Studies on the chipboard

Part 2. Swelling properties of chipboard

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This report is the results of investigations on the effects of manfacturing method on the swelling properties of chipboard.

I Experemental method

The size of chips used are 20 ~ 30 mm long, 1.5 mm wide, and 0.2 mm or 1.0 mm thick. Preperation of panel is made in the same way as in report I excepting that urea resin added is diluted with water to the required density.

Test pieces are 5 cm × 5 cm area and 4 ~ 6 mm thick and they are immersed in water for 20 hours after oven dried. Rate of water absorption and expansion in thickness is calculated by following formulas.

$$\textit{Rate of water absorption}\ (\%) = \frac{\textit{Weight after immersion} - \textit{Weight of oven dried}}{\textit{Weight of oven dried}} \times 100$$

$$\textit{Rate of expansion in thickness}\ (\%) = \frac{\textit{Thickness after immersion} - \textit{Thickness of oven dried}}{\textit{Thickness of oven dried}} \times 100$$

II. Experimental results and discussions

1. Effect of binder on the swelling properties of chipboard.

First, experiments were done about **the effect of curing conditions** of urea and formaldehyde on the swelling properties of chipboard. Though the effect of catalyzer, value of pH, heating temperature, heating time, and etc. on the swelling properties of panel were not remarkable, the good result was obtained when the curing was proceeded in comparatively high temperature under the adjustment of pH between 7.5 to 5.4 with NH_4OH and Na_2HPO_4 as catalyzer as shown in Table 1.

The relation between **mol ratio of urea to formaldehyde** and the thickness recovery of chipboard is shown in Fig. 1 and according to this figure it seems that the stability of panel is increased at the small value of ratio and this value deviates slightly from

Fig1. Effect of mol ratio of urea (U) and formaldehyde (F) on the rate of expansion in thickness.

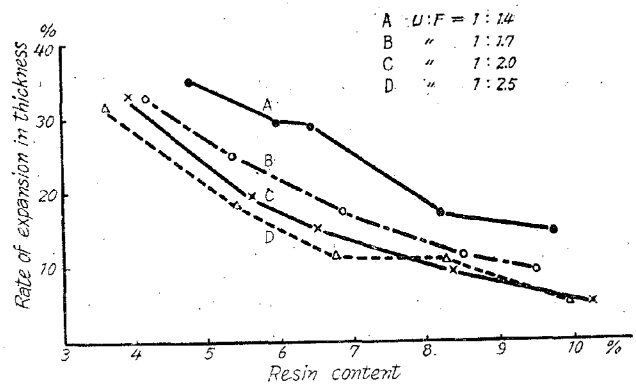


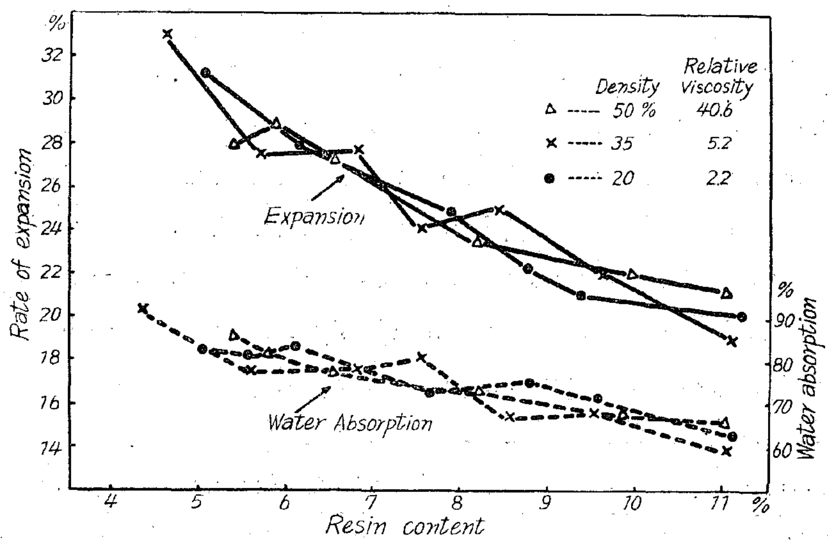
Table 1. Curing condition of urea fromaldehyde resin

	$CO(NH_2)_2$	40% HCOOH	10% Na_2HPO_4	28% NH_4OH	Na_2PO_3	pH	Water	heating temp.	heating time
1st Process	125	310	1	12	0	7.5～5.4	0	90°C	30′
2nd 〃	25	0	3.5	0	0	6.8～6.0	25	93°C	30′
3nd 〃	0	0	0	0	1.5	7.0	0	55°C	30′

reasonable one in preperation of urea resin adhesive. From this results the authers presume that, in case of chipboard, amount of adhesive added is so little that adhesive must have strong affinity to wood.

