APPENDIX B

YACHT CONSTRUCTION RULES

The following three sets of rules for construction methods and scantlings for wooden yachts were compiled separately by Nathanael G. Herreshoff, Henry B. Nevins, and Lloyd's Register of Shipping. These rules were formulated and effected by the trial-and-error evolution of wooden hull construction. The workable methods were retained and refined, and, naturally, unserviceable methods were deleted. The resulting rules, though formulated by three different sources, appear quite similar, but there are important variations that are interesting to compare. As I use these rules in making building decisions, I like to keep in mind the panting, twisting, and hogging strains that will be exerted on a sailing hull, along with my ultimate aim, which is to produce a boat that will be long-lived and relatively easy to repair should it be damaged.

The first wooden yacht construction and scantling rules included here, compiled by Nathanael G. Herreshoff of Bristol, Rhode Island, in 1927, probably produce the lightest hull of the three. The boats built strictly to this rule—using steam-bent frames, fully ceiled interiors, external keel strapping, and screw fastenings with double-skinned planking—will have a light, strong racing hull. But for a boat slated to be used for some offshore cruising, I would look toward the rules compiled by Henry B. Nevins of City Island, New York, during the mid-1930s. This set of rules produces a hull of more conventional construction that would tend to have slightly heavier scantlings than Herreshoff's. The third scantling rules included are those recommended by Lloyd's Register of Shipping in London. They were updated to 1979 and include not only more detail than the other two scantling rules, but also rules for the use of modern materials, such as adhesives and sheathings that were not common before World War II. Not surprisingly, many of the recommendations are very close to those used by Herreshoff and Nevins.

The Lloyd's Rules read quite differently because they are recommendations to be used in compiling drawings, which are then submitted to the Lloyd's Register (Yacht and Small Craft Services) for approval before construction begins on a hull. The boat is then built under the supervision of a Lloyd's surveyor, who can suggest changes or additions to ensure that the hull is of adequate strength for its intended use and therefore is suitable for certification as "built to Lloyd's specifications and standards."

These three sets of rules were formulated for the types of hulls that are built in the majority of cases—racing boats and racer/cruisers. Many designers increase these scant-

lings by 15 to 25 percent when a hull is destined for the rough service of offshore cruising. Almost all oceangoing yachts under 40 feet tend to be overloaded and down on their designed waterline at times. We found that 30- to 40-foot boats floating 8 inches below their designed waterline were not uncommon among the offshore fleet. The hundreds of extra pounds that cause this makes the boat far stiffer and harder on its hull and gear. The extra 6 or 8 inches of draft lowers the ballast keel, which also makes the yacht stiffer. This gives it increased sail-carrying ability, which puts even more strains on the rigging, chainplates, bulkheads, frames, and floors. In the case of *Taleisin*, a boat designed for ocean cruising, the design weight was 17,400 pounds. For short inshore race courses, we keep her lighter than that, or about 16,800 pounds. But when she sets off fully loaded for extended passagemaking, her weight is about 18,600 pounds for the first leg of the journey, and she is noticeably stiffer. As the general propositions of Herreshoff's Rules point out, the strains on the framing and planking of a hull increase dramatically as the displacement increases.

To enter both Nevins's tables and Herreshoff's tables, you must know the displacement of the hull in cubic feet. To determine this, divide the loaded displacement in pounds by 64 (the weight of a cubic foot of seawater). In the case of *Taleisin,* designed to displace 17,400 pounds when floating at her designed waterline, the cubic displacement is 272.

In the Lloyd's Rules, depth of hull is measured from the centerline of the main deck to the bottom of the ballast keel. All measurements in this rule are metric.

Herreshoff's Rules for the Construction of Wooden Yachts (1927)

Captain Nat Herreshoff, known as the Wizard of Bristol, was probably the most innovative and progressive designer/builder the world has ever known. He designed and then built hundreds of yachts in his own shipyard, a yard with its own timber mill, pattern shop, foundry, and sail loft. The Wizard himself controlled every detail of the hull at every step of the construction. The boatyard was set up for production wooden boat building, and many of the construction ideas shown in the following rules reflect this.

Captain Nat designed several different boats for one-design racing, then built dozens of each of these hulls on building molds, so the finished boats were exactly alike in every detail from materials to sails. Thus, he evolved methods that best suited what was in effect a boatbuilding factory. Unfortunately, it would be impractical for someone with a one-man boatbuilding shop to duplicate many of these clever weight- and labor-saving production methods.

General Propositions

Frame Spaces: To be dependent on the displacement of the yacht or boat when at load conditions. FUNDAMENTAL FACTOR (I)

Planking: Also Decking, Keel, Clamps, Ceiling, and all other fore and aft members. To be dependent on the displacement of the yacht modified by the ratio of depth to length of hull. FUNDAMENTAL FACTOR (II)

Stem Siding: Also Timbers, Floor Timbers, including Plank Floors, etc. To be dependent on the displacement of the yacht. FUNDAMENTAL FACTOR (III)

Deck Beams: Molded ways to be dependent on the displacement of the yacht modified by the breadth of beam. FUNDAMENTAL FACTOR (IV)

Sided ways to be dependent on the displacement of the yacht. FUNDAMENTAL FACTOR (III)

House Deck Beams: Molded ways to be dependent on the displacement of the yacht modified by the length of the longest house beam. FUNDAMENTAL FACTOR (V)

These Fundamental Factors depend upon special formulas developed at Bristol, and involve the practice of the Herreshoff Manufacturing Company during the years from 1878 to 1918. These formulas have been reduced to tabular form, and the resulting tables for finding these factors, directly from the principal dimensions of the yacht, are given below.

Notation and Symbols Used

L.W.L. or l.w.l. Length of water line at load conditions, corresponding to L.W.L. as fixed for Universal Rule by New York Yacht Club in 1913 (same as D.W.L.).

O.a.l. or o.a. Extreme length of hull as measured for Universal Rule—between plumb lines.

L. L.W.L. plus ⅓ of overhangs or $\frac{2 \text{ L.W.L.} + \text{O.a.l.}}{3}$

B. Extreme breadth of hull, without moldings, taken at 55% of L.W.L. from the fore end of the water line. (Generally called "beam.")

Q.b.l. Quarter beam length as used in Universal Rule.

b. Breadth of hull taken at L.W.L. at 55% of L.W.L. from the fore end of the water line.

d_w or d. Extreme draft of water.

d_h. Depth of hull from top of deck beams to rabbet line taken at 55% of L.W.L. from the fore end of the water line.

b.c.g. Depth of outside ballast from top face to centre of gravity taken at 55% of L.W.L. from the fore end of the water line.

b_b. Breadth at top of outside ballast taken at 55% of L.W.L. from the fore end of the water line.

D. Displacement in cubic feet when in load condition. Corresponding to D in Universal Rule.

S. or S.a. Sail area in square feet. Corresponding to Sail area (S.A.) in Universal Rule.

All data dimensions in feet and decimals

RULES FOR THE USE OF THE TABLES

1. Enter the Table with $\sqrt[3]{D}$ and find at once the values of (I) and (III).
2. Enter the Table with L/d_h and find at once the value of a. Multiply this by (III) to find the value of (II). Formula: (II) = a × (III).
3. Enter the Table with $\sqrt[4]{D \times B}$ (the square root of the square root) and under (III) find at once the value of (IV).
4. Enter the Table with $\sqrt[4]{D \times \text{length of longest house beam}}$ (the square root of the square root) and under (III) find at once the value of (V).

GENERAL RULES AND SPECIFICATIONS

Frame Spaces

The distance between the centers of frames in inches is to be equal to the Factor (I).

Keel

In standard construction, white oak or teak, in as long lengths as possible.

When it is necessary to be in two or more pieces or where connecting to stem or after overhang timber and deadwood, the scarf or lap joint must extend at least

2½ frame spaces, and be well bolted with Navy or Tobin bronze through bolts having head and nut, the nuts being exposed in the inside when possible.

Yachts having the main keel cast in lead and included in the outside ballast, the lead is to be in depth not less than 1½ times the depth required for oak or teak and the casting is to be stiffened by containing not less than 5% or more than 7½% of antimony.

Keels for inside ballasted yachts or power yachts and launches are to be in siding not less than siding of stem and overhang timber, or less than .35 (II). Molded way or depth to be not less than .8 (II); except near ends of vessel it may be reduced to .5 (II).

Tables of the Fundamental Factors

used in connection with

HERRESHOFF'S RULES FOR THE CONSTRUCTION OF WOODEN YACHTS

Enter with	(I)	(III) and (IV)	a (inches)	*Enter with*	(I)	(III) and (IV)	a (inches)	*Enter with*	(I)	(III) and (IV)	a (inches)	*Enter with*	(I)	(III) and (IV)	a (inches)
3.0	5.91	3.35	1.14	6.0	11.03	7.18	1.24	9.0	15.89	11.21	1.31	12.0	20.59	15.38	1.36
.1	6.09	3.47	1.15	.1	11.20	7.31	1.25	.1	16.05	11.35	1.31	.1	20.75	15.53	1.36
.2	6.27	3.59	1.15	.2	11.36	7.44	1.25	.2	16.21	11.49	1.31	.2	20.90	15.67	1.36
.3	6.44	3.72	1.15	.3	11.53	7.57	1.25	.3	16.37	11.62	1.31	.3	21.05	15.81	1.36
.4	6.62	3.84	1.16	.4	11.69	7.70	1.25	.4	16.53	11.76	1.32	.4	21.21	15.95	1.36
.5	6.79	3.97	1.16	.5	11.86	7.84	1.26	.5	16.69	11.90	1.32	.5	21.36	16.09	1.36
.6	6.97	4.09	1.17	.6	12.02	7.97	1.26	.6	16.85	12.04	1.32	.6	21.52	16.23	1.36
.7	7.14	4.22	1.17	.7	12.19	8.10	1.26	.7	17.00	12.17	1.32	.7	21.67	16.38	1.37
.8	7.31	4.34	1.18	.8	12.35	8.24	1.26	.8	17.16	12.31	1.32	.8	21.82	16.52	1.37
3.9	7.49	4.47	1.18	6.9	12.51	8.37	1.27	9.9	17.32	12.45	1.33	12.9	21.98	16.66	1.37
4.0	7.66	4.60	1.18	7.0	12.68	8.50	1.27	10.0	17.48	12.59	1.33	13.0	22.13	16.80	1.37
.1	7.83	4.72	1.19	.1	12.84	8.64	1.27	.1	17.63	12.73	1.33	.1	22.28	16.94	1.37
.2	8.00	4.85	1.19	.2	13.00	8.77	1.27	.2	17.79	12.87	1.33	.2	22.43	17.08	1.37
.3	8.17	4.97	1.19	.3	13.17	8.90	1.28	.3	17.95	13.01	1.33	.3	22.59	17.23	1.37
.4	8.35	5.10	1.20	.4	13.33	9.04	1.28	.4	18.10	13.14	1.33	.4	22.74	17.37	1.37
.5	8.52	5.23	1.20	.5	13.49	9.17	1.28	.5	18.26	13.28	1.33	.5	22.89	17.51	1.37
.6	8.69	5.36	1.20	.6	13.65	9.31	1.28	.6	18.42	13.42	1.34	.6	23.05	17.66	1.38
.7	8.86	5.49	1.21	.7	13.81	9.44	1.28	.7	18.57	13.56	1.34	.7	23.20	17.80	1.38
.8	9.03	5.61	1.21	.8	13.97	9.58	1.29	.8	18.73	13.70	1.34	.8	23.35	17.94	1.38
4.9	9.20	5.74	1.21	7.9	14.13	9.71	1.29	10.9	18.88	13.84	1.34	13.9	23.50	18.08	1.38
5.0	9.36	5.87	1.22	8.0	14.30	9.85	1.29	11.0	19.04	13.98	1.34	14.0	23.65	18.23	1.38
.1	9.53	6.00	1.22	.1	14.46	9.98	1.29	.1	19.20	14.12	1.34	.1	23.81	18.37	1.38
.2	9.70	6.13	1.22	.2	14.62	10.12	1.29	.2	19.35	14.26	1.34	.2	23.96	18.51	1.38
.3	9.87	6.26	1.22	.3	14.78	10.26	1.30	.3	19.51	14.40	1.34	.3	24.11	18.66	1.38
.4	10.04	6.39	1.23	.4	14.94	10.39	1.30	.4	19.66	14.54	1.35	.4	24.26	18.80	1.38
.5	10.20	6.52	1.23	.5	15.10	10.53	1.30	.5	19.82	14.68	1.35	.5	24.41	18.94	1.39
.6	10.37	6.65	1.23	.6	15.26	10.66	1.30	.6	19.97	14.82	1.35	.6	24.57	19.09	1.39
.7	10.54	6.78	1.24	.7	15.42	10.80	1.30	.7	20.13	14.96	1.35	.7	24.72	19.23	1.39
.8	10.70	6.91	1.24	.8	15.58	10.94	1.30	.8	20.28	15.10	1.35	.8	24.87	19.38	1.39
5.9	10.87	7.04	1.24	8.9	15.74	11.07	1.31	11.9	20.44	15.24	1.35	14.9	25.12	19.52	1.39

Keels in rowboats and centerboard sailing yachts to be not less than .35 (II) in depth and not less than .55 (II) plus centerboard slot in width, the ends gradually tapering to match siding of stem and sternpost. In case of centerboard yachts having main keel of lead, the lower pieces of centerboard casing (centerboard logs) and arms to bolt timbers to (floor timbers) are to be cast as part of the keel. The top of lead to be above top of floor timbers to give a clear caulking seam. Planking rabbet to be cast into lead.

Keels in sailing yachts as developed by the Universal Rule, having outside ballast bolted on, to be of flat plank type with planking rabbet worked into edges.

When one piece of proper size is not obtainable, make keel in two pieces butted together amidships and bolted to a deadwood piece underneath—to be steamed and bent to form. The deadwood where butt is made is to be in depth not less than the keel pieces. Butt to be square-ended and made midway between two consecutive floor timbers and fastened with bronze through-bolts, with nuts above a bronze plate covering the joint. Or make the keel in three pieces: the middle one running from forward of the outside ballast to the intersection with the sternpost and laying directly on top of the outside lead casting; the forward section of keel to be scarfed on top of middle section, with its aft end molded deep enough to make scarf, and then running to stem piece, which is scarfed on; the after section to run over deadwood and to transom, with transom knee lying on top.

The middle section of keel may be dispensed with if the outside lead is properly designed with rabbet for garboard planking and satisfactory connection is made with the forward and after overhang pieces and after deadwood. The last plan is preferable in yachts that are hauled out of water for long periods in dry atmosphere.

Stem Piece

Of white oak or teak as standard woods; but in small classes, of not over 150 cubic feet displacement (row and power boats), hackmatac or other tough and lasting wood may be used. Siding to be .5 (III) and molded way over .7 (III) as required. In yachts of over 100 cubic feet displacement, the back rabbet is to be wide enough for double fastening of wood ends of planking.

The stem piece is to lap the keel at least 2½ frame spaces and to be well bolted with not less than 4 through-bolts set up with nuts. There must always be a breast hook piece, well bolted to sheer strakes and clamps and having a good fore-and-aft bolt through stemhead.

Transom

To be white oak or teak plank in yachts of over 500 cubic feet displacement; in smaller ones may be of lighter wood, as mahogany, butternut, etc. To be steamed and bent to form if curved, and to be reinforced at the edges with white oak in larger, and hackmatac in smaller, yachts. Transom to be rabbeted at edge and reinforcement, making back rabbet to receive fastenings of ends of planks.

To be quarter knees and center line knee on to keel, and framing timbers, if necessary. In small yachts, rowboats, etc., without corner reinforcing, transom plank to be not less than .18 (II) and wood-ends of planking exposed.

Timbers or Frames

To be of best quality of white oak selected for ability to bend to required form when steamed. There is comparatively little white oak that has the proper qualities for first-class timbers, but when obtained there is no other wood equal to it for the purpose.

Timbers must be bent over traps or molds and the larger sizes strapped to prevent splitting. They should be square in section, so best side can be selected for bending. This is important. The size to be .2 (III) at head, and in unballasted power boats and yachts and small open boats size to be uniform for full length.

In sailing yachts that are ballasted, timbers are to increase in size below head as follows:

Inside ballasted yachts are to be .22 (III) square and from 7.2 (III) below head are to taper to size at head .2 (III). Taper equal .1 in 36. = 1/32″ per ft. nearly.

Center-board and moderate draft yachts with ballast close to keel, timbers .23 (III) square and from 7.2 (III) below head are to taper to size at head. Taper .1 in 24. = 3/64″ per ft. nearly.

Deep draft yachts with ballast well below hull, timbers .24 (III) square and from 7.2 (III) below head to taper to size at head. Taper .1 in 18. = 1/16″ per ft. nearly.

In any case where the curvature of the bilge is too quick for timbers to bend safely without splitting or upsetting grain, it is best to split the timbers down with a fine saw into equal parts as far as bend extends, and have all planking fastening go through both parts.

In power yachts increase the siding of timbers that come in machinery section, 50% to 75%.

Floor Timbers

To be of white oak or equivalent in strength and lasting qualities. The arms should be long enough to lap the timbers from 6 to 9 times the size of timbers. Thickness of plank floors not less than .185 (III) and not less than 3 times diameter of keel bolts. Knee or crook floors are to be sided not less than .28 (III) with depth in throat not less than .32 (III) and arm ends not less than size of timbers.

There should be not less than 3 timber bolts each side, of diameter 1/6 to 1/8 size of timber, passing through timber and floor timber and set up with nuts. Bronze in smaller sizes, but over 5/16″, good galvanized iron or steel may be used.

Keel bolts should always be bronze if they come in contact with lead ballast. If not, sizes over 3/8″ may be good galvanized iron or steel. Have two keel bolts whenever possible, in diameter not less than 1/5 to 1/6 size of timber, but if only room for one bolt into keel to be larger, depending on character of keel and deadrise of hull section.

When floor timber bolts support outside lead ballast they are to be increased in size. Their diameter in inches is to be not less than the square root of weight of outside lead in tons divided by number of bolts supporting lead,

$$\sqrt{\frac{\text{Tons lead}}{\text{no. bolts}}}$$

If it is desirable to use bolts of different diameters, proper compensation should be made so the total bolt area is not reduced and when bolts are independent of floor timber bolts, their size is to be equivalent in size to the sectional area of adjacent floor timber bolts, as determined above.

Floor timbers over outside ballast are to be increased in size so their thickness is not less than three times diameter of bolts passing through them and length and depth sufficient to receive four timber bolts, each side.

Lead Bolts and Straps

Their diameter to be determined by the size and number of floor timber bolts as explained above. Always have them carefully distributed and as near each edge as possible, and have nuts at their upper end so they can be tightened up when necessary. One or more bolts at each end should pass way through lead. All others may be screwed into the lead and the threads that go into the lead should be similar to those on wood screws and lag screws. The bolts should penetrate the lead 8 diameters and the length threaded 7 diameters. The pitch of threads should be about $\frac{1}{5}$ diameter and depth 1/10 diameter.

All outside lead on wood yachts should have straps extending vertically to connect lead directly with timbers and planking. These straps are to be let in flush and to lap on lead about 5 times their breadth and on to the timbers and above the keel and deadwood about 8 times their breadth.

Tobin bronze appears to be the best material. There are to be 5 to 8 straps each side placed on consecutive timbers in the middle part and on alternate timbers near ends of lead. Their size to be determined by multiplying weight of outside lead in tons by ratio (depth of lead to center of gravity divided by breadth on top), *if over one* and if not, by one. Divide by one and eight-tenths times whole number of straps, which will give sectional area in square inches of each strap.

$$\frac{\text{b.c.g.}}{b_b} \times \frac{\text{Tons}}{1.8 \text{ number}} \text{ or } \frac{\text{Tons}}{1.8 \text{ number}}.$$

The breadth to be 4 times and thickness $\frac{1}{4}$ the square root of area.

