Chart 15: Strength, σ_f, against relative cost, $C_R\rho$

The chart guides selection of materials for cheap strong, components (material cost only). 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 relative cost C_R is calculated by taking that for mild steel reinforcing-rods as unity; thus

$$C_R = \frac{\text{cost per unit weight of material}}{\text{cost per unit weight of mild steel}}$$

The guide lines show the loci of points for which

(a) $\sigma_f/C_R\rho = C$ (minimum cost design of strong ties, rotating discs, etc.)

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

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

The value of the constants C increase as the lines are displaced upwards and to the left. Materials offering the greatest strength per unit cost lie towards the upper left corner.