John Lilley & Associates Marine surveyors & Shipwright timber/grp

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Timber construction & problems

Timber construction has evolved after countless centuries of experience and, although few vessels are constructed from Timber entirely at this time and, the likelihood that even fewer vessels will be constructed from Timber in future there still remain a considerable number of sound and prized timber vessels throughout this country and the world. Timber vessels will be available for many decades to come and perhaps beyond as, it would seem that in some circumstances their life can almost be indefinite if maintained and repaired when and where necessary.

Provided the original construction methods were sound with good quality workmanship and good quality materials then most timber vessels will outlive several sets of owners and, will still remain an enviable craft if in nice condition amongst a myriad of GRP modern designs.

However, this is totally dependent upon a good regime of maintenance and the knowledge of what needs doing and when.

This is when the services of an experienced timber yacht owner/shipwright/surveyor would be most beneficial.

A timber vessel can absorb a considerable amount of money and professional labour and, if one is not made aware of significant structural problems at an early stage, this can lead to the totally disappointing and disenchanting relationship with timber.

Timber vessels need not be frightening and, most new owners soon acclimatise to what appears to be very complicated structure to the uninitiated, and gain confidence in their understanding of what requires attention and how to maintain the vessel.

This is where the services of a good surveyor come in most useful as, in my particular case, any completed survey includes a comprehensive section of information on how to repair, when to repair, what to repair and how to fully maintain the vessel in future with suggestions on things to take note of for several years down the line.

Types of construction

Generally, the most common and sought-after construction is carvel construction. This consists of separate planks usually no less than approximately 3 in. wide and no more then 6 in. wide laid on to steam bent timber frames (ribs) fastened with copper rivets. These are basically long copper nails with a copper washer on the inside and the end is riveted over the copper washer.

There are variations on this including clench fastening which does not use a copper washer (rove) but merely bends the end of the nail back into the timber.

Carvel build

On heavy fishing vessel type construction, the fastenings will often be heavy ferrous blind nails, more accurately described as pointed bolts, these are driven into very heavy sawn frames and, to all intents and purposes are practically impossible to remove once fitted. This type of construction can be slightly problematic occasionally if the fastenings corrode.

Occasionally, one comes across planks that are fastened with bronze screws instead of copper rivets. Generally, copper rivets will outlive the bronze screws.

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The hull planking can be a multitude of materials including, mahogany, teak, Iroko, Oak, Larch, pitch pine and many other lesser known durable species.

The gaps between the planks are normally caulked with cotton with red lead putty to flush the seam off.

On some vessels the steam bent frames will be supplemented with sawn frames and, in some cases sawn frames will be used in their entirety however, sawn frames are not generally used uniquely in timber vessels other than hard chine vessels or heavily built fishing type vessels.

A sawn frame is merely one section of timber that is sawn to shape.

It will be connected to other sections of sawn frame to create a full span of the hull from the sheer to the keel.
The connection is called the futtock. Sawn frames can be extremely wasteful on material.

Another method of creating frames that is very labour-intensive is laminating curved frames for the full length. Steam bent frames will often be Oak or rock elm, sawn frames can be of any stout timber that is durable.

Laminated frames will be of a material that is well-suited for gluing and, various builders will have their own preferred material commonly mahogany, Iroko, Oak, and teak some of the preferred choices.

Clinker construction

This type of construction can make a lightweight extremely strong hull. Boat for boat, clinker construction will use slightly thinner planking and the planking is much the same dimension as the carvel in its width and uses the same type of framing but the lower edge of the plank overlaps the upper edge of the plank below.

This overlap is called the land and, the planking is fastened to the frames in the same way is carvel but, as an additional strength factor the land, where the two planks connect or overlap is also fastened with shorter fastenings through both planks. Commonly used on Folkboats,

Finesse series of sailing cruisers, the Dauntless sailing cruisers and many other east coast designs up to around about 29 ft..

Clinker designs longer than this are rare.

The majority of clinker built has no caulking and relies on the timber swelling along each seam against the copper fastenings to seal from water. If allowed to dry out excessively, they can be slightly problematic in taking up.

Finesse Class 20ft

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Strip build construction

This is a method that was adopted for ease of building for amateurs and, some professional boat yards.

The material wastage was much less than it is carvel construction and comprises of parallel planks, usually in the region of an inch by inch (25 millimetres by 25 millimetres), each plank is laid on the preceding plank and glued , fastenings are driven through the edge to pick up two or three planks below and a new plank is glued on top and the construction continues until the hull is completely formed.

