Chapter 5—Probing, Drilling, and Coring—Nondestructive Evaluation Methods

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Simple mechanical tests are frequently used for in-service inspection of wood members in structures. For example, pick- or probing-type tests are used to indicate the condition of a structural member. The underlying premise for such tests is that degraded wood is relatively soft and will have low resistance to probe penetration.

Drilling and coring are the most common methods used to detect internal deterioration in wood members. Both techniques are used to detect the presence of voids, and to determine the thickness of the residual shell when voids are present. Drilling and coring are similar in many respects and are discussed together. Drilling is usually done with an electrical power drill or hand-crank drill equipped with a 9.5- to 19-mm (3/8- to 3/4-in.) diameter bit Power drilling is faster, but hand drilling allows the inspector to monitor drilling resistance and may be more beneficial in detecting pockets of deterioration. In general, the inspector drills into the member in question, noting zones where the drilling becomes easier, and observes the drill shavings for evidence of decay. The presence of common wood defects, such as knots, resin pockets, and abnormal grain, should be anticipated while drilling and should not be confused with decay. If decay is detected, remedial. treatment can be added to the wood through the inspection hole. The inspection hole is probed with bent wire or a shell thickness gauge to measure shell thickness.

Another drilling technique that has been commercially developed is the resistance drill. system. The system was originally developed for use by arborists and tree care professionals to evaluate the condition of urban tress and locate voids and decay. It is now being utilized to identify and quantify decay, voids, and termite galleries in wood beams, columns, poles, and piles **(Figs. 5.1 and 5.2).**

Figure 5.1 - *Locating deterioation in a wall system with an instrumented drill.*

Figure 5.2 - *Testing an in-service pole.*

The resistance drill system measures the resistance of wood members to a 1.5-mm drill bit with a 3.0-mm head that passes through them. The drill bit is fed at a fixed movement rate allowing the inspector to determine exact location and size of the damaged area. This system produces a chart showing the relative resistance over its travel path. This cart can be produced either as a direct printout or can be down loaded to a computer. Areas of sound wood have levels of resistance, with voids showing no resistance. The user can determine areas of low, mild, and high levels of decay. Furthermore; termite galleries can be identified by the characteristic of high resistance (solid wood) followed immediately by no resistance (gallery). Larger diameter holes can be drilled and inspected with a magnified inspection scope to verify live termites.

Coring with an increment borer (often used for determining the age of a tree) also provides information on the presence of decay pockets and other voids (**Fig. 5.3**). The resultant solid wood core can be carefully examined for evidence of decay. In addition, the core can be used to obtain an accurate measure of the depth of preservative penetration and retention. It is also possible to determine the wood species from the core. To prevent moisture and insect entry, a bored-out core should be filled with a treated wood plug.

Probing with a moderately pointed tool, such as an awl or knife, locates decay near the wood surfaces as indicated by excessive softness or a lack of resistance to probe penetration and the breakage pattern of the splinters. A brash break indicates decayed wood, whereas a splintered break reveals sound wood. Although probing is a simple inspection method, experience is required to interpret results. Care must be taken to differentiate between decay and water-softened wood that may be sound but somewhat softer than dry wood. It is also sometimes difficult to assess damage in soft-textured woods such as western redcedar.

A quantitative test based on the premise that underlies mechanical tests (relative softness of degraded wood and consequent low resistance to probe

penetration) was developed by Talbot (1982. His test differed from the probing-type test in that instead of evaluating penetration resistance of a probe, it examined withdrawl resistance of a threaded probe, similar to a wood screw, inserted into a member. Talbot believed that a correlative relationship between withdrawal resistance and residual strength should exist and would be relatively easy to implement. To determine if such a relationship exsisted, he conducted an experiment using several small Douglas-fir beams in various stages of degradation as a result of exposure to decay fungi. Prior to testing the wood to failure in bending, probe withdrawal resistance was measured at the neutral axis of the beams. Bending strength and corresponding probe resistance values were then compared. The results revealed a relationship between withdrawal resistance and residual strength (Fig 5.4). Talbot Used this test in conjunction with stress wave techniques to assess the extent of damage to solid-sawn timbers of the football stadium at Washington State University.

