Manual

Step by step manual for a bow rack you can create yourself without any nails or screws.

Introduction

This document contains a Do It Yourself (DIY) tutorial on how to make a bow rack that can be mounted against a wall and is enabled to display a recurve bow. With this document one can completely recreate the building process by following the tutorial step by step, or one can integrate the used techniques to implement those in different projects.

The manual consists of the following sections. Firstly, there will be a summary of all the different types of materials and tools that have been used to create this bow rack. After this, each individual step will be thoroughly explained and with every step there will be some mentioning on how to take extra care in this particular step. This is mostly done to prevent mistakes, which may lead to starting all over with one of the parts.

Some steps will be labelled “Repeatable steps”, meaning that this step most likely will return further down the road. It can also be that this particular step will be one that needs to happen every time after a certain process.

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Summary of Materials and Tools

Materials:

Hardwood planed: Meranti
Dimensions: 45 x 45 x 2750 mm

Dowel: Beach wood
Diameter: 8 mm

Tools:

A: Pencil B: Protractor triangle
C: Ruler D: Measuring tape
E: Rafter Square

F: Japanese saw, double edged

G: Fretsaw

H: Hammer with rubberized headpiece

I: Triangle File 8 mm, 150 mm
J: Flat File 20 mm, 200 mm

K: Wood chisel 20, 16, 10 mm

L: Bessey Bar Clamps

M: Wood Glue

N: Sanding Paper,

Tools (Electric):

O: Electric Mitre saw

P: Circular saw

Q: Router drill with drill bits

R: Cordless drill with wood bit set

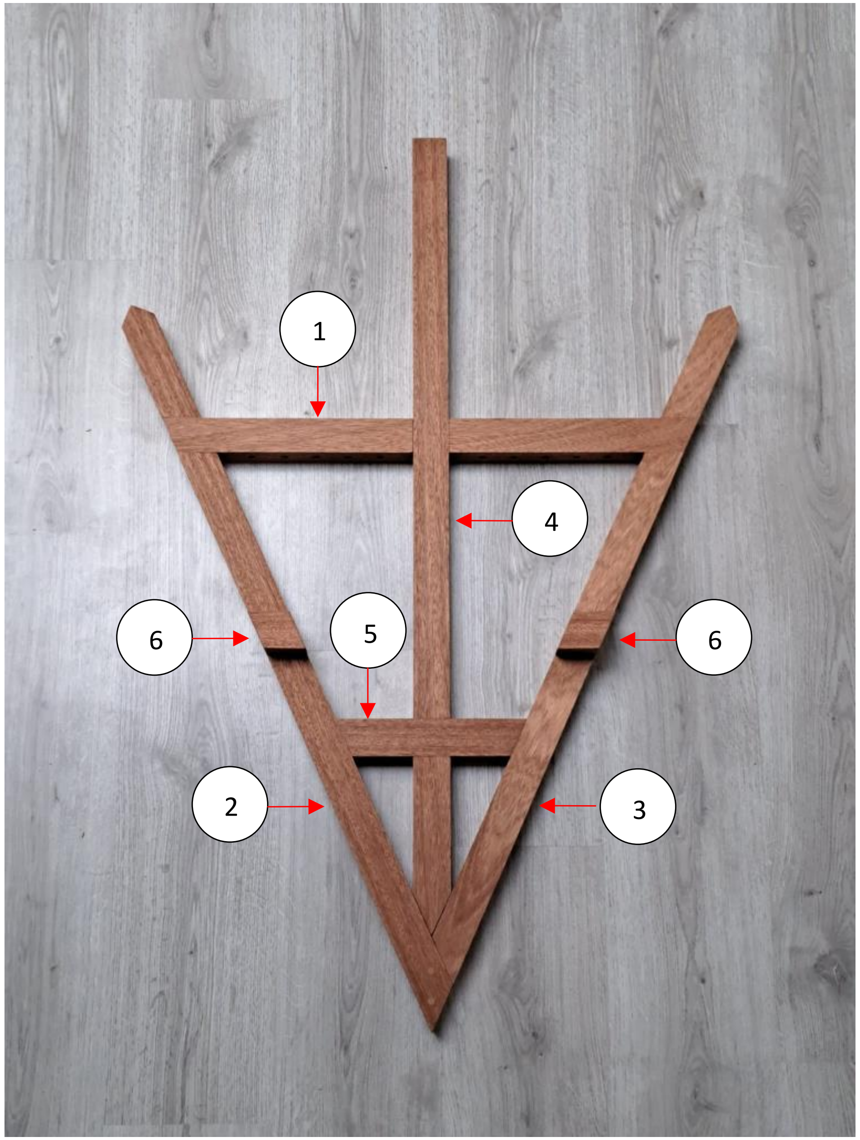
S: Work mate

Work sequence:

As seen in the picture, the bow rack is made up of 5 different beams. To make sure the product and all the different wood connections are made in de the right order, all the beams are labelled. During the process each beam is worked on separately until the connections are being fitted, in which multiple beams will be needed to ensure the connections fit.

The work sequences are as follows:

- Beam ❶: Top horizontal beam
- Beam ❷/❸: Angled beams that are connected to Beam ❶ and to each other at the bottom of the design
- Beam ❹: Long vertical Beam which is connected to Beam ❶ and is wedged between Beam ❷&❸
- Beam ❺: Small horizontal beam which is connected to Beam ❹ and is wedged between Beam ❷&❸
- Support pieces ❻: Small blocks to support the bow.
- Holes for the arrows
- Fine adjustments (if needed)
- Sanding
- Oiling



Beam 1

Step 1:

Measure out 70 cm with the measuring tape (D) and mark it with a pencil (A). With the rafter square (E) draw a line across the beam.

Step 2:

Place the beam underneath the sawblade of the Mitre saw (O). Make sure the sawblade is positioned to make an 90° angle with the beam. If provided, secure the beam with the clamps that are connected to the saw. Otherwise secure the beam with the Bessey bar clamps (L) to the Mitre saw (O).

Step 3: (Repeatable step I)

Before making the cut with the saw, make sure the saw blade is positioned on the outside of the marked line. This will ensure that the beam has the correct length needed after the cut is made.

Step 4: (Repeatable step II)

Every time a cut is made on any piece of wood, rough edges and shavings are left behind from the saw blade. Using sanding paper (N) and slightly sanding all the edges ensures all the rough ridges disappear. This is necessary to ensure that the marking off the following measurements can be done properly.

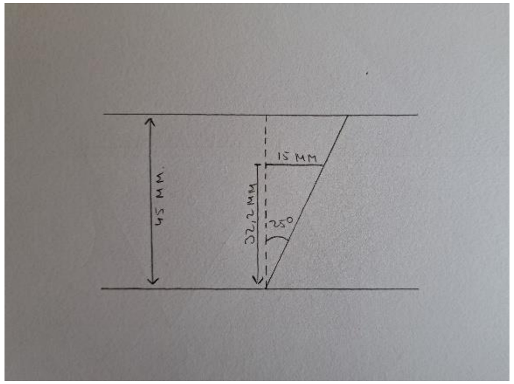
This can also be done with the fine groove of the flat file (J).

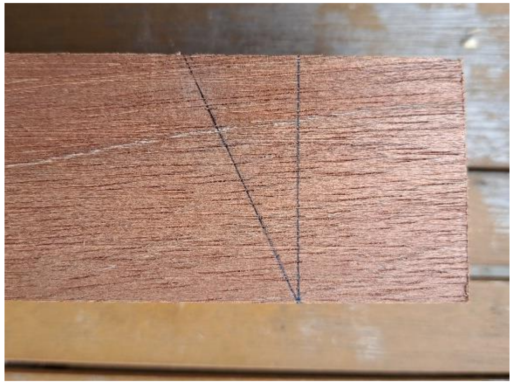
Step 5:

Measure out 67 cm on the 70 cm beam using a pencil (A), measuring tape (D) and rafter square (E).

Step 6:

Measure out an angle of 25˚ from the 67 cm mark using a pencil (A) & protractor triangle (B).

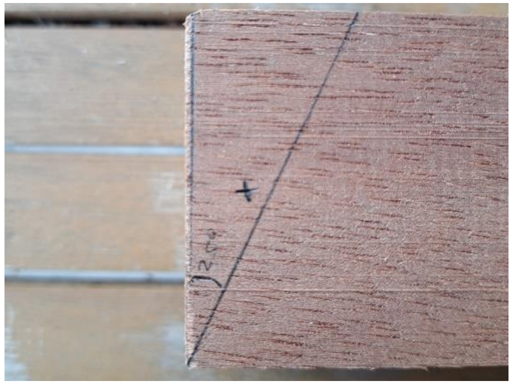




Step 7:

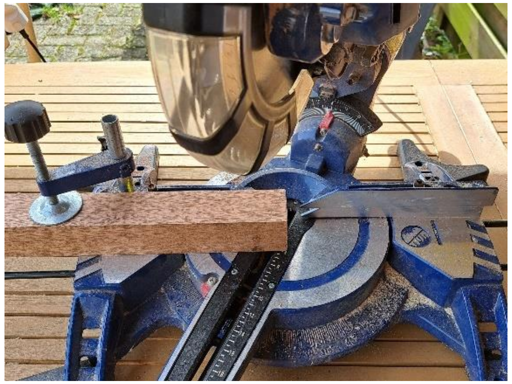
On the opposite side of Beam 1 and on the same surface also measure out an angle of 25° from the end of the beam with A & B.

Make sure that both angles are pointing to each other, so that they merge somewhere outside of the beam. Don’t make the angles parallel to each other.



Step 8:

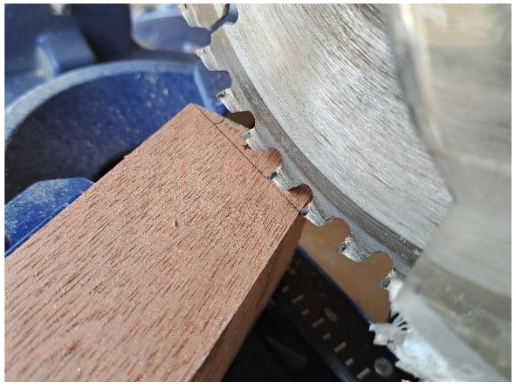
Change the angle of the Mitre saw (O) to 25° using the turn dial. Place the beam on the Mitre Saw (O) and secure it with the clamps (or with L).

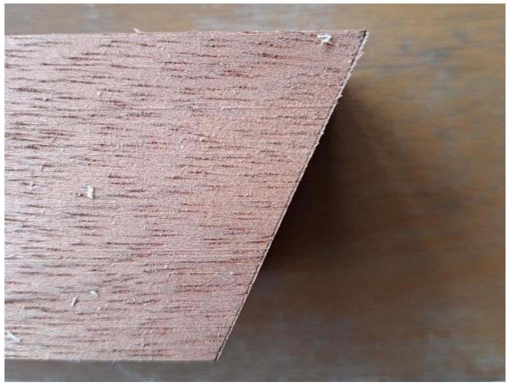


Step 9/Repeatable step I:

Again, make sure the saw blade is positioned outside of the marked line to ensure the remaining part is the correct length.

If done accurately the result looks like the far-right picture.





Step 10:

Repeat steps 8 & 9 to the other side of Beam ❶.

Repeatable step II:

Make sure all the rough edges on both sides of Beam ❶ are sanded after the cuts.

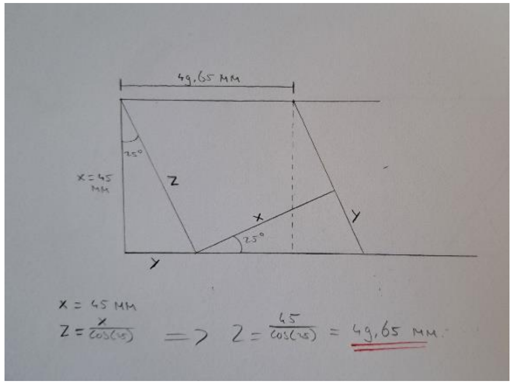
After all these 10 steps Beam ❶ should look like the following picture.

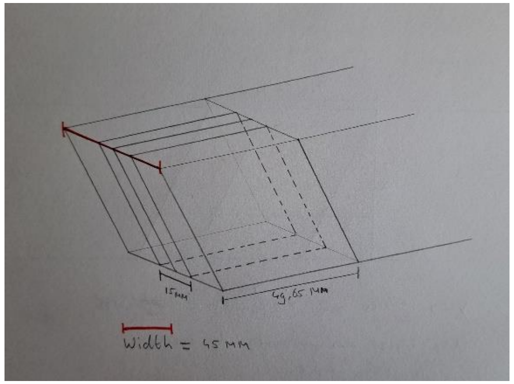
Note: As shown, the angles of both cuts point downwards.

Step 11:

On both sides of Beam ❶ draw out the following markings using a pencil (A) and the protractor triangle (B).

For all the calculations of the dimensions see Appendix I.





Step 12:

The markings should look like the following picture. It is important that the angled line should be parallel to the outside of the Beam. The markings on the top of the Beam should be measured from the middle and drawn across the length of the Beam (See pictures from step 11 as reference).

