BUILDING A GROUND-LEVEL AZ/EL MOUNT: Volume III

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Contents

ROTATING BASE STRUCTURE

Full Square Base Fabrication

A first step in fabricating the rotating base structure is to decide which portion to begin fabricating. It is probably best to start with the square base subsection of the rotating base structure, meaning the complete square not the 'truncated' square subsection. The photograph below shows the subsection of the rotating base structure we will begin fabricating.

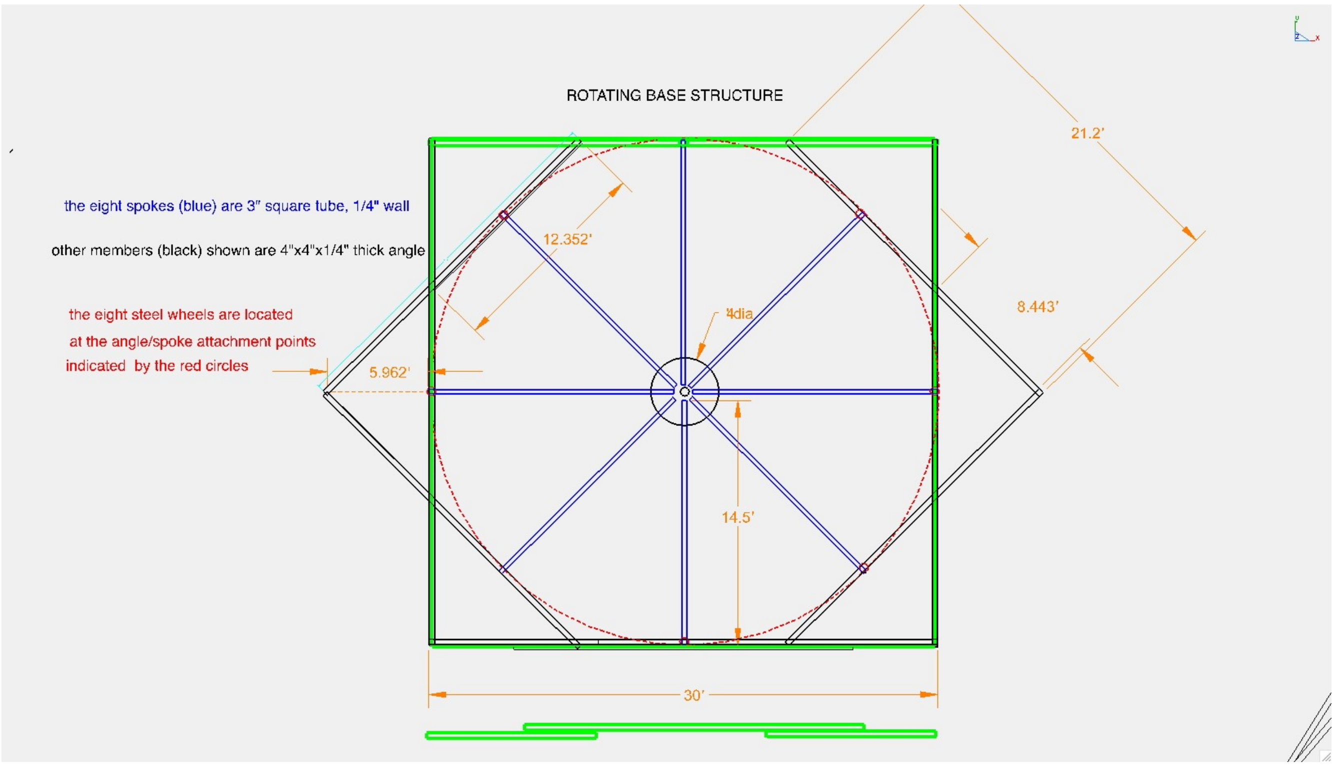

Figure 1. The square base subsection of the rotating base structure is highlighted in green. The green bars below the diagram show how a side will be fabricated from three pieces.

As our angle steel inventory is in 20' joints it will be necessary to use two joints to form each side of the 30' square. There are, of course, numerous ways to construct a 30' side from two 20' joints of angle steel. To maximize strength I have decided to use one uncut 20' joint in the center of a side and two 10' pieces (cut from one 20' joint) overlapping the center piece at each end, as indicated in the diagram above. This scheme will allow about 5' overlap of the end pieces with the center piece. When welded or bolted together, it is hoped that the final structure will be suitably strong.

