

pavilion at Cumberagunja

construction methods A
workbook 2

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semester 1 2021

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Located 28km north-east of Moama, on Yorta Yorta country, the community of Cummeragunja sits on the New South Wales side of the Murray River / Victorian Border. Initially established as the Cummeragunja Mission Station in 1888, Cummeragunja as it is locally referred, is known historically as the site of the 1939 Cummeragunja Mission Walk-Off. This event is considered the first mass-strike of Aboriginal People in Australia. In an act of self-determination, some 200 residents walked off the mission, crossing the border to Barmah in protest of the living conditions at the mission, and their treatment as Aboriginal people. Many descendants of the original protestors still live at Cummeragunja

As a collaboration between the community, the University and high school students from the ASHE program, over four days we set about laying the foundations for a pavilion that would one day provide a place of respite and connection to country for the elders and broader community.



Cummeragunja, New South Wales
-36.028, 144.960

00 site



The original location of the pavilion site was directly on the edge of the Murray River **(A)**. After community discussion, this was relocated further inland **(B)**, and across a dirt road to allay the concerns of some community members that the initial location would deteriorate the river bank.

Site B offered a full view of the river, and was directly accessible from the community centre to its immediate south. It was suggested that site B offered further potential for associated landscaping elements to enhance the pavilion space later down the track once it was constructed.





indicates a safety warning



eye protection required



eye and ear protection required



heavy load

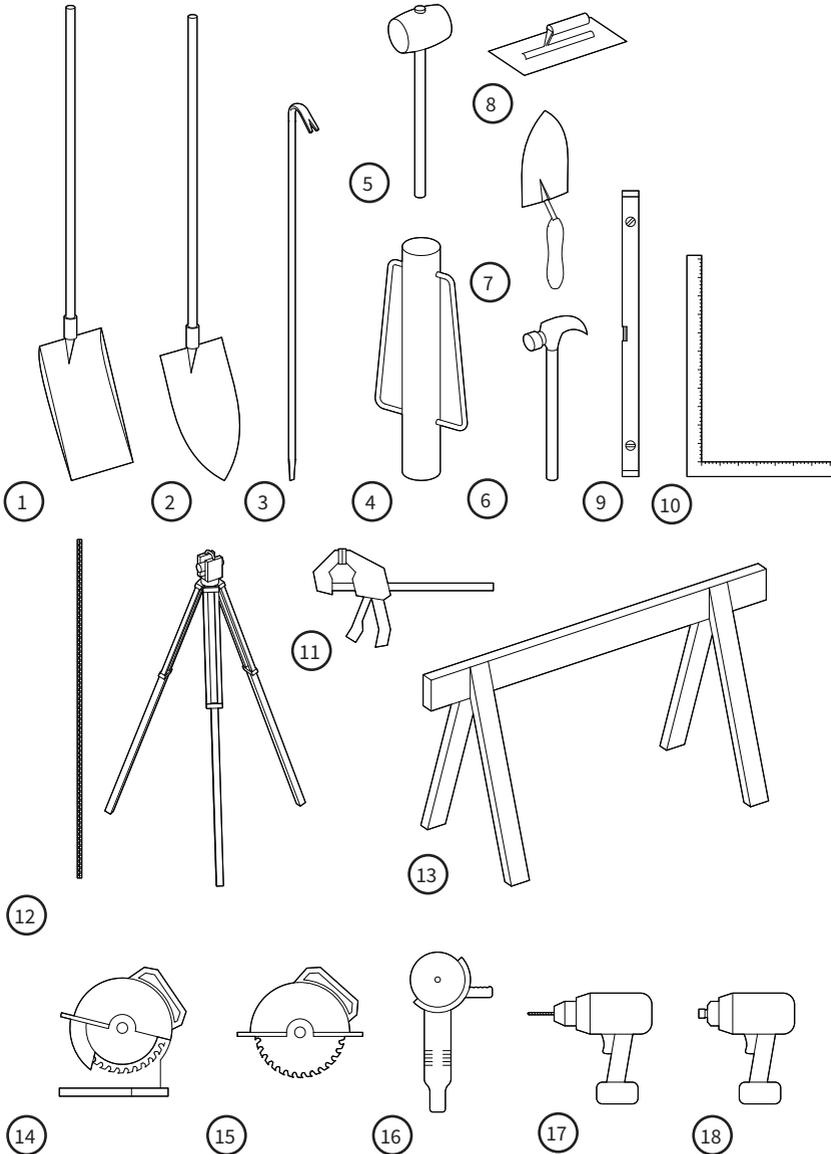


gloves required



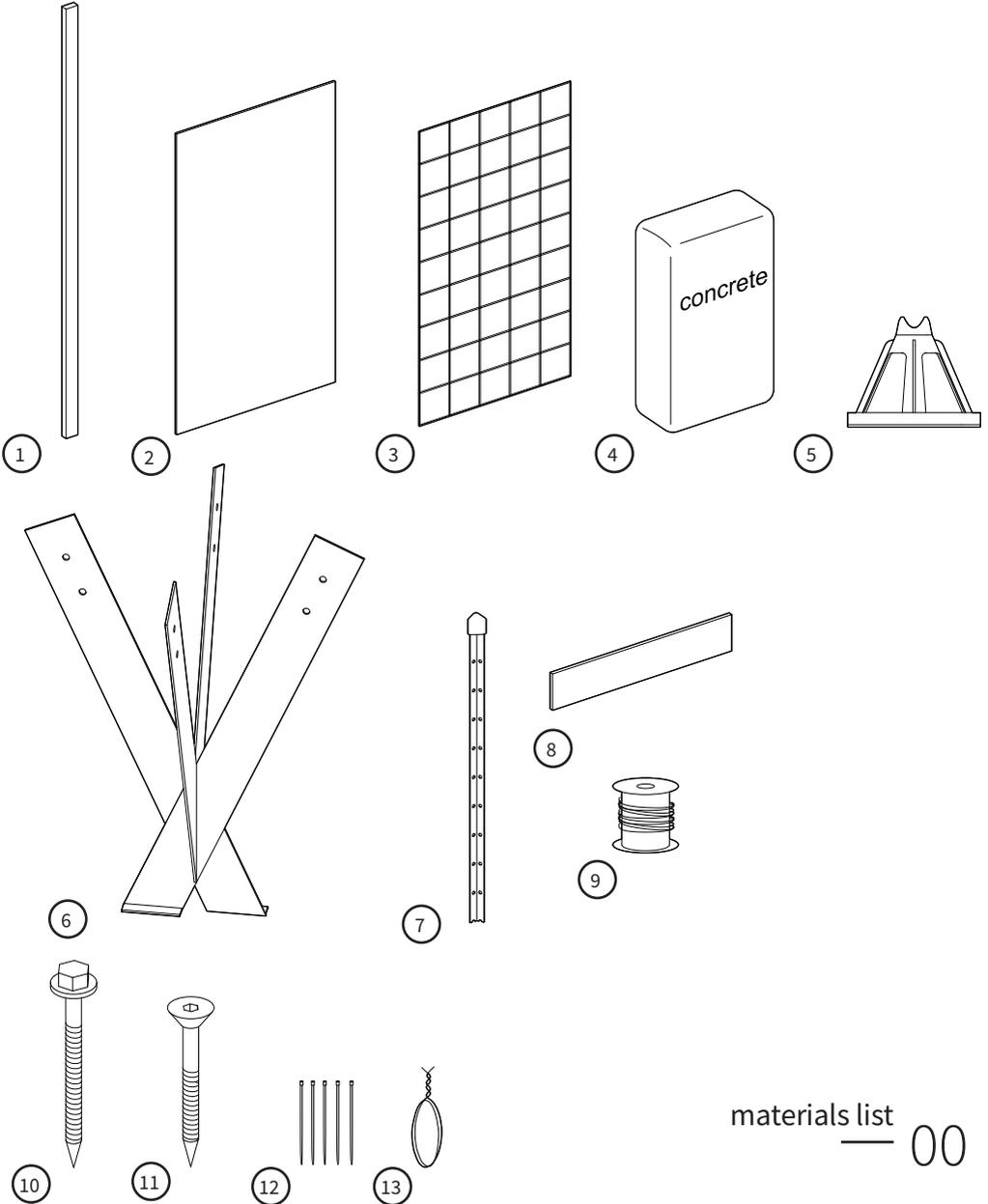
risk of fire

00 tools list



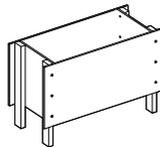
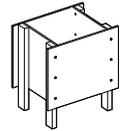
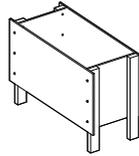
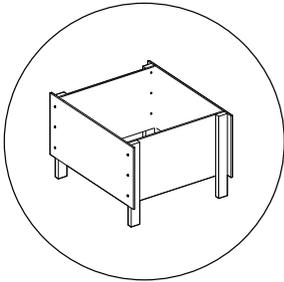
- | | | | | | |
|----|-------------|-----|------------|-----|---------------|
| 1. | spade | 7. | spade | 13. | saw-horse |
| 2. | shovel | 8. | trowel | 14. | drop saw |
| 3. | crow-bar | 9. | level | 15. | power saw |
| 4. | post driver | 10. | square | 16. | angle grinder |
| 5. | mallet | 11. | clamp | 17. | drill |
| 6. | hammer | 12. | theodolite | 18. | impact driver |

1. 3 x timber framing 3000 x 90 x 45mm
2. 2x sheets formply 16mm THK.
3. 3x sheets 1800 x 1000 x 200 x 7mm THK. STL. reinforcing mesh
4. concrete (volume varies)
5. 4x 75-90mm bar chair
6. pre-welded 200 x 8mm THK. STL. quad
7. 20x star pickets
8. 8x timber hurdle
9. string
10. GALV. STL. Tek screw 14G x 65mm
12. batten screw 14G x 50mm
13. steel wire

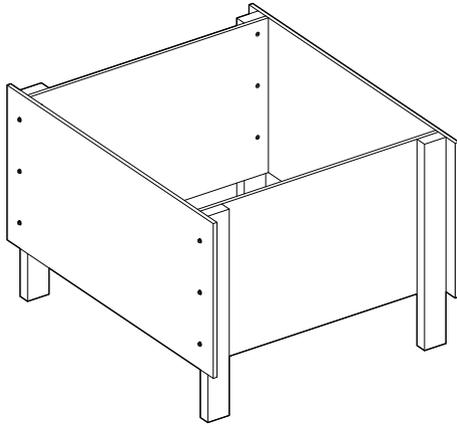


01 — formwork pre-site construction

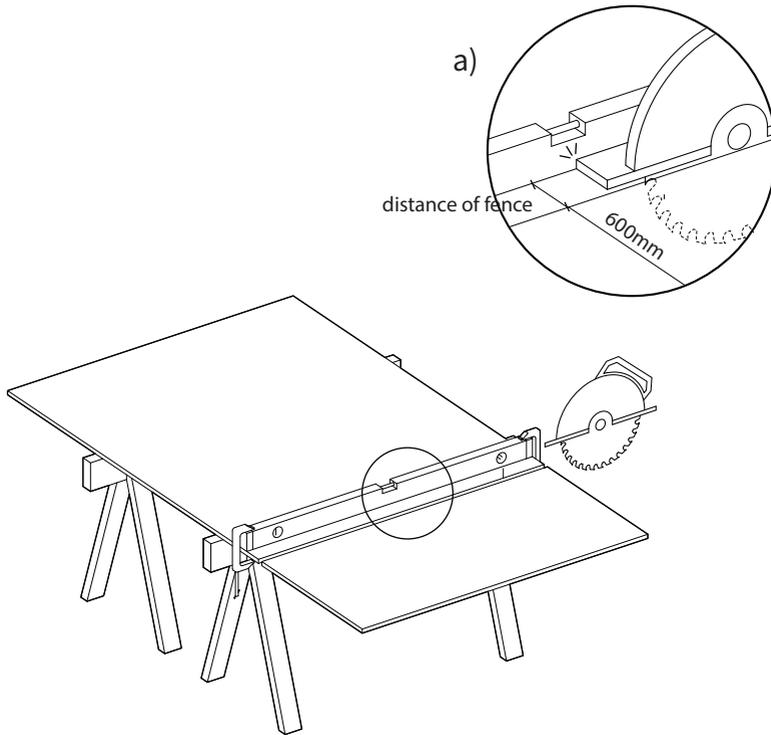
south-west quad



The following section details the construction of the outer formwork box. This was constructed prior to our arrival on site, and then transported to Cumberagunja separately. The benefit of pre-site construction is both in the construction time saved on site and the access to a full workshop while in Melbourne.



