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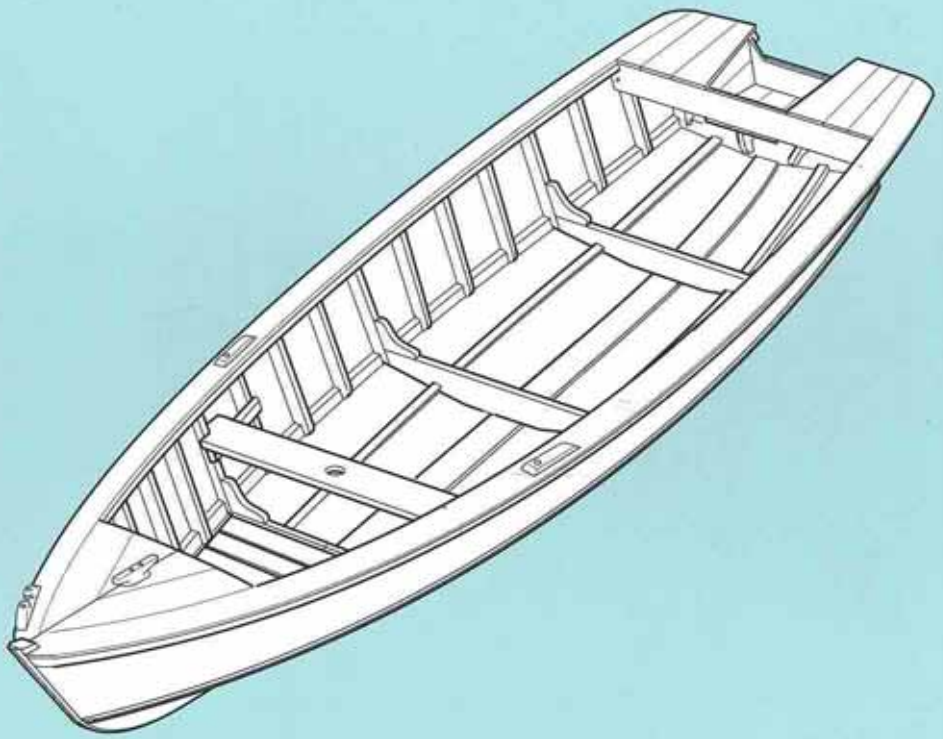

Fishing boat designs: 2 V-bottom boats of planked plywood construction

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by
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PREPARATION OF THIS DOCUMENT

The first edition of V-bottom boats (FAO Fisheries Technical Paper 134 - Fishing boat design: 2) written in 1974 proved to be one of the most popular publications of the Fishing Technology Service (formerly the Fish Production and Marketing Service) of the Fishery Industries Division. This updated and completely revised publication supersedes the Rev. 1 which was published in 1997. It follows an exhaustive study by the author in collaboration with research institutions and engineers on structural timber design applied to wooden boat construction. The designs included are appropriate for inshore and coastal fisheries and emphasis has been placed on relative ease of construction and minimum wastage of timber.

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FAO Fisheries Technical Paper. No. 134, Rev. 2. Rome, FAO. 2004. 64p.

ABSTRACT

Timber remains the most common material for the construction of boats under 15 metres in length. There has been a change towards fibre-reinforced plastic in most developed countries and some developing countries but, in Africa, Asia and the Pacific, probably more than 90 percent of small fishing vessels are built of wood. The cost advantage of timber versus other materials is still sufficient to ensure that it will remain the dominant boatbuilding material for a long time to come in developing countries. However, unrestricted or illicit access to forest resources and the introduction of rational forestry management policies have caused and will continue to cause a scarcity of the sections of timbers traditionally favoured by boatbuilders. The resultant scarcity and high cost of good quality timber have not meant that less wooden boats are being built, but rather that vessel quality has deteriorated through the use of inferior timber and inadequate design strength.

This updated and completely revised publication supersedes Revision 1 of FAO Fisheries Technical Paper 134 published in 1997. It follows an exhaustive study on structural timber design applied to wooden boat construction. The publication includes the designs of four small fishing vessels (from 5.2 to 8.5 metres), with comprehensive material specifications and lists, and provides detailed instructions for their construction, both planked and of plywood. The designs are appropriate for inshore and coastal fisheries and emphasis has been placed on relative ease of construction and minimum wastage of timber.

The first FAO publication on V-bottom boats was issued in 1974. The purpose was to present a series of open fishing boats from 4.8 m (16 ft) to 9 m (30 ft) for use in inshore and coastal fishery.

The main features of the design are:

i Construction of planks or plywood on the same building jig and with the same construction procedure.

ii Utilizing local timber of standard commercial sizes.

iii Shape of the boat given by a few main frames.

iv Planking done with boards of uniform width to simplify building and reduce wastage.

v Hull shape well adapted to economical, low powered engines.

This new issue of the V-bottom boat publication maintains the basic principles of the first issue as outlined above. However, more than 20 years' development in the field of boatbuilding in developing countries has shown the need for a change in several aspects and with a greater emphasis on the use of illustrations rather than words.

1) Construction methods

Plywood has maintained its role as a material well adapted to use in small scale boatbuilding. Because of the sheet construction, it is relatively easy for carpenters without boatbuilding skills to achieve a watertight boat. For boats that are frequently hauled out on the beach, plywood gives a light boat without planking seams that open when the timber dries out. The service life of a plywood boat is determined by the quality of the plywood and dry timber is required to obtain a good glue bond. Traditional boat construction with nails and bolts has the advantage of being able to use cheaper local timber and often timber of better rot resistance than the low grade interior veneers used in plywood. Traditional construction, where each plank has to be sawn and planed to the correct shape, requires great skill to obtain a watertight and strong boat. There is a need to simplify the construction method as much as possible to bring it within the reach of people with little boatbuilding experience. In this new issue of the V-bottom boat publication, only the V-version with the bottom planked transversely or cross planked has been maintained. A longitudinal planked bottom requires closely spaced transverse frames. In temperate climates, oak has been used traditionally for steamed frames together with copper fastenings.

Most of the tropical hard woods do not steambend well and imported copper fastenings are expensive. Bolted frames for small V-bottom boats are expensive and time consuming to make and they clutter up the interior of the boat. In the construction of small flatbottom boats, the cross planked bottom is widely accepted as the simplest way to build a boat and it is a method used by boatbuilders in countries as wide apart as Bangladesh and the USA. The cross planked V-bottom boat is little known outside the USA and Australia, but it has the same advantages as cross planking in a flatbottom boat: the reduction in the number of transverse bottom frames. The bottom planking carries the load to the sides and the keel. The bottom framing can be longitudinal, mainly serving to hold the planks together to avoid leaks. This longitudinal bottom framing is similar to the system used in plywood boats which permits the same main frame system to be used whether the boats are built of planks or plywood, as shown in this publication. Longitudinal planks on the side demand intermediate frames but these can be simply bolted to the chine and do not require much bevelling for the planking.

2) Types of boats

The previous issue had V-bottom designs of typical "Western" proportions with a rather wide beam in relation to the length. In most developing countries fishermen prefer long and slender, canoe-shaped boats and for very good reasons. The longer boats will give a better speed with a small engine than a short, fat boat. A certain beam is required for a satisfactory stability. For open boats a

waterline beam of around 1.5 m (5 ft) will ensure sufficient stability. The boats in this publication maintain this waterline beam with an over all beam of 1.9 m (6 ft). The advantage of the longer boats in terms of speed is clearly demonstrated in that the 8.5 m boat will achieve 7 knots versus 5.5 knots for the 5.2 m boat using the same 8 Hp engine. Because of the sharp bow, the longer hulls have very low resistance in waves.

3) Engine installation

The cost of operating a small fishing boat is to a far greater extent influenced by the choice of engine type and power than by the construction material in the boat. It is known that for the same power, diesel engines consume only half the fuel of the outboard engine. The previous publication therefore showed the installation of small, marine diesel engines with built-in reverse/reduction gear. However, the cost of these engines, in spite of all their advantages, has effectively excluded them from use by fishermen in developing countries. Here the market for boat engines below 15 Hp is dominated by either kerosene outboard motors or multi-purpose single cylinder diesel engines fitted without reduction/reverse gear. This latter type of engine is now the dominant small boat engine in Indonesia, Thailand and Bangladesh. The engine is fitted in a conventional way inboard with a sterntube, but without reduction to the propeller which means a fairly small propeller turning at the same rpm as the engine, that is 2 000-2 200 rpm, which gives rather low propulsion efficiency. Alternatively, the engine is fitted with a "long tail" and sits on the stern of the boat like an outboard motor with the shaft extending down into the water aft of the boat. Lifting the propeller out of the water acts as a neutral position in a gearbox. In condition with waves there is the disadvantage that the propeller operates near the surface of the water.

To overcome some of these disadvantages, the FAO/SIDA "Bay of Bengal Programme" developed a new installation suitable for beachlanding craft on the East Coast of India. The engine is installed inside the boat and is mounted together with the propeller shaft in such a way that the whole unit can be tilted and the propeller and rudder lifted out of the water. A rubber bellow ensures watertightness between the pivoting sterntube and the hull. There is a belt drive between the engine and the propeller shaft giving a 2:1 reduction and thereby a larger and more efficient propeller. As for the long tail, there is a "neutral" position when the propeller is lifted out of the water. This is also required for beachlanding and convenient for clearing fishing nets entangled in the propeller. The 9 Hp engine utilized is the horizontal cylinder, watercooled diesel engine widely used for pumping water, generating sets and small tractors. It is produced in large series and therefore at a fraction of the cost of the specially built small marine diesel engine. In 1996 this engine with the complete liftable propeller installation cost US$ 1 150 which was less than the imported 8 Hp kerosene outboard engine.

The liftable propulsion unit can be made in a workshop with lathe and welding machine.

A detailed description of how to make this unit is given in the technical report: BOBP/MAG/14

"Building a liftable propulsion system for small fishing craft - The BOB drive"

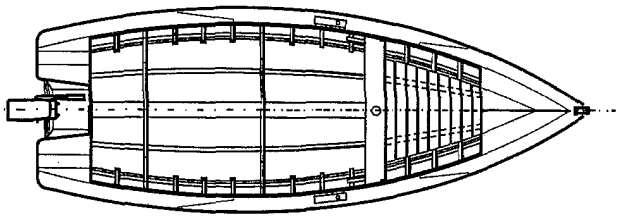
published by the Bay of Bengal Programme and obtainable from:

Fishing Technology Service
Fishery Industries Division
FAO
Viale delle Terme di Caracalla
00100 Rome, Italy
e-mail: FI-Inquiries@fao.org

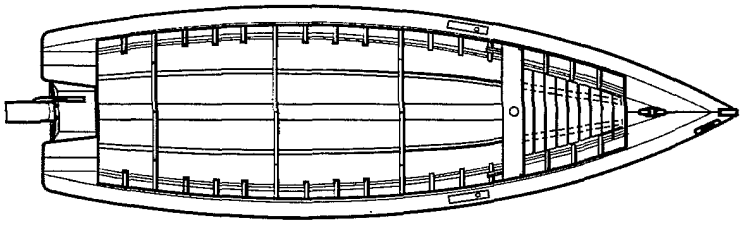
In this publication the liftable propulsion system is shown on the two larger craft.

It must be stressed that the designs and the construction shown in this publication are intended for low powered engines giving speeds of up to 7 knots. More powerful engines and higher speed will give high slamming load on the hull and the scantlings are not designed for this.

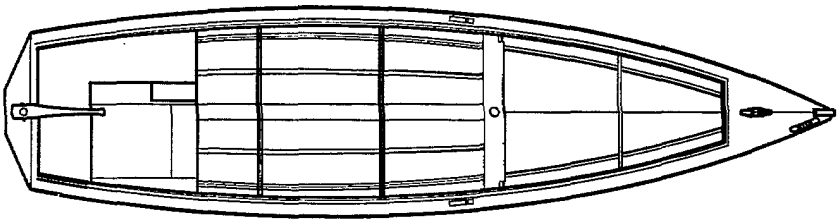
All the boats can be built of plywood or of planked construction. The frame dimensions are the same and the same building jig can be used. All boats are designed for use with outboard engines below 10 Hp. The two larger boats can also be fitted with an agricultural, one cylinder diesel engine of 6 - 8 Hp and a liftable propulsion system developed by FAO for beachlanding on the East Coast of India.



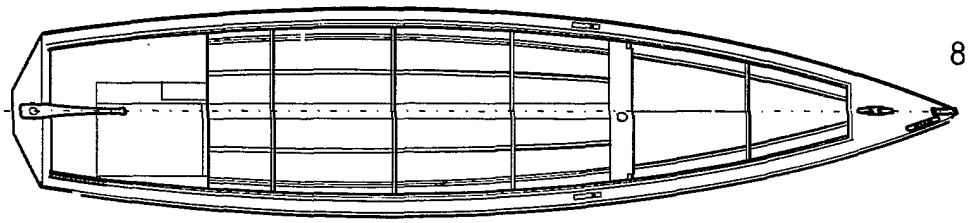
5.2 M BOAT



6.3 M BOAT

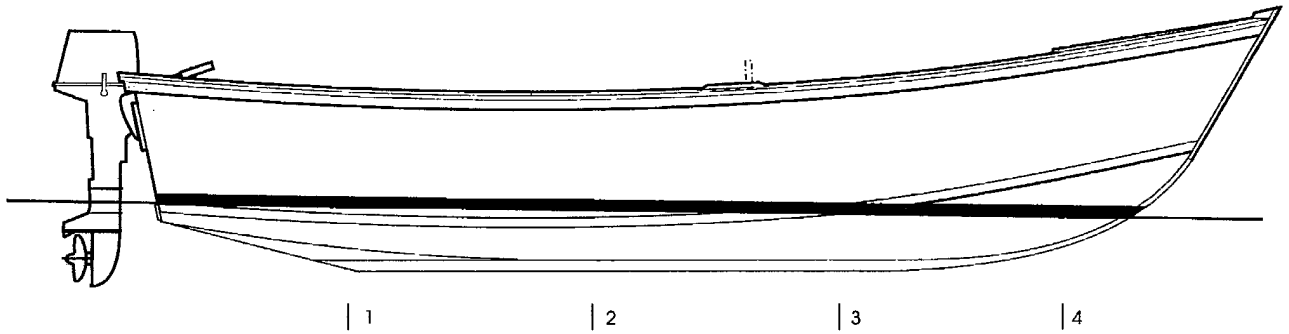


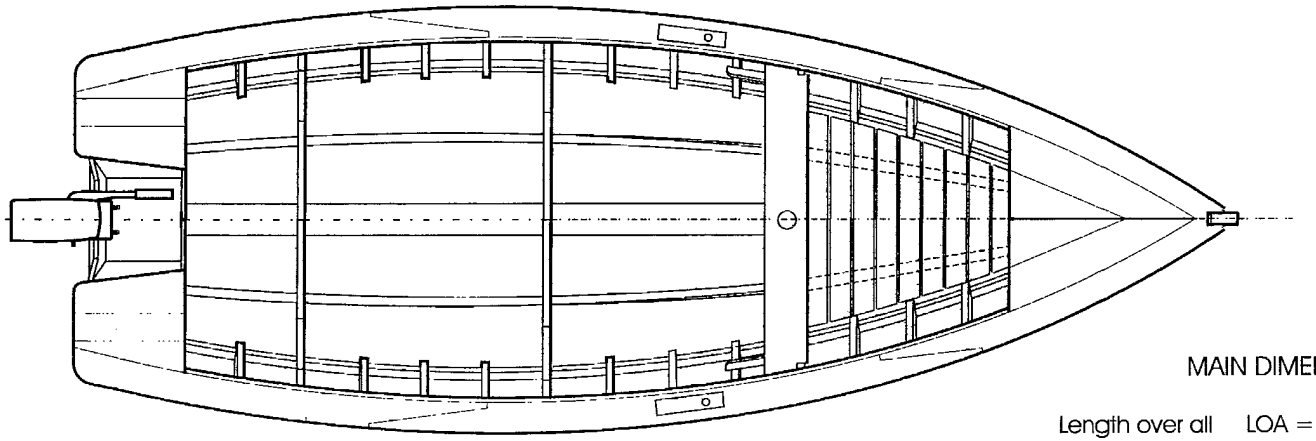
7.4 M BOAT



8.5 M BOAT

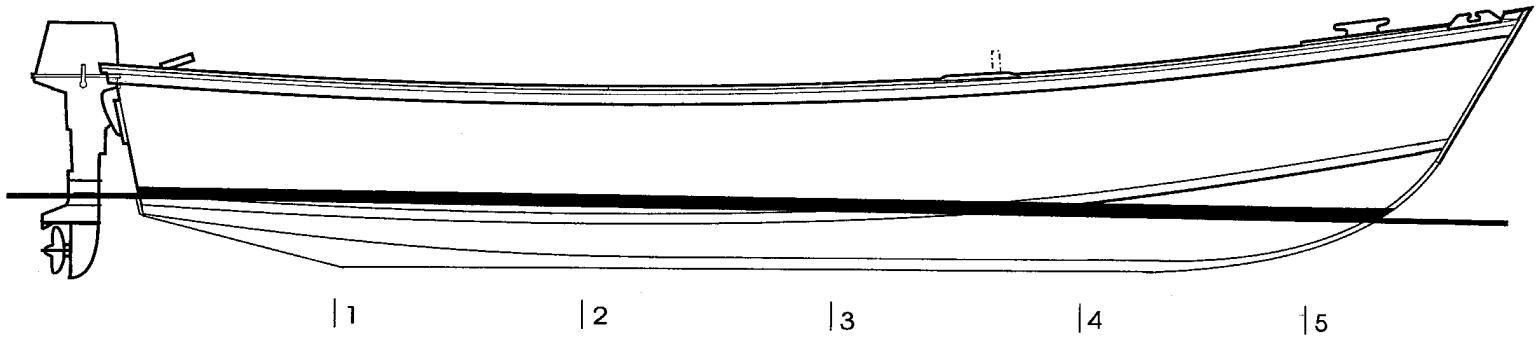
5.2 M BOAT

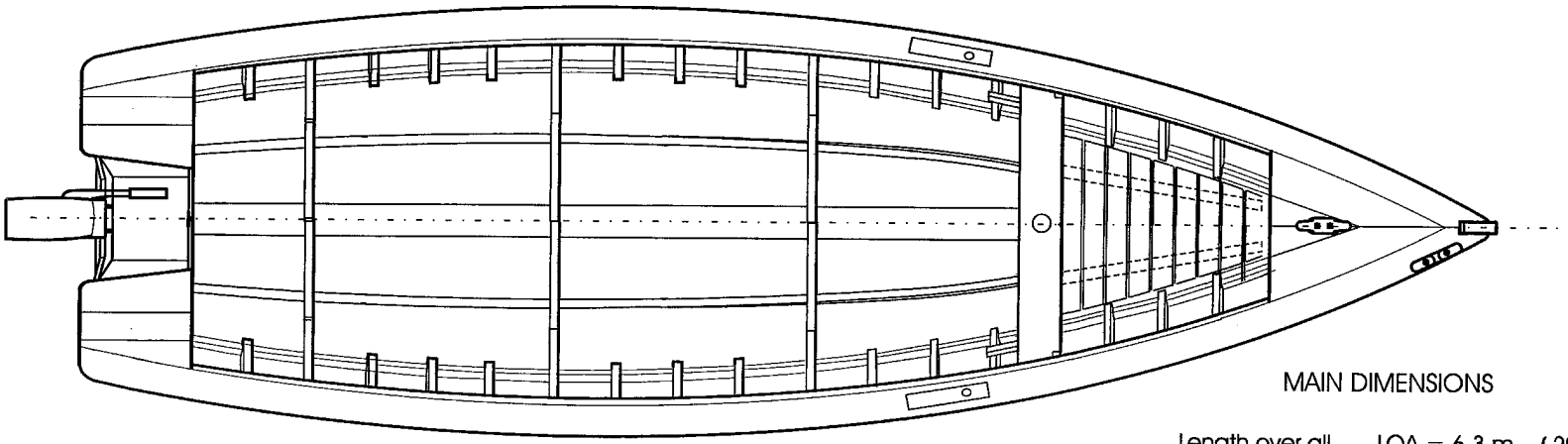




MAIN DIMENSIONS

Length over all	LOA = 5.2 m (17 ft)
Beam moulded	BMD = 1.85 m (6 ft)
Depth moulded	DMD = 0.72 m (2ft 4 in)
Cubic number	LOA x BMD x DMD = 6.9 m^3
Weight empty	400 kg
Load	300 kg
Weight loaded	700 kg
Recommended engine	4-6 Hp
Service speed	5.5 knots



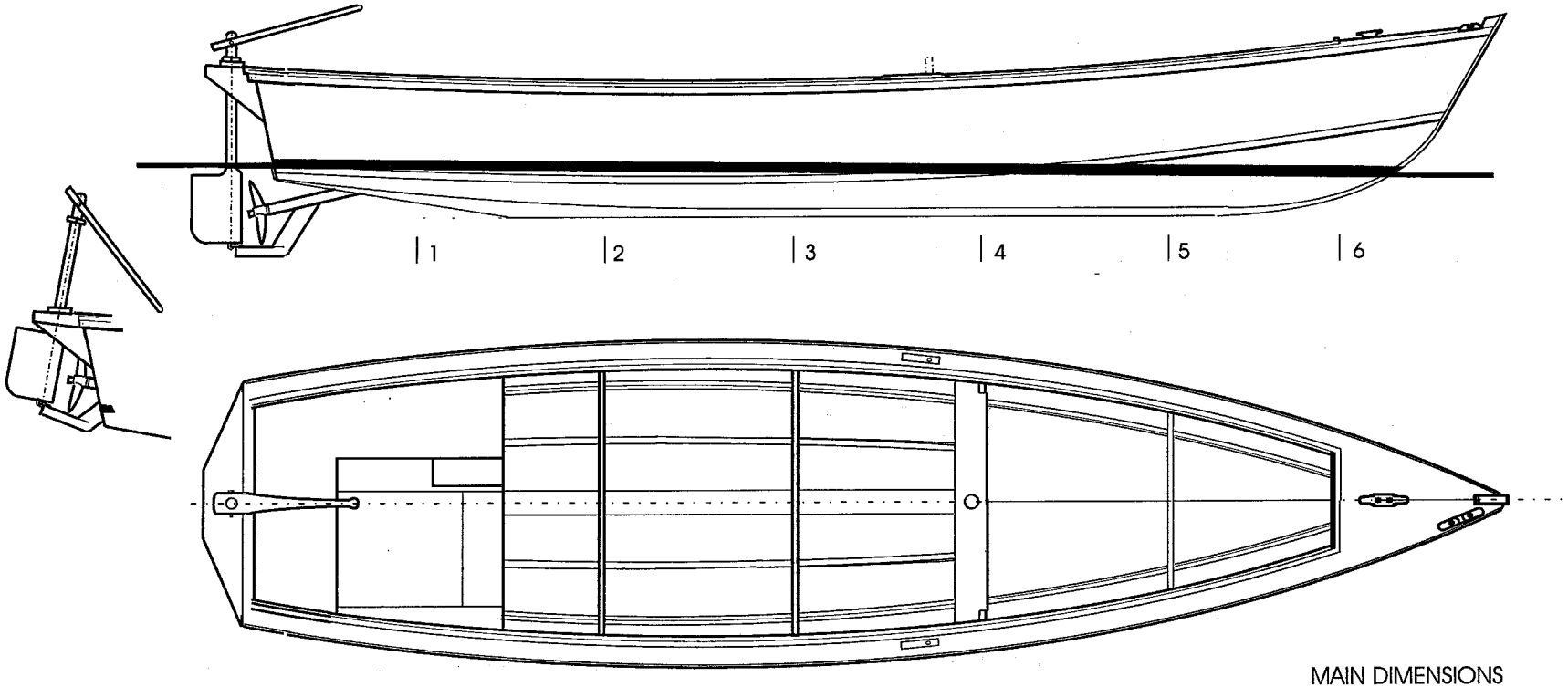


1.0 0.5 0 1 2 m

MAIN DIMENSIONS

Length over all	LOA = 6.3 m (20 ft 8 in)
Beam moulded	BMD = 1.85 m (6 ft)
Depth moulded	DMD = 0.72 m (2ft 4 in)
Cubic number	LOA x BMD x DMD = 8,4 m ^{3}
Weight empty	490 kg
Load	350 kg
Weight loaded	840 kg
Recommended engine :	5 - 8 Hp
Service speed :	6 knots

7.4 M BOAT

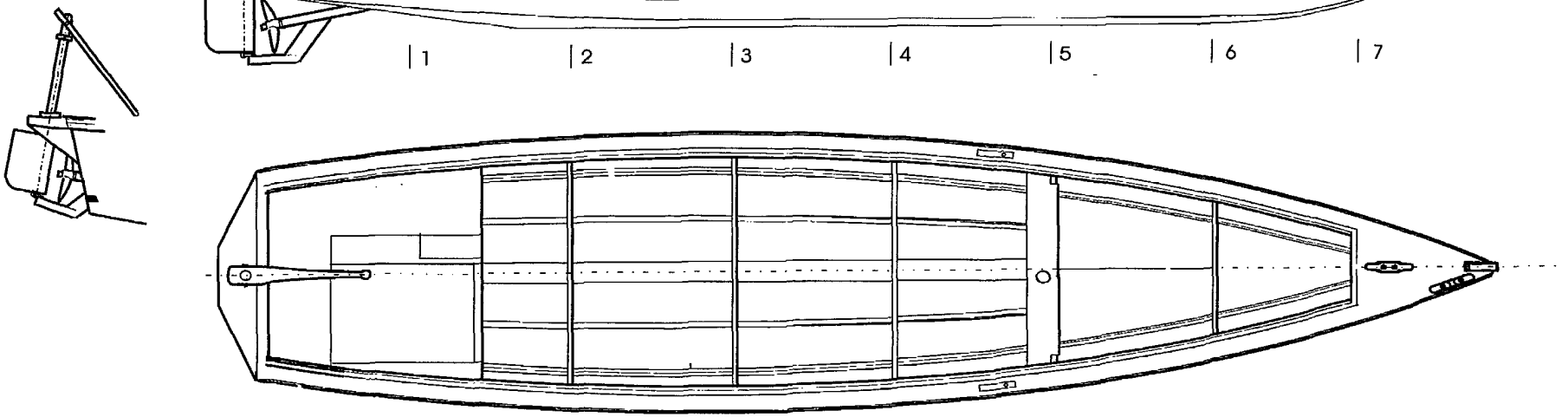


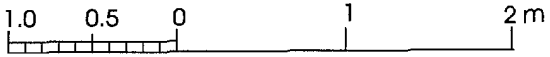
Engine installation shown is the liftable propulsion system developed by FAO for beachlanding craft on the East Coast of India. The diesel engine is a single, horizontal cylinder watercooled engine made for agricultural purposes. For more information on this installation, contact Fishery Industries Division, F.A.O, Viale delle Terme di Caracalla, 00100 Rome, Italy

1.0 0.5 0 1 2 m

MAIN DIMENSIONS

Length over all LOA = 7.4 m (24 ft 4 in)
Beam moulded BMD = 1.85 m (6 ft)
Depth moulded DMD = 0.72 m (2ft 4 in)
Cubic number LOA x BMD x DMD = 9.9 m^3
Weight empty 700 kg with diesel engine
Load 400 kg
Weight loaded 1100 kg
Recommended engine : 6 - 8 Hp
Service speed : 6.5 knots



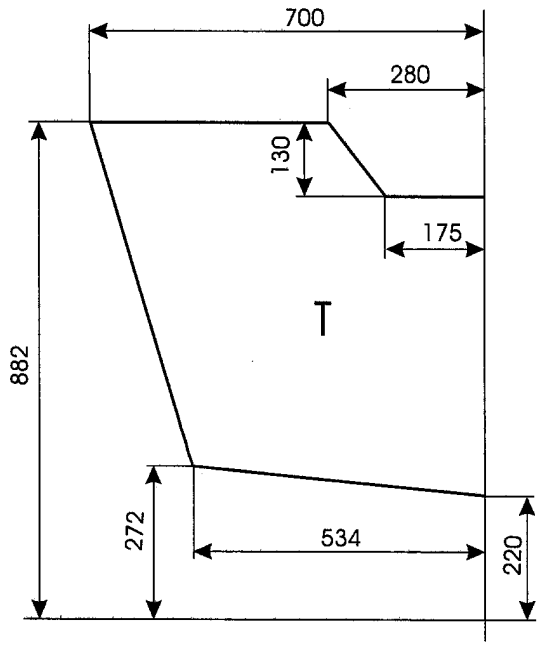


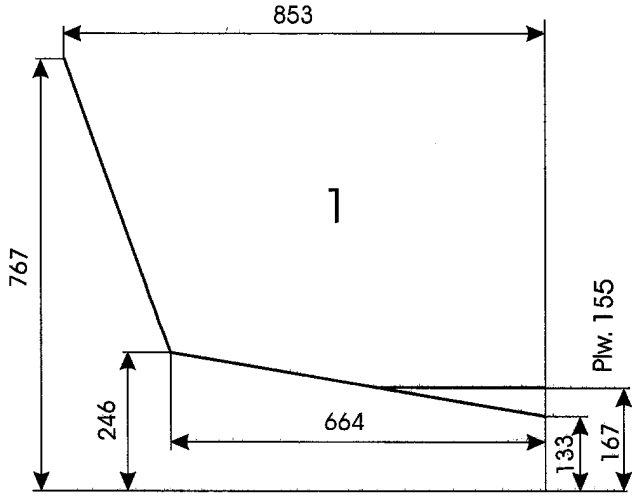
MAIN DIMENSIONS

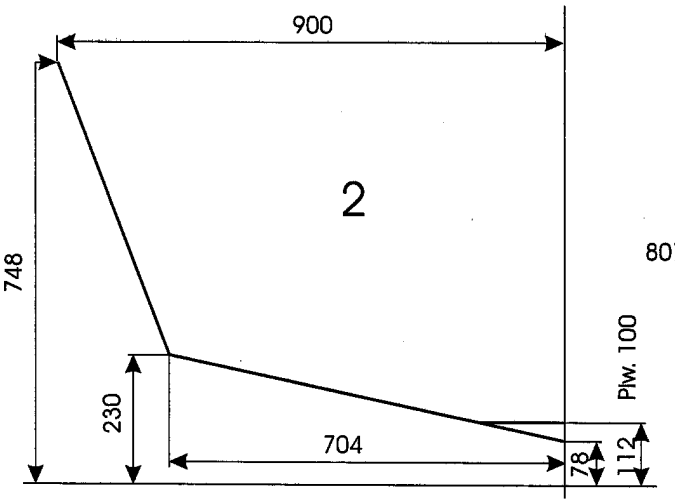
Length over all	LOA = 8. 5 m (28 ft)
Beam moulded	BMD = 1.85 m (6 ft)
Depth moulded	DMD = 0.72 m (2ft 4 in)
Cubic number	LOA x BMD x DMD = 11.3 m^3
Weight empty :	800 kg with diesel engine
Load	500 kg
Weight loaded:	1300 kg
Recommended engine :	8 Hp
Service speed :	7 knots

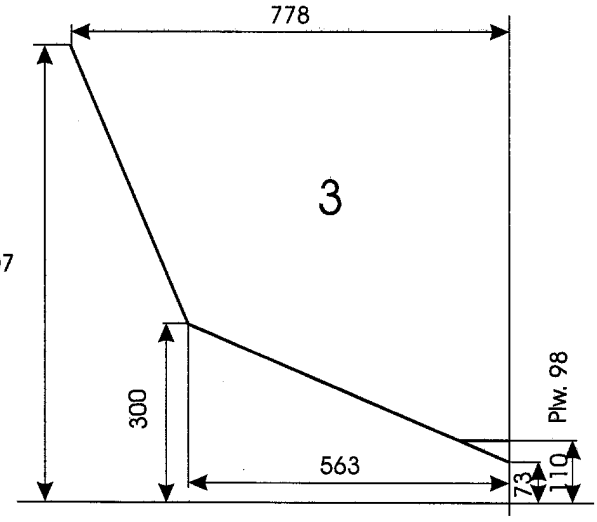
5.2 M BOAT - FRAME DIMENSIONS

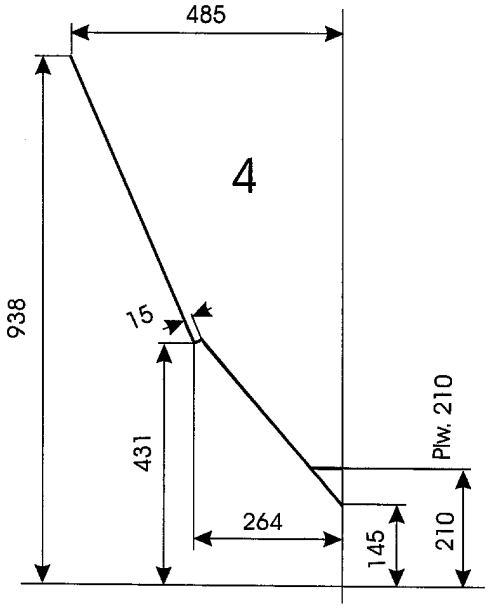
NOTE THE CHANGE IN THE BOTTOM FRAME
FOR PLYWOOD CONSTRUCTION = Plw.





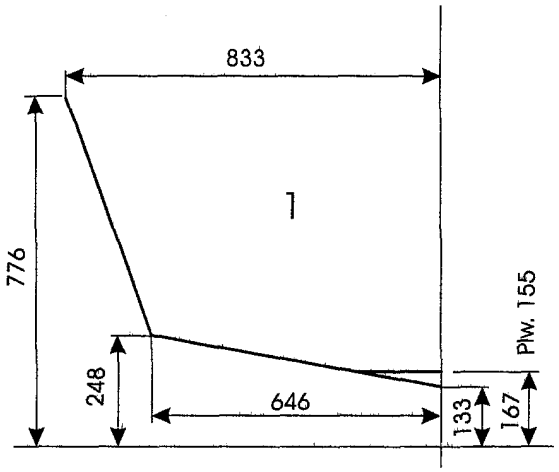


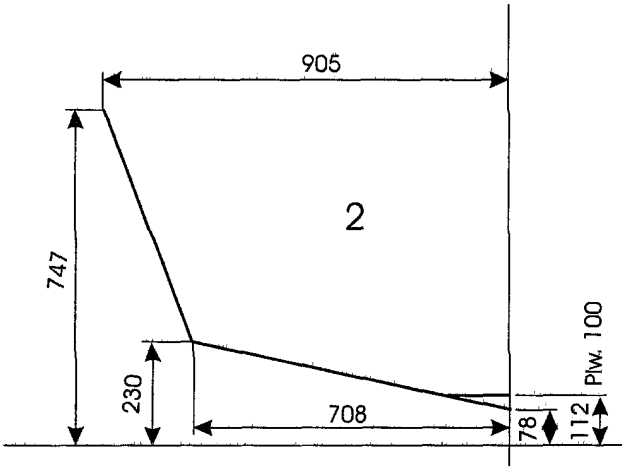


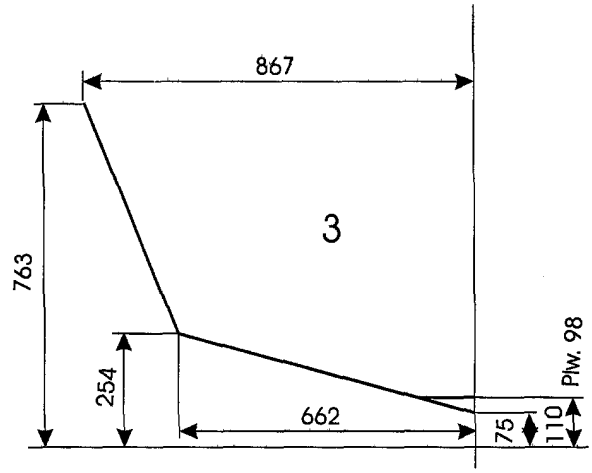


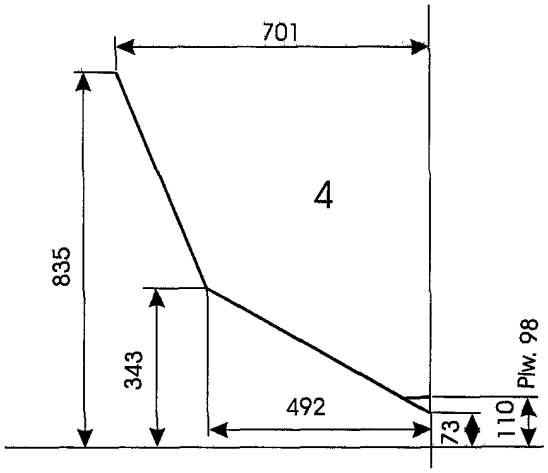
TRANSOM IS SAME AS FOR 5.2 M BOAT.

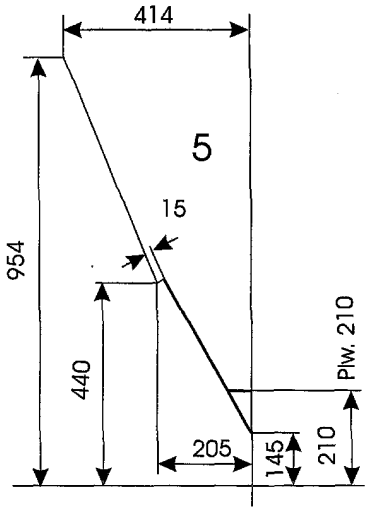
NOTE THE CHANGE IN THE BOTTOM FRAME
FOR PLYWOOD CONSTRUCTION = Plw.







