Seleção de Materiais

SMM0194 – Engenharia e Ciência dos Materiais II

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Eixo cilíndrico sólido submetido a uma tensão de torção

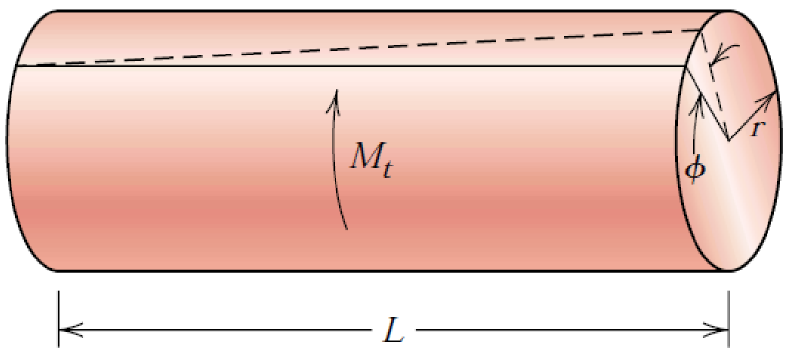

FIGURE 20.1 A solid cylindrical shaft that experiences an angle of twist ϕ in response to the application of a twisting moment M_t.

Procuramos um material que resulte em um cilindro com resistência suficiente para a aplicação desejada, menor massa (visando a economia de combustível, por exemplo) e de menor custo.

