Application of Construction Waste Mixture in Jingzhong Road Subbase

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Abstract: In order to test the usage of recycled mixture of concrete and brick slag in the road subbase, engineering test was carried out. By improving the construction technology of subgrade mixture, recycled concrete and recycled brick are mixed together with a weight ratio of 8:2 that applied to the municipal road subbase, and the purpose of reasonably utilizing construction waste and meeting the demand of municipal road base could be achieved. It was a beneficial attempt to the recycling of construction waste.

1. Introduction

Construction waste, mainly composed of bricks, concrete blocks, crushed stones, muck, waste metal, waste wood and waste plastic, refers to the useless discharge materials for buildings and structures generated in the process of construction, demolition, decoration and maintenance [1]. According to the theory of circular economy, garbage is called misplaced resources. The aggregates produced by the proper processing of construction garbage can be reused in the engineering construction, so it is still a valuable resource. Recycling of construction waste has become an indispensable part of the whole life cycle of buildings, which plays a key role in the realization of resource conservation and energy conservation and emission reduction in the construction field.

The internal composition of construction waste recycling material is complex, and the content of brick, concrete and mortar is very uneven, and the parameters (such as the maximum dry density, the best moisture content, compressive strength, etc.) determined by the Institute's laboratory test are highly discrete [2-6]. The engineering characteristics of construction waste recycling material cannot be fully defined on site only relying on the preliminary research and the test parameters sent by the Institute. In this paper, based on practical application and relevant national standards, Engineering laboratory with corresponding qualifications was selected to carry out the physical engineering test and field test work, and the recycled mixture of concrete and brick was applied to the subbase of urban submain road, which is a beneficial attempt to apply the construction waste to the municipal road base technology.

2. Project overview

Jingzhong Road is located in Mazhai Town, Erqi District of Zhengzhou. It is a newly built urban secondary trunk road in north-south direction. The Jingzhong Road width of the red line is 30m, and the total length is about 1360m, and the designing speed is 40km/h. it is planned to be a road of single cross section. The construction scope of Jingzhong Road starts from Pinghu Road in the South and ends at Nansihuan Road in the north. The terrain along the road fluctuates greatly. A comprehensive pipe gallery is under the existed road of the red line within the scope of K0+038–k1+515.
In order to ensure the quality of the project, save resources and make rational use of the construction waste recycling materials, the research achievements on the recycling of construction waste in recent two years was used to design and build Jingzhong Road \[1,7\]. For the whole Jingzhong Road base course, the construction waste recycling material is selected for construction, 8:2 concrete and brick recycling mixture with a thickness of 18cm is selected for the subbase course (cement: mixture recycling material = 5.5:94.5; concrete recycling material: Brick recycling material = 80:20); the 18cm thick concrete recycling mixture is selected for the lower base course and upper base course (cement: concrete recycling material = 5.5:94.5).

3. Engineering construction

3.1 Recycled construction waste

Construction waste recycling material comes from an open-air processing plant of construction recycling material in the western suburb of Zhengzhou (Figure 1, Figure 2). In addition to the relatively large number of needle and flake particles, recycled coarse aggregate of skeleton dense graded concrete can form a good skeleton inlay structure, inhibit the volume shrinkage caused by capillary action, adsorption action and intermolecular action due to the reduction of water content, and has good strength and anti dry shrinkage performance (Figure 1). The brick recycled material is a type of large discontinuity, high water absorption, high crushing value and limited strength, so it can only be used as filling material (Figure 2).

![Figure 1. recycled concrete (25mm coin)](image1)
![Figure 2. recycled brick (25mm coin)](image2)

Based on the production status of construction waste in Zhengzhou area \[1\], by reasonably adjusting the particle size of recycled material, the recycled concrete material and brick slag recycled material are mixed according to 8:2. Henan Construction Engineering Quality Inspection and Test Center Station Co., Ltd. is entrusted to carry out engineering test, and the test results meet the requirements of municipal road subbase mixture.

3.2 Site construction

Recycled materials are applied to the construction of water stable semi-rigid subbase of Jingzhong Road, and plant mixing method is adopted for construction. According to relevant specifications \[8,9\] and combined with the performance characteristics of recycled materials, the construction process of recycled materials applied to subbase of Jingzhong Road is formulated according to relative codes.

On the basis of relevant preparations, the whole subbase construction process must be carried out in strict accordance with relevant specifications (Figure 3) \[8\]. Based on the engineering characteristics of the construction waste mixture, the external conditions such as weather and environmental protection were carefully considered during the construction period, the process is surely adjusted as followed:

1. The subsoil layer shall be watered and cleaned once a day before the mixture paving, and before the paving construction, the subsoil layer shall be watered once again to ensure that the contact surface is clean, moist and free of water;

2. The water content of the paving construction is adjusted to the optimal water content + 2% (no
lumping and bleeding phenomenon of the mixture is found during rolling and vibration);

(3) During the loading process, the "U" type movement of the vehicle is required to avoid the serious segregation of large and small particles;

(4) The rolling process is divided into: initial rolling, re-rolling and final rolling, and the method of combining static pressure, dynamic rolling and rubbing is adopted. The light roller is adopted to improve the driving speed of the vibratory roller and increase the number of compaction of tire roller.

![Figure 3. site construction picture](image1)

![Figure 4. field sampling of subbase mixture](image2)

3.3 **Construction inspection**

After the completion of the subbase paving, the artificial watering shall be carried out immediately for curing (after 24 hours, the curing is mainly carried out by watering cart). The surface layer shall be kept wet throughout the curing period, and the traffic shall be closed during the curing period. After 7 days of curing, core drilling samples shall be carried out on the site (Figure 4). Ten recycled concrete core materials with diameter*height=150mm*150mm shall be selected. No unformed or discrete samples are found in the whole sampling process.

The test results of the Engineering Laboratory (Figure 5) showed that the strength of the recycled mixture of construction waste used on site met the specification and design requirements, and the better load value reaches 2.4MPa. It is feasible to apply the recycled mixture of concrete and brick to the municipal road engineering.

![Figure 5. experimental results of recycled mixture](image3)

4. **Conclusion**

There are not many cases of building waste recycling materials that put into actual engineering projects, and it has not been found that brick recycling materials were directly applied to specific projects. More test sections are needed to verify the reuse of construction waste, and more detailed and comprehensive analysis is needed to discuss the impact of construction waste recycled materials in the test section and the actual construction process.

Based on the practical application of Jingzhong Road subbase and the research results on the recycling of construction waste in recent years, the engineering laboratory with corresponding qualification was selected to carry out the physical engineering test and field test, the concrete and
brick mixture recycling material was applied to the municipal road subbase. An useful attempt of putting the recycling of construction waste to use was made.

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