

Study of the Application of Expansive Cement in Building Construction

Ziyun Yuan*

Huangshan Zhonghui Industrial Co., Ltd., Huangshan 245000, Anhui Province, China

*Corresponding author: Ziyun Yuan, 9905444@163.com

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Abstract: A China's construction industry continues to develop, the amount of building construction has increased significantly, and construction technology has been continuously advancing. In particular, the application of expansive cement in building construction is becoming more popular. The correct use of construction technologies can not only speed up the progress of the construction project, but also reduce the project cost significantly. In this paper, the application of expansive cement building construction is discussed in detail, and the solutions of related problems are proposed.

Keywords: Building construction; Expansive concrete; Construction technology; Application strategy

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1. Introduction

Concrete cracks and the number of formwork turnover are common problems in traditional concrete construction that will affect construction quality. In this case, expansive concrete can be used to improve the efficiency and quality of building construction, so it is very important to study its application in building construction.

2. Introduction of expansive cement

2.1. Performance of expansive cement in building construction

High-performance concrete expansion agent (ZY type) chemical expansion agent is added to cement, and its amount is adjusted for different projects to achieve the required physical expansion rate. The rate of expansion often depends on the shrinkage parameters and elastic dimensions. The higher the shrinkage parameter or the elasticity, the larger the amount of expansion cement and vice versa. Under suitable conditions, the addition of ZY type chemical expansion agent will lead to different degrees of expansion, thereby preventing the concrete from cracking. However, its effect is susceptible to reinforcement and specific fixed positions. Therefore, in the construction process of expansive cement materials, it is necessary to reduce the amount of cement used. It is necessary to adjust the amount of the chemical expansion agent according to specific conditions and requirements, which not only reduces the construction costs, but also achieves the ideal quality of the concrete, thus effectively ensuring the construction quality. ZY type chemical expansion agent has good performance, and its characteristics are shown in **Table 1**.

Table 1. Performance characteristics of ZY type expansion agent

Performance characterization	Main feature	Effect of application
Good degree of swelling	7% ZY < 13% u-type expansive agent (UEA)	It increases cracking suppression of reinforced concrete frame
Low alkali concentration	$B_{21} \leq 0-4\%$ (alkali concentration)	Prevents alkali-aggregate reaction
Small amount of material required	7% ZY < 13% conventional expansion agent	Reduce material cost
Good quality	It is not affected by cement slump and has a wide range of applications	Compatible with commercial cement and concrete pumps
Easily activated	Complete hydration reaction	It can completely replace concrete
Enhances the performance of cement	Increasing cement strength	It can completely replace concrete
Excellent cement impermeability	P21-P31 (antibiotic penetration label)	Good waterproof effect

2.2. Application principle of expansive cement in construction

The principle of applying expansive cement is that the concrete is mixed with an appropriate amount of expansion agent, and the expansion agent will react with the cement. As a result, the concrete begins to expand outward, and the reinforced concrete generates stress during the process of expansion. Due to various factors, the concrete undergoes internal shrinkage during the curing process, and the expansion agent offsets the stress generated by internal shrinkage, which prevents cracks, which in turn improves the quality of the concrete and prolongs its service life ^[1].

2.3. Advantages of using expansive cement

2.3.1. Improve the earthquake resistance of the building

An expansive agent is added to the expansive concrete to increase the shrinkage tension of the concrete, and other additives are also added into the cement, thereby improving the integrity of the concrete structure and the earthquake resistance of the structure itself.

2.3.2. Prevents cracking

Concrete cracking is a common problem in building construction, which is due to various reasons such as temperature difference in the working environment and excessive structural stress, which will inevitably affect the overall strength of the structure itself. In the process of using expansive cement, the expansive agent is added to the cement very early on so that the expansion force generated during the concrete setting process prevents early compression of the concrete, thus reducing the possibility of cracking.

2.3.3. The service life of the building structure is effectively prolonged

Expansive cement will generate prestress, improve the internal prestress of the concrete structure and the shrinkage capacity of the concrete itself, and effectively play the compensating role of the expansion agent, so as to extend the life of concrete structures.

3. Application strategy of expansive cement in building construction

3.1. Installation of expansion reinforcement belt

“Jointless structure” refers to the effect of using concrete under ideal conditions. The possibility of this situation happening in actual construction is very small. Therefore, expansive cement is usually used as the main building material, and steel strips are mainly used for seamless construction. Steel strips protective nets can be set at both ends to effectively solve the problem of concrete penetration. At the same time, ZY expansion agent is added reasonably and accurately to ensure that the expansive cement meet the standards

and ensure the construction quality. The specific requirements are shown in **Table 2**.

Table 2. Expansive concrete mix ratio

Parts	Label	Cement	Sand	Pebbles	ZY	Fly ash	Admixture	Water
Roof	C30, P6	284	776	1071	22	76	8.2	180
Reinforcement belt	C35, P6	317	746	1073	33	86	8.9	185

3.2. Installation of compensation reinforcement

Expansive cement will generate internal stress during the maintenance process, and the concrete structure should also be equipped with compensation reinforcement to balance the internal stress and improve the integrity of concrete after molding. There are a few aspects to take note of in the installation of compensation reinforcement. (1) Concrete solidification is directly related to temperature control. Therefore, we should pay attention to temperature changes, choose the appropriate time for the installation, and reduce the effects of temperature on the solidification of the concrete. (2) To determine the position of the compensation reinforcement, based on previous experiences, the position of the compensation reinforcement should be perpendicular to the steel strips, the insertion depth of the compensation reinforcement concrete should be greater than 50 cm, and its material properties should also match the original structural reinforcement material. (3) It is necessary to control the relevant parameters. The diameter of the reinforcement rod should be shorter than that of the original structural rod, with a difference of 1–2 grades. At the same time, rails should be fixed to improve the effect of compensation reinforcement [2].

