U.S. DEPARTMENT OF AGRICULTURE • FOREST SERVICE • FOREST PRODUCTS LABORATORY • MADISON, WIS.
In Cooperation with the University of Wisconsin

U.S. FOREST SERVICE
RESEARCH NOTE
FPL-099
MARCH 1965

RAISED, LOOSENED, TORN, CHIPPED, AND FUZZY GRAIN IN LUMBER

Summary

Raised grain, loosened grain, torn and chipped grain, and fuzzy grain are forms of defective surfaces on lumber. Causes and remedies are discussed in this report.

Improper seasoning and storage methods and improperly maintained woodworking machinery have much effect on the development of raised grain. Uneven or corrugated surfaces and loosened annual growth layers develop more frequently and intensively on the pith side of the board than on the bark side. This factor does not appear to be fully recognized by manufacturers.

Damage from torn and chipped grain generally can be reduced by proper maintenance of equipment. However, some damage results from abnormal grain direction and inherent characteristics of the wood, such as fuzzy grain in broad–leaved species, trace–able to tension wood in most cases.

RAISED, LOOSENED, TORN, CHIPPED, AND FUZZY GRAIN IN LUMBER[1]

By

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

Introduction

Raised grain, loosened grain, and torn or fuzzy surfaces of lumber that appear after planing or sanding are frequent sources of difficulty during fabrication, arid of degrade or loss of finished articles. Descriptions of those defects and some discussion of known or probable causes and their prevention or remedy may be helpful.

Definitions

Raised grain is defined in American Lumber Standards for Softwood Lumber as an uneven surface on dressed lumber in which hard summerwood is raised above the seller springwood but not torn loose from it.

Loosened grain is described as a "small portion of the wood loosened but not displaced."

Torn grain is described as a "part of the wood torn out in dressing."

Chipped grain is not classed as "torn." It is an area where the surface is chipped or broken out below the line of cut.

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[1] This Research Note is a revision of Forest Products Laboratory Rpt. 2044 of the same title, originally issued in 1955 and revised in 1959.

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

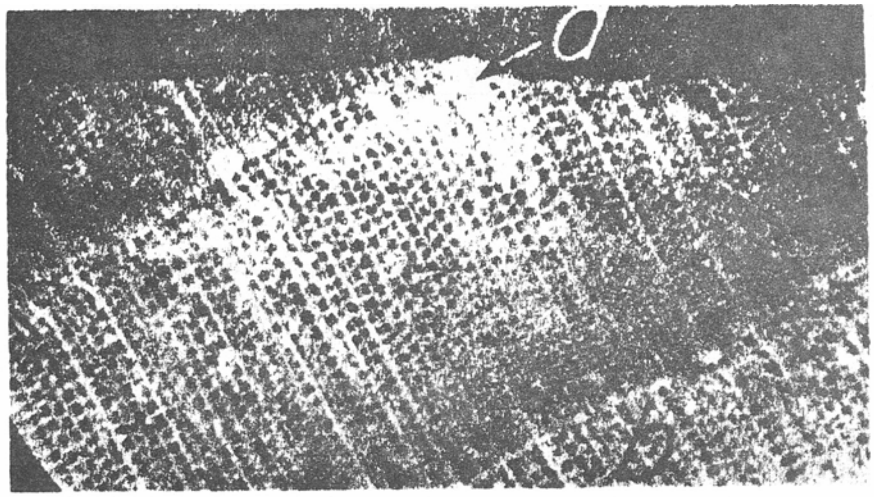

Figure 1.--Springwood cells are crushed under the summerwood near the surface at (a) in an enlarged cross section of corrugated white fir. Note that the springwood cells (b) in the annual ring below are not crushed.

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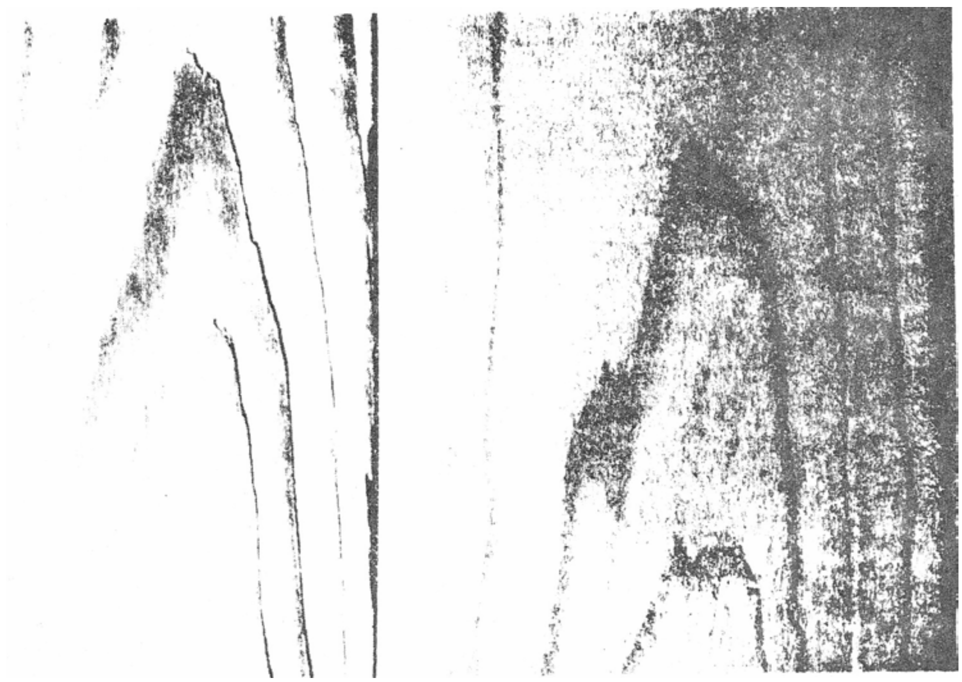

Fiure 2.--Raised grain is present on the pith side of a white spruce board (left), and absent on the bark side of the same board (right).

