1.1.Machine design philosophy,procedure considerations

Q.1. What is Machine design? Give its Classification

Ans: "Machine Design is the process of selection of the Materials,shapes, sizes and arrangements of the mechanical elements so that the resultant machine will perform the prescribed task."

The subject of machine design is the creation of new and better machines and improving the existing ones. A new or better machine is one which can perform the same things in "Cheaper,Faster and Easier" Manner.

Classifications of Machine Design :

The machine design may be classified as follows :

1. Adaptive design. In most cases, the designer's work is concerned with adaptation of existing designs. This type of design needs no special knowledge or skill and can be attempted by designers of ordinary technical training. The designer only makes minor alternation or modification in the existing designs of the product.
2. Development design. This type of design needs considerable scientific training and design ability in order to modify the existing designs into a new idea by adopting a new material or different method of manufacture. In this case, though the designer starts from the existing design, but the final product may differ quite markedly from the original product.
3. New design. This type of design needs lot of research, technical ability and creative thinking. Only those designers who have personal qualities of a sufficiently high order can take up the work of a new design.

The designs, depending upon the methods used, may be classified as follows :

(a) Rational design. This type of design depends upon mathematical formulas of principle of mechanics.

(b) Empirical design. This type of design depends upon empirical formulas based on the practice and past experience.

(c) Industrial design. This type of design depends upon the production aspects to manufacture any machine component in the industry.

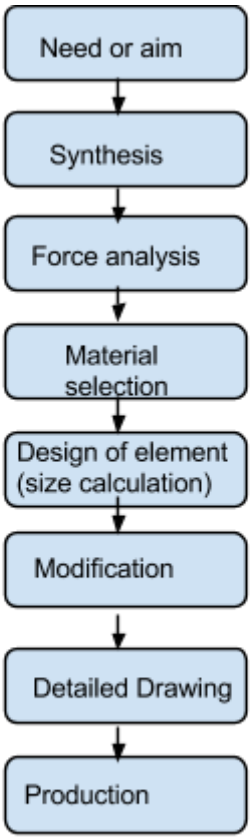
(d) Optimum design. It is the best design for the given objective function under the specified constraints. It may be achieved by minimising the undesirable effects.

(e) System design. It is the design of any complex mechanical system like a motor car.

(f) Element design. It is the design of any element of the mechanical system like piston, crankshaft, connecting rod, etc.

(g) Computer aided design. This type of design depends upon the use of computer systems to assist in the creation, modification, analysis and optimization of a design. This type of design is based on commercially available softwares like Auto-cad, Pro E, CATIA and Unigraphics.

Q.2. What are the STEPS involved in general design procedure. OR Enlist various PHASES involved in the process of machine design.



General design steps

Ans : In designing a machine component, there is no rigid rule. The problem may be attempted in several ways. However, the general procedure to solve a design problem is as follows :

1. Recognition of need:
First of all, make a complete statement of the problem, indicating the need, aim or purpose for which the machine is to be designed.

2. Synthesis (Mechanisms):
Select the possible mechanism or group of mechanisms which will give the desired motion.

3. Analysis of forces :
Find the forces acting on each member of the machine and the energy transmitted by each member.

4. Material selection : Select the material best suited for each member of the machine.

5. Design of elements (Size and Stresses) :
Find the size of each member of the machine by considering the force acting on the member and the permissible stresses for the material used. It should be kept in mind that each member should not deflect or deform than the permissible limit.

6. Modification :
Modify the size of the member to agree with the past experience and judgment to facilitate manufacture. The modification may also be necessary by consideration of manufacturing to reduce overall cost.

7. Detailed drawing :
Draw the detailed drawing of each component and the assembly of the machine with complete specification for the manufacturing processes suggested.

8. Production : The component, as per the drawing, is manufactured in the workshop.

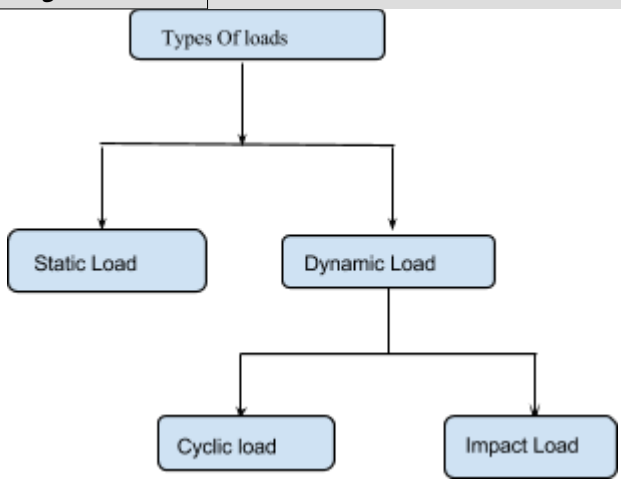
Q.3. State the general design consideration in machine design.

Ans : Following are the general considerations in designing a machine component :

1) Type of load and stresses caused by the load.
2) Motion of the parts or kinematics of the machine.
3) Selection of materials.
4) . Form and size of the parts.
5) Frictional resistance and lubrication.
6) Convenient and economical features.
7) Use of standard parts.
8) Safety of operation.
9) Workshop facilities.
10) Number of machines to be manufactured.
11) Cost of construction.
12) Assembling.