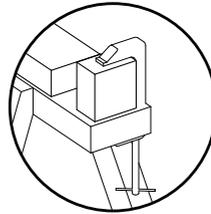
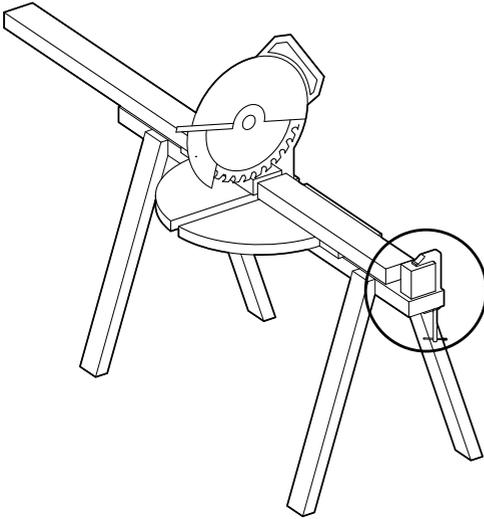
01 formwork pre-site construction measuring and sawing formply



Begin by selecting two 1200 x 2400 x 16mm THK. formply sheets. Measure and draw a line **600mm + the distance of the power saw fence (a)** inset from the outer 1200mm edge of the formply. Clamp a straight edge parallel to this line. Butt the power saw fence up against the straight edge and check to see whether the blade is cutting exactly 600mm from the edge of the formply. Proceed to cut four 600 x 1200mm lengths of formply, re-drawing the 600mm + fence distance line after each cut. This ensures that you are not subtracting the width of the blade each time (approx. 3mm).

Repeat this process, shortening two of the 1200 x 600mm sheets to 1000 x 600mm

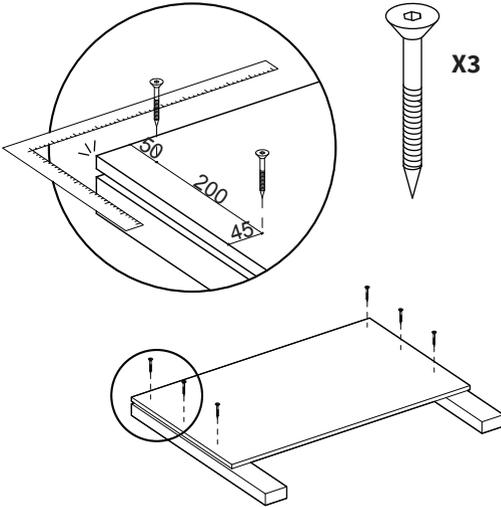
Using a mitre-saw mounted to a saw-horse, clamp a wooden stop 800mm from the edge of the blade. The wooden stop will function as jig to ensure that each length of framing is uniform. Proceed to cut the two 3m lengths of 90x45mm timber framing into 4 equal lengths of 800mm.



Ensure that the framing timber is butted up flush against the wooden stop each time before lowering the blade. Failure to do so will result in varied lengths.



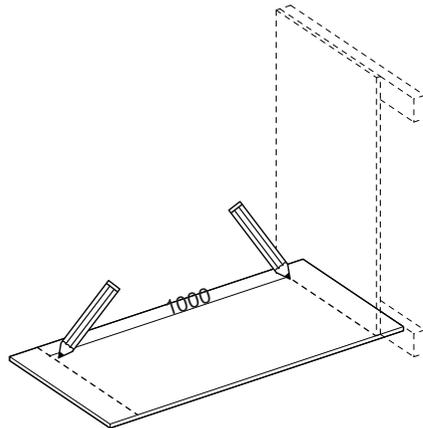
01 formwork pre-site construction fixing formply to timber framing



Place the cut timber framing lengths on a flat surface. Lay the cut 1000 x 600mm formply sheet on top, ensuring the top and side edges of the formply are square and flush with the edges of the timber framing beneath.

Secure the formply to the timber framing by screwing 3x Batten screws along the length of the joint.

Measure and draw 2x lines **exactly 1000mm** apart from each other (approximately 100mm from each end depending on formply width variation). The inside edge of the 1000mm formply box side made in the above step will align with this pencil line.

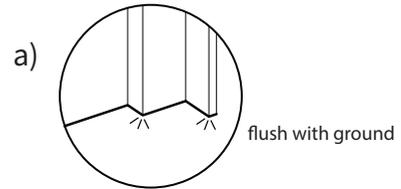
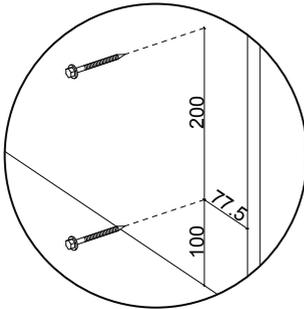
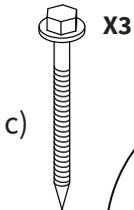
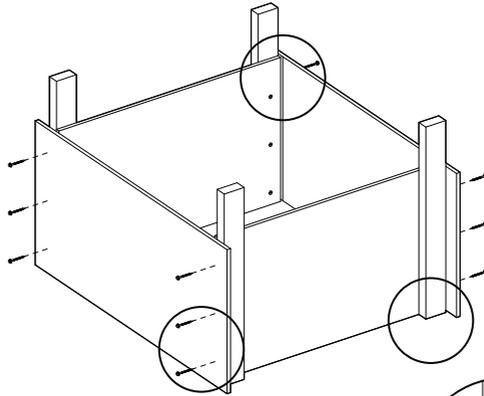
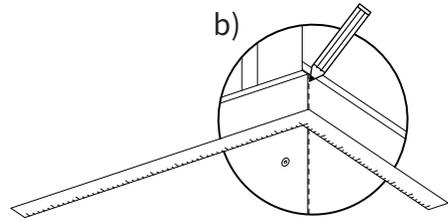


Ensure that these measured lines are square with each other and the long edge of the sheet.



Place the unassembled box upside down on a flat surface to ensure that all top edges of the box are flush with each other and the ground **(a)**.

Align the 1000 x 600mm box side with the pencil line measured and drawn on the the longer formply sheet, ensuring that the the angle remains totally square along the length of the join **(b)**.

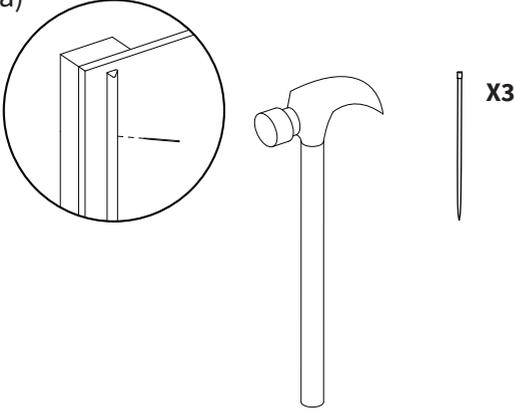


Either hold or clamp the sides of the formply box together and screw 3x batten screws along the length of the join **(c)**.

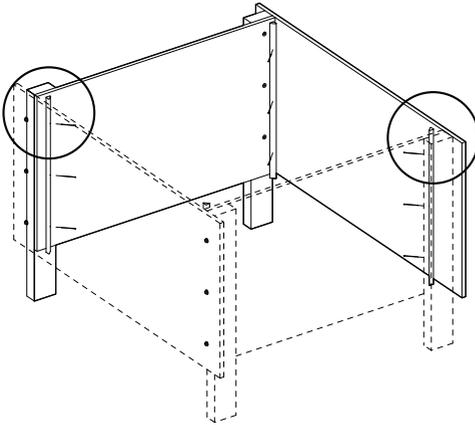


01 formwork pre-site construction fixing tri-mould

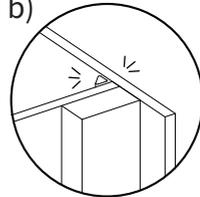
a)



Cut a length of tri-mould into 4x 600mm lengths. Nail this into each internal corner of the assembled formwork box with 3x nails spaced evenly apart **(a)**.



b)



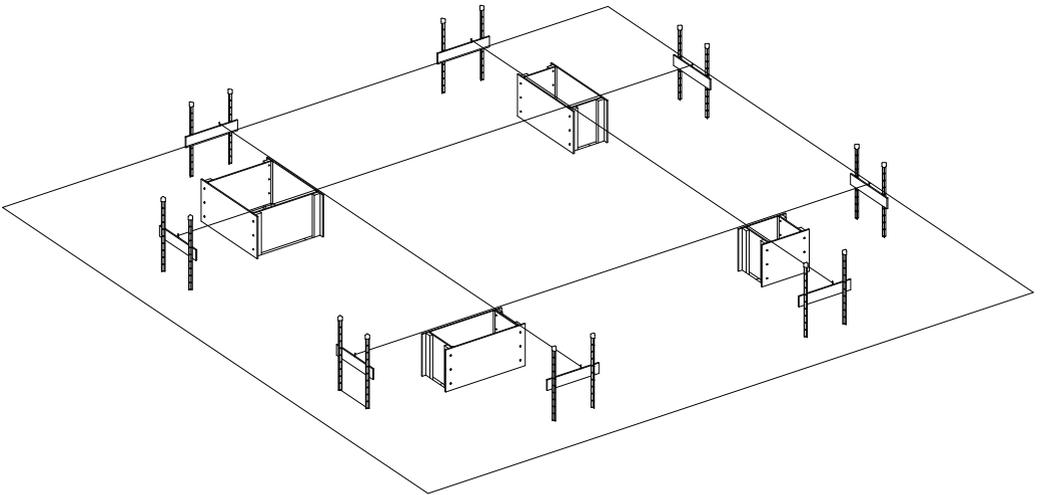
flush with top edge

Ensure the top of the tri mould is flush with the top edges of the formwork box **(b)**.

