EFFECTS OF KILN DRYING ON THE

PLANING OF LUMBER

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HOW KILN DRYING AFFECTS THE PLANING OF LUMBER

This subject is very interesting and affords the opportunity of airing a variety of aspects that affect the quality and appearance of the finished lumber. A small volume could be written on this subject if all phases were followed in detail. For the purpose of our relatively short meeting this afternoon, we will attempt to cover the subject in short form. This being a meeting of the Dry Kiln Club, perhaps a short review on planers will be in order so a common understanding of the principles invloved can be mutually understood.

A PLANER

We might start by asking, "What is a Planer?" We know there are many kinds of planers from the hand tool used by carpenters, on the one extreme, to a modern high speed, powered machine, capable of surfacing lumber at feed speeds over 1000 FPM. The word "plane" as defined by Webster, means "flat, level, even, without elevations or depressions, a flat or even surface." Therefore, if we are to accept such a definition as applied to our application, a "planer" is a machine used to surface one or more sides of a piece of lumber without elevations or depressions - flat - level - and even. Such a machine is much more involved. Our modern planers provide a feeding mechanism to propel the material through the cutter stations. It also provides various devices to confine a piece of material so that it will be surfaced flat, level, even and without elevations or depressions.

Planers are used throughout the world on the various species of wood grown and on both kiln dried and unseasoned material. There are innumerable concepts in the arrangement of feed rolls and cutting stations. The number of feed rolls vary and likewise, the number of cutter stations.

For the purpose of our discussion we will dwell only on those major functions of a planer which are pertinent to the subject -- the effect of kiln drying on surfacing lumber. The handling of that lumber before and after drying has a direct effect, not only on the drying but also on the surfacing. Therefore, it is considered as a part of the general subject. Those major functions of a planer involved will be:

The Planer Feed Rolls.
The Cutterheads.
The "Confined Path" of the lumber through a planer to accomplish the flattening, leveling and evening, without elevations and depressions.

THE FEED ROLLS

The purpose of planer feed rolls is to propel the material through the planer. The rolls must exert enough feeding traction, by means of pressure on the lumber, plus the type of roll surface, to overcome all the feeding resistance throughout the length of the planer, which is caused by the action of the cutterheads and all the various confining devices employed on the planer.

The feed roll surfaces vary. Some rolls are smooth, others may be fluted, knurled or made of bars with voids between the bars. Some feed rolls are made in sections, each section may yield under pressure. Still other type rolls are made to ride only on a portion of a board's surface, as has been used on machines made to surface cupped lumber.

Probably the most important thing to remember about a planer feeding system is that the lumber is "pushed" through the planer by the feed rolls. Therefore, the lumber ends must be square cut and the pieces must butt "end to end". Usually the outfeed rolls are used only to clear the lumber from a planer.

CUTTERHEADS

The purpose of a cutterhead is to smooth the surface or form some particular shape on a piece of lumber and at the same time inflict no degrading characteristics. Some of the usual degrading characteristics may be a mark from a knicked knife, an excessively dull knife, a low or high knife, chipped grain, torn grain, loosened grain, raised grain or fuzzy grain. Not all of these, however, are caused by the effects of drying.

The number of cutting stations may vary from only one to six or more, depending on the purpose of the machine. The cutterhead used at these various stations normally is a circular body, with removable knives or cutter bits, shaped and sharpened to remove a portion of material from the piece of lumber being surfaced. The knife or bit may be straight or formed to some particular pattern, depending on the intended purpose. The number of knives may range from only one to perhaps 20 knives or more per cutterhead. There are many different types of cutters employed, but for our particular discussion we need only consider the usual jointer type straight knife. We will, likewise, only consider the conventional type cutterhead.

The number of knives used is related to the rate of planer feed speed employed. The general range of knife cuts per inch on seasoned lumber will be from about 8 cuts per inch on construction lumber to approximately 16 cuts per inch on high grade clears. The number of knife cuts per inch has a direct effect on the quality of the surfaced finish, other factors considered.

Some of the other factors are, the moisture content of the material, the specie, the amount of distortion in a given piece of lumber, the cutting angle of the knives, and others.

