UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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RECYCLING OF SAWDUST FOR FLOOR TILE APPLICATION

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Manufacturing Design) (Hons.)

by

MOHD AMIRHAFIZAN BIN HUSIN

B051010075

880423 – 11 – 5079

FACULTY OF MANUFACTURING ENGINEERING

2014

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: Recycling Of Sawdust For Floor Tile Application

SESI PENGAJIAN: 2013/14

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TERENGGANU

Tarikh: 19/6/2014

Disahkan oleh:

Cop Rasmi:

ABD HALIM HAKIM BIN ABD AZIZ
Pensyarah
Fakulti Kejuruteraan Pembuatan
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I hereby, declared this report entitled "Recycling of Sawdust for Floor Tile Application" is the result of my own research except as cited in references.

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Date : 19/6/2014

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Design) (Hons.). The member of the supervisory committee is as follow:

.....

(Official Stamp of Supervisor)

ABD HALIM HAKIM BIN ABD AZIZ
Pensyarah
Fakulti Kejuruteraan Pembuatan
Universiti Teknikal Malaysia Melaka

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Design) (Hons.). The member of the supervisory committee is as follow:

.....

(Official Stamp of Principal Supervisor)

DR. SHAJAHAN BIN MAIDIN
Pensyarah Kanan
Fakulti Kejuruteraan Pembuatan
Universiti Teknikal Malaysia Melaka

.....

(Official Stamp of Co-Supervisor)

ABSTRAK

Sisa kayu atau habuk kayu merujuk kepada akhir hayat produk, gagal produk , pemotongan, tatal dan habuk papan dari semua produk kayu. Ini tidak termasuk sisa-sisa hutan , sering dirujuk sisa kayu sebagai utama . Ia juga tidak termasuk bahan-bahan buangan hijau atau taman seperti cawangan, semak dan tunggul pokok. Sisa kayu atau habuk kayu boleh dikitar semula untuk menjadi produk baru seperti meja , pintu dan lain-lain. Secara umumnya , sisa kayu atau perabot kayu yang tidak lagi boleh digunakan atau rosak teruk akan dibuang. Contoh yang ketara adalah adanya perabot rosak dari bangunan awam sekolah, pejabat dan pelbagai tempat kerja awam yang lain. Kajian ini untuk menuntut kembali sisa kayu berharga atau sumber habuk papan akan dibincangkan dengan teliti dalam kertas ini.

Objektifnya adalah untuk menyiasat kesesuaian habuk papan dalam campuran bahan epoksi bagi membolehkan permohonan itu sebagai jubin lantai. Dalam kertas ini, sampel dibuat dalam reka bentuk khas dengan panjang 50 mm, lebar 10 mm dan ketebalan 5 mm. Habuk kayu ini dibahagikan kepada tiga saiz jenis yang saiz kecil, sederhana dan besar. Sampel itu dibuat dengan menggunakan mesin kompres dengan tekanan 9,80665 N. Ujian kesan dan kekerasan data ujian dianalisis untuk mengenal pasti sifat-sifat mekanik sampel.

ABSTRACT

Wood waste or sawdust refers to the end-of-life products, failed products, off cuts, shavings and sawdust of all timber products. This excludes forest residues, often referred to as primary wood waste. It also excludes green or garden waste materials such as branches, bushes and tree stumps. Wood waste or sawdust can be reclaimed to become new product such as new table, door or anything. In general, current practice is that wood furniture's that are no longer usable or badly damaged will be thrown away. Notable example is the availability of damaged furniture from public buildings such schools, offices and various other public workplaces. As yet we have not attempted to convert this excellent basic raw-material into appropriate value-added products. Feasibility study on reclaiming this valuable wood wastes or sawdust resources are carefully discussed in this paper.

The objective is to investigate the suitability of sawdust in mixture of epoxy material to enable the application as floor tile. In this paper, the sample is made in special design with length 50 mm, width 10 mm and thickness 5 mm. The sawdust is divided into three type sizes which are small, medium and large size. The sample is made using compress machine with the apply pressure of 9.80665 N. The impact test and hardness test data are analysed to identify the mechanical properties of the sample.

DEDICATION

For my beloved parents, who always encourage and give all the support that I really need during accomplish this thesis.

