Trina Tracker

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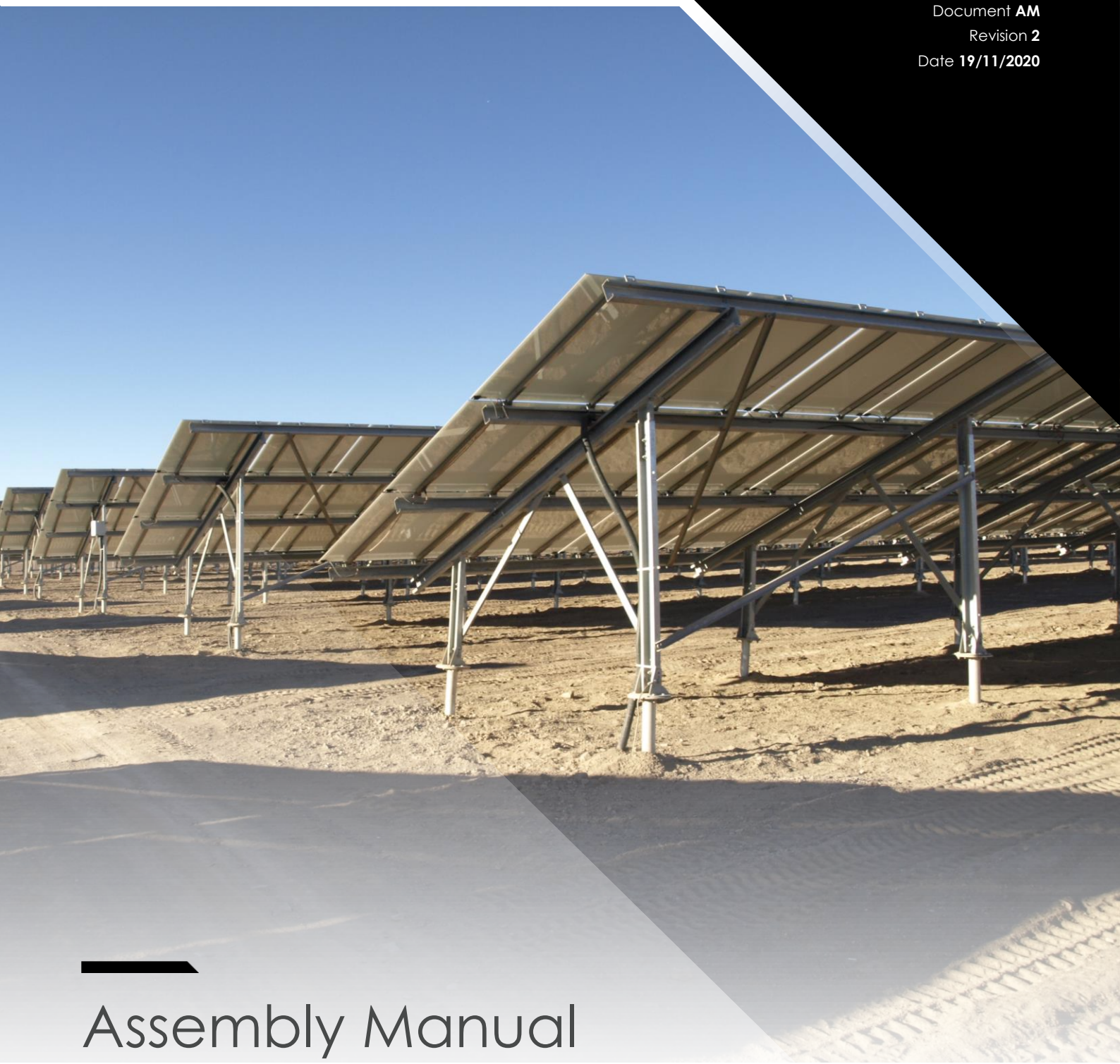

Assembly Manual

Fixed Tilt Structure - Bipile

STANDARD MANUAL

This is the standard manual. It shall be customized for each project during the design phase. Copyright © 2017-2021, Trina Solar Co., Ltd. All rights reserved.

CONTROL REVISION

REV	DATE (dd/mm/yy)	DESCRIPTION	ELABORATED	REVISED	APPROVED
1	12/01/17	INITIAL DOCUMENT	VBG	 JAM	 MAI
2	22/11/17	NEW TEMPLATE	 JAM	 MAI	JSL
3					
4					

CONTENT

ILLUSTRATIONS

1 GENERALITIES, RESPONSIBILITIES, SECURITY AND TRANSPORTATION

This manual is intended as a guide for the correct assembly of the metallic structure. Please, read it carefully before starting assembly. The team undertaking the assembly must be qualified and specialized in this type of work. If you have any questions, please contact the Technical Department of TrinaTracker. Defects caused by the negligence of untrained users and misuse of the components are not included in the warranty.

TrinaTracker manufactures different models of structures and solar trackers, several drawings for the same area can be found in the manual; in each case the customer will choose the option that fits their product.

This is the main assembly manual. Some parts showed in this manual could be different or custom-made so prior the assembly the structure and assembly drawings must be consulted and dimensions, measures and parts checked. The specifications in this manual are subject to possible changes without previous notice.

TrinaTracker is only responsible for the items it supplies. The instructions given in this manual must be followed faithfully; otherwise, the manufacturer is exempt from any liability. Modifications or alterations made without authorization from the manufacturer, as well as the utilization of unapproved spare parts, exempt the manufacturer from any liability related to the proper functioning of the solar structure and the safety of the persons handling the unit.

We recommend the exclusive presence of authorized personnel for the installation of the solar tracker. Also, the people working in or travelling through the work zone are required to respect basic safety standards for protection and prevention. They shall be equipped with the required clothing and personal protective equipment (helmet, gloves, harness, safety shoes, etc.) and take preventive measures such as not standing under suspended loads, wearing gloves to avoid injury from irregularities in the surfaces of ferrous materials, checking the moorings of the pieces, making sure that slings and cables have sufficient strength to withstand the weight of the pieces to be raised and any other measures that are applicable to the work being performed at all times.

The structure is transported in various sets: posts, structural profiles, parts and accessories.

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1.1. Limitations

Following eventualities are excluded from the warranties:

1. Incidents resulting from incorrect assembly of the structure and/or components by the user or construction company.
2. Incidents resulting from incorrect use of the structure and/or components by the user.
3. Incidents caused by external elements or conditions not taken into account and listed in the project specifications.
4. Damage and failures produced due to non-compliance with instructions for installation, use and assembly as established in the installation manual of TrinaTracker.
5. Defects related to aesthetic aspects of the structure except those involving non-functioning or performance thereof will be declared not eligible for warranty claim.
6. Incidents resulting from the civil works.
7. Damage caused by an inadequate maintenance and the no respect of the instruction from the maintenance manual of TrinaTracker.
8. Damages caused by the event of nature.
9. Warranty will not be applicable if the customer executes any modification in the installation supplied by TrinaTracker without previous written authorization issued by TrinaTracker.
10. Warranty will not be applicable if the potential difference between the metallic structure and the soil is modified due to an electric installation made by the customer and not considered in the project design and calculation.