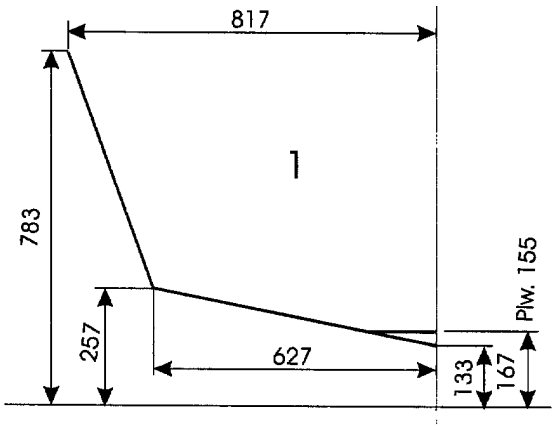


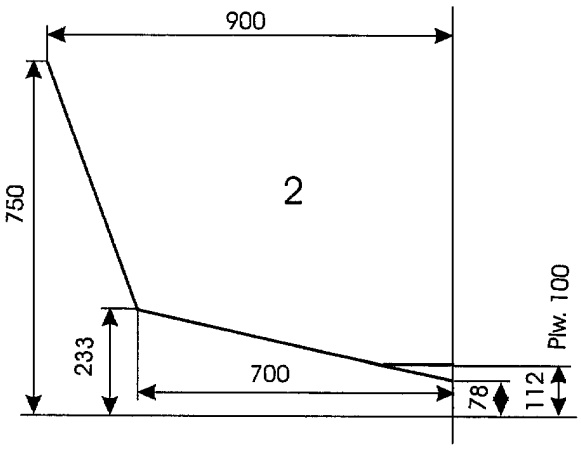


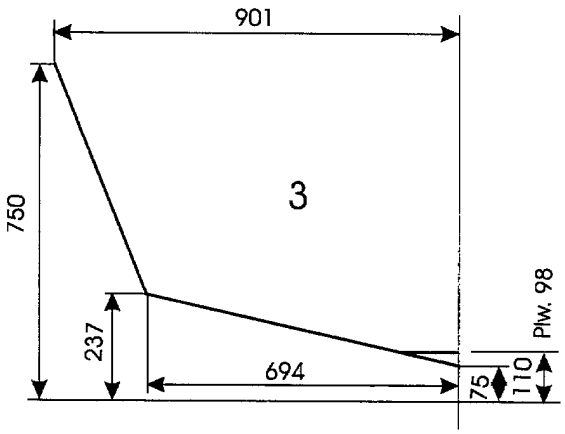
7.4 M BOAT - FRAME DIMENSIONS

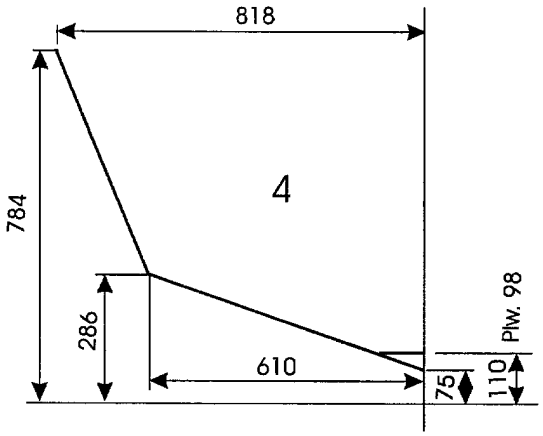
TRANSOM IS SAME AS FOR 5.2 M BOAT

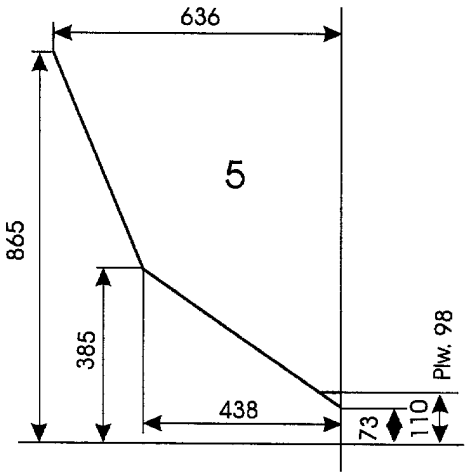
NOTE THE CHANGE IN THE BOTTOM FRAME
FOR PLYWOOD CONSTRUCTION = Plw.

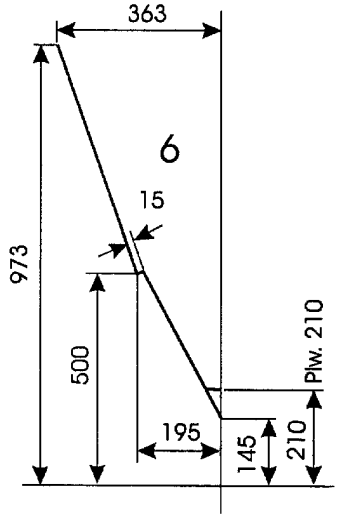






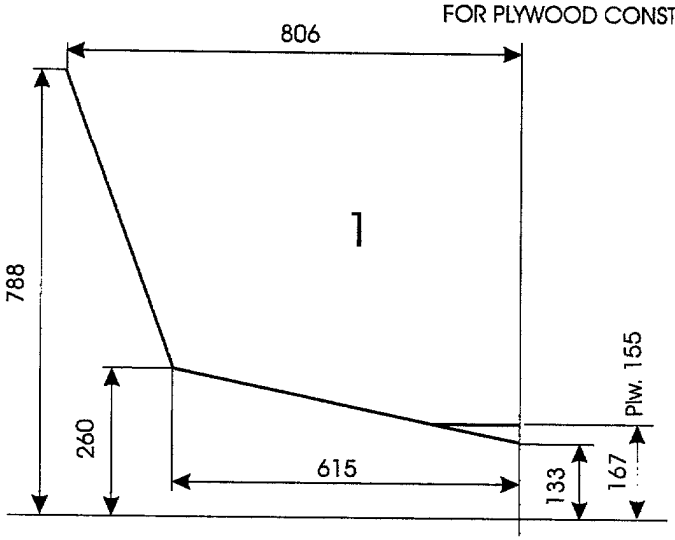


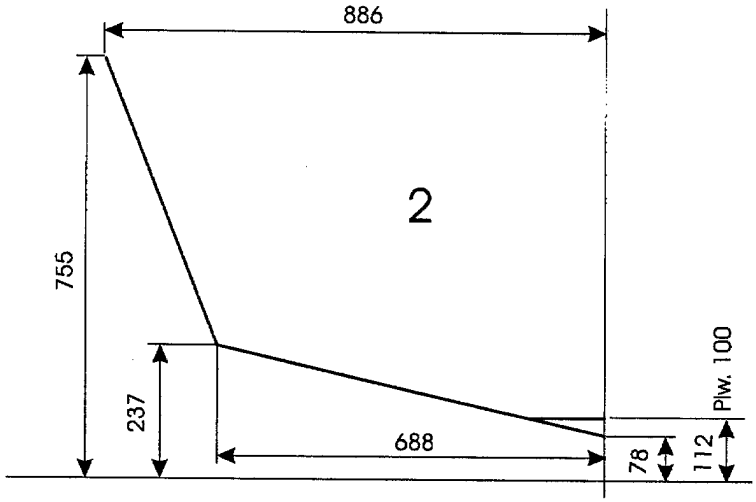


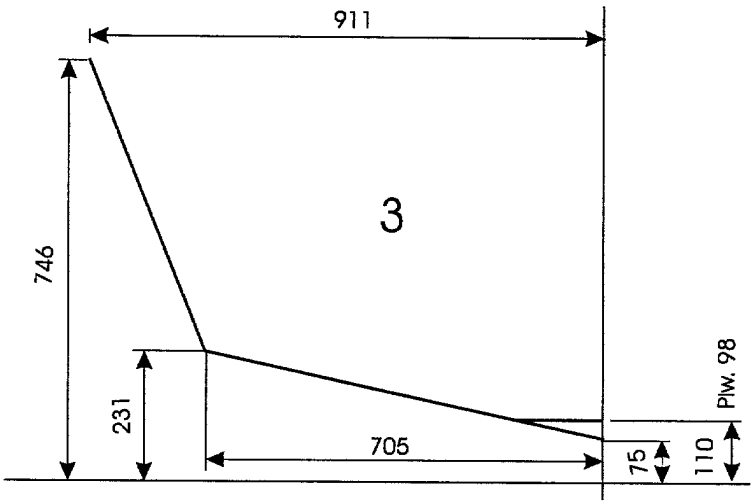


TRANSOM IS SAME AS FOR 5.2 M BOAT.

NOTE THE CHANGE IN THE BOTTOM FRAME FOR PLYWOOD CONSTRUCTION = Plw.

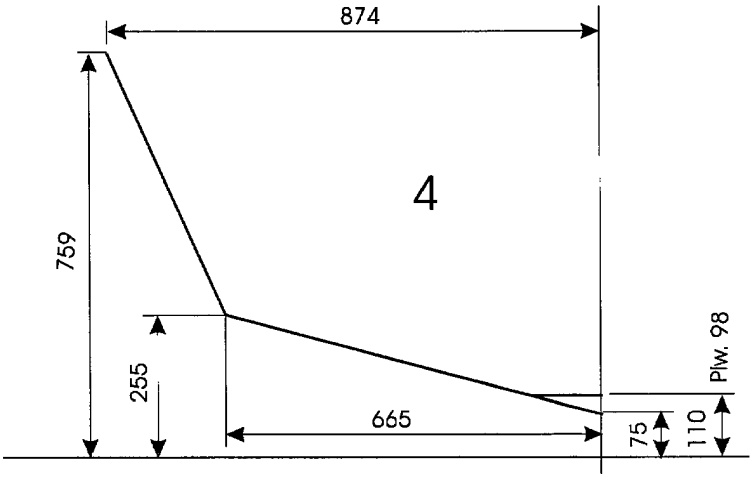


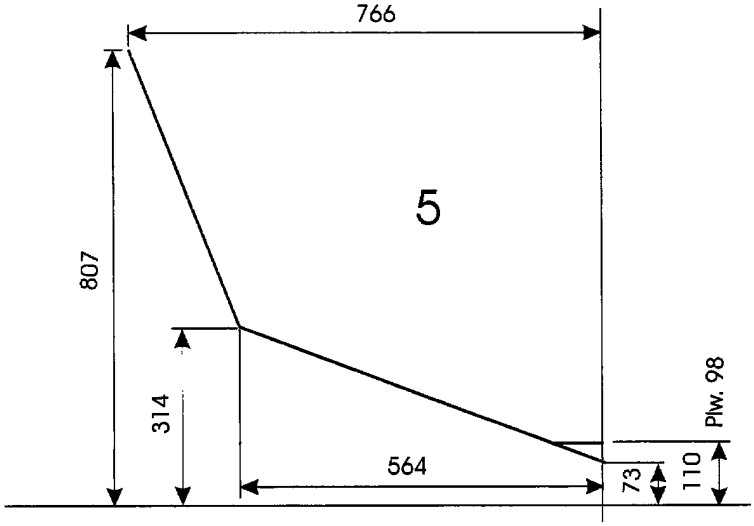


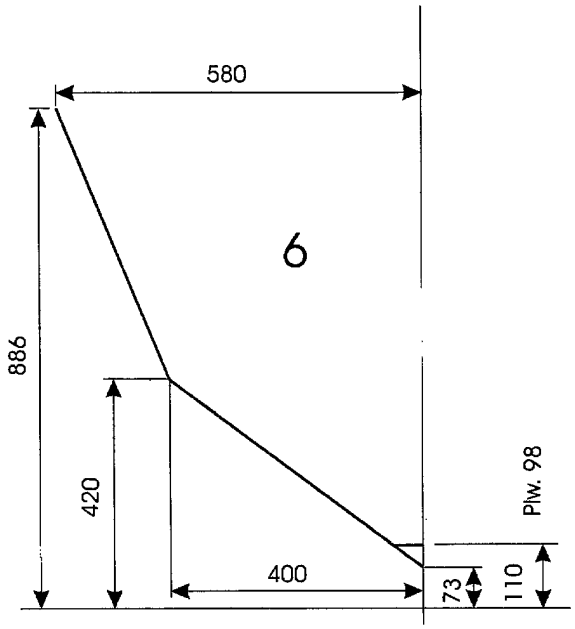


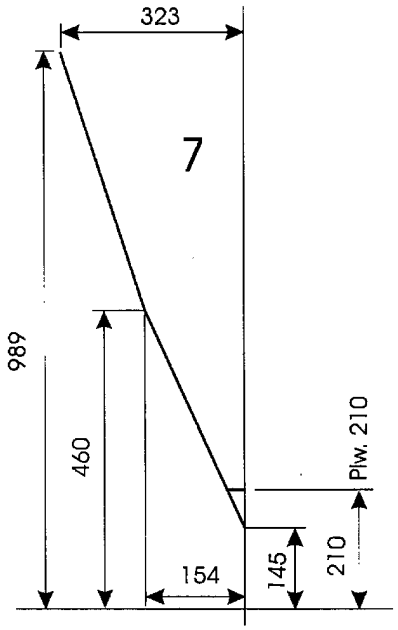
8.5 M BOAT - FRAME DIMENSIONS

NOTE THE CHANGE IN THE BOTTOM FRAME
FOR PLYWOOD CONSTRUCTION = Plw.

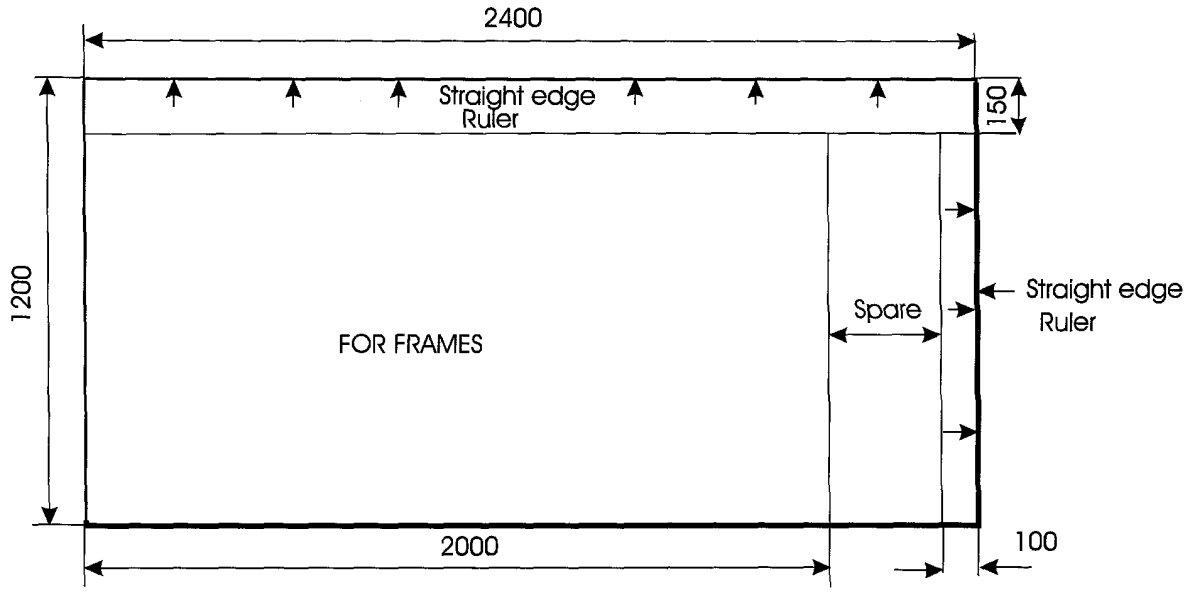


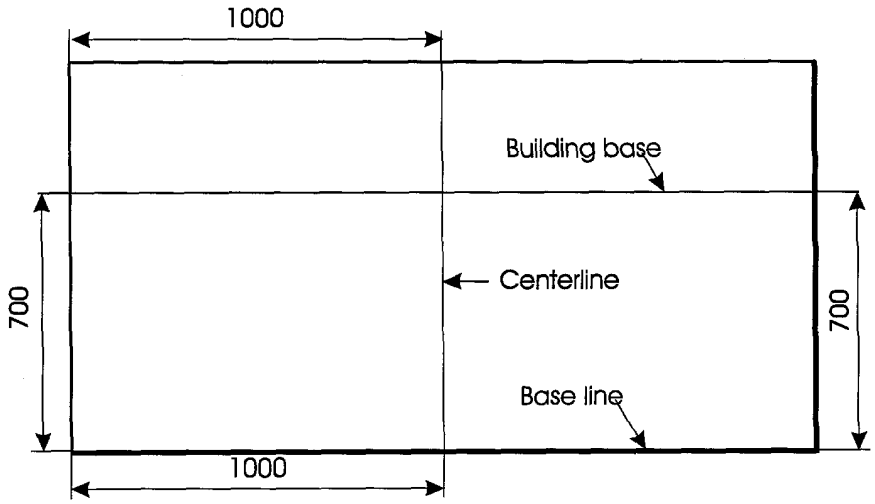




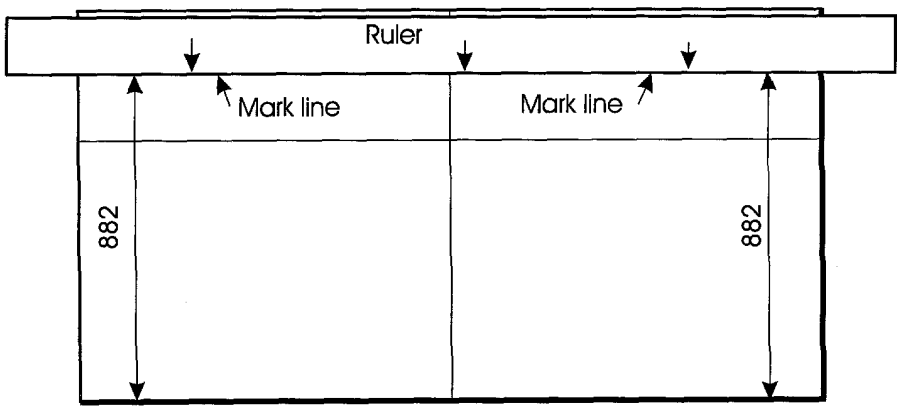


Use a sheet of ordinary plywood, thickness = 9 mm or 12 mm and cut as shown.



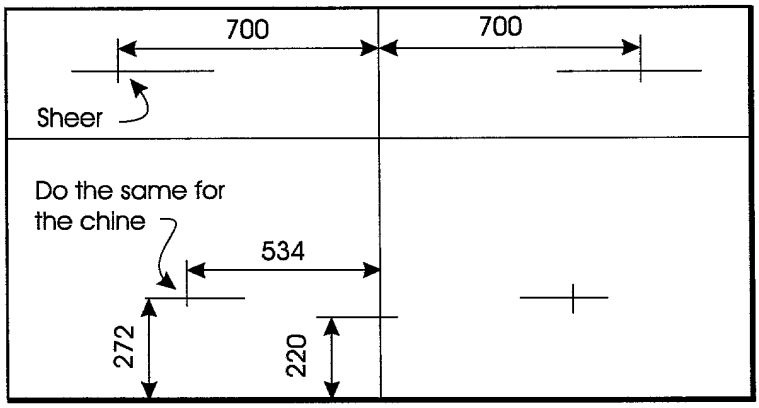


EXAMPLE : TRANSOM = T

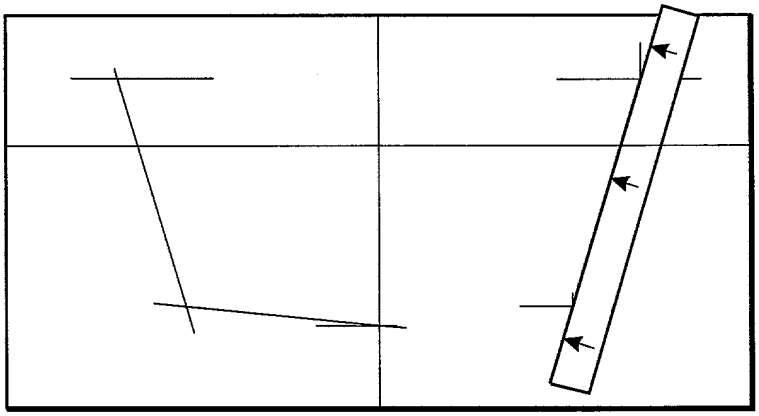


1

2


700
700
Sheer
Do the same for
the chine
534
272
220

3



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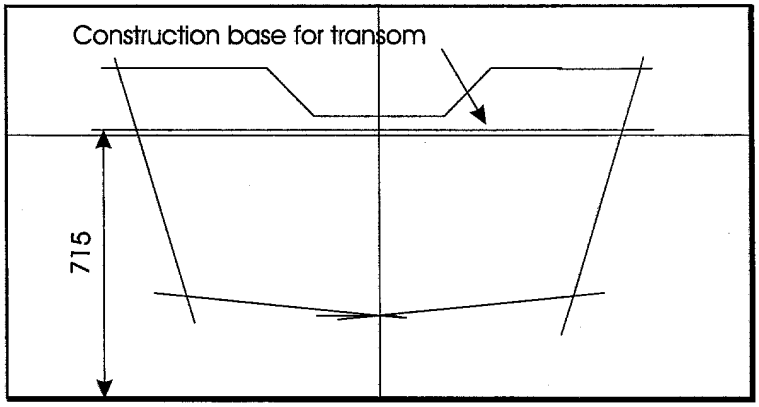
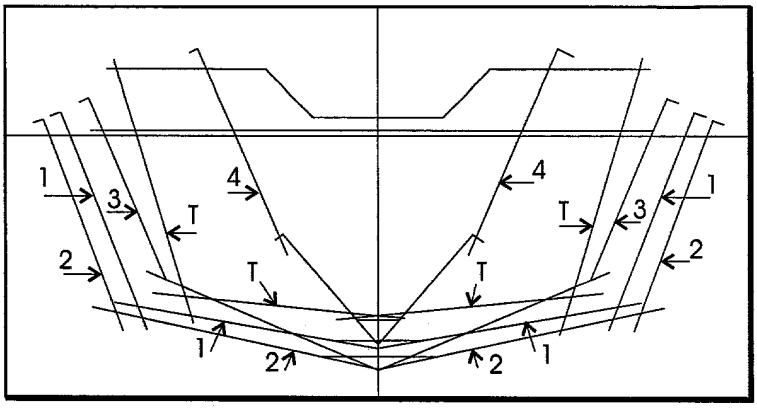
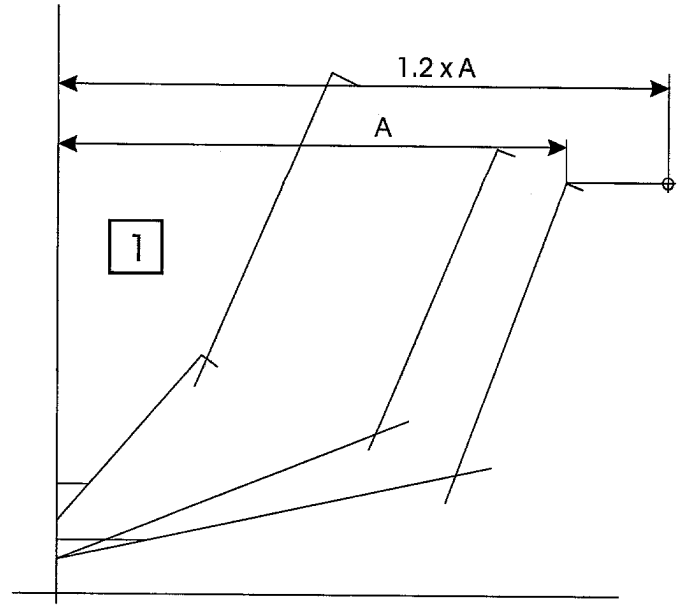

Construction base for transom
715

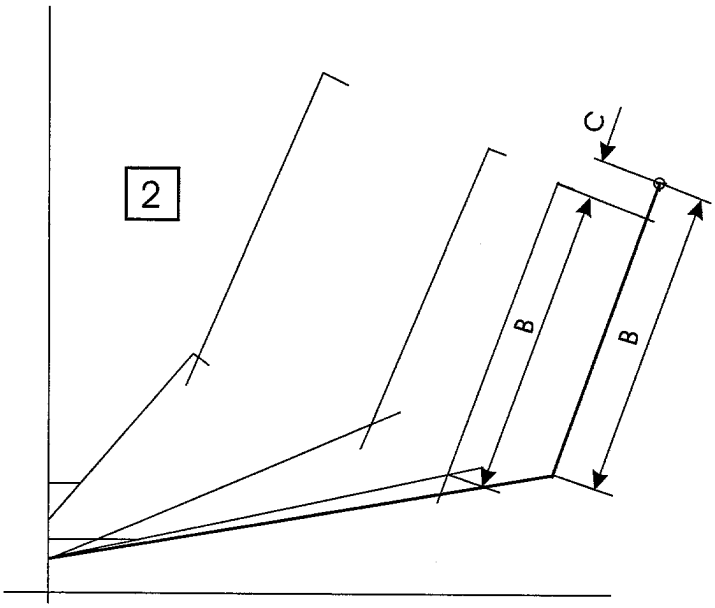
5


1
3
T
4
2
T
1
2
T
4
T
3
1
2

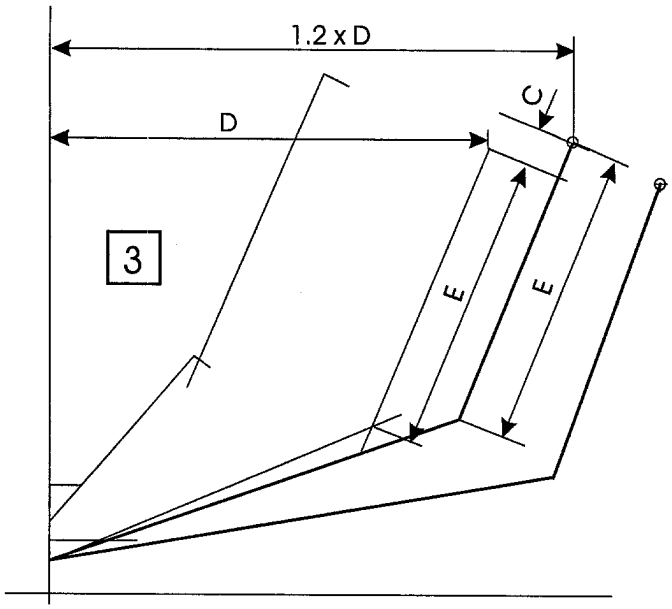


The beam of the various boats can be modified on the basis of the frame dimensions given in pages 6 to 10. The maximum increase in the beam is 20 % which means that the moulded beam increase from 1.85 m to 2.20 m.

As an example how this is done is taken the frames from midship and forward.
Start with the widest frame and multiply the half beam with the chosen factor of increase, in this case = 1.2.
Draw a line parallel with the base line and mark off the new beam.

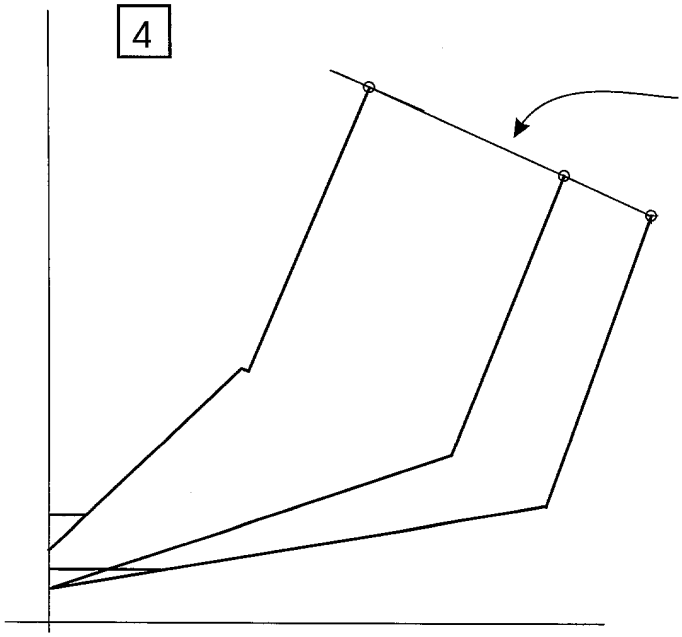


From this new sheerpoint, draw a line parallel with the old sideframe and transfer the length of the sideframe= B and mark off the new chinepoint.
Draw the new bottom frame.
Draw a line at right angle to the side - frame through the old sheerpoint.
Measure the distance C from the new sheerpoint down to this line.



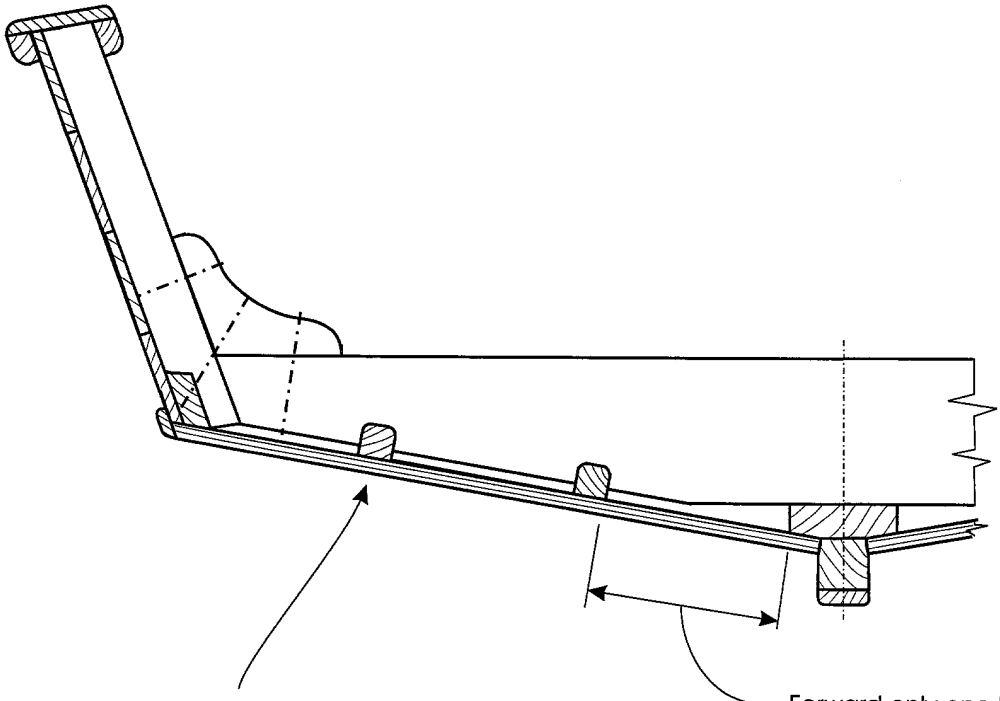
On the next frame, draw a line through the sheerpoint and at right angle to the sideframe. Draw a parallel line at a distance = C.
Multiply the halfbeam of this frame with the factor = 1.2 and mark off the new sheerpoint on the parallel line drawn earlier.
Transfer the length of the old sideframe = E to the new sideframe in the same way as done for the midship frame.
From the new chinepoint draw the new bottomframe.

4



Modify the remaining frames in the same way.
Check the result by drawing a line through the sheerpoints. This should give an even curve close to a straight line.

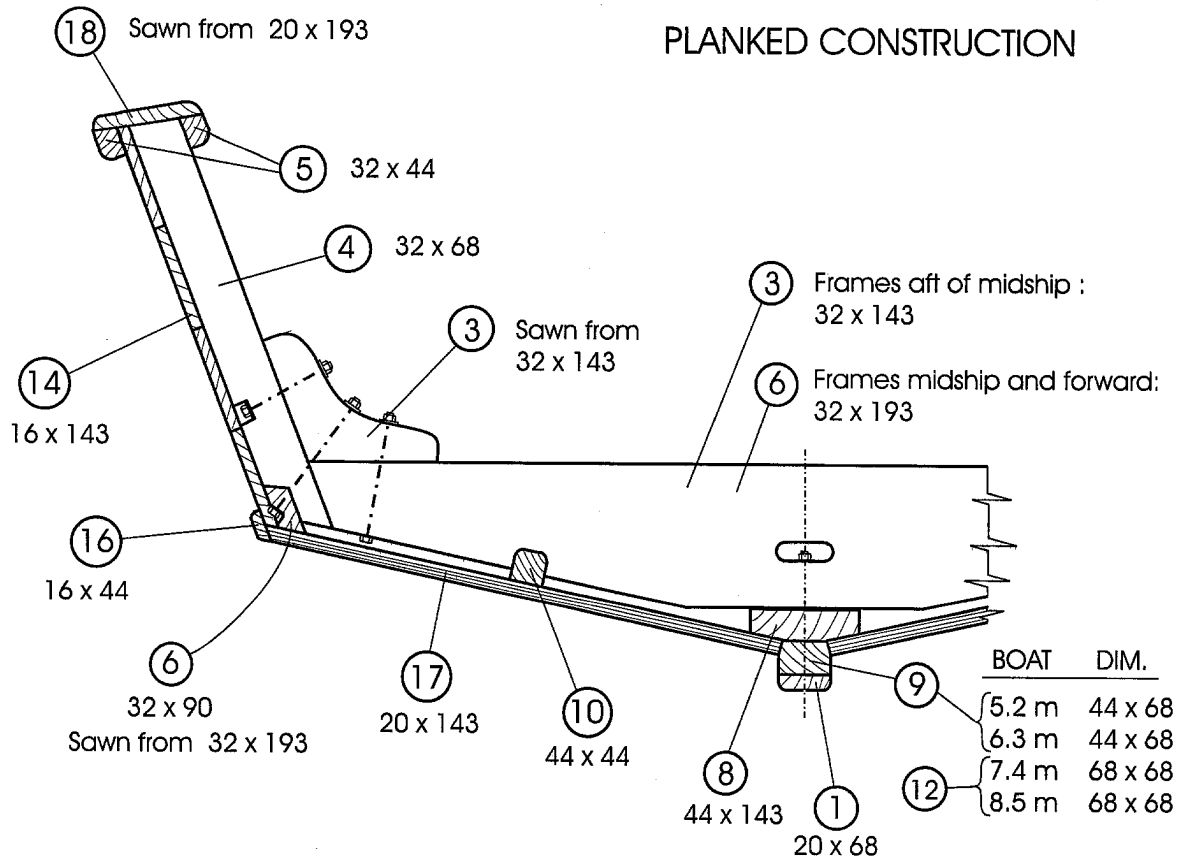
Do the same for the frames aft of midship, starting with the midship frame.



Increasing the beam from the original designs will require an extra batten in the bottom.

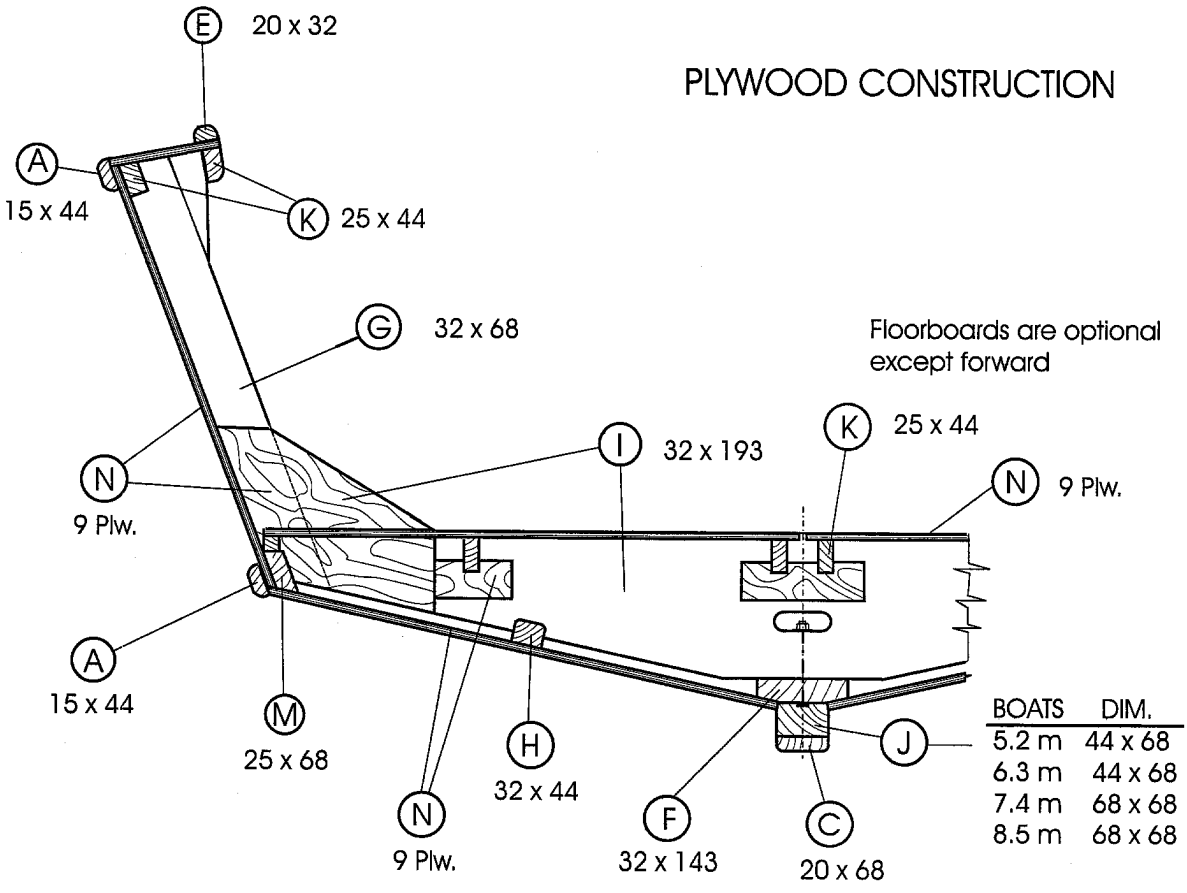
Forward only one batten is required provided the span of the planking is below 270 mm.

PLANKED CONSTRUCTION



BOAT	DIM.
5.2 m	44 x 68
6.3 m	44 x 68
7.4 m	68 x 68
8.5 m	68 x 68

PLYWOOD CONSTRUCTION



BOATS	DIM.
5.2 m	44 x 68
6.3 m	44 x 68
7.4 m	68 x 68
8.5 m	68 x 68

TYPE A

A timber of medium weight, between 650 kg / m^3 and 750 kg / m^3 when air-dried.
This heavier timber has two important advantages compared with a lighter timber:

1. It will hold fastenings such as nails and bolts well and in a wooden boat the strength is mainly dependent on the fastenings.
2. Heavier timber is usually more rot resistant than lighter timber and this is important in parts of the boat that are difficult to change such as frames, keel and the stem.

Through experience , boatbuilders have been able to determine which local timber is suitable for these items and it is safest to follow their advice. The more known timbers of type A are oak, iroko, kapur, afromosia, opepe, gurjun and teak, but there are many other species that might be known locally as suitable.

