Design of External Dimensions of Grout Free Self-locking Blocks

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Abstract. The design inspiration for grout free self-locking blockscomes from the principle of "building blocks" in traditional masonry. No professional masonry techniques or bonding materials are required. Simply stack the blocks in the prescribed manner to create a sturdy wall structure. This article is based on the basic principle of "building blocks", designing the shape and size of the grout free self-locking blocks, developing the mold for the block, curing and pouring it, without the need for cement mortar for on-site masonry. Aligning with the national push for energy conservation and emission reduction, it significantly reduces costs and also shortens the construction duration.

Keywords: grout free self-locking block; conserve energy; reduce emissions

1 Introduction

The research on grout free self-locking blocks started earlier and is more in-depth in foreign countries. Research in this area has been limited in China. In the late 1990s, scholars and corporations began investigating this topic[1]. Due to the widespread adoption of cast-in-place reinforced concrete structures, masonry and prefabricated structures have become less prominent, leading to a reduced demand for masonry materials and consequently stalling research on dry-laying blocks. In recent years, as national standards for energy conservation and emission reduction have risen, prefabricated industrial buildings have once again garnered attention and are now more widely used in construction projects. How to develop new wall materials that are more suitable for the characteristics of new rural buildings, such as insulation, energy saving, green and low-carbon, based on existing blocks is currently the research focus in the construction of new rural areas under the dual carbon background. This article explores the application of grout-free self-locking blocks as wall materials in the construction of new rural areas[2].

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2 Introduction and Characteristics of Grout Free Self-Locking Blocks

The design of grout free self-locking blocks draws inspiration from the "building blocks" principle in traditional masonry. Its construction method is straightforward and convenient, eliminating the need for specialized masonry skills. By stacking the blocks according to the prescribed method, a sturdy, integrated wall structure can be created. This special connection method not only reduces the labor intensity and technical requirements during the construction process, but also improves the speed and efficiency of masonry[3]. It can be widely used in the infrastructure construction of beautiful rural areas, as well as the restoration and reconstruction of disaster areas. The blocks are constructed using a grout free self-locking method, and we must strictly control the errors in the size design of the blocks. On this basis, we have made improvements to the design by adopting concave convex self-locking on the top, bottom, left and right sides, ensuring a tight bite. To prevent collision and damage between the blocks, a clever cylindrical design was adopted, with a radius of 50mm and a height of 50mm.In the initial phase of the experiment, the chosen radius was too small, making it susceptible to crushing under stress. Subsequently, adjusting to an appropriately larger size reduced the risk of breakage, improved the integrity and safety of the wall construction, and minimized the likelihood of block collision and fragmentation. The design diagram is illustrated in Figure 1[4].

At present, the relevant technical standards for grout free self-locking blocks are not yet perfect, and there is a lack of unified production and construction specifications, which leads to problems such as unstable quality and inconsistent specifications in practical applications[5]. This article preliminarily studies the external dimension design of grout free self-locking blocks, and mechanical problems encountered during the research process are not the focus of this article[6].

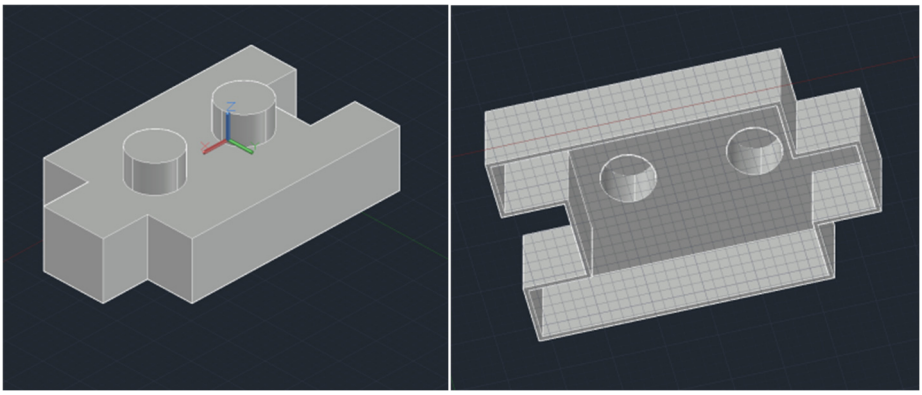

Fig. 1. Design drawing of grout free self-locking block

The size of standard blocks is 200mm × 400mm × 200mm. Different material ratios are used to make test blocks for testing, and basic performance tests are conducted after

the curing period is over[7]. To save costs, we self cut molds and assemble them. The mold is shown in Figure 2. This study mainly focuses on the size design experiment of test blocks, supplemented by functional experiments on compressive and shear properties, as well as insulation, heat insulation, and waterproofing. During the experimental process, the size of the test block and the material ratio were adjusted in a timely manner based on the experimental results. After repeated experimental research, the grout free self-locking block with all required properties was finally obtained[8].

Fig. 2. Mold splicing drawing

Fig. 3. Maintenance diagram of grout free self-locking block

In the initial design, it was originally intended that the grout free self-locking block would have a cylindrical appearance, but this design was difficult to model and could

not be directly presented in the mold. At the initial stage of the experiment, non cylindrical blocks were temporarily poured for research and discussion, and the curing result is shown in Figure 3[9].

