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Effects of mat moisture content and press closing speed on the formation of density profile and properties of particleboard

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Abstract Isocyanate resin-bonded 0.5 and 0.7 g/cm^3 lauan (*Shorea* sp.) particleboards were produced from mats with uniform and distributed moisture content (MC) distributions, using three hot press closing speeds. The effects of these processing variables on the formation of density profile in particleboard and board properties were analyzed statistically. A definition of the density profile was introduced, and the correlations among the various defining factors were established. The results are summarized as follows. (1) The peak density (PD) of particleboard could be increased, with a slight reduction in the core density (CD), using mats with different MC distributions. (2) In a conventional density profile, CD and PD are highly dependent on the board mean density (MD); and the gradient factor (GF), peak distance from the faces (Pdi), and peak base (Pb) are significantly correlated to each other, at the 99% significance level. (3) Greater press closing speed reduces Pdi and Pb, with an increase in GF. (4) Greater press closing speed could increase the PD in board of low MD, with minimal effect on CD. (5) The modulus of elasticity (MOE) of particleboards from mats with high MC near the faces were consistently higher than those from mats with uniform MC, irrespective of the press closing speed, whereas their modulus of rupture (MOR) became indifferent at higher MD under slow and fast closing speeds. (6) Sanding does not improve the MOR and MOE of particleboard significantly.

Key words Particleboard · Mat moisture content · Press closing speed · Density profile · Board properties

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Introduction

The behaviors of heat, moisture, and pressure during the hot pressing of dry-formed wood-based composites were investigated and modeled in earlier studies.[1–5] Attempts have also been made to model the vertical density profile of particleboard by simulating the hot pressing process.[6] Understanding the above processes could result in improved final product performance by producing board of optimum density profile via hot pressing process control. In this regard, the correlations among critical production variables, density profile formation, and its effects on board properties are crucial.

Our previous paper reported on the formation of density profile and its effects on the properties of particleboard, where the quantitative correlations between the properties and the density profile were established based on homo-profile and conventional particleboards.[7] The density profile of particleboard has long been the center of discussion where board properties, especially bending performances, are concerned.[8] Until recently the density profile of particleboard has been determined mostly by gravimetric methods, where the sample is weighed and measured repeatedly after removing thin layers from the surface.[8–11] Therefore, the main focus of density profile along the thickness of particle or fiber boards has been dominantly on the peak and core densities, which can be determined easily using the above method. Lately, nondestructive radiation-based measurement systems have been introduced, and it is possible to investigate the vertical density profile in greater detail with higher reliability.[12–15]

As a continuation from earlier work, this study investigates the effects of mat moisture content (MC) distribution and press closing speed on the formation of the density profile to establish the correlations among the various density profile-defining factors and the effects of these factors on the board properties. The effect of sanding on the bending performance of particleboard is also discussed.

Materials and methods

Raw materials

The raw material used in this study is the same as in the previous study, that is, lauan (*Shorea* spp.) particles with an air-dried density of $0.4 g/cm^3$ prepared using a knife-ring flaker and screened to exclude fines. To produce boards with more uniform properties, the particles used were relatively fine and uniform: 80% were of 0.13–0.61 mm thickness, 0.3–1.4 mm width, and 4–8 mm length. All particles were air-conditioned to 10% MC. To obtain particles with 20% MC the particles were sprayed with the required amount of water and kept in plastic bags for at least a week; 0% MC particles were prepared by oven-drying at about 60°C.

The resin adhesive used was polymeric isocyanate, UL4811, formulated by Gun-ei Chemical Corporation, at 8% resin content level based on the oven-dried weight of the particles. Twenty percent of acetone was added, based on the isocyanate resin, as resin diluent for better resin distribution.

Particleboard fabrication

Conventional particleboards of 350 × 400 × 12 mm were fabricated at 0.5 and $0.7 g/cm^3$ mean density (MD) levels using mats with different MC distributions, as summarized in Table 1. The particleboards were produced by hot pressing at 160°C for 3 min, and distance bars were used to control the final board thickness. In this experiment, the boards were pressed using a hot press of 200 tons capacity, and the maximum specific pressure exerted onto the mat during hot pressing was about $70 kgf/cm^2$.

In addition to the above processing conditions, the effect of press closing speed was also investigated by hot pressing boards of 10MC, MC20/0-1/8/1, and MC20/0-1/4/1 at three speeds [slow (1.3–1.6 mm/s), medium (2.1–2.9 mm/s), fast (3.2–4.0 mm/s)] for $0.5 g/cm^3$ boards and slow (1.3–1.5 mm/s), medium (2.3 mm/s), and fast (2.8–3.5 mm/s) for $0.7 g/cm^3$ boards. The press closing speed was varied by adjusting the flow controller on the hot press.

Evaluation of particleboards

For conventional evaluation of mechanical properties and dimensional stability, the particleboards were conditioned for 1 week under controlled temperature and relative humidity (RH) (20°C and 65 ± 5%, respectively). The unsanded boards were then tested based on the Japanese Industrial Standard for Particleboards (JIS A5908, 1994).

The static bending test was conducted on three specimens (a total of six specimens for two MC20/0-1/8/1-S boards) of 40 × 200 mm from each board, using a three-point bending test over an effective span of 180 mm, at a loading speed of 10 mm/min. For the wet bending test, the samples were boiled for 2 h followed by 1 h soaking in 20°C water and then tested while they were still wet. Four internal bond (IB) specimens with dimensions of 50 × 50 mm were prepared from each board. Prior to IB testing, the vertical density gradient of these specimens was determined using a density profiler (Institute of Geological and Nuclear Sciences, 1994), by means of gamma radiation transmitted through the sample along the thickness at intervals of 0.1 mm.

