Assignment

Homework HW2

Master program in Music and Acoustic Engineering

Musical Acoustics

course code: 051483

Academic year 2023/2024

POLITECNICO
MILANO 1863

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Problem

Plate characterization and string-plate interaction

Consider a square thin plate with clamped edges and side a = 0.15 m. The plate has a thickness of 1 mm, and it is made with aluminum (E = 69 GPa, ρ = 2700 kg/m^3, ν = 0.334).

a) Compute the propagation speed of quasi-longitudinal and longitudinal waves;

b) plot the propagation speed of the bending waves as a function of the frequency for the considered plate;

c) find the modal frequencies of the first six bending modes of the plate;

d) consider the plate to be made by Sitka spruce and it is realized using the quarter-cut scheme. The main dimensions of the plate are aligned with the longitudinal and radial directions of the wood. The length of the side along the radial direction is a = 0.15m. Predict the length b of the side parallel to the fibers so that the ring and x modes can be observed.

Consider now that a string is attached to the considered aluminum square plate, and its fundamental mode is tuned to the frequency of the first mode of the plate. The string is made with iron (ρ = 5000 kg/m^3), its cross section is circular with a radius of 0.0011 m, and its length is L = 0.45m. Due to internal losses and sound radiation, the plate at the frequency of the considered mode dissipates energy, and the merit factor is Q = 25.

e) Compute the tension of the string so that its fundamental mode is tuned with the first mode of the soundboard.

f) Neglecting the stiffness of the string, compute the frequencies of the modes of the string-soundboard system considering the coupling between the plate and the string.

Provide the solution by Oct. 21, 2023, using the WeBeep assignment tool.

- **The report must fit in 6 pages of the Latex template available at https://www.overleaf.com/read/rnkchgybrrsm;**
- **Answer concisely;**
- **Describe – concisely - the procedure used to obtain the results: if an error is present, I cannot identify the reason – numerical or conceptual - if the procedure is not described: in grading I will be forced to use the worst-case option.**
- **All students who participated to the same group must upload the report;**
- **In the PDF file and in the filename, specify the name, surname and ID of all the students participating to the HW, if more than one student worked on it.**