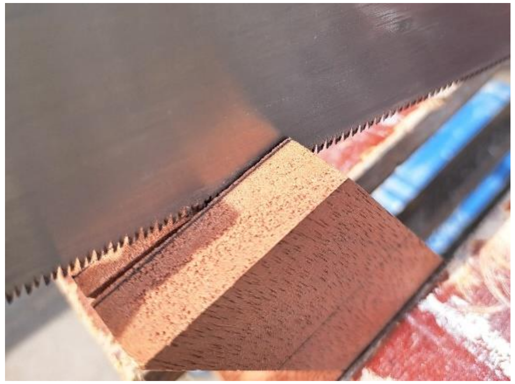
Step 13:

Place the Beam in a Work mate/table (S) and secure it tightly.

It is highly recommended to use a piece of spare wood cut with the same angle as the Beam to use as a placeholder/guidance (see the picture). This piece is secured next to the beam and rests on a part of the Work mate, so that the side of the beam that has been cut is placed horizontally. This makes it easier to saw straight, otherwise this has to be done at an angle, which can be quite a challenge.

Step 14:

Using the Japanese saw (F) carefully saw out the middle part of the marked area. Start slowly and try to stay within the marked lines. Here it's also important to saw within the markings.



Step 15:

Keep gently sawing and making sure you stay parallel to the marked lines until you reach the horizontal cross line. Make sure you don't cross this horizontal line on both sides of the Beam.

Step 16:

Repeat this process (step 14 & 15) on the same end of the Beam but on the other side off the marked area. Keep still in mind to stay within the marked lines to avoid sawing of too much of the excess wood.

Interim Result:

After carefully sawing, the result should be similar to the pictures shown.

You can see clearly here that the depth of the saw hasn't passed the horizontal cross line.

Step 17:

Turn the beam and secure it on its side on the Workmate (S) so that the saw lines lay horizontally. Insert the Fretsaw (G) in the saw line and position is as shown.

Step 18:

Gently start sawing with the Fretsaw (G) and stay parallel to the cross line until you've reached the other saw line from the end result of step 16.

Sidenote, it may be possible you won't saw through the material in one go with the Fretsaw. To avoid making larger indent with the saw and without completely sawing through, turn the Beam upside down and start from the other saw line until you've reached your initial Fretsaw line.

Interim Result:

After discreetly sawing through the beam with the Fretsaw (G) your side of Beam 1 should like the following picture

Step 19:

Because the saw lines are within the marked area, there is still too much excess wood and the gap has therefore not yet reached it thickness. To make sure the pieces fit together eventually, the excess wood has to be filled of using the flat and triangle file (I & J).

To make sure the right thickness is achieved, keep switching sides to file on. This ensures that the gap is evenly spaced and is symmetrical from the middle of the Beam.

Step 20:

Using a pre-made piece of scrap wood that has the right amount of wood cut away from both direction of the beam, using the Router and the drill bits (Q), you can test if the gap in Beam 1 has the correct thickness. If this is not the case, keep filling away on both sides of the cut, until the pre-made piece of scrap wood fits tightly in the gap of Beam 1

The pre-made piece of wood was also used to set the router to the right depth (See step 4 in the next chapter).

Step 21:

When finished with one side of Beam ❶, the exact same steps need to be recreated on the other side of the beam.
Repeat step 11 up to 20 to create the same cut with the same thickness on both sides of the beam. Test this side also with the pre-made piece of scrap wood from step 20.

Step 22:

When the steps are performed with precision, the following result follows at both ends.

Step 23:

In the end, Beam ❶ looks like the following:

Beam ❶ will still be used while making Beams ❷ & ❸ to test the wood connection.

After that, Beam ❶ will be worked on again when making Beams ❹, ❺ and the holes for the arrows.

Beam ❷ (& ❸)

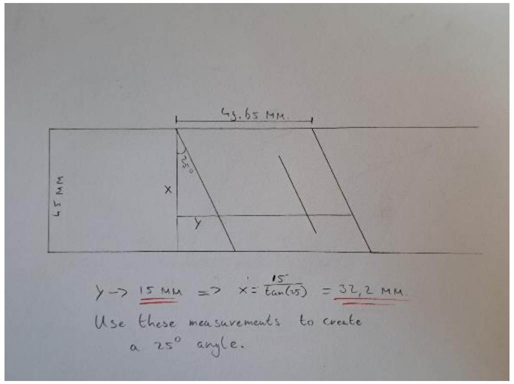
Step 1:

Using the same Beam from which Beam ❶ was cut, a distance of 15 cm is measured and marked using a pencil (A), protractor triangle (B) & measuring tape (D).

Step 2:

From the 15 cm mark draw out the following shape with the following dimensions:

This area will also be drawn on the other side of the beam and these area's will be cut using the Router drill. The space that is cut away will be filled with the "teeth" of the "fork" from Beam ❶.



Step 3:

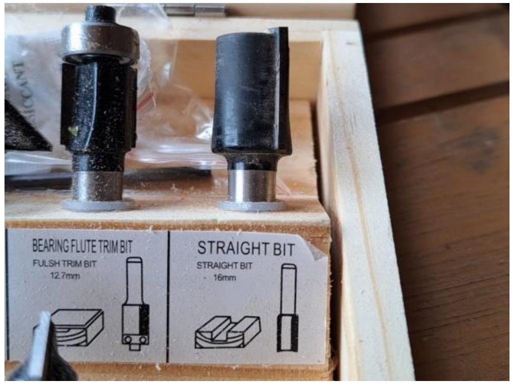
Measure out the distance between the router bit and the side of the router drill. Mark the same distance on the surface of Beam ❷ parallel to the marked lines from step 2. (This also has to be done on the other side of Beam ❷, make sure that the direction of the marked area is consistent and the angles for the marked lines are pointing in the same direction.)

These lines will be used as a guideline for a scrap piece of wood. Using this piece of wood and placing it alongside the marked line, the router bit will be placed on the exact location to cut away the excess wood. The piece of wood will function as a guideline for the router drill and de the router bitt will stay parallel to the marked line from step 2.

Step 4:

Measure out the needed depth of the router bit (C & Q). For this project the depth was set at 15 mm (1/3 of the total thickness of the beams).

The drill bit that was used was a straight bit with a diameter of 16 mm.



Step 5:

Secure Beam ❷ to the workmate/table using the Bessey bar clamps (L). With the same clamps, secure a piece of scrap wood to the marked line from step 4.

Step 6:

Using the router drill (Q), cut away a piece of the marked area. Use the secured piece of scrap wood as a guideline to make sure the cut is parallel to the markings and stays within the marked area.

Interim result:

When finishing the first cut, Beam ❷ should look like this:

Step 7:

Repeat step 5 & 6 on the other side of the marked area and remove the remaining piece of excess wood. This can be done without using the scrap wood piece as guideline, but remain precise and secure.

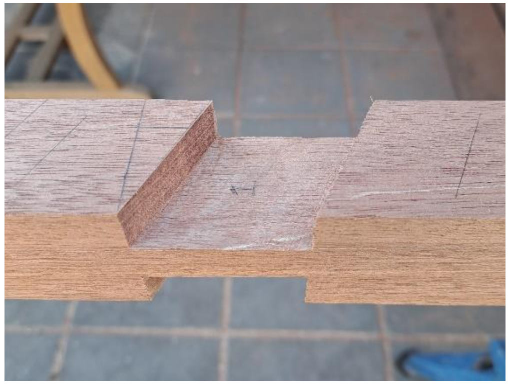
Step 8:

Repeat step 3 up to step 7 on the other side of Beam ❷.

After all those steps make sure all the rough edges are filed away and that all the surfaces are smooth using the flat file (J).

When done with precision, Beam ❷ should have slots like shown in the far most right picture.

(Note: it may look like the lines are not perpendicular, this is because of an error with the camera of the phone)



Step 9:

Now try to slide the “teeth” of the fork of Beam ❶ into the slots that have just been created on Beam ❷.

If this does not fit, it is probably because of the distance between the “teeth” of the fork are too narrow. If so, perform the next step, if not, skip the first next step.

Step 10:

Use the wood chisel (K), flat file (J) and the sanding paper to make the distance between the teeth wider.

TIP: Take the piece of wood that has been cut out in step 18 from Beam ❶ and take some sanding paper. Cut the sanding paper so it fits on one of the sides of the piece of wood. Glue it to the side and use the piece of wood as a tool to carefully sand away excess wood in between the teeth. (See the picture shown for an example)

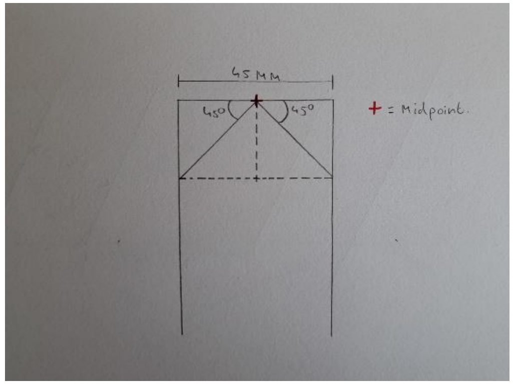
Interim result:

If the clearance is wide enough and everything fits tightly, it looks like this:

It may be possible that the connection won't fit all the way. If this is the case, one can use the hammer with rubberized headpiece (H) and a piece of scrap wood and hammer the beams together until the connection fits properly.

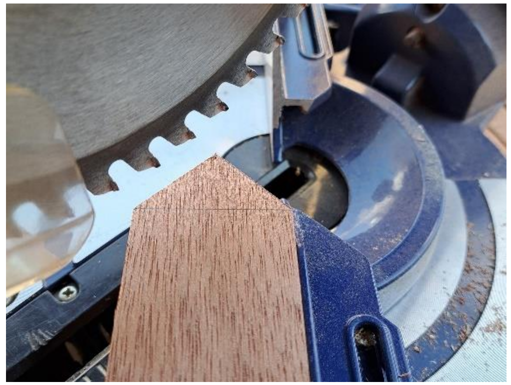
Step 11:

At the end of Beam ❷, from where the 15 cm was measured out in step 1, draw out the following:



Step 12:

With the electric Mitre saw (O), cut away the corners, creating a point in the beam.



Step 13:

Repeat step 1 up to 12 to create Beam ❸. This time, start with a new beam of wood (not with the remaining beam that was left after finishing Beam ❶) and follow all the mentioned steps that have been executed for Beam ❷.

Side note: Make sure that it is clear which beam corresponds with which fork from Beam ❶. During the process of making the two beams, slight alterations can be made to the fork on one side of Beam ❶ to allow one of the Beams ❷ or ❸ to fit correctly. If the other beam is used on the different side of Beam ❶, it is possible it won't correctly.

To overcome this problem, indicate the corresponding beams with a small marking. This can lead to less chance of errors when assembling the rack.

Interim result:

After completing both Beams, Beam ❷ & ❸ should look identical and each individual beam should fit tightly in one end of Beam ❶.

Step 14:

The next step in the progress is to make the end lap connection which connects Beam ❷ & ❸ with each other. To do this the length of both the beams has to be determined.

To enable this, secure one of the side beams (❷ or ❸) to Beam ❶. With the remaining side beam, create the following setup:

See the following pictures to get a closer look on each setup.

A:

On this side of the rack, Beam ❶ is connected to Beam ❷.

B:

On this side Beam ❸ is placed on top of Beam ❶, so that the two beams cross each other on top op each other. The opening of Beam ❸ is placed like shown so that if Beam ❸ was connected to Beam ❶, it would also fit correctly.

C:

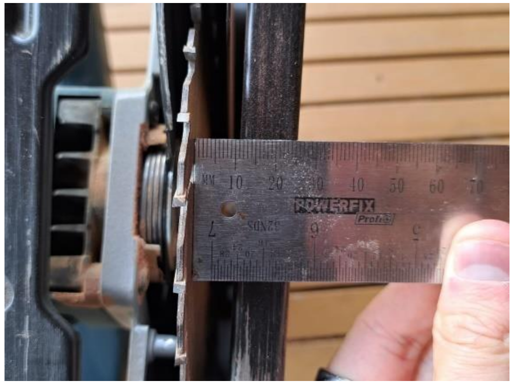
Beam ❸ intersects Beam ❷ on the top side of the last mentioned beam. With the protractor triangle (B), verify if the angle between the two beams measures 50°. This corresponds to the angle times two that has been used in all previous steps which included a marking with an angle.

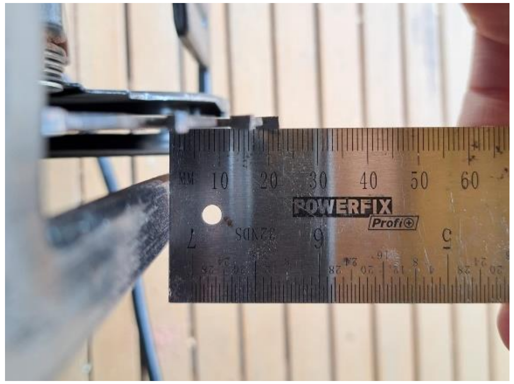
On both beams, mark where they intersect and make sure that it has the right dimensions (49,65 mm apart). This will be needed for the next few steps.

Step 15:

Measure out the distance between the blade of the circular saw (P) with the ruler (C). (In the this case that would be 26 mm)

Set the depth of the circular saw blade (P) to a depth of 22,5 mm (this is half the thickness of the beams that are used) using the ruler (C).

