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Properties and utilization of Canadian Poplars

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CANADA
DEPARTMENT OF FORESTRY

PROPERTIES AND UTILIZATION OF CANADIAN POPLARS

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Technical Note No. 24

FOREST PRODUCTS RESEARCH BRANCH

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PLATE 1. Trembling aspen plot, Riding Mountain National Park, Manitoba.

Properties and Utilization of Canadian Poplars

INTRODUCTION

The poplars account for nearly 60 per cent of Canada's merchantable hardwood timber and 11 per cent of the entire Canadian merchantable forest resources (3)*. Until recently, poplars were considered to be "weed trees", that is, trees having little or no economic value. Before 1939, they were used primarily for fuel, excelsior, and to a small degree, for pulpwood. World War II brought about increased demands for wood and, as a result, investigations into the utilization of the poplars. Consumption of poplar began to rise because of the acceptance of poplar plywood and new developments in the pulping of hardwoods. In the period 1949 to 1956, Canadian consumption of poplar for sawlogs, pulpwood, and peeler logs increased from 36,395 to 55,590 thousand cubic feet (3). This annual cut was still far below the allowable on the basis of the available growing stock.

Because of the great volume of the poplars available in Canada and their potential value to the forest industries, this report has been prepared with the hope that recognition of the species' worthwhile characteristics will create a greater demand for poplars in an expanding forest economy.

GENERAL DESCRIPTION

The genus *Populus*, which includes the aspens, cottonwoods, and balsam poplar, consists of some 35 species widely distributed throughout the Northern Hemisphere. The following eight species are native to Canada, and the first five occur in commercial size and quantity.

Common Name	Botanical Name
1. Trembling aspen (quaking aspen, popple)	*Populus tremuloides* Michx.
2. Largetooth aspen (largetooth poplar)	*Populus grandidentata* Michx.
3. Balsam poplar (balm of Gilead, tacamahac)	*Populus balsamifera* L.
4. Eastern cottonwood (cottonwood)	*Populus deltoides* Marsh
5. Black cottonwood (western balsam poplar)	*Populus trichocarpa* Torr. and Gray
6. Lanceleaf cottonwood	*Populus acuminata* Rydb.
7. Narrowleaf cottonwood	*Populus angustifolia* James
8 Plains cottonwood	*Populus sargentii* Dode

*Numbers in parentheses refer to literature cited at the end of this publication.

SPECIES DESCRIPTION**

Trembling Aspen

Trembling aspen is the most common and widely distributed tree in North America. In Canada, it extends from Newfoundland and Labrador, west along the northern limit of the tree line and into northwestern Alaska. As indicated by its tremendous geographical range, trembling aspen is an extremely adaptable species. Both with regard to climate and soil, trembling aspen grows under widely varying conditions. The soil on which it grows may range from rock or shallow sand to loamy or heavy clay.

It is a fast-growing, but short-lived, pioneer species. Good seed crops are produced every four or five years, with light crops in most intervening years. Trembling aspen also reproduces by means of root suckers and occasionally from root collar sprouts and stump sprouts. It is an exceedingly intolerant tree and under competition develops a long slender bole with a small rounded crown. Areas which have been burned or clear cut are ideal sites for trembling aspen, and pure stands of this species often spring up and serve as a nurse crop for the more tolerant hardwoods.

Largetooth Aspen

In Canada, largetooth aspen occurs from Nova Scotia, westward throughout southwestern Quebec and southern Ontario, south of the height of land dividing the basins of the Great Lakes and Hudson Bay. Although it is also found in southeastern Manitoba, it is essentially a tree of Southeastern Canada. It is a medium-sized tree, 50 to 60 feet in height (occasionally reaching 100 feet), with a slender trunk 1 to 2 feet in diameter.

Largetooth aspen prefers rich, moist, sandy soils as found along river-banks and borders of swamps. It is found in pure stands or mixed with white pine, trembling aspen, balsam poplar, or white birch. Reproduction is principally by root suckering despite the seemingly large potential for regeneration by seed. It is one of the most intolerant of deciduous forest trees and is incapable of reproduction under its own shade. It tends to be a pioneer species in succession, which moves in and occupies open areas.

Balsam Poplar

Balsam poplar is a species of transcontinental distribution in Canada and also occurs across most of the Northern United States. It is a medium-sized tree averaging 60 to 80 feet in height and 1 to 2 feet in diameter. At maturity, well-stocked stands may have volumes of 10 to 15 thousand board feet per acre. Balsam poplar is usually confined to moist, alluvial soils such as those found along river bottom-lands. On rich soils it may develop in small pure stands, but more commonly it occurs with red alder, white birch, elm, balsam fir, white cedar, or other poplars.

Although balsam poplar is a prolific seeder it reproduces mostly through root suckers. It is very intolerant to shade and will not grow with other species

**For identification of the poplars see "Native Trees of Canada [illegible] 5. This book, available from the Queen's Printer, Ottawa, contains illustrated descriptions of leaves, flowers, fruit, twigs and bark.

unless it is in the overstory. This species can stand very severe climatic conditions. For example, the Mackenzie River Valley is considered too cold for most trees, but it is here that balsam poplar becomes the largest and most characteristic species.

Eastern Cottonwood

Eastern cottonwood is found scattered throughout southern Ontario and Quebec, and west of the Great Lakes, where it is limited to the extreme southern boundaries of the Prairie Provinces. It is one of the largest of the poplars, frequently reaching heights of 80 to 100 feet and diameters of 2 to 3 feet or more. It can endure extremes in climate, but needs full light for best development. Eastern cottonwood prefers the rich moist soils found along river banks or lake shores. The growth is rapid in early life, and in the United States, annual increases of 5 feet in height and 1 inch in diameter may occur (1). The tree reaches maturity in 50 to 60 years, after which it begins to deteriorate rapidly.

Courtesy B.C. Forest Service FPRB 7-357

PLATE 2. Mature black cottonwood in the vicinity of Quesnel, B.C.

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Black Cottonwood

Black cottonwood is the largest broad-leaf tree found in the Pacific Northwest and is the most important hardwood in British Columbia. It is one of our fastest growing deciduous trees and attains a height of 80 to 125 feet and a diameter of 3 to 4 feet in 150 to 200 years.

This species is found in Canada from Alaska and the southern Yukon, southward through British Columbia. It has also been planted successfully throughout the Prairie Provinces as a shelterbelt species. Although it is sometimes found in small pure stands, it most commonly develops in association with Douglas fir, grand fir, white spruce, Engelmann spruce, red alder, western white birch, and bigleaf maple.

