Quality Control Technology of Conversion Layer Which Using Single High Mixing Ore Powder in Coastal Areas

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Keywords: Single-admixture, mineral powder, cooling plan, temperature control.

Abstract: The project is located on the northern of Malaiyia Johor Bahru, where is very little fly ash and coastal areas. Super-high single-admixture mineral powder system with high chloride ion impermeability was used on the mixing ratio design, but it has problems such as high hydration heat in early stage, difficulty in mineral powder storage, no compound admixture and so on. To address the above problems, ice water and raw materials cool down were used to reduce the early hydration temperature, powder hopper waitting for cooling was used to expand the storage capacity of low-temperature powder, the admixtures possess retarded components was used to control the early hydration process, and an emergency cooling plan is adopted to ensure the concrete quality during the high temperature period. The temperature control effect is obviously according to the above technical scheme of mass transfer layer concrete poured, which the surface is smooth and clean without obvious cracks after mold removal.

1. Introduction

Overseas business is expanding on the background of The Belt and Road, especially in tropical regions such as Malaysia. The project is located on the northern of Malaiyia Johor Bahru, which consists of an underground 4-storey garage and 35-storey houses and the designed service life is 50 years. Besides, the conversion layer with C50 strength grade is located in the fourth floor above the ground, and the 2.5m slab is poured in 1m and 1.5m twice, which belongs to mass concrete.

The configuration of high strength concrete needs to increase the amount of glue material to ensure the strength, but high degree of hydration can easily lead to serious water loss and shrinkage in concrete[1]. Obviously, it is necessary to reduce the amount of glue for cut down the hydration temperature rise to control the temperature shrinkage crack[2]. Research shows that the use of admixture can significantly reduce the amounts and release rate of slurry hydration heat, especially the use of fly ash[3]. However, local admixture resources are scarce, and fly ash is basically monopolized by cement manufacturers, basically without grade I and grade II ash. In addition, considering the requirements of coastal areas on the permeability of chloride ions, we chose a super-high single-doped mineral powder system in the mix ratio design. Significantly, compared with the dual-doped system dominated by fly ash, the early hydration heat was increased[4].

The main difficulties of quality control for mass concrete with only high mixing of mineral powder are as follows: 1. The average daytime temperature in the local area is 35℃ which is relatively high and lead to faster heat release rate in early stage of concrete hydration, that is easy to cause cracks by temperature contraction. 2. The mineral powder factory is in Singapore and the cement factory is in Kuala Lumpur. The temperature control of the powder is difficult in continuous production because of a long-distance transportation and a limited storage capacity of the powder. 3. The construction supporting is low especially for the admixture compounding technology, so the setting time fluctuates greatly because of there is not slump protection component and the local admixture factory does not provide compound admixture.

Focus on the problems such as high hydration heat in early stage, difficulty in mineral powder storage, no compound admixture, ice water and raw materials cool down were used to reduce the early hydration temperature, powder hopper waitting for cooling was used to expand the storage capacity of low-temperature powder, the admixtures possess retarded components was used to control the early hydration process, and an emergency cooling plan is adopted to ensure the concrete quality during the high temperature period.

2. Mix Proportion

2.1. Optimal Raw Material

According to relevant technical indicators and raw material conditions: CIMA (NS) silicon cement is used. S95 grade ore powder is adopted. Fine aggregates are selected with medium sand with hard grain and good gradation. Coarse aggregates are selected with good gradation, hard texture and continuous gradation of gravel with particle size ranging from 5 to 20mm. Water reducer and retarder are used as admixtures.

2.2. Design of Mix Proportion

According to the project requirements and raw material inventory, the mix proportion of large-volume C50 concrete is shown in table 1, it can meet the design requirements after re-inspection.

Table 1: The mix proportion of large-volume C50 concrete.

Raw material	Cement	Ore powder	Sand	Stone	Water	Water reducer	Retarder
Specifications and varieties	P·O 42.5	S95	mediu m	5-20mm	/	Mighty 150	Mighty 85RA
Mix proportion kg/m³	145	270	820	925	155	6.23	1.31

3. Construction Arrangement

3.1. Raw Material Reserve Cooling

Materials should be prepared at least 24h in advance, among which cement should be prepared 36h in advance.The production capacity of one-time reserve raw materials is limited due to the limitation of the site. So we can keep producing more than 3000 square meters after coordinate with the vehicles to wait in the station at the beginning of the construction (Figure 1). In addition, new ore can be directly used for production under 40 ° c, and if more than 60 ° c should not be used immediately, the powder should be tested after entering the site temperature, sampling, visual measurement, screening and recording, abnormal conditions should be prohibited into the tank.

