Research on the Application of Municipal Green Concrete Floor Technology Based on Sponge Grass Planting Cavity

Xu Zhigang, Gao Peng, Liang Wenxian, Zheng Baorong , Hong Xiujun, Li Shuhua, Cai Zhenjie, Qi Xiaozhong, Wang Bizhen, Chen Jike

***Abstract*—The design of grid shaped cast-in-situ concrete and oval petal shaped blocks connected with each other is adopted to realize that the entire bearing layer of the floor is a network structure with stable structure, high bearing performance and high durability, forming a sponge floor system. The surface bearing body of the porous lawn concrete pavement system reinforced by continuous steel bars cast on site is a concrete pile connected at the lower part and independent at the upper part, and the bottom layer is continuous (reinforced) concrete, with the maximum bearing weight of about 60 tons. The design of connecting the surface planting cavities realizes the stable structure, high bearing performance and high durability of the lawn planting system.**

***Index Terms*—Grass planting cavity of cavernous body; Hardened pavement; Sponge city.**

I. INTRODUCTION

With the development of science and technology, green environmental protection and ecological civilization have gradually entered all walks of life. People live in harmony with nature, and a new generation of urban rain flood management concept sponge city is ready to emerge; The traditional urban construction mode is mainly used to harden the road surface. In case of heavy rain, the drainage mainly depends on pipe channels and pump station facilities. The rapid drainage and centralized control at the end are the main methods, which often lead to the phenomenon that water logging will occur in case of rain, and drought and flood will turn sharply; In order to achieve ecological civilization and save water, the state advocates the construction of sponge cities, focusing on slow release and decentralized control of sources, and organizing drainage through green measures. At present, more and more porous pavements and floors are used in urban construction. In order to solve the above problems, the design of grid shaped cast-in-situ concrete and oval petal shaped whole blocks connected with each other is adopted to realize that the entire bearing layer of the floor is a network structure with stable structure, high bearing performance and high durability, forming a sponge floor system; The survival rate of turf is greatly improved by adopting the curved surface design in the grass planting cavity.

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II. ANALYSIS ON THE TECHNOLOGY OF MUNICIPAL GREENING CONCRETE FLOOR OF SPONGE GRASS PLANTING CAVITY

The sponge reflects the structure of the grass planting floor as shown in Figure 1. The concrete thickness of the high bearing cast-in-place grass planting floor is determined by the unified rubber mold, which is 150 mm. This thickness is a reasonable thickness verified by years of practice.

The design modulus of the floor must be an integral multiple of the length and width of the whole mold, otherwise it may be necessary to cut the mold, which is a considerable waste; Flat dense concrete can be poured between parking spaces through the empty mold gap to form naturally. In addition, the exposed parts without grass after forming are oval petal shaped concrete, and the grass will be completely covered by the spreading grass. For the grass planting floor frequently used by vehicles of more than 5 tons, it is necessary to consider adding reinforcement mesh. The added reinforcement mesh must be bound between the connecting holes at the lower part of the mold at the site according to the location of the mold. The specification of the reinforcement determines the bearing capacity of the pavement, Φ 8 Deformed steel bars are commonly used. The whole bearing layer of the cast-in-place grass planting floor is a network structure, leaving a passage between the grass and the soil layer. The surface bearing body is an independent small pile, but the lower part is connected, so that the surface grass planting cavities are connected with each other and the structure is stable. Grass grows among these small piles and has a high survival rate.

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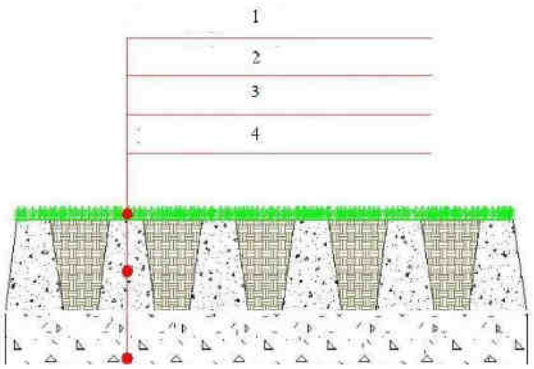

1 Grass planting 2 Grass planting floor 3 Base course sand or gravel 4 Plain soil compaction drawing

Fig.1 Structure of Cast in situ Grassland

III. TECHNICAL PROCESS AND KEY OPERATION POINTS OF MUNICIPAL GREENING CONCRETE FLOOR WITH COTTON GRASS PLANTING CAVITY

A. Base course foundation treatment

1) After clearing the site, backfill 300 mm thick plain soil, roll it evenly, and the compaction coefficient shall not be less than 0.93.

2) The second step is to backfill 150 mm thick graded crushed stone with a tamping degree of not less than 0.9 to ensure no settlement

3) Backfill 30 mm thick medium coarse sand leveling layer.

