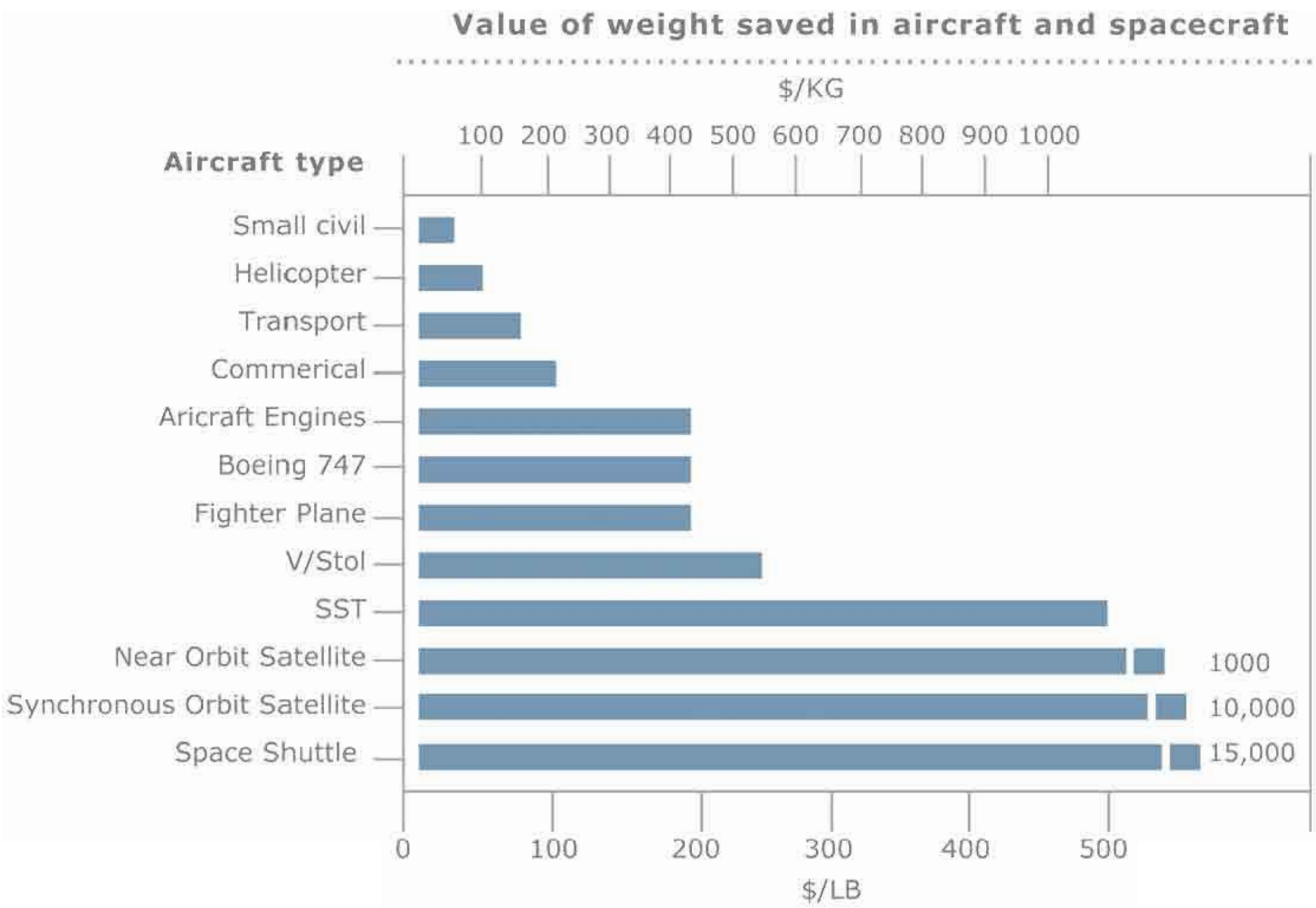
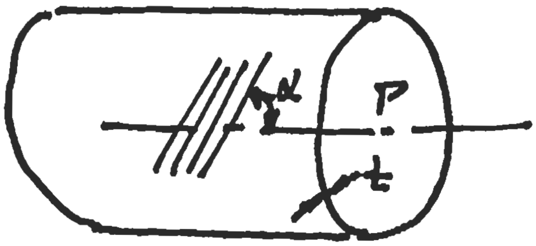
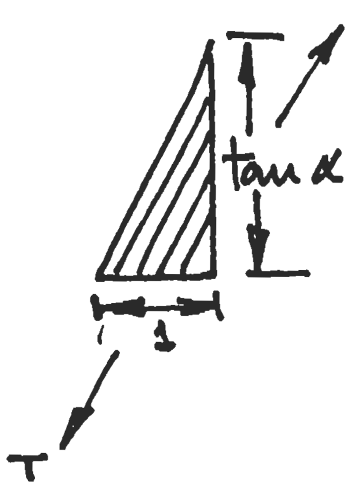
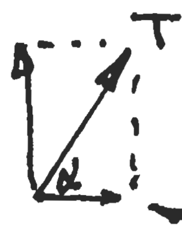