Four 50 × 50 mm test specimens were prepared from each sample board for thickness swelling (TS) and water absorption (WA) tests. In addition to the standard testing, the specimens were subjected to dimensional stability evaluation under the following dry/wet conditioning cycle: soaking in ambient-temperature water (20°C) for 24 h, oven-drying at 60°C for 72 h, soaking in 70°C water for 24 h, oven-drying at 60°C for 72 h, 4 h of boiling, oven-drying at 60°C for 72 h, and finally conditioning at 20°C and 65 ± 5% RH until equilibrium is reached.

Definition of density profile

In many cases where the vertical density profile is concerned, peak and core densities are regarded as the dominant factors affecting the properties of particleboard. However, the board properties may not be solely dependent on these individual factors; rather, they are affected by the interaction of these factors, in other words, the overall density profile. Consequently, an attempt is made here to define the density profile in greater detail, as illustrated in Fig. 1.

The peak density (PD) refers to the mean of the highest densities measured within each half of the profile. The core density (CD) is the average density of the central region situated within 20% of the total board thickness. The distance of the PD from the board surface is denoted by peak distance (Pdi), and the peak base (Pb) is the distance between the intersections of the density profile contour and the line of the MD. The gradient of the profile facing the core is expressed as the gradient factor (GF), which is the horizontal distance between the central line (CL), from the midpoint of the vertical distance between the PD and the CD to the profile contour. A large GF and Pdi with small Pb indicates a slimmer peak and vice versa. Peak area (PA) represents the area enclosed by the density profile contour above the MD. The density profile is assumed to be symmetrical on the two sides of the central board thickness. The discrete values of Pdi, GF, and Pb are means of the data from the two symmetrical halves and are, respectively,

Table 1. Distribution of moisture content in particle mats

Code	Moisture content (%) face : core : face	Particle proportion face : core : face
10MC	10[a]	–
MC20/0-1/4/1	20 : 0 : 20	1 : 4 : 1
MC20/0-1/8/1	20 : 0 : 20	1 : 8 : 1

MC, moisture content.
[a] Uniform MC distribution.

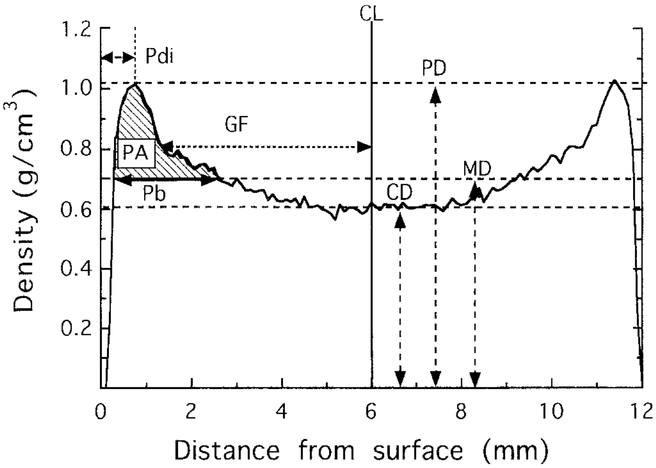

Fig. 1. Definition of density profile along the thickness of particleboard. *MD*, mean density; *PD*, peak density; *CD*, core density; *PA*, peak area; *CL*, central line; *GF*, gradient factor*; *Pdi*, peak distance*; *Pb*, peak base*; *values expressed as percent of the total board thickness

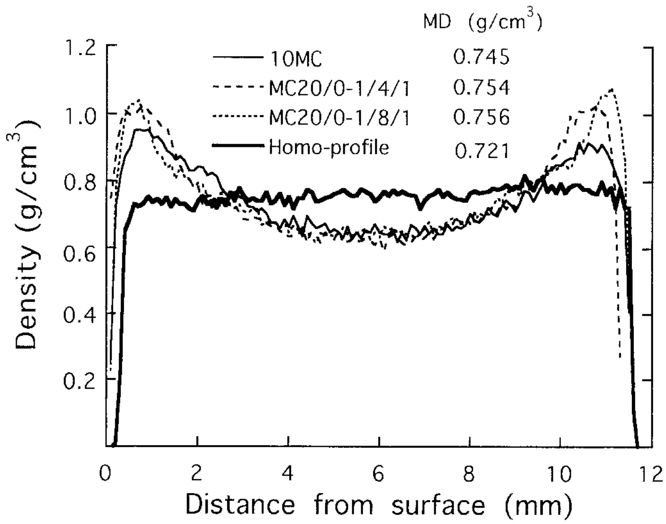

Fig. 2. Density profile of various types of particleboard. Refer to Table 1 for the codes. All boards were produced using medium closing speed

expressed as percentages of the total board thickness. A statistical analysis was conducted to investigate the correlations among the above-mentioned density profile-defining factors and their effects on the physical and mechanical properties of particleboards.

An attempt was also made to examine the effects of mat MC distribution and closing speed and to correlate the board properties with the above-mentioned density profile defining factors. Multiple regression analysis was used for this task.

Results and discussion

Effects of processing conditions on the density profile formation

Figure 2 shows the typical density profiles of particleboard produced from mats with uniform MC and distributed MC of 20:0:20% at 1:4:1 and 1:8:1 particle proportions in the faces and core. For reference, the density profiles obtained from the homo-profile boards fabricated in the earlier study[7] are also illustrated in Fig. 2. Similar to previous observations, MC20/0-1/8/1 has higher, slimmer peaks near the surface compared to uniform MC. Despite having similarmat MC distribution, MC20/0-1/4/1 boards were found to have a broader and slightly convex, rather than a concave, gradient on the peak contour facing the core region. The formation of this convex peak may be due to a greater reduction in compressive resistance at the comparatively thicker layer of high MC particles near the face and a sudden increase in resistance at the boundary of 0% MC core. This is also reflected in the board thickness, where MC20/0-1/4/1 boards are generally slightly thinner than the MC20/0-1/8/1 boards.

