METHOD FOR OBTAINING WOOD/BARK ADHESION MEASUREMENTS ON SMALL SAMPLES

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ABSTRACT

Using the Instron Tester, a procedure has been developed for measuring wood/bark adhesion on small samples. Using very small, specially prepared samples, wood/bark adhesion measurements were made on twenty-four hardwoods and eighteen conifers. High dormant season wood/bark adhesion in hardwoods was found to be associated with the presence of fibers in the inner bark. The procedure appears to be useful in identifying difficult-to-debark species and evaluating methods of reducing adhesion.

Keywords: Wood/bark adhesion, debarking, shear parallel to grain.

INTRODUCTION

Adhesion between wood and bark has been the subject of research for many years. A number of apparently satisfactory but relatively crude techniques were developed for measuring adhesion (Wilcox et al. 1954; Berlyn 1965; Zakharov 1963). A major part of the wood/bark adhesion research was initiated during the 1950s when there was considerable interest in the chemical debarking of standing trees (McIntosh 1951; Wilcox et al. 1956; Schutt 1960). Most of these early tests were designed for use on bolts or standing trees and were judged to be unsatisfactory for examining adhesion changes in smaller samples or chips.

A test developed at The Institute of Paper Chemistry for accurately measuring seasonal changes in wood/bark adhesion is described. This test was designed for small wood/bark samples and measures shear parallel to the grain. The test is also useful in assessing the effects of treatments to reduce wood/bark adhesion.

METHODS AND MATERIALS

Field sampling techniques involved either removing a disk at breast height (4½ feet) from an appropriate, typical tree or else removing a wedge-shaped sample with a chain saw. The disk or wedge was placed in a plastic bag and kept cold (approximately 40 F) until tested. A storage study indicated that samples could be kept this way for up to 72 hours with no appreciable change in adhesion. From these disks, a small ($^3/_{16}$- × $^3/_{16}$- × $1^1/_4$-inch) tab was prepared, with incorpo-

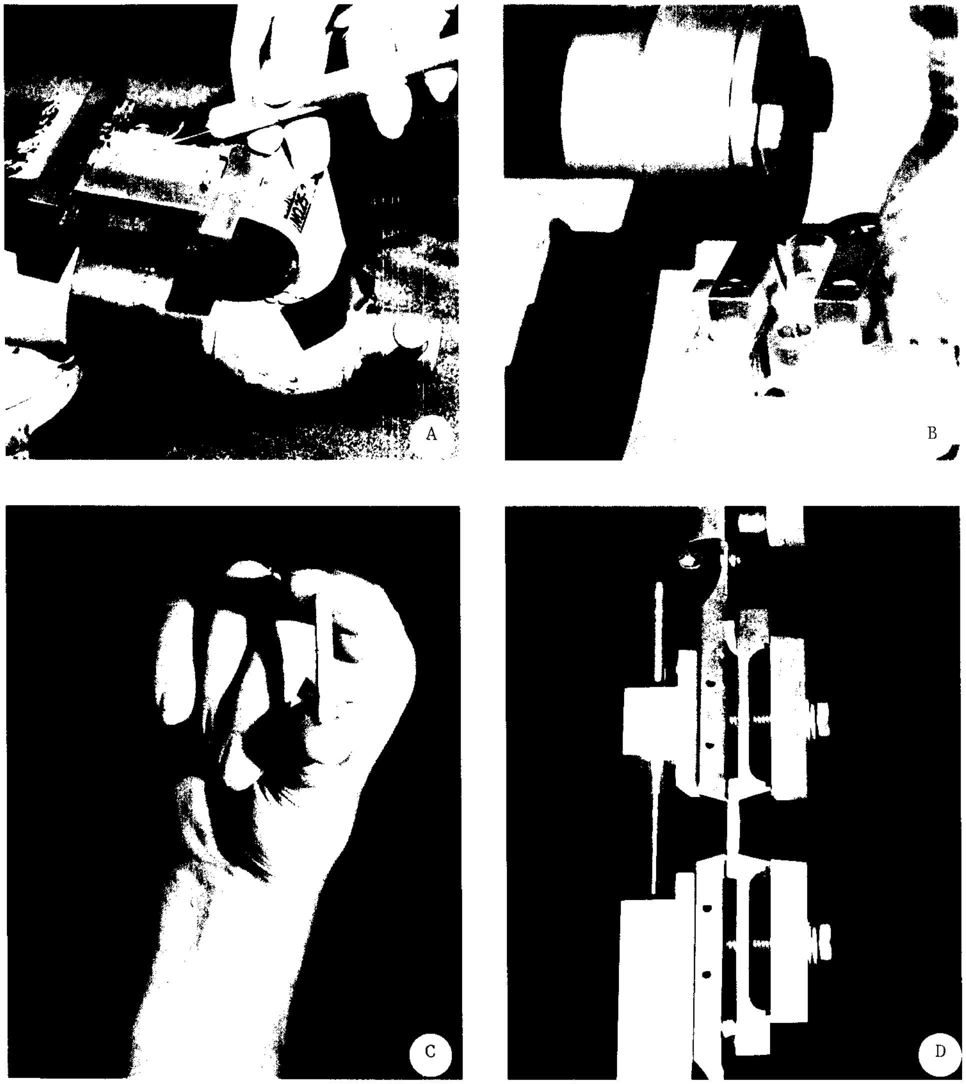

FIG. 1. Small test samples suitable for use in the Instron Tester were prepared by cutting the sample to approximate size on the band saw. The samples were then: (A) shaved to the exact dimensions, (B) cuts made through the bark and wood to the cambium, (C) removed from the jig used in holding the sample during cutting, (D) tested for adhesion (shear parallel to grain) in the Instron Tester.

