Experimental study on seismic behavior of cast in situ lightweight composite wall

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Abstract: Based on the cast-in-situ light composite insulation wall, through the experiment, analyze the natural frequency and the aseismatic performance of the wall. It is concluded that the natural frequencies of the wall before and after vibration test are 10.01Hz, which indicated the wall stiffness without damage, and always in the elastic state. According to the seismic response analysis can determine the wall is always in elastic state, and it is in accordance with the provisions of the code. The composite wall meets the requirements of earthquake resistance in 9 degree, which provides a theoretical basis for the maintenance of the wall.

Introduction

In order to implement the national energy-saving building wall materials innovation policy, promote the development of the construction industry, innovation and entrepreneurship training programs for college students in University of Science and Technology Liaoning has developed a new type of wall-cast-in-situ light composite insulation wall.

The wall is a kind of new energy-saving wall material[1].Its basic structure of the utility model is a light steel keel.Both sides covered with fiber cement flat formwork.The hollow part is poured into the new type of light and rigid by chemical foaming in tailings powder and other industrial wastes as the main raw material of insulation materials.The wall has the characteristics of light weight, high strength and environmental protection and energy saving, which can be used as a filling wall for frame structure [2].

For the non structural elements in the frame structure, the infill wall can consume the seismic energy [3], and reduce the influence of the earthquake on the main structure.Although it is not considered in the calculation of structural design, it is necessary to prevent the collapse caused by the inertia force caused by the earthquake.At home and abroad, it is concluded that the plane failure of the infill wall will not collapse, but the collapse of the wall is easy to collapse, the risk and the loss caused by it are much larger than that in the plane [4-5].The filler wall collapse of frame structure under earthquake action is one of the main failure modes, and cast out of plane seismic performance of cast-in-situ light composite insulation wall is unclear , so it is necessary to study the seismic performance of the plane.

In this paper, the seismic performance of cast in situ metal tailings concrete composite wall is studied by means of simulating shaking table test.

Text design

The H steel is assembled into a steel frame, and the bottom of the frame is provided with eight bolt holes,which is connected with the shaking table by bolt.The base frame size is 1.8m x 1.8m, the framework of high 2.81M; the test of the 1 dimensions of 1.2m x 2.4m wall, the wall thickness of 200mm.

Symmetrical layout of the two sides of the wall specimen model axonometric drawing shown in Figure 1.The cast in place metal tailings concrete composite wall is composed of a sandwich plate, which is composed of a light steel keel, a panel (fiber cement plate) and an inner cavity filler (metal tailings concrete).The internal wall of light steel keel is composed of two channel columns with batten plate bolted splicing, the top and bottom wall keel layout and frame beam is connected with high strength bolt.The position and direction of the keel in the wall are shown in Figure 2, and all the two light gauge steel inside the wall are of the same size.

The experiment was carried out on the shaking table of the earthquake resistant Laboratory of Dalian University of Technology, and the steel frame was fixed on the shaking table through the bolt through the reserved hole.

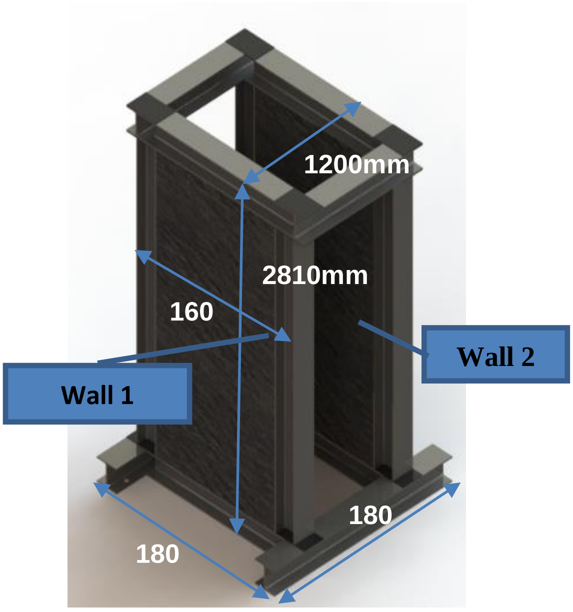


Fig. 1 model of the test specimen

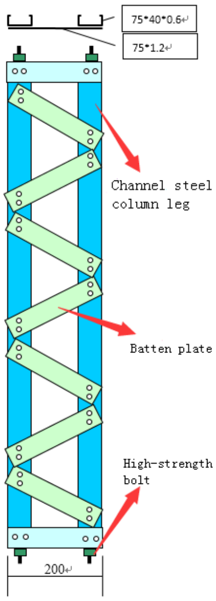


Figure 2 light steel keel

Test use acceleration sensor acceleration response measurement, using Optotrak Certus HD (synchronous dynamic three-dimensional displacement test system) displacement response measurement, selection of strain gauge on the keel strain in different parts of the response measurement.

