CONSERVATION OF A GROUP OF FRAMES FROM YK 16 SHIPWRECK

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ABSTRACT

Thirty-seven medieval shipwrecks, dated at between the 5th and 11th centuries, were uncovered by the salvage excavations under the supervision of the Istanbul Archaeology Museums Directorate. The conservation work on 31 of these shipwrecks has been implemented by the Istanbul University's Department of Conservation of Marine Archaeological Objects (Kocabaş 2015:5). The conservation of frames from the Yenikapı 16 (YK 16) shipwreck, the conservation of which is ongoing, was carried out with Kauramin® treatment. This study describes the conservation procedures made by using Kauramin® in the treatment of a collection of low density, highly waterlogged and decomposed frames from the YK 16.

Keywords: Yenikapı shipwrecks, conservation, restoration, Yenikapı 16, Kauramin.

YENİKAPI 16 BATIĞINA AİT BİR GRUP EĞRİNİN KONSERVASYONU

ÖZ

5. ve 11. yüzyıllar arasına tarihlenen dünyanın en büyük ortaçağ batık gemi koleksiyonu İstanbul Arkeoloji Müzeleri Müdürlüğü Başkanlığında ortaya çıkarılmıştır. Söz konusu gemilerin 31'inin konservasyon çalışmaları İstanbul Üniversitesi Sualtı Kültür Kalıntılarını Koruma Anabilim Dalı tarafından gerçekleştirilmektedir (Kocabaş 2015:5). Konservasyon çalışmaları devam eden Yenikapı 16 (YK 16) batığına ait bir grup eğrinin koruma çalışmaları ise Kauramin® yöntemi ile tamamlanmıştır. Bu çalışmada yüksek oranda su çekmiş düşük yoğunluğa sahip ileri derecede bozulmaya uğramış YK 16'ya ait bir grup eğrinin Kauramin® yöntemi ile tamamlanan konservasyon çalışmaları anlatılmaktadır.

Anahtar Kelimeler: Yenikapı batıkları, konservasyon, restorasyon, Yenikapı 16, Kauramin.

INTRODUCTION

General conservation methods for waterlogged wood are polyethylene glycol (PEG), freeze-drying and Kauramin® (Giacchi, et al. 2011). Kauramin® is a form of melamine formaldehyde-based resin (Hoffmann, Wittköpper, 1999: 163). Impregnation is carried out with a water-soluble low molecular mass (400 to 700 g/mol) melamin formaldehyde polymer, Kauramin®. In Yenikapı Shipwrecks project, Kauramin® was used in 25% concentration for the conservation of frames of YK 16 after the desalination process had been completed. Kauramin® solutions were prepared with triethylene glycol, triethanolamine (TEA), urea and sometimes with glycerol diacetate to enhance the solution and to obtain different properties for the waterlogged wood that would be conserved (Kılıç 2011: 186).

Galleys were rarely uncovered in excavations and one of these galleys, namely YK 16, was uncovered at Yenikapı (Fig. 1) (Özsait-Kocabaş 2008: 176).The experiments were conducted on samples from YK 16. The studies carried out in Yenikapı, indicated that Kauramin® treatment yielded better results in waterlogged frames from the YK 16 shipwreck, the low- basic density and water content of which was high.

Fig. 1 Yenikapı 16 shipwreck.

Impregnation takes place at around 20-25°C and the pH should be kept at 8 to 9 by adding TEA. The solution will eventually become acidic, despite adding TEA and when the pH drops to 6–7, the chemicals poly-condensate and form a three-dimensional, insoluble and hard polymer in the wood. Impurities in the bath, oxygen, carbon dioxide, acidity and temperature have impacts on the impregnation and curing process.

The impregnation time can take from a few weeks to one year depending on the size (thickness) and state of preservation of the wood. Conservation methods for waterlogged wood of Yenikapı Shipwrecks are polyethylene glycol (PEG), freeze-drying and Kauramin® (Kılıç, 2015: 204). The conservation of YK 16 was carried out with PEG method. The conservation of the highly decomposed frames from the YK 16 shipwreck was carried out with Kauramin® treatment.

