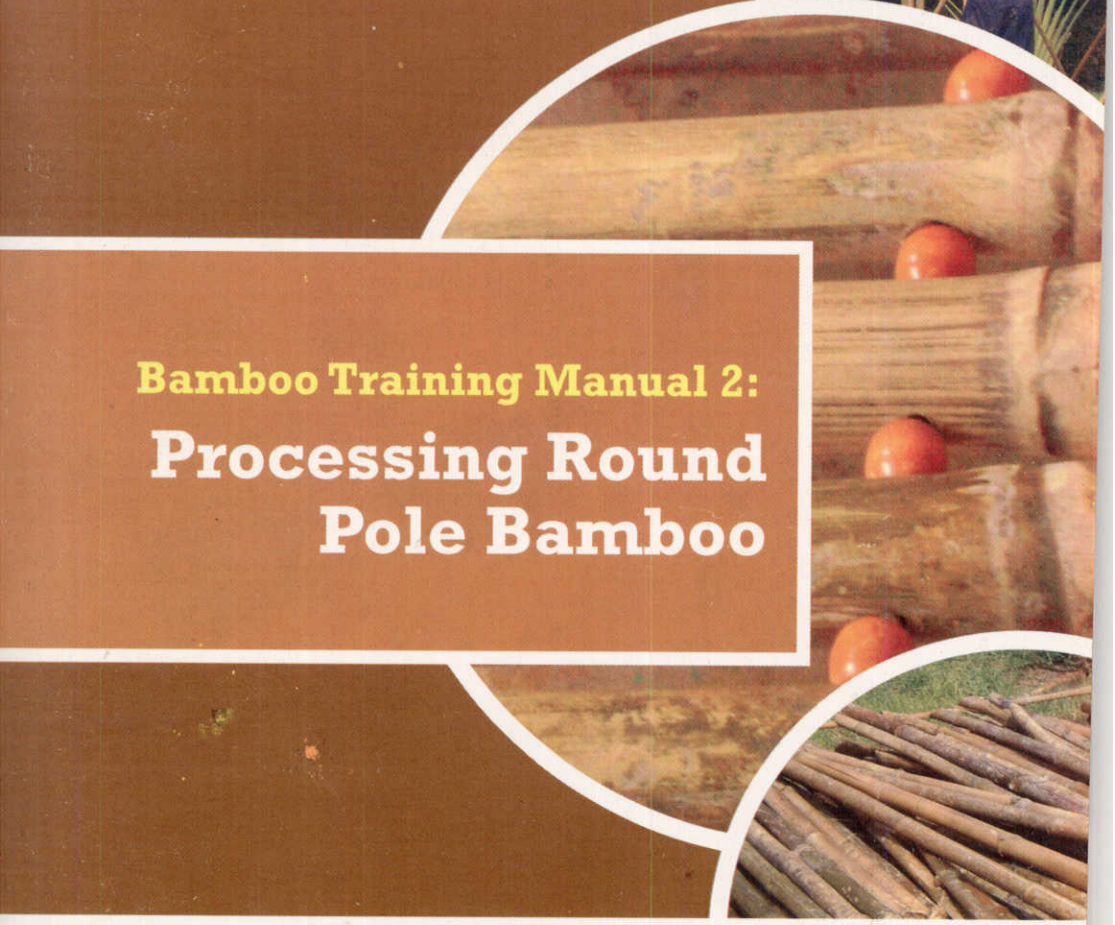
BamCraft – Crafting a Green Future: Bamboo in the curio and souvenir industry of Kenya



Bamboo Training Manual 2:

Processing Round Pole Bamboo

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Introduction

Bamboo is a natural and renewable resource capable of rapid growth. Its use a timber substitute can help reduce pressure on forests and contribute to preserving precious tropical rainforests. Bamboo is a material that carpenters and builders find easy to cut without sophisticated tools or equipment. To communities with minimal resources, it provides a source of income and is a low cost solution for making a wide range of products, including furniture and housing.

Bamboo's circular form and hollow sections make it a light building material, which is easy to handle, transport and store. In each of its nodes, the bamboo culm has a dividing wall that maintains strength and prevents rupturing when bent. Because of this inherent characteristic, bamboo structures are highly resilient to mechanical stress.

This booklet is the second in a series of training manuals prepared as part of the BamCraft project in Kenya. It is intended for those interested in making use of bamboo as a wood substitute for building products and structures.

By focusing on a few examples, this manual provides a basic introduction to round pole bamboo carpentry. It is hoped that the examples will encourage the reader to work with bamboo and develop skills to become a full-fledged bamboo artisan.

Getting Started

Before starting any carpentry project, prepare a cut list detailing the name and function of each part, the size and dimensions of each piece, and the number of pieces required.

Always check the quality of the bamboo and make sure that it is preserved, dry, and devoid of cracks.

Bear in mind that bamboo culms do not have an equal diameter throughout their length. The thickness of the culm walls also varies throughout the length of the culm. Carefully inspect the pieces of bamboo to be used to ensure that they meet the requirements of the product.

In order to make long lasting products or structures it is necessary to subject bamboo to a preservation treatment and slow drying process. Unless properly selected, preserved and dried, the durability of bamboo will be very limited.

If bamboo is not preserved there is a high risk that it will be attacked by borers. It is also important to remember that bamboo shrinks when it dries. If it dries too quickly it will crack.

A simple method of bamboo preservation using 5% Borax solution is recommended in ***Bamboo Training manual 1: Bamboo Harvesting and Preservation.*** The reader is strongly advised to master the technique of preserving bamboo, or at least to work with well-preserved bamboo before engaging in carpentry project.

Dowel Making

Tools & Materials:

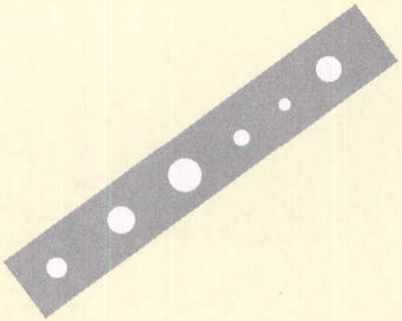
- Mallet or hammer
- Star splitter
- Metal bar
- Scrapping Knife
- Metal Template

Dowels:

- A dowel is a solid cylindrical rod that is used in carpentry for structural reinforcement in making cabinets, furniture or other timber products. Dowels are often cut into short lengths called dowel pins. Dowels are usually made of wood, but can also be made of bamboo.
- Finely crafted bamboo furniture or structures require the use of dowels to secure two sections together with precise alignment in a dowel joint.
- For crafting bamboo products that involve joinery, it is essential to use bamboo dowels rather than iron nails. It is important to keep in mind that bamboo can easily crack or split when a nail is driven into it. For this reason, the use of bamboo dowel pins is absolutely necessary.
- Using a bamboo dowel requires boring holes in 2 bamboo sections that are to be joined. The drilled holes should have the same diameter as the dowel pin. The sections should then be aligned and the dowel pin is inserted into the holes using a mallet.

