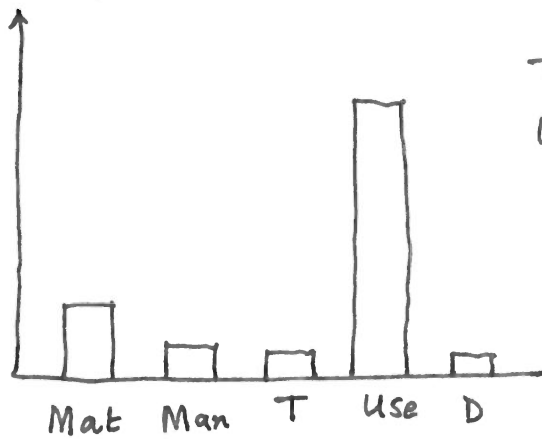


REMINDER : USE phase

energy



T transport D disposal
Use $\neq$ transport!

car being produced in Germany
moved to Italy = transport

car moving around = use

↓ energy in use

↓ reduce thermal losses

↓ reduce electrical losses

} LOSS = something to
be recovered
with additional
energy

↓ mass

↑ $I = \frac{E^n}{\rho}$ to avoid excessive
deformation

↑ $I' = \frac{\sigma_f^m}{\rho}$ to avoid failure

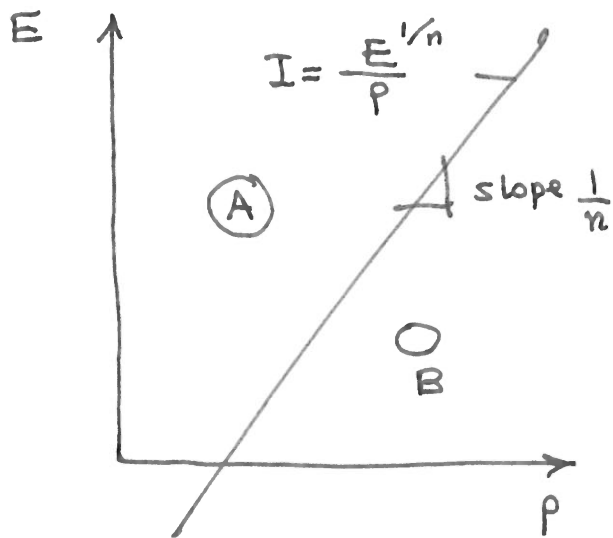
NO benefit from

$$I'' = \frac{E^n}{\rho H_m}$$

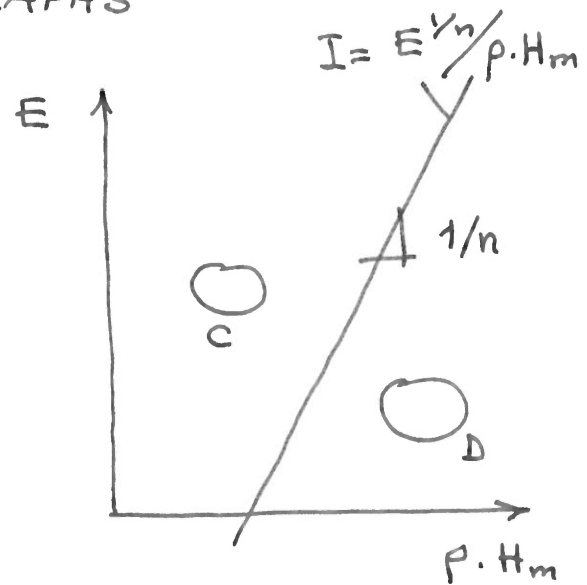
$$I''' = \frac{\sigma_f^m}{\rho H_m}$$

} expressions of
indices to
reduce energy
demands
in "Materials"
phase

REMINDER : GRAPHS

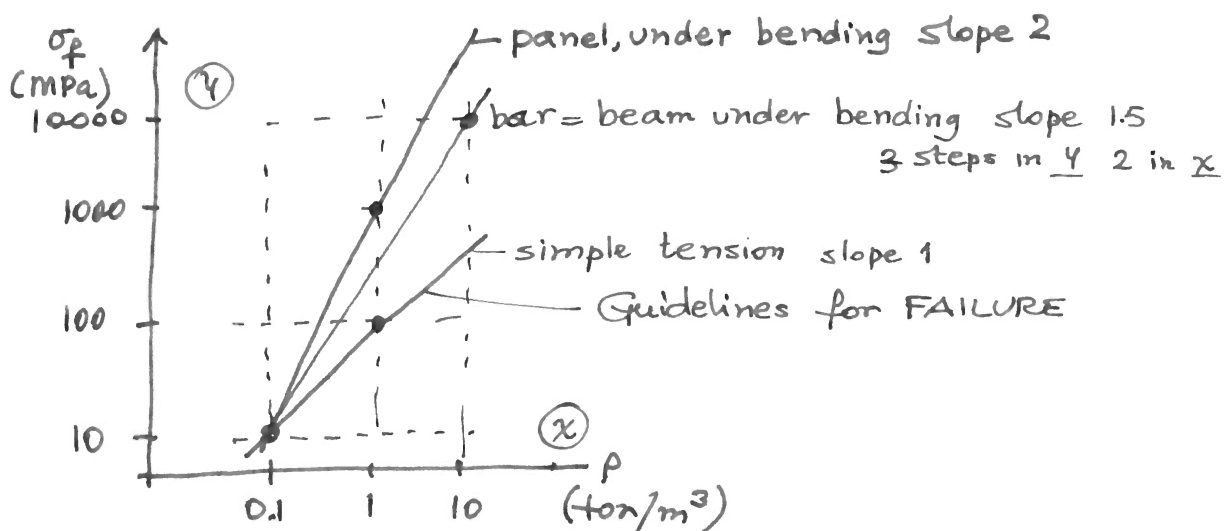
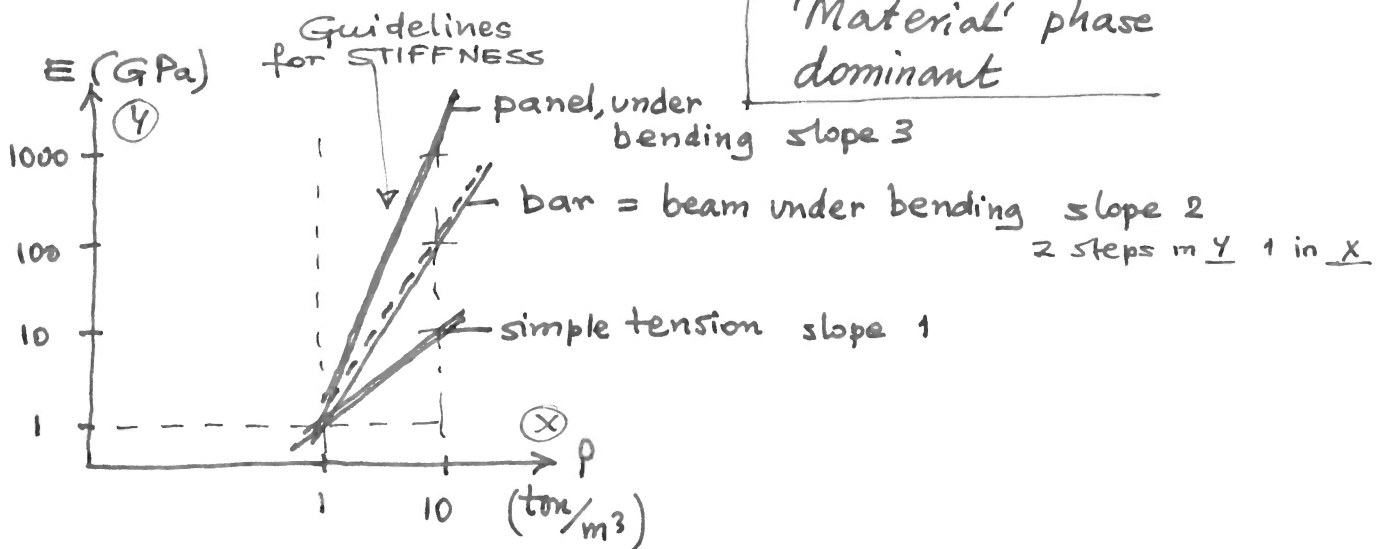


