The Effectiveness of Various Sound Barriers in Shelters

HIROSE Minagi　KINOSHITA Takahiro　KOSEKI Kazuyoshi
Nakamura tomomi, MIYANO yumeko

Abstract

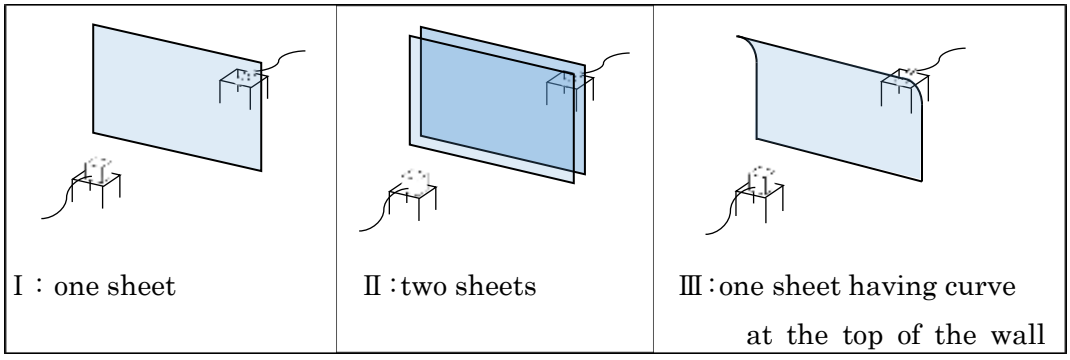
The purpose of this study is to create effective soundproof barriers using cardboard, a material that is cheap and environmental friendly. From the results of our experiment, the number of cardboards doesn't significantly affect the soundproofing effect. We are going to find the ideal barriers by changing the amplitude and frequencies.

Introduction

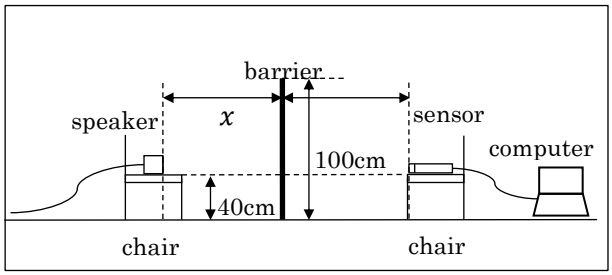
Japan has many natural disasters, so there is a high demand for emergency shelters. We frequently have earthquakes and people evacuate to school gyms. Noise is a serious problem in the shelters. Therefore, it is important to create sound barrier walls that fit the needs of the shelters. Effective, cheap, and light sound barriers would improve people's lives in shelters. We thought that cardboard would be a good material because it is light, cost effective, and we can get it anywhere. We hypothesized that we would get a higher performance barrier if we used more cardboard. We made three types of barriers and we compared their effectiveness by measuring sound pressure based on decibel.

Experiment1

We made three types of soundproof walls with cardboard as below:



We installed the experiments as below:



We measured the loudness of the sound passing through Barrier A ten times, when x=37.5cm. We also performed the same experiment for when x=75cm, 150cm, and 300cm, and this operation was repeated five times. The average value calculated by this measurement was regarded as average (A). We performed the same experiment for Barrier B and Barrier C, and the average (B) , average (C) were calculated.