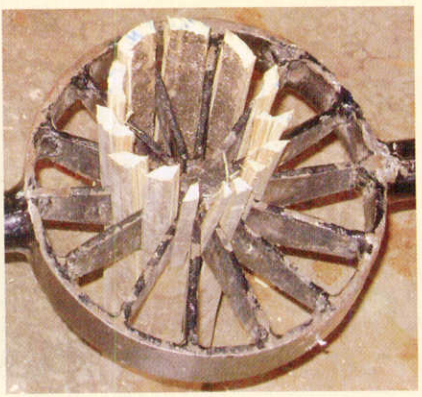
STEP 1

- Prepare a template for shaping dowels of different diameters using a strong metal plate with dimensions of 20cm long x 6cm wide x 0.8cm thick.
- To do this, drill holes of different diameters into the metal plate.



STEP 2

- Select a well dried bamboo culm section and cut it to the length of the required dowel.
- Place the star splitter on top and hammer it towards the ground.



STEP 3

- Split the bamboo into several pieces.

Note:

You may also split the bamboo using a knife.

STEP 4

- Sharpen one end of each piece to facilitate driving them through the metal template.

STEP 5

- Use a mallet to drive the bamboo sticks through a hole (with the required diameter) of the template.
- This will produce dowels of the required size.

STEP 6

- The dowels are ready for use.

Bamboo Hammock

Tools & Materials:

- Hack saw
- Hand drill
- File
- 4mm Nylon rope
- Candle
- Beads
- Match-box

STEP 1

Prepare a cut list with the following details:

- Name/ function of each piece.
- Size and unit of each piece.
- Quantity of material to be used in each piece.

Cut-list For Hammock

50 Hammock segments are required. Diameter of each segment is about 3 cm and lengths range from 30-60 cm. Lengths indicated below are approximations.

	Function	Material	Diameter (cm)	Length (cm)	Quantity
1.	Hammock segment	Bamboo	3	30.00	2
2.	" "	" "	3	31.25	2
3.	" "	" "	3	32.50	2
4.	" "	" "	3	33.75	2
5.	" "	" "	3	35.00	2
6.	" "	" "	3	36.25	2
7.	" "	" "	3	37.50	2
8	" "	" "	3	38.75	2
9	" "	" "	3	40.00	2
10	" "	" "	3	41.25	2
11	" "	" "	3	42.50	2
12	" "	" "	3	43.75	2
13	" "	" "	3	45.00	2
14	" "	" "	3	46.25	2
15	" "	" "	3	47.50	2
16	" "	" "	3	48.75	2
17	" "	" "	3	50.00	2
18	" "	" "	3	51.25	2
19	" "	" "	3	52.50	2
20	" "	" "	3	53.75	2
21	" "	" "	3	55.00	2
22	" "	" "	3	56.25	2
23	" "	" "	3	57.50	2
24	" "	" "	3	58.75	2
25	" "	" "	3	60.00	2

Total = 50 segments (25 pairs)

STEP 2

Make a selection of evenly sized bamboo with narrow diameters:

- Cut sections with nodes at both ends using the middle portion of the culm.
- Do not use the bottom portions of the culm because they are usually too heavy, and do not use top portions because they are too weak.
- Use culm segments of 30 - 60cm in length.
- Use water and a rag to clean the surface of bamboo.
- Approximately 50 culm segments are needed to make a 2.5m long hammock.

STEP 3

- Cut segments with nodes on both ends.
- Cut maximum of 2.5cm away from the node.

STEP 4

- Smoothen sharp edges with a file or sand paper.

STEP 5

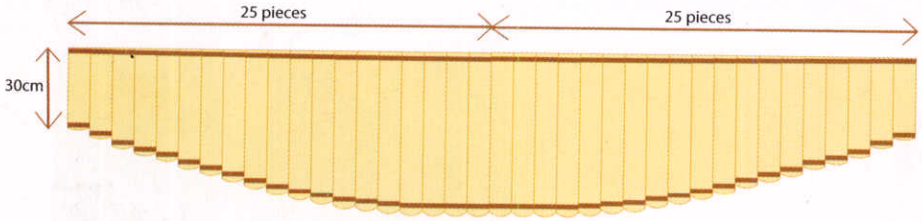
- Clean each piece of bamboo with steel wool in order to have a clean and smooth surface.

STEP 6

- Drill holes exactly 5cm from the ends of each piece of bamboo.
- Carefully sink in the tip of a 12mm drill bit on each side.
- Drill with a 6mm bit through the sunken holes.

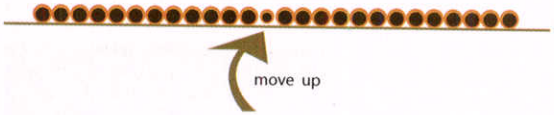
NB: In case there are variations in diameter of the culm sections, adjustments are needed in drilling so that the culms can be strung together to form a hammock with a level top surface.

ASSEMBLY OF BAMBOO SEGMENTS:

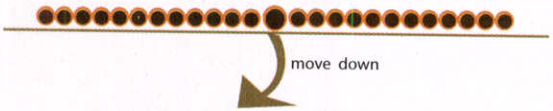


a) **A hammock assembly made with segments of even diameters.**

b) **A hammock assembly with uneven diameter segments.**
In order for the hammock to be comfortable, it must have a level surface. If the segments that are used to make the hammock do not have the same diameters, then some segments will have to be moved up or down to level the surface.



Small diameter segments should be moved up.



Large diameter segments should be moved down.

STEP 7

- Lay out the fifty (50) bamboo segments that have been prepared in a hammock shape.
- Position them in progressive lengths from the end to the centre of the hammock for a 2.5m long hammock.
- Make sure you achieve an even number on both sides, for a nicely curved design.

STEP 8

- Cut nylon rope (with 4mm Ø) into a piece that is 7m long.
- Burn the loose ends of the nylon rope to ease in the fitting.

