STUDY ON WC OF FRESH AND HARDENED CONCRETE CONTAINING DIFFERENT PERCENTAGE OF CHIPBOARD WASTE

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ABSTRACT

Nowadays people are paying more attention to the sustainability in construction field. So, the engineers are finding the ways to improve the quality of the concrete using recycle or waste product. One of the methods is to mix the chipboard with the concrete. In the research, a waste chipboard is already available at Terang Bersih Landfill is used. The chipboard was replaced with coarse aggregate in the proportion of 10%, 20% and 30% by weight of cement. The laboratory tests include slump test, vebe test, compaction factor tests, compressive strength test and flexural strength test. All test methodology is referring to British Standard (BS). Concrete cubes of size 150 x 150 x 150 mm were casted for compressive strength and concrete beams of sizes 150 x 150 x 750 mm were casted for flexural strength test. Concrete with lowest percentage of chipboard replace in concrete has lower workability. For compressive strength, concrete with 10% chipboard content provides the highest strength compare to other percentages of chipboard but it still lower than the control set. For flexural strength test, concrete with 30% chipboard content shows the highest strength. The workability and compressive strength were decreased when more percentage of chipboard were added into concrete mix.

ABSTRAK

Manusia pada zaman sekarang semakin menitikberatkan isu kemapanan dalam bidang pembinaan. Maka, jurutera-jurutera sedang mengkaji cara-cara untuk meningkatkan kualiti konkrit dengan menggunakan bahan buangan atau produk kitar semula. Salah satu cara yang dikaji ialah dengan mencampurkan konkrit dengan papanserpai. Dalam kajian ini, sisa buangan papanserpai yang digunakan boleh didapati di Terang Bersih Landfill. Papanserpai telah digantikan dengan agregat kasar sebanyak 10%, 20% and 30% mengikut berat simen. Ujian makmal yang dijalankan termasuk ujian penurunan, ujian vebe, ujian factor pemadatan, ujian kekuatan mampatan dan ujian lenturan. Semua metodologi ujian merujuk kepada British Standard (BS). Kiub konkrit bersaiz 150 x 150 x 150 mm telah dituangkan untuk ujian kekuatan mampatan dan rasuk konkrit bersaiz 150 x 150 x 750 mm telah dituangkan untuk ujian kekuatan lenturan. Daripada ujian yang dijalankan, telah didapati bahawa konkrit dengan peratusan paling rendah yang diganti dengan papanserpai mempunyai kebolehkerjaan yang paling rendah. Untuk kekuatan mampatan konkrit dengan kandungan papanserpai sebanyak 10% memberikan kekuatan tertinggi berbanding dengan peratusan lain tetapi ia masih lebih rendah daripada konkrit kawalan. Untuk ujian kekuatan lenturan konkrit dengan kandungan papanserpai sebanyak 30% menunjukkan kekuatan tertinggi. Kesimpulannya, nilai kebolehkerjaan dan kekuatan mampatan telah menurun apabila lebih peratusan papanserpai ditambah ke dalam campuran konkrit.

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BS	-	British Standard
Al_2O_3	-	Aluminium Oxide
C-S-H	-	Calcium Silicate Hydrate
$C_a(OH)_2$	-	Calcium Hydroxide
H_2O	-	Water
C_aO	-	Calcium Oxide
kg	-	Kilogram
N/mm^2	-	Newton per millimeter square
mm	-	Milimeter
S	-	Second
ASTM	-	American Society for Testing and Materials
UTM	-	Universal Tensile Mechine
C_3S	-	Tricalcium Silicate
SiO_2	-	Silicon Dioxide
Fe_2O_3	-	Iron (III) Oxide

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Concrete is the one of the main components in the construction industry. The use of concrete in construction is essential to build the main structures of the core in a building. Production of good concrete are reviewed regularly to ensure good quality of concrete produce. To produce a good quality of concrete is depend on the quality of raw materials that used in the method mixture, method of transportation and way how to compact it. If the raw materials used are not qualified, then the resulting of concrete has low in quality of the resulting of concrete that become concrete not strong and does not meet the prescribed specifications.

