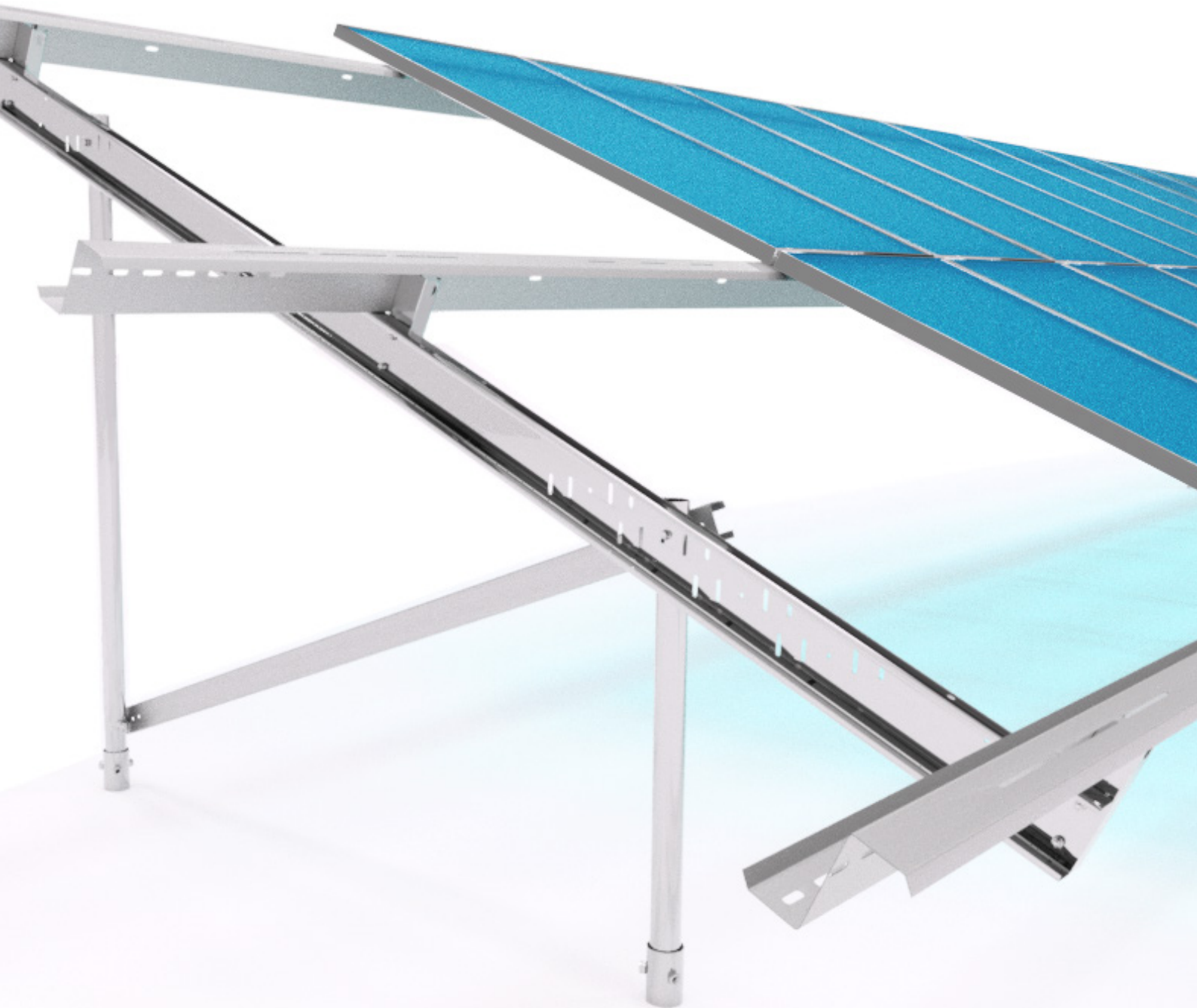


# TITAN<sup>DUO</sup>



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## EQUIPMENT CHECKLIST

### EQUIPMENT REQUIRED

ANCHOR DRIVING EQUIPMENT

### TOOLS REQUIRED

- TAPE MEASURE
- LEVEL
- ANGLE INDICATOR
- TORQUE WRENCH
- CORDLESS DRILL OR IMPACT DRIVER
- RUBBER MALLET
- SOCKET WRENCH
- SOCKET DRIVER (9/16" & 5/16")
- BOX END WRENCH (9/16" & 5/16")
- STRING LINE
- OTHER COMMON CONSTRUCTION TOOLS  
AS REQUIRED

### SAFETY EQUIPMENT (PPE)

- SAFETY GLASSES
- HARD HAT
- STEEL-TOE BOOTS
- REFLECTIVE SAFETY VEST OR SHIRT
- GLOVES - WHEN REQUIRED
- KEVLAR SLEEVES OR EQUIVALENT - WHEN  
REQUIRED

## PARTS LIST

### STRUCTURAL MEMBERS

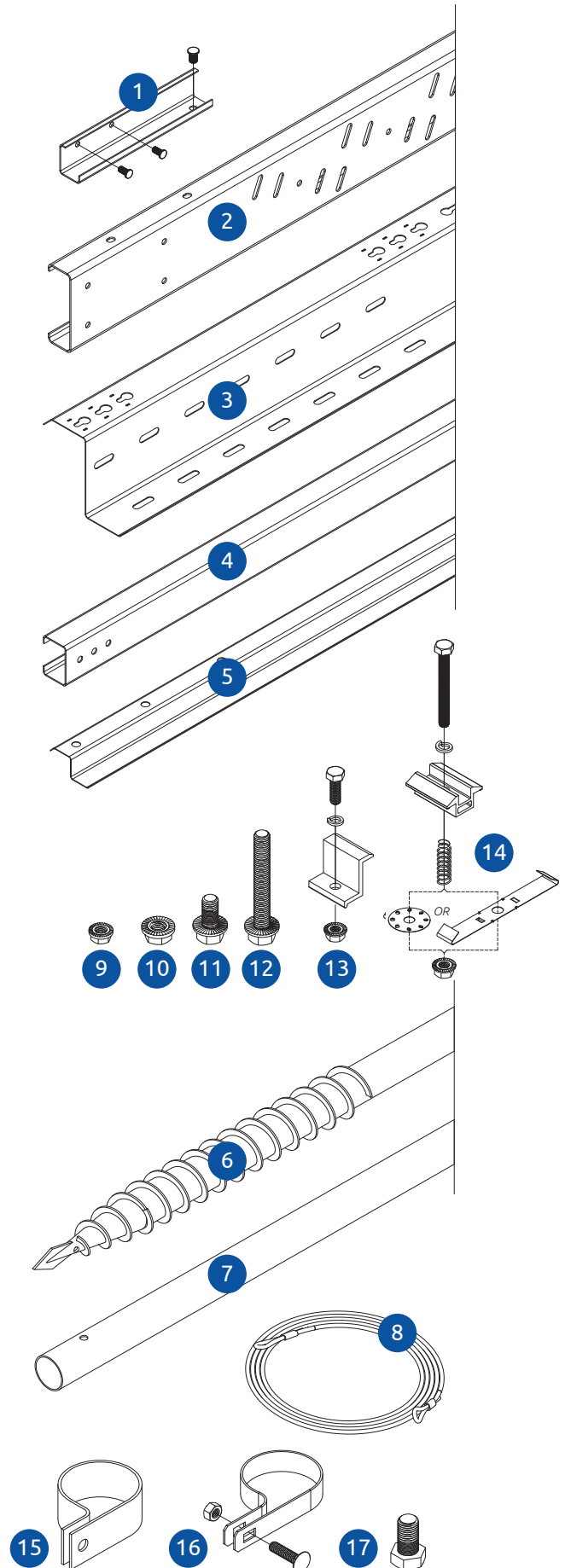
- [1] ROLL BRACKET ASSEMBLY  
2X 3/8-16X1.0" PUSH-IN STUD  
1X 1/2-13X1.0" PUSH-IN STUD
- [2] NS CHORD
- [3] EW ZEE PURLIN
- [4] KNEE BRACE
- [5] TRANSVERSE BRACE
- [6] SCREW PILE
- [7] ANCHOR POST
- [8] CABLE BRACE

