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Study on Stress and Deformation Control Method of Road and Bridge Construction Based on IOT Technology

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Abstract: Due to the traditional control method, the stress-deformation controller adopts the single-channel mechanism to operate during the stress and deformation control of road and bridge construction, so the control deformation is high and the stress and deformation control of road and bridge construction cannot be realized. In order to solve this problem, a method of controlling the stress and deformation of road and bridge construction based on IOT technology is proposed. The pre-stress of road and bridge construction is calculated by empirical formula and written into the instruction set of RISC-A;

By considering the stress-deformation relationship of road and bridge construction as a curve relationship, the deformation amount of the road and bridge is calculated and substituted into the IOT stress-deformation microcontroller; Programmability of IOT technology defines a MAC enhancement mechanism that providing global collaborative control function for design methods; The bearing capacity of the bridge under the strain value is calculated, and the control instruction is given according to the corresponding bearing capacity, so as to improve the accuracy of the stress and deformation control of the road and bridge construction. Analysis of design examples shows that the design control method can control the deformation to a minimum of 0.158mm, while the control group controls the deformation to a minimum of 0.654mm. The design control method can achieve road and bridge construction stress and deformation control.

Keywords: IOT technology; Road and bridge; Construction stress deformation; Control method; Study

1. Introduction

According to the stress tension quality control requirements of 2K320103 mastering urban road and bridge engineering, it is necessary to carry out matching verification through jacks and pressure gauges to determine the relationship between the tension and the pressure gauge, so as to control effectively. The main control principle of the traditional road and bridge construction stress and deformation control method is to make timely and effective control decisions through the specific conditions of the road and bridge construction site [1]. Further optimization of stress and deformation control method is an inevitable choice for the development of the construction industry, which is committed to minimizing construction risks. IOT is essentially an Internet of things technology, which refers to the Internet of objects that are simple to use and don't require much complexity. To put it simply, the IOT technology itself is to replace the communication module, cancel the original concentrator in the data transmission process of the monitoring terminal, and instead directly transmit the data of the monitoring terminal through the operator's base station. In this process, the communication interface needs to be adjusted accordingly. IOT technology sets the instruction code as a 12-bit control function code in the GMTS network architecture to ensure that the minimum number of instructions is adopted. It has the advantages of low power consumption, large capacity and low deployment cost, and can be realized directly on the GMTS or LTEG network architecture. It has become the most popular Internet of things technology with its powerful advantages [2]. IOT technology can also realize multi-network deployment, providing strong technical support for the design of stress and deformation control methods of road and bridge construction. Therefore, this paper proposes the design for stress and deformation control method of road and bridge construction based on IOT technology.

2. The Stress and Deformation Control Method of Road and Bridge Construction based on IOT Technology

2.1. Calculate the pre-stress of road and bridge construction

Considering the vertical displacement and panel deflection generated during road and bridge construction, the virtual storage MMU in IOT technology is used to connect all construction stresses to the network, and on this basis, empirical formulas are used to predict road and bridge construction stress and deformation. It is assumed that the material porosity of road and bridge construction materials is about 20%; the valley coefficient is set to 2.86, which is analogous to the stress and deformation of ordinary road and bridge construction, and an empirical formula for predicting the stress and deformation of road and bridge construction is obtained, as shown in formula (1).

$$S_2 = S_1\left(\frac{H_2}{H_1}\right)^2 E_1 \tag{1}$$

In formula (1), S_2 refers to the pre-stress of road and bridge construction ; S_1 refers to the equivalent residual stress of road and bridge construction ; H_2 refers for the longitudinal residual stress of road and bridge construction; H_1 refers to the transverse residual stress of road and bridge construction; E_1 refers to the stress deformation modulus of road and bridge construction. The calculated construction pre-stress of road and bridge is written into the instruction set of RISC-A. Considering that the IOT technology is a network based on authorized spectrum, the stress-strain relationship of road and bridge construction can be determined according to RFID in the IOT125 kHz band and 13.56 MHz band in the RISC- A instruction set. [3].

