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# The foundation mass concrete construction technology of Hongyun Building B tower raft

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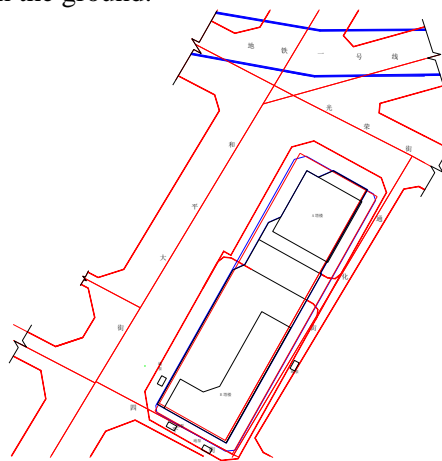
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**Abstract:** The foundation of Hongyun building B tower is made of raft board foundation which is 3300mm in the thickness and 2800mm beside side of the core tube. It is researched that the raft foundation mass concrete construction technology is expatiated from temperature and cracks of the raft foundation and the temperature control and monitoring of the concrete base slab construction and concrete curing.

## 1. Project overview

Hongyun Building B tower for raft foundation was shown in Fig. 1. B tower has four floors underground and thirty floors on the ground.



**Fig. 1** Hongyun Building B Tower Project

## 2. Construction technology of mass concrete of raft foundation

### 2.1. Requirements for commercial concrete manufacturers

After the calculation of the B tower raft concrete requirements: Section I is about 4000m<sup>3</sup>, Section II is about 7500 m<sup>3</sup>, due to the raft thickness (3300mm, 2800mm), vertical and horizontal to reach 55



meters long, the amount of concrete pouring is quite large. In order to ensure that the concrete does not appear cold joints, we must ensure that the continuous supply of concrete and pouring, the normal operation of the machine.

## 2.2. Technical difficulties

(1) The floor thickness of up to 2.8 ~ 3.3m, in addition to the strength and durability requirements must be met, in particular, need to control the temperature stress produced shrinkage cracks. Because of different cooling conditions, concrete slab and concrete slab centre heat slowly on the surface, but the basic side mode, plug wall column reinforced heat quickly, so how to take measures to reduce water temperature, reducing the temperature, properly reduce stress deformation caused by the change of control is the key technology of construction quality of the concrete floor large volume basis.

(2) The temperature difference between day and night is large which daytime temperature is -1°C and the minimum night temperature can reach -17 °C. All for the negative temperature concrete construction process, the temperature difference between inside and outside was produced with the temperature loss form heat of hydration after the construction. The above factors are more likely to make the concrete temperature cracks, so we must take into account the concrete thermal insulation emergency measures.

(3) According to the empirical formula of the maximum temperature of the centre of mass concrete in high rise building, the temperature of the core of 3.3m thick concrete is calculated:

$$\begin{aligned} T_{\text{MAX}} &= T_J + (WQ/c_p) \times 0.90 + F/50 \\ &= 25 + (287 \times 330 / 0.963 \times 2460) \times 0.90 + (123) / 50^\circ\text{C} \\ &= 63.4^\circ\text{C} \end{aligned}$$

$T_{\text{MAX}}$ ——Maximum temperature of concrete core;

$T_J$ ——Concrete casting temperature;

$W$ ——Cement dosage kg;

$Q$ ——Hydration heat per kg of cement, 330J/kg;

$c$ ——Concrete specific heat (J/kg.K), generally take =0.963 J/kg.K;

$\rho$ ——Bulk density of concrete kg/m<sup>3</sup> 2460 kg/m<sup>3</sup>;  $F$ ——Admixture dosage kg.

The results show that the difference between the maximum temperature and the surface temperature of the concrete center.  $T_{\text{max}} - T_{\text{b(i)}} = 51.87 - 33.69 = 18.18^\circ\text{C}$ . No more than 25 °C.

## 2.3. Temperature and crack control measures

(1) Reduce the heat of concrete from the mix design.

Aiming at the technical difficulties from reducing the concrete temperature difference between inside and outside was solved to use the technology of both fly ash and super plasticizer, high performance concrete, hydration heat, which can effectively reduce the concrete, so as to effectively control the temperature deformation of concrete cracks, and improve the pump send and easy.

