

Development and Application of a Concrete Apparent Beautifying Agent

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Abstract. The exquisite appearance of concrete components not only reflects the management level of construction units and the overall quality of operators, but also transmits the reliability of the inherent quality of the whole project and the aesthetic feeling of art.. The new demoulding agent prepared in this paper can effectively develop concrete demoulding agent, which can be sprayed, rolled, and constructed easily. The area of the template can be sprayed about 100 square meters with a kilogram of water-based demoulding agent, and more than 40 square meters can be rolled with a kilogram of oil-based demoulding agent. The template after use is easy to clean, safe and non-toxic, and has no pollution to the environment. The surface of concrete demoulding agent has less air bubbles and no residual oil pollution. It is a new generation of green environmental protection building materials. After a large number of laboratory experiments, a series of optimization of emulsifier, emulsifying temperature and emulsifying speed in the emulsification process were made. The best scheme was selected for pilot test in Wuhan New Building Material Factory, and was verified by the experiment in the North Fourth Ring Project.

Introduction

In recent years, China's real estate, high-speed rail, subway, dam, road and bridge projects have been carried out on a large scale, and the demand for concrete is also growing. Compared with other building materials, concrete has become the largest artificial material because of its good comprehensive performance. Nowadays, people are demanding more and more aesthetic feeling. Architecture is the art of solidification, which requires concrete structures not only to ensure the safety and reliability of the structure, but also to have beautiful appearance. The use of concrete demoulding agent is an effective way to ensure the appearance of concrete structures.^[1]

Most of the early concrete projects in China used oil or waste oil as demoulding materials. Although this kind of demoulding agent has a good demoulding effect, it has a long drying time after coating, which easily pollutes the clothes of construction operators and reinforcing bars. After concrete hardening and demoulding, there are often oil spots on the surface of the structure, which affects the beauty of the concrete surface, and has a very negative impact on the later decoration of the concrete surface, such as brushing, painting and plastering. In the past 30 years, with the rapid development of commercial concrete demoulding agent abroad, various demoulding agent products have emerged in China, which are active in the construction market all over the country.

Throughout China's current concrete demoulding agent market, the main raw materials of demoulding agent are mostly mineral oil series, which are non-renewable resources. Under the dual pressure of environment and population, it is of great significance to find renewable materials as raw materials for concrete demoulding agents.

The separation between concrete and formwork must overcome the bonding force between formwork and hardened concrete or the cohesion of concrete surface. The composition of concrete surface optimizer should be designed according to the mechanism of physical lubrication, film-forming isolation and chemical action of release agent. Vegetable oil is a kind of non-toxic, non-polluting and non-irritating solar energy material with abundant output and relatively low price in China. Because of its film-forming lubricity, it has better demoulding effect. Vegetable oil itself can prevent rust and protect template effectively. Because of its easy sprayed property and safety, the emulsion type demoulding agent has gradually become a hot spot in the development of mold release agent. The emulsion release agent usually contains no organic solvents, so it has no

flammable and harmless to the human body and the environment. It is an environmentally friendly green release agent. In view of the above reasons, we consider emulsifying vegetable oils to prepare emulsion release agents^[2].

Experimentation

Major Raw Materials and Instruments

Vegetable Oil, Emulsifier, Sodium Carboxymethyl Cellulose, Hansen Gum, Xanthan Gum, Diatomite, Triethanolamine.

Four flasks (1L), electric agitator (PTFE agitator), centrifuge, electronic balance, vacuum dryer, beaker.

Preparation of Concrete Apparent Beautifying Agent

Vegetable oil emulsion release agent takes rapeseed oil as raw material, water as dispersing system, including emulsifier, stabilizer, rust inhibitor, etc. The specific preparation steps are as follows:

(1) Pre-dispersion of emulsifier in vegetable oil: pour the weighted vegetable oil into the reaction vessel, slowly add oil-soluble emulsifier at a certain stirring speed, until the emulsifier is completely dispersed in vegetable oil, the system is dark yellow and turbid.

(2) the formation of oil in water emulsion: under the condition of high-speed dispersing and stirring, the water (emulsified water) with water soluble emulsifier, stabilizer and rust inhibitor can be added slowly to the upper step system until the emulsion is turned to phase.

(3) emulsion phase change: when emulsion water is added to a certain amount, the emulsion will turn into phase, then stop adding emulsified water and keep stirring for a certain time (about 10min).

(4) formation of oil in water emulsion: after the emulsion is converted, the remaining emulsion water is added to the system slowly. At this time, the dispersion speed is 1200~1500r/min, and the total time of adding emulsified water slowly is 20min.

(5) the final formation of vegetable oil emulsion: after the emulsion water has been added, the dispersion speed will rise to 1500 r/min. After mixing 20min, add diluted water quickly and reduce the rotational speed to 1200 r/min, and then discharge after 10min.

