SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
An Autonomous Institution

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A+' Grade
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF MECHANICAL ENGINEERING

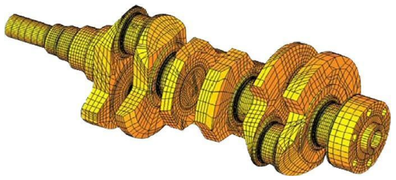
19MET301 – DESIGN OF MACHINE ELEMENT

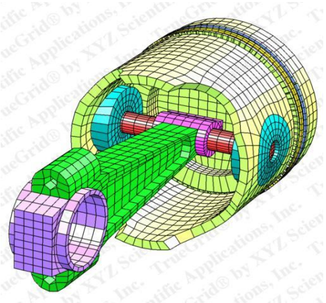
III YEAR V SEM

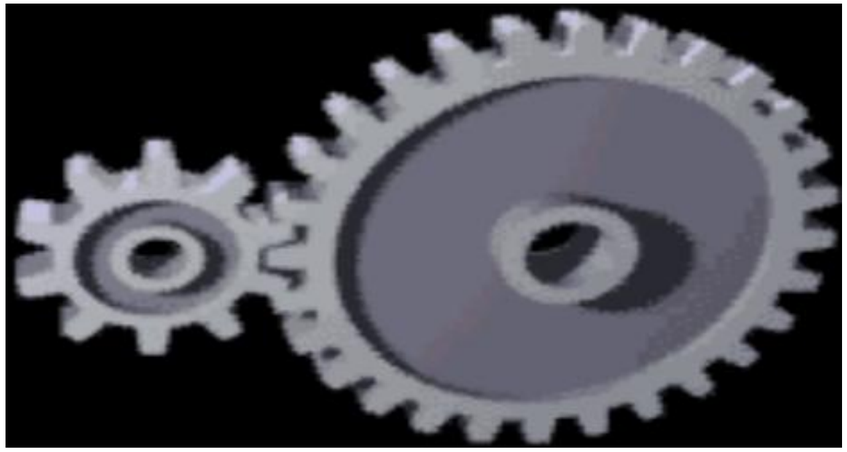
UNIT 2 – VARIABLE STRESS AND JOINTS

TOPIC 1 –DESIGN AGAINT FATIQUE

What Are All The Types Of Stress Involved In The Machine Element?

