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DATE : 23-06-2020

SUB : TPSSL DESIGN IMPROVEMENT SUMMARY FOR EESL MNRE MMS STRUCTURE

The Tata Power Solar Systems Ltd drawing / document no. TPS-PUMP-EESL-9MMS-002 and TPS-PUMP-EESL-10MMS-002 was reviewed by us and compared along with the Module Mounting Structural designs provided in the NIT/Bid Doc. No. : EESL/06/2019-20/KUSUM/SWPS/Phase-1/10HP/Off Grid/192012030. The description of the TPSSL documents is as follows :

Sl. No.	Configuration / Size	Document No.	Contents
1	9 Module Mounting System (MMS)	TPS-PUMP-EESL-9MMS-002	• Report for STAAD-Pro analysis as per IS standard. • Wind Load Calculations as per IS 875 • Pile Foundation Design as per IS standard. • Structural drawings of the Module Mounting System.
2	10 Module Mounting System (MMS)	TPS-PUMP-EESL-10MMS-002	• Report for STAAD-Pro analysis as per IS standard. • Wind Load Calculations as per IS 875 • Pile Foundation Design as per IS standard. • Structural drawings of the Module Mounting System.

The above mentioned TPSSL documents have been duly certified by us vide certificates dated 23-06-2020 which form a part of this document and shall be read in conjunction with these certificates. The improvements and advantages of the TPSSL designed structure in comparison to MNRE-2019 design have been mentioned in the Table 1.0 of Annexure 1 of this document.

LIST OF ANNEXURES TO THIS DOCUMENT :

Thanking You

Yours Sincerely

Dr. Jayaramappa N (Bangalore University)

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ANNEXURE 1

TPSSL DESIGN IMPROVEMENT SUMMARY OVER MNRE STRUCTURES

Table 1.0

<table>
<tr><th>Sl. no.</th><th>Short Description</th><th>MNRE - 2019</th><th>Improved design</th></tr>
<tr><td>1</td><td>Additional cross members provided.</td><td>No cross beam structural members provided in MNRE 2019 MMS designs. The purlins are carrying weight of the rafters.</td><td>Additional cross beam members have been provided to avoid excess deflection and stresses. This feature is absent in the MNRE design. The complete behaviour of the structure has been modelled and analysed on STAAD-Pro software.</td></tr>
<tr><td>2</td><td>Top Plate Gussets.</td><td>4 nos. Gussets provided on top plate of the structure.</td><td>8 nos. Gussets provided on the top plate of the structure.</td></tr>
<tr><td>3</td><td>Structural Material Strength</td><td>MNRE - 2019 guidelines for yield strength :
<table><tr><th>Component</th><th>MNRE Yield Strength</th></tr><tr><td>Purlins</td><td>250 MPa</td></tr><tr><td>Rafter</td><td>250 MPa</td></tr><tr><td>Base Column</td><td>250 MPa</td></tr></table></td><td>TPSSL design uses High Yield Strength materials for better safety margins :
<table><tr><th>Component</th><th>TPSSL Yield Strength</th></tr><tr><td>Purlins</td><td>350 MPa</td></tr><tr><td>Rafter</td><td>310 MPa</td></tr><tr><td>Base Column</td><td>310 MPa</td></tr></table>All materials grades used in the structure are as per IS standards.</td></tr>
<tr><td>4</td><td>Dimensions of main structure members</td><td>Base pole and Supporting pipes are main load bearing member for the structure.

MNRE 2019 guidelines :
<table><tr><th>Component</th><th>MNRE Diameter</th></tr><tr><td>Base Pole Diameter</td><td>139 mm</td></tr><tr><td>Supporting Pipe 1 dia.</td><td>41 mm</td></tr><tr><td>Supporting Pipe 2 dia.</td><td>33 mm</td></tr></table></td><td>TPSSL has used larger diameter base pole and Supporting Pipes for high strength and low deflections :

TPSSL Design :
<table><tr><th>Component</th><th>TPSSL Diameter</th></tr><tr><td>Base Pole Diameter</td><td>152 mm</td></tr><tr><td>Supporting Pipe 1 dia.</td><td>42.7 mm</td></tr><tr><td>Supporting Pipe 2 dia.</td><td>33.7 mm</td></tr></table></td></tr>
</table>

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Sl. no.	Short Description	MNRE - 2019	Improved design
5	Deflections and Stress	Structure to be designed as per IS 875 . MNRE does not mention anything on deflection limits of the structure.	Structure designed as per IS 875 for a wind velocity of 150kmph with maximum stress ratio 90.8 %(9MMS) and 93.7% (10MMS). No members are 100% loaded. Structure designed not only with minimum deflections but also with stress considerations which are complying with IS standards.
6	Pile design.	MNRE is silent on pile design guidelines.	Pile length designed as per IS 2911 with 300% safety margin considering utilization of the pile in clayey soil. Full 2m deep length steel structure column provided for sub-surface pile with surface anchors for adhesion to pile cap.
7	Theft proofing.	J-bolt type bolted foundation which can be easily dismantled with a spanner and thus prone to theft easily.	Central mounting column which is the heaviest component of the structure has been designed as a fully embedded structure. This cement embedded structure cannot be dismantled easily and thus discouraging theft.
8	Land Utilization.	MNRE has given guidelines for module mounting structures. The guidelines requires combination of 4MMS , 6MMS and 8MMS only. Combination of MMS and foundations required will be more in case of MNRE recommended structures since number of modules per structure is lesser.	Tata Power Solar Ltd has alternatively developed 9MMS and 10MMS structures. The number of modules per structure in TPSSL design are more compared to MNRE structure hence require lesser number of structural combinations and foundations. Thus leaving more productive land for agricultural utilization.

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ANNEXURE 2

ABOUT BANGALORE UNIVERSITY

Bangalore University is located in the Garden City of Bangalore aptly hailed as the "I.T. Capital of India", was established in July 1964 as an off shoot of the University of Mysore, primarily to include institutions of higher learning located in the metropolitan city of Bangalore and the districts of Bangalore, Kolar and Tumkur, which eventually became a separate university. Initially, the two premier colleges of the city, the Central College (CC) and the University Visvesvaraya College of Engineering (UVCE) formed the nucleus of Bangalore University.

Soon after the establishment of Bangalore University, as a first step in the re-organization of courses instructions, the University introduced Honours Courses in the year 1965-66. Three year Honour's courses in Botany, Chemistry, Economics, English, Geology, Kannada, Mathematics and Zoology which were offered only at the University Post Graduate Departments have attracted many brilliant students. Honours passed students were admitted to Post Graduate Courses on priority and B.A./B.Sc. graduates, who marginally missed admission to the Post Graduate Courses were given an opportunity to join the final year Honours course and seek admission to Post Graduate Courses, thereafter. Since 1964, Bangalore University has grown both in size and strength to include a large number of affiliated colleges, P.G. Centers with a rich diversity of programme options. In consonance with this expansion, in 1973, the University moved into a new campus named 'Jnana Bharathi' (JB) located on a sprawling 1100 acres of land and shifted many of its post graduate departments to this newly established campus. At present, the JB Campus houses the office of the Vice Chancellor, Registrar, Registrar (Evaluation), Finance Officer and a large number of post graduate departments, Directorates, Centres of higher learning, NSS Bhavan, Outdoor Stadium and other support services. The University Law College, started in 1948 and The College of Physical Education, started in 1959 are located in the JB Campus.

The University has also established Gandhi Bhavan, Dr. B.R. Ambedkar Study and Research Centre, and Centre for Study on Social Exclusion and Inclusive Policy. Bangalore University has completed Fifty-two years of fruitful existence and has come to be hailed as one of the largest universities of Asia. Though originally intended to be a federal university, it has eventually emerged as an affiliating University. The University was first accredited in 2002 by NAAC with Five Star Status, re-accredited in the years 2008 and Nov. 2016 in 2nd and 3rd Cycles with 'A' Grade.

According to QS University Ranking: BRICS-2016, an international agency ranked Bangalore University at 151st position amongst BRICS nations. As per ***Hansa Research Survey 2016*** published in THE WEEK-May 29, 2016 issue, Bangalore University is ranked at No. 15 in the Top Multi-

disciplinary Universities at All India level, at No.9 in the Top State Multi-disciplinary Universities, No.5 in the South Zone and No.1 in the State of Karnataka.

Academically, the University is structured into six faculties- Arts, Science, Commerce & Management, Education, Law and Engineering. It has 48 Post Graduate Departments, One post graduate Centre at Kolar, (started during 1994-95), four University colleges, 684 affiliated colleges and several other Centres and Directorates of higher learning and research under its purview. At present, the University offers 50 Post Graduate Courses and Employment Oriented Diploma and Certificate Courses. The University has launched the Five years Integrated Courses in Biological Sciences.

The University is also reaching out to the society by organizing endowment and extension lectures apart from bringing out publications on issues of contemporary relevance through its Prasaranga division.

Bangalore University has achieved milestones by establishing MOUs with Universities and Institutions of national and international repute. To cater to a student population of over three lakhs, the University is striving to provide access, expansion and excellence in higher education. The vision of the University is to make distinctive and significant contributions to the cause of higher education in Humanities, Social Science, Law, Commerce, Science & Technology. The University is providing quality teaching and encouragement to research in frontier areas with social relevance that would reflect its mission and goals aptly symbolized by its emblem 'JNANAM VIGNANA SAHITHAM'.

Undergraduate Engineering Courses offered :

I. Civil Engineering
   a. High Way Engineering
   b. Prestressed Concrete Engineering
   c. Structural Engineering
   d. Geo-Technical Engineering.
   e. Water Resources Engineering.
   f. Construction Technical Engineering.
   g. Environmental Engineering.
II. Mechanical Engineering
III. Electrical and Electronics Engineering.
IV. Electronics and Communication Engineering.
V. Computer Science & Engineering.
VI. Information Science & Engineering.
VII. Bachelor of Architecture.

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Post-Graduate M-Tech / M-Arch Courses offered :

I. Department of Civil Engineering

1) Structural Engineering

2) Geotechnical Engineering

3) Environmental Engineering

4) Highway Engineering

5) Prestressed Concrete

6) Construction Technology

7) Water Resources Engineering

8) Earthquake Engineering

II. Department of Mechanical Engineering

9) Machine Design

10) Manufacturing Science and Engineering

11) Thermal Science and Engineering

12) Advanced Materials Technology

III. Department of Electrical Engineering

13) Power Systems

14) Power Electronics

15) Control and Instrumentation

IV. Department of Electronics and Communication Engineering

16) Electronics and Communication.

V. Department of Computer Science and Engineering

17) Computer Science and Engineering

18) Information Technology

19) Computer Networking

20) Software Engineering

21) Bio Informatics

22) Web Technologies

VI. Department of Architecture

23) Landscape Architecture

24) Project and Construction Management

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ANNEXURE 3

CREDENTIALS OF THE EVALUATOR

Dr. Jayaramappa N, Professor
Dept Of Civil Engg, UVCE,
Bangalore University, Bangalore

1	Qualifications:	B.E.(Civil) ,GBDT, Davangere 1990 M.E.(Structures), SIT,Tumkur, BU ,2001 Ph.D - 2017, Bangalore University CIC (IGNOU), GATE-1994 Qualified.
2	Date of Birth :	22-07-1965
3	Teaching Experience:	From Aug 1991 to 31.10.2002,Lecturer and from 1.11.2002 to 31.3.2003 Senior Lecturer, SSIT,Tumkur. From 3.4.2003 to 25th .October 2006, Lecture, BMS Evening, Bangalore From 25th October 2006 to till date UVCE ,Bangalore Professor From 25th July 2019 , UVCE ,Bangalore
4	Publication:	41 Journals 27 Papers , 16 International conferences, 10 National conferences 03 papers at Japan ,Presented 01 Paper at USA, Presented 01 Paper at South Koria, Presented
5	Membership:	MISTE(Life member), MICI (Life member) IGASE IGS(Life member)
6	Course Conducted:	CAD Training Programme (from Auto disk) organized for Civil Engg Faculty of UVCE ,Bangalore NISA Training Programme (from Karnes Software) Proposed for ME Students,
7	Committee:	BE and ME Syllabus Revision ,for UVCE ME, SSC Question paper setting , BU,VTU, and other Universities , SSC questions papers and selection committee and etc .
8	Expert Lecture:	1. PES University Bangalore. 2. Ph.D Advisory committee Member MSRIT (VTU). 3. Ph.D Doctoral Committee Member , Sri Siddhartha Academy of

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Higher Education.

9	Guidance :	Guidance for 45 ME Students
10	Membership :	Nirmithi Kendra Bangalore Rural Governing Council Member Since 10 years
11	Reviewer :	Reviewer for **ICRITCSA – 2019** , International Conference MSRIT Bangalore, Scopus Indexed Journal.

12 **Professional Consultancy Projects**

- Feasibility Study of RBI Bangalore.
- Feasibility Study of BHEL Bangalore.
- Feasibility Study of KV schools Bangalore.
- Design vetting to IITDM Karnolu,
- Design vetting to CRPF Belgaum
- Design vetting to USMANIA University
- Design and vetting to Post office Building Bangalore, Devanahalli and T. Narasipur
- DCF Office Devanahalli Bangalore
- Design and vetting more than 25 Projects of Bangalore Nirmithi Kendra (Rural)
- Design and vetting to BBMP Retaining wall and buildings
- Design and vetting to CPWD and MES (Military Engineering Services buildings).
- Design and vetting to KIRDL buildings.
- Design and vetting to Railway Department.
- Design and vetting to PEB structures MES
- Design and vetting to BBMP solid waste disposal PEB.
- NAIE Doddaballapura to Gouribedunur Serviceability of Bridges.
- Nirmithi Kendra Bangalore Rural Governing Council Member Since 10 years. About 150 to 250 Crore projects Design, and Third Party Quality Assurance (TPQA) Works.
- Similar works of state Government, Postal Department and MES Third Party Quality Assurance (TPQA) Works.

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Date : 23-06-2020

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TO WHOMSOEVER IT MAY CONCERN

Dwg / Doc. Ref : TPS-PUMP-EESL-9MMS-002

NIT/Bid Doc. No. : EESL/06/2019-20/KUSUM/SWPS/Phase-1/10HP/Off Grid/192012030

This is to certify that the design and analysis for 9 module mounting structure (TPS-PUMP-EESL-9MMS-002) being offered by M/s Tata Power Solar Systems Limited is reviewed. The design and analysis work submitted by M/s Tata Power Solar System Limited is validated to work upto 150km/hr wind speed and is complying to the EESL NIT/Bid document number mentioned above.

Thanking You

Yours Sincerely

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Dwg / Doc. Ref : TPS-PUMP-EESL-10MMS-002

NIT/Bid Doc. No. : EESL/06/2019-20/KUSUM/SWPS/Phase-1/10HP/Off Grid/192012030

This is to certify that the design and analysis for 10 module mounting structure (TPS-PUMP-EESL-10MMS-002) being offered by M/s Tata Power Solar Systems Limited is reviewed. The design and analysis work submitted by M/s Tata Power Solar Systems Limited is validated to work upto 150km/hr wind speed and is complying to the EESL NIT/Bid document number mentioned above.

Thanking You

Yours Sincerely

Dr. Jayaramappa N (Bangalore University)

TATA POWER SOLAR SYSTEMS

10 MODULE MOUNTING STRUCTURE (MMS)

Document No.: TPS-EESL-10MMS-N-TP-PVPT-F-001

TATA

TATA POWER SOLAR SYSTEMS LIMITED

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BANGALORE 560100
INDIA

REV. NO.	R0								ISSUE
	INITIALS	SIGN	INITIALS	SIGN	INITIALS	SIGN	INITIALS	SIGN	
PPD BY	Harisha								R0
CHD BY	Sunil								
APD BY	Nilesh								
DATE	01.08.2020								

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19/8/020

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INTRODUCTION

This document covers structural design and analysis of 10 Module Mounting Structure (MMS) for mounting of solar panels of Solar Water Pumping System meant for Agricultural, Drinking Water and other purposes. The analysis has been carried out using STAAD software simulation of the structure. The structure has been designed to withstand a wind velocity of 150kmph.

1 SCOPE

The scope of the report is limited to providing structural design of module mounting structure as described in section 5.1. The solar yield analysis shadow effects, construction procedure are outside the purview of the report.

2 REFERENCE DOC/CODES

IS 875 : Part -1	Design load for Building and Structures – Code of practice for Dead Load
IS 875 : Part -3	Design load for Building and Structures – code of practice for wind load
IS 800 : 2007	General Construction In Steel - Code of Practice
IS 1079-2009	Hot Rolled Carbon Steel Sheet And Strip- Specification
IS 4759-1996	HDZ- Coating on Structural Steel products
IS 2062 - 2011	Hot Rolled Medium and High Tensile Structural Steel-Specification
IS 811 -1987	Specification For Cold Formed Light Gauge Steel Structural Member

3 DESIGN BASIS

BASIC DATA ASSUMED FOR STRUCTURAL DESIGN

A MATERIAL CONSTANTS

1	Characteristic strength of concrete (for foundation)	: 25 N/sq.mm
2	Unit wt. of concrete	: 2400 kg/Cu.m
3	Unit wt. of steel	: 7850 kg/Cu.m
4	Steel grade	: IS 2062 E250A /E250B/ E350A / IS 4923 Yst 310 / IS 1161 Yst 310.
5	Bolt Grade	: 8.8

B DEAD LOADS

1	PV module weight	: 24 kg per module

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C WIND LOAD

1	Basic Wind Speed	:	42 m/s	IS 875 2015 - Part 3
2	Terrain Category	:	Category 3	IS 875 2015 - Part 3
4	Topography factor	:	1.0	IS 875 2015 - Part 3
5	Importance Factor (k_3)	:	1.0	IS 875 2015 - Part 3

E DESIGN CODES

1	Steel Structure	:	IS 800 :2007/ IS 801 :1975
2	Wind load Calculation		IS 875 : 2015 Part -3

F SOFTWARE

1	Structural Analysis	:	STAAD Pro

4 INPUT DATA

The input data refer module data sheet and tender document (i.e. Structural configuration, Tilt angle, Members used, Module data, etc.) is as per tender document.

4.1 STRUCTURAL DESCRIPTION.

The MMS (Module Mounting Structure) supports 10 modules suitable for TPSSL Modules of dimensions 1.984m x 1.004 m and 1.956m x 0.992m and PV Power Tech Module of dimension 1.960 x 0.989m. The modules are arranged in 2x5 Portrait arrangement. The angle of inclination for seasonal tilt provided is 15 to 20 degree to the horizontal so that inclination can be adjusted at the specified tilt angle. Manual tracking with 3 times tracking per day has also been provided to maximise the water output and enhance the SPV water pumping systems. The structure has a single leg arrangement. Reactions were obtained from the analysis and are used for the pile foundation design. The members were designed by STAAD Software.

5 STRUCTURAL PRE-REQUISITIES

The following are the pre-requisites for the module supporting structure to qualify for structure and foundation sufficiency study,

- The module supporting structure is deemed to have been designed using relevant IS codes to satisfy both strength and serviceability criteria.
- Execution quality compliance on material quality, safety in construction and proper construction practices are deemed taken care.

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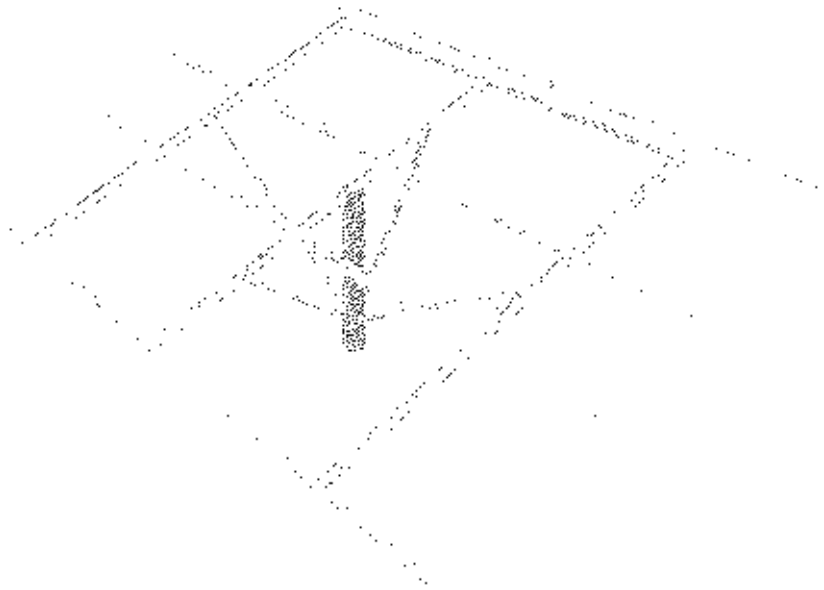
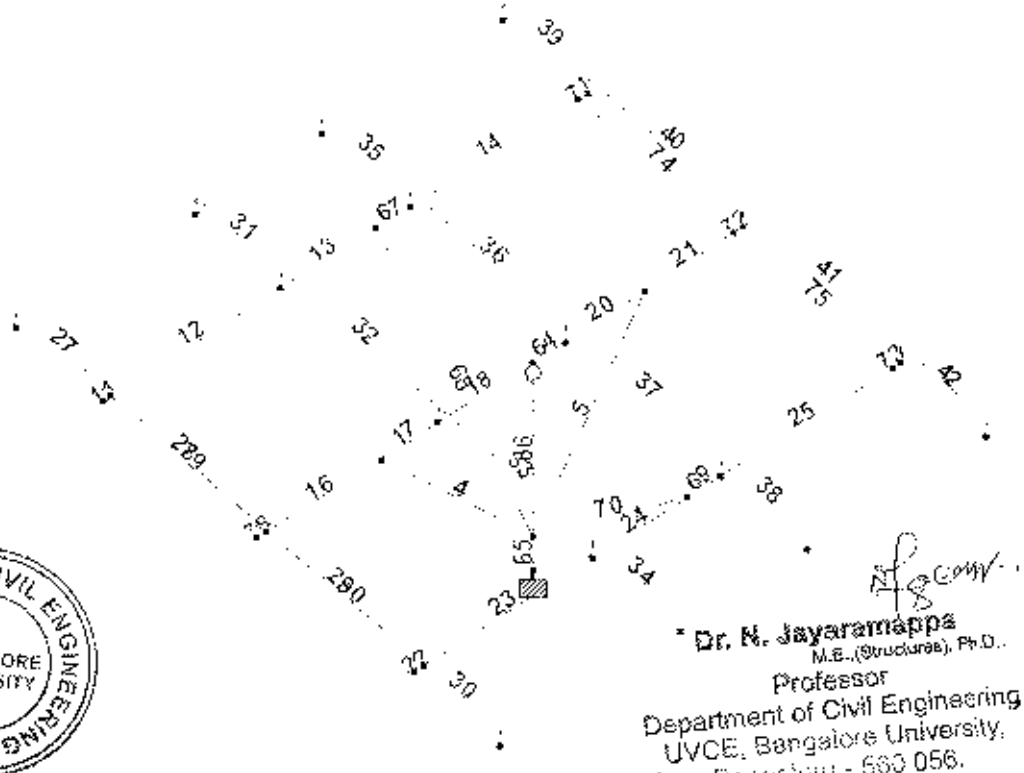
6 STAAD MODELING

6.1 STAAD MODEL



6.2 STAAD MEMBER NUMBER



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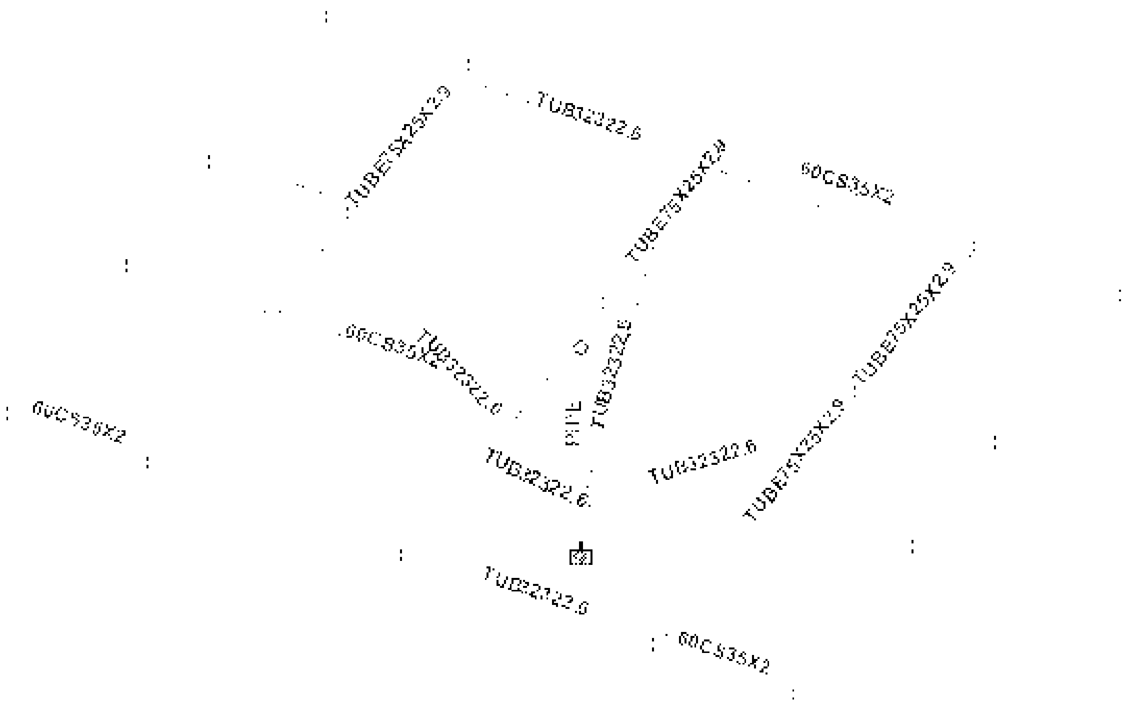
6.3 STAAD MEMBER PROPERTIES



prop	Section	Dimensions	Area(cm2)	Iyy(cm4)	Izz(cm4)	J(cm4)	material
1	PIPE	Ø152mm x3.6mm thk	[illegible]	450.54	[illegible]	[illegible]	STEEL
2	TUB32322.6	Tube 32x32x2.6mm	2.85	[illegible]	[illegible]	6.907	STEEL
3	TUBE75X25X2.9	Tube 75x25x2.9 mm	5.464	[illegible]	34.07	[illegible]	STEEL
4	60CS35X2	C 60x35x12x2mm thk	3.92	[illegible]	15.625	—	STEEL

7 LOAD CALCULATION

The module mounting structure is subjected to the following loads :

- Module dead load
- Wind Load

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7.1 DEAD LOAD

Module dead load–

- Weight of Module = 24 kg (from Module Data Sheet)
- Panel Dimensions = 1.984m x 1.004 m and 1.956m x 0.992m (from TPSSL Module data sheets) & 1.960 x 0.989m (from PV Power Tech Module sheet)
- Load due to module = (Weight of the module/Area of module) x (length of the module/2)

  = (0.24/1.984*1.004) x (1.984/2) = 0.12 kN/m
- Self-weight of module supporting structure.

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	10 MMS PUMP STRUCTURE	SHEET 7 of 16

7.2 WIND LOAD

WIND LOAD CALCULATION: (AS PER IS:875 Part-3 2015)

Basic Wind Speed=	42	m/s	150 kmph	Fig : 1
Design Life N =	25		(for 25 year design life)	
Tilt angle =	20			From GA DWG
Risk Co-efficient, k1=	0.97			Table 1
Terrain =	3			Clause 6.3.2.1
Building height =	10			From GA DWG
Terrain, Height and Structure size factor, k2=	0.91			Table 2
Topography Factor, k3=	1		(Upwind Slope = 0)	Clause 6.3.3
Importance Factor, k4=	1			
Design Wind Speed Vz=	34.61	m/s		Clause 6.3 Vz=k1xk2xk3xk4
Wind pressure at height z Pz=	0.659	kN/m2		Clause 7.2 Pz=0.6Vz^2
Directionality factor Kd=	0.9			Clause 7.2.1
Avg Area of module=	20			From Layout DWG
Area averaging factor Ka=	0.93			Table 4
Combination factor Kc=	1.00			Clause 7.3.3.13
Design Wind Pressure Pd=	0.553	kN/m2		Clause 7.2 Pd=KaxKdxKc
Considering 20 % reduction	0.4	kN/m2		From GA DWG

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Wind Load calculation along X direction

Tilt Angle 20 degrees — Table 8

Condition	Cp	Wind Pressure	Contributory width	Total Uplift / Downward in kN/m
Uplift	1.39	0.4	0.98	0.56
Downward	0.8	0.4	0.98	0.35

Condition	Cp	Wind Pressure	Contributory width	Total Uplift / Downward
column	1	0.40	3.15	3.06
Rafter	2	0.40	3.06	3.06
bracing	1	0.40	3.02	3.01
secondary rafter	2	0.40	3.08	3.05

7.3 PRIMARY LOADS AND COMBINATION

Primary Load Cases

Number	Name	Type
1	DEAD LOAD	Dead
2	WIND LOAD +X	Wind
3	WIND LOAD -X	Wind
4	WIND LOAD +Z	Wind
5	WIND LOAD -Z	Wind

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Combination Load Cases

Case	Combination LC Name	Primary	Primary LC Name	Factor
1	COMB1	1	DEAD LOAD	1.5
		2	WIND LOAD +X	1.5
2	COMB2	1	DEAD LOAD	1.5
		3	WIND LOAD -X	1.5
3	COMB3	1	DEAD LOAD	1.5
		4	WIND LOAD +Z	1.5
4	COMB4	1	DEAD LOAD	1.5
		5	WIND LOAD -Z	1.5
5	COMB5	1	DEAD LOAD	1.5
		2	WIND LOAD +X	1.5
6	COMB6	1	DEAD LOAD	1.5
		3	WIND LOAD -X	1.5
7	COMB7	1	DEAD LOAD	1.5
		4	WIND LOAD +Z	1.5
8	COMB8	1	DEAD LOAD	1.5
		5	WIND LOAD -Z	1.5
9	COMB9	1	DEAD LOAD	1.5
		2	WIND LOAD +X	1.5
10	COMB10	1	DEAD LOAD	1.5
		3	WIND LOAD -X	1.5
11	COMB11	1	DEAD LOAD	1.5
		4	WIND LOAD +Z	1.5
12	COMB12	1	DEAD LOAD	1.5
		5	WIND LOAD -Z	1.5
13	COMB13	1	DEAD LOAD	1.5
		2	WIND LOAD +X	1.5
14	COMB14	1	DEAD LOAD	1.5
		3	WIND LOAD -X	1.5
15	COMB15	1	DEAD LOAD	1.5
		4	WIND LOAD +Z	1.5
16	COMB16	1	DEAD LOAD	1.5
		5	WIND LOAD -Z	1.5
17	COMB17	1	DEAD LOAD	1.5
		2	WIND LOAD +X	1.5
18	COMB18	1	DEAD LOAD	1.5
		3	WIND LOAD -X	1.5
19	COMB19	1	DEAD LOAD	1.5
		4	WIND LOAD +Z	1.5
20	COMB20	1	DEAD LOAD	1.5
		5	WIND LOAD -Z	1.5
21	COMB21	1	DEAD LOAD	0.9
		2	WIND LOAD +X	1.5
22	COMB22	1	DEAD LOAD	0.9
		3	WIND LOAD -X	1.5
23	COMB23	1	DEAD LOAD	0.9
		4	WIND LOAD +Z	1.5
24	COMB24	1	DEAD LOAD	0.9
		5	WIND LOAD -Z	1.5

7.4 STAAD INPUT

```
STAAD SPACE
START JOB INFORMATION
ENGINEER DATE 23-03-19
END JOB INFORMATION
INPUT WIDTH 79
UNIT METER KN
JOINT COORDINATES
4 -1.51029 0.991035 -1.675; 6 -0.392049 1.39804 -1.675;
7 0.397295 1.68532 -1.675; 9 1.51554 2.09233 -1.675; 10 -1.51029 0.991035 0;
11 -0.392049 1.39804 0; 12 0.397295 1.68532 0; 13 1.51554 2.09233 0;
14 -1.51029 0.991035 1.675; 16 -0.392049 1.39804 1.675;
17 0.397295 1.68532 1.675; 19 1.51554 2.09233 1.675; 20 -1.51029 0.991035 -2.6;
21 -0.392049 1.39804 -2.6; 22 0.397295 1.68532 -2.6; 23 1.51554 2.09233 -2.6;
24 -1.51029 0.991035 2.6; 25 -0.392049 1.39804 2.6; 26 0.397295 1.68532 2.6;
27 1.51554 2.09233 2.6; 36 0.191 0.526001 0; 45 0.190563 1.61008 0;
46 0.191 0.310001 0; 48 0.190562 1.61008 -1.675; 49 0.190562 1.61008 1.675;
50 1.45682 2.07096 -1.675; 51 1.45682 2.07096 0; 52 1.45682 2.07096 1.675;
53 -1.45156 1.01241 -1.675; 54 -1.45156 1.01241 1.675; 55 -1.45156 1.01241 0;
56 0.895333 1.86659 0; 58 -0.749132 1.26808 0;
MEMBER INCIDENCES
4 36 58; 5 36 56; 11 4 53; 12 6 53; 13 6 48; 14 7 50; 16 55 58; 17 13 58;
18 11 45; 20 12 56; 21 51 56; 22 14 54; 23 16 54; 24 16 49; 25 17 52; 27 4 20;
28 10 4; 29 14 10; 30 24 14; 31 21 6; 32 6 11; 33 11 16; 34 16 25; 35 7 22;
36 12 7; 37 17 12; 38 26 17; 39 23 9; 40 9 13; 41 13 19; 42 19 27; 61 45 12;
65 46 36; 66 36 45; 67 48 7; 68 36 48; 69 49 17; 70 36 49; 71 50 9; 72 51 13;
73 52 19; 74 50 51; 75 51 52; 78 55 10; 79 53 55; 80 55 54;
START USER TABLE
TABLE 1
UNIT MMS NEWTON
TUBE
PIPE75X25X2.9
546.36 75 25 2.9 348708 56840.4 156326 435 145
END
UNIT METER KN
MEMBER OFFSET
27 TO 42 START 0 0.1 0
27 TO 42 END 0 0.1 0
DEFINE MATERIAL START
ISOTROPIC STEEL
E 2.05e-08
POISSON 0.3
DENSITY 76.8195
ALPHA 1.2e-05
DAMP 0.03
TYPE STEEL
STRENGTH FY 253200 FU 407800 RY 1.5 RT 1.2
END DEFINE MATERIAL
MEMBER PROPERTY INDIAN
```

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65 66 TABLE ST PIPE OD 0.152 ID 0.1448
MEMBER PROPERTY INDIAN
74 75 79 80 TABLE ST TUB3232.6
UNIT MMS NEWTON
MEMBER PROPERTY INDIAN
11 TO 14 16 TO 18 20 TO 25 64 67 69 71 TO 73 78 UPTABLE 1 TUB6.75X5X2.0
MEMBER PROPERTY COLD-FORMED INDIAN
27 TO 42 TABLE ST C6C5x5X2
MEMBER PROPERTY INDIAN
4 5 68 70 TABLE ST R R3232.6
UNIT METER KN
CONSTANTS
BETA 20 MEMB 31 TO 34 39 TO 42
BETA 340 MEMB 27 TO 30 35 TO 38
MATERIAL STEEL ALL
MEMBER TRUSS
4 5 68 70
SUPPORTS
46 FIXED
UNIT MMS NEWTON
MEMBER RELEASE
66 END MY MZ
UNIT METER KN
LOAD 1 LOADTYPE Dead TITLE DEAD LOAD
SELFWEIGHT Y -1.1 LIST ALL
MEMBER LOAD
27 TO 42 UNI GY -0.12
LOAD 2 LOADTYPE Wind TITLE WIND LOAD (X)
MEMBER LOAD
65 66 UNI GX 0.07
4 5 68 70 UNI GX 0.02
27 TO 42 UNI X -0.35
LOAD 3 LOADTYPE Wind TITLE WIND LOAD (-X)
MEMBER LOAD
65 66 UNI GX -0.07
4 5 68 70 UNI GX -0.02
27 TO 42 UNI Y 0.55
LOAD 4 LOADTYPE Wind TITLE WIND LOAD (Z)
MEMBER LOAD
65 66 UNI GZ 0.07
4 5 68 70 UNI GZ 0.02
11 22 67 69 71 73 UNI GZ 0.08
64 72 78 UNI GZ 0.08
LOAD 5 LOADTYPE Wind TITLE WIND LOAD (-Z)
MEMBER LOAD
65 66 UNI GZ -0.07
4 5 68 70 UNI GZ -0.03
11 TO 14 16 TO 18 20 TO 25 64 67 69 71 TO 73 78 UNI GZ -0.08
Serviceability Case
LOAD COMB 100 DL WLOX

