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Structure Design and Construction Requirements Analysis of the Post-Pouring Strip Based on Data Mining Technology

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A post-pouring strip is a temporary construction joint in the corresponding position of foundation floor, wall and beam in order to prevent harmful cracks caused by uneven shrinkage or uneven settlement of cast-in-place reinforced concrete structure in construction. A post-pouring strip can solve the problem of settlement cracks, concrete shrinkage deformation and temperature stress caused by cracks in the construction project. It plays An important role in simplifying the structural design of a construction project, shortening the construction period, advancing the construction progress and saving investment. This paper proposes the use of data mining technology to process and analyze the data on post-pouring strip structure design and the construction process and discusses the role of the post-pouring strip in a concrete floor, including the spacing, width and closing time of post-pouring strips.

Keywords: Public art; Interactive experience; Information interaction model

1. INTRODUCTION

People's living conditions are improving and there are ever-increasing requirements to improve the quality and comfort of buildings. The construction industry has also made remarkable achievements. In the field of construction, the problem of structural cracks has become increasingly serious and has had a serious negative impact on the overall quality of construction projects. A post-pouring strip is a way to solve the problem of cracking and has the advantages of being simple to apply, it has a good control effect and a fast construction speed hence it is widely used in building construction. This paper proposes the use of data mining technology to improve the post-pouring strip structure design and construction [1].

A post-pouring strip is a temporary deformation joint retained during construction for a certain period of time according to specific requirements and is then filled and closed to connect the structure as a whole. The purpose of leaving the post-pouring strip open is to reduce restraint-induced cracking and stresses in concrete structures. To properly set up the post-pouring strip of a construction project, it is necessary to understand the design points and construction technology points and to take into consideration the specific conditions of the construction to better solve the problem of structural cracking.

2. CLASSIFICATION AND FUNCTION OF POST-POURING STRIP

There are two types of post-pouring strips, the settlement post-pouring strip and the telescopic post-pouring strip. The settlement post-pouring strip is set between the podium and the main building and its purpose is to minimize the adverse

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effects of settlement on the building structure. After the main structure is completed and the settlement of other parts is stabilized,construction can be carried out, the post-pouring strip can be filled. The telescopic post-pouring strip solves the problem of cracking and deformation caused by temperature. Generally, it is necessary to leave a gap along the direction of the foundation. When the concrete appears early shrinkage, can take corresponding measures, in order to improve the mechanical properties of the structure, avoid shrinkage and temperature difference stress to the whole construction structure to cause adverse effects.

A post-pouring strip has two functions. The first is to solve the problem of differential settlement, which is an important factor affecting the quality of construction [2]. In the design of the building and podium structure, due to the influence of various internal and external factors, settlement differences may occur. This problem can be effectively solved using a post-pouring strip. In addition, a post-pouring strip can reduce the cracking caused by temperature shrinkage. In construction engineering, concrete materials are widely used, but in some cases, concrete will harden through a chemical reaction with water call hydration. In construction, if the temperature changes, it will result in concrete deformation and cracking. If the deformation and cracking exceed the standard range, a number of cracks of varying size will appear in the concrete, which will seriously affect the stability of the building structure and construction quality. Moreover, under the change of temperature difference, thermal stress will appear in the building structure, which will cause cracks and seriously affect the whole construction performance. The post-pouring strip can solve this problem, reduce shrinkage stress, reduce cracking in buildings and improve building stability. Post-pouring strip technology provides room to limit the cracking and deformation of concrete, reduces the adverse impact of concrete deformation on the quality of housing construction and ensures the stability of the building.

3. KEY POINTS OF STRUCTURE DESIGN OF POST-POURING STRIP

3.1 Scientific Proportioning of Concrete Composition

The composition of the concrete used in a post-pouring strip structure needs to be scientifically and accurately proportioned, and sometimes admixtures can be added. For example, in the process of constructing post-pouring strips, some expansive admixtures can be added to the concrete to improve the performance of the concrete. In addition, attention should be paid to the ratio of concrete to moisture which needs to be scientifically established a reasonable design plan[3].

