

## Research on Construction Technology Control of Concrete Permeable Pavement in Sponge City Construction

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**Abstract:** Resilient adaptation is the characteristic of sponge city, which has good resilience in adapting to environmental changes and coping with natural disasters caused by rain. Based on the construction concept of sponge city and utilizing the new construction technology of concrete permeable pavement, this paper points out the key points of the construction technology for the non-motorized lane construction of an east-west urban road engineering section in the core of a sponge city pilot area, in order to provide reference for improving the construction quality of sponge city construction.

### 1. Background

In the construction of sponge city, the study on the hydrological characteristics of the built environment and the suitability of “sponge” technology is an indispensable part to promote the construction of sponge city [1]. To maximize the benefit of sponge system, the key is to couple the two, that is, to take “mutual fitness” as the core to analyze the particularity of site environment and the suitability of “sponge” technology, so as to select an effective site design method. In the design process, multiple factors should be considered, including the natural environment such as rainfall, soil, terrain, etc., as well as the site’s own characteristics of water discharge and catchment, water requirements, etc[2]. In urban construction, the surface runoff velocity of rainwater is high due to the hardness of road surface. Meanwhile, the traditional municipal rainwater pipeline is often the only drainage outlet. This water supply and drainage pipeline brings huge pressure, resulting in slow drainage and water accumulation on road surface [3]. Moreover, in the process of the whole water cycle, as rainwater cannot permeate, the soil moisture and groundwater cannot receive timely and effective supplement; as a result, the underground water level is relatively low and the urban soil water generally lacks. Based on the construction concept of sponge city, this paper explores the construction control technology of urban road paving.

This project is located in an east-west urban road in the core of a sponge city pilot area, with a total length of 1685.603m and width of 32m; the road grade of urban branch. The project adopts the fully permeable structure [4]. The road structure layer is composed of plain soil compaction, 300mm thick graded sand and stone, 30mm thick sand filter, 90mm thick 10mm particle size permeable concrete, 30mm thick 6mm particle size C25 (D50) colored strong solid permeable concrete, and the surface layer is sprayed with double-propyl polyurethane sealing treatment. Road cross slope is 1.0%. Road traffic stones are set on both sides of the road. The colored permeable concrete pavement is provided with a transverse water collecting concealed conduit every other 10m. The concealed conduit adopts a hard permeable pipe with an inner diameter of 75mm. The permeable concrete structure layer is shown in Figure 1.

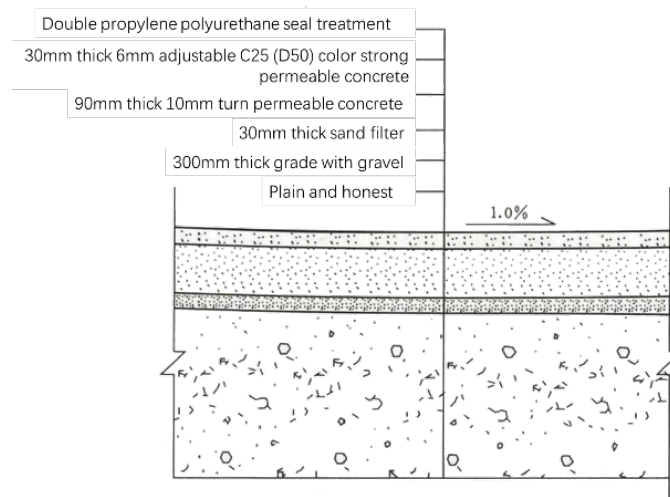


Figure 1 Concrete structure layer

## 2. Preparation before construction

### 2.1. Coordination and preparation

Before pouring the permeable concrete, firstly organize the relevant construction workers to make technical disclosure, give a detailed description of the key and difficult points and key links in the construction, and coordinate the personnel, materials, machinery and other aspects. Strictly control the mix proportion of permeable concrete. Check whether the mechanical equipment is in good condition before construction, and ensure that the emergency safeguard measures are in place to guarantee that the construction quality of permeable concrete meets the design requirements.

### 2.2. Proportion of permeable concrete and transportation mode

Mix proportion technology of permeable concrete is an important factor determining the quality of concrete. Strength and porosity should be considered in the mix proportion design, and the mix proportion design of permeable concrete should be conducted according to the design drawings and relevant specifications [5]. Firstly, the relative performance of pervious concrete is tested by matching the mixture with the calculated target. The dosage of cement concrete slurry and admixture should be reasonably provided to ensure that the slurry will not fall much under the action of vibration and can evenly wrap the aggregate. The water-binder ratio is determined by test, and the selection range is controlled at 0.25-0.3. In addition, according to the test, the relationship between strength, porosity and water-binder ratio of pervious concrete is obtained, and the cement dosage and water dosage are determined to get the final mixing ratio. After multi-party comparison and selection, a mixing station is set up on the left side of K3+400, the mixing site is hardened, and the aggregate distribution bin is stacked and covered. Considering the width limitation of the non-motorized lane, a tricycle is used to transport the mixture.

## 3. Construction quality control

### 3.1. Raw material control

The cement adopts 42.5R grade Red Lion ordinary Portland cement. The crushed stone adopts counterattack broken gravel, which is hard, durable, clean and compact. The crushed value and needle flake content are all  $< 15\%$ . Mud content  $< 1\%$ . The permeable concrete mixture is reinforced by the “Lianggu No. 1 binder” with the company’s own intellectual property, which has a solid content of 40%-50%, elongation  $\geq 150\%$ , ultimate elongation  $\geq 1\%$ , and activity  $\text{SiO}_2$  content of  $> 85\%$ .