TYPE B

A timber of relatively light weight of between 500 kg / m^3 to 600 kg / m^3 when air-dried.
The timber is mainly used for planking and deck, and the most important quality is low movement in service, that it does not swell or shrink much with changing humidity.
Known timber suitable for this is mahogany, Douglas fir and European redwood, but there are many other species.

QUANTITY OF TIMBER FOR THE BOATS

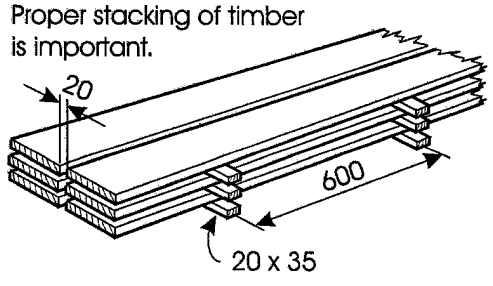
Below is given a list of sawn timber required for the various planked boats. Timber for the buiding jig is given on page 25.
The quantity includes a wastage factor of 25 %. The wastage factor could be lower or higher dependent on the quality and the length of timber available. Longer lengths of timber gives less wastage. However an advantage of the cross-planked bottom is the utilization of short lengths of timber.

TYPE OF TIMBER	DIMENSION FROM SAWMILL		TOTAL LENGTH OF TIMBER IN METRES			
	MM	INCH	5.2 M BOAT	6.3 M BOAT	7.4 M BOAT	8.5 M BOAT
A	25 x 150	1 x 6	7	9	10	12
	38 x 150	1 ½ x 6	32	39	45	52
	38 x 200	1 ½ x 8	15	18	21	25
	50 x 150	2 x 6	18	22	20	22
	75 x 150	3 x 6	4.0	4.0	6.5	7.6
	100 x 250	4 x 10	1.4	1.4	1.4	1.4
A m^3			0.54	0.65	0.76	0.86
B	20 x 150	¾ x 6	63	76	90	103
	25 x 150	1 x 6	58	70	82	94
	25 x 200	1 x 8	34	41	48	55
B m^3			0.58	0.70	0.82	0.95
Total volume A + B m^3			1.12	1.35	1.59	1.81

AIR DRYING OF TIMBER

After sawing, the timber must be stored under a roof protected against sun and rain. The drying time depends on the season. During the dry season a 25 mm plank will dry in 3 months, but it will take 9 months during the rainy season.

Proper stacking of timber is important.



PLANKED BOAT 5.2 M - TIMBER

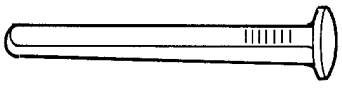
FOR THE OTHER BOATS MULTIPLY THE LENGTHS WITH THE FACTOR F :
6.3 M BOAT. F = 1.2. 7.4 M BOAT : F = 1.4. 8.5 M BOAT: F = 1.6.
NOTE: The keel for the 7.4 m and the 8.5 m boat is 68 x 68 sawn from 75 x 150

TYPE OF TIMBER	DIMENSION FROM SAWMILL mm	TOTAL LENGTH m	SAWING INTO SMALLER SECTIONS mm	TOTAL LENGTH m	PLANED DIMENSION mm	ITEM NUMBER
A	25 x 150	3	25 | 75 | 75	6	20 x 68	1
		4	25 | 50 | 50 | 50	12	20 x 44	2
	38 x 150	8	38 | 150	8	32 x 143	3
		14	38 | 75 | 75	28	32 x 68	4
		10	38 | 50 | 50 | 50	30	32 x 44	5
	38 x 200	14	38 | 200	14	32 x 193	6
		1	38 | 100 | 100	2	32 x 93	7
	50 x 150	7	50 | 150	7	44 x 143	8
		5	50 | 75 | 75	10	44 x 68	9
		6	50 | 50 | 50 | 50	12	44 x 44	10
	75 x 150	2.5	75 | 150	2.5	68 x 143	11
		1.3	75 | 75 | 75	2.6	68 x 68	12
	100 x 250	1.4	100 x 250	1.4	93 x 240	13
B	20 x 150	57	20 | 150	57	15 x 143	14
		2	20 | 75 | 75	4	15 x 68	15
		4	20 | 50 | 50 | 50	12	15 x 44	16
	25 x 150	58	25 | 150	58	20 x 143	17
	25 x 200	29	25 | 200	29	20 x 193	18
		5	25 | 100 | 100	10	20 x 93	19

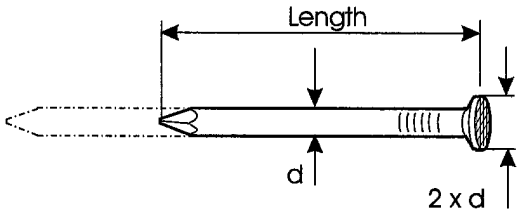
ALL FASTENINGS MUST BE HOT DIPPED GALVANIZED

Hot dipped galvanized fastenings have a dull grey and rough surface because of a thick zinc-coating. Electroplated fastenings which are also sold as " galvanized " have a shiny, smooth and silvery surface. The zinc coating is very thin and gives no protection in salt water.

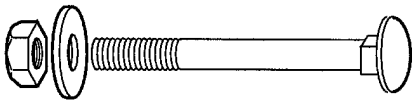
Always specify " hot dipped galvanized" not just "galvanized".



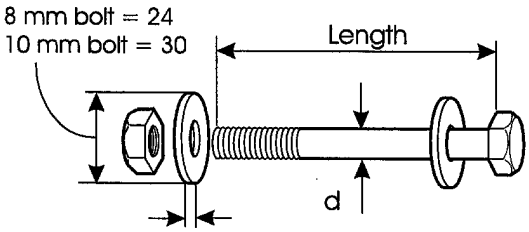
BOAT NAIL



ROUND WIRE NAIL

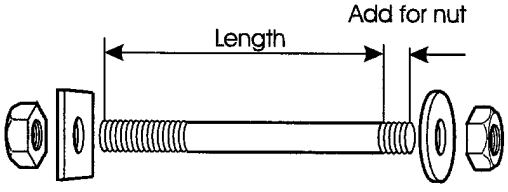


CUP - SQUARE COACH BOLT



Minimum 2.5 mm for 8mm bolt
3 mm for 10 mm bolt

HEXAGONAL HEAD BOLT



If round washers are not available use square washers of same thickness and width as round washers.

THREADED BOLT

NAILS

If specially made boatnails are available they are the best choice. Boatnails are square in section and are thick in relation to the length.
In most developing countries these nails cannot be bought locally. Round wirenails are however widely available. Used for house construction they are thin in relation to the length. When used for boat building they must be cut down in length before galvanizing, or a special order made from the nail factory.
Tests have shown that round wire nails are as strong as square nails provided the diameter is equivalent.
It is important that the head of the nail is large, about twice the diameter of the nail.

For the boats in this publication three sizes of nails are required. Predrilling must be done for all nails.

DIAMETER	LENGTH	PREDRILL
4 mm (8 SWG)	50 mm (2 in.)	3.5 mm
5 mm (6 SWG)	75 mm (3 in.)	4.0 mm
5 mm (6 SWG)	100 mm (4 in)	4.0 mm

The nailhead should be countersunk about 2-3 mm for the 4 mm nail and 4 mm for the larger nails and it will in harder wood be necessary to predrill for this before drilling the main hole. The nailhead should be covered with mastic to assist against corrosion.

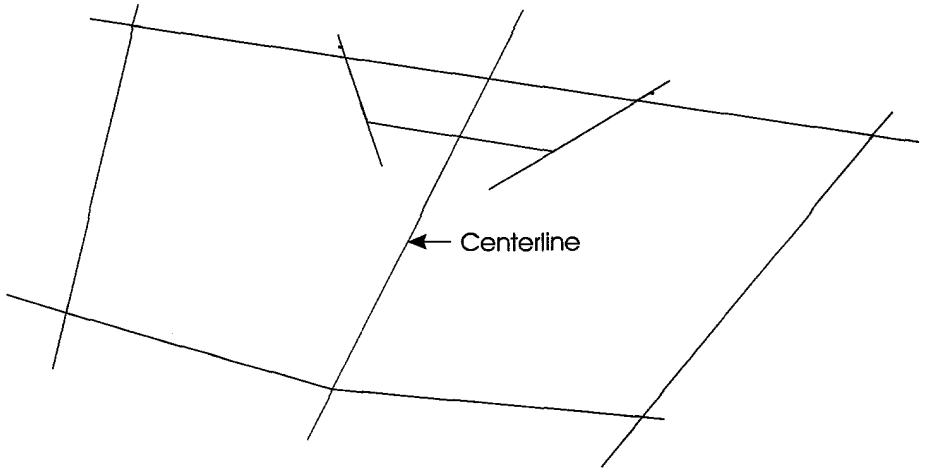
BOLTS

Coach bolts also called carriage bolts or more correctly cup-square coach bolts are used in boat building but they are increasingly being seen as "specials" and often only made with an electroplated finish.
Ordinary hexagonal head steelbolts are easier to buy hot dipped galvanized. For timber construction they must be fitted with large washers.
Most bolts for the boats in this publication are 8 mm and normally not available in lengths above 120 mm. Longer bolts must be made from a hot dipped galvanized rod and threaded in both ends. The zinc-coating on the nut will provide some protection also for the bare threads, but in addition the threaded part should be smeared with bitumastic compound before inserting the bolt.
Rods threaded all along should not be used since the bearing area against the wood is reduced.

ITEM		QUANTITY			
		5.2 m	6.3 m	7.4 m	8.5 m
Hexagonal head bolt, hot dipped galvanized, with nut. Alternative: Cup - square coach bolt, hot dipped galvanized, with nut.					
	8 x 80	31	45	51	57
	8 x 100	8	19	20	21
	8 x 120	14	16	18	20
	8 x 140	9	11	13	15
	8 x 150	2	2	2	2
	8 x 170	10	12	14	16
	10 x 80	2	2	2	2
	10 x 100	2	2	2	2
	10 x 120	3	4	5	6
	10 x 170	1	1	1	1
Rod, hot dipped galvanized of 8 mm and 10 mm will be required if the sizes given above is not available.					
Washer, large size, round or square, hot dipped galvanized. The quantity must be increased if bolts are to be made from rod.	For bolt 8	140	220	260	280
	For bolt 10	18	20	22	24
Nut, hot dipped galvanized Quantity depend on the number of bolts that have to be made from rod.					
Nails, hot dipped galvanized, either boat nails or round wire nails cut down in length or specially ordered from local nail factory.					
Diameter =4 mm (8 SWG) x 50 About 170 nails / kg		8 kg	10 kg	12 kg	13 kg
Diameter = 5 mm (6 SWG) x 75		0.5 kg	0.5 kg	0.5 kg	0.5 kg
Diameter = 5 mm (6 SWG) x 100		0.5 kg	0.5 kg	0.5 kg	0.5 kg
Bitumastic compound (Roofing compound, Hydroseal etc.)		5 kg	5 kg	6 kg	7 kg
Nylon fly screen, 1 m wide		1 m	1 m	1.5 m	2 m
Caulking cotton, quantity depends on what is available in trade.					
Filler		1 kg	1.5 kg	2 kg	2 kg
Wood primer		5 kg	6 kg	7 kg	7 kg
Paint		6 kg	7 kg	8 kg	8 kg
Antifouling paint		1 kg	1 kg	1.5 kg	1.5 kg
Paint thinner		2 L	2 L	2 L	3 l
Buoyancy material, polyurethan, polystyrene, plastic container etc.		0.1 cub.m	0.1 cub.m	0.1 cub.m	0.1 cub.m
Sailing rudder fitting, emergency sail see drawing.					

22 TRANSOM

1



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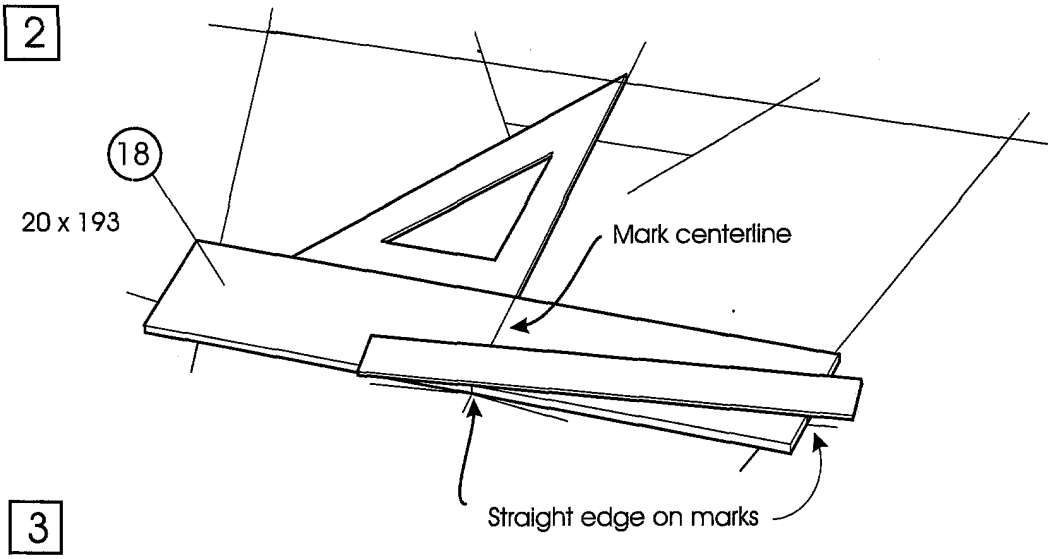

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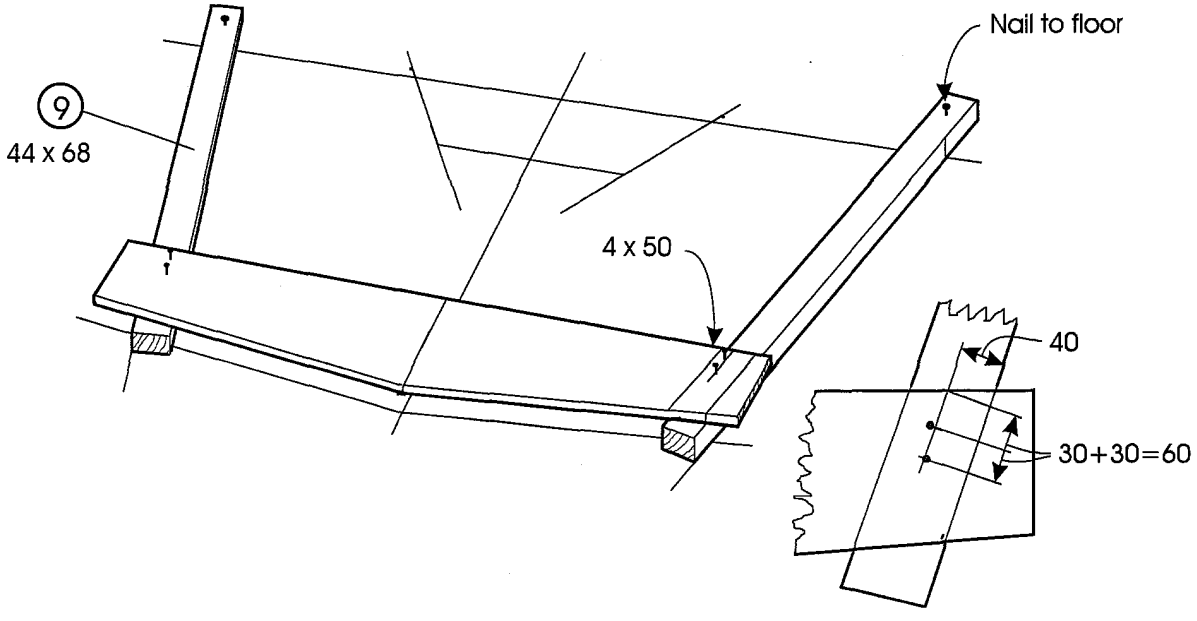

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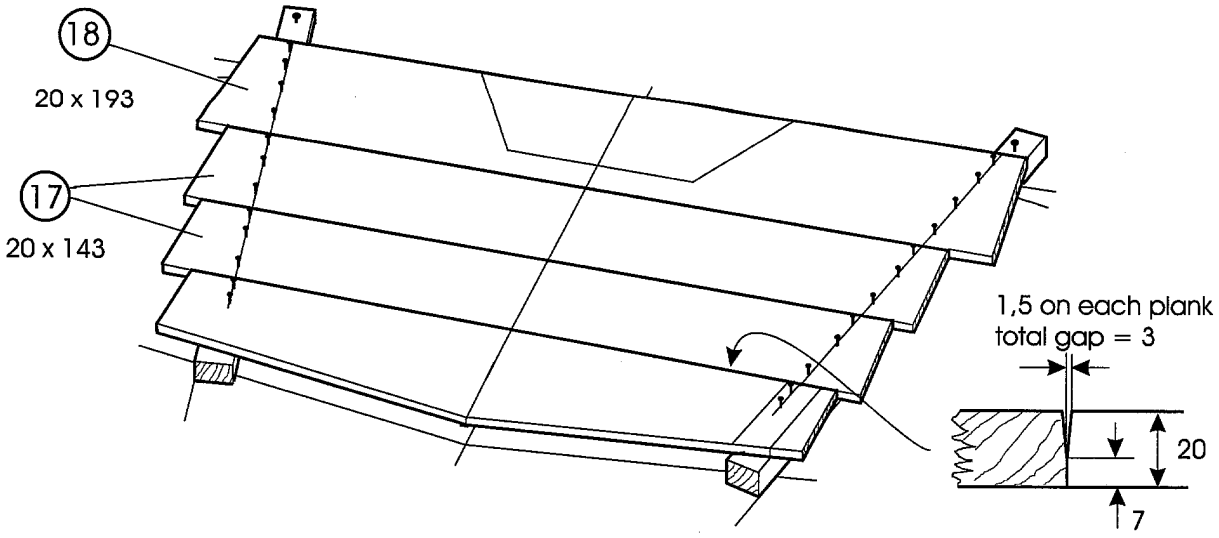
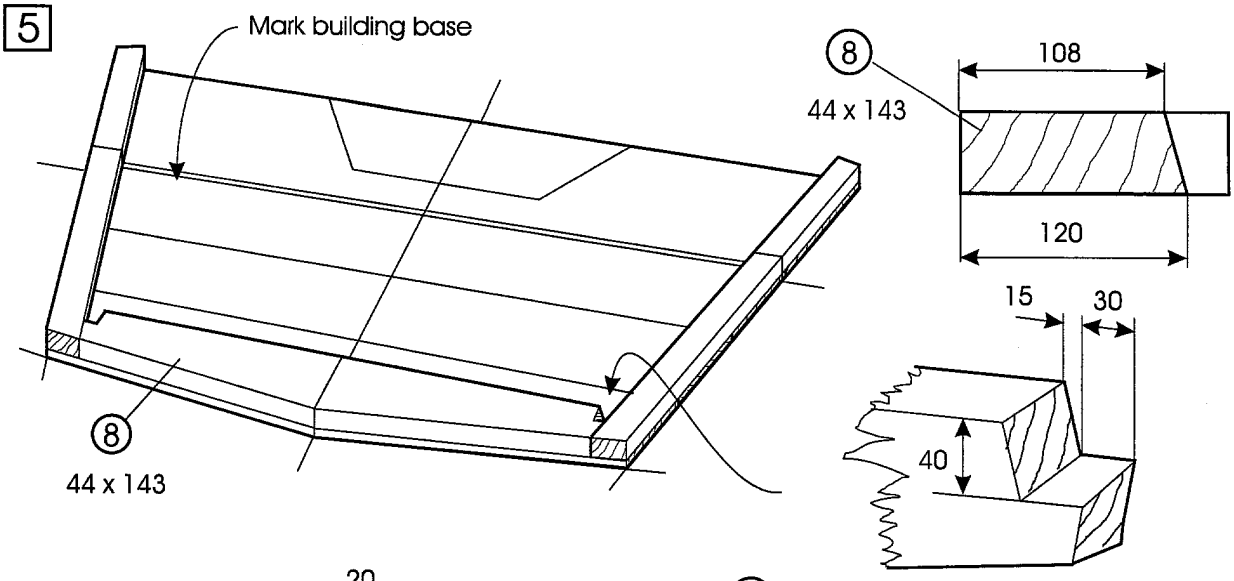
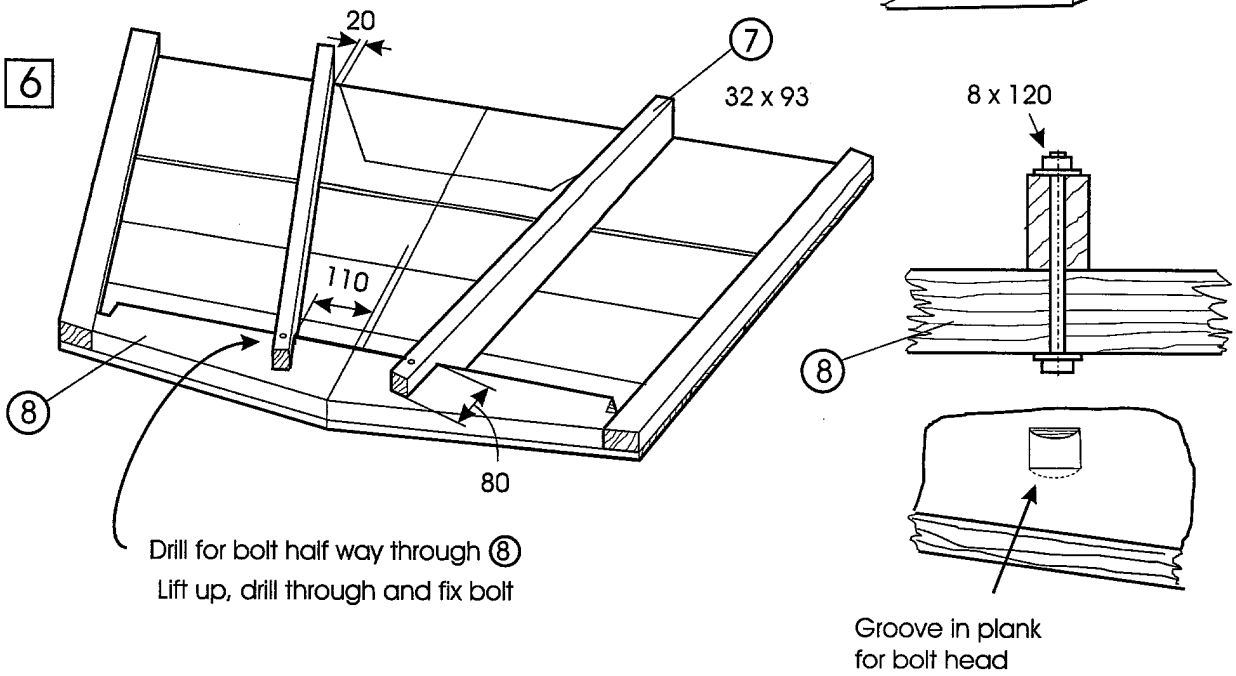

18
20 x 193
17
20 x 143
1,5 on each plank
total gap = 3
20
7

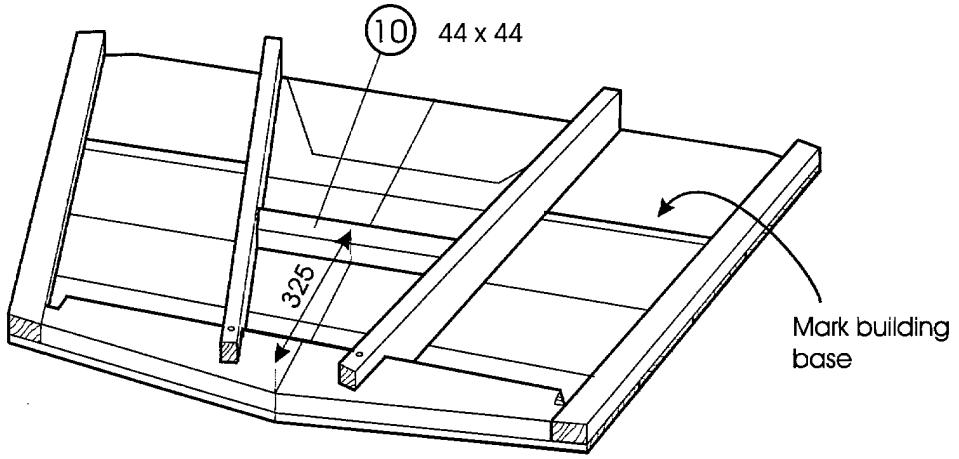
5


Mark building base
8
44 x 143
108
120
15
30
40
8
44 x 143

6


20
7
32 x 93
8 x 120
110
8
80
8
Drill for bolt half way through 8
Lift up, drill through and fix bolt
Groove in plank
for bolt head

7



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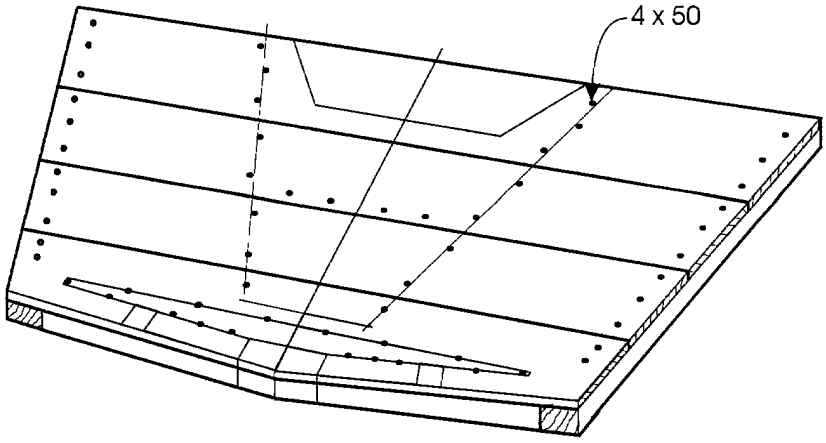
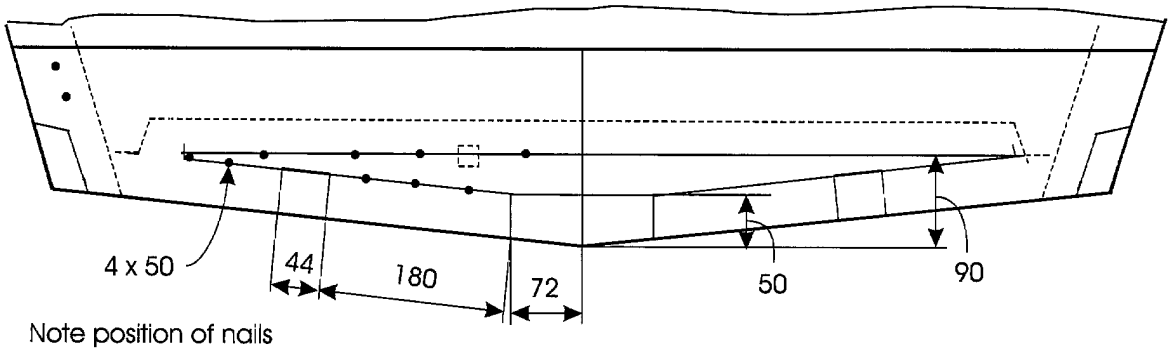
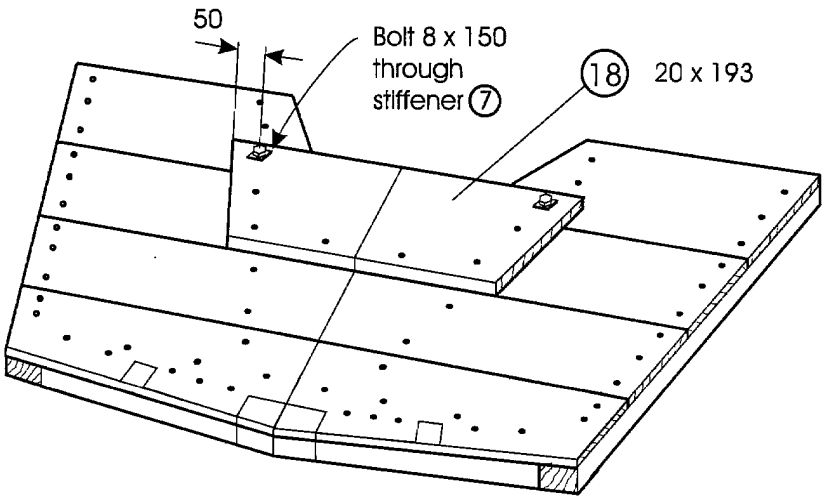


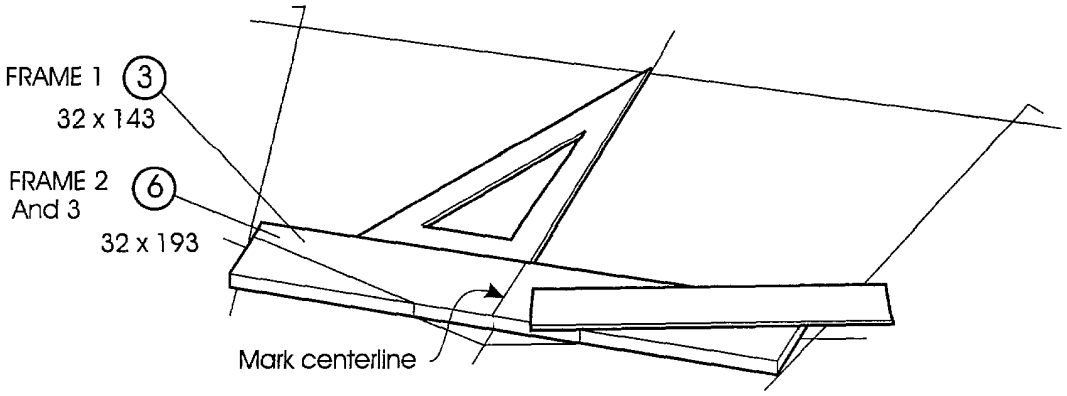


Note position of nails

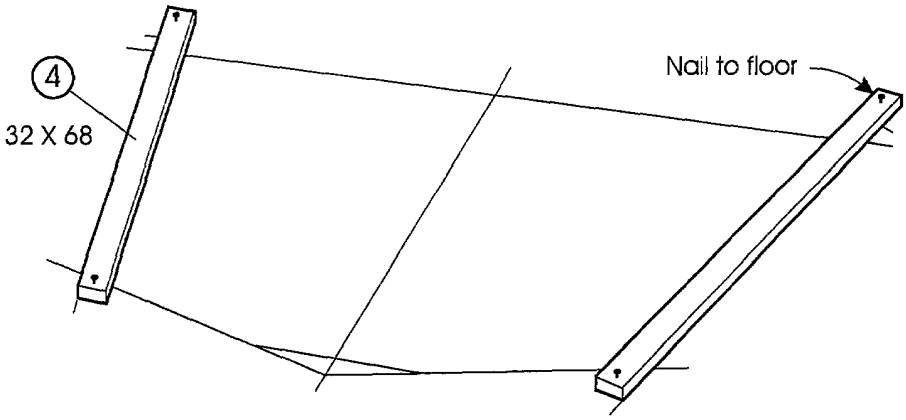
9



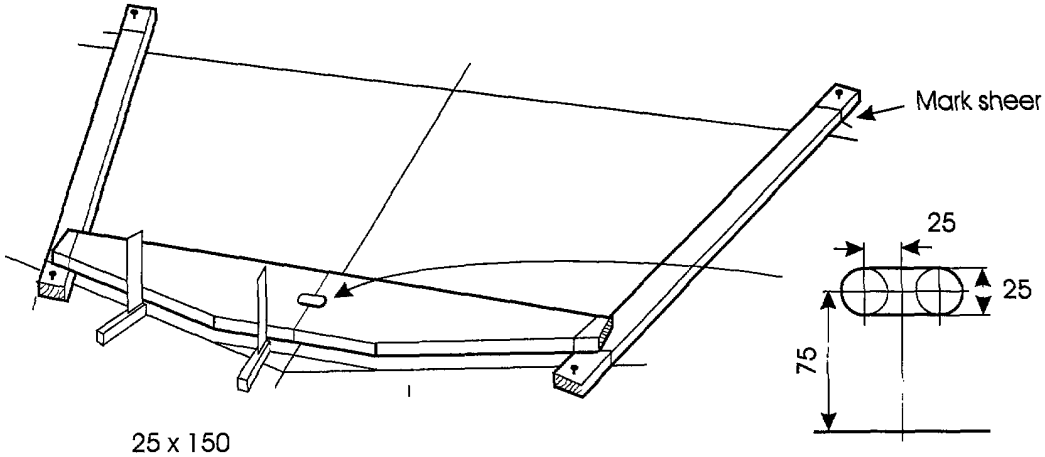
1


FRAME 1 (3)
32 x 143
FRAME 2
And 3 (6)
32 x 193
Mark centerline

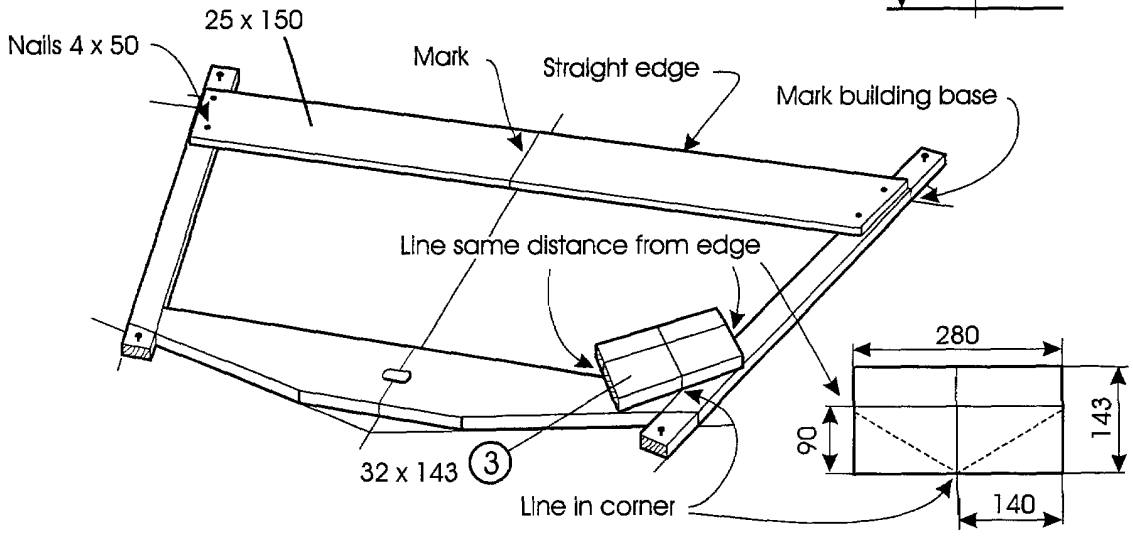
2


(4)
32 X 68
Nail to floor

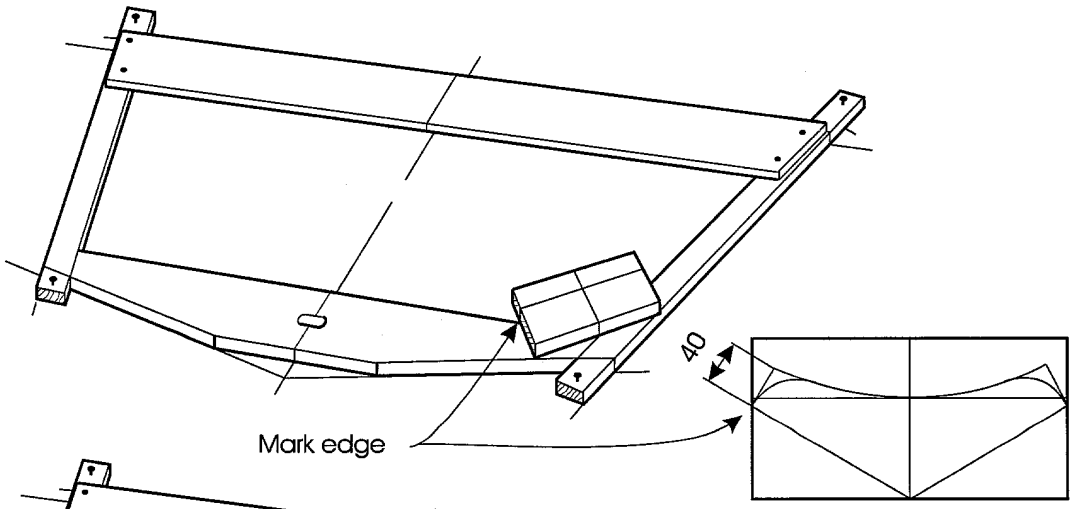
3


Mark sheer
25
25
75

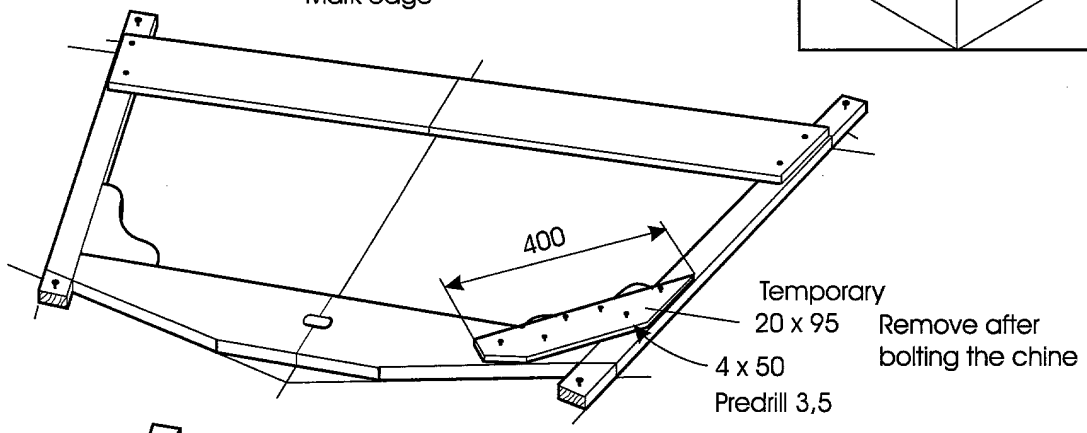
4


Nails 4 x 50
25 x 150
Mark
Straight edge
Mark building base
Line same distance from edge
280
90
143
140
32 x 143 (3)
Line in corner

