JGJ

INDUSTRY STANDARD OF THE

PEOPLE'S REPUBLIC OF CHINA

UDC

P **JGJ 107-2016**

Registration No. J 986-2016

Technical specification for mechanical splicing of steel reinforcing bars

钢筋机械连接技术规程

Issued on: February 22, 2016 **Implemented on: August 01, 2016**

Issued by: Ministry of Housing and Urban-Rural Development of PRC

Table of Contents

Technical specification for mechanical splicing of steel reinforcing bars

1 General provisions

1.0.1 In order to standardize the application of rebar mechanical connection in reinforced concrete structural engineering, so as to be safe, applicable, advanced in technology, economical and reasonable, to ensure quality, this specification was formulated.

1.0.2 This specification is applicable to the design, construction and acceptance of rebar mechanical connection in reinforced concrete structures of construction projects.

1.0.3 The steel reinforcing bars used for mechanical connection shall comply with the current national standards “Steel for the reinforcement of concrete - Part 2: Hot rolled ribbed bars” GB 1499.2, “Quenching and self-tempering ribbed bars for the reinforcement of concrete” GB 13014, “Stainless steel bars for the reinforcement of concrete” YB/T 4362, “Steel for the reinforcement of concrete - Part 1: Hot rolled plain bars” GB 1499.1.

1.0.4 In addition to this specification, the rebar mechanical connection shall also comply with the relevant national standards.

2 Terms and symbols

2.1 Terms

2.1.1 Rebar mechanical splicing

A connection method for transmitting a force in one reinforcing bar to another reinforcing bar through mechanical occlusion of a reinforcing bar with a connecting member or other intervening material or pressure bearing effect on a reinforcing bar's end face.

2.1.2 Splice

In a complete set of devices of rebar mechanical connection, a shorted name of rebar mechanical connections.

2.1.3 Connectors of mechanical splicing

It connects the various components for reinforcing steel bar, including sleeves and other components.

2.1.4 Coupler or sleeve

A steel sleeve used to transmit the axial tensile or compressive force of a reinforcing steel bar.

2.1.5 Rebar threaded sector

A threaded section at the end of a reinforcing steel bar in a splice.

2.1.6 Length of mechanical splice

The length of the splice's connector plus the length of the segment of the variable cross-section of the reinforcing steel bar at both ends of the connector of mechanical splicing. The exposed threaded head and upset transition segment of the threaded sector belong to variable cross-sectional segments.

2.1.7 Tensile strength of splice

The maximum tensile stress value of the splice sample during the tensile test.

2.1.8 Residual deformation of splice

After the splice sample is loaded and unloaded according to the specified loading system, the deformation measured within the specified gauge distance.

2.1.9 Total elongation of splice sample at maximum tensile force

4 Splice applications

4.0.1 The selection of splice grades shall meet the following requirements:

1 In the concrete structure, where the strength of the steel reinforcing bar is required to be fully exerted or where high ductility is required, it shall select the grade II or grade I splices; when the area percentage of the steel splices in the same splicing segment is 100%, it shall select grade I splice.

2 In the location of the concrete structure where the steel reinforcing bar has high stress but has low requirements for the ductility, it may select the grade III splices.

4.0.2 The thickness of the concrete protective layer of the connector of mechanical splicing should comply with the provisions of the current national standard “Code for design of concrete structures” GB 50010, meanwhile it shall not be less than 0.75 times the minimum protective layer thickness of steel reinforcing bars and 15 mm, whichever is larger. If necessary, it may take anti-rust measures for the connector of mechanical splicing.

4.0.3 The splices of longitudinally stressed steel reinforcing bars in structural members should be staggered from each other. The length of the connecting segment of the rebar mechanical splicing shall be calculated as 35d. When the steel reinforcing bars with different diameters are connected, it should be calculated based on the steel reinforcing bar of smaller diameter. The area percentages of the rebar mechanical splicing located in the same connection segment shall meet the following requirements:

1 The splice should be set at the place where the stress of the structural member's tensile steel reinforcing bar is relatively small. When the splice is set at the high stress part, the percentage of the splice area of the grade III splice in the same connection segment shall not be greater than 25%; the area percentage of the grade II splices shall be not more than 50%. Except for the conditions as listed in item 2 and item 4 in this clause, the splice area percentage of the grade I splices may be not limited otherwise.