Given that there are four sides to fabricate for this square subsection it will be necessary to cut four 20' joints of angle steel in half, creating eight 10' end pieces to use with four full-length center sections. The cutting process is shown in the photograph below.

Figure 2. Ten foot long end pieces are being cut from a twenty foot long angle steel piece.

In the photograph above one full length piece has already been cut in half with the ten foot pieces resting on the two wooden beams. A second full length piece is shown in the metal saw being cut in half.

The four full-length (i.e., 20' long) center pieces will have a steel wheel assembly mounted at the center of each. The photograph below shows how bolt hole positions are straightforwardly marked on the piece by placing a wheel assembly onto the angle steel and spray painting the base plate of the wheel assembly.

Figure 3. Spray painting the base of the wheel assembly to mark bolt hole positions.

The photograph below shows a center side piece with bolt hole positions marked.

Figure 4. Center side piece with bolt hole positions marked.

The photograph below shows two center side pieces with wheel assemblies installed.

Figure 5. Two center side pieces with wheel assemblies bolted in place.

The bolt holes were bored using a 9/16” diameter annular cutting tool with the magnetic drill press shown in the photograph. The wheel mounting plates are designed for ½” diameter bolts so four hot-dipped galvanized ½” diameter x 2” long bolts with washers and nuts were used to mount each wheel assembly to the angle steel.

The photograph below shows all components of the square base structure positioned near the circular rail ready to be assembled and installed.

Figure 6. Components of the square rotating base structure are positioned near the circular rail ready to be assembled and installed (24MAR2023).

The four sides of the square structure will be temporarily supported at the corners by stacks of concrete blocks and spacers to ensure things are properly level and square before welding or bolting the side pieces together and before putting the entire weight of the square structure onto the circular rail. The stacks of blocks shown in the photograph are ready to be put into position and leveled.

Figure 7 shows how the tractor forklift works to help with assembly of the heavy sides of the square rotating base.

Figure 7. Tractor forks help to put the heavy components into position during assembly of the square rotating base structure.

Note that a light snow fell overnight but it won't interfere with assembly and fitting of the structure. The photograph below shows how a carpenter's square is used to initially fit the components into a square and true assembly.

Figure 8. Using a carpenter's square to ensure things are square and true.

A bubble level is also used, of course, to ensure that the horizontal elements are actually level during assembly.

The photograph below shows the first half of the rotating base structure components approximately in position.

Figure 9. Components of the first half of the rotating base structure are in place ready for final fitting to square everything and lock it in place (25MAR2023).

Final fitting and lock down of the assembled components will be done next. I have decided to bolt the eight end extension pieces onto the center side pieces rather than weld them in place. This is because welding those pieces would require welding upside down on half of the welds and I'd prefer to not attempt that type of welding on this structure. Instead, the magnetic drill press and cutter tool will be used to bore bolt holes horizontally and vertically through the center and end extension pieces for bolts to hold those components together. Other components will likely be welded where it is straightforward to do so.

Truncated Square Base Fabrication

After squaring up the full square base structure fabrication of the truncated square base structure was begun. The wheel assemblies on the truncated square structure must be mounted on the underneath side of the steel angle sections so that the flat horizontal surfaces of the truncated sides and full square sides are in contact. Unfortunately, the wheel assembly base plates are too large to allow mounting the wheels in the steel angle inside of the steel angle when using 4”x4” angle so it is necessary to use angle that has at least one side larger than 4” and that that side be turned horizontal and upward with the wheel assembly mounted underneath. The material I selected to use for the truncated sides is therefore 4”x6”x3/8”thick steel angle. This material is quite heavy in 20’ lengths, weighing in at 250 lbs per joint. That much weight is more than I can handle barehanded so I will need to rely on the tractor forks to position those pieces for me as I work with it. Each side of the truncated square needs to be a bit more than 21’ in total length. This is longer than my 20’ stock material so I will need to use two pieces to get the desired length. I have decided to use a 15’ long piece and a 10’ piece to get the required length by overlapping the two pieces as necessary to achieve the desired final length.

The photograph below shows a 15’ length of 4”x6” angle clamped into position, ready for installation of a wheel assembly and bolting to the full square structure.

