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Research Status of Foamed Concrete

Qin xin
College of Civil Engineering, Chongqing Jiaotong University Chongqing China

Abstract
Foamed concrete as a new type of lightweight, high-strength and energy-saving building materials, is widely used in the construction industry. As its high quality performance and broad space for development, Foamed concrete has been respected by the construction industry. This paper which based on the foam concrete properties and preparation process analyses the research progress of Blending material, admixtures and fibers' effect on the performance of foamed concrete, puts forward the problem about development and application of the foam concrete in current research, and points out that the sustainable development is the basic idea of the foam concrete further research and application in future.

Keywords: foamed concrete; Preparation technology; performance; application problem

Introduction
Foamed concrete [1] is manufactured by a kind of mechanical foaming method, which makes the vesicant foam in the foaming system of the foaming machine, then the foam can be fully and evenly mixed with the material such as cement paste. And then we construct or mold by the pumping system inside the foam machine. It is a new type of building materials which contains many closed bubbles and is formed in the natural conservation. Because of the foam concrete has light weight, good insulation properties, good fire-proof performance, good seismic performance, durability and other excellent construction performance, it has a very broad application prospect and significance of the research in the construction market in our country.

2. Characteristics of foamed concrete and its preparation process
2.1 characteristics of foamed concrete [2-8]
(1) Light weight. The density of foamed concrete is low than ordinary concrete about 50%-80%, and its apparent density is usually maintained at 300-1200kg/m³. Because of its low density and small load, the weight of today's construction can reduce weight about 25% whether its application on the inside(outside) wall or column structure, sometimes even reach 30%-40% of the overall quality of the structure.
(2) Good heat-insulating property. Foamed concrete is a kind of heat preservation and insulation material which is mainly used in building wall and roof, and has high efficiency of energy saving. Its interior has many uniform pores which control the air in a large part and prevent from the cold and the heat exchanging. The thermal conductivity of the commonly used foam concrete is about 0.1W (K /m), which is 7 times less than that of the clay brick and 14 times less than that of the ordinary cement concrete.
(3) High fire resistance and sound insulation. Foamed concrete is mainly composed of cement paste, aggregate, other inorganic materials (which don't have the chemical characteristics of spontaneous combustion) and dispersed pores, so it has the good fire resistance. At the same time, because of the existence of many closed pores, the foam concrete has a good sound insulation performance.
(4) Good seismic performance. The foamed concrete is of light weight, small density and small elastic modulus. It is a kind of porous structure with many closed bubbles. The foam concrete is a kind of building material with excellent seismic performance when it is subjected to the action of earthquake wave, which can diffuse and absorb the impact load.
(5) Other performance. Because of the porous structure, foamed concrete has good frost-resisting property and corrosion resistance. The foam comes from foaming machine in the stirring process can play a role in reducing the water and lubricating. The foam concrete can use large quantities of industrial waste and other materials, which is not only conducive to the environmental protection, but also reduce the production cost.

2.2 Preparation technology of foamed concrete
The foam is dispersed in the cement slurry evenly, then the cement slurry concretes the foam in the condition of natural curing, thereby foamed concrete is formed. Therefore, the foam's own stability and foaming capacity play an important role in the formation of foamed concrete [9-10]. The pore structure of foamed concrete are formed through three stages [11]. first of all, the bubble is injected into the cement slurry by the foaming machine, gas-liquid interface turns to gas-liquid-solid interface; then cement slurry gradually hardens and wraps the foam, and gradually turns to gas-solid interface; Finally, bubble turns to air vent, the stable gas-solid interface is formed.
The production process of foamed concrete is mainly composed of four parts [12], which are mixing, foaming, mixture stirring and molding. The mixing process is the formation process of cement slurry; foaming process is the process of preparing uniform and stable foam; mixture stirring is the process of making the foam and cement slurry stir evenly; molding is the process of making the mixing slurry cast.

3. Research progress of foamed concrete
The performance of foamed concrete mainly includes physical properties, mechanical properties, durability and functional properties [7]. The additive, admixture, fiber and other factors

have a significant influence on the performance of foamed concrete. So, the author based on a large number of references discusses the main factors which have influence on the performance of foamed concrete.

