CHARACTERISTICS OF LAMINATED FLOORING MATERIALS

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APPROVAL SHEET

This Final Year Project report entitled **"CHARACTERISTICS OF LAMINATED FLOORING MATERIALS"** was prepared by **WONG LIP GEN** as a partial fulfillment of the requirement for the Bachelor of Engineering (Hons.) Mechanical Engineering and Manufacturing System is here by read and approved by:

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WONG LIP GEN

This project is submitted in partial fulfillment of
the requirements for the degree of Bachelor of Engineering with Honours
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Faculty of Engineering
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Dedicated to my beloved family and friends

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ABSTRACT

In this study, the surface and moisture characteristics of commercially manufactured laminated floorings and engineered hardwood floorings were evaluated. The influences of outdoor exposure on surface quality of the samples ranging from 1 week to 3 weeks were determined using Stylus technique. In additional, the influences of the indoor moisture conditions on the surface roughness, absorption rate and swelling thickness of the samples soaked from 2 hours to 15 days were investigated. Two roughness parameters, average roughness R_a and maximum roughness R_{max}, calculated from the surface profiles of the samples employing a profilometer were used for the analyses. The samples have higher R_a and R_{max} values when the Stylus tip traversed across the grain compared to along the grain. Statistically, a significant difference existed between laminated and engineered hardwood floorings. As a result, the engineered hardwood showed higher values for the outdoor and indoor tests compared to laminated flooring in terms of R_a, R_{max}, moisture absorption rate and swelling thickness. The experimental result also proven the influence of moisture have higher tendency

damaging the flooring samples compared to the influence of environment. Throughout the experiment, engineered hardwood samples degraded the most. This is because they are prone to moisture and weathering damages. The experimental results also showed laminated flooring samples have better surface quality, higher moisture resistance and are more durable.

It was concluded that the laminated and engineered hardwood floorings is only limited for interior installation except for bathrooms. Laminated flooring is suitable to be used for the damp places such as kitchen, dining rooms and vicinity nearby the bathrooms which have higher tendencies exposed to the moisture. For engineered hardwood, the applications only limited to interior parts with the lowest moisture exposure such as living room, bedrooms, and staircase.

ABSTRAK

Dalam kajian ini, sifat kekasaran dan kelembapan lantai berlaminar dan lantai kayu keras kejuruteraan telah disiasat. Faktor yang mempengaruhi kualiti permukaan sampel semasa pendedahannya terhadap persekitaran selama satu sehingga tiga minggu telah dikenal pasti dengan menggunakan teknik Stylus. Selain itu, pengaruh daripada kelembapan keadaan dalaman keatas sifat kekasaran permukaan, kadar penyerapan, dan penebalan setelah direndam dalam air selama 2 jam hingga 15 hari telah dikajikan. Keduaan parameter iaitu purata kekasaran R_a dan kekasaran maximum R_{max}, telah dikirakan dari permukaan profil sampel dengan menggunakan profilometer bagi tujuan menganalisis. Kesemua sampel telah mempamerkan nilai R_a dan R_{max} yang lebih tinggi sekiranya penghujung Stylus merentasi ira dengan melawan orientasinya dibangdingkan mengikuti orientasi ira. Perbezaan statistik yang nyata wujud diantara lantai berlaminar dengan kayu keras kejuruteraan. Sebagai akibatnya, sampel kayu keras kejuruteraan mempamerkan nilai keseluruhan yang lebih tinggi yang merangkumi aspek R_a, R_{max}, kadar penyerapan mahupun dari segi penebalan saiz. Sepanjang tempoh eksperiment

dijalankan, kualiti kayu keras kejuruteraan merosot dengan ketara. Penyerosotan kualiti sampel tersebut berpunca daripada sifat semula jadinya yang lebih cenderung terhadap kerosakkan yang diakibatkan oleh kelembapan dan penukaran cuaca yang tidak menentu. Keputusan eksperimen juga menunjukkan bahawa lantai berlaminar mempunyai kualiti permukaan yang lebih baik, sifat pertahanan kelembapan yang tinggi dan lebih tahan lama.

Sebagai kesimpulan, lantai berlaminar dan lantai kayu keras kejuruteraan hanya dihadkan untuk kegunaan dalaman sahaja kecuali bilik mandi. Lantai berlaminar sesuai untuk kawasan yang berkecenderungan tinggi terdedah kepada kelembapan seperti dapur, bilik makan, dan perkeliling bilik mandi. Lantai kayu keras kejuruteraan applikasinya hanya terhad kepada kawasan yang kering sahaja seperti ruang tamu, bilik tidur dan tangga.

