

The research summary for construction waste recycled aggregate concrete

Yonglong Wu

School of Civil Engineering and Architecture, Southwest Petroleum University, Chengdu 610500, China

1040009789@qq.com

Abstract

Based on the growing construction waste and the huge raw stone material dosage of concrete, this paper aims to summarize the research about construction waste recycled aggregate concrete at home and abroad. For the foreign construction waste dispose, on one hand, the origin of it has been payed much attention. That is to say, scientific ways would be used to control the waste production before the construction waste is formed. On the other hand, for the existing construction waste, the relevant properties, production processes and standards of it has been studied to get the whole set of solution techniques. That can make its resource revival and performance high-efficient. However, for the domestic construction waste dispose, it is still at primary stage, and mainly focuses on the research of strength performance and its economy. According to these, the future research prospects and directions of construction waste recycled aggregate concrete has been put forward.

Keywords

Construction waste; Recycled aggregate concrete; The future research direction.

1. Introduction

With the development of urbanization construction in our country, the construction concrete dosage increases sharply and the construction waste has been grown fast. On one hand, Buildings and infrastructure construction needs huge concrete. According to calculation, the sand and stone about 1700-2000 kg would be need for producing each $1 m^3$ concrete, which could increase the demand of sand and stone as concrete aggregate. Therefore, the huge demand of sand and stone would cause lots of mountains cut to quarry and river sands dug, which can greatly destroy the natural ecological environment. On the other hand, no matter the old building demolition, or the new building completion, they would produce a large number of construction waste which can be seen in Fig.1. The total amount of construction waste caused by the old building demolition and new building completion is about 240 to 360 million every year for our country recently. However, at present, most of construction wastes have not been recycled but been transported to the outskirts or rural for piling or landfill by the open-air ways. This would occupy a large number of cultivated land and soil, groundwater and atmosphere would be polluted for the long time piling or landfill. The car which is not hermetic has been used in the process of transportation, which can make the dusts and wastes fly and the large amount of harmful chemicals in the construction waste pollute and destroy the ecological environment.

For the purpose of protecting the ecological environment, How to effectively solve the contradiction between the increasing construction waste and the lack of natural stone material has become the common concern topic for the construction industry. Construction wastes include the residue, waste concrete, waste mortar, brick and tile fragments, old asphalt, metal scrap materials and so on. For most of them, especially for the building demolition wastes, the waste concrete, waste mortar, brick and tile fragments of them can be pick out and gone through the process of crushing, screening, removing impurity and so on. They could be made into recycled coarse-fine aggregate with a certain particle size, which can replace some or all of the natural sand to prepare the recycled aggregate

concrete. It can be shown in Fig.2. This can not only solve the issues that construction wastes piling occupy a large number of cultivated land and pollute environment but also reduce the environment destruction caused by the mountain cut to quarry. There is good economic, social and environmental effect. Therefore, the research on construction waste recycled aggregate concrete is very necessary.



Fig.1 The construction waste formed at the time of building demolition



Fig.2 The crushing process of construction waste (a) and the construction waste recycled aggregates (b).

From the point of view above, in this paper, the research about construction waste recycled aggregate concrete at home and abroad would be summarized to get the relevant foreign and domestic research. Based on these, the future research prospects and directions of construction waste recycled aggregate concrete would be put forward.

2. The research status of construction waste recycled aggregate concrete at home and abroad

The related research of construction waste recycled aggregate concrete at home and abroad both have existed [1-3]. However, there is difference between them. At abroad, the developed countries have developed the construction waste recycled aggregate concrete rapidly, which means it has been in the practical stage. But in our country, Researches on construction waste recycled aggregate concrete start late and is just in an early stage of development.

