ADHESION OF FINISHING MATERIAL: INFLUENCE OF TIMBER SPECIES AND COATING LAYERS

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Abstract

The adhesions of coating material (Nitrocellulose Lacquer) on Malaysian hardwood timbers were ascertained. The effects of different timber species such as Resak (Vatica spp) (655-1152 kg/m^3), Chengal (Neobalanocarpus heimii) (915-980 kg/m^3), Keruing (Dipterocarpus spp) (550-985 kg/m^3), Meranti (Shorea spp) (385-755 kg/m^3), Kedondong (Canarium spp) (495-975 kg/m^3) and Rubberwood (Hevea brasiliensis) (560-640 kg/m^3) with different number of undercoat layers (1, 2 and 3 layers) were determined. Conventional air spray gun was used for finishes application and air drying method to cure the coating. The American Society for Testing and Material (ASTM D3359:2009) standard testing and procedures were used. The result revealed that the lowest density of Malaysian hardwood timbers and the min number of under coating layer were strong enough for the adhesion of furniture finishes. Thus, it can be concluded that Meranti with 1 layer of under coating is better than other species to be used in furniture production.

Keywords: Finishing, Malaysian Hardwood Timbers, Nitrocellulose Lacquer (NC)

INTRODUCTION

Surface coatings include paints, varnishes and drying oils, synthetic clear coatings and other products whose primary is to protect the surface of an object from the environment and also enhance the aesthetic appeal of an object by accentuating its surface features or even by concealing them from view (Bierwagen, 2011).

Coating is a covering that applied to the surface of an object, usually referred as the substrate. In many cases coatings are applied to improve surface properties of the substrate, such as appearance, adhesion, wetability, corrosion resistance, wear resistance, and scratch resistance (Anonymous, 2011).

Most surfaces coatings materials that employed in industry and by consumers are based on synthetic polymers. Synthetic polymers that is, industrially produced substances composed of extremely large, often interconnected molecules that form tough, flexible, adhesives films when applied to surfaces. Besides that, solvents or carrier liquid, which provide a liquid medium for applying the film-forming ingredients, and additives, which provide a number of special properties (Bierwagen, 2011).

The choice of coating material depends on the type of wood, the use of the furniture, the time available to do the coating job and how the piece of wood to look when you are through

(Fulcher, 1989). Once the purpose of the coating has been identified, there are certain basics principles that can be followed to produce an effective coating (Weldon, 2009). Good preparation of the materials will give the greater result of the finishing (Bendtner, 2006)

In order to get good result in applying wood coating, general guides need to be followed and maintained such as work in a room where there is good ventilation, keep dust to a minimum, if possible do not sand and coating in the same room, remove all dust from the wood piece with a tack rag prior to applying the coating, work in room with temperature is a around 70° F and with low humidity, follow the recommended directions on the label, finish under parts and interiors first before do the outside and put all used rags into the garbage (Dresdner, 1992).

From a theoretical point of view, adhesion is the result of surface forces, of wetting and of the coating's curing process at the substrate coating interface. The natural porous of wood is a main difference in comparison to other substrates such as metal and plastic. The liquid coating material is partly absorbed into the wood by the action of capillary forces. This presents an additional challenge to the ultraviolet (UV) curing coatings as the absorbed material will cured if only with present of UV energy (Weikard and Fischer, 2011).

In this work, most of the manufacturing variables for finishing in furniture industry were kept constant in order to visualize the specific effect of the density of substrates, surface roughness and layer of under coat finishes. These include effect of the surface roughness of mix Malaysian hardwood timbers and apply on the surface with three different layers under coating of Nitrocellulose Lacquer (NC Lacquer).

The main objective of this study was, therefore, to evaluate the influence of different substrates species and under coat layers, on the surface roughness of different Malaysian hardwood timber species and their performance towards adhesive performance.

MATERIALS AND METHODS

Samples as known as wood substrates of six different species of mix Malaysian hardwood timbers with different density were produced. The substrates were industrially produced sawn timbers and were preserved according to the supplier. Besides that, these species were high durable species in hardwood groups (Menon, 1993).

