

Meaban Construction Sheets

6.8m Trailerable Sloop Yacht

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Sheet 5: Epoxy Impregnation

Benefits of epoxy impregnation

Epoxy impregnation can be done on all parts of plywood, the hull on a small boat or wooden slats, and even applied on all wood components.

The impregnation strengthens surface hardness of wood and forms a barrier against moisture, thereby ensuring greater strength and longevity to the boat and reduces maintenance.

It is strongly recommended in the following cases:

- All pieces of plywood "any okoumé, fairly soft wood and medium sustainability, if not protected.
- Edge protection of plywood, where they are and whatever type of plywood.
- Edge protection in small strips (especially non-laminated) to reduce the effects of humidity variations.
- Preparing surfaces to receive sheathing.
- Surface preparation before paint or varnish, subject to verification of compatibility.

Note that we should not impregnate epoxy wood elements which will then be "oiled" with products such as Deks Olje-oil or teak.

Epoxy is not a flexible material. It is therefore not advisable to use a solid wood structure that works. Traditional systems with oil paint are then more appropriate. If we decide to impregnate epoxy, it should be everywhere, inside and outside, to enclose (encapsulate) the wood completely and minimize the internal humidity variation. This is achievable in practice on light structures and moderate thickness.

Products to use

Epoxy resins are the subject of constant research in their formulation to improve the properties. The best resins for impregnation are very fluid (almost like water), the size of their molecules to penetrate the wood fibers.

Manufacturers offer more specific resins for impregnation (Wood Impreg in Sicomin example).

There is even, especially in Resoltech, resins in aqueous phase (diluted with water), more pleasant to use, low binding on the environmental conditions (temperature, humidity). Note that this only serves to resin impregnation, other products should be used for bonding and lamination.

Except in the case of a boat stored systematically under shelter, or if space is not subject to light (buoyancy tank, accommodations), impregnation will always be covered with a varnish or paint finish, especially to protect Epoxy from a good resistance to ultraviolet rays.

General conditions in using epoxy resins

I only give general advice here which will be supplemented by a careful reading of the documentation of the supplier selected.

- Scrupulously respect the conditions of temperature and humidity requirements. The usual minimum temperature is 18 °C. The maximum humidity is 70%. However, manufacturers are striving to make their products more tolerant. Elevated temperature ensures the fluidity of the resin and good wettability. It is strongly advisable to have a thermometer and a hygrometer in the local construction industry.
- Please note that the temperature should not rise during polymerization. This could create small bubbles. It is better to heat through beforehand (resin, wood, local) and allow the temperature to decrease slowly thereafter.
- Also observe very strictly the proportions of resin and hardener mixture. Weighing a newsletter is a good tool for small quantities. For large containers can be used graduated. There are also metering pumps offered by some suppliers.

We can make a small scale with simple piece of wood hanging from the middle. At each end, a wire loop is disposed to hang a plastic disposable. We use screws or bolts in a glass, resin and hardener in the other. It adds the appropriate number of screws to get the right proportion.

- The mixed resin and hardener is an exothermic reaction. Use flat containers that will prevent a rapid heating of the mixture and reduced working hours. Do not throw the mixture into a trash can that could ignite or leave it in a plastic container which could melt.

Impregnation Procedure

- For plywood, especially if it comes precut (kit), it is highly preferable to perform the impregnation vessel before installation. We work in a horizontal position in less uncomfortable. Obviously it takes a minimum of space!
- For the first impregnation, use a spatula to about 15 cm wide to spread and to penetrate the resin. Then we work on short-nap roller disposable.
- Apply number of coats recommended by the manufacturer with the required spacing layer (which will significantly reduce a tedious sanding). It makes impregnation: Do not apply layers of fat that will create extra thickness difficult to remove and then on which paint or varnish will find it difficult to hang.
- In general, it requires a sequence-paint-varnish impregnation that minimizes the sanding jobs that are large consumers of time and energy and is never pleasant.
- Treat very thoroughly the songs of plywood, especially for hulls lap, with a small brush.

Organization

The work of the epoxy requires good organization and planning, at all of the construction project (we may consider the seasons), as at the retail level. Do not mix when all equipment is ready and available. Keep everything in good clean condition.

Security

Epoxyes are dangerous products (toxicity, allergies). Carefully follow the manufacturer's instructions: cleanliness, ventilation, gloves, masks ...

Sheet 6: Wood Gluing and Epoxy Filleting

Introduction: epoxy resins

Development, relatively recent, epoxy resins has considerably renewed the possibilities of timber construction. Boats plywood or small strips involve impregnation epoxy (sheet 05), collage, often leave the joint, and more or less widespread in the bedding epoxy (sheet 07).

Each manufacturer has its specificities and resin should always read the data sheets that accompany them. We give here only some general rules that will help in selecting products to purchase, then the particular use can be made during the construction of boats on my plans.

Reread the plug 05 (epoxy impregnation) which gives general recommendations for the use of epoxy.

A property of epoxy adhesives is to be satisfied with poor connections to the point sometimes discourage the amateur job well done! But the epoxy is still much more expensive than wood. Always bear in mind that a good wood-epoxy construction should only appeal to moderate consumption of resin.

Bonding

To fill the voids and cavities, while retaining good mechanical properties, are used charges "reinforcing". For bonding, charges are mainly based on microfibers (for filling defects and provide mechanical strength) and colloidal silica (to thicken and prevent runs). These products are offered by manufacturers of resin. You can also, especially in matters of color (and / or economy) get the contents of your bag sander, provided they are of course content.

Attention to the fact that the resin should always penetrate the wood. It is often preferable, especially for plywood scarfs, to impregnate the first parts to be assembled and, after waiting a quarter of an hour, apply with a spatula or brush the resin bonding.

It is not necessary to tighten the parts. He must do enough to avoid non-cavity filled with glue, not too much not to expel all the glue! Use clamps, screws, nails, etc. ... these may be temporary.

Note that the wood has only limited resistance in the transverse to the fibers. The mechanical connections (screws, bolts, rivets) are complementary binding in all essential areas responsible or liable for any shocks.

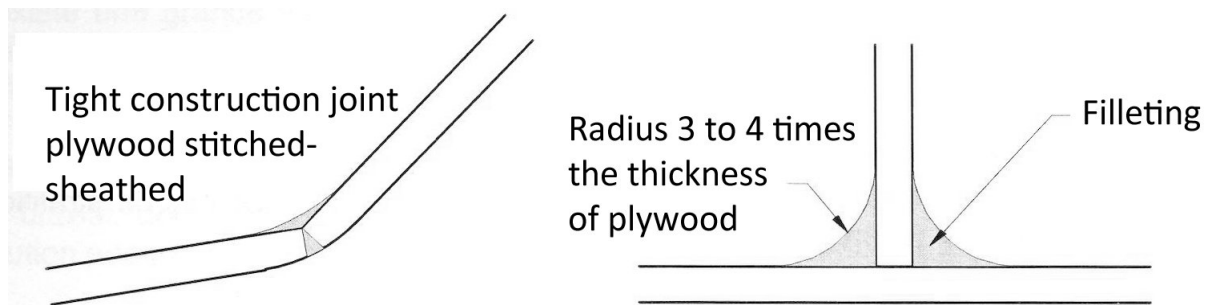
Filleting

The joints can leave strengthen links between two elements when the bonding surface is insufficient to ensure good resistance of the assembly. In practice this removes the piece of wood that is usually used to join two pieces of plywood. The construction file shows the main routes to deal with that. Some will be further strengthened by a local sheathing.

The main use case on my plans are:

- Links-lined walls,
- Liaison between-lined them (sewn-laminate plywood)
- Daggerboard, fund structure,
- Buoyancy tanks.

Do not abuse the filleting, especially in areas visible if you wish to preserve the character "timber" of the boat. They are not always discrete-gloss finish and the generalization of angle "rounded" paintings give the impression that your boat is plastic.



Leave the joint is obtained by adding to the resin of specific charges, or as reinforcing fillers for bonding, or charges "claim" (hollow microspheres). They allow to perform leave "low density" and does not justify a boat where you do a moderate use of filletting.

The application process is:

- Immobilize the parts to assemble,
- Sand, clean, grease, dust,
- Apply sealant or with a spatula or with a thick plastic bag containing the sealant was cut with an angle
- Smooth with a rounded spatula (the radius of the joint to achieve), the back of a spoon, a small piece of PVC pipe ...
- Remove the knife painter protrusions on the periphery.

If the seal is laminated leave, it is best done in the wake (wait until the joint begins to harden).

It is preferable to use a strip of glass fabric biaxial, i.e. whose fibers are oriented at + and - 45 °. If there are only small amounts to do, we can just ordinary cloth cut into strips.

Sheet 07 discusses sheathing wood with epoxy.

Sheet 7: Wood Sheathing

Areas of use

Sheathing wood is used in major cases include:

- Sheathing of outer hulls sewn-plywood laminate
- Sheathing of inner hulls sewn-laminated plywood. In this case, sheathing can be total or limited to bands covering each bilge,
- Sheathing and possibly outer inner hulls into small strips,
- Sheathing of money on flat-bottomed hull (chine or lap)
- Strengthening local sheathing, for example at a butt of plywood, a rudder or a drift of a pole in the area of mast partner, etc ...
- Sheathing on filleting to strengthen a bond (eg lined-partition).
- Repairs.

Function performed as the case is one or more of the following:

- Provide better sealing of the hull,
- Improve resistance to abrasion and impact,
- Increase the mechanical strength of the hull overall or individual (sewn seams, small strips)

Laminating epoxy is transparent provided that they remain in such non-structural layers indicated below. It is quite possible to cover with a painted and have a nice finish, where the presence of the fabric is almost undetectable. There are even specialized epoxy resins, more transparent and UV resistant.

In terms of implementation, two cases arise:

- Surface sheathing, more or less, with a glass fabric,
- Sheathing of a seal with tape.

Choice of resin

The polyester has poor adhesion to the timber. This creates surface tension which over time lead to delamination. The Mirror, this small plywood dinghy English designed and built in 1963 to more than 70,000 copies, was originally in PA sewn polyester laminate. Today it sells repair kits for Epoxy Mirror.

Use a resin suitable for marine use, with good fluidity. Resins sold in hardware stores, often more viscous, generally ill suited to our program.

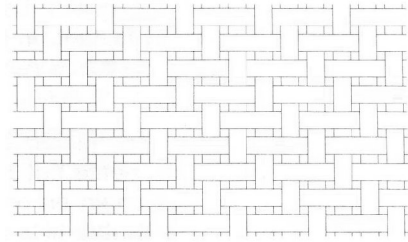
The weight of resin required (excluding pre-impregnation) is 1.3 times the weight of fabric laminating. This ratio, which depends on the products and application conditions is an order of magnitude guide to determine how much to prepare.

Refer to Sheet 05 "Epoxy Impregnation" for general information on epoxy resins. Note that if it's hot, it will be advantageous to use a slower hardener to avoid a long pot life is too short.

Fabric selection

We do that here use on boats whose wood is still the basic structural material. The modern performance fabrics, carbon, Kevlar, more difficult to implement, are not taken into account. In practice, we primarily use the fabric (woven roving) of ordinary glass supply current, called E-glass. In contrast, the "mat" of glass, consisting of non-woven fibers is not appropriate here.

There are a wide variety of fashion weaving (taffeta, twill, satin, biaxial) but again commodities are adequate. Preferring the "serge" whose manner of weaving (design) is a good compromise between strength, flexibility to adapt to the curvature of the hull and ease of implementation.



A biaxial, whose fiber direction is + or - 45 ° is an even better solution if you move.

The thickness is 200 g / m² for a kayak or boat ultra-lightweight, 300 g / m² in the other case, until the goal is a surface protection.

For use in a band, you can simply cut the fabric for a limited application in small quantities. In this case, it is best to cut 45 ° in a twill weave to get something that looks like a biaxial. We can buy tapes, as far as possible biaxial, for a more systematic. The strip biaxial much more flexible, easier to install and wife better angles. It appears that suppliers often offer the biaxial tape obtained by cutting the desired width from a roll of fabric biaxial.

Warning: the tissues of trade are not all suitable for epoxy resin. In other words, you can buy fabric in a DIY shop for all small applications (example: building an end of rowing) but sheathing hull, you'd better buy the fabric from the seller or a resin dealer.

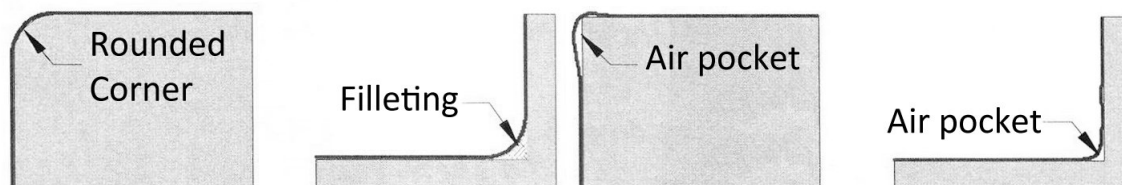
Besides constituting the fabric sheathing itself, one can use a "peel ply." Installed at the end of sheathing, it improves the surface quality and reduces sanding. Of course, it is justified especially for large surfaces and more particularly for a complete sheathing of the hull plating.

Surface preparation for sheathing

Compliance with a rigorous process is essential for obtaining a perfect sheathing, which is normally the goal especially in the case of sheathed outer hull, the finish is varnished or lacquered. A good method also reduces substantially the work of sanding, which is often an important part of work to do and never a cakewalk. The epoxy is hard. If there are protrusions, it will always be painful to remove.

Some precautions must be taken prior to sheath before:

- Round all corners, otherwise the stiffness of the fabric will create air pockets without resin.



- On one edge, the book raises appendages, fake bowling slats protection, soft strips, etc. ... that will be done after sheathing.
- Gaps are, and even coat, then sand the surface irregularities, if any.
- Although sand the laminate surface and finish with a good dusting.
- Conduct a pre-impregnation. The aim is that the laminating resin is not absorbed by the wood, what would happen especially with some media, especially Okoume plywood or cedar. If it was made from the start (soak pieces of plywood at the start of construction), so much the better. If not immediately precede the infiltration sheathing as described below.

Prepare sheathing

We describe here the particular case of sheathed hull plating. The other cases, generally simpler, can be deduced.

We assume of course that the boat is upside down. Note that if the vessel size permits, you can tilt the hull by an edge then the other. It is indeed easier to work on near horizontal surfaces than on vertical surfaces where the resin flows.