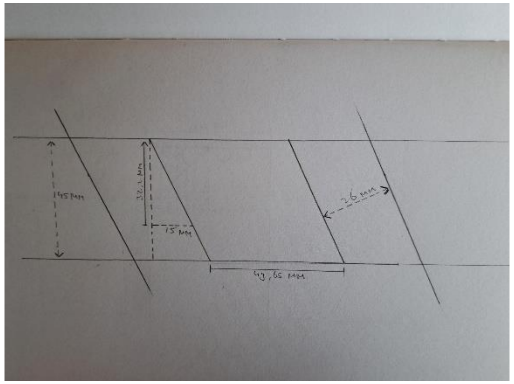




Step 16:

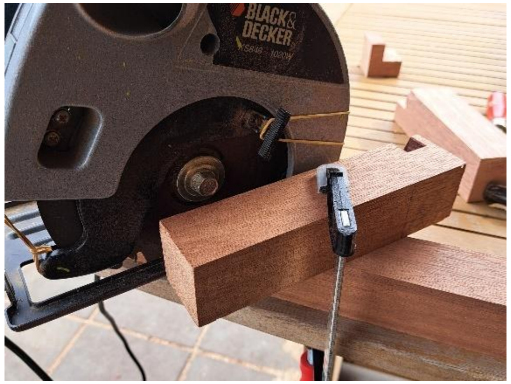
From the intersect lines from step 14C on one of the two beams, measure out the distance from step 15. Mark the distance and use this guideline and a scrap piece of wood as mentioned in step 5 of Beam ❷.

Secure the piece of scrap wood with the Bessey bar clamps (L) parallel to the guideline.



Step 17:

Take the circular saw (P) and position it against the scrap piece of wood. Verify if the saw blade is on the inside of the marked area, so it only cuts away what is needed to be cut away. Make the necessary adjustments if needed and make the cut.



Step 18:

Repeat step 16 & 17 on the opposite side of the surface to get the following result:

Step 19:

Using the circular saw (P) cut away the excess wood in between the already cut lines. It is possible to do this freehandedly without the piece of scrap wood, just be careful not to intersect the pre-made cuts.

It is possible to saw away all the material in this way, but one can also choose to saw away a new piece every so many mm. The latter results in the following:
With the help of a chisel (K) and a hammer (H), chip away the little pieces of wood that are left behind until the whole gap is cleared.

Step 20:

Using the flat file (J) smooth out all the surfaces and edges and try to fit a piece of wood in the cut out area.

If it is to tight, file away some excess wood away until the beam fits correctly.

Interim results:

After these last few steps, the beams should fit like the following:

The beams cross each other, while the top beam sticks out and the gap from the bottom beam covers half of top beam.

Step 21:

Repeat step 15 up to step 20 on the other beam. Perform each step carefully and take care not to make mistakes.

Interim results:

After finishing both beams, they should fit tightly and form an X shape, as shown in the following picture.

If done correctly, both surfaces should at the same height and there shouldn’t be an offset or a little jump between the two surfaces of both beams.

As seen, the beams are still quite long and continue beyond the connection. The reason for this was to avoid mistakes and should the openings be too narrow or too wide, it still can be adjusted afterwards.

Step 22:

Secure one of the beams on the workmate/table (S) with the bessey bar clamps (L). Position the Japanese saw (F) against the outer most edge and place it in the previously cut gap. Saw away the end of the beam and make sure the saw blade stays positioned against the outer edge.

Step 23:

Repeat step 22 on the other beam, so both beams are cut of at the end of the gap and look like the following:

Note: The beams are not identical, but are mirrored. So the dimensions of the cut is the same, only the orientations is different.

Step 24:

Assemble the three beams and make the following construction.

It is possible, due to minor errors and margins, that the end pieces of beam ❷ & ❸ won't connect and that there is some distance between the two beams. For this project this was the case and that's why the end pieces are being held together with clamps.

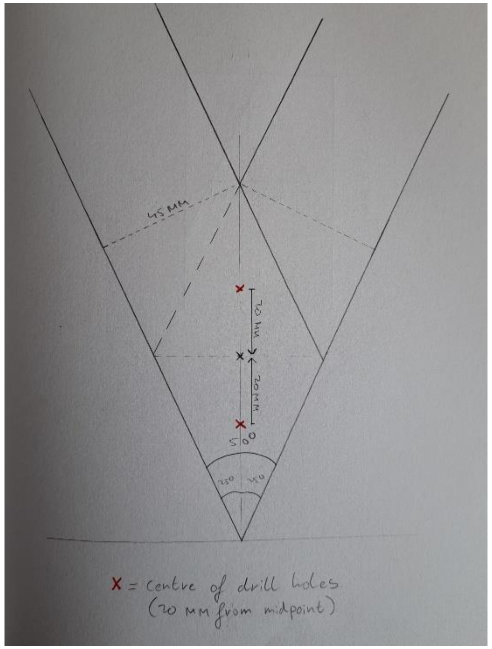
The clamps make it possible to check if all the pieces connect and fit, so the triangle shape can be realised.

There is no need to worry, as the connection between Beams ❷ & ❸ will be secured tightly with the help of dowels. This will be explained in the next few steps.

Step 25:

Secure the triangle shape to the workmate/table (S) with bessay bar clamps (L) and make sure the outer ends of Beams ❷ & ❸ meet correctly (if needed, clamp the ends together to secure it). Draw a vertical line from the bottom point to the top where the two beams meet.

Mark two point measured out 20 mm from the middle of the line. These will be the drill marks.



Step 26:

Position the drill (R) with the wooden drill bit (8 mm diameter) on one of the marked points.

Start drilling and drill all the way through both the beams as shown.

Step 27:

Grab the Beach wood dowel (8 mm diameter) and measure out at least 55 mm. The dowel is wider than the thickness of the beams, to ensure the dowel will stick out on both sides of the beam.

With the Japanese saw (F), saw of the measured piece of the dowel.

Step 28:

Take the dowel from step 27 and apply some wood glue (M) on it. Push it in the hole from step 26 and make sure both ends stick out of both sides of the beams.

Remove any excess glue and secure the pieces with the bessey bar clamps (L) to let the glue dry.

Step 29:

Repeat step 26, 27, & 28 on the other marked point from step 26.

Result:

After the last step, it is important to allow the glue of the dowels to dry properly. By clamping Beams ❷ & ❸, the glue can dry and all the beams are positioned correctly.

The picture shows the lap joint that is secured with dowels from both sides . The clamps are secured to keep everything together and allows the glue to dry.

Half way point

The project finally begins to look like a bow rack, after finishing the previously mentioned steps. The basic shape of the rack is now formed. Up next are the last two beams, the supports, the holes for the arrows and the finishing touches.

Beam 4

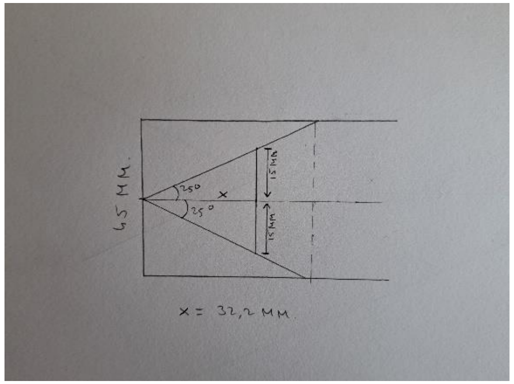
Step 1:

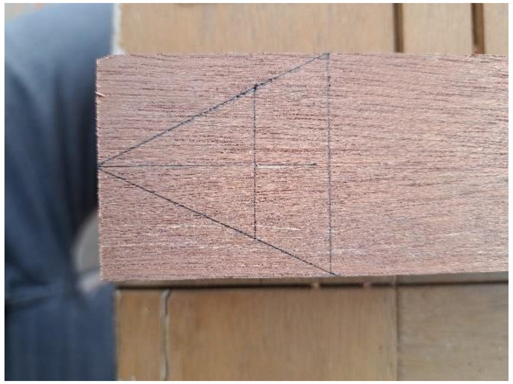
For Beam ❹, use the left over wood from Beam ❸. Measure out at least 120 cm and draw a line at 100 cm.

(The length of Beam ❹ in the end model is 100 cm, the extra 20 cm is just in case mistakes are made whilst making the cut in the next step)

Step 2:

At one end of Beam ❹ draw out the following shape with angles of 25° (see drawing). Use A, B, & E.





Step 3:

Set the Mitre saw (O) at an angle of 25° and position the beam as shown in the picture on the Mitre saw (O).

Make sure the saw blade says on the outside of the marked line, to only cut away the excess wood.

Step 4:

Make the cut on both sides of the beam to get the following result:

Step 5:

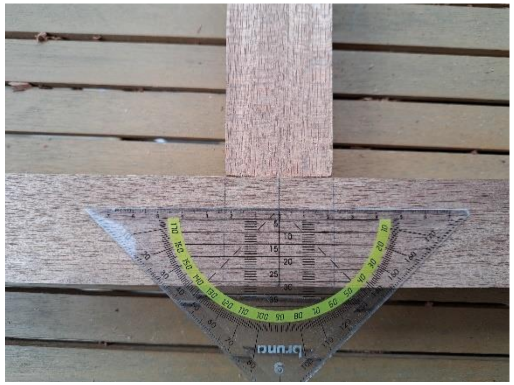
Take the already made basis shape and measure the outer most distance from Beam ❶.

In this case, this is 67 cm wide.

Step 6:

Determine the middle (in this case 33,5 mm) on Beam ❶ and measure out the width of the beam (45 mm).

Draw perpendicular lines on Beam ❶ with A & E and check if a beam fits between the drawn lines with the help of B.



Step 7:

(For a more comprehensive explanation, refer to steps 15 up to step 20 of the previous beam (Beams ❷ & ❸) before performing steps 7, 8, 9 & 10)

Measure out the distance between the saw blade of the circular saw (P) and place a piece of scrap wood on the marked line.

Make sure the piece of scrap wood is positioned in a 90° angle in regard to Beam ❶.

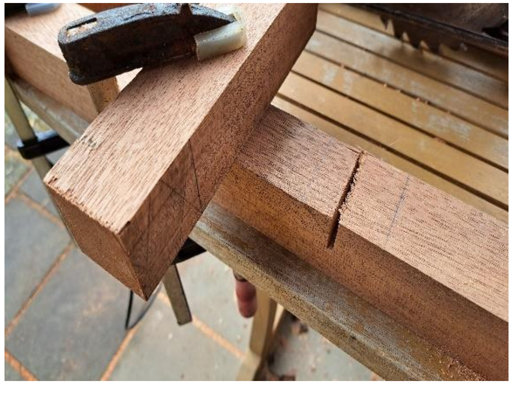
Step 8:

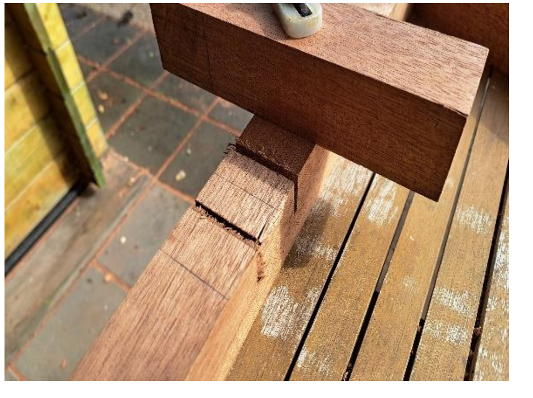
Position the circular saw (P) against the piece of scrap wood and check that the blade is still only cutting half of the thickness of the beam (45/2 = 22,5 mm).

Make the cut with the saw to get the following result:

Step 9:

Repeat step 7 & 8 on the same surface, but on the other side of Beam ❶.





Step 10:

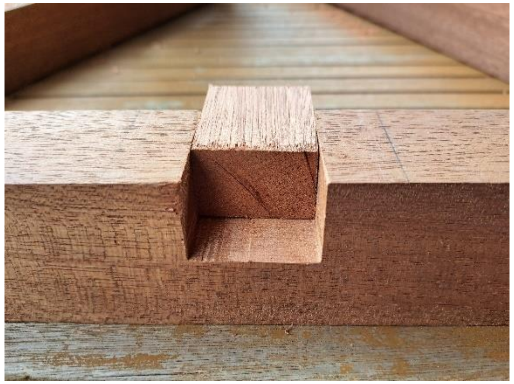
Cut away the remaining bit of wood with the circular saw (P). (See step 19 and 20 from the previous beam for a more detailed explanation)

File away any remaining pieces and rough edges with the flat file (J) to even the gap.

Step 11:

Use a piece of scrap wood, that has the same type of cut, to verify if the gap is wide and deep enough.

(This piece was used to set the circular saw to the right depth)



Step 12:

Take the base shape and Beam ❹ and place them on top of each other as follows:

Wedge Beam ❹ in the gap from step 11 and the point from step 4 in between Beams ❷ & ❸. Secure it tightly and check with the rafter square (E) if the angle between Beam ❶ and ❹ is 90°.

If everything fits nicely, turn around the project and mark the cross line from Beam ❶ on beam ❹ (see the last picture as reference).

