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Replacing GB/T 14370-2007

Anchorage, grip and coupler for prestressing tendons

预应力筋用锚具、夹具和连接器

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Foreword

This standard was drafted in accordance with the rules given in GB/T 1.1-2009.

This standard is the revision of GB/T 14370-2007 “Anchorage, grip and coupler for prestressing tendons”; AND as compared with GB/T 14370-2007, the main technical changes are as follows:

- MODIFY the scope (SEE Chapter 1; Chapter 1 of the 2007 version);
- MODIFY the terms and definitions, symbols (SEE Chapter 3; Chapter 3 of the 2007 version);
- MODIFY the product classification, code and markings (see Chapter 4, Chapter 4 of the 2007 version);
- DELETE the “requirements of use” (SEE 5.1 of the 2007 version);
- MODIFY the parts forging blank requirements (SEE 5.12; 5.3.4 of 2007 version);
- ADD the performance requirements for bearing plate material (SEE 5.1.3);
- ADD the requirements for rust treatment (SEE 5.2.5);
- MODIFY the requirements and test methods for static load anchorage performance (SEE 6.1.1 and 7.3; 5.5.1 and 6.2 of 2007 version);
- MODIFY the requirements and test methods for fatigue load performance (SEE 6.12 and 7.4; 5.5.2 and 6.3.1 of 2007 version);
- DELETE the periodic load performance and its test methods and associated inspection rules (SEE 5.5.3, 6.4 and 7 of 2007 version);
- ADD the requirements and test methods for force transmission performance in anchorage zones (SEE 6.1.3 and Appendix A);
- ADD the requirements and test methods for low temperature anchorage performance (SEE 6.1.4 and Appendix B);
- ADD the requirements and test methods for bearing plate strength (SEE 6.1.5 and 7.7);
- MODIFY the requirements and test methods for internal shrinkage (SEE 6.1.6 and Appendix C; 5.5.4.1 and 6.6.1 of 2007 version);

Anchorage, grip and coupler for prestressing tendons

1 Scope

This standard specifies terms and definitions, symbols, product classification, code and marking, general requirements, requirements, test methods, inspection rules and marking, packaging, transport and storage of anchorage, grip and coupler for prestressing tendons.

This standard applies to anchorages and couplers used for the anchorage, grip, coupler and cable used in the prestressed structure of internal and external reinforcement with bonding, without bonding, or with slow bonding AND in the special construction process.

2 Normative references

The following documents are essential to the application of this document. For the dated documents, only the versions with the dates indicated are applicable to this document; for the undated documents, only the latest version (including all the amendments) are applicable to this Standard.

GB/T 197 Common thread - Tolerances

GB/T 230.1 Metallic materials - Rockwell hardness test - Part 1: Test methods (A, B, C, D, E, F, G, H, K, N, T)

GB/T 231.1 Metallic materials - Brinell hardness test - Part 1: Test methods

GB/T 1348 Spheroidal graphite iron castings

GB/T 1804 General tolerances - Tolerances for linear and angular dimensions without individual tolerance indications

GB/T 5223 Steel wire for prestressing of concrete

GB/T 5223.3 Steel bars for prestressed concrete

G/T 5224 Steel strand for prestressed concrete

GB/T 9439 Gray iron castings

GB/T 9969 General principles for preparation of instructions for use of industrial products

GB/T 12361 General specification of steel die forgings

GB/T 15822.1 Non-destructive testing - Magnetic particle testing - Part 1: General principles

GB/T 16825.1 Verification of static uniaxial testing machines - Part 1: Tension/compression testing machines - Verification and calibration of the force-measuring system

GB/T 16923 Normalizing and annealing of steel parts

GB/T 16924 Quenching and tempering of steel parts

GB/T 20065 Screw-thread steel bars for the prestressing of concrete

GB/T 21839 Steel for prestressed concrete - Test methods

GB/T 26743 Fiber reinforced composite bars for civil engineering

JB/T 5000.8 General technical requirements for heavy machinery - Part 8: Forgings

JB/T 5000.9 General technical requirements for heavy machinery - Part 9: Cutting workpieces

JB/T 5000.10 General technical requirements for heavy machinery - Part 10: Assembly

JB/T 5000.13 General technical requirements for heavy machinery - Part 13: Packaging

JB/T 5000.15 General specification for heavy machinery - Part 15: Nondestructive testing of steel forgings

JG/T 330 Construction of cable

JG/T 351 Fiber reinforced composite standard

3 Terms and definitions, symbols

The following terms and definitions apply to this document.

