PART II – Building the MDV-1

The MDV-1 is a simple, easily–driven, seaworthy boat intended for both rowing and power propulsion. Its general-purpose design is suitable for inshore waters around the world.

Because the boat is moderate in size and light in weight, it can be easily pulled up on the beach. One or two fishermen can readily handle the boat and, under normal conditions, a 5 hp engine provides sufficient power. For waters with more current, a 10 hp engine may be needed; however, since the boat was not designed for speed, there is little to be gained by using a larger engine.

To construct the MDV-1, a mould is required. If a mould does not already exist for this boat, one must be made. A mould is constructed using a plug that looks just like the finished boat on the surface. Since the plugs' only purpose is to provide a base for lamination of the mould, it does not have to be as rigid as a boat.

The boat plug consists of the main plug jig, or hull plug, and separate centre and aft thwart plugs, and a deck plug.

MAKING THE PLUG

A plug consists of a number of separate parts that can be made of wood, gypsum, metal or any other material which is not attacked by styrene monomer.

It is very important to remember that the surface of the mould (and the boat) is mirrored in the surface of the plug. The smoother the plug, the better the finished boat will be and look. Achieving a good finish involves the elimination of any imperfection by the use of putty and by sanding and polishishing the resulting surface. When using a porous material like wood or gypsum, it is important to finish the plug with a good two-component paint which is resistant to styrene monomer.

An old wooden boat may also be used as a plug for an FRP design. Information on this approach is contained in Appendix 1.

The frames and sections of the 4.5 m MDV-1 are shown in the "LINES" drawings in Figure 39. The scale of the original drawings is 1:20. The offset table in Appendix 4 could also be used.

The principle of working with wood and setting up the frames is set out in the *FAO Fisheries Technical Paper 134, Rev. 2: Fishing boat designs: 2. V-bottom boats of planked and plywood construction.*

A stable structure can easily be achieved by building the frames, shown in Technical drawing "PLUG JIG" (Figure 40), out of plywood or fibre boards. See also the subsequent picture (Figure 41).

FIGURE 39
Technical drawing

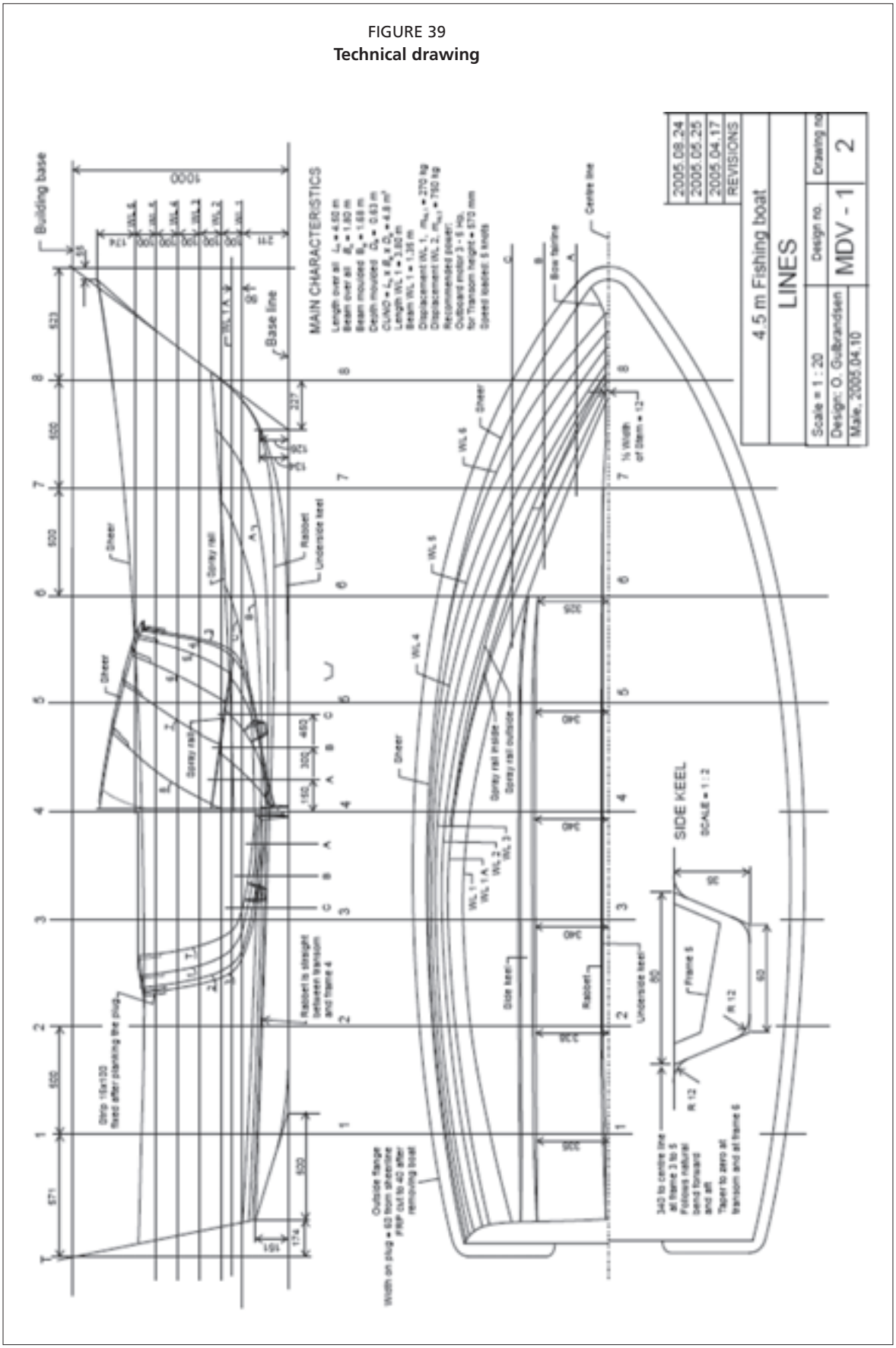
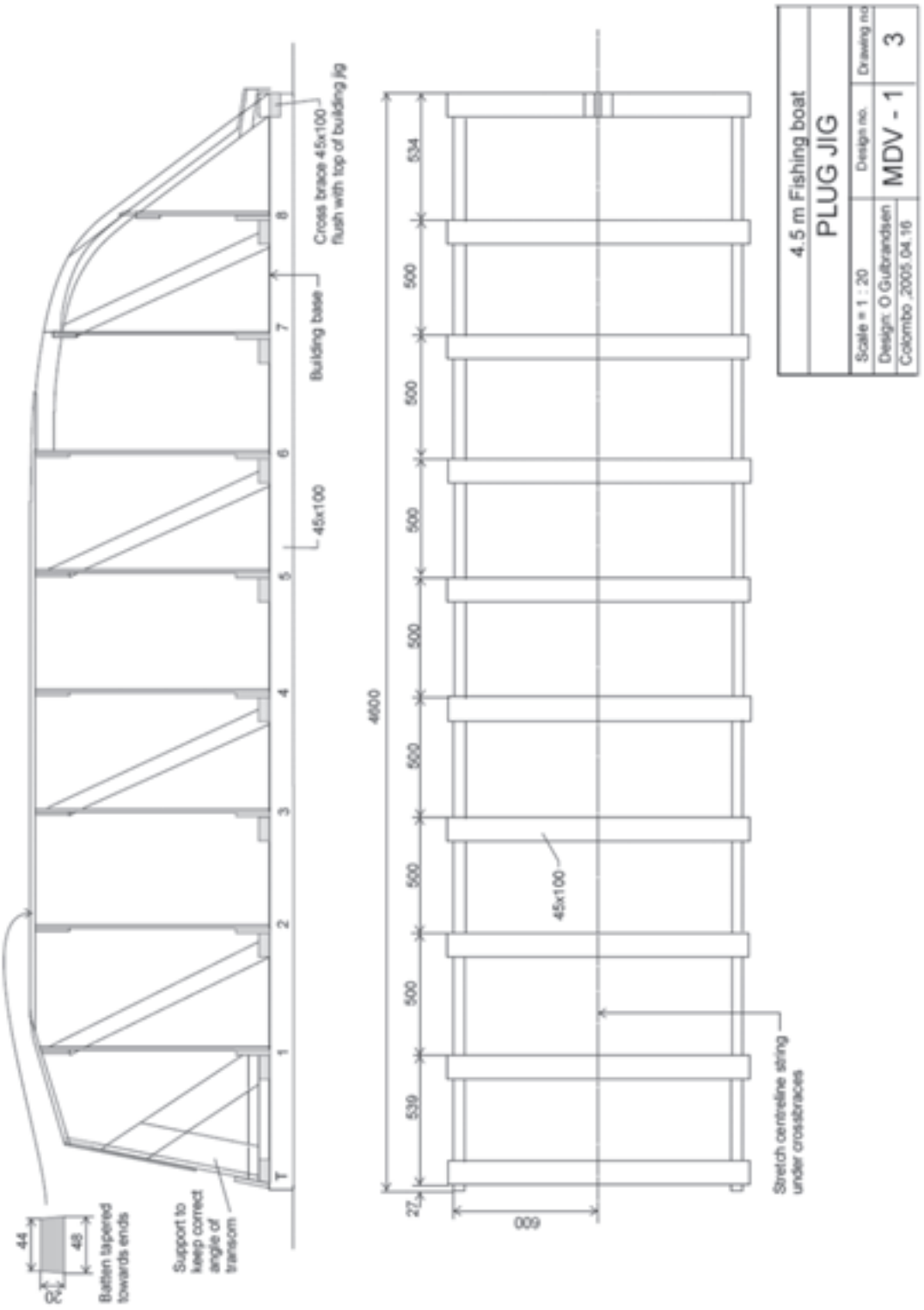


