SEASONING DIMENSION STOCK

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By O. W. TORGESON, Engineer

Forest Products Laboratory,[1] Forest Service
U. S. Department of Agriculture

Reducing seasoning degrade, at a reasonable cost, increases profits. This general fact applies specifically to dimension stock from operations in the north central and the northeastern states. Accordingly the Forest Products Laboratory made drying studies of such stock, both at the Laboratory and at commercial plants. Beech, yellow and paper birch, and sugar maple were the species examined. This article presents some of the results.

In the north central states, birch and maple dimension stock is cut primarily to utilize waste material. Such stock, from small and inferior logs and mill waste, is air seasoned and then sold in the open market. Squares make up a large part of the total output. In the northeastern states, where beech is also produced, dimension stock is commonly cut for more specific purposes and therefore a greater number of manufacturing and seasoning methods are employed. Air seasoning, however, is preferred here also; little or no stock is kiln dried green from the saw. The bolt method of manufacture is usual in the northeast and flitches from bolts as well as from longer logs are often seasoned before the additional cutting.

Air Drying Compared with Kiln Drying

The practice of air drying dimension stock comes not only from the fact that many purchasers prefer to do their kiln drying, but also from a general opinion that dimension stock can be air dried with less degrade than it can be kiln dried. This opinion becomes fact only when unsuitable kilns or equipment and ignorant or careless operation produce extremely bad drying conditions. Further, such conditions must be so bad that they are worse than the uncontrollable adverse outdoor conditions; some faulty air seasoning practices, of course, can be corrected. The warp of kiln dried stock is often thought to exceed that of air dried. When it actually does exceed, the reason is usually a difference in final moisture content; the kiln dried stock is drier. Tests of the species examined have shown that the schedule, within reasonable limits, has little effect on the amount of warp.

The studies showed also that checking is governed mainly by the initial relative humidity and that for beech this humidity must be above 80 percent, possibly as high as 85 percent. It is reasonable to conclude, then, that air drying cannot be so efficient, from the standpoint of checking, as proper kiln drying. End coating of air drying stock, however, would help to reduce this degrade.

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

Flitches Compared with Dimension Stock for Drying

Drying dimension stock in the form of flitches has both advantages and disadvantages, and no definite general decision in regard to the choice is possible. Cutting a log directly into dimension stock is more efficient from a cutting standpoint, but demands a definite knowledge of the sizes that can be used or sold. More unit warp should be expected when drying dimension stock as such and in addition more end area is exposed for checking. On the other hand, surface checking is more common in wide than in narrow stock. Flitches are more quickly piled on kiln trucks, but, because of the usual variety of lengths, widths, and contours, box piling is required. A kiln truck of random-length flitches will yield less than two-thirds the dimension stock that can be piled on such a truck. From a yield standpoint, however, drying as flitches appears the better because of the fact that all defects, both natural ones and those caused by drying, are visible at the time of cutting. For instance, cupping is often concentrated at the part of the board that is nearest the heart and, if a badly cupped board is ripped at this place, the two pieces may have little cup. Bark falling from dried flitches is a nuisance, yet the bark of sugar maple and paper birch will stay on fairly well during drying and gives trouble only at the time of taking down and sawing. At 7 to 8 percent moisture content the maple bark will fall off more readily than the birch bark.

The bolt method of manufacture is a compromise that seems excellent from a seasoning standpoint. As used here the bolt method of manufacture refers to the cutting of logs into short bolts and then sawing these into flitches by slabbing one face and then turning the sawed surface down and sawing the bolt through and through. The uniformity of length and the straightness of at least one edge of these flitches simplifies piling and greatly increases the capacity of the kiln trucks.

Piling Flitches for Air Drying

The air drying of flitches is practically identical with that of lumber, especially random-length pieces. Hence, the piling of flitches is one of the important problems in the air drying process.

The requisites for good drying include high, firm foundations, stickers not more than 2 feet apart and aligned vertically, as few overhanging ends as possible, vertical flues, and sloping roof set at least 6 to 10 inches above the top layer. Circulation within an air drying pile is mainly vertical and therefore openings in the pile and also space adjoining it must be provided at the top and the bottom for the air to pass in and out.

Assume, for example, that flitches varying in length from 16 down to 3 or 4 feet are being cut. Since it usually is not practical to have a separate pile for each length, such a lot must be box piled. Even this method will not make a satisfactory pile if the diversity of lengths is carried too far. The least that can be done is to put the 12, 14, and 16-foot lengths in one pile and make another for the 10-foot and shorter lengths; sorting more extensive than this inexpensive minimum would pay at some mills.

Piling Flitches on the Kiln Truck

In piling flitches on a kiln truck, especial care should be taken to avoid excessive loads on unsupported stickers. Although such stickers may look straight and satisfactory when piled, under the higher temperatures and relative humidities of the kiln they weaken and sag, causing warp and possibly an unstable load. For this reason, closer stickering is recommended for kiln drying than for air drying. The floor of the kiln truck should also be strong enough to remain straight under kiln conditions. If 16-foot kiln trucks are used, 16-foot and 8-foot box piles may be the most practical, in which event two trucks may be used or two 8-foot piles may be built on top of a partially built 16-foot one.

Piling Dimension Stock for Air Drying

Cutting logs directly into dimension stock is often desirable and in this event as well as when stock is cut from slabs and edgings it must necessarily be seasoned in relatively small pieces. From a warp and piling standpoint leaving the stock in multiple lengths is excellent practice even if it is necessary to leave small knots and other defects in the pieces until the dried pieces are cut into their final sizes. A multiple length, up to 4 or 5 feet, is more beneficial in reducing unit bow, crook, and twist than a multiple width.

