

# ANNEXURE TO TENDER NO. DPS/MRPU/1/1/4439

## SECTION-C

**Technical specification for supply, installation and commissioning of 1.73 Plus MWp grid connected (without battery bank) solar power plant at IGCAR, Kalpakkam.**

### 1.0 SCOPE OF SUPPLY / WORK

- 1.1 The scope of work covers the design, manufacture, testing at manufacturer's works, packing, transportation by road, supply, safe delivery at site, unloading, handling and storage at site, complete installation, testing, integration, commissioning and training of 1.73 plus MWp Grid Connected Solar Photo Voltaic Power Plant (GCSPVPP) complying to the detailed specifications in this document.
- 1.2 The GCSPVPP shall function without battery back-up. The power plant shall export power generated at low voltage level. The inverter shall be designed to convert DC power produced by SPV modules into AC power and automatically synchronize with the grid and which shall work on maximum peak power tracking (MPPT) technology to get maximum power output from the solar PV modules.
- 1.3 The scheme drawing for the GCSPVPP is shown in Fig.1.
- 1.4 Supplied solar panels shall be installed on existing steel structures erected in vehicle parking area for four and two wheeler vehicles.
- 1.5 The plan and side view of the structures for four wheeler parking and two wheeler parking on which solar PV modules are to be installed are attached with this specification. Structure required for mounting the solar PV modules are already installed at site. Required GI fasteners are to be provided by the supplier. In case of any minor modification involving cutting or drilling or adding small GI plates to the existing structure, it shall be carried out by edge finishing and cold galvanising spray by the supplier at free of cost as directed by the dept engineer.
- 1.6 The bidders are requested to visit the site and get aquatinted with the site conditions
- 1.7 **A separate work order for annual maintenance contract will be placed after successful commissioning of the grid connected Solar Photo Voltaic power plant (GCSPVPP). Details about annual maintenance are given in Clauses 27.0 and 28.0.**
- 1.8 PROJECT DATA  
The Project is located at IGCAR, Kalpakkam, and Tamil Nadu. The Contractor may note the severe condition existing in the region with co-incident humidity, salt laden atmosphere and high temperature.
  - a. Location : IGCAR, Kalpakkam
  - b. Ambient Air Temperature : 50°C.
  - c. Installation location : Outdoor
  - d. Power supplies at the Site : 415V, 3 Phase, 4 wire, 50 Hz solidly grounded.

### 2.0 HANDLING AND TRANSPORT FACILITIES AT SITE:

The bidder shall be responsible for handling and transport of all parts of equipment and material (unless otherwise specified) covered in this contract. The contractor shall make their own arrangements for unloading and transporting materials from Stores at IGCAR / various locations of IGCAR to worksite as and when required and specified in subsequent Sections. The Contractor shall make necessary arrangement for loading and unloading of materials covered in this Contract at his own cost.

### **3.0 TIME SCHEDULE**

- 3.1 Project has to be completed within **8 months** from the date of receipt of order.
- 3.2 The supplier shall plan the various activities to ensure the strict adherence to the time schedule and as per the priorities to be decided by the Department.

### **4.0 EVALUATION CRITERIA FOR TECHNICAL BID**

- 4.1 The bidders shall meet all the following criteria.
- a) Should be a manufacturer of mono perk solar modules in India. However for Indian Government PSUs which are involved in manufacturing of solar PV cell / module activities are exempted from this condition.
  - b) The firm must have designed, manufactured, tested, supplied, erected, commissioned at least 3 grid connected solar PV power plant (off grid / grid connected) of minimum plant capacity of 1.7 MWp which are in successful operation on the date of bid opening. Document proof for the same shall be attached with the bid.
  - c) The firm must produce performance certificate from end user of a solar plant of minimum 1.7MWp capacity installed by the bidder, with one year performance ratio > 75%. Supporting inverter & solar radiation data-log with time stamp to be provided along with performance certificate.
  - d) The proposed solar PV power plant shall have Estimated Performance Ratio (with temperature correction) >75%. Detailed calculation for peak power produced by the solar PV plant at standard test conditions as specified in IEC shall be furnished along with the offer.
  - e) Test certificate from IEC / NABL / BIS accredited lab for the solar PV module similar to the PV module proposed for this project shall be submitted.
  - f) Guaranteed Technical Particulars as per the format in Section D and the full technical particulars of the products offered shall be submitted. Offers received without this will not be considered for evaluation.
  - g) The system design, products, installation, testing & commissioning shall fully comply with this specification and to meet the site conditions. The bidders are requested to visit the site & get aquatinted with the site conditions.
- 4.2 Bidders shall furnish documentary proof for the eligibility criteria specified above without which the offer will not be considered for further processing. Technical suitability of the offer will be evaluated based on the documents furnished by the bidder. **All technical and commercial details / test reports / supporting documents shall be furnished along with the bid itself. Offers will be evaluated based on the details provided along with the offer only and NO CORRSPONEDICE will be made seeking documents/clarification after bid opening. If the details provided are insufficient, the offer will be summarily rejected.**

4.3 **Bidders shall give compliance to each clause in this specification with supporting documents (if applicable).**

## **5.0 EVALUATION CRITERIA FOR FINANCIAL BID**

- a) Offers meeting the technical and commercial terms & conditions of the entire specification will only be considered for financial evaluation.
- b) Cost for maintenance of the system for Ten years shall be quoted along with offer. Offers received without this will not be considered for evaluation.

To arrive at the lowest bid overall basic cost quoted by each qualified bidder will be compared. Overall basic cost comprises of basic supply cost of solar PV power plant, installation, commissioning and 10 year AMC charges.

## **6.0 FACILITY TO BE PROVIDED BY THE PURCHASER**

- 6.1 3 Phase, 415 Volts, 50 Hz temporary service connection power Supply and Water Supply will be provided by the Department free of cost for installation, testing & commissioning at site. The supplier shall however make his own arrangements for receiving and distribution of the power/water supply.
- 6.2 The Department will make available the GI structures for installation of solar PV grid connected power plant. **The drawing of GI structure is attached** with this specification.
- 6.3 Department will earth the GI structures at two different points, the supplier shall make earth looping of all equipment like ACDB, inverter cabinets, data concentrator, cable tray, solar panels & any other devices or systems and connect to the earth points provided at structure earthing point.
- 6.4 The LT power cables required for evacuation of power from ACDB to the nearest power source will be provided & laid by the purchaser. Further distribution & termination of power, earthing & communication cables within the GCSPVPP shall be done by the supplier.
- 6.5 Storage space (Open) as required for storing of SPV Module shall be provided by department for a period of maximum one month or till the completion of Installation & Commissioning whichever is earlier.

## **7.0 GUARANTEED PERFORMANCE RATIO (PR)**

- 7.1 Contractor shall guarantee the Performance Ratio (PR) of the proposed plant as 75% (minimum). PR shall be calculated as specified in Clause 20.

## **8.0 PACKING, DELIVERY, UNLOADING AND STORING**

- 8.1 Supplier shall prepare all the items & equipment covered by this specification for transport in such a manner as to protect it from damage in transit & ingress of water/moisture and shall be responsible for and make good at his own expense any and all damage due to improper packing. The contents shall be identified on the package. The packing shall be marked with lifting & hook-up points for unloading.
- 8.2 The Supplier shall make his own arrangements for the transportation and unloading at site, safe storage & transportation to the work spot including lifting up to the top level of the GI structure level by suitable means. The Supplier shall also make his own arrangements for all the tools & equipment required for satisfactory completion of work.

