Historic England

Conservation of surface recovered material from the Stirling Castle, protected wreck

Angela Middleton

Discovery, Innovation and Science in the Historic Environment

Research Report Series no. 45-2016

Research Report Series 45-2016

Stirling Castle
Goodwin Sands
Kent

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ISSN 2059-4453 (Online)

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SUMMARY
The report summarises the conservation work carried out on surface recovered material from the protected wreck site *Stirling Castle*.

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ACKNOWLEDGEMENTS
I am grateful to the following people: Roger Wilkes (former EH) for building the tank. Alexandre Poudrou (former EH intern) for his assistance during recording, cleaning and X-radiography. Karla Graham (HE) for her assistance during X-radiography and freeze drying. James Pearce (HE) for his assistance during freeze drying and building a box. Claire Tsang (HE) for her assistance and advice regarding archiving questions. Alison James (HE) for her support and advice throughout.

ARCHIVE LOCATION
Historic England Archive, Swindon (digital archive); Isle of Thanet Archaeological Society (physical archive)

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INTRODUCTION

Surface recovery licences for protected wreck sites play an important role to mitigate against knowledge loss. Historic England's close working relationship with licence holders, called Licensees, is an essential part of the way in which England's protected wreck sites are managed. The PWA (Protection of Wrecks Act) licensing system utilises the volunteer role of Licensee to involve individuals with sites as effective voluntary custodians. Their support, commitment and enthusiasm for these nationally important sites is crucial for furthering understanding of these sites, enabling stewardship and under-pinning effective management of them into the future.

Surface recovered finds can happen at short notice; and often the divers have to make quick decisions, as artefacts can otherwise be lost forever due to strong currents or shifting sediment. Studying and conserving these surface recovered artefacts means that we are continuously adding to the growing body of knowledge about our seafaring past.

The wreck of the *Stirling Castle* lies on the Goodwin Sands, off the East coast of Kent, an area that suffers from shifting sandbanks, which periodically uncover the wreck, exposing it to detrimental conditions. The site has been under investigation on and off since the 1990s. During two separate investigations several artefacts were lifted: barrel staves, head pieces and a fixed block, believed to be part of the steering mechanism of the ship.

The archive of the *Stirling Castle* is dispersed over several repositories and is in various stages of preservation. Artefacts can be seen at Ramsgate Maritime Museum, Shipwreck Museum Hastings and the National Maritime Museum Greenwich. A recent project, funded by Historic England (then English Heritage) and run by the Maritime Trust (then Hampshire and Wight Trust for Maritime Archaeology) aims to consolidate the archive and produce a monograph presenting the known archives in one volume (forthcoming).

SITE HISTORY

The *Stirling Castle* was a 70-gun ship of the line. She was built in 1678 at Deptford as part of Samuel Pepys' regeneration of the Restoration Navy. The *Stirling Castle* was part of a squadron returning from the Mediterranean which had anchored in the Downs, just off the coast of Kent. The vessel was lost with many of her crew on the Goodwin Sands during the 'Great Storm' of 1703, which also claimed other warships.

The site was first located in 1979 when local divers from Thanet were investigating a fisherman's net fastening. At the time it was exposed due to a movement of sand. The exposed hull was remarkably well-preserved and intact, with enormous potential to provide information on the late 17th/early 18th century English navy; consequently the site was designated under the Protection of Wrecks Act 1973 in 1980.

At this time the *Stirling Castle* was purchased by the Isle of Thanet Archaeological Unit (now the Isle of Thanet Archaeological Society) but once more disappeared into the sand.

In the following years the site has been periodically monitored. During the 1980s and 1990s film footage and still photographs of the site were collected and a variety of geophysical techniques have been employed to study the movements of the sediment. In 1998 the vessel once more began to emerge from the sand and a team formed under the name 'Operation Man O' War' carried out survey work in 1999 (Peacock 1999). This survey indicated that the ship had undergone substantial movement and internal collapse.

SURFACE RECOVERY 2002-2006

The fixed double block was found in 2002 (Wessex Archaeology 2003, 20). The barrel remains were lifted by Wessex Archaeology (WA) in 2006 (Wessex Archaeology 2007). The whereabouts of the objects between recovery and arrival at Fort Cumberland is not clear. It is also not clear when the pieces arrived.

CONSERVATION

Documentation

In addition to before and after conservation photographs (Appendix 1), the barrel components were drawn (1:1), head piece 2255 and the fixed block were illustrated (Appendix 2).

Assessment

Assessment for conservation was carried out in 2008. A total of 20 artefacts were assessed: 13 barrel staves, 6 head pieces and one fixed double block.

The objects were packed well; individually wrapped in bubble wrap and containing WA finds numbers on labels on the inside and outside of the packaging. The artefacts were stored in the cold room, at Fort Cumberland. Some timbers had started to dry out in small areas. These areas often showed signs of mould infestation.
All artefacts were unwrapped, examined visually and apart from the fixed double block (1050) cleaned under running tap water with soft brushes and wooden sticks. The wood was exposed on the seabed for some time, which was evident in marine growth, which was removed as much as possible with pairs of tweezers.

Description of individual pieces:

Table 1 gives an overview of the artefacts assessed:

Table 1: Description of surface recovered artefacts

	Head Piece 2242: This piece forms one of the central parts of a head piece. It is almost complete and only slightly damaged on one side. There are two dowel holes on either side with dowel remains. The piece is slightly damaged by marine wood borers.
	Stave 2243: This stave is almost complete. One end is broken off; the fragment is kept attached to the object in a perforated bag. This broken end shows one groove. Two iron nail remains can be found on the other undamaged end.
	Stave 2244: This stave is slightly damaged on either end. One end shows two grooves, the other end has a large crack running from the end, towards the middle in the centre of the stave. There is moderate marine borer damage.
	Stave 2245: This stave is slightly damaged at one end. The other undamaged end has two grooves. It is slightly damaged by marine borers.
	Head Piece 2246: This piece forms one of the central planks of a head piece. It is slightly damaged but no marine wood borer damage is visible. Two dowel holes and dowel remains are visible on one side. There might be a hole (not through) on the surface.

	Stave 2247: This stave is slightly damaged on one end. The other end is grooved and bevelled. There are remains of two iron nails at the damaged end, and possibly two more. The stave has slight marine borer damage.
	Stave 2248: This stave is only slightly damaged on the ends. It shows one groove on each end and is moderately damaged by marine wood borers.
	Stave 2249: It is not clear whether this rather knotty and bendy piece of timber is a barrel stave. It is damaged on both ends. One iron nail remain can be found. It is moderately damaged by marine wood borers.
	Stave 2250: This stave is slightly damaged on either end. Two grooves are present at both ends. There is also one wooden peg at one end. It has slight marine wood borer damage.
	Head Piece 2251: This head piece forms one of the central pieces of a head piece. It is complete and no borer damage is visible. There are two dowel holes with dowel remains on either side. 4 inscribed lines can be found on one side (makers/ owners mark?)
	Head Piece 2252: This head piece is almost complete and only one end is slightly damaged. It forms one of the central planks of a head piece. It has two plugged holes on the surface and three dowel holes on the sides. No marine borer damage is visible.

	Head Piece 2253: This is one of the central planks of a head piece. It is complete and has one iron nail remain in one corner. The ends are bevelled. There are four dowel holes, two along either side. Two holes are still filled with dowel fragments. Slight marine borer damage can be detected.
	Stave 2254: This stave is broken at one end. The other end displays two grooves. It has moderate marine wood borer damage.
	Head Piece 2255: This head piece is complete. The edges are bevelled and no marine wood borer damage is visible. There are two holes with dowel remains on the side. This piece forms one of the outer planks of a head piece. This head piece was used in the Stirling Castle Wood Recording Project (Karsten and Earl 2010).
	Stave 2256: This stave is damaged on both ends and has moderate marine wood borer damage.
	Stave 2257: This stave is severely damaged by marine wood borers and damaged on both ends.
	Stave 2258: This stave has severe marine wood borer damage and is also severely damaged. It has one iron nail remain at the wider end. One broken off fragment is stored in a perforated bag.

