

Study On Recycled Aggregate Permeable Concrete in Urban Slow Moving System

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Abstract—In this paper, a new type of anti-blocking permeable concrete pavement structure is proposed. the upper layer of the structure adopts hard, dense and strong permeable concrete, the lower layer adopts recycled aggregate permeable concrete, and the permeable geotextile is laid on the recycled graded sand. The application of construction waste recycled aggregate to road engineering alleviates the current situation of construction waste accumulation and reduces the pollution problems caused by construction waste accumulation to soil and water source. at the same time, it reduces the adverse impact on the surrounding environment in the process of construction waste disposal, avoids the environmental pollution caused by dust, dust and sand in the process of transportation and storage, and saves a lot of land resources. It is one of the ways of recycling construction waste. Construction waste recycled aggregate instead of natural aggregate can reduce the purchase of new stone, save a lot of ore resources, reduce the negative impact on the natural environment caused by mountain quarrying and river sand mining, protect resources, and achieve remarkable social benefits.

Index Terms—recycled aggregate; permeable concrete; urban slow moving system

I. INTRODUCTION

Permeable concrete is a kind of green environmental protection and ecological road material commonly used in sponge city, which has good permeable effect, sufficient collection by rain water, and good economic and ecological environmental benefits [1-4]. At the same time, permeable concrete road has the functions of sound absorption and noise reduction, anti-flood disaster, alleviating urban "heat island effect" and so on. However, in the course of use, ordinary permeable concrete often enters the permeable pores because the solid materials suspended in rain water's runoff, such as fine sand, organic fine particles, etc. The solid materials will enter the permeable pores, resulting in pore blockage and permeability decreasing gradually. As a result, the service life of permeable concrete pavement is reduced.

In urban construction, the demolition, waste stacking and landfill of a large number of buildings will have an adverse impact on the environment. For example, the amount of waste from abandoned buildings in China is as high as more than 1.5 billion tons every year, but the effective utilization rate is less than 5%. If the waste masonry and concrete materials were used to improve the re-utilization rate of waste building materials, the shortage of natural aggregates would be effectively alleviated to a certain extent, not only

save resources, but also protect the environment. However, the scope of use of recycled aggregate is often limited due to the decrease of material strength. Taking the project as the object and the technology as the core, the construction method of recycled aggregate permeable concrete in urban slow moving system is developed.

II. PROCESS PRINCIPLE

This method puts forward a new type of anti-blocking permeable concrete pavement structure, in which the upper layer adopts hard and dense strong permeable concrete, the lower layer adopts recycled aggregate permeable concrete, and the permeable geotextile is laid on the recycled graded sand and grade. The permeable geotextile can filter the flowing soil particles in the water, prevent the blockage of the bearing layer, ensure the smooth passage of the water and prolong the service life. The recycled aggregate is pretreated with water glass and sodium fluorosilicate solution to improve the cementation strength of recycled aggregate. The difference of compressive strength of recycled aggregate permeable concrete under different aggregate size combinations and different substitution rates is analyzed experimentally. The best particle size combination and substitution rate are selected to improve the feeding sequence of concrete materials and improve the strength of recycled aggregate permeable concrete. Recycled aggregate permeable concrete has a series of color formulations, which can be arbitrarily matched with recycled aggregate permeable concrete with different colors, textures and particle sizes to meet the requirements of different environments and individuals. The design is flexible, which greatly improves the natural landscape decoration effect of the road surface.

In this method, recycled aggregate is pretreated with water glass and sodium fluorosilicate solution to improve the cementation strength of recycled aggregate. The best particle size combination of recycled aggregate and the best replacement rate of recycled aggregate are selected through experiments, to improve the feeding sequence of concrete materials and the strength of recycled aggregate permeable concrete. This method makes full use of construction waste, reduces the mining of ore materials, and creates a new way for the recycling of construction waste. It has remarkable social and economic benefits to save the material cost, reduce the project cost and reduce the disposal expenses such as cleaning, transportation and landfill of construction waste. The recycled aggregate permeable concrete in this method can be arbitrarily coloured with different colors, natural and beautiful, and the pattern is flexible, which greatly improves the natural landscape decoration effect of the pavement.

