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STUDY ON FAILURE MODE OF HUSK MORTAR ENERGY-SAVING WALLBOARDS

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This paper focuses on husk mortar wallboard, which is a new type of energy-saving composite wallboard with new materials and complex working mechanism. There are eight total different dimensioned panels tested. Six of them are openings (window or door), with different opening rates; the other two are full panels with same dimensions. Based on the experimental data, they are analyzed under both horizontal and vertical direction loading, combined with the finite element analysis to reveal the working characteristics. The finite element model of husk mortar energy-saving wallboards is established by ANSYS software. Finally, the finite element results are compared with the experimental results from three aspects: ultimate load, failure mode and load displacement curve, which verifies the correctness of the finite element model.

Keywords: Opening, Finite element analysis, Ultimate load.

1 INTRODUCTION

Husk mortar energy-saving wallboard is a new type of energy-saving composite wallboard with new materials and new type of structure, which brings excellently energy-saving performance, but also leads to complex working mechanism (Huang 2014, Zheng *et al*. 2011).

The main contents are as follows: first, the basic situation related to the new structure type are described in detail which are used to analyze the experimental data of this new type of wallboard, including number, size, constructing, opening rate, location of measuring points and loading type (Huang *et al*. 2013, 2014, Zhang *et al.* 2011).

Then, the finite element model of husk mortar energy-saving wallboards is established by ANSYS software and the finite element results are compared with the experimental results from three aspects: ultimate load, destroy mode and load displacement curve (Huang *et al*. 2015, Zhang *et al.* 2008, 2009, 2010a).

Finally, based on comparative analysis, the correctness of the finite element model was verified and revealed the working mechanism of husk mortar energy-saving wallboards (Zhang *et al.* 2010b).

2 EXPERIMENT

A total of eight pieces tested husk mortar composite wallboard, the eight wallboard is divided into two groups. The number of each group is a four, four wall panel in the husk mortar composite wallboard with different rates of opening and hole location. In the two groups of wallboard, corresponding wall plate size and location are the same open hole. The dimensions, in detail, are shown in Table 1.

Table 1. The dimensions of wallboards.

Group 1	Group 2	Configuration	Dimensions
1-1	2-1	Full	Whole panel: 3,300 mm × 2,800 mm × 250 mm
1-2	2-2	Window	Whole panel: 3,300 mm × 2,800 mm × 250 mm Window: 1,500 mm × 1,600 mm × 250 mm
1-3	2-3	Door	Whole panel: 2,400 mm × 2,800 mm × 250 mm Door: 900 mm × 2,100 mm × 250 mm
1-4	2-4	Window & Door	Whole panel: 3,300 mm × 2,800 mm × 250 mm Window: 1,500 mm × 1,600 mm × 250 mm Door: 900 mm × 2,100 mm × 250 mm

The main component of husk mortar composite wallboard has three, namely: the benzene board (instead of asbestos board) after layer, layer and the cavity surface. Benzene in horizontal and vertical reinforced rib platelayer, in order to form within reinforced rib, benzene plate internal layer of benzene plate was cut into many small pieces and leave a gap between each small piece. Between surface layer and benzene board filled with insulation mortar, adhesive and fixed role in order to achieve. Put a 10 mm diameter steel reinforced rib; Surface of husk mortar, setting up a steel fabric in the surface layer to reduce the cracks, the reinforcement of HPB235. Wall 1-1, for example, husk mortar composite wall body structure as shown in Figure 1.

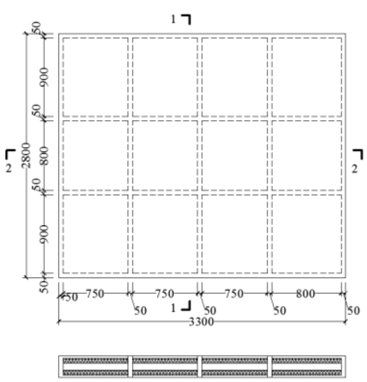


Figure 1. Construction and Size of husk mortar composite wallboard No. 1-1and 2-1.