	Stave 2259: This almost complete stave has one groove on either end. One end is bevelled. The remains of an iron nail can be found near the bevelled end. It is slightly damaged by marine wood borers and has one superficial crack.
	Stave 2260: This fragment is severely damaged by marine borers and very fragmented. One groove is visible at one end.
	Fixed Double Block 1050: The function and use of this fixed double block are published by Ensor (2004). The block is made of elm, is approximately 1.22m long, 366mm wide and 178mm deep. Two angled sheaves are considerably harder and better preserved than the rest of the block. It is suspected that these sheaves are made of *Lignum Vitae*. The sheaves are still in position on their original pegs and still move. The remains of three iron bolts can be seen. These are heavily concreted. Concretions have also spread to the adjacent areas of the wood. The whole block is severely damaged by marine wood borers. This damage is minimal to the sheaves. The block is more damaged towards one side, where marine wood borer damage and therefore material loss increase. It is assumed that this area of the block was exposed (*ie*: not covered with sediment but exposed to seawater) for longer.

Visual examination revealed the varied state of preservation across the assemblage. The main cause for material loss is damage by marine wood borers.
Maximum water content (Umax) was calculated as described in Grattan 1987 (see formula below). Prior to weighing, samples were submerged in water under vacuum to establish the maximum water content. The moisture content increases with on-going decay in waterlogged wood and is therefore a good indication of preservation.

$$\text{Maximum Moisture Content \%} = \frac{(\text{Waterlogged Weight} - \text{Oven Dry Weight})}{\text{Oven Dry Weight}} \times 100$$

Results can be separated into class I – III: with class I wood considered in a poor and class III in a good state of preservation.

Class I (> 400% Moisture Content)
Class II (185 – 400% Moisture Content)
Class III (< 185% Moisture Content)

The results (Table 2) show that the barrel staves are generally speaking better preserved than the fixed block.

Table 2: Maximum moisture content results for selected timbers

Timber Number	Wet Weight g	Dry Weight g	Moisture Content U_{max} %	Class
2245 (a)	7.068	1.999	253.58	II
2245 (b)	9.658	3.864	149.95	III
2256 (a)	6.180	1.791	245.06	II
2256 (b)	9.264	2.584	258.51	II
2257 (a)	9.553	2.721	251.08	II
2257 (b)	9.787	3.352	191.97	II
1055 fixed double block	5.890	0.887	564.04	I

X-radiography

Film X-radiography was used to image the wood and the concretion. Due to the size of the fixed block, several exposures were necessary (Fig 1).
X-radiography showed one additional bolt in the centre, taking the total number of bolts up to four. It visualised the varied states of preservation across the block, which is better preserved at one end. The concretions are superficial but dense. However, the actual iron has corroded away as indicated by a hollow corrosion outline on one of the bolt shafts.

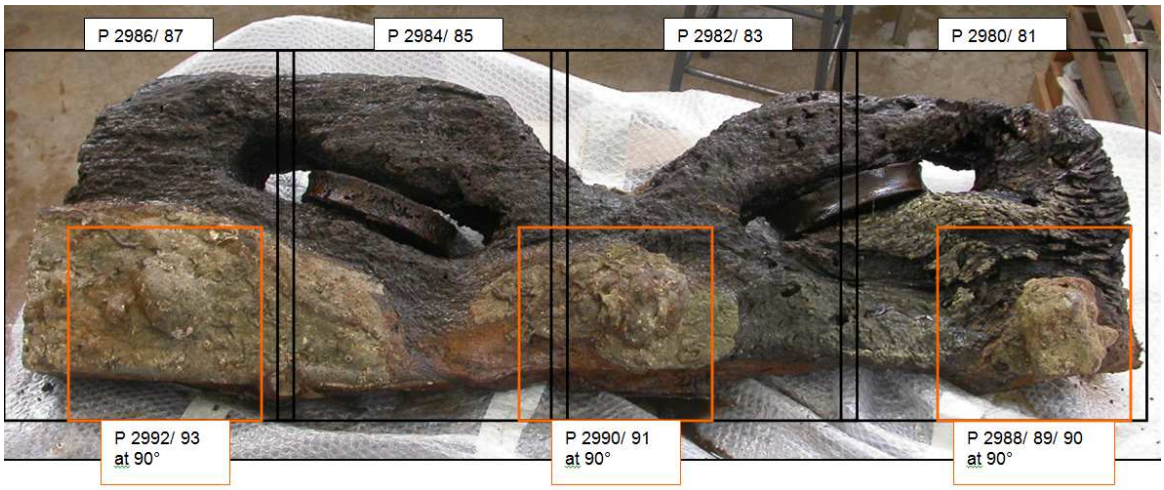

Fig 1: Positioning of the X-ray plates with respective X-ray numbers (Fig 2 = black squares, Fig 3 = orange squares)

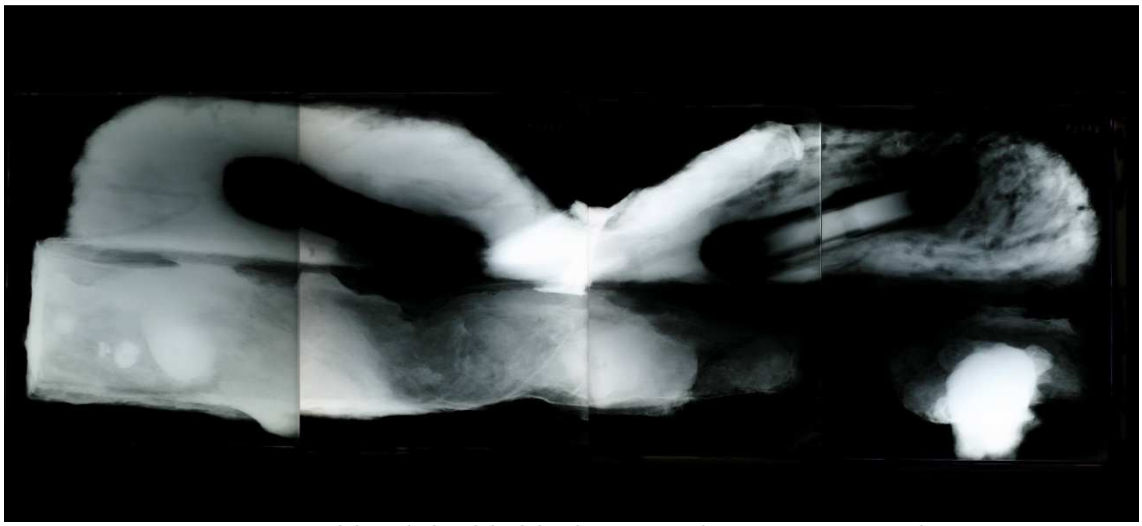

Fig 2: X-ray "mosaic" of fixed double block. Note: decrease in wood preservation from left to right is illustrated by a decrease in density (black squares in Fig 1)

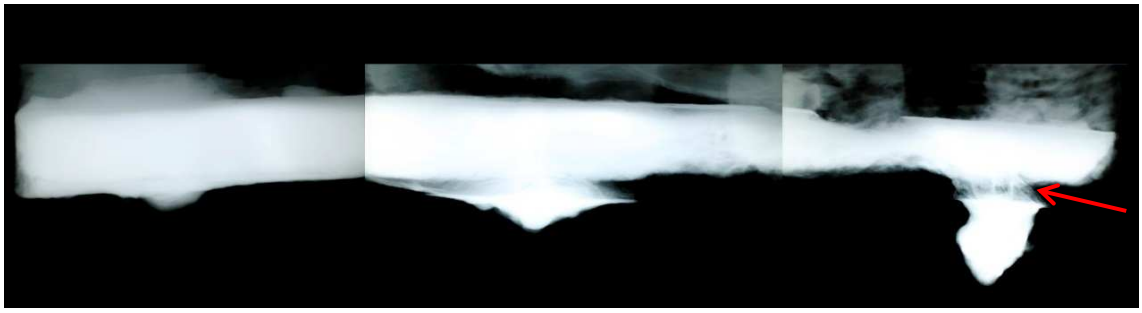

Fig 3: X-ray "mosaic" of concreted bolts on the fixed double block (orange squares in Fig 1); arrow indicates hollow condition of wrought iron in the bolt shaft

Desalination

Desalination was carried out using distilled water and recording the conductivity of the wash water.

Conservation- Impregnation

The barrel staves were incorporated into a larger program of wood conservation. A two-stage polyethylene glycol (PEG) treatment was proposed (Table 3) in order to cater for the different degradation stages of various wooden remains from different sites. All timbers were placed in the tank in February 2010 and PEG solution was added. Using the BRIX measurements, the solution had to be adjusted and stirred using a submergible pump to achieve even distribution and the required PEG concentration.

