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Sound Insulation Performances of a Log-House and a Reinforced Concrete House (II)[†,*1]

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ログハウス及び鉄筋コンクリートハウスの遮音性能について（第2報）[†,*1]

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本研究は，ログハウスと木質材料を内装したRCハウスの遮音度及び環境騒音を検討した。遮音度及び騒音レベルの測定はそれぞれJIS A 1417とJIS Z 8731に準じた。測定には，帯域雑音発生器，増幅器，スピーカー，騒音計，オクターブ分析器を用いた。ログハウスの遮音度は，500 Hzで比較するとドア（23 dB），壁（17 dB），窓（15 dB），RC-ハウスでは，ドア（16 dB），壁（15 dB），窓（13 dB）の順で小さくなる。RC-ハウスを木質材料で内装すると，三者の500 Hzにおける遮音度は19 dB迄上昇した。木製机，椅子を設置すると，ログハウスの室内の等騒音レベルは1～2 dBまで低減した。

The purpose of this study was to compare the sound insulation and environmental noise of a log-house with those of a reinforced concrete (RC) house finished with wood-based materials. Measurements of sound pressure level differences were made using the outer sound source method in accordance with JIS (Japan Industrial Standard) A 1417. The noise level was measured as described in JIS Z 8731. The sound level analyzer consisted of a random noise generator (RION SF-05), a power amplifier, a speaker (RION SS-02), a sound level meter, and an octave band analyzer (RION NA-29). On the basis of a 500 Hz frequency, the order of sound pressure level differences in a log-house was: door (23 dB) > walls (17 dB) > window (15 dB). The order in a RC house was: walls (16 dB) > door (15 dB) > window (13 dB). After being finished with wood-based materials, the sound pressure level difference of the RC house increased to 19 dB. After the placement of wooden desks and chairs in the log-house, a decrease in the indoor space the equivalent continuous sound level (L_{Aeq}) of about 1-2 dB was obtained.

Keywords: sound insulation, sound pressure difference, log-house, reinforced concrete house.

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1. INTRODUCTION

Enviromental noise has a great influence on human life. Therefore, how to improve the living space and decrease the noise pollution are important to our quality of living.[1-3] The wood and wood-based materials used in a building play a very important role for the acoustic property.[4-7] The purpose of this study was to compare the property of sound insulation between a log-house and a reinforced concrete (RC) house.[8] Furthermore, the improved efficiencies of the wood-based materials that were used in the buildings, such as panels, floors, and ceilings, also were investigated.

The log-house prevails in Taiwan. On the object of testing and analysis, only the measurements of the air borne sounds were considered. The methods for expressing the properties of sound insulation include (1) the sound transmission loss (TL), and (2) the sound pressure level difference (D). That is, the first is used in acoustic experiment rooms to measure the properties of sound transmissions of wall boards or materials, and the second always is used to evaluate the properties of sound insulations of wall parts of buildings.

2. EXPERIMENTAL PROCEDURE

2.1 Tested-houses

The tested-houses were a yellow pine (*Pinus* sp.) log-house and a RC house as shown in Fig. 1. Note that their sizes, volumes, and directions are the same. These houses were built on the balcony of the Forestry Building (Dept. of Forestry, National Chung-Hsing University, Taichung, Taiwan). The area of each house was very small, about 18 square meters 328 cm (W)*1 × 550 cm (L)*1. The RC house was furnished with China fir (*Cunninghamia lanceolata* (Lamb.) Hook.) panels (9 cm (W) × 1.8 cm (T)*1), a red oak (*Quercus* sp.) floor (1.5 cm (T)), and an insulation board ceiling (30 cm (L) × 30 cm (W)). The mean sound pressure level differences of the walls, window, and door in the RC house were measured. Six wooden desks and 12 chairs were placed in the log-house as shown in Fig. 2, to evaluate their effects.

