Building a 15 metre Multi Purpose Fishing Boat for West Sumatra Sumatra Fisheries Development Project

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BUILDING A 15m MULTI PURPOSE FISHING BOAT FOR WEST SUMATRA

SUMATRA FISHERIES DEVELOPMENT PROJECT

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INTRODUCTION

Boatbuilding for a small scale developing fishery is a specialised subject in itself. Because boatbuilding is largely traditional in all parts of the World, it is not easy to apply European standards and values to a S.E.Asian country. A European boat has a certain set of relationships between length, breadth and depth by which the European fisherman feels comfortable in the sea conditions he is familiar with. Engineering standards are determined by good reliable back up on shore for service and spare parts.

The S.E.Asian fisherman, on the other hand, has always favoured a lighter constructed and narrower beamed boat with very rudimentary standards of accommodation. Increasing these criteria to meet European standards simply puts up the cost of the boat without changing his way of working or increasing his earnings. The fisherman, his gear and his boat are a closely knit unit anywhere in the World. Put one out of step by enforcing too many new ideas too soon and the development of a fishery will come to nothing.

In designing these vessels for the Sumatra project, the Sea Fish Industry Authority have recognised fully the needs of the local small scale fisherman and concentrated on setting certain standards of construction which they believe will make the boats more durable and safe.

A prototype of the multi purpose vessel has been built and is now in operation based at Bungus, W. Sumatra.

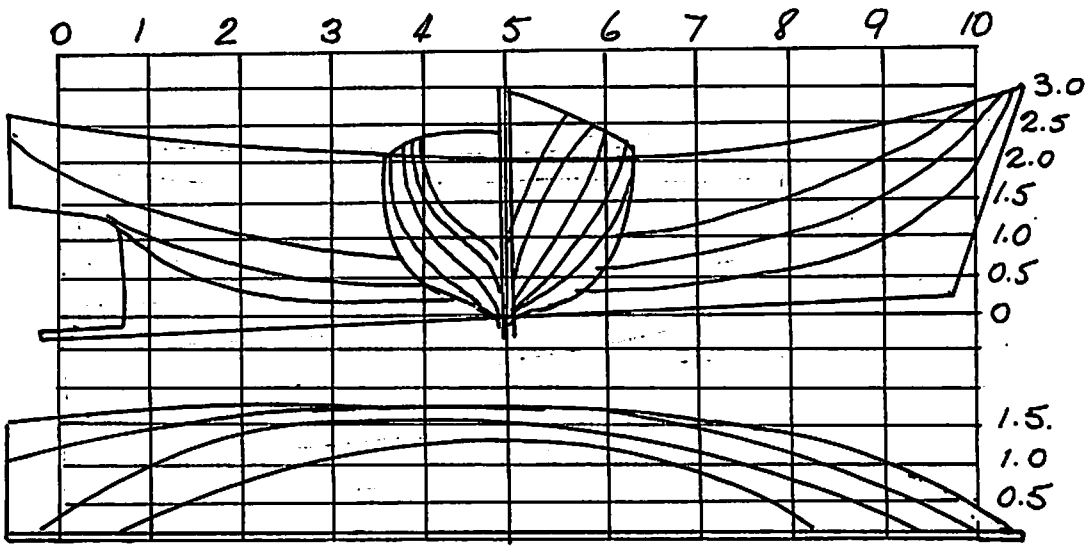
This report describes the complete building process and may be considered to be a manual of boatbuilding for typical small scale fisheries.

1. LOFTING

1.1 The Loft Floor

The first step in the building is draw out to full size the hull shape of the vessel from the lines plan and the table of offsets provided by the Naval Architect. The lines plan is drawn to a scale of perhaps 1/20 or 1/25. Any inaccuracies in the lines plan are magnified when drawn out to full size. Therefore lofting serves the purpose of checking the drawing and to fair the lines and provide detailed dimensions and information for the construction of the boat.

The first requirement is a mould loft floor. Ideally this should consist of a flat wooden surface without any bumps or ridges on which should be laid plywood sheets. When the lofting is completed, these plywood sheets can be lifted and stored for future reference. It is advisable to have the loft floor large enough to draw the vessel to full size, remembering that it must be drawn in three views, i.e. elevation plan, plan view and body plan. If possible there should also be space for a drawing board for the plans, a workbench with vice, etc., for pattern making. For the 15m vessel an area 20 x 7m is needed.



NAVAL ARCHITECTS LINES PLAN

1.2 Lofting Tools

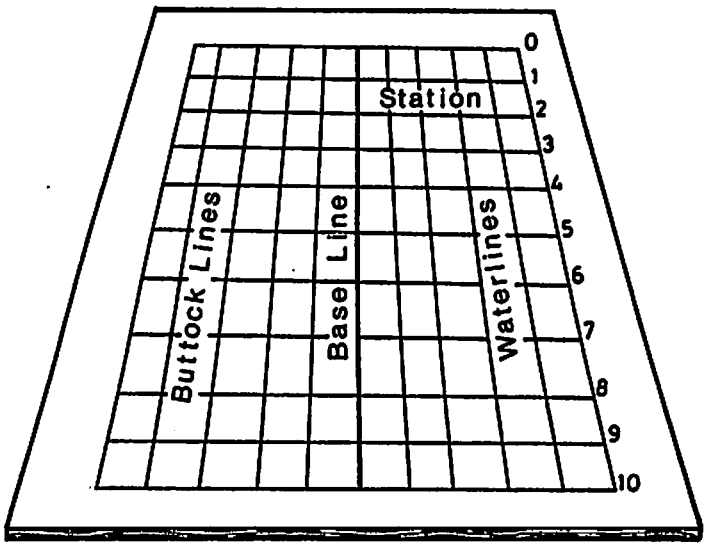
The main tools for loft work are battens to draw the curves, claw hammer, saw and nails to retain the batten in position.

Battens

The battens to draw the curves should be made from long strips of wood with a straight grain which will bend easily and give a fair line. The cross section of the battens will depend on the curves to be drawn. For long and easy curves such as the sheer line in elevation, a batten of 40mm x 35mm should be sufficient. For a 15m boat, it is ideal to have a batten extending the full length of the boat. If this is not available, a shorter batten can be used by overlapping the batten at least 2.0m each time a length of line is drawn to ensure a fair continuation. For waterlines in the plan view two battens of 25mm x 10mm and 20mm x 20mm cross section and for the sections in the body plan a batten of 10mm x 10mm cross section are required.

1.3 Grid Lines

Before the lines of the hull can be drawn down, certain steps must be completed. A base line must be laid down and stations erected square to it. Parallel lines for the waterlines in elevation and buttock lines in plan view must be drawn.

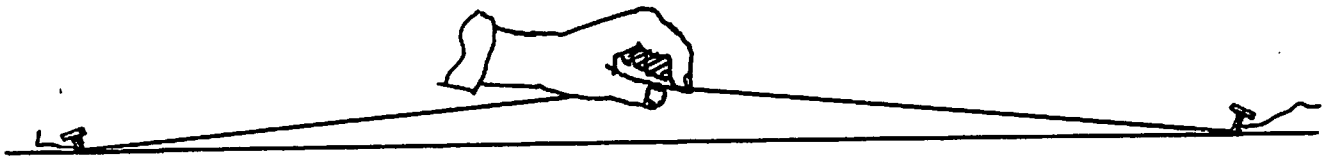


Basic Grid Lines

There are two methods for drawing a long straight line and these are:

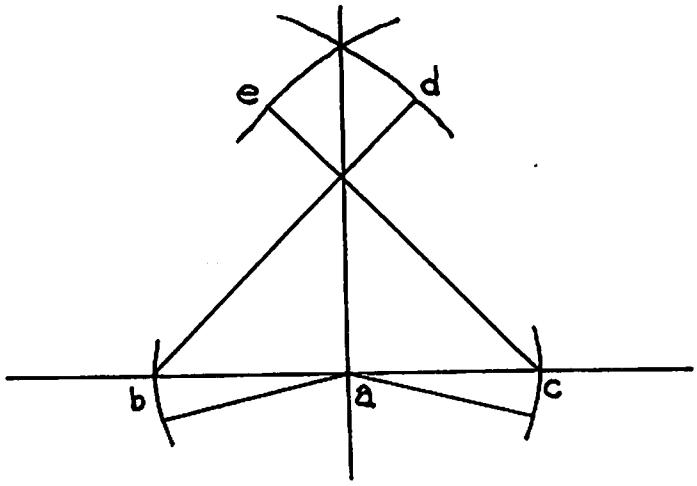
(a) Set up a block of wood at each end of the mould loft floor and stretch a length of strong cord between them, taking care that at no point does it touch the floor. At intervals place a set square up from the floor against the cord. Mark the point at the corner of the square with a pencil and draw a line through all these points with a straight edge.

(b) A nail is driven into the floor at one end of the intended line. A loop in one end of a strong cord which has been thoroughly dusted in chalk is then slipped over the nail. The cord is then stretched to the other end of the floor and raised vertically above the floor at its centre. The cord is then released and allowed to snap down on to the floor. The impact leaves a straight line where it strikes. Care should be taken that the cord be raised vertically from the floor, otherwise it will result in a slightly curved line because of striking the floor at an angle.

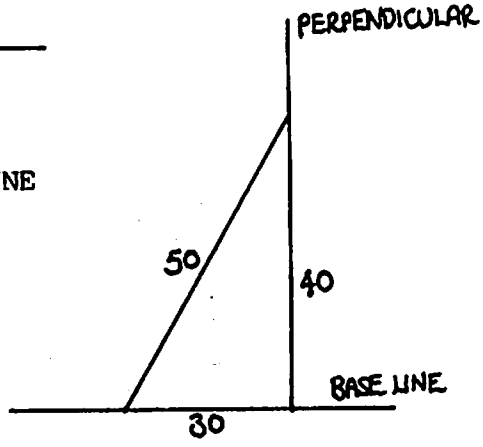


SNAPPING A CHALK LINE

The next stage is to draw the perpendiculars for stations from the base line. The first step is to decide on the position of the midship station from the lines plan and mark this point on the base line. From this point an arc is swept to the left and right. These arcs a-b and a-c must be of equal length. From the point of intersection with the base b and c two more arcs are swept b-d and c-e. At the point where these arcs intersect, a line is drawn down to the base at point a to give a perpendicular at 90^{o} to the baseline.



SETTING UP A PERPENDICULAR FROM BASE LINE

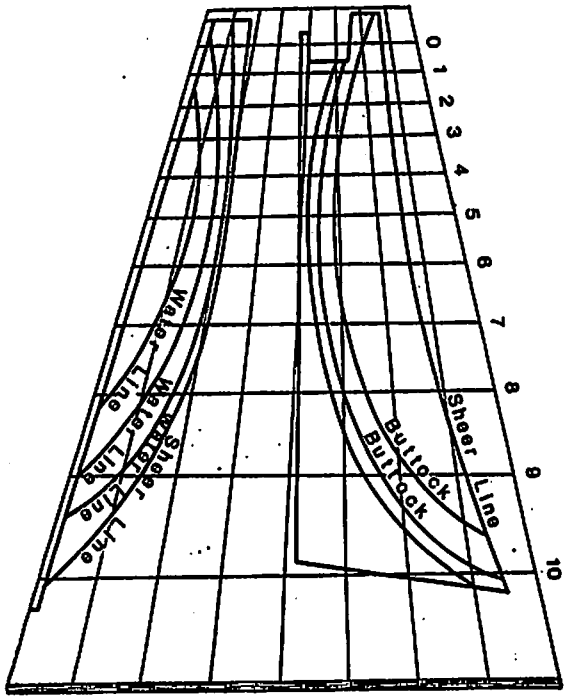


THREE FOUR FIVE METHOD

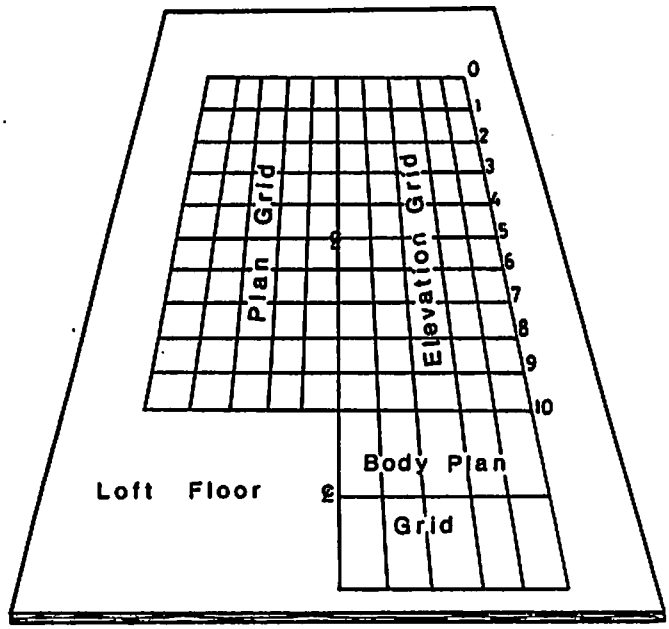
This may be checked by the three, four, five method. 30cm is laid along the baseline and 40cm along the perpendicular and the measurement between these points in a straight line will be 50cm. Multiples of three, four or five may be used such as nine, twelve and fifteen to check long perpendicular lines.

