Asia-SAME Transactions on Engineering Sciences, ISSN: 2377-8970
ISBN: 978-1-948012-15-7 https://doi.org/10.7508/aste.01.2020.01.08

Experimental Study on Mechanical Behavior of Fabric Reinforced Cement Composites Based on Modern Concrete

Xiaoxi Bi*, Yang Yv, Zhijun Zhang, Fangli Lv, Peitao Qiu
Xuzhou University of Technology, Xuzhou 221000, China
*Corresponding author: 404603448@qq.com

From 2020 International Conference on Engineering Research, Beijing, China. 12-14 April 2020, Organized by University of Science and Technology Beijing and International Association of Management Science and Engineering Technology (IAMSET).

Abstract: The fabric is formed on the basis of three-dimensional structure generated by the textile technology, belonging to a kind of advanced form of short fiber. Therefore, fabric yarn in the process of application reflects the clear direction, and the fabric surface characteristics and short fiber has the remarkable difference. With the contrast of short cut fiber, fiber fabric of cement matrix enhancement mechanism is more obvious. After the optimized treatment, the cement-based composite has the advantage of short fiber and significant enhancement efficiency. In this paper, the mechanical properties and characteristics of the typical fiber-reinforced and cement-based composites are studied by analyzing and discussing the experiments of different types of fiber-reinforced and cement-based composites.
Keywords: Modern concrete, fabric, cement-based composites, mechanical behavior.

Introduction

Based on the fabric fiber reinforced and cement-based composite material, it has become the basic way to effectively strengthen the interface properties and mechanical properties of the concrete matrix [1]. The fiber with higher elasticity can obviously improve the strength of the matrix, but its toughness enhancement effect is not good. On the contrary, the effect of fibers with lower elasticity on matrix toughness enhancement is extremely obvious, but the effect on strength is not obvious. At present, woven fabric is often used as geotextiles in the field of construction, not only in the production process of fabric-based reinforced and cement-based sheet, but also in the repair and renovation of buildings. Both fibers and woven fabrics have their own characteristics. Fiber is often used in aerospace and other industries because of its thermal and anticorrosive properties. At present, the application of carbon fiber is to enhance the matrix function. Therefore, in recent years, the application function of carbon fiber in composite material has attracted wide attention from scholars. In addition, it is a difficult problem to give full play

to the advantage function of fiber. The composite material formed by fabric can fully show the mechanical properties of fiber, especially its advantages.

Fine concrete material

Cement-based materials are artificial composite materials, known for their bulk characteristics, which are usually used in construction and structural engineering. At present, the world's cement production is up to 3 billion tons, and the production of cement-based materials is much higher than the production of cement, so the use of cement with the construction of infrastructure gradually increased. In the early process of building materials, cement-based materials have a variety of components, including Portland cement and sand. In particular, the production components of fine concrete are more abundant. The function of fine concrete is to effectively bond the fiber fabric with the matrix, while fine concrete is developed by selecting advanced technologies on the basis of optimal design [2]. As analysis and exploration of green cement base material, the cement base material is improved and optimized to some extent. In the process of research and development to enhance the mechanical properties of cement base material, the toughness and practicability is enormously enhanced, and be continuously toward the environmental protection and energy saving industry rapid development, which significantly reduces the energy consumption. Therefore, its coordination and durability characteristics is critical for cement base composite material, especially for fabric has the advantages of function that are even more significant. In addition, in order to meet the needs of composite materials for matrix, the selection of concrete materials should meet various requirements in the production process, so as to develop TRC composite materials with better performance.

Research on fiber reinforced cement-based composites

Both at home and abroad, fiber-reinforced and cement-based composites have been thoroughly analyzed and short-cut fibers have been used as advanced forms of fabric. For example, the multiple performance of concrete can both be enhanced, such as prevent the practical performance, such as crack, tensile and gives concrete special function, such as radiation protection, prevent infiltration and shrinkage compensation performance. In addition, it also makes the building have some intelligent functions, such as temperature independent regulation and damage diagnosis [3]. The surface characteristics of fabric are different from those of staple fibers, so they have different strengthening mechanism and effect on concrete substrate. After optimized treatment, the cement-based composite formed by mesh fabric not only has the advantage of short fiber, but also has significant enhancement efficiency, which can bear a part of the force for steel reinforcement [4].