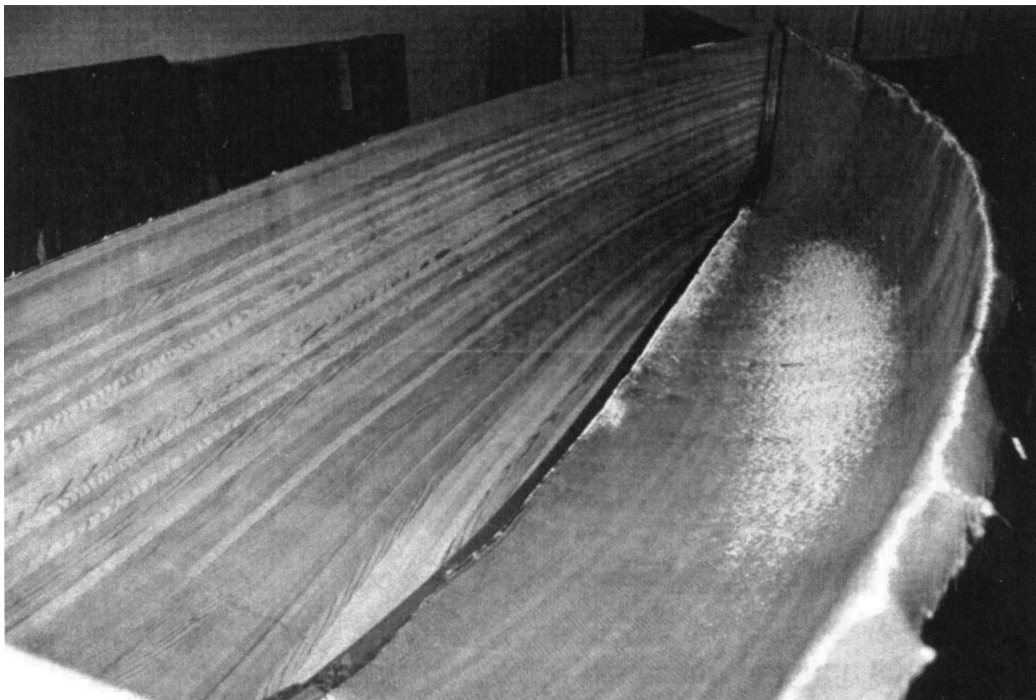
By presenting them on the spot, cut in advance of fabric with margins at the periphery. On a small hull, there will be a piece by side and one for the table. On a single-chine hull we can put a seal near the bilge. For larger hulls, it will take several parts in the length of the boat with seals. Roll and cut pieces, labeled and ready to serve.

Once lamination is complete, the parts will be cross-checked to achieve a seal, edge to edge without overlapping. The seal should never be on a very rounded or near a corner. For a chine, or the table, the connection will be at 3 cm from the angle. Note that if the sheathing contributes to the structural strength, it will be overlap joints, the price of a working coating and additional sanding.

At the bow part of one of the edges will circle back to a few cm back on the opposite side. If the vessel has reported a false stem, glued laminated or solid wood, we can even stop the sheathing at the rabbet line. This preserves the angularity of the bow of a classic wooden boat will be protected by a soft metal band.

Note that for a drift or a rudder, we can do overlap the fabric at the edges that are subject to heavy wear.

All necessary materials (brushes, rollers, debubblers, cutters, peel ply, disposable gloves, ...) to the bedding should be ready before starting to mix the resin. Similarly, think carefully about the order of operations to implement. The pot life of the resin being short, it is important not to waste time once the sheathing has begun. Whenever possible two to do the job (and even more on a big boat).



Presentation of the fabric before sheathing on a small slats Aber

Sheathing procedure

Apply a layer of resin. If the timber has not previously been impregnated and the resin is absorbed as to become dull, and let harden before sanding again. If sanding does not seem essential to a good finish, we can apply a second coat of resin on the heels without waiting for final set (also refer to the instructions from the resin supplier), but we take more risk and it is better to reserve this option when you already have some experience.

If the surface remains shiny after application of the resin, laying the fabric and applied to the roller (preferably models sold specifically for laminating epoxy). Tissue arises preferably starting from the keel and going to the first. Attention is the trickiest part. One can use a brush to spread the wallpaper to fabric. The more hands to manipulate the fabric, the better. If you do it for the first time, start with small areas to try your hand. Avoid too much iron roll because you might create tiny bubbles in the resin.

When two overlapping pieces of fabric, cut with a knife the two folds. Remove the drop from above. Then lift the cloth to remove the drop below and re-apply as cleanly as possible the two fabrics edge to edge.

Finally, apply a peel ply can be removed from hardening or several days later. It improves the surface and absorbs excess resin and it offsets the time spent on placement. In addition it protects the surface from contamination until it is painted or varnished.

In the case where one would not use a peel ply, some suppliers recommend applying a layer of resin after installation of additional fabric and before complete curing of the resin to coat the fabric. It remains to be seen by everyone, depending on the resin used, the thickness of resin applied before laying the fabric, paints and varnishes which will then ... etc. In practice many variations are possible in the circumstances. It also depends Compromise time - quality that we give ourselves. More thin coats are multiplied, either at the stage impregnation or lamination, the less of runs and the better the quality. This is particularly important for sheathing on vertical surface. Another general rule: avoid excess resin, they needlessly complicate and result in many cases by "excess" sanding

If the surface to be covered is large, we can move forward in stages. Apply the resin from one side, lay the fabric, apply the resin on the other side, etc. ...

Dry method

If you want to work less stressed by the time it takes for the resin to harden, it is also possible to sheath the "dry". We put the first fabric, bound with tape to the periphery and then the resin is applied. The application of the resin through the fabric is less easy, but you can take your time. This method is suitable for someone working alone, in addition to flat work, but is not recommended for vertical surfaces.

In summary, before moving to the wet method, more productive and more universal, a beginner's interest to proceed in stages, even if it increases the work:

- Complete impregnation followed by sanding,
- Dry lamination then if necessary by tilting the hull to be close to horizontal.

An alternative is to start laying the fabric to dry while the last layer of impregnation is still a little sticky. The tissue adheres somewhat but can still be repositioned if necessary. Then, proponents say that this method, it does not slip off when the resin is applied on top.

Note: It seems there are almost as many methods as sellers of resin. I have tried to present here those are the most recognized and best suited to amateur builders of boats on my plans.

Sealer

For sheathing bordered on being painted, those who want a superb finish to apply a coating to eliminate surface defects. Use this end of the epoxy loaded with hollow glass microspheres to form a light coating, easy to apply and sand.

Caution: too much to want to do, everyone will think you have a plastic boat!

Sheet 8: Epoxy Impregnation - Cold Weather

Introduction

Epoxies are now excellent and versatile solution for impregnation, bonding, filleting, layering in the context of building a wooden boat. But they have one major flaw: that of imposing a minimum working temperature of around 18 ° (sometimes less, suppliers trying to reduce this threshold).

But most manufacturers, and even many craft projects, do not enjoy these conditions.

We are dealing here with the methods and products to build in an unheated.

Site planning

A homebuilt often takes place over a long period, the order of the year. It is therefore possible to carefully plan the construction taking into account the following ideas:

- Produce certain documents in its housing: frames and bow glued-prefabrication daggerboard and rudder, rudder and drift lamination ... Note: I assume no responsibility for the consequences family!
- Do in the summer all the transactions for which there is no good alternative, especially sheathed hull.

Timber storage

Solid wood and plywood should not be wet when their bonding. It is imperative to store them in a dry and ventilated, if possible, leave a couple of days in a heated before use, especially for impregnations and layering.

Using epoxy in cold weather

Above all, have thermometer and hygrometer in the room.

Use the right products in the range of the supplier. There are often several hardeners, slow or fast. It will then choose the one that gives the fastest polymerization.

For impregnation, use Résolcoat 1010 of RESOLTECH, diluted with water and used up to 10 ° C.

For gluing and filleting, you can work in cold weather subject to implement the following methods:

- Store resin, hardener and additives in a heated (preferably to 25 °) until use. It is important that the mixing is done with products well fluids. Some manufacturers place the bottles in hot water.
- Heat the work area, which can be done with a plastic tarp covers the party and a heater which can be limited to a single lamp. Caution still not cause a fire. Note that the epoxy off much solvent. The same method would be dangerous to other products.
- Wait before removing the clamps: curing will take longer but will anyway.

For sheathing, especially large surface (plating), the problem is more difficult to treat. The risk is having the bubbling phenomena in the resin and to see them form a veil whitish internally. The problem is the same in the rest impregnation with epoxy resins common. Especially if you intend to varnish thereafter, arrange to work in summer or heat the room momentarily one day not too cold. With a painted finish, we can together with the precautions listed for bonding, work under temperature conditions deteriorated. Also the installation of reinforcing strips can be done more easily (it is normally easy to heat the area). Only a careful reading of product information used to estimate the threshold will qualify. In general, it is not exposed to major problems above 15 ° C for a product considered for use at 18 ° C.

In case of impregnation or sheathing in boundary conditions, we can see a veil of surface fat is not removed by solvents. In this case wash with water and scrubbing with a scouring pad and make a sanding before proceeding to the next step.

Polyurethane glue

Adhesives polyurethane (PPU 100 in France, Balcotan 100 in Britain) are also available in DIY store with features that seem equivalent. The SSP 100 is in chandlers.

They can be applied by minimum temperatures of 5 to 10 ° C.

The characteristic of these products is to moss of a blank space appears. But the foam did not at all the same mechanical seal that properly applied. We must adjust the wood pieces to assemble and then tighten very hard to avoid foaming. If these conditions are not met, the collage will eventually let go. I am experiencing one of my boats where delaminations began after a decade, and even much faster for highly stressed parts (footrest).

That said, taking care of the adjustments and increasing the mechanical connections (nails, screws, bolts, rivets), we can make a boat of the same quality construction epoxy. As for the epoxy adhesive layers spend two to 30 minute intervals if you stick around a very porous wood, including plywood, planed (scarfs, wink). Then wait 30 minutes before assembling the parts.

Polyurethane glue has a big advantage is to be one component and therefore very easy to use. In some cases, it is an interesting alternative to epoxy, even without a temperature problem. I think especially at a small hull battens, especially if it is then laminated to the outside. This avoids prepare a mixture for the installation of each slat.

The polyurethane adhesive is also a good solution for the installation of double large area, such as a bridge. If there are areas where contact between the two panels of plywood is unsteady, the space will be sealed by the foam. It was Jean-Jacques Herbulot who was the promoter of the glue PPU for which he adapted several of his famous shots (Varmint, Corsair, Figaro).

Attention to the fact that the polyurethane does not care that a few months in its packaging, and even less frequent when opening the container. Therefore, for a small construction spread over time, it will always be less costly to use one product for everything and it is clear that this epoxy is still the champion.

The polyurethane adhesive sealant

Sold to gun cartridge, the best known are the Sikaflex 291 and 292 but there are equivalents in other brands. Verify that this is because the polyurethane or silicone sealant others are for different needs. Unlike other glues and resins already mentioned, the polyurethane sealant is sticky and gasket keeps a certain thickness to be taken into account. There is an alternative to the SSP, where it is inappropriate, especially for joints that are not perfect. It should provide means for clamping powerful as the product spreads well anywhere to get out of the joint and work quickly enough because the product cures fast enough.

Sikaflex 291 is doubled if necessary by mechanical connections, which is usually the case. Sikaflex 292 is a true structural adhesive and few passing screws or other. It is especially useful for connecting wood-poly but it's out of our subject.

As the SSP, these products are used to 5 ° C.

They are quite suitable for bonding structural elements rather massive but never perfectly adjusted, as well drift keel, ribs cut in the hull. I also used for bonding winks clamped by rivets.

Its main drawback is that the spray application at hand is quickly tiring and long. In addition to the product, which is used in large quantities, is relatively expensive. It should therefore be treated instead as an add-in solution when or epoxy, or the SSP, are applicable.

Resorcinol

Formerly widely used before the advent of epoxy, it is in the form of two components with one powder. Its color is reddish brown. I will not quote for the record because it is difficult to supply (the most common is Aerodux 185). I think his interest is mainly an amateur to a hull size large enough. Professional still use it because it retains advantages, not least the ease of cleaning drips (water, simply).

Sheet 15: Scarfig Wood Panels

Vocabulary

- A scarf is a bonded connection of two pieces of wood glued on an obliquely fitted joint.
- The shell is the set of "outer skin" of the vessel, internally reinforced by bulkheads, frames, floors, etc. ...
- A shell is an elementary piece constituting the longitudinal hull.
- A strake is a set of planks whose scope goes back to the front of the boat.

Format plywood

The scarfs are made necessary by the standard length of plywood: 2.50 or 3.10 meters, or 8 or 10 feet. Warning: there are still on the market (abroad) panels 8 feet making only 2.44 m in length. The 6 cm may be missing an issue.

Baseline

The pieces of plywood that can be scarfées are essentially the edges (clinker hulls or bilge hulls) or plywood needed to achieve these edges, the same simple method applicable to other cases.

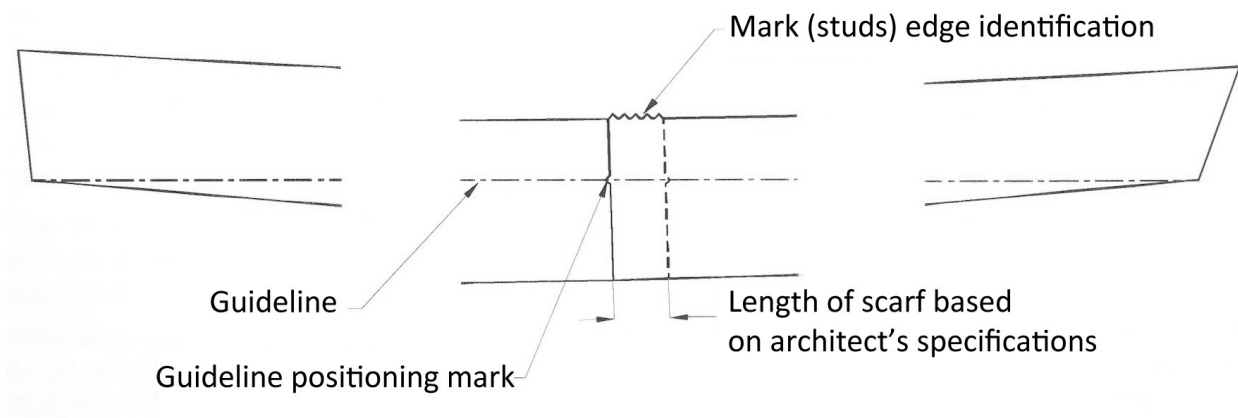
In the case of pre-cut edged (delivered as a kit or cut by hand from an array of dimensions or a plane), the objective is to establish strake from the length of which is lined limited by standard sizes of plywood.

Warning: it is preferable to place the seal "fish scale" and therefore is planing scarfs in opposite directions depending on whether the hull is to starboard or port. Take the time to mark in advance planing the sides because errors are common.

Edge alignment

It is essential when pasting aligned properly lined up a strake. A very small angular deviation will result in several millimeters or centimeters of error at the end of the boat, errors that may be irretrievable.