Table 3: Conservation plan

Stage	PEG	Duration
1-a	10% PEG 400	4 month
1-b	20% PEG 400	4 month
1-c	30% PEG 400	4 month
2	30% PEG 4000	5 month

The concentration and the pH of the treatment solution were tested on a monthly basis. The PEG concentration was measured according to BRIX[1] (Table 4).

Table 4: PEG concentrations and BRIX equivalents

Solution	Percentage %	BRIX Scale ºBx
Tap Water	100	0
PEG400	10	10
	20	17
	30	28
	40	36
	100	>50 (off the scale)
PEG4000	10	10.5
	20	19
	30	26.5

The fixed double block was treated separately. As with the barrel staves, a two stage treatment was carried out. However, PEG impregnation started at 30% PEG400, as the wood was much more degraded. After 6months, the solution was changed to 30%PEG4000 for 3 months.

Conservation – Vacuum Freeze Drying

Freeze drying commenced in June 2011 (2m length x 0.75m diameter chamber). Freeze drying involved removing excess PEG from the wood surface by dabbing with tissue paper, wrapping timbers in cling film and pre-freezing in a domestic chest freezer at approximately -25 to -30ºC. After 2 weeks timbers were unwrapped and placed in the vacuum chamber of the freeze dryer at -30ºC.
The end point of the freeze drying process was determined by weighing (*see* Appendix I). Due to their small seize, the barrel staves were weighed every 2-3 days. The fixed double block was pre-frozen and freeze dried as described above. However, weighing intervals were increased.

Conservation – Post drying cleaning

After freeze drying, excess PEG was removed mechanically with brushes or damp swaps. All barrel staves had a pleasing surface finish after conservation (see Appendix 1).

[1] BRIX measures the sugar content of an aqueous solution. The equivalent value for PEG concentrations on the BRIX scale can be established by using standard solutions.

Due to the very riddled and uneven surface of the block, it required more time and effort to remove PEG after freeze drying. The white residues (Fig 4) were removed with dental picks, wooden skewers, brushes and cotton swabs (50:50 IMS:water). Occasionally heat was applied with a domestic hair drier in an attempt to melt the PEG residues. Some of the concretions became loose during vacuum freeze drying and could be removed at this point (Fig 5 and 7). Two square nail holes were discovered under the concretion, next to one of the bolts (Fig 6). The wood surface underneath the concretions is physically better preserved and darker, due to reduced oxygen levels when covered and corrosion products that migrated into the wood. These areas form a contrast to the otherwise marine wood borer damaged wood, and give a good idea of what the wood once looked like.

Not all concretions were removed. Even though an attempt was made to reveal the shape of the bolt head on the far right (Fig 4), it was deemed too risky. The bolt shaft is hollow, indicating that the wrought iron largely remains as an empty shell (Fig 3 – arrow). Any impact exerted onto the bolt head and shaft in an attempt to remove concretion, could result in the bolt breaking at the shaft.

Further loss occurred during the lengthy conservation process which involved extensive handling of the block. As a result one of the pegs failed. As well as some loss occurring around one of the sheave cavities. These fragments were retained where practical and conserved separately (Fig 8 and 9). It was not attempted to reattach the peg or the sheave. For this, dowels would be required, causing further material loss. The sheaves protrude out of the block. When it is in a flat position the block normally rests on the sheaves, exerting pressure onto the pegs. Even if the block should go on display, the sheave can easily be put in place. The small wooden fragments from around the sheave cavity could not be re-attached as their riddled condition did not allow for a good fit.

Fig 4: Fixed double block immediately after vacuum freeze drying

Fig 5: Fixed double block after conservation and removal of excess PEG

Fig 6: Remains of the bolt in the centre of the image and 2 square nail holes to the left

Fig 7: Fixed double block after conservation and removal of excess PEG

Fig 8: Sheave and peg from the fixed block, after conservation

Fig. 9: Wooden fragments from the fixed block, after conservation

FURTHER RECOMMENDATIONS

The artefacts should be stored at 50%RH (+/- 5%). The block will benefit from support and cushioning during storage, to take pressure off the sheave and peg remaining *in-situ*.
The condition of the concreted remains should be monitored.

CONCLUSION

The investigation and conservation on this assemblage from the *Stirling Castle* wreck has resulted in a stable archive, suitable for deposition.
The condition of the timbers meant that they were received in a physically weak state of preservation. This is especially true for the artefacts that have suffered from extensive marine wood borer damage. Further loss occurred during water changes and handling, as can be seen for example on the fixed block, where one of the pegs failed and the sheave fell out.
This material from the *Stirling Castle* illustrates the extent of loss that can occur when wooden artefacts become uncovered on wreck sites. Unknown is the length of time this material was exposed and therefore conclusions on the rate or speed of damage cannot be drawn.

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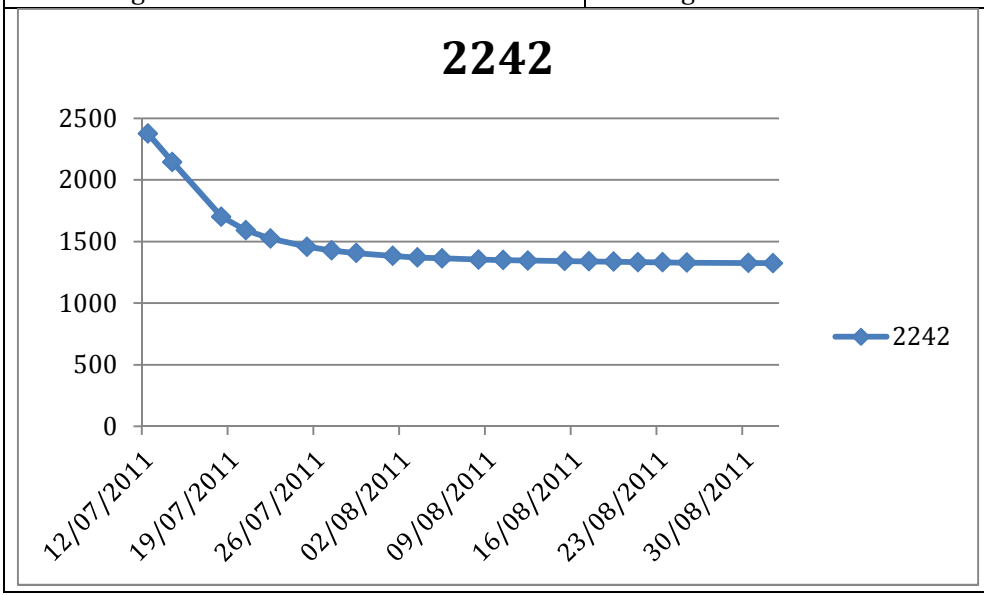
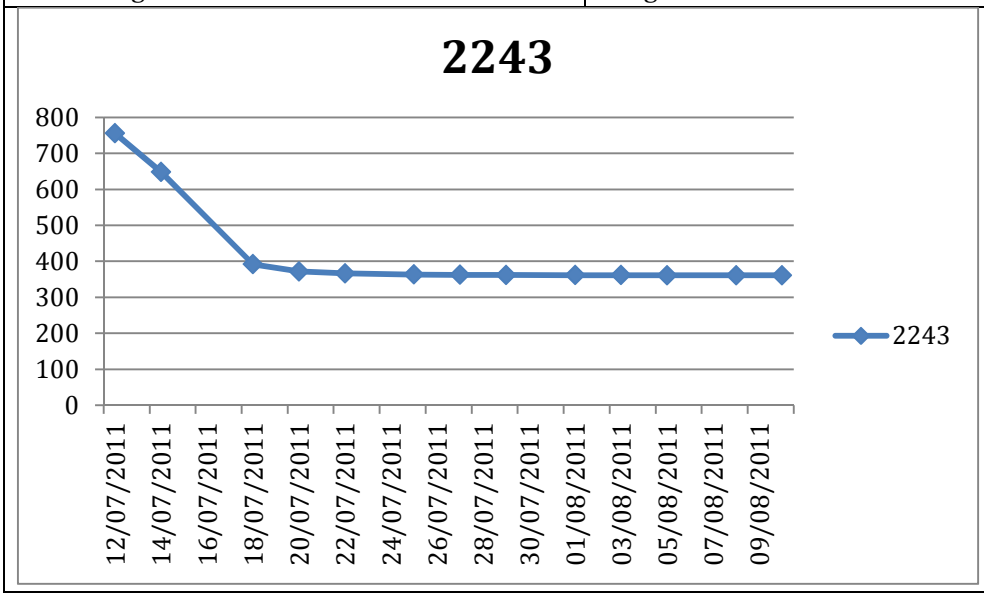
APPENDIX I – WOOD CONSERVATION RECORD