In order to solve the above modeling difficulties, we thought of the PVC pipe and the corresponding outer diameter of the PVC plug cover, using the plug cover to insert 50mm from the bottom of the pipe can not only form the appearance of convex and concave but also solve the problem of cylindrical appearance. The PVC shrink fit pipe and cover are shown in Figure 4. During the pouring process, place the shrinkage tube in the mold according to the corresponding size to form a whole. In the process of pouring, the shrink pipe is directly poured into the mold according to the corresponding size to form a whole. Place the PVC shrink pipe in the mold, as shown in Figure 5. The finished pouring diagram is shown in Figure 6[10].

Fig. 4. PVC Shrinkage Pipe and Cap Diagram

Fig. 5. Picture of PVC shrink pipe placement

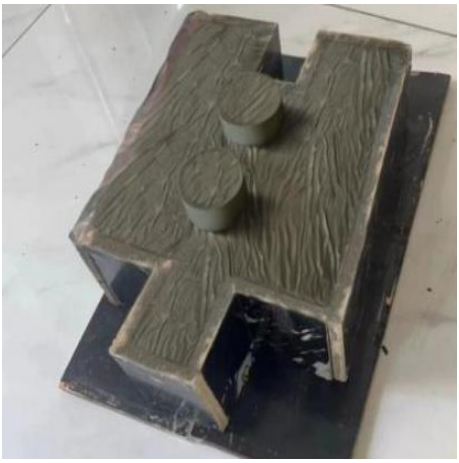

Fig. 6. Schematic diagram of pouring completion

3 Academic and Applied Value

As a new type of building material, grout free self-locking blocks have important academic and application value, mainly reflected in the following aspects:

Environmental friendliness: The grout free self-locking block adopts a masonry method that does not require cement slurry, avoiding the large amount of waste and environmental pollution generated in the traditional masonry process, which conforms to the concept of modern building green environmental protection.

Energy saving: the grout free self-locking block can greatly save the consumption of cement and other resources in the production and construction process. At the same time, due to its own design characteristics, it has good thermal insulation performance, which can reduce the energy consumption of the building.

Technological innovation: The grout free self-locking block adopts a special geometric structure and material formula, which has the characteristics of self-locking and self stabilization, which can reduce the labor intensity and technical requirements during construction and improve construction efficiency.

Application potential: The grout free self-locking block is suitable for various types of building walls, partitions, slope protection and other projects, with broad application prospects, especially in rural construction, ecological construction and other fields with huge promotion potential.

Economic benefits: Using grout free self-locking blocks for construction can reduce building costs, improve construction speed, and reduce maintenance costs in the later stages, thereby bringing significant economic benefits.

At present, the relevant technical standards of slurry-free self-locking blocks are not perfect, and they lack of unified production and construction specifications, leading to problems such as unstable quality and inconsistent specifications in practical application. This paper preliminarily studies the dimensional design of self-locking block, and

the mechanical problems encountered in the research process are not discussed in this paper.

4 Conclusion

This article adopts the method of concave convex self-locking, which does not require mortar for masonry and can accelerate construction efficiency. This article presents a preliminary design of the external dimensions of grout free self-locking blocks, which can achieve the expected self-locking effect. However, further exploration is still needed on the proportioning and strength issues of non grouted self-locking block materials.

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References

[1] Nagori A ,Jadhav K S ,Guru K P , et al.Development and performance evaluation of paddy straw based insulating block composite for low temperature storage application[J].Energy & Buildings,2024,317114379-.

[2] McKee K ,Rothschild D ,Young R S , et al.Looking Ahead: Advancing Measurement and Analysis of the Block Design Test Using Technology and Artificial Intelligence[J].Journal of Intelligence,2024,12(6):53-.

[3] Aduldejcharas R .Bio responsive block: The performance of bio waste material with reduced environmental impact[J].Results in Materials,2024,23100589-100589.

[4] A. A B A ,Abu B B ,Joseph U U , et al.Evaluating the behaviour of axially loaded hollow concrete block masonry walls with small-size openings: Various opening positions and their influence on experimental results[J].Engineering Structures,2024,301117346-.

[5] Turgut P, Alas M C, Gurel M A. Lightweight masonry block without Portland cement[J]. Engenharia Sanitaria e Ambiental, 2021, 26: 945-953.

[6] Moravvej M, Rashidi M. Structural performance of self-compacting concrete[M]//Self-Compacting Concrete: Materials, Properties and Applications. Woodhead Publishing, 2020: 371-387.

[7] Zhong MS, Yang D. Research and Application of Self-Locking Concrete Hollow Block Construction Technology [J]. Building Materials and Decoration, 2016, 12(51): 30-32.

[8] Assiamah S, Abeka H, Agyeman S. Comparative study of interlocking and sandcrete blocks for building walling systems[J]. International Journal of Research in Engineering and Technology, 2016, 5(1): 1-10.

[9] Okamura H, Ouchi M. Self-compacting concrete[J]. Journal of advanced concrete technology, 2003, 1(1): 5-15.

[10] Jin XN, Tang DX. nnovative Insulated Wall Systems-- Mortarless Insulated Block Masonry [J]. Journal of Harbin University of Architecture, 2000, (04): 62-65.