Design and Mechanical Properties of a New Clamp-Type Carbon Fiber Materials Tension Anchoring System

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Abstract. Carbon fiber materials are widely used in bridge reinforcement techniques, while conventional carbon fiber material tensile anchoring equipment produces a large prestressed loss. This paper analyzes the deficiencies of existing tensile anchoring systems at home and abroad, summarizing the cause of prestressed losses, and combining with existing anchoring systems, a new type of clamp type carbon fiber cloth tension anchoring system is proposed. The amount of deformation of the anchoring system is reduced by about 20%, which in turn reduces the system prestress loss caused by the system deformation. The ABAQUS finite element analysis software is used to numerically simulate the thickness of the tension anchor system and the force of the fixture at different inclination angles. Compare the experimental measurement data, under consideration of the mechanical properties of the system, making errors, and installation convenient prerequisites, the mechanical properties of the system are optimal when the thickness of the fixed plate is 30mm and the clamp tilt angle is 5°.

Keywords. Bridge reinforcement, carbon fiber, tension anchor system, finite element.

1. Introduction
Carbon fiber composite material is a new type of material that gradually emerged in the 1960s. Because of its own advantages of light weight, high strength, and good corrosion resistance, it has been widely used in strengthening concrete structures. Nowadays, directly pasting carbon fiber material tensile anchoring equipment produces a large prestressed loss. This paper analyzes the deficiencies of existing tensile anchoring systems at home and abroad, summarizing the cause of prestressed losses, and combining with existing anchoring systems, a new type of clamp type carbon fiber cloth tension anchoring system is proposed. The amount of deformation of the anchoring system is reduced by about 20%, which in turn reduces the system prestress loss caused by the system deformation. The ABAQUS finite element analysis software is used to numerically simulate the thickness of the tension anchor system and the force of the fixture at different inclination angles. Compare the experimental measurement data, under consideration of the mechanical properties of the system, making errors, and installation convenient prerequisites, the mechanical properties of the system are optimal when the thickness of the fixed plate is 30mm and the clamp tilt angle is 5°.
anchoring system [4]; Nanjing Mankate Technology Co., Ltd. independently designed a perforated self-locking tension anchoring system, but the flatness of the bottom surface of the beam is relatively high, which will be affected during the construction process. The phenomenon of uneven stress on the carbon fiber cloth occurs.

Relevant test data show that the loss of prestress of mechanical clip anchorage system is greater than that of winding anchorage system [5-6]. In order to reduce the loss of prestress of anchorage system and improve the reinforcement efficiency of CFRP, based on the existing research results, this paper uses the theory of prestressed carbon fiber cloth to strengthen concrete beams and analyzes the reasons for the insufficient reinforcement efficiency [7-8]. Based on the force analysis, a new set of clamp-type carbon fiber cloth tension anchors is proposed. The system uses finite element simulation software to optimize the thickness and inclination angle of the anchoring system by setting the material parameters and the contact mode between the components. By comparing with the experimental data, the anchor system is studied in the stage of tensioning the carbon fiber cloth. The deformation conditions of the optimized system verify the stability of the optimized system under the action of external forces, which may provide a strong mechanical basis for the engineering application of the anchoring system.

2. Design of a New Clamp Type Carbon Fiber Cloth Tension Anchor System

2.1. The Structure of a New Clamp Type Carbon Fiber Cloth Tension Anchor System

The pre-stressed carbon fiber cloth tension anchor system proposed in this paper is mainly composed of a tension end, an anchor end, a cloth reeling shaft, and a tension device. Close to the bottom of the beam. The system can meet the tensile force of 50% ultimate tensile strength of 4 to 8 layers of grade I carbon fiber cloth, and its value is 227 kN. The schematic diagram of the new clamp type prestressed carbon fiber cloth tension anchor system is shown in figure 1.

