Mokchae Konghak 36(2) : 56~62, 2008

Characteristics of Surface Strand Orientation and Strand Mat Thickness Variation and Its Effect on the Bending Properties of Commercial OSB*[1]

Sei Chang Oh*[2]†

ABSTRACT

The surface and edge structure of OSB is defined by surface strand orientation and strand mat thickness variation parallel to the length of the panel using video-microscope. The bending strength of OSB was correlated with surface strand orientation and decreased with increasing the orientation angle in the direction parallel to length of the panel. Average strand mat thickness variation parallel to the length of the panel did not influence the bending strength, but the bonding characteristics among the outermost strands affects the bending strength of OSB. Hankinson formula can be used to predicts the MOE according to strand orientation in the surface of OSB, and more precise strand alignment and reducing thickness variation should be important in the structural performance of OSB panels.

Keywords : OSB, bending strength, strand orientation, strand mat thickness, hankinson formula

1. INTRODUCTION

Oriented Strand Board (OSB) is an engineered wood product and commonly used as a sheathing material for roof and wall structure. As the wood construction market is fast growing in Korea, OSB is taking a main position of the structural panel applications. OSB is made of wood strands that are arranged some degree of orientation with respect to major panel axis. Similarly to plywood, OSB is composed of cross laminates in adjacent layers and the strand in surface of OSB is oriented along the major panel axis and core is oriented 90° to the major panel axis.

It is well known that the strength of OSB is strongly related to specific gravity, void contents and orientation of strand. The variation of specific gravity within the panel has to be controlled as small as possible in manufacture. The density variation within the panel and the effect of the density variation on panel strength were studied (Suchsland and Xu, 1989; Lang and Wolcott, 1996; Dai and Steiner, 1997; Kruse, 2000). Also, void effects of OSB were investigated (Dai and Steiner, 1993; Lenth and

*1 Received on March 6, 2008; accepted on March 13, 2008.
This research was supported by the Daegu University Research Grant, 2005
*2 Department of Forest Resources, College of Life and Environmental Science, Daegu University, Kyongsan 712-714, Korea
† Corresponding author : Sei Chang Oh (osc@daegu.ac.kr)

Kamke, 1996; Wu, 2004). In general, the well arranged strands give good mechanical properties to OSB and this is a critical factor in manufacturing of OSB. In spite of small variation of specific gravity within panel under controlled condition, it is difficult to say that the specific gravity fully affects mechanical properties of OSB. Recently several researches dealted with strand orientation using image analysis (Nishimura, etc., 2001, 2002, 2004). As noted previous study, the bending strength of OSB is affected by surface strand orientation where the bending moment is highest and the strand orientation is an important factor. The core layer oriented to 90° to major axis contributes little to bending properties and the orientation of surface strand and strand mat thickness will affects strength of OSB.

Most of research focused on the effect of horizontal density variation, strand shape and size, void contents on the strength of OSB, but it is still not fully understand the effect of strand mat thickness variation and strand orientation. The purpose of this paper is to present a relationship among strand mat thickness variation, strand orientation and bending properties of OSB. The strand mat thickness variation parallel to the length of the panel, strand orientation is measured using video-microscope, and the results provide characterization and prediction of the strength properties of OSB.

2. MATERIALS and METHOD

2.1. Test Materials

The commercial OSB commonly used for structural application were chosen for the test. OSB grade was 24/16, 12 mm (15/32") and Exposure 1. Product standards are PS 2-92 and CSA 0325. Bending test specimens were cut from the panels along and across its length parallel to long direction of the panels. Specimen size was 50 mm in width, 500 mm in length for specimens with along the panel length, and 250 mm in length for specimens with across the panel length respectively, and 12 mm in thickness.

2.2. Measurement of Strand Orientation and Strand Mat Thickness Parallel to the Length of the Panel

The video microscope was used to determine the strand orientation and strand mat thickness parallel to the length of the panel. The strand orientation was measured with an angle in strands major axis to along the major axis (length) of the panels. The strand major axis were its center parallel to their long dimension of the strand. The measurement was done on each specimen’s face and back side. After capture the image, the angle was determined using analysis software. Thickness of surface layer was determined at 5 mm intervals in the middle portion of the specimens. It was predicted that bending failure would be occurred within the middle portion of the specimens, +／－3 cm from the center was chosen to measure the strand mat thickness parallel to the length of the panel.

