Research on Application of Slotting Innovation Repair OF Partition Wall Based on Box Shell Structure

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Abstract. With the development of modern building technology, light partition wall has been widely used in the field of building internal partition wall because of its construction convenience and economy. However, the traditional slotting and repairing methods often cause damage to the structural strength of the partition wall body, affecting its sound insulation performance and use safety. In this paper, a light partition wall slotting repair process and its structure based on box shell structure are proposed. The technology combines the design of π slot and π clamp. Through the installation of top plate and bottom plate, as well as the filling of the inner protective screen board and gypsum mortar, the mechanical strength and sound insulation performance of the slotted partition wall are effectively improved. The support adjustment assembly further ensures the stability of the roof and bottom plate, and allows the adaptation of different sizes of working slots. Through similar examples, this paper demonstrates the significant benefits of the repair structure in strengthening the wall structure, simplifying the installation process, and improving environmental adaptability. The results show that this method not only optimizes the repair quality of the light partition wall, but also provides structural support for the installation of the electrical box shell, and significantly enhances the comprehensive performance of the wall.

Keywords: Light partition wall; Slotted repair; π limit slot; Box shell structure; Gypsum mortar; Sound insulation performance; Structural strength; Construction technology

1 INTRODUCTION

In modern architecture, light partition wall is widely used because of its light weight, high efficiency and environmental protection, which provides good heat and sound insulation effect. However, in the process of slotted wiring and pipe-line installation, the structural integrity and performance of the partition wall may be damaged, and the research indicates that structural cracks are the major cause of structural failure and significantly impact their strength and durability[1,2]. Most researchers only sorted out the crack control methods from various engineering links such as design, materials, repair through admixtures, polymers, epoxy resins and bacteria, and process[3], resulting in the existing repair methods failing to effectively solve problems such as insufficient

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strength, poor durability and complex construction. Therefore, this study aims to develop an innovative lightweight wall crack repair technology. By adopting the concept of box-shell structure and specific combination and filling materials, the defects of traditional methods can be solved, which can not only make the whole show a high density[4], but also quickly and effectively maintain the original function of the wall, so as to meet the requirements of modern construction industry for construction speed. After being verified by engineering practice, it shows broad application potential and promotion prospects.

2 ANALYSIS OF THE STATUS QUO OF SLOTTING AND REPAIRING OF LIGHT PARTITION WALL

Light partition wall has been widely used in modern architecture because of its economic, efficient and environmental protection characteristics. However, in the implementation of electrical wiring, pipeline installation and other construction processes, it is inevitable that these partition walls need to be slotted, which often weakens the structure and function of the partition wall. According to the existing literature, at this stage, the repair of light partition walls after grooving is mostly done by traditional reinforcing methods, such as using patch plates[5], filling materials[6], etc. However, these methods often have some problems such as unsatisfactory repair effect, poor durability and influence on aesthetics. Therefore, exploring a new repair method to maintain or improve the original performance of the partition wall is the focus of current research.

Box structure, as a kind of high efficiency three-dimensional bearing system, has been increasingly widely adopted in modern architectural design. The structure is composed of a number of mutually vertical support plates, creating a closed form similar to the box, showing excellent structural strength and rigidity. From bridge engineering to skyscrapers to aerospace, box-type structures have been used in numerous applications. Academic studies have shown that, based on its superior resistance to bending, torsion and shear, the application of box structures in the construction field significantly enhances the stability and durability of structures. In addition, its modular structure also greatly improves the speed and engineering quality of construction.

The functional requirements of the partition wall are also many, including the stability of the structure, sound insulation performance, thermal insulation performance, fire performance and durability. In order to achieve these indicators, a variety of improvement strategies are constantly being proposed and refined. The current research shows that the selection of better materials and improved structural design can significantly improve the overall performance of partition walls. For example, the selection of porous materials can enhance the sound insulation of partitions, the integration of thermal insulation improves their heat insulation, and the use of non-combustible materials also improves the fire protection standards of walls. Studies have also shown that by incorporating innovative technologies and novel approaches, such as taking advantage of box construction, grooving walls can be repaired effectively and quickly while retaining the original function of the partition. These advances not only enhance the

application efficiency of the partition wall, but also promote the progress of construction technology.

3 THE DESIGN PRINCIPLE AND CHARACTERISTICS OF THE BOX SHELL STRUCTURE

The box shell structure is a closed structure system consisting of top plate, bottom plate and side plate rigidly connected along its edge. Its core characteristic lies in its excellent flexural, torsional and shear resistance, thanks to its unique geometry and structural integrity. The box shell structure can effectively carry and distribute loads, so it can maintain higher stability and uniform stress distribution when subjected to external forces. The sealing characteristics of the structure also provide good sound and thermal insulation properties.

