



Digital processing technology of steel mesh of special building

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Abstract. This paper takes the construction of Haihuadao Theme Park in Hainan as the background. It forms a complete and mature set of construction technology of rockery plastic stone-shaped steel mesh by summarizing the technical process in the construction process. In the face of large-scale plastic stone rockery volume, complex shape, and other issues, the ability to plastic stone rockery through the modeling of accurate identification, zoning deconstruction, divided into different regions of the shaped mesh components, and then tens of thousands of other forms of three-dimensional mesh components bending and processing, positioning and assembling, solving the existing molding equipment for large-size, large diameter, arbitrary shape of the components of the products of the positioning of inaccurate, low quality of molding and other technical difficulties. The technology has solved technical problems such as imprecise positioning and low molding quality of existing molding equipment for large-size, large wire diameter, and arbitrary shape products. The practice shows that this technology has a remarkable effect on speeding up the construction progress, ensuring production quality, and shortening the construction cycle, and can produce great social and economic benefits.

Keywords: special mesh processing; artificial rock rockery; automation control; technological process; digitization

1 Introduction

Large theme parks highlight the unique theme of thought and artistic design; its internal architectural shape is often used in complex structures, the construction process is more complex, the overall construction difficulty is also higher, and plastic rockery is one of the typical representatives[1]. Plastic stone rockery is a typical representative. Currently more popular domestic rockery process is reinforced concrete rockery, its outline shape and artistic effect is usually achieved through the site directly welded modeling, its shortcomings are too dependent on the craftsmen's personal skills and experience,

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Q. Gao et al. (eds.), *Proceedings of the 2024 7th International Conference on Structural Engineering and Industrial Architecture (ICSEIA 2024)*, Atlantis Highlights in Engineering 30,

https://doi.org/10.2991/978-94-6463-429-7_26

the quality of the project and the effect is easy to get out of control, or can not reach the expected artistic effect and rework, and at the same time, due to the heterogeneous structure can not be formed to form a safe and reliable platform for the construction of the existence of personnel investment, safety At the same time, because the shaped structure can not create a safe and reliable construction platform, there are many personnel investment, safety risks and other shortcomings, resulting in a lot of security risks[2].At the same time, because the shaped structure can not form a safe and reliable construction platform, there are shortcomings such as more personnel investment and high safety risk, resulting in many safety hazards.

Wang[3] in the application of reinforced welded mesh process in the construction of a super high-rise building, the use of processed finished reinforced welded mesh instead of manual tying of reinforcing bars in bulk not only realizes the factory and standardized production of supporting bar processing, but also eliminates the processing site at the site, saves time and labor for lifting and installation, and the tying speeds up the construction progress and improves the quality of reinforcing bars in the field. Gao et al. [4]Through the use of BIM software, the wigwam shape is transformed into a three-dimensional digital model. An automatic rebar bending machine is used to complete the tensile correction, bending, cutting, and other rebar work, casting each rebar's shape on the ground according to 1:1. Then, the shape of the rebar is placed in the projection position for comparison to determine the placement of each shape of the rebar. The deviation is significant to solving the problem of the mechanical bending of the rebar molding; the positioning of the steel skeleton needs to be more accurate, mesh modeling can not be restored, and there are other technical difficulties. Jia [5]A steel mesh automatic bending and forming system is used to solve the problem of automatic forming and processing of beam skeleton, which is a typical component of prefabricated assembled building reinforcing steel skeleton, and adopts multi-machine linkage automated control of assembly line processing method to realize bending and forming and combination assembly of reinforcing steel mesh and semi-finished prefabricated assembled building reinforcing steel skeleton based on reinforcing steel mesh. Shi[6] Through three-dimensional laser scanning, collect three-dimensional information data of the entity model, process the three-dimensional point cloud data, import the relevant professional modeling software, reverse reconstruction of the three-dimensional characteristics of the entity of the information collection object according to the processed point cloud data, and carry out a series of application extensions based on this model to clearly and reflect entirely the styling situation of the wigwam.For steel together, J. Cortsen[7]manufactured a hyperboloid steel structure, and considering the position of the deviation between the steel bar, put forward with a robot control method based on a sensor, steel bending and delivered by a robot to the structure, and by another robot assembly, verified, bending steel shape stable and accurately splicing together.