The effect of viscosity or density of binder on the swelling properties of chipboard are presented in Fig. 2 ～ 3.

Fig. 2. Effect of density and viscosity of resin on water absorption and thickness recovery of panel. (thickness of chip : 0.2 mm)



When the panel was made of thin chips, swelling properties of board were unaffected by the density or viscosity of urea resin (Fig. 2). On the contrary in case of thick chips, thickness recovery and water absorption of panel increased by increasing of density or viscosity of resin (Fig. 3). For the reason of this phenomenon, the authors suppose that in case of low viscosity a part of the resin penetrates easily into the chips and it hinders the swelling properties of board, and when panel is made of thick chips this anti-swelling efficiency appears markedly.

Fig 3. Effect of density and viscosity of resin on water absorption and thickness recovery of panel. (thickness of chip : 1.0 mm)

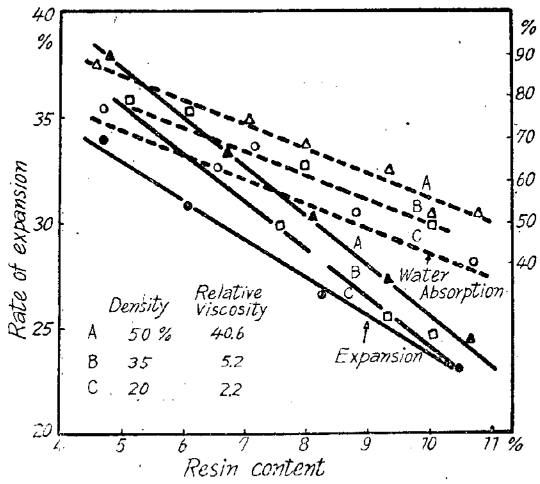
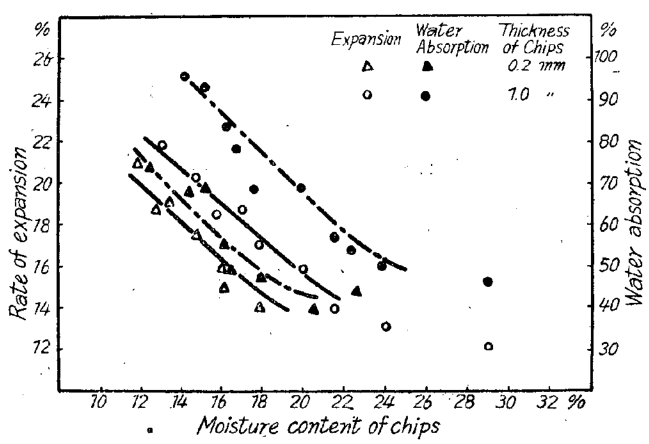


Fig 4. Fffect of moisture content of chips on water absorption and thikness recovery of panel.



2. Effect of pressing conditions on swelling properties of chipboard.

The moisture content of chips was found to have a pronounced effect on the swelling properties of chipboard and the data were presented in Fig. 4. From this figure, thickness recovery and water absorption of panel decrease in proportion to the increase of moisture content.

This result is unreasonable in the viewpoint of mechanism of adhesion, but it may be consequent on the increase of plasticity of the wet chips.

Fig. 5 and 6 show the relation between applying pressure, thickness recovery and water absorption of chipboard in each resin content. In these cases the rate of water absorption decrease uniformly with increase of pressure, while the rate of expansion in thickness shows the curves which are maximum at the pressure of 15 or 20 kg/cm^2.

The relations of **specific gravity** with the rate of water absorption and thickness recovery of panel are presented in **Fig.** 7 ~ 8.