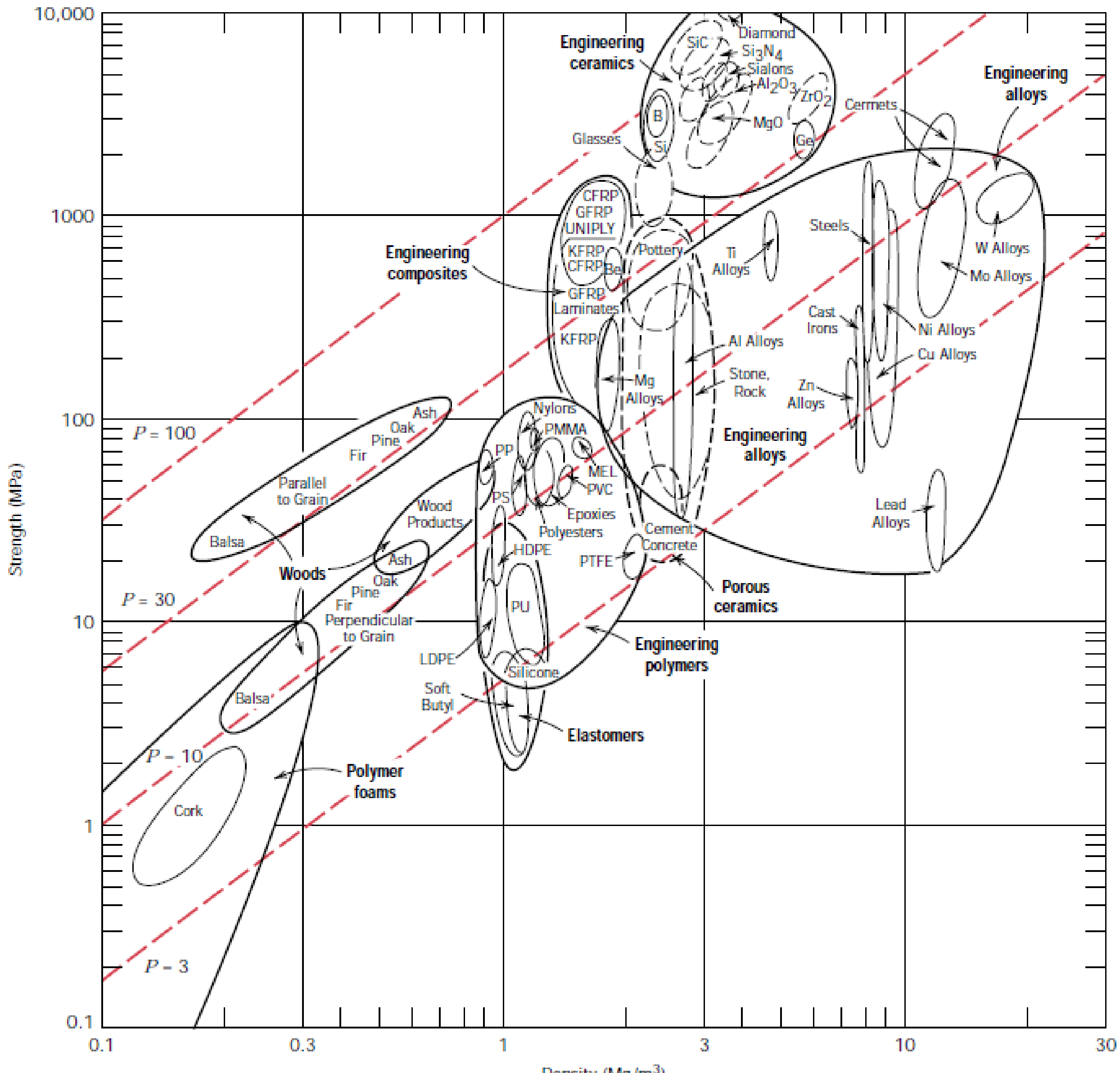

FIGURE 20.2 Strength versus density materials selection chart. Design guidelines for performance indices of 3, 10, 30, and 100 $(MPa)^{2/3}m^3/Mg$ have been constructed, all having a slope of $\frac{3}{2}$. (Adapted from M. F. Ashby, *Materials Selection in Mechanical Design*. Copyright © 1992. Reprinted by permission of Butterworth-Heinemann Ltd.)