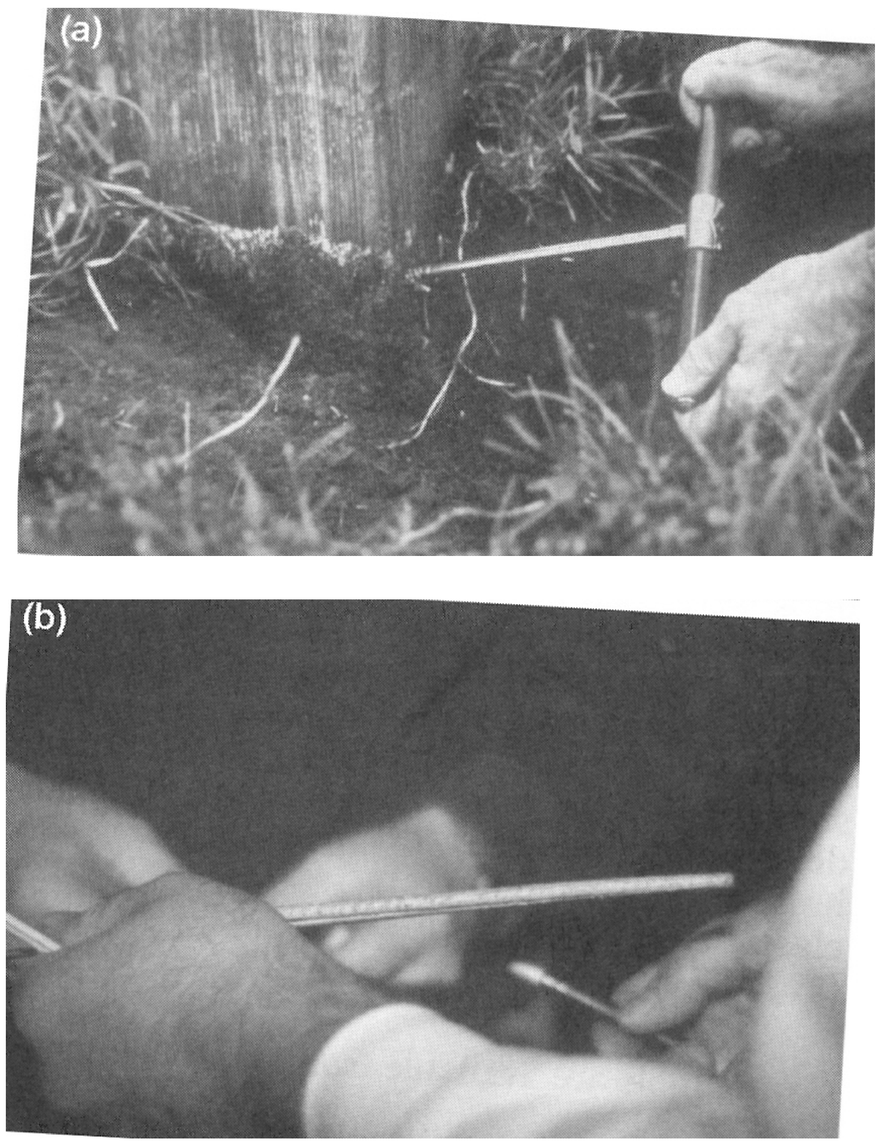

Figure 5.3 - *Locating decay pockets and other voids with an increment borer: (a) boring the core from the wood; (b) examing the core for decay.*

