Surface Quality of Commercially Manufactured Particleboard Panels in Indonesia

Salim Hiziroglu, Yusuf Sudo Hadi, and Dede Hermawan

Abstract

This study is an attempt to evaluate surface roughness of commercially manufactured particleboard in Indonesia. Four different types of particleboard panels were used to measure their surface roughness on a stylus type of profilometer. Three roughness parameters, namely average roughness (R_a), mean peak-to-valley height (R_z), and maximum roughness (R_{max}) were employed to quantify roughness of the samples. Panel type-D had the roughest surface characteristics with an average R_a value of 14.20 μm while panel type-A had the smoothest corresponding value of 6.13 μm. Panel types C and D had relatively rough surface as compared to surface of typical commercially manufactured particleboard panels due to having large particles on the surface layers. In further studies surface roughness of such samples could be investigated following a sequence of sanding process to improve their surface qualities.

Key words: particleboard, Indonesia, surface roughness.

Introduction

Over harvesting and increasing demand for wood products significantly influenced wood based panel industry in Indonesia. Currently low quality Dipterocarp such as Shorea and Rubberwood (*Hevea brasilensis*) are main raw material resources in addition to waste from plywood and lumber manufacturers to produce particleboard. Average production capacity of particleboard in Indonesia is 349,000 m^3 /year from 2001 to 2005 (Anonymous, 2005a; Anonymous 2005b). Average export capacity for above period is 120,000 m^3/year having approximately 34% of total production capacity (Anonymous 2006; Sutigno 1997). Asian countries including South Korea, Taiwan, Hong Kong, Vietnam, and Malaysia are main export destinations. Most of particleboard produced in Indonesia is used as substrate for thin veneer and paper overlays for furniture and cabinet industry. When particleboard is used as substrate for such thin overlays their surface characteristics in terms of roughness play an important role in determining quality of final product. In general the degree of surface roughness is a function of both raw material characteristics such as species, particle size, fiber distribution and manufacturing variables including press parameters, resin content, face layer densification and sanding process of the panels. There are various methods to evaluate surface roughness of composite panels which include acoustic emission, pneumatic, laser, and stylus (Faust 1987; Hiziroglu and Kosonkorn 2006; Hiziroglu and Baba 1999; Peter and Cumming 1970). The stylus techniques is widely used and well established to quantify surface roughness of industrial metal and plastic parts. The main advantage of stylus method is having standard numerical parameters and profile of the surface. Variables such as stylus tip radius, the surface force produced by the stylus, and cut-off length can be controlled to have accurate information about the surface. Applications of stylus techniques in determining surface of wood and wood composites were discussed in several past studies (Hiziroglu *et al.* 2004; Ho 1993; Hoag 1992; Stombo 1963). Currently there is no information about surface roughness of commercially produced particleboard panels in Indonesia. Therefore the objective of this study is to evaluate surface roughness of particleboard using a stylus tracing method to provide an initial data to Indonesian wood based panel manufacturers.

Material and Method

A total of 40 samples from four types of particleboard panels manufactured by different producers were used for roughness measurements. Four samples in 50 mm by 50 mm and their thickness ranging from 9 mm to 15 mm from each type of panel were randomly selected for the tests. The specimens were conditioned in a room with a temperature of 21°C and relative humidity of 65 % before any measurements were carried out. Table 1 displays properties of the samples. Fourteen roughness measurements seven along and seven across the sandmark with a span of 13 mm were taken from each side of panel type-A, type-B and type-C. Since panel type-D has not been sanded random fourteen measurements were taken from both surfaces.

Table 1. Characteristics of the samples.