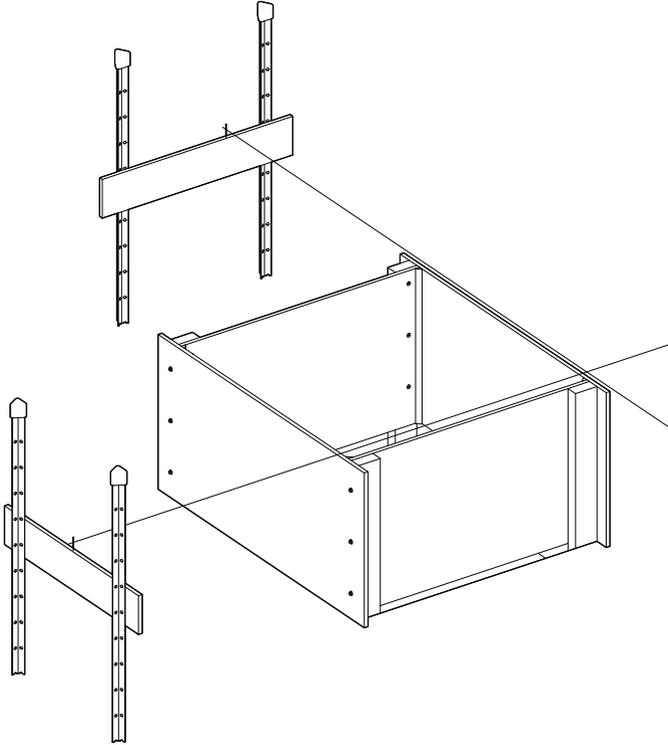


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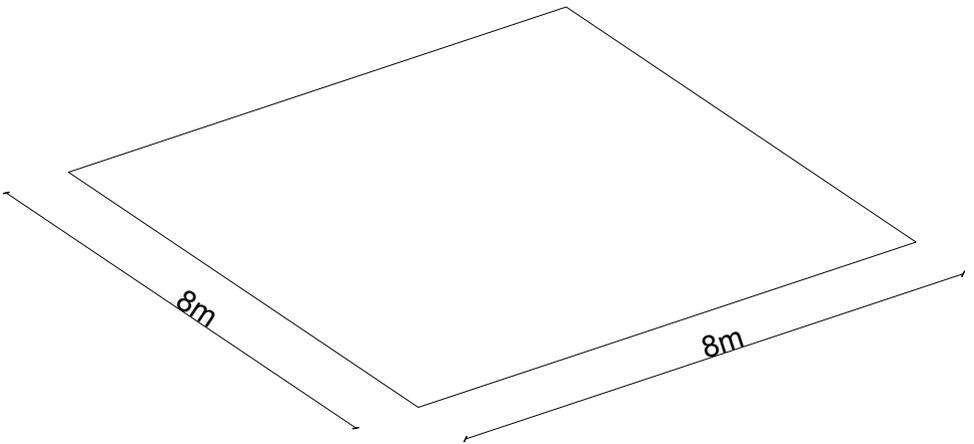
02 — site preparation
south-west quad



The following section details the site preparation and laying of the pre-made formwork box. This will be examined through the steps involved in the erection of the south-west quad (pictured).

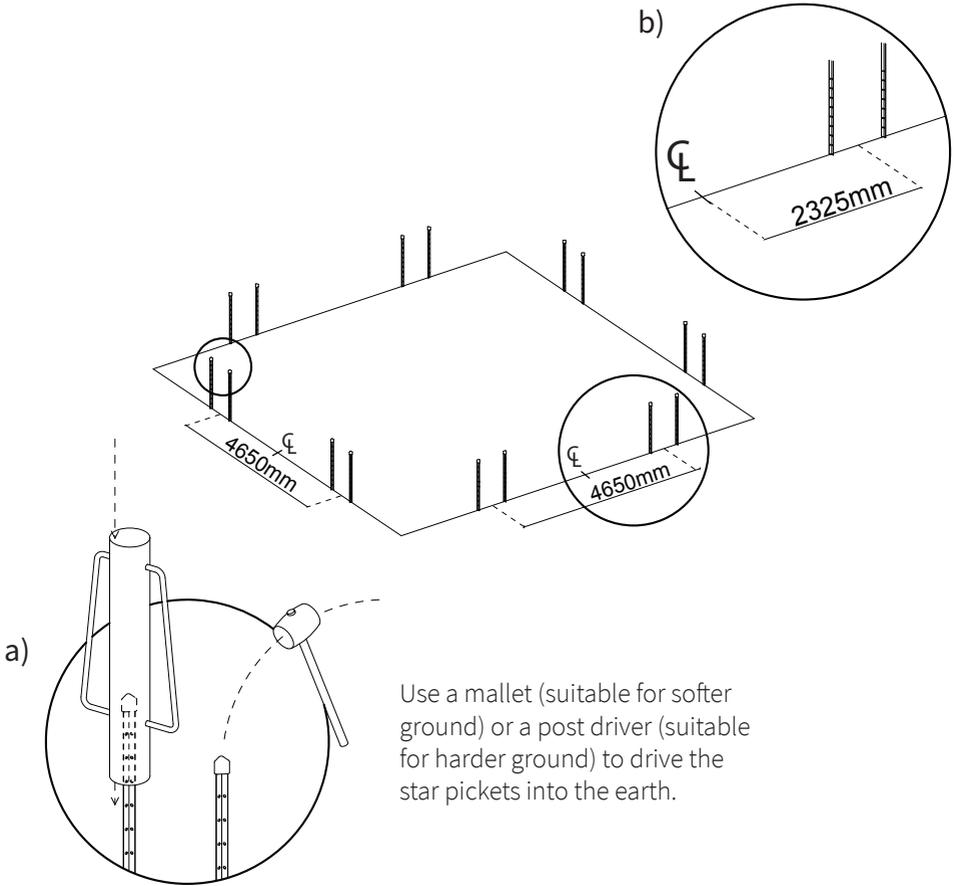


02 site preparation measuring out site



Measure out an 8x8m square on the site. Check that the corners are square, however variation in the order of some centimetres is satisfactory for this step. Clear the area of any loose debris – branches, grass, sticks, rocks etc.

Along each 8m side of the square, drive 2x pairs of star pickets into the ground **(a)**. The distance between the centre of each pair should be approximately 4650mm from each other and equal distance (2325mm) from the centre line of each side. **(b)**

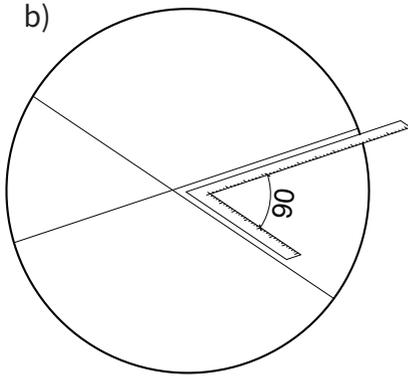


Use a mallet (suitable for softer ground) or a post driver (suitable for harder ground) to drive the star pickets into the earth.



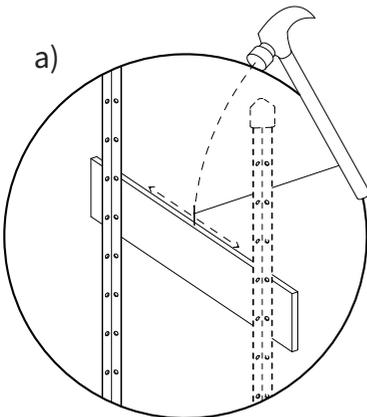
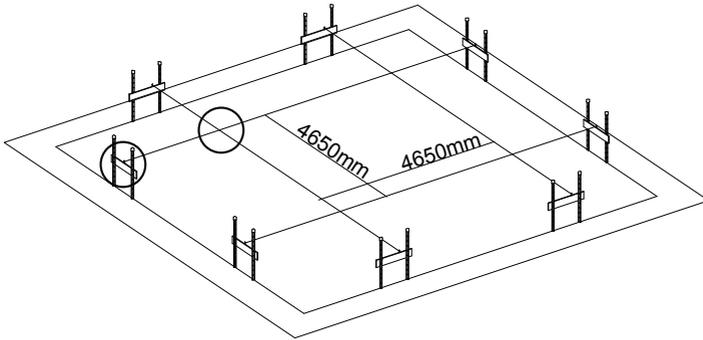
02 site preparation erecting hurdles (cont.)

Fix wooden hurdles (any timber offcut will be suitable) between each pair of star pickets. Ensure that the top edge of the hurdle is more than 600mm above ground.



Hammer one nail into the top of each hurdle **(a)**. The distance between the two nails on each side of the square must be exactly 4650mm.

Tie a connecting piece of string between each nail and the nail on the opposite side of the square. Ensure that the angle of each overlapping string line is exactly square **(b)**.

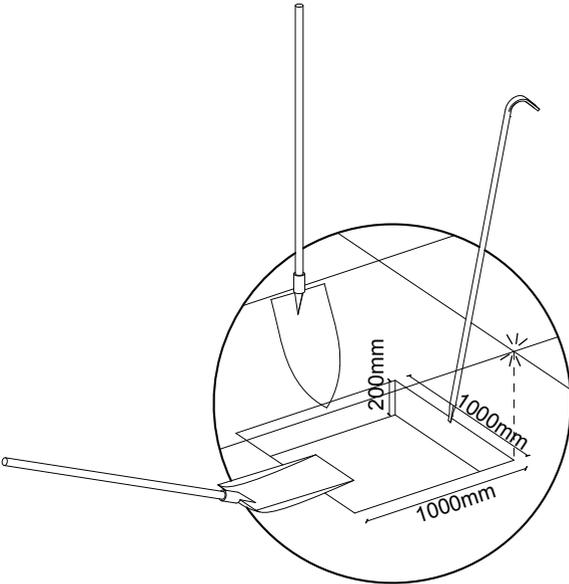


Adjust the placement of the nail on each hurdle accordingly so that it satisfies points **(a)** and **(b)**.

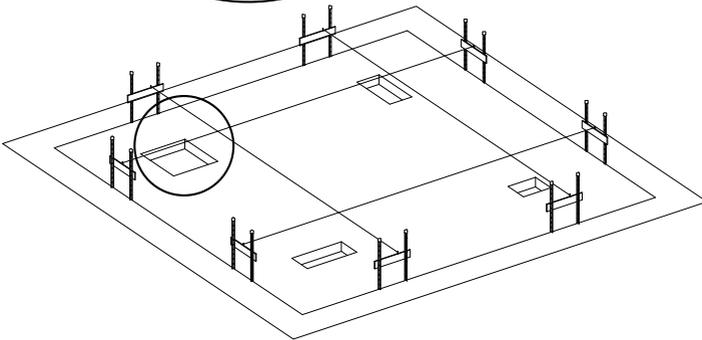


Use a combination of a spade, shovel and crow-bar to excavate the earth to a depth of 200mm*. Crow bars and spades are suitable for digging into the ground, while shovels are primarily used to remove loose earth.

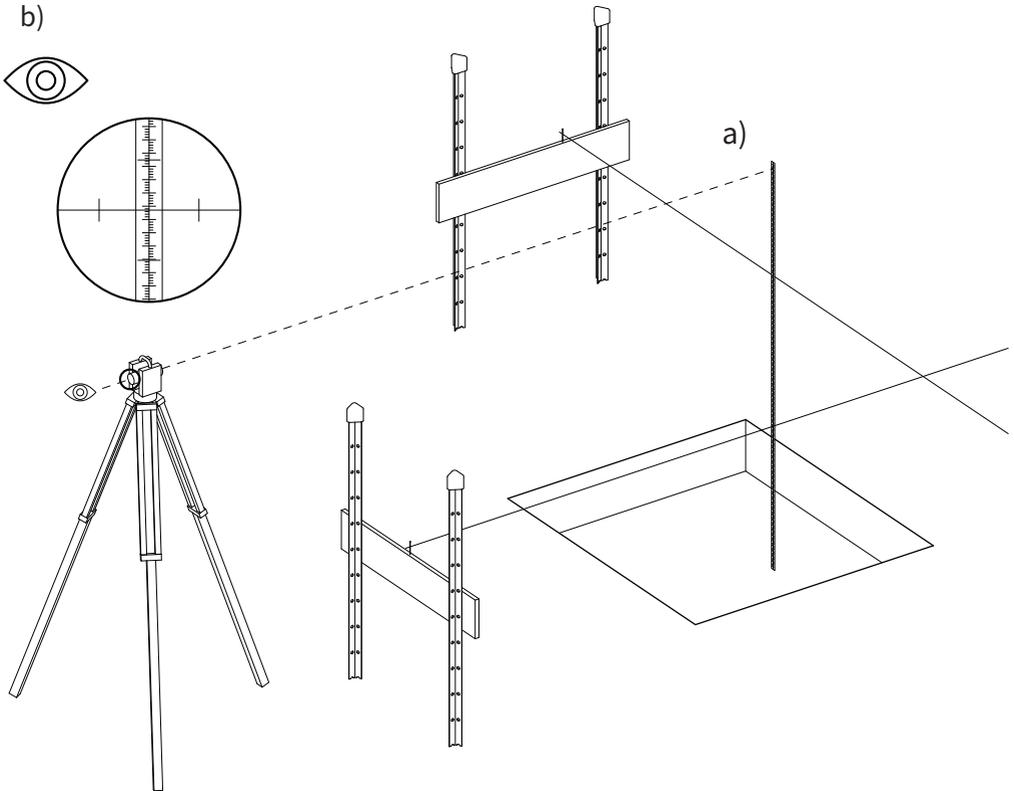
*200mm is a nominal depth suitable for the current project. If you have not reached clay at 200mm depth, continue to excavate until you do.