### HARDWARE

- [9] 3/8-16 SERRATED FLANGE NUT
- [10] 1/2-13 SERRATED FLANGE NUT
- [11] 1/2-13X1.0" SERRATED FLANGE BOLT
- [12] 1/2-13X3.5" SERRATED FLANGE BOLT
- [13] END CLAMP ASSEMBLY  
M8X1.25 25MM HEX BOLT  
M8 LOCK WASHER  
END CLAMP (SIZED FOR PANEL)  
M8X1.25 SERRATED FLANGE NUT
- [14] \*MIDCLAMP ASSEMBLY  
M8X1.25 70MM HEX BOLT  
M8 LOCK WASHER  
MID CLAMP  
SPRING  
M8X1.25 SERRATED FLANGE NUT
- [15] KNEE BRACE CLAMP
- [16] CABLE CLAMP ASSEMBLY  
CABLE CLAMP  
5/16 HEX NUT  
5/16 CARRIAGE BOLT
- [17] M16X2.0 30MM HEX BOLT

\*FOR OUTER ZEE PURLINS; MIDCLAMPS:  
WEEB WASHER

\*FOR CENTER ZEE PURLIN, MIDCLAMPS:  
GRAVITY CLIPS



## CONSTRUCTION 101

All structures, regardless of how complex, are built one step at a time. Each new step builds on the previous. In order for the final structure to be complete, it is best to ensure that each step is correct. It is far easier, faster, and cheaper to take your time to ensure each step is done correctly, before moving on. There is no remedy for an error other than a correction. Time and effort will be put forth eventually to redo steps, reconstruct, and make adjustments, but far less effort is required to correct mistakes as they appear. If errors are fixed immediately, each subsequent step will begin correct and projects will run more efficiently.

It is recommended to completely install a test row from beginning-to-end of the row, and from beginning-to-end of all steps (from layout, to panel installation, and adjustments). This will help you understand not only how to install the product, but understand how tolerances stack up, how mistakes in one step cause errors in other steps, and how to make the adjustments required to keep everything in tolerance and looking good.

## SITE PREPARATION

Site preparation should be conducted prior to construction. This will typically involve grubbing, rock and debris removal, and any other preparation that will facilitate swift and unhindered installation.

## UTILITIES

All utilities should be marked before any construction begins.

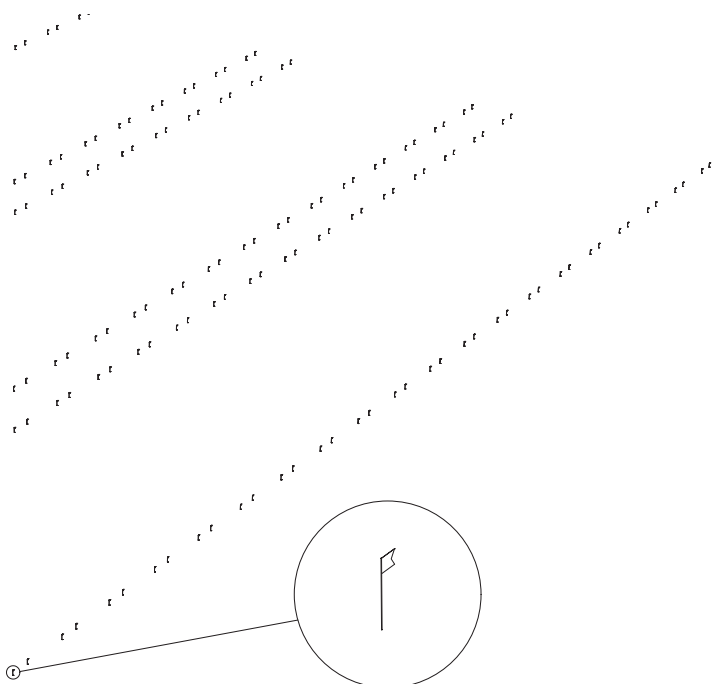
## SURVEYING

To ensure the solar array is installed according to customer plans, the beginning and end of each row must be surveyed and staked, according to spacing determined by AP Alternatives. This will typically be survey points for the piles at each row end, for every row. This includes the north and south pile location for the Titan Duo system. Longer rows will also require additional, auxiliary stakes, to assist in keeping rows straight. For projects with significant topography, additional auxiliary stakes may also need to be installed.

## NOTE

Ideally, pile locations should be surveyed by a professional surveyor, who can stake out end of row post locations to the highest precision.

### PRO TIP I



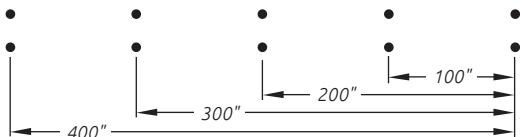
## REVIEW & INSTALLATION PREPARATION

After site preparation has been completed and the site surveying is done, the piles are ready to be installed. It is the responsibility of the site lead to review and understand the site foundation layout, surroundings, installation procedures, and to manage the installation to completion. Each project has different requirements (embedment depths, spans, etc.) that need to be met according to site testing and data gathered prior to the start of the project. The site lead must verify that the piles on site match the order and project requirements.

Dimensions in the East-West direction will change depending on row length, row location, and location within the row. Closely follow the construction plans and if there are any questions/discrepancies, bring them up to the site lead or project manager before installing any piles.

## MEASURING

All measurements in the East-West direction must be made with a steel tape, and made from the start of the row, not pile to pile. For example, if the plans were to call for the first 4 spans to be 100" each, the tape should be staked to the ground, and the ground should be marked at 0", 100", 200", 300", 400".

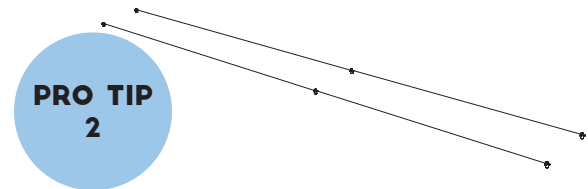


Measuring from pile to pile allows tolerances to stack up. In this case, a 2" tolerance would have stacked up to be 8" off by only the fifth pile, and will cause major installation issues further down the road. If necessary, tapes should be marked prior to usage or prints should be marked up to indicate additive measurements (ie. 0", 8'4", 16'8", 25'0", 33'4").

For Titan duo systems, the North and South points must remain in line with each other (one should not "chase" the other). Ensure the points are square every few sets by measuring diagonals. If marks are found to be out of square, make adjustments to correct.

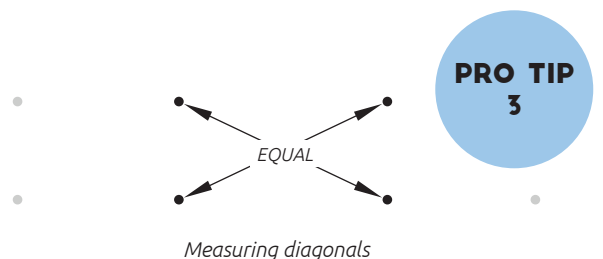
## STRINGING

1. Install a pile at the initial starting point. Remove the initial pile marker and line the point of the screw pile with the location where the marker was.
2. Ensure the pile is held plumb and in the proper location using a level and steel measuring tape.
3. Drive the pile to the correct depth as indicated by the construction documents (for Duo, this typically means that the top of the screw is 6" from the ground).
4. Repeat further down the row with another pile to create the next attachment point for the string line, once again measuring and ensuring plumbness.
5. Continue to the end of the row, as required to set a string line.
6. Run a string line between all piles at the same height.



For consistency, the string line should run along the same side of the pile for the entire site (for example, always wrap counterclockwise, then install new piles on the south side of the string). This will help prevent zig-zagging.

When topography is present, intermediate pile or stakes must be installed so that the string line can transition through hills and valleys at a moderate rate. Although the racking will follow terrain, it has limits. Therefore, ensuring smooth flow will greatly aid the installation process.



## FLAT SITES

Drive the pile with a single-point, starting at one end of the site. The string line method is best for ensuring a straight line and a perfect plain of the array. Alternatively, use location lasers or GPS to keep in a straight line. Use height lasers to ensure correct depth, or story sticks if not equipped. If using a story stick, ensure measurements are taken from the relative ground height, and not a localized non-conformance, ie. mole hills, divots, rocks, etc.