1.2.Types of Loads and Stresses

Q.4. State the different types of load a machine member can be subjected to.



Static load is been defined as the load which does not vary in magnitude or direction with respect to time after it is applied. Static load is gradually applied to the member and once it gets applied it does not changes its magnitude or direction. examples. weight of machinery,forces in nuts and bolts..

Dynamic load is a load which varies in both magnitude and direction with respect to time, after it is applied. There are two types of dynamic loads namely Cyclic load and Impact load.

Cyclic load is a load which when applied varies in its magnitude in repetitive manner. In this type of loading the pattern of loading is repeated after cycles..examples. forces induced in gear tooth,rotating shafts etc.

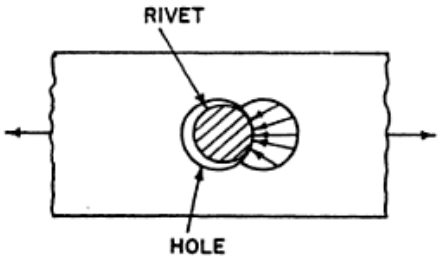
Impact load is a load which is applied to a member suddenly and at high velocity. example of this load is the load applied by the punching machine on the metal sheet.

Q.5. Explain the terms 1.Bearing stress 2. Bearing Pressure Intensity

Ans : Bearing Stress (or Crushing stress):

This is a special type of compressive stress which occurs at the surface of contact between two members which are relatively at rest.

"Localized stresses occurring at the area of contact between two members at rest is called bearing/crushing stress."



Bearing stress distribution is not uniform as shown in figure, but depends on the shape of the surface in contact and the properties of the two materials. Generally the bearing stress is calculated by formula,

$$Bearing\ Stress = \frac{Load}{Projected\ area} \text{.....} N/mm^2$$

for cylindrical surface,

$$Bearing\ Stress = \frac{Load}{Length \times diameter} \text{.....} N/mm^2$$

Bearing Pressure Intensity:

This is a special type of compressive stress which occurs at the surface of contact between two members which are in motion with each other. "Localized stresses occurring at the area of contact between two members having relative motion is called Bearing pressure intensity."

Generally the bearing stress is calculated by formula,

$$Bearing\ pressure\ intensity = \frac{Load}{Projected\ area} \text{.....} N/mm^2$$

Q.6. Explain 1.Torsional shear stresses 2.Transverse shear stress

Ans : Torsional shear Stress :When a machine member is subjected to the action of two equal and opposite couples, acting in parallel planes, then the machine member is said to be in torsion and the stress set up in this case is called as the torsional shear stress.

it is calculated by using the torsional equation..

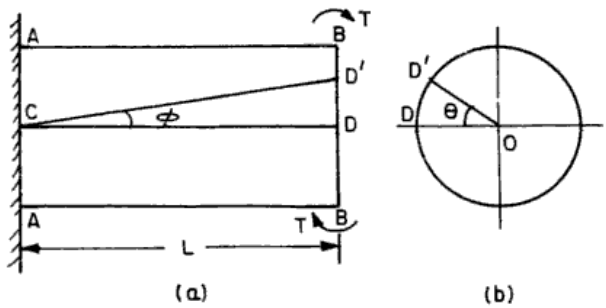


Fig. 21.2. Shaft fixed at *AA* and subjected to torque *T* at *BB*.

$$\frac{T}{J}=\frac{\tau}{r}=\frac{G\theta}{l}$$

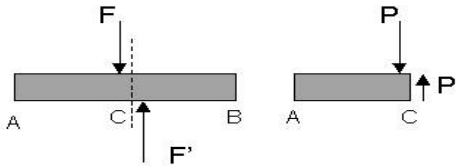
where T= Torque acting on shaft in N-mm, J= Polar moment of inertia in mm4

fs= Shear stress (N/mm2), r =radius of shaft (mm)

C= modulus of rigidity (N/mm2), $\theta = Angle\ of\ twist\ (radians)$

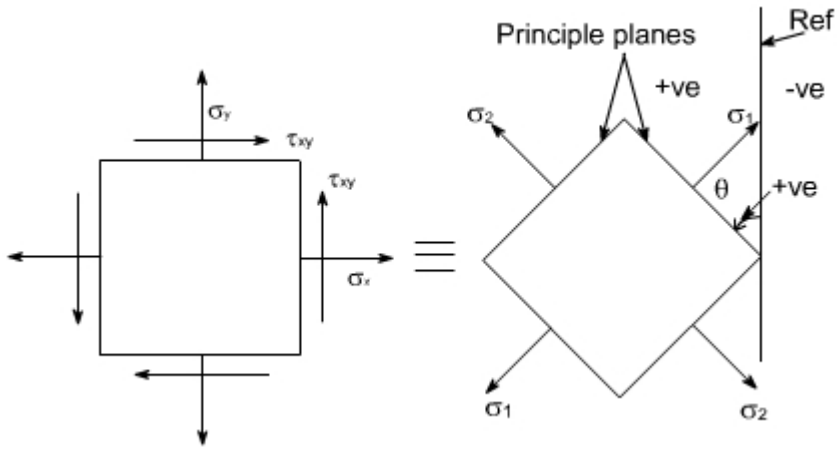
l = length of shaft (mm)

Transverse shear Stress :



"When a mechanical component is subjected to two equal and opposite forces acting tangentially across the resisting section, it tends to shear off across the section. The stress induced in such section is known as transverse shear stress. "

Q.7. Explain the term Principal Stresses.