3.1 terms and definitions

3.1.1

plate for the purposes of improving the concrete cracking resistance and ultimate bearing capacity of the anchorage zone.

3.1.15

Draw-in

It refers to the shrinkage of the prestressing tendon in the anchoring process of the prestressing tendon due to the relative displacement and the local plastic deformation between different components of the anchorage AND between the anchorage and prestressing tendon.

3.1.16

Prestress loss due to friction at anchorage device

It refers to the prestress loss of the prestressing tendon at the anchorage and the corner of the tensioning end bearing plate flange mouth due to friction.

3.2 Symbols

The following symbols apply to this document.

A_{pk} - The nominal cross-sectional area of the prestressing tendons, in square millimeters (mm^2);

F_{pm} - The measured mean ultimate tensile strength of a single sample of prestressing tendons, in kilo-Newton (kN);

F_{ptk} - The nominal ultimate tensile strength of prestressing tendons, in kilo-Newton (kN);

F_{Tu} - The measured ultimate tensile strength of the assembly of prestressing tendons-anchorage, grip or coupler, in kilo-Newton (kN);

F_u - The measured damage load of the anchorage zone under the force transmission test, in kilo-Newton (kN);

$f_{ck,o}$ - The characteristic compressive strength to be achieved by the concrete member in the case of full preloading being allowed, in Megapascal (MPa);

$f_{cm,e}$ - The measured mean compressive strength of the concrete cube as cured under the same conditions as that of the anchorage zone force transmission performance test, in Megapascal (MPa);

5 General requirements

5.1 Material

5.1.1 The materials used in the product shall comply with the design requirements, AND have mechanical properties and chemical composition certificate, as well as quality assurance. Materials shall be subjected to acceptance test after entering into factory, AND only those passing the test can be used.

5.1.2 Parts forging blanks shall comply with the provisions of GB/T 12361 or JB/T 5000.8.

5.1.3 The material of the bearing plate shall not be less than HT200 when the gray cast iron is used, and shall comply with the provisions of GB/T 9439; AND it shall comply with the provisions of GB/T 1348 when the spheroidal graphite cast iron is used.

5.2 Manufacturing

5.2.1 The product shall be processed in accordance with the requirements of the technical documentation. The cutting parts shall comply with the provisions of JB/T 5000.9.

5.2.2 The unattended grade of the thread shall not be lower than 7H/8g in GB/T 197. Threads with special requirements shall comply with the requirements of technical documentation.

5.2.3 The tolerance level of the machined parts without tolerance dimension indications shall not be less than the level C in GB/T 1804.

5.2.4 Heat treatment of products shall be carried out in accordance with the technical documentation AND shall comply with the requirements of GB/T 16923 or GB/T 16924.

5.2.5 It is preferable for the surface of the parts of anchorage, grip and coupler to be subjected to rust treatment, AND it shall give priority to the use of environmentally friendly rust treatment process. The surface of the bearing plate and the spiral reinforcement shall not have any paint or grease that affects its adhesion to the concrete.

5.2.6 The product assembly shall comply with the requirements of JB/T 5000.10.

5.3 Appearance, dimension and hardness

5.3.1 The appearance of the product shall be in accordance with the technical documentation AND shall comply with the following:

a) All products shall not have crack;

b) The bearing plate and the coupler body shall be subjected to surface magnetic particle detection AND shall comply with the requirements of level II requirements of JB/T 5000.15.

5.3.2 The dimension and deviation of the product shall comply with the requirements of the technical documentation.

5.3.3 The hardness of the product shall comply with the requirements of the technical documentation.

5.4 Quality documents

Anchorages, grips and couplers shall have complete design documents, quality documentation of raw materials, manufacturing batch records, and performance inspection records, all of which shall be traceable.

5.5 Other requirements

5.5.1 Anchorage

5.5.1.1 It is preferable for the anchorages and their accessories requiring duct grouting to have grouting holes or vent holes. The grouting hole position and diameter shall comply with the grouting requirements AND have the structure used to connect the grouting pipe.

5.5.1.2 The anchorage used for low stress for which the cable is replaceable shall be provided with loosening proof replaceable device.

