Research on Application Practice of Rebar Mechanical Connection

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Abstract. The development of rebar connection technology is the key to improve the construction quality of construction projects, and the application of related technologies can also improve the construction quality and efficiency of construction projects. The connection process of mechanical connection of steel bar requires higher requirements, which is different from the welding and binding connection of steel bar. The quality of mechanical joint also needs strict inspection. At present, grade I joints are widely used in high-rise buildings. How to ensure the quality of mechanical connection has become one of the key points of high-rise building quality control. Combined with specific engineering projects, this paper mainly analyzes the practical application of rebar mechanical connection technology in construction, and elaborates on rebar processing, product protection, quality control, etc., in order to provide technical reference for the work of relevant personnel in the field of construction engineering.

Keywords. Mechanical connection, rebar, straight thread sleeve connection, practical research.

1. Introduction
The steel bars with a diameter greater than 16 mm in this project are connected by a straight threaded sleeve (I grade connectors), a rebar joint with a straight threaded sleeve connection, and the same vertically forced rebar should not be set up with two or more connectors. Mechanical connections (I grade connectors) should be used in the following areas.

(1) The vertical ribs of the frame pillar and the frame support beam.
(2) The vertical joint in the frame beam, column and shear wall dark column: the sub-level, the first-level parts and the second-level bottom column bottom and wall bottom strengthening part.
(3) The part of the wall rib joint: special first, first, second bottom strengthening part of the vertical rib.
(4) The column vertical rebar total distribution rate is more than 3%.
(5) The main ribs of the foundation base plate and the base of the pile raft.

2. Construction Preparation
2.1. Technical Preparation
(1) Familiar with the construction drawings, and learn the relevant norms, procedures, in accordance with the requirements of the specifications to prepare the "reinforced mechanical connection sleeve special construction program" [1].
(2) Familiar with the rebar straight thread connection process procedures and specifications.
(3) Do a good job of technical bottoming for the construction work team to ensure that construction workers in strict accordance with the relevant norms and regulations of the construction.

2.2. Personnel Preparation
The personnel involved in the construction of rolling straight thread joint must receive technical training, and can only operate with certificates after passing the examination [2]. The principle of construction personnel allocation is as follows: the rebar workers should consider that the binding capacity of rebar is 0.4~0.5 t/ day. Personnel preparation shows as table 1.

| Serial Number | Type of work       | Number of people | Remarks                                |
|---------------|--------------------|------------------|----------------------------------------|
| 1             | On-site coordinator| 1                |                                        |
| 2             | Rebar workers      | 80               | Rebar production and processing        |
| 3             | Rebar workers      | 150              | Rebar tied                             |
| 4             | Shelf worker       | 20               | Rebar straps are set up with an operating platform |

Table 1. Personnel preparation.

2.3. Material Preparation
Material preparation shows as table 2.

| Serial Number | The name of the material                                           | Number          |
|---------------|--------------------------------------------------------------------|-----------------|
| 1             | Rebar with a diameter of 16 to 32 mm                                | About 3400 tons |
| 2             | Sleeves that match the corresponding diameter rebar                | About 34,000    |

Table 2. Material preparation.

2.4. Mechanical Preparation
Mechanical preparation shows as table 3.

| Serial Number | The name of the machine                                          | Model | Number |
|---------------|------------------------------------------------------------------|-------|--------|
| 1             | Straight threaded wire machine                                   | GHB-40| 14     |
| 2             | Angle polisher                                                   |       | 10     |
| 3             | Rebar wrench                                                     |       | 30     |
| 4             | Torque wrench                                                    |       | 5      |
| 5             | Gauge (tooth gauge, card gauge, straight thread plug gauge)      |       | 5      |

Table 3. Mechanical preparation.

3. Main Construction Methods

3.1. Rebar Processing
Before rebar processing, the following points need to be confirmed:

(1) The varieties, specifications and appearance of steel bars to be processed shall comply with the design requirements, and there shall be factory certificates and test reports.
(2) The operators who participate in rebar processing have passed the technical training and examination, and can be certified to work [3].