The samples or substrates were supplied by trusted local sawmills that sold timbers to the industry. The substrates were mixture of Malaysian hardwood timbers with different density such Resak (*Vatica spp*) ranging from 655-1152 kg/m^3, Chengal (*Neobalanocarpus heimii*) ranging from 915-980 kg/m^3, Keruing (*Dipterocarpus spp*) ranging from 550-985 kg/m^3, Meranti (*Shorea spp*) ranging from 385-755 kg/m^3, Kedondong (*Canarium spp*) ranging from 495-975 kg/m^3 and Rubberwood (*Hevea brasiliensis*) ranging from 560-640 kg/m^3. Each species were represented by 5 replicates with 150mm X 70mm X 12mm sizes.

The finishes were industrially produced Nitrocellulose Lacquer (NC Lacquer) and were supplied by Polycure coatings. This study was used NC Sealer Clear 32-P for under coats, NC 100 Clear 33-01 for top coat and NC Reducer TH-325 for diluting.

Then, the substrates were sand using sand paper grit of 120 follow 240. To remove defects caused by planning, 120 grit of sand paper was used. After that, 240 grit of sand paper was used to smoothest the surface possible. To get uniform smooth of the substrates surface, it was sanded by the same grit of sand paper. The surface roughness of selected substrates was measured with Surface Roughness Tester (SRT-6210).

The next step was applying the lacquer onto the substrates surface. Before spray, the lacquer needs to mix with reducer at 1:1 for its ratio. The viscosity for the lacquer was measured by Efflux flow cup in range 12 to 16 seconds for better viscosity. The lacquer application systems 1:1, 2:1 and 3:1 were used. The systems were variables in under coat layers and fixed top coat layer. In Figure 1 shows the experimental design of this study.

The samples were tests using Surface Roughness Tester (SRT-6210) for determined the surface roughness and using ASTM D3359:2009 for test method of Measuring Adhesion by cross-cut tape test. In Table 1 shows the classification of the adhesion result.

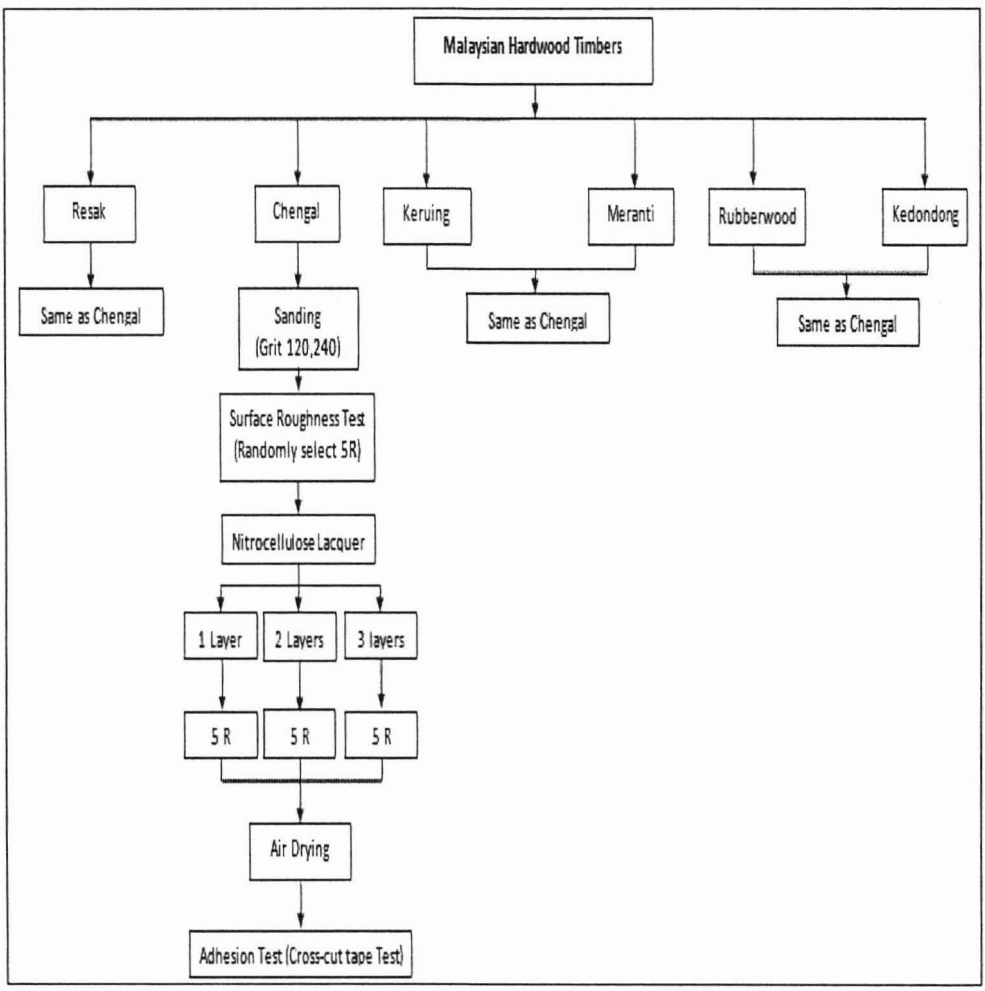
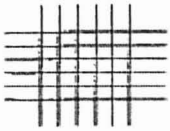
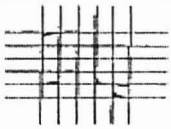
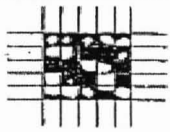