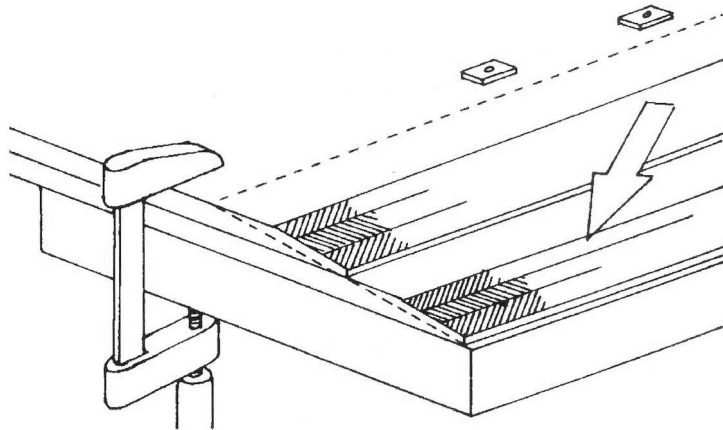
To this end, we draw on each plank a guideline (marked by "spikes" in digital cutting or used to track when cutting manual). To be a strake, it is necessary that the guidelines are all aligned:



The length of scarf is specified by the architect. In general, it takes 8 times the thickness of plywood.

Planing scarf

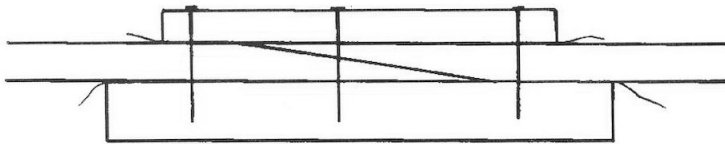
We start by planing a joint of the specified length. To this end, we superimpose the two panels to be assembled by nailing on a rigid plane and aligning the side scarf. The work plane is in the direction indicated by the arrow.



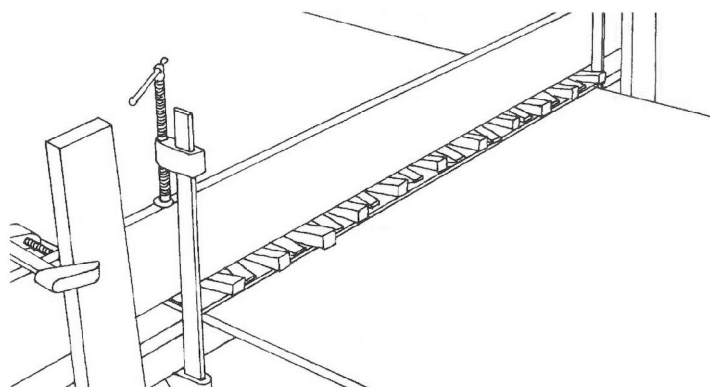
Gluing the scarf

For gluing, practice as follows:

- Ask all either horizontally (eg benches or assembly site before asking couples) with, under the seal, stand thick plywood or hardwood (good for keeping nails). Thinking of placing a sheet of cellophane to prevent the glue from adhering to the substrate.
- Glued in two steps (impregnation and bonding), as planed plywood will absorb much of the glue, and take care to align the two panels on each other. Prevent slippage of the joint by nailing a few points outside the joint.
- Install a lightweight plywood on the seal (and still the cellophane) and tighten with clamps and need some tips so that the gasket is applied everywhere. The holes are filled, then with epoxy putty.



- In the case of full panels or screw spikes are of course inevitable. In smaller thicknesses can also use weights. If we want to avoid the holes, we can perform the assembly shown in FIG.



As in the assembly of the lined, mark them with their numbers, the edge (port or starboard) and the face (interior and exterior). There is indeed a significant risk of error and, for example, then make a chamfer on the wrong side.

Sheet 16: Timber Gluing and Lamination

Use

You can choose to apply the technique of glulam elements such as floors, frames, curved bench, angle picture ... They will gain strength or will get by if we do not have a well-connected timber. For frames, we can achieve in one piece durable this would be done in several parts assembled into conventional construction.

We generally use epoxy glue (sheet 05 and 06), or possibly the polyurethane adhesive (sheet 08).

Thickness of blades or slats

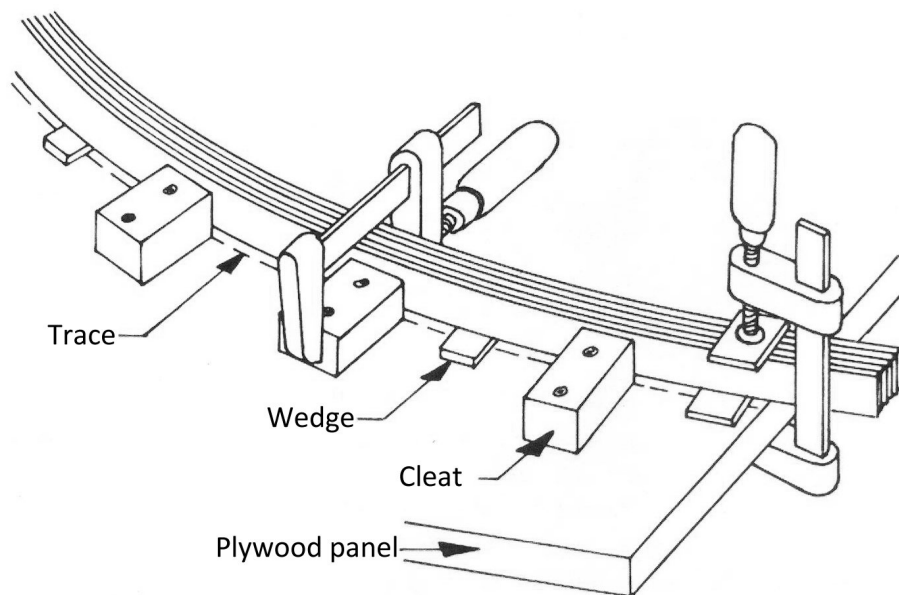
A simple rule of thumb to define the thickness of the blade: this, expressed in millimeters is equal to the radius of curvature expressed in decimeters. Of course the flexibility of wood varies considerably from one species to another and it will be advantageous to do a test in borderline cases.

The width of the blades will be determined taking into account a loss of 2 mm for planing the faces and the inevitable misalignment of the blades to each other.

For the flow of the slats, it is preferable to use a circular saw blade with a fixed appropriate that will make a clean cut. In this way, there will not planing blades, which reduces the ability of the blades sticking out. Too smooth slats would need to be sanded with a coarse paper to ensure good adhesion of the glue ...).

Parts produced on mold

The figure below shows an example cons assembly for producing a piece glulam. The line outside the room was dropped on a thick plywood panel. When we have a plan or chart ratings, we will draw interest directly on the panel. If you have a true path to greatness polyester layer, the layer can be bonded on the panel and work on top. Cleats, in sufficient numbers to control the shape of the piece are screwed into the panel.



Then placed some shims to avoid direct contact of the piece with the panel. The slats are provided with at least 10 inches of extra length at each end. Make a test in place before moving on to collage.

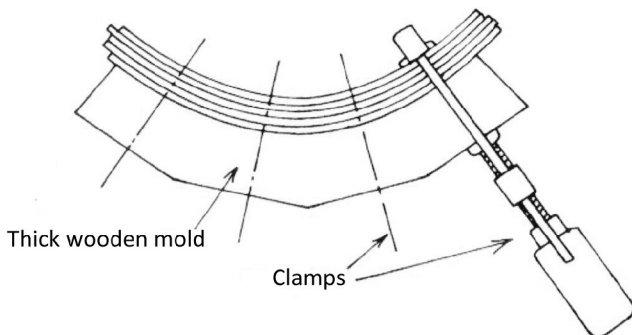
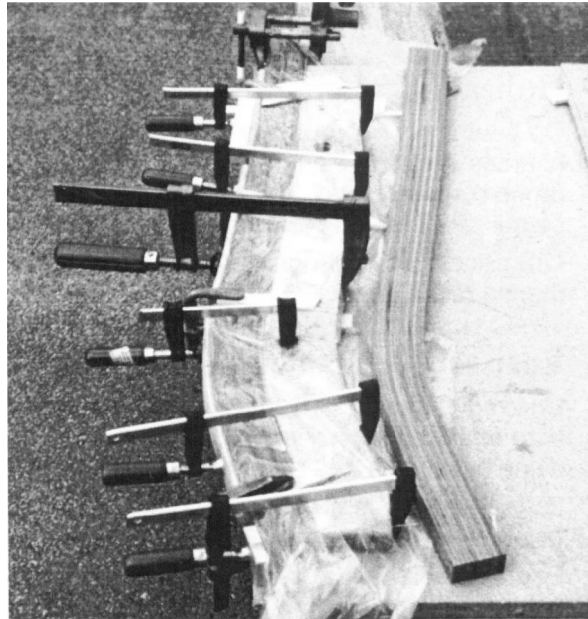
The slats glued (it takes the method!) Are gathered in bundles and wrapped in cellophane. We place progressively clamps at each stop to tighten the battens to each other. It also places clamps to apply the beam against the panel at several points (if you drill in advance of large diameter holes in which the clamps are slipped). Attention slats glued easily slide over each other: everything must be perfectly maintained and the clamping force applied to the beam axis of slats.

It is expected that the piece glued-laminated relaxes, losing some of its camber. We can anticipate this by adjusting the location of the cleats, but only one test is used to quantify this release. If you have several pieces to do (eg a lot of frames) starting with the less curved, which will be make a sufficient idea of the corrections to give to others.

After unpacking the room, remove the drips of glue (preferably with a belt sander for the epoxy when it will be well cured) and shave each side until the surface clean.

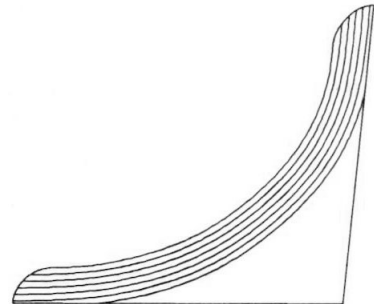
Note that the PPU glue, subject to ensure a tight fit of the slats, is easier to clean out the glue joints is a foam that comes off easily with a rasp.

The right picture shows a collage piece being completed and an identical part.



For small rooms, it is easier to cut a thick board a mold to the outer profile of the desired shape, as shown in the example on the left.

It can also keep a portion of the mold to form a curve or a square bench table:



Laying of laminated frames in-situ

One may want to make a piece glued directly using the hull as a mold. This is particularly useful for laying booms but also other parts in contact with the hull, for example support a greenhouse bench or lay a false keel or girth.

We describe here the particular case of framing, a technique that is an alternative to steam bent frames.

- Prepare the hull sanding, cleaning, etc. ...
- Glue the slats beam (from one side to the other, except possibly at the ends or at the daggerboard,
- The wrap in cellophane and keep it tight at some points with adhesive tape,
- Place it inside the hull in the now temporarily with clamps in each wale,
- Screw the beam in the hull with screws for chipboard interim Phillips 30 or 35 mm and a diameter as small as possible (max. 3 mm outside mesh). Start with the keel. For a small hull battens, a batten screwed into three. In a blink of hull, screw to the point of contact with the hull.
- Before the installation of each screw together the boards with a small clamp and drill a hole in all battens (it is best to use a stop on the bit) to the outside diameter of the screw.
- After making glue, disassemble, clean, shave the sides, bevelling interior angles.

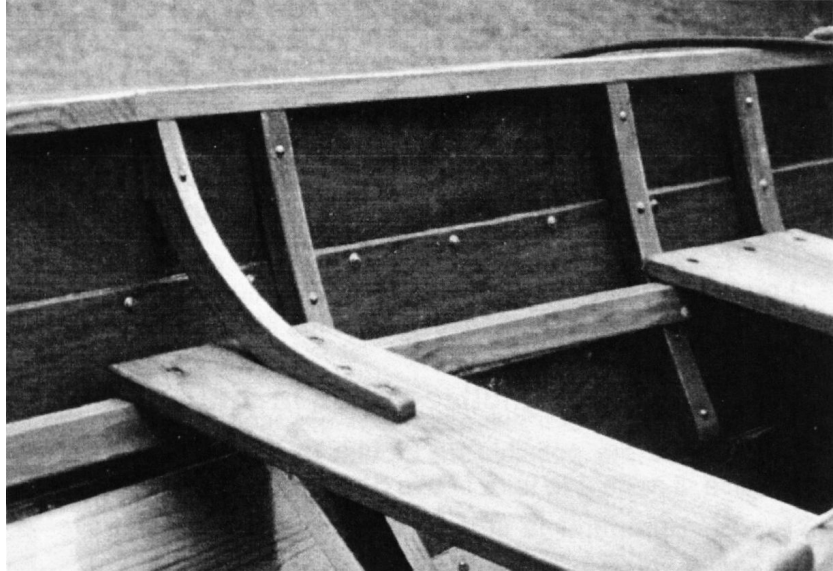
- Place the frame with rivets vessel diameter at least equal to the holes made previously (16 or more JP JP 18, see page 12).

Note that it is normal, on both sides of the keel, there is no contact between ribs and planking. We can then glue a small filled, leaving an open area for flow of water in the bilges (anguillier). Do not screw into the area.

The rivet is the bonding mode best suited in the case of ribs. For other cases, or if you find it difficult to obtain rivets, screws are used. For parts attached to the hull is then screwed to the outside. We will then have to screw other points that temporary screws and holes reseal them.

Photo: Example of laminated frames in situ. You can also see a second plane partial frame which improves the holding of the clamp *bauquière* at the bench.

Note also the curved glued-laminated bench.



Laying of the fin or skeg

The fin or skeg can be made of solid wood, but no band saw, it is difficult for an amateur to cut and adjust properly to the hull.

We will then use the solution of the glulam. The folds will make 15 to 20 mm after the bend. They are placed successively being secured by screws or nails. Pre-drilled at each screw. Mark the position of the screws to avoid "collisions" that would require patching. Attention also give free tips of screws or areas to be subsequently planed.

The use of clamps (photo) behind the table reduces the need for screws.



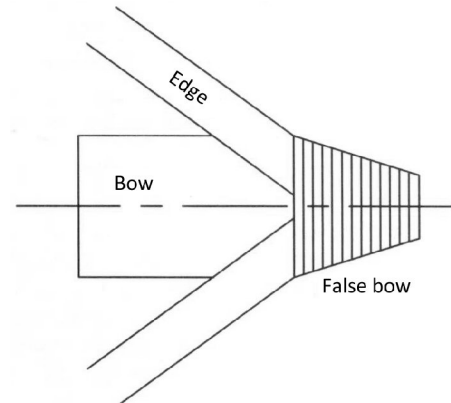
False-stem glued-laminated

With a modern timber construction in small strips or lap, rabbet is avoided by performing the traditional bow into two parts: an inner bow which receives the ends of planks, an outdoor or false bow that covers the end edges and gives it a more traditional boat.

Whenever possible we use the bow, before laying on the model construction, as a mold to make the false stem. This allows proper planing each face of the false bow on the bench.

Before laying the false bow, properly prepare the surface: it must be perfectly straight in the transverse and uniform curvature in the other direction.