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III. CONSTRUCTION TECHNOLOGY

3.1 Construction preparation

Clean up the stagnant water and floating soil on the surface of the work surface, and adopt measures such as sprinkling water to ensure the wetness of the work surface.

1) Before construction, the construction site should be surveyed, and the location and elevation of underground concealed facilities should be checked according to the design document. Parts and construction conditions, determine the construction plan, work out the construction organization design, and carry out detailed implementation to the construction personnel. Technical and technical disclosure.

2) Before construction, facilities such as water and electricity supply, traffic roads, mixing and stacking sites, sheds and warehouses, fire protection, etc., should be solved. The construction site shall be equipped with rain-proof and moisture-proof material stacking sites, and the materials shall be stacked according to the marks, and shall not be thrown at will during loading, unloading and handling.

3) The construction site shall be equipped with auxiliary equipment, auxiliary materials, construction tools and safety protection measures to ensure that the aggregate is dry and moisture-free, and the construction mix ratio shall be determined according to the on-site conditions.

4) The transportation time between the mixing place and the working surface should not exceed 0.5 h. In order to prevent concrete from sticking and fouling the construction site, protective plates should be used in a certain area of the lower part of the mixer.

5) Bounce the elevation line according to the design elevation before construction.

3.2 Blind pipe laying

After the road groove reaches the design elevation, the road groove is leveled with a grader, scraped out the road arch, and the amount of compaction is reserved, and finally compacted with a road roller, and the filling is compacted by a heavy vibratory roller, which is compacted in layers according to the method of first light and then heavy, and is compacted according to the compaction standard of fill compaction. Before compaction, check and confirm that the thickness, flatness and water content of the fill layer meet the requirements before rolling. Where the roller can not be compacted, a small compaction machine is used to tamp, so that the compaction is uniform, and there is no leakage pressure or dead corner, then check the compactness and wait for the graded crushed stone cushion to be laid.

The blind ditch layout of the road is carried out according to the road requirements or site requirements combined with the distribution of the drainage network to ensure effective drainage during the heavy rain. The blind ditch adopts trapezoidal ditch, the upper mouth is 400 mm, the bottom width is 250 mm, the depth can be adjusted according to the actual situation, generally not less than 300 mm. When the thickness of graded sand and gravel is 300 mm, the depth of the blind ditch should be 500 mm. The trench is rammed with 40-75 mm gravel or pebbles. The blind ditch drainage outlet is connected with other Rain Water scenting wells.

Before laying the blind pipe, the appearance quality of the blind pipe must be checked to eliminate defects and ensure

the tightness of the interface installation. The bottom and middle of the blind pipe are filled with larger gravel or pebbles (particle size 20mm~40mm). On both sides and upper parts of the gravel or pebbles, they are stratified according to a certain proportion (layer thickness is about 15mm). The finer particles (medium sand, coarse sand, gravel) are made into filter layers, and the particle size ratio decreases layer by layer according to 4:1.

3.3 Blind pipe laying

The maximum particle size of macadam used for cushion should not exceed 37.5mm (square hole screen), and the crushing value should not be greater than 35%. There should be no clay blocks, plants and other harmful substances in the gravel, and the content of needle-like particles should not exceed 20%. Choose gravel that is hard, wear-resistant, clean and close to a cube in shape.

The use of excavator filling, dump truck transport, bulldozer paving, grader leveling, road roller compaction. The roadbed is controlled by parallel lines and paved in layers, and the thickness of loose paving is greater than 250mm. The width of each layer and each side of the filling material exceeds the designed width of the filling layer 200mm, which ensures that the edge of the road must have sufficient compaction after trimming the edge of the roadbed.

3.4 Lay permeable geotextiles

The permeable geotextile is laid on the recycled graded sand and gravel, and the permeable geotextile can filter the flowing soil particles in the water, prevent the blockage of the bearing layer of permeable concrete, and ensure the smooth passage of water in the bearing layer of permeable concrete. prolong the service life of the bearing layer of permeable concrete.

3.5 Permeable concrete construction

Before the construction of the surface layer, the inspection and acceptance of the base and drainage system shall be carried out in accordance with the regulations, and the construction of the surface layer can be carried out only after meeting the requirements. Before the construction of permeable concrete surface layer, the base should be cleaned, and the surface of the treated base should be rough, clean, free of stagnant water and free of oil pollution.