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Fuzzy grain (not defined in American Lumber Standards) is sufficiently different from the other definitions to call for special consideration. Fuzzy grain is a surface condition in which small groups of fibers or even individual wood fibers are loosened at one end in large numbers. These projections become rather curly and give the surface of a board a fuzzy appearance. Fuzzy grain occurs frequently in certain kinds of hardwood lumber.

Raised Grain

The corrugated appearance of the surface of lumber, as here referred to, is due to the summerwood (the outer, harder portion of each annual growth ring) being projected above or depressed below the level of the softer springwood. liaised grain occurs particularly in woods with pronounced difference in structure between the summerwood and the springwood, especially among the softwoods, but has also been observed in wood with such relatively uniform structure as yellow-poplar.

In flat-grain lumber, corrugation of the surface is due principally to a crushing of the hard summerwood into the softer springwood beneath it by the planer knives. The summerwood subsequently rises as the springwood cells underneath gradually resume their original shape. Figure 1 shows a magnified cross section of a piece of white fir with crushed springwood cells near the surface at a. This crushing force was not transmitted through the summerwood of the top annual ring to the springwood b of the ring below.

Pounding of the summerwood into the springwood is evidently aggravated by planer knife dullness. In some boards planed with a sharp planer at the Forest Products Laboratory, there was no evidence--under the microscope--of crushing of the springwood. Other machine conditions, such as the bevel of the knife edge, the heel on the knives, the knife speed, and the pressure of feed rolls, may also affect the amount of raised grain. Wood planed by hand shows very little corrugation.

Corrugation of flat-grain lumber was found to be more common and more pronounced on the pith side of a board than on the bark side (fig. 2). This difference in behavior of the two sides can be attributed to the difference in transition from springwood to summerwood on the two sides.

On the pith side of a flat-grain board there is a sudden transition from the outermost and hardest part of the summerwood of an annual ring to the innermost and softest portion of the springwood of the annual ring underneath it, as at A

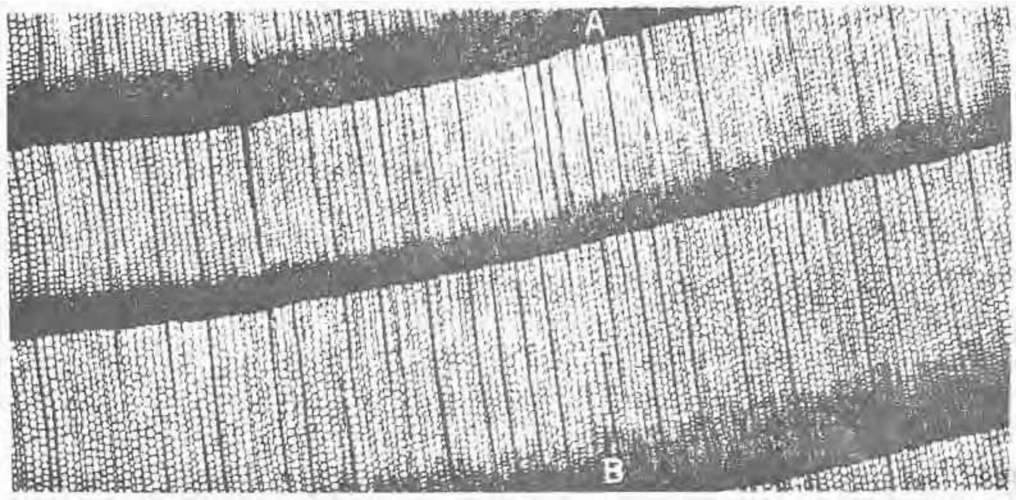

Figure 3.--Enlarged cross section of a thin Douglas-fir board (See text).