Mechanical behavior test of fabric reinforced and cement-based composites

Tensile test of fabric reinforced and cement-based composites

TRC cement base composite material has stronger ability of deformation. If under a certain force, the change of the concrete crack is increasing, which also leads to the occurrence of more crack in cement-based and composite materials tensile strain hardening at the same time. In the process of cement-based and composite materials continuing to stress, because the fabric has the function of adhesion will change, so the crack of the fiber bond function reduce to seamless state of matrix. And the matrix of crack for fiber are adhesive to the function of each other between the bridge and the coupling, which changes the form of crack, and from the larger original single fracture morphology into smaller fracture morphology, which effectively changed the concrete material before the shape of the trough.

Due to the effect of tensile sample of TRC composites, thus early cracking load and crack strain is very critical, aiming at this situation, the famous professor Xu Shiliang organized professionals to further study the short cut fiber TRC cement-based composite materials with the function, and the final result shows that: in the short cut fiber content under the premise of keeping in a reasonable scope, cutting short PVA fibre in TRC composites matrix obviously optimize the tensile properties. Although the manufacturing process of TRC composite materials is convenient and easy, the test of samples and the production results are crucial, so in order to prevent the potential defects of the matrix itself in the production process of finished products, and the test phase of samples in the early stage must be better.

In order to obtain more accurate and objective test information during the test process of TRC composite samples, the test standards and methods should refer to the specifications, standards and methods based on fiber reinforced resin matrix composites.

The toughness and practicability of TRC composite material are very significant, while the melting of alkali resistant glass fiber makes TRC composite material have the characteristics of anti-magnetism and anti-corrosion, and optimize the mechanical properties. The test of the sample can fully demonstrate the properties and effects of the composite material. The most important function of TRC composite material is its mechanical properties, which promotes the research on the stressed part of the composite material.

The most common solution to the application of fiber mesh to reinforced concrete substrates is to melt the fibers into epoxy colloid, which has the function of fusing the filaments in the fiber mesh bundles to form a complete individual. The experimental results show that the interfacial properties between the fiber and the matrix can be improved effectively after simple treatment. Moreover, the treated fiber bundle can disperse the stress, thus improving the mechanical properties of interfacial bonding. The fiber fabric mentioned in this paper is basically formed after treatment. According to the research and exploration of the above contents, the treatment process of the fiber braided net structure should be more difficult and complicated than the reinforced concrete materials used in the past.

Test of pulling out of fabric reinforced cement-based composite material

For composite materials, unidirectional fiber bundle has relatively weak bearing function. In addition, the experiment of TRC composite material is still in the stage of continuous research and exploration. In order to highlight the main factors, the thinking mode of scholars is probably the fiber pull out test with unidirectional fiber pulling out in the concrete matrix as the starting point. This test experiment can provide a key reference for the enhancement of TRC composite material performance, thus realizing the optimization of interface performance, and providing data support for the formation of interface theoretical model and enhancement of performance. In addition, the pull-out tests scientifically choose fabric type, select more high-quality fabrics to enhance the performance of the interface, thus optimizing the component performance. According to the fact that fabric has the unique characteristics of woven mesh for concrete substrate with good anchoring function, the TRC composites interface performance is significantly improved. In addition, the existence form of the fiber fabric and the manufacture method of the matrix can effectively improve the mechanical properties of the TRC interface [5], so as to fully demonstrate the function and effect of the fabric. Most scholars consider the fabric and the functions of short cut fiber diversity research, and the final result shows that: fabric fiber enhanced performance is far more than the short cut fiber, and fabric fiber can not only be under of the force direction, but also can withstand strong force, so the application of fiber and fabric development prospects will be wider and wider.