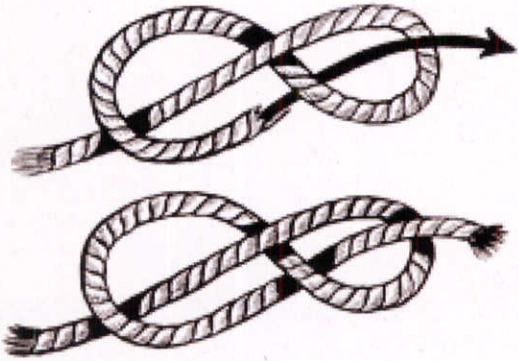
WARNING:
Do not use ropes made of other plastics or natural fibres since they are not reliable for this purpose.

- Insert the nylon rope through the drilled holes.

- Beads are both functional and aesthetic so use them to separate each bamboo segment.

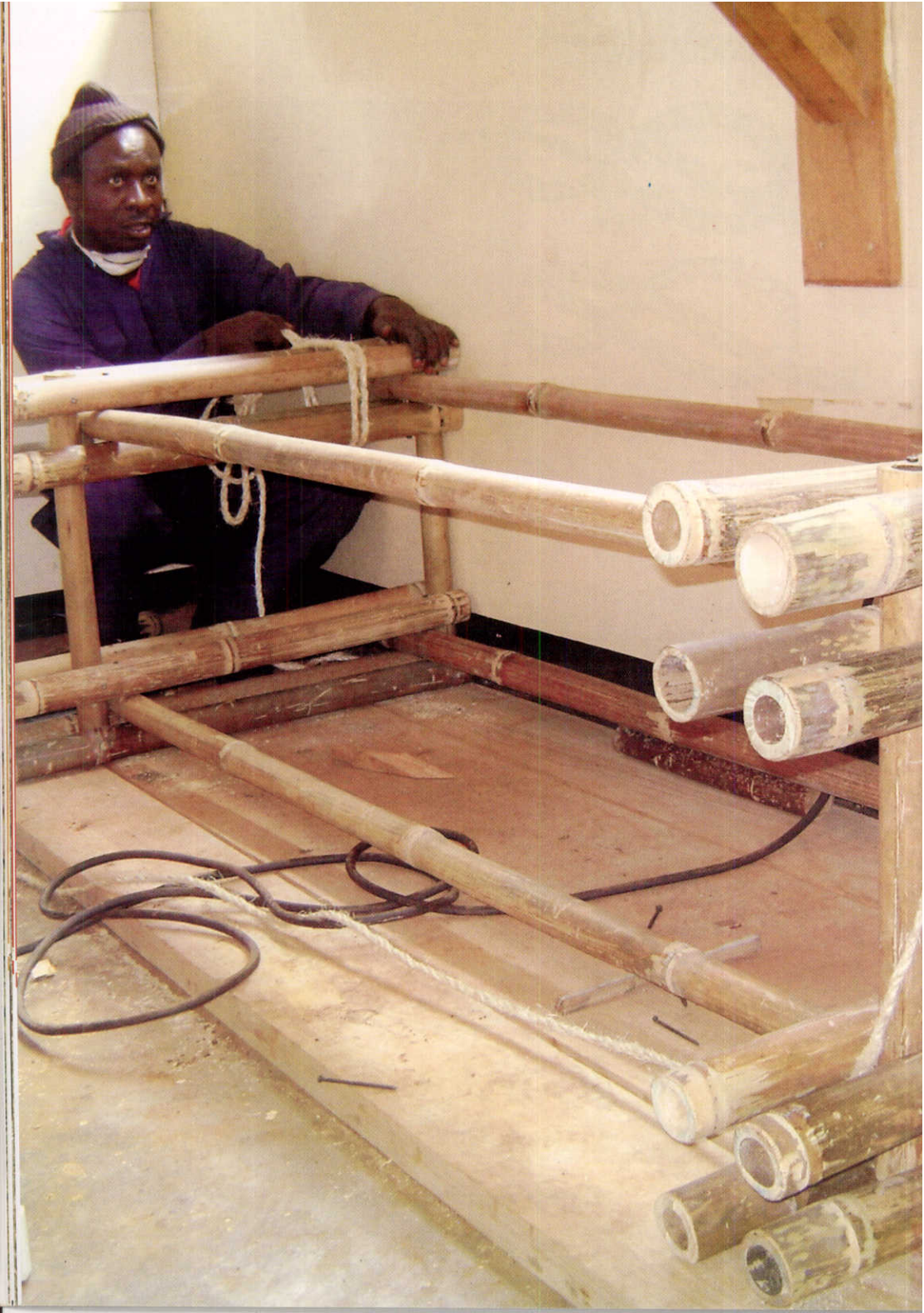
- You can roll the hammock for easy transportation and storage.

- You can use a figure-eight knot to fasten your hammock on both ends.
- The figure-eight knot does not open on its own and is always easy to untie.



How to make a figure-eight knot.

Enjoy your Hammock!



Making a Bamboo WORK BENCH

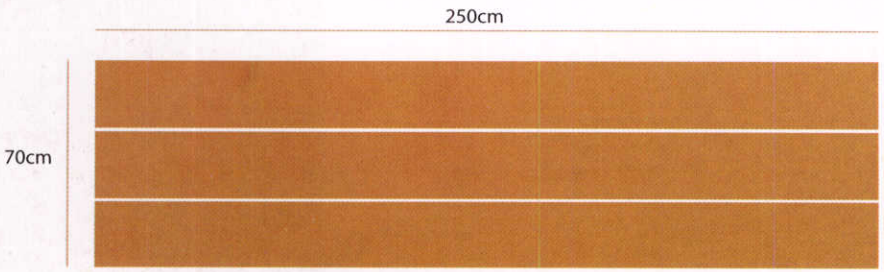
Tools & Materials:

- Drill (hand or electric)
- Hammer
- Tape measure
- Nails
- Sisal rope
- Mallet

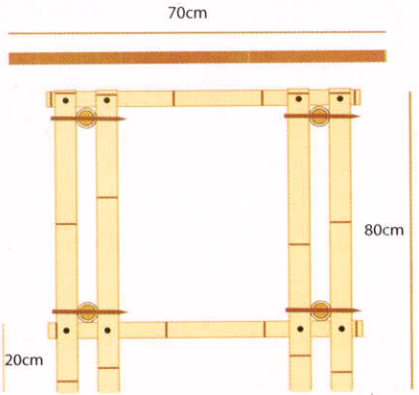
STEP 1

- Make scale drawings for the work bench indicating the lengths and dimensions of each part.