2 Splices should avoid the beam-end and column-end stirrup-densified areas of the frame which has seismic fortification requirements; when it cannot be avoided, it shall use the grade II splices and grade I splices. Meanwhile the splice area percentage shall be not greater than 50%.

3 The percentage of splice area can be unrestricted for areas with small tensile stress of tensioned steel reinforcing bars or longitudinally compressed steel reinforcing bars.

4 For structural members that are directly subjected to repeated loads, the

5 Initial type testing of splices

5.0.1 Type testing shall be performed in the following cases:

1 When determining the splice's performance grade;

2 When the sleeve's material, specifications and splice processing technology are changed;

3 When the type testing report is over 4 years.

5.0.2 Splice's type testing samples shall meet the following requirements:

1 For each type, grade, specification, material, and process of rebar mechanical splicing, the number of samples for type testing shall not be less than 12; of which, the number of samples for tensile strength test of the base metal shall be not less than 3; the number of samples for unidirectional tensile test shall be not less than 3; the number of samples for high-stress repeated tension-compression shall be not less than 3; the number of samples for large-deformation repeated tension-compression shall be not less than 3;

2 The steel reinforcing bars of all samples shall be cut from the same steel reinforcing bar;

3 The splice sample shall be installed in accordance with the requirements of clause 6.3 of this specification;

4 The samples for type testing shall not use the pre-drawn samples.

5.0.3 The type testing of the splices shall be carried out in accordance with the provisions of Appendix A of this specification. When the test results meet the following requirements, they shall be assessed as qualified:

1 Strength testing: The actual measured value of the strength of each splice sample shall meet the strength requirements of the corresponding splice grade in Table 3.0.5 of this specification;

2 Deformation testing: The average value of the measured values of the total deformation of the three samples under the residual deformation and the maximum force shall meet the requirements of Table 3.0.7 of this specification.

5.0.4 Type testing shall record the parameters of the connectors of mechanical splicing and splices in detail. It should issue a testing report and assessment conclusion according to the format of Appendix B of this specification.

5.0.5 When the splice is used for components that are directly subjected to

6 Machining and installing of splices on site

6.1 General requirements

6.1.1 On-site processing of rebar threaded sector and installation of splices shall be performed according to the processing and installation technical requirements of the providers for splice technology. The operators shall go to work after passing the professional training. The staff shall be stable.

6.1.2 Processing of rebar threaded sector and installation of splices shall be carried out only after passing the technical testing.

6.2 Machining of splices on site

6.2.1 The processing of straight threaded rebar threaded sector shall meet the following requirements:

1 The end of the steel reinforcing bar shall be leveled by a band saw, grinding wheel saw or a special steel reinforcing bar cutting machine with a circular blade;

2 The upsetting head shall not have a transverse crack perpendicular to the axis of the steel reinforcing bar;

3 The length of the rebar threaded sector shall meet the product design requirements; the limit deviation shall be 0 ~ 2.0p;

4 The rebar threaded sector should meet the grade 6f accuracy requirements. It shall use a special straight thread gauge for inspection. The go-gauge shall be able to screw in smoothly and reach the required screw-in length. The screw-in of no-go-gauge must not exceed 3p. The number of self-tests for each specification shall not be less than 10%; the inspection pass rate shall not be less than 95%.

6.2.2 The processing of the conical threaded rebar threaded sector shall meet the following requirements:

1 There must be no local bending at the end of the steel reinforcing bar that affects thread processing;

2 The length of the rebar threaded sector shall meet the product design requirements; the rebar threaded sectors after tightening must not contact each other; the limit deviation of the processing length of the threaded sector shall be -0.5p ~ -1.5p;

7 Inspecting and accepting of splices on site

7.0.1 When splices are used in engineering, the relevant technical data of splices submitted by the splice technology provider shall be reviewed and accepted, which shall include the following:

1 The valid type testing report of splices used in the project;

2 Relevant technical documents for product design of splices, processing and installation of splices;

3 Certificate of qualification of splice products and quality certificate of raw materials for connectors of mechanical splicing.

7.0.2 The splice process testing shall be carried out for the steel reinforcing bars of different production plants. When the steel reinforcing bar plant or splice technology provider is replaced during construction, it shall make additional process testing, which shall meet the following requirements:

1 All types and models of splices shall be subject to process testing, which includes unidirectional tensile ultimate tensile strength and residual deformation;

2 There shall be not less than 3 samples of each type of steel splices;

3 After measuring the residual deformation of the splice sample, the ultimate tensile strength test can be continued; meanwhile it should carry out the test according to the unidirectional tensile loading system in Table A.1.3 of this specification;

4 The ultimate tensile strength of each sample and the average value of the residual deformation of the 3 splice samples shall meet the requirements of Table 3.0.5 and Table 3.0.7 of this specification;

5 When the process testing fails, it shall adjust the process parameters. After passing the test, it can use the finally determined process parameters the splices can be processed in batches according to the final confirmed process parameters.

