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Study on the Influence of the Length of Cemented GFRP Anchor Rod on its Tensile Strength

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Abstract

GFRP materials are widely used in anchoring projects because of their many technical advantages and material properties. However, the anchoring strength of GFRP bolts is far less than its tensile strength, which limits its application in geotechnical engineering, so most scholars have conducted research based on their anchoring strength. There are few studies on the tensile strength of the test piece directly. Based on this, this paper uses steel sleeve bond anchors to study the anchoring strength and tensile strength of GFRP bars. In the anchoring strength test, GFRP bars with a diameter D of 18 mm were used, and two groups of GFRP bars with 2D and 3D bonding lengths were used to measure the impact on the anchoring strength before and after crimping. The following main conclusions are drawn: (1) When the bonding length is 2D, the ultimate bearing capacity before and after crimping increases by 53%; when the bonding length is 3D, the ultimate bearing capacity before and after crimping increases by 46%. (2) Before and after crimping, the GFRP tendon with a bonding length of 3D is greater than the GFRP tendon with a bonding length of 2D. In the GFRP tensile strength test, six kinds of GFRP bolts with different lengths were used, and a sleeve-bonded anchor was used for the pull-out test to determine the effect of the GFRP bolt length on its tensile properties. The following main conclusions are drawn: (1) The whole process of the specimen from the beginning to the ultimate load is elastic deformation. After the ultimate load is reached, the specimen fractures, which is a kind of brittle failure. (2) The use of steel sleeve-bonded anchorage and pouring of planting glue can make GFRP bars reach the ultimate tensile strength. This anchoring method is effective. (3) Under the same anchoring length, the ultimate tensile strength of GFRP anchors increases with the increase of length, and the displacement during failure gradually increases with the length of the specimen, but the rate of increase gradually changes slow.

Keywords

FRP, GFRP anchor rod, Specimen length, Tensile strength, Anchor strength.

1. Introduction

In recent years, in order to improve the structural stability engineering problem in geotechnical engineering, anchoring technology has been widely used, and steel bolts have been used in many aspects of civil engineering. The tie rod part of the anchor rod is very important, and there are special requirements for the material of this part, because the tie rod part needs to transfer the anchor head tension to the anchor solid. Therefore, high strength, strong corrosion resistance and low relaxation are geotechnical engineering. The problem that civil engineering urgently needs to solve is to solve the corrosion of steel bars and improve the durability of reinforced concrete structures.[1] Basic requirements for materials. GFRP tendon, also known as glass fiber reinforced plastic, is composed of glass fiber and bonded matrix. It is a composite material with polymer resin as matrix. It can also contain other ingredients such as auxiliary materials and additives. The main role of the resin is to

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protect the machinery and the environment, help transfer stress between the fibers, prevent individual fibers from bending, and compensate for different expansion rates in the fibers.

Handong Liu [2] (2005): The GFRP tendon was processed into a dumbbell shape. In order to prevent the destruction of the end clamping part, copper wire was wound on the surface of the GFRP.

Xilin Lv[3] .(2007): It is believed that under fire and high temperature environment, the bonding performance between FRP tendons and concrete will decrease, which is not conducive to the transmission of force between them.

Jian Ma [4] (2008): After a numerical analysis of the stress field of the reinforced section, it was concluded that the reinforcement method needs to be improved.

Xiaojun Sun [5] (2013): The existing large-diameter GFRP tensile test end anchoring method is unreasonable, and the selection of effective length and anchoring length is not uniform.

Xiaoyong Luo [6] (2015): Analyzed the bonding properties of GFRP bar anchors with different diameters and different surface morphologies, and concluded that the bonding strength decreases with increasing diameter.

In this paper, the anchor strength and tensile strength of GFRP bars are studied using steel sleeve bond anchors. The two groups of GFRP bars with different bonding lengths are measured before and after crimping. Influence and pull-out test of GFRP bars with 6 different specimen lengths. The effect of GFRP specimen length on the tensile strength of specimens was studied through experiments.

2. GFRP Tensile Strength Test

2.1 Test Plan

2.1.1 Sub-section Headings

In this test, six GFRP rib sleeves with different lengths and the same diameter were bonded, and the two ends of the GFRP ribs were inserted into the steel sleeve, and the gap was filled and cemented with planted ribs. After the bonding strength was fully exerted, The pull-out test was conducted under the RRH-6010 through-core jack. This test is a failure test to determine the effect of the length of the GFRP bar specimen on the tensile properties and the anchor strength of the GFRP bar at both ends.

2.2 Test Piece Production and Test Equipment.

In this experiment, a group of GFRP anchors of 50 cm, 75 cm, 100 cm, 125 cm, 150 cm, and 175 cm in length and 18 mm in diameter were selected, and the two sides were grouted with reinforced rubber and placed after grouting. After waiting for several days for the gel to solidify and the anchoring end to be stable, a hydraulic pull-through jack (as shown in Figure 2.1) was used for the pull-out test.

Fig 2.1 Hydraulic jack

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2.3 Measurement Content and Method.

