Research on Sorting and Process Improvement of Road Recycled Materials from Construction Waste

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Abstract. The construction waste in China is mainly composed of concrete blocks and bricks, and the output is huge. However, there are significant differences in the technical properties of concrete blocks and bricks, and the non separated recycled aggregates produced from Two kinds of engineering materials often find that it difficult to meet the requirements for the use of high-grade road base course. This article applies the optoelectronic technology method for the sorting of construction waste that is the most widely and successful used for grain processing and sorting. The technology is applied to design the brick and concrete block separation scheme and improve the traditional process of construction waste sorting. The improvement is expected to achieve high value-added resource utilization. At the same time, it actively responds to national policies on energy conservation and emission reduction, circular economy, and the construction of a conservation-oriented society.

Keywords: construction waste · recycled materials · photoelectric technology · sorting

1 Introduction

With the rapid economic and social development of China, a large amount of construction waste is generated as a result of construction development. It is estimated that China currently generates more than 1.5 billion tons of urban construction waste each year, and the production of construction waste is still growing, and the figure is expected to exceed 1.8 billion tons by 2026. Due to the huge production of construction waste, but also has the property of resource. Using construction waste to produce road materials is not only conducive to avoiding the problems of storage area and environmental pollution, but also conducive to reducing excessive resource consumption caused by massive mining of sand and stone resources caused due to road construction. At the same time, it is also beneficial for reducing the cost of using building materials [1].

According to a survey on the composition of construction waste, the proportion of waste concrete blocks and bricks is the highest. There are great differences in the technical properties of bricks and concrete materials in engineering use. The unseparated

S. H. B. D. M. Zailani et al. (Eds.): ICMSEM 2023, 259, pp. 1130–1136, 2024.
https://doi.org/10.2991/978-94-6463-256-9_113

recycled aggregate produced by this method is usually difficult to meet the requirements for the use of high-grade road base course, and can only build roadbed [2] or be used as street brick, and the promotion and application are limited to a certain extent, which is difficult to reflect the value of construction waste recycling.

Based on the traditional construction waste separation process, the paper applies photoelectric technology method for the construction waste separation process that is the most widely used and most successful used in grain processing and sorting. Through the photoelectric technology, the brick and concrete block separation scheme is designed, and the traditional construction waste separation process is improved, with a view to improve the market price of recycled construction waste materials, promote resource utilization and save engineering construction costs [3].

2 Composition of Construction Waste

According to the different sources of construction waste, it usually includes three types: building construction waste, building renovation waste, and building demolition waste [4], and building demolition waste is the largest proportion of these three categories of construction waste.

Most of the old buildings demolished at this stage are residential buildings with brick and concrete structures, followed by frame and shear wall structures [5]. This type of building is represented by old industrial factories and buildings. The study conducted an analysis of the composition of demolition waste, which accounts for the largest proportion of construction waste, in Tianjin. The first source is the demolition waste of a brick concrete residential building in Hongqiao District, Tianjin (Fig. 1), and the second source is the demolition waste of an old factory building with a frame structure in Tianjin (Fig. 2).

Different sources of construction waste cause the difference in the proportion of construction waste components, among which the most obvious proportion is discarded cement blocks and bricks [6]. Although the source is different, the two components of waste concrete block and brick account for 70% ~ 90%.

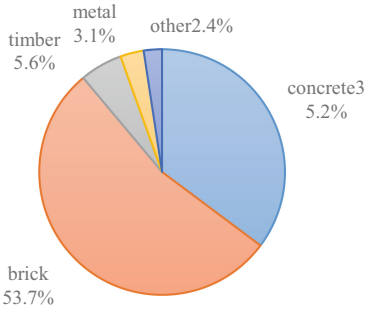

Fig. 1. Brick and concrete residential building

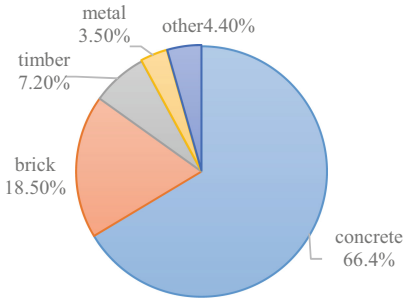

Fig. 2. Old factory building with frame structure

3 Traditional Processes for Sorting and Recycling Construction Waste

At present, the main separation methods for construction waste include manual sorting, vibrating screen sorting, magnetic separation, wind separation, flotation, etc. [7], as shown in Table 1.