According to these figures, plots of the rates of water absorptions and specific gravities

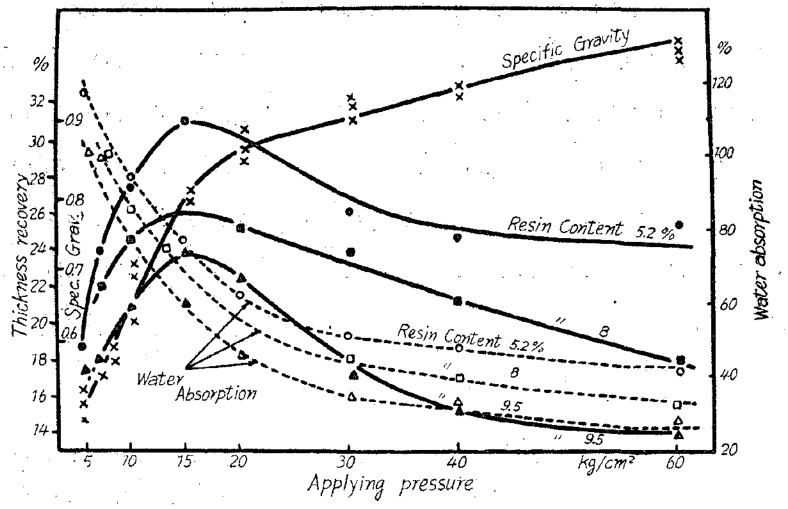


Fig 5. Effect of applying pressure on water absorption and thickness recovery of panel. (thickness of chip : 0.2 mm)

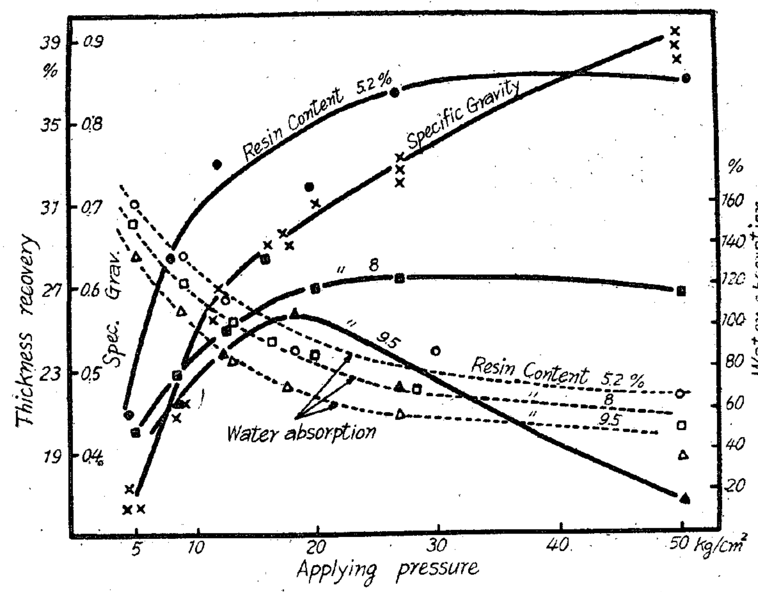


Fig 6. Effect of applying pressure on the water absorption and thickness recovery of panel. (thickness of chip : 1.0 mm)

Fig 7. Relation of specific gravity to water absorption and thickness recovery of panel. (thickness of chip : 0.2 mm)