(3) Straight threaded wire machine and other mechanical equipment after maintenance trial, force wrench after verification, can meet the construction requirements.

(4) Thread sets and rebar ends have been cleaned, rust removal, de-fouling, according to the size of the specifications of processing, storage spare.

3.2. Rebar Mechanical Connection

3.2.1. Common Connector Connection Methods. There are three commonly used joint connection methods:

(1) Common joints with the same diameter or different diameters: screw the lower steel bar and the connecting sleeve, the connecting sleeve and the upper steel bar to the specified torque with a torque wrench.

(2) Unidirectional adjustable joint: screw the lower reinforcement and connecting sleeve, adjustable connector and upper reinforcement to the specified torque value with torque wrench, and then tighten the lock nut and connecting sleeve.

(3) Two-way adjustable joint: screw the lower steel bar and adjustable connector, adjustable connector and upper steel bar to the specified torque value with a torch wrench, and keep the exposed thread number of the adjustable connector equal, then clamp the upper and lower adjustable connectors respectively and tighten the connecting sleeve [4].

The first (1) above is adopted for the connection method of steel bar joints in this project.

3.2.2. Rebar Mechanical Connection Process Flow. The manufactured rebar is mechanically connected on site, and its construction process shows as figure 1.

![Figure 1. Rebar mechanical connection process flow chart.](image)

3.2.3. Precautions for Rebar Mechanical Connection. Pay attention to the following points when making rebar mechanical connection on site:

(1) When connecting rebar, rebar specifications and sleeve specifications must be consistent, and rebar and sleeve threads should be clean and intact.
(2) When embedded joints are used, the position, specification and quantity of connecting sleeves shall meet the design requirements. Rebar with connecting sleeve should be fixed firmly, and the exposed end of connecting sleeve should have protective cover.

(3) Pipe tongs and torque wrenches shall be used for the construction of straight threaded joints, and two rebar stringings shall be pressed against each other in the middle of the sleeve. During use, when the torque wrench makes a crisp sound \[5\]. It will reach the tightening torque value of the joint of this specification, and the tightening torque of the joint shall comply with the provisions in table 4. The accuracy of torque wrench is 5%.

| Table 4. Tightening torque of the joint. |
|----------------------------------------|
| Rebar diameter (mm) | ≤16 | 18~20 | 22~25 | 28~32 |
| Tightening torque (N.m) | 100 | 200 | 260 | 320 |

(4) After tightening the rolling straight thread joint should be marked, unilateral exposed wire buckle length should not exceed 2P.

(5) The rebar connector position should be staggered from each other, its staggered spacing should not be less than 35d, and not less than 500mm, the end of the connector rebar bend starting point should not be less than 10d.

(6) The connector should avoid the clamp encryption area located on the section with the largest pull stress and the frame beam end and column end with seismic fortification requirements. The rebar connector on the same section of the structure's pulled section must not exceed 50% of the total number of rebars.

(7) No more than two connectors shall be exceeded on the same rebar between the spans of the same component or within the height range of the layer \[6\]. Chongqing area of rebar and supporting sleeves made detailed provisions, as detailed in "rebar mechanical connection sleeve and silk head matching table" (sleeve standards according to JG/T163-2013).

3.3. Rebar Mechanical Connection Sleeve Detection

The quality inspection of this project is carried out by entrusting a third-party inspection unit; Take the form of on-site sampling and witness inspection.

The sleeves of this project are all grade 1, and the materials, processes and specifications of the sleeves for rebar mechanical connection are provided by the manufacturer.

4. Finished Product Protection

Effective protection measures should be taken for the rebar that has been processed:

(1) After the quality inspection of connecting pipe threads is qualified, both ends shall be protected with plastic sealing covers.

(2) Special equipment and water-soluble cutting lubricant should be used when threading the rebar end; Wear a plastic protective cap immediately after threading to ensure that the threads are not damaged; At the other end, the connecting sleeve can be tightened according to the specified torque value \[7\].

(3) Connecting semi-finished products shall be stacked neatly for use according to specifications and shall not be thrown at will.