7.0.3 The rebar threaded sector's processing shall be subject to self-inspection in accordance with the requirements of clause 6.2 of this specification. When the supervision or quality inspection department disagrees with the processing quality of rebar threaded sector on-site, it may randomly take 3 splice samples for the testing of the ultimate tensile strength and unidirectional tensile residual deformation. If the ultimate tensile strength of one sample or the average value of the residual deformation values of three samples is unsatisfactory, it shall

2 For the sleeve extruded splices, it shall take 10% splices according to the acceptance batch. The diameter of the indentation or the length of the sleeve after extrusion shall meet the requirements of item 3 of clause 6.3.3 of this specification; the depth of the steel reinforcing bar inserted into the sleeve shall meet the product design requirements. When the number of unqualified inspections exceeds 10%, it may take 3 samples from the unqualified splices in appearance inspection in this batch to carry out the ultimate tensile strength test; it is evaluated in accordance with clause 7.0.7 of this specification.

7.0.7 For each acceptance batch of splices, it shall randomly cut 3 splice samples from the engineering structure for ultimate tensile strength test. It is evaluated according to the splice grade required by the design. When the ultimate tensile strength of the three splice samples meets the strength requirements of the corresponding grades in Table 3.0.5 of this specification, the acceptance batch shall be evaluated as qualified. When the ultimate tensile strength of only 1 sample does not meet the requirements, it shall take another 6 samples for re-inspection. In the re-inspection, if the ultimate tensile strength of one sample still fails to meet the requirements, the acceptance batch shall be rated as unqualified.

7.0.8 For closed ring rebar splices, rebar cage splices, buried sleeve splices for underground diaphragm walls, stainless steel rebar splices, rebar splices between prefabricated structural members, the splices with fatigue performance requirements, it may perform witnessed sampling. From the processed and qualified finished products of rebar threaded sectors, randomly cut rebar samples; follow the requirements of clause 6.3 of this specification, assemble them with the mobilized sleeves as randomly taken to form 3 splice samples, to carry out the ultimate tensile strength test. It is evaluated according to the splice grade as required by design. The conformity assessment of the acceptance batch shall comply with the provisions of clause 7.0.7 of this specification.

7.0.9 For the on-site inspection of the same splice type, same model, same grade, same specification, if the one-time qualification rate of the tensile strength tests of the samples from 10 consecutive acceptance batches is 100%, the number of splices in the acceptance batch can be expanded to 1000. When the number of splices in the acceptance batch is less than 200, it may randomly take 2 samples according to the sampling requirements same as those in clause 7.0.7 or clause 7.0.8 of this specification, to perform the ultimate tensile strength test; when the ultimate tensile strength of the 2 samples meet the strength requirements of clause 3.0.5 of this specification, it shall take another 4 samples for reinspection; if there is still 1 sample fails in the ultimate tensile strength test, this acceptance batch shall be rated as unqualified.

7.0.10 For validly certified splice products, the number of acceptance batches

3 δ_2 is the deformation value represented by the distance between the intersection points of the parallel line of S and the abscissa at an unloading force of $0.5f_{yk}\,A_s$ and a reverse loading force of $-0.25f_{yk}\,A_s$ after 4 repeated loading of $2\varepsilon_{yk}\,L_1$;

4 δ_3 and δ_4 are the deformation value obtained in the same way as δ_1 and δ_2 after $5\varepsilon_{yk}\,L_1$ is repeatedly loaded 4 times.

A.1.4 The load stress rate when measuring the residual deformation of the splice sample should be $2N/mm^2 \cdot s^{-1}$, which shall not exceed $10N/mm^2 \cdot s^{-1}$. When measuring the total elongation or ultimate tensile strength of the splice sample under the maximum force, the separation rate of the tester chuck should be $0.05L_c$ per minute, wherein L_c is distance between the chucks of the tester. The relative error of the speed should not be greater than ± 20%.

A.1.5 The numerical rounding off and judgment of the test results shall comply with the provisions of the current national standard “Rules of rounding off for numerical values & expression and judgement of limiting values” GB/T 8170.