2.2. Determine the stress and deformation relationship of road and bridge construction

The specific contents of the basic assumptions in this paper include: the stress and deformation of road and bridges during construction must maintain a flat shape; the error values caused by the stress and deformation of road and bridge due to different tensile strengths of concrete are excluded. When the stress and deformation of road and bridge construction occurs, the bending stress of the reinforced beam and the bending strain of the reinforced beam have an ideal elastic-plastic relationship. Once the bearing capacity fails, the stress remains unchanged and there is a flexural stress and deformation relationship of reinforced beams. The relationship of stress and deformation in road and bridge construction can be regarded as a curvilinear relationship, as shown in figure 1.

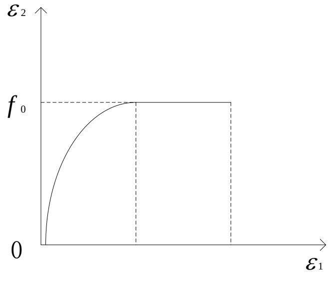

Figure 1. Stress and deformation curve of road and bridge construction

In figure 1, ε_1 refers to resultant force of the straight part of a reinforced beam subjected to bending stress; ε_2 stands for the resultant of the bending strain on the straight part of the reinforced beam; f_0 refers to the resultant force of the bending part of the quadratic parabolic reinforced beam in the stress-strain curve. When the road and bridge are under bidirectional stress, the flexural capacity of the road and bridge will decrease with the increase of the bending stress of other bending stress on the bridge until the bending capacity of the reinforced beam fails [3]. Based on the strain linear relationship of bending stress of reinforced beams, according to the curve of calculation results, the calculation formula of stress and deformation of road and bridge construction can be summarized. The deformation of road and bridge in two-dimensional state of stress can be calculated to prepare for the design of TOT stress-deformation microcontroller in the next stage. Assuming the deformation of road and bridge is σ , and then its calculation formula is shown in formula (2).

$$\sigma = \left[-1.6\frac{\beta}{f_0} - 0.9\right] f_0 \tag{2}$$

In formula (2), β refers to the maximum tensile stress that the bridge can bear. On the basis of determining the stress and deformation relationship of road and bridge construction, choose appropriate construction procedures to control the stress and deformation of road and bridge construction centrally. In this paper, by designing the IOT stress and deformation microcontroller, according to the characteristic value of the construction stress and deformation amount and the corresponding characteristic component of IOT stress and deformation microcontroller, according to the 12-bit control function code and operation code, the instruction set is conducted selection for the construction program [4]. As the control part of the design method, the IOT stress and deformation microcontroller uses 751410 as a microprocessor to realize the calculation of various control algorithms automatically [5]. One end of the IOT stress and deformation microcontroller is connected to the internet of things system trunk, and the pulse control of the road and bridge construction stress and deformation is realized through a closed-loop parallel control. The IOT stress-deformation microcontroller adopts an incremental type, and uses the programmability of IOT technology to define a MAC enhancement mechanism and provide a global collaborative control function for the design method, avoiding the amount of deformation that is likely to occur during the control process, thereby improving the precision of stress and deformation control of road and bridge construction.

2.3. Realize the stress and deformation control of road and bridge construction

In Figure 1, according to the stress and deformation value corresponding to the end point of the quadratic parabola, the height of the quadratic parabola is calculated as the bearing capacity of the bridge under the strain value. Setting the bearing capacity of bridge under strain as y , then its calculation formula is shown in formula (3).

$$y=\frac{\varepsilon_1}{\varepsilon_2}xr_1=\frac{20}{33}xr_1 \qquad (3)$$

In formula (3), x refers to the area of bridge under bending section ; r_1 refers to the concrete strength grade of the bridge. The load capacity of the bridge at the strain value is substituted into the IOT stress and deformation microcontroller, give control instructions according to the corresponding bearing capacity, first, query BTB based on IOT technology application principle to see if it hits, and then query BHT if it hits; Check to see if a branch has occurred in the corresponding branch history table, and if so, return the signal that the branch occurred and the branch target address. The stress bearing capacity of road and bridge construction is directly related to the amount of deformation. In actual engineering, it is usually controlled at a response rate of 2.5%. Considering that the IOT stress and deformation microcontroller will constantly updating the decoding layer according to the input control commands and performance indicators [6]. In the process of actual control work, the response rate can be automatically adjusted to ensure the real-time performance without affecting the effect of the stress and deformation control of road and bridge construction [7]. In order to prevent the stress and deformation of road and bridge construction from causing excessive deformation and stress on the surrounding seam and the nearby panel, the panel near the surrounding seam must be uniform and dense, so as to achieve the stress and deformation control of road and bridge construction.