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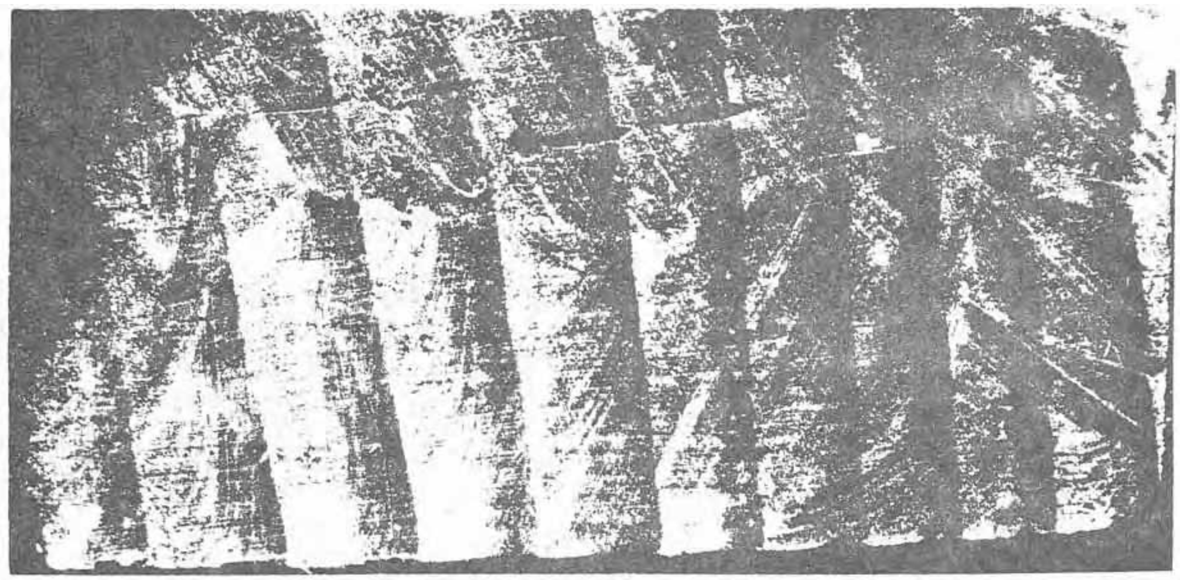

Figure 4.--Corrugation on a edge of dried, edge-grain, Douglas-fir board dressed while at high moisture content.

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in the upper side of the board (fig. 3). This hard portion of the summerwood, where it wines to the surface in thin edges, offers the maximum resistance to cutting, and the soft springwood underneath offers the least resistance to indentation; hence, a maximum crushing of summerwood into springwood occurs at that point.

On the bark side of the board, it is the inner and softer portion of tho summer–wood that diminishes to an edge where the summerwood band intersects the surface at B (fig. 3). This comparatively soft portion of the summerwood is underlain by the harder portion of the springwood band of the same annual ring, as in the lower side of the board in figure 3. Consequently, the summerwood at that point docs not offer as much resistance to cutting, and the springwood offers more resistance to indentation. Farther to the right along the lower surface of figure 3, where the summerwood is both harder and thicker, the stresses caused by the pounding of the planer knives are partly absorbed and more evenly distributed before they reach the softest portion of the springwood beneath. As a result, crushing does not usually take place on the bark side of the board.

In general, the least amount of corrugated surface develops in species that have little contrast between springwood and summerwood, such as white pine and cedar.

In edge–grain lumber, a difference in tangential shrinkage between springwood and summerwood causes corrugated surfaces: summerwood shrinks more than the springwood. Hence, if edge–grain lumber is dressed when it is at a relatively high moisture content, the summerwood bands will recede below the level of the springwood bands as the lumber dries, giving the surface a “washboard” appearance (fig. 4). If dry edge–grain lumber is surfaced and later allowed to absorb moisture, the summerwood will stand out above the springwood and the washboard appearance will again result.

The continuity of the summerwood bands inward from the surface of edge–grain lumber is responsible for considerable shrinkage stress and deformation. In flat–grain lumber, however, each summerwood band extends inward only a very small distance before it alternates with a springwood band of less shrinkage potential. Therefore, purely shrinkage differences do not produce such pronounced effects as in edge–grain lumber. Furthermore, the fact that the tangential shrinkage is comparatively high––in some species more than twice the radial shrinkage––augments the shrinkage effect on edge–grain faces.

Compressed wood swells more when absorbing moisture than does normal wood. Hence, if flat–grain lumber is planed while dry and later allowed to

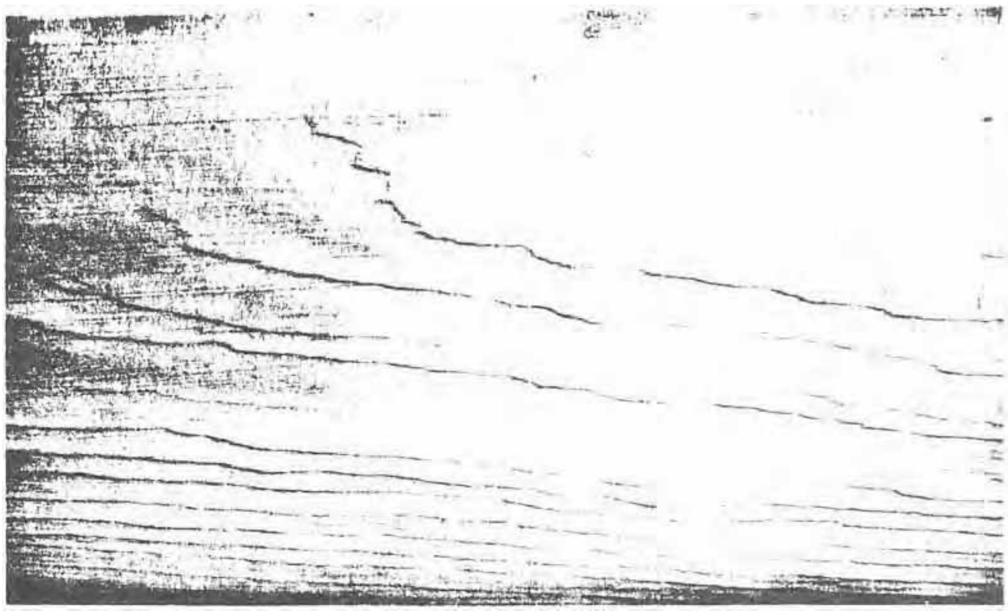

Figure 5.--Grain pattern shows through coating of paint on southern pine board.