This construction is entirely dependent upon the original glue used and the security and quality of the fastenings.

Quite often steel nails were used as edge fastenings and, unfortunately, the majority of the glue used , certainly up until the 1980s would likely are only had a lifespan of approximately 35 years. Internally the planks are laid against frames as in carvel construction but, the frame spacing is usually wider. They will often be fitted with a mixture of bent frames and sawn frames.

Note the narrow strips and laminated stem. Note the decay in one hood end

The frame fastenings to the planking could be copper nails or bronze screws.

Modern strip build use epoxy saturation techniques with a minimum of fastenings, totally relying upon the integrity of the epoxy and its ability to permanently seal the timber from moisture ingress.

The method of construction differs in that external and internal diagonally placed veneers on the internal core add extra rigidity and plank security. There are various methods of building up the hull skin with epoxy and timber laminations. It could be seen as a cross between strip building and cold moulding where, cold moulding merely used thin laminates laid diagonally over a mould with alternating diagonal strips glued to these and held in position with staples until the glue sets.
This process continues until an adequate thickness of hull has been built up.
No caulking is used in either type of strip build construction, unless, there has been some glue line failure or other problem.

The centre line construction

Whichever method is adopted the vessel has to have a centre line construction, this will be the stem, the timber keel, the ballast keel and the stern post.

Most commonly these will be separate sections of timber, usually Iroko elm or Oak below the waterline and possibly mahogany Oak Iroko or teak above waterline. They are large sections of timber that are cut to shape and connected together with what would be known as a stem apron at the front or bow and a stern knee at the stern. These large sections of timber are generally all bolted together with what I known as scarf bolts.
Occasionally, the stem and stern sections will be laminated from thinner sections of timber to avoid wastage.
The ballast keel is attached to the central timber keel with bolts or studs depending on the builder but always generally with internal nuts or boltheads.

Some of these constructional bolts such as scarf bolts and such cannot ever be removed once the ballast keel is fitted as, the ballast keel is in the way of their removal.

In order to strengthen the bilges and try and retain the shape of the hull with a heavy ballast keel attempting to twist the vessel in some conditions, floors are fitted. This is a slightly confusing term as it does not refer to a floor that you would walk on but it is a shaped section of wood or metal that locates across the top of the inside of the keel and up the hull bilges.

It will be generally fastened to two or three planks up from the keel and fastened to the timber keel. The method of fastening to the timber keel varies from builder to builder, for maintenance the best method is using the floor for a keelbolt position as, whenever the keelbolt is replaced, the floor fastening is also replaced.

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However, some builders fit floors at intermediate position between the keel bolts which means fitting bolts through the timber keel which, unfortunately, can never be removed without removal of the ballast keel as, the head for the bolt is between the ballast keel and the underside of the timber keel.

Floor material construction is also particularly relevant, for longevity and relative ease of maintenance, sawn timber floors are usually the most effective however, for high initial strength and rigidity, bronze or steel floors will be used in high-performance vessels, the downside of this is that these floors are apt to corrode particularly if steel and cause considerable plank problems due to the method of fastening which has to be bolts through the planking.
There is also in extreme possibility of electrolytic damage to any timber caused by metal corrosion of either the floor or the floor fastenings.
Timber floors will usually use screws or blind copper nails, the copper nails being quite long lived. Bronze screws are subject to corrosion & checking.
The Deadwood is an area of filler timber supporting the stern tube and the rudder at the stern end aft of the planking

Hillyard deadwood & new rudder

Other methods of timber construction.

There are one or two other methods were referring to here, this includes plywood hull construction which, was used with success for a great many designs including the Eventide, the Golden Hind, the much smaller Silhouette and similar designs.

Triple keel Golden Hind 31

The majority of these incorporated flat sections with single or multi chine hulls. Several designers designed specifically for plywood including Maurice Griffiths and Robert Tucker.
Unfortunately, in many cases the lifespan of some plywood vessels was somewhat limited,
and very few have survived the decades.

Double diagonal planking is rarely used nowadays and was primarily used for power driven vessels and consisted of a skin of multi layers of thin planking, in most cases the planking would be parallel and laid approximately 45° to the vertical over a mould, a new skin of similar planking would be laid at the opposite 45 degree angle and through fastened with copper rivets.

At each junction there would generally be four copper rivets, as one can see this is an inordinate amount of fastenings. Between the two skins a layout of calico would be used for proofing however, this membrane was subject to rot and decay after 40 years or so and, as can be seen, practically impossible to remove or replace. Variations on this theme included triple diagonal planking.