3.2 Scientific Determination of Layered Pouring

Since the post-pouring strip concrete usually adopts the layered pouring method during the pouring process, the layered pouring should be reasonably determined during the pouring process. Reasonable determination of layered pouring can make the density and strength of the post-poured concrete fully exerted, so as to better overcome the hazards caused by structural settlement and deformation [4].

3.3 Sufficient Distance between Vibrator and Steel Wire Formwork

To ensure that the concrete has enough compactness and strength after vibration and to prevent the loss of cement slurry in the process of vibration, attention should be paid to the distance between the vibrator and the steel wire formwork, otherwise it is easy for cement slurry to be lost. In addition, in the construction of the vertical construction joint, the steel drill vibration method should be used to ensure the quality of the post-pouring strip reaches the standard.

3.4 Scientific Treatment of Vertical Construction Joints after Concrete Pouring

To build a vertical construction joint after the concrete has been poured, a steel wire formwork is used for construction, the construction joint is washed with water when the concrete initially solidifies and the debris in the vertical construction joint is removed to expose the aggregate. In addition, when flushing the construction joint, the steel mesh is also flushed to remove impurities and dirt. When the concrete is completely solidified, the steel mesh formwork is removed and the surface of the vertical construction joint is washed with high-pressure water to ensure an improvement in the quality and service performance of the post-pouring strip in the construction project [5].

3.5 Suitable Time for Concrete Placement

To ensure the quality of the post-pouring strip, the time of the concrete pour should be carefully determined. Generally speaking, the concrete pour time of the expansion post-pouring strip is about two months after construction; however, in special cases, the engineering design team will have special requirements in relation to the retention time of the post-pouring strip. In this case, a special design scheme is needed to which the construction unit undertaking the work on the post-pouring strip will adhere.

4. APPLICATION OF DATA MINING TECHNOLOGY IN THE STRUCTURAL DESIGN OF THE POST-POURING STRIP

Many items need to be monitored during the structure design and construction of the post-pouring strip, e.g., the original

temperature of each material of the concrete, the mixing temperature after mixing the concrete, the mold temperature and the pouring temperature; sometimes in order to grasp the thermal properties of concrete, the temperature of hydration heat is also measured in two specimens. To monitor the real-time changes in temperature after the concrete has been poured, we use a data mining system for the data collection and analysis.

4.1 Data Mining and Acquisition System

At the construction site, It is important to monitor changes in the poured concrete on a construction site. When the concrete enters the mold, it is important to record the temperature of the concrete and quickly feed this information back to the concrete mixing station so any necessary adjustments can be made to the concrete mix and any leakage can be controlled. During the initial hydration heat mixing after pouring the concrete, it is necessary to check the internal surface temperature difference in detail. It is also necessary to strengthen the inspection and recording of the cooling rate, so that the concrete can control the tensile stress within the range of scientific value.

The data must be obtained quickly and accurately to be analyzed by the data mining system and fed back to the construction personnel. Moreover, the monitoring of large-volume concrete structures often takes a long time, and the data mining system can help to record the changes in a timely and stable manner over a long time.

The main advantages of the data mining system are as follows: the field multi-point sampling is turned into synchronous scanning sampling, which avoids the time difference of the data in time, and reflects the accuracy of the data; it enables the data to be automatically and continuously recorded in a way which accurately reflects the situation at the construction site in a timely manner; the data recorded at each moment can be selectively sent to the host data recorder for reference by the construction personnel.

4.2 Data Processing System

The information processing of the post-pouring strip construction site is key to the data mining system. The data acquisition software sets the acquisition time and step length according to the actual needs of the project, and the data measured in 24 hours is automatically collected by the data acquisition system and recorded in the terminal device. The collected data can also be selected automatically and abnormal data can be proactively identified which triggers an alarm. Then, the image processing software generates two-dimensional and three-dimensional curves, such as the whole process change curve of the hydration heat temperature field, the hydration heat temperature stress process curve, etc. Finally, after rigorous analysis based on the data obtained over time, the relevant curves and pictures are generated again, e.g., temperature distribution along the thickness, temperature stress distribution along the length, etc. [6]. Finally, the data, curves and surfaces obtained are outputted by the terminal as monitoring reports for relevant engineering personnel.