Figure 1: Experimental design

Table 1: Classification of Adhesion test result

CLASSIFICATION OF ADHESION TEST RESULTS		
CLASSIFICATION	PERCENT AREA REMOVED	SURFACE OF CROSS-CUT AREA FROM WHICH FLAKING HAS OCCURRED FOR SIX PARALLEL CUTS AND ADHESION RANGE BY PERCENT
5B	0% None	
4B	Less than 5%	
3B	5 - 15%	
2B	15 - 35%	
1B	35 - 65%	
0B	Greater than 65%	

RESULTS AND DISCUSSIONS

Table 2 shows the summary of Analysis of Variance (ANOVA) of the effect of species and axis on the surface roughness. The surface roughness shown to significantly affected by species and axis. But, their interaction showed no significant effect.

Table 2: ANOVA of the effects of species and axis on the SR

VARIABLES	df	SR
SPECIES	5	5.195 ^{x}
AXIS	1	29.630 ^{x}
SPECIES*AXIS	5	1.229 ^{n}

Note: ns- Not significant p>0.05, ^{x} - Significant at p<0.05,

Figure 2 shows the surface roughness of different Malaysian hardwood species indicates little different of value which Resak indicates 5.869 μm for the lowest roughness and Meranti indicates 9.873 μm for the highest roughness. The lowest value is representing the smooth surface and highest value represent coarse surface. Resak was not significant different with Chengal and Keruing but, significant different with Rubberwood, Kedondong and Meranti. Meanwhile, Chengal was not significant different with Keruing and Rubberwood but, significant different with Kedondong and Meranti. Besides that, Keruing was not significant different with Rubberwood and Kedondong but, significant different with Meranti. Then, Rubberwood was not significant different with Kedondong and Meranti. Lastly, Kedondong was not significant with Meranti.

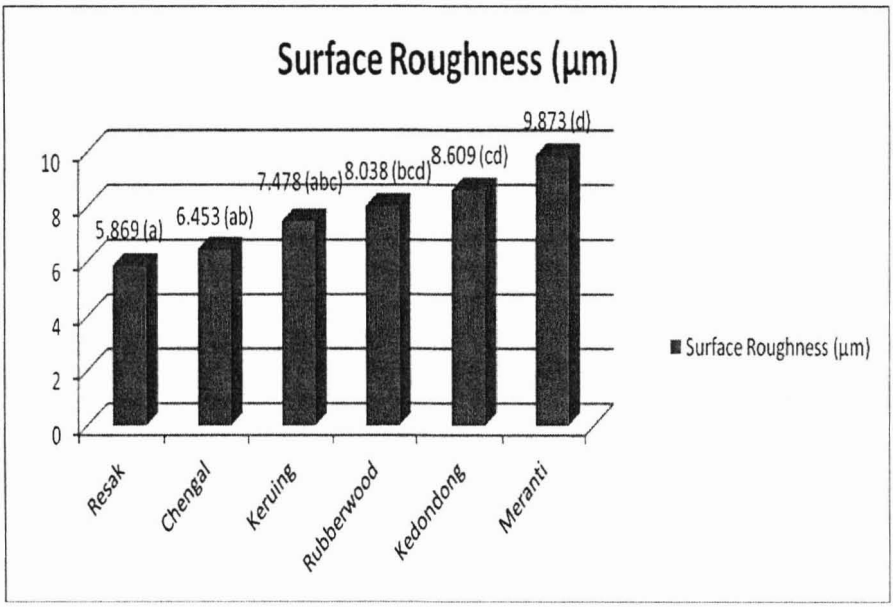


Figure 2: Effect of different species on the SR

Figure 3 shows the surface roughness of different axis indicates large different value on horizontal and vertical at 6.299 μm and 9.141 μm. Both horizontal and vertical were significant different.

