EXAM 2 REVIEW

MET 4501

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CHAPTER 6 – FATIGUE FAILURE RESULTING FROM VARIABLE LOADING

- Introduction to fatigue
- Overview of fatigue analysis methods
  - Linear-elastic fracture mechanics
  - Strain-life method
  - Stress-life method
- The stress-life method in detail
  - The S-N diagram
  - Endurance limit modifying factors
  - Stress concentration & notch sensitivity
  - Characterizing fluctuating stresses
  - Fatigue failure criteria
    - Yield (Langer)
    - Goodman
    - Morrow
  - Fatigue failure analysis recipe for:
    - Completely reversing simple loading
    - Fluctuating simple loading
    - Combination of loading modes

The S-N diagram is used to represent:

A. Strain versus number of cycles

C. Stress versus strain

B. Stress versus number of cycles to failure

D. Shear stress versus normal stress

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Endurance limit modifying factors (Marin factors) in fatigue analysis account for all of the following EXCEPT:

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B. Temperature

D. Size of the component

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C. Mohr's circle

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PRACTICE PROBLEM

A rotating shaft made of steel is subjected to an alternating bending stress with a maximum value of 300 MPa and a minimum value of 100 MPa. Using the Goodman criterion, determine if the shaft will fail, assuming a factor of safety of 1.5. The ultimate tensile strength of the material is 700 MPa, and the fully corrected endurance limit is 300 MPa.

1. Calculate the mean and alternating stresses:

$$\sigma_a = \frac{\sigma_{\max} - \sigma_{\min}}{2} = \frac{300\ \text{MPa} - 100\ \text{MPa}}{2} = 100\ \text{MPa}$$

$$\sigma_m = \frac{\sigma_{\max} + \sigma_{\min}}{2} = \frac{300\ \text{MPa} + 100\ \text{MPa}}{2} = 200\ \text{MPa}$$

2. Apply the Goodman criterion (for $\sigma_m \geq 0$):

$$n = \left[\frac{\sigma_a}{S_e} + \frac{\sigma_m}{S_{ut}}\right]^{-1} = \left[\frac{100}{300} + \frac{200}{700}\right]^{-1} = 1.6$$

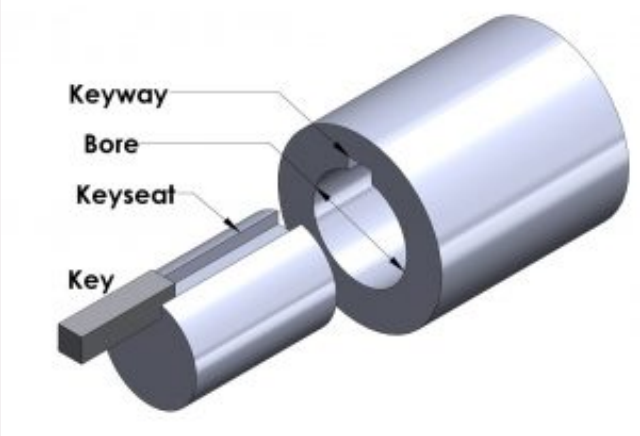
The calculated safety factor is greater than 1.5, so failure is not predicted.

MODULE 3: DESIGN OF MACHINE COMPONENTS

Shafts & shaft components (Ch. 7)

Mechanical springs (Ch. 10)

Keys



Splines

What is the primary advantage of using splines instead of a key in a shaft-hub connection?

