Serving the Forest Products Industry in Products Development, Process Improvement and Training

TECHNICAL NOTE – LVL PRODUCTION ON CONTINUOUS PRESS SYSTEM

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DISCLAIMER

THIS DOCUMENT IS COMPILED BY TTS INC. AS A RESULT OF REPEATED GENERAL & SPECIFIC INQUIRIES BY SUPPLIERS AND BUYERS OF THE CPS LINE REGARDING THIS NEW TECHNOLOGY FOR LVL MANUFACTURE.

WHILE IT REPRESENTS THE VIEWS OF TTS EXCLUSIVELY, IT IS PREPARED TO PROVIDE SOME ANSWERS TO FREQUENTLY ASKED QUESTIONS REGARDING THE CPS LINE. IT IS NOT PREPARED TO PROVIDE ADVICE TO ANY SPECIFIC OPERATION. THEREFORE, TTS DOES NOT ASSUME ANY DIRECT OR INDIRECT RESPONSIBILITY WHATSOEVER FOR ANY DECISION MADE BY ANY BODY BASED ON THIS REPORT.

INTRODUCTION

LVL is borne out of the plywood and veneer industries. As an engineered product destined for structural applications however, more attention is required in the preparation of veneer for LVL manufacture than is traditional to the plywood industry. Even more attention needs to be given to the processing technology. LVL lay-up and pressing technologies that were available up until recently however, followed a design approach that developed larger plywood processes for LVL manufacture.

The first continuous steel-belt LVL line started in October 1997. This technology has been established in the MDF/Particleboard industries for several years. Along with some technical challenges of adopting this technology for LVL manufacture, one of the biggest challenges was to determine the economics associated with the relatively higher capital requirement for such a line compared to batch processing.

The bases for the technical specifications of the new line were examining the performance of conventional lines, knowledge of the input material and the expected requirements and future growth potential of the final product. These included the interaction of wood moisture relations to processing conditions and the impact of this relationship on the properties and the unit cost of the final product. As such, the entire process, from drying the veneer to the final product mix of current and future products was considered in the plan. TTS has been involved in providing the technical and performance requirements of the new line. In particular, the requirement set for the performance of the microwave system has proven to be critical for the success of the line and its expected benefits.

Like many other breakthroughs, the performance of this technology was questioned by the industry from the beginning. TTS has been getting several inquiries regarding this technology even though the third such plant is due to start this month. It appears that most of the questions are associated with lack of information regarding the new line.

This paper is prepared to explain some of the fundamental differences between the CPS line and batch manufacturing of LVL. The intent of the paper is to provide some critical information for those considering the purchase of an LVL line and only areas of major difference/impact are discussed in the following sections. While TTS has been involved from concept development to the start-up and optimization of the first CPS LVL line, it is beyond the scope of this paper to involve in detailed technical discussions. Those who require more detailed technical information or require elaboration on any of the points raised in this document are encouraged to contact the author.

VENEER MOISTURE CONTENT

Most LVL manufacturers using batch processing today use the same level of veneer moisture content as is traditionally used in the plywood industry (5%). Actually some manufacturers apparently use even drier veneers to avoid “blows”. The resulting average LVL moisture content from such operations is 4-6%. Using the microwave-pre-heater, the CPS line can accommodate average veneer moisture contents of more than 6% with even higher moisture spots.

It is obvious that, the drier the veneer the longer the drying time and/or the higher the energy cost. The industry (plywood/LVL) average production on a 20 section COE dryer is about 14 M3/8th per hour when targeting an average veneer moisture content of 5% or lower. An increase of the average moisture content to 6% increases dryer production by 2-3% and reduces glue spread by a minimum of 5%. While these are the direct benefits of higher veneer moisture content, the indirect benefits include faster pressing cycles, higher LVL moisture content, and to some extent more consistent product. These aspects are discussed later.

LAY-UP

The continuous lay-up system provides a uniform open assembly time, which enhances the consistency of product properties, and allows for a better control of pressing strategies. Even under high level of process control it is difficult to get the same level of product consistency on conventional lay-up lines. Further the dual layer lay-up configuration breaks the overlap joints into two plains through the thickness of LVL. This results in the distribution of the weak point as observed on conventional lay-ups and enhancing product properties as well as uniformity. The economic benefits of product uniformity are discussed under product properties.