Black cottonwood annually produces large crops of seeds which show a brief viability. Moist sandy soils are the most desirable seed beds, and under these conditions regeneration is excellent. It is very intolerant of shade, and less vigorous trees are soon suppressed by their more rapidly growing associates.

Pure mature stands have yielded up to 100 M f.b.m. per acre, and yields of 30 to 40 M f.b.m. are fairly common (14).

Narrowleaf Cottonwood and Lanceleaf Cottonwood

In Canada, both these species are confined to southern Alberta. They are usually medium size trees of 35 to 40 feet in height and 12 to 18 inches in diameter. On favourable sites they may attain a height of 60 feet and a diameter of 24 inches. The narrowleaf cottonwood is a slender tree with a narrow, pyramidal crown. The lanceleaf cottonwood has a stout trunk with a rounded, compact crown. Both the species are moisture-loving and grow together with willows along the banks of streams. They are rarely found in pure stands or on dry sites. Except for fuelwood and fence posts, these two species have little commercial importance.

Plains Cottonwood

The plains cottonwood is a relatively unimportant species occurring in Canada from southwestern Manitoba, westward to southern Alberta. It is a medium to large tree, 40 to 100 feet in height, and 2 feet or more in diameter. A moisture-loving species, it does well along the streams and rivers of the Prairies. Unlike the poplars previously discussed, the plains cottonwood does not reproduce readily from root suckers and depends on its small tufted seeds for regeneration. This species is of little commercial importance, but is used locally for fuelwood, fence posts, and as a shade tree.

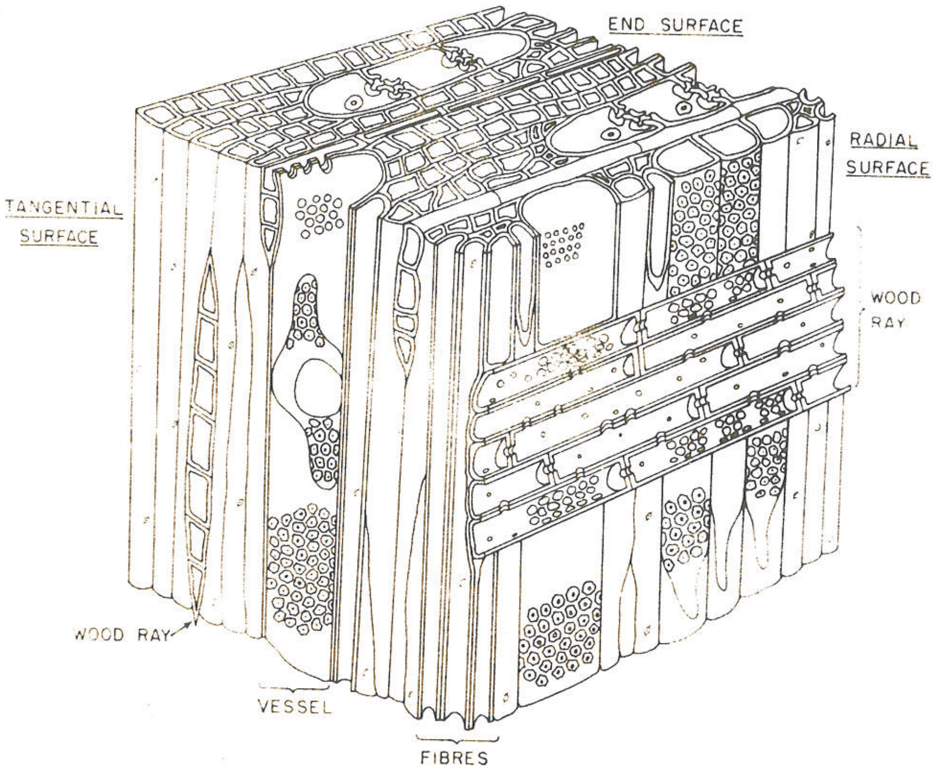
PROPERTIES OF THE WOOD

The five species of commercial importance, for the sake of convenience, and because they have generally similar properties, are described herein as a group and spoken of as "poplars". Exceptions to this conformance are noted as they occur.

Appearance and Structure

The wood of the poplars is generally light in colour. The sapwood is nearly white, while the colour of the heartwood varies from off-white to light creamy-brown with a greyish tinge. A distinct colour boundary distinguishing sapwood from heartwood is lacking. The aspens have a more pronounced lustre than the other poplars, the whole group tending to have a slightly disagreeable odour when moist.

Poplars are diffuse-porous and of uniform texture. The pores, as well as the rays, are indistinct without a hand lens. The pores, which have a relatively uniform distribution throughout the growth ring (Plate 3), show a slight increase in size from summerwood to springwood. Due to the above characteristics it is often difficult to distinguish the boundary of the annual growth layers, which appear as fine lines. The larger pores in the cottonwoods and balsam poplar create a slightly coarser texture than that of the aspens. On surfaced stock, the uniform texture is typically reflected in a plain appearance without apparent figure or with a very slight grain pattern.



FPRB 4-407

FIGURE 1. Three-dimensional view of a small block of poplar wood greatly enlarged.

90839-2—2½

Poplars are low-density hardwoods. Black cottonwood, air-dry (at 12 per cent moisture content, commonly attained by protected wood used in construction), weighs 22 pounds per cubic foot, one pound more than eastern white cedar, Canada's lightest wood. The remainder of the group, which are more dense, come within one pound of each other and average 28 pounds per cubic foot. Their weight is very close to that of red alder, basswood, and the spruces.

The very high moisture content of green poplar logs gives them little buoyancy and makes it inadvisable to float them in that condition since they also absorb water rapidly.

Working Qualities

The poplars machine, for the most part, like other low-density hardwoods such as willow and basswood. There may be a certain incidence of fuzzy grain in machining due to the pulling, rather than the clean severance, of fibres in boards where tension wood is present. Optimum surface quality in planing is realized when the stock is surfaced at low moisture content, taking a shallow cut with a cutting angle of from 25 to 30 degrees (11).