A. Splines provide a tighter fit, eliminating the need for lubrication

C. Keys allow for higher torque transmission compared to splines.

B. Splines distribute torque more evenly across multiple contact surfaces, reducing stress concentrations.

D. Keys are preferred because they eliminate the need for axial alignment of the shaft and hub.

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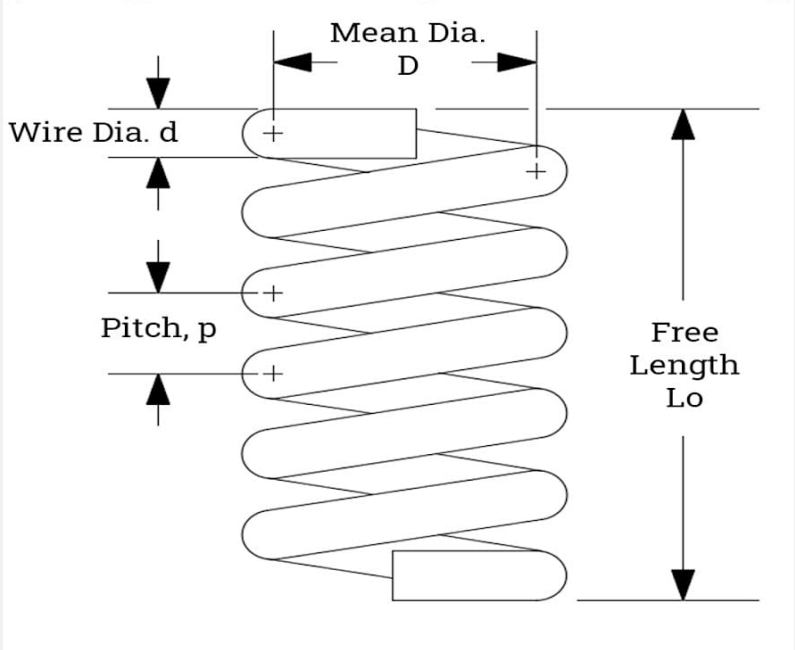
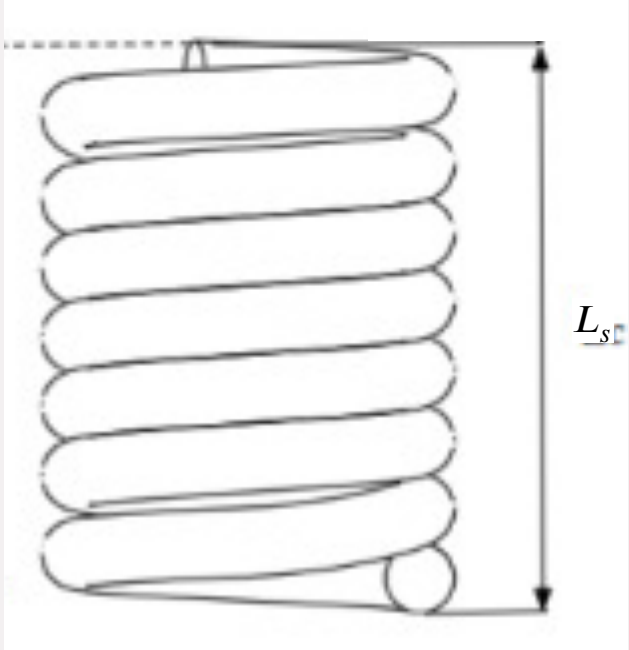
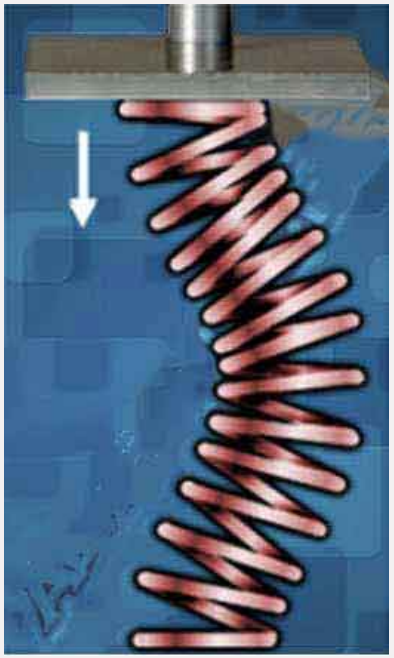
Geometry



Closure



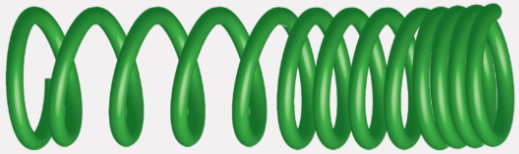
Buckling



Materials

Fatigue Failure

Spring Surge



To avoid resonance, the natural frequency of a mechanical spring should be about:

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C. 5-10x less than the forcing frequency

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