## UNEVEN GROUND

For sites with ungraded or rolling topography, the string method can be used as well. It is important to ensure that the posts are set to the correct depths, and that the finished system should appear to conform to the landscape. These posts will need to be measured individually from the ground to the top to ensure they are at the correct height. In cases where post locations can not be marked on the ground (uneven terrain), it is advised to have the surveyor mark the location of every post, rather than just the beginning and end of each row.

**PRO TIP**  
4

## OBSTRUCTIONS

If an impassable object is encountered at the desired post location, it is best to relocate it 6-8" East or West of the original location and drill new holes in the EW zee purlins. For Duo, you must also move its mating post. Example: If you move a North (tall) post, you must also move the South (short) post (and vice versa) in the same direction and distance to ensure they properly mate.

**PRO TIP**  
5

## HEIGHT ADJUSTMENTS

When posts are secured at the incorrect height, an adjustment may need to be made. Tie a string from one known good height post to another, on either side of the affected pile. Use this line to determine the correct height for the enclosed posts. If the post is too tall, loosen the pile bolts and adjust the post to the correct height. If the post is too short and there is not enough post length to adjust to the proper height (due to terrain), a post splice or longer post may need to be used.

**PRO TIP**  
6

## PILE INSTALLATION

1. Install a pile at the initial point. Remove the initial pile marker and line the point of the screw pile, or the center of the helical pile, with the location of where the pile marker was.
2. Ensure the pile is held plumb and in the proper location using a level and steel measuring tape.
3. Drive the pile to the correct depth as indicated by the construction documents (typically the top is 6" from ground).
4. Repeat further down the row with another pile to create the next attachment point for the string line, once again measuring and ensuring plumbness.
5. Continue to the end of the row, as required to set a string line.
6. Run a string line between all piles at the same height.

For consistency, string line should run along the same side of the pile for the entirety of the site (for example, always wrap counterclockwise, then install new piles on the south side of the string). This will help prevent zig-zagging.

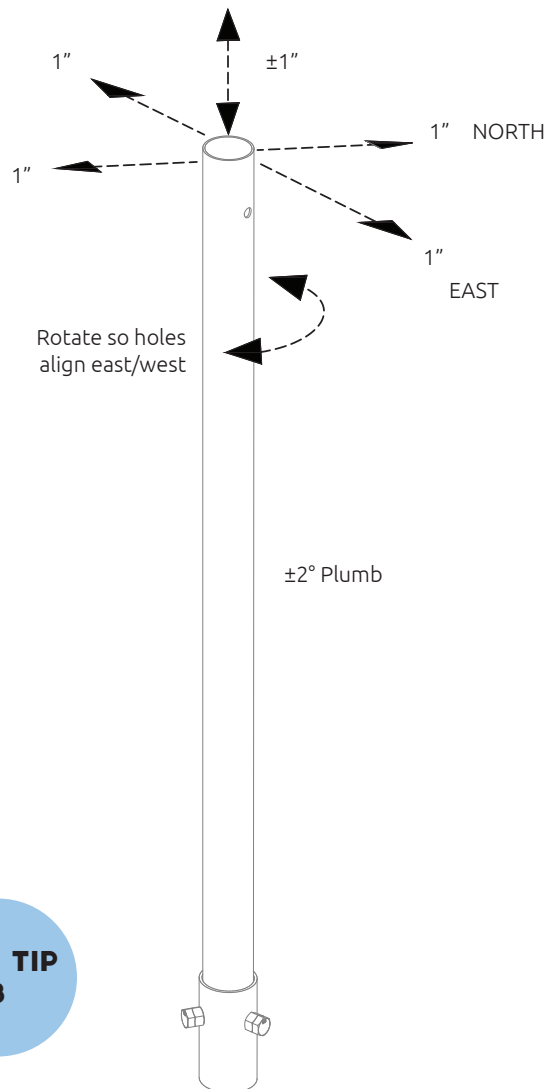
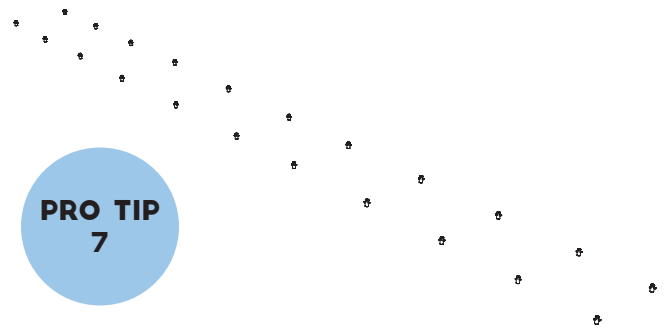
When topography is present, intermediate piles or stakes must be installed so that the string line can transition through hills and valleys at a moderate rate. Although the racking will follow terrain, it has limits. Therefore, ensuring smooth flow will greatly aid the installation process.

7. Install all remaining piles, as above, using the string-line as a guide for placement and height.

## ALTERNATE PILE INSTALLATION

For sites with medium to heavy rock or bedrock, holes may need to be piloted and backfilled prior to pile install. When required, perform the following steps prior to step 2 above.

1. With an auger or rock drill, drill a pilot hole to correct depth and diameter.
2. Fill the hole with stone as indicated by APA.



**NOTE**  
Check all survey before pilot drilling.

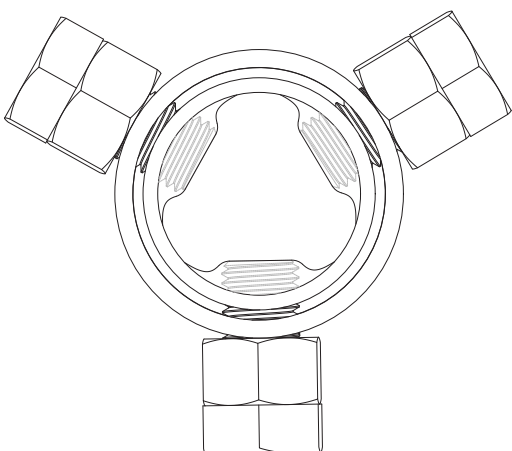
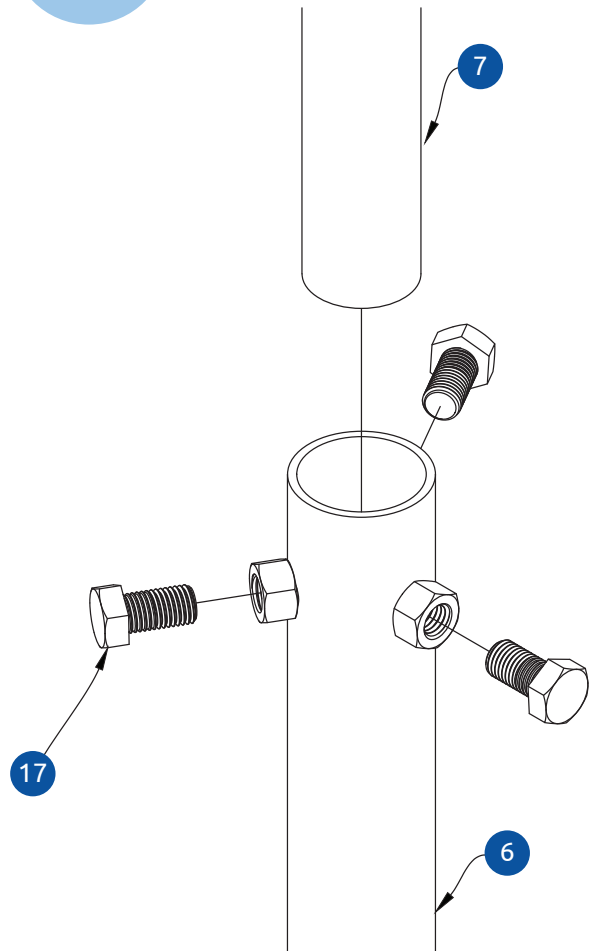
## ANCHOR POST-TO-PILE

1. Insert the short anchor post (pipe) in the front (South) pile.
2. Measuring from the ground to the top of the post, ensure the posts are at the correct height according to the construction plans. Also ensure the upper bolt holes are rotated to align in the East-West direction.
3. Secure the post at the pile with three (3) bolts. Screw each bolt a little at a time so that all bolts engage the same amount.