From the lines plan it is now possible to obtain the distance between stations and these can be laid on the floor parallel to

the perpendicular midship section. The same applies to the buttock lines in plan view and water lines in elevation. These lines will be parallel to the baseline.



The Loft Floor

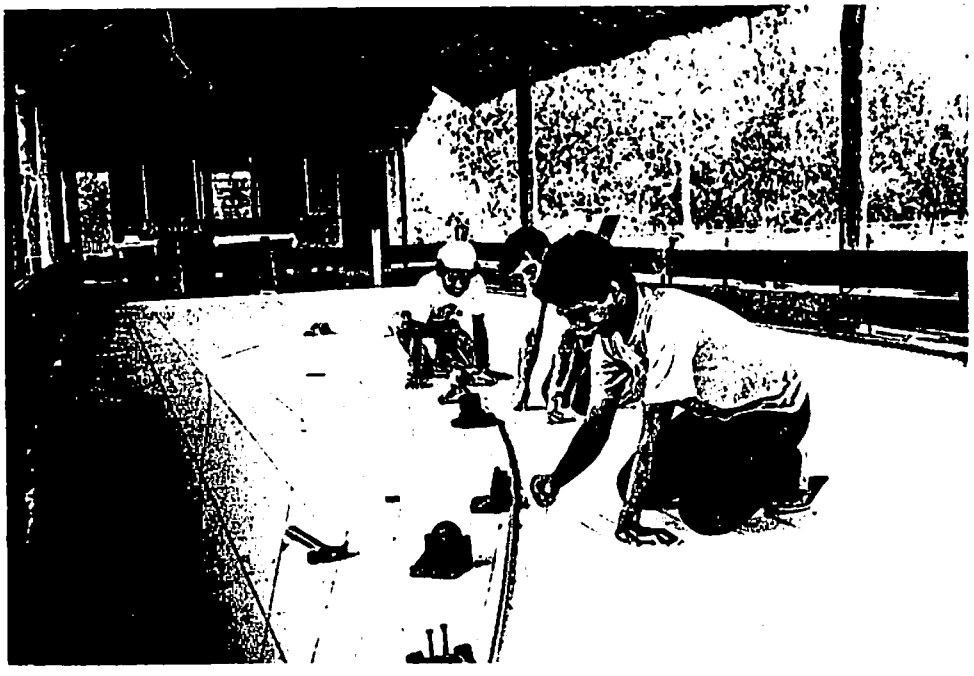


Extended Grid Lines

The layout grid is now prepared in plan and elevation views. There now remains the body plan, i.e. the frame stations. On the lines plan these are set off from the midship station in the elevation view but as this can often lead to a confusion of lines on the loft floor, it is preferable to lay them off to the right of the elevation view. This can be done by extending the base line and water lines and drawing a perpendicular through the waterlines from the baseline. This perpendicular will be the centreline of the boat. The frame stations forward of the midshipsection will be drawn to the right of the centreline and the after body to the left. The buttock lines to be drawn parallel from the centreline.

1.4 Elevation or Profile

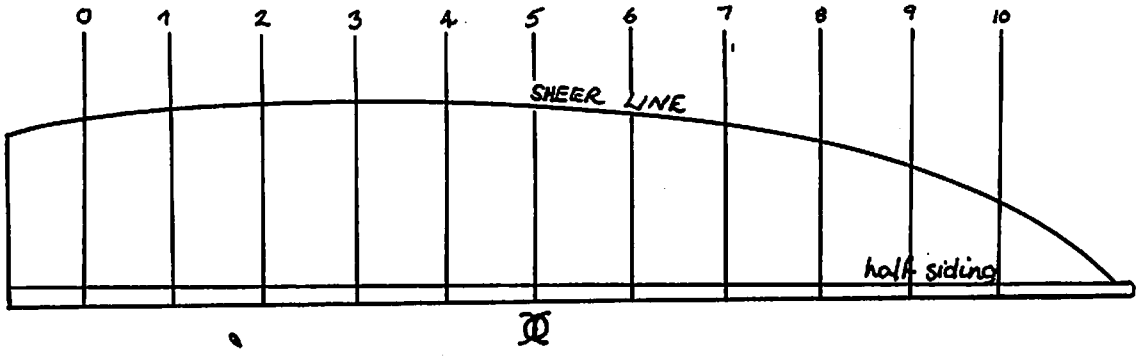
The first lines to be drawn are the profile of the keel, stem, stern and sheer. First draw the line representing the bottom of the keel, taking the measurements from the table of offsets. Next draw the stem profile; the measurements for the stem will not be found on the table of offsets, but are obtained from a perpendicular at station 10, measuring along the water lines to the front of the stem. Lay these out on the floor and draw in the stem, fairing it into the keel with a light batten. The same procedure applies to the stern. When this is completed, the rabbet lines are drawn. Finally the sheer line is then drawn in, taking the heights from the baseline on the table of offsets and placing them on the loft floor at each frame station. A nail is driven in at each point and a batten laid against the nails whilst other nails are driven in on the other side of the batten to hold it in place. The loftsman should look along the batten to check that it is a fair line. If there is an irregularity at a point, the nail should be removed and the batten allowed to spring to a fair curve. The same procedure should be followed for all curves.



1.5 Plan View

The next step is to draw the half breadth plan. Using the base line as the centre line of boat, mark off the half siding of keel, stem and stern. From the table of offsets take the half breadth of frame stations at the sheer line and mark them at their respective positions on the floor. To obtain the end positions of the half breadth at sheer height at the stem and stern, measure the intersection of the sheer line and rabbet line in elevation from a perpendicular station and transfer to plan view. This point must be transferred to the half siding of the stem and not the centreline.

At the stern, which for the 15m multi purpose vessel, is a transom stern, the intersection of the sheer with transom in elevation is transferred to plan view and the half breadth taken from the table of offsets. This represents the half breadths or deck edge at the sheer line.

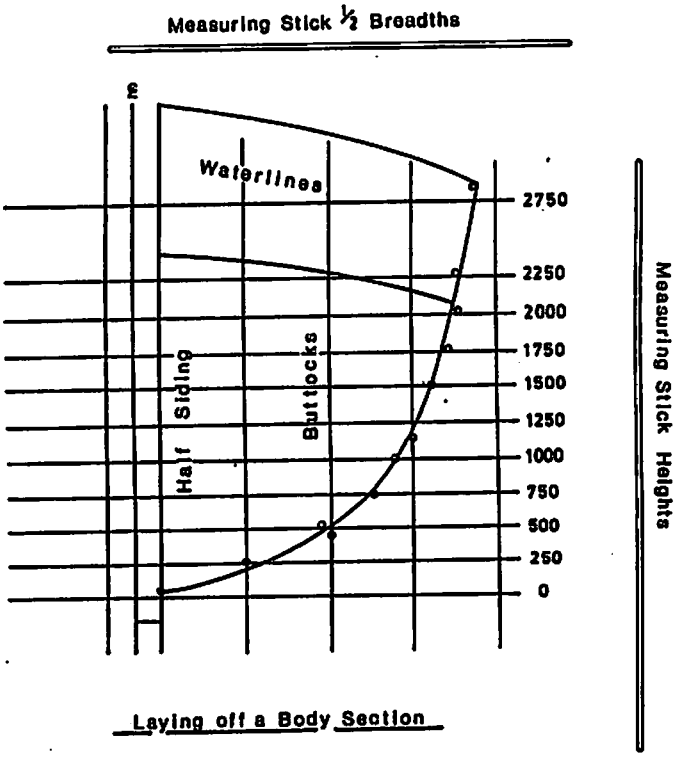


PLAN VIEW SHEER LINE

1.6 Body Plan

In this view the frame stations or sections are drawn. The half siding of the stem, keel and stern post must first be drawn in. The stem and keel to the right of centreline and the sternpost and keel to the left. Before commencing to draw these sections, it is advisable to prepare two measuring sticks. As the dimensions in one view must correspond exactly with the same dimension in another view, it is necessary to transfer the dimensions very carefully from one view to another. The measuring sticks should be of straight smooth wood. The one to measure the heights from the base line to the sheer line should be a little longer than the highest part of the profile while the one measuring the half breadth should be a little longer than the widest part of the half breadth.

To measure the heights in elevation from the base line, place the measuring stick with one end on the base line and mark bottom of keel, rabbet line and sheer height at each station in turn. The same is then done with the second batten for the half breadths in the plan view. These marks are then transferred to the body plan.



Laying off a Body Section

Draw the midship section first. Place the stick with the heights along line which is the half siding of the keel and stem, and mark off bottom of keel and rabbet line. Next the sheer height is marked off in the same manner at the approximate half breadth. Then place the stick with the half breadths parallel to this height with one end against the centreline and mark off. The intersection of the two marks is the half breadth of the sheer. Using the table of offsets, read off the half breadths at each water line for the midship section and mark them on their respective waterlines on the loft floor.

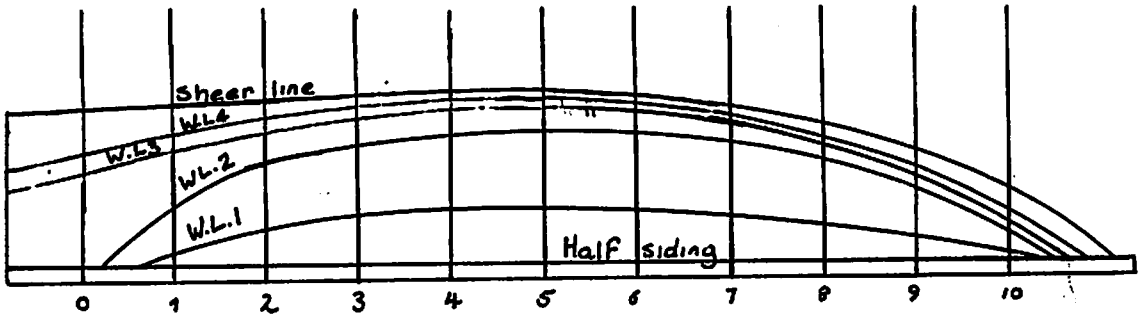
Next take the dimension from the base line to the buttock heights in the table of offsets and transfer these to the floor also. Nails are now driven into these points and a batten bent around them as was done for the sheerline. It may be seen that the curved line is not very fair, especially in the lower waterlines, this is due to the long crossing of the section profile and waterline. Any irregularity should be adjusted on these waterlines and the line drawn in fair.

Repeat the same process for all sections and transom.

1.7 Waterlines in Plan View

The next stage in the lofting is to draw the waterlines in plan view to check that the curves drawn in the body plan will give a smooth and fair waterline. First draw the waterline which will be approximately midway between the sheer and the keel. This is at 1.0m. Take the half breadth measuring stick, which has been cleaned of all previous marks, and lay one end against the centre line in the body plan, and lay it along the 1.0m WL and to the right of centreline. Mark off all the section intersections of the forward body. Then reverse the stick and do the same to the left side, marking all the intersections of the afterbody.

