# UCCS/GLI Produce Storage Facility Assembly Instructions

**Materials:**

Refer to the material list in the final report for items and quantities. Locally available materials may vary from the UCCS list.

**Tools List:**

Spade Shovel

String

Stake – wood or metal

Hammer

Nails

Steel bar for breaking and/or prying rock

Tamper for compacting soil and footing material

Spirit Level

Tape Measure

Saw – hand or cordless

Knife

Cold Chisel

Bucket

Wheelbarrow

**SAFETY FIRST!**

Please note that this project requires considerable physical ability to complete. We have designed the building to require the minimum level of skill and equipment while also maintaining a safe working environment for all involved. Even with these efforts to keep workers safe, each worker should take responsibility for his or her own personal safety by wearing appropriate close-toed shoes at all times, work gloves when possible, and eye protection when using tools. Being aware of the environment and others working around you is key to avoiding injury.

**Wood Preservation:** Prior to and during this project, treating your native lumber to protect it from pests and rot will be essential to the longevity of the facility. The UCCS team discovered that a European student project entitled, "Critical Concrete" has done extensive research and testing with wood preservation methods. Please refer to the following link for their expert instruction on how to adequately preserve your lumber: https://criticalconcrete.com/natural-wood-protection/

**INSTRUCTIONS:**

1. **Location:** Mark the perimeter of where you would like the building. This is best accomplished by driving a stake into the ground in the center of the location you have chosen. The exposed height of the stake should extend a minimum .7 meters above the ground. Tie a loop in both ends of a string so that the extended length of the string with one loop slid over the center stake reaches a minimum 1.75 meters from the stake. Slide the outer loop of the string over a 1.5 meter stick, pole, or other reasonably straight object (or you can use a can of marking paint). Mark the perimeter of the hole to be dug by dragging the pole in a circle around the stake, keeping the string taut. It's important to keep the string level to the horizon while performing this task. Have one person adjust the string position on the center stake while another person adjusts the string position on the marking pole. Drag the pole across the ground to leave an impression that can be easily seen.

2. **Hole Excavation:** With the perimeter circle marked, start by digging at the perimeter and work inward until the floor of the hole is level with the lowest part of the perimeter circle. NOTE: EARTHEN WALLS (CALLED "TRENCH WALLS") CAN COLLAPSE SUDDENLY CAUSING SEVERE INJURY OR DEATH. THE DEEPEST PART OF THE EXCAVATION FROM FLOOR TO SURFACE SHOULD NOT EXTEND PAST 1.3 METERS FOR SAFETY. IF THE HOLE MUST BE EXCAVATED DEEPER THAN 1.3 METERS FOR THE FLOOR TO BE LEVEL WITH THE LOWEST PART OF THE PERIMETER CIRCLE, THE HIGH SIDE OF THE TRENCH WALL MUST BE SLOPED AWAY FROM THE FLOOR TO KEEP WORKERS SAFE.

3. **Air Inlet and Drainage Trench:** A key function of the cooling ability of this facility design is to use the cool subsoil temperature to draw heat and humidity from the outside air as it flows through the pipe into the building. The UCCS model for cooling used an air inlet pipe distance of 20 feet or about 6 meters from the center of the building to the outside air inlet location. The air inlet pipe needs to sit deep in a trench to perform well; however, a drainage pipe must also be buried to keep groundwater from rising up through the floor of the building. **The UCCS prototype consisted of a French drain pipe buried beneath the air inlet pipe, but this method has been reversed for better performance: The air inlet pipe should be buried beneath the French drain pipe, as the cooling capacity of the inlet pipe will increase with the added depth of the pipe in the trench, and is a sealed pipe not subject to water intrusion from groundwater.** Excavate a trench about 60 cm deep starting from the center of the floor, aligning it with the steepest line of slope in the hillside. The trench will need to run downhill at a slight grade for a minimum of 6 meters if possible, or until reaching daylight. The longer and deeper it runs underground, the more cooling capacity the air inlet manifold will have.

4. **Assemble the Air Inlet Manifold:** The 4-inch inlet air pipe needs to reduce down to 3 inches just below the tee. Cut and assemble the inlet air manifold with PVC glue so that the arms branching off of the 3-inch tee extend 89 cm from center of the tee to center of the upturned 90° elbow on each side for a full span from vent to vent of 178 cm on center. Cut 3-inch straight pipe stubs to extend vertically 0.5 meters.

The stub pipes will be trimmed down later and elbows attached (temporary caps on these pipes will prevent material from falling in during the remaining construction). Fold a piece of pest screen over the air inlet end of the pipe and clamp it in place. Now bury the air inlet pipe below with tamped earth until the deepest part of the trench is about 30 cm deep. This will create a thermal reservoir around the air inlet pipe.

**Drainage Pipe:** Put about 8 cm of 1-1/2" river rock or clean rock into the trench. Place a cap over the uphill end of the perforated drain pipe. If available, place a non-woven drain sock over the pipe and lay the pipe in the trench, making sure it lays at a constant downhill grade with no low spots so that it drains correctly. The perforated drain pipe should reach daylight and needs to be capped with a screen in similar fashion to the air inlet pipe to keep pests out. Bury the drain pipe completely with clean rock until the trench has been filled. **Note that due to our recommended reversal of the order of burying the air inlet and drainage pipes, the UCCS prototype photos show the drain pipe buried first, with the inlet air pipe being buried last.**

5. **Locating the Brick Circle:** With the hole cleared of debris, locate the center of the circular floor and drive a rigid stake into the location (directly above the air inlet tee), keeping the stake as close to vertical as possible. Using the same process used in Step 1 to make a circle, draw a circle with a radius of 132 cm. This circle defines the inside edge of what will be the circular brick wall. The locations of the timber poles depend on the door position, which should be placed at the lowest point of the excavated area, pointing downhill. Additionally, the timber pole positions avoid interference with the air inlet and French drain pipes. Temporarily lay the first brick such that an imaginary line through the middle of the doorway would bisect the center of the brick. Then, place 35 more bricks (total of 36) circumferentially so that they are evenly spaced and not touching each other. This will serve as the base circle for the wall of your facility. See the top view in Figure 1, below:

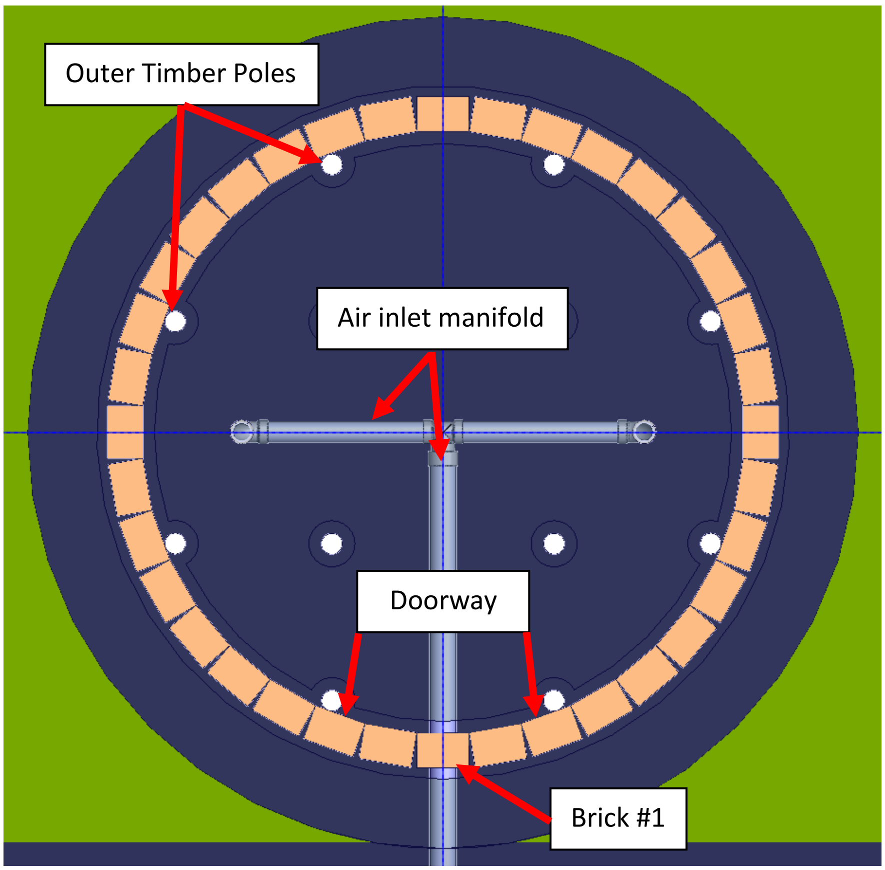
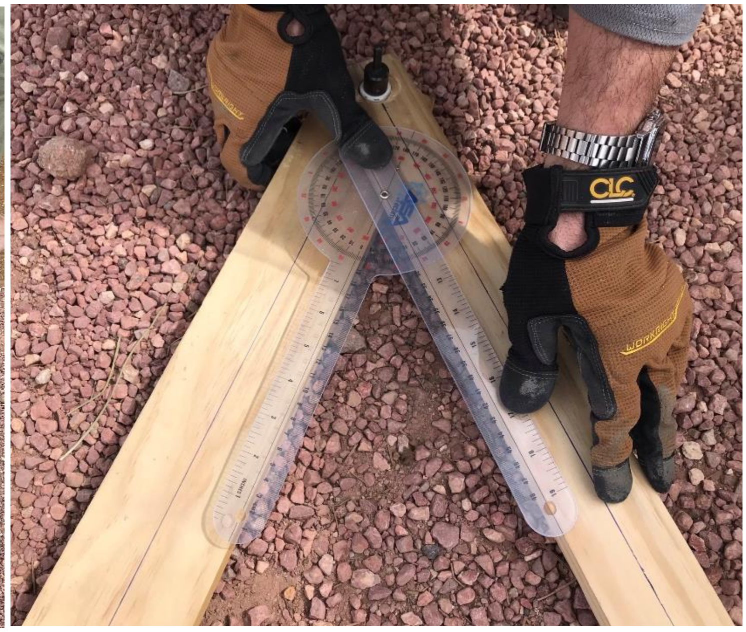
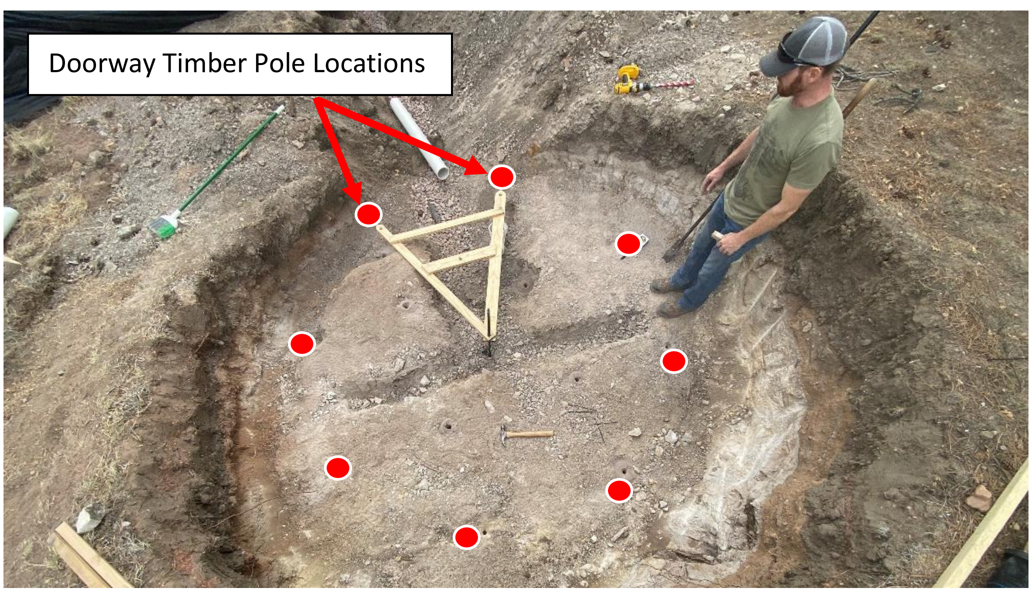



