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Research Article

# Study on Steel Bar Construction Technology of Frame-shear Wall in High-Rise Buildings

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**Abstract:** The development of the construction sector is rapidly growing, which induce competition at global level. In order to achieve the current economic development, more high-rise buildings construction projects were commenced without considering importance of the land to human and other living organism. On the other hand, the quality and safety aspect of the engineering technology used must be analyzed carefully and to be the primary aim for engineers to reduce any risk of harm in future. Many of the high-rise buildings in China consist of a frame or skeleton of reinforced concrete wall which need to be strengthened with shear walls to improve the stability and safety of the structures. According to practical work experience and relevant theoretical knowledge, the researcher introduced the reinforcement construction technology of frame-shear wall for high-rise buildings in depth from aspects like the arrangement of steel bar, construction preparation, steel bar anchorage, precautions to follow for the related work in future.

***Keywords:*** *high-rise buildings; frame-shear wall; steel bar construction*

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## 0 Introduction

Construction technology using frame-shear wall reinforcement is a widely used technology, and is a part of current construction system. Hence, a comprehensive assessment of human resource, machines, raw material and method used should be evaluate crucially to identify the influence factors of the application. In order to achieve this, we need an extensive research design, reasonable layout, standard use of material, and a professional force for operation. Additionally, focus should be given to the construction cost control and the feasibility of the corresponding technical operation to reduce the complications which will improve the net income. This could be more beneficial for the advancement of reinforcement construction level of frame-shear wall for high-rise buildings.

## 1 Reinforcement arrangement of frame-shear wall of high-rise buildings

Different model, location, and density of the steel in sheer-wall will give different effect, hence the arrangement of steel bars need to design based on the requirements of building project. To ensure minimal usage of material, the blueprint should be well planned with accurate scale and building elements. After practical verification, the factors to be considered in the calculation of the steel bar layout of shear wall are as shown in the following Figure 1.

### 1.1 Horizontal distribution of steel bars

To improve the stability of high-rise buildings using horizontal distribution of steel bars in shear wall structure, the double row arrangement pattern is commonly used. Together with the vertical distribution of steel bars arranged on the inner side; the horizontal distribution of steel bars arranged on the outer part, which has strong resistance to temperature and to avoid temperature caused cracks in concrete. It was demonstrated by practice that the layout of this type of steel bars is tough for some long but thin wall. In the whole structure of the shear wall, the spressure of the steel bars on different directions is vary, which is embodied in the force direction and size. The horizontal

  