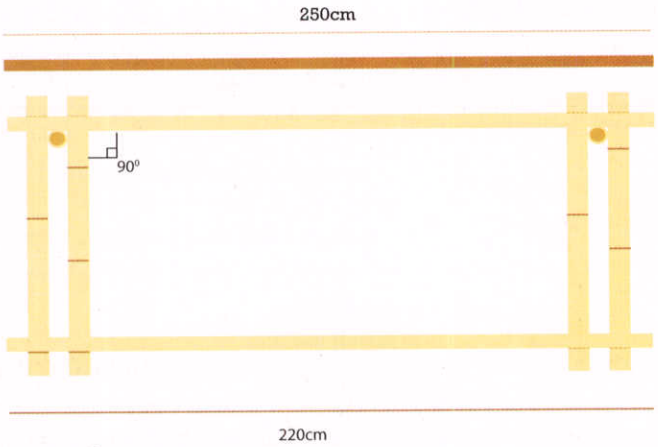
TOP VIEW



FRONT VIEW:



SIDE VIEW:



STEP 2

Prepare a cut list with the following details:

- Name/ function of each piece.
- Size and unit of each piece.
- Quantity of material to be used in each bench.

Cut- List for Work Bench:

a) Bamboo components

	Function	Material	Length (cm)	Diameter (cm)	No. of Pieces	Remark
1.	Legs	Bamboo	80	5	16	4 pcs per leg
2.	Long Beam	Bamboo	220	5	4	
3.	Short Beam	Bamboo	60	5	4	
4.	Nails / Dowels	Bamboo	20	1.2	20	

b) Wood components

	Function	Material	Length (cm)	width (cm)	Thickness (cm)	Quantity	Remark
1.	Top pine board	pine wood	250	23.3	4	3	Top Width= 3 pcs x 23.3 cm = 70 cm
2.	Small support boards	pine wood	60	5	4	5	

KEEP IN MIND THE FOLLOWING WHEN CUTTING BAMBOO CULMS:

- Select poles with same diameter and wall thickness.
- Ensure that the culms are straight and pay careful attention to curves and defects on the poles (culms that are not straight and defective are not useful in this case).
- Be sure to clean the surface.
- Start by cutting the longest pieces.

STEP 3

- Position the three pine wood boards to be used face down on the floor.
- Align them perpendicularly to each other.

STEP 4

- Prepare the leg framework by positioning four poles perpendicularly to a wall .
- Using the bamboo nodes is very important to ensure stability and structural strength of the work bench. The nodes are the strongest points of the bamboo culm. Make sure that a node is present at the end of the top portion of the legs (which will support the top board. Nodes should also be present as close as possible to the bottom portion of the legs.
- Use a bamboo spacer to separate the two poles on each side of the frame work.
- Position them in a right angle against the wall.
- Assemble in packs of four poles, (one pack per leg).

STEP 5

- Tightly fasten the pack of four poles together with a tourniquet using a sisal rope.

STEP 6

- Drill the joints where the poles cross each other.
- Make sure you drill at a 90^0 angle.

STEP 7

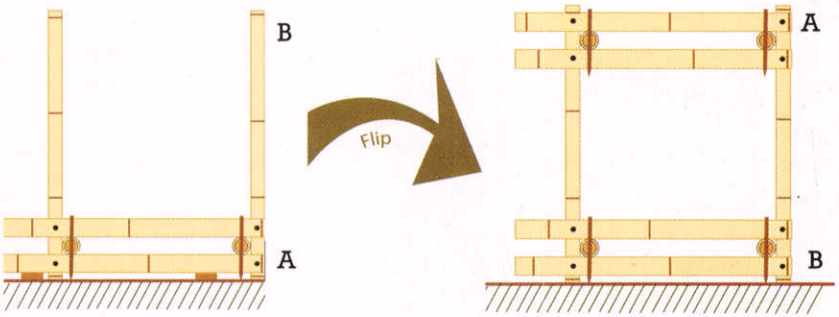
- Drive the dowels into the drilled holes with a mallet or a heavy hammer.

Note
Use very dry bamboo for your dowels and make sure that they have the same diameter as the hole.

STEP 8

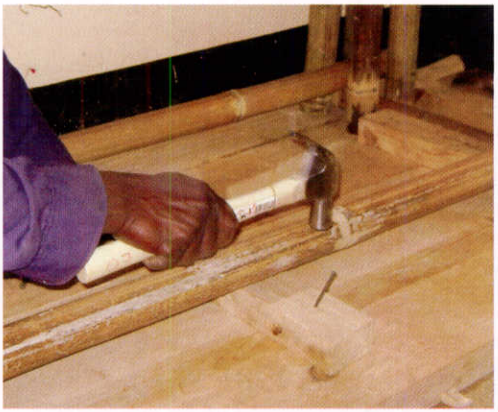
Flip the bench over:

- After fixing one side, flip bottom up.
- Make sure there is no gap to the wall.
- Make sure that all angles of the ensemble are right angles (90^0).
- Repeat step 7 to fix the other legs using dowels.



STEP 9

- Position the assembled bamboo leg framework on top of the pine wood boards with the legs facing upwards.
- Join the three wooden pine boards by using small wooden rails, fixed with nails from the bottom side.



STEP 10

- Use a spacer between two legs in order to adjust the three boards precisely on top of the bamboo frame.
- Do not nail the top board and the leg framework together so that you can carry the two different elements (board & rack) separately.