Diameter of screws and bolts to be $\frac{1}{9}$ breadth of strap and there are to be not less than 8 brass wood screws into lead and not less than 9 bronze through-bolts with nuts through planking and timbers. Countersinking for heads of screws and bolts should not be over $1\frac{3}{4}$ diameter of bolts and the heads worked down flush after being set up.

Outside Planking

The thickness to be not less than .105 (II).

White cedar is the best wood for all small craft under 75 to 100 cu. ft. displacement.

In sizes from 75 to 200 or 250 cu. ft. a somewhat firmer wood is preferable, as Port Orford cedar, Mexican mahogany or Douglas fir. Larger yachts should have planking of woods of still harder texture as Georgia pine, western oak of good quality, teak or mahogany of hard texture.

Small lap streaked boats should have the laps well fastened with copper clinch nails or copper through fastening with bars.

Single planking with square seams should be well and closely fitted and caulked with cotton in small and intermediate sizes. The large sizes with hard wood planking, okum caulking may be used.

When double planked, it is found most practicable to have both layers parallel and the seams about equally lapped. The layers are to be well cemented together. Shellac is found best, but when there is plenty of time (2 or 3 months for setting) white lead is as good, or better in large work. The inner layer should be $\frac{3}{8}$ to $\frac{1}{2}$ of total thickness and softer or lighter wood may be used, as cedar or cypress with Mexican mahogany or Douglas fir outside. Have the layers well screw-fastened from inside between the timbers. It is always best to have garboard and sheer strakes single thickness and a good practice is to have a few strakes above the garboards also single.

The edges to receive double planking should be rabbeted to make a lap joint with one of the layers.

Sheer strakes should be of a hard wood that will well hold drive or screw fastening as white oak, teak, mahogany of hard texture, etc., and to be well seasoned. The molded form is desirable in smaller yachts and the thickness through swell about $1\frac{1}{4}$ times thickness of planking. Extra thickness in larger yachts than thickness of planking is also desirable—to have more wood for the vertical fastening of plank-sheer and rail.

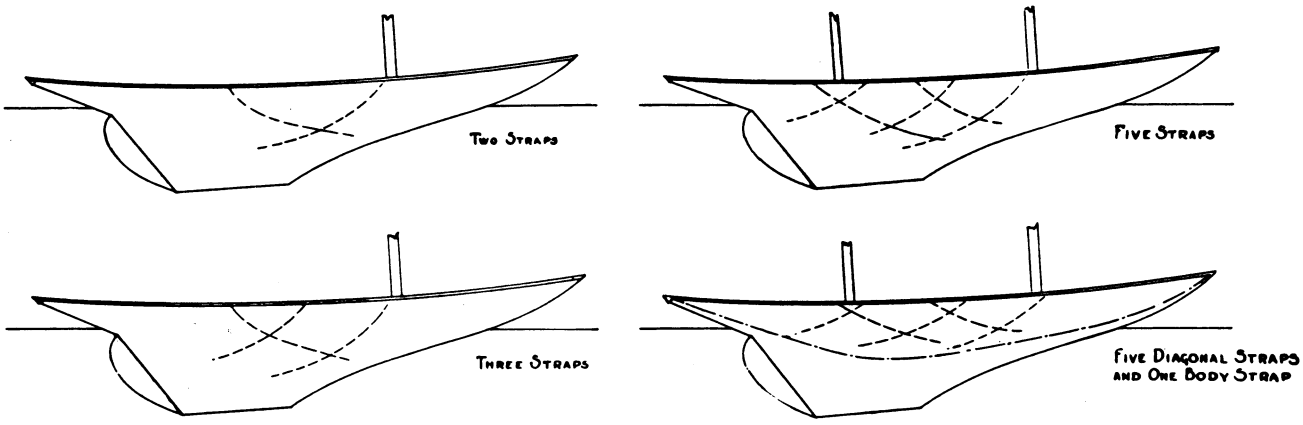
Diagonal Strapping

In small yachts, under 100 cubic feet displacement, it is not necessary. In larger ones strap as follows:

Single planked, 100 to 175 cu. ft. displ. Double " 175 to 300 " " "	2 straps
Single planked, 175 to 300 cu. ft. displ. Double " 300 to 500 " " "	3 straps
Single planked, 300 to 500 cu. ft. displ. Double " 500 to 900 " " "	5 straps
Single planked, 500 to 900 cu. ft. displ. Double " 900 to 1500 " " "	5 diagonal and body strap
Single planked over 900 cu. ft. displ.	7 diagonal and body strap

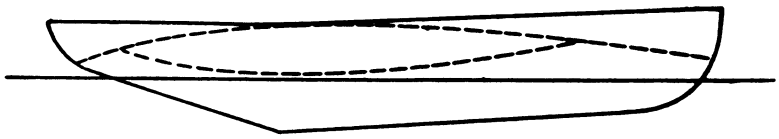
Yachts over 1,200 cubic feet displacement had better be of composite build. The straps are to be arranged as shown in the diagrams below.

Diagonal strapping



When body straps are used, the diagonal straps are to be fastened to them.

Light draft sailing yachts and power yachts of any considerable size, say over 300 cubic feet displacement, should be diagonally strapped or stiffened in some way. In hulls of from 300 to 500 cubic feet displacement a very good way is to have arched stringers intersected by short bilge stringers of oak or yellow pine, thus



The arched stringers if in two or more lengths to be well secured at the butts, and the bilge stringers well secured to the arch stringers at their ends. All to be well fastened to the inside of the timbers. Larger yachts to have the regular system of diagonal strapping laid on to the outside of the timbers before planking. Their arrangement depends so much on the character of hull and distribution of weights, it is difficult to formulate a rule, but generally, drooping of ends and sagging at position of machinery have to be looked out for.

In the sailing yachts that have body bands, they should be well secured to the stem near its head and run aft under the lower part of body amidships, finally terminating at the quarters where they should be well secured. The lower end of all diagonal straps should terminate at these bands and be well secured to them. Arranged this way straps do not go into the bilge-water and therefore are not subjected to intense corrosion.

The size of straps to be about the same as determined for lead straps, or possibly a little wider and thinner, and body bands about the same thickness but 50% to 75% wider. Screw fastening at each edge into planking and also into timbers. Tobin bronze is standard but in larger sized yachts galvanized steel banding is usual.

Clamps

Clamps for supporting deck beams and making a longitudinal tie should be continuous from breast hook to quarter knees, and if in more than one length avoid if possible having any butt near amidships. The best practice is to have a long length amidship and butted to two shorter ones at ends. Connection to be made by a short filling piece between the clamp and sheer strake between adjacent timbers (the butt being midway of a frame space) and a long butt piece on the inside of clamp covering 5 frame spaces, and well through fastened. This inside piece may be of wood same as clamp or of galvanized steel angle. Bevel clamps at outside so top surface is level and correctly fays to the deck beams, which are to have a level seating. Their size before beveling should be .24 (II) each way and the inner lower corner may be chamfered away about .05 (II) excepting under butt pieces.

In the smaller classes, spruce or other stiff light wood may be used but in larger ones woods of harder texture, as Douglas fir, Georgia pine or oak, and in as long lengths as possible.

In yachts having long cabin trunks, or houses, that cut off the deck beams, it is desirable to have a secondary clamp inside the primary, and well bolted to it.

In many yachts having high topsides and flush decks clamps may be omitted, and the deck beams supported by metallic drop knees or brackets, bolted to deck beam and timber, both being placed in the same plane. If this construction be used longitudinal strength shall then be made up by having a molded or thicker sheer strake and a heavier plankshеer or waterway.

Breast Hook and Quarter Knees

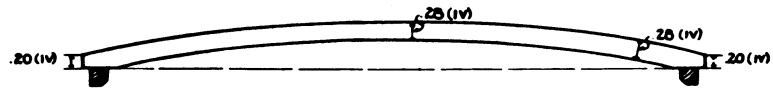
There should always be a breast hook to connect the stem, sheer strakes and decking securely together. In the modern sailing yacht it becomes a chunk of wood to receive bolts and fastening, but it should be selected with care for soundness and durability, and it must be well seasoned. There should be a long fore and aft bolt passing through stem and set up with a nut inside. The forward end of clamps should also be bolted to under side of breast hook.

Quarter knees must be fitted to securely connect the sheer strakes, clamps, and transom, and also a ledge piece to receive wood ends of deck. Take particular care that the quarter knees and other pieces in the vicinity are of thoroughly seasoned wood that is not subject to dry rot.

Deck Beams

The most desirable wood is white oak or yellow-bark oak, in the larger sizes. Yellow-bark oak, white ash or chestnut in intermediate sizes, and white ash, chestnut or butternut in smaller. It is recommended they be placed on large side of every frame space, the timbers being on the small, or side towards ends of vessel, excepting at frames where there are hanging knees or when there is no clamp, but knee brackets, then they should be in same plane as timber.

The molded size to be .28 (IV). Camber for both top and bottom sides should be the same, for all beams, and between $\frac{1}{3}''$ and $\frac{1}{2}''$ per foot of beam of vessel, or between $\frac{B}{36}$ and $\frac{B}{24}$. The radius of curvature between 9B and 6B. Make the depth of end of all beams .20 (IV), and the under side on level line until intersected by molded or cambered part, as below.



The regular size for siding of deck beams to be .17 (III). Beams each side of mast, and each side of hatches with not more than two beams cut, and at position of belt frames, to be sided .23 (III). At hatches cutting more than two beams, and at breaks of deck, to be sided .30 (III).

Half beams with inboard end supported by hatch coaming or cabin house side may be molded .20 (IV) and sided .17 (III), and there are to be wedge shaped shims between under sides and clamps.

Deck Diagonal Strapping

In yachts over 175 and under 350 cubic feet displacement have one pair running from gunwale to gunwale and crossing near mast partners. Yachts between 300 and 700 cubic feet displacement 2 pairs, and over 700 three or more pairs—all placed where they can best run from gunwale to gunwale and not be cut by hatchways or other deck openings. The angle with center line between 30° and 45°. The size to be about the same as for planking straps. They may be cut into deck beam flush or fairing pieces, thickness of straps placed on top of beams laid in white lead. To be fastened into deck beams and also into deck between beams, with brass screws.

Margin Plank or Planksheer

To run continuously from stemhead over sheerstrakes and deckbeam ends, to and around transom and return on other side. To be worked in long lengths as possible with butts on buttblocks between timbers, and shifted two or more frame spaces from butts of sheerstrakes and clamps. The thickness to be not less than main deck and more is better if deck is bright for holystoning. Breadth to be .38 (II). To be screw fastened into sheerstrake and beam ends. If deck planks are to be laid straight, make breadth .42 (II) to allow nibbing in ends of decking. Best woods are teak, white oak, mahogany of hard texture, in larger; and mahogany, Georgia pine or Douglas fir, in small yachts.

Main Deck

The best wood is clear white pine free from sap and shakes. If a deck is to be canvas covered, which is always recommended in decks less than $1\frac{1}{4}''$ thick, other light woods are good, as Washington spruce, Port Orford cedar, white cedar, etc.

The best practice is to lay with square seams of thoroughly dry stock and to be tightly caulked with cotton. Bare decks to have seams filled with marine glue after caulking. When canvas covered, seams puttied flush.

In the heavier decks a good practice is to get the stock out square so to be able to select the best side to be up, which must always show edge of grain. Such a deck has one fastening to each beam. For two fastenings, breadth should be from 1¾ to 2½ times thickness .185 (II) to .260 (II). Standard thickness to be .105 (II), and if canvas covered, thickness may be reduced to .1 (II)—.05". If teak is substituted for white pine in the larger sizes, thickness to be .075 (II). It is generally desirable to lay the deck parallel to the margin plank, with ends nibbed into a king plank when approaching center line.

Cabin Trunks, or Houses

If sides are of plank of soft wood, thickness to be .110 (II), and if mahogany, .1 (II), or if teak, .095 (II). The sides should be edge bolted at spacing not over 2 frame spaces.

The house deck beams should be secured to house sides either by a white oak lining strip in width 1¾ times molded size of beams and thickness .1 (II). The beams to be dove-tailed into it. Or by metal brackets or clips, securely fastened.

If the sides are framed and with glass or wood panels, frame to be either mahogany or teak .12 (II) in thickness, and glass not less than 7/32" thick or .018 (II), and with wood panels, .06 (II).

House deck beams may be dove-tailed into upper rail of framed side provided it is increased in thickness to .175 (II) and not cut through, but leaving not less than .70 (II) of wood at end of beam.

The molded depth of house or trunk deck beams to be .28 (V): where the factor (V) is taken from Table III by entering with $\sqrt[4]{D \times \text{length of longest beam.}}$ (Square root of the square root); but not less than ⅔ molded depth of main deck beams. The spacing,—siding of beams and thickness of deck, to be in proportion to corresponding scantling of main deck as the square root of the ratio of length of house to the mean length of hull (L), but not less than ⅔ of corresponding dimensions of main deck, and to be of equivalent grade of wood. Beams each side of mast hatches, etc., are to be increased as in main deck beams.

Camber to be between 1/24 and 1/36 of length of longest house beam.

House deck to be laid in same manner as main deck, and same allowance of thickness for canvas to be made.

When the house deck extends forward of a mast it must be diagonally strapped as thoroughly as the main deck.

Mast Partners and Steps

At the position of each mast, bitts, capstan, mooring cleats, etc., the deck should be reinforced between deck beams by a well seasoned hardwood plank running thwartships,—in thickness .125 (II) and length equal to 2½ frame spaces, for mast, bitts and main capstan, and not less than 1½ frame spaces for other

major deck fittings. Each side of a mast or bitt hole should be edge bolted, passing through adjacent deck beams and set up with nuts.

Mast steps should be of hard wood—white oak is best—and well supported against the intense thrust of the mast. They should rest on 3 or 4 floor timbers of extra size, and in the larger sizes of racing yachts, extra timbers and intermediate timbers or straps connecting with chainplates and passing down under mast step is desirable.

Inside Ceiling

Every wood framed yacht should be ceiled from the cabin sole to within a frame space length of the deck beams, or higher, and for at least ¾ length (¾L) in middle part, but to extend as much farther as is necessary to reach by any sleeping berth. The thickness of ceiling to be .20″ + .025 (II). To be laid in reasonably long lengths, seams close and to be well fastened to timbers. Use cedar in smaller sizes and harder woods in larger, ranging up to Douglas fir or Georgia pine in the largest.

Bilge Stringers

Are not necessary in any yacht that is well ceiled as directed. In cases where a yacht is liable to lay aground and over on her bilge, it is well to have outside protection in the form of one or two or three thick bilge strakes of planking for the middle ⅓ length, or a bilge keel in lieu of it.

Hanging Knees and Belt Frames

In larger sizes of sailing yachts—over 500 cubic feet displacement with outside ballast—they should be strengthened by belt frames and hanging knees. They can generally be placed at frame spaces that will not interfere with berth spaces, and at partitions, and not closer than 6½ to 8 feet apart. Have two on each side on yachts between 500 and 900 cubic feet displacement and 3 or 4 each side on yachts over 900 cubic feet displacement. The belt timber to be .23 (III) square of best white oak, steamed and bent to place. These timbers should be fitted inside the ceiling and *not* cut it, and hanging knees should connect them to the deck beams of same siding as belt frames: have through fastenings of size for lead straps, with heads bunged into outside planking and passing through timber, ceiling, and belt timber, with nuts inside and not over 1 (III) apart.

The lower end of belt frames to be well fastened to face of plank floors, as are the main timbers.

Cabin Floor, or Sole

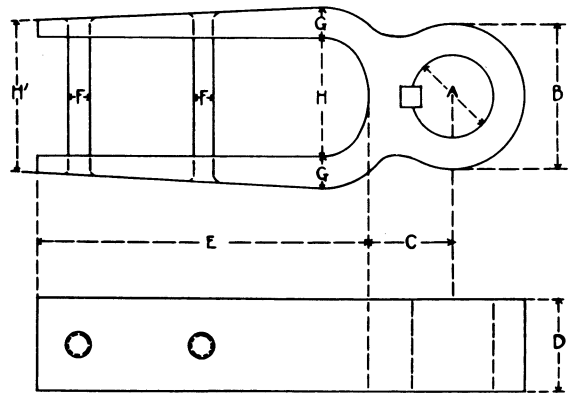
Should be laid on oak beams, spaced same as main timbers and substantially secured to them, and to be stanchioned to floor timbers where necessary to prevent vibration. Floor may be cedar in small boats, ranging up to Douglas fir and Georgia pine in the largest. The thickness to be .20″ + .035 (II). Beams to be sided .2″ + 0.55 (II) and depth 2½ times siding.

Rudder Stocks

Tobin bronze is standard material for all wood constructed yachts. The diameter in inches for sailing yachts to be not less than .155 times breadth of yacht in feet, (.155B) and also not less than the fourth root of 2/100 times distance of center of area of rudder blade from axis, times area of blade, times mean length of vessel, all in feet. ($\sqrt[4]{.02 \times v \times a \times L}$)

The connection of rudder blade to stock to be by two bronze castings with double arms in the general form as shown. To be fitted and keyed tight to stock, and held to blade by two or three copper rivets.

Proportions:
If the diameter of the stock A is 1:
then the other dimensions should be
B = 1¾ C = 1 D = 1⅛
E = 4 G = ⅜ K = ¼
F = ¼ or 7/32 if 3 bolts.
H and H′ as required for
the thickness of the blade.
K is the size of key.



It is difficult to make a close rule for stocks to rudders of power vessels. As a rough rule: When blades are supported by a step or pintles. Diameter in inches not less than .18 (III), and not less than .85 (dia. of propeller shaft).

If blade is pendant, then stock to be not less than .225 (III) and not less than 1.25 (dia. of propeller shaft) and if twin screw, 1.5 (dia. of shafts).

Planking and Deck Fastenings

Brass wood screws are usually used and give good results generally, although occasionally there is trouble from electrolysis, and a different composition than that usually used in wood screws that is not subject to it would be better. For the special purpose, screws that are threaded but six-tenths of length, so the body part will extend into timber to give better sheering resistance, is better. Care should be taken to bore correct sizes for screw end—body and bung, and special bitts that will bore the three sizes at once are desirable. The sizes of screws under No. 10—it is generally more practical to putty or wax the heads instead of bunging, and in that case ⅛ inch longer screws can be used and not counter-bored, but the head set in a short distance.

Table of Sizes of Screws for Planking and Deck Fastenings

Planking Thickness	*Approximate Diameter*	*Screw Gauge Number*	*Length*	*Diameter of Bung*
3/8"	9/64"	6	3/4"	5/16"
7/16"	5/32"	7	7/8"	5/16"
1/2"	11/64"	8	1"	3/8"
9/16"	3/16"	9	1 1/8"	3/8"
5/8"	3/16"	10	1 1/4"	7/16"
3/4"	7/32"	12	1 1/2"	7/16"
7/8"	1/4"	14	1 3/4"	1/2"
1"	17/64"	16	2"	9/16"
1 1/8"	19/64"	18	2 1/4"	5/8"
1 1/4"	5/16"	20	2 1/2"	11/16"
1 1/2"	11/32"	22	2 3/4"	11/16" or 3/4"
1 3/4"	3/8"	24	3"	3/4" or 13/16"
2"	13/32"	26	3 1/2"	13/16"

For double planked yachts use table sizes for inner plank fastening to timbers and same gauge but length as required for fastening between timbers. For outer plank use sizes for total thickness of both inner and outer planking.