Figure 3 shows the effects of mat MC distribution and closing speed on the CD and PD in particleboard manufacturing. Particleboards produced from mats with different MC distribution have substantially higher PD and slightly lower CD compared to those with uniform MC, at both 0.5 and 0.7 g/cm^3 MD levels. In MC20/0-1/8/1 boards, the surface layers are more compressed owing to the plasticity of the moist chips, whereas the less compressible dry, brittle core remains more porous, giving rise to a higher contrast in face and core densities. Strickler reported that a high initial pressure resulted in high surface density and correspondingly low CD.[9]

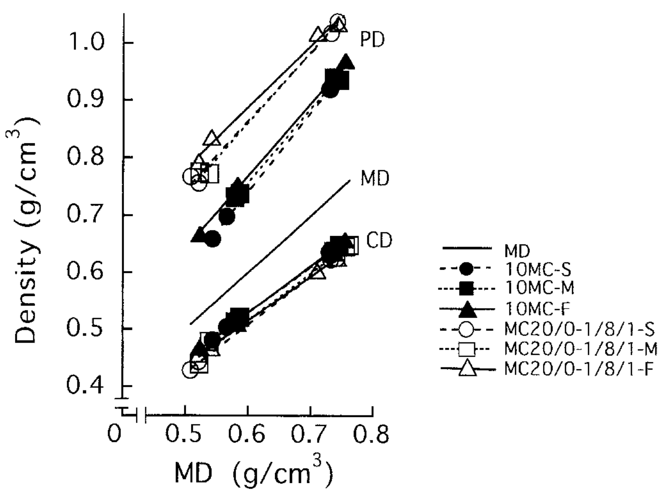

Fig. 3. Effects of mat moisture content (*MC*) distribution and press closing speed on core density (*CD*) and peak density (*PD*) of particleboard as related to the mean density (*MD*). Refer to Table 1 for the definitions of 10MC and MC20/0-1/8/1; *S*, *M*, and *F* represent slow, medium, and fast press closing speeds, respectively

In Fig. 3 it can be seen that with a similar mat MC distribution, a faster closing speed did increase the PD to a certain extent at 0.5 g/cm^3 MD, but this difference diminished as the board density increases. Figure 4 shows that there is a conspicuous difference in the rate of mat thickness

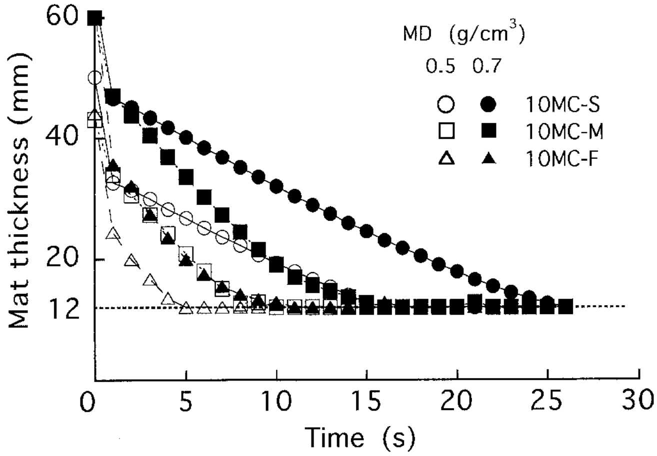

Fig. 4. Variation of mat thickness with respect to press closing time under different press closing speeds. Refer to Fig. 3 for the explanation of the codes

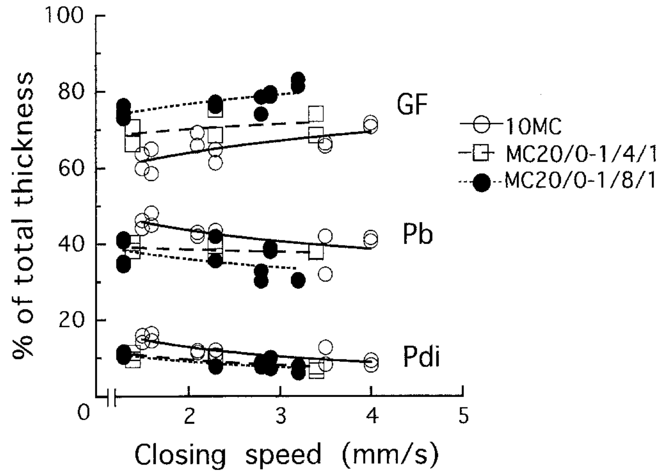

Fig. 5. Effect of press closing speed on gradient factor (*GF*), peak base (*Pb*), and peak distance (*Pdi*). Refer to Table 1 for the explanation of the codes

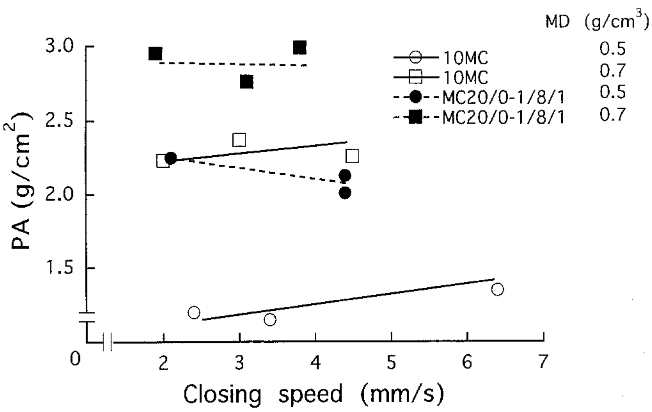

Fig. 6. Variation in peak area (*PA*) with press closing speed in different board categories. Refer to Table 1 for the explanation of the codes

reduction during hot pressing using different press closing speeds in both 0.5 and 0.7 g/cm^3 boards of 10MC. A similar trend was observed in MC20/0-1/8/1 boards, but this difference is reflected in the PD in 0.5 g/cm^3 boards, not in 0.7 g/cm^3 boards. In 0.5 g/cm^3 boards, heat was transferred to the core via convection, bringing about the hardening of resin and the density profile formation in the mat where a sufficient degree of interaction among heat, moisture, and pressure occurs. In 0.7 g/cm^3 boards, the permeability of the mat upon hot pressing is greatly reduced owing to the higher board density. Consequently, the rate of moisture and heat movement into the core did not vary much despite the change in press closing speed. Confinement of the heat to the surfaces resulted in the formation of similar PDs near the face, arising from a similar extent of element plasticization and bond strength development.