Take the stick to the plan view and transfer the marks to their respective stations. To find the ends of the waterline look to the elevation view, and where the 1.0m WL intersects with the rabbet line at the stem, measure this intersection from a station and transfer it to the plan view on the half siding of the stem. At the stern transfer the intersection of the waterline with the transom in the same manner to the half breadth of the transom. Drive in nails at each point and lay the batten along to these nails and draw in the waterline, first checking that the line is fair. If there are any bumps or hollows, the batten must be released at that point and allowed to spring to a fair curve. It must be remembered, however, that any changes made in fairing this line must also be changed in the section lines of the body plan, so that the dimensions in both views are exactly the same. The same procedure is followed for all the waterlines.

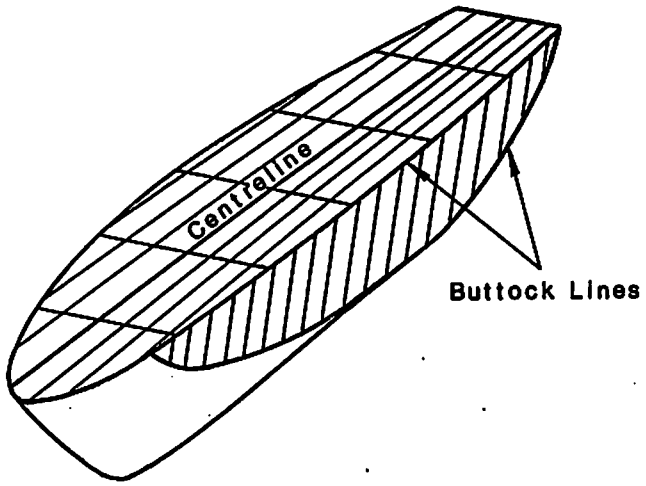


WATERLINES

The most probable reason or any lack of fairness is that the dimensions quoted on the table of offsets have been taken from a small scale lines plan where it is difficult to read the dimensions with complete accuracy and only when drawn to full size are these differences apparent.

1.8 Buttock Lines in Elevation

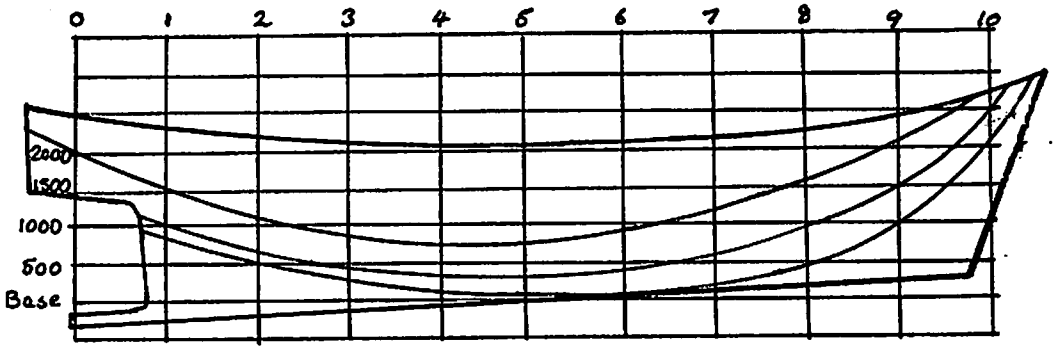
The buttock lines are slices through the hull shape in a plane parallel to the vertical centreline in a fore and aft direction.



A Buttock Line is a Slice Through The Boat

These lines we have already drawn in the plan and body views and must now be transferred to the elevation view. Again using a measuring stick, transfer the buttock dimensions from the body plan to the elevation view. Lay the stick along one of the buttock lines to the right of the centreline in the body plan with its end against the baseline and mark off the intersections with the stations. Then go to the same buttock line on the left side and mark off the remaining stations. Return to the elevation view and mark off the heights from the base line at each station. To position the forward end of the buttock, refer to the plan view. Where the buttock line crosses the sheer line in plan, measure the distance from the nearest perpendicular station and transfer the dimension to the sheer line in elevation. Additional points can be taken from the intersections of buttock lines and waterlines in plan view.

For instance, when drawing the No.1 buttock line where it intersects with each waterline in plan view, it can be projected up on to the corresponding waterline in elevation. This completes all the points at the stations and also the water- lines in elevation. When a nail has been put in all these points and a batten bent around, it should result in a fair curve. If the line has to be faired at any point, the same correction must be made in the plan and body views so that dimensions in all three views agree. Follow the same procedure for each buttock line.



BUTTOCK LINES

2. PATTERN MAKING

2.1 Frame

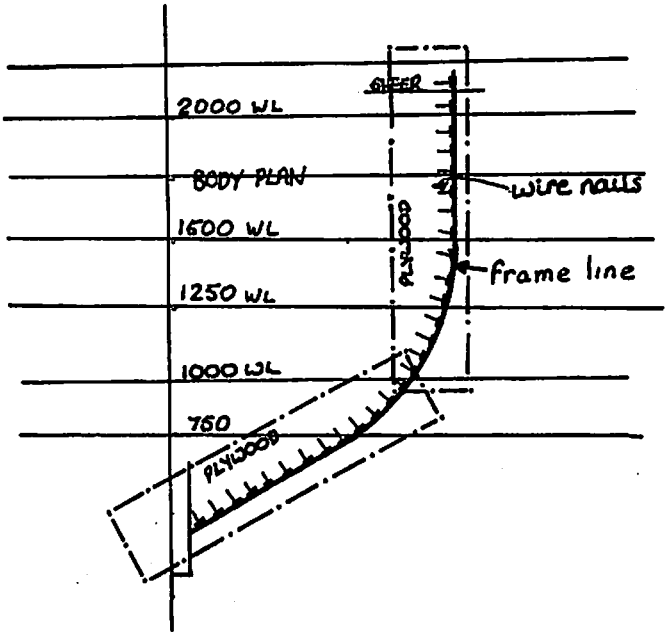
The next stage is to draw in the frames. It can be seen from the structural drawing that the midship frame is positioned at the midship section. From the designer's specification take the dimension of frame spacing, which in this case is 380mm. Measure the frame spacing forward to the stem from the midship section. When this is done repeat the same from midship section to the transom. Then draw perpendiculars from these points, through the waterlines in plan view parallel to the stations and passing through the sheer line in elevation. When all the lines have been drawn and numbered from aft, use the measuring sticks to mark off waterline widths in plan view and the rabbet line, buttock line and sheer line heights in elevation, and transfer them to the body plan in the same manner as for the stations. The shape of each frame can now be drawn in the body plan.

2.2 Frame Patterns

For pattern making, sheets of cheap grade plywood (6mm) are ideal. Standard size of sheets are approximately 2.3m x 1.2m.

Commence by making the pattern for 'frame 20' which is the midship section. Cut two lengths from the plywood sheet. These should be long enough, the one to reach from just above the sheer height down to below the curve of the bilge, and the other to reach from just past the centre line to above the bilge. Place nails on their sides with their heads on the frame line at approximately 5cm spacing. Carefully place the plywood over the nails and tap the upper side with a hammer.

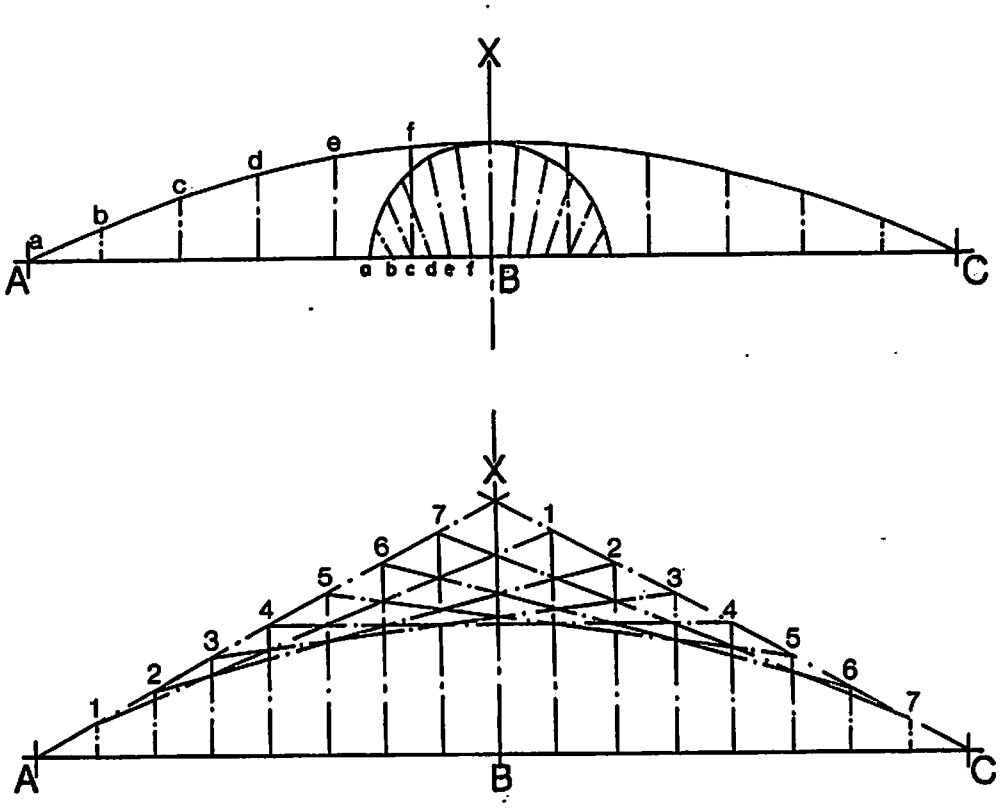
This will cause the heads of the nails to leave an impression in the wood. Before removing the wood, mark off the sheer line height and a waterline. The pattern is then lifted off and a line drawn through the nail head impressions with a light batten.



MAKING FRAME PATTERNS

Repeat the same with the lower portion of frame profile, remembering to mark on the wood the position of centreline and a waterline. Cut the patterns to the profile drawn and replace them on the floor, lining up with the centreline, waterlines and sheer height. Next mark off and cut so that the two pieces can be butted together and joined with a butt strap. We now have the pattern made to the outside of planking. From the specification that the hull planking thickness is 40mm, so a gauge is set to this thickness and marked along the outside edge so that it is possible to cut off the thickness of planking. The frame size is 90mm at the sheer, 120mm at the bilge and 140mm at the centreline. These dimensions are marked

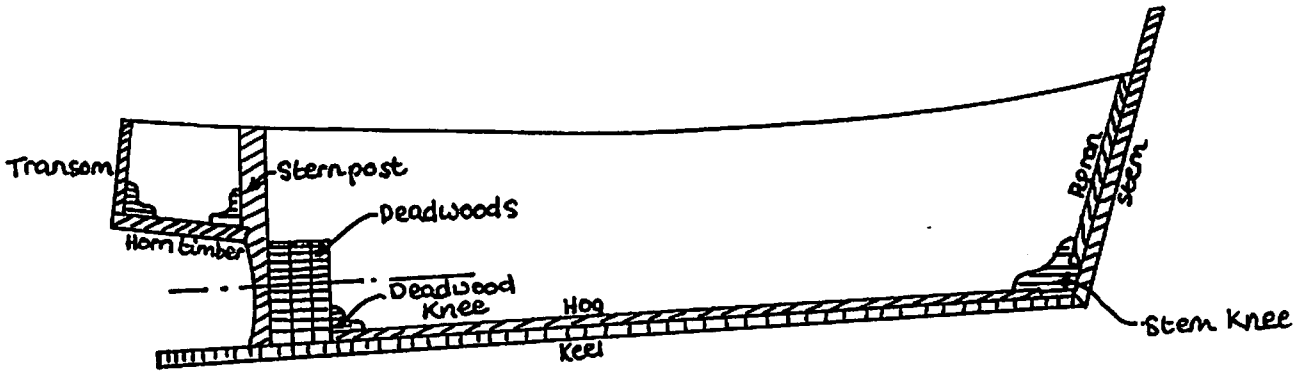
on their respective positions on the pattern and the inside edge of the frame marked by a batten. After cutting the inside edge, the pattern is produced. The pattern is replaced in position on the floor to check for any errors. Repeat this procedure for all frame patterns.