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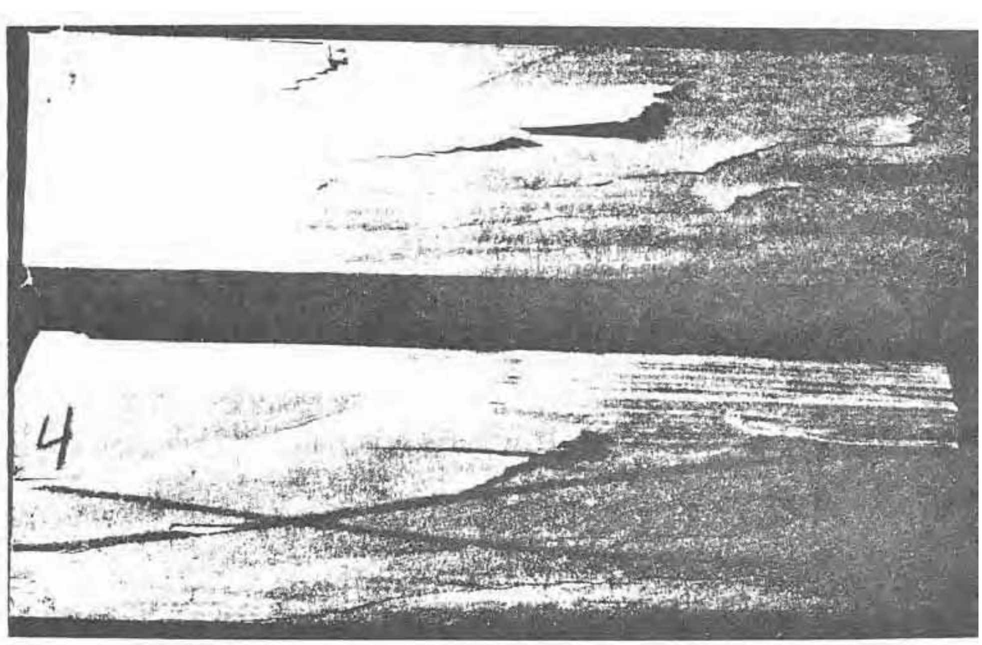

Figure 6.--Window sash stiles of western white pine with loosened grain on the pith side.

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absorb moisture, the summerwood may rise considerably because the crushed springwood returns nearly to its origional size. In general, the least corrugation takes place in lumber in which no change in moisture content occurs after machining. The greatest corrugation takes place in lumber planed at a low moisture content and subsequently placed in damp air.

The amount of raised grain evidently can be reduced by sharpening planer knives properly and then keeping them sharp. Further, the surface of the lumber should not be allowed to change appreciably in moisture content. For outside work, the second suggestion cannot be applied because wood exposed to the weather will change in moisture content, even when painted (fig. 5).

Loosened Grain

Loosening of the tips and edges of the annual rings on the surface of flat-grain lumber is also clue primarily to dull or improperly sharpened planer knives and to changes in moisture content. The actions of these two factors here, however, are somewhat different from those that produce raised grain.

The pounding action of the planer knives may be severe enough to break down the springwood immediately below the first layer of summerwood so that little or no subsequent shrinkage stress is required to separate the annual rings near the surface. The fact that pounding wood on its flat-grain face will separate the annual rings was known to the Indians and early settlers, who used the method to obtain splints from black ash for basket weaving.

Pronounced shrinkage stresses are developed where springwood adjoins summerwood, because the springwood teiids to shrink less transversely and more longitudinally than the summerwood. The stress resulting from this difference in shrinkage is localized at the boundary between annual rings, where the transition between springwood and summerwood is very abrupt. It is at the tips of the annual rings that the largest and most uniform flat expanses of springwood and summerwood occur near the surface; these portions develop the greatest differential shrinkage stresses when the moisture content of the surface changes. Therefore, separation usually takes place first at the tips of the summerwood bands, arid then along the edges where the summerwood comes to the surface (fig. 6).

Shelling of the annual rings is much more pronounced on the pith side than on the bark side of flat-grain lumber (fig. 7). This difference is related to the