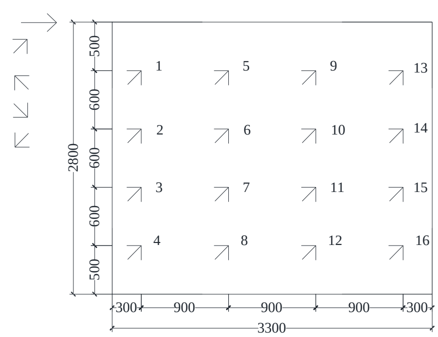


Figure 2. The number and location of measuring point of strain on No.1-1 and 2-1.

All wallboards are loaded by horizontal direction and vertical direction both in plane. The horizontal loading is forced step by step, and the vertical one is constant. The situation of loading in detailed is shown in Table 2.

Uniform distribution of measuring points on the whole wallboard, both sides have a point and location, each measuring point layout have rectangular strain rosette, number of observation points and positive strain gauge arrangement as shown in Figure 2. And the test results of creaking patterns are seen in Figure 3.

Table 2. The situation of loading.

No. of panels	Horizontal loading situation	Horizontal Loading per step (kN)	Constant vertical load (kN)
1-1	Hysteresis loading	5	5
1-2	Hysteresis loading	5	30
1-3	Unidirection loading	3	15
1-4	Unidirection loading	3	30
2-1	Unidirection loading	3	7
2-2	Unidirection loading	3	15
2-3	Unidirection loading	3	7
2-4	Unidirection loading	3	0

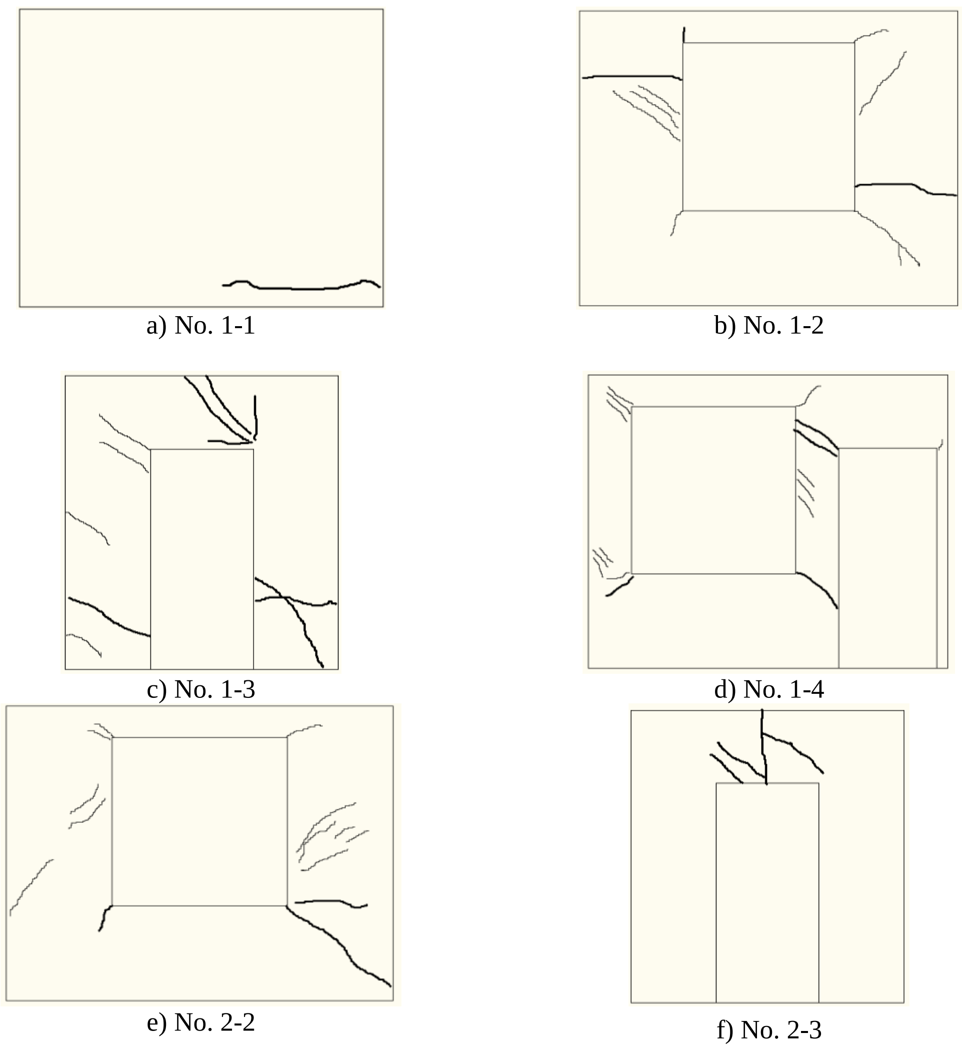


Figure 3. Cracking patterns of tests.