3.3. Mixing and transporting expansive cement

In order to improve the quality and efficiency of using expansive concrete, the mixing time of expansive concrete should be optimized, because a suitable mixing time can not only improve the mixing of the concrete, but also the quality of concrete. The formwork should be cleaned before the concrete is poured. To avoid waste and concrete accumulation during construction, the concrete at the discharge port should be vibrated. The depth of the vibrator entering the concrete and the range of motion of the vibrator are key factors affecting the construction quality, so confinement work is required during the actual vibration period and concrete joints should be looked out for. Besides the amount of concrete used in the pouring area should also be calculated in advance [3].



Figure 1. Stirring and transportation of expansive concrete

3.4. Surface maintenance

In order to avoid concrete cracking, the expansive concrete shall be plastered after pouring. Plastering should be done during the maintenance phase when the concrete is just setting, usually within 10 hours after the concrete is placed. After the initial concrete setting stage, in order to ensure the flatness of the building, the secondary mortar should be added. The maintenance effect of expansive cement directly affects the service life of the concrete. Therefore, the staff should pay attention to the maintenance of the concrete. The maintenance usually takes about half a month. The staff should pay attention to the curing process and try to avoid exposure of the expanded concrete to the sun, so as to further improve the quality of the concrete.



Figure 2. Surface maintenance

3.5. Management and control of the reinforcement binding process

The reinforcement connection process also affects the performance of expansive cement, so attention needs to be paid to the management and control of the reinforcement connection process. Reinforcement connection will lead to a significant change in the temperature stress of the expansion zone. Therefore, it is necessary to keep the temperature stress of the expansion steel bar at a high level. The following points should also be noted: Firstly, during the binding process, it is important to ensure that the bars are straight and parallel with each other. Secondly, it is necessary to pay attention to the distance between the steel bars, and appropriately adjust the position of the steel bar according to the actual needs of the project, so that the distance increases with the expansion of the steel bar at both ends of the building structure, so as to ensure the construction quality. It is important to manage the construction process and follow the relevant procedures to create a good construction environment while using expansion cement. If the reinforcement bonding process is not managed well, it will affect the construction of concrete expansion joints ^[4].



Figure 3. Rebar binding

3.6. Strictly controlling the use standards of technology

In the application of expansive cement, the proportion of expansion agent will directly affect the final effect of concrete molding. According to previous experiences, before determining the proportion of materials, it is necessary to conduct appropriate tests, and determine the optimal proportions based on the test results and apply the technique. Before this, a project manager should be appointed to understand the on-site working environment and determine the material configuration based on the site conditions. In addition, the requirements of site operation and management standards, along with national construction standards and local standards, should be followed. Besides, feasible standards should also be developed to speed up the construction process.

3.7. Application of joint treatment technology

In addition to the aforementioned applications, joint treatment technology is also one of the technologies used for the subsequent treatment of the structure. The techniques of concrete pouring can be divided into continuous pouring and intermittent pouring. Before pouring, the construction personnel should ensure that the area is clean and free of debris. Besides, the wetting process should be carried out properly, and after the project is completed, concrete of the same performance is inserted into the joints to improve the overall structure integrity.

4. Matters needing attention in the application of expansive cement construction technology

4.1. Strictly controlling the construction process

Managers must strictly control the entire construction process to ensure the smooth progress of the project, and the monitoring of the adhesion of expansive concrete can effectively ensure that the quality of the entire construction is up to standard.

4.2. Performing scientific calculations

Before adding the expansion agent, the proportion the expansive cement should be scientifically calculated, taking into account the equipment used, material classification, local climate conditions, etc., so as to correctly determine the amount of expansion agent needed.

4.3. Strictly controlling the selection of concrete

Strict quality control and the use of high-pressure expansive cement are very important to improve

construction quality. Expansive cement is used and handled fundamentally differently compared to normal cement because of the addition of expansive agents and other building components to the material. In some cases, the preparation of reinforced concrete should be carried out in strict accordance with the national technical requirements. Even if no expansion agent is used, it should still be prepared in strict accordance with the specifications, and each procedure should be well-controlled.

4.4. Strictly control the implementation technology of concrete

Strengthening the engineering control of the concrete in the non-expansion area (the area without expansion agent) and its construction equipment will greatly improve their technical performance. Concrete reinforcement welding should be continuously improved after high pressure expansion is attempted to achieve seamless welding in order to understand the compressive stresses of reinforced concrete on the main structure of the building. Secondly, when preparing the expansion agent, the expansive cement should be rationally configured and controlled according to the structures of the main body of the building. The modified concrete significantly improves the production quality and use efficiency.

5. Conclusion

With the development of the construction industry, new technologies are constantly emerging and widely used in the construction industry, which not only contributes to the development of the construction industry, but also the development of the economy. As mentioned above, mastering the correct construction techniques and technologies in building construction, preparing for construction in advance, along with good construction techniques and proper supervision and inspection, building construction can be completed successfully. This new type of expansive cement will be more widely used in building structure construction as it reduces costs, shorten the construction time, and most importantly, prevent concrete cracking, reduce the cost of raw materials, and significantly improve economic and social benefits.

Disclosure statement

The author declares no conflict of interest.

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