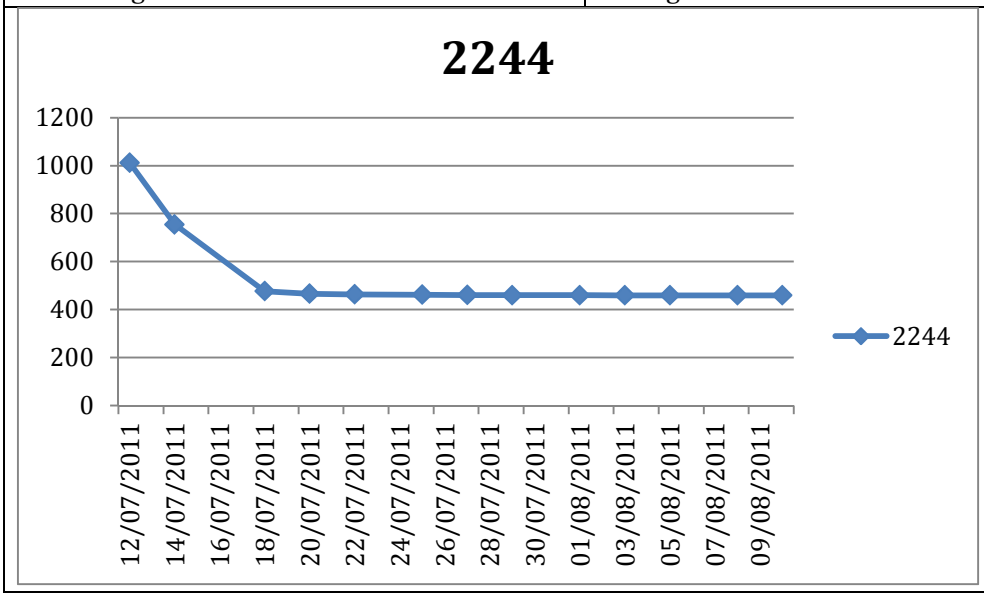
Head Piece 2242	
	
Fig: Head piece 2242 before conservation	Fig: Head piece 2242 after conservation
Start Date Drying	12.07.2011
End Date Drying	01.09.2011
Initial Weight	2376.2g
Final Weight	1324.3g



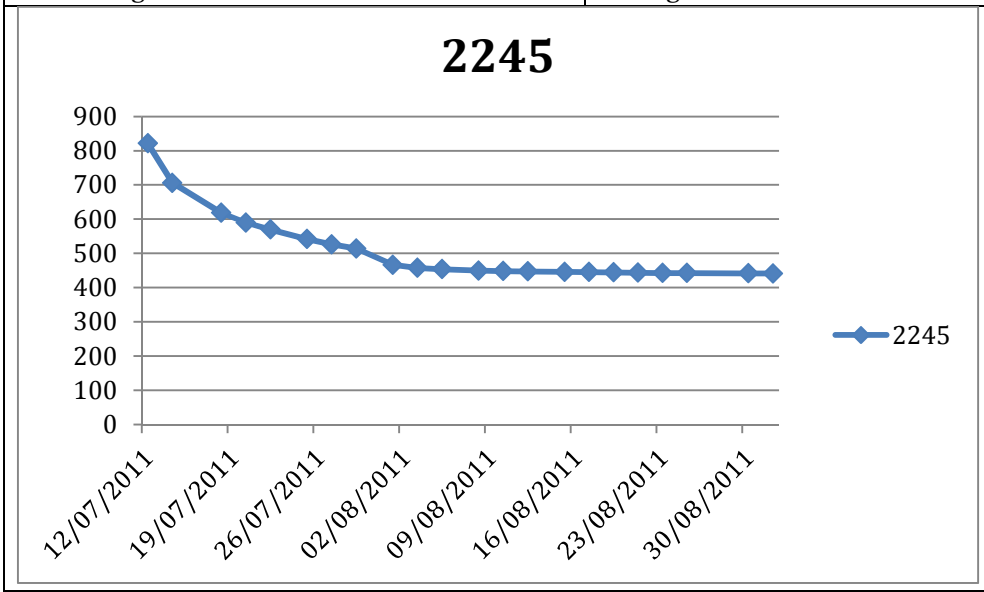
Barrel Stave 2243	
	
Fig: Barrel stave 2243 before conservation	Fig: Barrel Stave 2243 after conservation
Start Date Drying	12.07.2011
End Date Drying	10.08.2011
Initial Weight	755.2g
Final Weight	361g



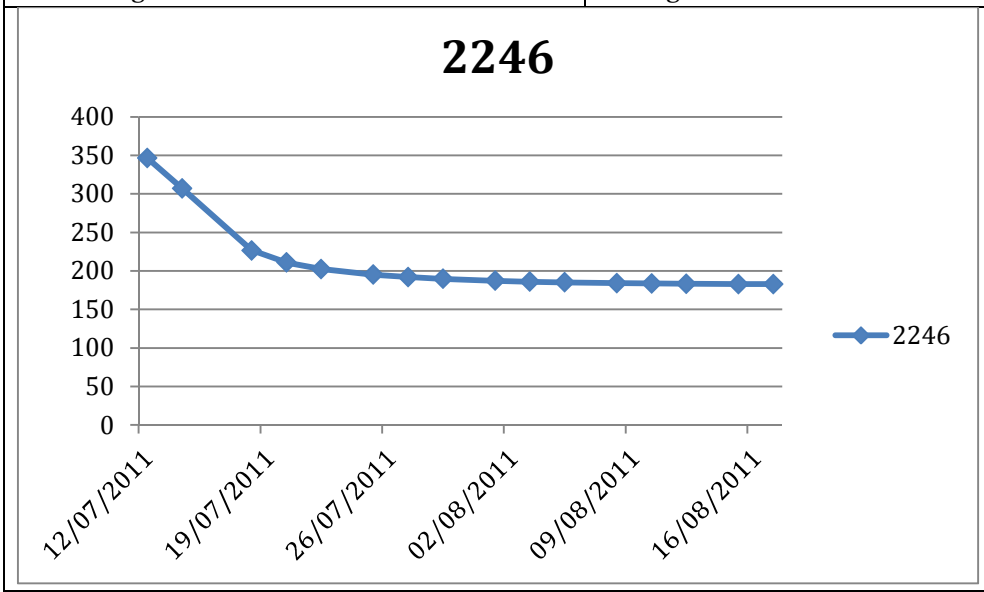
Barrel Stave 2244	
	
Fig: Barrel Stave 2244 before conservation	Fig: Barrel Stave 2244 after conservation
Start Date Drying	12.07.2011
End Date Drying	10.08.2011
Initial Weight	1012.1g
Final Weight	459.4g



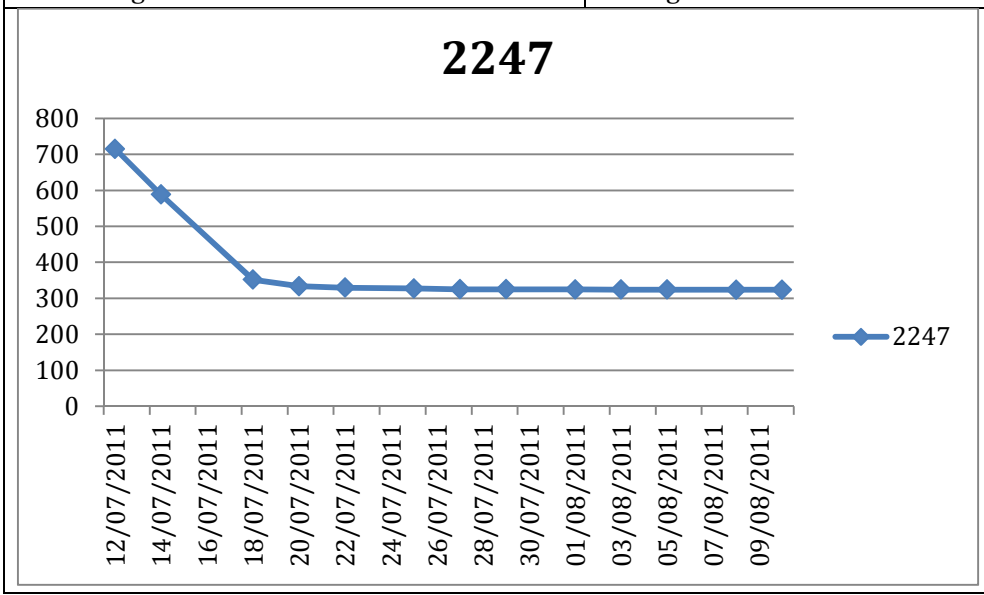
Barrel stave 2245	
	
Fig: Barrel stave 2245 before conservation	Fig: Barrel stave 2245 after conservation
Start Date Drying	12.07.2011
End Date Drying	01.09.2011
Initial Weight	821.4g
Final Weight	441.3g