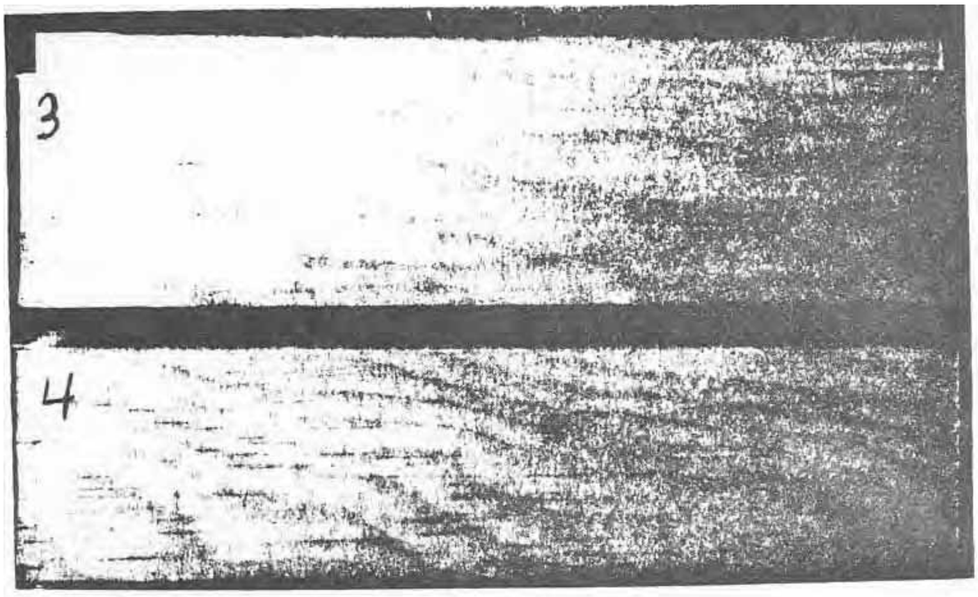

Figure 7.--Loosened grain absent on the bark side of the same pieced shown in figure 6.

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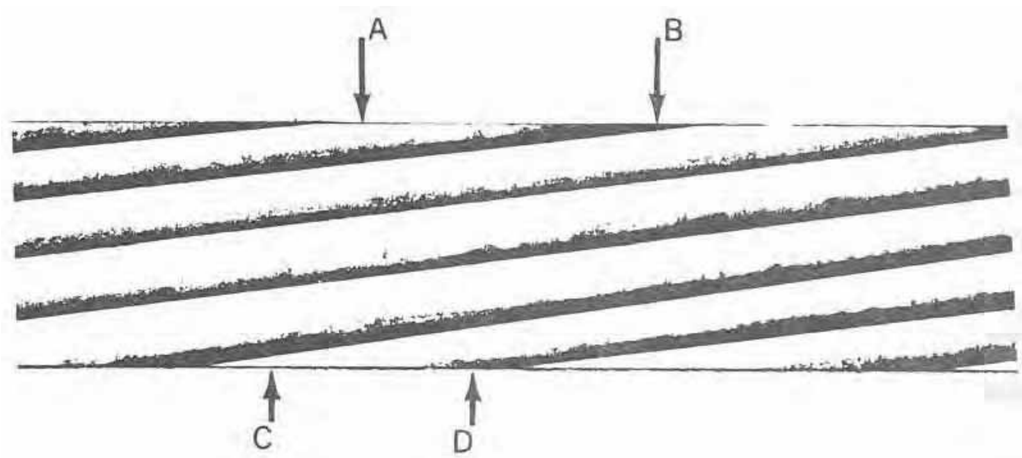

Figure 8.--Schematic edge niew of flatsawn board illustrating microstress differences that often cause shelling. (see text).
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reversal in sequence of density changes in the growth rings encountered when pressure is applied radially to the pith or to the bark side of the stock.

In the edge view of a flatsawn board (fig. 8), pressure at A on the pith side is applied to low density springwood supported first by springwood of increasing density and then by summerwood of even greater and increasing density, thus distributing the load without abrupt changes in microstress. At B, however, the load applied to the highest density summerwood is transmitted directly to the adjacent and weakest springwood cells, which may be crushed and ruptured--as was illustrated in cross section at a (fig. 1).

When pressure is applied to the bark side at C (fig. 8). a low density springwood is supported by the highest density summerwood of the adjacent underlying growth ring. As the load point moves to D, the surface becomes increasingly dense and underlying support decreases in density gradually, not abruptly. The greater longitudinal shrinkage of springwood causes failure at the interface between adjacent rings; subsequently the shrinkage differential between the springwood and summerwood of the loosened ring causes it to curl away from the underlying stock (fig. 9). In addition, the curvature of the annual rings makes it easier to bend an annual layer of growth away from the surface on the pith side, just as it is easier to bend a quill point inward than outward (fig. 10, b).

Objections to shelling of the annual layers of growth are clear. The projecting slivers make handling, working, and painting difficult and dangerous. In flooring, such slivers are particularly objectionable when mopping and dusting. When the wood layers loosen up along their edges, in service, they not only break any paint film but also make repainting difficult.

To minimize shelling of growth layers--which occurs especially in softwoods--follow the same precautions recommended to reduce corrugation of the surface. Again, for outside work, keeping the moisture content of the surface nearly constant is not so practical as maintaining the planer properly. Whenever pattern lumber is worked, the hark side—unless it has prohibitive defects--should be made the face side.

In addition to occurring as the result of improper planing (fig. 9), loosened grain has been observed to occur when too much pressure is applied by the rolls of a sanding machine. Figure 11 shows a sanded western white pine window sash mullion in which the annual rings loosened on one side. Examination of a smoothly cut cross section of the narrow mullion revealed buckling of the rays and distortion of the fibers in the springwood of the annual rings as far down as in the sixth ring beneath the surface. Figure 10 a shows a magnified view of a cross section next to the surface of a wider stile from the same lot