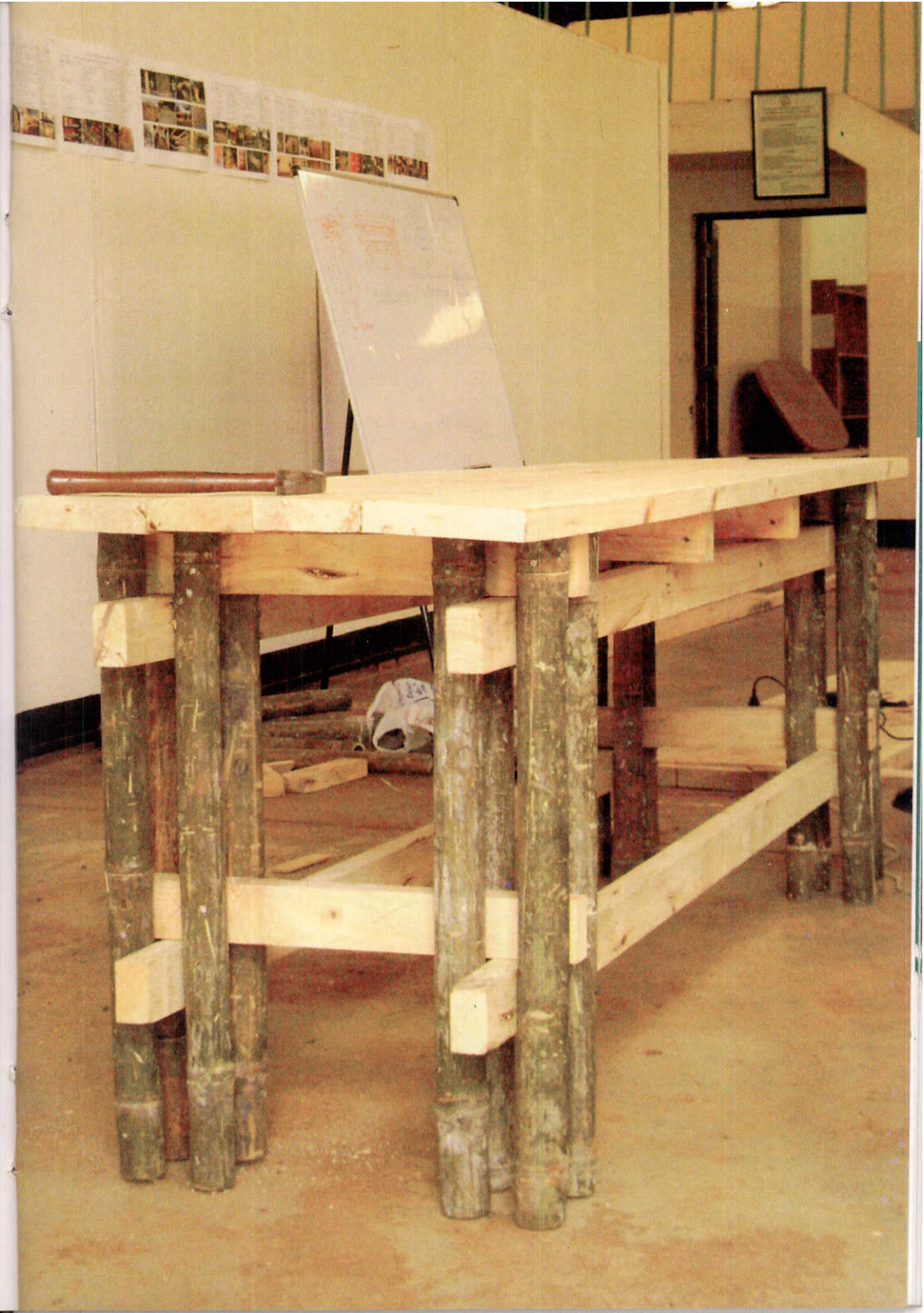
STEP 11

- Flip the table and let it stand upright.
- It is now ready for use.

Work bench reinforced with diagonal braces.

Note:

If you need more stability, introduce diagonal braces between the columns



Making a Foldable Chair

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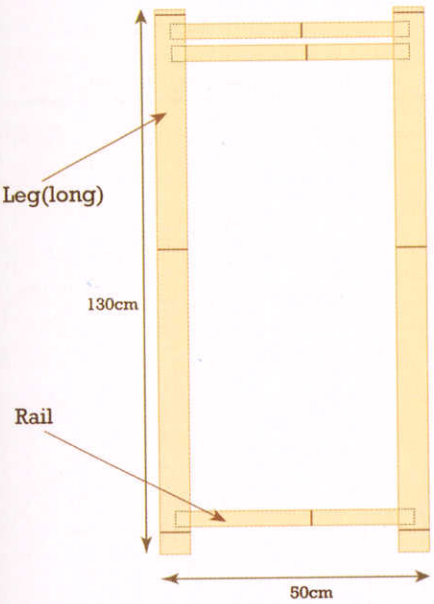
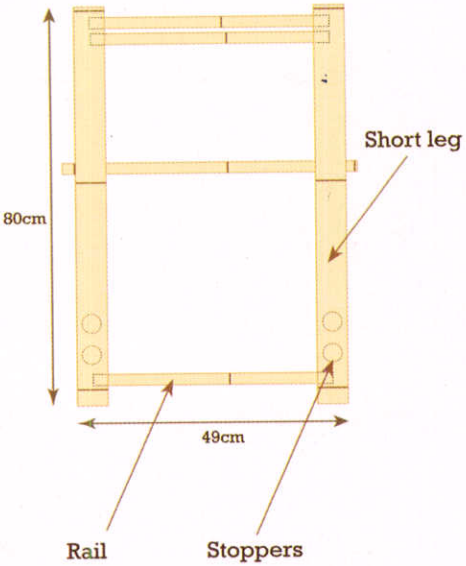
Tools & Materials:

- Drill (hand or electric)
- Hammer
- Tape measure
- Nails
- Sisal rope
- Mallet
- Half round file
- Sand paper
- Big Knife
- Match box
- Clamps

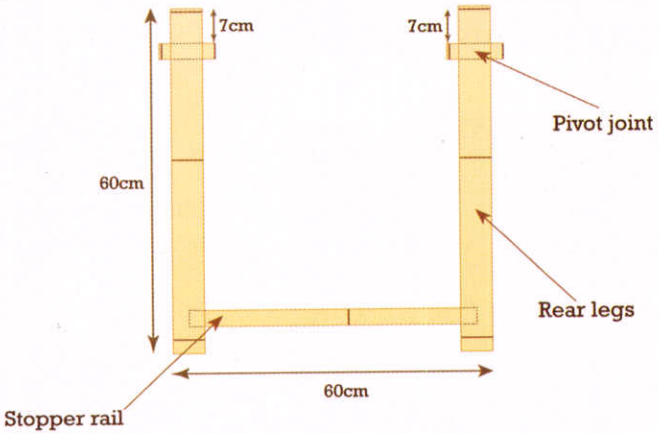
Outer Frame:



Inner Frame:



U Frame:



	Component	Function	Diameter (cm)	Quantity	Length (cm)	Total (m)
a)	**Outer Frame**					
		Legs(long)	6.50	2	125	2.50
		Rails	3.20	3	60	1.80
b)	**Inner Frame**					
		Legs(short)	6.50	2	80	1.60
		Rails	3.2	3	49	1.47
		Support Rail	2.5	1	55	0.55
		Stoppers	3.2	4	9	0.36
c)	**U Frame**					
		Rear Legs	3.2	2	39	0.78
		Stopper Rail	3.2	1	65	0.65
		Pivot Joint	2.5	2	10	0.20
		Stoppers	3.2	4	9	0.36
d)	**Seat**					
		Seat Rails	3.0	35	Range between 30 - 39	Max. 14

STEP 1

- Select treated bamboo poles according to the cutting list.

