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**Technical specification for pervious cement concrete
pavement**

透水水泥混凝土路面技术规范

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Technical specification for pervious cement concrete pavement

1 General provisions

1.0.1 This Specification is formulated in order to enhance the quality of pervious cement concrete pavement projects and make them technologically advanced, economical, reasonable, convenient and applicable.

1.0.2 This Specification applies to the design, construction, acceptance and maintenance of pervious cement concrete pavements such as newly built urban light load roads, light load roads in gardens, squares and parking lots. This Specification does not apply to pavements in severe cold areas, collapsible loess areas, saline soil areas, and expansive soil areas.

1.0.3 The structural form of pervious cement concrete pavement shall take into account geological conditions, load levels, landscape requirements, environmental conditions, construction conditions and other factors.

1.0.4 This Specification specifies the basic technical requirements for the design, construction, acceptance and maintenance of pervious cement concrete pavement. Where this Specification conflicts with the provisions of national laws and administrative regulations, the provisions of national laws and administrative regulations shall prevail.

1.0.5 The design, construction, acceptance and maintenance of pervious cement concrete pavement shall not only comply with the provisions of this Specification, but also comply with the provisions of the relevant current national standards.

2 Terms and symbols

2.1 Terms

2.1.1 Pervious cement concrete

Concrete, with a continuous void structure, which is formed by mixing coarse aggregate and cement-based binder.

2.1.2 Continuous void

The percentage of the volume of continuous void existing inside pervious cement concrete to the volume of pervious cement concrete.

2.1.3 Water-washing pervious cement concrete

Pervious cement concrete whose coarse aggregate on the surface is exposed after the cement-based binder wrapped on the surface of the coarse aggregate is water-washed before final setting.

2.1.4 Reinforcer

An additive used to improve the bonding performance of coarse aggregate and binder and increase the strength of pervious cement concrete.

2.1.5 Permeability coefficient

An index indicating the water permeability of pervious cement concrete.

2.1.6 Light load road

Urban roads, and roads such as parking lots and residential areas, on which only vehicles with an axle load of less than 40 kN are allowed to travel.

2.1.7 Total pervious structure

Road structure system where road surface water can directly penetrate into the subgrade soil through the surface and base of the road.

2.1.8 Semi-pervious structure

Road structure system where road surface water can only penetrate into the surface and not into the subgrade soil.

2.2 Symbols

h_1 – pervious cement concrete pavement surface thickness;

4.2 Surface design

4.2.1 When the sidewalk design adopts a total pervious structure, its pervious cement concrete surface strength level shall not be less than C20, and its thickness (h_1) should not be less than 80 mm. For other pavements, when using the total pervious structure, its pervious cement concrete surface strength level shall not be less than C30, and its thickness (h_1) should not be less than 180 mm; when using the semi-pervious structure, its pervious cement concrete surface strength level shall not be less than C30, and its thickness (h_1) should not be less than 180 mm.

4.2.2 The structure design of the pervious cement concrete pavement is divided into monochrome layer or two-color combination layer. When the two-color combination layer is adopted, the thickness of the surface layer shall not be less than 30 mm.

4.2.3 The pervious cement concrete pavement shall be designed with vertical and transverse joints. The distance between vertical joints shall be determined according to the width of the pavement in the range of 3.0 m ~ 4.5 m. The distance between transverse joints should be 4.0 m ~ 6.0 m; the plane view size of the square should not be greater than 25 m², and the length-width ratio of the surface plate should not exceed 1.3. When the base has structural joints, the surface contraction joint shall be consistent with the position of the corresponding structural joint, and flexible materials shall be filled in the joint.

4.2.4 When the construction length of the pervious cement concrete pavement exceeds 30 m, expansion joints shall be set. Expansion joints shall be set at the connection between the pervious cement concrete pavement and other constructions such as side gutters, buildings, gutter inlets, surfacing blocks and asphalt pavement.

4.3 Drainage system design

4.3.1 The drainage design of pervious cement concrete pavement should comply with the relevant provisions of the current industry standard *Code for design of urban road engineering*, CJJ 37.

4.3.2 When designing the total pervious structure, drainage under the pavement shall be considered. The drainage under the pavement can be set with drainage blind ditch which shall be connected to the municipal drainage system during the road design. The combination of the gutter inlet with the base and the surface shall be designed into the pervious form to facilitate the gathering of excess water from the base to the gutter inlet. Impervious geotextile with a width of not less than 1 m shall be set on the subgrade surface around the gutter inlet (Figure 4.3.2).

