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RECYCLED CONCRETE AGGREGATE FOR IBS COMPONENT

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Abstract:

The demolition of an existing building and then replace it with a new one are becoming a trend. This trend leads to an increasing number of waste disposal which simultaneously reduce landfill spaces and pollute the environment. Besides, with rapid industrialisation, the usage of aggregate is rapidly increasing due to the fact that it is one of the important materials for concrete. Hence, an alternative to overcome this issue is by using recycled concrete aggregate. The purpose of this study is to present an overview about the application of recycled concrete aggregate in construction project and to propose design mix of concrete with recycled concrete aggregate in Malaysia. Desk study on relevant research that is related to recycled concrete aggregate will be conducted and also a study on the critical review to relevant design mix of recycled concrete aggregate. The data and information will be tabulated to compare the most suitable design mix for local application. The expected findings of this study will be the design mix and method to conduct the experiment. Recycled concrete aggregate will not only help to preserve the natural resources but also reduce waste disposal as well as provide sufficient space for other waste at the landfill.

Keywords: Demolished Concrete; Waste; Recycling; Recycled Concrete Aggregate

1.0 INTRODUCTION

In this urbanization era, the demolition of old and unpreserved buildings, and their substitution with new ones, is a frequent phenomenon (Malesev et. al, 2010). The development of a construction project has contributed to the environmental issues especially in the production of construction waste. The major physical waste generated from construction activity is identified in the form of material waste like concrete leftover, demolished debris, and others (Nagapan et. al, 2011). The percentage of total solid waste generation of the construction industry in Malaysia is approximately 41% (Mei and Fujiwara, 2016) and the wastes from construction and demolition waste are of a large volume and it is increasing with time. Growing number of waste generation is due to several factors which include economy, demand, living standard, population growth and industrial and urbanisation (Rahim et. al, 2017).

Due to the rapid growth of the construction industry, it indirectly requires a large amount of construction materials like aggregate and sand. These materials are needed in order to produce concrete. Concrete is the most valuable material in the construction industry as it acts as the material that creates the building. Thus, the mining and quarrying industry should guarantee the adequate and continuous supply of raw material to the construction sector to sustain the economic development of the country (Ismail et. al, 2013). The decrease in the number of raw material like aggregates and sand will result in an increase in cost due to the high demand from client and this will burden the contractor. However, the usage of recycled concrete aggregate is not a common practice in Malaysia's construction industry because there is no depletion of natural aggregates yet. But, the time will come when the sources of natural aggregate will soon deplete and Malaysia will encounter a reduction of supply.

A possible way to avoid shortage of raw material especially aggregate is by recycling it. Aggregate is one of the most vitally important materials used for production as it profoundly influences

concrete properties and performances. Recycled concrete aggregate can be defined as crushed concrete composed of aggregate fragments coated with cement paste or cement mortar from the demolition of the old structures (Essays, 2013). Recycled concrete aggregate is generally produced by two-stage crushing of demolished concrete, and screening and removal of containants such as reinforcement, paper, wood, plastic and gypsum (Malesev et. al, 2010). The advantages include saving of natural resources, saving cost of disposal of demolished concrete and promote recycling amongst contractor and developer as the government encourages the use of recycled and reuse materials for construction industry.

The main purpose of this study is to identify the application of recycled concrete aggregate and to identify the properties of recycled concrete aggregate in order to achieve the next objective which is to propose a new design mix of concrete with a combination of natural aggregate with recycled concrete aggregate. These objectives are meant to be attained and most importantly, the application of recycled concrete aggregate in Malaysia's construction industry must be implemented.

2.0 LITERATURE REVIEW

In recent years, many countries had developed the application of recycled materials in their construction projects. Some of the countries implement the usage of recycled aggregate in their concrete production. Many researches have dedicated their work to explain and describe the properties of this kind of aggregate.

2.1 Application of Recycled Concrete Aggregate

The application of recycled concrete aggregate in Brazil has been utilized only in non-structural concrete and the recycled aggregates are divided into two classes, recycled concrete aggregate and mixed aggregate which is the combination of recycled aggregate and natural resources (Goncalves, 2007). In Japan, there are three types of recycled aggregate which are high-quality recycled aggregate (Type H), medium quality (Type M) and low quality (Type L). For type H, it can be used in structures with nominal strength lower than 45 MPa. Type M aggregates can be used in piles, underground beams, and concrete filled in steel tubes. Lastly, type L could be used in backfilling, filling and leveling concrete applications (Pellegrino & Faleschini, 2016).