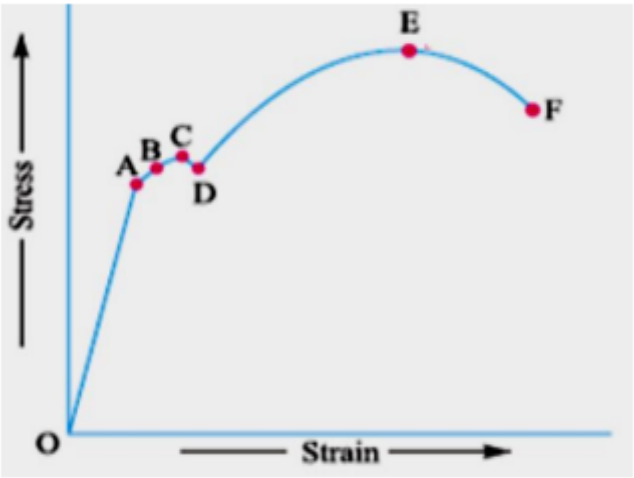


Ans : Principal stress : When a component is subjected to combination of loads in various directions. The resultant stress on each plane can be resolved into two perpendicular directions, one component is called Normal stress and other is called Shear stress

Principal planes are those plane which carry no shear stress. And the stresses on principal planes are called the principal stresses.

There are two principal planes, which will be mutually perpendicular to each other, one plane would have the maximum value and is called to as the major principal plane and other plane would have the minimum value and is called minor principal stress.

Q.8. Draw Stress strain diagram for ductile and brittle materials. Name points on the diagram.(*****)



Proportional limit (A): The stress is proportional to strain. Beyond point A, the curve slightly deviates from the straight line. It is thus obvious, that Hooke's law holds good up to point A and it is known as Proportional limit.

Elastic limit (B): If the load is increase between point A and B, the body will regain its original shape when load is removed; it means body possesses elasticity up to point B, known as Elastic Limit.

Upper yield point (C): If the material is stressed beyond point B, the plastic stage will reach and the material will start yielding known as Upper Yield Point.

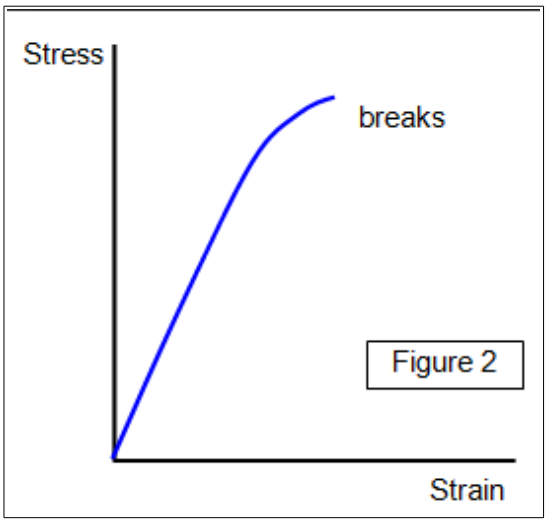
Lower yield point (D): Further addition of small load drops the stress-strain diagram to point D, as soon as the yielding start, this point 'D' is known as Lower yield point.

Ultimate stress point (E): After the end of yielding, if the load is increase beyond point 'D', there is increase in stresses up to point E and thus maximum value of stresses at point 'E' is called as Ultimate Stress point.

Breaking Stress point (F): After the specimen has reached the ultimate stress, a neck is formed, which decreases the cross-sectional area of the specimen. The stress corresponding to point F is known as Breaking stress.

Diagram for Brittle material

For brittle material there is no yield points stress but it simply breaks when the breaking stress is reached.



As shown in graph it follows the Hooke's law upto certain point and then after increasing load further it just breaks.

1.3.Factor of Safety

Q.9.Define factor of safety ? Define it for Ductile and Brittle material

Ans: While designing the component it is necessary to insure that sufficient reserve strength is kept to deal with uncertain situation. Factor of safety is taken into account for this safety.

" It is defined as the ratio of Maximum stress to Working or design stress."

Mathematically,

$$\text{Factor of safety} = \frac{\text{Maximum stress}}{\text{Working stress or design stress}}$$

For Brittle : It is the ratio of the Ultimate stress to the working or design stress

$$\text{Factor of safety} = \frac{\text{Ultimate stress}}{\text{Working stress or design stress}}$$

For Ductile: It is the ratio of the Yield stress to the working stress

$$\text{Factor of safety} = \frac{\text{Yield stress}}{\text{Working stress or design stress}}$$

Q 10. State the factors that govern the selection of FOS?(*****)

Ans : Factors on basis of which FOS is selected are given below.