According to Figure 3, it can be found that cracks are mainly distributed in corners or weak parts, such as location of doors and windows, around the edge of opening. This result is consistent with our theoretical knowledge absolutely. Further, it demonstrates that the test is successful and experimental data are credible.

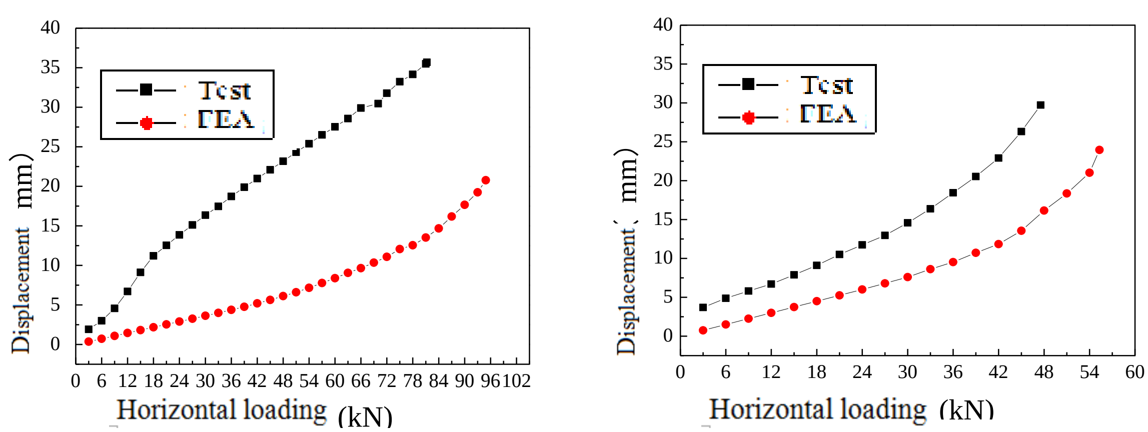
3 SIMULATION

Using finite element analysis (FEA) software ANSYS to establish the model of husk mortar composite wallboard, it carries on the force analysis. And then the finite element results are compared with the test results, to validate the reliability of the model.

Using ANSYS to simulate the analysis of the specific steps can be divided into the following steps: choose the unit type, define material properties, real constant definition unit, create the finite element model, mesh, define the structure boundary condition and load condition, specify the analysis type, and then set the output requirements, finally submitted to solve task computing, and data post-processing. In the FEA model, we choose the SOLID65 unit type. Lack of space forbids further discussion of other parameters at this point. Comparative results of ultimate load between test and FEA are shown in Table 3. And the load displacement curves by horizontal direction in plane are seen in Figure 4.

Table 3. Comparative ultimate load.

No. of panels	Ultimate load by test result (kN)	Ultimate load by finite element result (kN)
1-1	93.64	115.32
1-2	78.54	83.28
1-3	62.31	63.96
1-4	47.52	62.54
2-2	81.26	94.88
2-3	47.55	55.31
2-4	41.35	50.56



a) No. 2-2

b) No. 2-3

Figure 4. The load displacement curve.

Based on Table 3 and Figure 4, it can be found that simulation results are very close to the experimental results. We believe that this simulation can reflect the actual results. That is, the established FEA model can simulate and get the complex working mechanism of husk mortar energy-saving wallboard.

4 CONCLUSION

Structural state analysis theory and method is applied in this article, based on the experiment data of husk mortar composite wallboard stress analysis. Wallboard is established finally, using the ANSYS finite element model. Comparing the results between numerical simulation and actual test, it is verified that the FEA model can reveal wallboard stress characteristic, and working mechanism.

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