

WASTE WOOD BLOCK AS PARTIAL COARSE
AGGREGATE REPLACEMENT IN
REINFORCED CONCRETE BEAM

LEE CHUN HOONG

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Thesis submitted in fulfilment of the requirements
for the award of the degree of
B. Eng (Hons.) Civil Engineering

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LIST OF SYMBOLS

%	Percentage
mm	Millimeter
g	Gram
kg	Kilogram
kN	Kilo Newton
°C	Degree Celsius
w/c	Water to Cement Ratio
MPa	Mega Pascal
GPa	Giga Pascal
µm	Micrometer
kg/m ³	Kilogram per Meter Cube
m ³	Meter Cube

LIST OF ABBREVIATIONS

ACI	American Concrete Institute
ASR	Alkali-silica Reaction
ASTM	American Society for Testing and Materials
CEM	Certified Energy Manager
CO ₂	Carbon Dioxide
C&D	Construction and Demolition
DPE	Density Polyethylene
EN	European Standard
KSK	Kembang Semangkok
LVDT	Linear Variable Displacement Transducer
MS	Malaysia Standard
PCC	Portland Composite Cement
PET	Polyethylene Terephthalate
SG	Strength Group
spp.	Species
WB0	0% of Wood Block
WB1	3% of Wood Block
WB2	6% of Wood Block
WB3	9% of Wood Block

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ABSTRACT

Most of the solid waste materials are not properly managed and cause pollution to this earth. In addition, the use of natural aggregate in construction lead to huge quarrying activities. Hence, by recycling the waste materials to replace the coarse aggregate can assist to lower the environmental impact. Performance of concrete properties possessing wood block as partial replacement of coarse aggregate were presented in this study. All the wood block were immersed into water before mixing with concrete to avoid it from soaking up the water required during mixing process. Thirty six cube specimens and four beam specimens were prepared. The concrete mix was casted according to the concrete mix design with different replacement contents of the wood block, which are 3%, 6% and 9% respectively. Test for hardened concrete properties including concrete density, compressive strength and flexural test were conducted. The concrete density decreased as the percentage of wood block increased. At the same time, as the wood aggregate content was increased, the compressive strength was decreased. For flexural test, the concrete beam containing 3% of wood aggregate able to sustain maximum load and perform smaller deflection compared to the other replacement beams. This study indicated that the wood aggregate was suitable to replace the coarse aggregate and the 3% of wood block was found as the best content of this study for replacement as the compressive strength was higher than control concrete and the flexural behaviour was closed to conventional concrete.

ABSTRAK

Kebanyakan sisa pepejal tidak diuruskan dengan baik dan menimbulkan masalah pencemaran. Di samping itu, penggunaan agregat semula jadi dalam pembinaan menyebabkan banyak aktiviti kuari berlaku. Oleh itu, dengan mengitar semula bahan-bahan buangan untuk menggantikan agregat kasar boleh membantu untuk mengurangkan kesan terhadap alam sekitar. Prestasi ciri-ciri konkrit memiliki blok kayu sebagai penggantian separa agregat kasar dibentangkan dalam kajian ini. Semua blok kayu direndam ke dalam air sebelum dicampur dengan konkrit untuk mengelakkan ia dari menyerap air yang diperlukan semasa proses pencampuran. Tiga puluh enam spesimen kiub dan empat spesimen rasuk telah disediakan. Campuran konkrit dicampurkan mengikut reka bentuk campuran konkrit dengan kandungan penggantian blok kayu yang berbeza, iaitu 3%, 6% dan 9% masing-masing. Ujian bagi sifat-sifat konkrit keras termasuk ketumpatan konkrit, kekuatan mampatan dan ujian lenturan dilakukan. Ketumpatan konkrit menurun apabila peratusan blok kayu bertambah. Pada masa yang sama, ketika kandungan kayu agregat meningkat, kekuatan mampatan menurun. Untuk ujian lenturan, rasuk konkrit yang mengandungi 3% agregat kayu dapat menampung beban maksimum dan melaksanakan pesongan yang lebih kecil berbanding rasuk penggantian yang lain. Kajian ini menunjukkan bahawa agregat kayu adalah sesuai untuk menggantikan agregat kasar dan 3% blok kayu adalah kandungan terbaik dalam kajian ini sebagai penggantian kerana kekuatan mampatan adalah lebih tinggi daripada konkrit kawalan dan sifat lenturan adalah hampir sama dengan konkrit konvensional.

