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STUDY OF SOUND INSULATION PROPERTIES OF CONCRETE HOLLOW BRICK WALL

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Abstract

In this paper, sound isolation properties of concrete hollow brick wall were studied through the experimental research and theoretical analysis. The results of experimental research showed that sound isolation properties of common concrete hollow brick wall completely reach the level as excellent as that of clay solid brick wall. The results of experiments and analysis can be references for designers and researchers

Key Words

Concrete hollow brick, sound isolation properties, experimental research

1 Introduction

Based on the wide application of concrete hollow block and large quantity experiences from practical engineering, concrete hollow brick was developed as a new wall material. In a sense, it is a a small concrete hollow block which has the properties of clay solid brick. The raw material and production process of concrete hollow brick are similar to that of small concrete hollow block. And Its dimension of concrete hollow brick is same to the clay cellular brick and clay hollow brick that applied in present, coinciding with the standard of unified module. Its dominant dimension is 240x115x90mm with 3.8~4.4kg in weight, 1680~1780kg/m^3 in average density. The layout of its holes is double rows with six holes and the spread grout surface is a blind holes. Namely, there are six holes in one surface and the other is plane. The shape of the holes is rectangle and half-rounds are adopted to transit at the return corners. The holes of upside and that of underside are staggered and the total void ratio approximates 30 percent. As a new wall material , its sound isolation properties are worthy to be studied.

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2 Experimental research of concrete hollow brick wall's sound isolation properties

The sound isolation index of concrete hollow brick wall was determined by measureing its sound transmission loss in this experiment. Consequently, its sound isolation properties were evaluated and determined. Sound isolation trials of a series of common concrete hollow bricks and ceramisite concrete hollow bricks were tested respectively. The present tests were carried out at the No.7 mansion in Changsha University of Science & Technology.

The tests were based upon the following norms: ISO140-78III, SO140-78IV, ISO140-78V, ISO/R717, GBJ75-84, GBJ121-88 and GBJ118-88.

Two masonry members whose areas are 10m^2 were constructed (with normal masonry work and moderate skilled workers) between the sound source room and receiving station. Member 1 is a common concrete hollow brick wall whose thickness is 240mm and 8mm thickness mortar was plastered on its double surfaces. And its planar density of the wall is 386kg/m^2; Member 2 is a ceramisite concrete hollow brick wall whose thickness is 115mm and no mortar for coating on it's any surface (fair-faced wall) planar density of the wall is 130 kg/m^2.

The standard sound source was mounted in the sound source room, at the same time, the quantity of noise attention was tested at the two sides of the partition wall (see Figure 1).

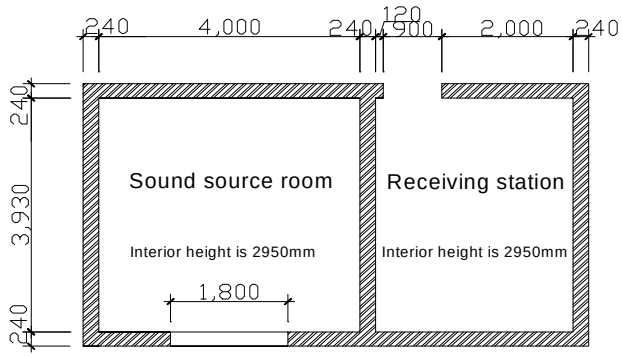

Figure 1. Plane figure of testing the sound isolation properties

The test proceeded according to the provision of "Code for sound isolation survey of building" (GBJ75-84).

The range of sound isolation surveying in this test is 125~400 H_Z. The results of this test were obtained (see Table 1 and Table 2).

Table 1 The frequencies sound isolation properties of member 1 (dB)

Place	Frequency (H_Z)						R_r
	125	250	500	1000	2000	4000	
Sound source room L_{r1}	79.5	75	78.3	82	80	79	79
Receiving station L_{r2}	40	35	28.5	27	24.5	19	29
Sound transmission loss L_{RI}-L_{R2}	39.5	40	49.8	55	55.5	60	50

Table 2 The frequencies sound isolation properties of member 2 (dB)

Place	Frequency (H_Z)						R_r
	125	250	500	1000	2000	4000	
Sound source room L_{r1}	78.5	75	75.5	78.8	82.3	79.3	79.1
Receiving station L_{r2}	54.5	35	50.5	49.3	46.8	41	47.4
Sound transmission loss L_{RI}-L_{R2}	39.5	24	25	29.5	35.5	38.3	31.7

3 Theory study of the sound isolation properties of concrete hollow brick wall

The properties that sound energy is decreased in the course of transmission are named sound isolation properties that are judged from the sound isolation index. It is an index that was determined by International Organization for Standardization (ISO) whom used the method of single count evaluation in allusion to the sound isolation properties of the air in space enclosing structure, which is expressed with decibel (dB). The sound isolation properties are better with the index increasing. On the contrary, if the index is smaller, the sound isolation properties are worse.

