MORE ABOUT LOOSENED GRAIN

Slightly Revised April 1949

(Report) **No. R1742**

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
FOREST PRODUCTS LABORATORY
Madison 5, Wisconsin
In Cooperation with the University of Wisconsin

MORE ABOUT LOOSENED GRAIN[1]

By ARTHUR KOEHLER, Chief
Division of Silvicultural Relations

Forest Products Laboratory,[2] Forest Service
U. S. Department of Agriculture

The causes of loosened grain on lumber and methods of avoiding it were discussed by the author in certain lumber journals about a decade ago.[3] At that time loosened grain was attributed primarily to the pounding action of dull or improperly sharpened planer knives which crushed the wood more or less near the surface. The purpose of this article is to describe a number of other apparent causes of loosened grain which have since come to the attention of the Forest Products Laboratory.

The term "loosened grain" as here used conforms to American Lumber Standards nomenclature, namely, "small portion of the wood loosened but not displaced" if "not displaced" is interpreted as "not completely detached." The most common type of loosened grain is that in which the "tips" of the annual rings become loosened where they come to the surface of lumber. See figures 1 and 2.

In addition to occurring as the result of improper planing, as in figure 1A, this type of loosened grain also has been observed to occur in sanding when too much pressure was applied on the rolls of the sanding machine. Figure 2A shows a Western white pine window sash mullion in which the annual rings loosened on one side after sanding. Examination of a smoothly cut cross section of the narrow mullion revealed that the springwood of the annual rings had been crushed as far down as in the sixth ring beneath the surface, as indicated by the buckling of the rays and distortion of the fibers. Figure 3A shows a magnified view of a cross section next to the surface of a wider stile from the same lot of sash. The distortion of the rays can be seen in the first, second, and third rings beneath the surface. Planed lumber from the same shipment as the one from which these sash were made showed no compression of the wood near the surface as a result of planing. When strips two inches wide cut from such planed lumber were put through the sanding machine, the springwood near the surface was crushed even when the rolls were adjusted to what would be considered

---

[1] Published in Southern Lumberman, December 15, 1940.

[2] Maintained at Madison 5, Wis., in cooperation with the University of Wisconsin.

[3] "Raised Grain: Its Cause and Prevention," Southern Lumberman 137:210-M-210-O, Dec. 15, 1929; The Lumber Trade Jour., pp. 17-18, Dec. 15, 1929; Wood Working Industries 7:41-42, Jan. 1930. Same under "Cause and Prevention of Raised Grain," The Timberman 31(4):162, 164, 166, Feb. 1930. Also "What Causes Raised Grain," Indus. Wood Working, pp. 25-28, Nov. 1931.

moderately light pressure for wider stock and progressively more so as the pressure was increased. Narrow pieces, for obvious reasons, are more easily crushed than wider ones under the same total pressure.

Too Much Pressure on Wood Responsible

The crushing of the springwood undoubtedly is the initial cause of the loosening of the annual rings, since crushing weakens the wood in resistance to stresses that may result from shrinking or bending. The crushing is greatest at the beginning, or pith side, of the springwood and in that same area separation also occurs as a rule, indicating that there is a relation between the two phenomena. Furthermore, in practically all samples of loosened grain examined by the author the springwood was partly crushed in one or several annual rings just below the surface.

Loosened grain also has been found to occur in turned articles in which too much pressure apparently was exerted by the cutting tool. Figures 1C and 1D respectively show a southern yellow pine and a white ash dowel in which the annual rings have loosened near the surface. Here also the springwood of the first few annual rings was partially crushed, as is shown in magnified cross sections in figures 3D and 3E.

Figure 2C shows loosened layers on the back of a piece of basswood moulding three inches wide, the face of which had been embossed by irregular compression of the wood. The annual rings, however, did not loosen on the face but on the back, which is the pith side.

Loosening of the grain does not necessarily develop only as a result of improper manufacture. It may also occur from too hard use. Figure 1B shows a piece of soft maple flooring in which the tips of the annual rings have loosened at the surface, producing highly objectionable slivers. A magnified view of a cross section shows considerable distortion of the rays next to the surface. See figure 3C. Although the use that the flooring had been put to is not known, the surface was unfinished, marred, and dirty, indicating that it probably had seen heavy service -- too heavy for soft maple -- which crushed the surface layer of wood and caused loosening of the grain.

In figure 2B a Douglas-fir dowel one inch in diameter is shown in which the annual rings could be easily separated along their length after giving them a start with a wedge-shaped tool. Although the history of this sample is not known, similar separation of Douglas-fir into laminae has been effected by pounding the wood with a blunt club or hammer. Loosened grain also has been noted in Douglas-fir flat-grain flooring subjected to hard usage.

