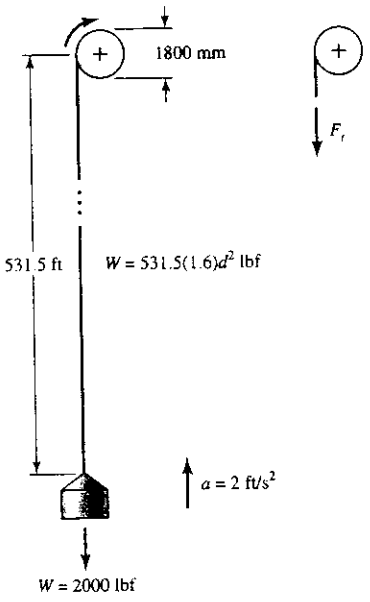
EXAMPLE 17–6 Given a 6 × 19 monitor steel ($S_u = 1655$ MPa) wire rope.
(*a*) Develop the expressions for rope tension F_t, fatigue tension F_f, equivalent bending tensions F_b, and fatigue factor of safety n_f for a 162-m, 8900-N cage-and-load mine hoist with a starting acceleration of 0.6 m/s^2 as depicted in Fig. 17–23. The sheave diameter is 1800 mm.
(*b*) Using the expressions developed in part (*a*), examine the variation in factor of safety n_f for various wire rope diameters d and number of supporting ropes m.

Solution (*a*) Rope tension F_t from Eq. (17–46) is given by

Answer
$$F_t = \left(\frac{W}{m} + wi\right)\left(1 + \frac{a}{g}\right) = \left[\frac{8900}{m} + 36.184d^2(162)\right]\left(1 + \frac{0.6}{9.81}\right)$$
$$= \frac{9444}{m} + 6.22d^2 \text{ N}$$

Table 17-27

Figure 17–23
Geometry of the mine hoist of Ex. 17–6.



For max. life

From Fig. 17–21, use $p/S_u = 0.0014$. Fatigue tension F_f from Eq. (17–47) is given by

Answer
$$F_f = \frac{(p/S_u)S_u Dd}{2} = \frac{0.0014(1655)(1800)d}{2} = 2085.3d \text{ N}$$

Equivalent bending tension F_b from Eq. (17–48) and Table 17–27 is given by

Answer
$$F_b = \frac{E_r d_w A_m}{D} = \frac{(83\,000)0.067d(0.40d^2)}{1800} = 1.236d^3 \text{ N}$$

Factor of safety n_f in fatigue from Eq. (17–50) is given by

Answer
$$n_f = \frac{F_f - F_b}{F_t} = \frac{2085.3d - 1.236d^3}{9444/m + 6.22d^2}$$

(*b*) Form a table as follows:

	n_f			
d	$m = 1$	$m = 2$	$m = 3$	$m = 4$
6	1.27	2.48	3.63	4.74
9.5	1.87	3.55	5.05	6.42
12.5	2.27	4.15	5.74	7.10
16	2.56	4.48	5.97	7.12 ← max.
19	2.66	4.47	5.77	6.76
22	2.63	4.23	5.31	6.09
25	2.46	3.81	4.66	5.25

Wire rope sizes are discrete, as is the number of supporting ropes. Note that for each m the factor of safety exhibits a maximum. Predictably the largest factor of safety increases with m. If the required factor of safety were to be 6, only three or four ropes could meet