1.The reliability of the properties of material and change of these properties during service.

2.The Reliability of test results and accuracy of application of these results to actual machine parts.

3.The Reliability of applied load.

4.The certainty as to exact mode of failure.

5.Extent of simplifying assumptions.

6.The extent of localized stresses.

7. The extent of initial stresses set up during manufacture.

8.The extent of loss of life if failure occurs. Higher factor of safety is chosen if there is more risk of life.

Situation when Higher FOS is generally Selected

1) Where the magnitude and exact nature of forces is unknown, higher FOS is selected.

2) Where there is possibility of Impact or unseen sudden loads , higher FOS is selected

3) Where there are chances of residual or initial stress in the component, higher FOS is selected.

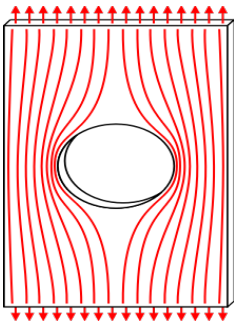
4) Where there is very high risk of life/property in case of failure , higher FOS is selected.

5) When very high reliability is expected from the components, higher FOS is selected.

6) Where the components are non-accessible for repairs, or failure of that component causes lot of inconvenience higher FOS is selected.

1.4.Stress concentration

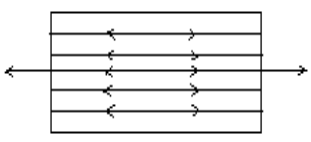
Q.11.Define stress concentration. What are causes of stress concentration. What are remedies for stress concentration. (*****)



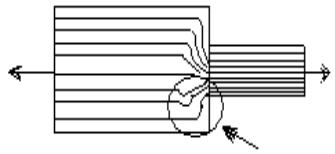
Ans : Whenever a machine component changes the shape of its cross section, the simple stress distribution no longer holds good and the neighborhood of the discontinuity is different.

The irregularity in the stress distribution caused by abrupt change of form is called stress Concentration. It occurs for all kind of stresses in the presence of fillets, notches, holes, key-ways, splines, surface roughness are scratches etc.

Consider a member with different cross section under a tensile load as shown in figure . It shows that nominal stress in the right and left hand sides will be uniform but in the region where the cross section is changing, a re – distribution of the force lines within the member must takes place. The material near the edges is stressed considerably higher than average value. The maximum stress occurs at same point on the fillet and is directed parallel to the boundary at that point.Stress flow lines are denser near hole/notch.



No Stress concentration



Stress concentration area

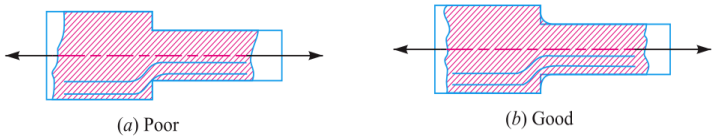
Causes of Stress Concentration :

1. Abrupt change in cross-section of machine member e.g. stepped shaft, key way's ,oil groove.
2. Concentrated load applied on small area – examples of this are
   i) Contact between wheel & rail ii) Contact between ball & race.iii) Contact between gear teeth.
3. Variation in properties of material From point to point - examples of this are
   i) Internal cavities or blow holes. ii) Cavities in welding. iii) A non metallic inclusions.

Remedies of Stress Concentration {How to reduce stress concentration}

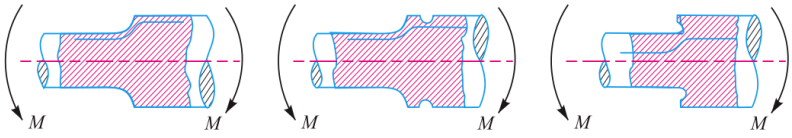
The presence of Stress concentration cannot be totally eliminated but it may be reduced to some extent. To reduce the stress concentration the stress flow lines should maintain their spacing as far as possible .The change in the cross section should be gradual to the possible extent. This can be achieved through numerous ways. Some of the methods are shown below.

A) Method of reducing stress concentration by shoulder.



(a) Poor (b) Good

B) Method of reducing stress concentration by providing groove cuts.

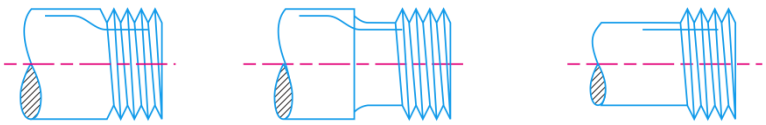


(a) Poor (b) Good (c) Preferred

C) Method of reducing stress concentration by providing additional holes

(a) Poor (b) Preferred

D) Method of reducing stress concentration in threads by providing under cut



(a) Poor (b) Good (c) Preferred

The principle in all methods remains the same i.e. to reduce the slope of stress flow lines.

Q.12.State the effect of stress concentration on the material in case of static loading and cyclic loading.