Panel Type	Thickness (mm)	Density (g/cm^3)	Raw material
PB-A	15	0.73	Rubberwood
PB-B	9	0.75	Rubberwood
PB-C	12	0.74	Mixed hardwood
PB-D	12	0.76	Rubberwood

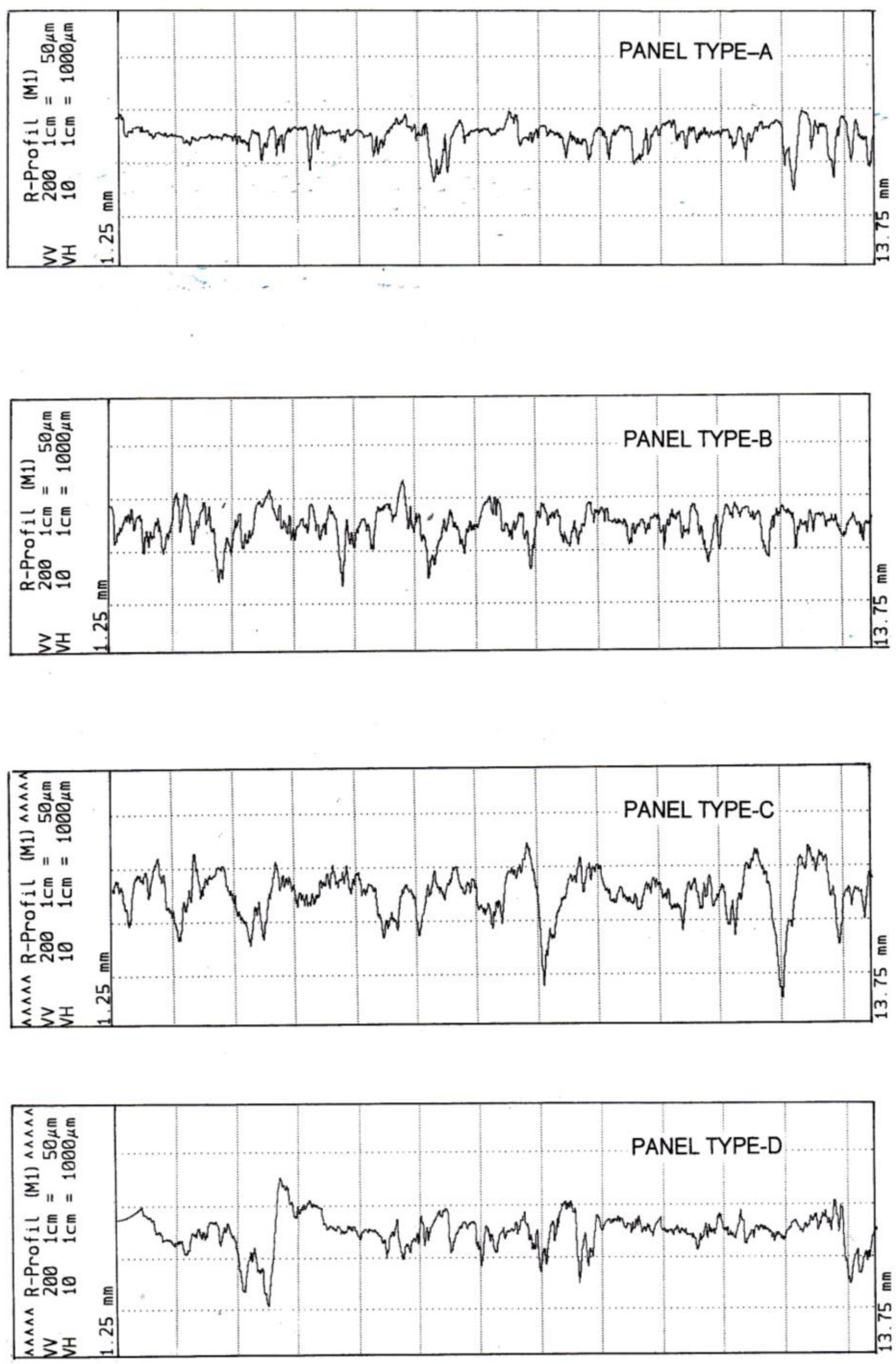

Figure 1. Typical roughness profiles of particleboard samples.

Table 2. Results of roughness measurements.

