Broads Mill Repairs – Problems of maintenance and suggestions for prolonging the life of repairs.

Today, the windmills of the Norfolk Broads are being repaired in much the same way as they were when still in use for drainage. This is in accordance with the current conservation philosophy of maintaining every original component as it was.

The downside of this is that, whereas in the past the mills received regular maintenance and painting, today maintenance is almost absent due to its cost. A further problem is that the timber available for repairs today has poor lasting qualities compared with that of the original construction. Economic downturns make it difficult to justify spending on mills when social services are being cut, so the mills lose out every time.

The consequences of this are very unfortunate: Mills are falling to pieces and require "re-restoration" every 20 years or so. This is very costly, causes original fabric to be lost, and may eventually result in mills being abandoned.

When the mills were built, they were not designed to last more than a few decades, but now we expect them to last *indefinitely*. Their function deliberately placed them where they would face the onslaught of the worst weather, but historically this was combated by regular maintenance and repair, paid for by the income from farming. Prime timber was imported through Great Yarmouth from America and Scandinavia, and this provided the best construction material for sails, caps, floors etc.

Today, the mills are retained for their landscape value and historic interest. There is little regular income for their upkeep, and good timber is in short supply. This leaves the mills in great danger if present policy remains unchanged.

One possible solution is to use more long-lasting modern materials to construct some of the external parts that are vulnerable to early decay. These are the components that have been renewed in the near past, and therefore have little intrinsic value. In new restorations from derelict, all the components under consideration are likely to be missing.

Before any components are changed, the mills need to be thoroughly recorded by measured drawings so that all details of timber, joints, etc are saved. This would allow a change back to traditional materials should circumstances alter. The process is, therefore, reversible.

The interior components should be repaired as originally, using timber. A good weatherproof exterior will protect the historic fabric, ensuring that it is saved for the future.

This kind of strategy has been followed on the Continent of Europe in Holland, Belgium and Germany. Metal stocks have been in use in the Low Countries since the 1890s, and have a good record for longevity. Steel is commonly used for cap winding beams, and even weather beams.

Specific Proposals.

Sails and stocks etc.

Timber Stocks

Local stocks were often very long (16–19 metres), and difficult to match today using one-piece timbers. The high quality pitch-pine timber used in the past is not available, the forests in North and Central America having become exhausted. Home-grown timbers like Douglas Fir or Larch can be used, but have a mixed record for longevity as they tend to grow too quickly in our climate, which reduces their durability.

Laminated timber for stocks (glulam) has been used since the 1960s, and is often used today. Made from premium grade softwood, they are more expensive than solid wood, but very recently, the use of durable Siberian Larch for these stocks has ceased due to cost and moisture-content difficulties. That leaves just Douglas Fir and Redwood (Scandinavian or Eastern European pine) for future glulam stocks. These timbers are only moderately durable and little better than solid timber.

In the cheaper glulam beams there is a tendency to incorporate poor quality timber for the internal laminates, using the best timber just for the outside faces. This cannot be detected easily, but can come to light when boring bolt-holes or re-shaping. Another short-cut is merely to butt-join the ends of the laminates. Even if these joints are staggered, they can open up and allow moisture to enter, as well as forming weak points in highly-stressed areas. In the best laminated work, the components are finger-jointed which ensures maximum strength and forms a barrier to moisture ingress.

Using pressure-treated laminates for glulam beams would help to increase their service life as stocks, but such beams are not presently available. Most of today’s glulam beams are made in Scandinavian countries where wood preservatives are banned due to their poisonous ingredients.

A new preservative process for timber has been developed in Holland called Accoya. This involves treating timber with a form of acetic acid which changes its structure, making it less likely to absorb moisture and less palatable to fungi. It is also claimed to increase the strength of the wood, and is non-toxic. The process is applied to quick-growing North American Monterey Pine, and claims to make the durability of that wood equivalent to a tropical hardwood. Accoya wood is only just becoming available in England, and is expensive. It is only applied to thin wood that it can penetrate fully, so any stocks made from it will need to be laminated. Glulam Accoya wood has been used for the stocks and whips of the reconstructed windmill in Jerusalem, the beams being made in Germany. Accoya timber seems to offer a solution to the problem of decaying stocks, but is extremely expensive, difficult to obtain, and untested.

Steel Stocks.

