

PROPERTIES OF CRUSHED RECYCLED FINE AGGREGATE IN CONCRETE  
MIXES

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To my beloved wife, family, lecturers and friends

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## ABSTRACT

In many developing countries, the construction activities growth tremendously with sometimes, constituting large amount of waste produce by Construction and Demolition (C&D) works. Since C&D waste had been disposed incorrectly, many researchers and concrete engineers suggested that reused or recycling the waste is more profitable and an appropriate alternative to improve the construction method. The utilization of waste material is able to conserve the raw material but also preserve the environment. This study discusses on several physical and mechanical properties of crushed recycled fine aggregates to replace fine natural aggregate (sand) in the production of new concrete. Recycled Fine Aggregate (RFA) concrete is crushed into the fine aggregate with particles size less than 5mm diameter. The replacement level or RFA is varied, by replacing to 0%, 25%, 50%, 75% and 100%. Sieve analysis, specific gravity and water absorption test have been examined to check on fine recycled aggregates characteristic. In order to achieve the objectives, test for concrete samples were conducted in two categories which is fresh concrete test and hardened test. For fresh concrete test, slump test were conducted to measure the degree of the workability of the fresh concrete. The hardened test such as compressive strength, flexural strength, density of cube and ultrasonic pulse velocity test were investigated. It was obtained that the compressive and flexural strength decrease with increment of replacement. However, after 28 days of curing time, the concrete containing recycled aggregate rates of strength development are almost similar to the natural concrete. It was cleared that at 25% replacement the reduction of concrete strength is at 2% - 3%. Meanwhile, it was found that the water absorption of the fine crushed concrete waste much greater than natural aggregate. Finally, it can be conclude that it is possible to replace the normal fine aggregate with the fine crushed concrete waste aggregate since the properties obtained were similar to the conventional concrete.

## ABSTRAK

Aktiviti pembinaan semakin pesat berkembang di kebanyakan negara maju dan membangun. Maka, secara tidak langsung penghasilan bahan terbuang daripada aktiviti pembinaan dan kerja perobohan menjadi semakin meruncing. Memandangkan pembuangan bahan tersebut dilakukan secara salah, ramai penyelidik dan jurutera konkrit menyarankan alternatif lain iaitu dengan penggunaan semula bahan terbuang tersebut yang bukan sahaja lebih menguntungkan malah memelihara alam sekitar dan mengelakkan masalah pengurangan agregat semulajadi. Kajian telah dijalankan untuk menentukan kesan penggantian agregat halus semulajadi (pasir) dengan agregat halus konkrit terbuang dalam penghasilan konkrit baru. Kadar penggantian iaitu sebanyak 0%, 25%, 50%, 75%, dan 100% konkrit terbuang terhadap kandungn pasir di dalam campuran konkrit telah disediakan. Analisis ayak, graviti tentu dan air ujian penyerapan telah diuji untuk memeriksa ciri-ciri agregat halus dikitar semula. Dalam usaha untuk mencapai objektif, ujian bagi sampel konkrit telah dijalankan dalam dua kategori iaitu Ujian Konkrit Segar dan Ujian Ketahanan Konkrit. Untuk Ujian Konkrit Segar, ujian kejatuhan telah dijalankan untuk mengukur tahap keboleherjaan konkrit segar. Terdapat beberapa Ujian Ketahanan Konkrit dijalankan seperti kekuatan mampatan, kekuatan lenturan, ketumpatan kiub dan ujian halaju denyutan ultrasonik. Kekuatan mampatan dan lenturan konkrit yang mengandungi agregat konkrit terbuang didapati menurun dengan pertambahan kadar penggantian. Walaubagaimanapun, selepas umur 28 hari, kekuatan mampatan konkrit hampir sama dengan konkrit kawalan dengan perbezaan hanya 2% - 3%. Jelas sekali dapat diperhatikan pada kadar penggantian 25% konkrit terbuang. Sementara itu, kajian mendapati agregat terbuang menyerap lebih banyak air berbanding dengan agregat semulajadi. Oleh itu, dapat disimpulkan penghasilan konkrit berdasarkan agregat halus konkrit terbuang adalah tidak mustahil kerana sifat-sifatnya adalah hampir sama dengan sifat konkrit biasa.

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**LIST OF SYMBOLS**

$W_1$	-	Steel mould with sample
$W_2$	-	The empty steel mould
$W_a$	-	Weight in air
$W_w$	-	Weight in water
$L$	-	Path length between the test face
$t$	-	transit time

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## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 Introduction**

Concrete is the most widely used as construction materials in the world. In fact, concrete is used in virtually everything and there is still no viable substitutes are available for many of its application. Without concrete, the community and society today could not exist. Therefore, lots of researchers and engineers are doing the research of the aggregate sources. All these research as alternative sources for the replacement of the natural aggregates in producing concrete in the various future construction works.