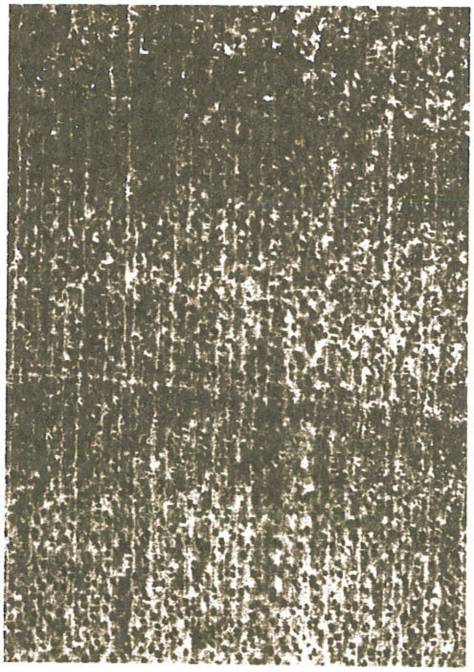


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PLATE 3. Trembling Aspen — Transverse section—15X

The shrinkage of the poplars, excepting the slightly higher value of black cottonwood, is moderate and close to that of red alder and yellow birch, while being considerably less than that of basswood. See Table 2 for values.

The poplars can be glued satisfactorily with a wide range of glues. Since poplar absorbs water very rapidly from the glue line, control of the glue mix is important.

Strength and Decay Resistance

Detailed strength values and related properties for five species of poplar, as well as basswood, red alder, white spruce, and red pine are presented in Table 2. For a number of purposes, suitable grades of poplar may be substituted for basswood. Red pine and white spruce are included as softwood species with which poplars are often compared for structural purposes and other general uses. Considerable variation exists between the strength properties of the different poplars, and identification of the separate species is difficult once the stock is in a manufactured form.

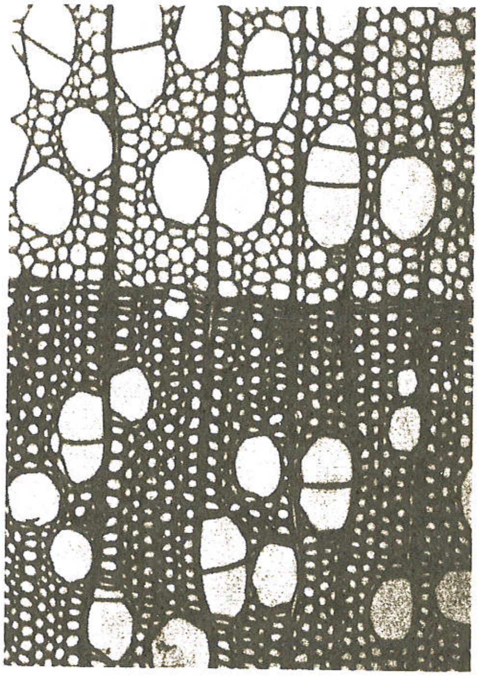

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PLATE 4. Black Cottonwood — Transverse section—100X

With respect to decay resistance, the poplars are classed with basswood, ash, red oak, and maple as non-durable woods. The rate of deterioration for the poplars is more rapid than that of the denser woods listed in this group. Thus for safe use in situations favouring decay—locations in which humidity or direct contact with moisture raises the moisture content of the material above 20 per cent—preservative treatment is vital.

Painting and Finishing Qualities

The fine and uniform texture of the poplars provides a good surface for paints and finishes. No preliminary filling treatments are required. Due to its texture no grain pattern shows through a painted surface. In the event that fuzzy grain persists after surface preparation for finishing, it may be sanded off after setting the fibres with a wash coat.

Microscopic Structure

As in other hardwood species, the wood of poplar is composed mainly of the following types of cells: vessel members, fibres, and parenchyma cells.

Vessels, which appear as pores on the cross-sectional surface of wood, are made up of vertically aligned vessel members which are in lengthwise communication with each other through large simple apertures (simple perforations) in their common wall (Plate 5).

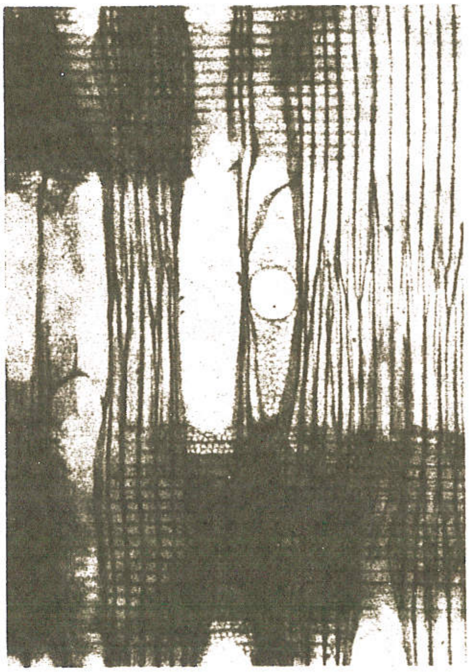

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PLATE 5. Trembling Aspen—radial section —100X

The pores (cross-sections of vessels) are relatively small, the tangential diameter of the largest pores being nearly 100 microns in aspen and up to 150 microns in cottonwood and in balsam poplar. The diameter of pores decreases gradually from early wood to late wood. In the early wood the pores are somewhat more crowded than in late wood. The pores occur both singly and in multiples of two to several.

The length of vessel members varies from approximately 0.5 mm. to approximately 0.7 mm., being generally less in wood close to the pith. The bordered pits on the walls of vessels are oval or angular through crowding. They are relatively large, 8 to 13 microns in diameter. Pitting from vessel members to ray cells is simple and confined, with occasional exceptions, to the marginal cells of the ray (Plate 5). Spiral thickenings in the walls of vessels are lacking.

Tyloses, which are outgrowths from adjacent parenchyma cells into the cavities of vessels, are occasionally present in poplar. They are thin-walled and relatively few in any given vessel member.

FPRB 4-380

PLATE 6. Trembling Aspen - Tangential section—100X

Fibres constitute the main portion of wood tissue. It has been estimated that approximately 55 per cent of the volume of the wood of poplar is made up of fibres. The walls of the fibres are thin to moderately thick. The average diameter of fibres varies in aspen from approximately 23 to approximately 33 microns. In cottonwood and balsam poplar, the diameter of fibres is somewhat larger, reaching up to approximately 40 microns.

The fibre length varies from approximately one millimeter or less close to the pith to approximately 1.3 to 1.5 mm. in the outer portion of the stem of a mature tree.

Wood parenchyma is composed of relatively short, brick-shaped cells with simple pits. Parenchyma occurs in wood in two systems: (1) in rays as ray parenchyma and (2) as axial parenchyma which is directed along the grain.

Rays of poplar are one cell wide (uniseriate) as seen in tangential section (Plate 6). They are essentially homogeneous, being composed of cells of the same morphological type—cells with the longest axis in radial direction (Plate 5). This characteristic—homogeneous rays—serves as the distinguishing feature for separating the wood of poplar from that of willows (*Salix* spp.). In the rays of the wood of willows, the marginal rows are composed of vertically elongated parenchyma cells, giving heterogeneous structure to the rays.