5.5.1.3 The anchorage for external prestressing tendon and the anchorage for cable shall have corrosion proof measures AND comply with the structural durability requirements.

5.5.2 Grip

5.5.2.1 Grip shall be reusable.

5.5.2.2 Grip shall have a reliable self-anchoring performance and good anchor loosening performance.

5.5.2.3 During the use, it shall ensure the safety of the operators.

5.6 Anchorage and coupler for cable

be less than 80 MPa. When there are special engineering requirements, the upper limit of the test stress and the magnitude of the fatigue stress can be determined otherwise;

b) The test stress upper limit and the fatigue stress amplitude of the fatigue load performance of the cable shall, based on the cable types, be in accordance with the provisions of the relevant national standards OR in accordance with the design requirements;

c) When the anchored prestressing tendons are fiber reinforced composite bars, the upper limit of the test stress shall be 50% of the nominal tensile strength f_{ptk} of the prestressing tendon, AND the fatigue stress amplitude shall not be less than 80 MPa.

6.1.2.2 Prestressing tendon - anchorage assemblies shall not be subjected to anchorage fatigue damage after 2 million times of cycling load. The fatigue damage cross-sectional area of the prestressing tendons due to holding effect of the anchorages shall not be greater than 5% of the total cross-sectional area of the prestressing tendons in the assembly.

6.1.3 Anchorage zone force transmission performance

The bearing plate and the spiral reinforcement fitted with the anchorage shall be capable of transmitting the preload applied by the anchorages to the anchorage zone of the concrete structure. The dimensions of the bearing plate and the spiral reinforcements shall match with the concrete characteristic strength as required when the tension is allowed. As for the concrete force transmission test member of the specified dimensions and strengths, at least 10 cyclic loads are applied, AND the force transmission performance during the test shall comply with the requirements below:

a) When the cyclic load reaches the upper limit load of $0.8F_{ptk}$ for the first time, the crack width of the concrete component shall not be greater than 0.15 mm;

b) When the cyclic load reaches the lower limit load of $0.12F_{ptk}$ for the last time, the crack width of the concrete component shall not be greater than 0.15 mm;

c) When the cyclic load reaches the upper limit load of $0.8F_{ptk}$ for the last time, the crack width of the concrete component shall not be greater than 0.25 mm;

d) At the end of the cyclic loading process, the crack width, longitudinal strain and transverse strain reading of the concrete component shall be stable;

7.1.2.6 For the assembly for which the clamping part of the prestressing tendon does not bend (all the anchor holes are perpendicular to the anchor plate bottom surface), the prestressing tendon shall be tensioned in a parallel manner, AND the side surface shall not have contact points which interfere with tensioning or is in abrasion with the prestressing tendon (SEE Figure 1); if there is a direction turning angle between the clamping part of the prestressing tendon and the axis of the assembly (the anchor hole is not perpendicular to the anchor plate bottom surface OR the extrusion head of the coupler needs installed in a inclined manner), it shall add the turning restriction steel ring at the design corners, AND such ring shall, when the assembly is under tension force, not subjected to relative sliding between the prestressing tendon.

7.1.3 Test equipment and instruments

The measuring system of the testing machine shall be calibrated in accordance with the provisions of GB/T 16825.1 AND its accuracy shall not be less than level 1; as for the measuring device for total elongation of the prestressing tendon within the measuring range, the relative indication error shall not exceed ± 1%.

7.2 Appearance, dimension and hardness test

7.2.1 Product appearance shall be tested using the visual observation method; the anchor plate and the coupler body shall be subjected to surface magnetic powder detection in accordance with the requirements of GB/T 15822.1; AND other parts surface may be checked by magnifying lens.

7.2.2 The product dimension shall be tested with ruler, vernier caliper, screw micrometer, plug gauges, and other measuring tools.

7.2.3 The hardness test shall be based on the surface location, hardness value type, and hardness range as specified in the product technical documents to select the corresponding hardness measuring instrument in accordance with the requirements of GB/T 230.1 or GB/T 231.1.