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1 1.0 2 1.0
LOAD COMB 101 DL+WL(-X)
1 1.0 3 1.0
LOAD COMB 102 DL+WL(Z)
1 1.0 4 1.0
LOAD COMB 103 DL+WL(-Z)
1 1.0 5 1.0
********** ***********
LOAD COMB 104 DL 0.8WL(X)
1 1.0 2 0.8
LOAD COMB 105 DL 0.8WL(-X)
1 1.0 3 0.8
LOAD COMB 106 DL 0.8WL(Z)
1 1.0 4 0.8
LOAD COMB 107 DL +0.8WL(-Z)
1 1.0 5 0.8
********** ***********
Seismic Case ******
LOAD COMB 200 1.5(DL+WL(X))
1 1.5 2 1.5
LOAD COMB 201 1.5(DL+WL(-X))
1 1.5 3 1.5
LOAD COMB 202 1.5(DL+WL(Z))
1 1.5 4 1.5
LOAD COMB 203 1.5(DL+WL(-Z))
1 1.5 5 1.5
LOAD COMB 204 0.9DL+1.5WL(X)
1 0.9 2 1.5
LOAD COMB 205 0.9DL+1.5WL(-X)
1 0.9 3 1.5
LOAD COMB 206 0.9DL+1.5WL(Z)
1 0.9 4 1.5
LOAD COMB 207 0.9DL+1.5WL(-Z)
1 0.9 5 1.5
PERFORM ANALYSIS PRINT ALL
DEFINE ENVELOPE
100 TO 107 ENVELOPE TYPE SERVICEABILITY
END DEFINE ENVELOPE
LOAD LIST 200 TO 207
PARAMETER 1
CODE IS800 LSD
FU 420000 MEMB 4 5 11 22 64 TO 73 78
FYLD 250000 MEMB 4 5 11 TO 14 16 TO 18 20 TO 25 64 TO 75 78 TO 80
KY 0.85 MEMB 4 5 68 70
KZ 0.85 MEMB 4 5 68 70
MAIN 200 MEMB 4 5 11 TO 14 16 TO 18 20 TO 25 64 67 TO 75 78 TO 80
CHECK CODE MEMB 4 5 11 TO 14 16 TO 18 20 TO 25 64 TO 75 78 TO 80
LOAD LIST 100 TO 107
PARAMETER 2
CODE IS80

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UNIT MMS NEWTON
PRINT MEMBER STRESSES LIST 15 11 22 27 TO 42 64 TO 73 78
FINISH

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8 STRUCTURAL DESIGN

8.1 MEMBER DESIGN (STAAD)

Beam	Design Property	Actual Ratio	Allowable Ratio	Normalized Ratio (Actual/Allowable)	Clause	L/C
80	TUB32322.6	0.754	1	0.754	Sec. 9.3.2.2	200
79	TUB32322.6	0.754	1	0.754	Sec. 9.3.2.2	200
78	TUBE75X25X2.9	0.051	1	0.051	Sec. 8.2.1.2	205
75	TUB32322.6	0.396	1	0.396	Sec. 9.3.2.2	200
74	TUB32322.6	0.396	1	0.396	Sec. 9.3.2.2	200
73	TUBE75X25X2.9	0.275	1	0.275	Sec. 8.2.1.2	205
72	TUBE75X25X2.9	0.682	1	0.682	Sec. 8.2.1.2	205
71	TUBE75X25X2.9	0.275	1	0.275	Sec. 8.2.1.2	205
70	TUB32322.6	0.312	1	0.312	Sec. 7.1.2	200
69	TUBE75X25X2.9	0.781	1	0.781	Sec. 9.3.2.2	200
68	TUB32322.6	0.312	1	0.312	Sec. 7.1.2	200
67	TUBE75X25X2.9	0.781	1	0.781	Sec. 9.3.2.2	200
66	PIPE	0.261	1	0.261	Sec. 8.2.1.2	201
65	PIPE	0.335	1	0.335	Sec. 8.2.1.2	201
64	TUBE75X25X2.0	0.213	1	0.213	Sec. 9.3.2.2	205
42	60CS35X2	0.202	1	0.202	6.7.1(T)	100
41	60CS35X2	0.698	1	0.698	6.7.2(a)2	101
40	60CS35X2	0.698	1	0.698	6.7.2(a)2	101
39	60CS35X2	0.202	1	0.202	6.7.1(T)	100
38	60CS35X2	0.219	1	0.219	6.7.1(T)	100
37	60CS35X2	0.556	1	0.556	6.7.2(a)2	101
36	60CS35X2	0.556	1	0.556	6.7.2(a)2	101
35	60CS35X2	0.219	1	0.219	6.7.1(T)	100
34	60CS35X2	0.202	1	0.202	6.7.1(T)	100
33	60CS35X2	0.782	1	0.782	6.7.2(a)2	101
32	60CS35X2	0.782	1	0.782	6.7.2(a)2	101
31	60CS35X2	0.202	1	0.202	6.7.1(T)	100
30	60CS35X2	0.219	1	0.219	6.7.1(T)	100

29	60CS35X2	0.92	1	0.92	6.7.2(a)1	101
28	60CS35X2	0.92	1	0.92	6.7.2(a)1	101
27	60CS35X2	0.219	1	0.219	6.7.1(T)	100
25	TUBE75X25X2.9	0.528	1	0.528	Sec. 9.3.2.2	200
24	TUBE75X25X2.9	0.712	1	0.712	Sec. 9.3.1.1	200
23	TUBE75X25X2.9	0.216	1	0.216	Sec. 8.2.1.2	200
22	TUBE75X25X2.9	0.45	1	0.45	Sec. 8.4	200
21	TUBE75X25X2.9	0.549	1	0.549	Sec. 8.2.1.2	200
20	TUBE75X25X2.9	0.549	1	0.549	Sec. 8.2.1.2	200
18	TUBE75X25X2.9	0.256	1	0.256	Sec. 8.2.1.2	200
17	TUBE75X25X2.9	0.836	1	0.836	Sec. 8.2.1.2	200
16	TUBE75X25X2.9	0.836	1	0.836	Sec. 8.2.1.2	200
14	TUBE75X25X2.9	0.528	1	0.528	Sec. 9.3.2.2	200
13	TUBE75X25X2.9	0.712	1	0.712	Sec. 9.3.1.1	200
12	TUBE75X25X2.9	0.216	1	0.216	Sec. 8.2.1.2	200
11	TUBE75X25X2.9	0.45	1	0.45	Sec. 8.4	200
5	TUB32322.6	0.247	1	0.247	Sec. 7.1.2	200
4	TUB32322.6	0.184	1	0.184	Sec. 7.1.2	200

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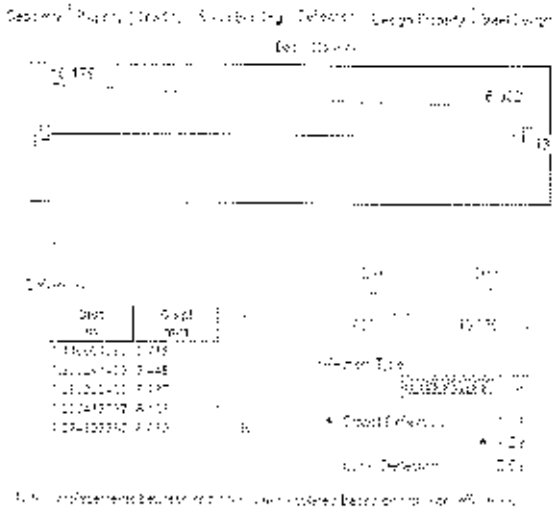
8.2 DEFLECTION CHECK

Permissible Lateral Deflection for Column = 1300 / 180 = 7.2 mm

Maximum deflection for columns = 2.3 mm (Node-45, LC-101)

Simply supported portion,



Permissible Vertical Deflection for Purlins = 1800 / 150 = 12 mm

Maximum Vertical Deflection of structure = 10.179 – 6.08 = 4.1 (beam 40, LC-101)

9 SUPORT REACTION

			Horizontal	Vertical	Horizontal	Moment		
	Node	LC	Fx kN	Fy kN	Fz kN	Mx kN-m	My kN-m	Mz kN-m
Max Fx	46	101 DL+WL	4.139	-6.784	0.000	-0.000	0.000	-4.028
Min Fx	46	100 DL+WL	-2.715	10.807	0.000	-0.000	-0.000	1.505
Max Fy	46	100 DL+WL	-2.715	10.807	0.000	-0.000	-0.000	1.505
Min Fy	46	101 DL+WL	4.139	-6.784	-0.000	-0.000	0.000	-4.028
Max Fz	46	103 DL+WL	-0.000	3.956	1.065	1.163	0.146	-0.682
Min Fz	46	102 DL+WL	-0.000	3.956	-0.308	-0.268	-0.001	-0.682
Max Mx	46	103 DL+WL	-0.000	3.956	1.065	1.163	0.146	-0.682
Min Mx	46	102 DL+WL	-0.000	3.956	-0.308	-0.268	-0.001	-0.682
Max My	46	103 DL+WL	-0.000	3.956	1.065	1.163	0.146	-0.682
Min My	46	102 DL+WL	-0.000	3.956	-0.308	-0.268	-0.001	-0.682
Max Mz	46	100 DL+WL	-2.715	10.807	0.000	0.000	-0.000	1.505
Min Mz	46	101 DL+WL	4.139	-6.784	-0.000	-0.000	0.000	-4.028

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ANNEXURE 1 – FOUNDATION DESIGN

FOUNDATION DESIGN FOR 10 MMS STRUCTURE			
Borehole no		Minimum value	
Angle of internal friction (degrees)	20.00	20.00	ASSUMED
Density (kN/m^3)	15.80	15.80	ASSUMED
SPT N values	[illegible]		

AXIAL AND UPLIFT CAPACITY BY STATIC FORMULA OF IS-2911 Part 1 Sec-2, Annexe B				
OUTER STRUCTURE				
Pile length below NGL	L	2.00	m	
Pile diameter	d	0.35	m	
Pile Cross sectional area	$A_p = \pi d^2/4$	[illegible]	m^2	
Pile shaft perimeter	$A_s = \pi d L$	[illegible]	m^2	
Soil density	γ	15.80	kN/m^3	
Angle at soil-pile contact (δ)		20.00	degrees	
Stress at NGL		0.00	kN/m^2	
Stress at pile tip (up to GWT)	$P_D = γL$	34.76	kN/m^2	
Effective vertical stress (average)	[illegible]	17.38	kN/m^2	
Coefficient K	As per code	1.00	1.00 to 1.50	
Unit skin friction along shaft	[illegible]	6.03	kN/m^2	
Skin friction Q_s	[illegible]	15.30	kN	
End bearing factor N_q	Figure 1, Annex B	10.00	[illegible]	
End bearing Q_b	$A_p P_D N_q$	33.44	kN	
Safe axial load $(Q_s+Q_b)/2.5$	FOS is 2.5	15.91	kN	FOS 2.5
Self weight of pile SW	[illegible]	4.8[illegible]	kN [illegible]	
SAFE UPLIFT LOAD excluding SW	$Q_s/3$	5.10	kN	FOS 3.0
SAFE UPLIFT LOAD including SW	$Q_s/3+SW$	10.39		

Note
Pile capacities shall be confirmed by load tests
Uplift is governing the length
Safe uplift computed is inclusive of self weight of pile
Pile bore collapse is not ruled out
Proper precaution necessary. Use of bentonite not permitted

Design requirement (kN)			
Structure	Axial	Uplift	Lateral
Required	13.800	5.60	4.20
Geotechnical Capacity (kN)			
Computed	15.908	10.39	7.57
Design summary			
Design safe	Safe	Safe	Safe

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Use Broms formula for calculating ultimate lateral load

Diameter	0.08 [illegible]	m	
Soil density		[illegible]	[illegible]
Angle	30.000 [illegible]		
L	2.000 [illegible]	m	
[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	
e	[illegible]	Portion of pile above GL	
Calculate [illegible]	[illegible]	Cohesionless soil approach	
[illegible]		0.56 [illegible]	
[illegible]	[illegible]	[illegible]	
[illegible]	25 [illegible]	[illegible]	
E	[illegible]	[illegible]	Converted
	[illegible]	[illegible]	6
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]		
[illegible]	[illegible]		
[illegible]	[illegible]	Table [illegible]	
[illegible]	[illegible]	Table [illegible]	
[illegible]	[illegible] short pile		
Ultimate lateral	[illegible]	[illegible]	Broms formula
FOS	2		
Allowable lateral	[illegible]	KN	[illegible]

[illegible]	[illegible]
4	6.4
[illegible]	2.5
[illegible]	0.35
[illegible]	[illegible]

Table [illegible] Criteria for [illegible] Based on [illegible] Length

Use Broms formula for deflection check

Deflection			
[illegible]	0.10000	No curve [illegible] necessary	
Broms Coefficient	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]		
Deflection [illegible]	[illegible]	m	
[illegible]	[illegible]	KN	

7.87 KN

Load test to be performed at one to check deflection and least of design and load test value to be taken
[illegible]
Pile load testing necessary to confirm load capacity

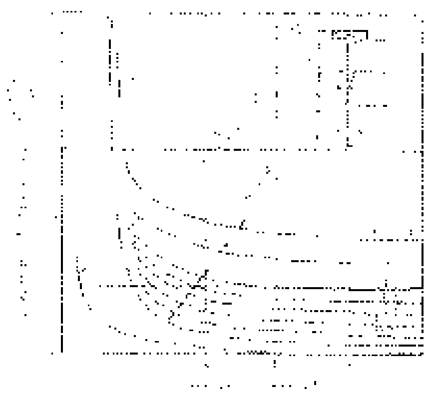

Table [illegible] Modulus of subgrade reaction for Granular Soils, η_h, in kN/m³

[illegible]

Note :
Calculations are based on parameters assumed
IS 2911-Part 1 Sec-2 lateral capacity [illegible] is based on deflection criteria whereas Broms gives both shear & deflection
For lateral capacity estimated [illegible] & verified by tests [illegible]

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BILL OF MATERIAL FOR 10MMS SOLAR WATER PUMP STRUCTURE

SL NO	PART NUMBER	DESCRIPTION	SPEC in mm	MATERIAL GRADE & STD	DIMENSION STANDARD	FINISH	WEIGHT kg/m	WEIGHT per each in kg	QTY	TOTAL WEIGHT in kg
				BASE PIPE ASSY						
1	B1.1	BASE PIPE	ø152x3000Hx3.6 0T	Yst310 IS1161	IS 1161		33.17	99.5	1	99.5
	B1.2	FLANGE PLATE	ø300x10 THK	Gr.E250A IS:2062	IS 2062	HDG-80 Micron		5.55	1	5.5
	B1.3	RING (Strip Weld)	ø174x10x10 THK	Gr.E250A-IS:2062	IS 2062	HDG-80 Micron		0.23	4	0.9
	B1.4	TOP PLATE GUSSET	75x40x6 THK	Gr.E250A-IS:2062	IS 2062	HDG-80 Micron		0.01	8	0.1
	B1.5	LUGS	100 DIA x 75	Gr.E250A-IS:2062	IS 2062	HDG-80 Micron	0.61	0.05	27	1.2
				CIRCULAR BRACKET ASSY						
2	C1.1	CIRCULAR PLATE (Strip Weld)	ø1614x50x5 THK	Gr.E250A-IS:2062	IS 2062	HDG-80 Micron		0.70	2	1.40
	C1.2	TUBE MOUNTING PLATE	70x50x5	Gr.E250A-IS:2062	IS 2062	HDG-80 Micron		0.14	8	1.1
3		REAR SUPPORTING SQ TUBE(40x40x2.6)	SQ40x1000 L	Yst310-IS4923	IS 4923	HDG-80 Micron	2.92	2.92	1	2.9
4		FRONT SUPPORTING SQ-TUBE(40x40x2.6)	SQ40x700 L	Yst310 IS4923	IS 4923	HDG-80 Micron	2.92	2.04	1	2.0
5		LFH & RFH-SUPPORTING SQ-TUBE(32x32x2.6)	SQ32x1905 L	Yst310 IS4923	IS 4923	HDG-80 Micron	2.26	4.31	2	8.6
6		JOINING TUBE SQ-TUBE_Rear side(32x32x2.6)	SQ32x560 L	Yst310-IS4923	IS 4923	HDG-80 Micron	2.26	1.27	1	1.3
7		JOINING TUBE SQ-TUBE_Front side(32x32x2.6)	SQ32x760 L	Yst310-IS4923	IS 4923	HDG-80 Micron	2.26	1.72	1	1.7
				TOP PLATE ASSY						
8	T1.1	TOP PLATE	ø300x10 THK	Gr.E250A-IS:2062	IS 2062	HDG-80 Micron		5.55	1	5.5
	T1.2	MID PLATE	150x120x8THK	Gr.E250A-IS:2062	IS 2062	HDG-80 Micron		2.33	2	2.3
	T1.3	BOTTOM PIPE	ø42.6x150x3.2	Yst310-IS1161	IS 1161	HDG-80 Micron	3.1	0.47	1	0.5
				MAIN RAFTER ASSY						
9	M1.1	MAIN RAFTER	REC75x25x2.9x3280 L	Yst310-IS4923	IS 4923	HDG-80 Micron	4.11	13.48	1	13.5
	M1.2	ANGLE PLATE	170x220x8THK	Gr.E250A-IS:2062	IS 2062	HDG-80 Micron		1.28	2	2.6
	M1.3	MM-L-BRACKET	60x60x4THK	Gr.E250A-IS:2062	IS 808	HDG-80 Micron	3.70	0.15	4	0.6
	M1.4	RAFTER CONNECTION PLATE	REC40X40X4THK	Gr.E250A-IS:2062	IS 2062	HDG-80 Micron		0.05	8	0.4
	M1.5	SUPPORTING U BRKT	U65x70x65x5THKx40 L	Gr.E250A-IS:2062	IS 2062	HDG-80 Micron		0.31	2	0.63
				SECONDARY RAFTER ASSY						
10	S1.1	SECONDARY RAFTER	REC75x25x2.9x3780 L	Yst310-IS4923	IS 4923	HDG-80 Micron	4.11	13.48	2	27.0
	M1.3	MM-L-BRACKET	60x60X4THK	Gr.E250A-IS:2062	IS 808	HDG-80 Micron	3.70	0.15	8	1.2
	M1.4	RAFTER CONNECTION PLATE	REC40X40X4THK	Gr.E250A-IS:2062	IS 2062	HDG-80 Micron		0.05	8	0.4
	M1.5	SUPPORTING U BRKT	U65x70x65x5THKx40 L	Gr.E250A-IS:2062	IS 2062	HDG-80 Micron		0.31	2	0.63
11		CROSS MEMBER	REC52x32x2.6x1650 L	Yst310-IS4923	IS 4923	HDG-80 Micron	2.26	3.73	4	14.9
12	12.1	MODULE MOUNTING PURLIN LH	CS60x35x12x2.0Tx5100 L	E350A IS:2062	IS 811	HDG-80 Micron	2.24	11.42	2	22.8
	12.2	MODULE MOUNTING PURLIN RH	CS60x35x12x2.0Tx5100 L	E350A IS:2062	IS 811	HDG-80 Micron	2.24	11.42	2	22.8
13		C-clamp	ø161x300x4	Gr.E250B-IS:2062	IS 2062	HDG-80 Micron		0.69	2	1.4
14		Patti	REC30x500x4	Gr.E250B-IS:2062	IS 2062	HDG-80 Micron		0.47	2	0.9
				GRAND TOTAL FOR EACH STRUCTURE						186.6

DEPARTMENT OF CIVIL ENGINEERING
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10MMS ASSEMBLY VIEW

DEPARTMENT OF CIVIL ENGINEERING
BANGALORE UNIVERSITY

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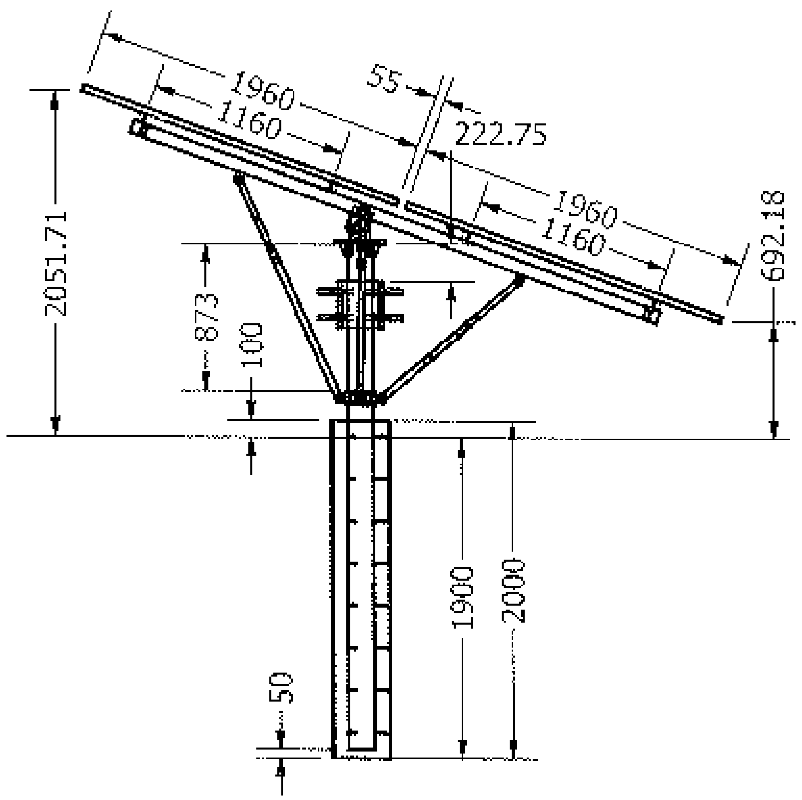
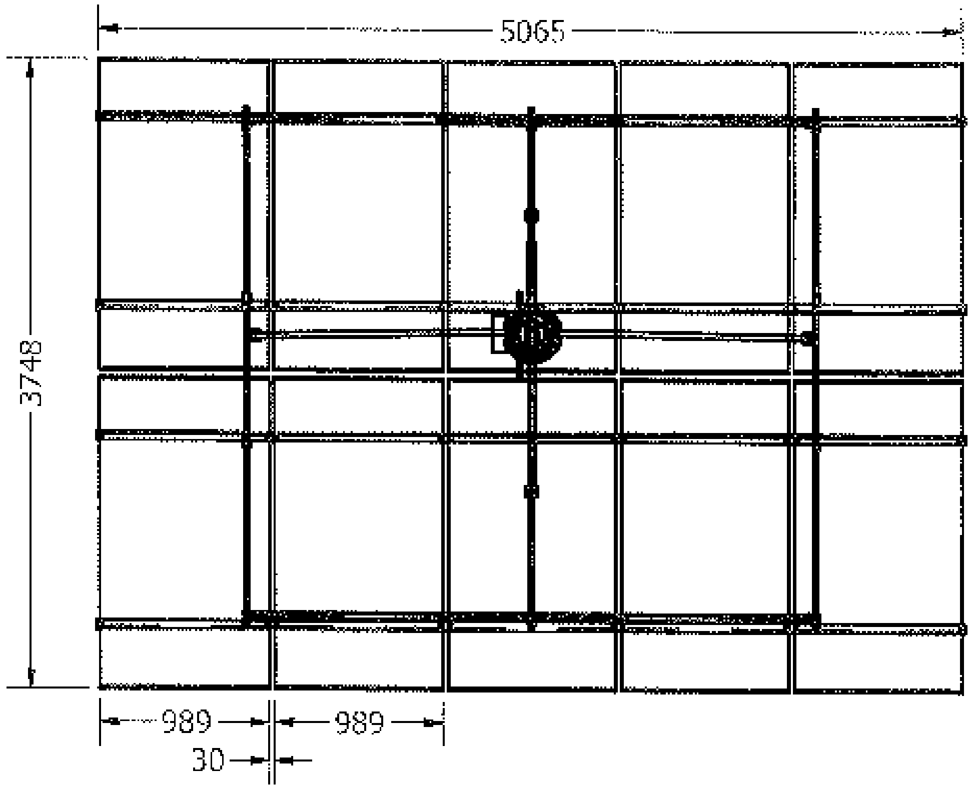
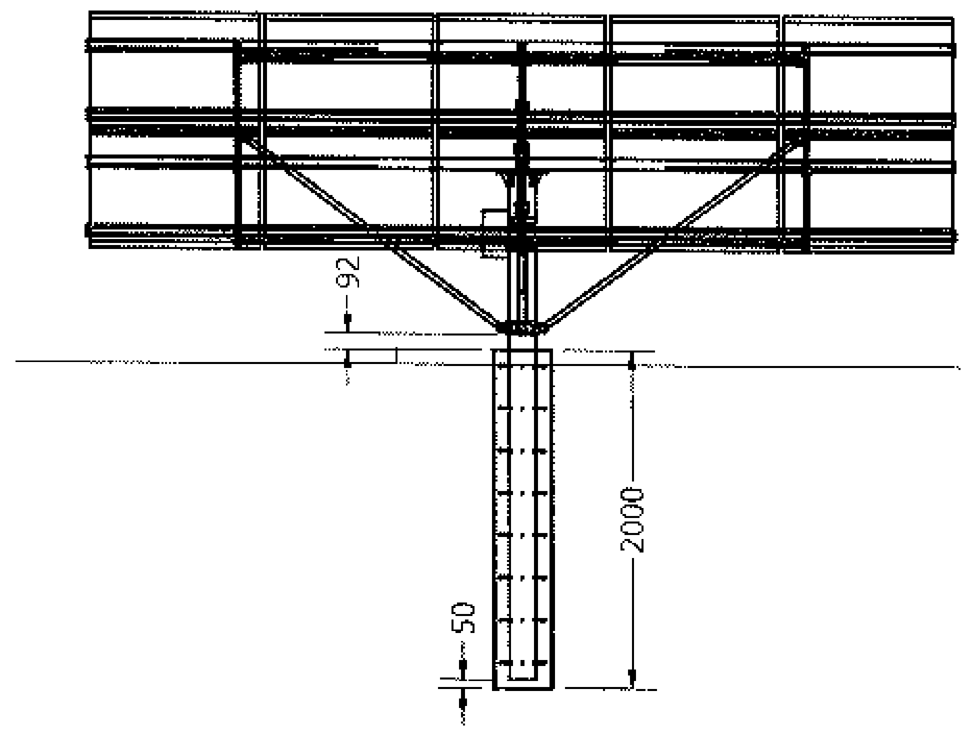
Bengaluru - 560 056.



FGL





FGL

NOTE:
* REMOVE BURR & DENT
* REMOVE SHARP CORNER & MAKE CHAMFER 1MM (UNLESS SPECIFIED)

REV.	DATE	DESCRIPTION	DRAWN	CHKD.	APPR.
4	22-07-2020	[illegible] MOUNTING DUAL MODULES	SACHIDANANDA S	HARISHA	SUNIL
3	[illegible]	CHANGES IN MATERIAL GRADES IN BOM LIST	SACHIDANANDA S	HARISHA	SUNIL
2	[illegible]	CHANGES IN SOME FASTENERS ITEMS LENGTHS	SACHIDANANDA S	HARISHA	SUNIL
1	[illegible]	[illegible] NEW MODULES	SACHIDANANDA S	HARISHA	SUNIL

THIRD ANGLE PROJECTION

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No.78, Electronics City,
Hosur Road, Bangalore - 560 100. INDIA.

MATERIAL	FINISH
REFER BOM	REFER BOM

UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS ARE IN MM

TOLERANCES			
NO D.P.	ONE D.P.	TWO D.P.	ANGLES
± 1	± 0.5	± 0.25	±1°

SCALE

PRODUCT TITLE:

10 MMS SOLAR WATER PUMP STRUCTURE

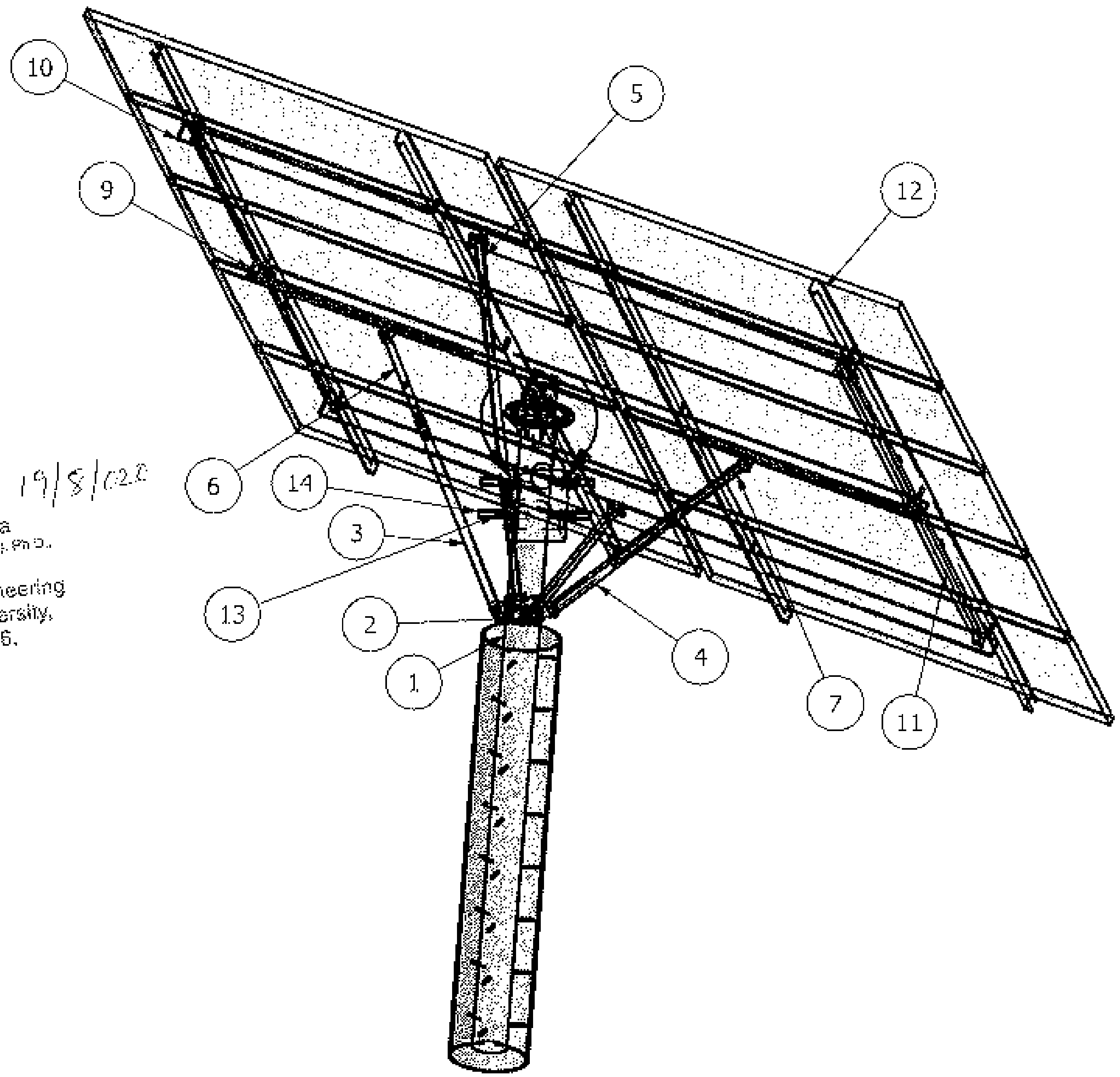
DRAWN	CHKD.	APPR.	
SACHIDANANDA S	HARISHA	SUNIL	
DATE 22-07-2020	DATE 22-07-2020	DATE 22-07-2020	REV 4

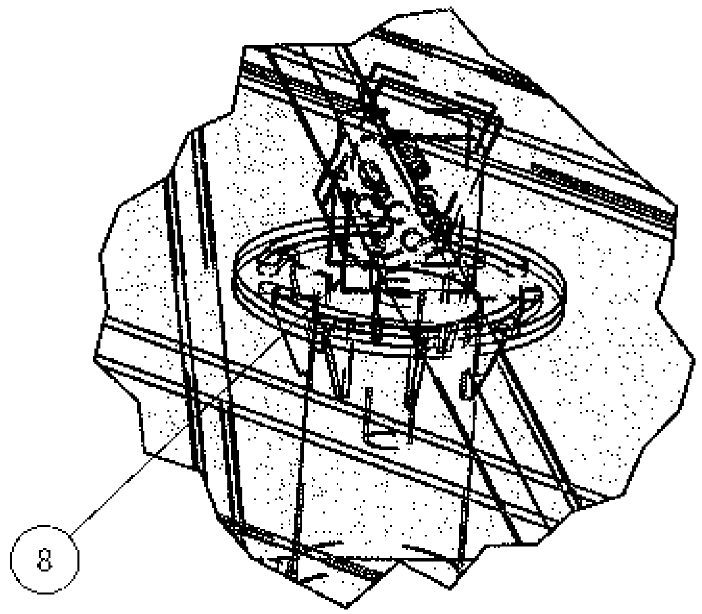
PART/DWG NUMBER: TPS-EESL-10MMS-N-TF-PVPT-F-001

SHEET SIZE A3

Part Name: 10MMS ASSEMBLY DRAWING
Material Grade: Refer Bom
Finish: Refer Bom
Tilt angle: 0,15,20,35 deg
No. of modules: 10

10MMS ISOMETRIC VIEW





DETAIL C
SCALE 0.15 : 1

DEPARTMENT OF CIVIL ENGINEERING
BANGALORE UNIVERSITY

19/8/020

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Bengaluru - 560 056.

NOTE:
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* REMOVE SHARP CORNER & MAKE CHAMFER 10MM (UNLESS SPECIFIED)

REV	DATE	DESCRIPTION	DRAWN	CHKD.	APPR.