    As a reference, for the application of the warranty, the potential difference between the metallic structure and the soil, measured with a copper/copper sulphate reference electrode must be higher than 850 mV before and after the electrical connection of the plant.
11. Warranty will not be applicable if galvanic couples appear between the structure and elements not considered in the design of the structure.

2 GENERAL INFORMATION

2.1. General information

The purpose of this manual is to be a guide for the correct assembly of the TrinaTracker fixed structure for the photovoltaic modules.

Before starting the installation, please, read it carefully before starting assembly. The team in charge of assembling the structure must be qualified and specialized in this type of works. If there is any question, please, contact the Technical Department of TrinaTracker. Defects caused by the

negligence of untrained users and misuse of the components are not included in the warranty. TrinaTracker is only responsible for the items it supplies.

TrinaTracker manufactures different models of fixed structures, to adapt to the needs of each client. Therefore may be some of the drawings, can be found in this manual, aren't exactly the option of your structure, being the difference the number of the modules and their orientation. Below there are included some examples.

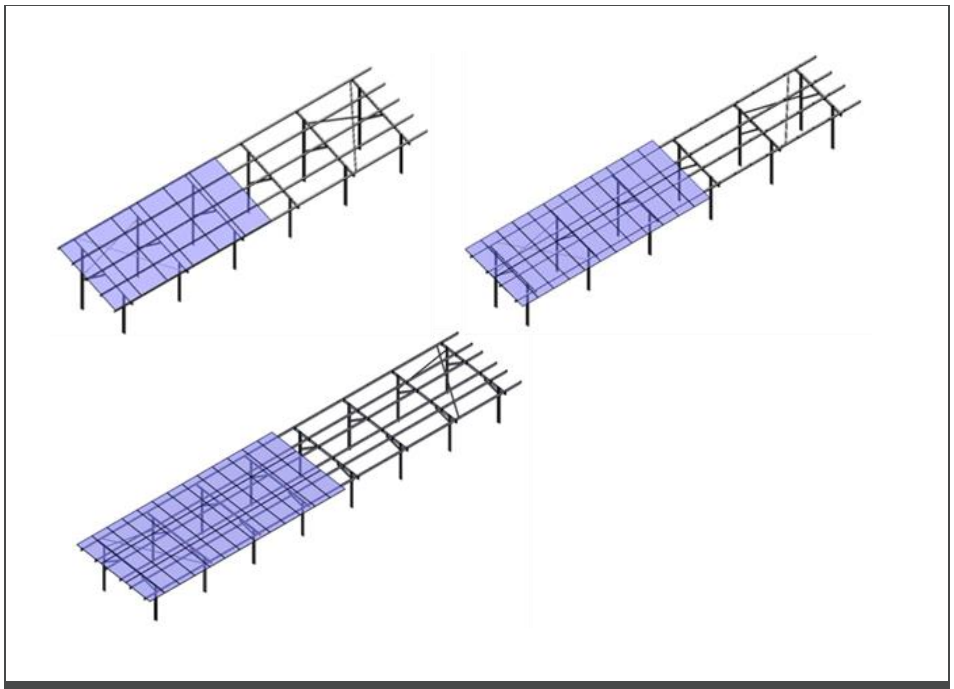

Illustration 1: Fixed tilt structure

The fixed structure with the photovoltaic modules is the set named "table".

Please check design and assembly drawings provided by TrinaTracker design, disposition and parts could change depending on the model and project.

3 MAIN COMPONENTS OF THE TRACKER

Below, there are the main structural elements required to assemble the tracker:

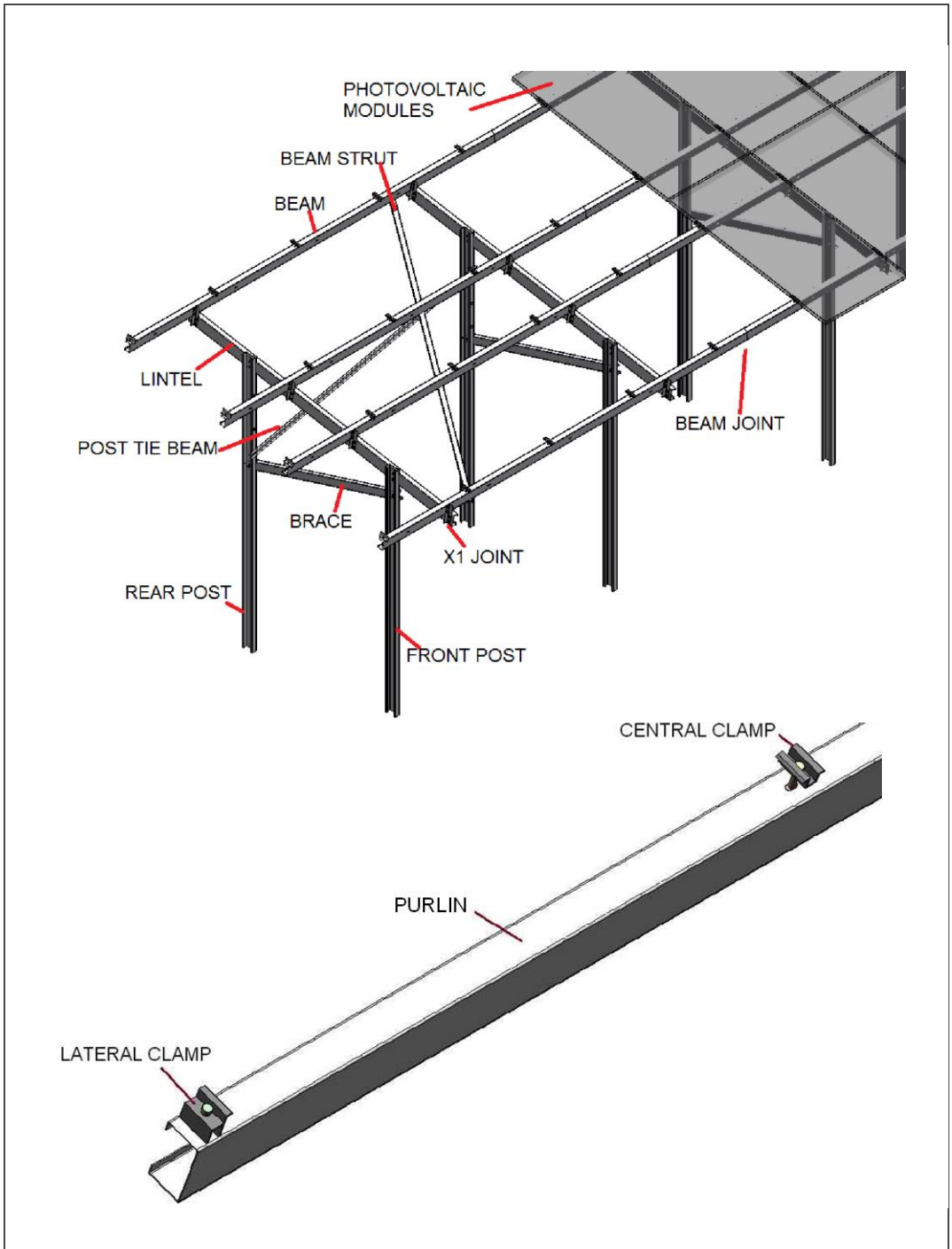

Illustration 2: Main components

3.1. Assembly between structural elements

In the following chart is detailed the hardware used to fix the different structural elements:

REFERENCE	Fastener
Post + Lintel	M16
Post + Lintel (Block)	M6
Post +Post tie beam	M12
Post + Brace	M16
Joint X1 + Lintel	M12
Joint X1 + Beam	M12
Beam + Beam joint	M12
Beam + Tie beam	M12
Beam + Aluminium Clamp	M8

3.2. Bolts tightening torque

Below is a table indicating the tightening torque for the most common bolts, to serve as a reference:

REFERENCE	Tightening torque (Nm Quality A2-70	Tightening torque (Nm) Quality 8.8
M8 (joints without contact between the surfaces)*	10	10
M12 (rigid joints)	57	77
M16 (rigid joints)	140	190

* Subject to changes depending on the PV module manufacturer.

- Rigid joints are defined as when connected pieces are in contact, or the separation between them is so small that when is tighten to the correct torque they are totally in contact.

- Joints without contact are defined as when the connected pieces are not in contact after tightening to the correct torque. In this case if they are tightened excessively, they could break or deform.

Initial pre-tensioning strengths might be reduced due to possible variations in temperature, internal stress, friction, or the effect of non-rigid elements between joints.

Therefore, when following the "check list", the same tightening torque shall be applied and under the same temperature conditions as those followed during the assembly process. The admissible tolerances when following the installation "check list" are:

- The tolerance of the tightening torque for rigid joints shall be ±15%
- The tolerance of the tightening torque for joints with no contact shall be +0/-15%

TrinaTracker reserves the right to modify the tolerance values described in this document.

The screws shall be tightened following bolt tightening procedure:

1. Pre-tighten the bolts to 75% of the torque level according to the tightening toque table above, starting with the top screws and then the bottom screws, crosswise. The tighten shall be done mechanically (with torque wrench) or manually, in both cases using calibrated impact head tools with the purpose of preventing any form of erosion on the edges of the screw due to wear on the head. The tool head shall be replaced when damage is detected on the edges of the screw.
2. Final tighten: Calibrated and certified torque wrench shall be used to apply the specified tightening torque within tolerances as referenced above. Once the torque is applied, is mandatory that the bolt shall be marked with permanent marker.

Do not proceed to step 2 until step 1 has been applied in all the screws in the joint. Bear in mind, symmetrical joints have their own specific tighten sequence.

However, rust can appear on some edges of the screw heads during assembly. These shall be repaired by the company responsible for performing the assembly tasks with Zinc rich paint.

TrinaTracker is not responsible for hardware that is damaged during the assembly stage or the repairing works related to it.

3.3. USE OF DIN 6923 NUTS

Important: Take into consideration the details of the procedure of using DIN 6923 self-locking nuts.

These nuts dispose of a flange with grooves which makes it a self-locking mechanism when is tightened, without the need of any kind of washer.

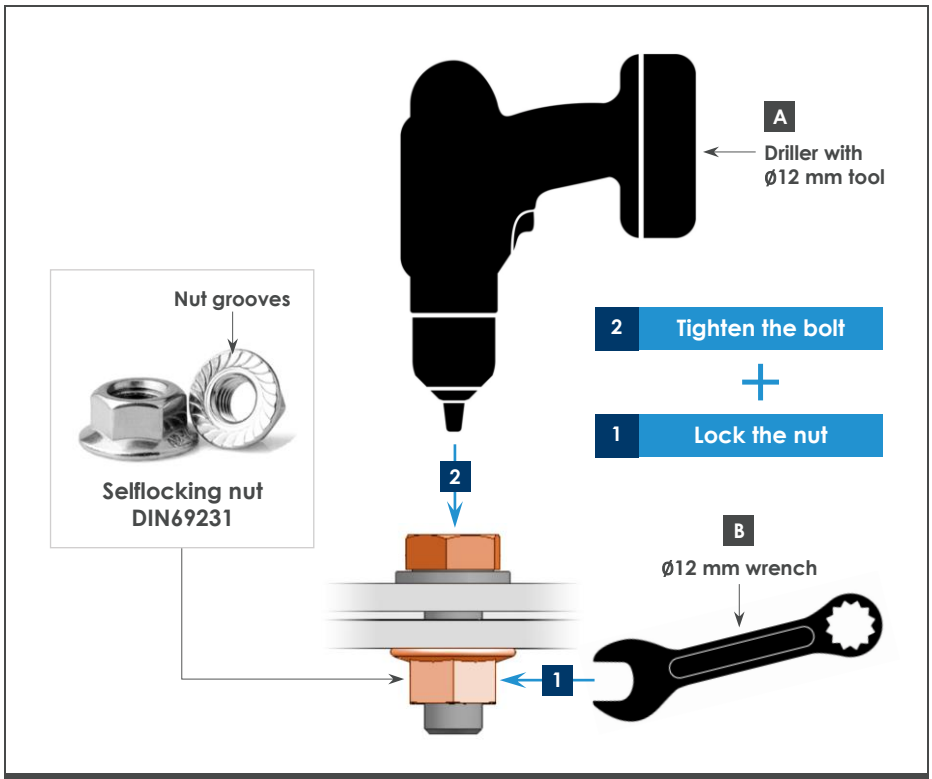

Illustration 3: Tightening process

This system will only work correctly if the nut remains stationary whilst the bolt is tightened,, so that the grooves grip and hold the parts together.

TrinaTrackerreserves the right to change this procedure

4 ASSEMBLY STEP BY STEP

Described below is the procedure to be followed for the correct and satisfactory assembly of the fixed structure.

4.1. Topographical marking and positioning of piles

The staking out work shall be done based on the topographical survey conducted on the site.

The area to be staked out shall be clear and free of foliage so as to avoid interrupting the marking work.

The existence of abrupt changes in ground level shall be notified to TrinaTracker.

The number of points to be staked depends on the ground slopes and the needs of the installation team. The reference points to be marked are:

- Marks of each row, the first and the last pile of each row
- The line-up points between the ends of the rows depends on the orography and the terrain characteristics. The topographer shall mark the line-up point at 25 meters at least, in some cases this distance will be insufficient and additional line-up points will be marked.

