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Study on the Application of Non-Plastering Technology of BM Lightweight Aggregate Interlocking Block

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Abstract: Benchmark (BM) lightweight aggregate interlocking block has the characteristics of energy saving, no plastering, convenient construction, etc., which can be used for internal infilled walls at all parts (240 mm thick block can also be used for external infilled walls). The U-shaped bricks are used in building ring beams, structural columns and lintel formwork. It eases the formwork construction process, saves energy consumption, shortens the construction period, and reduces the materials used, achieving the purpose of ensuring a high-quality building at minimum construction cost. Taking the practical project as an example, this paper studies the performance and characteristics of BM light aggregate interlocking block, and introduces the key construction technologies, aiming to provide relevant reference for the application of BM light aggregate interlocking block in practical projects.

Keywords: BM lightweight aggregate; Interlocking block; No plastering; Construction procedure

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1. Introduction

The use of benchmark (BM) light aggregate interlocking block technology in practical projects saves energy and improves the efficiency of construction. Qin et al. [1,2] studied the application of BM light aggregate interlocking block construction technology in actual residential projects, introduced the application of BM light aggregate in residential projects, and the problems that need to be addressed in various projects. Zhang et al. [3,4], used an actual project as an example to explain the engineering characteristics, difficulties, construction preparation, construction points, and comparative analysis of advantages and disadvantages of BM light aggregate interlocking block, and had put forward reasonable suggestions. Heng X et al. [5-7] found that the application of BM light aggregate interlocking block simplified the construction process of masonry engineering, thus shortening the process masonry construction, thereby shortening the construction period, and reduced the cost of the project. At present, BM light aggregate is widely used in practical projects, but its characteristics and application precautions have not been well discussed. Therefore, this paper takes the actual project as an example to study the performance and characteristics of BM light aggregate interlocking block and introduces the key construction technologies as a reference for practical projects.

2. Project overview

The total construction area of a residential quarter project is about 141956 m^2, which is 26 floors. The main structure is constructed with aluminum formwork, the flooring is made of fabricated laminated plates, and the filler wall is made of BM lightweight aggregate interlocking block (hereinafter referred to as BM interlocking block). The block strength is MU5.0 and is bound with a special bonding mortar. The original architectural design was free of plastering, but in order to improve the quality and appearance, 2 mm thick gypsum was painted on the inner wall under the request of the contractor and the consent of the designer.

3. Properties and characteristics of BM lightweight aggregate interlocking block

3.1. Specifications

BM lightweight aggregate partition wall interlocking blocks are divided into five series of specifications (90–110 mm, 140 mm, 190 mm, and 240 mm in width; 150 mm, 170 mm, and 290 mm thick BM blocks can be added if necessary) with a height of 195 mm. The main blocks are BM-1 and BM-2 with a length of 395 mm, and the auxiliary blocks are 1/2 and 1/4 with a length of 195 mm and 95 mm respectively. In addition, porous multifunctional bricks are used for the structural treatment of individual positions.

3.2. Performance index

(1) The compressive strength of the block within the range of strength grade and density grade is MU5.0; Block density ≤ 1000kg/m^3.
(2) The value of heat transfer coefficient K is 1.2 W/(m^2·k) for 200mm thick wall.
(3) Fire endurance: the fire endurance of 150 mm thick wall shall not be less than 3h.
(4) The weighted sound insulation loss of airborne sound meter is 43dB for 100 mm thick wall, 45 dB for 150 mm thick wall and 48dB for 200mm thick wall.

3.3. Bonding mortar

Mortar BM light aggregate interlocking block masonry adopts special bonding mortar, and the mortar grade is M5. Technical requirements: consistency ≤ 90 mm, layering degree ≤ 20mm, water retention ≥ 80%, 28 d compressive strength ≥ 5MPa, initial setting ≥ 2 h, final setting ≤ 10 h, shrinkage ≤ 0.5%.

3.4. Characteristics

(1) BM block is small hollow block with light and high strength.
(2) U-shaped bricks are used in building ring beams, structural columns and lintel formwork without formwork supporting process.
(3) The holes and grooves for the installment of pipelines shall be embedded accurately in advance for effective slotting.

4. Key construction technologies

4.1. Rebar planting

The materials and equipment needed are chemical steel planting glue, drilling machinery, hole cleaning tools, and many more. The holes shall be drilled according to the anchoring depth required by the atlas, and the hole diameter shall ensure that the reinforcement gap at each side is greater than 2 mm. Clean the hole with air pump to remove the dust. Fill up the hole with reinforcement glue. Screw in the reinforcement gently to make the hole slightly overflowed with glue. The reinforcement should be left to cure for 24 hours. After 24 hours, each layer of rebar planting should undergo a pull-out test.

4.2. Masonry

According to the block arrangement drawing, the wall line shall be divided into blocks to determine the length and draw lines. The methods and requirements for arranging blocks are as follows:

To reduce the on-site cutting workload, avoid waste, and facilitate batching, the block arrangement design shall be done well before construction, and the main block arrangement with a length of 400 mm should be selected. The blocks shall be arranged from the door opening to the edges. The main block shall be used as much as possible, and the auxiliary block shall be used for staggered joints. The upper and lower holes of the blocks at the door and window sides shall be basically aligned to facilitate the pouring of the core column. Cleanouts shall be reserved at the lower part of the core column. During masonry, the upper and lower skins shall be staggered and overlapped. The overlapping length shall be 200 mm, and one cycle shall be carried out every two skins. When individual holes cannot be aligned, staggered hole masonry is allowed, but the overlapping length shall not be less than 100 mm. During vertical block arrangement, cement mortar or fine aggregate concrete can be used to level the floor before the first block is built, so as to meet the elevation of door and window openings.