Figure 1 Powder trucks waiting for early entry.

3.2. Main Cooling Mode

Main cooling modes are aggregate cooling and water cooling： The bone bin is covered with sunshade cloth, and water is sprayed evenly and appropriately to keep the surface aggregate moist. Check every hour, and increase the frequency in the period of high temperature. It is worth noting that coarse aggregate cooling sprinkling should not be too much, to wet the surface is appropriate (too much water content will reduce the amount of "ice water", and make the concrete machine temperature rise) [5]. The temperature should be controlled in about 30℃. Fine aggregate should be covered shading cloth to avoid too high surface temperature, not cool down sprinkling. Usually we cool the production water in the reservoir and water tank by adding ice 4 hours before production, and arrange special persons to test and add ice. The water temperature of the reservoir should be controlled below 9℃, and the water temperature of the tank should be controlled below 7℃.

Auxiliary cooling measures：1) cover the two storage tanks and production water delivery pipes with foam or sponge boards 40mm thick to keep them insulated. 2) Sand and stone in aggregate bunker are covered with sunshade, and appropriate amount of water shall be applied to cool down the temperature. 3) After the tank truck returns to the mixing station, spray water to cool down the outside of the tank during high temperature period. The cooling measures adopted on site are shown in Figure 2.

Figure 2: Powder trucks waiting for early entry.

3.3. Emergency Cooling

Aggregate cooling, cooling water and crushed ice is adopted as the high temperature period emergency plan: The emergency plan shall be adopted if the temperature of concrete exceeds 30℃. During the production process, manually add crushed ice on the conveyor aggregate flat belt (minus the production water of the same quality) according to the amount of crushed ice of 15kg-30kg per square. The aggregate cooling and cooling water preparation measures are the same as above.

3.4. Maintenance Means

As is shown in Figure 3, the main maintenance means used for concrete maintenance are water storage, covering gunny bags, spraying and watering, etc. After the first pouring and ramming is completed, water storage and curing (high 10cm) is adopted, and water conservation with 2 layers of sacks is adopted after the second pouring and ramming. Among them, the second pouring and ramming shall discharge the stored water, and the curing time shall be no less than 14 days or the temperature difference between the internal maximum temperature and the external temperature shall be less than 25℃.

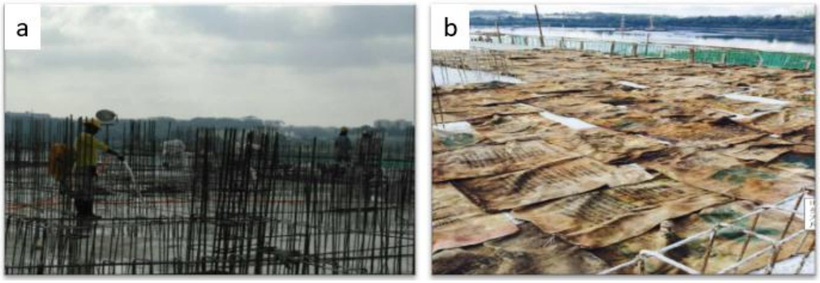

Figure 3: a water storage, b covered with gunny bag and spray.

3.5. Arrangement of Temperature Measurement Points

Figure 4 show the layout of the points and the actual monitoring of the temperature measuring point is shown in Figure 5.

Embedded with different temperature measuring lines that attached to 10 steel bar, used for testing the surface, medium and lower temperature of the bottom plate. Abnormal data should be retest half an hour, and temperature difference should be analyzed timely.