However, all the above sorting methods have their own scope of application. Usually, in the construction waste sorting process [9], various methods are combined to a waste sorting production line.

The traditional process of sorting and recycling construction waste has the advantages of large output and high production efficiency, but the aggregates produced are often recycled aggregates mixed with bricks and concrete. There is a significant difference

Table 1. Method for sorting construction waste

Sorting method	Category of sorting debris
manual sorting	It is mainly selected for debris that is difficult to handle by mechanical means without magnetic impurities such as metals, glass, ceramics, etc.
vibrating screen sorting	The separation of coarse and fine materials is under the action of mechanical force, through the screen surface is smaller than the size of the screen hole particles, while leaving on the screen surface than the screen hole larger particles.
Magnetic separation	The separated rebar is sucked out by strong magnetic force, and then the recycled aggregates and metals such as scrap rebar are completely separated [8].
wind separation	The lightweight substances in construction waste can be sorted and eliminated using wind power, such as plastics, sawdust, etc. with low density.
flotation	In water, recycled aggregates of construction waste that have been roughed up float impurities that are less dense than water to separate impurities such as non-ferrous metals.

Table 2. Comparison of properties of recycled materials

Component	Colour	Engineering property
Recycled aggregates mainly composed of bricks	Mostly red, followed by cyan	1. Low strength and firmness; 2. High water absorption; 3. A large proportion of needle-like bricks, which are prone to brittle edge cracking [10].
Recycled aggregates mainly composed of concrete	Grey	1. High strength and sturdiness, about 2–3 times that of bricks; 2. Low water absorption, only 1/5–1/6 of that of bricks; 3. Relatively low proportion of needle flakes.

in engineering properties between recycled aggregates mainly composed of bricks and recycled aggregates mainly composed of concrete, see Table 2.

In summary, bricks and concrete blocks have great differences in strength, water absorption, needle and flake content and so on. Mixed utilization will inevitably bring defects in strength and stability. In this paper, a certain separation method is adopted to separate the bricks and concrete blocks of the above engineering properties.

4 Research on Improvement of Sorting and Recycling Process of Construction Waste

4.1 Principle of Photoelectric Separation Technology

Optoelectronic sorting technology is currently the most widely and successful used method in grain processing detection, which mainly includes optoelectronic conversion technology, digital signal processing technology, and digital image processing technology [11]. It is a combination of optical technology and electronic information technology to achieve various measurements. Using the principle of photoelectricity to study the color, shape, and ability of light radiation and reflection of construction waste. Due to differences in appearance or internal quality, their ability to penetrate light is also different, and there are also differences in their response to light and electricity, thus grading them. Due to differences in appearance or internal quality, etc., their ability to transmit light is different, and there are differences in light and electrical reflections, which lead to their classification.

In this paper, the above method is introduced in the separation of construction waste brick and concrete, based on the different characteristics presented by different light sources irradiation, to identify construction waste concrete and brick with digital signal processing technology, so as to achieve the separation of brick and concrete.

4.2 Design of the Brick and Concrete Block Separation System with Photoelectric Technology

The photoelectric separation system of construction waste is mainly used for the efficient separation of waste concrete and brick. The photoelectric separation system consists of vibration discrete system, high speed transmission system and photoelectric separation system. First, the construction waste through the traditional separation of wood chips, plastic, glass; Then the remaining waste brick and waste concrete mixture is dispersed and uniform through the vibration discrete system, that is, the waste brick mixture after being broken by the jaw crusher is broken loose, and the metal material is removed by the magnetic separation equipment. Then the waste brick mixture is transported to the photoelectric sorting system through the high-speed transmission system that is composed of belt conveyors; Finally, the separation of waste brick and waste concrete is realized efficiently in the separation room, and the dust recovery is also realized. The waste brick hybrid photoelectric sorting system designed according to the above objectives is shown in Fig. 3.