Axial parenchyma is relatively sparse in the wood of poplar. Its presence is restricted to the outer margin of an annual layer (terminal parenchyma). It forms there either a continuous or an interrupted narrow band, one or two cells in thickness.

MILLING AND GRADING

In Eastern Canada, poplar lumber is usually sawn on the conventional circular headrig along with such species as spruce, balsam fir, and jack pine. Vertical band saws are more commonly used in British Columbia to convert the large black cottonwood logs into lumber. There are very few mills in Canada which specialize exclusively in sawing one or more species of poplar—usually this genus forms part of the production of both the softwood and the hardwood mills.

While poplar has generally been sold on a mill-run basis in Canada, appropriate grading rules are available. Canadian rules may be obtained from the Canadian Lumbermen's Association, Ottawa, the Quebec Lumber Manufacturers Association, Quebec, or the Maritime Lumber Bureau, Amherst, N.S.

SEASONING

For air-drying, poplar should be box-piled to avoid projecting ends of boards since poplar has a tendency to warp if it is not kept in place during seasoning. If better quality sap boards are piled separately, dry stickers should be used to avoid sticker stain, or if green stickers are used, they should be given an anti-stain dip or application.

Kiln-drying schedules are presented for aspen (covering largetooth and trembling aspen), eastern cottonwood, and black cottonwood (7) (12). Balsam poplar may be dried according to the schedule for eastern cottonwood.

It should be borne in mind that schedules are a guide to drying, and that peculiarities of stock and kiln facilities may call for an adjustment of a schedule to accelerate or to retard the rate of drying.

A definite risk of collapse is involved in the kiln-drying of very wet poplar, green from the saw. Wet streaks of excessively high moisture content frequently occur in poplars in the zone of sapwood-heartwood transition. They are frequently associated with areas of discoloration. Such material will very likely collapse in kiln-drying green from the saw and should be air-dried first, which precaution will reduce the hazard, although not altogether guarantee freedom from the condition.

Good piling with adequate stickering is essential to satisfactory results in kiln-drying the poplars.

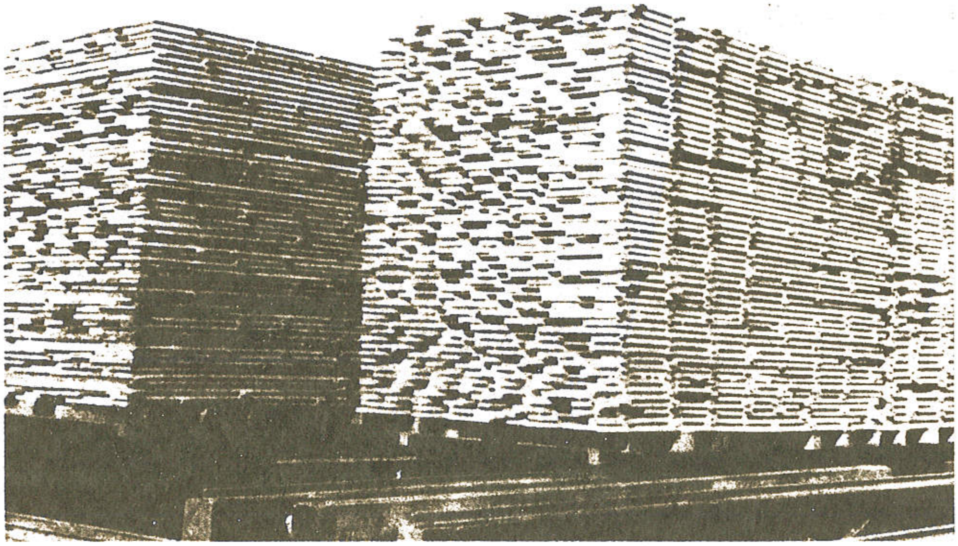

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PLATE 7. Black cottonwood lumber piled for kiln drying.

Drying Schedule for 4/4 to 6/4-Inch Aspen

Moisture Content (Per Cent)	Temperature °F.		Relative Humidity (Per Cent)	Equilibrium Moisture Content (Per Cent)
	Dry Bulb	Wet Bulb		
Over 40	160	142	62	8.5
40-30	170	136	40	4.7
30-dry	180	130	26	3.0
Conditioning	180	171	81	12.6

Drying Schedule for 7/4 to 9/4-Inch Aspen; 4/4 to 6/4-Inch Eastern Cottonwood and Balsam Poplar

Moisture Content (Per Cent)	Temperature °F.		Relative Humidity (Per Cent)	Equilibrium Moisture Content (Per Cent)
	Dry Bulb	Wet Bulb		
Over 40	140	133	81	14.3
40-30	150	130	57	7.9
30-dry	170	120	24	2.9
Conditioning	170	161	80	12.7

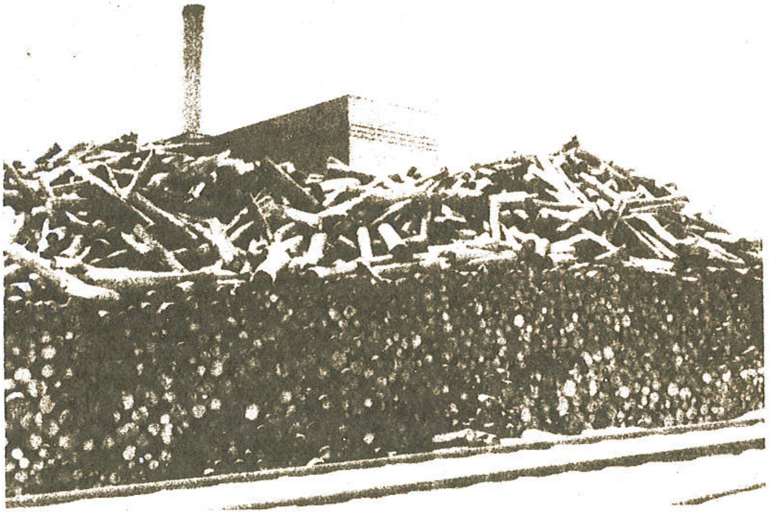
Drying Schedule for 7/4 to 9/4-Inch Eastern Cottonwood and Balsam Poplar

Moisture Content (Per Cent)	Temperature °F.		Relative Humidity (Per Cent)	Equilibrium Moisture Content (Per Cent)
	Dry Bulb	Wet Bulb		
Over 40	135	129	84	15.4
40-30	140	130	75	12.5
30-25	150	135	66	9.8
25-dry	165	115	23	2.9
Conditioning	165	156	80	12.9

Drying Schedule for 4/4 and 5/4-Inch Black Cottonwood

Moisture Content (Per Cent)	Approximate Time (Hours)	Temperature °F.		Relative Humidity (Per Cent)	Equilibrium Moisture Content (Per cent)
		Dry Bulb	Wet Bulb		
Green to 45	0-180	170	166	91	17.1
45-40	180-204	175	167	83	13.4
40-30	204-216	180	170	79	11.9
30-20	216-228	185	172	74	10.2
20-10	228-240	190	168	60	7.0
10-dry	240-dry	190	160	49	5.3

The above schedule for 4/4 to 5/4 black cottonwood may be adapted for 8/4 stock by lowering both the dry bulb and wet bulb temperatures by 10 degrees for each stage.