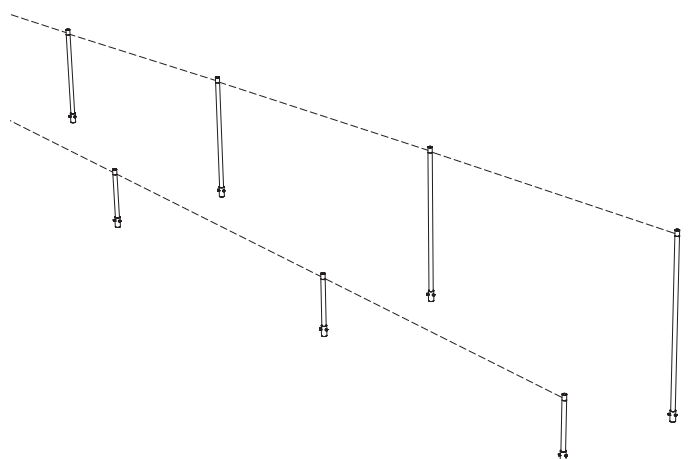
- [6] SCREW PILE
- [7] ANCHOR POST
- [17] M16X2.0 30MM HEX BOLT

4. Do the same by installing the long post in the rear (North) pile.
5. Repeat a distance further down the row as you did with the piles. Continue to the end of the row.
6. Run a string line between all the front posts and between all the rear posts.
7. Using string line as reference, install the intermediate anchors as before.
8. Ensure the heights of all anchors are correct and flow with the terrain in the method indicated in the construction plans.
9. Once heights are verified correct and rotation is correct, bolts can be tightened. Fully tightened bolts deform the posts creating a very strong bond and further adjustments are typically not possible.

**PRO TIP**  
9



Top view of anchor post and fully tightened bolts

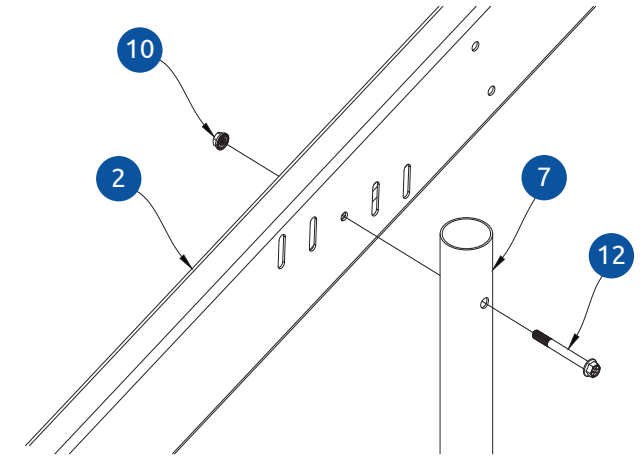




## N/S CHORD-TO-REAR POST

1. Attach the N/S chord to the rear post.
2. Ensure the N/S chord is on the West side of the post, with the flat side against the post, and the smaller flange with the slots pointing upwards, as shown.
3. Secure with a bolt and a nut through the single hole. Fasten loosely.

- [2] NS CHORD
- [7] ANCHOR POST
- [12] 1/2-13X3.5" SERRATED FLANGE BOLT
- [10] 1/2-13 SERRATED FLANGE NUT



## KNEE BRACE & CHORD-TO-FRONT POST

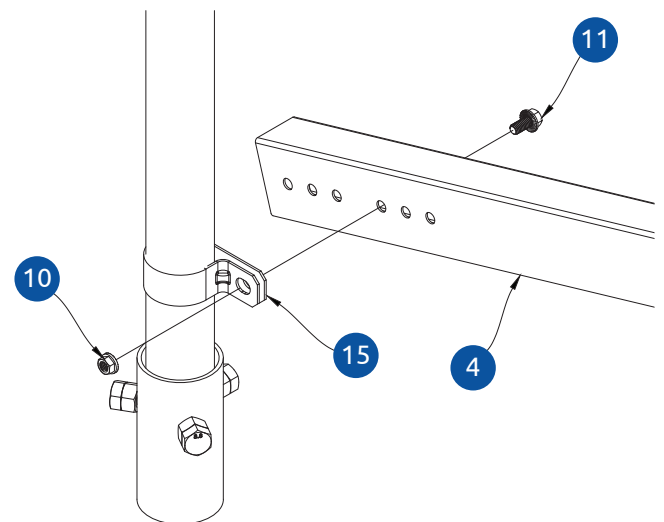
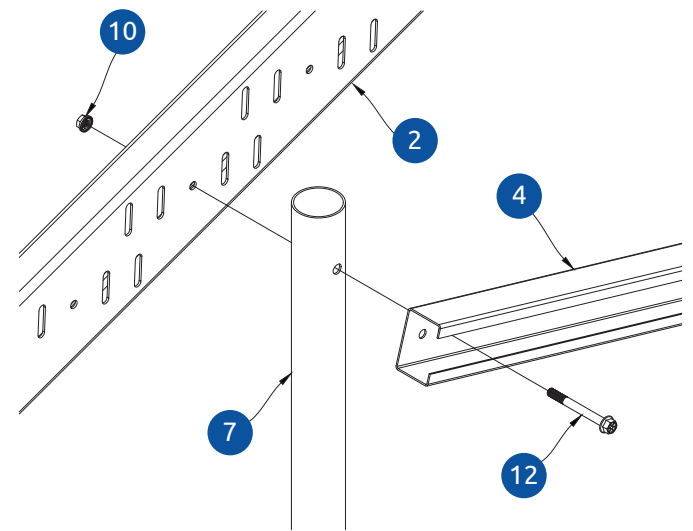
1. Attach the N/S chord and the knee brace to the front post at the same time.
2. Refer to the construction drawings for the correct nominal attachment holes/slots in both the knee brace and the N/S chord. Additional holes/slots can be used for adjustments.
3. Knee brace is symmetrical at both ends. Ensure the flat side is against post.
4. Secure with a bolt and a nut through the single hole. Fasten loosely.

- [4] KNEE BRACE

## KNEE BRACE-TO-BRACE CLAMP

1. Slide the brace clamp over the rear post prior to attaching the N/S chord or stretch the clamp apart, fit it around the post, and squeeze it back to its original shape.
2. Ensure the long, flat side of the clamp is facing the East so it can mate flush with the knee brace, as shown.
3. Secure through the nominal hole as indicated in the construction documentation with a bolt and a nut. Fasten loosely.

- [15] KNEE BRACE CLAMP
- [11] 1/2-13X1.0" SERRATED FLANGE NUT



**PRO TIP**  
10

### NOTE

Images are for reference only. Ideal hole/slot connection points may vary.

## ROLL BRACKET-TO-N/S CHORD

1. Along the flat side of the N/S chord, with the slots on the N/S chord pointing up, attach a preassembled roll bracket.

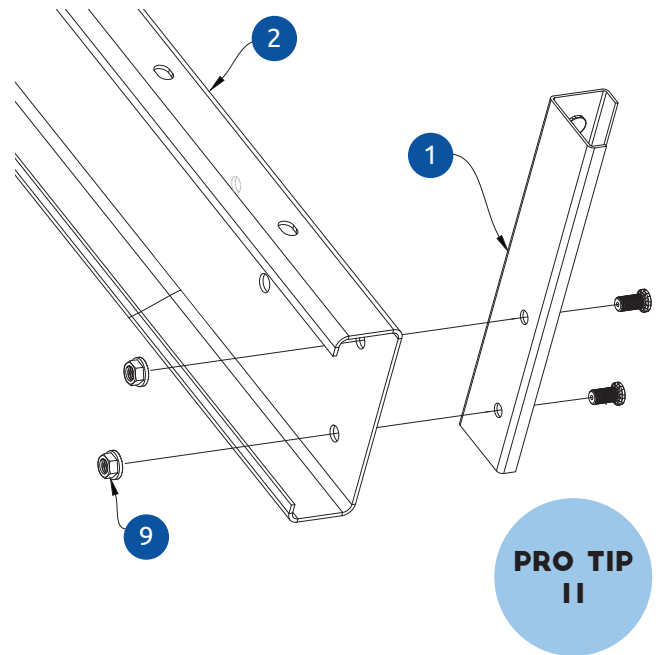
2. Match the two (2) studs in the roll bracket assembly in the correct hole set at the front of the part.

