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PDCA Control Method for Forming Quality of Pre-grooved HVAC Pipes in Cast-in-place Walls

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Abstract

In the field of construction in my country, the reserved grooves for HVAC pipes are usually installed after the structural wall is poured and before the wall decoration stage. The installation of the HVAC pipes needs to be reserved for the wall picking equipment to install the pipes. The main defects in the construction of HVAC pipe grooves on the wall of the structure are as follows: First, the reserved grooves for HVAC pipes are not flat and the surface appearance is poor. Second, the structural quality is difficult to guarantee. Third, the cast-in-place wall is difficult to pick. Fourth, waste materials and high labor costs. The author team's in-depth research on the forming of reserved grooves for HVAC pipes and the application of quality control methods is of great significance. Through specific engineering examples, this paper elaborates on the actual application of HVAC pipeline reserved groove forming research and PDCA management and control method in the reconstruction project of Linhe shanty town in Shunyi, Beijing. It focuses on summarizing the practical experience and achievements of PDCA management and control technology in the project.

Keywords

HVAC Pipeline Reserved Groove; PDCA Cycle; Cast-in-place wall.

1. Introduction

Now the reserved pipe grooves often use pre-embedded slats, and then pick up the wall after the pouring is completed. In this way, the reserved pipe groove of the pipeline is uneven, the forming quality is poor, and the excavation is difficult, which consumes materials and wastes labor. During the fine decoration of the project, there are many interspersed constructions between civil works and equipment installation, and the pre-buried and reserved procedures that affect the later decoration during the structural construction process are the focus of management and control. The specification[1-4] requires that the qualified rate of molding quality of reserved grooves for HVAC equipment should not be less than 80%, and the owner requires that the qualified rate of molding quality of reserved grooves should not be less than 90%. Therefore, the molding quality of reserved grooves for various equipment pipes should be focused on control.

Table 1. Specific analysis of current situation investigation

Serial number	situation	Frequent and continuous	rate of recurrence(%)
1	Center point position deviation	21	34
2	Surface concrete damage	32	52
3	Size deviation	4	6
4	Internal slag	2	3
5	Edge leakage	2	3
6	other	1	2

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2. Defect analysis and countermeasures

The construction area of this project is 120,000 square meters, and it is composed of 4 21-story residential buildings, 3 3-story commercial buildings and 10 units of underground garages. Through on-site measurements on the 2nd to 3rd floors of 1# building of this project, a total of 200 points were investigated and 62 unqualified points appeared. The current pass rate of this project is 69%. The specific circumstances of unqualified are shown in Table 1:

It can be seen from Table 1 that the deviation of the plane position of the reserved groove and the damage of the concrete surface of the reserved groove are the main reasons for the unqualified. For this reason, this paper mainly uses the "brainstorming method" to analyze the position deviation of the reserved groove of HVAC equipment and the serious damage of the concrete after the reserved groove is formed to the end factors. Draw an association diagram. In view of the above two main problems, a total of 8 end factors as shown in the figure below are found.