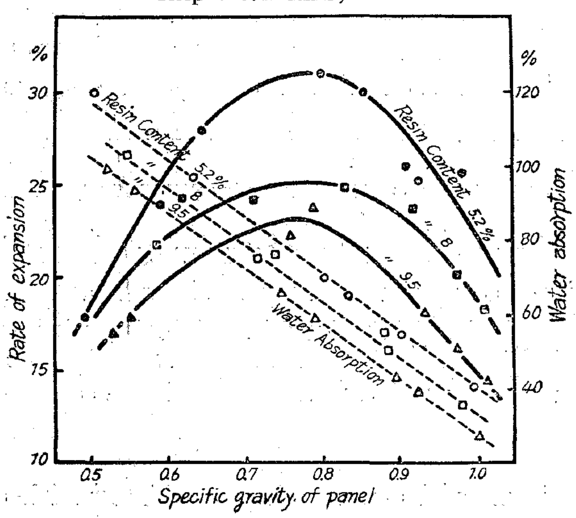
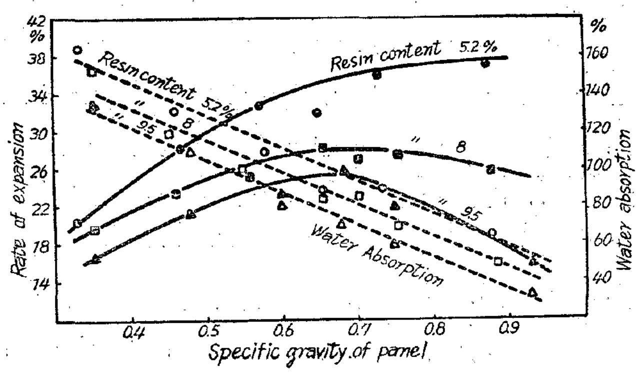
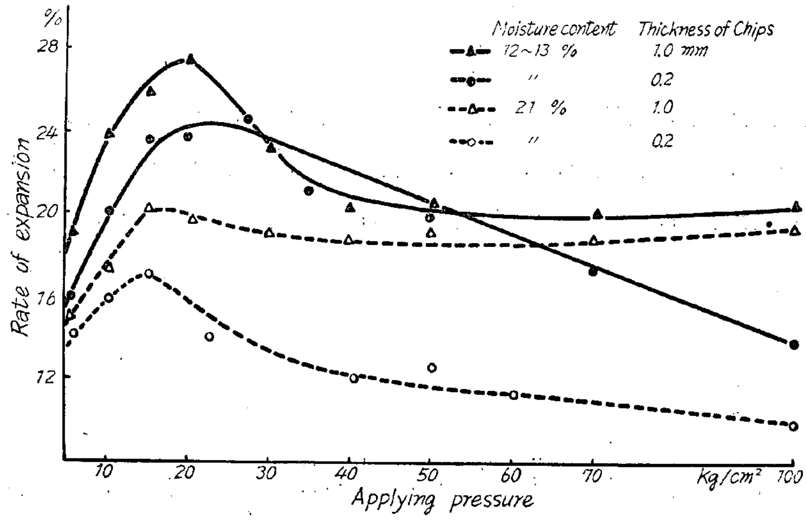


Fig 8. Relation of specific gravity to water absorption and thickess recovery of panel. (thickness of chip : 1.0 mm)



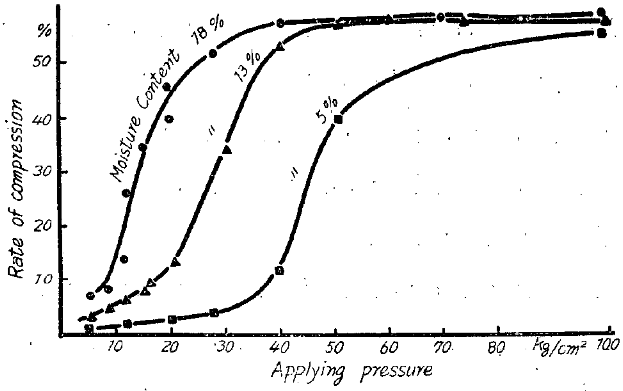
of chpboard fall on a straight line, on the other hand the relation of the rate of expansion to the specific gravity is shown as the curves as in the case of Fig. 5 and 6. However, these data vary greatly depending on the moisture content of the chips before pressing, and Fig. 9 shows an example about the relation between **moisture content**, applying pressure and thickness recovery of chip. As the results of these figures, in case of high moisture content, not only the rate of expansion becomes small but also applying pressure which shows the maximum thickness recovery removes to the side of low pressure.

Fig 9. Effect of applying pressure and moisture content on the thickness recovery of panel.



