Discussion on the Research Status of New Epoxy Resin Concrete Assembled Truss Joints

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Abstract. The new epoxy resin concrete has the advantages of high strength, good durability, fast strength growth, good toughness, short molding time, and easy construction. It is widely used in the field of materials. This paper summarizes the research and application status of epoxy resin concrete, the principle and development of truss structure, and the research status of truss joints at home and abroad, and discusses the prospects and prospects of new epoxy resin concrete in the field of assembled truss joints.

1. Introduction
In this paper, the new epoxy resin concrete is used as the structural material to study and discuss the truss structure. The basic force unit of this structural system is a truss, which is formed by connecting the new epoxy resin concrete chord, web rod and node plate with bolt. It has the advantages of superior overall performance, high bearing capacity, strong plasticity, high rigidity and short curing time. The node area is the most complicated area in the whole truss structure. In order to ensure the joint force and coordinate deformation of the node area, the study of the bearing performance, failure mode and ultimate bearing capacity of the node affects the stability and safety of whole truss structure. Therefore, research on the mechanical properties and ultimate bearing capacity of truss joints is particularly important. In this paper, the research and discussion of epoxy resin concrete and truss nodes provide theoretical support for the future research on the material properties of epoxy resin concrete and the bearing capacity of truss nodes. Since the advent of epoxy resin concrete, scholars at home and abroad have conducted extensive research and exploration on it. The mechanical properties of epoxy resin concrete composite materials have made great progress and breakthroughs, but there are also many problems. All professional scholars have not formed a unified standard for the mix ratio of epoxy resin concrete. The mechanical properties of epoxy resin concrete obtained from different studies are obviously different. The research on this material still needs to be systematically improved.

2. Overview, research and application status of epoxy resin concrete
2.1. A subsection Overview of epoxy resin concrete

New epoxy resin concrete is the most widely used in polymer concrete. Epoxy resin concrete uses epoxy resin as the main material, mixed with an appropriate amount of curing agent, plasticizer, thinner and filler as an adhesive, and sand and stone as Aggregate, a composite material shaped by mixing, molding and curing, also known as new epoxy resin concrete, is a kind of pure polymer concrete. The new epoxy resin concrete not only has the strong points of high strength, good toughness, high impact strength, fast strength growth, good toughness, short molding time, etc. At the same time, it also has strong wear resistance, water resistance, chemical resistance and Good properties such as frost resistance; The cured new epoxy resin concrete has a strong resistance to the atmosphere, moisture, chemical media, bacteria, etc ; The epoxy resin concrete material has good properties and has been obtained in municipal facilities and construction projects Certain applications[1].

2.2. Research status of epoxy resin concrete

Epoxy concrete is a type of polymer concrete[2]. Polymer resin concrete was used in commerce in the United States in the mid-twentieth century[3]. In the 1970s, polymer resin concrete was used in the repair of Portland cement concrete components, mainly highway and bridge components[4]. In the 1980s, a large amount of research on polymer resin concrete was carried out in the US government. There are still a variety of precast polymer concrete components on the market, including drainage components, manholes and manhole covers, and machine tool components[5]. In the 1990s, M. Saiti and F. Gordaninejad and others studied graphite epoxy concrete composite beams through experiments [6]. At the beginning of the 20th century, J. Reis and A. Ferreira used short carbon and glass fibers to reinforce the fracture properties of epoxy polymer concrete, and analyzed the influence of fibers on the mechanics and fracture properties of polymer concrete [7]. Marinla and Barbuta et al. Studied the mechanical and physical properties of epoxy polymer concrete exposed to temperatures up to 250 ° C, and concluded that when exposed to temperatures below this temperature, epoxy polymer concrete has High mechanical properties [8]. Sadowsk et al. Evaluated the three-dimensional roughness height parameters of concrete substrates and the adhesion to epoxy resins [9]. Nan Ji Jin and Jaeheum Yeo and others studied the mechanical properties of bisphenol f-type epoxy resin concrete under the influence of curing temperature and curing agent [10]. In the past two years, Lei Wolong and others from Tianjin University have studied the mechanical properties and deformation characteristics of rubber particles on epoxy resin concrete. The experiment draws the deflection curve of epoxy resin concrete with different particle sizes and different amounts of rubber particles loaded under 7 days. In the experiment, different sand substitution ratios were compared to study the effects of different content and particle size of rubber particles on the compressive strength, split strength, flexural strength and deformation characteristics of non-standard epoxy resin concrete specimens. Experiments have obtained the mechanical properties and ultimate strain values of different rubber dosages and particle sizes [11]. Wang Wei, Zhu Cixiang and others conducted thermal stress analysis of epoxy resin-concrete laminated structure, combined with the analysis of abaqus finite element software to analyze the structure of the structure in the epoxy resin curing stage, curing stage, post-curing stage and use stage According to the stress analysis of the system, it is proposed that the thermal stresses in the epoxy resin at various stages include shrinkage stress, curing stress, post-curing stress and temperature stress. The elastic modulus of the epoxy resin is 131.9MPa and the ultimate tensile strength is 4-5MPa. According to the test, it is analyzed that curing after high temperature will reduce the linear expansion coefficient of the epoxy resin and increase its elastic modulus[12].