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By permission of E. B. Eddy Co. Ltd., Hull, P.Q.

PLATE 8. Block pile of eastern poplar.

PRESERVATIVE TREATMENT

In conditions favouring decay, poplar shows little resistance to deterioration. For such conditions some form of preservative treatment is necessary to secure moderate service life, otherwise poplar in its natural condition will last a very short time.

Poplar sapwood receives preservatives satisfactorily by means of pressure or diffusion treatments. On the other hand, poplar heartwood receives preservative in an unsatisfactory manner. Penetration is patchy, some areas being so impermeable as to receive no preservative. This distinction in treating behaviour means that, for practical purposes, round timber (since it is encircled by sapwood) treats satisfactorily, while squared or sawn stock (from a large part of which the sapwood has probably been removed) receives patchy and unsatisfactory penetration. Thus for use under decay hazard, poplar in the round should be used to take advantage of its good sapwood penetration characteristics.

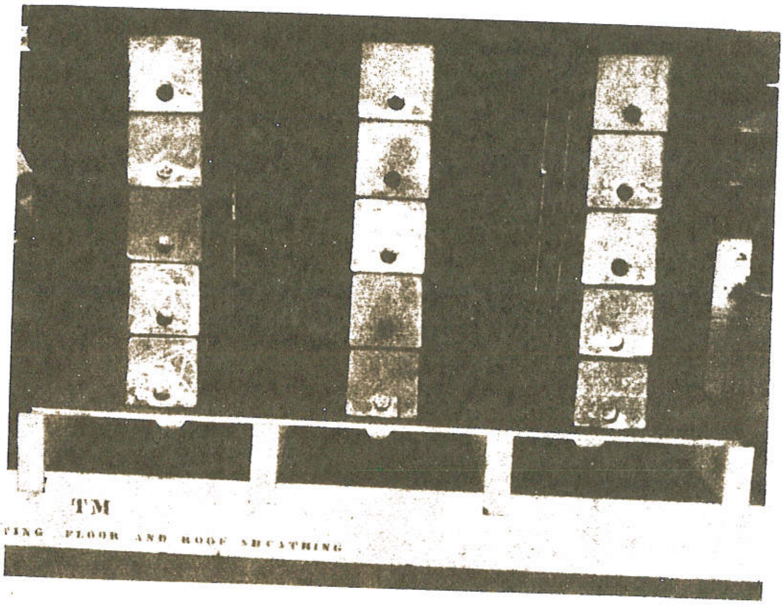

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PLATE 9. Exterior-type plywood of eastern poplar undergoing an evaluation of its strength properties. This 4′ x 4′ sheet is supporting a load of 3,000 lbs. without sign of failure.

THE USE-PICTURE FOR POPLAR

With the help of technological advances, specialized processing of wood for particular end purposes has arrived. Economic pressure, as a result of shortages in traditional species, prompts investigations for possible substitutes. As a result there is a growing increase in the consumption of poplars—formerly poor relations in the forest community.

The major uses of Canadian poplars are in this order: pulp and paper, lumber, veneer, and plywood.

Pulp and Paper

Poplar as a raw material for pulp is becoming increasingly important. According to Dominion Bureau of Statistics figures in 1957, Canada used more than 450,000 cords of poplar in the manufacture of pulp, representing more than 3 per cent of all the wood used in the various pulping processes. This quantity of poplar is more than double that used for pulp in 1946. A number of factors are responsible for this increase, including the depletion of the common pulpwood species, such as spruce and balsam, in certain localities, and the development of high yield pulping processes which are well suited to deciduous woods.

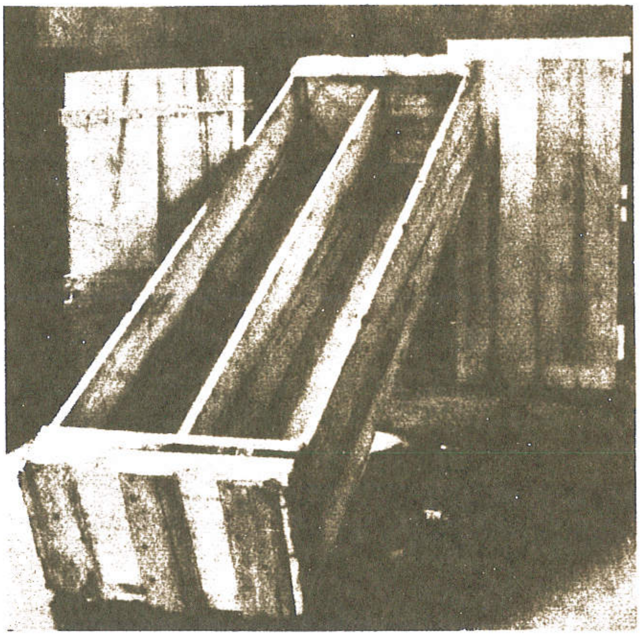

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PLATE 10. Shell box of ½-inch eastern poplar after severe handling in a 14-ft. revolving drum in which it received 30 drops. This poplar box with a weight of 134 pounds including contents, weighed less and performed better than the metal box with which it was being tested.

Very strong pulps can be produced from poplar by semi-chemical processes, with yields ranging from 65-75 per cent, compared to less than 50 per cent yield by full chemical processes. In the semi-chemical processes, the chips are partially cooked in relatively weak cooking liquors and subsequently refined—usually in a disc type refiner. The semi-chemical kraft pulps are mainly used in the production of corrugating board. Semi-chemical sulphite pulp is used in many papers and to a limited extent in place of the conventional sulphite pulp in the furnish for newsprint. The high pentosan content of the hardwoods, compared to the softwoods, is largely responsible for the high strength of these pulps, in spite of the shorter fibre length of the hardwoods.