2.3. Bending Test of Test Specimens

After measurement of strand orientation and strand mat thickness parallel to the length of the panel, bending test was conducted for each specimens. The bending strength and MOE in the along and across direction of the panels were determined by three point bending test. The test speed was 5 mm/min and span length was 350 mm for along and 230 mm for across direction, respectively. After test, specific grav-

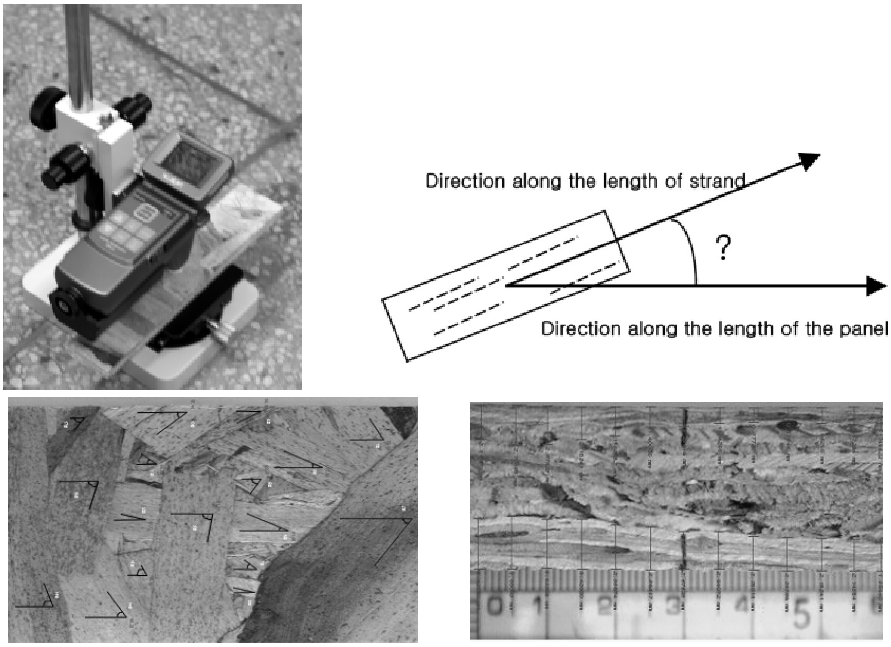


Fig. 1. Schematics of determination of strand orientation and surface thickness.

ity was determined by the samples cut from the undamaged part of the ruptured specimens.

3. RESULTS and DISCUSSION

3.1. Strand Orientation in Test Specimens

The results for strand orientation in face and back of OSB were in Fig. 1 and Fig. 2. As indicated Fig. 1, most of strand were aligned along the major axis and 67% of all strand were oriented less than 20° to the major axis. The major axis means long direction of the panels. 10～20° strand orientation was highest in the face and back of the tested panels and 90° strand orientation was not found in the face. Some strand orientation over the 40° were found and this was due to small strand that were difficult to align in forming stage. This means large strands seem to have a better in strand orientation rather than smaller strands and small strand is difficult to orient desired direction.

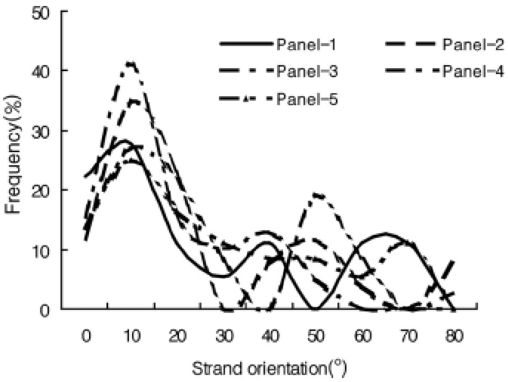


Fig. 2. The strand orientation angle distribution of each panel.

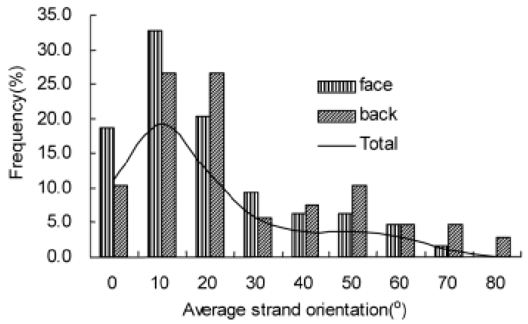


Fig. 3. Average strand orientation distribution.

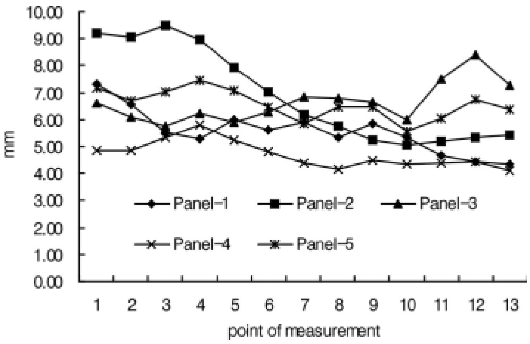


Fig. 4. Mean surface thickness variation along the length of each specimens.