Grain Loosens on Pith Side Only

In all of the cases here described and in those illustrated, the loosening of the grain has occurred on the pith side only. This is further shown strikingly in the same pieces of Western white pine window sash in which loosened grain was prominent on the pith side but entirely absent on the bark side. The reason for this characteristically different behavior of the pith and bark sides has already been described in the publications referred to, but it might be well to review the earlier findings.

The separation of grain is more common in species with relatively hard summerwood and softer springwood. The summerwood bands of flat grain lumber that run out on the inner (pith) surfaces may be forced into the springwood so that the thin-walled cells of the latter are crushed by the pressure and pounding action of the cutter head knives. Thus, pressure of the knives on the pith side of lumber can be severe in crushing springwood cells immediately beneath the thick-walled summerwood cells at the end of a preceding annual ring. However, forces applied on the opposite surfaces of lumber (toward the bark) are less effective in crushing springwood cells because of a more gradual transition in thicknesses of the cell walls from summerwood to springwood. In the latter case, crushing has been observed only when extremely high pressures are applied to surfaces of lumber.

There is no reason why the injury from crushing alone should cause separation of the annual rings of growth or within them. The ultimate separation undoubtedly is the result of various stresses in the wood, due in most cases to differences between springwood and summerwood in transverse and longitudinal shrinkage. Such stresses may develop in the wood in initial drying, before the springwood is crushed or subsequent to crushing, as a result of changes in moisture content. Bending of wood, either intentionally or in rough handling, also may set up sufficient stresses to facilitate separation along the rings of growth if the springwood is crushed.

Springwood Shrinks More Longitudinally Than Summerwood

The usual curvature of the loosened layers away from the body of the piece on the pith side is due to the greater longitudinal shrinkage of the springwood as compared with the immediately underlying summerwood of the same annual ring. That the springwood shrinks more longitudinally than the summerwood is shown in figure 4 in which slats only one annual ring in thickness, about three-eighths inch wide, and about nine inches long, all with the bark side up, are shown in edge view. The structure of the annual rings of these splits ranges from that of a highly uniform type of basswood at the top and that of basswood in which the inner part of the annual ring is slightly more porous than the outer part, just below, to that of ash with decided contrast between springwood and summerwood at the bottom. All of these splints were whittled from straight-grained wood. Figure 4A shows them in the green or resoaked condition, in which all are practically straight, and figure 4B shows the same splints after room drying. The

greater shrinkage of the springwood on the lower side of each splint is shown by the downward curvature of the ends of the dry splint. It is zero in the basswood of uniform texture and very pronounced in such woods as Douglas-fir, southern yellow pine, oak, and ash, all of which have distinct bands of springwood and summerwood in each annual ring. It is largely this tendency of individual annual rings to curve lengthwise when dry, with the concave side toward the pith, that causes them to loosen and curve up when the springwood beneath has been weakened by crushing.

On the bark side, the springwood of each annual ring is below the summerwood and therefore does not tend to lift up any portion of the annual ring even though the springwood may be crushed.

Some Practical Suggestions

Two lessons, therefore, which do not seem to be sufficiently understood, may be learned from this discussion, namely: To avoid loosened grain do not use dull knives or tools or other objects that will compress the springwood in manufacture or use, and whenever there is a choice between bark and pith sides, make the bark side the face side. When narrow, flat-grain pieces are run through the planer or sander, or are later put to use, care must be taken not to apply a greater pressure or load than is consistent with the width and kind of wood. Another means of avoiding loosened grain on flat pieces is to use edge-grain lumber, although even in edge-grain flooring the tongue and lips have been known to develop loosened grain, presumably from too much pounding by the tongue and groove-cutting knives.

Some species of wood evidently are more subject to loosening of the grain than others. It sometimes even seems that there is an intrinsic variation within certain species in that respect. That is, the springwood of some pieces of a species apparently is either crushed more easily or separates more easily with the same amount of crushing than other pieces of the same species. Whether that actually is the case remains a subject for further study.