When installing the false-stem, screw next opportunity inside or outside (or two alternating better).



False-stem-glued laminated in situ

If it was not possible to mold the false bow on bow, it remains to do in situ as follows:

- Properly prepare the surface that receives the false-stem (see above)
- Install and glue the strips successively with nails (galvanized or stainless steel) or screws (especially the ends). For screws, it is imperative to pre-drill. They can be removed subject to reseal the holes. Otherwise locate their positions. The slat width is decreasing to limit the finishing work.
- Use long screws for the last trick.
- Alternatively, glue the slats packet with screws. It must then pierce the outer diameter of the threads as and when the beam application by ensuring that chips do not fit between the slats.



Sheet 22: Strongback Assembly

Introduction

This fact sheet describes the "placing on site" of the boat. This is a milestone for the three-dimensional geometry of the vessel will be constructed and any mistake will be difficult to overcome later.

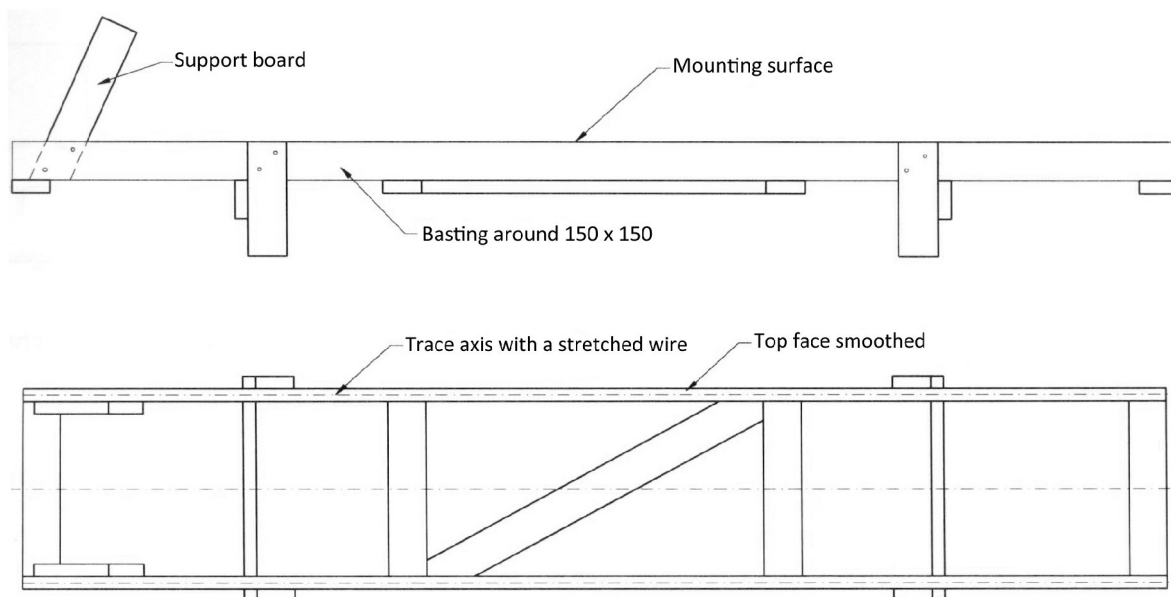
It consists of the following tasks:

- Realization of a project which supports rigid construction,
- Assembly on site templates, frames or walls
- Laying the bow and transom
- Laying the floor, or the keel

In principle all these elements have been traced, cut and made in advance, before the project occupies an important place. However, to facilitate understanding of the text, we discuss also in this sheet manufacturing components to assemble, without seeking to enforce the order of assembly, above.

Construction Site

It is a timber structure, as rigid as possible, carried out according to the following principle:



A wire stretched over one of the girders used to draw a longitudinal line of reference (at a fixed distance from the axis of the boat). Along this line, mark the position of the pairs of alignment, shape according to plan, generally equidistant if built on templates. When constructing in bulkheads or frames, it is rather the structure plan which will indicate the position of couples.

Depending on available materials, we can vary the mounting yard. One can for example use cinder blocks to put in height. It can also stick to the ground (polyurethane glue) to secure the property, thereby making the lighter. In extreme cases, the templates can be placed directly on the ground but we must consider the need to work at height and good power to go below for some operations (riveting, cleaning drips of glue before polymerization ...).

Some manufacturers provide wheels (possibly retractable) to move the site during construction, which can be very useful to better manage the available space.

Note that some kit (Minahouet, milk) include the work site but realized in ordinary plywood pre-cut, with notches to receive templates or partitions. The geometry is thus completely defined but we will still stiffen the mounting interest in adding pieces of solid wood.

Templates pairs

We build on a template when the frames are placed "in situ" inside the hull after it overturned. The templates are not part of the finished boat. The site can be reused for other buildings the same. In some cases, especially for deck boats, there may be alternating patterns, and partitions, the latter part of the vessel structure.

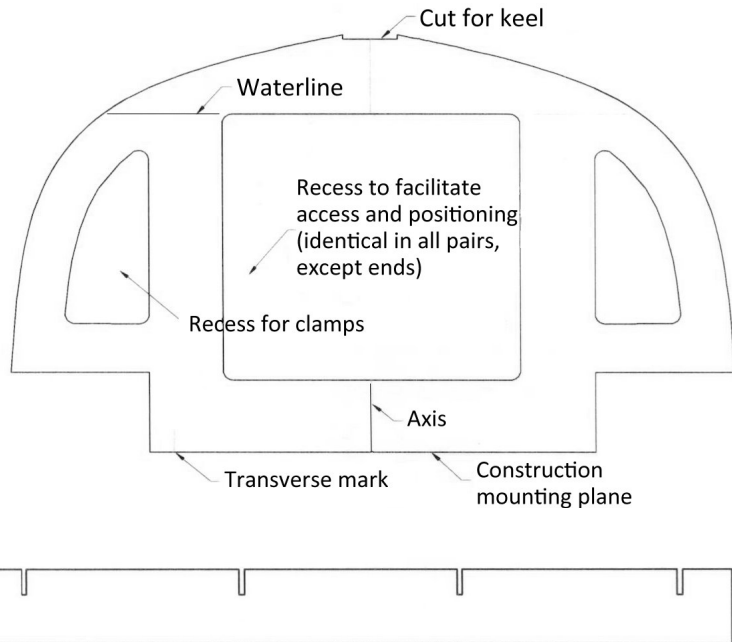
The templates are cut out of plywood or plain particle board or medium (agglomerated finer and more resistant). The standard thickness is 10 to 15 mm.

The plot is based on drawings supplied (inside hull, called "off-Member") or a path full-scale polyester layer, greatly preferable solution.

We plot the maximum marks: axis of the boat, waterline, etc. ... then that will be useful to properly align the assembly.

We'll recesses in the template, in order:

- Facilitate access to the interior of the vessel during construction,
- Allow decision-clamps to hold provisional lined,
- Facilitate their alignment and spacing through spacer plates with notches in wood or plywood (see figure below).



Warning: it is essential to protect template side bordered with tape type adhesive packaging to ensure that the glue used for setting bordered sticking and prevents the "release" of the vessel.

Bulkheads

If there are plans to build on partitions, they will be conducted in accordance with plans and "squared" as we shall see in the ribs. Bulkheads should be based on the layout plan, or through extensions that will be cut after turning the hull, or by cleats attached thereto provisionally.

Frames

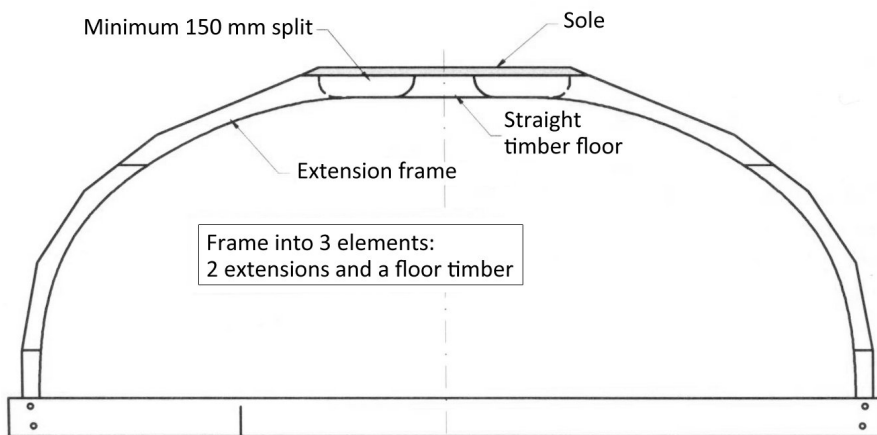
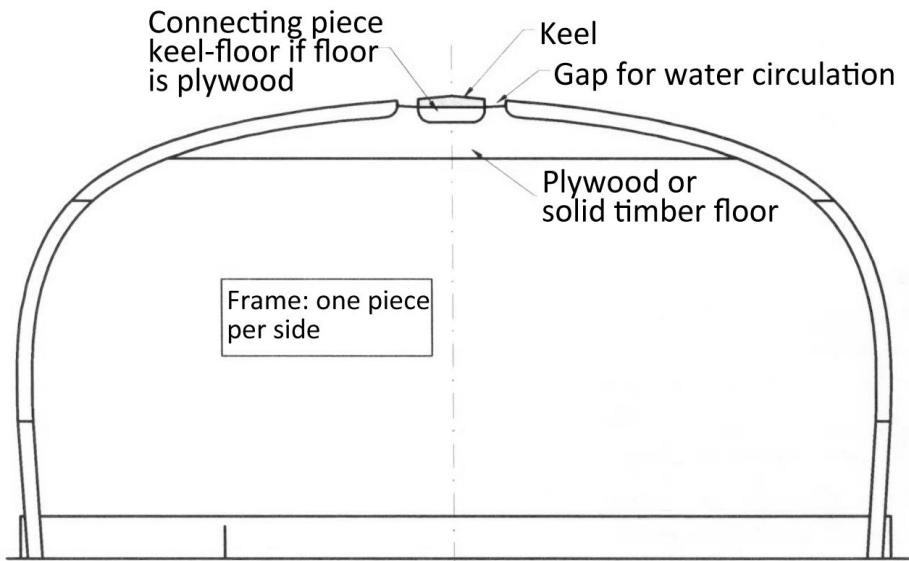
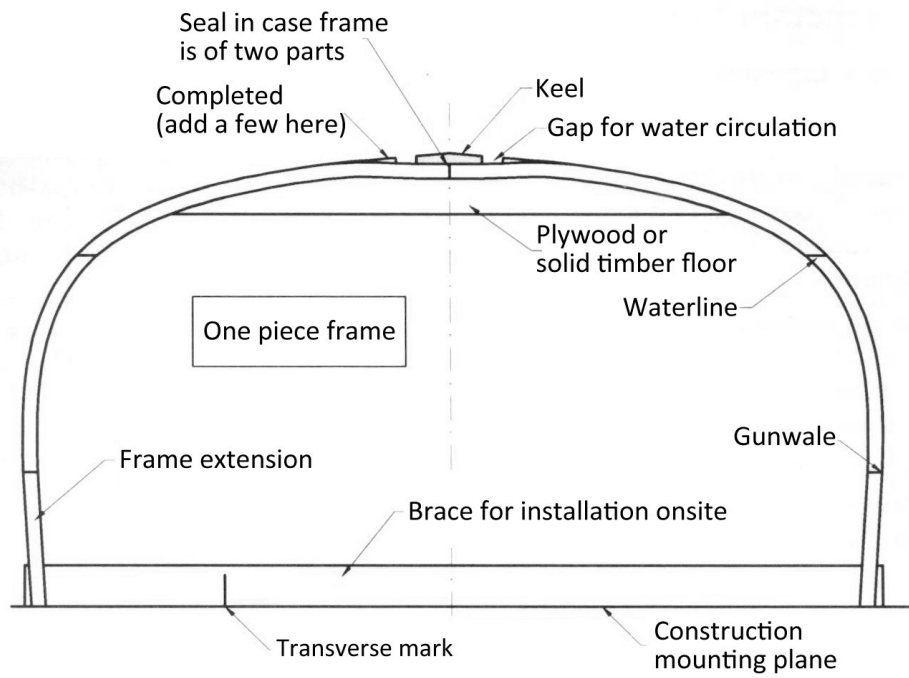
They are most often made of glulam (see page 16), in a single element from one side to another, or several elements together. It is always interesting to each side separately using the same mold. However the assembly of several parts is likely to weaken the structure and complicate the squareness (see below).

Figures on the next page provide some type of case frames.

For installation on site, the frames should be extended over the gunwale (upper edge of the hull) until the plane lands on site. A cross is so firmly fixed as it is she who will be based on site .

Place the whole frame-crossing on the route (or path layer polyester that has been done yourself a light plywood) to properly adjust the position of each piece and in particular the level spacing of the ties. We must be careful because a piece glued-laminated tend to relax a bit after release and it is laying the sleepers that are somewhat correct.

Score maximum marks (floating, sheer, etc ...) then that will be useful to properly align the assembly.

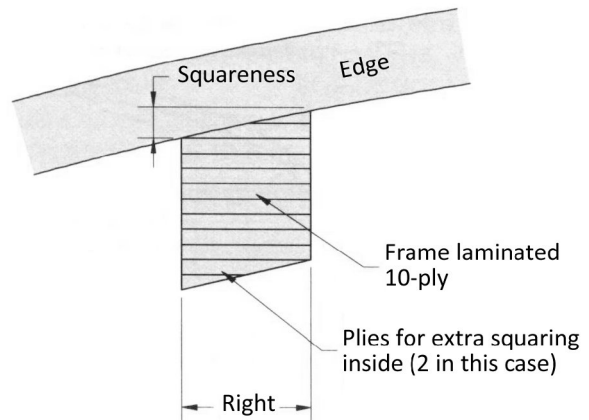


The squareness of the frames

'Sides, especially the ends, is applied to the ribs obliquely. It is therefore necessary to roughen the outer surface of the frame. In general, we must also squarely face that receives internal structural elements such as clamps *bauquière*. In addition it will be more beautiful and traditional.

From the point of achieving the laminated frames, we must consider the square by adding additional folds at the ends to keep a total equivalent sampling.

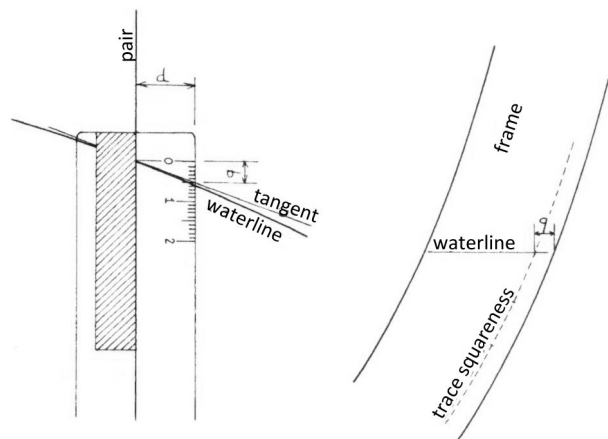
When I provide a plot of pairs of polyester layer, squareness therein. It can be easily carried over to the room.



