# Influence of Thinning Regime on Wood Quality Attributes

**Maheshnaik B L[1*], Venkatesh L[2] and Chethan B L[3]**

[1]*Ph.D. Scholar, Department of Silviculture and Agroforestry*
[2]*Assistant Professor, Department of Silviculture and Agroforestry*
[3]*M.Sc. Scholar, Department of Silviculture and Agroforestry*
*College of Forestry, Sirsi, Uttara Kannada-581 401*
*University of Agricultural Sciences, Dharwad, Karnataka*

**Corresponding Author**
Maheshnaik B L
Email: mnaik4422@gmail.com

**OPEN ACCESS**

**Keywords**

Silviculture, Thinning, Wood quality, Modulus of elasticity, Wood density, Microfibril Angle, Juvenile Wood, Tracheid Length, Compression Wood

*How to cite this article:*

Maheshnaik, B. L., Venkatesh, L. and Chethan, B. L., 2024. Influence of Thinning Regime on Wood Quality Attributes. *Vigyan Varta* 5(11): 172-176.

**ABSTRACT**

Thinning serves as a means of regulating both growth and the qualities of wood. Thinned plantations yield larger and higher quality logs, which are characterized by superior wood quality. The influence of thinning on crown development and growth rate can impact wood quality. Thinning induces earlier activity of the cambium in thinned stands compared to un-thinned ones, yet it leads to delayed production of latewood. Wood quality refers to wood's suitability for specific end uses. Many wood quality attributes are hereditary, and variations in quality among trees of the same species can be attributed to genetic distinctions. The standards for wood usage are outlined in terms of lumber grading. Key wood quality attributes encompass wood density, density variance, distribution of juvenile and mature wood, heartwood-to sapwood ratio, fiber length, fibril angle, compression wood, knots, and grain orientation.

## INTRODUCTION

Wood quality is defined as the attributes that make logs and lumber valuable for a particular end use. The wide scope encompassed by this definition creates ambiguity in the matter because desirable attributes in one product may not always coincide with the desirable attributes in another product. In the production of pulp and paper, low density wood combined with long fibers results in collapsible, easy bonding fibers that exhibit low porosity and high strength. These fiber characteristics result in higher quality paper products. Conversely, structural lumber manufacturing requires wood with high density, small knots, and straight grain characteristics to ensure a high-quality product. Also, the stiffness, or modulus of elasticity (MOE), is an important characteristic associated with the structural quality of lumber (Johnson and Gartner, 2006). The raw material requirements for plywood prioritize the same characteristics used in determining wood quality for lumber products. Generally, the main components for assessing wood quality for structural purposes are strength, stiffness, and dimensional stability; while pulp and paper quality requirements include strength, tracheid dimensions, and chemical composition. The quality of wood is determined through various wood characteristics such as: density, microfibril angle, proportion of juvenile wood, fiber length, compression wood, and knots. The following sections will discuss how these wood properties affect end use quality of raw materials.

### Wood properties affecting quality

**Density:** Wood density, or specific gravity, is considered the main characteristic for determining the mechanical properties of lumber and the resulting yield of pulping processes. Relative density of specific gravity is defined as the ratio of cell wall substance to lumen volume in wood. The importance of density is increased because it is a property which directly influences many wood attributes including strength, shrinkage, and pulp yields. These attributes, in combination with density, ultimately affect the suitability of the timber to be processed into lumber, panel products, or pulp and paper. Density is directly related to clear wood strength. Therefore, the structural performance of timber is often associated with its density. In a study of Eucalyptus trees, their density alone accounted for 81 percent of the variation in their MOE. Generally, wood with higher specific gravity is used for applications that have high strength demands. However, the sole use of density is not always the most accurate means of assessment to predict structural lumber's mechanical properties, density only partially influences the stiffness (MOE) and other mechanical properties of softwoods; furthermore, its degree of influence differs between individual mechanical properties. It was determined the relationship between MOE and density is best represented in a non-linear function. Therefore, the prediction of lumber's mechanical properties based solely on density may not always provide accurate valuation (Hart, 2010).