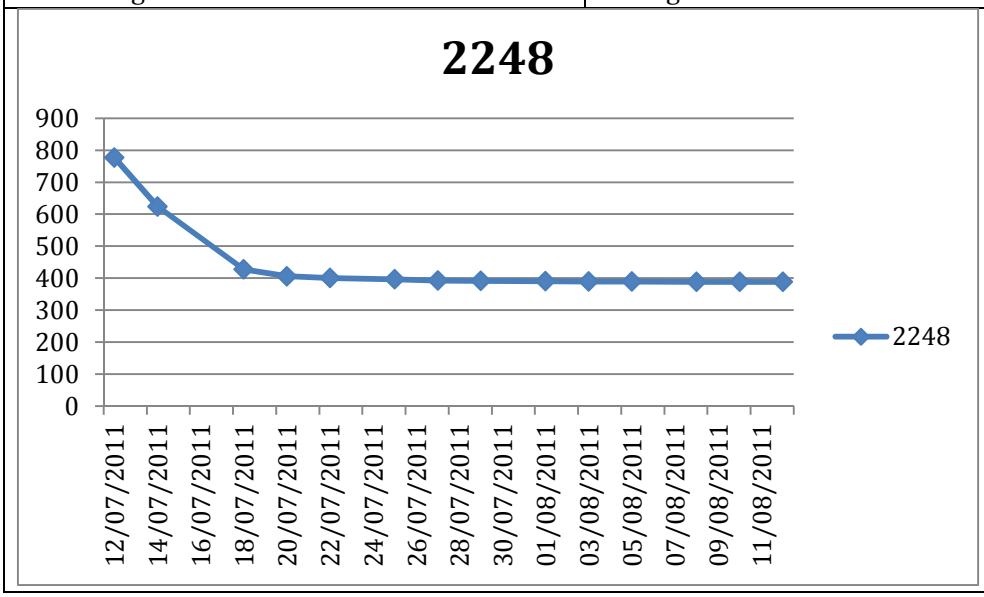
Head Piece 2246	
	
Fig: Head piece 2246 before conservation	Fig: Head piece 2246 after conservation
Start Date Drying	12.07.2011
End Date Drying	17.08.2011
Initial Weight	346.4g
Final Weight	182.8g



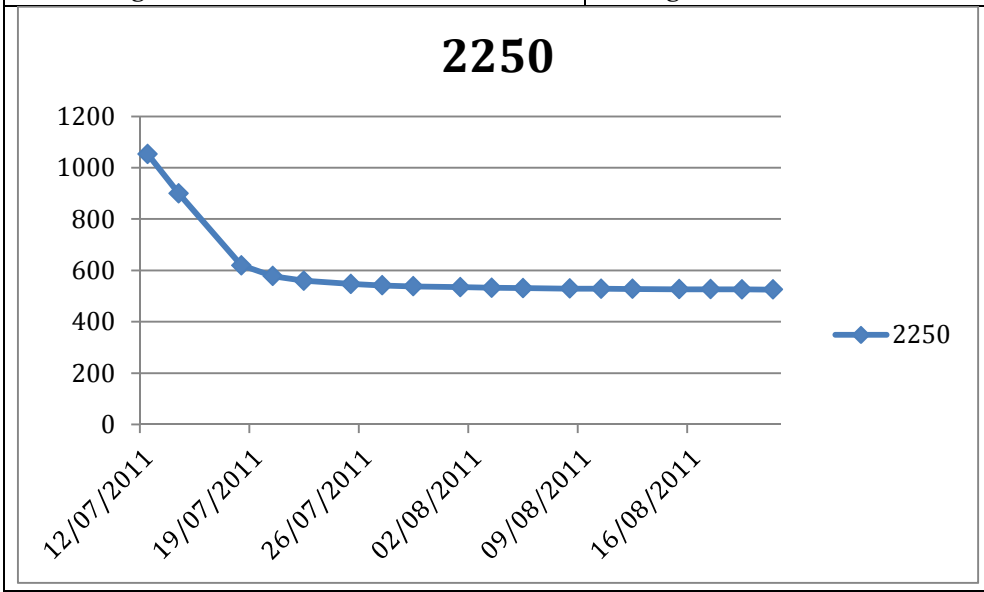
Barrel Stave 2247	
	
Fig: Barrel stave 2247 before conservation	Fig: Barrel stave 2247 after conservation
Start Date Drying	12.07.2011
End Date Drying	10.08.2011
Initial Weight	714.9g
Final Weight	323.8g



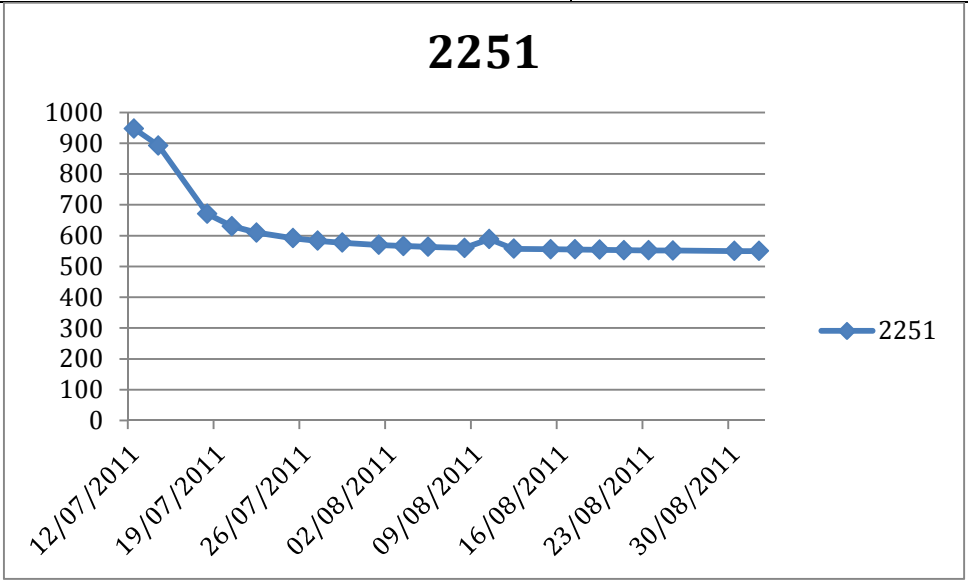
Barrel Stave 2248	
	
Fig: Barrel stave 2248before conservation	Fig: Barrel stave 2248 after conservation
Start Date Drying	12.07.2011
End Date Drying	12.08.2011
Initial Weight	777.2g
Final Weight	388.5g



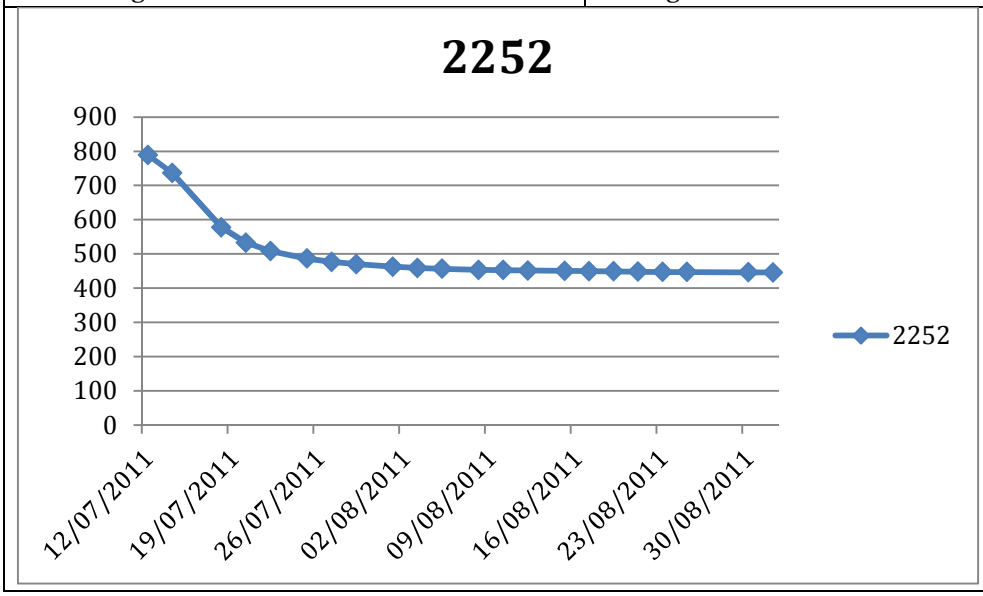
Barrel Stave 2250	
	
Fig: Barrel stave 2250 before conservation	Fig: Barrel stave 2250 after conservation
Start Date Drying	12.07.2011
End Date Drying	21.08.2011
Initial Weight	1053.5g
Final Weight	525.2g