Figure 10. A portion of a 4”x6” truncated square side is clamped into position ready for bolting to the full square structure and mounting of a wheel assembly.

The photograph below shows the 15’ portion of a truncated square side bolted into position with a wheel assembly installed and riding upon the circular track.

Figure 11. A 15’ long portion of a truncated square side piece is shown bolted onto the full square structure and a wheel assembly is shown installed on it with the wheel resting upon the circular rail (28MAR2023).

The 10’ extension piece will be installed shortly. A spoke is temporarily resting atop the side piece above the wheel on one end and on the AZ mount at the other end. Note that with this new truncated structural member in place it is no longer necessary to have support blocks under the full-square corner. The full square pieces are bolted together at the corner and also where the truncated side piece crosses them. Bolts used in assembly of the truncated square sides are ¾” diameter 10-threads-per-inch x 2” long or longer if needed, except for the wheel assemblies which use ½” diameter bolts as per the wheel assembly design specifications.

It is now necessary to cut steel angle beams appropriately to form the remainder of the truncated square sides. The photograph below shows a 20’ length of 4”x6”x3/8” thick steel angle being loaded into the metal saw using a tractor.

Figure 12. Using a tractor with forks to load the heavy beams into the metal saw (31MAR2023).

The 20’ beams of steel angle are too heavy for one person to lift (250 lbs) so a tractor with forks is used to load the beams into the metal saw for cutting to appropriate lengths to form the truncated square sides. Two 20’ beams are cut in half to form four 10’ lengths that will become the extension ends and corners of the truncated square. Four 20’ beams are cut to 15’ each to form the main portions of the truncated square sides. The remaining 5’ from each of those four beams will be used later to construct portions of the tripod lifting structures that will mount atop the rotating base. Already cut beam components are visible to the right of the tractor in the photo. These will be moved to the assembly area of the rotating base and installed to form the completed truncated square structure.

The photograph below shows two of four main portions of the truncated square installed. No temporary spoke is in place on the new cross piece in this photograph. The temporary block support for the section is no longer needed and has been removed.

Figure 13. Two of four main cross pieces of the truncated square base structure are now installed (31MAR2023).

Six of eight total wheels are now in place on the circular rail. The other two main cross pieces will be installed next then the end extensions will be added to all four cross pieces to form the truncated square base structure corners.

Careful examination of the photo above suggests that the wheel placements on the truncated square cross pieces are slightly off from the optimum location. To check this possibility string was strung corner to corner on the full square base structure.   The string across the left-back corner (in the photo above) is shown in the photograph below.

Figure 14. A corner-to-corner string across the full square base structure shows that the truncated square position for the 'southwest' wheel is not perfect.

It can be seen that the truncated square wheel position at the (presently) southwest oriented truncated square cross member is in error by about 2 inches along the circular rail from the center of the wheel assembly. That is, in the photo the wheel is seen to be slightly to the right side of the marker string.

The photograph below shows that the truncated square wheel position at the (presently) southeast oriented truncated square cross member is also in error by a magnitude similar to the southwest oriented cross piece, namely 2", but in the opposite direction along the circular rail.

Figure 15. Southeast truncated square wheel position is revealed to be in error by about 2" along the circular rail in the opposite direction from the southwest wheel (31MAR2023).

The wheel mounted to the (presently) southeast truncated square cross piece is seen in the photo above to be about 2" to the left side of the marker string relative to the center of the wheel assembly.

These position error observations are a bit disappointing to see because some care was exercised in positioning those wheels visually (not using string markers originally). The question arises as to whether these amounts of errors are significant to the performance of the rotating base structure or not. If so, then the wheels and cross members need to be re-positioned, new bolt holes bored at the proper wheel positions and at both ends of the cross pieces where they cross the full square members and all bolted together anew.

The amount of angular positioning error introduced by these mounting errors can be calculated by

angular error = (lateral displacement error / rail circumference) x 360 degrees = (2” / (94.2’ circumference x 12”/’) x 360 degrees = 0.002 degree.

This amount of angular error in the structure is almost certainly negligible regarding possible performance degradation and weakening of the rotating base structure. As long as the wheels are aligned accurately with a tangent to the circular rail at the actual point of mounting the small placement error along the rail should be insignificant for the project. Care was taken in both to ensure that the wheels were aligned well with the tangent to the circular rail at the mounting positions.