Two Methods for Laying out the Camber of a Beam

2.3 Centreline Frame Pattern

As the name suggests, this is the centreline section, or it may be called the 'backbone' of the vessel. It is the first stage of construction and consists of the keel, stem, stem knee, sternposts, hog and deadwoods, etc.



CENTRELINE FRAMING

The outer lines of these members are already drawn in the elevation view and from the structural drawing and specification, the dimensions are found for the inner lines which can then be drawn in position on the floor.

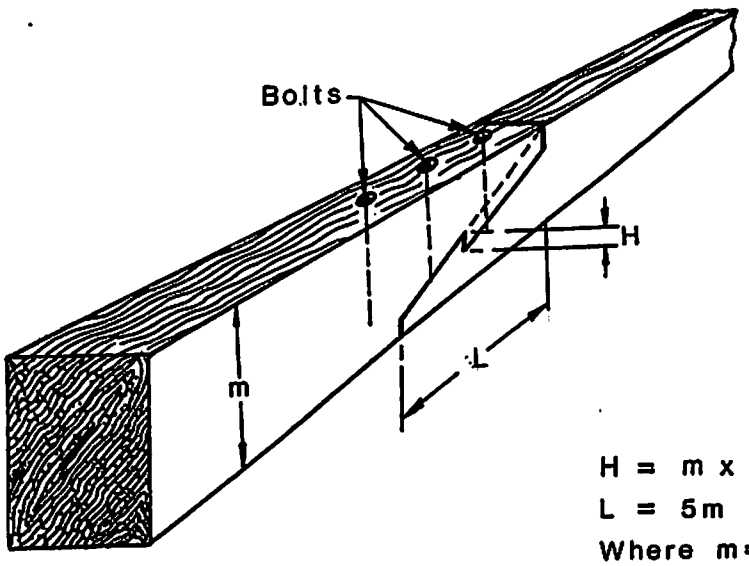
3. CONSTRUCTION

Once the patterns are made, it is then possible to commence construction with considerable confidence that any timber cut will be of the right size when assembled on the boat. Using the techn ues described in Section 2, other patterns can be quickly made, for example, beam knees.

The centreline structural members are cut first. Before assembling the centreline frame, the work is made easier by marking off and cutting all the bevels for the rabbet from the sheer height on the stem along the keel to the stern post.

3.1 Keel

For a vessel of 15m the keel is preferred in one length, but if the required lumber is not available then it can be scarphed or joined form two pieces. If the keel is jointed, the scarph should be kept well clear of the engine position, in this case at the forward part of the vessel. The length of scarph should not be less than five times the moulded depth of the keel and should be of a lockfast design bolted with galvanised screwbolts.

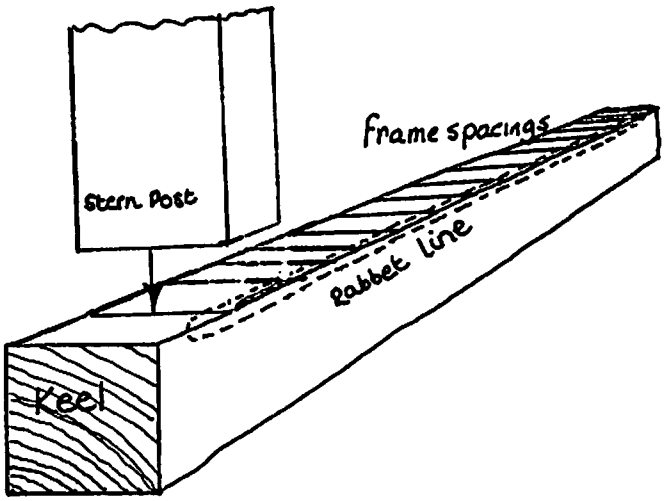


H = m x 0·15
L = 5m
Where m=Depth of the Keel

Keel Scarph

Mark and square off on the keel the position of the aft side of sternpost and all the frame spacings forward to the stem. Then mark the line of rabbet at the outside of planking on the sides of the keel.

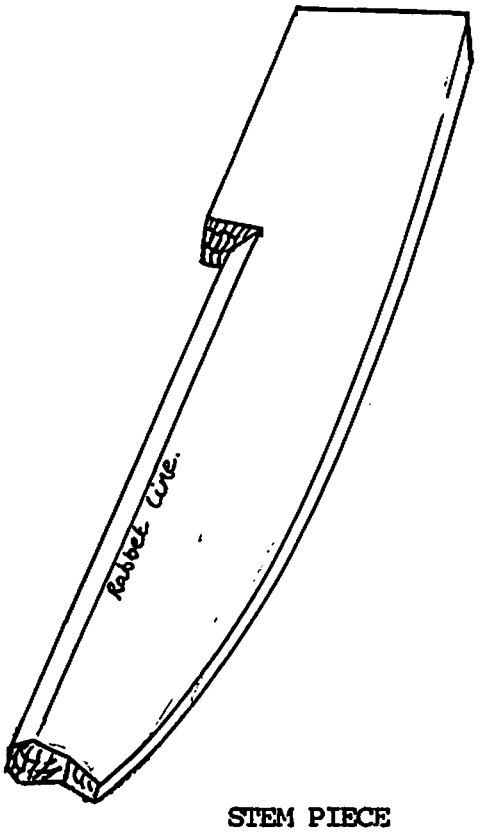
From the section or body view on the loft floor, we draw an inner profile line at each frame station the thickness of the planking from the profile. The point at which this intersects the top of keel is transferred and marked at its respective position on the keel; then a line is drawn through these points. Chamfer off to these lines taking care not to chamfer past the end of rabbet at the sternpost and the inside of stem.



MARKING OFF THE FRAMES AND RABBET LINE ON THE KEEL

3.2 Stem

The stem is marked in a similar manner but using the waterlines. Place the stem in its position on the loft floor and mark along the side of the stem each waterline and the sheer height and square off. The rabbet line is marketed on the side of the stem and from the plan view and on each waterline mark the intersection of inside of planking with the inside of stem. Transfer these dimensions to the stempiece and line off. Chamfer to these lines in the same manner as the keel.

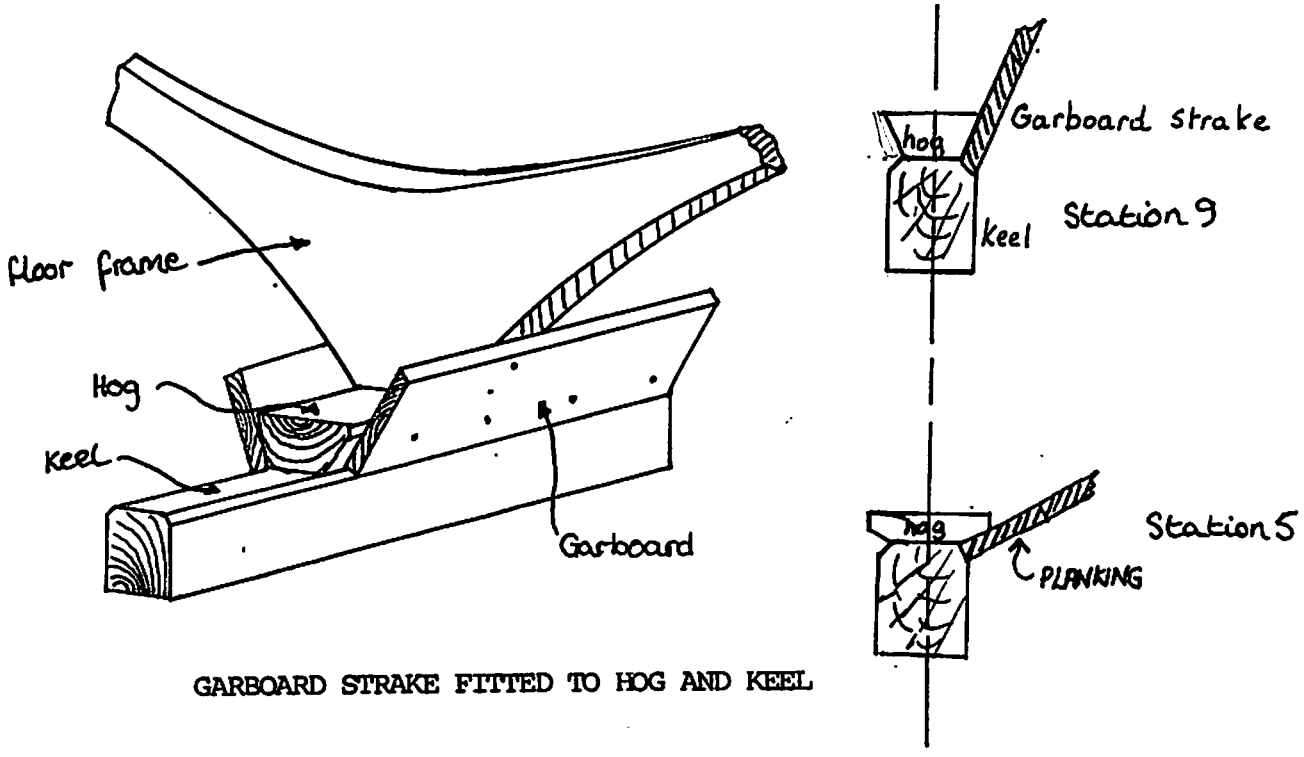


STEM PIECE

3.3 Hog

The hog is the structural member fitted to the top of the keel for additional strength and also to give a larger surface for the garboard planking to rest against between the frames. In a vessel of 15m it should be in one length, fitting under the stem knee at the forward end and under the deadwoods at the after end. It is wider than the thickness of the keel and of a thickness that enables a bearing surface of at least three times the thickness of the garboard strake. Mark off the centreline of hog on both top and bottom surface and square off position of frame stations on the top surface.

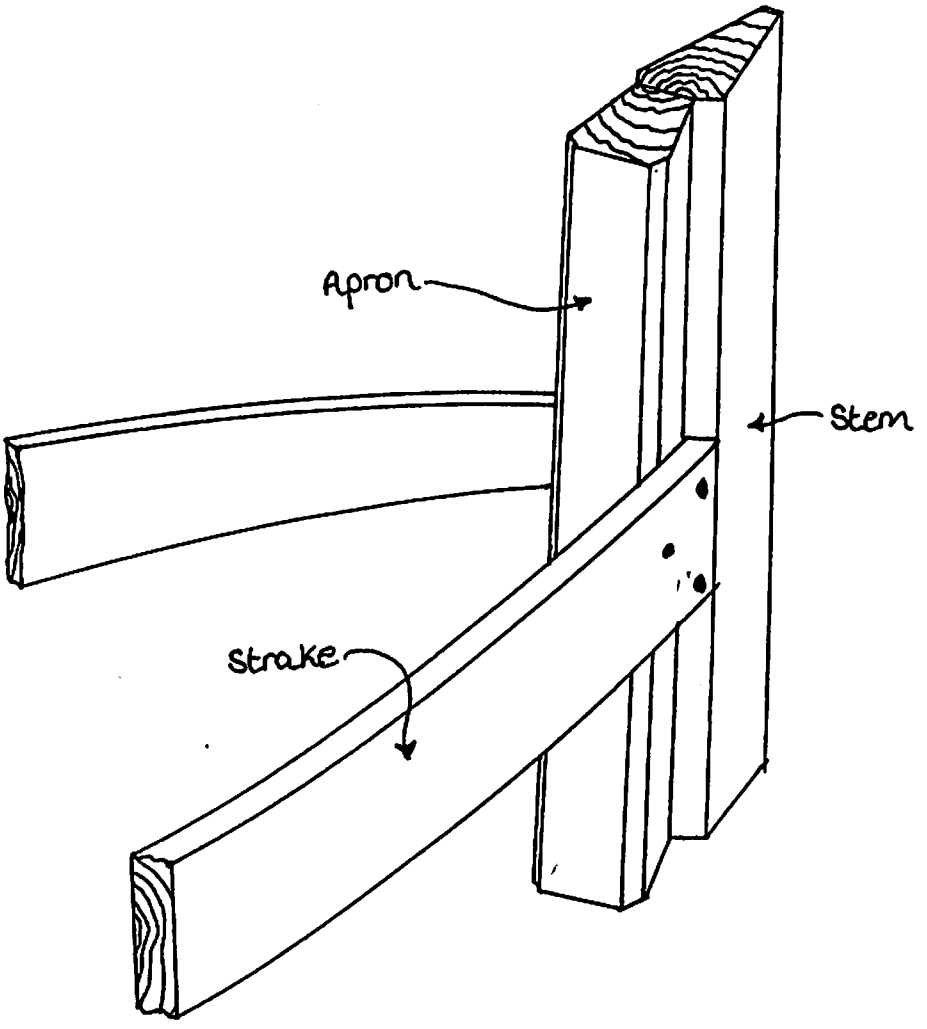
The width and top of the hog is marked in on the framing sections. Where the planking profile intersects the side of the hog, at each frame this dimension may be transferred to its position on the hog. We find that this intersection point is lowest at the midship section and rising as it goes forward and aft. This is due to the changing angle of entry of the frames to the keel. Place a batten along to these points and draw in the line. On the bottom of the hog on each side of the centreline draw in the half width on the top of keel after it has been chamfered. The hog can then be shaped to these lines to give a flat bearing surface for the garboard plank.