Hainan South Flower Island World Fairytale Paradise, for the first time, applied the digital processing technology of shaped construction steel mesh, taking the three-dimensional electronic model as the basis, digitally cutting and splitting all the mesh reinforcement to get the precise bar contour size, and using the automatic bending equipment for the bar bending processing, and finally get the 100% restored degree of

the outer contour of the steel bar mesh. The digital and automated processing of profiled construction steel mesh solves the problem of poor molding accuracy, and a few details of steel mesh significantly improve the construction efficiency and quality of construction, reduce the length of overhead work, and ensure the safety of construction personnel.

2 Technical requirements

The large rockery is a three-dimensional shaped steel mesh processing technology that is the core component of the plastic rockery construction technology, which determines the level of artistic expression of the outer contour of the mountain and the simulation accuracy. The digital processing technology of its steel mesh integrates multidisciplinary and multidisciplinary technical content, which can present the artistic effect of the large-scale plastic rockery and the artistic conception of the design team perfectly.

2.1 Technical principles

2.1.1 3D Modeling Processing and Module Deconstruction for Shaped Structures.

The use of self-designed three-dimensional model processing strokes and professional deconstruction procedures, the plastic stone rockery into a digital three-dimensional model through the special three-dimensional software for model processing after a large variety of natural stone surface effects of the collection, screening, and categorization of the basis of the development of particular strokes suited explicitly to the theme park plastic stone rockery surface texture, the mechanism effect of the specific strokes, the digital model of the visualization of the Repeatedly carve the digitized model to form the final artistic effect (figure 1).

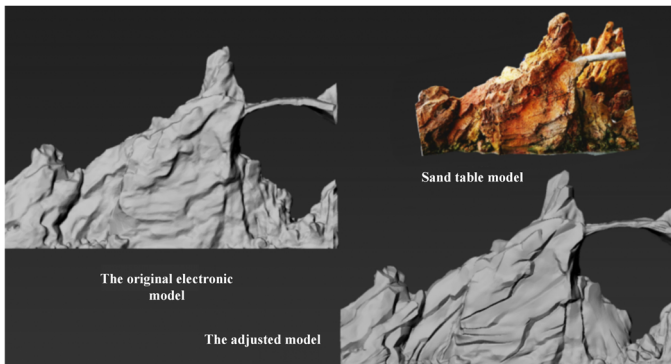


Fig. 1. Process of optimization of electronic model modification

In the factory prefabrication module, the self-developed software system that can realize automatic cutting, rebar generation, and drawing output is utilized to carry out efficient automated drawing according to the parameters set in advance, saving much time for deepening. At the same time, the software realizes the deconstruction analysis

of the model and the automatic formation of machine-recognizable drawing information, which significantly improves the accuracy and efficiency of the design stage. Each module can be prefabricated in advance in the production base and then transported to the site for installation, and the wigwam can be shaped (figure 2).

The specific process is as follows: (1) model decomposition, using self-developed and designed professional deconstruction software to decompose the three-dimensional model of the wigwam into several modules, and at the same time can calculate the number and location of the required supporting steel structure; (2) modeling rebar computing, through professional software to calculate the number and shape of modeling rebar required by each module, and produce separate data for each rebar, for the machine digitized processing to do (3) Automatic production of drawings, according to the design requirements of the project to set the data parameters such as rebar spacing, type, size of assembly fixture, etc., to determine the degree of optimization of rebar, the use of self-developed mesh design software for the automatic generation of drawings.

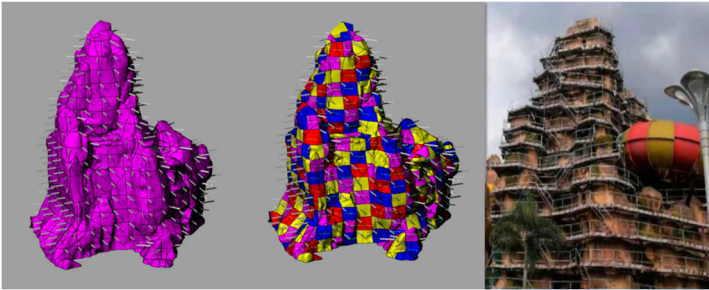


Fig. 2. Model deconstruction analysis and the final entity effect

2.1.2 Automated bending equipment.

For the processing of shaped reinforcing steel mesh for large-scale plastic rock wigwams, each reinforcing steel bar is of different shapes, and the processing efficiency using the existing equipment is so low that it is impossible to realize the assembly line operation. Wang et al. [8]Plastic rock rockery for structural design and mesh design, independent preparation of automatic steel bending machine operating procedures to complete the bidirectional bending of reinforcing bars, to achieve digital automated processing of steel mesh production, to solve the mechanical bending of steel processing deviation, inaccurate positioning of steel assembly mesh modeling reproduction and other problems. The key to automated bending equipment lies in the software and automatic control system to realize the bending equipment to automatically read the rebar drawing files without manually entering the processing code, significantly improving the processing efficiency; at the same time, connected with the offline two-dimensional code printer, automatically print the two-dimensional code corresponding to each rebar, to improve the efficiency and accuracy of the process of processing of profiled reinforcing steel mesh (figure3).