Note: At the front & rear locations there are multiple hole sets (inner & outer). Refer to site build plans to determine which set to use. Correct usage is based on specifications provided by the module manufacturer, and will remain consistent on each project (assuming only one module model is used).

3. Secure both studs, each with a nut.

4. Repeat steps for all remaining roll brackets. There are three (3) roll brackets per N/S chord.

- [2] NS CHORD
- [1] ROLL BRACKET ASSEMBLY
- [9] 3/8-16 SERRATED FLANGE NUT



## ZEE PURLIN STAGING

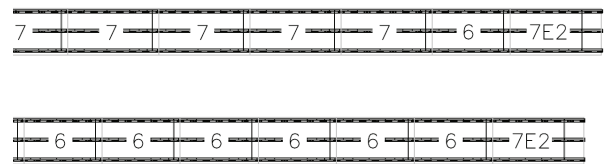
Stage the zee purlins by setting them on the N/S chord and resting above the roll brackets.

1. Refer to the build plans to ensure the correct zee purlins are in the correct position. There are differences in either length or hole patten in the zee purlins, so ensure the correct part number is used. There typically are multiple zee purlins of the same length, with only slightly different hole patterns.

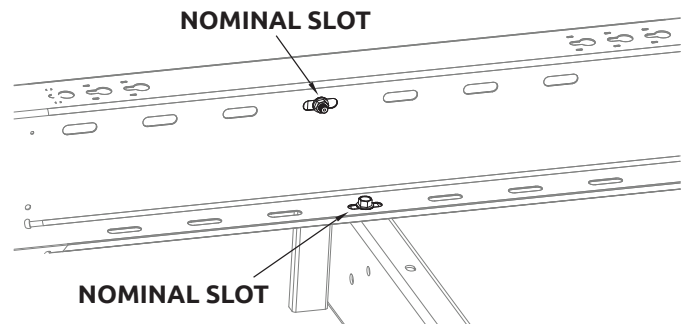
2. Ensure the zee purlins are in the correct orientation, as shown, with the slotted side facing up and towards the front of the rack.

3. The stud should typically go through the center slot (4th slot) on both purlins. Occasionally, the other slots may need to be used to resolve foundation installation errors.

4. The direction of the overlap (which zee purlin is on top) is unimportant, and either order is acceptable.



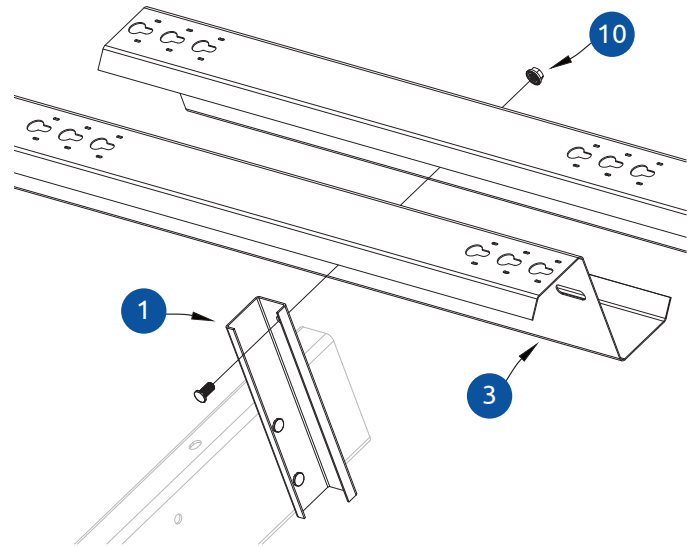
Example zee purlin layout



## ZEE PURLINS TO ROLL BRACKET

1. Ensure the stud goes through both zee purlins.
2. Secure with a nut. Fasten loosely.
3. Repeat at all locations for each N/S chord. There are three (3) roll brackets and connections required per N/S chord.

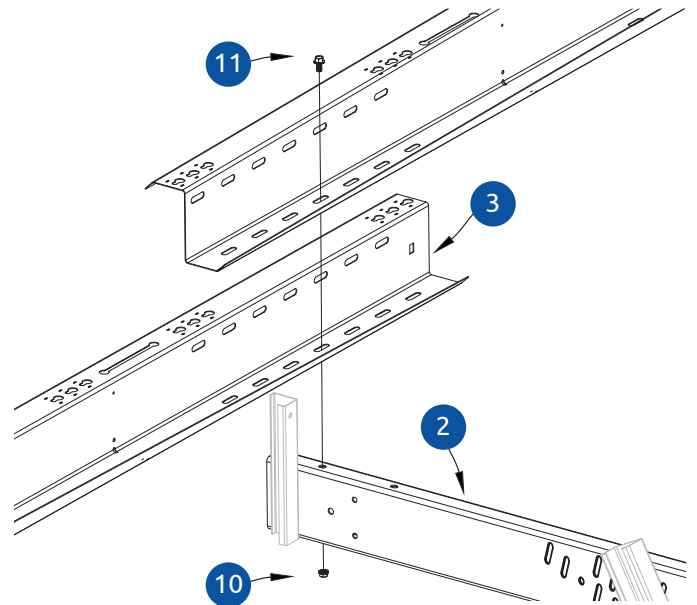
- [3] EW ZEE PURLIN
- [1] ROLL BRACKET ASSEMBLY
- [10] 1/2-13 SERRATED FLANGE NUT



## ZEE PURLINS-TO-N/S CHORD

1. The zee purlins should already be in the correct location and loosely fastened by now.
  2. Fasten the zee purlins to the N/S chord with a bolt and nut. Ensure the bolt is facing down (to keep wire tray clear). Fasten loosely.
- Note: the lower slots are matched to the middle slots, so there is no choice in slots at this points. See note about nominal slots in the ZEE PURLIN STAGING step.
3. Repeat at all locations for each N/S chord. There are three (3) connections required per N/S chord.

- [11] 1/2-13X1.0" SERRATED FLANGE BOLT
- [2] NS CHORD



**PRO TIP**  
12

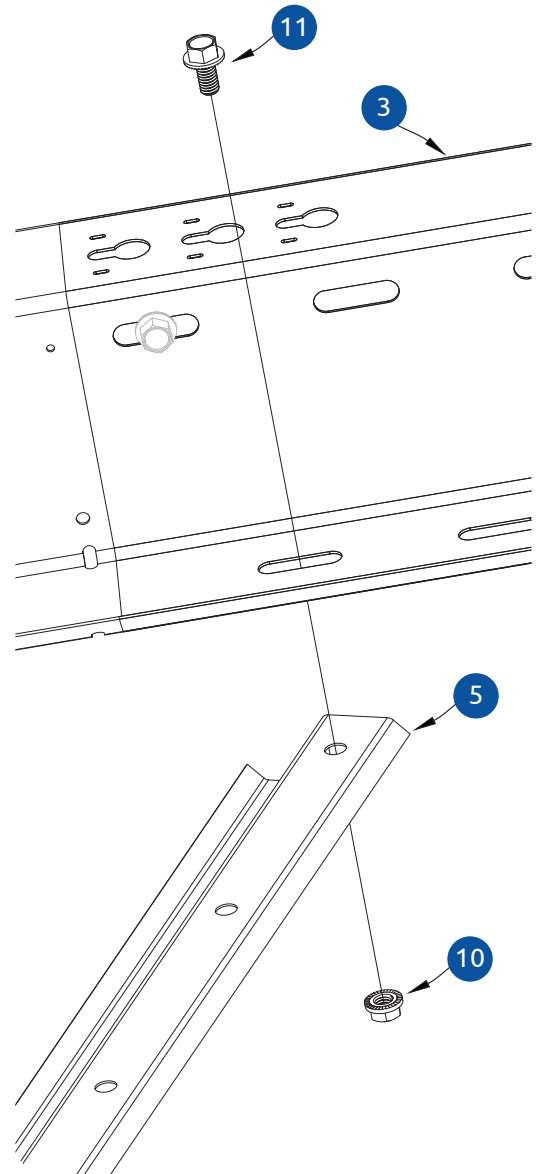
## TRANSVERSE BRACE-TO-ZEE PURLIN

1. Install the transverse braces to the zee purlins at the locations required per the construction plans. Braces are always installed in sets of two (2); one pointing East, and one pointing West. Braces are required at the first and last purlin splice on each row, and at increments required per the plans.

