

Challenges and Opportunities of Gypsum-Based Self-Leveling Materials

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Abstract

Gypsum-based self-leveling material is made of gypsum as the base material, adding aggregate, filler and various additives. It is an ideal material for building leveling. It has good economic benefits and market development prospects. But at present, gypsum-based self-leveling materials are also facing some challenges. We will focus on the analysis of their performance, and explore the problems and improvement methods, looking for opportunities in the market of self-leveling materials.

Keywords

Gypsum-based, self-leveling material, application, performance.

1. Introduction

Self-leveling material is a new type of ground material developed in the 1980s. It is based on inorganic cementitious materials and modified by adding various additives. It has strong bond with ground base, good fluidity, stability, no segregation, stratification and bleeding before hardening. It can level automatically under the action of its own gravity or micro-external force. After hardening, it forms a smooth surface without manual smoothing. It has fast construction speed, time-saving and labor-saving. This is an innovation to the traditional manual leveling construction method.

Self-leveling materials can be divided into cement and gypsum systems according to the different base materials. Among them, gypsum-based self-leveling material is an ideal self-leveling ground material, which has the advantages of light weight, stable volume, not easy to empty and shrink cracking, good sound insulation and heat insulation effect, and is widely applicable to low humidity ground environment. Gypsum-based self-leveling materials are mainly composed of cementitious materials, aggregates, additives and mineral fillers. The performance of gypsum-based self-leveling materials will be changed due to the different composition of base materials or additives, thus affecting the actual use effect. At the same time, in order to further develop and utilize gypsum-based self-leveling materials, we need to analyze the current problems faced by gypsum-based self-leveling materials and explore their solutions to provide a new direction for green building materials. So in this paper, we will focus on the performance evaluation, application, problems and improvement methods of gypsum-based self-leveling materials [1].

2. Application Status and Prospect of Gypsum-based Self-leveling Material

At present, energy-saving building materials are widely used abroad. New energy-saving wall materials in developed countries in Europe and America account for 60-90% of the whole wall materials and 80-100% of new residential buildings adopt high-efficiency thermal insulation materials, which have reached the prescribed thermal insulation standards. The development and application of building thermal insulation materials have attracted more and more attention all over the world, and new types of thermal insulation materials are constantly emerging. For example, two new thermal insulation materials NEOPOR and PERIPO, developed by BASF in Germany, can reduce the water absorption and thermal conductivity of the products, while the latter can be used as

basement exterior wall thermal insulation materials. Tomlinson and Heberle of Oak Bridge National Laboratory in the United States conclude that in solar houses, phase change stone is used as thermal insulation material. Paste wallboard can significantly reduce the consumption of additional energy, the return period is about 5 years. The laboratory's Stevall T.K. and Tomlinson evaluated the potential benefits of phase change wallboard in the middle heating climate zone. They believed that wallboard had little impact on residents' comfort, but could significantly save energy load without increasing energy consumption [2].

At present, the widely used thermal insulation materials in China are mainly organic and inorganic. Among them, organic thermal insulation materials are mainly various plastics, which have good properties such as light weight, thermal insulation, heat insulation, sound absorption and so on. They have a long history of use in cold areas. But in the construction of exterior wall insulation, the working procedure is very complicated, the construction technology is difficult, the cost is high, and the combination of organic materials and brick wall is difficult, the intensity is low, the fireproof performance is poor, and it is easy to cause accidents such as empty drum and falling off. Moreover, the anti-aging ability of foam plastic products is poor, and the service life of foam plastic products is only 20 different from that of buildings. The waste materials are caused white pollution. Inorganic thermal insulation materials, especially inorganic thermal insulation mortar, are non-combustible materials. While meeting the requirements of thermal insulation, they have good compressive and tensile properties, the same life as the main body of the building, convenient construction and low cost of thermal insulation. They have good application prospects.