Fig. 3. Automated bending equipment

2.1.3 Cloud platform digital information management system.

In the process of steel mesh processing, the digital information management system under the construction of the Internet of Things platform (figure 4), which mainly has the information collection module, decentralized control module, database access module, data scheduling module, etc., can realize the database integration and access to the digital information management platform for steel mesh processing. This cloud platform's digital information management process adopts computer information processing and software control methods to carry out the process control of steel mesh processing and improve the efficiency and precision of shaped steel mesh processing.



Fig. 4. The MCC mesh management system

2.2 Technical advantages

2.2.1 Digital processing and deconstruction analysis of shaped building models.

Based on the intuitive and easy-to-modify characteristics of 3D architectural models, the visualization of digital models through repeated sculpture to achieve the effect of what you see is what you get. Digital processing and deconstruction analysis of the electronic model to complete a separate modeling mesh unit by the specified order of assembly can be presented as a whole of the expected artistic effect, three-dimensional deconstruction modeling plastic stone rockery technology in the saving of materials, saving labor, environmental protection, etc. are better than the traditional rockery construction process (figure 5).

The software has the following features:

(1) Various parameters can be freely adjusted, including fixture size, rebar spacing, rebar diameter, critical rebar setting, and rebar optimization principle.

(2) Non-essential reinforcement can be optimized to varying degrees depending on the parameter settings.

(3) It can quickly and accurately output mesh assembly drawings, including essential reinforcement reference size labeling.

(4) It is possible to automatically name all rebars regularly and quickly output rebar processing data. In contrast, rebars are output with head, tail, and rotation directions according to fixed rules.

(5) Automatically generate all the mesh and rebar processing data and information, such as mesh area, mesh weight, rebar length, etc.; simultaneously, the same diameter rebar will be packaged and sent to the same bending equipment.

(6) A full preview of all the rebar in the mountain can be made, and the front and back of the mesh can be marked automatically.

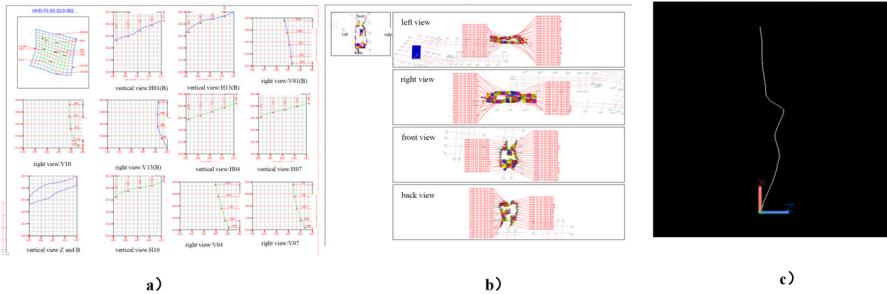


Fig. 5. Mesh assembly, arrangement and processing of components

2.2.2 Automated molding equipment for shaped architectural meshes.

Existing wire-forming equipment is for specific products, through manual input or pre-programmed ways to control the machinery to produce the corresponding products; this control method can only be realized for a small number of arbitrary products for automatic processing and production[9]. This way of control can only discover the automatic processing and output of some arbitrary products. The automated molding equipment for shaped architectural mesh further solves the problems of processing many random products while further solving the issues of controlling their processing accuracy and automatic identification numbering. The equipment consists of the control system, molding system, and other auxiliary systems and other systems, and has many unique features in its structure, as follows:

(1) Unique algorithm design allows arbitrary component curves to be fitted with higher accuracy, achieving a balance between processing efficiency and processing accuracy with minimal distortion;

(2) Through the equipment control system, automatic identification and reading of component drawings are realized, significantly reducing the probability of errors generated by human input of machining instructions;

(3) For a large number of products, the equipment automatically connects to the printer to provide two-dimensional code identification for each component, providing a guarantee for later assembly production;

(4) The design of the auxiliary pressure bar significantly reduces the large size and large wire diameter products in processing variance and improves the bending accuracy. The control system provides a time-segmented processing rate, considerably improving processing accuracy and ensuring production safety.