Step 13:

Repeat step 7, 8, 9, 10 & 11 on Beam ❹. Start from the cross lines that have been set in step 12.

Step 14:

If all steps have been performed, Beam ❹ can be cut to the appropriate length of 100 cm. Use the Mitre saw (O) or the Japanese saw (F) to achieve this.

Interim result:

If all previous step have been implemented, Beam ❹ should fit precisely in the gap in Beam ❶ and in between Beams ❷ & ❸.

The result should be the following:

Again it may be possible that the hammer with rubberized headpiece (H) is needed to tightly secure the two beams by hammering the beams in place.

(It may look like the angles are not 90°, this is due to a wrong setting with the camera on the mobile phone. The angels in the most left picture are perpendicular.)

Beam 5

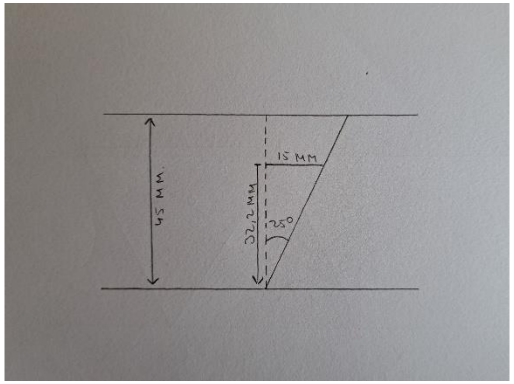
Step 1:

Use a piece of wood that is left from either one of the initial beams and make sure it is longer than 35 cm.

Measure out a distance of 23 cm on this beam. In the pictures there is a distance measured of an initial 7 cm and a total of 30 cm (23 cm difference) . This has been done to simplify measuring out the angles in the next step.

Step 2:

Draw out the following shapes with an angle of 25° on both sides of the measured distance. Make sure the angles are not parallel, but concurrent at one point.



Step 3:

With the help of the Mitre saw (O), which has been set to an angle of 25°, saw across Beam ❺. Make the same cut on the other side of the marked area on the angled line.

Keep in mind to place the saw blade on the outside of the marked area, so the marked area won’t decrease in size.

Interim result:

After making both cuts, Beam ❺ should look like this:

Step 4:

Measure out the middle of Beam ❺. Measure out the width of the beam and mark this from the middle of Beam ❺.

Step 5:

For this step up ahead, repeat all the techniques used in the following steps from Beam ❹.

Steps that need to be repeated: 7, 8, 9, 10 & 11.

After this, Beam ❺ should look like the following:

Step 6:

This step follows the same process as step 12 from Beam ❹, only this time with beam ❺.

Place Beam ❺ with the gap from step 5 on Beam ❹ and make sure that both angled endings make contact with Beams ❷ & ❸ (See the picture for reference).

Mark the cross lines on Beam ❹ where Beam ❺ intersects.

Step 7:

Repeat step 7, 8, 9, 10 & 11 from Beam ❹ again on Beam ❹, but this time on the part that has been marked in the previous step.

Make sure to verify if Beam ❺ fits in place and connects on all contact points.

Interim result:

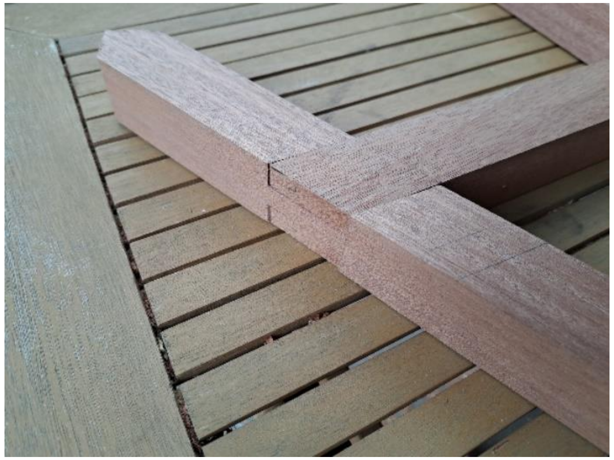
After finishing all the previous mentioned steps, Beam ❺ should fit tightly in the gap on Beam ❹ and should make contact on both sides with Beams ❷ & ❸. If Beam ❺ won't fit all the way, use the hammer with rubberized headpiece (H) and a scrap piece of wood to knock the beam in its place.

Results:

After completing Beams ❶, ❷, ❸, ❹ & ❺ the bow rack should look like this:

Detail view of all the different connections and corners



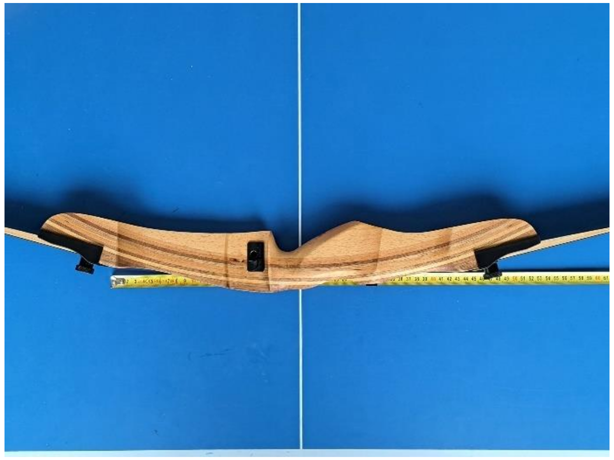

Support pieces 6

Step 1:

Take your own bow and measure out (D) the length of the outer most points of the handle on which the bow will rest.

Take note: Choose wisely on which side your bow will rest and try to find the centre of mass in the handle. For my recurve bow I found it wisely to rest the handle by having the bow aimed downwards, so to speak.

(If you have a different type of bow, try to find the best positioning and distance that works best for that type of bow. This is just an example of the bow that I own, but other options are also viable.)



As shown in the photo's the distance between the points on which the handle will rest are 44 cm apart.

Step 2:

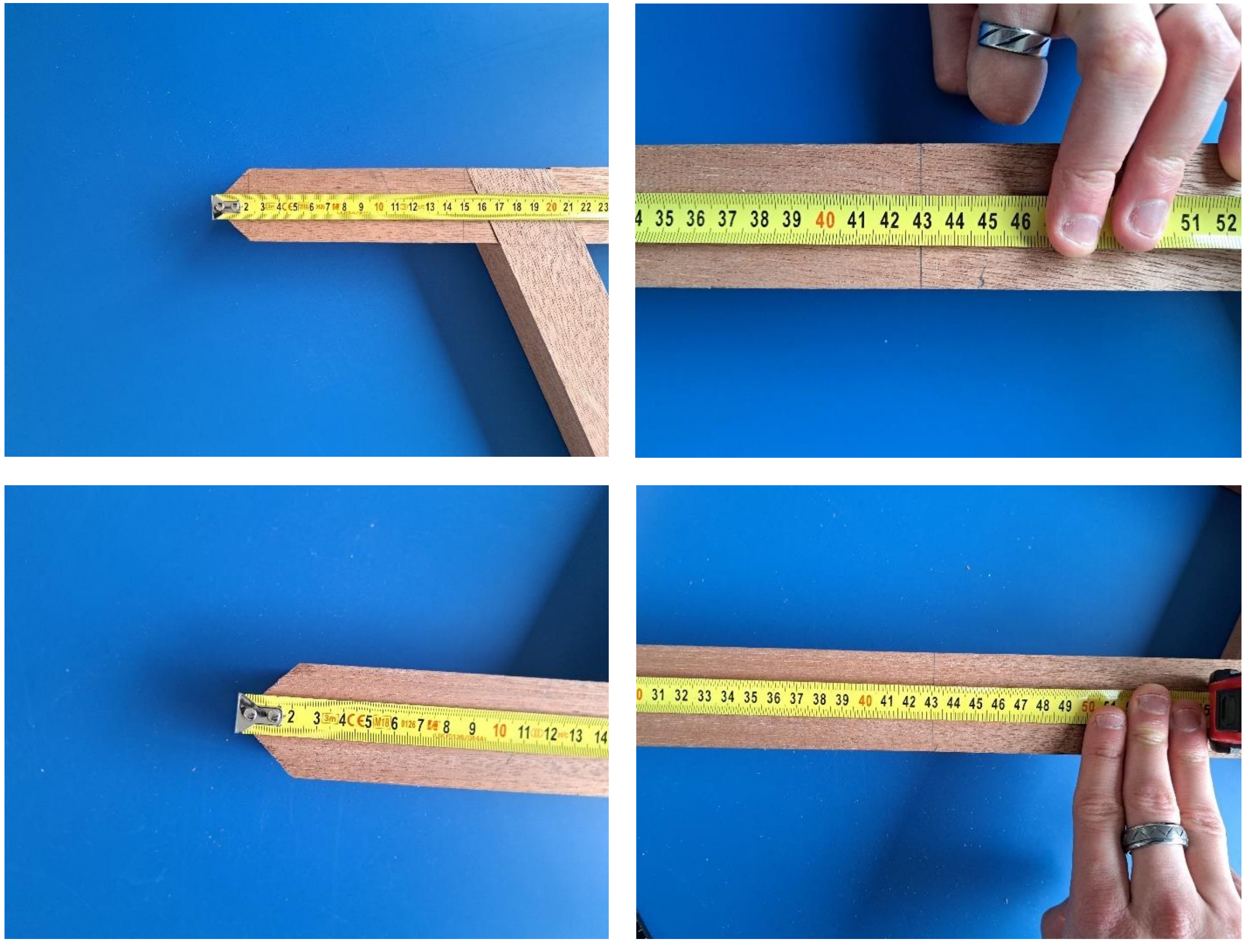
Measure out the same length from step 1 and match this on the front side of the bow rack. Make sure the measuring tape is placed perpendicular to Beam ❹ so that the middle of the bow handle is in the middle of that beam. On both Beam ❷ & Beam ❸ mark the 44 cm distance.

As shown the distance between the outer most points on which the handle will rest is 44 cm.

Step 3:

Measure out a distance of 43 cm from the pointed top of Beams ❷ & ❸ and make a perpendicular line, if done correctly, this line should end in the point which was marked in step 2. Verify if this is also the case on the other beam.

If this is the case, you can proceed to the next step.



Step 4:

Use some undamaged leftover wood and draw the following dimensions.

Step 5:

With the Mitre saw (O) set at an angle of 25°, cut out this angled block. The support blocks should look like a equilateral diamond, so all the sides have the same length.

Again make sure to cut outside of the marked line, so the dimensions of in between the lines stays unaffected.

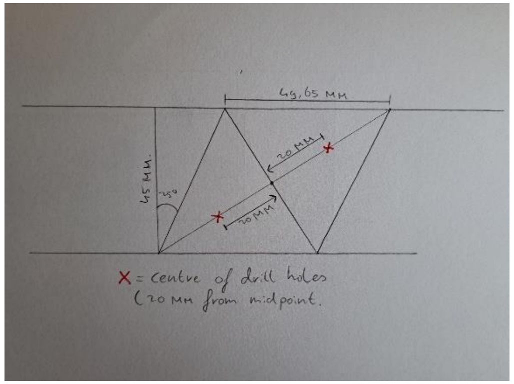
Step 6:

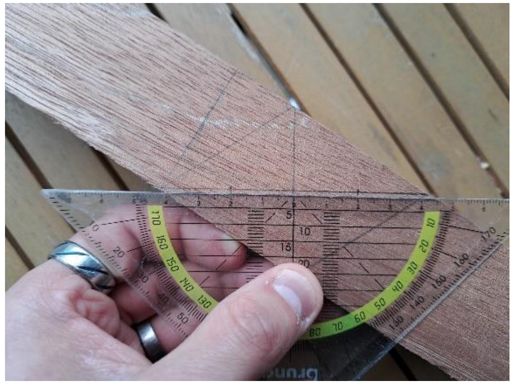
Draw the same dimensions on both sides on Beams ❷ & ❸. The front side will be used as guidelines in which the support block from step 5 will be placed. The backside will be used to drill holes through Beams ❷ & ❸ and partially in to the support blocks.

Step 7:

Draw the diagonal lines from each corner to corner to find the middle of the equilateral diamond. From the midpoint measure out 20 mm on the longest diagonal line and mark those points.

These point will be the centre of the drill holes.





Step 8:

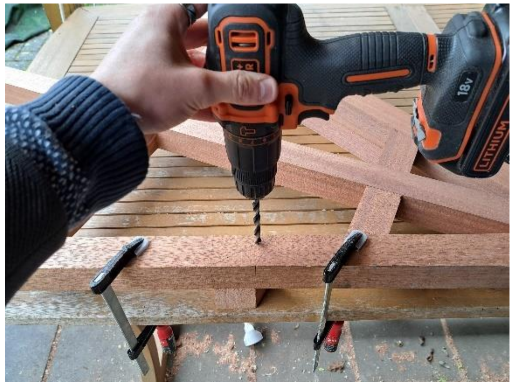
Position the support block underneath the bow rack and make sure it is positioned in the marked area from step 6.

Secure the bow rack tightly to the workmate/table with the Bessey bar clamps (L) as shown in the picture.

Step 9:

Place the drill with the wooden drill bit (8 mm diameter, R) on one of the marked points.

Drill through the beam from the bow rack and partially drill into the support block. This will create a hidden opening for a dowel to connect the support block to the bow rack.



