Comparison between epoxy resin concrete and traditional materials under high temperature

Yujie Jin¹,a, Jiahui Liu¹,b, Xinying Xie¹,c,d and Lian Zhai¹

¹ Jilin Jianzhu University, Changchun, China

Abstract. The mechanical properties of epoxy resin concrete are compared with those of ordinary silicate concrete and steel under high temperature. The results show that the mechanical properties of epoxy resin concrete under high temperature are better than those of steel and ordinary silicate concrete, and the toughness of epoxy resin concrete under normal temperature is better than that of ordinary silicate concrete. In theory, epoxy resin concrete can be used in structural repair and reinforcement engineering.

1. Introduction
Currently, concrete and steel are commonly used materials for truss structures. However, there are some problems in the process of using concrete and steel. The compressive strength of concrete is high, but the tensile strength is not ideal, and the concrete is easy to crack and has poor chemical resistance. The cost of steel is more expensive than that of concrete, and the high temperature resistance of steel is poor. When the temperature of the structure is higher than 500 degrees, the overall collapse may occur. Secondly, the steel is easy to erode. When the steel is in a humid environment, protective measures must be taken. In this regard, domestic and foreign countries are working on a composite of organic and inorganic materials polymer concrete. Among them, epoxy resin concrete is a type of polymer concrete. The mechanical properties of epoxy resin concrete are significantly improved compared to ordinary concrete, and its tensile strength, compressive strength, and shear strength are all higher than those of ordinary concrete. Epoxy resin concrete also has strong abrasion resistance, water resistance, chemical resistance and frost resistance. Secondly, epoxy resin has high bonding strength with metal and non-metal materials. This indirectly compensates for the disadvantages of low tensile strength, poor crack resistance, and high brittleness of epoxy resin concrete. Moreover, the price of epoxy resin concrete is more economical than the price of steel products. After curing, epoxy resin concrete has strong resistance to the atmosphere, chemical media, moisture, and bacteria. These are not achieved by ordinary steel materials. Therefore, it can be widely used in building structures and small projects such as repair and reinforcement of structures.

2. Steel structure under high temperature
Epoxy resin is a kind of building material between the coagulation of steel and ordinary silicates. The price of epoxy resin is slightly more expensive than that of ordinary steel. On Material Properties, Epoxy resin concrete also has mechanical properties that many steels and ordinary portland concretes do not possess. Every year, frequent building fires occur in our country. The heavy losses after the disaster are also startling. Steel as the main material of the steel truss structure itself is not a...
combustion body, but its fire resistance is not ideal. Many experiments have been conducted on the fire-resistance of steel at home and abroad and have achieved satisfactory results\[4\]. Experiments show that when the general steel temperature reaches 350°C, 500°C, and 600°C, the steel strength will drop to 2/3, 1/2, and 1/3 in turn. Under normal circumstances, the steel will lose the stability of dynamic equilibrium when the temperature reaches 550°C. It can be seen that when a fire occurs, the reduction of the mechanical properties of the steel will lead to local destruction of the truss structure, and the local damage will lead to the overall imbalance of the truss structure. The internal force of the components will occur under the action of external force and self-weight distributed\[5\].

3. Normal concrete at high temperature
Ordinary concrete under the action of fire, high temperature will make the absorbed water in the concrete, free water and chemical crystal water rapid steam overflow, in the coagulation soil internal voids produce considerable steam pressure, when the steam pressure exceeds the tensile strength of concrete, will make the concrete internal micro crack expansion, so as to change the mechanical properties and thermal properties of concrete\[5\]. At high temperature, the material properties of concrete will deteriorate. with the increase of temperature, the volume expansion and strength of concrete will decrease. On the surface of the concrete will appear crack, even crisp, protective layer off, steel exposed and peeling, section thinning phenomenon such as\[6\]. Moreover, the mechanical properties of ordinary silicate concrete will gradually decrease with the increase of temperature.

4. Epoxy resin at high temperature
As a comparison of the mechanical properties of epoxy resin at room temperature and high temperature, the compressive strength of epoxy resin concrete at room temperature is basically the same as that of ordinary portland concrete, but the compressive strength is significantly lower than that of ordinary portland concrete. This shows that the deformation of epoxy resin concrete under the same load is significantly greater than that of ordinary silicate concrete, that is, the toughness of epoxy resin concrete is significantly better than that of ordinary silicate concrete. When the temperature rises, the compressive strength and elastic modulus of epoxy resin concrete are similar to those of ordinary silicate concrete, both of which increase first and then decrease with the increase of temperature. High temperature around 100°C can further strengthen the fixed-line epoxy resin system, so as to enhance its mechanical properties. Compared with ordinary silicate concrete, in the temperature range of 100 - 900°C, the compressive strength and elastic modulus of epoxy resin concrete tends to be consistent, and the attenuation range of the test index value is more uniform in each temperature interval. at 500°C, 700°C and 900°C, the compressive strength loss value of epoxy resin concrete is about 14%, 19%, 16%, and the loss value of elastic modulus is about 20%, 21%, 19%, respectively. The ultimate residual values of compressive strength and modulus of elasticity of epoxy resin concrete are about 52% and 42% of the initial values, respectively. The mechanical properties of epoxy resin concrete are better than ordinary silicate concrete at high temperature. Ordinary silicate concrete due to the internal contains a large number of crystal water, easy to produce a larger vapor pressure at high temperature, when the temperature reaches 300 - 600°C can produce burst (specific temperature depends on the strength grade and moisture content of concrete)\[7\]. And epoxy resin concrete binder for epoxy resin binder, which does not contain water, so there is no risk of bursting, and theoretically can be used in the repair and reinforcement of damaged concrete, but the epoxy resin concrete at high temperature of the internal temperature field distribution, deformation, various types and size of the bearing capacity of structural members still need to be determined by further research.

5. Conclusion
At room temperature, the compressive strength of epoxy resin concrete is almost the same as that of ordinary portland concrete, but the compressive strength is lower than that of ordinary portland concrete, which indicates that the toughness of epoxy resin concrete is better than that of ordinary portland concrete.
In the temperature range of 25 - 900 °C, the elastic modulus and compressive strength of epoxy resin concrete will increase slightly first and then decrease gradually, and the decline of each index tends to be consistent, and the attenuation amplitude of the test index value is more uniform in each temperature compartment. This shows that the mechanical properties of epoxy resin concrete are better than ordinary silicate concrete at high temperature.

Because epoxy resin does not contain moisture, its main binder is epoxy resin binder, so the epoxy resin concrete does not have the risk of bursting under high temperature.

Compared with the steel structure, the epoxy resin at high temperature does not deform due to the increase of temperature and lose its stability.

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