

Preparation Technology of Polyurethane Foam Concrete

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Abstract. Polyurethane foam concrete is prepared by solventless two-component polyurethane materials, cement, KC-15 composite blowing agents and calcium stearate foam stabilizer. It discussed the synthesis mechanism and studied the preparation process for the preparation of polyurethane foam concrete in the paper. The effects of materials addition order for foams quality and molded concrete are analyzed in detail. The key factor affecting foams quality is the additional order of polyurethane aggregates and foams. Two cement systems are suitable for polyurethane film forming and foams stable. Post addition of polyurethane aggregates can significantly decrease the bubble bursting. The preparation method referred a reference for the preparation of polyurethane foam concrete.

Introduction

Foam concrete is determined that mixing with the slurry and gas bubbles, new lightweight insulation materials, containing a large number of closed pores, are made after curing and molding. Foam concrete is usually used in roof and wall insulation, replacing other organic insulation materials such as polystyrene boards, etc. Foam concrete has a low density, good thermal insulation properties, strong adhesion and structural bonding, good seismic performance etc. But some weakness such as low strength, easy to crack, higher water absorption has become increasingly prominent, limiting the development of foam concrete.

Polyurethane is one of the best synthetic resins, which is widely used in coatings, adhesives, foams, fibers and elastomers.

In the current situation, it is an important direction for development of fire insulation materials in the future to prepare an organic-inorganic composite material playing organic and inorganic materials' advantages and overcoming their shortcomings. The paper analyzed the synthesis mechanisms of polyurethane foam concrete and combined solventless two-component polyurethane with foam concrete, controlling the addition order of raw materials, to prepare lighter, better insulation, higher strength and good durability polyurethane foam concrete.

Features and Synthesis Mechanism of Polyurethane Foam Concrete

Material Features. Foam concrete has good thermal properties for containing a large number of closed small pores. There is a good energy saving effect when using foam concrete as building walls and roofing materials. Compared with foam concrete, polyurethane foam concrete has better gas barrier properties, better waterproof performance, better insulation effect and little strength reduction.

Polyurethane foam insulation materials are organic, whose most important shortcoming is not

fireproof. Compared with the pure polyurethane foam insulation materials, polyurethane foam concrete has mainly inorganic phase composition, reaching A-level fire resistance rating, high strength, good overall performance, and achieving thermal insulation structure integration without bonding other inorganic materials.

In summary, polyurethane foam concrete will play a major role in thermal insulation, fire resistance, waterproof materials in the future for having the dual advantages of polyurethane and foam concrete, overcoming their respective shortcomings.

Synthesis Mechanisms. Currently some studies on polyurethane modified cement mortar in China are processed. By adding a small amount of polyurethane, the adhesion and durability of cement mortar has been improved. The addition of the organic polymer materials improves the performance of cement mortar. In polyurethane modified cement study, Xinggui Li [1,2] noted that the polyurethane itself reduced cement mortar strength, but increased the impermeability, frost resistance and shrinkage resistance of cement mortar. And superplasticizer improved the strength of polyurethane modified cement mortar. The difference between polyurethane and other polymers is that the polyurethane materials have not water-reducing effect. By contrast, polyurethane molecules are reactive with water to lose moisture, to hinder hydration of cement, thus reducing the strength.

Cement hydration and polyurethane film forming are the main controlling factors for polyurethane modified concrete. Cement hydration process is prior to polyurethane film-forming process, forming the composite phases. Further, polyurethane modified concrete should reduce the interaction between the slurry and polyurethane, making closed pores and polyurethane film-forming in compatible work. For foam polyurethane film and closed pores, polyurethane foam concrete has good water resistance, thus prevent the intrusion by moisture or air, .

Preparation Materials

Polyurethane. Solventless two-component polyurethane materials, produced by the Foshan Hongbao Li Chemical Co., Ltd., consist of two components commonly known as polyurethane black materials and polyurethane white materials. Black materials are isocyanate semi-prepolymer polyol components, using half the MDI prepolymer-modified to get good mechanical strength of the film formation. White materials are hardeners mainly containing polyol components primarily to accelerate the rate of polymerization of polyurethane.

Cement. 42.5# Portland cement is chosen which is produced by Beijing Jinyu Cement Plant.

Vesicant. KC-15 composite vesicant, produced by Beijing Branch Prudential Building Materials Co., Ltd. Diluted 40 times by water, the vesicant foamed by foaming machine. Blowing agents are dark brown liquids. Prepared foams have high stability, which decrease the possibility of foam concrete sinking and the slurry bubbles bursting caused by volume shrinkage under the pressure of its own weight. Meanwhile vesicant is conducive to enhance foam concrete condensation and hardening rates so that slurry bubbles have been fixed by thickened or hardened paste before bursting.

Foam stabilizer. Produced by Luoyang Hui Er Nami Technology Co., calcium stearate foam stabilizers are used. As a role of waterproof addition agent in the process of cement foaming, calcium stearate foam stabilizers can reduce the water absorption of cement foam boards. And foam stabilizers make foams more stable.

Preparation Methods

There are three orders of raw materials addition to explore the most appropriate order of addition of polyurethane foam concrete.