In static loading, stress concentration in ductile materials is not so serious as in brittle materials,because in ductile materials local deformation or yielding takes place which reduces the concentration. In brittle materials, cracks may appear at these local concentrations of stress which will increase the stress over the rest of the section. It is, therefore, necessary that in designing parts of brittle materials such as castings, care should be taken. In order to avoid failure due to stress concentration, fillets at the changes of section must be provided.

In cyclic loading, stress concentration in ductile materials is always serious because the ductility of the material is not effective in relieving the concentration of stress caused by cracks, flaws, surface roughness, or any sharp discontinuity in the geometrical form of the member. If the stress at any point in a member is above the endurance limit of the material, a crack may develop under the action of repeated load and the crack will lead to failure of the member.

1.5.Designation of Materials

Material Designation

A) Designation of steel on the basis of Strength.

1) Fe 290

* This material is carbon and low alloy steel.
* It has Ultimate tensile strength of 290 N/mm2

2) Fe E 230

* This material is carbon and low alloy steel.
* It has yield strength of 230 N/mm2

B) Designation of Plain Carbon steel (steel with Manganese)

1) 40 c 8

* This material is carbon steel with manganese.
* It contains $\frac{40}{100} = 0.4\%$ average carbon percentage.
* It contains $\frac{8}{10} = 0.8\%$ average Manganese percentage.

2) 35C8

* This material is carbon steel with manganese.
* It contains $\frac{35}{100} = 0.35\%$ average carbon percentage.
* It contains $\frac{8}{10} = 0.8\%$ average Manganese percentage.

C) Designation of Alloy steel {Low and Medium Alloy Steel}

1) 47 Mn2

* This material is Alloy steel.
* It contains $\frac{47}{100} = 0.47\%$ average carbon percentage.
* It contains $\frac{2}{4} = 0.5\%$ average Manganese percentage.

2)40 Cr 4 Mo 2

* This material is Alloy steel.
* It contains $\frac{40}{100} = 0.40\%$ average carbon percentage.
* It contains $\frac{4}{4} = 1\%$ average Chromium percentage.
* It contains $\frac{2}{10} = 0.2\%$ average Chromium percentage.

Table for dividing the content of alloying element

Element	Dividing factor to obtain percentage content
Carbon {first number indicates carbon}	100
Cr,Co,Ni,Mn,Si and W	4
Al,V,Pb,Cu,Ti and Mo	10
P,S and N	100

E) Designation of High Alloy Steels

Designation of these steels starts with letter X. Then a number indicating the 100 times the carbon percentage and then followed by the actual percentage {no dividing factor} of the alloying element content.

1) X 10 Cr 18 Ni 9

* This material is high Alloy steel.
* It contains $\frac{10}{100} = 0.10\,\%$ average carbon percentage.
* It contains 18 % average Chromium percentage.
* It contains 6 % average Nickel percentage.

2) 1) X 15 Cr 16 Ni 2

* This material is high Alloy steel.
* It contains $\frac{15}{100} = 0.15\,\%$ average carbon percentage.
* It contains 15 % average Chromium percentage.
* It contains 2 % average Nickel percentage.

F) Designation of High Speed Tool Steels

Designation starts with letter XT and then followed by Then a number indicating the 100 times the carbon percentage and then followed by the actual percentage {no dividing factor} of the alloying element content.

Example XT72W18Cr4V1

This material is high speed tool steel
It contains 72/100=0.72 % of Carbon
It contains 18 % of W
It contains 4% of Cr
It contains 1% of V

	Description	*Example*
IS: 1570 Part I	Steels are designated on the basis of mechanical property (σ_{ult} or σ_y in MPa) followed by the symbol Fe or Fe E	Fe 290, σ_{ult} = 290 MPa Fe E 250, σ_y = 250 MPa
IS: 1570 Part III/Sec-I	Designated on the basis of chemical composition of manganese and sulphur used for free cutting steel.	40C10S18 0.18% sulphur 1.0% manganese 0.40% carbon
IS: 1762 Part I-1974	Used for medium and low alloy steel designated on the basis of chemical symbols for alloying element with different multiplying factors.	40Ni2Cr1Mo28 28/10 = 2.8% 1/4 = 0.25% 2/4 = 0.5% 40/100 = 0.4%
IS: 1570 Part V-1985	Used for high alloy steel (stainless steel and heat resisting steel) and designated with the letter X, chemical symbols for alloying element and figures for the % contents.	X40Cr17Nil2Mo2 2% Mo 12% Ni 17% Cr 40/100 = 0.4% C
IS: 7291-1981	Used for high speed tool steel with the letter XT, chemical symbols for alloying element and figures indicating % content.	XT72W18Cr4V1 1% V 4% Cr 18% W 72/100 = 0.72% C W- Tungsten

G) Designation of Irons (Grey cast iron & Spheroidal graphite iron)

A) Grey Cast iron

1) FG 150

* This material is Grey cast iron.
* It has tensile strength of 150 N/mm2

2) FG 400

* This material is Grey cast iron.
* It has tensile strength of 400 N/mm2

B) S.G.Iron

1) SG 700/2

* This material is Spheroidal Graphite cast iron.
* It has tensile strength of 700 N/mm2.
* Minimum percentage elongation 2.

