

## Research Status of Recycled Concrete

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### Abstract

**The exploitation of recycled concrete has become an effective way to recycle and reuse waste concrete. It is necessary to study and reuse waste concrete in view of conservation of resources, protection of environment and sustainable development. This paper runs back over the state of development of study on recycled concrete in China, besides puts forward to some issues to be solved immediately on the study, exploitation and reuse of recycled concrete.**

### Keywords

**Waste Concrete; Recycled Aggregate; Recycled Aggregate Concrete.**

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### 1. Introduction

In modern civil engineering construction, the concrete almost become the indispensable materials, the extent of its application was less than other materials, in recent years, with the sustained and rapid development of national economy, a lot of old buildings have been demolished, demolition of the old year, the new building produced about 80 million tons of garbage, in all of the construction waste, The amount of concrete waste is the largest, accounting for about one-third. With the further acceleration of China's economic construction, the discarded concrete blocks will still increase in the future. The traditional construction waste disposal method is mainly transported to the outskirts of the pile or landfill, not only occupy a large amount of land, but also pollute the environment. The huge disposal cost of abandoned concrete and the environmental problems caused by it have been very prominent and become a major public hazard in the city.

Recycling of urban construction waste has been one of the goals of environmental protection and sustainable development strategy pursued by many countries in the world, especially developed countries since the 1990s. All countries in the world are using the demolished concrete waste as recycled aggregate in the reconstruction project, effectively saving the high-quality aggregate of natural resources, which is of great significance for saving energy and resources and protecting the ecological environment.

### 2. Research Status of Recycled Concrete

After the waste concrete blocks are broken, cleaned and graded, they are mixed in a certain proportion to form recycled aggregate, and the concrete prepared by partially or completely replacing natural aggregate is called recycled aggregate concrete(RAC), referred to as recycled concrete. As early as after the Second World War, some developed countries in the world, such as the Soviet Union, Germany, Japan and other countries, began to study the recycling and reuse of waste concrete. Three international conferences on the recycling of waste concrete have been held [1], and it is proposed that concrete must be green. The International Conference on the Sustainable Development of the Cement and Concrete Industry, held in Ottawa, Canada, included the technology of "using recycled concrete as aggregate or other recycled structural materials" as one of the exchange topics. In 2001, the Sustainable Development Research Institute provided eco-label for recycled aggregate [2]. The utilization of waste concrete has become a common research topic in developed countries. Some

countries have also adopted legislation to ensure the development of research and application. Since the 1990s, the development and utilization of recycled concrete in developed countries have been developing rapidly. China's research on recycled aggregate is relatively late, and now it has become a hot spot in the field of concrete research. The long-term strategy of rejuvenating the country through science and education and the strategy of social sustainable development formulated by the Chinese government also encourages the research and application of waste.

## 2.1 Abroad

Japan regards construction waste as a "by-product of construction" and attaches great importance to the redevelopment and utilization of waste concrete as a renewable resource. As early as 1977, the Japanese government formulated the Code for the Use of Recyclable Aggregate and Recyclable Concrete, and successively set up recycling processing plants in various places to deal with concrete waste and produce recycled aggregate and recycled concrete, and also formulated a number of regulations to ensure the development of recycled concrete. According to the statistics of the Ministry of Construction of Japan, In 1995, the utilization rate of concrete was 65 percent, and the reuse rate of abandoned concrete blocks was required to reach 90 percent by 2000. In addition, Japan has also systematically studied the water absorption, strength, mix ratio, shrinkage and frost resistance of recycled concrete. In the United States, the government has enacted laws to provide legal protection for the development of recycled concrete. In addition to encouraging the use of recycled concrete, its performance has been studied in the United States. For example, according to the two roads paved with recycled concrete in Michigan, the experimental research on the dry shrinkage performance of recycled concrete shows that the dry shrinkage rate of recycled concrete is greater than that of natural aggregate concrete. American companies using microwave technology, can be 100% recycling recycled old asphalt concrete road fabric, its quality and new mix of asphalt concrete pavement the same, and the cost is reduced by 1/3, at the same time to save garbage clearance and transport and other costs, greatly reduce the city's environmental pollution. Each year in Germany, demolition waste concrete is about 0.3 tons per person, this number will continue to grow in the future, with Germany's recycled concrete is mainly used for highway pavement, Germany is one of the double layer with the recycled concrete, concrete road 19 cm using recycled concrete, its underlying surface layer 7 cm configuration using natural aggregate concrete, Germany is expected to 80% of the recycled aggregate for 10% ~ 15% of the concrete project, the German reinforcement committee in August 1998 put forward the "application guide of the use of recycled aggregate in concrete", requiring the use of recycled aggregate configuration of concrete must be fully in line with the national standard of natural aggregate concrete. In Belgium and the Netherlands, waste concrete is used as aggregate to produce recycled concrete, and its strength, water absorption, shrinkage and other characteristics are studied[3]. In France, masonry concrete blocks are produced by using waste broken concrete blocks and broken bricks, and the concrete blocks obtained have been measured. Comply with NBNB21-001 (1998) standards related to masonry and concrete materials. The experiments in Austria show that the strength of recycled concrete with 50% recycled aggregate can reach the Austrian standard B225-300, and the salt erosion resistance is improved, and the elastic modulus of recycled concrete is reduced.