2.3.1 Measurement content

The main research contents of this test are the influence of the anchor strength of GFRP bars and the length of the test piece on the tensile properties of GFRP. In the experiment, the anchor glue was poured into the anchor, and six GFRP bars of different lengths were selected so that the bonding length between the anchor and the GFRP was 17 cm. Through the pull-out test, the GFRP bonding performance and the GFRP test were judged The effect of piece length on tensile properties.

2.3.2 Measurement methods

This test is a failure test. The test is stopped when the GFRP bar is pulled or pulled out from the anchoring end. The hydraulic jack is used to generate the pulling force on GFRP, and the displacement of the GFRP anchor rod is recorded through a dial indicator. Starting from 3 Mpa, the displacement of the hydraulic jack dial is recorded every megapascal, until the specimen is destroyed, the maximum pressure and displacement are recorded, and the ultimate tensile strength of the GFRP bar is measured by formula conversion.

2.4 Test Results

The six GFRP bars of the same specification and different lengths were sequentially pulled out. During the pressurization of the hydraulic jack, the test piece did not make a sound at the beginning, and occasionally heard the cracking sound of colloid damage. As the manual hydraulic pressure was continuously pressed The pump and GFRP tendons are getting more and more strained. At this time, the manual hydraulic pump is more and more difficult to press. It needs to be pressed hard. When a loud noise is heard, the hydraulic jack is quickly depressurized, and the test piece is taken out and observed. Dispersion occurs and separates in a radial pattern. The specimen is broken into two parts. Partially broken GFRP ribs are shown in Figure 2.2.

Fig 2.2 Partially broken GFRP tendons

2.5 Analysis of Test Results

2.5.1Failure mode analysis

The failure mode of the test piece is that the test piece is only broken into two parts in the middle of the test piece, and no pull-out failure of the anchor rod occurs at the reinforced end of the anchor rod, indicating that the GFRP reinforcement and high-strength grouting material at the anchor end of the sleeve The bonding force satisfies the condition of exerting the ultimate tensile strength of the rod body. When the bonding length of the GT18 type sleeve is 17 cm, it is an effective anchoring method.

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Based on the analysis of the GFRP anchor component, the GFRP tendons under load initially bear the load together with the glass fiber and resin. As the load continues to increase, the resin first enters the shape-reinforced state, and the glass fiber begins Under load, when the glass fiber reaches the breaking strength, the GFRP tendon bolt breaks and loses its bearing capacity.

2.5.2 Relationship between GFRP length and its tensile strength

In the case of GT18 anchors with anchorage strength of 17 cm, 6 GFRP anchors with a diameter of 18 mm are all used. The ultimate tensile strength of GFRP anchors with a length of 50 cm is 452.04 Mpa; the ultimate tensile strength of GFRP anchors with a length of 75 cm is 456.27 Mpa; the ultimate tensile strength of GFRP anchors with a length of 100 cm is 519.64 Mpa; the length is The ultimate tensile strength of 125 cm GFRP anchor is 418.62 Mpa; the ultimate tensile strength of GFRP anchor with a length of 150 cm is 494.30 Mpa; the ultimate tensile strength of GFRP anchor with a length of 175 cm is 490.07 Mpa.

The author believes that the sudden fluctuation of the data at 100 cm should be caused by the error, so that the tensile strength of the GFRP tendon increases slowly as its length increases.

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The author believes that the sudden fluctuation of the data at 100 cm should be caused by the error, so that the tensile strength of the GFRP tendon increases slowly as its length increases.

2.5.4Relationship between GFRP Length and Displacement of Anchor Bolt

In the case of GT18 anchors with anchorage strength of 17 cm, 6 GFRP anchors with a diameter of 18 mm are all used. The displacement of a GFRP anchor with a length of 50 cm is 15.37 mm; the displacement of a GFRP anchor with a length of 75 cm is 15.49 mm; the displacement of the GFRP anchor with a length of 100 cm is 20.34 mm; the length is The displacement of the 125 cm GFR anchor was 25.32 mm; the displacement of the GFRP anchor with a length of 150 cm was 27.22 mm; the displacement of the GFRP anchor with a length of 175 cm was 27.85 mm.

It can be seen from this that the displacement of the GFRP anchor when the bond anchorage length is 17cm is gradually increased with the increase of the length, but the rate of increase is gradually slowed down.

3. Conclusion

Since the tensile strength of GFRP tendons is often greater than the anchor strength at both ends, the key to determining whether GFRP can be widely used in practical engineering is the anchor strength at the anchor end of GFRP tendons.

In the pull-out experiment, observe the stress process and failure form of the test piece, and measure the load-displacement curve; analyze the influence of different test piece lengths on the tensile strength of the GFRP anchor under the same diameter and the same bonding strength. The following main conclusions are drawn:

(1) The whole process of the test piece from the beginning of loading until it reaches the limit load is elastic deformation. After the limit load is reached, the test piece breaks, which is a brittle failure.

(2) The use of GT18 reinforced sleeve bonded anchorage and pouring of planting glue can make GFRP bars reach the ultimate tensile strength. This anchoring method is an effective anchoring method.

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(3) Under the same anchor length, the ultimate tensile strength of GFRP anchor rods increases with the increase of length, and the displacement during failure also gradually increases with the increase of the length of the specimen, but the rate of increase gradually Slow down.

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