Therefore, for now and until proven otherwise necessary, the mounting of the two truncated square base wheels will remain as they currently are, with the known placement errors present. String markers will be used to determine mounting positions of the remaining two wheels to try to avoid such positioning errors with them.

The photograph below shows all cross pieces for the truncated square base structure are installed as well as all eight wheel assemblies with the wheels on the circular rail.

Figure 16. All cross pieces and wheel assemblies are installed onto the circular rail (1APR2023).

The temporary block support pillars have been removed. Next step is to install the extension end pieces on the four cross pieces to form the two corners which will complete assembly of both the truncated square base structure and the full square base structure except for connections of spokes to the AZ mount.

The photograph below shows one corner of the truncated square base structure is installed.

Figure 17. One corner of the truncated square base structure is completed.

As the corners of the truncated square base will support one leg of each of the side mounted tripod lifting structures and that the corners will to large extent be hanging from the bolts at the cross over positions double bolts were used at those positions to provide extra hanging strength. The double bolts can be seen at the cross over positions in the photograph below.

Figure 18. Double hanging bolts are used at the cross over positions for the truncated square corners (2APR2023).

It should be noted that most of the dish weight will be supported by two tripod lifting structures to be mounted on opposite sides of the rotating base, onto the truncated square corners and sides of the full square structure. The center-of-lift for each tripod will be over a full square side center. Most of the lift weight will therefore be borne by the two legs of each tripod that attach to the side of the full square base structure; those two legs will be referred to hereafter as the “principal” legs of each tripod and the third leg will be referred to as the “auxiliary” leg. To be more clear, it perhaps should be noted that the top lifting point of each tripod is not centered over the center point of the triangle formed by it legs at the bottom (refer to the model images if this is surprising to you) but will instead be located over the center point of a line between the principal legs and, concurrently, over the center point of a full square side.

The low ends of the principal tripod legs will not be located at the outermost points of the corners of the full square base structure, instead they will be inset some distance from each corner to increase the maximum lift height for each tripod when using a full 20’ length of material for the tripod legs. Reasons for this will be discussed later when considering what the maximum lift height should be for the EL rotation axis of the dish atop the rotating base. Conversely, the auxiliary (third) leg of each lifting tripod will be attached to the outermost point of the floating truncated square corner. The lengths of the auxiliary legs should also not exceed the standard 20’ material length that is being used. These features will be made more clear later when construction of the lifting tripods is undertaken.

The photograph below shows how forks are helpful as an extra pair of “hands” during assembly of the corner angle beams.

Figure 19. Using forks to assist in assembling the corner angle beams.

The final corner to be assembled is checked to be sure that it is square before boring holes and bolting the beams together, as shown in the photograph below.

Figure 20. The final corner of the base structures is checked to ensure that it is square before holes are bored and beams are bolted together.

The photograph below shows all corners of the truncated square base and full square base structures are now fabricated and installed.

Figure 21. Final corner of the truncated square base structure is installed (3APR2023).

Next task is to fabricate 3/8” thick spacers for the four full square wheel assemblies to correct for the 3/8” thick material that was used to fabricate the truncated square base structure. Installing the truncated square wheel assemblies put the truncated square wheels at a different height compared to the height of the full square wheel assemblies. The spacers will put all wheel assemblies at the same position with respect to the circular rail and the rotating base structures.

While a straightforward way to fabricate such spacers would be to use 6” wide x 3/8” thick flat bar none of that material happens to be in our stock at the moment so the spacers will be formed instead by cutting 12” long pieces from left over 4”x6”x3/8” thick angle steel from earlier work. As the spacers will require wheel mounting bolts to pass through, bolt holes will need to be bored through the spacers to permit it. To mark the bolt positions for boring, a wheel assembly will be temporarily removed from one of the full square sides and used as a template to mark positions to bore holes through the angle spacers. After boring, the spacers will be inserted between the top of the wheel assemblies and the bottom of the full square sides then the wheel assemblies will be re-bolted into position.

The photograph below shows how the spacers are being fabricated from a piece of the 4”x6”x3/8” thick angle steel.

