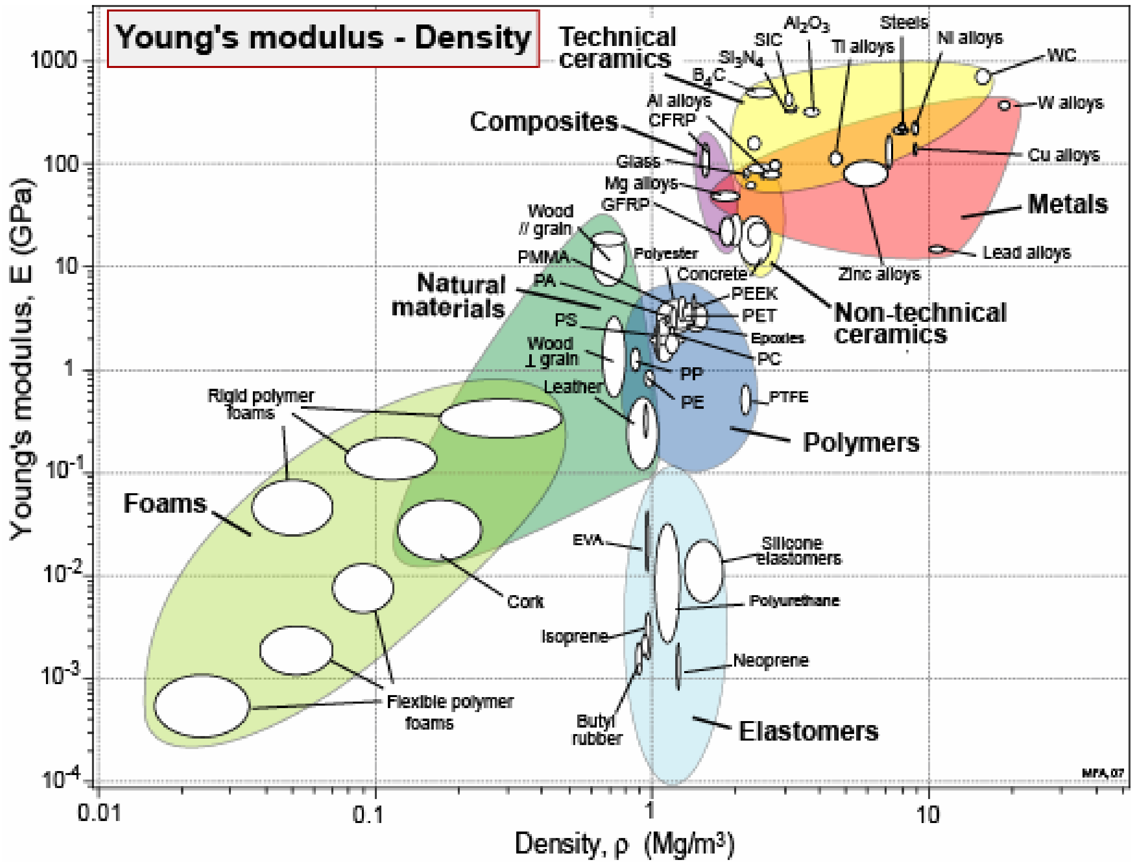
SE104 Homework 7

1. The speed of sound is proportional to $\sqrt{E/\rho}$, where E is the Young's modulus and ρ is the mass density. According to the chart below, what (a) natural materials and (b) alloys have similar sound speeds with steel?



2. We are choosing material for a round rod. The length of the rod must be close to 1 m, and its cross-sectional diameter must be between 1 mm and 3 mm. Its natural frequency of vibration, f, should be as low as possible. (a) Clearly list the constraints, objective, and free variables. (b) What is the performance index of the material? (c) According to the chart above, what are the best 2 metallic material candidates? Hint: Natural frequency of a rod $f = (C_2/2\pi)(I/AL^4)^{1/2}(E/\rho)^{1/2}$, where C_2 is a geometrical factor, I is the moment of inertia, A is the cross-sectional area, L is the length, E is the Young's modulus, and ρ is the mass density.

3. We are choosing material for a round rod. Its length must be close to 1 m, and its mass must be below 1 kg. Its natural frequency of vibration, f, should be as low as possible. (a) Clearly list the constraints, objective, and free variables. (b) What is the performance index of the material? (c) According to the chart above, what are the best 2 metallic material candidates? Hint: Natural frequency of a rod $f = (C_2/2\pi)(I/AL^4)^{1/2}(E/\rho)^{1/2}$, where C_2 is a geometrical factor, I is the moment of inertia, A is the cross-sectional area, L is the length, E is the Young's modulus, and ρ is the mass density.

4. As shown in the figure below, a panel is subjected to a centralized load, F. The length of the panel, L, must be exactly equal to the distance between the supports, L_0. The weight of the panel should not exceed W_0, the capacity of the supports. Under a given load F^*, the deflection of the loading point, δ, must be close to a specified value, δ_0. The panel should be as thin as possible. (a) What are the constraints, objective(s), and free variable(s)? (b) Derive the performance index of material, M. (c) Find two best material candidates.