Usually a separate pile is made for each length, but certain combinations of lengths may be piled together. Complete shelter from sun and rain is the most important consideration. In other respects the essential features of pile construction are the same as for lumber of flitches. Dry, straight 1-inch stickers 1-1/2 inches wide with a spacing of 15 to 18 inches are usually satisfactory for 1-inch stock. A greater spacing is permissible for 2-inch stock. Squares may be piled in solid layers except for a 2 or 3-inch vertical flue for every 10 or 12 inches in width.

Piling Dimension Stock for Kiln Drying

For forced circulation kilns with horizontal circulation no vertical flues are necessary, but the width of the pile should not be so great as to cause a large temperature drop between the entering air and the leaving air sides. For natural-circulation kilns some form of vertical flue is necessary. The piling on a 16-foot truck may be by layers or by tiers, but in either event it would be best to level the top for a layer of 16-foot flitches or lumber. This top layer would give not only stability, but also protection from ceiling drip or excessive heat. From a warp standpoint, some weight on top seems desirable. The data indicating this, showed a considerable reduction in warp from the top down to the fifth and sixth layers, although from that point on down the warp remained about constant.

Piling brings out another advantage of sawing in multiple lengths and the resultant saving would partly compensate for the cost of a second sawing operation. Where a variety of short lengths are piled together, combinations of them must be worked out to make what may be called multiple lengths. It is important to use enough stickers to support all ends and to prevent short pieces from falling between layers, thus stopping circulation. Spaces, preferably on the leaving-air side, should be left for moisture-content samples, which are necessary for an intelligent use of drying schedules.

Multiple Sizes

Often the thickness allowed for warp is insufficient. Small pieces have greater unit warp during drying than large ones and dressing the warp out of the small ones wastes a considerably greater percentage of wood than would be wasted if pieces of the small size were cut out from larger ones. In other words, warp does not keep pace with increase in size. Furthermore, the smaller the piece the greater the percentage of loss caused by end trimming.

A frequent question is whether to dry squares as squares or in plank form. The squares bow, twist, and diamond, while the planks check more readily. The square can deflect in two directions equally well and the maximum bow governs the finish size. The plank deflects less edgewise than flatwise, and this edgewise deflection, called crook, can be ripped out with comparatively small loss. Diamonding of squares is caused by the difference in radial and tangential shrinkage and cannot be avoided where the growth rings run diagonally across the end of the piece. Beech, because it shrinks more than twice as much tangentially as it does radially, diamonds and cups badly. It also checks readily, but high relative humidity schedules and end coatings will reduce checking. Birch has a small ratio of tangential to radial shrinkage and therefore does not diamond or cup badly. It also does not check easily and can therefore be seasoned in either form. Maple falls in between, but behaves more like the beech than the birch.

If warp is not a serious defect, then there can be no objection to drying stock as squares; heel stock, for example, may be dried in this way. At times this method may even be advantageous. For instance, during drying a wide cross-grained piece may develop a long check extending nearly across the piece, thus ruining several possible squares, at least some of which would have been saved if the pieces had been cut up before drying.

End Coating

Beech checks so readily that end coating is virtually a necessity. Sugar maple checks readily, but not quite so readily as beech. Birch does not check easily and, unless it is to be dried under a low relative humidity schedule, end coating is not so necessary as for beech and maple.

The coatings commonly recommended for this purpose should not be thinned merely for ease of application. A heavy coat on the end surfaces is necessary, and not one that soaks in. The danger of excessive thinning is greatest during cold weather, when the patience of the painter is taxed extremely. One coat of ordinary shellac, varnish, or paint is not satisfactory. Commercial end coatings are very effective if applied at the consistency that is about the limit for brush work.

End coatings should be applied to green material as soon as possible after cutting. Beech end checks almost immediately on exposure to the atmosphere and especially when it is also exposed to the sun, and checks well started cannot be stopped by an ordinary coating.

Kiln Schedules

In kiln drying beech, yellow and paper birch, and sugar maple dimension stock the exact schedule used is important only insofar as its effect on checking, honeycombing, and drying time is concerned. As long as opposite sides of a piece are subjected to the same conditions, the effect of schedule on warp is negligible. Whatever effect may exist is probably in favor of a low temperature and low relative humidity schedule which, by causing a steep moisture gradient, sets the surface so quickly that shrinkage and therefore warp is reduced.

In general, schedules satisfactory for lumber are satisfactory for dimension stock. Precaution a little greater than that for lumber must be taken in drying dimension stock, however, because end checks, which cause only a small percentage of loss in lumber, may cause a prohibitive loss in dimension stock. Uncoated beech, which is extremely hard to dry green from the saw without end checking, seems to require an initial relative humidity as high as 85 percent. Maple does not check quite so easily and birch can be seasoned with less care than maple. Birch when end coated will stand an initial relative humidity of 60 to 65 percent.