## 2.2 Domestic

In China, the related research on the recycling and utilization of waste concrete is relatively late, and the recycling efficiency is low, and the main way to take is still rough stacking and landfill. However, in the past 30 years, China's construction industry has developed rapidly, and the speed of building metabolism has also been increasing. The ecological problems caused by a large amount of construction waste have gradually attracted public attention and attention. At present, the amount of construction waste in China has accounted for 30-40% of urban waste, of which 50-60% is abandoned concrete. China's construction waste utilization rate is very low, generally used as backfill and basic materials of buildings or roads and other low-level utilization; The concrete prepared as coarse and fine aggregate is less widely used in building structural components (such as block), road surface layer and cement manufacture. The vast majority of construction waste is disposed of in the open or

in landfills without any treatment. This not only occupies a large amount of arable land and consumes construction funds such as garbage removal and transportation, but more importantly, causes serious waste of resources and environmental pollution. It is necessary to study and utilize recycled concrete from the perspective of saving resources, changing the extensive production mode and taking the road of sustainable development. Our government also begins to attach importance to circular economy gradually. Since the "Twelfth Five-Year Plan for Circular Economy Development" was released in 2012, the national government has actively constructed a green circular industrial system, increased the support and preferential policies for the construction waste recycling industry, and promoted the industrialization of renewable resources. Drawing lessons from foreign advanced technology and long-term engineering practice, China has the technical conditions for the resource utilization of waste concrete and gradually forming, in the production equipment, production technology, product quality and other links are constantly improved, and the relevant products have been tested in practice.

### **3. Characteristics and Application Technology of Recycled Concrete**

#### **3.1 Recycled Concrete Technology**

Generally, the aggregate obtained after cleaning, crushing, grading and matching of waste concrete in a certain proportion is called "recycled aggregate", while the concrete prepared by using recycled aggregate as part or all aggregate is called "recycled aggregate concrete", which can also be referred to as "recycled concrete". Obviously, the development and application of recycled concrete, on the one hand, a large number of waste concrete can be used as recycled aggregate after treatment to replace natural aggregate, so as to reduce the consumption of natural bone material in the construction industry; On the other hand, a certain amount of fly ash and other industrial slag can be mixed into the preparation process, which makes full use of the industrial waste residue. At the same time, the development and application of reclaimed concrete also fundamentally solves the problems of the increasing shortage of natural aggregate and the worsening of ecological environment caused by a large amount of concrete waste, which ensures the sustainable development of human society. At present, reclaimed aggregate is mainly used in the preparation of medium and low strength concrete.

#### **3.2 Application of Recycled Concrete in Subgrade and Pavement**

The recycled aggregate obtained by crushing the abandoned pavement on site and applying it to the base or base surface of new roads is the main recycling application technology of cement concrete pavement in China, and the actual road maintenance and maintenance projects also usually use this method. In 2004, Nanjing adopted this technology in some sections of the main roads in and out of the site, and in 2007, the municipal test sections also adopted this method, but the overall utilization rate of waste concrete resources in Nanjing is relatively low.