Ensure that the inward-facing corner of each pit aligns vertically with the overlap of the string line above.

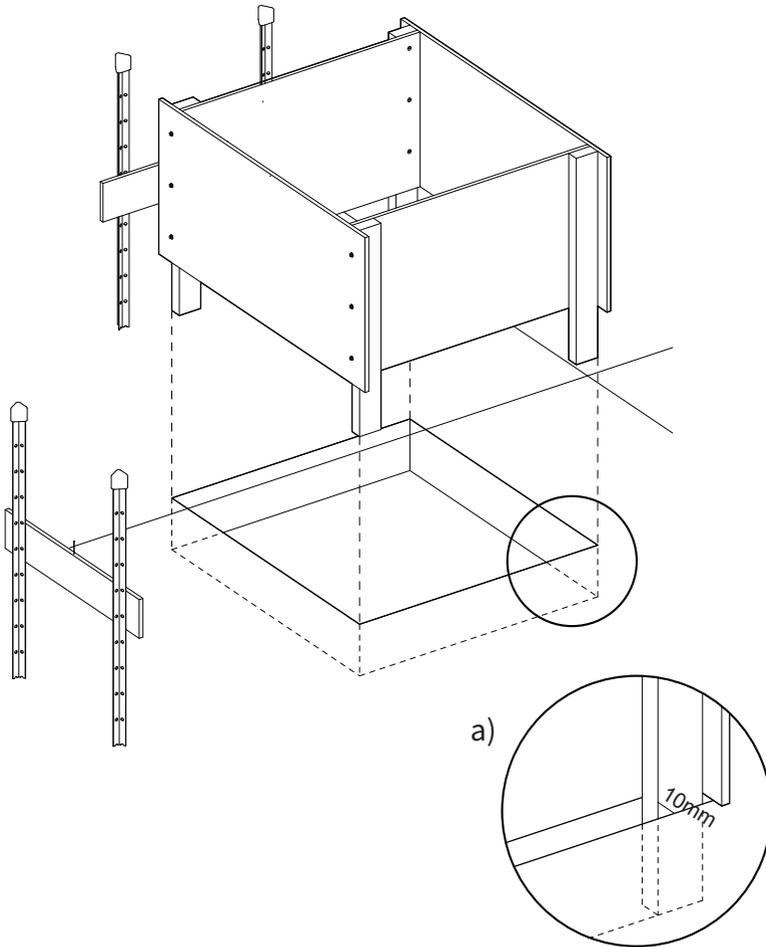


02 site preparation measuring pit depth

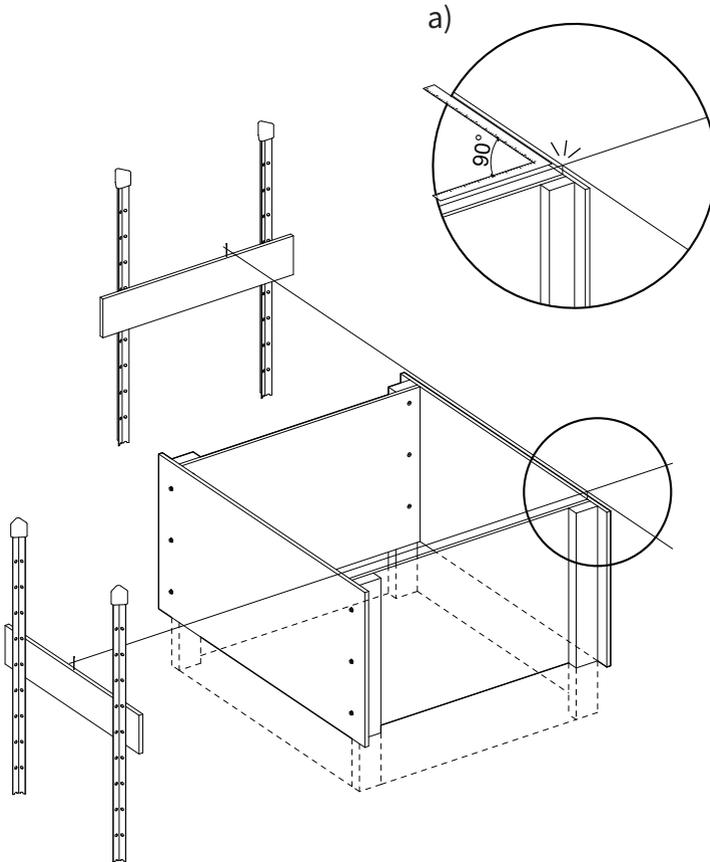


Use a theodolite to measure the depth of the pit. One person needs to hold the surveyor's staff vertically at the base of the pit **(a)** while another person views the staff through the telescopic vision lens. The cross-hairs of the lens should align with the required depth for the project — 200mm **(b)**.

Lower the formwork box into the excavated pit. Ensure that the the length and width of the pit is not bigger than the outside edge of the timber framing. A tolerance of 10-20mm is accepted **(a)**.



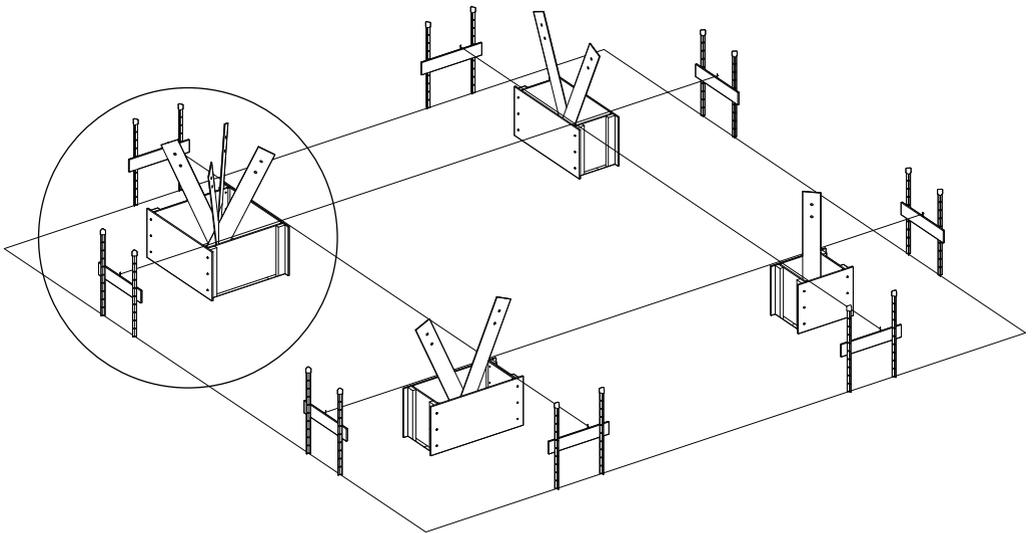
02 site preparation placement of formwork on site (cont.)



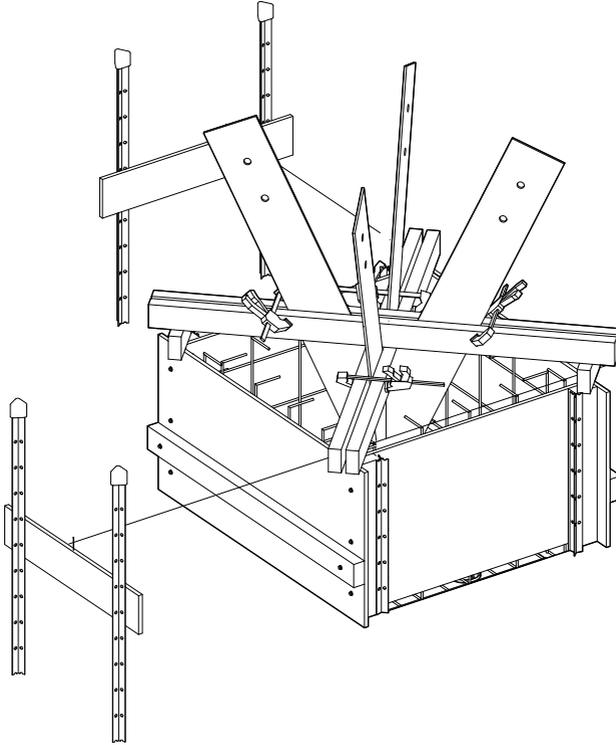
Align the inward facing corner of the formwork box with the string line above. Ensure that both these corners (formwork and string line) are entirely square (**a**). Ensure that the box is not touching the string line as this will distort the straight edge of the string. If the box is touching, it may be a sign that a pit is not deep enough.

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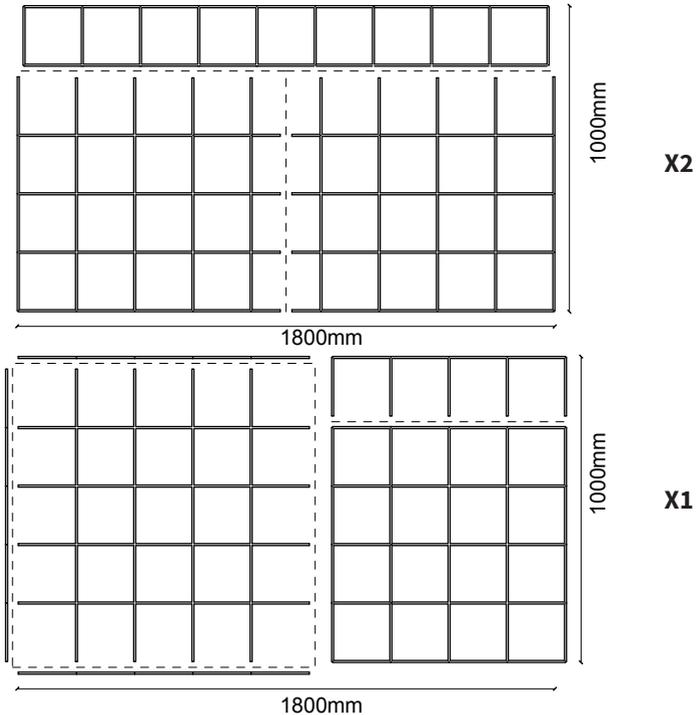
03 — formwork site construction
south-west quad



The following section details the formwork construction necessary to prepare the site for the concrete pour. Further project-specific re-inforcement may be necessary, as addressed in the annotations.

