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MACHINE DESIGN

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Lect. Mechanical Engg.

CHAPTER-01

Introduction :

The subject machine design is the creation of new and better machines and improving the existing ones. A new or better machine is one which is more economical in the overall cost of production and operation. The process of design is a long and time consuming one

→ Machine design is a subject which deals with the plan, construction, modification and analysis of machine elements. It is also called as Design of machine element.

Classification :

The different types of machine design are
1. Adaptive Design 2. Devlopment design 3. New design.

1. Adaptive Design :-

→ It is a design in which minor modification is done in the existing design or product.

→ In case of Adaptive design only some basic technical skills are required

2. Devlopment Design :-

→ This type of design needs considerable scientific training and design ability inorder to modify the existing design into a new idea by adopting a new material or different method of manufacturing

→ In this case, though the designer starts from the existing design but the final product may be differed from the original product.

3. New design :

→ This type of design needs alot 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.

Mechanical and Physical properties of Engineering Materials.

Mechanical properties :-

1. **Strength** :- It is the ability of the material to resist the externally applied forces without breaking or yielding.
2. **Stiffness** :- It is the ability of the material to resist deformation within elastic limit. The modulus of Elasticity is the measure of stiffness
3. **Elasticity** :- It is the property of the material to regain its original shape after deformation when applied load is removed
4. **Plasticity** :- It is the property of the material which undergoes permanent deformation whe external load is removed
5. **Ductility** :- It is the ability of the material that can be drawn in to thin wire with the application of tensile force.
6. **Brittleness** :- It is the property of breaking of the material with little permanent distrision. It is the property of a material opposite to ductility.
7. **Malleability** :- It is the property of the material that can be rolled or hammered into thin sheets
8. **Toughness** :- It is the property of the material to resist fracture due to high impact load. It is measured by the amount of energy that a unit volume of material has absobed after being stressed upto the fracture point.
9. **Machinability** :- It is the property of the material the material can be cut or removed by any maching operation.
10. **Resilience** :- It is the property of of a material to absorb energy and resist shock and impact loads. It is measured by the amount of energy absoobed per unit volume within elastic limit

11. Creep :- When a material or part is subjected to a constant stress for a prolong period at an elevated temperature, it will undergo a slow and permanent deformation called as creep.

12. Fatigue :- When a material is subjected to repeated stress, it fails at stress much below the yield point stress. Such type of failure of the material is called as fatigue.

13. Hardness :- It is a very important property of the metals and has a wide variety of meaning. It embraces many different properties such as resistance to wear, scratching, deformation & machinability.

Physical properties of the metals :- The physical properties of the metals include lustre, colour, shape and size, density, electrical and thermal conductivity, melting point etc.

Working stress, Yield stress, Ultimate stress & factor of safety :-

* Working stress :- When designing machine parts it is durable to keep stress lower than the maximum or ultimate stress to prevent failure. This stress is known as "working stress" or "design stress" or "safe stress" or "allowable stress".

Failure :- Failure is not meant actual breaking of the material. Some machine parts are said to fail when they have plastic deformation set in them

Ultimate Stress :- It is the maximum stress a material can bear with out fracture.

Yield Stress :- Stress corresponding to yield point is know as yield stress.

$$F.O.S = \frac{\text{Yield point stress}}{\text{working stress}}$$

$$= \frac{\text{Ultimate stress}}{\text{working stress}}$$

* F.O.S increases the design strength.

Factors to be considered During Machine Design :-

When designer designs the machine elements or complete machine, they have to consider several parameters. These are some of the important factors to be considered while doing machine design.

① **Cost :** Cost has always become the major factor of consideration while designing the m/c elements or machine and in this age of competion it is more important.
→ The best design is one which helps to get the finished product with all the major functionalities and high possible qualities at lowest possible cost.