Otherwise, use the following method:

We assume first work in the upper part of the hull above the chine, our goal was to define the squaring-up for each frame in each water line:

- Prepare a ruler transparent sticky tape underneath opaque in order to materialize the width of the frames (called the sampling on the right)
- Draw on the top view of the plan as a tangent to the waterline at Frame,
- Place the ruler as shown in the figure, and read the squareness q
- Report this value directly on the couple (supposedly glued and planed on which it will route the water lines and longitudinal) as shown in FIG. Warning: this delay is along the water line.



In the lower part of the hull, it operates on the same principle using longitudinal. We can then trace the squareness of each frame by linking all the points so defined.

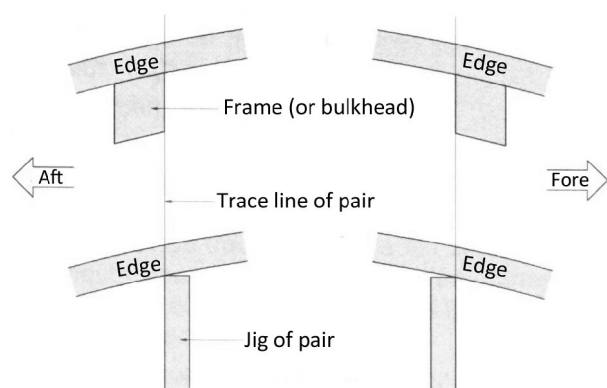
This method, limited in its accuracy, will at least outline the squareness. By submitting a latte on the templates installed on site, we can complete the work.

The placement of template, bulkheads, or frames on site

The positioning of the templates on the one hand, partitions or ribs on the other hand is different because the former are not squares and the latter are.

The figure below shows cons in each case the position relative to the line drawing of the couple. The plot line is that the couple plan form. It's normally the one that is listed on the plans.

While watching the plans as there may be occasional exceptions to this general rule.



To create the templates, frames or walls, to bring cleats, large squares of plywood or chipboard, and as many clamps as possible. These have the advantage of easy adjustment of position, alignment, assembly orthogonality. Place also in the recesses of the stage separation. Warning: much of the quality of the final is played at this stadium.

Use Phillips screws to agglomerate preferably Nails for assemblies. The hammer may indeed disrupt the assembly. Some links may be removed gradually later if they bother being laid hull.

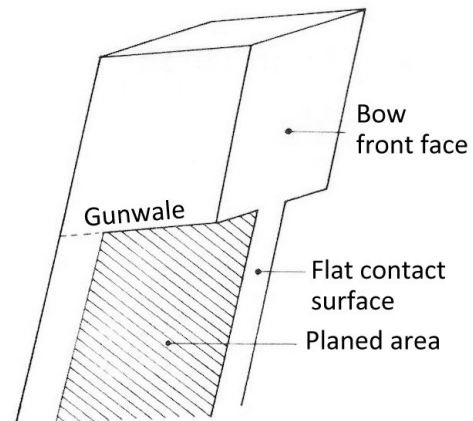
Do not forget that the boat must be returned, the shipyard and its templates are attached. Make sure all screws are accessible to dismantle once the ship is lined. We can use string to make some connections. Simply cut the turnaround.

The bow

The bow is made of laminated wood, planks or plywood assemblies as shown on the plans of the boat. It is usually based on the last couple before, which facilitates its positioning.

I always plan squareness of the stem, it is easy to obtain since the plan was done on my naval architecture software.

Warning: as indicated in the drawing, it should not be squaring up head bow. Moreover, it is often convenient to extend the stem upward until it rests on a cross of the site (see more photos below).

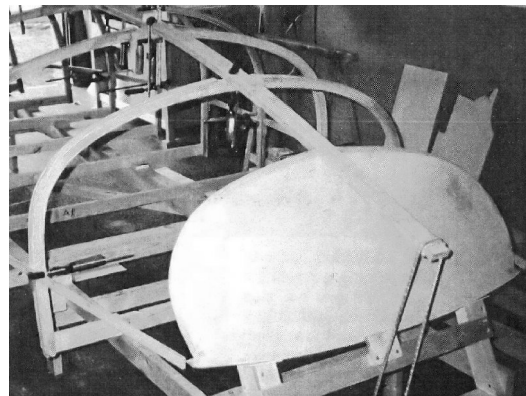


Transom

The transom is less easy to position and must therefore put great care. From the plans of the boat, we use template-shaped brackets which serve to fix in a place the two supports for the transom we have shown in the site plan in the first page of this sheet. This bracket can also position the table vertically.

It is often expected that a skag connects the keel to the transom. If you have a real-life plot size, its outline is provided. Similarly, a template is included in the kits. Otherwise, it must draw from plans but may require adjustments.

Maximize use of clamp connections. During the installation of the keel, we can ensure that all these pieces fit together well and then fix them permanently to each other.



A rope keel forced down, thus giving it a natural curvature. This principle can also apply to the edges.

Photos Zimmermann (Switzerland).

The transom should also be squared. This squareness is difficult to determine on plan and it will be defined with a straight edge resting on the transom and pairs.

The squaring himself to be sided electric plane, saw or chisel. It will be adjusted depending on the direction of the wood planer, the Spokeshave (photo), a grater or with a belt sander.

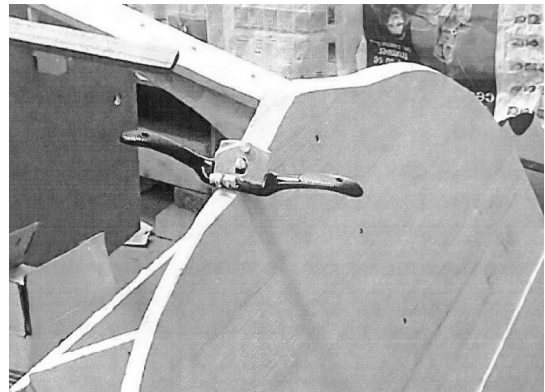


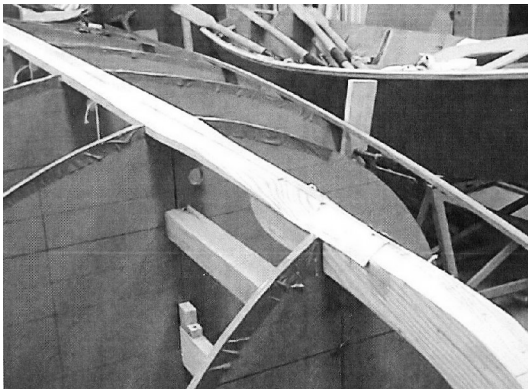
Photo Jean-François Docks / Boat Sèvres

The keel or sole

The laying of the keel, or the sole case of a flat-bottomed boat, completes the construction site by linking to one another all the elements. The boat is then ready for plating.

Note that on some ships, it is planned to include other elements at this stage, such as a daggerboard. It will also cut into the keel passing drift, which is much easier to do before installation on site.

The keel needs to be squared on each side to receive the sides. We can define the angle by presenting the couples but it will be advantageous to put it back on the bench for planing. The same applies to a sole.



Only after the laying of the keel that can be squaring the forefoot area (lower part of the stem). It will plane by simulating lined with a soft board.

Note on the photo above against the tape which will prevent from sticking to the planking templates.

Photo Jean-François Docks / Boat Sèvres

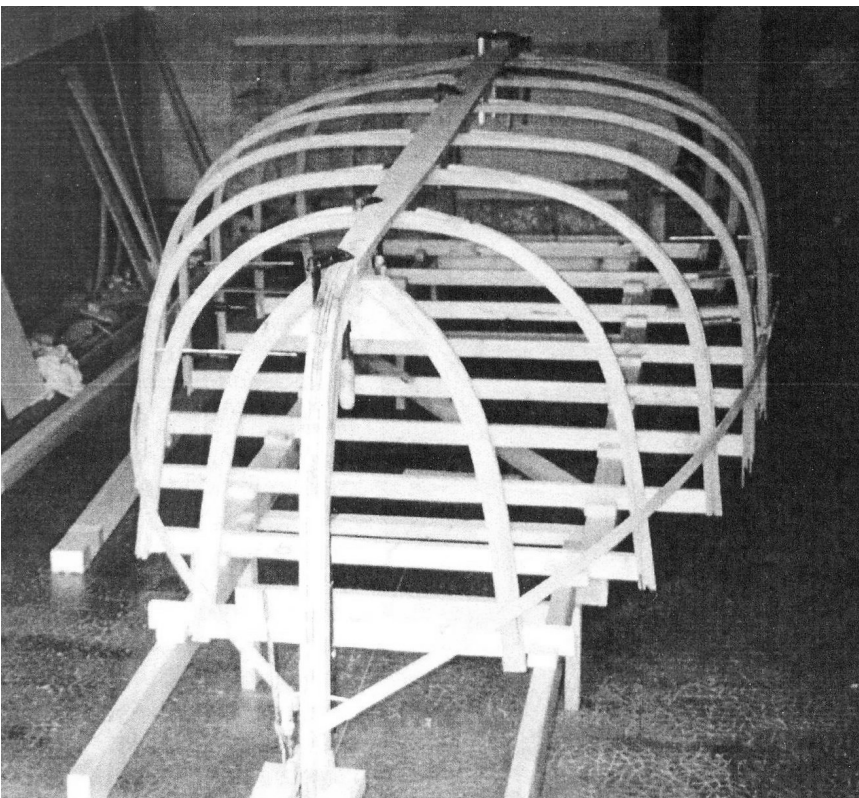
Sample mounts



Ebihen being mounted on frames. Bulkheads with juxtaposed frames are also in place, which helps to stiffen the assembly.

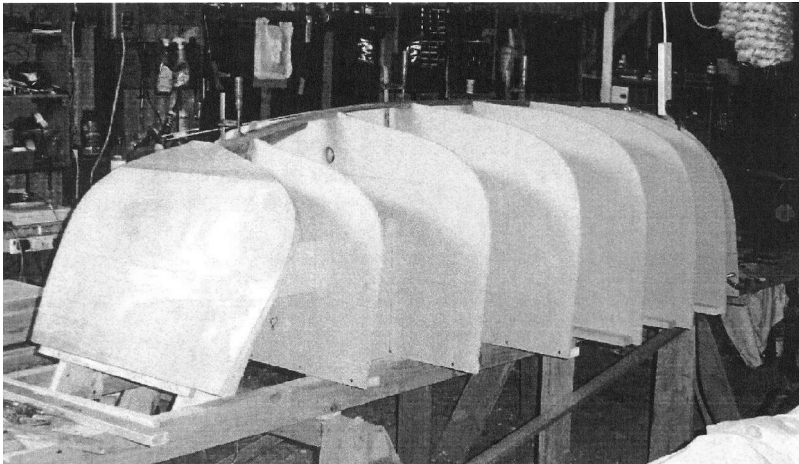
The plot was made from layers of polyester, which gives high quality of fit.

Photo Clabeck.



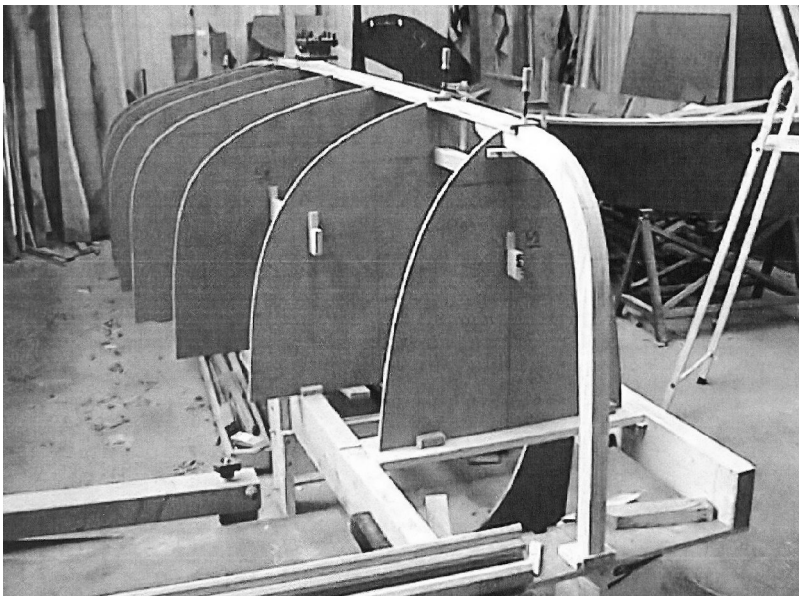
Aber under construction, also on frames. Bow, bowling and table are in place. We can see the "full", on both sides of the keel, which ensure contact between frame and edged close to the keel.

Photo Zimmermann - Switzerland



Construction of template for this Kernic to be edged in small strips. The table is solid wood.

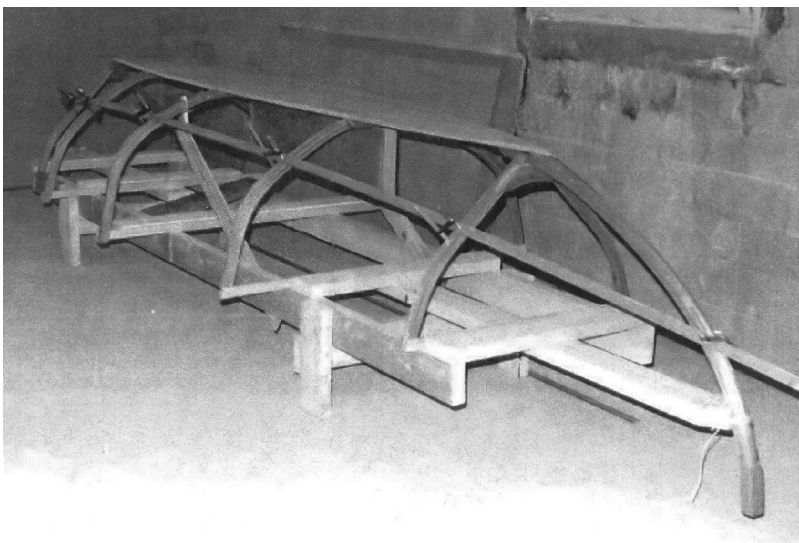
Photo Twist - United Kingdom



Ilur under construction at the Watersports Centre Sèvres. We notice boards with longitudinal slots through which the templates to maintain gauge.

The bow is based on the template before and on a cross. The keel is made.

Photo Jean-François Docks / Boat Sèvres



Youkou-Lili: construction booms with sole. The sharp rear is treated exactly like the bow. A latte is presented to verify the squareness of ribs and stem.