4.3 Signal Sensor

The signal sensor is the most important part of the construction site test and monitoring. If there is no sensor function for the amount of signal change, the advanced equipment is not able to identify any slight changes in construction. In the construction process of post-pouring with concrete, the sensors used are temperature stress sensors [7]. A temperature stress sensor that can directly test the constrained stress is designed, which avoids the systematic error in the process of software calculation. The sensor uses a six-core wire output terminal, and the output is the stretching in the measured direction, which eliminates the influence of physical quantities, such as lateral deformation and torsion. The production of the stress sensor is more complicated in terms of technology and requires multiple procedures such as selection, polishing, quenching and baking.

5. ANALYSIS OF POST-POURING STRIP STRUCTURE REQUIREMENTS

5.1 Spacing between Post-Pouring Strips

The spacing of the post-pouring strip ensures that the concrete structure between post-pouring strips meets the service performance under the action of early shrinkage deformation of concrete, without cracking or only producing tiny cracks which means the post-pouring strip is a section of a concrete slab which is left open to control shrinkage and elastic shortening to avoid cracking. There are many factors that affect the shrinkage and temperature stress of a concrete structure, such as the shrinkage of the concrete material itself, changes in environmental temperature over time and the stiffness characteristics of the structure. In this paper, it is assumed that the ambient temperature does not change during the setting of the post-pouring strip, and the deformation of the concrete at this stage is only caused by the shrinkage of the material itself [8]. If the reinforcement in the post-pouring strip is broken, the concrete on either side of the post-pouring strip is not connected before the post-pouring strip is closed, so it can be considered as two independent units. Otherwise, the reinforcement will transfer the tensile stress between the two sides of the concrete pour.

For reinforced concrete structures, the axial tensile stress of concrete caused by concrete shrinkage deformation will be superimposed with the bending tensile stress under load [9]. Therefore, the allowable tensile stress in the shrinkage stage is smaller than the tensile strength of concrete, which is related to the reinforcement ratio of concrete members and the allowable crack width. The calculation formula of allowable tensile stress is as follows:

$$\sigma = 0.82\rho\sigma_{sk}$$

The stress of the steel bar at the crack is set as $\sigma_{sk} = f_y/1.3$, the reinforcement ratio is $\rho = 1\%$, $f_y = 300MPa$. To simplify the calculation, the indirect stress caused by concrete shrinkage deformation is calculated by the elastic finite element method. Considering the influence of concrete creep and other factors, the allowable tensile stress is 1.5MPa.

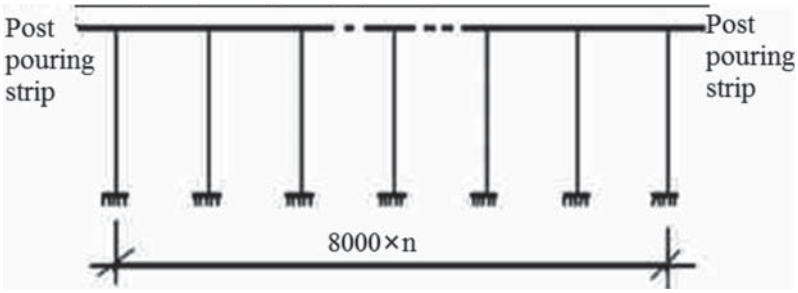

Figure 1 Single layer frame model for calculating post-pouring strip spacing.

Table 1 Theoretical spacing of post-pouring strip.

Cross section of the column/mm	Sjrinkage value ε		
	1×10^{-4}	2×10^{-4}	3×10^{-4}
550 × 600	104	64	56
550 × 700	88	56	40
550 × 800	80	48	40
550 × 900	72	40	32
550 × 1100	64	40	32

Table 2 Theoretical spacing of post-pouring strip.

Time	Two weeks	Three months	One year	Twenty years
Ratio	0.14–0.30	0.40–0.80	0.60–0.85	1

Based on the above assumptions, a single-layer frame model as shown in Figure 1 is established to explore the factors which influence the post-pouring strip spacing.