material A leading to a lighter component, compared to B



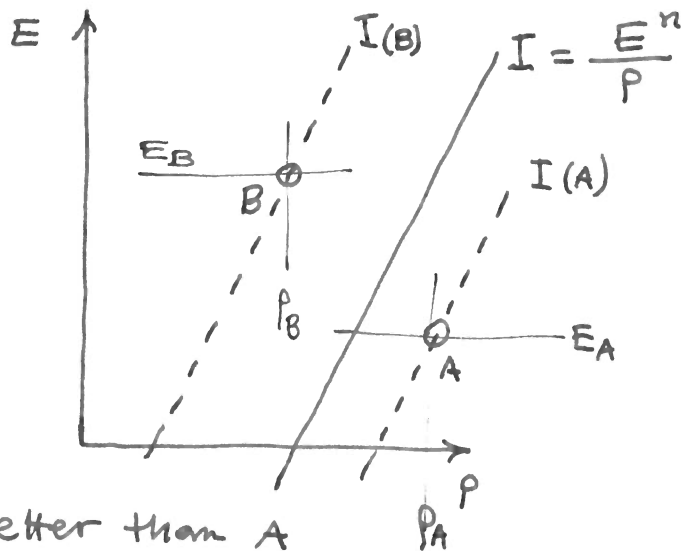
material C leading to a more sustainable* component, compared to D

* in the hypothesis of 'Material' phase dominant



REMINDER: GRAPHS AND ACTIONS FOR IMPROVEMENT

Improvements = "moving on the left"



B better than A

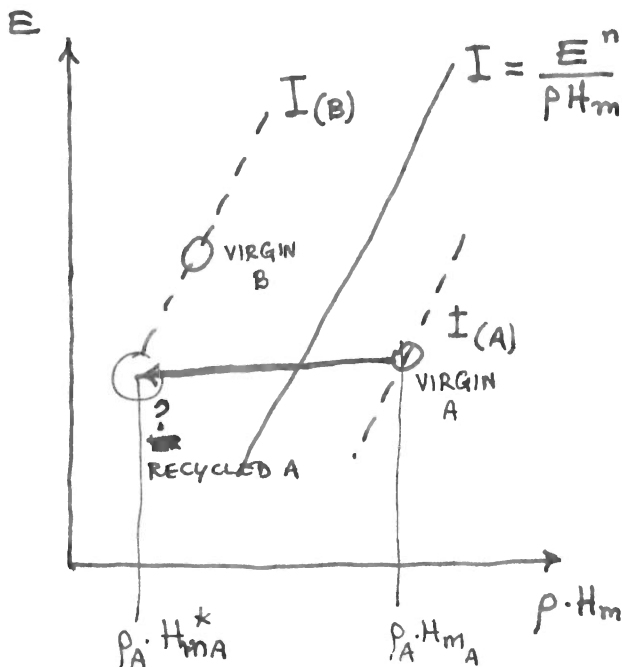
since if we have $I = \frac{E^n}{\rho}$

$$I_B = \frac{E_B^n}{\rho_B} > \frac{E_A^n}{\rho_A} = I_A$$

HOW TO 'IMPROVE' A?

- increasing E: possible for polymers, embedding C fibres

- applying ϕ (SHAPE) $I(A)_{\text{new}} = \frac{(E\phi)^n}{\rho}$



B better than A $\frac{E_B^n}{\rho_B H_{mB}} > \frac{E_A^n}{\rho_A H_{mA}}$

recycling as possible improvement

hp. B from virgin raw materials

A from recycled material

$$H_{mA}^* = H_{mA} (1-r) + r H_{rA}$$

↑
embodied energy for virgin material

↑
embodied energy for recycled material

r = recycled content

e.g. $r = 0.3 = 30\%$

$$H_{mA}^* < H_{mA}$$

if: r is HIGH (close to 1, or 100%)

$$: H_{rA} < H_{mA}$$