1) SG 400/15

* This material is Spheroidal Graphite cast iron.
* It has tensile strength of 400 N/mm2.

* Minimum percentage elongation 15.

Q 13. State the composition of the following materials

1) Fe E 230 2) X 20 Cr 18 Ni 2 3) 35 C8 4) 40 Ni 2 Cr 1 Mo 20

Materials used for various common engineering components

Component	Material used	Justification
Pistons of Petrol /Diesel engine	Aluminum alloy	Light weight, anti corrosive, high thermal conductivity, capacity to withstand high temperature
Connecting rod	Forged Alloy Steel	High compressive/tensile strength, capacity to withstand high temperatures
Cylinder Block	Cast Iron	High compressive strength, ease of machining, low cost
Crankshaft/camshaft	Alloy steel	ability to withstand torsional stress, ease of machining/forging, case hardening ability
Flywheel	Cast iron	Economic consideration, as flywheel are not subjected to any forces.
Gearbox shafts	Medium carbon steel	Ease of processing, readiness for heat treatment, economical cost.
Machine beds	Cast iron	High compressive strength, single piece production, no change in dimension (bending) even after decades of use
Propeller shaft and axles	plain carbon steel	ability to withstand torsional stress, ease of machining/forging, case hardening ability
Nuts, Bolts and studs	Alloy steel {40Ni10Cr3Mo6}	high tensile strength,ease of machining and heat treatment.
Gears	Plain carbon steel or Alloy steel	ease of manufacturing, ability to case harden, good wear resistance
Turbine blades	Stainless steel or aluminium alloy	Corrosion resistance and high thermal conductivity
leaf and coil springs	Alloy steel3 {55si7}	Higher strength and toughness, good resilience
Automobile bodies and hoods	plain carbon steel {7c4}	Easy to shape, low cost, availability in the form of sheets

1.6.Concept of Creep and fatigue

Q.14. What do you mean by Creep? Draw Creep curve.(***)

When a component is under constant load for long period of time. It may undergo progressive plastic deformation this time dependent strain is called creep.

Creep is defined as " Slow & progressive deformation of the material with time under constant stress".

Creep is function of stress and temperature therefore creep deformation is higher at higher temperature. Creep is important in following situations.

1. Bolts & pipes in thermal power plant
2. Blades of steam & Gas turbine.
3. Furnace supports bars.
4. Connecting rod of I.C. engine.

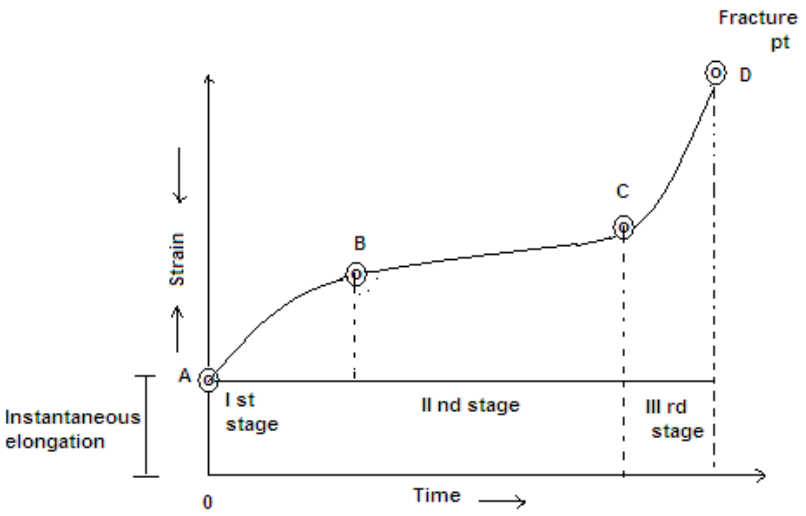


Figure shows creep curve. When the load is applied at the beginning instantaneous elastic deformation (OA) occurs, this elastic deformation followed by creep curve ABCD.

As shown in figure creep occurs in three stages.

Stage AB : In primary stage creep rate decreases with time.

Stage BC: In secondary creep (B to C) the creep rate is constant. The designer is mainly concern with this stage.

Stage CD: In 3rd stage creep rate accelerate & finally there is fracture at pt. D.

Q.15.What do u mean by fatigue failure?Draw S-N curve.(*****)

Fatigue Failure -

It is observed that when component is subjected to reversed repeated stresses it fails at stress below its Yield Strength this phenomenon is called fatigue failure.

