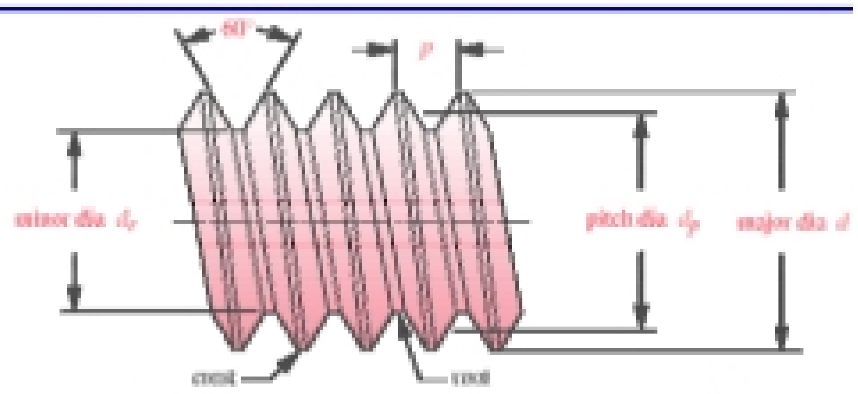
Fastening (more complex shapes = better function)

- Non-permanent
  - Bolted
- Permanent
  - Bolted
  - Welded
  - Bonded

Outline

- General Thread Nomenclature & Types
- Power Screws
- Stresses in Threads
- Preloading Fasteners/Joints
- Fasteners in Shear

Threads



p	pitch	in./thread
d	diameter (major)	in.
d_p	pitch diameter	in.
d_r	minor diameter	in.
L	Lead	in.

Screw Classifications

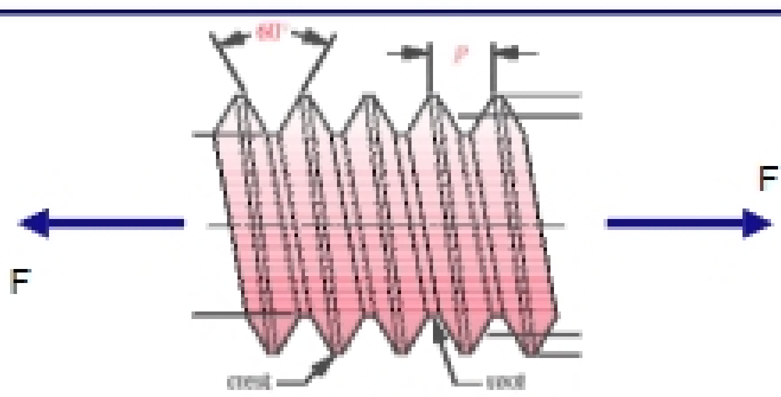
	Unified National Standard	ISO (Metric)
Thread Pitch	UNC –coarse UNF –fine UNEF –extra fine	coarse fine
Tolerance	Class 1 Class 2 Class 3	several levels

d=0.25" → ¼-20 UNF –2A (fine; Class 2; 20 threads/in.; external threads)

metric → M12 x 1.75 (d=12mm; p=1.75 mm/thread)

see Tables 14-1 and 14-2 for standard sizes

Tensile Stress



$$\sigma_t = \frac{F}{A_t} \qquad A_t = \frac{\pi}{4}\left(\frac{d_p}{2}+\frac{d_r}{2}\right)^2$$

A_t also in Tables 14-1 and 14-2

Outline

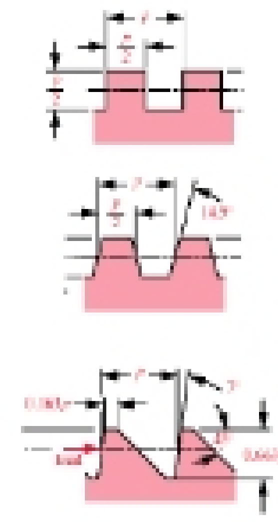
- General Thread Nomenclature & Types
- Power Screws
  - Threads
  - Loads
  - Self-locking
  - Efficiency
- Stresses in Threads
- Preloading Fasteners/Joints
- Fasteners in Shear

Power Screw Applications

Where have you seen power screws?

- jacks for cars
- C-clamps
- vises
- Instron material testing machines
- machine tools (for positioning of table)

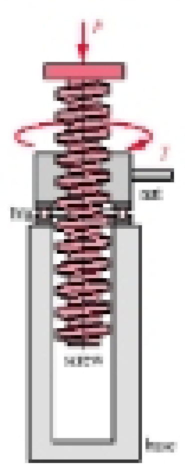
Power Screw Types

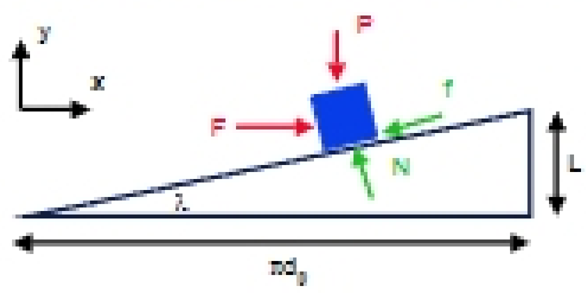


- Square
  - strongest
  - no radial load
  - hard to manufacture
- Acme
  - 29° included angle
  - easier to manufacture
  - common choice for loading in both directions
- Buttress
  - great strength
  - only unidirectional loading