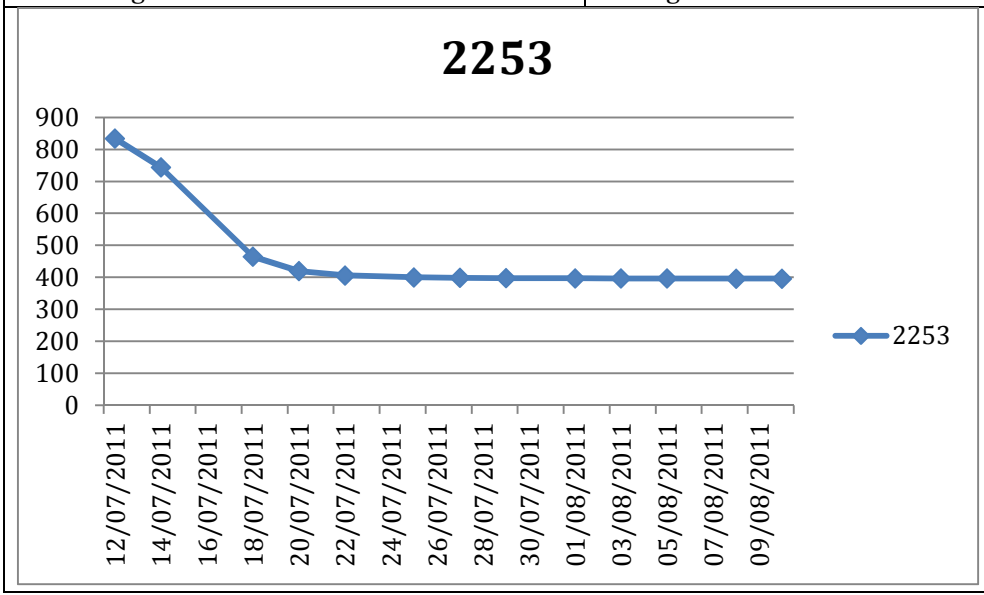
Head Piece 2251	
	
Fig: Barrel stave 2251 before conservation	Fig: Barrel stave 2251 after conservation
Start Date Drying	12.07.2011
End Date Drying	01.09.2011
Initial Weight	947.5
Final Weight	549.8g



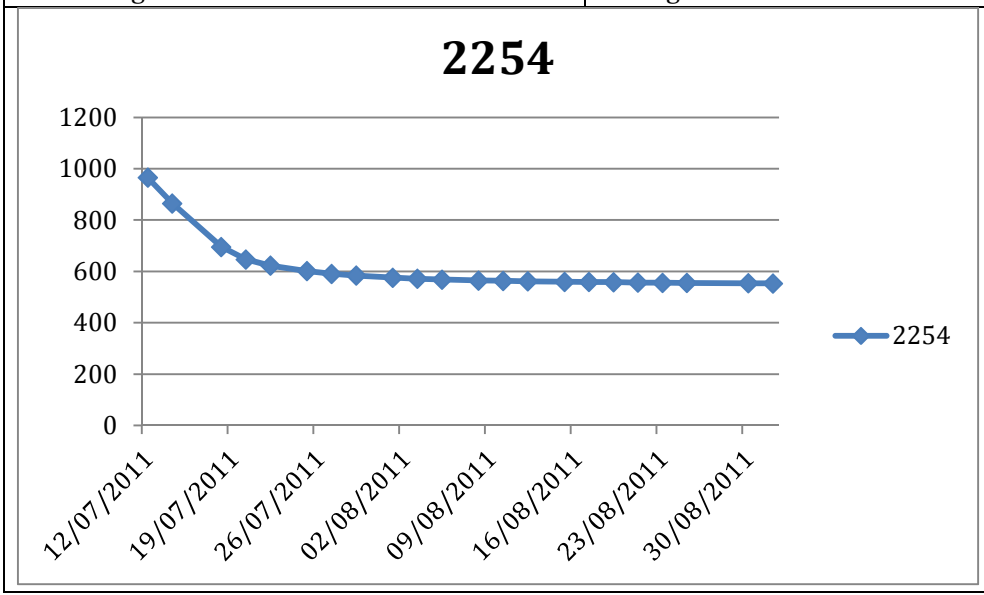
Barrel Stave 2252	
	
Fig: Barrel stave 2252 before conservation	Fig: Barrel stave 2252 after conservation
Start Date Drying	12.07.2011
End Date Drying	01.09.2011
Initial Weight	788.9g
Final Weight	446.1g



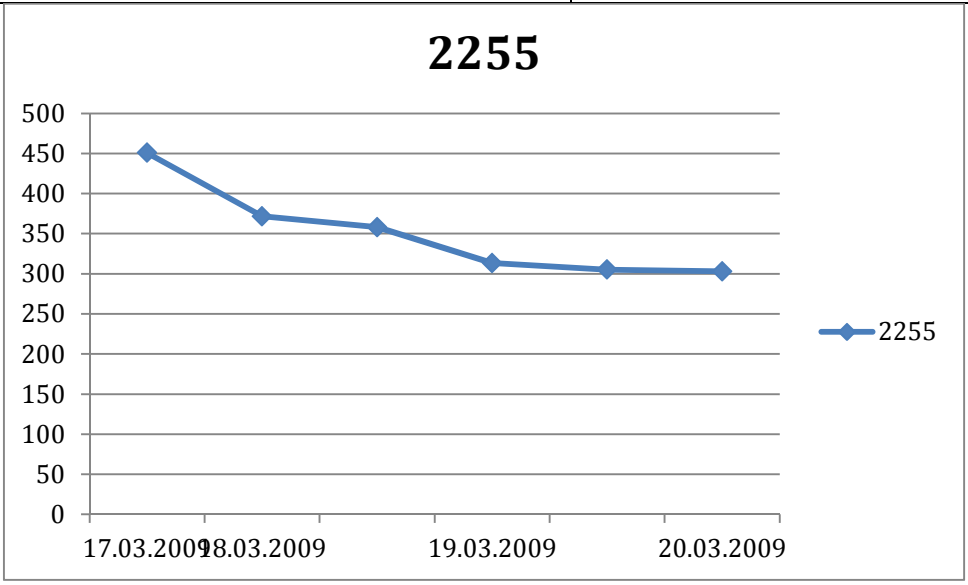
Head Piece 2253	
	
Fig: Head piece 2253 before conservation	Fig: Head piece 2253 after conservation
Start Date Drying	12.07.2011
End Date Drying	10.08.2011
Initial Weight	833.6g
Final Weight	396.2g



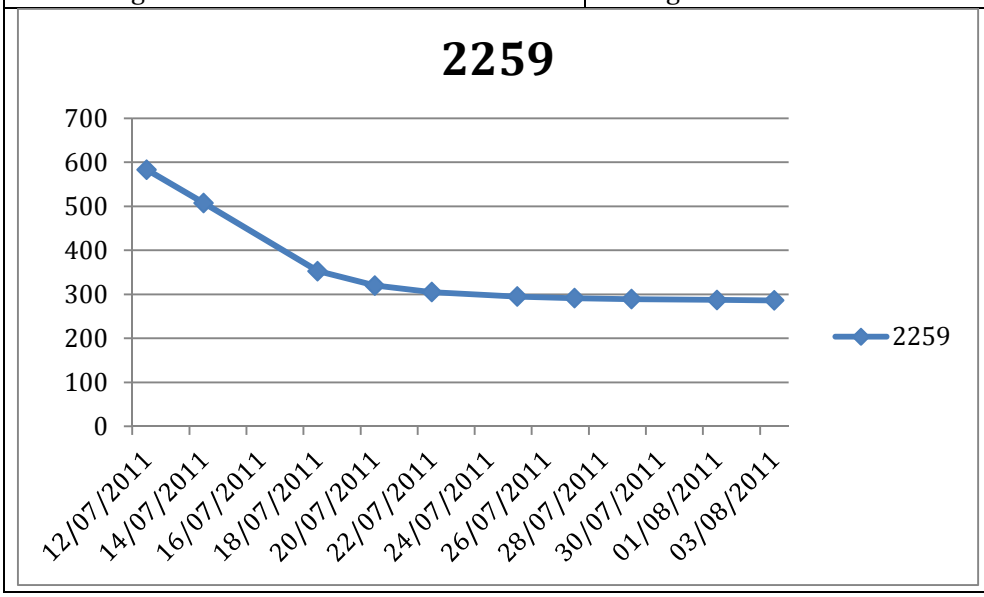
Barrel Stave 2254	
	
Fig: Barrel stave 2254 before conservation	Fig: Barrel stave 2254 after conservation
Start Date Drying	12.07.2011
End Date Drying	01.09.2011
Initial Weight	965.2g
Final Weight	553.5g