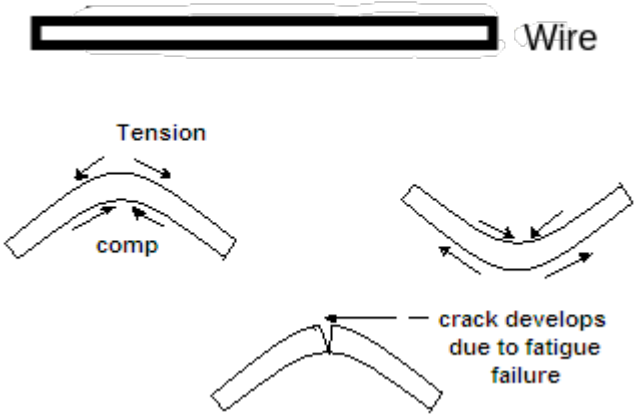


Figure shows a wire of 2 to 3 mm diameter which is subjected equal & opposite forces. This causes the wire to bend as shown the figure b .If we reverse the applied stress ,it causes the bending of wire in reverse direction, this completes the one cycle. If we repeat the same process it is observed that a crack is developed in wire which causes it to break into two pieces, such failure is called fatigue failure.

S-N Curve for steel:

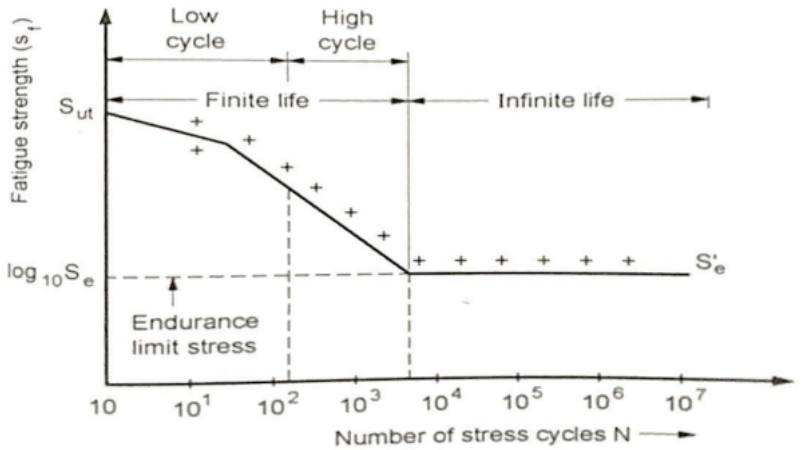


Figure shows S.N. (stress – no. of cycles) curve for steel from graph it is clear that if stress value is higher the component fails after fewer cycle , as the stress value is decreased the component can withstand more number of cycles. There is certain value of stress below which the component can withstand infinite (106 cycle) cycles ,this stress value is called endurance limit for that material.

Definition of Endurance Limit – "The maximum value of stress at which the specimen can withstand infinite (106 cycle) is called endurance limit."

1.7.Theories of Elastic Failures

Q.16. List the various theories of failure and explain any one of them.

Ans: Following are the various theories of failure

1. Maximum principal or normal stress theory (Rankine's)
2. Maximum shear stress theory (Guest's Theory)
3. Maximum principal or normal strain theory (Saint Venant theory)
4. Maximum strain energy theory (Haigh's Theory)
5. Maximum Distortion energy theory

Q.17.Explain maximum shear stress theory. Where it is used?

Ans : This theory States that," The failure or yielding begins whenever the maximum shear stress in any mechanical element becomes equal to the maximum shear stress in a tension test. " This theory is valid for the ductile material and according to this theory shear strength is 0.5 times the tensile strength.

According to maximum shear stress theory,

$Ssy = 0.5\,Syt$

Means Ssy= Maximum Shear Stresses

Syt= Maximum yield stress

Q.18.Explain maximum principal stress theory. Where it is used?

Ans : This theory states that ," The failure or yielding will occur when the maximum principal stress in a complex stress system reaches the elastic limit stress in a simple tension." Since the maximum principal or normal stress theory is based on failure in tension or compression and ignores the possibility of failure due to shearing , therefore it is not used for ductile materials. However, for brittle materials which are relatively strong in tension and compression but weak in shear this theory is not generally used.

Q.19.Explain maximum distortion energy theory. Where it is used?

According to this theory," The failure or yielding occurs at a point in a member when the distortion strain energy per unit volume in a biaxial stress system reaches the limiting distortion energy{as obtained by standard tension test specimen}."This theory is mostly used for ductile materials and gives more accurate results for the ductile materials.

Q.20. Why maximum shear stress theory is used for ductile materials and not for brittle materials? or Why maximum principal stress theory is used for brittle material and not the ductile material?

Ans: "Ductile materials have typically equal strength in tension and compression ,whereas compressive strength of brittle material is much higher than tensile strength." Maximum shear stress theory assumes that yield strength in tension is equal to yield

strength in compression hence this theory is best suited for ductile material and not brittle material.

Maximum principal stress theory is best suited for the brittle materials because brittle materials do not fail by yielding but they fail by fracture.

1.8.Modern design Considerations

Q.21. Define Ergonomics. State its importance ?

Ans :"Ergonomics is the Process of Designing workplaces, products and systems so that they fit the people who use them."

Ergonomics introduces the HUMAN FACTOR and the environment to the man machine interaction. It is mainly concerned with the following areas of machine designed. Ergonomics aims to create safe, comfortable and productive workplaces and products by bringing human abilities and limitations into the design. It considers the body size, strength,skill, speed, sensory abilities in design. Following are the areas which are addressed in ergonomic design.

