

# Discussion on Construction Technology of Mass Concrete in Super High-rise Building

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**Keywords:** Super high-rise building, Mass concrete, Key points of construction technology

**Abstract:** The planning innovation of mass concrete project is the embodiment of the future science and technology field in the construction work, and it is also the key to improve the architectural design level. In the future, the scale of high-rise buildings and super-high-rise buildings will be further expanded, and the role of mass concrete will become more critical. To this end, this study has also carried out technical discussion and process optimization scheme, aiming at improving the existing engineering mode, maintaining the construction quality and using different technological means to achieve the project development goals.

## 1. Introduction

In the aspect of quality control of mass concrete, China has issued relevant technical regulations, such as "Code for Construction of Mass Concrete" (GB50496-2009) and "Regulations for Mix Proportion Design of Ordinary Concrete". Generally speaking, the construction of mass concrete should conform to the principles of safety, applicability and quality, and avoid harmful cracks and other related problems in concrete structures. For the construction under special climatic or environmental conditions, it is also necessary to effectively control the quality of finished concrete products.

## 2. Characteristics of Construction Method

On the whole, the process is clear and simple, which is conducive to the construction personnel to clearly grasp the construction requirements. Secondly, the control of the construction process is the key to ensure the construction quality, and to a certain extent, it can prevent the emergence of cracks and other problems in mass concrete construction.

First of all, we need to analyze the causes of cracks in mass concrete: the temperature of hydration heat of cement, shrinkage deformation, base constraints and so on. Comprehensive prevention and control technology and one-time concrete pouring method are beneficial to improve the integrity and seismic performance of the structure, and ensure the seismic performance of the building. Finally, using mass concrete construction technology, to a certain extent, the tools between constructions are reduced, the construction process is cross-simplified, the construction period is shortened, and the quality is enhanced. After improving the construction method, we need further planning in the aspects of material selection, construction mix proportion, construction technology selection and maintenance management, and implement the construction requirements according to the corresponding technical standards.

## 3. Process Principle

There is a close relationship between the selection of raw materials and cement. According to the performance requirements of ordinary Portland cement in General Portland Cement in China, in order to further avoid hydration heat or other harmful structural cracks in the concrete curing process, we should tend to choose ordinary Portland cement with low hydration heat and good stability when selecting materials, and at the same time control its performance indicators. If other

kinds of cement are used, its performance index should also meet the national standard, for example, the hydration heat of 7d should be less than or equal to 270kJ/kg. The data of cement loss on ignition, setting time and hydration heat obtained after comparative test can provide key data support for our project.

Preparation and transportation process. Combined with the requirements of the national standard "Ready-mixed Concrete" (GB/T14902), consider the influence of construction process on technology, such as mold slump and temperature. Before concrete production, calibration shall be carried out according to the requirements in Ready-mixed Concrete. In the production process, the moisture content of aggregate shall be measured. If the moisture content changes greatly or construction is started in rainy days, the set value in the production system shall be controlled according to the actual moisture content.

#### 4. Construction Process and Operation Requirements

Construction preparation work in technological process should be set before mass concrete construction, such as mechanical equipment scheduling, labor preparation, etc. In order not to affect the normal production of concrete, raw materials shall be supplied according to the layout plan to ensure the flatness of the casting area. In the production part, according to the requirements of the area where the project is located and the construction progress, the production and supply routes are formulated in advance, and the number of stations, transportation distance, transportation routes are determined, especially in emergency personnel design, and simulation and drills are carried out in advance. The overall arrangement is for different stations to cooperate in production and then provide special transport vehicles. We can refer to the parameter requirements of concrete construction performance, as shown in Table 1.