![Figure 1. Schematic diagram of new clamp tension anchoring device.](image-url)
2.2. Axis Analysis of Carbon Fiber Cloth
The anchoring system utilizes the frictional force between carbon fiber cloth and carbon fiber cloth, and carbon fiber cloth and steel to realize self-locking under the action of external force, that is, no relative movement occurs. The static friction coefficient between carbon fiber cloth and carbon fiber cloth is \( \mu_1=0.2 \) [9], and the static friction coefficient between carbon fiber cloth and steel is \( \mu_2=0.1 \) [10]. The self-locking ability of the anchoring system is verified by the differentiation method, as shown in figure 2:

From the differential calculus:

\[
dF = \mu dN , \quad dN = F d\theta
\]

Then:

\[
\ln F = \mu \theta + C \quad (C \text{ is a constant})
\]

Suppose \( F+dF=F_2 \); then \( \theta=0 \), \( F=F_2 \); we can get \( C=\ln F_2 \); Bring it into the second equation:

\[
F=F_2e^{\mu \theta}
\]

Anchor plate \( \theta=\pi \), \( \mu_1=\mu_2=0.2 \), So the critical state:

\[
T_2 = T_1 e^{-\pi \mu_1}
\]

\[
T_3 = T_2 e^{-\pi \mu_2} = T_1 e^{-\pi (\mu_1+\mu_2)} = 0.28 T_1
\]

Because of the friction between the carbon fiber cloth, \( T_4<T_3 \), the maximum friction from \( T_1 \) to \( T_2 \) is:

\[
f_{1,2}=T_1 T_2=T_1 (1-e^{-\pi \mu_1})=0.47 T_1
\]

Because of \( f_{1,2}>0.28 T_1>T_4 \), \( T_3=0 \), therefore the carbon fiber cloth between \( T_4 \) and \( T_3 \) will not slide relative to each other, that is, the friction force can be used to realize the self-locking of the carbon fiber cloth. In the actual installation process, because the roll-up shaft is in contact with the cover plate and the fixed bottom plate during the force application process, this increases the vertical force \( N \), which makes \( f_{1,2} \) far greater than the above in actual situations. The calculated value makes the combination of two adjacent layers of carbon cloth closer, and its self-locking ability is stronger.

2.3. Force Analysis of Oblique Section Carbon Fiber Cloth
The schematic diagram of the friction force of the carbon fiber cloth in the splint is shown in figure 3. It is the force of the single layer of carbon fiber cloth when the anchoring system is tensioned, the inclination angle of the clamp contact surface, and the friction force of the carbon fiber cloth in the clamp. The cover plate is applied to the normal pressure of the carbon fiber cloth by screw tightening, and the force relationship is shown in equation (6) – (8).
Figure 3. Schematic diagram of oblique section stress.

\[ F = R(\mu_1 + \mu_2) \]  
(6)

\[ \frac{P}{8} = F \cos \alpha + R \sin \alpha \]  
(7)

Then:

\[ F = \frac{P}{8.35 \times [\sin(\alpha + 73.3)]} \]  
(8)

It can be seen from the above formula that at 0~16.7°, the frictional force decreases with the increase of \( \alpha \). Since the cutting angle \( \alpha \) of secant processing equipment in most mechanical processing plants is generally not greater than 8°, and carbon fiber cloth is a flexible fabric, it has the properties of tensile and non-shearing mechanically, so its friction should not be too large. Taking the above two points into consideration, in order to further optimize the design of the anchoring system to achieve the most reasonable stress conditions, because the diameter of the roll shaft is 26mm, the system length is 200mm, and the inclination angle below 4° cannot meet the size of the roll shaft. Therefore, this paper intends to select 7°, 6°, 5°, and 4° inclination angles for finite element analysis. The inclination angle of the cover plate and the bottom plate is 4°, and the cover plate and the bottom plate use 6 inner diameters of 10mm. Hexagonal bolts are connected with a total pressure of about 100kN. Substituting 4° into equation (8) can be obtained. Under the maximum design tension of the system, the sliding friction force generated by the outermost carbon fiber cloth is 27.9kN. Substituting into equation (6) can be obtained. The pressure is 92.9kN, and the pressure between the two plates is 93.6kN, that is, when the inclination angle of the fixture is below 7°, the system can meet the requirements of system stability under the design tension.

2.4. Calculation of the Shear Capacity of the System

According to the United States "Structural Concrete Building Code Requirements" (ACI318-2011), the calculation formula of group anchor shear design value \[ 11 \] is shown in equation (9):

\[ F_{R,S} = \phi n(0.6A_S f_u) \]  
(9)

where: \( F_{R,S} \) are the design values of anchor bolts under shear; \( \phi \) is the reduction factor of anchor bolt strength; \( n \) is the number of anchor bolts; \( A_S \) is the cross-sectional area of anchor bolts; \( f_u \) is the design value of anchor bolt tensile strength.