Step 10:

Saw of a piece of the dowel with the Japanese saw (F) and with the help of wood glue (M), secure the bow rack and the support block to each other.

Step 11:

Repeat step 9 & 10 on the other marked point from step 7.

Step 12:

Repeat steps 6, 7, 8, 9, 10 & 11 on the other beam from the bow rack.

Step 13:

If both support pieces are secured with dowels to Beams ❷ & ❸, flip the bow rack and make sure all support pieces are clamped with the Bessey bar clamps (L). This fastens the drying process of the wood glue.

Test to see if the handle of the bow rests on the support blocks, it should lay flat on both support blocks.

Step 14:

When the glue has finished drying, the excess bits of dowel can be removed.

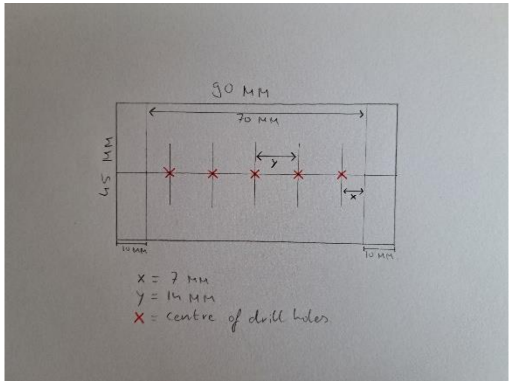
With the Japanese Saw (F) carefully saw away the excess pieces of dowels form the previous steps. Also saw away the excess pieces from the connection of Beam ❷ & ❸.

Tip: Try to saw very softly and don’t push the sawblade down. This will otherwise leave damages in the bow rack, which is unwelcome.

Result:

After sawing away the excess pieces the bow rack should look like this:

Holes for the arrows



Step 1:

Firstly determine how many arrows are set to be displayed. For this project 10 arrows were chosen to be displayed.

Secondly measure the thickest part of the arrow, in this case this was the arrow head, which had a diameter of 6,8 mm.

Remove Beams ❹ & ❺ from the bow rack. It is not necessary to reconnect them, but in this example they were connected again.

On the top of Beam ❺ the space between Beam ❷/❸ & Beam❹ was measured. This was approximately 90 mm. From both ends 10 mm was left alone and the other 7 cm was used to space out the holes for the arrow tips. Draw a centre line on the top side of Beam ❺ and measure out the 70 mm with the 10 mm spare on both sides. Use this for the next dimensions.

70 mm / 5 arrows = 14 mm between each arrow. Starting from the 10 mm spacing, add the half of the measured spacing (14 / 2 = 7 mm). This will be the starting point from where the arrows will be evenly divided. Mark the 5 evenly spaced distances for the drill holes.

Step 2:

With the drill bit (R), measure out approximately 1 cm from the tip of the drill bit. With the help of some tape, tape of the rest of the drill bit. The tape enables the drill bit to only drill to a depth that was measured out with the tape. This will ensure that all the holes in Beam ❺ have the same depth.

Step 3:

Drill out 5 holes with a depth of 10 mm using the drill and taped off drill bit (R).

Beam ❺ should look like this afterwards:

Step 4:

Repeat step 1, 2 & 3 on the other side of Beam ❺.

After this, the tape can be removed from the drill bit.

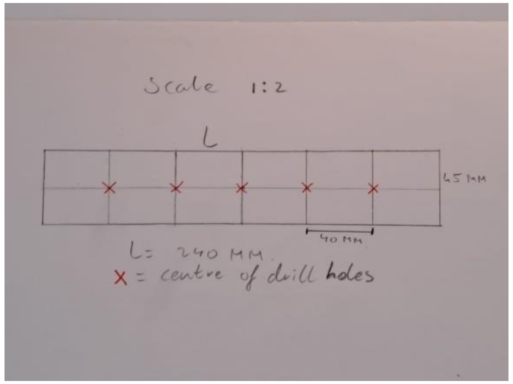
When finished, assemble the rack back together for the following step.

Step 5:

On the bottom side of Beam ❶, draw out the following 5 points.

These point are measured out as follows: The bottom side of Beam ❶ (between Beam ❹ and Beam ❷ or ❸) is 240 mm wide. Divide 240 by 6 to give 5 equal spaced out lines across the beam.

240 / 6 = 40 mm. So starting from one side of the beam, draw out 5 lines that are 40 mm apart from each other (See the drawing for help).



Step 6:

For this step, use a large ruler of a left over beam to help you draw the required lines (in this the latter was used).

Position the ruler on the first point (the points for the drill holes) on Beam ❺. Position the other end of the ruler on the first point on Beam ❶ from step 5. Draw a line across Beam ❶ parallel to the ruler. This creates an angled line on the surface of Beam ❶. This line represent the direction in which the holes will be drilled.

Step 7:

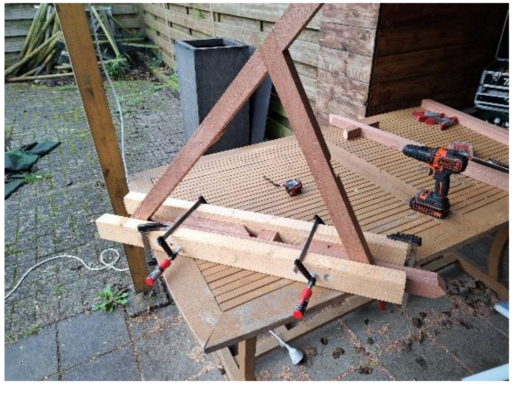
With the rafter square draw a line on the top side of Beam ❶ from each line from step 6.

On each line mark the centre point with an X.

Step 8:

Take out Beams ❹ & ❺ from the bow rack. Position the remaining rack as follow:

Make sure the rack is secured to the workmate/table (S) with the help of the Bessey bar clamps (L)



Step 9:

Position the protractor triangle (B) parallel to the marked lines on the surface of Beam ❶ (step 6) and secure it with a Bessey bar clamp (L).

Step 10:

Position the drill bit on one of the marked X from step 7 (top surface of Beam ❶) and align the drill bit with the protractor triangle from step 9. Drill a hole about ¾ through the beam whilst making sure the drill goes straight through the beam, but follows the line projected by the protractor triangle.

The holes for the arrow will be drilled entirely through the beams, but this will be done by drilling on both sides of the beam. This prevents damages to the bow rack that may form when drilling only from one side. These types of damages can occur: splitting, splinter, chipping or any other kind of damages. After removing these damages, it may leave imperfections on the wood which will always be visible. This is something that is unwanted for any kind of furniture/object displaying any item.

Step 11:

Repeat step 9 & 10 on all the 5 marked X from step 7 to get the following result:

Step 12:

When all the holes are drilled for ¾ of the depth of the beam, position the rack like the following:

Again make sure the piece is secured tightly with the help of the Bessey bar clamps (L).

Step 13:

Position the protractor triangle again alongside the marked lines from step 6. Also, secure it tightly again with the Bessey bar clamps (L).

Step 14:

Position the drill bit on the marked X and align it alongside the protractor triangle.

Start drilling and again make sure to drill straight and parallel to the protractor triangle.

Keep drilling until you've reached the already drilled hole from step 10 & 11.

If done accurately, the two holes should align and form one single hole through the beam.

Step 15:

Repeat step 13 & 14 on the other marked X spots to get the following result:

Step 16:

To make sure if all the holes are drilled straight, first try to fit an arrow through each hole. If the holes are straight, the arrow should go through smoothly.

Step 17:

To see if all the holes have the right angle, assemble the rack back together first by putting Beams ❹ & ❺ back in its places.

Put 5 arrows through each individual hole on one side of the bow rack and place the arrow tips in the holes in Beam ❺ (step 3 & 4).

The bow rack should look like the following, when 5 arrows are placed on one side of the bow rack.

Step 18:

Repeat step 5 up to step 17 on the other side of Beam ❶.

After this, your bow rack should look like the following:

As shown in the picture, 10 arrows are spread evenly across Beam ❶ and rest in the holes drilled in Beam ❺.

Fine adjustments

In the case that some parts, surfaces or joints don't align correctly, it may be advisable to secure the beams with the help of a dowel.

In the case with this project, the entrapment of Beam ❹ between Beams ❷ & ❸ was not firm and strong enough. There was space between the beams, so there was margin and movement in the connection. To prevent this remaining margin and movement, Beam ❹ was secured with a dowel. This was placed through Beam ❸ and ends in Beam ❹.

The following steps briefly explain how this dowel was placed. ***(For a more detailed instruction on how to place a dowel, see step 9 up to 14 from "Support blocks")***

Step 1:

Secure the bow rack to the workmate/table. Also secure Beam ❹ with bessey bar clamps to Beams ❷ & ❸ to keep it in its right place.

Step 2:

Determine the middle of one of the angled corners from Beam ❹ (the tapered tip) and mark this. With the help of the rafter square (E) draw a line form the marked point across the front surface of Beam ❸.

Step 3:

After this draw a second line from on the side surface of Beam ❸ from the previous line, again use the rafter square. On this line, mark the centre point which will be the centre of the drill hole.

Step 4:

Determine the depth of the dowel hole with the drill bit by placing it on front surface alongside the marked line from step 2.

Step 5:

Drill a hole through Beam ❸ and into Beam ❹. Drill until it has reached the depth determined in step 4.

Step 6:

Saw of a piece of the dowel wood and after applying some wood glue, push it into the hole from step 5.

Leave everything in place until the glue has completely dried off. When the glue is dry, saw off the excess piece of dowel with the Japanese saw (F).

The final result should be the following:

Sanding

When all the beams, connections, holes and adjustments are made, the bow rack is almost complete.

Before the bow rack can be oiled, the surface has to be sanded. This will be done to give the surface a smooth finish. In addition, any unevenness remaining on the beams will also be removed by sanding. These unevenness's can be slight damages, dents or scratches which may occur when using all the different tools when making the bow rack. They can also be some unevenness between the different beams, as there might be a slight misalignment between two or more beams.

To remove all of the above mentioned imperfections, sanding the surfaces is the best option. To do this, one can choose to do this by hand or using a power tool. Sanding by hand takes quite some time, while an power tools simplifies the process and will take less time.

For this project a cordless sander was used (See picture for an example), a sander with cord can also be used. Apply any electric sander that is available.

The sander was equipped with two grains of sanding paper. These 80 grit and 240 grit.

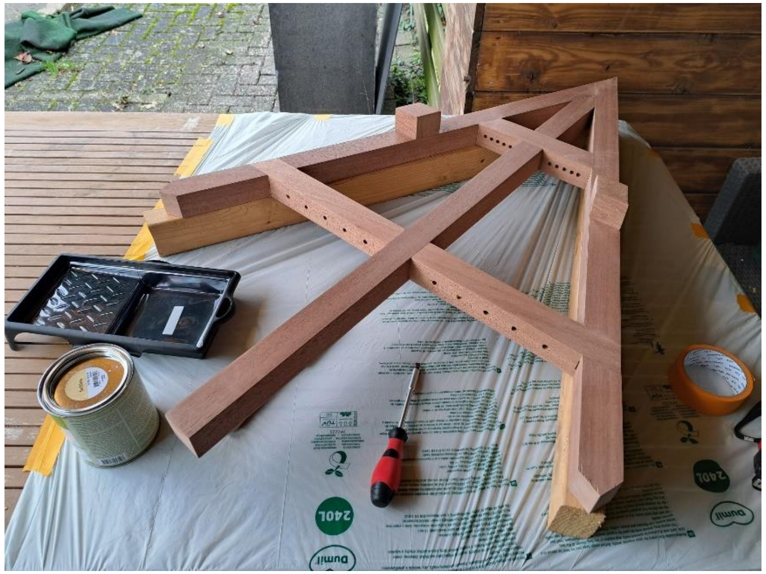
The 80 grit sandpaper was used to remove the more extreme imperfections, such as the unevenness between the different beams. The 240 grit sandpaper was used for a finer finish on the surface.

Determine which surfaces need to be sanded and take time to sand each surface, don't rush it. Sand the surfaces by hand which are difficult and/or impossible to reach with the electric sander.

It is also possible to use any type of grit that one has available and/or prefers, the smoothness of the surfaces is completely free to determine.

During and after sanding make sure to remove the excess dust. This can pile up on the surfaces until a point the surface feels smooth, but still isn't. To ensure each surface is of the predestined smoothness, remove the excess dust during the process.

At the end of the sanding process in this example, the bow rack looked like the pictures on the next page:



Oiling

After the sanding process, it is time to apply the final touches. After this step, the building process of the bow rack is complete.

The final step involves applying wood oil to the project.

Wood oiling enhances the natural colour of the wood. A transparent oil is often used, which better accentuates the warm colour of the wood. Furthermore, the oil protects the wood from humidity, wear and dirt. In addition, its purpose is to make wood last as long as possible.

The following product are important for applying wood oil: the oil, brushes, paint tray, cotton cloth and a tarpaulin.

During this project, a universal transparent hardwood oil was chosen. The choice of oil is completely free and depends on what kind of wood is used, the colour of the wood and the personal preference.

For this project, the table was initially covered with a tarpaulin to prevent leaking oil from getting onto the table. It is also wisely to oil outside in a dry environment, where the product can properly dry afterwards.

