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Condition Assessment of a Historic Trout Rearing Station in Upper Michigan

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Abstract

Michigan Technological University's (Michigan Tech) School of Forest Resources and Environmental Science maintains a log cabin on the north branch of the Otter River in southern Houghton County (Portage Township), Michigan. The cabin was built in 1934–1935 and measures 150 m^2. The cabin's location is less than 10 m from the river, and when combined with the region's high snowfall (5+ m per year) and subsequent spring melting, is highly susceptible to occasional flooding and subsequent water damage and decay.

The history and use of the cabin dates back to the mid-1930s. The Michigan Conservation Department (predecessor of the Michigan Department of Natural Resources) and the Civilian Conservation Corps built the cabin in 1934–1935 to house workers who used the site as a trout hatchery.

Since 1998 Michigan Tech, in cooperation with the USDA Forest Products Laboratory (FPL), has conducted periodic inspections of the cabin. This report summarizes results obtained from the inspection conducted in 2013. It includes a brief summary of the nondestructive testing techniques used, observations, and data from tests conducted on the cabin.

Keywords: Nondestructive assessment, decay, moisture content

Contents

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Introduction

Michigan Technological University's (Michigan Tech) School of Forest Resources and Environmental Science maintains a log cabin on the north branch of the Otter River in southern Houghton County (Portage Township), Michigan, USA. The cabin was built in 1934–1935 and measures 150 m^2. Untreated red pine (*Pinus resinosa*) logs were used as the primary construction material. The cabin's location is less than 10 m from the river, and when combined with the region's high snowfall (5+ m/year) and subsequent spring melting, results in it being highly susceptible to occasional flooding and subsequent water damage and decay.

The history and use of the cabin dates back to the mid-1930s. The Michigan Conservation Department (predecessor of the Michigan Department of Natural Resources) and the Civilian Conservation Corps built the cabin in 1934–1935 to house workers who used the site as a trout hatchery. Grayling (*Thymallus arcticus*), rainbow (*Oncorhynchus mykiss*) and German brown (*Salmo trutta*) trout were propagated at the site. The cabin was transferred to Michigan Tech in 1955 with the reservation that public rights of hunting, fishing, and trapping would be maintained. The cabin has been used regularly by students of Michigan Tech's School of Forest Resources and Environmental Science. Access to the cabin is also granted to a variety of user groups within the local community.

Ongoing maintenance of the cabin is required because of its proximity to the river and the region's heavy annual snow fall. Excessive water exposure as a consequence of flooding of the nearby river has resulted in the deterioration of several of the logs of the cabin during its service life. For example, in 1959, deteriorated logs were removed and replaced with a ventilated crawl space using a red sandstone foundation. Several attempts to mitigate the effects of snow on the roof have been undertaken. Asphalt shingles replaced the original cedar shake roof in 1956, and in 1990 a metal roof was installed.

Since 1998, Michigan Tech has conducted periodic inspections of the cabin in cooperation with the USDA Forest Products Laboratory (FPL). This research note summarizes results obtained from the inspection conducted in 2013. It includes a brief summary of the techniques we used and observations and data from tests conducted on the cabin.

Methods

We inspected the cabin on July 30, 2013. Figure 1 is the cabin, and Figure 2 illustrates the location of the cabin relative to the Otter River.

Similar inspections of the cabin were completed in 1998 and 2008. In these inspections, we used accepted inspection techniques to assess the condition of the timbers that comprise the cabin. These techniques are discussed in detail in

Figure 1—Otter River cabin, 2013.