2.2 Testing methods

The testing methods were according to JIS (Japan Industrial Standard) A 1417-1974, Method for Field Measurement of Sound Pressure Level Difference and JIS Z 8731-1966, Methods for Measurement of Sound Level. Neither the log-house nor the RC house had any conjoint wall. Therefore, the outer sound source method (Fig. 3) was used. During the experiment, the

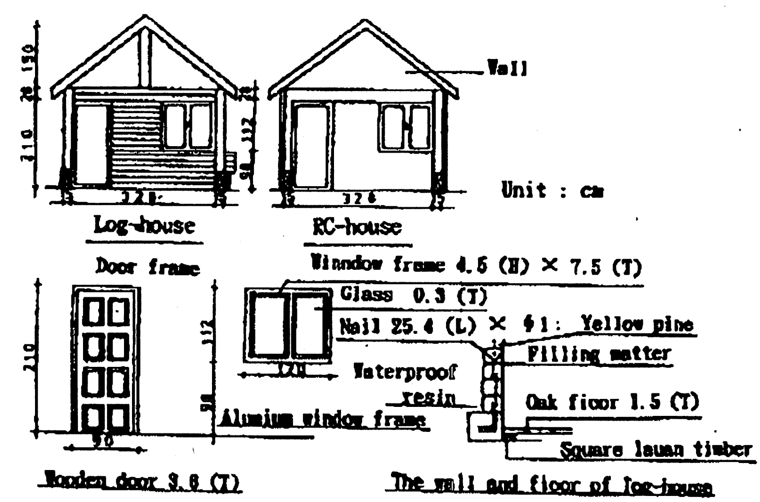

Fig. 1. Elevation view of tested houses and the structures of doors and windows.

*1 W : Width, T : Thickness, L : Length, H : Height.

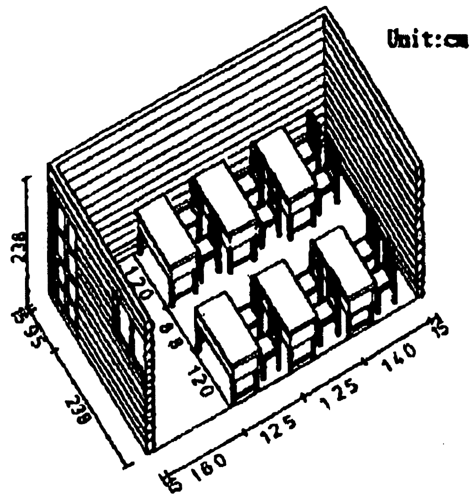

Fig. 2. The pictorial drawing of wooden desks and chairs in the testing log-house.

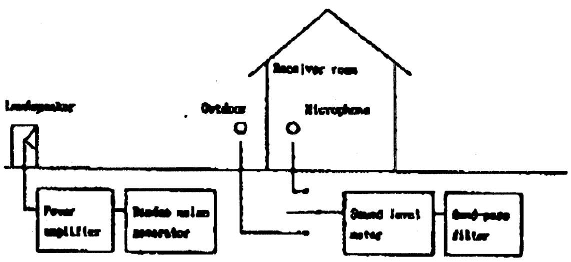

Fig. 3. Instrumentation equipment for the outer sound source method.

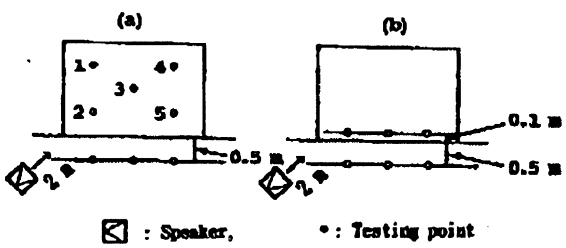

Fig. 4. The measurement points of the outer sound source method; (a) wall and room, (b) internal wall and outer wall.

instrument system consisted of a sound level meter octave band analyzer (RION NA-29), a random noise generator (RION SF-05), and a speaker (RION SS-02). The processes of testing were as follows: (1) five testing points were set in the room, on the door, a window, and a wall as shown in Fig. 4; (2) speaker was set at the corner of tested-house at an optical angle of 45° and a distance of 2 meters; (3) microphone was 1.2 to 1.5 meters in height, and 0.5 meter away from the wall; (4) measurements were taken in the order of testing point 1, 2, 3, 4, 5. The center frequency of the octave band measured was 125, 250, 500, 1,000, 2,000, and 4,000 Hz. The reading time for each frequency was one minute. (5) the frequency weighting network was A-weighting; (6) formulations applied in the mean sound pressure level difference followed JIS A 1417.