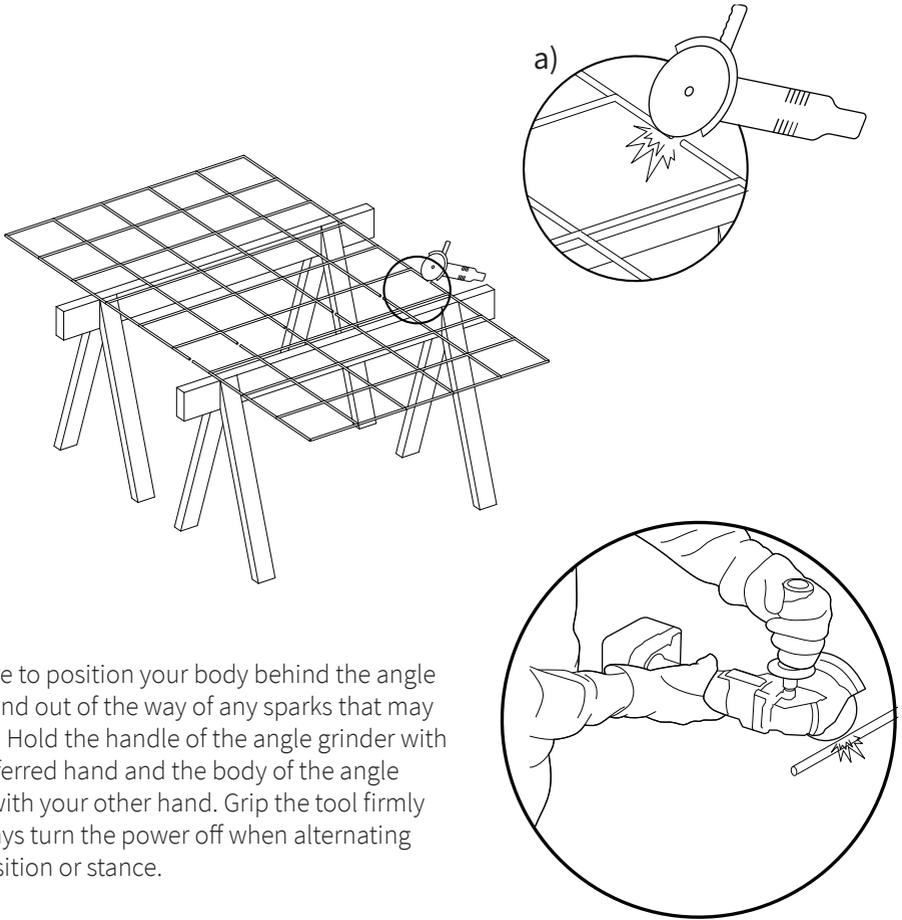


03 formwork site construction measuring & cutting reinforcing steel mesh sheet



The 1000 x 1000 x 800mm formwork box will require three 1800 x 1000 x 200 x 7mm thick steel reinforcing sheets. Use the following cutting diagram above to mark out where cuts will need to be made with the angle grinder in the following step.

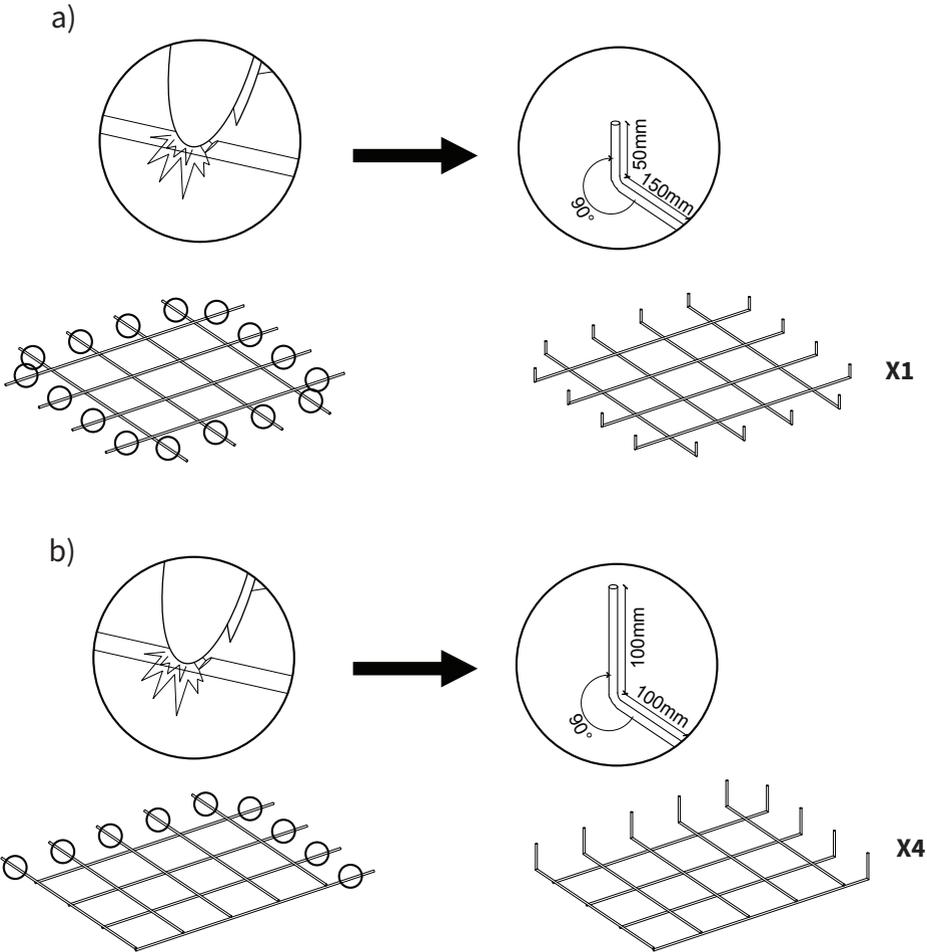
Lay the steel reinforcing sheet across two saw horses and ensure that the steel sheet feels stable. Clear the area of any loose material - leaves, grass, timber and any other objects - which may pose a fire hazard in the event of loose sparks flying. Holding the angle grinder firmly with both hands, cut along the marks ensuring the blade remains vertical and pointing down and (a).



Make sure to position your body behind the angle grinder and out of the way of any sparks that may be flying. Hold the handle of the angle grinder with your preferred hand and the body of the angle grinder with your other hand. Grip the tool firmly and always turn the power off when alternating body position or stance.



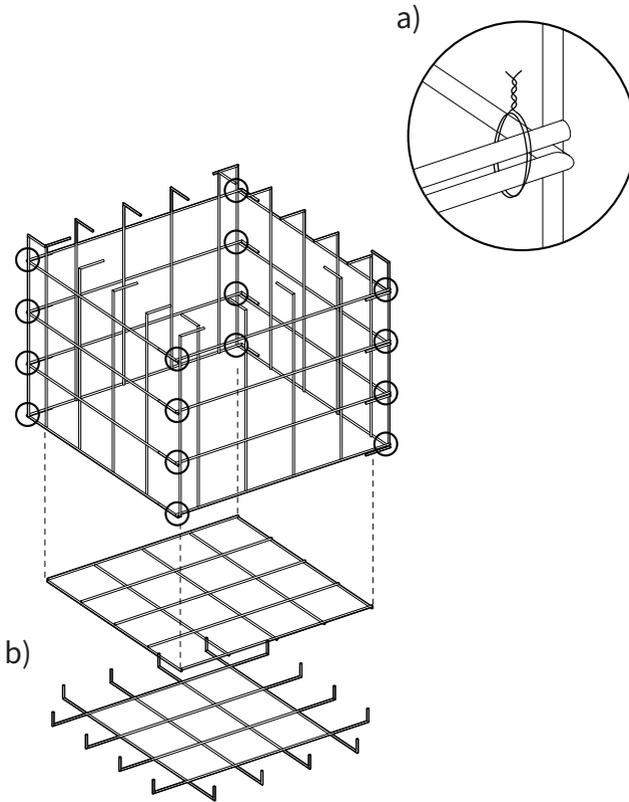
03 formwork site construction cutting & bending reinforcing steel mesh sheet



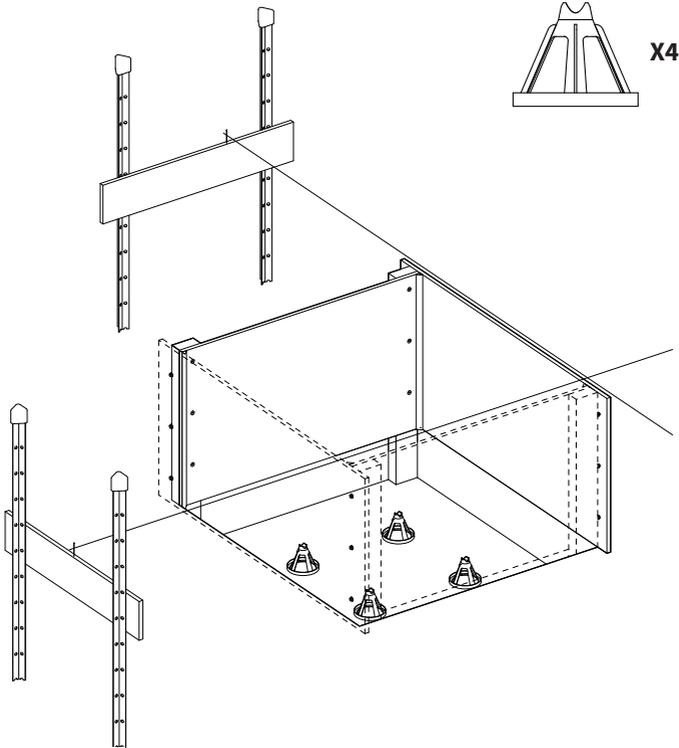
Cut a groove at the points indicated on the 6x sheets of reinforcing steel mesh **(a)**. This will provide a bending joint so that the ends of each protruding rod can be bent upwards at 90 degrees **(b)**.

Use steel wire to tie the angled protruding rod at the end of each sheet to the adjacent sheet at the points indicated **(a)**.

The 4x rectangular sheets will form the sides of the reinforcing steel box and the two square sheets will form a double layered base **(b)**.