1) Formwork support

Formwork should be made of materials with solid texture, small deformation and large stiffness, and separate formwork and regional formwork should be carried out according to the design requirements. When there is a pattern in the design, the graphic compilation work such as marking color and graphic dividing line should be done well; the dividing line cutting should be within the 1cm, and the dividing strip should be installed. According to the selection of support method according to the formwork material, the spacing of steel bar support should not be greater than 500mm, and the depth of embedded base should not be less than 200mm. When using wood plywood, the back corrugated should be added behind the formwork, and the formwork should not be embedded in the base. In the formwork support, attention should be paid to the plane position, height, verticality, flooding slope and so on. The surface of the formwork in contact with permeable concrete should be coated with isolating agent. If the conditions are suitable, you can also use the completed brick paving stone as a formwork.

2) Mixing and transportation of permeable concrete

The surface of recycled aggregate can be modified by pretreatment with the solution of water glass and sodium fluorosilicate, which improves the problem of low strength of concrete caused by weak interface transition zone in the application of recycled aggregate. Fill the cracks formed during the crushing of recycled aggregate and solidify the loose samples on the surface of recycled aggregate: the most important thing is that the surface of recycled aggregate can react with cement or mineral admixture in liquid phase environment when preparing permeable concrete. Optimize the interface transition zone between paste and aggregate to achieve the purpose of improving strength.

The mix ratio, as shown in Table 1, is carried out strictly according to the design requirements, each can of cement and strengthening materials are designed according to the whole bag, the stones are weighed by trolleys, and all kinds of auxiliaries are accurately measured in bucket containers; in order to measure quickly, a clear line can be drawn in the car and barrel after the first weighing, but it still has to be weighed each time. Stirring: put the crushed stone and liquid auxiliaries in the mixer first, and then add cement, reinforcements and powder auxiliaries after the material surface is wet. After stirring for one minute, add water according to the workability of the mixture until the mixture meets the requirements. When there are many kinds of colored aggregates in the design of permeable concrete pavement, they should be mixed in batches, and the mixtures of different colors of aggregates should not be mixed.

Table 1 Allowable Blasting Vibration Safety Standards

No	Cement (kg/m ³)	Water (kg/m ³)	Aggregate (kg/m ³)
1	306.7	82.2	1094.4
2	290.0	80.0	1128.9
3	301.1	84.4	1108.9
4	315.6	90.0	1147.8

After the permeable concrete mixture is discharged from the mixer, it should be transported by a dump truck, and the maximum allowable time for paving, compaction and pouring at the construction site shall be determined by the laboratory according to the operating time of the adhesive and the construction temperature, which should be 40 minutes.

3) Paving and compaction

When the recycled aggregate permeable concrete is spread, it is evenly apportioned and paved by manual work to find out the smoothness and drainage slope. At this time, the paving height is 10mm higher than the designed paving height (the concrete thickness will decrease its height due to compaction, about 10mm). Then vibrate with a plate vibrator. The elevation of permeable concrete generally takes the bitumen or formwork on both sides as a reference, and it is necessary to control the pervious concrete in the middle of the road to maintain the level on both sides, and there must be no local elevation or depression.

The paving of permeable concrete foundation and surface layer should be carried out synchronously, such as the interface treatment should be paid attention to, as shown in Fig.1. If the interval is more than 30 minutes, the method of grouting should be used in interface treatment, and it is strictly forbidden to sprinkle cement slurry directly on the permeable foundation layer. If the foundation paving time is too long (more than 2 hours), it is necessary to cover the foundation

concrete effectively to avoid the influence of water loss on the strength of permeable concrete.



Fig.1 Permeable concrete paving

After the paving is finished, the permeable concrete material is laid by using scraping bars to control edge leveling on both sides, and then rolling with special low frequency vibration compactor or plate vibrator and special rolling tools. Avoid continuous vibration in one position when vibrating with a plate vibrator.