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Concrete is a common and important material which is used extensively in constructing structural building, from basic concrete mixing work to high-rise structure in the construction industry. Concrete is a material with mixture of cement, water, and aggregates (fine and coarse) in different ratios, which must be workable, low permeability and economical. The different grades of the concrete can be obtained by using dissimilar quantity and quality of materials in mixing the concrete.

Wood had been cut down and processed in the factory to produce different type of product such as paper, furniture and construction material. However, a lot of wastes are produced during the process to manufacture products in the furniture industries and installing the wood material in the construction process. Hence, the waste material should be reuse to make another product instead of been disposed or burned because this process will affect and destroy the natural environment. It can be used as recycled material and as substitution for the certain material in concrete mix.

This study has ventured into performance of concrete when various percentages of waste wood block as coarse aggregate replacement is added and to determine the strength and flexural behaviour of the samples. Throughout this chapter, all details about background of the study, problem statements, objectives, scope of the study and study significant will be explained to give an overview for this whole study.

1.2 BACKGROUND OF THE STUDY

Issues on waste materials from manufacture and construction sector had become a more serious problem to both environmental and mankind in the world. In Malaysia, most of the production sector and construction industry produces a lot of unwanted waste which will cause negative impact to the environment. The average number of municipal solid waste produced in one day is approximately 0.5 to 0.8 kilogram per person and, at the same time, our country is also facing problem of insufficient landfill due to lack of places for the construction of new landfills (Kathirvale et al., 2004). Thus, immediate action must be taken to handle the huge amount of waste materials, such as waste wood due to the improper waste management.

Reuse and recycling those solid waste materials like PET and wood as replacement of aggregate in concrete is one of the suggestions to reduce the amount of waste and produce low cost concrete for construction. Polyethylene terephthalate (PET) and high density polyethylene (DPE) are two type of plastic commonly used in making the mineral water bottle and other plastic products due to their light weight and long life span properties. However, most of the plastics are non-degradable, resulting in large landfill required for disposal. Thus, this plastic waste can be reused to make new and economical materials in construction industry (Siddique et al., 2008).

According to Kartam et al. (2004), the construction and demolition (C&D) waste are mainly come from building maintenance and renovate work as well as old structural buildings that been demolished. This wastes can be used as recycled products to save land area for landfill. Figure 1.1 shows the composition of C&D wastes produced from construction site, where wood waste is the fourth highest waste materials been generated. Hence, by replacing the aggregate with waste wood block, also can be done as a solution to deal with the waste accumulation and help to protect the ecosystem.

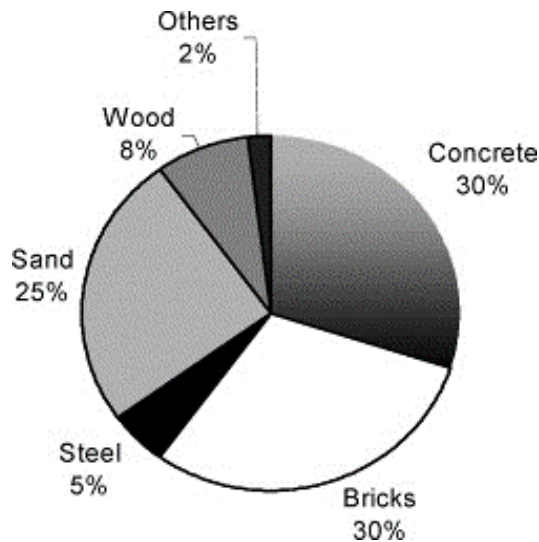


Figure 1.1: C&D wastes

Source: Kartam et al. (2004)

1.3 PROBLEM STATEMENTS

The rapid development of construction industry results in the increasing demands for the construction materials like cement and aggregate. In addition, the cost of materials in concrete mix including coarse aggregate is increasing from year to year. To deal with this problem, one of the solutions suggested is to use the waste wood block as coarse aggregate replacement with a portion by total volume of the coarse aggregate. This type of concrete can be made cheaper by replacing some of the coarse aggregate with this solid waste.

Besides that, it will also reduce the waste from the wood industries and assist in decreasing the pollution impacts on the environmental. It also helps to minimize the quarrying activities which often end up in a great negative effect on the mother earth. This replacement of aggregates will help in minimizing the wastes and reduce the quarrying activities (Henry & Kato, 2012). Thus, study on the characteristics, properties and strength of concrete with waste wood block as part of concrete mixture is conducted to determine the maximum strength of the concrete.