Improvement of construction waste resource treatment process

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Abstract. With the continuous increase of construction waste production in China, the treatment of construction waste resources is an important way to reduce. In this paper, the problems existing in the traditional process are improved and optimized. The improved process flow is optimized from four aspects: increasing the crushing ratio, improving the screening effect, enhancing the aggregate strength and reducing the dust. The focus is on the particle shaping and strengthening process, gel strengthening process and crushing spray dust removal process of the crushed aggregate, which makes up for the shortcomings of the current treatment process and improves the treatment efficiency and quality of construction waste. The focus is on the particle shaping and strengthening process, gel strengthening process and crushing spray dust removal process of the crushed aggregate, which makes up for the shortcomings of the current treatment process and improves the treatment efficiency and quality of construction waste. It can provide reference for the treatment of construction waste resources.

1. Introduction
With the rapid development of China's economy and society and the rapid advancement of urbanization, the demolition of buildings and the proliferation of new buildings have led to an increase in the amount of construction waste generated in China. At present, there is no accurate official statistics on the amount of construction waste produced in China. It is estimated that the annual production has exceeded 1.5 billion tons, and it is expected to exceed 2 billion tons in 2020. At present, the utilization rate of construction waste resources in China is less than 5%. Most of the construction waste is still treated by open storage, landfill and other extensive treatment methods. It has problems such as occupying land, polluting the environment, affecting city appearance and sanitation, and causing safety hazards. Realizing the resource treatment and utilization of construction waste is imminent [1].

In terms of construction waste recycling, South Korea and Japan are in the forefront of Asia, and the legislative technical regulations and market mechanisms are relatively complete. For example, Japan requires that a certain amount of recycled materials must be used in public buildings to increase the recycling rate of construction waste [2]. And China started late in these areas. The earliest area for construction waste resource treatment projects was Guangxi in the 1980s, which replaced waste sintered bricks with light aggregates [3]. In this paper, we will improve and optimize the problems existing in traditional processes.
2. Conversion of construction waste into resources

2.1. Construction rubbish
According to the “Regulations on the Management of Urban Construction Waste and Engineering Dregs (Revised Draft)”, Construction waste refers to the residual mud, residual residue, mud and other waste generated during the construction, demolition, repair and decoration of various buildings and structures by construction, construction units or individuals. According to the source, construction waste can be divided into five categories: land excavation, road excavation, old building demolition, building construction and building materials production waste. The specific classification of construction waste in China is shown in Figure 1.

![Figure 1. China's construction waste classification](image)

2.2. Construction waste recycling
Recycling refers to the management and technology to recover useful substances and energy from construction waste [4]. The recycling of construction waste can be divided into secondary resource and primary resource. At present, the demolition-type construction waste is mainly secondary resources, which is used for the preparation of general backfilling, concrete blocks, burn-free bricks, permeable bricks, and landscape bricks. The original level of resource utilization is the most ideal and optimal resource-based way of building waste treatment, and at the same time, it has good economic benefits. Recycled aggregates for construction waste are an important part of the original recycling of construction waste. The effective resource treatment of construction waste, while turning waste into treasure and realizing green recycling, has good economic benefits and important social significance [5].

3. Treatment process

3.1. Disadvantages of traditional disposal processes
The traditional processing process is simple, the sorting level is single, and the sorting technology is not closed; The grading process is not perfect enough to make the construction waste unclear; The more serious dust generated by the crushing process may pollute the surrounding environment; The quality of
recycled aggregates is not high, resulting in limited use and low added value, making it difficult to achieve market-oriented applications.

3.2. Disadvantages of traditional methods for handling aggregates

In the traditional construction waste treatment, the aggregate formed by the crushing process has defects compared with the natural aggregate, specifically:

(1) The performance of recycled aggregate produced by ordinary technology is poor. It is characterized by simple broken and recycled aggregate particles with many angular edges, rough surface and adhered with hardened cement mortar; concrete blocks accumulate in the process of crushing and cause a lot of microcracks inside the crushing process; The material has large porosity, high water absorption, small bulk density, low strength and high crushing index [6].

(2) The performance of aggregates is unstable. The performance of recycled aggregates prepared by simple crushing and sieving of concrete of different strength grades is very different. The needle-like particles of the products are uneven and the quality dispersion is also large, which is not conducive to popularization and application.

3.3. Process design improvement

3.3.1. Design goals. Improve and design new process and equipment based on current treatment methods to improve construction waste utilization efficiency and improve the overall quality of recycled aggregates, with a view to forming “building materials – buildings – construction waste – high quality recycled raw materials” Loop mode.

3.3.2. Improve process design features. Based on the general processing flow, the research improves and optimizes the problems existing in traditional processes. The new process uses multi-stage screening, multi-step dust removal, aggregate shaping and strengthening processes.

(1) Secondary crushing, multi-stage screening process. After the construction waste is fed, the first crushing is carried out, and the large construction waste is broken into smaller particle diameters; after the bricks and concrete are separated, the brick primary aggregate and the concrete primary aggregate are formed, and then the second crushing is performed separately. Separation of clods from bricks and concrete blocks by one screening; Separation of steel bars from concrete and concrete by magnetic separation; Separation of bricks and concrete blocks by secondary screening; Fine material, medium material, coarse material.

(2) Multi-step dust removal and dust reduction. In the process of feeding, crushing and aggregate shaping, dust removal and dust reduction measures are taken to effectively reduce dust. Dust reduction in the feeding section: The sprinkler is installed in the crushing section of the feed port, and the wet operation is carried out during the feeding to reduce the dust. In the crushing process, the crushing device is provided with a micro-spraying system. When the material is broken, the micro-spray forms a water mist, and the solid particles are adsorbed to suppress the dust. In the aggregate shaping section, the active air supply and the induced air are formed on the aggregate shaping equipment to maintain a negative pressure inside the equipment to prevent the dust from escaping; at the same time, the fine dust is absorbed by the dust collector and collected centrally.