3.1 Mineral admixture on the properties of foamed concrete

With the rapid development of urbanization, the construction market develops fast. Due to the natural resources isn't renewable, people began to add admixture into the foam concrete for achieving the purpose of saving resources. Zheng niannian [13] made the foam concrete mix design with cement, fly ash and other raw materials in the low water binder ratio, and prepared a light weight, high strength, low dry shrinkage, good heat-insulating property foamed concrete which mixed with large amount of fly ash. Therefore, Add appropriate fly ash into the foam concrete can strengthen its late strength [14]. At the same time, Zhang Xi [15] made foamed concrete with high alkali glass fiber, phosphorus slag, ceramic, construction waste powder and other kinds of admixture, and analyzed the influence on its performance. The results show that the best effect on the foam concrete is construction waste powder according to the density and strength performance. Zhang Ming [16] conducted some experiment to study the effect of fly ash, slag and silica fume on the performance of foamed concrete. On the basis of the stability of slurry, dry density, compressive strength, thermal conductivity and other comprehensive evaluation, the silica fume has the best effect. Therefore, it is advisable to select the fly ash or silica fume to replace some of the cement to product foamed concrete, and the amount of fly ash should be controlled by 10%-20%, the content of silica fume should be controlled in 6%-8%.

3.2 Effect of additives on properties of foamed concrete

Because of the application of foamed concrete is more and more extensive, people have special requirements on the performance in different conditions. So it is necessary to add different types of additives to meet the requirement of the foam concrete. Guan wen [17] analyzed the different application effects of three kinds of water reducing agent (poly carboxylic acid water reducing agent, melamine water reducing agent and naphthalene series water reducing agent) were used in foamed concrete. Results show that naphthalene reducing agent has the best effect, it makes the cement has a high dispersion, increases the 7d and 28d compressive strength of foamed concrete and reduces the natural drying shrinkage, mass water absorption rate and volume water absorption rate. Wang Jianping [18] added some triethanolamine into the foam concrete and found that triethanolamine can not only improve the early strength of the foam concrete but also its compressive strength is increased. Adding HPMC (hydroxypropyl methyl cellulose)is not only can improve the pore structure and distribution of foamed concrete, increase fluidity of slurry and improve the workability, but also can achieve good foam stabilizing effect. Therefore, in the actual production, we should product the foam concrete with triethanolamine and HPMC mixed.

3.3 Influence of fiber on properties of foamed concrete

With the application of foamed concrete is more and more widely, people' research on it is gradually thorough, and we began to add fibers into the foam concrete to improve its tensile strength, crack resistance and anti-deformation capability. Kearsley [19] improved the cracking strength of foamed concrete through the addition of a suitable amount of synthetic fiber. The effect of polypropylene fiber on shrinkage performance of concrete was studied by Zollo [20]. The results show that the incorporation of polypropylene fiber can greatly reduce the plastic shrinkage of concrete. And M.R.Jones [21] made other research found that polypropylene fiber can also enhance the tensile strength of the foam concrete. In addition, basalt fiber, polyvinyl alcohol fiber and glass fiber can improve the early compressive strength and flexural strength at an appropriate amount, and improve the performance of foamed concrete [22-24].

4. Existing problems in the research and application of foamed concrete in China

Application of foamed concrete in China is very wide, but the domestic scholars study on it is still in a primary level. There is lack of comprehensive and micro study on the performance of foamed concrete. Research on the properties of foamed concrete will further promote the application of it. At the same time, foamed concrete in the actual application process also exists some problems [2], such as: foaming technology in China is not mature enough; the mixing of foam cement slurry has a poor stability; finished product of foamed concrete is easy to crack and exists high water absorbing and shrinkage; strength of the product is low; the product with a high density has high conductivity.

5. Conclusion

Sustainable development is an eternal topic, we should make full use of all kinds of industrial waste slag or building materials to produce foamed concrete. At the same time, we should make comprehensive and meticulous research on the performance of foamed concrete, so that it's excellent performance can be reasonable applied. The development direction of China's foamed concrete is clear, the policy environment is possessed, the application market is broad, we will make a breakthrough in the future and make it better serve the construction industry.

6. References

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