A.2 On-site inspection

A.2.1 The instrument layout, measurement gauge distance and loading rate of splice deformation test for residual deformation inspection during on-site process inspection shall meet the requirements of clauses A.1.1 and A.1.4 of this specification. In the field process inspection, when the residual deformation inspection of the splice is carried out according to the loading system in clause A.1.3 of this specification, it may use a tensile force of not more than $0.012A_sf_{yk}$ as the nominal zero load.

A.2.2 The ultimate tensile strength test of spot checked splice sample shall adopt a one-time loading system from zero to failure.

A.3 Fatigue testing

A.3.1 The splice sample used for fatigue test shall be manufactured and installed according to the relevant technical requirements of the splice technology supplier. The bending angle of the sample after assembly shall not exceed 1°; the length of the tested segment of the sample should not be less than 400 mm.

A.3.2 The fatigue performance test of splice sample should be performed by the use of a low frequency test machine; the stress cycle frequency should be selected from 5Hz to 15Hz. When a high frequency fatigue test machine is used for fatigue tests, the stress amplitude or test results should be corrected. During the test, when the temperature of the sample exceeds 40 °C, it shall take cooling measures. When the rebar splice is used in high and low temperature environments, the splice’s fatigue test shall be performed under the

Table of Contents

1 General

1.0.1, 1.0.2 This specification makes uniform requirements for the performance requirements of rebar mechanical splicing in concrete structures of construction projects, application of splices, on-site processing and installation of splices, and on-site inspection and acceptance of splices, which is used in combination with the current national standard “Code for design of concrete structures” GB 50010, to ensure the quality and reasonable application of various mechanical splices. In addition to construction works, general structures (including towers such as television towers, chimneys, containers, municipal public infrastructure, etc.) and other engineering structures such as highway and railway bridges, dams, nuclear power plants, may refer to this specification.

After the promulgation and implementation of this specification, all kinds of rebar mechanical splices, such as sleeve extruded splices, tapered threaded splices, straight threaded splices, etc. shall comply with the provisions of this specification. Reinforced sleeve grouting splices have special requirements and shall comply with the relevant provisions of the current industry standard “Technical specification for grout sleeve splicing of rebars” JGJ 355.

1.0.3 This clause specifies the applicable standards for steel reinforcing bars used for rebar mechanical splicing; adds relevant provisions for hot-rolled round steel reinforcing bars, residual heat treated steel reinforcing bars, stainless steel reinforcing bars. China's stainless steel rebar industry standards have been promulgated and implemented. The stainless steel rebar mechanical splicing had been applied in Hong Kong-Zhuhai-Macao Bridge and other projects. Based on domestic experience in applying stainless steel rebars, this specification has formulated relevant provisions for the use of stainless steel rebars for mechanical splicing.

2 Terms and symbols

2.1 Terms

2.1.1 ~ 2.1.5 Introduce the definition of terms such as rebar mechanical splicing, splices, splices, connectors of mechanical splicing, sleeves, rebar threaded sectors, etc.

According to this definition, the commonly used types of rebar mechanical splicing are as follows:

① Sleeve extruded splice: A splice formed by tight engagement between the steel sleeve of the connector of mechanical splicing under the plastic deformation due to extruding force and the ribbed steel reinforcing bar.

② Taper threaded splice: A splice formed through engagement by the special taper thread of the steel reinforcing bar end and the taper thread of the connector of mechanical splicing.

③ Upset straight threaded splice: A splice formed through engagement by the straight thread produced by upsetting the end of the steel reinforcing bar and the thread of the connector of mechanical splicing.

④ Rolled straight threaded splice: A splice formed through engagement by the straight thread as produced by rolling directly at the end of the steel reinforcing bar or rolling after stripping the rib and the thread of the connector of mechanical splicing.

⑤ Sleeve grouting splice: A butt splice of steel reinforcing bar which realizes force transmission through hardening the mixture after inserting a single ribbed steel reinforcing bar and injecting grouting mix into a metal sleeve.

⑥ Molten metal filling splice: The splice formed by the filling of molten metal which is produced by the reaction of the high-temperature agent in between the steel reinforcing bar and the sleeve of the connector of mechanical splicing.

The latter two types of splices rely mainly on the ribs on the surface of the steel reinforcing bar and the mechanical occlusion of the hardened cement slurry or molten metal, which transmits the tensile force or pressure in the steel reinforcing bar to the connector of mechanical splicing, then to the other steel reinforcing bar through the connector of mechanical splicing.