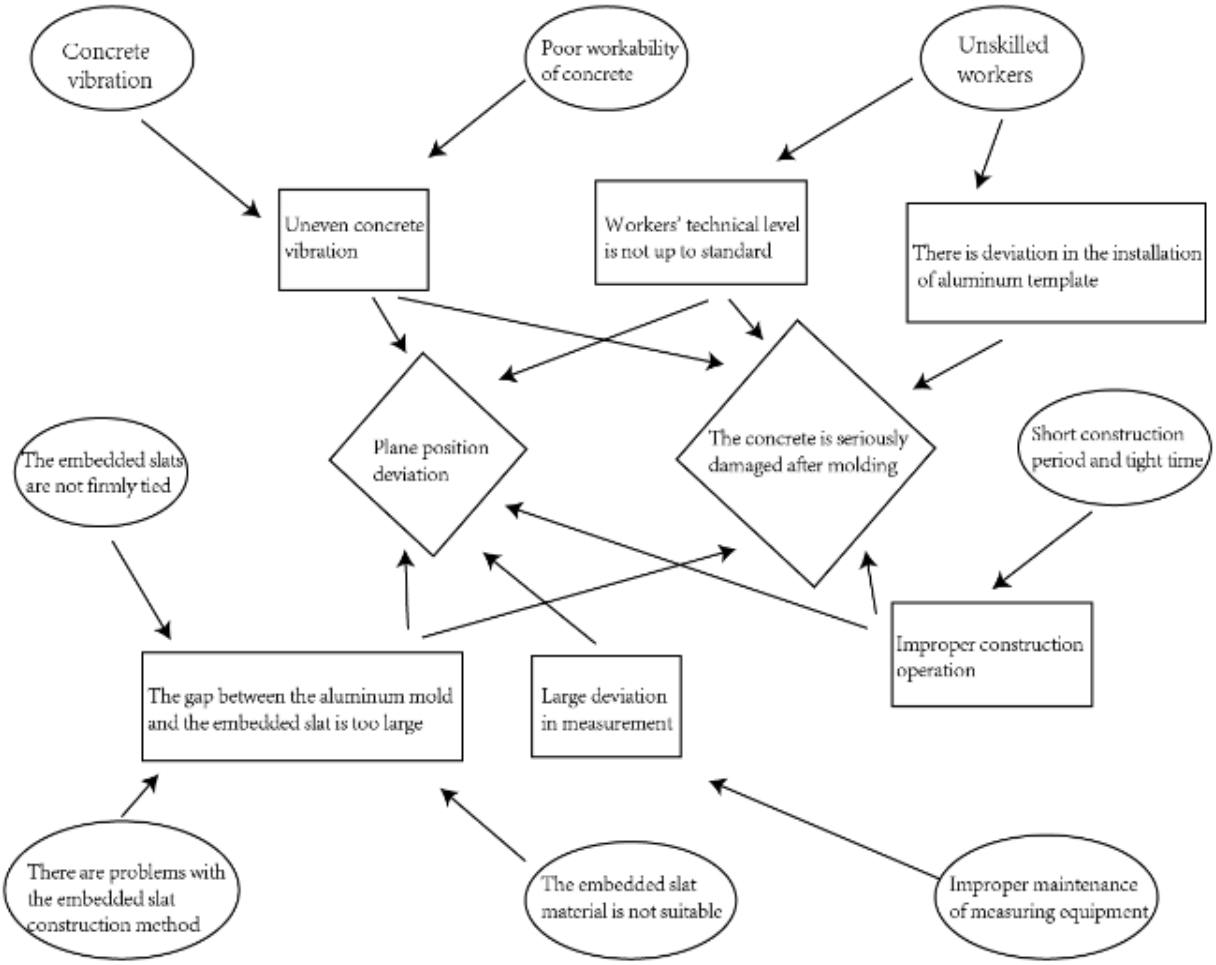

Figure 1. The correlation diagram of terminal factor analysis

And the 8 reasons are being confirmed one by one, as shown in Table 2.

According to the main causes analyzed, feasible countermeasures are proposed, and various countermeasures are comprehensively evaluated. For example, in view of the construction process of embedded slats, two schemes were proposed to cancel the embedded slats and use the later slotting method (plan 1) and fix the slats on the aluminum alloy formwork (plan 2). The two programs were evaluated, and the evaluations are shown in Table 3.

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Table 2. Specific measures

Serial number	End cause	Method	Confirmation standard
1	Business unskilled	Assessment training	100% pass rate of assessment
2	Loose lashing	inspect on the spot	The position is accurate, the binding is firm and not loose
3	Process problem	inspect on the spot	Change the pre-embedded slat process to ensure that the qualified rate of appearance molding quality after demolding is over 95%
4	Improper material of embedded slats	inspect on the spot	The embedded materials are not bent and deformed during the removal process, and the embedded materials are not clean
5	Poor concrete workability	testing on the spot	Concrete slump is 140-180mm
6	Concrete vibration	Site investigation	concrete vibrating close-grained, not after the leakage of vibration, vibration
7	Improper maintenance of equipment	research analysis	Instrument inspection qualified
8	Short construction period and tight time	Site investigation	Ensure high-quality completion process construction

Table 3. Problems in the construction process of embedded slats

Program	Evaluation				Score	Selected plan
	Effectiveness	Feasibility	Economy	Timeliness		
One	3	3	2	2	10	Second choice
Two	4	5	5	4	18	Preferred

In view of the unsatisfactory quality effect of ordinary multi-layer board forming, two schemes of changing to U-shaped steel pipe and changing to PVC plate are proposed, and the schemes are evaluated, as shown in Table 4.

Table 4. The material of the embedded slats is inappropriate

Program	Evaluation				overall ratings	Second choice
	Effectiveness	Feasibility	Economy	Timeliness		
One	5	4	5	4	18	Preferred
Two	3	4	3	4	14	Second choice

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3. Countermeasure implementation and effect evaluation

After the countermeasures are implemented, spot tests will be conducted on the 4th to 6th floors of the 1# building, the 4th to 6th floors of the 8# building, the 2nd to 4th floors of the 2# building, and the 1st to 2nd floors of the 7# building. A total of 200 points were randomly tested, and a total of 6 quality problems occurred. The pass rate reached 97%. Sort and classify the measured data. As shown in Table 5.

Table 5. Completion of quality objectives

Serial number	Check item	Frequent and continuous	rate of recurrence
1	Offset of center position of reserved slot	0	0%
2	Concrete breakage of reserved groove forming surface	3	50%
3	Offset of reserved pipeline groove size	0	0%
4	Slag inclusion in reserved groove	1	16.7%
5	Slurry leakage at the edge of reserved groove	1	16.7%
6	other problems	1	16.7%

The PDCA management and control method implemented by the team has greatly improved the quality of reserved pipeline troughs for the project, laying the foundation for the HVAC pipeline installation and decoration process, and effectively ensuring the smooth completion of subsequent decoration surface construction. On November 17, 2019, the project successfully passed the acceptance of the Beijing Structural "Great Wall Cup" Gold Award. The expert team gave a high evaluation of the quality of the reserved pipeline trough.

During the construction of the project structure, the use of pipeline groove molds reserved for HVAC equipment saved a total of about 85,000 yuan in project funds.

4. Conclusion

By carrying out PDCA management and control, the forming quality of HVAC pipeline reserved grooves in structural engineering has been improved. The research adopts the integrated construction technology of aluminum alloy formwork and steel pipe, and the project achieves the goal of "saving costs and reducing consumption, improving quality and efficiency". This article can provide reference for similar projects, let more applicable projects use this method, and make this method exert greater economic and social benefits.

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