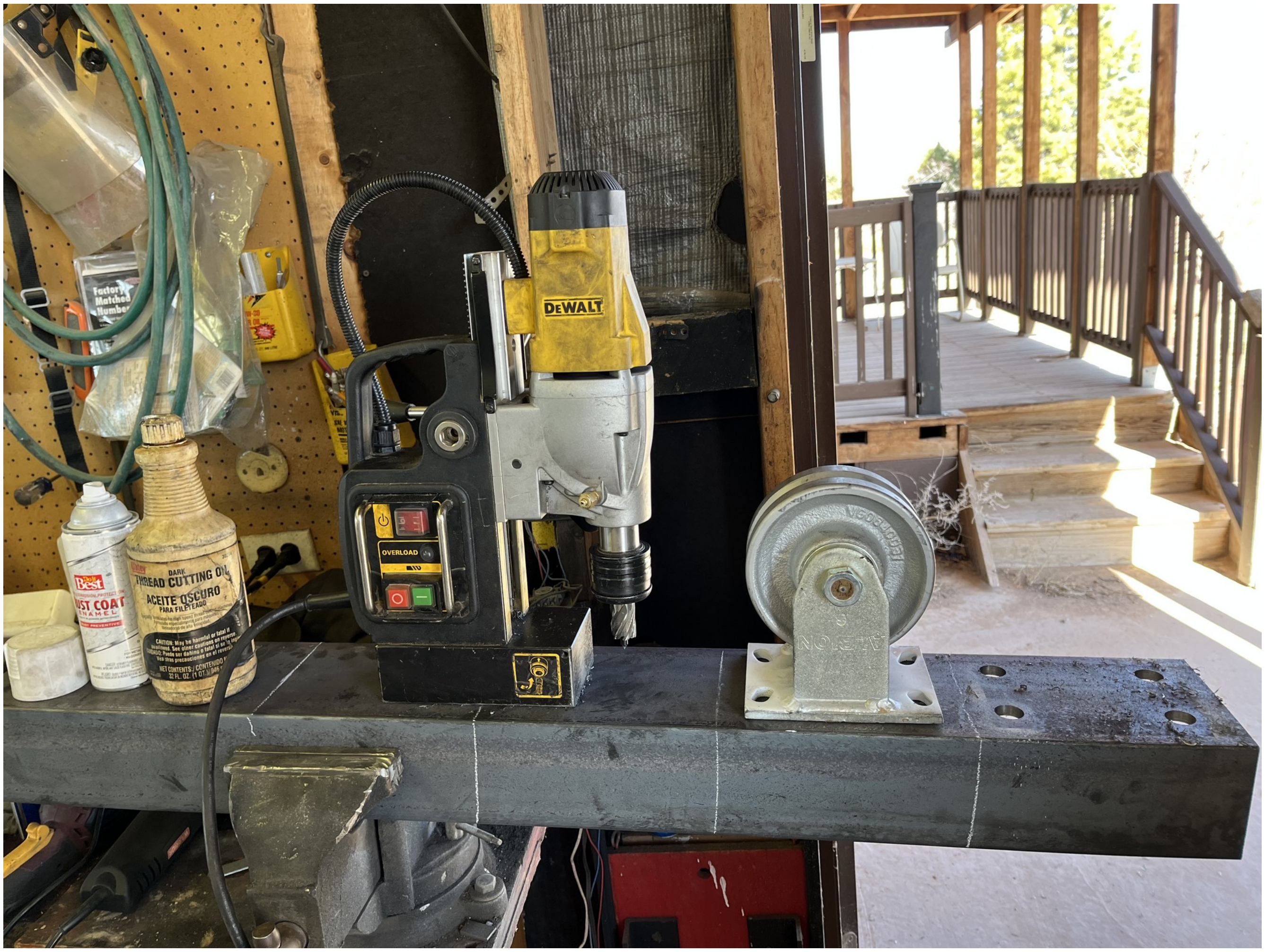

Figure 22. Setup to bore holes for the four wheel spacers.

After the pass-through bolt holes are bored into the angle steel piece the four spacers will be cut from the angle steel to form the completed spacers. Cutting of the spacers from the angle steel is shown in the photograph below.

Figure 23. Using a metal saw to cut the four wheel spacers from angle steel.

The fourth and final wheel spacer is shown being cut from the angle steel in the photo above. The photograph below shows one of the wheel spacers installed between the wheel assembly and the full square base structure.

Figure 24. A wheel spacer is shown installed between the wheel assembly and the full square base structure.

The photograph below shows all four wheel spacers installed.

Figure 25. All four wheel spacers are installed on the full square base structure sides (5APR2023).