Some poplar is also used for the production of bleached sulphite pulp. The resultant pulp is weak and bulky. This pulp is usually used, blended with softwood sulphite, for the production of tissue papers and specialty papers such as book and drawing papers. A limited amount of groundwood pulp for paper is also made from poplar. This pulp is also weak and bulky. It is usually used mixed with softwood groundwood.

Poplar is extensively used in the production of fibreboards in Canada, present production of which amounts to approximately 300,000 tons per year from wood. Poplar, mainly in the form of round wood, accounts for about 36 per cent of this raw material. In the case of insulating fibreboard, 46 per cent of the wood used to make pulp is poplar. About 14 per cent of the pulp for hard-pressed fibreboard is made from poplar.

Lumber

In 1956, Canadian production of poplar was 55,434 M f.b.m. (8). This represented 0.7 per cent of our total lumber production.

The diameter of mature trees manufactured and the related lumber sizes and quality are important factors influencing the production and use of poplar lumber.

Black cottonwood, the commercial poplar of the West Coast, provides lumber in adequate sizes and is a dominant hardwood lumber species in that area. Lumber of this species is used for furniture core stock, limited quantities going into solid furniture, and also for construction and containers.

Unlike the west coast cottonwood, eastern poplar is in direct competition with a good supply of traditionally used hardwoods as well as with the softwood construction species. This circumstance, along with some unfounded prejudices, has retarded the general acceptance of the eastern species.

Veneer and Plywood

High grade black cottonwood veneer from large peeler logs on the West Coast has been manufactured into plywood by Douglas fir plywood mills for some time. It is usual to combine black cottonwood faces with a Douglas fir core. This type of panel is ideal for use in the furniture industry as a core for overlaying with fancy veneers or plastic laminates.

Within the past ten years considerable interest has developed over the introduction of aspen and balsam poplar plywood. Several mills using poplars, primarily, have been built in Ontario, Quebec, and the Prairie Provinces. This plywood finds a considerable market as underlayment for flexible flooring. Use for it is also developing as a wall and roof sheathing material and as subflooring.

Black cottonwood and other poplar plywoods are used extensively in house construction for cupboards and kitchen built-ins. They have the advantage of being able to take a smooth paint finish without the grain showing through.

Information on the production of veneer and plywood from poplar and other species is available from the Forest Products Laboratories of Canada* (4).

Particle Board

Poplar is a satisfactory raw material for the manufacture of particle board. The present production of particle board in Canada is at the rate of approximately 60,000 tons per year, of which poplar constitutes 43 per cent. An increasing market for poplar should develop as its consumption keeps pace with the rapidly expanding particle board industry.

Fuel

The heating values for four species of poplar are given in Table 1. The heating value of sugar maple is given for comparison.

TABLE 1

Species	Gross Calorific Value (Millions of B.T.U. per Air-Dry Cord)
Eastern cottonwood (Populus deltoides)	16.8
Black cottonwood (Populus trichocarpa)	15.5
Balsam poplar (Populus balsamifera)	17.2
Largetooth aspen (Populus grandidentata)	18.2
Sugar maple (Acer saccharum)	29.0

Poplar is a low-performance fuel which must be well seasoned to make a satisfactory fire.

Excelsior

Good quality excelsior is manufactured from the poplars. It is low in weight, light in colour, and makes strong and resilient strands. Presently, competing packing materials are causing a decline in excelsior production.

Match Splints and Charcoal

The manufacture of wooden match splints consumes between 15,000 and 20,000 cords of poplar per year in Canada (13). Most of this production is composed of trembling aspen and is centered in Ontario and Quebec. Wooden matches, however, have been steadily losing their market position to paperbook matches.

Poplar can also be used for the manufacture of charcoal, but, due to its low density, yields are much lower than for such hardwoods as birch or maple.

Boxes and Crates

Poplars are used extensively in the manufacture of boxes and crates. They are classed, regarding suitability, with the pines and spruces. Since their decay resistance is rather low, poplars should be selected for containers which will not face a prolonged decay hazard. The high initial moisture content of poplar lumber prompts extra attention in ensuring that stock for containers is well seasoned before manufacture. This measure will prevent shrinking and twisting of stock in the box and will thus eliminate the adverse stresses which would otherwise occur in the nailed joints.

* Now designated as the Forest Products Research Branch.

The eastern poplars have a certain advantage in toughness over the softwoods. Rather than snapping off cleanly after taking a load over the maximum, poplar members will remain intact while sustaining severe bending, thus maintaining a lengthwise supporting action. In addition, the poplars contain no contaminants, and have a light-coloured surface for clear stencilling and labelling.

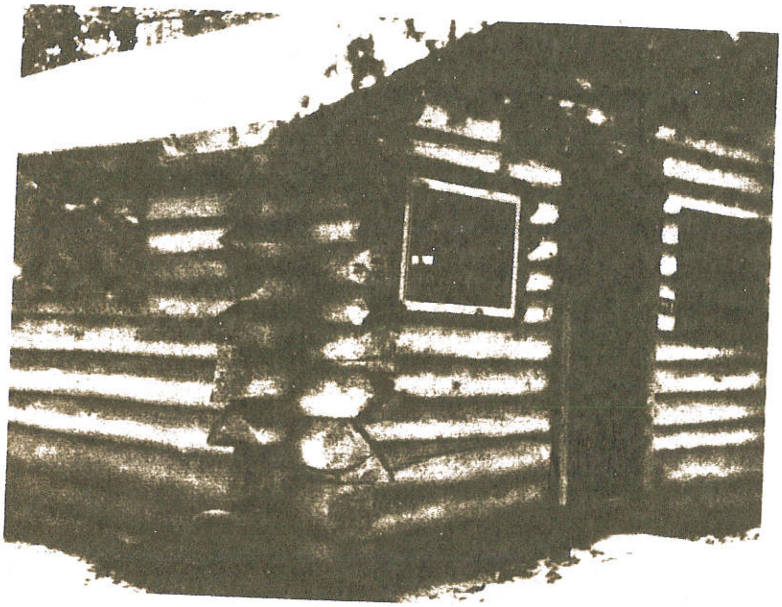

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PLATE 11. Log cabin, 21 years old, walls of largetooth aspen, near Carnarvon Ontario.

FUTURE DEVELOPMENTS

The use of hardwoods in the pulp and paper industry is expected to increase substantially. Performance of poplar hybrids is being evaluated in Canada with a view to profiting from their rapid growth and high yield of suitable fibre, attainable with a short rotation.