4.3.3 When designing the drainage system, municipal drainage ditches or gutter inlets can be used. The pervious cement concrete can be directly laid to the municipal drainage ditches or gutter inlets. Squares of large area should be set with drainage blind ditches (Figure 4.3.3).

5 Construction

5.1 General requirements

5.1.1 Before construction, the construction site shall be inspected, the location and elevation of underground hidden facilities shall be reviewed, the construction plan shall be determined based on the design documents and construction conditions, and the construction organization design shall be prepared.

5.1.2 Before construction, water and electricity supply, traffic roads, mixing and stacking sites, work sheds and warehouses, fire protection and other facilities shall be solved. The construction site shall be equipped with a rainproof and moisture-proof material storage area. Materials shall be stacked according to markings and must not be thrown randomly during loading, unloading and transportation.

5.1.3 Before surface layer construction, the base layer and drainage system shall be inspected and accepted according to regulations. Surface layer construction can only be carried out after meeting the requirements.

5.1.4 Before the construction of the pervious cement concrete pavement, the base layer shall be cleaned, and the treated base surface shall be rough, clean, free of water, and kept in a certain moist state.

5.1.5 The construction site shall be equipped with auxiliary equipment, auxiliary materials, and construction tools required for construction, and shall be provided with safety protection facilities.

5.2 Mixing and transport

5.2.1 Pervious cement concrete should be mixed with a mandatory mixer. The capacity of the mixer shall be selected based on parameters such as engineering quantity, construction progress, construction sequence, and transportation means. The transportation time of fresh concrete from the machine to the working surface should not exceed 30 minutes.

5.2.2 The raw materials entering the mixer must be measured accurately and shall meet the following requirements:

1 Bagged cement shall be randomly checked for accuracy of bag weight;

2 The moisture content of the aggregate shall be accurately measured before mixing in each shift, and the water consumption in the pervious cement concrete ratio shall be adjusted based on the moisture content of the aggregate. The construction mix proportion shall be determined through on-site testing;

3 The allowable error of pervious cement concrete raw materials (by mass) shall not exceed the following regulations:

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- 2) The plane position and elevation of the formwork shall meet the design requirements, and the surface of the formwork in contact with the concrete shall be coated with separant.
 - 3) Before paving the pervious cement concrete mixture, a comprehensive inspection shall be conducted on the height, support stability, etc. of the formwork.
- 2** The pervious cement concrete mixture shall be paved evenly, and the flatness and drainage slope shall meet the requirements. The paving thickness shall consider the coefficient of loose paving material, which should be 1.1.
- 3** Pervious cement concrete should be rolled using a leveling compactor or a low-frequency flat vibrator and other special rolling tools. Compaction shall be supplemented by manual feeding and leveling. During manual leveling, construction workers shall wear pressure-reducing shoes for operation.
- 4** After the pervious cement concrete is compacted, a trowelling machine should be used for surface finishing of the pervious cement concrete. If necessary, it should be assisted by manual compaction and leveling. During leveling, the top surface of the formwork must be kept clean and the board surfaces at the joints shall be flat.
- 5** The removal of formwork shall comply with the following regulations:
- 1) The formwork removal time shall be determined based on the temperature and concrete strength growth;
 - 2) The corners of the concrete pavement shall not be damaged when removing the formwork, and the permeable cement concrete blocks shall be kept intact.
- 5.3.2** When the two-color combination layer of colored pervious cement concrete is used for construction, the upper layer shall be laid before the lower layer is initially set.
- 5.3.3** The construction of water-washing pervious cement concrete shall be the same as the construction of ordinary pervious cement concrete. The process after paving and smoothing shall meet the following requirements:
- 1** Check the initial setting status of the construction surface at any time. If there is initial setting, spray an appropriate amount of retarder evenly, use plastic film covering and other methods for maintenance, and prevent direct sunlight.
 - 2** Before the final setting of the surface concrete, the surface layer shall be washed with a high-pressure water gun in time to remove the cementitious material on the surface and expose the natural stone evenly, so that the particles are not loose.
 - 3** After rinsing the surface, the remaining slurry on the surface and in the air gap shall be removed in time, and the surface shall be covered with plastic film for moisturizing and curing.
-

5.4 Joint construction

5.4.1 The cutting depth of pavement contraction joints should be $(1/2 \sim 1/3) h_1$; the pavement expansion joints shall be the same as the thickness of the pavement. Construction joints can replace expansion joints during construction.