Now, with the spacers in place, all wheels have roughly similar weights on them, except for the two wheels that are located on the two full square base structure sides corresponding to the truncated sections of the truncated square sides. These two wheels have slightly less weight on them at the moment because the full square sides where the truncation occurs do not have weight at those two opposing points (i.e., across the circle) associated with beams that form corners elsewhere where no truncation exists. The truncation is needed in this particular installation, as explained earlier, to gain additional lateral clearance for motor vehicles between the rotating base structure and nearby structures when the rotating base structure is positioned appropriately to align a truncated side toward a nearby structure. When the "trolley" portion of the elevation system is installed on the AZ rotating base structure the weight on the wheels of the two truncated sides will increase. In any case the current distribution of weight among the eight wheel assemblies seems to be reasonable and adequate for our purpose.

At this point in the project one can manually push the rotating structure along the circular rail. It rolls easily along the circular rail with no apparent problems. Of course, "easily" is a relative term as used here. In this case, remember that the rotating base structure is quite heavy in absolute terms, several thousand pounds in fact, so to relate 'easily' in this context to something that is perhaps more familiar consider that the effort required to manually move the rotating structure along its circular rail at this stage is roughly similar to that needed to push a small vehicle (in neutral gear) along a level road.

Next stage of the construction project is to design, fabricate, and install the spoke system that will be used to couple the AZ mount to the rotating base structure.

Spoke Design, Fabrication, and Installation

It has been decided that 3" square x ¼" wall steel beams will be used to form the eight spokes coupling the AZ mount top plate to the rotating base structure. A few of the earlier photographs show some of the spoke materials temporarily resting in their approximate final positions spanning the distance between the AZ mount and the rotating base structure at the centers of the square base structure sides. None, however, to this point have included details as to how the spokes will attach, at either end. What follows is a brief description of such attachments, as currently envisioned.

At the rotating base structure end of each spoke a bolt plate will be welded to the 3" square beams. Each bolt plate will be cut from 6" wide x ¼" thick x 6"-10" long (this dimension is presently being evaluated) steel bar and bored to accept four ¾" diameter bolts to attach to the rotating base structure beams unless the spoke position actually coincides with the location of a wheel assembly. In such a case the mounting bolts of the wheel assembly will also be used to attach the spoke bolt plate.

The spoke bolt plates will be fabricated and installed next. Attachment of the spokes to the top plate of the AZ mount will involve welding eight short (roughly 12" long) pieces of 3" square tube onto the top plate at 45 degree angle positions around the top plate. The spoke ends will then bolt onto the tops of these short pieces using two ¾" diameter x 3-1/2" long bolts for each spoke with the bolts passing through the spokes vertically and bolting to the short pieces with the nuts located inside the short pieces at the ends of the short pieces. Whether these attachment schemes are actually workable and satisfactory for this project remain, of course, to be demonstrated. The attachment schemes are presently being evaluated for viability.

The photograph below shows the AZ mount top plate with string markers showing positions for the spoke attachment brackets.

Figure 26. String markers placed on the top plate of the AZ mount to show where spoke mounting brackets will be positioned.

The string markers lie along radii from the top plate center to wheel assembly positions. There is one position that is initially problematic due to an old bracket on the top plate that will interfere with one of the spoke mounting bracket placement. This position is shown more clearly in the photograph below.

Figure 27. An existing bracket on the top plate (left side of string above) must be removed as its position interferes with the position needed for a spoke mounting bracket whose position is indicated approximately by the string.

A 4-1/2” grinder fitted with a thin cutoff blade was used to cut the welds of the undesired bracket. The photograph below shows the position after removing the old bracket and cleaning the area with a metal rotary brush.

Figure 28. Area where the old bracket was located after removal of the bracket and cleaning with a rotary metal brush.

The photograph below shows that all spoke mounting brackets have been cut and are temporarily positioned on the top plate of the AZ mount.

Figure 29. Spoke mounting brackets temporarily positioned on the top plate of the AZ mount prior to cleaning the surface with a rotary brush and welding them in place (6APR2023).

The white PVC cap in the photo above is the weather shield for the AZ encoder for the mount.

