

Appendix 1: Concrete Biosand Filter Version 10.0 Mold Design

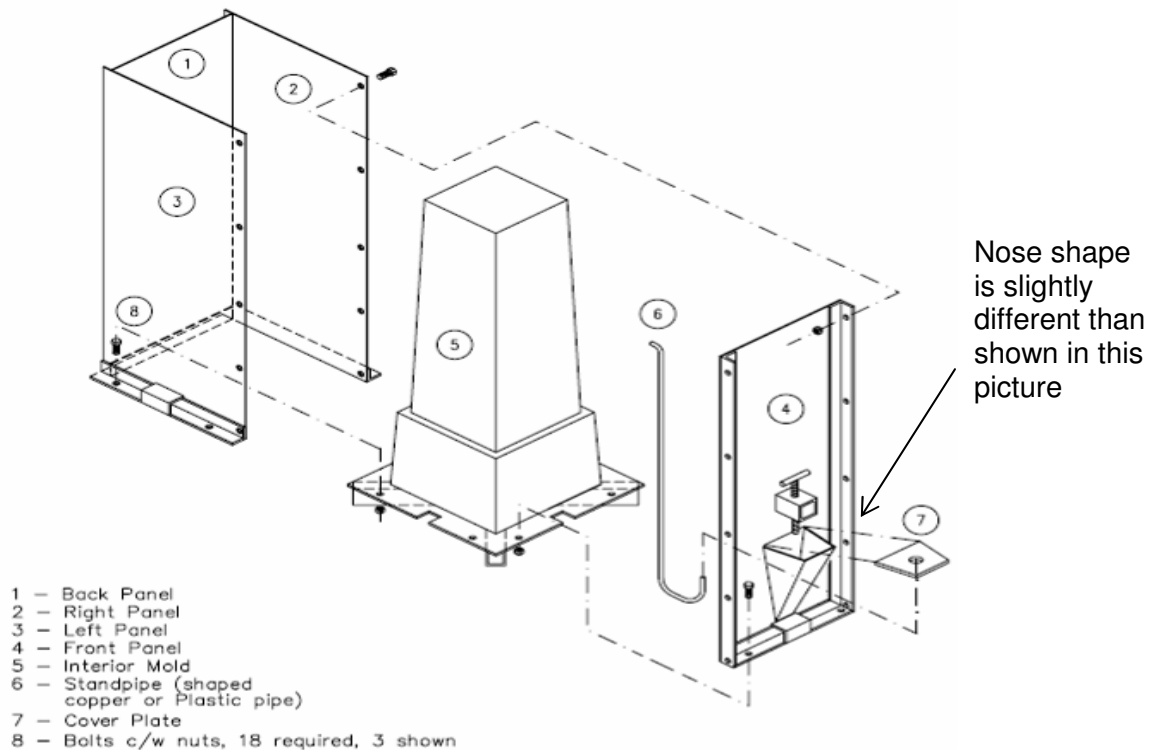
Biosand Filter Manual



Tips for Working with a Welder

- The first time you have a mold made, book one week of time to work directly with the welder or check in periodically to make sure they understand the instructions – don't expect to simply drop off the drawings and come back later to pick up a finished mold.
- Explain to your welder what the mold is for and what are the most critical parts of it – if they don't know what it does, they won't know what's necessary to make it work.
- Set up a contract with your welder that states you must have a working mold which has been tested and produces a concrete filter before you will pay in full.
- Take the time to select sheet metal and angle iron that is straight and flat with as little rust as possible on the sheet metal.
- The 3-sided piece of the exterior mold can be bent from one piece of sheet metal instead of welding 3 pieces together, if the welding shop has the tools to do so. Be sure to adapt the measurements to fit the requirements of the mold.
- It may be useful to build jigs to keep the plates square while welding.
- If you are having trouble keeping the interior mold boxes square, consider welding braces across all the openings (on the inside of the box).
- All measurements are in millimeters (imperial units in brackets) unless otherwise stated.
- **If you have questions, email us – that's what we're here for! cawst@cawst.org**

Overview of the Steel Mold



Part A: Cutting the Pieces

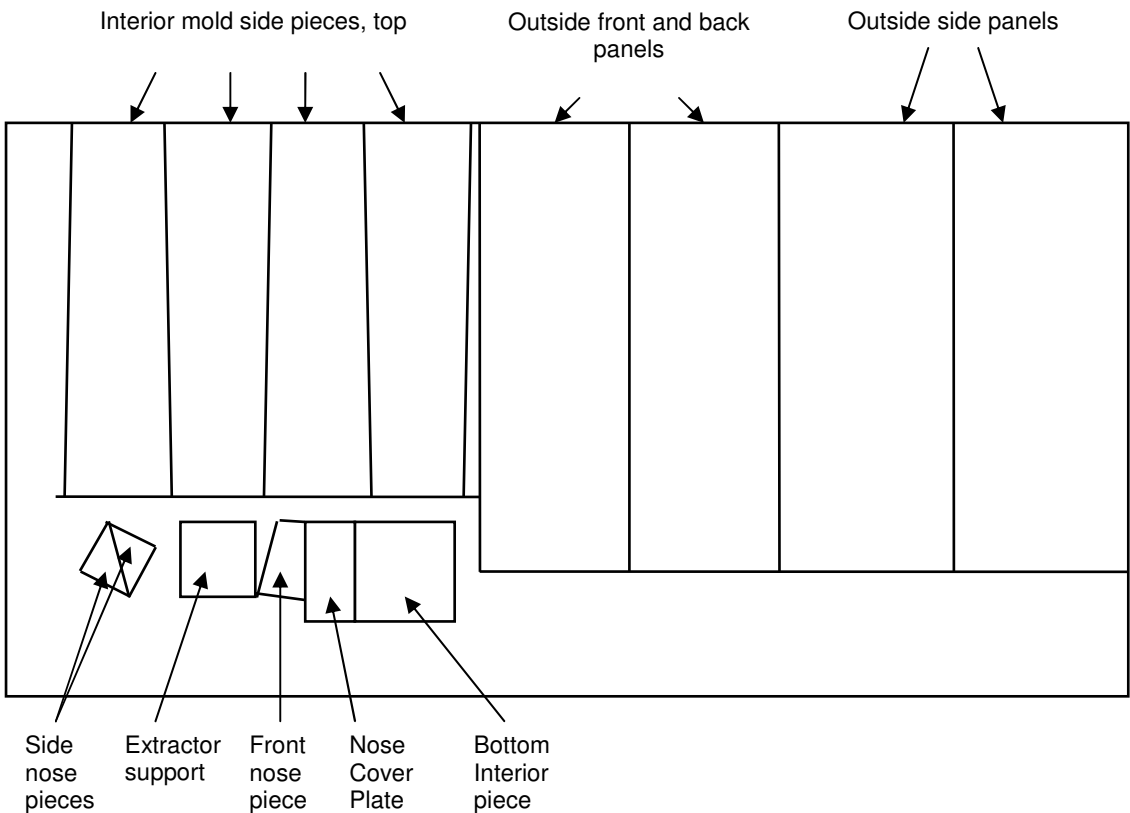
Quantity	Description
1 sheet*	3 mm (1/8") thick steel plate, often available in 1220 mm x 2440 mm (48" x 96") sheets. Recommend using new steel plate that is not rusted.
1† 1	6 mm (1/4") thick steel plate – one piece 1016 mm x 160 mm (40" x 6.5") – one piece 387 mm x 387 mm (15 1/4" x 15 1/4")
3210 mm (127")	38 mm (1 1/2") x 38 mm (1 1/2") x 3.2 mm (1/8") (wall thickness) angle iron
1435 mm (56 1/2")	38 mm (1 1/2") x 38 mm (1 1/2") x 3.2 mm (1/8") (wall thickness) square tubing
610 mm (24")	16 mm (5/8") diameter steel rod (or four 5/8" diameter bolts 152 mm (6") long)
229 mm (9")	25 mm (1") diameter threaded rod (also known as all-thread or ready-rods)
2	25 mm (1") nuts (these nuts must be able to thread onto the 1" threaded rod)
140 mm (5 1/4")	13 mm (1/2") diameter threaded rod
1	13 mm (1/2") nut
28	10 mm (3/8") diameter bolts – 19 mm (3/4") long
28	10 mm (3/8") nuts

* Do not use steel that is less than 3 mm (1/8") to construct the steel mold. The mold bends and warps easily if steel less than 3 mm (1/8") is used. Use 4 mm (0.17") steel if 3 mm (1/8") steel is unavailable.
 † 6 mm (1/4") steel is best for creating the diffuser ledge and a strong base, especially if you are using a diffuser plate and not a diffuser basin. Use 5 mm (1/5") steel, if 6 mm (1/4") steel is unavailable.