Comparing Figs. 3 and 4, it seems that the degree of initial impact on the mat during hot pressing has an effect on the PD. During the first second of press closure, the reduction in mat thickness for a fast closing speed is significantly greater than those with slow and medium closing speeds, as shown in Fig. 4. This difference is reflected in Fig. 3, where relatively higher PD was detected in boards produced using a fast closing speed.

Figure 5 illustrates the reduction in Pdi and Pb and the increment in GF as the closing speed increases. Based on statistical analysis, it was found that closing speed had a significant effect on the GF, Pdi, and Pb but not on the CD or PD, at the 95% significance level. Statistical analysis also revealed that, except for Pdi at fast closing speed, all the other density profile definers are affected by uneven distribution of MC in the mat at the 95% significance level at slow, medium, and fast closing speeds.

At similar MD, MC20/0-1/8/1 boards had a higher peak area (PA) above the MD level, compared to 10MC boards (Fig. 6). However, no specific trend of variation in PA for different closing speeds was recorded for all types of board. The PA in each individual MC distribution category did not differ much in general, despite the difference in closing speed. Based on the data acquired, it is still not possible to draw specific conclusions about the exact effect of press closing speed on PA.

Correlations among the density profile-defining factors

Table 2 summarizes the correlation analysis of the various density profile-defining factors. It was found that with a conventional density profile these factors could basically be classified into two main groups: [CD, PD, MD] and [GF, Pdi, Pb]. CD and PD are highly dependent on the MD of the board, whereas GF, Pdi, and Pb are significantly correlated to each other, at the 99% level. GF, however, is negatively correlated to CD at the 95% level. An increase in Pdi increases Pb significantly, and higher Pdi and Pb would result in a significant reduction in GF.

Based on the multiple regression analysis, the individual density profile-defining factors may be expressed in terms of the other profile factors:

Table 2. Correlations among various density profile-defining factors

Factor	MD	CD	PD	GF	Pdi	Pb
MD	1.0000					
CD	0.9896**	1.0000				
PD	0.9182**	0.8592**	1.0000			
GF	−0.3002	−0.3891*	0.0500	1.0000		
Pdi	−0.0246	0.0489	−0.2454	−0.7193**	1.0000	
Pb	0.0847	0.1657	−0.1806	−0.6796**	0.5902**	1.0000

MD, mean density; *CD*, core density; *PD*, peak density; *GF*, gradient factor; *Pdi*, peak distance; *Pb*, peak base.
*Significance level ≤95%; **significance level ≤99%.

$$CD = 0.41 + 1.0(MD) - 0.18(PD) \quad R^2 = 0.995$$
$$PD = -0.26 + 3.4(MD) + 0.005(GF) - 2.5(CD) \quad R^2 = 0.843$$
$$GF = 84 - 300(MD) - 0.97(Pdi) + 184(CD) + 104(PD) \quad R^2 = 0.896$$
$$Pdi = 31 - 0.29(GF) \quad R^2 = 0.517$$
$$Pb = 75 - 0.51(GF) \quad R^2 = 0.462$$

Selection of the factors was based on a minimum improvement of 1% in R^2 as each additional factor was included. From the expressions above, it can be seen that Pdi and Pb have a low correlation with other factors and are difficult to deduce based on other profile factors.

Effect of density profile on board properties

Involvement of too many factors makes it complicated to establish the correlations among processing variables, density profile definers, and board properties. To simplify the following discussion on the cause-and-effect of processing conditions and density profiles on particleboard properties, comparisons are limited to 10MC and MC20/0-1/8/1 boards produced using various press closing speeds, which are representatives of the main processing variables investigated in this study.

Bending properties

Theoretically, the top and bottom surfaces of the board bear most of the load during bending; thus the presence of higher density near the face means better bending performance. This point is clearly illustrated when comparing particleboards with a conventional density profile to those with a flat, homogeneous profile.[7]

The modulus of elasticity (MOE) of MC20/0-1/8/1 was consistently 11%–14% and 6%–8% higher than that of 10MC at 0.5 and 0.7 g/cm³, respectively, irrespective of the closing speed (Fig. 7). Despite this small difference in numerical values, statistical analysis revealed that the MOE of MC20/0-1/8/1 is significantly higher than that of 10MC at all closing speeds. As shown in Fig. 3, higher PD is obtained in MC20/0-1/8/1 boards than in 10MC boards. The consistent improvement in MOE with different closing speeds and MD levels in response to the increase in PD shows that MOE is sensitive to, and highly dependent on, the board PD.

