Design of a piano

Soundboard characterization

Consider a rectangular plate of dimensions 1m x 1.4 m, to be used as a soundboard. The plate is assumed to be clamped.

The thickness of the soundboard is 1cm, and the material is assumed to be Sitka Spruce and the grain is directed in the shorter direction of the plate (i.e. 1m), while the other dimension corresponds to the radial direction.

a) Compute in Comsol the input impedance of the soundboard as a function of the position *(x, y)* and of the frequency *f*. Assume the reference frame to be centered in the lower left corner of the soundboard. Compute the impedance for 10 points in the x direction and 14 points in the y direction (i.e. sampling period 10 centimeters).

String pairing

Consider pairs of strings (approximation wrt reality!) mounted on the soundboard. The pairs are deputed to produce the notes F2 (f_0 =349.23 Hz) A4 (f_0 = 440 Hz), C5 (f_0 = 523.25Hz), E5 (f_0 = 659.25Hz), G5 (f_0 = 783.99 Hz).

b) Design the shape of the bridge for producing the above notes, so that the input impedance at the force application points is not at a maximum. In the design, assume that the bridge transfer energy to the soundboard at the point where the string is mounted.

c) For all the strings assume that the weight per unit length is 10.8g/m. One of the strings in the pair is tuned to produce f_0 (i.e. $\omega_1 = 2\pi f_0$), while the second is detuned and $\omega_1 = 2\pi f_0(1 + 2\varepsilon)$. Compute the eigenfrequencies of the two strings in the pairs.

d) Compute the decay times for the two eigenfrequencies for all the pairs.

Notes & suggestions:

- 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.
- Upload the report by Jan.9, 2023 .
- **All students 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.