*Figure 1: Top-Down View*

6. **Template:** Build a 45-degree template similar to the one shown. The template should allow for fitment to the center stake, spanning exactly 45° between arms and extending to 128 cm (the point of each arrow should mark the center of the timber pole location; however, this assumes timber poles are about 8 cm in diameter. You may have to modify the locations a little to accept larger diameters. The most important thing here is placing the poles at 45° intervals, where each pole rests against the brick circle.). Cutting arrow points on the ends of the template arms is beneficial for pointing to the exact location of the center of the timber poles, but is not required. **Note that the cross piece with the hole drilled in the center of the template is not needed.**




7. **Locating Outer Timber Poles:** Now mark the 8 outer timber pole locations in relation to the brick circle, starting with the two poles at the door location so the poles don't obstruct the entrance, then rotating to the next location in sequence.



When the eighth outer timber pole location has been marked, the other arm of the template should line up with the first timber pole location adjacent to the door. If it doesn't, the angle of the template isn't exactly 45°. This will still work as long as the template arm ends within a few centimeters of the door pole location.

8. **Excavating the Pole Locations:** Each timber pole location should be excavated to a depth of 60 cm, at a diameter large enough to accommodate the pouring of concrete or the tamping of damp course back into the hole. Mark out an inner and outer edge for the footing of the brick circle. Follow local guidelines for the width of the footing (For the UCCS prototype, we used 30 cm for a footing width, with the centerline of the brick circle 15 cm from each footing edge.). Note that the footing circle intersects each of the eight outer timber pole holes. Remove the bricks from the footing area. See Figure 2 below.

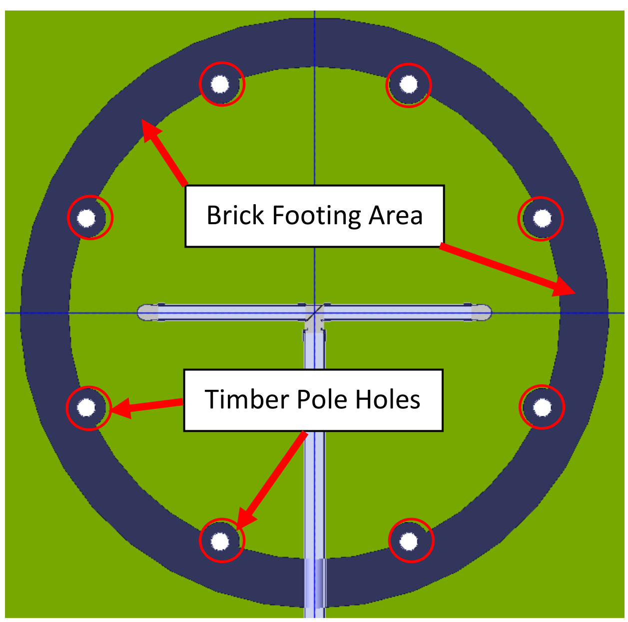



*Figure 2: Footing Location*

9. **Excavating the Brick Circle:** Excavate the brick circle footing to a depth of 30 cm and again mark out the 132 cm circle that defines the inner edge of the brick wall. Lay the bricks out again following the same procedure in Step 3, Figure 1. This is a critical step, because each timber pole will be slightly different in diameter but ALL timber poles need to touch or stand as close to the bricks as possible for structural integrity (poles will be anchored to the brickwork with brick ties). The brick circle will define the exact radial position of each outer timber pole as it sits in its hole.

10. **Plumbing and Bracing the Timber Poles:** Depending on what roof pitch you've chosen, you'll need to make sure your timber poles are of ample length. The UCCS team used 12-foot dimensional 4"x4" lumber to accommodate our 1:3 ratio of rise over run. Any ratio smaller than this (1.5:3, 2:3, etc…) must be accommodated with longer poles. Place a timber pole into one of the eight holes, adjusting it until it just touches the inner brick face (make sure there is sufficient room in the hole to tamp in the damp course on all sides of the pole). Fasten two braces to the pole as shown, at approximately 90° from each other and extending out toward the ground. Holding the pole as vertical as possible (the UCCS team's use of dimensional lumber in place of natural timber poles enabled us to use a spirit level to plumb each pole), have a partner drive stakes into the ground so that the braces can be nailed to the stakes. This task will keep your poles from moving while you tamp in the base course or pour in the concrete. Repeat this process for all eight outer poles.



Fill and tamp the eight outer timber poles until reaching the elevation of the brick footing. Now fill and tamp the entire brick footing and remaining timber pole cavities until they reach the floor elevation. **Note that the UCCS prototype was done differently due to the bedrock, and the footing was built on top of the bedrock rather than in an excavated trench. Also note that the four inner poles were installed in an earlier step on the UCCS prototype, which does not apply to the process we are recommending to GLI.**

11. **Locating the Inner Timber Poles:** The outer eight poles now standing solid, pull strings across the circle from pole to pole as shown in Figure 3 below. The quadrants adjacent to the string intersections identify the locations of the four inner timber poles. Mark the pole locations and excavate to a depth of 60 cm, again keeping the hole diameter large enough to accommodate tamping damp course or pouring in concrete.

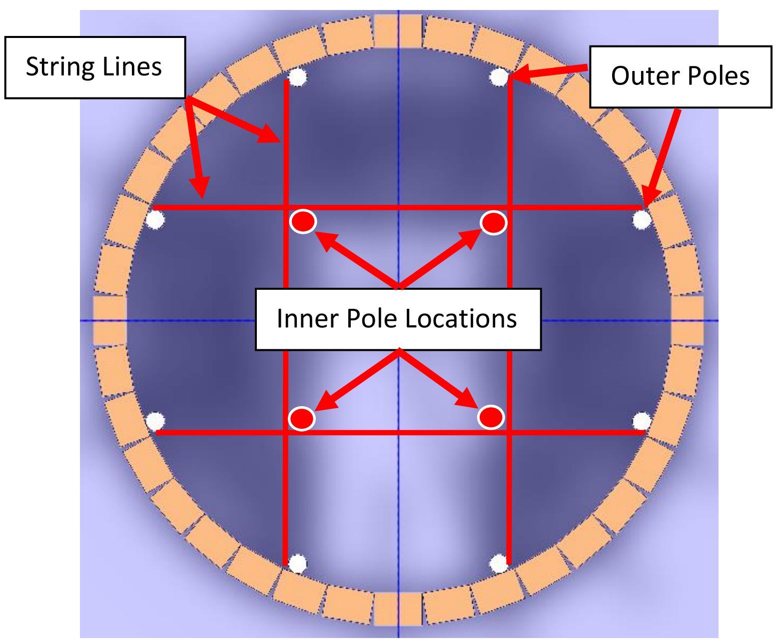



*Figure 3*

Nail braces across the outer poles in place of the strings used to the mark the inner pole locations (these braces are temporary, and not structural). Set an inner timber pole into one of the holes and position as vertically as possible, touching both braces. Drive a nail through each brace into the pole to temporarily secure it. Fill the hole with damp course or concrete as done in Step 9. Repeat for the other three inner poles.

12. **Brace the Poles:** With all 12 poles standing solid, nail temporary bracing to the tops to hold them firmly (this step will make it easier to nail to them later on). See photo below:

13. **Leveling the Footing:** Prepare the area for brickwork by removing any unnecessary tools or equipment. Ensure that the footing is level by placing a spirit level atop a long, straight board spanning across the footing adjacent to opposite timber poles. Level the board and scribe a mark on each adjacent pole. Move the board and level around the footing, marking all eight opposite poles at the locations where the board is level. Now measure from the mark on each pole down to the footing and note the distance. Fill and/or excavate the high and low areas of the footing until all these distances measure the same. You are now ready to begin brickwork.

14. **First course of bricks:** Be sure that all bricks are clean and dry (surface dirt will keep the mortar from bonding). Stage the bricks close to the footing so they are easily within reach. Once again, temporarily layout a 36-brick base circle such that the centerline of the doorway bisects the middle doorway brick, shown in Figure 4 below. Ensure the bricks are touching the outer timber poles and evenly spaced. Mix a batch of mortar per the mortar supplier's recommended ratio. Placing your mortar mix on a wet board makes it easy to move around and work with.