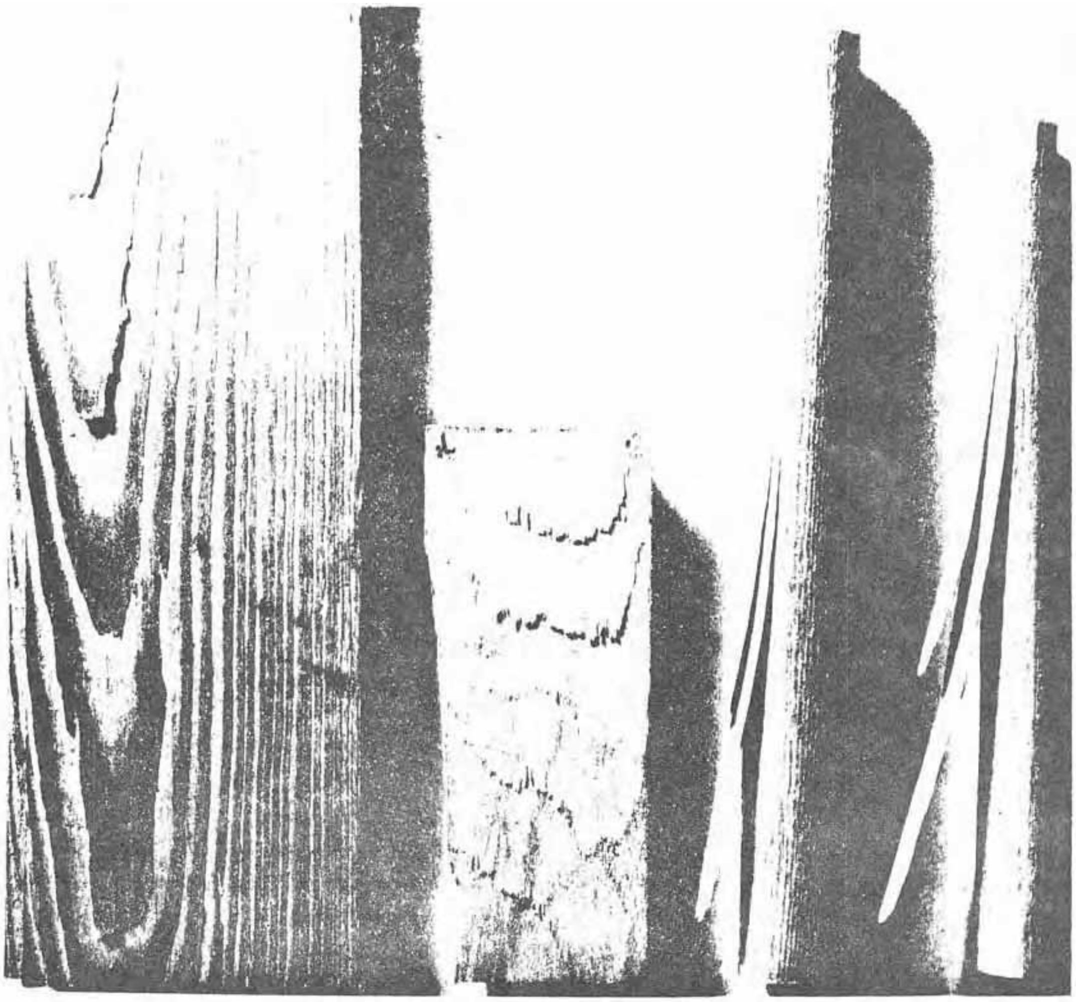

Figure 9.--Loosened grain in, left to right, southern pine flooring, soft maple flooring, southern pine dowel, and white ash dowel.

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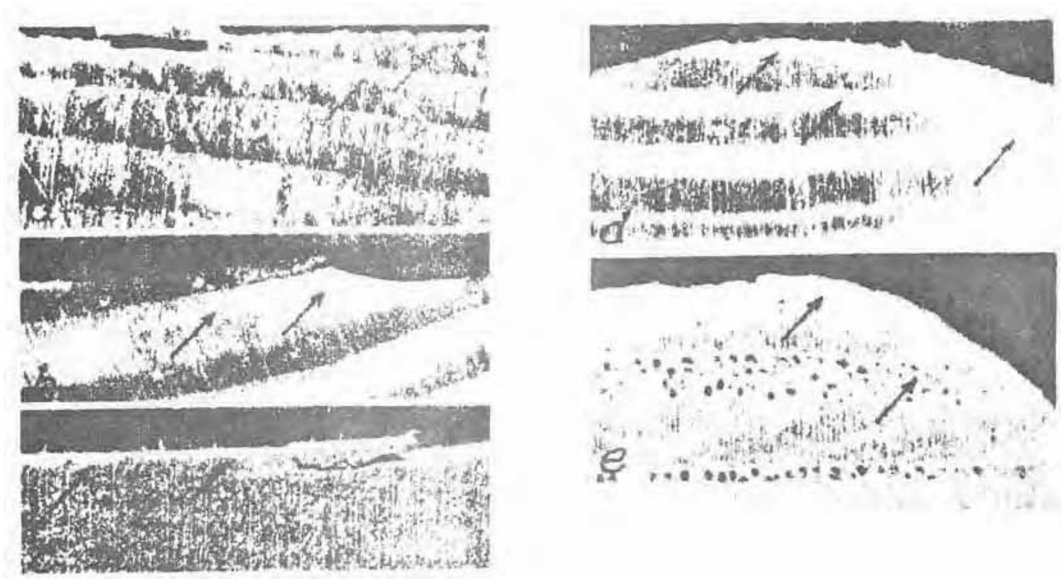

Figure 10.--Cross sections from path side of: a, Western white pine window sash stile; b, southern pine flooring; c, soft maple flooring; d, southern pine dowel; and e, white ash dowel. All expect a were taken from corresponding samples in figure 9. Arrows indicate partially crushed wood.