2.2.3 Digital processing management of shaped construction steel mesh.

Adopt the Internet of Things management thinking, establish the information integration and management standards [10], improve production efficiency, transportation, construction, and other aspects, and realize lean construction [11].According to the demand of actual production, facing the vast number of modeling components and the requirement of accurate positioning of modeling components, a digital management system and multi-assisted production supervision system is a favorable guarantee to complete the above production tasks. The mesh management system is a self-developed and designed data system specializing in the production and processing management of wigwam mesh, including two parts: the mobile end and the computer end (figure 6). The system records all the information on workforce, equipment, raw materials, steel parts, mesh parts, shelves, etc., in the form of QR code, integrates the information of logistics and data in the database to form the completed management system, and carries out the exemplary management of the whole processing process of the mesh through the code-sweeping equipment; at the same time, all the data are stored in the cloud server, which can be viewed remotely, and it is convenient to monitor the progress of the processing of the mesh remotely.



Fig. 6. Digital processing flow of shaped construction steel mesh

2.3 Key technologies

Rebar bending machines have been widely used in various fields of the construction industry; the current rebar bending machine is mainly used for repeated processing of a single shape of rebar; you need to manually calculate the relevant data in advance and compile it into the processing code, enter the machine to realize the production of large quantities. For the processing of shaped rebar, each is a different shape and has no repeated parts, so the use of existing equipment for processing efficiency is shallow and can not realize the assembly line operation. The bending equipment is controlled through the software and automated control system, which automatically reads the bar drawing files without manual input processing code, significantly improving processing efficiency.

To get the rebar drawings for machine processing, it is necessary to automate the slicing and rebar generation of the mountain model in advance, and the traditional practice is to use three-dimensional design software, such as Rhino, to manually slice and project the rebar curves, and then output them into the format of drawings that can be read by computers, and at the same time, it is also necessary to manually draw the assembling drawings of each mesh. For every 10,000 square meters of the mountain, about 2,500 mesh assembly drawings and 100,000 rebar processing drawings are needed, and it is a significant workload to complete the cutting work manually, even with the assistance of design software. The key to solving this problem is to develop a software system that can realize automatic cutting, rebar generation, and drawing output, which can efficiently automate the drawing according to the parameters set in advance and save a lot of deepening time.

In the actual production process of the factory, hundreds of thousands of mesh and rebar components of different shapes, welding process component position, head and tail, and direction need to be precisely by the drawings for the combination of traditional records to track the processing of such a large number of components, it is difficult to avoid errors and omissions and is not easy to count. Each element is given an independent two-dimensional code based on modern logistics management methods. Using code-scanning equipment to control the entire process digitally improves the management of quality and efficacy.

3 Reinforcing steel mesh processing and production process

Large rockery three-dimensional shaped steel mesh processing technology using information technology modeling calculations can realize the controllable, accurate, and convenient intelligent manufacturing of plastic rockery; the processing process is generally the original model checking and deepening - mesh cutting number - drawing generation - intelligent CNC molding equipment processing mesh -Modeling mesh space positioning assembly - engineering applications to complete a total of six panels (figure 7).

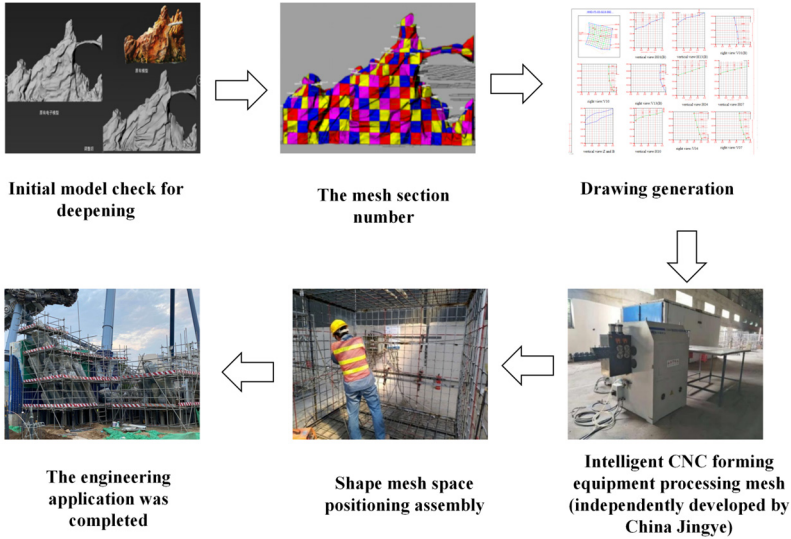


Fig. 7. Processing flow of shaped construction reinforcing steel mesh

4 Engineering applications

Hainan South Flower Island World Fairytale Paradise Project F area water park project snow mountain volume, complex shape, the overall shape from the digital software design to the factory processing and production, and then to the site mechanized installation, the construction team to fully master the digital design and construction of the core technology of the wigwam, the actual realization of the “What You See Is What You Get” full-process intelligent design and construction, modeling mesh fabrication area of more than 50,000 square meters.