There are two types of flanges that will be used at the outward ends of the spokes: one for the full square base structure and one for the truncated square structure. This is necessary because of the difference between the orientation and size of materials used for the two. There are four flanges of each type that are fabricated from 6"wide x ¼" thick steel bar, all are 8" long and bored to accommodate four ½" diameter bolts through each flange. The eight flanges have been fabricated and bored for bolts. The flanges used for the full square structure spokes have a bolt pattern offset from centered whereas flanges for the truncated square structure spokes use a centered bolt pattern. The photograph below shows a completed full square flange installed, the spoke is in position for welding.

Figure 30. A flange for the full square structure is bolted onto the full square side with its spoke in place ready to be welded to the flange.

The spoke flanges use existing wheel assembly bolts for attachment. Thus spokes will be centered over the wheel assemblies. The photograph below shows a flange for the truncated square structure installed.

Figure 31. A flange for a truncated square side is bolted to the side piece with the spoke end in position to be welded onto the flange (7APR2023).

As of today five of the eight total outward-end spoke flanges have been bolted in place onto the respective side pieces with the associated spokes positioned and ready to be welded to the flanges. Welding spokes onto the flanges after the flanges have been bolted to the side pieces ensures alignment of the flange bolt holes with the wheel assembly bolts. Bolting the remainder of the outward-end spoke flanges to the respective square structure side pieces is underway.

The photograph below shows all eight spoke outward-end flanges in positions for welding and all eight inward-end spoke brackets in positions for welding.

Figure 32. All spoke flanges and brackets are cut and in positions for welding (8APR2023).

Before welding the spoke brackets to the AZ mount top plate and welding the spoke flanges to the spokes through holes will be bored through the eight inward-ends of the spokes and the top surfaces of the eight 3”x3”x1/4”wall x 13” long brackets so that spokes may be bolted to the brackets prior to welding brackets to the AZ top plate. Each spoke bracket uses two ¾” diameter x 4-1/2” long bolts installed through both the top surface of the bracket and through the spoke to attach the 3”x3”x1/4” wall square spoke to the bracket. This bolting scheme for the spokes permits removal of a spoke after installation without cutting welds should such removal ever become necessary or desirable to do.

All 48 holes for inward-end spoke attachment have been bored through the various surfaces needed to attach the eight spokes to the spoke brackets and ¾" diameter x 4-1/2" long bolts have been installed. The photograph below shows the inward-ends of the spokes with attachment brackets installed and positioned for welding to the AZ mount top plate.

Figure 33. Inward-end spoke brackets are installed onto the spokes and are now ready to be welded to the AZ mount top plate (9APR2023).

The photograph below shows how the spoke inward-end brackets are welded to the AZ top plate.

Figure 34. View of how a spoke inward-end bracket is welded onto the AZ mount top plate.

The photograph below shows how a spoke flange is welded onto a spoke.

Figure 35. View showing how a spoke flange is welded onto a spoke (10APR2023).

Five of the total eight spokes are now welded to their respective attachments and flanges and the five are therefore completed, installed, and ready for AZ rotation system testing as soon as the other three spokes are likewise finished.

The photograph below shows the AZ rotation base structure with all spokes installed.

Figure 36. All spokes are installed and initial rotation testing has begun (11APR2023).

Now that all spokes are installed, testing and analyses of the rotation behavior of the entire structure can begin using the center AZ mount to drive it.

It is observed that the drive system has no difficulty in providing the required power and torque to move the structure along the circular rail. That result in itself is positive and answers an earlier question regrading the feasibility of using the AZ mount drive. The AZ mount drive is suitable for the task.

As the spokes were only just now finished, thus far only limited rotations have been done with the structure and these were simply to verify that the AZ drive system can in fact move the structure as envisioned. With rotations of roughly +/- 90 degrees azimuth it is observed that a couple of wheels seem to try to climb out of their grooves after 90 degrees of AZ rotation or so. This behavior will be examined to see if a suitable set of adjustments can be applied to eliminate the tendency of these particular wheels to climb off the circular rail. On the other hand, other wheels seem not to have the problem at all, under the restricted rotations thus far applied.

Adjusting Wheels And Rail Supports For Best Rail-Tracking Performance

While the rotation system is not initially tracking perfectly on the circular rail for all wheels this first result is nonetheless encouraging to the extent that the basic motion does occur as planned and also the fact that all wheels do not track perfectly initially is not entirely surprising. Our hope was that the floating rail alone could accommodate any imperfections in motion but the floating rail alone appears to not be sufficient to keep all wheels on track, at least this seems to be the case with no added load applied yet upon the system.