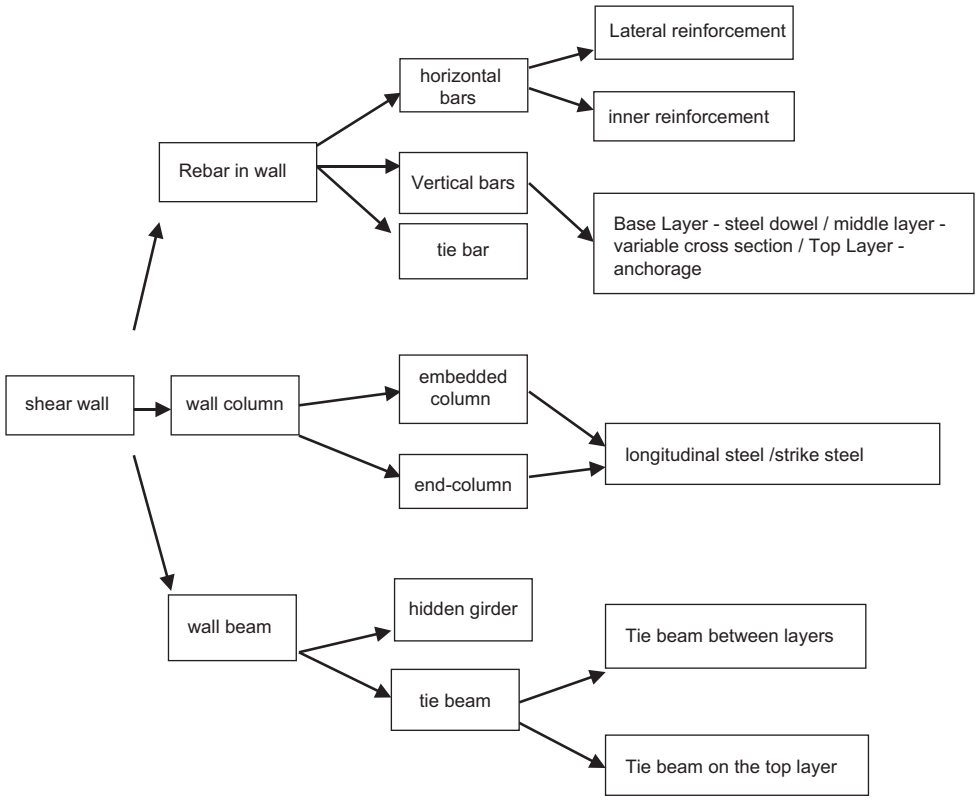


**Figure 1.** Factors to be considered in the calculation of the steel bar layout of shear wall

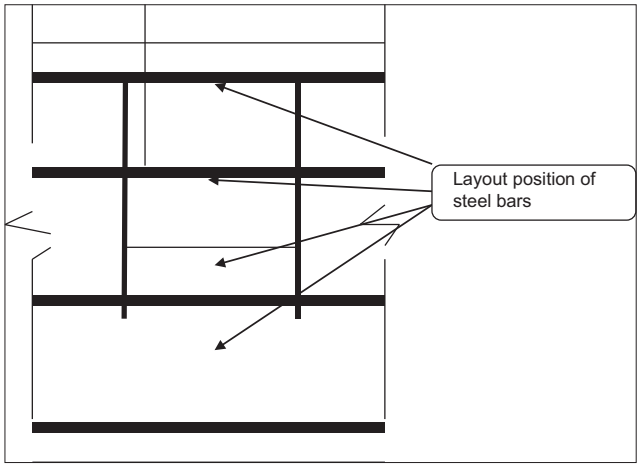


**Figure 2.** The layout of horizontal bar in the shear wall

steel which supporting the shearing force is to prevent oblique cracks on the wall and will reduce the probability of brittle failure of the wall, which shows that the layout of horizontal bar in the shear wall is the core content of the technology[1].

## 1.2 Vertical distribution of steel bars

The vertical steel bars which can pass through the hidden beam continuously are located on the inner side of the horizontal steel bars, and it needs to

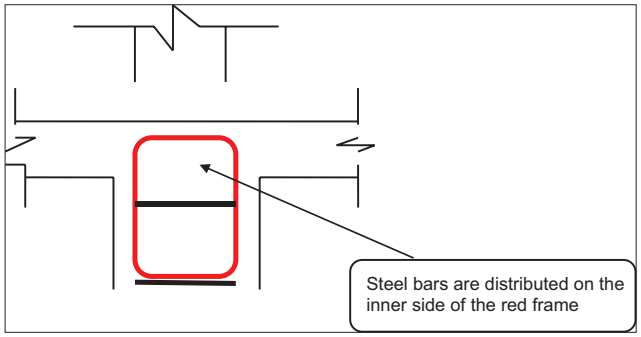


**Figure 3.** Vertical steel bars on the shear wall pass frames and hidden beam continuously

be arranged on the inner side of the hidden beam vertically. It has been introduced that the shear walls are vertically distributed steel bars with two layers of layout, and the position of the vertical reinforcement layout should be based on the wall thickness. If the wall is thin, then it cannot be arranged inside, so the vertically distributed bars are needed to put on the outside of the vertical bars on hidden beam. At the same time, it is necessary to use the tensile tendons to fix the vertically distributed steel bars and longitudinal bars on hidden beam. The main function is to withstand the force of bending and to avoid horizontal cracks in shear walls.