According to the design plan, prepare the required materials. Under normal circumstances, the main materials of the prefabricated box shell include 201、π type limit slot; 3、top plate; 301、π-shaped card block; 4、bottom plate; 501、the first protective net board; 502、the second protective net board; 503、border plate body; 504、protective isolation net; 6、support adjustment components; 601、X type cross movable frame; 6011、clamp column; 602、the first upper mounting head; 6021、right Angle active slot; 6022、U-bayonet; 6023、positioning screw; 603、the second upper mounting head; 604、the upper limit with threaded straight rod; 605、the first installation head; 606、the second lower installation head; 607、lower limit with threaded straight rod; 608、positioning hexagon nut (FIG. 1 to FIG. 6). Make sure the quality and specification of the material meet the design requirements.

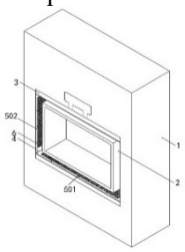

Fig. 1. Left view

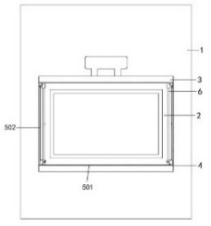

Fig. 2. Main view

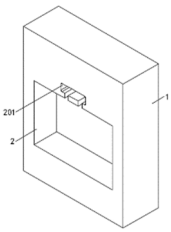

Fig. 3. Right view

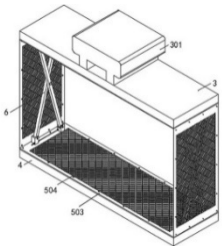

Fig. 4. Box shell

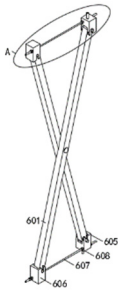

Fig. 5. Support adjustment component

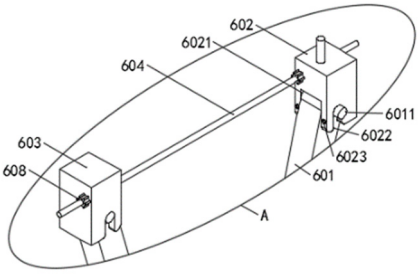

Fig. 6. Support adjustment component details

The design of π limit slot and clamp block is the key design to ensure the accurate positioning and firm connection of the shell structure in the repair process (FIG. 3, FIG. 4). The π limit slot is a special joint slot, which can precisely receive the clamp block, so as to achieve fast and accurate structural combination. The design of the card block focuses on providing a powerful locking function and ensuring the stability of the structure through card cooperation. This design can not only improve the construction efficiency and reduce the interference to the original structure, but also maintain or improve the overall performance of the partition wall after repair.

The roof and bottom plate play a sealing and bearing role in the shell structure, and their design is crucial to the performance of the entire structure. The top plate mainly bears the pressure from above, while the bottom plate supports the entire structure and distributes the downward load. When designing, the top plate and bottom plate should be guaranteed to have sufficient thickness and rigidity to avoid deformation when bearing the load. At the same time, they need to be connected in a way that ensures sufficient sealing to maintain the sound and thermal insulation characteristics of the box shell structure. In the repair application, the design of the roof and bottom plate should also consider the compatibility with the existing partition material, ensuring seamless docking and the recovery of the overall performance during the repair process.

In terms of slot repair process, the most prominent innovation in this paper is the research and development of support adjustment components (FIG. 5, FIG. 6). This device allows the operator to make small adjustments in the placement of the box structure, ensuring its precise positioning and horizontal state in the partition wall. The advantage of this design is that it can adapt to the slight unevenness inside the wall, and adjust the position of the box structure during the construction process to ensure the stability of the structure and the best fit degree. The design of this support adjustment component greatly improves the accuracy and application range of the repair process.

When considering the repair process of partition walls, sound insulation performance is an important indicator that cannot be ignored, especially in residential and office environments. In order to verify the influence of the slotted repair process of the partition wall based on the box shell structure on improving the sound insulation performance, the test and analysis method taken in Table 1:

Table 1. Evaluation of sound insulation performance improvement through slotted repair process in partition walls

Transmission Loss (TL) test	This test measures the energy reduction of sound waves as they pass through the repaired partition wall. The higher the TL value, the better the sound insulation effect. This test is usually performed in a professional acoustics lab and uses standard sound source and receiving equipment to measure precisely
Standard Sound Transmission Class (STC) rating	The STC is a commonly used index for evaluating the sound insulation performance of partitions. By measuring the TL value at different frequencies, and then comparing with the standard curve, the STC value is calculated. The STC value provides a quantified indicator of sound insulation performance to evaluate the effectiveness of the patching process