**Microfibril Angle:** The Microfibril angle (MFA) is defined as the angle between the cell axis and the cellulose microfibrils. It is commonly studied in reference to the S2 layer MFA of the cell wall. A decrease with age is a common trend for MFA. MFA is largest in the innermost rings and decreases in the rings further from the pith. Also, MFA decreases for the same ring at higher positions within a tree observed by Bergander and Brandstrom and is larger in the large growth rings of fast-growing trees.

**Juvenile Wood:** Juvenile wood is defined as the annual rings closest to the pith produced under the influence of the apical meristem and the live crown; wood formed below the live crown is referred to as mature wood. Trees grown in faster rotations produce higher proportions of juvenile wood. As the juvenile wood zone reaches maturity, wood characteristics are constantly changing. The change from juvenile wood to mature wood cannot be specifically defined to a particular annual ring because particular wood properties reach a mature stage at different times with differing degrees of abruptness. However, the transition from juvenile to mature wood usually occurs between five and twenty rings depending on the tree's species cross section at a given height within the stem.

**Tracheid Length:** Tracheid length is proportional to the age of an annual ring and is inversely proportional to ring width. Lindstrom (1997) found tracheid length is dependent on a logarithm of cambial 9 age and growth ring width. Shorter tracheid development during periods of accelerated growth and longer tracheid length development when growth rates were decreased. Tracheid length increases with tree height causing intra-tee variability that greatly differs between species. Tracheid length is also inversely proportional to Microfibril angle. A study of silver Birtch trees reported that Microfibril angle decreases and fiber length values increase to minimum and maximum values, respectively, reaching maturity at the same annual ring. This suggests fiber length and Microfibril angle characteristics are closely related. A review of several studies on the relationship confirms a strong, negative correlation between tracheid length and microfibril angle. While tracheid length is regarded as less important to solid wood products, it is an important characteristic influencing the mechanical properties of wood pulp. For example, long fibers are desirable for paper requiring high strength characteristics for its end use. A study of fiber length determined that it has a strong, direct effect on tear index, bending stiffness and pulp yield.

**Compression Wood:** Compression wood is formed on the underside of leaning stems. Ring formation is often characterized by the lower side of these leaning stems having abnormally wide growth rings that cause the pith to be off-center. It is thought to develop due to stress on the stem, namely gravity, but is also found to be produced in juvenile wood of trees experiencing rapid height growth.

**Knots:** Knot size and frequency are known to negatively impact the quality of wood in its end use. The negative effects of knots on wood properties depend on both knot size and frequency. The MOR of wood is shown to have a negative correlation with knot size. The strength of wood, both in compression and tension is reduced due to the occurrence of knots. The surrounding decreased strength and stiffness of wood with to knots is attributed to the distorted grain surrounding knots. This distorted grain is an area where failure commonly occurs. The magnitude of knot negative impact on the mechanical properties of wood is ranked in decreasing severity: tensile strength, MOR, parallel to grain compression strength, and MOE.

**Effects of Silviculture on Wood Quality:**

Silviculture is the process by which forests are tended, removed, and replaced by new trees. It is also defined as the manipulation of a forest stand to suit the needs for a particular end use. All of the properties discussed in the above sections are integral to the effective quality of wood when applied towards particular end uses. The quality can be affected by various silvicultural techniques both at the microscopic and macroscopic levels. Silviculture treatments are most often implemented with the goal of manipulating tree growth to enhance vigor or crown size. Common treatments include spacing, respacing/thinning, pruning, and fertilization. Techniques following this approach are ultimately linked to the resulting wood characteristics. Many of the techniques that change growth rates will compromise the resulting wood characteristics. Growth rate is important in silvicultural practices but it is not the focus of this paper. Therefore, one should remember that silvicultural induced growth rate changes may contribute towards, or be the cause of, observed variation in wood characteristics. The next section of this paper reviews the effects of several silvicultural techniques on the previously discussed wood properties.