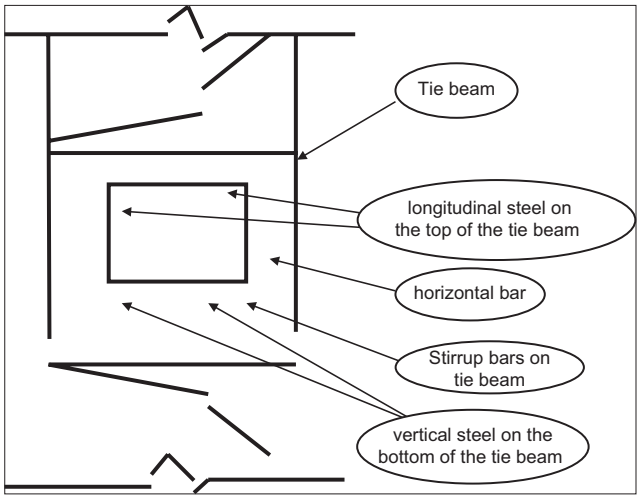


**Figure 4.** Steel bras layout on the tie beam and hidden beams

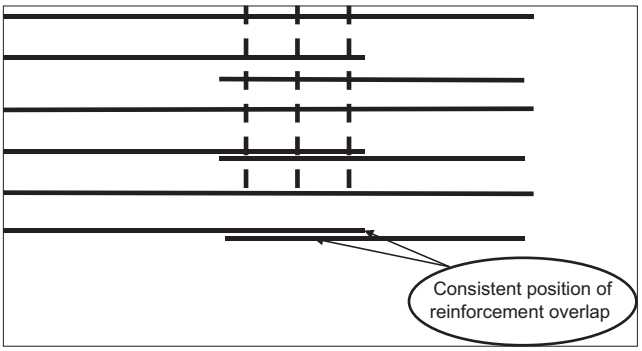


**Figure 5.** Binding schematic diagram of steel bar

### 1.3 Layout of steel bars on the beam and hidden beam

The longitudinal steel bars on the beam of the shear wall should be designed according to the component condition, usually its located on the inner side, while the longitudinal steel bars of the hidden beam should be arranged on the inner side of the longitudinal ribs of the hidden column. In addition, the two ends of bars need to be anchored in the hidden column, mainly to ensure the stability of the steel bar and avoid displacement which will results in change of stress situation and affects the stability of the building. In meantime, the structure of the hidden column in the shear wall and its arrangement are essential whereby it can resist the bending bearing capacity and restrict the concrete of the shear wall to make it more adjustable.[2]

## 2 The preparation of construction

Before constructing the steel bar, thorough ground work should be done. In common practice, the preparation work should include the following aspects as below to ensure efficient and quality construction.

### 2.1 Learn more about the project

The designer, developer, construction team leader, supervision personnel must attend formal meeting to know the member involved in the reinforcement construction project and survey the actual direction of the project in detail, such as geological conditions, seismic grade, wall force requirements. Followed by the selection and installation of steel. Through this process the amount of steel bar can be reduced and this will reduce costs substantially according to the situation.

### 2.2 Ensure the professionalism of the construction personnel

The construction team should be exposed to technical training before construction begin, so that they understand the layout of the steel bar, technical points, key links and other matters. This will ensure that the steel bar layout is in accordance with the requirements for construction later. To improve the construction quality, need frequent supervision, develop responsibility system model, focus on acceptance and process management, consulting experienced construction personnel, and remove man-made errors. In order to achieve this goal, the researcher recommends the use of performance appraisal and the whole process of quality supervision mode, the corresponding measures is to improve staff's motivation and attitude, hence the quality can be ensured[3].

### 2.3 Materials of steel bar should be scientific and be saved reasonably

The choice of steel bar can be based on the following points. Firstly, survey the steel price, and choose one main material which has high quality and economical in accordance with the design requirements. Secondly, before making the selection, the corresponding performance test should be carried out to detect the tensile strength, shearing resistance, toughness and stiffness of the rebar, to ensure that it meets the needs of the use. Thirdly, the preservation of the steel bar should be standardized and reasonable, different types of steel bars need to be classified before storage and set the label with relevant information in the location to avoid confusion and construction quality problems. In addition, anti-rust and anti-corrosion issues need to address to avoid quality problem due to improper maintenance. Before using, sampling and retest should

be carried out for different specifications of the steel to ensure material quality[4].

### 2.4 Standard processing and professional operating of the steel bar

Before the reinforcement, each component need to be checked in detailnext is review by the technical staff to ensure that the specifications of the processing components and materials are match as planned. Finally eliminate unwanted materials in processing period and ensure to retain the quality parts. Following that, qualification test needs to be carried out to ensure that it meets the standard requirements. In order to enhance the management process and improve employee's responsibility awareness, good quality of processing inspection and records acceptance need to be complete. The supervision staff need to confirm and maintain the corresponding records, when problem arise, accountability of the staff can be refer back.