Step 1: Layout and cut 3 mm (1/8") steel plate

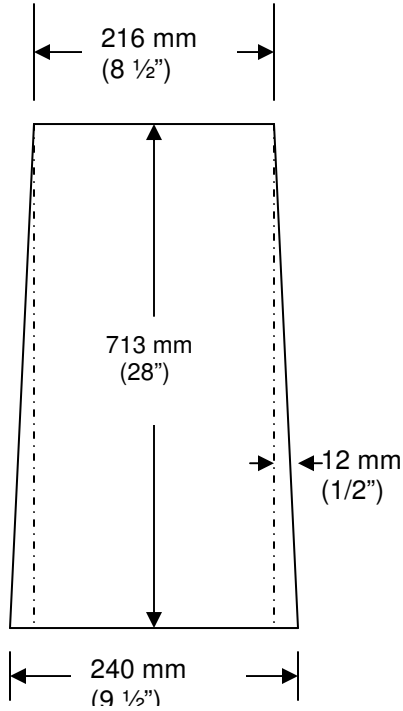
All the 3.2 mm (1/8") thick pieces can be cut from a single sheet, as shown below. These pieces must be cut from uniformly **flat steel** (without any concave or convex areas). At least one side of these metal sheets should be **free of rust** (rust causes concrete to stick).

Note: The image below does not include the width of the cut lines, which will vary depending on the cutting apparatus used.

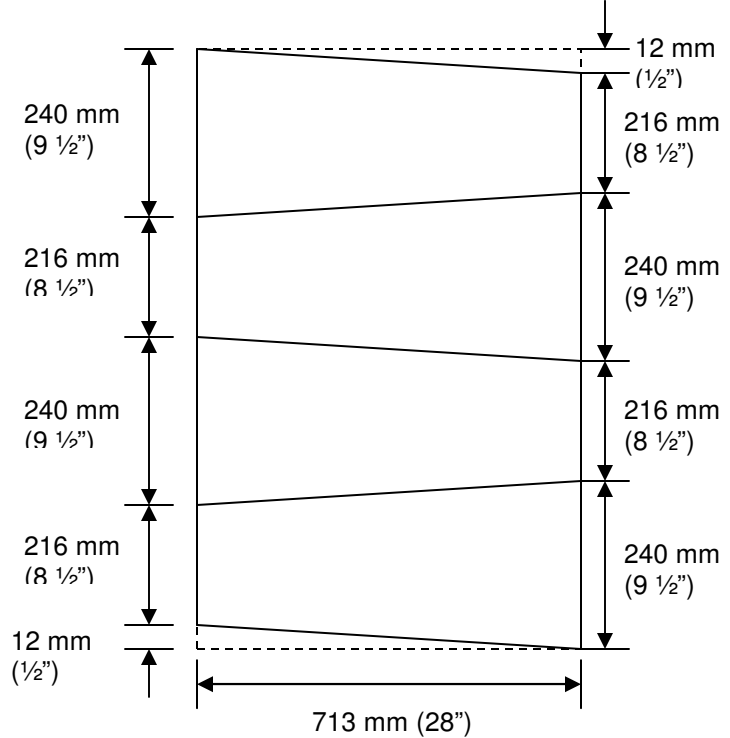


Step 1: Layout and cut 3 mm (1/8") steel plate – continued

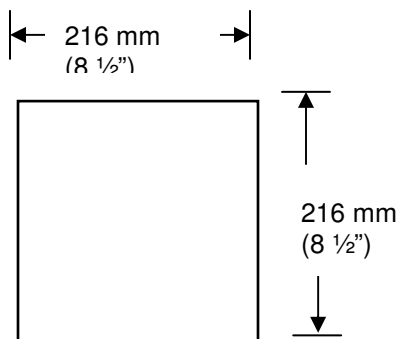
Interior side pieces, top (4 pieces)



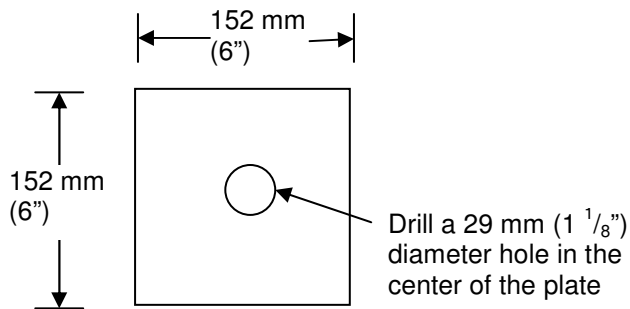
OR, cut these plates from one sheet as shown, but account for the width of the cuts



Bottom Inside Plate (1 Piece)



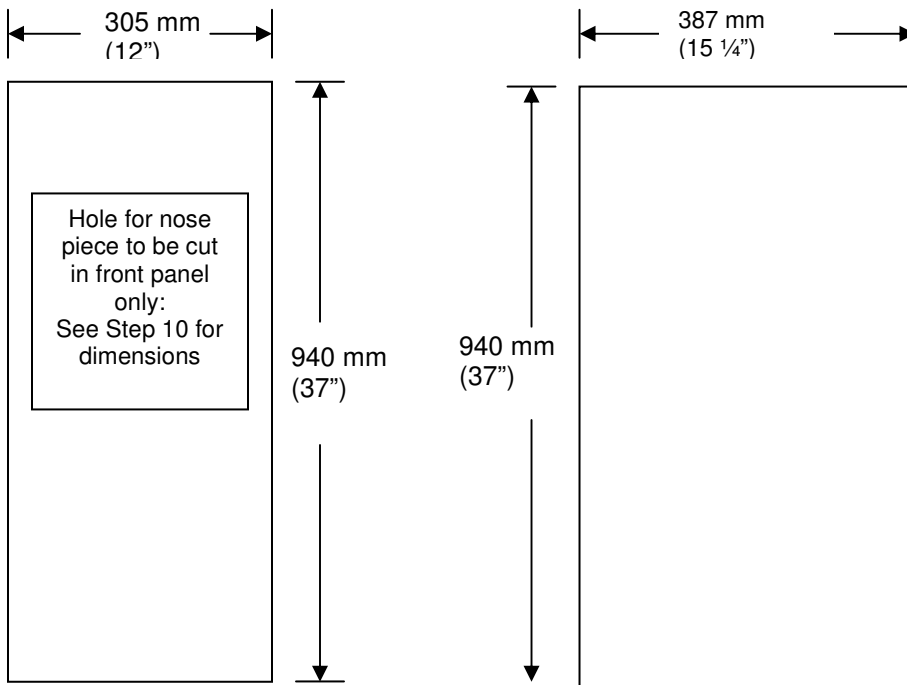
Extractor support (1 Piece)



Step 1: Layout and cut 3 mm (1/8") steel plate – continued

Exterior Back and Front panels (2 pieces)

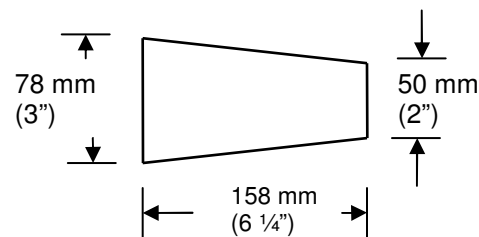
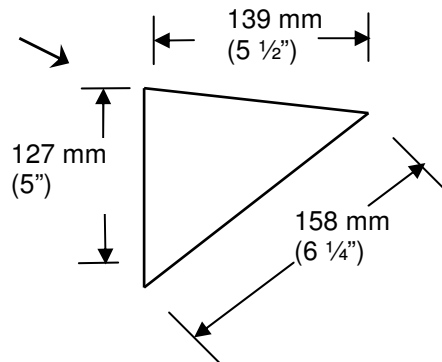
Exterior Side panels (2 pieces)



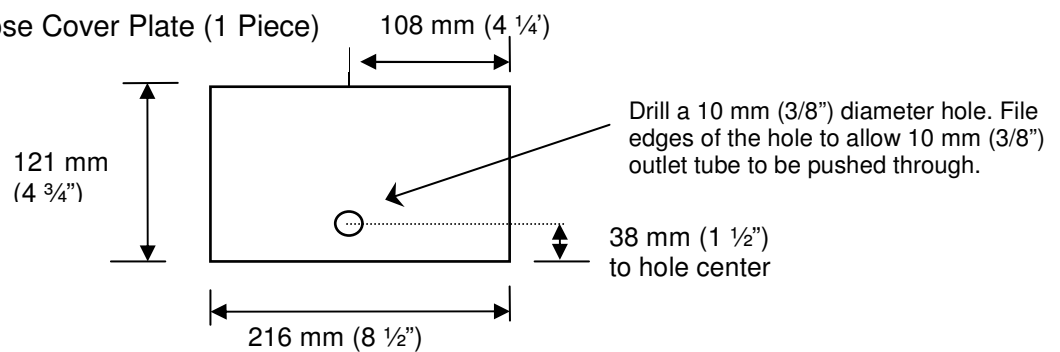
Side Nose Pieces (2 Pieces)

Front Nose Piece (1 Piece)

Note: this is not a right-angle triangle.