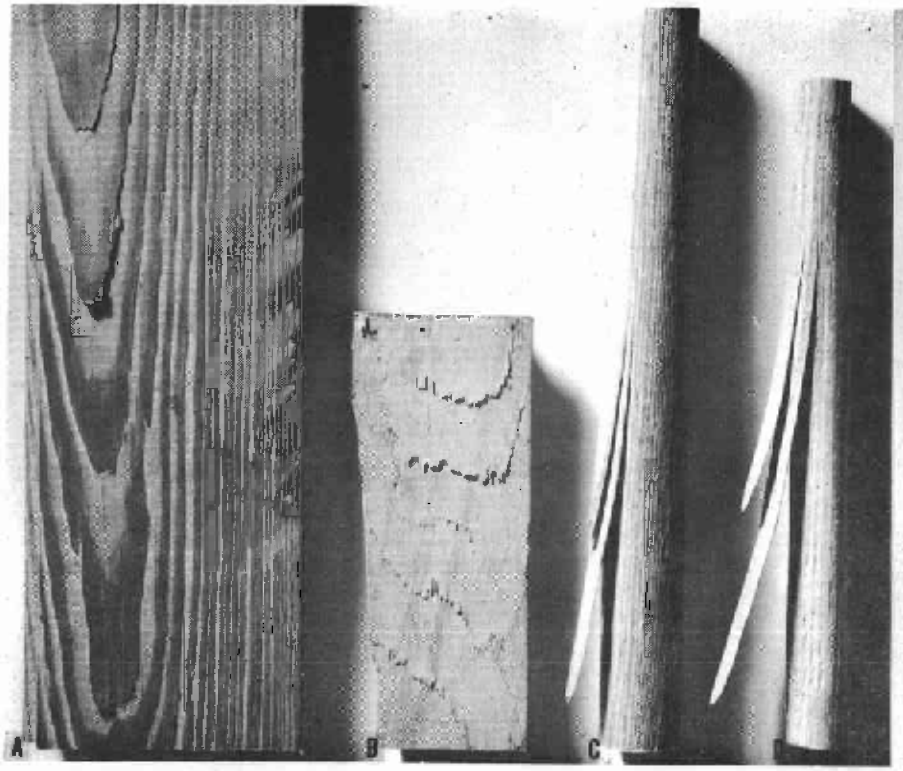

Figure 1.--Loosened grain of (A) southern pine flooring, (B) soft maple flooring, (C) southern pine dowel, and (D) white ash dowel.

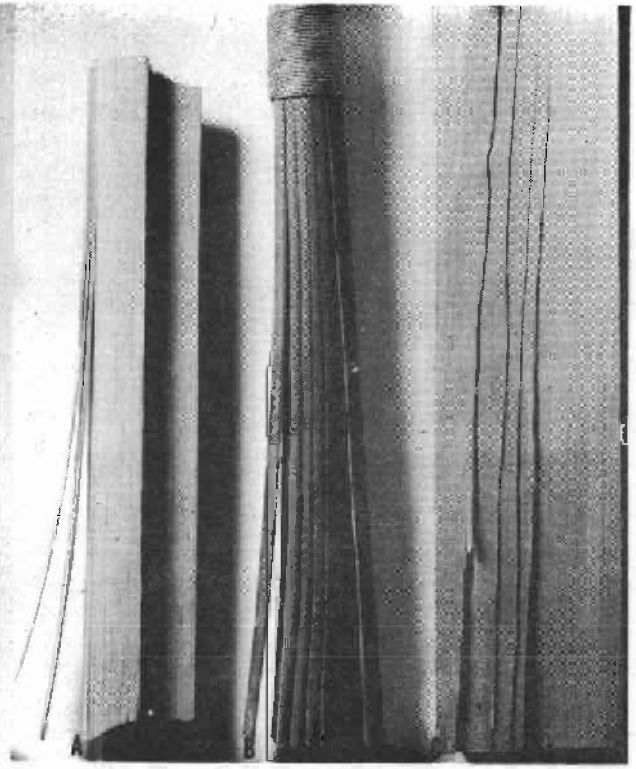

Figure 2.--Loosened grain of (A) Western white pine sash mullion, (B) Douglas-fir dowel, and (C) basswood molding.

Z M 81177 F

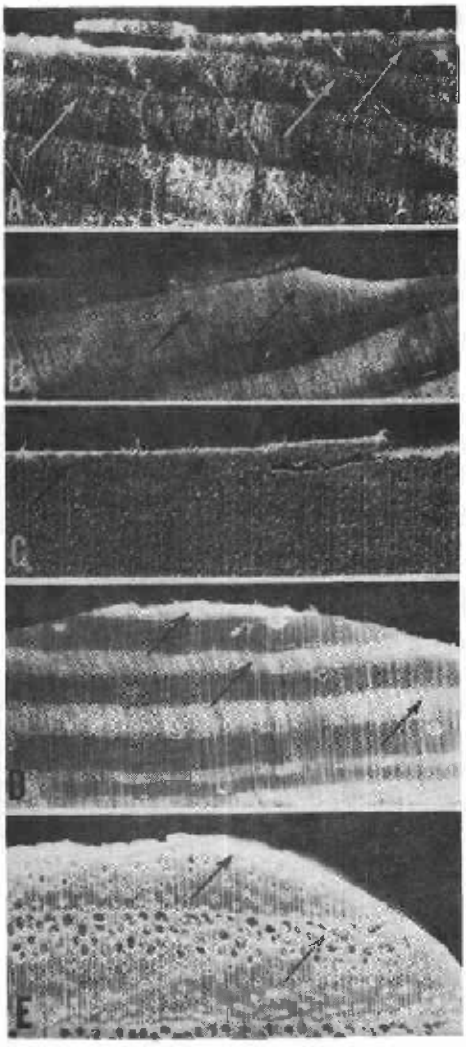

Figure 3.--Cross sections of part of pith side of (A) Western white pine window sash stile, (B) southern pine flooring from piece in figure 1A, (C) soft maple flooring from piece in figure 1B, (D) southern pine dowel from piece in figure 1C, and (E) white ash dowel from piece in figure 1D. Arrows indicate partially crushed wood. All magnified 6.25 times.