Effect of High Temperature

Increasing the kiln temperature decreases the drying time. Two-inch green squares dried to 7 percent moisture content at temperatures from 125° to 155° F. required 34 days. Through using a constant temperature of 160° F. and the same equilibrium moisture-content values for the different stages of drying, this time was cut to 16 days. A further increase in temperature to 190° F. cut the time to 10 days. Yet increasing the drying temperature increases the degrade also, often costing more than it saves. At 160° F., all three species showed 10 to 15 percent of the pieces honeycombed to some extent, while at 190° F. 98 percent of the birch, 88 percent of the beech, and 52 percent of the maple pieces honeycombed. Birch, which does not check readily at ordinary kiln temperatures, honeycombs badly at high ones. On the other hand, maple, which checks readily at the lower temperatures, does not honeycomb so easily at the high. Beech both checks at low and honeycombs at high temperatures. To avoid honeycombing the initial temperatures must be below 160° F. (Fig. 1.) Recommended kiln drying schedules for 1- and 2-inch squares of beech, birch, and maple are given in Forest Products Laboratory report D1791[1].

Circulation and Temperature Drop

It is impossible to dry stock according to a given schedule without adequate circulation at the beginning of the run. For the hardwoods this means a minimum velocity, at any one place within the load, of possibly 100 to 150 feet a minute, and even with these rates of circulation the temperature may drop to the dew point. If it does drop that far the stock will become dripping wet and moldy, which will reduce further the circulation at that place.

Mold has been observed to grow rapidly on wet lumber in kilns run at 120° to 125° F., but at 130° to 135° little if any will develop.

Because of possible drops in temperature through the pile, a low-temperature, high-humidity schedule is more easily followed in a kiln having a good rate of circulation. For beech, birch, and maple, low initial temperatures are not essential, but high initial relative humidities must be used, especially for beech, to prevent checking. A properly designed natural-circulated kiln, which depends on differences in temperatures for circulation, should be satisfactory for these species, but if a wet spot develops it may be necessary to open up the pile by providing larger vertical flues.

In some forced-circulation kilns the lower portion of the leaving air side may be the wet section and in that event a greater circulation to that place must be obtained, either by increasing the output of the fan, or using thicker or double stickers for the lower layers.

A slow-drying spot can be remedied in a natural-circulation kiln by providing a larger air passage from the heat source to the spot, in a forced-circulation kiln by increasing the fan output and in both kinds by reducing the volume of stock in the affected portion. Increasing the severity of the drying conditions at one place to obtain drying at another is not good practice, even though it is sometimes done.

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[1] "Schedules for the Kiln Drying of Wood" by O. W. Torgeson, Feb. 1951.

Warp

Knowing where to place the blame is always satisfying and frequently is useful. If lumber warps during drying it is perhaps natural to blame only the drying conditions, or possibly to conclude that air drying is better than kiln drying. Yet the fact is that a certain amount and kind of warp for a given species, size, and moisture content are unavoidable and can be cared for only by an allowance in thickness or width. As long as wood shrinks much of it will warp, and the more unevenly it shrinks, the greater will be the warp.

The total shrinkage from the green to the oven-dry condition, expressed as a percentage of the size when green, that should be expected for beech, yellow birch, and sugar maple is:

	Beech	Birch	Maple
Radial........................	5.1	7.2	4.9
Tangential....................	11.0	9.2	9.5
Ratio of tangential to radial..	2.16	1.28	1.94

No figures of longitudinal shrinkage by species are available, but it may be taken as less than 0.5 percent for all three species.

Definition of Kinds of Warp

To avoid confusion, the following definitions are necessary. (Fig. 2.)

Bow.--Deviation flatwise from a straight line drawn from end to end of a piece.

Crook (sometimes called spring).--Deviation edgewise from a straight line drawn from end to end of a piece.

Cup.--Deviation crosswise from a straight line drawn from edge to edge of a piece.

Twist.--Rise of a fourth corner above the plane of the other three corners.

Diamond (for convenience this definition is limited to squares).--Maximum deviation of one side of a square from a line drawn perpendicular to an adjoining side.

The lengthwise deflection of a square is measured only on the side of maximum deflection and is called bow.

Causes of Warp

Bowing and Crooking

Now and then pieces of beech, birch, and maple that are perfectly straight grained are excessively bowed or crooked. In the study such pieces were invariably bowed toward the bark or sap side. Several explanations are possible. Tension along the grain may have existed in the outer portion of the trees; in some trees it did exist and was so great that flitches when cut would split nearly from end to end. Other possible explanations are that the longitudinal shrinkage of the sapwood may have been greater than that of the heartwood, or that the wood toward the outer part of the tree was less dense and therefore may have had greater longitudinal shrinkage. As a rule, wood of low density shrinks more longitudinally and less transversely than similar wood of higher density.

In warping, difference in amount of shrinkage is the prime factor. Hence, wood of irregular grain will warp more than straight-grained pieces. (An exception is the condition mentioned in the preceding paragraph.) If the grain on one side of a board varies more from the longitudinal direction than the grain on the other side, then the first side will have more transverse shrinkage in the longitudinal direction and the board will become concave on that side. In other words, the direction of bowing and crooking will be the same as that of the grain. Curly grained pieces bow and crook badly.

Cupping

The primary cause of cupping is the difference between the amount of shrinkage parallel to the growth rings (tangential) and that perpendicular to them (radial). An excellent way to compare the cupping tendencies of different species is to take from a shrinkage table the ratios of tangential to radial shrinkage for those species and then to compare the ratios directly. Since the tangential shrinkage is the greater, the cupping from this cause will usually be toward the sap side of the piece. For beech, yellow birch, and sugar maple these ratios are, respectively, 2.16, 1.28, and 1.94, while cup measurements of some boards 1 inch thick and 4 inches wide showed 0.032, 0.010, and 0.023 inch, respectively. Changing the highest figure in each group to unity, these figures become, respectively, 1.0, 0.6, and 0.9 for the shrinkage ratios and 1.0, 0.3, and 0.7 for the cup measurements.