(1) Firstly uniformly mixing cement and water, polyurethane black materials were added into cement grouts when stirring. Then put polyurethane white materials, rapidly mixing and stirring. After a while, blend the mixtures with foam stabilizers. Finally put into foams made by SDJ36-20 foaming machine.

(2) Firstly uniformly mixing cement and water, polyurethane black materials were added into cement grouts when stirring. Then put polyurethane white materials, rapidly mixing and stirring. The above mixtures are taken as polyurethane aggregates. Stir additional cement slurry and add foam stabilizers. The additional cement system is mixed and stirred with foams made by SDJ36-20 foaming machine. After that, foam concrete is formed. Finally blend and stir polyurethane aggregates with foam concrete evenly.

(3) Firstly uniformly mixing cement and water, polyurethane black materials were added into cement grouts when stirring. Then put polyurethane white materials, rapidly mixing and stirring. The above mixtures are taken as polyurethane aggregates. Stir additional cement slurry and add foam stabilizers. The additional cement system is mixed and stirred with polyurethane aggregates. Finally blend and stir with foams made by SDJ36-20 foaming machine in the common mixtures evenly.

Using SDJ36-20 foaming machine, a proportion of foaming diluents turned into foams. Foams mixing time is determined by achieving fine, uniform and stable foams. Forming polyurethane aggregates are based on the principle that polyisocyanate of the polyurethane responded with water in the slurry rapidly, so that the polymer chains and viscosity increased in a short time. As a result, the polyurethane changed from a liquid state into an original solid state[3].

According to the above three different orders, foamed state and molded state of polyurethane foam concrete is different. The first addition order of polyurethane foam concrete is completed in one cement system under two materials addition, in which polyurethane foams are constrained by blowing agent foams evidently. When forming, the bubbles burst seriously. In the second approach, polyurethane and blowing agents are put into different cement systems to response at first, but polyurethane foam concrete cell will collapse after a period of time. The addition of polyurethane aggregates made foam crushing directly. The third addition order of polyurethane foam concrete is also carried out in two cement systems and the addition of polyurethane aggregates is prior to foam. The post-bubble will not affect the morphological to get fine, uniform and stable foams. After comprehensive comparison, choose the third approach in the experiment.

Preparation Process

The preparation of polyurethane foam concrete should control two aspects. Firstly, film generation of polyurethane and cement hydration are responded adequately at the same time. Secondly, the foaming of polyurethane foam concrete does not affect the polyurethane film-forming as well as foams generated by blowing agents. The key factor in the preparation process is controlling the order of materials addition. Preparation process are shown in Figure 1. Specific operations are as follows.

Step 1, polyurethane aggregates are prepared.

a. According to a water-cement ratio of 0.35, water was added into cement. Stir cement paste evenly.

b. Add polyurethane black materials to step a and stir as quickly as possible. The stirring time is 20 seconds to 30 seconds. The mass of polyurethane black materials is up to 10% of cement mass.

c. Add polyurethane white materials to step b and stir as quickly as possible. The stirring time is 20 seconds to 30 seconds. The mass of polyurethane black materials is up to 10% of cement mass.

d. After about 5 minutes, foams in the mixtures do not change. Then polyurethane aggregates with particle diameter of 0.5-3mm are formed.

Step 2, cement paste is prepared. Mix water and cement together in the proportion of 0.45 and stir cement paste evenly in the container.

Step 3, polyurethane foam concrete is prepared.

a. Polyurethane aggregates made by step 1 are put into cement paste produced by step 2, stirring for 15 seconds to 20 seconds. Polyurethane aggregates take up 20% mass of cement paste mass.

b. Add calcium stearate foam stabilizers which are accounted for 1% of the cement mass into step a. Stir mixtures for 20 seconds to 30 seconds.

c. KC-15 composite foaming agents take account of 1.5% cement mass. A certain amount of foams produced by foam machine are blended to step b.

d. Standing for about 5 minutes, polyurethane foam concrete with no foams changing was obtained.

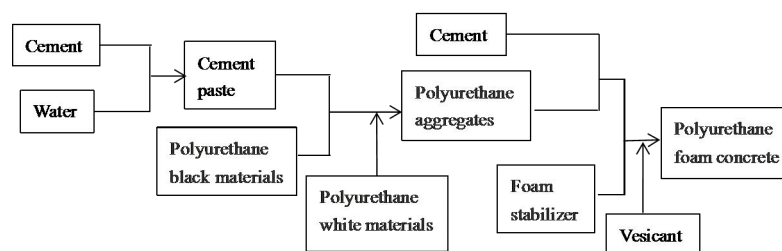


Fig.1 Preparation process of polyurethane foam concrete

Conclusion

Adopted two kinds of cement systems under the post polyurethane aggregates addition, polyurethane foam concrete prepared easily with last mixing blowing agent foams. The post polyurethane aggregates addition method eliminates mutual influences between foams and polyurethane aggregates.

Post polyurethane aggregates addition can significantly decrease the bubble bursting and provide a reference for the preparation of polyurethane foam concrete.

Polyurethane foam concrete is light, soundproof high temperature resistant, corrosion resistant and durable in performance. It can be widely used in roof insulation, wall insulation and floor soundproofed cushion and so on.

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