Many of the older larger Motor vessels were built this way, including the MTB vessels and Naval tenders/patrol boats & RAF tenders.

Cold moulding was also once a popular method for some boat builders and this used even thinner sections of planking laid diagonally opposite angles but no fastenings were generally used, just relying on glue.

Hot moulded hulls used a similar technique but relied upon the heat and a vacuum membrane to compress all of the veneers together to form one extremely strong thin skin. Possibly the most famous of these were the vessels constructed by Fairy Marine including the Fairey Fisherman and, the Fairey Atlanta although, the company to produce a considerable amount of smaller hot moulded dinghies including the Fairey Duckling

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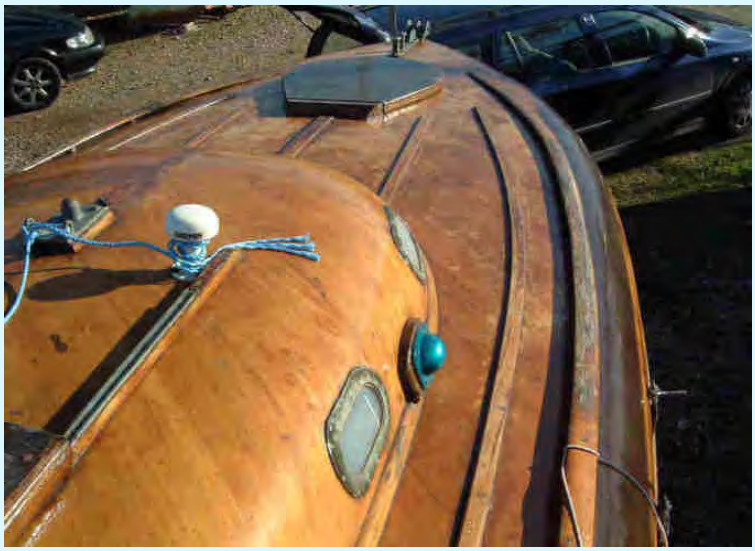
Hot moulded hulls by Fairey Marine were produced in Agba, which is a lightweight but durable timber.

Once compressed in the vacuum and heat treated, it became practically impermeable to marine borers, ,decay and exceptionally strong.

The well known Swordsman, Huntsman & Huntress powerboats were testament to the strength and reliability of build.



The deck and "Upturned dinghy" coachroof on hot moulded Fairey Atlanta

Deck construction

This has always been an area looking for new methods for effectively keeping the rain out and the vessel structurally rigid.

The common method available prior to approximately 1960 was tongue and groove planking.

This was merely pine boarding , usually about an inch thick depending upon the vessel length, it would be fastened to sawn curved deck beams with either nails or screws and along the hull edge on to the first plank from the deck known as the sheerplank.

It would be then covered with cotton duck canvas and painted.

This would last usually a minimum of 10 years before breaking down and allowing water into the structure.

A plastic material known as Trackmark also became available and was used in a similar fashion to canvas but, this also cracked with age after about 10 years.

As soon as rain water penetrates timber for a continual length of time, there is always a risk of fresh water decay and, this was the demise of many a good vessel, rotted from the deck down.

An alternative to pine deck was a solid teak deck, which although considerably more expensive had the same problems with deck leaks causing structural decay.

Occasionally, a teak deck would be laid directly upon the pine deck.

From about 1960, builders started to rely upon the properties of plywood.

This effectively made the deck quicker to construct and moreover, had a considerable improvement upon rigidity being a more mono construction.

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At first, some of these decks were merely painted or canvas covered with the same drawbacks as the canvas covered pine deck but later, builders saw the benefits of epoxy sheathing and, plywood decks were generally universally used with epoxy sheathing to finish off.

A few high-class timber vessels will built with a plywood sub deck with teak laid deck on the surface, this teak deck would normally be approximately half inch thick and seam caulked in the conventional manner.

The downside of this is that, when the caulking begins to breakdown and allow water between the teak and the top of the plywood, unseen decay causes substantial and expensive problems.

The main drawback of plywood is that it is nowhere near as resistant to fresh water decay and deterioration as solid timber once any breach has been made where water can leak into the edge of plywood and, with a plywood deck, it is obvious there are extremely long vulnerable edges that have to be sealed.

Here can be seen a series of discovering the rot, replacing all the underlying quarter knee that had completely disintegrated and the final finishing. This was caused by water leaking in the pushpit fastenings