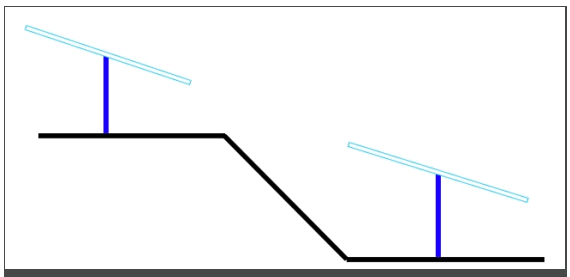

Illustration 4: Abrupt changes in ground

4.1.1. Pile positioning

Based on the topographic marking, it's possible to start to mark the intermediate points; these points are where the posts will be positioned. Starting from the points marked in each row; to join two followed marked points with one suitable rope, which allows tensing to ensure the linearity of the row; and with that to start with the marks corresponding to the points of the posts locations, according with the layout.

If the terrain has slope, it's necessary to do the marks of the points like are indicated in the following drawing:

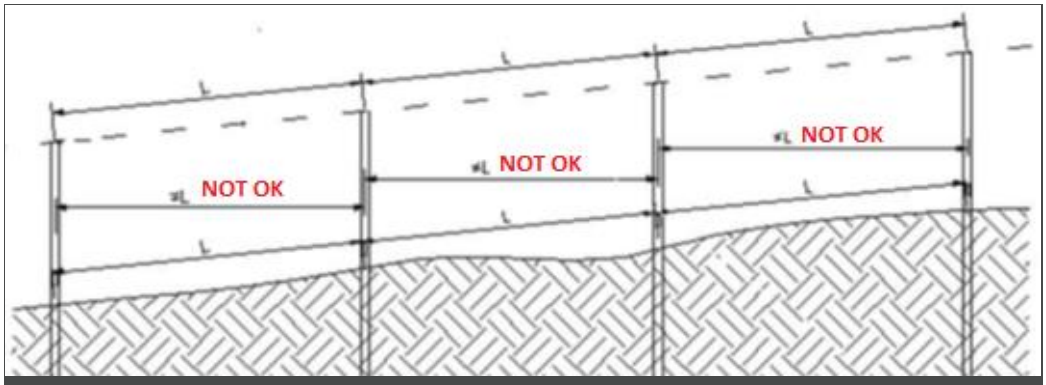

Illustration 5: How to measure

4.2. Material distribution

As soon as the pile position markers have been staked, materials that will be installed shall be placed at those points.

Illustration 6: Distributed mateial

The distribution is carried out with suitable machinery, adapted to the ground and to the limitations existing between the rows. Only materials or equipment that will be installed immediately shall be distributed to these points.

Important:

- Use protective materials on the distribution machinery to ensure that no damage is caused to the tracker elements during the distribution phase.
- All materials or equipment shall be stored in a dry area, especially bolts.

4.3. Installing piles in the ground

When the marking and the positioning of the piles is done, the installation of the piles in the ground can commence.

Whatever attachment method used; the verticality of each pile shall be checked in both directions with a level.

You shall also ensure that the gradient from the first module of the first tracker to the last module of the last tracker in a row is continuous and unbroken. And that there is no deviation of module heights between the end modules of a row of trackers. Alignment and continuity between consecutive trackers shall be maintained.

Pile level execution example: the first pile of a Tracker and the first pile of the following Tracker are positioned, afterwards these two piles are joined to extract the height of the remaining posts that make up the first tracker.

As general information, it's necessary to take into account several factors for executing. The principal one and most bounding factor is the terrain, its composition and the distribution of slops can slow down the execution. Also, the weather, unpredictable, can hinder and suspend the works.

4.3.1. Pile driving works

It is essential for the subsequent assembly and operation of the tracker ***that the top edge of all the piles run along the same straight line.*** For this reason, we shall be very careful with possible ground unevenness.

If the ground is irregular, we shall study the slopes of the land so that the straight line formed by the top edge of the tracker piles meets the following requirements:

- Minimum ramming length
- Minimum/maximum height of the outer pile above the ground
- Dimensions available in the latest version of technical documentation, which also illustrates the data required for each type of file driving.
- The pile driving regulation to ensure that the heads of piles are align in a straight line within tolerance defined section "Tolerances" of this document, refer to *Terrain preparation procedure*, section "2.3 Irregularities"

A hydraulic pile driver must be available to perform these operations. The most suitable power rating will be associated with the hardness of the terrain and the time available to complete the task.

Illustration 7: Pile driving works

In general, two people will perform these tasks. One handling the control panel of the pile driver and another one positioning the pile, checking the verticality of the pile in the North-South and East-West direction at regular intervals.

Important: in order not to damage the piles during pile driving, it is recommended that a guard protector made of rubber or another material is used, fitting to the pile shaped notch in the drive mold.

This machine uses a special mold with a notch in the shape of the pile and hits its head repeatedly, progressively driving it into the ground to the required depth. It is not permitted to use molds that are empty and/or that have gaps that would warp the pile heads during the driving work.

Only TrinaTracker may reject or validate the piles based on any warping after the driving.

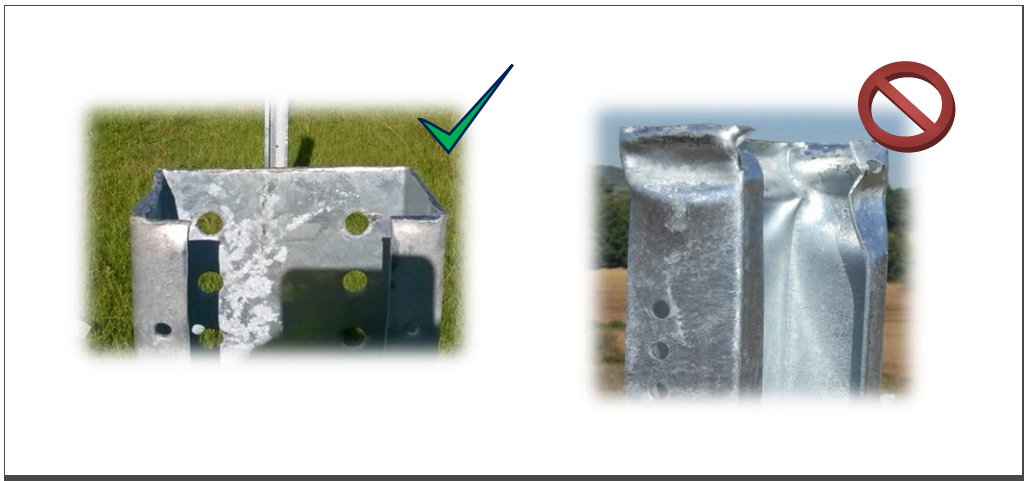

Illustration 8: Pile dvalidation

It is in the assembly contractor's scope to carry out the Pull-Out Tests for validation and the works on the piles related with them. The objective of these tests is to validate the piles in any of these cases:

- The pile has not reached its minimum driving length (foundation design length).
- Some incidence has been observed during pile driving.
- Areas where earthworks over 20 cm thick has been carried out.