GARBOARD STRAKE FITTED TO HOG AND KEEL

3.4 Apron

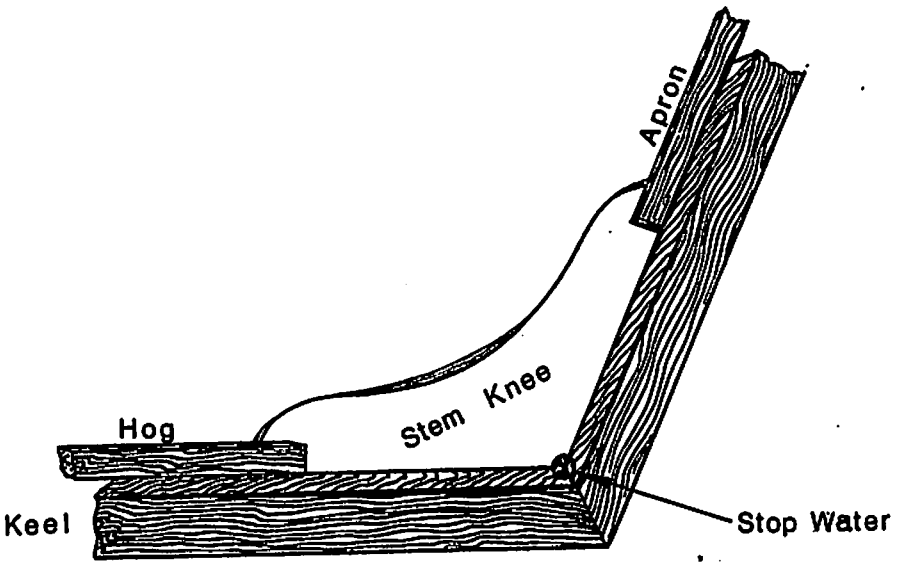
The apron is a single length of timber positioned on the aft side of the stem serving the same purpose as the hog with the keel. The angle from the back of the stem to the side of the apron may be taken by drawing its position at each waterline in plan view on the loft floor, and once again transferring the intersection of the inside of planking on a waterline with the side of the apron.



STRAKE FITTED TO STEM AND APRON

3.5 Stem Knee

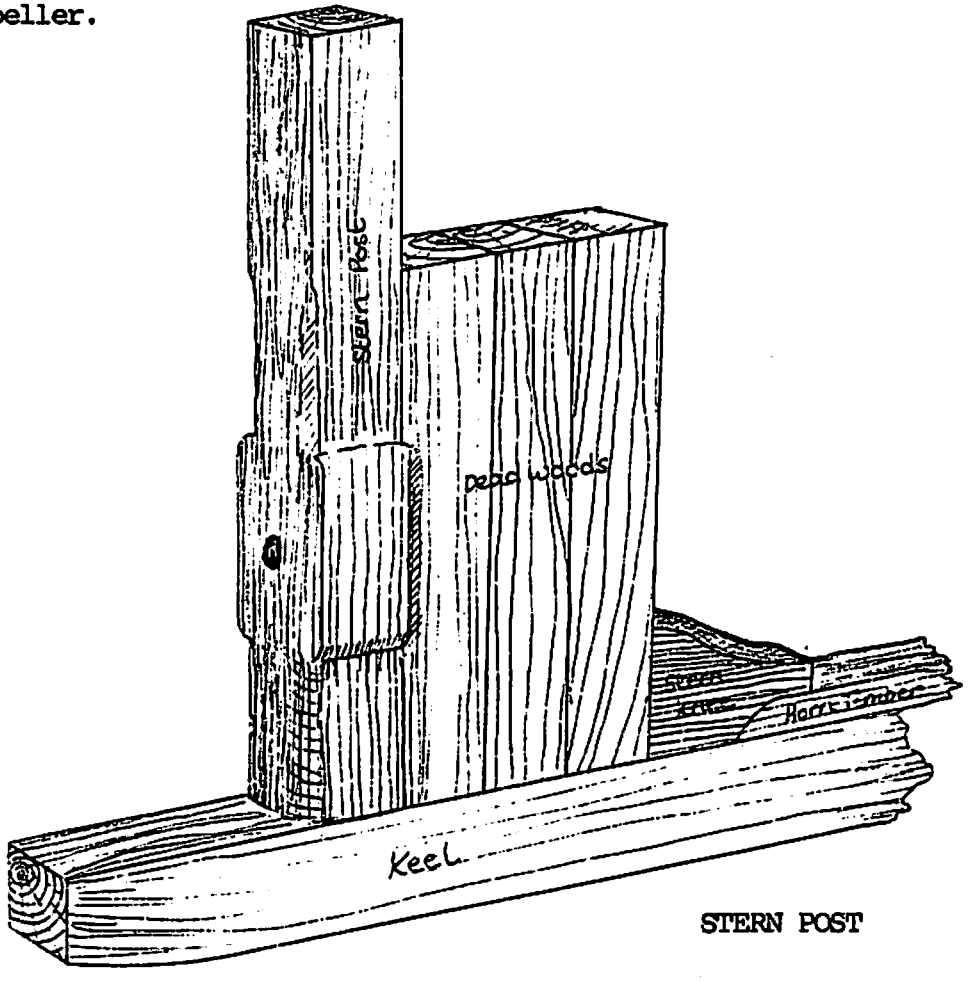
The stem knee connects the stem with the keel and must be thick enough to give a good bearing surface for the plank ends (3 times plank thickness). It can be shaped to give a flat bearing surface by once again taking the dimensions from the mould loft floor. Each arm should be long enough to position three bolts through the stem and three bolts through the keel.



Stem Knee

3.6 Sternpost

The sternpost is the main upright structure at the aft end of the vessel, tenon jointed into the keel and carried up to the deck level where it is eventually fastened to the deck beams. The breadth of the sternpost must be such that when the sterntube is fitted through it there must be enough wood each side of the sterntube after the rebate has been formed to be not less than one quarter of the keel siding. After the sterntube is drilled, it can be faired in to meet the keel and eventually streamlined so that a good flow of water is obtained at the propeller.



STERN POST

The sternpost deadwoods are fitted to the fore side of the sternpost. These will be the same breadth as the sternpost and are there to strengthen the sternpost and carry the sterntube and frames. A deadwood knee is fitted on the keel against the forward side of the deadwood and extends forward over the hog.

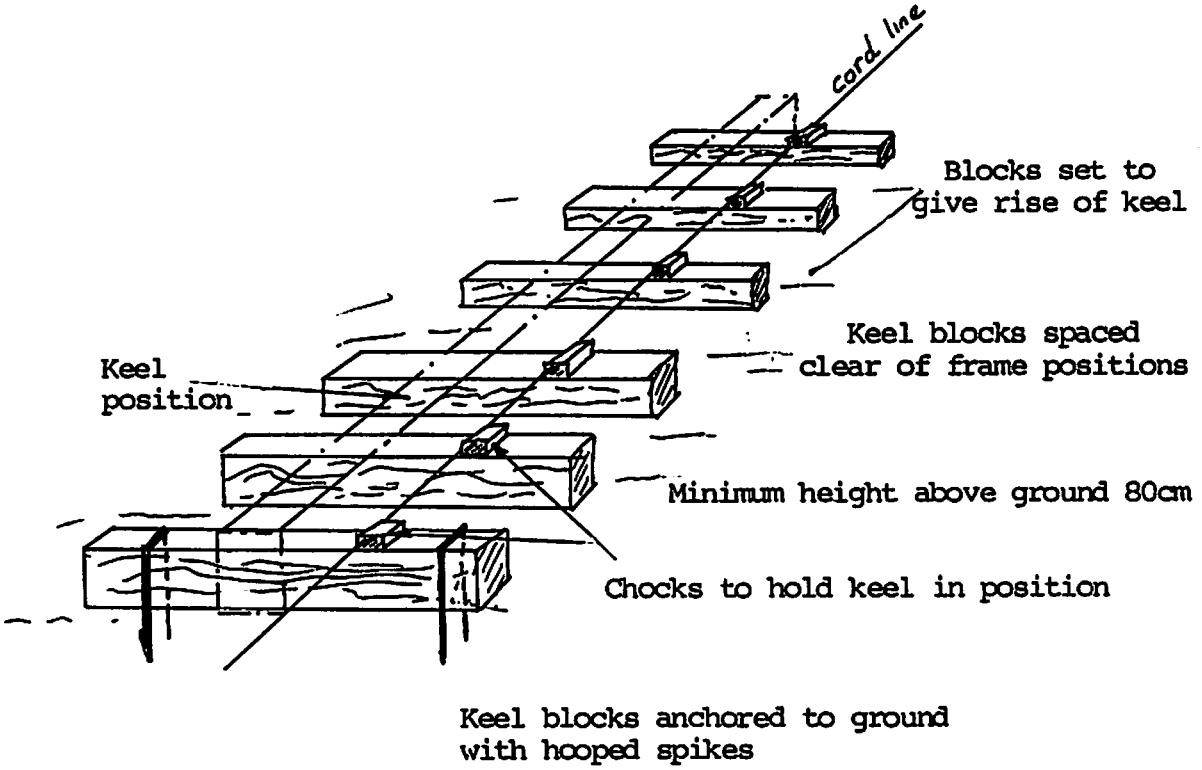
3.7 Centreline Frame Assembly

Now that all the main parts for the centreline assembly have been cut and shaped, they may be clamped together and holes drilled for bolting as indicated on the structural drawing. It is always good practice to paint all jointing surfaces before assembly with thick paint. All outside ends of boltholes must be countersunk to take the head of bolts and a strand of caulking cotton or oakum dipped in paint twisted around the shank under the head of bolt before it is finally driven into place. When the bolts have been tightened up, wooden plugs dipped in thick paint should be driven into the countersunk hole to cover the heads of bolts.

The centreline frame may now be set up into its permanent position as the first step in construction of the vessel. The best method on a vessel of 15m is the laying of keel blocks at intervals and at right angles to the direction of the keel, making sure that when the keel is laid on position, these keel blocks will not interfere with the bolting of floor frames at a later stage of construction. The blocks should be laid down to the rise of keel, as shown on the loft floor. The keel blocks should be firmly secured to the ground to provide a solid foundation for the frame to rest on. Next, stretch a length of strong cord from the top of the after block to the forward block along the line and to the side of where it is intended to place the keel. Where the line passes over each block firmly nail a chock of wood. The keel can then be laid against these chocks and more chocks nailed again the other side to retain it in a straight condition.

Most of the vessels seen under construction in Indonesia were built with their keel laid very close to the ground. This causes many problems when fitting and fastening the garboard and bottom planks and it is recommended that the minimum height of keel block at the midship section be not less than 80cm.

