Chart 3: Fracture toughness, K_{Ic}, against density, ρ

Linear-elastic fracture mechanics describes the behaviour of cracked, brittle solids. It breaks down when the fracture toughness is large and the section is small; then J-integral methods should be used. The data shown here are adequate for the rough calculations of conceptual design and as a way of ranking materials. The chart guides selection of materials for light, fracture-resistant components. The guide lines show the loci of points for which:

(a) $K_{Ic}^{4/3}/\rho = C$ (minimum weight design of brittle ties, maximum rotational velocity of brittle discs, etc.)
$K_{Ic}/\rho = C$

(b) $K_{Ic}^{4/5}/\rho = C$ (minimum weight design of brittle beams and shafts)
$K_{Ic}^{2/3}/\rho = C$

(c) $K_{Ic}^{2/3}/\rho = C$ (minimum weight design of brittle plates)
$K_{Ic}^{1/2}/\rho = C$

The value of the constant C increases as the lines are displaced upwards and to the left. Materials offering the greatest toughness-to-weight ratio lie towards the upper left corner.