If the tests have been satisfactory for any of these situations and TrinaTracker validates these tests, these piles will be validated.

In addition to the validation tests described above, a test shall be carried out by post type and by installed MW.

The remaining piles whose minimum driving length has been reached without incident will be automatically validated.

In case of rejection during pile driving, the assembly contractor shall conduct validation tests and pile repairs.

Once the detailed engineering of the project has been carried out, a detailed validation protocol adjusted with the design loads (refer to Protocol for pile validation) will be supplied by TrinaTracker for this purpose. This document is different from the protocol used for the POT tests in the design phase.

If a pile requires machine cutting or any metallic tracker component requires galvanization repairs, the latest version of the following procedures shall be followed

- - Machining and repair of posts
- - Galvanized Repair with Zinc PAINT
- - Galvanized Repair with Zinc SPRAY

4.3.2. Pile driving alternatives

When direct ramming is not possible, there are alternatives for fixing the piles in the ground:

- Pre-drilling, back filling and ramming.
- Drilling, pile positioning and filling with concrete or concrete footing.
- Special cases.

All these alternatives for fixing the piles to the ground will be explained in a procedure.

4.3.3. Trenches alongside piles

Once the piles are set into the ground at the installation site, avoid digging ditches alongside them, as the strength and compactness of the land, originally assessed by the characteristics of the soil, would be considerably reduced and the piles would not function properly in the structure.

If it is unavoidable and necessary to dig a ditch, the person doing so shall ensure a minimum distance of **1m (40")** from the E-W face of the pile and **1m (40")** from the N-S face of the pile and then, once the ditch has been closed, check the firmness of the soil that has been moved to

ensure the consistency of the impacted piles, either compacting the ground or filling in with concrete.

Illustration 9: Trenches alongside piles

4.3.4. Tolerances

This document explains the general tolerances that shall be met to drive the piles. You shall contact the TrinaTracker engineering department to verify installation tolerances. TrinaTracker will provide drawings with a complete description of the dimensions and tolerances for each project. Only TrinaTracker will have total authority to validate the driving of the piles.

The piles shall be installed according to the initial topographical layout (maintaining parallelism and perpendicularity between rows), at the height of the line formed by the head of the piles.

To check that the consecutive tables have continuity, the tables must support the alignment and the continuity between their posts, although there are slopes in the ground.

The maximum permissible tolerance for the deviation of the head of the poles, with respect to the theoretical design position is as follows:

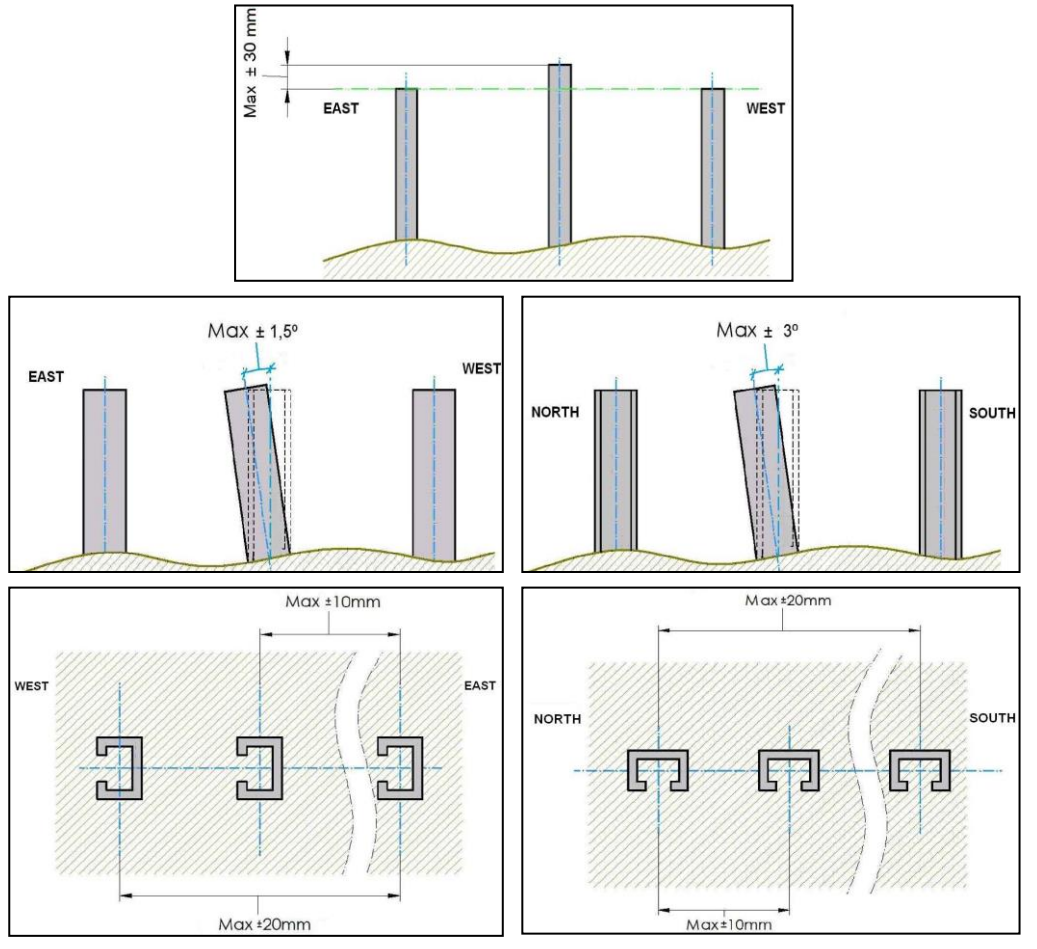

Illustration 10: General post disposition

This is a general post disposition for structures located on the northern hemisphere (PV modules south-oriented). In southern hemisphere projects the orientation should be changed 180º.

TrinaTracker reserves the right to modify the tolerance values here described.

4.4. Assembly of structural elements involved

When the posts are on site, it is possible to start with the assembly of the structural elements involved in the structure. The order is detailed below:

4.4.1. Lintel

The lintels are "C" profiles where the beams will be supported.

The lintel will be placed and fixed to both post with a M16 bolt, do not tighten completely yet. This profile disposes of slotted hole that summed up with the several holes, for a M6 bolt, to allow absorbing some misalignments or height differences during the assembly with a M6 bolt.