The improvement effects of setting wooden desks and chairs in the log house were measured by the L_{Aeq} difference. The environmental noise level was determined by the preferred noise criteria (PNC) method.

3. RESULTS AND DISCUSSION

3.1 The sound pressure level differences of the tested-houses

The log-house had greater sound pressure level differences on the door and window, but the sound pressure level differences on the walls of the log-house and the RC house were nearly the same. On the basis of a 500 Hz frequency, the order of sound pressure level differences in the log-house was: door (23 dB) > walls (17 dB) > window (15 dB). The order in the RC house was: walls (16 dB) > door (15 dB) > window (13 dB) as shown in Figs. 5, 6, and 7. The center frequencies of the octave bands measured were 125, 250, 500, 1,000, 2,000, and 4,000 Hz, and were expressed in logarithmic values in this study.

The results showed that the sound pressure level differences of the door, window, and walls of the log-house were better than those of the RC house; the main reason may be the greater absorption power of the inner surfaces of the log-house. The diversity of sound pressure level differences of the doors between the log-house and the RC house were greater than those of the windows and walls because the construction leakage defects of the walls and door of the log-house would cause inferior air tightness on the one hand[9] and on the other hand, the wave-like and rough wall surfaces would lead to an increase of the total wall area.

3.2 The sound pressure level difference of the RC house which had been finished with wood based materials

The sound pressure level differences of the RC house that had been finished with wood-based mate-

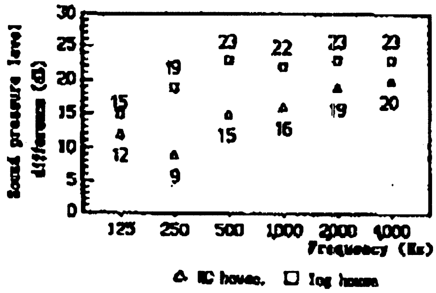

Fig. 5. The sound pressure level differences of doors of the tested houses.

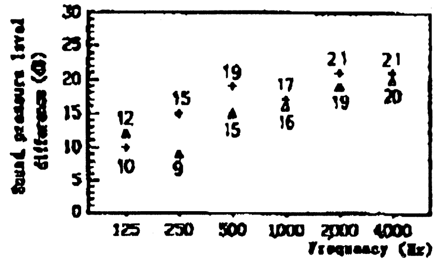

Fig. 8. The sound pressure level differences of the door of the RC house (after finishing with wood-based materials).

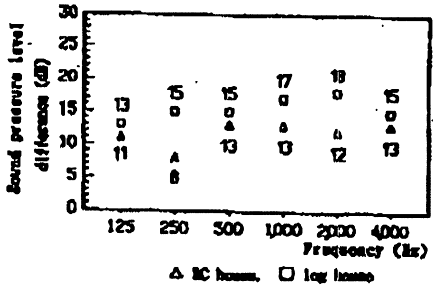

Fig. 6. The sound pressure level differences of windows of the tested houses.

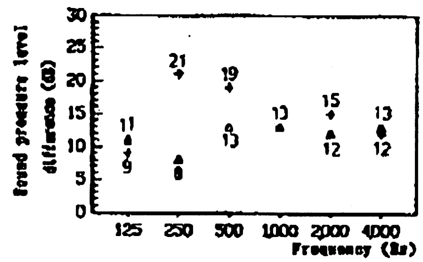

Fig. 9. The sound pressure level differences of the window of the RC houses (after finishing with wood-based materials).

