FINISHING PROPERTIES OF COATED CEMENT-BONDED PARTICLEBOARD

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AHMAD SHAKRI MAT SEMAN & RAHIM SUDIN. 1989. Finishing properties of coated cement-bonded particleboard. Locally manufactured cement-bonded particleboard (CBP) coated with two common types of finishing materials, penetration and film-forming, were tested for their water repellency, finishing properties and exterior performance. Results show that the film-forming type finishes were effective in retarding moisture absorption into CBP and provided better protection against weathering compared to the penetration finishes.

Key words: Cement-bonded particleboard - penetration-type finishes - film-forming finishes - water repellency - finishing quality - exterior performance

Introduction

Cement-bonded particleboard (CBP) is a panel material made of wood fibres as aggregate and Portland cement as binder. In Malaysia, rubberwood (*Hevea brasiliensis*) is the only species used as wood aggregate in CBP manufacture. The logs are passed through a rotary debarker and drum knife ring flaking machine to convert into smaller particles (10-30 *mm* long and 0.20-0.35 *mm* thick). The wood-cement admixtures, consisting of about 60% cement, 20% wood particles and 20% water (based on weight) is placed under pressure and cured under controlled temperature. The wood aggregate is normally treated with chemical additives to improve its bonding properties with cement (Anonymous 1986). The boards have been claimed to possess good resistance against moisture, fire, fungi and termites, and are also good sound insulators (Dinwoodie 1983, Rahim 1987). CBP is widely used for interior purposes such as wall partition, toilet cubicles, fascias and weatherboard. It also has good elasticity under static loads (Anonymous 1975). However, its use for exterior purposes is rather limited due to lack of information on its behaviour against exposure to moisture and sunlight. This study examines the water repellency, finishing quality and exterior performance of rubberwood CBP coated with penetration and film-forming types of finishing quality materials.

Materials and methods

Cement-bonded particleboard

Specimens of CBP were obtained from a local manufacturer. The samples were randomly selected from the mill and cut according to the dimensions specified for testing water absorption and thickness swelling (Anonymous 1986), finishing quality and exterior weathering (Anonymous 1977). Three different thicknesses of the board were used in this study: 10 *mm* for water absorption and thickness swelling; 18 *mm* for finishing quality; and 25 *mm* for exterior weathering tests. The dimensions of the specimens for the water absorption, finishing quality and exterior weathering tests were 100 × 100 × 10 *mm*, 125 × 100 × 18 *mm*, and 300 × 100 × 25 *mm* respectively. Ten specimens were randomly selected for each condition in water absorption and thickness swelling and finishing quality tests; and five specimens for each condition in exterior weathering tests. Prior to applying any finishes, the specimens were smooth sanded with 180 grit-number sandpaper.

Finishing materials

Three types of penetration and four types of film-forming exterior finishes were used. Penetration types consisted of:

Product A - Solvent-based with alkyd binder
Product B - Solvent-based with resin binder
Product C - Solvent-based with resin binder

Meanwhile, film-forming types included:

Product D - Water-based with acrylic binder
Product E - Solvent-based with alkyd binder
Product F - Gloss paint
Product G - Emulsion paint

Application of finishes

Two coats each of products A, B, C, D and E were applied by brushing them on the entire surfaces of the specimens. For product F and G, a complete system of painting, consisting of primer, undercoat and topcoat was given. The edges of the specimens for the absorption test were also painted with finishes. For the exterior weathering test, the edges of the specimens were painted with epoxy paint in order to reduce moisture absorption. The painting procedure was based on the manufacturer's recommendations. Control specimens were

not coated with any finishes.

Water absorption and thickness swelling

Ten specimens were used for each trial in this test. Another ten without any finishes were used as control. All of the specimens were weighed and measured to the nearest 0.01 *g* and 0.01 *mm* respectively. These specimens were then soaked in ordinary water at room temperature for 24 *h* as specified in the Malaysian Standard MS 934 (Anonymous 1986) to determine water absorption and thickness swelling.