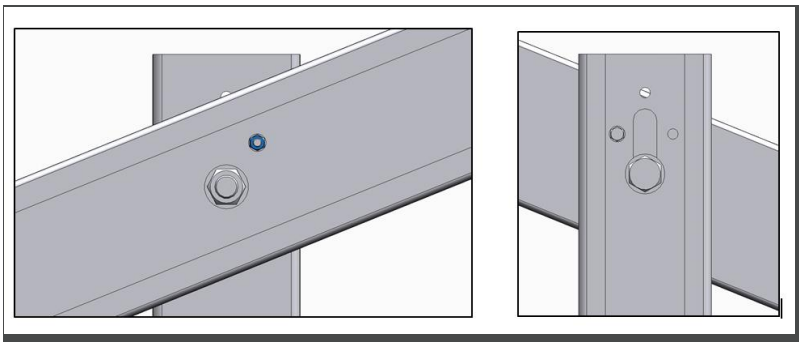

Illustration 11: Lintel position

4.4.2. Braces

To consolidate the structure, the braces must be joined with the posts. This joint will be with M16 bolts, and it allows to slightly adjust or correct the tilt of the structure.

After joining them, do not to tighten totally until finishing the assembly

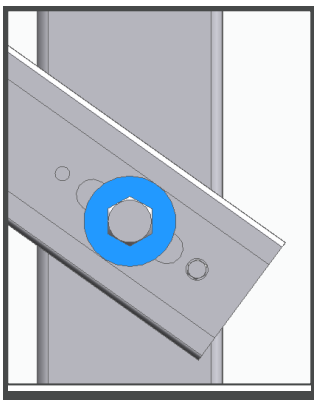

Illustration 12: Braces assembly

4.4.3. X1 joint

This is a 90º angular piece. Above each lintel there will go so many pieces X1 as number of beams needs the table.

The beams are supported by the lintel, both elements fixed and bolted trough the X1 joint. The design including slotted holes allows absorbing small misalignments and correcting the assembly position.

Both joints use M12 screws. It is recommended to tighten with the required torque only the screws of the joint between X1 and lintel.

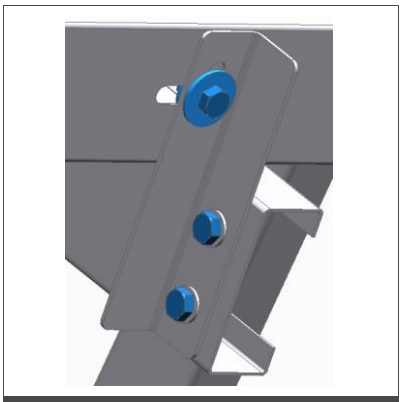

Illustration 13: X1 joint assembly

4.4.4. Post tie beam

The post tie beam is a C or U-shaped profile, which is bolted to the posts through M12 bolts. This piece helps to align the posts and reinforces the structure.

In each table two tie beams will be installed, one in each end of the table. This M12 bolts will be slightly tightened without reach the nominal torque

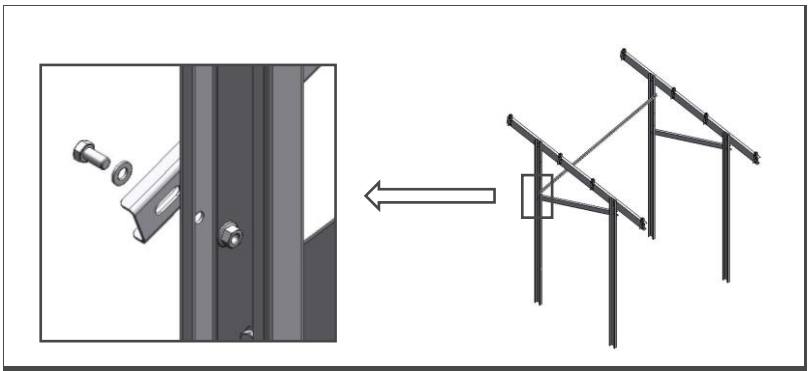

Illustration 14: Post tie beam

4.4.5. Beams

The next step, the beams must be placed.

They are placed on the lintel and supported by the Joints X1, anchored with M12 screws. The number of beams could change according to the project.

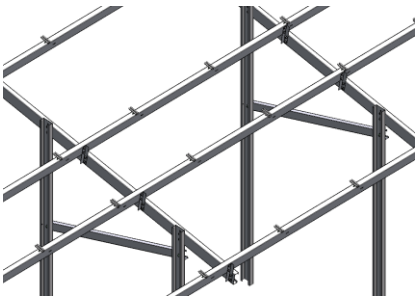

Illustration 15: Beams assembly

4.4.6. Beam joint

This piece is the element that joins two consecutive beams. This joint uses M12 bolts.

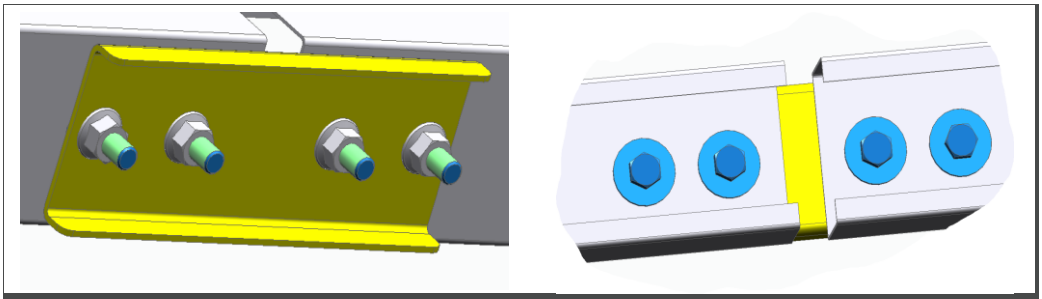

Illustration 16: Beam joint

4.4.7. Tie beam

The tie beam of the beams is "C" or "U" profile. It is bolted in each intersection point with each beam using M12. This element will help to align the beams and provide stiffness to the structure.

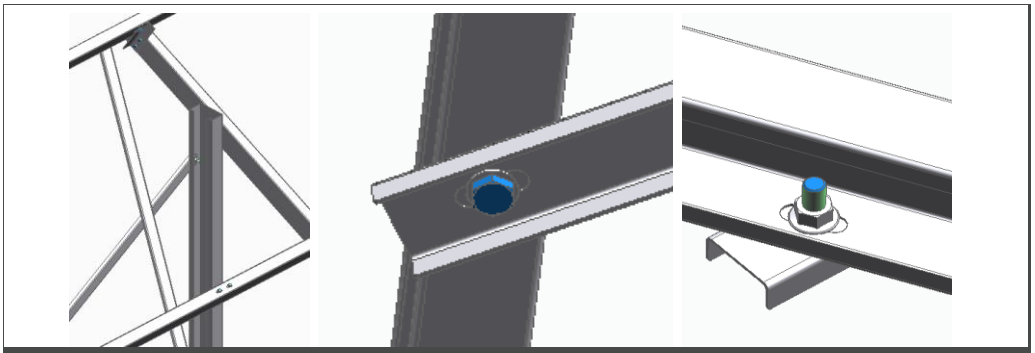

Illustration 17: Tie beam

Two Tie beams will be installed in each table, one in each end of the table. These bolts (M12) will not be totally tightened.