#### **3.3 Recycling Concrete to Make Porous Brick**

The recycled aggregate after crushing is not suitable for high strength concrete due to its reduced strength, but can be mixed with cement, lime and other additives and extruded into porous brick by vibration [4], which is suitable for frame structure and filled wall.

#### **3.4 Modification Technology of Recycled Concrete**

The untreated recycled aggregate used in concrete often has the problem of substandard strength. The related properties of recycled aggregate can be changed by physical and chemical means to improve the strength of aggregate. Han Lanlan uses chemical means to improve the density of aggregate and reduce its water absorption rate, so as to realize aggregate strengthening[5]. Modified recycled aggregate can be applied to a wider range of projects.

### **4. Some Problems of Recycled Concrete**

Not only constitutes the concrete aggregate skeleton, and determines the concrete in large degree on the mixture workability, mechanical properties of the hardened concrete and the durability, and recycled aggregates with high porosity, large water imbibition, low intensity, characteristics, which

differ with the nature of the natural aggregate is larger, so lead to there are some problems in the application of recycled concrete [6].

#### 4.1 Intensity

As the amount of recycled aggregate increases, the compressive strength of concrete decreases. The addition of recycled fine aggregate makes the reduction phenomenon particularly prominent. Therefore, the influence of the amount of recycled aggregate on the strength of concrete should be considered when preparing recycled concrete.

#### 4.2 Large Shrinkage Rate

High shrinkage rate is the fatal defect of recycled concrete, because the result of high shrinkage rate is to make the concrete structure crack large and through the inside and outside, the water in the environment and other harmful corrosive media are easy to penetrate into the concrete through these cracks, so that the waterproof performance and freeze-thaw resistance of recycled concrete are reduced.

#### 4.3 Durability

Due to the high porosity and water absorption of recycled aggregate, the impermeability of recycled concrete is worse than that of ordinary concrete with the same mix ratio.

### 5. Conclusion

The research and development of recycling technology of waste concrete will promote the formation of a resource-saving and environment-friendly society in China, which is conducive to the construction of green circular economy. Based on the research and development of the resource utilization of waste concrete at home and abroad, the following suggestions are proposed for the development of this technology in China:

- 1) Control the source of construction waste and strengthen the classification of waste concrete. Construction enterprises are required to quantitatively utilize the waste concrete produced in the project and dispose different waste concrete in different categories.
- 2) The government should strengthen the support for recycled concrete enterprises, such as tax incentives, low-interest loans, local subsidies, technical subsidies, etc., strengthen the market guidance and publicity of this product, and improve the market competitiveness of relevant industries.
- 3) To improve the policies, regulations and technical standards for the recycling of waste concrete, and to refine all aspects of the recycling of waste concrete by referring to the relevant foreign systems.
- 4) Learn from the advanced experience of foreign countries and combine with the characteristics of China's own waste concrete materials, strengthen the research in this field of technology, strengthen the exchange of relevant technology at home and abroad.

### References

- [1] Michihiko Abe. Efficient utilization of building by-products [J]. Civil Engineering Construction (Japan), 1995, 36 (13).
- [2] T. Du, H. Q. Li, Y. H. Chang. A new type of green building materials with recycled concrete [J]. Fujian Building Materials, 2002, (1) 23-25.
- [3] T. T. Liu, T. Zhang. Research Status and Existing Problems of Reclaimed Concrete [J]. Shandong Building Materials, 2005(04): 58-60.
- [4] L. Zhou, Z. H. Su. Progress and thinking on the resource utilization of waste concrete in China [J]. Sichuan Cement, 2021(05): 7-8.
- [5] L. I. Han, Z. X. Xing, Z. Z. GAO, et al. Research on strengthening modification method of construction waste aggregate [D]. Sichuan Building Materials, 2018 (11) : 49-50.
- [6] C. I. Yan, H. F. Zhao, Y. G. Tian. Orthogonal test of compressive strength of recycled coarse aggregate concrete [J]. Journal of Henan Polytechnic University (Natural Science Edition), 2016, 35 (5) : 738-744.