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HOW THE STRENGTH OF WOOD IS TESTED IN CONSTRUCTION

A STUDY OF THE PROPERTIES OF THE VARIOUS KINDS IN USE—EFFECT OF MOISTURE CONTENT UPON STRENGTH—CONDITIONS AND NATURE OF TESTS—STRENGTH OF CANADIAN SPECIES

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FROM time immemorial, wood has been used for construction purposes more than any other material, yet it is a curious fact that our information regarding its strength is not nearly so complete as in the case of steel, cement and other materials which have come into use in comparatively recent times. For a few kinds of wood our knowledge of their strength is fairly satisfactory, for a number of others it is still rather vague, whilst for the great majority of them it is almost a negligible quantity.

Selection of Material.—Every wood-worker knows that great variations occur in the appearance, weight, hardness and strength of any given kind of wood. For example, heartwood differs from sapwood, body-wood from limb-wood, butt logs from top logs, etc., etc., and it is therefore a matter of great importance to know the origin of the material being tested and the conditions under which it was grown. A piece of wood is not simply a material but a *structure*, just as much as a railroad bridge or a balloon frame, and as such varies greatly even in wood from different parts of the same tree. The fact of the matter is that it is almost impossible to understand the behavior of the material being tested without a somewhat intimate knowledge of its internal structure, because the size, character and arrangement of the tiny fibres composing it have a very important bearing upon its behavior when subjected to external forces. This is well illustrated in the case of weight, strength and hardness, which are closely related to the thickness of the cell walls. Unlike metals and artificial products with a homogeneous structure, such as steel and cement, wood is an exceedingly complex and heterogeneous structure, and it is therefore necessary to consider separately the stresses applied to it and the resultant strains.

Methods of Testing.—The strength of a piece of wood may be tested for: Elasticity; cross-breaking strength; endwise crushing strength; crushing strength across the grain; shearing strength; hardness; tension along the grain; or, torsional strength.

So far, most of the studies conducted have been for the determination of elasticity, cross-breaking strength, and endwise compression strength, whilst crushing strength across the grain, shearing strength, hardness, etc., have received comparatively little attention.

Whilst the various tests are made separately, it is, of course, evident that the fitness of wood for a given purpose depends upon a combination of several qualities. For example, railroad ties must be hard enough to resist mechanical abrasion, strong enough not to break and tough enough to prevent splitting and to hold spikes; a wagon spoke must be stiff, strong, hard, resilient and tough; furniture wood should be hard enough to resist indention, take a good polish, etc., etc.

Importance of Knowing Moisture Content.—One reason for dry wood being so much stronger than green material is due to the increased number of woody fibres to the square inch as the material seasons, and it is worthy of note that this increase in strength does not become apparent until the percentage of moisture falls below 40% of its kiln dry weight. The explanation of this lies in the fact that for more than 40% of moisture the water fills not only the cell walls but also the cell cavities themselves. As the weakening effect comes only from the wetting of the cell walls, it therefore follows that after they are fully saturated, any excess of water which occupies the cell cavity would be inoperative. Consequently, no increase in strength is noticeable until the cell walls themselves begin to dry out—after which the increase in strength takes place very rapidly, and becomes approximately two and one-half times that of the wood as it comes from the tree, as shown by the following figures (Table I.) by Tiemann:—

It should be clearly understood that the percentage of moisture is always calculated upon the weight of the wood when absolutely dry.

TABLE I.

	Bending Strength,		Endwise Crushing Strength,	
	12% Moisture.	3½% Moisture.	12% Moisture.	3½% Moisture.
Long leaf pine	1.5	2.5	1.7	2.9
Red spruce	1.9	2.8	2.4	3.7
Chestnut	1.6	2.1	1.8	2.8

Much of the pioneer work in testing the strength of wood is unreliable because sufficient care was not exercised in determining either the percentage of moisture present in the test pieces or their physical structure, both of which have a most important bearing upon the strength of wood. In fact it is only recently that these sources of weakness or strength have been studied exhaustively, and even yet an enormous amount of work remains to be done before our knowledge of the subject has been placed upon a satisfactory basis.