Note that the possibility exists that under heavy load the wheels will have enough downward force to keep the rail in the wheel grooves for all wheels for any rotation position as the ½" thick rail material is quite stiff and a light load might not provide sufficient force to adequately shift the rail laterally if a slight wheel misalignment occurs. But, of course, our goal is to adjust things such that even under no load conditions all wheels will stay on the rail for any rotation position. It remains to be seen at this moment whether a few simple adjustments on a few wheels or on the circular rail can be made to produce the desired behavior. If not, then more drastic steps will be taken as needed to accomplish the goal.

In order to give the floating rail move room for shifting a few top plate nuts and washers have been removed on a few support posts. This is illustrated for one support post in the photograph below.

Figure 37. The outside-top nuts and washers on this support post were removed as shown to allow more room for the floating rail to shift as needed to keep wheels on the circular track during rotations.

The result of initial testing for rotations greater than 360 degrees reveals that there are two wheels that occasionally climb off the rail. These two are located at the truncated square sides where the least amount of downward force (lightest load) presently exists. This result strongly suggests that under load the behavior will be improved as the other six wheels which are more heavily loaded currently do not climb off the rail under the rotations. This hypothesis will be tested shortly by placing a few steel beams onto the structure at those two positions and testing again to see if an increased load cures the issue.

To aid in observing wheel and rail assemblies during rotations and to aid while working on the AZ/EL systems a local remote control has been installed. The hand-held controller is shown in the photograph below.

Figure 38. A hand-held remote control for the AZ mount drive has been installed to allow control of rotation locally while at the mount (13APR2023).

Sufficient cable length is included on the hand-held controller to allow one to walk to any portion of the structure with controller in hand. Later, remote elevation control for the AZ/EL mount will also be wired into the hand-held controller.

Adding weight in the form of a couple of 20' long 4"x4"x1/4"thick steel pieces temporarily to the lightly loaded sides cured the tendency of those two wheels to climb off track. Thus, for the moment at least it seems likely that the current weight of the rotating structure is a bit light to be able to reliably shift the circular rail laterally to compensate for structure imperfections. As additional structures are built upon the rotating structure it is expected that the associated additional weight will result in suitable tracking behavior for all rail wheels.

It is noted that as rotation occurs and stress on a wheel to move the rail laterally increases, a slight hesitation in rotation occurs. It is believed that the hesitation occurs while flexing the spokes slightly until the stress builds sufficiently for the wheel to overcome the resistance of the rail to move laterally, at which time rotation proceeds smoothly again until another wheel tries to shift the rail somewhere along the circle. It has been found that adding a set of "stiffening" members between spokes eliminates the hesitation and results in smooth rotation throughout. Therefore a set of stiffening members will be added to the spoke design so that smooth rotation can be achieved.

The photograph below shows how a set of temporary stiffening members between spokes was clamped onto and between the spokes for testing of the hypothesis that such members would cure the hesitation behavior.

Figure 39. A set of various steel members were temporarily clamped onto the spokes, as shown, to check whether such members could stabilize the hesitation behavior observed without them.

Adding the temporary stiffening members between spokes solves the hesitation issue nicely. Therefore, permanent members will be added between spokes. The stiffening members are being fabricated now.

The photograph below shows that eight 4”x4”x1/4”thick x 5’ long steel angle beams have been welded between adjacent spokes to stiffen the spokes.

Figure 40. Spoke stiffener beams have been welded between adjacent spokes (16APR2023).

The manner in which the spoke stiffeners have been welded to the spokes will make cutting of the welds straightforward later should it be necessary to remove one or more spokes at some point or if/when the ground-mounted AZ/EL structure needs to be disassembled entirely.

The photograph below shows the completely assembled AZ rotation platform.

Figure 41. AZ rotation platform is fully assembled (17APR2023).

At the moment there are a few steel beams setting on top of the AZ rotation platform, for two reasons:

1) the temporary additional weight on the rotating structure keeps the truncated square side wheels in firm contact with the circular rail for improved rail tracking while additional weight is added to the rotating structure and

2) the additional beams are conveniently located for further work as they will used in the construction of the tripod lifting structures next to be fabricated and installed.

The successful completion of this stage is a major milestone for the project. This report concludes Volume III of the real-time progress report series. Further progress will be described in Volume IV of the project series.