(3) Aggregate shaping and strengthening. The gel is sprayed, and the recycled aggregate is immersed, rinsed, dried, and the like to strengthen the recycled aggregate. Alternative gels are waterborne polyurethanes, oily polyurethanes, sodium silicates, propylene gels, nail gels, modified epoxy resins, fluorenone resins, lignin, and the like. The main principle of the gel used in this process is that it is beneficial to the crack filling, good stability and strong cementing ability of the aggregate. Considering the dynamic spraying, the waterborne polyurethane gel is selected by comparison.

The aggregate is sprayed by adding a gel spray device at the end of the process. After the gel is sprayed, the vibration of the secondary vibrating screen causes the gel to penetrate into the aggregate void and envelop the aggregate surface to achieve the purpose of strengthening the aggregate.
3.4. Brief description of improved process flow

The process of the construction waste sorting system is: Feeding - primary vibration screening (soil, slag separation) - primary crushing - magnetic separation (iron, slag separation) - secondary screening (brick, concrete separation) - brick, concrete again Screening - brick initial aggregate (fine material, medium material, coarse material) and concrete primary aggregate - brick (concrete) fine material, medium material, coarse material - concrete aggregate reinforcement modification - new aggregate. The construction waste of mixed bricks and concrete is removed from the construction waste by vibration feeding and sifting device; after being crushed by a large jaw crusher, the steel bars are removed by magnetic separation equipment; The concrete mixture enters the separator and separates the bricks from the concrete and separates them into their respective production lines for processing. The concrete primary aggregate is crushed again by the fine jaw crusher to meet the design size requirements, and then reaches the vibrating screen through the conveyor belt. After the screening, the aggregate is output, and then the aggregate enters the particle shaping equipment for mechanical processing enhancement treatment, and the dust is removed by the dust remover. After the finished product is output. The finished product is gel sprayed according to needs and uses to form a gel-reinforced aggregate. The brick crushing process is basically the same as the concrete primary aggregate crushing process, but there is no aggregate shaping and aggregate reinforcement process. The improved process improves the traditional crushing and screening steps into multi-stage screening and secondary crushing, and achieves different screening effects through different screening principles. After the aggregate is formed, it is recovered by a particle shaping device, and the gel spray is increased to increase the strength of the aggregate.

4. Traditional treatment process and improved process comparison

4.1. Test indicators and data analysis

In order to test the effect of the new treatment process, for the treatment of 4 t construction waste materials, the waste is mainly waste concrete blocks and contains a small amount of bricks. Therefore, the test is based on the concrete block treatment process. Under the same conditions, the same amount of construction waste is treated with an improved process, and the crushing ratio, screening efficiency, dust reduction rate, available aggregate amount and other indicators are measured in the process, and compared with the traditional treatment process indicators. The results are shown in Table 1.

| Table 1. Comparison results of the improved process and the traditional process |
|--------------------------------|----------|----------|----------------|----------------|----------------|
| Different indicators          | Size reduction ratio | Broken quantity/ % | Screen efficiency / % | Dust reduction rate / % | Amount of available aggregate / % |
| Traditional technology        | 10        | 0.45     | 0.52           | 0.10           | 0.35           |
| Improve process               | 14        | 0.85     | 0.91           | 0.95           | 0.90           |

4.2. New process aggregate characteristics

Compared with natural aggregates, the simple crushed aggregate has rough surface and more angular edges, and a large amount of cement mortar is wrapped on the surface of the aggregate. At the same time, the aggregate impact is large during the crushing process, resulting in more slight cracks and further increasing the porosity. These factors cause the original aggregate to have large pores and increase the water absorption rate, which is unfavorable for recycling. The gel spraying process is added at the end of the process, and the gelation and chemical action of the gel can reduce the porosity of the original aggregate porosity filling gel, reduce the water absorption rate of the aggregate, and further
improve the strength of the aggregate and form an enhancement. The water absorption test of the natural aggregate, the primary aggregate and the produced reinforced aggregate was carried out, and the results are shown in Table 2. It can be seen that the water absorption of the reinforcing aggregate is greater than the water absorption of the natural aggregate, but it is superior to the water absorption of the primary aggregate.

| Table 2. The physical properties of the recycled aggregates (10~15 mm) |
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| **Norm** | **Fine aggregates** | **Coarse aggregates** |
| | Natural aggregate | Simple broken aggregate | Enhanced aggregate | Natural aggregate | Simple broken aggregate | Enhanced aggregate |
| Stacking density/(kg.m⁻³) | 1615 | 1225 | 1425 | 1425 | 1195 | 1335 |
| Dense density/(kg.m⁻³) | 1735 | 1365 | 1560 | 1560 | 1355 | 1525 |
| Apparent density/(g.cm⁻³) | 2.65 | 2.45 | 2.50 | 2.50 | 2.55 | 2.60 |
| Voidage/% | 0.40 | 0.50 | 0.45 | 0.45 | 0.55 | 0.48 |
| Water Absorption/% | 0.85 | 8.30 | 8.30 | 7.50 | 4.70 | 2.90 |

5. Outlook
The high-efficiency treatment process design studied in this paper has improved the four aspects of improving crushing, screening rate, aggregate reinforcement rate and dust reduction rate, and improved the treatment efficiency and utilization rate of construction waste. In the subsequent experimental research, the problems of production noise and other problems in the improvement process need to be further solved; the quality of construction waste recycled aggregates needs to be further improved.

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