Gypsum-based vitrified microsphere thermal insulation mortar inherits many advantages of traditional thermal insulation mortar. At the same time, because gypsum is used as cementitious material, the material also has a certain performance of temperature and humidity regulation, which has a good effect on maintaining the balance of temperature and humidity in the indoor environment of buildings and improving the comfort degree of buildings. New gypsum-based building materials in China have developed to a certain extent. However, due to the low strength and poor water resistance of gypsum, the share of gypsum building materials in China's construction market is still very low. At present, the proportion of gypsum building products in wall materials in China is very low, which is far from 85% of wall materials in developed countries, especially in the United States. The application of gypsum-based non-load-bearing wall materials such as gypsum hollow strip board, shrinkage rate gypsum board and gypsum insulation board still lags far behind that of foreign countries, while the application of gypsum-based exterior wall materials lags far behind that of developed countries such as Europe and the United States. Under the new situation of building energy saving and wall reform, with the concept of ecological building and green building materials increasingly accepted by people, green ecological building materials with gypsum as the main body will be more and more favored by the construction industry. From the point of view of ecological architecture, environmental protection, resource development and chemical gypsum resource utilization, gypsum building materials including gypsum-based thermal insulation materials are all green building materials worthy of vigorous development [3].

3. Performance evaluation of self-leveling materials

According to the actual construction and service performance, self-leveling mortar should have the following properties. First, after mixing with water into slurry state, it should have good fluidity, operability and construction performance, as well as suitable setting and hardening time, without segregation and bleeding before setting and hardening. Second, the required strength growth rate should be achieved after condensation and hardening. Third, it requires that the process of condensation hardening shrinkage is small, the condensation hardening layer does not crack, and there is a good bonding performance between the ground base, not falling off, not empty drum. Fourth, the strength grade should meet the design requirements, have good wear resistance, appropriate elastic modulus and flexibility requirements. Fifth, the construction and use process will not have a negative

impact on the environment, that is, it has environmental protection characteristics. Sixth, it is low cost and perdurable, easy to maintain and renovate.

The specific indicators are as follow:

Liquidity

Fluidity is an important indicator of slurry properties of self-leveling materials. The fluidity is usually characterized by the spreading degree of the paste on the glass plate. The European Standard stipulates that the initial fluidity should not be less than 140 mm, while the French Standard stipulates that the initial fluidity should be between 150 and 157 mm. The industry standard of China "Gypsum-based self-leveling mortar" (JC/T1023-2007) regards 145 mm as the initial fluidity of gypsum-based self-leveling mortar samples. At this time, the initial fluidity of gypsum-based self-leveling mortar is added, and the 30 minute fluidity loss in the standard is used as the technical performance index to characterize the fluidity of gypsum-based self-leveling mortar and the control index to maintain the fluidity.

Setting time

Generally, the longer the retarding time of slurry, the smaller the loss rate of fluidity with time, and the better the construction operability, but the earlier strength decreases or grows slowly. Conversely, the larger the loss rate of fluidity with time, the worse the construction operability, but the earlier strength increases faster. At the same time, the condensation time of self-leveling ground has a direct impact on the construction speed of the whole ground. As the actual construction application situation in China, in order to ensure the sufficient construction time of gypsum-based self-leveling mortar, according to the actual application effect and the verification test results, the initial setting time of gypsum-based self-leveling mortar is more than one hour, and the final setting time is less than 6 hours. In any case, the setting time of self-leveling material slurry should meet the requirements of construction.

Compressive strength

As an integral part of the ground structure, the self-leveling ground must have sufficient strength to ensure the overall working capacity of the whole ground structure. For the test method of compressive strength of self-leveling ground materials, cement-based self-leveling ground materials can generally refer to the test method of compressive strength of cement or mortar. The Korean standard stipulates that the compressive strength of ground materials is generally more than 20MPa, and that of industrial materials is more than 28MPa. The standard of Japanese Residential Association stipulates that the compressive strength of self-leveling floor materials should be greater than 12MPa and the compressive strength of self-leveling floor materials sold is generally greater than 15MPa. As a ground material, the strength index should conform to the corresponding construction specifications. Usually the compressive strength of domestic ground mortar layer should be greater than 15Mpa. Therefore, the dry compressive strength index of gypsum-based self-leveling mortar should be no less than 20Mpa.

Flexural strength

The Korean industry standard stipulates that the flexural strength of industrial ground self-leveling material should be greater than 6MPa. The flexural strength of self-leveling cement floor materials sold in Germany is greater than 7MPa. The flexural strength of self-leveling cement floor material in the United States is greater than 10MPa. French products are more than 8MPa and domestic products are more than 7MPa.