Finishing quality

For the finishing quality test, polyurethane-based (PU), acid-catalyst (AC) and nitrocellulose-based (NC) lacquer were also applied on the top coat of the specimens. The finishing quality of the painted specimens was evaluated in terms of the specimen's appearance and mechanical properties of the coatings. The appearance of the coatings was assessed visually. The adhesion of coatings on substrate was measured by the cross cut test and film hardness by the pencil hardness method (Anonymous 1977).

Exterior exposure test

The painted specimens were placed on an exposure frame at 45° facing south at a location in the Forest Research Institute Malaysia. Inspections were carried out every six months for a year to assess the performance of coated specimens against weathering. Assessments were done by visual observation and rated on a scale of 0 to 10. The higher the number, the better the finishing quality of the specimens (Anonymous 1977).

Results and discussion

Water absorption and thickness swelling

Results obtained from the absorption and thickness swelling tests are shown in Figure 1. The water absorption properties of CBP were clearly improved by the application of coating materials. The percentage of water absorption of the coated CBP ranged from 0.32 to 5.54% compared to 13.42% of the control specimens. In an earlier study, Shakri (1989) observed that most of the finishes are water repellent.

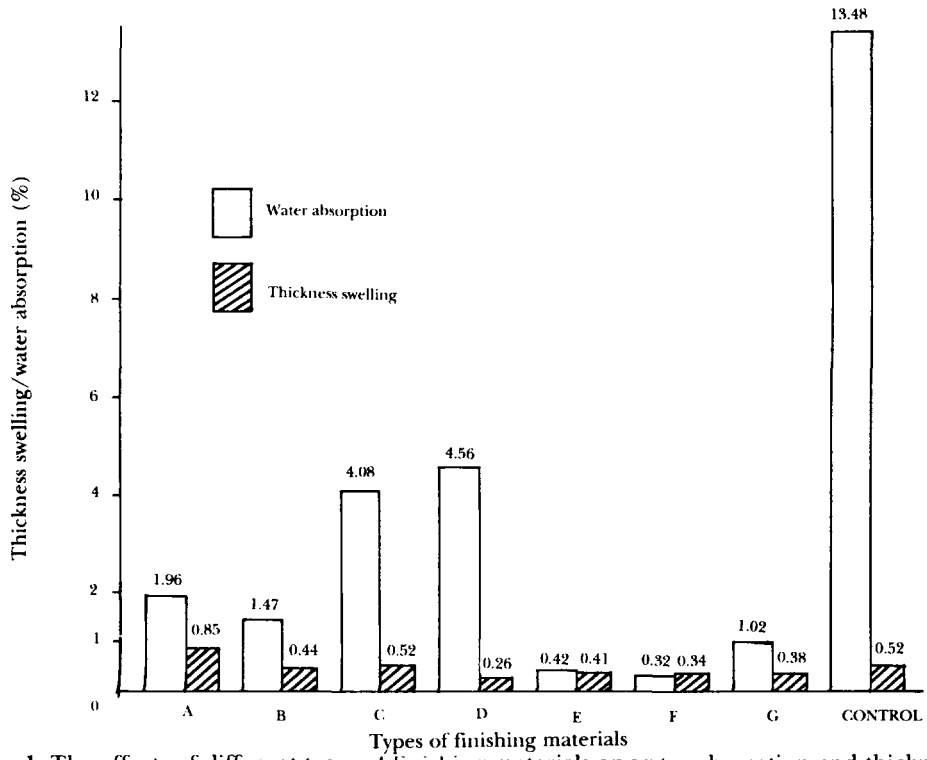

Figure 1. The effects of different types of finishing materials on water absorption and thickness swelling of cement-bonded particleboards

Specimens coated with finishes of penetration type absorbed more water compared to the film-forming type of finishes. Except for product D, specimens coated with film-forming finishes were found to absorb less than 1% of water. Specimens coated with the penetration type of finishes absorbed more water, between 1.47 - 4.08% (Figure 1). Product D absorbed more water (4.56%) probably due to its water-based formulation which allowed water to penetrate through. The product is a water-based system and consists of acrylic binder.

