Discussion on Construction Technology of Masonry Structures in Building Engineering

Shukui Wu

Anhui Tudai Construction Engineering Co., Ltd., Hefei, Anhui, 230000, China

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Abstract: This paper focuses on the construction technology of masonry structures in building engineering. Addressing current issues such as difficulty in quality control, high resource consumption, and insufficient crack prevention, it conducts research by sorting out the application process of masonry structure construction technology and exploring optimization strategies. The study systematically analyzes the key operational points of core stages including pre-construction material and site preparation, setting out and positioning, block masonry, and tie reinforcement installation. It also discusses the application methods of technologies such as high-strength mortar selection, ready-mixed mortar processes, block arrangement optimization, and crack prevention and control. The results aim to demonstrate that standardizing construction processes and rationally applying optimization technologies can effectively enhance the construction quality of masonry structures, reduce resource consumption, improve structural durability, and provide practical technical references for masonry structure construction.

1. Introduction

Masonry structures have been widely used in residential buildings, office buildings, other civil structures and industrial ancillary facilities due to the advantages of easy material availability, low cost and flexible construction in building engineering. Nevertheless, problems such as non-standard material inspection, insufficient setting out precision, high mortar waste rate and property of wall cracking have become important constraints for engineering quality improvement with construction industry raising requirements in terms of project quality. These problems not only reduce the safety and durability of building structures, but also lead to unreasonable increase of later maintenance costs or even engineering hazards if these problems are not effectively solved in time. So the discussion on the construction technology of masonry structure construction process and optimization measures are beneficial to promote the technological upgrading of masonry structure construction, guide engineering quality inspection.

2. Application Process of Masonry Structure Construction Technology

2.1 Pre-construction Material Inspection and Site Preparation

For batch-wise blocks need inspection during material inspection process on arrival. Samples from each batch are divided into three random samples, with 10 blocks per sample. It is tested with respect to compressive strength and moisture content as per standards. Fired perforated brick has compressive strength of at least MU15, while the moisture content of autoclaved aerated concrete block must be solidly between 4% and 6%. When the water content exceeds the standard, it needs to be dried naturally until it is within the qualified range, otherwise dry shrinkage cracks will appear after masonry [1]. Similarly, by ensuring the 28-day compressive strength of the mortar is equal to or above that of design grade for M7. 5 mortar mix, should be 230~260 kg of cement consumption per cubic meter You should remove topsoil and soft soil layers in construction areas as part of the site preparation process. Site compaction done on a vibratory roller, minimum 6 passes; This treated foundation after compacting should satisfy the design demand, which is above 180 kPa for its

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bearing capacity. Brick walls 200 mm high shall be constructed to divide the material storage areas. Do not stack the blocks higher than 1.8m, and there must be a rain shelter in the mortar mixing area, equipped with electronic weighing devices to keep materials weighing accuracy error within ±2%, which lays a reliable foundation for follow-up construction.

2.2 Setting Out, Positioning, and Elevation Control Operations

High-precision total stations will complete the primary control measurement, based on the axis coordinates in the construction drawings. The permanent control points are marked in four corners of the site to form a closed traverse network. The relative traverse closure error should be controlled within the specified range of 1/5,000. Yeah electronic level, after axis measurement elevation is transferred, the construction unit provides the benchmark level point to be transferred on-site above more than 3 temporary level point. Level points that are placed temporarily need to be checked again periodically as well and must not exceed a recheck cycle of over 7 days. The elevation transfer error is to be controlled within ±1 mm/m [2]. In case of setting out operations the wall center line and outer face are first marked with chalk line. 200 mm wide control lines are also snapped at the location of windows and doors to aid in the alignment of masonry. The story pole is of dry, undeformed squared timber. In addition to traditional information, the locations of tie reinforcements and the bearing length of lintels should also be marked. During the installation of story pole, a level is required to perform point-by-point calibration and the elevation deviation of each story pole throughout the whole building should not exceed ±3 mm. Due to the fact that accumulated errors in construction can affect its quality, the axis and elevation should be run through just before masonry of each wall.

2.3 Block Masonry and Mortar Fullness Control

Water and moisten the blocks 24 hours prior to masonry. Uniform water penetration is dispensed through spraying. The moisture content of the surface should be controlled at 10%-15%, and direct soaking is not allowed to reduce the strength of blocks. The wall masonry: 2381 masonry is followed; mortar spread length 2 m, masonry height 1.8 m, mortar joint thickness controlled between 8-12 mm [3]. Mortar fullness checks need specialist tools. It is inspected using a feeler gauge at points spaced at intervals not to exceed 2 m in horizontal joints. At each point 3 measurements are carried out, ensuring that the fullness of horizontal joints is not lower than 90% on average. Vertical joints are ultrasonically inspected with minimum 5 inspection points per wall. Vertical joints must achieve a full 80%.