## 3 Anchorage and connection of steel bars

### 3.1 Anchorage of steel bars

For the technical introduction of the reinforcement anchorage of the shear wall, the analyses were from the minimum anchorage length and the anchorage length of the shear wall distribution, as shown below.

#### 3.1.1 The minimum anchorage length

The main role of anchoring is to ensure the stability of the steel bar and the overall safety of the structure, therefore the minimum anchorage length must achieve. According to the relevant provisions in the *Technical Specification of Concrete Structure of High Buildings*, the minimum aseismic anchorage length of the bar is different under different seismic requirements, and whether the anchorage length is reasonable will affect the work progress and the safety of the project and will also destroy the original structure. However, too small anchorage is difficult to be fixed, and too large anchorage will cause damage to the anchor point, so the appropriate anchorage length needs to be determined. In the earthquake-prone areas, the minimum anchorage length of the bar is $L_{aE}$. When the requirement of aseismic grade design is first or second grade, the anchorage length is 1.15 L; when the seismic grade is third, the anchorage length is 1.05 L; when the seismic grade is fourth, the anchorage length is 1.0 L. So, the anchorage length decreases with the increase of seismic grade. Detailed specification is shown in the following Table 1.

#### 3.1.2 Anchorage of steel bar distribution of shear wall

It is necessary to extend the horizontally-distributed steel bar of the shear wall, and the extent degree needs to reach the end position. At the same time, the horizontal bending treatment with the bending degree is 10 times-diameter of horizontally distributed steel bar. In the process of concrete treatment, the end of shear wall is different and the treatment methods are different: If the end belongs to the wing wall or the corner wall, the horizontally distributed steel bar which is located on the inner side of the outer wall and the horizontally distributed steel bar on both sides of the inner wall need to extend to the outside of the wall end, facing both sides, horizontally bending, and the horizontal bending length is not less than 15 times of diameter of horizontally distributed steel bar. In the process of dealing with the extension and bending of the corner wall, the wall end can be bent into the wing wall and lapped with the outer of the wing wall, and the lap length is controlled to be 1.2 La. For the shear wall with a border, the steel bar must be carried through the column and beam, anchored in the wall or on the basement[5].

### 3.2 Connection of steel bars

There are three ways to connect steel bars in shear walls: Binding connection, welding connection and mechanical connection. But the specific use of them should in accordance with the right situation. According to practical experiences, the use of binding connection is more common, mainly because this model is easy to operate, and the binding effect is better, which will introduce as following.

**Table 1. Spacing of shear walls**

| Floor system | Non-seismic | Seismic fortification intensity | | |
|---|---|---|---|---|
| | | VI, VII degree | VIII degree | IX degree |
| In-Situ | ≤5.0B, ≤60.0 m | ≤4.0B, ≤50.0 m | ≤3.0B, ≤40.0 m | ≤2.0B, ≤30.0 m |
| integrally assembled | ≤3.5B, ≤50.0 m | ≤3.0B, ≤40.0 m | ≤2.5B, ≤30.0 m | |

### 3.2.1 Binding requirements

In the process of binding, it is necessary to operate according to different distribution of steel bar. For horizontally distributed steel bars, the lap length control is 1.2 La, and joint spacing's static distance between the upper and lower adjacent bar needs to be less than 500.0 mm. While for vertically distributed bars, the binding needs to be operated based on the seismic level, and under normal circumstances, when the earthquake-resistant level higher than the second level, the diameter length of each bar should be considered, and set up. If the diameter is less than 12.0 mm, the length is below 4.0 m diameter is more than 12.0 mm, the length is below 6.0 m. so, the length of each part in the horizontal direction should be controlled under 8.0 m. Further long bar will affect the overall binding firmness, and too short bar will increase the tie quantity and waste binding material and working hour.

### 3.2.2 Binding key points

In the process of binding the steel bar, it is necessary to ensure that the steel bar is clean, and the binding point is free of debris, so that the reinforcement is securely bound. Firstly, comb 2-4 longitudinal steel bar, divide reasonably for the length of each section, then bind and fix horizontal tendons (no more than 2) under it, and then start bind orderly. Bind the longitudinal reinforcement first, then the transverse reinforcement closely followed. In addition, the bind of hidden pillar and the hidden beam should be performed first. In the process of the binding, the main principle is that the procedure is straight forward, the binding is firm and the binding joint is dense. Overall, for the binding of steel bar, it is necessary to ensure that the binding position is accurate proper method is followed operation is standard and the binding process is integral which make the binding process strong and convenient[6].