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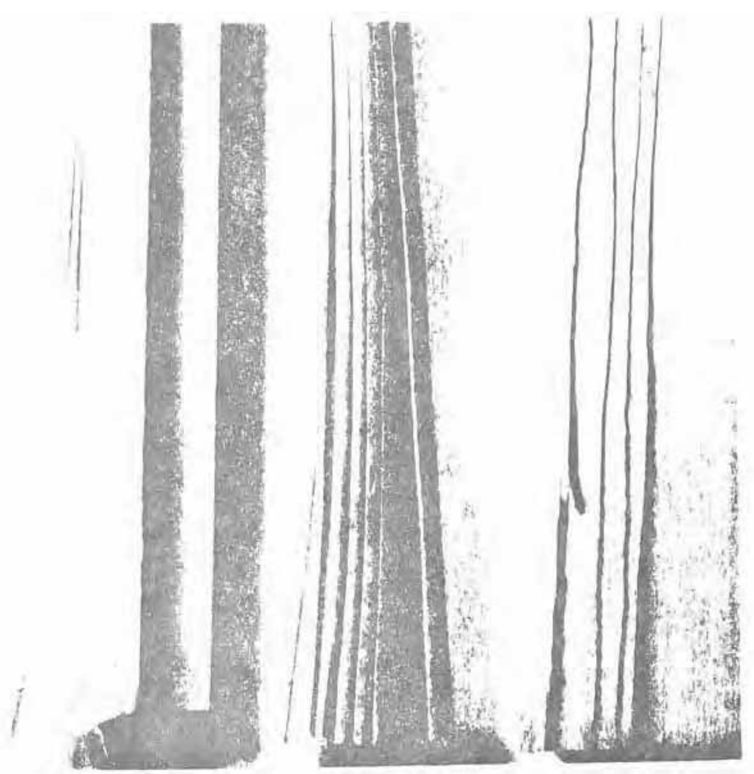

Figure 11.--Loosened grain in, left to right, western white pine sash mullion, Douglas-fir dowel, and basswood molding.

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of flash. 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 that from which this sash was made showed no compression of the wood occurring near the surface during planing. When strips 2 inches wide were cut from such planed lumber and put through the sanding machine, the springwood near the surface was crushed—even when the rolls were adjusted to what would be considered moderately light pressure for wider stock.

Loosened grain has been found to occur in turned articles that apparently were subjected to excessive pressure by the cutting tool. Figure 9 shows a southern 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 shown by magnified cross sections in figure 10, d and e.

Figure 11 shows loosened layers on the back of a piece of basswood molding 3 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 of the piece. Loosening on the face may occur, however, if the embossing is deep, with rather sharp changes in direction.

Loosening of the grain does not necessarily develop only as a result of improper manufacture. It may also be caused by too much hard use. Figure 9 shows a piece of soft maple flooring in which the tips of the annual rings have loosened at the surface, and produced highly objectionable slivers. A magnified view of a cross section shows considerable distortion of the rays next to the surface (fig. 10 c). This indicates service conditions too severe for soft maple. Loosened grain also has been noted in Douglas-fir flat-grain flooring subjected to hard usage.

Torn and Chipped Grain

Torn grain and chipped grain refer to wood surfaces from which fragments have been torn or chipped out below the line of cut in planing. Torn grain may be due to a combination of factors such as dull cutting edges and irregular grain direction that tends to extend into the wood. Torn grain apparently results when the loosened fragments do not break so readily as in chipped grain. In both cases, the remedy probably lies mostly in keeping cutting edges in good condition. When chipping is evident, it can be reduced by reversing the direction of the board through the planer in subsequent passes. When each surace is planed separately and completely in a single pass, chipping can be avoided or reduced by turning the stock over or endways so that the sloping grain runs out toward the tail end of the stock on the surface being planed. In double surfacers, when both sides are planed during the same pass, sloping grain will be properly directed on only one face--hence, turning the board over will not alter the face on which chipping may occur. If, however, the slope of grain on the best face runs out toward the head end of the stock, reversal of ends will throw the risk of chipping to the poor face.

Fuzzy Grain

The type of raised grain in which the fibers fuzz up aggravates wood finishers because the projecting fibers make it difficult to secure a smooth finish. Figure 12 shows projecting fibers on the surface of a sanded piece of wood. Some species of wood fuzz up more than others, and, in general, the hardwoods are more troublesome in this respect than the softwoods. Even in wood of the same species there is considerable variation in the smoothness of surface that may be obtained under identical working conditions. The tendency for the fibers to fuzz up becomes more pronounced with increasing moisture content. This is particularly true in ring-porous species such as the oaks, where groups of fibers may be pressed into the large pores during machining or sanding operations.

Sanding is responsible for more fuzzing than planing because the grains of sand tear up parts of fibers (fig. 12, top), whereas the planer more frequently cuts through the fibers and consequently leaves fewer loose ends sticking up (fig. 12, bottom). However, under certain conditions, especially a high moisture content, some types of wood fuzz up badly under the planer knives. This fuzzing can sometimes be reduced by feeding the board through the machine so that the knives cut with the grain, as with chipped grain.