Some connectors of mechanical splicing are composed of a sleeve and other components in order to meet the different functions of the splice. The connector of mechanical splicing is a general term for multiple components including the sleeve.

The above-mentioned different types of splices can be divided into different

3 Performance requirements of splices

3.0.1 The splice shall meet the requirements of strength and deformation performance. Its performance is graded based on this.

3.0.2 This clauses stipulates that the sleeve material shall comply with the relevant provisions of the current industry standard “Couplers for rebar mechanical splicing” JG/T 163. In recent years, the raw materials for connecting sleeves are mostly No.45 cold-drawn or cold-rolled precision seamless steel tubes, which is commonly known as bright tubes. The internal stress of this type of processed steel tube is very large. If it is not annealed, its elongation is very low. There are hidden dangers in quality, meanwhile the sleeve is also easy to crack in engineering applications. The product standard “Couplers for rebar mechanical splicing” JG/T 163 specifies that for the use of this type of tube materials, in addition to be “annealed”, it shall also meet the requirements that the strength is not more than 800 MPa and the elongation at break is not less than 14%. This specification reiterates that the product standard requires that such tubes shall be annealed to remind users to pay attention to the quality control of such tubes.

3.0.3 The strength and deformation of a splice under uniaxial tension are the basic properties of the splice. The high-stress repeated tension-compression performance reflects the ability of the splice to withstand high stress repeated tension-compression under wind loads and small earthquakes. The large-deformation repeated tension-compression performance reflects the load-bearing capacity of the splice in the plastic deformation stage of the structure under the strong earthquake.

The above three performances are the basic inspection items for splice’s type testing. The fatigue performance is a selective test item according to the application of the splice.

On-site process inspection requires inspection of unidirectional tensile residual deformation and ultimate tensile strength.

3.0.4 This clause stipulates that the splice shall be divided into three grades of I, II, III according to the ultimate tensile strength, residual deformation, total elongation at maximum force, repeated tension-compression performance under high-stress and large-deformation conditions.

Grade I splice: The ultimate tensile strength of the connector of mechanical splicing is greater than or equal to 1.1 times the standard value of the tensile strength of the connected steel reinforcing bars. The residual deformation is small; it has high ductility and repeated tension-compression performance.

Grade II splice: The ultimate tensile strength of the connector of mechanical splicing is not less than the standard value of the ultimate tensile strength of the

requirements of relevant standards of United States, Japan, France as well as ISO for the splice strength, most of the highest-grade splices are required to be not less than the standard value of the ultimate tensile strength of steel reinforcing bars. This revision makes the above adjustments. After the adjustments, the grade I splices shall still reach 1.1 times the standard value of the ultimate tensile strength of steel reinforcing bar even the connector of mechanical splicing fails. The failure of the connector of mechanical splicing includes: the sleeve breaks under tension, the sleeve is longitudinally cracked, the steel reinforcing bar is pulled out from the sleeve, the failure of other components in the assembled splice.

3.0.6 After the splice is subjected to repeated high-stress repeated tension-compression and large-deformation, it shall still meet the requirements of not less than the ultimate tensile strength of the steel reinforcing bar, to ensure that the steel reinforcing bar can exert its ductility.

3.0.7 Rebar mechanical splices will produce additional plastic deformation during tension and repeated tension-compression; it will form unrecoverable residual deformation after unloading (also known as slip in foreign countries), which will adversely affect the crack width of concrete structures. Therefore, it is necessary to control the residual deformation performance of the splice. This specification stipulates that the residual deformation is used as the splice deformation control index during unidirectional tension and repeated tension-compression.

This specification stipulates that the unidirectional tensile residual deformation testing of the splice shall be carried out during the process inspection at the construction site, thereby solving the disadvantages of the disconnection between the type testing and the quality of the splice on the site to a certain extent, which is of great value to improve the quality of the splice; on the other hand, if the residual deformation index is too strict and the failure rate of on-site inspection is too high, it will obviously affect the construction progress and acceptance of the project. Considering the above factors and referring to the comparison test results of the 6 reinforced splice beams and whole-reinforced beams completed by the compilation team in recent years, the unidirectional tensile residual deformation index in Table 3.0.7 was developed. Grade I splices allow 100% connection in the same member's cross-section, with the strictest limit value of u_0. For the grade II and III splices, 50% splice area percentage is used; therefore, the limit value can be appropriately relaxed.

