Academic Education Publishing House

Industry Science and Engineering Vol. 2 No. 7, 2025

Research on the Integrated Device for Detecting and Replacing Hollow Bricks on Side Walls

Meng Jing

School of Achitectural Engineering, Zibo Polytechnic University, Shandong, China

Abstract: This paper presents an integrated device for detecting and replacing hollowed-out bricks on side walls, which is used for quality inspection of paved brick walls and replacement of hollowed-out bricks. Research and experiments have shown that the analysis algorithm module in the device can accurately control the movement of the roller, mark and cut the gaps between wall bricks, effectively saving workers' time for inspection and replacement of wall bricks.

Keywords: Hollowing Detection; Analysis Algorithm Module; Brick Wall; Quality Inspection

1. Research Background Technology

When the ambient temperature drops sharply, if the wall tiles are laid before the cement paste is fully dried, all the moisture in the mortar will evaporate. When the temperature rises again, due to thermal expansion and contraction, voids will appear between the wall tiles and the substrate, resulting in the phenomenon of hollowing. In the real estate sector, wall hollowing is a common yet significant issue that cannot be overlooked. Timely and accurate inspection of wall hollowing is crucial for ensuring the quality of the house and the safety of its occupants.

The existing wall tile hollow detection device for building inspection can measure the hollow phenomenon in wall tiles by repeatedly striking the tiles with a measuring head in a longitudinal reciprocating motion. the device includes a measuring hammer head, a measuring hammer handle fixedly mounted at the rear end of the measuring hammer head, a first guide rod and a second guide rod respectively fixedly mounted on both sides of the inner wall of the measuring hammer head, a first slider slidingly mounted inside the first guide rod, a second slider slidingly mounted inside the second guide rod, a baffle fixedly mounted inside the measuring hammer head, a first connecting rod fixedly mounted on one side of the first slider, one side of the baffle fixedly mounted on the first connecting rod, a second connecting rod fixedly mounted on one side of the second slider, the second connecting rod fixedly mounted on the other side of the baffle, a fixed plate mounted inside the measuring hammer head, a reset spring and a push rod arranged at the bottom of the baffle, the reset spring fixedly mounted on the fixed plate, and a measuring pressure head arranged at the bottom of the push rod. the inner bottom of the measuring hammer handle is fixedly mounted on a support base, a micro motor is arranged on the top of the support base, and the output shaft of the micro motor is fixedly mounted on a transmission rod.

However, due to the consistent striking force and rapid frequency, the existing wall tile hollow detection device requires decoration workers to make timely judgments based on the sound, which is prone to errors in judgment. the detection quality of wall tiles is low, and it is impossible to replace hollow wall tiles. Therefore, there is an urgent need for an integrated device for detecting and replacing hollow wall tiles.

2. Internal Structure of the Integrated Device for Detecting and Replacing Hollow Bricks on Side Walls

Addressing the aforementioned technical issues, this project has developed an integrated device for detecting and replacing hollow side wall bricks, which includes a support mechanism, an adjustment mechanism, a detection mechanism and a control system.

2.1 Supporting Mechanism

The support mechanism comprises a bottom plate and a top plate, with a lifting mechanism positioned between them. the top plate is equipped with a detection mechanism and a control system. the lifting mechanism includes a primary rectangular tube, a secondary rectangular tube, a tertiary rectangular tube, and a quaternary rectangular tube. the primary

rectangular tube is fixedly mounted on the bottom plate, while the secondary rectangular tube is slidingly mounted inside the primary rectangular tube. A lead screw is rotatably mounted on the bottom plate. the tertiary rectangular tube is slidingly mounted inside the secondary rectangular tube. A second set of main racks is fixedly mounted to the tertiary rectangular tube, while the quaternary rectangular tube is slidingly mounted inside the tertiary rectangular tube and fixedly mounted to the top plate. A follower telescopic assembly is positioned between the tertiary and quaternary rectangular tubes.