4.5. Completing the assembly

After installing all the indicated elements; the table will be something similar to the drawing below:

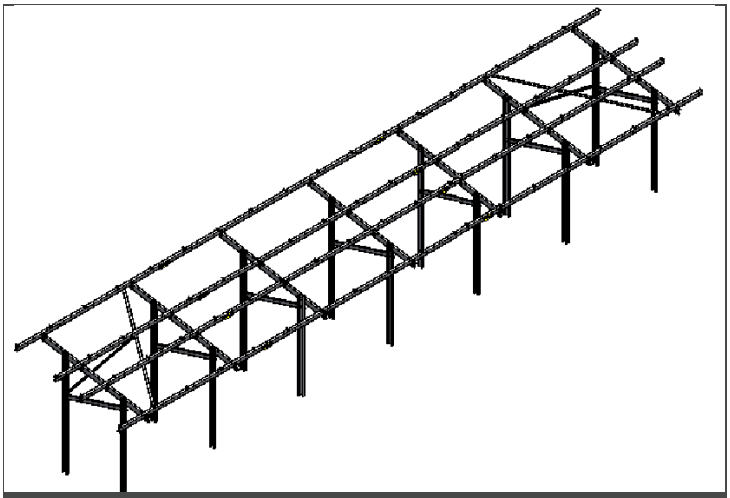

Illustration 18: Assembly

4.5.1. Checking the structure

The bolts are only placed and not tightened yet, except the bolts of the post reinforcement and the join between the X1 and the lintel. To continue fixing all the rest of the bolts with its nominal torque, it's necessary to:

Put the beams well positioned. The beams have to be parallel and aligned between them; to get their correct position, it's necessary to use a square set. This square has two perpendicular profiles between them and an oblique Tie beam to ensure the perpendicularity.

The vertical profile placed in a side of the table, coinciding with the end of the beams or with the first hole to fix the modules. After that, the horizontal profile will be placed at the bottom of the lowest beam. This action will be done in several points of the table, to ensure the correct positioning of the beams, their linearity and distance.

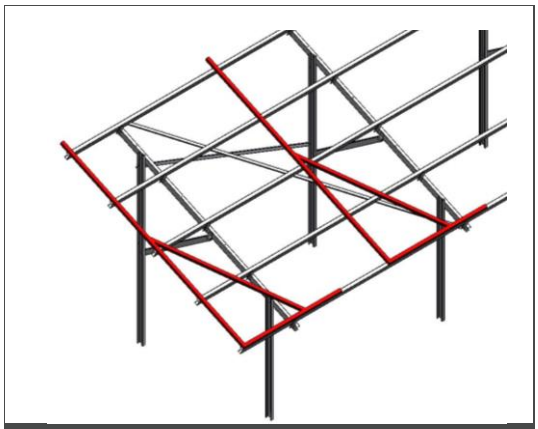

Illustration 19: Checking

Check if the structure position is correct; checking the angle of the lintel, the distance from the modules to the ground and the beams are perfectly aligned.

When all is checked and all is perfectly aligned, that is the moment to start tightening with the required torque, starting with the bolts in the Tie beam of the beams, and after them the rest of the bolts, in the same order than in the assembly. While fixing the bolts, it is required to check that the alignments and distances remain according to the drawings.

4.5.2. Clamps for the photovoltaic modules

Now, the lateral and central Clamps of Aluminum are installed. The height of the lateral clamps will depend of the module, but the central clamps will be always similar. The screws for the fixation of the clamps (M8) will be the same in both places.

The holes of the beams to place the bolts are slotted. Its position will depend on the table configuration.

If the modules are in horizontal position (landscape), the beams will have the slotted holes perpendicular to the beam length. Otherwise, if the modules are installed in vertical position (portrait), the slotted holes will be in the lengthwise sense of the beam.

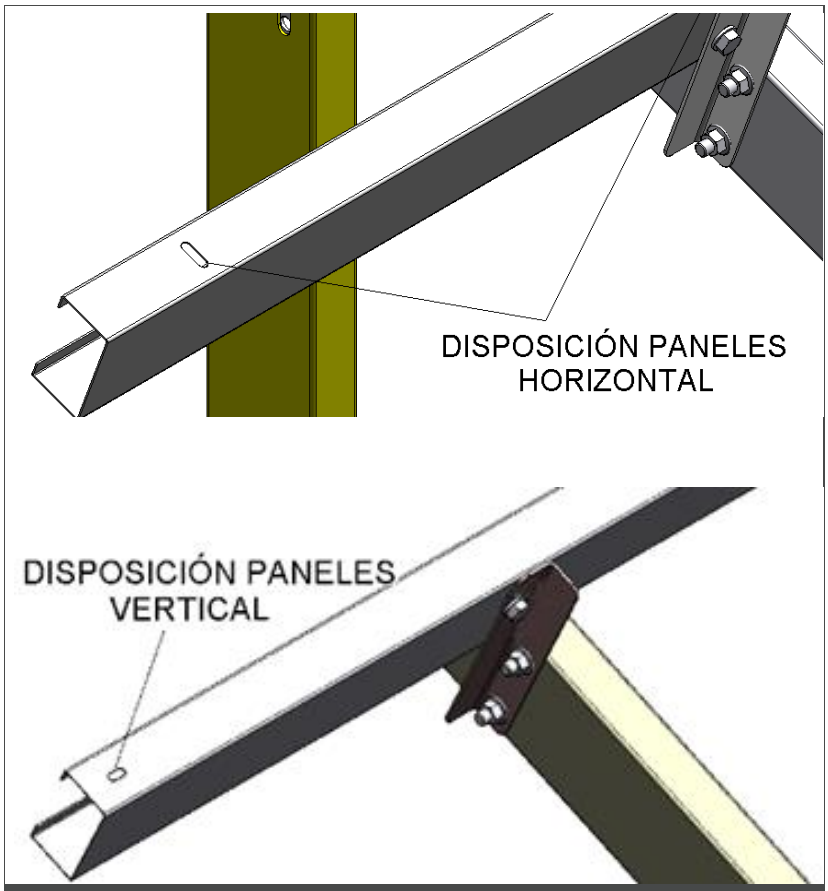

Illustration 20: Clamp assembly

4.5.3. Photovoltaic modules assembly

When the clamps are on site in the structure, it's the moment to start to install the modules.

There are different methods to achieve the correct alignment of them. A method is to install the first and the last module of each table and to connect the bottom of the both modules with a rope, marking the limit position of the modules frame. Thus, it's possible to have the alignment of all the intermediate modules to install.