Repeated tension-compression tests under high-stress and large-deformation conditions are inspection requirements for the stress conditions of rebar splices under wind loads, light earthquakes, strong earthquakes. Under wind loads or small earthquakes, when the steel reinforcing bar has not yet yielded, it shall be able to withstand more than 20 times of high-stress repeated tension-compression, meanwhile meet the strength and deformation requirements.

4 Splice applications

4.0.1 The grading of splices provides conditions for structural designers to select different grades of splices according to the importance of the structure and the application of the splice. This specification specifies a grade I splice of the highest quality level based on the development of domestic rebar mechanical splicing for steel reinforcing bars and previous design habits. If necessary, this type of splice is allowed to be used in any part of the structure except for the frame beam end and column end stirrup reinforcement areas where seismic fortification is required, meanwhile the splice area percentage is not limited. This requirement creates conditions for solving special occasions that require the implementation of 100% rebar splicing on the same cross-section, such as the connection of underground continuous walls and horizontal steel reinforcing splicing; the connection of vertical members and horizontal steel reinforcing bars in slipform or lifting form construction; the connection of steel reinforcing bars at the splice of the fabricated structure; the butt joint of reinforcement cages; the connection of steel reinforcing bars for segmented construction or at the joint of new and old structures, etc.

Splice grading is beneficial to reduce the sleeve's material consumption and splice cost. It is also conducive to determining whether to downgrade according to the application parts and splice area percentage limits of different grades of splices when the spot check of splice at construction site is unqualified.

The grade I and grade II splices in this specification are high-quality splices; they can be used in the structure without restriction, but the allowable splice area percentages are different.

4.0.2 The thickness of the concrete protective layer of the splice stipulated in this clause has been relaxed compared with the thickness of the stressed rebar protective layer, changing from "shall" to "should". This is because the cross-section of the splice in the rebar mechanical splicing is larger, which is generally 10% ~ 30% or more larger than the cross-sectional area of the steel reinforcing bar. The connector of mechanical splicing is not as sensitive to the local corrosion as the corrosion of steel reinforcing bar. In addition, because the thickness of the protective layer of the splice is a local issue, excessively strict requirements will affect the spacing of all the main stressed bars and the thickness of the protective layer, which will cause certain difficulties economically and practically. Therefore, it can be appropriately relaxed, meanwhile the splice may also be subjected to anti-corrosion treatment. Considering the different requirements for the thickness of the reinforced concrete's protective layer under different environmental conditions, this clause was revised from "not less than 15 mm" in the "Technical specification for mechanical splicing of steel reinforcing bars" JGJ 107-2010 to "not less than 0.75 times the minimum protective layer thickness of steel reinforcing bar and 15 mm, whichever is larger". If necessary, anticorrosive treatment can be

5 Initial type testing of splices

5.0.1, 5.0.2 This clause specifies when and how to perform splice type testing. Its main function is to grade various types of splices according to their performance. After the grade is determined by type testing, it only needs to perform on-site inspection at construction site. When there is a serious problem with the quality of the on-site splices, the cause of which is unclear and there are major doubts on the conclusion of the type testing, the superior authority or the engineering quality supervision agency may request a re-type testing.

Because type testing is more complicated and expensive, for all types of steel splices, such as rolled straight thread splices or upset straight thread splices, only type testing of standard splices is required.

In addition, when the same type of straight threaded splice or tapered threaded splice is used to connect steel reinforcing bars of different strength levels (such as 500 MPa, 400 MPa), the steel reinforcing bars of higher strength can be selected for type test of the splice sample. Under the condition that the size, material, internal thread and on-site threaded sector processing technology of the sleeve are unchanged, the type testing report of the 500 MPa grade rebar splice can be used to substitute the type testing report of the 400 MPa grade rebar splice, otherwise it is not allowed.

The strength test of the base metal of the steel reinforcing bar is used to judge the properties of the base metal and the designation of the steel reinforcing bar for the splice sample.

According to the feedback from the testing organization, the testing department does not have the ability and function to supervise and manage the installation of splices. This clause abolished the requirement that the type testing samples shall be delivered to the testing organization in bulk. The type test sample shall be ensured that it has not been pre-tensioned, because pre-tensioning can eliminate most of the residual deformation. This clause requires the testing organization to record in detail the parameters of the connector of mechanical splicing and splice for the type testing sample with reference to the Appendix B of this specification, in order to check and accept the rebar splice products at the construction site.