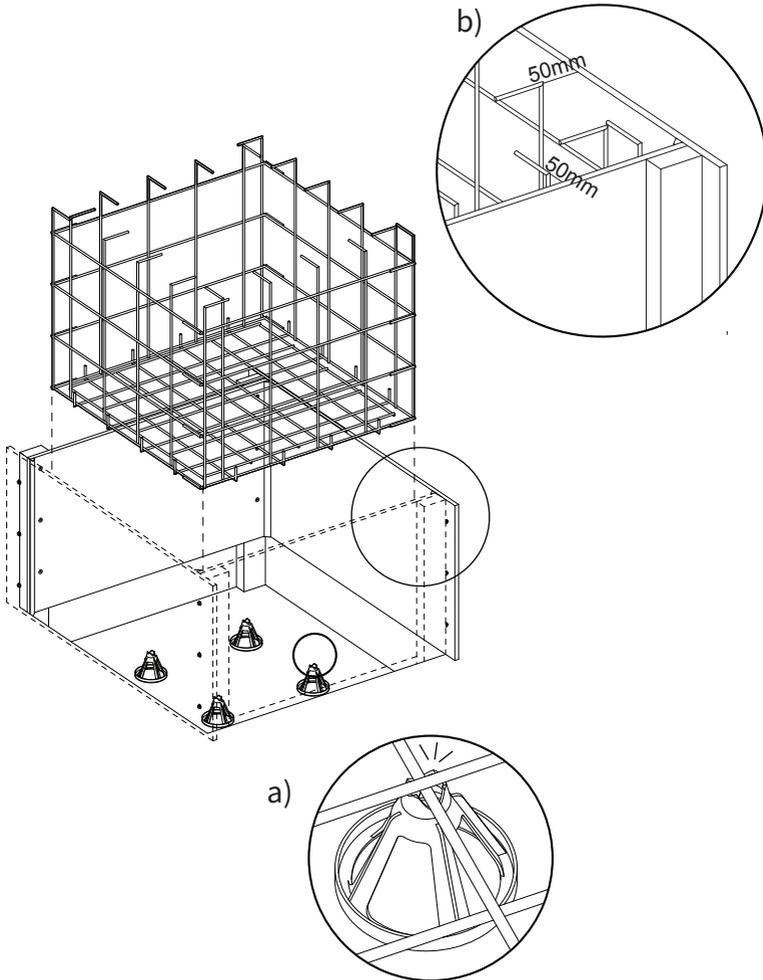


03 formwork site construction laying bar chairs

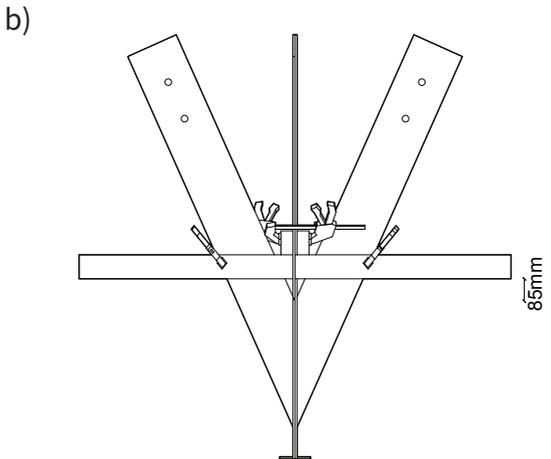
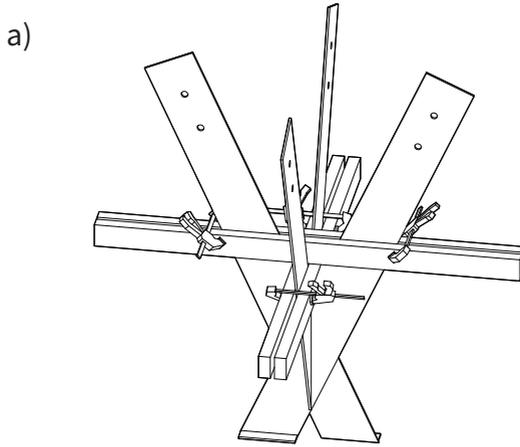


Lay 4x bar chairs at the base of the pit. These will ensure that the steel will remain suspended 70mm off the ground, within the concrete and away from any moisture. Reinforcing steel located within 30mm of a concrete face is subject to moisture contact and rust, which compromises its structural quality.

Lower the tied-together steel reinforcing cage into the formwork box, ensuring that the rods of the base sheet intersect with the handles of the bar chair. The overlapping of the rods should correspond with the double-height handles of the bar chair **(a)**. Ensure that the sides of the steel reinforcing cage remain 50mm from all inner sides of the formwork box **(b)**.



03 formwork site construction preparing cast-in steel plate



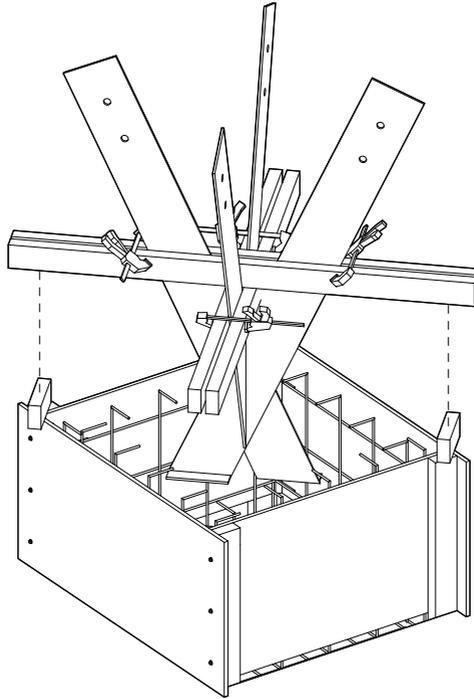
In order to suspend the cast-in steel plate structure within the formwork box during the concrete pour, the steel structure must be raised off the base of the steel reinforcing cage. To do this, clamp 2x structural pine lengths perpendicular to each other along each of the angled steel faces **(a)**.

The timber must be longer than the diagonal corner-to-corner distance of the formwork box. Ensure that the lowest edge of the timber is exactly 675mm above the base of the steel plate flange **(b)**. This will raise steel 100mm off the base of the steel reinforcing cage, while maintaining approximately 85mm of concrete depth above the steel apex.

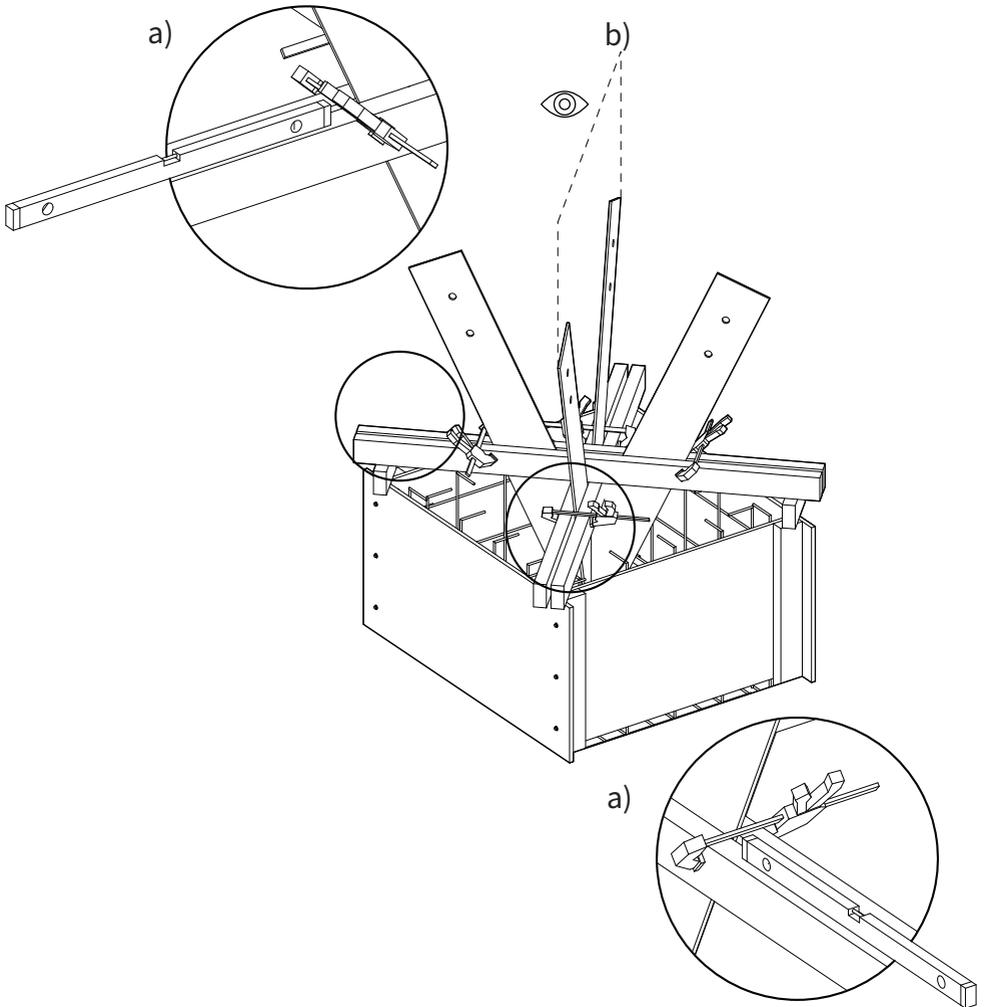
Before lowering the clamped steel plate into the formwork, place 2x wooden chocks at two opposing corners **(a)**. These must be the same height as the bottom clamped timber length (90x45mm). This will ensure that the steel will remain equally supported and suspended at each corner of the formwork box, despite the varying heights of the clamped timber.

Carefully lower the steel plate into the formwork, making sure the steel flange of the plate remains clear of the protruding steel reinforcing cage rods. This will require at least one person on each side (min. 4 people).

a)



03 formwork site construction locating cast-in steel plate within formwork (cont.)

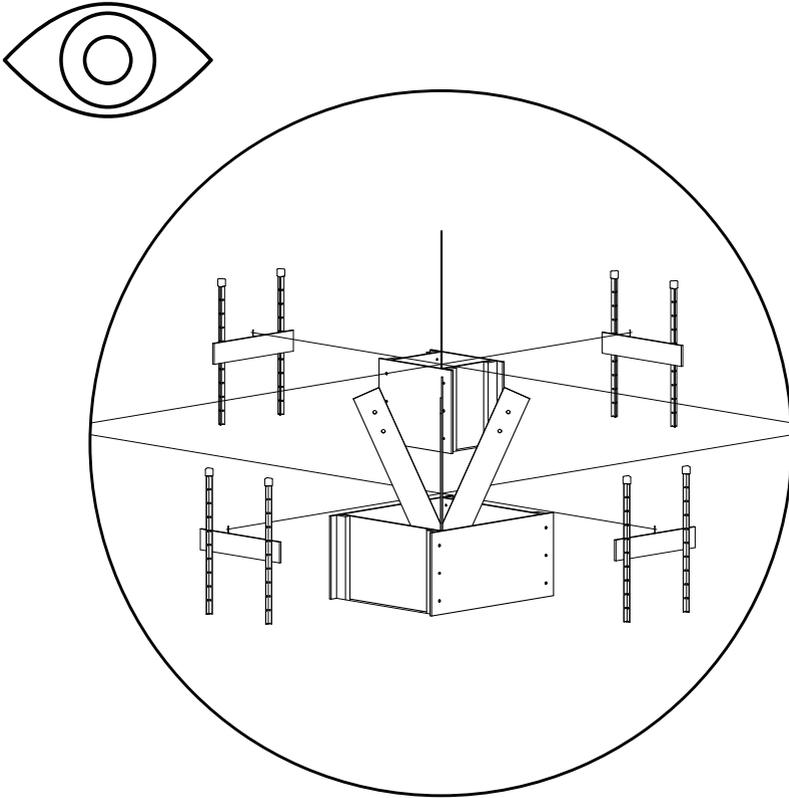


Manoeuvre the steel plate around as necessary to ensure that it is sitting centred, and exactly diagonal to the formwork box. Check the level of the horizontal clamped timber lengths to ensure that the entire steel structure remains level **(a)**. This process may take some time, as adjustments to the level will likely in turn shift the structure off-centre. Be patient.

