INVESTIGATION ON CONCRETE WITH RECYCLED AGGREGATE

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ABSTRACT

The use of recycled aggregates in concrete opens a whole new range of possibilities in the reuse of materials in the building industry. The utilisation of recycled aggregates is a good solution to the problem of an excess of waste material, provided that the desired final product quality is reached. The studies on the use of recycled aggregates have been going on for 50years. In fact, none of the results showed that recycled aggregates are unsuitable for structural use. However, some hypothetical problems related to durability aspects resulted in recycled aggregates being employed practically only as base filler for road construction. This paper focuses on the possibility of the use of recycled aggregate concrete as a structural material. For that purpose an experimental study of the shear behaviour and strength of beams made with recycled aggregate concrete was studied. Twelve beam specimens with the same compression strength, four concrete mixtures using different percentages of recycled coarse aggregates (0%, 25%, 50% and 100%) and three different transverse reinforcement arrangements were cast and tested up to failure.

1. INTRODUCTION

1.1 Introduction of Recycled Aggregate

Recycling is the act of dispensation the used material for use in creating fresh product. The habit of natural aggregate is getting more and more intense with the advanced maturity in infrastructure area. In order to reduce the usage of natural aggregate, recycled aggregate can be used as the substitute materials. Recycled aggregate are comprised of crushed, graded inorganic particles processed from the materials that have been used in the constructions and devastation debris. These resources are usually from buildings, road and rail network, bridges, and sometimes even from catastrophes, such as wars and earthquakes.

Figure 1.1: Recycled Aggregate

1.2 Historical Background

The applications of recycled aggregate in the construction areas are wide and they had been used long time ago. Wilmot and Vorobieff (1997) confirmed that cast-off aggregate have been old in the road business for the last 100 years in Australia. They also stated that the use of recycled aggregate for the construction and treatment of local government roads has a great improve in the last five years. C & D Recycling Industry (n.d.), the fact file confirmed that from

the time of the Romans, the stones from the earlier roads were reused when rebuilding their vaunted set of roads. It also confirmed that since the end of planet war two, the recycling business had been well recognized in Europe. According to Seecharan (2004), the Detroid News confirmed that in 1980s, the old concrete compressed into a fine particles was a popular road builder at Michigan, USA.

1.3 Applications of Recycled Aggregate

Traditionally, the application of recycled aggregate is used as landfill. Nowadays, the applications of cast-off aggregate in structure areas are wide. The applications are unlike from country to country.

• Concrete Kerb and Gutter Mix

Recycled aggregate have been used as concrete kerb and gutter mix in Australia. According to Building Innovation & Construction Technology (1999), Stone says that the 10mm recycled aggregate and blended recycled sand are used for concrete kerb and gutter mix in the Lenthall Street project in Sdyney.

Figure 1.2: Application of Recycled Aggregate as Road Kerb (Source: Building Innovation & Construction Technology, 1999)

2. REVIEW OF RECYCLED AGGREGATE

The applications of recycled aggregate in the construction area are very wide. There are many testing based on the recycled aggregate have been carried out all around the world. Hanson and Torben (1986) stated that since 1945, the research on recycled aggregate had been carried out in many countries. Some of the literature reviews on recycled aggregate are shown as below.

The main aim that testing the recycled aggregate is to find out the result of the strength characteristic on it and analysis whether recycled aggregate is suitable to apply in the construction area. According to Rammamurthy and Gumaster (1998), the compressive strength of recycled aggregate concrete was relatively lower and variation was depended on the strength of parent concrete from the obtained aggregate. Limbachiya and Leelawat (2000) found that recycled concrete aggregate had 7 to 9% lower relative density and 2 times higher water absorption than natural aggregate.

According to their test results, it shown that there was no effect with the replacement of 30% coarse recycled concrete aggregate used on the ceiling strength of concrete. It also mentioned that recycled concrete aggregate could be used in high strength concrete mixes with the recycled concrete aggregate content in the concrete. Sagoe, Brown and Taylor (2002) stated that the difference between the characteristic of fresh and hardened recycled aggregate concrete and natural aggregate concrete is relatively narrower than reported for laboratory crush recycled aggregate concrete mixes. There was no difference at the 5% significance level in concrete compressive and tensile strength of recycled concrete and control normal concrete made from natural aggregate.

In the same year, poon (2002) reported that there were not much effect of the compressive strength of brick specimens with the replacement of 25% and 50% of recycled aggregate. But when the percentage of recycled aggregate replacement increased, the compressive strength of the specimens was reducing. Mandal, Chakarborty and Gupta (2002) also found that there will no effects on the concrete strength with the replacement of 30% of recycled aggregate. But the compressive strength was gradually decreasing when the amount replacement of recycled increased. They concluded that the properties and the strength characteristic of recycled aggregate concrete were deficiency when compared to the specimens that made by the natural aggregate.

Limbachiya (2003) found that there is no effect by using up to 30% of coarse recycled concrete aggregate on the standard 100mm concrete cube compressive strength. But when the percentage of recycled concrete aggregate used increased, the compressive strength was reducing.

