RECYCLED CONCRETE, CHARACTERISTICS AND SUSTAINABLE DEVELOPMENT

Nurafzal Qaytmas
Lecturer, Civil Engineering Department, Engineering Faculty, Faryab University, Afghanistan
Email: nurafzalqaytmas@gmail.com

ABSTRACT

Demolition of old buildings and their replacement with new buildings is a frequent phenomenon in a large part of the world, which leads to the generation of construction waste. Among the construction wastes are concretes, which is the most common method of managing these wastes, through their disposal in landfills. On the other hand, the production and use of concrete is increasing rapidly, which leads to the increase in the consumption of natural materials as the largest component of concrete. A possible way to solve these problems is to recycle destroyed concrete and produce alternative aggregates for structural concrete. Based on documentary studies, this article aims to introduce recycled concrete and its characteristics with a descriptive-analytical method.

Keywords: recycled concrete, properties of recycled aggregates, properties of recycled concrete, existing obstacles

Introduction

Demolition of buildings and their replacement with new buildings have different reasons. Among its main reasons can be mentioned the change of use, deterioration of the structure, change in the fabric of the city, expansion of traffic direction, natural disasters, etc.

The wastes resulting from the demolition of buildings are placed in landfills, which causes many environmental pollutions. Concrete is one of the construction wastes that can be recycled and reused. Concrete recycling is becoming a popular way to reuse leftover materials from building demolitions.

In addition to reducing environmental pollution, concrete recycling also includes reducing construction costs. Therefore, in this article, an attempt has been made to investigate the characteristics of recycled concrete as well as its advantages and disadvantages.

Research Methodology

In collecting information, library and documentary methods have been used. In this article, the successful experiences of projects implemented in other countries as well as the research of researchers have been used.

General properties of concrete with recycled materials

After the destruction of concrete, the aggregates contain a certain amount of cement paste. This mortar is the main reason for the low quality of recycled concrete compared to concrete with natural aggregates. The method of producing recycled concrete is different from the method of producing concrete with natural aggregates.

Because recycled aggregates contain cement mortar, they have higher water absorption than natural aggregates.

Therefore, in order to achieve the desired efficiency of recycled concrete, if water-reducing additives are not used, it is necessary to add a smaller amount of water to saturated aggregates compared to natural aggregates. (Nagataki etal.,2004)

Properties of aggregates

Recycled concrete materials can be prepared from the following:

1- Samples prepared for concrete testing

2- Destruction of concrete buildings

In making conventional concrete, only the cement paste surrounds the aggregates, but in recycled concrete, the aggregates may contain salt, bricks, tiles, plastics, dust, etc.

Numerous tests have shown that recycled aggregates after separation from other wastes, and sieves, can be used as a substitute for coarse aggregates.

However, checking the quality of recycled aggregates in terms of grain size distribution, friction and water absorption is particularly important. (Crentsil et al., 2001; Ajdukiewicz and Kliszczewicz, 2002)

The size of the aggregates

After sifting the aggregates and separating them, it is necessary to place the aggregates in a crusher to achieve the desired size for making concrete. It is generally accepted that recycled aggregates, both coarse and fine aggregates, are obtained from impurities by crushing once and twice. In order to achieve the right size, larger aggregates are placed in successive crushers.

The best aggregates size is obtained by using the first and then the second crushing, but from an economic point of view, the first crushing is more suitable. In the initial crushing stage, the size of the grains is reduced to about 50 mm, and on the way to the second stage, electromagnetism is used to remove metal materials. The second crushing step reduces

the particle size to about 14-20 mm. Necessary care should be taken during crushing, because finer materials are produced than in the initial stage and concrete crushing stage. (Corinaldesi et al., 2002)

Friction

There is little information about the friction of aggregates. In countries such as the United States and the United Kingdom, recycled aggregates are used in road surface layers. However, the studies conducted show promising results about the use of recycled aggregates in sub-base layers in flexible pavements. (Gilpin et al., 2004; Khalaf et al.,2004)

Absorption

Recycled aggregates have very high water absorption compared to natural aggregates. This high absorption is caused by the porosity caused by the binding of the mortar to the aggregates. Water absorption in coarse aggregates can be considered as about 3-12% of natural aggregates, and these percentages depend on the type of cement used to produce aggregates. (Katz,2003;Rao, 2005)

Properties of hardened recycled concrete

Compressive strength

Although researchers have reported a reduction in strength in recycled concrete, it should be noted that the amount of strength reduction depends on parameters such as the type of cement used to make recycled concrete, the water per cement ratio, and the moisture conditions of recycled aggregates, etc. has it. For example, in the Katz test, it was found that at a high water per cement ratio (between 0.6 and 0.75), the strength of recycled concrete is about 75% of normal concrete. (Katz, 2003)

In Rao's test, it was also found that the strength of recycled concrete can be considered equal to normal concrete, with the condition that the ratio of water per cement ratio is higher than 0.55.