Studies of a number of broad-leaved species reveal that fuzziness is associated with an abnormal type of wood known as tension wood.[3] Tension wood occurs most prominently on the upper sides of leaning broad-leaved trees. The tension wood fibers frequently cause unusual behavior of lumber surfaces. Projecting fibers were common on sawed surfaces of lumber and on veneer surfaces in which tension wood was detected by microscopic examination. Figure 13 shows a sawed surface of aspen lumber with such groups of projecting fibers. Some planed or shaped surfaces also had zones of torn grain in the parts that included tension wood. Examinations of surfaces with projecting fibers and torn grain

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[3] Pillow, Maxon Y. Effects of tension wood in hardwood lumber and veneer. Forest Products Laboratory Rpt. 1943. 14 pp., illus., 1962.

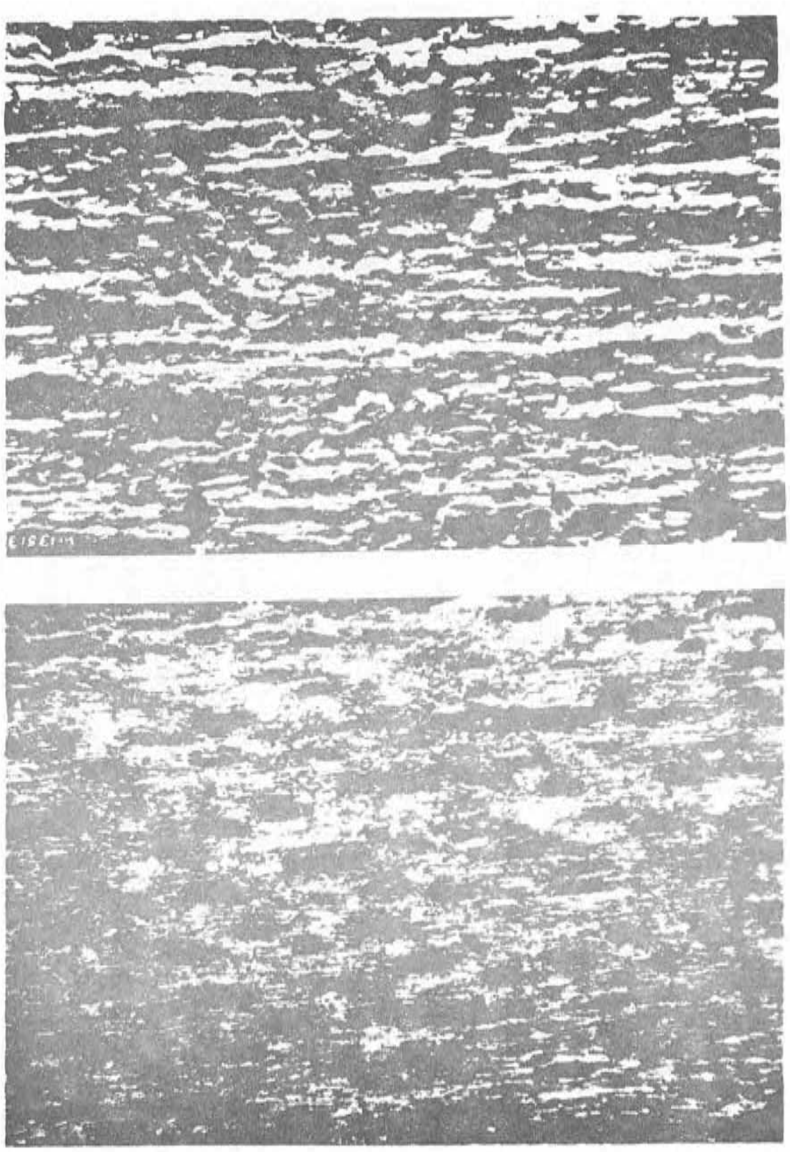

Figure 12.--Upper, sanded surface of a mahogany board with numerous projecting fibers; lower, planed surface of same board.

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Figure 13.--Projecting groups of fibers indicate areas of tension wood on aspen boards.

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showed that tension wood fibers tended to be torn partly loose instead of being cut clean by saw teeth or knives of cutting heads. Groups of these fibers held together tenaciously in lengths of 1/4 inch to as much as 3/4 inch. When aspen and cottonwood lumber was planed in a green or even an air-dried condition, severe tearing of surface fibers was relatively common.

Defects associated with tension wood are. more serious than the chipped grain that may occur when normal lumber with cross grain is planed against the direction of the grain. Planing tension wood against the grain usually causes tearing, while planing with the grain tends to raise the grain. Turning pieces to circular cross sections, as for furniture parts, also has resulted in fuzzy surfaces of the parts that contained tension wood fibers.

Presence of tension wood fibers, together with the high moisture content of green lumber, is frequently associated with cell collapse. With these conditions, surfaces and edges of boards have longitudinal zones that appear sunken, and the cells of the wood as seen through a microscope are extremely distorted. Heartwood, particularly in such species as aspen, cottonwood, oak, and willow, shows considerable tendency to collapse in areas of lumber that include tension wood.

There is no rule-of-thumb by which material with tension wood can be rejected. Nevertheless, valuable material and some labor can be saved by practical selections of lumber and veneer with respect to tension wood. Whether material is to be rejected depends on the kind of end products, the amount of labor required in processing, and the possible salvage value of the rejected material.