Table 1 Requirements of concrete construction parameters

Initial setting time	Final setting time	Maximum mold entry temperature	Gas content > 5.0%	slumps	divergence	Sand ratio
26-28h	30-32h	32°C		200-220mm	>500mm	38-42%

#### 5. Materials and Equipment

According to the previous specifications of similar concrete mix design, combined with engineering characteristics, we can design relevant construction mix requirements. Before construction, all materials are surveyed. In order to ensure the construction performance of concrete, fine adjustment of aggregate gradation is needed to facilitate construction. In order to reduce the total temperature rise of mass concrete, control the temperature difference between inside and outside the structure and plan the concrete outgoing temperature, we should adopt the method of combining calculation with field investigation to avoid the occurrence of similar cracks.

(a) In the choice of admixture, mineral powder, fly ash and other materials are common, aiming at improving the performance of concrete itself, reducing or delaying the release time of hydration heat. When the concrete has impermeability requirements, the content of tricalcium aluminate in the cement to be used should not be greater than 8%. When all materials come into play, we should take performance indicators as technical requirements for the inspection of their varieties and packaging.

Table 2 Performance Requirements of Fly Ash

Type of fly ash	Grade	Fineness requirement	Water content	Water demand	Loss on ignition
Required value of national standard	Class II	≤25.0%	≤1.0%	≤105%	≤8%
General products	Class II	16.0%-23.0%	0.4%	99.0%	2.5%-3.0%

(b) In the selection of fly ash, the "double mixing" method will be adopted in the current engineering practice, adding water reducing agent at the same time as adding fly ash to prepare concrete with better performance, ensuring its workability and strength, reducing hydration heat, and meeting the high technical requirements of different projects. Here we can refer to the standard values under the requirements of national standards.

(c) Aggregate. In addition to meeting the current national standards, aggregate should also meet certain regulations. The grain size is controlled between 5-40mm and the silt content is less than 1%. If the aggregate is used for non-pumping construction, the selection of force input can be appropriately increased. According to "Technical Code for Application of Concrete Admixtures" and "Fly Ash Used in Cement Concrete" (GB1956), we need to reduce the hydration heat of water in the process of concrete hardening to improve its performance, and usually choose low alkali active materials. The fine aggregate is mainly medium sand with fineness modulus greater than 2.3 and silt content below 3%.

(d) Admixtures. When necessary, high efficiency water reducing agent with water cement ratio less than 0.24 should be added. Then the slump is controlled at about 200mm, and the final setting time is controlled at about 30h. According to the requirements of environmental protection, it meets the technical standard of "Application Technology of Concrete Admixtures" GB50199.

(e) Concrete mix ratio. Construction slump loss, strength, concrete shrinkage cracks, such technical defects should be avoided by taking reasonable raw material control measures, controlling the technical parameters of each process, and preventing the construction period and quality from being hindered. If the slump meets the pumping requirements, the slump in the mix design should be kept between 120-140 mm. If we use double mixing technology, according to the above requirements, the slag powder can be appropriately increased, but the maximum mixing amount should not exceed 1/2 of the cement consumption. Under the condition of meeting the strength requirements, the amount of cement used can be reduced as much as possible, and some high-quality fly ash should be added to reduce the hydration heat. In the process of concrete trial preparation, the same raw materials as those used in engineering construction are used for concrete experiment, which is carried out according to the requirements of relevant technical regulations such as Standard for Test Methods of Ordinary Concrete Mechanics Skills.

## 6. Quality Control

In order to ensure the smooth pouring of mass concrete, the main supply station should also allocate a special concrete production line to ensure the supply capacity. Before the actual start of the project, it is necessary to arrange special departments and personnel to go deep into the construction site to determine the vehicle transportation route. For example, for the construction of some city centers or commercial districts, there may be one-way driving requirements in some areas, so concrete supply should pay attention to road condition information in combination with site requirements to meet the supply demand and provide some temporary motor vehicles. Especially for some large-scale mechanical equipment in mass concrete construction, it is necessary to carry out maintenance and test run in advance, which will cause technical problems in the construction process. The approved construction plan configures and arranges the monitoring equipment of concrete, and manages the operation process according to the requirements of special personnel.