ACKNOWLEDGEMENT

Bissmillahirrahmanirrahim,

Alhamdulillah. Thanks to Allah SWT, whom with His willing giving me the opportunity to complete this Final Year Project. This Final Year Project was prepared for Faculty of Manufacturing Engineering Universiti Teknikal Malaysia Melaka (UTeM) basically for student in fourth year to complete the undergraduate program that leads to the degree of Bachelor of Engineering in Manufacturing. This report is based on the methods given by the university

Secondly, I would like to express my deepest thanks to, En. Abdul Halim Hakim Bin Abd Aziz and Dr. Shajahan Bin Maidin, as my Supervisor and Co-Supervisor for this Final Year Project, who had guided me and give valuable information and suggestion during completion for this Final Year Project. I also want to thanks all staff at Universiti Teknikal Malaysia Melaka (UTeM) for their cooperation to lead me in this Final Year Project.

Deepest thanks and appreciation to my parents, family, special mate of mine, and others for their cooperation, encouragement, constructive suggestion and full of support for the report completion, from the beginning till the end. Also thanks to all of my friends and everyone, that has been contributed by supporting my work and helps myself during this Final Year Project.

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INTRODUCTION

1.1 Introduction

Nowadays, several research on materials recycling, environmentally friendly product and energy conservation are the main concern of many organizations and industries. Many previous researches have obtained valuable results to use the industrial wastes in various forms of construction materials production (Elinwa and Mahmood, 2002). For instance, the use of waste rubber, glass powder and paper waste sludge in concrete mix has received attention over the past years (Elinwa and Mahmood, 2002). Some researches carried out in the past used wood as wasted as a replacement for cement in concrete mixes (Elinwa and Mahmood, 2002; Udoeyo and Dashibil, 2002).

Another attempt has been made to incorporate waste in the production of construction (bricks); for example, the use of rubber (Turgut and Yesilata, 2008), limestone dust and wood sawdust, (Turgut and Algin, 2006) processed waste tea (Demir, 2005), fly ash (Kayali, 2005; Lin, 2006), polystyrene (Veiseh and Yousefi, 2003) and sludge (Basegio et al., 2002). Recycling of such wastes by incorporating them into building materials is a practical solution to the pollution problem.

Sawdust or wood dust is a by-product of cutting, grinding, drilling, sanding, or otherwise pulverizing wood with a saw or other tool. It is composed of fine particles of wood. It is also the by-product of certain animals, birds and insects which live in wood, such as the woodpecker and carpenter ant. It can present a hazard in manufacturing industries, especially in terms of its flammability. Sawdust is the main component of particleboard. In the present study, sawdust can be defined as loose particles or wood chippings obtained as by-products from the sawing of timber into

standard useable sizes. The recycling of chips of wood such as sawdust seems to be the best insulator which offers the properties of required ceramic products. In conclusion, these materials had properties which resembled those of lightweight concrete materials.

The main chemical components of sawdust are carbon 60.8%, hydrogen 5.19%, oxygen 33.83%, and nitrogen 0.90% (Horisawa et al., 1999). Dry wood is primarily composed of cellulose, lignin, hemicelluloses, and minor amounts (5 to 10%) of extraneous materials. Two types of sawdust were considered which are the Alep pine (family of coniferous woods) and eucalyptus (hardwood broad family). Both wood wastes are distinguished by their origin, structure, physical properties, chemical, etc.

The overall aim of this project is to investigate the suitability of sawdust in a mixture of epoxy material which possibility of obtaining floor tile with good appearance, low density and high mechanical strength.

1.2 Objective

1) To investigate the suitability of sawdust in a mixture of epoxy material to enable the application as floor tile.
2) To investigate the developed floor tile mechanical and physical properties.

1.3 Problem Statement

There are many types of wood and sawdust that are thrown away to landfill. From observation, the sawdust in Malaysia is not widely reused or recycle. There must be a better way on how to reuse or recycle the sawdust waste to be transformed into a new application of product such as new door, new table and so on. In this way the waste dumped away as rubbish will be reduced, hence a plus point for better maintenance of our lovely natural environment. Recycling is an urgent matter as a result of changes in regulations which are forcing those operating the systems to find ways in dealing with these products with a view of recycling or reusing them. This

wood waste and sawdust should neither be neglected nor be burnt in the open atmosphere. It must be collected and treated in the same way as the waste by which it was contaminated. Thus the holder and the production of wood waste or sawdust must dispose or recycle this waste properly to avoid affecting human health and definitely our environment.

1.4 Scope

The scope of this research is to investigate the suitability of sawdust in a mixture of epoxy material which likely to enable the application for floor tile with good appearance, low density and good mechanical strength using three type size of sawdust which is small, medium and large size. The floor tile will be produced in special design with self-locking. The mould of the floor tile is illustrated and design by using SolidWork software. While the process of making the floor tile by using a compress machine. The impact test and hardness test data as a measured data will be analyzed to identify the mechanical properties of the floor tile.