5.4.2 Contraction joints and expansion joints during construction shall be embedded with elastic joint materials.

5.5 Curing

5.5.1 After the construction of pervious cement concrete pavement is completed, methods such as covering it with plastic film should be adopted for curing. The curing time shall be determined based on the strength growth of pervious cement concrete, and the curing time should not be less than 14 days.

5.5.2 During the curing period, the pervious concrete pavement shall not be opened to traffic, and the integrity of the covering material shall be ensured.

5.5.3 Pervious cement concrete pavement shall not be put into use before it reaches the design strength. The strength of pervious cement concrete pavement shall be based on the strength of pervious cement concrete test blocks.

5.6 Seasonal construction

5.6.1 During construction, the start and end times of winter, summer and rainy season shall be determined according to the climate environment of the project location.

5.6.2 During rainy season construction, contact with the meteorological department shall be strengthened, to keep abreast of changes in meteorological conditions and be prepared for precautions.

5.6.3 During rainy season construction, the terrain and existing drainage facilities shall be fully utilized to ensure rain-proof and drainage.

5.6.4 Base course construction should not be carried out on rainy days, and pervious cement concrete pavements shall not be poured on rainy days.

5.6.5 When paving the base course after rain, the subgrade condition shall be checked first, and paving can only be carried out after meeting the requirements.

5.6.6 When the daily average outdoor temperature is below 5 °C for 5 consecutive days, pervious cement concrete pavement shall not be constructed.

5.6.7 The construction of pervious cement concrete pavement in summer shall comply with the following regulations:

6 Acceptance

6.1 General requirements

6.1.1 The construction quality of pervious cement concrete pavement shall be inspected and accepted according to the following requirements:

1 Engineering construction shall comply with the requirements of engineering survey and design documents; engineering construction quality shall comply with the provisions of this Specification and relevant professional acceptance specifications.

2 Personnel from all parties involved in engineering construction quality acceptance shall have the required qualifications.

3 The acceptance of engineering quality shall be based on the construction unit's own inspection and assessment.

4 Before the concealed work is concealed, the construction unit shall notify the supervision unit and relevant units to conduct concealment acceptance. After the concealment is confirmed to be qualified, a concealment acceptance document shall be formed.

5 The supervision unit shall conduct parallel testing and witness sampling testing of test blocks, test pieces and on-site testing items in accordance with regulations.

6 The quality of the inspection batch shall be inspected and accepted by the dominant items and general items.

7 The unit responsible for re-inspection or testing shall be an independent third party with corresponding qualifications.

8 The appearance quality of the engineering shall be jointly confirmed by the acceptance personnel through on-site inspection.

6.1.2 The following information shall be collected during construction:

1 Design documents and completion data;

2 Completion acceptance report;

3 Test report of test pieces;

4 Engineering construction and material inspection or material testing records;

5 Inspection records;

6 Documents for handling major engineering issues.

6.1.3 When there is doubt or dispute about the quality of pervious cement concrete during construction, the construction unit shall organize a physical inspection under the witness of the supervision unit or construction unit. Physical inspection shall be entrusted to a testing agency with corresponding qualification levels.

6.1.4 When the construction quality of pervious cement concrete pavement does not meet the requirements, it shall be dealt with according to the following provisions:

1 In case of rework and reform, it shall be re-accepted.

2 Where the design requirements are met after detection and identification carried out by a qualified testing unit, it shall be accepted.

3 Where the design requirements are not met after detection and identification by a qualified testing unit, but the structural safety and functional requirements are met after calculation and approval by the original design unit, it may be accepted.

4 The repaired or reinforced partial engineering, which can still meet the use requirements although the external dimensions have been changed, can be accepted according to the technical treatment plan and negotiation documents.

6.1.5 Pervious cement concrete pavements that cannot meet the requirements for safe use after repair or reinforcement are strictly prohibited from acceptance.

6.2 Quality test standards

Dominant items

6.2.1 The quality of raw materials shall meet the following requirements:

1 The variety, grade, quality, packaging and storage of cement shall comply with the relevant national standards.

Inspection quantity: For cement from the same manufacturer, the same grade, the same variety, the same batch number, and that enters the site continuously, bagged cement not exceeding 200 t is a batch, and bulk cement not exceeding 500 t is a batch, sampled once per batch.

When the cement leaves the factory for more than 3 months, it shall be re-inspected and can only be used after passing the re-inspection.

Inspection method: Check the product certificate, factory inspection report and on-site re-inspection report.

2 The quality of admixtures added to concrete shall comply with the current national standards *Concrete admixtures*, GB 8076, and *Code for utility technical of concrete admixture*, GB 50119.