In this study, the conservation outcomes using Kauramin® treatment on the Eastern plane woods and elm tree wood, which were highly saturated in water and had a low density, obtained from the YK 16 shipwreck are evaluated. The study also attempts to identify a method that can be applied to other types of waterlogged wood having similar rate of decomposition. The frames used within the scope of the study were obtained from Eastern plane trees and can disintegrate even when lightly pressed by hand. It was found that as the water content decreases and the basic density of the wood increases, the wood becomes more resilient to manually exerted force. Conversely, the manual handling of frame, which has a low density and is highly saturated in water, is generally impossible. In fact, the frames from the YK 16 shipwreck, which were, as previously mentioned, made from Eastern plane wood, could not be lifted by hand, and instead had to be hoisted using special epoxy supports (Fig. 2). It was noted that marks on the frames were caused by manual handling.

Fig. 2 Frame from YK 16 being handled with epoxy support.

MATERIAL AND METHODS

The degree of degradation of waterlogged wood is usually correlated with its basic density and maximum water content (Babiński et. al. 2014: 373). Wood samples, approximate 1–1,5 g, were taken from the YK 16 shipwreck in order to determine maximum water content and basic density in the wood of the ship. According to these analyses, maximum water content of woods was between 963% to 1467% and basic density was 0,07 to 0,10 g/cm^3 (Table 1). Waterlogged wood is often classed according to maximum water content: Class I: over 400 percent, Class II: 185- 400 percent and Class III: less than 185 percent (McConachie, et al. 2008:30). Based on this, classification of the woods from YK 16 Shipwreck was considered as Class I, and conservation procedure was carried out based on the following parameter.

Frame number	**Identification (Species)**[1]	**Basic density (g/cm^3)**	**Maximum water content (% w/w)**
E01	Eastern plane	0,09	1063
E2	Eastern plane	0,10	983
E03	Elm tree	0,08	1125
YBO 3	Eastern plane	0,08	1202
YBO 05	Eastern plane	0,07	1378
E5	Eastern plane	0,07	1324
E16	Eastern plane	0,10	963
E17	Eastern plane	0,08	1233
E18	Eastern plane	0,07	1392
E20	Eastern plane	0,07	1467
E33	Eastern plane	0,09	1100

Table 1 Maximum water content and basic densities of waterlogged wood.

[1] Identification of wood made by Prof. Dr. Ünal Akkemik from İstanbul University Faculty of Forestry, Department of Forest Botany (Akkemik and Kocabaş,2012:34).

Woods of YK 16 were drawn on a 1/1 scale on acetate prior to the application of the preserving coat in order to be able to observe cracking and shrinkage. Verification of dimensional change, shrinkage and cracking following the treatment was conducted using these drawings.

Firstly, the boxes used for treatment were covered with polyethylene film. After that, Kauramin® solutions were prepared. An amount of 10% (w/w) triethylene glycol was added to the Kauramin® to try to obtain a more flexible structure for the wood. TEA, in the amount of 0.5% (w/w), was added to the solution as an alkaline buffer to prolong the life of the Kauramin® solution (Hoffmann, Wittköpper 1999: 164). Formaldehyde in the Kauramin® solution is very risky for human health. In order to decrease the effects of free formaldehyde, urea at a ratio of 5% (w/w) was added to Kauramin® solutions. Urea also increases the ability of the solution to be absorbed into the wood by decreasing the viscosity of the solution and produces a more durable resin by forming a urea-formaldehyde resin (Wittköpper 1998). 25 % concentration Kauramin® solutions were prepared. Impregnation of the woods of YK 16 was started in the boxes (Fig. 3). Melamine formaldehyde prepolymer, which condenses to a three dimensional, insoluble and hard polymer in the wood, dissolved in water, (Hoffmann, Wittköpper 1999: 163).

Fig. 3 Wood placed in the prepared solution.

RESULTS AND DISCUSSION

It was important to monitor the solution systematically during the impregnation. The *raki* point and pH measured periodically in order to follow-up and termination of the impregnation process. The r*aki* point occured when a matte white color emerged after the Kauramin® solution was dropped into distilled water. The *raki* point was related to a decrease of the acidity level of the solution. When the Kauramin® solution reached the *raki* point, the impregnation was terminated and the wood was taken out of the solution. The pH of the Kauramin® solutions measured periodically. The pH of the solution measured 6,8 to 7,4 when the *raki* point started. At the beginning, the pH of the solution measured 8,5 to 8,9. 1% glycerol diacetate was used in order to determine the effect on the solution acidity in some solutions. In the solutions, which glycerol diacetate was used, the *raki* point was realized quicker. In some applications, the process of reaching the *raki* point was accelerated by increasing the acidity of the solution when impregnation was fully completed. The wood had to be taken out of the bath once the *raki* point had reached in the Kauramin® solution or a white colored layer is formed on the wood. It is not possible to clean this white colored layer off the wood surface without causing any damage. In order to prevent this situation, it was crucial that periodical pH measurements and *raki* point tests were conducted.