**9.0 CAPACITY OF GCSPVPP & EFFECTIVE AREA AVAILABLE**

- 9.1 Solar PV modules shall be installed on 30 supporting structures which are designated to be used for parking of two wheeler and four wheeler vehicles and solar PV modules mounted on the structure will serve the purpose of shade to vehicles parked. NINE(9) structures were designated to be used for four wheeler parking and remaining TWENTY ONE (21) structures were to be used for two wheeler parking. Refer Fig.2 for structural details of four wheeler parking and Fig.3 for structural details of two wheeler parking.
- 9.2 Solar PV modules with minimum capacity of 380Wp shall be mounted on structure covering entire effective area. Minimum number of modules as mentioned in the specification shall be provided. The entire available area shall be covered. Additional Excessive gap between modules with an intention to reduce the total number of modules is not permitted. Gap between the panels shall be between 20 to 30 mm.
- 9.3 Details of structures are as below

The width (North – South direction) of supporting structure is 10m leaving the central portion of 0.29m which is provided to access to the top of the structure.

**Four wheeler parking bays**

Dimensions of the parking bays are as below

Parking Bay No.	Dimension	Effective Area of each bay	Minimum number of panels / bay.	Remark
No.1 to 8	56m x 10 m	560 sq.m	280 No.	Allowed projection - East & West end of the structure is 0.25m each
No9	32m X 10 m	320 sq.m	160 No.	

Scope of work includes setting up of solar PV plant for 9 SETs of four wheeler parking covering entire effective area of 4800sq.m. This shall have minimum peak generating capacity of 912 kW.

**Two wheeler parking bays**

Parking Bay No.	Dimension	Effective Area of each bay	Minimum number of panels / bay.	Remark
No.1 to 18	34m x 6 m	204 sq.m	102 No.	Allowed projection - East & West end of the structure is 0.25m each
No. 19 to 21	36m x 6 m	216 sq.m	108 No.	

Scope of work includes setting up of solar PV plant for 21 SETs of two wheeler parking covering entire effective area of 4320sq.m. This shall have minimum peak generating capacity of 820.8 kW.

- 9.4 Any uncovered area in the supporting structure where a single PV module cannot be placed shall be covered with dummy GI panels resembling PV panels, so that the entire parking area is covered.

## 10.0 MAJOR BILL OF MATERIALS & SERVICES

The schedule given below only lists the major bill of materials and services for GCSPVPP. Supply of all the material required for the satisfactory completion of the system as per the detailed specification is in the scope of the Supplier.

Sl. No.	Brief Description	Qty/Units
1	Solar Photo Voltaic (SPV) modules with PV module mounting accessories	4560 No.
<b>Note:</b> 1. Drilling in GI structure to be avoided to the extent possible; if there is any requirement for drilling, the drilling shall be carried out by the supplier & after that cold galvanizing spray shall be applied as directed by the Engineer-in-Charge. 2. If any additional structural members are required for installation of PV modules other than the GI structure provided by the Purchaser, the same shall be provided by the Supplier which shall be made of hot dip galvanized MS.		
2	Grid interactive MPPT inverter / Power Control Unit (PCU) with plant data Logger, remote monitoring software required for remote monitoring of performance of solar plant as per specification	60Nos.
3	Pyranometer, temperature sensors	1 Sets (Minimum)
4	Array Junction Boxes with fuses & SPD	30 Set
5	AC DB as per Specifications with input & output switchgear, SPD & Energy meter	30 No.
6	LT power cables Note1: Power cables between Solar PV modules, Array JBs, MPPT inverters, ACDB shall be provided by the Supplier.	30 Lot. As required at site
7	Lightning protection system consisting of IEC tested vertical air terminals as per Specification. Connecting vertical air terminals with down conductors of size 95 sq.mm tinned stranded copper conductor to Earth point provided at GI structure earthing point	30 set
8	Electrical drawings and installations & O&M manuals	3Set
9	1.5hp jet pumps for cleaning the solar PV panels	1 Nos.
10	GI structure and sheet for mounting ACDB, Inverter, datalogger	30 Sets

## 11.0 SOLAR PHOTOVOLTAIC MODULES

11.1 The solar PV module shall be of Mono PERC crystalline silicon type and must be qualified as per below standards (documentary proofs to be submitted)

- i. IEC 61215
- ii. IEC 61730 Part I
- iii. IEC 61730 Part II
- iv. IEC 61701 for salt mist corrosion

11.2 Solar PV modules shall qualify with BIS / IEC certification.

11.3 Solar PV modules shall qualify to the requirements of Application class Class A for PV-modules as defined in IEC 61730. Shall be suitable for solar plant cum parking application, where general contact access is anticipated. Modules shall be qualified for safety through IEC 61730 and IEC 61730-2 and within this application class and

shall meet the requirements for safety class II. (Application Class: Class A, Protection/safety Class II)

- 11.4 Fill factor of Solar PV modules shall be > 75%
- 11.5 The minimum peak capacity of each Mono PERC crystalline solar PV module shall be 380 Wp and bidder can choose the higher wattage panels as well.
- 11.6 Minimum efficiency of each solar PV module shall be 18% at standard test conditions as per IEC / BIS
- 11.7 The PV module shall perform satisfactorily in humidity up to 95% RH with temperature between -10°C to + 85°C.
- 11.8 The predicted electrical degradation at the end of the period of 10 years shall be less than 10 per cent of the full rated original output.
- 11.9 Raw materials and technology employed in the module production processes shall have to be certified and a certificate giving details of major materials i.e. solar cell, Glass, back sheet, their makes and data sheets to be submitted for the modules being supplied by the bidder along with the offer.
- 11.10 The rated peak power of any PV module shall have a maximum positive tolerance of +3% and zero negative tolerance with reference to the declared value of peak power produced per PV module. The voltage & current corresponding to the peak-power point of any PV module shall not vary more than 3% from the respective arithmetic means for all modules in a string.
- 11.11 The module frame shall be made of anodized aluminium of minimum size 40mm with anodization thickness of  $18 \pm 3$  microns or shall be made of a corrosion and UV resistant material which shall be electrolytically compatible with the structural material used for mounting the modules.
- 11.12 Each PV module shall be provided with an IP67/68 rated terminal box with a bypass diode. In case the terminal box is damaged within 10 years due to inherent material defects, that PV module must be replaced. Onsite repair of terminal box is not permitted as it violates the wet leakage test conditions of the module.
- 11.13 Weatherproof MC4 connector and a lead cable shall be provided as part of the PV module for making connections easier and secure.
- 11.14 Each PV module shall be provided with RFID. The following information must be mentioned for each PV module:
  - i. Name of the manufacturer of PV module
  - ii. Name and manufacturer of the solar cell
  - iii. Month and year of manufacture;
  - iv. I-V curve,
  - v. Wattage,
  - vi.  $I_m$  &  $V_m$  for the module;
  - vii. Unique serial number
  - viii. Model number
  - ix. Date of obtaining IEC PV module qualification certificate
- 11.15 Each solar PV module must have 10 year product guarantee (replacement guarantee against material & performance defect).
- 11.16 In order to guarantee minimum generation loss due to increase in module temperature, the temperature coefficient of power should not be more than -0.4 %/°C and the temperature coefficient of open circuit voltage ( $V_{oc}$ ) should not be more than -0.3 %/°C.