THIRD ANGLE PROJECTION

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TOLERANCES

NO D.P.	ONE D.P.	TWO D.P.	ANGLES
± 1	± 0.5	± 0.25	±3

SCALE

PRODUCT TITLE:

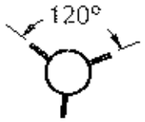
10 MMS SOLAR WATER PUMP STRUCTURE

DRAWN	CHKD	APPR.	
DATE	DATE	DATE	REV.
			4

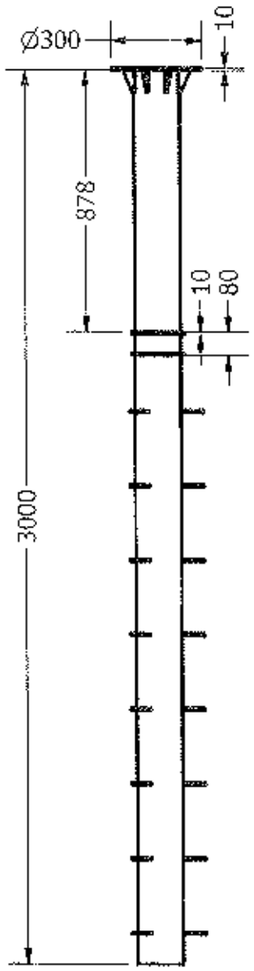
PART/DWG NUMBER:
TPS-EESL-10MMS-N-TP-PVPF-F-001

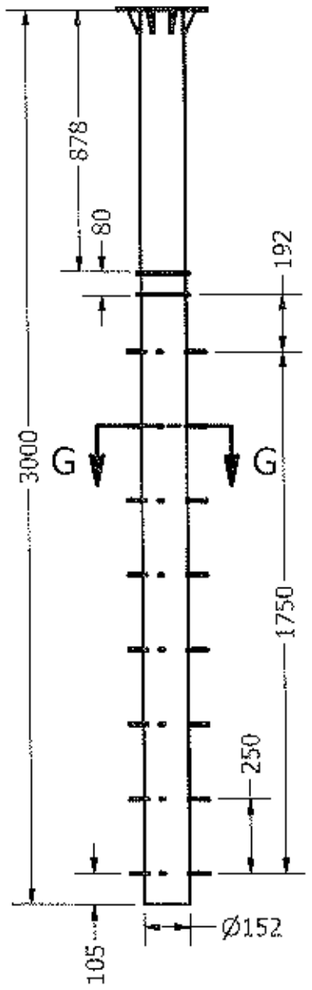
SHEET SIZE
A2

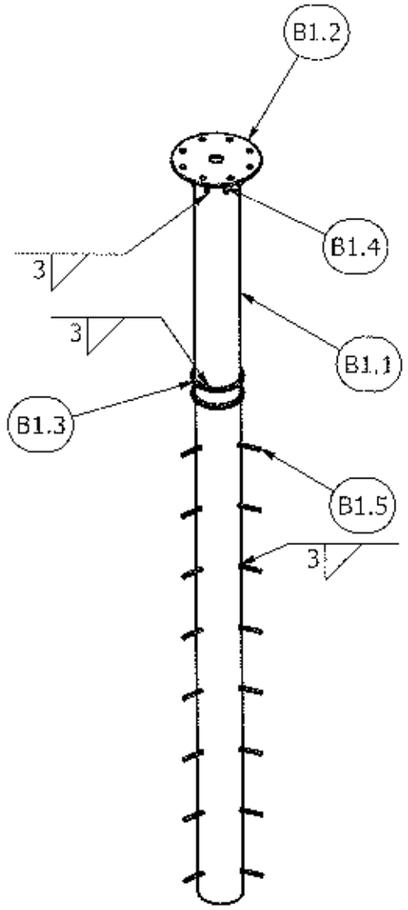
1.BASE PIPE ASSEMBLY

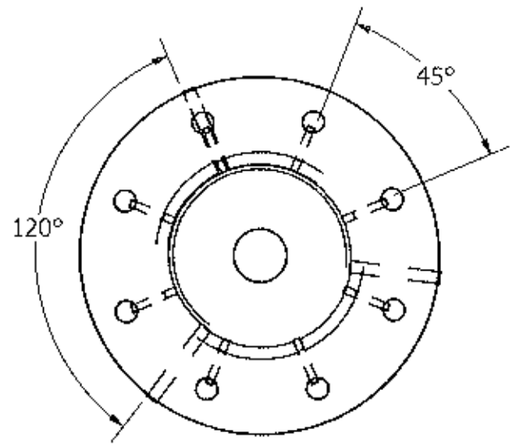


SECTION G-G
SCALE .05









NOTE:
~ REMOVE BURR & DENT
~ REMOVE SHARP CORNER & MAKE CHAMFER 1.0MM (UNLESS SPECIFIED)

REV.	DATE	DESCRIPTION	DRAWN	CHKD.	APPR.

THIRD ANGLE PROJECTION

DO NOT SCALE THIS DRAWING OR IN DOUBT ASK

TATA POWER SOLAR SYSTEMS LIMITED
No.76, Electronics City,
Hosur Road,Bangalore - 560 100, INDIA.

MATERIAL: REFER BOM
FINISH: REFER BOM

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN MM

TOLERANCES				SCALE
NO D.P. ± 1	ONE D.P. ± 0.5	TWO D.P. ± 0.25	ANGLES ±1°	NTS

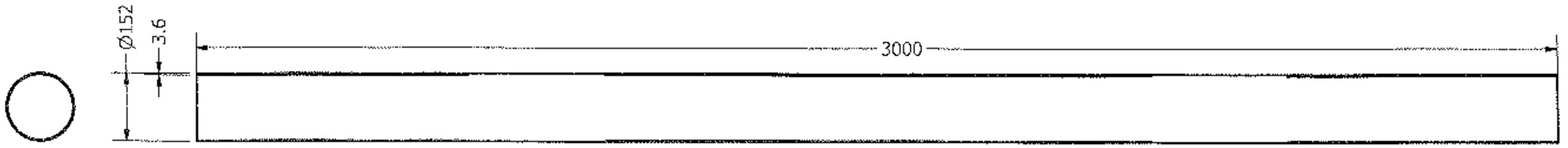
PRODUCT TITLE:
10MMS SOLAR WATER PUMP STRUCTURE

DRAWN	CHKD.	APPR.	
SACHIDANANDA	DAPISHA	SUNIL	
DATE 26-07-2020	DATE 27-07-2020	DATE 28.07.2020	REV 4

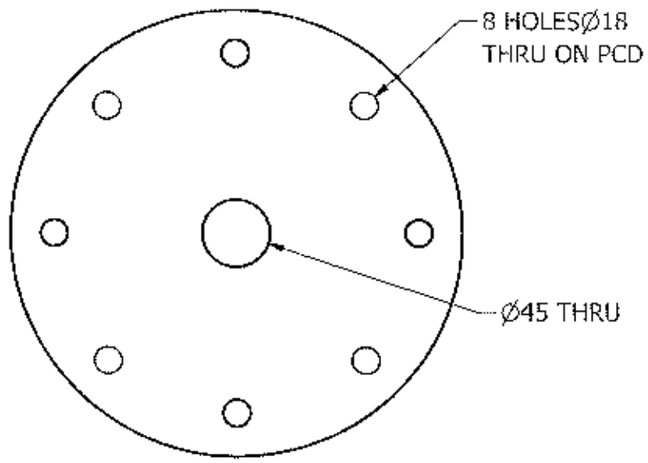
PART/DWG NUMBER: TPS-EESL-10MMS-N-TP-PVPT-F-001

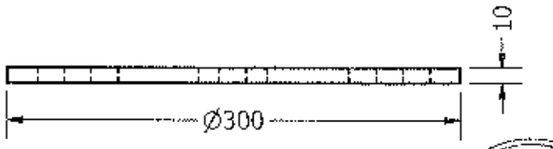
SHEET SIZE A3

B1.1. BASE PIPE

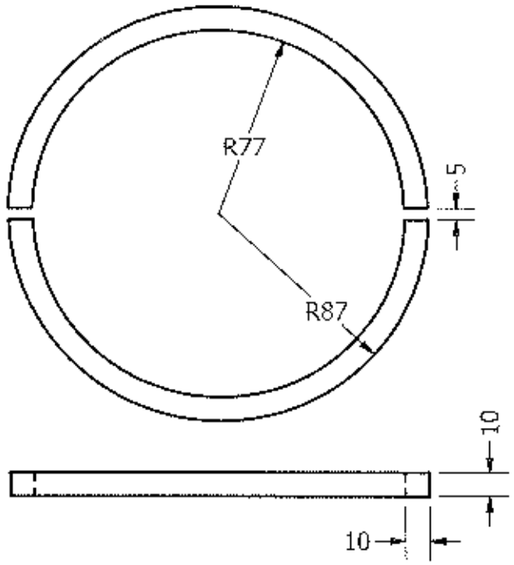


B1.2. FLANGE PLATE

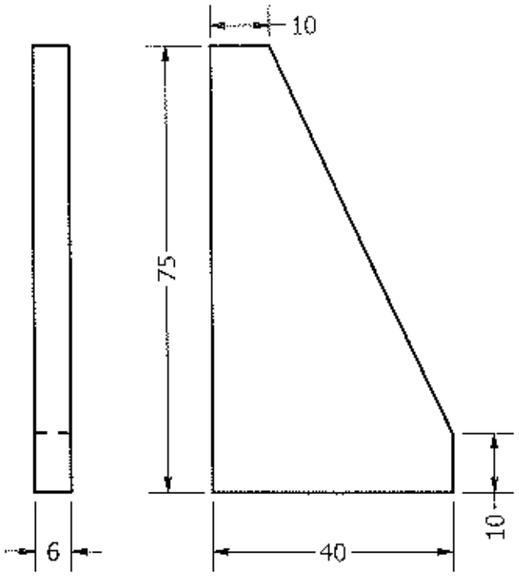




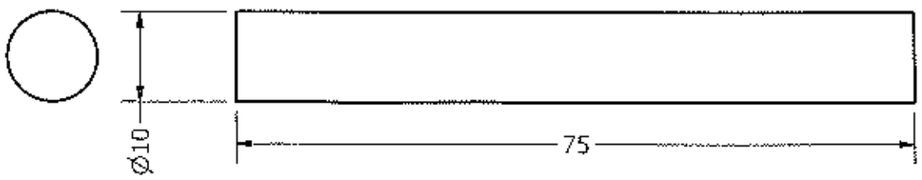
B1.3.RING



B1.4. TOP PLATE GUSSET



B1.5. LUGS



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DEPARTMENT OF CIVIL ENGINEERING
BANGALORE UNIVERSITY

NOTE:
* REMOVE BURR & DENT
* REMOVE SHARP CORNER & MAKE CHAMFER 1MM MAX (UNLESS SPECIFIED)

REV.	DATE	DESCRIPTION	DRAWN	CHKD.	APPR.

THIRD ANGLE PROJECTION

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TATA POWER SOLAR SYSTEMS LIMITED
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MATERIAL: REFER BOM

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TOLERANCES

NO D.P.	ONE D.P.	TWO D.P.	ANGLES
± 1	± 0.5	± 0.25	°

SCALE

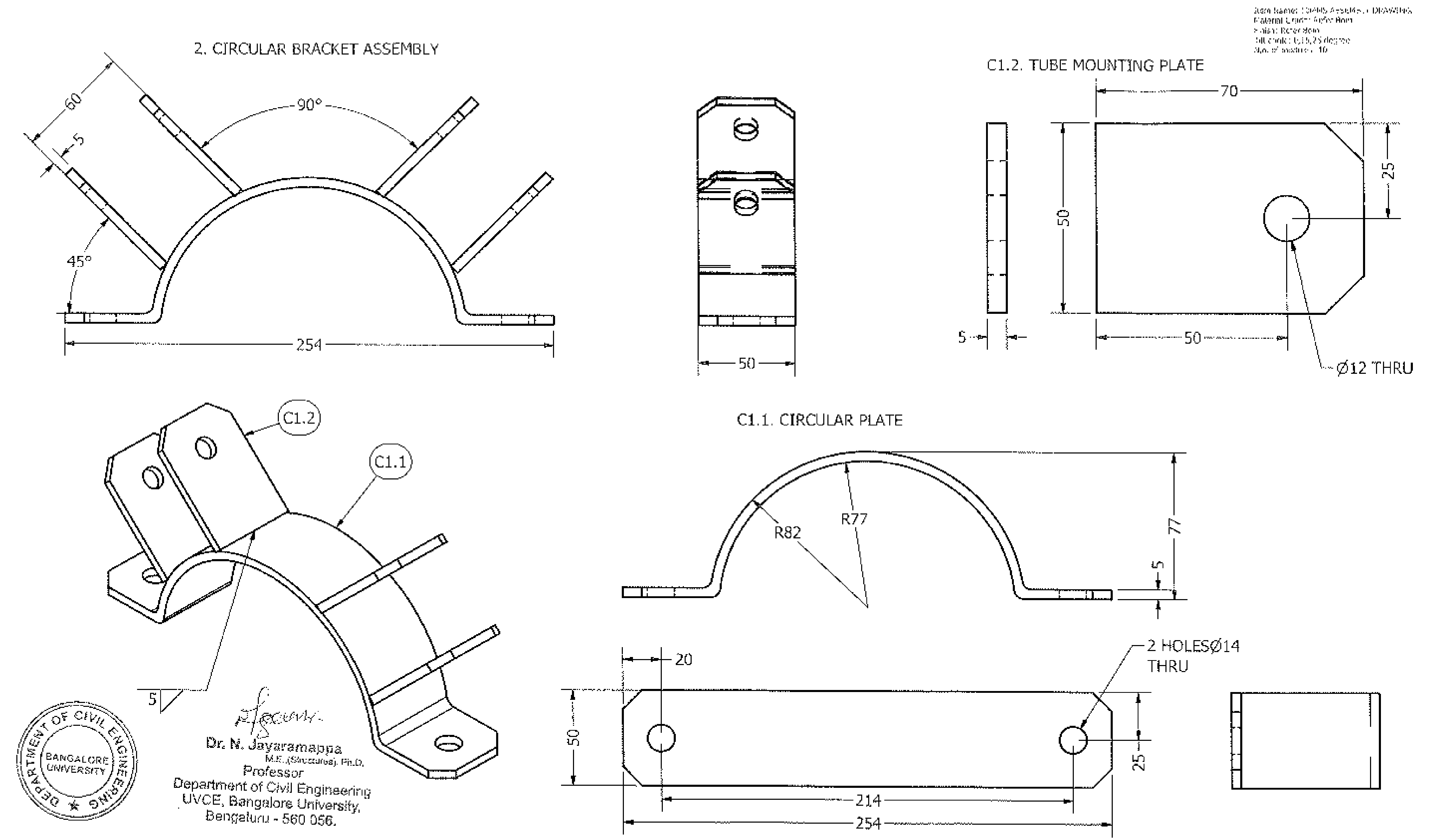
PRODUCT TITLE:

10MMS SOLAR WATER PUMP STRUCTURE

DRAWN	CHKD.	APPR.	
DATE	DATE	DATE	REV.
			4

PART/DWG NUMBER: TPS-BESL-10MMS-N-TP-PVPT-F-001

SHEET SIZE A0



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NOTE:
* REMOVE BURR & DENT
* REMOVE SHARP CORNER & MAKE CHAMFER 10MM (UNLESS SPECIFIED)

THIRD ANGLE PROJECTION	DO NOT SCALE THIS DRAWING IF IN DOUBT ASK	TATA POWER SOLAR SYSTEMS LIMITED No.78, Electronics City, Hosur Road, Bangalore - 560 100. INDIA.	MATERIAL: REFER BOM		FINISH: REFER BOM		
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			NO D.P. ± 1	ONE D.P. ± 0.5	TWO D.P. ± 0.25	ANGLES ±1°	

REV.	DATE	DESCRIPTION	DRAWN	CHKD.	APPR.

PRODUCT TITLE:

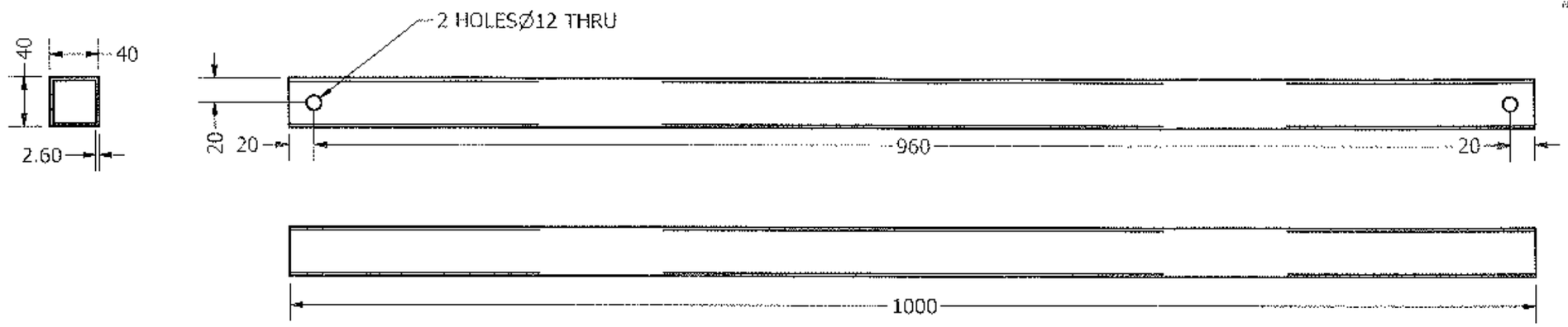
10 MMS SOLAR WATER PUMP STRUCTURE

DRAWN	CHKD.	APPR.	
DATE	DATE	DATE	REV. 4

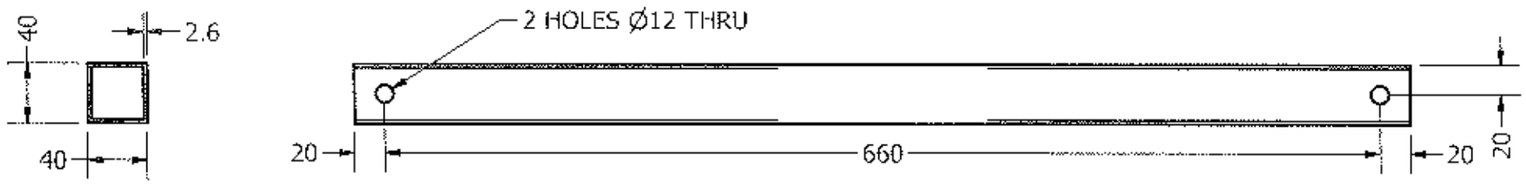
PART/DWG NUMBER: TPS-GESL-10MMS-N-TP-PVPT-F-001

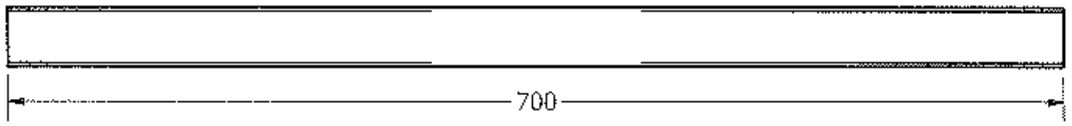
SHEET SIZE A3

3. REAR SUPPORTING

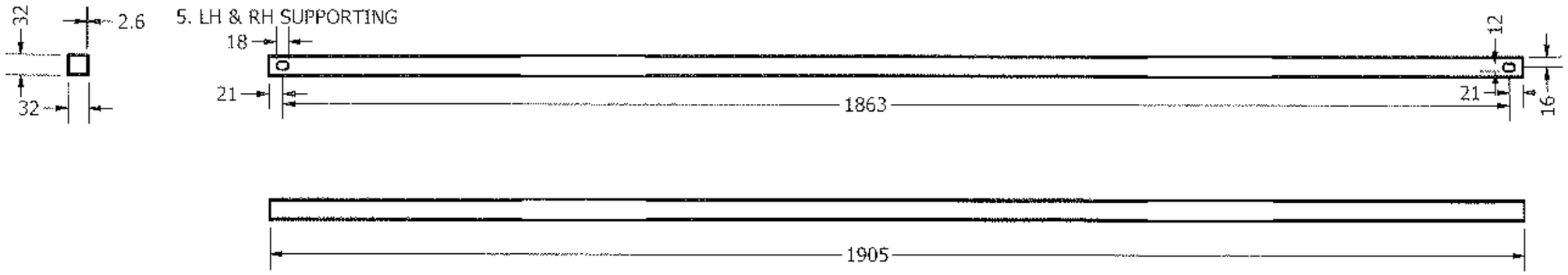


4. FRONT SUPPORTING





5. LH & RH SUPPORTING



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Bengaluru - 560 056.

DEPARTMENT OF CIVIL ENGINEERING
BANGALORE UNIVERSITY

NOTE:
* REMOVE BURR & DENT
* REMOVE SHARP CORNER & MAKE CHAMFER 1MM (UNLESS SPECIFIED)

REV	DATE	DESCRIPTION	DRAWN	CHKD.	APPR.

THIRD ANGLE PROJECTION

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Hosur Road,Bangalore - 560 100. INDIA.

MATERIAL: REFER BOM

FINISH: REFER BOM

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TOLERANCES: NO D.P. ± 1; ONE D.P. ± 0.5; TWO D.P. ± 0.25; ANGLES ±1°

SCALE

PRODUCT TITLE:

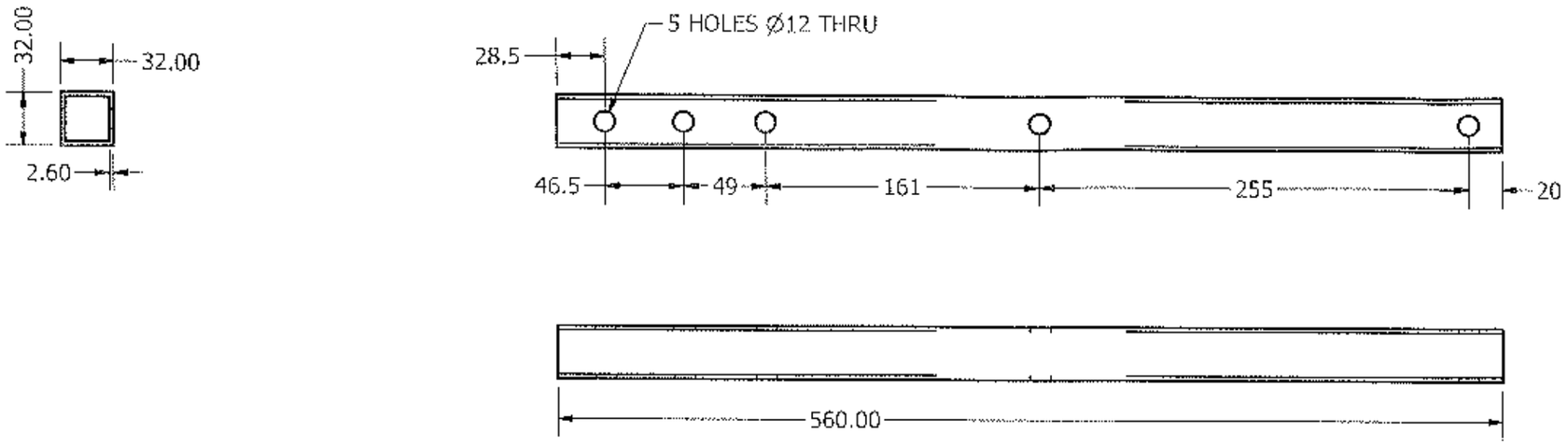
10MMS SOLAR WATER PUMP STRUCTURE

DRAWN	CHKD.	APPR.	
DATE 22-02-2016	DATE 22/02/2016	DATE 22-02-2016	REV. 4

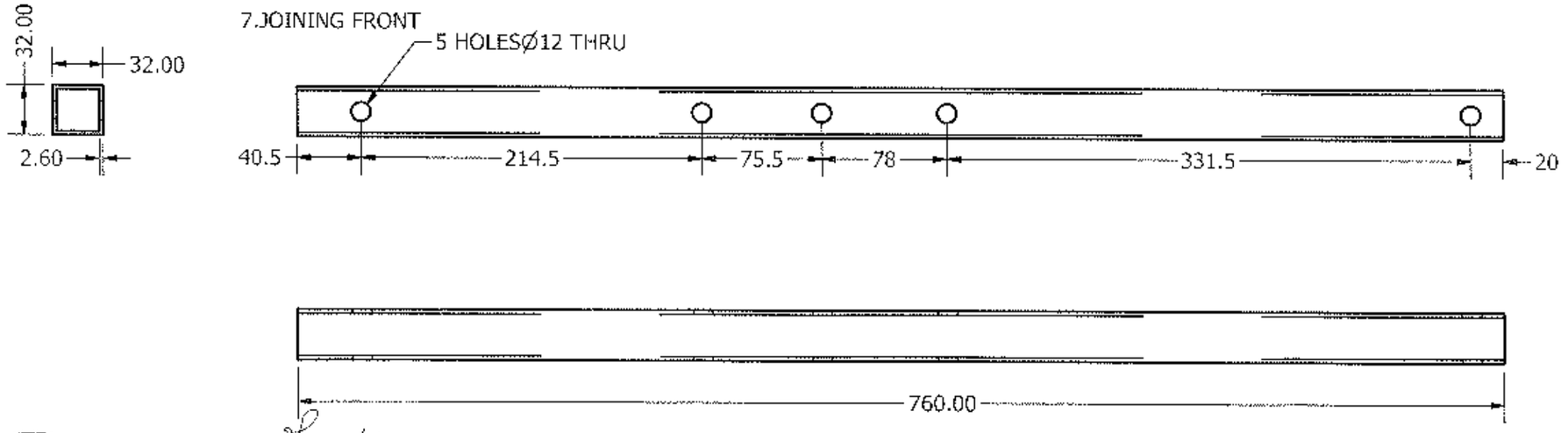
PART/DWG NUMBER: TPS-EESL-10MMS-N-TP-PVPT-F-001

SHEET SIZE A1

6.JOINING REAR



7.JOINING FRONT



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Bengaluru - 560 056.

DEPARTMENT OF CIVIL ENGINEERING
BANGALORE UNIVERSITY

NOTE:
1. REMOVE BURR & DENT
2. REMOVE SHARP CORNER & MAKE CHAMFER 1MM (UNLESS SPECIFIED)

REV.	DATE	DESCRIPTION	DRAWN	CHKD.	APPR.

THIRD ANGLE PROJECTION

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Hosur Road,Bangalore - 560 100, INDIA.

MATERIAL: REFER BOM

FINISH: REFER BOM

UNLESS OTHERWISE SPECIFIED,ALL DIMENSIONS ARE IN MM

TOLERANCES				SCALE
NO D.P.	ONE D.P.	TWO D.P.	ANGLES	
± 1	± 0.5	± 0.25	±0	

PRODUCT TITLE:

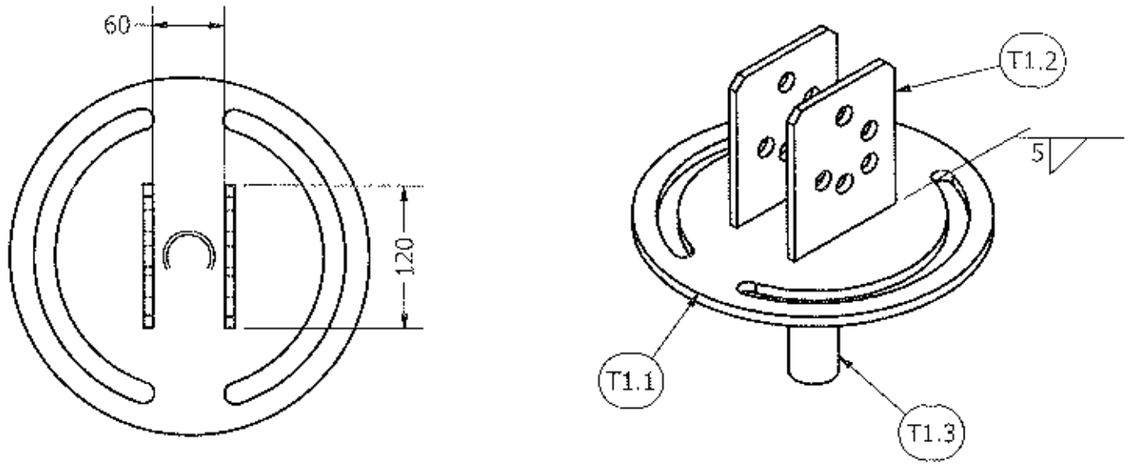
10 MMS SOLAR WATER PUMP STRUCTURE

DRAWN	CHKD.	APPR.	
DATE	DATE	DATE	REV.
			A

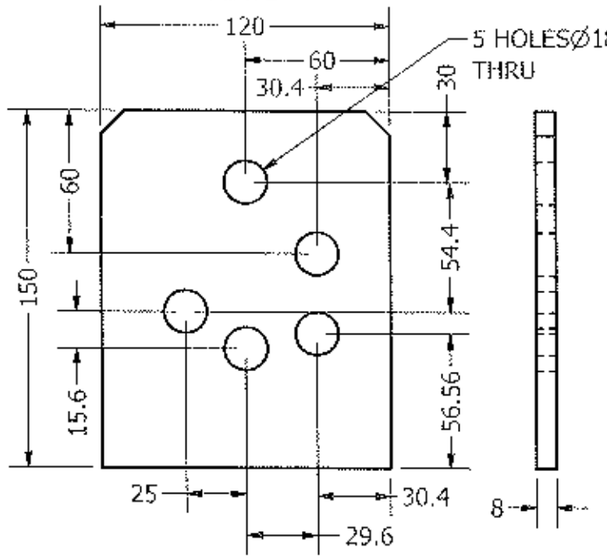
PART/DWG NUMBER: TPS-CESL-10MMS-N-TP-PVPT-F-001

SHEET SIZE A3

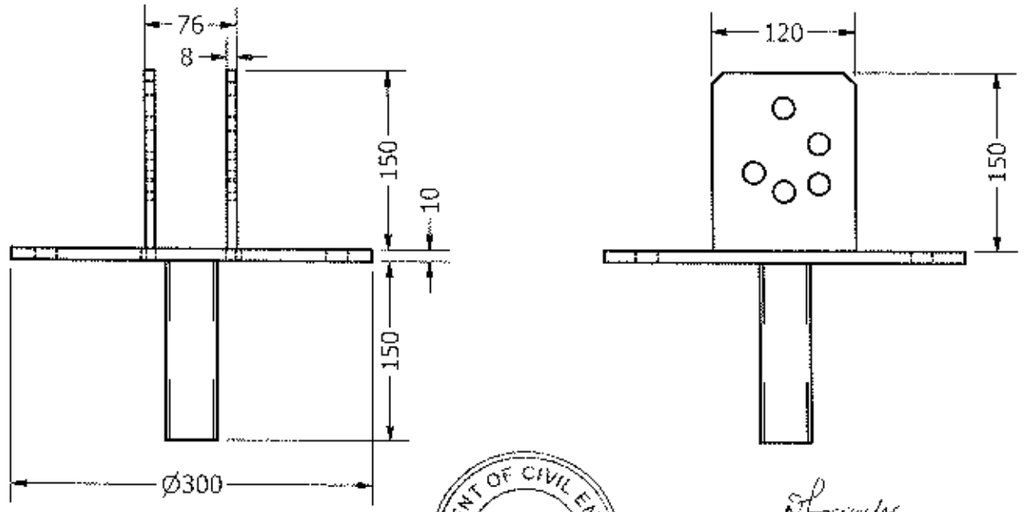
8. TOP PLATE ASSEMBLY



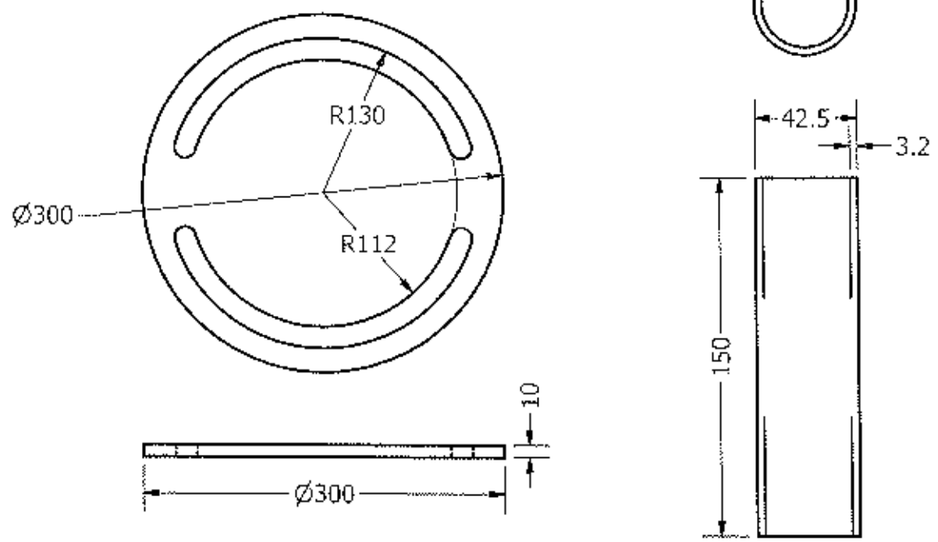
T1.2. MID PLATE



T1.1. TOP PLATE



T1.3. BASE PIPE



DEPARTMENT OF CIVIL ENGINEERING
BANGALORE UNIVERSITY

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Professor
Department of Civil Engineering
UVCE, Bangalore University,
Bangalore - 560 056.

NOTE:
1. REMOVE BURR & DENT
2. REMOVE SHARP CORNER & MAKE CHAMFER 10MM (UNLESS SPECIFIED)

REV.	DATE	DESCRIPTION	DRAWN	CHKD	APPR.

THIRD ANGLE PROJECTION | DO NOT SCALE THIS DRAWING IF IN DOUBT ASK

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No.78, Electronics City,
Hosur Road,Bangalore - 560 100. INDIA.

MATERIAL: REFER BOM | FINISH: REFER BOM

UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN MM.
TOLERANCES:

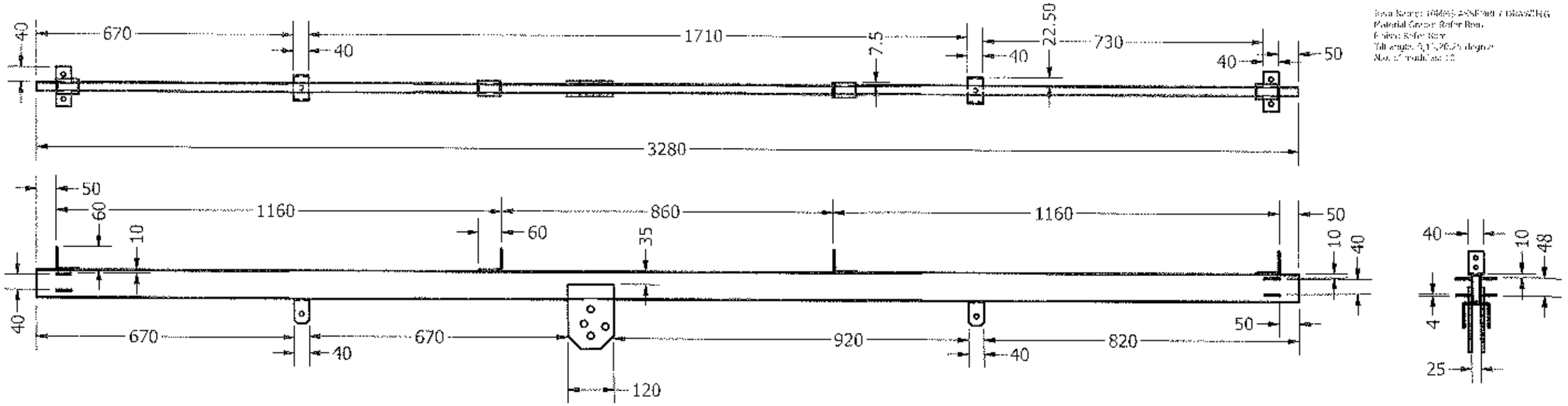
NO D.P	ONE D.P.	TWO D.P.	ANGLES	SCALE
± 1	± 0.5	± 0.25	±1°	

PRODUCT TITLE:
10MMS SOLAR WATER PUMP STRUCTURE

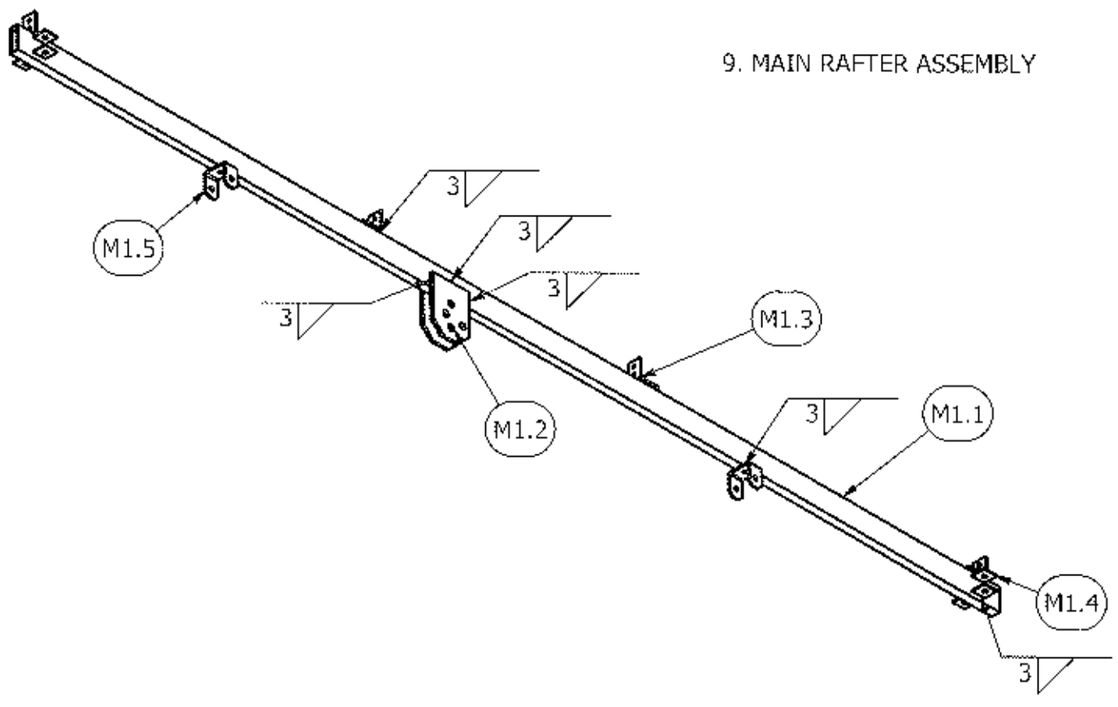
DRAWN	CHKD.	APPR.	
DATE	DATE	DATE	REV.
		23.07.2020	4

PART/DWG NUMBER: TPS-EESL-10MMS-N-1P-PVPT-F-001

SHEET SIZE



9. MAIN RAFTER ASSEMBLY



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UVCE, Bangalore University,
Bengaluru - 560 056.

