MEC-E1070 Selection of Engineering Materials
Task 2, Benjamin Gustafsson 664996

2.1

Design requirements

Function	Frame structure of transportation vehicle (beam) Cost-efficient, light, sufficient stiffness
Constraints	Sufficient stiffness Water-resistant Length L is specified Section shape square
Objectives	Minimize the mass m Minimize the cost C
Free variables	Choice of material Cross-section area A (A = b*b)

Beam in bending:

Mass objective function:

$$m = AL\rho$$

Bending stiffness:

$$S \leq \frac{C_2 EI}{L^3}$$

Where C_2 = constant, second moment of area I:

$$I = \frac{A^2}{12}$$

For a specified length, stiffness is adjusted by the size of the square section. Removing A:

$$m = \left(\frac{12SL^3}{C_2}\right)^{0.5} L\left(\frac{\rho}{E^{0.5}}\right)$$

S, L and C_2 specified. Best materials for mass objective are given by:

$$M_1 = \frac{E^{0.5}}{\rho}$$

Cost objective function:

$$C = ALC_m\rho$$

Where C_m = € / kg and cost of making component of mass m is mC_m. Proceeding as before:

$$M_2 = \frac{E^{0.5}}{C_m\rho}$$

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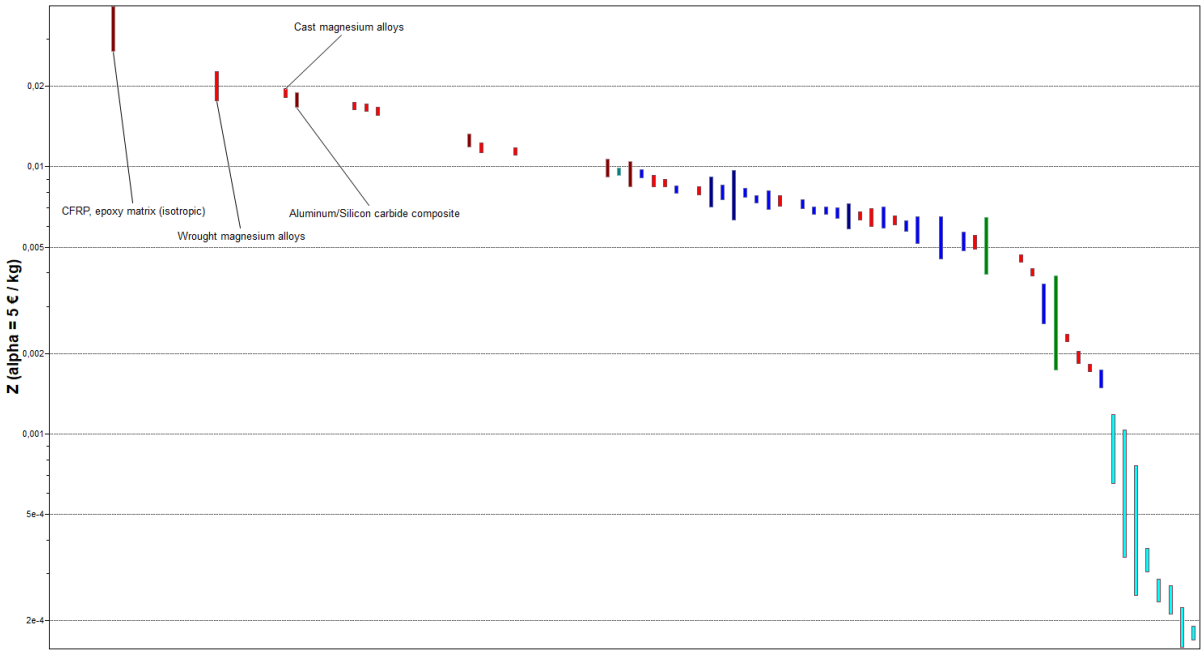
Penalty function:

$$Z = C + \alpha m = M_2 + \alpha M_1$$

Where α = 5 € / kg (Passenger car) and α = 250 € / kg (Commercial airplane)

Passenger car:



Commercial airplane:

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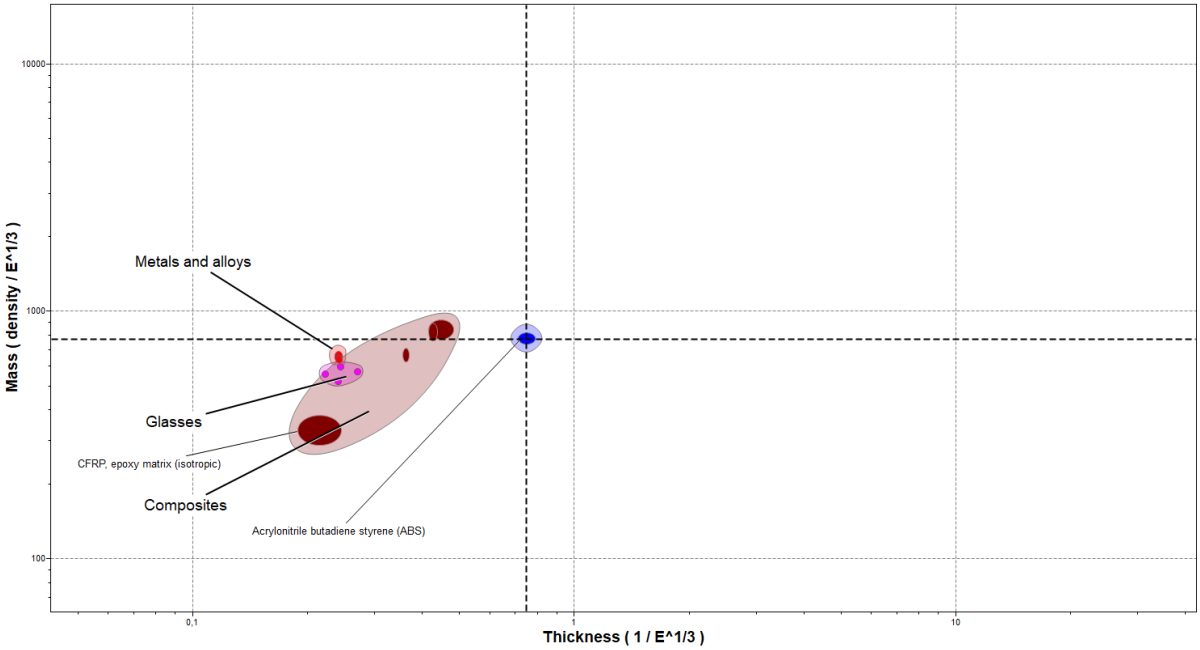
2.2

Material properties compared to ABS:



(lower = better)

Compared to ABS, materials used today provide both better mass to strength ratios as well as thickness to strength ratios. Materials such as aluminum, carbon fiber and glass provide:

- Better durability. Glass, carbon fiber and aluminum are generally more durable and resistant to wear and tear. They can withstand drops, impacts and especially scratches better than ABS plastic.
- Light weight. In addition to being generally more durable, the comparison materials are lighter in weight.
- Environmental considerations. Materials such as glass, carbon fiber and aluminum are more environmentally friendly compared to ABS plastic.
- Heat dissipation & signal transmission. Aluminum and carbon fiber are better at both dissipating heat generated by the phones components as well as allowing for signals, such as cellular and Bluetooth, to pass through.
- Rigidity. Aluminum, carbon fiber and glass provide greater structural rigidity to the body of the mobile phone, providing better protection for its internal components.