Research on mix proportion and solid rebound detection of high strength concrete in super high rise building

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Abstract: At present, the application of high performance concrete in super high-rise building engineering structure is more and more extensive. The mix proportion of high-strength concrete is the basic variable of concrete, and the rebound detection of building structure is carried out. On this basis, the design method of building pressure matching is proposed. Due to the large error of the estimated value of the strength test curve unified by the whole country, in a new project in Xi'an, the rebound method and core drilling method are carried out on several concrete members, and it is concluded that the test results of rebound method and core drilling method with different strength levels are quite different. In view of the difference of test results of mix proportion rebound method of high-strength concrete of super high-rise buildings in Xi'an area, the correction method of rebound difference of different strength levels is put forward.

1 Introduction

With the continuous development of concrete science, the application of concrete is more and more extensive. However, due to the higher requirements of concrete quality and cost in practical engineering application, reasonable concrete mix proportion design is very important. The specification of mix proportion of high-strength concrete for super high-rise buildings mainly guarantees the strength and durability of concrete[1]. On the premise of ensuring the engineering quality and construction requirements, reasonable selection of material concrete varieties and dosage can reduce the cost of super high-rise buildings and improve economic benefits. The concrete mix proportion is calculated according to the solid rebound detection results. In the process of mix proportion and solid rebound detection of high-strength concrete in super high-rise buildings, relevant national and local design, construction and maintenance specifications should be strictly followed to ensure that the strength of high-strength concrete meets the design requirements[2]. In terms of engineering quality acceptance standards, there are relevant standards such as separation of inspection and quality, strengthening acceptance, improving means and process control, which clearly stipulates the content of engineering quality acceptance, and is also the main basis for engineering quality acceptance in China. The research results of mix proportion and solid rebound detection of high-strength concrete in super high-rise buildings ensure the quality acceptance of engineering. The effectiveness is of practical significance to the sampling inspection of engineering concrete structures.

2 Mix proportion of high strength concrete

2.1 Mix density algorithm of high strength concrete

According to the needs of engineering design and construction, the raw material concrete suitable for the production of concrete is selected, and the appropriate proportion and dosage are selected according to the concrete performance and economic principle determined by the design. Limited by the site construction environment and local special material concrete, it is not very scientific[3]. The general concrete mix proportion design includes two aspects: select the appropriate raw material concrete according to the specification requirements; reasonably prepare various raw material concrete to make it meet the requirements of concrete technical index and achieve the medium strength allowance of engineering design and construction. The concrete mix proportion is the key to the quality control of concrete, which directly affects the construction difficulty, internal quality, external feeling and cost of concrete[4]. Therefore, how to optimize and adjust the concrete mix proportion is very necessary and urgent[5]. Based on the theoretical study of strength and rheological properties of solidified soil, a concrete mix design method based on concrete filling and compaction

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is proposed. The aggregate concrete D is reduced to an equivalent sphere with diameter:

\[ V_{\text{fill}} = \frac{6\pi D^2}{6} + \frac{p}{\rho} \]  

(1)

In the equation, \( \delta \) is the thickness of high-strength concrete coating for high-rise buildings, \( M \) is the quality of super high-rise concrete building, \( \rho, \rho' \) are the apparent density and bulk density of concrete, and \( p \) is the cumulative rate of concrete.

The density coefficient \( e, \) of aggregate concrete refers to the filling amount of concrete per cubic meter[6]. The application parameters of fine stone formula in concrete mix design are calculated

\[ m_g = e_s \left( \frac{m_{cs}}{\rho_c} + \frac{m_{wa}}{\rho_{wa}} \right) \]  

(2)