Value of weight saved in aircraft and spacecraft
$/KG
100 200 300 400 500 600 700 800 900 1000
Aircraft type
Small civil
Helicopter
Transport
Commerical
Aricraft Engines
Boeing 747
Fighter Plane
V/Stol
SST
Near Orbit Satellite
Synchronous Orbit Satellite
Space Shuttle
1000
10,000
15,000
0 100 200 300 400 500
$/LB

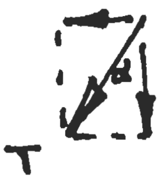
Netting Analysis - balanced pattern







$$\frac{nT\cos\alpha}{(\tan\alpha)(t)} = \frac{pr}{2t} \qquad (1)$$



$$\frac{nT\sin\alpha}{(1)(t)} = \frac{pr}{t} \qquad (2)$$

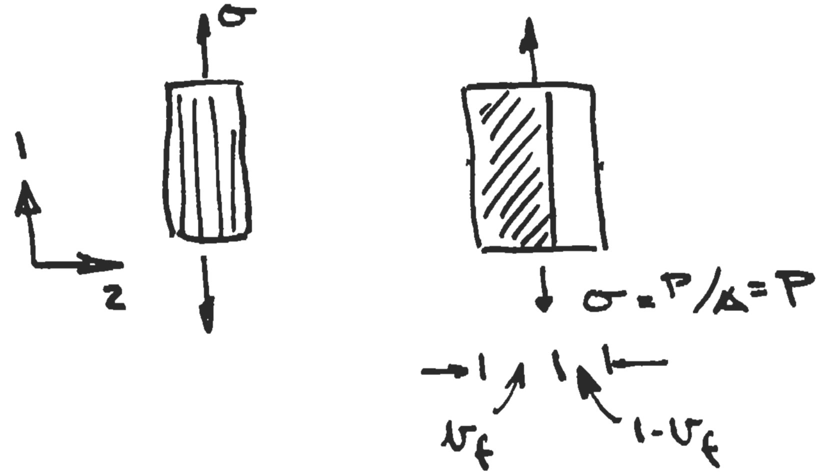
$$\frac{(2)}{(1)} \Rightarrow \frac{nT\sin\alpha \cdot \tan\alpha}{t \cdot nT\cos\alpha} = \frac{pr/t}{pr/2t} = 2$$

$$\rightarrow \tan^2\alpha = 2$$

$$\alpha = \mathrm{Tan}^{-1}\sqrt{2} = 54.7^\circ$$

Micromechanics of Laminae

- Parallel reinforcement



$$\epsilon_f = \epsilon_m = \epsilon$$

$$P_f + P_m = P$$

$$\sigma_f v_f + \sigma_m v_m = \sigma \ (1)$$

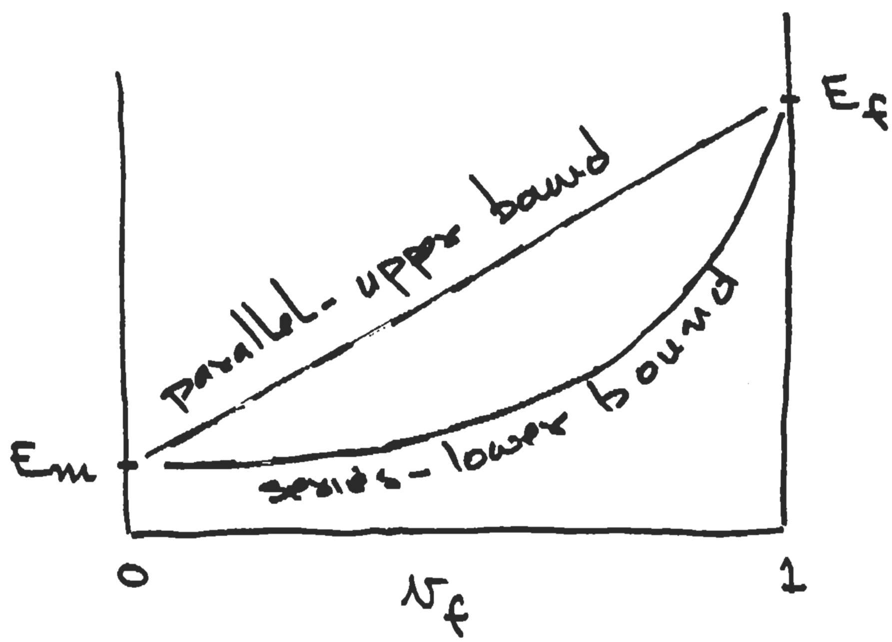
$\div \epsilon$ $$E_f v_f + E_m v_m = E_1$$

