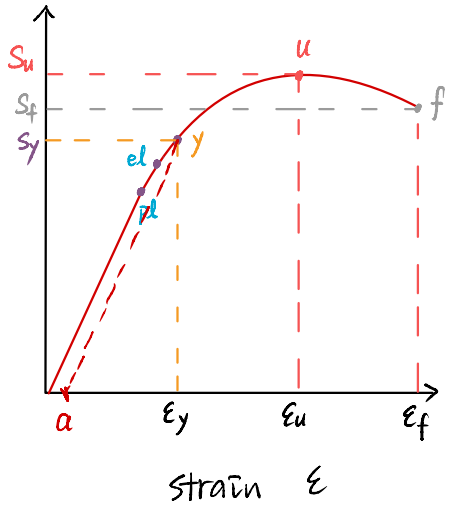
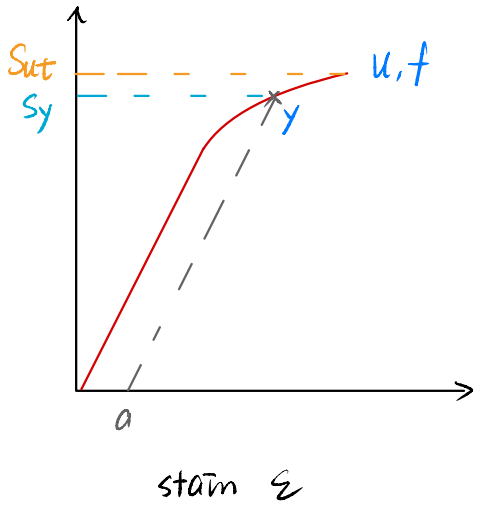
1. Fundamental concepts

(1) Sketch the stress-strain curve of brittle and ductile materials

ductile material



brittle material



Title :

(2) Desirable the below mechanical properties of materials, and mark the parameters in the curves if possible.

- Young's modulus

linear relationship between stress and strain in a material.

. in diagram, slope

. mechanical prop of linear elastic material

measure of stiffness of a solid material.

- Shear modulus

a measure of elastic shear stiffness of a material.

- Poisson's ratio

the coefficient of expansion on transverse axis.

- Yield strength

onset of plastic deformation

- Ultimate strength

maximum stress that can be sustained by a structure in tension

- Toughness

capacity of a material to absorb energy without fatigue.

$$u_T = \int_0^{\varepsilon_f} \sigma \, d\varepsilon$$

- Resilience

capacity of a material to absorb energy within its elastic range.

$$u_R = \int_0^{\varepsilon_y} \sigma \, d\varepsilon$$

Title :

(3) Describe the differences between SN and EN approaches.

△ stress-life method.

- estimate life to fracture, ignoring details of crack nucleation and propagation.
- base on comparison to experimental test specimens.

× NOT USEFUL FOR
- high stresses
- plastic strains
- low cycles

✓ High-cycle fatigue domain

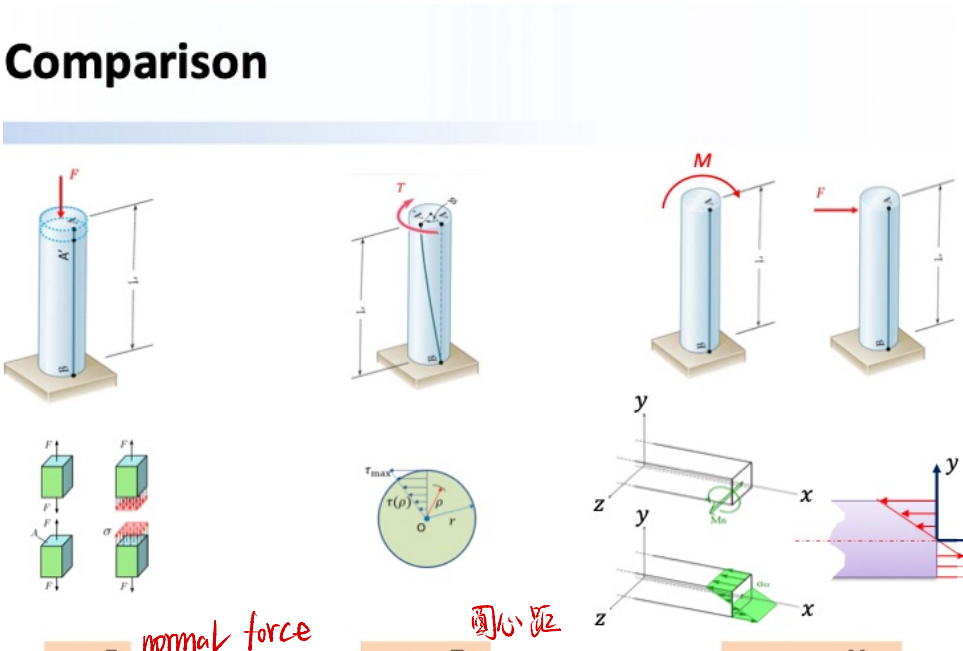
△ strain-life method.

- focus on crack nucleation.
- detailed analysis of plastic deformation at localized regions

✓ low-cycle fatigue domain.

Title :

(5) Write the stress of the columns under axial force, torsion and bending moment, respectively, and specify the parameters in the formulas.



$$\sigma = \frac{F}{A}$$

normal force

=

section area

$$\tau(\rho) = \frac{T\rho}{J_O}$$

圆心 距离

=

polar moment of inertia

$$\sigma_b(y) = -\frac{M_z y}{I_z}$$

=

axial moment of inertia.

(6) Describe the common gear types and their applications

- spur gear
- helical gear
- bevel gear
- worm gear

Title :

(8) How to measure the life of bearing? Describe the definition of L_{10}, C_{10} and C_0, respectively.