According to the "Code for Design of Reinforcement of Concrete Structures" (GB50367-2013) issued by my country, the shear failure calculation equation \[ 12 \] for anchor bolts without lever arms is shown in equation (10):

\[ V_a = \psi_{E,V} f_{ud,V} A_i \]  
(10)

In the formula: \( V_a \) is the design value of anchor bolt under shear; \( \psi_{E,V} \) is the reduction coefficient of the anchor bolt subjected to seismic calculation, and the value is 1 when there is no requirement for seismic resistance \[ 13 \]; \( f_{ud,V} \) is the calculated value of anchor bolt strength and shear resistance; \( A_i \) is the total area of anchor bolts.
According to the formulas (9) and (10), the minimum value of the maximum shear force that the anchor bolt can withstand is 241 kN. At the same time, according to the first three types of failures of high-strength bolts proposed in the "Code for Design of Steel Structures" (GB50017-2017) Form of calculation method of bearing capacity [14-15], the calculated ultimate shear bearing capacity of the bolts is 234 kN, which is greater than the 50% ultimate tensile strength of the system's 8-layer carbon fiber cloth, 227 kN, so the tensile anchoring system meets the requirements of shear design.

3. Finite Element Analysis and Optimization of a New Clamp-Type Carbon Fiber Cloth Tension System

3.1. Material Constitutive Relationship and Parameter Determination

Refer to the concrete constitutive relationship given in "Specifications for Design of Concrete Structures" (GB50010-2012), regard concrete as a homogeneous linear elastic material, and use the elastoplastic model in ABAQUS for the tension anchor system, and use the VonMises yield criterion to simulate [16-17]. Regarding carbon fiber cloth as an ideal elastic and brittle material, the tensile strength is ignored, and Hooke's law is satisfied before breaking [18]. The performance parameters are shown in table 1.

According to the material structure and force characteristics, C3D8R solid elements are used to simulate concrete and steel, and the universal shell element (S4R) element for carbon fiber cloth joints is simulated; structural meshing technology is used to mesh the carbon fiber cloth tension anchor system Lattice division [19-20].

| Material name                  | Elastic Modulus (GPa) | Poisson's ratio |
|-------------------------------|-----------------------|-----------------|
| Concrete (C40)                | 32.50                 | 0.20            |
| Anchor (Q345)                 | 210                   | 0.30            |
| Fixed component and tension screw | 213                   | 0.31            |
| Carbon fiber cloth            | $E_x=235$             | $u_{xy}=0.23$   |
|                              | $E_y=10$              | $u_{xz}=0.35$   |
|                              | $E_z=10$              | $u_{yz}=0.35$   |

3.2. Determination of the Thickness of the Fixed Plate

The finite element model of the fixed plate at the tension end was established, and the system displacement and force of the fixed plate with thicknesses of 25mm, 30mm, 35mm, and 40mm were analyzed under the same force to determine the optimal thickness. The finite element model of the fixed plate is shown in figure 4; the displacement change of the fixed plate with different thicknesses is shown in figure 5.

![Figure 4. Grid division diagram of fixed plate.](image-url)
According to the analysis results of the fixed plate, the maximum displacement of the plate is where the tension screw and the fixed nut contact the fixed plate, and as the thickness of the plate increases, the overall deformation of the system gradually decreases, which is in line with the actual force. It can be seen from the displacement curve in figure 5 that the change rate of the fixed plate thickness between 25mm and 30mm is faster than that of the plate thickness between 30mm and 35mm and 35mm and 40mm. When the thickness of the fixed plate is 30mm, the rate of displacement change begins to ease. When the external force reaches 227 kN, the maximum stress value of the fixed plate at this time is 325MPa, which does not reach the yield strength of the material. Considering that the size of the equipment is too large, it will affect the ease of installation and cause waste of materials, so the thickness of the bottom plate and the fixed plate is 30mm.

