The Design and Research of High-Rise Building Reinforced Concrete Structure Based on BIM

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Abstract. In recent years, the application of BIM technology for the AEC field in China is in the ascendant, the theory and application research continue to deepen, and the standard compilation work is carried out in an all-round way. Promoting the application of BIM has become the consensus and unified action of the government, industry and enterprises. The structure stability of the surrounding has been a practical problem in high-rise building concrete structure, and then conduct an analysis of the detailed model. The evolution process of design model has been clear through the analysis of the data model, at the same time, through the research of detailed the design process has established the model of business architecture, clear the orientation and function of the structure design BIM model. At the same time, the business structure of the model is established through the study of detailed design process, and the positioning and role of BIM model in detailed design of structure is clarified. On this basis, the detailed design software was developed combined with China's reinforced concrete structure design standards and structure atlas.

1. The BIM model of reinforced concrete structure
The analysis model come from the transformations of design model through shielding the design attributes, supplying mechanical properties, and this is used in mechanical calculations and as a finite element analysis models. The analytical model focuses on the expression of mechanical properties, and the expression of this model should make pure, efficient, and general as the basic principle. The internal force of building structure can be obtained through finite element analysis and calculation based on the structural analysis model, and the results are calculated to facilitate the design of standards-based structures.

2. The architectural analysis of reinforced concrete structure design model
The reinforced concrete structure detailed design model is an excessive BIM model from the design stage to the construction stage, it is a realization that the simulation and visualization of real world reinforced concrete structures based on structural design analysis results. Its component information, on the basis of reinforcement information, component split and combination information, the detailed design information include geometric shape, position, lap, anchorage and avoidance have been integrated. The structural system is building through a single component objects connect to each other, and assembles component objects to form continuous component objects. Based on continuous component, component connection object and component object, the structure-based reinforcement
object, reinforcement anchor object and reinforcement connection object can be realized, as shown in figure 1.

Figure 1. The Data object diagram of reinforced concrete structure detailed design model

In order to establish the automatic formation mechanism of reinforced concrete structure detailed design model conforming to China's standards, this paper constructed a detailed design business structure that can automatically complete reinforcement generation, avoidance based on the research of detailed design data structure. This business architecture is divided into four levels, as shown in the figure 2.

1) Generate components and component connection objects;
2) Detailed design of column, beam and other linear components;
3) Detailed design of wall body, plate and other planar components;
4) Local adjustment based on collision check and manual intervention.

Figure 2. The Data object diagram of reinforced concrete structure detailed design model
The generation of component and component connection object is the foundation of component detailed design. It forms a single component object based on component information, information and combined component split component reinforcement information, then according to the reinforcement geometry information form the connection object, so that based on the connection object to form the boundary of the horizontal component and vertical component, and according to the geometric information and reinforcement information to generate continuous component object, component connection object and continuous component object associated with single component object establish relationships to reinforced query and modify the object. Based on object component connection of reinforced avoid adjustment can solve the problem of section steel collision, on this basis, through the collision check algorithm and the method of manual intervention to further adjust the local steel objects, to realize the reinforced concrete structure detailed design model in accordance with China's standards and construction requirements.

3. Organization of the Text

Now, the mixed steel-concrete structure has been widely used in the ultra - high buildings with the development of the height and structural alterations of the buildings building. A larger ratio of height to width is adopted to in this design, and this way can increase the weight of the structure, but it can reduce the stiffness of the structure ,Therefore, the structure may be in an unstable state. Then phenomenon of Instability and collapse may occur when subjected to wind or other loads. Therefore, it is necessary to attach great importance to and do a good job in the stable design of the structure. It can enhance resist lateral-rigidity and reduce structure displacement by setting strengthened story, but a new weak story would be formed for the inhomogeneous vertical rigidity.

(1) The shear type structures

Shear instability mainly refers to the whole floor instability, the side force witch might cause buckling occurs throughout the floor is produced due to double curvature bending. In the approximate calculation process, if the axial deformation of the column is not considered, the critical load can be expressed as:

$$\left[\sum_{i=1}^{n} G_i\right]_{at} = D_i H_i$$

Where, the left side of the equal sign is critical load, which is equal to the product of lateral stiffness and height.

(2) The bending and bending shear

For curved cantilever bar, its critical load can be expressed as follows formula

$$P_{at} = \pi^2 EJ/4H^2$$

Where, the left side of the equal sign is the critical load, EJ represents bending stiffness, and H represents the height of the structure. In order to facilitate calculation, the critical load can be replaced by gravity,

Then the formula (2) will change to the following form

$$\left[\sum_{i=1}^{n} G_i\right]_{cr} = \frac{3\pi^2 EJ}{4H^2} = 7.4 \frac{EJ}{H^2}$$

4. The verification of reinforced concrete structure detailed design model

The detailed design model of reinforced concrete structure which was according to standard of our country was accomplished based on the research of detailed design BIM model and the development of detailed design software “PbimsConcrete”. The depth of reinforcement at the edges of beam-column joints and shear walls can best reflect the fineness of reinforced concrete structure detailed design model. In the book of “The Concrete structure construction reinforcement layout rules and structural details”, according to the rules of steel bar arrangement of beam-column joints of frame structure, the two types
of beam-column joints are divided into middle node and top node. The two types of beam-column joints are further subdivided into middle node and end node to agree on the rules of arrangement.

The further research on BIM application can be carried out based on detailed design model. First, the detailed analysis of the structure can be realized on account of the deepening design model. The nonlinear static dynamic analysis of the whole building based on the refined model. In addition, on the basis of deepening the design model, the construction resources, time and cost information of the structure are endowed to control the quality, cost and progress of the construction stage, so as to realize the application of forward BIM.

5. Conclusion
The promotion and application of BIM technology cannot be separated from the support of BIM model and BIM platform. In different stages of projects, different majors and analysis directions all establish their own unique data models in the field of architecture. At present, most models in the stage of architectural design and construction have been implemented in the platform, we can come to the conclusions:

(1) The BIM model of design stage and construction stage in the architectural field is summarized, and the structural model is refined into structural user, analysis, design, construction drawing, deepening design and fine analysis model, etc. based on the design process of our country, so as to establish the model basis for the realization of information exchange among the models of structural specialty based on MVD;
(2) The to study the evolution process of the reinforced concrete structure design model, has been clear about the deepening design model to achieve the necessary conditions and information requirements, abstracts the basic data objects of deepening the design model and the relationship between objects, and based on the structural design specification and construction in our country business architecture atlas deepen design model is established;

(3) The deepening design software “Pbims Concrete” was developed, and the function of automatic deepening design based on reinforcement information was completed on the basis of reinforcing bar deepening design functions such as anchorage, lap and bending, so as to realize the rapid establishment of deepening design model in line with China's design and construction standards.

Through this study, it explores a feasible technical way for the information exchange of all majors and whole life cycle based on IFC standard, which has important theoretical value and broad application prospect for promoting the application and development of BIM.

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