Choose any brick to start. Apply mortar to the bottom and to one end of the brick (**Note that the UCCS team found it difficult to apply mortar to the ends of the bricks during laying, and instead chose to set each brick course entirely, then packing the vertical joints with mortar by hand before setting the next course.)**, then set the brick accordingly and lightly apply pressure to ensure the mortar is pressed into the footing. Use a small spirit level to level the brick lengthwise and transversely. Repeat this process for the second brick, this time leveling the second brick with the first. Continue this process until the first course is laid entirely. **NOTE: A heavy layer of mortar will be necessary for the brick(s) directly above the buried drain and inlet pipes, due to the porous nature of the rock covering the trench).** Be sure the vertical gaps in the brickwork are completely filled with mortar, and that the beginning and ending bricks lie level with each other.

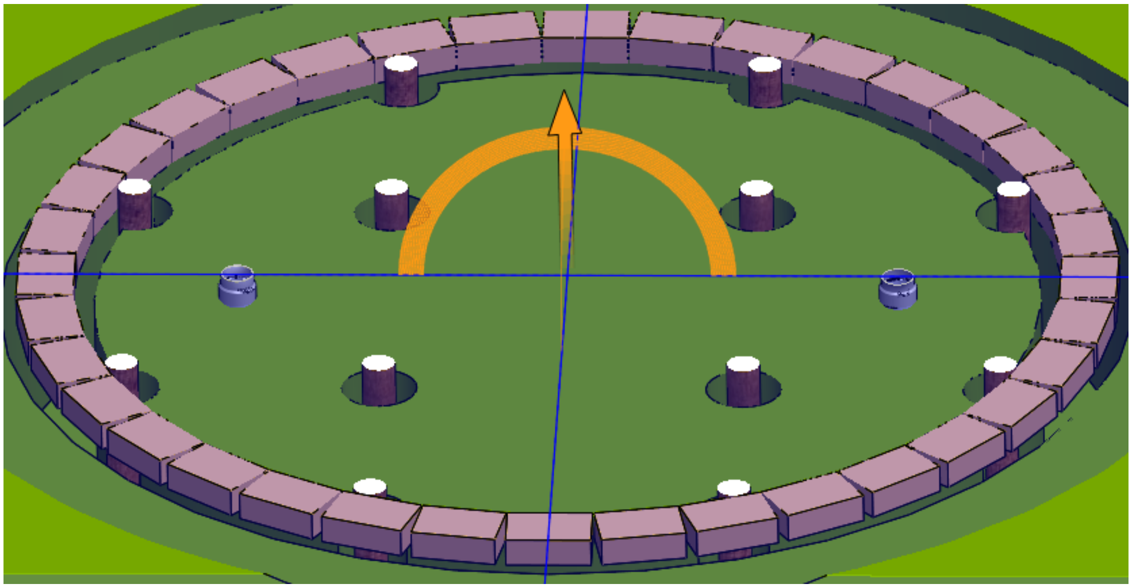


*Figure 4: First Course of Brick*

**Second course:** Start from the first brick on either side of the doorway as shown Figure 5 below, aligning the brick in such a way that its center line bisects the mortar joint of the bricks beneath it. Continue around the circle until arriving at the other doorway timber pole.

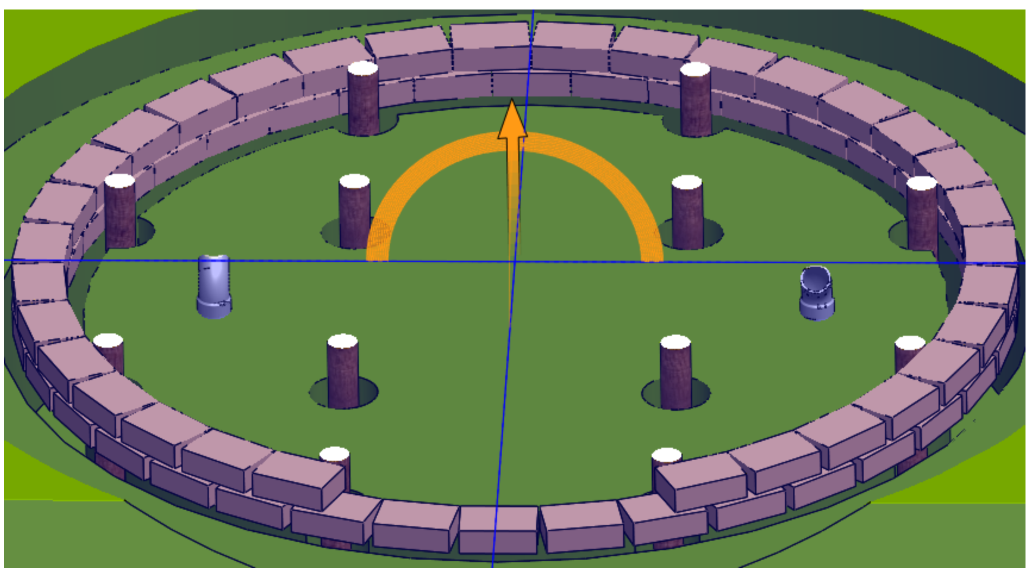


*Figure 5: Second Course of Brick*

**Third course:** The third course differs from the first two in that it needs to begin atop the doorway brick of the second course, but the starting brick needs to be cut to half the length of a standard brick in order to stagger the mortar joints of the course, shown in Figure 6 below. Measure and mark a line on a brick at half its length. Using a cold chisel, score the line around all four sides of the brick. Set the brick on firm ground or atop a wood plank, and tap the scored lines on each side of the brick with hammer and cold chisel. After tapping all the way around the brick to the starting point, place the chisel at center of the scored line and give it a firm hit with the hammer. The brick should break along the score all the way through. If it doesn't break, repeat the tapping pattern to score the line deeper and try again. Continue this process until the brick cleanly breaks. You should now have half-bricks for both sides of the doorway. Lay the third course of brick in the same manner as the first two. As you lay bricks, place brick ties in the vertical mortar joints that align to timber poles. Place brick ties 3-4 courses apart on each timber pole as your wall climbs upward. Continue laying brick courses until the 26$^{th}$ course is complete.

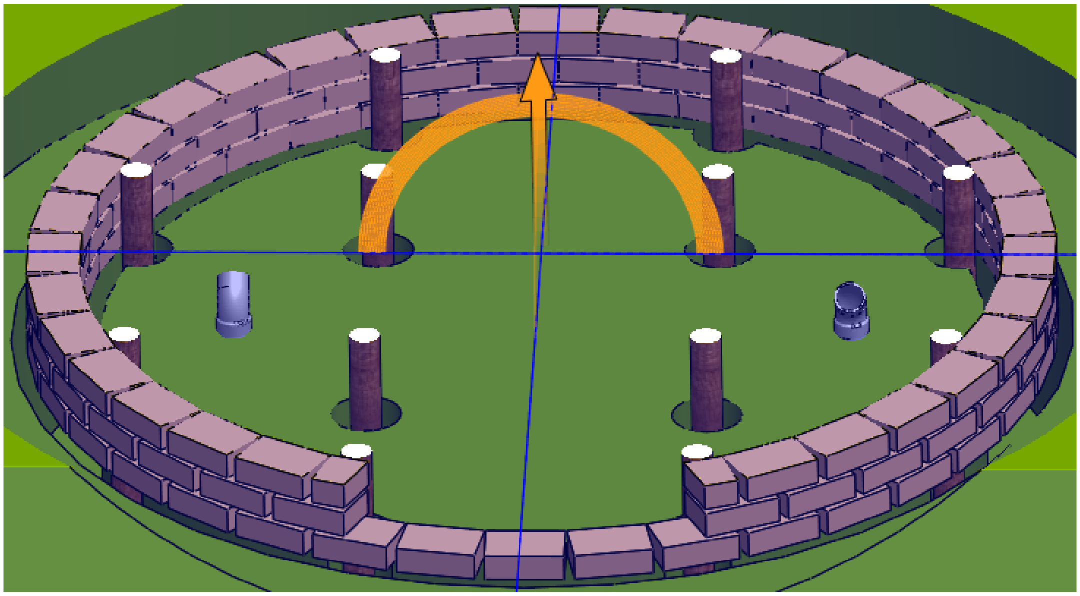
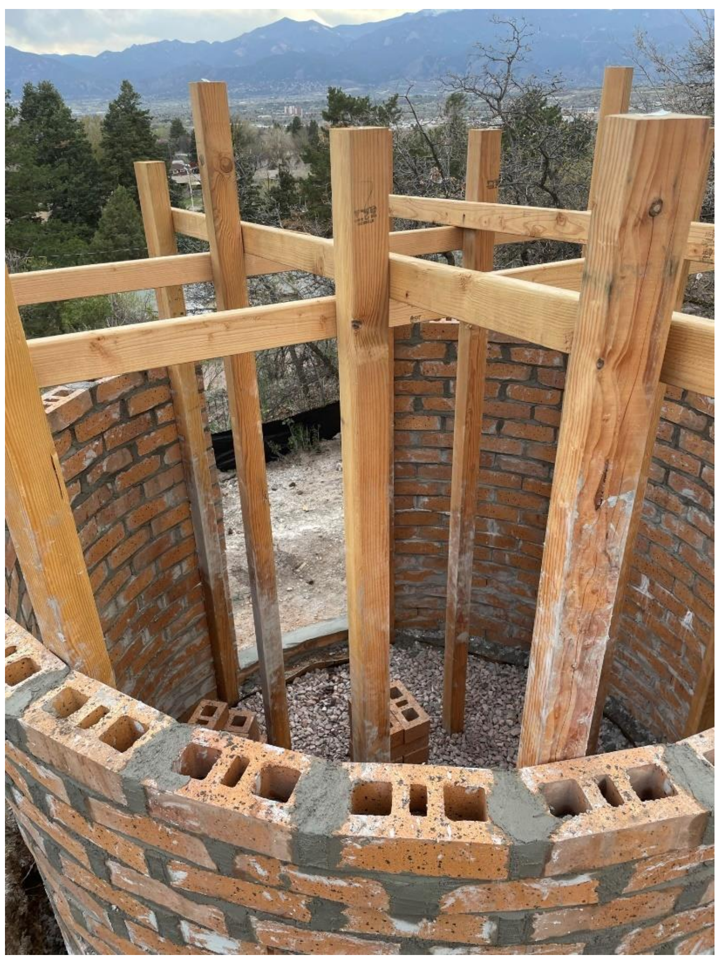


