United States
Department of
Agriculture

Forest Service

Forest
Products
Laboratory

Research
Note
FPL–RN–0327

Condition Assessment of a 2,500-Year-Old Mummy Coffin

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Abstract

This work was conducted to assess the condition of a 2,500-year-old mummy coffin. The coffin, part of a collection of funerary objects at the Nelson–Atkins Museum of Art in St. Louis, Missouri, is made of wood obtained from a sycamore fig tree, *Ficus sycomorus*. Visual and acoustic-based nondestructive testing techniques were used to inspect the coffin. The upper portion of the coffin was remarkably well preserved; both visual and acoustic tests revealed no signs of deterioration. An area of deterioration in the bottom portion of the coffin was found. Based on our assessment, museum staff were able to design and construct a case that enabled them to display the coffin in a vertical orientation.

Keywords: mummy, coffin, nondestructive evaluation

Acknowledgment

Dr. Turker Dundar thanks The Scientific and Technological Research Council of Turkey (TUBITAK) for their support of this research.

April 2012

Ross, Robert J.; Dundar, Turker. 2012. Condition Assessment of a 2,500-Year-Old Mummy Coffin. Research Note FPL-RN-0327. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 3 p.

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Condition Assessment of a 2,500-Year-Old Mummy Coffin

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Introduction

Wood is one of the oldest materials used by humans; ancient civilizations used wood effectively for both structural and nonstructural applications. However, very few ancient wood artifacts have survived to modern times as a consequence of exposure to various biological agents that can cause their deterioration.

The country of Egypt provides us with some of the best preserved wood artifacts because of several factors. First, despite the paucity of indigenous trees capable of producing wood in sufficient sizes to make large timbers, ancient Egyptians used wood extensively in a wide variety of applications. Second, the arid climate in Egypt provides an excellent environment for the long-term preservation of wood. As a consequence, excavations of various archeological sites in Egypt have yielded many well-preserved wood artifacts.

It is interesting to note that early Egyptian woodworkers developed specialized techniques, which are very similar to those used today, to utilize small, low-quality timber as components of larger, ornately decorated items (Nicholson and Shaw 2000). To date, the oldest piece of plywood found came from a Third Dynasty Egyptian coffin; it consists of six layers of wood, each 4 mm thick, held together by wooden pegs. Similar to modern plywood, the grain of its layers are arranged crosswise to give added strength (Lucas and Harris 1999).

Mummy coffins are the best examples of Egyptian wood artifacts. As some of the most precious, ancient pieces at the largest museums in the world, mummy coffins provide scientists very important information about social, religious, and cultural beliefs of ancient Egyptians. The oldest wood mummy coffin found to date is estimated to be 5,000 years old and was made from cedar wood (*Cedrus* spp.). It was found at Sakkara, near Cairo, Egypt, in 2003 and had been placed in a tomb thought to date from 3100 to 2890 BC, under Egypt's First Dynasty (BBC 2003).

The work reported here was conducted to assess the physical condition of a 2,500-year-old wood mummy coffin (Fig. 1), dated to the first millennium BC. This coffin is part of an exceptionally fine group of funerary objects that were acquired by the Nelson–Atkins Museum of Art, Kansas

Figure 1. 2,500-year-old mummy coffin.

City, Missouri, in 2007 and scheduled for display in 2010 in a newly designed gallery space. The assessment was conducted to provide information on the condition of the coffin to museum staff responsible for designing and constructing appropriate support mechanisms for its display.

Methods and Results

We utilized visual and ultrasound nondestructive evaluation techniques to assess the condition of the coffin. In addition, a small wood sample taken from the coffin was used to determine the tree species of origin.

Species Identification

The wood was determined to be from a sycamore fig tree, *Ficus sycomorus*. This tree species was known as the "tree of life" in ancient Egypt and was cultivated commonly (Assmann and Lorton 2005, Medley 1993). The fruit, timber, and twigs are richly represented in the tombs of Early, Middle, and Late Kingdoms; it is also commonly mentioned in ancient Egyptian texts. The wood of this species was used for making roof timbers, coffins, wagons, and statues (Paul and Shaw 2000, Assmann and Lorton 2005).

Visual Inspection

The upper and lower sections of the coffin were visually inspected. Results of our visual inspection revealed the following: (1) Mechanical damage, possibly incurred at some point during its transport, was observed in several locations. (2) The upper section, when viewed from inside the coffin, showed no evidence of deterioration. The wood appeared to be in excellent condition. (3) The wood in the lower section, upon which the mummy would rest, was covered with a layer of dark red, brittle material. This area also contained numerous splits and cracks.