3.3. Determination of the Tilt Angle of the Fixture

The finite element model of the anchoring end fixture was established, and the stress and displacement of the fixtures with oblique section angles of 7°, 6°, 5°, and 4° under the same tension were analyzed to determine the best oblique section angle. The optimized model of the anchoring end is shown in figure 6.
Table 2. Maximum stress results of fixture with different inclination angles (MPa).

| Tension  | 7°   | 6°   | 5°   | 4°   |
|----------|------|------|------|------|
| 50kN     | 122.1| 120.2| 117.7| 115.5|
| 80kN     | 168.4| 159.4| 151.4| 148.5|
| 114kN    | 218.9| 208.4| 192.2| 186.4|
| 150kN    | 261.6| 249.2| 229.2| 217.4|
| 170kN    | 292.3| 275.3| 262.8| 255.5|
| 227kN    | 364.3| 346.7| 341.0| 332.7|

Figure 7. Mises stress diagram of fixture under 227 kN.

It can be seen from table 2 and figure 7 that as the force applied to the carbon fiber cloth increases, the Mises stress value of the fixture is also increasing. When the external load is less than 120 kN, 7°, 6°, 5°, 4°, the growth rate of the clamp stress value of the included angle is almost the same. When the tensile force is greater than 120 kN, the growth rate of the clamp stress difference between the 7° and 6° angles is significantly greater than that of the 4° and 5° clamps. When the tensile force reaches 227 kN, the Mises stress value of the fixture with the included angle of 7° and 6° has reached the yield value of the steel, and the Mises stress value of the fixture with the included angle of 5° and 4° is close to the yield value of the steel, 4°, 5°. The force state and law of the included angle in the force process are relatively similar.

Figure 8. Fixture displacement diagram under different tension.
Table 3. Fixture displacement at different inclinations (mm)

| Tension | 7°   | 6°   | 5°   | 4°   |
|---------|------|------|------|------|
| 50kN    | 0.132| 0.126| 0.094| 0.108|
| 80kN    | 0.265| 0.234| 0.168| 0.186|
| 114kN   | 0.376| 0.324| 0.255| 0.273|
| 150kN   | 0.488| 0.423| 0.345| 0.382|
| 170kN   | 0.538| 0.485| 0.398| 0.421|
| 227kN   | 0.638| 0.604| 0.543| 0.573|

From the data in figure 8 and table 3, it can be concluded that under the action of external force, the displacement value of the clamp increases with the increase of external force. Under the action of tensile force, the carbon fiber cloth transmits the force to the cloth winding shaft, and the cloth winding shaft applies the force to the fixture system. Under the action of this force, the system will deform and move. This phenomenon will affect the wedge of the fixture front end. The carbon fiber cloth in contact with the part produces a reaction force. Due to the poor shear resistance of the carbon fiber cloth, this force may damage the carbon fiber cloth, and the displacement will also cause a certain loss of prestress. Therefore, the smaller the value is, the less the impact of the system. From the results of the analysis, it can be concluded that under the tension of 227 kN, the displacement value is the smallest when the included angle is 5°, and when the included angle is 7°, the displacement value exceeds 1.4 times the included angle of 5°.

3.4. Analysis of the Optimization Model

Model the anchor end and the tension end according to the principles introduced above, and apply a tensile force of 50% of the ultimate tensile strength of the 4-layer carbon fiber cloth (114 kN) and 50% of the ultimate tensile strength of the 6-layer carbon fiber cloth (170 kN), divided into 8 layers of carbon fiber cloth with 50% of the ultimate tensile strength and 60% of the tensile force (227 kN, 272 kN) (figure 9, table 4).

![Figure 9. Stress changes of main components of anchor end under different tensile forces.](image)

Table 4. Average deformation scale of stressed parts at anchoring end (mm).

| Tension | Part          | Cover | Bottom plate | Rolling shaft | Anchor bolt | Bolt | Total deformation |
|---------|---------------|-------|--------------|---------------|------------|------|------------------|
| 50kN    |               | 0.092 | 0.006        | 0.068         | 0.029      | 0.016| 0.211            |
| 114kN   |               | 0.243 | 0.018        | 0.126         | 0.038      | 0.035| 0.460            |
| 170kN   |               | 0.325 | 0.025        | 0.174         | 0.042      | 0.039| 0.605            |
| 227kN   |               | 0.427 | 0.033        | 0.199         | 0.053      | 0.056| 0.768            |
Analyzing the finite element simulation results, it is concluded that the greater the prestress applied, the tighter the connection between the cloth reeling shaft and the fixture, and the uniform force, the stronger the self-locking ability of the system. The overall force of the tension anchoring system is relatively uniform, and there will be no stress concentration and other phenomena. The place where the cover plate of the clamp system is in contact with the cloth winding shaft and bolts, and the contact part of the bottom plate with the anchor bolts are more stressed than other parts; The stress on the contact point of the bottom plate and within a certain depth of the contacted concrete is relatively large; the maximum stress position of the carbon fiber cloth is at the clamp port, and the force in the clamp is basically uniform. The stress on both sides is slightly larger than the middle part, mainly due to the tightening pressure of the bolts. The force conditions of its various components basically conform to the force characteristics of the structure. Under different external forces, the stress change law of the cover plate, the bottom plate and the cloth winding shaft is relatively consistent, and the stress change speed of the anchor bolt is faster. When the external load reaches 227 kN, the clamp stress is 341 MPa, which is close to the yield state. When the load value is 272 kN, the clamp system and anchor bolt stress has reached the yield stage, but has not reached the ultimate stress value of the material, so in the 8-layer carbon fiber cloth under the action of 60% ultimate strength, the anchoring end state is still stable, and it can fully reach the application of the specified design value of the system (figure 10, table 5).