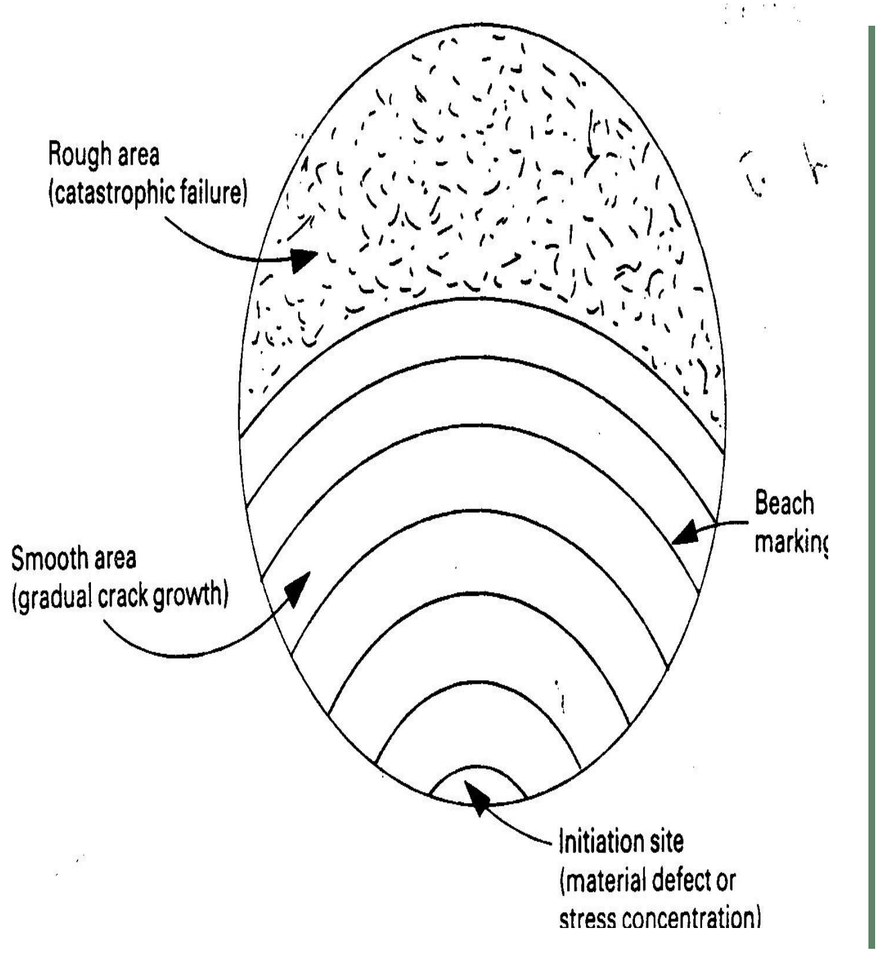






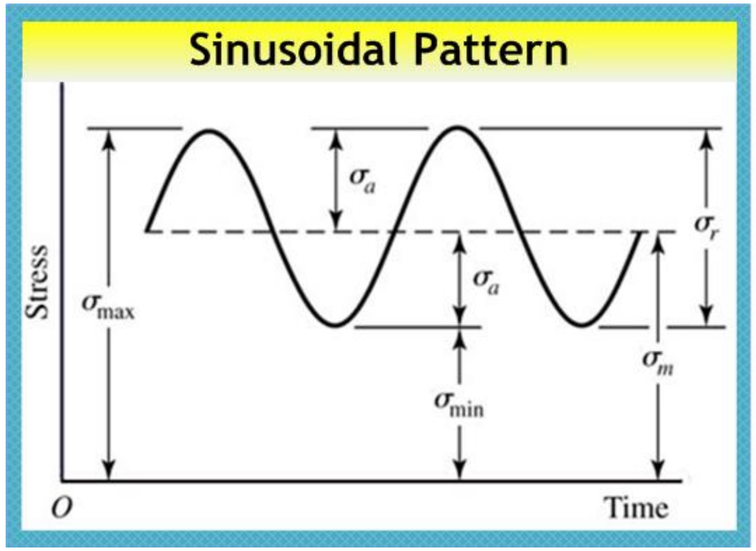
Designing Against Fatigue

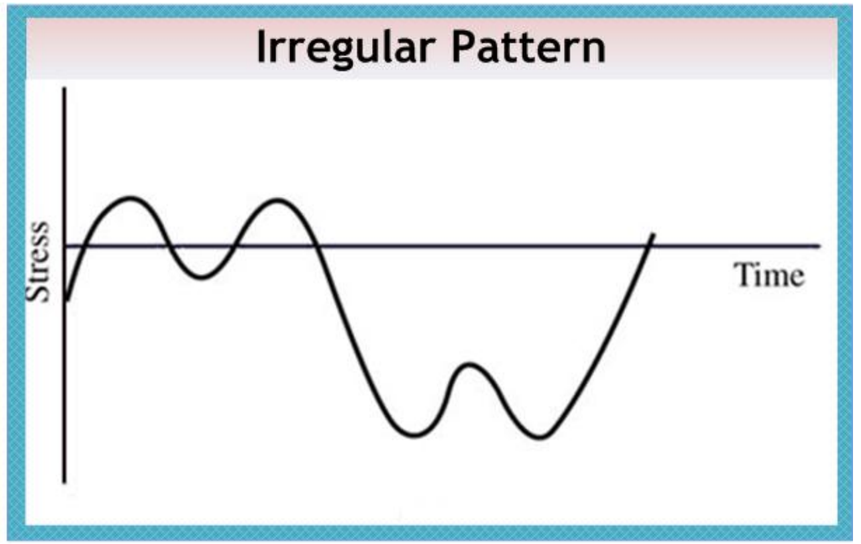
- Fracture surface which usually exhibits smooth areas which correspond to the gradual crack growth stage, and rough areas, which correspond to the catastrophic fracture stage.
- The smooth parts of the fracture surface usually exhibit beach marks which occurs as a result of changes in the magnitude of the fluctuating fatigue load.