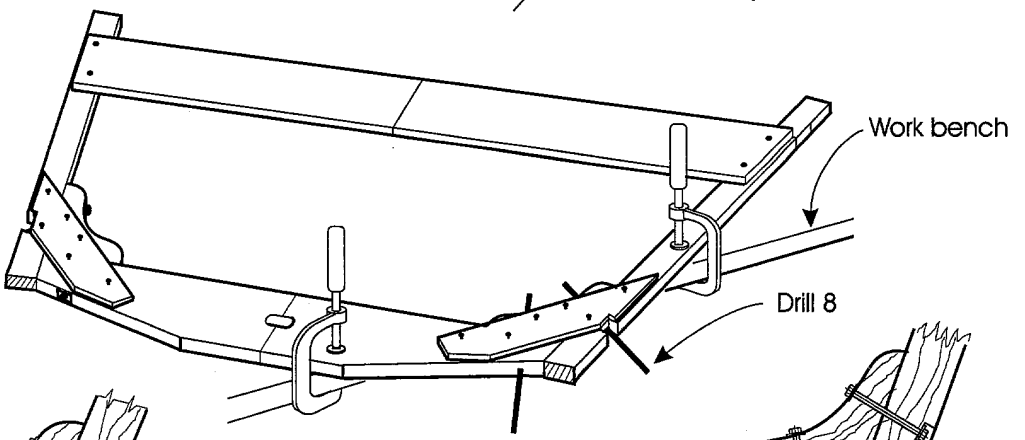
5

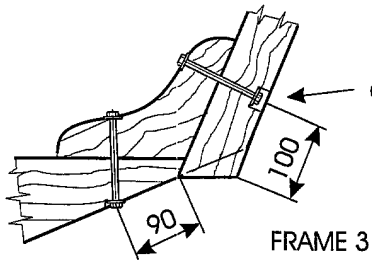


6

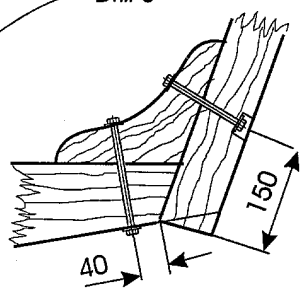


7



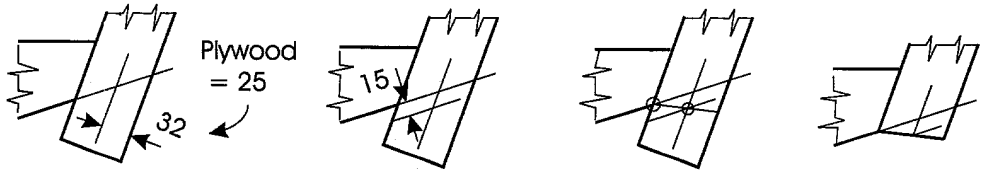


FRAME 3



FRAME 1 and 2

CUTTING THE SIDE FRAME



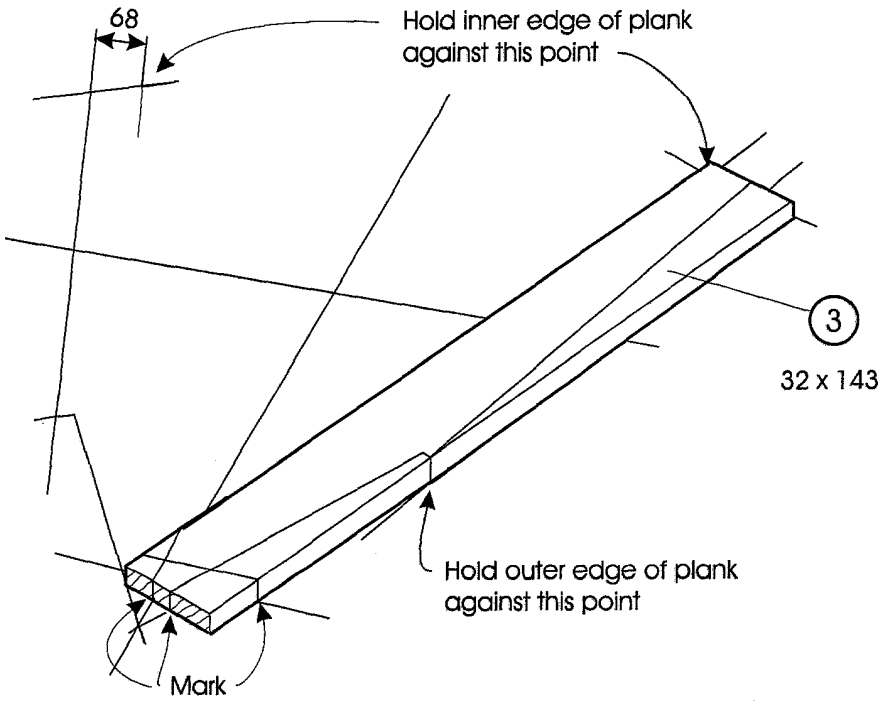
1. Mark a line the width of the chine

2. Mark a line below bottom line.

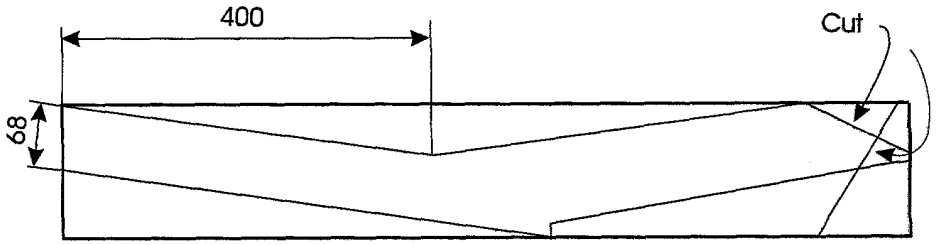
3. Draw a line through the two points

4. Cut off the frame along the line

1



Make a second copy



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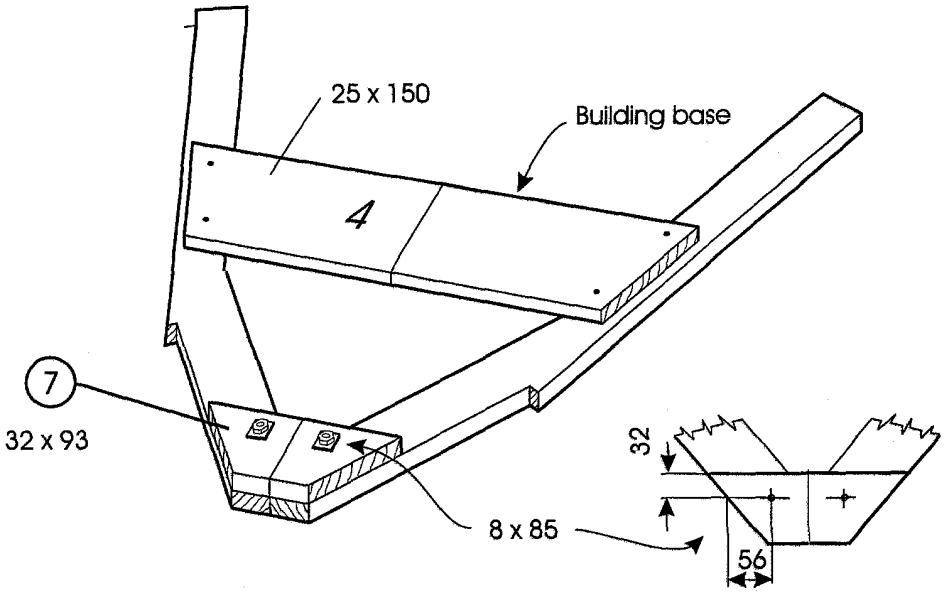
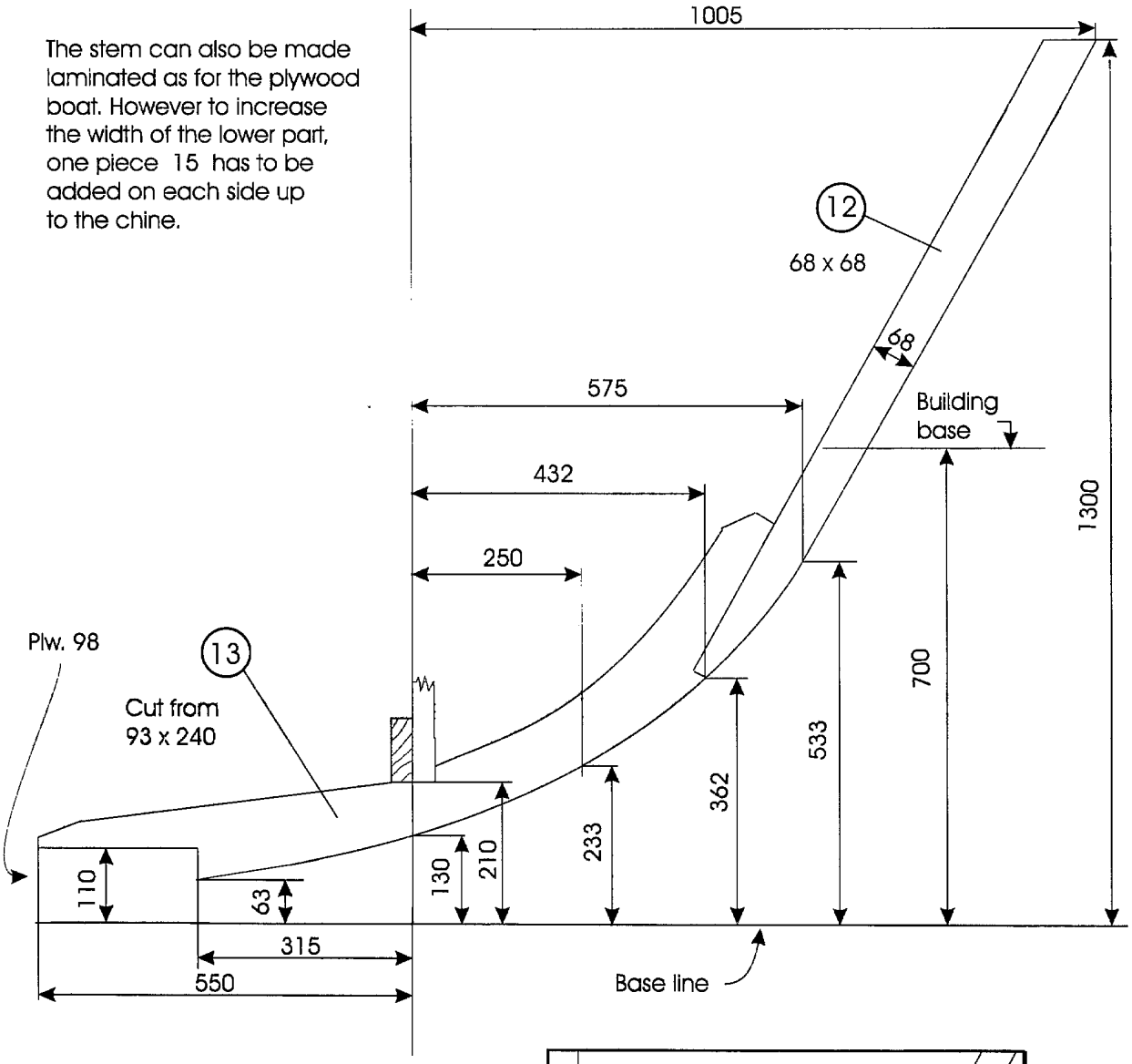
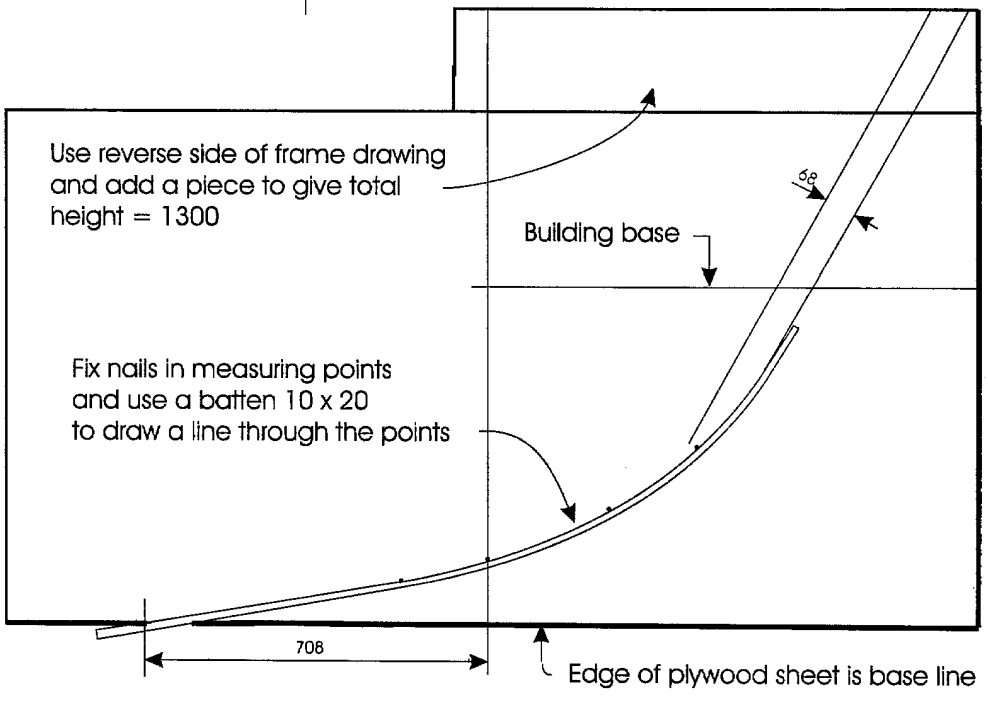


The stem can also be made laminated as for the plywood boat. However to increase the width of the lower part, one piece 15 has to be added on each side up to the chine.



1



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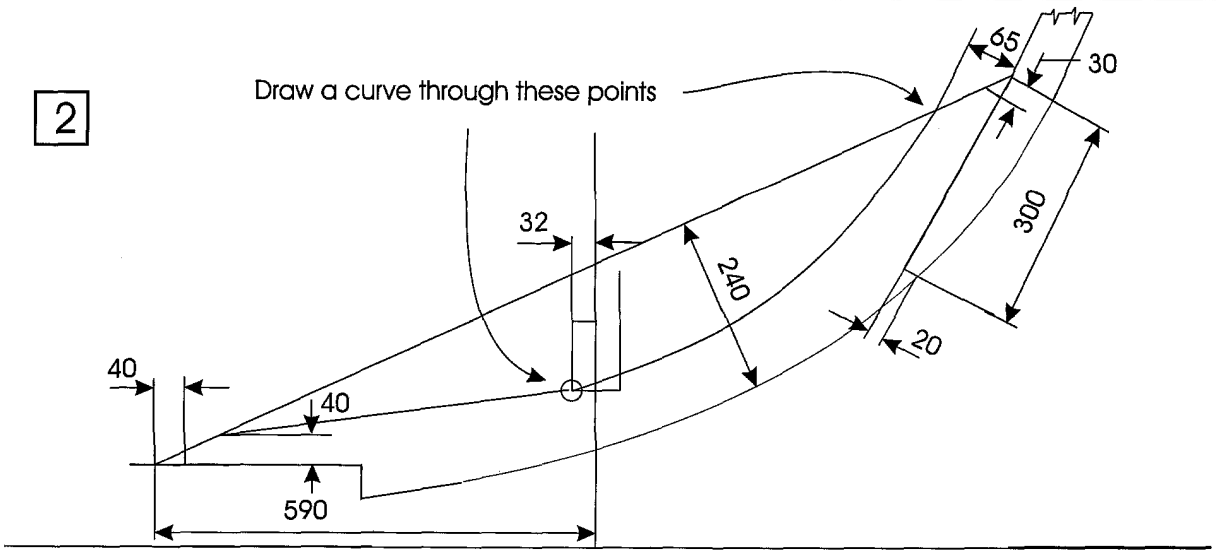
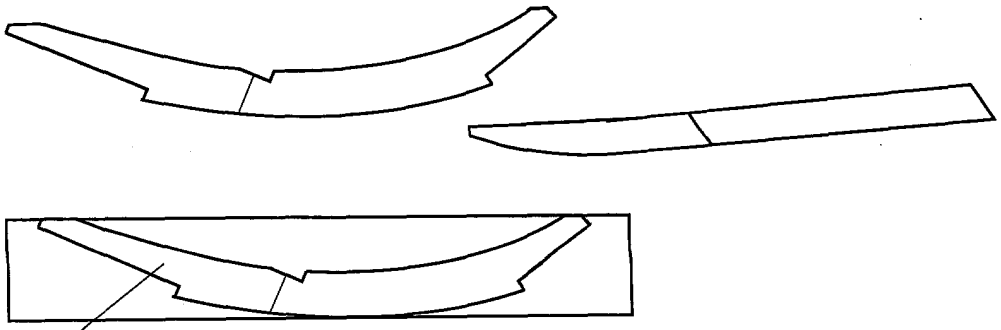


Make pattern from plywood 4 - 6 mm

3



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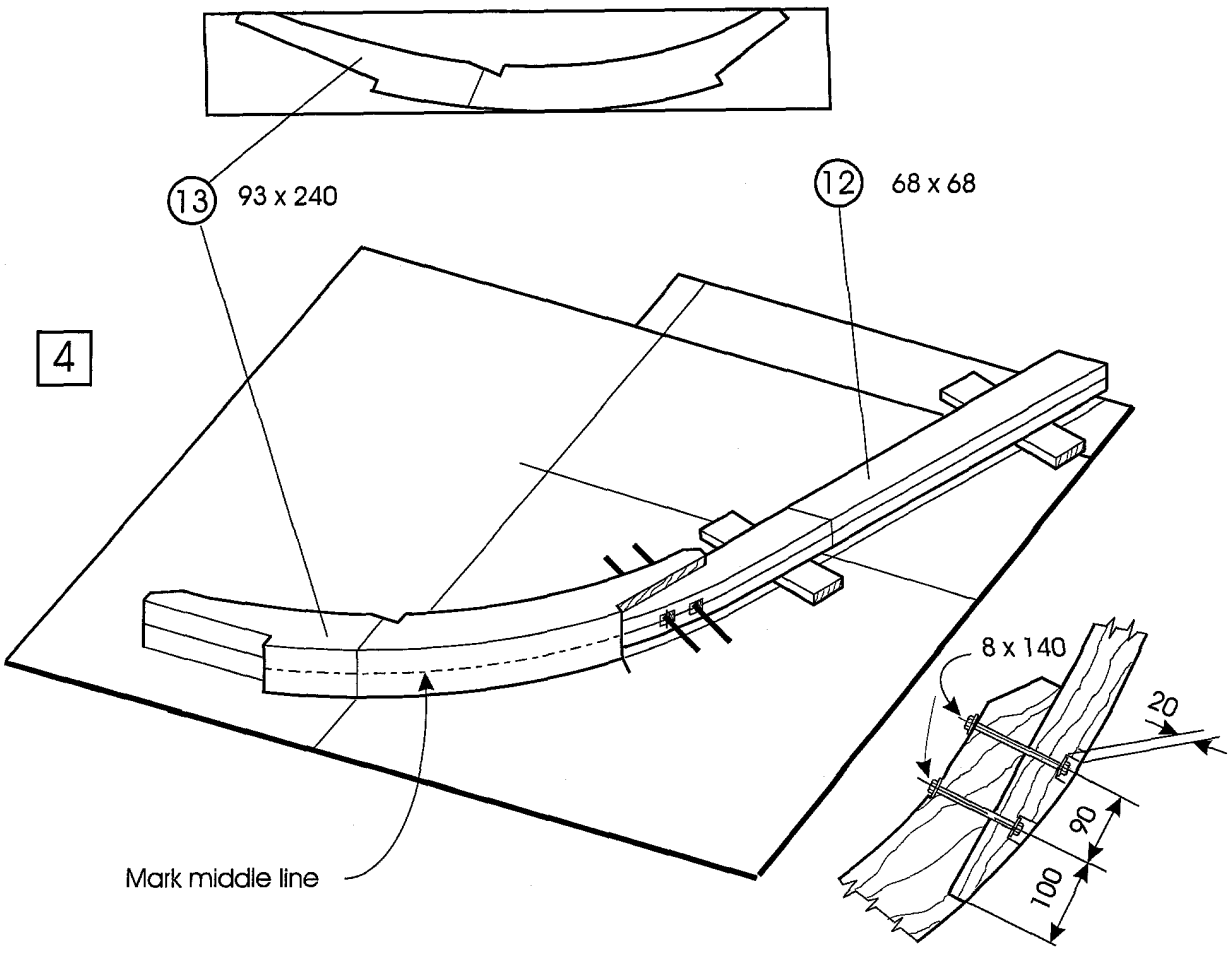
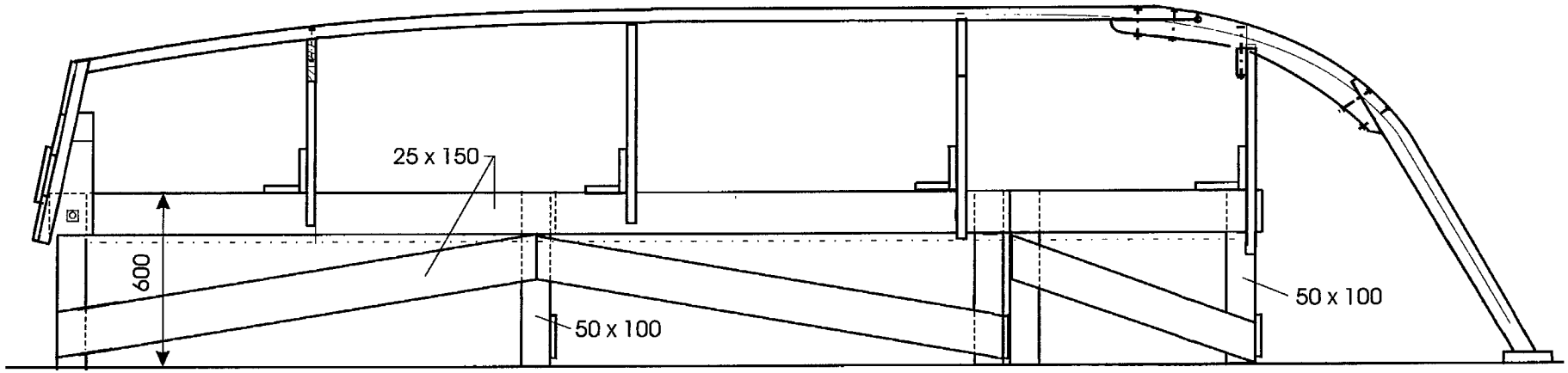
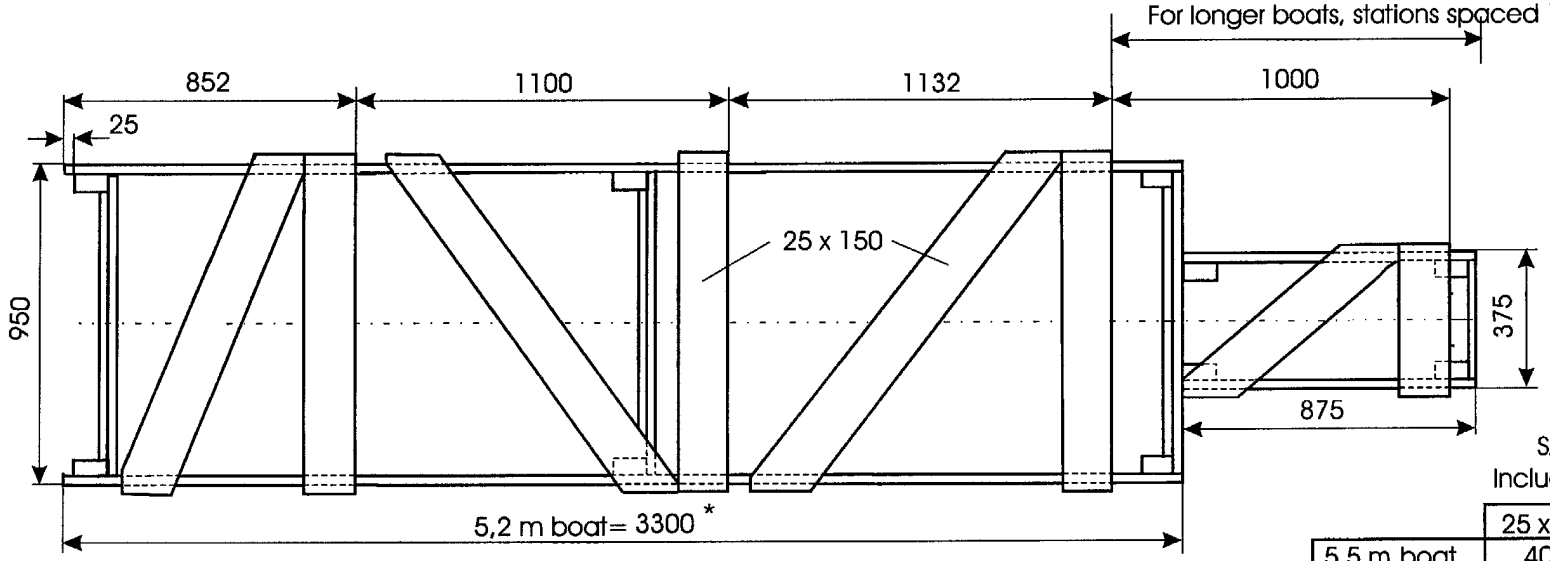






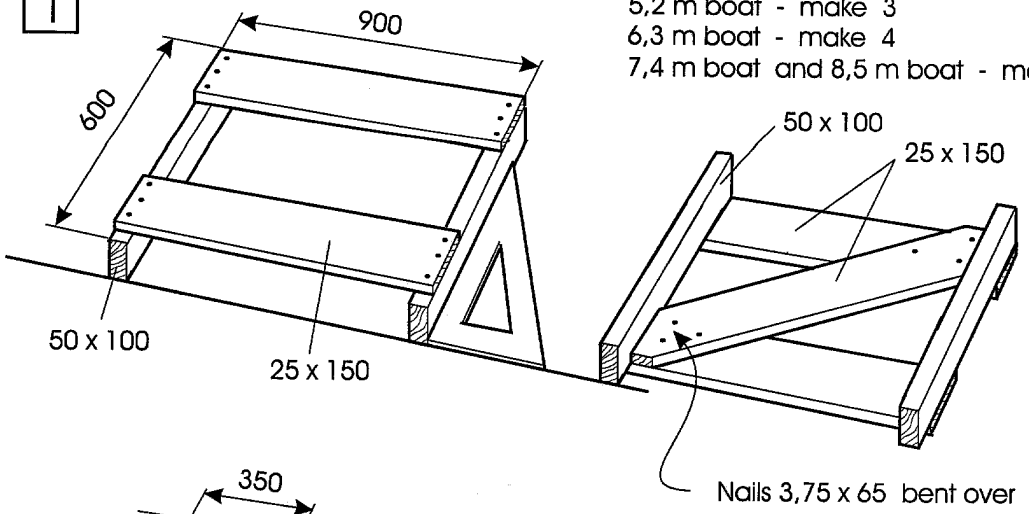
* 6,3 m boat = 4400
7,4 m boat = 5500
8,5 m boat = 6600

NAILS : 3.35 x 65 - 1,5 kg
BOLTS : 10 x 120 - 2 pieces with washers

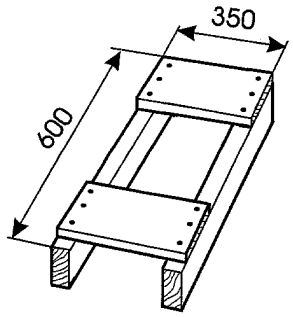
SAWN TIMBER
Including 25 % waste

	25 x 150	50 x 100
5.5 m boat	40 m	7 m
6.3 m boat	48	9
7.4 m boat	56	10
8.5 m boat	64	10

1



5,2 m boat - make 3
6,3 m boat - make 4
7,4 m boat and 8,5 m boat - make 5



All boats - make 2

2

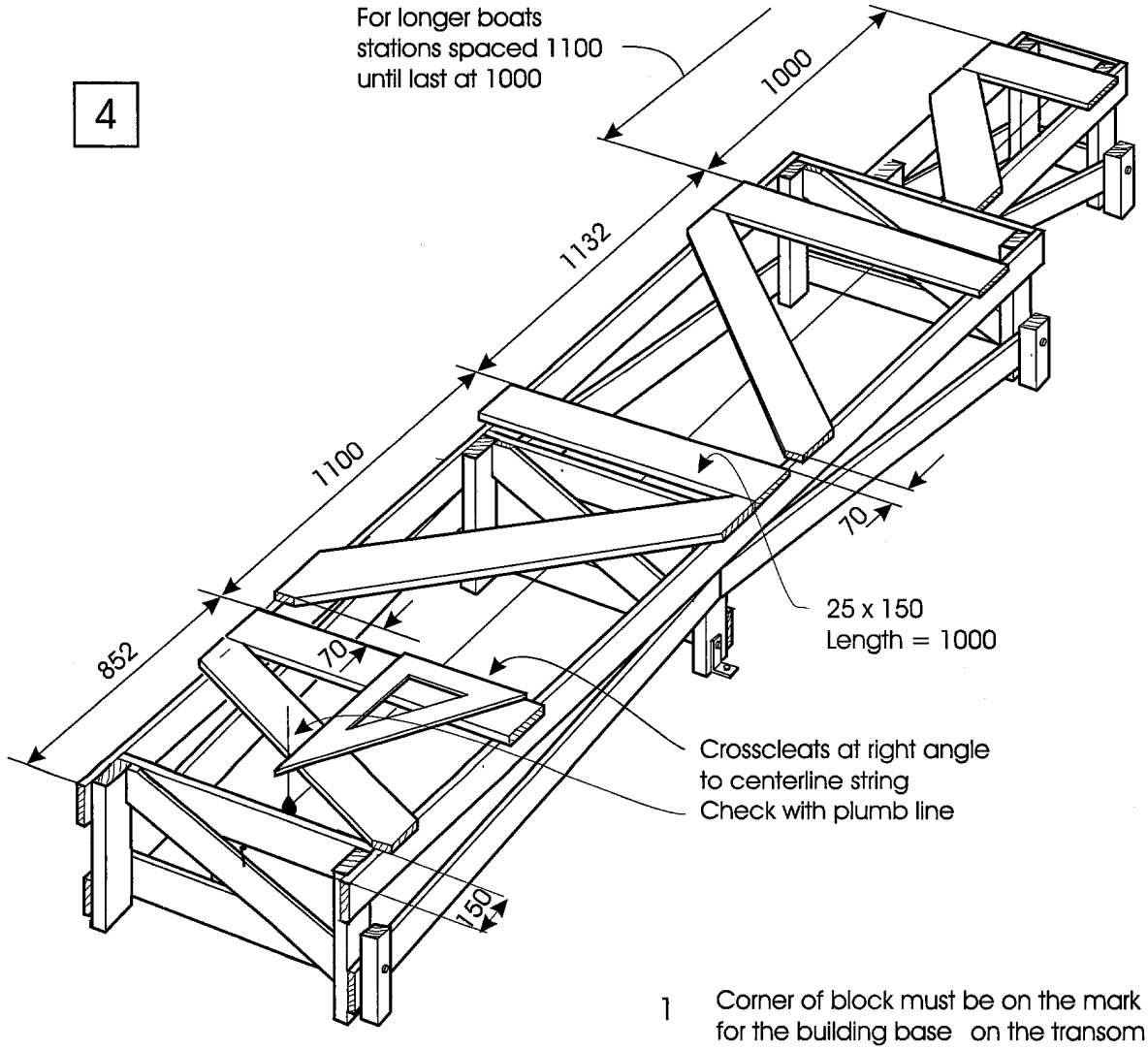
Plane the top edge straight
Check with string and ruler

3

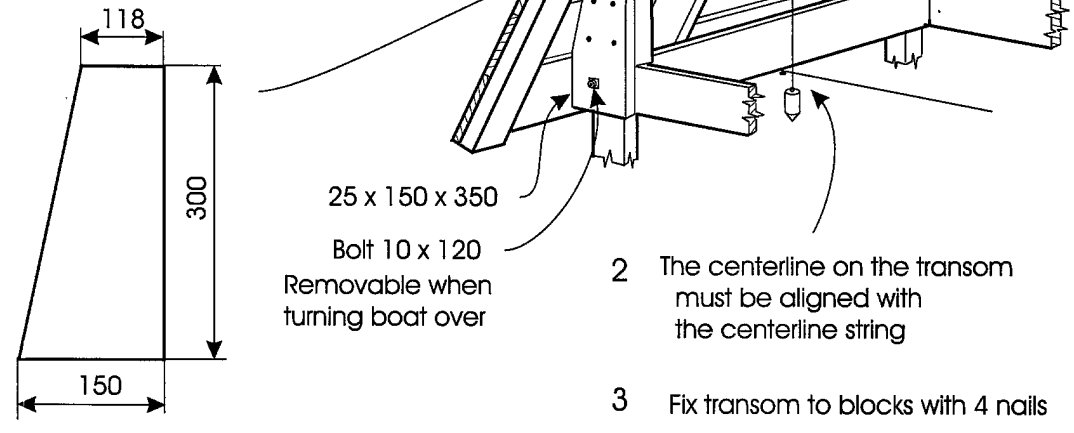
5,2 m boat A = 3300
6,3 m boat A = 4400
7,4 m boat A = 5500
8,5 m boat A = 6600
All boats B = 875

BUILDING JIG

4

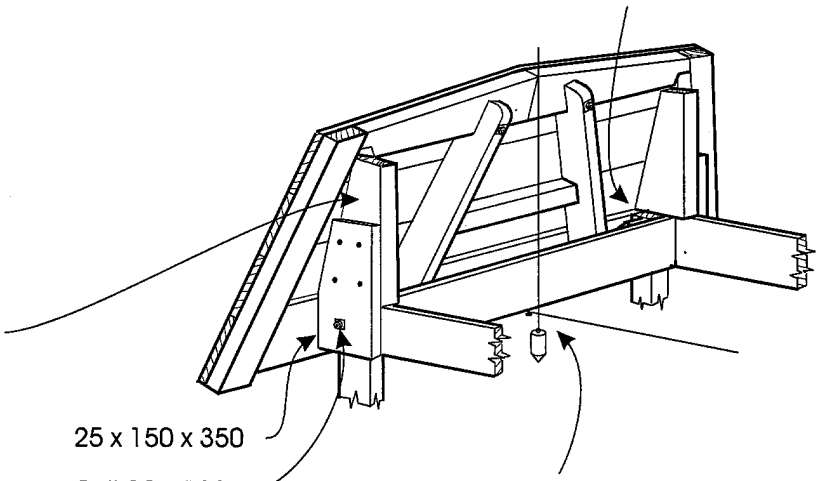


5



Thickness = 50

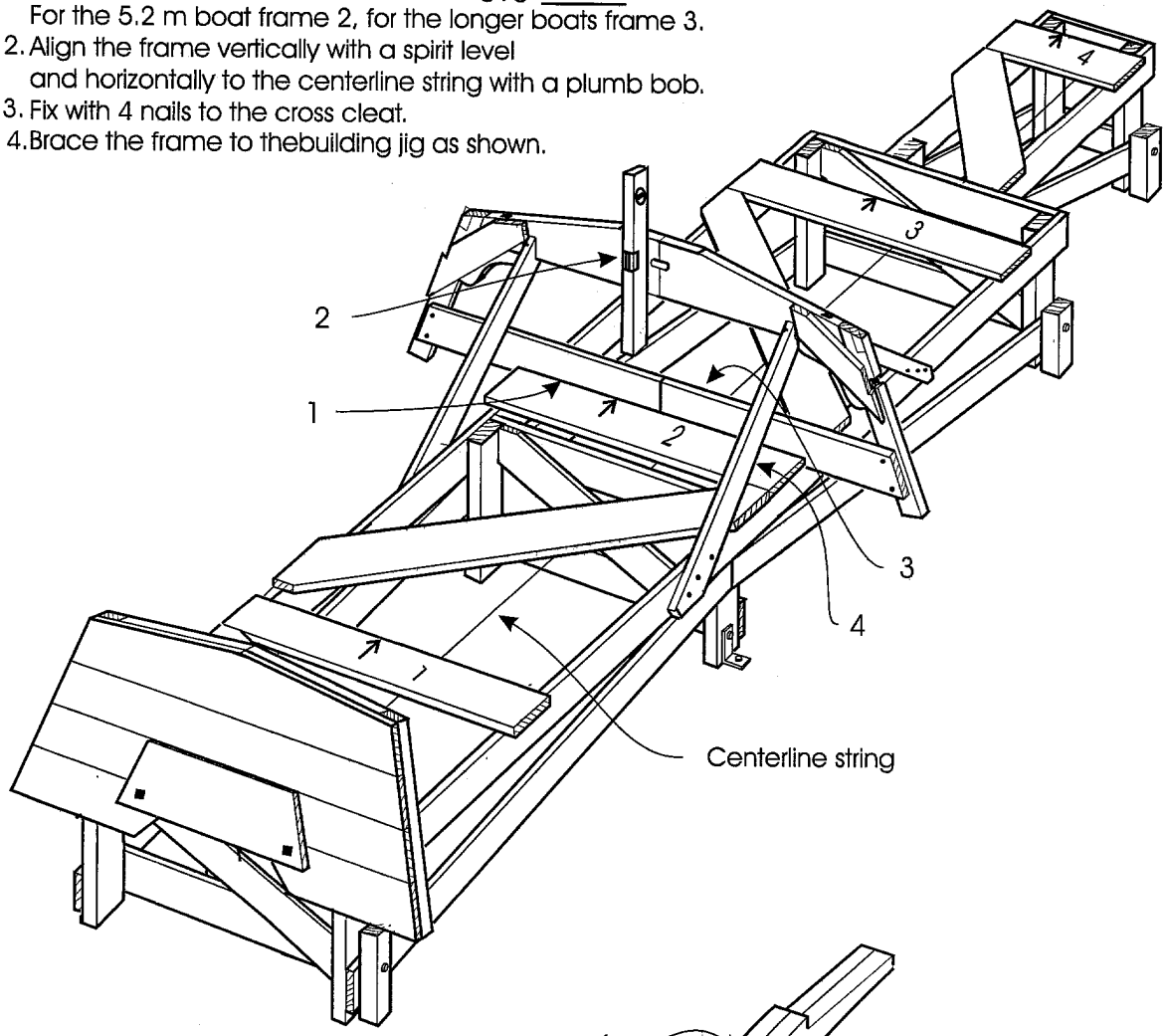
1 Corner of block must be on the mark for the building base on the transom



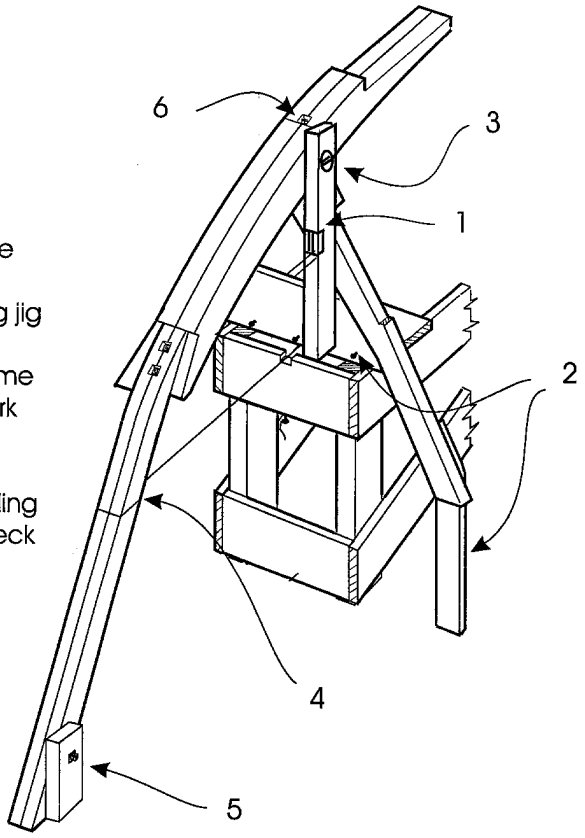
2 The centerline on the transom must be aligned with the centerline string

3 Fix transom to blocks with 4 nails

1. Place the middle frame on the building jig forward of the cross cleat. For the 5.2 m boat frame 2, for the longer boats frame 3.
2. Align the frame vertically with a spirit level and horizontally to the centerline string with a plumb bob.
3. Fix with 4 nails to the cross cleat.
4. Brace the frame to thebuilding jig as shown.