![Figure 10. Force change diagram of main components of tension end under different tension.](image)

*Figure 10. Force change diagram of main components of tension end under different tension.*

| Tension | Fixture system | Fixed plate | Steel | Anchor bolt | Tension bolt | Total deformation |
|---------|----------------|-------------|-------|-------------|--------------|------------------|
| 50kN    | 0.304          | 0.078       | 0.029 | 0.296       | 0.707        |
| 114kN   | 0.600          | 0.188       | 0.042 | 0.483       | 1.313        |
| 170kN   | 0.814          | 0.261       | 0.046 | 0.721       | 1.842        |
| 227kN   | 1.084          | 0.385       | 0.052 | 0.965       | 2.486        |

From the finite element simulation results, under the action of external force, the stress of each part of the tension end is relatively uniform. The stress value of the tension screw at the connection with the nut is 10% higher than the stress value of the other parts. The fixed steel plate is at the anchor. The bolt position receives the greatest force, and the result accords with the actual force condition. Under the action of 227kN, the maximum stress of the fixed steel plate reaches 325 MPa, which is close to the yield strength of the material. Under the action of 272 kN, its stress value is as high as 405.4 MPa, reaching the yield strength of the material, but not the ultimate strength. At this time, the system is
stable as a whole.

Based on the analysis results of the anchoring end and the tensioning end, it is concluded that the force of the carbon fiber clot is relatively uniform under the action of external force. Under the action of 114 kN, 170 kN, and 227 kN, the total deformation of the system is 1.773 mm, 2.447 mm, 3.254 mm, and the overall deformation increases linearly, which is about 20% less than that of the traditional anchoring system. It can be seen that the amount of system prestress loss caused by the deformation of the tension anchor system is greatly reduced. The stress distribution law of the anchor bolts at the tension end and the anchor end is almost the same, but under the same load, the stress value of the anchor bolt at the tension end is slightly higher than that at the anchor end. The main reason is that the anchor bolt at the anchoring end is mainly subjected to shear and tension, while the anchor bolt at the tension end is mainly subjected to shearing force. The shear resistance of the anchor bolt is weaker than its tensile capacity. Under the 50% ultimate tensile stress of the 8-layer carbon fiber cloth, the system does not reach the yield strength of the material, and the system is stable and reliable as a whole, which can meet the current tensile requirements for carbon fiber cloth.

4. Reinforced Concrete Beam Bending Member Test

4.1. Introduction to the Test

The test was carried out in accordance with the above-mentioned prestressed carbon fiber cloth anchoring device design method. The width of the carbon fiber cloth used in this experiment is 100 mm, the nominal thickness is 0.167 mm, the standard value of tensile strength is greater than 3.0×10³ MPa, the tensile modulus of elasticity is greater than 2.1×10³ MPa, and the tensile elongation at break is greater than 1.5%. Tensile bonding strength is greater than 2.5 MPa and cohesive failure of concrete, interlayer shear strength is greater than 35 MPa. Anchoring and tensile tests of carbon fiber cloth were carried out on a concrete beam with suitable reinforcement configuration. The cross-section of the concrete beam was 450 mm wide, 200 mm high, and 400 mm long. The concrete was made of C40 commercial concrete. Longitudinal tensile steel bars are HRB400-grade steel bars, and vertical reinforcement and stirrups are HPB300-grade steel bars. Reinforcement principle: The lower part of the beam is equipped with 8 longitudinal bars with a diameter of 12 mm, and the top surface is equipped with 6 erecting bars with a diameter of 10mm. The tensioning and anchoring devices and the carbon fiber cloth are all arranged on the bottom surface of the beam. The main purpose of this experiment is to test the effect of the above-mentioned new clamp type carbon fiber cloth tensile anchoring system for prestressing, that is, the deformation of the beam during the tensioning process, the strain value of the tensile steel bar, the concrete strain value and the development of cracks. The test setup is shown in figure 11.