Load Analysis

What "simple machine" does a power screw utilize?





$$\tan\lambda = \frac{L}{\pi d_p} \qquad T_{S_u} = \frac{P d_p}{2}\frac{(\mu\pi d_p + L)}{(\pi d_p - \mu L)}$$

Friction Coefficients

$$\mu_{\text{oil lubricated}} = \mu_{\text{collar w/ bushing}} = 0.15 \pm 0.05$$

$$\mu_{\text{collar w/ bearing}} = 0.015 \pm 0.005$$

Ball Screw

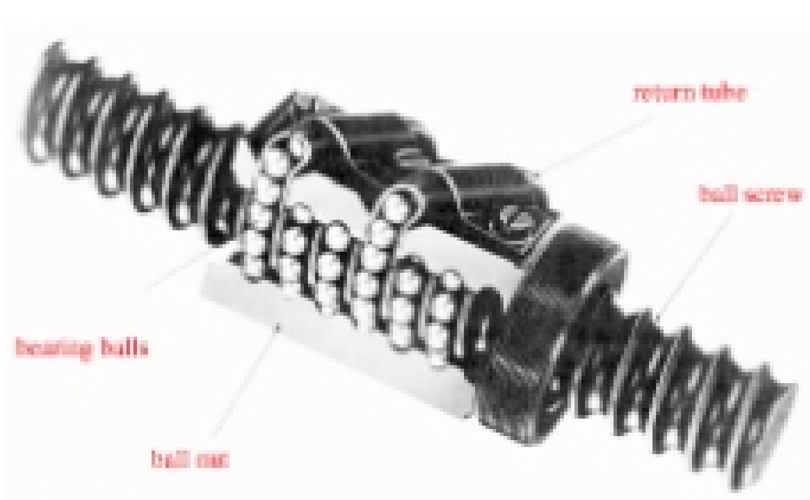


FIGURE 14-9

Outline

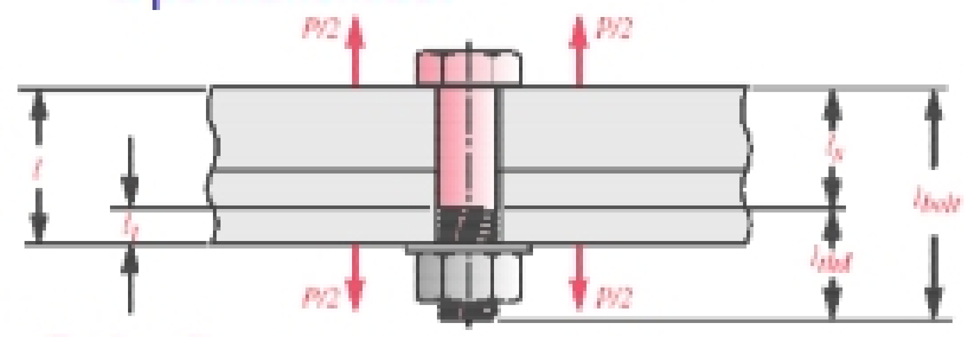
- General Thread Nomenclature & Types
- Power Screws
- Stresses in Threads
  - Body Stresses
    - Axial
    - Torsion
  - Thread Stresses
    - Bearing
    - Bending
  - Buckling
- Preloading Fasteners/Joints
- Fasteners in Shear

Outline

- General Thread Nomenclature & Types
- Power Screws
- Stresses in Threads
- Preloading Fasteners/Joints
  - Proof Strength
  - Spring Behavior
  - Loading & Deflection
  - Separation of Joints
- Fasteners in Shear

Preloading & Proof Strength

- S_p → stress at which bolt begins to take a permanent set

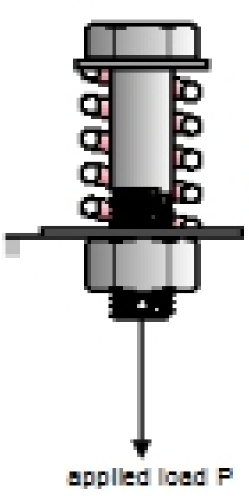


Preloading

- static loading: preload at roughly 90% of S_p
- dynamic loading: preload at roughly 75% of S_p

Spring Behavior

BOTH material being clamped and bolt behave as springs (up to yield/permanent set stresses)



$$k = \frac{AE}{l}$$

for the bolt, threaded vs unthreaded have different spring constants:

$$\frac{1}{k_b} = \frac{l_t}{A_t E_b} + \frac{l_s}{\frac{\pi d^2}{4} E_b}$$

Strategy Reviewed

See Example 14-2, p. 906

Given: joint dimensions

Find: bolt

set preload equal to 90% S_p
find l_t so that you can find k_b
find k_m

calculate C, then P_b, P_m, then F_b, F_m
find stress in bolt and seperation load

Such that: factors of safety>1

Dynamic Loading of Fasteners

- Bolt only absorbs small % of P
- Stresses
  - Bolt is in tension
  - Material is in compression
- Fatigue is a tensile failure phenomenon
- ∴ Preloading helps tremendously in fatigue

Outline

- General Thread Nomenclature & Types
- Power Screws
- Stresses in Threads
- Preloading Fasteners/Joints
- Fasteners in Shear
  - What is Shear?
  - Straight Direct Shear