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Earthen Walls Authoritative in Sound Transmission Loss at Residential Unites

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Abstract: The conventional walls are not so effective in sound reduction. Earthenware with the benefits of lightness and its cavitations might be more effective in sound transmission lose. The assessment of the effect of earthenware on sound transmission reduction is the aim of this study. This experimental study was carried out by using an academic sound detector (model: TMS 0302-xx), different sounds generation in the actual field. Sound measurement was taking place. The obtained data revealed the sound transmission lose rate is diminishing within the decreasing of sound severity higher than 60 dB, whereas, it meet an increasing in transmission lose with dropping down sound severity bellow 60 dB. Difference between these two range were significance (P-value<0.05). The study is concluded that the earthen walls barrier using in residential and others spaces could be appreciated for residential relaxation against sound nuisance. It has been suggested that in order to identify the role of cavitations in sound transmission lose, an experimental research with different size, shape focusing on the empty spaces of this material take place. The authors express the best attitude to departments of environmental and occupational health of the Public Health School of Kermanshah University of Medical Sciences, due to their supporting of this student project.

Key words: Earthen · Noise transmission loss (NTL) · Leq and Lpt

INTRODUCTION

Sound is among physical pathogens creating many problems for industry and factory employees added to disrupting mental solace of residents in neighboring apartments and destroying their peace and tranquility [1].

Nowadays, since development of residential and institutional constructions as apartments and residential complexes has created different forms of common walls with the neighbors and sound transmission between units, it seems necessary to take some serious measures for minimizing transmitted sound level separating wall between units. That is, the level of sound transmission is to be reduced by using proper building materials so as to free residents of units of annoyance caused by loud noises. In this regard, Department of Housing and Urban Development developed different laws and regulations and always seeks to do research grounded on sound absorption coefficient of building materials and their level of sound transmission aimed at devising materials of high sound absorption coefficient with lessened sound transmission level [2].

In accordance to article 18 of this department sound insulation of walls, doors, windows and other passages of sound is one of the regulations that require consideration. Thus, building and apartment constructors as well as contractors are required to follow it and they should use materials that reduce sound transmission to a high degree

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so that audio sources do not annoy and disturb other units' residence [3]. Ceramic is among building materials widely used due to having embedded holes that damps sound energy and reduces the level of sound transmission. Therefore, it not only is a sound insulator but also plays a critical role to control environment temperature [4]. The current project aims at determining sound transmission level (i.e. the level of sound transmission loss) of ceramic laid in walls separating residential units.

MATERIALS AND METHODS

In this experimental study, using sound generating instruments, we produced similar sound with various levels of pressure in a unit (sound source) so that measures changes of sound pressure over time was less 5 dB. As long as the source were making sound, the sound pressure level in the neighboring unit, (experimental unit) separated from source unit with ceramic wall, was being measured constantly. With regard to the obtained level of sound pressure of these two units, average and total level of sound pressure were also calculated.

The length, width and height of the source and testing units were 3×5×8, respectively. There was no sound generating source in the testing unit. The two units were totally the same separated just by one ceramic wall with 3x5 dimensions. Thickness of the ceramic wall was equal to 15 cm with mud plaster cover at both sides (testing unit in one side and control unit on the other side). On the surface, it was coated with a thin layer of plaster having 21.7 overall thickness.

A Sound Level meter (SLM) (CEL-450-B2) was used to measure sound pressure of both units at network A, low-state and total level. Before use, SLM was calibrated with CEL 110/1 at a frequency of 100 Hz and 114/5 dB. Sound-generating sources were placed at a hall while in the neighboring unit (test unit) there were no such sources and the two units were in complete silence during the measurement in order to avoid interfering conversation factors. Both halls were divided to forty 1x1 m^2 stations at the center of which the instrument was reset every 5 second. In order to measure high level pressures, some of the sound-generating sources turned on once in a while. Using different sound generating sources, we first measured sound pressure level of each station, average and total pressure. Then, we compared them to obtain sound transmission loss. In doing so, TMS 0302-xx method is applied and the following equations are used [1, 2, 5, 6].

$$lp_T(dB) = 10\log\left[\sum_{i=1}^{n} 10^{\frac{lpi}{10}}\right]$$

$$\overline{lp}(dB) = 10\log\left[\frac{1}{n}\sum_{i=1}^{n} 10^{\frac{lpi}{10}}\right]$$

$$NR(dB) = spl_1 - spl_2$$

The analysis of variance (ANOVA) was developed along with Tukey post-hoc test and regression method to analyze the obtained data.

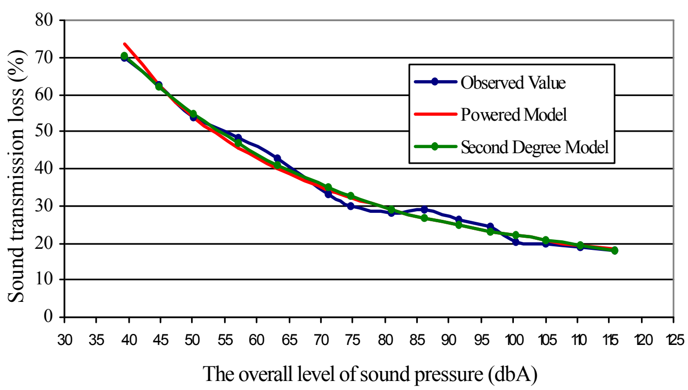

Fig. 1: Changes of sound transmission loss (%) based on the overall level of sound pressure (dBA)