Variable Stress

- Fluctuating stresses in machinery often take the form of sinusoidal pattern because of the nature of the nature of some rotating machinery.
- Other patterns some quite irregular do occur





VARIABLE STRESS-CONTINUED..,

$$F_m = \frac{F_{max} + F_{min}}{2} \qquad F_a = \left| \frac{F_{max} - F_{min}}{2} \right|$$

F_{max} : largest force

F_{min} : smallest force

F_m : midrange (mean) component of force

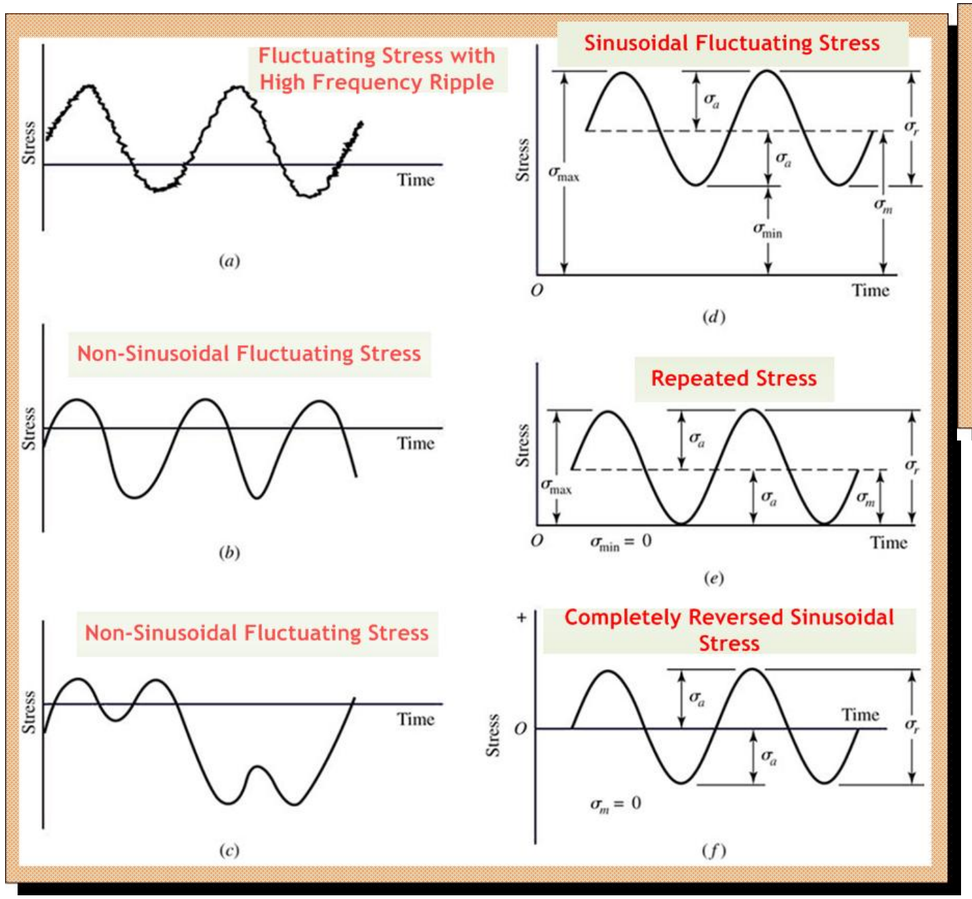
F_a : amplitude component of force

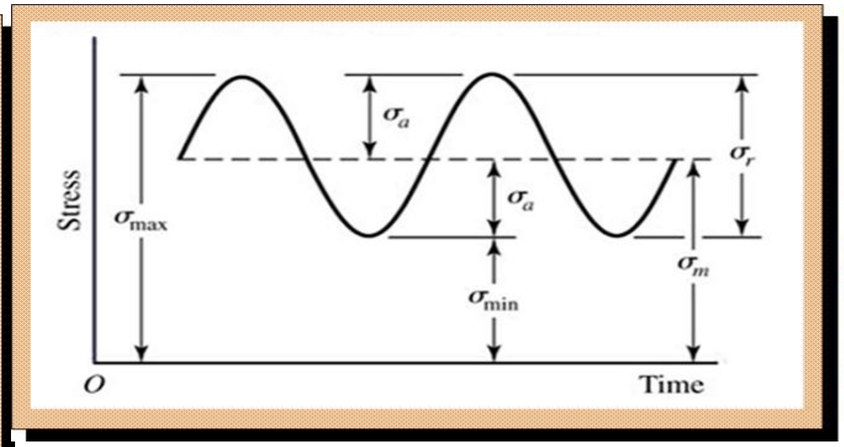
- In periodic patterns exhibiting a single maximum and single minimum of force, the **shape of** the wave **is not important.**
- The **peaks on both sides (maximum, minimum) are important.**
- $\mathbf{F_{max}}$ and $\mathbf{F_{min}}$ in a cycle can be used to characterize the force pattern.
- A steady component and an **alternating component** can be constructed as follows:

ASSESSMENT – 1

LIVE EXAMPLE OF VARIABLE DESIGN

Types of Variable Stress





$$\sigma_m = \frac{\sigma_{max} + \sigma_{min}}{2}$$

$$\sigma_a = \left| \frac{\sigma_{max} - \sigma_{min}}{2} \right| \quad (7\text{-}39)$$

$$\text{Stress Ratio } R = \frac{\sigma_{min}}{\sigma_{max}} \quad (7\text{-}40)$$