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REV.	DATE	DESCRIPTION	DRAWN	CHKD	APPR.

THIRD ANGLE PROJECTION | DO NOT SCALE THIS DRAWING IF IN DOUBT ASK

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No.78, Electronics City,
Hosur Road,Bangalore - 560 100. INDIA.

MATERIAL: REFER BOM
FINISH: REFER BOM
UNLESS OTHERWISE SPECIFIED,ALL DIMENSIONS ARE IN mm.
SCALE

FOLERANCES			
NO D.P.	ONE D.P.	TWO D.P.	ANGLES
± 1	± 0.5	± 0.25	±1°

PRODUCT TITLE:
10 MMS SOLAR WATER PUMP STRUCTURE

DRAWN	CHKD.	APPR.	
DATE 22.07.2020	DATE 22.07.2020	DATE 22.07.2020	REV. -1

PART/DWG NUMBER: TPS-EESL-10MMS-N-TP-PVPT-[illegible]-001
SHEET SIZE A3

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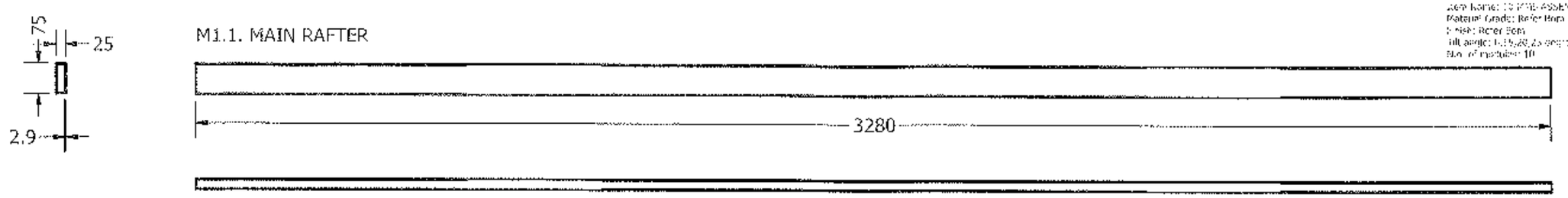

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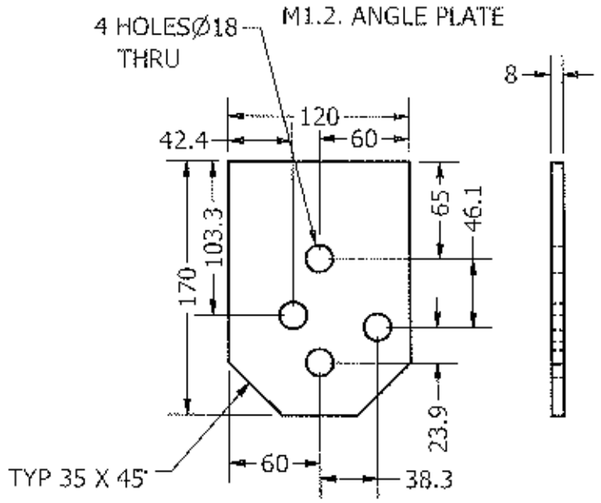

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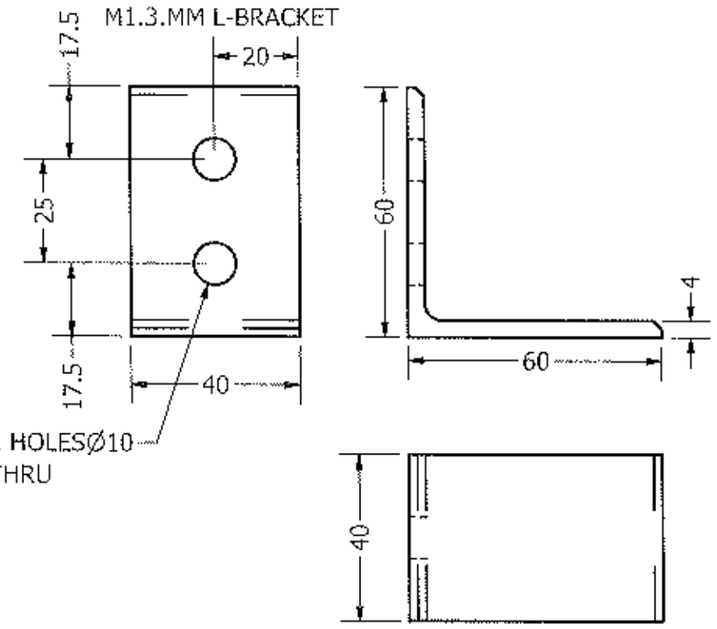

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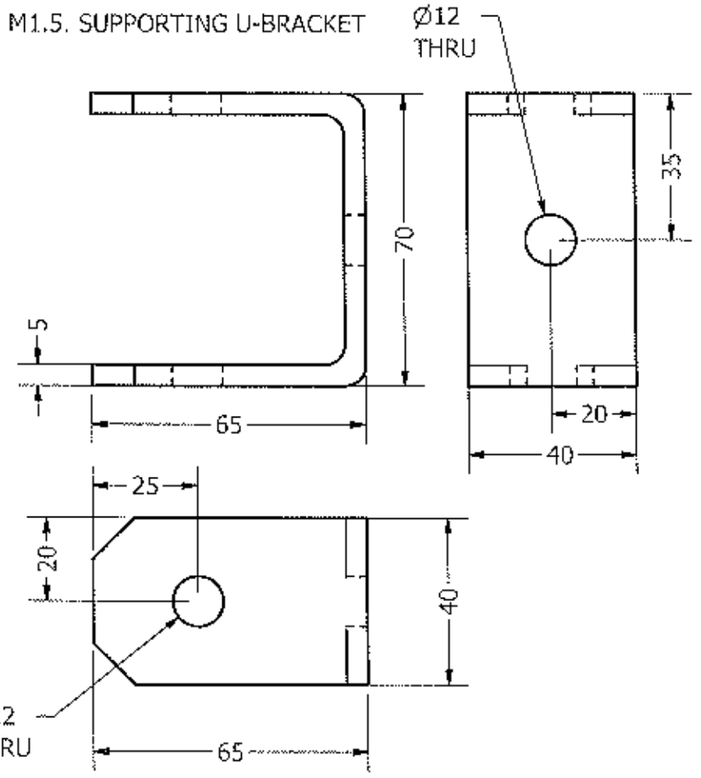
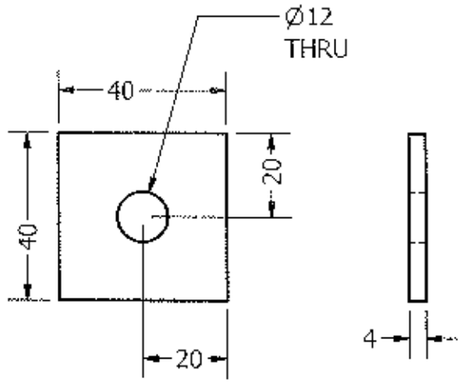


M1.4.RAFTER CONNECTION PLATE



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2. REMOVE SHARP CORNER & MAKE CHAMFER 1MM (UNLESS SPECIFIED)

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TOLERANCES			
NO D.P.	ONE D.P.	TWO D.P.	ANGLES
± 1	± 0.5	± 0.25	±5

PRODUCT TITLE:

10 MMS SOLAR WATER PUMP STRUCTURE

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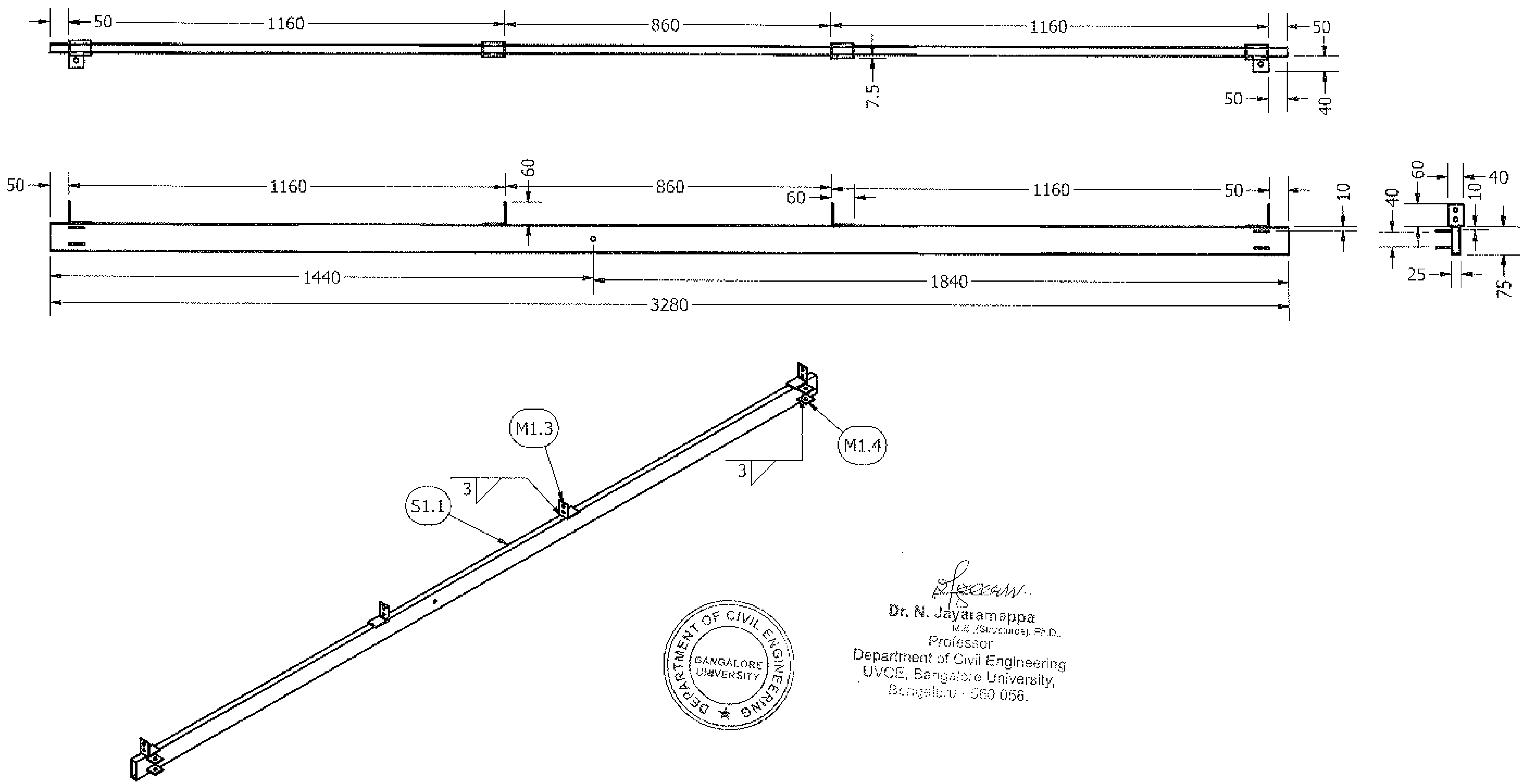
DATE	DATE	DATE	REV.
			4

PART/DWG NUMBER: TPS-EESL-10MMS-N-TP-PVPT-F-001

SHEET SIZE A4

10.SECONDARY RAFTER ASSEMBLY



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TOLERANCES			
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± 1	± 0.5	± 0.25	±3

SCALE

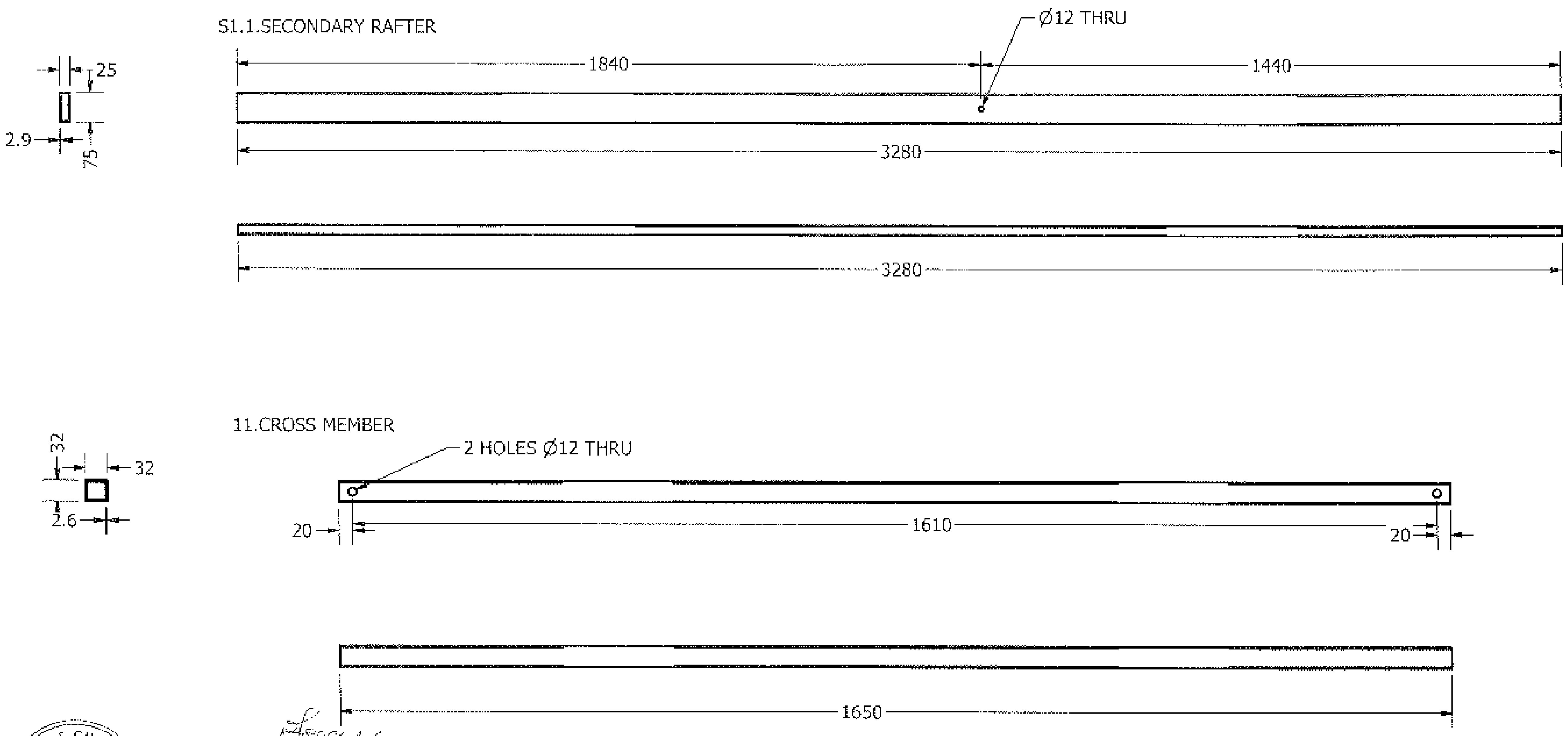
PRODUCT TITLE:

10 MMS SOLAR WATER PUMP STRUCTURE

DRAWN	CHKD.	APPD.	
SACHIDANANDA S	HARISHA	SUNIL	
DATE 22-07-2020	DATE 22-07-2020	DATE 22-07-2020	REV. 4

PART/DWG NUMBER: TPS-EESL-10MMS-N-TP-PVPT-F-001

SHEET SIZE A3



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TOLERANCES			
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± 1	± 0.5	± 0.25	±1°

REV.	DATE	DESCRIPTION	DRAWN	CHKD.	APPR.

PRODUCT TITLE:

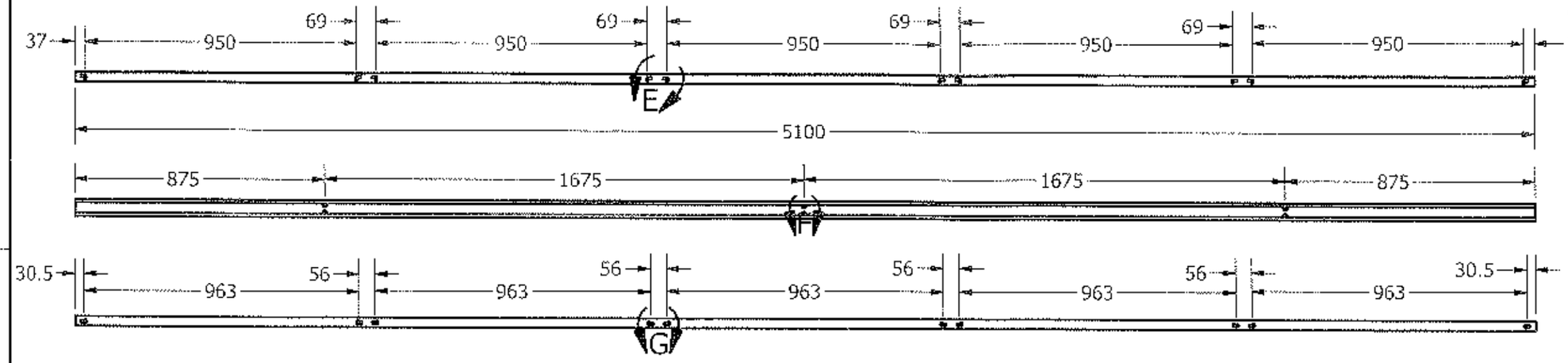
10MMS SOLAR WATER PUMP STRUCTURE

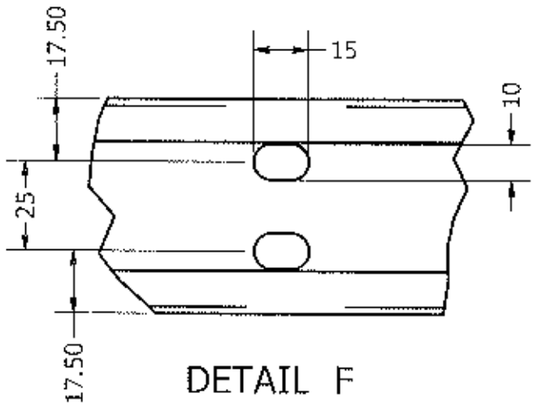
DRAWN	CHKD.	APPR.	
SACHIDHANANDAN S	[illegible]	[illegible]	
DATE 22-07-2020	DATE 22-07-2020	DATE 22-07-2020	REV. -

PART/DWG NUMBER: TPS-EESL-10MMS-N-TP-PVPT-F-001

SHEET SIZE A3

12.1.MM-PURLIN-LH





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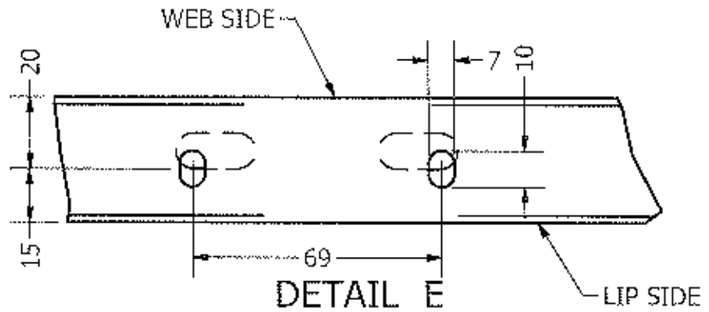

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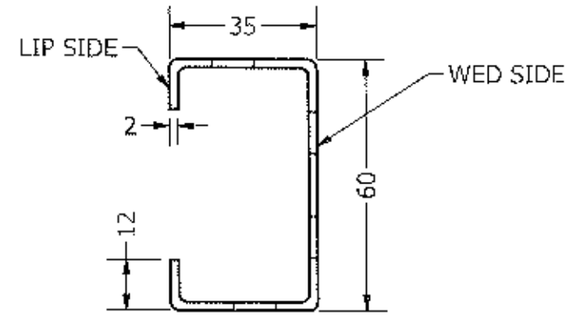

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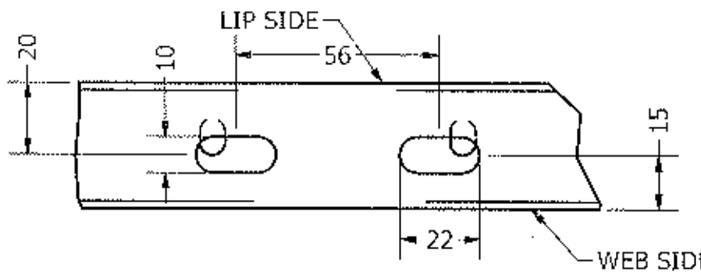

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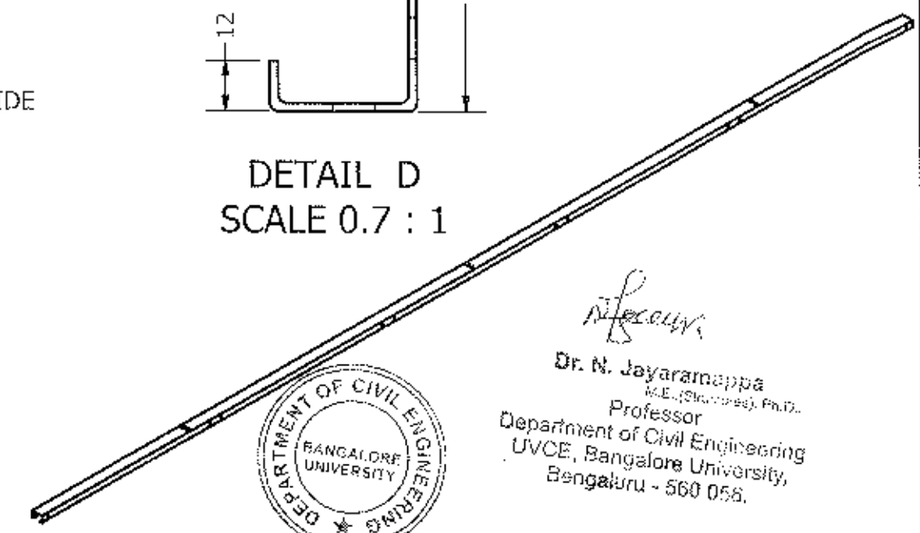

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SCALE:

TOLERANCES			
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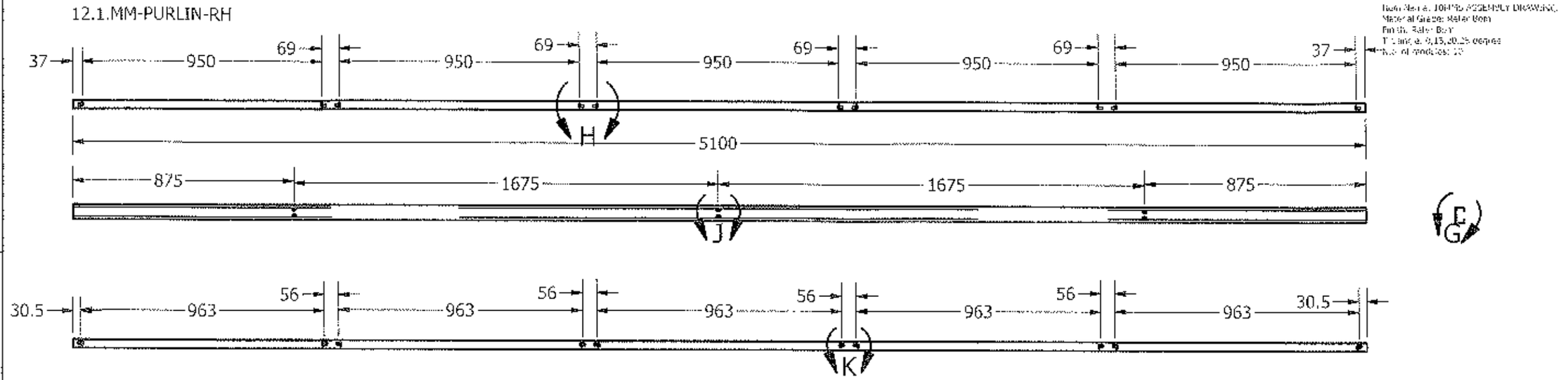
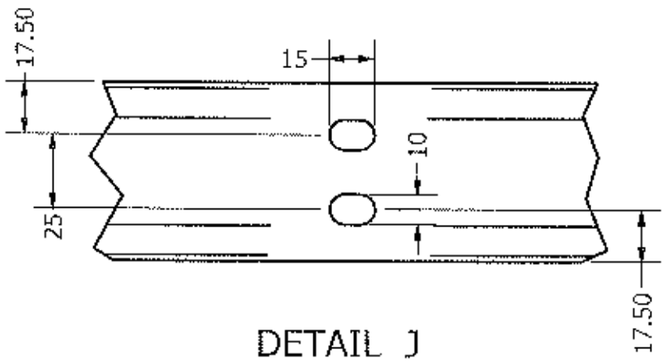
DRAWN	CHKD.	APPR.	
DATE	DATE	DATE	REV.
			4

PART/DWG NUMBER: TPS-EESL-10MMS-N-TP-PVPT-F-001

SHEET SIZE A3

12.1.MM-PURLIN-RH





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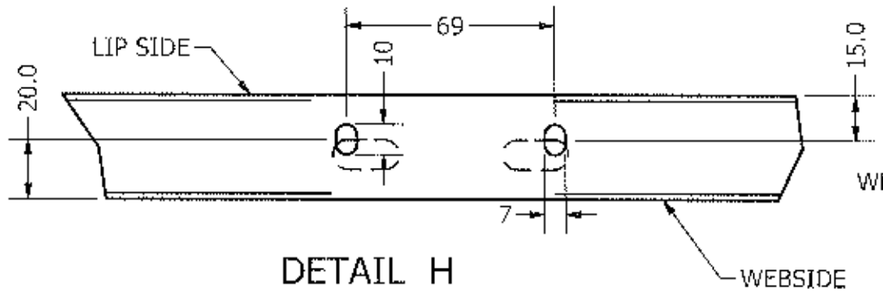

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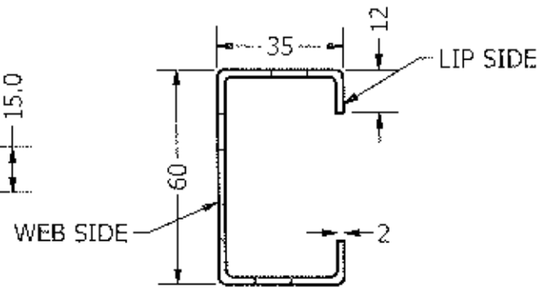

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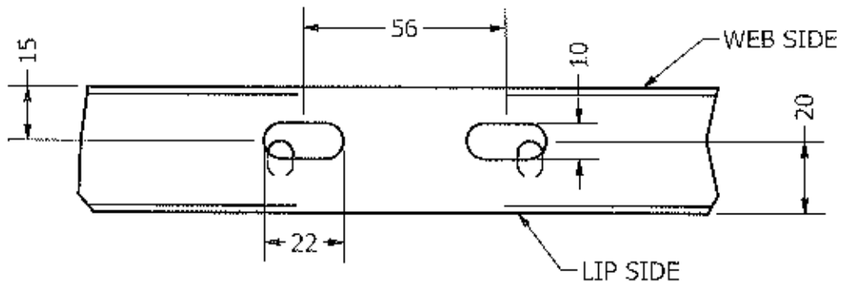

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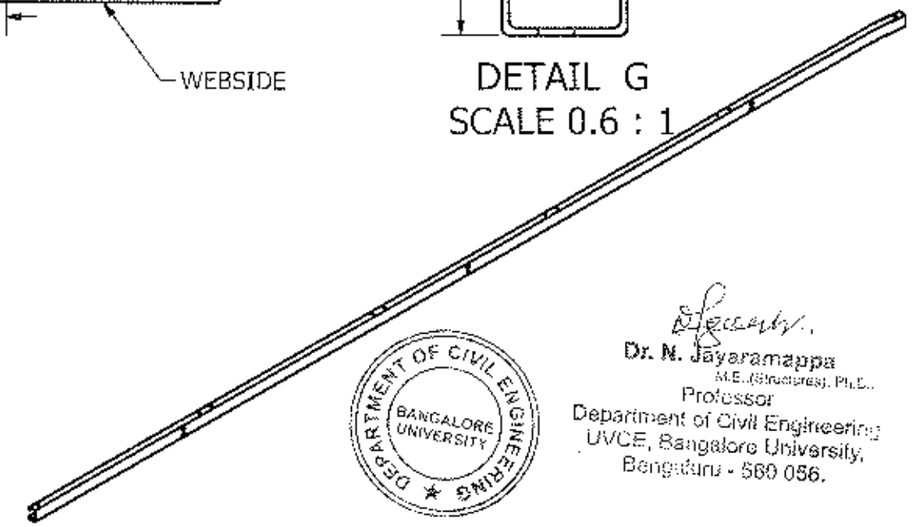

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TOLERANCES				SCALE
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PRODUCT TITLE:
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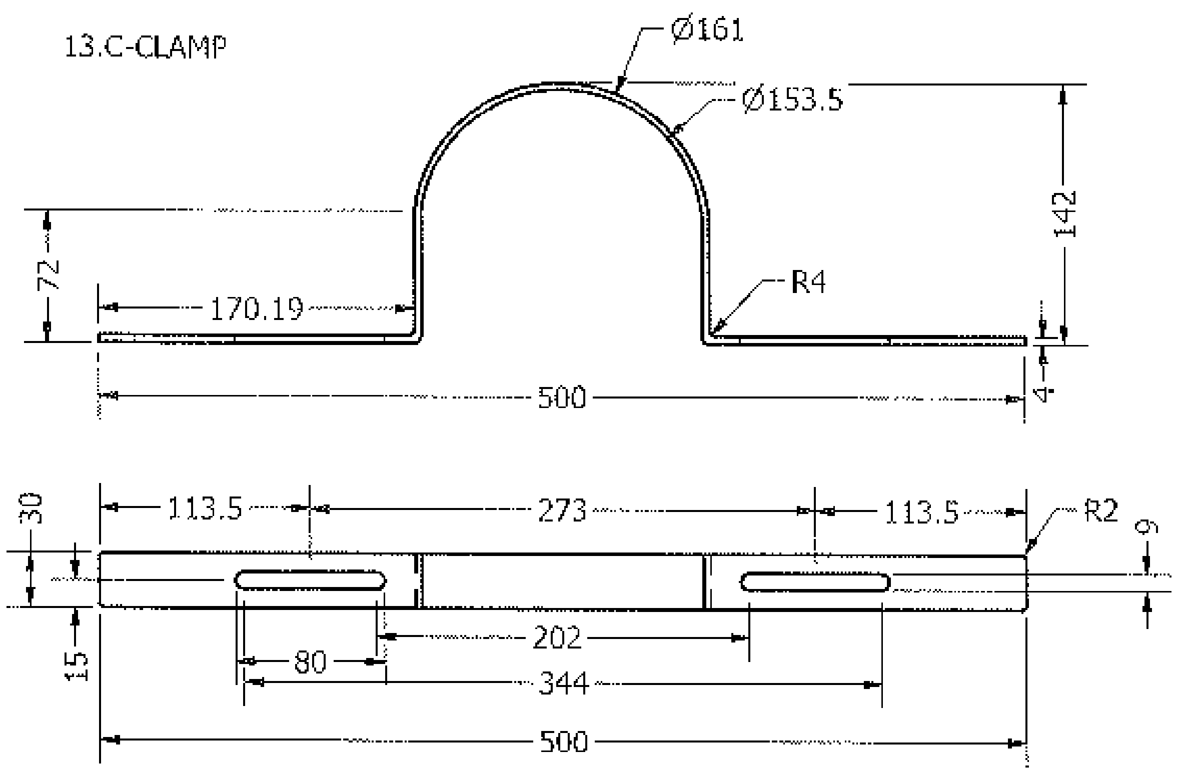
DATE 22-07-2008	DATE 22.07.2008	DATE [illegible]	REV. 4

PART/DWG NUMBER: TPS-EESI-10MMS-N-TP-PVPT-F-001

SHEET SIZE A3

EESL CLAMP

13.C-CLAMP



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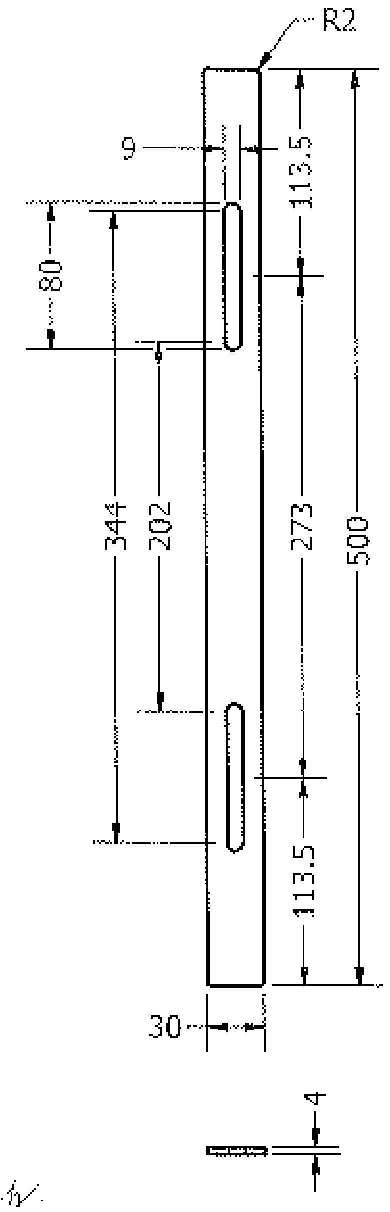

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2	PATTI	IS 2062 GR.B [illegible]	HDG 80 MICRON	[illegible]	2
3	BOLT	MS	HDG 80 MICRON	M8 X 50MM LONG [illegible]	4
4	NUT	MS	HDG 80 MICRON	M8 X [illegible]	4
5	WASHER	MS	HDG 80 MICRON	M8	[illegible]