MICROWAVE PRE-HEATING

A lot has been achieved using RF systems on conventional lines. This technology is, however, used as a supplementary heater with the primary heat coming from the press. The drawback in this approach is that there are no fundamental changes in the slope of the initial temperature gradient and the direction of heat migration. In these systems, heat travels in the top/bottom and side-to-side directions towards the center relatively faster due to the supplementary heat source. This means that there is no uniformity in the curing process and the last-cured zone in the profile of the LVL (the center of billet) determines the cycle time resulting in lack of product uniformity and only limited gains in cycle times. Some of this drawback could be alleviated using post-curing inventory. The problem with this technique is that it requires extra handling and inventory, which increases the unit cost.

The primary design consideration for the microwave pre-heater on the CPS line is that it targets the core-line of the LVL assembly reversing the temperature gradient between the core and the surface of LVL. This approach has two major benefits one of which is obviously a reduction in cycle time. This is achieved, primarily due to reduced temperature gradient in the lay-up and not due to the use of extra heat source. This technique further enhances product uniformity as well as the use of relatively higher moisture content veneers than could be used on conventional lines. While resin doping may be used to further exploit the benefits of the microwave system, there is no need to use specialty resins on this line.

TTS does not have direct experience with RF technology. The claim from RF supplemented batch processors is a 12-14 minutes cycle times on a 1.5" LVL as opposed to 9-11 minutes that are achieved on the CPS line. While the industry average to make the same product without pre-heating or supplementary heating is between 16-18 minutes there is enough evidence to suggest that as low as a 7minutes cycle time can be achieved using microwave pre-heating. It should be noted as well, that operations using RF technology do not normally use the RF power on such thickness (too thin) for economic reasons. This is a very fundamental difference, with major operational/financial implications, between the designs of the two technologies.

PRESS

The three major variables that are often used in most conventional plywood and LVL presses are pressure, temperature and cycle time. On batch processing lines the temperature during one pressing cycle is fixed. Most such technologies do not use thickness/position control. Unless they are fitted with position control systems as an option, the amount of pressure used, the number veneers and the individual veneer thickness usually determine the thickness of the final product on such lines. On the CPS line thickness/position can be controlled with relatively more independence from the input variables. Further, temperature can be changed through time providing greater flexibility. While this may appear to pose a challenge in the development of pressing strategies, it provides more opportunity for the optimization of the production process. For example, on the CPS line there is no need for the 15-60 seconds degassing cycles that is required on conventional presses.

The major moisture escape roots while pressing LVL on stationary presses are the two ends as opposed to only one end on the out feed of the CPS. Some vapor escapes around overlap joints in both cases. This feature contributes, not only towards reduced pressing cycles, but also in the retention of more moisture in the LVL.

Regarding the length of LVL, the product mix that can be made on batch presses is fixed while the CPS allows for an infinitely variable product mix. The economics of this flexibility is dependent on the length of the batch press under consideration.

PRODUCT PROPERTIES

Wood is naturally variable. It appears though; this fact overshadows the need and the benefits of consistency in the manufacture of engineered wood products. Consistency of product properties has been mentioned at several occasions in this report. Product consistency is however, one of the most important elements that is often undermined or even overlooked in considering a forest product process. This aspect of product attribute has direct financial implications in terms of the unit cost of manufacturing as well as raw material costs.

Figure I is an example of the impact of product variability on the allowable design strength of LVL. This linear relationship is based on the requirements of ASTM D5456-96 for developing design values for strength (MOR). Most LVL made on conventional lines has a Coefficient Of Variability (COV) of about 15% as opposed to lower than 10% that can be achieved on the CPS line. According to the current standard, all other engineering design properties except stiffness (MOE) are affected by variability in a similar manner. The slope of the curve, which is associated with the severity of loss, is dependent on the K-factor used for a specific property.

The implication of this is that LVL made on conventional lines (high variability) can result with lower design values than the same veneer grade LVL made on the CPS line (low variability) even if the average test values may be the same. This problem is usually covered up during certification by the use of an excessive number of test samples, but the variability problem continues to show on lower yield of high strength veneer. This problem eventually gets resolved by reducing the UPT threshold for the grade.

Figure II represents a typical UPT CDF curve for most species and qualitatively demonstrates the volume of veneer that is associated with small changes in UPT. The amount of money lost in this regard in an operation is dependent on a number of factors such as wood species, specific veneer grade, etc.

