A novel Technology of Ground Joint Construction on Floor of Aircraft Hangar

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Abstract: A maintenance hangar of in Guangzhou Baiyun International Airport was selected as an engineering case to show a novel technology of ground joint construction presented in this paper. The construction of the ground joint was described in detail and some conclusions were therefore summarized to show the effectiveness of the technology. The total area of the test section is 33,000 square meters, which made a great difficulty in construction process. In order to avoid cracking in concrete, the ground concrete was casted by block and a new implement name “armor seam” was used to control boundary between different concrete blocks. After the implementation of new technology and implement, the flatness and wear resistance of ground, the compactness and integrality of concrete all had great improvement.

1. Introduction

The engineering example presented in this paper is selected from the No.18 maintenance hangar project of GAMECO aircraft maintenance facility phase III of Guangzhou Baiyun International Airport of China Southern Airlines. The test section is selected as named DP13 section. The total area of the test section is 33,000 square meters with a width of 16.2m every single block and a length of 91.35m. There is a great difficulty in the construction of large area concrete, and the flatness and wear resistance of ground are also used to assess the quality of construction[1]. In order to avoid cracking in concrete, the ground concrete was casted by block and a new implement name “armor seam” was used to control boundary between different concrete blocks. After the implementation of new technology and implement, the flatness and wear resistance of ground, the compactness and integrality of concrete all had great improvement.

2. Main construction techniques

2.1 Construction preparation

- Material preparation: laying vacuum aluminized polyester film, setting up isolation plate, setting up reinforcing steel mesh sheet.
- Tool preparation: regulate the height of concrete surface before casting and the laser leveling
instrument is used to regulation accuracy.

2.2. Concrete casting and mechanical levelling

- The construction area of this project is about 1800~3000 square meters every single plate, which is casted by coagulation pump truck.
- Before concrete casting, the slump of concrete was measured to ensure the smoothness of the ground surface. The slump value was selected between 140-160mm without bleeding or segregation.
- After the concrete is placed ready, the concrete was paved manually according to the designed floor elevation reference point, and corner parts were firstly paved before the middle. During the paving process, tamping rods were used to tamp the concrete especially the part in corner. The vibrator should not hit embedded components and cannot too much close to the boundary.
- The concrete is leveled by small laser leveling machine[1, 2].
- The manual scraping ruler scraped the floor twice to improve the flatness of concrete.

2.3. Cement finisher for calendering

At the first beginning solidification of the concrete base (about 3~5 mm settlement when feet stand on the concrete surface), the trowel machine is used for overall calendering. During the construction process, two important matters should be carefully concerned as show listed below,

- Because the water loses quickly at column edge, wall edge, door edge and template edge, the manual operation should be carried out firstly. During manually troweling process, timely check of flatness should be conducted for necessary adjustment.
- After the pressure light process and the flatness satisfied requirements, the calender with blades is used for overall grinding and pressing. The speed of calender and the angle of the blade should be adjusted according to the hardening of the wear-resistant material for 3~4 times repeatedly.

2.4. Hardener process

First of all, the concrete seam line was cut according to the design. And then, the A/F cement hardener is applied immediately. The depth of the concrete seam was selected to be 50 mm. The main process and requirements of curing agent are as follows[3, 4]:

1. Concrete surface should be clean up without any dust;
2. Ground wear resistance ≥6.3;
3. Mohs hardness ≥ 8;
4. The impermeability < 0.088ml/h;
5. Curing agent material quantity ≥0.25kg/m²;
6. The curing agent seep into the ground with a depth of 5 to 8mm.

2.5. Covering geotextile for concrete curing

After the construction of curing agent, the water curing was used at the first two hours in order to prevent the rapid evaporation of surface moisture. The double-layer curing method of curing film and geotextile are both adopted. In order to ensure the subsequent construction, some measures are taken to effectively protect the poured floor. After the concrete strength grade reaches 2.0 MPa/mm², the following construction can be continued. After the construction process is finished, the field should be cleared up. During the first 7-days of curing work, the safety isolation was taken out to prevent people from going in and out. After 7-days of curing work, people are allowed to go in and out but the heavy facilities should wait until the 29th day.

2.6. Calendering

After the curing work of the concrete was all finished, the ground is cleaned up and the calender is applied for dry calendering.
2.7. Caulking and gluing
Before the ground floor is put into use, the cuttings seam should be carefully cleared up. The foam strip is put into the cutting seam and its diameter is chosen based on the width of the seam. Then, a glue gun is utilized to fulfill polyurethane elastic sealant. During the sealant process, the air must be exhausted out of the seam.