There is every reason to believe that the consumption of poplar will increase. It is probable that an ever-increasing percentage of the greater volume harvested will supply the raw material for reconstituted products: paper, boards, particle board, and plywood.

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TABLE 2 Strength and Related Properties of Five Species of Poplar; with Red Alder Basswood, Red Pine, and White Spruce

GREEN

Species Common and Botanical Names	Place of Growth of Material Tested	No. of Locations Sampled	No. of Trees Tested	Rings per Inch	Summer-wood (per cent)	Shrinkage From Green to Oven-Dry Based on Dimensions when Green (Per Cent)			Specific Gravity		Weight per Cu. Ft. as Tested (lb.)	Moisture Content Based on Weight Oven-Dry (per cent)
						Radial	Tangential	Volumetric	Basic: Volume Green Weight Oven-Dry	Oven-Dry: Volume Oven-Dry Weight Oven-Dry		
1	2	3	4	5	6	7	8	9	10	11	12	13
Poplar, Trembling Aspen.... (Populus tremuloides)	N.B., Man., Sask.	3	20	12		3.6	6.6	11.7	0.38	0.42	53	123
Poplar, Largetoothed Aspen... (Populus grandidentata)	Ontario	1	10	7		3.2	6.7	11.9	0.39	0.44	48	99
Poplar, Balsam (Populus balsamifera)	Ont., Man	2	10	13		3.9	6.4	11.6	0.37	0.42	48	107
Poplar, Eastern Cottonwood (Populus deltoides)	Ontario	1	5	3		3.1	7.8	11.8	0.36	0.39	58	157
Poplar, Black Cottonwood (Populus trichocarpa)	British Columbia	1	7	5		3.6	8.8	11.7	0.29	0.33	50	175
Alder, Red...... (Alnus rubra)	British Columbia.	1	6	6		4.2	7.0	11.7	0.37	0.42	47	101
Basswood (Tilia americana)	Quebec.	1	4	10		6.7	9.3	18.4	0.36	0.42	48	115
Pine, Red (Pinus resinosa)	Ontario, N.B	4	25	16	24	3.5	5.9	9.6	0.39	0.42	52	114
Spruce, White (Picea glauca)	Que., N.B., Man., Sask.	5	27	13	22	3.4	6.1	10.8	0.35	0.38	38	75

AIR-DRY (12 PER CENT MOISTURE CONTENT*)

Species Common and Botanical Names	Place of Growth of Material Tested	No. of Locations Sampled	No. of Trees Tested	Shrinkage From Green to Air-Dry, Based on Dimensions when Green (Per Cent) Radial	Tangential	Volumetric	Specific Gravity Nominal Volume Air-Dry Weight Oven-Dry	Weight per Cubic Foot Air-Dry (lb.)
1	2	3	4	7	8	9	10	12
Poplar, Trembling Aspen (Populus tremuloides)	N.B., Man., Sask.	3	18	2.7	5.7	8.4	0.40	28
Poplar, Largetoothed Aspen (Populus grandidentata)	Ontario	1	5	—	—	8.8	0.40	28
Poplar, Balsam (Populus balsamifera)	Ont., Man.	2	8	—	—	9.5	0.41	26
Poplar, Eastern Cottonwood (Populus deltoides)	Ontario	1	5	—	—	9.8	0.39	27
Poplar, Black Cottonwood (Populus trichocarpa)	British Columbia	1	7	—	—	8.6	0.32	22
Alder, Red (Alnus rubra)	British Columbia	1	6	—	—	[illegible]	0.41	28
Basswood (Tilia americana)	[illegible]	[illegible]	1	—	—	13.4	0.42	29
Pine, Red (Pinus resinosa)	[illegible]	4	22	2.9	4.1	6.5	0.40	28
Spruce, White (Picea glauca)	Quebec, N.B., Man., Sask.	5	[illegible]	[illegible]	4.1	[illegible]	[illegible]	26

*The air-dry strength values have been adjusted by mathematical formula [illegible] strength equivalent to that at a [illegible] content of 12 per cent. Impact loading values are excepted as they do not lend themselves to this mathematical adjustment.

TABLE 2 (cont'd)

GREEN

Species Common and Botanical Names	Static Bending: Stress at Proportional Limit (p.s.i.)	Static Bending: Modulus of Rupture (p.s.i.)	Static Bending: Modulus of Elasticity (1,000 p.s.i.)	Static Bending: Work in Bending (in. lb. per cu. in.): To Proportional Limit	Static Bending: Work in Bending: To Maximum Load	Static Bending: Work in Bending: Total	Impact Bending: Stress at Proportional Limit (p.s.i.)	Impact Bending: Modulus of Elasticity (1,000 p.s.i.)	Impact Bending: Work to Proportional Limit (in. lb. per cu. in.)	Impact Bending: Drop of 50-lb. Hammer at Complete Failure (in.)	Compression Parallel to Grain: Stress at Proportional Limit (p.s.i.)	Compression Parallel to Grain: Maximum Crushing Stress (p.s.i.)	Compression Parallel to Grain: Modulus of Elasticity (1,000 p.s.i.)
1	14	15	16	17	18	19	20	21	22	23	24	25	26
Poplar, Trembling Aspen (Populus tremuloides)	2,900	5,500	1,350	0.35	6.9	19.3	[illegible]	1,500	[illegible]	26	1,480	2,360	1,280
Poplar, Largetoothed Aspen (Populus grandidentata)	2,800	5,400	[illegible]	0.40	8.8	[illegible]	8,200	1,390	2.72	33	1,270	2,370	1,200
Poplar, Balsam (Populus balsamifera)	2,600	4,900	[illegible]	0.34	5.2	13.8	7,300	1,210	2.49	18	1,300	2,080	1,260
Poplar, [illegible] Cottonwood	2,600	4,800	[illegible]	0.45	9.2	28.3	7,100	1,110	2.63	38	1,170	1,980	920
Poplar, Black Cottonwood (Populus trichocarpa)	2,300	4,100	970	0.30	4.8	6.1	8,200	1,150	3.32	17	1,130	1,860	1,120
Alder, Red (Alnus rubra)	3,500	6,300	1,200	0.59	8.0	14.9	9,000	[illegible]	2.83	24	2,370	3,020	1,200
Basswood (Tilia americana)	2,700	5,000	1,070	0.39	6.2	20.5	9,000	1,500	3.00	24	1,140	2,270	1,190
Pine, Red (Pinus resinosa)	2,800	4,900	1,040	0.44	5.8	[illegible]	8,700	1,370	3.10	27	1,540	2,260	1,080
Spruce, White (Picea glauca)	2,800	5,100	1,150	0.38	5.8	15.0	7,700	1,290	2.61	22	1,840	2,470	1,270