*Figure 6: Third Course of Brick*

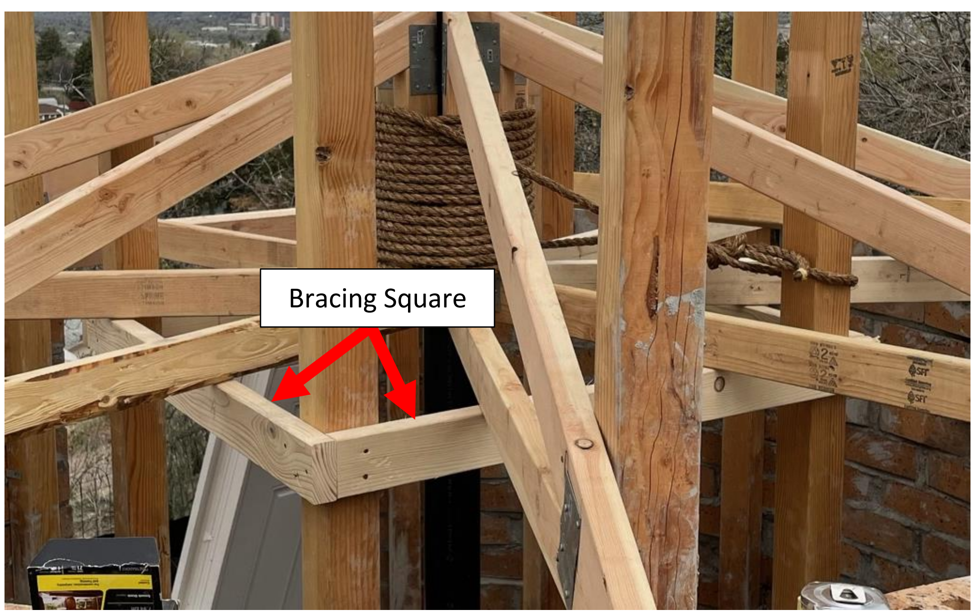
Upon finishing the 26th course of brick, the building should look similar to the image below. **Reminder: Be sure to nail the brick ties you set into the brick mortar to the timber poles.**



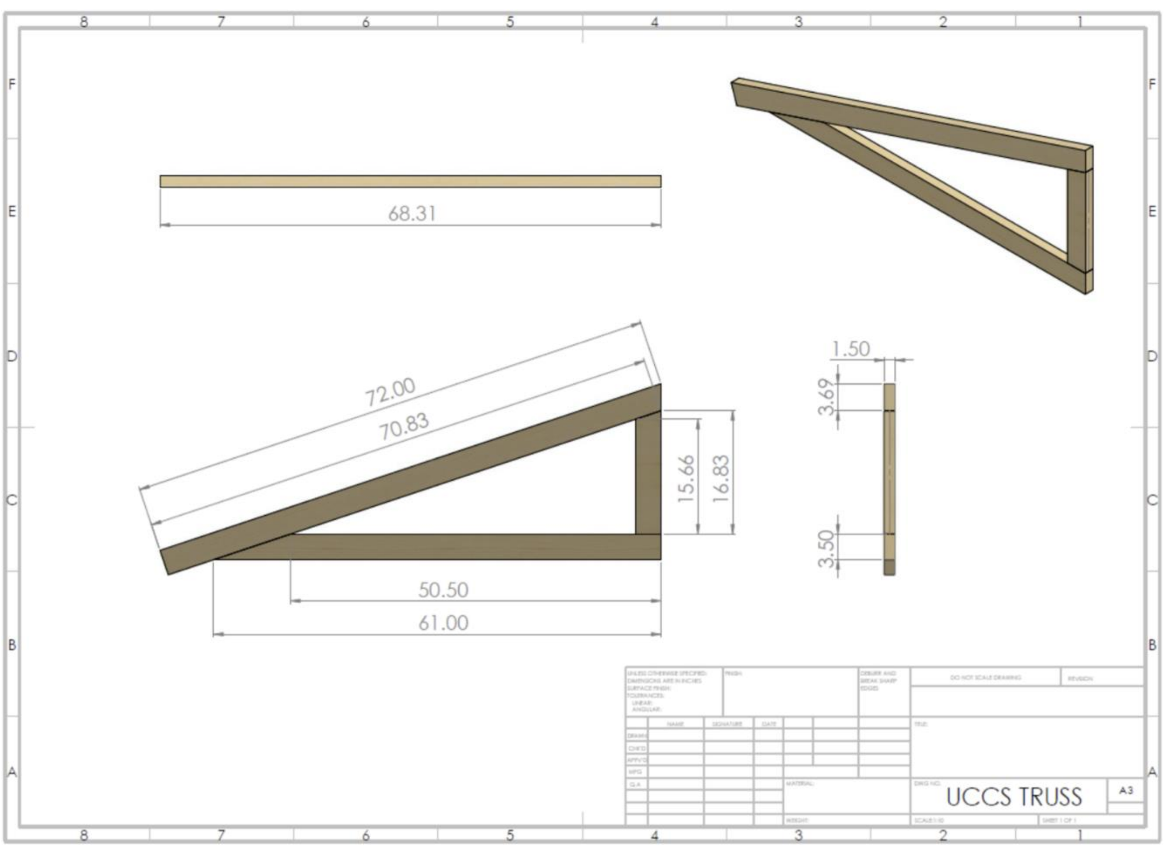
15. **Build the door header:** A header will need to be built to span the top of the door. The header will sit atop a bed of mortar on the 26th course of brick, spanning the positions that would be occupied by half-bricks. Then, a 27th course of brick will be laid, with the starting and ending bricks lying adjacent to the header on both sides of the door. The UCCS prototype header was built by gluing and nailing 3 pieces of 2” x 4” pine lumber together, then trimming to match where the edge of the half-brick would normally be. You can build the header a number of different ways and we recommend following local standards; however, it is important that the top of the header lie in plane with the top of the 27th brick course so that the roof lies perfectly flat against the header and brick.

Place the header on a bed of mortar as shown, and set the 27th course of brick. **NOTE: Be sure NOT to fill the vertical mortar gaps between the bricks in this last course, as they will be filled later on.** Use brick ties to nail the doorway timber poles to the door header.

16. **Make a Bracing Square for the Trusses to Rest Upon:** The roof designed by the UCCS team is polyhedral, and consists of 8 equal triangular panels at a 1:3 slope ratio (rise over run). To begin framing, detach the two lower temporary braces attached to the top of the timber poles in step 11. Let them fall down to rest on the top layer of brick. Mark where bottoms of these two braces touch the inner timber poles. Remove these two braces and repeat with the remaining two braces, so that the four inner timber poles show marks representing the top of the brick wall. Now cut dimensional lumber (preferably 2” x 4” or larger) to build a bracing square around the four inner timber poles. This bracing square will provide the resting place for the trusses, as shown below:

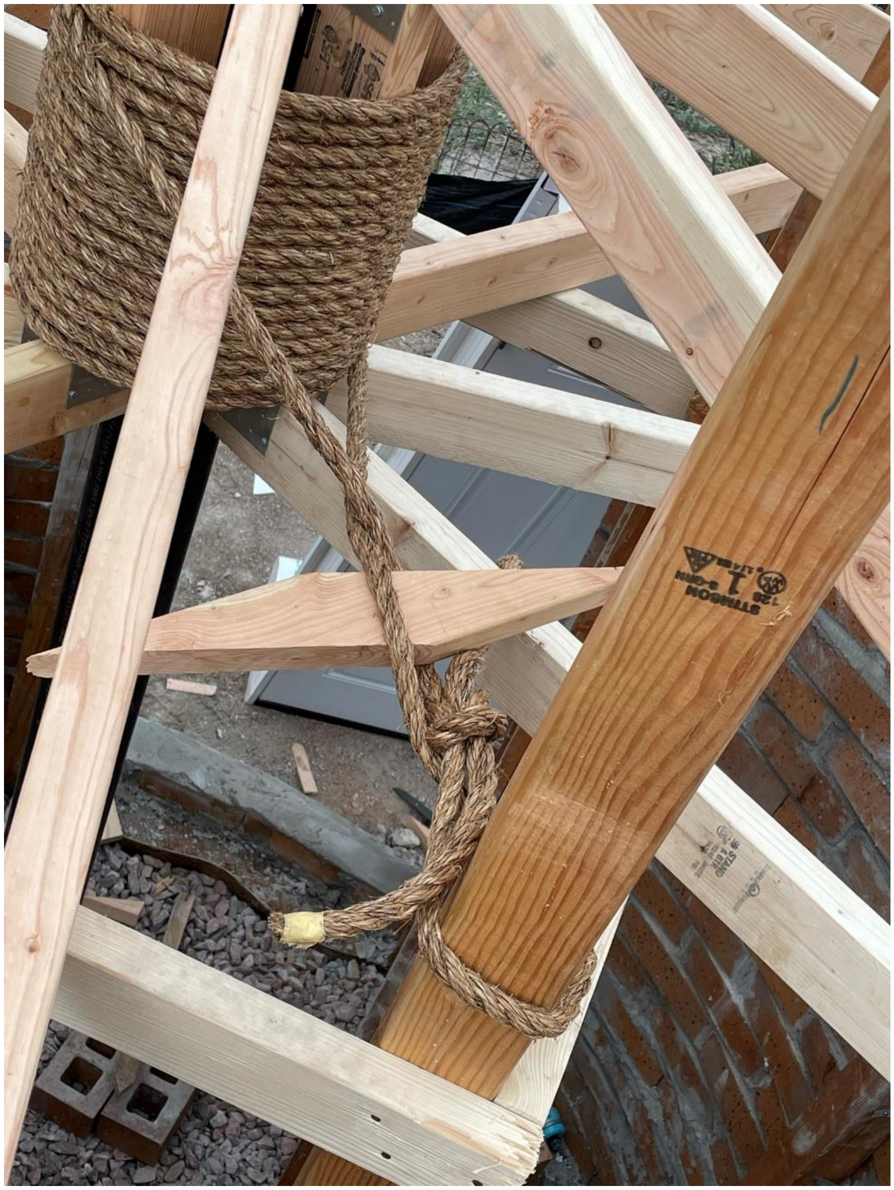


17. **Building trusses:** Eight trusses will be needed for the roof. We recommend choosing the rise-over-run ratio according to local standards, keeping in mind that the lower the ratio, the steeper the roof and the more difficult it is to work on. The UCCS prototype facility truss drawing shown below is provided for your reference. The UCCS prototype was built with galvanized steel "mending" plates nailed to dimensional 2" x 4" lumber with galvanized joist nails. We recommend building one truss, then using that truss as a template for the remaining seven trusses. This ensures they are all identical.



