ERRATA for

PE Mechanical: Machine Design and Materials Practice Exam

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Revisions are shown in red.

Question 24:

The hydraulic cylinder shown in the figure has a 2.75-in.-diameter piston (area, A = 5.94 in^2) and is subjected to a maximum load from a maximum pressure of 3,000 psi. The effective column length of the high-strength rod is 50 in. The rod end is guided. Assume both ends are pinned. Use a safety factor of 2.0 with respect to buckling on a material having a yield strength of 36,500 psi and modulus of elasticity of 30 × 10^6 psi. The required rod diameter (in.) is most nearly:

Question 41:

Rivet diameter, d_R = 5/8 in.

Safety factor, SF = 5

Shear strength of rivets, τ_R = 44,000 psi

Tensile strength of plate, σ_P = 55,000 psi

Rivet bearing strength, σ_{RB} = 100,000 psi

Plate bearing strength, σ_{PB} = 95,000 psi

Solution 24:

Entire solution is replaced.

Moment of inertia:

$$I = \frac{\pi d^4}{64} \qquad A = \frac{\pi d^2}{4}$$

Slenderness ratio:

$$S_r = \frac{l}{r} = \frac{l}{\sqrt{\frac{I}{A}}} = \frac{4l}{d}$$

Safety margin = 2

Load applied, $F = 2 \times \frac{\pi}{4}(2.75)^2 \times 3{,}000 = 35{,}637$

$$(S_r)_D = \sqrt{\frac{2\pi^2 \times 30 \times 10^6}{1^2 \times 36{,}500}} = 127$$

Assume intermediate column.

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Solution 24 continued:

$$35,637 = \frac{\pi}{4} d^2 \left[36,500 - \frac{1^2}{30 \times 10^6} \left(\frac{36,500}{2\pi} \times \frac{4 \times 50}{d} \right)^2 \right]$$

$$35,637 = 28,667 d^2 - 35,339$$

$$d = 1.58 \text{ in.}$$

$$S_r = \frac{4 \times 50}{1.58} = 126.21$$

$$S_r < (S_r)_D$$

$126.21 < 127$ Hence intermediate

Check against compressive yield required diameter.

$$A = \frac{\sigma_{\text{yield}}}{F} = \frac{36,500}{35,637}$$

$$\frac{\pi}{4} d_{\text{yield}}^2 = \frac{36,500}{35,637}$$

$$d_{\text{yield}} = 1.14$$

$$d > d_{\text{yield}}$$

$1.57 > 1.14$

THE CORRECT ANSWER IS: C

Solution 40:
Failure of the plate:

$$P_{\text{tensile}} = (12,000 \text{ psi})(1.5 \text{ in.} - 0.5 \text{ in.})\left(\frac{3}{8} \text{ in.}\right) = 4,500 \text{ lb}$$

$$P_{\text{bearing}} = 25,000(0.5)\left(\frac{3}{8} \text{ in.}\right) = 4,688 \text{ lb}$$

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Solution 41:

Rivet shear:

$$F_{RS} = 2\left(\frac{1}{4}\pi d_R^2\right)\frac{\tau_R}{\text{SF}} = \frac{1}{2}\left[\frac{1}{4}\pi\left(\frac{5}{8}\right)^2\right]\left(\frac{44{,}000}{5}\right) = 5{,}400 \text{ lbf}$$

Plate bearing:

$$\frac{\sigma_{PB}}{\text{SF}} = \frac{F_{PB}}{2td_R} \qquad F_{PB} = \left(\frac{95{,}000}{5}\right)(2)\left(\frac{3}{16}\right)\left(\frac{5}{8}\right) = 4{,}453 \text{ lbf}$$

Rivet bearing:

$$\frac{\sigma_{RB}}{\text{SF}} = \frac{F_{RB}}{2td_R} \qquad F_{RB} = \left(\frac{100{,}000}{5}\right)(2)\left(\frac{3}{16}\right)\left(\frac{5}{8}\right) = 4{,}687 \text{ lbf}$$

Plate tensile failure:

$$F_{PT} = \left[5 - 2\left(d_R\right)\right]t\frac{\sigma_P}{\text{SF}} = \left[5 - 2\left(\frac{5}{8}\right)\right]\left(\frac{3}{16}\right)\left(\frac{55{,}000}{5}\right) = 7{,}476 \text{ lbf}$$

Solution 54:

$$\theta = \frac{TL}{GJ} = \frac{(1{,}890)60 \text{ in.}}{\left(11.5 \times 10^6\right)(0.09817)} = 0.1004 \text{ rod} = 5.7°$$