11.17 Solar panel mounting clamp shall be fabricated / modified based on site condition.

## **12.0 GRID INTERACTIVE MPPT INVERTER / POWER CONTROL UNIT (PCU)**

12.1 The grid interactive MPPT string inverter / power control unit (PCU) must be qualified as per below standards (documentary proofs to be submitted)

- i. IEC 62109-1
- ii. IEC 62109-2
- iii. EN 50530 / IEC 62891
- iv. IEC 62116/ UL 1741/ IEEE 1547
- v. IEC 60068-2

12.2 The PCU shall include an easily accessible emergency OFF button and earthing terminals.

12.3 Inverter DC/AC ratio shall be selected to meet the required performance ratio and to reduce loss in the system.

12.4 Components and circuit boards mounted inside the enclosures shall be clearly identified with appropriate permanent designations, which shall also serve to identify the items on the supplied drawings.

12.5 All exposed surfaces of ferrous parts shall be thoroughly cleaned, treated & powder coated or otherwise suitably protected to survive a nominal 20 years design life of the unit. The inverter shall have IP65 or superior ingress protection as per IEC 60529. Moisture condensation and dripping of water shall be prevented in the PCU enclosure. All doors, covers, panels and cable exits shall be provided with gasket or otherwise designed to limit the entry of dust and moisture. All doors shall be equipped with locks. Each inverter shall be provided within an additional enclosure over and above the IP65 enclosure.

12.6 The inverter shall be rated suitably considering incident sun light, ambient air temperature, reduction in heat dissipation due to additional enclosure and other parameters which affects the temperature rise of the inverter. The rating of individual inverters shall be 100% of the sum of rated peak power produced by the string of solar PV modules connected with inverter. If two inverters are provided per parking bay then each inverter shall be rated for 50% of power capacity of each parking bay.

12.7 The string inverter shall be microprocessor controlled voltage source inverter type with IGBTs. It should convert DC power produced by SPV modules in to AC power and adjust the voltage & frequency levels to synchronize with 3ph, 415V AC (nominal), 50Hz (nominal) grid. PCU shall automatically synchronize & to be phase locked with the grid to export power generated by the solar power plant to the grid. The PCU shall be capable of complete automatic operation, including wakeup, synchronization & shut down.

12.8 The inverter shall be provided built-in micro processor based Maximum Power Point Tracking (MPPT) controller and associated control devices.

12.9 The PCU shall satisfy the following performance requirements.

- i. Efficiency at full load >98%
- ii. THD <3%
- iii. THD level in current and voltage THDs shall be as per IEC.
- iv. Power control – MPPT
- v. Number of MPPT – minimum 2
- vi. Night power consumption <3.5W
- vii. DC current injection <1%
- viii. Power factor > Adjustable in the range of 0.8 lagging to 0.8 leading

- 12.10 The inverter shall be provided with the following self diagnostic and self protective features to protect itself and the PV array from damage by disconnecting the faulty segment of the power system.
- i. Over load
  - ii. Short circuit: Fast acting semiconductor type current limiting fuses at the main incoming to protect the inverter from the grid short circuit conditions and to avoid contribution of fault current by GCSPVPP.
  - iii. Earth leakage current protection: an integrated earth fault device shall have to be provided to detect earth fault on DC & AC system.
  - iv. Over temperature
  - v. Over voltage protection both at input & output against lightning, surge voltage at grid, internal faults in the power conditioner, operational errors and switching transients.
  - vi. Over/under grid frequency
  - vii. Anti-islanding protection
  - viii. LVRT (Low Voltage Ride Through)
  - ix. DC reverse connection protection
  - x. Reverse power flow: It shall ensure that no back feeding of grid supply happens in all circumstances including the time when SPV plant is not generating. The PCU shall disconnect the solar power plant in the event of loss of the grid supply.
  - xi. Neutral voltage displacement
- 12.11 **Inverter shall have facility to download data to laptop through USB or Ethernet port. Inverter shall not require internet connectivity for downloading the data. Internet connection cannot be provided.**
- 12.12 During operation, if the output changes / output waveform is different / if the system or unit trips. Then the supplier shall investigate the cause, submit report and replace the faulty component.
- 12.13 Both AC&DC lines shall have suitable fuses and contactors to allow safe start up and shut down of the system. The PCU shall have provision for input & output isolation. Each solid-state electronic device shall have to be protected to ensure long life of the inverter as well as smooth functioning of the inverter.
- 12.14 The PCU shall have trip against sustainable downstream fault and shall not start till the fault is rectified. The PCU shall go to shutdown / standby mode / with its contacts open in case of insufficient solar radiance or before attempting an automatic restart after an appropriate time delay.
- 12.15 The Electromagnetic Interference (EMI) shall be within limits as specified in the IEC. It should not cause malfunctioning of electronic and electrical instruments including communication equipment. EMI / EMC type test certificates shall be submitted along with the offer.
- 12.16 The inverter and data logger shall have RS485 communication port with MODBUS RTU protocol. In addition, the supplier shall provide the detailed MODBUS register address mapping of all key parameters of the inverter so as to integrate it with SCADA system.
- 12.17 Pyranometer, temperature sensor and any other sensors required for this purpose shall be provided by the supplier.
- 12.18 The following parameter shall be available at the data logger and shall be accessible by MODBUS protocol.
- i. Energy produced on a pre determined interval basis & cumulative



- ii. Total runtime
- iii. Total active power
- iv. Power factor
- v. AC voltage, current & frequency
- vi. DC voltage & current
- vii. Equipment temperature, solar radiation and solar panel temperature
- viii. Operating state monitoring and failure indication
- ix. Fault records
- x. Daily efficiency curve
- xi. Monthly histogram of kWh generated.
- xii. Representation of monitored data in graphics mode or in tabulation mode.
- xiii. Measurement & continuous acquisition of solar radiation, PV module temperature, PCU output voltage, current and output frequency
- xiv. Sensor datas
- xv. String voltage

- 12.19 Data logger shall have internal storage facility for storing the above mentioned data in clause 12.18 for latest one month.
- 12.20 All the system parameters of each bay shall be available for integration with SCADA system available at site. Individual data logger and inverter have RS 485 port and shall be looped.
- 12.21 Data logger and Inverter shall support Modbus RTU communication protocol.
- 12.22 The Data logger and all communication equipments shall be IP65 rated
- 12.23 DATA logger, Inverter shall not require internet connectivity or cloud connectivity for processing data and communication of data.
- 12.24 Software for remote and local viewing parameters shall be a part of Data logger. The parameter label, bay label, site name etc shall be editable at site by user.
- 12.25 Supplier shall demonstrate SCADA/HIM for remote viewing by connecting
- 12.26 Inverter shall use only solid state capacitors.

### **13.0 ARRAY JUNCTION BOX**

- 13.1 The Array Junction Boxes (AJB) shall be made of poly urethane coated MS box with dust, water & vermin proof arrangement and shall satisfy the IP65 requirements as per IEC 60529. All wires/cables must be terminated through cable lugs. The AJBs shall be designed such that input & output termination can be made through suitable cable glands made of FRP / cast Aluminium / tinned copper.
- 13.2 The AJBs are to be provided in the PV yard for interconnection of cables from PV modules. The AJBs shall be provided with suitable termination arrangements made of copper bus bars / terminal blocks. Suitable markings shall be provided on the bus-bars for easy identification and cable ferrules will be fitted at the cable termination points for identification.
- 13.3 Suitable capacity MOVs / SPDs shall be provided within each box to protect against lightning / surge voltages.

### **14.0 AC DISTRIBUTION BOARD (ACDB)**

- 14.1 The ACDB shall be IP65 rated as per IEC 60529. AC Distribution Board shall receive the AC power from the inverter and should have necessary control switchgear, surge

arrestors conforming to IEC 61643-11:2011 / IS 15086-5 (SPD) and a multifunction meter (MFM). All switchgear components should confirm to IEC 60947.