FIGURE 40
Technical drawing



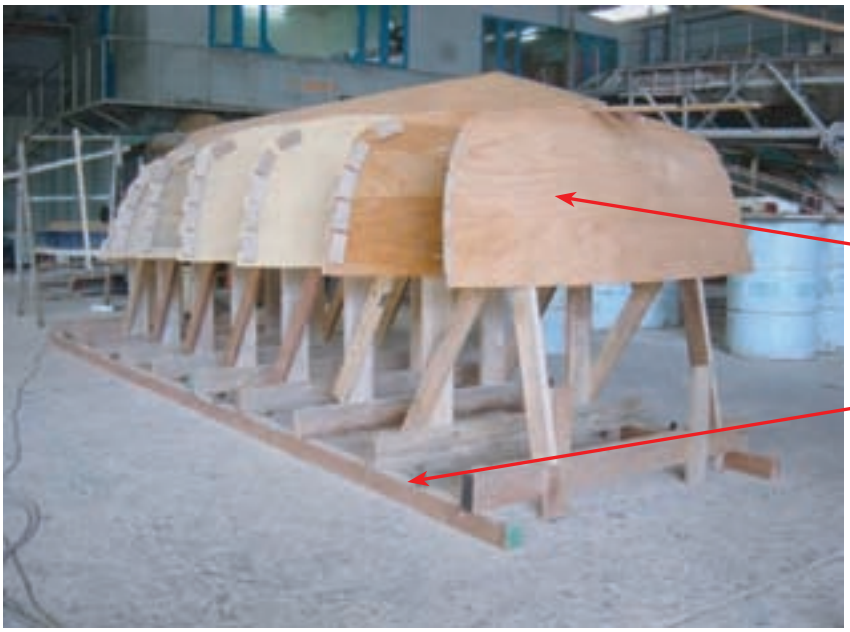
There are different preferences for the type and dimensions of the wood battens used to run horizontally along the surface of the plug. In this example, wooden strips have been used, 12 mm wide by 45 mm high on the relatively flat surfaces on the sides of the boat, and 12 mm wide by 30 mm high on the more curved surfaces where the sides become the bottom of the boat. The strips are fastened with small nails horizontally, at intervals of 5 to 10 cm, along the length of the boat just where the wooden blocks have been added on the frames.

The difference in height between the 45 mm and 30 mm battens must be roughly levelled out before beginning to put on the plywood.

Strips of 3 mm plywood (for example, Fancyply) should be attached diagonally to the battens (see Figure 45) for better surface stability and also because they shape more easily over the chine.

In addition to tacks, some glue should also be used to fasten the strips.

FIGURE 41



This picture shows the plug jig set up and ready for the addition of hotizontal wooden strips or "battens".

Small blocks of wood are fastened to the perimeter of each frame to provide better attachment for the nails holding the battens in place.

In this boatyard, the frame has been bolted to the floor. This improves the frame's three-dimensional stability and makes working easier to apply pressure during puttying and sanding.