Tensile strength of interfacial bond

In actual construction, the base is usually cast concrete. Therefore, the bonding state of the interface between the self-leveling layer and the base layer will directly affect the overall performance of the ground. It is necessary to specify the bonding strength between the self-leveling material and the base layer. The standard stipulates that the tensile bond strength index of gypsum-based self-leveling mortar is not less than 1.0MPa.

Shrinkage rate

The shrinkage rate is related to the shrinkage crack of self-leveling material after hardening. The standard contraction rate is not more than 0.05% [4].

4. Existing Problems and Improvement Methods of Gypsum-based Self-leveling Materials

4.1 Problems

Firstly, the most effective method for pretreatment of chemical gypsum is washing method, but washing method will bring secondary pollution. As a result, the neutralization of lime with low cost, no pollution and good effect is generally selected. However, due to the influence of raw material sources and production conditions of chemical gypsum, it is difficult to control the optimal amount of lime in pretreatment.

Secondly, the composition of chemical gypsum is complex, and there are many kinds of impurities in it. Although the content of chemical gypsum is small, it seriously affects the performance of chemical gypsum. Because of the difference of source and production technology, the chemical gypsum discharged by different enterprises and the composition of waste residue discharged by the same enterprise in different time periods will also have great differences, which seriously affects the utilization of chemical gypsum.

Thirdly, before 2007, there was no unified national or industry standard for self-leveling of gypsum system in China. So far, the research on Preparation of self-leveling materials from chemical gypsum has different construction technology and performance requirements due to different reference standards, and the construction cost is high.

Fourthly, the physical properties of chemical gypsum self-leveling floor materials, such as compressive strength, flexural strength, water resistance and abrasion resistance, are different from those of cement-based self-leveling floor materials, which are limited to the ground buildings which do not require high strength, such as residential buildings and supermarkets.

Fifthly, some chemical gypsum contains a small amount of toxic chemicals and radioactive substances due to different sources, production environment and pretreatment process, which seriously restricts consumers' acceptance of chemical gypsum-based self-leveling materials.

Sixthly, chemical gypsum is generally free resources, which is the driving force to promote the development of chemical gypsum self-leveling materials. However, with the continuous advancement of the utilization of chemical gypsum resources, when the utilization rate increases, the supply industry is relatively tight and may charge fees, which will affect the research and utilization of chemical gypsum to prepare self-leveling materials and other by-products.

Seventhly, at present, the cost of chemical gypsum pretreatment, additives and crystallizers is relatively high, resulting in the cost of producing cement-based self-leveling materials is basically equal. It seriously restricts the application and promotion of chemical gypsum-based self-leveling materials.

Eighthly, the Ministry of Economy is developed in China, and the people usually choose cement mortar with lower cost to directly lay the ground. This kind of material is not suitable for the national conditions. Moreover, the construction technology and equipment are relatively backward, and the self-leveling material has not entered the national vision.

4.2 Improvement Method

Chemical gypsum impurity is an important factor affecting its application. It is the only way to accelerate the preparation of chemical gypsum self-leveling materials to study the influence of impurities on the leveling performance. Scientists can choose low-cost pretreatment methods and additives to reduce the production cost of chemical gypsum-based self-leveling materials [5].

5. Conclusion

With the development of social economy and the continuous improvement of people's living standards, people are demanding more and more comfort in the thermal environment of buildings. In our country, this demand is becoming more and more urgent, which is related to the climate characteristics of cold winter and hot summer in most areas of our country. Improving residential thermal environment must be combined with saving building energy consumption. In order to save energy on the basis of improving building thermal comfort step by step, it is also possible to improve thermal comfort conditions only by saving energy. The thermal insulation, heat insulation and air tightness of traditional buildings in China are not good, and the residential thermal environment is poor. Modern energy-saving buildings adopt eco-green building materials and efficient energy-saving technology, which not only reduces building energy consumption, but also improves the thermal comfort of residential environment. So it can achieve the effective utilization of building energy, improve the thermal comfort environment of building residence, and promote the coordinated development of social economy and ecological environment.

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