The interfacial properties of TRC composites are significantly related to their bearing capacity, while the interfacial properties of TRC composites are significantly related to the fabric structure. TRC composites are significantly different from early cement-based materials. After the rough treatment of the fiber fabric, such as the coating treatment of coarse sand, and the composite material is generated. The interface performance of TRC composite material is not stable, so the analysis and exploration of the interface performance is very tedious. The distance from the place where the composite is subjected to the melting point of coarse sand in the matrix needs to be calculated accurately. When the fiber is pulled out from the matrix, it can be seen that there are two points at the interface, namely the designing point and the starting point. According to the study of effects of fabric in the root, the pull-out tests remove the test base of the neck pieces of matrix in the preparation of the test. However, in order to prevent matrix of fiber bundles being destroyed, all of the links are selected the same way, but still it can't completely clear the debris and only parts of the concrete substrate fragments, so pulling out the fraction of matrix is not affected by any. During the pull-out process, the pull-out of the fiber consists of four parts, namely the initial pull-out load, the peak pull-out load, the pull-out work and the peak pull-out work.

Cement-based composites are a kind of polyphase composites, whose components include hardened cementstone and aggregate interface. For cement-based composites, the interfacial viscosity of polyphase materials is

of vital importance, especially the bonding property between fiber single bundle and TRC composite interface. During the preparation period of the test, due to the influence of various factors in the test process, most of the pull-out tests were only limited to the static environment. These dynamic pulsation tests have not been reported, either in terms of temperature load differential studies or impact of velocity differential analysis. This chapter focuses on the research of fabric pull-out test, and studies the mechanical properties of pull-out in detail and systematically. On the premise of this pull-out test, the effects of velocity and temperature on pull-out performance were analyzed.

In the fabric selection of pull-out tests, two kinds of different fabrics are usually adopted. The formation of four types of sample is extracted and mainly analyzes the four types of pull out test and specimen will happen in the case of different velocity and temperature on the mechanical performance of change to do a detailed statistics and summary. Then it adopts the method of quantitative analysis on the change rule of the pull out performance evaluation. In the pull-out test, the mechanical properties generated by the interface between the woven fiber and the matrix can be clarified, and the prediction formula for the bonding properties is preliminarily formed, which provides information basis for the application of TRC composites in real life.

Mechanics performance optimization of TRC composite materials is based on the interface properties. Therefore, net braid to improve the performance of the concrete substrate interface test is more critical. The TRC composites structure updates and is fixed with reference to the role of sexual enhancement, as well as after the analysis formation of the theoretical model providing data support.

Pull-out tests are in the static and dynamic process, and the pull out test results clearly reflect the composite interface cohesive performance, which provides the data for the mechanism of interfacial viscosity research support under the premise to form the theory related to the interfacial viscosity model. Detailed and objective tests describe the behavior characteristics of structural mechanics, and also provide the interface model of improved information basis, according to the analysis result shows that the application of TRC composites in different spatial structure are supported by data and guidance.

Analysis on the technical thinking of the application of fabric reinforced and cement-based composite material

It is very important to study and explore the correlation between various properties and structures of composite materials for fabric reinforced and cement-based composite materials. At the same time, certain analysis theories are formed to provide guidance for optimal design of cement-based composite materials. For example, the components selection of cement-based composite materials requires not only the selection of high-performance fiber fabric, but also the selection of high-performance concrete. However, from the perspective of fabric, the following measures are available.

Optimize the selection of textile raw materials

The optimization of textile materials is the basic measure. The higher the performance of textile fibers, the more obvious the effect of fabric reinforcement on the matrix. It is important to consider not only the mechanical properties of the fibers, but also the sensitivity of the fibers to the relevant environment. Aveston et al. fully studied the practical time for different types of fibers to withstand constant load in a certain humidity environment. Through analysis of the test results, it can be seen that carbon fiber has no correlation with humidity, while glass fiber has a significant correlation with humidity.

Smith pointed out that aramid fibers can increase water content by 6 percent after being placed for 30 hours at 96 percent humidity, although the effect is not affected at normal temperatures, but significantly decreased at high humidity. Therefore, textile raw materials should be optimized according to the application conditions of composite materials, and special treatment should be given to textile materials to enhance their performance if necessary [6].

