Computer Model and Analysis on Pavement Performance and Pavement Structure of Polypropylene Fibre Material Concrete

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Abstract. With the great progress of road construction ability and construction technology, new materials are constantly developed, the choice of road surface materials is more diversified, and the pavement structure is more reasonable and the performance is more optimized, which brings great convenience for the first paving and later maintenance of the road. In this paper, by studying computer modeling and analysis technology, the polypropylene fiber concrete pavement in the road is analyzed and studied, and the experiment is designed in detail to describe the current actual situation, and the conclusion is drawn for study and research reference.

Keywords: Computer Modeling, Polypropylene Fiber, Concrete

1. Introduction

With the enhancement of China's overall strength, the rapid development of the national economy and the improvement of people's living standards, all kinds of motor vehicles in China are increasing day by day, and the destruction of road surface is accelerating day by day. From the existing cement concrete pavement, especially the cement concrete pavement built in the late 1980s, due to raw materials, design level, construction capacity, construction management, quality control, natural conditions and over-limit transportation and other reasons, put into use for two ~ five years need large area repair. Some roads are in urban areas or more important areas, the time of opening traffic is limited, so it is necessary to study a cement concrete pavement repair material, open traffic time 4~6 h, can achieve thin and thick layer repair, the same speed as ordinary concrete construction, wear resistance, impact resistance, corrosion resistance and other aspects are superior to traditional concrete, and achieve vibration-free. In recent years, the research on pavement repair materials is relatively hot[1]. Experts and scholars have carried on the experimental research to the cement concrete pavement multifunctional quick repair material, proposed that the borax, the fly ash to the setting time adjustment function is limited, when the ordinary Portland cement content
exceeds 70%, the setting time may extend significantly. The compound early strength rapid repair agent is developed by multi-element composite technology, which has the advantages of high early strength and stable later strength development. An organic and inorganic cement concrete pavement rapid repair material has been developed\textsuperscript{[2]}, it has high strength and hardness, excellent wear resistance and is firmly bonded with cement concrete pavement slab. It can be used for rapid repair of local damage of cement concrete pavement. Based on the analysis of concrete diseases and repair types, this paper classifies the concrete repair materials and discusses the selection principle of concrete repair materials. However, there are few studies on the influence of polypropylene fiber on cement concrete pavement repair materials, and on the impermeability and wear resistance of polypropylene fiber rapid pavement repair materials\textsuperscript{[3]}.

2. Concept of computer modeling

With the computer technology going deep into the political, economic, scientific and technological application fields of society, the research of complex system modeling and modeling tools based on computer technology has attracted more and more attention and discussion. To measure the maturity of a computer modeling approach, the degree of adaptation and mutual support of its three organic components can be examined. These three organic parts are. (1) Correct methodology. It is enough to guide the modeling work to reach the set goal; it can guide the development of the next modeling method, expand the application population and application field, reduce the learning threshold and shorten the learning cycle. (2) Feasible engineering modeling route or process. (3) Effective computer support. We think that the methodology of studying complex systems can use the whole model method; the prototype method can be used to establish the computer model of complex systems; the spreadsheet software is a fairly widely used software for modeling complex systems, or this software is a meta-model software for complex systems. Figure 1 is a schematic diagram of the computer modeling mechanism\textsuperscript{[4]}.

![Figure 1. Schematic diagram of the computer modeling mechanism](image)

2.1. Whole model method

It is a methodology for studying complex systems. The whole model method regards the typical problems of the selected problem domain as an organic whole with its own internal relation, pays attention to and recognizes the multi-directional inherent relation between the
basic elements of the system, and avoids the influence of the model elements on the multi-directional, holistic, effective, grow-able, and so on. We should respect the laws of the real world and avoid making the objects of the problem domain fit the model form of a priori. In the process of expressing and adapting objective laws with computer tools, we are ready to establish new models and model types at any time, enrich the understanding of world diversity with practice, and improve the ability to use objective laws[5]. This method is the correct way to build complex system models for many unknown domains. With the support of the National Natural Science Foundation of China, we developed a decision-making support system for overseas investment capital of Chinese enterprises.

2.2. Prototype method

In recent years, in the development of various computer applications, the development route using prototype method has gained more general recognition. This is because computer technology goes deep into more complex application problems, and computer technology becomes more obvious and necessary to solve the problem from the demand of solving the problem. The so-called prototype method is to form the initial version of the operational system model at the beginning of the system modeling. By running the system prototype, the discussion of the real system and the computer model system between the user, the upper supervisor and the modeler is carried out early, and the improvement scheme of the model system is formed.

3. Research Status of polypropylene fiber concrete

Fiber Reinforced Concrete usually refers to the composite materials that add appropriate amount of fiber to cement concrete to improve the performance of cement concrete, and improve the mechanical properties and durability of concrete by adding fiber to concrete. The fiber used has metal fiber, inorganic fiber and organic fiber, polypropylene fiber belongs to organic fiber, because polypropylene fiber has the advantages of cheap raw materials, good alkali resistance and chemical stability, polypropylene fiber has become a widely used fiber at present. Compared with ordinary concrete, polypropylene fiber concrete has many advantages, such as lower brittleness, better fatigue resistance, better impact resistance and better crack resistance. Recent studies have shown that there are two main reinforcement mechanisms of polypropylene to concrete, one is fiber spacing theory. The other is composite material theory. Fiber spacing theory holds that there are inherent cracks and defects in concrete. Adding appropriate amount of polypropylene fiber can reduce the stress concentration caused by micro-cracks and early shrinkage cracks in concrete. The composite theory regards the material as a multiphase system[6].