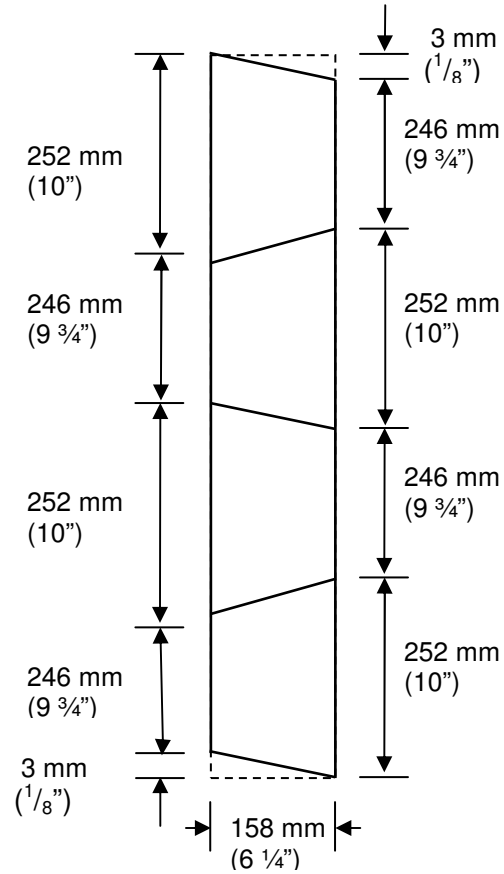
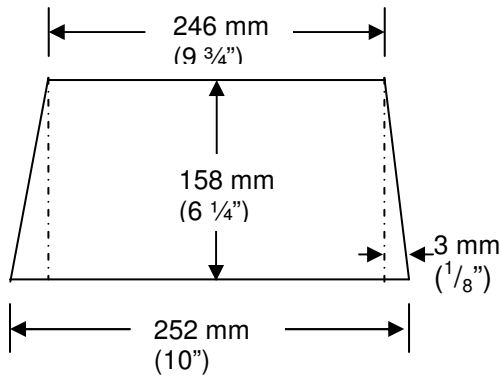
Nose Cover Plate (1 Piece)



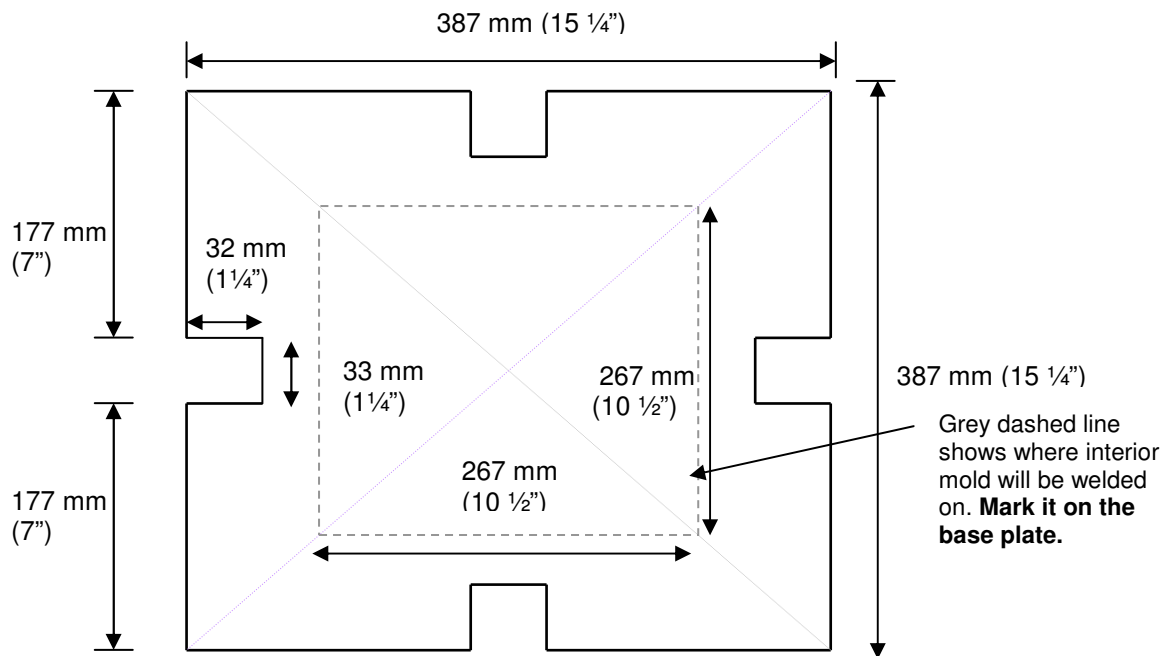
Step 2: Layout and cut 6.4 mm (1/4") steel plate

Interior side pieces, bottom (4 pieces)

OR, cut these pieces from one plate as shown below, but you must account for the width of the cuts

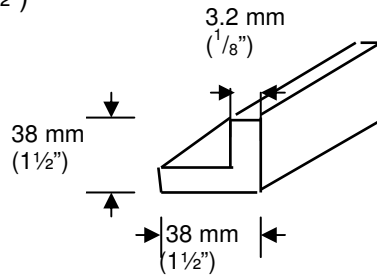


Base plate (1 piece) **Note: It is symmetrical.**

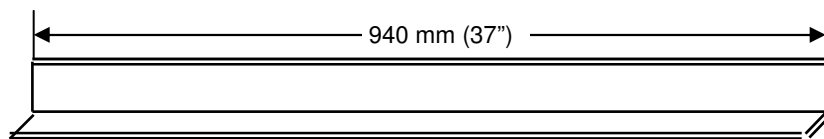


Step 3: Cut 38 x 38 (1 1/2" x 1 1/2") angle iron pieces

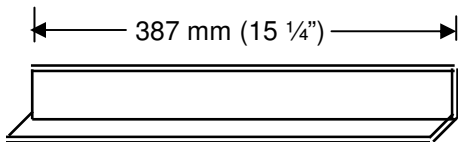
Total angle iron needed: 3213 mm (126 1/2")



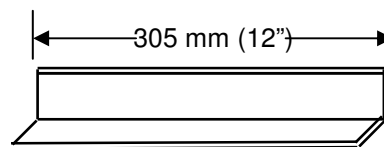
Two 940 mm (37") long pieces



Two 387 mm (15 1/4") long pieces



Two 305 mm (12") long pieces



Step 4: Drill holes in angle iron

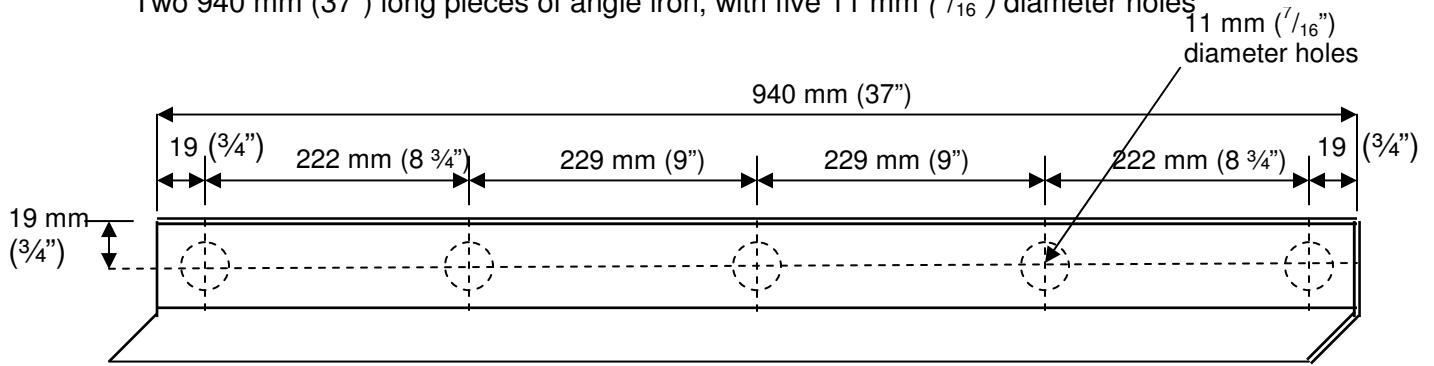
Note: Our recommended hole locations are shown below; however, the specific positions of the holes are not critical. The most important thing is to ensure that the holes on one piece of the mold match up with the holes on another piece of the mold after it is welded. If you drill the holes on every piece separately, they won't line up exactly and it will be difficult to insert the bolts each time you assemble the mold.