$$Percent = 8670.263x^{-1.298}$$

$$Percent = 171.416 - 3.63x + 0.0306x^2$$

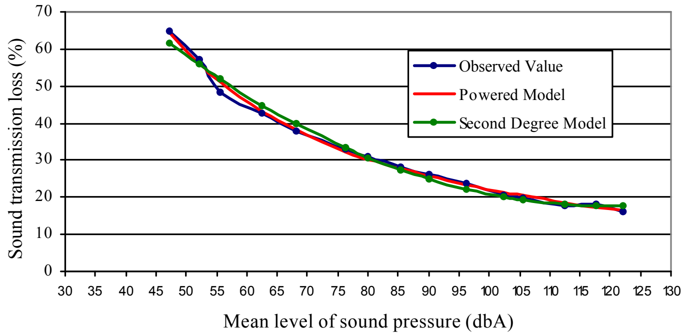

Fig. 2: Changes of sound transmission loss (%) based on the mean level of sound pressure (dBA)

$$Percent = 816138.83 \times x^{-1.434}$$

$$Percent = 137.765 - 2.013x + 0.00845\, x^2$$

Table 1: Overall levels of sound pressure and sound transmission loss (dBA) in both control and test units

Total sound pressure level			
Sound generating unit	Testing unit	The level of sound transmission loss	Sound transmission loss (%)
115.8	94.8	21	18.1
110.6	89.7	20.9	18.9
105.1	84.1	21	20
100.4	80.3	20.1	20
96.5	72.8	23.7	24.6
91.6	67.6	24	26.2
86.1	61.3	24.8	28.8
80.9	58.2	22.7	28.1
74.8	52.3	22.5	30.1
71.1	47.7	23.4	32.9
63.3	36.3	27	42.7
57.1	29.6	27.5	48.2
50.2	23.2	27	53.8
44.7	16.7	28	62.6
39.4	11.9	27.5	69.8

RESULTS

The results of measurements are presented in Table 1 and 2 below.

As you can see in Table 3, while overall level of sound pressure is increasing, the rate of sound transmission loss is decreasing. Statistically, when the pressure level is less than 65 dBA, transmission rate is different from the other two groups (65-90, >90) ($p<0.05$).

Considering the rate of sound transmission loss based on the overall level of sound pressure, the following relations are obtained and the regression functions are shown in Figure 1.

As you can see, as the mean level of sound pressure is increasing, the rate of sound transmission loss is decreasing (Table 4) which indicates a significant statistical difference between the three groups ($p<0.05$).

Considering the rate of sound transmission loss based on the mean level of sound pressure, the following relations are obtained and the regression functions are shown in Figure 2.

DISCUSSION

Sound control or improving sound transmission loss by using proper building materials for residential, entertainment, educational, welfare and medical centers is an important issue. In this regard, it is necessary to determine physical parameters of materials used in buildings. The present study indicated that the level of sound pressure in the neighboring places is significantly different when compared to that of sound-generating place. We also found that the change of sound transmission loss is highly dependent to its intensity.

Table 2: Means levels of sound pressure and sound transmission loss (dBA) in both control and test units

Mean sound pressure level			
Sound generating unit	Testing unit	The level of sound transmission loss	Sound transmission loss (%)
122.2	102.3	19.9	16.3
117.7	96.2	21.5	18.3
112.4	92.3	20.1	17.9
105.6	84.6	21	19.9
102.3	81.4	20.9	20.4
96.2	73.3	22.9	23.8
90.1	66.5	23.6	26.2
85.4	61.2	24.2	28.3
80.1	55.3	24.8	31
76.4	51.2	25.5	33
68.2	42.3	25.9	38
62.6	35.9	26.7	42.7
55.5	28.6	26.9	48.5
52.1	22.4	29.7	57
47.3	16.6	30.7	64.9

Table 3: Changes of sound transmission loss (%) based on the overall level of sound pressure (dBA)

The overall level of sound pressure (dBA)	No.	Sound transmission loss (%) Mean ± Sd
< 65	5	55.4±10.9
65 – 90	4	30±2.1
90 +	6	21.3±3.3
Total	15	35±16.6

Table 4: Changes of sound transmission loss (%) based on the mean level of sound pressure (dBA)

Mean level of sound pressure (dBA)	No.	Sound transmission loss (%) Mean ± Sd
< 65	4	53.3±9.7
65 – 90	4	32.4±4
90 +	7	20.4±3.5
Total	15	32.4±15

Based on our statistical analysis, we developed a model to calculate sound transmission loss. Our proposed model, that facilitates calculating sound transmission loss for the materials studied here, may be regarded as a new approach guiding us toward using relatively proper materials with specified potentials to maintain health and welfare.

Statistically, when overall pressure level is less than 65 dBA, transmission rate is significantly different from the other two groups (65-90, >90) ($p<0.05$). At the mean level of pressure, there are differences between the three groups. One reason may be due to distance from the wall; as the distance increases, the level of sound transmission loss increases.

In a study carried out by the Center for Housing Studies on 10 cm ceramics, they showed that mean level of sound transmission loss is 20 dB [7]. Another study is also carried out by Building and Housing Research Center found that the mean level of sound transmission loss is 46 dB in 15 cm Leca blocks [8]. In another study conducted by the Institute of Ceramic Industry, researchers revealed that there is relationship between sound transmission loss and frequency in concrete walls where the lower frequency leads to higher sound transmission loss [9]. In still another study, we can see that sound transmission loss mount to 48 dB in brick walls [10]. In other words, the mean level of sound transmission loss in brick is more than ceramic since sound transmission loss increases with the brick's density. Ceramic, despite its potential to increase sound transmission loss because of containing embedded holes, one may ask whether density or porosity plays more critical role in increasing sound transmission loss. To answer this question further study are required to be conducted.

CONCLUSION

Despite its potential to increase sound transmission loss because of containing embedded holes, one may ask whether density or porosity plays more critical role in increasing sound transmission loss. To answer this question further study are required to be conducted.

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