Onsite sound insulation test	Sound insulation test in the actual living or working environment can provide the sound insulation performance of the repair process under realistic conditions. This usually involves placing a sound source and receiver on each side to measure the reduction in sound penetration through the partition wall
Low frequency sound insulation performance test	Low frequency sound waves are usually more difficult to isolate, so specifically evaluating the isola-tion effect of repaired partitions against low frequency noise is also an important aspect of verifying the improvement in sound insulation performance

By adding sound absorbing materials[7] can be objectively evaluate whether the sound insulation performance of the partition wall has been substantially improved after the repair of the box shell structure. Data collection and analysis can help determine whether the design of the repair process is effective in reducing noise transmission and whether the need for sound insulation in a particular environment is met. This information is critical in guiding future refinements and optimizations of the patching process.

4 APPLICATION OF SIMILAR EXAMPLES

In the construction process of residential project and workshop in July 2023, it was observed that the strategy of wall water and electricity piping adopted on site was to finish masonry first and then make slotting. In this order, after the construction of the pipeline, it is necessary to lay steel wire mesh and plaster treatment at the notch. Although this is convenient and quick in the early stages of construction, vertical and horizontal notching can negatively affect the structural strength and stability of the wall, thereby weakening the integrity and safety of the infill wall. This not only creates unnecessary problems for subsequent installation and decoration work, but also poses a potential safety risk. Based on these considerations, we explore and summarize a new masonry construction technique that does not require grooving.

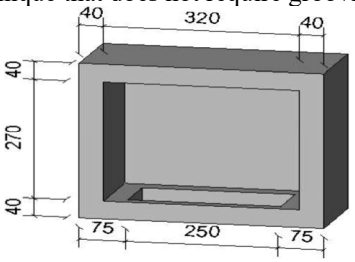

Fig. 7. Multimedia box

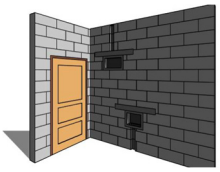

Fig. 8. Modeling 1

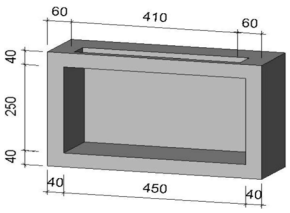

Fig. 9. Lighting box

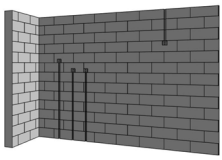

Fig. 10. Modeling 2

Fig. 11. Implementation 1

Fig. 12. Implementation 2

Brick arrangement plan design: The brick arrangement design must comply with the codes and design drawings to ensure the accurate layout of the masonry structure. This design needs to integrate electrical engineering drawings and pipe and box installation

data obtained from field measurements to further refine the brick layout diagram. For the prefabricated box, it is necessary to customize the mold according to the actual measured size and the thickness of the embedded wall. These prefabricated components are made of C20 fine stone concrete, and ensure that the edge of the mold is at least 4 cm wide (FIG. 7), while reserving 1 cm of installation space. The bottom design should take into account the size of the pipeline and ensure that there are appropriate openings (FIG. 8). As for the bricks with grooves (FIG. 9), grooves (FIG. 10) should be reserved in advance according to the diameter of the wire pipe and the specific position of the wire box, so that when the diameter of the pipeline is 2 cm, the grooves can provide enough depth (5 cm) and width (8 cm) to fit.

Construction of the wall: First check and confirm the 1 meter horizontal refer-ence line on the masonry, and then build the wall according to the brick arrangement diagram. Install prefabricated box and channel bricks: precisely place the pre-made special-shaped box and pre-channel bricks according to the position of the brick layout drawings, and ensure that the position, elevation and size of each element in the laying process strictly follow the requirements of the design drawings (FIG. 11). Pipe layout and box installation: In the pipe layout, the wire box and box must be installed in the predetermined holes and notches, to avoid new grooves on the wall; At the same time, the pipeline should be reliably fixed by using clasps (FIG. 12). Pipe and box gap sealing: Once the pipe and box are installed in place, a 1:2 ratio of cement mortar should be used to fill the surrounding gaps. The surface of the wall should be wetted before construction, so that the mortar can fill the gap tightly and ensure that the surface and the wall remain smooth.