Table of Dimensions in Terms of the Fundamental Factors

INCHES AND DECIMALS

	Deep Keel	*Moderate Draft, Center-Board: Outside Ballast*	*Inside Ballast Sailing Yachts: Power-Boats*
FRAME SPACES:	(I)	(I)	(I)
KEEL:			
Depth, or thickness at ends:	.28 (II)	.35 (II)	.80 (II)
Width:		.55 (II)	.55 (II)
		+ c. b. slot	+ c. b. slot
STEM PIECE:			
Sided:	.50 (III)	.50 (III)	.50 (III)
Molded:	.70 (III)	.70 (III)	.70 (III)
TRANSOM:			
Thickness:	.095 (II)	.095 (II)	.095 (II)
Reinforcing thickness:	.18 (II)	.18 (II)	.18 (II)
TIMBERS:			
At head (square)	.20 (III)	.20 (III)	.20 (III)
Maximum (square)	.24 (III)	.23 (III)	.22 (III)
Length of taper:	7.20 (III)	7.20 (III)	7.20 (III)
Taper (per foot)	1/16"	3/64"	1/32"
FLOOR TIMBERS:			
Plank Floors: thick	.185 (III)	.185 (III)	.185 (III)
Crook Floors: thick	.28 (III)	.28 (III)	.28 (III)
deep	.32 (III)	.32 (III)	.32 (III)
OUTSIDE PLANKING:			
Thickness:	.105 (II)	.105 (II)	.105 (II)
CLAMPS:			
Before beveling:	.24 (II)	.24 (II)	.24 (II)
Chamfer (not over):	.05 (II)	.05 (II)	.05 (II)

	Deep Keel	*Moderate Draft, Centre-Board: Outside Ballast*	*Inside Ballast Sailing Yachts: Power-Boats*
DECK BEAMS:			
Molded: maximum:	.28 (IV)	.28 (IV)	.28 (IV)
at ends:	.20 (IV)	.20 (IV)	.20 (IV)
Sided: regular	.17 (III)	.17 (III)	.17 (III)
at mast & small hatches:	.23 (III)	.23 (III)	.23 (III)
at large hatches:	.30 (III)	.30 (III)	.30 (III)
Half Beams:			
Molded:	.20 (IV)	.20 (IV)	.20 (IV)
Sided:	.17 (III)	.17 (III)	.17 (III)
PLANKSHEER:			
Thickness:	same as deck	same as deck	same as deck
Breadth:			
Curved deck:	.38 (II)	.38 (II)	.38 (II)
Straight deck:	.42 (II)	.42 (II)	.42 (II)
MAIN DECK:			
Thickness: Pine:	.105 (II)	.105 (II)	.105 (II)
Teak:	.075 (II)	.075 (II)	.075 (II)
Canvas:	.100 (II)	.100 (II)	.100 (II)
	—.05″	—.05″	—.05″
CABIN TRUNKS:			
Solid Plank:			
Soft wood:	.110 (II)	.110 (II)	.100 (II)
Mahogany:	.100 (II)	.100 (II)	.100 (II)
Teak:	.095 (II)	.095 (II)	.095 (II)
Glass or paneled:			
Frame (Mahogany or Teak):	.120 (II)	.120 (II)	.120 (II)
Panels	.060 (II)	.060 (II)	.060 (II)
Deck Beams:			
Molded depth:	.28 (V)	.28 (V)	.28 (V)
MAST PARTNERS AND DECK FITTINGS:			
Thickness:	.125 (II)	.125 (II)	.125 (II)
INSIDE CEILING:			
Thickness:	.025 (II)	.025 (II)	.025 (II)
	+.20″	+.20″	+.20″
BELT TIMBER:			
Square:	.23 (III)	.23 (III)	
CABIN FLOOR, OR SOLE:			
Thickness:	.035 (II)	.035 (II)	.035 (II)
	+.20″	+.20″	+.20″
Beams:			
Sided:	.055 (II)	.055 (II)	.055 (II)
	+.20″	+.20″	+.20″
Depth:	2.5 × siding	2.5 × siding	2.5 × siding

Nevins's Scantling Rules for Wooden Yachts

For many years, Henry B. Nevins owned and operated one of the most highly acclaimed boatyards in the United States at City Island, New York. His yachts were known for being not only handsome but also extremely strong. Before and after World War II, his boats earned a reputation as powerful, modern, functional ocean racers. A majority of the boats he built were for and under the supervision of the Sparkman and Stephens design team. The rules he compiled would be more applicable to the man with a small boatyard, because these methods are suited to building one-off hulls, not a whole class of production boats, as Herreshoff often did.

General Clause. The cube root of the displacement in cubic feet, $\sqrt[3]{\text{Disp. cu. ft.}}$, (with the yacht in load condition) is the basis upon which scantlings are calculated.

Keel

Material: White Oak, Teak, or Mahogany.
Molding: Not less than $\sqrt[3]{\text{Disp. cu. ft.}}$ multiplied by .7.
Siding: Not less than double the molding at the widest point of keel.

Stem

Material: White Oak, Teak, or Mahogany.
Molding: Not less than siding.
Siding: At head not less than four times the thickness of the planking. Below head the siding of stem and bow timber shall be gradually increased to siding of keel to provide proper back rabbet.

Sternpost

Material: White Oak, Teak, or Mahogany.
Molding: Not less than siding.
Siding: Not less than four times thickness of plank.

Horn Timber

Material: White Oak, Teak, or Mahogany.
Molding: Not less than twice the thickness of plank.
Siding: Not less than twice the molding.

Frames

Material: White Oak, steam-bent.

Sectional Area: At heel in accordance with table sizes. May be straight-tapered to head to not less than 75% of the heel area. (See below.)

Where untapered frame is used, rule size shall be maintained for ¾ of D.W.L. length. Fore and aft of the ¾ length, the area may be gradually reduced to the ends of the yacht where it may be 15% less than amidships.

Where tapered frame is used, the rule shall be applied to the longest frame in the yacht, establishing thereby a standard taper for all other frames. The head size of the longest frame shall be maintained throughout the yacht, and the established taper applied therefrom to the heel, thereby decreasing the areas at the heel as the frames grow shorter fore and aft of the longest frame.

Spacing: To be in accordance with table. (See below.)

Molding: Optional. Table dimensions are recommended. In no case less than is required to entirely bury the plank fastenings of the length specified for screws.

Siding: Optional. Table dimensions recommended.

Where severe bends are encountered, making it impractical to use a solid frame, it is recommended that the frame be split, in a fore and aft direction, from the end to just beyond the point of extreme bend; or a double frame may be used, one member bent inside the other. In both instances, plank fastenings should extend through outer member well into inner member and the two be drawn tightly together.

If *sawn frames* are to be used, they shall be double, with the members adequately bolted or riveted together. *Sectional Area*—50% heavier than the table size of frames.

Belt Frames

Material: White Oak, steam-bent.

Molding: ¾ that of frames.

Siding: Equal to frames.

Belt frames are to be applied to yachts which are ceiled and there must be at least four on each side. They shall be applied after ceiling is installed.

In the case of single-masted vessels and yawls, one set of belt frames are to be located immediately forward and one immediately aft of main mast, and are to be kneed to heavy partner deck beams.

Belt frames should be used whenever possible, but, should they interfere with any unusual condition inside the yacht, may be omitted, provided the regular frame at that location is doubled in sectional area, or two frames of rule size placed alongside each other and bolted or riveted together. Yachts which are not ceiled are to be fitted with heavy frames having a sectional area of 1¾ times the area of main frames and located in a like manner to the belt frames of ceiled yachts.

In the case of two-masted schooners or ketches, one set of belt frames are to be located immediately forward and one immediately aft of each mast and are to be kneed to heavy partner deck beams.

In the case of three-masted yachts, there shall be 6 pairs of belt frames, one set located immediately forward and one immediately aft of each mast and kneed to heavy partner deck beams.

Planking

Material: Teak, Mahogany, Long Leaf Yellow Pine, and Douglas Fir.

Thickness: In accordance with table. (See below.)

Butts to be shifted so that no two butts shall come on same frame or in same frame space, except there be 3 clear planks between, and in no adjacent plank be nearer than 3 frame spaces.

If teak is used, thickness may be reduced 10%.

Ceiling

Material: Long Leaf Yellow Pine, Douglas Fir, or Spruce.

Thickness: 40% of the table thickness of outside planking. No reduction allowed where teak planking is used.

Ceiling shall be fitted in all yachts having a $\sqrt[3]{\text{Disp. cu. ft.}}$ of over 10, and shall extend for at least the water line length of the vessel and from cabin sole to underside of clamp.

Bilge Stringers

Material: Long Leaf Yellow Pine or Douglas Fir.

Sectional Area: Equal to 3 times the table area of frames for ¾ of D.W.L. length.

Bilge stringers shall be used in all yachts which are not ceiled. There shall be one on each side, to extend from stem to stern wherever possible, and they may be straight-tapered to ends to not less than 50% of the area amidships.

Clamp and Shelf

Material: Long Leaf Yellow Pine or Douglas Fir.

Sectional Area: 3½ times the table area of frames for ¾ of the water line length.

They shall extend the full length of the yacht but may be straight-tapered to the ends to not less than 50% of the area amidships.

A single clamp, or a clamp and shelf of required area, may be used.

Deck Beams

Material: Oak, Chestnut, Douglas Fir, Long Leaf Yellow Pine, Teak, Mahogany, and Ash.

Sectional Area: At center line of boat in accordance with table and may be reduced at ends to 75% of the sectional area at center.

Spacing: Same as table for frames.

Molding: Optional. May be reduced at ends to 75% of the molding at center.

Siding: Optional, but to be not more than 65% of the molded depth at center.

There shall be partner beams and hatch beams whose siding shall be 1¾ times the siding of the main beams.

Half beams and beams beyond the ends of the D.W.L. may be reduced to 75% of the area of the main beams.

Decking

Material: White Pine, Cedar, Spruce, Cypress, or Douglas Fir.

Thickness: Same as outside planking

If teak is used, the thickness may be reduced 10%. If covered with canvas, thickness may be reduced $\frac{1}{8}$".

Floors

Material: White Oak, Teak, Mahogany.

Spacing: One to each pair of frames.

Molding: To be sufficient to allow at least 4 fastenings to heels of frames, whose spacing shall be not less than $1\frac{1}{2}$ times siding of floor, but in no case shall the sectional area over the keel be less than 2 times the sectional area of frames.

In way of lead keel, siding of floors taking keel bolts shall be increased to regular siding, plus the diameter of the keel bolt. Molding to be same as regular floors.

There shall be no concave on top of any floor to show up cross grains at ends.

In any yacht where it is necessary to use the space occupied by wooden floors to install tanks or to meet any special conditions, metal floors—of approved design and of equal weight and strength to the wooden floors—may be used.

Siding: Not less than frame.

Hull Straps

Material: Bronze of not less than 60,000 pounds per square inch of tensile strength.

Width: Twice the planking thickness.

Thickness: .1 the plank thickness. (Other dimensions may be used but shall produce an equal cross-sectional area.)

There shall be 2 diagonal straps on each side at each mast, extending from underside of deck to keel between outside of frame and inside of planking.

Straps shall be fastened at each crossing of frame and between frames to the planking.

Deck Straps

Material, Width, Thickness: Same as hull straps.

Deck to be fitted with 2 diagonal straps at each mast, extending from gunwale to gunwale between top of deck beam and under side of deck and not cut by deck openings.

To be fastened at each beam crossing and between beams into deck.

Hanging Knees

Material: Wood, cast bronze, steel, or bronze plate flanged to frames or deck beams.

Length of Arms: 1.75 times table frame spacing.

Shall be fitted to all belt frames, all extra heavy frames, and partner beams.

Plank Fastenings

Material: Wood screws of noncorrosive metal.

Length: Twice the plank thickness from heel to turn of bilge; from turn of bilge to head may be shortened to suit molding of frame.

Size:

Plank Thickness	*Gauge No.*	*Plank Thickness*	*Guage No.*
5/8"	9	1 1/2"	20
3/4"	10	1 3/4"	22
7/8"	12	2"	24
1"	14	2 1/4"	26
1 1/8"	16	2 1/2"	28
1 1/4"	18		

Should other type of fastening be used—such as bolts, rivets, or drift fastenings—they shall be of equal cross-sectional area to those in the table for wood screws, and of suitable length.

Lead Keel Bolts

Material: Bronze, having a tensile strength of not less than 60,000 pounds per square inch.

The number and size to be sufficient to give not less than 1 square inch of sectional area of bolt for 1500 pounds of outside ballast.

Nevins' Table for Size and Spacing of Frames, Deck Beams, and Planking

$\sqrt[3]{\text{Disp. cu. ft.}}$	*Planking Thickness In.*	*FRAMES*			*Deck Beam Area Sq. In.*
		Area Sq. In.	*Siding and Molding In.*	*Spacing In.*	
3.8	0.56	0.65	0.81	6.03	0.75
4.0	0.56	0.65	0.81	6.03	0.75
4.2	0.59	0.75	0.87	6.30	0.88
4.4	0.62	0.86	0.93	6.58	1.03
4.6	0.66	1.00	1.00	6.84	1.18
4.8	0.69	1.13	1.07	7.12	1.33
5.0	0.72	1.28	1.13	7.38	1.49
5.2	0.75	1.43	1.20	7.64	1.65
5.4	0.79	1.60	1.27	7.91	1.81
5.6	0.82	1.80	1.34	8.18	1.98
5.8	0.86	1.98	1.41	8.44	2.15
6.0	0.90	2.20	1.48	8.70	2.33
6.2	0.93	2.40	1.55	8.97	2.50
6.4	0.96	2.61	1.62	9.22	2.67
6.6	1.00	2.83	1.69	9.49	2.85
6.8	1.04	3.10	1.76	9.73	3.03
7.0	1.08	3.34	1.83	10.00	3.22
7.2	1.12	3.59	1.90	10.25	3.42
7.4	1.15	3.84	1.96	10.50	3.62
7.6	1.18	4.12	2.03	10.75	3.82
7.8	1.22	4.40	2.10	11.00	4.02
8.0	1.25	4.70	2.17	11.25	4.22

$\sqrt[3]{\text{Disp. cu. ft.}}$	Planking Thickness In.	FRAMES			Deck Beam Area Sq. In.
		Area Sq. In.	Siding and Molding In.	Spacing In.	
8.2	1.29	5.00	2.24	11.50	4.43
8.4	1.32	5.30	2.30	11.75	4.64
8.6	1.36	5.60	2.34	12.00	4.86
8.8	1.40	5.90	2.43	12.25	5.09
9.0	1.43	6.23	2.50	12.50	5.32
9.2	1.46	6.53	2.56	12.75	5.55
9.4	1.50	6.89	2.63	13.00	5.78
9.6	1.53	7.22	2.69	13.23	6.02
9.8	1.56	7.58	2.76	13.47	6.27
10.0	1.60	7.92	2.82	13.72	6.53
10.2	1.63	8.30	2.88	13.95	6.79
10.4	1.66	8.70	2.95	14.20	7.05
10.6	1.70	9.10	3.02	14.44	7.31
10.8	1.73	9.50	3.09	14.68	7.58
11.0	1.76	9.92	3.15	14.92	7.85
11.2	1.80	10.36	3.22	15.16	8.12
11.4	1.83	10.80	3.29	15.40	8.41
11.6	1.86	11.29	3.36	15.63	8.70
11.8	1.90	11.78	3.44	15.88	9.00
12.0	1.93	12.30	3.51	16.12	9.30
12.2	1.96	12.80	3.58	16.35	9.60
12.4	1.99	13.31	3.65	16.60	9.91
12.6	2.02	13.87	3.73	16.83	10.22
12.8	2.05	14.42	3.80	17.07	10.53
13.0	2.09	15.00	3.88	17.31	10.84
13.2	2.12	15.55	3.95	17.55	11.16
13.4	2.15	16.14	4.02	17.80	11.49
13.6	2.18	16.74	4.09	18.03	11.82
13.8	2.22	17.33	4.16	18.28	12.16
14.0	2.25	17.95	4.24	18.50	12.60
14.2	2.28	18.60	4.32	18.75	12.84
14.4	2.31	19.20	4.39	19.00	13.18
14.6	2.34	19.87	4.46	19.22	13.52
14.8	2.37	20.50	4.53	19.45	13.86
15.0	2.40	21.12	4.60	19.70	14.21
15.2	2.43	21.80	4.67	19.95	14.58
15.4	2.46	22.50	4.75	20.18	14.95
15.6	2.50	23.17	4.82	20.42	15.31
15.8	2.53	23.90	4.89	20.65	15.68
16.0	2.55	24.60	4.96	20.88	16.05
16.2	2.58	25.30	5.03	21.12	16.43
16.4	2.60	26.00	5.10	21.36	16.80

Rules and Regulations for the Classification of Yachts and Small Craft (© Lloyd's Register of Shipping, 1979)

These rules have terms that North American builders may not recognize. For this reason, diagrams are included to help with what is only a translation problem. Many of the timber species mentioned are described in Appendix A.

Wood and Composite

SECTION 1
Materials

1.1 Timber species

1.1.1 The species of timber which may be used for the various constructional members, *see* Figs. 4.1.1 and 4.1.2, are given in Tables 4.1.1 and 4.1.2. A general indication of their known performance in service has been indicated, but in view of the differences in construction methods and in the use of the craft, design considerations may influence the selection of species.

1.1.2 Group A are the species of timber considered to be the most suitable for the purposes set out in Table 4.1.1. Groups B and C are in descending order of preference, but within each group no attempt has been made to list the individual species in order of preference. It is presumed that the designer will relate the known characteristics, e.g. strength, density, bending and working capabilities, of particular species to the constructional design.

1.1.3 The inclusion of a timber in Table 4.1.1 and 4.1.2 does not imply that all material available under the particular name is suitable for the use shown, and care must be exercised to ensure that an appropriate grade is obtained.

1.2 Timber quality

1.2.1 The timber is to be of good quality and properly seasoned and is to be free from heart, sapwood, decay, insect attack, splits, shakes and other imperfections which would adversely affect the efficiency of the material. It is also to be generally free from knots, although an occasional sound intergrown knot would be acceptable.

1.2.2 The timber for the centreline members is to be reasonably seasoned and, where there is a risk of excessive drying-out, it is to be coated with boiled linseed oil or varnish, as soon as erected, to prevent splitting.

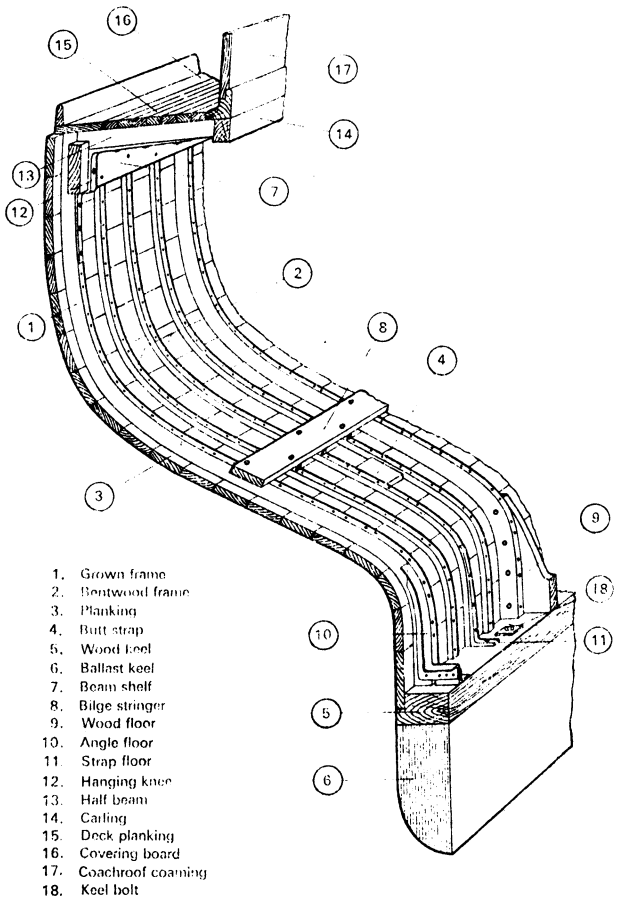


Fig. 4.1.1 Midship section of a sailing or auxiliary craft showing terms used in these Rules

Table 4.1.1 Guidance on the selection of timbers for constructional members *(see continuation)*

Timber species	Average density air-dried, kg/m³	Keel and false keel	Dead-wood	Stem	Stern-post	Bilge and chine stringer	Beam shelf, stringer and clamp	Floors	Frames		Hull planking	
									Grown	Bent-wood	Below water-line	Above water-line
Afrormosia	690	B	B	B	B	—	—	B	B	—	—	—
Afzelia	815	B	B	—	B	—	—	—	—	—	B	B
Agba	515	—	—	—	—	—	—	—	B†	—	C	B
Cedar,Western Red	385	—	—	—	—	—	—	—	—	—	—	—
Douglas Fir	530	—	—	—	—	C	C	—	—	—	C	C
Elm, English	545	B	B	B	B	—	—	—	—	—	—	—
Elm, Rock	705	—	—	—	—	B	B	—	—	A*	—	—
Elm, Wych	670	B	B	B	B	—	—	—	—	—	—	—
Guarea	580	—	—	—	—	—	—	—	—	B	—	—
Gurjun	735	C	C	C	C	—	—	C	C	—	B	C
Ipil	720	—	—	—	—	—	—	—	B	A	—	—
Iroko	640	—	—	—	—	—	B	A	A	—	A	A
Kapur	735	B	B	B	B	B	B	B	B	—	B	B
Keruing	735	C	C	C	C	—	—	C	C	—	B	C
Keyaki	625	B	B	B	B	—	—	B	B	—	—	—
Larch	560	—	—	—	—	B	B	—	B†	—	B	C
Mahogany, African	530	C	C	C	C	C	C	C	B†	—	C	B
Mahogany, Honduras	545	B	B	B	B	—	—	B	—	—	B	B
Makore	625	B	B	B	B	—	—	B	B	—	—	—
Oak, American White	770	B	B	B	B	B	B	B	B*	A*	B	B
Oak, English	720	B	B	B	B	—	B	B	B*	A*	B	—
Opepe	735	B	B	B	B	—	—	C	—	—	C	C
Pine, Pitch	705	—	—	—	—	—	B	—	—	—	A	B
Redwood, European	515	—	—	—	—	C	C	—	—	—	C	C
Robinia	720	B	B	B	B	—	—	B	B	B	—	—
Sapele	625	C	C	C	C	C	C	—	C	—	C	C
Spruce, Sitka	450	—	—	—	—	C	C	—	—	—	C	C
Teak	655	A	A	A	A	A	A	A	A	—	A	A
Utile	655	—	—	—	—	—	—	—	—	—	A	A
Yacal	990	B	B	B	B	B	B	B	B	—	—	—
Yang	735	C	C	C	C	—	—	C	C	—	B	C

Beam and frame timbers marked * are suitable in both the natural and laminated form. Those marked † are suitable only when laminated.