The concrete is the oldest material is extensively used in the construction industry. A resource from the Polytechnic's website Sultan Azlan Shah was states that, the Assyrians and Babylonians used mud as cement in their concrete mix. During the Roman Empire, the concrete produced by using a combination of quick line, pozzolanic ash/pozzolana and aggregate was made from pumice that resembles modern Portland cement concrete. In the year 1756, a British engineer, John Smeaton founded the use of Portland cement in concrete, using gravel and powdered brick as a aggregate.

The concrete characteristics have been changed since the days of Rome and Egypt, when it is added to a mixture of volcanic ash that can allows it to harden under water. Romans also knew that adding horse hair made concrete less shrink during hardening process of concrete. Currently, researchers have added other materials to create a very strong concrete, lightweight, even concrete that can conduct electricity. Concrete is a mixture of cement, coarse aggregate, fine aggregate and water. But have ever wondered whether these materials can survive or not? How much can it meet the market demand? Found that, there are gaps for improvement studies conducted by the researchers. For improvements to the study of concrete, it may use the materials that can be classified as waste materials can be used as a replacement for concrete base materials.

This study is to examine the appropriateness of the use Chipboard to replace the coarse aggregate in a certain percentage to determine the strength and workability of the concrete after replaced Chipboard as coarse aggregate. This is because, the percentage of Chipboard waste in landfill is rising today. Knowing that Chipboard readily available and the study were also conducted to determine the flexural strength of concrete if it can be used as a replacement material for coarse aggregate.

1.2 Problem Statement

An increase material price to produce concrete at the present time is influenced by several factors such as demand, lack of materials and difficulty in obtaining the materials. The uses of coarse aggregate are growing now due to advances in the construction sector, that caused the issues of coarse aggregate are depleting and rising in market prices. Arising from here, the uses of replacement material for coarse aggregate in concrete is seen to help to solve this problem. For this experimental project, by using the recycle material as a coarse aggregate replacement, it can give more benefit for others. Other than that, by recycle the waste material, it can produce the new product and also can less uses of landfill space. There is extremely good for society and environment by recycling the waste material at landfill.

For support the problem statement, Connor R Sullivan (2009) writes that "Recycling helps to create an eco friendly environment and as more people start to understand the benefits of recycling, incinerators and landfills will soon be eliminated." For this experimental project, the proposed of replacement material is from waste disposal sites that are too often dismissed by the factory. The proposed waste material that suitable to replace coarse aggregate is chipboard. According to statistic from Terang Bersih landfill, Kuantan, waste chipboard said to be about 10 000 tons per month. Apart from being cost effective to produce concrete, it also can reduce the waste chipboard at the landfill.

1.3 Objective of Study

The objectives of this study are:

i. To determine the properties of the workability of fresh concrete containing 0% , 10%, 20% and 30% of chipboard.
ii. To determine the compressive strength of concrete with different percentage of chipboard as a coarse aggregate replacement.
iii. To determine the flexural strength of concrete containing chipboard as a replacement material in concrete with various percentage of chipboard.

1.4 Scope of Study

This experimental study focused on determining the workability of fresh concrete containing different percentage of chipboard. Hence, to find the compressive strength and flexural strength of chipboard concrete. For the sample collection, 36 numbers of cubes sample with dimension 150mm x 150mm x 150mm and 12 numbers of beam sample with dimension of 150mm x 150mm x 750mm will be prepared. Four different mix proportion with 0%, 10%, 20% and 30%of chipboard will be designated as sample A, sample B, sample C and sample D respectively. Chipboard is a waste material that is readily available and waste material from the factory. It is available on-site landfills. Type of concrete to be used is concrete grade M35 because follow the JKR standards. Table 1 show the quantity of mix proportion to produce the concrete grade M35.

