This paper discusses the numerical simulation analysis and practical application method of tower crane selection in a super high-rise construction project

Hao Meng[1], Jinlong liu[1], Shijun Li[1], Yikun Su[2,*]

[1]The second construction Co. Ltd. of China Construction First Group

[2] Northeast Forestry University

* Killeranother123@gmail.com

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Abstract. In the development of modern social construction, civil engineering structural stress testing means will be widely used during construction to comprehensively monitor the parameter changes of various structures in the construction of super high-rise structures, so as to provide effective protection for the safety management of site construction while warning and analyzing the hidden risks of the project. Therefore, on the basis of understanding the accumulated experience in the construction management of super high-rise structure construction projects in recent years, this paper, based on the numerical simulation analysis and practical research status of tower crane selection, takes a construction project as an example, mainly explores the tower crane selection and design scheme of super high-rise construction projects, and then judges the effectiveness of practical application method according to the numerical simulation. In order to provide effective basis for urban construction management in the new era.

Keywords: Super high-rise structure; Construction project; Tower crane selection; Numerical simulation; Positioning and installation.

1. Introducion

Under the development trend of economic globalization, in order to better meet the living and working needs of social residents, the number of urban construction projects is increasing, and the requirements of project construction management are becoming higher and higher. From the current research results of on-site construction monitoring at home and abroad, the structural health monitoring technology is mainly used to assess the severity and location of structural damage. It will be used to measure the response of the structure before and after ultra-long loads, and evaluate the severity and main location of structural damage according to the characteristics of the system. Generally, the structural design uses the calculation model under load as the basis, but this method is only for conventional structure. For some special purpose building structures, the mechanical properties of conventional design will change greatly during construction, and the structural load, construction geometry, boundary conditions and so on will be different from those in the design stage. [1-3]Therefore, a comprehensive consideration of the influencing factors during structural design and construction is the basic requirement to ensure the quality and safety of super high-rise structure construction projects. Nowadays, with the continuous improvement of social economy and scientific and technological level, architectural theories and calculation methods at home and abroad are becoming more and more perfect. Although the construction scale of large complex structures is characterized by high difficulty, complex operation, long cycle and large scale, scholars have proposed a new numerical simulation technology based on the selection and structural design of tower cranes in order to solve the safety risks during construction management. At the same time, the simulation method and monitoring method of structure construction are studied in depth to provide effective basis for structure design and construction. For example, Beijing Ocean Ledi Port is located at the northeast corner of the intersection of Xinhua North Road and Tongzhou

Beiguan Bridge. As a comprehensive office building integrating office and catering, it not only has a large use area, but also belongs to the construction project of super high-rise structure. In the follow-up application and promotion, it can help enterprises expand business contacts and recruit elite talents. It has laid a solid foundation for social and economic development. Therefore, during the construction planning period of the project, relevant enterprises put forward the reasonable use of large tower crane equipment and construction scheme after clarifying the construction content and technical means of the building structure. The final construction project quality meets the expected requirements, and the application of tower crane equipment plays an important role in it. Therefore, after understanding the accumulated experience of domestic and foreign super high-rise structure construction projects, based on the currently mastered technical means and basic requirements of tower crane selection, this paper mainly explores the numerical simulation analysis and practical application effect of tower crane selection in a certain super high-rise structure construction project, and provides effective basis for urban construction and development in the new era.[4-6]

2. Method

2.1 Selection requirements

Tower crane is a common mechanical equipment in urban construction management. During the construction of high-rise building structure, vertical transportation basically needs to be completed by tower crane. Therefore, practical work efficiency and work quality directly affect the project construction level. According to the accumulated experience in the construction of super high-rise structures in recent years, the selection of tower cranes mainly has the following requirements: First, the appropriate type of tower cranes should be selected according to the project construction scale. For example, small economic tower cranes can be selected for small pier construction projects, and because tower cranes are not required for many times in small projects, walking tower cranes are often chosen in order to consider increasing the coverage area of tower cranes. In the selection of tower cranes in medium and large projects, large equipment is preferred, because vertical transportation capacity directly affects the speed of structural construction, but at the same time, we should consider the price difference of different tower cranes and accelerate the progress of the comprehensive economic effect, only in this way to ensure that the project construction can be orderly; Secondly, it is necessary to ensure that the type of tower crane meets the needs of mobilization. After the construction unit defines the basic requirements of the project construction, on the one hand, it should consider the requirements of various heavy objects on the tower crane capacity. On the other hand, it should judge whether the tower crane has the corresponding lifting capacity according to the storage location, transportation location, distance from the tower crane center, etc. If the tower crane type does not meet the transfer requirements, then it should be adjusted scientifically according to the site construction situation in time; Finally, to meet the site construction coverage area requirements. The type of tower crane determines the length of the arm of the tower crane, so it is necessary to avoid covering the blind area when installing the tower crane at the construction site, but this requirement is not completely absolute. For example, when dealing with the problem of corner coverage, you can temporarily rent the car tower crane. You must not blindly increase the number or size of the tower crane, but choose the economical and suitable scheme after comparative analysis.[7-9]