Kauramin® solution impregnated woods were wrapped in cellulose paper immediately after they were removed from Kauramin® solution (Fig. 4). The aim of wrapping process is the absorption of the Kauramin® solution that might ooze out of the wood during the heated drying process, thus preventing resin deposits on the wood surface. The cellulose paper was soaked with water after wrapping. The aim of soaking the cellulose paper is to prevent it drying out during the heating, as it is difficult to remove from the wood surface when dry. After the woods were wrapped in wet cellulose paper, they were wrapped in polyethylene film and placed in an oven set to 50 °C. A sample of the Kauramin® solution was also put in the oven in order to observe the behavior of Kauramin® solution at 50° C. The drying process was terminated when the solution was completely hardened. The drying period of woods was from nine to eleven days. The woods were stored wrapped in a polyethylene film in order to prevent the direct contact with air. Cracks have been observed on woods that allowed the interaction with the air.

Fig. 4 Preparation of wood for oven drying.

The effects of the additives were examined in detail. Previous experiments showed that the *raki* point occurred earlier in solutions without the addition of TEA. The addition of TEA is recommended for woods with thickness over 4 cm. In this method, the curing of the solution was prevented and it was possible for all the parts of the wood to absorb the solution.

Urea increases the ability of the solution to be absorbed into the wood by decreasing the viscosity of the solution. Urea also produces a more durable resin by forming a urea-formaldehyde resin. In the experiments, it was observed that there were few or no transversal fractures on the woods treated with triethylene glycol. The woods with triethylene glycol were more flexible.

Before conservation, stains of iron from iron nails used during the assembly of ship components and corrosion were observed during the examinations. PEG used in the conservation process of shipwreck is an electrolyte carrying an effective ion that reacts with the iron used on wood assembly elements. After the PEG impregnation procedure, the oxidation of the sulphur was shown to be catalyzed by iron species following the reaction (Giorgi, et.al. 2005: 10743-10748). In Kauramin® treatment, neither the wood where iron nails had been used, nor the sections impacted by these was cleaned; however, using Kauramin® treatment, the conservation of the wood can be accomplished without cleaning away the iron and its compounds (Fig. 5).

Fig. 5 Frame No. E 03 before (above) and after (below) conservation.

CONCLUSION

It was observed that cracking and shrinkage were minimal on frames of YK 16 shipwreck (Fig. 6). In some frames of YK 16, very rare transversal cracks or slight dilation of pre-existing cracks were observed. Additionally, the color of the wood in iron nails parts was determined to be darker (Fig. 7-8-9). Results of the treatment indicated it is possible to obtain dimensional stability using the Kauramin® treatment on higly decomposed woods (high maximum water content and low basic density) (Fig. 10-11-12-13-14-15). Conservation of similar samples may take years, and can be very costly; furthermore, depending on the method of conservation used, artifacts may be damaged due to inappropriate air-conditioning within the museum environment (Kılıç, 2015a: 212, Kılıç 2015b). Kauramin® treatment is one of the most suitable conservation methods for artifacts to be exhibited in these conditions. Moreover, the equipment used in the handling and the conservation of waterlogged wood artifacts is rather expensive. Kauramin® treatment is a preferred procedure, due to its low cost and speed of application. Even so, it should be kept in mind that the treatment is irreversible. Therefore, instead of wasting the artifact, it should be possible and at the discretion of the conservator, to preserve its integrity using Kauramin® treatment.

Fig. 6 Frame No. YBO 05 before (above) and after (below) conservation.

Fig. 7 Frame No. E 01 before (above) and after (below) conservation.

Fig. 8 Frame No. YBO 3 before (above) and after (below) conservation.

Fig. 9 Frame No. E 18 before (above) and after (below) conservation.

Fig. 10 Frame No. E 33 before (above) and after (below) conservation.

Fig. 11 Frame No. E 16 before (above) and after (below) conservation.

Fig. 12 Frame No. E 20 before (above) and after (below) conservation.

Fig. 13 Frame No. E 17 before (above) and after (below) conservation.

Fig. 14 Frame No. E 5 before (above) and after (below) conservation.

Fig. 15 Frame No. E 2 before (above) and after (below) conservation.

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