Wind Load Electrically Controlled Automatic Assembly through Computer BIM Model

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Abstract. In recent years, many Chinese construction enterprises began to use building information modeling technology (hereinafter referred to as BIM). This is a global trend designed to maximize automation and speed up the design process and document approval. This paper presents the key advantages of the BIM approach and discusses the possibility of using digital building models for wind load simulation (the automation of this process) to expand the "profit margin". At present, it is possible to automate application-based wind impact analysis methods. Possible application scenarios are listed and the advantages of wind load automatic assembly are described. At the same time, a possible method for load analysis in BIM design process is proposed.

Key Words: BIM, digital building models, automatic assembly.

1. Introduction
Information modeling technology (or BIM) is becoming increasingly popular in China. Through the introduction of information modeling technology, the construction industry designs the life cycle management system of capital construction projects, thus promoting the overall development of the construction industry.

2. The relevance and scientific value of the theme
Under the development trend of the era of big data, the integration of prefabricated buildings and building information can rely on information technology to break the upstream and downstream connection of the traditional construction industry, realize the information sharing of the industrial chain and promote the intelligent upgrading of prefabricated buildings. Integrating BIM technology into the whole process of prefabricated building project construction and speeding up the research and development of supporting software can realize data sharing in all links of the industrial chain. With the rise of the prefabricated building market, BIM technology and its integrated application have become more in-depth. The component production of prefabricated building is an important link in the production cycle of prefabricated building, as well as an important link connecting the design and construction of prefabricated building. Once the component production errors, then the design cannot be reflected, the construction can not be carried out. Therefore, all design data and parameters are directly converted into processing parameters in the form of barcode, so as to realize the direct connection between design information and production system, avoid production errors, and improve
the degree of automation and production efficiency of prefabricated components. Production. In the process of production, the production information can also be transmitted to the construction unit in real time to facilitate the scheduling of the construction party.

The typical 5D BIM process is as follows:

Approach 1: control in advance
First, check whether there are conflicts and collisions in the BIM 3D model provided by the user. If problems arise, optimize the BIM3D build model by communicating with the user and proposing solutions. Secondly, BIM is used to calculate the three-dimensional engineering quantities of the optimization model, and the sub-engineering quantities are quickly calculated. Finally, according to the owner's requirements and contract terms, design and contrast the construction plan, the development of the construction schedule. The main result of the pre-control stage is the BIM 5D budget model.

Path 2: In process control
Firstly, according to the daily plan, weekly plan and monthly plan, simulate the construction in advance, guide the actual construction, find out the possible problems in the construction process, and ensure that the actual progress is consistent with the planned progress; Secondly, with WBS as the main line, the BIM 5D actual model is established through rapid cost information statistics. Finally, the BIM 5D actual model is compared with the budget model to determine whether the project schedule and control plan have been implemented. If there is a deviation between the actual and the budget, the construction team will analyze the reason through the earned value method and take corrective actions accordingly. The main outcome of the process control phase is the BIM 5D actual model and rectification.

Path three: Late control
After the completion of the sub-project or the whole project, analyze the cost and loss of the project, summarize and analyze the deviation between the plan and the actual construction process, and improve the cost and schedule control strategy of the enterprise.

3. Statement of the problem
Strength stability calculation is an important work in building structure design. Under modern conditions, a special settlement system (lira-cad, ING+) helps to reduce calculation time and improve calculation accuracy. Currently, the possibility of communication between the calculation program and the BIM design program is being actively studied (for example, to realize the two-way integration of LIRA-SAPR and Autodesk Revit). However, the calculation is not fully automated. The designer must spend a lot of time and energy to compile the initial data of the calculation: collect and systematize the load, and model it (the correct application of the design solution). In particular, it takes a long time to collect wind loads. At the same time, in the BIM design process, a model containing a large amount of data was established for automatic modeling of wind loads (building height, surface shape, spatial direction, wall materials, etc.). In addition, other necessary information (geographic location, terrain type) can be added to the BIM model. Therefore, with only a few modifications, a building model with sufficient information can be obtained to automatically simulate wind loads. The research task of this paper is to use information modeling technology to find a way to simplify and automate wind load collection.