2.2 Tower Crane Types

Tower crane is the most common vertical transportation machinery and equipment in the construction of the structure. When dealing with the concrete composite frame structure, it should not only vertically transport the steel bar and turnover materials, but also be used for the lifting of steel column and steel beam. Therefore, when choosing the type of tower crane, it is necessary to consider the weight and transportation needs of steel members comprehensively. It is reflected in

the following points: First of all, the weight of the steel frame and the transportation demand play a decisive role in the performance of the tower crane, so it is necessary to deepen the design of the steel column segment before the selection; Secondly, during the construction of the building structure, it is necessary to divide the main tasks of the tower crane on the site, and truly achieve the coordination between the reinforced concrete construction and the steel structure construction, to avoid the collision between the mechanical construction; Thirdly, after mastering the main parameters of the tower crane, the overall situation of the site construction should be integrated and analyzed to ensure that the free height of the tower crane is not lower than the overall height of the building, the safe operating height, the height of the sling, the height of the component, etc., in line with the needs of the tower crane construction. Finally, cost performance is the focus of super high-rise structure construction projects. Therefore, when selecting tower crane models for project construction, comprehensive consideration should be given to the requirements of project cost and engineering practicability. On the basis of ensuring the quality and safety of site construction, tower cranes with high efficiency and low cost should be given priority.[10-12]

2.3 Tower Crane Positioning

According to the accumulated experience in the construction of current super high-rise building projects, tower crane positioning has the following requirements: First, the building and construction site should be covered as far as possible, the tower crane should be attached to the outside of the building, the construction surface is only semicircle, and the small tower crane can be used to replace the large tower crane in the internal positioning; Secondly, the obstacles on the construction site should be effectively reduced to ensure a safe distance between the tower crane and the obstacles, so as to avoid safety risks in the application process and operation methods during the construction of the project. Thirdly, the optimal distance between the tower crane equipment and the building should be ensured to avoid the blind spot in the hoisting work around the tower crane. Finally, it is necessary to meet the basic requirements of the material supply surface and ensure that the positioning of the tower crane can ensure that all the working surfaces of the construction are within the coverage and supply surface range of the tower crane.

2.4 Tower Crane Installation

The installation quality of the tower crane directly affects the subsequent construction efficiency and quality of the tower crane, so the construction unit should choose the installation unit with the disassembly license, formulate an effective construction plan before the installation, and arrange professional installation after the approval. The relevant technical personnel shall disclose and sign the safety technology, and stop the installation work when the wind at the construction site exceeds level 4.

3. Result analysis

After clarifying the requirements of tower crane selection for construction projects of super high-rise buildings, this paper takes the financial center project of a region as an example to conduct numerical simulation analysis on the tower crane and its support structure, so as to judge the effectiveness of tower crane selection. From the perspective of design and application, the numerical simulation of the tower crane structure during construction is actually to calculate the load working condition of the tower crane under working condition, so as to provide correct judgment for the rationality of the construction scheme and theoretical basis for the stress monitoring and effective control of the tower crane structure. Based on the analysis of the working status of the tower crane load shown in Table 1 below, it can be seen that the tower crane load will be transferred to the embedded parts through the support frame structure. All the support frame structures have four bull leg embedded parts in total. Because the Angle between the tower arm and the main beam is different during the transportation of the tower crane, the concentrated bending

moment of the tower crane is constantly changing, and the force shared by different embedded parts is not balanced.[13-15]

Table 1 Load analysis of tower crane

Two-way attached tower crane	In service	M （T＊m）	H1（T）	H2（T）	V（T）	Wind speed (M/s)
		1462	89	82	320	20
	Out Of Service	M	H1	H2	V	wind speed
		1200	116	68	237	53.8

In the experimental analysis, the numerical simulation results of embedded steel bars are shown in Table 2 below:

Table 2 Numerical simulation results of reinforcement

Reinforcement gauge 2-5 length /m	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
0°Directional stress /MPa	5.13	4.58	3.82	3.03	2.41	1.97	1.66	1.43	1.32
45°Directional stress /MPa	3.78	3.13	2.50	1.97	1.45	1.16	1.03	0.96	0.88
90°Directional stress /MPa	10.28	9.32	8.13	6.67	5.41	4.32	3.78	3.25	2.87
135°Directional stress /MPa	6.05	5.29	4.62	3.75	2.87	2.23	1.87	1.63	1.43
180°Directional stress /MPa	7.64	6.73	5.70	4.47	3.58	2.95	2.36	2.02	1.85

Based on the analysis of the above table, it can be seen that with the increase of the length of the steel bar meter embedded in concrete, the stress of the steel bar meter will continue to decrease. The maximum stress is at the embedded parts of the bull leg and the welding of the steel bar meter, the maximum compressive stress and tensile stress can reach more than 30Mpa, and the minimum is at the stress end of the steel bar meter. The analysis is because part of the stress on the steel bar will be transferred to the surrounding concrete with the buried depth of the steel bar meter.