Hollow steel stocks have already been used in some cases in the Broads from the 1970s onwards. The stocks were formed by welding together pressed steel components, and incorporating tubes through which bolts could be fitted. Local millwright John Lawn pioneered this in Norfolk, and the firm of E. Hole and Son of Burgess Hill, fitted many steel stocks in Sussex and Kent. These steel stocks look like wooden ones, and can only be recognised by a knowledgeable person from the ground.

The experiment with steel was not entirely successful, often because timber-built post-mills and smock-mills became over-burdened by the extra weight which caused sinking and distortion. The earliest steel stocks were merely painted,

Broken steel stock at Denver Mill.

and lack of regular maintenance and a maritime climate led to unsightly rusting. Rusting could also occur inside the hollow steel, which could not be seen, and in time, could compromise strength. Whilst steel stocks were long-lived on static mills, working mills proved to be a different matter. Frequent rotation puts more strain on these stocks due to the extra weight of the shutters and the constantly reversing stresses. Breakages began to occur, so the design was modified and the stocks were galvanized.

Despite these changes, the breakage of a steel stock on the working mill at Denver in 2011 showed that the design was still inadequate. Lessons learned were: Sudden changes in the thickness of the steel must be avoided, full-sized sails need to be attached by 4 bolts rather than 3, galvanizing is essential to prevent rusting. In addition, Denver Mill had no clamps, despite having had them in its old working days, and these would have prevented the breakage.

Designing a viable steel stock isn't "rocket science" in the 21st century. The properties of steel are well known, and a competent engineer could easily arrive at the best compromise between strength, weight and tolerance to flexing. The stocks need to be constructed by a reliable fabricator, and quality control exercised. Steel stocks are likely to be somewhat heavier than wooden ones so caps and curbs need to be in good condition to bear any extra weight.

Clamps

All Broadland mills had pairs of long wooden clamps to reinforce the stocks at the centre. Clamps can still be made from good quality air-dried home-grown timber and treated against decay, and it is proposed that the use of wood is continued. In the past, a combination of through–bolts and encircling cramps were used to fasten the clamps in place. It is proposed that the through-bolts be omitted and replaced by extra cramps to avoid boring holes through the timber. All steelwork needs to be hot-dip galvanized.

Thurne Mill with steel stocks and wooden clamps.

Whips and Sail-frames.

The sail whips can be made from home-grown air-dried timber as described for clamps. Once all the woodwork is completed, the whips need to be treated against decay so that all the mortises and holes are protected.

The sail framing may be made from imported red pine or home-grown timber, and treated as for the whips.

When the frames are assembled, all joints and holes need to be painted before and during assembly.

All steelwork and fastenings need to be hot-dip galvanized or of stainless steel.

Vanes (shutters).

All the components of the vanes are susceptible to deterioration. A full set of 200 vanes is very expensive to make, and costly to maintain if constantly decaying. The wooden spine and natural canvas covering have proved to be very vulnerable to rot, and the wire frame will rust, as will the cast-iron fittings. It is impossible to prevent rainwater from collecting between the canvas and the woodwork, and inside the canvas where it is wrapped and stitched round the wire frame. This causes early decay, as the sails remain static most of the time, unlike during their working days.

Rusting can be prevented by galvanizing the fittings and frames, or using stainless steel wire for the frames. Man-made sailcloth, painted to combat ultra-violet degradation, is currently under test, and should not decay easily.

The wooden spines could be made from Western Red Cedar, or maybe from the Accoya treated wood, mentioned before.

Today, some windmill shutters are made from ply-wood, glass reinforced plastic, aluminium etc. These compromises have been made in the quest for cheapness and long life. It is felt that the method detailed above is, perhaps, more acceptable than the others.

Fantail.

Fan-stage.

Traditionally, the entire fan-stage frame would be constructed from oak or pine. As explained for the stocks, today’s timber has a short life in these applications. Even base timbers made from home-grown oak decay in about 20 years, and the whole fan-stage has to be renewed.

The old millwrights recognised this, and started to make the sheer extensions from cast-iron as seen at Howard's Mill, Halvergate and Neave's Mill, near Ludham Bridge.

Cast-iron sheer extensions at Neave's Mill.

As an alternative to wood, the base timbers of the fan-stage (sheer extensions/overlays and cross member) could be made from hollow steel square or rectangular sections. These could be fastened together by welding or bolts as convenient. The components and fastenings would need to be hot-dip galvanized, and could then be painted. Such a fan-stage base would be virtually indistinguishable from the wooden original, but would last almost indefinitely. It would be no heavier than wood, and lighter than cast-iron.