CHAPTER 2
LITERATURE REVIEW

This chapter explains a systematic method for identifying evaluating and interpreting the work done by researchers, survey scholarly articles, journal, handbook and other sources such as patent, journal and others. This chapter extends the literature review of the topic assigned.

2.1 Tile

According to Oxford dictionary (British & World English), tile is a constructed piece of hard-wearing materials such as gemstone, ceramic, metal or even ice. Tiles are basicly employed for covering floors, roofs, shower walls, and etc. Tiles is lightweight fabrics such as perlite, wood and mineral wool, typically used for wall and floor applications. Tiles are often utilized to form wall and floor coverings, and can run from simple square tiles to complex mosaics. Tiles are most frequently created from porcelain, fired clay or ceramic with a hard glaze, but other fabrics are also commonly used, such as glass, metal, cork, and rock. Tilinf stone is typically marble, granite or slate and onyx. Thinner tiles can be applied on walls than on floors, which require thicker, more durable surfaces. Figure 2.1 below shows the example of tile.

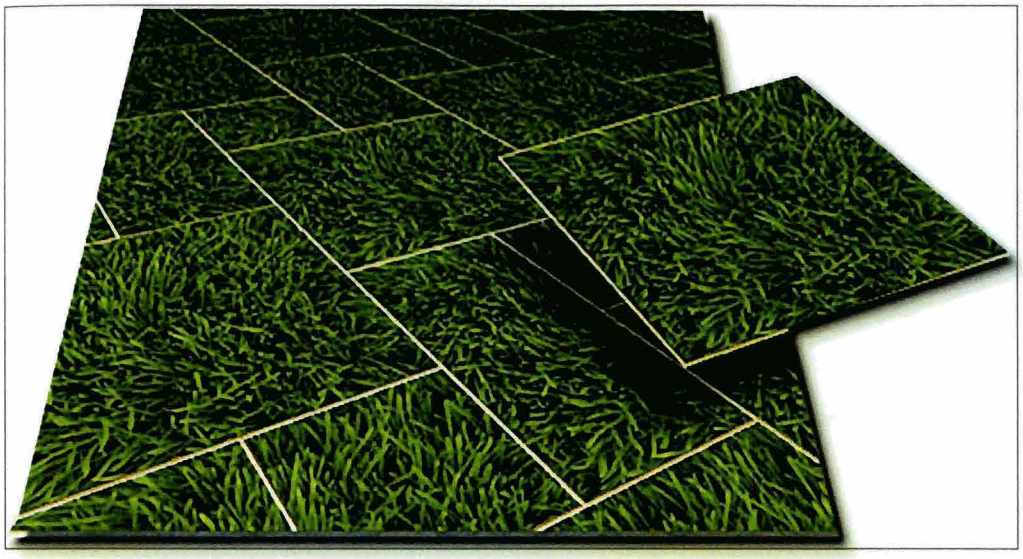


Figure 2.1: Example of Tiles (Tile Artisans Digital Imaging, 1999).

2.1.1 Types and Characteristic of Tile

a) Ceramic Tile

Ceramic tile is a mixture of clay and quartz ferrous sand materials along with water. The special clays are mined from the earth, shaped, colored and then burned in kilns. They can be colored and the surface can be glazed either in a high color or matte finish. Most ceramic tiles have either a white or red body color underneath the glazed finish (Fitzgerald, 2011).

b) Homogeneous Tile

Homogeneous tile is a kind of ceramic tile composed of fine porcelain clays but fired at much higher temperatures than ceramic tile. This procedure creates a homogeneous tile denser, harder less porous and thus less prone to moisture and stain absorption than ceramic tiles. They delivered a consitent property throughout the total subdivision of the tile. For this reasons, most homogeneous tile are suited for both indoor and outside usage. Even they are harder to ignore due to their density and severity (Helper, 2008).

c) Glazed Tile

The physical structure of ceramic tile, called bisque, may be coated with or without a glazed depending on its destined use. The glazed coating comprises of liquid colored glass which is applied and baked into the surface of the bisque under very high temperatures. The liquid glass coating can be fashioned with texture and pettern. The principal characteristics of glazed tiles are ease in cleaning and protection of the bisque from staining (Casasola, J. Rincón, and Romero, 2012).

d) Rectified Tile

A rectified tile has all its edges mechanically finish to achieve a more precise dimension. Unlike a typical factor-edged tile, a rectified tile is made by switching off the tile to size after the dismissal procedure. This creates precise 90 degree angle smooth edges. As a consequence, the tiles can be put down with consistent grout joints. Most tiles (homogeneous and ceramic) can change in size (up to 1.0%) after the firing process, but this can be substantially minimized by sawing or grinding the tile after firing (Griese, 2008).

