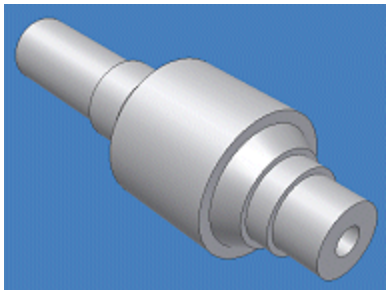
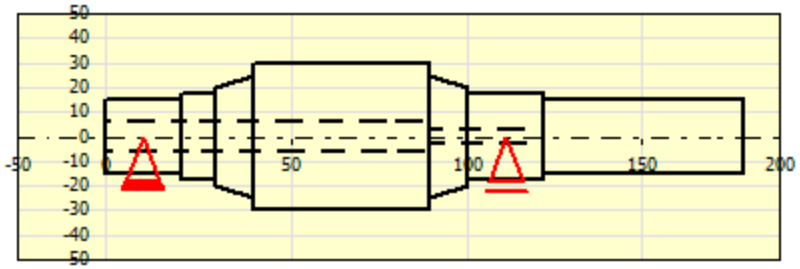
Shafts and Axles





Introduction

- In machinery, the general term "shaft" refers to a member, usually of circular cross-section, which supports gears, sprockets, wheels, rotors, etc., and which is subjected to torsion and to transverse or axial loads acting singly or in combination.
- An "axle" is a non-rotating member that supports wheels, pulleys,… and carries no torque.
- A "spindle" is a short shaft. Terms such as *lineshaft, headshaft, stub shaft, transmission shaft, countershaft,* and *flexible shaft* are names associated with special usage.

Considerations for Shaft Design

1. Deflection and Rigidity

(a) Bending deflection

(b) Torsional deflection

(c) Slope at bearings and shaft supported elements

(d) Shear deflection due to transverse loading of shorter shafts

2. Stress and Strength

(a) Static Strength

(b) Fatigue Strength

(c) Reliability

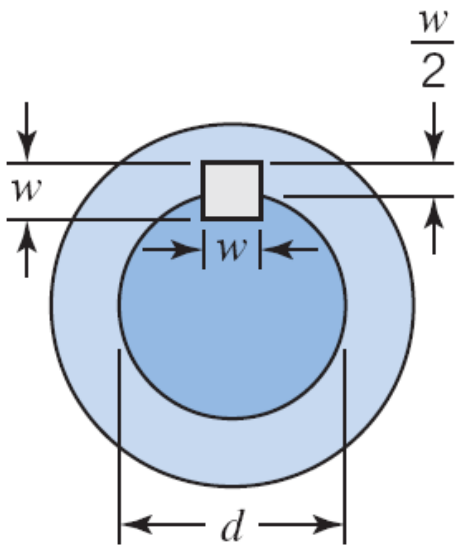
Considerations for Shaft Design

- The geometry of a shaft is that of a stepped cylinder bending.
- Gears, bearings, and pulleys must always be accurately positioned

Common Torque Transfer Elements

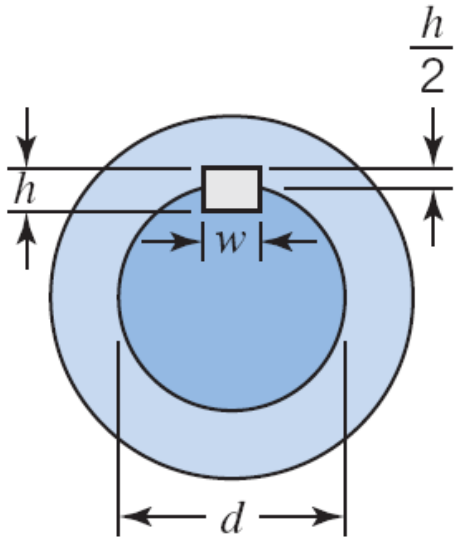
- Keys
- Splines
- Setscrews
- Pins
- Press or shrink fits
- Tapered fits

Common Types of Shaft Keys.



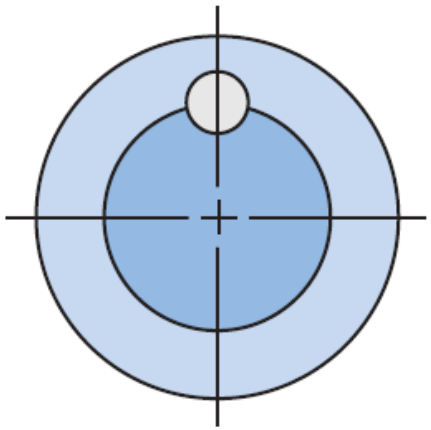
$w \approx d/4$

(a) Square key



$w \approx d/4; \quad h \approx 3w/4$

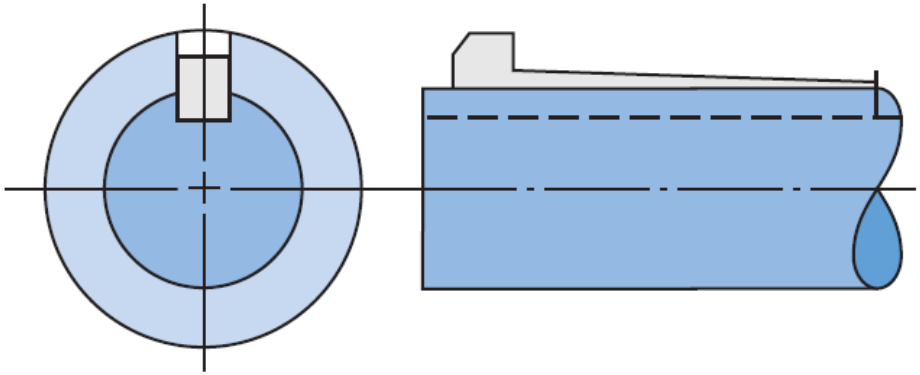
(b) Flat key



Key usually has drive fit; is often tapered

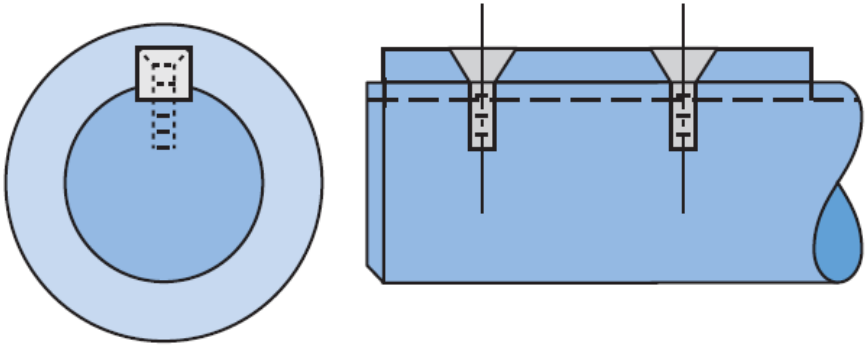
(c) Round key

Common Types of Shaft Keys.



Usually tapered, giving tight fit when driven into place; gib head facilitates removal

(f) Gib-head key



Key is screwed to shaft; hub is free to slide axially – easier sliding is obtained with two keys spaced 180° apart

(g) Feather key

Strength Constraints

The design of a shaft involves the study of

1. Stress and strength analyses: Static and Fatigue
2. Deflection and rigidity
3. Critical Speed