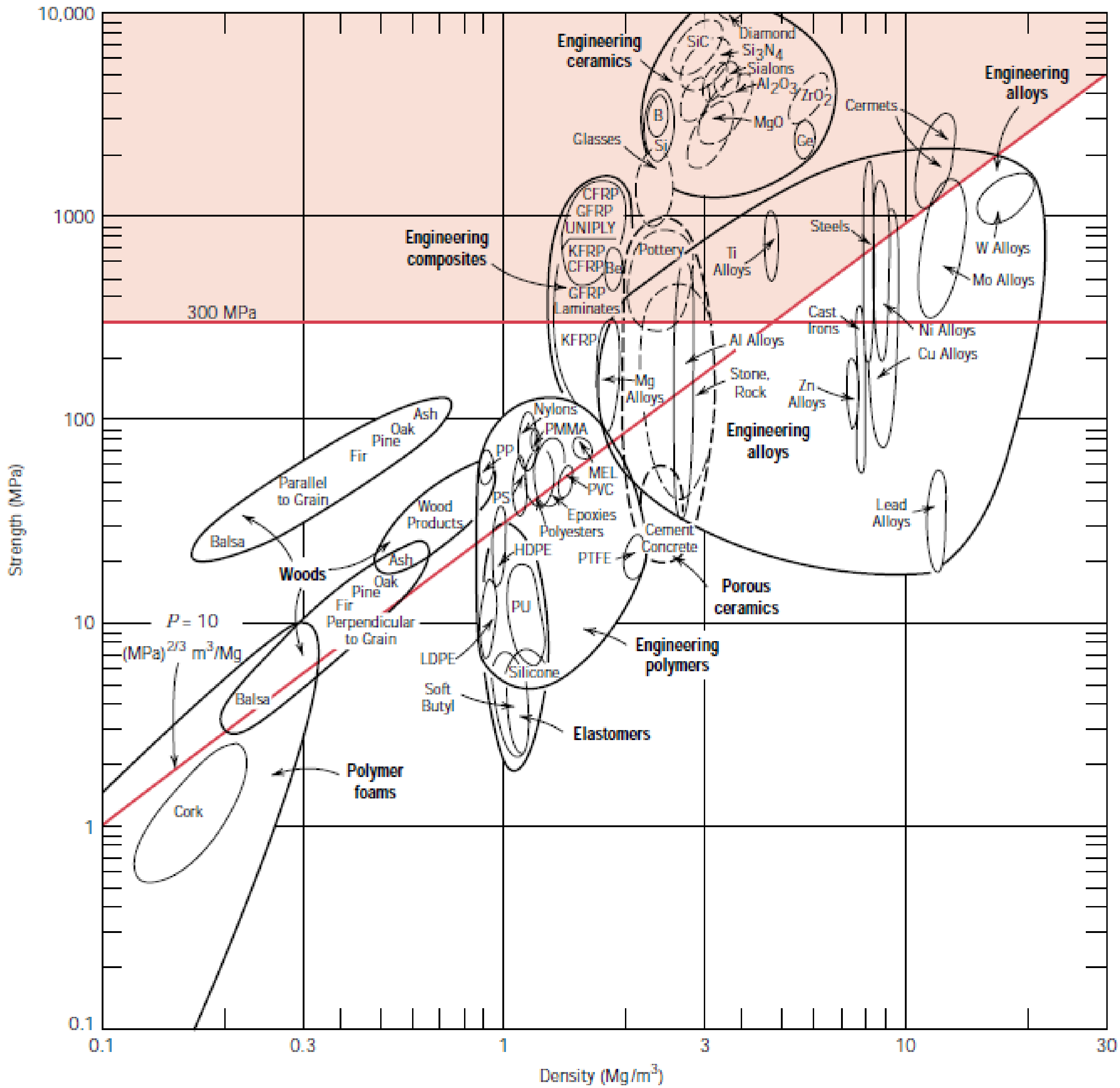

FIGURE 20.3 Strength versus density materials selection chart. Those materials lying within the shaded region are acceptable candidates for a solid cylindrical shaft which has a mass-strength performance index in excess of 10 $(MPa)^{2/3}m^3/Mg$, and a strength of at least 300 MPa (43,500 psi). (Adapted from M. F. Ashby, *Materials Selection in Mechanical Design*. Copyright © 1992. Reprinted by permission of Butterworth-Heinemann Ltd.)

Table 20.1 Density (ρ), Strength (τ_f), the Performance Index (P) for Five Engineering Materials

Material	ρ (Mg/m^3)	τ_f (MPa)	$\tau_f^{2/3}/\rho = P$ [$(MPa)^{2/3}m^3/Mg$]
Carbon fiber-reinforced composite (0.65 fiber fraction) [a]	1.5	1140	72.8
Glass fiber-reinforced composite (0.65 fiber fraction) [a]	2.0	1060	52.0
Aluminum alloy (2024-T6)	2.8	300	16.0
Titanium alloy (Ti-6Al-4V)	4.4	525	14.8
4340 Steel (oil-quenched and tempered)	7.8	780	10.9

[a] The fibers in these composites are continuous, aligned, and wound in a helical fashion at a 45° angle relative to the shaft axis.

Table 20.2 **Tabulation of the $\rho/\tau_f^{2/3}$ Ratio, Relative Cost ($\bar{c}$), and the Product of $\rho/\tau_f^{2/3}$ and $\bar{c}$ for Five Engineering Materials**[a]

Material	$\rho/\tau_f^{2/3}$ [10^{-2} {Mg/(MPa)$^{2/3}$m^3}]	$\bar{c}$ (\$/\$)	$\bar{c}(\rho/\tau_f^{2/3})$ [10^{-2} (\$/\$){Mg/(MPa)$^{2/3}$m^3}]
4340 Steel (oil-quenched and tempered)	9.2	5	46
Glass fiber-reinforced composite (0.65 fiber fraction)[b]	1.9	40	76
Aluminum alloy (2024-T6)	6.2	15	93
Carbon fiber-reinforced composite (0.65 fiber fraction)[b]	1.4	80	112
Titanium alloy (Ti-6Al-4V)	6.8	110	748

[a] The relative cost is the ratio of the prices per unit mass of the material and low-carbon steel.

[b] The fibers in these composites are continuous, aligned, and wound in a helical fashion at a 45° angle relative to the shaft axis.