2.3. Application status of epoxy resin concrete

In recent years, with the emergence of many new polymer epoxy resin materials, the application of epoxy resin materials in the fields of water conservancy engineering, industry, and construction has gradually increased. Through in-depth research on epoxy resin concrete, epoxy resin concrete is being extensively used in the field of civil engineering. Epoxy glue made of epoxy resin is an important
application of epoxy resin in the field of concrete. This material is widely used in the bonding and repair of concrete components, bridge engineering, repair of airstrips, highway repairs, concrete structures Crack reinforcement and other fields.

3. Principle, development and application of truss structure

3.1. Principle of truss structure
The truss in the truss structure refers to the truss beam, which is a lattice structure. From a mechanical point of view, the stress of each member is mainly unidirectional tension and compression. If the members are correctly arranged, it can better adapt to the bending moment and shear force distribution inside the structure, and can give full play to the performance of materials [13]. In the truss structure, the bars that intersect at the nodes are usually called chords and webs. The webs are divided into vertical webs and diagonal webs according to different arrangements. In the design of truss, the joints are generally regarded as articulated, that is, only the axial tension and compression force of the members are considered. The truss structure is divided into plane truss and space truss according to the space form. Plane truss means that the truss is in the same plane and can only bear the load of the same plane; space truss is a structure different from plane truss. The cross section of space truss is composed of web rods and chords. The abdominal rods form a certain geometric shape, and common ones include triangles and rectangles. The truss structure is suitable for large-span projects that cannot meet the design requirements with a single member.

3.2. Truss structure development
Two thousand years ago, the stability of the triangle was discovered by primitive humans, and the triangle truss was invented, which was extensively applied to ancient wooden roofs. As a building material, wood is rich in resources, made from nature, easy to process, and convenient to transport. The triangular truss that has always been accompanied by human civilization has only two diagonal upper chords and one horizontal lower chord. The ancient Romans used trusses to construct the superstructure of the Trejon Bridge across the Danube. Based on practical experience, three webs were added to the position of the midpoint of the chord in the triangle, and two basic forms of single-post truss and double-post truss were evolved. As the span increases, more webs and chords need to be added, that is, to raise the number of nodes. To the 19th century, various modern truss forms appeared, such as Warren truss, Howe truss, Fink truss, Pratt truss, etc. For a long time, the connection node of the tension member has been the weak point of the wooden truss. Howe replaced the wood with cast iron for the truss vertical rod, which simplified the complex tenon joint structure at the node and increased the service life of the truss. Moreover, Howe uses a threaded rod, and the two ends are fixed with nuts, which makes the vertical rod an adjustable tension member. By changing the length of the rod, the large deformation of the bridge during use can be partially restored. This is one of the most important characteristics of Howe truss. Howe truss is therefore considered to represent the highest achievement of a wooden truss bridge, and also a starting point for the transition of truss beams from wood to metal materials. Pratt truss structure form is inclined rod as tie rod, vertical rod as compression rod. Pratt truss began to be used in large quantities in the late 19th century for simple statically determinate structures. The most widely used triangular truss has also become the Warren truss, but it was not popular in the 19th century. When the span is large, the equilateral triangle can be divided into two right triangles with vertical rods to reduce the node spacing and improve support Stiffness. On the basis of the truss material distinction, the truss material is not limited to wood, but can also be divided into steel truss, reinforced concrete truss, rigid and concrete combined truss, etc. According to the connection mode of the node, it can be divided into rigid truss and articulated truss; geometrically, it is divided into simple truss, combined truss and complex truss. Due to the diversification of specific forms of truss structure, the classification of truss has diversity [14].