Panel Type	R_a// (μm)	R_z// (μm)	R_{max}// (μm)	R_a-/ (μm)	R_z-/ (μm)	R_{max}-/ (μm)	Average R_a (μm)	Average R_z (μm)	Average R_{max} (μm)
PB-A	6.13 (0.75)	40.14 (6.72)	79.20 (9.30)	7.39 (0.81)	43.70 (6.22)	86.13 (8.20)	6.76 (0.78)	41.92 (6.47)	82.66 (8.75)
PB-B	9.23 (0.83)	55.20 (5.99)	86.92 (6.71)	13.10 (0.78)	63.14 (6.31)	94.91 (9.02)	11.16 (0.80)	59.17 (6.15)	90.51 (6.36)
PB-C	12.30 (0.85)	59.29 (7.79)	95.92 (8.90)	14.20 (0.84)	60.46 (9.34)	102.90 (9.10)	13.25 (0.84)	59.96 (8.56)	99.41 (9.00)
PB-D	-	-	-	-	-	-	14.66 (0.67)	65.76 (6.80)	118.67 (8.76)

(Values in parentheses are standard deviation)

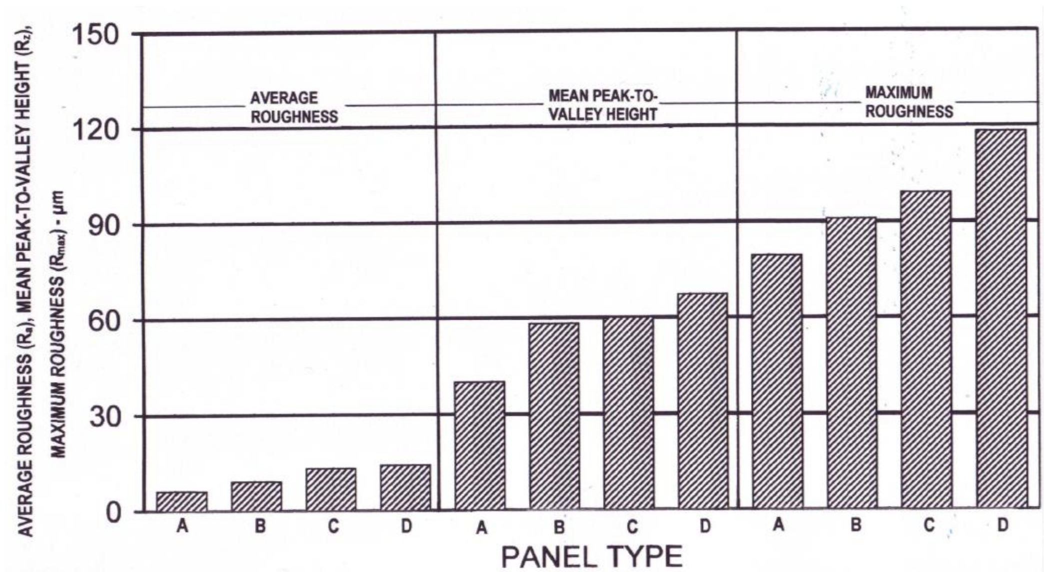

Figure 2. Average roughness values of the samples.

In the case of sanded samples sandmark for both types of panels was identified using a China marker prior the measurements. A portable stylus type profilometer the Tester T-500 unit was employed for the roughness tests. The profilometer consists of main unit and pick-up which has a skid type diamond stylus with a 5 μm radius and 90˚ tip angle. The stylus traverses the surface at a constant speed of 1 mm/s over 13 mm tracing length (Hiziroglu *et al.* 2004). Vertical displacement of the stylus is converted into an electrical signal by a linear displacement of detector prior the signals are amplified and transferred into digital information. Standard roughness parameters including average roughness (R_a) and mean peak-to-valley height (R_z) and maximum roughness (R_{max}) can be calculated from the digital information. Definitions of these three parameters were discussed in details in previous studies (ANSI 1985; Drew 1992; Mummery 1991). Figures 1 illustrates typical surface profiles of particleboard samples along the sandmarks.

Results and Discussion

Average values of R_a, R_z, and R_{max} parameters taken from the surface of the samples are presented in Table 2. Average R_a values of 6.13 μm and 14.20 μm were found as the smoothest and the roughest surfaces for particleboard panel types D and B, respectively. Overall average R_a was found as 10.12 μm for particleboard samples which can be considered as rough surface for a typical particleboard panel. In a previous study carried out to determine surface roughness of commercially manufactured Thai particleboard resulted in an average R_a value of 8.2 μm (Hiziroglu *et al.* 2004). Among the specimen panel type-A was produced using with higher resin content on the face layers which resulted in relatively smooth surface with an average R_a value of 6.13 µm. Due to more densification of the face layers. Measurements taken along and across sandmark directions of the panels showed significant difference from each other in the case of panel type-B and type-D at 95 percent confidence level. The highest difference between R_a values taken in two sandmark directions was only 8.7 percent as in the case of panel type-D. Overall R_z and R_{max} measurements of the surfaces were consistent with the R_a values and followed the similar trend to that of R_a in all cases.