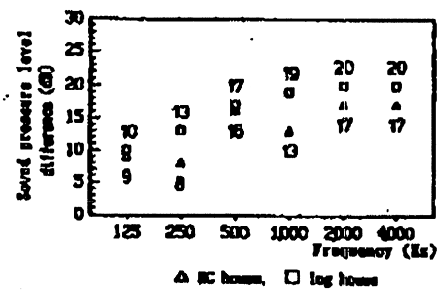

Fig. 7. The sound pressure level differences of walls of the tested houses.

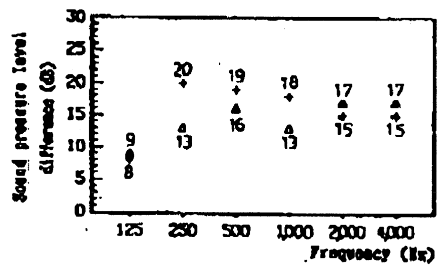

Fig. 10. The sound pressure level differences of the walls of the RC house (after finishing with wood-based materials).

rials increased from 16 to 19 dB for walls, from 15 to 19 dB for the door, and from 13 to 19 dB for the window, as shown in Figs. 8, 9, and 10.

The absorption power of the RC house was improved after being finished with wood-based materials. It seems that the effects are the most obvious at 250 and 500 Hz.

3.3 The improved effects of the log-house which had been furnished with wooden desks and chairs

The L_{Aeq} difference decreased 1-2 dB in the indoor space of the log-house when it had been furnished with wooden desks (6 pieces) and chairs (12 pieces) as shown in Fig. 11. The acoustics of the room were improved with this furniture due to the damping of the sound waves in the room, resulting in a smaller

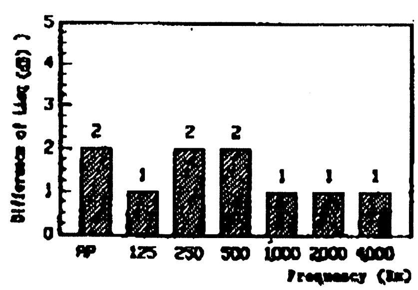

Fig. 11. The L_{Aeq} difference after furnishing wooden desks and chairs to the log-house.

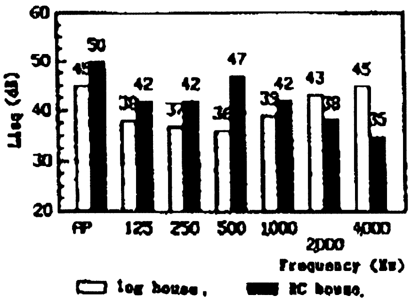

Fig. 12. The environmental noise levels of the log house and the RC house (after finishing with wood-based materials) (1 KHz, 24 hr.).

L_{Aeq}.

3.4 The preferred noise criteria (PNC) of the tested-houses

The environmental noise levels (1 kHz, 24 hr) were 39 dB in log-house, and 42 dB in the finished RC house. The environmental noise levels in both house were of medium qualities as shown in Fig. 12.

4. CONCLUSIONS

(1) The log-house had greater sound pressure level differences for the door and window, where as the sound pressure level difference of the walls of both the log-house and the RC house were nearly the same.

(2) On the basis of a 500 Hz frequency, the order of sound pressure level differences in the log-house was: door (23 dB) > wall (17 dB) > window (15 dB). The order in the RC house was: walls (16 dB) > door (15 dB) > window (13 dB).

(3) The effects of wood-based materials that had been used in the RC house were obvious. The sound pressure level differences had been increased from 16 to 19 dB for walls, from 15 to 19 dB for the door, and from 13 to 19 dB for the window.

(4) After the placement of the wooden desks and chairs in the log-house, a decrease in the indoor space L_{Aeq} of about 1-2 dB was obtained.

(5) The environmental noise level (1 kHz, 24 hr) was 39 dB in the log-house, and 42 dB in the finished RC house.

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