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ENGINEERS ACADEMY

RPSC - A.En.

Assistant Engineering

MECHANICAL

Rajasthan Public Service Commission (RPSC)

Volume - 8

Machine Design

SIERRA INNOVATIONS

INTRODUCTION TO MACHINE DESIGN

THEORY

1.1 | ENGINEERING DESIGN

(i) Mechanical Engineering Design

(ii) Civil Engineering Design

(iii) Electrical Engineering Design

(iv) Chemical Engineering Design etc.

Problem of Society → Engineering Design → Product, device or system.

Resources men, material, machine, money → Engineering design → Product, device or system to satisfy human need.

Engineering design as iterative decision making activity to produce, a plan or drawing to convert resources optimally into a product or device or system to satisfy the human need.

The ultimate aim of design is to develop a drawing [i.e. to select an appropriate shape, material, size and manufacturing process details) in such a way that the resulting machine component will perform given functionality satisfactorily (i.e. without fracture).

A machine component is said to be failure when it doesn't perform given objective satisfactorily.

A machine is defined as a combination of stationary and moving machine elements and they are assembled in such a way that either to produce or transform or utilize mesh energy. Ex. motor, engine turbine, generators, pump, compressor, automobile machine etc.

1.2 | STEPS USED IN DESIGN OF A MACHINE ELEMENT

(i) Specify function of machine element

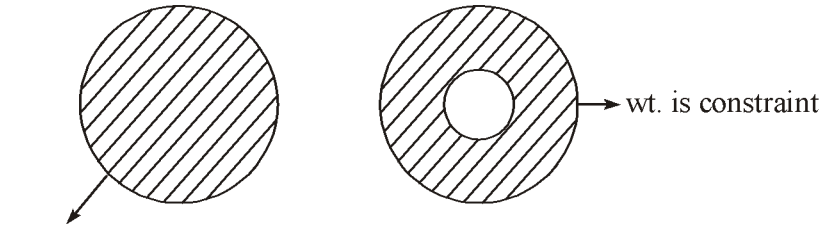
Ex. Shaft load = kN at N = rpm

(ii) Analysis (determination of load acting of machine element)

Ex. $T = \frac{P \times 60}{2\pi N} \times 10^6 =$ ____ Nmm

(iii) Selection of appropriate shape for a given X s/c

Ex. Circular X s/c



(iv) Selection of appropriate material. Here after selection of material mechanical properties are noted down.

Ex. Low power transmission → M/S.

High power transmission →HCS

(v) Modes of failure

(a) Failure of material by yielding system

(b) Failure by fracture system.

(c) Failure by excessive deformation.

(vi) Calculation of dimension by using- strength of material equation like strength criterion or rigidity criterion

(vii) Selection of manufacturing Process.

(viii) Preparation of drawing.

Basic Requirement of Machine Element :

High strength → High rigidity → Low weight → High service life → Low cost → High wear resistant.

Design Criterion :

Strength criterion → maximum stress induce ≤ permissible stress

Maximum deformation ≤ permissible deformation.

Factor of Safety :

Used to determine permissible stress given by

$$N = \frac{\text{Failure stress}}{\text{permissible or safe or allowable stress}}$$

The failure stresses are :

- Yield strength for Ductile material
- Ultimate strength for Brittle material
- Endurance limit for fatigue load

reserve strength = failure stress – permissible stress

Reason to Keep Reserved Strength :

(1) Unknown environmental and loading conditions.

(2) Imperfect workmanship.

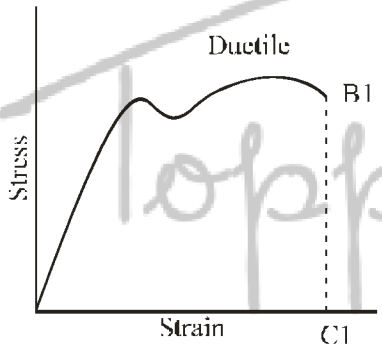
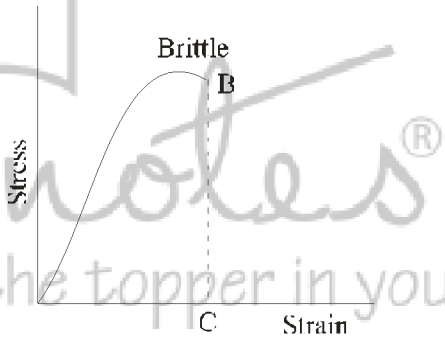
(3) Unreality of assumption made in basis of some equations.

(4) Stress concentration effect.

FOS can also be called as Factor of Ignorance.

1.3 | Machine Design

Design is a decision making process which is used to satisfy human need and to create something with physical reality.

	Ductile Material		Brittle Material
1.	Resistance to yielding < Resistance to separation	1.	Resistance of separation < Resistance to yielding
2.	Failure takes place by yielding	2.	Failure takes place by separation
3.	$(\sigma_y)_{tension} = (\sigma_y)_{compression}$	3.	$(\sigma_{UTS})_{tension} \neq (\sigma_{UTS})_{comp}$
4.	A Material like copper is known as ductile i.e. It will flow and can be drawn out into a wire without fracture	4.	Material such as Glass that can be extended but do not show plastic deformation and will easily fracture
5.	In Failure theories Yield strength is used for Ductile material	5.	In Failure theories Ultimate strength is used for brittle material
6.		6.	

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