rated both wood and bark. The specimens were first cut on a band saw to an approximate size of $1/4 \times 1/4 \times 1\,1/4$ inches long. Next, wood and bark surfaces were trimmed with a razor blade to make them as nearly parallel to the interface as possible. The two surfaces were then clamped in a jig, as shown in Fig. 1A; the specimen was aligned so that the grain direction was parallel with the long dimension of the jig; and the two exposed surfaces were trimmed flush with the $3/16$-inch dimension of the jig. The specimen was then turned in the jig and aligned

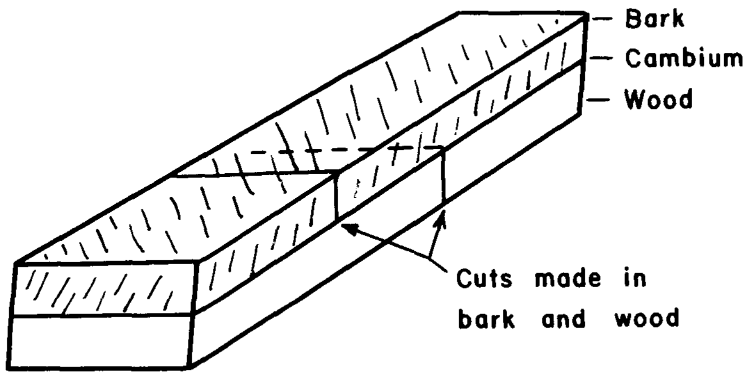

FIG. 2. Diagram of the wood/bark adhesion test sample. The dimensions of the test tab are $^{1}/_{16}$ × $^{3}/_{16}$ × $1^{1}/_{4}$ inches, and the area between the two cuts tested for adhesion is 0.0234 square inches (0.151 square cm).

so that the wood/bark interface corresponded with the bottom of the $^{3}/_{32}$-inch cutout of the jig and the wood and bark surfaces again trimmed flush. The resulting tab had the wood/bark interface centered with respect to the thickness of the specimen.

To facilitate making the final two cuts in the specimen, the apparatus shown in Fig. 1B was used, together with the shaper attachment on a machine lathe. The specimen was held in a U-shaped jig and supported on the bottom during cutting. The cutting tool was an X-acto No. 23 two-sided blade with a ground-down cutting edge held in the chuck of the lathe. The specimen was positioned just behind the blade with the latter displaced $^{1}/_{16}$ inch with respect to the center of the U-shaped jig. The specimen was raised until the tip of the blade coincided with the wood/bark interface, and the setting of the depth index was noted. The specimen was then lowered to a position where the blade just cut the surface and a cutting pass was made by moving the shaper forward. The specimen was raised 0.010 inch and a second cutting pass was made by moving the shaper backward. Similarly, additional cutting passes were made until the depth of cut was 0.005 inch below the wood/bark interface. The specimen was then inverted and a cut made in the same manner from the opposite side, again with the blade positioned $^{1}/_{16}$ inch off center of the U-shaped jig. Hence, the distance between the two cuts was $^{1}/_{8}$ inch, the bottom of the two cuts overlapped 0.010 inch, and the surface area of the wood/bark interface tested was 0.0234 square inch or 0.151 square cm. Figures 1C and 2 illustrate the size and shape of the test specimens.

For testing, the specimens were mounted in an Instron Tester, as shown in Fig. 1D. The clamping jaws were 0.02-inch wide and were separated by a distance of 0.75 inch. The specimens were strained at a rate of 0.2 inch per minute. At least four specimens were tested for each sample.

Tests can be made in any normal room temperature and humidity environment. The specimens should be kept in small, closed containers before testing to prevent moisture loss. Preferably, they should also be stored under refrigerated conditions if more than a few hours elapse before testing.

RESULTS AND DISCUSSION

Wood/bark adhesion was measured for twenty-four hardwoods and eighteen conifers. Growing season wood/bark adhesion was very similar for all species tested, ranging from 245 to 588 kPa. The failure zone was consistently located in the cambium zone or in the newly formed, nonlignified xylem cells just outside the cambium zone. Dormant season wood/bark adhesion varied greatly from species to species, usually being higher for hardwoods than conifers. Hardwood dormant season adhesion varied from 3,000 kPa for shagbark hickory to 706–765 kPa for white oak. Conifer dormant season adhesion varied from 1,775 kPa for black spruce to 431 kPa for western larch. High dormant season wood/bark adhesion in hardwoods was associated with the presence of fiber in the inner bark. Sclereids in the inner bark resulted in decreased dormant season wood/bark adhesion.

An important limitation of this method is that, during the dormant season, when failure occurs in the bark, the magnitude of the test value is dependent upon the strength of the inner bark of the species involved. All that can be said about the values obtained during this period is that adhesion in the cambium zone and in the bark and wood elements immediately adjacent to the cambium zone is in excess of the values obtained. The principal limitation of the test is that it does not provide a suitable value that can be used to compare wood/bark adhesion differences between species during that part of the year when adhesion is high but instead measures the strength (resistance to shear) of the inner bark. However, it does identify those species with extremely high wood/bark adhesion which would be difficult to debark. Within-species comparisons, between-species comparisons during the growing season, and the evaluation of methods of reducing adhesion can be adequately measured by the testing procedure.

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