Initially, it is suggested that this approach be applied only to the base timbers of the fan-stage which, being horizontal, are very vulnerable to wet-rot. When these decay, the rear of the cap has to be cut open to get new timbers in, which is an expensive and destructive process. The fan uprights, braces etc could be made from air-dried home-grown timber, treated against decay. Vertical timbers tend to last longer than horizontal ones, providing the joints are treated and painted. Fastenings would need to be hot-dip galvanized or stainless steel.

Decking and small components.

These could be made from naturally durable imported timber, or home-grown wood as described before, and would include: joists, decking boards, Y-wheel hangers, chain pole, handrails etc.

Fan.

The fan could still be made traditionally as for the sails, using naturally durable or treated timber, and galvanized fastenings.

Caps.

Traditional Norfolk boat-shaped caps are difficult to weatherproof, and almost always leaked to the detriment of the timbers inside. Weather-boarding is a poor covering for a roof, and would not be used for any other type of building. Only very frequent painting and attention to the joints kept the caps reasonably sound in the past. Often they were covered with painted canvas as a repair, or joints were covered with lead to try and keep the rain out. Inevitably, the boards rotted and had to be renewed.

Recent cap rebuilds have used Western Red Cedar boards instead of traditional red pine. Soakers and flashings of aluminium or lead have been used to weatherproof the joints. This has worked reasonably well, but in time the cedar boards rot. For this method to be successful, very good quality materials and a high degree of dedication and skill are required.

As an alternative, the traditional weather-board covering could be retained, but suitably bevelled to remove sharp corners, and covered in glass reinforced plastic, pigmented white. This would retain a good appearance inside and out, and provide the

GRP coating to the cap at Willingham Mill, Cambs.

necessary weatherproofing.This method has already been carried out on several mills e.g. Denver, Willingham, Swaffham Prior to mention just a few. Thus existing old caps have been kept weatherproof where they would have needed a costly rebuild with the loss of original fabric. New caps could be protected in the same way. The G.R.P. bridges over the many joints in the timberwork, and is a long lasting material. G.R.P. has been in use for roofing for many years, and offers a 50 year life, with only occasional painting to maintain the surface and appearance. Any damage can be repaired easily without dismantling. A G.R.P. skin requires less skill to apply, and the weatherboards beneath can be of standard quality.An alternative covering would be high-purity aluminium sheet. This could be dressed over the weatherboarding, and fastened with aluminium alloy nails. Joints could be overlapped and bedded on mastic. The surface could then be primed and painted white.

Towers.

The brick towers need to be maintained using traditional methods in the short term. Bare brickwork will always need occasional re-pointing and the renewal of eroded bricks, but the pointing needs to be harder than normal to resist wind erosion. The bricks too need to be hard, particularly under the curb to resist the shifts of weight and vibration.

Tarred towers will need to be re-tarred regularly to keep the coating continuous. Black barn paint has been tried at Norton Staithe Mill, but its efficacy needs to be proved. Other products may offer better protection, but evidence is needed to ensure that there is no long term harm to the towers.

Paints.

Steel.

Galvanized steel will need to be primed using a special primer for the purpose. It may then be painted with one of the many long-lasting paints designed for steel, and developed for North Sea drilling platforms etc.

G.R.P.

G.R.P. Requires a special 2-pack paint which will last 10 years or so. Little preparation is normally needed.

Woodwork.

Despite extravagant claims made for modern alkyd and other resin paints, traditional linseed oil paint seems still to be the best for woodwork. Most recently, Kreidezeit stand oil paint has been used with apparent success, but is still being evaluated. Stand oil is an oxidised form of linseed oil, and provides a harder skin than either raw or boiled linseed oil. However, like all linseed oil paints even this eventually breaks down and powders off, but is relatively easy to repaint, requiring little preparation.

The sails and fan are relatively easy to access for repainting.

Conclusions.

Whilst the above methods are a departure from tradition, they offer significant advantages:

1. Intervals between painting of roughly double the existing intervals.

2. The vulnerable outside structures will have a much longer life, and be safer than at present.
3. Interior structures and machinery will be well protected against decay.
4. The appearance of the mills will be almost indistinguishable from their original appearance.
5. Constant major repairs will not be needed for preserved mills, and more mills could be repaired instead.
6. The changes are reversible.

V.G. Pargeter, Millwright, Chelmsford, Essex.

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