The cutting angle of the knives affect the quality of surfaced lumber. The normal cutting angle used in the Northwest on our relatively low density Conifers will range from about 30° to possibly $22\text{-}1/2^{\circ}$. The general rule of thumb, regarding the cutting angle, is the softer the wood, the greater the angle and the harder or more dense the material, the lesser cutting angle. However, since most operations handle both green and dry on the same planer, a happy medium must be reached. A scraping angle usually caused raised grain and fuzzy grain on wet or low density material and the greater cutting angle, such as 30°, will cause chipped and torn grain on the higher density or dry material. Since most lumber becomes firmer, harder and more brash when dried to a low moisture content, and is the opposite when green or only partially dry, some compensation is usually necessary. That compensating factor is usually by controlling the planer feed speed or regulating the number of knife cuts per inch on the lumber. It must be remembered that the conventional cutter-head rotates against the direction of lumber movement through a planer. The knife enters the cut at approximately the finished level of cut and therefore has a lifting effect on that portion of material removed by shavings. The knives also have a lifting effect on the portion of the material not yet removed in the form of shavings. In this respect, it can be visualized how a greater cutting angle, say 30° will cause a more severe lifting effect than a 10° angle.

If the stock is very dry and brash and at the same time the grain of the wood slopes into the piece, the portion removed may break off below the cutting level of the knives. This particular action is known as torn grain or chipped grain.

THE "CONFINED PATH" OF LUMBER THROUGH A PLANER

If we were to view a planer from the operator's side at a level, even with the bottom cylinder, as on a conventional machine, the bed of the planer which the lumber rides upon is level as a table, except that portion before the bottom cylinder. That portion of the machine's bed line will be lowered by the amount of stock removed by the bottom head, providing a cut is being taken. In other words, if a piece of lumber is distorted even the slightest amount, it must be flattened to the bed line by the feed rolls or other confining devices along the length of the planer. In a smilar manner, the edge of the lumber is held against a straight edge or guide by holdovers and other methods to assure the objective of the planing process. Therefore, any distortion along the edge or surface of lumber passing through a planer must be "ironed out" or some form of degrading characteristic will result.

LUMBER DISTORTION

Distortion or warp in lumber is the cause of many surfacing problems which can result in poor mill work and direct loss in the finished lumber value. The meaning of distortion in lumber includes all of the various kinds and are described in a grading manual as crook, twist, bow, bend, cup and pieces with kinks.

The kiln operator, in defense of his vocation, may ask, "Why direct the subject to me?" In explanation, let us look at green lumber as it comes from the saw mill and then after drying. On most any green chain, freshly cut lumber is usually straight and free from most any distortion. Dried lumber, kiln dried or otherwise, may be distorted in any one of the above classifications or a combination of them.

Distortion can be caused by many things. Some can be controlled and other types have been found to be very difficult. Some of the more common causes of distortion are as follows:

Stacking: As is commonly acknowledged, it is most important to place the kiln sticks in lumber piles before entering the kilns, one directly above another so that the weight of the lumber pile or piles is carried by the equivalent of a single column, preferrably with one layer of sticks at each end to prevent a free end from warping into some form of distortion. Likewise, pile blocks used between loads must be in line with a course of stickers in green storage, during the kiln drying process and in dry storage before surfacing. The obvious reason is to prevent the lumber from having a permanent wave.

Uneven lumber thickness can cause distortion by permitting a thin piece of lumber to be dried between two thicker pieces. Since it may not be held or weighted down, growth stress could result in a distorted piece of lumber. For this reason, blanking lumber before drying is considered in some operations.

Drying lumber of random length in the same pile, where the ends of pieces protrude. Normally, those free ends become over-dried and distorted.

Some of the other reasons for distortion are the severe cases of growth stress that are very difficult or impossible to control.

Distortion, such as a ski end may not butt the end of the adjacent piece when feeding into a planer and can overlap or underlap before entering the feed rolls. This not only wastes material but causes objectional production delays.