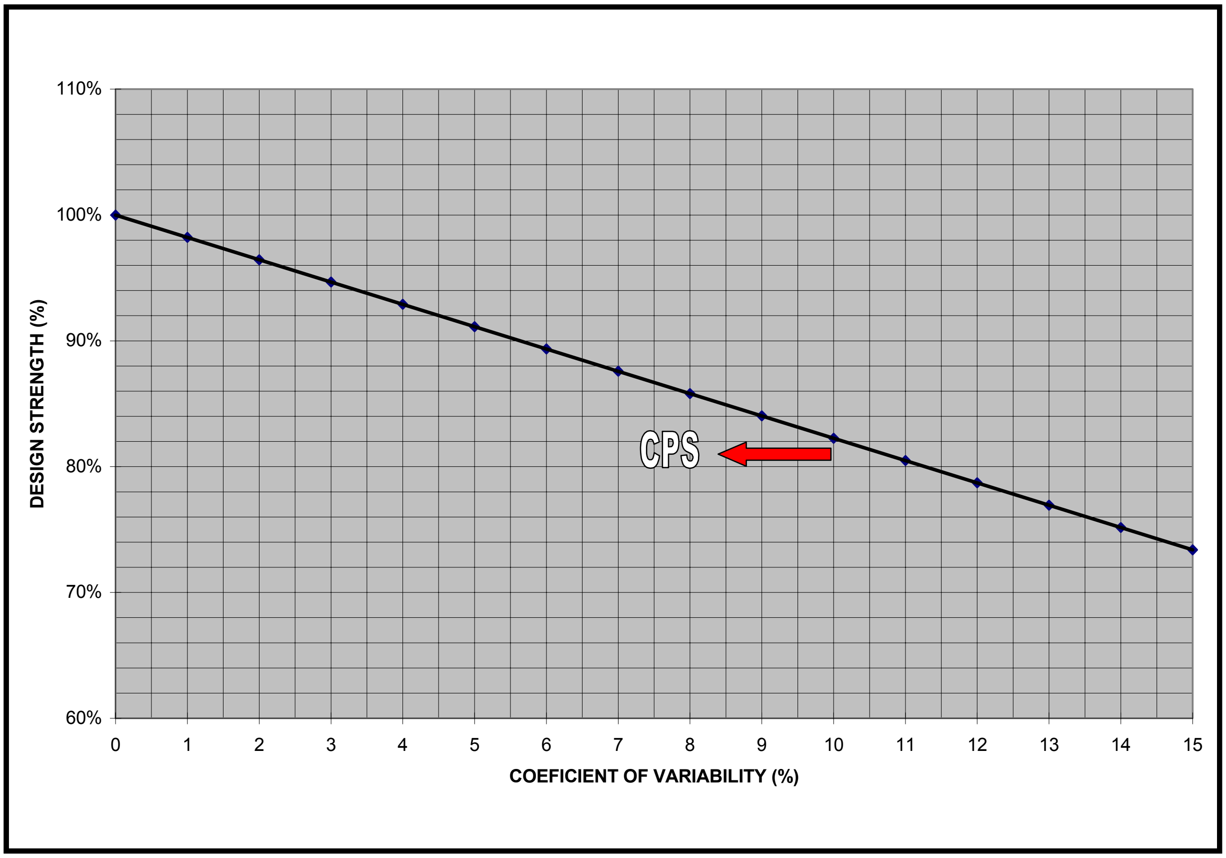

FIGURE I: COV vs. % DESIGN STRENGTH (f_b)