Depending on the available tools, there are three different options:

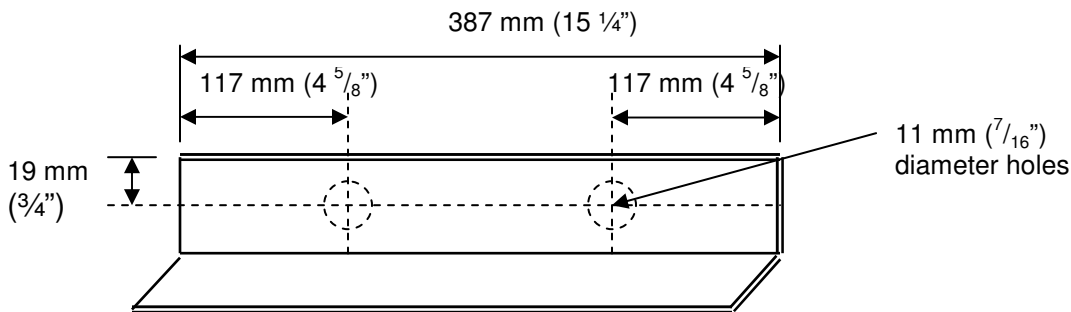
1. Drill the holes in the angle iron now but wait to drill the corresponding holes on the plates until the mold has been assembled (the method described in this manual).
2. Drill pilot holes (less than 11 mm) on every piece (angle irons and plates) as you go, but wait to finish drilling the holes to 11 mm (7/16") until the mold is assembled
3. Mark the holes now, but wait to drill all the holes until the mold is clamped together at a later stage (must be done with a handheld tool, not a drill press)

Step 4 - continued

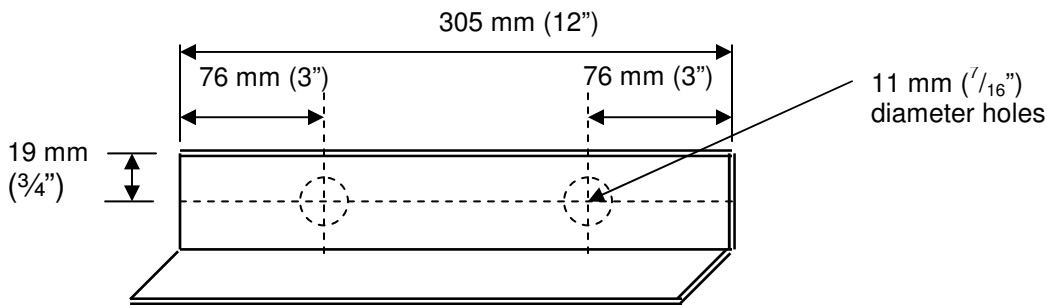
Two 940 mm (37") long pieces of angle iron, with five 11 mm ($\frac{7}{16}$ ") diameter holes



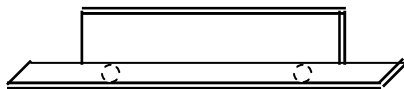
Two 387 mm (15 1/4") long pieces of angle iron, with two 11 mm ($\frac{7}{16}$ ") diameter holes



Two 305 mm (12") long pieces of angle iron, with two 11 mm ($\frac{7}{16}$ ") diameter holes

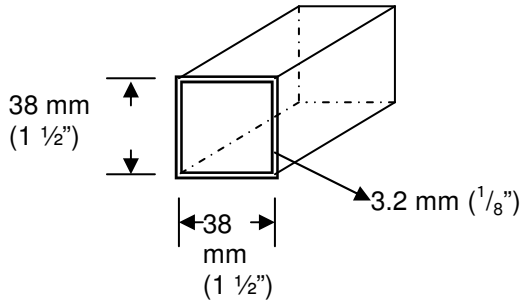


For only one of the 305 mm (12") pieces of angle iron, cut 38 mm (1 1/2") off each end of the angle iron, but only on the side that has no holes, as shown below.

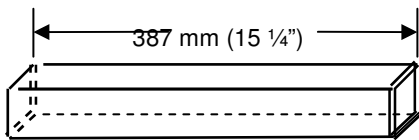


Step 5: Cut 38 mm x 38 mm (1 1/2" x 1 1/2") square tubing pieces

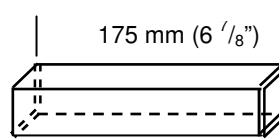
Total square tubing needed: 1435 mm (56 1/2")



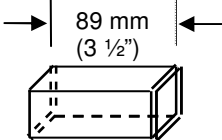
One (1) 387 mm (15 1/4") long piece



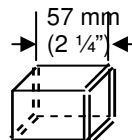
Two (2) 175 mm (6 7/8") long pieces



Five (5) 89 mm (3 1/2") long pieces

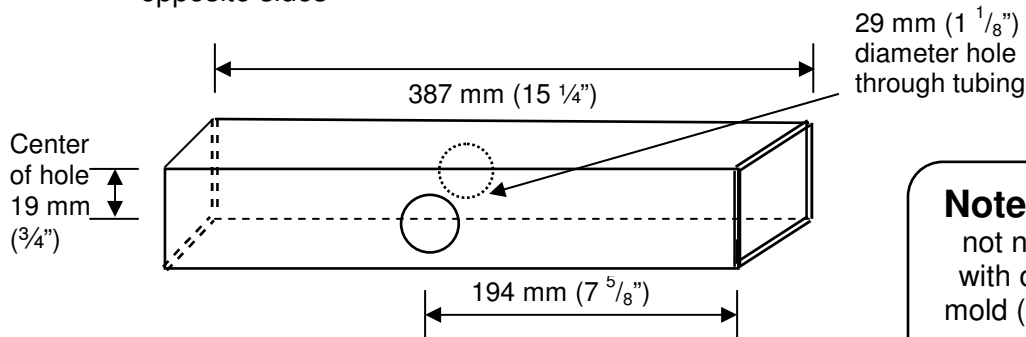


Four (4) 57 mm (2 1/4") long pieces



Step 6: Mark and drill holes in square tubing

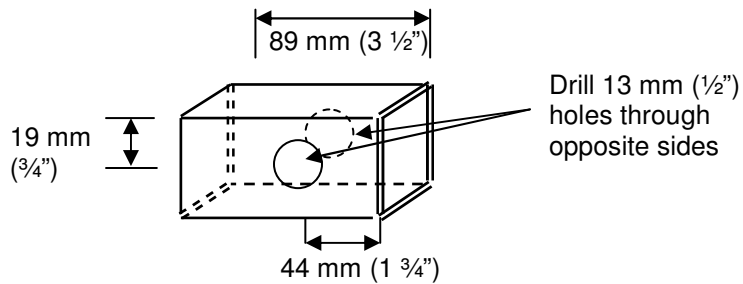
One (1) 387 mm (15 1/4") long piece of square tubing, with 29 mm holes through two opposite sides



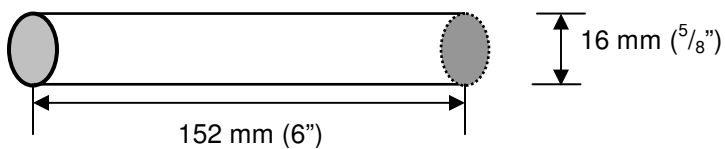
Note: These holes do not need to match up with other parts of the mold (as in Step 4), and can be drilled now.

Step 6: Mark and drill holes in square tubing – continued

One (1) 89 mm ($3\frac{1}{2}$ ") long piece of square tubing, with two (2) - 13 mm ($\frac{1}{2}$ ") holes through two opposite sides (this piece will be used in Step 10).