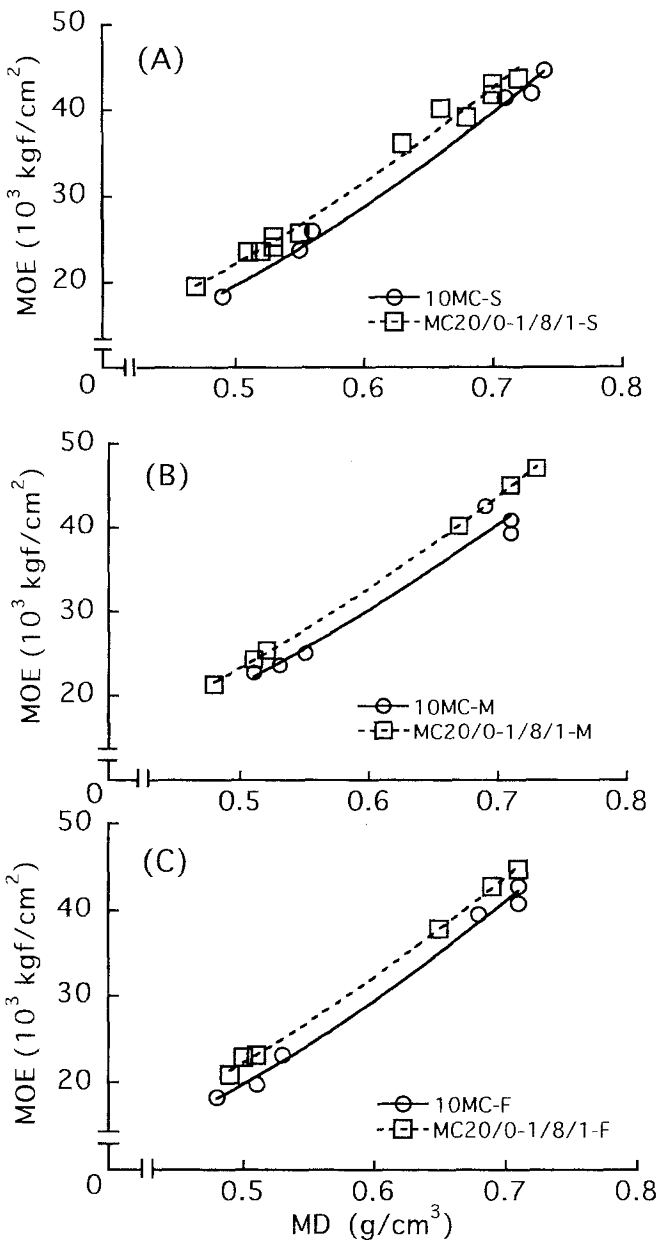

Fig. 7. MOE of 10MC and MC20/0-1/8/1 boards produced using slow (**A**), medium (**B**), and fast (**C**) press closing speeds. Refer to Fig. 3 for the explanation of the codes

Kollman et al.[16] concluded that bending strength reaches its maximum at a surface layer chip MC of 18%–20%, where raising the chip MC by conditioning is more effective than by spraying. In this study the extent of improvement arising from mat MC distribution was found to be dependent on the board MD. At $0.5\,g/cm^3$ MD, the modulus of rupture (MOR) of MC20/0-1/8/1 boards produced was 32%, 22%, and 16% higher than that of 10MC boards at slow, medium, and fast closing speeds, respectively (Fig. 8). At $0.7\,g/cm^3$ MD, the MOR of MC20/0-1/8/1 board produced by medium closing speed exceeded that of 10MC boards by 12%. The general effect of PD on MOR is similar to that on MOE. However, the indifference in MOR under fast and slow closing speeds shows that, in contradiction to MOE, the effect of PD on MOR is not consistent, and MOR is subjected to the effects of many other factors. Statistical analysis showed that MC distribution has a significant effect on the board MOR at medium closing speed but not at slow and fast closing speeds.

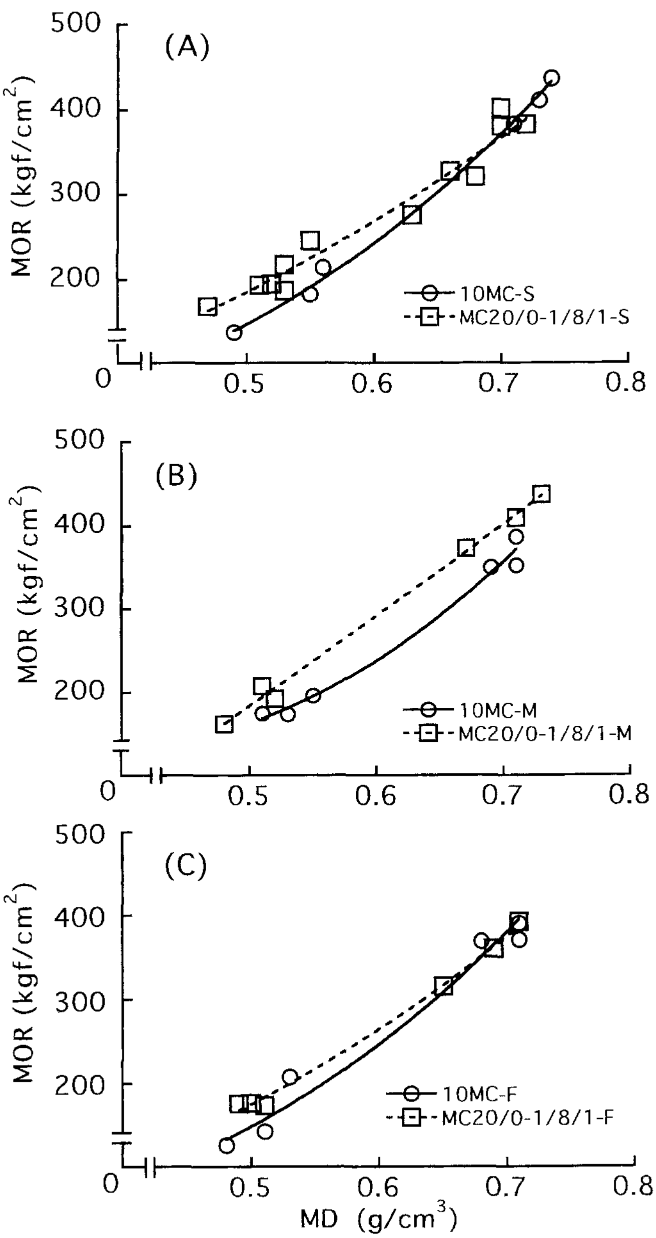

Fig. 8. MOR of 10MC and MC20/0-1/8/1 boards produced using slow (**A**), medium (**B**), and fast (**C**) press closing speeds. Refer to Fig. 3 for the explanation of the codes

With reference to Fig. 9, the MOR and MOE of 10MC and MC20/0-1/8/1 boards were improved slightly by a faster closing speed. The bending properties of the boards produced with the fast closing speed were not particularly higher than those produced with slow and medium closing speeds. Statistically, the closing speed has significant effects on the MOR (95%) and MOE (99%) of MC20/0-1/8/1 boards but not the 10MC boards. The PDs of the boards were increased by faster closing speed, which could result in some improvements in the MOR and MOE. However, the improvements in MOR and MOE due to this increment in PD could have been diluted by a simultaneous reduction in the peak width, which could be detrimental to the bending performance, as the load-bearing zone becomes thinner. Consequently, any improvement brought about by an increment in PD may be offset by the formation of a slimmer peak. In this respect, a high density nearer the surface may not contribute significantly to improved board bending properties but could serve to produce board with good surface smoothness and finishing quality.

