24th INTERNATIONAL CONGRESS ON SOUND AND VIBRATION
23–27 July 2017, London

AN AUDIO DEMONSTRATION OF HOW EARS ARE MORE SENSITIVE TO CHANGES IN LOW FREQUENCY NOISE – FOR INSTANCE GROUND-BORNE NOISE FROM TUBE TRAINS

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The Ground-borne Noise and Vibration Group thought it would be a good idea to remind people of how our ears work and their relative sensitivity to low, mid and high frequency noise. Whilst our ears are less sensitive to low frequency noise than mid and high frequency noise they are more sensitive to change at low frequencies. The paper is an introduction to the Ground-borne Noise session and the audio demonstration will play equal loudness tones at octave bands from 63Hz to 8kHz and demonstrate what 10dB difference sounds like in each of these octave bands. This will clearly show that the 10dB reduction at 63Hz is subjectively much bigger than at 1kHz. Recordings of tube trains will also be played along with a simulation of what the train would sound like if the building was to be isolated on elastomer bearings or springs. A powerful sound system will be used to provide a very effective demonstration.
Keywords: ground-borne noise, vibration, buildings, trains

1. Introduction

The human ear is a complicated and extraordinary device which allows us to hear. The ear consists of the outer, middle and inner ear (see Figure 1) and is designed to collect and amplify pressure waves. These are then transmitted via nerves to the brain and is registered as sound.

The normal hearing frequency range for a healthy young person is 20Hz to 20kHz. However the ear is not a linear device and Figure 2 shows how our ears are more sensitive to mid and high frequency sound than low frequency sound.

A difference of 10 phons is subjectively a factor of 2. So if a sound is 10 phons greater then it is subjectively twice as loud. The equal loudness curves converge at low frequencies therefore meaning that changes in sound energy at low frequencies are subjectively much more noticeable than at mid and high frequencies.

This audio demonstration will demonstrate this.

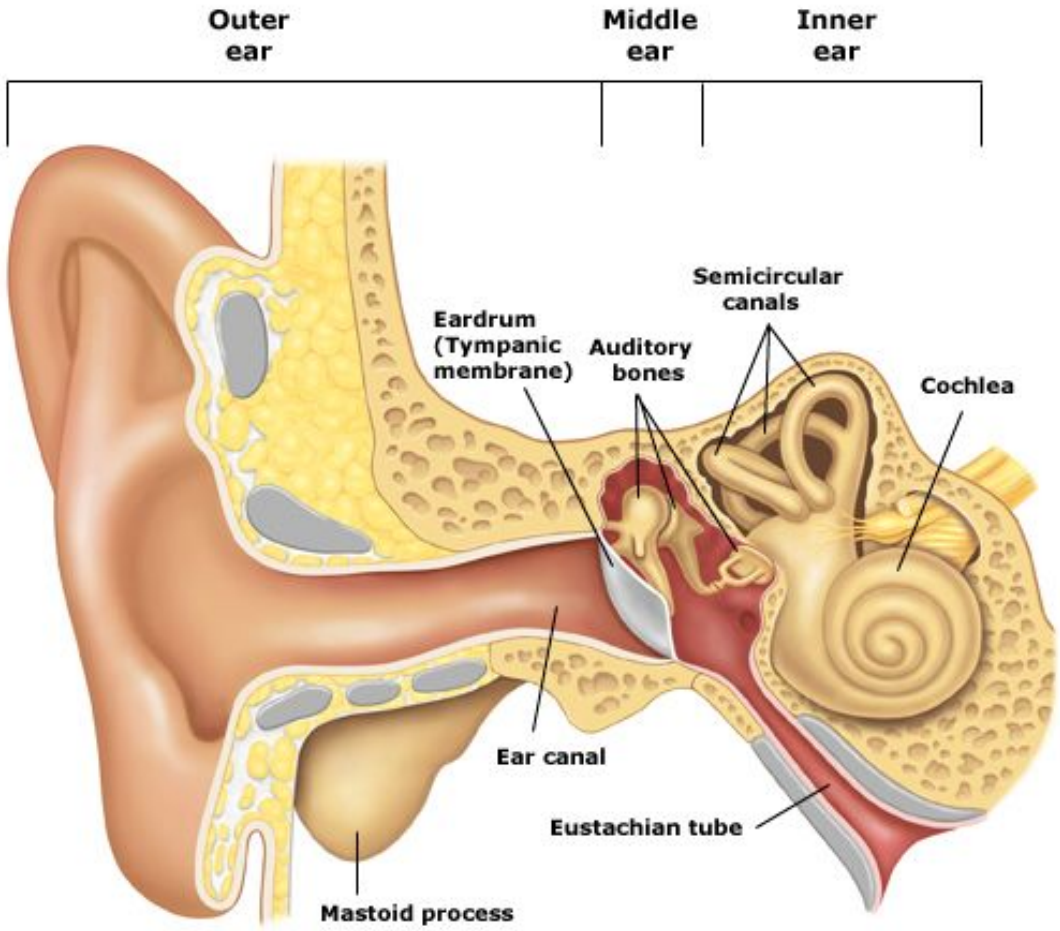

Figure 1: Section through Human Ear[1]