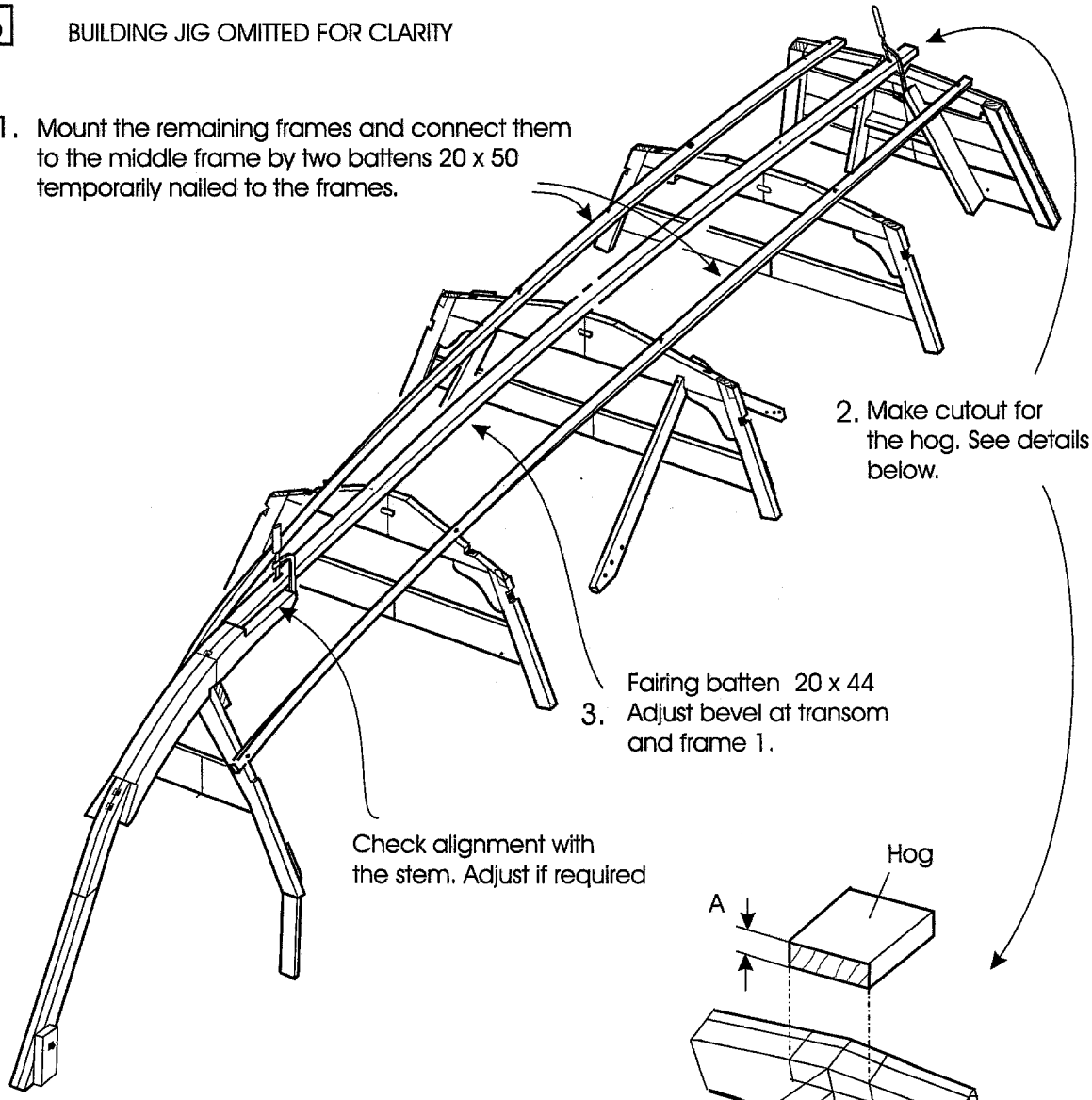


1. Align the forward frame on the building jig in the same way as the middle frame.
2. Nail the frame to the building jig and support it to the ground.
3. Place the stem on to the frame and align with the centermark on the frame.
4. Stretch a line along the top of the building jig corresponding to the construction base. Check that this line meets the mark for the construction base on the stem.
5. Fix the end of the stem firmly to the ground.
6. Drill hole and bolt the stem to the frame.



3 BUILDING JIG OMITTED FOR CLARITY

1. Mount the remaining frames and connect them to the middle frame by two battens 20 x 50 temporarily nailed to the frames.

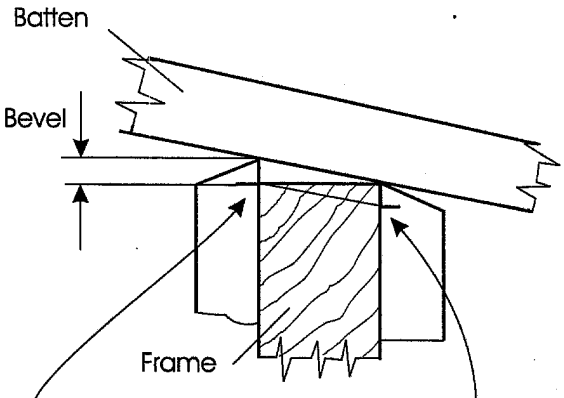


2. Make cutout for the hog. See details below.

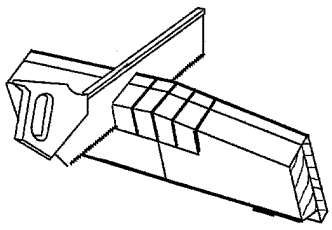
Fairing batten 20 x 44

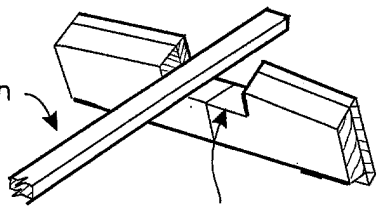
3. Adjust bevel at transom and frame 1.

Check alignment with the stem. Adjust if required



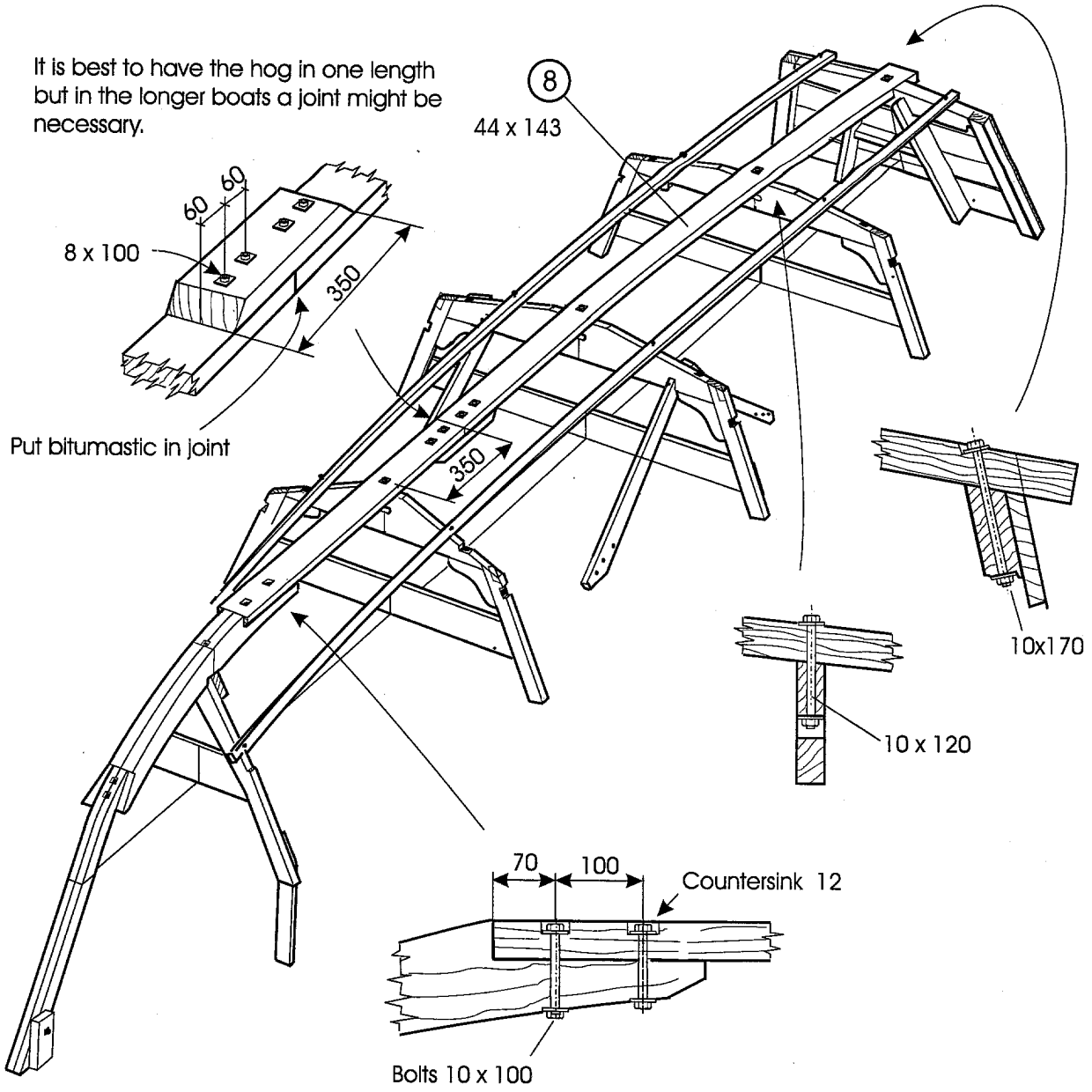
Mark gap between batten and frame = bevel on a stick and transfer to the other side of the frame.

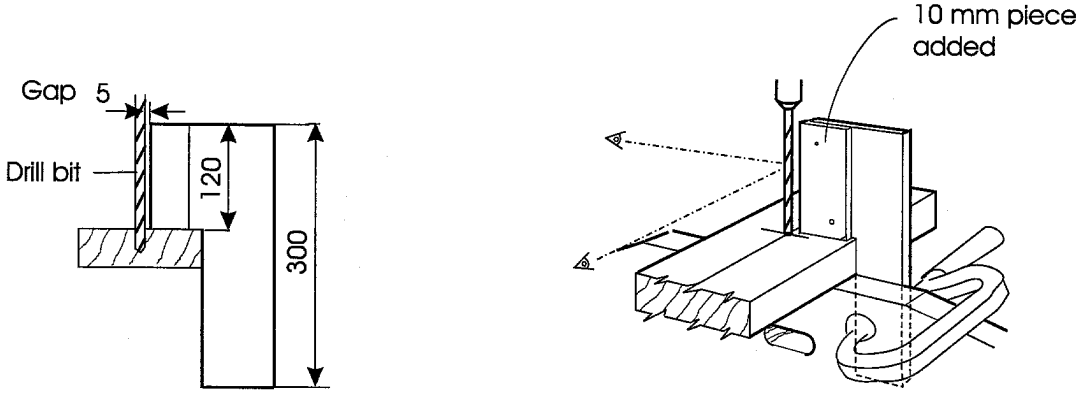




Do not cut below this line

It is best to have the hog in one length but in the longer boats a joint might be necessary.



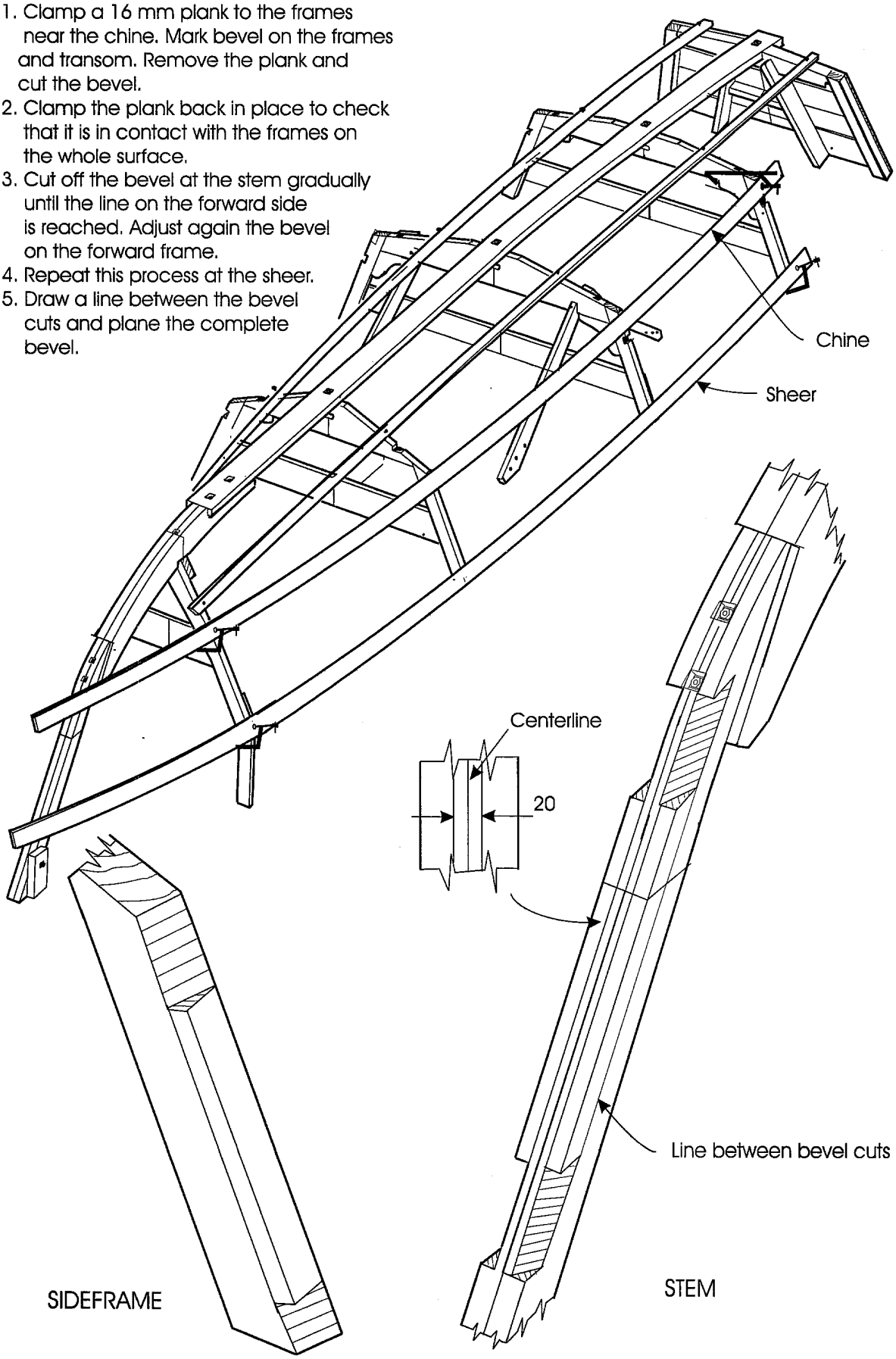


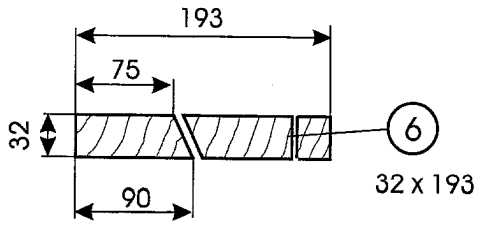
GUIDE FOR DRILLING

Two persons checkling by sight the direction of the drillbit before starting the drill

BEVELLING OF SIDES

1. Clamp a 16 mm plank to the frames near the chine. Mark bevel on the frames and transom. Remove the plank and cut the bevel.
2. Clamp the plank back in place to check that it is in contact with the frames on the whole surface.
3. Cut off the bevel at the stem gradually until the line on the forward side is reached. Adjust again the bevel on the forward frame.
4. Repeat this process at the sheer.
5. Draw a line between the bevel cuts and plane the complete bevel.



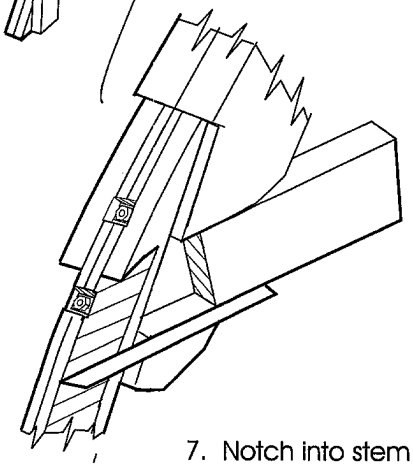


1. Saw and plane two chines. Cut off a piece of 100 mm length.
2. Buttjoin a plank 15 x 143 to cover the length of the boat. Check that the edge of the plank is straight. See detail below.
3. Clamp the plank at the transom and the forward frame.

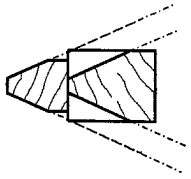
Keep top of block level with plank.

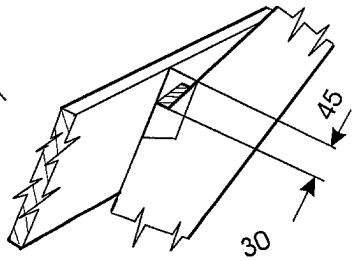
4. Adjust the plank up or down so that the corner of the block meets the edge of the transom. Use a small ruler to mark on the frame..

6. Corner of block level with frame

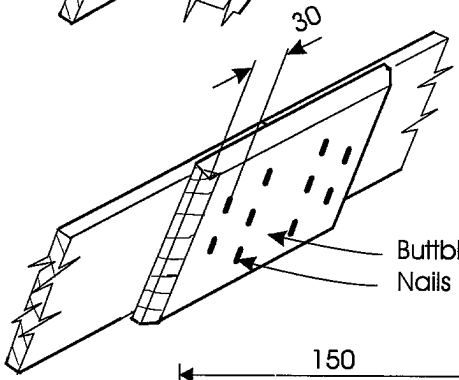


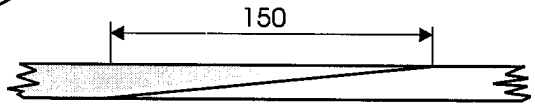
7. Notch into stem knee.





5. Adjust the plank on the forward frame

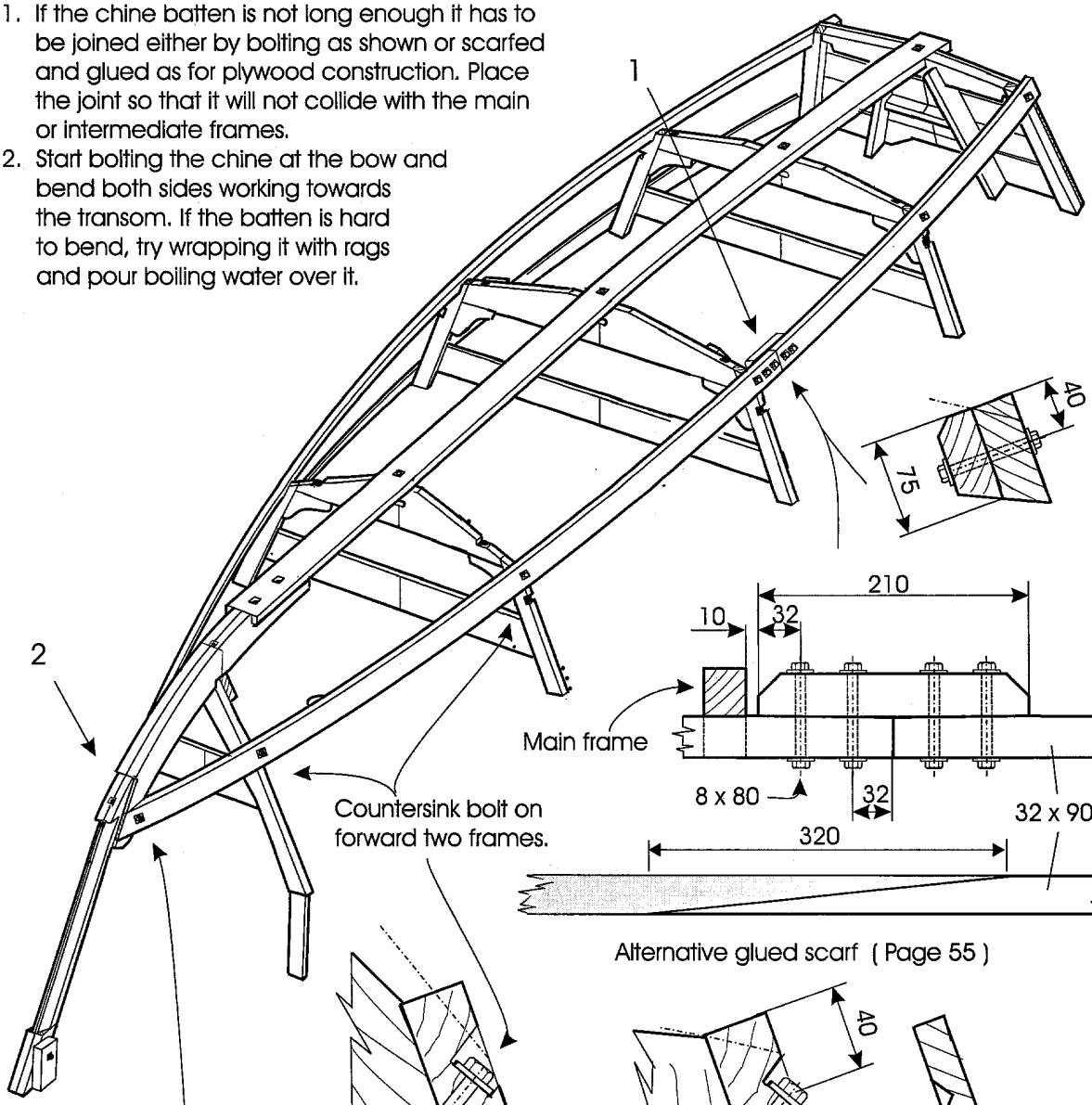




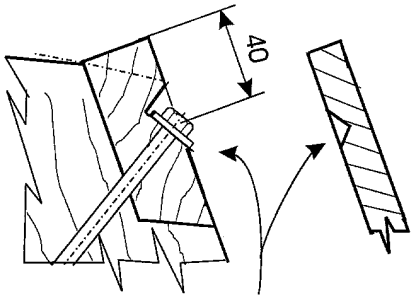
Alternative glued scarf (Page 55)

BOLTING OF CHINE

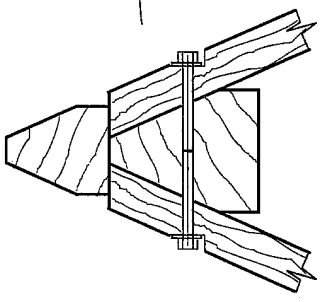
1. If the chine batten is not long enough it has to be joined either by bolting as shown or scarfed and glued as for plywood construction. Place the joint so that it will not collide with the main or intermediate frames.
2. Start bolting the chine at the bow and bend both sides working towards the transom. If the batten is hard to bend, try wrapping it with rags and pour boiling water over it.

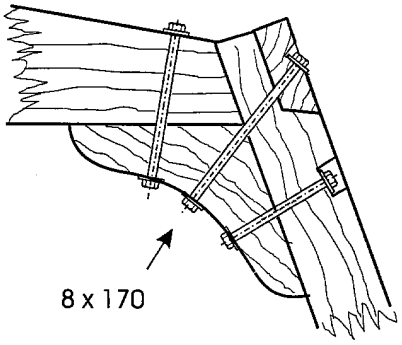


Alternative glued scarf (Page 55)

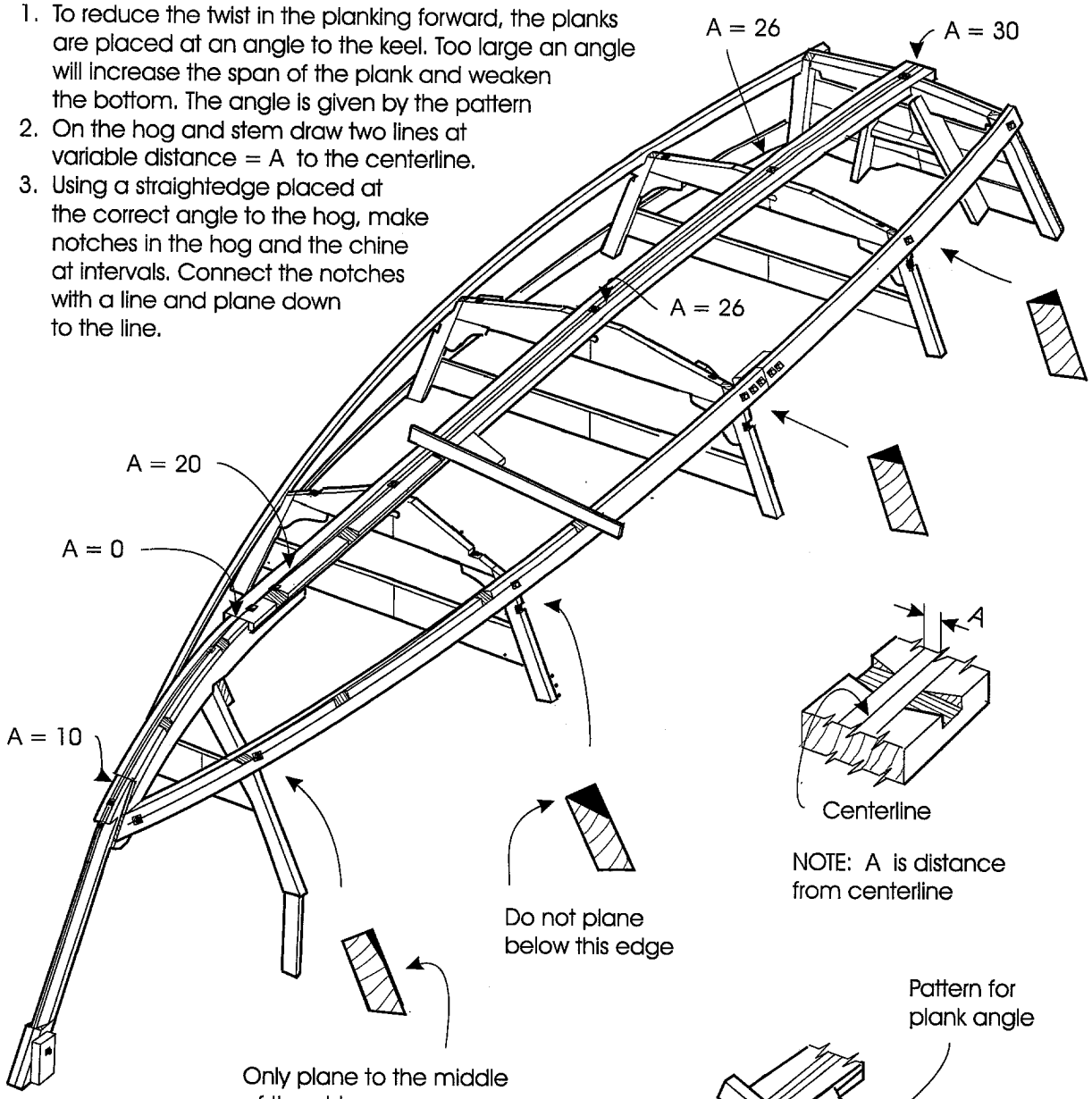


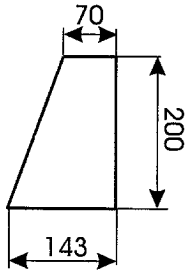
Only countersink sufficient for
the bearing of the washer. A groove
is later made in the sideplanking



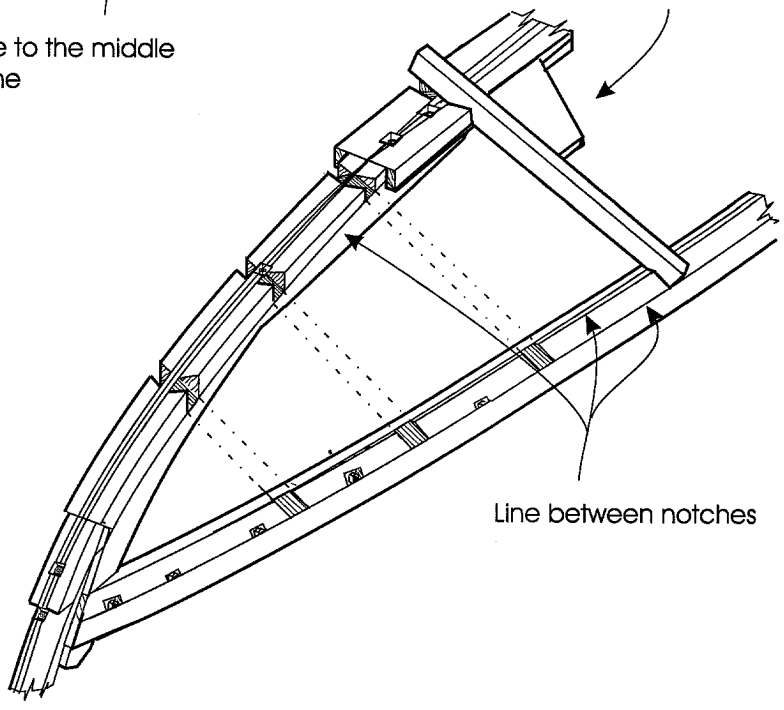


1. To reduce the twist in the planking forward, the planks are placed at an angle to the keel. Too large an angle will increase the span of the plank and weaken the bottom. The angle is given by the pattern
2. On the hog and stem draw two lines at variable distance = A to the centerline.
3. Using a straightedge placed at the correct angle to the hog, make notches in the hog and the chine at intervals. Connect the notches with a line and plane down to the line.





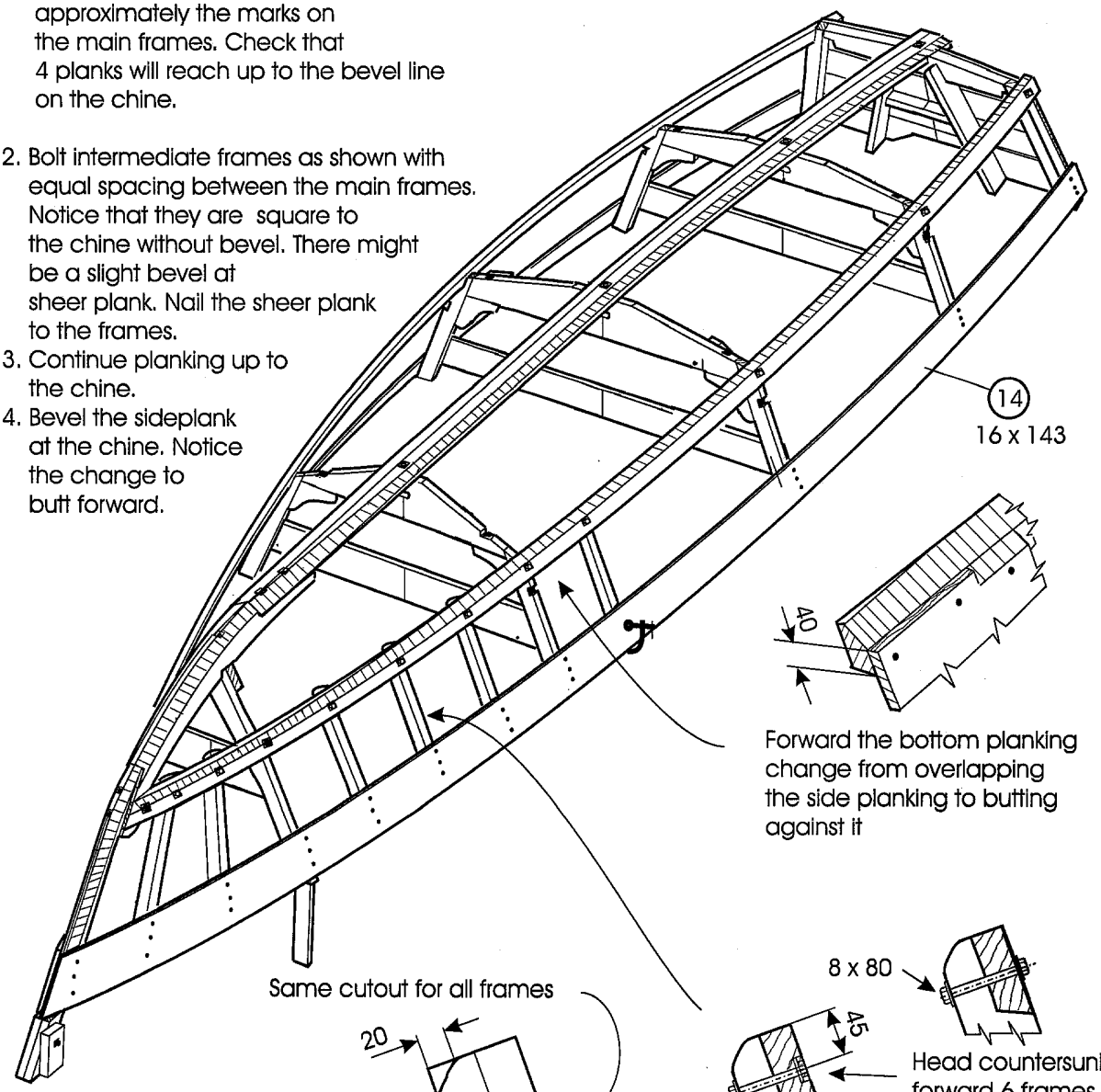
Pattern for bottomplanking angle



40 INTERMEDIATE FRAMES AND SIDE PLANKING

1. Clamp the sheerplank so that it follows approximately the marks on the main frames. Check that 4 planks will reach up to the bevel line on the chine.

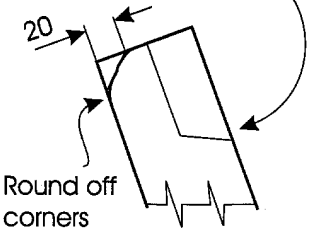
2. Bolt intermediate frames as shown with equal spacing between the main frames. Notice that they are square to the chine without bevel. There might be a slight bevel at sheer plank. Nail the sheer plank to the frames.
3. Continue planking up to the chine.
4. Bevel the sideplank at the chine. Notice the change to butt forward.



(14) 16 x 143

Forward the bottom planking change from overlapping the side planking to butting against it

Same cutout for all frames



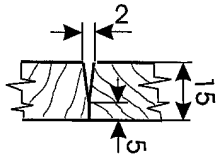
Round off corners

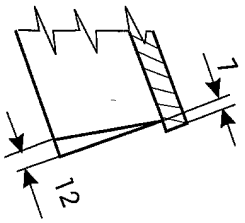
Head countersunk forward 6 frames

(4) 32 x 68

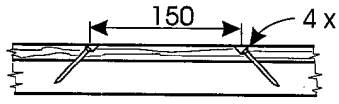
Adjust bevel if required before fixing.