2. Starting at the southern purlin splice (front), fasten the transverse brace to the purlin through the outer-most lower slot of the zee purlin (slot #1 or #7). The holes in the transverse brace must face up, but the orientation (which direction the flanges point) is unimportant. The correct hole in the transverse brace must also be used. This is dependent on the location of the roll bracket (inner or outer) and should be indicated on the construction plans. If the roll brackets are installed in the outer location, the outer-most holes at each end of the transverse purlin are used. If the roll brackets were installed at the inner location, the middle holes in the transverse brace should be used.

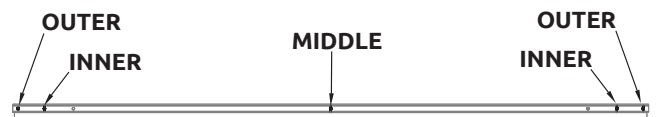
3. Secure with a bolt and nut (ensuring the bolt is facing down). Fasten loosely.

- [3] EW ZEE PURLIN
- [5] TRANSVERSE BRACE
- [11] 1/2X1.0" SERRATED FLANGE BOLT
- [10] 1/2-13 SERRATED FLANGE NUT



### NOTE

Transverse braces are not for squaring the structure but to minimize transverse movement (racking) and keep the rack square. If the rack is not square to begin with, the transverse braces will not fit or function correctly. If different holes than outlined here must be used, the rack is not square and further installation of the panels will not be correct. Ensure transverse braces are installed prior to panels installation.



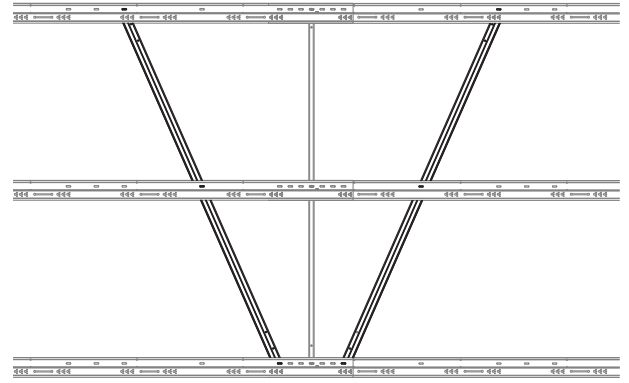
## TRANSVERSE BRACE-TO-ZEE PURLIN (CONTINUED)

4. Repeat at the opposite end of the transverse brace, directing the brace away from the splice. There is a solo slot approximately 5' from the outer splice hole. Fasten through this hole using the outer or middle hole in the transverse brace (same as step 2).
5. Finally, fasten the transverse brace to the middle zee purlin using the middle hole of the middle set of holes in the transverse brace.
6. Repeat steps 2-5 and install the matching transverse brace on the opposite side of the splice, and angle it in the opposite direction.
7. Repeat steps 2-6 for all remaining braces as indicated on the construction plans.

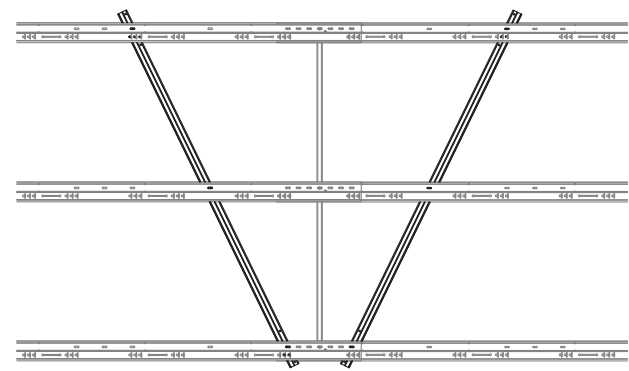
## ZEE PURLIN-TO-ZEE PURLIN (SPLICE)

1. Splice the zee purlins together once the transverse braces are installed and the purlins are attached to the N/S chords.
2. Each splice should have four (4) additional bolts at each location. Ideally, these should be at the outer-most slots at the center web and on the lower flange of the zee purlins.
3. If the splice is already connected at the lower flange with a transverse brace, only the two (2) connections in the center web are needed. If the N/S chord is located at either outer-most hole, those splice bolts should be moved inward one (1) set. All splices should have six (6) connections in total.
4. Secure each with a bolt and nut. Fasten loosely

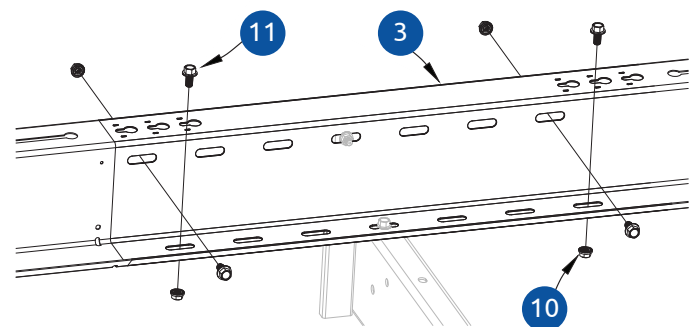
- [3] EW ZEE PURLIN
- [11] 1/2X1.0" SERRATED FLANGE BOLT
- [10] 1/2-13 SERRATED FLANGE NUT



*Roll Brackets (and Zee Purlins) set to outer holes, use brace outer holes*



*Roll Brackets (and Zee Purlins) set to inner holes, use brace inner holes*



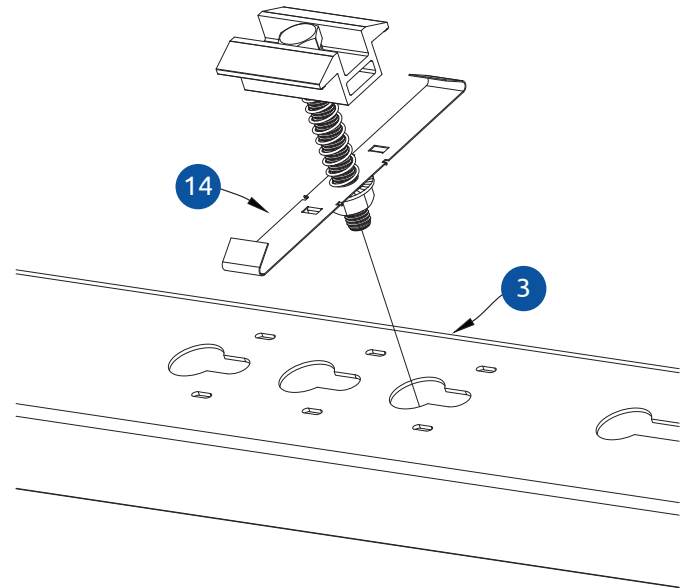
## GRAVITY CLIP PREINSTALLATION

1. On the center zee purlin, install the gravity clip assembly (midclamp assemblies with the gravity clip).
2. Refer to the construction documentation for the precise locations of where the gravity clip assemblies are required. Two gravity clip assemblies are required per panel (which are shared with the panel above or below it).
3. Gravity clip assemblies should typically only be installed in the short keyslots (there are three short keyslots for each set. Refer to construction documentation for correct slot usage).
4. Install by holding the assembly with the nut down towards the zee.
5. Push the nut through the large hole in the keyslot, and slide the assembly over until the two tabs on the gravity clip engage with the two slots above and below the keyslot. This keeps the gravity clip in place and prevents rotation and movement in further steps.
6. If needed, rotate the midclamp so that the long side aligns with the zee purlin. Do not tighten.
7. Install all remaining gravity clip assemblies for the row.