$$\text{Stress Ratio } A = \frac{\sigma_a}{\sigma_m} \quad (7\text{-}41)$$

σ_{max} : maximum stress

σ_{min} : minimum stress

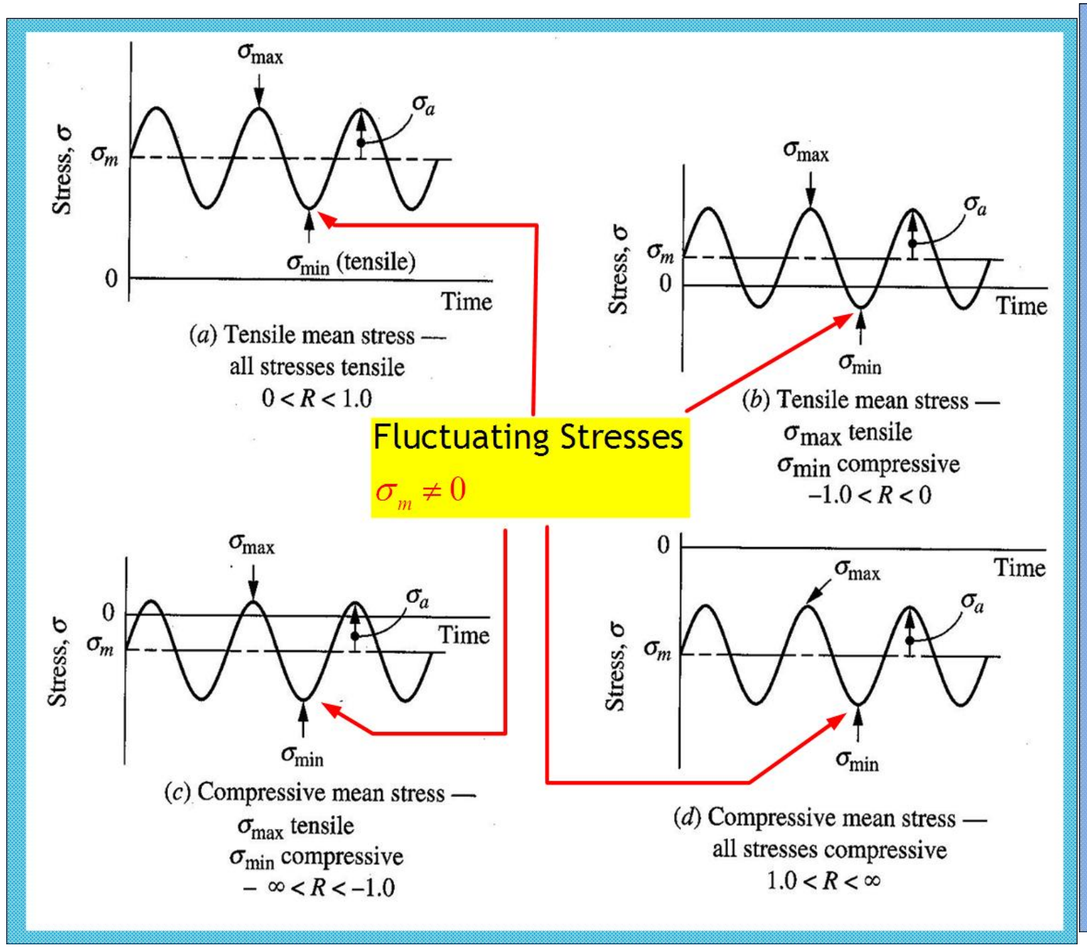
σ_a : amplitude (alternating) component

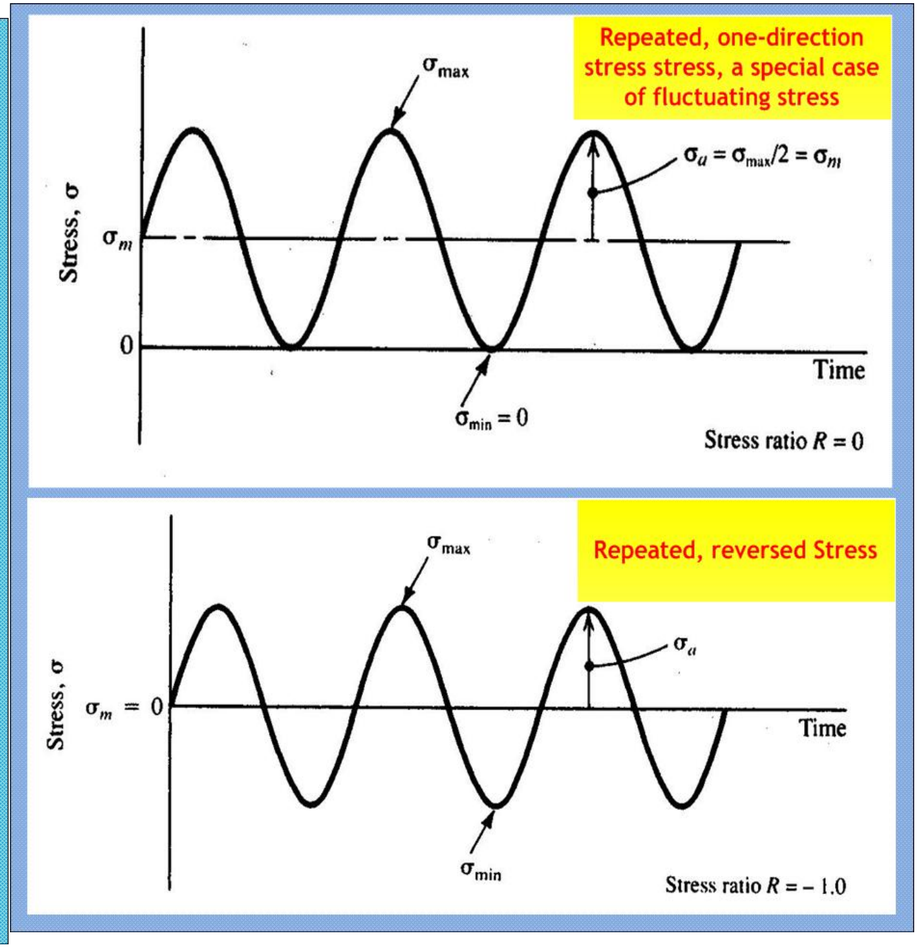
σ_m : midrange (mean) component

σ_r : range of stress

σ_s : static or steady stress

Fluctuating Stress





Mean and Alternative Stress

Mean Stress: $\sigma_m = \frac{1}{2}(\sigma_{max} + \sigma_{min})$

Alternating Stress: $\sigma_v = \frac{1}{2}(\sigma_{max} - \sigma_{min})$

The Mean Stress is analogous to a static stress, while the Alternating Stress represents the amplitude of the fluctuating stress.