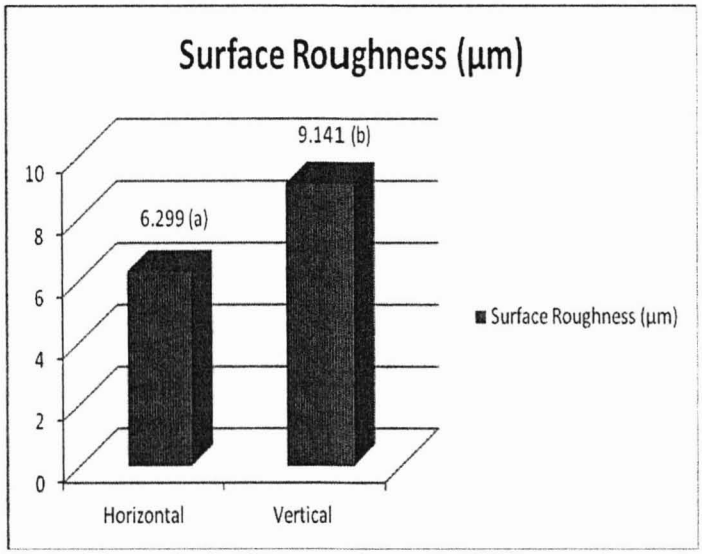


Figure 3: Surface roughness at different axis

Table 3 shows the Analysis of Variance (ANOVA) on the species and layers. The percentage removed on species and layers was highly significant at 4.166% and 91.796%. Meanwhile, the interaction between species and layers was not significant at 1.283%.

Table 3: Statistically analysis of F-Value on the effects of adhesion at different species and layers P<0.05.

VARIABLES	df	PR
SPECIES	5	4.166 ^{x}
LAYERS	2	91.796 ^{x}
SPECIES*LAYERS	10	1.283 ^{nS}

Note: ns- Not significant p>0.05, ^{x}- Significant at p<0.05,

Figure 4 shows the percentage removed of different species of Malaysian hardwood indicates increasingly constant value which Meranti indicates at 20.60% for the lowest percentage removed and Resak indicates at 31.20% for the highest percentage removed. The lowest percentage removed is representing good adhesion between nitrocellulose lacquer (NC Lacquer) with the wood substrates. Meranti was not significant different with Kedondong but, significant different with Rubberwood, Keruing, Chengal and Resak. Meanwhile, Kedondong was not significant different with Rubberwood, Keruing and Chengal but, significant different with Resak. Besides that, Rubberwood was not significant different with

Keruing and Chengal. Then, Keruing was not significant different with Chengal and Resak. Lastly, Chengal was not significant different with Resak.