5. Recovery Method

5.1. Recovery of Steel Plate Walls and Steel Beams

(1) The varieties and specifications of rebar must meet the design requirements, and the quality meets the current national standards of "rebar concrete with hot rolled ribs" and "rebar concrete with waste heat treatment".
(2) The material of sleeve and cable mother shall comply with GB699-99, and shall have quality inspection sheet and certificate of approval, and the geometric dimensions shall meet the requirements.

(3) Rebar joint type inspection: the inspection results shall comply with the current industry standard "General Technical Specification for rebar Mechanical Connection" (JGJ107-2011) [8].

(4) Before the rebar connection project starts, the rebar and joints of different specifications shall be inspected according to the technical documents and process standards of the technical provider.

(5) Rebar joint strength inspection: rebar joint strength must reach the strength value of the same type of steel, and the on-site inspection of joints shall be conducted according to the acceptance batch. Joints of the same grade, form and specification of the same batch of materials shall be adopted under the same construction condition, and 500 joints shall be inspected and accepted as one acceptance batch, and less than 500 joints shall also be taken as one acceptance batch.

Ten acceptance batches are inspected continuously at the site, and when all the unidirectional tensile tests pass the sampling at one time, the number of joints in the acceptance batches can be doubled [9].

For each acceptance batch, three specimens shall be randomly selected from the engineering structure for uniaxial tensile test. When the tensile strength of the three specimens does not meet the strength requirements of less than design, the acceptance is judged as qualified. If the tensile strength of a specimen does not meet the requirements, double sampling shall be conducted for re-inspection.

5.2. General Items

5.2.1. Processing Quality Inspection

(1) Quality inspection of rebar stringing shows as table 5.

| Serial Number | Inspection item   | Inspection requirements                                                                 |
|---------------|-------------------|-----------------------------------------------------------------------------------------|
| 1             | Presentation quality | The tooth shape is full, there is no defect of broken teeth or bald teeth, and it is consistent with the tooth shape of the tooth shape gauge. The surface is smooth and the number of complete thread turns should meet the requirements |
| 2             | Appearance dimension | The length should meet the requirements                                                  |
| 3             | Thread size        | The general gauge or sleeve can be screwed into the thread smoothly                        |
|               |                    | The stop gauge is allowed to engage with the end thread, and the screwing amount should not exceed P(P is the pitch) |

(2) Quality inspection of sleeve shows as table 6.

| Serial Number | Inspection item   | Inspection requirements                                                                 |
|---------------|-------------------|-----------------------------------------------------------------------------------------|
| 1             | Inspection item   | Inspection requirements                                                                 |
| 2             | Presentation quality | Anti-rust treatment, no rust, oil stain, crack, black skin and other defects            |
| 3             | Appearance dimension | Length and outer diameter shall meet the requirements of dimensional tolerance        |
10% and no less than 10 processing batches of each specification are randomly selected for visual inspection. Rebar stringings should match the sleeve specifications, and the processing inspection records of rebar straight threads should be filled in. If one stringing is unqualified, all the processing batches should be inspected. Unqualified stringings should be reprocessed, and can only be used after passing the re-inspection.

5.2.2. **Rebar Joint Quality Inspection.** Beam and column components shall be 15% of the joint number, and the joint sampling number of each component shall not be less than one joint. Every 100 joints of foundation, wall and plate members shall be taken as an acceptance batch, and less than 100 joints shall also be taken as an acceptance batch, and 3 joints shall be sampled in each batch [10]. All joints sampled shall be qualified; if one joint is unqualified, the joint of the acceptance batch shall be inspected one by one, and the found unqualified joint shall be reinforced; if it cannot be reinforced, it shall be discarded, and the quality inspection record of rebar straight thread joint shall be filled in.

6. **Conclusion**
In the construction of this project, the rebar mechanical connection technology is widely used, which makes the rebar extension process efficient, high-quality and low-cost, and has won unanimous praise from the design, supervision and construction units. This connection technology reduces the labor burden and pressure of workers during construction, which is safe, reliable and pollution-free. The working environment of workers is greatly improved, and the fire caused by welding construction is greatly reduced.

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