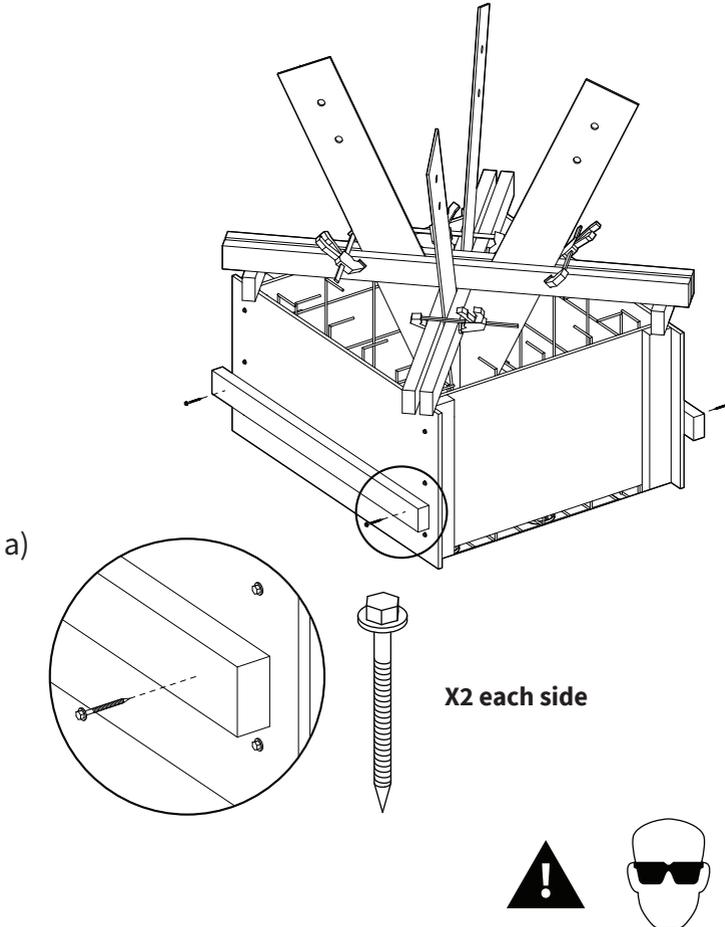
Provided the steel is at 45 degrees to the form box, two of the steel arms should align perfectly with the cast-in steel plate of the diagonally opposite formwork box in the north-east corner of the site **(b)** (following page)

Visually align the angled steel plates of the south-west and north-east formwork boxes. If the steel plates align along the same plane (as shown) your steel plate is positioned correctly.

b)

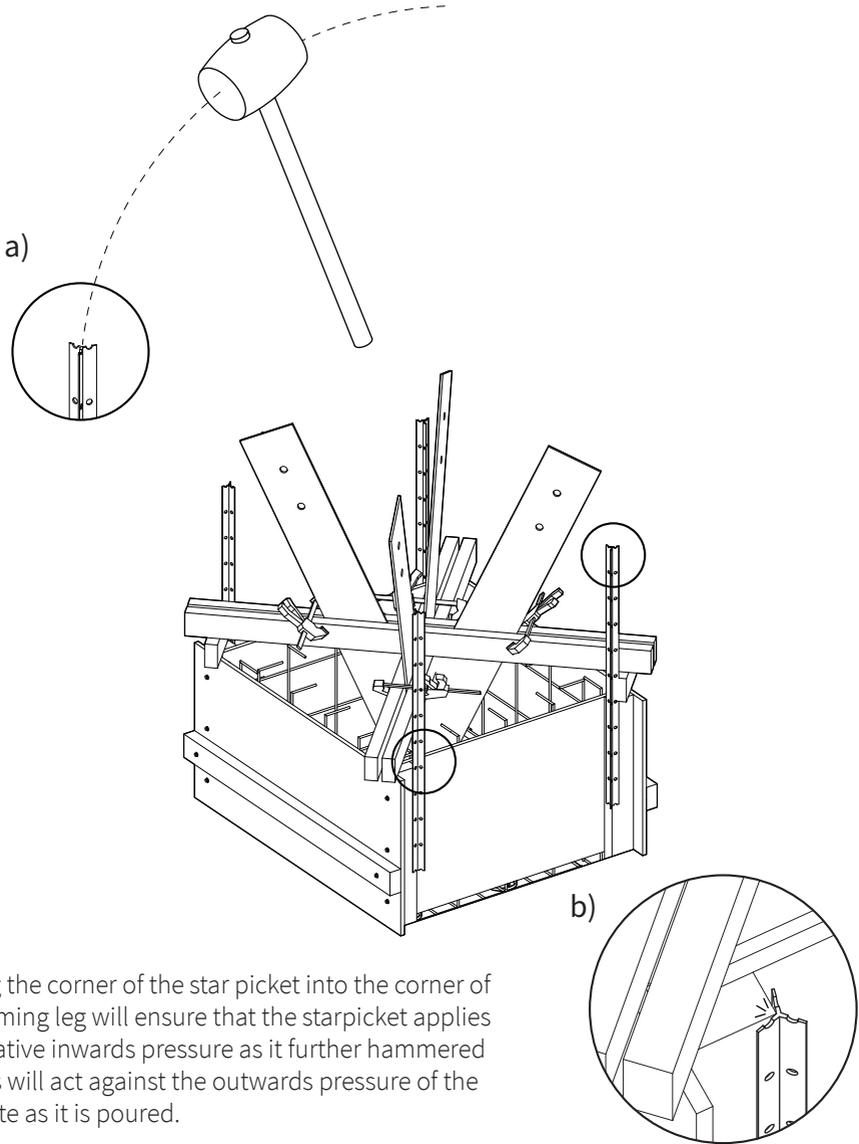


03 formwork site construction further formwork reinforcement (if required)



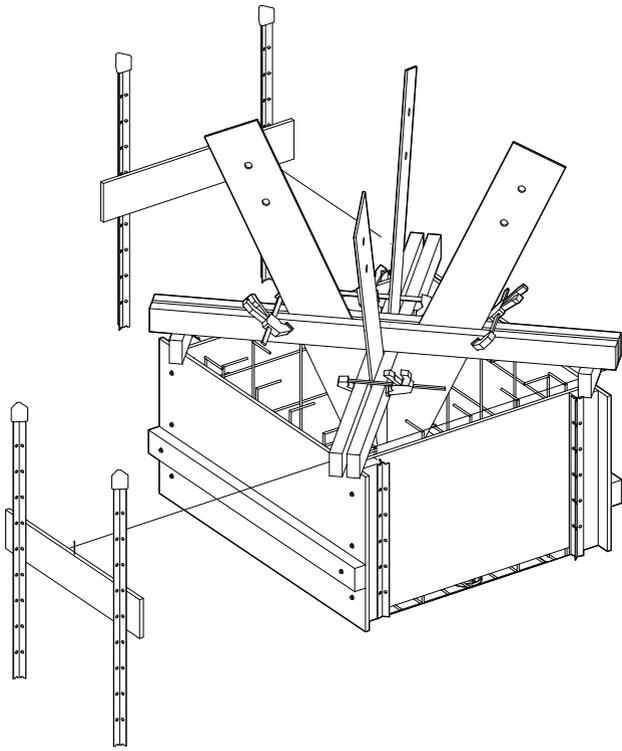
Affix 1x timber framing timber length on each of the two longer sides of the formwork box with TEK screws **(a)** at approximately 1/3 of the height of the formply. Ensure that the screws align with and penetrate into the vertical framing leg of the formwork box. This will provide lateral bracing, to counteract the outwards cumulative pressure of the concrete as it is poured. This step may not be necessary, but is suggested for any formwork box that will have side lengths of 1000mm or longer.

Using a mallet or hammer, drive 4x additional starpickets into the corners of the formwork box **(a)**. Ensure that these butt-up against and press into the timber framing legs of the formwork box **(b)**.



Driving the corner of the star picket into the corner of the framing leg will ensure that the starpicket applies cumulative inwards pressure as it further hammered in. This will act against the outwards pressure of the concrete as it is poured.

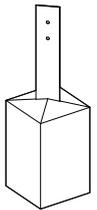
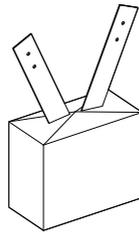
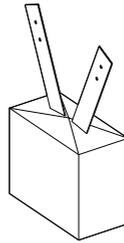
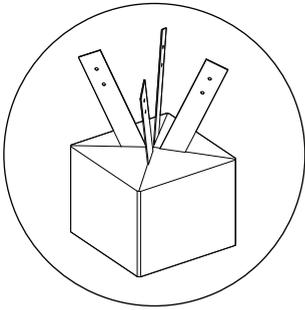
03 — formwork site construction



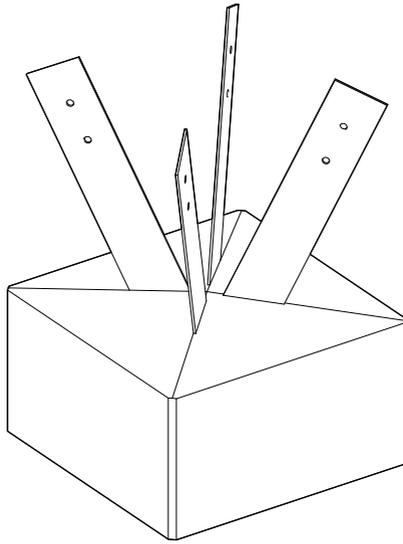
By this point your formwork box should be ready to for the concrete pour.

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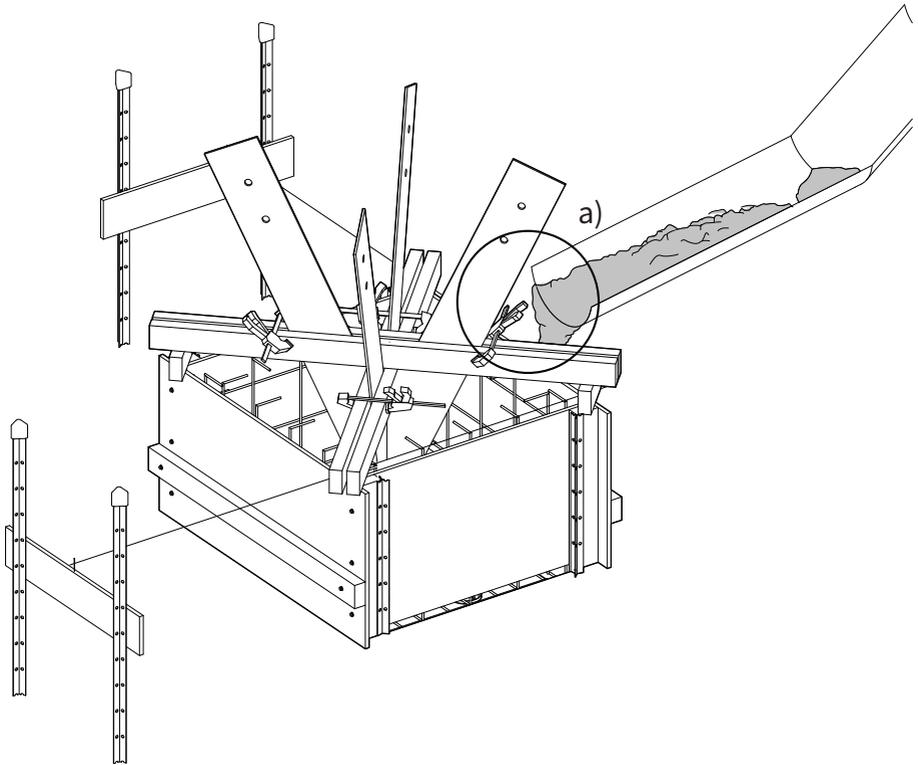
04 — concrete pour
south-west quad



The following section details the process involved in the concrete pour. It is advised to hire a concrete pourer for this stage, due to the difficulty involved in mixing concrete by hand in this quantity. To calculate the overall volume of concrete required, add the volume of the formwork box to the volume of the excavated pit (this will vary project to project).