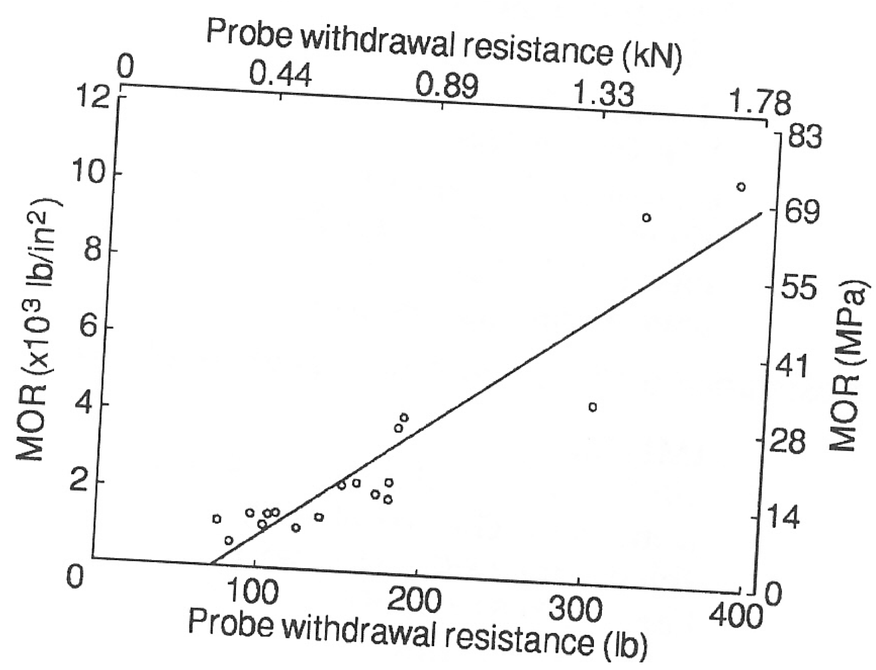

Figure 5.4 - *Relationahip between withdrawal resisance and residual strength.*

A modified approach to Talbot's technique was developed for use in evaluating in-service strength of fire-retardant treated (FGRT) plywood in the early 1990s. A portable screw withdrawal system was utilized to inspect FRT panels and identify those that had experienced substantial degrade. An extensive research effort was devoted toward investigating the use of Talbot's test for assessing the residual strength of in-service panel products treated with fire

retardant. Winandy *et al.* (1998) designed and conducted tests on a large sample of plywood specimens that were treated with fire-retardant chemicals and subsequently exposed to elevated temperatures. Screw withdrawal loads were determined for each specimen prior to static bending tests. Correlative relationships were then established between screw withdrawal strength and static bending properties. The relationships found were similar to those used for determining strength of lumber from modulus of elasticity measurements **(Fig. 5.5).**

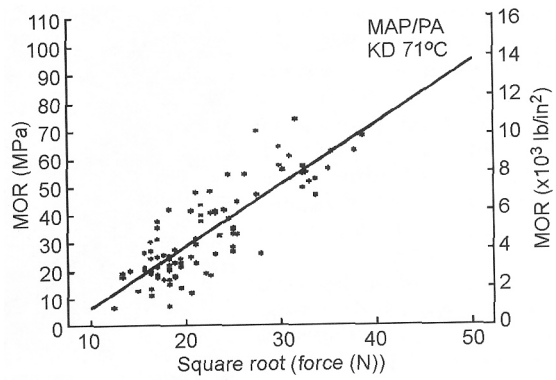

Figure 5.5 –Relationship of screw-withdrawal force to bending strength for 12-mm (1/2-in.) thick plywood from Factors Study. MAP is mono-ammonium phosphate; PA, phosphoric acid; KD is dry-bulb kiln-drying temperature.

Coring tools are available from the following companies:

Forestry Supplies, Inc.
P.O. Box 8397
Jackson, MS 39201 USA
Telephone: (601) 354–3565
Fax: (601) 292–0165
wwwforestry-suppliers.com

Ben Meadows Company
P.O. Box 20200
Canton, GA 30114 USA
Telephone: (770) 479–3130
Fax: (770) 479–3133
www.benmeadows.com

Resistance drilling equipment is available from:

IML Inc.
1950 Barrett Lakes Blvd., Suite 2212
Kennesaw, GA 30144 USA
Telephone: (888) 514–8851
Fax: (770) 514–8351
www.imlusa.com

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2a Merrow Lane, Guildford
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Telephone: +44(0) 1483 440 724
Fax: +44(0) 1483 440 727
www.sibtec.com

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Cover photos courtesy of Donald W. Neal, P.E., Neal Engineering Associates, Beaverton, OR; USDA Forest Service, Forest Products Laboratory, Madison WI; Washington State University, Pullman WA; and USDA Forest Service, Forest Products Laboratory Madison, WI.

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ISBN 1-892529-26-2

Publication No. 7250

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Printed in the United States of America.

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