Balance Principle of Rigid Rotor

南台科技大學　機械工程系
王永鵬

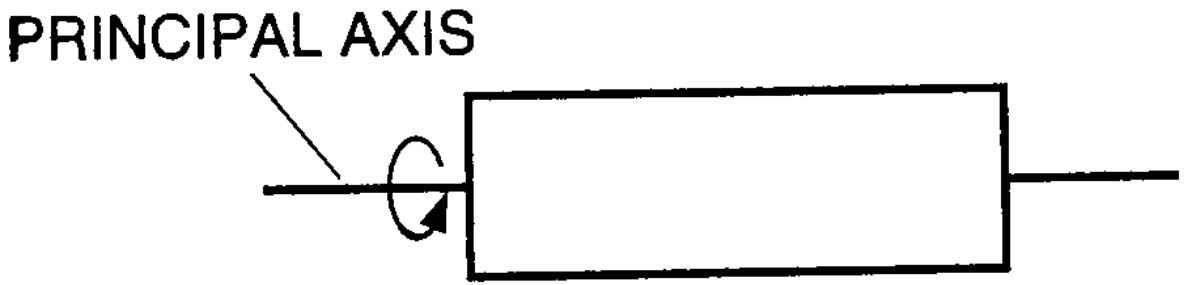
Unbalance

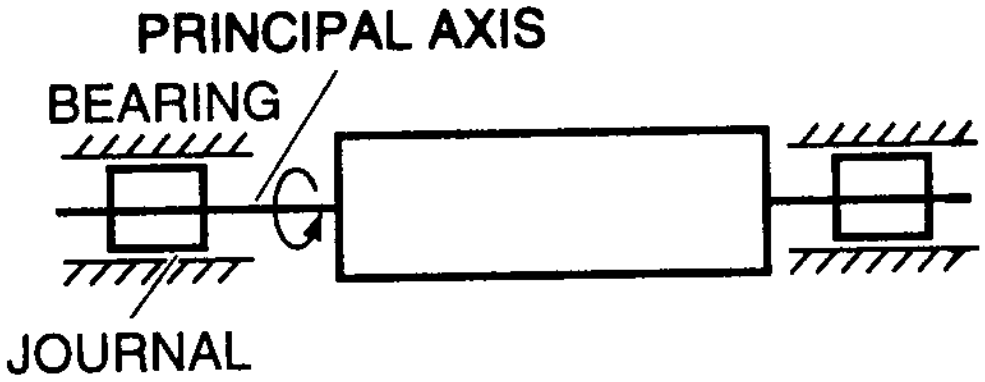
- Perfect Balance
- Rigid Rotor Unbalance
  - Static Unbalance
  - Dynamic Unbalance
- Flexible Rotor Unbalance
  - Critical Speed
  - Mode Shape

Perfect Balance

- A ***rigid rotor*** has a uniform speed of rotation about one of its three principal inertia axes.
- The ***rigid rotor*** rotates about the axis of rotation without wobbing; i.e., the principal axis coincides with a line fixed in space.

