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DEEP APPLICATION OF BIM + 3D SCANNING IN STEEL STRUCTURE AND CURTAIN WALL ENGINEERING

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Abstract: There are many factors that affect the deformation and stress of steel structure in the construction process. Therefore, it is necessary to consider the deformation of steel structure affected by many factors before pre-assembly. How to control the machining and installation accuracy of these complex steel components is a difficult problem in the industry. BIM + 3D laser scanning technology is used to collect three-dimensional data of steel body construction, and accurate three-dimensional point cloud model is obtained. The deviation value of steel structure and design concept model can be easily judged by professional three-dimensional analysis software, which can not only effectively control the machining and installation accuracy of steel body structure, but also fully record the engineering site condition, and provide strong support for the reliability of data.
Keywords: Special-shaped steel structure; 3D laser scanning technology; BIM application; Point cloud data; Installation and measurement

1 INTRODUCTION

In recent years, China 's steel structure industry has developed rapidly, especially in the civil high-rise, public buildings, industrial buildings and other fields are mostly steel structure design, high-rise buildings have been more than 500m, such as Shanghai center height of 632m, Dubai Khalifa height of 828m. The maximum span of public buildings has exceeded 100 m, such as the span of Beijing Wukesong Blue Ball Stadium is 120 m, the long axis span of the National Stadium is 332.3 m, and the short axis is 296.4 m. With the development of large-span and super high-rise buildings and the increasing improvement of people 's aesthetic concepts, steel structure, as an advantageous structural system, is widely used. However, due to the large number of multi-directional and multi-angle complex steel members in its complex structural system, how to control their processing and installation accuracy is a big problem in the industry[1].
At present, a better way to solve this problem is to use a three-dimensional laser scanner to measure the three-dimensional steel components to obtain an accurate three-dimensional model. The deviation of the steel components is obtained through software analysis, which plays a more accurate role in the implementation of installation[2].

2 APPLICATION OF 3D SCANNING IN STEEL STRUCTURE ENGINEERING

2.1 Three-dimensional Scanning of Steel Structure

Figure 1 On-site scanning

The large space 3D scanner is used to scan the overall architecture. The inclinometer function of the equipment is used to process the scanning data, which can effectively make the scanning data reach the horizontal state[3]. Through professional comparative analysis software, compared with the design model, the actual deviation is reflected in the form of chromatomap, and the specific deviation degree is determined by measuring the deviation size.

2.2 Steel Structure Model Analysis

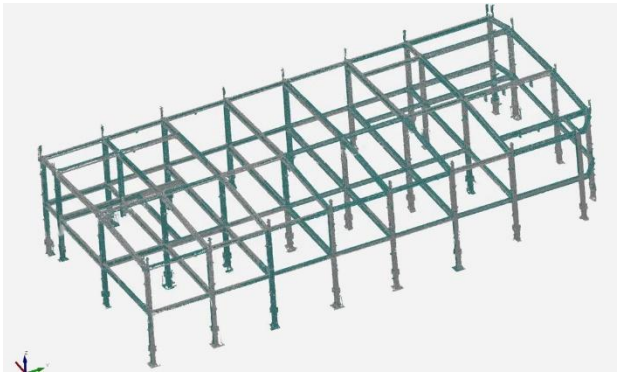

Figure 2 Three-dimensional scanning point cloud data

Due to the point cloud data acquisition process, redundant data and noise data will inevitably be generated. Manually delete the noise points that can be recognized by the naked eye, and delete the noise points that cannot be recognized by the naked eye with professional software. After denoising, the point cloud is merged.

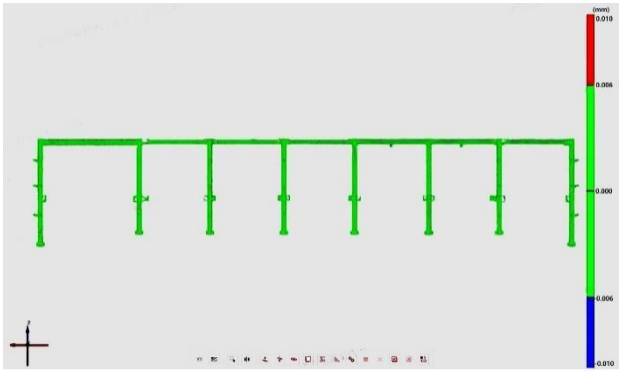

Figure 3 Model analysis

Import the complete point cloud data into the modeling software to establish the overall three-dimensional model of the steel structure. The whole three-dimensional model is imported into the professional software to match the design model, and the deformation and displacement values of the solid model relative to the design model are compared and analyzed to detect the deformation of the steel structure.