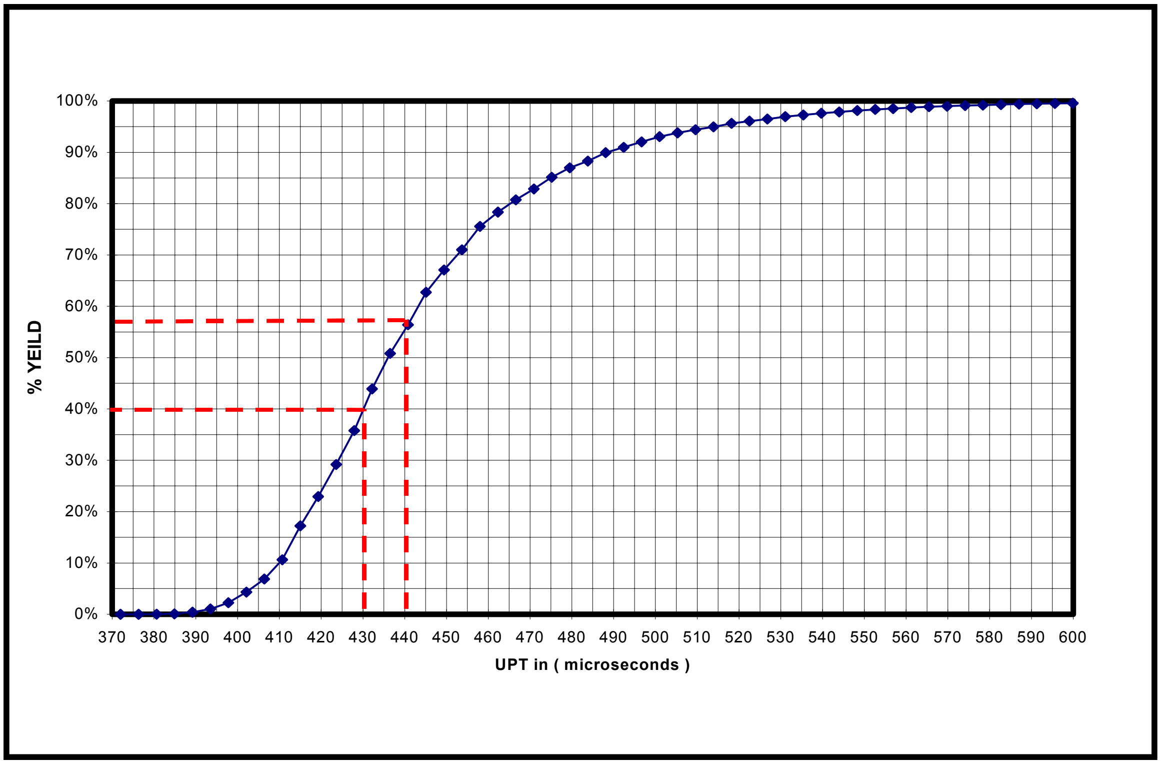

FIGURE II: TYPICAL CDF FOR UPT OF SPECIES

Another product characteristic with substantial financial implications and yet often undermined is moisture content. The Equivalent Moisture Content (EMC) of LVL products vary between 10-12% depending on species, processes, resin, etc. ASTM D2915-94 requires that all test results be adjusted to EMC obtained under standard conditions. Most LVL operations develop a correlation between production/QC tests and tests from specimens conditioned under standard conditions. Figure III represents the adjustment factor that MOE from QC needs to be reduced by to meet the requirements of the standard assuming an EMC of 11%.