Table 4.1.1 Guidance on the selection of timbers for constructional members (*conclusion*)

Deck planking	Beams and carlings	Knees		Covering boards, kingplanks and margins	Natural durability	Resistance to impregnation	Ease of gluing	Timber species
		Hanging	Lodging					
—	B	B	B	B	Very durable	Extremely resistant	Satisfactory	Afrormosia
—	—	—	—	—	Very durable	Extremely resistant	Satisfactory	Afzelia
B	—	—	—	—	Durable	Resistant	Satisfactory	Agba
C	—	—	—	—	Durable	Resistant	Satisfactory	Cedar, Western Red
B	B	—	—	—	Moderately durable	Resistant	Satisfactory	Douglas Fir
—	—	—	—	—	Non-durable	Moderately resistant	Satisfactory	Elm, English
—	—	C	C	—	Non-durable	Resistant	Satisfactory	Elm, Rock
—	—	—	—	—	Non-durable	Resistant	Satisfactory	Elm, Wych
—	—	—	—	—	Durable	Extremely resistant	Satisfactory	Guarea
—	—	—	—	—	Moderately durable	Resistant	Satisfactory	Gurjun
—	—	—	—	—	Moderately durable	Resistant	Satisfactory	Ipil
A	—	—	—	A	Very durable	Extremely resistant	Satisfactory	Iroko
B	B	B	B	B	Very durable	Extremely resistant	Satisfactory	Kapur
—	—	—	—	—	Moderately durable	Resistant	Satisfactory	Keruing
—	—	B	B	—	Durable	Resistant	Satisfactory	Keyaki
—	B	B	B	—	Moderately durable	Resistant	Satisfactory	Larch
B	B†	—	—	C	Moderately durable	Extremely resistant	Satisfactory	Mahogany, African
—	B†	—	—	B	Durable	Extremely resistant	Satisfactory	Mahogany, Honduras
—	B†	—	—	—	Very durable	Extremely resistant	Satisfactory	Makore
—	B*	B	A	B	Durable	Extremely resistant	Satisfactory	Oak, American White
—	B*	B	A	B	Durable	Extremely resistant	Satisfactory	Oak, English
B	—	—	—	C	Very durable	Moderately resistant	Satisfactory	Opepe
B	B	—	—	—	Moderately durable	Moderately resistant	Variable	Pine, Pitch
C	—	—	—	—	Non-durable	Moderately resistant	Satisfactory	Redwood, European
—	—	—	—	—	Durable	Extremely resistant	Satisfactory	Robinia
—	—	—	—	—	Moderately durable	Resistant	Satisfactory	Sapele
C	C*	—	—	—	Non-durable	Resistant	Good	Spruce, Sitka
A	A	A	A	A	Very durable	Extremely resistant	Satisfactory	Teak
A	—	—	—	—	Durable	Extremely resistant	Satisfactory	Utile
—	—	B	B	—	Very durable	Extremely resistant	Satisfactory	Yacal
—	—	—	—	—	Moderately durable	Resistant	Satisfactory	Yang

1.2.3 The material for hull and deck planking is to be generally straight grained and, for deck planking, is to be quarter sawn.

1.3 Timber moisture content

1.3.1 The timber is to be stored under dry conditions and is to have an air-dried moisture content of not more than about 20 per cent before use. Care is to be taken to avoid excessive drying-out during building.

1.3.2 The moisture content of material which is to be glued is to be about 15 per cent. Contents slightly above this value are recommended when resorcinal glues are used, and contents slightly below this value are recommended when phenolic or urea-formaldehyde resins are used. It is recommended that the material to be used in laminating members should be kiln-dried to about 15 per cent.

1.3.3 The moisture content of hull and deck planking which is to be sheathed using synthetic resins is to be as low as practicable, to avoid affecting the efficiency of the sheathing bond.

1.4 Plywood

1.4.1 The plywood used in the hull and deck structure is to be of an approved high grade marine quality with good quality face and core veneers of a durable hardwood species and made with high standards of workmanship in the lay-up and manufacture. The veneers are to be bonded with a WBP (water and boil proof) type adhesive, although in special circumstances an adhesive of slightly lesser durability will be considered. Material complying with BS 1088, or other equivalent specification, is acceptable.

1.4.2 Other plywood may also be of quality and standard similar to that of the material in 1.4.1, but may be made from a less durable timber species which has been treated with a wood preservative. The timber is to be of a species which can be satisfactorily treated. The preservative is to be of a tar-oil, waterborne or other suitable type, and is to be applied in accordance with a recognized standard at either the veneer stage or after manufacture. Plywood complying with BS 3842 for treated plywoods for marine use, or equivalent specification, is acceptable. Treatments TO 1, WB 1 and WB 2, or similar, may be used on material of acceptable quality and standard.

1.4.3 Timber species suitable for marine plywood and their durability are given in Table 4.1.3. Timbers of species other than those specified may be used subject to approval.

1.4.4 Plywood sheets are to be stored flat on a level bed and under dry, well ventilated conditions. The moisture content is not to exceed 15 per cent.

1.5 Timber preservatives

1.5.1 Preservatives are to be of suitable types, either from the waterborne fixed salt group such as copper chrome type to BS 3452 and copper-chrome-arsenic types to BS 3453, or from the organic solvent group, such as naphthenates of zinc and copper and pentachlorophenol. Other types of preservatives will be considered.

1.5.2 In the selection of type of preservative, due regard should be paid to the effect on varnish and paint coatings, and on synthetic resins, where sheathing is to be applied.

1.6 Timber adhesives

1.6.1 The glues to be used in the construction and lamination of structural members are to be of a type approved by the Society and of a gap-filling resorcinol or phenolic type, such as those complying with BS 1204 WBP, or other adhesives which have similar durability and can give a WBP bond.

1.6.2 Modified urea-formaldehydes may be used as described in 2.4.2.

1.6.3 The glues are to be mixed and applied in accordance with the manufacturer's instructions with regard to the shop temperature and humidity requirements. Attention is also to be paid to the application techniques for the species of timber being glued, and the manufacturer's advice should be sought in the working of difficult timbers and the effect of preservatives on the adhesive.

1.7 Metal fastenings

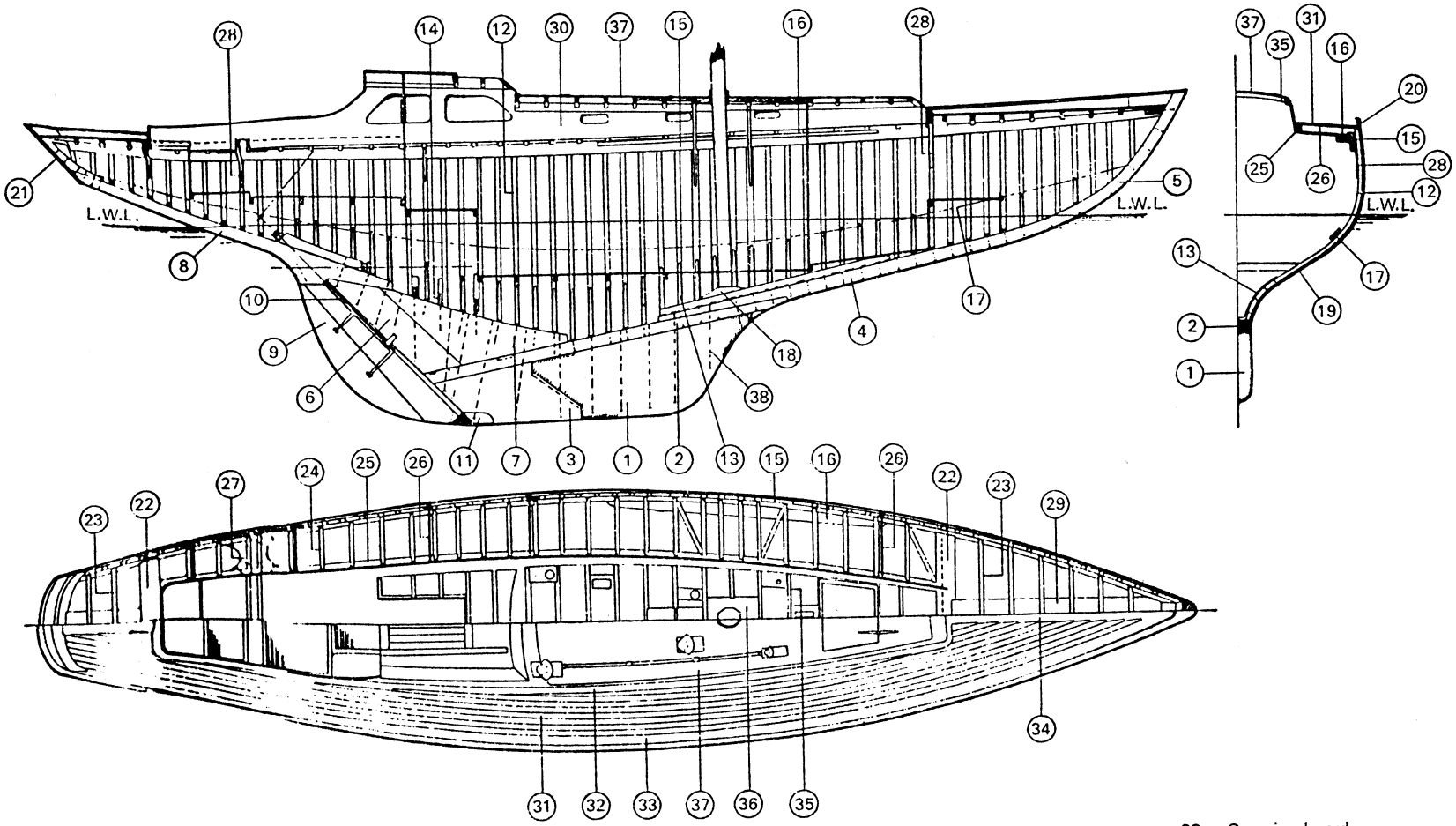
1.7.1 The materials used for fastenings are to be a suitable composition of the following metals:—

Copper
Gunmetal
Galvanized iron
Galvanized steel
Silicon bronze
Aluminium bronze
Stainless steel
Monel

Table 4.1.2 Suitable timbers for moulded hull construction

Species	Group	Average density air-dried, kg/m³
Agba	B	515
Cedar, Central American	B	485
Cedar, Honduras	A	485
Mahogany, African	A	530
Mahogany, Honduras	A	545
Makore	A	625

NOTES
1. For grouping of timbers, *see* 1.1.2.
2. *See also* Notes to Table 4.1.1.



1. Ballast keel
2. Wood keel
3. False keel
4. Lower stem or forefoot
5. Upper stem
6. Sternpost
7. Deadwood
8. Counter timber
9. Rudder
10. Rudder stock
11. Rudder heel fitting
12. Frames or timbers
13. Strap floors
14. Wood floors
15. Beam shelf
16. Clamp
17. Bilge stringer
18. Mast step
19. Outside planking
20. Bulwark
21. Transom
22. Strong beams
23. Ordinary beams
24. Half beams
25. Carling
26. Tie rods
27. Lodging knees
28. Hanging knees
29. Under deck chocks
30. Coachroof coaming
31. Deck
32. Margin plank
33. Covering board
34. Kingplank
35. Coachroof beams
36. Mast partner chock
37. Coachroof top
38. Keel bolts

Fig. 4.1.2 Typical construction profile and deck of an auxiliary craft showing terms used in these Rules

Table 4.1.3 Guidance on the selection of timbers for use in marine plywood

Common name	Botanical name	Density at 15 per cent moisture content, kg/m³	Natural durability of heartwood
Durable hardwood timbers in natural state			
Agba	*Gossweilerodendron balsamiferum*	500	Durable
Gedu Nohor	*Entandrophragma angolense*	540	Moderately durable
Guarea	*Guarea spp.*	580	Durable
Idigbo	*Terminalia ivorensis*	540	Durable
African Mahogany	*Khaya spp.*	500	Moderately durable
Makore	*Mimusops heckelii*	620	Very durable
Omu	*Entandrophragma candollei*	620	Moderately durable
Light Red Meranti Light Red Seraya	*Shorea spp.* (*see* Note 2)	530	Moderately durable
Sapele	*Entandrophragma cylindricum*	620	Moderately durable
Utile	*Entandrophragma utile*	660	Durable
Timbers requiring preservative treatment			
Douglas Fir	*Pseudotsuga taxifolia*	530	Moderately durable
Gaboon/ Okoume	*Aucomea klaineana*	430	Non-durable

NOTES
1. It should be noted that behaviour towards marine borers and insects, including termites, is not equated to this durability scale.
2. Because of reduced durability, the use of *Shorea spp.* below the density quoted is not recommended unless it is treated with a preservative.

1.7.2 Steel and iron fastenings are to be hot-dipped galvanized, but black iron keel bolts may be coated with a suitable composition. Small screw fastenings below about 20 mm in length which cannot be satisfactorily hot-dipped may be electroplated zinc, provided that the coating is of a reasonable thickness and to an approved specification, such as BS 1706: 1960 Grade Zn 10.

1.7.3 Stainless steel fastenings are to be of a suitable grade of austenitic steel.

1.7.4 Gunmetal fastenings may be used, but where increased strength and corrosion resistance is desired it is recommended that silicon bronze be used. Aluminium bronze may be used, in the larger bolt sizes, where increased strength is desired. Brass fastenings are not to be used for structural purposes.

1.7.5 Ballast keel fastenings are to be in accordance with Ch 6,4.2.

1.8 Other materials

1.8.1 Other materials intended for structural use are to be of good quality, suitable for the purpose intended and to comply with the Society's requirements appropriate to the material. Details of these materials are to be stated on the relevant construction drawings.

1.8.2 Suitable arrangements are to be made to insulate aluminium alloys from timber and dissimilar metals. Paints containing either lead, mercury or copper are not to be used in conjunction with these alloys.

● End of Section

SECTION 2

Construction procedure

2.1 Workshop requirements

2.1.1 The craft is to be suitably protected during the building period from adverse weather and climatic conditions. The minimum protection to be provided is normally a substantial and efficient roof projecting beyond the length and breadth of the craft. Where laminated glued construction is being extensively used, a building shed with controlled temperature and humidity levels may be required.

2.1.2 Workmanship is to be well executed and carried out under adequate supervision throughout the preparation and building of the craft. The various parts of the structure are to be properly faired and fitted.

2.2 Preservative treatment

2.2.1 The faying surfaces of frames, beams, stringers, floors and shelves are to be treated with one of the types of timber preservative indicated in 1.5.

2.2.2 The preservatives are preferably to be applied by dipping and soaking or by pneumatic spray but where these methods are not practicable a liberal application by brush can be used. The timber is to be treated when all work on the member is complete, but where cut or bored after treatment a liberal brush application is to be applied to the exposed timber.

2.3 Plywood

2.3.1 All edges and cut-out areas are to be throughly sealed by glues, varnishes, paints or other suitable compositions to prevent moisture penetrating along the end-grain.

2.4 Gluing process

2.4.1 The timber is to be clean and dry, and the joining surfaces are to be properly prepared and free from dust and grease. The adhesive, complying with 1.6, is to be evenly applied and the joint closed within the manufacturer's recommended closing time in order to obtain a thin and uniform glue line. Sufficient clamps and other pressure devices are to be used and the pressure is not to be released until the joint has set.

2.4.2 Modified urea-formaldehydes may be used in parts of the structure which will not be commonly subjected to continuously wet conditions and will be well ventilated. These parts include the coachroof and superstructures in both wood and plywood craft and internal structural assemblies which are clear of the bilges in plywood craft only. The glue lines in these structures are to be protected by several applications of varnish or paint.

2.4.3 The glues are to be mixed and applied in accordance with the manufacturer's instructions and with due regard to the shop temperature and humidity requirements. Due attention is to be paid to the application techniques for the species of timber being glued and the manufacturer's advice should be sought in the working of difficult timbers and the effect of preservatives on the materials.

2.5 Laminated timbers

2.5.1 The layers forming the lamination are generally to be of the same timber species and are to be of an even moisture content. The grain of the layers is to be approximately parallel to the length of the member, and special attention is to be paid to grain in the selection and assembly of the timber.

2.5.2 Where practicable the layers are to be continuous, and if this is not possible, the layers are to be scarph jointed, the slope of the scarph being not greater than 1 in 10.

2.5.3 Where the layers are bent to produce members of curved form, the thickness of each layer is to be such that the layer will not be unduly stressed in forming, and that a satisfactory interlaminar bond can be achieved.

2.5.4 The glues are to be resorcinol or phenolic resorcinol types complying with 1.6 and are to be applied in accordance with 2.4.

2.6 Fastening practice

2.6.1 Attention is to be paid to the fastenings throughout, particularly the size and disposition. The boring of the timber to receive the fastenings is to be properly executed, according to the density of the timber and the type and material of the fastening.

2.6.2 All hull and deck through-fastenings are to be of a composition similar to that of any metal members they secure. Where this cannot be arranged, suitable insulation is to be fitted to prevent contact between dissimilar metals.

2.6.3 Where craft are sheathed with copper or other non-ferrous metals, iron or steel fastenings are not to be used in way.

2.6.4 Through bolts are to be clenched on rings or washers or are to be fitted with nuts. Nuts, rings or washers are to be of the same material as the bolts.

2.6.5 Short dump or nail fastenings are to be of the same sectional areas as required by Table 4.9.2 for bolt fastenings.

2.6.6 Where bolt fastenings pass through the outside planking or centreline structure, cotton or other suitable grommets are to be fitted under the heads. Keel bolt and centreline fastening holes are to be treated with a suitable composition.

2.6.7 Copper through fastenings are to be clenched on rooves.

2.6.8 Where screw fastenings are used, the thread of the screw must enter the frame or beam a minimum distance equal to the thickness of the hull or deck planking.