Boards with one side exposed to the alternating action of the sun and the rain will cup badly on that side regardless of the fact that it may be the heart side of the board. For explanation, assume that rain falls upon one face of a dry, flat board. This face will then swell and compress, causing downward cupping and a certain amount of compression failure. On redrying, the compressed wood will shrink to a size smaller than normal, thus causing the board to cup upward. Such action when repeated sufficiently will increase the compression set enough to make the cupping far in excess of that caused by the difference in tangential and radial shrinkage. This condition, however, can be guarded against and should not cause trouble in either air drying or kiln drying. On the other hand, the cupping caused by difference in shrinkage cannot be prevented, although it can be reduced somewhat by using stickers enough to distribute evenly the weight of the stock in the pile.

Diamonding

Diamonding of squares is also caused by the difference in tangential and radial shrinkage, and it too cannot be prevented. Naturally, the diamonding will be greatest for those pieces having growth rings running from corner to corner. Where diamonding is a defect and where the species used has a large ratio of tangential to radial shrinkage, the stock should be dried in plank form. As in cupping, a shrinkage table will indicate the tendency of different species to diamond. The observed diamonding of 2-inch beech, birch, and maple squares was, respectively, 0.092, 0.038, and 0.080 inch. These results are in keeping with the ratios of tangential to radial shrinkage of 2.16, 1.28, and 1.94.

Twisting

Twisting is mostly a result of other kinds of warp. A difference in bowing of two edges of the same piece or a difference in cupping of the two ends may cause the cocking up of one corner. All this goes back to changes in the direction of transverse shrinkage caused by irregularity in the direction of fibers or growth rings. The larger the piece, the less effect small irregularities will have on unit twist. In one instance maple dimension stock dried as such had twice as much twist as when the same sizes were dried in the form of flitches.

Amount of Warp

The amount of warp is dependent on so many variables, such as size during drying, species, grade of stock, and care in piling, that the resulting averages are numerous enough to be confusing. By grouping certain factors that do not differ greatly in their effect on warp, however, these averages may be cut down to a more practical number. The effect of an individual factor in a group must then be estimated.

Since an average value for warp takes care of only about 50 percent of the pieces, a value that applies to 90 percent or more is often of greater service. Figures 3 to 6, inclusive, therefore, give both. These figures, however, should be used only as a general guide when estimating the most probable average warp and maximum warp that may occur in drying beech, yellow and paper birch, and sugar maple to 7 percent moisture content.

The bowing averages of these three species, which do not differ greatly, are grouped. The curves for the bowing of squares show considerably larger values than those for flat stock. This is not so much the effect of width as it is the method of measuring. Only one measurement was taken and that was on the side of maximum deflection. Crook was not considered. The values for flat stock represent an average for a 4-inch width and should be reduced slightly for wider stock and increased slightly for narrower stock.

Yellow and paper birch have very nearly the same ratio of tangential to radial shrinkage and, in keeping with this, the observed cupping was very nearly the same for the two species.

The diamonding measured was that of 2-inch squares only. The values for other sizes can be estimated by assuming a straight-line relationship from zero on up through the 2-inch size.

The twisting of sugar maple and beech was similar enough to be represented by one average curve. The same is true of yellow and paper birch.

In estimating thickness allowance for warp, the values given by the curves must be doubled in order to provide for dressing both sides. If bowing and cupping occur together, the given values for both must be added and then doubled. These figures can be used only when straight stock is desired, and if a little warp is permissible in the finished product then the amount should be deducted from the value given by the curves.

The allowance for warp is the allowance for dressing it out.

The bow or cup per unit of measurement can be obtained by dividing the maximum deflection by the square of the total length or width.