Caulking bevel



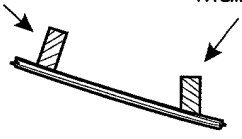


Nailing to chine

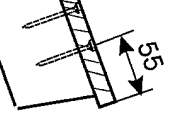


Intermediate frame

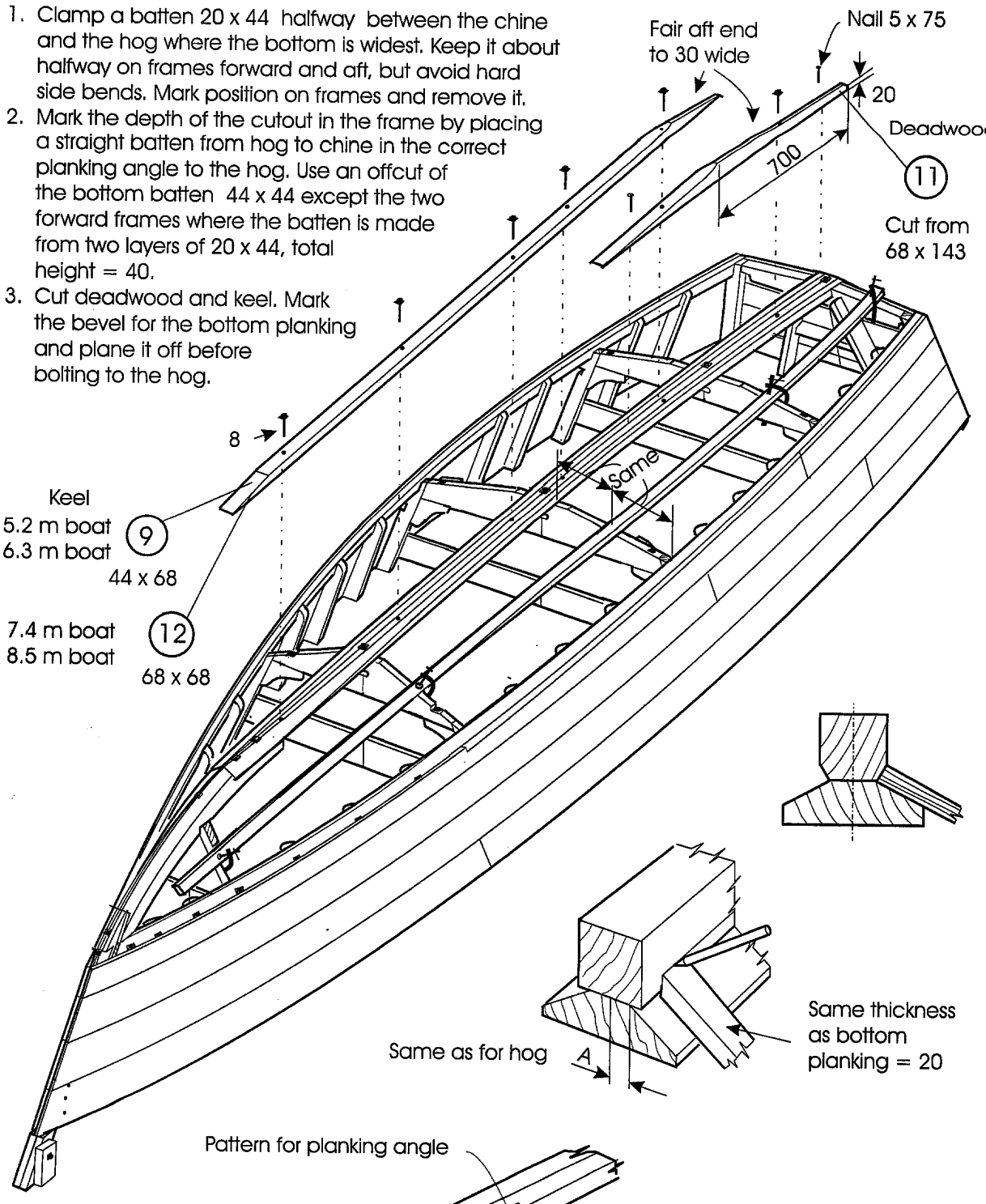
Main frame

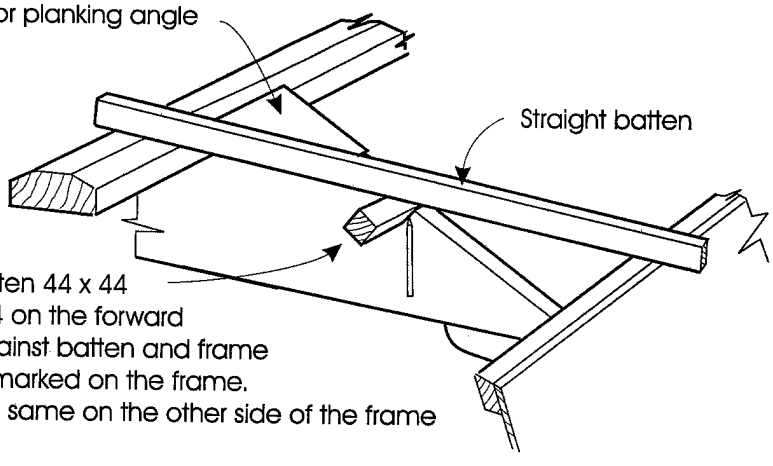


4 x 50



1. Clamp a batten 20 x 44 halfway between the chine and the hog where the bottom is widest. Keep it about halfway on frames forward and aft, but avoid hard side bends. Mark position on frames and remove it.
2. Mark the depth of the cutout in the frame by placing a straight batten from hog to chine in the correct planking angle to the hog. Use an offcut of the bottom batten 44 x 44 except the two forward frames where the batten is made from two layers of 20 x 44, total height = 40.
3. Cut deadwood and keel. Mark the bevel for the bottom planking and plane it off before bolting to the hog.

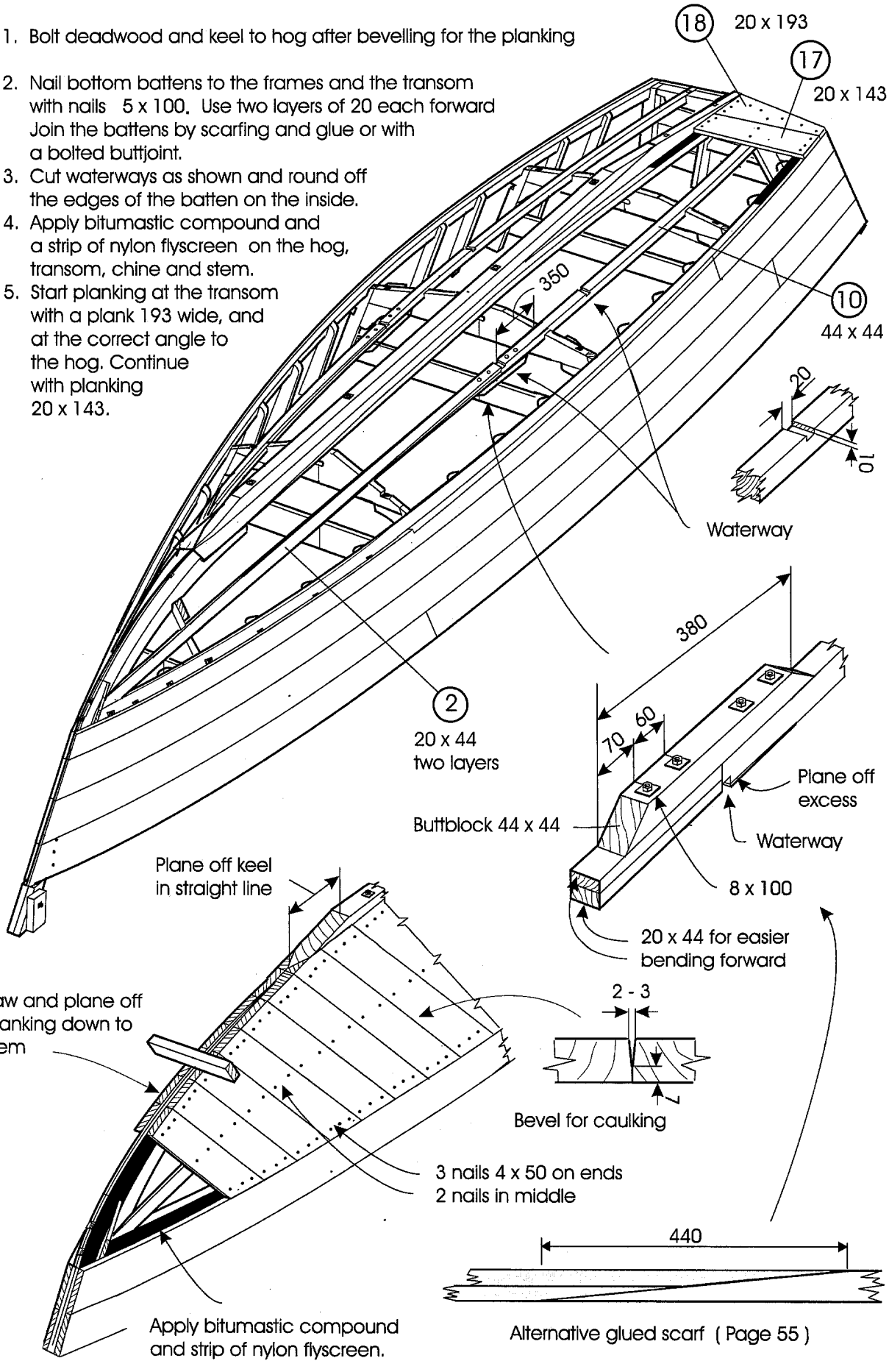




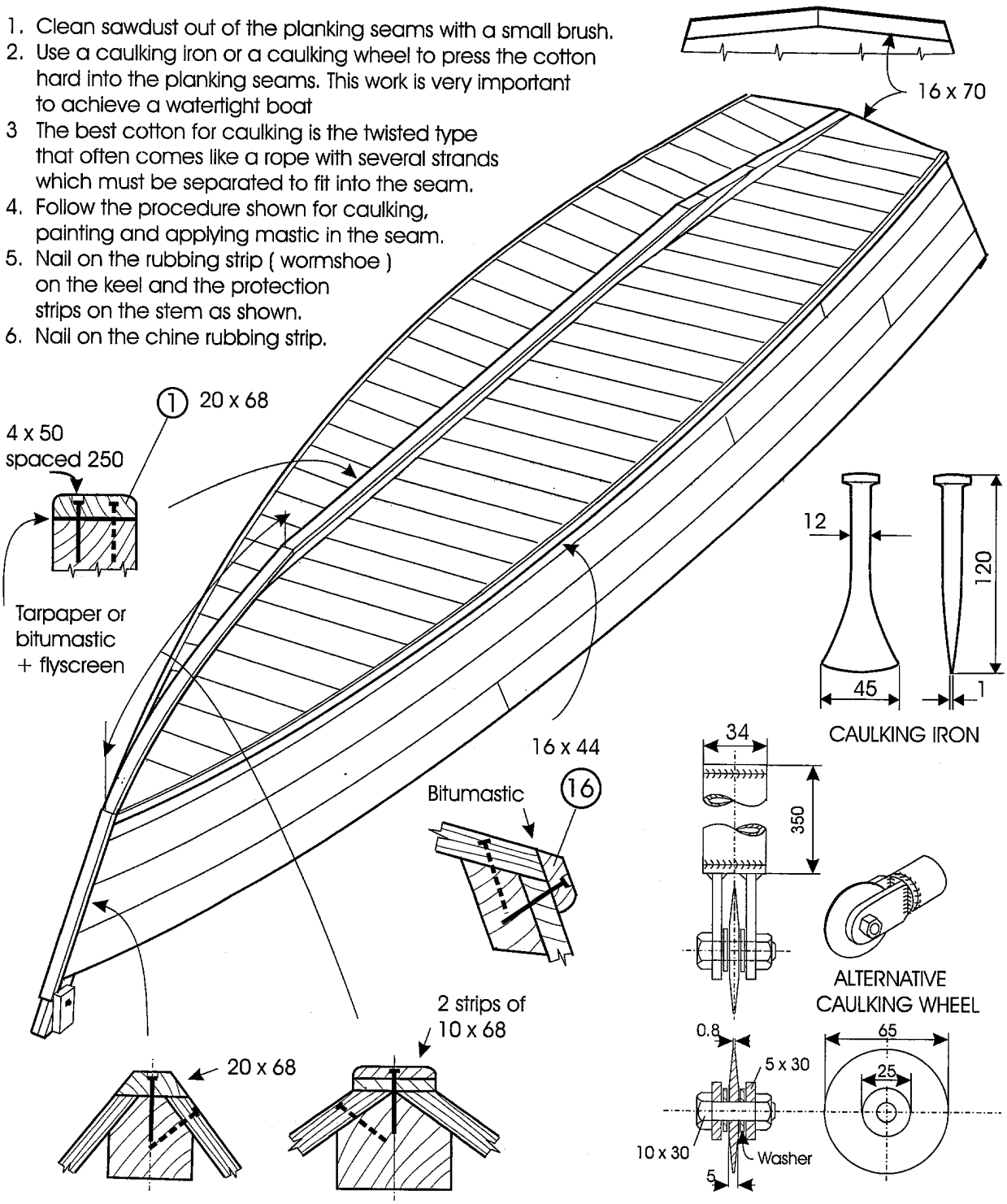
Offcut from bottom batten 44 x 44 midship and aft, 40 x 44 on the forward two frames. Hold up against batten and frame at the position already marked on the frame. Mark with pencil. Do the same on the other side of the frame

BOTTOM BATTENS AND PLANKING

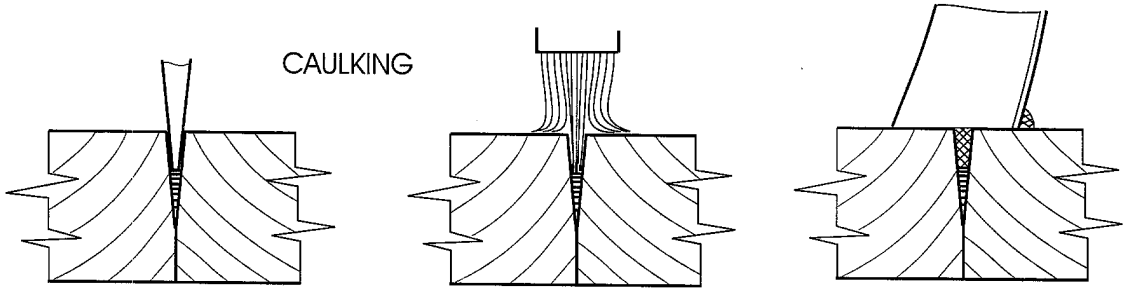
1. Bolt deadwood and keel to hog after bevelling for the planking
2. Nail bottom battens to the frames and the transom with nails 5 x 100. Use two layers of 20 each forward Join the battens by scarfing and glue or with a bolted buttjoint.
3. Cut waterways as shown and round off the edges of the batten on the inside.
4. Apply bitumastic compound and a strip of nylon flyscreen on the hog, transom, chine and stem.
5. Start planking at the transom with a plank 193 wide, and at the correct angle to the hog. Continue with planking 20 x 143.



1. Clean sawdust out of the planking seams with a small brush.
2. Use a caulking iron or a caulking wheel to press the cotton hard into the planking seams. This work is very important to achieve a watertight boat
3 The best cotton for caulking is the twisted type that often comes like a rope with several strands which must be separated to fit into the seam.
4. Follow the procedure shown for caulking, painting and applying mastic in the seam.
5. Nail on the rubbing strip (wormshoe) on the keel and the protection strips on the stem as shown.
6. Nail on the chine rubbing strip.



CAULKING

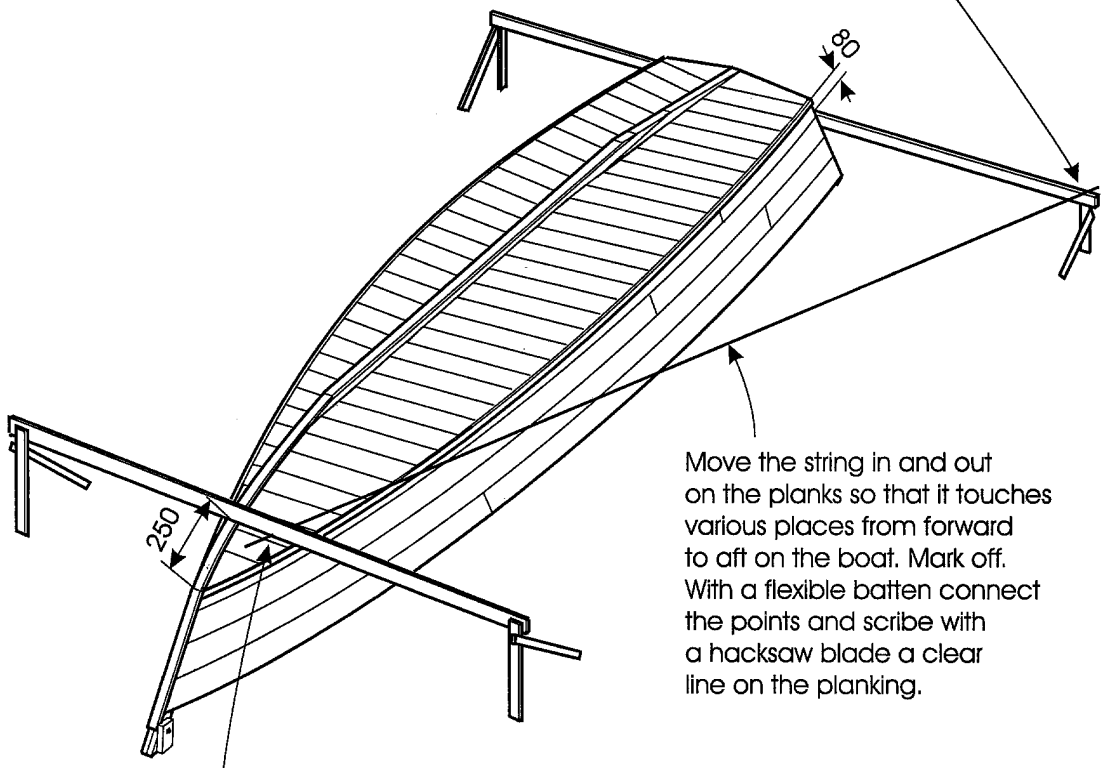


A. Press the cotton hard into the seam with the caulking iron or caulking wheel

B. Brush thinned paint in seams over the waterline. Use black-varnish below.

C. Fill the seam with mastic Below waterline: Black-varnish + chalk putty.

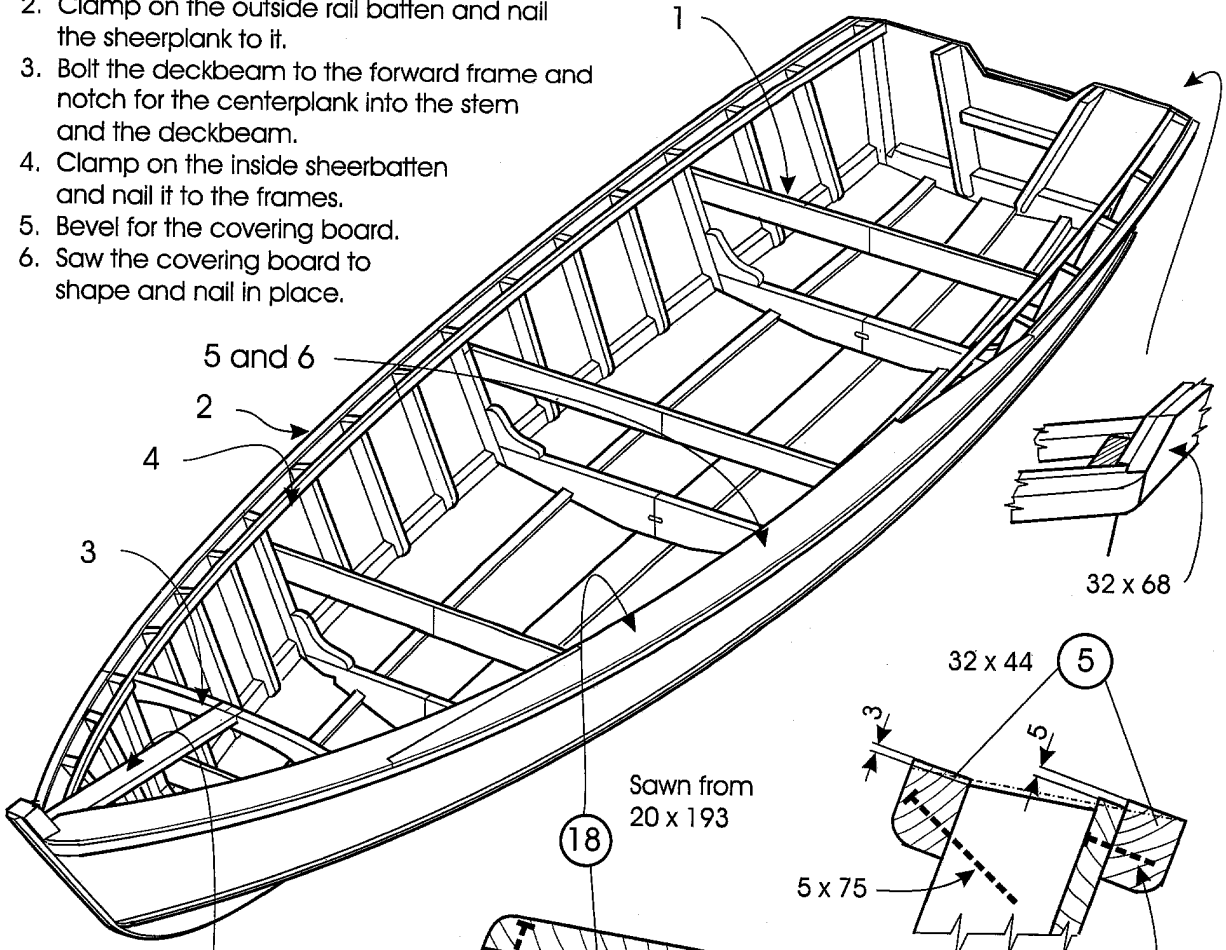
Fix a plank with top edge 80 below chine corner. Check that it is horizontal with a spirit level. The string rests on top of this plank.

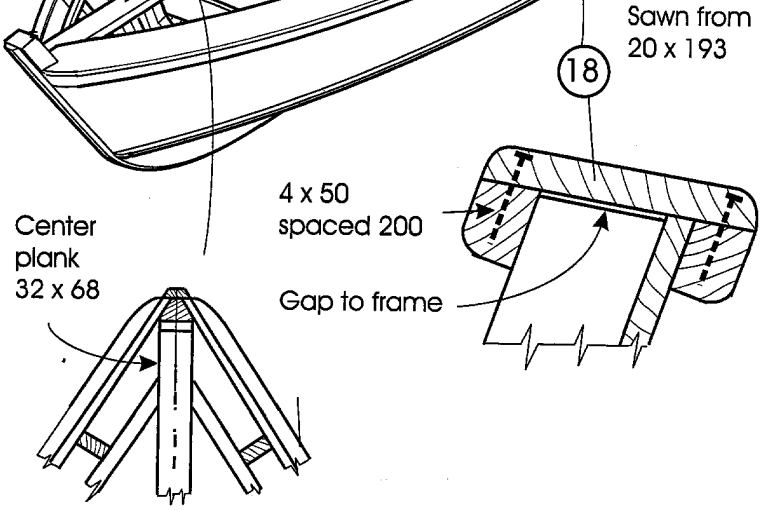


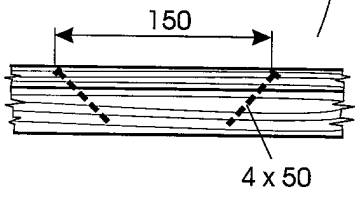
Move the string in and out on the planks so that it touches various places from forward to aft on the boat. Mark off. With a flexible batten connect the points and scribe with a hacksaw blade a clear line on the planking.

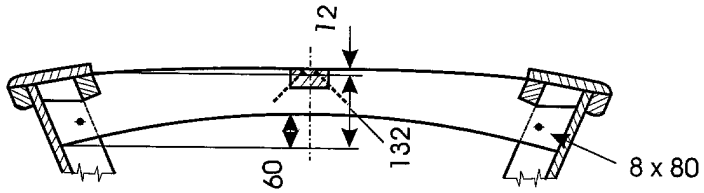
Fix a plank with the lower edge at the waterline mark at the stem. Brace it level. The string rests on the lower edge of this plank.

1. Remove the boat from the building jig, but keep the cross braces until the rail is complete.
2. Clamp on the outside rail batten and nail the sheerplank to it.
3. Bolt the deckbeam to the forward frame and notch for the centerplank into the stem and the deckbeam.
4. Clamp on the inside sheerbatten and nail it to the frames.
5. Bevel for the covering board.
6. Saw the covering board to shape and nail in place.

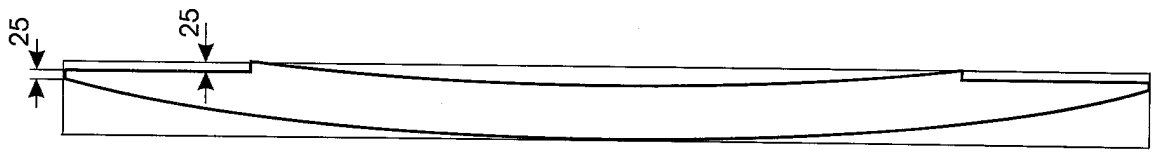








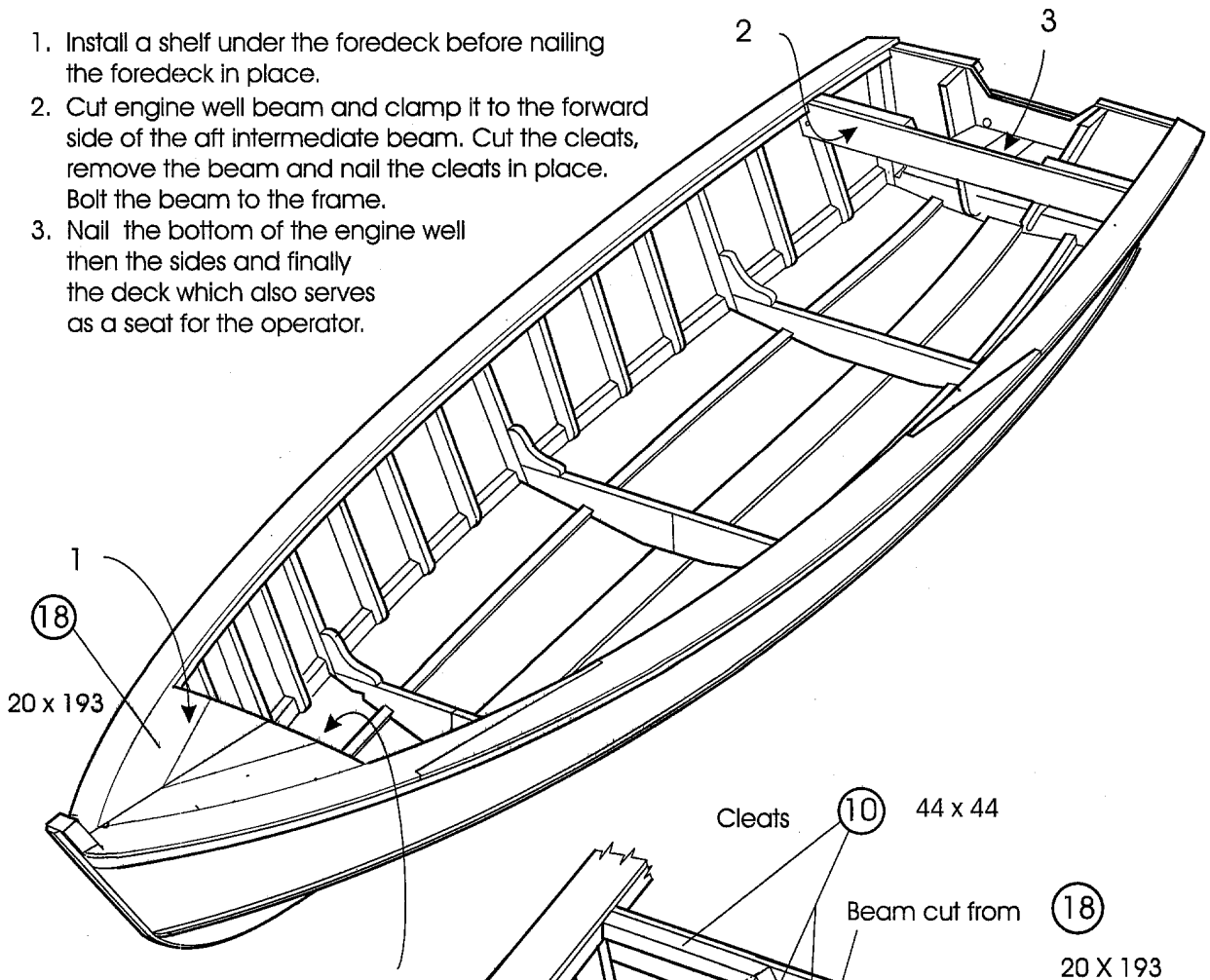
Deckbeam sawn from (6) 32 x 193

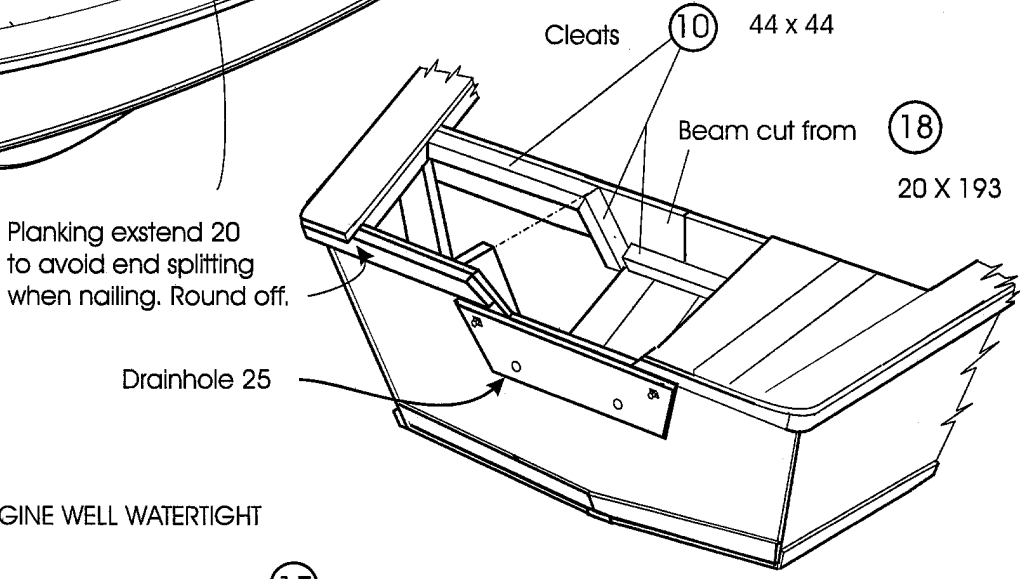


Covering board sawn from (18) 20 X 193

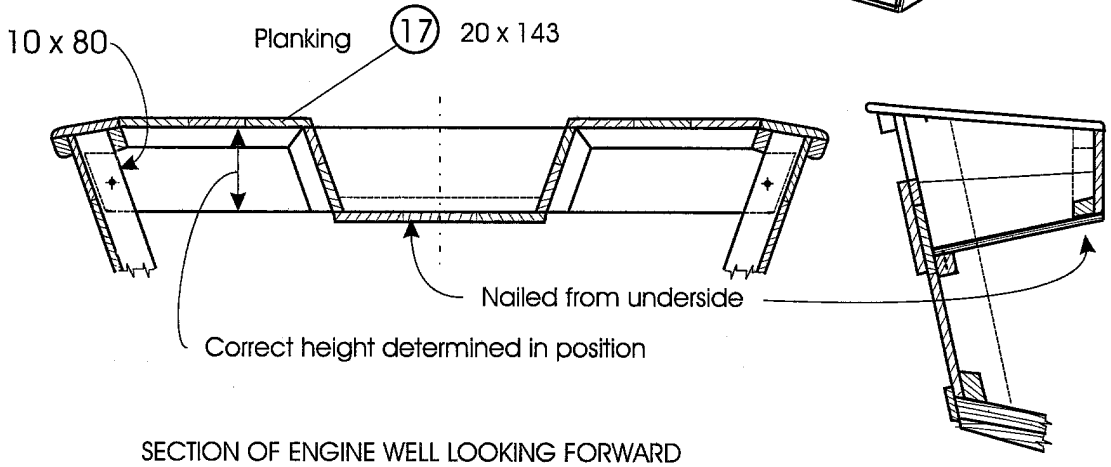
OUTBOARD ENGINE WELL

1. Install a shelf under the foredeck before nailing the foredeck in place.
2. Cut engine well beam and clamp it to the forward side of the aft intermediate beam. Cut the cleats, remove the beam and nail the cleats in place. Bolt the beam to the frame.
3. Nail the bottom of the engine well then the sides and finally the deck which also serves as a seat for the operator.



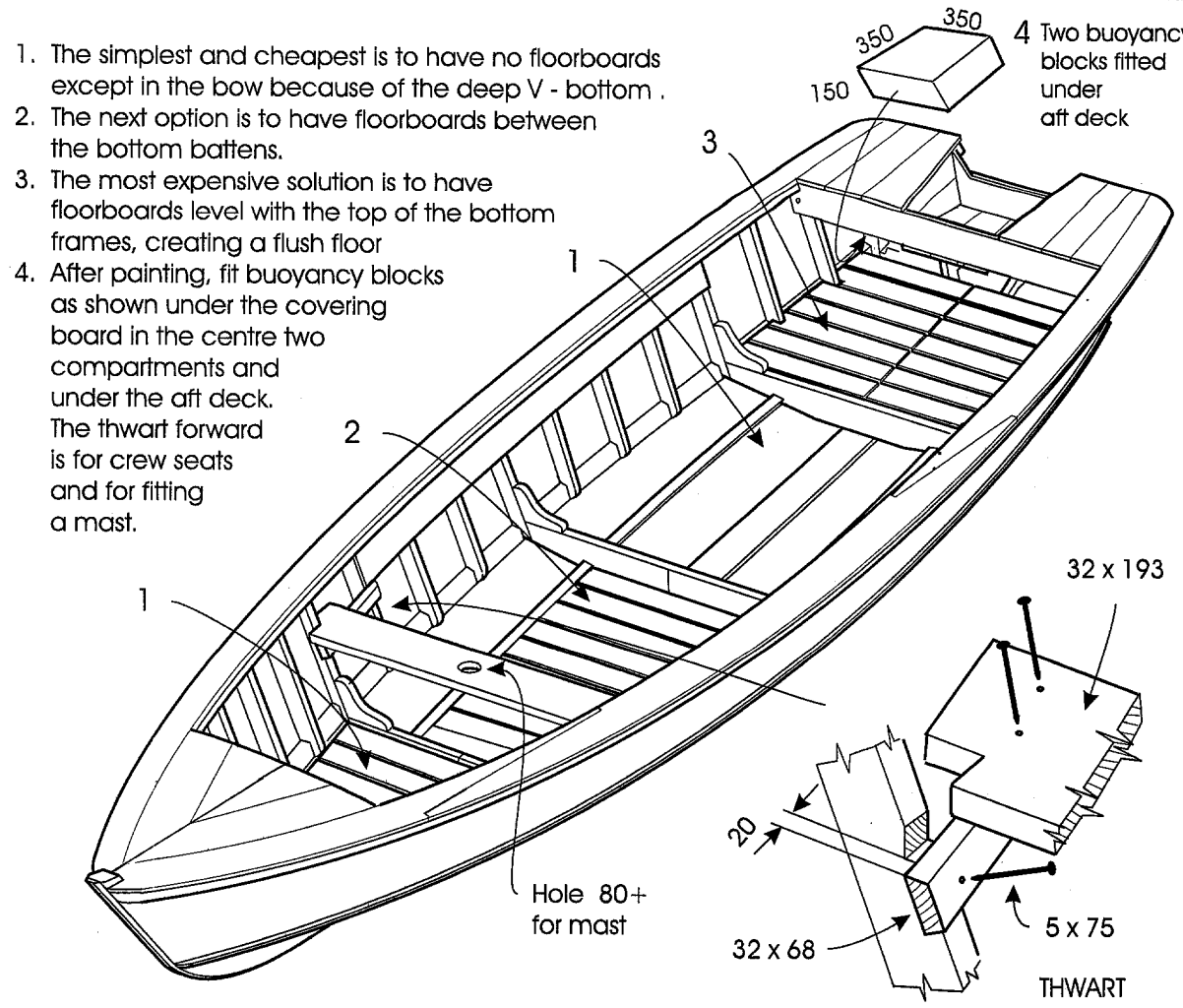


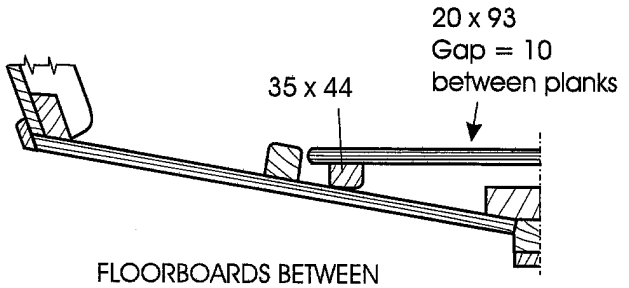
MAKE ENGINE WELL WATERTIGHT



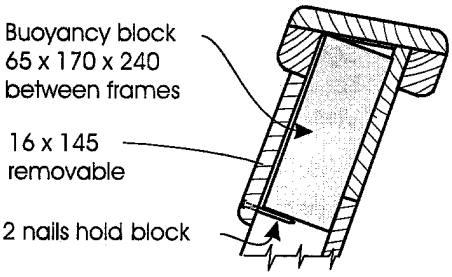
SECTION OF ENGINE WELL LOOKING FORWARD

1. The simplest and cheapest is to have no floorboards except in the bow because of the deep V - bottom .
2. The next option is to have floorboards between the bottom battens.
3. The most expensive solution is to have floorboards level with the top of the bottom frames, creating a flush floor
4. After painting, fit buoyancy blocks as shown under the covering board in the centre two compartments and under the aft deck. The thwart forward is for crew seats and for fitting a mast.