- 14.2 The MFM shall be suitable for 3 Phase 4 wire system, digital display type of size 96mm x 96mm & flush mounting type. The MFM shall display of 3-phase Voltages, Currents, kW, kWh, kVA, kVAh, power factor, frequency, and record Maximum Demand, energy consumption. The MFM shall be class 1 accuracy with RS 485 communication port and operate on 230V single phase auxiliary supply. The meter shall be conforming to IEC 61036 / 62053.
- 14.3 CT required for metering purpose shall be provided in ACDB. Each phase shall be provided with 1 number resin cast type CT of minimum 5VA burden & Class 1 accuracy.
- 14.4 ACDB shall be of Polyurethane coated MS box.

## **15.0 CABLES & WIRES**

- 15.1 All the cables excluding the cables from ACDB to nearest power source (Feeder pillar installed by the department) required for the complete installation, testing, and commissioning of the GCSPVPP is in the scope of the supplier.

### **15.2 Cable specifications:**

- 15.2.1 Minimum of 4sqmm copper cable for SPV Module integration to be used.
- 15.2.2 Multi strand, annealed high conductivity copper conductor
- 15.2.3 Un-armoured PVC Copper cables
- 15.2.4 PVC type 'A' pressure extruded insulation
- 15.2.5 Overall PVC sheath for UV protection and confirm to IEC 69947 or equivalent.
- 15.2.6 All wires & cables shall conform to IEC 60227/IS 694, IEC 60502/IS 1554 (Part 1 & 2) respectively.
- 15.2.7 The size of cables shall be selected such that the maximum voltage drop across the cable is limited to 3%. Voltage drop calculation of the selected cable shall be furnished for approval.

### **15.3 Cable connectors:**

- 15.3.1 All connections between integral cable provided with PV modules and extension cable must be done using MC4 connectors only.
- 15.3.2 These are single-contact connectors used for connecting photovoltaic panels. They shall have a minimum of 4 sq.mm contact assembly pin. These connectors shall be UL rated at 20A and 600V.
- 15.3.3 If multiple cables are required to be connected to one terminal block then the parallel connections must be done using suitable MC4 male/female and Y-connectors.
- 15.3.4 All cable connections must be made using suitable terminations for effective contact.

### **15.4 Installation of cables:**

- 15.4.1 The PVC Copper unarmoured cables must be run in GI trays with covers for protection. Armoured cable shall be properly dressed and clamped by 25x3 mm GI

clamps and 25x6mm GI spacers at 600 mm interval in the vertical run and 750 mm intervals in the horizontal run / based on the size of the cable.

- 15.4.2 Clamps and spacers shall be made of mild steel (MS) and hot dip galvanized after fabrication. All fixing fasteners shall be of GI.

## **16.0 EARTHING**

- 16.1 The PCU, DCDB, ACDB, etc. shall be connected to the earth junction by 2 runs of 95 Sq.mm. size tinned stranded copper flexible.
- 16.2 All metal casing / shielding / equipment / instruments of the plant should be thoroughly grounded in accordance with Indian electricity Act/IE Rules.

## **17.0 LIGHTNING PROTECTION**

- 17.1 IEC type tested Lightning masts made of 8mm (minimum) diameter GI of minimum 1mtr length should be provided and the same shall be connected to the GI supporting structure of the PV array using holding clamp. The mast shall be fixed in such a way that the shade of the mast should not affect the performance of the modules.
- 17.2 The number of lightning masts required for the array field shall be calculated by the bidder as per the IEC 62305 standard. Risk analysis along with design documents shall be submitted to the purchaser for approval. Early streamer emission methodology for calculation of lightning masts will not be accepted.

## **18.0 TOOLS, SHACKLES**

- 18.1 All required tools and shackles shall be provided by the supplier during erection, testing, commissioning and for the entire AMC period.

## **19.0 QUALITY CONTROL& PRE-DESPATCH INSPECTION**

- 19.1 All the components of the system must confirm to IS or IEC standards.
- 19.2 Supplier shall submit all drawings/documents for approval before procurement. Purchaser shall verify the drawings/documents to verify the product meeting the technical specification. Purchaser has all rights to modify the drawings/documents to meet technical criteria. Below is the indicative list of drawings/documents to be submitted for approval
- a. Calculation of total power produced for entire plant as per IEC
  - b. General arrangement of solar PV modules and other components on each structure
  - c. Fixing arrangement of solar PV modules on each structure
  - d. Cable sizing calculation
  - e. Scheme drawing detailing the connections
  - f. AJB GA and internal wiring/connection drawings
  - g. DCDB GA and internal wiring/connection drawings
  - h. ACDB GA and internal wiring/connection drawings
  - i. Design of lightning protection for each structure as per IEC62305
- 19.3 All the tests shall be conducted at works in the presence of the Purchaser's representative on all components and the assembled units.

- 19.4 All the Items covered by this specification to be supplied by the Supplier shall be offered for Pre-despatch inspection to the Purchaser or his authorised representatives. Items/Components found unsatisfactory as to workmanship or deviates from the specification shall be removed by the Supplier and replaced at no extra cost with Items / Components which are satisfactory and meeting the technical specification.
- 19.5 All the Items / Components covered by this specification to be supplied by the Supplier shall be despatched only after obtaining the written Shipping Release from the Purchaser. Waiving off pre-despatch inspection or acceptance of the items by the quality surveyor shall not relieve the Supplier/Manufacturer from the responsibility of furnishing the items and workmanship in accordance with this specification.
- 19.6 The Purchaser or his authorised representative shall have at all reasonable times access to the Supplier's or sub-Supplier's works for the purpose of witnessing the tests and to ascertain that the items being manufactured conforms to the requirements of this specification. The Purchaser shall be given at least 15 days advance notice prior to the commencement of testing so that the representative of the Purchaser can plan to visit and witness the tests. All the tests indicated in this specification shall be carried out in the presence of the representative of the Purchaser by the manufacturer and shall provide all the facilities & equipment for testing.
- 19.7 The Supplier and Manufacturer of the equipment shall carry out the checks as per the Check List which will be provided by the Purchaser on approval of Drawings and confirm the compliance to the Specification/Check-List prior to issue of Inspection Call to the Purchaser.
- 19.8 Despatch clearance will be given only after satisfactorily completion all the tests as per this specification.
1. Visual Inspection and Dimensional checks
  2. Module testing
  3. 100% In-process inspection, parameter monitoring
  4. EL, IV Test
  5. Wet Leakage Test
  6. Ground Continuity Test
  7. Visual Checks
  8. Insulation and Hipot Test

## 20.0 CRITERION FOR ACCEPTANCE OF SOLAR POWER PLANT

- 20.1 Daily PR of the PV Plant shall be calculated according to IEC 61724 Ed.2 for the consecutive 5-day duration as per the below formula.

$$PR = \frac{Y_a}{Y_r} \times \frac{1}{(1 - DF)} \times [1 - \alpha (T_{avg} - T_{cell})]$$

$$Y_A = E_{ac} / P_{Nom}$$

$$Y_R = IR_{Site} / IR_{STC}$$

Where,

- $Y_a$  = Final PV system yield (representing the number of hours that the system would need to operate at its rated output power  $P_{Nom}$  to contribute the same energy to the grid as was monitored).
- $Y_r$  = Reference yield (representing the number of hours during which the solar radiation would need to be at STC irradiance levels in order to contribute the same incident energy as was monitored).