Compared with the traditional post-slotting construction method, the adoption of the new construction technology reduces the workload of pipe slotting, repairing the tank body, solving plastering cracks, cleaning construction waste, and significantly reduces the labor cost[8]. Take Building 21 of the second phase of Plot K of Greenland Smart Financial City as an example. This building is a super high-rise residential building with a total construction area of 16,256.42 square meters, including one underground floor and 34 above-ground floors, each floor area of 485 square meters. The specific cost savings are as follows in Table 2:

Table 2. Cost savings analysis for new construction technology

Slotting labor cost	Save 8 workdays per layer, 120 yuan per workday cost, a total of 960 yuan per layer
Slotting repair labor cost	Save 10 workdays per layer, 150 yuan per workday cost, a total of 1500 yuan per layer
Repair material cost	Save 500 yuan per layer
The cost of cleaning rubbish	200 yuan per layer
Masonry material processing labor costs	Save 5 workdays per layer, 120 yuan per workday cost, a total of 600 yuan per layer
Total labor cost saving	A total of 2560 yuan per layer saving (calculation process is 960+1500+500+200-600)
According to the construction area	The cost saving per square meter is 5.28 yuan (the calculation process is 2560 divided by 485)

5 CONCLUSION

Through its innovative design, the repair process of box shell structure provides a new solution for wall damage repair. The key advantages include as shown in Table 3:

Table 3. Key advantages of the box shell structure repair process

Structural strengthening	The slotted and embedded box shell structure can effectively strengthen the bearing capacity of the repair area and restore or even enhance the original structural integrity of the wall
Construction efficiency	Compared with the traditional repair method, the grooving process is simple, and the construction speed is fast, which reduces the impact on daily use
Environment friendly	The optimized environmental protection materials reduce the burden on the environment, while reducing the waste generation in the repair process
Long-term stability	The materials and processes used ensure the long-term performance of the repair area and reduce later maintenance costs

Although the box shell structure repair process has obvious advantages, it also faces some problems and challenges in practice, as shown in Table 4:

Table 4. Problems and challenges in the box shell structure repair process

Technology popularization	How to popularize this advanced repair technology to a wider range of engineer-ing practices, and improve the industry acceptance is a challenge
Standardized process	The lack of uniform operating standards and quality control processes may lead to uneven construction quality
Cost control	Although the material utilization rate is high, the initial equipment investment and technical training may increase the overall cost
Complex environmental adaptability	Under different geographical and climatic conditions, the adaptability and durability of the repair process need to be further verified

Future research directions development can be concentrated as shown in Table 5:

Table 5. Potential directions for future research development

Material innovation	The research and development of new materials with high performance, cost effectiveness and environmental friendliness aimed at expanding the applicability and effectiveness of repair techniques
Engineering integration	Research on how to more effectively integrate shell structure repair methods into contemporary building construction processes to optimize construction efficiency and improve compatibility
Automation development	To explore the introduction of automation and robot technology in the repair process, with the aim of reducing manual dependence, while improving the accuracy and speed of the operation
Specification and certification	Establish accurate process specification and certification system to ensure the quality and effectiveness of the repair process
Multi-functional performance	The development of repair technology with multiple functions such as heat insulation and fire prevention to cope with more complex repair needs
Continuous monitoring and evaluation	Design a long-term monitoring system to monitor the performance of the repaired structure in real time and find potential problems in time

The research results not only provide effective solutions for wall damage repair, but also bring new technical ideas and application examples to the building maintenance industry. In the future, as this technology is further improved and popularized, it is expected to be more widely used in the field of building maintenance and repairs.

REFERENCES

1. Yasmine E., Mohamed A.E., Mohamed M., Ahmed A.E., Seleem S.A., Kaori N. (2024). Investigating the bacterial sustainable self-healing capabilities of cracks in structural concrete at different temperatures. Case Studies in Construction Materialse03188-.
2. Peng Y.Q. (2023). New ALC panel wall installation quality control and reinforcement measures. Journal of Physics: Conference Series(1).
3. Raza M.N., Hussain S., Singh M., Yadav J.S. (2023). A review and bibliometric study of bacteria-based self-healing of concrete. Multiscale and Multidisciplinary Modeling, Experiments and Design(1),1-14.
4. Tang X.L. (2023). Key points and application of concrete crack repair construction technology. Chinese Building Metal Structures (10),81-83.
5. Jiang L.F., Qian C.Y. (2023). Discussion on the comprehensive solution of the crack problem of indoor light partition wall. Construction Worker (11),49-52.
6. Zhang S.J. (2024). Research on improving ALC lightweight board building performance and carbon emission reduction measures. Foshan Ceramics (01),39-41.
7. Tarık S.B., Sevtap Y.D. (2020). The Experimental Research of Sound Absorption in Plasters Produced with Perlite Aggregate and Natural Hydraulic Lime Binder. Acoustics Australia(prepublish),1-19.
8. Christopher L.D.C., Patricio C.J., Melanie P. (2021). Indirect Material Cost Reduction by Eliminating Manual Derailing Process through Process Simplification. Journal of Engineering Research and Reports1-12.