With the centreline frame now in position it should be checked with a plumbob that the stem and sternpost are truly vertical and firmly braced against any possible movement caused by erecting other parts of the boat.



KEEL BLOCKS

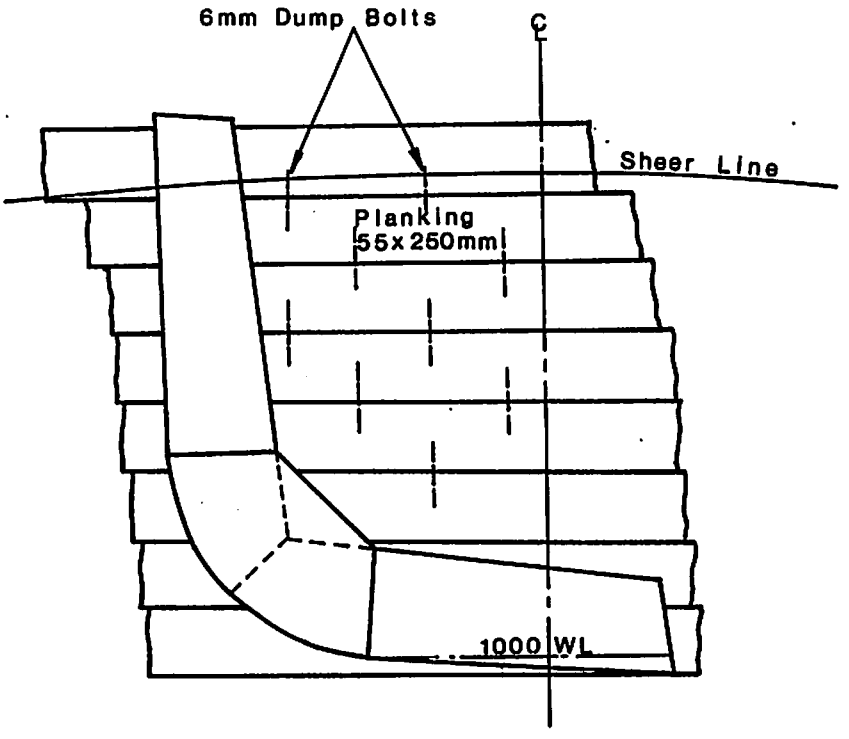
3.8 Horn Timber, Transom Post and Transom

The horn timber is fitted to the after side of the sternpost to form the upper part of the aperture for the propeller. It carries the transom and all frames aft of the sternpost. It can be the same width as the keel and jointed into the sternpost with a knee fitted at the angle of the horn timber and sternpost and through bolted. Fashion pieces are fitted and bolted each side to carry the planking. These fashion pieces

can be extended and checked into the sternpost to provide additional strength. Care must be taken that the horn timber is fitted to the sternpost at the correct angle taken from the loft floor. If this is not done, it will result in putting the transom and frames out of line with the rest of the framing making it difficult, if not impossible, to fit the planks. It must also be erected in line with the centreline of keel for the same reason.

The transom post is fitted on top of the horn timber to carry the transom. The siding of the transom should be the same as for the horn timber. A knee is fitted at the angle of the two members and through bolted. It should be checked to be vertical and in line with stem and sternpost and securely braced.

The transom is the extreme aft end of the vessel and in the 15m multi purpose, constructed of single solid planking of 55mm thickness x 250mm width. Enough planks to make up the area of the transom are clamped together. Before clamping, holes are drilled in the edges to take 6mm bolts. These bolts are driven into one edge of each plank and the planks lined up with the corresponding holes in the other planks and clamped together. Mark off the vertical centreline on the transom and the sheer height. Make a transom pattern showing the sheer height and centreline and mark these on the transom profile. Fashion pieces are fitted to the forward side of transom and through bolted before cutting out the transom planks. These are to keep the transom ends rigid and to take plank fastenings. The transom bevels must be applied when cutting the profile. These can be found by the same method as for frame bevels, see 3.9. The transom can now be cut it is then placed on the horn timber and through bolted the transom post and through bolted, after checking that it is in its correct transverse position.



Assembly and Marking off Transom

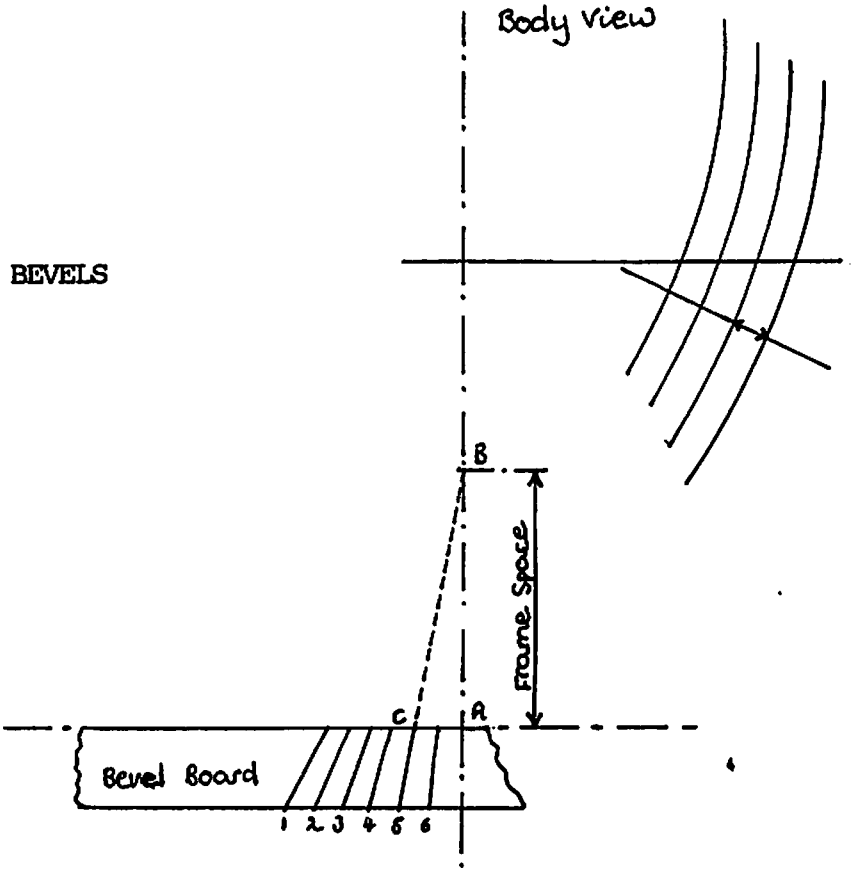
3.9 Frame Bevels

The frame bevel is the angle of the outside edge of the frame. This angle varies on each frame and along its length according to the shape of the hull. It is possible to calculate these angles from the body view on the mould loft floor. A level board made from a piece of plywood about 1 metre long x 125mm wide is required. On one side will be marked the frame bevels of the forward body and the other side of the bevels of the after body.

For an example, take frame 27, which is halfway between the midship frame and the stem. Divide the length of the frame up into the number of points at which the bevel is to be calculated. On these frames, six points should be sufficient. Place a straight edge at each point in turn and mark off a line at right angles to the profile to intersect the next profile forward. Then, using the centre line and baseline, measure 380mm along the centreline from the baseline point 'A' and mark

point 'B'. Next, measure the distance along the line at right angles to the profile from one frame to the next and mark it along the baseline from the centreline point 'C'. The angle at point 'C' is the bevel of the frame. Lift this angle from the floor and place it on the bevel board. Repeat this at each of the six points. It must be emphasised that the bevel must be marked on the board always from the left side, otherwise mistakes may occur when applying bevels from the board to the frame.

FRAME BEVELS

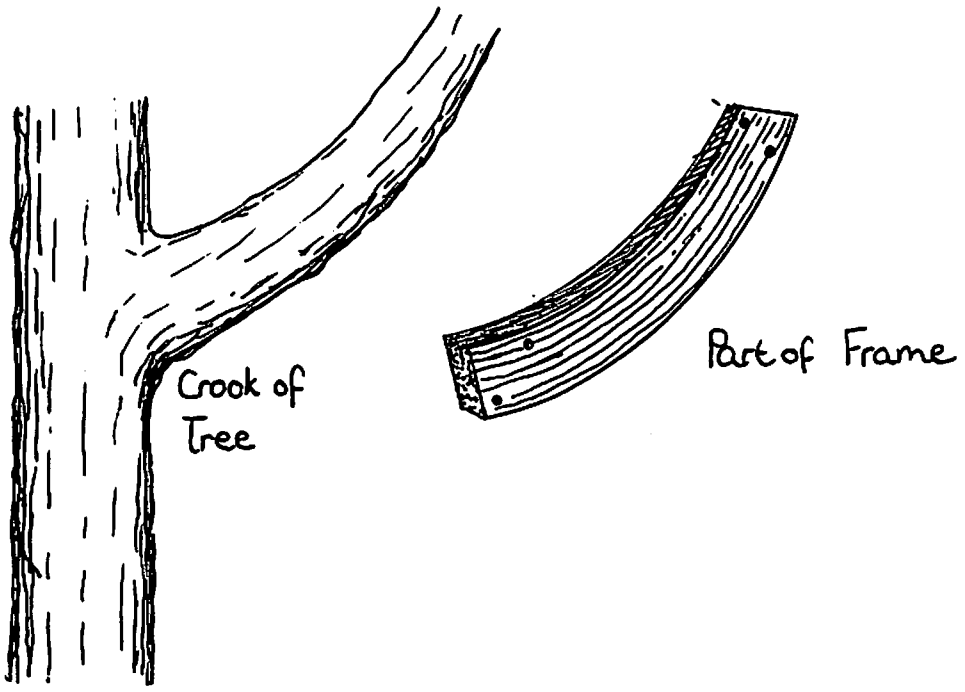


When the bevel for each frame has been calculated, take the frame pattern, place it in its position on the floor and mark off each bevel point. These will be later transferred to the frame.

3.10 Frame Construction

The first frames to be constructed are the main frames. These comprise of the midship frame No.20, and each fourth frame forward and aft from this station, i.e. frames 24, 28, 32 and 36 forward, and frames 16, 12, 8 and 4 aft. The reason for this will be made clear in the next section on setting up of frames.

On this vessel the timber used is Leban. This is a very hard wood and the shapes are cut from a crook of a tree in which the line of the grain follows the curve of the frame.



As patterns have been made for half frames only, the two sides are made from the same pattern and joined together on the loft floor by a temporary cross brace at the sheer height with temporary diagonal braces from its centre to the bilge. Frame floors with the same siding as the frame are fitted to extend across the hog for a length of not less than one third the breadth of the vessel at that point.

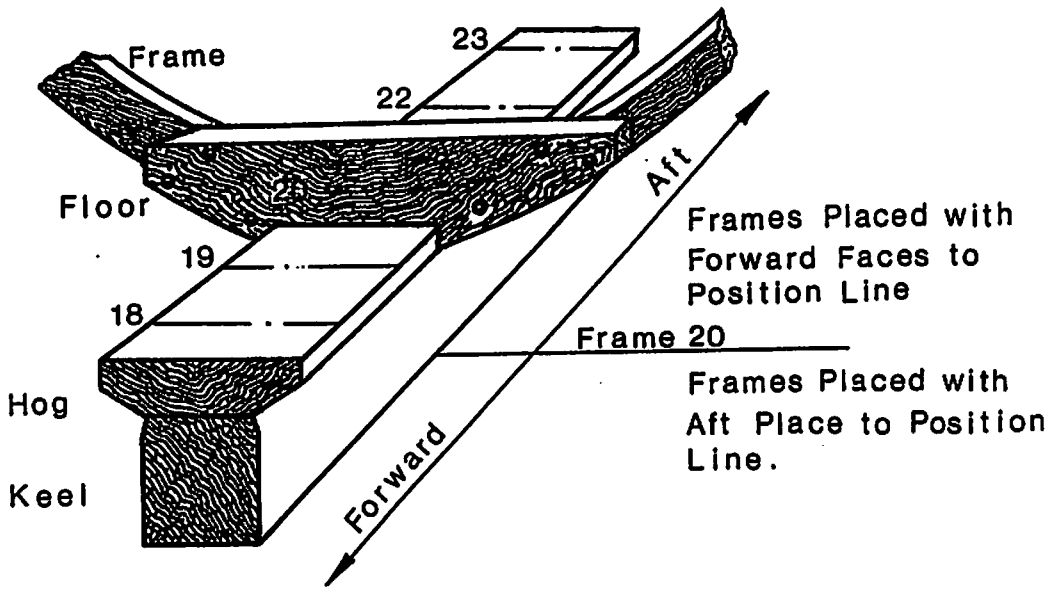
The half frame will be made in two parts, the head which is from the sheer down to the bilge, and the foot which reaches from the bilge to the centreline of the vessel at the hog. The two parts are butted and held together with a buttstrap. The siding of the frame is 70mm and the buttstrap must be of a length not less than six times the siding of the frame on either side of the butt and fastened to the frame with through bolts. Care should be taken that the butts are not at the same height from frame to frame.