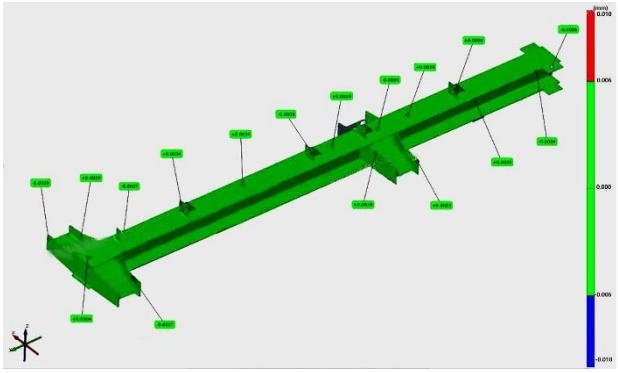

Figure 4 Three-dimensional detection data of steel members

Through the chromatomap, the actual deviation of the steel structure can be intuitively analyzed, and the specific deviation degree can be determined by measuring the deviation size. After scanning all the constructions that need to be assembled, the real model obtained by scanning is assembled in real time in the software, and the conclusion that can be assembled is obtained intuitively.

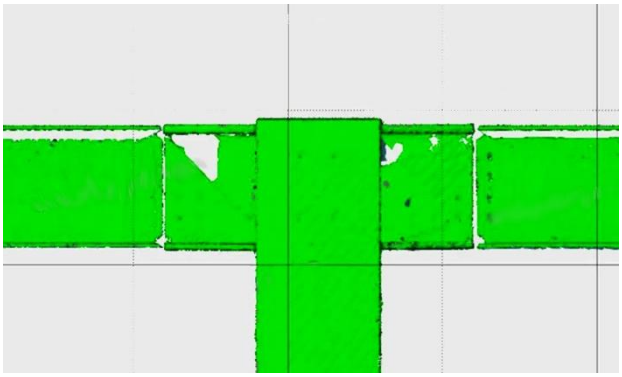

Figure 5 Three-dimensional scanning point cloud data of some steel members

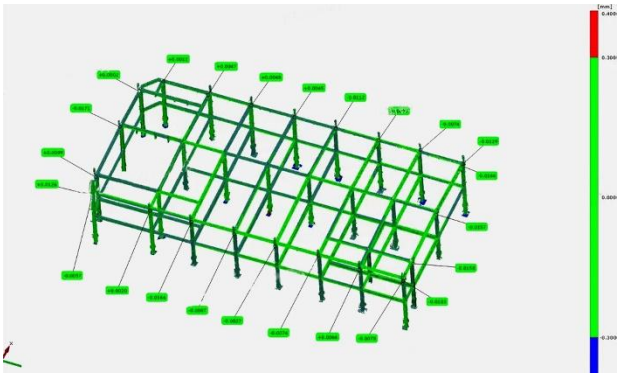

Figure 6 Deviation Analysis of Bottom Pipe

Through the above model deviation analysis, the deviation parts can be clearly captured, and the accurate deviation data can be obtained, which plays a vital role in controlling the quality of the project. Compared with the traditional entity detection and pre-installation process, three-dimensional scanning technology has the advantages of saving construction investment, reducing a large number of construction sites, manpower and machinery investment, and can greatly improve construction efficiency and construction quality, and reduce construction costs. Truly achieve low cost, high efficiency, high efficiency standards[4].

3 APPLICATION OF 3D SCANNING IN CURTAIN WALL CONSTRUCTION

With the demand of large-scale urban construction, some unique ' landmark buildings ' have emerged in various places. The special-shaped buildings with large space and large span are increasing, and the application of building curtain wall with special-shaped space modeling is becoming more and more extensive[5]. How to accurately detect the size of the special-shaped curtain wall is an important part to ensure the construction quality.

3.1 Technical Difficulties of Steel Structure Curtain Wall Construction

1) Such buildings often use complex steel structures as the main base. Due to the large manufacturing and installation errors, large temperature deformation, and many changes in spatial angles of such steel structures.
2) The traditional wire measuring blanking and installation technology can not meet the needs of such projects in terms of operational safety, accuracy, schedule, cost and quality.