In Asia, the construction activities are extremely emerging. Parallel to that, one of the main problems in urban areas is the vast amount of construction and demolition waste produce everyday. In many population growth and developing countries, construction and demolition waste often had been disposed incorrectly. Since an obligation of searching the solutions, recycling of the waste is the profitable and appropriate alternative that will improve the construction method. The utilization waste materials will help to avoid several environmental or health damages, reduce the exploration of natural resources, and increase the lifetime of the landfill.

The abandoned concrete waste products are generated in a significant amount during the production process or the demolition of the buildings. It has causes a large land required storing it and consequence in land pollution. These problems will spend a lot of money. In order to make sure the continuously of crushed aggregates supply, the recycling or reuse the concrete waste as an alternate source as an aggregate replacement. Hence, the sustainable development concept will be achieve due to the concern over the depletion of natural resources and deterioration of the global environment while preserving the environment for the benefit of future generation. Some works of the possibility of using crushed recycled concrete as an aggregate replacement in concrete has been carried out. However, there are only several researches of concrete waste as a substitute of the raw material and the knowledge of the effect of concrete waste properties in concrete is inadequate, only few works have been used recycled concrete in the construction.

While according to Rao et al, (2006), the construction and demolition waste management is widely well practice by some develop countries such United States of America, Japan, European Union, Bulgaria, Hong Kong and Taiwan. As for rapid economy, population, and industrialization growth such as Malaysia certainly the construction works is promptly increasing. Since most of the civil works will be using the concrete, by reducing the consumption of natural resources and the generation of waste is the critical task for the construction industry. Hence, conduct more study of the waste materials like crushed recycled concrete properties and their effects on characteristic of the concrete.

Replacing the natural coarse aggregate with the recycled aggregate in the production of new concrete is conducted in most of work or studies. Consequently, this paper discusses and reports on the concrete properties for hardened and fresh concrete by replacing the normal aggregate (sand) with the fine crushed concrete waste.

## **1.2 Problem Statement**

For economic, technological and ecological points of view, the aggregate replacement materials have an undoubted role to play in the future of the construction industry. There are lots of benefits in term of economy, preserving the environment, raw materials or natural resources conservation, and energy saving are all substantial. Therefore, the extensive consideration should be applied to the sources and types of aggregates since they can give various effects to the concrete.

Lots of concrete waste is abandoned during the construction and demolition works. For years, the recycled concrete aggregates is been used and still one of the important construction materials instead of other materials. However, the usage of this waste is not too extensive in the construction world today. The reasons of recycled concrete will be used in some of construction works are because of the limited knowledge and research of its performance in the concrete, behavior in the mixing, effects on properties and characteristics to the concrete, and lack of information about the specific standard and capability to the concrete structure.

Since some of the crushed concrete waste properties characteristic are similar to the normal course aggregates, so that the crushed concrete waste can be recycled and substitute as the fine aggregate to the structure. Consequently, the scrupulous understanding of the crushed recycled concrete properties and effect on concrete structure as the coarse aggregate replacement is essential on order to reduce the waste generated and enhance the knowledge of new concrete mix proportion.

## **1.3 Objective**

The main objectives of this project are described as follows:



- a) To determine the fine crushed recycled aggregate characteristics.
- b) To determine fresh and hardened concrete properties containing fine recycled concrete aggregate.
- c) To identify the optimum proportion for replacement the natural fine aggregate with fine crushed recycled concrete.

#### **1.4 Scope of Study**

The concrete waste were crushed to fine aggregate with the maximum aggregate size of 5mm. Then, the concrete design mix proportion was prepared where the batching of the concrete material was done by volume. The mix design proportion with concrete strength of Grade 20 be used. The scope of this study is the replacement of natural fine aggregate (sand) with fine crushed recycled concrete aggregate. The ratio of sand replace to recycled fine concrete aggregate are 100:0% as control, 75:25%, 50:50%, 25:75% and 0:100%.

Sieve analysis, specific gravity and water absorption test had been examine to check on fine recycled aggregates characteristic. In order to achieve the objectives, test for concrete samples were conducted in two categories which is Fresh Concrete Test and Hardened Test. For Fresh Concrete Test, slump test were conducted to measure the degree of the workability of the fresh concrete. There are several Hardened Test were conducted such as compressive strength, flexural strength, density of cube and ultrasonic pulse velocity test were investigated. The samples were tested at the age of 7, 14, 21 and 28 days after casting which is during the curing works. No admixture was used in this experiment. So, the workability of the concrete cannot be improved. The results were analyzed and the graphs were plotted form the data. All the parameters from the test can be determined. So that, the results of the optimum proportion of fine crushed recycled concrete aggregate will be determined.

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