UNIVERSITI TEKNOLOGI MARA

BIO-ROOF MATERIAL BASED ON OIL PALM FIBRE

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

Nature of roof that covers the very top of the building, has encouraged related research, especially regarding the properties, types, problems and materials for roofs. In recent years, awareness about environmental pollution and sustainability, has driven the demand for roof coverings that are more sustainable. Currently, the use of local raw materials that are easily found, in addition to reducing waste, and reuse of materials is a key features of construction materials. The use of recycled materials based on palm oil can be profitable for the farmers and consumers in general. The objective of this research is to produce an advanced composite material from oil palm empty fruit bunch (EFB) at the same time exploring the mechanical and physical properties of this material as a preparation to develop a substitute's material for sustainable roofing material. The mechanical and physical properties of oil palm EFB as roofing material is originally tested as per American Standard (ASTM) and British Standard (BS). Materials are selected based on normal concrete mix with the addition of oil palm empty fruit bunch fibres in various batches. The oil palm empty fruit bunch (EFB) fibre is obtained from MPOB Research Centre and there is no treatment done to the selected fibre. The selected cement to sand ratio used is 1:2, with six different water to cement ratio (0.32, 0.37, 0.42, 0.47, 0.52 and 0.57). The thickness of the sample is 10mm and percentage of fibre used is 0.5%, 1.0&, 1.5% and 2.0%. Fibre sizes are divided into four categories; OS, LS, MS and SS. The sizes are range from 0.7mm -14.04mm length. The river sand is used as an aggregate with sizes ranging from 0.06 to 2mm which is passing a 2mm to 2.5 mm mesh size sieve. The sample is tested and the impact of the sample on the five different variables which are cement to sand ratio, water to cement ratio, fibre volume, size and weathering condition are analysed. The samples are tested based on the flexural strength, density and water tightness only. Fibre volume of 0.5% is found as the appropriate volume for this mixture design. The highest flexural strength recorded is 6.44N/mm² which exceed from the minimum requirement of ASTM for roofing slates. Flexural strength is increases when using the large size of fibre, it is found that the size of 6.4-14.04mm fibre length, 396-471µm width; achieve the highest flexural strength at 6.44N/mm² for sample C3-15-42. Fibre size is categorised as LS (Large Size) with 0.37 water cement ratio. Weathering condition gave a big effect to the sample as there is an increment in strength for samples mixed with oil palm fiber through the curing process from 7 to 28 days. The highest increment is 63.46% for sample C2-27-52 with 1.0% fibre content. Even though the highest strength is using 0.42 water cement ratio, but 0.47 water cement ratio gave constant result for other samples compares to other variables. The highest density recorded is from the LS fibre (water cement ratio 0.42) with 1.0% fibre volume and 28 days immersion in wet condition. The density of the sample is 2030.99kg/m³. The lowest reading of density is 1247.73kg/m³ with water cement ratio 0.32 (MS fibre), 2.0% of fibre volume and 28 days immersion in dry condition. An average density is also indicated which between 1562.51kg/m³ to 1997.19kg/m³. Unfortunately, all samples failed the water tightness test with 49g water retention which is 44g more compare to the minimum requirement.

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CHAPTER ONE
INTRODUCTION

1.1 INTRODUCTION

A roof envelops the uppermost part of a building. A roof protects the building and its contents from the effects of weather. The characteristics of a roof depend upon the purpose of the building, the available roofing materials and the local traditions of construction and wider concepts of architectural design and practice. The properties of materials for the building will affect the rate of heat transfer in and out of a building. Therefore, the need for suitable roofing materials that least absorbs heat is very crucial to maintain the thermal comfort in a building which at the same time can reduce the energy usage.

Sustainable development has become a major concern globally as natural resources deplete and energy cost becoming increasingly expensive. Building and the built environment play a major role on human impact on the natural environment and the quality of life (Sudin & Swamy, 2006) . Sustainable design is very relevant today as it integrates consideration of resources and energy efficiency, healthy building and materials. Sustainable design can significantly reduce adverse human impacts on the natural environment while simultaneously improving quality of life and economic well-being of the occupants.

In sustainable building analysis, three most important elements of building is put on stress which are energy, water and materials (Anink, Mak, & Boonstra, 1996).The application of renewable and recycled sources is promoted, because the life cycle of a building as a whole and its elements can be closed: renewable are renewed by nature; recycled products and materials get a second life and become an input product for the next final product. Selection of materials is performed with the least environmental impact taking into account the complete lifetime of a building (Chwieduk, 2003).

This research attempt to utilised the usage of empty fruit bunch (EFB), a biomass produced by the oil palm plantation as a roofing material as an alternative sustainable material for roofing. The physical characteristic and the thermal performance are analysed before producing the material into roof tiles. Finally, all data