Research Progress of Epoxy Resin Concrete

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Abstract: The paper describes the research and development status of epoxy resin concrete composite materials at home and abroad, as well as the development and application in civil engineering field. This paper summarizes the development direction of epoxy resin concrete composite materials and puts forward the viewpoint that epoxy resin concrete is applied to truss structure.

1.Introduction
Epoxy resin concrete is a new kind of concrete material. It has high strength, fast growth strength, good toughness, short forming time and easy construction, etc. In addition, it also has good performance with abrasion resistance, water resistance, chemical corrosion resistance and freeze resistance. Epoxy resin concrete is widely used in practical engineering field.

2.Research progress of epoxy resin concrete abroad
The epoxy resin concrete is a kind of engineering materials in polymer concrete, which has been used rapidly than others. Polymer concrete has been used in the business in the middle of the 20th century in the United States. in the 1970s, Polymer resin concrete is used to repair Portland cement concrete members, mainly used to repair road and bridge components[1-2]. In the 80 s, the U.S. government conducted a lot of polymer resin concrete research, a variety of polymer concrete prefabricated, including drainage component, cellar, cellar cover and machine components, etc[3]. Marinela, Barbuta et al, studied that the mechanical and physical properties of epoxy polymer concrete exposed to the temperature as high as 250 ° C. It is concluded that epoxy polymer concrete has higher mechanical properties compared with the ordinary cement concrete when it exposed to the temperature below 250 ° C. L Sadowski, S Czarnecki, et al, evaluated the height 3D roughness parameters of concrete substrate and the adhesion to epoxy resin. Nan Ji Jin, Jaeheum Yeon, et al, studied the effects of curing temperature and hardener type on the mechanical properties of bisphenol F-type epoxy resin[4-7]. Studies mainly focus on macroscopic mechanical properties and microstructural aspects of polymer concrete materials in the United States, Japan and Europe.

3.Domestic research progress of epoxy resin concrete
In the middle of the 20th century, China began to study and apply polymer concrete. However, the research on epoxy resin concrete in our country is on the mechanical properties of the material itself at present, so the epoxy resin concrete has a very extensive research and development space. [8]Liu Keifei et al, used the independent research and development of epoxy resin concrete adhesive to make the experiment of temperature contraction coefficient, when the initial temperature and the final...
temperature difference reached 40 degrees Celsius, the concrete temperature shrinkage coefficient curve is drawn. The temperature shrinkage performance of epoxy resin concrete was analyzed by using cement concrete as asphalt concrete and epoxy resin concrete at the same level. The compressive strength and compressive modulus of epoxy resin concrete and cement concrete were tested by Liu Kefei and Xu Zhisheng at room temperature and high temperature. It is concluded that mechanical properties of epoxy resin concrete is better than that of cement concrete under the high temperature.

Cheng Jingwei studied the impact of the base concrete and aging performance of epoxy resin. The finite element model is established and the analysis of the test data is compared in the master's thesis. After the mixture ratio continuously optimizing, a new type of epoxy resin base concrete is designed to meet the basic mechanical properties such as compressive performance, tensile properties, bending resistance and interface adhesion performance. Furthermore, the shocking resistance and aging resistance of new materials were analyzed and studied[9].

In recent two years, [10]Lei Wolong from Tianjin University who studied the rubber particles on the mechanical behavior and deformation characteristics of epoxy resin concrete. The deflection line under the loading of 7 days of epoxy resin concrete with different particle sizes and different content of rubber particles was drawn. The experiment was carried out with different sand substitution ratio in the research of rubber particles with different proportion of different size of epoxy resin concrete non-standard specimen of compressive strength, splitting strength, flexural strength and deformation characteristics. The mechanical properties of particle size and ultimate strain values of different rubber content were obtained.

The thermal stress analysis of epoxy resin concrete laminated structure was carried out by Wang Wei, Zhu Cixiang, et al. [11]Abaqus is used to analyze the stress of the structure in curing stage, curing stage, post-curing stage and using stage. It is predicted that the interfacial strength of epoxy resin concrete is higher than that of general type. The influence of the elastic modulus of the aggregate of epoxy resin concrete is given.

Epoxy resin concrete has been widely used by domestic and foreign scholars since its introduction. After half a century of trials and exploration, the mechanical properties of epoxy concrete composite materials have made great progress and breakthrough.