(1) acceleration sensor placement

The test used piezoelectric acceleration sensor to measure and test two acceleration sensors arranged on the vibration table, the arrangement of 3 acceleration sensors in each wall, are located in the wall of the bottom, middle and top, in an acceleration sensor is arranged at the top of the frame beam, the arrangement of two accelerometer on vibration table; the acceleration sensor are arranged at the outer wall of the specimen.

(2) displacement sensor placement

Using Optotrak Certus HD test (synchronous dynamic three-dimensional displacement testing system) for measuring displacement of different positions on the 1 wall, in the wall surface through the specified location layout Mark (induction device), acquisition system using the Mark signal of the camera to capture the displacement of Mark position recorded in the test collection equipment and response. The wall mark (displacement sensing device) layout as shown in figure 3.

The test for incentive direction 90 degree (perpendicular to the wall direction, perpendicular to the No. 1) with the outside of the wall to encourage positive direction, as shown in figure 4. The actual test model without a corresponding, unable to determine the related and the actual structure of earthquake intensity, site conditions and so on. Therefore, selecting seismic records when should consider the differences of different site conditions.

The seismic wave selected for this test is El Centro wave, and the related parameters are shown in Table 1.

Table 1 seismic records and related parameters

Seismic record	Direction	Duration time（s）	Step size（s）	Type of site soil
El centro wave	E-W	53.6	0.02	Ⅲ

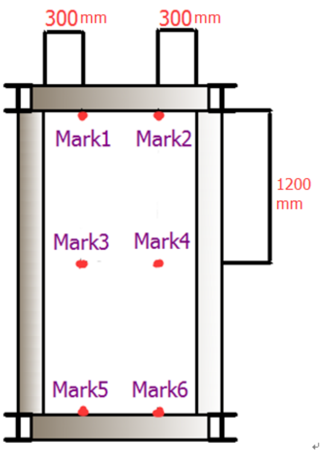


Fig. 3 arrangement of displacement sensors

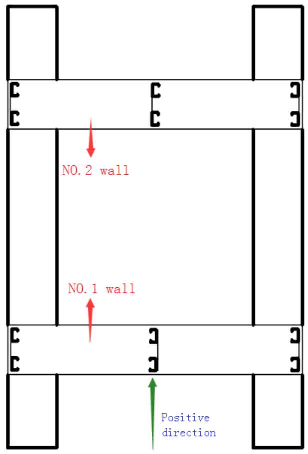


Fig. 4 excitation direction

The acceleration time history curve and the corresponding fourier spectrum of each seismic record are shown in the following figure 5 (the peak value of the acceleration time history curve is 1.0g).

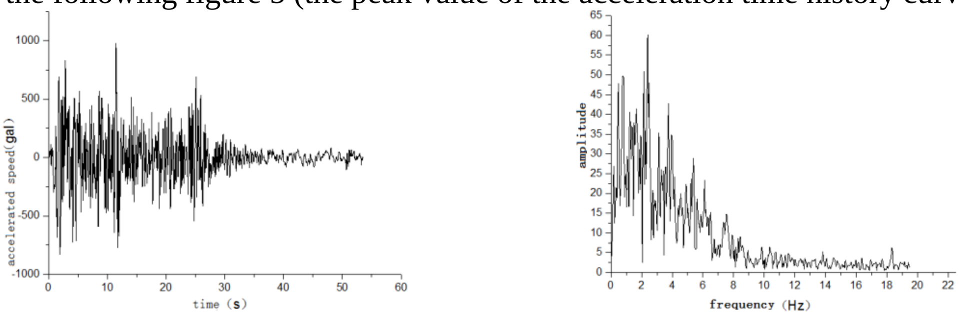


Figure 5 El Centro time history curve and Fourier spectrum

Experimental results

self vibration frequency analysis

In order to monitor the rigidity of the wall is damaged with seismic loading process, analyze the natural frequency on the wall, the variation of natural frequencies and determining whether the wall stiffness damage test. Through seismic records each working load after the wide spectrum of random wave swept by the wall vibration frequency.