Pressure should be supplemented by manual feeding and leveling, manual leveling, construction personnel should put on decompression shoes for operation, and should check the formwork at any time, if there is sinking, deformation or loosening, it should be corrected in time. The permeable concrete is roughly flattened manually and then leveled with a friction machine. When paving with a friction machine, it is necessary to ensure that under the condition of continuous filling, the number of leveling shall not be less than 3 times to ensure that the permeable layer reaches the ideal dense state.

4) Polishing

The compacted and permeable concrete surface is flattened by a concrete grinder, and the surface constructed by the machine is smoother and smoother than the manual surface, which can greatly improve the compactness and wear resistance of the concrete surface, as shown in Fig.2. and the efficiency is more than 10 times higher than that of manual work. If necessary, cooperate with manual patting and smoothing, to make up for the missing grain. At ordinary times, it is necessary to keep the top surface of the template neat and smooth at the seams.



Fig.2 Polishing the surface

5) Maintenance

No pedestrians or traffic shall be allowed until the adhesive is fully cured. After the permeable concrete pavement surface solidifies, it should be covered with film or

color stripe cloth maintenance, and regularly sprinkle water to keep moist, as shown in Fig.3. The pavement is not allowed to be put into use until it reaches the design strength. The strength of permeable concrete pavement should be based on the strength of permeable concrete standard test block. When the formwork is removed, the demoulding time should be determined according to the air temperature and the growth of concrete strength: the demoulding shall not damage the edges of the concrete pavement, and the permeable concrete surface should be kept intact.



Fig.3 Film covering maintenance

6) Cutting and filling joints on the pavement

The permeable concrete pavement began to cut and fill joints after 3 days of alcohol maintenance. Expansion joint requirements: a. The joint spacing is less than 6m, the joint width is 5-8mm, and the joint depth is not less than 1 stroke 3 of the concrete thickness: (the shrinkage joint should be completed when the concrete strength reaches 25% ~ 30% of the design strength) b. The distance between the expansion joints is less than 18m, the joint width is 15-20mm, and the joint depth runs through the concrete to reach the graded sand and gravel layer. c. Different from other working faces (different from the foundation) and the three-dimensional junction of the building, the settlement joint is set, the joint width is 15-20mm, and the joint depth runs through the concrete to reach the graded sand and gravel layer: d. Fill the swell seam with a seam filler.

7) Spray sealant

After the construction of all the above procedures, the surface of permeable concrete is cleaned with a high-pressure cleaning machine, and the surface can be sprayed with sealant, as shown in Fig.4, after drying for 72 hours. It is required that the spraying should not be rainy or foggy, nor can there be strong wind, so as to affect the spraying quality and protect the marble edge and its roadside stone. A protective fence or an eye-catching warning should be set around the newly sprayed floor to prevent pedestrians and vehicles from entering, so as to avoid surface contamination or damage to the wet sealant coating. Spraying sealant to enhance durability and aesthetics can prevent the air space of permeable concrete from being fouled and plugged for too long.



Fig.4 Spray sealant

IV. PROJECT CASE ANALYSIS

1 Using recycled aggregate in pavement structure is not only a specific construction technology, but also a revolutionary change for the whole construction industry, which covers the construction management and technical content of the whole construction process of highway reconstruction and expansion in our country. In terms of implementation effect, it will gradually show the reduction of environmental pollution, the effective protection and full utilization of shortage resources, and then make due contributions to the country's sustainable and rapid development and the effective improvement of human living environment.

2 In the construction technology of recycled aggregate permeable concrete in urban slow moving system, recycled aggregate permeable concrete is taken as the main material of urban slow moving system, and the solution of water glass and sodium fluorosilicate is used to pretreat recycled aggregate. the problem of low concrete strength caused by the weakness of interface transition zone in the application of recycled aggregate is improved, and the strength of recycled aggregate permeable concrete is effectively improved. Recycled aggregate permeable concrete has a series of color formulations, which can be arbitrarily matched with recycled aggregate permeable concrete with different colors, textures and particle sizes to meet the requirements of different environments and individuals. the design is flexible, which greatly improves the natural landscape decoration effect of the road surface. The construction mechanization of recycled aggregate permeable concrete is high, which can improve the construction efficiency and shorten the construction period to a great extent. The test shows that the cost is about 15% lower than that of the traditional construction method, and good economic benefits have been obtained.

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