SCANNING TECHNIQUE TO IDENTIFY BIOLOGICALLY DEGRADED WOOD

by R.J. Ross and R.C. DeGroot

The USDA Forest Service, Forest Products Laboratory (FPL), has been developing nondestructive evaluation (NDE) techniques to identify degradation of wood in structures and the performance characteristics that remain in the structure. The FPL's work has focused on using stress wave transmission NDE techniques for both laboratory and field investigations.

In a previous publication,' we reported on an inexpensive experimental technique that was developed to observe longitudinal stress wave behavior in small-sized wood specimens. The technique utilized a mechanical impactor to induce a wave in wood specimens. Wave propagation in the specimens was observed by placing a piezo film sensor on the wood's surface. Output of the sensor was recorded and displayed on a digital storage oscilloscope. Such a technique enabled us to examine fundamental relationships between wave propagation characteristics and the biological degradation of wood.

Baaed on the encouraging results **observed** in our previous work, we investigated the use of speed of stress wave transmission to locate degraded regions in wood members. The following describes the experimental setup that we utilized and typical results obtained from its use.

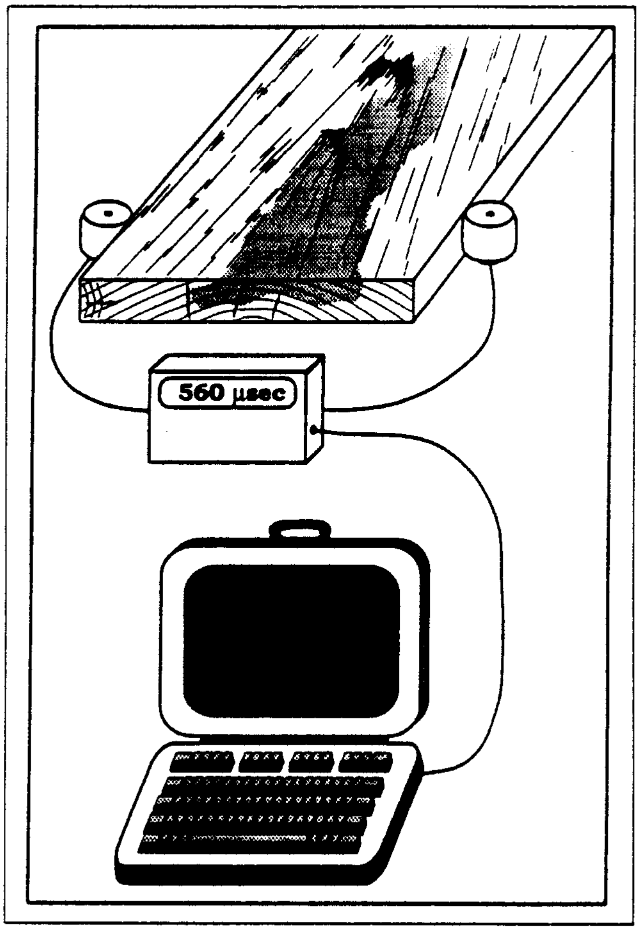

Fig. I: Schematic of key components of the NDE setup, illustrating a typical transmission time of 560 usec for a decayed member.

EXPERIMENTAL SETUP

The test setup consisted of two 84 kHz rolling transducers, coupled to an ultrasonic transmitting and receiving unit. A schematic and photograph illustrating key components of the setup are shown in Figs. 1 and 2. A stress wave was introduced into the specimen in the transverse direction by the transmitting transducer. The wave was then received by the opposing transducer. Stress wave transmission times were displayed by the unit and recorded on **a** personal computer. Transmission times were measured at increments along the length of the specimens at the locations illustrated in Fig. 3.

Note that measurements were made in 3-in (76-mm) increments near the ends of the specimens and in 6-in. (152-mm) increments elsewhere along the length Each specimen was tested several times. Excellent agreement was observed among scans for individual specimens.

RESULTS

Results obtained from two typical scans are shown in Fig. 4. The scan illustrated in Fig. 4a shows results obtained from a 2- by 4-in. by 8-ft-(50-mm by 100-mm by 2.4-m-) long Southern Pine specimen that was free of naturally occurring defects (knots) and was not exposed to decay fungi. Knot-free specimens were selected in an attempt to minimize variability between specimens. Such defects will alter stress wave transmission characteristics, but their effect has been found to be of secondary importance when decayed material is present. Note that little or no variation in transmission times was found along the length of the specimen. Also, the observed times were similar to those previously reported for clear wood[3-6]

It is interesting to examine the scan obtained from a similar type of specimen that has been placed in an outdoor situation for 45 months. Fig. 4b shows a scan obtained from a specimen of the same species and size as that corresponding to Fig. 4a. Note the elevated transmission times for the exposed specimen.