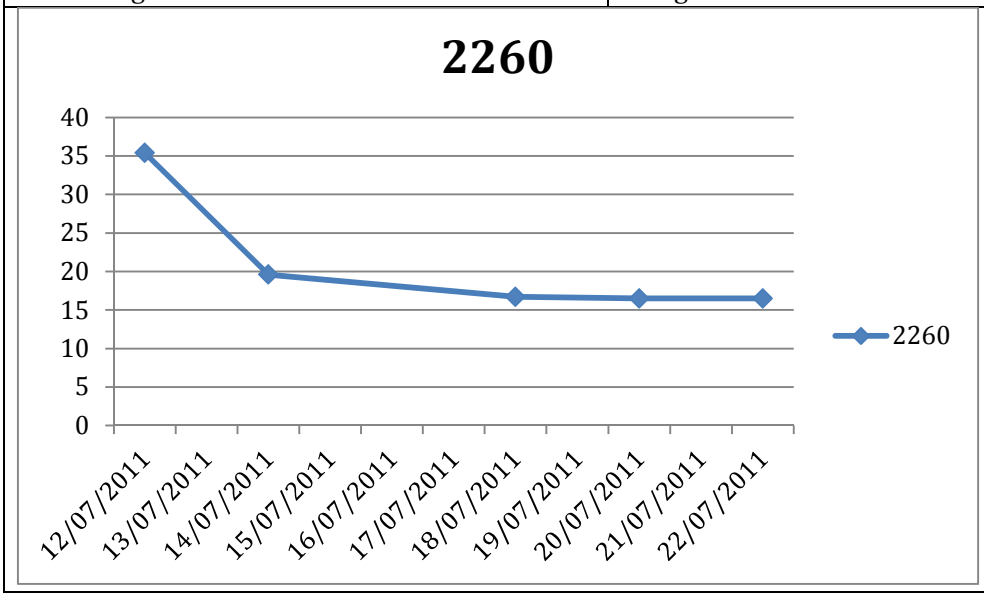
Head Piece 2255	
	
Fig: Head piece 2255 before conservation	Fig: Head piece 2255 after conservation
Start Date Drying	17.03.2009
End Date Drying	20.03.2009
Initial Weight	450.8g
Final Weight	302.9g



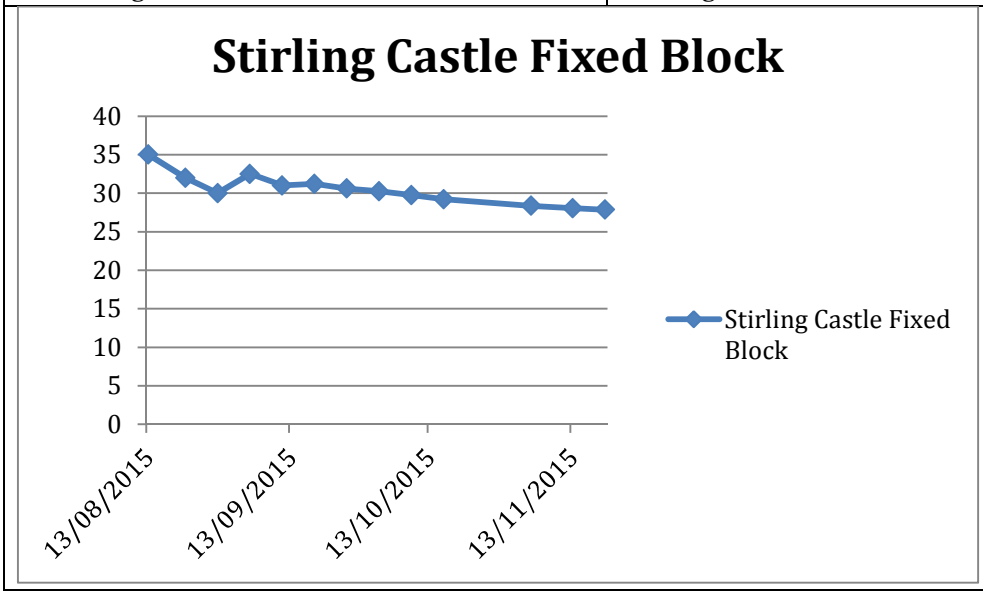
Head Piece 2259	
	
Fig: Barrel stave 2259 before conservation	Fig: Barrel stave 2259 after conservation
Start Date Drying	12.07.2011
End Date Drying	03.08.2011
Initial Weight	583.3g
Final Weight	286.3g



Barrel Stave 2260	
	
Fig: Barrel stave 2260 before conservation	Fig: Barrel stave 2260 after conservation
Start Date Drying	12.07.2011
End Date Drying	22.07.2011
Initial Weight	35.4g
Final Weight	16.5g



Fixed Double Block 1050	
	
Fig: Fixed block 1050 before conservation	Fig: Fixed block 1050 after conservation
Start Date Drying	13.08.2015
End Date Drying	20.11.2015
Initial Weight	35kg
Final Weight	27.85kg