Any distortion will cause a planer to feed harder because additional roll pressure must be exerted to overcome the feeding resistance of flattening the piece out in it's passage through the planer. The necessary additional end pressure and shock may cause a breakup in the planer and costly down time. The additional roll pressure has a tendency to compress the wood cells on the top and bottom surface of the lumber. Since most manufacturers are material conscious, they are cutting lumber as thin as possible. If this is the case, the cutterheads may not remove enough stock to clean up below the compressed wood cells and if so, will result in damaging raised grain.

Damage in the form of "kinks" near either end, twists, etc., usually are a direct cause of end snipes, top, bottom, or edges, when surfacing lumber. Distortion in any form makes it difficult, and if severe enough, impossible to machine an accurate pattern on lumber because the piece may be <u>too</u> rigid to flex into proper machine alignment. Such a severe case, also may result in skipped areas which will require trimming and consequently a loss in value.

The normal human reaction is usually to maintain roll pressure necessary to feed the most difficult pieces. In other words, the operator normally will not release the roll pressure after a difficult piece has been forced through a planer but will let the pressure remain. Consequently, all pieces are subjected to the same punishment. Also the feed works of the machine suffer unusual stress and wear. This naturally results in higher maintenance costs.

CASE-HARDENED LUMBER

Case-hardening definitely affects surfacing and also the condition of the material after surfacing. We must consider this condition on two classification

The over-dried skin or outer portion of the piece.

The moist or wet skin and the dry core.

The overdried skin, if excessively low in moisture content, will cause that portion of the piece to be brittle in the area that shavings are removed and usually results in damaging, chipped and torn grain. The second damaging reaction results in cupped surfaced lumber. Since the amount of material removed on the bottom cylinder is a very thin cut and is in most cases too shallow to entirely remove all of the over-dried shell in tension. Whereas, a much heavier cut is normally removed by the top cylinder, which usually removes all or at least most of the over-dried shell. Since the piece is under tension on the one side and not on the opposite side, the natural result will be a cupped piece.

The moist or wet skin with the dry center sets up stresses in the reverse. The outer skin under compression will normally cause a surfaced piece of lumber to cup in the opposite way.

In addition, if the outer portion of the piece has been softened by having a greater moisture content with a firmer inner core, raised grain will most certainly result. This is especially true on the bottom side where a very thin cut is taken.

In many plants lumber is sawn, as an example, in two inch thickness, kiln dried and resawn. If the stock is case-hardened or under stress, the cupping action is very pronounced and easily recognized. If the material is surfaced afterward in the cupped condition, extreme damage can develop in the form of so-called "roll splits". Since the planer feed rolls must be tight enough to push the lumber through the planer, the piece is flattened out and will center split as a result. More on this subject later.

NON-UNIFORM DRYING

Lumber, kiln dried but not of a uniform moisture content, can result in unsatisfactory mill work. As briefly explained under cutterheads, regarding the cutting angle of the knife, the cutting angle is not normally changed when surfacing dry lumber or green lumber. Dry lumber is normally run slower than green, resulting in more knife cuts per inch. This in turn helps to prevent chipped and torn grain, etc. Should the planer be adjusted for dry lumber and then occasional wet pieces or wet spots occur, such as under a wide kiln stick for instance, raised grain and fuzzy grain may be caused in those spots. The change in appearance may be very slight, but when looking over the length of the piece, the contrast usually is quite noticeable.

OVER DRYING

Over drying or lumber dried to an excessively low moisture content usually is the cause of unnecessary distortion and consequent damaging action, as previously covered. Such a condition causes excessive brashness which results in costly breakups as well as chipped and torn grain. Most kiln operators and lumbermen are fully aware of these conditions and do all possible to prevent it.

SURFACING "HOT" LUMBER

Care must be taken to prevent lumber from being surfaced before completely cooled after kiln drying. This can be quite an involved subject if pursued in depth, but we will not attempt to get too deep in this discussion.