## 4 Announcements

In the application process of the construction technology of steel bar in frame shear wall in high-rise buildings, the following points need to examine.

### 4.1 Design

In the process of designing specific construction plan, the number of rebar, direction, model and other aspects of the design need to fulfill the requirement and demand of actual needs of the steel bar, and it can be modified according to the project. The main aim is to ensure that the wall can be tensile, compressive, shearing and so on to avoid cracks in the wall. In this process, we should avoid the problem of reducing cost without paying attention to quality, realizing the lowest cost and best quality.

### 4.2 In technic

This construction technology needs to be implement in accordance with relevant regulations, and supervision strengthen need to monitor to ensure technical compliance. For example, in the process of determining the steel bar connection technology, more than one method can be used, in different ways for different locations to connect, which can be more flexible to avoid low efficiency due to single way and poor banding effect. In addition, technical operations need to follow the process to ensure the compliance, such as the order of the binding, so that the key points and positions can be first bind, followed by the identification of datum point and provide guidance for the subsequent binding to ensure the binding position is accurate. Besides that, during the concrete pouring, fusion between the steel bar is important to ensure that concrete can be compacted to avoid cracks. Therefore, the reinforcement construction needs to be considered in the whole project and the density should be set accordingly. If the pouring is not dense enough, then the compaction process should be carried out.

### 4.3 In supervision

In the construction process, effective supervision and management system are needed to ensure the effective implementation of the work. We must strengthen the supervision in each stage of construction process, which can be lead by the supervision personnel together with the construction personnel's coordination, thus forming the full participation management pattern. For example,to reward personnel who raised positive suggestions or found any problems in order to motivate their effort. In the process of construction, cultivate good quality awareness,examine and promote business ability, to avoid quality problems caused by improper attitude or poor professional level[7].

### 4.4 In innovation

This paper has introduced the related content of the construction technology of the frame shear wall of high-rise building, but in order to improve the construction

effect, we need to innovate and improve the technology. For example, in the process of reinforcing steel anchorage, how to determine the minimum anchorage length more accurately, how to improve the efficiency of steel bar component processing, cold bending and hot bending of steel bar and so on, all these need to be evaluated thoroughly, to serve the project construction smoothly. In order to achieve this goal, the use of experiment simulation model, simulate under the same condition, obtain the corresponding data, and get the corresponding scheme. In addition, in the process of reinforcement layout, binding and other processes, use of the GPS system to analyze positions to ensure the accuracy of location.

## 5 Conclusion

To sum up, for the steel bar construction technology of frame shear wall structure of high-rise building, focus should be on the actual situation investigation and analysis, ensure that the design can meet the demand, choose economical and high-quality materials, preserve and process scientifically to meet the standard. At the same time, inspection and review should be done before use to ensure product performance and quality. Strictly control the construction process and employ experienced and professional construction staff to carry out the work, supervise the whole process of implementation dynamically to ensure that each link can be regulated in accordance with the requirements of the operation, and ultimately to achieve the maximum project dependencies.

## References


[1] Zhang Fei. Reinforced Concrete Construction Technology of High-rise Shear Wall Residence[J]. Housing and Real Estate, 2017(33): 23-24.

[2] Zhao Junxia. Construction Technology Analysis of the Structure of Building Frame Shear Wall [J]. Building Materials and Decoration, 2016(37): 56-57.

[3] Yao Zhiyang. Research on Construction Technology of Frame Shear Wall Structure of Building Engineering [J]. Global Market, 2017(5): 320-320.

[4] Liao Cheng. Study on Construction Technology of Frame Shear Wall Structure [J]. Construction Technology and Design, 2016(4): 98-99.

[5] Hong Yi. Construction Technology Application of Frame Shear Wall Structure [J]. Metallurgical Collections, 2017(6): 51-52.

[6] Zhu Tianxia. Discussion on Construction Technology of Frame Shear Wall Structure of High-rise Building [J]. Low Carbon World, 2017(8): 143-143.

[7] Gong Huijian. Construction Technology of Frame Shear Wall Structure in Architectural Engineering [J]. Development Guide to Building Materials, 2017, 15(21): 56-57.