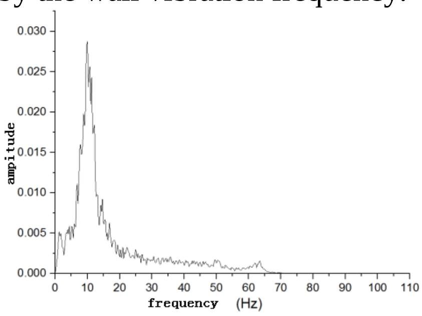


Fig. 6 the first sweep effect of random wave

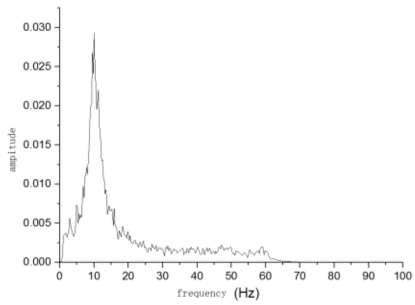


Fig. 7 the first sweep effect of Qian'an wave action

Before the earthquake records, the first wide spectrum random wave sweep frequency is measured on the wall, and the natural vibration frequency of the 1 wall is measured to be 10.01Hz, and the result of the sweep of the wall of the 1 is shown in figure 6.When the El Centro peak acceleration is loaded to 0.45g, the frequency spectrum of the two pieces of the wall is measured by. The results show that the natural vibration frequency of the 1 pieces of the wall is 10.01Hz, which is shown in figure 7.

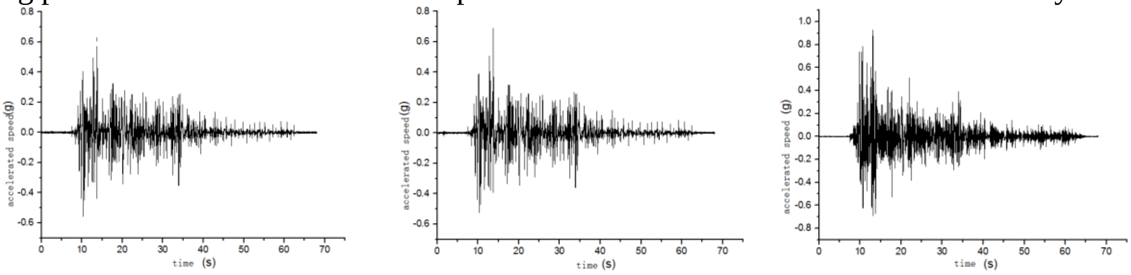
The wall in the shaking test before the vibration frequency is 10.01Hz, the El Centro wave after loading wall vibration frequency is 10.01Hz. from the analysis, the wall in seismic records after loading frequency did not change, that the rigidity of the wall without damage, the wall is still in good condition, in the elastic state.

wall seismic performance analysis

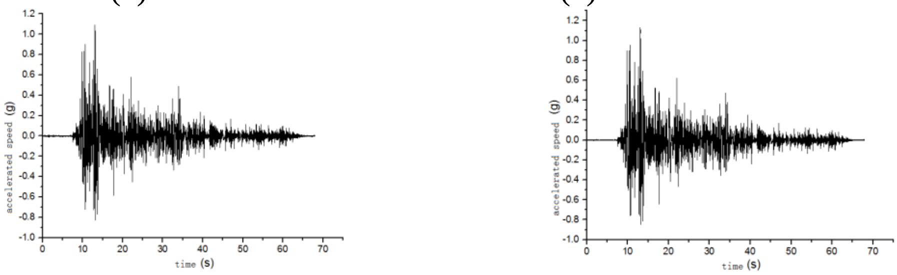
The earthquake induced ground motion, load of the building itself is random, the records of seismic performance analysis according to the construction site, the seismic acceleration as the loading selection III site (El Centro earthquake records) were analyzed.

In simulation, the III site seismic record El Centro wave. The initial velocity and acceleration are zero, along the E-W direction of input earthquake acceleration records. Parts of the wall under the loading response analysis of acceleration, displacement response of each part of the wall, the wall keel parts of strain and verification of masonry wall the displacement angle is consistent with the requirements of.El Centro wave loading, increasing peak acceleration gradually from 0.1g to 0.45g.