- No. of revolution of inner ring, until the first tangible evidence of fatigue.

- No. of hours of use at a standard angular speed until the first tangible evidence of fatigue.

L_{10} : Rating life, life required for 10% sample to fail.

C_{10} : catalog load rating, constant radial load cause 10% groups of bearings to fail at the bearing manufacturer's rating life.

C_0 : static load rating, static radial load corresponds to a permanent deformation of rolling element and race at the most heavily stressed contact of 0.0001 d.

(9) Describe the meaning of the numbers in the bolt specification M12 × 1.75.

12 : nominal diameter

1.75 : pitch

Worm:

- Lead angle λ
- Lead L

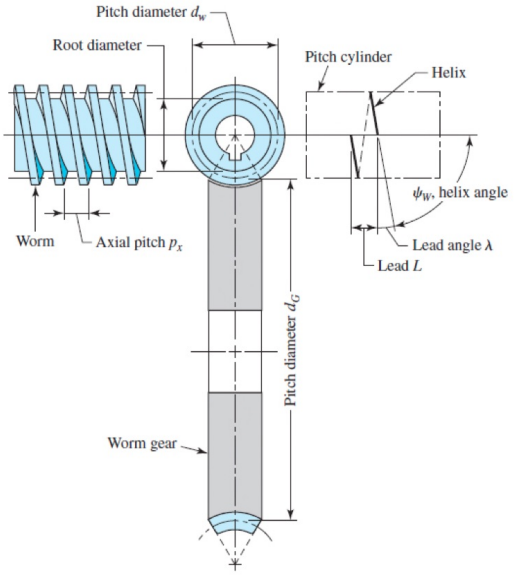
- Axial pitch p_x
- Pitch diameter of the worm d_W

Gear:

- Helix angle ψ_G
- Transverse circular pitch p_t
- Pitch diameter of the gear d_G

When the shaft angle is 90°, what is the relation between the axial pitch p_x and transverse circular pitch p_t?

$p_x = p_t$



(14) How to estimate the tensile strength, torsional yield strength for spring materials?

$$S_{ut} = \frac{A}{d^m}$$

$$S_{sy} = 0.45\, S_{ut}$$

seen Table 10.4 、10.6 (pp.517 , pp.518)

Title :

(7) Describe the features of flexible drives

✓ advantages

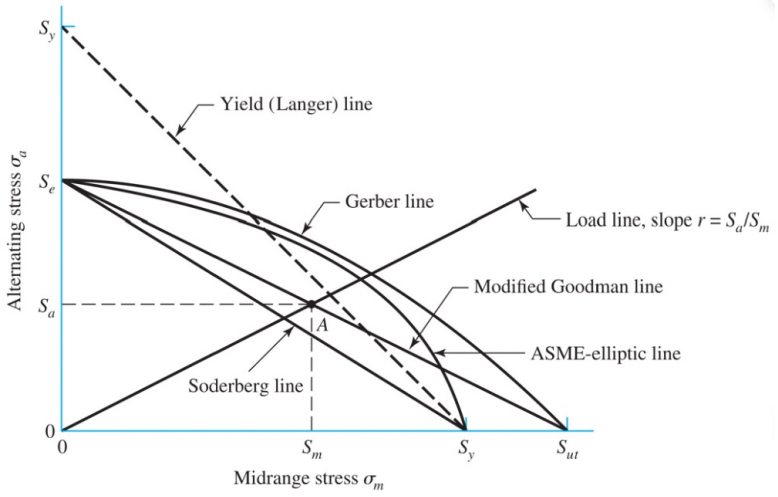
- long distances between shafts
- less expensive
- adjustable centers
- tolerates some misalignment better than gears

× disadvantages

- not as compact as gears
- same speed limits
- power and torque limits
- short life than gears, shafts

(4) Sketch the diagrams of the Soderberg, the modified Goodman, the Gerber and the ASME-elliptic criteria.

Fatigue failure criteria	safety factor n	
	$\sigma_a \Longrightarrow n\sigma_a$ $\sigma_m \Longrightarrow n\sigma_m$	
Soderberg	$\frac{S_a}{S_e}+\frac{S_m}{S_y}=1$	$\frac{\sigma_a}{S_e}+\frac{\sigma_m}{S_y}=\frac{1}{n}$
Mod-Goodman	$\frac{S_a}{S_e}+\frac{S_m}{S_{ut}}=1$	$\frac{\sigma_a}{S_e}+\frac{\sigma_m}{S_{ut}}=\frac{1}{n}$
Gerber	$\frac{S_a}{S_e}+\left(\frac{S_m}{S_{ut}}\right)^2=1$	$\frac{n\sigma_a}{S_e}+\left(\frac{n\sigma_m}{S_{ut}}\right)^2=1$
ASME-elliptic	$\left(\frac{S_a}{S_e}\right)^2+\left(\frac{S_m}{S_y}\right)^2=1$	$\left(\frac{n\sigma_a}{S_e}\right)^2+\left(\frac{n\sigma_m}{S_y}\right)^2=1$



Title :

(13) Know the below definitions in the spring analysis.

- Total length

- Solid length

the length of a spring when it is compressed by enough load to bring all the coils into contact with each other.

- Free length

the length of a die spring before it is subject to any operating force or load.

- Active coils

all of the coils that aren't on the ends of a spring.

- End coils

the coils at the ends of spring.

- Total coils

inactive coils + active coils

not allowed to deflect in any way.

- Spring constant

stiffness of spring.

$$k = \frac{F}{\Delta x}$$

Title :

(10) Describe the definitions of the symbols illustrated in the below image.