AIR-DRY (12 PER CENT MOISTURE CONTENT)*

Species Common and Botanical Names	Static Bending: Stress at Proportional Limit (p.s.i.)	Static Bending: Modulus of Rupture (p.s.i.)	Static Bending: Modulus of Elasticity (1,000 p.s.i.)	Static Bending: Work in Bending (in.-lb. per cu. in.) To Proportional Limit	Static Bending: Work in Bending (in.-lb. per cu. in.) To Maximum Load	Static Bending: Work in Bending (in.-lb. per cu. in.) Total	Impact Bending: Stress at Proportional Limit (p.s.i.)	Impact Bending: Modulus of Elasticity (1,000 p.s.i.)	Impact Bending: Work to Proportional Limit (in. lb. per cu. in.)	Impact Bending: Drop of 50-lb. Hammer at Complete Failure (in.)	Compression Parallel to Grain: Stress at Proportional Limit (p.s.i.)	Compression Parallel to Grain: Maximum Crushing Stress (p.s.i.)	Compression Parallel to Grain: Modulus of Elasticity (1,000 p.s.i.)
1	14	15	16	17	18	19	20	21	22	23	24	25	26
Poplar, Trembling Aspen (Populus tremuloides)	4,500	10,100	1,730	1.05	11.0	22.5	10,500	1,850	3.37	26	3,320	5,140	1,830
Poplar, Largetoothed Aspen (Populus grandidentata)	4,800	9,700	1,300	0.94	12.5	22.5	—	—	—	—	2,450	4,570	1,610
Poplar, Balsam (Populus balsamifera)	5,100	10,300	1,680	0.95	11.3	20.2	—	—	—	—	2,900	4,750	1,840
Poplar, Eastern Cottonwood (Populus deltoides)	3,600	7,500	1,080	0.75	14.7	36.4	9,500	1,630	3.12	25	2,350	4,020	1,290
Poplar, Black Cottonwood (Populus trichocarpa)	4,100	7,100	1,280	0.75	6.4	9.8	11,900	1,880	4.25	21	2,560	4,020	1,510
Alder, Red (Alnus rubra)	5,900	10,700	1,460	1.34	9.6	13.3	12,400	2,000	4.32	29	3,990	5,800	1,330
Basswood (Tilia americana)	4,300	8,900	1,400	0.76	[illegible]	16.2	11,300	2,220	3.21	27	2,620	4,980	2,000
Pine, Red (Pinus resinosa)	5,700	10,000	[illegible]	1.35	10.3	16.7	10,900	1,980	3.39	26	3,400	5,320	1,320
Spruce, White (Picea glauca)	5,100	8,700	1,370	[illegible]	7.5	13.2	9,300	[illegible]	2.84	22	3,470	5,160	1,550

*The air-dry strength values have been adjusted by mathematical formula to a strength equivalent to that at a moisture content of 12 per cent. Impact loading values are excepted as they do not lend themselves to this mathematical adjustment.

TABLE 2 (cont'd)

GREEN

Species Common and Botanical Names	Compression Perpendicular to Grain	Hardness			Shear Parallel to Grain		Cleavage		Tension Perpendicular to Grain	
	Stress at Proportional Limit (p.s.i.)	Load Required to Imbed 0.444 in. Sphere to Half Diameter (lb.)			Maximum Stress (p.s.i.)		Splitting Strength (lb. per in. Width; Length 3 in.)		Maximum Stress (p.s.i.)	
		Radial Surface	Tangential Surface	End Surface	Radial Plane	Tangential Plane	Radial Plane	Tangential Plane	Radial Plane	Tangential Plane
1	27	28	29	30	31	32	33	34	35	36
Poplar, Trembling Aspen (Populus tremuloides)	200	340	350	370	730	780	180	220	390	510
Poplar, Largetoothed Aspen (Populus grandidentata)	210	400	420	380	730	850	190	220	360	470
Poplar, Balsam (Populus balsamifera)	170	260	300	290	620	680	150	170	290	340
Poplar, Eastern Cottonwood (Populus deltoides)	210	410	440	430	730	810	190	250	400	580
Poplar, Black Cottonwood (Populus trichocarpa)	100	200	210	260	500	620	110	160	210	360
Alder, Red (Alnus rubra)	360	430	440	530	870	960	210	270	380	530
Basswood (Tilia americana)	200	320	340	390	660	780	150	190	370	530
Pine, Red (Pinus resinosa)	260	310	340	310	710	710	180	190	310	370
Spruce, White (Picea glauca)	250	280	290	340	700	720	150	160	280	330

AIR-DRY [illegible]

Species Common and Botanical Names	Compression Perpendicular to Grain	Hardness			Shear Parallel to Grain		Cleavage		Tension Perpendicular to Grain	
	Stress at Proportional Limit (p.s.i.)	Load Required to Embed 0.444 in. Sphere to Half Its Diameter (lb.)			Maximum Stress (p.s.i.)		Splitting Strength (lb. per in. Width Length 3 in.)		Maximum Stress (p.s.i.)	
		Radial Surface	Tangential Surface	End Surface	Radial Plane	Tangential Plane	Radial Plane	Tangential Plane	Radial Plane	Tangential Plane
1	27	28	29	30	31	32	33	34	35	36
Poplar, Trembling Aspen (Populus tremuloides)	490	500	520	660	[illegible]	1,150	[illegible]	[illegible]	[illegible]	[illegible]
Poplar, Largetoothed Aspen (Populus grandidentata)	520	440	460	600	[illegible]	1,250	280	280	[illegible]	720
Poplar, Balsam (Populus balsamifera)	380	420	470	660	840	980	220	240	430	510
Poplar, Eastern Cottonwood (Populus deltoides)	460	400	480	650	[illegible]	1,310	270	270	600	820
Poplar, Black Cottonwood (Populus trichocarpa)	260	300	310	450	760	960	150	230	420	580
Alder, Red (Alnus rubra)	580	540	580	980	1,080	1,230	280	230	390	440
Basswood (Tilia americana)	420	530	480	580	1,060	1,290	240	260	600	790
Pine, Red (Pinus resinosa)	[illegible]	440	500	570	1,050	1,040	210	250	470	560
Spruce, White (Picea glauca)	490	420	460	600	1,100	1,460	230	230	[illegible]	480

*The air-dry strength values have been adjusted by mathematical formula to a strength equivalent to that at a moisture content of 12 per cent. Impact loading values are excepted as they do not lend themselves to this mathematical adjustment.

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