3.3. Truss structure application
With the continuous development of the construction industry, architectural design needs to content the advantages of large span, many shapes, beautiful appearance and so on. The truss structure is a relatively common structural form in engineering practice, and generally applies to large public civil buildings such as bridges, stadiums and airports. At present, the truss form is classified according to the material type: steel structure truss, wood structure truss, reinforced concrete or prestressed concrete truss, combined structure truss. With the constant innovation of building materials, the truss gradually develops from the traditional single material to the combined truss structure, which promotes its wide application in the field of civil engineering.

4. Research status of truss joints at home and abroad

4.1. Theoretical research and experimental research of truss joints

In 1936, Rathburnt proposed the slope deflection method and applied it to the elastic analysis of nodes. In 1970, Ronstad and Sumrananian first proposed the bilinear model of the bending moment-rotation relationship, that is, for the connection of most members, axial deformation and shear deformation are very small compared with rotational deformation, so from the practical experience of engineering It is concluded that only the rotational deformation of the connecting piece needs to be considered. After the 1990s, experts and scholars are no longer limited to the study of the mechanical properties of the joint itself, and began to study the impact of the node on the entire structural member. Liu Yongjian carried out a series of work on the rectangular steel tube concrete truss node[15]. As the first domestic test in the thesis, the carrying capacity of rectangular steel tube concrete T, Y, X, K type nodes and rectangular steel tube Y, X, K type nodes was studied, and the filling concrete, the geometrical size of the node, the chord shaft were compared and analyzed. The influence of force and other parameters on the bearing capacity of the node. It can be used for reference by technicians in the truss design room.

4.2. Research on Ultimate Bearing Capacity of Truss Node

Wang Haijun produced three 1: 3 ear plate type combined truss node models. Through horizontal monotonic static loading and finite element simulation analysis of the model. It is concluded that the failure mode of the node model mainly includes local buckling of the compression web and tension web and the cracking of the concrete in the core area of the node. High force, PBL shear key group and node plate effectively connect the web and chord into a whole. Zhou Lingyu conducted monotonic static tests on three external rigid-concrete composite truss nodes using PBL connectors and applied the finite element software ANSYS to analyze the whole process. It is concluded that the failure of the nodal plate is mainly due to the slippage of the connecting tension rod and the nodal plate bolt, the cracking of the concrete, and the stress concentration at the contact part between the steel and the concrete. Increasing the thickness of the joint plate can effectively improve the yield strength and ultimate bearing capacity of the joint. Zhang Shiyu conducted experiments and finite element analysis on complex nodes in the transition layer of the podium in Raffles City, Changning, Shanghai. Equivalent strain is used to represent the strain development process of the node core area during the entire loading phase. Tests have shown that under low-cycle repeated loads, the plastic deformation of the two nodes is mainly concentrated at the junction of the steel reinforced concrete column and the chord flange, and the chord and the web have almost no yield. The failure mode is the shear failure at the junction of the column and chord flange, which is accompanied by the cracking and crushing of the concrete. This kind of damage belongs to the failure of column hinges, and such nodes should be strengthened in engineering design. Chinese and foreign scholars have conducted various designs and experimental studies on different types and different materials of nodes, which provide an effective reference for the design of new epoxy resin concrete truss nodes.
5. Summary
This paper introduces the research and application status of epoxy resin concrete, the principle and development of truss structure through reference to a large number of documents, and combined with the research status of truss joints at home and abroad, summarizes and analyzes the new epoxy resin concrete truss structure is a new structure form. It gives full play to the respective advantages of the two different materials, increasing the strength and rigidity of the structure, increasing the bearing capacity, reducing maintenance and repair costs, and can be easily transported and assembled. New epoxy concrete truss structure has broad application prospects. Although there have been some experimental research results and examples at home and abroad, there are differences in load standards and construction techniques caused by different test materials and node types, and the force mechanism of epoxy resin concrete truss structures is not well understood at present. Therefore, this research has important theoretical value and practical significance.

6. Conclusion
With the unceasing innovation of domestic science and technology and the rapid expansion of construction industry, China began to research and explore more economical and environmentally friendly materials in combination with foreign advanced technology. Better earthquake resistance than concrete structure, cheaper cost than steel structure, better plasticity than wood structure, can be assembled and simple construction process "and other advantages, has a very broad development prospects and application space.

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

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