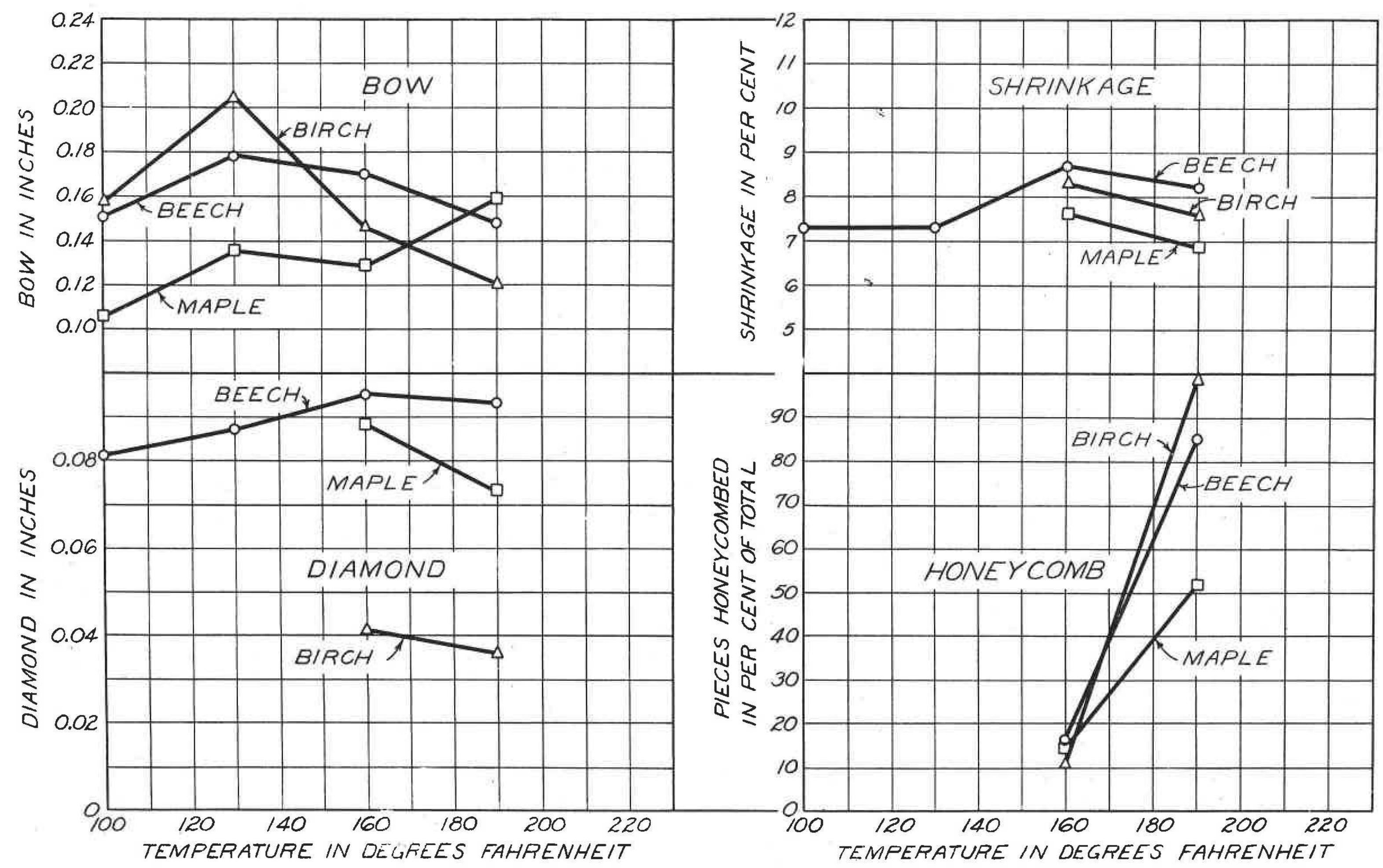

Figure 1.--Effect of temperature on bowing, diamonding, shrinking, and honeycombing. Each of the four kiln runs contained 100 pieces each of beech, birch, and maple, 2 by 2 by 48 inches.

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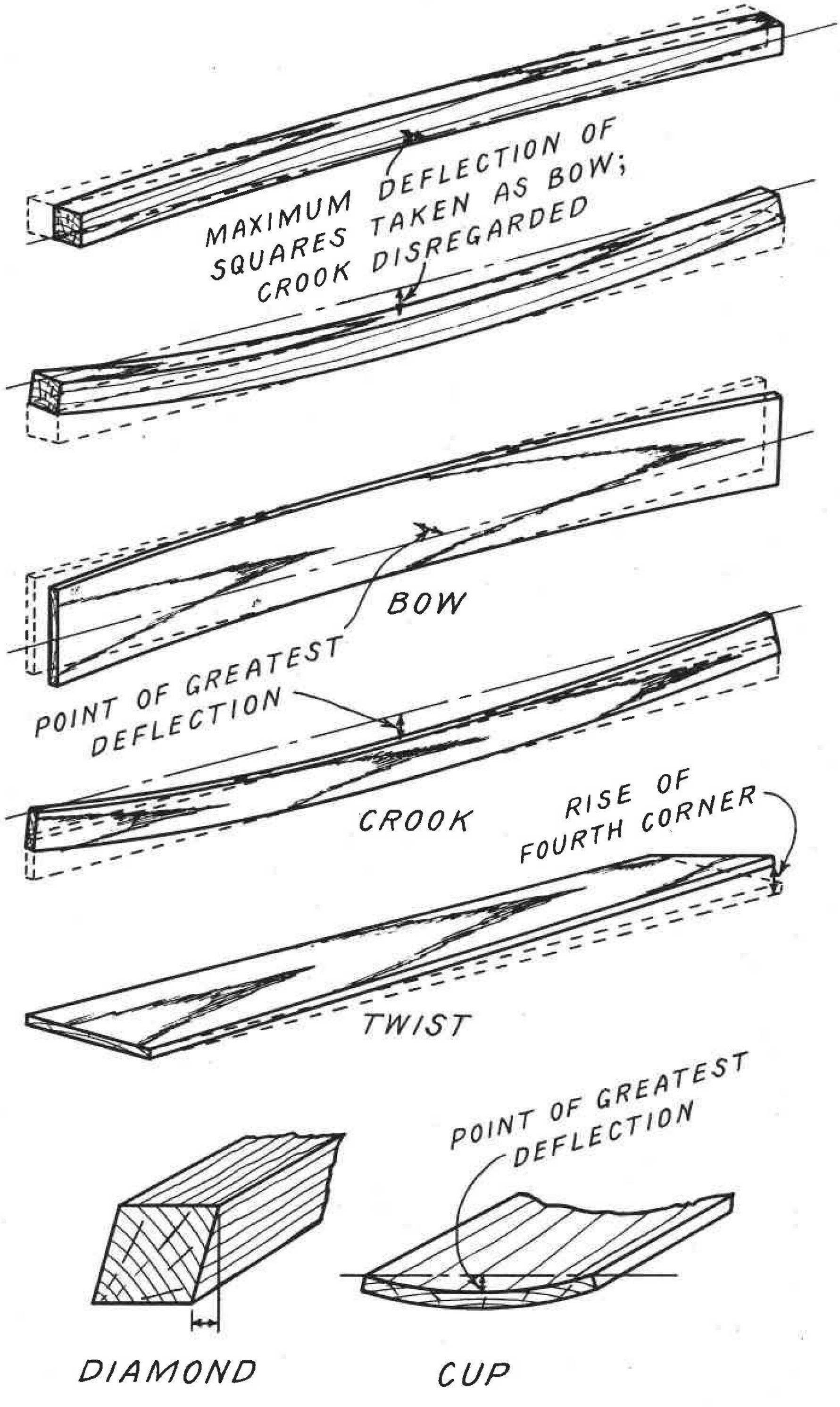

Figure 2.--Illustrating various kinds of warp.