2.8. Quality of concrete curing
- The ordinary Portland cement is used without retarding agent or early strength agent. In order to ensure the construction quality, a test area is constructed at DP13 to provide initial data for guidance of the following large-scale construction.
- The percentage of silt in concrete aggregate should be seriously under control. And the silt content of sand is less than or equaled to 3%, and the silt content of gravel is less than or equal to 1%.
- The coarse sand with higher density is used as fine aggregate, and the particle size of gravel aggregate is less than or equaled to 40mm.
- The surface of the geotextile maintained wet by spraying water and the curing time is greater or equaled to 7 days.
- After the flatness met the requirements, bleeding water is wiped away with rubber pipe before the initial setting of concrete.

3. Applications of armor seam technology
In the process of large area floor construction, the concrete block joints are traditionally constructed by angle steel; but the welded steel bars on the angle steel cannot provide enough force to connect the angle steel and concrete. Therefore, the angle steel and concrete would separate and the concrete block boundary cannot be protected efficiently. It means that a new crack appears between concrete and angle steel[4, 5] as shown in Figure 1 and the large area of floor is unable to satisfied usage requirement. Secondly, it is hard to construct the seam with enough precision using angle steel and the surface is also hard to be flat enough. Both of them would cause concrete cracking and bad effect on normal use of a large area of floor.

![Figure 1. The ground surface using angle steel](image)

Finally, the width of angle steel is generally 4 to 5 cm so that some bubbles are hardly able to escape from the conners of angle steel. That would produce great number of cavity in the concrete and therefore reduce the concrete strength. In summary, the use of angle steel for construction joint construction is unable to meet the usage requirements of the project. So, a new seam generator named as armor seam tool shown in Figure 2 is applied to improve the construction quality of large area concrete ground.

3.1. Advantages of the armor seam tool
The new armor seam tool is designed in a grid cutting form, which enables continuous anchoring between the concrete and the steel plate. Cutting at any section along it will not cause separation of
concrete and the tool. Therefore, it can provide a better connection between concrete and the seam tool. Also, the armor seam tool is made of alloy which do not rust and has better durability. Secondly, the armor seam tool is a kind of standard product as shown in Figure 2. It can be prefabricated before construction and can be directly put into use in the construction process, which can greatly shorten the construction period. Moreover, the installation of the armor seam tool is simple and convenient, which benefit the in-field construction a lot.

![Figure 2. Armor seam tool](image)

Comparing to the effect of using angle steel as shown in Figure 1, concrete cracking does not happen at the splitting position after using the new seam tool as shown in Figure 3, so that the outlook of the seam has a great improvement. Therefore, the application of the new seam generator has significantly improvement on the overall flatness, compactness and wear resistance of the floor, and can effectively prevent the cracking of large areas of concrete.

![Figure 3. The ground surface using armor sewing](image)

### 3.2. The construction of the new seam

The thickness of concrete ground in this project is 400mm. And the armor seam tool with length of 180 mm was used. The armor seam tool is positioned by the bottom steel bars and sealed with wood formwork. After the concrete casting was finished, the wood formwork was removed and the 220 mm concrete at the bottom was made of isolating material.

During the installation of the armor seam tool, we should pay attention to whether the central plastic screws are loose or not. Since there may be some bumps during transportation that may lead to screw loosening, we firstly imprison the plastic screws before installation if any loosening is found. The screws
should be made of plastic because the plastic screws can be easily pulled off after the concrete shrinks but the steel screws cannot). Then the armor seam tool is fixed firmly with a regular space of 600mm. And in the process of reinforcement, we must ensure tightness and seamless, which is related to the quality of the product. When measuring the height of the surface of the seam, it is necessary to make sure the surface of the seam and the ground is at the same level. The pop-up line of the floor height or infrared ray technology can be either used to make it. In order to ensure the free shrinkage of concrete under the influence of temperature, the plastic cover should be installed on the armor seam tool before concrete casting. The plastic cover can avoid concrete cracking due to extra-large adhesive force.

The framework around pillars is made by three thick and thin steel plates as shown in Figure 4. The inner-side concrete near to the pillar was casting 7 days after the completion of the ground surface casting, so as to prevent the happening of ground crack due to the unbalanced settlement of the wall and pillar. The wall is isolated by EPE pearl cotton board, so that the surrounding concrete is able to deform freely to prevent the happening of cracks.

![Figure 4. Construction around pillars](image)

### 4. Conclusions

Compared with Capital Airport A380 Aircraft Maintenance Depot Project[5] and Jingmen New Energy Automobile Park Welding Workshop Project[5, 6], the ground floor in this program is casted by block and the armor seam tool is used to control the quality of boundary concrete. The armor seam tool has positive effect on the concrete block separation, protect boundary concrete and adjust the edge elevation. Furthermore, it can prevent framework from extra expansion and concrete from crush. At the same time, the construction results show that the new ground joint technology can greatly improve the flatness and wear resistance of ground, the compactness and integrality of concrete.

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