Rao also showed that if the water per cement ratio is reduced to 0.4, the strength of recycled concrete will be only about 75% of normal concrete. (Rao, 2005)

Apart from the water per cement ratio, the moisture conditions of the aggregates also have a significant effect on the compressive strength. (Rao,2005; Poon et al., 2004)

Creep and shrinkage

Recycled concrete has high shrinkage due to the high absorption of its aggregates. Studies show that the shrinkage of recycled concrete on the 90th day is about 0.55mm/m to 0.80mm/m. While the acceptable amount of shrinkage in normal concrete is around 0.30

mm/m. Laboratory results for creep are not completely clear, even some studies have shown opposite results, for example, in an experiment, creep in recycled concrete is reported to be about 20% less than normal concrete after 1 year. (Ajdukiewicz and Kliszczewicz, 2002) It seems that recycled concrete and conventional concrete will be comparable when the simultaneous effect of creep and shrinkage is considered.

Modulus of elasticity

The modulus of elasticity for recycled concrete is reported to be about 50-70% of normal concrete, depending on the water per cement ratio. (Oliveira et al., 1996)

Bending and tensile strength

Studies conducted by Rao show a reduction in strength of about 15-20% of normal concrete. In another study, where only the tensile strength of concrete was investigated, the difference in the tensile strength of recycled and normal concrete at day 28 was reported to be less than 20%. **(**Ajdukiewicz and Kliszczewicz, 2002**)** Studies have shown that the use of admixtures such as microsilica, etc. helps to improve the properties of recycled concrete.

Comparison of recycled concrete with concrete with natural aggregates

- Increase water absorption

-Increasing the amount of organic impurities (if the concrete is in contact with the ground during its life

-Decrease of compressive strength

-Increase creep

-Decrease the modulus of elasticity

- Specific weight loss

- Reducing friction resistance

Properties of fresh recycled concrete

Many researchers have reported lower workability for recycled concrete than conventional concrete with the same amount of water. In order to improve efficiency, special measures have been proposed regarding changing the moisture content of recycled aggregates. (Topcu and Sengel,200) Recycled concrete contains more air (about 4% to 5.5%) than conventional concrete. This extra air can be attributed to the greater porosity of the aggregates. (Katz, 2003)

The density of most concrete made with natural aggregates is 2400 kg/m3, while the density of concrete made with recycled aggregates is less than 2150 kg/m3. One of the reasons for reducing the density of recycled concrete is the presence of excess air in this type of concrete. (Topcu and Guncan, 1995; Katz, 2003)

Obstacles to using recycled concrete

People's lack of trust in the use of recycled materials due to inappropriate culture, as well as the low prices of materials in developing countries are obstacles for recycling operations, and the only thing that can convince manufacturers or owners to recycle waste is imposing Landfill costs. These issues can all hinder the promotion of the use of recycled aggregates in concrete.

Lack of government support

Unfortunately, there is a lack of government support for the development and progress of the recycling industry in developing countries, but the motivation for collecting information and documenting them and consequently controlling the management of recycled materials can be realized with the existence of a suitable policy in the legal framework.

Lack of knowledge

One of the factors that cause the continuation of landfilling is people's lack of awareness of the benefits of recycling, as well as their lack of awareness of the consequences of the absolute use of freshly mined aggregates. To overcome these barriers, we need to raise awareness and disseminate information about the consequences of repeated use of quarry aggregates as well as the characteristics of recycled concrete to stimulate public opinion towards recycled materials. We can also create space for the growth of recycled materials by participating and pushing the construction industry to use recycled materials in projects.

Lack of appropriate technologies

The methods or technologies of eliminating wastes on an economic scale should have high speed and low cost. However, regarding concrete recycling, there are few feasible technologies.

Absence of appropriate codes and standards

Regarding the use of recycled materials, except RILEM and JIS (RILEM, 1994) and what is used in Hong Kong, there are a limited number of standards and codes.

In Hong Kong, for common applications, except for water protection buildings, the use of 100% recycled aggregates is allowed for low-grade concrete, but for high-grade concrete, only 20% of the aggregates can be used from recycled aggregates.

In Japan, JIS pursues a program entitled Recycled Concrete with Recycled Aggregates, which promotes the use of recycled concrete.

Expanding the standards related to recycling and reuse of aggregate, in addition to providing specific goals for the producer,

also provides the consumer's confidence about the quality of concrete.

Conclusion

The production of solid waste is the product of various human activities, which today has changed a lot with the change of lifestyle and comprehensive development compared to the past.

One of the solid waste materials is building waste, which is increasing in volume day by day.

Due to the limitation of natural resources and environmental protection, the most optimal solution is to reuse waste.

The use of recycled grains in concrete is a promising solution to solve the problem of construction waste management.

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