$E_{ac}$	= AC energy injected into the grid during a clearly specified amount of time (kWh).
$P_{Nom}$	= Installed nominal peak power of modules (Nameplate rating at STC) (kWp);
$IR_{Site}$	= Irradiation on the module plane of array during a clearly specified amount of time (measured with a pyranometer installed on the plane of array, POA) (kWh/sq. m)
$IR_{STC}$	= Irradiance at STC (kW/ sq. m); 1000W/sq.m
$T_{average}$	= Average cell/ module temperature ( $^{\circ}C$ ) over a period of time
$T_{cell}$	= STC cell/ module temperature ( $^{\circ}C$ ); $25^{\circ}C$
$\alpha$	= temperature coefficient of power (negative sign) corresponds to the installed module ( $\%/^{\circ}C$ ) (as per PV Module Datasheet)
DF	= Module degradation factor, 0.7% per year

- 20.2 Average of 5 days PR reading will be considered as final PR for acceptance of the system.
- 20.3 Performance Ratio (PR) of the plant during this period shall be  $\geq 75\%$  for acceptance of the system.

## **21.0 TESTING AT MANUFACTURER'S WORKS**

- 21.1 Solar PV modules shall be tested in the presence of the Purchaser as per the IEC 61215/IS 14286 and IEC 61730 standards in IEC /NABL/MNRE accredited laboratory.
- 21.2 MPPT inverters (PCU) shall be tested as per the IEC standards from any of the NABL/ IEC / BIS Accredited Testing Laboratories or MNRE approved test centres.
- 21.3 Insulation Resistance (IR) value test for all power carrying components such as PCU, ACDB using minimum 500V IR tester and the IR value shall be  $> 50$  MOhm.
- 21.4 Inverter shall be tested as per relevant IEC Standards/ international standards. Test report shall be submitted to the purchaser for acceptance.
- 21.5 HIPOT test on ACDB & DC DB using minimum 2kV.
- 21.6 The PCU shall be tested to demonstrate operation of its control system and the ability to be automatically synchronized and connected in parallel with a utility service, prior to its shipment.
- 21.7 Test to ensure there is no reverse flow of power from grid to the PCU and PV system.
- 21.8 Operation of all controls, protective and instrumentation circuits shall be demonstrated by direct test if feasible or by simulation operation conditions for all parameters that cannot be directly tested.
- 21.9 Special attention shall be given to demonstration of utility service interface protection circuits and functions, including calibration and functional trip tests of faults and isolation protection equipment.
- 21.10 Operation of start up, disconnect and shutdown controls shall also be tested and demonstrated. Measurement of phase currents, stable operation, tests to confirm efficiencies, harmonic content and power factor at rated nominal power of the PCU and response to control signals shall also be tested and demonstrated.
- 21.11 A factory Test Report (FTR) shall be supplied with the unit after all tests. The FTR shall include detailed description of all parameters tested qualified and warranted.

21.12 Three copies of the test certificates / reports shall be handed over to the purchaser.

## **22.0 INSTALLATION TESTING AND COMMISSIONING AT SITE**

22.1 The plan & elevation of GI structure provided over the parking area is attached with this specification.

22.2 All materials/equipments required for installation and commissioning is in the scope of the supplier. Extra arrangements required if any to suit the site conditions shall be borne by the contractor without any additional charge. Each module can be mounted on a mounting structure fabricated from hot dip galvanised MS, using appropriate clamps (Either GI/SS//non-corrosive) and trapezoidal sheet holders, rail track connectors, and fixtures. To the extent possible drilling on the GI structure to be avoided. If there is any requirement for drilling GI structure at site, the drilled hole & surrounding area shall be cold galvanized. Necessary clamps/fixtures shall be used between SPV Modules to ensure SPV Modules will withstand severe climatic conditions.

22.3 The inverter shall be installed outdoor under the rain hood shed to protect it from rain and sun at both East & West ends of the GI structure provided over the parking area. Preferably separate MPPT inverters of same capacity shall be provided for South facing solar modules (with 5 degree slope) & North facing solar modules (with 5 degree slope) in order to avoid reduction in power produced due to mixing of low & high power producing (i.e. North & South facing) solar PV modules.

22.4 The ACDB will be installed adjacent to the inverter unit at West end of the structure.

22.5 The system with all its components after completing the installation in all respects shall be tested for validating all the design parameters referring to performance. Final acceptance of the integrated system will be given only after validating the performance of the system.

22.6 The manufacturer shall depute his Engineers and check whether the installation has been carried out as per the approved drawings, specifications and also to ensure trouble free performance. After carrying out necessary pre-commissioning checks such as specified by the Purchaser and satisfied that the installation has been completed satisfactorily, the manufacturer shall clear the installation for usage.

### **22.7 Commissioning Tests:**

Prior to connecting the power plant to the grid, electrical continuity and conductivity of the plant's various subcomponents should be thoroughly checked by the bidder. Once mechanically and electrically complete, the following tests should be conducted on all module strings and on the DC side of the inverters:

- i. **Polarity Check:** The polarity of all DC cables should be checked. This is one of the simplest and most important safety commissioning tests. Several rooftop fires involving PV systems have been traced back to reverse polarity.
- ii. **Open Circuit Voltage (Voc) Test:** This test checks whether all strings are properly connected and whether all modules are producing the voltage level as per the module data sheet. The Voc of each string should be recorded and compared with temperature-adjusted theoretical values. For plants with multiple identical strings, voltages between strings should be compared to detect anomalies during stable irradiance conditions. Values from individual strings should fall within 5% of each other.
- iii. **Short Circuit Current Test (Isc):** This test verifies whether all strings are properly connected and the modules are producing the expected current. The Isc of each string should be recorded and compared with temperature-

adjusted theoretical values. For plants with multiple identical strings, voltages between strings should be compared to detect anomalies during stable irradiance conditions. Values from individual strings should fall within 5 % of each other.

- iv. **Insulation Resistance Test:** The insulation resistance of all DC and AC cabling installed should be tested with a megger. The purpose of the test is to verify the electrical continuity of the conductor and verify the integrity of its insulation.
- v. **Earth Continuity Check:** Where protective or bonding conductors are fitted on the DC side, such as bonding of the array frame, an electrical continuity test should be carried out on all such conductors. The connection to the main earthing terminal should also be verified.

After the above commissioning tests have been successfully completed and the correct functioning and safe operation of subsystems have been demonstrated, commissioning of the inverters may commence. The inverter manufacturer's directions for initial start-up should always be adhered to.

### **23.0 DRAWINGS & MANUALS**

- 23.1 Three copies of bound volumes of drawings and O&M manuals are to be supplied.
- 23.2 Bidders shall provide three sets of complete technical data sheets for each equipment and detailed report on design basis of the system.

### **24.0 GUARANTY**

- 24.1 All the components of the system shall be guaranteed for any manufacturing defect or inferior components for a period of TEN years from the date of commissioning.
- 24.2 The system shall have minimum 90% output at the end of 10 years.

### **25.0 TRAINING**

- 25.1 The supplier shall provide training to at least 5 departmental operators on the O & M aspects of the system at site.

### **26.0 POINTS TO BE NOTED ON MAJOR COMPONENTS**

- 26.1 Solar Modules: Bidder shall note that the solar modules offered shall be manufactured in India only.
- 26.2 MPPT Inverter: The inverter offered shall be of a make who have robust service support especially in southern part of India. The offer shall be supported by relevant documents towards this.