STEP 2

- Clean the recessive areas of the nodes with the half round file.

STEP 3

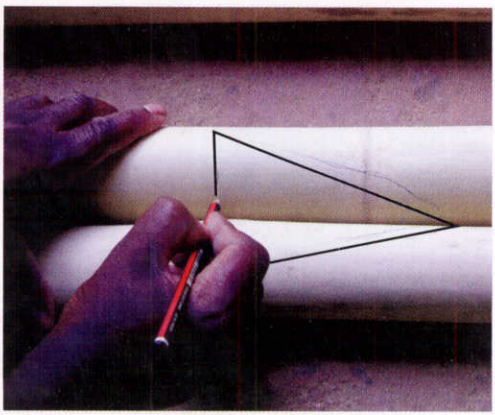
- Clean the surface of the pieces by scraping with a knife.

STEP 4

- Start sanding with the 80 grit sandpaper to remove the marks that were made from scratching outer skin with knifes and cleaning the nodes with the half round file.
- Continue sanding with 120 grit sand paper until all the sanding scratches have been removed.
- The next step is to sand the surface with grit 150 and finally with 180 grit paper.

STEP 5

- The final sanding has to be done with a grit (P180). Sanding should be done in the direction of the grain (i.e. parallel to the fibre direction). Use 3M Scotch Brite™ pads or similar products that adapt better to the shape of the culm than the sand paper.



STEP 6

- Use lines and/or symbols for marking adjacent parts to facilitate assembly.

STEP 7

- Drill holes for stoppers, connecting rails and pivot joints according to the required diameters.

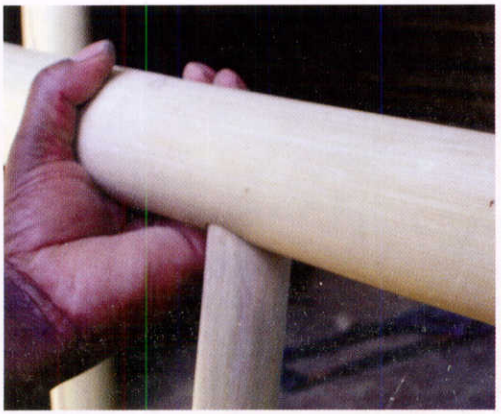
STEP 8

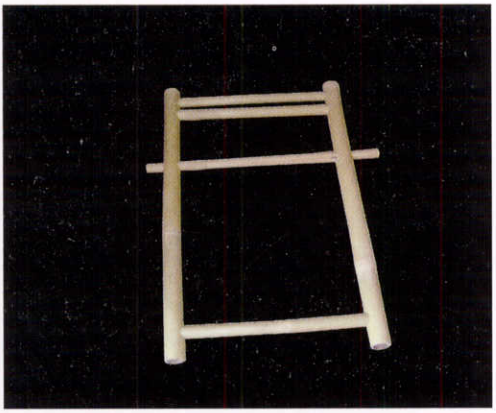
- If needed, adjust the size of the drilled holes to the diameter of culm section that is to be inserted into the hole.

Attention: do not reduce the diameter of the culm that will be inserted into the hole because this can be easily seen and reduces the aesthetic quality of the product.)

STEP 9

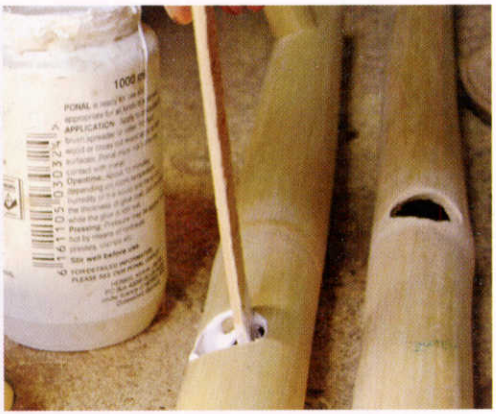
- Check for loose fibres at the connections and carefully remove them using a sharp knife
- Do not hammer culms into the holes because the culms crack easily.





STEP 10

- Assemble the inner frame and make a dry run without glue.
- During the dry run assembly you may notice that some parts have not been prepared correctly.
- Make sure that all dimensions are according to the design and verify that all parts fit together properly.



STEP 11

- Before applying any glue make sure that ropes are ready at hand in order to fasten the pieces together.

STEP 12

- Bear in mind that the glue dries quickly so pieces should be well fastened with rope immediately after the glue is applied.

STEP 13

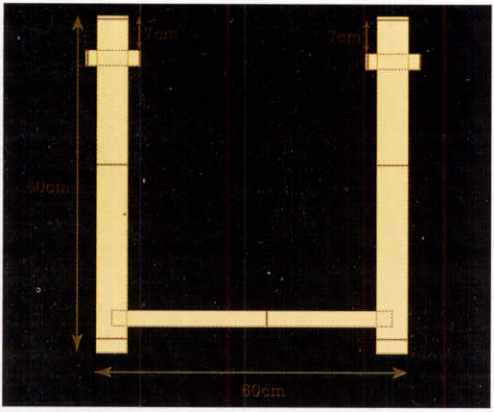
- Assemble each spaced column using four poles and spacers.

STEP 14

- Mark the points where to connect the outer frame to the inner frame.
- Make a dry run assembly of the outer frame.
- Ensure that the inner frame (which is already glued together) fits precisely into the outer frame.

STEP 15

- Make necessary adjustments to the outer frame so that all parts fit together properly.
- Assemble on a flat surface and double check alignment and fitting before gluing.

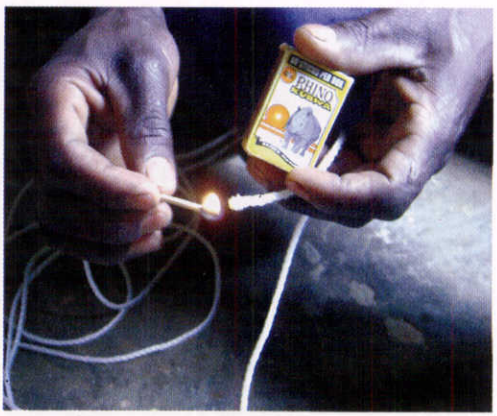


STEP 16

- Prepare the U frame.
- Follow the same procedure used in making the inner and outer frames.
- Ensure that all parts fit together.