Sheet 31: Strip Planking

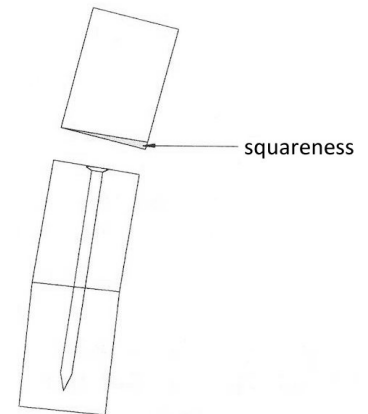
Introduction

Border into small strips, cover the entire hull is a simple juxtaposition of lath width and thickness. This method removes the "spiling" traditional goal of creating a specific shape, more or less time on each panel.

The only adjustment needed is the squareness of each slat to ensure proper port on the previous one (figure). And again, we see that it is possible to remove this squareness under certain conditions.

This technique has gained interest with modern glues and resins of epoxy that does not require a high clamping pressure, hard to get here. Indeed only the nailing of a latte on the previous ensures the contact during the curing of the glue.

Note that some manufacturers use battens which have been given to the top profile in an arc to eliminate the need for squaring. Modern epoxy glues and the additional cost of such an operation, especially for an amateur, do not seem to justify this method is not described here.



Small strips and strip-planking

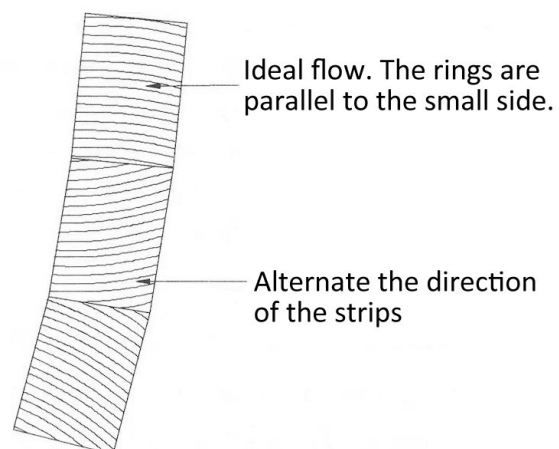
In recent years there has been a generalization of the term "strip planking" which is simply the English translation of small slats. However, the strip planking today means primarily a method of sandwich construction: wood is a core material, covered on both sides with a durable epoxy lamination. The result is a lean, well suited to performance boats.

The technique of small slats that we describe is more traditional. The slats are resistant structure and are not necessarily sheathed. If they are, it is mainly to make them more inert to changes in temperature and humidity. Incidentally sheathing makes the hull less vulnerable to mechanical damage (essential for red cedar planking, wood very soft).

The planking battens small indeed behaves like a board-width that will play in response to changes of wood moisture. It may open too dry, too wet it may curl under pressure. That's why I recommend taking precautions outlined in the following paragraph.

Precautions

- Give preference to a little wood working (African mahogany, utile, especially cedar), cut long,
- Slice the slats on neighborhood, as shown in the figure and rotate the direction of the wood. The swelling of wood is in fact lower in the radial direction.
- Before laying the planking store wood under conditions of temperature and humidity "average." Avoiding it is too wet in winter, too dry if you build in the summer. Just prior to installation of frames, if you do not plan to sheath, moisten the bilges with wet rags for a few days. This area remains very often wet, thus avoiding the ribs to prevent swelling.
- Prefer construction of glued-on frames of good sampling frames bent rather than steam,



- Sheath the outside (see page 07) to reduce the effects of variations in humidity, especially if the hull is varnished or painted a light color.
- Impregnating epoxy surfaces unsheathed and especially the bilges inside.
- Prefer a clear paint to protect the hull from the sun. Book varnishes and paints is dark vessels afloat, is mostly stored in the shade.

All these recommendations may seem very restrictive. In fact it happens that small boats have slats aging problems, especially if they are poorly constructed and poorly maintained. It is not necessary to follow them all, but the more you approach it, the more the boat will be built healthy, lasting and resistant to abuse.

Rightly, the selection of small plates is often done in order to have a beautiful wooden building painted. Conifers (spruce, pine or Douglas Oregon) will then give the best cosmetic result. Be aware that such construction should be carefully maintained, and stored mostly under cover, especially for open boats. A very fine quality wood and dry (not always easy to find), an outer lamination, the laminated frames, then to help ensure the longevity of the boat.



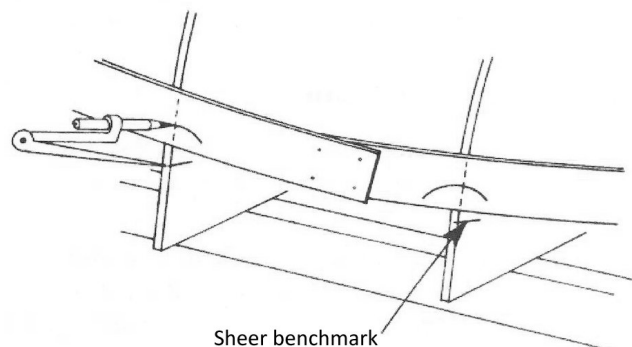
*We can make a very beautiful boat with a painted hull
as this Aven Pont l'Abbé
(To see in color on my website).*

The laying of wales

On boats of traditional inspiration, it is aesthetically preferable to ask a wale "spiling", ie described as a traditional construction (painted dark picture of Aven above). It also provides a rigid base for the first point slats and spindle shape of the wale also reduces the curvature of the slats of the funds. The wale has a thicker than other edges (3-5 mm more).

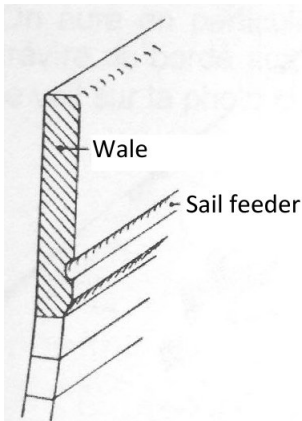
Proceed as follows:

- Prepare three strips of plywood Light 8 cm wide,
- Place them on the frame at the site of a wale, but without covering the sheer marks (figure), attaching bands to one another in their overlapping zones,
- Y give the position of the table, couples or templates frames, bow, then a reference to a constant distance from the deck line (with a compass for example, following the principle of the figure)
- Remove all and put it on the wooden tray in which the wale will be cut,
- Report on the position of this plateau gunwale
- Using a straight edge lined, draw a curve of sheer good regular



The top line is the sheer plane

- Noting the width of the wale in terms of form, mark the outline below and draw a nice latte to spindle shape (in general, the width is 65% at the stem, 70% in the table).
- Cut the wale, the present and adjust until you are satisfied,
- Draw and cut the second wale identically,
- Planing thickness in the front end of wales. Our method of construction (false bow reported) makes it necessary to bring the wale to the same thickness as the other side. Working on the inside, so there appear anything.



If you want to give some elegance to the boat, dig a sail feeder 8 mm in breadth along the lower edge (Figure 6).

- Shave the lower edge of outer wales to connect the thickness of the hull adjacent to that.
- Glue and screw the wales on the bow and the table also ensure a good bond on the provisional templates.

The laying of wales is a very important of their design will depend on the sheer of the boat - and God knows it takes little for it is not perfect! The symmetry may also be affected by this operation because the rigidity of the mold is never perfect.

It is possible to simplify the installation of wales by applying the principle of small laths described below (a little thicker slats). In this case, the first plank is placed along the markings livet. The second, identical, then rests. But the one or ones are thin at their ends, so that the guard wale its traditional form in time. This method is rather reserved in case of a painted finish.

Gluing battens

Epoxy bonding

The best product for gluing strips is epoxy. One can even use a mix prepared everything for bonding and seal off. We will just have to mix two products, without adding to the charges for each time to thicken the mixture. It is strongly advised to remove the drips of glue before tightening. The disadvantage is that the epoxy will have to prepare for each collage (1 batten on each side, perhaps with a more efficient organization of work), which is long and tedious. The use of a filled epoxy has the advantage of bridging the gaps. It may therefore not squaring the slats, except perhaps in some areas (near the bilge table). The slats are then joined at the interior, allowing a beautiful polished finish and slightly spaced out, which is not a problem if you paint.

You can even use a seal for bonding low density (with microballoons) and runny little advantage to have a hardness equivalent to that of wood, which makes sanding the hull (no point). The holding of the bond then being worse. I did a test of strength with RESOLTECH 8020, called mastic end sweep, and it is wood that has broken. I advise all the same in this case to sheath the outside of the hull and reserve the method to relatively soft wood (softwood).

The epoxy adhesive is satisfied with a minimal tightening. We may have enough points spaced (every 30 to 40 cm) in length only fit about 10 mm in the lath underneath.

In all cases, to ensure a better quality of bonding, it can permeate the slats before the epoxy fluid (especially for porous wood) and / or make sure the surfaces to be a bit rough (the ideal is having slats charged with a circular saw of good quality does not require planing).

Other adhesives

If the temperature conditions are not satisfactory or in case of allergy problem, you can use glue PPU (see page 08) which is one component. Beware that this task wood glue. For a high-gloss finish, a thorough sanding will be needed (not very easy on the inside). PPU glue requires a clamping force substantially greater than the epoxy. It

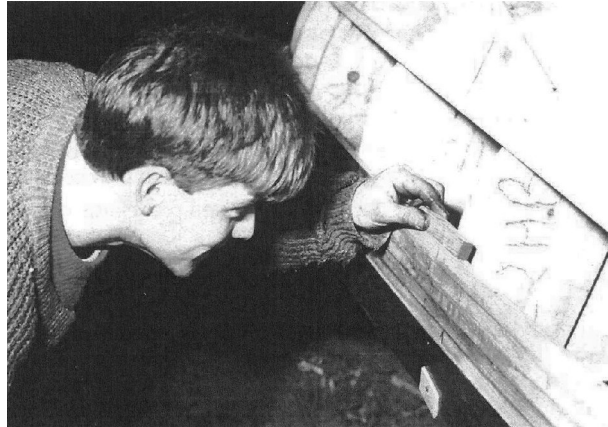
will multiply the points (every 10 to 15 cm) and take a little longer (15 mm in the lath bottom). On the other hand, the squareness of the slats is strongly recommended for a good bond. Resorcinol can also be used for gluing the slats, with the same precautions as for the SSP (squareness, tight fit ...).

The installation of the hull

The principle is simple: the slats of rectangular and constant, are nailed on edge (short side) and one after another, starting with the one adjacent to the wale. We alternate the work on the starboard and port to prevent deformation of the hull.

We will start by sorting the boards: eliminate those nodes, use the prettiest for senior, reserve the right to more flexible wire for the bilge and funds.

We use the plane for squaring each slat if necessary and ensure good contact with the previous one. Assessing the squareness is in the eye with the help of a small piece of lath introduced in front of each template (photo).



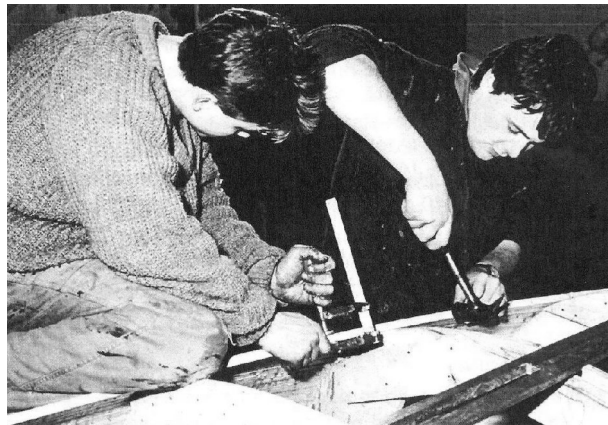
Rating squareness - © Francis Holveck in Douarnenez

Stagger the ends of a slat to another (note the position of the tip of a pencil stroke on the outside). It uses either stainless steel serrated peaks, or galvanized steel nails. This second solution is often satisfactory, especially when impregnated with resin over the side. More galvanized spikes grip better than stainless steel, even serrated.

It is important to orient the tips and not splitting the wood (the risk is highest with the Sipo and Oregon pine or Douglas). It will almost always pre-drill the battens to paste. The diameter of the hole will be of $\frac{1}{2}$ to $\frac{3}{4}$ the diameter of the tips depending on the hardness of the wood. It may be driven to cut the tip of the nail cutter: this is the wood fiber of the lath bottom is cut instead of being discarded, thereby avoiding the bursting of the slats. It is advisable to experiment with wood and spikes that will be used. We can also test the bond strength by breaking the samples cut from a zone without points.

Presses provide the necessary links with the templates for the curing of the glue. If we built on frames, it can be screwed or nailed directly to the battens (and paste), making it much easier. Then put a screw or edge all three boards. Obviously, if the hull is painted it will buffer the screws.

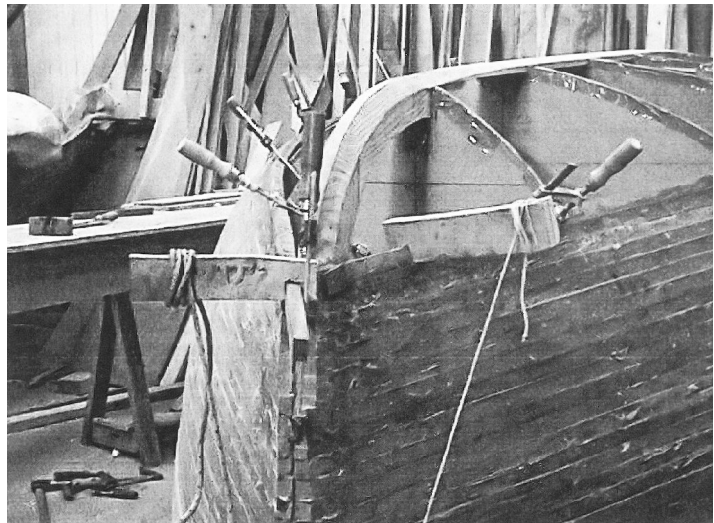
At first, it leaves exceed the slats of the table and bow. They were leveled off after curing the glue. Then, when the slats on the lead keel, it is necessary to adjust them before gluing. It is permissible to let a few imperfections, because this joint is then covered by the false-keel.



Nailing a latte - © Francis Holveck in Douarnenez

The planking of the bilge demands Trevire slats, i.e. the twist on themselves is accomplished with the help of a clamp. The helping hand of a companion is desirable.

We will especially need to force Trevire planking at the ends as shown in the photo-cons.



Wooden levers to facilitate Trevire slats
© Jean-Francois Dockes

The closure of the hull

When there is more to close a gap of about fifteen centimeters in width, cutting a massive board, which can also be obtained by gluing strips together. This plate (close) is adjusted by leaving with the last slat asked one day by a few millimeters, slightly open outwards. This space will be filled with epoxy putty (same product for a joint holiday - see page 06).

Note that it is also possible to fill this space (and even a greater width in the forms) by the marine plywood (all sapele, or makore moabi) the same thickness as the hull. This will strengthen the structure around the well if there is drift and make the fund less prone to moisture absorption.