2.2 Properties of Recycled Concrete Aggregate

In terms of morphological characteristics, recycled aggregate is less favorable than natural aggregate. The grains are irregular, mostly with angular shape, rough and with cracked surface and porous (Malesev et. al, 2010). He also stated that recycled aggregate has a significantly higher absorption level compared to natural aggregate. The water absorption of recycled aggregate increased according to the size of the recycled aggregate. The overall absorption percentage for the three sizes of recycled aggregate is below 5% and this proved that recycled aggregate can be used in any construction application.

Table 1: Design mix of Recycled Concrete Aggregate

No	W/C ratio	Cement (kg)	Sand (kg)	Coarse Aggregate (kg)	Dolomite (%)	Recycled aggregates (%)	Slumpt without admixtures (mm)	Slumpt with admixtures (mm)
1	0.55	400	600	1200	100	0	60	140
2	0.55	400	600	1200	75	25	40	115
3	0.55	400	600	1200	50	50	15	100
4	0.55	400	600	1200	0	100	5	60

Sources : Abdel-Hay (2017)

The best ratio of recycled aggregate to natural aggregates is the mixing ratio of 50% and that when they are cured in air and the maximum value of the compressive strength and tensile strength was obtained at age of 28 days (Abdel-Hay 2017) . In all cases of recycled aggregates ratios, curing in water causes a decrease in the concrete permeability.

3.0 METHODOLOGY

In this research, desk study will be conducted on relevant research related to recycled concrete aggregate such as referring to books, articles, journals and the Internet. Other than that, some information and data are obtained through a critical review of previous study about the properties and design mix of recycled concrete aggregate. There are approximately 9 articles that have been reviewed and differentiated according to the topics.

4.0 ANALYSIS AND FINDINGS

In a nutshell, the findings of this research are that the application of recycled concrete aggregate has been introduced around the world. There are various types of recycled aggregate properties, method and application that have been implemented. Many researchers all over the countries have conducted studies about the design mix of concrete with recycle concrete aggregate. The data and information are tabulated as below in Table 2. However, there are still quite a few numbers of applications of recycled concrete aggregate in Malaysia. This is because there are no signs of natural aggregate depletion crisis in Malaysia. The availability of supply encourages the contractor or client’s not to focus on the use of recycled aggregate (Ismail et. al, 2013). Other than that, lack of knowledge and experiences were found due to the minimum information on the practices of recycled concrete aggregate in Malaysia which resulted in lack of usage of the recycled concrete aggregate. Hence, by designing a new design mix of concrete where the application is suitable to use in Malaysia’s climate, the expected outcome is that the number of application of recycle concrete aggregate will be increasing, not only in Malaysia, but all over the world, to ensure that the natural resources are well preserved.

Table 2: Table on findings regarding the research

Findings	Explanation	
Application	In Brazil: They used recycled concrete aggregate in non-structural concrete elements	In Japan: <u>Type H</u> : used in structures, nominal strength below 45 MPa <u>Type M</u> : used in piles, underground beam, concrete filled in steel tubes <u>Type L</u> : used in backfilling, filling and leveling concrete
Properties	Grains irregular with angular shape, rough and cracked surface with porous	Higher absorption level. Water absorption increases according to the size of recycled concrete aggregate
Design Mix	The best ratio is 50% of recycled aggregate in the design mix	Cured in air and the maximum value of the compressive strength and tensile strength was obtained at age of 28 days

5.0 CONCLUSION

Of late, natural resources have depleted in time. It is imperative for the world to concern about reducing, recycling and reuse. Moreover, for the Malaysian construction industry, it is essential to make a greater use of natural resources by recycling them. Recycling concrete aggregate may sound unfamiliar but this recycled aggregate is extremely reliable. Recycled aggregate is seen to be the best solution to preserve the natural resources that we have here in Malaysia. The benefits gained from applying it in here, is that it reduces the number of demolition waste and giving an adequate space at the landfill so that there’s no problem in lack of space. Review of several studies suggested that the use

of recycled materials has a positive impact on different aspects. Hence, all parties involved in construction industry in Malaysia especially the Government, should take an action in promoting the application of reducing, recycling and reusing in the construction project as well as educating the people to encourage parties to use recycled aggregate in their concrete production.

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