4. Theoretical part
For the proper automation of any process, it is important to first understand its nature and logic. For this reason, it is necessary to consider the currently used wind load setting methods. Currently, there are two main approaches to wind load modeling: a mass, "manual" approach that meets minimum regulatory requirements; Use special software (such as COMSOL Multiphysics, Autodesk CFD) to analyze complex special situations. These methods can be used as the basis for collecting wind loads from BIM models. Consider the first approach. SP 20.13330.2016 "Loads and Effects" document sets out the main regulatory requirements for payload collection in China. In order to comply with the
Chinese standard, the load collection results must consider: major wind loads; Peak wind load; Resonant vortex-induced vibration; Aerodynamically unstable vibrations, such as galloping, diverging, and flutter. You can also highlight what information you need about the building (which should be included in the digital model) to calculate wind loads based on a set of rules: the geographical location of the building; Ground height of various buildings; The size of the building scheme; Terrain type (characterized by wind); The shape of the building. It is worth noting that this manual states the need to consider overspeed, divergence, flutter and other unstable aerodynamic vibrations, but does not consider the rules or standards for these vibrations. Multi-function design method of high-rise building and the effect of the combination of load and file provides the classification of wind effect, illustrates the determine the average wind load and the algorithm of ripple component, shows the formula to determine the peak wind load (which correspond to the same rules given in the calculation) set), as well as the strength of the vortex excitation effect, to calculate the resonance And the conditions under which the effect appears, such as gallop or divergence. Sometimes, when designing more complex and unique objects, more detailed and complex calculations are required.

It can be tested in a physical wind tunnel, or simulated in simulation software such as Autodesk CFD, ANSYS or COMSOL Multiphysics. From the perspective of computational automation, the use of simulation software should be considered in more detail, and it is not recommended to link model testing with BIM models. The COMSOL software package uses finite element methods to solve numerical equations, and COMSOL Multiphysics can be used to calculate wind load analysis based on finite elements. In order to solve this problem, it is necessary to select a volume calculation plane (for example, "a parallelepiped much larger than the research object") and a model describing the physical process (in this case, use the K-ω equation "interface, boundary Condition and volume force"). The program simulates the object and the calculation grid, and then performs the calculation. Therefore, the distribution of speed, pressure and wind turbulence that occurs becomes clear.

In Autodesk CFD, you can create a calculation model based on the imported 3D model. Using this calculation model, the program generates a calculation grid, and the CFD and CFD2 solvers calculate the pressure under wind. The program also contains tools for analyzing and visualizing the results.

In this paper, the ANSYS software package is used to analyze the calculation problems of complex geometric buildings under the action of wind. Most BIM design software can create extensions (or plug-ins). Based on this possibility of the BIM program, it is recommended to create an extension of "collecting wind loads". Most BIM design programs (especially Autodesk Revit) can create extensions (or plug-ins). As one of the most popular programs for creating BIM models, Autodesk's Revit has an application programming interface (API) that allows applications to be written in any .NET language (a language that meets the requirements of the CLI common language infrastructure specification) integrated into the main program space program. Considering the above method, it is recommended to create a plug-in that allows to determine the wind load at any point on the building surface (or more precisely, on its BIM model).