(2) Control the quality of raw materials

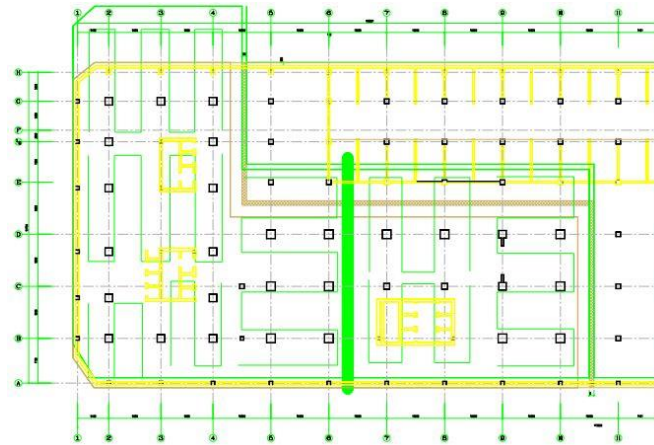
To strictly control the amount of mud and water graded aggregate, coarse aggregate by 5 ~ 31.5mm continuously graded gravel, mud content < 1%; fine aggregate by sand mixed with sand gradation, fineness modulus of sand, mud content of <3.0%, decrease the mixing water, with a smaller decrease rate of sand concrete shrinkage.

(3) Reduce the temperature and pouring temperature of concrete

The temperature of the concrete pouring will accelerate the hydration of cement and rises concrete core temperature, it reduce the cooling time available. The increase of the atmospheric temperature difference is not conducive to reduce the maximum temperature of concrete. In order to reduce the total temperature rise of concrete and reduce the temperature difference between inside and outside, it is an important measure to control the temperature of the concrete.

#### 2.4. Floor concrete construction

Pouring sequence and route see Figure 2. The pouring of the bottom plate concrete is poured once the steel reinforcement of the bottom plate is completely tied. 1 segment includes pouring point 1 from 9-10/A-D, pouring point from 7-9/A-C, pouring point from 7-9/C-D. 2 segments include pouring point from 4-6/A-D, pouring point from 1-4/A-C, pouring point from 1-4/C-E, pouring point from 1-4/E-B. Pouring sequence is from deep to shallow, the first 3.3 meters deep to the end of the last 1.2 meters.



**Fig. 2** The concrete pouring sequence and route of Hongyun Building B tower bottom

##### (1) Concrete pouring

Section of the concrete pouring is about  $4000 \text{ m}^3$ , set up a total of three pumps, pumping about  $120 \text{ m}^3$  per hour, after deducting the impact of various factors, one day and a night pouring about  $2000 \sim 2500 \text{ m}^3$ . Concrete pouring is about  $6500 \text{ m}^3$ , set up a total of four pumps, pumping about  $150 \text{ m}^3$  per hour, one day and a night pouring about  $3000 \sim 3600 \text{ m}^3$ . The concrete pouring should be adopted by the deep and shallow layer pouring, gradual advance, inclined layer, natural flow, continuous casting, and a top method. Concrete pouring should meet the requirements of the overall continuity in order to avoid construction cold seam the person is set to control in charge of uniform cloth according to the 8h the initial setting time. According to the order of cloth covered, the concrete is divided into 600 layers covered by the height of each cloth 1000mm. It is to avoid the cold cracks of concrete and vibration leakiness, to ensure quality take to the uniform under the command of the fabric vibration. The high temperature of concrete in the internal, concrete hydration speed, setting time will need to further increase the speed of pouring in the pouring process. It is to avoid cold crack concrete covered with cloth in the exposed surface before the initial setting.