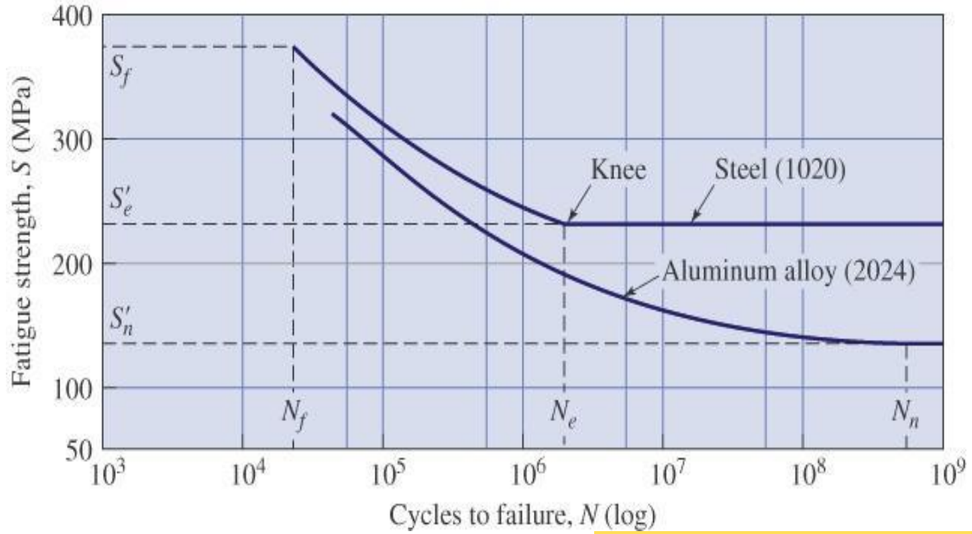


Figure (a) – S-N curves for carbon steel

(b) S-N curves aluminum alloy

Factor Influencing Machine Design

$$s_e = k_a k_b k_c k_d k_e k_f k_g k_h s_e'$$

Where s_e = endurance limit of component

s_e' = endurance limit experimental

k_a = surface finish factor (machined parts have different finish)

k_b = size factor (larger parts greater probability of finding defects)

k_c = reliability / statistical scatter factor (accounts for random variation)

k_d = operating T factor (accounts for diff. in working T & room T)

k_e = loading factor (differences in loading types)

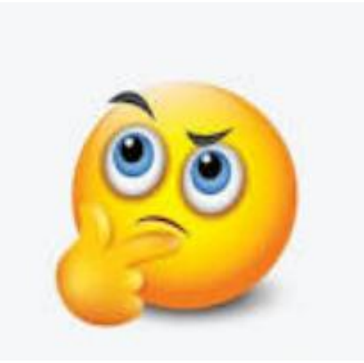
k_f = stress concentration factor

k_g = service environment factor (action of hostile environment)

k_h = manufacturing processes factor (influence of fabrication parameters)

Assessment – 2

The machine component is subjected to a flexural stress which fluctuate between +300MN/m^2 and 150MN/m^2.Determine the value of minimum ultimate strength according to 1.Gerber relation 2.Modified Goodman relation and 3.Soderberg relation. Take yield strength=0.55 Ultimate strength; Endurance limit=0.5 Ultimate strength and F.O.S=2.



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