4.1 Efficient electronic deepening software

Electronic deepening software is a software system that can realize automatic cutting, rebar generation, and drawing output, which can learn efficient automated drawing, save a lot of deepening time, simplify complicated drawing work, and significantly improve the efficiency of design, production, installation, and management.

4.1.1 Original model scanning phase.

Electronic model deepening can quickly check the accuracy and completeness of the model and make hill repair adjustments without the need to recreate the hill model. At the same time, the software can calculate the amount and shape of modeling reinforcement required for each module and produce separate data sheets for subsequent processing.

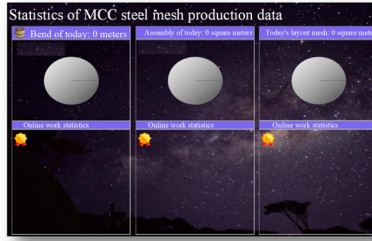


Fig. 8. Global monitoring interface for mesh production

4.1.2 Mesh Slicing and Drawing Generation Phase.

MCC mesh design software specialized in deepening drawings for plastic stone wigwam mesh can realize automatic cutting, rebar generation, and drawing output software system, according to the parameters set up in advance for efficient automated drawings, the output speed is not less than 5 / min, saving a lot of time to deepen. The accuracy of drawing output is as high as 99.9%.

(1) Taking a mountain of 10,000 square meters as an example, it will be cut into 3,000 mesh sheets to form several hundred mesh layout drawings, 3,000 mesh assembly drawings, and more than 100,000 reinforcement drawings.

(2) With the traditional method, it takes 2,500 hours, while with the MCC mesh deepening system, it takes only 25 hours.

4.2 Digital mesh production process

4.2.1 MCC mesh processing management system.

The mesh processing management system is associated with the mesh design software, which automatically obtains all the processing information, including the processing steel bar code, processing machine code, processing time, etc. At the same time, the software automatically records the detailed data of the processing process, which prevents the machine from mishandling, and the production information is traceable, which vastly improves the efficiency of the production management and can realize the exemplary management of the whole processing process (figure 8).

4.2.2 CNC mesh molding machine.

The equipment is self-developed mesh forming equipment, which can realize the bending equipment to automatically read the rebar drawing file without manually inputting the processing code through the software and automated control system, avoiding the human error that may occur in the data import in the traditional processing; at the same time, it connects with the offline two-dimensional code printer to automatically print the two-dimensional code corresponding to each rebar, improving the efficiency and precision of the processing of profiled reinforcing steel mesh.

Mesh forming machine technical advantages:

- (1) To achieve HPB300 and the following materials, 10mm and the following diameter of steel bending processing.
- (2) A bending angle can be reached at any angle.
- (3) The angle error is not more than 0.5° .
- (4) Length error is not more than 1%.
- (5) Processing speed is not less than 1 / min.
- (6) The processing size limit is not less than 2.5m.

5 Conclusion

Shaped steel mesh processing technology is the core component in the construction technology of plastic stone rockery in the theme park, which determines the level of artistic expression of the outer contour of the mountain. This key technology integrates multi-disciplinary and multi-professional technical contents such as mechanical equipment, automation control, software development, three-dimensional modeling and calculation, factory management, etc. It provides a detailed construction process and critical points analysis for architectural shapes such as plastic stone rockery, significantly reducing the construction risk and improving the construction efficiency in plastic stone rockery projects. The successful development of this technology has enriched the digitalization degree of the domestic industry using digital automated processing and production of shaped construction steel mesh, realizing the digital output of steel, rapid correction, accurate welding, and assembly, which has an excellent value of popularization and application. With the successive landing of domestic medium and high-end theme park construction projects, the emergence of the technology to enhance the overall construction level of the wigwam construction process plays a key role; the current domestic medium and high-end theme park projects are also increasingly aware of the importance of the digital processing mesh technology, the technology will face a fast-growing market, the future can be expected to be very significant economic benefits.

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