Based on the statistical analysis of the actual engineering test data, the density coefficient of concrete fine aggregate concrete is obtained, which further shows that the concrete strength is 28d. Because the density coefficient of fine aggregate concrete is greatly affected by the slump requirement, the slump T=160mm is taken as the calculation index. According to the preset dosage limit, the initial annealing temperature \( T_k (k = 0) \) is initialized to generate the initial solution \( S_0 \) with the average number of concrete component[7]. When the temperature \( T_k \) reaches the equilibrium state, repeat the following operations: generate a new solution \( S' \). Calculate \( C (s') - C (s) \), where \( C (s) \) is the evaluation function; if the result of the above formula is less than 0, the current solution is accepted[8]. At the temperature of \( T_{k+1} = a \times T_k, k = k+1, \) when \( a(0) = a(S) = a. \) If the selection of the density coefficient of coarse aggregate concrete is consistent with the derivation process of the formula of fine aggregate concrete, the formula of coarse aggregate concrete per unit volume of concrete is as follows:

\[ m_g = [T_k + 1]-a(S) / e_m \left( \frac{1}{\rho_c} + \frac{1}{\rho} \right) + C(S) \]  

(3)

According to the optimum density of mortar and concrete, the design method of concrete mix proportion is put forward. The specific design steps are as follows: calculate the water cement ratio; determine the unit water consumption; determine the density of fine concrete according to the design strength; determine the amount of fine concrete in unit volume concrete; determine the density coefficient theory of coarse concrete by looking up the table; take concrete as the research object, the determination of the density coefficient of fine concrete and coarse concrete is the key, and the density coefficient of fine concrete is the strength and strength[9]. The function of fluidity and compactness coefficient of coarse concrete is the function of particle size and workability of concrete. The goal of concrete mix proportion optimization is to meet the performance requirements of concrete and minimize the unit cost. The unit price of raw concrete includes raw material concrete. One is the price of concrete and the other is the installation cost of equipment, which is the average unit cost of concrete.

\[ \Delta p = p_0 + p' / m_g * N_0 \]  

(4)

In the calculation formula, \( p_0 \) is the price of raw material concrete itself; \( p' \) is the equipment installation cost of raw material concrete; \( N \) is the total amount of concrete to be produced. Using the principle of simulated annealing, the global optimal solution can be obtained with enough iterations. Therefore, the simulated annealing method is used to optimize the ratio[10].

**2.2 Specification for mix proportion index of high strength concrete**

As an important link to ensure the quality of construction engineering, the quality and physical acceptance evaluation work of construction engineering quality inspection standard has been paid more and more attention, which makes it more prominent in the construction process. The main raw material concrete for high performance concrete construction includes water, concrete, mineral admixture concrete, superplasticizer, cement, etc[11]. the quality of raw material concrete should be strictly controlled according to the building materials standard. Improve the professional quality of testing personnel, accurately grasp the proportion of each component in the original concrete, manage strictly according to the regulations, and do a good job in basic guarantee[12]. The strength index of high performance concrete can be achieved by using high performance water reducing agent[13]. After the concrete is prepared, the mixing water consumption is reduced without affecting the cement dosage, and the working performance of the concrete is ensured[14]. The binder content of effective water reducing agent should be controlled between 0.8% and 1.5% in the actual concrete mixing. Even if the concrete is added to a certain standard, it will not change greatly. The appropriate dosage can reduce the cost and achieve effective coordination effect[15].The type and content of raw concrete needed for preparing high performance concrete were determined[16]. Ensure the strength and stability of concrete, guide the actual mix design operation and control.