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NOMENCLATURE

HDF	-	High Density Fiberboard
MDF	-	Medium Density Fiberboard
PVC	-	Polyvinyl Chloride
VOCs	-	Volatile Organic Compounds
Al_2O_3	-	Aluminum Oxide
UV	-	Ultra-violet
H_j	-	Janka hardness (Pa)
S	-	Surface area of the ball (mm^2)
F	-	Force (N)
R	-	Radius of the ball (mm)
h	-	Depth of impression (mm) or thickness of the specimens (mm)
R_a	-	Arithmetic mean of the absolute departures of the roughness profile from the mean line (μm)
R_{max}/R_t	-	Maximum roughness aka. maximum peak to valley profile height (μm)
CoF	-	Coefficient of friction
TP	-	Test Person
ANOVA	-	Analysis of variance
ZnB	-	Zinc Borates
PB	-	Particleboard
UF	-	Urea-formaldehyde
PF	-	Phenol-formaldehyde
SEM	-	Scanning Electron Microscope
ΔM (t)	-	Moisture uptakes (%)

m_o	-	Mass of the specimen before aging (kg)
m_t	-	Mass of the specimen during aging (kg)
W_a	-	Air-dried weight of the material (N)
W_o	-	Oven-dried weight of the material (N)
m_i	-	Initial weight of the moisture in the material (kg)
m_s	-	Weight moisture in the materials when the material is fully saturated
D	-	Mass diffusivity in the composite
t	-	Time (s)
j	-	Summation index
M_m	-	Maximum weight gain
d	-	Sample thickness in (mm)
t_{70}	-	Time taken to reach 70% saturation (s)
k	-	Initial slope of a plot of M (t) versus $\sqrt{t}$
HFRUPE	-	Hemp fiber reinforced unsaturated polyester
DI	-	De-ionized
UPE	-	Unsaturated polyester
CSM	-	Chopped Strand Mat
ASTM	-	American Society of Testing and Materials
RHF	-	Rice-husk flour
WF	-	Wood flour
RHP	-	Rice-husk powder
MAPP	-	Maleated polypropylene
PP	-	Polypropylene
ρ	-	Density (kg/m^3)
LF I	-	Laminated flooring panel with the thickness of 0.8 cm
LF II	-	Laminated flooring panel with the thickness of 1.2 cm
WAL	-	Walnut panel
ASH	-	White Ash

CHAPTER 1

INTRODUCTION

This chapter will briefly discuss the flooring options available in the market. Among all the flooring options available, the main focus will be the laminated flooring materials. Other than that, the engineered flooring materials will be used as comparison. After that, the objectives and problem statement of this study were drawn out.

1.1 Background Study

Before our early ancestors built shelters, they very likely softened their primitive caves with sweet grasses, warm animal's skins, and clean sand. All those materials provided practical aids to comfort and cleanliness, as well as aesthetic and tactile pleasure. Our ancestor wisdom has been evolving into today sophisticated modern flooring technology. The flooring materials are categories into two types "hard" and "soft". The hard flooring materials include tile, stone, hardwood, and laminated flooring. Meanwhile the soft flooring materials are such as cork, linoleum, vinyl, carpet, and rubber. Normally hard flooring materials reflect more sound than soft materials since the hard surface is an ideal sound reflector [1].

Laminated flooring has been widely used in Europe for over 20 years and recently it is getting popular in North America [2]. In Malaysia, laminated flooring is considering as a relatively new flooring option but it has gained a tremendous response among Malaysian. The term “laminate” is defines as overlay (a flat surface) with a layer of protective material or manufacture by placing layer on layer [3]. Generally the layout of the laminated flooring made up of four layers. The layers are such as overlay, decorative paper, high density fiberboard (HDF), and backing [4, 5, 6, 7]. The engineered hardwood flooring is considered as the competitor to the laminated flooring. The term “engineered” in the engineered hardwood flooring referring to products that have several layers of wood laminated together to form one board [8,9,10,11,12]. The layers of the engineered hardwood flooring are such as finish layers, wear layer, rubberwood core, and bottom ply [9, 11]. The similarity between laminated and engineered hardwood flooring are both also wood-based materials which made up of several layers. With the innovation of nowadays flooring technology both floors are available as floating floors. The floating floors are those floors that are not mechanically fastened to the subfloor. They are suspended on top of the floor while resting on a cushioned underlayment [13]. Therefore, floating floors are easily to install or dismantle as compared to granite, marble, and tile which are fixed to the ground. Originally only one method called “glue together” for the installation of the floating floors where a bead of glue is squeezed into the grooves of each plank or on top of the tongue. After the glue applied, the floating floors will be tapped into place with hammer and tapping block [13]. The further improvement had changed the installation method of the floating floors from glue together into lock and fold method. This lock and fold method is more simple and no glue or tapping

required, Figure 1.1, 1.2, and 1.3 illustrated how the floating floors were joined together.

