Comparison and analysis of the main technological factors of influencing mechanical properties of scrimber and PSL

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Abstract: The main mechanical properties of scrimber and Parallel Strand Lumber (PSL) were researched through technological test. Experimental materials of scrimber are small log of Aspen, Dahurian larch and Birch. Experimental materials of PSL come from fishtail veneer strips at plywood plant of Aspen and Birch. In the laboratory conditions low quality small log and wood residues can yield scrimber and PSL with high strength. After the technological conditions of scrimber were compared with that of PSL, the main factors of influencing their properties were separately pointed out and the reasons influencing properties have been analyzed in this paper. The results showed that the hot-pressing pressure is an important technological factor for scrimber. The ratio of veneer-strand length to thickness is a key technological factor for PSL.

Key words: Scrimber; Technological factors; Mechanical properties
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Introduction

Both Scrimber and PSL are new kinds of man-made solid wood developed at last twenty years in the world (Kelly 1990). Scrimber and PSL, used as man-made solid wood, have some same features such as high orientation and strength, good nail-holding and processing ability, low creep and so on. They can be used as construction materials instead of natural wood. But the technological parameters, conditions and equipment of manufacturing scrimber were different from those of PSL. In order to manufacture scrimber and PSL with superior properties, the relations of their technological factors that influence mechanical properties have been researched in this paper and key factor of influencing each material has been analyzed.

Methods

The experiments were conducted at laboratory of composition board from 1995 to 1999. Experimental tree species of scrimber are Aspen, Dahurian larch and Birch, the average diameter of these blocks is about 70-120 mm. First, these small logs are debarked and crossly sawed into shorter blocks. Then they are rolled to become wood webs by special rolling machine (Jin *et al.* 1997). Experimental materials of PSL come from fishtail veneer strips at plywood plant. Species of tree are Aspen and Birch. The waste veneers are cut into definite width strands by special machine and crossly cut different length according experimental condition (Jin *et al.* 1999). The main technological method of scrimber is the same as that of PSL, including drying, glue spreading, forming, hot-pressing, and treatment and finishing. The technological parameters for final samples have been determined through repeated experiments.

Results

Influence of hot-pressing pressure on scrimber properties

The experimental results show that the main mechanical properties of scrimber and PSL, such as bending strength (MOR), elasticity modulus (MOE), nail-holding ability, and so on are all over superior to those of particle board or medium density fiber board. They are most similar to original properties and strengths of natural wood (William 1990). Scrimber and PSL remain the superior properties of natural wood; the wood defects are also picked out by hand during processing. In addition, the core wood and side wood are random and uniform distributed inside products. Therefore they have the superior properties that natural wood doesn't have, and these properties are hardly or impossibly obtained by other manufacturing methods.

Although the properties of scrimber and PSL are most similar to that of natural wood among all types of composition board, they all are not natural wood but man-made solid woods. Therefore their mechanical properties are not uninfluenced by some technological factors during processing, such as species, geometry dimensions of wood web or veneer strand, glue added and gluing methods, hot-pressing technological parameters, and so on. In many cases, changing some factors will bring about their properties alterations. It is difficult to evaluate mechanical properties of scrimber or PSL by a definite numerical value. The

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experimental results only illustrate their properties under certain technological conditions. In this paper, it is found that during processing there is a key technological factor to influence material properties separately for scrimber and PSL. Properties of scrimber are considerably influenced by its density that is determined by hot-pressing pressure (Fig.1 and Fig. 2) (Jin *et al.* 1998). Under certainly technological conditions, for example, when pressure is 4.0 MPa for scrimber and 2.0 MPa for PSL, the density of scrimber and PSL made of Aspen is nearly same. Their physical and mechanical properties were shown in Table 1.

Table 1. The main physical and mechanical properties of scrimber and PSL

Material	Density /g·cm^{-3}	MOR /MPa	MOE /GPa	Front nail-holding /N	Side nail-holding /N	Expand ratio of water-absorbing thick %	Moisture content %
Scrimber	0.81	48.32	6.650	2312	1039	12.47	5.3
PSL	0.82	53.53	5.478	1350	1900	7.16	10.07

Notes: MOR--- bending strength; MOE--- elasticity modulus.

The density of scrimber can be controlled artificially. The hot-pressing pressure may result in increasing product density (Jin *et al.* 1998). Density of scrimber should not be lower than 0.8 g/cm^3. If the densities of scrimber product were higher than 0.9 g/cm^3, its bending strength and elesticity modulus would increase notably (Table 2).

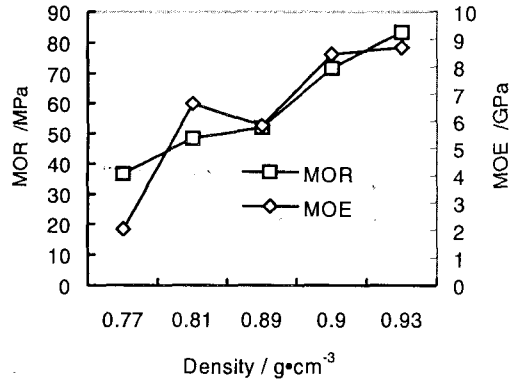

Fig. 1 The relationship between density and mechanical properties of scrimber from Aspen

Table 2. The relationship between density and mechanical properties of scrimber made of Aspen and Dahurian larch

Scrimber materials	Density /g·cm^{-3}	MOR /MPa	MOE /GPa
Aspen	0.770	36.54	2.050
	0.810	48.32	6.650
	0.890	51.98	5.830
	0.901	71.57	8.470
	0.931	83.26	8.690
Dahurian larch	0.765	34.47	5.050
	0.855	70.74	8.220
	0.982	74.61	8.599
	0.981	80.84	9.977
	1.063	89.93	11.901

The density of PSL, normally about 0.6-0.8 g/cm^3, is lower than that of scrimber, and mainly has relations with its raw material, but hot-pressing pressure does not influence its density remarkably because the mechanism produced wood webs of scrimber is different from that of veneer strands of PSL. During processing wood webs of scrimber, first, the wood blocks that have been preliminary processed are transported into a rolling machine. Pressure rollers flatten wood blocks so that they are split along grain direction. Then the flatter wood blocks become several pairs of shaped rollers that twist and press blocks into curtain wood webs. Wood webs are looser than nature wood and are easily compressed. But veneer strands of PSL are compressed by knives and nose bar during peeling and their thickness decreasing process with a compressed rate of 10%-20%. Compressed veneer is further squeezed by a pair of circle knives equipped on veneer-strand cutting machine and separated into veneer strands. The veneer strands are extruded from four sides so that they are more compact than natural wood and not easily compressed further. Therefore as hot pressing, the pressure on board blanks formed by veneer strands should not be too great in order to avoid higher internal stress that will bring about product deformation. But board blanks pressure for 4.0 MPa can make scrimber product to be more compact, not only its properties are better, but also its surfaces without small hole are smoother.

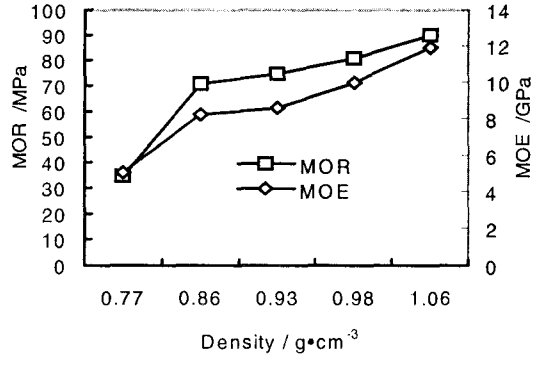

Fig. 2 The relationship between density and mechanical properties of scrimber from Dahurian larch

Influence of ratio of veneer-strand length to thickness on PSL properties

PSL mechanical properties are considerably influenced by veneer-strand geometry dimensions, especially veneer-strand length, besides width and thickness. As their thickness is fixed, the longer veneer strand is, the better quality is (Fig.3 and Fig.4). As doing experiments, the PSL test samples are separately made of veneer strands with same thickness (2 mm) and different length. Their length and thickness are in the ratio of 40:1 or 120:1 (Table 3).

Table 3. The relationship between ratios of veneer-strand length to thickness and PSL mechanical properties

Veneer strands		Density	MOR	MOE
Width/ mm	Ratio of length to thickness	/g·cm^{-3}	/MPa	/GPa
10	40	0.820	53.53	5.478
	120	0.614	105.55	6.952
20	40	0.820	79.39	4.213
	120	0.667	120.403	10.742

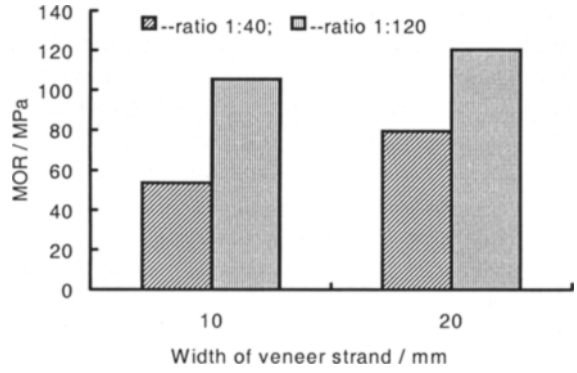

Fig. 3 Comparison of PSL MOR at different ratios

PSL samples have less density, as the ratio of length to thickness is greater. The reason caused this result is that the less ratio of veneer- strand length to thickness is, the more joining ends along veneer-strand longitudinal directions are. The veneer-strand ends overlap each other, which can makes density increase, and strength decrease. In addition, the formed lairs actually increase and result in the compressing deformation increase so that PSL products easily generate deformation as well as the expand ratio of water-absorbing thickness increases. During processing PSL, the veneer-strand length should be increased to the full so that their ratio of length to thickness increases and jointing ends decrease; endless blank is best if technological conditions and product specifications are available. As it is necessary to keep more joining ends for getting longer products, the veneer-strand ends must be stagger definite distance each other. Therefore the jointing-end number at every cross section is essentially same and products can have highest and most uniform strength properties, which are available to be used as construction wood.

Comparison with PSL, scrimber wood webs joining length are easily to do. As wood blocks are rolled to become wood webs, wood fibers, especially for some species such as birch, sometimes are broken to produce fragmentary wood webs. Loose web ends are usually joined together well, which doesn't have influence upon scrimber mechanical properties considerably.

Conclusions

Both scrimber and PSL are all man-made solid wood made of low quality wood. They can take the place of natural wood and be used as construction materials. Hot-pressing pressure is an important technological factor for scrimber since it determines scrimber density. Under normally conditions, MOR, MOE and other main properties increase with its density increase. The ratio of veneer-strand length to thickness is an important technological factor for PSL. PSL mechanical properties increase with increasing of its ratio of length to thickness remarkably.

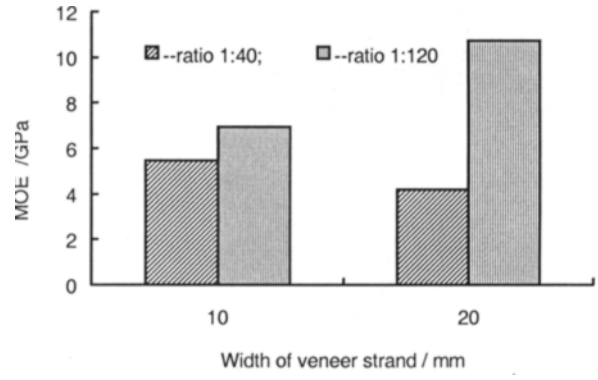

Fig. 4 Comparison of PSL MOE at different ratios

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