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Construction Method for Large Area Diamond Sand Wear-resistant Floor

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Abstract

Diamond aggregate, chemically known as silicon carbide, is widely used in industry due to its high chemical stability and abrasion resistance. When combined with concrete, the resulting diamond aggregate concrete is known for its solid texture, excellent wear resistance, and good impact resistance. With the rapid economic growth and urbanization, the construction industry has seen unprecedented development, and the number of large-scale construction projects is on the rise. The quality requirements for their diamond aggregate flooring have also increased. To meet these demands, an integrated construction method for diamond aggregate flooring is now employed. This article will focus on the construction process and the challenges involved.

Keywords

Silicon Carbide Flooring; Construction Techniques; Construction Industry.

1. Introduction

Silicon carbide wear-resistant flooring, as a new high-end flooring material, is becoming increasingly popular. After several large-scale flooring projects, the construction quality control methods for large-area silicon carbide wear-resistant floors have been summarized. This article will focus on the construction methodology, key operational points, and quality defect analysis.

2. Construction Methodology

The construction process for the silicon carbide wear-resistant floor is as follows: site leveling → base layer pouring and cleaning → measurement and line marking → rebar tying → steel mold installation → concrete pouring → vibrating and leveling → first sprinkle of wear-resistant particle additives → smoothing and extracting slurry → second sprinkle of wear-resistant particle additives → extracting slurry, polishing → surface finishing and curing → cutting joints → cleaning.

2.1 Substrate Preparation.

The grade of the base concrete should not be lower than C_{15}. The pouring quality of the base concrete will significantly influence the construction quality of the wear-resistant flooring, so the pouring and curing process of the base concrete must be strictly controlled. In areas prone to hollowing and cracking, an additional layer of plain cement slurry should be applied to ensure the bond between the concrete layer and the base layer.

2.2 Measurement and Layout

Use 200mm high channel steel as the elevation control line and the template for floor casting, with the grid controlled between 3×3m to 4×4m.

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2.3 Concrete Pouring

For large-area wear-resistant floors, the strength of the base concrete should reach C25 or higher, with a water-cement ratio not exceeding 0.45. The slump of the on-site mixed concrete should not exceed 5cm, and the slump of the pumped concrete should be controlled at around 12cm, but no more than 16cm.Before pouring C_{25} concrete, debris and trash on the subbase layer should be cleaned up, and the subbase should be sprinkled with water to remain damp, ensuring a good bond between the subbase and the base layer. Concrete should be poured in one go to the specified elevation. If any areas do not reach the elevation, they should be filled with concrete and vibrated. The use of mortar for repair is strictly forbidden. No cement powder should be sprinkled and smoothed over the wet concrete surface. Surface bleed water should be removed using absorbent cloth or sponge. During vibration, a flat vibrator should be used, with a span width that should not be too wide, generally within 4m. After scraping the concrete level, the cement slurry that emerges on the surface should be at least 3mm thick.After the concrete construction is completed, rubber tubes or vacuum equipment can be used to remove the bleed water. After repeating this process at least twice, construction of the carborundum surface layer can begin. If the schedule is flexible, you can wait for the concrete to set for 2 to 4 hours (depending on the site conditions), and then manually spread $5kg/m^2$ of carborundum on the surface layer.