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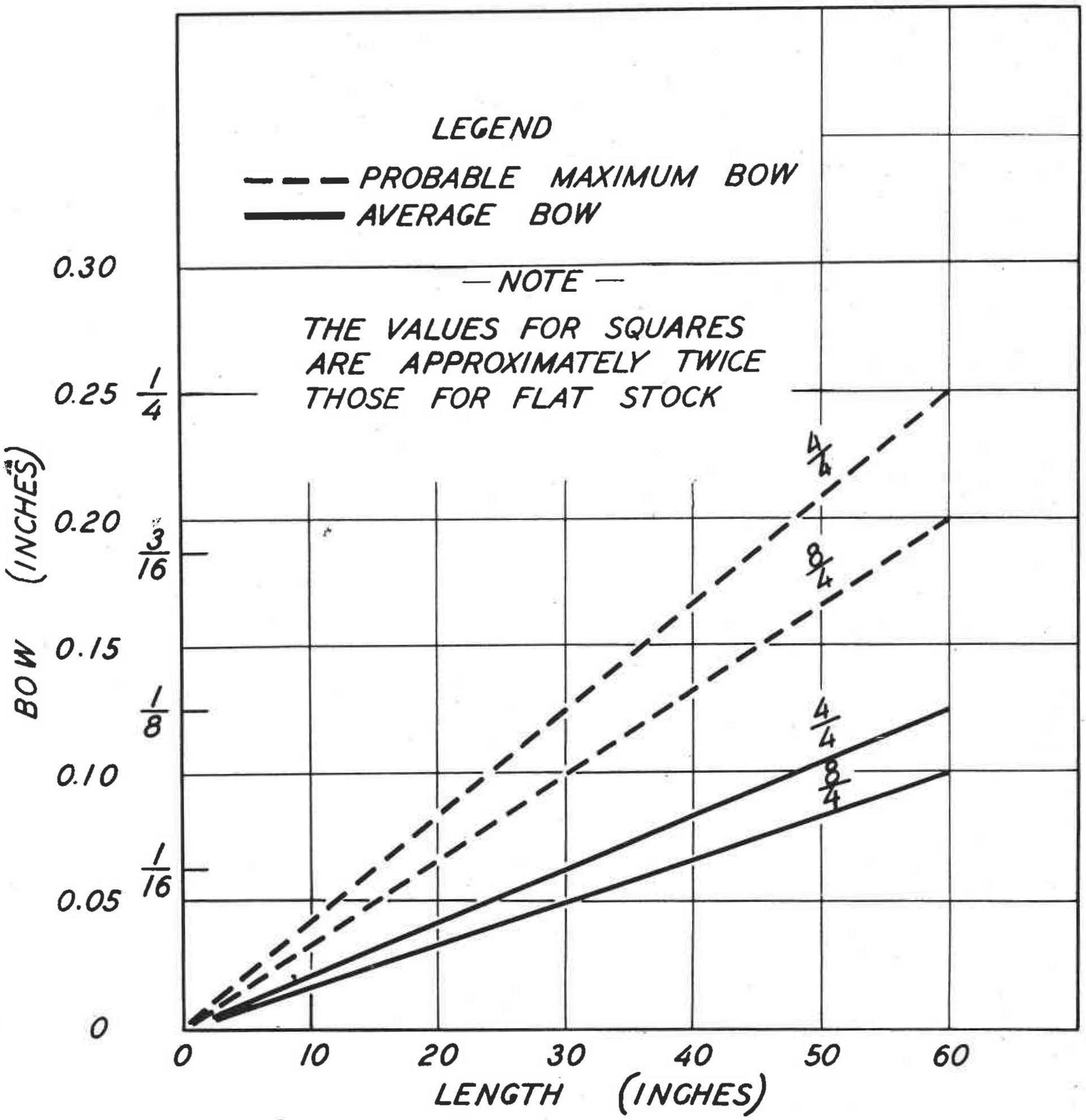

Figure 3. --Bow in kiln-dried beech, yellow and paper birch, and sugar maple, 2 to 6 inches wide, at 7 percent moisture content.