Table 1. Test results of surface thickness variation of the test specimens (mm)

Panel No.	Face		Back		Total	
	Mean	COV	Mean	COV	Mean	COV
1	2.15	0.25	3.40	0.14	5.55	0.15
2	2.51	0.37	4.40	0.21	6.91	0.26
3	3.42	0.09	3.22	0.17	6.64	0.11
4	2.24	0.21	2.48	0.19	4.71	0.11
5	3.12	0.15	3.44	0.05	6.56	0.08

* Total average : 6.07 mm

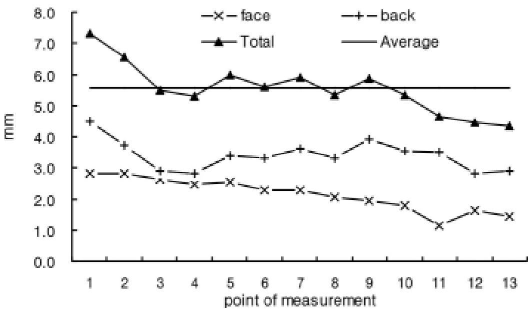


Fig. 5. Surface thickness variation along the length of the panel in +/-30 mm at the center of the specimen-1.

3.2. Surface Thickness Variation in Test Specimens

Surface thickness was determined as the thickness of deposited strand layers parallel to the length of the panel. The results were Table 1. In general, face strand layer thickness was less than backside strand layer thickness and the difference was highest in panel No. 2 and this panel showed the highest mean surface layer thickness and coefficient of variation (COV) among the test panels. Total mean surface layer thickness was 6.07 mm and this is the about half of the panel thickness.

Within the panel, the thickness variation seems to lead strength variation in one panel. Also, this also leads to have a tendency that density variation within the panel is more variable than expected. Within the one panel, the thickness variation in face, back was plotted in Fig. 5. From point to point, the thickness variation was more in face rather than back, and middle position showed less variable than outer portion.

3.3. Bending Properties of Test Specimens According to Strand Orientation and Surface Thickness

The bending strength showed good correlation with MOE. Moreover, the bending strength was appeared to be a negative correlation (r = 0.43) with strand orientation. This was plotted

Table 2. Test results of bending test

Panel No.	Bending		Strand orientation	Surface thickness
	MOR (Mpa)	MOE (Gpa)		
1	18.3	1881	29.77	5.55
2	20.5	1945	41.20	6.91
3	15.1	1769	29.89	6.64
4	23.5	2181	32.68	4.71
5	14.3	1674	37.31	6.56

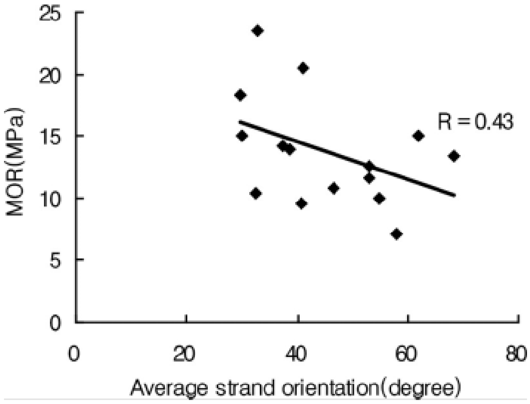
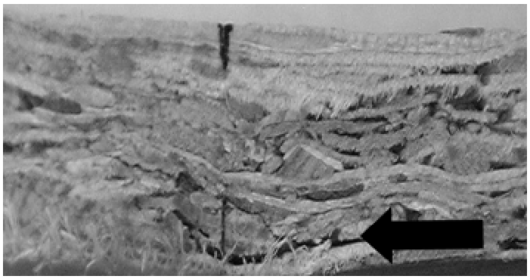


Fig. 6. Correlation between strand orientation and bending strength (MOR).

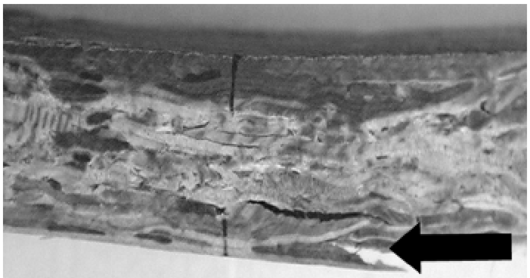
in Fig. 5. This tendency was very similar with Nishimura (2001)'s results and he suggested that better axial orientation should improve the bending strength.

The bending strength showed negative correlation with surface thickness. But this is the average values and the failure of OSB depends on strand alignment and surface mat structure. No. 3 panel was thick in surface mat, but the strength was low due to the cleavage in the outermost strands (Fig. 7(a)). This means poor adhesion between strands and better adhesion in surface layer should be needed to improve strength properties of OSB (Fig. 7).

Relationship between strand orientation and



(a)



(b)

Fig. 7. Failure in outertmost strand layer.