### **27.0 ANNUAL MAINTENANCE**

- 27.1 **A separate work order for annual maintenance contract will be placed only after successful commissioning of the grid connected Solar Photo Voltaic power plant (GCSPVPP).**
- 27.2 The bidder shall quote separately the price of maintenance during the guaranty period of 10 years along with the offer.
- 27.3 **CONTRACT PERIOD: 120 Months from the date of commissioning of the system.**

- 27.4 SPARES, ACCESSORIES, PARTS OR COMPLETE UNIT : The spare parts, accessories, parts of the systems and complete units required for replacement if any, shall be replaced at free of cost till the completion of 120 months maintenance period.
- 27.5 VISITS: Quarterly visits shall be made every year for preventive maintenance of the system. If any breakdown calls for emergency service, the same shall be attended within 24 hrs. One of the scheduled preventive maintenance shall also be completed during such visits. However in case the number of emergency calls exceeds Four (4) no extra payment will be applicable. Visits also shall be made for the upkeep of the system to ensure guaranteed Performance Ratio and Capacity Utilisation Factor (CUF).
- 27.6 SCOPE OF AMC: The annual maintenance contract includes servicing including PV panel cleaning with water and by other means, repairing, maintenance and supply and replacement of all components as required for Solar Power System for the satisfactory running of the system.
- 27.7 Bidder shall make necessary arrangement for cleaning of SPV Modules like hose pipe, cleaning mop, water pump if required etc. as per the site requirement. Water will be provided by department at free of cost. Mounting clamps shall be tightened at regular interval.

## **28.0 OPERATIONAL ACCEPTANCE**

- 28.1 Performance Ratio (PR) will be measured for operational acceptance of the plant and measured every year as per the formula in clause 20.1.
- 28.2 Energy losses attributable to following events shall not be considered for performance guarantee evaluation:
- a) Non availability of grid due to scheduled outages, grid backdown condition i.e. forced grid backdown situation imposed by IGCAR and unscheduled grid outages due to events like transmission line breakdown etc. for evacuation of the power from the solar power plant which is beyond the control of the contractor;
  - b) Force majeure
  - c) Vandalism or theft
  - d) Modifications at the site or its surroundings due to factors out of control of the Contractor (i.e. shadowing due to new installations on the site or next to the site etc.
- 28.3 PR shall be calculated on annual basis from the date of operational acceptance of the plant till the end of AMC period. Module degradation factor will not be considered for first year for PR calculation. Module degradation factor, as per above will be considered from second year of operation.
- 28.4 **During the demonstration of yearly PR, in case the Plant PR is less than 75%, then the total Contract Performance Security submitted by the contractor will be forfeited.**



## SECTION –D

### A. Check List

S.No.	Criteria / Parameters	Status / Values
	<b>Check List</b>	-
1.	Does PV modules offered were IEC / BIS certified? Test certificates shall be from IEC / NABL / BIS certified lab.	Yes / No (Submitted Document)
2.	Bidder is a manufacturer of mono perk solar modules in India? Indian Government PSUs which are involved in manufacturing of solar PV cell / module activities are exempted from this condition.	Yes / No (Submitted Document)
3.	The firm must have designed, manufactured, tested, supplied, erected, commissioned at least 3 grid connected solar PV power plant (off grid / grid connected) of minimum plant capacity of 1.7 MWp which are in successful operation on the date of technical bid opening.	Yes / No (Submitted Document)
4.	Certificate for compliance to IEC 61215 for Solar PV modules	Yes / No (Submitted Document)
5.	Certificate for compliance to IEC 61730 Part I and II for Solar PV modules	Yes / No (Submitted Document)
6.	Certificate for compliance to IEC 61701 for Solar PV modules	Yes / No (Submitted Document)
7.	Solar modules offered shall be manufactured in India only.	Complied / Not Comply
8.	The inverter offered shall be of a make who have robust service support especially in Southern part of India. The offer shall be supported by relevant documents towards this	Complied / Not Comply
9.	Certificate for compliance to IEC 62109 Part 1 & 2 for Inverter	Yes / No (Submitted Document)
10.	Certificate for compliance to EN 50530 / IEC 62891 for Inverter	Yes / No (Submitted Document)
11.	Certificate for compliance to IEC 62116/ UL 1741/ IEEE 1547 for Inverter	Yes / No (Submitted Document)
12.	Certificate for compliance to IEC 60068-2 for Inverter	Yes / No (Submitted Document)
13.	Minimum peak capacity of each solar PV module shall be 380 Wp	Complied / Not Comply
14.	The solar PV module shall be of Mono PERC crystalline silicon type and must be qualified as per the standards given in the specification	Complied / Not Comply
15.	Guaranteed Performance Ratio for PV plant proposed shall be $\geq 75\%$	Complied / Not Comply
16.	The predicted electrical degradation at the end of the period of 10 years shall be less than 10 per cent of the full rated original output	Complied / Not Comply

17.	PV Modules shall be qualified for safety through IEC 61730 and IEC 61730-2 and within this application class and shall meet the requirements for safety class II. (Application Class: Class A, Protection/safety Class II)	Complied / Not Comply
18.	The inverter/PCD, Array Junction box, ACDB shall have IP65 or superior ingress protection as per IEC 60529	Complied / Not Comply
19.	Each PV module shall be provided with an IP67 or superior ingress protection rated terminal box with a bypass diode	Complied / Not Comply
20.	Does the ACDB, Array Junction Box (each string) provided with SPD?	Yes / No
21.	Certificate of compliance to IEC 69947 for Cables & Wires	Yes / No (Submitted Document)
22.	Certificate of compliance to IEC 60502/IS 1554 for Cables & Wires	Yes / No (Submitted Document)
23.	Does the ACDB provided with multifunction meter (MFM)?	Yes/ No
24.	Weatherproof connector and a lead cable shall be used as part of the PV module	Complied / Not Comply

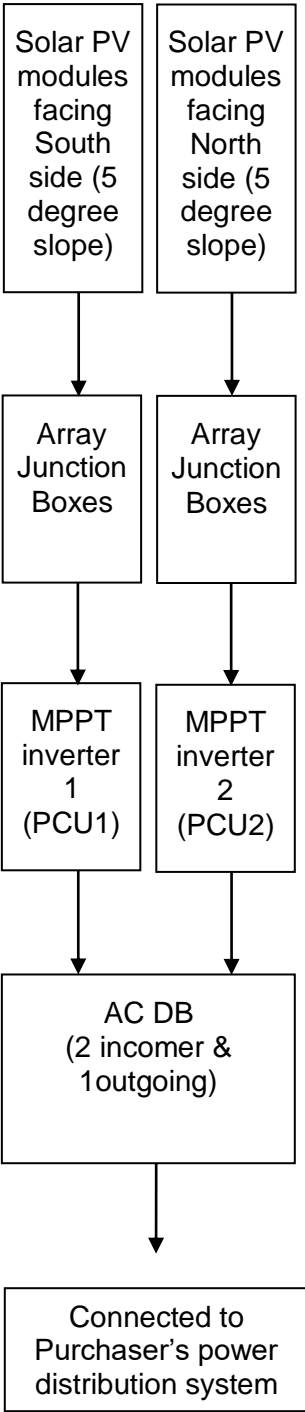
### B. Format for filling Guaranteed Technical particulars