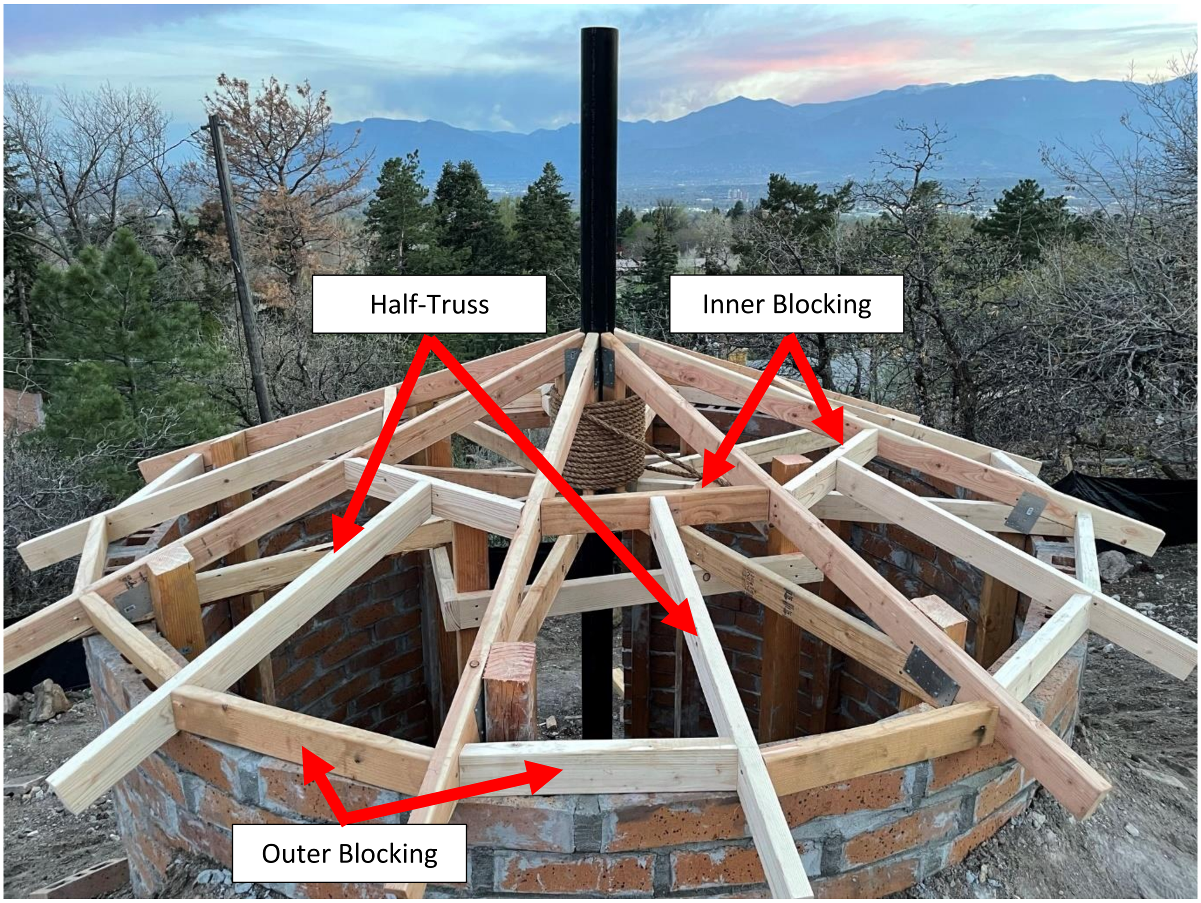
18. **Setting the Trusses:** Measure the inside diameter at the top of your brick wall in three or four places so that you can derive its average inside diameter (despite best efforts it will not be consistently the same diameter). Divide the average inside diameter by two and subtract half of the outside diameter of the outlet air pipe. The resulting number is the distance at which you should place your first two trusses from the inside brick. Set two trusses 45° apart atop the inner timber pole bracing square and on the top of the brick wall. Position each truss adjacent to a timber pole in the outer circle and at the distance you calculated from the wall to the inside face of the truss that will sit against the outlet air pipe. Drive nails through these two trusses into their adjacent outer timber poles. Set the remaining trusses in the same fashion, however do not nail them to their adjacent timber poles. Position the outlet air pipe between the eight trusses at center of the circle. Snug the pipe up to the two trusses you nailed to the poles and evenly space the remaining trusses around the pipe. Tie one end of a 60 meter rope to the inner pole between the first two trusses (The UCCS team used ¾" rope. Thicker rope results in fewer windings but may be harder to work with.). Push the knot down toward the bracing square. Now hold the rope taught while you wrap it around the eight truss posts, drawing them in tight against the pipe. Have a partner adjust the pipe to a height of about 1 meter above the tallest point of the trusses (you may have to keep monitoring the pipe position until the winding is tight enough to keep it from sliding downward), then monitor the spacing of the trusses around the pipe as you wind the rope upward, keeping the winding tight and the spacing even (The UCCS team performed this task with two people, however it would have been easier with three). Upon reaching the top, untie the lower rope tail from the pole (try to keep it held taught), pull it around the pole it was tied to, and tie it to the upper rope tail using a square knot. Don't worry if the rope tails have a little slack.

    Use a strong piece of wood or steel to make a rope twister. The piece you use to twist the rope should be long enough to lodge against the truss at the location you twist from. Position the twister between the two rope tails midway between the inner timber pole and the outlet air pipe. Now angle the rope twister so that you can twist it without hitting the top or bottom of the truss. Twist the ropes until the winding tightens sufficiently (the outlet air pipe should not be moveable) and then straighten the twister to lodge it against the truss. As long as the rope twister is lodged against the truss the entire assembly will not move. Now nail the loose ends of the other six trusses to their adjacent posts. See images below:

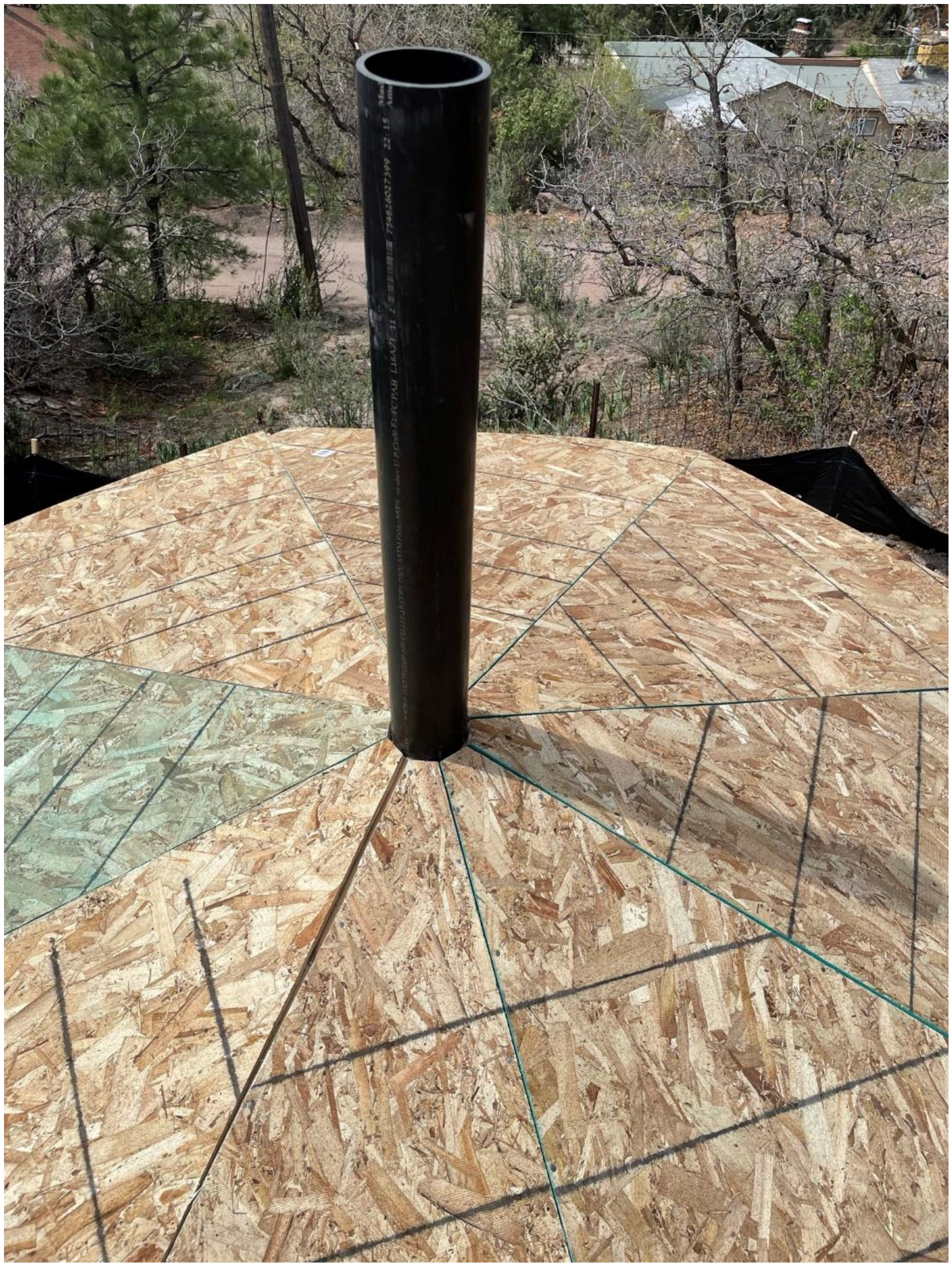


19. **Roof Blocking (bracing):** Colorado building codes require not more than 2 feet of space between roof trusses due to heavy snow loads that can occur during winter months. For this reason, the UCCS prototype contains half-trusses in between the full trusses. The blocking (which is our term for “bracing”) is located at the position where the distance between trusses reaches 2 feet. Then, a rafter board is attached to the blocking to mimic the top of a truss, thereby creating a sort of half-truss to provide additional load support between the widest span of the trusses. You’ll see in the design of the UCCS prototype that the blocking is staggered back and forth from truss to truss to ease access with hammer and nails. Install the shorter blocking in every-other truss span first, then you’ll have access to nail the longer pieces.