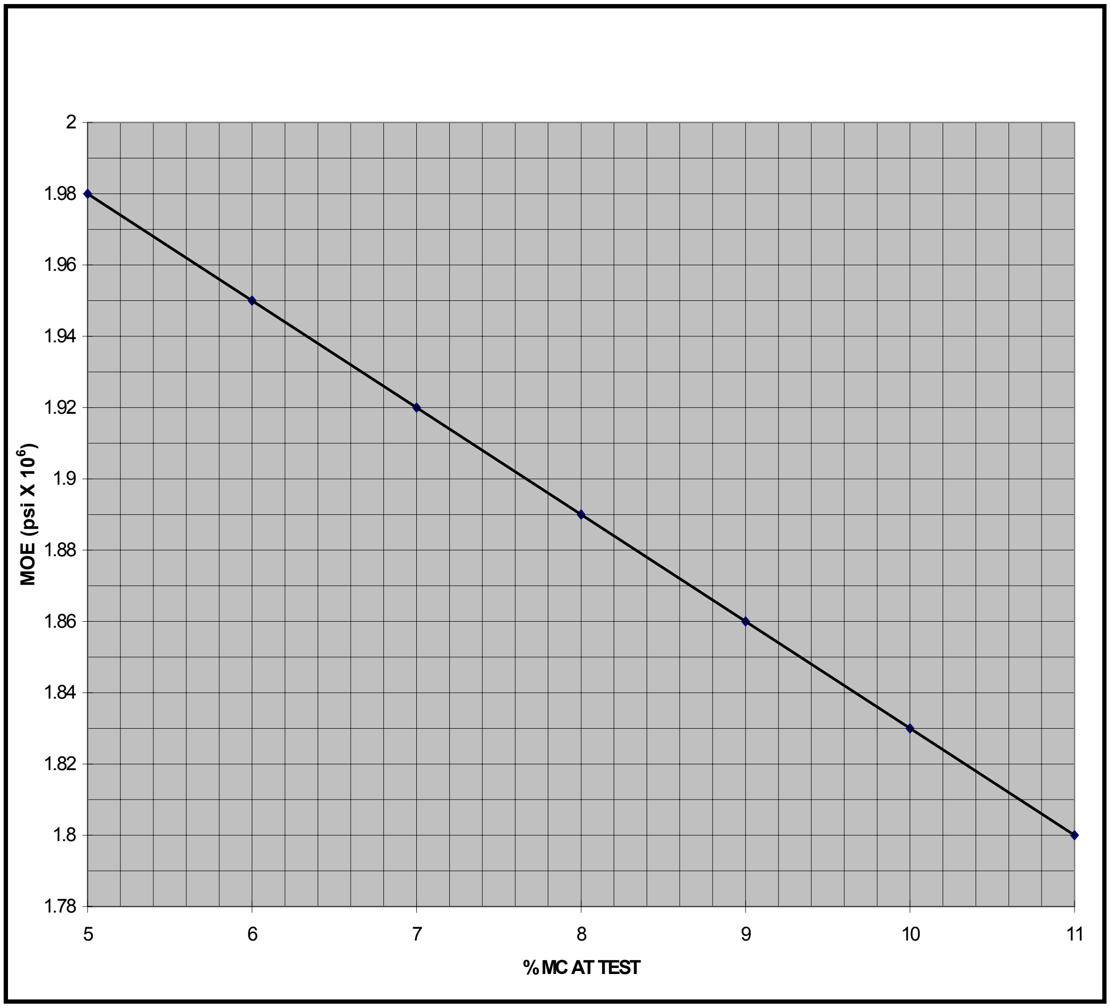

FIGURE III: % MC AT TEST VS REQUIRED MOE FOR A 1.8E LVL at 11% EMC (REF. ASTM D2915-94)

As indicated on the graph the lower the LVL moisture contents the higher the loss. For every percent moisture content away from the EMC there is a loss of 30,000 psi in MOE. Most LVL made on conventional lines has moisture content of 5-6% as opposed to LVL that can be manufactured on the CPS line at average moisture content of 9-10%. Further the lower the moisture content of the product (below EMC) the more susceptible it is for dimensional instability thus the need for edge sealing.

SUMMARY

The various financial and technological benefits the CPS line compared to conventional lines are discussed. Readers should be able to formulate detailed and specific financial analysis suited to their situation. Below is an outline of the most direct benefits of the new LVL technology.

1) 2.5% increase in dryer production and better dryer recovery due to reduced breakage loss.
2) A minimum of 5% reduction in glue consumption.
3) Over 23% reduction in cycle time over RF processes.
4) Over 41% reduction in cycle time over conventional processes.
5) Increased product consistency resulting in increased post-stress graded veneer yield.
6) Increased LVL moisture content resulting in increased post-stress graded veneer yields and reduced need for moisture sealing depending on shipments and destinations.

It is our hope that this document provides sufficient basic information to be considered in the determination of the financial benefits of the new line. It should be noted however, that the impact of the above listed benefits on the unit cost of LVL is dependent on the specific cost structure of each operation. This document is based on the experiences of TTS on the first CPS line designed to manufacture LVL. Some of the factors that could be serious constraints to the level of actual benefits are essentially specific operational strategies adopted by mills considering the purchase of the CPS line. These include:

1) Veneer preparation and handling.
2) Start-up strategy.
3) Pressing strategy.
4) Current and future product mix.
5) Other operational activities, i.e. quality control etc.

These variables can actually be dealt with only in operation. However the fact that there is sound evidence in the underlying assumptions mitigate the risk of not realizing the benefits of the CPS line for LVL manufacture.

CONCLUSION

LVL is currently sold on the basis of products standard, which is specific, to specific manufacturers. Due to the growing market for engineered wood products there is an increasing number of manufactures, each with its own proprietary product standard, coming into the market place. This will continue to create confusion among users in the market place and there is already a push towards the development of a performance standard. Such a standard is actually developed for I-Joist by APA. It is a matter of time before LVL follows the same route. The implication of this is that engineered wood products will start being sold in the commodity market based on performance, not as a matter of choice but due to the evolution of the product and its growing abundance.

While the market for engineered wood products will continue to increase in the foreseeable future, most of it is going to be enjoyed by a younger generation engineered wood product; Laminated Strand Lumber (LSL) which is recently introduced for the same applications as LVL. While the capital cost for LSL may be relatively higher, this product does not require the high grade feed stock required for manufacturing veneer and the process uses relatively faster pressing cycles, thus making LSL more price competitive than LVL. In this regard we find it worth reminding readers what OSB did to plywood in the past 15-20 years and the initial reaction of most plywood manufacturers.

The above points are serious strategic issues that need to be considered in planning for the development of a new LVL operation today. Given the current state of available technology and knowledge of the material, it is economically feasible to manufacture LVL with even more uniform and more predictable properties. Besides its implications on production efficiencies, this enables LVL to get into more demanding applications with better value. Some of the major challenges, however, have been the manner in which veneer is prepared and handled to cope with what the technology has to offer. While there may be some experience that can be transferred from plywood processes into making LVL, LVL is very far from a glorified plywood product.