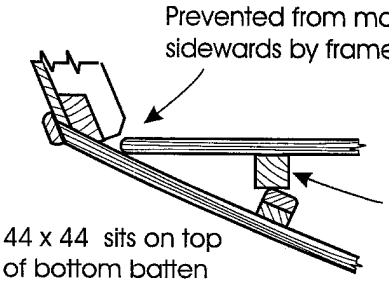




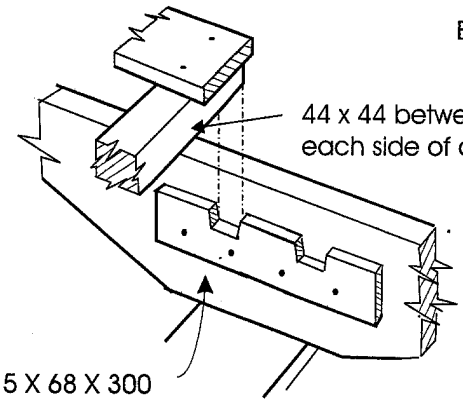
FLOORBOARDS BETWEEN BOTTOM BATTENS



BUOYANCY



FLOORBOARDS FORWARD ARE REQUIRED



FLOORBOARDS LEVEL WITH TOP OF FRAMES

Floorboards divided at centerline

1. PLYWOOD

All plywood for exterior use is glued with the same phenolic glue. It carries the mark WBP = water boil proof.

The durability of plywood is entirely dependent on the species of wood used in the veneers. Often the manufacturer saves money by having a good but thin surface veneer, but species with low rot resistance in the core veneers.

The difference between "WBP Exterior" plywood and "Marine plywood" is in the species of timber accepted for the veneers and the thickness and number of layers. "Marine plywood" should have a minimum of 5 layers in plywood between 6 and 9 mm thickness. More layers give more equal strength along the sheet and across the sheet. The thickness of the layers should be :

Outer layers: Minimum 1.4 mm
Inner layers: Maximum 2.5 mm

Unless the veneers have been treated against rot at the factory, the durability of the plywood is dependent on the type of wood used. The following list of species for marine use has been prepared by Lloyds in England:

Common name	Natural durability
Agba	Durable
Gedu Nohor	Moderately durable
Guarea	Durable
Idigbo	Durable
African Mahogany	Moderately durable
Makore	Very durable
Omu	Moderately durable
Light Red Meranddi	Moderately durable
Light Red Seraya	Moderately durable
Sapele	Moderately durable
Utile	Durable

Douglas fir and Gaboon/Okoume are acceptable provided they are given preservative treatment at the factory. Gaboon/Okoume has very low natural durability.

In plywood construction it is important to seal all edges with epoxy glue. Especially where the deck overlaps the side there are problems of rot if the edge is not well sealed before fastening the sheer batten.

2. TIMBER

The timber for the plywood boat must first of all be suitable for gluing. Generally the heavier type A timber as described on page 18 does not give as good a glue bond as the lighter timber. An exception to this is Iroko and Kapur. Generally type B timber is therefore used in plywood boat construction. The keel and keel-shoe should preferably be of a heavier and harder timber.

3. GLUE

There are two types of glue with a proven record as waterproof glue: Epoxy and Phenol Resorcinol.

Epoxy has a better gap filling ability which means that less clamping pressure is required to achieve a good bond. However, epoxy presents a greater health risk. Contact with the skin should be avoided as some people develop a skin rash after having used epoxy over a period. The hardener powder of phenol resorcinol is toxic and should be handled with care.

The following rules are important for a good glue bond.

a) The correct measuring of quantities of resin and hardener and proper mixing is very important for a good bond. Use a postal scale if necessary and follow the instructions on the tin carefully. Glue is expensive so do not spoil the result by careless mixing.

b) The lids of the glue tins should be put on properly and the tins stored in a cool place 5-20 °C. Storage time will then be 1-2 years. In a hot climate the "shelf life" of the glue is much reduced.

c) Plane the timber to equal thickness with a machine planer. Although epoxy has a gap filling property, the surfaces should be fairly even.

d) Freshen up the wood surface. If time from planing is more than 48 hours before gluing, the wood should be freshened up with sandpaper followed by brushing off the dust. This gives fresh wood directly in contact with the glue.

e) Use timber of correct moisture content. Wet timber will not glue well and too dry timber puts high stress on the glueline when swelling takes place after the boat is put into service.

4. FASTENINGS

The purpose of the fastenings is to provide sufficient pressure until the glue sets. The fastening itself will take no load as long as the glueline is intact. Only in an emergency with glue failure might the fastening provide some additional safety. Use screws only where the bend in the plywood is too extreme.

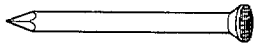
Nails

The best type of fastening is the annular ringed or barbed bronze nail. The nails also carry the name "Gripfast". For the 9 mm plywood used in these boats the following size is recommended: Diameter = 2 mm (14 SWG), Length = 25 mm (1 in).

If these nails are not available, hot dipped galvanized nails can be used. The nails should have a small head so that they can be countersunk below the surface of the plywood and the hole plugged with a filler to avoid any surface corrosion. For 9 mm plywood the dimension should be: Diameter = 2.65 (12 SWG), Length = 30 mm

The length of these nails means that they have to be set at an angle in the 25 mm battens to avoid splitting the inside surface.

Barbed bronze nail



Round wire nail, countersunk head hot dipped galvanized

50 PLYWOOD BOAT 5.2 M - TIMBER (including 25% waste)

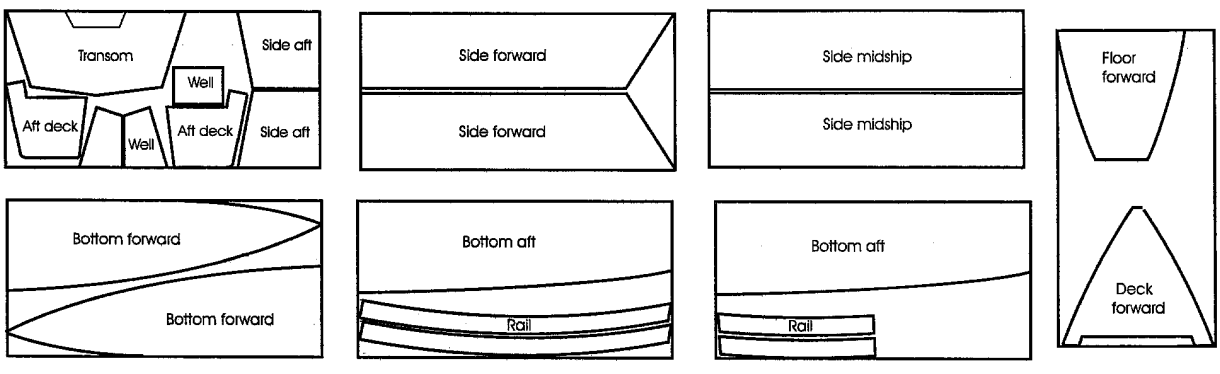
FOR THE OTHER BOATS MULTIPLY THE LENGTHS WITH THE FACTOR F :
6.3 M BOAT. F = 1.2. 7.4 M BOAT : F = 1.4. 8.5 M BOAT: F = 1.6.
NOTE: The keel for the 7.4 m and 8.5 m boats is 68 x 68 sawn from 75 x 150

TYPE OF TIMBER	DIMENSION FROM SAWMILL mm	TOTAL LENGTH m	SAWING INTO SMALLER SECTIONS mm	TOTAL LENGTH m	PLANED DIMENSION mm	ITEM LETTER
B Except where marked timber A	20 x 150	8	20 | 50 50 50	24	16 x 44	A
	25 x 150	15	25 | 150	15	20 x 143	B
		2 A	25 | 75 75	4	20 x 68	C
		1	25 | 50 50 50	3	20 x 44	D
		4.5	25 | 37 37 37 37	18	20 x 32	E
	38 x 150	9	38 | 150	9	32 x 143	F
		3	38 | 75 75	6	32 x 68	G
		4.6	38 | 50 50 50	14	32 x 44	H
	38 x 200	5	38 | 200	5	32 x 193	I
	50 x 150	3.2 A	50 | 75 75	6.4	44 x 68	J
		8	50 | 37 37 37 37	32	25 x 44	K
	75 x 150	2,5 A	75 | 150	2.5	68 x 143	L
		5	75 | 37 37 37 37	13	25 x 68	M
						N

Marine plywood 9 mm in sheets 1.2 m x 2.4 m

Total = 7 sheets
6.3 m Boat = 9 sheets
7.4 m Boat = 10 sheets
8.4 m Boat = 13 sheets

Optional floorboards not included except forward.



TIMBER (Including 25% waste)

TYPE OF TIMBER	DIMENSION FROM SAWMILL		TOTAL LENGTH OF TIMBER IN METRES			
	MM	INCH	5.2 M BOAT	6.3 M BOAT	7.4 M BOAT	8.4 M BOAT
A	25 x 150	1 x 6	2.0	3.5	5	6
	50 x 150	2 x 6	3.2	4		
	75 x 150	3 x 6	2.5	2.5	8	9
A m^3			0.06	0.07	0.09	0.12
B	20 x 150	¾ x 6	8	10	11	13
	25 x 150	1 x 6	21	22	23	24
	38 x 150	1 ½ x 6	17	20	24	27
	38 x 200	1 ½ x 8	5	6	7	8
	50 x 150	2 x 6	8	10	11	13
	75 x 150	3 x 6	5	6	7	8
B m^3			0.35	0.41	0.47	0.53
Total volume A + B in m^3			0.41	0.48	0.56	0.65
MARINE PLYWOOD , 9 mm, , sheet of 1.2 x 2.4 m			7 sheets	9 sheets	10 sheets	13 sheets

FASTENINGS AND MISCELLANEOUS

ITEM		QUANTITY			
		5.2 M BOAT	6.3 M BOAT	7.4 M BOAT	8.5 M BOAT
Bolt, hexagonal head, hot dip galvanized with nut. Alternative: Cup - square coach bolt, hot dip galvanized with nut	8 x 80	2	2	2	2
	8 x 90	5	6	2	2
	8 x 100	3	4		
	8 x 110			5	6
	8 x 120	4	4	4	4
	8 x 140	2	2	2	2
Barbed ringnail, flat head, bronze	2.0 x 25 (14 SWG x 1 in)	2.5 kg	3.0 kg	3.5 kg	4.0 kg
	3.2 x 32 (10 SWG x 1 ¼ in)	0.3 kg	0.4 kg	0.4 kg	0.5 kg
	3.2 x 45 (10 SWG x 1 ¾ in)	0.6 kg	0.7 kg	0.8 kg	1.0 kg
Alternative : Round wire nail, countersunk head, hot dip galvanized					
	2.6 x 30 (12 SWG x 1 ¼ in)	3.5 kg	4.0 kg	4.5 kg	5.0 kg
	3.2 x 45 (10 SWG x 1 ¾ in)	0.6 kg	0.7 kg	0.8 kg	1.0 kg
Woodscrew, AISI 316 Stainless steel					
	4.0 x 25 (8 Gauge x 1 in)	100	100	100	100
	5.0 x 50 (10Gauge x 2 in)	60	75	85	100
	5.0 x 63 (10 Gauge x 1 ½ in)	20	25	30	35
Epoxy glue including hardener		5.0 kg	6.0 kg	7.0 kg	8.0 kg
Filler for epoxy glue		1.0 kg	1.2 kg	1.4 kg	1.6 kg
Wood primer		5.0 kg	6.0 kg	7.0 kg	7.0 kg
Paint		6.0 kg	7.0 kg	8.0 kg	8.0 kg
Antifouling paint		1.0 kg	1.0 kg	1.5 kg	2.0 kg
Paint thinner		2 L	2 L	2 L	2 L
Buoyancy material, polyurethane, polystyrene, Emergency sail and rudder fittings, see drawing.		0.1 cub.m	0.1cub.m	0.1 cub.m	0.1 cub.m
Note: Two component polyurethane paint will give a much more durable finish than ordinary oil paints.					

DIMENSIONS OF FRAMES ARE SAME AS FOR PLANKED CONSTRUCTION

The bottom part of the frames forward of midship must be curved because of the natural bending of the plywood. The depth of the cutout for the batten must be determined in place as shown on page 41 and 56.

FRAME 3

Straight line from frame dimensions

20

Use flexible batten to draw curve

Remember that this distance is 12 mm lower than for planked construction except for the forward frame

FRAME 4

20

TRANSOM

Plywood pad on inside glued in place

Wood plate 20 x 193 bolted on outside same as for planked transom

100

H

32 x 44

N

Plw 9

Curve in aft deck determined after fixing sheer batten

Construction base

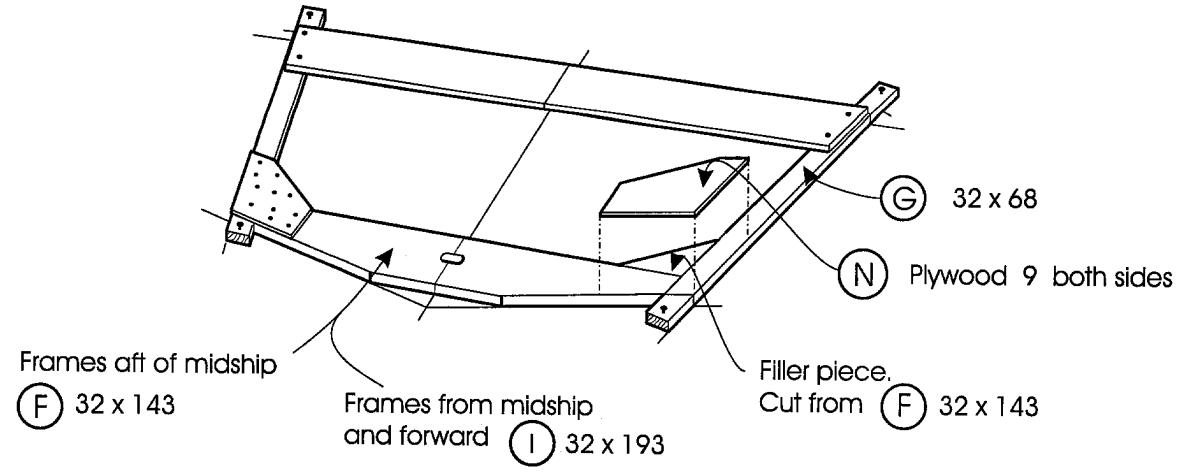
Cut from F 32 x 143

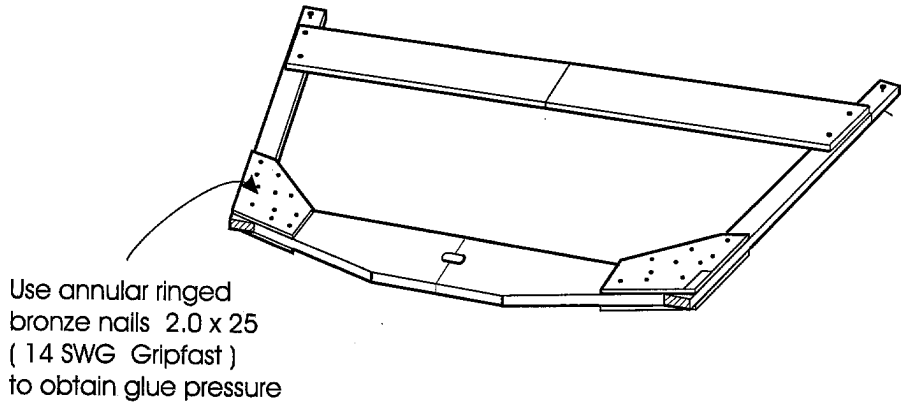
96

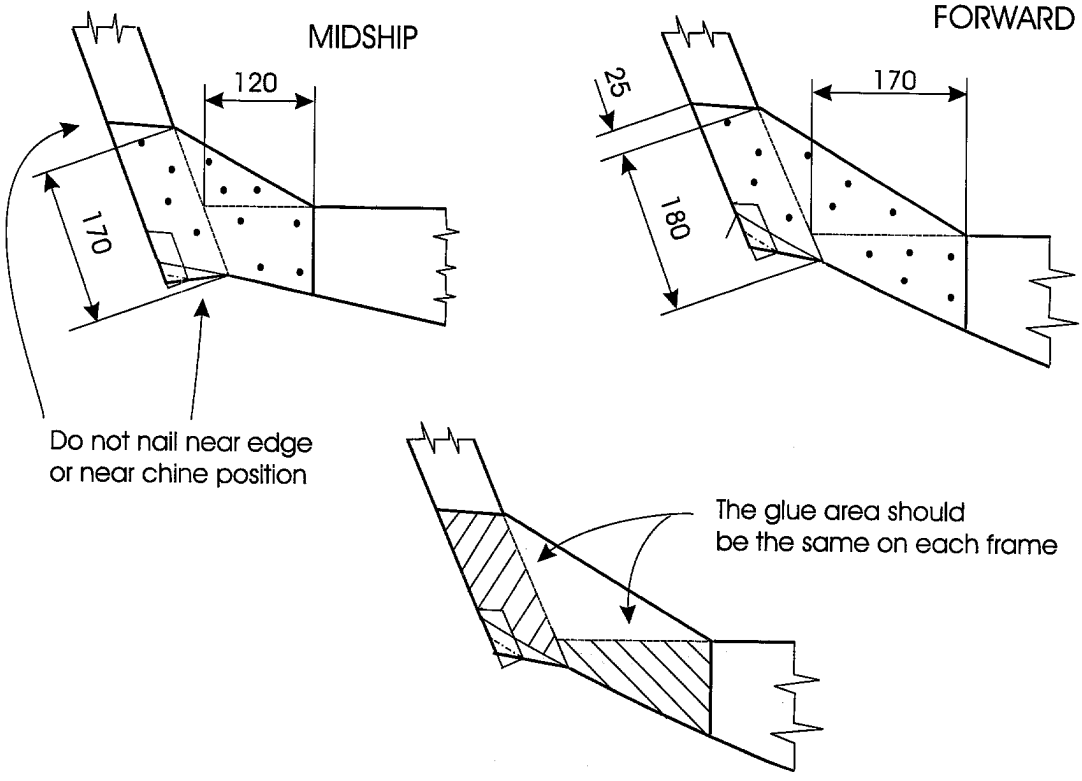
32

108

FRAME CONSTRUCTION IS SAME AS SHOWN FOR PLANKED CONSTRUCTION EXCEPT FOR GLUED GUSSET

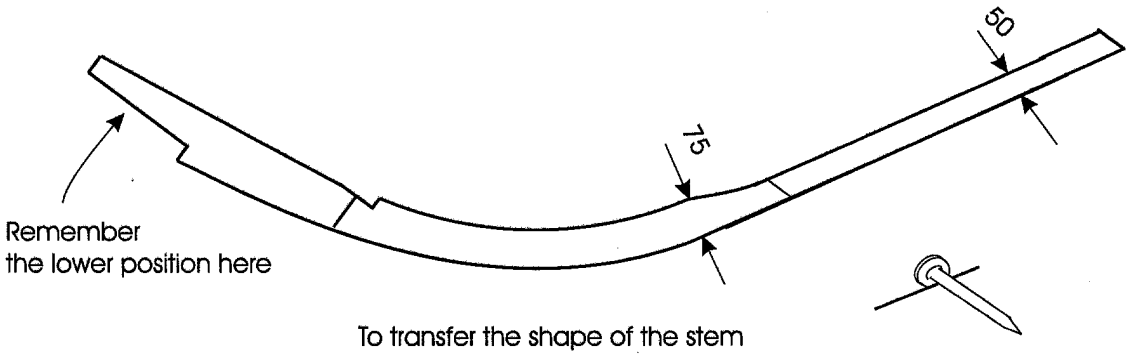






1

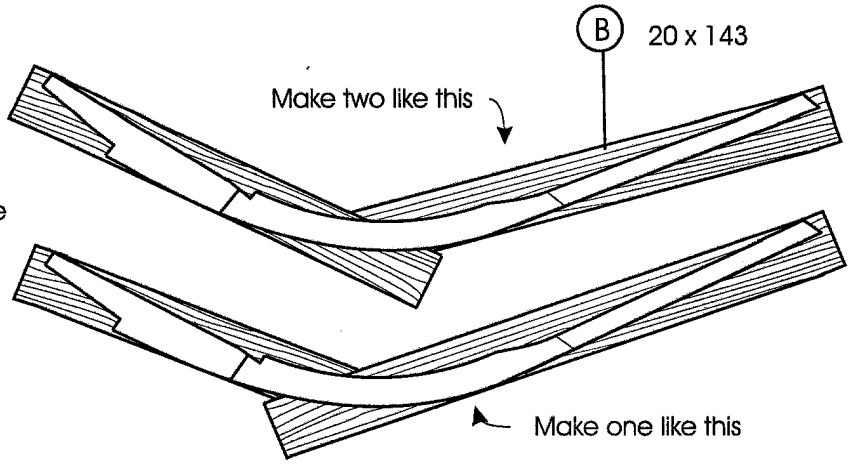
The forward side of the stem has the same shape as the planked boat. The width of the stem is modified as shown below:
Make a pattern of the stem out of 4 mm plywood.



To transfer the shape of the stem from the drawing on the plywood sheet, use transparent drawing paper or place the head of nails along the line, hammer the head so the nail does not roll and press the 4 mm sheet onto the nailheads to leave marks of the curve.

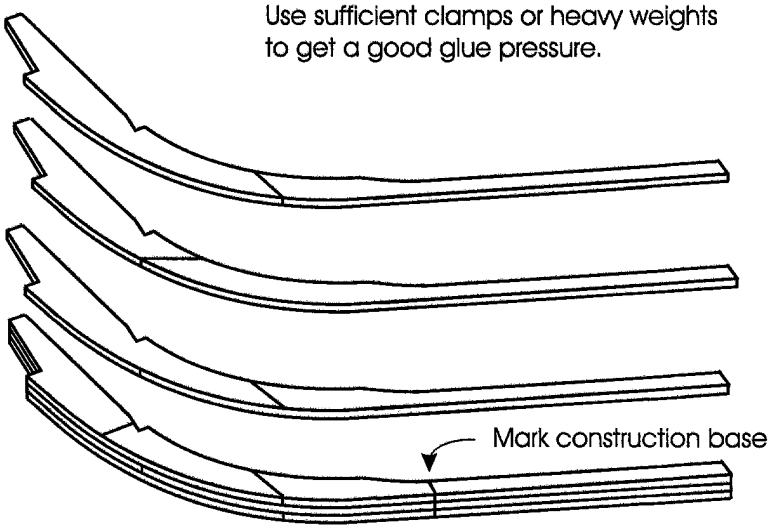
2

Cut the end of one board so that the pattern is inside the edges of the two boards. Trace the shape and cut.



3

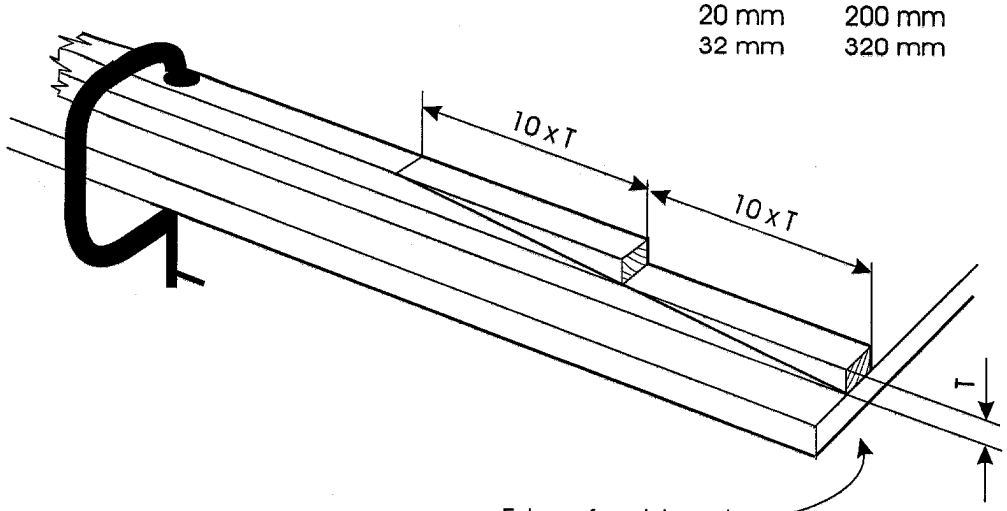
The three layers are laminated together. Use sufficient clamps or heavy weights to get a good glue pressure.



1

Plane the scarf in the two battens to be joined at the same time

T	SCARF LENGTH
20 mm	200 mm
32 mm	320 mm



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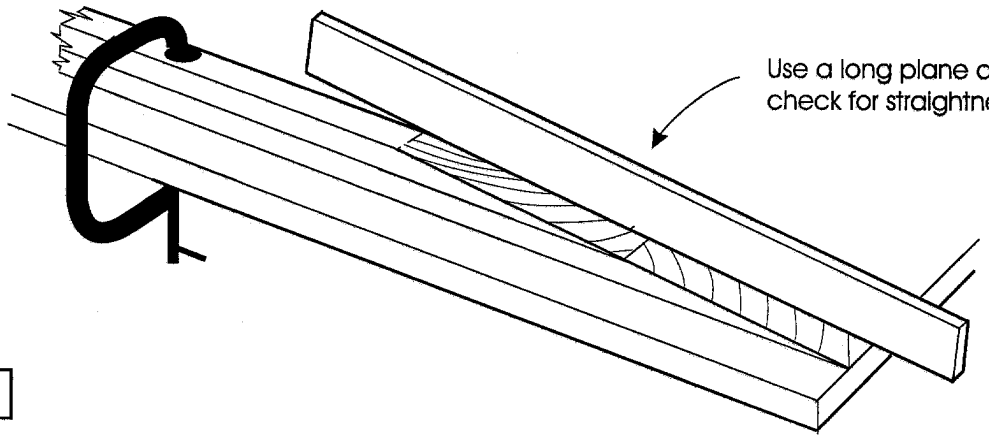
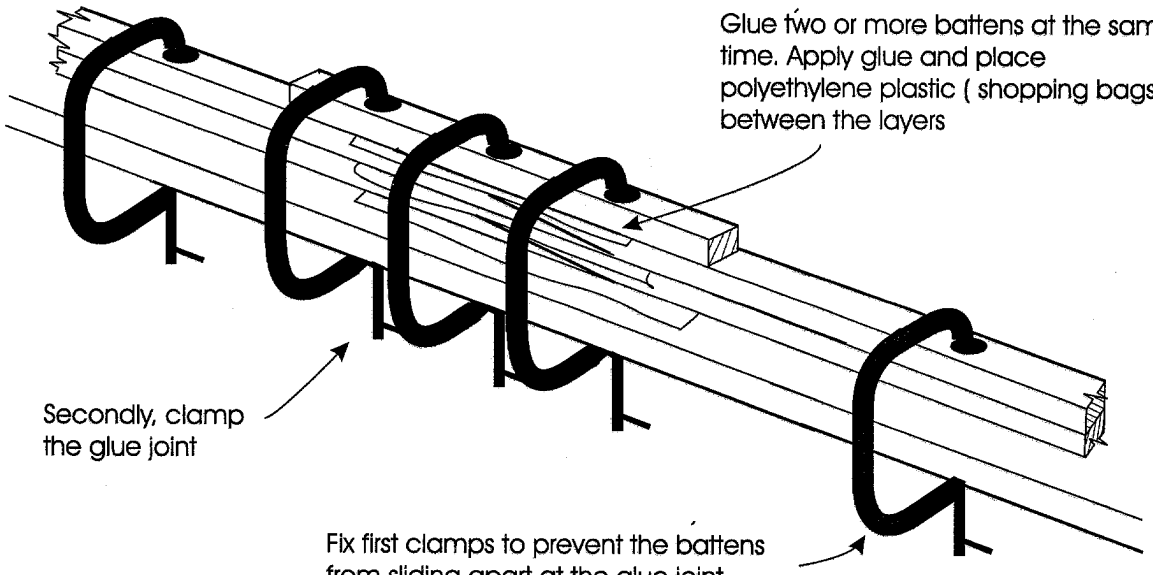


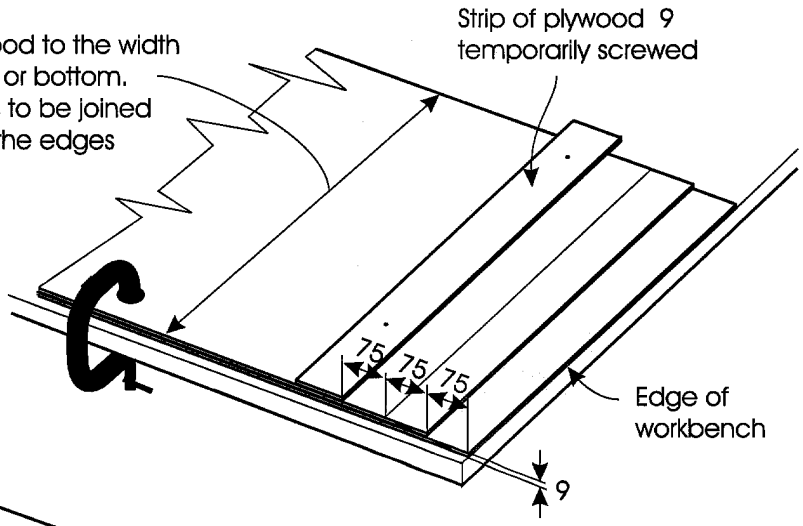
3



SCARFING PLYWOOD

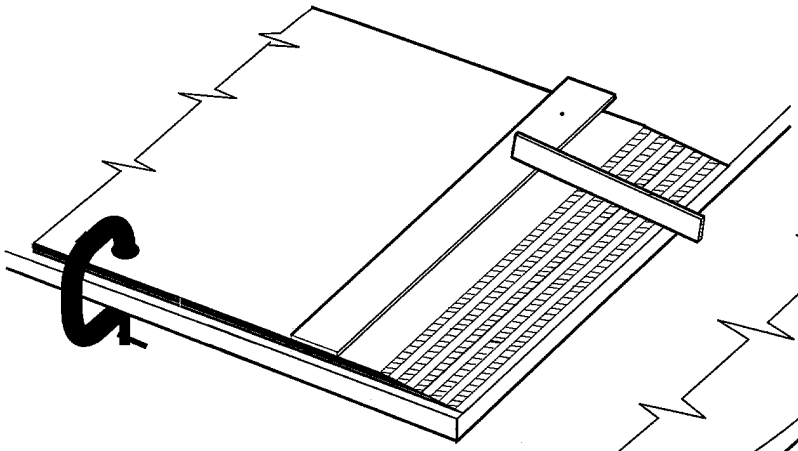
1

Cut the sheet of plywood to the width required to cover side or bottom. Clamp the two panels to be joined to the worktable with the edges staggered as shown.



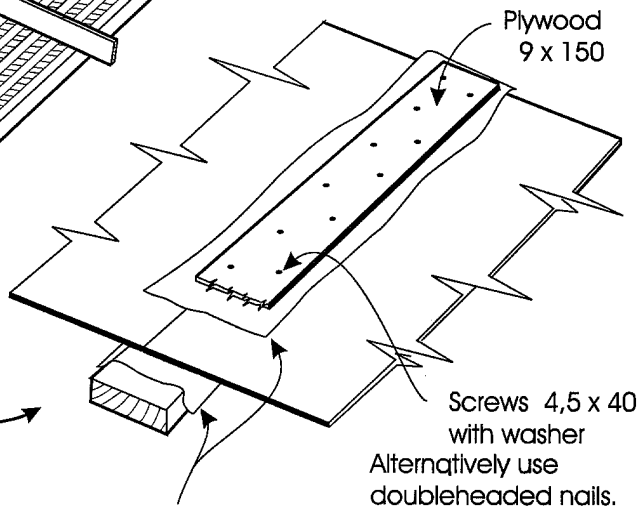
2

Plane the scarf with a long plane and check for straigtness

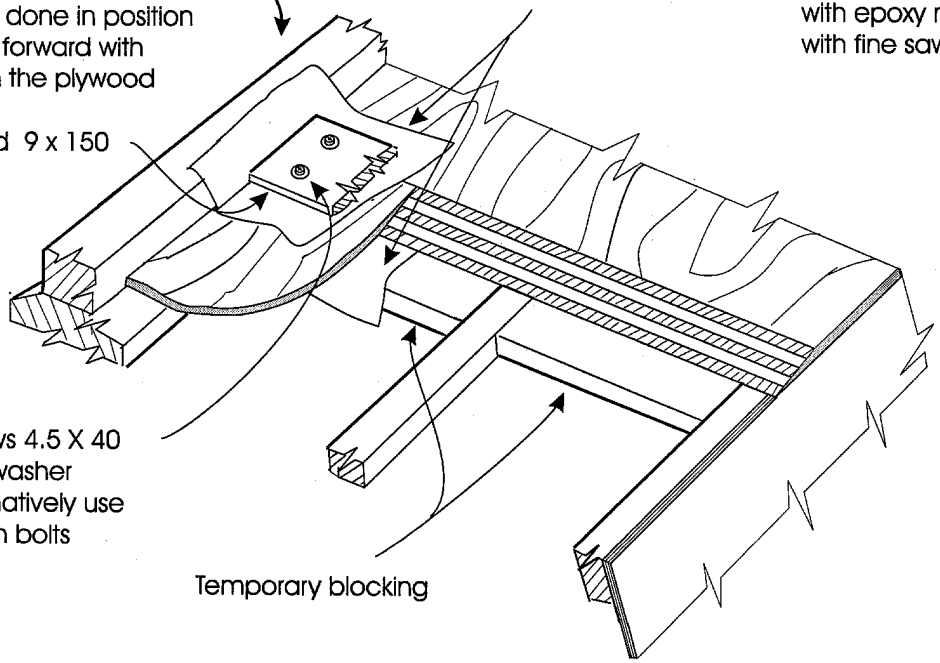


3

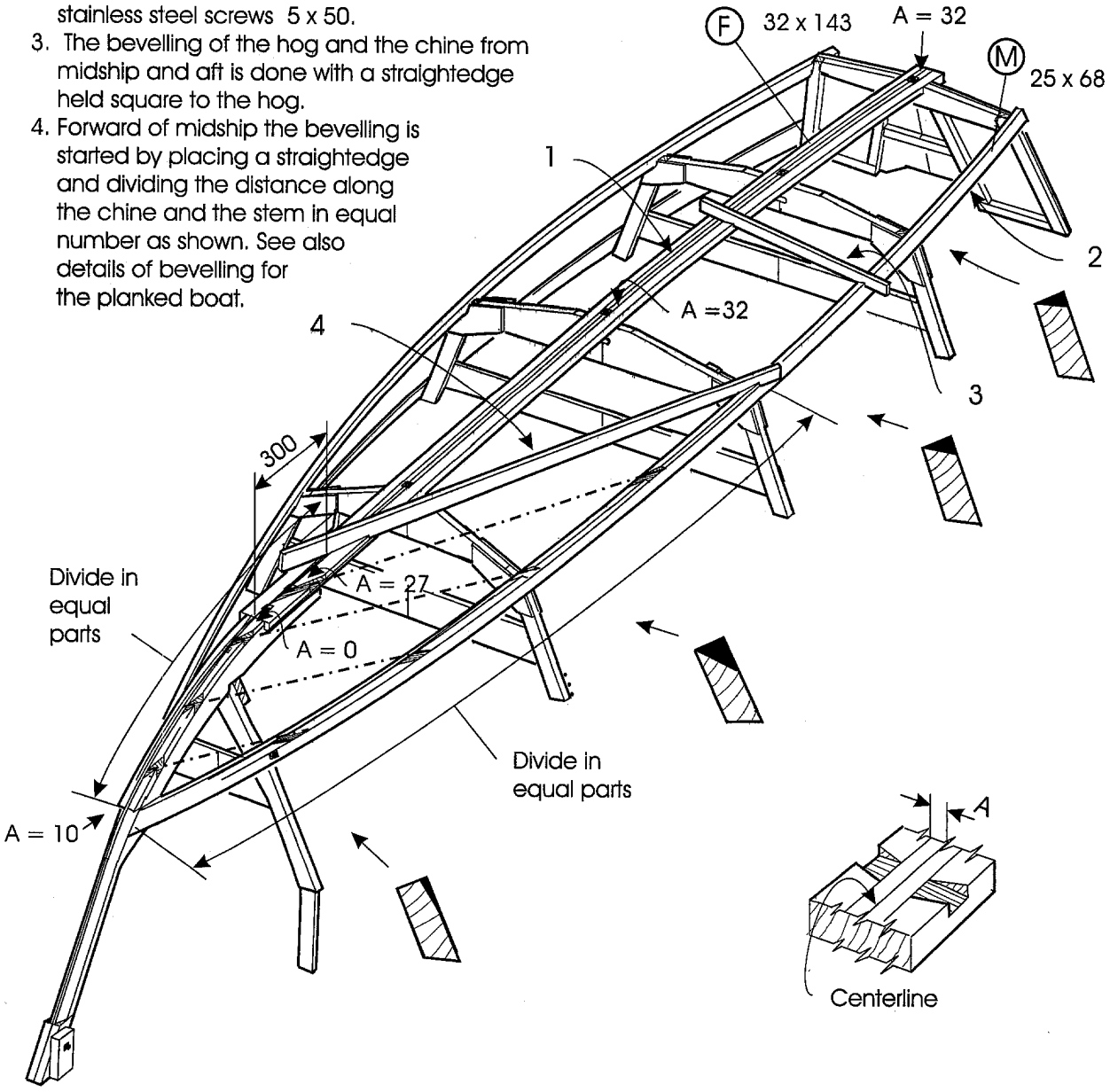
A Gluing can be done by supporting the panels on the floor and screwing into a wooden beam

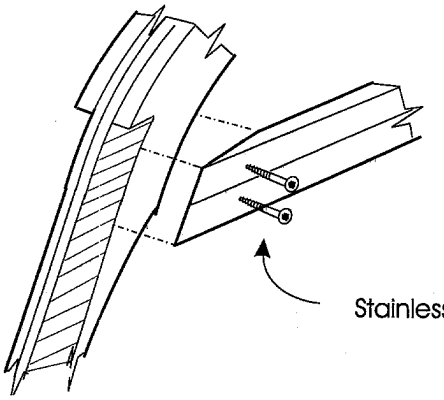


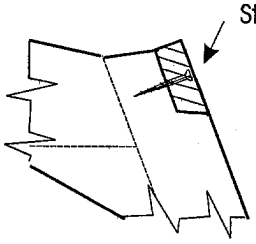
B On longer boats the gluing can be done in position but not forward with bend in the plywood



1. The hog is bolted to transom , frames and stem with 8 mm bolts, hot dip galvanized or stainless steel.
2. The position of the chine is determined in the same way as for the planked boat. The chine is fixed with stainless steel screws 5 x 50.
3. The bevelling of the hog and the chine from midship and aft is done with a straightedge held square to the hog.
4. Forward of midship the bevelling is started by placing a straightedge and dividing the distance along the chine and the stem in equal number as shown. See also details of bevelling for the planked boat.