Along with X, Y in the role of the El Centro wave, the acceleration of the various parts of the wall with the change of time and the corresponding changes, figure 8 gives the number of walls in the 0.45g peak acceleration of the various parts of the wall of the acceleration time history curve.



(1) the curve of the table (2) the curve of bottom of the wall (3) the curve of middle of the wall

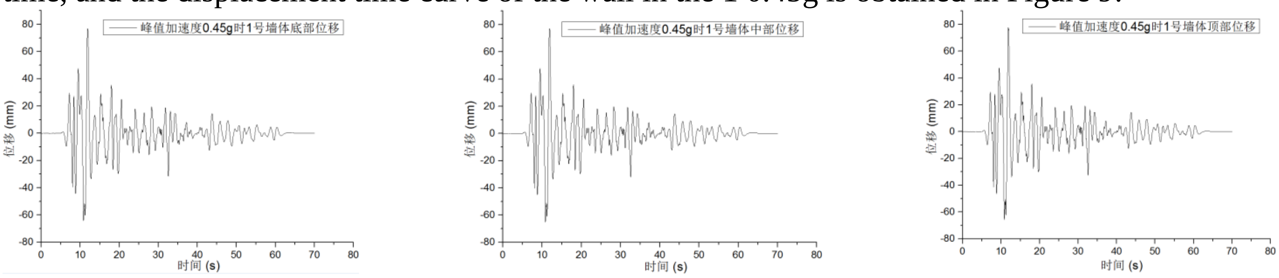


(4) the curve of top of the wall (5) the curve of top frame beam

Fig. 8 the acceleration time history curve of the wall of 0.6g in Qian'an under the action of

Through the analysis of figure 8 shows that in the earthquake, the maximum acceleration occurs at the top of the wall, the middle position of the corresponding value decreases, the minimum value occurred in the bottom wall, consistent from top to bottom, attenuation trend, and the trend is more obvious. The visible composite wall great response in seismic wave under the action, but still keep stable vibration state, less damage.

Under the action of the El Centro wave, the displacement of each part of the wall changes with time, and the displacement time curve of the wall in the 1 0.45g is obtained in Figure 9.



(1) the curve of bottom of the wall (2) the curve of middle of the wall (3)the curve of top of the wall

Figure 9 the wall No. 1 peak value of displacement of each part under the action of El Centro wave

Table 2 gives the comparison between the displacement and the story drift angle of the seismic fortification intensity of the wall and the limit of the code.

Table 2 Comparison between the displacement angle and the standard limit

Fortification intensity	Displacement between the layers （mm）	Interlayer displacement angle	Specification limits
more than 8 degrees in	0.558	1/4301	1/550
7 degrees rarely met	1.113	1/2156	1/50
8 degrees of shock	1.506	1/1594	1/50
7 dregees rarely met（0.15g）	1.857	1/1292	1/50
8 degrees rarely met	1.918	1/1251	1/50
9 degrees of shock	2.005	1/1197	1/50
8 degrees rarely met（0.30g）	0.558	1/4301	1/550
9 egrees rarely met	1.113	1/2156	1/50

El Centro wave peak acceleration by 0.1g loaded into the 0.45g process, the wall without any change. In the loading process of wall surface without cracks, wall edge daub off, specifically in Figure 10.

Figure 10 clay shedding locations and details of map

conclusions

In this paper, on the basis of the experimental report of JK1601, the seismic performance of the cast-in-place lightweight composite thermal insulation wall is simulated by the seismic shaking table of Dalian University of Technology.

(1)through the analysis of the natural frequency, the natural vibration frequency of the wall before and after the vibration test is 10.01Hz, which shows that the stiffness of the wall is not damaged, and the wall is in good condition.

(2)the position of peak acceleration and wall acceleration amplification coefficient increases with the acceleration increasing, each part of the wall with the increase of relative displacement and acceleration increased linearly, the wall has been described in elastic state.

(3)the maximum inter story displacement is 2.005mm, the inter story drift angle is 1/11977, and the inter story displacement angle is less than the limit value of 1/50, which is in accordance with the requirements of seismic fortification of 9 degrees.

(4)through the seismic response analysis, we can fully understand the seismic performance of the wall, and provide a theoretical basis for the maintenance of the wall.

Acknowledgements

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