3. Instance Analysis

3.1. Experiment preparation

According to the design of the above control method, an example analysis is carried out. The content of this experiment is to test the control deformation under two control methods. The amount of control deformation is a key indicator to measure the effect of stress and deformation control of road and bridge construction. Under the same process parameters, the value of the amount of control deformation can be divided into regions to determine the accuracy of the control method.

The control deformation is less than 0.2mm, which proves that this control method can achieve accurate control; the control deformation is between 0.2mm and 0.4mm, which proves that the control method can be operated, but the control accuracy is general; the control deformation is between 0.4mm and 0.6mm, which proves that the control effect of this control method is poor; The control deformation is between 0.6mm and 0.8mm, which proves that the control effect of this control method is extremely poor. The traditional control method and the control method designed in this paper are used for the experiment respectively, and the traditional control method is set as the experimental control group.

3.2. Analyses of experimental results and conclusions

According to the above designed experimental steps, experimental data are collected, and the control deformation amount under the two control methods is made into a curve for comparison. The comparison results of the control deformation amount are shown as in figure 2.

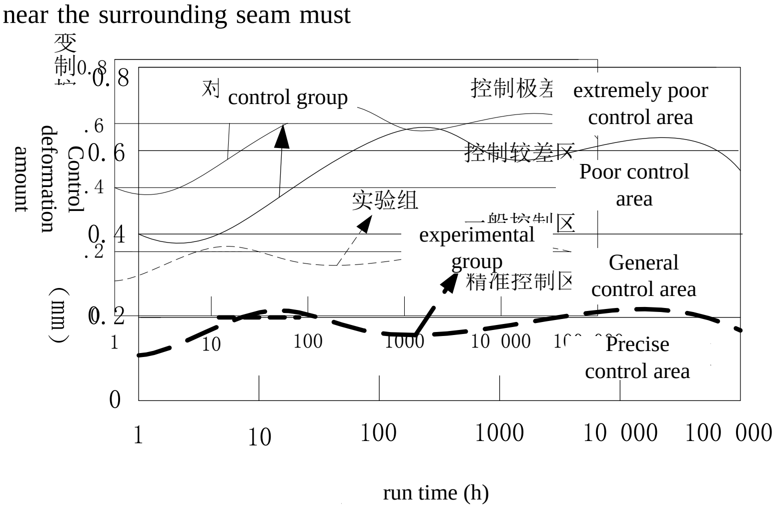

Figure 2. Comparison diagram of control deformation amount under two control methods

The following conclusions can be drawn from figure 2: the control method designed in this paper can control deformation amount to a minimum of 0.158mm, while

the control deformation of control group reaches to a minimum of 0.654mm, the design control method can realize the stress and deformation control of road and bridge construction with lower deformation. Therefore, the amount of control deformation obtained under the design control method in this paper can meet the overall design requirements and can be widely used in the stress and deformation control of road and bridge construction.

4. Conclusions

Through the study of the stress and deformation control method of road and bridge construction based on IOT technology, the authenticity and reliability of the design control method are proved. The IOT technology can not only optimize the data collection process of traditional control methods, but also write the RISC-A instruction set and adjust according to the collected stress and deformation data. Through the design of IOT stress and deformation microcontroller, achieve the control objectives that cannot be achieved by traditional control methods. Therefore, it is of practical significance to design a new stress and deformation control method of road and bridge construction based on IOT technology, which can meet the overall requirements for stress and deformation control methods of road and bridge construction and provide academic significance for the stress and deformation control method. To sum up, the research investment of IOT technology in control methods can be increased to lay a good foundation for the realization of stress and deformation control of road and bridge construction. The only shortcoming of this paper is that it does not check the accuracy of the output and execution of the stress and deformation control of road and bridge construction, which can be used as one of the future research directions.

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