3.2 Three-dimensional Scanning of Steel Curtain Wall

Figure 7 Curtain wall three-dimensional scanning site

The engineering structure and architectural modeling of this project are complex. Due to the difficulty of detailing design, construction and installation of the curtain wall, the first step is to carry out on-site investigation in the scanning area, understand the on-site environment, analyze and deploy the whole scanning task, and use the total station and 3D laser scanner to carry out 3D scanning of the installed steel members.

Figure 8 Curtain wall point cloud data

Preprocessing the collected point cloud data is generally to process the original data, check the consistency of the point cloud data and the integrity of the data, smooth the noise data in the point cloud data, fill the missing part of the point cloud, and remove the impurity point cloud data.

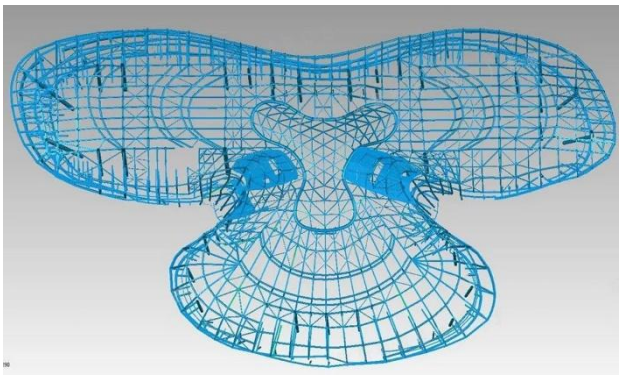

Figure 9 Three-dimensional model of curtain wall

Noise point mainly refers to the external environment such as moving vehicles, pedestrians and trees on the road that mask or block the scanned target. In addition, the uneven reflection characteristics of the surface quality of the measured target itself lead to the situation that the scanned point cloud data we finally obtained contains unstable points or error points. For the more obvious noise points (such as scattered points and outliers) discrimination ,we generally used to determine through naked eye and then directly delete.

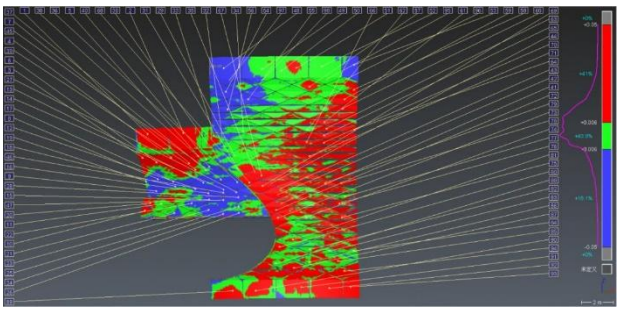

Figure 10 Noise reduction

In order to ensure the quality of these point cloud data, it is necessary to simplify and smooth these point cloud data, so that the application of the whole data is more stable and fast.

Figure 11 Curtain wall point cloud data processing

The three-dimensional laser scanner is used to obtain the point cloud data of the object. After data preprocessing, the three-dimensional modeling of the building is carried out, so as to quickly determine the size of the building curtain wall and carry out batch cutting.

Thus, three-dimensional laser scanning high-density acquisition technology greatly shortens the data acquisition cycle, and the traditional single-point measurement efficiency of tens of thousands of times ; high-precision measurement greatly meet the high-precision installation requirements for the design of buildings is construction and technology provides a strong guarantee.

4 APPLICATION OF 3D LASER SCANNING TECHNOLOGY IN STEEL STRUCTURE DEFORMATION DETECTION

For large steel structure buildings, due to the good ductility of steel, the deformation is more complicated when it is stressed, and single point detection cannot reflect the deformation of the tower well.

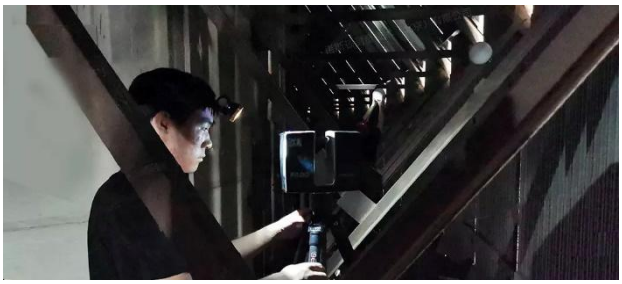

Figure 12 Three-dimensional scanning scene diagram of pressure equalization chamber

In order to obtain complete, comprehensive, continuous and related panoramic point cloud data. Technical team used FRAO three-dimensional scanner to measure the multi-angle and multi-directional structural deformation of the tower pressure cabin, and quickly obtained accurate data on the surface of the steel structure.