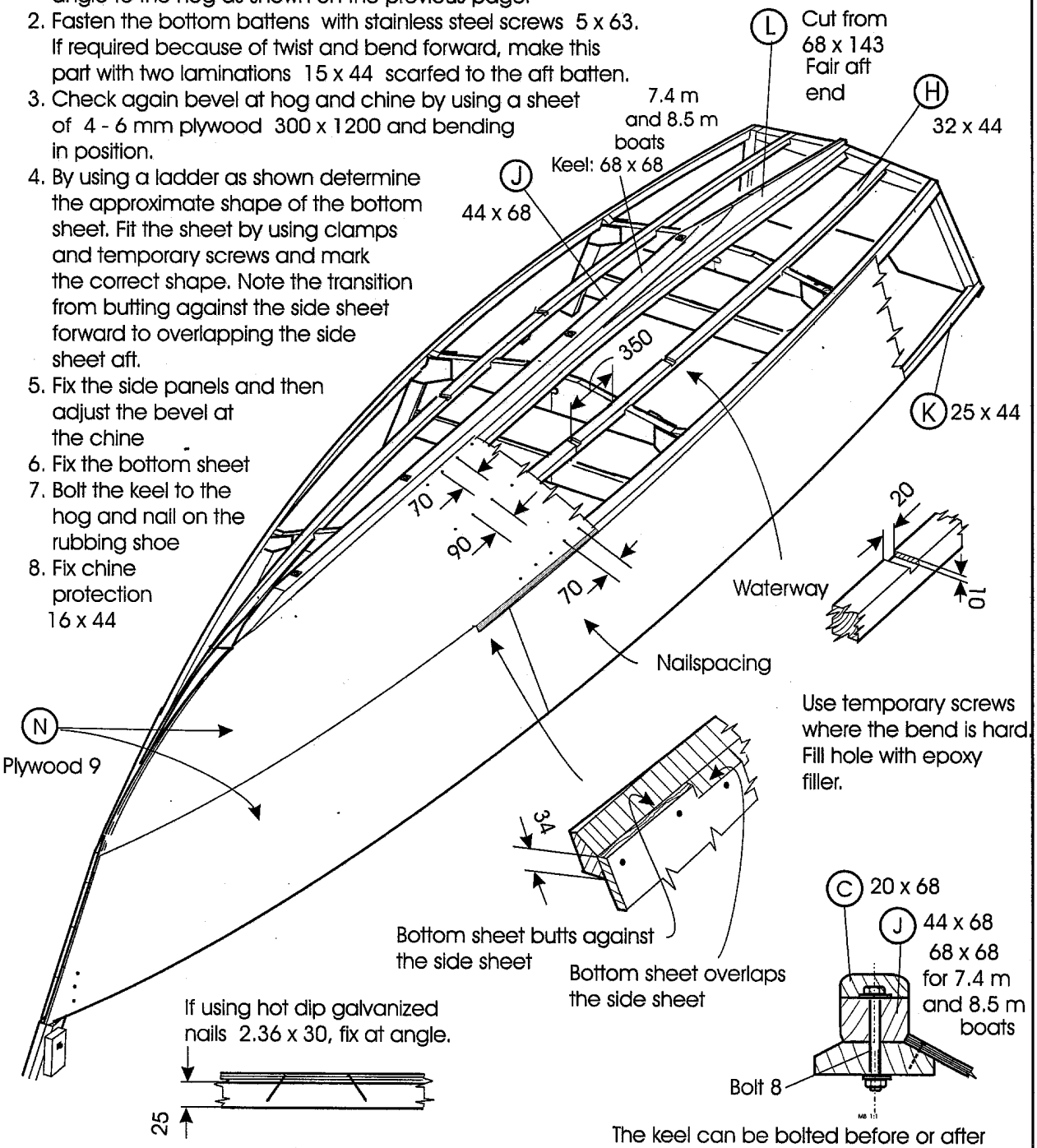




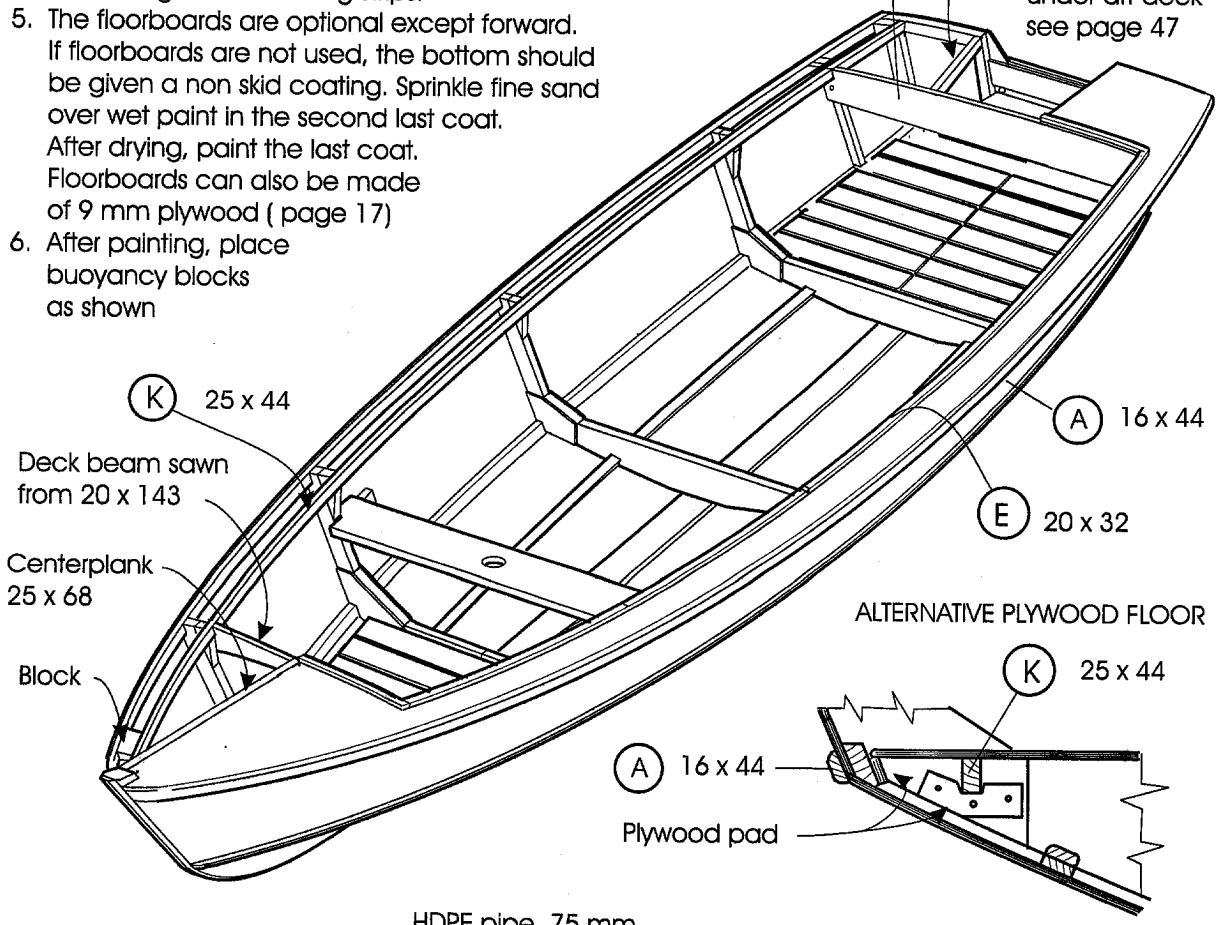


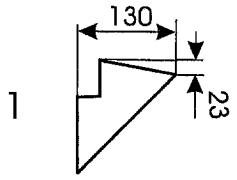
PLYWOOD - SIDE AND BOTTOM

1. Determine the depth of the cutout in the frames for the bottom battens in the same way as for planked construction, however it is very important that the straightedge is placed in the same angle to the hog as shown on the previous page.
2. Fasten the bottom battens with stainless steel screws 5 x 63. If required because of twist and bend forward, make this part with two laminations 15 x 44 scarfed to the aft batten.
3. Check again bevel at hog and chine by using a sheet of 4 - 6 mm plywood 300 x 1200 and bending in position.
4. By using a ladder as shown determine the approximate shape of the bottom sheet. Fit the sheet by using clamps and temporary screws and mark the correct shape. Note the transition from butting against the side sheet forward to overlapping the side sheet aft.
5. Fix the side panels and then adjust the bevel at the chine
6. Fix the bottom sheet
7. Bolt the keel to the hog and nail on the rubbing shoe
8. Fix chine protection 16 x 44



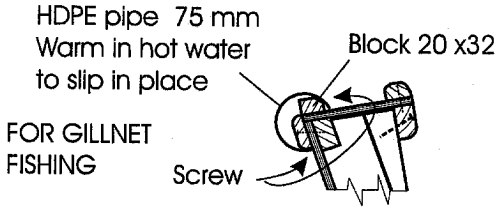
1. Glue and nail a piece to increase the width of the rail. By using a pattern draw the rail angle and cut below the sheer batten.
2. Screw the coaming batten to the frames and to blocks at the transom and the stem. Bevel the battens. Fix deck beams forward and aft, the center plank and the framing for the engine well.
3. Nail and glue the plywood in the engine well and the deck. Plane edges and seal with epoxy glue.
4. Nail and glue the rubbing strips.
5. The floorboards are optional except forward. If floorboards are not used, the bottom should be given a non skid coating. Sprinkle fine sand over wet paint in the second last coat. After drying, paint the last coat. Floorboards can also be made of 9 mm plywood (page 17)
6. After painting, place buoyancy blocks as shown

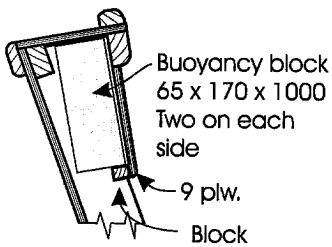


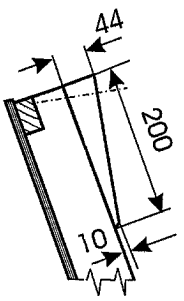


1

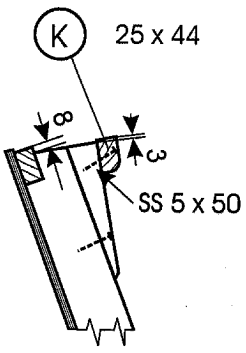
Plywood pattern for rail angle







2



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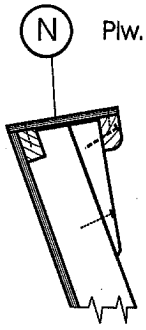

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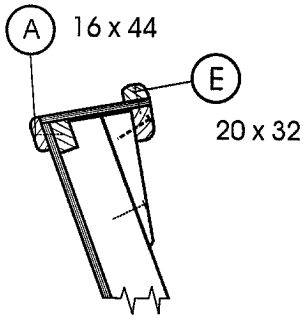
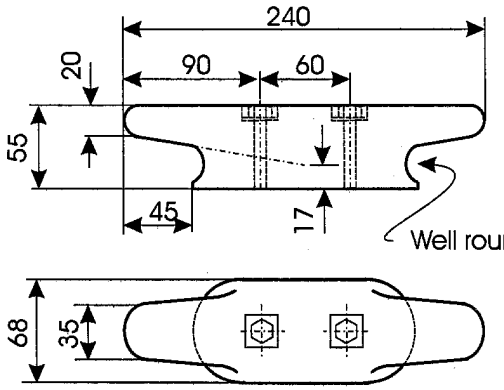
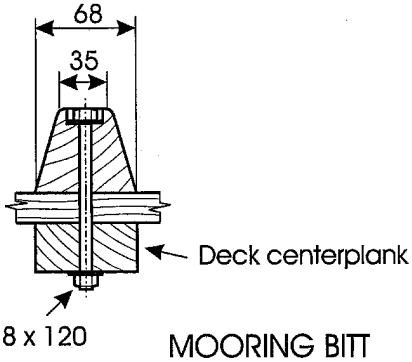


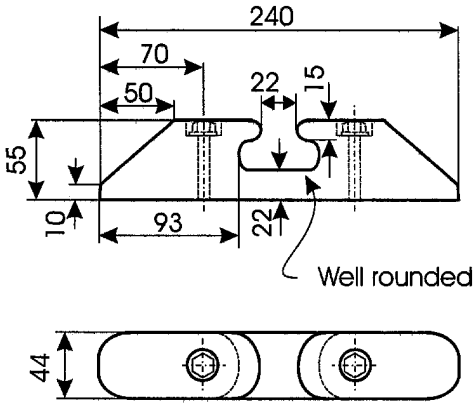
5

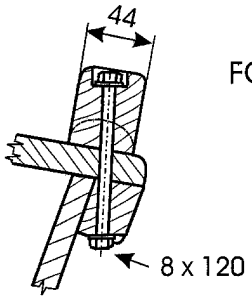
60 MOORING BITT AND FAIRLEAD



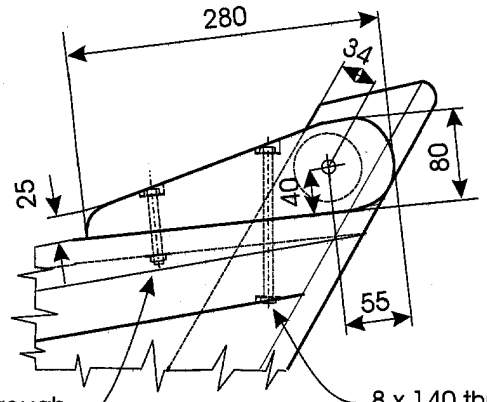


MOORING BITT
ON FOREDECK



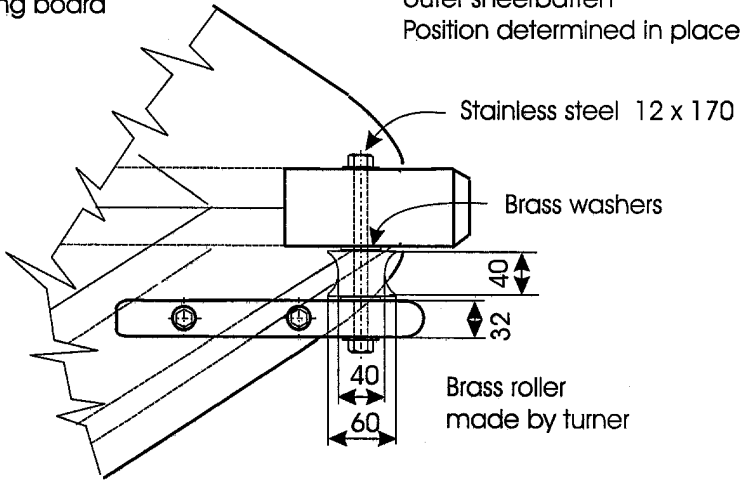


FAIRLEAD
FOR ANCHOR ROPE

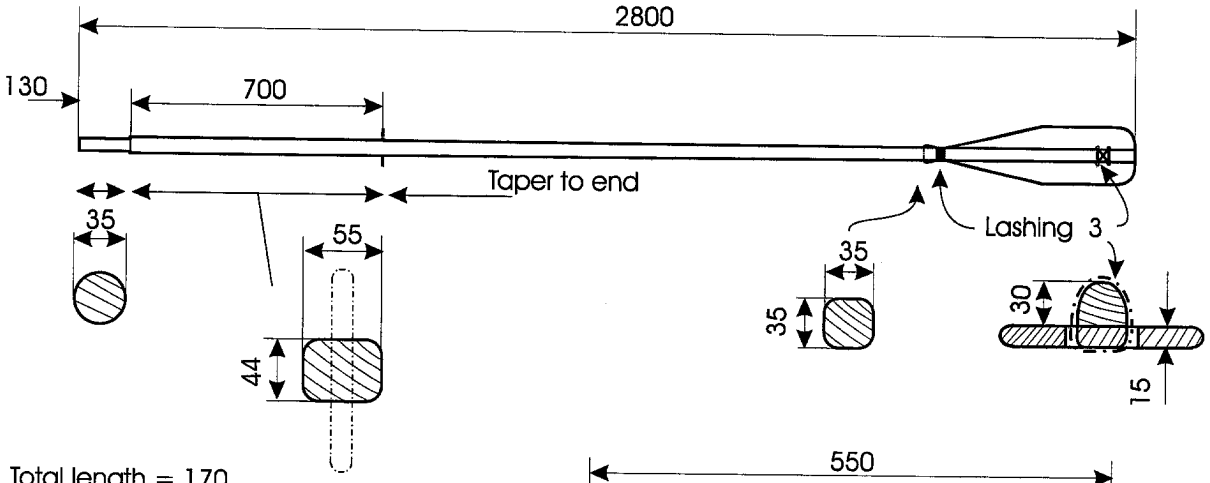


Alternative
BOW ROLLER

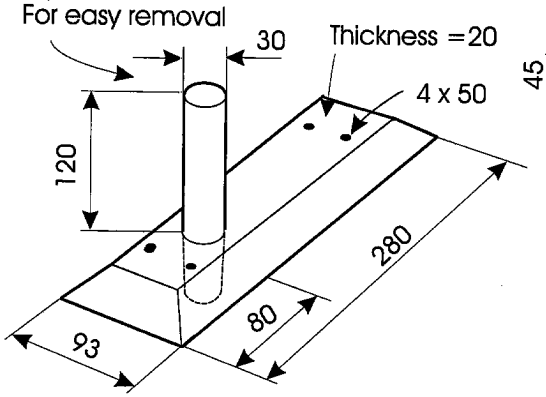
Preferable to fairlead
if anchor is used often

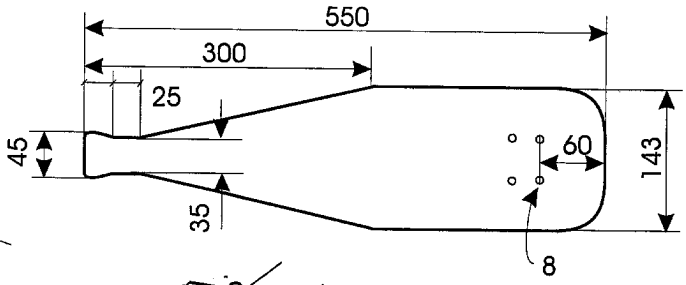


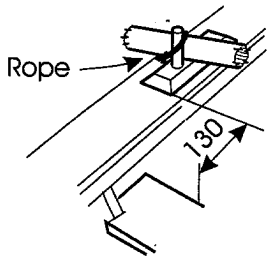
Wood about 500 kg / m^3. Can also be made from a pole.



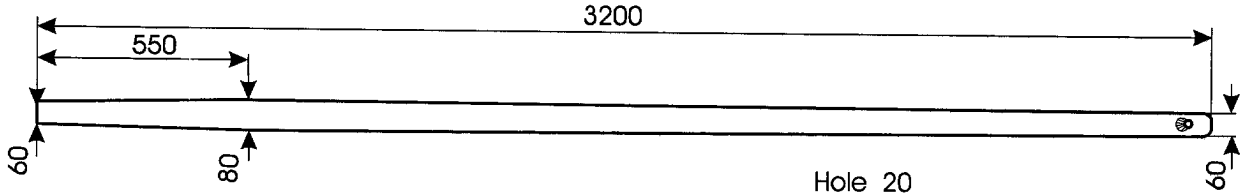
Total length = 170
Tapered last 50
For easy removal



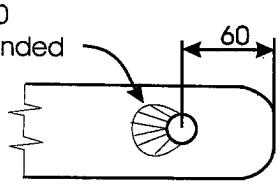




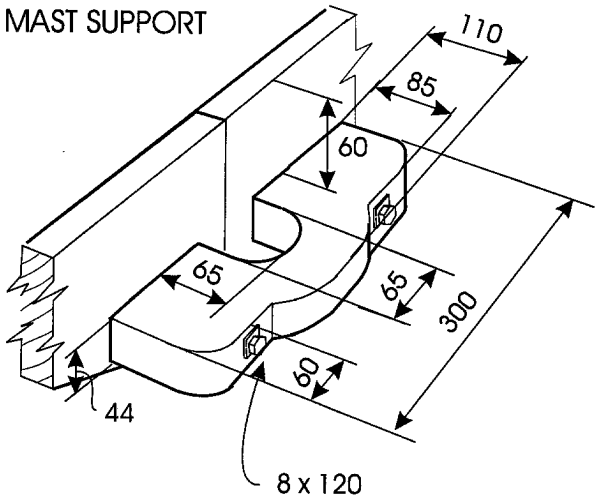
The mast can be made from a pole since small irregularities are of no importance

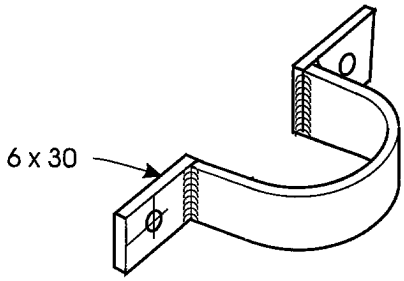


Hole 20
well rounded

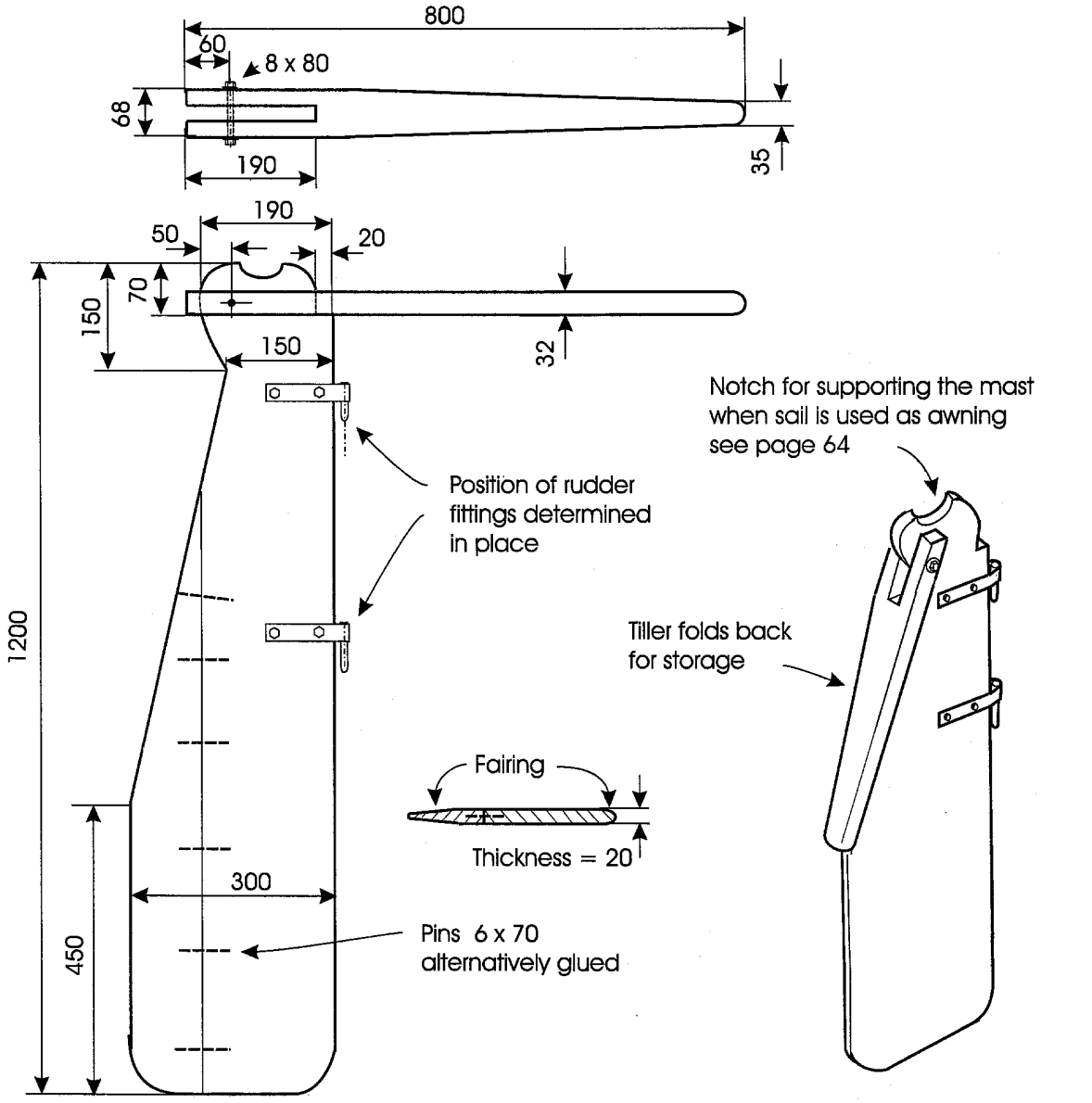


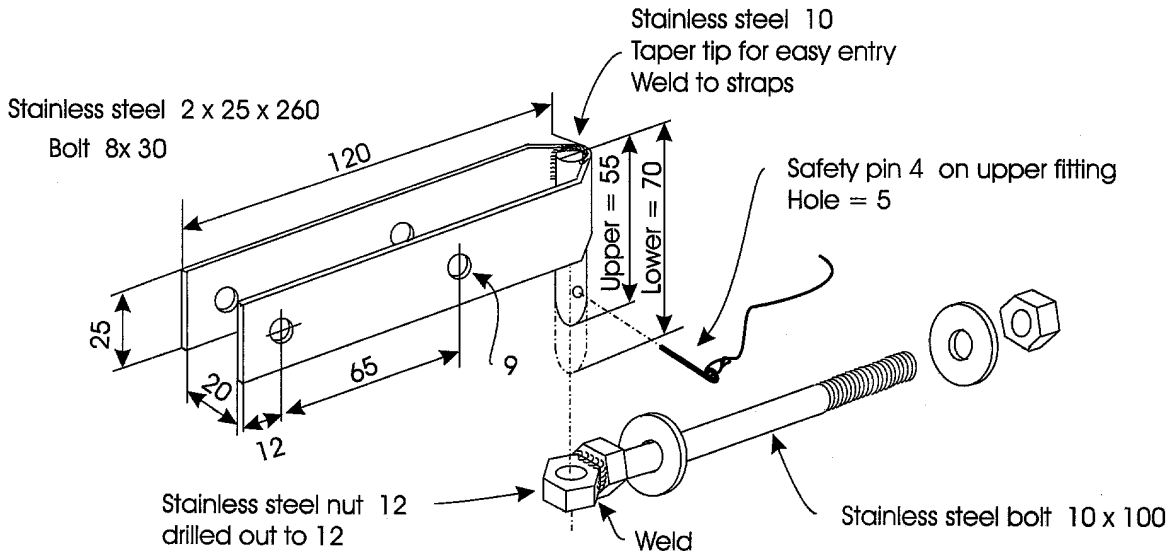
MAST SUPPORT



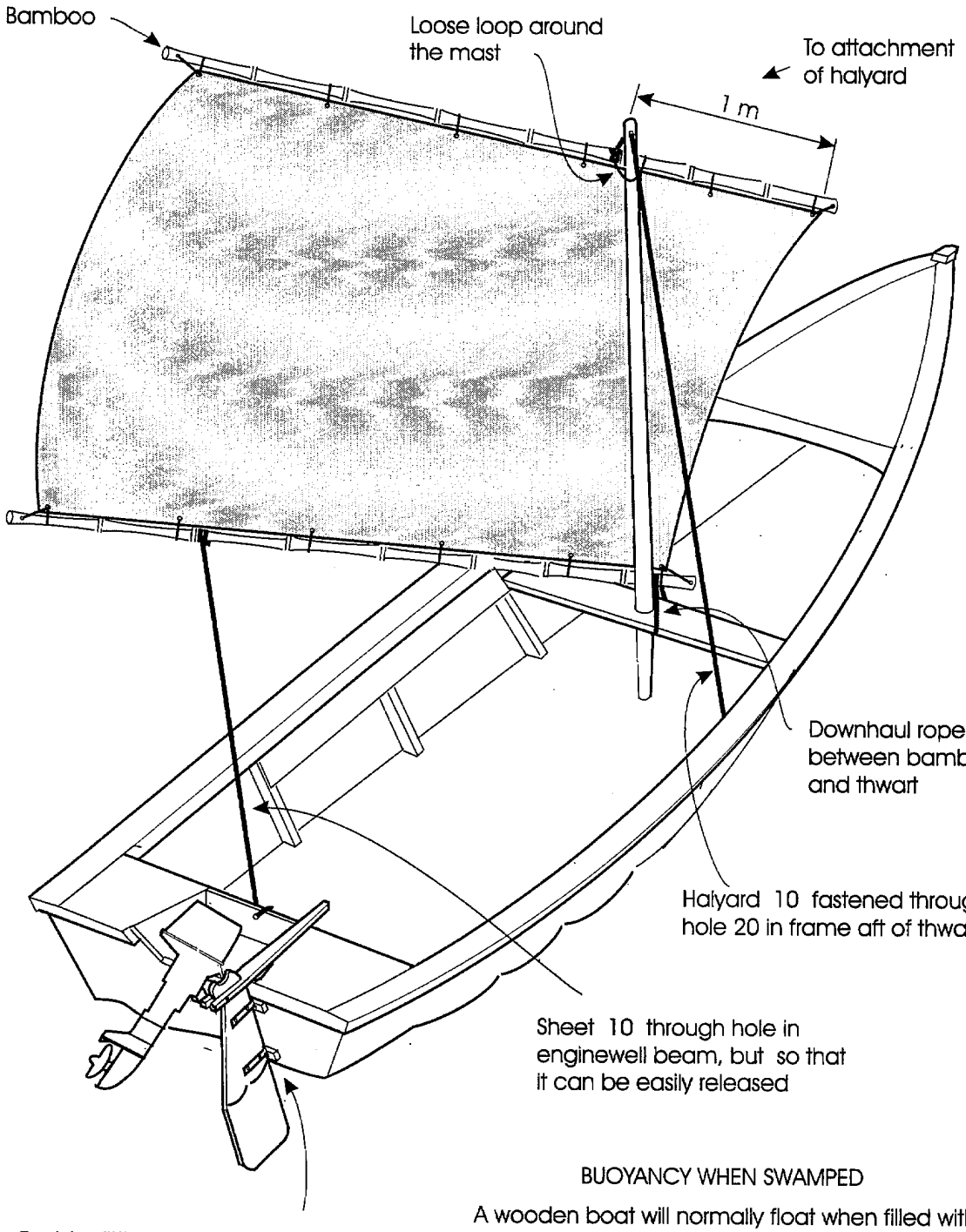


ALTERNATIVE MAST SUPPORT


800
60
8 x 80
68
190
35
190
50
20
70
150
150
32
Notch for supporting the mast
when sail is used as awning
see page 64
Position of rudder
fittings determined
in place
1200
Tiller folds back
for storage
Fairing
Thickness = 20
300
Pins 6 x 70
alternatively glued
450


Stainless steel 10
Taper tip for easy entry
Weld to straps
Stainless steel 2 x 25 x 260
Bolt 8x 30
120
Upper = 55
Lower = 70
Safety pin 4 on upper fitting
Hole = 5
25
20
65
9
12
Stainless steel nut 12
drilled out to 12
Weld
Stainless steel bolt 10 x 100

The emergency sail is a standard reinforced polyetylene tarpaulin of 2 x 3 m. It can also serve as rain protection for the crew as shown on next page.



Rudder fittings fixed as closely to centerline as possible but clearing engine. Use blocks to obtain sufficient clearance to the aft deck.

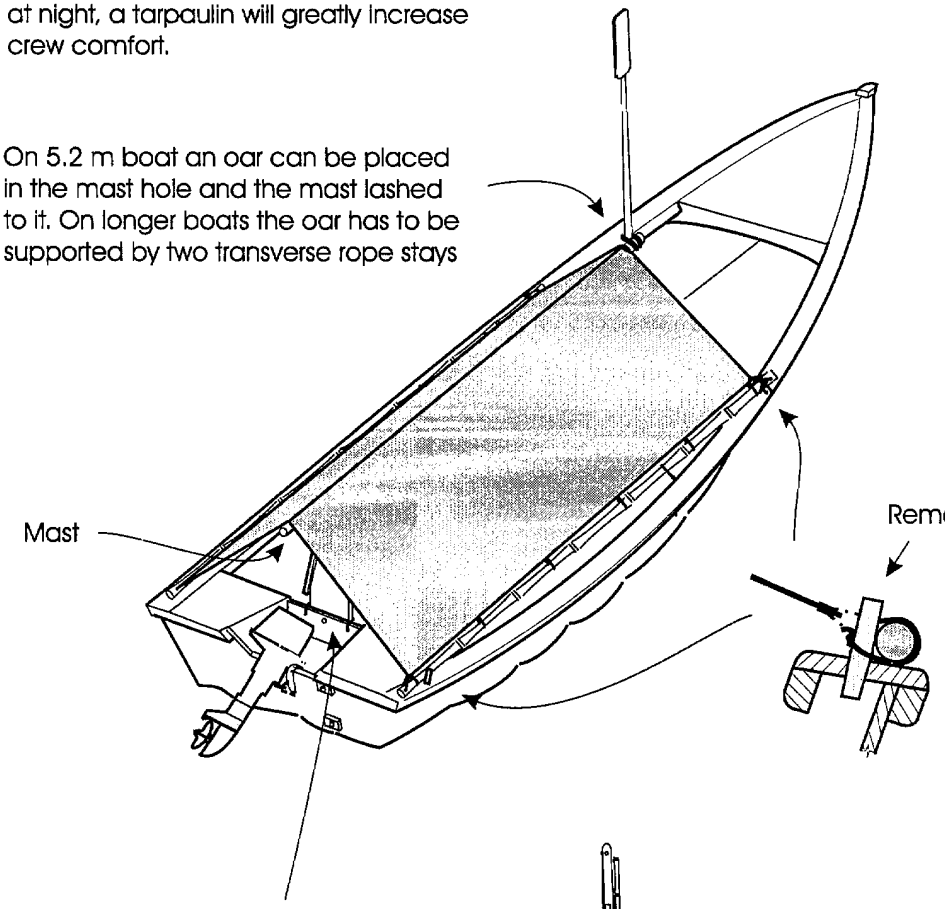
THIS IS AN EFFICIENT DOWNWIND SAIL AND CAN BE USED FOR FUELSAVING WITH A FAVOURABLE WIND

BUOYANCY WHEN SWAMPED

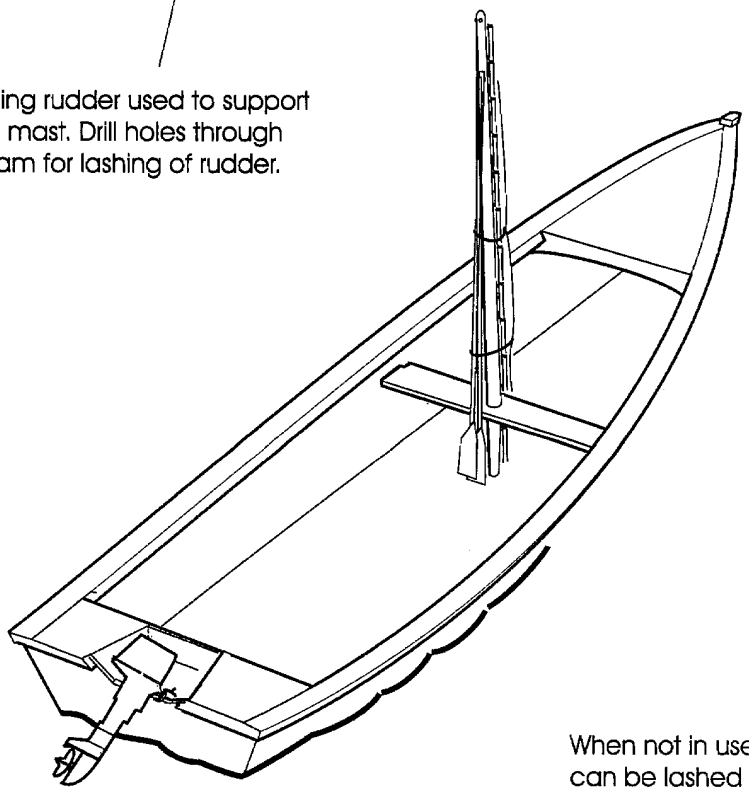
A wooden boat will normally float when filled with water. Additional buoyancy blocks are however required to ensure a level floatation and a minimum stability in swamped condition to permit bailing out the water (always carry a bucket). The buoyancy blocks under the covering board and under the aft deck is sufficient to ensure that the boat will float level when swamped. Additional buoyancy blocks must be fitted aft if the boat is equipped with an inboard engine as shown on pages 6 and 7.

During the rainy season when gillnetting at night, a tarpaulin will greatly increase crew comfort.

On 5.2 m boat an oar can be placed in the mast hole and the mast lashed to it. On longer boats the oar has to be supported by two transverse rope stays



Sailing rudder used to support the mast. Drill holes through beam for lashing of rudder.



When not in use, oars and tarpaulin can be lashed to the mast so that they are not in the way for the fishing operation

Timber remains the most common material for the construction of boats under 15 metres in length. There has been a change towards fibre-reinforced plastic in most developed countries and some developing countries but, in Africa, Asia and the Pacific, probably more than 90 percent of small fishing vessels are built of wood. The cost advantage of timber versus other materials is still sufficient to ensure that it will remain the dominant boatbuilding material for a long time to come in developing countries. However, unrestricted or illicit access to forest resources and the introduction of rational forestry management policies have caused and will continue to cause a scarcity of the sections of timbers traditionally favoured by boatbuilders. The resultant scarcity and high cost of good quality timber have not meant that less wooden boats are being built, but rather that vessel quality has deteriorated through the use of inferior timber and inadequate design strength.

This updated and completely revised publication supersedes Revision 1 of FAO Fisheries Technical Paper 134 published in 1997. It follows an exhaustive study on structural timber design applied to wooden boat construction. The publication includes the designs of four small fishing vessels (from 5.2 to 8.5 metres), with comprehensive material specifications and lists, and provides detailed instructions for their construction, both planked and of plywood. The designs are appropriate for inshore and coastal fisheries and emphasis has been placed on relative ease of construction and minimum wastage of timber.

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