The results of stress monitoring and numerical simulation of main beam are shown in Table 3 below:

Table 3 Numerical simulation results of main beam

Measuring point 2-1 Horizontal direction	0°	45°	90°	135°	180°
Monitoring value /MPa	-2.88	3.08	5.18	2.65	-2.34
Analog value /MPa	-3.54	3.98	5.91	2.07	-1.95
Difference /MPa	0.68	-0.80	-0.73	-0.58	-0.39
Error /MPa	19.21	20.10	12.35	28.02	20.00

Based on the analysis of the above table, it can be seen that with the increase of the length of the steel bar meter embedded in concrete, the stress of the steel bar meter will continue to decrease. The maximum stress is at the embedded parts of the bull leg and the welding of the steel bar meter, the maximum compressive stress and tensile stress can reach more than 30Mpa, and the minimum is at the stress end of the steel bar meter. The analysis is because part of the stress on the steel bar will be transferred to the surrounding concrete with the buried depth of the steel bar meter.

The results of stress monitoring and numerical simulation of main beam are shown in Table 3 below:

Table 4 Numerical simulation results of main beam

Steel bar measuring point 2-5	0°	45°	90°	135°	180°
Six adhesion monitoring values /MPa	2.62	-62.1	5.55	3.09	3.96
Nine-channel attachment monitoring values/MPa	2.95	-65.9	6.28	3.43	4.28
Analog value /MPa	2.41	1.45	5.41	2.87	3.58
Difference 1/MPa	0.21	-63.5	0.14	0.22	0.38
Difference 2/MPa	0.54	-67.3	0.87	0.56	0.70

Error 1/%	8.71	-	2.59	7.67	10.61
Error 2/%	18.30	-	16.08	19.51	19.55

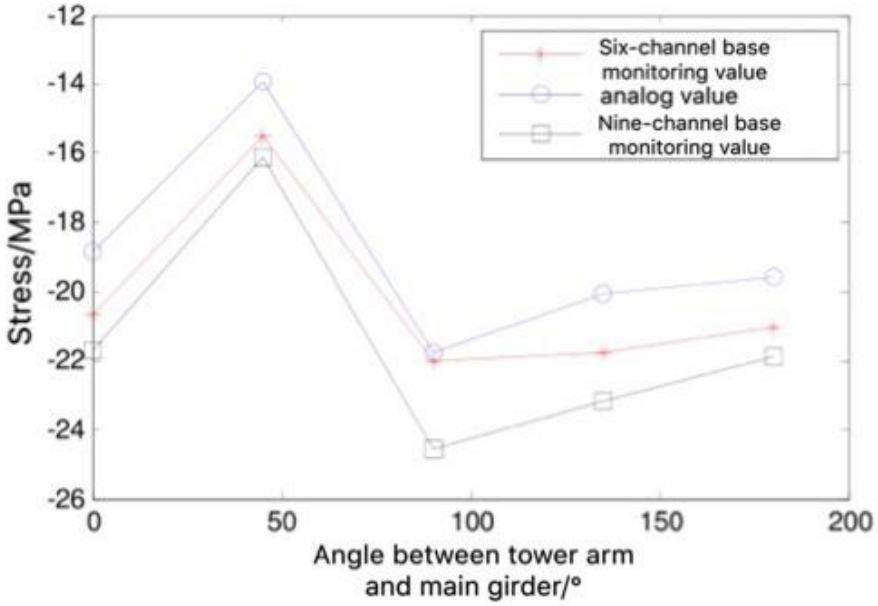

FIG. 1 The results of monitoring values compared with you and the values

Based on the analysis of the above table, it can be seen that the surface situation of the reinforcement was not fully considered during the numerical simulation, so there are still big differences in the data obtained from the practical research. During the on-site construction, the value of the steel bar meter test point was abnormal, which reached more than 60Mpa. After analysis, the reason was that the shrinkage and heat release of concrete during the construction of the core tube produced great compressive stress. In the overall experimental study, the stress of the main beam and embedded steel bar is mastered by numerical simulation, and the monitoring values of the site main beam and embedded steel bar are compared and analyzed, which can help construction personnel and management personnel to accurately grasp the stress change law of the two aspects. Therefore, the future construction projects of super high-rise structure should continue to deeply explore the numerical simulation and application measures of tower crane selection. Only in this way can we provide technical basis for site construction.

4. Conclusion

To sum up, Chinese construction enterprises should, after integrating the research results of field monitoring and numerical simulation at home and abroad, strengthen the research on tower crane type selection of super high-rise structure construction projects, pay attention to master the stress changes under different conditions in combination with practical needs, and then use advanced software technology to comprehensively monitor the field construction structure and understand the stress status of the structure in real time. Avoid unnecessary conflicts during construction management.

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