12.43 For this problem, the load is given at which a circular specimen of aluminum oxide fractures when subjected to a three-point bending test; we are then are asked to determine the load at which a specimen of the same material having a square cross-section fractures. It is first necessary to compute the flexural strength of the aluminum oxide, Equation 12.7b, and then, using this value, we may calculate the value of F_f in Equation 12.7a. From Equation 12.7b

$$\sigma_{fs} = \frac{F_f L}{\pi R^3}$$

$$= \frac{(3000\ \text{N})(40\ \text{x}\ 10^{-3}\ \text{m})}{(\pi)(5.0\ \text{x}\ 10^{-3}\ \text{m})^3} = 306\ \text{x}\ 10^6\ \text{N/m}^2 = 306\ \text{MPa}\quad (42,970\ \text{psi})$$

Now, solving for F_f from Equation 12.7a, realizing that $b = d = 12$ mm, yields

$$F_f = \frac{2\sigma_{fs} d^3}{3L}$$

$$= \frac{(2)(306\ \text{x}\ 10^6\ \text{N/m}^2)(15\ \text{x}\ 10^{-3}\text{m})^3}{(3)(40\ \text{x}\ 10^{-3}\text{m})} = 17,200\ \text{N}\quad (3870\ \text{lb}_\text{f})$$