2.6.9 Approved countersunk barbed headed nails may be used in lieu of screw fastenings. The size of the nails is to be the same as that required for screws. The Owner's attention must be drawn to the use of these barbed nails in view of difficulties which may arise should it be necessary to withdraw them.

● End of Section

SECTION 3

Determination of scantlings

3.1 General

3.1.1 The scantlings of motor, sailing and auxiliary craft of conventional form and proportions, up to a length of 30 m are to be determined from Tables 4.4.1, 4.5.1, 4.6.1, 4.6.2, 4.7.1, 4.8.1, 4.9.1 to 4.9.4, 4.10.1 to 4.10.3 and 4.12.1 and 4.12.2.

3.1.2 The scantlings will be specially considered where the craft is of unusual design, form or proportions or where either the speed exceeds 20 knots or the length, L, exceeds 30 m.

3.2 Timber density

3.2.1 The scantlings for the timber members shown in Tables 4.4.1, 4.5.1, 4.6.1, 4.7.1, 4.9.1, 4.10.1, 4.12.1 and 4.12.2 are based on the following standard densities, which are for an air-dried condition of about 15 per cent moisture content:—

Frames Floors	720 kg/m³
Keel Stem Sternpost Deadwood Counter timbers	640 kg/m³
Hull planking Shelves and clamps Stringers Beams and knees Coachroof coamings	560 kg/m³
Deck planking	430 kg/m³

3.2.2 Where the density of the proposed timber differs from the standard density shown in 3.2.1, the tabular siding, s, thickness or modulus, sm^2, is to be increased or decreased by direct proportion in relation to the ratio of the densities, i.e.

Required siding, thickness or modulus =

$$\text{Tabular siding, thickness or modulus} \times \frac{S}{W}$$

where S = the standard density of the timber, in kg/m³
W = the density of the proposed timber, in kg/m³
m = the tabular moulding.

The tabular siding or thickness is, however, not to be decreased by more than 6 per cent, except where specifically allowed.

3.2.3 The scantlings of laminate members are to be based on the density of the natural timber and are not to be corrected for the final density in the laminated condition.

3.3 Laminated timber scantlings

3.3.1 Where the centreline assembly, bilge stringers, beam shelves, chines, frames or beams are of glued laminated construction, the scantlings are to be the same as those determined for solid timber, with the exception of frames and beams as indicated in 5.3.1 and 10.1.3, respectively.

● End of Section

SECTION 4

Centreline structure

4.1 Wood keel

4.1.1 The scantlings of wood keels or, for motor craft, the wood keel and hog are given in Table 4.4.1. The Rule moulding is to be maintained throughout but the siding may be tapered towards the ends where it is to be not less than the Rule siding of the stem or sternpost. The scantlings of craft having deep fin keels will be specially considered.

4.1.2 The rabbet for the garboard strake is to have a faying surface not less than twice the thickness of the garboard strake or, for plywood, as given in Table 4.9.3.

4.1.3 When the length, L, does not exceed 10 m the wood keel is to be in one length. In larger craft, the keel should, where possible, be in one length but when a scarph is necessary in the centreline structure it is to have a length, l, not less than 6 times the moulding, m, of the item. The scarph is to be of the hooked or tabled type if bolted (*see* Fig. 4.4.1), or plain type without lips if glued. The depth of the lips is to be about $\frac{1}{4}$ to $\frac{1}{7}$ of the moulding.

4.1.4 Softwood stopwaters are to be fitted in bolted scarphs in keels and other centreline structure, in way of plank back rabbet and in other positions where considered necessary by the Surveyor. For typical details, *see* Figs. 4.4.2 and 4.4.4.

4.1.5 Scarphs in the keel and hog are to be at least 1,5 m apart and the keel scarph, where fitted, is to be clear of engine seating and, if practicable, of the mast step.

4.1.6 Where the keel is cut for a centreboard the siding is to be increased.

4.1.7 Where a mast passes through the deck, the heel is to be supported by a suitable mast step extending well forward and aft. The step is to be adequately fastened to the floors and to the wood keel.

4.1.8 Where a wood false keel is fitted abaft the ballast keel a suitable scarph or tenon is to be arranged. *See* Fig. 4.4.3.

4.1.9 For size of fastenings, *see* Table 4.4.1.

4.1.10 Structural arrangements in way of centreboard casing will be specially considered.

4.1.11 For ballast keel and fitting internal ballast, *see* Ch 6,4.

4.2 Stem

4.2.1 The scantlings of the stem are given in Table 4.4.1 and are to be uniformly tapered from head to heel. The scantlings at the heel may be required to be increased, depending on the shape of the forefoot, to enable an adequate scarph to the keel to be arranged. *See* Fig. 4.4.4.

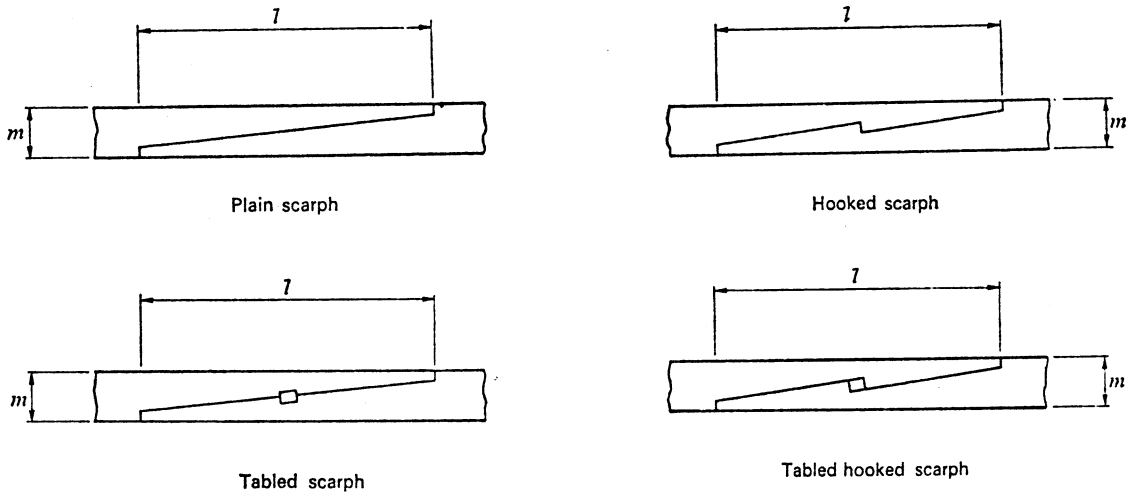


Fig. 4.4.1 Common types of bolted scarphed joints

Table 4.4.1 Keel, hog, stem, sternpost and fastenings for motor, sailing and auxiliary craft

Length, *L*, m	Moulding and siding of keel				Siding and moulding of stem at heel, mm		Siding and moulding of stem at head and sternpost, mm		Diameter of bolts, mm, in	
	Sailing and auxiliary		Motor							
	Moulding, mm	Siding, mm	Minimum siding of keel, mm	Sectional area of keel or keel and hog, cm²	Sailing and auxiliary	Motor	Sailing and auxiliary	Motor	Centreline structure	Keel scarph
6	75	150	70	80	90	75	75	75	10	8
8	90	185	80	130	105	90	90	85	10	8
10	110	220	90	190	120	110	100	95	12	8
12	125	255	105	250	140	125	115	105	14	10
14	140	285	115	310	155	140	125	115	14	12
16	160	320	125	380	170	160	140	125	16	12
18	175	355	140	450	190	175	150	140	18	12
20	195	385	150	520	205	195	165	150	20	14
22	210	410	165	600	220	210	175	160	20	14
24	230	435	180	690	240	230	190	170	20	14
26	245	455	190	770	255	245	200	180	20	14
28	260	470	205	860	270	260	215	190	20	16
30	280	480	220	950	290	280	230	200	22	18

NOTES

1. In motor craft, the moulding of the keel is to be not less than the siding, and the moulding of the hog is to be not less than twice the thickness of the outside planking.
2. The Table scantlings are based on a timber having a standard density of 640 kg/m³ and where timber of a different density is to be used the scantlings are to be modified in accordance with 3.2.2.

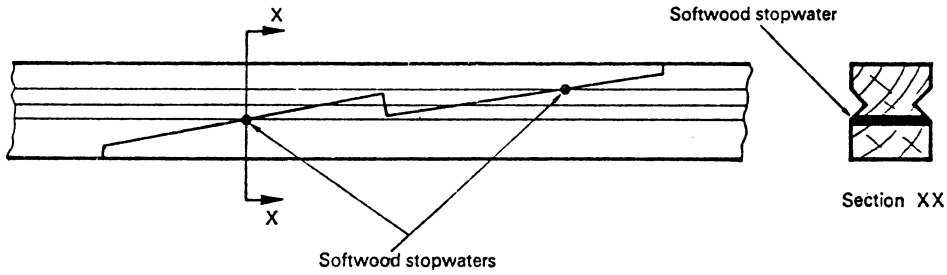


Fig. 4.4.2 Typical hooked keel scarph showing position of stopwaters

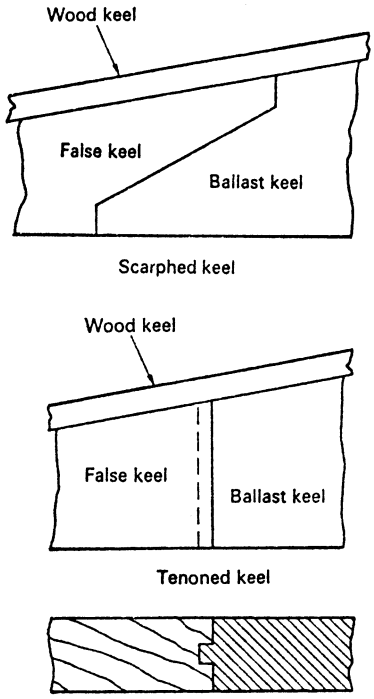


Fig. 4.4.3 Typical connections of ballast keel to false keel

4.2.2 Where the hull form is such that there is a large radius at the stem head a suitable apron (or fashion pieces) is to be provided to give adequate landing for the outside planking.

4.2.3 For size of fastenings, *see* Table 4.4.1.

4.3 Sternpost

4.3.1 The scantlings of the sternpost are given in Table 4.4.1. The sternpost may be tapered to suit the form of the craft but the siding at the after edge of the back rabbet is to be not less than that required by Table 4.4.1 and care is to be taken to ensure there is adequate material to take the fastenings of the outside planking.

4.3.2 The lower end of the sternpost is to be tenoned or half-lapped to the keel. An inside deadwood or knee is to be fitted and adequately through fastened to the sternpost, and false keel, if fitted. *See* Fig. 4.4.5.

4.3.3 For size of fastenings, *see* Table 4.4.1.

4.4 Counter timber

4.4.1 The area of the counter timber at its forward end is to be not less than the Rule area of the sternpost and may gradually be reduced to 75 per cent of this area at its after end.

4.4.2 The counter timber is to be securely fastened to the sternpost and it is recommended that, where practicable, the sternpost should be tenoned or scarphed to the counter timber and through fastened.

4.4.3 For size of fastenings, *see* Table 4.4.1.

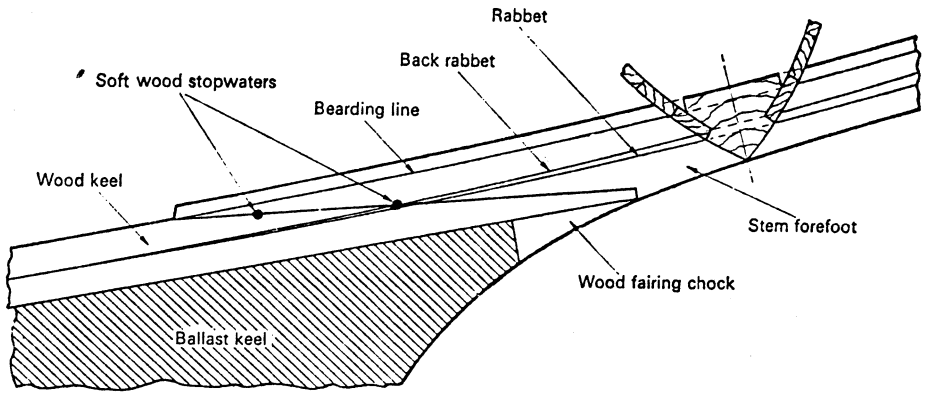


Fig. 4.4.4 Typical scarph connecting stem to wood keel

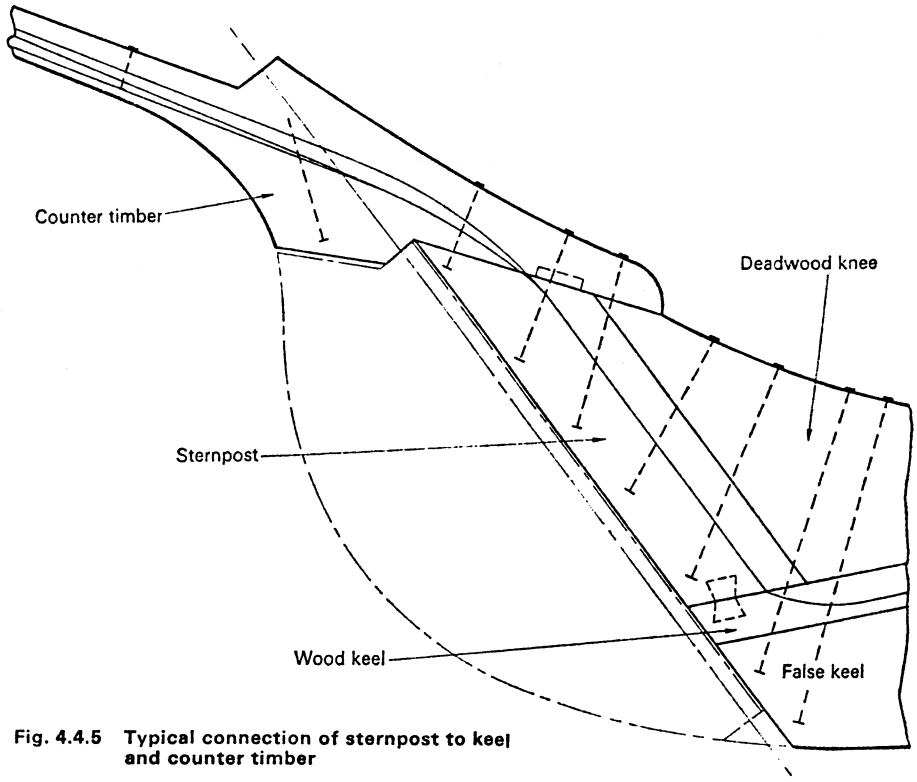


Fig. 4.4.5 Typical connection of sternpost to keel and counter timber

● End of Section

SECTION 5
Framing

5.1 General

5.1.1 The hull is to be provided with an efficient system of side and bottom framing in conjunction with stringers, bulkheads or web frames to provide transverse ridigity.

5.1.2 The framing may be arranged transversely or longitudinally or may be a combination of both.

5.1.3 All frames are to be bevelled or formed to fay closely against the planking.

5.1.4 Where the heels of frames terminate at the centre-line construction members they are to be let into and fastened to them unless floors are fitted at every frame.

5.2 Types of frames

5.2.1 The following types of frames may be used, subject to the limitations given in 5.2.3 and 5.2.4:—

Type 1 Bent frames only
Type 2 Grown frames only
Type 3 Laminated frames only
Type 4 Steel frames only
Type 5 Grown, laminated or steel frames with 1 bent frame between
Type 6 Grown, laminated or steel frames with 2 bent frames between
Type 7 Grown, laminated or steel frames with 3 bent frames between

5.2.2 Alternative framing systems to those in 5.2.1 will be specially considered.

5.2.3 The use of Type 1 is to be confined to craft having a depth, D, not exceeding 3,0 m for sailing and auxiliary or 2,7 m for motor craft, and Types 5, 6 and 7 are to be confined to depths, D, not exceeding 3,6 m and 3,0 m, respectively.

5.2.4 Where the depth, D, exceeds 3,6 m for sailing and auxiliary craft or 3,0 m for motor craft the framing must be Type 2, 3 or 4.

5.3 Scantlings

5.3.1 The scantlings and spacing of the various types of frames are given in Table 4.5.1.

5.3.2 Where the actual frame spacing of timber frames differs from that given in Table 4.5.1 the strength of grown, bent or laminated frames is to be modified in direct proportion, i.e.

$$\text{Actual } (sm^2) = \text{Table } (sm^2) \times \frac{\text{actual spacing}}{\text{Table spacing}}$$

where s and m are the siding and moulding, respectively; the Table siding is to be that after correction for density. *See* 3.2.2.

5.3.3 In no case is the mean moulding of grown, bent or laminated frames to be less than two-thirds of the actual siding except where an increase in the siding is required by 5.3.6. In all cases the siding is to be suitable for the required fastenings.

5.3.4 Where the spacing of steel frames differs from that given in Table 4.5.1 the section modulus is to be modified in direct proportion.

5.3.5 The scantlings determined from Table 4.5.1 are to be maintained for $\frac{3}{5}L$ amidships. Forward of and abaft this region the following reductions may be made:—

Bent or laminated frames	Siding reduced by 10 per cent.
Grown frames	Moulding at heel and siding at head and heel reduced by 20 per cent.
Steel frames	Thickness reduced by 10 per cent.

5.3.6 In sailing and auxiliary craft the framing adjacent to the mast is to be increased each side as given below or equivalent arrangements provided:—

Type 1: Bent frames only — Three grown or laminated frames of Type 2 or 3 scantlings (*see* Table 4.5.1) are to be fitted or, alternatively, the siding of three bent frames increased by 60 per cent.

Type 2: Grown frames only
Type 3: Laminated frames only
— The siding of three frames increased by 50 per cent.

Table 4.5.1 Frames for motor, sailing and auxiliary craft (*see continuation*)

Depth, D, m		Type 1 Bent wood frames only			Type 2 Grown frames only				Type 3 Laminated frames only		
						Moulding, mm					
Motor	Sailing and auxiliary	Siding,	Moulding,	Frame spacing,	Siding,	at heel	at head	Frame spacing,	Siding,	Moulding,	Frame spacing,
		mm	mm	mm	mm			mm	mm	mm	mm
1,5	1,8	24	19	155	24	31	24	205	25	25	205
1,8	2,1	34	25	170	34	40	31	230	31	34	230
2,1	2,4	40	30	185	42	50	37	255	37	43	255
2,4	2,7	48	36	200	52	61	46	280	43	51	280
2,7	3,0	56	40	215	62	74	55	305	50	61	305
3,0	3,3	65	45	230	72	87	65	330	57	74	330
3,3	3,6	—	—	—	81	100	80	355	62	87	355
3,6	3,9	—	—	—	90	117	98	380	69	105	380
3,9	4,2	—	—	—	100	140	117	405	78	126	405

NOTES

1. For limitation on use of Types 1, 5, 6 and 7, *see* 5.2.3 and 5.2.4.
2. The Table scantlings of timber frames are based on a timber having a standard density of 720 kg/m³, and where timber of a different density is to be used the scantlings are to be modified in accordance with 3.2.2.
3. The frame spacing given in the Table is measured from centre to centre or, for steel frames, from heel to heel of angles.

Type 4: Steel frames only	Reverse angles or face flats of the size required for plate floors are to be fitted on two frames if D does not exceed 3,3 m or on three frames when D is 3,3 m or greater.
Types 5, 6 and 7: Grown, laminated or steel frames with bent frames between	The siding of three grown or laminated frames increased by 50 per cent or reverse angles or face flats fitted to three steel frames.

5.3.7 Where internal ballast is fitted the frames may be required to be increased in strength.

5.4 Grown frames

5.4.1 Grown frames are to be cut to shape from timber having the required curvature of grain.

5.4.2 The siding of each grown frame is to be uniform over its length and the moulding is to be a fair taper from heel to head.

5.4.3 Grown frames may be butted or scarphed. Scarphs are to be glued and have a length not less than 6 times the siding. Where frames are butted, the butts are to be close fitted and side clamps arranged. The clamps are to have a sectional area not less than that of the frame and a length not less than 12 times the frame siding. The clamp is to be through fastened to the frame by not less than three fastenings on each side of the butt and is to fay closely to the planking.