Elevated sound transmission times, which correspond to a decrease in speed of stress wave transmission, are indicative of degradation caused by decay fungi.[2] Visual examination of the specimen revealed signs of degradation from decay fungi. Note that transmission times vary considerably along the length of the specimen, with the longest times near the

R.J. Ross is Supervisory Research General Engineer with USDA Forest Service, Forest Products Laboratory, Madison WI., R.C. DeGroot is Research Plant Pathologist with USDA Forest Service, Forest Products Laboratory, Madison, WI.

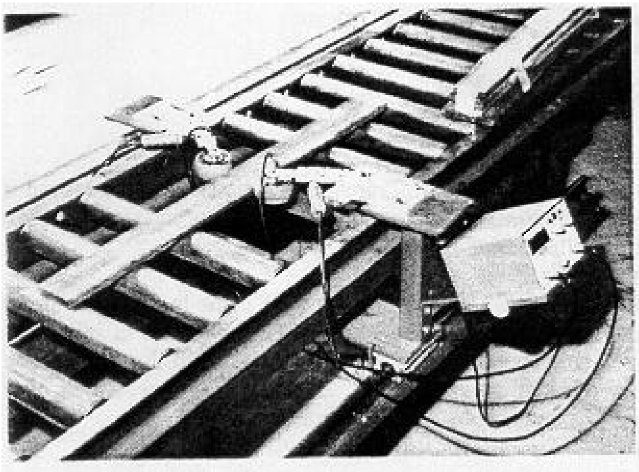

Fig. 2: The NDE testing group.

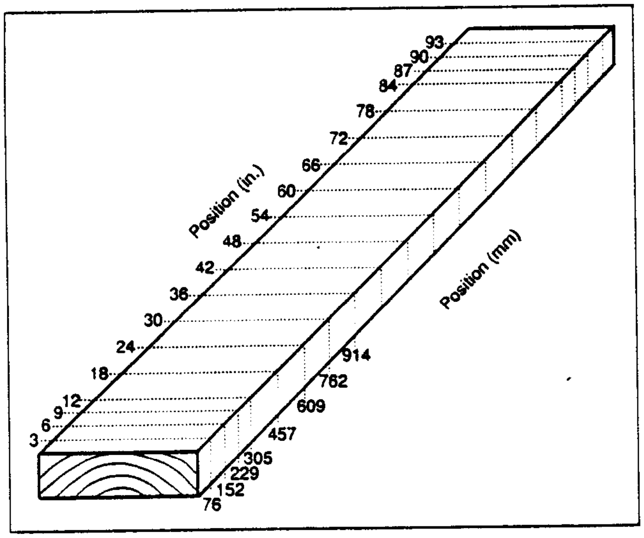

Fig. 3: Transmission times were measured at increments along the length of the specimens at the locations shown.

ends. This would indicate that decay fungi infect the ends of the members first, and then migrate along the member's length.

CONCLUDING REMARKS

We developed an experimental technique to scan wood members for the presence of biologically degraded areas. The technique utilizes an ultrasonic transmitting and receiving unit coupled to two 84 Khz rolling transducers. With this technique, we were able to locate biologically degraded sec-

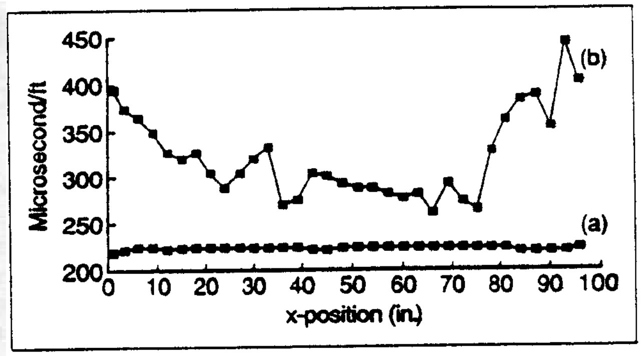

Fig. 4: Two typical scans showing transmission time as a function of position along the specimen: (a) results from a 2- by 4-in. by 8.ft- (50-mm by 100-mm by 2.4-m-) long Southern Pine specimen that was free of naturally occurring defects (knots) and not exposed to decay fungi; (b) results from a specimen of the same species and size as (a). Note the elevated transmission times for the exposed specimen. (1 ft = 0.3 m; 1 in. = 0.03 m)

tions within wood members. Such a technique has considerable potential applications for in-place assessment of degradation of wood members and quality assessment of lumber during manufacturing.

ACKNOWLEDGMENT

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