The example is an ordinary reinforced concrete frame structure with a beam span of 8m, a beam section of 400mm × 800mm and a column section of 550mm. In the concrete frame structure, the main factors that affect the lateral stiffness of the columns are H/h (H is the height of the column and h is the height of the section of the column). The influence of lateral stiffness change is reflected by changing h to 600mm, 700mm, 800mm, 900mm and 1000mm respectively. The shrinkage of concrete before the closure of the post-pouring strip depends on the retention time of the post-pouring strip. The influence of the closure time of the post-pouring strip is considered in three cases: 1×10^{-4}, 2×10^{-4} and 3×10^{-4}. The width of the post-pouring strip is 1000mm, which is arranged in the middle of the span. According to the condition that the shrinkage stress is less than the allowable stress, the calculation results are shown in Table 1.

As shown in Table 1, the earlier the sealing time, the smaller the shrinkage strain before sealing, and the larger the allowable post-pouring strip spacing. This does not mean that the earlier the closure, the better the improvement effect of the pouring strip on the temperature and shrinkage stress. However, the earlier the post-pouring strip is closed, the greater the amount of shrinkage that occurs after sealing, and the indirect stress caused by this part of the shrinkage cannot be solved by the post-pouring strip. It can also be seen that the spacing of the post-pouring strip has a relatively obvious relationship with the lateral stiffness of the vertical support structure. Under the condition of a certain floor height, the larger the cross-section of the column and the greater the lateral stiffness, the greater the tensile stress of the floor under the same shrinkage amount, and the spacing of the post-pouring strip should be appropriately dense to control the tensile stress before closing.

5.2 Closing Time of Post-Pouring Strip

According to the specific construction conditions, after the post-pouring strip is kept open for a certain period of time, it is filled and closed to form a continuous and integral structure without expansion joints. To reduce the temperature stress, the total shrinkage is divided into two parts. During the first part of the shrinkage experience, the initial shrinkage deformation of concrete is relatively large, and the shrinkage stress caused is also relatively large, dividing the structure into many segments, and a post-pouring strip is left between each segment. Before the post-pouring strip is closed, the concrete structure between the post-pouring strip independently bears shrinkage deformation, effectively reducing shrinkage stress; in the later stage of construction, many construction sections are poured into a whole, and continue to bear the second part of the shrinkage and temperature difference, and then produce temperature shrinkage stress. The superposition of the temperature shrinkage stress of the two parts is less than the concrete tensile design strength, and the structure will not crack. The early stage of concrete shrinkage develops rapidly, and the relationship between its development degree and time is shown in Table 2.

The temperature stress of a long prestressed concrete frame structure under three working conditions is analyzed using the

Table 3 Stress calculation results of each span plate.

Working condition	Stress					
	The first span	The second span	The third span	The fourth span	The fifth span	The sixth span
1	3.2	4.8	5.6	6.5	7.9	8.9
2	2.8	3.7	4.9	5.2	6.8	6.2
3	1.9	3.1	4.1	4.9	5.9	5.4

finite element method. The structure has 11 spans, each span is 12m, and the post-pouring strip is set at the sixth span. The setting time of the post-pouring strip is 40 days and 60 days. Assuming that 40% of the final shrinkage is completed in 40 days and 60% in 60 days, the final shrinkage of the concrete is 3.8×10^{-4}. The calculation results are shown in Table 3.

As shown in Table 3, after the post-pouring strip has set, the temperature stress of working conditions 2 and 3 is lower than that of working condition 1; working condition 3 has a longer retention time than that of working condition 2, the shrinkage and deformation are more completed in the early stage, and the temperature stress in each span is reduced.

6. CONCLUSIONS

A post-pouring strip has a very important role and significance in construction engineering. When setting up a post-pouring strip for construction projects, it is important to understand its characteristics so it can be set up correctly and accurately, in strict adherence to the design principles. Post-pouring strips should be utilized to solve the quality problems caused by cracks in a concrete structure. To guide the structural design and monitor the construction of the post-pouring strip, we propose the use of data mining technology to process and analyze the data of the post-pouring strip structure design and construction process. This paper also discusses the role of the post-pouring strip in the concrete floor, the spacing, width and closing time, etc. It can be concluded that the function of the post-pouring strip is to release the shrinkage deformation which occurs during the retention period and reduce the temperature shrinkage stress to prevent cracking in the concrete floor. In addition, the later the closing time of the post-pouring strip, the greater the contraction stress that the post-pouring strip can release. In engineering, the structure and schedule should be combined, and a reasonable time should be selected so that the post-pouring strip is closed as late as possible.

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