5.5 Bent frames

5.5.1 The siding and moulding of bent frames are to be uniform over the length of the frame. Each frame is to be in one piece from keel to gunwale and, where the form is suitable, may be continuous from gunwale to gunwale.

5.6 Laminated frames

5.6.1 The timber and glue used in laminating frames are to be as required by 2.5.

5.7 Frames for cold moulded laminated hull

5.7.1 Where cold moulded laminated hull construction is adopted and the skin thickness is in accordance with 9.1.4 the spacing of the frames may be increased and the scantlings will be specially considered.

Table 4.5.1 Frames for motor, sailing and auxiliary craft (*conclusion*)

Type 4 Steel frames only			Types 5, 6 and 7 Combinations of grown, laminated and steel frames with intermediate bent wood frames					Depth, D, m	
Frame		Frame spacing,	Intermediate bent wood frame		Spacing of grown, laminated or steel frames, mm				
Scantling,	Modulus,		Siding,	Moulding,	One bent frame between Type 5	Two bent frames between Type 6	Three bent frames between Type 7	Motor	Sailing and auxiliary
mm	cm^3	mm	mm	mm					
30 × 30 × 3	0,7	205	25	20	365	470	545	1,5	1,8
30 × 30 × 3	0,8	230	31	23	405	505	580	1,8	2,1
35 × 35 × 4	1,2	255	37	26	440	540	620	2,1	2,4
45 × 45 × 4,5	2,0	280	40	29	475	580	655	2,4	2,7
50 × 50 × 5	3,0	305	43	33	515	620	695	2,7	3,0
60 × 60 × 5,5	4,9	330	47	37	565	665	745	3,0	3,3
65 × 65 × 8	7,9	355	50	43	620	725	800	3,3	3,6
75 × 65 × 8,5	11,5	380	—	—	—	—	—	3,6	3,9
85 × 65 × 8,5	14,6	405	—	—	—	—	—	3,9	4,2

4. Where the spacing differs from that given in the Table, the value of sm^2 (or, for steel frames, the section modulus) is to be modified in direct proportion.
5. Where Types 5, 6 and 7 are adopted, the scantlings of the grown, laminated, or steel frames are to be as required for Types 2, 3 or 4, respectively.

● End of Section

SECTION 6
Floors

6.1 General

6.1.1 Wood floors are to be cut from timber having a suitable grain or may be laminated.

6.1.2 Where, at the ends, the frames are continuous across the centreline structure, floors are not required but, where practicable, the frames are to be attached to the centreline structure by two through fastenings.

6.1.3 Limber holes are to be provided in the bottom structure as required for efficient drainage of the craft.

6.2 Type of floors

6.2.1 The type of floor to be fitted is dependent on the frame type adopted as follows:—

Type 1: Bent frames only	(a) Strap floors on every frame within $\frac{3}{5}L$ amidships (on alternates if D does not exceed 2,7 m for sailing and auxiliary craft or 2,4 m for motor craft) and on every third frame forward and aft.
	(b) Angle floors spaced as for strap floors in (a).
	(c) Where $\frac{3}{5}L$ amidships falls within the waterline length floors are to be on alternates to end of waterline.
	(d) The fitting of wood floors in association with bent frames will be specially considered.
Type 2: Grown frames only Type 3: Laminated frames only	(a) Wood floors on every frame. (b) Steel floors on every frame. (c) Strap floors on every frame. (d) Angle floors on every frame.
Type 4: Steel frames only	(a) Steel plate floors at every frame.
Types 5 and 6: Grown, laminated or steel frames with 1 or 2 bent frames	(a) On grown and laminated frames as for Type 2. (b) On steel frames as for Type 4. (c) On bent frames as for Type 1 within $\frac{3}{5}L$ amidships. If D does not exceed 2,4 m no floors are required on bent frames outside $\frac{3}{5}L$ amidships.
Type 7: Grown, laminated or steel frames with 3 bent frames	(a) As for Types 5 and 6 but a floor as required for Type 1 is to be fitted to the middle bent frame.

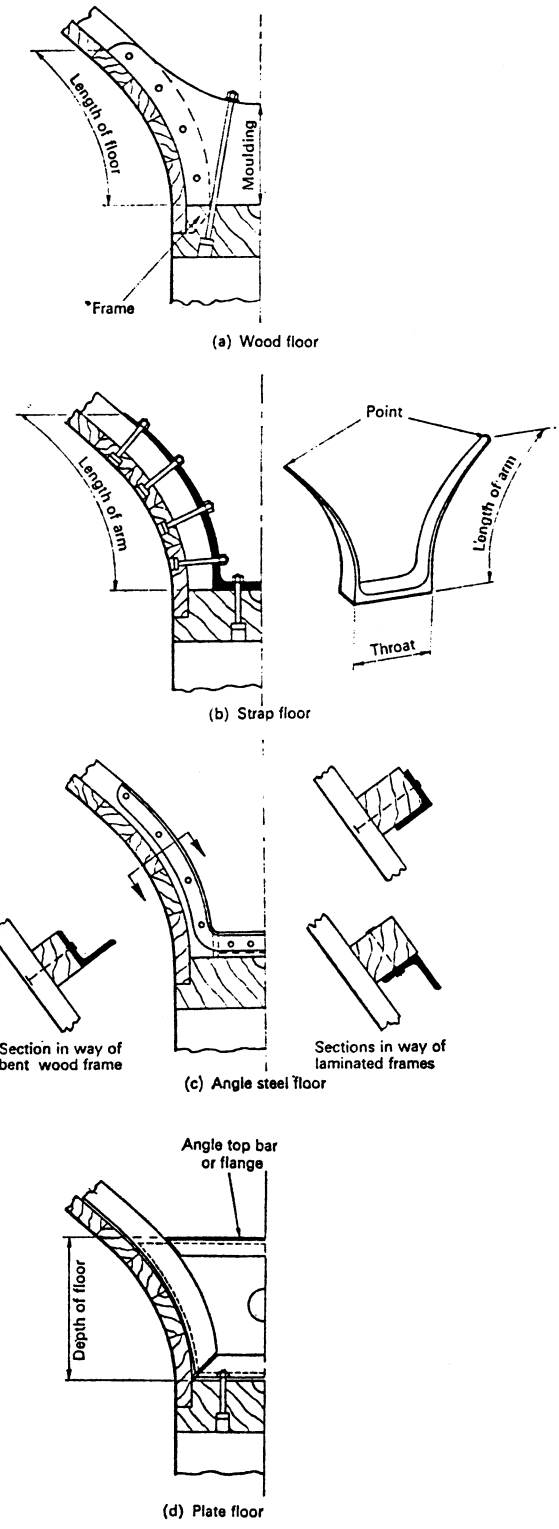


Fig. 4.6.1 Typical floors

*To be checked into centreline member where required by 5.1 4.

6.3 Scantlings and construction

6.3.1 The scantlings of floors are to be as given in Table 4.6.1 and the lengths of arms, etc., are to be measured as shown in Fig. 4.6.1. At the ends of the craft the length of arms need not exceed one-third the length of the frame.

6.3.2 The cross-sectional area at the ends of the arms is to be not less than half that given in Table 4.6.1 for the middle line.

6.3.3 Where bolts attaching the ballast keel pass through wood floors, the siding of the floors for the breadth of keel is to be not less than $3\frac{1}{2}$ times the bolt diameter. It may be tapered to the Rule siding at the ends of the floors.

6.3.4 Angle steel floors are to be fitted on top of bent frames and it is recommended that this arrangement be adopted when angle floors are fitted to grown frames.

6.3.5 Where angle floors are fitted to grown frames it is recommended that they be fitted so that the frame fits into the bosom of the angle with a lug fitted to take the throat fastening.

Table 4.6.2 Floor fastenings for motor, sailing and auxiliary craft

Depth, *D*, m		Diameter of bolts in throat, mm		Diameter of bolts at arms, mm	
Motor	Sailing and auxiliary	Grown, laminated or steel frames	Bent frames	Grown, laminated or steel frames	Bent frames
1,5	1,8	8	6	6	6
1,8	2,1	10	8	8	6
2,1	2,4	12	8	8	6
2,4	2,7	12	10	10	8
2,7	3,0	14	12	12	8
3,0	3,3	18	12	12	10
3,3	3,6	20	12	12	10
3,6	3,9	20	—	14	—
3,9	4,2	20	—	16	—

NOTES

1. Throat to keel: not less than 2 bolts (*see* 6.4.3).
2. Arms to frames: 3 bolts when arm length does not exceed 250 mm,
   4 bolts when arm length exceeds 250 mm.

6.3.6 Steel plate floors are to be stiffened at the upper edge with a reverse angle, face flat or a flange having the same breadth as the Rule angle. The thickness of flanged floors is to be increased by 10 per cent. The bottom angle in way of the keel is to be 2,5 mm thicker than the floor, and its flange is to be sufficient to take the ballast keel bolts or throat fastenings.

Table 4.6.1 Floors for motor, sailing and auxiliary craft

Depth, *D*, m		Floors on grown or laminated frames							Floors on bent wood frames				Steel plate floors on grown or steel frames, mm	
		Length of arms, mm		Strap floors, mm		Wood floors at middle line		Steel angle bars, mm	Length of arms, mm	Strap floors, mm		Steel angle bars, mm		
Motor	Sailing and auxiliary	For $\frac{1}{4}L$ amidships	Beyond $\frac{1}{4}L$ amidships	At throat	At point	Moulding, mm	Siding, mm			At throat	At point		For $\frac{1}{4}L$ amidships	At ends beyond $\frac{1}{4}L$ amidships
1,5	1,8	380	250	25 × 10	20 × 10	55	25	30 × 30 × 5	250	25 × 6	15 × 6	25 × 25 × 5	150 × 3	110 × 3
1,8	2,1	430	300	35 × 13	30 × 10	75	35	35 × 35 × 5	300	25 × 9	17 × 6	25 × 25 × 5	190 × 3	140 × 3
2,1	2,4	480	350	45 × 16	40 × 10	95	45	45 × 45 × 5	350	25 × 12	19 × 6	30 × 30 × 5	230 × 4	170 × 4
2,4	2,7	530	390	50 × 19	45 × 10	115	55	50 × 50 × 5	390	27 × 12	21 × 6	35 × 35 × 5	260 × 4	190 × 4
2,7	3,0	580	430	55 × 22	50 × 12	135	62	55 × 55 × 6	430	29 × 15	24 × 6	40 × 40 × 4	280 × 4	210 × 4
3,0	3,3	630	480	62 × 25	53 × 14	155	70	65 × 65 × 7	480	32 × 16	26 × 6	40 × 40 × 4	300 × 5	230 × 4
3,3	3,6	680	530	70 × 28	56 × 16	170	80	75 × 75 × 7	530	35 × 17	29 × 6	40 × 40 × 4	320 × 5	240 × 4
3,6	3,9	730	570	75 × 31	60 × 18	185	90	80 × 80 × 7	—	—	—	—	340 × 6	250 × 5
3,9	4,2	780	620	80 × 31	63 × 20	200	100	90 × 75 × 7	—	—	—	—	360 × 6	260 × 5

NOTE

1. The Table scantlings of timber floors are based on a timber having a standard density of 720 kg/m³ and where timber of a different density is to be used the scantlings are to be modified in accordance with 3.2.2.

6.3.7 In the machinery space of motor craft, steel plate floors are to be stiffened at the upper edge with a face flat and the thickness of the floors increased by 1 mm above that required by Table 4.6.1.

6.4 Fastenings

6.4.1 The size of the floor fastenings are to be as given in Table 4.6.2.

6.4.2 There are to be not less than three fastenings in each arm where the length of arm does not exceed 250 mm or four when the arm is 250 mm or greater.

6.4.3 The throat is to be attached to the wood keel by not less than two through bolts where practicable.

● End of Section

SECTION 7

Beam shelf and clamp, bilge stringers, breast hooks and bottom girders

7.1 Beam shelf

7.1.1 The cross-sectional area of beam shelf for $\frac{3}{5}L$ amidships is to be as given in Table 4.7.1. Outside this length the area may be gradually reduced to the ends where it may be 25 per cent less than that amidships.

7.1.2 The area of beam shelf determined from Table 4.7.1 is to be that clear of beams; the section removed for the beam end is not to impair the efficiency of the shelf.

7.1.3 Where the beam shelf is not fitted in one length, a plain glued scarph is to be arranged. Scarphs are to be suitably positioned in relation to joints in other longitudinal members and to hanging knees, etc. The face of the scarph is generally to be in the vertical plane.

7.1.4 Where there is a raised deck, it is recommended that the main beam shelf be carried to the ends. Where, however, this is not done suitable arrangements are to be made to maintain the longitudinal continuity of the shelf, and the frame scantlings in way may be required to be increased.

7.1.5 The beam shelf is to be attached to each frame by one through fastening where the moulding of the shelf does not exceed 180 mm and by two through fastenings where the moulding exceeds 180 mm. The size of fastenings is given in Table 4.7.1.

7.1.6 Where the framing is of Type 5, 6 or 7 (*see* 5.2.1), chocks are to be fitted between the intermediate bent frames and the shelf.

7.1.7 Lugs are to be fitted to steel frames to take the shelf fastenings.

7.1.8 Where steel frames are fitted in association with steel beams, a beam shelf is not required but a deck stringer plate, a sheerstrake and a stringer angle of the scantlings 10.2 are to be fitted. Beam knees are also to be provided in accordance with 10.5.

7.1.9 For size of fastenings, *see* Table 4.7.1.

7.2 Beam clamp

7.2.1 In way of the mast in sailing and auxiliary craft, a clamp is to be fitted to the inboard side of the shelf with its upper surface faying closely to the under side of the beams. Alternatively the clamp may be fitted below the shelf and it is to fay closely to the shelf and to the frames.

7.2.2 The length of the clamp is generally to be not less than the breadth of the craft in way of the mast, and its cross-sectional area is to be not less than 75 per cent of the beam shelf area at the centre and may be tapered to 50 per cent of this section at the ends.

7.2.3 The clamp is to be through fastened to the beams or frames as appropriate.

7.2.4 Where steel construction is adopted, *see* 10.5.6.

7.3 Bilge stringer

7.3.1 A bilge stringer is to be fitted where the framing is Type 1 (bent only) or Type 7 (three bents between grown, laminated or steel), or where the length, L, exceeds 9,0 m for Types 2, 3, 5 and 6. For steel construction (Type 4), *see* 7.3.9.

7.3.2 The cross-sectional area of bilge stringers for $\frac{3}{5}L$ amidships is to be as given in Table 4.7.1. Outside this length the area may be gradually reduced to the ends where it may be 25 per cent less than amidships. The greatest dimension of the stringer is to be fitted against the frames.

7.3.3 Scarphs in the port and starboard stringers are to be staggered and suitably positioned in relation to joints in other members. The face of the scarph in the stringer is to be cut parallel to the frames.

7.3.4 Stringers are to be attached to each frame by one through fastening where the moulding of the stringer does not exceed 180 mm and by two through fastenings when the moulding exceeds 180 mm.

7.3.5 Where the framing is of Type 5, 6 or 7 (*see* 5.2.1), chocks are to be fitted between the intermediate bent frames and the stringer.

7.3.6 Lugs are to be fitted to steel frames to take the stringer fastenings.

7.3.7 As an alternative to the fitting of a bilge stringer two or more side stringers may be fitted. Where two side stringers are fitted the cross-sectional area of each is to be not less than 60 per cent of the Rule area for the bilge stringer.

Table 4.7.1 Beam shelf and bilge stringer scantlings and fastenings for motor, sailing and auxiliary craft

Length, *L*, m	Cross-sectional area of beam shelf, cm²		Cross-sectional area of bilge stringer, cm²		Diameter of bolts, mm, in			Steel side keelson and bilge stringer angles, mm
	Sailing and auxiliary	Motor	Sailing and auxiliary	Motor	Arms of breast hooks	Beam shelf stringers	Hanging knees	
6	29	32	25	22	8	6	6	—
8	40	40	32	29	8	6	6	—
10	50	50	40	35	8	6	6	—
12	70	60	50	50	10	8	8	—
14	90	80	65	60	12	8	8	60 × 60 × 4,0
16	110	100	80	70	12	8	8	60 × 60 × 5,5
18	130	110	90	85	12	10	10	65 × 65 × 6,5
20	150	130	105	100	14	12	12	75 × 65 × 5,5
22	170	150	120	110	14	12	12	75 × 65 × 6,5
24	190	170	140	125	14	12	12	75 × 65 × 7,0
26	220	190	160	140	14	12	12	90 × 65 × 5,5
28	250	210	175	150	16	12	12	90 × 65 × 6,0
30	280	240	190	165	18	14	14	90 × 65 × 6,5

NOTE
1. The Table scantlings for the beam shelf and bilge stringer are based on a timber having a standard density of 560 kg/m³ and where timber of a different density is to be used the scantlings are to be modified in accordance with 3.2.2.

7.3.8 For size of fastenings, *see* Table 4.7.1.

7.3.9 For bilge stringers, etc., in steel construction, the arrangements are to be as follows:—

(a) Where the framing is Type 4 (steel frames) a bilge stringer is to be fitted where the depth from top of floor to deck at side amidships exceeds 2,4 m unless a cabin deck is fitted.
(b) A side keelson is to be fitted when the half-breadth at the top of the floor amidships exceeds 2,4 m.
(c) The scantlings of the bilge stringer and side keelson are given in Table 4.7.1. These are to extend as far forward and aft as practicable.
(d) Bilge stringers and side keelsons are to be welded to the frames or attached by frame lugs with not less than two rivets.

7.4 Breast hooks

7.4.1 The beam shelf and stringer ends are to be efficiently attached to the centreline construction. Breast hooks and transom quarter knees are to be fitted as necessary.

7.4.2 The ends of the craft are to be suitably strengthened, and particular attention is to be given to this where there is a large overhang.

7.4.3 For size of fastenings, *see* Table 4.7.1.

7.5 Bottom girders

7.5.1 The engine seatings are to be of substantial construction to suit the power of the machinery.

7.5.2 The longitudinal girders forming the engine seatings are to extend as far forward and aft as practicable and are to be adequately supported by transverse floors and/or brackets.

7.5.3 Additional side girders may be required in the machinery space and in the bottom of the craft forward.

● End of Section

SECTION 8

Bulkheads

8.1 General

8.1.1 Watertight bulkheads are to be provided in accordance with Ch 6,1.2.

8.1.2 The scantlings of wood bulkheads will be specially considered depending on the method of construction.

Table 4.8.1 Bulkhead plating and stiffeners for motor, sailing and auxiliary craft

Bulkhead plating and spacing of stiffeners			Stiffeners with free ends					
Depth of bulkhead at middle line below upper deck, m	Thickness of plating, mm	Spacing of stiffeners, mm	Overall length of stiffener, m	Height of upper deck above top of stiffener, m				
				0	0,6	1,2	1,8	2,4
				Modulus, cm^3				
1,5	2,5	300	1,5	2,5	4,6	6,6	8,7	11,0
1,8	3,0	325	1,8	4,8	8,0	11,0	14,0	17,0
2,1	3,5	350	2,1	8,0	13,0	17,0	22,0	27,0
2,4	4,0	375	2,4	13,0	20,0	26,0	33,0	39,0
2,7	4,5	400	2,7	20,0	29,0	37,0	46,0	55,0
3,0	5,0	425	3,0	29,0	40,0	52,0	63,0	75,0
3,3	5,0	450	3,3	40,0	55,0	70,0	85,0	—
3,6	5,5	475	3,6	56,0	75,0	93,0	—	—
3,9	5,5	500	3,9	75,0	98,0	120,0	—	—
4,2	6,0	525	4,2	98,0	125,0	—	—	—
4,5	6,0	550	4,5	125,0	160,0	—	—	—
4,8	6,5	575	4,8	160,0	—	—	—	—

NOTES

1. When the spacing of stiffeners differs from that given in the Table, the thickness of the plating is to be modified at the rate of 0,5 mm for each 100 mm difference in spacing. The modulus of the stiffeners is to be modified in direct proportion to the stiffener spacing.
2. The moduli given in the Table are for unbracketed stiffening sections in association with plating.
3. Where stiffening sections are bracketed at the top and bottom the Table modulus, corrected in accordance with Note 1, is to be multiplied by the factor, F_f, determined from the following formula:—

$$F_f = 0{,}8 - \frac{h}{3{,}75(2h+l)}$$

where h = height of upper deck above top of stiffener, in metres.
l = length of stiffener, in metres.