The thickness swelling of all specimens was below 1% for all types of finishes applied including the control. There was not much difference in thickness swelling between treated CBP and the control. However, the thickness swelling of all boards tested was below 0.85%, much below the 2% level as specified by the Malaysian Standard (Figure 1).

Finishing quality

The finishing quality and the performance of finishes applied on the CBP are given in Table 1. The visual appearance of the coated panels varied depending on the types of products. Products A, B and C showed rough surfaces with slight pinholing. These products penetrated into the substrate and also formed a coating on the surfaces. The uneven penetration of the first coat might have

given the second coating a rough appearance with slight pinholing. Products D, F and G gave a good appearance with smooth and even surfaces. These materials which are classified as paints provided better surfaces when a complete system of painting is applied. Product E gave quite a rough surface. CBP coated with PU, AC and NC lacquer gave slightly rougher surfaces. These might be due to the rough texture of the substrates.

Mechanical properties of the coating layer such as adhesion and hardness are given in Table 1. The adhesion of the coating film varied depending on the products. In general, the adhesion of every product was good. The film hardness of product D, PU and AC lacquer was good. In general, the film-forming type of finishes provided a better finishing quality when applied on the surface of CBP.

Exterior exposure performance

The assessment on the performance of CBP coated with different types of finishing materials after one year exposure, is given in Table 2. It can be seen that finishing products D, E, F and G performed better than others in exterior conditions. The panels and coatings of these products still appeared in good condition except product F which showed slight checking, cracking and erosion. Products A, B and C were slightly faded, cracked, checked and eroded. All the panels were still in good condition after one year exposure except panels with finishing products A, B and C which were slightly cracked and checked.

The control panels were checked and eroded. With the exception of products B and D, the surfaces of the coated panels were discoloured to different degrees. This discolouration was due to dirt and mould that were collected and developed during the exposure. Products D, E and G showed excellent performance without any checking, cracking, erosion, flaking, blistering and chalking. Some defects of either flaking or erosion occurred when the penetration-type finishes were used. Thus these film-forming finishes provided a better protection against exterior weathering.

Table 1. The appearance, adhesion and hardness properties of different types of finishing material on cement-bonded particleboard

Products	A	B	C	D	E	F	G	PU lacquer	AC lacquer	NC lacquer
Properties: Coating appearance	Surface quite rough, pinholing	Surface quite rough, pinholing	Surface quite rough, pinholing, uneven coating	Smooth surface, even coating	Surface quite rough	Smooth surface, no defect observed	Smooth surface, no defect observed	Surface slightly rough	Surface slightly rough	Surface slightly rough
Adhesion (2 *mm*)	-	-	-	18/25	19/25	15/25	22/25	20/25	24/25	15/25
Hardness	-	-	-	H	5B	B	HB	H	H	HB

Table 2. The performance of cement-bonded particleboard coated with different types of finishing material after one year exterior exposure

Assessment	Products							
	A	B	C	D	F	F	G	Control
Coating appearance	Faded, eroded, cracked, checked, peeled off	Faded, peeled off, eroded, checked, cracked	Eroded	Good	Slightly faded	Slightly checked, cracked, eroded	Good	-
CBP appearance	Good	Slightly cracked	Checked and eroded	Good	Good	Good	Good	Checked and eroded
Fungi/mould	Discoloured	None	Slightly discoloured	None	Slightly discoloured	Discoloured	Discoloured	None
Degrees of: - discolouration	6	10	8	10	8	2	4	4
- checking	6	4	-	10	10	8	10	-
- cracking	6	4	-	10	10	8	10	-
- erosion	6	8	-	10	10	8	10	-
- flaking	6	2	-	10	10	8	10	-
- blistering	10	10	-	10	10	10	10	-
- chalking	10	10	-	10	10	10	10	-

Conclusion

Based on the tests and observations carried out on the Malaysian cement-bonded particleboard, it can be concluded that products E, F and G of the film-forming type of finishes reduced the moisture absorption and thickness swelling. The finishing quality of the particleboards coated by these products was also found to be good in appearance and mechanical properties. The exposure tests also confirmed that film-forming finishes were effective in maintaining the performance of cement-bonded particleboard.

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