PROB 3-20 FS | USING THE PREVIOUS RESULTS FOR 3-20 AND A FACTOR OF SAFETY OF 2. DETERMINE A MATERIAL IN TABLE A-22 THAT CAN BE SAFELY USED.

GIVEN:
1. PRINCIPAL STRESSES $\sigma_1 = 21.04$ ksi, $\sigma_2 = 5.27$ ksi, $\sigma_3 = -27.71$ ksi
2. FACTOR OF SAFETY

ASSUMPTIONS:
1. LINEAR ELASTIC RESPONSE
2. MATERIAL BELOW YIELD

FIND:
1. AN APPROPRIATE MATERIAL FROM A-22

SOLUTION:

$$\sigma_{vm} = \sqrt{\frac{1}{2}\left[(\sigma_1-\sigma_2)^2 + (\sigma_1-\sigma_3)^2 + (\sigma_2-\sigma_1)^2\right]} = \sqrt{\frac{1}{2}\left[(21.04\,ksi - 5.27\,ksi)^2 + (21.04\,ksi + 27.71\,ksi)^2 + (5.27\,ksi + 27.71\,ksi)^2\right]}$$

$$= 43.09 \text{ ksi}$$

$$\sigma_{vm} = \frac{S_y}{n} \implies S_{y,min} = n \cdot \sigma_{vm} = 2 \cdot 43.09\,ksi = 86.17\,ksi$$

THE ONLY TWO MATERIALS THAT CAN BE LOADED AS STATED ARE STEEL 1045 & 4142

Table A-22

Results of Tensile Tests of Some Metals* Source: J. Datsko, "Solid Materials," chap. 32 in Joseph E. Shigley, Charles R. Mischke, and Thomas H. Brown, Jr. (eds.-in-chief), Standard Handbook of Machine Design, 3rd ed., McGraw-Hill, New York, 2004, pp. 32.49–32.52.

Number	Material	Condition	Strength (Tensile) Yield S_y MPa (kpsi)	Ultimate S_u MPa (kpsi)	Fracture, σ_f MPa (kpsi)	Coefficient σ_0 MPa (kpsi)	Strain Strength, Exponent m	Fracture Strain ϵ_f
1018	Steel	Annealed	220 (32.0)	341 (49.5)	628 (91.1)†	620 (90.0)	0.25	1.05
1144	Steel	Annealed	358 (52.0)	646 (93.7)	898 (130)‡	992 (144)	0.14	0.49
1212	Steel	HR	193 (28.0)	424 (61.5)	729 (106)‡	758 (110)	0.24	0.85
1045	Steel	Q&T 600°F	1520 (220)	1580 (230)	2380 (345)	1880 (273)‡	0.041	0.81
4142	Steel	Q&T 600°F	1720 (250)	1930 (280)	2340 (340)	1760 (255)‡	0.048	0.43
303	Stainless steel	Annealed	241 (35.0)	601 (87.3)	1520 (221)‡	1410 (205)	0.51	1.16
304	Stainless steel	Annealed	276 (40.0)	568 (82.4)	1600 (233)‡	1270 (185)	0.45	1.67
2011	Aluminum alloy	T6	169 (24.5)	324 (47.0)	325 (47.2)†	620 (90)	0.28	0.10
2024	Aluminum alloy	T4	296 (43.0)	446 (64.8)	533 (77.3)‡	689 (100)	0.15	0.18
7075	Aluminum alloy	T6	542 (78.6)	593 (86.0)	706 (102)†	882 (128)	0.13	0.18

*Values from one or two heats and believed to be attainable using proper purchase specifications. The fracture strain may vary as much as 100 percent.
†Derived value.