![Figure 11. Test device of new clamp type carbon fiber cloth tension anchor system.](image-url)
4.2. Test Results and Analysis

A hydraulic jack is used to apply a monotonous, static load to the test beam, with 10 kN as the first-level load, close to the bending and cracking load, and then with 5 kN as the first-level load, until the beam has flexural failure, and the deflection of the concrete beam in the middle of the span changes as figure 12, the change in the strain value of the steel bar in the middle of the span is shown in figure 13.

Figure 12. Variation of beam mid-span deflection with loading force for different anchoring systems.

As the loading force increases, the deflection of the beam and the strain of the steel bars continue to increase. It can be seen from figure 12 that the concrete beam using the new clamp-type carbon fiber cloth tensile anchoring system designed in this paper, under the same loading force, the beam mid-span deflection is significantly reduced compared with the traditional anchoring system. Before 20kN, the deflection increasing rate of the new anchoring system and the traditional anchoring system was basically the same; after 20kN, the deflection increasing rate of the traditional anchoring system began to increase, while the deflection increasing rate of the new anchoring system remained basically the same, showing a linear change.

Figure 13. Variation of strain values of steel bars in the middle span of beams with different anchoring systems as a function of loading force.
It can be seen from figure 13 that the strain increase rate of the beam longitudinal reinforcement in the new anchoring system is the smallest. When the loading force reaches 120kN, the longitudinal reinforcement still has not yielded, and the strain value changes linearly overall. In the traditional anchoring system, the strain value of the longitudinal reinforcement of the beam body begins to decrease when the loading force reaches 100 kN, indicating that the steel bar yields. Under the same loading force, the strain of the longitudinal bars is reduced by about 20%. At the same time, during the entire tensioning process, the readings of the same set of strain gauges on the same section are relatively uniform, indicating that the stress distribution of each bundle of the carbon fiber cloth of the same section is relatively uniform.

5. Conclusion
Research on the reinforcement of damaged projects by carbon fiber materials has always been the focus of attention by scholars and scientific research institutions at home and abroad. This paper introduces the theoretical calculation method of carbon fiber cloth reinforced beam. By analyzing the shortcomings of the existing prestressed carbon fiber material anchoring system, a new clamp-type tension anchoring system that can tension and anchor 4 to 8 layers of carbon fiber cloth is proposed. And given a set of proprietary construction technology, using finite element software to analyze it, combined with the reinforced concrete beam bending member test, verify the stability of the system, and draw the following conclusions:

(1) The carbon fiber cloth tension anchoring system proposed in this paper is suitable for anchoring and tensioning multi-layer carbon fiber cloth. It has the advantages of light volume, convenient installation, avoiding slotting treatment on the bottom of the reinforced beam, strong anchoring ability, and easy factory processing. At the same time, the differential method is used to analyze the self-locking of carbon fiber cloth, which verifies the self-locking ability of the new clamp-type tension anchor system. It will not only reduce the installation cost of the system, but also avoid the loss of prestress of the system caused by the displacement of the carbon fiber cloth.

(2) Taking the manufacturing error of the system and the force of the system into account in this design and research process, through the comparative analysis and optimization of finite element software, it is concluded that when the fixed plate thickness is 30mm and the fixture inclination is 5°, the performance of system is the best.

(3) Using finite element software to analyze the force performance of the tension anchoring system, it is concluded that the material will not yield under the effect of the maximum design force. At the same time, it is concluded that under the action of 114 kN, 170 kN, and 227 kN, the deformation of the system is 1.773 mm, 2.447 mm, and 3.254 mm, respectively. The deformation of the system changes almost linearly under the action of external force. Combined with the test of the reinforced concrete beam flexural member, it is verified Compared with the traditional anchoring system, the new type of carbon fiber cloth anchoring system reduces the amount of deformation by about 20%, thereby reducing the loss of system prestress caused by system deformation.

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