2.1 The research at abroad

Recently, the utilization of recycled aggregate concrete made by the waste concrete has been studied in many countries and regions. Japan has established 《the use principles of recycled aggregate and recycled concrete》 [4]. The broken concrete is used as the aggregate to prepare the recycled concrete and the production process or properties of it has been studied. Renewable factories has been

established to deal with the waste concrete for producing the recycled aggregates. There are remarkable achievements for the concrete recycled pavement in America and eight states of it removed and recycled concrete road for more than 160 miles from 1984 to 1985[5]. Besides, in America, «concrete aggregate standard» has indicated that the broken cement concrete with hydraulic property can be taken as the building aggregate. The Waste concrete production rate is about 1.2 ton each year for every person in Austria and the experimental research shows that the strength of concrete added 50% recycled aggregate is equal to B225~300 standard in Austria. What is more, the frost resistance and salt resistance have also been improved. In Netherlands, the principle that recycled aggregate is used to make the plain concrete, reinforced concrete and prestress force reinforced concrete has been put forward [6], which stipulates the specific technical requirements. The recycled concrete can be made according to the design and preparation methods of general natural aggregate concrete when the recycled aggregates content is less than 20 percent.

In addition to these, many foreign scholars do research on construction waste recycled aggregate concrete too. In 1946, Glushge [7] firstly put forward the concept of construction waste recycling and studied the basic properties of recycled concrete. The mix proportion design of recycled concrete and the related characteristics of new recycled concrete has been studied in Turkey Osmangazi University [8]. By using the two stage method to prepare the recycled concrete, Vivian WY Tam etc. [9] obtained that the strength of the concrete would be improved when the replacement ratio of recycled aggregate is from 25% to 40% and from 50% to 70%. Through a series of tests, Khaldoun Rahal[10] has indicated that the 28 d cube compression strength, cylinder compression strength, and shear strength of recycled aggregate concrete is about 90% of each corresponding strength for natural aggregate concrete.

2.2 The domestic research

For the research on construction waste recycling, our country is in an early stage of development. But relevant scholars still do lots of research works and has got some corresponding results. JB Zhang etc.[11] studied the characteristics and the durability influence mechanism of pore structure for recycled aggregate concrete made by the waste concrete recycled aggregate. By studying the feasibility that construction waste artificial sand can be used in concrete fine aggregate, XP Jiang etc.[12] obtained that construction waste artificial sand can be used as the low strength concrete fine aggregate and the strength of concrete artificial sand became smaller with the higher replace rate artificial sand. DY Kong [13] indicated that the coarse aggregate species had huge influence on concrete performance. The strength formula should consider the influence of coarse aggregate types when concrete is designed. With the same mixture ratio, the performance of concrete would be better when the concrete strength is higher and the performance of recycled aggregates is better. HQ Li and T Du designed a set of construction waste dispose technology and evaluated the economy of recycled aggregate [14]. JZ Xiao and ZP Sun [15] optimized the production process of construction waste recycled aggregate. According to study, ZX Xing [16] obtained that the compression strength of the concrete made by the recycled concrete aggregate is only lower 9% than that of standard concrete and the tensile strength is only lower 7% lower than that of standard concrete when the mixture ratio is the same. JG Shi [17] studied the applicable scope of the construction waste after the earthquake. JL Fu and YW Fu [18] discussed the recycling technology for old cement concrete pavement.

2.3 The conclusions for the researches at home and abroad

From the point of view above, at abroad, through the researches of Japan, America, Netherlands etc. And other relevant scholars for construction waste recycled aggregate concrete, there are some conclusion as follow. On one hand, the origin of it has been payed much attention. That is to say, scientific ways would be used to control the waste production before the construction waste is formed. On the other hand, for the existing construction waste, the relevant properties, production processes and standards of it has been studied to get the whole set of solution techniques. That can make its resource revival and performance high-efficient.

However, recently, the environmental damage caused by the construction wastes in our country make construction wastes revival utilization imminent. Some relevant scholars studied the strength influencing factors of construction waste recycled aggregate concrete, such as water cement ratio, high efficiency water reducing agent, silica fume, fly ash and so on. Meanwhile, the economic evaluation standard is discussed. Totally, construction waste revival utilization and corresponding technology in China are in an early stage, and do not form a system of specifications for the preparation and application of recycled concrete. Therefore, there are still some issues needed to be solved.

3. The future research directions of construction waste recycled aggregate concrete

In order to solve the problems that construction wastes piling not only occupy a large number of cultivated land but also pollute environment and reduce the environment destruction caused by the mountain cut to quarry, green concrete material must be developed. This can fully act the positive effect of construction waste recycling. Therefore, the future possible research directions of the SBS modified asphalt have the following aspects.