Optimize the textile structure of the fabric and its roving

Fabrics are usually used to strengthen cement-based materials' open mesh holes, which can strengthen the fusion of fabric and matrix. Today, textile technology can produce textile structures that combine geometric shapes with normal mesh. In addition, the textile appearance of the three-dimensional structure can correspond to the geometric shape of the component, thus eliminating such steps as cutting and stitching. Even the fiber distribution and orientation of three-dimensional textiles should be defined according to the needs, and the yarn system should be matched with the strength part of the concrete matrix. Therefore, cement-based composites based on three-dimensional structural textiles will receive more extensive attention.

Nowadays, a famous university in Germany has carried out a lot of researches. For example, Diren Mecit elaborated on the correlation between the existence form in his master's thesis, and structural model, density and strength of three-dimensional structural textile and its performance. Vera Hanisch et al. treated three roving yarns that were different in all aspects with adhesive dip, and then demonstrated that roving structure had the function of optimizing interface performance based on the analysis of tensile and pull-out test results. However, in order to make the roving fabric have both tensile effect and interfacial properties, the selection of the adhesive amount remains to be proved [6].

Special attention should be paid to the fact that the fabric structure can change the propagation mode of matrix cracks, thus enhancing the interfacial properties of composites. Therefore, the mesh fabric structure and yarn geometry can be used to enhance the adhesion function of the fabric in the matrix.

Fabric dipping and shaping

In the early research on fabric impregnation, Markus Schleser et al. pointed out that the utilization rate of alkali-resistant glass fabric was 30% due to the damage in the application process and the weak bonding function of concrete matrix interface. Then the fabric was impregnated with glue, which effectively promoted the bonding between the yarn and the matrix, and the ultimate bearing capacity was increased by about 2 times. This paper takes the research of fabric reinforced concrete sheet as a starting point. During the early test, the fabric was put into the epoxy resin liquid, and the strengthening effect of the fabric was very obvious. After the tensile test, despite the destruction of the matrix interface, the roving of carbon fiber was not damaged. However, the strengthening effect of the fabric without any adhesive treatment was not obvious enough, which significantly reduced the tensile strength of the concrete sheet specimen, and the roving was basically uneven. Therefore, for intensifying the strength of concrete matrix, fabric impregnation is an effective way and measure to disperse the force.
In addition, before the colloid solidification can also optimize the design of the fabric, so as to produce high strength after colloid solidification and the framework of system at the same time. This process is obviously different from space of fabric production compared with the reinforcing cage manufacture process, which is easier.

Conclusion

Fabric reinforced and cement-based composites based on modern concrete are new materials, and most of the experimental and theoretical studies are in full development. However, the research on mechanical mechanism still needs to be strengthened, and there are many uncertain factors. The combination of macro and micro is the most effective way.

Acknowledgements

National Natural Science Foundation Project (51904269) key project of national construction material industry science and technology innovation plan (z2018j08).

References

[1] Ferrier, E., Si, L., A., Georgin, J.F. The new hybrid cement based composite material externally bonded to control the beam cracking. Construction & Building Materials, 36: 36-45.
[2] Jiang, Y.B. The experimental study on microbe resistance performance of cement based composite material. Advanced Materials Research, 598: 328-331.
[3] Luciano, O. 2014. Concrete confinement with a cement based high strength composite material. Journal of Composite Structures, 109.
[4] Fediuk, R.S., Mochalov, A.V., Bituev, A.V., Zayakhanov, M.E. 2019. Structuring behaviors of the composite materials-based on cement, limestone,

and acidic ash. Journal of Inorganic Materials, (10).
[5] Wang, Z.P., Li, H.X., Jiang, Z.W., Chen, Q. 2017. Properties of bamboo charcoal and cement-based composite materials and their microstructure. Journal of Wuhan University of Technology (Materials Science), 32 (6): 1374-1378.
[6] Luciano, O. 2015. Structural structure of reinforced concrete construction strengthened in shear with a cement based fiber composite material. Composite Structures, 122.