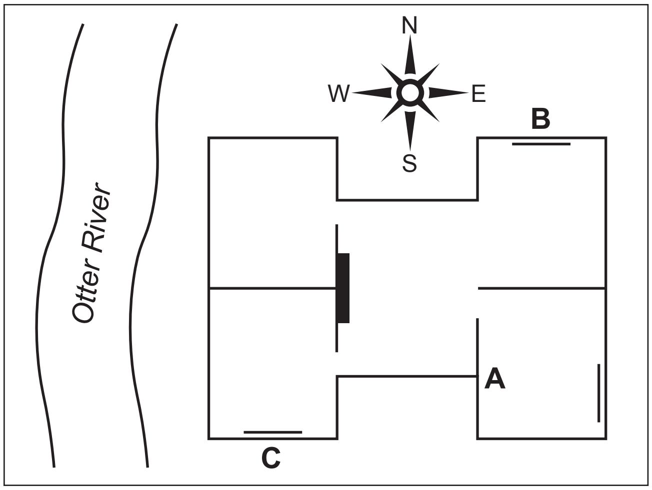

Figure 2—Orientation of the cabin relative to the Otter River. Note the location of walls A, B, and C.

Figure 3—Testing of wall timbers using a stress-wave timing device.

Figure 4—Micro-drilling resistance of wall timber in Otter River cabin.

Wood and Timber Condition Assessment Manual, Second Edition (White and Ross 2014). A brief description of the techniques we used follows.

Visual Inspection

The simplest method for locating deterioration in wood members is visual inspection. An inspector observes the structure for signs of actual or potential deterioration, noting areas that require further investigation. Visual inspection is useful for detecting intermediate or advanced surface decay, water damage, mechanical damage, or failed members. Visual inspection cannot detect early stage decay or deterioration. Several key indicators are looked for in visual inspections: fruiting bodies (evidence of advanced decay), staining or discoloration of members (indicators of water damage), evidence of insect activity (holes, frass, and powder posting), plant or moss growth in a member, deep checks or splits, and failed or missing members.

In our inspection of the cabin, we specifically looked for the following: 1. Evidence of water intrusion and subsequent damage, especially near its foundation, and 2. Evidence of structural failure of the timbers and noting collapsed timbers near the foundation and at hips and valleys of the roof.

Sound Transmission

A significant volume of research has been devoted to the use of sound waves for locating areas of deterioration in timber structures, and a practical set of guidelines for their use has been prepared by FPL (Ross and others 1999). In summary, the transmission of sound in wood is affected significantly by the presence of deterioration. Consequently, ultrasound and stress-wave based technologies have been developed and are widely used to inspect wood structures (Allison and others 2008; Brashaw and others 2005; Clausen and others 2001; Emerson and others 2002; Ross and others 1999; Ross and others 2001; Ross and Wang 2005; Ross and others 2006) and have been used for the assessment of culturally significant historic ships and artifacts (Ross and others 1998; Wang and others 2008; Dundar and Ross 2012).

We used a simple, inexpensive stress-wave timer in our inspection (Fig. 3). Sensors were placed on opposite sides of a timber. The timber was then struck, generating a stress wave. The time it took for the wave to travel between the sensors was measured by the timer and recorded. Transmission times for wood from several species are known and were used as a baseline. Transmission times significantly longer than baseline values indicated the presence of deteriorated wood.

Micro-Drilling Resistance

Simple mechanical tests are frequently used for in-service inspection of wood members in structures. Drilling and coring are the most common, simple tests used to detect internal deterioration. Both are used to detect the presence

Figure 5—Visual evidence of deterioration of wall timbers.

Figure 6—Visual evidence of severe deterioration of wall timbers.

of voids and to determine the thickness of the residual shell when voids are present.

Micro-drilling resistance is a commercially developed technique originally developed for use by arborists and tree care professionals to evaluate the condition of urban trees and locate voids and decay. It is now being used to identify and quantify decay, voids, and termite galleries in wood beams, columns, poles and piles (Fig. 4) (Brashaw and others 2005). The underlying premise for this technique is that degraded wood is relatively soft and will have low resistance to drill penetration.

Our tests were conducted using a micro-drilling resistance device manufactured by IML, Inc. (Instrument Mechanic Labor, Inc., Kennesaw, Georgia). We conducted micro-drilling resistance tests in areas of the timbers that we believed contained deteriorated wood, based on results from our visual assessments and stress-wave testing.