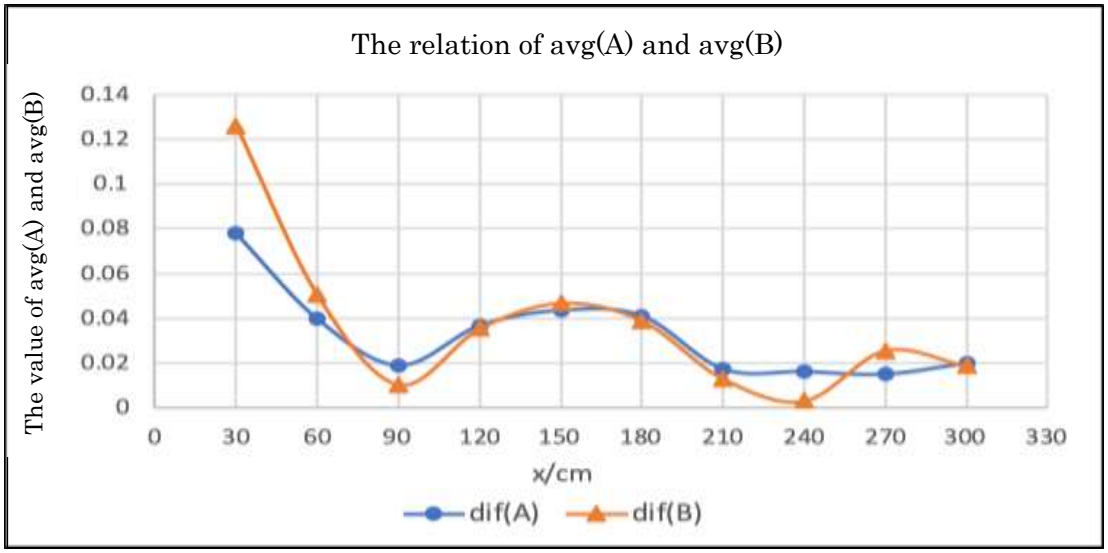
Hypothesis

① Average (A) > average (B)
We expected that the more sheets the wall has, the harder it is for sound to penetrate it.

② Average (A)>average (C)
Sound diffracts, but if we use Barrier C, we expected that we can prevents more sound from penetrating because Barrier C has the structure of elliptical curve, similar to an oval curve.

Result

The result is as below:



① Compared average (A) with average (B)
When x=37.5cm, 150cm, average (A) was greater than average (B).
When x=75cm, 300cm, average (B) was greater than average (A)

② Compared average (A) with average (C)
When x=75cm, the result: average (A) > average (C).
When x=150cm, 300cm, the result: average (A) < average (C)

Consideration

① We tried to find some law of soundproofing but we could not find it because there were only four data for x.

② When the value of x is 37.5cm or 75cm which is relatively small, the result was as expected; average (A) > average (C). However, when the value of x is large, the result was average (A)≒average (C) because the role of the curve structure became negligible. We found that Barrier C was more effective to use in the shelter than Barrier A because we rarely talk at a 300cm interval in the shelter.

We tried another experiment because there were only few data and the experimental environment was not prepared.

Experiment2

We set two types of device Barrier A and Barrier B, as Experiment 1 and moved the barriers from 30cm to 300cm.We moved the barrier 30cm for every experiment. And we measured the sound pressure 30 times in every distance. During this experiment, we also measured sound in an environment without barriers. We came up with a formula and we evaluated the average of the pressure with barriers and the average of pressure without barriers and subtracted the average. We did this to make sure that those pressure cannot offset the surrounding environment.

Hypothesis

In experiment 2, we expect that those pressure will decrease monotonically as the distance increases and pressure of Barrier A is not as large as pressure of Barrier B at any distance.

Result

The result is as follows.

In the result, contrary to our expectations, those graphs have wave-like shape and the pattern of the wave was not constant.

Consideration

In the result, we were able to observe that something happened between 60cm and 90cm because there is a graph dip between 0cm and 60cm, while the graph is in wave-like line between 60cm and 300cm. What happened between 60cm and 90cm? We suspected that it was due to the effect of diffraction. We would like to do a third experiment to find out the relationship between the conditions where diffraction occur and their distance.

Future Outlook

In Experiment 1, we could not give a satisfying explanation on why we got the result. In the next step, we will continue to discuss why we got the result and how to explain it scientifically. Moreover, we need to do another experiment to prove our new hypothesis generated from Experiment 2. When we did Experiment 1 and 2, we focused on changing the volume by

moving the wall and changing the distance between the speaker and the barrier, but we thought it would be interesting to focus on changing the actual volume or frequency from the speaker. In an emergency shelter, people do not make noise at a fixed volume or frequency, so we thought this research will be more significant.

Reference

Sakagami Kimihiro（2018） Acoustical Materials and Backing Structure，The Journal of the Acoustical Society of Japan 74(8) 448-455

Matumoto Gensei Fujiwara Kyoji Omoto Akira（2001）Influence of the Directivity of a Sound Source on Insertion Loss of a Noise Barrier，The Journal of the Acoustical Society of Japan 57(4) 272-281

Key Word

Cardboard…段ボール Soundpoof…防音の Node…節 Antinode…腹