The density profile of a static bending specimen could not be determined owing to its large dimension. Because Pdi, GF, and Pb are not related to the MD, it is possible only to estimate the PD and CD based on the measured MD and correlate the MOR and MOE to these factors. In this regard, further study is planned to investigate the effects of various density profile-defining factors on the bending properties of particleboard with various density profile designs using the finite element method (FEM).

A wet bending test prior to which the samples were boiled for 2h followed by 1h soaking in 20°C water was conducted. This resulted in about 50% reduction in the MOE and MOR of all types of boards.

Effect of sanding on the bending performance of particleboard

The sanding process removes the low-density, loose, precured surfaces of board, creating surfaces with high density, which could result in improved bending performance. MC20/0-1/8/1 boards from slow press closing speed were used to examine the effect of sanding on the bending performance. Based on the board density profile, a layer of 0.5mm was sanded off from each surface, following which the peaks were drawn nearer to the surfaces. Removal of 1mm reduced the board weight negligibly but reduced the total volume by about 10%, giving rise to an average 8% increase in board MD. The sander dust might have filled the pores at the surfaces, resulting in a negligible reduction in weight.

Numerically, sanding upgraded the MOE of the boards by 6%–8%, with a minimal or even detrimental effect on MOR. This effect occurs because MOR may be more sensi-

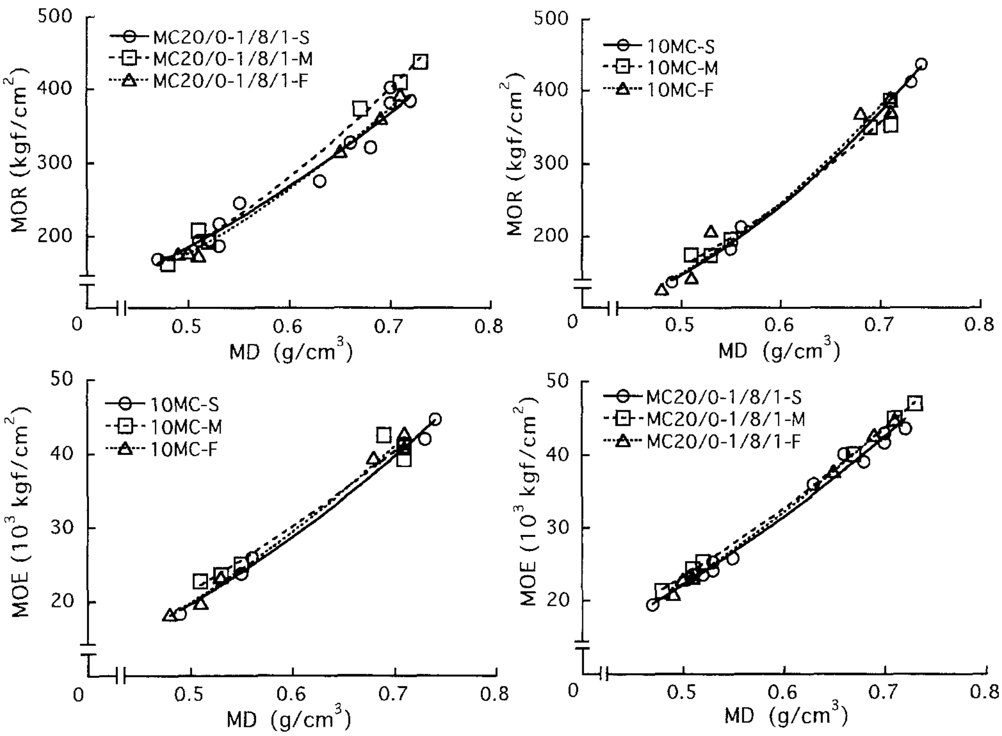

Fig. 9. Effects of press closing speed on the MOR and MOE of 10MC and MC20/0-1/8/1 boards. Refer to Fig. 3 for the explanation of the codes

tive to defects, and the sanding process could have resulted in some structural damage at the surfaces. Based on the increments in MD and MOE summarized in Table 3, it can be concluded that sanding resulted in only a superficial improvement in MOE due to the relative increase in MD, as illustrated in Fig. 10. However, the hardness and smoothness of the board surfaces are improved by sanding, giving rise to boards that are more conducive to direct application or further finishing processes.

Internal bond strength

Comparison of the correlations between IB and MD of 10MC and MC20/0-1/8/1 boards shows that the IB of the former is slightly higher than that of the latter at 0.5 g/cm³ density but indifferent at 0.7 g/cm³, as shown in Fig. 11A. Fig. 11B shows that, irrespective of the production method, the value of IB is always proportional to the CD of the board. The correlations between both MD and CD and IB were better compared to those reported in an earlier study,[17] probably due to the presence of a smoother density profile. In addition to MD, CD, and PD, the IB was not

Table 3. Effects of sanding on particleboard bending properties

MD (g/cm³)	MOR_s/MOR_{us}	MOE_s/MOE_{us}	MD_s/MD_{us}
0.5	0.90	1.06	1.11
0.7	1.02	1.08	1.06
Mean	0.96	1.07	1.09

MOR, modulus of rupture; *MOE*, modulus of elasticity; *MD*, mean density; MOR_s, MOR_{us}, sanded and unsanded *MOR*; MOE_s, MOE_{us}, sanded and unsanded *MOE*; MD_s, MD_{us}, sanded and unsanded *MD*.