FIGURE 42
Technical drawing

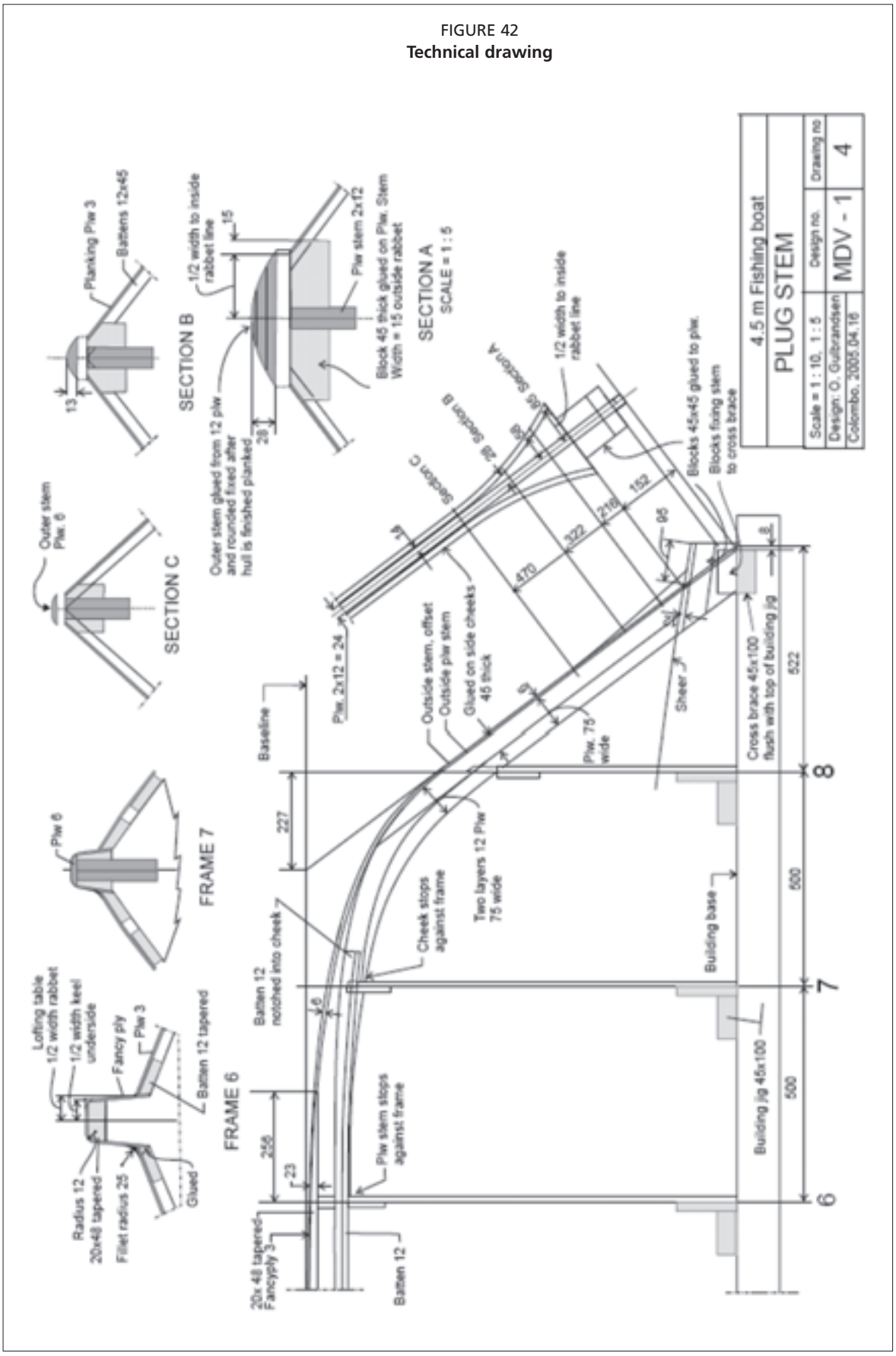


FIGURE 43
Technical drawing

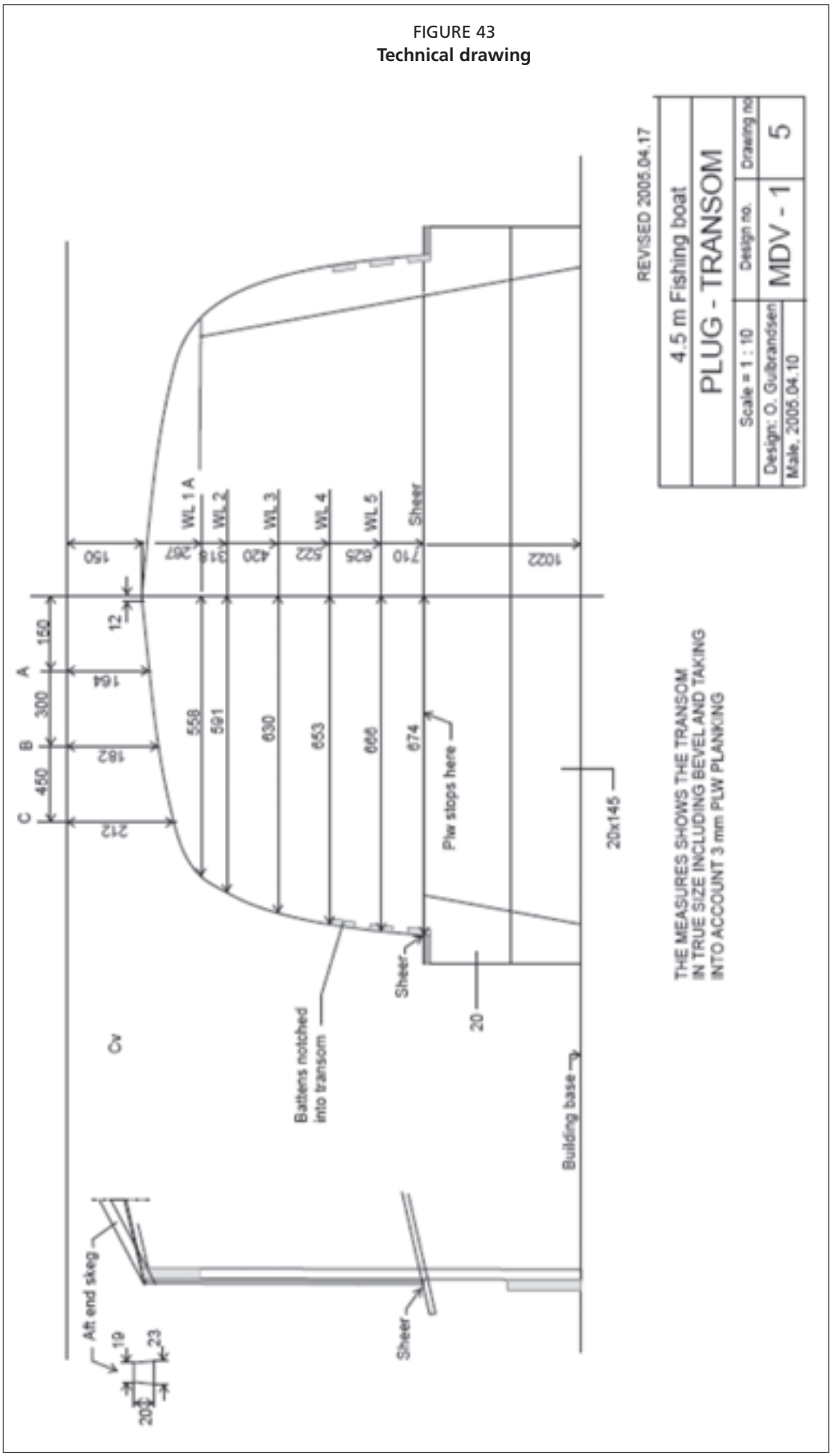


FIGURE 44
Technical drawing

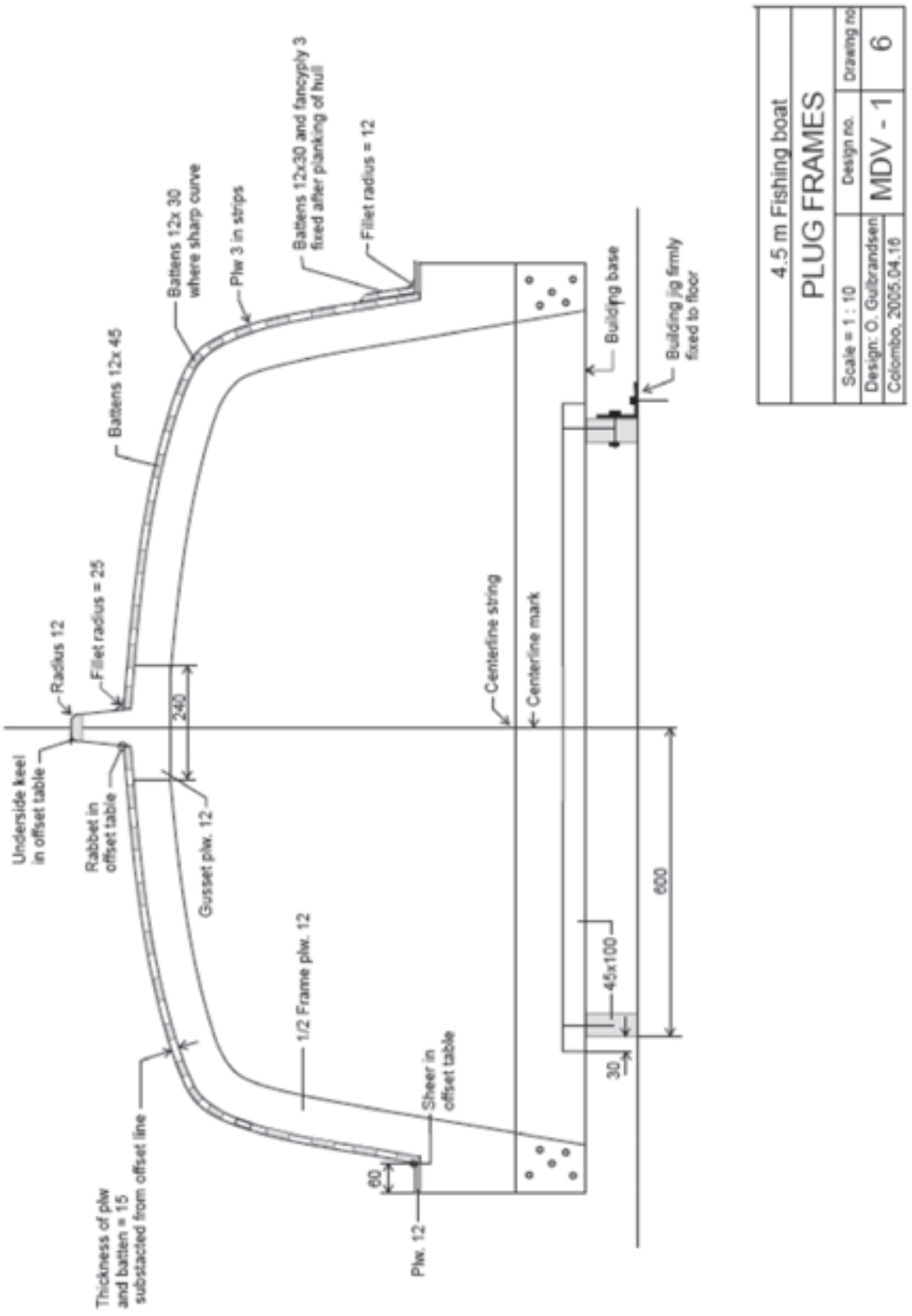


FIGURE 45
Principal build up of the surface of the plug

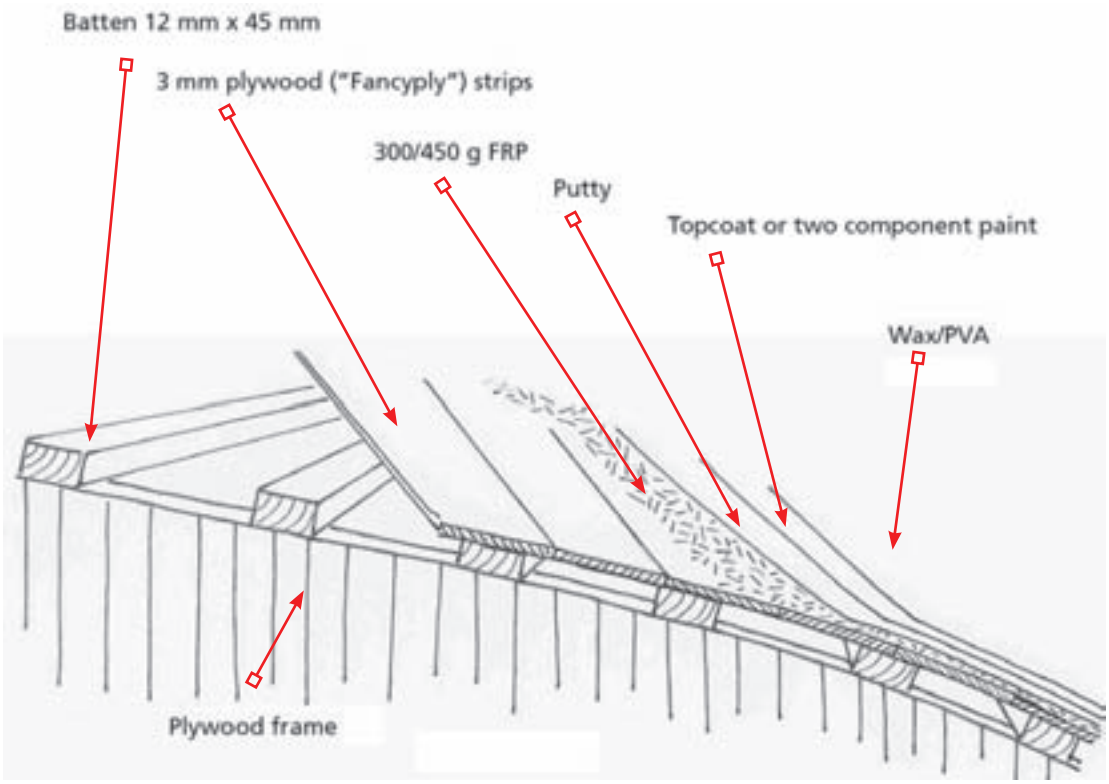


FIGURE 46
Photo showing some details of the stem

Note that on the "PLUG STEM" (Technical drawing 42) some differences in measurements from the "LINES" drawing (Technical drawing 39) are shown.

FIGURE 47

This view shows the frame with all the battens in place.

The next step is to start fastening plywood planking (strips) diagonally over the battens.

FIGURE 48

Sometimes, the battens (wooden strips) are placed further apart, and a thicker plywood "skin" is used on top.

When a thicker plywood skin is used, it is necessary to take an equal measure off the frames to compensate for the extra thickness.

Once the plywood is securely in place, the surface has to be evened off and smoothed with sandpaper.

FIGURE 49

After sanding is complete, the wood surface is sealed / primed and prepared for the laminate layer.

If only one mould is to be made from this plug and/or if the plug is to be painted with two-component paint, there is no need for the layer of fibreglass laminate.

FIGURE 50

A layer of 300 or 450 g fibreglass mat is laminated over the plug to ensure its strength and stability.

The surface of the plug is then built up with several layers of putty, and sanded to even out any imperfections in the lines.

FIGURE 51

Here is the plug almost ready for gelcoating. Only the side keels need to be fitted on and blended in. Different colours of putty are used to make it easier to recognize locations of imperfections.