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TOLERANCES			
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± 1	± 0.5	± 0.25	[illegible]

SCALE: NTS

PRODUCT TITLE:

PUMP CONTROLLER MOUNTING CLAMP
EESL

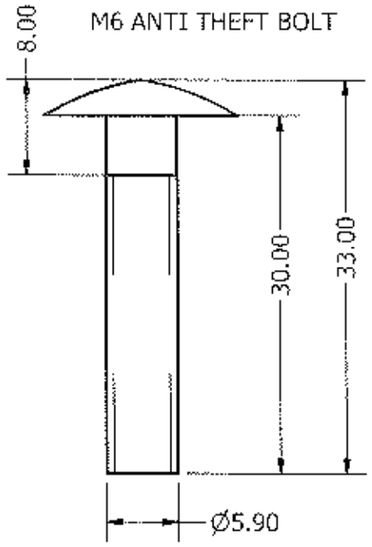
DRAWN	CHKD.	APPR.	REV.
[illegible]	SUNIL	SUNIL	4

PART/DWG NUMBER:
TPS-EESL-10MMS-N-TP-PVPT-F-001

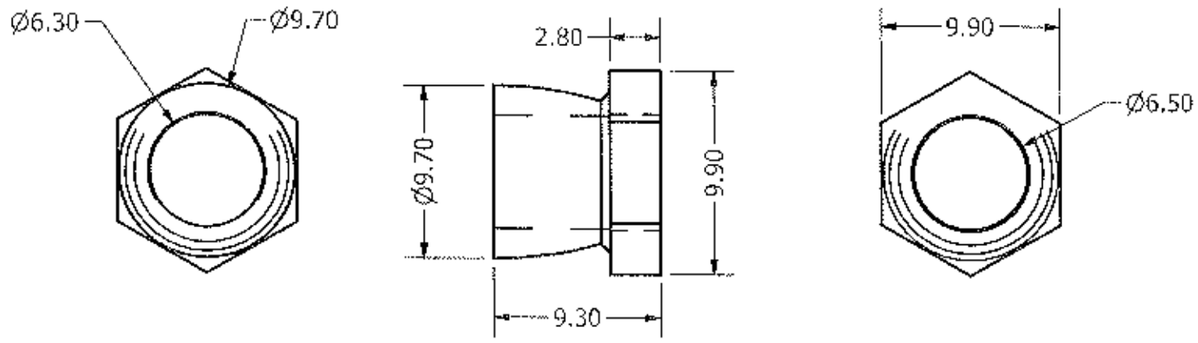
SHEET SIZE A3

M6 ANTI THEFT BOLT, NUT AND WASHER MINIMUM DIMENSIONS FOR
9MMS & 10MMS EESL STRUCTURES

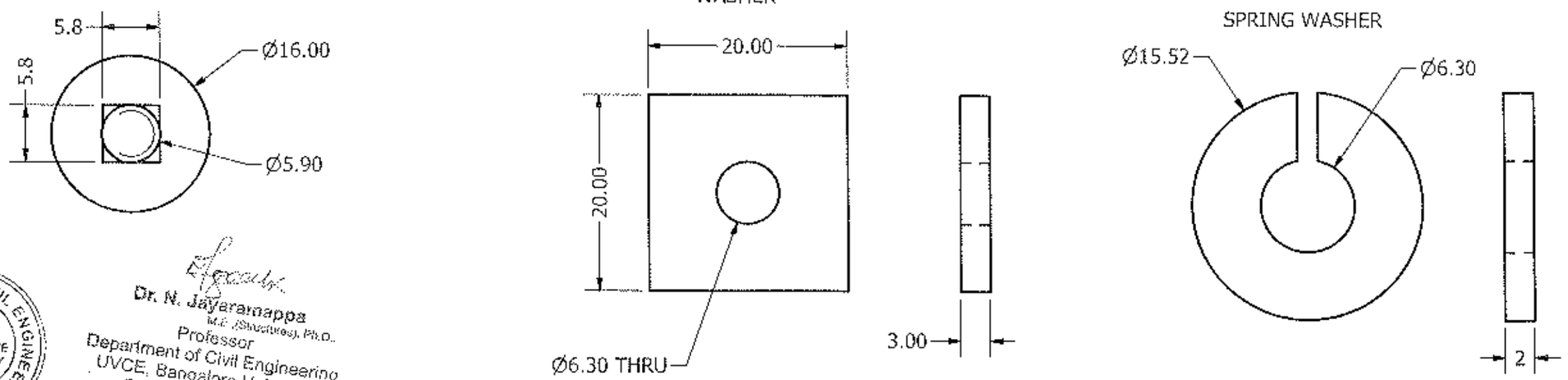
M6 ANTI THEFT BOLT



M6 ANTI THEFT NUT



WASHER



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± 1	± 0.5	± 0.25	±1°	

SCALE: NTS

PRODUCT TITLE:

M6 ANTITHEFT BOLT FOR 9MMS & 10MMS EESL PROJECT

DRAWN	CHKD.	APPR.	
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DATE [illegible]	DATE [illegible]	DATE [illegible]	REV. 4

PART/DWG NUMBER: TPS-EESL-10MMS-N-TP-PVPT-T-001

SHEET SIZE A3

TATA POWER SOLAR SYSTEMS

9 MODULE MOUNTING STRUCTURE (MMS)

Document No.: TPS-EESL-9MMS-N-TP-PVPT-F-001

TATA

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19/8/2020

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REV. NO.	R0								ISSUE
	INITIALS	SIGN	INITIALS	SIGN	INITIALS	SIGN	INITIALS	SIGN	
PPD BY	Harish								R0
CHD BY	sunil								
APD BY	Nilesh								
DATE	01.08.2020								

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INTRODUCTION

This document covers structural design and analysis of 9 Module Mounting Structure (MMS) for mounting of solar panels of Solar Water Pumping System meant for Agricultura, Drinking Water and other purposes. The analysis has been carried out using STAAD software simulation of the structure. The structure has been designed to withstand a wind velocity of 150kmph.

1 SCOPE

The scope of the report is limited to providing structural design of module mounting structure as described in section 5.1. The solar yield analysis shadow effects, construction procedure are outside the purview of the report.

2 REFERENCE DOC/CODES

IS 875 : Part -1	Design load for Building and Structures – Code of practice for Dead Load
IS 875 : Part -3	Design load for Building and Structures – code of practice for wind load
IS 800 : 2007	General Construction In Steel - Code of Practice
IS 1079-2009	Hot Rolled Carbon Steel Sheet And Strip- Specification
IS 4759-1996	HDZ- Coating on Structural Steel products
IS 2062 – 2011	Hot Rolled Medium and High Tensile Structural Steel-Specification
IS 811 -1987	Specification For Cold Formed Light Gauge Steel Structural Member

3 DESIGN BASIS

BASIC DATA ASSUMED FOR STRUCTURAL DESIGN

A MATERIAL CONSTANTS

1	Characteristic strength of concrete (for foundation)	: 25 N/sq.mm
2	Unit wt. of concrete	: 2400 kg/Cu.m
3	Unit wt. of steel	: 7850 kg/Cu.m
4	Steel grade	: IS 2062 E250A/ E350A / IS 4923 Yst 310 / IS 1161 Yst 310

B DEAD LOADS

1	PV module weight	: 24 kg per module

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C WIND LOAD

1	Basic Wind Speed	:	42 m/s	IS 875 2015 - Part 3
2	Terrain Category	:	Category 3	IS 875 2015 - Part 3
4	Topography factor	:	1.0	IS 875 2015 - Part 3
5	Importance Factor (k_d)	:	1.0	IS 875 2015 - Part 3

E DESIGN CODES

1	Steel Structure	:	IS 800 :2007/ IS 801 :1975
2	Wind load Calculation		IS 875 : 2015 Part -3

F SOFTWARE

1	Structural Analysis	:	STAAD Pro

4 INPUT DATA

The input data refer module data sheet and tender document (i.e. Structural configuration, Tilt angle, Members used, Module data, etc.)

4.1 STRUCTURAL DESCRIPTION.

The MMS (Module Mounting Structure) supports 9 modules suitable for TPSSL Modules of dimensions 1.984m x 1.004 m and 1.956m x 0.992m and PV Power Tech Module of dimension 1.960 x 0.989m. Modules are arranged in 5+4 portrait arrangement. The angle of inclination for seasonal tilt provided is 15 to 20 degree to the horizontal so that inclination can be adjusted at the specified tilt angle. Manual tracking with 3 times tracking per day has also been provided to maximise the water output and enhance the SPV water pumping systems. The structure has a single leg arrangement. Reactions were obtained from the analysis and are used for the pile foundation design. The members designed by STAAD Software.

5 STRUCTURAL PRE-REQUISITIES

The following are the pre-requisites for the module supporting structure to qualify for structure and foundation sufficiency study.

- The module supporting structure is deemed to have been designed using relevant IS codes to satisfy both strength and serviceability criteria.
- Execution quality compliance on material quality, safety in construction and proper construction practices are deemed taken care.

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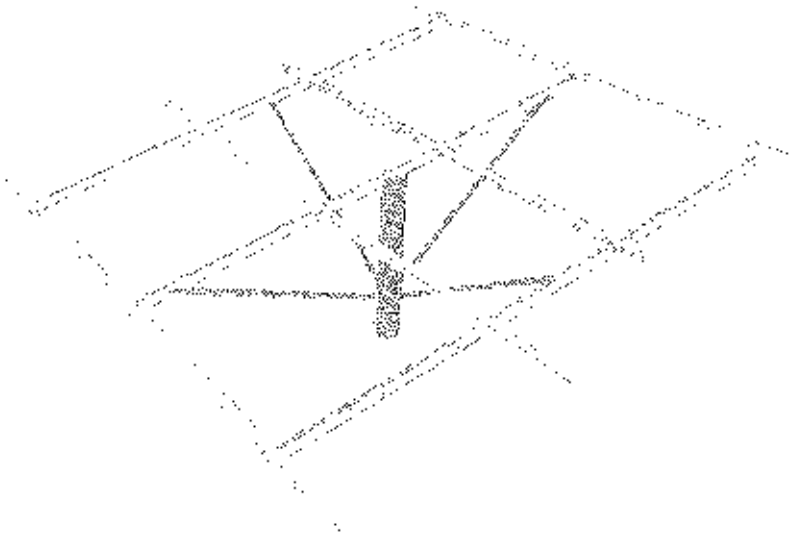
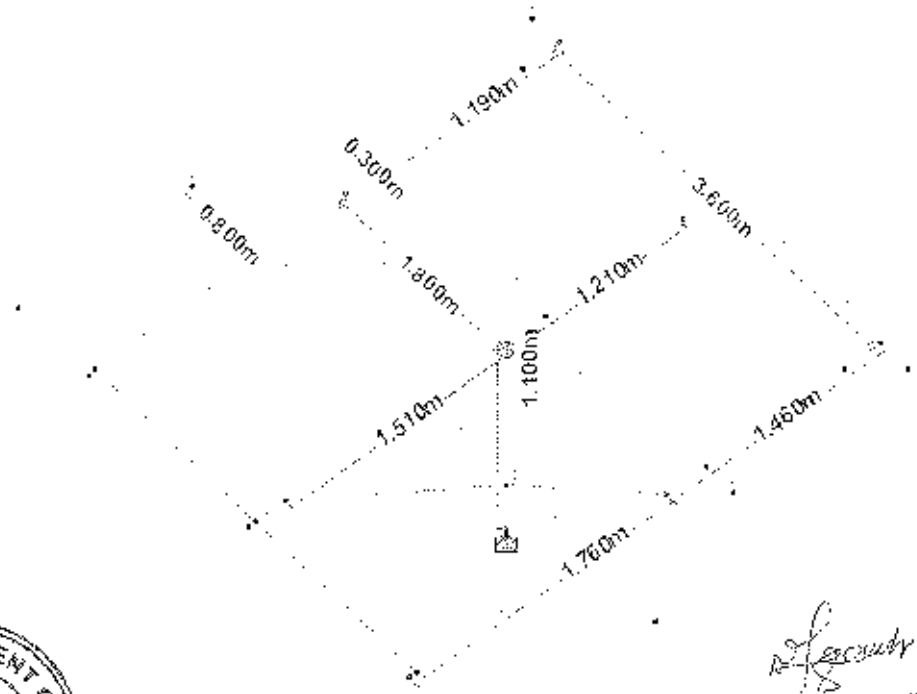
6 STAAD MODELING

6.1 STAAD MODEL





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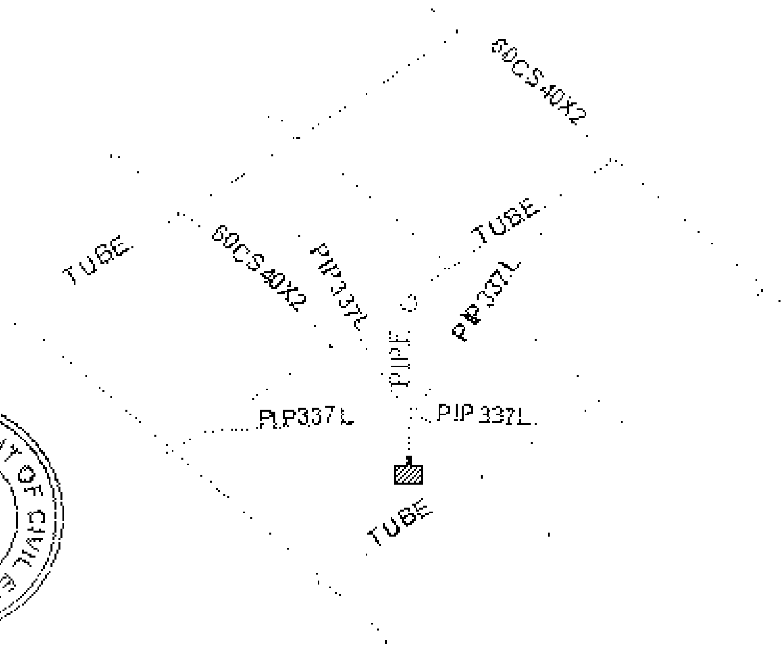
6.2 STAAD MEMBER NUMBERS AND NODE NUMBERS

6.3 STAAD MEMBER PROPERTIES



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Prop	Description	Section	Dimentions	Area(cm2)	Iyy(cm4)	Izz(cm4)	J(cm4)	Material
1	cross member	TUB32322.6	32x32x2.6mm thk	2.93	4.02	4.02	[illegible]	STEEL
2	purlin	60CS40X2	C lip: 60x40x15x2	3.09	7.1	17.8	–	STEEL
3	column	PS152	Pipe Ø152x3.6mm	16.734	462	462	924	STEEL
4	side rafters	TUB70252.9	70x25x2.9mm thk	5.43	5.934	34.87	15.8	STEEL
5	bracings	PIP337L	Pipe Ø33.7x2.6mm	2.54	3.09	3.09	6.2	STEEL
7	main rafter	TUB70252.9	70x25x2.9mm thk	5.46	5.934	34.87	15.8	STEEL

7 LOAD CALCULATION

The module mounting structure are subjected to following loads

- Module dead load
- Wind Load

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7.1 DEAD LOAD

- Weight of Module = 24 kg (from Module Data Sheet)
- Panel Dimensions = 1.984m x 1.004 m and 1.956m x 0.992m (from TPSSL module data sheets) & 1.960 x 0.989m (from PV Power Tech module data sheet)
- Load due to module = (24*9.81)/(1.984*1000) = 0.12kN/m.
- Self-weight of module supporting structure.

7.2 WIND LOAD

WIND LOAD CALCULATION: (AS PER IS:875 Part-3, 2015)

Basic Wind Speed=	42	m/s	150 kmph	Fig 1
Design Life N =	25		for 25 year design life	
Tilt angle =	20			From GA DWG
Risk Co-efficient, k1=	0.91			Table 1
Terrain =	3			Clause 6.3.2 i
Building height =	10			From GA DWG
Terrain, Height and Structure size factor, k2=	0.91			Table 2
Topography Factor, k3=	1		(Upwind Slope < 3)	Clause 6.3.3
Importance Factor, k4=	1			
Design Wind Speed Vz=	34.81	m/s		Clause 6.3 Vz=k1xk2xk3xk4
Wind pressure at height z Pz=	0.666	kN/m2		Clause 7.2 Pz=0.6Vz²
Directionality factor Kd=	0.9			Clause 7.2.1
Avg Area of module=	38			From Layout DWG
Area averaging factor Ka=	0.95			Table 4
Combination factor Kc=	1.00			Clause 7.3.3.19
Design Wind Pressure Pd=	0.56	kN/m2		Clause 7.2 Pd=KaxKcxKdxPz
Considering 20 % reduction	0.4	kN/m2		From GA DWG

Wind Load calculation along X direction:

Tilt Angle 20 degrees — Table 8

Condition	Cp	Wind Pressure	Considered width	Total Uplift / Downward in kN/m
Uplift	-1.30	0.4	0.96	-0.5
Downward	0.8	0.4	0.96	0.34

Condition	Cp	Wind Pressure	Considered width	Total Uplift / Downward
column	1	0.4	0.15	0.06
rafter	2	0.4	0.06	0.05
bracing	1	0.4	0.03	0.01
purlin	2	0.4	0.05	0.03

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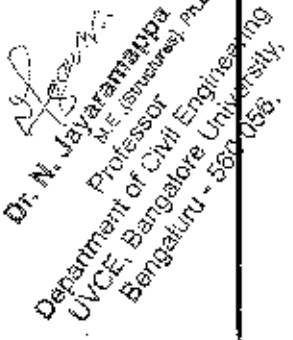
7.3 PRIMARY LOADS AND COMBINATION

Primary Load Cases

Number	Name	Type
1	DEAD LOAD	Dead
2	WIND LOAD (X)	Wind
3	WIND LOAD (-X)	Wind
4	WIND LOAD (Z)	Wind
5	WIND LOAD (-Z)	Wind

Combination Load Cases

Combo	Combination LC Name	Primary	Primary LC Name	Factor
1		1		1.5
		2		1.5
2		1		1.5
		3		1.5
3		1		1.5
		4		1.5
4		1		1.5
		5		1.5
5		1		1.5
		2		0.9
6		1		1.5
		3		0.9
7		1		1.5
		4		0.9
8		1		1.5
		5		0.9
9		1		1.5
		2		0.9
10		1		1.5
		3		0.9
11		1		1.5
		4		0.9
12		1		1.5
		5		0.9
13		1		1.5
		2		0.9
14		1		1.5
		3		0.9
15		1		1.5
		4		0.9
16		1		1.5
		5		0.9
17		1		1.5
		2		0.9
18		1		1.5
		3		0.9
19		1		1.5
		4		0.9
20		1		1.5
		5		0.9
21		1		1.5
		2		0.9
22		1		1.5
		3		0.9
23		1		1.5
		4		0.9
24		1		1.5
		5		0.9



7.4 STAAD INPUT

```
STAAD SPACE
START JOB INFORMATION
ENGINEER DATE 25-07-19
END JOB INFORMATION
INPUT WIDTH 79
UNIT METER KN
JOINT COORDINATES
4 -1.47068 0.865401 -1.8; 6 -0.352437 1.2724 -1.8; 7 0.436907 1.55969 -1.8;
8 1.32027 1.8812 -1.8; 9 1.55515 1.9667 -1.8; 10 -1.47068 0.865401 0;
11 -0.352437 1.2724 0; 12 0.436907 1.55969 0; 13 1.55515 1.9667 0;
14 -1.47068 0.865401 1.8; 16 -0.352437 1.2724 1.8; 17 0.436907 1.55969 1.8;
18 1.32027 1.8812 1.8; 19 1.55515 1.9667 1.8; 21 -0.352437 1.2724 -2.6;
22 0.436907 1.55969 -2.1; 23 1.55515 1.9667 -2.1; 25 -0.352437 1.2724 2.6;
26 0.436907 1.55969 2.1; 27 1.55515 1.9667 2.1; 28 -1.23575 0.950902 0;
29 1.32027 1.8812 0; 32 -1.42369 0.882501 -1.8; 33 -1.42369 0.882501 1;
34 -1.42369 0.882501 1.8; 40 0.182965 1.46732 0; 41 0.182964 0.367275 0;
42 0.182964 0.627275 0; 43 0.18319 1.46735 -1.8; 44 0.18319 1.46735 1.8;
45 -1.47064 0.865401 -2.6; 46 -1.47064 0.865401 2.6;
MEMBER INCIDENCES
4 42 28; 5 42 29; 11 4 32; 12 6 32; 13 6 43; 14 7 8; 15 8 9; 16 28 33;
17 11 28; 18 11 40; 20 12 29; 21 29 13; 22 14 34; 23 16 34; 24 16 44; 25 17 18;
26 18 19; 31 21 6; 32 6 11; 33 11 16; 34 16 25; 35 7 22; 36 12 7; 37 17 12;
38 26 17; 39 23 9; 40 9 13; 41 13 19; 42 19 27; 46 33 10; 47 32 33; 49 33 34;
50 12 40; 53 7 43; 55 17 44; 58 41 12; 59 42 40; 61 42 43; 63 42 44; 64 45 4;
65 4 10; 66 10 14; 67 14 46;
DEFINE MEMBER
UNIT NUMBER 1
START USER TABLE
TABLE 1
UNIT MMS NEWTON
TUBE
TO REFERENCE 9
546.76 75 25 2.9 348708 56840.4 156326.435 145
END
UNIT METER KN
MEMBER OFFSET
31 TO 42 64 TO 67 START 0 0.06 0
31 TO 42 64 TO 67 END 0 0.06 0
DEFINE MATERIAL START
ISOTROPIC STEEL
E 2.05e+08
POISSON 0.3
DENSITY 76.8195
ALPHA 1.2e-05
DAMP 0.03
TYPE STEEL
STRENGTH FY 253200 FU 407880 RY 1.5 RT 1.2
END DEFINE MATERIAL
```

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```
MEMBER PROPERTY INDIAN
47 49 TABLE ST TUBE2532.6
UNIT MMS NEWTON
MEMBER PROPERTY COLDFORMED INDIAN
31 TO 42 64 TO 67 TABLE ST SQCS40X2
MEMBER PROPERTY INDIAN
58 59 TABLE ST PIPE OD 152 ID 144.8
16 TO 18 29 21 46 50 TABLE ST TUBE TH 2.9 WT 25 DT 75
11 TO 15 22 TO 26 53 55 TABLE ST TUBE TH 2.9 WT 25 DT 75
4 5 61 63 TABLE ST PIPE37L
UNIT METER KN
CONSTANTS
BETA 20 MEMB 31 TO 34 39 TO 42 64 TO 67
BETA 340 MEMB 35 TO 38
MATERIAL STEEL ALL
MEMBER TRUSS
4 5 61 63
SUPPORTS
41 FIXED
UNIT MMS NEWTON
MEMBER RELEASE
59 END MZ MZ
UNIT METER KN
LOAD 1 LOADTYPE Dead TITLE DEAD LOAD
SELFWEIGHT Y -1.1 LIST ALL
MEMBER LOAD
31 TO 42 64 TO 67 UNI GY -0.12
LOAD 2 LOADTYPE Wind TITLE WIND LOAD +X
MEMBER LOAD
58 59 UNI GX 0.07
4 5 61 63 UNI GX 0.03
31 TO 38 64 TO 67 UNI Y -0.35
UNIT MMS NEWTON
39 TO 42 UNI Y -0.35
UNIT MMS KN
LOAD 3 LOADTYPE Wind TITLE WIND LOAD -X
MEMBER LOAD
58 59 UNI GX -0.07
4 5 61 63 UNI GX -0.03
31 TO 42 64 TO 67 UNI Y 0.52
LOAD 4 LOADTYPE Wind TITLE WIND LOAD +Z
MEMBER LOAD
58 59 UNI GZ 0.07
4 5 61 63 UNI GZ 0.03
11 TO 18 20 TO 26 46 50 53 55 UNI GZ 0.07
LOAD 5 LOADTYPE Wind TITLE WIND LOAD -Z
MEMBER LOAD
58 59 UNI GZ -0.07
4 5 61 63 UNI GZ -0.03
11 TO 18 20 TO 26 46 50 53 55 UNI GZ -0.07
```

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```
***Serviceability Case***
LOAD COMB 100 DL+WL(X)
1 1.0 2 1.0
LOAD COMB 101 DL+WL(-X)
1 1.0 3 1.0
LOAD COMB 102 DL+WL(Z)
1 1.0 4 1.0
LOAD COMB 103 DL+WL(-Z)
1 1.0 5 1.0
*************************
LOAD COMB 104 DL+0.8WL(X)
1 1.0 2 0.8
LOAD COMB 105 DL+0.8WL(-X)
1 1.0 3 0.8
LOAD COMB 106 DL+0.8WL(Z)
1 1.0 4 0.8
LOAD COMB 107 DL+0.8WL(-Z)
1 1.0 5 0.8
*************************
***Collapse Case***********
LOAD COMB 200 1.5 DL+WL(X)
1 1.5 2 1.5
LOAD COMB 201 1.5(DL+WL(-X)
1 1.5 3 1.5
LOAD COMB 202 1.5 DL+WL(Z)
1 1.5 4 1.5
LOAD COMB 203 1.5(DL+WL(-Z)
1 1.5 5 1.5
******
LOAD COMB 204 0.9DL+1.5WL(X)
1 0.9 2 1.5
LOAD COMB 205 0.9DL+1.5WL(-X)
1 0.9 3 1.5
LOAD COMB 206 0.9DL+1.5WL(Z)
1 0.9 4 1.5
LOAD COMB 207 0.9DL+1.5WL(-Z)
1 0.9 5 1.5
PERFORM ANALYSIS PRINT ALL
DEFINE ENVELOPE
100 TO 107 ENVELOPE 1 TYPE SERVICEABILITY
200 TO 207 ENVELOPE 2 TYPE STRENGTH
END DEFINE ENVELOPE
LOAD LIST 200 TO 207
PARAMETER 1
CODE IS800 LSD
FYLD 310000 MEMB 4 5 11 TO 18 20 TO 26 46 50 53 55 58 59 61 63
FPY 0.85 MEMB 4 5 61 63
FPZ 0.85 MEMB 4 5 61 63
MAIN 200 MEMB 4 5 61 63
CHECK CODE MEMB 4 5 11 TO 18 20 TO 26 46 50 53 55 58 59 61 63
```

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LOAD LIST 100 TO 107
PARAMETER 2
CODE IS801
FYLD 350000 MEMB 31 TO 42 64 TO 67
LY 0.5 MEMB 31 TO 42 64 TO 67
TSA 0 MEMB 31 TO 42 64 TO 67
CHECK CODE MEMB 31 TO 42 64 TO 67
PRINT MEMBER STRESSES LIST 4 5 11 14 15 17 20 TO 22 25 26 31 TO 42 46 58 59 - 61 63 TO 67
FINISH

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8 STRUCTURAL DESIGN

8.1 MEMBER DESIGN (STAAD)

Beam	Analysis Property	Design Property	Actual Ratio	Allowable Ratio	Normalized Ratio (Actual/Allo	Clause	L.C	Ax cm2
4	PIP337L	PIP337L	0.283	1	0.283	Sec. 7.1.2	200	2.5
5	PIP337L	PIP337L	0.253	1	0.253	Sec. 7.1.2	200	2.5
11	TUBE	TUBE	0.475	1	0.475	Sec. 8.4	200	5.5
12	TUBE	TUBE	0.114	1	0.114	Sec. 8.2.1.2	200	5.5
13	TUBE	TUBE	0.467	1	0.467	Sec. 8.2.1.2	200	5.5
14	TUBE	TUBE	0.289	1	0.289	Sec. 9.3.2.2	200	5.5
15	TUBE	TUBE	0.123	1	0.123	Sec. 8.2.1.2	201	5.5
16	TUBE	TUBE	0.238	1	0.238	Sec. 8.2.1.2	200	5.5
17	TUBE	TUBE	0.238	1	0.238	Sec. 8.2.1.2	200	5.5
18	TUBE	TUBE	0.142	1	0.142	Sec. 8.2.1.2	202	5.5
20	TUBE	TUBE	0.173	1	0.173	Sec. 9.3.2.2	205	5.5
21	TUBE	TUBE	0.155	1	0.155	Sec. 8.2.1.2	200	5.5
22	TUBE	TUBE	0.475	1	0.475	Sec. 8.4	200	5.5
23	TUBE	TUBE	0.114	1	0.114	Sec. 8.2.1.2	200	5.5
24	TUBE	TUBE	0.467	1	0.467	Sec. 8.2.1.2	200	5.5
25	TUBE	TUBE	0.289	1	0.289	Sec. 9.3.2.2	200	5.5
26	TUBE	TUBE	0.123	1	0.123	Sec. 8.2.1.2	201	5.5
31	60CS40X2	60CS40X2	0.147	1	0.147	6.7.1(T)	100	3.1
32	60CS40X2	60CS40X2	0.628	1	0.628	6.7.2(a)2	101	3.1
33	60CS40X2	60CS40X2	0.628	1	0.628	6.7.2(a)2	101	3.1
34	60CS40X2	60CS40X2	0.147	1	0.147	6.7.1(T)	100	3.1
35	60CS40X2	60CS40X2	0.022	1	0.022	6.7.1(T)	100	3.1
36	60CS40X2	60CS40X2	0.452	1	0.452	6.7.2(a)2	101	3.1
37	60CS40X2	60CS40X2	0.452	1	0.452	6.7.2(a)2	101	3.1
38	60CS40X2	60CS40X2	0.022	1	0.022	6.7.1(T)	100	3.1
39	60CS40X2	60CS40X2	0.021	1	0.021	6.7.1(T)	100	3.1
40	60CS40X2	60CS40X2	0.483	1	0.483	6.7.1(T)	101	3.1
41	60CS40X2	60CS40X2	0.483	1	0.483	6.7.1(T)	101	3.1
42	60CS40X2	60CS40X2	0.021	1	0.021	6.7.1(T)	100	3.1
46	TUBE	TUBE	0.045	1	0.045	Sec. 8.4	200	5.5

47	TUB32322.6	TUB32322.	0.929	1	0.929	Sec. 9.3.2.2	200	2.9
49	TUB32322.6	TUB32322.	0.929	1	0.929	Sec. 9.3.2.2	200	2.9
50	TUBE	TUBE	0.084	1	0.084	Sec. 9.3.2.2	205	5.5
53	TUBE	TUBE	0.528	1	0.528	Sec. 9.3.2.2	200	5.5
55	TUBE	TUBE	0.528	1	0.528	Sec. 9.3.2.2	200	5.5
58	PIPE	PIPE	0.23	1	0.23	Sec. 9.3.1.3	201	16.8
59	PIPE	PIPE	0.136	1	0.136	Sec. 9.3.1.3	202	16.8
61	PIP337L	PIP337L	0.361	1	0.361	Sec. 7.1.2	200	2.5
63	PIP337L	PIP337L	0.361	1	0.361	Sec. 7.1.2	206	2.5
64	60CS40X2	60CS40X2	0.147	1	0.147	6.7.1(T)	200	3.1
65	60CS40X2	60CS40X2	0.995	1	0.995	6.7.2(a)1	101	3.1
66	60CS40X2	60CS40X2	0.995	1	0.995	6.7.2(a)1	101	3.1
67	60CS40X2	60CS40X2	0.147	1	0.147	6.7.1(T)	100	3.1

8.2 DEFLECTION CHECK

			Horizontal	Vertical	Horizontal	Resultant	Rotational		
	Node	L/C	X mm	Y mm	Z mm	mm	rX rad	rY rad	rZ rad
Max X	40	100 DL+VL	-0.126	-0.012	0.000	0.126	0.000	0.000	0.000
Min X	49	101 DL+VL	-0.923	0.006	-0.039	0.923	-0.000	-0.000	0.001
Max Y	40	101 DL+VL	-0.923	0.006	-0.039	0.923	-0.000	-0.000	0.001
Min Y	40	100 DL+VL	-0.126	-0.012	0.000	0.126	0.000	0.000	0.000
Max Z	46	102 DL+WL	-0.460	-0.035	0.379	0.596	0.001	0.000	0.000
Min Z	48	103 DL+WL	-0.460	-0.035	0.379	0.596	-0.001	-0.000	0.000
Max R	46	102 DL+WL	-0.460	-0.035	0.379	0.596	0.001	0.000	0.000
Min R	48	103 DL+WL	-0.460	-0.035	0.379	0.596	-0.001	-0.000	0.000
Max Rx	49	101 DL+WL	-0.923	0.006	0.039	0.923	-0.000	-0.000	0.001

Maximum deflection for columns = 0.93mm (Node-40, LC-101)

Allowable deflection is span/180=1300/180=7.22 mm

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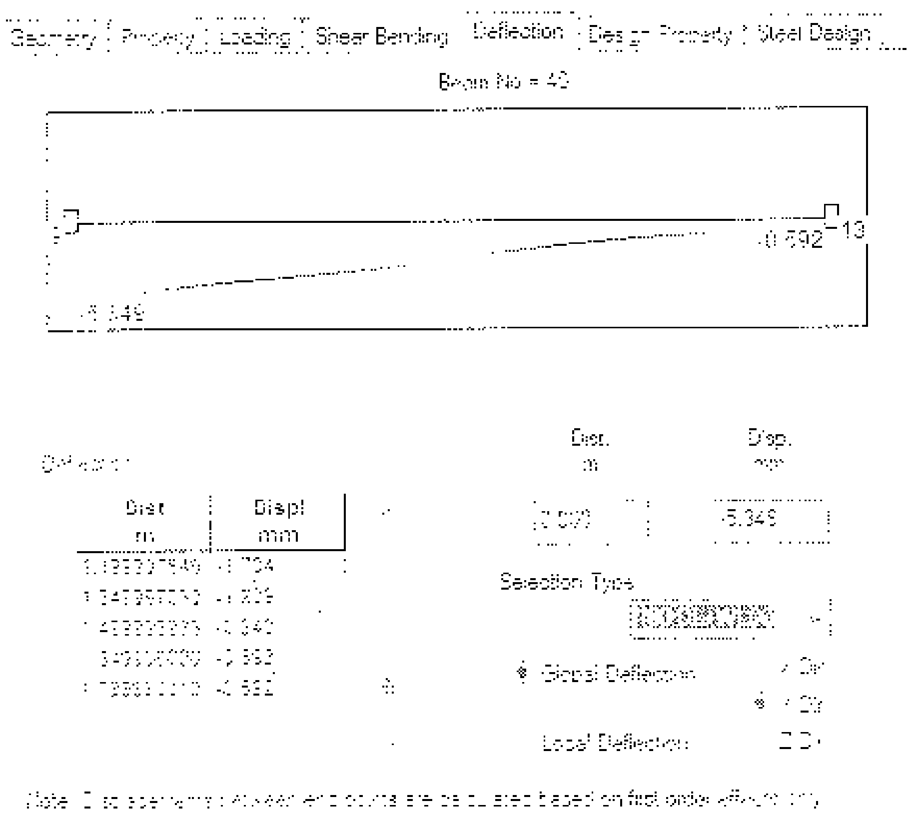

Maximum deflection for purlin = 5.35 mm (beam 40, LC-100)

Allowable deflection is span/180=1800/180=10mm

9 SUPORT REACTION

			Horizontal	Vertical	Horizontal	Moment		
	Node	L/C	Fx kN	Fy kN	Fz kN	Mx kN-m	My kN-m	Mz kN-m
Max Fx	41	101 DL+WL	3.634	-5.802	-0.000	0.000	0.000	-2.415
Min Fx	41	100 DL+WL	-2.541	9.768	0.000	-0.000	-0.000	0.232
Max Fy	41	100 DL+WL	-2.541	9.768	0.000	-0.000	-0.000	0.232
Min Fy	41	101 DL+WL	3.634	-5.802	-0.000	0.000	0.000	-2.415
Max Fz	41	103 DL+WL	0.000	3.585	0.967	0.896	0.097	-0.859
Min Fz	41	102 DL+WL	0.000	3.585	-0.967	-0.896	-0.097	-0.859
Max Mx	41	103 DL+WL	0.000	3.585	0.967	0.896	0.097	-0.859
Min Mx	41	102 DL+WL	0.000	3.585	-0.967	-0.896	-0.097	-0.859
Max My	41	103 DL+WL	0.000	3.585	0.967	0.896	0.097	-0.859
Min My	41	102 DL+WL	0.000	3.585	-0.967	-0.896	-0.097	-0.859
Max Mz	41	100 DL+WL	-2.541	9.768	0.000	-0.000	-0.000	0.232
Min Mz	41	101 DL+WL	3.634	-5.802	-0.000	0.000	0.000	-2.415

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ANNEXURE I : FOUNDATION DESIGN

FOUNDATION DESIGN FOR 9 MMS STRUCTURE

Soil parameters		Minimum value	
Angle of internal friction, degrees	20.00	20.00	ASSUMED
Density kN/m³	15.90	15.90	ASSUMED
SPT N values	[illegible]		

AXIAL AND UPLIFT CAPACITY BY STATIC FORMULA OF IS-2911, Part I Sec-2, Annexe B

OUTER STRUCTURE

Pile length below NGL	L	[illegible]	m	
Pile diameter	d	0.35	m	
Pile Cross sectional area	$A_p = \pi d^2/4$	0.0962	m²	
Pile shaft perimeter	$A_s = \pi d L$	2.1991	m²	
Soil density		15.90	kN/m³	
Angle at soil-pile contact δ		20.00	degrees	
Stress at NGL		0.00	kN/m²	
Stress at pile tip	$P_D = \gamma L$	34.78	kN/m²	
Effective vertical stress (average)	[illegible]	17.38	kN/m²	
Coefficient K	As per code	1.00	1.00 to 1.50	
Unit skin friction along shaft	[illegible]	6.33	kN/m²	
Skin friction Q_s	[illegible]	[illegible]	kN	
End bearing factor N_q	Figure 1 Annex B	10.00	Limited as soil is very loose	
End bearing Q_b	$A_p P_D N_q$	33.44	kN	
Safe axial load $(Q_s+Q_b)/2.5$	FOS is 2.5	15.91	kN	FOS 2.5
Self weight of pile (SW)	[illegible]	4.81	kN (γ=25 kN/m³)	
SAFE UPLIFT LOAD excluding SW	$Q_s/3$	5.60	kN	FOS 3.0
SAFE UPLIFT LOAD including SW	$(Q_s/3)+SW$	10.39		

Note

Pile capacities shall be confirmed by load tests

Uplift is governing the length

Safe uplift computed is inclusive of self weight of pile

[illegible]

Proper precaution necessary, use of bentonite not permitted

Design requirement (kN)			
Structure	Axial	Uplift	Lateral
Required	[illegible]	5.70	3.80
Geotechnical Capacity (kN)			
Computed	15.908	10.39	7.57
Design summary			
Design safe	Safe	Safe	Safe

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Use Broms formula for calculating ultimate lateral load

Diameter	0.35	m	
Soil density		kN/m³	Buoyant weight
Angle	25.000		
L	2.000	m	
[illegible]	0.342		
[illegible]	[illegible]	[illegible]	
e	0.2	Portion of pile above GL	
Cohesion	[illegible]	Cohesionless soil assessed	
[illegible]		0.35	
[illegible]	1450	[illegible]	
[illegible]	25	[illegible]	
E	[illegible]	[illegible]	Converted
	[illegible]	[illegible]	6
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]		
[illegible]	[illegible]		
[illegible]	[illegible]	Table 5 of Annexe C, IS code, short pile	
[illegible]	[illegible]	Table 5 of Annexe C, IS code, long pile	
[illegible]	[illegible] short pile		
Ultimate lateral	[illegible]	[illegible]	Broms formula
FOS	2		
Allowable lateral	[illegible]	kN	Shear

Table 5 Criteria for Behaviour of Pile Based on its Embedded Length

SPT N	η_h
4	2.4
10	2.6
[illegible]	0.35
7	1.45

Use Broms formula for deflection check

Deflection			
[illegible]	0.10000	As curve, judgement necessary	
Broms Coefficient	2.0000	From chart	[illegible]
[illegible]	[illegible]		
Deflection y	0.0050	m	7.57 kN
[illegible]	[illegible]	kN	

Load test to be performed at site to check deflection and least of design and load test value to be taken.
Boring shall be dry. If sides collapse, use temporary casing. Use of bentonite not allowed.
Pile load testing necessary to confirm load capacity.