**Step 7: Cut 16 mm ($\frac{5}{8}$ ") diameter steel rods**

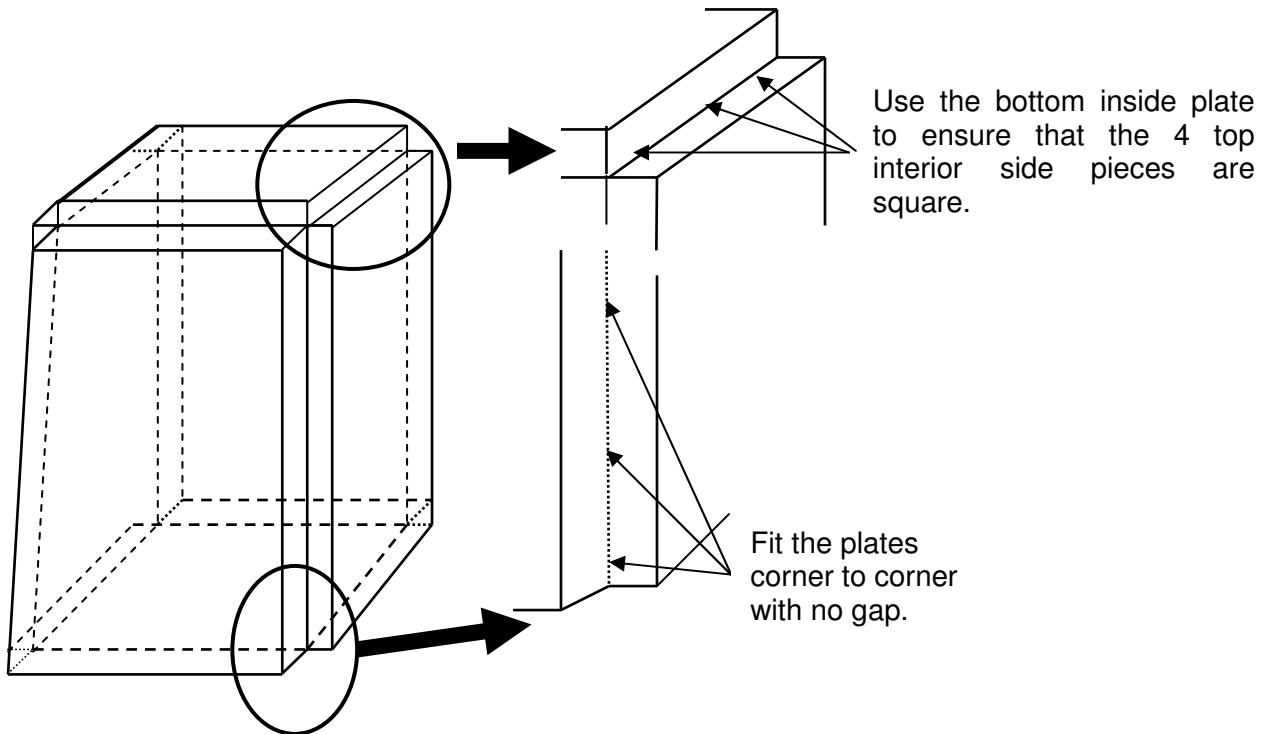
Cut four (4) 152 mm (6") long rods as shown below:



Part B: Welding

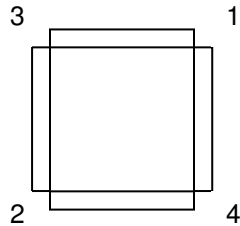
Step 8: Interior mold box

1. Welding the 3.2 mm ($\frac{1}{8}$ ") sheet steel: Stand the 4 'top interior side pieces' with the narrow ends up.



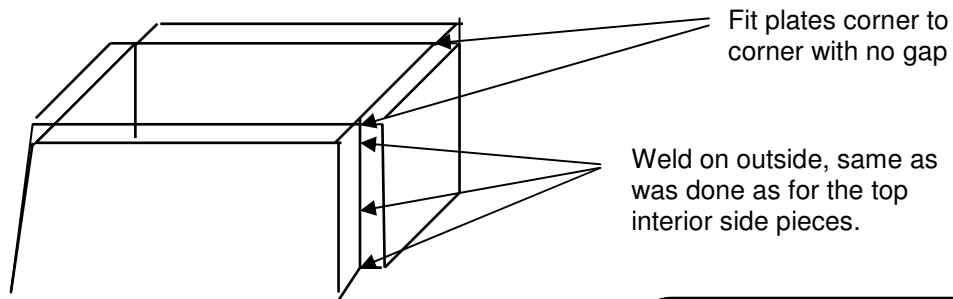
Step 8: Interior mold box - continued

2. Tack weld the top interior side plates together.
3. Check that the box is still square. If not, fix it.
4. Tack all 4 sides of the bottom inside plate to the top interior side plates.
5. Check that the box is still square. If not, fix it.
6. Weld the complete lengths joining the 4 top interior side plates, in the order shown:



7. Check that the box is still square. If not, fix it.
8. Weld the edges of the top plate to the edges of the four side plates all the way around.
9. Welding the 6.4 mm ($\frac{1}{4}$ ") sheet steel bottom interior side pieces: Stand the 4 'bottom interior side pieces' with the narrow ends up.

Note: The following is the most important part of welding the mold. This part of the interior mold box must be square so that the thickness of all the concrete filter walls will be consistent. Take the time to make sure that these pieces are welded together squarely and attached squarely to the rest of the interior mold.

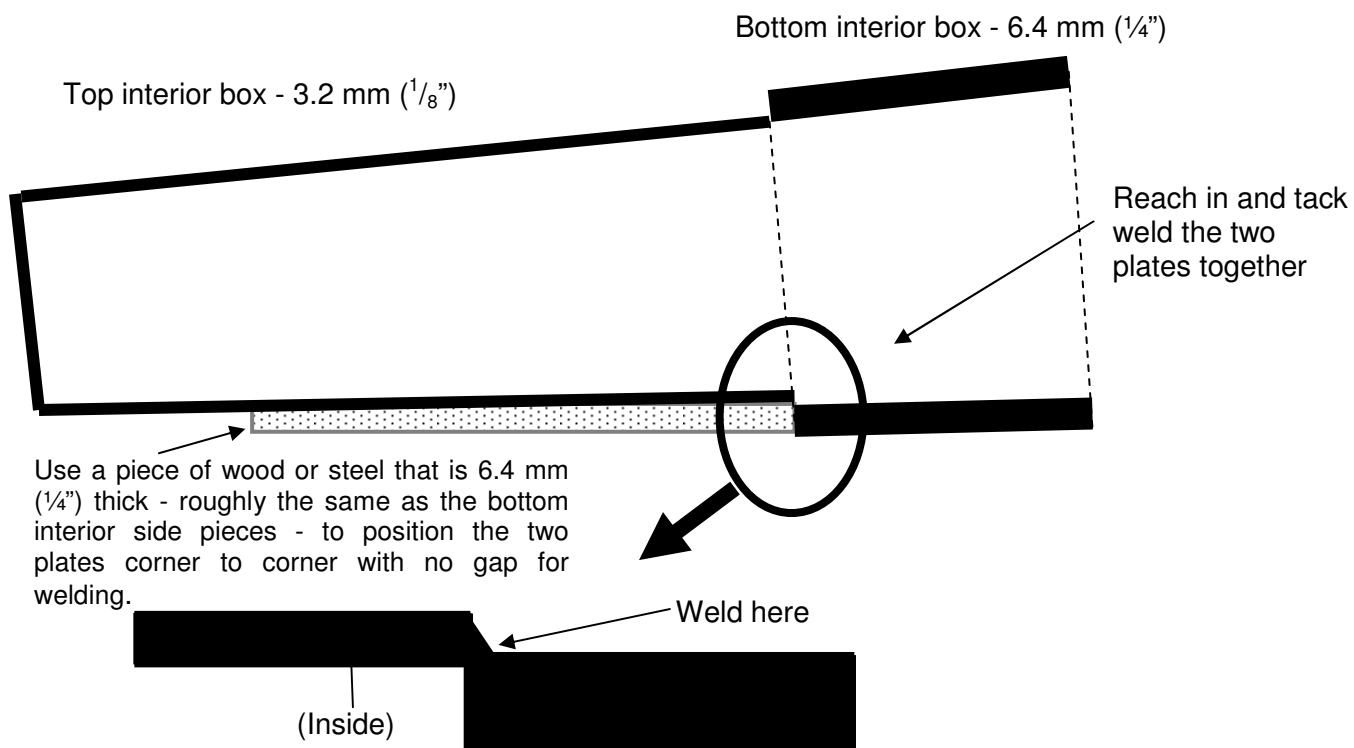


10. Tack the bottom interior side plates together.
11. Check that the box is still square. If not, fix it.

Note: Grind the welded edges to a smooth round corner along the full length. These form the inside corners of the filter when it is cast in concrete.

Step 8: Interior mold box - continued

12. Weld the complete lengths joining the 4 bottom interior side plates, in the order shown in instruction 5 (above).
13. Check that the box is still square. If not, fix it.
14. Place the top interior box (built in instructions 1-8) inside of the bottom interior box (instructions 9-12) as shown below.