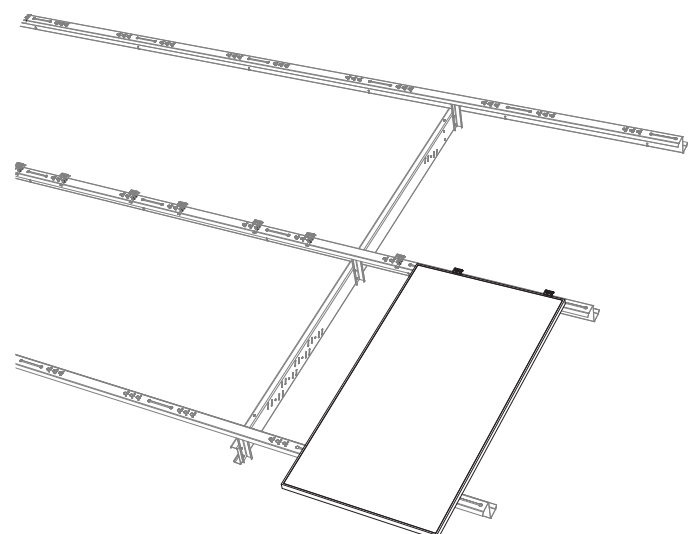
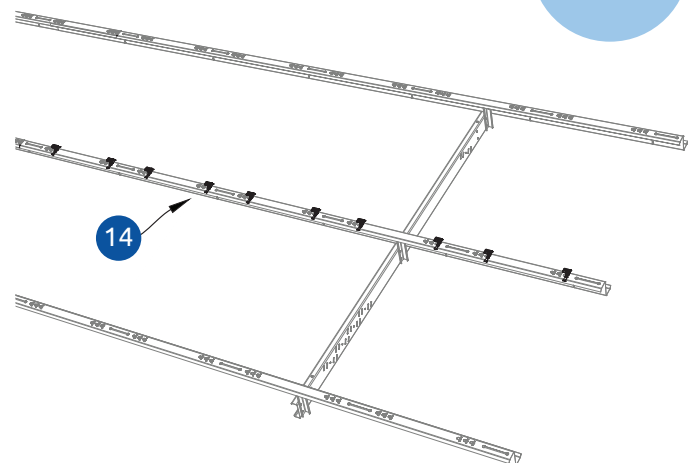
- [3] EW ZEE PURLIN
- [14] GRAVITY CLIP & MIDCLAMP ASSEMBLY
- [14b] WEEB WASHER & MIDCLAMP ASSEMBLY
- [13] END CLAMP ASSEMBLY

## PANEL INSTALLATION

1. Starting at one end, begin setting the pv modules. Refer to the construction documentation to determine the correct orientation of the panel (to correctly align the junction boxes at the rear of the module).
2. Stage the first lower module by hanging the module on the lower hooks of the first two preinstalled gravity clip assemblies.
3. Stage the upper module directly above the lower module, ensuring the module aluminum frame is against the gravity clip. Failure to ensure a good fit may result in the grounding teeth not engaging properly.

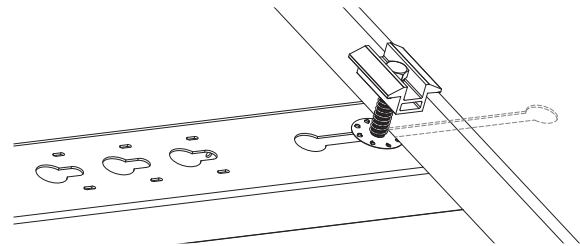
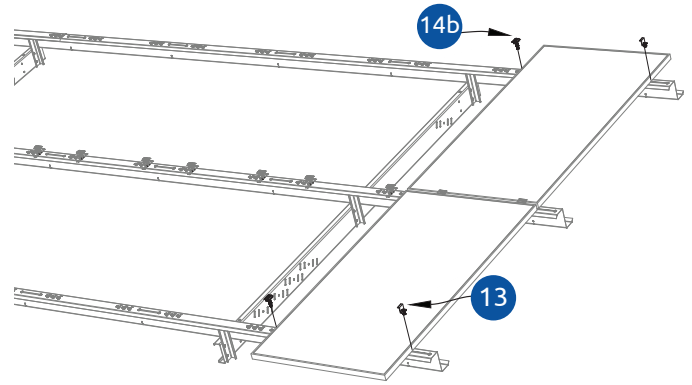


**PRO TIP  
13**

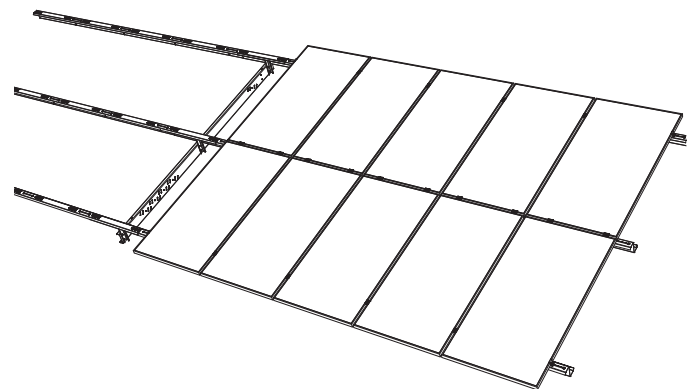


## PANEL INSTALLATION (CONTINUED)

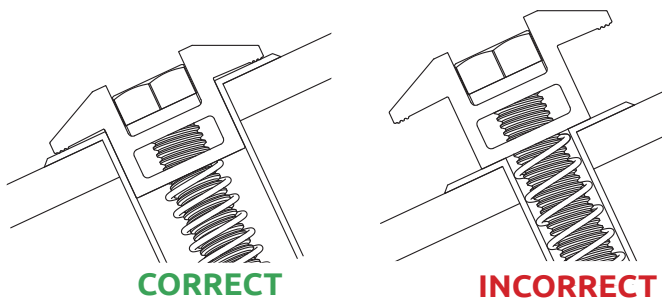
4. Align the long edges of the modules so they are flush.
5. Install an end clamp at the beginning, on both the top and bottom modules, in the long keyslot. Keep loose.
6. Install midclamp assemblies (with the weeb washer) on the inner edges of the top and bottom modules, typically in the long keyslots. Keep loose.
7. Continue staging modules and placing midclamp assemblies up to the reset point (the point which requires more endclamps). Each time, stage the lower panel, then upper module, then both midclamp assemblies.
8. Adjust the modules East to West until they are all in the correct place, and the long edges are flush and square.
9. Tighten the hanger clamp assemblies. One person should push the lower and upper modules up slightly so the module frame is against the side of the aluminum clamp (both the front and rear side). If the clamp is above the module frame, tighten assembly slightly to ensure frame does not touch the bolt/spring. Another person must tighten the nut from below the rack.
10. Tighten the endclamp assemblies.
11. Adjust and tighten remaining modules, gravity clip assemblies, and midclamp assemblies, each time ensuring that all modules are tight against the aluminum clamps both above/below and to the clamps to the sides.
12. Tighten endclamps. Ensure all grounding barbs are engaged in the aluminum module frames.
13. Repeat steps 1-12 to the end of the row, in sections.



*Midclamps may be preinstalled from either side of the long keyslot*



### PRO TIP 14



### WARNING

**DO NOT** stage an entire row of modules. Only stage enough modules required to properly adjust them left to right (east to west). **DO NOT** leave modules unattended with untightened clamps, as wind may blow them off and cause damage.

