Architectural Acoustics

Week 7: Exercises Building Acoustics

25-03-2020

Question 1

In solid media, we can distinguish various wave types, whereas in air, we only have longitudinal waves as regards sound propagation.

a) Why do we not have more than one wave type in air?

b) Describe, in words, the difference between longitudinal waves and transverse waves.

Question 2

You are standing in a long corridor and at the far end of the corridor, a person slams a door. Assume that the walls of the corridor (which are connected to the door) are made of 0.1 thick lightweight concrete with a bending stiffness 2.85 10^5 N.m^2, Youngs modulus 3.42 10^9 N/m^2 and Poisson ratio 0.5.

What is the first sound you hear from the slammed door: the sound from the wave that has travelled through the corridor, the sound radiated from the bending waves in the wall close to you or the sound radiated from the extensional waves in the wall close to you. Explain your answer.

Question 3

You live in an old a flat, and the façade consists of a single window pane with a thickness d = 20 mm, a density of 2500 kg/m^3 and a bending stiffness 3.33 10^4 N.m^2.

A road is situated parallel to the façade with a distance of 20 m from the center of the façade.

a) When a single car passes by, at what position of the car is the sound insulation of the window best regarding the noise of the car?

b) The car produces most noise at 1000 Hz. For what position of the car is this noise best audible in your flat?

c) What thickness should the glass pane to avoid the 1000 Hz to be above its critical frequency?

Question 4

With lightweight building techniques, several options exist to improve sound insulation, which is in particular critical for the low frequencies.

a) Why is it difficult to obtain a high sound insulation for low frequencies with lightweight building techniques.

b) If you are to design a lightweight double leaf partition and a minimum requirement is set for R_A at and above 100 Hz, what would be your design suggestion if the both masses of the leafs are known? (describe in words)

c) A colleague designs a lightweight single leaf partition wall and he suggests to improve the insulation by increasing the internal loss in the material (this reduces the amplitudes of the bending wave vibrations). The critical frequency of the wall is 2000 Hz. Does this suggestion improve R_A at 100 Hz?

Question 5

Two adjacent student rooms are built with concrete floor, wall and ceiling elements. All floor and ceiling elements have a thickness of 0.2 m and all walls have a thickness of 0.1 m. The rooms have a dimension of LxWxH = 5m x 3m x 2.5m, with 3m the width of the partition wall between the rooms. For the frequency of 500 Hz, which is above the critical frequency of both elementss, the sound reduction index is 42 dB for the 0.1 m elements and 51 dB for the 0.2 m element.

a) Why is the sound reduction index of the 0.2 m elements higher?
b) How many first order flanking sound transmission paths should be included in the calculation of the total sound reduction index R' between the two rooms? (Consider all sound paths that cross a junction between two elements as flanking sound transmission path)
c) Compute R' between the student rooms. How much do the flanking paths influence the sound reduction index (compared to R from the partition wall alone)?