4. Progress of epoxy resin concrete in civil engineering field

With the appearance of many new polymer epoxy resin materials, the application of epoxy resin materials in the field of hydraulic engineering and industry has been increasing in recent years. When the research goes deeper, epoxy resin concrete is widely used in the field of civil engineering, especially the reinforcement technology of epoxy resin concrete applied in building structure reinforcement[12]. Epoxy resin adhesive for epoxy resin have important applications in the field of concrete, the material is widely applied to concrete members of adhesive and repair, bridge engineering, runway repair, road repair and structural fracture reinforcement, etc. Epoxy resin concrete is widely used in the bonding and repair of concrete members. With the rapid development of industrial and civil construction in our country, many large-scale bridge actual traffic volume has exceeded the original plan of the design traffic volume. When there is local crack or damage in the bridge needs to be repaired in time, which leads to traffic congestion, inconvenience to travel and transportation. Application of epoxy resin concrete adhesive on the broken surface can be used to repair damaged road sections.

Epoxy resin concrete is also used in bridge engineering. In the civil engineering structure, the bridge can withstand great stress and the prestressed reinforced concrete is also used in the construction of the bridge. The material composition and characteristics of modified epoxy quick patch materials are introduced and the construction technology of the expansion joint replacement is described by Zhang Junjuan, et al. The construction process of the expansion joint replacement has been used for six months and the performance test results shows that it has excellent effect. Through the research and test of the concrete pavement of epoxy resin in steel bridge, the method of quality
control in the construction of epoxy resin concrete under steel bridge is found by Kang Benjin, Ren Hongmei, et al. Yun Wen, et al, concluded that the concrete pavement structure of perfusion epoxy resin has good adaptability to high stress, high water resistance, good fatigue resistance and good rutting performance. The successful application of perfusion epoxy resin concrete in chongqing yongchuan Yangtze river bridge has achieved good results[13].

Epoxy resin concrete is used in road repair and airstrip field as well. The runway has high requirements for wear resistance and impact resistance. When paving the road, epoxy resin or appropriate plasticizer can be added into the cement paste, such a runway has good abrasion resistance and impact resistance. The highway and national highway also have a high demand for abrasion resistance, especially in the rainy weather to prevent the car from turning or skidding on the brakes[14].

Epoxy resin concrete reinforced concrete shear wall is an important application of epoxy resin concrete.[15] In 2012, Hu Zhirong from south China university of technology, studied the fire resistance of reinforced concrete shear wall with epoxy resin concrete from his master's thesis. The experimental data and analysis method are provided for the fire-resistant design of reinforced concrete shear wall with epoxy resin concrete, which has certain guiding significance for the design and application of the actual reinforcement engineering. In 2017, Zhou Wenping and Huang Haikun used the prestressed steel bar method to reinforce the difficult problems of the materials used in the upper and lower end of the new prestressed steel rod and the anchorage end of the shear wall. The experimental study used epoxy resin concrete instead of the original cement grouting material as the filling material for reliable work. The test results show that the epoxy resin concrete meets the design and construction requirements[16]. The application of epoxy resin concrete to concrete structure has certain guiding significance for the design and application of the actual reinforcement engineering. It receives more and more attention and recognition from the engineering department and people from all walks of life.

5. Development trend of epoxy resin concrete composite materials
At present, there are many problems in epoxy resin concrete composite materials which deserve further study. For example, domestic experimental research has limited the singularity. The focus is mainly on the mechanical properties of epoxy resin concrete, and the preparation cost, processing technology and construction level of the material itself are neglected. Its further research has several main development directions:

1. Study on the properties of epoxy resin concrete. The properties of epoxy resin concrete under the influence of different conditions and environmental factors, such as abrasion resistance, fire resistance, chemical corrosion resistance, impact resistance, aging property, damping performance, etc.

2. The gradation study of epoxy resin concrete. According to the requirements of different design strength, various additives need to be further studied in terms of the proportion of concrete performance improvement.

3. Research on reinforcing and repairing of epoxy resin concrete. Epoxy resin concrete is used in the repair of structure or component, due to the lack of structural local bearing capacity or structural local damage.

4. The economic research of epoxy resin concrete. Strengthen the research of cost reduction, make its price reach the range that people generally accept, make its economic benefit more reasonable, more objective.

5. The research of epoxy resin concrete as load-bearing component in the field of civil engineering.

6. Conclusion
Epoxy resin concrete has high strength, good durability, fast growth strength, good toughness, forming time is short, and the advantages of easy construction, etc. As a high performance material, it is applied in many fields such as machinery, construction, chemical industry, etc. Although epoxy resin concrete
has been widely used in civil engineering in recent years, most of them are used as patching materials, rather than being made into prefabricated components that can be used in engineering to improve structural performance. With the continuous improvement of domestic production technology and the rapid development of the construction industry, China has begun to study and explore more economical and environment-friendly materials with the advanced technology of foreign countries. Based on epoxy resin concrete component of truss structures, with its high strength, better seismic resistance than concrete structure, lower cost than steel structure, better plasticity, assembly and simple construction technology than wood structure, it has a very broad prospects for development and application space.

Acknowledgments
This work was financially supported by the National Natural Science Foudation of China (51678274).

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