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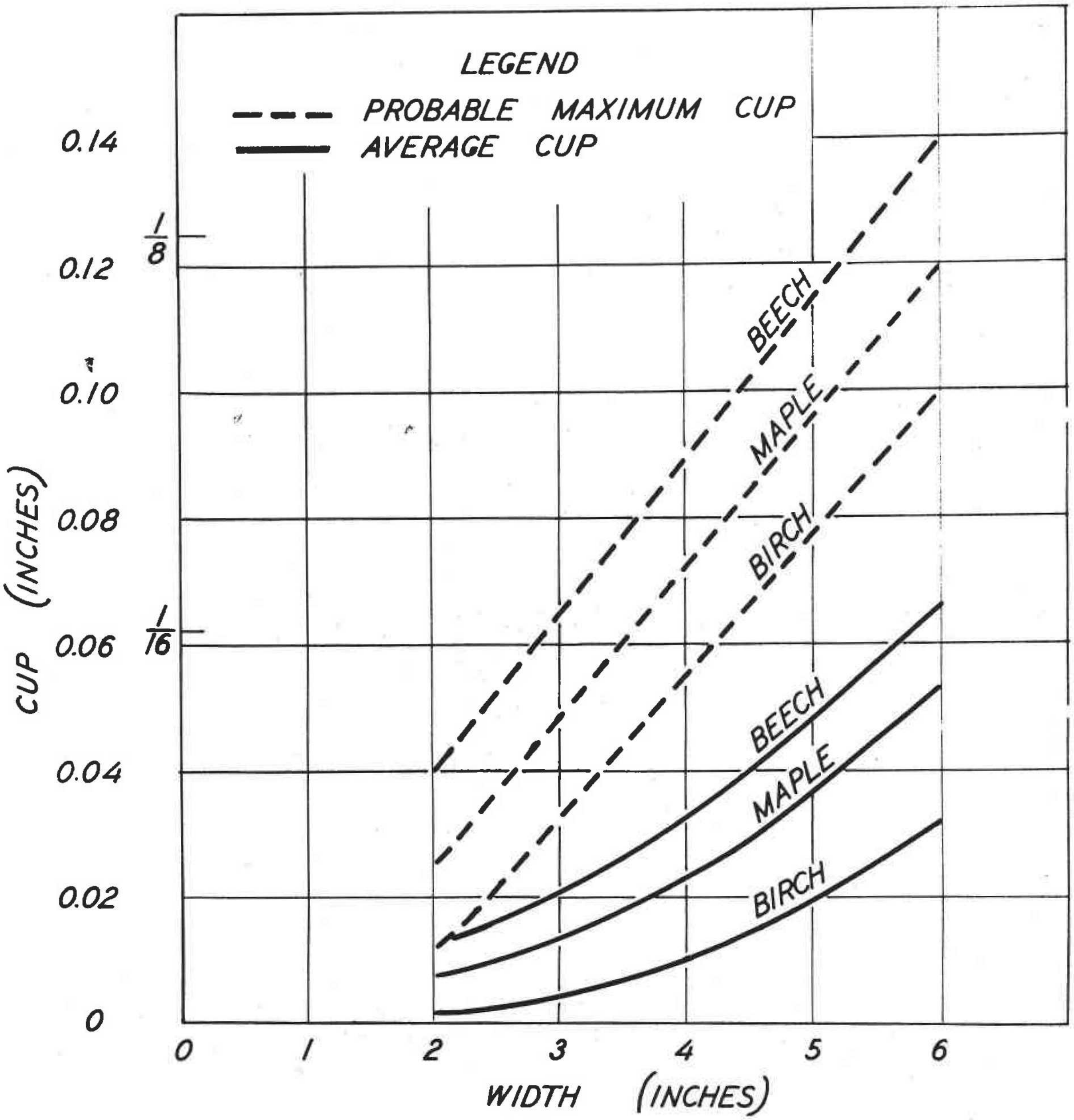

Figure 4.--Cup in kiln-dried 1-inch beech, yellow and paper birch, and sugar maple at 7 percent moisture content.

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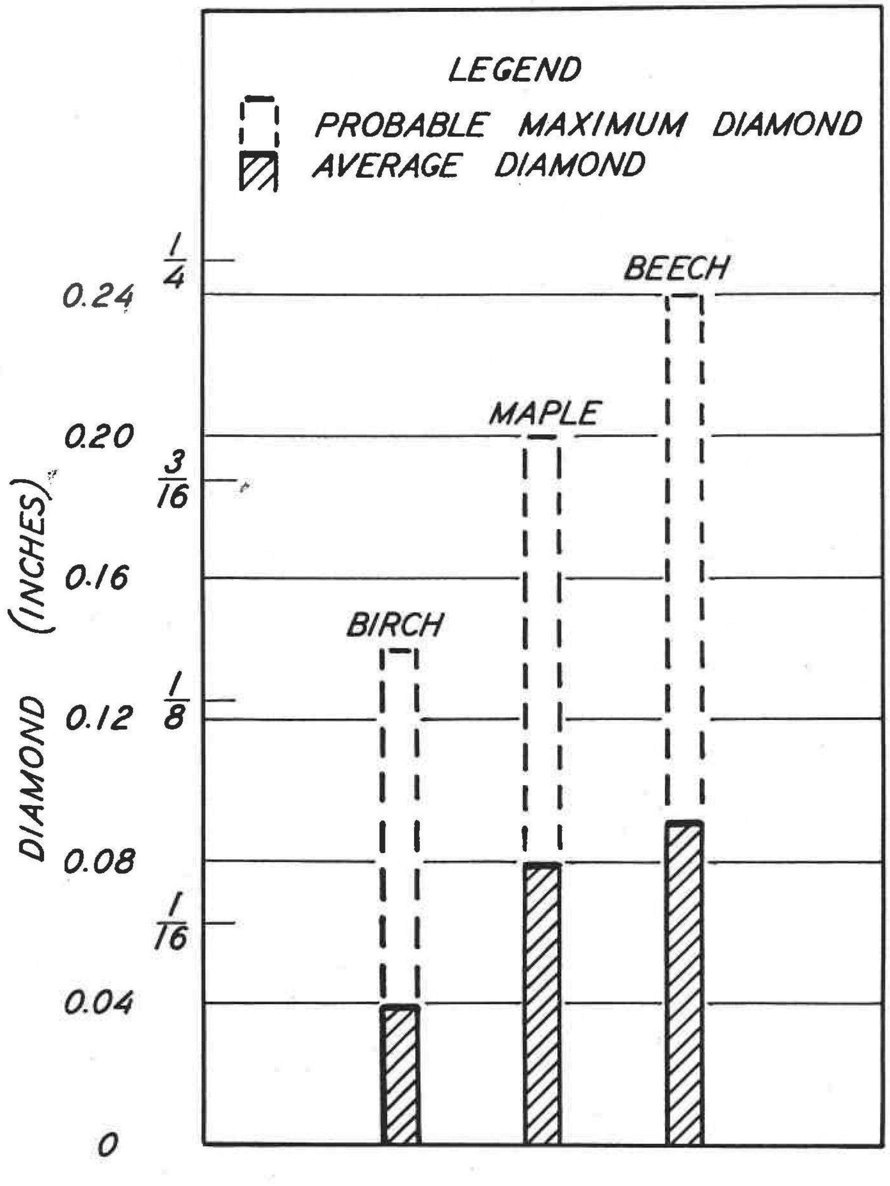