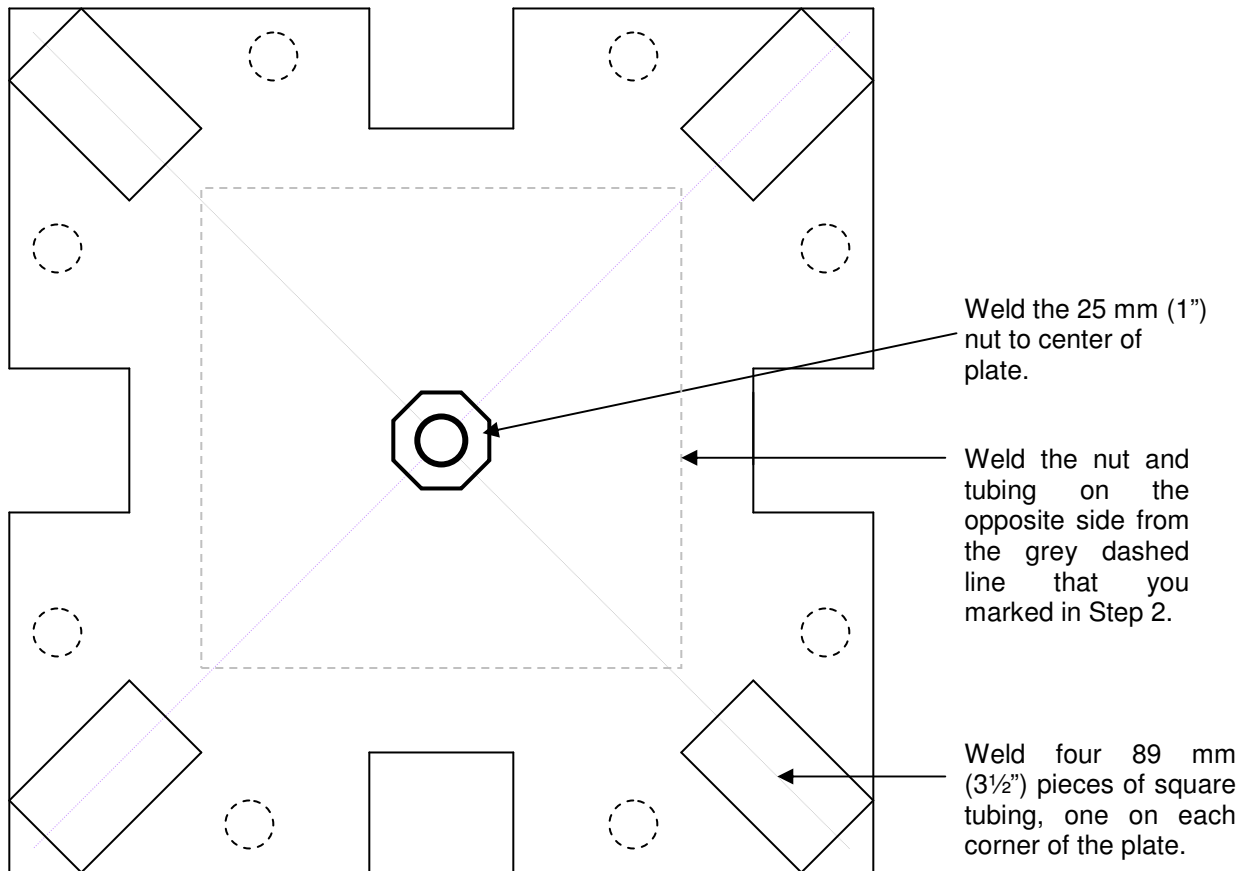


15. Tack weld all 4 sides of the top interior box to the bottom interior box on the inside.
16. Finish welding the boxes together, all the way around on the inside.

Note: This weld must be made on the inside of the box to ensure that a sharp lip is left on the outside of the box. That lip will form a ledge in the concrete to support the diffuser plate.

Step 9: Interior mold base

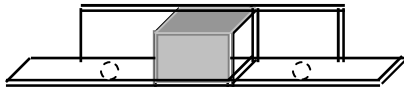
Weld four pieces of 89 mm (3 1/2") square tubing and one 25 mm (1") nut onto the base plate, as shown below. (Leave the 89 mm (3 1/2") square tubing with a hole through it for Step 10.)



Do **not** drill the holes in the plate at this time. They are drilled once the exterior box has been constructed. See Step 12.

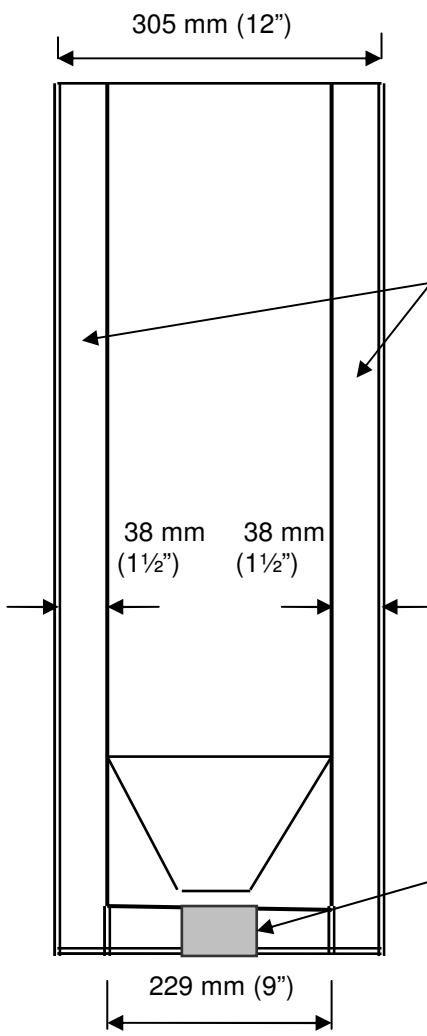
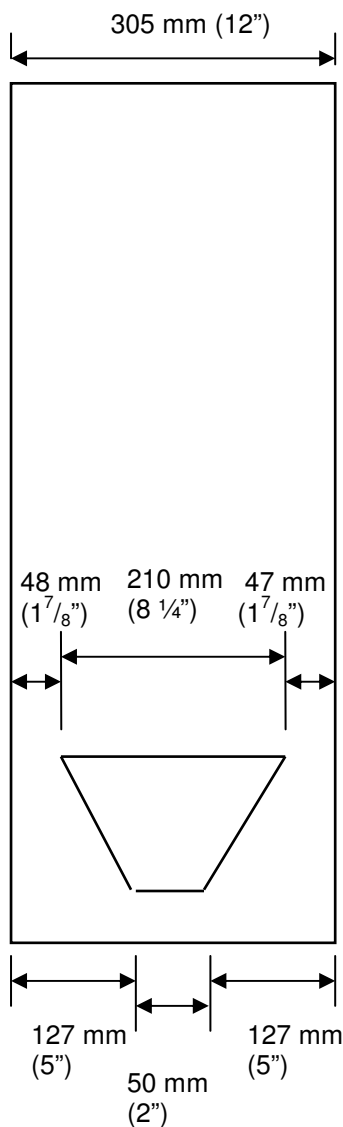
Step 10: Exterior mold - front panel

Take the one 305 mm (12") angle iron that has the ends cut off. Weld a 57 mm (2¼") square tubing onto the centre of the angle iron. Leave the other 305 mm (12") angle iron for Step 11.



Cut a hole for the 'nose' in one of the 305 mm x 940 mm (12" x 37") exterior panels as shown below:

Then, weld angle iron onto 3 sides of the panel as shown below.



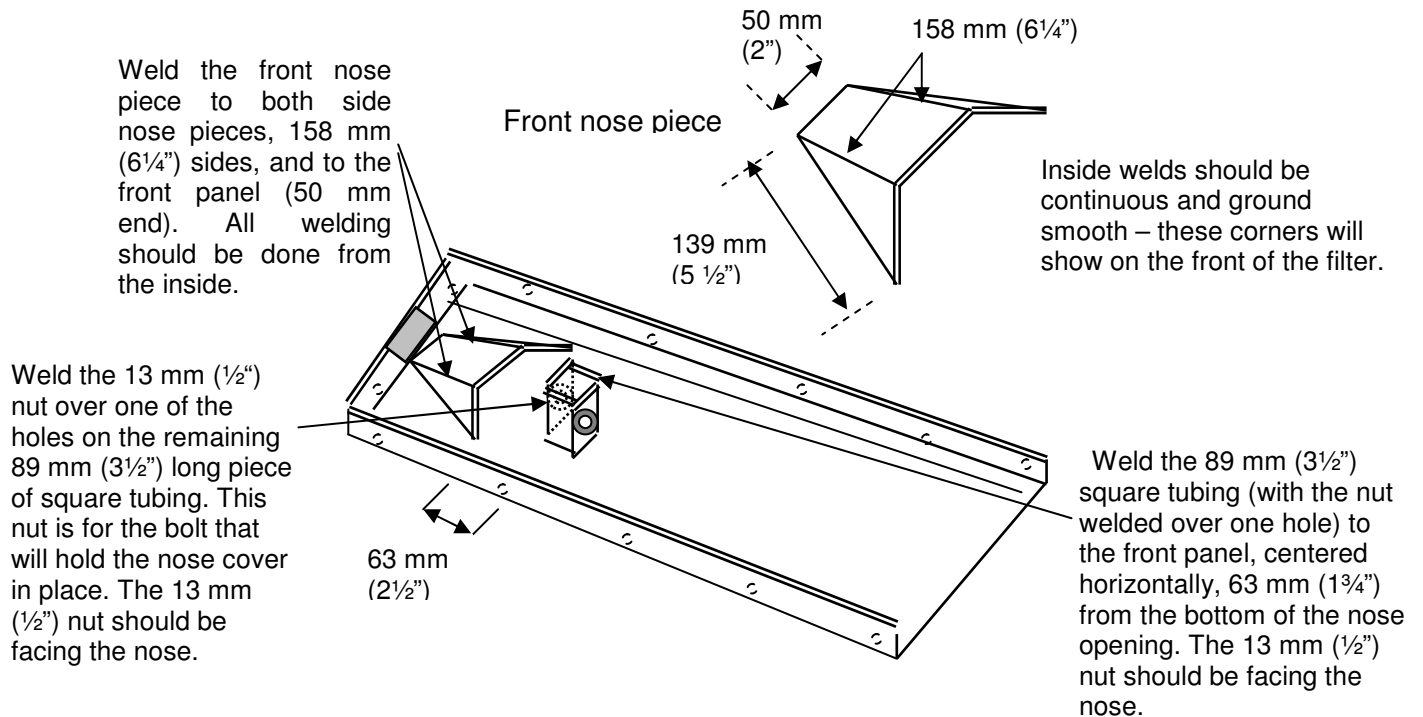
Weld a 940 mm (37") long angle iron onto each side of the plate as shown.