8.1.3 The scantlings of steel watertight bulkheads are given in Table 4.8.1.

8.1.4 In collision bulkheads the spacing of stiffeners is to be not greater than 460 mm.

8.1.5 At the level of the decks below the upper deck, angles or flats are to be suitably attached to the bulkheads for taking the fastenings of the wood deck.

8.1.6 Steel bulkheads are to be attached to wood frames of the size required for grown frames or to a boundary angle of the size required for steel frames.

● End of Section

SECTION 9

Hull planking

9.1 General

9.1.1 The outside planking may be single skin (carvel or clinker), strip, double skin, single skin plywood or cold moulded laminations.

9.1.2 The thickness for single skin carvel or strip construction is to be as given in Table 4.9.1.

9.1.3 Where the frame spacing differs from that given in Table 4.5.1 the thickness of planking determined from Table 4.9.1 is to be modified as follows:—

Type 1: bent frames 1,5 mm per 25 mm difference
Other frame types 1,5 mm per 38 mm difference

9.1.4 The thickness determined from Table 4.9.1, after correction for frame spacing and, except for plywood, density of timber, may be reduced for the type of planking as follows:—

Clinker	10 per cent
Diagonal double skin	10 per cent
Cold moulded laminate Single skin plywood	The reduction will depend on the framing or stiffening system adopted and will be a maximum of 25 per cent

9.2 Single skin

9.2.1 Butts of the outside planking are to be spaced not less than 1,2 m apart and no butts are to be in the same frame space unless there are three strakes between, *see* Fig. 4.9.1. The arrangement of butts at the ends of the craft is to be to the Surveyor's satisfaction.

Table 4.9.1 Outside and deck planking for motor, sailing and auxiliary craft

Length, *L*, m	Basic thickness, mm	Length, *L*, m	Basic thickness, mm
6	19	20	41,5
8	21,5	22	43,5
10	24	24	45,5
12	28	26	47,5
14	32	28	50
16	36	30	52
18	39		

NOTES

1. The Table thicknesses of outside and deck planking are based on a timber having a standard density of 560 kg/m³ and 430 kg/m³, respectively, and where timber of a different density is to be used the thickness is to be modified in accordance with 3.3.2.
2. For frame and beam spacing corrections, *see* 9.1.3 and 11.1.3, respectively.
3. The basic thicknesses are applicable to single skin carvel or strip outside planking and to a laid deck. For corrections for other types of construction, *see* 9.1.4 for outside planking and 11.1.5, 11.1.6 and 11.1.7 for deck planking.

9.2.2 The butts in the garboard strake are to be kept clear of the keel scarph. Butts in the sheerstrake are to be clear of butts in the covering board.

9.2.3 Butts in the planking are to be strapped or scarphed.

9.2.4 Wood or metal butt straps are to be arranged between the frames but a drainage space is to be left between the strap and the frame. The breadth is to be sufficient to overlap the adjacent planks by about 12 mm.

9.2.5 Wood butt straps are to have the same thickness as the planking. Metal straps are to be not less than $\frac{1}{6}$ of the planking thickness, *see* Fig. 4.9.2.

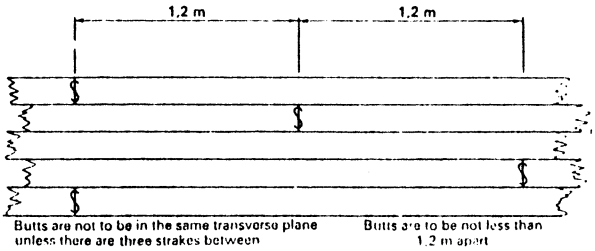


Fig. 4.9.1 Spacing of butts

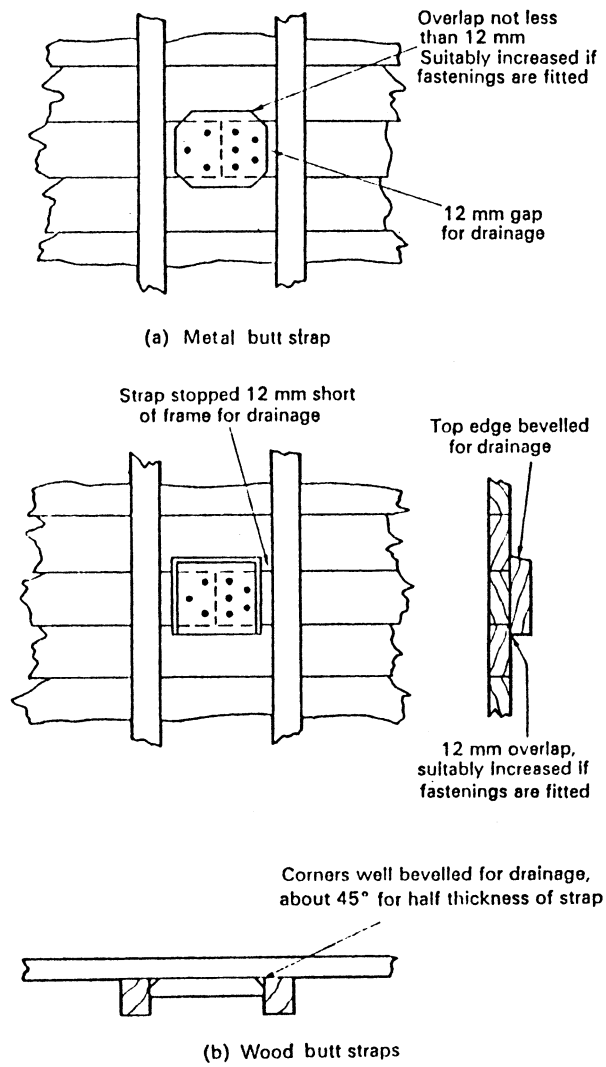


Fig. 4.9.2 Typical butt straps on single skin hull planking

9.2.6 The planking and the straps are to be through fastened. The size of the fastenings is to be as required by Table 4.9.2 for planking to frames, and the number is to be as follows:—

Width of planking, mm	Number of fastenings in each plank end
Under 100	3
100 and under 200	4
200 and under 250	5

9.2.7 The length of a scarph is to be not less than four times the thickness of the planking. The scarph is to be positioned on the frame, and glued and fastened to it.

Table 4.9.2 Fastenings for outside and deck planking in motor, sailing and auxiliary craft

Planking thickness, mm	Size of fastenings										Number of fastenings per plank				
	Outside planking							Deck planking			Width of plank				
	Grown, laminated or steel frames					Bent frames									
	Bolts, Dia., mm	Wood screws Dia., mm	Gauge	Copper boat nails* Size, mm	Gauge	Copper boat nails Size, mm	Gauge	Wood screws Dia., mm	Gauge	Bolts, mm	Under 100 mm	100 mm and under 150 mm	150 mm and under 180 mm	180 mm and under 205 mm	205 mm and under 225 mm
19	5	5	10	4,5	7	2,5	12	4,5	8	5	2	2	3	3	3
20,5	5	5	10	5	6	3	11	5	10	5	2	2	3	3	3
22	6	5	10	6,5	3	3,5	10	5	10	6	2	2	3	3	3
23,5	6	5	10	6,5	3	3,5	10	5	10	6	2	2	3	3	3
25	6	5,5	12	6,5	3	3,5	9	5	10	6	1	2	2	3	3
26,5	6	5,5	12	6,5	3	3,5	9	5,5	12	6	1	2	2	3	3
28	6	5,5	12	6,5	3	4,5	7	5,5	12	6	1	2	2	3	3
29,5	6	5,5	12	6,5	3	4,5	7	5,5	12	6	1	2	2	3	3
31	8	6,5	14	7,5	1	5	6	5,5	12	6	1	2	2	3	3
32,5	8	6,5	14	7,5	1	5	6	6,5	14	8	1	2	2	3	3
34	8	6,5	14	7,5	1	5,5	5	6,5	14	8	1	2	2	3	3
35,5	8	7	16	7,5	1	5,5	5	6,5	14	8	1	2	2	3	3
37	8	7	16	7,5	1	5,5	5	6,5	14	8	1	2	2	2	3
38,5	8	7	16	7,5	1	5,5	5	7	16	8	1	2	2	2	3
40	10	8	18	9,5	3/0	6	4	7	16	8	1	2	2	2	3
41,5	10	8	18	9,5	3/0	6	4	7	16	8	1	2	2	2	3
43	10	8	18	9,5	3/0	—	—	8	18	10	1	2	2	2	3
44,5	10	8	18	9,5	3/0	—	—	8	18	10	1	2	2	2	3
46	12	8,5	20	11	5/0	—	—	8	18	10	1	2	2	2	3
47,5	12	8,5	20	11	5/0	—	—	8	18	10	1	2	2	2	3
49	12	8,5	20	11	5/0	—	—	8	18	10	1	2	2	2	3
50,5	12	10	24	12,5	7/0	—	—	8,5	20	12	1	2	2	2	3
52	12	10	24	12,5	7/0	—	—	8,5	20	12	1	2	2	2	3

*For grown or laminated frames only.

NOTES
1. The diameter of the wood screws given in the Table is the nominal diameter of the unthreaded shank.
2. The gauge of wood screws given in the Table is British Standard Gauge, and that of copper boat nails is Imperial Standard Wire Gauge.

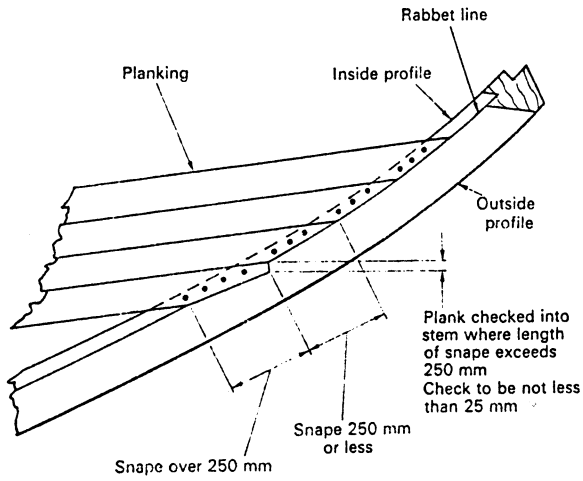


Fig. 4.9.3 Connection of single skin planking to centreline structure (for normal breadth of planking)

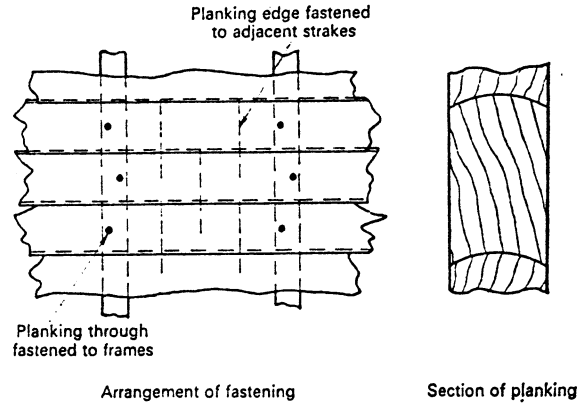


Fig. 4.9.4 Strip planking

9.2.8 In sailing and auxiliary craft, the garboard and adjacent strakes are to be of increased width at the after end to give a reasonable plank run, and the garboard strake is to be in as long a length as possible.

9.2.9 Where, with planks of normal breadth, the length of snaped ends exceeds 250 mm, the planks are to be checked into the centreline structure (*see* Fig. 4.9.3). The size of the fastenings are to be as for the garboard strake (*see* 9.2.11).

9.2.10 When strip planking is adopted, the top and bottom edges are to be rounded and hollowed respectively. Each plank is to be glued and edge fastened to the one below with non-ferrous fastenings. *See* Fig. 4.9.4. Suitable stealer planks may be fitted to suit planking arrangements.

9.2.11 The garboard strakes are to be screw fastened to the keel or hog. The screws are to be of the size required by Table 4.9.2 for outside planking to Type 2 grown frames. They are to be reeled, and are to be spaced not more than twelve diameters apart in each row and are to enter the keel or hog to a depth at least equal to the thickness of the garboard. In way of deadwoods a combination of dumps and screws may be used.

9.2.12 The size and number of fastenings attaching the outside planking to the frames are to be as given in Table 4.9.2. The types of fastenings are dependent on the framing as follows:—

Type 1: Bent frames	All through fastenings
Type 2: Grown frames Type 3: Laminated frames	Through fastenings to be arranged in way of beam shelf, bilge (or side) stringer, and tuck (in a sailing or auxiliary craft). The remainder may be screws
Type 4: Steel frames	Nut and screw bolts
Types 5, 6 and 7: Grown, laminated or steel frames with bent frames between	Bent, as for Type 1 Grown and laminated, as for Types 2 and 3 Steel, as for Type 4

9.2.13 Where frames are increased in way of the mast (*see* 5.3.6), they are to be through fastened throughout.

9.3 Double skin

9.3.1 Double skin planking may be arranged as follows:—

(a) Both diagonal,
(b) Inner diagonal, outer fore and aft,
(c) Both fore and aft.

9.3.2 The outer skin is to be approximately $\frac{3}{5}$ of the total thickness, and the diagonal planking is to be at approximately 45°.

9.3.3 The inner skin is to be either screw or nail fastened to the frames, and the outer skin is to be through fastened to the frames. In arrangements 9.3.1 (a) and (b) through fastenings are to be fitted at the plank crossings, and in 9.3.1 (c) the inner skin is to be screw fastened to the outer between frames. *See* Fig. 4.9.5.

9.3.4 In arrangements 9.3.1 (a) and (b) oiled calico dipped in linseed oil or an equivalent membrane is to be laid between the skins, and in 9.3.1 (c) it is recommended that resorcinol glue be used between the skins.

9.3.5 The arrangement at the gunwale is to be such as to ensure that the covering board can be made watertight. Typical methods are shown in Fig. 4.9.6.

9.4 Cold moulded laminate

9.4.1 In view of the importance of maintaining the correct temperature when the skin is constructed as a cold moulded laminate, the Surveyor is to be satisfied that the Builder's premises and facilities are suitable for this type of construction. *See* 2.1.1.

9.4.2 The material may be a suitable marine plywood or one of the timbers given in Table 4.1.2. The use of other timbers will be specially considered.

9.4.3 The breadth and thickness of the individual layers are to be such that they can be readily laid to the form of the craft, and generally are not to exceed 125 mm and 3,5 mm, respectively.

9.4.4 The number of layers is to be such that their combined thickness is not less than that required by Table 4.9.1 reduced in accordance with 9.1.4. The spacing and scantlings of the frames will be specially considered. *See* 5.7.1.

9.5 Plywood planking

9.5.1 Plywood is to be fitted in as large panels as practicable having due regard to the form of the craft. Panel butts are to be staggered between the bottom, side and deck and arranged clear of the mast, ballast keel and engine seating.

9.5.2 The width of longitudinal seam landings on the centreline structure, chine and gunwale members and on any longitudinal stringers is to be not less than that required by Table 4.9.3. Seams are to be glued and fastened with one or two rows of fastenings (*see* Table 4.9.3), and arranged to give maximum spacing of fastenings of 50 mm.

9.5.3 Butts and seams are to be scarphed or strapped where necessary. The length of a scarph is to be not less than 8 times the hull thickness. The scarph is to be glued and, if made *in situ*, fitted with a backing strap of a width not less than 10 times the hull thickness. The strap is to be glued and fastened to the hull with two rows of fastenings of the size given in Table 4.9.4 and spaced about 8 times the hull thickness.

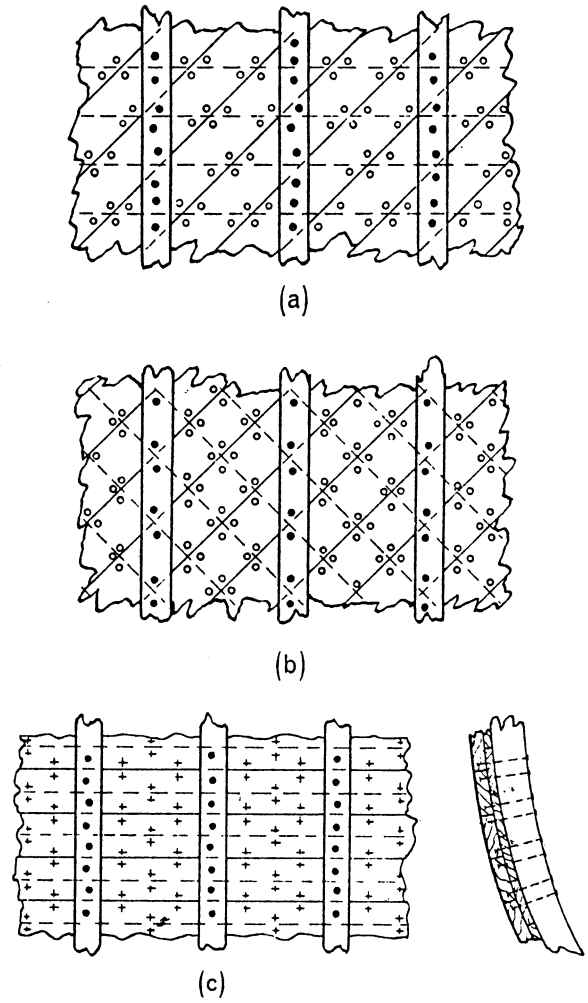


Fig. 4.9.5 Arrangements of fastenings in double skin hull planking

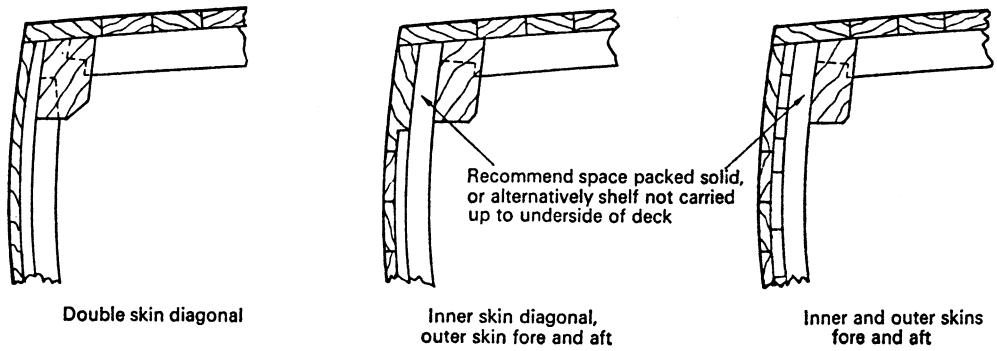


Fig. 4.9.6 Detail of gunwale for double skin planking

Table 4.9.3 Plywood planking: overlaps and fastenings for motor, sailing and auxiliary craft

Plywood planking thickness, mm	Minimum breadth of landing between		Fastenings		
	Hull planking and keel or chine, mm	Hull or deck planking and shelf or longitudinal, mm	Wood screws Gauge	Wood screws Dia., mm	Copper boat nails, gauge
6	25	25	8	4,2	10
8	28 (Single fastened)	28 (Single fastened)	10	4,9	10
10	32 (Single fastened)	32 (Single fastened)	10	4,9	8
13	44	35	12	5,6	8
16	50	44	12	5,6	6
19	57 (Double fastened)	50 (Double fastened)	14	6,3	6
22	63 (Double fastened)	57 (Double fastened)	14	6,3	3
25	63	57	16	7,0	3

NOTES
1. The gauge of wood screws given in the Table is British Standard Gauge, and that of copper boat nails is Imperial Standard Wire Gauge.
2. The diameter of the wood screw is the nominal diameter of the unthreaded shank.