Ultrasound Testing

Ultrasound nondestructive testing techniques are frequently used to determine if deteriorated wood is present in a structure. Specifically, velocity of sound transmission and attenuation characteristics are significantly affected by the presence of deterioration caused by fungal decay. We used a Sylvatest Duo (CBT–CBS, Les Écorces, France) unit to test several areas of both upper and lower sections of the coffin. To maintain the integrity of the coffin's painted surface, a limited number of measurements were made at points where the paint layer was mechanically damaged. Results obtained from these measurements are summarized in Table 1.

The acoustic properties of sycamore fig wood are not known. However, the acoustic wave velocities for wood from many hardwood and softwood tree species have been determined experimentally and have been found to vary from 3,300 to 6,000 m/s parallel to grain (parallel to the long axis of the fiber) and 900 to 1,750 m/s perpendicular to grain (perpendicular to the long axis of the fiber) at moisture content levels ranging between 4% and 12% (Pellerin and Ross 2002). The acoustic wave velocities observed for the upper section of the coffin were in the range of those known for wood that has not deteriorated. However, data from measurements on the lower section did indicate presence of wood deterioration. Acoustic wave velocity observed at one point was significantly lower than would be expected. As noted, visual inspection of this area revealed several splits and cracks. We could not ascertain if the wood was simply split from drying or was deteriorated from exposure to biological fluids or chemicals that might have been used in preserving the body.

Mechanical Property Estimates

In our work to estimate some mechanical properties of the wood, we used a value of 0.30 for its specific gravity (SG). This value is lower than reported values for this species (Medley 1993, Ross and others 2004). We used a lower value to be conservative in our estimates. The *Wood Handbook* (FPL 2010) provides information on the fundamental relationship between SG and various mechanical properties for both hardwood and softwood species. For our work, we used empirical relationships between SG and compression parallel to grain, modulus of elasticity, and modulus of rupture. The formulas derived from these relationships and corresponding property value estimates are summarized in Table 2. Note that because the wood in the coffin was essentially clear (no knots or other major strength-reducing

Table 1. Summary of ultrasound test results

Measurement number	Section	Orientation relative to grain	Possible deterioration of wood	Wave velocity (m/s)
1	Upper	Perpendicular	No	1,455
2	Upper	Perpendicular	No	1,155
3	Upper	Perpendicular	Yes	958
4	Upper	Perpendicular	No	1,905
5	Upper	Parallel	No	4,426
6	Lower	Perpendicular	No	1,572
7	Lower	Perpendicular	No	1,726
8	Lower	Perpendicular	No	1,430
9	Lower	Perpendicular	No	1,425
10	Lower	Perpendicular	Yes	508

Table 2. Summary of mechanical property estimates

Mechanical property	Formula[a]	Estimated value (lb/in^2)[b]
Compression parallel to grain	$11{,}030(SG^{0.89})$	3,800
Modulus of elasticity	$2.39(SG^{0.7})$	1.03×10^6
Modulus of rupture	$24{,}850(SG^{0.13})$	21,250

[a] SG, specific gravity.
[b] 1 lb/in^2 = 6.8948 kPa.

Figure 2. Coffin displayed in vertical orientation.

growth characteristics were observed), we believed it was appropriate to use these relationships with no additional modifications.

Concluding Comments

We had the opportunity to apply nondestructive evaluation techniques to aid in the assessment of a 2,500-year-old wood coffin. Using visual and acoustic nondestructive testing techniques, we were able to locate an area of deterioration in the coffin. We were also able to confirm that much of the wood in the coffin is solid, with no deterioration present. This information was useful to individuals assigned the task of designing and constructing the support mechanism so that the coffin could be displayed in a vertical orientation (Fig. 2).

References

Assmann, J.; Lorton, D. 2005. Death and salvation in ancient Egypt. Ithaca, NY: Cornell University Press. 504 p.

BBC. 2003. Wooden coffin yields ancient mummy. http://news.bbc.co.uk/1/hi/sci/tech/2903983.stm. (Accessed 2/15/12).

FPL. 2010. Wood handbook—wood as an engineering material. Gen. Tech. Rep. FPL–GTR–190. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Lucas, A.; Harris, J.R. 1999. Ancient Egyptian materials and industries. N. Chemsford, MA: Courier Dover Publications. 523 p.

Medley, K.E. 1993. Extractive forest resources of the Tana River National Primate Reserve, Kenya. Economic Botany. 47(2): 171–183.

Nicholson, P.T.; Shaw, I. 2000. Ancient Egyptian materials and technology. Cambridge, UK: Cambridge University Press. 724 p.

Pellerin, R.F.; Ross, R.J. 2002. Nondestructive evaluation of wood. Madison, WI: Forest Products Society.

Ross, R.J.; Brashaw, B.K.; Wang, X.; White, R.H.; Pellerin, R.F. 2004. Wood and timber condition assessment manual. Madison, WI: Forest Products Society. 73 p.