Weld the 305 mm (12") angle iron that you cut (above) to the front panel as shown

Note: The joints between the nose pieces and the front panel **DO NOT** form right angles.

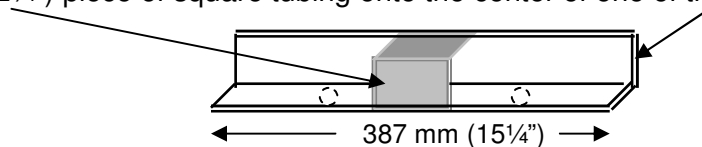
Step 10: Exterior mold - front panel – continued

Weld the 13 mm nut over one of the holes on the remaining 89 mm long piece of square tubing. This nut is for the bolt that will hold the nose cover in place.

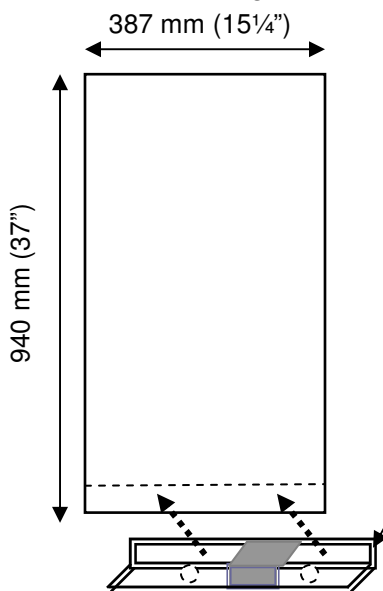


Step 11: Exterior mold – back and side panels

Weld a 57 mm (2 1/4") piece of square tubing onto the center of one of the 387 mm (15 1/4") angle irons.



Weld that angle iron to one of the 387 x 940 mm (15 1/4" x 37") exterior side panels.

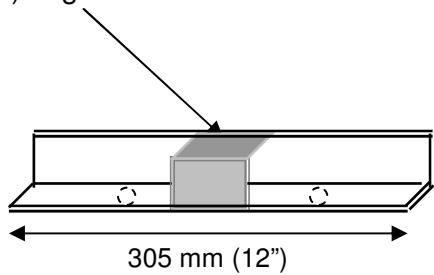


Weld angle iron across the 387 mm (15 1/4") end of the panel

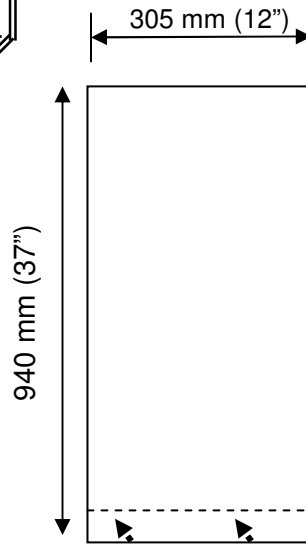
Repeat the entire process for the other 387 mm (15 1/4") angle iron and the other 387 X 914 mm (15 1/4" x 37") exterior side panel.

Step 11: Exterior mold – back and side panels – continued

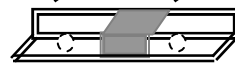
Weld a 57 mm (2¼") piece of square tubing onto the center of the remaining 305 mm (12") angle iron.



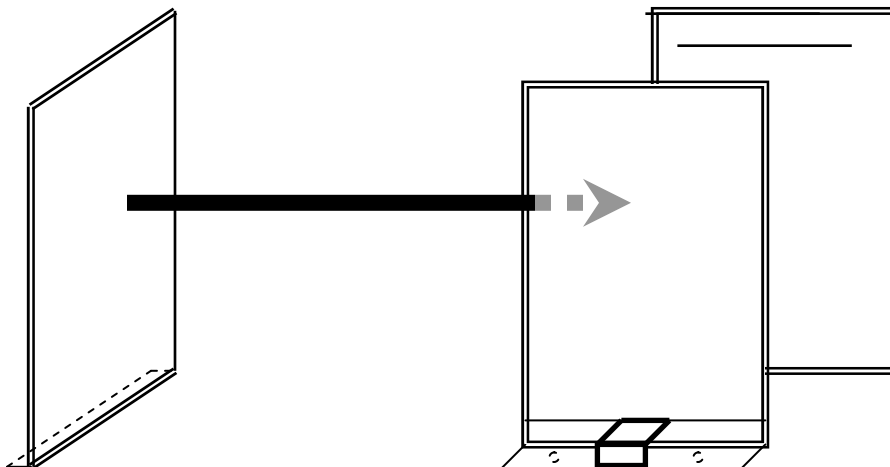
Weld that angle iron to the remaining 305 x 914 mm exterior panel as shown below.



Weld angle iron across the 305 mm (12") end of the panel.



Stand the exterior back and side panels as shown below.

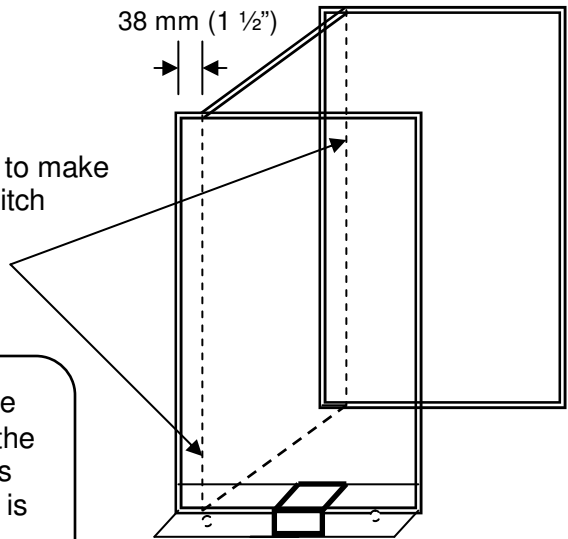


Place the exterior back panel 38 mm (1½") from the edge of the exterior side panels. Make sure the panels are square – at 90° angles to each other.

Step 11: Exterior mold – back and side panels – continued

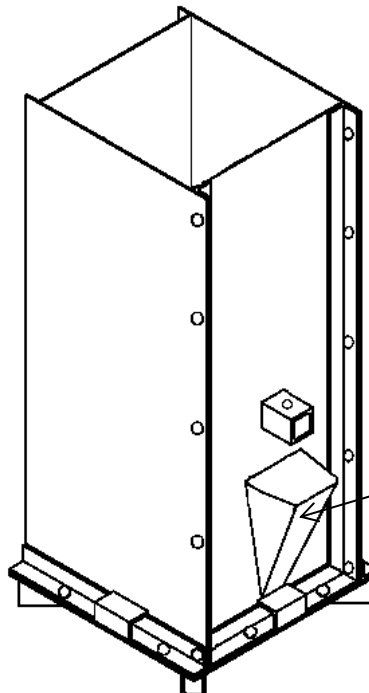
Tack weld the panels together and then check to make sure it's square. Once they are square, then stitch weld the panels together from the outside.

Note: It is not necessary to weld the entire length of the joints. A stitch weld which runs the length of the joint and has 25 mm (1") welds spaced 150 mm (6") apart (centre-to-centre) is sufficient.