Open the oilcan and mix the contents well, making sure that the contents remain well mixed even during the application. The pour some of the oil into a paint tray, where one can easily absorb the oil with a brush and then apply it to the wood.

After the table has been covered, the oil has been mixed well and is has been poured over into the paint tray, a layer of oil is applied over the chosen surfaces with the paintbrushes. After the layer of oil was applied, the project was left to dry for at least 24 hours (recommended by the instructions on the oil can). Here, one can choose to apply another layer of oil on the wood if deemed necessary. In this project one layer of oil coated the wood completely and gave the wood the desired finished look.

For this project, the choice was made to oil only the visible surfaces. This includes the front and both the sides (also the top and bottom for some beams), the back side is not oiled as this will be installed inside against a wall and is less in contact with moisture and dirt. Here, of course, one can also choose to oil all the surfaces, again this choice is completely free.

Tips: Use a piece of scrap wood to test how much oil is needed to coat the entire surface and give the piece of wood the desired look. Also, make sure to read the instructions on the oil can, these may vary per type of oil.

See the following picture for a clear difference in colour before and after oiling:

Before oiling: wood has a more greyish and dull colour, the grain is slightly visible and not very distinguishable.

After oiling: The wood has a warmer, darker red colour. The grain is also more visible and vibrant.

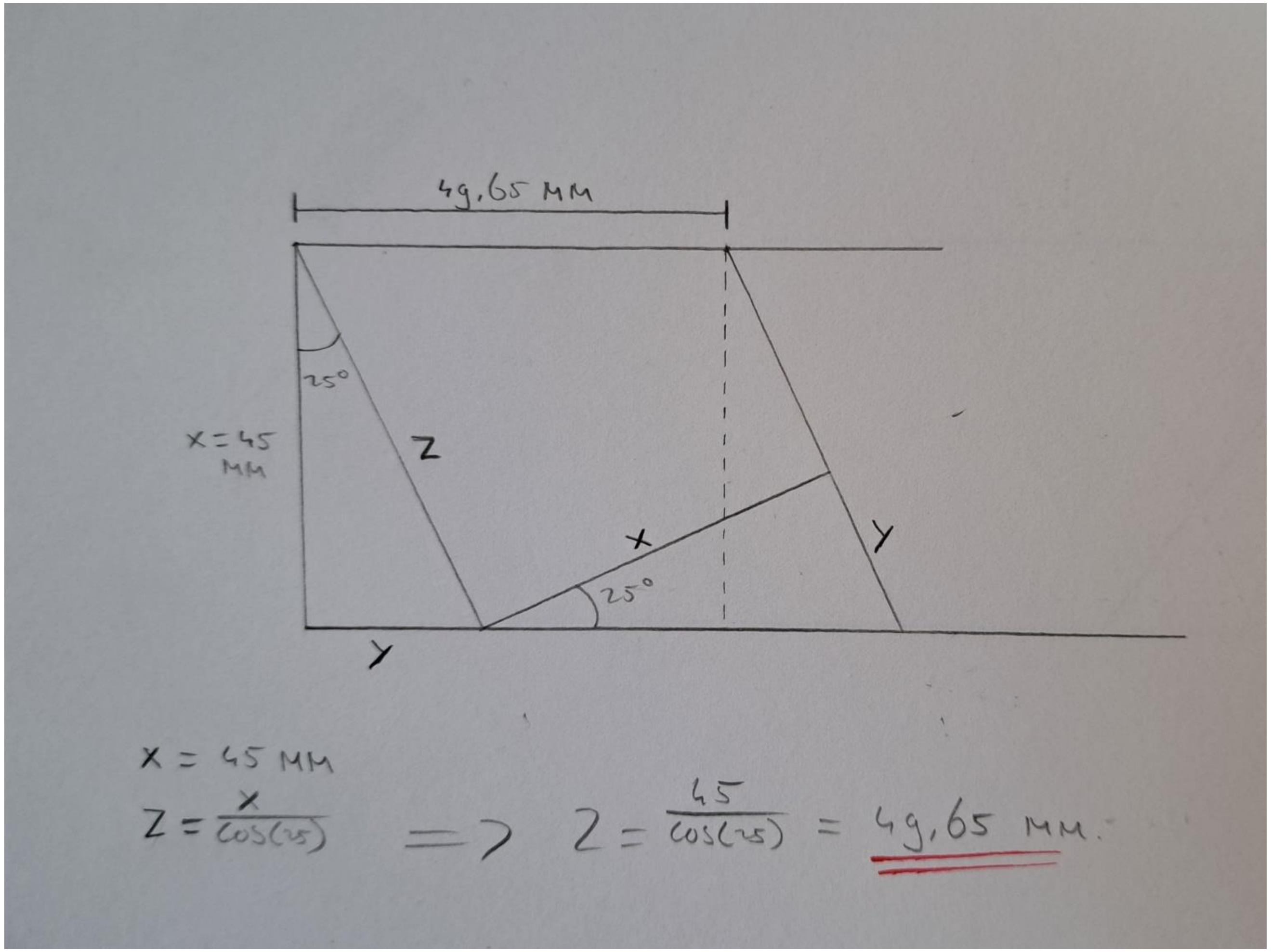
Final Product

Appendix I

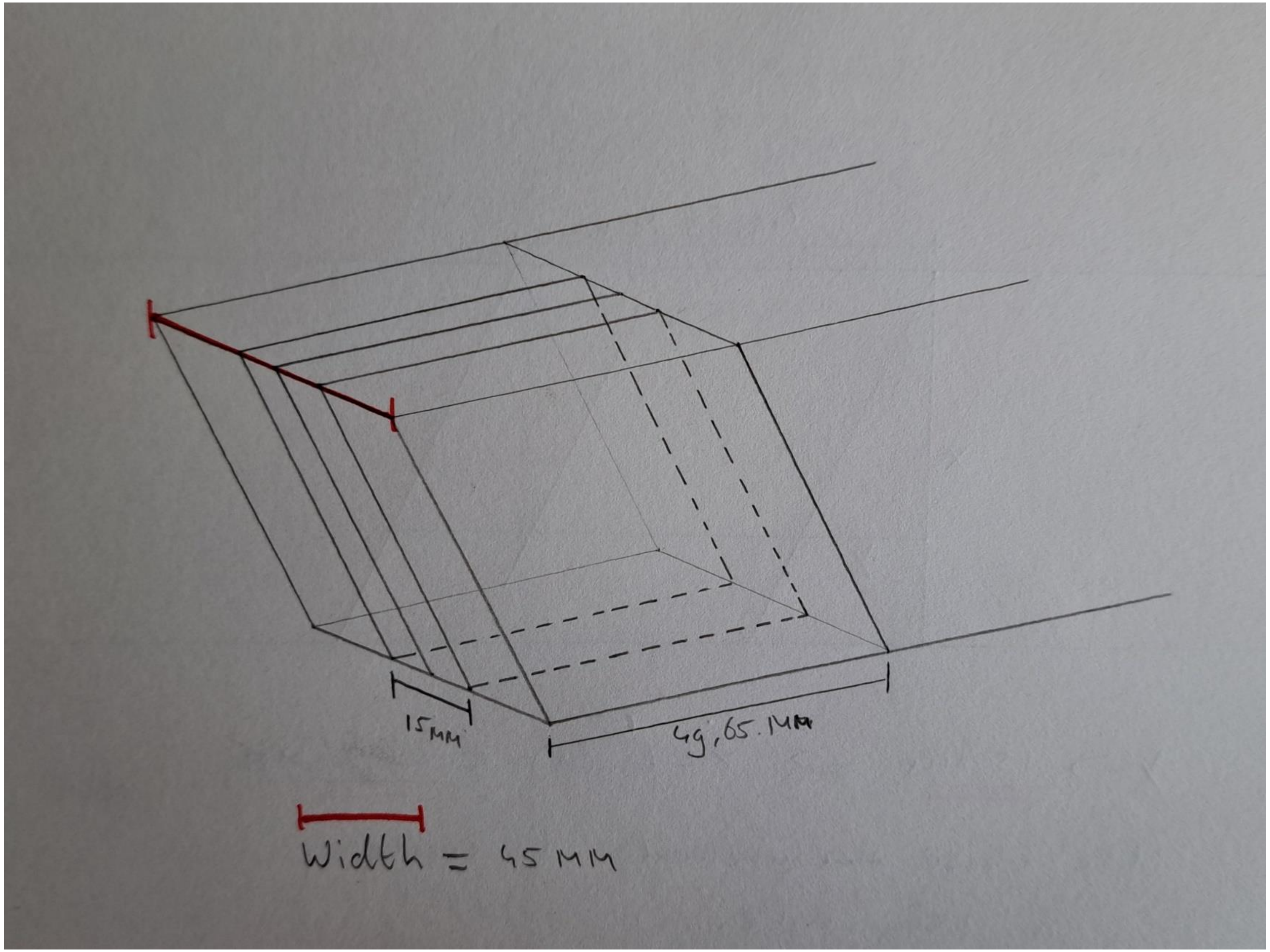
Calculations and measurements:

The following pictures show the different kind of angles, measurements and calculations that have been used during the entire building process. (all sketches are made on a scale of 1:1, except for the last sketch)