MOE was plotted in Fig. 8. MOE parallel to the length of the panel was decreased with the increasing the strand orientation angle, but the relationship was low correlated. Nevertheless low correlation, MOE values was greater than predicted values by Hankinson's formula. So, this formula predicts MOEs as a function of orientation angle and expressed as follows:

$$E_\theta = \frac{E_L \cdot E_T}{E_L \sin^2\theta + E_T \cos^2\theta}$$

Where E_L and E_T are the MOE of the parallel and across to the length of the panel. The elastic parameters were taken from the bending test results. Most of test results were accepted to predict the MOE according to grain orientation, and Hankinson formula can be used to predict MOE with the strand orientation of the OSB panels. From the results, it is possible to predict

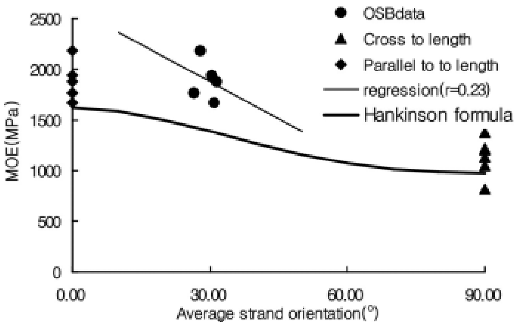


Fig. 8. Relationship between strand orientation and MOE.

approximately the MOE of OSB by checking the surface strand alignment. As indicated by Xu and Suchland (1998), the parallel orientation to grain improves MOE but reduces MOE across the grain direction levels off about 50～60%. Test results also showed similar tendency and verified Hankinson formula.

4. CONCLUSION

The strand alignment is the main factor in the structural performance of OSB and the strand alignment has been measured videomicroscope. Also, the relationship between strand orientation and bending strength was investigated and following results were obtained.

1) Most of strands were aligned along the major axis and 67% of all strand were oriented less than 20° to the major axis in the direction of parallel to the length of the OSB.

2) The face thickness of strand layer parallel to the length of the OSB was less than that of backside thickness in general and total average surface layer thickness was 6.07 mm and this is the about half of the panel thickness.

3) The bending strength of OSB showed good correlation with modulus of elasticity and the bending strength was appeared to be a negative correlation (r = 0.43) with strand orientation.

4) Hankinson formula can be used to predict MOE with the surface strand orientation of the OSB panels.

REFERENCES

1. Dai, C. and P. R. Steiner. 1993. Compression behavior of randomly formed wood flake mats. Wood and Fiber Science 25(4): 349～358.
2. Dai, C. and P. R. Steiner. 1997. On horizontal density variations in randomly formed short fibre wood composite board. Composites part A. 28A. 57～64
3. Kruse, K, C. Dai, and A. Pielasch. 2000. An analysis of strand and horizontal density distributions in oriented strand board (OSB). Holz als Roh-und Werkstoff 58: 270～277
4. Lang, E. M. and M. P. Wolcott. 1996. A model for viscoelastic consolidation of wood strand mat. Part 1. Structural characterization of the mat via monte carlo simulation. Wood and Fiber Science 28(1): 100～109.
5. Lenth, A. Christopher, and F. Kamke. 1996. Investigations of flakeboard mat consolidation. Part 1. Characterizing the cellular structure. Wood and Fiber Science 28(2): 153～167.
6. Sharma, V. and A. Sharon. 1993. Optimal orientation of flakes in oriented strand board (OSB). Experimental Mechanics, June 1993: 91～98
7. Suchland, O. and H. Xu. 1989. A simulation of the horizontal density distributions in flake board. Forest Prod. J.39(5): 29～33
8. Nishimura, T., M. P. Ansell, and N. Ando. 2001. The relationship between the arrangement of wood strand at the surface of OSB and modulus of rupture determined by image analysis. Wood Science and Technology 35: 555～562
9. Nishimura, T., M. P. Ansell, and N. Ando 2002. Evaluation of the arrangement of wood strands at the surface of OSB by image analysis. Wood Science and Technology 36: 93～99
10. Nishimura, T. and M. P. Ansell. 2002. Monitoring fiber orientation in OSB during production using filtered image analysis. Wood Science and Technology 36: 229～239
11. Nishimura, T., J. Amin, and M. P. Ansell. 2004.

Image analysis and bending properties of model OSB panels as a function of strand distribution, shape and size. Wood Science and Technology 38: 297～309
12. Xu, W. and O. Suchland. 1998. Modulus of elasticity of wood composite panels with a uniform vertical density profile: a model. Wood and Fiber Science 30(3): 293～300.
13. Wu, Q., J. N. Lee, and G. Han. 2004. The influence of voids on the engineering constants of oriented strand board: A finite element model. Wood and Fiber Science 36(1): 71～83.