The system works as follows: under the illumination of a light source, industrial cameras and scanning facilities above the sorting chamber interior capture the material images and pass them to the computer for image processing. After the computer identifies the material to be separated, the signal is transmitted to the corresponding valve group in the air spray device. After the valve group is activated, the high-pressure airflow generated by the nozzle at the shape of the required separation of the material to change the trajectory of movement, so that it falls into the sorting box 2. Not open the valve group above the material according to the trajectory of flat throwing motion into the sorting box 1. According to the working principle of the above waste brick and waste concrete sorting system, it can realize the efficient separation of waste brick and waste concrete. With the above analysis, in the whole waste brick waste concrete photoelectric sorting system, for the effective separation of materials, high-speed transmission and efficient sorting is the core part.

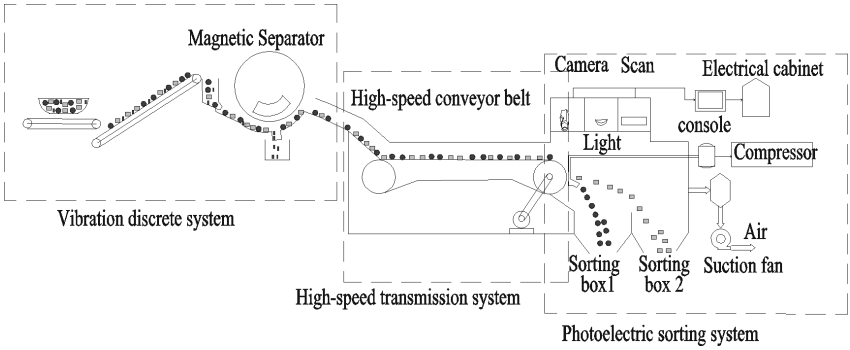

Fig. 3. Design scheme of brick and concrete photoelectric sorting system

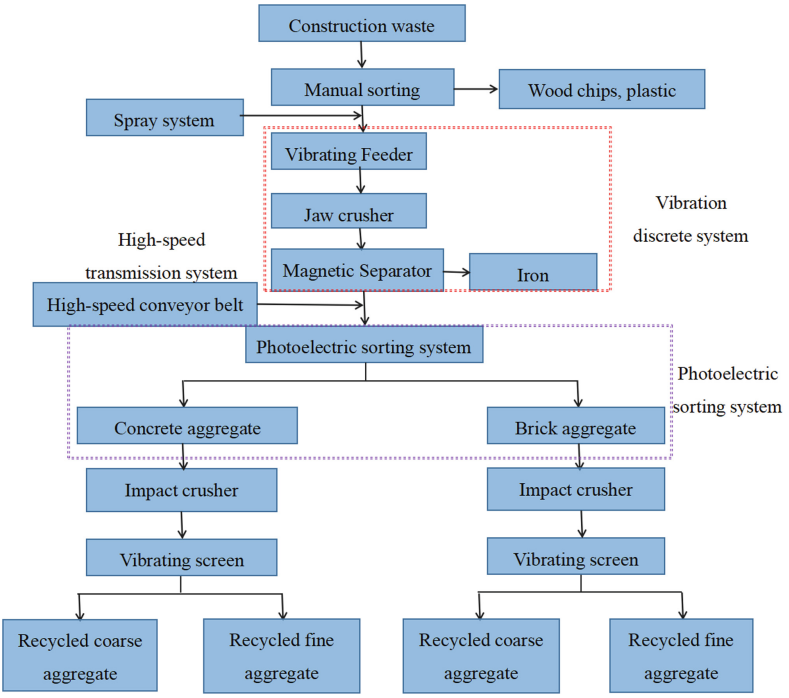

Fig. 4. Process flow chart of sorting and recycling improvement of construction waste

4.3 Analysis of Waste Separation and Process Improvement

The improvement of construction waste separation process is based on the traditional separation and regeneration process. The brick and concrete separation device of the photoelectronic separation system is added to the process production process, so that the discarded brick and concrete can be separated, avoiding the production of aggregate with different strength. The separated concrete production of recycled aggregate can be applied to the high-grade road base course. The disposal process after the improvement of construction waste separation process is shown in Fig. 4.

5 Conclusion

It is of great practical significance to study The brick and concrete separation technology of construction waste. Through the photoelectric separation system designed in this paper, waste brick and waste concrete are separated to produce different kinds of recycled aggregate. It not only can high value-added resource utilization be achieved, but also it will play a positive response role in national energy conservation and emission reduction policies, circular economy policies, and the construction of a conservation-oriented society.

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