For best results in achieving an even surface at this stage of the finishing, hand sanding with long boards should be used rather than power tools.

FIGURE 52

To achieve a proper high-gloss finish, topcoat or two component paint has to be applied over the putty.

If topcoat is chosen it has to be water-sanded, starting with a grit no coarser than 240 and ending up with grit sizes of 1 000 to 1 200 or even as high as 2 000.

The hull plug is finished off by buffing and polishing with wax.

NB! A flange for connecting the hull to the deck has to be made on the hull plug as shown on Technical drawing 44.

FIGURE 53
Technical drawing

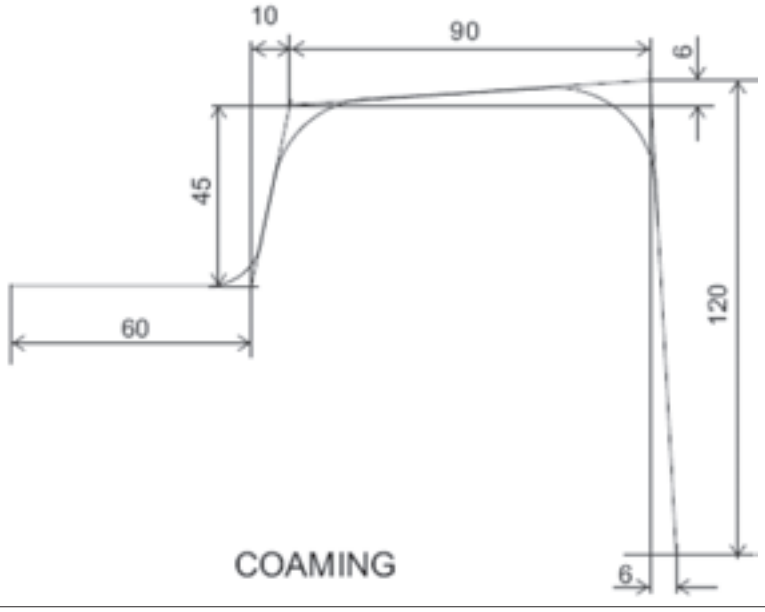


FIGURE 54

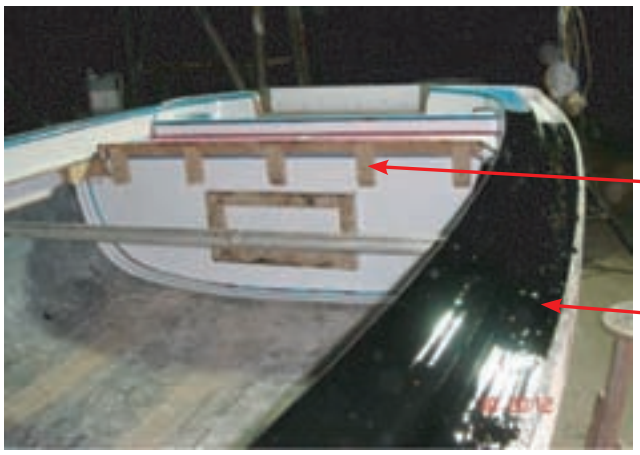
Before making the deck plug, the hull plug and mould have to be finished and a hull to be laminated (to be used to make the deck plug).

Next, steel pipe braces are laminated into the hull to keep the sides in position.

The coaming measure- ments are provided in Figure 53.

Vinyl anti-skid patterns are also glued in place to make a perfect "negative" print in the mould.

FIGURE 55



All the parts of the plug are shaped and fitted carefully to make sure all the laminated parts of the resulting boat will fit together.

In this picture, the aft thwart, containing a locker, is being fixed in place.

The first black layer of tooling gelcoat is also being painted on the deck plug in preparation for building the deck mould.

FIGURE 56

Separate thwart plugs also need to be constructed before beginning to make the mould. The centre thwart plug is shown at left.