    The outer row of blocking follows the same method as the inner row. Here the blocking is installed on top of the brick circle rather than further out at the 2-foot span. This method allows for the brick ties to be nailed onto the outside face of the blocking all the way around (nailing to this outer edge of the bocking will not loosen the nails holding the bocking to the trusses, whereas nailing from the inside might), with the brick ties hanging downward into the empty mortar gaps between the bricks. Once all the ties have been attached, pack all the gaps full of mortar. Use leftover mortar to fill any air gaps between the top course of brick and the roof framing. Cut the tops of the outer timber poles flush with the tops of the trusses. There is no need to cut the tops off the inner poles.


Half-Truss
Inner Blocking
Outer Blocking

20. **Sheathing the Roof:** At this point in the build process, local metal roofing customs should prevail over what was done on the UCCS prototype, as it was roofed with asphalt shingles and is exposed to a very different environment. The UCCS team cut 8 OSB (OSB is Oriented Strand Board) roof sheathing panels into large triangles that spanned the gap between each pair of trusses, laying over the partial trusses between. The UCCS team cut each panel individually, as they were not the same exact dimensions between trusses. Each panel was nailed down to the top chord of each truss with 8D glue-shank nails, the seams adjoining as tightly as possible. The assumption of the UCCS team is that using OSB in the Ugandan environment may be problematic due to it rotting from the high humidity. Again, local customs should prevail.



21. **Moisture Layer:** The UCCS team laid roofing felt (also called "tar paper") over the sheathing in overlapping layers starting with the felt hanging about 10 mm over the bottom edge of the sheathing, then working upward. Staples were used to attach the felt to the sheathing. It's important to ensure that all overlapping felt joints are facing downhill so that if water were to seep under the metal roof panels, it could not run under the felt and into the building.

22. **Pipe Seal:** After the metal roofing has been completed, cut a rubber pipe boot to fit tightly over the pipe. Slide it down and screw through the metal flange into the metal roofing. This will seal the pipe so water can't run down into the building. The boot used by the UCCS team was a Masterflash ¼"-5-3/4" boot, however you can use any similar size and brand such as the Flashers #4 Roof Jack Pipe Boot shown below. The boots are marked with dimensions indicating the diameter of the pipe it will slide over. Cut at the appropriate dimension (for standard schedule 40 4-inch pipe, the outside diameter is 4.5 inches).


23. **Pipe Cap:** Place a vented pipe cap over the outlet air pipe and tighten the adjustable clamps down. The UCCS team did not complete this step prior to graduation, therefore you won't see the part in the prototype photos. An example shown below is a Master Flow Adjustable Versa Cap.


24. **Roof Insulation:** The UCCS team planned to insulate the ceiling of the prototype facility but did not complete the task prior to graduation. The team was to cut and glue rigid 2-inch foam panels to the underside of the sheathing panels in each of the truss spans; however, any type of insulating material can be used to prevent heat generated by the metal roof from warming up the inside of the storage facility. This is a critical step to the cooling ability of the facility.

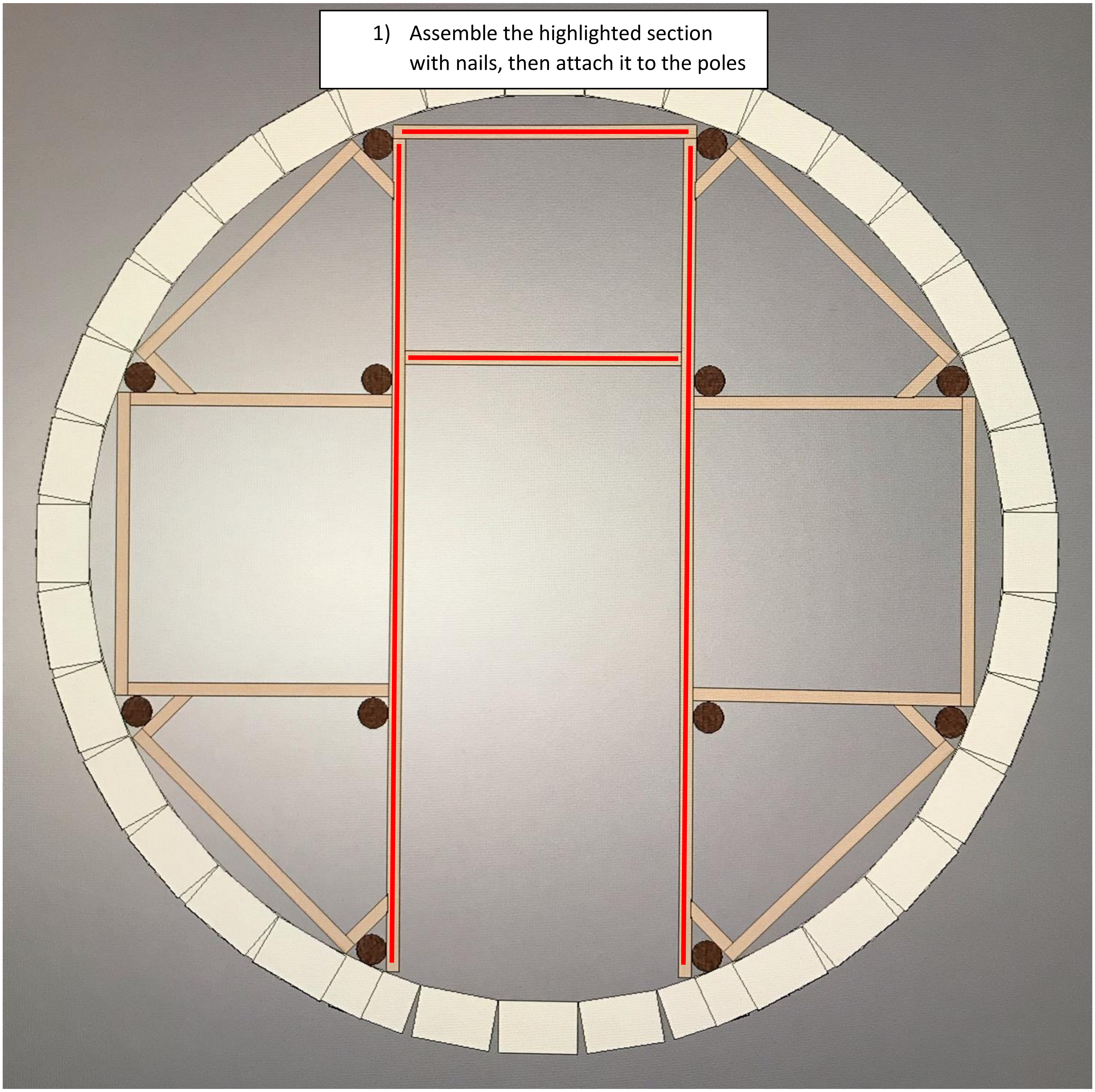
25. **Filling the Floor:** Smooth the floor out and cover with a moisture-permeable fabric barrier. Then, spread 1-1/2" clean rock over the fabric until the rock reaches about halfway up the first course of brick. At this point, the UCCS team spread activated carbon evenly throughout the rock floor. This layer serves as a purifier for the air in the building but is not required for the building to cool. Continue filling the floor with 1-1/2" clean rock until it is level with the top of the first course of brick. **NOTE: The UCCS team did not complete this step prior to graduation.**

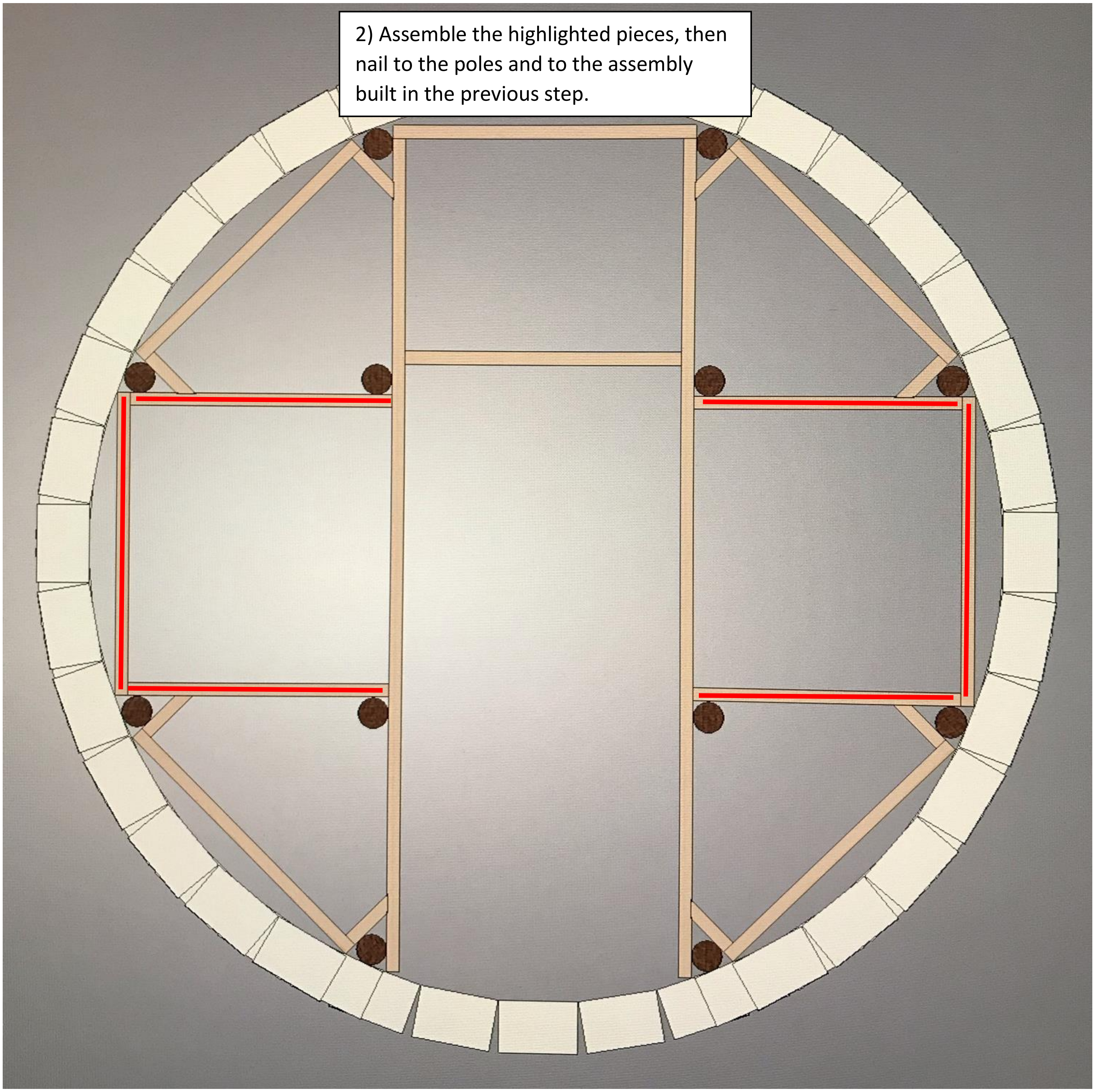
26. **Air Inlet and Air Outlet Pipe Manifolds:** Remove the PVC caps placed over the air inlet pipe manifold inside the building and cut to approximately 5 cm above the rock floor. Attach a 90° elbow to each pipe in opposing directions, as shown below:

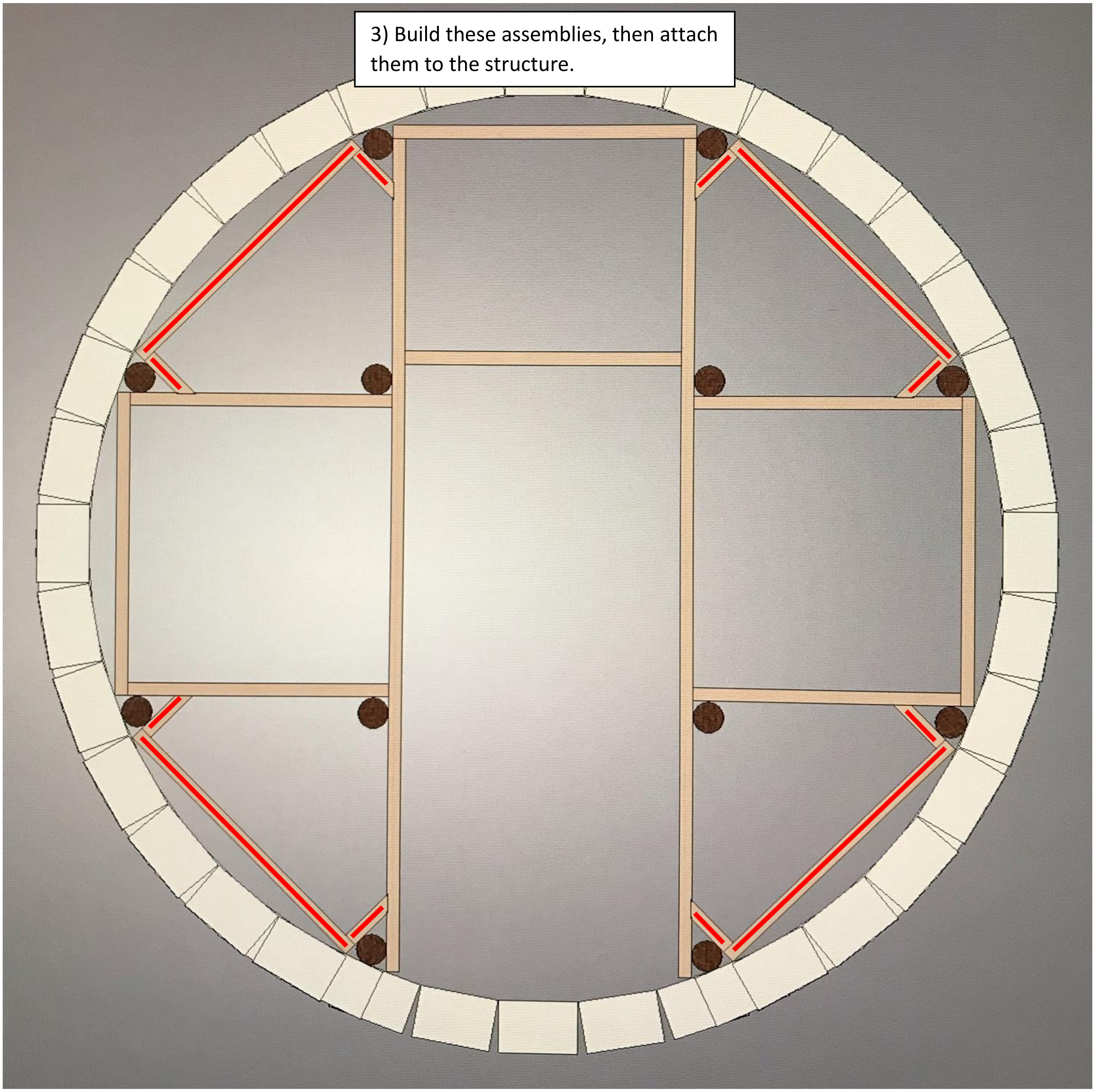
Cut the outlet air chimney pipe approximately 5 cm below the bracing square. Assemble the outlet air manifold in the same fashion as the inlet manifold, with a 3-inch reducer attaching to the bottom of the air outlet pipe, and a 3-inch tee attaching to the reducer. Extend the arms the same distance of 89 cm from center of the tee to center of each elbow inlet. Be sure that the elbows are turned in the opposite direction of the inlet air manifold elbows. **NOTE: The UCCS prototype manifolds were built with the elbows pointed opposite of direction in the model. The direction isn't important as long as the upper and lower manifold elbows are positioned to flow OPPOSITE each other.** Try to imagine the air entering the building swirling in a counter-clockwise direction upward until reaching the outlet air pipe, where it will enter the elbows directly.

*Figure 7: Looking Down into the Building at the Outlet Air Manifold*

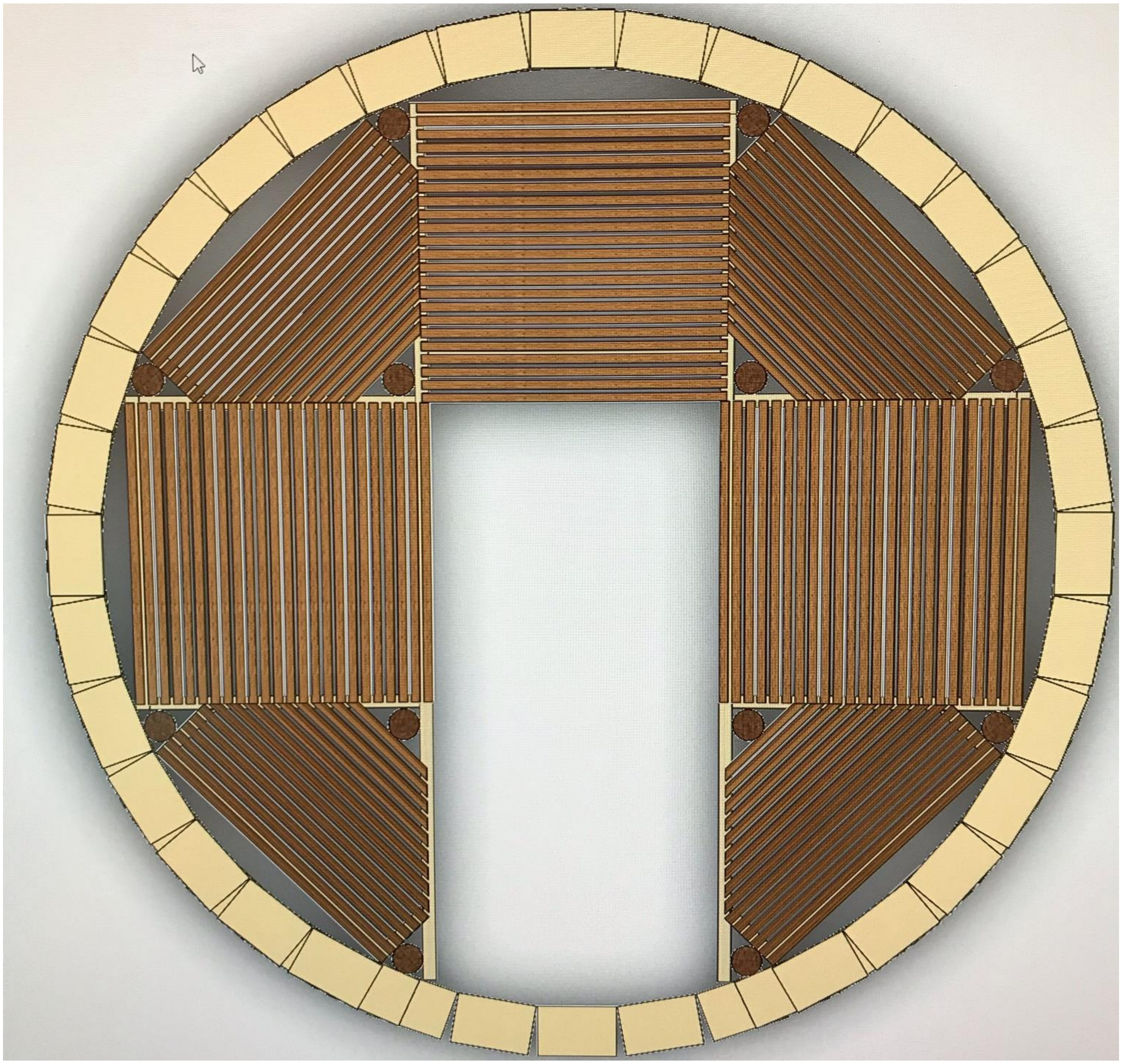
27. **Shelving Framework:** The UCCS team did not complete the shelving prior to graduation. We have provided a general concept for shelving in the images that follow. Specific instructions are not provided because the construction largely depends on whether dimensional lumber or rough timber is used for the shelf framework, and the dimensions between the timber poles will not be consistent despite your best efforts to build it precisely. If dimensional lumber is used, consider that some areas requiring nails won't have enough room to swing a hammer. The design shown in the following image sequence takes this into consideration and should allow for easy assembly. The UCCS design places three levels of shelves 58 cm apart from each other vertically. However, these can be modified and built to suit the specific crops of the farmers.