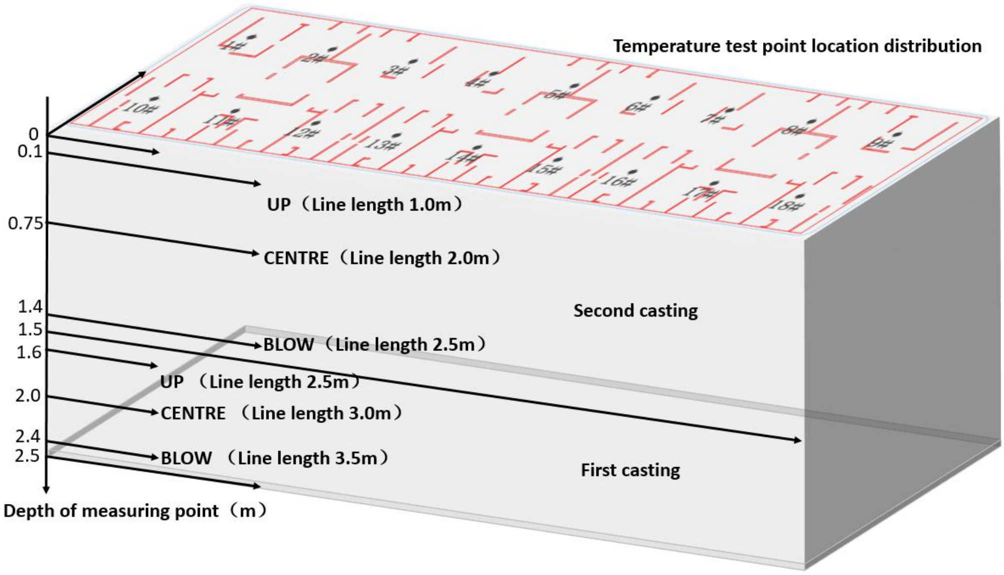

Figure 4: Location distribution of temperature measurement points.

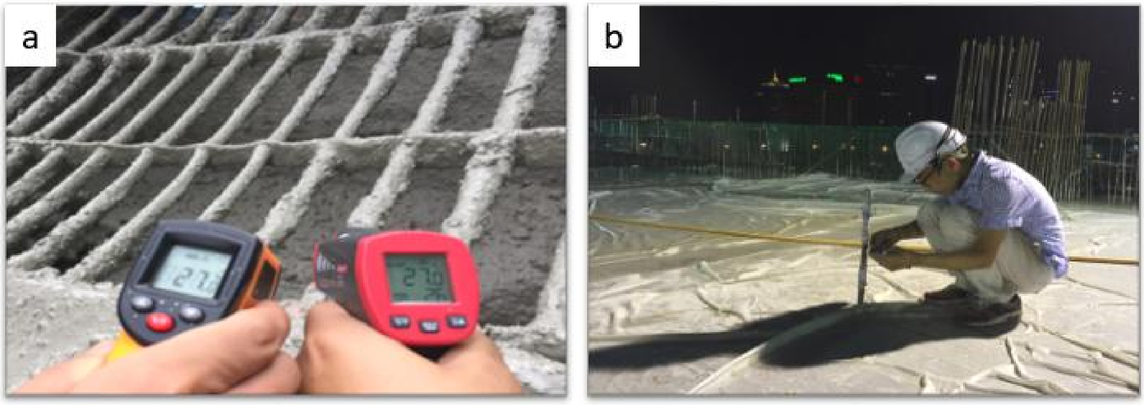

Figure 5: (a) outgoing machine temperature monitoring, temperature monitoring at point b.

3.6. Temperature Control Data and Effect

The main temperature control indexes for effect evaluation are shown in table 2, and Fig. 6 show the demounting status of 1000mm board on A7 floor.

Table 2 shows that the temperature of concrete entering the mold can be guaranteed to be lower than 30.0℃ by taking certain measures to reduce the temperature of entering the mold. According to the above construction technical scheme, the surface is smooth and clean without obvious cracks of the poured mass transfer layer concrete.

Table 2: Temperature measurement data analysis.

Board type	Test item	Temperature	Board type	Test item	Temperature
1000mm	Temperature of casting concrete /°C	25.3-29.4	1500mm	Temperature of casting concrete /°C	26.7-29.7
	Peak time of arrival /h	26-34		Peak time of arrival /h	38-48
	Central maximum temperature /°C	69.8		Central maximum temperature /°C	74.9
	Maximum temperature difference in meter /°C	20.5		Maximum temperature difference in meter /°C	24.5
	Environment temperature /°C	28-34		Environment temperature /°C	28-34

Figure 6: Demounting status of 1000mm board on A7 floor.

4. Summary

(1) In view of the high single admixture of mineral powder with high early hydration heat, methods such as cooling water admixture, raw material cooling and admixture with admixture of retarding components can effectively reduce the temperature of the early hydration environment and thus delay the hydration. (2) Using the powder hopper to wait for cooling at the same time can effectively expand the storage capacity of low-temperature powder and reduce the temperature of the mold. (3) The quality of concrete can be guaranteed by means of emergency cooling plan during high temperature period.

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