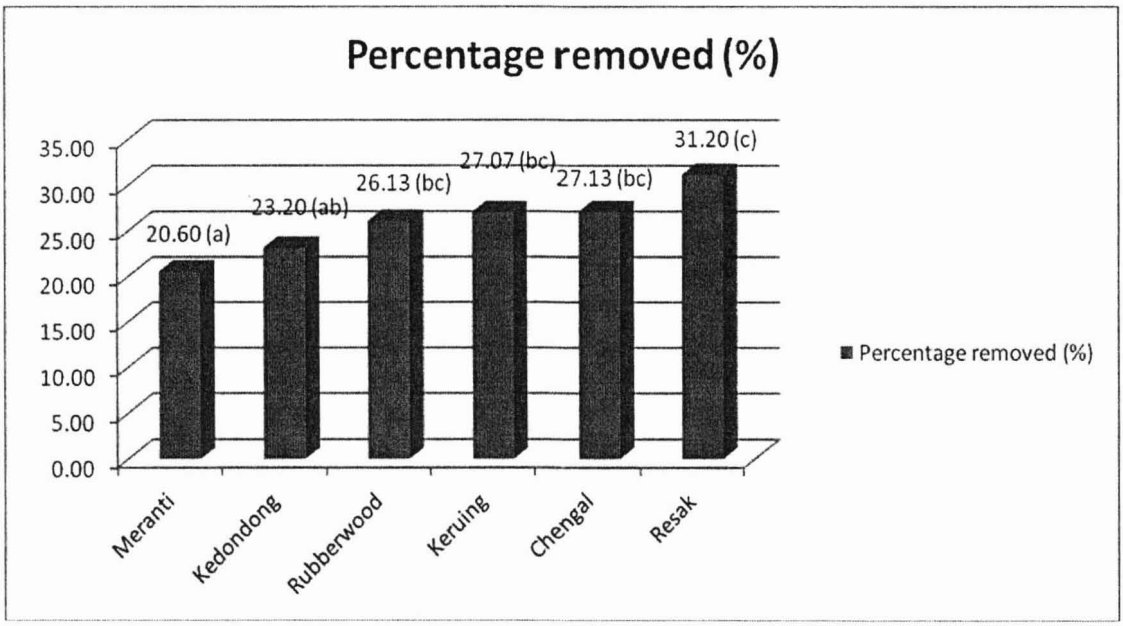


Figure 4: percentage removed with different species Malaysian hardwood

Figure 5 shows the percentage removed of different layers indicates large different value on 1 layer, 2 layers and 3 layers at 12.67%, 28.60% and 36.40%. 1 layer, 2 layers and 3 layers were significant different.

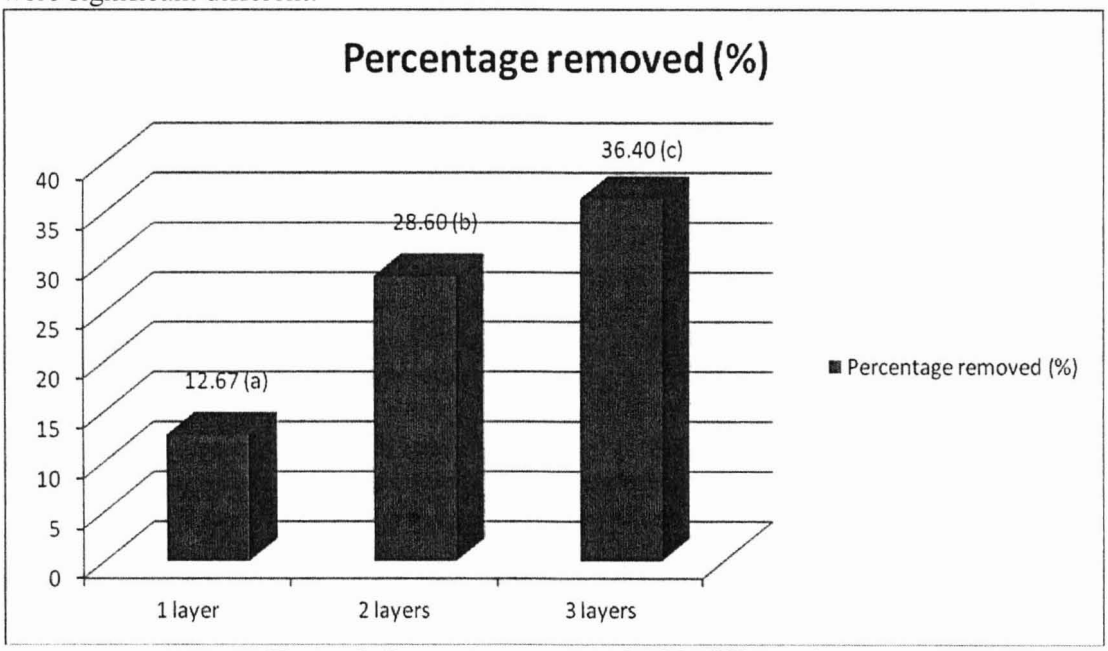


Figure 5: Percentage removed with different layers

CONCLUSIONS

From this study, it can be concluded that the surface roughness of each samples is increase constantly due to the species of Malaysian hardwood timbers. The anatomy for each species is also different and some of the species has significant effect the degree of the surface roughness. The axis of samples also significant affect the surface roughness so, the horizontal axis was along the grain and produced better and smoothest surface than vertical. This means the surface preparation and finishing is better on horizontal axis (along the grain).

As the conclusion, the species of Meranti with 1 layer of undercoat are more suitable for finishing in furniture industry. For general point of view, the moderate density of raw materials and minimum undercoat application can produce better finishing on furniture production. Besides that, it also can reduce the cost of production on selecting the raw materials and finishing materials.

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