2.4 Construction of Hardened Wear-resistant Layer

The timing for the first application of the carborundum mix varies depending on factors like climate, temperature, and the concrete mix ratio. If spread too early, the carborundum will sink into the concrete, losing its effectiveness; if too late, the concrete will have solidified, leading to poor adhesion and possible delamination. A method to determine the right time is by stepping on it; if you sink about 5mm, it's time to start the first spread. Begin with the edges and corners to prevent loss of effectiveness due to water evaporation, ensuring accurate material use, and then spread over the larger area with consistent thickness. The first application should use 2/3 of the total amount, sprinkling it uniformly without forcefully throwing to prevent separation. Afterwards, it should be smoothed with a wooden trowel. For the second application, use a screed or straightedge to measure the level, and adjust any unevenness from the first application. The direction of the second application should be perpendicular to the first. This second spread should start about 0.5 to 1 hour after the first troweling, depending on the environment and weather. Use the remaining 1/3 of the material. After it's dampened, immediately start polishing with a disc trowel and repeat at least twice, working in both directions to ensure evenness and prevent material accumulation. Manually smooth the edges with a trowel. Once the surface has hardened to the point of slight indentation upon pressing, adjust the rotation speed and angle of the polisher accordingly, overlapping in both directions at least three times. The flatness of the wear-resistant floor should have a maximum deviation of 5mm in any 2m square area and a maximum deviation of 10mm between the highest and lowest points of the same level. Efforts should be made to prevent cracking, delamination, and sanding.

2.5 Floor Surface Curing

Within 4 to 6 hours after the completion of the wear-resistant floor construction, it should be cured. Curing with a covering film prevents the rapid evaporation of moisture from the floor surface, ensuring the steady growth of the wear-resistant layer's strength. The curing period should last for more than 5-7 days.

2.6 Surface Cutting and Joint Filling

After 6 to 8 days, line snapping and cutting can be conducted. For joint filling materials, architectural sealant and silicone gel are used. The joint width is 4 to 6 mm, with a depth of 40 to 50 mm. The cutting should be done promptly to prevent the floor from cracking due to the cutting. Before cutting, snapping lines should be strictly carried out according to requirements to ensure straightness and aesthetics. After checking that the lines are correct, cutting is done along the snapped lines. The tool of choice for cutting is a disc cutter. During the cutting process, it is essential to control the cutting speed to ensure the depth of the cut and avoid deviation from the snapped lines, thus guaranteeing the appearance quality.

3. Challenges and Solutions in Large-scale Carborundum Wear-resistant Floor Construction

When carborundum is combined with concrete, the resulting carborundum concrete possesses solid texture, excellent wear resistance, and good impact resistance. However, during construction, issues like hollowing, cracking, unevenness, and poor aesthetic appearance can easily arise.

3.1 Hollowing Issue

Before construction, it is necessary to use mechanical grinding, scabbling, and sweeping to clean the base layer of the diamond sand floor. The base layer must be ensured to be cleaned thoroughly, with no loose, sandy, hollow, or peeling surfaces. The surface flatness, solidity, elevation, and contour dimensions of the base layer should meet the design requirements. Special attention should be paid to the base of columns and some dead corners when cleaning the base layer. After the floor cleaning is completed, the thickness of the concrete surface layer should not be less than 80 mm. Before the formal construction, a layer of plain cement slurry should be applied for scraping to enhance the adhesive strength of the concrete and reduce hollowing.

3.2 Cracking Issue

To prevent the occurrence of concrete cracking, it's necessary to coordinate with relevant units before pouring to ensure that all ground lights, pipelines, junction boxes, etc. have been properly pre-buried. During the concrete pouring, a dedicated person should be on-site to constantly inspect the slump of the concrete, aiming to keep it controlled between 110-140 mm. When vibrating the concrete, care should be taken to avoid missing any areas or over-vibrating, with the guiding principle being to ensure the paste surfaces during the vibration. This helps avoid issues like bleeding, segregation, or excessive shrinkage during the concrete hardening process. The base layer should be wetted before the concrete pour, and no water should be added once the concrete arrives on site. As the concrete is poured, it should be immediately leveled using a 2 m screed, and for final adjustments, a 3 m screed should be utilized. There should be someone specifically monitoring the rebar during pouring; if any rebar is found to touch the ground due to reasons such as stepping on it, it should be promptly corrected. After the concrete surface has been screeded and leveled, it should be handed over to the wear-resistant aggregate unit for further construction. In edge and corner areas where the screed can't reach, smoothing can be done using small steel plates or wooden files. The levelness required for the concrete base is a maximum deviation of 5 mm over every 2 m stretch. The timing for removing the forms is influenced by the strength grade of the concrete, temperature, humidity and generally occurs 24-36 hours after the completion of the concrete pour. When removing the forms, care should be taken not to damage the edges and corners of the concrete or leave any remnants of concrete on the forms.