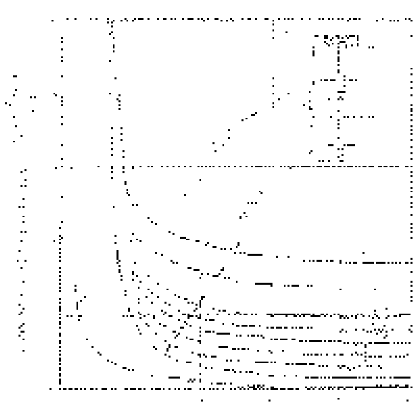

Table 3 Modulus of Subgrade Reaction for Granular Soils, η_h in kN/m³

[illegible]

Note:
Calculations are based on parameters assumed.
[illegible] capacity and is based on deflection criteria whereas Broms gives both shear & deflection.
[illegible] capacity estimated theoretically & verified by tests [illegible]

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BILL OF MATERIAL FOR 9MMS SOLAR WATER PUMP STRUCTURE

SL NO	PART NUMBER	DESCRIPTION	SPEC in mm	MATERIAL GRADE & STD	DIMENSION STANDARD	FINISH	WEIGHT kg/m	WEIGHT per each in kg	QTY	TOTAL WEIGHT in kg
				BASE PIPE ASSY						
1	B1.1	BASE PIPE	ø152x3000Hx5.6T	Yst310-IS1161	IS 1161	HDG-80 Micron	13.17	39.5	1	39.5
	B1.2	FLANGE PLATE	ø360x8 THK	Gr.E250A-IS:2062	IS 2062	HDG-80 Micron		4.22	1	4.2
	B1.3	RING (Side Weld)	ø124x10x10 THK	Gr.E250A-IS:2062	IS 2062	HDG-80 Micron		0.21	4	0.9
	B1.4	TOP PLATE GUSSET	75x60x6 THK	Gr.E250A-IS:2062	IS 2062	HDG-80 Micron		0.01	8	0.1
	B1.5	LUGS	20 DIAx75L	Gr.E250A-IS:2062	IS 2062	HDG-80 Micron	0.61	0.06	27	1.2
				CIRCULAR BRACKET ASSY						
2	C1.1	CIRCULAR PLATE (Strip Weld)	ø1b4x50x6 THK	Gr.E250A-IS:2062	IS 2062	HDG-80 Micron		0.63	2	1.26
	C1.2	PIPE MOUNTING PLATE	70x50x6	Gr.E250A-IS:2062	IS 2062	HDG-80 Micron		0.13	8	1.0
3		REAR SUPPORTING	Pipe 42.4x2.6 x900 L	Yst310-S1161	IS 1161	HDG-80 Micron	2.55	2.30	1	2.3
4		FRONT SUPPORTING	Pipe 42.4x2.6 x700 L	Yst310-IS1161	IS 1161	HDG-80 Micron	2.55	1.79	1	1.8
5		LEH & RIH-SUPPORTING	Pipe 33.7x2.6x2000 L	Yst310-IS1161	IS 1161	HDG-80 Micron	1.99	3.98	2	8.0
6		JOINING REAR	Pipe 33.7x2.6x600 L	Yst310-IS1161	IS 1161	HDG-80 Micron	1.99	1.19	1	1.2
7		JOINING FRONT	Pipe 33.7x2.6x677.5 L	Yst310-IS1161	Is 1161	HDG-80 Micron	1.99	1.35	1	1.3
				TOP PLATE ASSY						
8	T1.1	TOP PLATE	ø300x8 THK	Gr.E250A-IS:2062	IS 2062	HDG-80 Micron		3.77	1	3.7
	T1.2	VEE PLATE	150x170x6 THK	Gr.E250A-IS:2062	IS 2062	HDG-80 Micron		1.13	2	2.3
	T1.3	BOTTOM PIPE	ø42.6x150x3.2	Gr.E250A-IS:2062	IS 1161	HDG-80 Micron	3.1	0.47	1	0.5
				MAIN RAFTER ASSY						
9	M1.1	MAIN RAFTER	REC75x25x2.0x3280 L	Yst310-IS4923	IS 4923	HDG-80 Micron	4.12	13.51	1	13.5
	M1.2	ANGLE PLATE	170x170x8THK	Gr.E250A-IS:2062	IS 2062	HDG-80 Micron		1.15	2	2.3
	M1.3	MM-L-BRAKET	ISA-60x60x6THK	Gr.E250A-IS:2062	IS 808	HDG-80 Micron	3.70	0.15	4	0.6
	M1.4	RAFTER CONNECTION PLATE	REC50X50X4THK	Gr.E250A-IS:2062	IS 2062	HDG-80 Micron		0.08	4	0.3
	M1.5	SUPPORTING U BRKT	U65x70x65x5THKx40 L	Gr.E250A-IS:2062	IS 2062	HDG-80 Micron		0.31	2	0.63
	M1.6	U-CLEAT	ISA 60x40x5TH K	Gr.E250A-IS:2062	IS 808	HDG-80 Micron	3.70	0.15	2	0.3
				SECONDARY RAFTER ASSY						
10	S1.1	SECONDARY RAFTER	REC75x25x2.0x3280 L	Yst310-IS4923	IS 4923	HDG-80 Micron	4.12	13.51	2	27.0
	M1.3	MM-L-BRAKET	ISA-60x60x4THK	Gr.E250A-IS:2062	IS 808	HDG-80 Micron	3.70	0.15	8	1.2
	M1.4	RAFTER CONNECTION PLATE	REC50X50X4THK	Gr.E250A-Is 2062	IS 2062	HDG-80 Micron		0.08	4	0.3
	M1.5	SUPPORTING U BRKT	U65x70x65x5THKx40 L	Gr.E250A-IS:2062	IS 2062	HDG-80 Micron		0.31	2	0.63
11		CROSS MEMBER	REC52x32x2.6x1755 L	Yst310-IS4923	IS 4923	HDG-80 Micron	2.26	3.97	2	7.9
12	12.1	MODULE MOUNTING PURLIN LH	CS60x40x15x2.0Tx5300 L	E350A-IS:2062	IS 811	HDG-80 Micron	2.40	12.24	1	12.2
	12.2	MODULE MOUNTING PURLIN RH	CS60x40x15x2.0Tx5100 L	E350A-IS:2062	IS 811	HDG-80 Micron	2.40	12.24	1	12.2
	12.3	MODULE MOUNTING PURLIN LH-MINOR	CS60x40x15x2.0Tx1078 L	e350A-IS:2062	IS 811	HDG-80 Micron	2.40	9.79	1	9.8
	12.4	MODULE MOUNTING PURLIN RH -MINOR	CS60x40x15x2.0Tx1078 L	E350A-IS:2062	IS 811	HDG-80 Micron	2.40	9.79	1	9.8
13		L-Clamp	50L.5x121.5x3 THK	Gr.E250A-IS:2062	IS 2062	HDG-80 Micron		0.73	1	0.7
14		U Bolt	ø8.1x27.8HTx13.6 WTH	Gr.E250A-IS:2062	-	HDG-80 Micron		0.004	2	0.008
15		Lightening arrestor	ø12.5 X 1000LX3 THK	Gr.E250A-IS:2062	-	HDG-80 Micron		0.703	1	0.703
				GRAND TOTAL FOR EACH STRUCTURE						169.5

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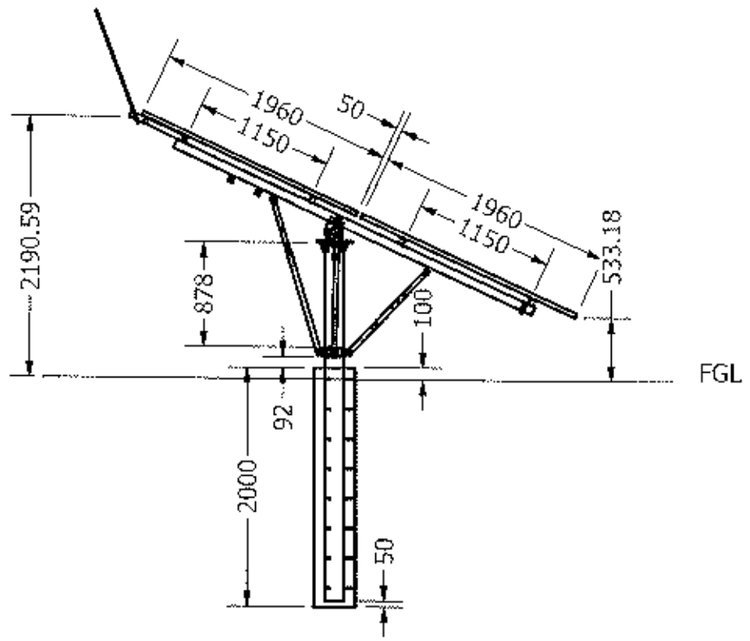
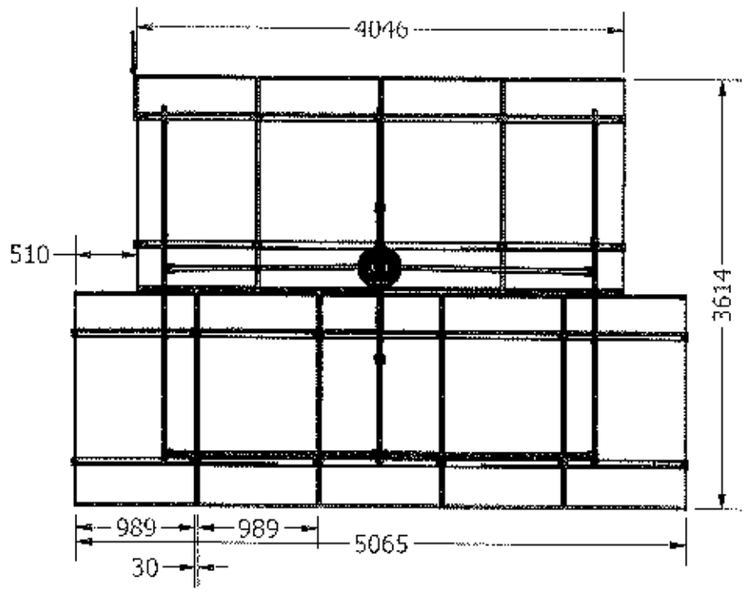
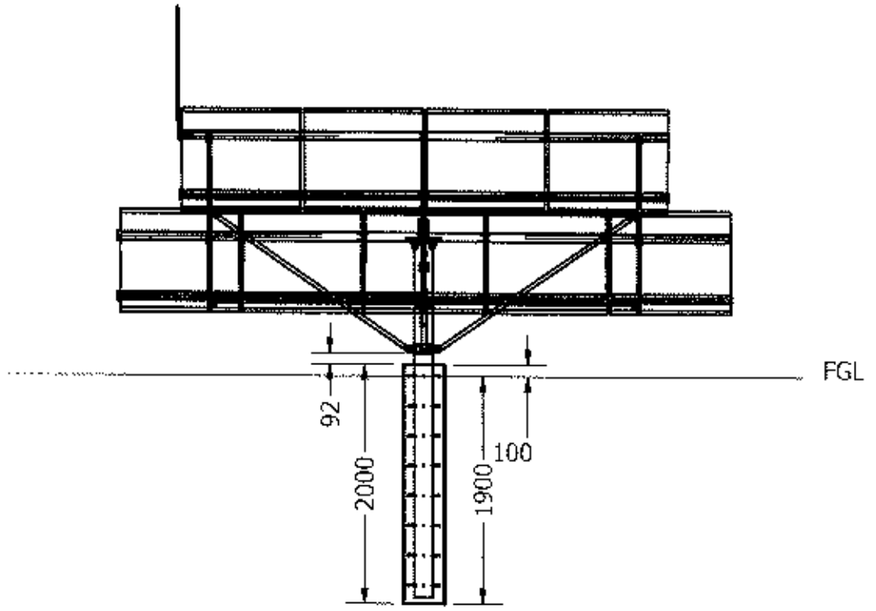
ASSEMBLY VIEW







REV.	DATE	DESCRIPTION	DRAWN	CHKD	APPR
4	22.07.2020	HOLES MADE IN PURLIN FOR DIAM MODULES MOUNTING	SACHIDANANDA	PARSHA	SUNIL
3	10-07-2020	HOLES MADE IN PURLIN AND FOR ACCOMADATING NEW MODULES	SACHIDANANDA	PARSHA	SUNIL
2	06-07-2020	HOLES FOR NAME PLATE ADDED	SACHIDANANDA	PARSHA	SUNIL
1	14.05.2020	LUG STIFFENER ADDED	SACHIDANANDA	PARSHA	SUNIL

NOTE:
* REMOVE BURR & DENT
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THIRD ANGLE PROJECTION | DO NOT SCALE THIS DRAWING. IF IN DOUBT ASK

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SCALE: NTS

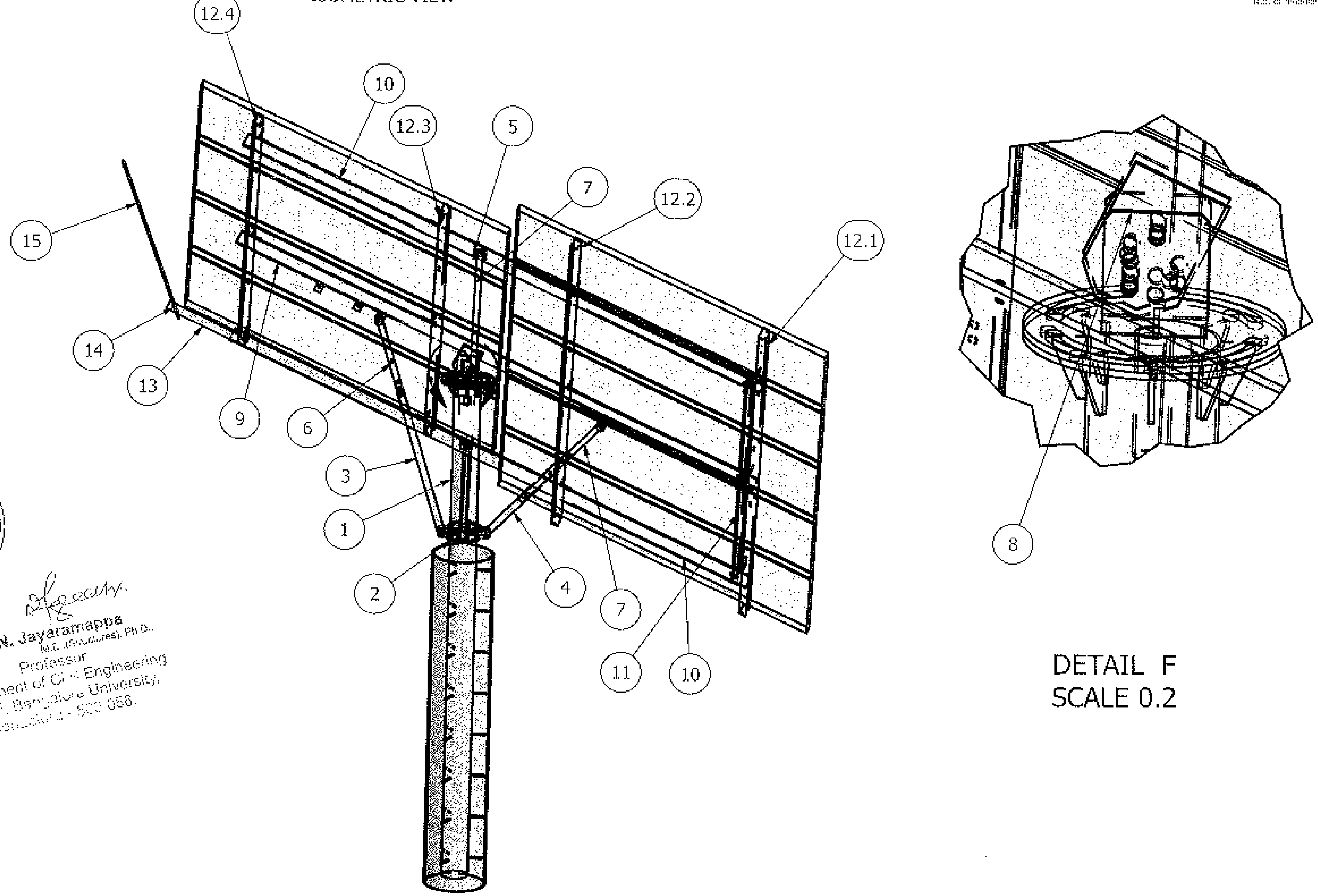
PRODUCT TITLE:
9MMS SOLAR WATER PUMP STRUCTURE

DRAWN	CHKD	APPR
SACHIDANANDA	PARSHA	SUNIL
DATE 22-07-2020	DATE 22-07-2020	DATE 22-07-2020

PART/DWG NUMBER: TPS-EESL-9MMS-N-TP-PVPT-F-001
REV: 4
SHEET SIZE: A3

Item Name: 9MMS ASSEMBLY DRAWING
Material Grade: Refer Bom
Finish: Refer Bom
Tilt angle: 0,15,20,25 degree
No. of modules: 9

ISOMETRIC VIEW



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			TOLERANCES			NTS
			NO D.P. ± 1	ONE D.P. ± 0.5	TWO D.P. ± 0.25	ANGLES ± [illegible]

REV.	DATE	DESCRIPTION	DRAWN	CHKD.	APPR.

PRODUCT TITLE: 9MMS SOLAR WATER PUMP STRUCTURE	DRAWN [illegible]	CHKD. [illegible]	APPR. [illegible]	
	DATE [illegible]	DATE [illegible]	DATE [illegible]	REV. [illegible]
	PART/DWG NUMBER: TPS-EESL-9MMS-N-TP-PVPT-F-001			SHEET SIZE A1

Item Name: 9MMS ASSEMBLY DRAWING
Material Grade: Refer bom
Finish: Refer bom
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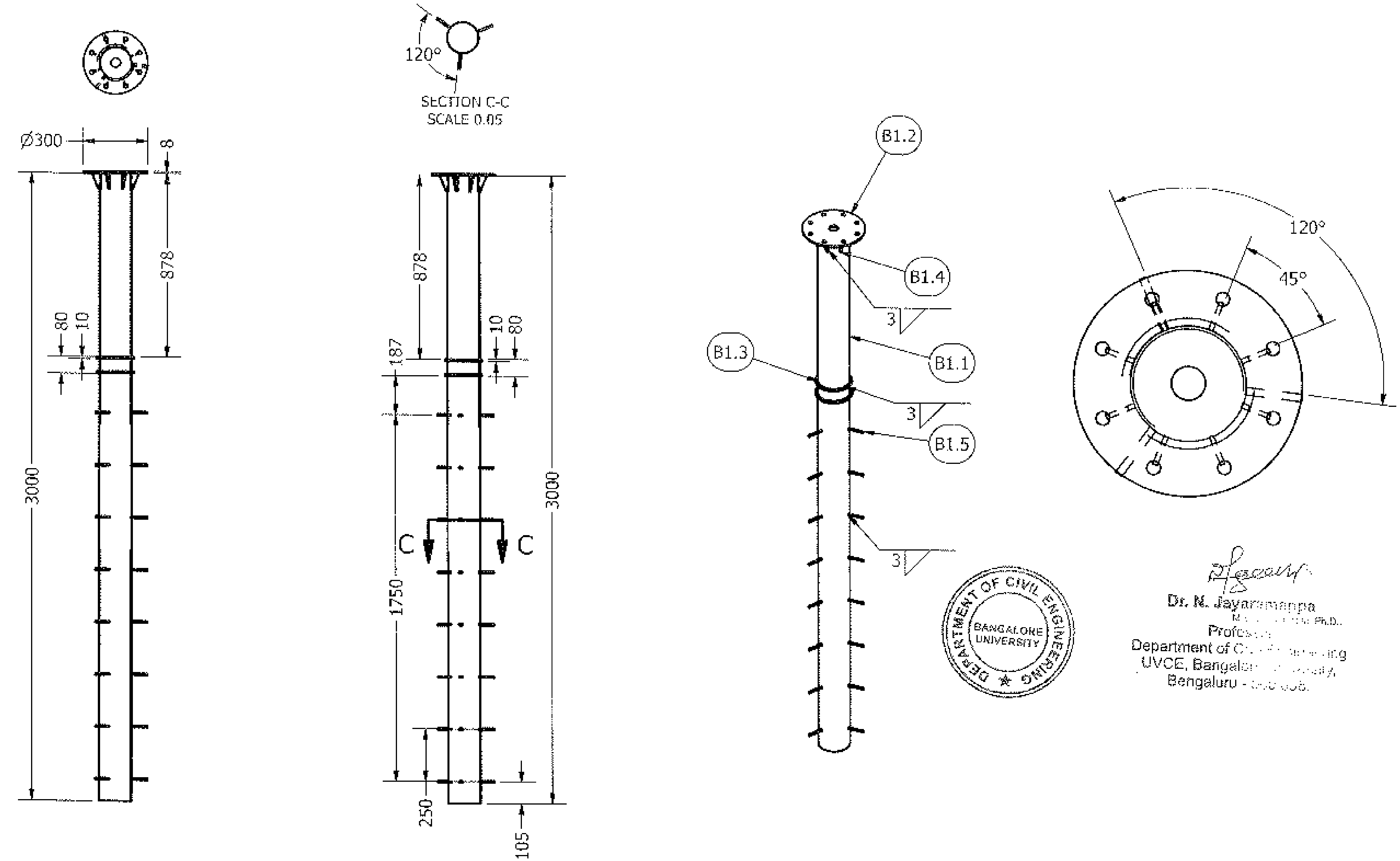
No. of [illegible]: 8

1.BASE PIPE ASSEMBLY



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TOLERANCES				SCALE
NO D.P.	ONE D.P.	TWO D.P.	ANGLES	NTS
± 1	± 0.5	± 0.25	[illegible]	

REV.	DATE	DESCRIPTION	DRAWN	CHKD.	APPR.

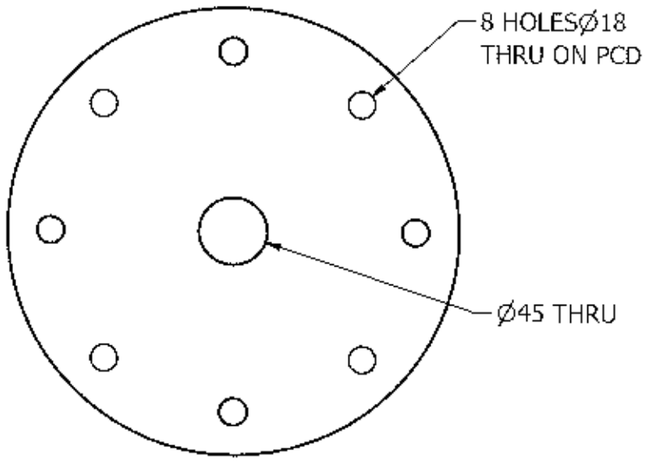
PRODUCT TITLE:

9MMS SOLAR WATER PUMP STRUCTURE

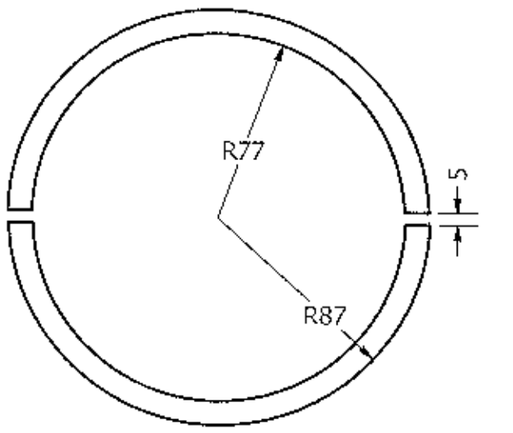
DRAWN	CHKD.	APPR.	
[illegible]	HARISHA	[illegible]	
DATE	DATE	DATE	REV.
[illegible]	[illegible]	[illegible]	4
PART/DWG NUMBER: TPS-EESL-9MMS-N-TP-PVPT-F-001			SHEET SIZE A3

B1.1. BASE PIPE

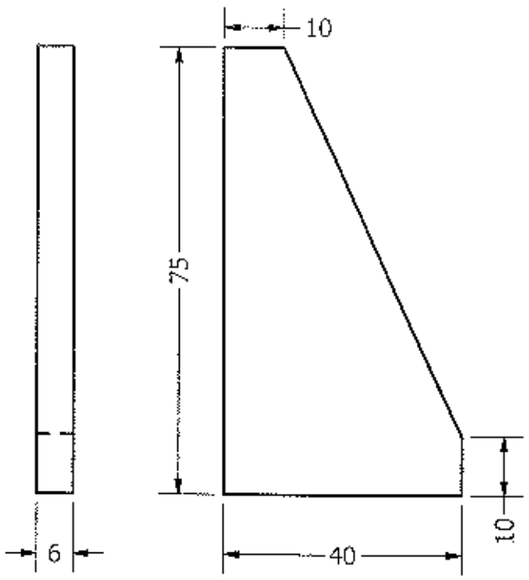
B1.2. FLANGE PLATE



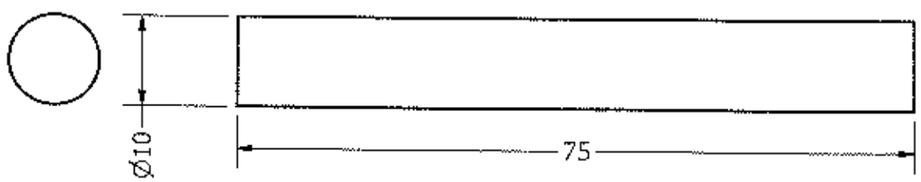
B1.3.RING



B1.4. TOP PLATE GUSSET



B1.5. LUGS



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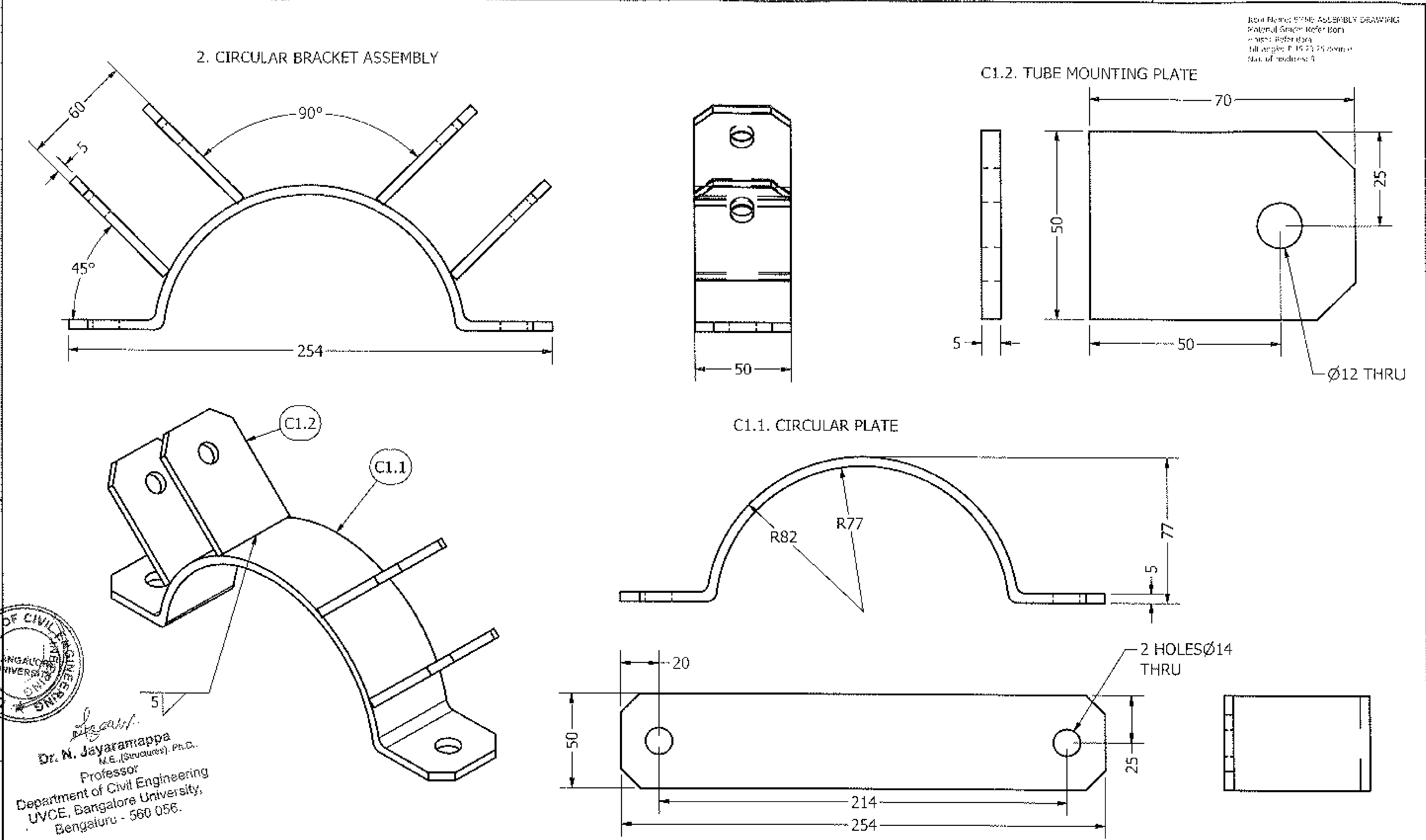
TOLERANCES
NO D.P: ± 1 | ONE D.P.: ± 0.5 | TWO D.P.: ± 0.25 | ANGLES: 1°
SCALE: NTS

PRODUCT TITLE:
9MMS SOLAR WATER PUMP STRUCTURE

DRAWN	CHKD.	APPR.	
DATE	DATE	DATE	REV.
			4

PART/DWG NUMBER:
TPS-EESL-9MMS-N-TP-PVP1-F-001
SHEET SIZE A1



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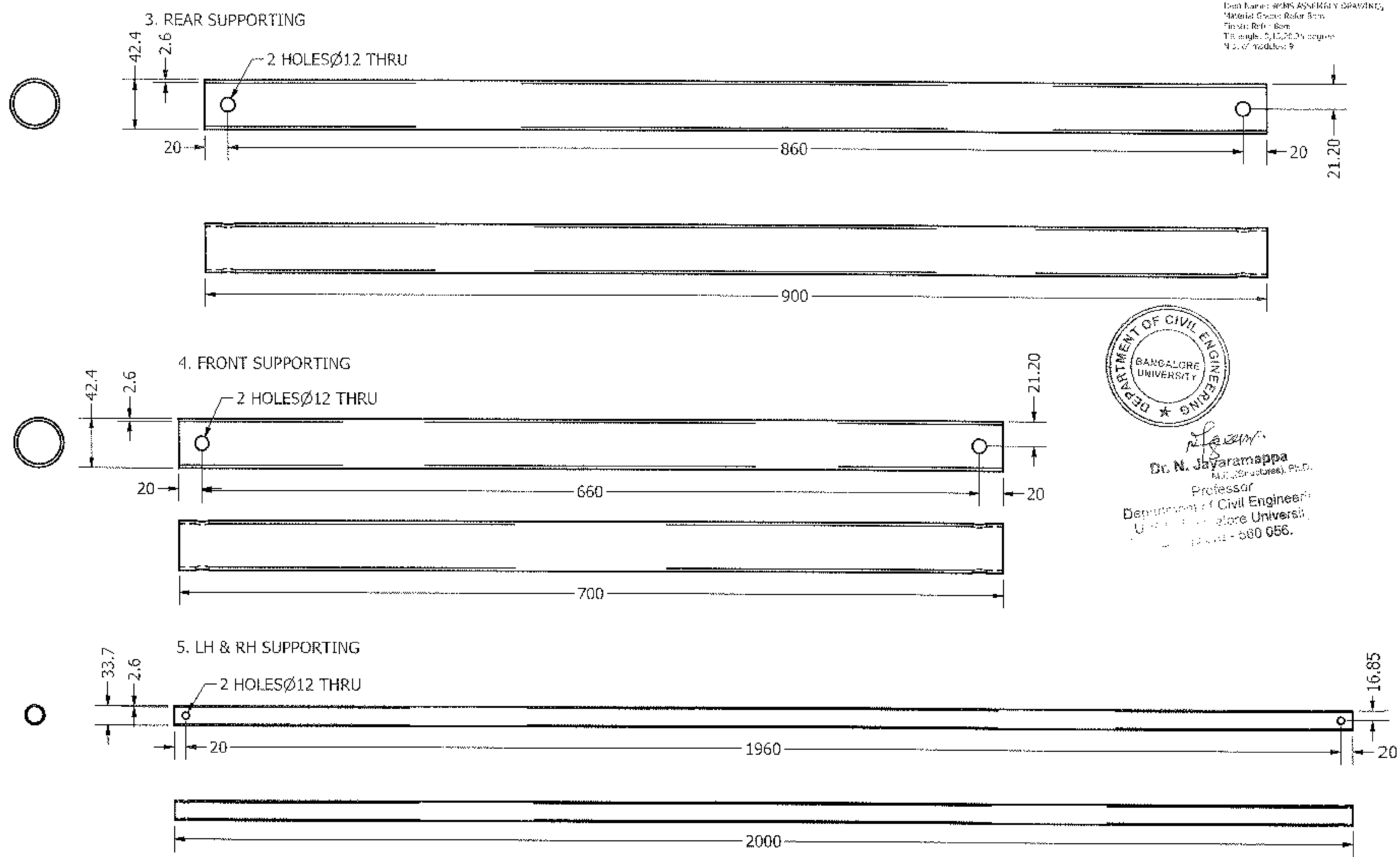
PRODUCT TITLE:

9MMS SOLAR WATER PUMP STRUCTURE

DRAWN	CHKD.	APPR.	
[illegible]	[illegible]	SUNIL	
DATE 02-07-2020	DATE 22-07-2020	DATE 22-07-2020	REV. 4

PART/DWG NUMBER: TPS-EESL-9MMS-N-TP-PVPT-F-001

SHEET SIZE A3



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REV	DATE	DESCRIPTION	DRAWN	CHKD.	APPR.