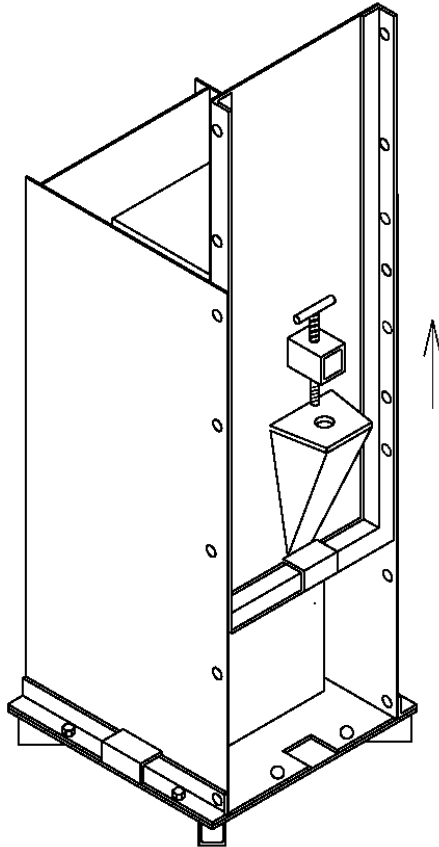
Step 12: Mold Completion

Place the exterior mold panels on top of the base plate as shown below. Clamp all the components together so that they will not move. Complete the drilling of the bolt holes – wherever there is a hole in the angle iron, drill through the corresponding plate.



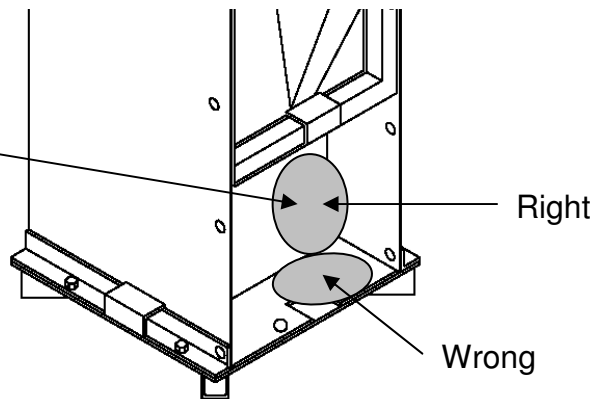
Nose shape is slightly different than shown in this picture.

Step 12: Mold Completion - continued



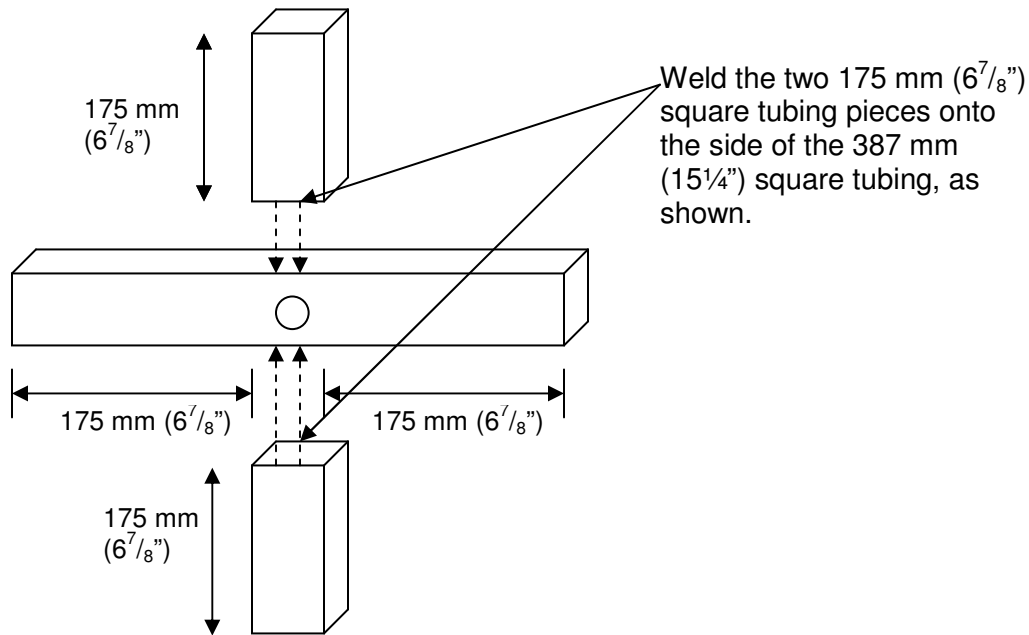
1. Bolt the 3-sided exterior panel to the base plate.
2. Place interior mold box on top of base plate.
3. Raise front panel one set of holes and bolt to side panels.
4. Make sure that the interior mold box is centred – equally distant from each side of the exterior mold, 22 mm minimum.
5. Reach in and tack weld the interior mold box in place.
6. Unbolt and remove all of the exterior mold panels.
7. Weld the interior mold box to the base plate all the way around.
8. On a non-working surface, mark the interior mold to indicate which side is front (facing the nose plate).

Note: Grind smooth the welds on the inner mold with the grinding wheel in this direction. **Do not** grind or sand into the inner mold because this will create a cavity that the concrete will fill and prevent removing the mold.

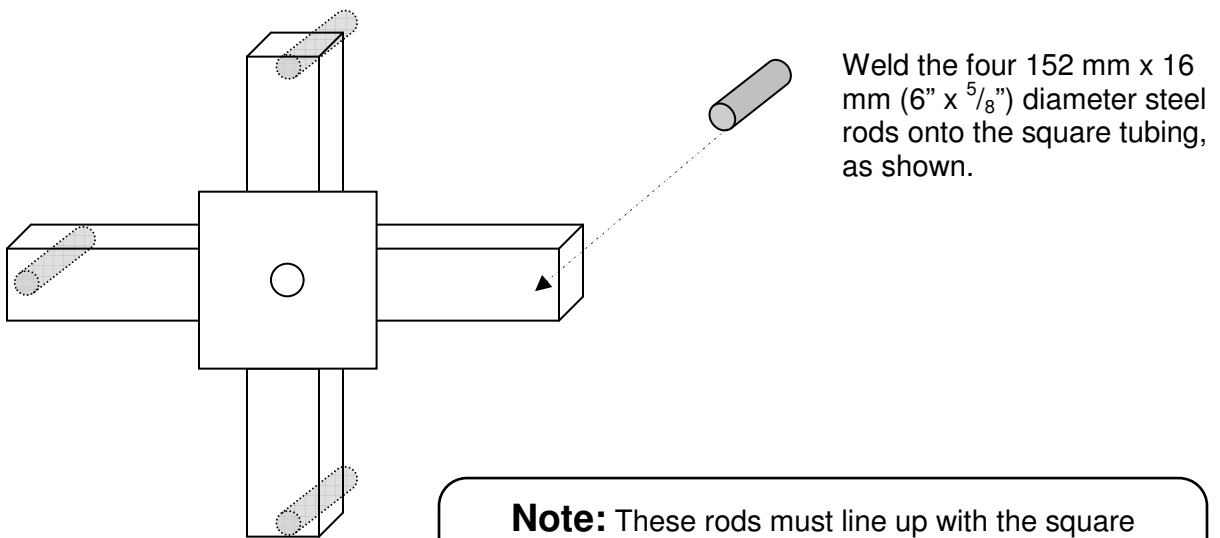


Step 13: Extractor

Take one 387 mm (15¼") square tubing and two 175 mm long pieces of square tubing.



Lining up the holes, weld the extractor support piece onto the square tubing. Weld the 152 mm x 16 mm (6" x 5/8") diameter steel rods onto the opposite side.



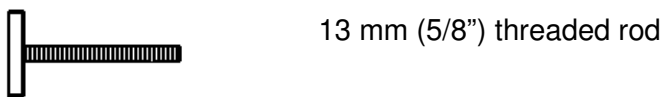
Note: These rods must line up with the square notches on each side of the base plate. **Test to make sure they line up before you weld.**

Step 13: Extractor - continued

Weld a scrap piece of rod approximately 50 mm (2") long to the end of the 25 mm (1") diameter threaded rod to form the extractor bolt.



Weld a scrap piece of rod approximately 63 mm (2½") long to the end of the 13 mm (½") diameter threaded rod to form the bolt which holds the nose cover in place.



Step 14: Finishing

- Welds on any surface that contacts concrete must be ground down to a smooth finish.
- The dark "mill scale" on the surface of sheet metal is the smoothest finish, so it can be left on surfaces that contact concrete unless there is weld material to be ground off.
- **DO NOT PAINT THE INSIDE OF THE MOLD** – (especially those surfaces that will contact concrete) it will cause problems in removing the hardened filter from the mold.
- **PAINT THE OUTSIDE OF THE MOLD** – use rust-proof paint to make your mold last longer.
- The pieces of the mold will be custom-fit to match each other, so mark each piece of the mold with an identifying mark (i.e. grind a notch into a non-working surface of each piece) to distinguish it from other molds.
- The mold should be oiled (with edible, food grade oil such as vegetable oil) for storage so that it doesn't rust, and stored indoors.