The working structure of this extension can be described as follows:
1. Request estimation of wind direction;
2. Collect necessary data of wind model components (ground height, exterior wall surface area, floor slab and floor slab, guardrail, etc.);
3. Request additional necessary data (geo-location, terrain type);
4. Calculate the wind pressure on the parts under consideration (all or part of the parts) using the formulas in the above rules and method documents;
5. Output of wind pressure values at various points on the surface of buildings (in the form of specific values or contour lines of required points). It is also recommended that "Professor Plug-in" identify special conditions (small building area, complex surface shape, etc.) that require special software (COMSOL Multiphysics, Autodesk CFD, ANSYS) to perform more complex calculations. In this case, a useful feature could be a bundle of one of these programs (for example, the ability to import 3D models into Autodesk CFD).
5. Realistic significance
It is important to note that the ideas considered have great potential for development because not only the assembly process of wind loads can be automated. The modeling of snow effects, payloads (for example, from equipment, people, animals, storage materials and products, vehicles, bridge cranes and bridge cranes), ice loads, and temperature effects merit similar improvements.

![Figure 1. Calculating the building for strength and stability when using BIM](image)

The main way to automate load collection using BIM models is to create separate plug-ins for different types of loads and their subsequent combinations. With the successful implementation of these plans, the time required to calculate the strength and stability of the building will be greatly reduced. Schematically, such a process is shown in Figure 1. It is recommended to create similar extensions for the various programs used in BIM design such as Autodesk Revit.

Through the research on the classification of buildings and structures, it is summarized from the aspects of building function, building scale, sub-project objects, structural forms, materials, joints and production, positioning and installation, etc., and found that there is a certain mutual relationship among them, and the following Expand the analysis.

6. Analysis of the relationship between digital prefabricated construction and itemized attributes

6.1. The relationship between digital prefabricated construction and building functional attributes and building scale
Throughout the architectural nature and functional areas of the cited cases, public buildings or buildings that can be participated by a large number of people are the main ones, such as traffic buildings, performance buildings, exhibition buildings, rest pavilions, etc. It can be seen that today's examples of assembly and construction using digital technology, especially objects with high image recognition, are distributed in categories that have the nature and role of public communication. Of
course, to a certain extent, this is also one of the important reasons for the existence of many rich and complex image buildings: the effect of dissemination of ideas is achieved through images with distinctive characteristics. In the ordinary image under the influence of the modernist concept of functional supremacy, the rich image brought about by the complexity of digital technology can achieve distinct cognitive effects. Investors and designers are also easy to hit it off and use this effect to realize communication and design concepts.

The spreading effect of this image is also related to the scale of the building. For large-scale urban public buildings with many participating users, the communication ability of their image is directly proportional to the visibility of the building. Large-scale public buildings in cities, especially buildings in the core area of the city, have relatively abundant investment budgets and preparation cycles, which objectively support the construction of complex image digital buildings that require more R&D and processing and construction costs. Under the non-standard or complex shape framework of the building, its decoration layer, isolation layer, maintenance layer, structure, and interior decoration layer generally reflect the principle of the unity of the building's internal and external forms, and will have non-standard results with the external form of the building. Therefore, digital design and digital assembly construction usually run through every part of the building inside and outside. On the other hand, for small-scale experimental buildings, due to the relatively small amount of construction work, the overall cost is still controllable under the condition of digital non-standard construction, which can break through a certain architectural functional framework and produce excellent Architectural works. Here, the internal and external structural materials of the building are more uniform, and even the integrated composite materials are used to directly make the building. This also requires the unification of digital design and digital assembly construction with building components. However, other classifications with scales between large public buildings and small experimental buildings often lack the above-mentioned economic capital characteristics, and their practical functional attributes are more clear. The digital non-standard forms that can be realized are often limited to a certain level. Within the scope of construction, such as interior design, decorative wall, roof, curtain wall and other sub-projects. Here, the objects of digital design and assembly construction tend to be specialized and individualized, and design and production tend to be in-depth exploration. There is an inherent logical connection between the assembly and construction objects under the digital technology and the function and scale of the building.

7. Conclusion
The obvious advantage of using the plug-in to be developed is that it saves time for designers by automating the process of modeling and collecting loads, and saves materials due to increased accuracy.

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