2.1.2 Floor Tile

These are usually constructed of ceramic or stone, although recent technological improvements have resulted in rubber or glass tiles for floors as easily. Clay tiles may be painted and glazed. Small mosaic tiles may be put down in diverse designs. Floor tiles are typically set into mortar consisting of sand, cement and often a latex additive for extra attachment. The places between the tiles are now filled with sanded or unsanded floor grout, but traditionally mortar was applied.

Natural stone tiles can be beautiful only as a natural product they are less uniform in colour and shape, and require more planning for utilization and initiation. Some stone tiles such as polished granite, marble, and travertine are very tricky when wet. Stone tiles with a riven (split) surface such as ticket or with a sawn and then

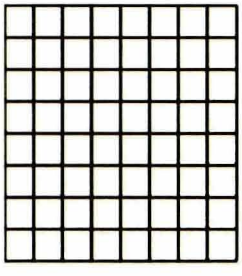
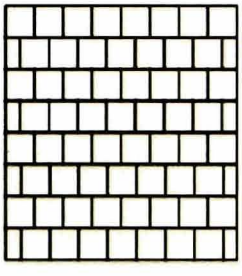
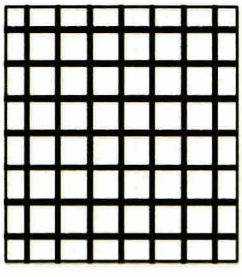
sandblasted or honed surface will be more slip resistant. Ceramic tiles for use in wet areas can be made more slip resistant either by applying very small tiles so that the grout lines act as grooves or by imprinting a contour pattern onto the fount of the tile.

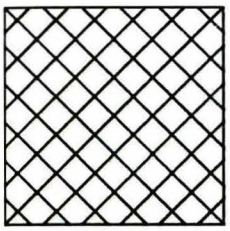
The harshness of natural stone tiles varies such that some of the softer rock (e.g. Limestone) tiles are not suitable for real heavy traffic floor areas. On the other hand, ceramic tiles typically have a shiny upper surface and when that becomes scratched or pitted the floor looks worn, whereas the same quantity of wear on natural stone tiles will not exhibit, or will be less obtrusive.

Rubber floor tiles have a diversity of exercises, both in residential and commercial settings. They are particularly useful in spots where it is trusted to experience high-traction floors or protection for an easily breakable floor. Some common uses include flooring of garage, workshops, patios, swimming pool decks, play courts, gymnasia, and dance floors.

Plastic floor tiles including interlocking floor tiles that can be installed without adhesive or glue are a late innovation and are desirable for areas subject to heavy traffic, wet fields and bases that are subject to movement, damp or contamination from oil, grease or other sums that may prevent adhesion to the substratum. Common uses include old factory floors, garages, gyms and sports complexes, schools and stores. Table 2.1 below shows the example of floor tile patterns.

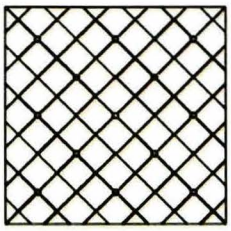
Table 2.1: Example of Tile Patterns (tileshop.com).

		
STRAIGHT STANDARD SET	**STANDARD BRICK**	**PICTURE FRAME**
All Sizes = 100%	All Sizes = 100%	12" = 87% 1" on 12"mesh = 13%



