UTILISATION OF POPLAR FOR WOOD COMPOSITES

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Introduction

To meet the growing shortage of industrial wood, large scale plantations of fast growing species have been raised in the country. Poplar is one such species widely planted in India in the States of Jammu and Kashmir, Punjab, Haryana, Himachal Pradesh, Uttar Pradesh, Uttaranchal, North Bengal and Arunachal Pradesh along rail and road side, canals, in agricultural fields, cities, parks and home compounds under various agro- and social forestry programmes.

Poplar wood possesses high timber and fibre value for industrial applications. Poplar is a medium density hardwood with an average density of 0.441 g/cm^3. Forest Research Institute has undertaken several studies on different utilization aspects of Poplar mainly of *Populus deltoides* and to some extent *Populus ciliata* because of the easy availability of the former. Many more such studies are still in progress.

Studies on *Populus deltoides* have been undertaken on its physical and mechanical properties (Shukla *et al.*, 1990), wood working and carving quality (Shukla *et al.*, 1991), plywood (Shukla *et al.*, 1986), hard board (Shukla, 1987), particle board (Singh *et al.*, 1995), pencil making (Krishna Rao *et al.*, 1994), etc. The timber has low natural durability but easy to treat with preservative chemicals (Dev and Kainth, 1989).

Studies on air drying behaviour revealed that though it is not difficult to dry, the material is prone to severe distortions (Sharma *et al.*, 1990). Its suitability for packing cases, match boxes, artificial limbs, tennis and badminton rackets etc, has been mentioned (Rajput *et al.*, 1991). The wood is now extensively used for manufacture of plywood, match boxes and packing cases etc., in the country.

Poplar wood from plantations is now coming in the market in a big way. In order to have its fuller utilization it is necessary to study in detail clone-wise properties of Poplar species and develop appropriate processing techniques and new products for diversifying the use of Poplar wood.

This paper describes the recent research and development work carried out on utilization of Poplar wood for reconstituted wood products at this Institute.

R & D Work at FRI

Veneer, Plywood and Blockboard

Optimum Conditions for Peeling : Uniformity of thickness in veneer is of great importance for its subsequent use in plywood, laminated wood, improved wood etc. Technologically lack of uniformity in thickness of veneer may result in poor bonding with adhesives. Keeping in view the above, optimum conditions for peeling Poplar into veneer having uniformity in thickness, tightness and strength were studied (Shukla *et al.*, 1992). Considering the results obtained during peeling of two species viz., *Populus deltoides* and *Populus ciliata*, the optimum conditions of peeling were determined as follows :

	Populus ciliata	*Populus deltoides*
Veneer thickness (mm)	1.61	1.61
Temperature of log conditioning (°C)	55	55
Speed of peeling (m/min)	39.62	45.72
Knife angle	91.2°	90°

Plywood and Allied Products : *Populus deltoides* (Poplar) obtained from Lalkuan, Haldwani (Uttaranchal) and *Populus ciliata* procured from Kotkhai Range, Shimla (HP) were studied for its suitability for making various grades of plywood and blockboards. Both the species did not offer any gluing problem and satisfactory glue bond can be obtained with common commercial adhesives like, PF and UF for making plywood. Experiments on 3 and 5 ply plywood indicated that the species is easy to treat with water borne preservatives and fire retardant chemicals and adequate loading of the chemicals can be obtained. Treatment with preservative (Copper-Chrome-Arsenic) and fire retardant-cum-antiseptic chemical (Ammonium Phosphate, Copper Sulphate, and Sodium Dichromate) did not adversely affect the glue bond. The species is suitable for making, (a) plywood for general purposes, (b) marine plywood, (c) plywood for concrete shuttering work, (d) preservative treated plywood, (e) fire retardant plywood, and also for (f) blockboards (Rajawat *et al*, 1989; Shukla *et al.*, 1986).

The service life of plywood from *Populus deltoides* can be increased by adopting glue line poisoning using arsenic tri oxide mixed in PF glue. The glue shear strength of treated as well as untreated plywood with three different thicknesses of veneers i.e. 0.8 mm, 1.6 mm and 3.2 mm was studied. Statistical analysis showed that the glue line treatment does not adversely affect the glue bond in plywood, while resists the termite attack considerably. (Dimri *et al.* 1995).

Laminated Veneer Lumber (LVL) : Laminated veneer lumber (LVL), a high strength engineered product can be used as a substitute for solid wood as they retain structural properties of wood. Veneers obtained from medium and small diameter logs are converted into strips and glued in parallel laminates or laminated veneer lumber (LVL) which has all the properties of thick wooden planks.

LVL can be manufactured in varying sizes and thicknesses, being dimensionally stable and having more uniform strength

properties, it is more versatile than sawn timber. Suitability of plantation grown *Populus deltoides* was evaluated for Laminated Veneer Lumber (LVL). Specific gravity of LVL is affected by pressure, pressing period and also the thickness of the veneer used. With decrease in veneer thickness, specific gravity in general increases (Shukla *et al*, 1996).

Compressed Wood : Compressed wood has improved strength and elastic properties and high resistance to wear. These properties make it suitable for use in textile industry/auxiliaries, door handles, bearings, rollers etc. Suitability of *Populus deltoides* and *Populus ciliata* was evaluated for compressed wood shuttle blocks. The density of poplars after compression varied within the range of 1.05 to 1.20 g/cm^3. The strength properties of the compressed wood from these two species meet the requirements specified for shuttle blocks and were comparable with imported *Cornus* spp., *Carpinus* and *Hornbeam* used at present for making shuttle blocks (Shukla and Bhatnagar, 1989).

Reconstituted Wood : Reconstituted wood product developed from lignocellulosic material has highly directional properties suitable for structural purposes (Coleman, 1981).

Reconstituted wood developed from lops and tops of Poplar has the strength properties comparable with Teak (Shukla, 1992). Thickness swelling some what higher than Teak could be reduced by incorporating suitable sizing agents as in case of particle board. The product has solid edge and can be bored, shaped, moulded, nailed and screwed with machine and hand tools. It can be painted and polished with case as in case of solid wood.

Laminated Doors and Windows : In solid wood the growth defects like knots are often localized and form the weakest part of the structure. The problem with Poplar for its utilization for doors and windows is that it is a light timber and the presence of knots in the whole length of the wood.

The physical and mechanical properties of short rotation Poplar wood could be considerably improved by applying the technique of laminations and

Table 1

Physical and Mechanical Properties of Structural Wood from Poplar and compared with Solid Wood of Poplar and Teak

Property	Structural wood	Solid wood	
	Poplar	Poplar	Teak
Density (g/m^3)	0.68	0.465	0.59
Volumetric shrinkage AD to OD (%)	4.95	11.9	4.05
Modulus of rupture (kg/cm^2)	1147	780	959
Compressive strength (kg/cm^2)	445	381	532
Shear strength (kg/cm^2)	101	90	102

simultaneous compression (Shukla, 1997). The construction of laminated wood may be either all veneer construction or solid wood core laminated with veneer. Since Poplar is not a durable timber, finished panels may be given pressure treatment with CCA preservative and dried before polishing. Plywood manufacturing units in the country using poplars can easily undertake the manufacture of laminated doors without any additional investment.

Plywood using Lignin Adhesives : For reducing the cost of synthetic resin, black liquor lignin based phenolic adhesives for plywood have been developed in which the phenol is replaced with black liquor for making adhesive. An attempt was made to develop exterior grade plywood from *Populus deltoides* using lignin based phenolic adhesives. The results showed that upto 30 per cent replacement of phenol with black liquor from pine needles, the plywood meet the BWP grade and upto 50 per cent for BWR grade requirements (Singh and Singh, 1994).

Fibre Board : Suitability of 1 and 2 years old *Populus deltoides* G3 without debarking was evaluated for hardboard manufacture (Shukla *et al.*, 1986), with a view to utilize whole tree stem.

Bark/wood ratio worked out on oven dry basis for some selected stems is given in Table 2.

The hardboards were prepared from 1 and 2 years old plants containing 30 and 21 per cent bark respectively. One per cent wax emulsion was used to reduce the water absorption of the boards. Both 1 and 2 years old *Populus deltoides* were found suitable for hardboard manufacture. However, 2 years old plants gave better board properties than 1 year old. This may be due to higher percentage of bark in 1 year old plants.

The effect of mixing *Populus deltoides* bark and wood on the physical and mechanical properties of hardboards was also studied (Shukla, 1997). It was observed that individually Poplar wood is suitable for hardboard but not the bark. However, certain quantities of bark could be mixed with wood producing satisfactory board. Bark to the extent of 20 per cent (OD) helps in improving the physical and mechanical properties of the board as compared to the boards prepared from wood alone. In standard hardboards, the bark content can safely be increased upto 50 per cent. *Populus ciliata* without bark was evaluated for making hardboards (Shukla *et al.*, 1985). It

Table 2

Moisture content and Wood/Bark ratio in 1 and 2 years old Populus deltoides stems

Plant age (years)	Middle dia (mm)	Moisture			Wood (%)	Bark (%)
		Overall	Wood	Bark		
1	7.26	12.5	13.8	9.5	70	30
2	8.30	11.0	11.2	10.2	79	21

was found to be a very suitable species for the purpose.

Utilization of Bark : In most of the wood based industries, the wood is generally used after debarking. Thus large quantities of bark constituting about 10 to 20 per cent of total timber used is accumulated at mill site which is not properly utilized. With increasing demand of wood raw material in recent years technologies have been developed to utilize bark for making building boards in many countries. The investigations carried out on utilization of bark from *Populus deltoides* show that satisfactory plain and veneered particle board meeting the requirements of specification are obtained (Singh *et al.*, 1995-96). Thus plywood industries using Poplar could utilize bark for manufacture of particle board without any additional investment on wood raw material and help in preventing the wastage of valuable lignocellulosic material.

Utilisation for Particle Board : With increasing forestry operations in the plantation areas substantial quantity of wood in the form of lops and tops, thinning etc., is expected to be available. Suitability of lops and tops of *Populus deltoides* with and without bark as a raw material for particle board manufacture was evaluated. The data indicated that *Populus deltoides* wood alone and with bark (about 19%) is suitable for making particle board. Satisfactory boards meeting the requirements are made using 10 per cent phenol formaldehyde resin and 1% wax emulsion as sizing agent in both the cases. However, the strength properties of the board without bark are slightly better than the board with bark (Singh *et al.*, 1995).

SUMMARY

To meet the growing shortages of industrial wood, large scale plantations of poplars have been raised in the country. Poplar wood possesses high timber and fibre value for industrial applications. Several studies on different utilization aspects of Poplar, including its physical and mechanical properties, wood working and carving quality, and its suitability for plywood, hardboard, particle board and laminated wood etc., have been undertaken. The wood is now extensively used in the manufacture of plywood, match boxes and packing cases etc. With increasing availability of Poplar wood in coming years, it is necessary to study in detail clone-wise properties and utilization of Poplar species for diversifying the use of Poplar wood. This paper describes the recent research and development work carried out on Poplar wood utilization for reconstituted wood products at this Institute.

काष्ठ संयथितों के लिए पोपलर का उपयोजन

एस०पी० सिंह व अनिल नेगी

साराश

औद्योगिक काष्ठ मिलने में बढ़ती जा रही कमी को पूरा करने के लिए देश में बड़े पैमाने पर पोपलर रोपवन लगाए गए हैं । औद्योगिक अनुप्रयोगों के लिए पोपलर की लकड़ी प्रकाष्ठ और रेशे के लिए बहुत मूल्यवान है । पोपलर उपयोजन के पक्षों का, जिनमें इसकी भौतिक और संधारी विशेषताएं, काटने-गढ़ने-छीलने की योग्यता और कारूकार्य गुणवत्ता तथा स्तरकाष्ठ कठोरफलक, कणफलक और आर्ट्रित काष्ठ आदि बनाने के लिए इसकी उपयुक्तता भी सम्मिलित है, अध्ययन किया गया है । अब इसकी लकड़ी स्तरकाष्ठ, दियासलाई की डिबियां और मालभराऊ पेटियां बनाने के लिए विस्तार से उपयोग में लाई जा रही है । आने वाले वर्षो में जब पोपलर की लकड़ी और अधिक परिमाण में मिलने लगेगी तो पोपलर काष्ठ

की कृन्तकवार विशेषताओं और उपयोगों का अध्ययन करना आवश्यक होगा ताकि इसकी लकड़ियों के उपयोगों का विविधि करण किया जा सके । प्रस्तुत अभिपत्र में इस संस्थान में इसके पुनर्निमित काष्ठोत्पादों के लिए पोपलर की लकड़ी के उपयोगों पर किए गए विगत अनुसन्धानों और विकास कार्यों का वर्णन दिया गया है ।

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