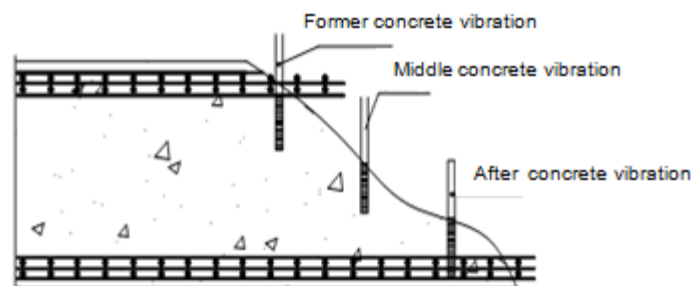
##### (2) Pumping

The construction of pumping pipe line from the bottom to step tube placement in order to improve the pumping efficiency and the pouring speed distributing tube in place, reduce concrete exposure, avoid pipes often removed, rinse and then long. The width of the concrete must be guaranteed to cover the newly poured concrete before the exposed surface of the concrete has been poured.

To check whether there is any coagulation residue in the pipe before the tube removed. The pipeline should be fixed firmly, especially the inclined pipe and vertical pipe to reduce the pressure loss of the pump. The pipeline is wetted with water before the pump used and then cements mortar lubrication pipeline and pump. The amount of concrete in the hopper is to maintain not less than 20cm to avoid the pump suction rate or low suction air blockage. When the pump is interrupted for a short period of time, the pump should be taken to make the concrete in the pipe formation of reciprocating movement to maintain a good pump.

##### (3) Concrete vibration

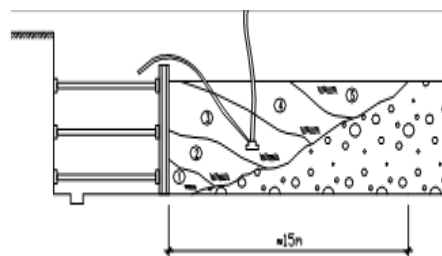
According to the order of the partition of the concrete the plug-in vibrator is used to vibration but steel intensive area using the extension of the vibrator. The upper part of intersection points of beam and column can't be directly formed by the material, only through the feeding of the point of intersection is vibrated with the vibrato and the surrounding layers of extruded material can be squeezed into the dense points. The insertion point distance is less than 0.6m where the concrete vibration rod inserted quickly pulled out slowly is straight up and down. In order to ensure that the upper and lower concrete with the compactness of the concrete time from 20 to 30 seconds is appropriate, the vibrating rod must be inserted into the lower 50 - 100mm in the vibration of upper concrete. So the surface of the concrete is no longer significant level of sinking, no longer appear bubbles, the surface of the mortar. Each pump must be equipped with three vibrators at which is the top of the concrete, a vibrator source concrete, a vibrator concrete in the middle (see Figure 3) along a vibrating concrete flow line. The two pumps to irrigate the surface of the concrete vibration should be strengthening to prevent leakage, under vibration. The surface of mortar is vibrated until the surface is level and no longer appears bubbles. The concrete is poured into the concrete road irrigation channel width 1000mm, high concrete face 300 mm.



**Fig. 3** Schematic diagram of concrete vibration

#### (4) Bleeding treatment and surface treatment of concrete

The water channel are formed along the slope of concrete bleeding and mud down to the bottom of the pit in high fluidity the concrete pouring and vibrating process. The most of bleeding with concrete forward was rushed to the pit side reserved whole pit row to the pit in the concrete construction. The top of the template in the near concrete slope the direction of the concrete pouring is changed pouring from the top back with the original ramp intersection into a water pit. In addition to consciously strengthen the concrete pouring speed on both sides of the template, the soft pump out timely is taken to eliminate the bleeding of the final stage in Figure 4.



**Fig. 4** The concrete pouring direction and bleeding out at the top

At the same time, the concrete surface treatment: Large volume pumping concrete surface cement slurry thicker, it should seriously be deal with at the end of the concrete pouring. The surface evenly is sprinkled a layer of floating 5-20mm (broken) stone that is rolled by the iron roller several times every 4 ~ 5h before the initial setting. The surface is scraped with the long scraping feet according to preliminary elevation. The artificial cracks are compaction in plaster.

## 2.5. Control and monitoring of concrete curing and temperature

### (1) Concrete curing

The internal free water and surface water are used by comprehensive maintenance method and thermal insulation timely cooling combined in order to ensure the concrete has a sufficient temperature, a suitable hardening conditions and micro expansion in the development process of humidity, prevent the loss of concrete early produce shrinkage cracks. The pouring must pay special attention to the protection measures in order to prevent the concrete surface at night the temperature drops too fast and the water surface of concrete freezing in the winter. The main purpose is to maintain the appropriate temperature and humidity conditions.