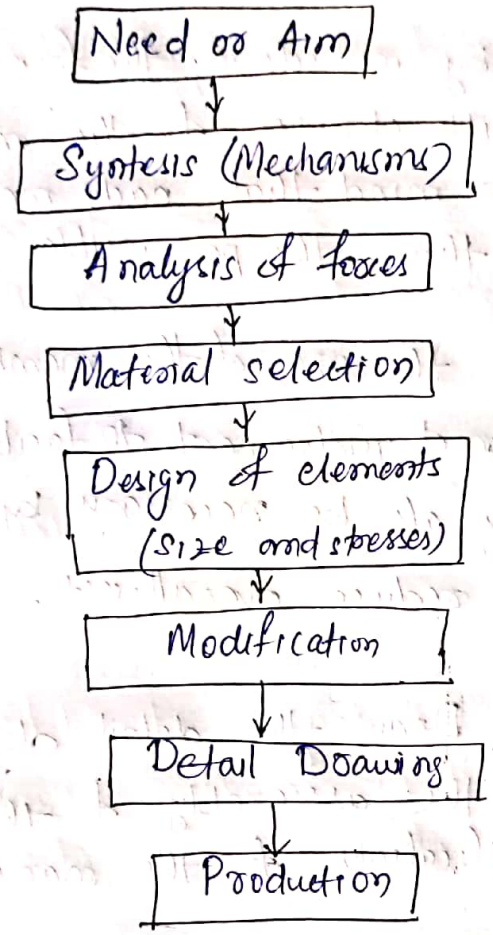
2. **High output & Efficiency :-** Earlier machines used to be heavy and consume lots of power. Now the trend is to manufacture full functional m/c consuming low power and giving high output in terms of number of products manufactured.

3. **Strength :** The machine element should be strong enough to sustain all the forces it is designed for, so that it is not damaged or permanently deformed during its life time.

4. **Stiffnes or Rigidity :-** The machine should be rigid enough to resist deformation due to external applied load

⑤ Wear resistance :- Wear is the removal of the material from the metallic surface when two surface rub with each other. If there is more wear then the component become weaker & it may fails.

General Procedure in Machine Design



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 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 you 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 of stress) :- Find the size of each member of the m/c 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 judgement to facilitate manufacture. The modification may also be necessary by consideration of manufacturing to reduce overall cost.

7. Detailed Drawing :- Draw the detail drawing of each component and the assembly of the machine with complete specification for the manufacting processes suggested.

8. Production :- The component, as per drawing, is manufactured in the work shop.

General considerations in Machine design

1. Types of load and ~~cost~~ stresses caused by load :- The load on m/c component, may act in several ways due to which the internal stresses are set up. Various types of loads are (a) dead or steal load, (b) Live or variable load (c) Suddenly applied load (d) Impact load.

2. Motion of the parts or kinematics of the m/c :- The successful operation of any machine depends largely upon the simplest arrangement of the parts which will give the motion required. The motion of the parts may be

(i) Rectilinear motion
(ii) Curvilinear motion
(iii) Const. velocity,
(iv) Const. or variable acceleration.

3. Selection of material :- It is essential that designer should have a through knowledge of the properties of the materials and their behaviour under working condition. Some of the important characteristics of materials are strength, durability, flexibility weight, resistance to heat and corrosion, ability to cast, welded or hardened, machinability etc.

4. Form and size of parts :- The form and size are based on judgement. The smallest practicable cross-section may be used, but it may be checked that the stress induced in the designed cross section are reasonable safe. It is important to anticipate any suddenly applied or impact load which may cause failure.

5. Frictional resistance and lubrication :- There is always loss of power due to frictional resistance and it should be noted that the friction of starting is higher than that of running friction. It is therefore essential that a careful attention must be given to the matter of lubrication of all surfaces.

6. Convenient and economical feature :- In designing, the operation features of the m/c should be carefully studied. The starting controlling and stopping levers should be located on the basis of convenient handling.

The economical operation of m/c which is to be used for production or for the processing of material should be studied, in order to learn whether it has the maximum capacity consistent with the production of good work.

7. Use of standard parts :- The use of standard parts is closely related to cost, because the cost of standard or stock parts is only a fraction of cost of similar parts made to order.

8. Safety of operation :- Some m/c are dangerous to operate. Therefore, any moving parts of the m/c which are within the zone of workers are considered ~~accent~~ accident zones may be the cause of injury. It is therefore, necessary that a designer should always provide safety devices for the safety of operation.

9. Workshop facility :- A designer should be familiar with the limitations of his employer's work shop, in order to avoid the necessity of having work done in some other workshop.

10. Number of m/c's to be manufactured :- The number of m/c's to be manufactured affects the design in a number of ways. The engineering and shop costs which are called fixed charges or overhead expenses are distributed over the number articles to be manufactured.

11. Cost of construction :- The cost of construction of an article is the most important consideration involved in design. In some cases, it is quite possible that the high cost of an article may immediately bar it from further

consideration. The aim of design engineer under all conditions, should be to reduce the manufacturing cost to the minimum.

12. Assembling :- Every m/c or structure must be assembled as a unit before it can function. Large units must often be assembled in the shop, tested and then taken to be transported to their place of service. The final location of any m/c important and the design engineer must anticipate the exact location and the local facilities for erection.