5.0.3 The strength requirements of splices are compulsory clauses. The strength qualification for type testing is that each test sample shall meet the requirements of Table 3.0.5; the measurement value of total elongation and residual deformation of the splice sample at maximum force are relatively scattered. Use the average of the three samples as the basis for inspection and evaluation.

5.0.5 The fatigue performance test of splices is an optional test item. When

6 Machining and installing of splices on site

This chapter specifies the quality requirements that various types of rebar splices shall observe during processing and installation at the construction site. Rebar splices have their particularities as products. Except for the connector of mechanical splicing which is produced at factory, the rebar threaded sectors are mostly processed at the construction site. The quality control of the rebar splices depends largely on the processing and installation of the splices at the construction site. The clauses in this chapter are the most important quality control requirements based on the summary of years of domestic construction experience of rebar mechanical splices at construction sites. The formulation of the clauses in this chapter simplified the visual inspection requirements of splices as much as possible. This is to consider:

1 There is no definite and quantifiable internal connection between the appearance of the splice and the splice performance so it is difficult to formulate specific inspection indicators scientifically;

2 The appearance of the products of each production plant is inconsistent, so it is difficult to specify uniform requirements;

3 The number of on-site splices is tens of thousands, so requiring the quality inspection department of the civil construction organization to perform a visual inspection of the mechanical products will cause a lot of unnecessary disputes and misjudgments;

4 It is more appropriate to include the content of visual inspection in the standards of each enterprise for self-control.

6.1 General requirements

6.1.1 The technology provider refers to the contracting organization for the purchasing and processing of splices, as well as the entrusting organization for an effective type testing report on splice performance.

6.1.2 The process inspection of splices is an important step to check the adaptability of the mobilized steel reinforcing bars and splice processing technology at the construction site. It shall, after the splice passes the process inspection, use the qualified process parameters to perform batch processing of the steel reinforcing bar at site, to avoid loss due to blind processing in large quantity.

6.2 Machining of splices on site

6.2.1 The straight-threaded rebar splices described include upset straight-threaded rebar splices, ribbed rolled straight-threaded rebar splices, direct rolled straight-threaded rebar splices. The processing of the rebar threaded

7 Inspecting and accepting of splices on site

7.0.1 This clause is an important step of strengthening construction management. It is emphasized that the splice technology provider shall submit a full set of technical documents, which shall include:

1 Valid type testing report of splices used in the project;

2 Relevant technical documents related to product design and splice processing and installation requirements of connectors of mechanical splicing; for example, the enterprise standards for rebar connections, the enterprise standards for sleeve products, etc.;

3 Certificates of quality of splicing products and quality certificates of splicing materials, etc. These are important links in the processing, installation and quality control of rebar splices at the construction site.

The valid type testing report of the splice means that the technical parameters such as the splice type, model, specification, steel reinforcing bar strength and splice performance grade in the report shall be consistent with the splice parameters used in the project, it shall especially check the consistency of the parameters of the screw thread and the socket thread, as well as that the validity period of the report shall cover the construction period.

The submission of the above documents is convenient for the quality supervision department to check and verify the processing quality of the sleeve products and threaded sector at any time. It includes checking the types of sleeve raw materials used in the project; for sleeves made of No.45 cold-drawn or cold-rolled precision seamless steel tubes (commonly known as bright tubes), it shall verify whether the steel tube's raw materials have been annealed and meet the requirements of current industry standard "Couplers for rebar mechanical splicing" JG/T 163 for the strength limit and elongation at breaking of the steel tube (according to the current national standard "Cold-drawn or cold-rolled precision seamless steel tube" GB/T 3639, wherein the δ_5 in the this standard shall be changed to A).

7.0.2 Before the start of the splicing project of steel reinforcing bar, it shall perform process inspection of the splice of the mobilized steel reinforcing bar from different steel plants. The main test is to check the splice types used by the splice technology provider (such as ribbed and rolled straight threaded splices, upset straight threaded splices), splice form (such as standard type, reduced diameter type, etc.), whether the processing technology parameters are compatible with the mobilized steel reinforcing bars in this project, in order to improve the qualification rate of sample in the actual project, reduce the economic loss caused by problems found after the application of the project. During the construction process, if the steel reinforcing bar's production plant is

The conditions for the same acceptance batch are as follows: 500 splices of the same steel reinforcing bar production plant, same strength grade, same specification, same type, same model is treated as one acceptance batch. If it is less than this number, it will also be considered as a batch.

