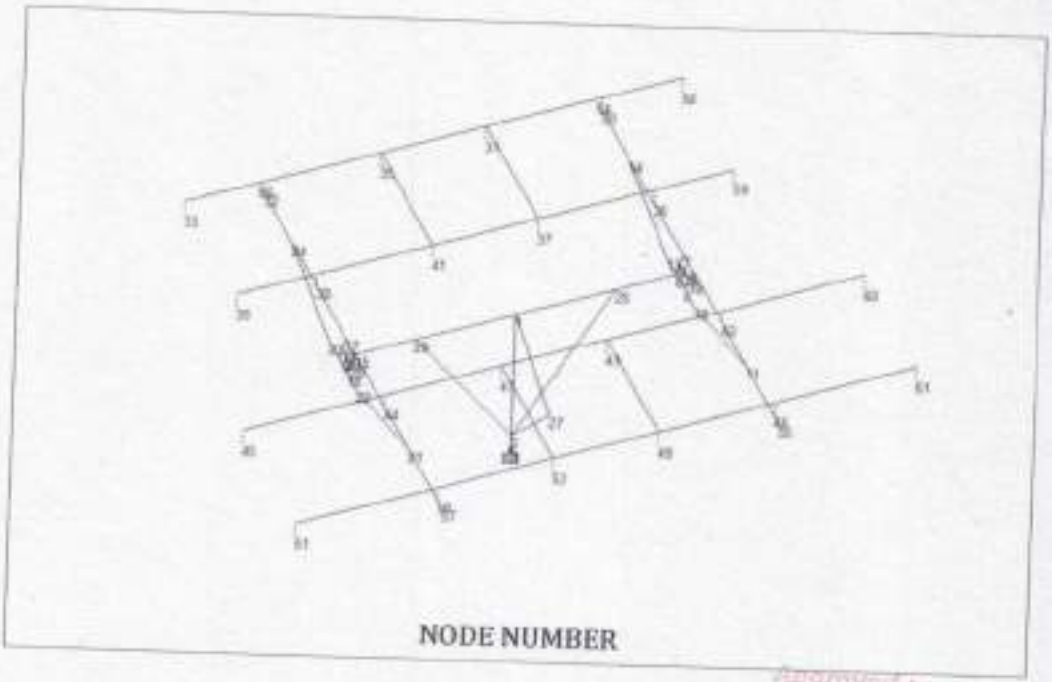
Deptt. of Civil Engineering
FAD Engineering & Technology
Jamia Millia Islamia
New Delhi-110025

3. STAAD MODEL:



STAAD 3D Rendered View



NODE NUMBER

Approved :-

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