Table 1.1 : Quantity of $1m^3$ Mix Proportion

Material	Sample A	Sample B	Sample C	Sample D
Cement (kg)	350	350	350	350
Fine Aggregate (kg)	725	725	725	725
Chipboard (kg)	-	119	237	356
Coarse Aggregate (kg)	1185	1066	948	829
Water (kg)	190	190	190	190

Determination of this objective will involve 5 tests that are Slump Test, Compaction Test, Vebe Test, Compressive Strength Test and Flexural Test. Concrete test are conducted on the concrete specimen at the specific ages. For the cube test, it's limited to the ages of 7, 14 and 28 days after production of the specimens. But for the testing of flexural, the specimen was test on the days 28 only.

CHAPTER 2

LITERATURE REVIEW

2.1 History of Chipboard

Chipboard is one of main inputs to furniture industry. A rapid development in the investments chipboard sector was observed where fiber board consumption was increasing from day to day. The history of chipboard sector as the main input of the furniture industry and has started in year 1941. For the time being, the total of 26 chipboard production facilities have 4 million m^3/year of the capacity where as the figure was total hardly to 3000 m^3/year for 50 years ago. Currently, the longest and latest technology chipboard and fiber board production lines was exist. Especially the recent investments boost this development in the production.

A Chipboard is a particle of wood engineering. It was consists of compressed fibers such as paper, wood dust and resin. It also has many uses that are from note pad backings, the business form, decorative scrapbook and also materials as subfloor (DoltYourselfstaff, 2011).

Chipboard is made from sawdust which is a byproduct of saw mills in Ghana. It is made by mixing the saw dust of 8% moisture content with 6% (solid basis) liquid phenol formaldehyde (1) and 1% (solid basis) wax and pressed at a temperature of 170^0C at a pressure depending on the density desired. The different types of boards with different engineering properties can be formed by varying the type and quantity of resin and wax, the manufacturing temperature and pressure and also the particle size (Miramare – Triste, March 1993)

2.2 Mechanical Properties of Chipboard

Mechanical properties were increased with increasing the density except for internal penetration. Found that the resistances to cutting the board are the tensile strength, modulus of rupture, shear strength and hardness. Impact strength is also varies in direct proportion to the density. Whereas, the degree of elasticity has a nonlinear relation with the density. Boards are stronger in bending than in compression and tension strength in the decline of strength (Miramare – Triste, 1993).

2.3 Physical Properties of Chipboard

Chipboard is made up of wood chips that bound together with resin and were pressed into a flat and rectangular shape. Chipboard is also available in three types that are normal, medium, and high density but it is depending upon the amount of pressure used in the formation of the board. There are some physical properties that described chipboard. It is density, permeability and porosity.

2.3.1 Density

Because it is a porous material, so a physical, thermal and mechanical property of chipboard is dependent on the density. The value of density is reported as bulk density because it is porous and adsorbent materials. To assess and calculate the density of chipboard specimens, it should be weighed and measured it dimensions (Miramare – Triste, 1993).

2.3.2 Permeability

Chipboard may be approximated to the consolidated porous media which is comprises a highly complex network of the channels. Some of the tiny pores in the board are interconnected (accessible to air flow from both ends of the pores), but some have dead end (connected to the outside of the board only from one end) and some are isolated (inaccessible to external air flow). The pores are neither straight nor of constant diameter (Miramare – Triste, 1993).

2.3.3 Porosity

A specimen dimensions must be measured to assess the total for the relocation of the specimens using conditioned of testing. The specimens were compressed without changing their lateral dimensions until they were practically incompressible. The compressed dimensions were measured to evaluate the compressed volume (Miramare – Triste, March 1993).

2.4 Characteristic of Chipboard

The characteristic of the chipboard is absorbing the water and the more percentage of chipboard was replace in concrete, it become quite difficult to compact and the surface on the cube cannot be flattened out well because the reduction of water was occurred. Lack of water also causes compacted concrete is difficult because there are spaces between chipboard and aggregate (Rohazak Bin Yaacob, 2010/2011).