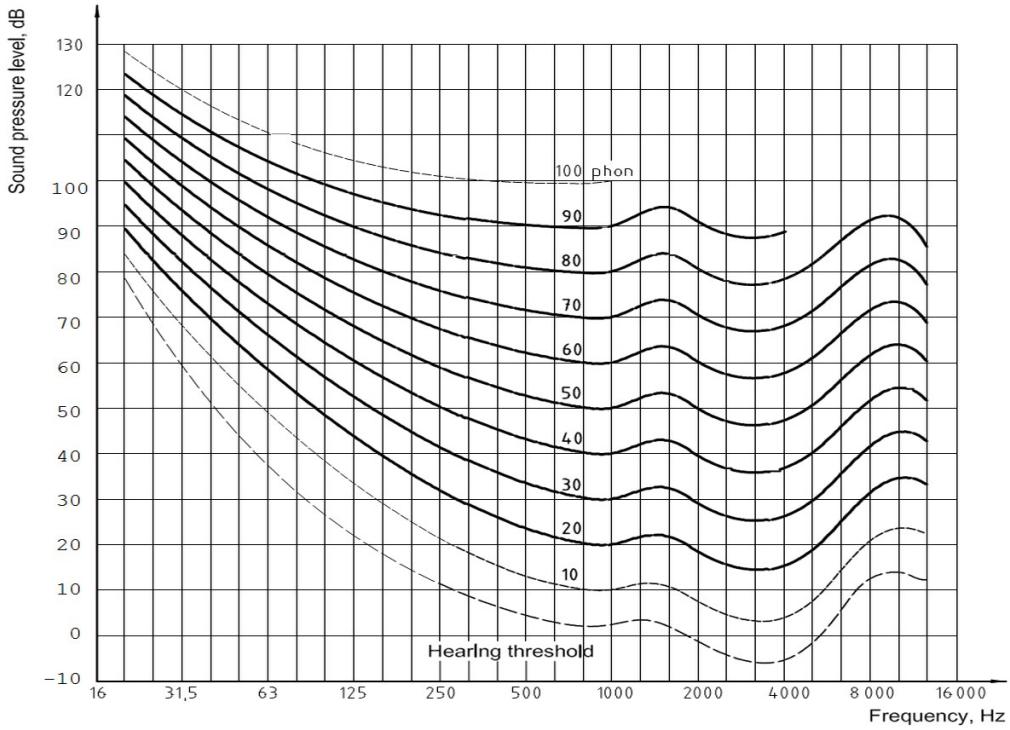

Figure 2: Equal Loudness Image[2]

2. Audio Demonstration

The audio demonstration will be coupled with a live video feed from a sound level meter placed centrally in the room and will contain the following:

- Tone Demonstration:
    - Tones at equal loudness: 8kHz, 4kHz, 2kHz, 1kHz, 500Hz, 250Hz, 125Hz & 63Hz
    - Each tone will be played shortly followed by the same tone 10dB quieter
- Ground-borne noise recordings from trains demonstration:
    - A recording of an actual underground train – this will be played louder than would normally be expected in an actual building to allow the differences to be heard
    - 15dB will be taken from this which will approximate the building being on elastomer bearings
    - 25dB will be taken off to approximate a building on springs
    - The demonstration will be repeated at actual levels to show that isolating a building will render the ground-borne noise inaudible
- Sound insulation demonstration of Robust Standard Detail (RSD) light-weight and heavy-weight separating floor construction:
    - A piece of modern popular music will be played as if the listener was in the living room of an apartment
    - A simulation of what this music would sound like in an upstairs apartment with a RDS lightweight and heavyweight floor construction

The demonstrations will show how important it is to improve low frequency noise within buildings.

REFERENCES

1 [Online.] available: https://uk.pinterest.com/explore/human-ear/

2 [Online.] available: https://acousticfirst.info/2014/02/