It is strongly recommended to soak the songs fluid epoxy plywood after adjustment and before gluing in place.



Ilur on this, we adjust the closure to close and solid wood
© Jean-Francois Dockes

For the record, the Aven built by Constructions Navales Loctudy, the closure was caulked with the adjacent slat. Thus, in case of drying of the hull, the seal opened without damaging the structure. After launching, the hull returns to its sealing after 1 or 2 days. It is a very good method, but to reserve for those who can caulk and proper equipment ...

Sheet 41: Spiling

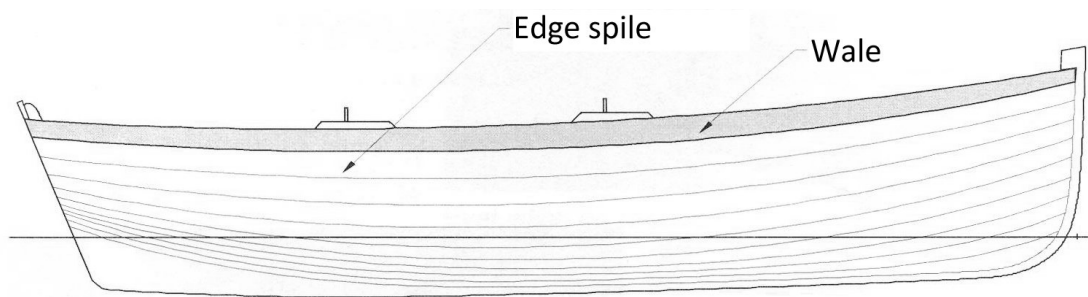
Use

Spiling is the operation that consists of drawing a hull, ie to define the exact profile to come to rest on the hull of the boat.

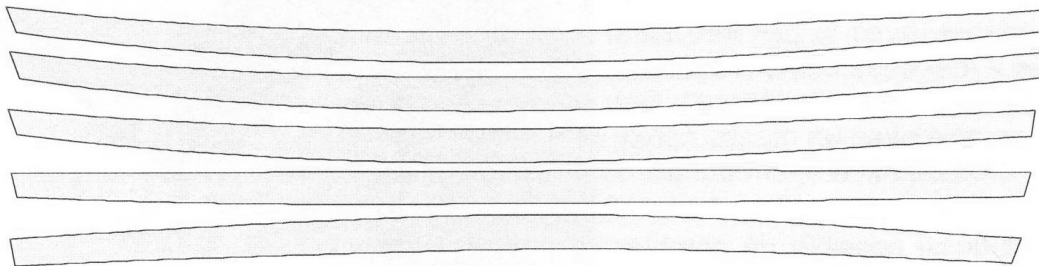
We describe here the particular case of a bounded spiled lap because it is the most common case where this method will be implemented as part of a building "modern" wood. The method described is similar in concept to that used in the construction of a traditional carvel.

Note that on a boat in small strips, it is interesting, if only on an aesthetic level, ask a wale (last bordered to top) of traditional form in time, a little thicker than other planking. This will then wale spiled the same way that the case described below.

Lap on a boat, we can also achieve wale solid wood painted, the rest being painted plywood:



Here's what look like lined the top of the boat:



The lap shell

By building a lap boat, we must bear in mind that this is the shape of the edges that gives the shape of the boat, the same way that the shape of a suit stems of cut pieces of fabric constitute it. The placement of the shell operation is essential. We must carefully and understand the method but, once lined the first installed, you will find that it is not as difficult as it seems. You be the judge! It also seems that previously the construction of boats twinkling was entrusted to apprentice carpenter.

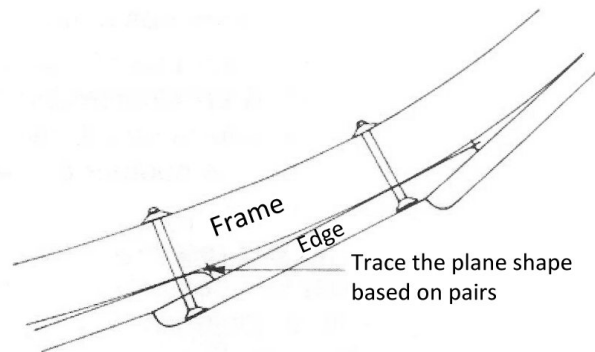
The installation begins with the plating Garboard first planking from the keel. The operations to be repeated at each board are the following:

- Spile the shell, ie make the outline of its exact form,
- The cut and fit,
- Shaping the ends, to eliminate duplication of bordered on the outcome on the bow and the table
- Put in place (bonding and / or riveting)
- Chamfer planing to receive the next leg.

The first two operations are detailed in the current sheet. For complete details, see sheets 42, 43 and 44.

The marks on jigs couples, partitions or ribs

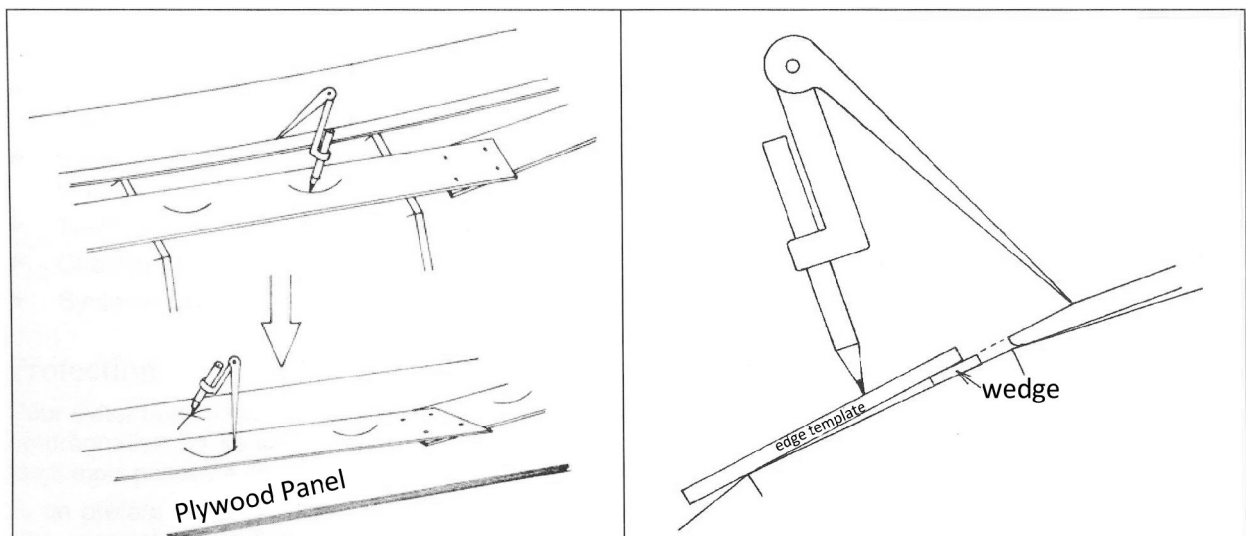
The plan shape of a ship lap is usually the transverse frames in the form of line segments. It is important to mark the templates couples, partitions or ribs on the location of each corner. On the basis of these brands that will be edged pike.



Spiling a hull

Follow the following process:

- Prepare three strips of plywood Light 8 inch in breadth to form a template hull,
- Place them on the frame, the location of the hull to ask, but without covering the side before (left figure)
- Fasten the strips to one another in their areas of overlap so much rigid, y locate the position of the table, couples and jigs bow
- Place if necessary a small shim between gauge and torque gauge hull for it to be in the same plane as the side to ask (right figure)
- Draw arcs every 20 cm (see both figures)
- Place template thus formed on the plywood panel (note the direction of scarfs and lag time, that they also reduce the rate of fall)
- See the outline of the compass lined (bottom left figure), the position of couples, extremities,
- Using a straight edge, draw a very regular curve (the quality of this line is essential to the aesthetics of the finished boat)
- Noting on each couple gauge the width of the hull, the same plot outline of the second hull,
- Cut the side to monitor and submit it fits well with the previous.



The hull that is put in place just needs to touch the templates, without forcing or depart from above. If it is not so, is that the spiling is bad. Do not be tempted to force an ill-fitting hull: it would show dips and bumps are difficult to correct later.

At first, until you are sure of yourself, you cut the hull, leaving him an inch more width, which allows an adjustment. Then we draw up the final cut after receiving the hull. This cup can be smoothed with a plane. Depending on the precision of the alignment, it is generally preferable to smoothing plane contour of the hull, even if it fails to comply fully brands templates torque.

In practice, the Garboard (first hull side keel) is the most difficult to install. There will much care. Get help in presentations so as not to break, especially in the forms before. If necessary we can relax the plywood wrapping a time in a cloth soaked in warm water. In this case, fix the side on an interim basis and do not paste until completely dry.

The following are bordered easier.

When you are fully satisfied with his work, we put the hull (in a good way) on the plywood to get the route lined symmetrically on the other side. The planking of the hull progresses by alternating port and starboard to avoid a general deformation.

Sheet 71: Benches and Floors

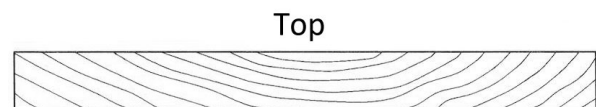
Scope

Banks (swimming, side, rear) and floor or partially decked vessel not.

Using solid wood

Preferably be used a resinous wood of beautiful quality and not too dense (the benches and floors can be an important part of weight estimate): spruce, pine, Oregon maritime pine. We may also use a red African wood light (mahogany benches, mahogany, iroko or sipo for floors, it is heavy but can easily be oiled only).

For all the massive wooden benches, in the absence of lumber on "neighborhood" (radially, so with rings vertical) position the wooden heart on it "to avoid its bowl shape with age:



Avoid too large widths of boards. 150 mm is a good compromise for the floors or decks. Failing to find good quality wood, we can either reduce the width and multiply the number of slats (but less pretty) or glue strips of approximately 50 mm wide (and returning a latte on two) form a laminated wood more inert.

Assembly benches and floors

Horizontal and submitted both to the aggressions of the rain, sun, sand and feet of the crew, usually varnished or oiled, benches and floors require fairly frequent maintenance.

It is therefore desirable to mount them in sets easily removable, allowing them to shelter for wintering or to redo protection.

Each set will be assembled by cleats attached subfloor. The connection between floor and cleats may be one of the following modes:

- Screwing from above, by covering the screw by clap of wood. The bracket must be at least 25 mm high in a wood not too soft. Note: there are special cutters that can be put on a drill that can do it yourself its clap (or stoppers).
- Screwing from below if the thickness of plates is greater than 18 mm. In this case, being generous on the number of screws and their diameter (5 mm). Pre-drill if necessary so as not to split the wood.
- Boat copper rivets.

The resulting assembly is attached to the boat by the following means which can co-exist:

- Visible screws, preferably in discrete locations (for benches or bridged, sometimes it can be screwed into a dowel through a wall). Use screws diameter 5 mm minimum.
- Jamming in a doubling or a cleat attached to a wall along the daggerboard, table ...
- Tourniquet wood or metal
- Through a peg frame.
- Jumper system (metal or leather strap) and corner.

Protection

To avoid a slippery surface, the method of protection is the most appropriate type of oil Deks Olje-(impregnation D1 only). The only constraint is that it is desirable to re-apply every 6 months at the outside about, as the wood becomes gray.

If you prefer to focus on aesthetics with a glossy finish, you can either apply a system Deks Olje-full (D1 + D2), a system consisting of an epoxy impregnating varnish followed by a high strength epoxy to protect the ultra violet (polyurethane two components).

Sheet 5: Rudder with a Pivoting Blade

Vocabulary

The rudder is the entire device providing steering the vessel, consisting in particular of the bar and blade which is the active part in the water.

Functionality

The rudder with a pivoting blade is the most commonly passed on my oars and sail small sailboats.

It facilitates the arrival of beach and stranding. Blade is weighted with a lead insert cast in situ. Blade is simply pushed down to the device. It is wound by means of a small rope that can even be omitted on smaller boats (blade goes alone in addressing the strike or is removed by hand help of a hole on the rudder)

Caution: Insert the rudder with his lead and gudgeons does not float. It is prudent to insure with a small rope.

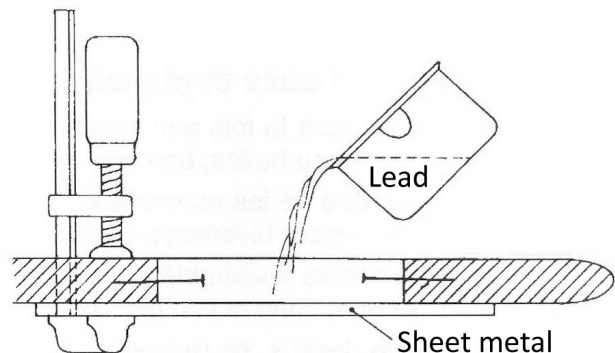
Insert Lead

The figure shows how run lead.

Points, nailed on edge in the cut before casting, hold the insert in place.

Note that we can then work with a plane to smooth the surface.

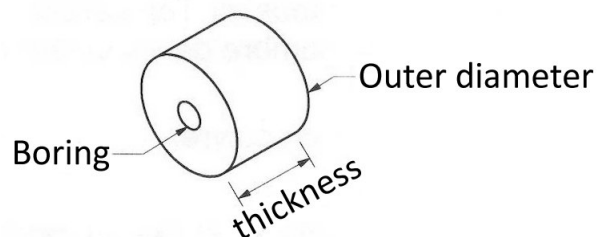
Warning: Lead is toxic. Operate at least in a well ventilated area.



Axis of rotation of the blade

This axis is an important element. Besides its function as an axis of rotation, it is now a spacer spacing of the cheeks of the rudder.

The best solution is to use axis as a brass ring. The blade is drilled in the outer diameter of the ring (30 mm for a vessel 4 to 5 m) with a few games. The inner diameter of the ring (bore) must allow the passage of the bolt which encloses the assembly (8 mm for a vessel 4 to 6 m).



The thickness will be equal to the spacing of the cheeks (add about 1 mm if the blade has the same thickness as the spacing of the cheeks). Playing on the clamping bolt (and edit the thickness of the ring if necessary) so that the blade rotates with the friction adequate: it must be operable but should not face alone navigation.

Note that you can also make this ring of plywood cut. In this case we adopt a larger outer diameter of about 60 mm and it will be enough to fix it with several screws from the outside (advantage: no nut that sticks out).

Pintles and gudgeons

Always allow a pintle lower longer than the upper pintle to facilitate implementation.

On small boats could capsize, use a latch (or tab blade) preferably stainless steel to prevent the blade of décapeler pintles.

Sheet 81: Masts and Spars

Solid wood or glulam

The masts and spars, oars or sail small sailboats can be made, either as a single piece of solid wood or glulam.

The first solution will be adopted whenever it has a sufficiently good quality wood: no or little knots speed drying and spreading the risk of deformation of the spar.