- Series reinforcement

$$P_f = P_m = P$$

$$\delta_f + \delta_m = \delta$$

$$\frac{1}{E_2} = \frac{v_f}{E_f} + \frac{v_m}{E_m}$$



Halpin-Tsai:

$$E_2 = E_m \frac{1 + \xi \eta v_f}{1 - \eta v_f}$$

$$\eta = \left(\frac{E_f}{E_m} - 1\right) \Big/ \left(\frac{E_f}{E_m} + \xi\right)$$

$\xi = \xi$ (geometry, packing)

- Strength - assume $\epsilon_{b,m} > \epsilon_{b,f}$

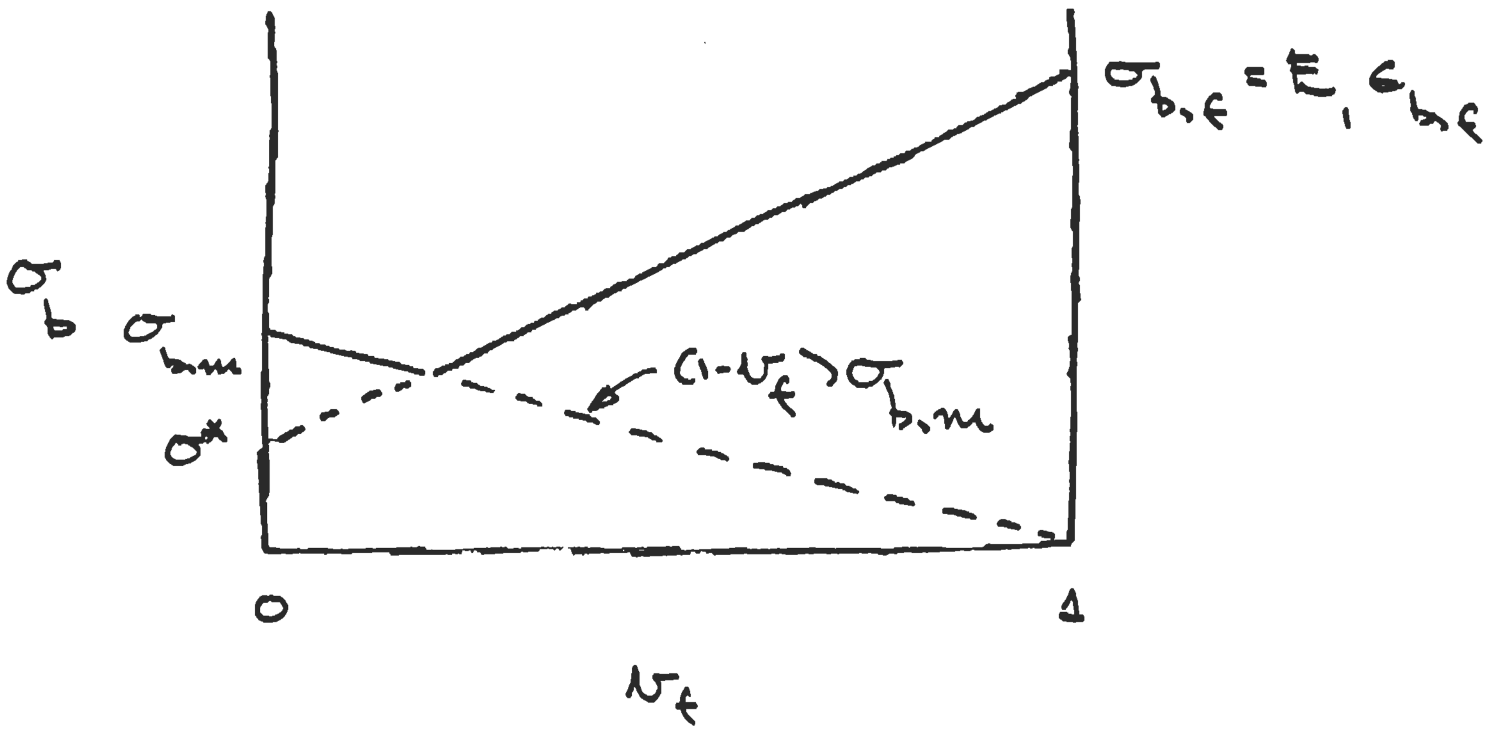
for rupture @ $\epsilon = \epsilon_{b,f}$:

$$E_1 = v_f E_f + v_m E_m$$

$\times \epsilon$:

$$\sigma_b = \epsilon_{b,f} E_1 = v_f \sigma_{b,f} + (1-v_f)\sigma^*$$

$$\sigma^* = \text{matrix stress} = \epsilon_{b,f} E_m$$



$$\sigma_{b,m} = E_m \epsilon_{b,m} = \text{breaking strength of matrix}$$