Chart 18: Strength, σ_f, against energy content, $q\rho$

The chart guides selection of materials for strong, energy-economic components. The 'strength' for metals is the 0.2% offset yield strength. For polymers, it is the stress at which the stress–strain curve becomes markedly non-linear — typically, a strain of about 1%. For ceramics and glasses, it is the compressive crushing strength; remember that this is roughly 15 times larger than the tensile (fracture) strength. For composites it is the tensile strength. For elastomers it is the tear-strength. The energy content per m^3, $q\rho$, is the energy content per kg, q, multiplied by the density, ρ. The guide lines show the loci of points for which

(a) $\sigma_f/q\rho = C$ (minimum energy design of strong ties; maximum rotational velocity of disks)

(b) $\sigma_f^{2/3}/q\rho = C$ (minimum energy design of strong beams and shafts)

(c) $\sigma_f^{1/2}/q\rho = C$ (minimum energy design of strong plates)

The value of the constant C increases as the lines are displaced upwards and to the left. Materials offering the greatest strength per unit energy content lie towards the upper left corner.