4) When backfilling graded crushed stone, attention shall be paid to the elevation control to ensure the flatness, which is consistent with or slightly higher than the surrounding green elevation, so as to ensure that the water will be drained to the surrounding green after the crushed stone layer of the parking lot is full of water.

5) 100 U-PVC pervious pipes (6 holes on the upper surface, arranged in quincunx shape) shall be laid at the same time as the base course. The pervious pipes shall be laid around the parking lot and connected with the water system of the park green sedimentation tank as a part of the water system.

B. Surveying and setting out

1) According to the design requirements, the dividing line, sideline and elevation of all parking spaces shall be measured, and the stakes shall be positioned.

2) During the measurement, it is necessary to ensure that the size of the same type of parking space is consistent and square, so as to avoid the discrepancy between the size and the modulus of the customized mold, so as to lay a good foundation for the subsequent pattern arrangement.

C. Installation of curbstone

1) The foundation trench of curb shall be excavated according to the stake positioning line measured. After the foundation trench is compacted, 150 mm thick C20 fine aggregate concrete shall be used to install the curbstone with the specification of 300 mm × 600 mm × 120 mm granite at 10 mm intervals and grouted with 1:2.5 cement mortar.

2) The curb stone separating the upper entrance and parking space is 20 mm higher than the parking apron, and the outer curb stone is 100 mm higher than the parking apron, and the upper entrance of the upper.

3) After the installation of curbstone, the site shall be leveled for the subsequent binding of reinforcement mesh.

D. Binding of reinforcement mesh

1) After the reinforcement is bound outside the site, the whole piece is hoisted into the parking space. When binding, pay attention to that the mesh size of the reinforcement should be uniform and match the concave convex and inch of the mold.

2) The reinforcement mesh shall be provided with cushion blocks to ensure the thickness of concrete protective layer, and the reinforcement shall be treated with rust prevention.

E. Formwork arrangement

1) According to the design requirements, plastic molds with fancy patterns are customized. The concrete area accounts for 47%, the cavity area accounts for 53%, and the mold size is standard size 610 mm × 610 mm × 150 mm, the concave and convex are connected with each other by stiffeners, and the upper part is slightly larger than the lower part, forming an oval platform (10 mm at the front, 7 mm at the bottom), which is convenient for forming and detaching; Two screws are arranged on a diagonal line on the upper surface of the mold for easy operation during mold lifting.

2) Arrange and install the molds. During the installation, pull the through line to ensure that the mold surface is flat, and the molds should be spliced neatly, and the seams and edges should be aligned; Before installation, the mold shall be coated with release agent to facilitate subsequent demoulding and concrete forming.

Fig.2 Formwork Arrangement Construction

F. Placing Concrete

1) Mixing: It is made of crushed stone, design grade concrete, water permeable admixture, water, color strengthening agent and stabilizer in a certain proportion through laboratory matching. After matching, the concrete is wrapped with a layer of thin slurry on the surface of coarse aggregate to form a honeycomb. 2 The concrete mix proportion must be well controlled and optimized. While reducing the fine aggregate, the clinker such as mineral powder and fly ash shall be added as the cementing material to ensure the concrete strength and other properties; Make the concrete form a certain gap, so as to improve the water storage capacity; Strictly control the slump of concrete, so as to improve the construction efficiency and facilitate formwork removal.

2) The commercial concrete plant is used for customized production to ensure the concrete quality. During mixing, the materials are put into the mixer according to the specified proportion of materials and the feeding sequence. The cement and crushed stone are mixed for about 30s, and then they are preliminarily mixed. Then the specified amount of water is added for 2 to 3 times to continue mixing for about 1.5 to 2 minutes.

3) Depending on the degree of uniformity of mixing, the mechanical mixing time can be appropriately extended, but it is not suitable to mix for a long time.

4) On the construction site, special personnel shall be assigned to be responsible for the proportion of materials.

5) The water cement ratio shall be strictly controlled, that is, the amount of water added shall be controlled. Water shall be added in two to three times during mixing, and it is not allowed to add water in one time.

6) In order to make the materials evenly mixed, the mechanical mixing time should be appropriately extended, but not too long.

7) Vibration: according to the characteristics of concrete and mold, the concrete shall be spot vibrated with micro low-frequency vibrator to ensure that every bump is filled by concrete, and each bump is connected with each other, so as to ensure the integrity of concrete.

8) The coefficient of loose paving is the ratio of material paving height higher than the actual height. According to the dry humidity of pervious concrete, it is generally between 1.1 and 1.15.

9) The vibration time shall not be too long to prevent excessive compaction and segregation. Pave as quickly and correctly as possible.

10) As pervious concrete has large porosity and fast water loss, when the weather temperature is higher than 35 ℃, the construction time should avoid noon and be suitable for construction in the morning and evening.

G. Mold lifting

1) Accurately mastering the concrete plasticity time is the key to mold lifting, and it is also necessary to master the concrete slump, mix ratio and temperature.