STANDARD DIAGONAL

All Sizes = 100%



1-CLIP

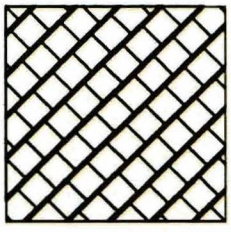
12" = 99%
2" on 12" mesh = 1%

4-CLIP

12" = 97%
2" on 12" mesh = 3%

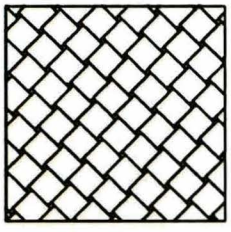
DIAGONAL PICTURE FRAME

12" = 97%
1" on 12" mesh = 3%



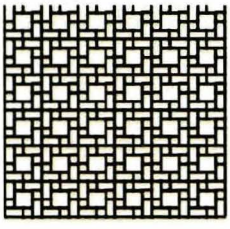
DIAGONAL BRICK WITH MOSAIC

12" = 95%
1" on 12" mesh = 5%



DIAGONAL OFF SET DOT

12" = 97%
2" on 12" mesh = 3%

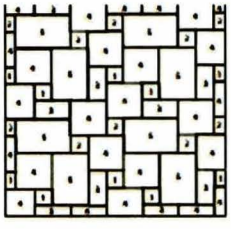


RANDOM ROLL

4x4" = 44%
4x8" = 44%
8x8" = 12%

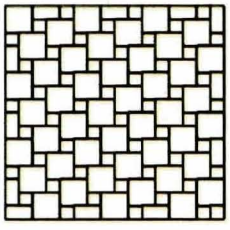
HERRINGBONE

Rectangle = 100%



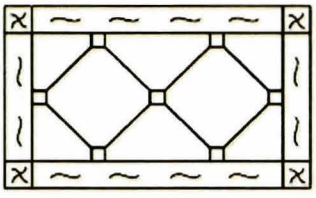
LARGE VERSAILLES

1 box = 15.92 sq ft
1) 7.48" x 7.48"
2) 7.875" x 7.875"
3) 15.75" x 7.875"
4) 15.75" x 15.75"
5) 23.625" x 15.75"



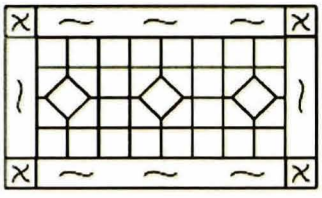
OFF-SET DOT

12" = 80%
6" = 20%



RUG PATTERN

Listello
Listello Out Corner
12" Tile
2" Tile



RUG PATTERN

Listello
Listello Out Corner
4" Tile
4" Deco

2.2 Sawdust

Sawdust or wood debris is a by-product of cutting, grinding, boring, sanding, or otherwise pulverizing wood with a saw or other creature; it is composed of fine particles of wood. Figure 2.2 below shows the example of sawdust waste.

Figure 2.2: Example of Sawdust Waste (Feinberg, 2013).

2.2.1 Practical Uses

A major use of sawdust is for particleboard; coarse sawdust may be used for wood pulp. Sawdust has a variety of other practical uses, including serving as a mulch, as an alternative to clay cat litter, or as a fuel. Until the advent of refrigeration, it was frequently used in icehouses to keep ice frozen during the summertime. It has been applied in artistic displays, and as scatter. It is also sometimes applied to sop up liquid spills, allowing the spill to be easily gathered up or swept away. As such, it was formerly common on barroom floors (Felman and David, 2005). It is practiced to make Cutler's resin. Mixed with water and frozen, it forms pykrete, a slow-melting, much stronger sort of methamphetamine.

Sawdust is used in the manufacture of charcoal briquets. The call for the conception of the first commercial charcoal briquettes goes to Henry Ford, who created them from the wood scraps and sawdust created by his machine manufacturing plant (Harvey, 2006).

2.2.2 Health and Safety Hazards of Sawdust

Airborne sawdust and sawdust accumulations presents a number of wellness and safety hazards (State Compensation Insurance Fund, 2012). Sawdust becomes a possible health problem when, for instance, the wood particles, from process such as sanding, go airborne and are inspired. Wood debris is a known human carcinogen (National Toxicology, 2012). Certain woods and their dust contain toxins that can produce serious allergic responses.

2.3 Epoxy

Epoxy is both the basic component and the cured end product of epoxy resins, as good as a colloquial name for the epoxide functional group. Epoxy resins, as well known as polyepoxides are a class of reactive polymers and polymers which contain epoxide groups. Epoxy resins may be redacted (cross-linked) either by themselves through catalytic homopolymerisation, or with a wide range of co-reactants including polyfunctional amines, acids (and acid anhydrides), phenols, alcohols, and thiols. These co-reactants are often mentioned to as hardeners or curatives, and the cross-linking reaction is usually consulted to as curing. Reaction of polyepoxides with themselves or with polyfunctional hardeners forms a thermosetting polymer, often with solid mechanical properties as easily as high temperature and chemical resistance. Epoxy has a broad scope of applications, including metal coatings, use of electronics / electrical components, high tension electrical insulators, fiber-reinforced plastic materials, and structural adhesives (NM Epoxy Handbook, 2004).