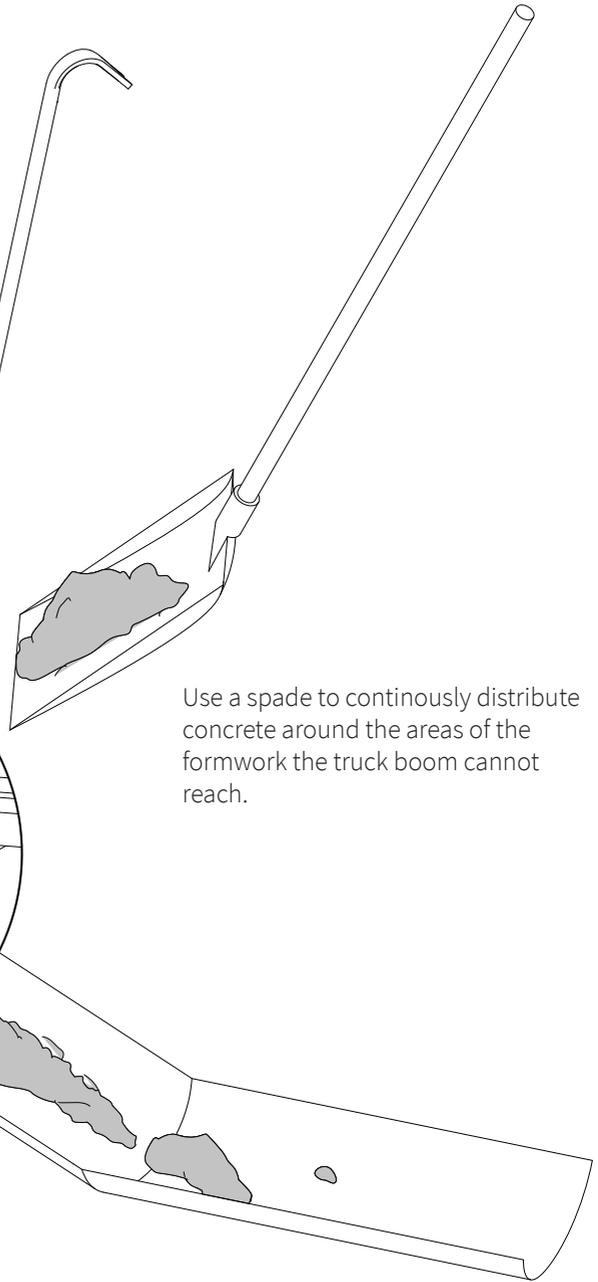
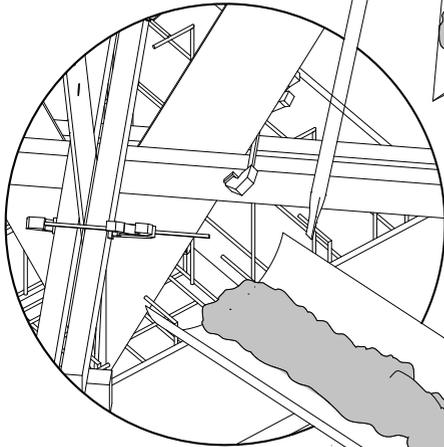
04 concrete pour pouring the concrete mix



Utilising a concrete truck is advised for the concrete pour due to the significant volume of concrete mix that will be required for the footings. Back the truck as close to the formwork as possible, while keeping clear of the other formwork boxes. Position the boom **(a)** of the concrete truck so that it can pour freely into one side of the formwork box cavity.

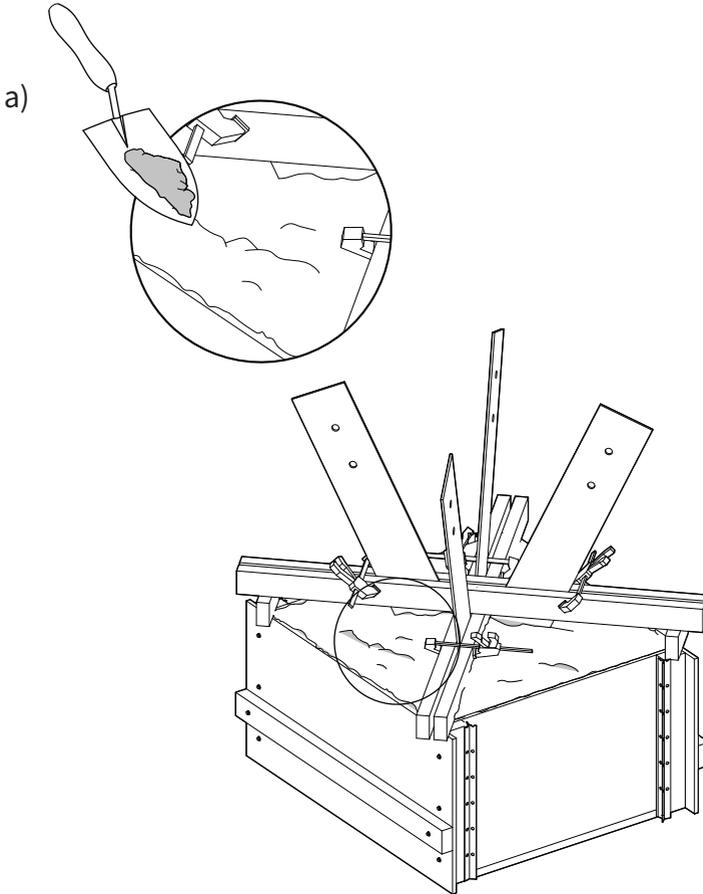
It is advised to keep the concrete mix moving around the inside of the formwork to prevent any build up of concrete within only one area, which may push the steel structure off-centre.

Use a crowbar to pump and push the mix throughout the various cavities around cast-in steel plate



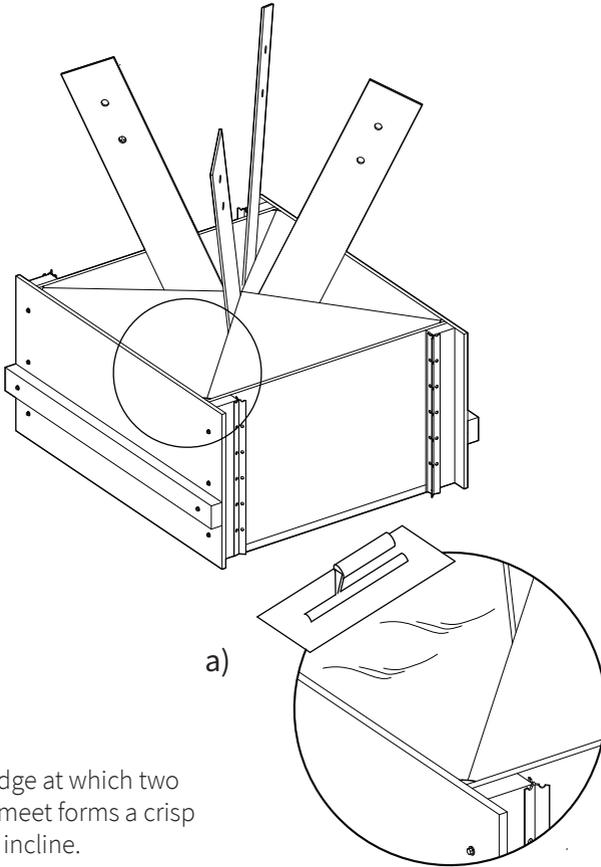
Use a spade to continuously distribute concrete around the areas of the formwork the truck boom cannot reach.

04 concrete pour levelling off the concrete mix



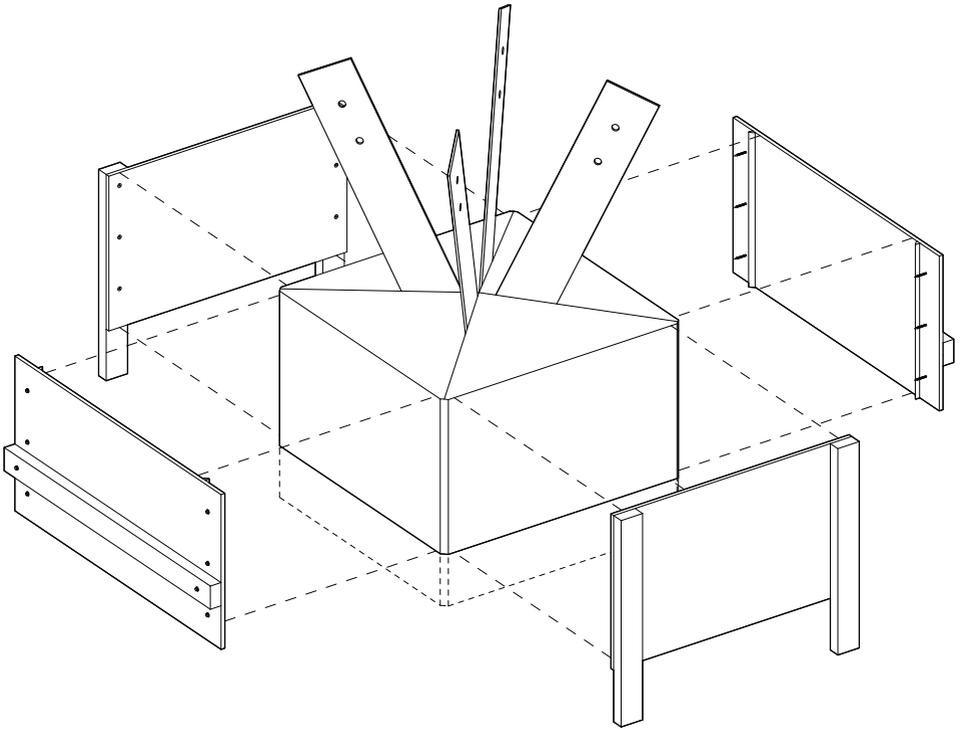
Once the entirety of the formwork as been filled, use a spade to build up the concrete mix above the level of the formply, inclining towards the apex of the cast-in steel plate **(a)**.

Use a trowel to smooth out this surface, to create a chamfered edge on each top face of the concrete **(a)**. This creates a wash on the top of the footing, preventing water from pooling around the apex of the steel by directing it off the edge.



Ensure that the edge at which two chamfered faces meet forms a crisp line with a gentle incline.

04 concrete pour removing formwork



Leave the concrete to cure for several days. After this time, you can carefully remove the formwork by un-drilling the tek screws on the external faces of the formply

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05 reflection
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pavilion at Cummeragunja



Reflecting back on the time spent up on the Murray River, it is clear just how fundamental a knowledge of basic construction techniques is to design. The steps involved in the erection of even something as seemingly simple as a concrete footing for a pavilion requires an in-depth knowledge of the ways certain materials, fixing systems and structural supports are each providing specific advantages and are working in conjunction with one another in real time. Pulled off the page, a design or drawing changes entirely into an order of sequences, in which certain processes have to happen first before you can progress to the next stage of the build.

It has likewise helped me to appreciate the complexity involved in even the simplest architectural forms. This seemed to become evident in the diagramming process for this workbook – drawings would become more and more complex as I was reminded of each step that had to happen, and the order this needed to occur in. The final point – the last drawing of this workbook and the photo opposite – seem to be the most simple, and yet are hiding a whole timeline of events which led to their present form. When otherwise I wouldn't have even noticed a cast-in concrete wall, now I am instantly aware of the formwork, preparation, transportation, erection and touch-up required to facilitate its current form.

Even between the two formats presented here – the workbook and the actual construction process – I have become aware of the limits of design and just how many contingencies need to be built into a design to make it work successfully as a built project. The drawings are by no means exhaustive, and yet I feel like so many things that happened on site simply can't be communicated in a step-by-step diagram. The decision to re-locate the site for instance was in response to an uncomfortable physical encounter, and a need to make the community feel like they were being heard in a project which should be entirely for them. It comes across here however as just another step in the process in this workbook. Talking together as a group and deciding which is the best way to clamp a certain joint, or carry across the steel plate structure to the pit is likewise brushed over in this workbook. These were organic conversations which had to happen in response to on-site factors. Furthermore, because of the nature of drawing and modelling (on a computer), the diagrams presented here are more of a perfect representation of what actually cannot be built – the lines are too neat and the measurements are too exact. On site, measurements would become less critical when you were confronted with the realities of uneven soil hardness in the trench, or warped timber framing. Instead, we would work around these problems and accommodate them into the construction process. If you didn't have a certain tool, you would use a rock as a wedge, or any offcut of timber lying around as a mallet.

I feel like my time spent up at Cummeragunja working with the community and the ASHE students has afforded me a completely different perspective on architecture. One not so rigid and formulaic, but organic and responsive.

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