Conclusion

The results of this work showed that stylus profilometer can be used to evaluate surface roughness variation due to sanding operation. Based on the initial findings of the experiments it appears that panel's types A and B had acceptable roughness characteristics as compared to those of manufactured at different countries. In further studies of additional parameters such as core roughness (R_k), reduced valley depth (R_{vk}) can be used to evaluate surface of the panels. Also determining surface stability of the samples overlaid with different papers and exposed to various relative humidity levels could provide detailed information about behavior of surface characteristics of the panels as function of variation in environment.

Acknowledgement

Partial funding provided by the United States-Indonesia Society (USINDO) to carry out this experimental study is greatly appreciated.

References

American National Standard Institute (ANSI). 1985. B64.1. Surface Texture (Surface Roughness, Waviness and Lay). New York, American Society of Mechanical Engineers. 43p.

Anonymous, 2005a. Forestry Statistics of Indonesia, Ministry of Forestry Indonesia, Jakarta, Indonesia.

Anonymous, 2005b. List of Forest and Estate Products Trade. Ministry of Industry, Jakarta, Indonesia.

Anonymous, 2006. Indonesian Statistics Center Agency. Indonesian Foreign Trade, Jakarta, Indonesia.

Drew, W.E. 1992. Surface Texture Measurement Errors, Stylus Type Instrument. Quality: October p.41-44.

Faust, T.D. 1987. Real Time Measurement of Veneer Surface Roughness by Image Analysis. Forest Products Journal 37(6): 34-40.

Hiziroglu S. and P. Kosonkorn. 2006. Evaluation of Thai Medium Density Fiberboard (MDF). Journal of Building and Environment 41(4): 527-533.

Hiziroglu, S. and I. Baba. 1999. Surface Roughness Evaluation of Medium Density Fiberboard Manufactured in Malaysia. Journal of Tropical Forest Products 5(1): 93-97.

Hiziroglu. S.; S. Jarusombuti; V. Fueangvivat. 2004. Surface Characteristics of Wood Composites Manufactured in Thailand. Journal of Building and Environment (39): 1359-1364.

Ho, K.S. 1993. The Effect of Planning Variables on Surface Texture of Meranti. Research Phamplet No 117, Kepong. Forest Research Institute Malaysia. 25p.

Hoag, M. 1992. Surface Testing of Particleboard and Medium Density Fiberboard for Laminating Applications. Tappi Journal (75): 116-121.

Mummery L. 1991. Surface Texture Analysis. The Handbook, Muhlhausen, Germany, Hommelwelke. 106 p.

Peter, C.C. and J.D. Cumming. 1970. Measuring Wood Surface Smoothness: A review. Forest Products Journal 20(12): 40-43.

Sutigno, P. 1997. The Development of Composite Products Industry in Indonesia: An Achievement in Indonesia. Ministry of Forestry, Jakarta, Indonesia.

Stombo, D.A. 1963. Surface Texture, Measuring Methods. Forest Products Journal 12(7): 299-303.

Received : 11 December 2007
Accepted : 14 December 2007
Final revision : 7 January 2008

Salim Hiziroglu
Department of Natural Resource Ecology and Management
Oklahoma State University
Stillwater, Oklahoma 74078-6013, USA
Phone : (405)744-5445
Fax : (405)744-3530
E-Mail : salim.hiziroglu@okstate.edu

Yusuf Sudo Hadi
Bogor Agricultural University (IPB)
Campus IPB Darmaga, Bogor, 16680, Indonesia
Phone/Fax : 62-251-621-677
E-mail : yshadi@indo.net.id

Dede Hermawan
Bogor Agricultural University (IPB)
Campus IPB Darmaga, Bogor, 16680, Indonesia
Phone : 62 251-620582
E-mail :dede_her@ipb.ac.id