The fit of the separate plugs must be checked against the hull plug before any of the moulds are built.

MAKING THE MOULD

Most moulds in common use are "female" moulds. This ensures a really smooth finish on the outer surface of the resulting boat when the cured product is pulled out of the mould.

To achieve such a finish, the plug must be worked up to a smooth finish and a perfect gloss before the mould is built. Being a mirror of the plug, every blemish is transferred to the mould and will show on the final product.

The lifespan and value of a mould is largely determined by the surface quality of the plug. If improvements or repairs to the surface of the mould are needed after the mould is pulled off the plug, valuable time will be lost. As long as the surface of the mould remains unbroken, only polishing or buffing is needed between uses and more products can pulled off the mould in a shorter period of time.

Prepare the surface of the plug with 5 to 10 layers of wax to achieve a perfect finish. If the quality of the finish is in any doubt or if the gelcoat on the plug was not given sufficient time for a proper pre-cure (2 to 3 weeks), a PVA anti-release agent should be applied to the surface of the plug.

FIGURE 57

Real tooling gelcoat must be used on the plug, not just regular gelcoat with a black color. Tooling gelcoat is generally harder than regular gelcoat and can hold a higher gloss. It also shrinks less.

A decently thick layer must be built up by applying at least 3 coats of tooling gelcoat with a 3 - 6 hour cure in between.

When all the coats have been applied, let the gelcoat cure for 3-6 hours, and then apply a surface layer.

FIGURE 58

The first thin layer of tissue mat /surface veil has to be put on carefully, worked completely free of air and left to be cured separately. If a tissue mat is not available, a 300 g mat can also be used or both can be used wet.

It is important to apply a good coat of resin to the surface of the mould before the surface mat is added. This will ensure that the mat is impregnated from the bottom, "pushing" the air out.

Careful butt-joining of torn edges is preferable the overlapping of cut edges as shown in this example.

The last wax layer must have been left to dry for at least 12 hours. After this drying period, apply one layer of mould wax and let it dry for at least 4 hours. Then, apply the PVA release film. This should be done with a piece of chamois, wettex or similar material. The chamois or cloth should be saturated with PVA solution, carefully squeezed out and applied lightly to build up a thin and even film.

NB! If the surface of the plug has been treated with fully cured two-component paint and the waxing has been done with care, the release film should not be used.

The procedure for building up the laminate to create a mould is more or less the same as for building up the laminate to create a boat (see Basic laminate building). It is **very important** to ensure that the surface layer is totally free of trapped air.

Special tooling resins are also available that are formulated to withstand better the repeated heat from exotherm during curing of succesive laminate layers and the strain of demoulding.

When using common GP polyester, no more than 3 layers a day should be laminated to allow the styrene to evaporate and avoid heat build up and excessive shrinkage. For this size of boat, a 10 mm thickness of laminate should be sufficient for the mould.

FIGURE 59
Cross-section showing the build up of laminate in a mould

Stiffeners made of FRP, plywood or steel must be laminated to the mould to ensure that it retains the intented shape after being pulled off the plug. The stiffeners and frames should not be fitted until the surface layers of the mould have cured for at least two weeks. This avoids them printing through.

FIGURE 60

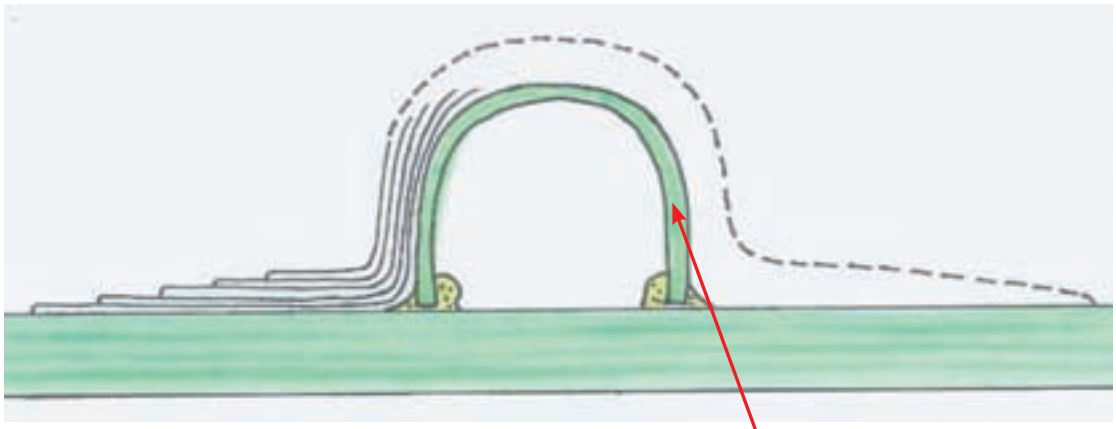


FIGURE 61

These figures show how stiffeners made from preformed tubes of FRP are fixed in place with putty and then laminated in with at least 5 layers of 450 g mat.

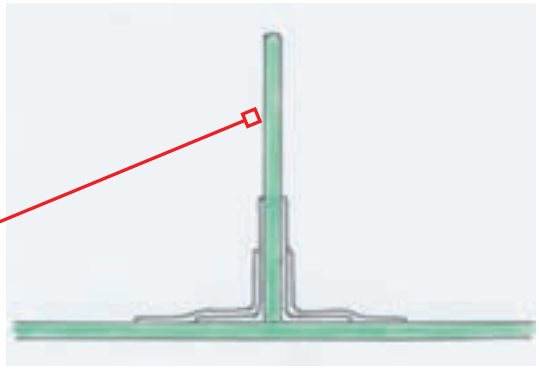
These additions greatly improve the rigidity of the mould while not adding much weight.

FIGURE 62

Here the finished mould is shown with stiffeners attached and a "cradle" beneath it.

The cradle is made of plywood supports, laminated in place in the same way as the FRP tubes were attached to the mould (see Figure 63).

FIGURE 63



A layer of gelcoat and fibreglass has already been applied inside the mould – the beginnings of the first boat to be made.

FIGURE 64

The deck mould ready for use.

FIGURE 65

A finished mould for the centre thwart. All the separate parts (structurals and other items) of the boat need their own mould.

Ideally, a new mould should be placed in a tent, heated to maybe 40 ºC, to pre-cure for a couple of days. In a tropical climate, maintaining the high temperature should be an easy task. The pre-cure should drive off most of the active styrene on the tooling surface and help prevent the fresh mould from sticking to the gelcoat on the first boat produced. After the first boat is completed and freed from the mould, prepare the mould's surface by wax, as described earlier in this chapter, before starting work on the second boat.

An inexpensive way of "breaking in" the mould involves construct of two "throw away" products built with extra hardener to create a "hot" gelcoat and two layers of laminate. This will helps to prevent the first real boat getting stuck in the mould.

While an easy precaution, the use of PVA mould release gives a poor surface finish. More rubbing and polishing will be required to achieve a proper finish on this boat.

NB! Tooling gelcoat is not UV stabilized so the mould should be protected against direct sunlight when it is being stored.

BUILDING THE BOAT

Prepare the mould as described in the previous section "Making the mould". Building the actual boat starts with the application of the proper thickness of gelcoat to the prepared mould. Two layers applied by brush (0.4 to 0.8 mm) are sufficient.

Laying down the skincoat laminate and bulk (structural) layers are the next steps. The processes for this work are described in an earlier section called "Basic laminate building" and according to the lay-up schedule set out in Figure 69. Appendix 3 may also be used.

FIGURE 66

The mould is prepared with wax.

Two layers of gelcoat are applied.

FIGURE 67

A skincoat laminate layer is added.

The main (structural) laminate layers are built.