If you want to do a spar hollow to save weight or just be satisfied with average quality wood, we adopt a manufacturing multiwall (glulam). It is best to limit the thickness of the folds to 25 mm. It can also be a spar into two folds only by putting them in opposition.

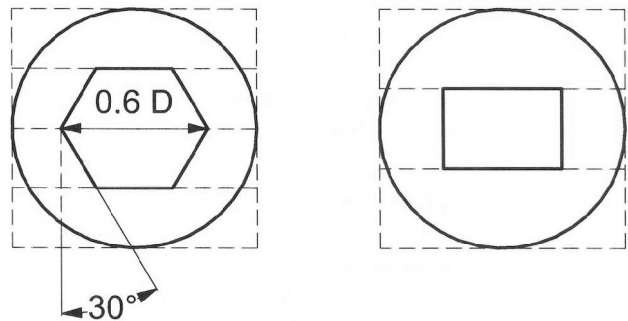
The collage will be to epoxy. It is important that the whole is laid flat during bonding, for example by using a series of trestles all set to the same height on stable ground. To tighten, you can complete the clamps with bungee cords or other devices, protecting them if necessary with a plastic film.

The wood is best suited for a small boat is the northern white pine or better yet the spruce. But they are hard to find in good quality. The Oregon pine quality is safer but its drawback is to be fairly dense and therefore heavier. Note that the adopter can reduce the diameter of about 4% for an equivalent resistance.

Hollow Spars

There are many ways to make hollow spars. For an amateur who has only a limited tool and performs only a few spars small, we can stick to the sections attached types.

Warning: the diameter is often variable and it must be taken into account by varying the width of cutting the hollow. Note that the drawing of the left, the two folds are cut circles with a jigsaw inclined. In both cases we can vary the size of the recess in only one direction (the width on the drawing and not the height)

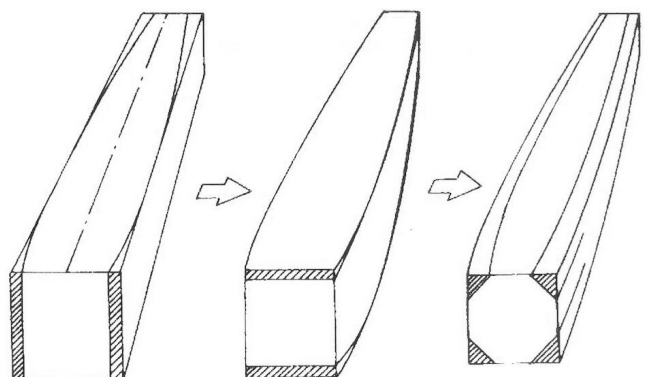


It will keep in full working areas strongly (mast partner) and those where we will put the hardware (cleats, sheaves ...).

Last round

Contrary to popular belief, it is not difficult to make a round spar. Also a round spar is much more beautiful than a square or rectangular spars, even with rounded corners.

From a piece of wood and square whose side is equal to the largest diameter. Trace the outline, taking into account reductions in diameter at the ends and planing surplus still maintaining a square section.

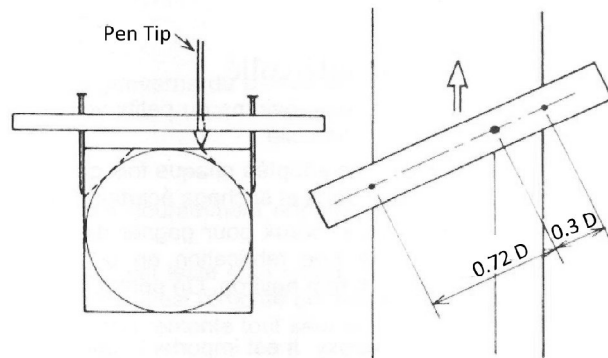


Then draw the edges of an octagon using the marking gauge shown in FIG.

Shoot down the edges until an octagonal cross section. The rest is in the eye without trace: switch to a polygon with 16 sides, then remove the sides.

It saves time by using a power planer. Anyway, the finals are at hand plane, preferably right length (jointer).

Finish with sandpaper working transversely if you want a good finish round (hold the paper at both ends by a U-turn on the spar).



D is the largest diameter at work

Note that it is not necessary to finish a round and perfect, that does not justify a boat with the character of a work boat.

For a perfect finish, using an abrasive belt sander (large) reversed (abrasive inside) driven by a drum mounted on a drill (to tinker yourself).

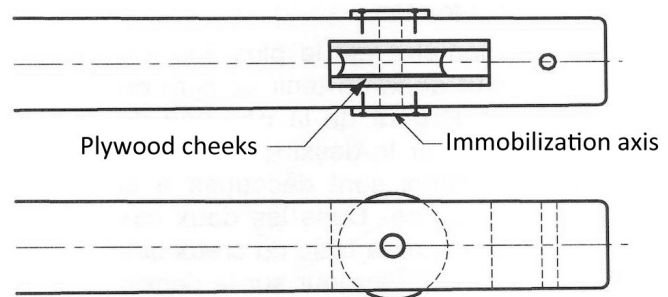
Halyard sheave

It often has a sheave halyard mast end (plus end tip-off).

This requires achieving a mortise. If the mast is glued, the mortise will be performed before bonding the folds between them. Attention to the orientation of the sheave: depending on the sail plan, it can be longitudinal or transverse.

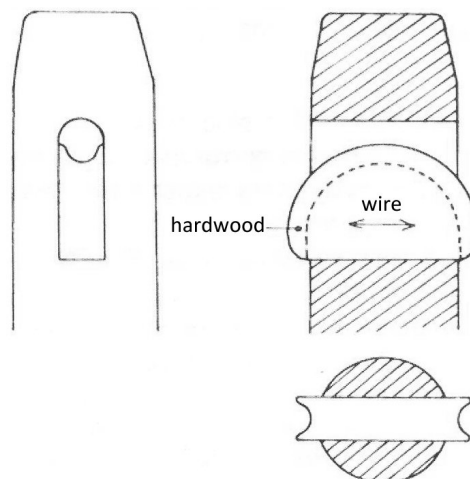
Better to start by buying the sheave diameter in the groove bottom is at least equal to the diameter of the mast at the location of the sheave. Thus we will be sure of the width of the cage to achieve.

The disadvantage of the sheave, is that the axis weakens the mast and is likely to crack under the tension of the rope. One way to avoid this problem is to glue pieces of plywood inside the cage as shown in the drawing. To stop the axis, one can point a screw or leather, a small piece of brass or glue a small piece of wood.



As an alternative to realistic, we can adopt a static system, inspired by traditional Breton Raken.

Achieving the first mortise. Then who will shape the Raken epoxy glued into the mortise, which allows to catch imperfections.



Protection

On boats sailing and rowing type, mast and spars are subjected to high friction: rocambeau, yard, dismasted during walking in rowing ... It is convenient to settle for a soak in oil-type Deks Olje D1. This product applies very fluid in many 'wet on wet "(every 30 minutes). Spars have a matt little fragile.

Suffice it to maintain by applying a layer occasionally.

If you prefer a more polished and shiny finish, the system Deks Olje-full (D1 + D2) is the one I prefer. I find it more pleasant to apply and maintain a patent.

Sheet 91: Paints and Varnishes

Introduction

This sheet is not intended to say everything about a subject that deserves a book all by himself. Its purpose is only to help select the most appropriate system in the context of building a small amateur wooden boat.

There is such a variety of products on the market, such as media and application conditions, there is no truly universal solution. I give here the main systems that are proven. But we can always find other solutions have their merits.

We do not treat the implementation itself and we simply recall that surface preparation and sanding intermediaries, are the keys to success. There are many publications on the subject to which we may refer.

The focus here mainly for the protection of external hull, deck, inside an open boat.

Paint or varnish?

It is for everyone to choose between paint or varnish the boat, or that part of his boat. I just give some background information here to keep in mind.

- A painted finish is much more demanding of quality and craftsmanship of the boat: best fits, not "catching up" in epoxy putty, pads of wood screws, strict temperature conditions in case of impregnating or laminating epoxy ...
- It is also more restrictive for the maintenance of the boat. This is not a problem for a small boat stored in a garage after each use. It is however an ensured steady work for a boat that remains outside, whether afloat or dry.
- Marine plywood is made from wood that have not held the same look that solid wood. A painted plywood never authenticity of a "real wood.
- With taste and good observation of traditional boats, it can do real wonders with the paint.
- Some form of construction, particularly small lattes, fear excessive heat and it is highly inadvisable to expose such a hull in the sun on a regular basis if it is varnished or painted a dark color.

On these bases, and after reading all of this record, everyone can decide what he takes to his boat. It is desirable to make the choice from the outset, because the construction process depends (you can easily paint varnish what was planned, but not always the opposite.)

In the following we distinguish the following systems recommended that the wood has not been treated or coated. It is obvious that the same boat may have impregnated zones / epoxy laminate, others not, areas painted and glazed areas and that we can standardize the systems employees based primarily on those represent larger areas.

Varnish on bare wood, not impregnated epoxy

Two cases arise:

- Nature mobile elements, such as mast, spars, rowing, bar, floors, benches removable ...
- Fixed elements such as the hull itself or simply gunwale strake, table, curved benches fixed, girders, etc. ...

In the case of moving parts, my preference is to use an oil-type Deks Olje D1 or equivalent. This product applies very fluid in many 'wet on wet "(every 30 minutes). The wood is of a matt who is also little slippery (benches, floors). Just keep applying a layer from time to time. If you prefer a more polished and shiny finish, the system Deks Olje-full (D1 + D2) is one that my preference for the more pleasant to apply and maintain a patent.

Because it is very fluid, Deks Olje-is ill-suited for use on fixed because the drips staining surrounding the painted parts. One exception: a beautiful wooden boat that is fully solid oiled.

In the case of conventional painted on solid wood, the most reliable system is composed as follows:

- Optional preliminary application of a dye that prevents yellowing of wood such as mahogany red (typically exists in the range of manufacturers of varnish). In addition, this product helps to homogenize the color if you have used a variety of wood species.
- Prior application of a "hard bottom" preferably bi-component. It's quite a permeating fluid is applied in several layers. The result is a hard layer that lends itself well to finishes.
- Topcoat compatible with the hard bottom in large numbers (at least 5, but more can be done). A single-component polyurethane gloss is usually the best choice. The disadvantage of bi-components, more efficient, is that it changes little to damage due to shocks or wear areas systematically and that these products are much more difficult to be removed for refurbishment, especially on soft materials.

Varnish on the wood laminate or epoxy impregnated

If the media is laminated epoxy method seen previously no longer applies. It then proceeds as follows:

- Subject to compatibility, the use of a dye is recommended on bare wood before application of epoxy.
- After sheathing or after impregnation epoxy layers, applying a consistent painted with epoxy and with a strong ability to filter ultra-violet. In practice, this patent will be a two-component polyurethane because it seems that the compatibility of polyurethane varnish-component is less obvious (it is unfortunately very difficult to obtain guarantees from suppliers, since resin and varnish are not the same mark). We are even beginning to see the market for epoxy resin (RESOLTECH).

This system is mandatory if the laminated substrate (hull small laths or plywood Okoume in particular), with corresponding benefits (resistance to abrasion, shock ...).

Its disadvantage is that it is less validated the use of more conventional products, including with respect to the difficulty of rebuilding that always end up win after a few years. On the other hand, the two-component products are less easy to apply. They are especially well suited to professionals who work at the gun and may reduce the number of layers and thus the time of labor. Therefore, absent a strong justification for epoxy impregnation, the use of more conventional system in the preceding paragraph seems preferable for the amateur.

Paint on bare wood, not impregnated epoxy

If the boat is regularly stored under cover, or if one is not afraid to do some restoration work of painting from time to time, or if one wishes to emphasize the aesthetic and have a large selection color, or finally if the boat is mostly solid wood, a traditional system based paint should glycerol altogether. It is easy to implement, easy to maintain, although its durability is less than the modern products we'll see.

If possible, choose a professional quality paint and take advantage of the opportunity that exists to prepare the color of their choice from a swatch.

The first layer or layers, depending on the absorbency of the wood will be diluted with white spirit or better at Rustol. Then apply 2 or 3 coats. It is not necessary to multiply the layers, if you think then add regularly. A clean sweep will be made when the number of layer or film degradation can no longer get a quality and satisfactory protection.

If you want to improve the durability, especially for vessels remaining outside, or if the support is mostly plywood, we apply a more modern system based on single-component polyurethane paint, preceded by an appropriate primer, as as recommended by the manufacturer. There are also several grades of primary, including epoxy primers.

Paint on wood or laminate epoxy impregnated

As for varnishes, we will then use a system compatible with epoxy, polyurethane generally mono-or bi-component. The difference with the patent, is that we may, following the advice of the supplier, first apply the epoxy primer suitable one, and then continue with the topcoats.

Again, two-component paints are more efficient but less easy to apply. The single-component polyurethane seems to be a good compromise for the homebuilder who has built his boat, is a priori more suitable to provide subsequent maintenance.

The choice of colors

I would not get here in an aesthetic debate, except to reiterate that a wooden boat can, through his painting or his nail, turn into works of art. I'm just some remarks:

- Beware of varnish and the dark colors on the hulls into small strips. The best way to cause irreparable damage virtually is to paint the black hull and then leave upside down in the sun in summer with water (reverberation) next.
- Lap on the hulls, light colors make clear the clapboard while the darker colors hide.

Underwater parts

I recall that the underwater parts are the submerged hull.

On small boats that are often out of the water, the use of antifouling is not recommended. We will implement a system similar to the hull. Hulls painted, except for very small vessels such as canoes and kayaks, are preferably painted below the waterline.

On boats transportable on trailer but still spend much of the season in the water, apply an antifouling die hard, accepting the dry periods and are highly resistant to abrasion. The same choice will be made to the hulls stranded in port tide.

Tracing the waterline

Draw a horizontal line. It is unsightly back to the waterline at the ends as we see sometimes. The only interest to do a little bit is to take into account variations in light boats base (the base is the pitch of the hull). The route of flotation will be placed several inches above the waterline real. This refines the silhouette of the boat and keeping grime that focus at this level. In addition the boats are often more depressed than the plans of architects (in my case, the plans forms are drawn with a moving average, which is neither that of the lightship, nor the boat fully loaded).

To draw the waterline, there are some conventional methods:

- If the boat is small enough and enough ground plane (concrete slab), the level up, if necessary by taking odds on the plans. It suffices then to take a dowel cut to the proper height and the walk around the hull marking the position of the waterline.
- If the boat is not level and it is difficult to move, trestles at each end at the proper height and tighten a wire that is moved successively to mark points along the hull.
- If the boat is level but you can not use the ground, another option is to use a pipe filled with water that is moved around the boat, the other end being maintained sufficiently high. There are "level" to be placed at each end of the pipe that allows a more accurate reading and more convenient.

We can also paint a band of color (usually white) to separate vitals and topsides. It's very nice but of course more work.