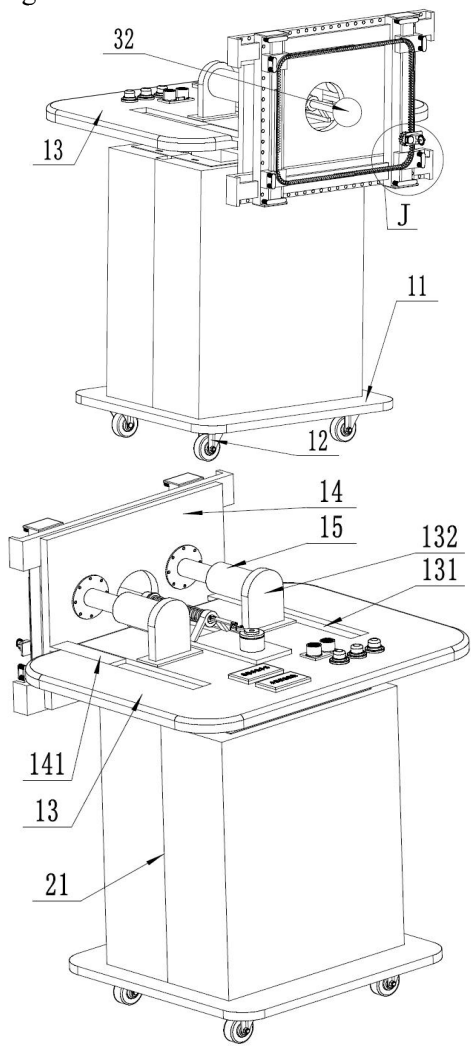

Figure 1. Schematic Diagram of the Device

11-Base plate; 12-Rolling wheel; 13-Top plate; 14-Support plate; 15-Air cylinder; 32-Hammer; 131-Rectangular slot; 132-Pin seat; 141-Rectangular block;

2.2 Detection Mechanism

The detection mechanism includes a detection plate and a hammer. the detection plate is fixedly installed on the top plate, and the hammer is slidingly mounted on the tripod of the detection plate. the detection plate is equipped with an intermittent assembly, which drives the hammer to perform reciprocal striking motion. the detection mechanism also includes a detection spring, which is slidingly mounted on a striking hammer. the striking hammer is equipped with a baffle plate, which is positioned between two sets of tripods. the detection spring is situated between the baffle plate and the tripod.

2.3 Adjustment Mechanism

The adjustment mechanism is arranged on the support plate and comprises two sets of cross rails and four sets of adjustment blocks. the two sets of cross rails are symmetrically fixed and installed on the support plate, and two sets of vertical rails are symmetrically slidably mounted on the two sets of cross rails. One set of vertical rails corresponds to two sets of adjustment blocks, and the two sets of adjustment blocks are symmetrically slidably mounted on the vertical rails. Each set of adjustment blocks is fixedly mounted with a right-angle rack, and adjacent two sets of right-angle racks are slidably mounted between each other. A cutting mechanism is slidably mounted on the right-angle rack, and the cutting mechanism, striking hammer, and control system are electrically connected.

2.4 Control System

The control system comprises an analysis algorithm module and an acoustic sensor. the analysis algorithm module and the acoustic sensor are fixedly mounted on the top plate. the acoustic sensor is electrically connected to the analysis algorithm module and the data acquisition module respectively. Two sets of rectangular grooves and pin seats are symmetrically arranged on the top plate of the support mechanism. the air cylinders are fixedly mounted on the pin seats respectively. the support plate is equipped with rectangular blocks. the output end of the air cylinder is fixedly mounted on the support plate. the air cylinder, roller, and control system are electrically connected. When the hammer strikes the wall tile, it generates acoustic waves. the acoustic sensor collects these waves and transmits them to the data acquisition module for data acquisition. the analysis algorithm module analyzes the data from the data acquisition

module and controls the movement of the roller.

3. Control and Operation Process of the Integrated Device

When the primary rectangular tube of the lifting mechanism fixed on the base plate in the device rotates through the screw rod, it drives the secondary rectangular tube to move upwards under the cooperation of threads. Under the meshing action of the main rack and the main gear, the main gear rotates. When the main gear rotates, it drives the driven gear to rotate. the driven gear drives the fourth-level rectangular tube to move upwards through the second set of driven racks. the fourth-level rectangular tube drives the top plate to move upwards, transporting the detection mechanism and adjustment mechanism to the target position to detect wall tiles of different heights.

Under the elastic force of the testing spring in the testing mechanism, the striking hammer is driven to move towards the wall tile. the striking hammer impacts the wall tile, generating sound waves. the sound wave sensor transmits the sound wave signal to the data acquisition module for collection.

The analysis algorithm module is fixedly installed on the top plate. the algorithm module analyzes data from the data acquisition module, controls the movement of the roller, and adjusts the position of the adjustment block based on the size of the wall tile, thereby ensuring that the movement trajectory of the cutting mechanism coincides with the wall tile gap. the driving cylinder brings the cutting mechanism on the right-angle rack into contact with the wall tile gap, cutting and marking the wall tile gap.