2.4 Wall Tie Reinforcement Installation and Inspection

Surface treatment of the concrete structure is required prior to the installation of tie reinforcements. Laitance of the surface should be removed using mechanical grinding which means good bonding between tie reinforcement and concrete [4]. Ties are done in HRB400 series reinforcement bars. In terms of diameter, φ6 bars are used for 120 mm thick walls, and 2 φ6 bars are set up for 240 mm thick walls. The bars have vertical spacing of 500 millimeters. Seismic requirements usually require that the length of the tie reinforcement going into the wall must be ≥ 1,000 mm. That will imply as it is embedded in concrete structure that length of 20d(d bar dia) should not be less than. Following installation, concealed acceptance inspection is required. Inspection checks include specifications for bar, quantity, spacing anchorage length and cover thickness. The rebar locator is used to detect the position deviation of tie reinforcements, and it should not be larger than ±5 mm. The pull-out tests measure the anchorage force of the ties. Three-samples is selected from each of inspection lot and the pull-out force value has to be greater than 1.05 times higher than the designed one.

3. Optimization Strategies for Masonry Structure Construction Technology

3.1 Selecting High-Strength Special Masonry Mortar to Reduce Waste

In the process of performing customization, one is required to determine grade of mortar strength series as per engineering load requirements. Then the base material is mainly composed of P.O 42.5R grade cement, and some admixtures should be used, such as modified starch ether, air-entraining agent to stabilize the 28-day compressive strength of M10 mortar above with impermeability grade P6 or more, but also in maintaining a water retention higher than 90%, which ensures mortar may be even lesser degree of losing water during masonry and segregation [5]. Before calculating how much we need to use based on the material size and joint thickness, approximate dosage control is determined. For example, the mortar consumption per cubic meter of masonry = 0.23 m³ when calculating a block with a dimension of 300 mm× 200 mm× 240 mm. Fully automatic measuring and mixing equipment on-site have been realized by controlling the measuring error of sand, cement, and admixture within ±0.5%, so that no mortar strength deficiency or waste will be caused by mix deviation. The other link is that the performance of mortar needs to be adjusted in real time according to the construction environment. In the case of ambient temperatures at building site lower than 5°C, and early-strength anti-freezing agents must be added to ensure that critical freezing strength of mortar 70% design strength. However, when the air humidity is less than 40%, the proportion of water-retaining components can be appropriately increased to make its working time stretch above 3 hours.

3.2 Adopting Standardized Construction Process with Ready-Mixed Mortar

In the production phase process, have special mix ratios prepared for engineering design requirements. Use twin-shaft forced mixing equipmentt, mix it 3-5min,trach standard homogeneous rate of mortar. Perform sampling tests for time consistency and compressive strength at an interval of every 50 m³ of produced mortar, data is uploaded in real-time to the quality supervision platform. Dedicated tankers with a GPS positioning function and temperature monitoring features are used for transportation. Spiral mixing blades installed on the inner wall of the tank Keep stirring at low speed during transportation to avoid mortar deposition. Normalizing the transportation radius up to 50 km. For more than 30 km, a retarder shall also be added to the tanker in order for the on-site workable time not less than 2 hours. Install mortar storage tanks with temperature stabilization functions on site at the construction location. Keep the storage tank temperature in the range of 15-25°C and use variable frequency metering pumps to control dosage when outputting mortar from storage tank, followed by one-time calibration measurement accuracy per hour [6]. Masonry construction has to use specific mortar spreaders and pointing tools, with a deviation of ±1 mm in thickness of the mortar joint, and fullness of horizontal joints above 95%. At the same time, conduct daily sampling inspection of construction quality, and the pass rate needs to remain above 98%. Build complete process quality traceability system from production to construction and greatly enhance the stability of masonry structure construction quality.

3.3 Optimizing Block Arrangement to Reduce Cutting Waste

The first step of this process is to do a preliminary layout which includes the creation of a 3D model based on the construction drawings of an architectural building. Execute virtual arrangement over standard block configurations, designed primarily for whole bricks. For walls of non-standard lengths, obtain whole brick splicing through fine-tuning with the joint thickness within the range of 8-12 mm. If it is unavoidable to have non-whole bricks, control it at more than 1/3 brick length, and the proportion of non-complex bricks ought not surpass 3%. Detailed drawing work of block arrangement guidance after layout completion, including the position, direction and specifications of each Note: The above points are distributed to relevant construction teams Verify the actual wall dimensions before on-site construction. The deviation from the drawings exceeds 8 mm, and the layout plan needs to be readjusted to avoid excessive cutting caused by size deviations. Cutting jobs should be done on a cutting table, and all must use CNC cutting machines. Mark the cutting line on block surface using laser line projector before cutting, and control the error into with respect to cutting [7]. Collect generated scraps by category. Scraps more than 150 mm is suitable for masonry wall waist lines, window sills and so on. For scraps with a bulk size between 50-150 mm, these pieces can be crushed to aggregate level to be used as mixing into fireproof masonry mortar instead. Small concrete precast components are made from scraps smaller than 50 mm. Through the construction of a block usage statistics and waste analysis mechanism, comparing theoretical use to actual use by this month every month, the layout plan is constantly optimized for successive months to reduce block cutting waste rate from 12% below 3%.