FIGURE 68
Technical drawing

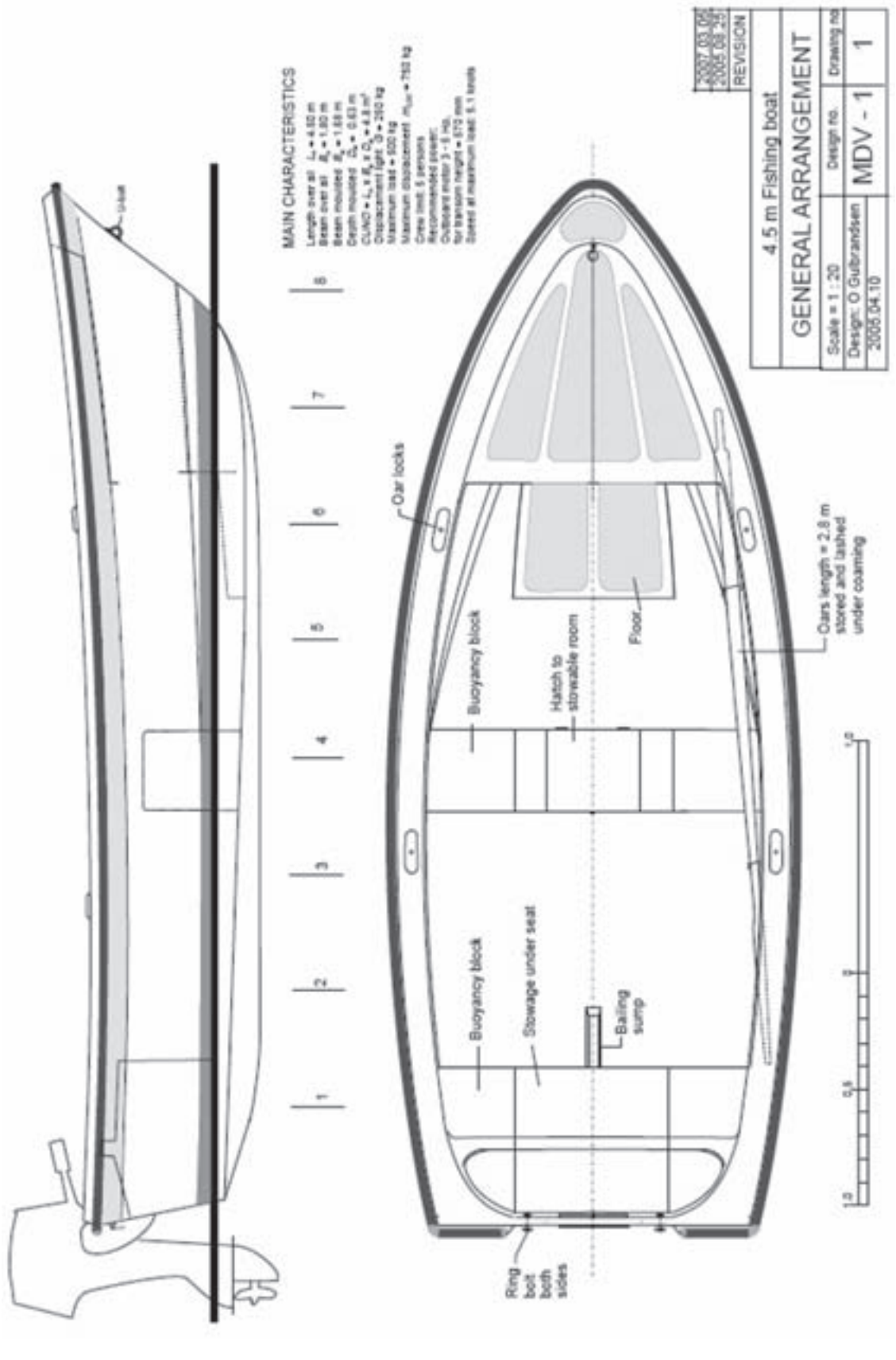
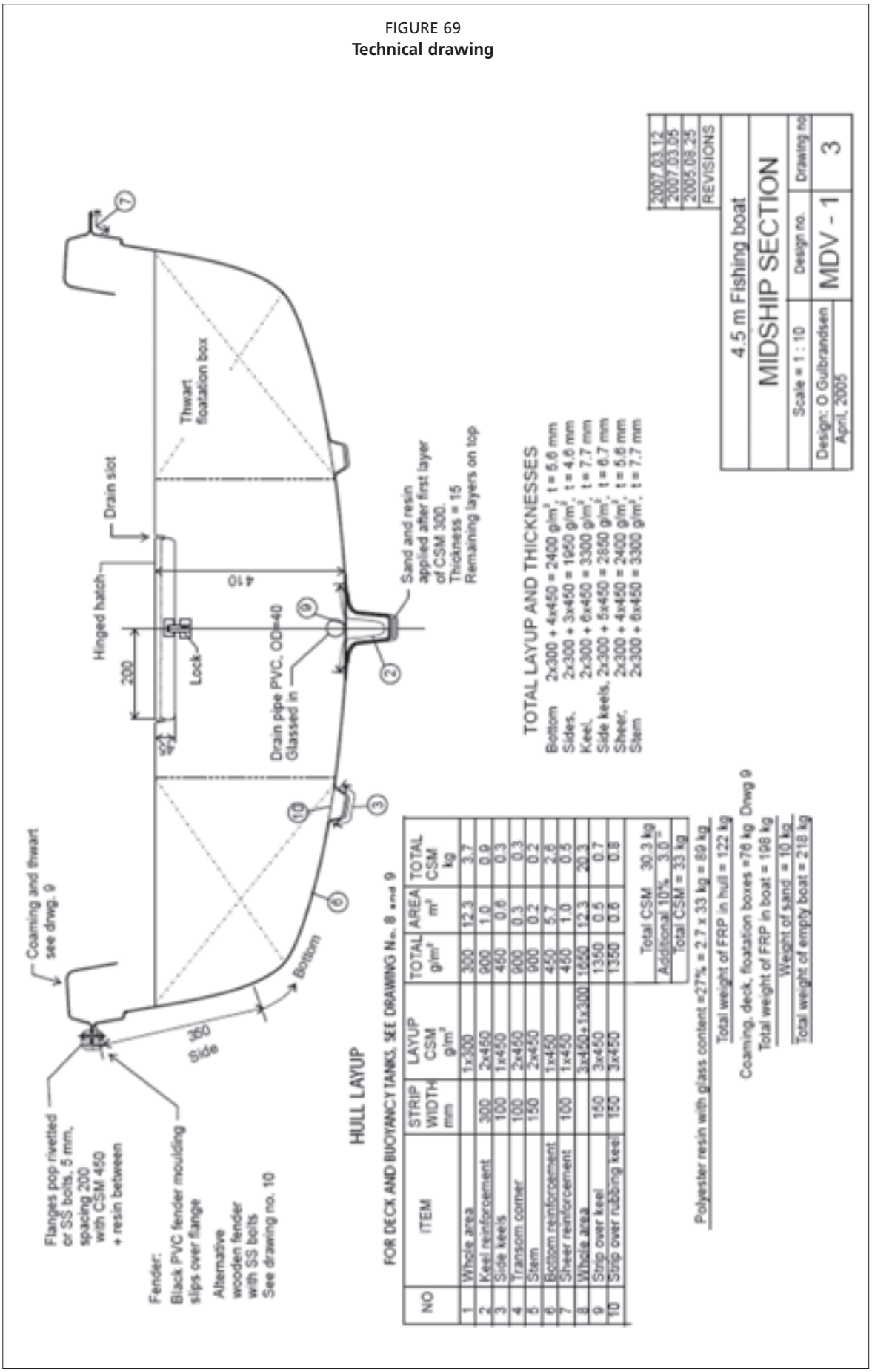


FIGURE 69
Technical drawing



NO	ITEM	STRIP WIDTH mm	LAYUP CSM g/m²	TOTAL g/m²	AREA m²	TOTAL CSM kg
1	Whole area		1x300	300	12.3	3.7
2	Keel reinforcement	300	2x450	900	1.0	0.9
3	Side keels	100	1x450	450	0.6	0.3
4	Transom corner	100	2x450	900	0.3	0.3
5	Stem	150	2x450	900	0.2	0.2
6	Bottom reinforcement		1x450	450	5.7	2.6
7	Sheer reinforcement	100	1x450	450	1.0	0.5
8	Whole area		3x450+1x300	1650	12.3	20.3
9	Strip over keel	150	3x450	1350	0.5	0.7
10	Strip over rubbing keel	150	3x450	1350	0.6	0.8

FIGURE 70

The transom is strengthened by adding two layers of 18 mm plywood bonded together for a total of 36 mm.