In view of environment protection, the problem of sound isolation becomes more and more important. Dead weight of the material ofen be thought a lot in the first instance and be used as a data index to judge the sound isolation properties sketchily. In fact, it is not sufficient without nothing but this index because the sound isolation properties of light and porous building materials are not always debase with the decrease of deadweight on the same level. According to the theory of sound isolation, the sound transmission loss is determined by the planar density of the wall within a certain frequency range to the monolayer and isotropic wall. On an average, its sound transmission loss increases with the planar density. It is 54dB that sound transmission loss of the clay solid brick wall whose thickness is 240mm and 20mm thick mortar was plastered on its double surfaces and its planar density is 580kg/m2, (see Figure 2). In consequence, it can be used in various buildings. Moreover, the clay solid brick walls of 240mm thickness were used widely as the partition walls of the special architectures (for example, the studio, recording chamber and so on) that require high level in respect of sound isolation.

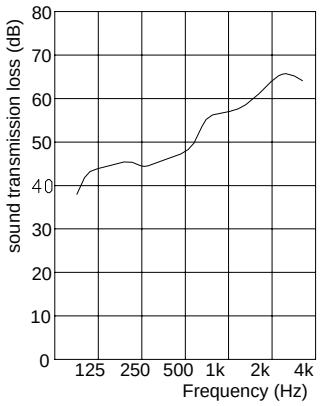

Figure 2 Sound transmission loss of clay solid brick wall whose thickness is 240mm

The locals of the concrete hollow brick walls where have holes amount to double-layer walls or multi-layer walls. Nevertheless, there are not real double-layer walls or multi-layer walls because of the ribs. According to the theory of sound isolation of double-layer walls, when the acoustic wave penetrate to the first layer of the double-layer walls the walls start to shake like films. At the sane time, the acoustic wavesare spread to air-layer and the vibration attenuates due to the elastic role of the air-layer. Then the acoustic waves were spread to the next layer and were functioned by the sound isolation of the second layer wall which make the sound transmission loss of the double-layer walls is larger compared to the monolayer wall with the same planar density. So the way that double-layer walls are adopted is not only economic but also excellent. For example, the tow brick wall's planar density is 960kg/m^2 and its sound transmission loss is 58dB. The planar density of the double-layer half brick wall whose air-layer's thickness is 100mm and their bases are departed is only 480 kg/m^2. The walls' weight is reduced to 50 percent of the two brick wall, but its average sound

transmission loss is enhanced to 64dB.
However, the double-layer walls' panels and the air-layer that between them form a resonance system. At the resonance frequency where its sound transmission loss is smaller than that of the monolayer wall. When the resonance frequency within the range of the sound isolation frequencies, there will cause disadvantageous effect. The sound transmission loss won't increase obviously or will even decrease when it is evaluated by weighted sound transmission loss. There are two rows holes in the concrete hollow brick. When the bricks are constructed to walls, there will be three or four rows holes in the walls, and the walls will be multi-layer walls whose planar density is somewhat greater than the concrete hollow block's and occurs stagger holes, which make the course of sound isolation very complicated so as to the sound transmission loss of the walls increased enormously.

4 Analysis of the concrete hollow brick wall's sound isolation properties test

Member 1 is a common concrete hollow brick wall whose thickness is 240mm and the thickness of the plaster layer on its duble surfaces is only 8mm because of the outline dimension of the brick is regular. If the thickness of the plaster layer is changed to 20mm, the sound transmission loss will reach 53dB which amount to that of the clay brick wall. From the preceding theory analysis, several conclusions can be gained, the planar density of the common concrete hollow brick wall (the thickness of the plaster layer that on its every surface is 8mm) is 386kg/m^2 and that of the clay solid brick wall (the thickness of the plaster layer that on its every surface is 20mm) is 580kg/m^2 , In terms of the planar density, the former is only 67 percent of the latter but the former's sound transmission loss reaches 92.5 percent of the latter'. This is related to the construction of the brick with double rows stagger holes. From Table1 and Table 2, another conclusion can be gained also that the sound transmission loss of the brick is great in despite of the frequency of the acoustic wave is low, in which the excellent sound isolation properties were demonstrated.
The results of test demonstrated that the sound isolation grade of the common concrete hollow brick wall (the thickness of the plaster layer that on its every surface is 10mm) reaches the primary grade and fulfils various requirement of architectural sound isolation completely.
Member 2 is the ceramisite concrete hollow brick fair-faced wall whose thickness is 115mm. If 20mm thickness mortar was plastered on its double surfaces, the sound transmission loss will reach 42dB, but its planar density is only 130kg/m^2 . The results of the test are related to the holes in the mortar joint in the fair-faced wall.
The results of the test showed that the sound isolation grade of the ceramisite concrete hollow brick wall (the thickness of the plaster layer that on its every surface is 10mm) reaches the third grade and it will reach the second grade if the thickness of the plaster layer is changed to 20mm.

5 Conclusion

(1) As the substitute of clay solid brick, Concrete hollow brick has not only excellent mechanical property but also excellent sound isolation properties becanse of the rational design of its hole shap.
(2) The sound isolation properties of common concrete hollow brick can reach the level of the clay solid brick completely and its sound isolation grade reaches the primary grade, which fulfil various requirement of architectural sound isolation.
(3) The sound isolation properties of the ceramisite concrete hollowbrick wall are somewhat worse compared with that of the common concrete hollow brick wall. The sound isolation grade of the wall whose thickness is 120mm doesn't reach the third

grade. So the valid measure must be taken on when it is applied to the practical engineering. But that of the wall whose thickness is 240mm (the thickness of the plaster layer that on its every surface is 20mm) reach the second or third grade that fulfils the sound isolation requirement of common civil architecture completely.

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