4.3. Laying of bottom bricks

The bottom bricks of kitchen and toilet shall be made of BM interlocking blocks with the same width as the wall thickness and height of 200 mm. The masonry can be continued until C20 concrete is filled and vibrated.

4.4. Mandrel setting

(1) When the infill wall is greater than or equal to 5m or twice the floor height, a core column shall be set every 4 m along the middle of the wall, and the spacing between the core columns, and between the core column and the main structural column shall not be greater than 4m.
(2) Core columns shall be set at the free end, corners, and at the vertical and horizontal intersections of the filled wall.
(3) For the wall with door- and window-openings, core columns shall be set on both sides of the openings, and the core column longitudinal bars shall be $2\Phi12$, C20 concrete pouring.
(4) When the filled wall has no hole, the wall length is ≥ 8 m or the wall height is ≥ 4.5 m, the structural column should be set, and the longitudinal reinforcement of the structural column is $4\Phi10@200$, C20 concrete pouring.
(5) The core column joint bar is connected with the beam slab or floor slab: the core column joint bar is connected with the beam slab (floor slab) through planting bars, and the planting depth is 10 d.
(6) The column base of each core column shall adopt a U-shaped masonry operation hole with a cleaning hole to remove the mortar and other sundries falling from the core column hole.
(7) The core column concrete can only be poured when the wall masonry mortar reaches 1 MPa. The concrete shall be poured continuously and tamped in layers (300mm–500mm). The concrete consumption of each core column shall be calculated in advance, and the concrete shall be poured by measurement. Pour every 3 blocks and use $\Phi20$ the reinforcement shall be tamped once.

4.5. Horizontal tie beam setting

(1) The horizontal tie beam shall be set along the height direction at the position with the spacing ≤ 1.6m, and the reinforcement shall be through.
(2) The horizontal tie beam of BM block 100 and 190 series wall adopts cast-in-place C20 concrete tie beam, with a height of 100mm and longitudinal bars $2\Phi10@200$.

(3) The horizontal tie beam of 150 series and above walls can be reinforced with U-shaped block groove and poured with C20 concrete. The height is generally the height of one piece of block (200mm), and the longitudinal reinforcement is 4 Φ 10@200 Otherwise, the formwork can be cast.
(4) The horizontal tie beam reinforcement is anchored to the main column and wall through chemical planting reinforcement, and the depth of the horizontal tie beam reinforcement anchored to the main column and wall is 10d.
(5) When there are openings for doors and windows on the wall, horizontal tie beams through the wall shall be set at the upper and lower part of the opening, and the upper part of the opening also serves as lintel.
(6) Under the horizontal tie beam of door and window openings, multi-layer boards and battens are used as supports, 50 × 100 battens are used as the main ridge and secondary ridge. Two longitudinal secondary ribs are arranged around the width of the wall thickness, and the transverse main ribs are arranged around the width of the door and window opening, with a spacing of 600 mm. 50 mm × 100 mm batten are used for vertical support, spacing between battens 600mm, two 50 mm × 100 mm batten iron nails shall be used along the height of the timber to reinforce the support system.

4.6. Construction of water and electricity pipelines and boxes

The electric box opening shall be reserved before masonry. Water and electricity pipelines shall be installed in place before masonry to avoid chiseling and damaging the wall in the later stage. When reserving grooves and holes for water and electricity, the pipeline installation shall be carried out simultaneously with the masonry work. It is strictly prohibited to remove the grooves of the riser after the completion of the masonry work (unless it is used for local rerouting). After the pipeline is installed, it shall be tightly filled with dry C20 micro expansive concrete. For the line from bottom to top, the block shall be sleeved during masonry; for the line from top to bottom, the side of the block shall be slotted during masonry, and the pipeline shall be sleeved into the block.

5. Precautions

(1) All chemical planting bars and various embedded parts, heating and sanitary fittings, electrical pipelines, and many more shall be protected and shall not be arbitrarily removed, modified, or damaged.
(2) The reserved holes for electrical and equipment disciplines on the masonry shall be reserved in advance. It is not allowed to chisel afterwards to damage the integrity of the masonry. If chiseling is necessary, it shall be approved by the technical department and technical measures shall be taken.
(3) When the horizontal tie beam formwork is erected, the masonry strength must meet the construction needs. The formwork shall not be erected immediately after the masonry is completed to prevent the masonry from being loosened.
(4) The bottom formwork can be removed only when the lintel concrete strength reaches more than 50% of the designed strength. The masonry construction on the upper part of the lintel can be carried out only when the concrete strength reaches 1.2 MPa. During the masonry construction, the beam concrete shall be protected to avoid damaging the edges and corners.
(5) When pushing the trolley in the room, it is must not collide with the door corner and handrail. The door corner should be protected with multi-layer boards.
(6) The temporary plug placed at the floor drain, water outlet and other parts shall be well protected to avoid blockage caused by debris.

6. Discussion

The practical application of BM light aggregate interlocking block technology conserves energy, protects the environment, does not involve plastering, and saves time. However, in view of its characteristics,

precautions should still be taken in actual project application, and it should be used in various projects in strict accordance with the specifications. Besides, due to the shortcomings of the masonry structure itself, it should be protected according to the actual situation of the project.

7. Conclusion

BM light aggregate interlocking block has the characteristics includes having a large hole, suitable density, and is light-weight, high-strength, energy-conserving and environment-friendly, which can effectively achieve the desired effect when applied to practical projects. The application of BM light aggregate in this project can achieve good practical effect, and the characteristics of BM light aggregate interlocking block can be fully reflected.

Disclosure statement

The author declares no conflict of interest.

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