<b>1.0</b>	<b>SOLAR PV MODULES</b>	-
a.	Make & model number of the solar PV modules	
b.	Type of solar PV module (MONO/POLY/MONO PERC)	
c.	Peak power output of each solar PV modules in Wp	
d.	Number of PV modules proposed for Four wheeler parking bay 1 to 8	
e.	Number of PV modules proposed for Four wheeler parking bay 9	
f.	Number of PV modules proposed for two wheeler parking bay 1 to 18	
g.	Number of PV modules proposed for two wheeler parking bay 19 to 21	
h.	Total power produced by solar PV modules installed over one four wheeler structure (of each type) at standard test condition (Guaranteed value)	
i.	Total power produced by solar PV modules installed over all four wheeler structure at standard test condition (Guaranteed value)	
j.	Total power produced by solar PV modules installed over one two wheeler structure (of each type) at standard test condition (Guaranteed value)	
k.	Total power produced by solar PV modules installed over all two wheeler structure at standard test condition (Guaranteed value)	
l.	Fill factor of solar PV module	
m.	Performance Ratio for PV plant proposed	
n.	Guaranteed Capacity Utilisation Factor (CUF) for PV plant proposed	
o.	Conversion efficiency of offered solar PV modules at standard test conditions	
p.	Specify the maximum value of RH for which the solar PV module operates	
q.	Specify the minimum & maximum value of temperature for which the solar PV module operates	
r.	Specify the % degradation in peak power produced at the end of the period of 10 years	
s.	Maximum positive & negative tolerance of peak power produced by any of the PV module from the declared peak power rating per PV module.	
t.	IP rating of terminal box of the PV module	

u.	Type of connector?	
v.	Confirm RFID is provided for each PV module and is in line with the requirement of the specification.	
w.	Temperature coefficient of Power for solar PV module	
x.	Temperature coefficient of open circuit voltage of solar PV module	
<b>2.0</b>	<b>GRID INTERACTIVE MPPT INVERTER / POWER CONTROL UNIT (PCU)</b>	
a.	Make & model number of the MPPT inverter	
b.	Power rating of the MPPT inverter	
c.	Maximum Power Point Tracking (MPPT) controller is available or not? If yes, mention No of MPPT's	
d.	Rating of ingress protection	
e.	Output voltage & frequency with tolerances	
f.	Efficiency at full load	
g.	THD	
h.	Night power consumption	
i.	List out the diagnostic and self protective features	
j.	List out the communication protocol with LAN / WAN options along with plant monitoring facility	
k.	IP rating of inverter unit	
l.	Do you agree to provide additional enclosure to be provided to the inverter as per specification?	
<b>3.0</b>	<b>ARRAY JUNCTION BOX</b>	-
a.	IP rating of AJB	
b.	Make & model number of AJB	
<b>4.0</b>	<b>AC DISTRIBUTION BOARD</b>	-
a.	Make & model number of the ACDB enclosure	
b.	IP rating of ACDB	
c.	Make & model number of the MFM	
d.	Make & model number of the CT	
<b>5.0</b>	<b>CABLES &amp; WIRES</b>	
a.	Make, type of cables	
<b>6.0</b>	<b>LIGHTNING PROTECTION</b>	
a.	Diameter & length of spikes provided	
b.	Number of lightning spikes required for the array field	
c.	Please submit the design note for the lightning protection system	

Note: All the details shall be filled up in the above table and if required additional sheets may be used.

**Scheme drawing for GCSPVPP**



**Figure 1**

Electrical/mechanical Operational interlock shall be provided such that inverter uses only the grid voltage as reference for synchronisation.