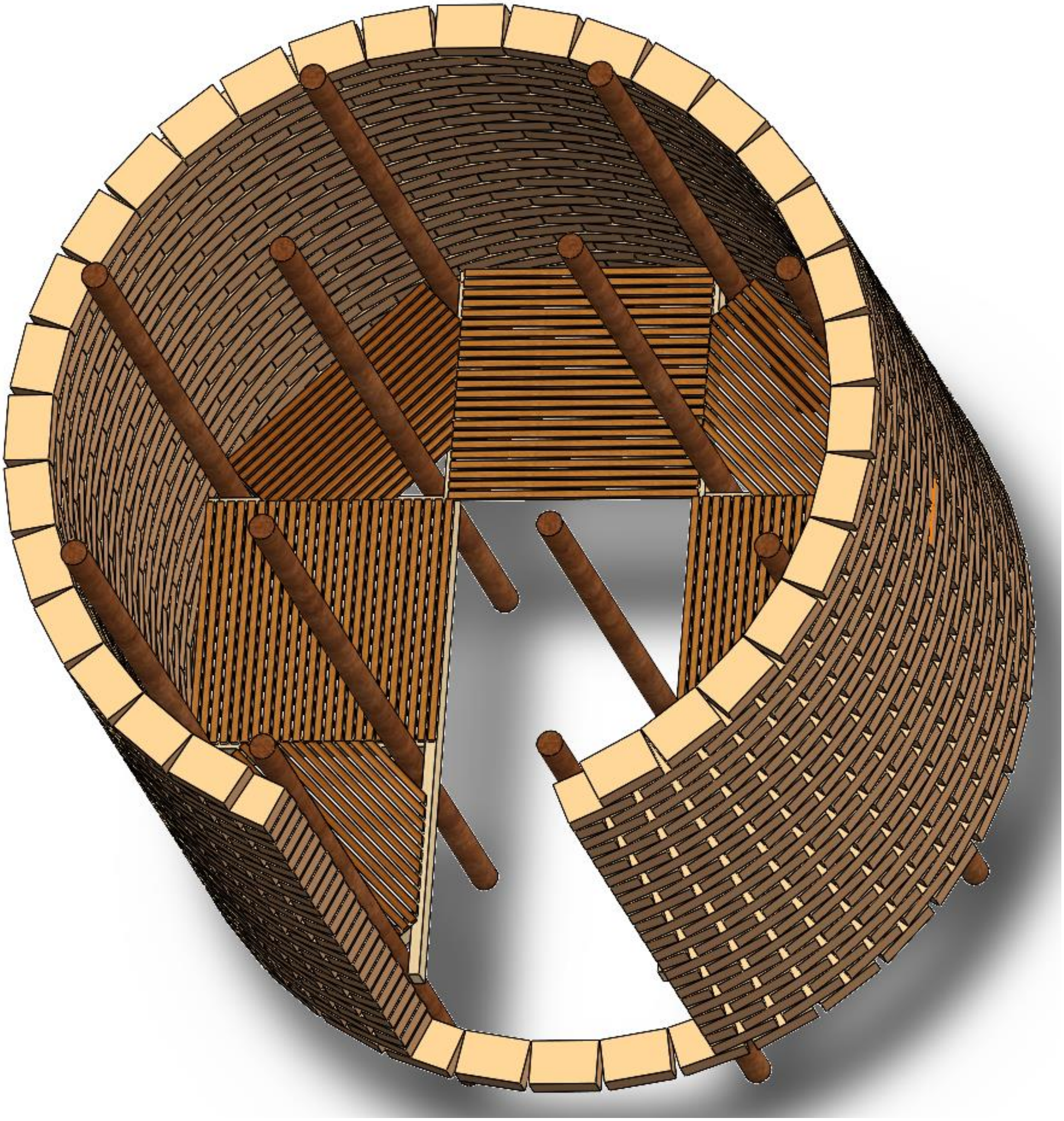


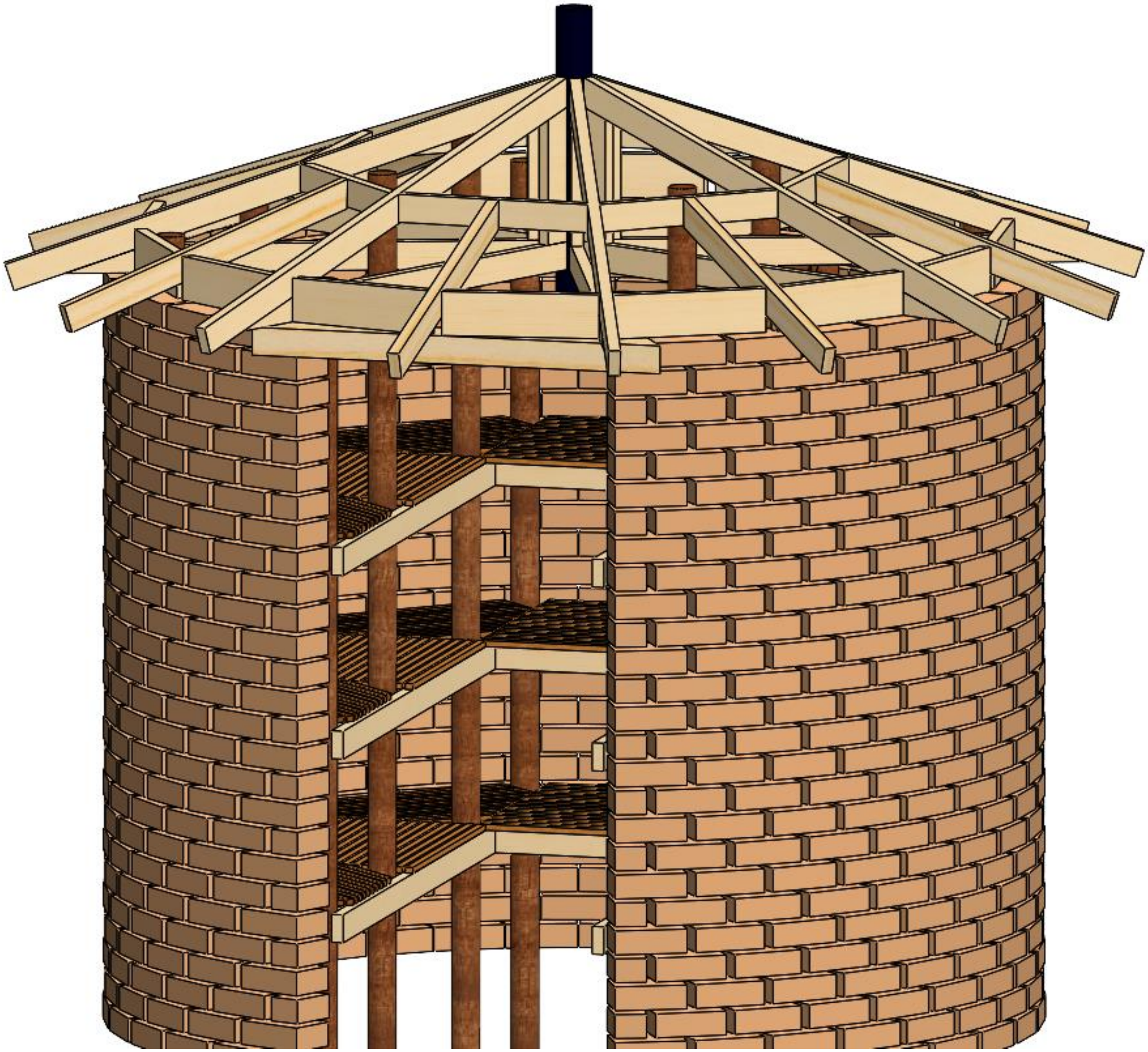

2) Assemble the highlighted pieces, then nail to the poles and to the assembly built in the previous step.


3) Build these assemblies, then attach them to the structure.

28. **Shelving Material:** The following three model images show ¾" x ¾" wood strips as the shelving material to be nailed with trim nails to the shelving framework. The cool air flowing upward through the shelving and across the surface of the produce is an essential process for extending the produce life; therefore, if you choose to use another type of material for the shelving, it needs to allow for ample air flow (netting or loosely-woven burlap could be a suitable substitute).







29. **The Door:** Having had the door custom-built to suit your needs, we recommend following installation instructions of your door maker. In the U.S.A., the built-in door threshold would be set on a level cured bed of mortar and sealed with 100% silicone adhesive. Then, the door would be shimmed on the sides so that it rests plumb in both planes. A masonry drill would be used to drill holes through the door frame and shims and into the brick. Next, special masonry screws called Tapcons would be screwed through the door frame into the holes in the brick using a power drill. Lastly, gaps would be insulated and sealed with trim boards and mortar.

30. **Installing a Water Barrier:** You will use the earth you excavated from the hillside to insulate the building. First, if available, wrap the building with an impermeable plastic vapor barrier. If unavailable, you may also apply an even coat of plaster over the bricks that will lie below the surface of the dirt. This step ensures that moisture in the hillside won't penetrate the bricks and dampen the inside of the building.

31. **Bury the Building:** Use the earth removed from the hillside during excavation of the hole to bury the wall of the building as high as possible. The dirt must be tamped in place and out-sloped appropriately as shown in the image below to minimize erosion and maximize insulation of the building from outside air temperature. Spreading native seed over the bare dirt will help ground cover to grow and stabilize the dirt.

This concludes construction of the UCCS Produce Storage Facility. Thank you for the opportunity to work with you on this project.

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