(a) Stirring. Strictly control the mixing time. If transportation vehicles are to be used, the time of concrete in the mixer shall be kept for more than 30 seconds from the time when all materials are put in. Before site construction, check whether there are any quality problems such as delamination, segregation, slump and so on.

(b) Vibrating. When vibrating, it is necessary to control the vibration spacing, because too thin and too dense vibration will affect the performance of concrete and even cause segregation.

(c) Maintenance. In terms of pouring and maintenance, reasonable pouring methods should be adopted according to the engineering characteristics and previous construction experience, and the interval of layered pouring should be shortened as far as possible during construction. Usually, the next layer of concrete is poured completely before the upper concrete reaches the initial setting, and

at the same time, no construction joints are formed between each layer of concrete. Therefore, we should flatten the concrete surface and cover it with plastic film in the curing process. Within 24 hours after the pouring work is completed, other people or equipment are not allowed to influence it, until the difference between the concrete surface temperature and the ambient temperature is within 20°C, all the protective materials will be removed [2]. When slump or other indexes do not meet the casting requirements, fine adjustment should be made with additives, and the dosage should not exceed 0.3% of the proportion. For the maintenance of concrete, plastic film should be selected to cover it, which can reduce heat loss, improve the overall strength of concrete and control the temperature difference between inside and outside.

## 7. Application Examples

A national mall is located in the core area of a city, in which about 25,000 cubic meters of floor concrete pouring needs to be completed at one time. The pouring time is from January to February, and the pouring method is long-distance pumping, and the pouring task is completed in about 40h. The specific technical requirements are as follows:

(a) Performance of concrete. The construction conditions of super high-rise buildings are harsh, and there is a big drop from the unloading of vehicles to the working face. There are clear requirements for the workability of concrete, which must have high fluidity, water retention and segregation resistance, and there is no obvious bleeding phenomenon on the surface. In addition, factors such as production, transportation, vibrating, and construction time should be considered comprehensively to ensure that concrete slump will not be lost at least in 3h. The environmental temperature, water temperature, concrete temperature and other records are required in the testing work, so as to ensure that the ex-factory temperature and injection temperature of concrete meet the quality control standards. In the production process, all production equipment is preheated first, then water and aggregate are premixed, and then admixtures are added for stirring. The mixing time shall be kept sufficient, and the quality control personnel shall make clear requirements on the water content of sand and gravel and the testing frequency, sample and test different performance indexes of concrete, including concrete temperature, etc., and finally adjust the production mix proportion according to the final testing results [4].

(b) Construction requirements in special period. Related technical requirements and technical difficulties are mainly reflected in the strength requirements of concrete floor. For example, the construction time is in winter, the temperature control index needs to be strictly implemented, and the large-scale concrete pouring task is relatively large at one time, and the simultaneous supply of multiple stations requires higher quality control of production and construction. At this time, according to the requirements of "Winter Construction Regulations of Architectural Engineering" on the quality of motive construction, the selection of raw materials should increase the cement consumption as required, and control the water consumption to reduce the contradiction between winter construction and the increase of hydration heat of mass concrete. However, in winter, it is easy to have bad weather, so attention should be paid to whether there is icing or impurity in the selection of aggregate. When necessary, we can flexibly adjust the outgoing temperature of concrete, and use warm water not exceeding 60°C for mixing.

(c) Technical control. In winter construction, if 60 days is used as the judgment basis, the age strength should meet the design strength of more than 115%. For example, when considering the aspects of construction technology, we have carried out the requirements of operation procedures from the aspects of raw materials, temperature measurement and improvement of water secretion. A circulating water pipe can be set in the middle of the concrete to circulate water according to the temperature measurement results, so as to reduce the internal temperature and the temperature difference between inside and outside to control the concrete cracking phenomenon.

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