3.4 Introducing Masonry Crack Prevention and Control Technical Measures

Current or up to date as on October 2023 You need to ensure matching of physical properties of both blocks and mortar in case of material selection Special surgical blocks with drying shrinkage rate lower than 0.5 mm/m and special anti-crack mortar were selected. Ensure the difference in linear expansion coefficient of mortar and blocks does not exceed $1\times10^{-6}/°C$ to avoid cracks resulting from differences of material shrinkage [8]. From the perspective of construction technology, we take a cement mortar leveling layer 20 mm thick on the top of base before wall masonry. The deviation of the flatness of the leveling layer should not be greater than 3 mm/2m to avoid uneven stress on the wall caused by an unqualified foundation. Control daily masonry height < 1.4 m during masonry. First mow masonry, then allow 6 days to perform the final closing course. Apply wedge unit for the top closure course with angle of inclination 65-70° . The expansion rate is controlled between 0.03%-0.05%, and the gap at the top of the wall is filled with micro-expansion mortar; If you have walls longer than 5 m, then locate structural columns at mid-span. Place a minimum of 400 mm spaced tie reinforcements at the juncture with the attachment columns and within a distance of 1,000 mm inside the wall section. Maintenance in the late stage is required to cover the wall with geotextile after completing masonry and cure it with water. Must be no less than 10 days for curing time. The ambient temperature variation during curing should be controlled at no greater than 8°C/day and humidity must not decrease less than 65%[9]. Paste 200 mm width alkali-resistant glass fiber mesh cloth at corners of door and window openings, wall corners and more prone-to-crack places. The lap length of mesh cloth should be no less than 100 mm. The above measures can reduce the incidence of not more than 25% of masonry cracks to less than 4%, and greatly improve the durability of masonry structures.

4. Conclusion

The systematic discussion above on construction technology of masonry structures in building engineering leads to the following conclusions: In detail, from pre-construction material inspection and site foundation layer preparation, to complex working links such as setting out and positioning, achieving block masonry link completion for wall tie reinforcement installation and site inspection etc. are all required strictly speaking following technical requirements so that ensuring performance of materials meet the standard with operational accuracy qualified can firstly lay a solid foundation for subsequent construction work. Use of high-strength special masonry mortar can reduce the waste; use of rational ready-mixed mortar processes can improve construction stability significantly; optimize arrangement of blocks can save resources; introducing technology for crack prevention and control into wall structural design specifications can provide superior durability. In a nutshell, when these optimization measures are uniformly used at higher levels, many pain points in traditional construction can be solved. Not only, but also collaborative management and control covering the whole construction process are indispensable. A complete quality control system made up of links such as material selection, process operation and quality acceptance has to be closely connected with each other to really improve the construction level of masonry structures, so as to satisfy the requirements of building engineering quality safety.

References

[1] Wang Ling, Wang Xueyi, Zhang Hui, et al. Reverse Construction Technology and Key Techniques for Base Isolation Bearing Installation in Existing Masonry Structure Buildings[J]. Construction Safety, 2025, 40(1): 24-27,32.

[2] Zeng Bingbing, Chen Tao, Zhao Wenju. Application Research on Construction Technology of High and Large Door and Window Encasement in Public Building Masonry Structures[J]. Ju Ye,

2024(4): 16-18.

[3] Wang Bianchun. Analysis of Construction Technology and Quality Control for Secondary Structure Masonry in Building Engineering[J]. Architecture Building Materials Decoration, 2023(23): 22-24.

[4] Guan Senyou. Practical Exploration of Masonry Structure Construction Technology in Building Engineering[J]. Sichuan Building Materials, 2024, 50(5): 127-129.

[5] Feng Juncai. Construction Technology for Preventing Common Quality Defects in High-rise Building Masonry Structure Engineering[J]. China Construction Metal Structure, 2023, 44(1): 81-83.

[6] Li Jianwei. Application of Infill Wall Masonry Structure Construction Technology in Building Engineering[J]. Henan Construction Materials, 2024(6): 98-100.

[7] Yin Xiaodong. Construction Technology and Quality Control Measures for Main Structure of High-rise Buildings[J]. Architecture Building Materials Decoration, 2025(8): 76-78.

[8] Kong Jianbo, L Hua'an. Study on Common Problems in Masonry Structure Construction and Improvement of Plastering Layer Construction Technology[J]. Brick and Tile World, 2025(3): 16-18.

[9] Qian Chengshou. Practical Exploration of Masonry Structure Construction Technology in Building Engineering[J]. Popular Science, 2024,45(17): 72-74.