STEP 17

- Prepare the seat component.
- When selecting the poles for the seating component make sure that you can drill close to the nodes. This will improve the strength of the seating component.
- After drilling the holes varnish (or oil) the pieces before the assembling them



STEP 18

- Heat the end of the nylon rope with a match or lighter to merge the nylon fibres.

STEP 19

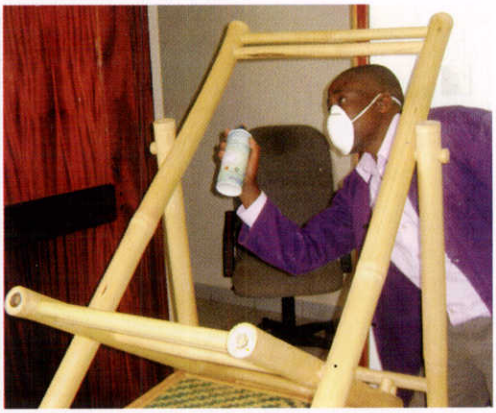
- When assembling the seat component, insert a pair of beads between each bamboo rail to reduce the overall weight of the seating component.

STEP 20

- Use a nylon rope to link the seat rails together.

STEP 21

- Remove dust from the surface with a clean fabric before starting to varnish.



STEP 22

Guidelines for Varnishing:

- Wear protection equipment (face mask).
- Work in a dust-free environment.
- Spray varnish using even motions.
- Spray all pieces evenly
- Do not forget to spray remote areas of the assembly, including those that are not easily accessible.
- Check that all parts are properly varnished before drying the product.

STEP 22

- After the varnished chair framework has dried, fix the ropes of the seating component to the double rails.

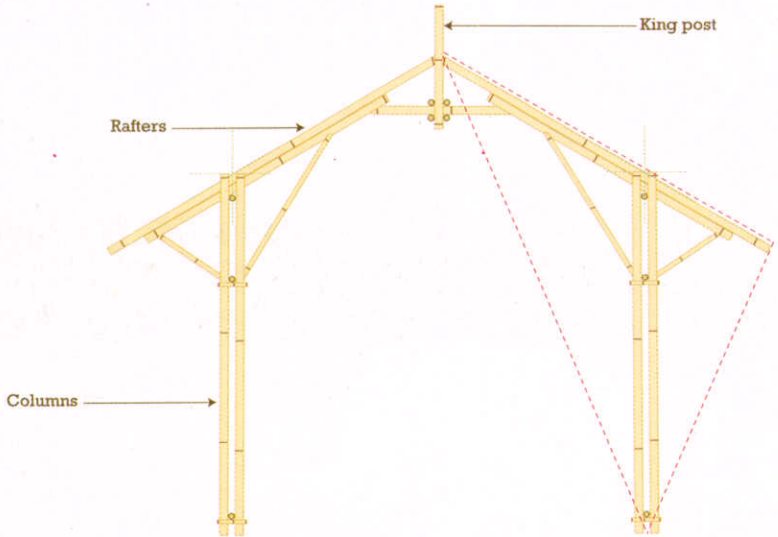
Gazebo

Tools & Materials:

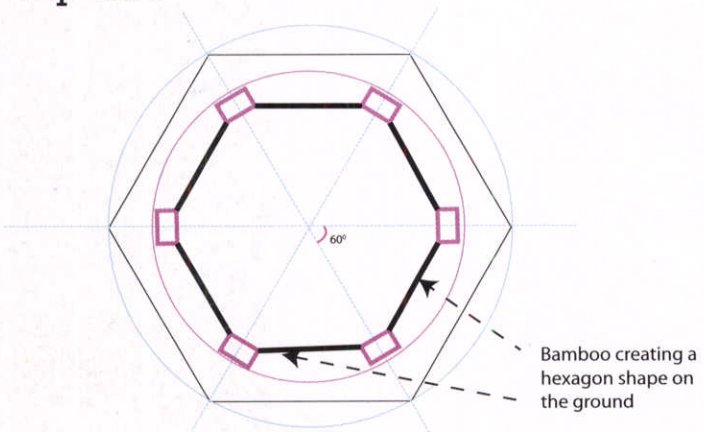
- Drill (hand or electric)
- Mallet
- Hammer
- Ladder
- Wheelbarrow
- Spade
- Metal rod (Y-12)
- Hacksaw
- Sisal rope
- Tape measure

STEP 1

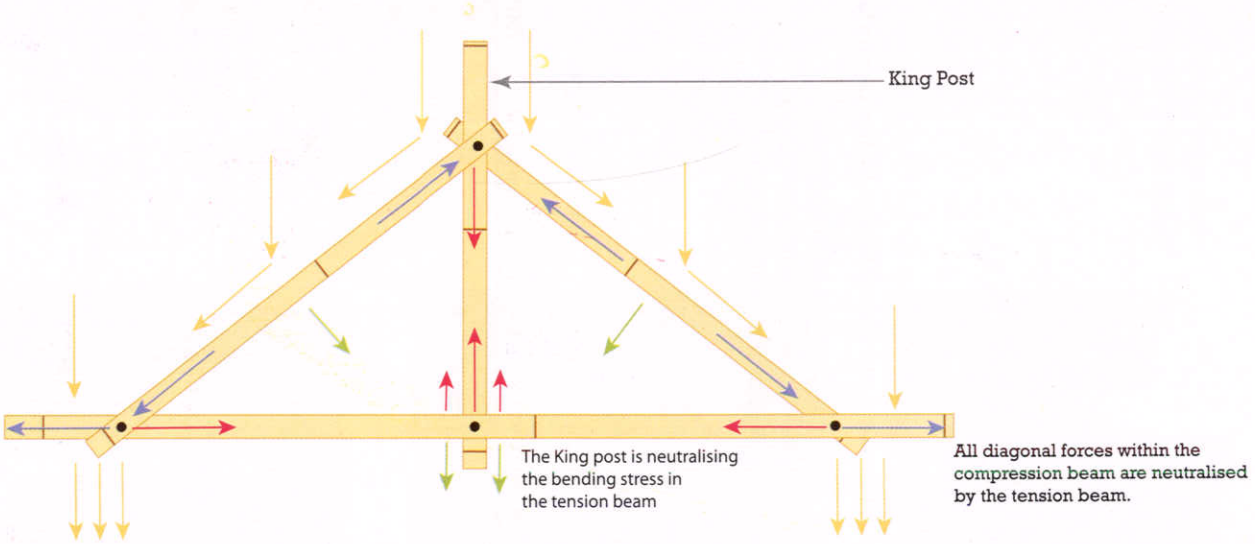
- Make scale drawings of the different parts of the Gazebo.