The stickiness of the concrete mix with replacement of chipboard causes the lower workability of concrete compare with pure concrete mix. The more content of chipboard in concrete, it can make the concrete contain less water because the chipboard absorbing water too much (Yong Woo Soon, 2009).

The higher in compacting factor, was indicates that the sample of concrete is more compacted than others (Tee Lian Yong, 1979). The shapes of particles influence the cement hydration with surface / volume ratio relative to spherical particles results in greater rates of hydration process (Jeffrey and Edward, 2006).

Chipboard is one of the lightweight that can be used in concrete but use of it can also lead to the problem like mixing difficulty (Ravindrajah, 2007). The chipboard is made from many small chips, that were soak up water due to capillary action from the wood fibers (Angela Brady, 2010).

The bonding strength between the aggregates in the concrete is weak due to the surface of the chipboard that is not rough and it cannot bind the aggregate together. This is also due to lack of water in the mixture, that cause the volume of concrete is less dense as chipboard absorbs water during the process of the concrete mix (Norshafida, 2009).

2.5 History of Concrete

Concrete is a material that used in the construction sector. It is consisting of a hard, chemically inert particulate substance, as known as an aggregate (usually made from different types of sand and gravel), that is bonded together by the cement and water.

The Assyrians and Babylonians used clay as the bonding substance or cement. The Egyptians used lime and gypsum cement. In the year 1756, British engineer, John Smeaton was made the first modern concrete (hydraulic cement) that is by adding small stones as a coarse aggregate and mixing powered brick into the cement mixed.

In year 1824, English inventor, Joseph Aspdin invented Portland cement, which has remained the dominant cement used in concrete production. Joseph Aspdin created the first artificial cement that is by burning ground limestone and clay together. The burning process changed the chemical properties of the materials and Joseph Aspdin created stronger cement than what using plain crushed limestone would produce (Mary Bellis,2010).

2.6 Properties of Fresh and Hardened Concrete

The properties of hardened concrete was including compressive strength, tensile strength, elastic properties, and the nature of shrinkage, creep, fracture resistance, electricity, heat, transportation and other properties. Aspects that the needs to be given special attention in terms of testing are the properties of concrete, interpretation, modeling and forecasting properties.

Other aspect should be taken into account is in correlation with the fresh concrete properties and durability, effects of special binders, recycled and natural aggregates, fiber reinforcement, mineral and chemical admixtures, and properties of special concrete.

2.6.1 Properties of Fresh Concrete

The fresh concrete behaves as yield stress fluids such as many materials in industry or nature. Therefore, there exists a minimum value of the stress that applied to the material for irreversible deformation and flow to occur. In terms of workability and practical, the yield can be attributed to fill up the capacity in general whether or not allow the concrete to flow under applied pressure. While, the plastic viscosity can be

related to the velocity. Over the past few years, the test result of the declining yield stress measurement. This test is the most usually test used in industry for fresh concrete only. They are related in certain circumstances for a given yield stress of the concrete (K.Kovler, N.Roussel / Cement and Concrete Research 41, 2011).

The properties of early ages for fresh concrete are workability, slump loss, segregation, bleeding, plastic shrinkage, time of set and temperature. Segregation is a coarse aggregate that tends to segregate due to gravity. There are typical of dry mixes. Bleeding is a water that rising to the surface. Workability is the effort required to manipulate a concrete mixture with a minimum of segregation (Paulo Monteiro).

2.6.2 Properties of Hardened Concrete

Properties of hardened concrete, mainly dependent on composition and materials used, but also on production processes. The properties of hardened concrete give effect to the strength, dimensional changes, durability and impermeability of concrete.

2.6.2.1 Strength

For the properties strength of the hardened concrete, it was achieve after 28 days of casting and the strength were increasing after 28 days. After 28 days of concrete, it can know as a characteristic strength of mix and also use for the design purposed. But for the concrete that does not achieved the full load within the 28 days of ages concrete especially for the foundation concrete, so the characteristic strength may be increased same as shown in Figure 2.1.