7.0.6 This clause specifies the inspection items and acceptance rules after the splices are installed. For the threaded splice, it mainly inspects the tightening torque; for the sleeve extruded splice, it mainly checks the diameter at the indentation or the sleeve length after extrusion as well as the length of the steel reinforcing bar inserted into the sleeve. This clause stipulates that when the inspection of above-mentioned external dimension of the extruded splice of the acceptance batch fails, the inspection of ultimate tensile strength of the acceptance batch may be performed by taking the samples from the splices that fail the above-mentioned external dimension inspection. Under normal circumstances, sampling from the extruded splices that failed the appearance inspection can improve the detection rate of unqualified splices and also help to eliminate doubts about the quality of the splices.

7.0.7, 7.0.8 According to the specific conditions in the engineering practice, under the principle of maintaining the representativeness and randomness of spot check of on-site splices, the contents of clause 7.0.7 of the original specifications are basically unchanged, but the mandatory provisions are changed to general provisions. It adds clause 7.0.8 to make special provisions for some cases where it is not suitable to randomly intercept splice samples in the project. Witness sampling is allowed. Under the supervision of the on-site supervision and quality inspector, from the processed and inspection-qualified rebar threaded sector, it randomly cut rebar sample to assemble the connector of the mechanical splicing which is randomly taken into splice sample, to avoid the confusion that it is not appropriate to cut the sample on site in individual cases.

This clause further clarifies that it allows for reinspection when “only” one sample in the acceptance batch fails to meet the requirements of tensile strength. When there are 2 or 3 samples failing in the tensile strength, it shall directly judge that the group is unqualified and it does not allow reinspection.

7.0.9 This clause stipulates that when the one-time qualification rate of the tensile strength test for the samples from 10 consecutive acceptance batches is 100%, the number of splices in the acceptance batch can be increased to 1000; considering that the number of splices in the same acceptance batch in most small and medium-sized projects is small, in this revision, it adds the rules for spot check and acceptance when the number of the samples in the acceptance batch is less than 200; it is reasonable to appropriately reduce the spot check number of splices, which will not affect the effective evaluation of the splice quality.

Appendix A -- Test method for splice samples

A.1 Type testing

A.1.1 In this clause, the gauge length of the residual unidirectional tensile deformation in the original specification is changed from $L_1 = L + 4d$ to $L_1 = L + \beta d$, where β is 1 ~ 6, d is the nominal diameter of the reinforcing bar, whilst the reducer splice d may take the average value. The modification is to minimize the variation of the measurement gauge length, reduce the measurement error, reduce the calibration work after the measurement instrument's gauge length changes. When measuring the unidirectional tensile residual deformation of the splice sample, the stress level of the steel reinforcing bar is relatively low. The steel reinforcing bars outside the range of the length of the rebar splice are in the elastic range, so there will be no residual deformation. The change of the gauge length will not affect the results of the residual deformation test. When meeting the gauge length requirements of the deformation measurement, the splice samples of different types and specifications should use the same measurement gauge length. The deformation measurement of the repeated tension-compression of splice in the type testing still uses $L_1 = L + 4d$ according to the requirements of the original specification. When the rebar splice sample is subjected to large-deformation repeated tension-compression, the steel reinforcing bars have entered the stage of plastic deformation. The measurement gauge length has a significant effect on the test results. The measurement gauge length shall remain unchanged.

A.1.2 This clause specifies the method for measuring the total elongation A_{sgt} of the splice sample under the maximum force in the type testing. The connector of mechanical splicing is not included in the gauge length of the deformation measurement, which excludes the effect of different splice lengths on the test results, so that the total elongation index A_{sgt} of the splice sample under the maximum force more objectively reflects the effect of the splice on the ductility of the steel reinforcing bar, because the structure's ductility mainly depends on the ductility of the steel reinforcing bar outside the splice, not the ductility of the splice itself. The modified A_{sgt} definition and measurement method are basically consistent with the relevant provisions of the international standard ISO/DIS 15835.

A.1.3 Appendix Table A.1.3 specifies the loading system during the type testing of splice sample. Figure A.1.3-1 ~ Figure A.1.3-3 further uses force-deformation relationship to explain the loading system and the meanings of the physical quantities in Table 3.0.5 and Table 3.0.7 of this specification.

A.2 On-site inspection

A.2.1 This clause specifies the method for measuring the unidirectional tensile residual deformation of splice sample during on-site process inspection. The

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