### 3.2. Construction process control

(1) Stir. The permeable concrete must be mechanically stirred, and the capacity of the mixer should be selected according to the size of the single construction project, the construction schedule, the construction sequence and the transportation vehicle parameters. On-site mixing is conducted with JS 500 forced mixer; the mixing order is: firstly add the aggregate and 50% water into the mixer to mix for 30s; then add cement, strengthening agent, admixture to mix for 40s; lastly add the remaining water to mix for 50s; it should guarantee that the cement slurry should be wrapped in a comprehensive aggregate with uniform distribution, as shown in Table 1. During mixing, the water consumption in the mix proportion of permeable concrete should be adjusted according to the actual moisture content of aggregate, and the actual mix proportion should be determined by the construction site test.

Table 1 Concrete construction mix proportion

	Water	Cement	Fine aggregate (5~10mm)	Coarse aggregate (10~20mm)	Binder	Colorant
m <sup>3</sup> /kg	143	394.74	1550	/	8.42	18.056
Weight ratio	141	398.23	/	1550	8.50	/
	0.362	1	3.93	/	0.02	0.046

(2) Transportation. Permeable concrete belongs to dry concrete, and its initial solidification is fast. Generally, the transport time of the mixture is controlled according to climatic conditions, and the transport is generally controlled within 10min [6]. During the transport process, the transport vehicle must be kept stable to prevent concrete segregation.

(3) Spreading. First of all, the initial coagulation of permeable concrete is faster and the paving must be timely; after the permeable concrete is taken out from the mixer, it is transported to the site for paving and compaction until the completion of the time used should not be greater than the cement initial set time; the upper layer of the sidewalk can be firstly wet, and then the roadbed can be wet by using sprinkling method. Secondly, with the method of mechanical construction with artificial renovation, according to the design of the drawings, the pavement is loosen, and isolation agent is spread on the contact surface of the permeable concrete and boundary stone or manhole cover. The concrete mixture slump of the second concrete mixing is not greater than 50 mm, loosely spreading coefficient is 1.1, paving mixture should be uniform to avoid secondary spreading, which may influence the surface layer construction quality, paving base and face; artificial spreading application material should use the shovel to clasp, and it is forbidden to throw; the spreading is more uniform; the paving flatness and drainage slope should comply with the requirements.

(4) Vibration and compaction. When the spreading exceeds a certain area, the water content of the mixture reaches the normal value and the structure layer is rolled. After spreading the permeable concrete mixture base, plate vibrator should be used for compaction. After spreading the fabric, firstly make leveling with manual scratching bar, and at the same time clean up the large gravel with particle size not in accordance with specifications and fill materials. After leveling, make manual edge, and then use Y836 Yayao driving double-disc leveling machine (weight 380 kg, rotation speed 0~150 r/min, power 22.1 pieces) to make leveling and polishing. At the leveling, the boundary stone top surface must be kept clean and tidy, the joint plate surface should be level, and the drainage slope and smoothness should meet the requirements.

(5) Joint treatment and maintenance. Every 30m of permeable concrete pavement should be equipped with a swelling seam, and the joints between permeable concrete surface layer and other structures should also be equipped with a swelling seam [7]. The seam shall be perpendicular to the center line of the road, the seam wall shall be perpendicular, the width of the gap shall be consistent, and no slurry shall be added in the seam. The upper part of the gap shall be filled with asphalt mortar caulking material, and the lower part shall be equipped with expansion plate, which shall be

made of polystyrene foam plastic board. Longitudinal shrinkage seam is made along the center line of permeable concrete pavement, and the longitudinal section is made every other 4m along the road. The width of the seam is 3-5 mm, and the shrinkage seam is cut. When the concrete reaches 35%-40% of the design strength, the cutting machine should be used for cutting. When cutting joints, cool them with water. The cutting depth should be 1/3 of the concrete thickness. When necessary, construction joints can replace expansion joints. However, water leakage into the base and soil should be avoided. After the construction of permeable concrete is completed, it is advisable to use plastic film to cover for health preservation, and the curing period shall not be less than 14 days. After permeable concrete health period arrives, clean and wash the concrete surface, wait for the ground to be dried thoroughly, paint Lianggu protective agent evenly.

(6) Others. Permeable concrete shall not be poured on rainy days or when the temperature is lower than 5°C, nor shall it be constructed when the temperature is higher than 32°C. In case of shower, construction should be suspended and plastic film should be used in time to fully cover the poured permeable concrete.

### 3.3. Acceptance

Bending strength and compressive strength should meet the design strength. Take sample once every other 100m<sup>3</sup>, and less than 100m<sup>3</sup> is counted as one time. One set of standard curing specimens is retained for each sampling. The number of retention groups of the specimens under the same condition for curing shall be determined according to the actual needs, and shall not be less than 1 group. The test report is as the criterion.

Permeability of permeable concrete  $\geq 0.5\text{mm/s}$ , porosity above 20%, abrasion resistance  $> 0.6\text{kg/m}^2$ . Water penetration shall not affect the strength and stability of roadbed, and shall not cause secondary disasters and pollution of groundwater. Sample test once every 500m<sup>2</sup> (3 pieces). The test report is as the criterion.

The thickness of permeable concrete should meet the design requirements. Take sample test once every other 500 m<sup>2</sup>, and drill with a steel ruler.

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