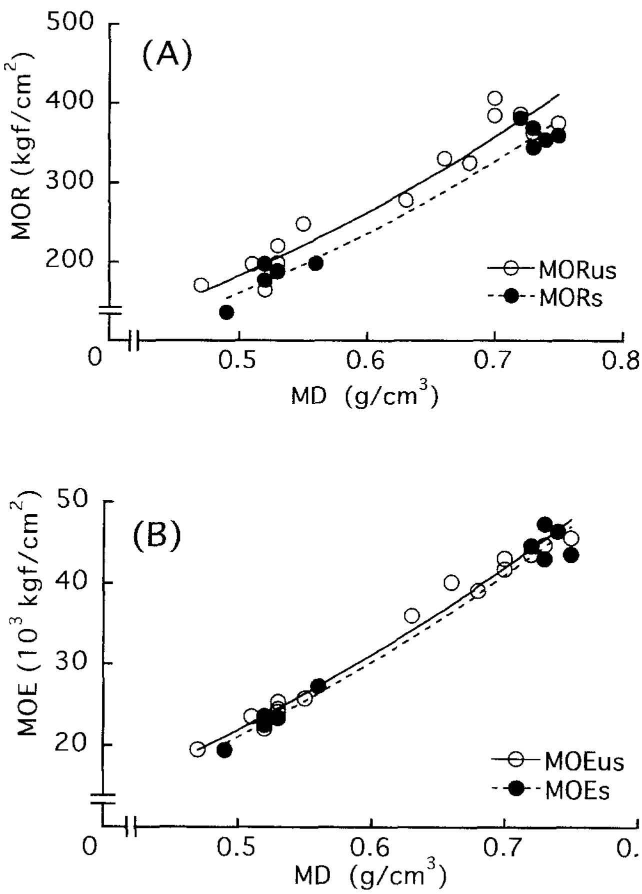

Fig. 10. Effect of sanding on the MOR (**A**) and MOE (**B**) of particleboards. *MORus*, *MORs*, unsanded and sanded MOR; *MOEus*, *MOEs*, unsanded and sanded MOE

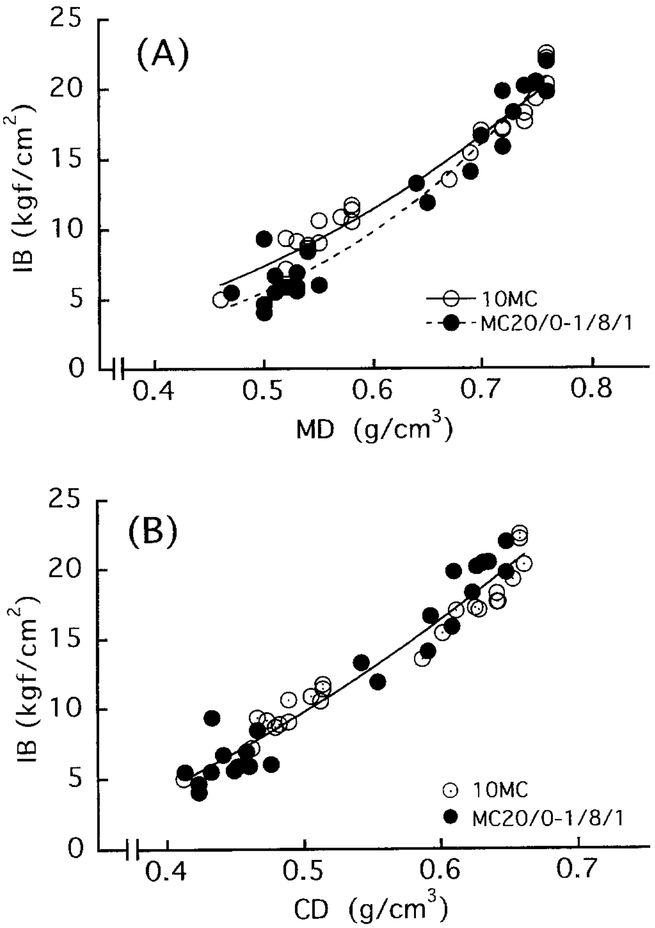

Fig. 11. Correlation between internal bond (*IB*) strength and mean density (*MD*) (**A**) and core density (*CD*) (**B**). Refer to Table 1 for the explanation of the codes

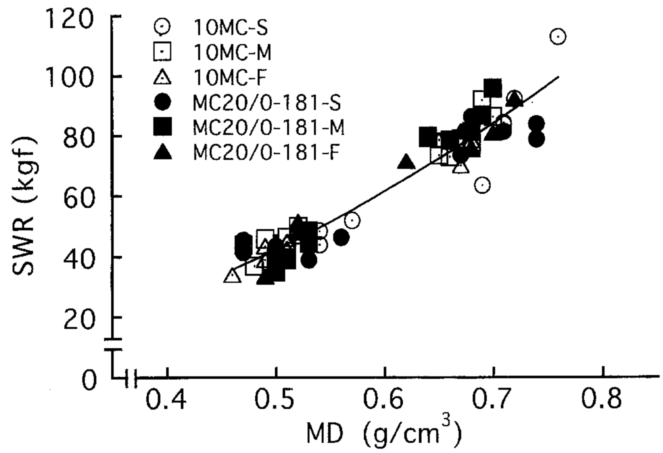

Fig. 12. Correlation between screw withdrawal resistance (*SWR*) and mean density (*MD*). Refer to Fig. 3 for the explanation of the codes

found to be correlated to other density profile-defining factors. Humphrey reported bond strengths to be lowest some distance away from the core layer of the panel.[5] Schulte and Fruhwald found the failing positions in particleboard during IB tests to range between 25% and 75% panel thickness, irrespective of board thickness.[17] In this experiment, all of the IB samples failed near the core region, and the IB recorded is thus the IB for the core, the density of which is highly dependent on the MD level. Statistical analysis also showed that the IB strength was not affected by the difference in closing speed and mat MC in general.