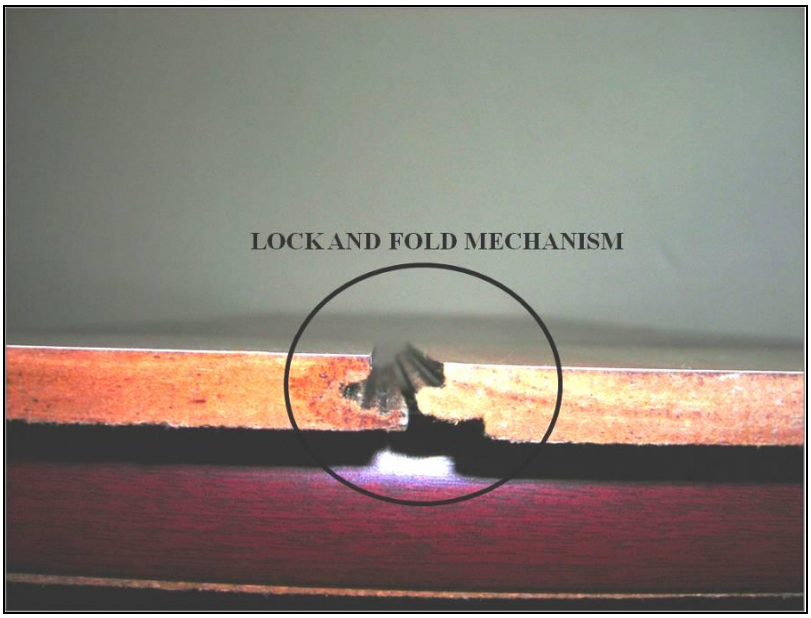

Figure 1.1: The lock and fold mechanism of the floating floors.

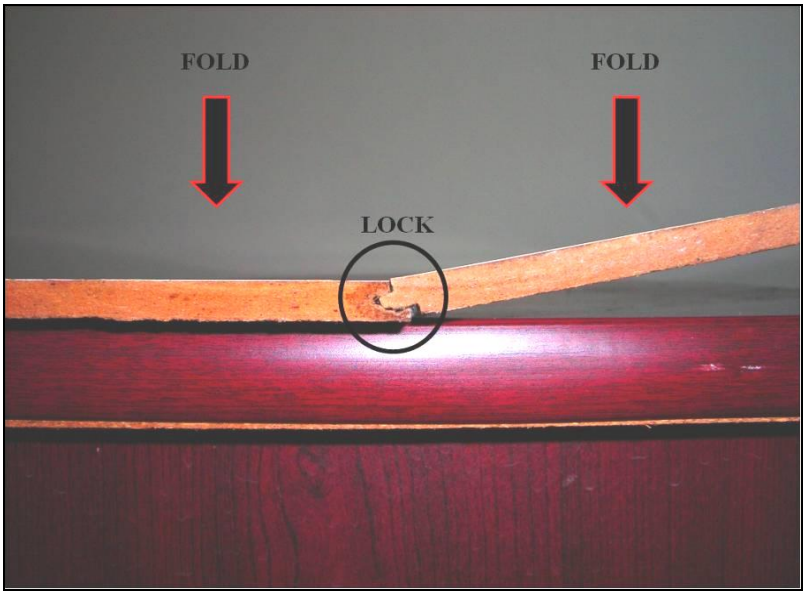

Figure 1.2: Boards are placed on a cushioned underlayment and ensure the boards were orientated in the right position. After that lock and fold it.

Figure 1.3: The floating floors were joined together without glue or tapping.

There are many types of flooring materials available in today market but most of the consumer facing difficulty to distinguish their qualities because the data regarding the surface and moisture characteristics are insufficient. In general, the degree of surface roughness is defines as 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 [45]. Whereas the moisture absorption is related with the swelling thickness of the material after soaked in water. The swelling thickness is directly proportional with the rate of moisture absorption whereby the percentage of moisture absorption can be calculated through the weight gained. Other than that, the microstructure of the flooring materials is directly affected by the moisture absorption. The moisture effect will weaken the mechanical properties of the wood-based flooring materials besides altering the microstructure of the materials.

Currently, the information for commercially produced laminated flooring is very limited. Therefore, the purpose of this study is to establish a database for the laminated flooring regarding their surface and moisture characteristics in order to clarify the queries from the consumer. In addition, the surface and moisture characteristics of engineered hardwood flooring will be included as a comparison with the laminated flooring. There are series of experiments will be conducted to determine the surface roughness and moisture absorption characteristics of the both flooring materials. After that comparison between both materials will be included in the database.