Table 4.9.4 Plywood planking: butts and butt straps for motor, sailing and auxiliary craft

Plywood planking thickness, mm	Breadth of butt strap, mm	Fastenings		
		Wood screws Gauge	Wood screws Dia., mm	Copper boat nails, gauge
6	150 (Double fastened)	8	4,2	10
8	175 (Double fastened)	10	4,9	10
10	200 (Double fastened)	10	4,9	8
13	260 (Double fastened)	12	5,6	8
16	280 (Double fastened)	12	5,6	6
19	330 (Treble fastened)	14	6,3	6
22	355 (Treble fastened)	14	6,3	3
25	380 (Treble fastened)	16	7,0	3

NOTES
1. The gauge of wood screws given in the Table is British Standard Gauge, and that of copper boat nails is Imperial Standard Wire Gauge.
2. The diameter of the wood screw is the nominal diameter of the unthreaded shank.

9.5.4 Butt straps are to be of withgiven in Table 4.9.4 and the same thickness as the hull planking. The strap is to be glued and double or treble fastened to the hull planking. The size of fastenings is to be as given in Table 4.9.4.

9.5.5 The hull planking is to be attached to the frames by fastening. The size of fastening is to be as given in generally not more than 75 mm apart.

9.6 Hull sheathing

9.6.1 Whilist it is not a requirement of the Rules that the outside planking be sheathed, if this is done it must be efficiently carried out to the Surveyor's satisfaction.

9.6.2 Copper sheathing should be bedded on bitumastic treated paper or felt. The sheets are to bve dressed to ensure that the sheathing is in close contact with the bedding. They are to overlap each other by about 22 mm; the vertical laps are to face aft and the horizontal laps are to face upwards. Fastening is to be by coppering nails spaced at not more than 40 mm at the sheet edges. In addition, the panel is to be tack fastened at spacing of not more than 75 mm veritically and 150 mm horizontally. The sheathing is to be stopped short of the rabbet line and a wrapper piece fitted.

9.6.3 Where synthetic sheathing is used, care is to be taken to ensure that the moisture content of the timber is as low as is practicable. All seams and fastening holes to be splined or dowelled or stopped with a compound which is compatible with the manufacturer's recommendations. Wherever possible, the sheathing is to be fitted around the wood keel and deadwood before the ballast keel is fitted.

• End of Section

SECTION 10

Beams

10.1 Scantlings—Timber

10.1.1 The scantlings of ordinary beams, half beams and strong beams are to be not less than those given in Table 4.10.1.

10.1.2 Where the actual beam spacing differs from that given in Table 4.10.1, the strength of ordinary and half beams is to be modified in direct proportion, i.e.

$$\text{Actual } (sm^2) = \text{Table } (sm^2) \times \frac{\text{actual spacing}}{\text{Table spacing}}$$

where s and m are the siding and moulding, respectively; the Table siding is to be that after correction for density. *See* 3.2.2.

10.1.3 Where laminated beams are fitted their siding may be reduced by 15 per cent.

10.1.4 Strong beams are to be fitted at ends of openings when two or more beams are cut. They may also be required to be fitted in way of the mast.

10.2 End attachments

10.2.1 All beams are to be fastened to the shelf by dovetails or dowels. *See* Fig. 4.10.1.

10.2.2 As an alternative to 10.2.1, where a plywood deck is fitted the beams need not be dovetailed or dowelled but may be carried past the shelf and checked over it. The depth of the check is to be about one-quarter of the depth of the beam and the beam is to be screw or dump fastened to the shelf.

10.2.3 Hanging knees are to be fitted as required by Table 4.10.1 and are to be arranged at the mast and other strong beams to give a suitable disposition over the length of the craft.

10.2.4 Hanging knees may be steel straps, flanged plates, angle bar, or grown or laminated timber.

10.2.5 The dimensions of strap hanging knees are given in Table 4.10.1 but at the ends of the craft the length of arms need not exceed one-third of the length of the frame or beam. Angle knees are to have equivalent strength.

Table 4.10.1 Beams and hanging knees for motor, sailing and auxiliary craft (*see continuation*)

Length of beam, m	Spacing of ordinary beams centre to centre, mm	Ordinary beams for $\frac{1}{2}L$ amidships				Ordinary beams beyond $\frac{1}{2}L$ amidships, half beams throughout			
		At middle		At ends		At middle		At ends	
		Siding mm	Moulding mm	Siding mm	Moulding mm	Siding mm	Moulding mm	Siding mm	Moulding mm
1,8	250	30	45	30	30	26	33	26	26
2,1	275	36	53	36	36	32	40	32	32
2,4	300	41	60	41	41	36	45	36	36
2,7	325	46	66	46	46	40	50	40	40
3,0	350	51	72	51	51	43	54	43	43
3,3	375	55	78	55	55	46	58	46	46
3,6	400	59	83	59	59	50	63	50	50
3,9	425	62	88	62	62	53	66	53	53
4,2	450	66	94	66	66	56	70	56	56
4,5	475	69	99	69	69	58	74	58	58
4,8	500	72	103	72	72	61	78	61	61
5,1	525	75	108	75	75	63	82	63	63
5,4	550	79	112	79	79	65	86	65	65
5,7	575	82	117	82	82	67	91	67	67
6,0	600	85	121	85	85	69	96	69	69
6,3	625	88	125	88	88	70	100	70	70
6,6	650	91	130	91	91	71	105	71	71
6,9	675	96	137	96	96	73	112	73	73
7,2	700	102	145	102	102	75	120	75	75

NOTES

1. The length of a wood beam is to be measured amidships to the inside of the beam shelf.
2. The Table scantlings of timber beams are based on a timber having a standard density of 560 kg/m³, and where timber of a

10.2.6 The minimum moulding at the throat of grown or laminated knees is to be 60 or 40 per cent, respectively, greater than that required by Table 4.5.1 for ordinary grown frames at the heel.

10.2.7 Each arm is to be connected to the beam and to the frame by four bolts of the diameter given in Table 4.7.1. The bolts need not pass through the deck or outside planking.

10.2.8 Bulkheads of substantial construction glued and screwed to the beams and frames will be accepted in lieu of hanging knees.

10.2.9 Lodging knees are to be fitted to the beams in way of masts and at ends of deck openings unless a plywood deck is fitted.

10.3 Local reinforcements

10.3.1 The beams and deck are to be suitably strengthened in way of masts, coachroof ends, windlass, cleats, sheet winches, etc. Where a mast is stepped on the deck the structural arrangements will be specially considered.

10.3.2 All deck openings are to be properly framed with carlings fitted to receive the half beams.

10.4 Cabin deck

10.4.1 Where the depth amidships from top of wood keel to top of beam at side amidships is 3 m or greater, cabin deck beams are to be fitted. The strength of these beams is to be at least 60 per cent of that required for upper deck beams, and the beams are to be efficiently attached to the craft's side.

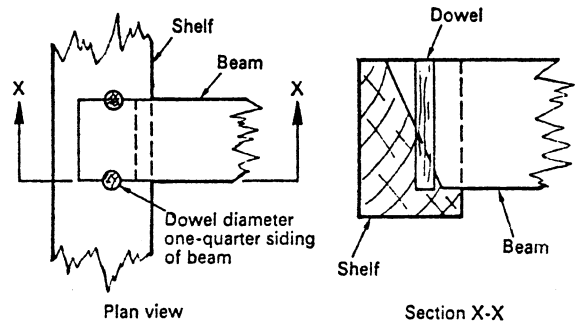


Fig. 4.10.1 Dowel fastening of beam at shelf

Table 4.10.1 Beams and hanging knees for motor, sailing and auxiliary craft (*conclusion*)

Beams in way of masts and at ends of deck openings				Strap hanging knees to deck beams					
At middle		At ends			Length of arms, mm				
Siding mm	Moulding mm	Siding mm	Moulding mm	Number on each side	For $\frac{1}{3}L$ amidships	Beyond $\frac{1}{3}L$ amidships	At throat, mm	At point, mm	Length of beam, m
39	55	39	39	3	300	240	22 × 8	19 × 4	1,8
46	65	46	46	4	325	260	22 × 10	22 × 4	2,1
52	74	52	52	4	350	280	25 × 12	22 × 6	2,4
58	83	58	58	5	375	300	30 × 16	25 × 6	2,7
63	90	63	63	5	400	320	34 × 19	30 × 6	3,0
68	97	68	68	6	425	340	38 × 19	35 × 6	3,3
73	104	73	73	6	450	360	42 × 22	40 × 8	3,6
77	110	77	77	7	475	380	46 × 22	40 × 8	3,9
82	117	82	82	7	500	400	50 × 25	45 × 8	4,2
86	124	86	86	8	525	420	52 × 25	45 × 8	4,5
90	129	90	90	8	550	440	55 × 27	50 × 10	4,8
94	135	94	94	9	575	460	58 × 27	50 × 11	5,1
98	140	98	98	9	600	480	61 × 30	50 × 11	5,4
102	146	102	102	10	625	500	64 × 30	52 × 12	5,7
107	151	107	107	10	650	520	67 × 30	52 × 12	6,0
112	156	112	112	11	675	540	70 × 33	54 × 14	6,3
119	163	119	119	11	700	560	72 × 33	54 × 14	6,6
127	172	127	127	12	725	580	74 × 33	57 × 16	6,9
135	180	135	135	12	750	600	78 × 36	57 × 16	7,2

different density is to be used the scantlings are to be modified in accordance with 3.2.2.

3. Where the beam spacing differs from that given in the Table, sm^2 is to be modified in direct proportion. *See* 10.1.2.
4. The siding of a laminated beam may be reduced by 15 per cent.

SECTION 11
Deck planking

11.1 General

11.1.1 Decks may consist of:—

(a) Laid planks,
(b) Plywood,
(c) Plywood sheathed with a laid deck.

11.1.2 The thickness of laid deck is to be as given in Table 4.9.1.

11.1.3 Where the beam spacing differs from that given in Table 4.10.1, the Table thickness is to be modified at the rate of 1,5 mm per 50 mm difference.

11.1.4 Where teak or other approved timber having a density exceeding 720 kg/m^3 is used the thickness may be reduced by 12 per cent.

11.1.5 Where plywood is used the thickness may be reduced by 30 per cent.

11.1.6 Where plywood is sheathed with a laid deck the combined thickness may be 30 per cent less than the thickness in Table 4.9.1 provided that:—

(a) the combined density of the plywood and sheathing is not less than 430 kg/m^3,
(b) the thickness of the plywood is not less than 30 per cent of the combined thickness and in no case is less than 6 mm, and
(c) where the laid planking is less than 19 mm, the seams are filled with an approved flexible seam compound.

11.1.7 Where the deck is covered with canvas, nylon, glass reinforced plastics or other approved sheathing, the thickness may be reduced by 1,5 mm.

11.1.8 All exposed canvas seams are to be sewn and not overlapped and tacked. Securing of canvas by tacks should be used only where the edges are protected by listings, etc. The canvas is to be suitably bedded to the deck.

11.2 Laid decks

11.2.1 Butts of the deck planking are to be spaced not less than 1,2 m apart and no butts are to be in the same transverse plane unless there are three strakes between. *See* Fig. 4.9.1.

11.2.2 The material for laid decks is to be quarter sawn.

11.2.3 Butts are to be arranged on a beam and are to be of the scarph or caulked lip type unless the siding of the beam is sufficient to allow a caulked square butt to be used. *See* Fig. 4.11.1.

11.2.4 Deck planks are to be attached to the beams by either screw fastenings from above, or side fastening by nails. *See* Fig. 4.11.2.

11.2.5 Where the beam spacing has been increased it may be necessary to fit horizontal dowels in the planking between the beams.

11.2.6 The number and size of screws are to be as given in Table 4.9.2. Deck covering boards are to be screw fastened to the sheerstrake and beams. The screws to the sheerstrake are generally to be spaced not more than 12 diameters apart.

11.2.7 Where steel beams are fitted, the fastenings are to be either nut and screw bolts or round head wood screws fitted from the under side of the beams. The number and size of bolts or screws are to be as given in Table 4.9.2.

11.3 Plywood decks

11.3.1 Plywood decks are to be fitted in panels as large as practicable.

11.3.2 Butts are to be clear of those in the side planking and are not to be placed in the vicinity of the mast. They are to be on a strong beam or are to be strapped.

11.3.3 Seams are to be strapped or scarphed or may be arranged on a longitudinal member having a width sufficient to give a landing of not less than that required by Table 4.9.3. Butts and seams are to be sealed watertight.

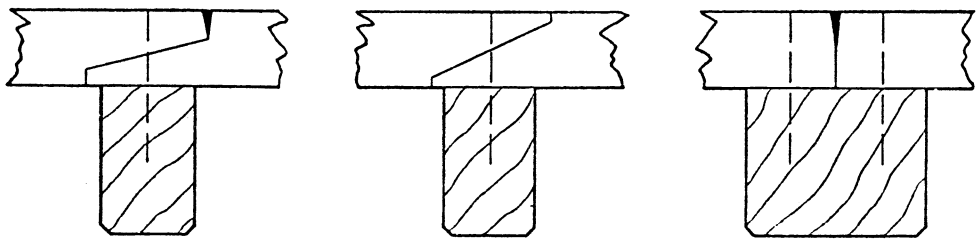
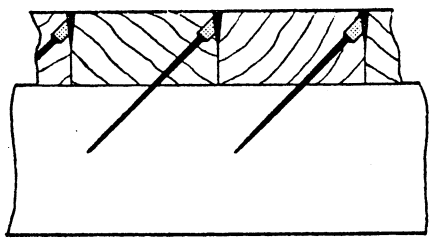


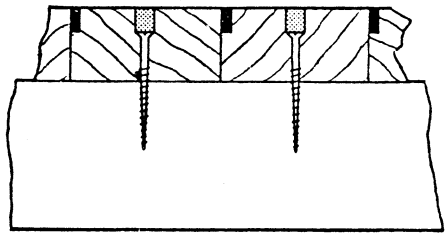
Fig. 4.11.1 Butts of deck planking

11.3.4 Plywood decks are to be glued or bedded to the beams and at the deck edges. They are also to be fastened to the beams and at the edges by screws or barbed nails, as required by Table 4.9.3. The fastenings in seams and butts landing on structural members are to be as required for deck edges. If a strap is fitted, it is to be as required by 9.5.4 for hull plywood planking.

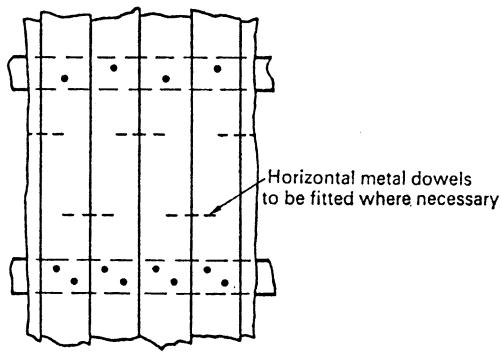
11.3.5 Where plywood decks are laid on steel beams, liners are to be fitted where stringer and tie plates are used. Liners are to be the same width as the beam and the same thickness as the plates.



Secret fastening



Screw fastening



Plan view showing arrangement of single or double fastenings

Fig. 4.11.2 Deck fastenings (laid decks)

11.4 Plywood sheathed with laid deck

11.4.1 Plywood decks sheathed with a laid deck are to comply with the requirements of 11.3.1 to 11.3.3.

11.4.2 Where thickness of the laid sheathing on plywood decks exceeds 50 per cent of the total thickness, the requirements of 11.2.1 and 11.2.2 are to be complied with. The sheathing is to be fastened through the plywood to the beams as for a laid deck. *See* 11.2.4 to 11.2.6.

11.4.3 Where the laid sheathing is less than 50 per cent of the total thickness the butts are to be suitably positioned, and the fastenings may pass through the plywood only and are to be in accordance with 11.3.4.

11.4.4 The laid sheathing is to be glued to the plywood with a resorcinol glue.

11.5 Watertightness

11.5.1 Laid decks are to be caulked and payed or an acceptable deck seaming compound, applied in accordance with the manufacturers' recommendations, may be used. Wood dowels are to be glued.

11.5.2 All weather decks are to be hose tested on completion.

11.6 Deck fittings

11.6.1 Fittings fixed to the deck are to be bedded on a suitable mastic compound to maintain the watertightness of the deck.

11.6.2 It is recommended that in way of heavy fittings such as windlasses, winches, fairleads, etc., the deck planking and the fastening holes be coated with a suitable wood preservative prior to the application of the mastic.

11.6.3 Guard rail stanchions are to be bedded on a suitable mastic compound and are to have not less than three fastenings through the palm, one of which is to be a through fastening.

● End of Section

SECTION 12
Coachroofs and deckhouses

12.1 General

12.1.1 Coachroofs and deckhouses are to be substantially constructed and efficiently connected to the carlings and beams.

12.2 Coachroofs

12.2.1 The scantlings of a coachroof are to be as given in Tables 4.12.1 and 4.12.2.

12.2.2 Where the coachroof deck is of plywood the thickness determined from Table 4.12.1 may be reduced by 30 per cent.

12.2.3 Where plywood is sheathed with a laid deck the combined thickness may be 30 per cent less than the thickness in Table 4.12.1 provided that:—

(a) the combined density of the plywood and sheathing is not less than 430 kg/m³,
(b) the thickness of the plywood is not less than 30 per cent of the combined thickness and in no case is less than 6 mm, and
(c) where the laid planking is less than 19 mm, the seams are filled with an approved flexible seam compound.

12.2.4 If the coachroof deck is covered with canvas or other approved sheathing the thickness determined from Table 4.12.1 may be reduced by 1,5 mm.

12.2.5 Where the coachroof beam spacing differs from that given in Table 4.12.2 the strength of the beams is to be modified in direct proportion and the deck thickness is to be modified at the rate of 1,5 mm per 50 mm difference.

12.2.6 On small coachroofs where it is desired to dispense with beams the deck thickness will be specially considered.

12.2.7 The coachroof and side deck are to be adequately stiffened in way of the mast. Where a mast is stepped on the coachroof the structural arrangements will be specially considered.

Table 4.12.1 Coachroof coaming and deck thicknesses for motor, sailing and auxiliary craft

Length, *L*, m	Coaming thickness, mm	Coachroof deck thickness, mm
6	17	13
8	19	15
10	22	17
12	24	19
14	26	22
16	29	24
18	32	26

NOTES
1. The Table thickness of coachroof coamings and deck are based on a timber having a standard density of 560 kg/m³ and 430 kg/m³, respectively, and where timber of a different density is to be used the thickness is to be modified in accordance with 3.2.2.
2. Where the coachroof coaming or deck is of plywood the Table thickness may be reduced by 30 per cent.
3. If the deck is covered with canvas or other approved sheathing the Table thickness may be reduced by 1,5 mm.
4. Where the beam spacing differs from that given in Table 4.12.2, the deck thickness is to be modified at the rate of 1,5 mm per 50 mm difference.

12.3 Deckhouses

12.3.1 The scantlings of a deckhouse are dependent on the size of the house but the general standard of strength is to be that required for a coachroof and proposals will be specially considered.

Table 4.12.2 Coachroof and deckhouse beams for motor, sailing and auxiliary craft

Length of beam, m	Spacing centre to centre, mm	At middle of beam		At ends of beam	
		Siding, mm	Moulding, mm	Siding, mm	Moulding, mm
1,2	255	28	41	28	28
1,5	280	30	44	30	30
1,8	305	34	48	34	34
2,1	330	38	53	38	38
2,4	355	41	57	41	41
2,7	380	43	60	43	43
3,0	405	44	63	44	44
3,3	430	44	65	44	44
3,6	455	46	68	46	46
3,9	480	48	71	48	48
4,2	505	50	75	50	50

NOTES
1. The Table scantlings are based on a timber having a standard density of 560 kg/m³ and where timber of a different density is to be used the scantlings are to be modified in accordance with 3.2.2.
2. Where the beam spacing differs from that given in the Table, the strength of the beam is to be modified in direct proportion.

● End of Section