Perfect Balance

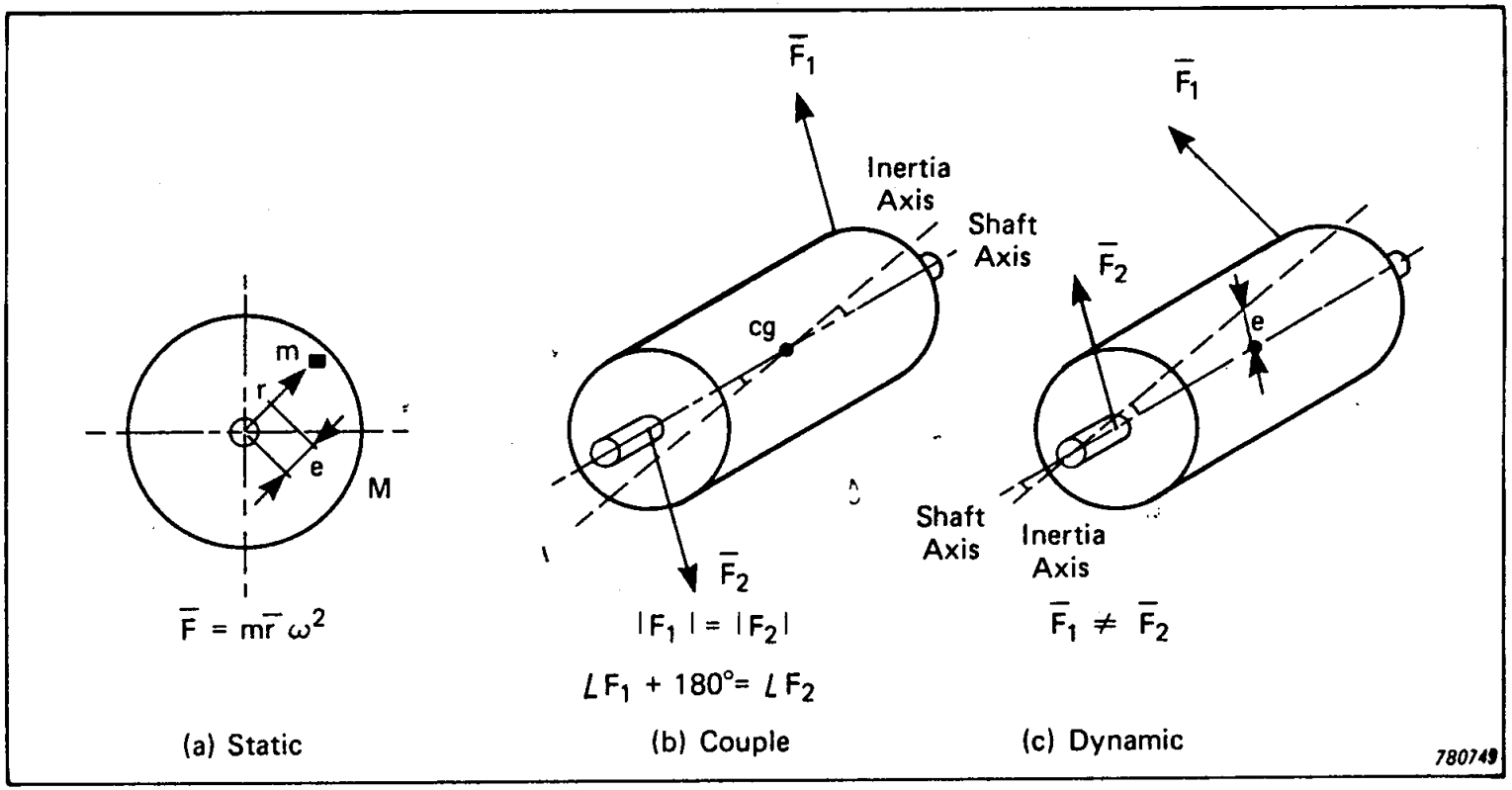




Rigid Rotor Unbalance

- Static Unbalance (Static Balancing)
- Couple Unbalance (Two-Plane Balancing)
  - Static Balance + Nonzero moment about center of mass when rotates
  - Tilting of the principal inertia axis about the shaft axis at the center of mass
- Dynamic Unbalance (Two-Plane Balancing)
  - Static Unbalance + Couple Unbalance
  - The principal inertia axis inclined to the geometric shaft axis

Rigid Rotor Unbalance



Rigid Rotor Unbalance

- Definition of Unbalance
  - $\boldsymbol{M}$: mass of a thin disc (unit: g)
  - $\boldsymbol{m}$: unbalance mass (unit: g)
  - $\boldsymbol{r}$: distance between the unbalance mass and axis of rotation (unit: mm)
  - $\boldsymbol{e}$: eccentricity, specific unbalance (unit: mm)
  - $\boldsymbol{F}$: centrifugal force (unit: μN)
  - $\boldsymbol{\omega}$: speed of rotation (unit: rad/sec)