Vegetable oil is rapeseed oil, and its HLB value is about 9.^[3] The dosage of emulsifier is 3%, emulsifier is non-ionic surfactant (Span-60, Tween-80), stabilizer is carboxymethyl cellulose ether, dosage is 1, antirust agent is triethanolamine, dosage is 2. The emulsifying temperature was 40°C and the emulsifying time was 60 min. The stirring speed is 1500 r/min, and the amount of emulsified water accounts for 78% of the total amount of water. The way of adding emulsified water is dripping.^[4]

Performance Testing

Material and Ratio for Performance Testing

a. Cement

According to the use of cement in concrete production enterprises, Huaxin P.O 42.5 cement is selected. The basic properties are shown in Table 1.

Table 1. Basic properties of test cement

Sample	Water consumption for standard consistency /g	Initial setting/min	Final setting /min	Density /(g/cm ³)	Specific surface area /(cm ² /g)	3d mortar strength /MPa	28d mortar strength /MPa
Huaxin Cement	120	150	225	3.02	4025	31.0	50.5

b. Mineral powder

S95 mineral powder (KF) from a new building material plant has a specific surface area of 4250 cm²/g, a density of 2.86 g/cm³, an activity of 86% on 7d and 97% on 28d.

c. Fly ash

The grade II fly ash of Macheng Power Plant is used with fineness of 2.5%, loss of combustion of 8.0% and water requirement ratio of 105%.

d. Sand

The river sand's (S) fineness modulus is 2.6, the mud content is 0.8%, and the mud content is 0.3%.

e. Gravel

C30 concrete adopts 5-31.5 mm continuous Graded Macadam with apparent density of 2730 kg/m³, mud content of 0.4%, mud content of 0.1%, needle-like content of 4.0%, crushing index of 6.5%.

f. Water

Tap water or groundwater meet the requirements of JGJ 2006 Water Standard for Concrete Mixing.

h. Admixture

The admixture is the finished product with 10% solid content produced by the company, which meets the requirements of GB8076-2008.

Table 2. The concrete mix

Strength grade	Cement	Fly ash	Mineral powder	Sand	Gravel	Water
C30	190	100	85	860	1020	135

Results and Discussions

Stability Experiment of Release Agent

The stability of emulsion has a significant effect on its performance. In this paper, the stability of emulsion is evaluated by centrifugal stability. The specific experimental methods are: loading the emulsion into 10mL centrifuge tube, putting it into a high-speed centrifuge, setting a speed of 4000 r/min, and centrifugally separating 10min, according to the 6 grades of emulsion stability.

The stability of the emulsion was improved by adding a certain amount of stabilizer. The water-soluble polymers such as sodium carboxymethyl cellulose and Hansen gum, xanthan gum and diatomite were selected as stabilizers. According to past experience, the amount of stabilizer is 1 per thousand of the total mass of the emulsion. In the process of preparing vegetable oil emulsion, stabilizer is added to the emulsion with the addition of emulsified water. That is to say, 10% vegetable oil emulsions were prepared by adding 1% sodium carboxymethyl cellulose, Hansen gum, xanthan gum and diatomite respectively. The stability of the vegetable oil emulsion was evaluated by centrifugation and its demoulding effect was tested. In terms of demoulding effect, xanthan gum was used as stabilizer, and the adhesion of demoulded formwork concrete was 2.7g/m², which met the industry standard of concrete, and the storage stability was up to 8 months. Considering the comprehensive consideration, xanthan gum is used as the stabilizer of the release agent emulsion.

Table 3. Emulsion stability and Adhesion of formwork concrete

stabilizer	Emulsion stability	Adhesion of formwork concrete (g/m ²)
-	90d	4.5
Sodium carboxymethyl cellulose	150d	4.7
Hansen gum	160d	3.9
Xanthan gum	250d	2.7
Diatomite	70d	3.4



Figure 1. The emulsion stability

Apparent Contrast of Concrete

- (1) Mould cleaning: before the mould is coated with release agent, it should be carefully cleaned.
- (2) the release of the release agent: the emulsion release agent should ensure that the mold release agent is uniform.
- (3) Concrete preparation: concrete with strength grade C30 is prepared according to concrete mix proportion.
- (4) Specimen forming: the fresh concrete is poured into the assembled mould, tamped and filled, and the top of the specimen is smoothed with a spatula. After forming, the edge of the mould is cleaned and placed horizontally. Standard maintenance was adopted, and the mould was demoulded after 24 hours of maintenance.
- (5) Characterization of demoulding effect: Visual inspection of the appearance, shovel down the concrete material adhering to the bottom of the mould with a spade, weigh it with a balance after collection, and calculate the amount of adhering per unit area. The amount of adhering concrete is less than 5g/m^2 , which is qualified.

As can be seen from Fig. two, the homemade emulsion type release agent has apparent uniformity after demoulding, and the large pore volume is obviously less than that of the oil release agent. After many experiments, the concrete residue and the appearance of concrete have been significantly improved.



Figure 2 Application Effect

Pilot Study

After a large number of laboratory experiments, a series of optimization of emulsifier, emulsifying temperature and emulsifying speed in the emulsification process were made. The best scheme was selected for pilot test in a new building material factory, and was verified by the experiment in the North Fourth Ring Project.



Figure 3. Application Effect

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