- (1) Because of the low strength of recycled concrete, making it high-performance will be the main direction of the future developments.
- (2) The mix proportion of recycled aggregate concrete should be enhanced more to improve the comprehensive performance of recycled concrete.
- (3) At present, the production technology investment of recycled aggregate is high and its energy consumption is huge, so the production process of recycled aggregate concrete should be optimized to reduce costs and attract businesses to invest. This would be also the important research subject of recycled concrete.
- (4) Because construction waste resource utilization starts late in our country, the existing management system, laws, regulations and policies are imperfect. Therefore, more detailed legal norms should be made to strengthen construction waste dispose.

References

- [1] IB Topcu, NF Guncan: Using Waste Concrete as Aggregate, Cement and Concrete Research, Vol. 25 (1995) No. 7, p. 1385-1390.
- [2] D Nik, Oikonomou: Recycled Concrete Aggregates, Cement and Concrete Composites, Vol.27 (2005) No. 2, p. 315-318.
- [3] Chi-Sun Poon, Dixon Chan: The Use of Recycled Aggregate in Concrete in Hong Kong, Resources Conservation and Recycling, Vol. 50 (2007) No. 3, p. 293-305.
- [4] KS Xiao: The research on the performance and modification of recycled concrete (Ph.D, Wuhan University of Technology, China 2004).
- [5] FL Liu et al: The recycle of America highway cement concrete, Journal of New Building Materials, Vol. 1 (2002) No. 6, p. 37-39.
- [6] LC Wang, YC Zhao: The disposal and re-utilization of construction waste (Chemical Industry Publishing House, China 2004).
- [7] Gluzhge PJ: The work of scientific research institute, Gidrotekhniches Koye Stroitel'stvo, Vol. 1 (1946) No.4, p. 27-28.
- [8] QH Li, P Sun: The research dynamic and developing trend of construction waste recycling at abroad, Foreign Building Materials Science and Technology, Vol. 26 (2005) No. 2, p. 37-39.
- [9] WY Vivian, CM Tam and Y Wang: Optimization on Proportion for Recycled Aggregate in Concrete Using Two-stage Mixing Approach, Construction and Building Materials, Vol. 21 (2007) No. 10, p. 1928-1939.
- [10] Rahal, Khaldoun: Mechanical Properties of Concrete with Recycled Coarse Aggregate, Building and Environment, Vol. 42 (2007) No. 1, p. 407-415.

-
- [11]JB Zhang, YS Wu, KW Sun: The experimental study of pore structure for recycled aggregate, *Silicate Bulletin*, Vol. 30 (2011) No. 1, p. 239-244.
- [12]XP Jiang, Y Li, SY Zhang: The test study of concrete made by construction waste artificial sand, *Cement and Concrete products*, Vol. 1 (2013) No. 11, p. 82-85.
- [13]DY Kong, WX Liu, C Fang, YP Chen: The preparation research of recycled aggregate concrete with high strength high performance, HPC2002, The fourth national high performance concrete conference symposia (Wuhan, 2002). Vol 1, p.414-419.
- [14]T Du, HQ Li, TP Guo: The economical analysis of waste concrete recycled aggregate application, *New Building Materials*, Vol. 1 (2006) No. 1, p. 30-33.
- [15]JZ Xiao, ZP Sun, JB Li: The research of waste concrete crushing and regeneration technology, *Architectural Technology*, Vol. 36 (2005) No. 2, p. 141-144.
- [16]ZX Xing, YN Zhou: The basic properties research of recycled concrete, *Journal of North China University of Water Conservancy and Electric Power*, Vol. 19 (1998) No. 2, p. 30-32.
- [17]JG Deng, H Deng, SZ Lin: Construction waste recycling approaches after the WenChuan earthquake, *FuJian Construction*, Vol. 1 (2008) No. 11, p. 27-29.
- [18]YW Fu, LC Cai, YG Wu: The whole recycling technology research of post-disaster waste cement concrete, *Journal of SiChuan University*, Vol. 42 (2010) No. 5, p. 263-270.