7.3 Static load anchoring performance test

7.3.1 Prestressing tendons - anchorage or grip assembly may be subjected to the static load anchoring performance test using the device as shown in Figure 2. The inner diameter of the annular support plate mounted underneath the tested anchorage shall be in line with the diameter of the upper mouth of the bearing plate used together; the prestressing tendon - coupler assembly may be subjected to the static load anchoring performance test using the device as shown in Figure 3; when the prestressing tendon (part 13) of the connected section is pre-tightened, it may add temporary plate underneath the tested

Description:

1, 12 - Tested anchorage;

2, 11 - Ring support plate;

3 - Loading jack;

4 - Bearing platform;

5 - Prestressing tendons at connection section;

6 - Total elongation measuring device;

7 - Direction turning restriction steel ring;

8 - Test coupler;

9 - Additional bearing cylinder or piercing jack;

10 - Load sensor;

13 - Prestressing tendons at connection section.

Figure 3 -- Schematic diagram of static load anchoring performance test device for prestressing tendon - coupler assembly

7.3.2 The tested prestressing tendon - anchorage, grip or coupler assembly shall be installed with all prestressing tendons.

7.3.3 Before loading it shall correctly install and calibrate all measuring instruments, make the initial stress of each prestressing tendon be uniform, AND the initial stress may be taken as 5% ~ 10% of the nominal tensile strength f_{ptk} of the prestressing tendon; AND the gauge length of the total elongation measuring device shall not be less than 1 m.

7.3.4 The loading procedure shall comply with the following requirements:

a) The preloading of the prestressing tendons is carried out at a constant speed. The loading procedures shall be in accordance with Table 4, at the loading speed not exceeding 100 MPa/min; the load is maintained for 1 h after loading to the highest load; AND then it is slowly loaded until damage occurs.

Table 4 -- Loading procedures for static load anchoring performance test

in Megapascal

Where:

ΔL_1 - The displacement of the loading jack piston when the test load is increased from $0.1F_{ptk}$ to F_{Tu}, in millimeters (mm);

ΔL_2 - The theoretical calculated value of the displacement of the loading jack piston when the test load is increased from 0 to $0.1F_{ptk}$, in millimeters (mm);

$\Sigma\Delta\alpha$- The sum of the relative displacements between the ends of the prestressing tendons and the anchorages, grips or couplers when the test load is increased from $0.1F_{ptk}$ to F_{Tu}, in millimeters (mm);

L_2 - The tension length of the prestressing tendon when the test load is $0.1F_{ptk}$, in millimeters (mm).

f) The damage parts and forms of the assembly shall comply with the following: it is not allowed for the clip type anchorage, grip or coupler clip to have cracks or fracture once loaded to the highest level load; it is allowed to have slight crack or longitudinal facture after reaching to the requirements of 6.1.1 or 6.2, BUT it is not allowed to have transverse or inclined fracture or breaking; the clip damage or fracture due to the intense breaking impact of the prestressing tendon is normal; AND as for the static load anchoring performance test of the grip type anchorage, it is normal after losing the griping force if complying with the requirements of 6.1.1.

7.3.6 The static load anchoring performance test of the three assemblies shall be carried out AND all test results shall be recorded. The test results of the three assemblies shall comply with the requirements of 6.1 or 6.2, AND it shall not use the mean value as the test result.

7.3.7 When the prestressing tendon is steel strand, if the steel strand breaks at the non-clamping portion beyond the anchorage, grip or coupler, AND meanwhile it does not comply with the requirements of 6.1.1 or 6.2, it shall replace the steel strand AND take sample again for test.

7.3.8 The test report shall, in addition to data records, also contain the image records of the damage part and form, as well as accurate text description.

7.4 Fatigue load performance test

7.4.1 The prestressing tendon - anchorage or coupler assembly shall be subjected to fatigue load performance test on the fatigue testing machine, AND it is preferable for the tested assembly to be fitted with all prestressing tendons; when the fatigue test machine capacity is not enough, it may reduce the

a) Appearance and dimension: the number of samples shall not be less than 5% of monthly production;

b) Hardness (parts with hardness requirements): the number of samples shall not be less than 3% of monthly production;

c) Static load anchoring performance: the number of samples from the anchorages, grips or couplers of same specifications shall be not less than 3 assemblies every two months;

d) The number of samples shall be increased if the quality of the aforementioned test results is not stable.

8.3.2 Type inspection

8.3.2.1 The same series of products shall be grouped in accordance with the following provisions, AND a representative product of one specification is selected from each group for the type inspection: 1 ~ 12 holes for the small specification group, 13 ~ 19 holes for the medium specification group, and 20 holes and above for the large specification group. The grouping of the anchorage zone force transmission test shall comply with the provisions of Appendix A.