Figure 13 Three-dimensional scanning station distribution map of ballast steel structure

Because of redundant data and noise data will inevitably be generated in the process of point cloud data acquisition. The noise points that can be identified by the naked eye are manually deleted, and the noise points that cannot be directly identified are automatically identified will be deleted by software. After denoising, point cloud splicing processing is performed. The complete point cloud data is imported into the modeling software to build a three-dimensional model of the whole steel structure.

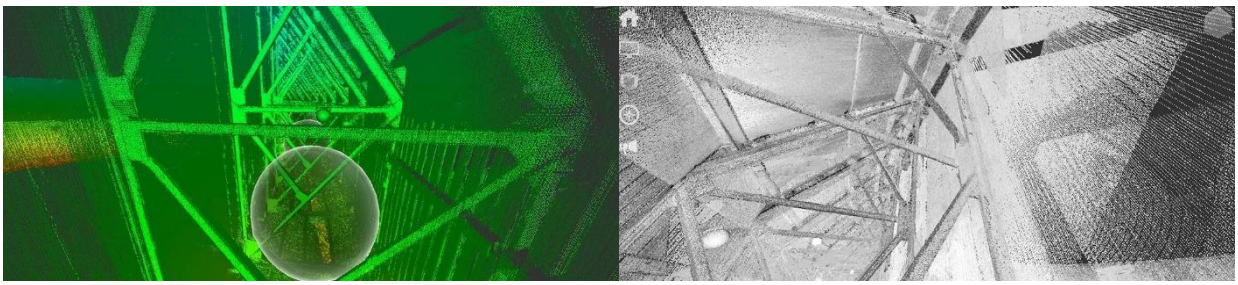

Figure 14 Point cloud diagram of steel structure of pressure equalizing cabin

The overall three-dimensional model is imported into professional software to match the design model, and the deformation and displacement values of the solid model relative to the design model are compared and analyzed to detect the deformation of the steel structure.

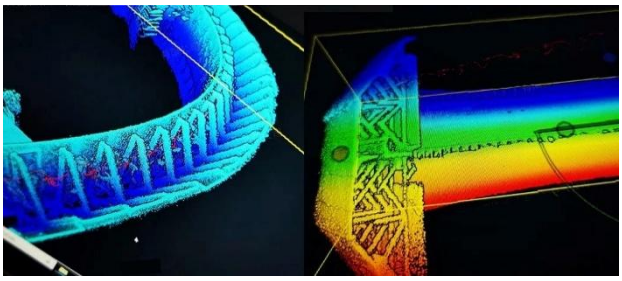

Figure 15 Value brought in

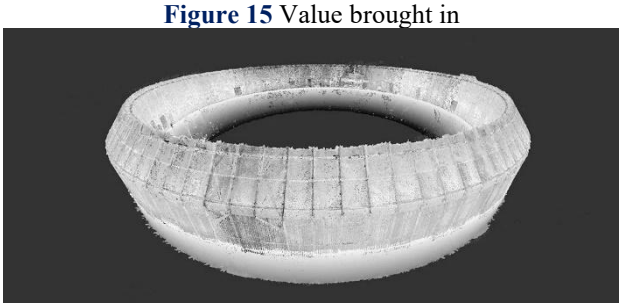

Figure 16 Integral point cloud map of equalizing cabin steel structure

Therefore, it can be seen that the three-dimensional laser scanning technology has the advantages of fast, accurate and comprehensive acquisition, processing and analysis of data in the deformation detection technology of special-shaped steel structure, and can be fully applied to the deformation detection application requirements of special-shaped steel structure[6]. At the same time, three-dimensional scanning technology is also gradually changing the traditional measurement methods. More and more fields that cannot be completed or difficult to complete by conventional measurement are being overcome by three-dimensional laser scanning technology.

5 GENERALIZE

Modern public building design should not only meet the functional requirements, but also pursue the beauty of the building, the suitability of the function, and the comfort of the environment. It is necessary to conduct in-depth research on various decorative elements to meet the requirements of modeling, function, use, and perception. Therefore, the combination of super-large steel structure framework and decorative curtain wall structure has become the main method to realize complex modeling. Among them, in the processing, hoisting and installation process of the steel structure framework will produce large deviation that caused great difficulty to decorative shaped curtain wall installation . The rapid and comprehensive characteristics of BIM + 3D laser scanning technology can quickly obtain the three-dimensional data of each stage of construction, which not only avoids the limitations of manual measurement, but also accelerates the production and installation of subsequent components, and provides a new measurement method for the detection of special-shaped steel structures.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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