1) Design of Controls. 2) Design of Display. 3) Design of lighting system.
4) Design of acoustic system (sound effects). 5) Design of surrounding temperature.
6) Design of humidity and air motion in workplace.

Q.22. State and describe in brief about any six ergonomics considerations in the designing of machine elements. (Important)

Ans:Ergonomics consideration in control design:

1)The control should be accessible and logically positioned.

2)The shape of control component which come in contact with hands should be comfortable with anatomy of hand.

3)Control should be painted in red color with grey background of machine tool for attention.

4)The control operation should involve Minimum motions.

Ergonomics consideration in Display design :

5) The scale on the dial indicator should be divided in suitable linear progression such as 0-10-20-30.

6)Number of subdivisions between divisions should be minimum.

7)Vertical figures should be used for stationary dials and radially oriented figures should be used for rotating dials.

8) The height of letters or numbers on display should be greater or equal to reading distance /200.

9) The pointer should have knife edge with a mirror to minimize parallax error.

10) The numbering should increase in clockwise direction on circular scale , rightward

on a horizontal scale and upwards on vertical scale.

Lighting :

11) The surrounding area including walls, ceiling, floor and other object should be bright and more colored than workplace. The light should be match the needs of the task as far as illumination is concerned.

Noise:

12) If the noise level is too high, it can be stopped at source by better maintenance of equipment, placing vibration isolating material,plug in ears and providing sound insulating walls.

Temperature:

13) In order to get efficiency to perform the task, the operator should feel neither too hot nor
too cold but comfortable.

14) When the heavy work is done, the temperature should be lowered and when the office work is done, it should be little higher.

Humidity and Air circulation:

15) Low humidity may cause discomfort through drying of the nose and throat.

16) Air humidity and air velocity become important at high temp. because they influence the amount of sweat, which can be evaporated from body surface to produce cooling effect.

Q.23. Define Aesthetics ? State meaning of common colors used?

Ans: "Aesthetics is the branch of science which deals with nature of art and beauty. It is related to the appearance of the product ."

When there are number of products in the market, having the same qualities of efficiency, durability and cost , the customer is naturally attracted towards the most appealing product. The external appearance is an important feature , which gives grace and luster to the product and dominates the markets.

Selection of proper colour is an important consideration in product aesthetics. The choice of colour should be compatible with the conventional ideas of the operator. Following table gives the meaning of the common colour..

Colour	Meaning
RED	Danger-Hazard-Hot
Orange	Possible Danger
Yellow	Caution
Green	Safety
Blue	Caution-cod
Grey	Dull

Q.24. Describe the importance of aesthetic consideration in design related to shape, colour and surface finish. (Important)

Ans: Aesthetic consideration in design related to shape ,colour& surface finish

Regarding Shape:

1) The shape should not be like blocks but various forms like sculpture, streamlined, aerodynamic, taper should be used.

2) The component should be symmetrical at lean about one axis.

3)proper shape of a product help to make the product more attractive.

4) The shape of the product should be regular, even & proportionate

Regarding Colour:

1) The colour & shape of component should be such that it should attract and impress customer.

2) The colour should match with conventions, moods e.g. red for danger, gray for dull, yellow
for cautions, green for safe etc.

3) Too bright colour should be avoided.

4) The colour should be compatible with conventional ideas of the operator.

Regarding Surface finish

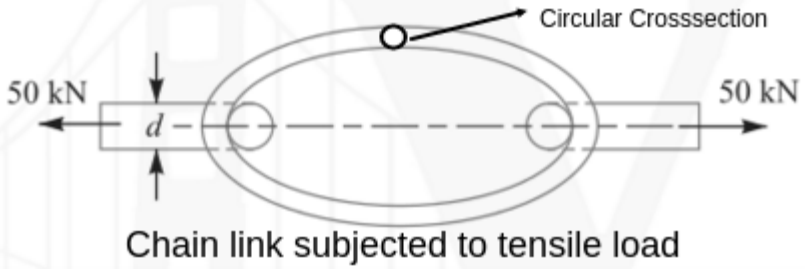
1) Products with better surface finish are always aesthetically pleasing'

2) The surface coating processes like spray painting, anodizing, electroplating etc greatly the aesthetic appeal of product.

Numerical Problems

Type:1.Simple problems on different types of stresses

Prob 1. A coil chain of crane is subjected to tensile load of 50 kN as shown in diagram, calculate the size of the chain stock if the allowable stress in the chain material is 75 MPa.



Chain link subjected to tensile load

Prob 2 : A reciprocating steam engine connecting rod is subjected to a maximum load of 65 kN. Find the diameter of the connecting rod at its thinnest part, if the permissible tensile stress is 35 N/mm 2 .

Prob 3. The maximum tension in the lower link of a Porter governor is 580 N and the maximum stress in the link is 30 N/mm 2 . If the link is of circular cross-section, determine its diameter.

Prob 4. Two circular rods of 50 mm diameter are connected by a knuckle joint, as shown in Figure below, by a pin of 40 mm in diameter. If a pull of 120 kN acts at each end, find the tensile stress in the rod and shear stress in the pin.