The sides must be tapered at least 45° before being laminated with 3 layers of 450 g mat.

Any drain holes for the engine well must be properly sealed to prevent water from coming in contact with the plywood.

FIGURE 71

The deck is strengthened by laminating stiffeners into the deck as shown at left.

In this example, the stiffeners are dried wood. Make sure the end pieces of the wood are cut and properly sealed with FRP.

Plywood, PU foam and preformed FRP tubes can also be used as moulds for FRP stiffeners. Another option is to make a sandwich with structural foam.

FIGURE 72

In both these pictures, inserts of plywood can be seen laminated into the deck.

These inserts will support the fastening of necessary deck hardware and also increase the stiffness of the structure.

FIGURE 73
Technical drawing

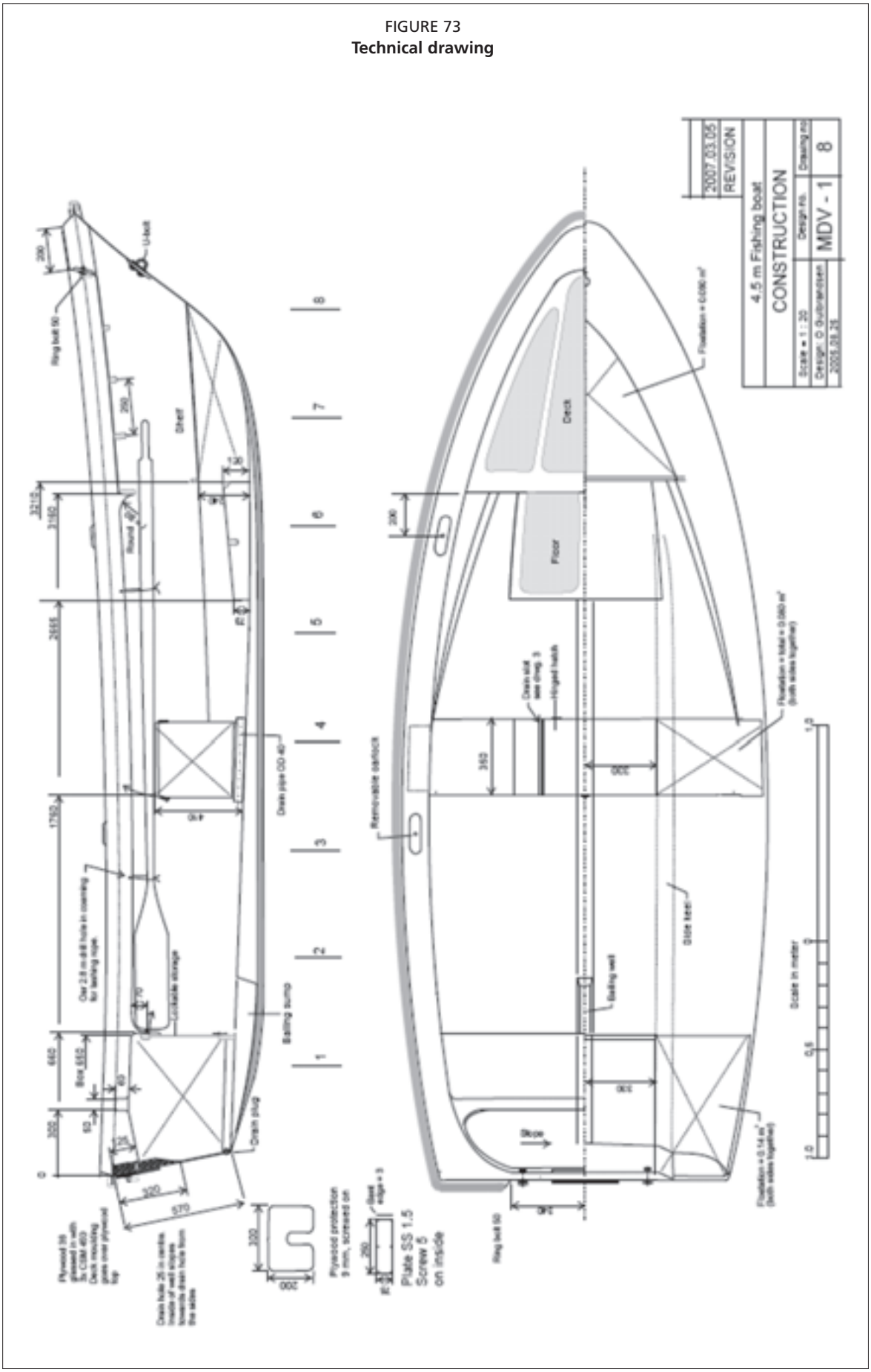
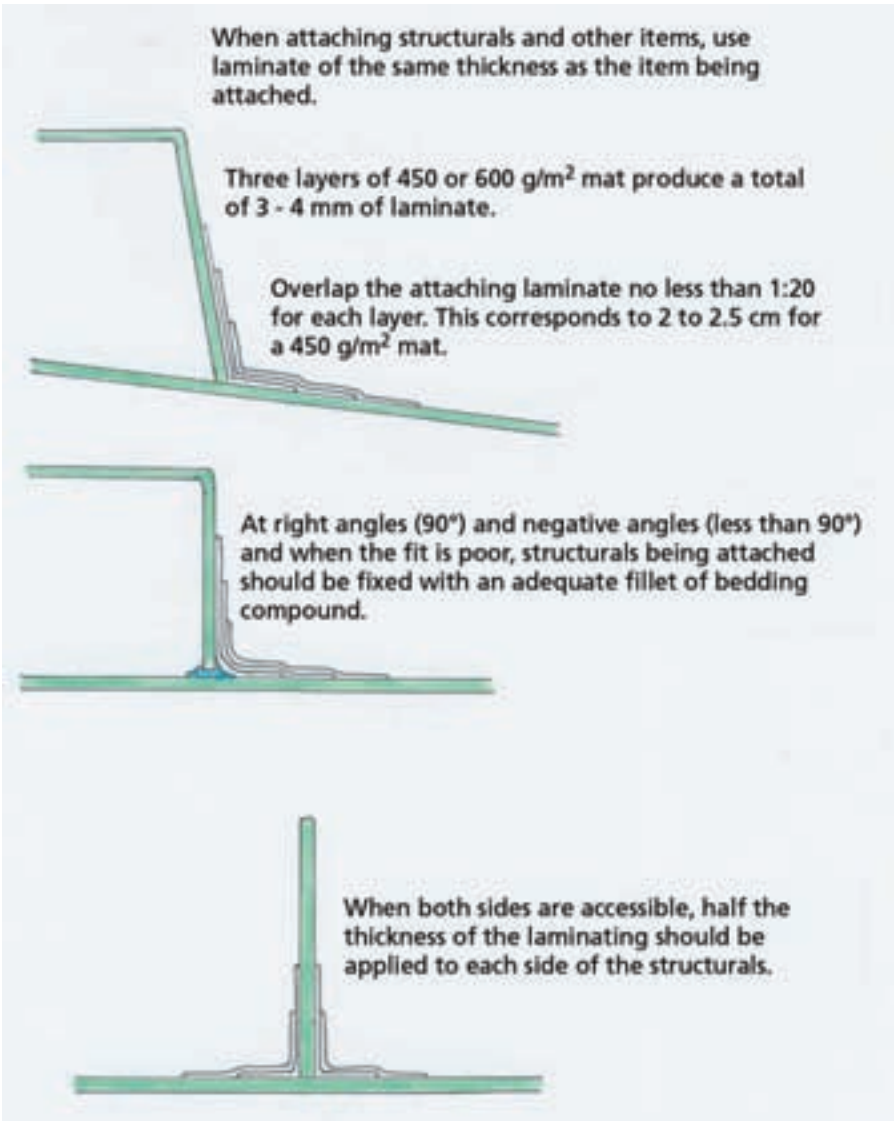


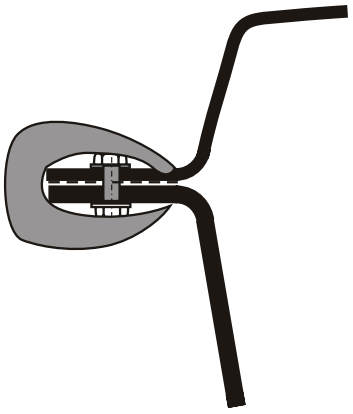
FIGURE 74
Laminating of structurals and other items



When preparing to attach the deck to the hull, a disc grinder should be used to grind the two flanges very flat and produce a rough finish. Two layers of laminate using 450 g CSM must be applied on the flange and the two parts clamped together to cure.