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TOLERANCES			
NO D.P.	ONE D.P.	TWO D.P.	ANGLES
± 1	± 0.5	± 0.25	1°

PRODUCT TITLE:

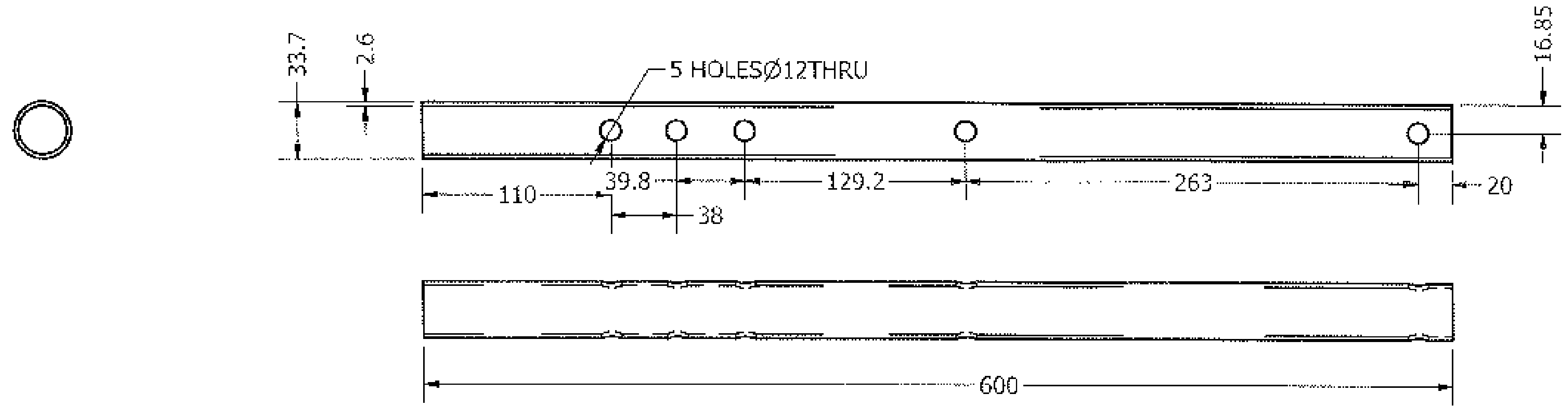
9MMS SOLAR WATER PUMP STRUCTURE

DRAWN	CHKD.	APPR.	
SACHIDHANANDAN S	MEERA	[illegible]	
DATE 22-07-2020	DATE 22-07-2020	DATE 22-07-2020	REV. 4

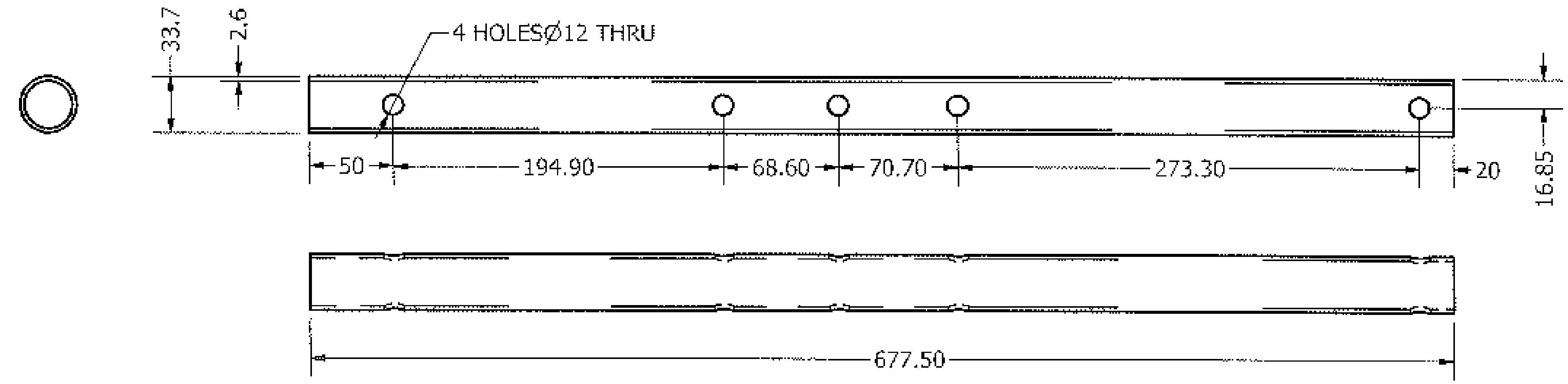
PART/DWG NUMBER: TPS-EESL-9MMS-N-TP-PVPT-F-001

SHEET SIZE A3

6.JOINING REAR



7. JOINING FRONT



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REV.	DATE	DESCRIPTION	DRAWN	CHKD.	APPR.

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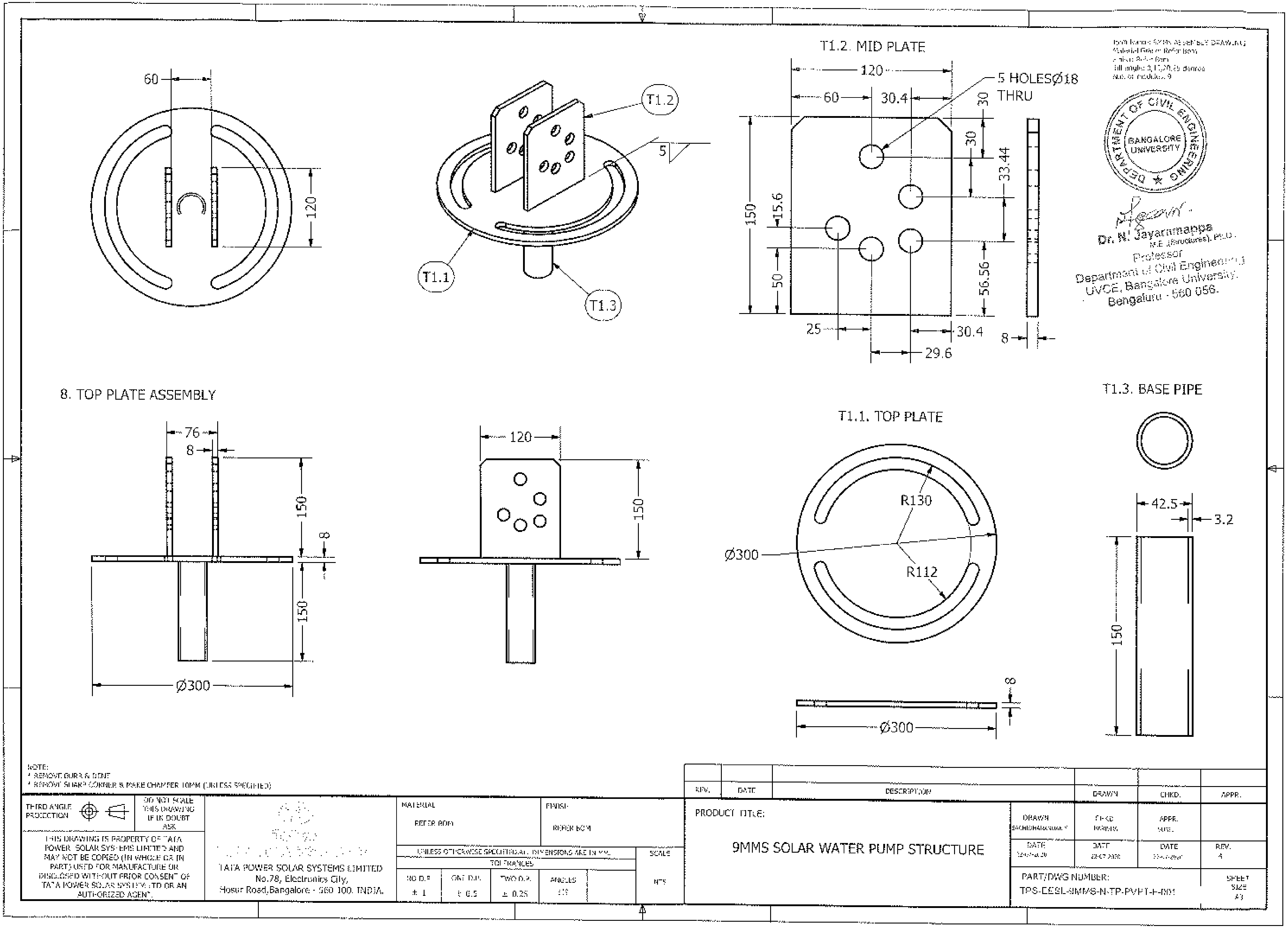
						PART/DWG NUMBER: TPS-EESL-9MMS-N-TP-PVP1-F-001			SHEET SIZE A3


8. TOP PLATE ASSEMBLY
T1.2. MID PLATE
5 HOLESØ18 THRU
T1.1. TOP PLATE
T1.3. BASE PIPE
T1.1
T1.2
T1.3
R130
R112
Ø300
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DEPARTMENT OF CIVIL ENGINEERING
Dr. N. Jayaramappa
Professor
Department of Civil Engineering
UVCE, Bangalore University,
Bengaluru - 560 056.
NOTE:
* REMOVE BURR & BENT
* REMOVE SHARP CORNER & MAKE CHAMFER 10MM (UNLESS SPECIFIED)
THIRD ANGLE PROJECTION
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TATA POWER SOLAR SYSTEMS LIMITED
No.78, Electronics City,
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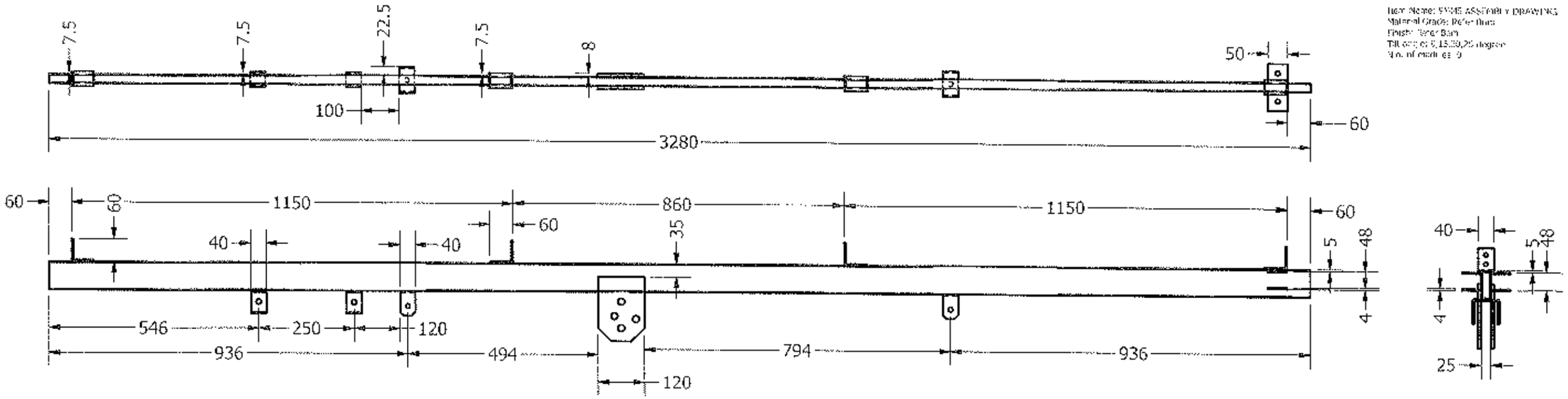
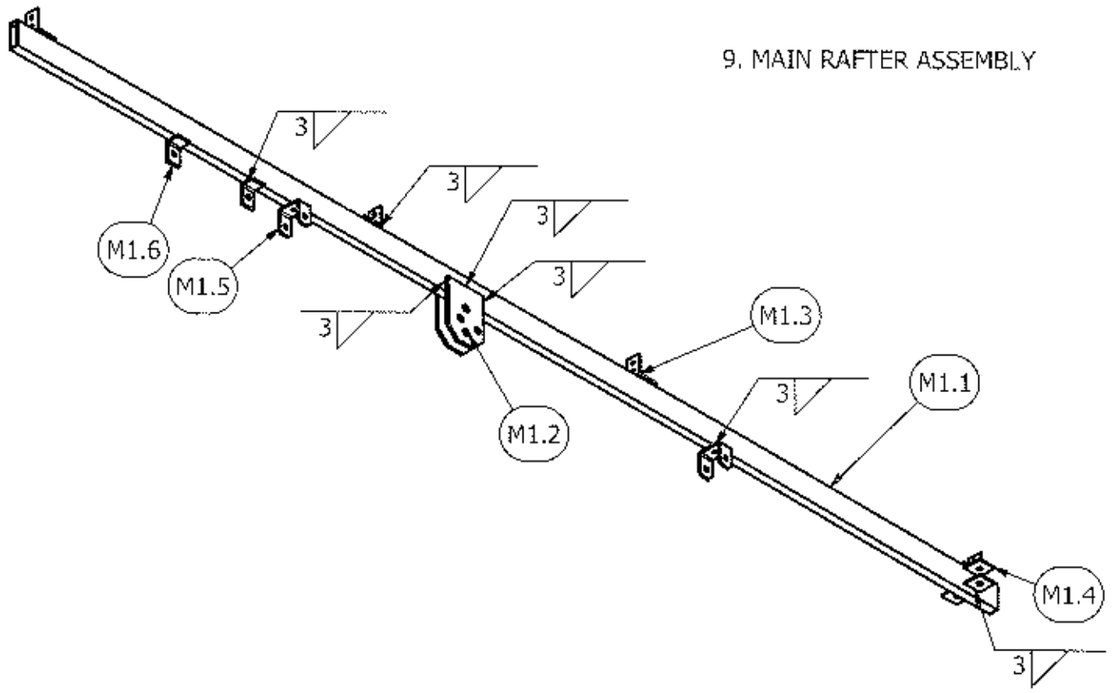
MATERIAL
REFER BOM
FINISH
REFER BOM
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN MM.
TOLERANCES
NO D.P ± 1
ONE D.P. ± 0.5
TWO D.P. ± 0.25
ANGLES
SCALE
NTS
REV.
DATE
DESCRIPTION
DRAWN
CHKD.
APPR.
PRODUCT TITLE:
9MMS SOLAR WATER PUMP STRUCTURE
PART/DWG NUMBER:
SHEET SIZE A3



9. MAIN RAFTER ASSEMBLY



DEPARTMENT OF CIVIL ENGINEERING BANGALORE UNIVERSITY

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REV.	DATE	DESCRIPTION	DRAWN	CHKD.	APPR.

THIRD ANGLE PROJECTION

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FINISH: REFER BOM

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TOLERANCES

NO D.P	ONE D.P.	TWO D.P.	ANGLES	SCALE
± 1	± 0.5	± 0.25	±1°	NTS

PRODUCT TITLE:

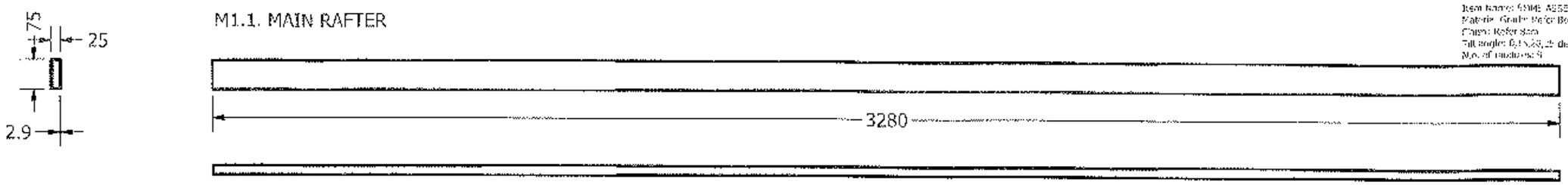
9MMS SOLAR WATER PUMP STRUCTURE

DRAWN	CHKD.	APPR.	
SADASIVAMURTHY S	HARISHA	SUNIL	
DATE 22-07-2020	DATE 22-07-2020	DATE 22-07-2020	REV. 4

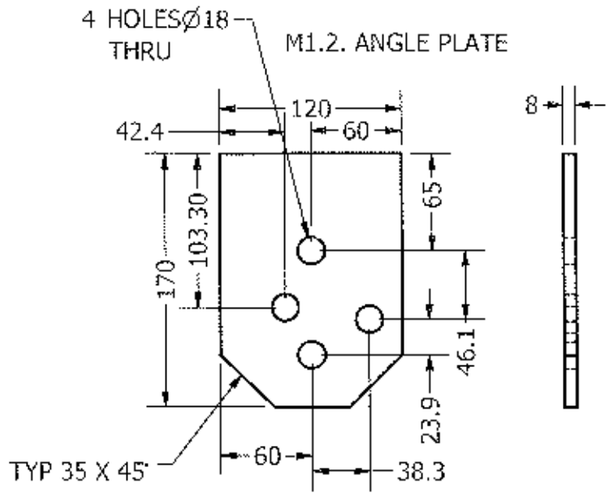
PART/DWG NUMBER: TPS-FESL-9MMS-N-TP-PVPT-F-001

SHEET SIZE A3

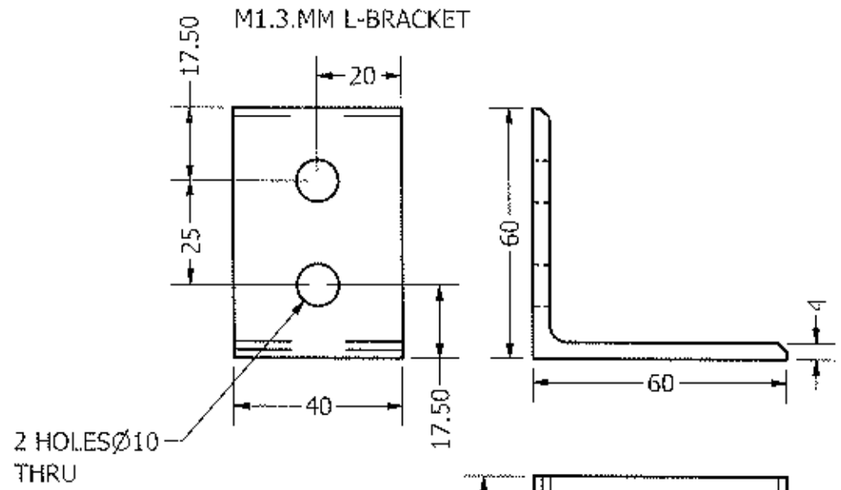
M1.1. MAIN RAFTER



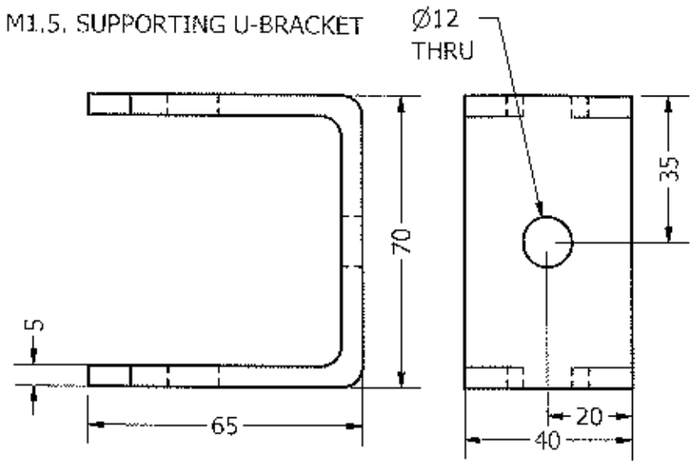
M1.2. ANGLE PLATE



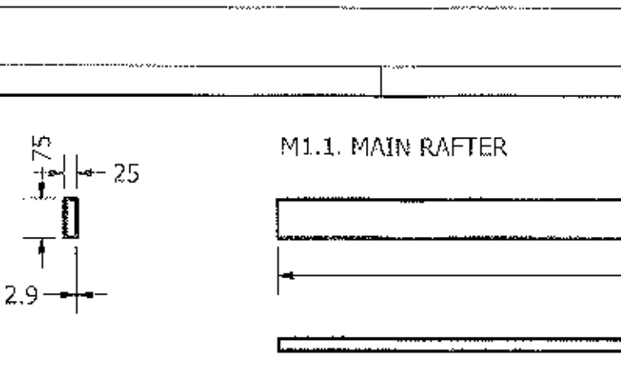
M1.3.MM L-BRACKET



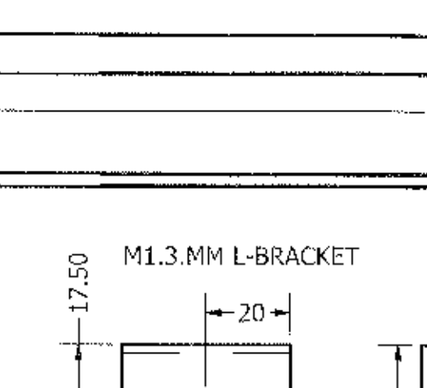
M1.5. SUPPORTING U-BRACKET

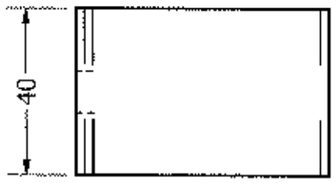


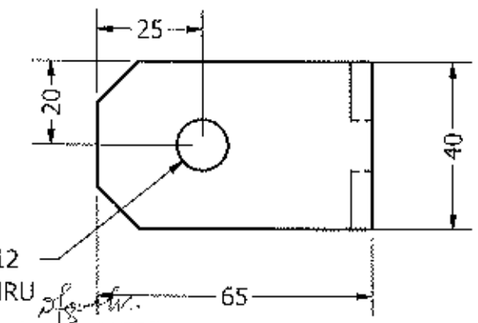
M1.6. L-CLEAT



M1.4.RAFTER CONNECTION PLATE







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REV.	DATE	DESCRIPTION	DRAWN	CHKD.	APPR.

THIRD ANGLE PROJECTION

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No.78, Electronics City,
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MATERIAL: REFER BOM
FINISH: REFER BOM

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TOLERANCES				
NO D.P.	ONE D.P.	TWO D.P.	ANGLES	SCALE
± 1	± 0.5	± 0.25	±1°	NTS

PRODUCT TITLE:
9MMS SOLAR WATER PUMP STRUCTURE

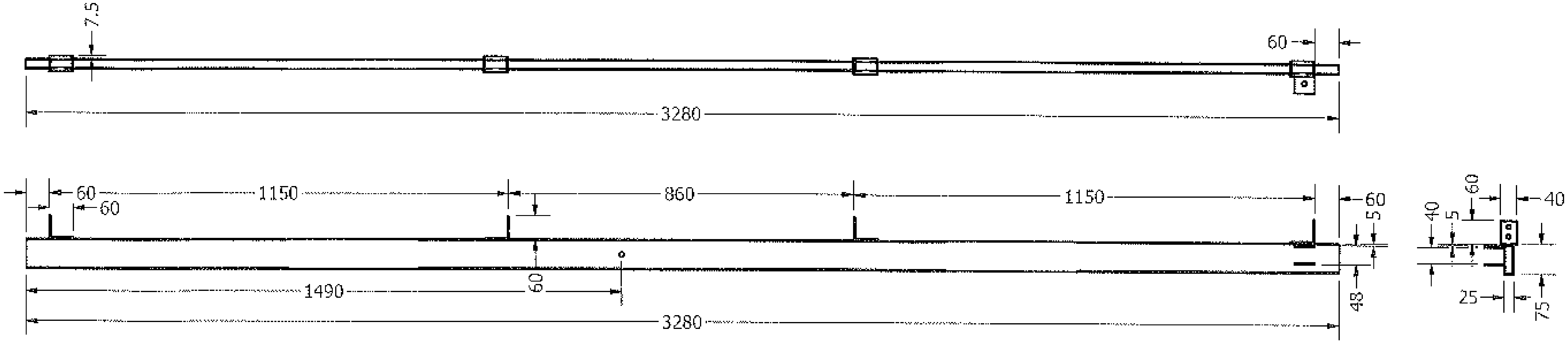
DRAWN	CHKD.	APPR.	
DATE 25-09-2020	DATE 29-09-2020	DATE 29-09-2020	REV. A

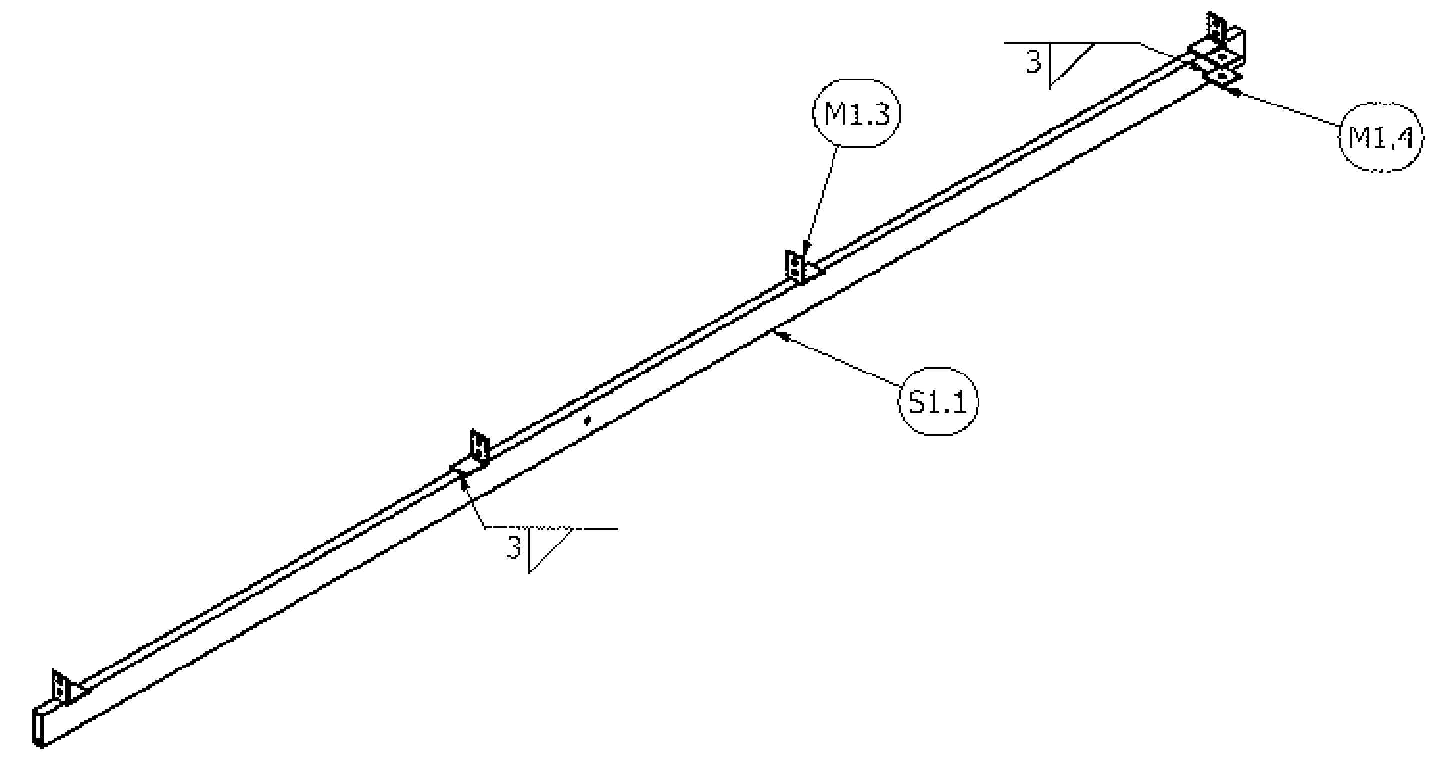
PART/DWG NUMBER: TPS-EESL-9MMS-N-TP-PVPT-F-001

SHEET SIZE A1

Item Name: 9MMS ASSEMBLY DRAWING
Material Grade: Refer Bom
Finish: Refer Bom
Tilt angle: 0,15,20,25 degree
No. of modules: 9

10.SECONDARY RAFTER ASSEMBLY





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REV.	DATE	DESCRIPTION	DRAWN	CHKD.	APPR.

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TOLERANCES				
NO D.P.	ONE D.P	TWO D.P	ANGLES	
= 1	± 0.5	± 0.25	[illegible]	

SCALE: NTS

PRODUCT TITLE:

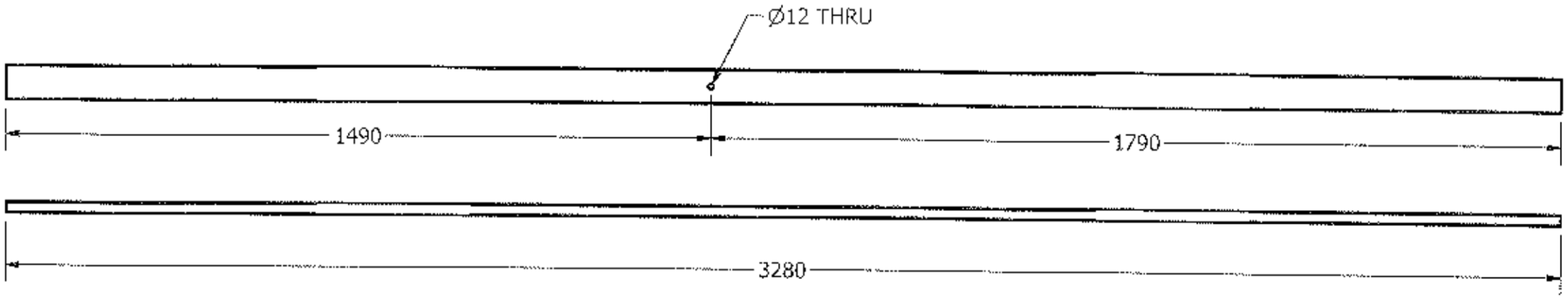
9MMS SOLAR WATER PUMP STRUCTURE

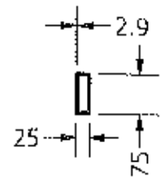
DRAWN	CHKD.	APPR.	
[illegible]	[illegible]	[illegible]	
DATE [illegible]	DATE [illegible]	DATE [illegible]	REV. 4

PART/DWG NUMBER:
TPS-EESL-9MMS-N-TP-PVPT-F-001

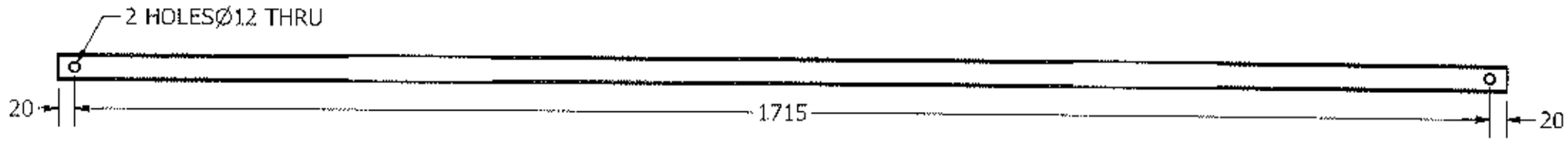
SHEET SIZE A3

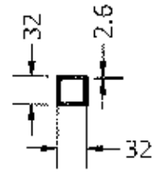
S1.1.SECONDARY RAFTER

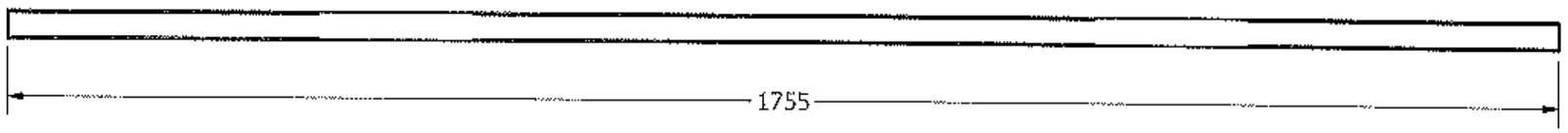




11.CROSS MEMBER







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REV.	DATE	DESCRIPTION	DRAWN	CHKD	APPD.