It is generally conceded that when wood is subjected to heat under humid conditions, the material softens, it can be bent easier than when cold or dry. If heated under humid conditions and bent or distorted from it's natural shape and then permitted to cool and dry, it has a tendency to remain in the distorted condition. This practice is frequently used in forming frame members in boat construction. We are also aware that this is more pronounced in some species than in others. As the amount of heat is increased, wood cells have a tendency to become plasticized, to a certain degree, although the normal kiln temperature may not reach such a degree of heat. However, it still may have some effect. Therefore, we must agree that warm or hot lumber is in somewhat of an unstable condition, to say the least.

The better practice is to permit the lumber of completely cool while on the sticks and kiln cars, the same as during the drying process. However, some operations unstack and re-pile into solid loads, but permit the lumber additional time to completely cool before surfacing.

If lumber is surfaced while hot, many changes may occur regarding it's shape and size afterward and degrading physical damage in the planing process may occur.

The lumber may cup because of a heavy cup being taken from one side and a light cut from the opposite. The lumber may shrink after surfacing and seriously affect a particular pattern. As an example, the lumber may be made into a flooring pattern. It is only reasonable to believe that the ends, being exposed to the cool air, will completely cool and set, while the center portion is still warm and unstable. The ends will remain the same size as when surfaced and the center portion shrinks and becomes narrower. Then if a piece is center-trimmed for grade or defect during the manufacturing process, two pieces of unequal width may be joined when laying the floor and an objectionable opening would show in some home owner's floor. For the same reason a groove has a tendency to close and thus result in the equivalent of a mismanufactured piece.

Surfacing hot lumber also generally is a cause of raised or loosened grain in various forms.

BLANKING LUMBER

The term "Blanking Lumber" refers to material planed on one or more surfaces to a size larger than the intended finished dimension or pattern.

BLANKING BEFORE DRYING

There has been considerable discussion, pro and con, about blanking lumber to a common size before drying. There are two principal objectives for entertaining such an idea. One reason is to bring the lumber to a common thickness and width for uniform stacking, and the other for a better grade segregation and possibly for better length and width sorting, in the same handling.

From the standpoint of surfacing, we know a much better job can be done if pieces are uniform in thickness and width when entering the planer, and if the pieces are straight and free from distortion. Many times a skip will occur, mostly on the bottom of a surfaced piece, where a kiln stick has made a deep impression across the width of a piece of lumber. That piece must have carried the lion's share of the weight and undoubtedly must have been thicker than other pieces in the same course of stacked lumber to have this happen. Blanking green lumber to a uniform size is one way of preventing this.

If all the lumber stacked for kiln drying were blanked to a uniform size, with no pieces too thick or too wide, certainly the kiln would hold a greater volume. It also seems reasonable to believe that the stock could be dried to a more uniform moisture content.

It has been reported that many plants cutting hardwood in the South and East have recently resorted to blanking green lumber. One of the principal reasons is to help overcome objectionable distortion characteristics of those woods. Also considerable green blanking is being done in Canada, according to reports.

A special green blanking machine has been developed to remove excess width and thickness in the form of saleable pulp chips. Such evidence bears out the fact that there are advantages in blanking green stock and since saleable pulp chips may be recovered, this practice certainly may become more prevalent in the future.

BLANKING AFTER DRYING & CUP BLANKING

Many different approaches have been used in blanking after drying and for many reasons, some are:

To separate grades before surfacing to the finished size and pattern.

To accumulate the proper amount of stock to fill an order as to grade, size or length.

To remove irregularities in preparation to accomplish top millwork.

To help prevent roll splits as may occur in severely cupped lumber.

The latter two could be the result of kiln drying. Many plants have experimented with blanking for various reasons but have usually given up the practice, in major volume, because of the extra cost involved. Most plants, however, blank some lumber for special reasons, examples as outlined above.

Since the benefits of blanking are generally acknowledged, and the costs have been found substantial, if not prohibitive, when handled as a separate operation, the resourceful mill operator has resorted to some very novel approaches. As one example, we may call it the "two in one approach" or the "pre-surfacer".

This is accomplished by positioning a very short coupled "blanker" between the feed table and planer. The blanker or presurfacer, equipped with infeed rolls, top and bottom cylinder, or perhaps only a top cylinder. The lumber is discharged from the presurfacer directly into the conventional planer's infeed rolls. In this manner the objectionable irregularities of rough sawn lumber can be removed and some distortion corrected in one handling, and at no additional handling cost. This practice results in higher quality millwork and less fall-down.