APPENDIX II – DRAWING RECORD

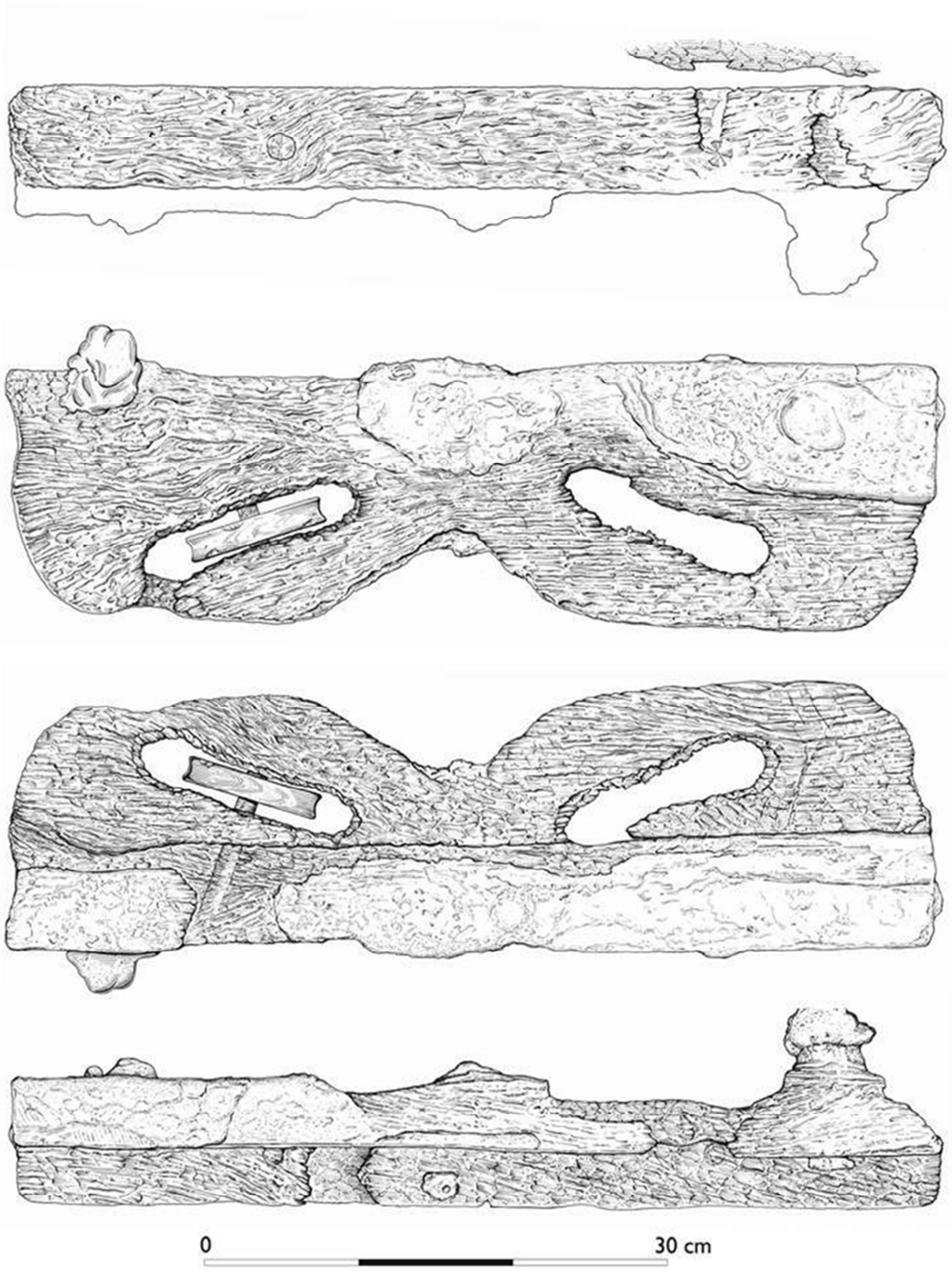


Figure II.1: Illustration of fixed block (by Chris Evans)

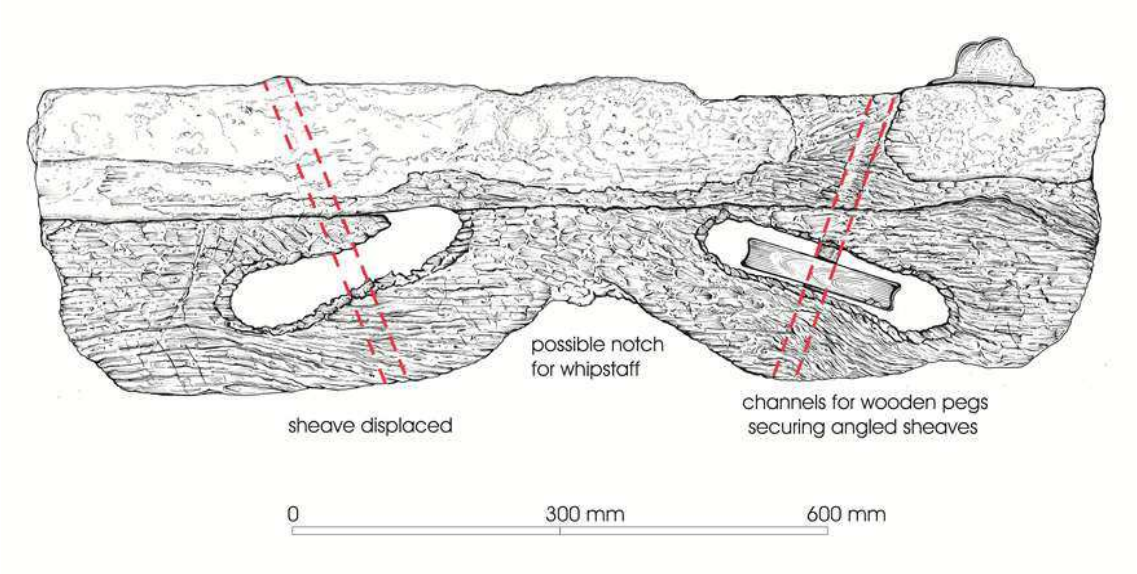


Figure II.2: Fixed block, position of wooden pegs indicated (by Chris Evans)

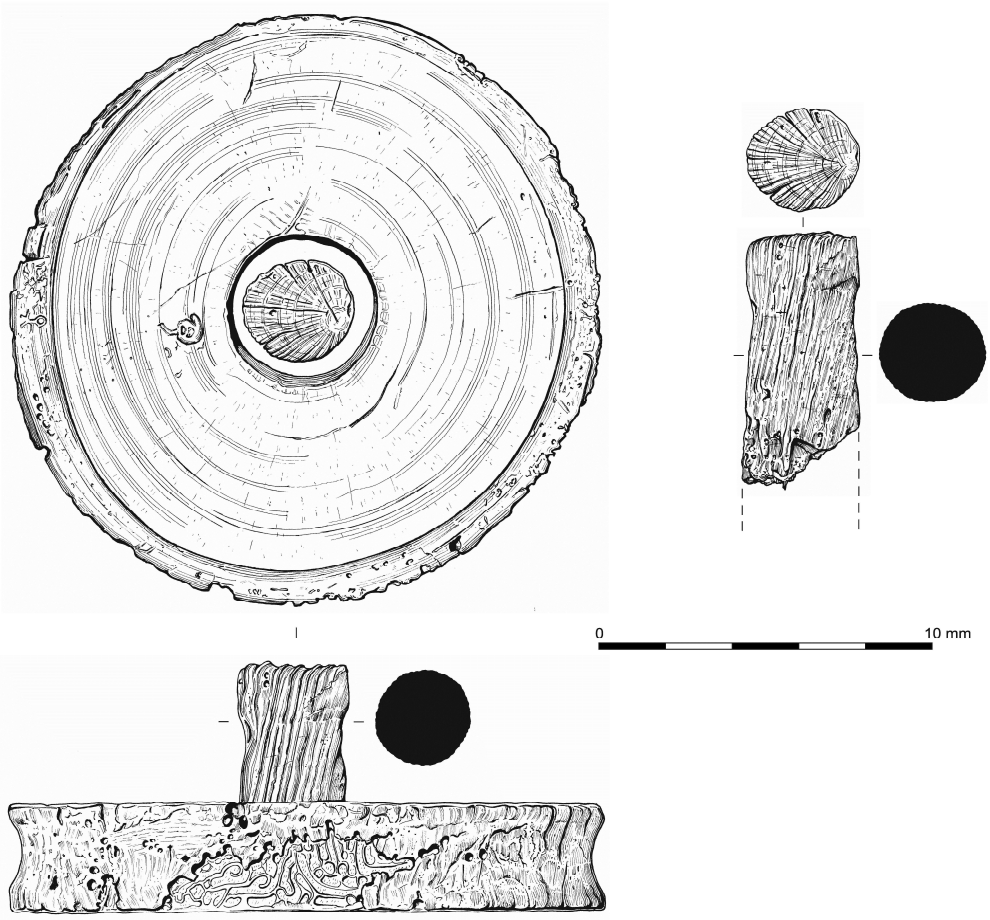


Figure II.3: Illustration of sheave and peg from fixed block (by Chris Evans)

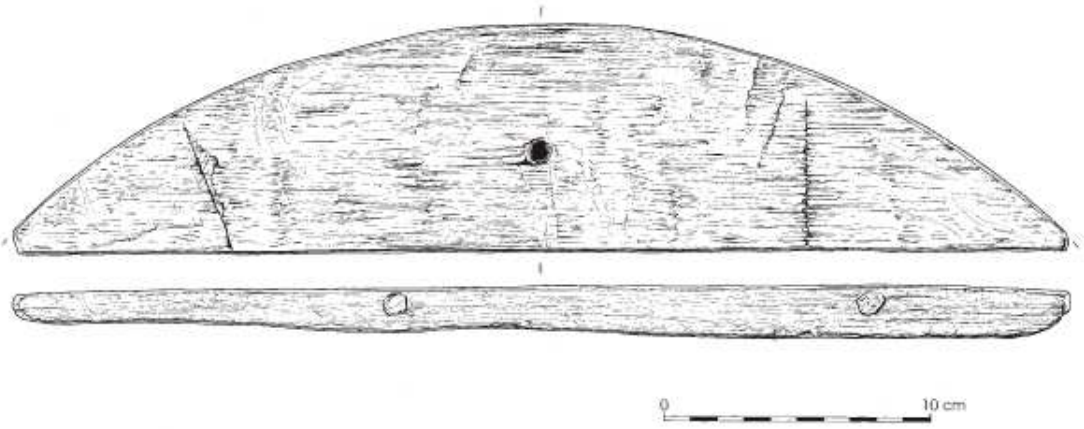


Figure II.4: Illustration of head piece 2255 (by Chris Evans)

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ISSN 2059-4453 (Online)