**Effects of Thinning on Wood Quality:**

Reducing stand density after initial planting is another silvicultural method used to decrease competition between trees. It bares several implications for the properties of wood produced. This modification is implemented at the pre-commercial or commercial stage of tree development. Pre- commercial thinning, or respacing, is the removal of trees, ranging from newly planted trees to developed trees with a wood value less than the cost of harvesting. Thus, commercial thinning, or thinning, pertains to the removal of merchantable trees. Respacing can be used as a 'weeding operation' to remove competing trees at a very early age, either within two years of planting or when, and if, low pruning is performed. Both respacing techniques promote rapid growth for un- felled trees. Early respacing, prior to canopy closure, has effects similar to the initial spacing on wood properties and quality (Moore *et al.*, 2009).

The similarities of effects are observed because respacing occurs before the live crown is forced to compete with adjacent trees. However, respacing is beneficial as it enables the retention of the most vigorous and healthy trees for continued growth and, conversely, the removal of low-quality wood producing trees - a benefit also potentially realized with thinning. Thinning has the same effects as spacing, namely, increased: knot size and frequency; occurrence of compression wood; and proportion of juvenile wood. It also has some effect on fiber length, and MFA. The effects of thinning on wood properties are discussed below. Crown growth increases after thinning and promotes branch growth. Larger branch diameters, and, subsequently, larger knots are produced Thinning affects crown size and is proportional to juvenile wood production after thinning. Again, the larger branch formation and increased crown vigor may cause increased compression wood production in the live crown. However, juvenile wood growth in the stem depends on how much the crown recedes before the stand is thinned, as it is only produced near the live crown portion of the stem. Thinning generally causes decreased fiber length and density, and increased MFA. Tracheid length is slightly decreased with thinning however, no differences were found for tracheid length and MFA in a study of *Taiwania cryptomerioides*. Under various thinning intensities which can likely be due to the young age of trees. A review of research on the thinning Douglas-fir stands concluded that density is only slightly reduced by thinning and that heavy thinning performed on 40-50-year-old trees does not impair quality. Supportive results from a study of two thinning regimes, of 20 per cent and 22.6 per cent stand basal area removal, resulted in 0.7 per cent and 1.2 per cent density decreases, respectively, relative to the control (Schneider *et al.*, 2008). Thinning has a slightly negative effect on structural wood quality and adversely affects wood quality for pulp and paper end use. Mechanical properties, compressive strength and bending strength, were concluded to only be slightly reduced due to thinning without a loss of wood quality is not lost.

## CONCLUSION:

The ultimate success of a plantation depends mainly on the availability of the resources at every stage of life of a tree. Thinning regulates the distribution of growing space for the purpose of improving the stand condition for the remaining trees. Apart from the tangible benefits, thinning also contributes certain environmental services to the stand. Among the methods of thinning, low thinning is widely practiced due to its ease in execution and higher increment and wood quality. Thinning with appropriate method and intensity based on the stand condition, will not only improve the growth of trees but also will cut down the required rotation age. Species- and Site-specific thinning practices- Implementation timing & application intensity. Quality control the forest products certification. Hardwoods, changes in wood properties in response to thinning regime is more complex than in softwoods. Thinning regime effectively affect to the structural properties of wood.

## REFERENCES

Hart, J. F. (2010). A review of the effects of silviculture on wood quality. University of British Columbia Library, Wood 493. (Cited in: Hart, 2010).

Johnson, G. R., & Gartner, B. L. (2006), Genetic variation in basic density and modulus of elasticity of coastal Douglas-fir. Tree Genetics and Genomes, 3: 25-33.

Lindstrom, H. (1997). Fiber length, tracheid diameter, and latewood percentage in Norway spruce: development from pith outward. Wood and Fiber Science, pp-21-34.

Moore, J., Achim, A., Lyon, A., Mochan, S. and Gardiner, B. (2009). Effects of early re-spacing on the physical and mechanical properties of Sitka spruce structural timber. Forest Ecology and Management, 258(7): 1174-1180.