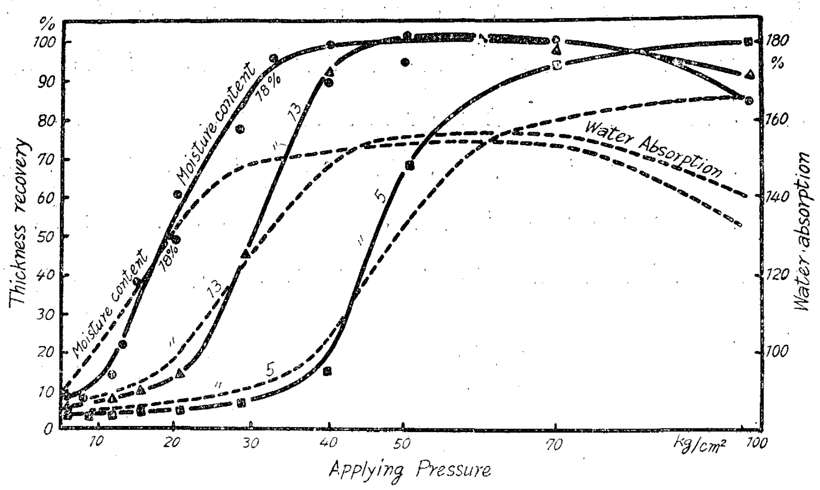
The similar experiment was made for the relation between applying presure, **rate of compression** and thickness recovery of Japanese cypress (HINOKI) sliced veneer. (Fig. 10 ~ 11)

Fig 10. Relation between applying pressure and the rate of compression in thickness of Japanese cypress (HINOKI) sliced veneer.



In these cases the curves of thickness recovery of veneer resemble well to the curves

Fig 11 Relation of applying pressure the thickness recovery and water absorption of Japanese cypress (HINOKI) sliced veneer.



of compression, and are also affected markedly by the moisture content.

From these results, the authors suppose that the swelling properties of chipboard are consequent on the thickness recovery of the chips which are compressed greately in hot pressing.

III. Summary

The experiments on the effect of binder and pressing conditions on the swelling properties of chipboard were performed, and the results are as follows ;

1. Effect of curing method of urea formaldehyde resin on the swelling properties of chipboard was not remarkable, but good result was obtained when urea resin had much methylol group.
2. The density or viscosity of urea resin before spraying was found to have no effect on the swelling properties of panel when it was made of thin chips, on the contrary in case of thick chips thickness recovery and water absorption of panel increased by increasing of viscosity or density of resin.
3. Moisture content of chips was found to have a pronounced effect on the swelling properties of panel, that is, with increasing of moisture content of chips the dimensional stability of chipboard increased.
4. Thikness recovery and water absorption of chipboard are greatly influenced by applying presure or specific gravity of panel, and these inclinations are resemble to the thickness recovery of Japanese cypress sliced veneer when it is compressed by hot press.

摘　　要

尿素樹脂を結合剤としてチップ・ボードを製造し、樹脂の製法と添加時に於ける濃度及び粘度，削片の含水率，圧縮力，比重等がその吸水性，膨潤性に与える影響について実験を行い大略次の如き結果を得た。

1. チップ・ボードに於いてはチップ表面に於ける結合剤添加量が極めて少量であるために結合剤は出来るだけ木材に対する親和性の大なることを必要とする。例えば尿素樹脂の縮合に際して使用するホルムアルデヒドは尿素1モルに対して2乃至2.5モル程度が良く，2モル以下のモル比に於いては樹脂添加量に関係なくチップ・ボードは常に大なる膨潤率を示した（第1図）。

2. 樹脂液の濃度及び粘度がチップボードのスタビリティーに与える影響は顕著ではないが厚さの大なるチップを原料とするチップ・ボードにおいては低濃度の樹脂液を使用した場合，スタビリティーが増加することを認めた（第2，3図）

3. チップの含水率とチップ・ボードの吸水膨潤率の関係は内部膨れを生ぜしめない範囲内に於いては略々直線的関係にあり含水率の増加に伴い吸水率，膨潤率はともに減少する（第4図）。かかる傾向は接着に於ける好適含水率に相反することであり，この原因は前述の低濃度樹脂に於けると同様チップの可塑性の増加及び尿素樹脂のアンティスウェリング・エフィシェンシイに基くものと考えられるが更に検討を必要とする。

4. 成板時に於ける圧縮力又はチップ・ボードの比重とその吸水，膨潤率は常に直線或は曲線的関係を示し（第5～8図），而もこの傾向はチップ含水率の増減によつて著しく変化した（第9図）。亦，同様の測定をヒノキ単板について行いその膨潤率と圧縮率が同様の傾向示し，且つ著しく含水率の影響を受けることを認めた(第10～11図)。

これらの結果よりチップ・ボードの厚さ方向に於ける膨潤性は圧縮されたチップの復元性に起因するものと考えられる。