Cupped lumber, however, has been a real outlaw to handle and has been given some very special consideration. Being among kiln operators, it may be advisable to explain that all cupped lumber is certainly not blamed on kiln drying. Some, naturally, may be caused by an improper schedule or handling, but this explanation is aimed at those boards cut from a particular portion of a log whereby the slope of the annual growth rings vary across the width of the piece. Such a piece of lumber, call it a 1 x 8 or 1 x 10, is cut from a small diameter log just to one side of the pith. The center area being flat grain and each edge developing into vertical grain or near vertical grain. Since the material shrinkage is greater tangentally than radially, uneven shrinkage occurs and a piece of cupped lumber results. This has been found especially severe in certain areas, such as plants which cut White Pine or small logs.

In an effort to prevent roll splits, the presurfacer or blanker has been developed a step beyond that explained above. The special presurfacer is called a cup blanker. The machine has special top infeed rolls, using a fixed, narrow roll about 3" wide, positioned adjacent to the guide which rides one edge of the board. Another similar narrow roll, but adjustable to ride the opposite edge of the board. The cupped lumber is fed with the crown up, and with no roll or roll pressure over the crowned part of the board, and consequently the roll splits do not occur. Special segmented top cylinder chipbreakers and pressure bar which yield easily are employed to help prevent splitting. A light cut is then removed from each edge on the bottom side and a cut removed in the center from the top. This method tends to minimize the cupped condition enough so the piece will not split when it enters the conventional planer. The blanker is adjusted to dress the stock oversize, leaving enough wood for finishing by the planer.

This procedure is certainly unusual, but has proven very effective. It does not prevent all roll splits but has been found practical.

The Western Pine Association conducted a study on this subject and have a very comprehensive report available to those who may be interested in additional information.

From the "cup blanker" story, the importance of feed rolls can easily be understood and how they may affect lumber subjected to their weight or pressure. Earlier, roll sizes and weights were mentioned and now can be summed up by saying the larger the roll area, the less tendency toward compressing wood cells, which results in raised grain, loosened grain or other damaging effects. However, on the other hand, the larger roll will usually weigh more and have a tendency to counteract the benefits of the larger contact area by the additional weight. But a good planer operator will control the roll pressure according to the needs and prevent damage to the lumber caused by excessive roll pressure.

Progressive lumbermen and planing mill machinery manufacturers are constantly striving to improve methods and machinery to overcome some of the problems we have just reviewed.

Within the last few two years, an improved bridge, between the planer and feed table, has been developed. This bridge is about twice as long as those previously used and the lumber is carried across the area by powered rolls, spaced close together and canted to direct the lumber against the guide as it enters the planer. The purpose of the long, live bridge is multiple.

The extra length makes it possible to operate the feed table only a little faster than the planer feed rate and still butt the pieces end-to-end as they enter the planer. By operating the feed table slower, it is less damaging to the lumber because of the softer acceleration. There is less end shock on the lumber when the pieces meet end-to-end and consequently less lumber breakage.

Hydraulic feed roll tensioning has recently been developed, making it possible to control the amount of roll pressure applied to the lumber. This variable hydraulic tension system replaces the former spring tension system. The hydraulic pressure may be decreased on soft and fragile lumber and consequently cause less damage. The old spring system, not controllable, was too severe on the narrow, soft material and many times insufficient on rugged, hard-to-feed lumber.

Also such developments as variable top cylinder chipbreaker pressure, controlled by air pressure through individual air cylinders on each chipbreaker segment, have helped control lumber damage.

These new planer features demonstrate that a sincere effort is being made throughout the industry to improve equipment and develop better techniques. The fact that your West Coast Dry Kiln Club is devoting your time in such a meeting as held here today, demonstrates that a sincere effort is being extended by those operating lumber plants. Certainly the combined knowledge and cooperation of those participating must be fruitful and beneficial individually and to the industry.

It has indeed been a pleasure and an honor to present this paper to the West Coast Dry Kiln Club. Thank you.