Z M 81178 F

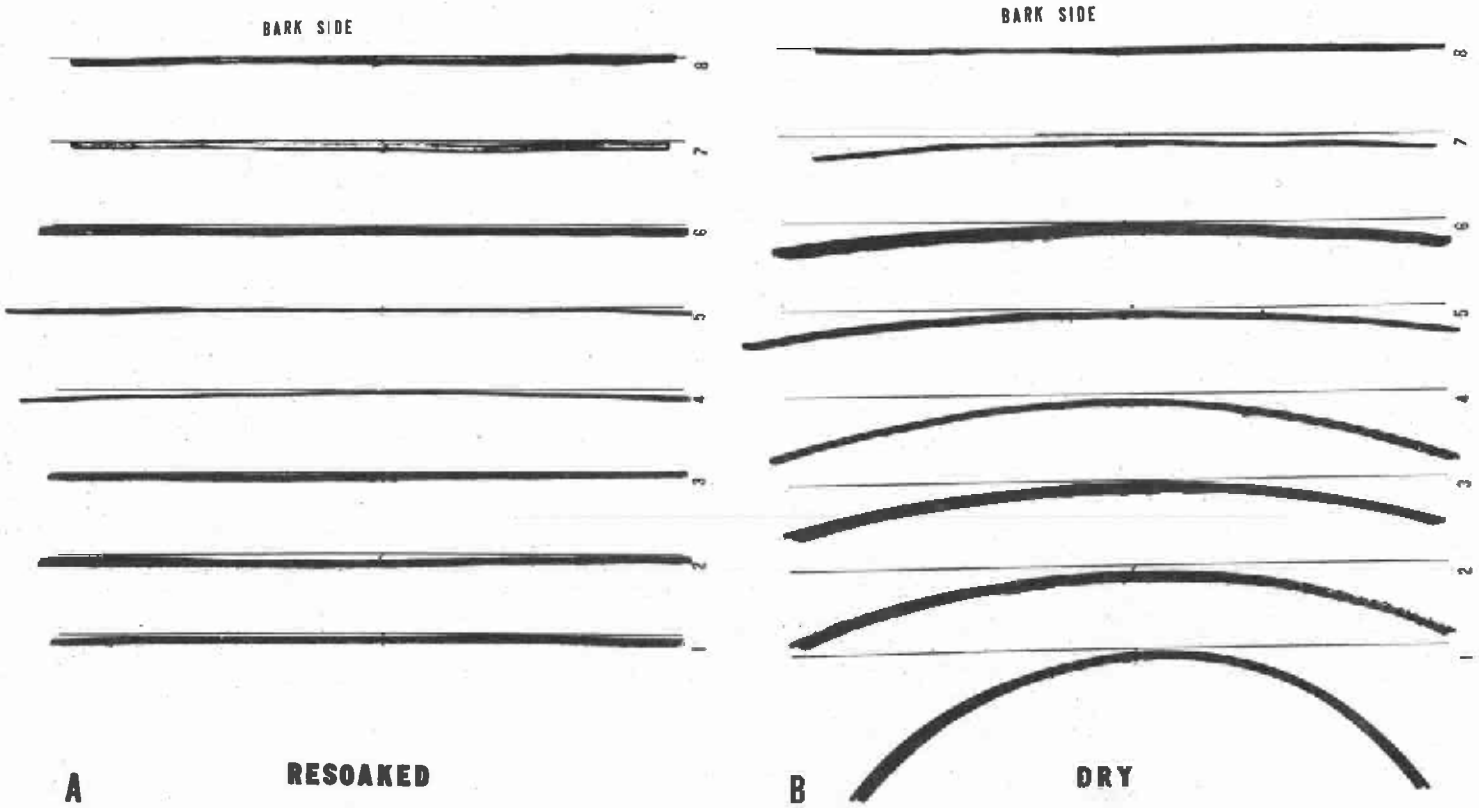

Figure 4.--Edge views of splints one annual ring in thickness whittled from straight-grained wood. Nos. 1 and 2 are ash, 3 is red oak, 4 is southern pine, 5 and 6 are Douglas-fir, and 7 and 8 are basswood. A, in wet, or natural, shape; B, the same, room-dried. The springwood is on the lower side in each piece.

Z M 81179 F