8.3.2.2 The batching number of the type inspection for the anchorages and the couplers permanently left in the concrete structure or component shall be not less than 30 pieces (sets), AND the sampling number shall comply with the following provisions:

a) Appearance, dimension and hardness (products with hardness requirements): 12 pieces (sets);

b) Static load anchoring performance: the amount of three assemblies;

c) Fatigue load performance: the amount of three assemblies;

d) Anchor plate strength: 3 pieces taken from the anchor plate which has passed the static load anchoring performance test;

e) Draw-in, prestress loss due to friction at anchorage device, anchorage zone force transmission performance, and tensioning anchorage process: the amount of three assemblies for each;

f) Low temperature anchoring performance: for anchorages with low temperature anchoring performance, the amount of one assembly shall be taken.

The type inspection shall be deemed as disqualified if any one of the aforementioned items is disqualified.

8.4.2.2 Draw-in, prestress loss due to friction at anchorage device

The draw-in and the prestress loss due to friction at anchorage device are data measuring items, which will not be used as the qualification judgment.

8.4.2.3 Tensioning anchorage process

This item is used to verify the adaptability of the anchorage to the tensioning process, which will not be used as the qualification judgment.

9 Marking, packaging, transport and storage

9.1 Marking

In the large end plane of the clip, the large end plane of the anchor plate and coupler cone hole, and the large end plane of the bearing plate, there shall be the enterprise logo and the product specification marking.

9.2 Packaging

9.2.1 Anchorage, grip and coupler shall, during exit-factory, be subjected to rust treatment AND packaging in boxes.

9.2.2 The outer wall of the packaging box shall be marked with the manufacturer name, product name, specification, model, product batch number and exit-factory date.

9.2.3 The product shall be packaged with the following documents during exit-factory which shall be placed into a moisture proof document bag:

a) Product certificate;

b) Product brochures;

c) Packing list.

9.2.4 The product certificate shall include the following:

a) Models and specifications;

b) Applicable prestressing tendon varieties, specifications, strength grade;

c) Product batch number;

Appendix A

(Normative)

Test method for force transmission performance of anchorage zone

A.1 General provisions

A.1.1 As for the same series of clip-type anchorage products of the same design methods and the same materials, it shall select the anchorage of such specifications as 7 holes, 12 holes and 19 holes, etc., and the matching bearing plate and spiral reinforcement; as for the anchorage of over 19 holes and the matching bearing plate and spiral reinforcement, the design unit shall select the representative specification for the test in the application of the project.

A.1.2 The products of same specifications shall be subjected to the anchorage zone force transmission performance test of 3 same concrete prism components.

A.1.3 The anchorages of other forms may make reference to this Appendix for the test.

A.2 Fabrication of concrete components

A.2.1 The bearing plate, spiral reinforcement and prestressing tendon hole as contained in the fabricated concrete prism component shall be same as those selected in the product system specification table or the design. The specifications shall be matched with each other, AND the position shall be aligned during pre-embedding.

A.2.2 The dimensions of concrete components shall comply with the following requirements:

a) The cross-sectional area of the concrete component is calculated in accordance with the equation (A.1)

$$A_c = a \times b \qquad \cdots\cdots (A.1)$$

Where:

Figure A.1 -- Schematic diagram of transmission performance test of anchorage zone

A.3.2 The resolution of the crack width measuring instrument and strain measuring displacement meter shall not be less than 0.01 mm; the installation method of the measuring device is as shown in Figure A.2. The distance from the transverse strain meter which is closer to the bearing plate to the upper surface of the concrete component is about 1.1 times the bearing plate height, AND the gauge range of the perpendicular strain measuring displacement meter is about 0.6b ~ 0.8b.

