

assigned April 12, 2006

due April 19, 2006

HOMEWORK #6

Sound and Hearing

Questions

- a. Calculate the sound level increase corresponding to a tripling of the acoustic intensity.
- b. The acoustic pressure of human voice can vary from $20 \cdot 10^{-4}$ to 0,2 Pa. What is the dB range covered by this pressure interval ?
- c. Show that the units of acoustic intensity correspond to the units of the ratio $p^2/(\rho \cdot v)$.
- d. Show that for an elongated source, any doubling in distance leads to an attenuation of 3 dB in sound level (acoustic power emitted at the extremities of the source will be neglected). Will the attenuation for a point source be stronger or smaller ?

Problems

1. Calculate the acoustic intensity corresponding to an acoustic pressure of $4 \cdot 10^{-3} \mu\text{bar}$.
Determine the sound level corresponding to an intensity of $1 \cdot 10^{-5}$, $2 \cdot 10^{-5}$, $4 \cdot 10^{-5}$ and $1 \cdot 10^{-5} \text{ W/m}^2$.
2. What intensity produces a sound level of 70 dB ?
3. In high traffic, a highway produces at 25 m a noise of 60 dB. How does this noise decrease with distance and what is its level at 1 km from the highway ?
What is, at this same distance, the additional sound muffling due to absorption by the air molecules at 1000 Hz and at 4000 Hz, during a warm, humid day (RH = 80%) ? Use Data sheet D.3.2 of your textbook to solve this problem.
4. After two years of complaints from the owners of a three-storey building situated in the vicinity of a highway, an anti-noise barrier of 6 m height was erected, placed 7 m from the axis of traffic and at 20 m from the building. The height of each level is 2.9 m, the ground is

considered perfectly flat (and horizontal) between the highway and the building, the source of the noise is estimated at a height of 0.5 m.

The owner of the apartment on the third level complains about getting more noise from the highway than the inhabitants of the ground floor apartment (level1). Calculate the characteristic frequency for both levels, considering that the people's ears are at 1.7 m from the floor, and deduce whether he is right or wrong to complain.

Design project:

Instructions for the Acoustics portion of the next report

Select a large space inside your building and observe and evaluate the acoustics in this space, preferably both when it is empty and full of people. Discuss the acoustics with the building's users to know more about their impression. Address the following points in your report so as to show whether the architectural design of the space is satisfactory or not from the acoustics point of view:

- Discuss the uses for the space and the criteria you think are most relevant for its evaluation
- Describe the space with sketches in plan and section, and comment on the types of finishes, and on the arrangement of furniture; identify the reflecting surfaces and state whether these reflections are useful
- Calculate the reverberation time at 500 Hz for the space empty and full
- Comment on the background noise level and other noise sources (from the outside typically) and on the extent to which they affect the acoustic conditions inside
- Conclude by providing an overall evaluation of the hearing conditions, given the use of the space, and recommendations about ways to improve the latter

Reading assignment from textbook

"Introduction to Architectural Science" by Szokolay: § 3.1 - 3.2

Additional readings relevant to lecture topics:

"How Buildings Work" by Allen: pp. 124-129 in Chap 14