2) Under normal circumstances, the best time to lift the mold is when the finger presses the concrete surface without obvious dent, and the mold is removed with a special lifting clamp.

3) During mold lifting, two workers cooperate. One worker knocks on the upper surface of the mold, and the other worker uses mold lifting pliers to pull up along the diagonal fixing screws of the mold, slowly pull out the mold, and clean the mold after lifting, as shown in Fig.3.

Fig. 3 Formwork cleaning

H. Curing

1) The pervious floor is easy to lose water due to a large number of holes, and it dries quickly. Therefore, the maintenance is very important, especially early maintenance. Attention should be paid to avoid large evaporation of water in the floor.

2) Generally, the formwork removal time of pervious concrete is shorter than that of ordinary concrete, so its sides and edges will be exposed to the air. Plastic film or color strip cloth shall be used to cover the road surface and sides in time to ensure that the humidity and cement are fully hydrated.

3) The pervious floor shall be watered for curing within 24 hours after pouring, and the curing time shall not be less than 7 days; Necessary corresponding measures shall be taken in special weather, such as covering with rainproof cloth in rainy days to avoid rain wash.

I. Earthwork

1) After the concrete reaches the corresponding strength or 28 days, each groove shall be filled with planting soil with a

small self-made hopper shovel.

2) It is not required to be tamped and naturally compacted, and the height is controlled to be 50 mm lower than the floor.

3) Attention shall be paid to ensure that each groove is the same as the ground before earth filling and is not filled with concrete.

Fig.4 Construction Drawing of Earthing

J. Grass planting

When purchasing turf, use a grass chopper to cut it into pieces with the size of grooves, and manually plant it in each groove of the terrace. Apply some fertilizer and water properly during cultivation, so as to ensure the survival rate of grass. See Figure 2.5 for the effect before and after grass planting.

Fig. 5 Grass planting effect

IV. SUMMARY OF TECHNICAL ADVANTAGES OF MUNICIPAL GREEN CONCRETE FLOOR WITH COTTON GRASS PLANTING CAVITY

The surface bearing body of the porous lawn concrete pavement system reinforced by continuous steel bars cast on site is a concrete pile connected at the lower part and independent at the upper part, and the bottom layer is continuous (reinforced) concrete, with the maximum bearing weight of about 60 tons. The design of connecting the surface planting cavities realizes the stable structure, high bearing performance and high durability of the lawn planting system. Through the patented design of the curved surface in the grass planting cavity, the porosity reaches 52%, realizing its unique "grass wrapped concrete" mode, making the concrete more easily covered by grass, and the greening rate can reach 60%~100%, which can solve the problem of low greening rate in the traditional "concrete wrapped grass" mode. Through the design of oval petal shaped grid of all grass planting holes on the grass planting floor, the turf grows in the gap, achieving a high survival rate of the turf, which can solve the problem that the survival rate of the prefabricated grass planting bricks isolated from each other by the traditional process of grass planting holes can be greatly improved compared with their turf. Through the adoption of grid shaped cast-in-situ concrete and oval petal shaped monolithic rubber for grass planting floor, the whole bearing layer of the floor is made into a network structure, forming a sponge floor system, which can solve the problem of water and soil loss caused by rainstorm scouring general vegetation land, and solve the problem of poor or even no water seepage of hardened ground. There are five layers of traditional grass planting bricks with a thickness of 33-46cm. The bottom layer is concrete or other dense cushion with poor water permeability or impermeability. There are three layers of cast-in-place grass planting pads with a thickness of 30-45cm. The bottom layer is gravel cushion and the main grass planting cavity is connected with the cushion, with good water permeability. The bottom layer of the cast-in-place grass planting floor is continuous (reinforced) concrete, which can bear the load uniformly after being compressed, without fracture and settlement. It has a long service life, no maintenance, and can bear up to 60T.

V. PROJECT CASE ANALYSIS

The project is located in Aotou Town, Conghua District, Guangzhou City. The main construction content of the project is the construction of sewage collection pipe network and rural domestic sewage treatment station in the community. The construction method of municipal greening concrete floor based on cavernous grass planting cavity is adopted. The bottom layer of the concrete floor is gravel cushion, the floor bearing layer is grid shaped cast-in-situ concrete, the oval petal shaped whole rubber mold is used, and the independent cylindrical small pile connected at the bottom has a high bearing capacity, For those with higher requirements for bearing capacity, they can be laid under the bearing layer Φ 8 Reinforcing mesh to improve the overall stability. After being pressed, it can bear the load evenly without fracture and settlement. It has a long service life and needs no maintenance. The maximum load can be 60T. The whole bearing layer of the cast-in-place grass planting floor is a network structure, leaving a passage between the grass and the soil layer. The surface bearing body is an independent small pile, but the lower part is connected, so that the surface grass planting cavities are connected with each other and the structure is stable. Grass grows among these small piles and has a high survival rate. The straw wrapped concrete model has a high greening rate and great economic and social benefits, which can be used for reference in other engineering applications.

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