## CABLE BRACE-TO-ANCHOR POST

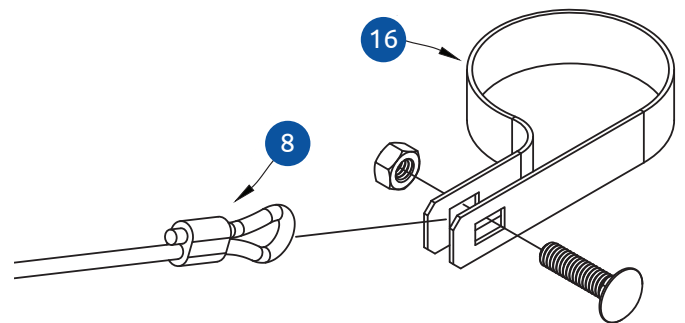
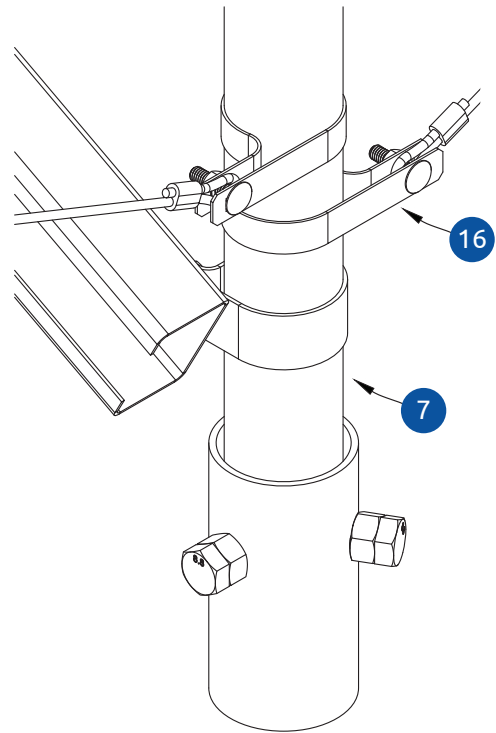
Depending on the array and project parameters, a set of anchor posts may get multiple sets of cable braces to limit movement and reduce fatigue. Refer to the construction documentation for locations, and frequency of cable bracing.

1. If clamps were not installed prior to installing the tilt brackets (highly recommended), spread the clamp apart, slide around the post, and re-compress it. Install one clamp each on the North and South anchor posts.
2. Once clamps are installed, string a cable between the two clamps (note: there may be multiple size cables on one job, refer to construction documentation to use the correct one).
3. Secure with bolts, loosely. Ensure that the bolts are pointing to the interior of the rack.
4. Position one clamp slightly above the knee brace clamp and fasten tightly.
5. Slide the opposite clamp as far as possible and fasten the bolt tightly. Cables should be taut and have no noticeable slack or sag.
6. Repeat for all remaining cables as indicated in the construction documentation.

- [7] ANCHOR POST
- [8] CABLE BRACE
- [16] CABLE CLAMP ASSEMBLY

### NOTE

Cable braces are not used to induce static tension, like trusses of a bridge, but instead only keep the posts from spreading or shifting.





## PRO TIPS

PRO TIPS are pieces of advice from installation experts. They are intended to provide practical solutions to real-world problems that you may encounter. But before implementing any of the below tips, make sure to request approval from APA's Engineering team, as not all solutions are allowed on every site.

**[1]** It is best to use 2 sets of string lines when following this technique. Have one string line running approx. 16-24" off of the ground, and a second string placed at the top of the pile where the collar of the pile driver stops and where the pile reaches embedment.

**[2]** When dealing with extreme topography, additional transitions will have to be added to make the racking flow with the terrain.

**[3]** Use a STEEL tape rather than a fiberglass tape to measure distances over the length of the row. Fiberglass can stretch over time and affect layout and installation lengths.

**[4]** With extreme topography, every pile must be marked and the string line must be attached to every pile, in order to ensure that the racking will flow at every high and low point.

**[5]** If an obstruction is still being hit after shifting the pile 6-8" E/W, which is often the case, addition movement can be made. The pile can be moved 12-16" in total. DO NOT EXCEED 16". If this value is exceeded, pile-to-pile spacing will have to be changed, potentially adding an additional piles between affected areas for load bearing purposes.

**[6]** While it is very difficult to make every post perfectly plumb and at the correct height, care should be taken to keep them within the tolerances specified in the plans in order to ensure that the system fits and functions as intended.

**[7]** Install the beginning, middle and end screw piles about 1/2 of the way to depth (typically until threads are not showing). Then attach a string line to these installed piles, creating a straight line for the installation process. This will give the installer a guide and ensure that the piles are plumb.

**[8]** If holes are pre-drilled, they must be filled with aggregate immediately, ensuring debris or water doesn't fall into the holes. If this happens, a void can be created causing the piles to possibly sink in the future.

**[9]** Use grip clamps when setting post transitions. This is the best technique to use so that no improper dimpling is done to the posts if adjustments are needed. Once desired flow is reached, then tighten the set bolts.

**[10]** Use a grip clamp to squeeze and close the brace clamp shut while installing the set clamp bolt. Connect the knee brace to the bracing clamp with a squeeze vise. This process takes less effort, as the brace clamps are very rigid.

**[11]** After the roll bars are installed and tightened, attach a string line to the roll bar at the top of the N/S chord. Tie a string line to every 4th roll bar (depending on topography), all the way to the end of the row. This process will ensure that the zee purlin is in a straight line. Fill in all remaining N/S chords to the string line. This will ensure that the module installation will go smoothly and be straight.

**[12]** Use a spud wrench to align key hole slots while installing the overlapping zee purlins. Use a spud wrench/alignment punch to pry onto the stud. At times, due to topography, the opposite side of the zee purlin will have to be lifted in the air to properly seat onto the previously installed zee purlin.

**[13]** When staging module clamps, tighten the bottom nut until the spring is slightly compressed. This will help the module installer free up one hand. If the spring is not compressed prior to staging, the clamp will spin and another installer will have to hold the panel.

**[14]** Using a 48" T-square or 1x4 board, align the modules, at both top and bottom, up together with the straight edge. Align the top and bottom with the purlin to ensure the modules are square with the racking.

## OPERATION & MAINTENANCE

Regular inspections and proper maintenance are essential to maintain the design life and warranty of the TITAN solar racking system. Solar racking is exposed to many elements from initial construction to seasonal changes and can even be susceptible to severe weather conditions. The following Operation and Maintenance procedures should be followed and performed on an annual basis to ensure the warranty for the racking system remains active. The procedures below highlight the critical points to be examined and maintained for a properly functioning solar racking system.

### BOLTED CONNECTIONS

Annually, bolted connections need to be visually inspected to ensure the components are properly joined together. At the beginning, middle, and end of each row, there are torque marked nuts/bolts per the APA QA/QC process. These marked locations should be visually inspected to confirm no movement of the bolted connections has occurred. If loose hardware is found, re-tighten to the specifications noted in the plan set for the racking system.

### SOLAR PANEL CLAMPS

Clamps need to be visually inspected annually to ensure modules are properly secured. If loose clamps are found, re-tighten to the specifications noted in the plan set for the racking system.

### GALVANIZE COATING

The galvanized coating ensures that the steel components are protected from corrosion and that the solar racking system will last for the entire project life. Annually, the solar racking system should be inspected for any areas of corrosion or rust. If areas are found, they should be repaired in a timely manner by cleaning the area and then generously applying cold galvanizing compound.

The cut, slit and sheared edges of the racking system are exposed steel that are expected to show corrosion or rust. This is normal and should be expected, but does not affect the structural integrity of the system.

Copper should be isolated and cannot touch the galvanized coating, as it will expedite corrosion.

### CROSS BRACING CABLE WIRE

If applicable to your project, the bracing needs to be visually inspected on an annual basis to ensure that it has not become loose. Cables are required to be taut for motion limiting, but do not need to be tensioned.

### SYSTEM DAMAGE

The solar racking system should be visually inspected for other types of damage. Examples include damage from mowing equipment, maintenance equipment, falling trees or branches, storm damage, system lean, soil erosion, etc. Any components that are damaged or deformed should be replaced as they may be weaker or corrode faster than intended. Some components may be able to be repaired onsite if replacement is not practical. For assistance with replacement parts or instructions on repairing a component, contact APA.

### GENERAL OPERATION

It is important to maintain the solar racking system to ensure the design lifespan.

Keep all vegetation managed and off of the racking system and solar modules.

Check that module cleaner solution, weed killer, or other chemicals used on or around the solar racking system are not corrosive to galvanized or stainless steels.

Check electrical wiring to ensure it is managed properly and protected.

Take note and log when inspections were performed and if any corrective actions were taken or need to be taken in the future.