A: In pouring concrete light received after condensation with plastic sheeting covered with three layer of straw, surface layer with a layer of colourful cloth cover and to overlap. The coverage is determined the increase or decrease according to the actual measured temperature change. The pouring concrete insulation is hung two layer straw and a layer of plastic cloth; The bottom side of the mould is plug-in caolian; Wall column and the insertion of tendons can be used in gunny bags (plastic sheeting) cut into strips.

In order to avoid the concrete setting to reach the critical strength before being frozen, the concrete surface temperature should be controlled arrange temperature. it should take timely measures (temperature less than 25 °C) in order to avoid the severe shrinkage of concrete foundation concrete. The cooling rate is lower than 1.5 °C /d.

B: The temperature of the concrete into the mould will be controlled at 5 degrees Celsius and the temperature of the concrete core is expected to be at the temperature of 51 degrees Celsius with taking the above technical measures through the heat preservation. The highest surface temperature of concrete is controlled no higher than 26 DEG C and average atmospheric temperature for 8 DEG C which can achieve the concrete centre and on the surface temperature does not exceed 25 degrees and temperature difference between surface and atmosphere on the concrete does not exceed 25 degrees. When the temperature difference is found to be close to the control value, the temperature measurement personnel immediately notify the technical supervisor to strengthen the concrete surface, so as to improve the surface temperature and the temperature of the foundation pit.

C: Maintenance period engaged in the work of the order, not allowed removing the maintenance cover.

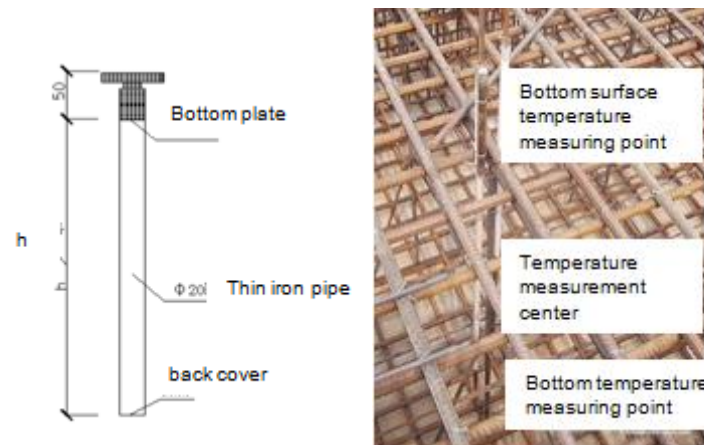
### (2) Temperature control and monitoring

During the mixing process, the actual temperature, ambient temperature, outlet temperature and mould temperature are monitored every 4 hours. The raft concrete temperature is controlled. The locations of the measuring point of the detailed layout are shown as Figure 5.

The temperature of the site is measured with the construction of electronic temperature measurement. The measuring points are vertical set along the bottom surface of the concrete, the center, the surface of the three layers of the layout, the distance between 2.5 and 5 meters. The distance between the measured point and surface structure edge is greater than 100mm. The temperature measurement hole uses the phi 20 thin wall iron pipe to carry on the burying, is higher than the concrete bottom plate surface 50mm, the tube bottom should close tightly. The position of the measurement point and thermometer sensor accuracy shall be subject to the supervision of personnel confirmation. The concrete temperature: the temperature is read every 2 hour reading time at rising stage. The thermometer is inserted into the temperature measurement hole in the shortest time to no less than 3 minutes. The thermometer must be plugged nozzle temperature measuring hole and cover insulation material. The temperature must be plugged nozzle temperature measuring hole and cover insulation material. The temperature is read every 4 hour reading time at drop stage and the test each test shall be read carefully recorded can be stopped when concrete core temperature and temperature difference in the pit all day long 25



DEG C. The temperature of concrete controlled with dynamic monitoring and management must be timely increase or removal of thermal insulation materials.



**Fig. 5** location and layout of the measuring points

### 3. Conclusion

Hongyun Building B tower building with raft foundation did not produce cracks in large volume concrete construction process by adopting the temperature crack control measures. The construction effect is good.

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