If the wall tile is not hollow, the warning light will not respond. the analysis algorithm module will drive the roller to rotate, and the detection mechanism and adjustment mechanism will be driven by the base plate to the next set of wall tiles. If the wall tile is hollow, the analysis algorithm module will analyze the collected data, the warning light will illuminate, the roller will be fixed, the intermittent motor will be turned off, the cylinder will be controlled to extend, the cutting blade will be brought into close contact with the gap of the wall tile, and the cutting blade and cutting motor will be started to cut the gap of the wall tile.

The cutting mechanism comprises a cutting plate and a cutting blade. A track is arranged on the right-angle rack, and the cutting plate is slidingly mounted on the track. the cutting blade is arranged on the cutting plate, and a cutting gear is rotatably mounted below the cutting plate. the cutting gear engages with the right-angle rack. When the cutting gear rotates, it drives the cutting plate to slide on the right-angle rack under the action of engagement with the right-angle rack, thereby driving the cutting blade to move on the right-angle rack. the cutting blade cuts the gaps at the four edges of the wall tile. Cutting the gaps of the hollow wall tiles facilitates workers to subsequently remove and replace the wall tiles. At the same time, the hollow wall tiles are marked, saving workers' time in replacing the wall tiles.

After cutting is completed, the analysis algorithm module controls the cylinder to retract, breaking the contact between the cutting blade and the wall tile gap. the analysis algorithm module also controls the roller to rotate, driving the detection mechanism and adjustment mechanism to move to the next set of wall tiles. the intermittent motor is restarted to detect the next set of wall tiles.

4. Conclusions

This study proposes an integrated device for detecting and replacing hollowed-out bricks on side walls, which pertains to the field of construction machinery technology. the device comprises an adjustment mechanism. the top plate is equipped with a detection mechanism and a control system. the striking hammer is slidingly mounted on a tripod of the detection plate. the intermittent component on the detection plate drives the striking hammer to perform reciprocating striking movements. the top plate is slidingly equipped with a support plate. the adjustment mechanism is arranged on the support plate. Two sets of horizontal rails are symmetrically fixed on the support plate. Two sets of vertical rails are symmetrically slidingly mounted on the two sets of horizontal rails. One set of vertical rails corresponds to two sets of adjustment blocks. the two sets of adjustment blocks are symmetrically slidingly mounted on the vertical rails. the right-angle racks on adjacent adjustment blocks are slidingly mounted between each other. the right-angle racks are slidingly equipped with a cutting mechanism. the cutting mechanism, striking hammer, and control system are electrically connected.

The distinct features of this device compared to

existing technologies are:

(1) This device features a lifting mechanism, which moves the detection and adjustment mechanisms to wall tiles at varying heights. In coordination with the control system, it achieves a high level of automation and offers strong practicality.

(2) This device is equipped with a detection mechanism that utilizes an intermittent assembly to drive the hammer to strike the wall tiles intermittently, thereby enhancing work efficiency;

(3) the device invention is equipped with an adjustment mechanism, and a fixing mechanism assists in adjusting the position of the adjustment block, thereby changing the shape of the right-angle rack. This allows the motion trajectory of the cutting mechanism to adapt to the dimensions of the wall tiles, making it highly practical and widely applicable.

References

[1] Han Jiaxuan, Wang Xianfang. Research on Intelligent Manufacturing Defect Detection Platform Based on Machine Vision [J]. Modern Electronic Technology. 2023, 46(8).

[2] Mao Xiaoqiang, Peng Yi. Construction Quality Inspection Method for Repairing Collapse Walls of High-Rise Buildings under BIM Model Supervision [J]. Modern Electronic Technology. 2020, (16).

[3] Zhou Jianguo, Zhao Siqi1 Luo Haitao. Wall Surface Defect Detection Method Based on Image Measuring Robot [J]. Journal of Safety and Environment, Issue 11, 2023:3906-3913.

[4] Li Yue, Wang Ran, Yao Hongquan, et al. A Device and Method for Detecting Hollow Areas in Building Walls. Sichu. Zhonghe Airuite Engineering Testing Co., Ltd., China Nclear Industry 24 Construction Co., Ltd. National Patent CN202411899960.6, 2025-03-28.

[5] Zhang Shanshan, Li Kang, Qiao Xue. A Device for Detecting Hollow Areas in Building Walls, Hebei Wuchuang Construction Engineering Co., Ltd. Utility Model Application/Patent No.: CN202322208513.9, 2024-04-02.