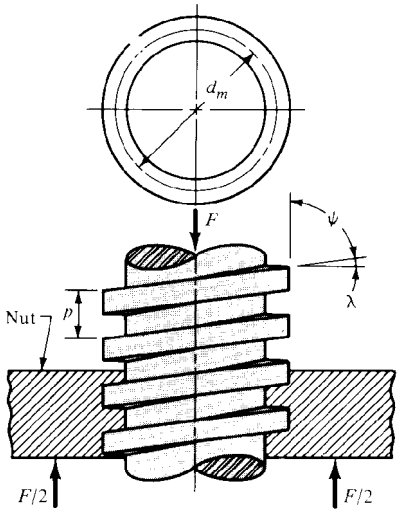
POWER SCREW EXAMPLE PROBLEM

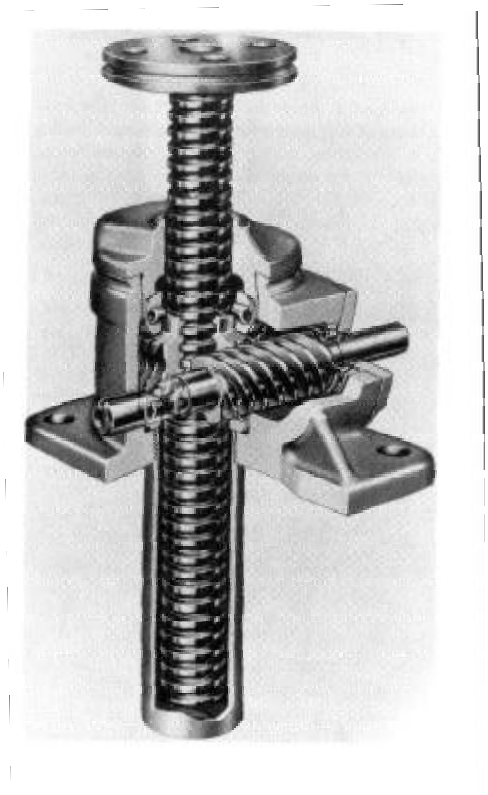
Reference: Shigley/page 332.

A square thread power screw has a major diameter of 32-mm and a pitch of 4-mm with double threads, and it is to be used in an application similar to that of the figure below. Applicable data are thread and collar coefficient of friction equal to 0.08, collar diameter of 40-mm, and a load of 6.4-kN per screw. Determine:

a. Thread depth, thread width, mean or pitch diameter, minor diameter, and lead.
b. Torque required to rotate the screw "against" the load.
c. Torque required to rotate the screw "with" the load.
d. Overall efficiency.



Power Screw



Joyce worm-gear
Screw Jack

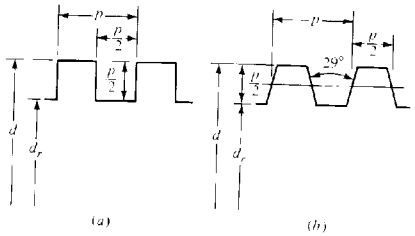
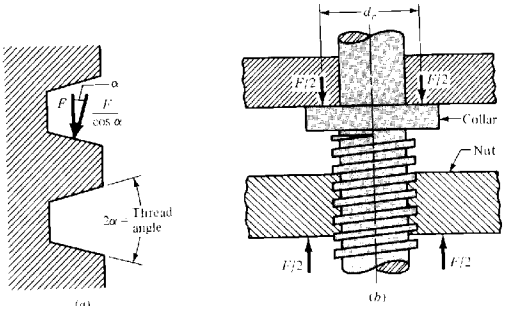


FIGURE 8-3
(a) Square thread; (b) Acme thread.

TABLE 8-3
Preferred Pitches for Acme Threads

d, in	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	1	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{3}{4}$	2	$2\frac{1}{2}$	3
p, in	$\frac{1}{16}$	$\frac{1}{14}$	$\frac{1}{12}$	$\frac{1}{10}$	$\frac{1}{8}$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{5}$	$\frac{1}{5}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{3}$

Square And Acme Threads with Preferred Pitches for Acme Threads



Screw Thread with Thrust Collar

(a) From the square thread figure above, it can be seen the thread depth and width are the same and equal to half the pitch, or 2-mm. Also

$$d_m = d - \frac{P}{2} = 32 - \frac{4}{2} = 30mm$$
$$d_r = d - P = 32 - 4 = 28mm$$
$$l = nP = 2 \times 4 = 8mm$$

(b) For a square thread, the torque required to raise the load is:

$$T_R = \frac{Fd_m}{2}\left(\frac{l + p m d_m}{p d_m - m l}\right) + \frac{F m_c d_c}{2}$$
$$T_R = \frac{6{,}400 \times 0.030}{2}\left(\frac{0.008 + p\,(0.08)(0.030)}{p\,(0.030) - 0.08(0.008)}\right) + \frac{6{,}400 \times 0.08 \times 0.040}{2}$$
$$T_R = 15.94 + 10.24 = 26.2\,Nm$$

(c) The torque required to lower the load, rotate the screw with the aid of the load is:

$$T_L = \frac{Fd_m}{2}\left(\frac{p\mu d_m - l}{p d_m + \mu l}\right) + \frac{F\mu_c d_c}{2}$$

$$T_L = \frac{6{,}400 \times 0.030}{2}\left(\frac{p(0.08)(0.030) - 0.008}{p(0.030) + 0.08(0.008)}\right) + \frac{6{,}400 \times 0.08 \times 0.040}{2}$$

$$T_L = -0.47 + 10.24 = 9.8 Nm$$

The negative sign in the first term indicates the screw alone is not self-locking and would rotate under the action of the load except for the fact collar friction is present; and, must be overcome, too. That is, torque required to rotate the screw "with" the load is less than necessary to overcome collar friction alone.

(d) Overall efficiency is:

$$h = \frac{Fl}{2pT} = \frac{6{,}400 \times 0.008}{2p(26.2)} = 0.31$$