3.3 Cracks Caused by Concrete Quality Issues

The construction requires a slump of 100mm for pumped concrete, a water-cement ratio of <0.5, and the use of a single mixing method. The concrete is pumped, and due to the narrow diameter of the pump pipe and a pumping distance exceeding 100m, the slump can only be controlled at 150(±20)mm. The concrete has a high water content and a high amount of fly ash, resulting in severe water bleeding, which is not conducive to concrete finishing. This affects the concrete strength, leading to fine cracks on the surface, compromising the appearance. Therefore, in suitable construction environments, vehicular transportation should be used to avoid pumping and reduce the amount of fly ash.

3.4 Flatness Issue

The quality of concrete is the primary factor affecting the flatness of the floor. The effect of improving flatness through the grinding process after the concrete has set is very limited. Moreover, the grinding process consumes significant manpower and time, which is not conducive to saving project costs. Therefore, the best time to control the floor's flatness is during the concrete pouring stage. At present, commercial concrete is very mature, and due to considerations of cost and time, most projects prioritize the use of factory-mixed concrete, which has stable output and reliable quality. However, due to differences in production processes and the age of equipment at various concrete mixing stations, there are slight variations in the slump of the produced concrete. Ensuring that the slump of the same batch of concrete remains within a reasonable range, as well as the timely delivery of concrete, are key control factors for ground flatness.

Flatness control during construction: Place multiple points, repeatedly check, and accurately mark the pouring height of the concrete. Use rigid channel steel and angle steel as control lines for the concrete pouring area, supplemented by laser leveling instruments. During the pouring process, corrections should be made as pouring progresses, controlling the height and position of the poured concrete surface.After the construction is completed, ensure timely and sufficient watering during the curing period to reduce interference with the ground, which can effectively reduce the formation of cracks. During the grinding process, ensure a stable grinding speed, sufficient grinding times, and timely slurry removal. Both during and after the grinding process, semi-finished and finished product protection must be applied to the ground.

4. Summary

The causes of cracks in diamond sand flooring are complex and cannot be completely avoided during construction. However, measures can be taken to reduce the formation of cracks, such as thorough and complete compaction, reducing the heterogeneity of concrete within the same slab; multiple compactions at areas with concentrated contact stress, timely groove cutting, ensuring the quality and duration of maintenance; and carefully considering the placement of embedded parts to ensure the thickness of the overlying concrete. Material control and procedure selection both play a significant role in controlling the flatness of diamond sand flooring. This includes the control of the finished concrete quality, the layout control of the casting area, selecting the appropriate construction method based on casting thickness, and quality control of diamond sand spreading and finishing. Material and construction procedures are general controls. In addition to this, during the construction of diamond sand flooring, it's essential to arrange the sequence of on-site cross-construction tasks rationally, minimizing the impact on the flooring construction as much as possible. Disturbance to the flooring during the concrete strength growth period should be reduced or avoided, ensuring the duration and quality of maintenance, and emphasizing the protection of semi-finished products and final products during the grinding phase.

References

[1] Liang and Xian, Analysis and Processing Method of Insufficient Anti-Floating of Basement Parking Garage Floor. Advanced Materials Research, 2012. 424-425: p. 1203-1206.

[2] Matysek, P. and M. Witkowski. Analysis of the causes of damage to the RC floor slab in the underground garage. 2019.

[3] Zhanhua, Z., et al., Analysis of Cracks in an Underground Garage and Research on the Load Test of reinforced pavement. E3S Web of Conferences, 2020.