Lay the pattern on the piece of wood to be used for the frame, in which grain roughly follows the curve of the pattern and mark off, putting on the sheer height, waterlines and bevel spots. The outside profile should be cut without a bevel at this stage and the inside cut to the maximum bevel for the frame. Apply the bevels from the bevel board to the outside edge and trim the shape to suit. Then turn the piece over and line up to the pattern and the shape. This procedure is followed on both the upper and lower parts of all frames.

The two half frame parts are now ready for assembly. This is done by laying them on a flat wooden platform. Lay the pattern in its position on the upper part and mark the position of the butt. Do likewise with the lower part. Cut each piece to the butt line and put together on the platform, laying the pattern on top to ensure it is the correct shape. Nail blocks to the platform each side of the frame to hold it in position. It may be necessary to run a saw through the joint to ensure a good fit. Then place a piece of wood with a suitable turn of grain over the butt to form the buttstrap. This can be marked and cut to the bevel of the frame, it is then through bolted to the frame. With the two half frames made, they are positioned on the loft floor and the frame floor is bolted in position and the cross braces fitted. The frame is now assembled ready for erecting on the centre line framework.

3.11 Setting up of Frames

The frame positions will have already been marked and squared across the hog. Start off with the midship frame No.20 and work forward and aft from this position. The midship frame and all frames forward will be placed with their after-faces to the position line on the hog and all the frames aft of midships will be placed with their forward faces to the line.



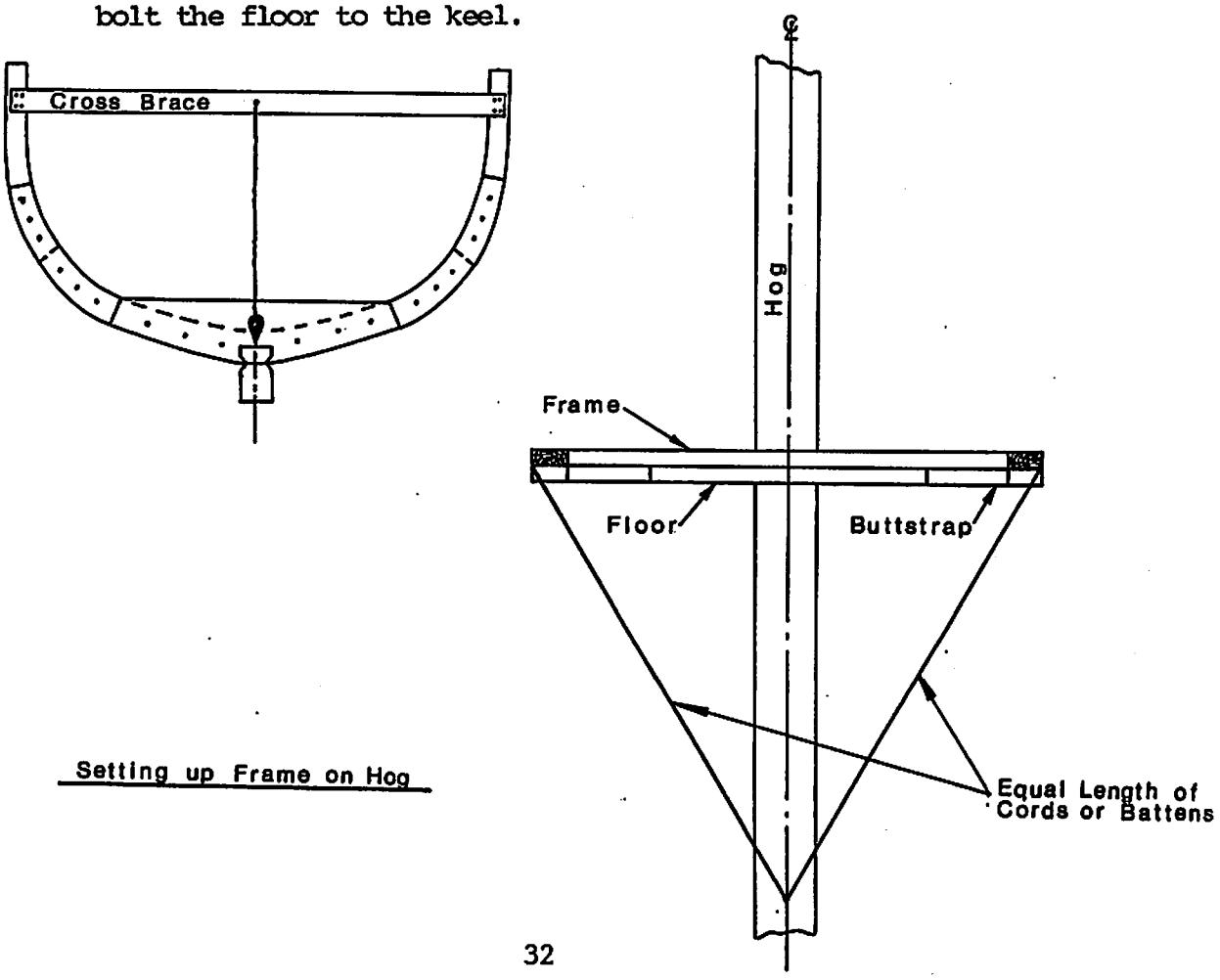
Setting up of Frames

This effectively means the spacing between No. 19 and 20 is greater by the thickness of the frame than all other frame spacings. The first frame must be erected vertically using a plumbline and also set perfectly square to the keel in the transverse plane. All the frames forward and aft of it can be erected using the midship frame as a datum for the correct spacings.

As the keel is sloped from forward to aft and the frame is vertical to the baseline, it is necessary to bevel the bottom of frame and frame floor to suit where it rests on the hog.

This bevel can be taken direct from the loft floor using the frame station and run of the keel in the elevation view. This bevel is constant for all frames positioned on the hog.

To check that the frame is vertical, suspend a plumbline from the centreline of the crossbrace at the sheer so that it is exactly over the centreline at the base. Having done this the frame is braced from the bilge to the ground on each side. To ensure that the frame is exactly at right angles to the keel in the transverse plane, pieces of cord of equal length are stretched from the sheer height position at each side of the frame to a point on the centreline of hog at frame No.12 aft or frame No.28 forward. The frame must be braced fore and aft to hold it rigid. When this is done check again with the plumbline. With the frame now in position drill and through bolt the floor to the keel.



Setting up Frame on Hog

The main frames i.e. every fourth frame forward and aft can now be erected parallel to the midship frame but checking each one with the plumbline that it is vertical and that it is perfectly square to the keel in the transverse direction. With all the main frames erected and through bolted to the keel, ribbands or long battens approx- imately 60mm x 30mm cross section are nailed from stem to transom along the line of where the planking will eventually be. Their purpose is to hold the main frames firmly in place and also to lay in the intermediate frames.

For the 15m vessel four ribbands each side should be sufficient: one at the sheer height, one along the line of the bilge, one midway between bilge and keel and one between bilge and sheer. Using measuring sticks, mark in the intermediate frame positions on the ribbands.

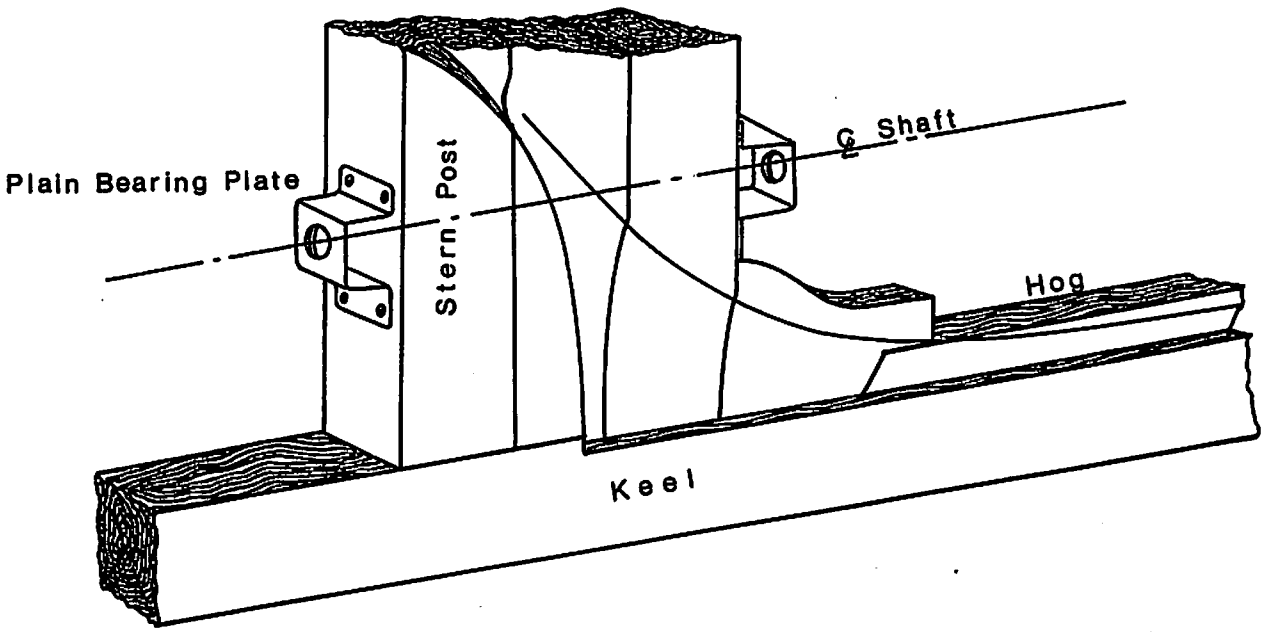
Each intermediate frame is made in the same manner as the main frames but for ease of erection the floor piece is unbolted and re-assembled when the frames are laid against the ribbands.

Towards the stem, due to the shape of the vessel, the frames will be almost straight, and can be made from one piece. These frames should be notched into the stem knee and through bolted with cross pieces instead of floors.

Towards the transom the frames will be fitted and securely fastened to the deadwood, sternpost and horn timber.

3.12 Fitting of the Sterntube

The correct installation of sterntube is very important factor in the construction. It acts as a bearing for the propeller shaft and is, therefore, subjected to the stresses set up by the engine while running at full revolutions and loads set up while towing the fishing gear. Accuracy in the drilling and



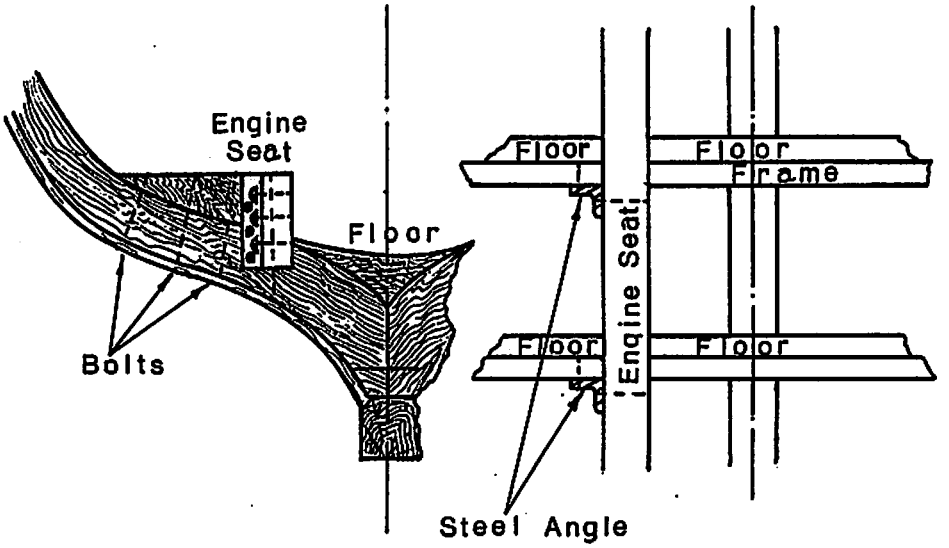
Setting up of Bearing to Drill Stern Tube

The first cutter is made to suit the initial cut, and the others made progressively longer so that a larger diameter develops with each change of cutter. This is usually in steps of 3 to 5mm at a time. To try and force a larger cut, may result in bending the bar.