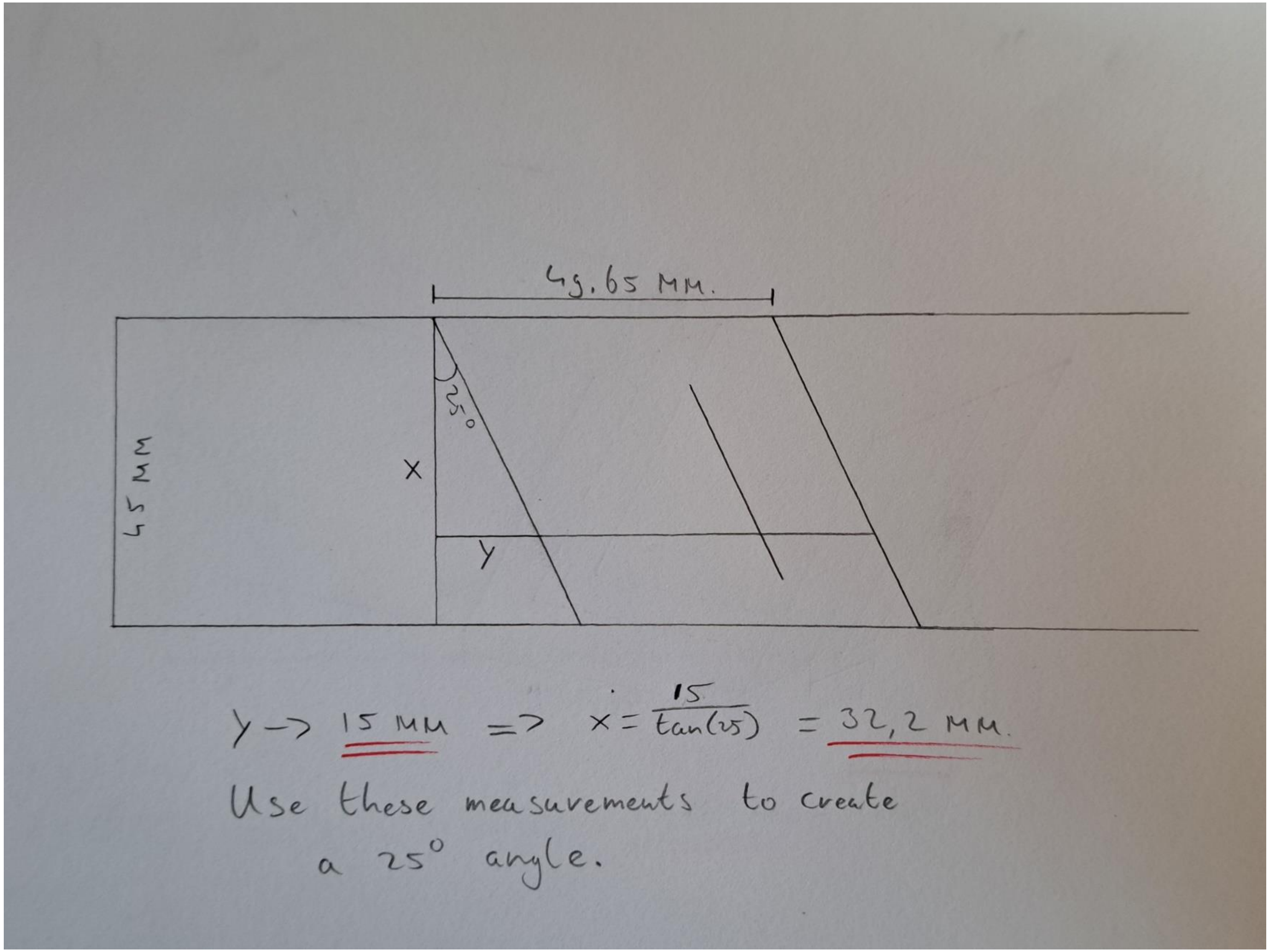
A: Calculations of angles



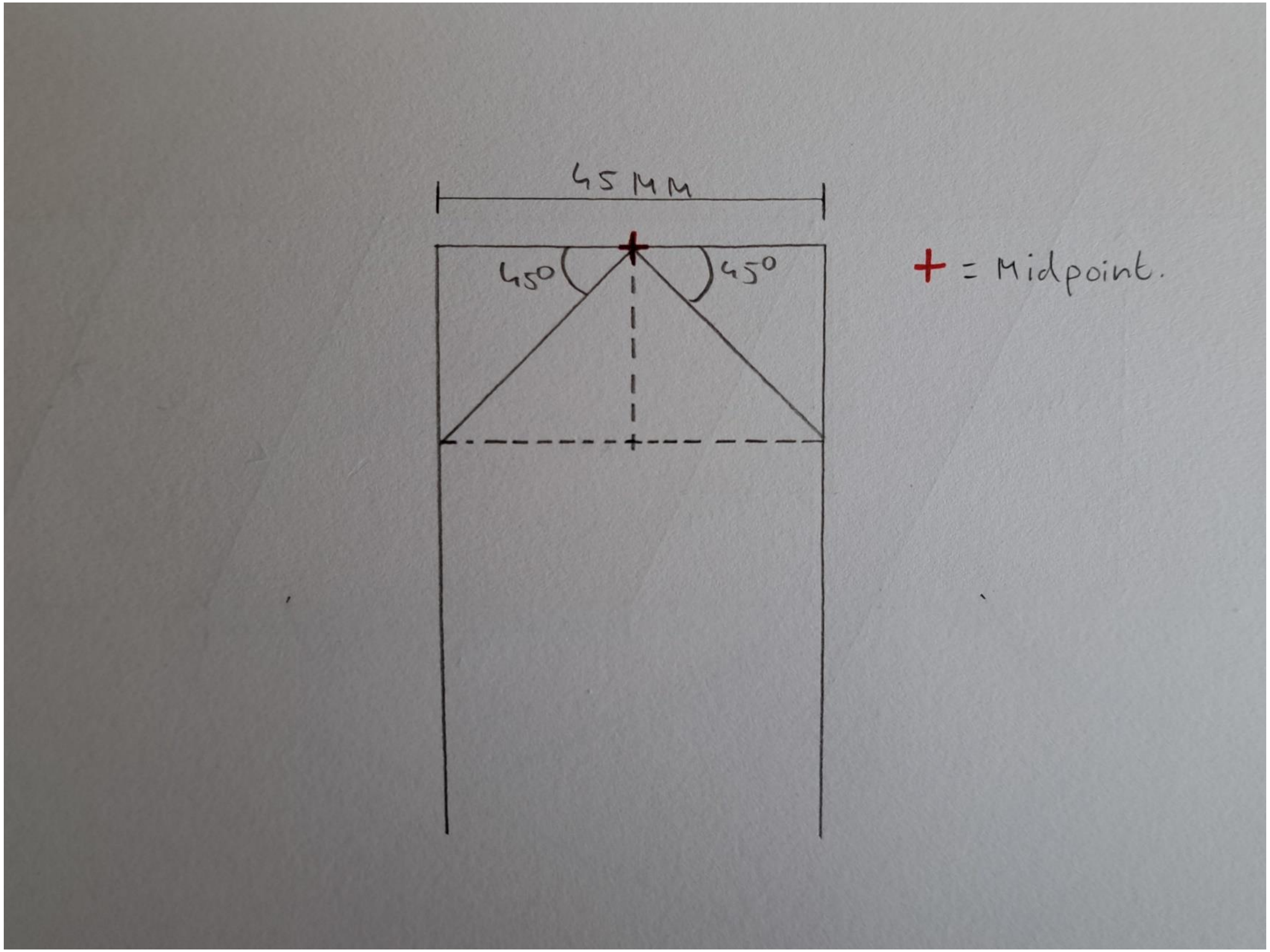
B: 3D view before sawing the centre of the beam



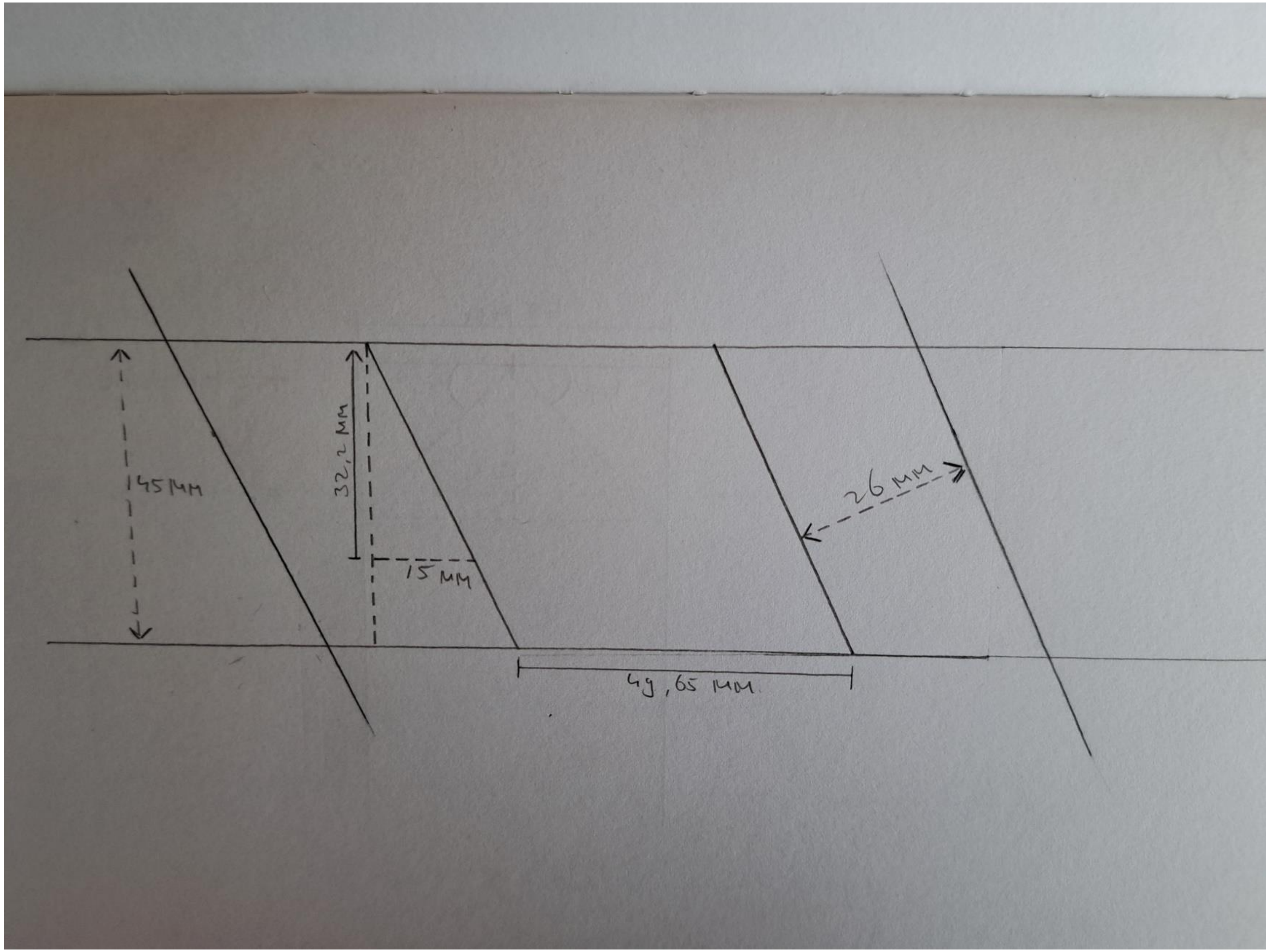
C: Calculations and sketch of the various angles.



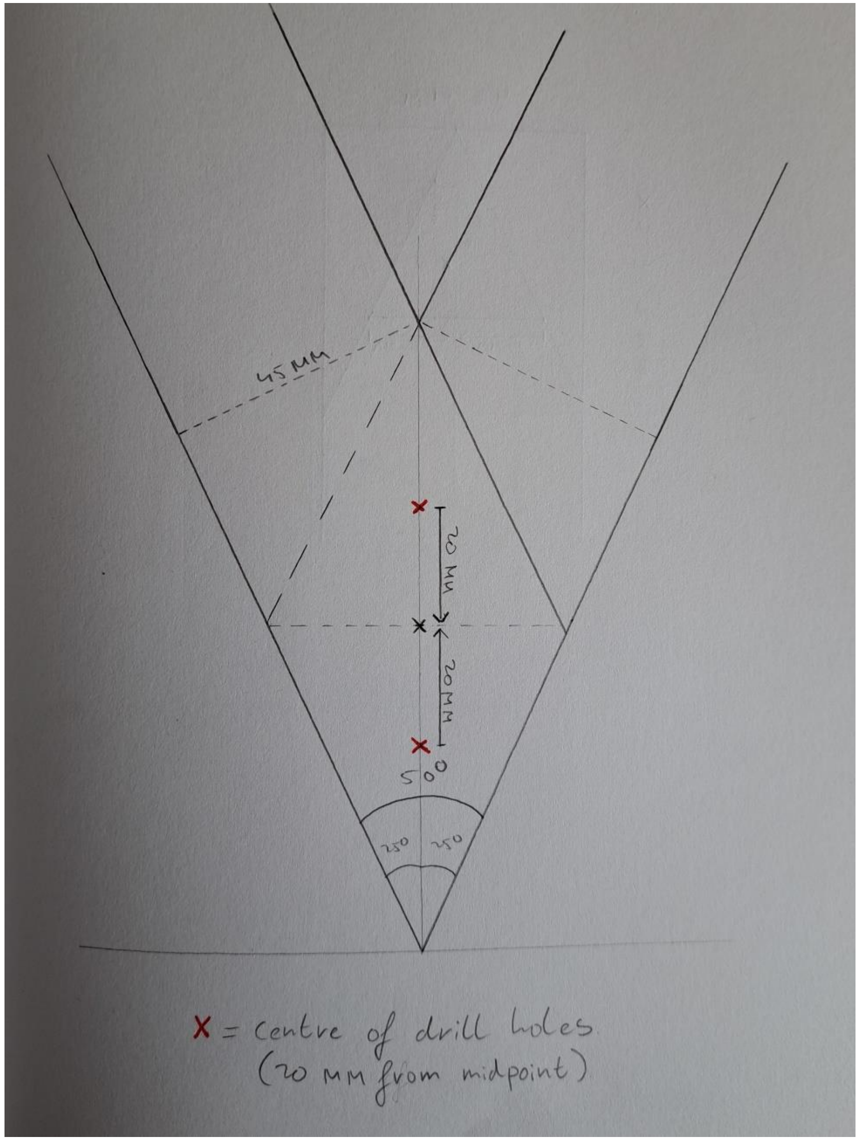
D: Sketch of the corner to be sawn off



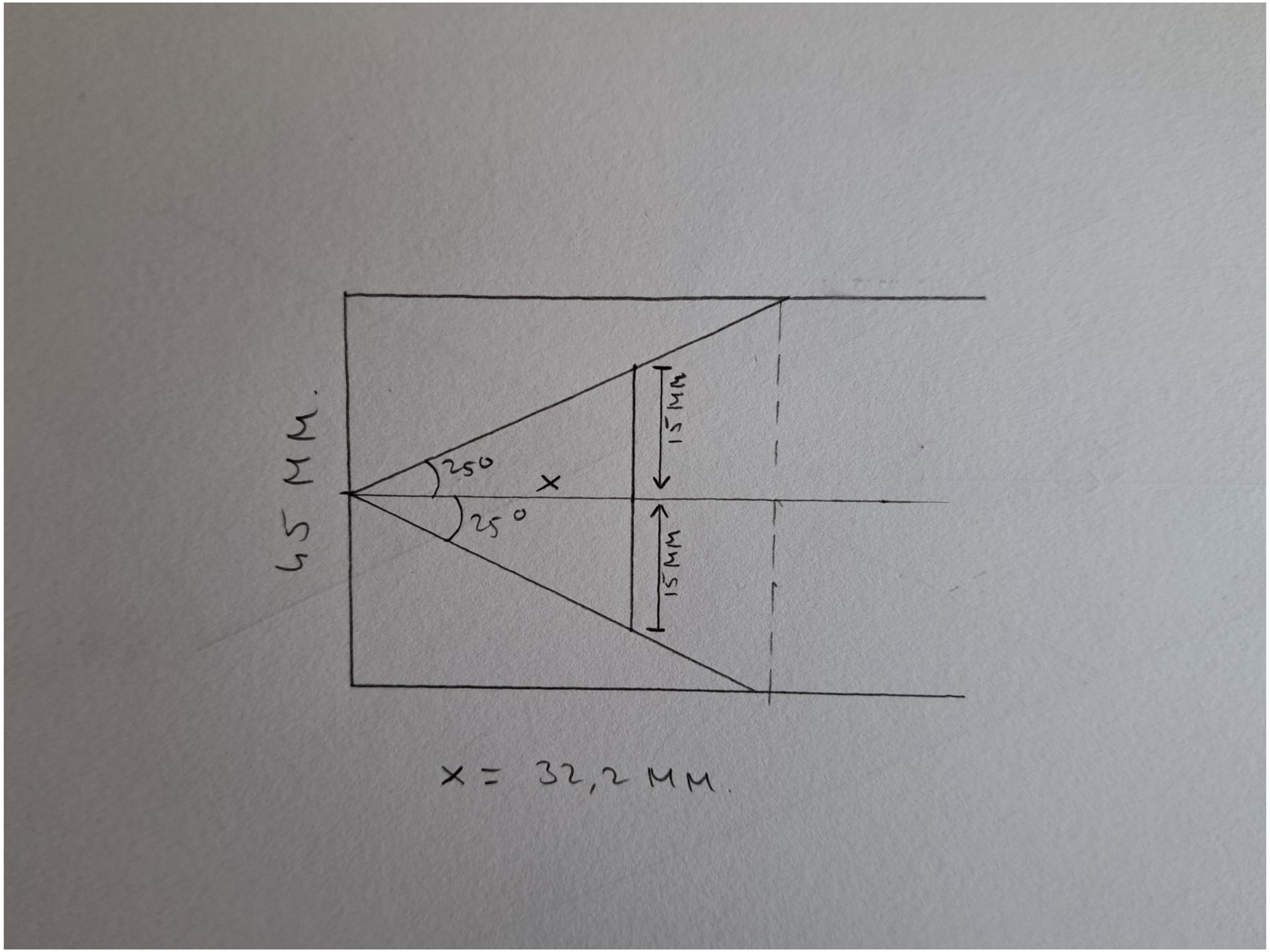
E: Sketch of the guidelines used for sawing and routing