Results

Visual Inspection

Figures 5 and 6 illustrate examples of the types of deterioration we found in our visual inspection. Note that the logs used in the construction of the cabin were not treated with a wood preservative; hence they are highly prone to deterioration from decay fungi. Many of the logs that are in direct contact with the sandstone foundation showed signs of significant deterioration. The log shown in Figure 5 is an excellent example of the type of deterioration we observed. It contained significant splits and cracks, and upon probing with a pocket knife was found to be soft, both indicators of advanced deterioration.

Many of the logs showed signs of severe deterioration, as shown in Figure 6, with the ends of several having been entirely destroyed. Several showed signs of mechanical failure.

Sound Transmission

Table 1 summarizes results from sound transmission tests for logs from several locations of the camp. Note that a baseline reading of approximately 200 micro-seconds or smaller indicates solid wood. Transmission times greater than 200 micro-seconds indicate deteriorated wood, and values greater than 250 indicate severe deterioration. Note that an electrical resistance moisture meter was used to determine their moisture content. Moisture content of the cabin's timbers ranged from 8.0% to 20.4%.

Micro-Drilling Testing

Tests results from logs that compromised Wall Section A confirmed that many were deteriorated. Most had an outer shell of solid material, whereas their core was severely

Table 1—Results from stress wave tests of timbers in the Otter River cabin

Wall	Timber position in the wall	Stress wave transmission time (µs)	Comments
A	1	250	Deteriorated
	2	241	
	3	289	Deteriorated
	4	262	Deteriorated
	5	246	
	6	319	Deteriorated
	7	248	Deteriorated
	8	526	Severe deterioration
B	1	135	
	2	130	
	3	145	
	4	153	
	5	145	
	6	235	Deteriorated
C	1	174	
	2	232	
	3	187	
	4	207	
	5	250	Deteriorated
	6	256	Deteriorated

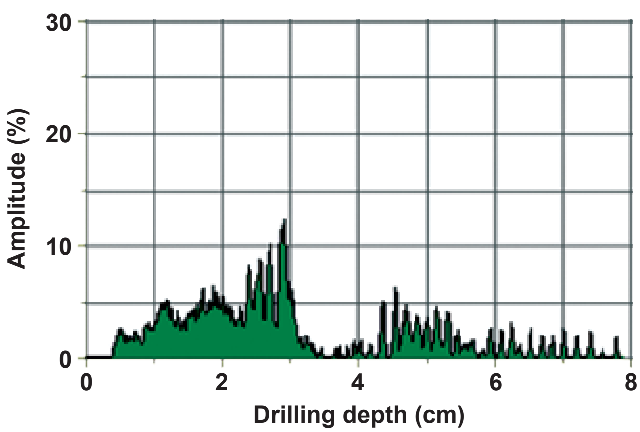

Figure 7—Typical results obtained from a micro-drilling resistance test of a deteriorated timber from the Otter River cabin.

deteriorated. Similarly, micro-drilling testing of several timbers in Wall Section C confirmed that they were significantly compromised (Fig. 7).

Summary

An inspection Michigan Technological University's Otter River Camp was conducted in August 2013. Several widely used techniques were used in the inspection. Because of its close proximity to the Otter River, the Camp's cabin has significant water damage. Several areas of the cabin have significantly deteriorated timbers.

Wall A is directly underneath a valley in the cabin's roof. Prior inspections revealed significant water damage. The roof was repaired subsequent to the 1998 inspection. The logs that comprise this wall section have been water damaged because of flooding from the river and water entering through the roof. All of the logs in this section are deteriorated, some severely. The logs in Wall B of the cabin showed no signs of deterioration. Several of the logs in Wall C were deteriorated.

Recommendation

We strongly recommend that the cabin be dismantled, salvaging the historic materials (hardware and any timber that is sound) and that a smaller structure be built on the site using the salvaged materials where appropriate.

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