Rigid Rotor Unbalance

$$F = mr\omega^2$$

$$= Me\omega^2$$

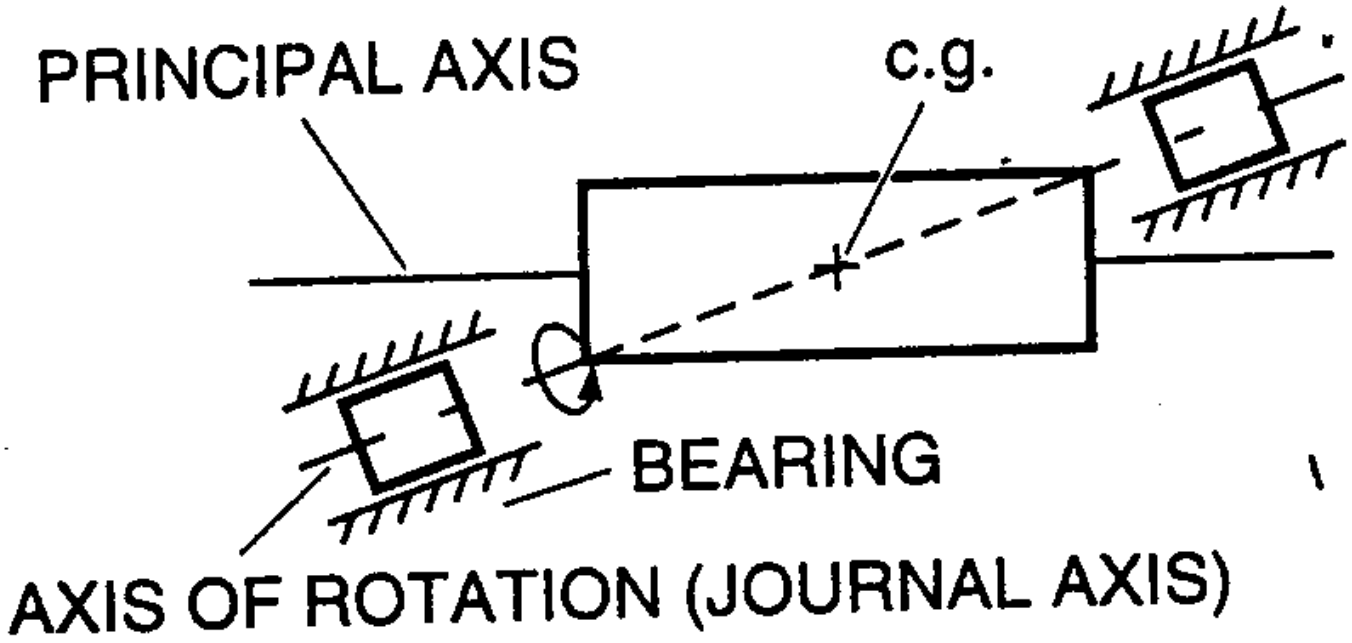
- Unbalance (u):

$$u = mr$$

- Specific Unbalance (e):