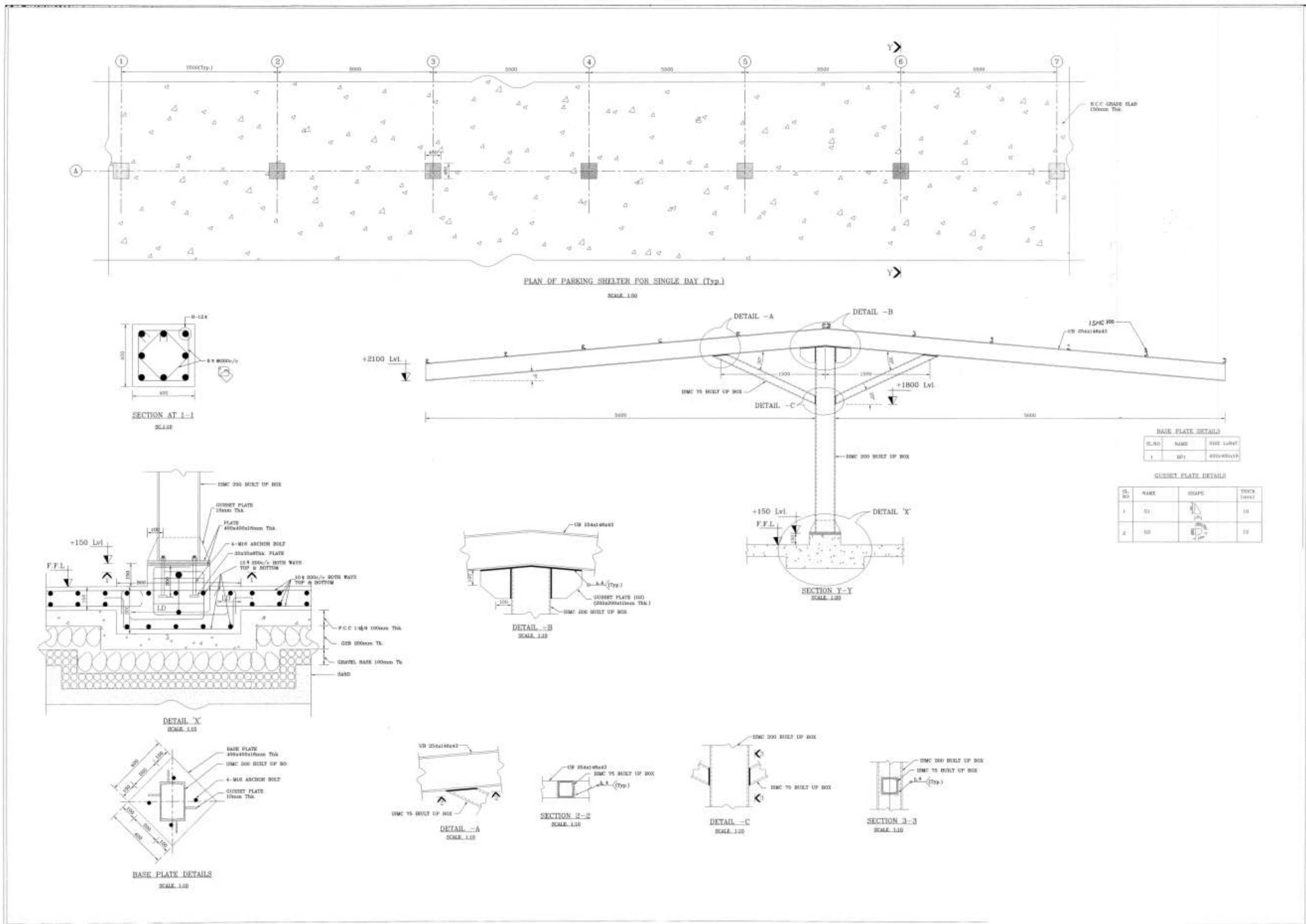


Figure 2. Section view of four wheeler structure

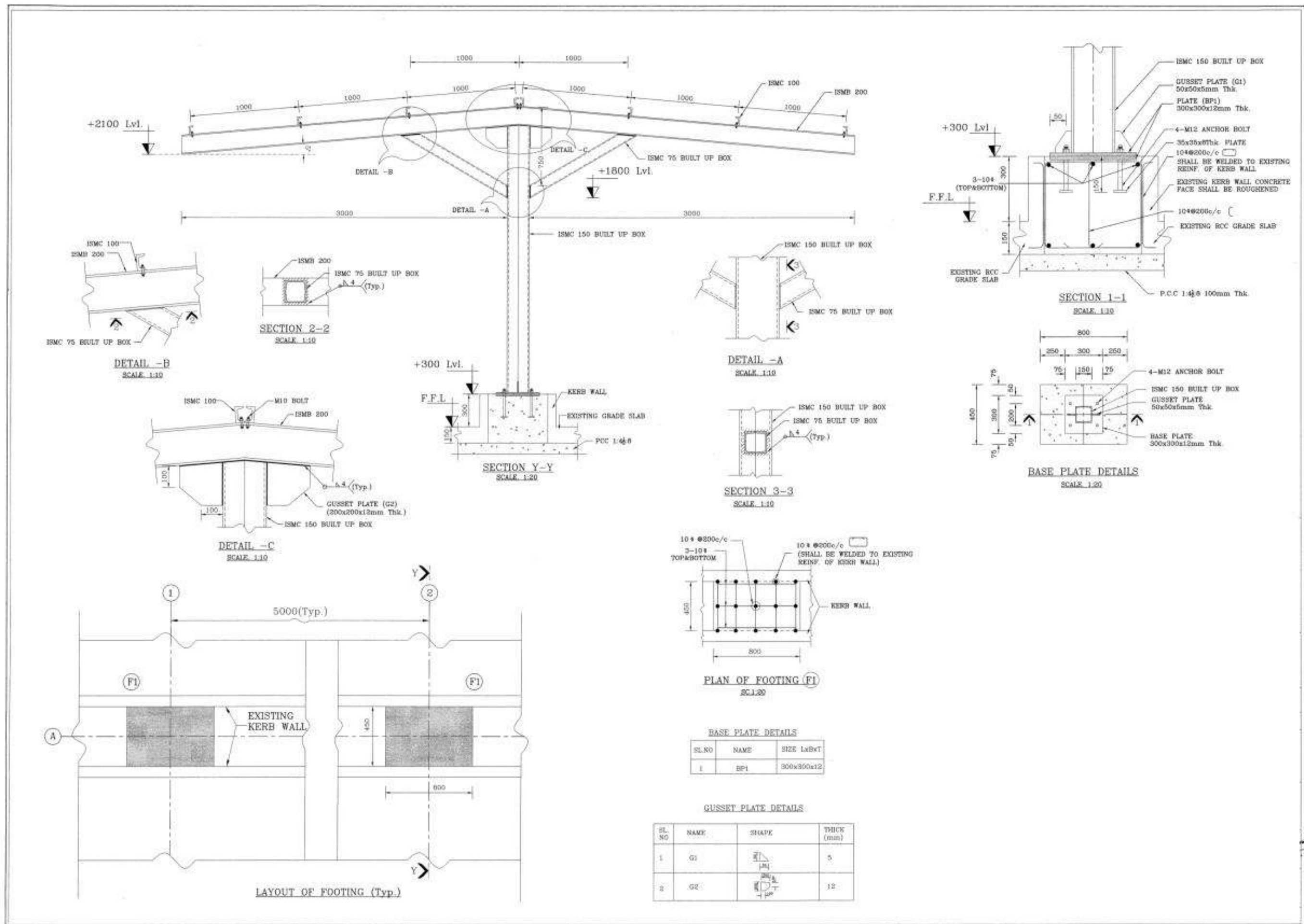
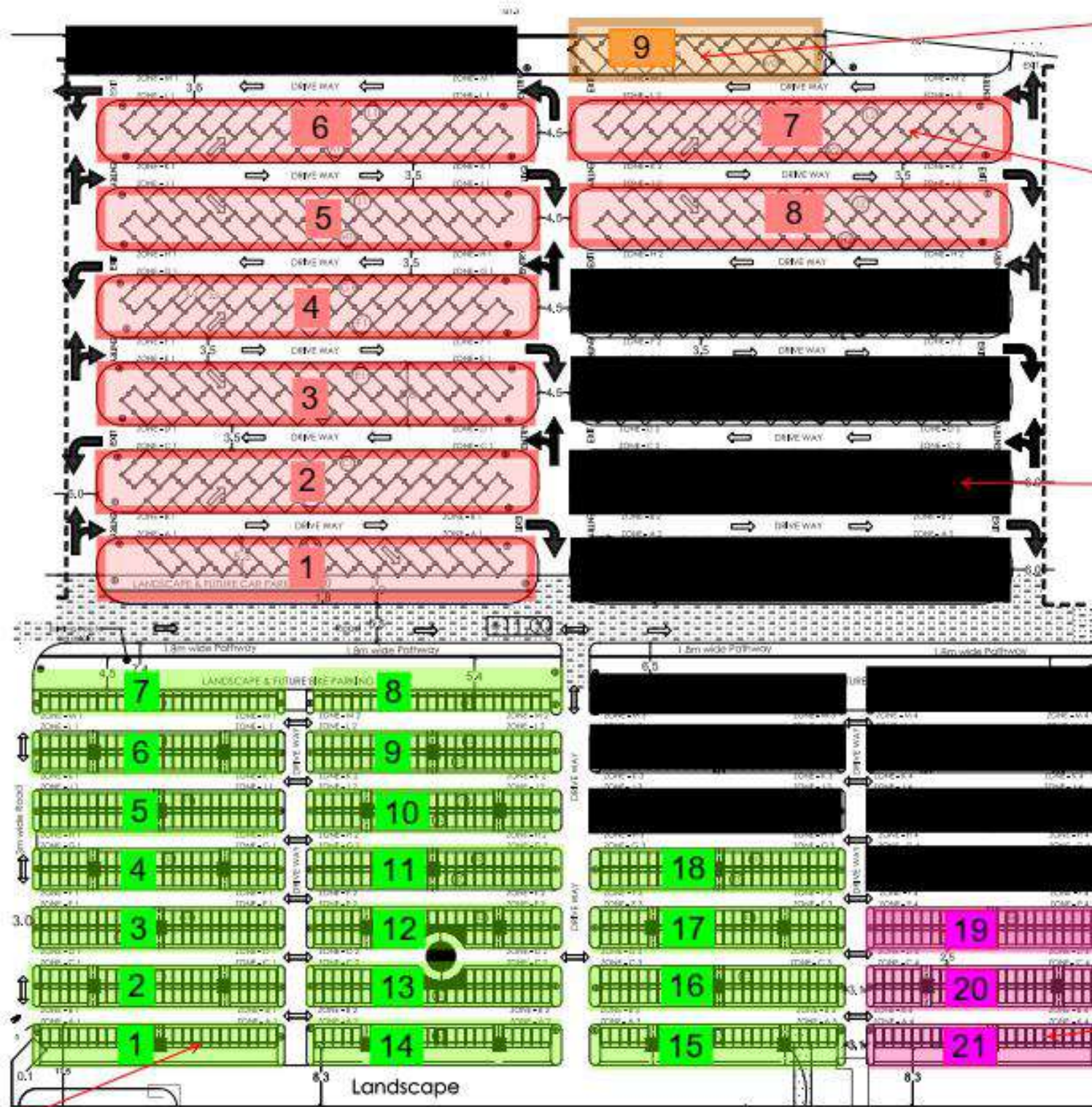


Figure 3 . Section view of Two wheeler structure



# Solar Parking Layout



Four Wheeler Parking - Effective area - 320 sq.m each (32mx10m)

Four Wheeler Parking - Effective area - 560 sq.m each (56mx10m)

Not in Scope

Two Wheeler Parking - Effective area - 216 sq.m each (36mx6m)

Two Wheeler Parking - Effective area - 204 sq.m each (34mx6m)