A.3.3 It may start the test when the measured mean compressive strength $f_{cm,e}$ of the concrete cube sample as cured under the same conditions complies with the requirements of equation (A.6). When the test duration exceeds 10 h, it shall re-determine the concrete cube sample strength $f_{cm,e}$ when the concrete component is loaded to damage, which is used to judge F_u.

$$f_{cm,e} \leqslant f_{cm,o} + 4 \text{ MPa}, f_{cm,o} = 1.15 \times f_{ck,o} \quad \cdots\cdots (A.6)$$

A.3.4 During loading, it shall ensure that the load on the compressive end surface of the concrete component is uniform AND free from eccentricity, twisting, or impact; the loading speed shall not exceed 100 MPa/min; the load is applied in levels at $0.2F_{ptk}$, $0.4F_{ptk}$, $0.6F_{ptk}$ and $0.8F_{ptk}$; after the load reaches to $0.8F_{ptk}$, at least 10 slow cyclic loadings will be conducted, with the upper load limit in $0.8F_{ptk}$ and the lower load limit in $0.12F_{ptk}$; after the cyclic loading, the load is gradually increased until the concrete component is damaged (Figure A.3).

The unit is in millimeters

Appendix B

(Normative)

Test method for low temperature anchoring performance

B.1 General provisions

Low temperature anchoring performance test shall choose the engineering anchorages of maximum specification to form the prestressing tendon - anchorage assembly, which shall comply with the provisions of 7.1.2.

B.2 Test methods

B.2.1 The low temperature anchoring performance test may be carried out using the apparatus as shown in Figure B.1 And it shall comply with the following requirements:

a) The temperature measurement range of the temperature sensor shall comply with the requirements of -200 °C ~ 20 °C, with the error not exceeding ± 2.5 °C;

b) The tension length of the prestressing tendons shall not be less than 3 m, AND the gauge length of the total elongation measuring device shall not be less than 1 m.

The unit is in millimeters

10 - Liquid nitrogen inlet;

11 - Test bracket;

12 - Low temperature end test anchorage;

13 - Sealed cover (liquid nitrogen bin);

14 - Temperature sensor inside the sealed cover;

15 - Temperature sensor on prestressing tendons;

16 - Temperature sensor on anchor plate;

17 - Bearing plate;

18 - Temperature sensor on the back of the bearing plate;

19 - Spiral reinforcement;

20 - Concrete pressure bearing component;

21 - Test bearing frame;

22 - Displacement sensor.

Figure B.1 -- Schematic diagram of low temperature anchoring performance test device

B.2.2 The test loading procedure shall comply with the following requirements:

a) USE the tensioning jack for construction purposes to apply load onto the assembly at four levels: $0.2F_{ptk}$, $0.4F_{ptk}$, $0.6F_{ptk}$, $0.8F_{ptk}$; ANCHOR it when the load reaches to $0.8F_{ptk}$; AND the loading speed shall not be more than 100 MPa/min;

b) USE the loading jack to continue loading until the load reach to $0.8F_{ptk}$; MAINTAIN this load for 1 h;

c) REDUCE the temperature of the lower end of the assembly from the room temperature T_0, until the temperature as measured by the temperature sensor on the anchor plate reaches to -196 °C; AND the load shall be kept at $0.8F_{ptk}$ without change during the cooling process;

d) When the temperature as measured by the temperature sensor on the back of the bearing plate is stable, MAKE 10 cyclic loadings, with the lower load limit during cyclic loading at $0.8F_{ptk}$ AND the upper load limit being at the tensile yield stress $F_{p0.2}$ when the non-proportional

2, 17 - Tool anchorage;

3 - Tensioning jack for construction purposes;

4, 15 - Alignment washer;

5 - Active end load sensor;

6 - Limit plate;

7 - Tested anchorage;

8 - Bearing plate;

9 - Spiral reinforcement;

10 - Concrete bearing component;

11 - Prestressing tendon hole;

12 - Pedestal;

13 - Steel restraint ring;

14 - Passive end load sensor;

16 - Loading jack.

Figure D.1 -- Test device schematics for prestress loss due to friction at anchorage device

D.2.2 The test shall comply with the following requirements:

a) During the test, it shall avoid the prestressing tendons from friction at the duct, AND the inner diameter of the reserved duct shall be slightly larger than the inner diameter of the small hole of the bearing plate;

b) It shall avoid the prestressing tendons in the passive end from the friction, AND the inner diameter of the steel restraint ring at the passive end shall be slightly smaller than the inner diameter of the small hole of the bearing plate;

c) The test loading speed shall not be greater than 200 MPa/min;

d) During the test, it shall respectively conduct tensioning at levels based on $0.75F_{ptk}$ and $0.8F_{ptk}$, the load maintenance time at each level shall be not less than 1 min, AND it shall take the reading of the load sensors at both ends during load maintenance at each level.

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