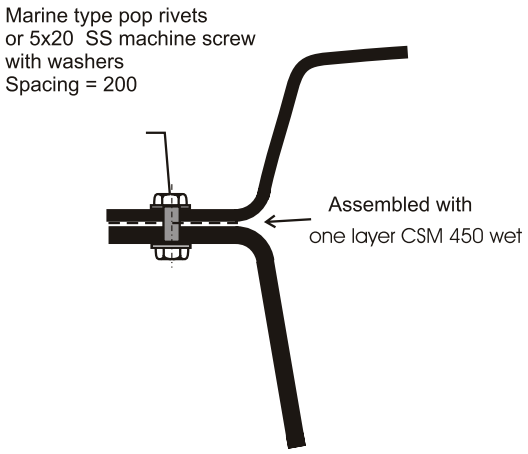
An even better, but slightly more expensive way, of fixing the two halves together would be by using Polyurethane or MS construction glue as a bedding compound. This glue should also be used to seal/bed the hardware, bolts and screws while mounting them. If mechanical fasteners are not used, a simple clamp could be made and used to keep the two halves together while the FRP or bedding compound is hardening.

FIGURE 75
Technical drawing

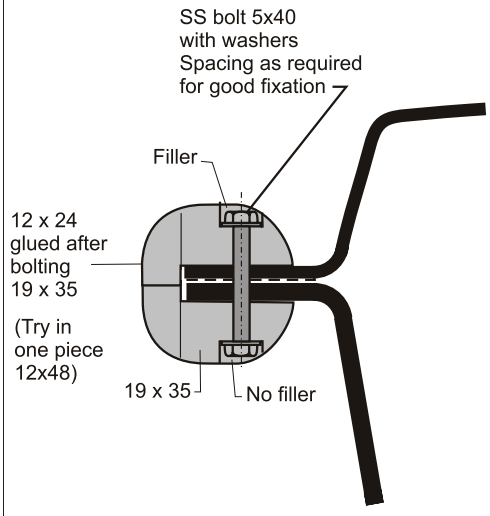


ALTERNATIVE PVC FENDER

Heated in hot water before application



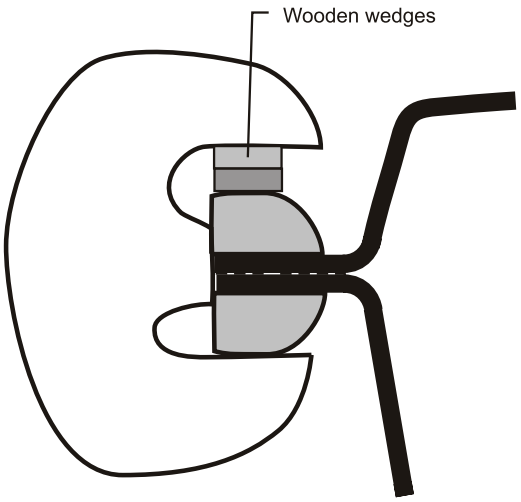
FLANGE ASSEMBLY



ALTERNATIVE WOODEN FENDER

Fixed after assembly of flanges

Use hardwood with high rot resistance



Clamp from 18 - 20 mm plywood

4.5 m Fishing boat		
HULL - DECK JOINT		
Scale = 2 : 1	Design no.	Drawing no.
Design: O Gulbrandsen	MDV - 1	10
Date: 2005.08.25		

FIGURE 76

This picture shows details of the storage area in the forward part of the boat.

PU foam can be poured into the flotation space below the storage area.

The edges have been ground in preparation for laminating.

FIGURE 77

This photo shows PU being poured into the flotation space. The correct volume of foam needed to fill the space must be carefully calculated. Manufacturer's directions concerning temperature, mixing ratio, and rate of expansion of the foam should be understood and carefully followed.

Approximately 1.6 kg of liquid PU makes 0.028 m^3 (1 ft^3) of foam.

FIGURE 78

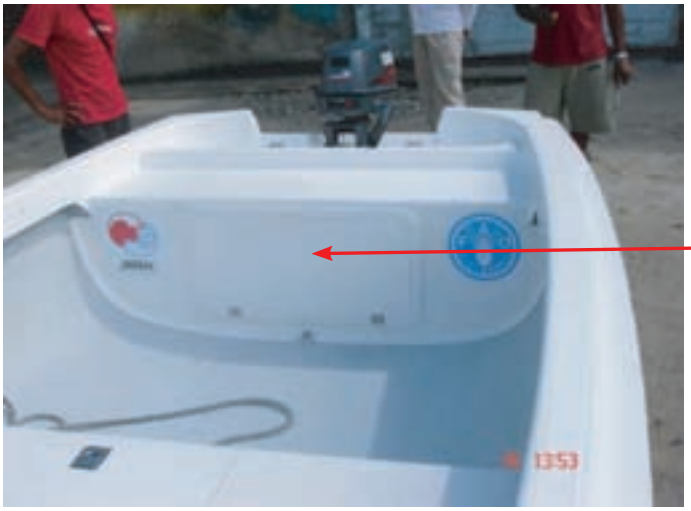
Thwart fixed in place, with oars stored out of the way.

FIGURE 79

Weighing the boat is a good way to calculate how much polyester and fibreglass has been used during construction.

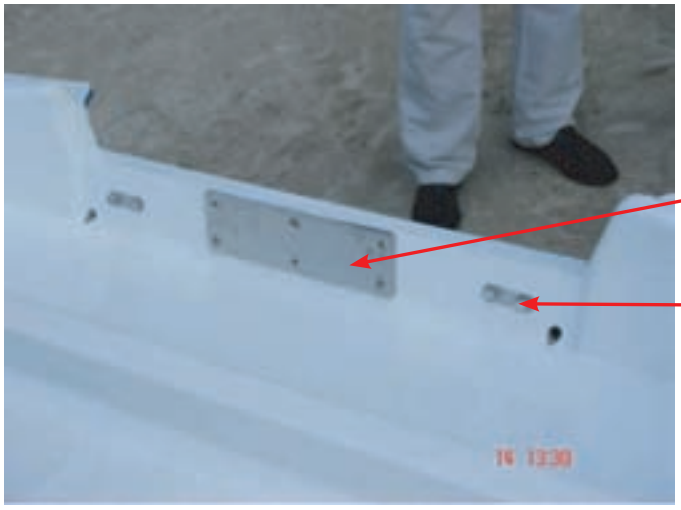
This picture shows the flotation spaces and the storage area aft.

FIGURE 80



The aft storage area is closed with a weathertight hatch in the finished boat.

FIGURE 81



A reinforcement plate made of steel or aluminium is added to provide extra support for the engine mount.

Installed location of U-bolts shown in Figure 82.

FIGURE 82

Eight (8) mm stainless steel U-bolts to be mounted in the bow and the transom as shown in Technical drawing 73.

FIGURE 83

Oarlocks can be made in different ways.

This is an example of one made locally in the Maldives.

FIGURE 84

The drain plug is mounted in the transom with two ½ inch number 8 taper head screws.

The drain plug must be completely sealed with bedding compound when mounting.

FIGURE 85

A 5 hp outboard engine is sufficient for use in calm waters. Where stronger currents are common, a 10 hp engine could be more suitable.

The cavitation plate must be in line with the bottom of the transom, as shown at left.

FIGURE 86

A completed boat without fender is shown in the foreground of the picture at left.