Top view



Forces within a King Truss



STEP 2

Prepare a cut list with the following details:

- Name/ function of each piece.
- Quantity of material to be used.
- Size and unit of each piece.

	Function	Diameter (cm)	Quantity	Length (cm)	Total (m)
1.	Column poles	7	6 x 4	2.75	66.00
2.	Spacers	5	6 x 5	0.30	10.80
3.	Main Rafters	6	6	2.75	16.50
4.	Auxilliary Rafters	5	6	2.40	18.60
5.	Outer brace	5	6	0.88	5.40
6.	Inner brace	5	6	1.50	9
7.	Clamps	4	6	1.80	10.40
8.	King Pole	8	1	1	1.00

STEP 3

- Assemble each spaced column using four poles and spacers.

- Fasten the pieces together with a tourniquet using sisal rope and stick.
- Drill the joints where the poles cross each other.
- Make sure you drill at a 90^0 angle.

STEP 4

- Use dry dowels of the same diameter as the drilled holes.
- Drive in the dowels with a mallet or a heavy hammer.

STEP 5

- Drill through the base nodes of each pole within the columns.

STEP 6

- Make a mixture of cement, sand and water to be poured into the poles.

STEP 7

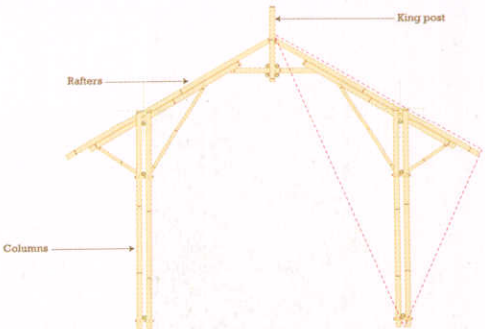
- Inject the cement mixture ensuring that it fills up at least one internode of each leg.

STEP 8

- Insert steel bars into the poles filled with the cement mixture.

STEP 9

- Using the scale drawing as a guide, use strings and markers to outline the assembly points on the floor.
- Assemble the columns following the markers on the floor.



Scale drawing

STEP 10

- Make sure that as you are working on your pillars, you have spacers at the bottom to allow the tips of the dowels to come out.
- Spacers have to be of the same thickness in order to assemble the culms properly.

STEP 11

- Cut and shape the end of culms to be used as rafters using "fish mouth" technique.
- Fish mouth joints look nice and allow seamless fitting parts.

Fish mouth

Samples of fish mouth joints

STEP 12

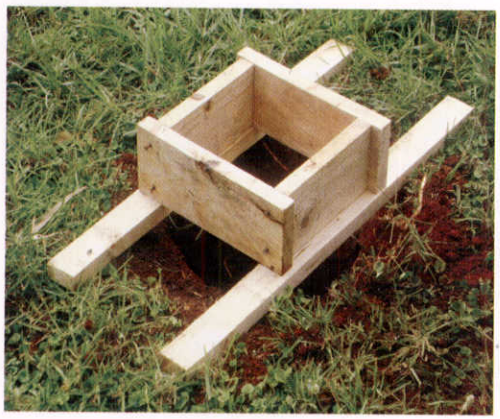
- Double check the position of the diagonals to make sure that the columns and rafters are as perfect and proportional as possible.

STEP 13

- Lay out six poles on the ground to form a hexagon that marks the position of the six columns of the gazebo. (Note: refer to top view illustration on page 44 of this manual.)

STEP 14

- Dig six holes from the centre of the hexagon, in accordance with the measurements of the design.



STEP 15

- Make wooden frames to be placed at the top surface of each hole.
- The frame should be high enough to protect the cement from rain and soil moisture.

STEP 16

- Mix cement, sand and gravel in the ratio of 1: 2: 3.
- Use little water and mix thoroughly.

STEP 17

- Fill in each hole with the mixture and place the wooden frame on top of the hole.

STEP 18

- Carry the preassembled trusses to the site.
- Be careful when transporting the assembly.
- As you transport the frame, ensure that the persons carrying the bottom parts stay astride to avoid deforming the assembly.

STEP 19

- Very carefully lower and insert the bases simultaneously into the cement filled holes.
- Take extra caution not to deform the shape.

STEP 20

- Ensure that the wooden frames are well filled to guarantee a strong and stable base for the pillars.
- During the next few days pour water over the cement base to keep it moist and prevent it from drying too quickly and cracking.

STEP 21

- Lay out the roof purlins according to their lengths, so that you can know where to position them.

STEP 22

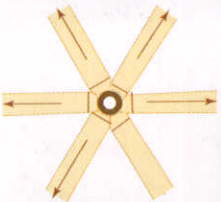
- Use temporary braces as supports to hold the pillars safely and firmly before the base is fully dry.

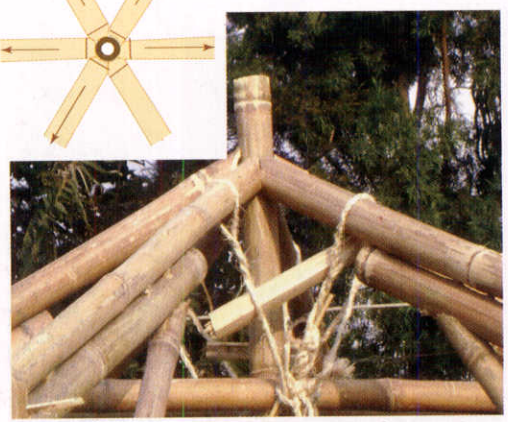
STEP 23

- Fasten the roof rafters together temporarily to the king post with ropes.

STEP 24

- Make sure that the rafters fit perfectly into the king post if necessary by finely adjusting the 'fish mouths' to aid in the fitting.
- The rafters have to be the same size as the king post.





STEP 25

- Fasten the rafters to the pillars tightly with ropes or rubber in order to facilitate drilling.

STEP 26

- Drill through the rafters and pillars.
- Insert dowels with a mallet.

- Cut off the protruding pieces of the dowels after fixing the joints.

- Fix all the rafters with appropriate spacing to aid in thatching the roof later.

STEP 27

- Prepare hay or grass to be used for thatching the roof.

STEP 28

- Thatch the roof using hay or grass fastened with sisal twine.

NOTES: