STRENGTH OF OSB SCARF JOINTS IN TENSION

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ABSTRACT

The use of scarf joints to join panel products can be found in structural applications such as wood I-joists and stress-skin panels. Design specifications for plywood scarf joints have been available for decades. Corresponding information on oriented strandboard (OSB) is not yet available despite its status as a suitable alternative to plywood as a structural panel product. This project was conducted to provide such design information. Three hundred joints were fabricated and tested in tension in a dry condition. These included two nominal thicknesses of OSB (11 mm and 18 mm) from two manufacturers. The adhesive used for the joints was a resorcinol formaldehyde. The joint strengths were compared with the material strengths in tension. The results showed that optimum joint strength was reached when the scarf slope was about 1 in 7 irrespective of manufacturer and thickness. At the optimum joint slope, no loss of strength was observed compared with unjointed material. For slopes less than the optimum slope, normalized joint strength decreased slightly. As the scarf slope increased from the optimum value, normalized joint strength decreased to a value of about 0.35 for a vertical scarf (butt) joint.

Keywords: Scarf joints, oriented strandboard, tensile strength, glued joints.

INTRODUCTION

Oriented strandboard (OSB) is a relatively new construction material. Until recently, OSB has been used primarily in residential construction such as subflooring, wall and roof sheathing where specific engineering design is not required. The use of OSB in engineered applications has increased due to the continued improvement of mechanical and physical properties and the availability of some design specifications. In Canada, the publication of design specifications so far is limited to material properties and nailed joint performance. Since OSB is also widely used in fabrication of glued engineered wood building systems such as wood I-joists and stress-skin panels, it is of use to the design community that corresponding design information on glued joints be available.

Scarf joints were first used in structural applications in the manufacture of glulam members (Jokerst 1981). The effects of scarf slope on strengths of scarf solid wood joints were studied by Richards and Goodrick (1959) and Jessome (1965). In general, strength decreased exponentially with increasing scarf slope. These researchers found that a scarf slope of 1 in 20 could retain 95% of clear wood strength in tension. Because of practical concerns related to wastage of material and difficulties in producing good quality scarf joints, they have largely been replaced by finger joints. In effect, a finger joint can be regarded as a series of short scarf joints.

For panel products, finger joints are difficult to produce because of the relatively small thickness. Scarf joints are more commonly used. For example, plywood scarf joints have been used in providing a continuous skin in the manufacturing of stress-skin panels. Patterson (1964) compared strengths of finger and scarf plywood joints subjected to tension and bending force. Various panel thicknesses (8 mm, 10 mm, 15 mm) and joint slopes (1 in 6, 1 in 8, and 1 in 10) were investigated. Normalized joint strength, which is defined as ratio of joint strength over material strength, ranged from 0.66 to 0.93. The major conclusions from his study are:

1. Panel thickness does not influence normalized joint strength.
2. Scarf joints have slightly higher strength than finger joints for the same panel thickness and joint slope.
3. Normalized strength increases moderately with decreasing joint slope.
4. Reduction in joint strength is higher for joints subjected to bending than tension.

In Canada, the timber design code (CSA 1994) provides strength reduction factors for scarf plywood joints but not OSB joints. the objective of this study is to produce corresponding information for OSB scarf joints.

MATERIALS AND METHODS

Material used in this study was 11-mm (7/16-in.) and 18-mm (23/32-in) thick O2 grade (CSA 1993) OSB. The OSB panels were obtained from two Canadian manufacturers. The adhesive used for the joints was a resorcinol formaldehyde meeting the requirements of CSA standard O122 (CSA 1977). Five joint configurations were tested: butt, 1 in 4, 1 in 6, 1 in 8, and 1 in 10 scarf joints. A control group of unjointed specimens was tested for each thickness. For each test group, thirty replicates were tested, with each supplier providing half the replicates. A total of 60 unjointed and 300 joint specimens were tested.

The scarf joint specimens were prepared using a clamping pressure of 1 MPa (150 psi) applied normal to the plane of the board. For the butt joints, an end pressure of 0.33 MPa (50 psi) was applied during glue curing. The pressure was maintained for a period of 24 h at a temperature of about 30°C. Thereafter, the joint specimens were wrapped in plastic to preserve the initial moisture condition and stored under a constant temperature of 20°C for a minimum of 3 weeks prior to testing. All tests were conducted using a Metriguard tension tester. The grip length was approximately 300 mm. The loading rate was selected to have failure at about 3 ± 2 min. Specimen size and shape are as described in Fig. 1. The specimens were shaped as illustrated in Fig. 1 to ensure that failure occurred in the central portion of the joint area. To minimize the possibility of 'size' effects of material outside of a scarf joint, the straight portion of the shaped region was maintained at a length equal to the joint length plus 100 mm. All tests were conducted with the load applied parallel to the major axis of the panel.

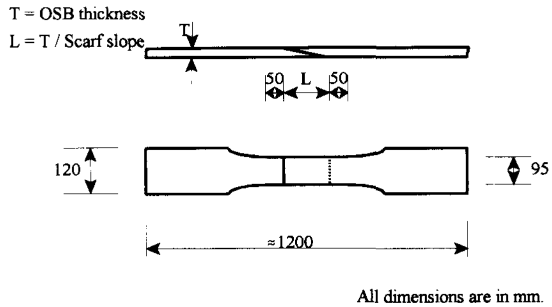

FIG. 1. Dimensions of test specimens.

RESULTS AND DISCUSSION

Summary statistics for test strengths are presented in Table 1. Figure 2 compares graphically the numerical strengths of joints for all combinations of manufacturer and thickness. It can be observed that specimens made from panels supplied by Manufacturer 1 had significantly higher material and joint strengths than corresponding specimens from Manufacturer 2. As expected, the thicker OSB specimens had lower material and joint strengths compared with the thinner OSB. Also presented in Table 1 is the normalized joint strength, which is defined as the average joint strength divided by the average tensile strength of the material. Scarf joint strength approaches that of the material strength when the scarf slope is less than 1 in 6. For the butt joints, they retained approximately 32–38% of the material strength.

As stated above, the ultimate objective of this study is to produce engineering design information for structural OSB scarf joints in the Canadian timber design code (CSA 1994).

TABLE 1. *Summary statistics for strengths and normalized joint strengths of OSB and OSB scarf joints.*

OSB thickness	Specimen type	Manufacturer 1 Strength* (MPa)	Manufacturer 1 Normalized strength	Manufacturer 2 Strength* (MPa)	Manufacturer 2 Normalized strength
11 mm	Material	15.27 (1.62)	1.00	13.46 (1.27)	1.00
	Butt	6.28 (0.8)	0.41	5.05 (0.65)	0.38
	1 : 4	12.31 (2.8)	0.81	10.81 (1.51)	0.80
	1 : 6	15.18 (1.6)	0.99	14.14 (1.77)	1.05
	1 : 8	14.64 (2.22)	0.96	13.4 (1.47)	1.00
	1 : 10	14.18 (1.05)	0.93	13.7 (1.8)	1.02
18 mm	Material	14.92 (1.0)	1.00	11.62 (2.08)	1.00
	Butt	4.86 (0.67)	0.33	3.67 (0.96)	0.32
	1 : 4	12.33 (2.4)	0.83	10.09 (2.38)	0.87
	1 : 6	14.7 (1.47)	0.99	10.88 (1.35)	0.94
	1 : 8	15.33 (1.24)	1.03	11.74 (2.1)	1.01
	1 : 10	13.81 (1.66)	0.93	11.21 (2.06)	0.96

* Values given are means with standard deviations given in parentheses.

The current design information for structural plywood takes the form of a normalized strength factor that is applied to the design tensile stress of the material—hence the presentation of the normalized strength information in Table 1 and Fig. 3. It can be noted in Fig. 3 that despite the relatively large differences in joint strengths between the two thicknesses and manufacturers, the relationship between normalized strength and scarf slope appears unaffected by these parameters. All four curves basically follow the same trend.

Also plotted in Fig. 3 is the corresponding design normalized tensile strength for plywood joints given in the Canadian timber design code (CSA 1994). The design normalized tensile strength for plywood is applicable to all structural grade plywood regardless of board thickness and ply arrangement. As stated above, a similar finding that normalized strength is insensitive to board thickness was also observed in this study. Figure 3 also indicates that the test normalized tensile strength values for OSB scarf joints are higher than the

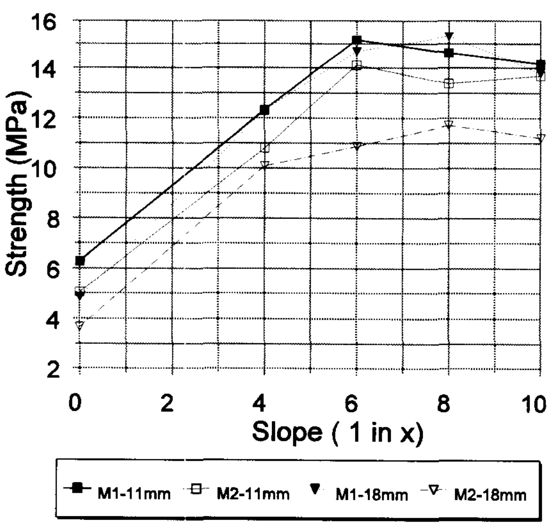

FIG. 2. Variation of joint strength with scarf slope.

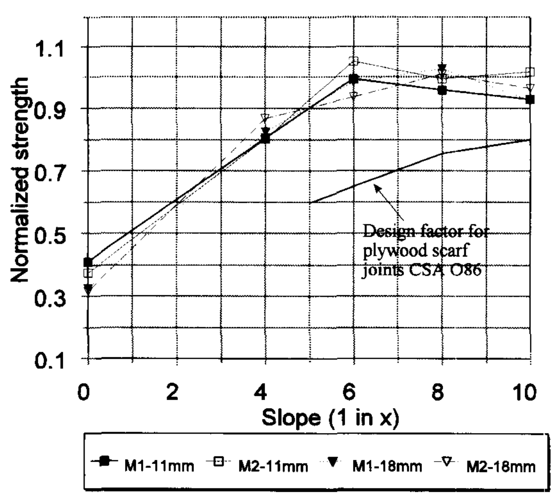

FIG. 3. Variation of normalized joint strength with scarf slope.

corresponding design factors for plywood. However, plywood design factors in the Canadian timber design code (CSA 1994) may well be conservative estimates to take into consideration factors such as workmanship.

Another observation from Fig. 3 is that there appears to be an optimum scarf slope for each thickness. The optimum scarf slopes are approximately 1 in 6 and 1 in 8 for the 11-mm and 18-mm boards, respectively. At the optimum slope, the normalized strength is approximately one, indicating no loss in strength. As the scarf slope decreases, there is a slight drop in normalized strength. This is probably due to the flaky nature of the OSB material, which has a tendency for the flakes at a thin scarf tip to break off causing a smaller bonding area. This effect was more pronounced for small scarf slope.

CONCLUSIONS

For scarf OSB joints subjected to a tensile force parallel to the major axis of the panel, the relationship between normalized strength and scarf slope is independent of board thickness and manufacturers, within the range of board thicknesses tested in this study. Normalized strength increases linearly from about 0.35 for a butt joint to an optimum value of 1 at a slope of about 1 in 7. No benefits can be gained by decreasing the scarf slope from the optimum value since the normalized strength decreases slightly thereafter.

ACKNOWLEDGMENTS

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