**3 Solid springback detection**

**3.1 Experimental environment and equipment**

In order to verify the effectiveness of this study, a super high-rise building located in the first development zone of Xi’an city is selected for research. The purpose of the design is to increase the column spacing and expand the building area. The columns of 2-4 floors are designed with C60 strength. On June 12 of that year, when the main building had been constructed to the fourth floor, the rebound test was carried out on the wall column concrete of the - 2 floor. It was found that the strength of the concrete part of the - 2 floor wall column was lower than the design requirements, and the concrete strength
grade of some columns was below C45, three grades lower than the design strength, but the strength of the same batch of concrete test blocks met the requirements. In view of this situation, the construction unit requires to continue construction for the reason of slow growth of fly ash concrete strength, wait for two months to test again, if the concrete strength still does not meet the design requirements, the relevant provisions shall be followed. There are 162 commercial concrete production enterprises registered with Xi'an housing and Urban Rural Development Bureau, including 5A level has 1, 54A level has 55. Although theoretically speaking, commercial concrete production enterprises can produce high-strength concrete with qualified raw material concrete, there is still a long way to go from laboratory test production to large-scale production of engineering construction, which requires not only large production scale, stable raw concrete source, strict quality control procedures, but also certain technical ability. Therefore, whenever the requirements for high-strength concrete are put forward in the design, the user should select the concrete supplier from the 5A, 4A commercial concrete production enterprises with higher enterprise credit rating.

3.2 Rebound test results and conclusions

As high strength concrete is a kind of multi-phase composite concrete, the rebound strength is affected by the characteristics of raw material concrete, age, curing and climate, etc., so the strength should be determined quantitatively in the process of construction control, and the special strength measurement curve should be adopted, and the correction coefficient should be set first. According to the different curing methods and standard curing conditions, the estimated rebound strength is greater than the compressive strength of the specimen. Based on the above-mentioned experimental equipment and environment, the compressive strength of concrete is recorded respectively to analyze the springback of structures in different regions. The specific detection results are shown in the following figure:

![Fig. 1 comparison test results](image)

Based on the above test results, the rebound baseline length of super-high-rise building structure is calculated

| Baseline number | Back calculation of baseline length by CORS measurement / M | Back calculation of baseline length / m by static measurement of known points | Absolute value of difference/mm |
|-----------------|-------------------------------------------------------------|------------------------------------------------------------------------------|--------------------------------|
| CP I 131B-JM558 | 124.15                                                      | 135.26                                                                       | 16.5                           |
| CP II 19B-JM546 | 135.49                                                      | 140.32                                                                       | 14.3                           |
| JM545-JM543     | 128.63                                                      | 165.40                                                                       | 12.4                           |
| JM545-JM544     | 144.52                                                      | 165.84                                                                       | 18.1                           |
| J544-JM543      | 163.48                                                      | 158.63                                                                       | 12.6                           |

As the strength of high-strength concrete directly affects the safety and seismic performance of the building structure, it is related to the life and death of the project. Therefore, in view of the mix proportion design of high-strength concrete, the quality of raw material concrete (the famous brand products in the market give priority to cement, the high-strength gravel is preferred to be used for gravel, and the water washed sand is preferred for sand), the acceptance of concrete entering the site, and the insulation protection after pouring is completed The special supervision and inspection system should be formulated to ensure the high strength concrete to play its due role. Generally, when the deviation between the compressive strength of super high-rise buildings and the average value exceeds 1.96 times of the standard deviation, the data is taken as the abnormal value, and the spare parts test is used to replace the deviation to meet the requirements. Under the condition that the rebound value is taken as the independent variable, the unified strength measurement curve, the special strength measurement curve and the pumping strength measurement curve are used to calculate the rebound strength, and the representative value and standard deviation are calculated by mathematical statistics method. The relative deviation was calculated and the compressive strength ratio was...
corrected. In order to ensure the optimal setting of high-strength concrete mix proportion of super high-rise building, so as to ensure the construction quality.

4 Conclusion

In order to improve the performance of concrete, the preparation performance of concrete is tested and analyzed. Through continuous innovation, high performance is expected to be achieved. The factors influencing the performance of concrete mix proportion are discussed. The springback detection is carried out, and the performance test data are analyzed and counted. Based on the experiment, the selection of cement and mixed concrete, the influence of fly ash content on the compressive strength of concrete and the comprehensive strength of concrete with water binder ratio are analyzed in detail. Through optimization, the water binder ratio and fly ash content ratio under ideal conditions are obtained, so that the performance of cement concrete can meet the requirements of the development of the times.

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