3.13. Fitting the Engine Seats

The timber used for the engine seats is Leban and in the 15m vessel they reach from frame No.8 forward to the bulkhead at frame No.19. They must be notched over every frame or floor but kept clear of the planking. This must be done very carefully to ensure a firm contact between engine seats and frames as any movement of the engine in service will cause severe damage. The height of the seats can be obtained by running the wire through the centre of the sterntube to its height forward of the engine position. The dimension from centreline of shaft to the engine mountings can be obtained from the engine installation drawing and transferred to the engine seats.

The seats are peferably through fastened at each frame before the hull planking is fitted. All bolts are to be fitted with plate washers and provision made to ensure that bolts can be tightened during service.



Engine Seat Construction

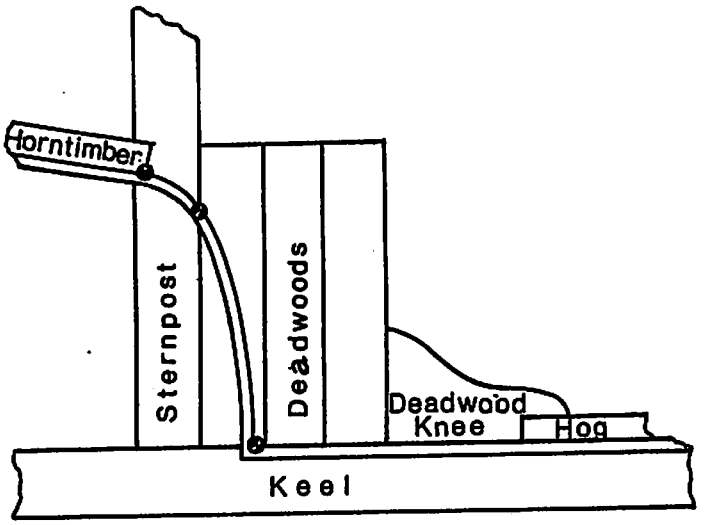
The seats are stiffened with side brackets at every second frame and reinforced with three cross members. The side brackets and cross members are of wood and are connected to the seats by bolting of steel angle bars.

4. LONGITUDINAL STRUCTURES

4.1 Stopwaters

Before planking stopwaters must be fitted to all joints and scarphs in the way of planking rebates. A hole of approximately 25mm throughout the length and centre of the joint and a softwood plug is driven into the hole making sure it is tightly fitting over the hole length of the seam.

Softwood is preferred to hardwood for the stopwaters since it expands to a greater degree in water, effectively sealing the joint.

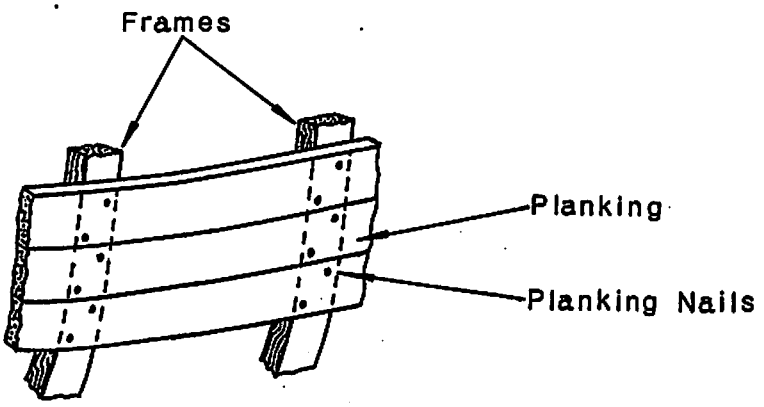


Stopwaters

4.2 Planking

The wood used for planking on the 15m vessel was Kulim, of very good quality and of a length which enabled the planks to be put up in one length thus eliminating the need for butt joints.

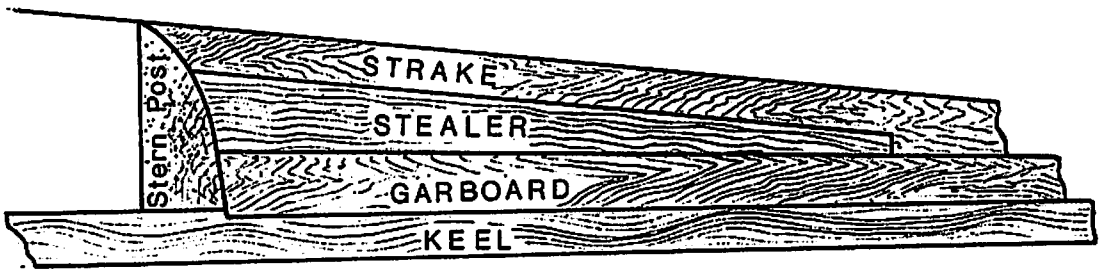
This is not always possible, however, and if butt joints are necessary, certain rules must be followed. The butts should not be spaced closer than four frame spaces in adjacent plank strakes and there must be at least three intermediate strakes between butts on the same frame.



Staggering Plank Fastenings to avoid Splitting Frames

The number of plank strakes to be fitted is determined by girthing the midship frame from the keel rabbetline to the sheer height. Bearing in mind that no plank (except the garboard strake) should be more than four times the width of its thickness, divid the length in a convenient way to establish the number of planks required. It can be seen from the body plan on the lines drawing that the width diminishes towards the stem and transom, therefore, the planks will have a gradual taper towards the ends. This applies mainly to the planking from the sheer or deckline down to the bilge. It is done to give a fair line of planks and to eliminate any unnecessary edge bevelling when cramping them up in position.

Due to the shape of the hull, it is necessary to fit in a wide plank near the heel of the sternpost to make up the width and eliminate unnecessary twist and edge strain. This plank is called a "stealer" and can be laid in from the sternpost forward to just aft of midships.



Method of Working a Stealer Strake

The width of the butt at the forward end must not be less than 1.5 times the thickness of the plank to allow for adequate fastening.

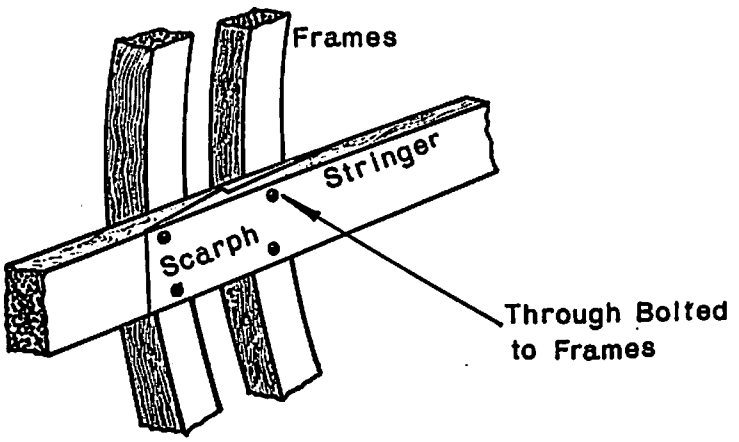
On the bottom planking also, at the stem, care should be taken that the strakes are of a width and shape to eliminate as much as possible the edge strain caused by the shape of the hull as it reaches midships.

Care should be taken when working the edge of the planks to ensure a good fit against the adjacent strake. Bevel spots can be put in several places along the length of the hull and bevels taken from the frame to edge of planks at these positions and transferred to the edge of the next plank.

The planks are fastened with two galvanised spiked nails in each frame. All the fastenings are staggered to avoid splitting the frame in the same line of grain.

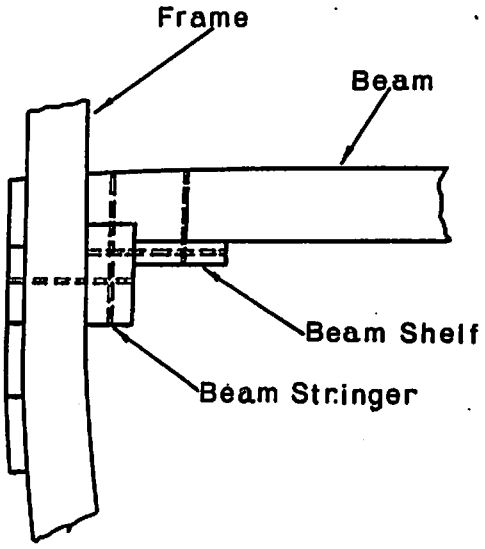
4.3 Beam and Bilge Stringers

These stringers run fore and aft from the apron to the transom. In this case they are made from Kulim and run the full length of the vessel. If, however, a scarphed joint is necessary, flat scarphs are preferred to edge scarphs. They are stronger with fastenings passing through both parts of the scarph to the frame and planking wheras in edge scarphs the edge bolting is all that holds the two members together. The scarphs should extend over three frames.



Stringer Scarph

The beam stringer provides a shelf for the beams to rest on and should be put in at a height which allows the beams to rest flush with the edge of the top strake at the deckline when they have been notched into the stringer.



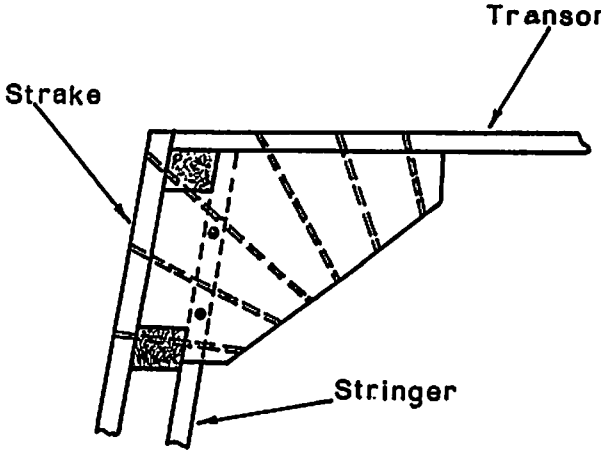
Beam Stringer

The bilge stringer is positioned along the line of the bilge. Both stringers are through bolted at each frame with 10mm bolts.

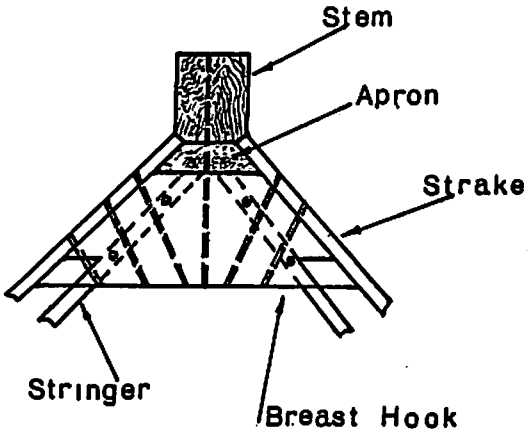
4.4 Breasthook and Quarter Knees

The breasthook connects the two sides at the stem and can be fitted on top of the beam stringer and against the apron or on the face of the stringers. On the 15m vessel it is preferable to fit it on top and bolt through the stringer and apron. It then provides a landing for the deck planking.

The quarter knees tie the stringer to the transom and in the same manner as the breasthook, provides support for the decking.



Quarter Knee



Breast Hook