HW05: Questions related to Elastic Constants

1.

A multiaxial stress state can be broken down into simpler stress states which, when summed, represent the multiaxial stress state. Using this concept show that:

$$B = \frac{E}{3(1-2v)}$$

Hint: decompose the hydrostatic stress state into three uniaxial stress states.

2.

Use the example of pure shear deformation to show that it does not encumber any change in volume, only a change in shape.

3. Show that while hydrostatic deformation is a three dimensional phenomenon, shear deformation can be presented in two dimensions.

4. Modulus-Strength

Metals and Polymers: Yield Strength
Ceramics and Glasses: Compressive
Strength Elastomers: Tear Strength
Composites: Tensile Strength   MFA:88-91

Youngs Modulus, E (GPa)

Strength σ_f (MPa)

Min. Energy
Storage per
Unit Volume
Yield before
Buckling

$\frac{\sigma_f}{E} = 10^{-4}$

$\frac{\sigma_f}{E} = 10^{-3}$

$\frac{\sigma_f}{E} = 10^{-2}$

$\frac{\sigma_f}{E} = 0.1$

$\frac{\sigma_f}{E} = C$

$\frac{\sigma_f^{3/2}}{E} = C$

$\frac{\sigma_f^2}{E} = C$

Design
Guide
Lines

Max Energy
Storage per
Unit Volume
Buckling
before Yield

Engineering
Alloys

Engineering
Ceramics

Engineering
Composites

Porous
Ceramics

Engineering
Polymers

Polymers
Foams

Elastomers

Woods

ll to
Grain

⊥ to
Grain

Cermets, WC, Si C, Boron, Si₃N₄, Mg Al₂O₃, Zr O₂, BeO, Silicon Cñ, Diamond
W, Mo Alloys, Beryllium, Steels, Ni Alloys, CFRP Uniply, Cast Irons, Cu Alloys, Zi Alloys, Ti Alloys, GFRP, Al Alloys, Common Woods, Brick Etc, Glasses, Cement + Concrete, Mg Alloys, CFRP Laminates, GFRP, Sn, Lead, Ash Oak Pine, MEL, Epoxies, PS, PVC Nylons, PMMA, Balsa, Wood Products, Polyester, Ash Oak, PP, Pine, HDPE, PTFE, Balsa, LDPE, Hard Butyl, PU, Cork, Silicone, Soft Butyl