Figure 5.--Diamond in kiln-dried 2-inch squares of beech, yellow and paper birch, and sugar maple at 7 percent moisture content.

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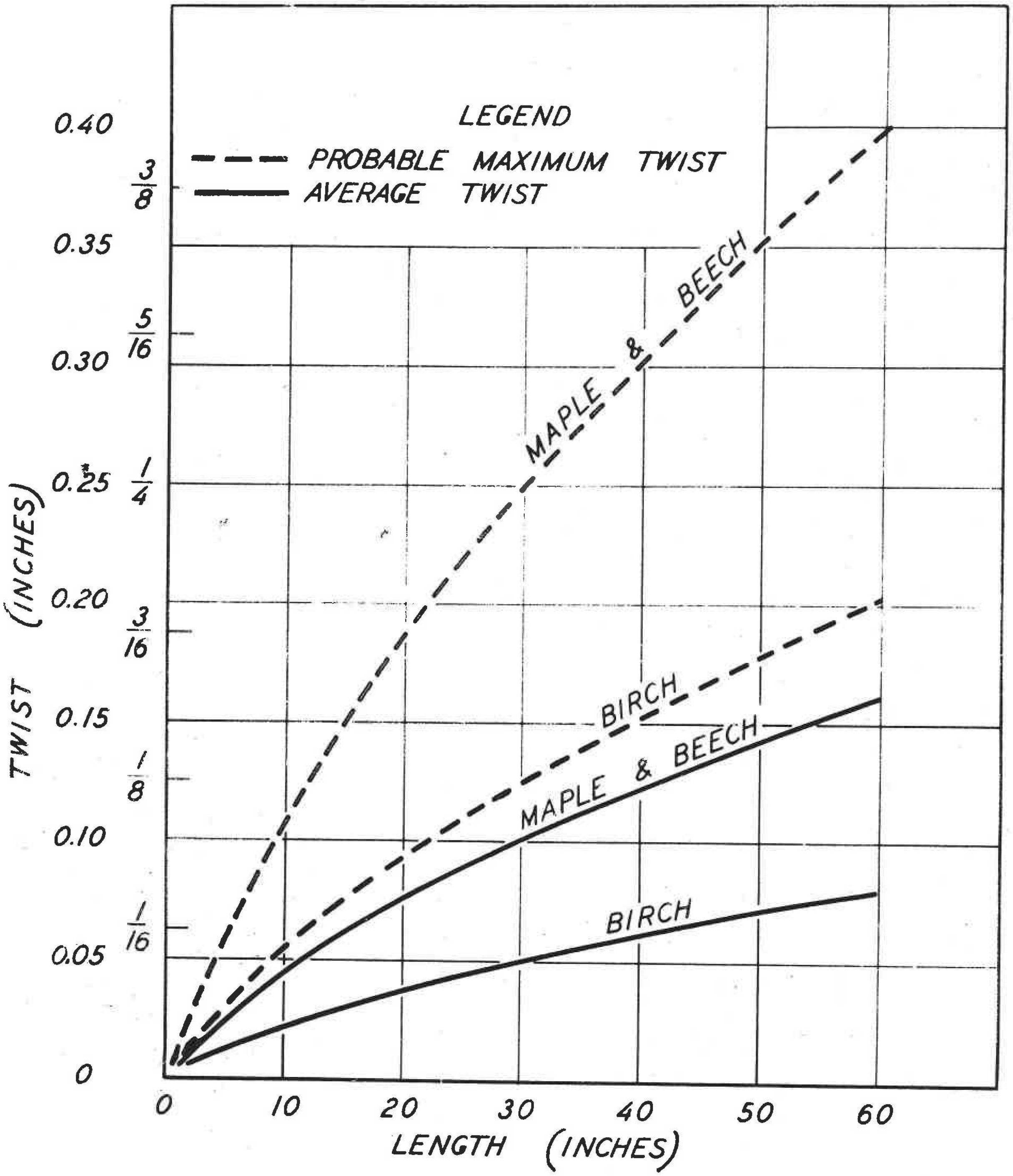

Figure 6.--Twist in kiln-dried 1- and 1-1/2-inch beech, yellow and paper birch, and sugar maple, 2 to 6 inches wide, at 7 percent moisture content.

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