$$e = \frac{mr}{M}$$

Rigid Rotor Unbalance



Rigid Rotor Unbalance

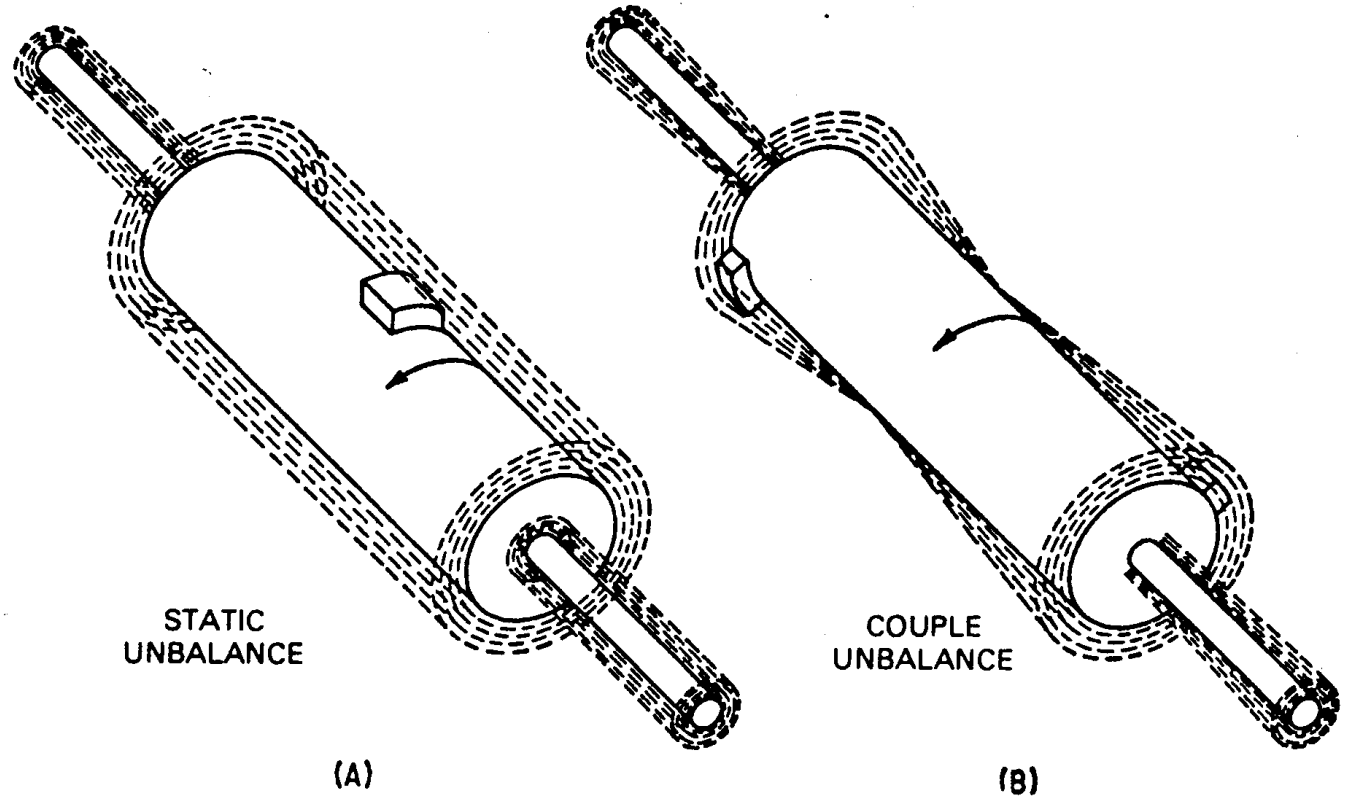
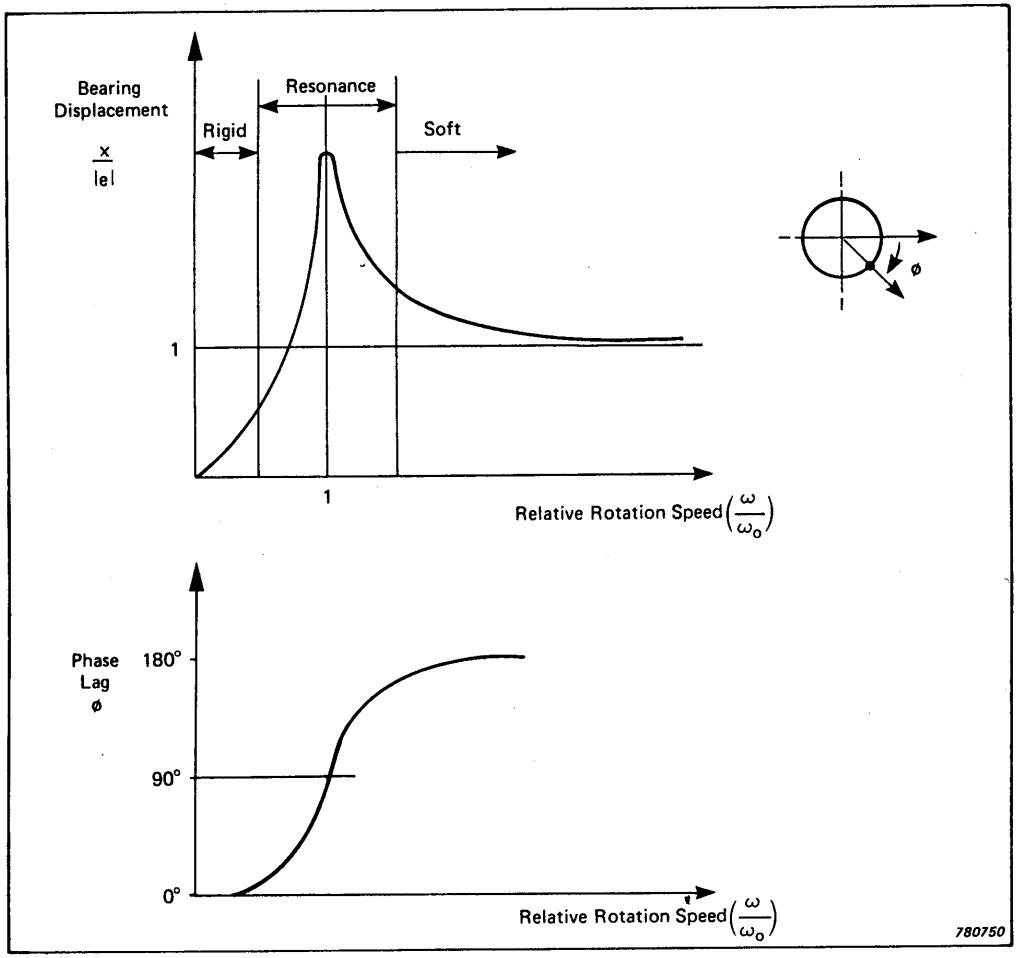


FIGURE 39.8 Effect of static and couple unbalance on free rotor motion.

Rigid Rotor Unbalance

Rigid Rotor and Bearing



Rigid Rotor Unbalance

Rigid Rotor and Bearing