3. PROPERTIES AND TESTING OF AGGREGATE

3.1 Particle Density and Water Absorption of Course and Fine Aggregate

Particle density is one of the important factors that used to determine the properties of aggregate. It is required when calculate the mix design for concrete. Australian Standard HB64 (2002) stated that in the concrete mix, substituting different density of aggregate would influence the yield, unit mass of concrete and quality of aggregate needed for a concrete volume. The particle density of aggregate is generally affected by the amount of moisture present and the geological properties of aggregate. In this project, particle density of aggregate was carried out to determine the volume and weight of aggregate needed for the concrete mixes. The determination of particle density was according to AS1141.5 and AS1141.6.1.

Water absorption is the amount of moisture absorbed in the aggregate. The water absorption capacity is based on saturated surface dry condition and oven dried condition. Australian Standard HB64 (2002) mentioned that the amount of water in a concrete mix has direct effect on the setting time and compressive strength of concrete. It also stated that moisture content of the aggregate had to determine first before preparing a mix design for a particular aggregate. If the moisture content of the concrete is not met the target, then more water have to add to avoid a loss of workability. If the moisture content exceeds the target, then less water should be added. The determination of water absorption of aggregate was according to AS1141.5 and AS 1141.6.1.

3.1.1 Apparatus and Test Procedure of Course Aggregate

The following apparatus and equipments used were complied with AS1141.2.

1. Wire Basket: With a suitable mesh and size, and with wire hangers for suspended it from the balance. 2. Water Bath: Appropriate size and shape to locate the basket and give a cover of at least 50mm water above the top of the immersed basket.

3. Balance: Sufficient capacity with a limit performance that not more or less than 5g and have a type which can locate a basket that containing the sample to be suspended from it and weight in the water. 4. Oven: Thermostatically controlled that gives a temperature of 105ºC to 110ºC.

5. Container: Suitable size for putting the sample.

6. Towels and Dry Cloths: To dry the surface of aggregate.

7. Dishes: Suitable Sizes

3.2 Sieve Analysis

Sieve investigation is used to find the quantity of different size of aggregate used in a concrete mix. It is accepted out to let the aggregate pass during a series of sieves. The sieve analysis can be done either by hand or sieve apparatus. It is recommended that using sieve machine will give more accurate result and can use several sieves in one time. The aggregate was air – dehydrated before accepted out the sieve analysis. According to Neville (1997), this is to evade lumps of fine particles being classified as bulky particles and prevent clogging of the more sieves. A process called 'sample reduction' was accepted out, where the amount of aggregate was compact from bucket by riffling. The aggregate was discharged in the riffle and composed in two boxes at the foundation of the chutes. One box was discharge and the other box was riffled repeatedly until met the specification. resolve of the sieve analysis was according to AS1141.11. In this assignment, sieve analysis was passed out base on course aggregate and fine aggregate. The sieve sizes for course aggregate was from 19mm to 1.18mm and sieve sizes for fine aggregate was from 2.36mm to 75µm.

3.3 Mix Design

Before having any concrete mixing, the selection of mix materials and their required materials proportion must done through a process called mix design. There are lots of methods for resolve concrete mix design. According to Sullivan (2003), the method called British Method was widely used in Australia. In this scheme, altogether eight batches of mixtures were unwavering in this assignment. The first mix batch will be 100% normal aggregate mix batch. Second mix batch was 80% ordinary aggregate and 20% recycled aggregate. There was enlarged of every 20% of used aggregate extra into every sequence of mix batch. To wholly evaluate the different types of full second hand aggregate concrete, there were three mix batches that restricted of 100% second hand aggregate. Two batches of 100% recycled aggregate were used dissimilar water cement ratio and the enduring one batch was mixed with blended cement. procedure of fly ash cement in structure had gained rising acceptance by structural engineers. According to Kelvin (2003), high quantity of fly ash concrete mixes may be used successfully for applications where the outside exposure is smallest. Kelvin (2003) affirmed that the difference between fly ash and Portland cement is the fly ash particles are globular in shape, which allowable them to flow and blend freely in mixture. This capability is one of the properties that make fly ash as a advantageous admixture for concrete. He also affirmed that the spherical shape of fly ash creates a "ball bearing", which better the workability of concrete mixes lacking assign more water. The sphere-shaped shape of fly ash also improves the consolidation of concrete. Other repayment that can attain through usage of fly ash in concrete are confrontation to corrosion of concrete reinforcement, molest from Alkali – silica response, sulfate harass, and salt attack.

CONCLUSION

Investigate on the convention of waste production materials is extremely significant due to the equipment waste is steadily growing with the improved of residents and increasing of town development. The reasons that many investigations and analysis had been made on recycled aggregate are because recycled aggregate is easy to obtain and the cost is cheaper than virgin aggregate. Virgin aggregate need to mine but recycled aggregate can ignore this process. This on-going research project is to

determine the strength characteristics of recycled aggregate for potential application in the high concrete structural concrete. The study shows that when the water/cement ratio was decreased, the compressive strength can reach 48MPa. This is classified as high strength concrete and they can be applied in the infrastructures, which need compressive strength up to 40MPa.

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