Screw withdrawal resistance

Similar to an earlier report,[7] the screw withdrawal resistance (SWR) of all board types was curvilinearly correlated to the board MD, as shown in Fig. 12. An earlier study showed that SWR is affected by the density profile, but it has not yet been possible to establish the exact effect of each density profile-defining factor on the SWR at this stage.[7] Statistical analysis, however, revealed that both MC distribution and closing speed had no significant effect on SWR at the 95% significance level. On the whole, the SWR of boards with different MC distributions and closing speeds do not differ much from each other.

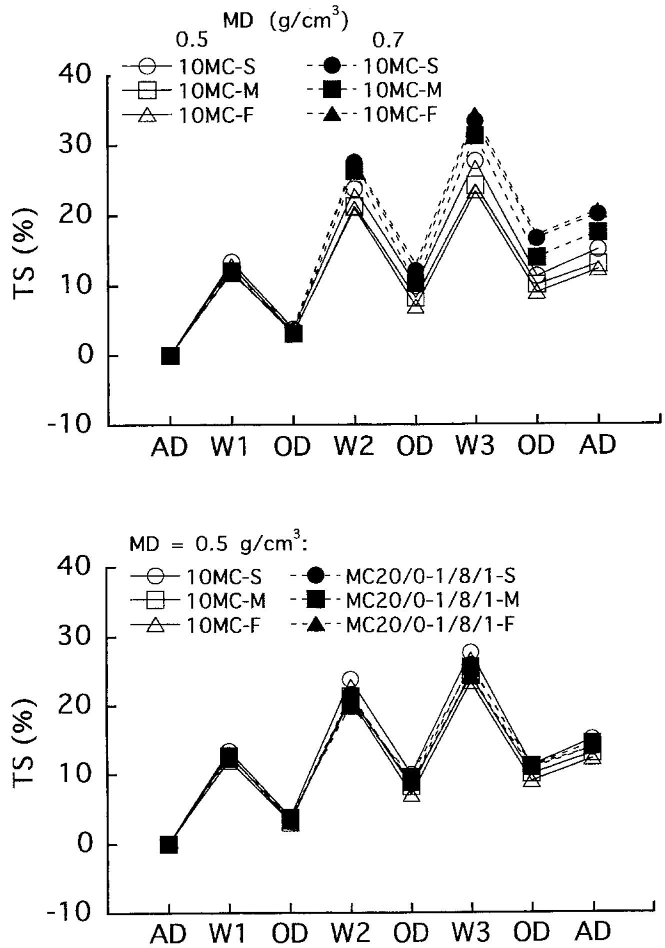

Fig. 13. Thickness swelling (*TS*) of 10MC and MC20/0-1/8/1 boards for the dry/wet cycle. *AD*, air drying; *W1*, water-soaking at 20°C for 24h; *OD*, oven-drying at 60°C for 72h; *W2*, water-soaking at 70°C for 24h; *W3*, boiling for 4h. Refer to Fig. 3 for the explanation of the codes

Thickness swelling and water absorption

Figure 13 shows the variable thickness swelling (TS) of 10MC and MC20/0-1/8/1 boards for the dry/wet conditioning cycle. In general, TS and WA increased with increasing MD. The TS of 0.7 g/cm^3 boards consistently exceeded those of 0.5 g/cm^3 boards by 1%–2% with mild accelerated aging conditioning, but the difference grew wider, to 4%–8%, after exposure to more severe conditioning. This difference is due to the release of greater compression stress in the high-density board at a later stage, compared to lower-density board.

High closing speed was found to reduce the TS after boiling by 3%–4% for both the 10MC and MC20/0-1/8/1 boards at 0.5 g/cm^3 MD. At 0.7 g/cm^3 MD, the TS values were similar, irrespective of the press closing speed. At similar press closing speed, the TS of MC20/0-1/8/1 was consistently slightly lower than that of 10MC. The 10MC boards had slightly higher MD than the MC20/0-1/8/1 boards manufactured using similar processing conditions. The difference is probably due to the lower compressibility of the 0% MC particles in the core of MC20/0-1/8/1 (resulting in a lower CD) and slightly higher thickness (thus with lower MD). Consequently, the compaction ratio of MC20/0-1/8/1 boards was lower than that for 10MC, giving rise to lower compression recovery. In addition, the higher MC at the surface of MC20/0-1/8/1 may encourage greater surface plasticization, which resulted in less water absorption and hence better dimensional stability of the board.

Conclusions

The effects of MC distribution in the mat and the press closing speed on the density profile and board properties in isocyanate resin-bonded 0.5 and 0.7 g/cm^3 lauan (*Shorea* spp.) particleboards were analyzed statistically. A more detailed definition of the vertical density profile of particleboard was introduced, and the correlations among the various defining factors were established. The effect of sanding on bending strength was also examined. The results can be summarized as follows.

Production of particleboard from mats with high and low MC particles at the faces and core could increase the PD by up to 22% and 12% at 0.5 and 0.7 g/cm^3 MD, respectively, with a slight reduction in the CD. With a conventional density profile the CD and PD are closely related to the MD of the board, and the GF, Pdi, and Pb are significantly correlated to each other at the 99% significance level.

Higher press closing speed reduces Pdi and Pb, with an increase in GF. At lower MD, the PD could be increased as much as 6% by applying a faster closing speed, but this effect diminishes eventually as the MD increases. The effect of closing speed on CD is minimal. Irrespective of the press closing speed, the MOR and MOE of MC20/0-1/8/1 generally exceeded those of 10MC, except at higher MD under slow and fast closing speeds.

Sanding does not result in improved specific MOE and MOR but could produce harder, smoother board surfaces for better secondary finishing. As far as the density profile is concerned, IB strength is largely dependent on the CD. The SWR of conventional particleboard is curvilinearly correlated to the MD. Particleboard with better dimensional stability can be produced using higher closing speed and mats with different MC distribution.

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