2 Stopwatch: The accuracy is 1 s.

3 Graduated cylinder: The capacity is 2 L, and the minimum scale is 1 mL.

4 Thermometer: The minimum scale is 0.5 °C.

A.0.4 The test water shall be airless water. Newly prepared distilled water can be used for exhaust treatment. The water temperature during the test should be (20 ± 3) °C.

A.0.5 Three cylinders with a diameter of 100 mm and a height of 50 mm shall be respectively prepared from the sample as test pieces.

A.0.6 The test should be carried out according to the following steps:

1 Use a steel ruler to measure the diameter (D) and thickness (L) of the cylindrical test piece twice and take the average value, accurate to 1 mm. Calculate the upper surface area (A) of the test piece.

2 Seal the surroundings of the test piece with sealing materials or other means to prevent water from escaping. Water only penetrates from the upper and lower surfaces of the test piece.

3 After the sealing material solidifies, put the test piece into the vacuum device, to evacuate to (90 ± 1) kPa, and maintain it for 30 minutes. While maintaining the vacuum, add enough water to cover the test piece and make the water level higher than the test piece by 100 mm; stop vacuuming; soak for 20 minutes; take it out; put it into the permeability coefficient test device; connect the test piece to the water permeable cylinder and seal it. Put it into the overflow tank; open the water supply valve; let airless water enter the container; when water flows out of the overflow hole of the overflow tank, adjust the water inflow to keep the water level of the permeable cylinder at a certain level (about 150 mm). After the water flow rate of the overflow port of the overflow tank and the overflow port of the permeable cylinder is stable, use a measuring cylinder to collect water from the water outlet; record the water volume (Q) flowing out in 5 minutes; measure 3 times, and take the average value.

4 Use a steel ruler to measure the difference (H) between the water level of the permeable cylinder and the water level of the overflow tank, accurate to 1 mm. Use a thermometer to measure the temperature (T) of the water in the overflow tank during the test to the nearest 0.5 °C.

A.0.7 The permeability coefficient shall be calculated according to the following formula:

$$k_T = \frac{QL}{AHt} \quad (\text{A. 0. 7})$$

Where

the stacking state before paving. The transportation time of fresh concrete from the machine to the working surface should not exceed 30 minutes.

5.2.3 The pervious cement concrete should be mixed by first adding the aggregate and 50% of the water to the mixer and mixing for 30 seconds, then adding cement, reinforcer, and admixture and mixing for 40 seconds, and finally adding the remaining water and mixing for more than 50 seconds. In order to feed the raw materials of ready-mixed pervious cement concrete, it is advisable to put the aggregate, admixtures and cement into the mixer first, to dry-mix for 10 seconds, then add 90% of the water and continue mixing for 40 s ~ 60 s, and adjust the remaining water according to the state of the mixture and continue mixing for 10 s ~ 20 s. The total mixing time shall not be less than 60 seconds; the slump shall comply with the current national standard *Ready-mixed concrete*, GB/T 14902.

5.2.5 During the transportation of pervious cement concrete mixture, segregation shall be prevented, and attention shall be paid to maintaining the humidity of the mixture. Covering and other measures shall be taken when necessary. The pervious cement concrete truck mixer shall comply with the current national standard *Concrete truck mixer*, GB/T 26408, and shall be provided with thermal insulation or heat insulation measures.

5.2.5A The loading capacity of the pervious cement concrete truck mixer shall be determined based on the transportation distance, traffic conditions, climatic conditions, and the paving volume per unit time. The mixture transported to the site shall be used as needed and must not be backlogged.

5.2.6 The allowable maximum time from the pervious cement concrete mixture is discharged from the mixer to it is transported to the construction site for paving, compaction, and pouring can be determined by the laboratory based on the initial setting time of the cement and the construction temperature, and shall comply with the provisions of Table 5.2.6. When transporting using a truck mixer, the maximum time should not exceed 1.5 hours.

5.3 Pervious cement concrete pavement paving

5.3.3 The construction of water-washing pervious cement concrete shall be the same as the construction of ordinary pervious cement concrete. The process after paving and smoothing shall meet the following requirements:

1 Before the final setting of the surface concrete, the surface layer shall be washed with a high-pressure water gun in time to remove the cementitious material on the surface and expose the natural stone evenly, so that the particles do not loosen or fall off.

2 After rinsing the surface, the remaining slurry on the surface and in the air gap shall be removed in time, and the surface shall be covered with plastic film for moisturizing and curing.

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