To sum up, the mechanical properties, durability and corresponding theoretical analysis of polypropylene fiber concrete have been carried out at home and abroad, but the corresponding properties of pavement are still relatively few, especially the research of polypropylene fiber concrete as overlay concrete almost null. In this paper, the mechanical properties, road durability, freeze-thaw and simulated wheel load properties of polypropylene fiber reinforced concrete are studied, and the deformation properties of polypropylene fiber reinforced concrete are also studied.

4. Research status of interface bond of new and old concrete
At home and abroad, the bond properties of new and old concrete have been tested, theoretical analysis and engineering application. The study shows that the main factors affecting the bond strength of new and old concrete are the strength of new and old concrete body, the roughness of bond interface, the type of interface binder, the treatment method of bond interface, the position of bond interface and the environmental factors of curing and using, etc. At present, the test methods of bonding mechanical properties of new and old concrete at home and abroad include cube bond splitting tensile strength, tensile strength test, bond shear strength test, bond flexural strength test and bond tensile strength test. The bond shear strength test includes direct shear strength test, tensile shear strength test and compressive shear strength test. The study shows that the bond strength of the bond surface is usually lower than the corresponding strength of the new and old concrete body. At present, the main treatment methods of bond interface at home and abroad are artificial chipping method, sand blasting method, high pressure water jet method, notch method, chemical corrosion method and so on. In a certain range, the roughness of the bond interface can be increased, and the evaluation methods of the roughness of the bond interface include sand filling method, aggregate exposure ratio method, fractional dimension method, roughness measuring instrument method and so on. It is pointed out that rough treatment of interface with interfacial binder is beneficial to improve the bond strength. When epoxy resin is used, the damage position can appear in other positions outside the bonding surface.

5. A study on the properties of polypropylene fiber cement paste by computer modeling

Cement concrete pavement panel is the main body of pavement structure which directly bears driving load and environmental factors. As the grouting material of pavement slab bottom, it should also have the same mechanical properties as the surface layer, such as high strength, low elastic modulus and small shrinkage deformation. In this section, the properties of concrete pavement and pavement structure of polypropylene fiber are studied mainly from the aspects of compressive and flexural strength of polypropylene fiber cement slurry by computer modeling.

5.1. Folding resistance

As pavement structure material, the mechanical properties of concrete are quite important. As a part of structural material, plate bottom grouting material must also have good mechanical properties. As cement concrete pavement slab bottom void grouting material, like pavement slab, need to resist driving load and environmental factors, the slab bottom grouting material should have a certain compressive strength and flexural strength.

5.2. Overview of the experiment

Make 40 mmx40mmx60mm of pure slurry specimens, the fiber volume mass was 0.1%, 0.2%, 0.3%, 0.4%, respectively, and 6 specimens with a mix ratio were cured under standard conditions until the mold was removed and put into the pool to maintain to the specified age. The strength test of cement mortar is carried out according to the regulations, and the flexural strength is tested by electric flexural testing machine of mortar.

5.3. Experimental data analysis

The test specimens prepared according to the specifications will be maintained to the specified age under the standard curing conditions, according to the provisions of cement
sand strength test method to test the flexural strength, to obtain different curing age, different volume of different volume of polypropylene fiber cement slurry test. The results of the test data are shown in Figure 2.

| Volume fraction | 12h | 1d  | 3d  | 7d  | 14d | 28d |
|-----------------|-----|-----|-----|-----|-----|-----|
| 0               | 1.50| 3.12| 4.64| 5.51| 6.23| 6.60|
| 0.1%            | 1.83| 3.58| 5.81| 6.20| 6.81| 7.21|
| 0.2%            | 1.79| 3.30| 5.26| 5.91| 6.34| 6.76|
| 0.3%            | 1.90| 3.98| 5.69| 6.07| 6.67| 6.80|
| 0.4%            | 1.96| 4.33| 5.92| 6.23| 6.93| 7.53|

**Figure 2.** The results of the test data

6. Conclusion

A very superior property of polypropylene fiber cement slurry is found through compression test, that is, with the increase of loading displacement, polypropylene fiber cement slurry specimen still better maintain the integrity of the specimen, increase the ductility of cement slurry compression failure, in the process of failure, there is no collapse phenomenon, so that the cement slurry shows the properties of ductile failure: while the contrast ordinary cement paste specimen cannot maintain the integrity of the specimen with the increase of loading displacement, the specimen damage becomes more and more serious until it cannot be loaded. It can be seen that the cement slurry of polypropylene orange fiber has better ductility than the ordinary cement paste, and has the ability to work with cracks.

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