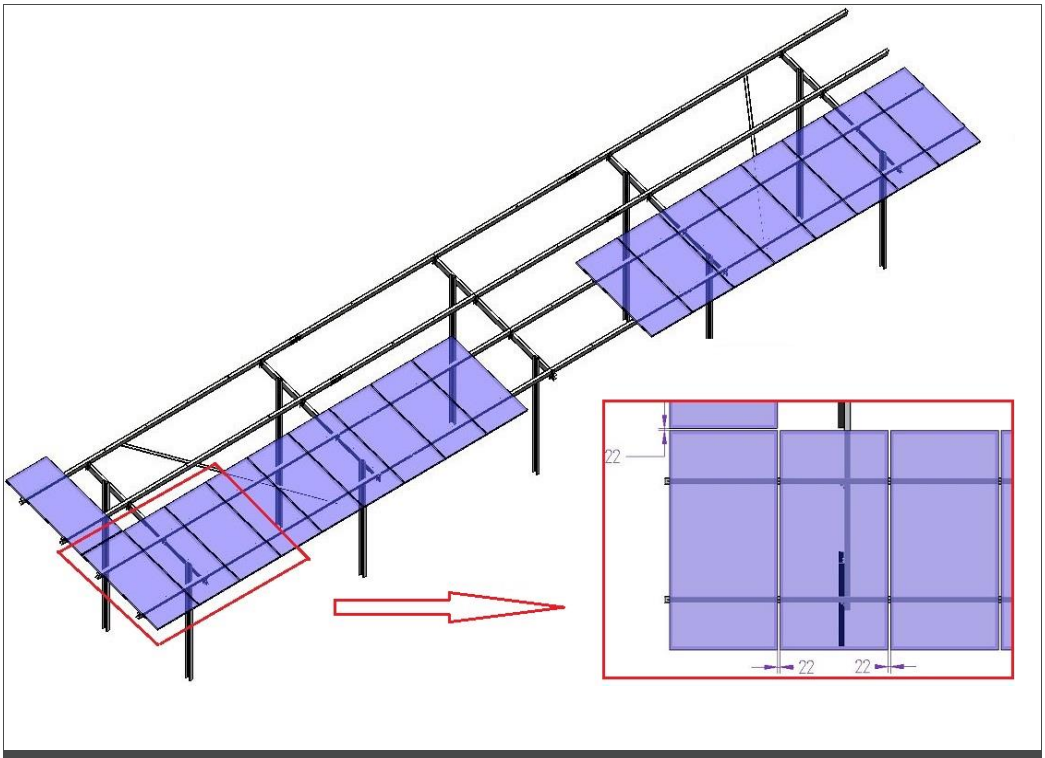

Illustration 21: Module assembly

While installing the modules, the bolts located in the clamps shall be tightened with the required torque.

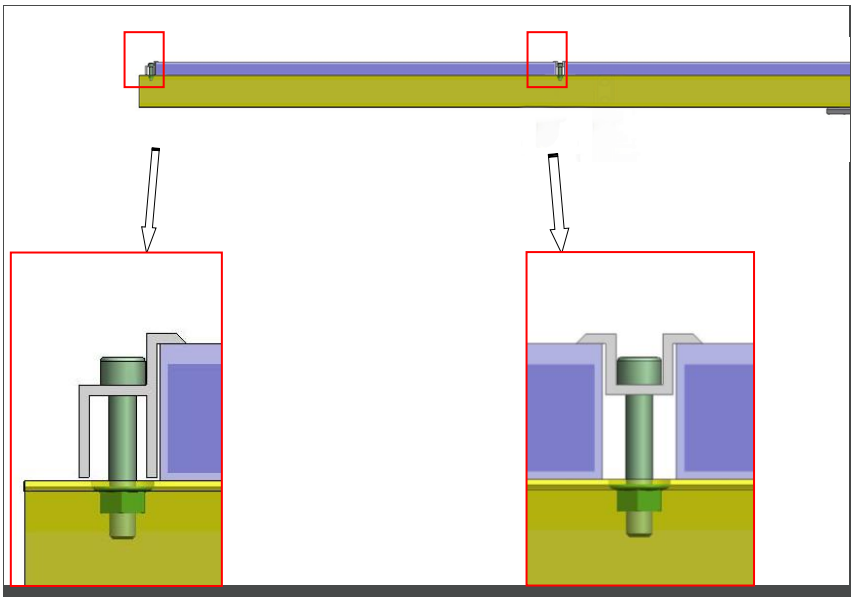

Illustration 22: Clamp assembly

4.6. Grounding

Grounding of the PV Modules is accomplished by the grounding clamps top down clamps using teeth to contact the metal, creating a bonded connection from module to module when torqued.

Expansion joints are used as additional bonding between two adjacent rails.

5 SUPERVISION

It's important to check the assembly and controlling the assembly of the structure until the final validation.

The first checking is performed by the company who runs the assembly, and which is responsible for it.

Always the first inspection is visual. After that visual inspection, the checks could be done with the appropriate tools.

5.1. Necessary tools

The controls will be done with the next tools:

- Torque wrench.
- Meter, metric tape or laser meter.
- Digital level

5.2. Procedure

The control procedure is divided into 2 groups:

- POSTS: This control will be made before assembly of the table.
- STRUCTURE: This control will be made during and at the end of the assembly of the table.

5.2.1. Posts

- To check the location, distribution of the tables and quantity of posts in the surface matches up with the layout.
- To check the distances between posts are the indicated in the layout; distances between posts of the same table and the distance between two consecutive tables.
- To verify that the tolerances of posts are fulfilled.
- Undamaged posts: Visual inspection of the post state, verifying its general state and that it hasn't got shocks, nor dents or other serious damages, that can cause problems while the assembly of the rest of the table.
- Visual inspection of the state of the posts and checking their cleanliness. In case of having faults, write down the remains found to notify the cleaning to the responsible company.

5.2.2. Structure

- Galvanized covering: A visual inspection will be done valuing the state of the covering of the steel profiles. Check their state and their absence of hits or deep scratches which can propagate the rust. The existence of creams or lumps on the galvanized coating is not considered a problem because it increases the microns, therefore increasing the protection of the steel.

  In the case of the ramming posts, the company has done the ramming, must always paint with galvanized painting the top of the posts.
- Complete groups of joint elements and the correct dimensions: Visual inspection of the table assembly and checking the joints assembly.
- Proper placement of different types of profiles: Visual inspection of the structure to ensure that the profiles are mounted according to the drawing.
- Tables inside the tolerances: Visual inspection of the structure (the lintel and braces also). If any abnormalities are observed, it's necessary to check the tilt, and with the help of the digital level, checking the value is inside the tolerances.
- Proper tightening torque on the bolting: Choose a random one different joint of each part of the table, and check with a torque wrench that the indicated torques are met, (for example choosing at random in a table: joint of post with lintel, joint of post with brace, joint of brace with lintel, joint lintel with X1, joint of X1 with beam).

  If in a position, the torque is not the indicated, check the torque next to the wrong torque position, to verify if it's an isolated event or not. If the mistakes are encountered at different points, the workers shall check each and every screw of the table to ensure the proper torque in that table.
- Cleaning the waste: Visual inspection of the state of the table and checking their cleanliness. In case of having faults, to write down the remains found to notify the cleaning to the responsible company.