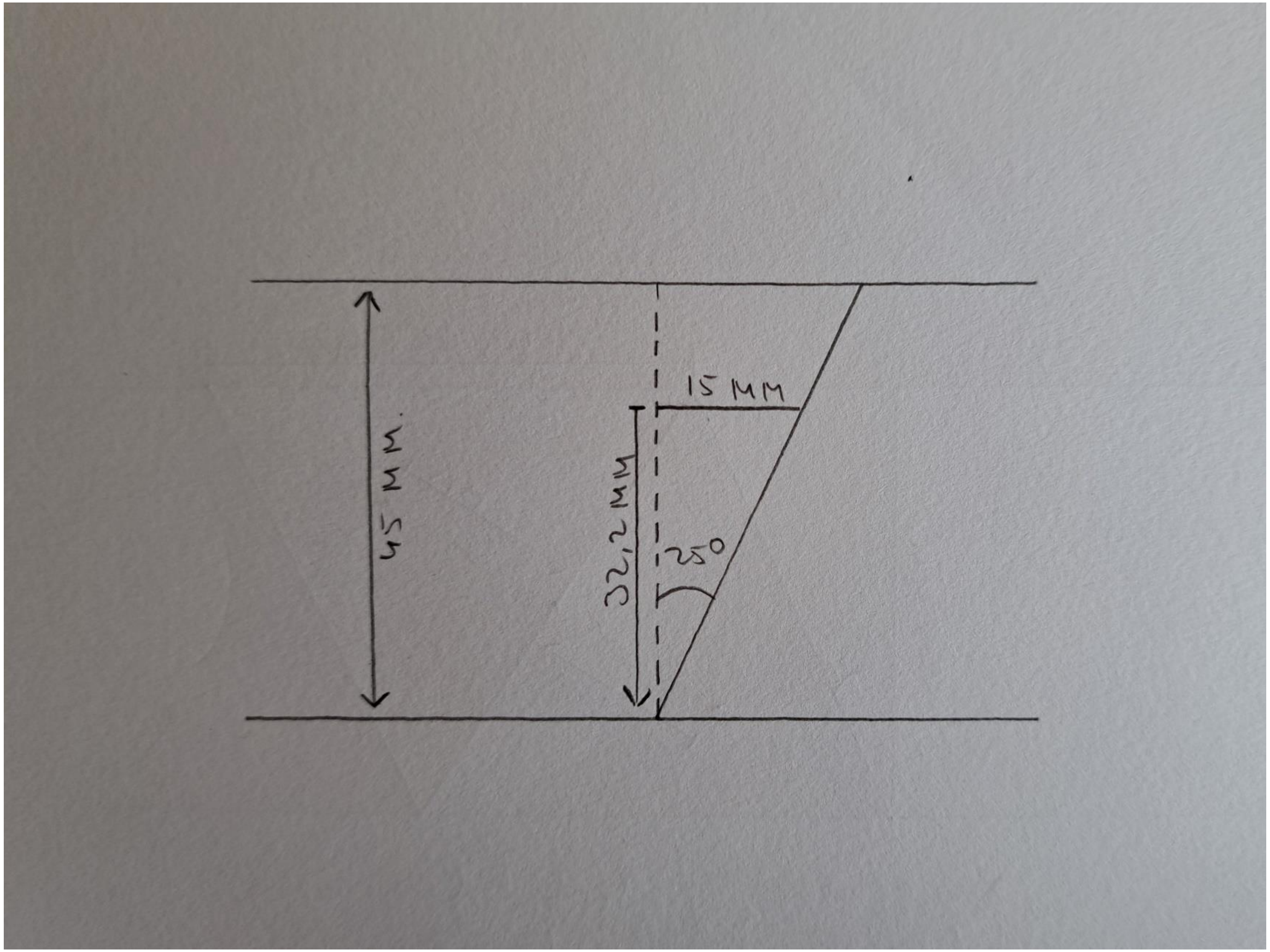
F: Sketch of the position of the dowels in the lower joint



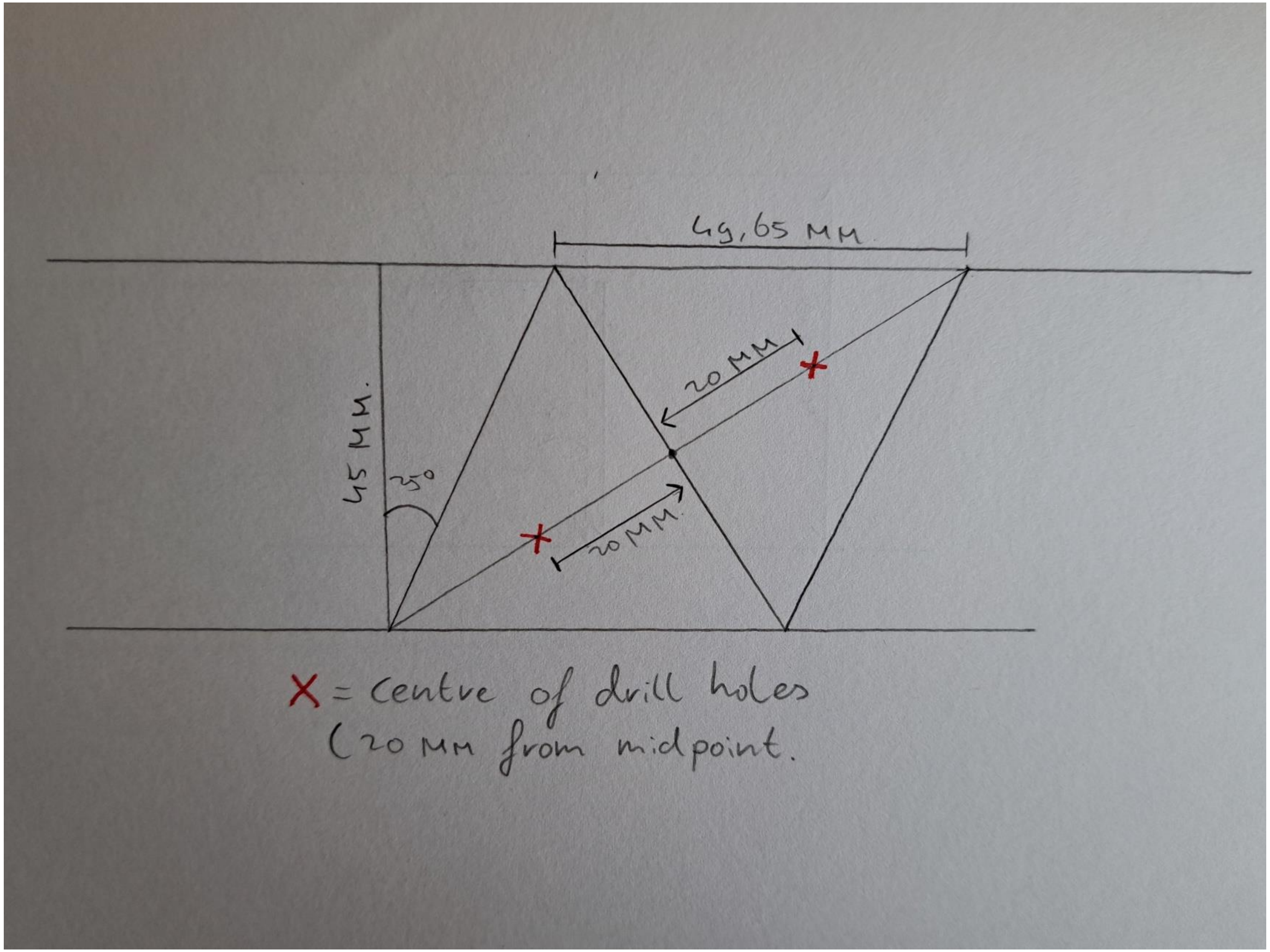
G: Sketch of the corner to be sawn off



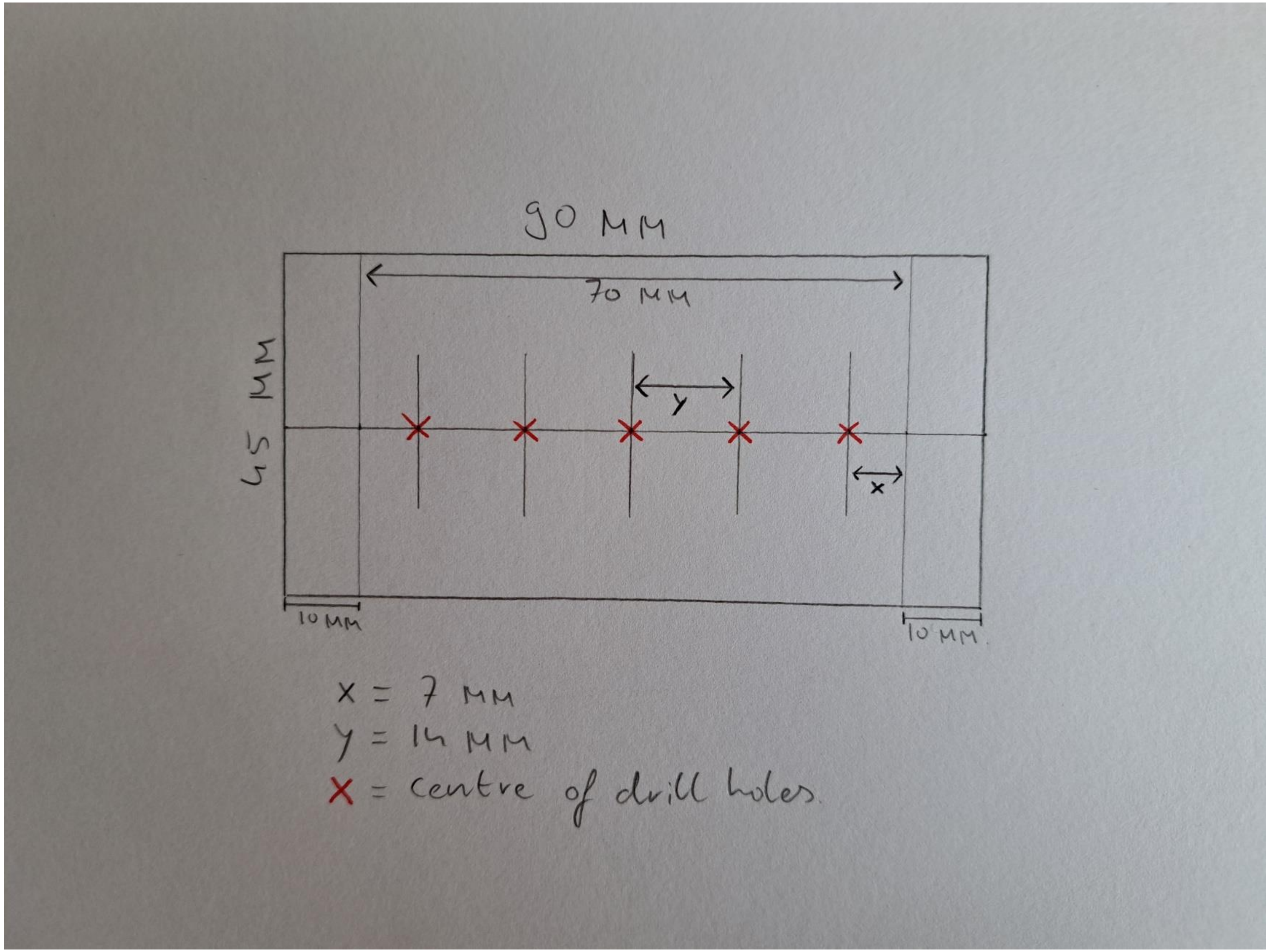
H: Measurements to determine the 25° angle



I: Measurement for drawing out the dowel holes for the support blocks



J: Distribution of arrow holes Beam ❺



K: Distribution of arrow holes Beam ❹