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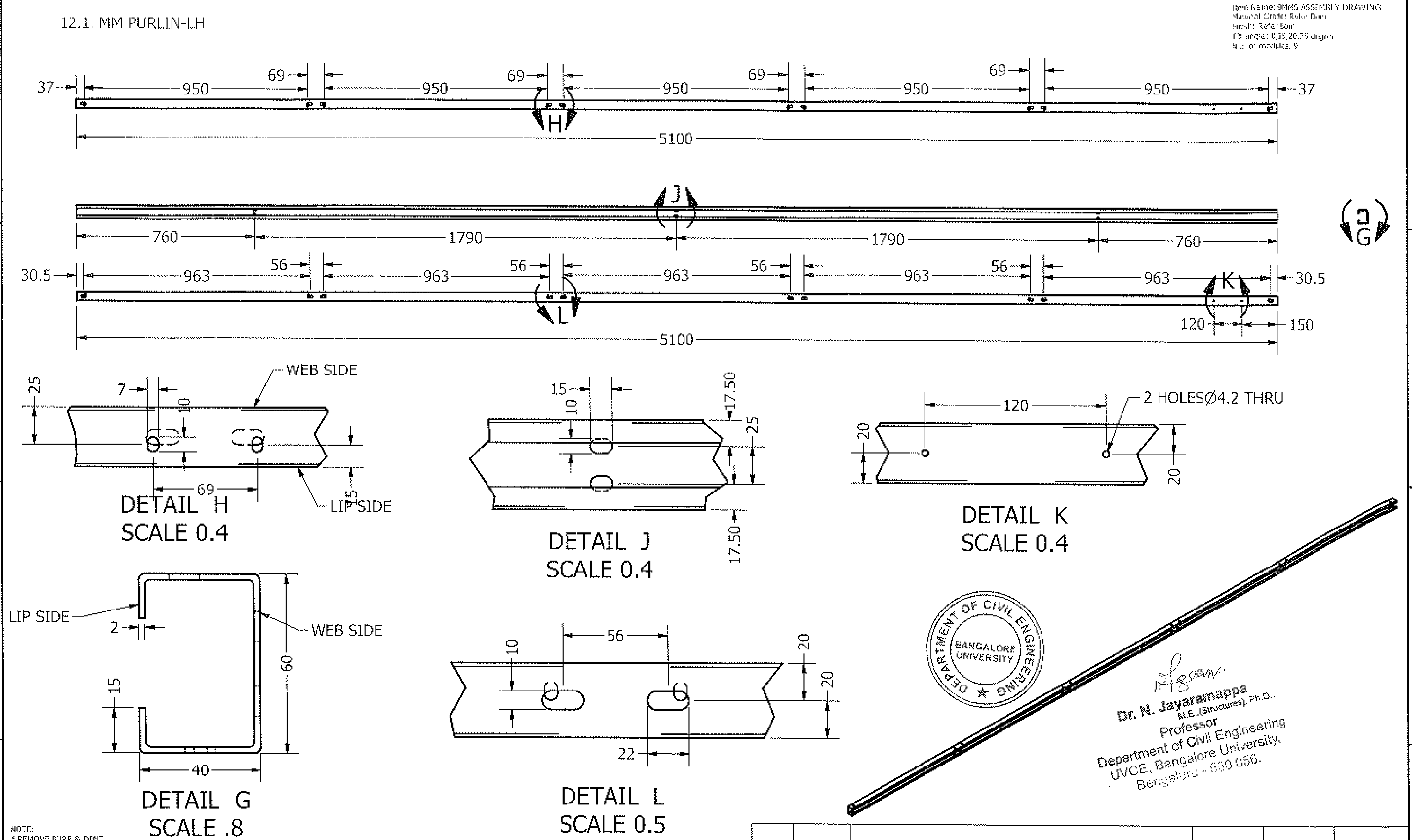
TOLERANCES: NO D.P. ± 1 | ONE D.P. ± 0.5 | TWO D.P ± 0.25 | ANGLES ±1°
SCALE: NTS

PRODUCT TITLE:
9MMS SOLAR WATER PUMP STRUCTURE

	DRAWN	CHKD.	APPR.
	[illegible]	[illegible]	[illegible]
DATE	DATE	DATE	REV.
22-07-2020	22-07-2020	22-07-2020	4

PART/DWG NUMBER: TPS-EESL-9MMS-N-TP-PVPT-F-001
SHEET SIZE: A3



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THIRD ANGLE PROJECTION	DO NOT SCALE THIS DRAWING IF IN DOUBT ASK		MATERIAL: REFER BOM			FINISH: REFER BOM		PRODUCT TITLE: 9MMS SOLAR WATER PUMP STRUCTURE
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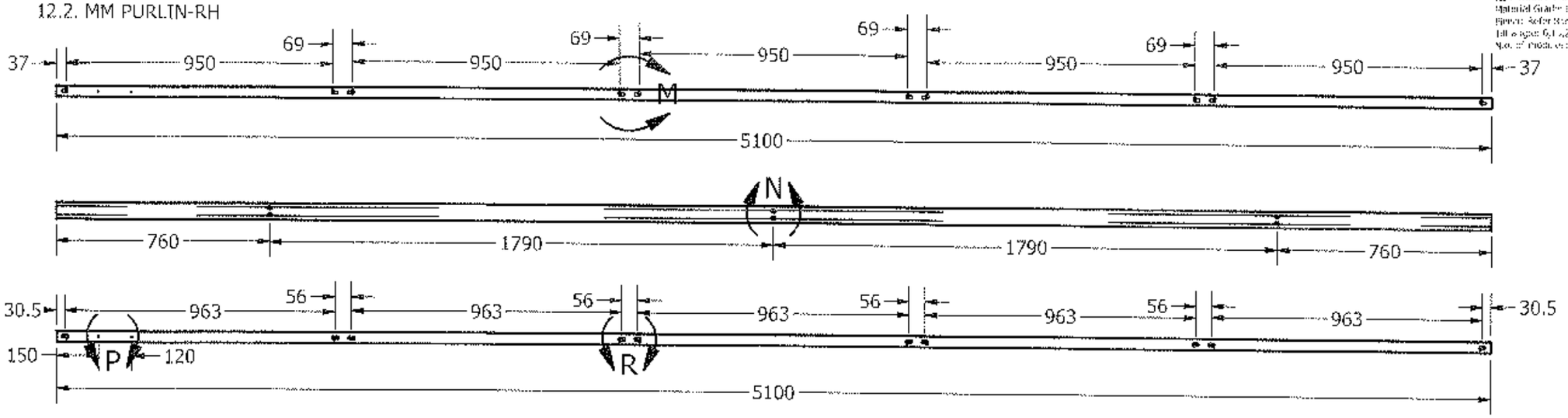
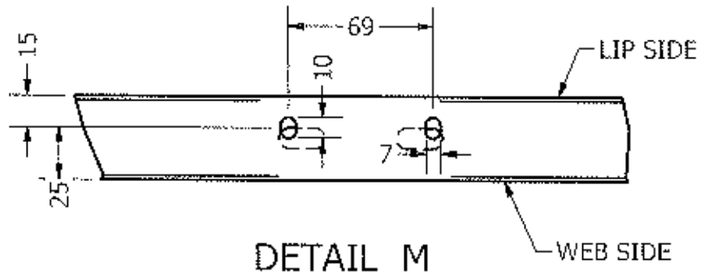
			NO D.P. ± 1	ONE D.P ± 0.5	TWO D.P ± 0.25	ANGLES ±0	NTS	

REV.	DATE	DESCRIPTION	DRAWN	CHKD	APPR.

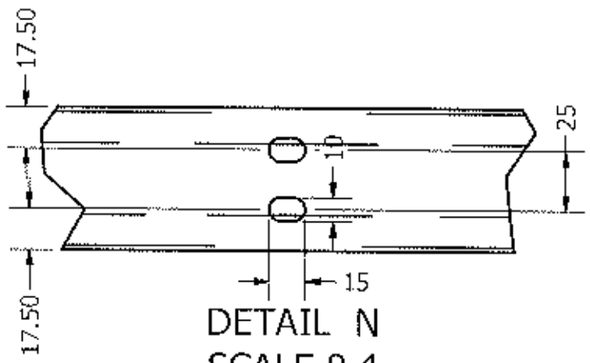
DRAWN	CHKD	APPD	
DATE	DATE	DATE	REV. 4
PART/DWG NUMBER: TPS-EESL-9MMS-N-TP-PVPT-F-001			SHEET SIZE A3

12.2. MM PURLIN-RH

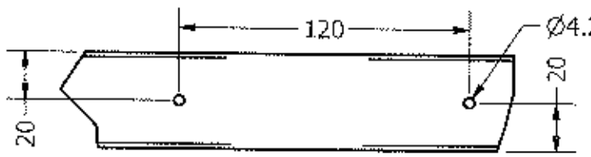




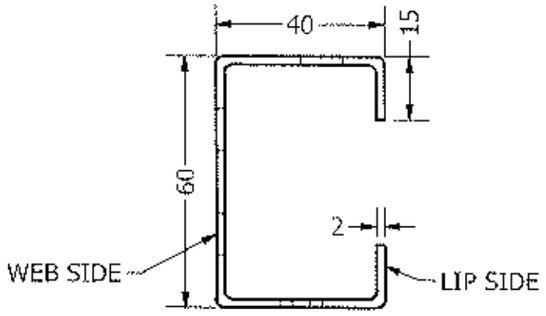
DETAIL M
SCALE 0.35



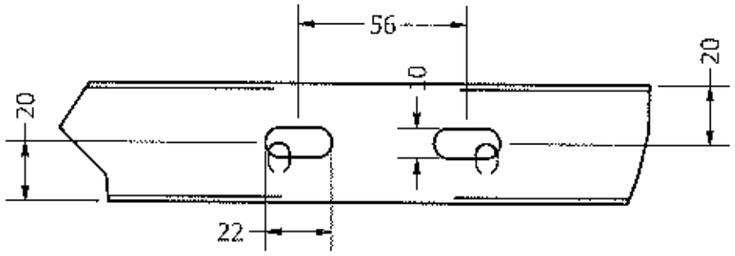
DETAIL N
SCALE 0.4



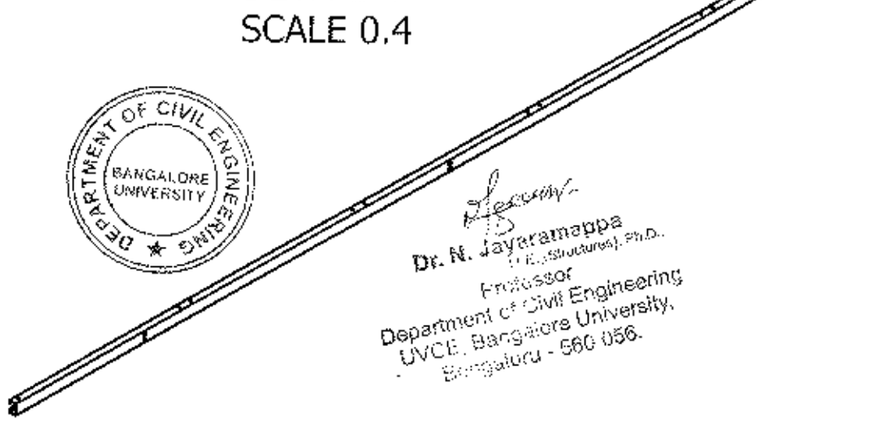
DETAIL P
SCALE 0.4



DETAIL L
SCALE .7



DETAIL R
SCALE 0.5



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REV.	DATE	DESCRIPTION	DRAWN	CHKD.	APPR.

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TOLERANCES				SCALE
NO D.P.	ONE D.P.	TWO D.P.	ANGLES	
± 1	± 0.5	± 0.25	±1°	NTS

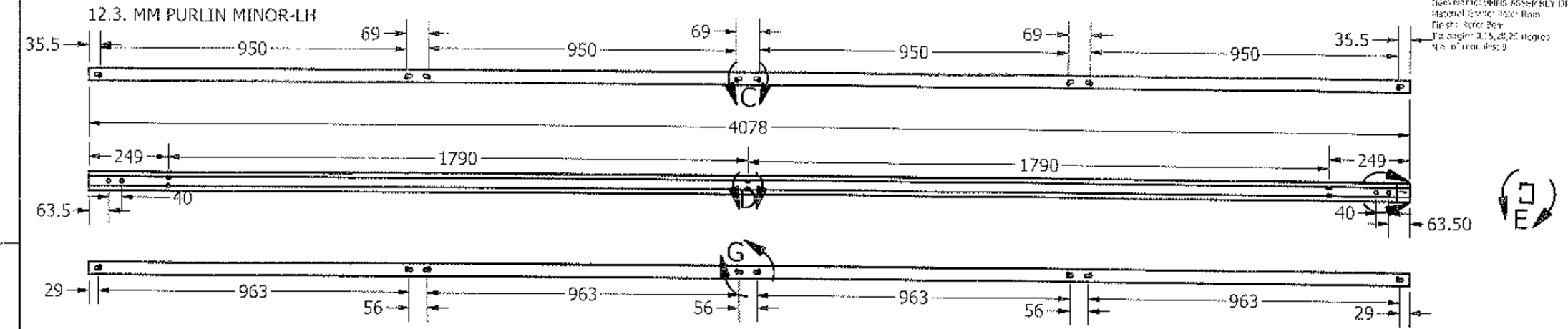
PRODUCT TITLE:
9MMS SOLAR WATER PUMP STRUCTURE

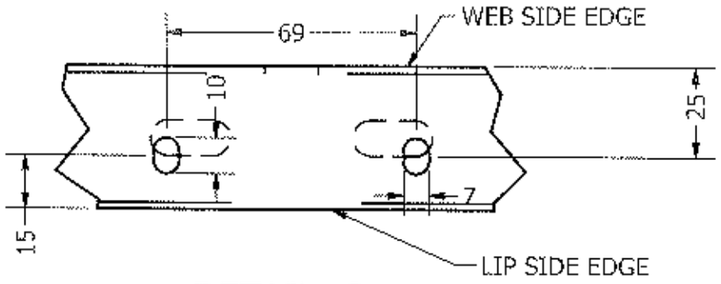
DRAWN	CHKD.	APPR.	
[illegible]	[illegible]	SUNIL	
DATE	DATE	DATE	REV.
22-07-2020	22-07-2020	22-07-2020	A

PART/DWG NUMBER: TPS-EESL-9MMS-N-TP-PVPT-F4001

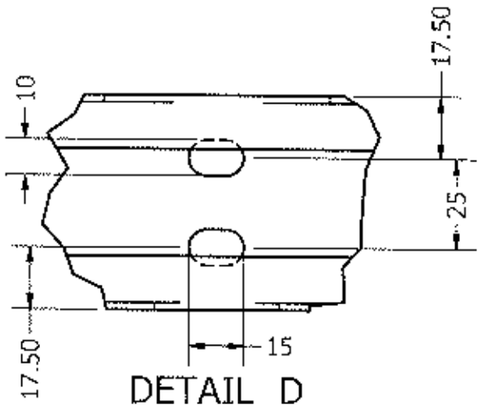
SHEET SIZE A3

12.3. MM PURLIN MINOR-LH

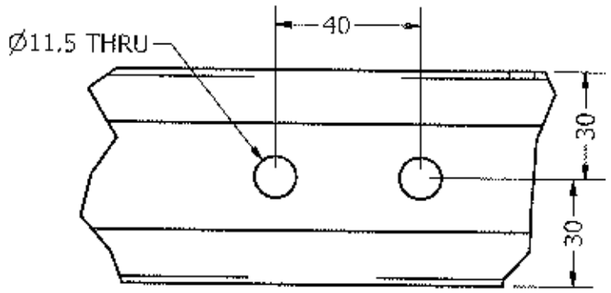




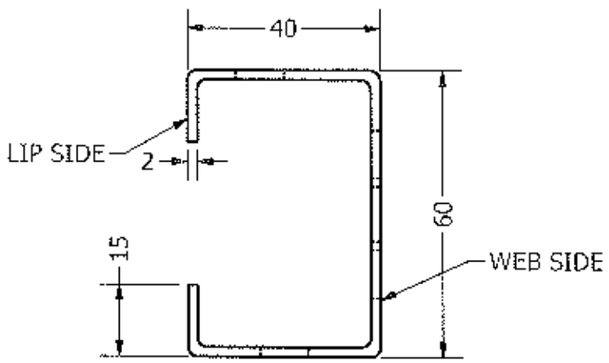
DETAIL C
SCALE 0.6 : 1



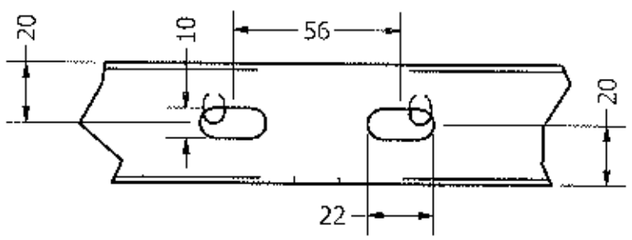
DETAIL D
SCALE 0.6 : 1



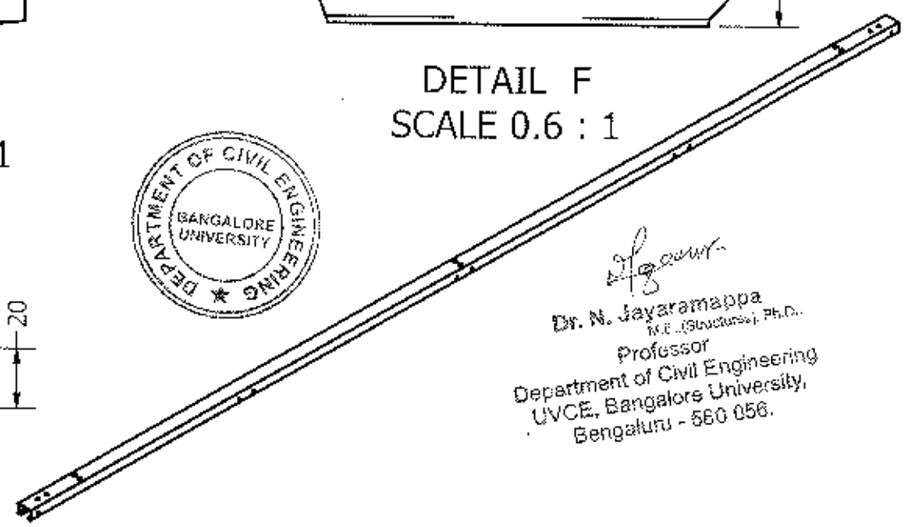
DETAIL F
SCALE 0.6 : 1



DETAIL E
SCALE 0.8 : 1



DETAIL G
SCALE .5



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REV.	DATE	DESCRIPTION	DRAWN	CHKD	APP'D

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TOLERANCES				SCALE
NO D.P.	ONE D.P.	TWO D.P.	ANGLES	
+ 1	± 0.5	+ 0.25	±1	NTS

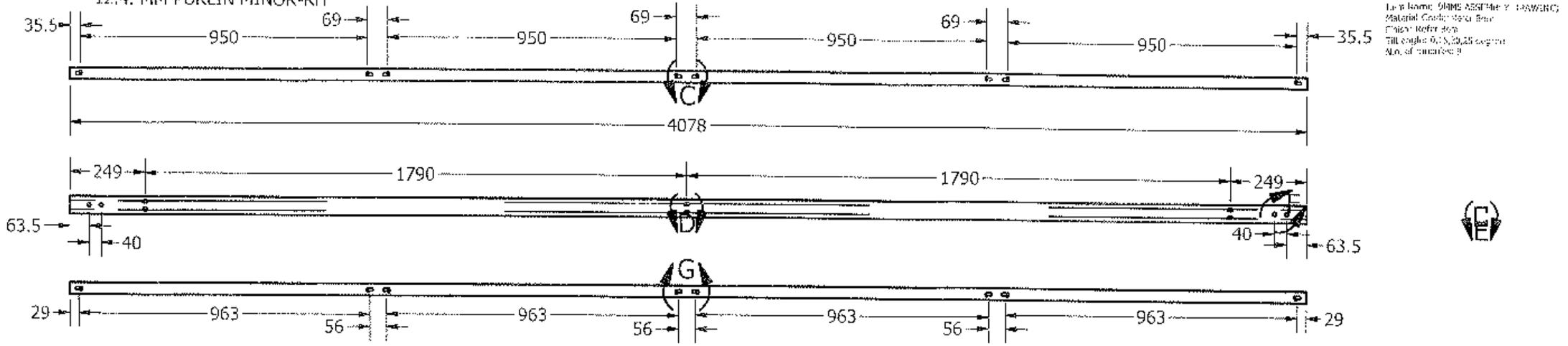
PRODUCT TITLE: 9MMS SOLAR WATER PUMP STRUCTURE

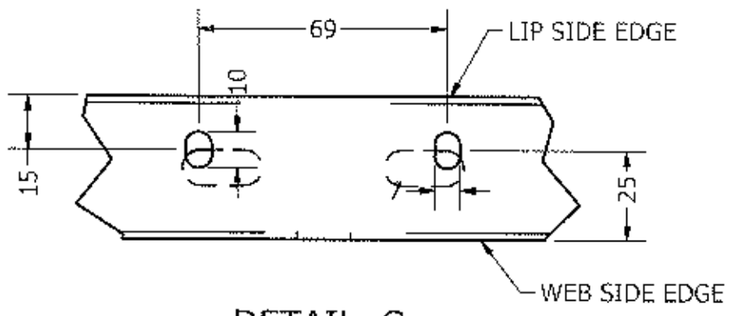
DRAWN	CHKD.	APPR	
DATE 22-07-2020	DATE 22-07-2020	DATE	REV. 1

PART/DWG NUMBER: TPS-EESL-9MMS-N-TP-PVPT-F-001

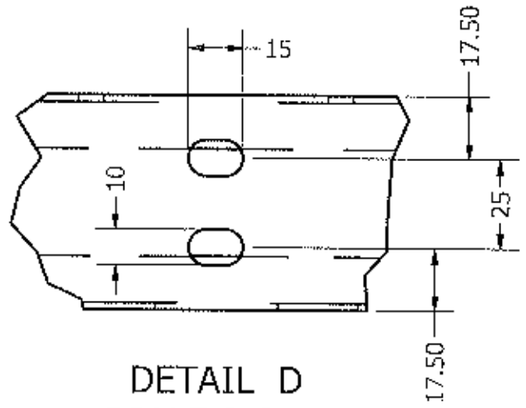
SHEET SIZE A1

12.4. MM PURLIN MINOR-RH

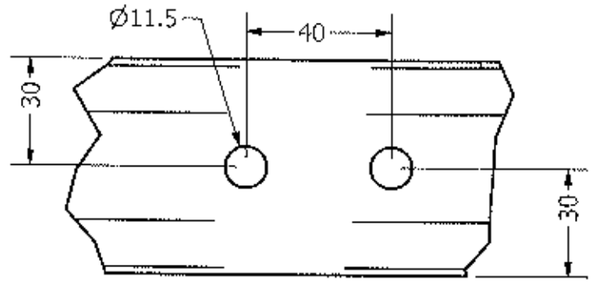




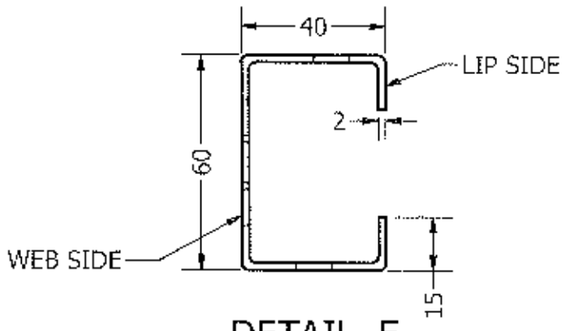
DETAIL C
SCALE 0.6 : 1



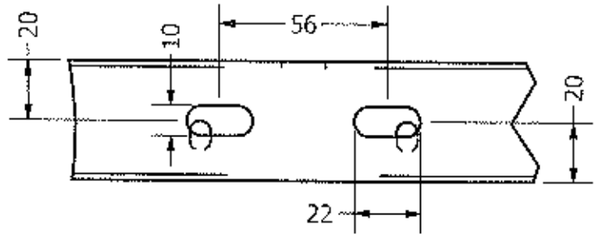
DETAIL D
SCALE 0.6 : 1



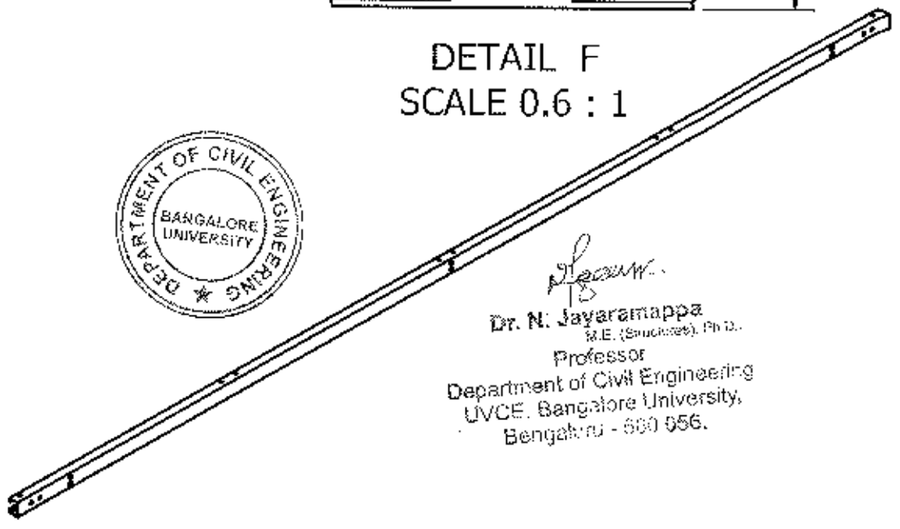
DETAIL F
SCALE 0.6 : 1



DETAIL E
SCALE 0.6 : 1



DETAIL G
SCALE .5



DEPARTMENT OF CIVIL ENGINEERING
BANGALORE UNIVERSITY

Dr. N. Jayaramappa
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Bengaluru - 560 056.

NOTE:
* REMOVE BURR & DENT
* REMOVE SHARP CORNER & MAKE CHAMFER 1MM (UNLESS SPECIFIED)

REV.	DATE	DESCRIPTION	DRAWN	CHKD.	APPR.

"THIRD ANGLE PROJECTION" | DO NOT SCALE THIS DRAWING IF IN DOUBT ASK

TATA POWER SOLAR SYSTEMS LIMITED
No.78, Electronics City,
Hosur Road,Bangalore - 560 100. (INDIA.

MATERIAL: REFER BOM | FINISH: REFER BOM

UNLESS OTHERWISE SPECIFIED,ALL DIMENSIONS ARE IN MM. | SCALE: NTS

TOLERANCES

NO D.P.	ONE D.P.	TWO D.P.	ANGLES	
± 1	± 0.5	± 0.25	±1°	

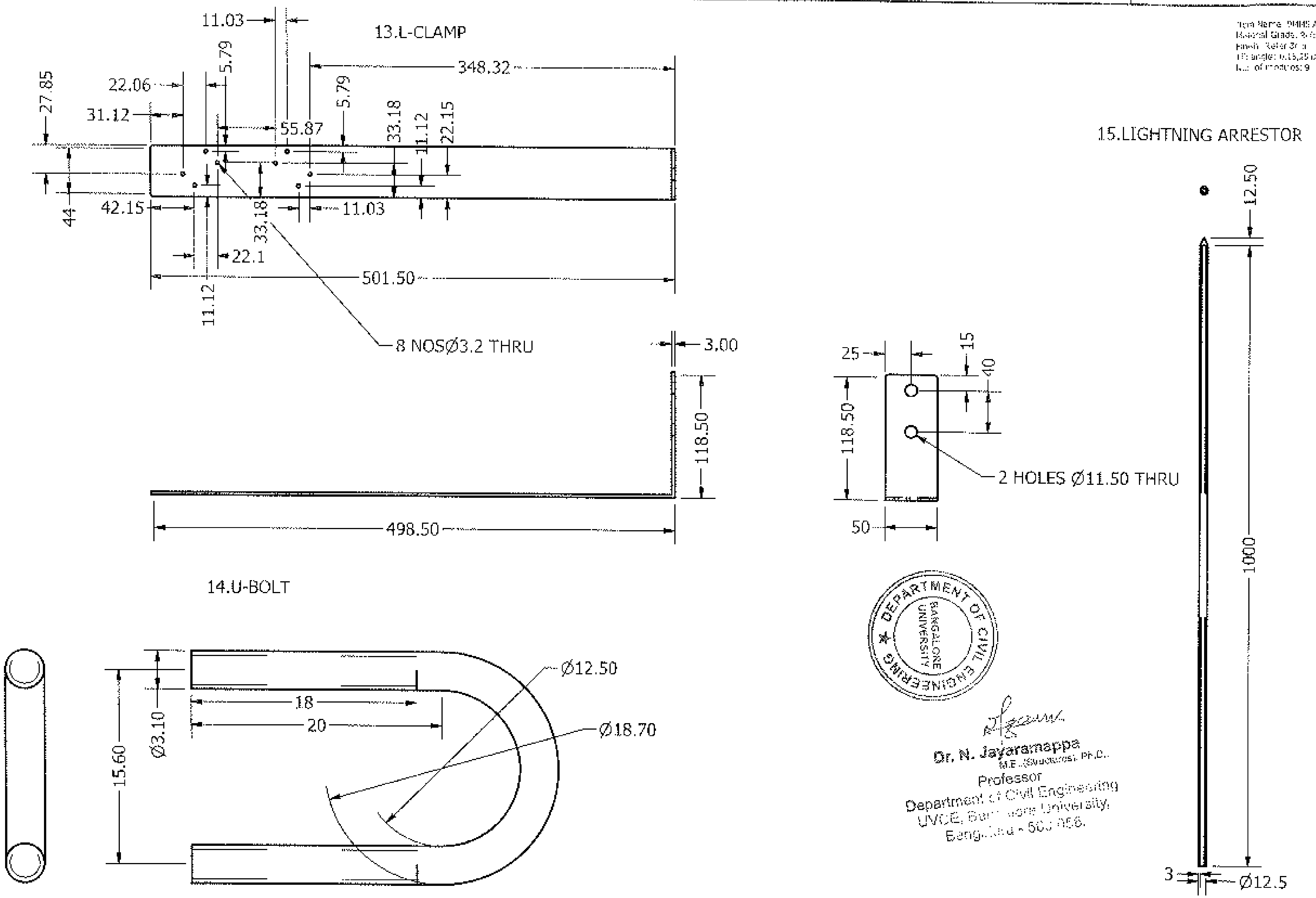
PRODUCT TITLE: 9MMS SOLAR WATER PUMP STRUCTURE

DRAWN	CHKD.	APPR.	
DATE 22-07-2020	DATE 22-07-2020	DATE 22-07-2020	REV. 4

PART/DWG NUMBER: TPS-EESL-9MMS-N-TP-PVP1-F-001

SHEET SIZE A3

Item Name: 9MMS ASSEMBLY DRAWING
Material Grade: Refer Bom
Finish: Refer Bom
Tilt angle: 0,15,25 Degree
No. of modules: 9



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REV.	DATE	DESCRIPTION	DRAWN	CHKD.	APPR.

THIRD ANGLE PROJECTION	DO NOT SCALE THIS DRAWING IF IN DOUBT ASK	TATA POWER SOLAR SYSTEMS LIMITED No.78, Electronics City, Hosur Road,Bangalore - 560 100, INDIA.	MATERIAL: REFER BOM	FINISH: REFER BOM	PRODUCT TITLE: 9MMS SOLAR WATER PUMP STRUCTURE

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TOLERANCES				SCALE
NO D.P	ONE D.P.	TWO D.P.	ANGLES	NTS
± 1	± 0.5	± 0.25	±3	

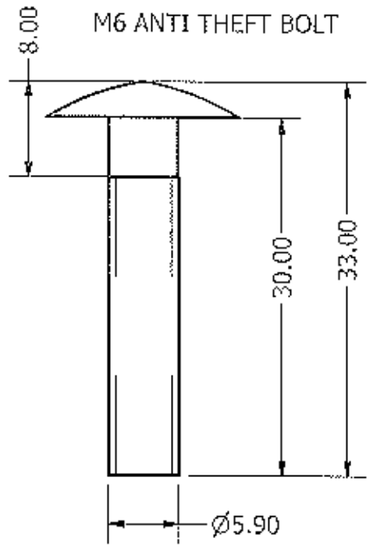
DRAWN	CHKD.	APPR.	
[illegible]	[illegible]	[illegible]	
DATE 21-07-2020	DATE [illegible]	DATE 21-07-2020	REV. 4

PART/DWG NUMBER:
TPS-EESL-9MMS-N-TP-PVPT-F-001

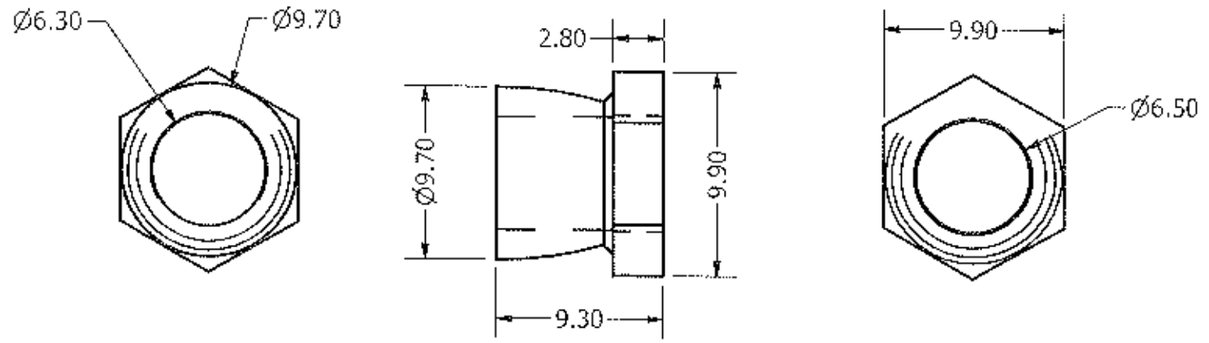
SHEET SIZE A3

M6 ANTI THEFT BOLT, NUT AND WASHER MINIMUM DIMENSIONS FOR
9MMS & 10MMS EESL STRUCTURES

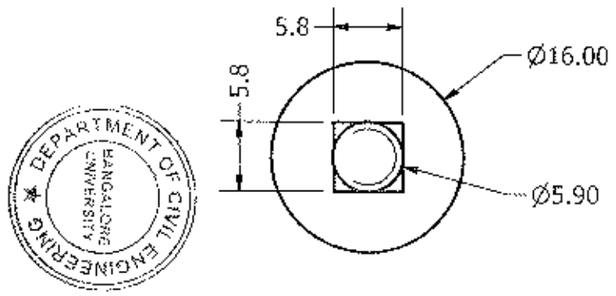
M6 ANTI THEFT BOLT

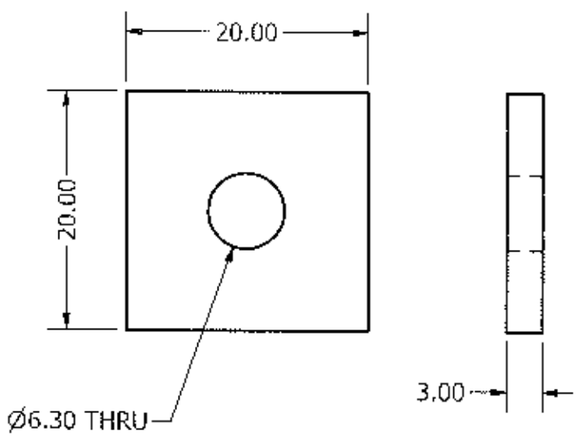


M6 ANTI THEFT NUT

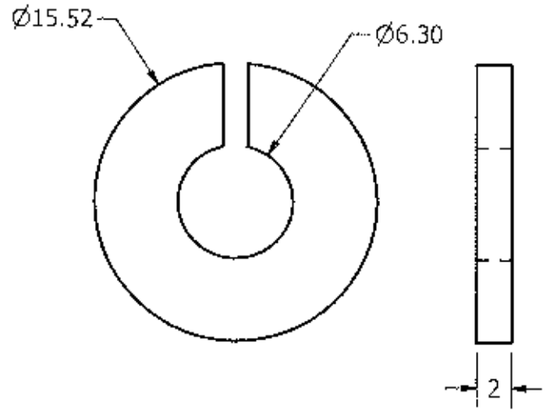


WASHER





SPRING WASHER



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REV.	DATE	DESCRIPTION	DRAWN	CHKD.	APPR.

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TOLERANCES				
NO D.P.	ONE D.P.	TWO D.P.	ANGLES	SCALE
± 1	± 0.5	± 0.25	±1°	NTS

PRODUCT TITLE:

M6 ANTITHEFT BOLT FOR 9MMS & 10MMS EESL PROJECT

DRAWN	CHKD.	APPR.	
DATE	DATE	DATE	REV.
			4

PART/DWG NUMBER: TPS-EESL-9MMS-N-TP-PVPT-F-001 | SHEET SIZE A3