GOVERNMENT POLYTECHNIC, SONEPUR

Lecture Note on

Design of Machine Elements(5^{th} Sem)

Prepared by:
Name - SWETAPARNA DASH
(Lect. In Mechanical Engineering)

DEPARTMENT OF MECHANICAL ENGINEERING

c) Explain the factors [illegible]

elements

→ factors governing the design of machine elements -

(i) Types of load and stresses caused by the load. Due to the application of loads internal stresses are set up in the machine element. These loads are stresses develop should be properly balanced and should not exceed the safe limit.

(ii) Motion of the parts or kinematics of the machine - The successive operation of any machine depends upon the simplest arrangement of the parts which will give the required motion.

iii) selection of materials :- The knowledge of materials and their properties is of great significance for a design engineer. The machine elements should be made of such material which has properties suitable for the conditions of operation.

iv) Form and side of the parts - In order to design any machine part for form and size, it is necessary to know the forces which the part must sustain.

v) Frictional resistance and lubrication - There is always losses of power in the machine parts due to friction. It is, therefore, essential that a careful attention must be given to the matter of lubrication of all moving surfaces in order to minimize frictional losses.

vi) Convenient and economical features of the machine operation - The economical and convenient features of the machine used for production or for processing of the materials should used to utilise the machine upto its maximum capacity consistent with its output.

vii) Use of standard parts - while designing the components for a machine, use of standard parts like gears, pulley, screws, nuts, bolts etc. should be made as far as possible in order to minimize the cost of machine or components, ease of production, ease of maintenance, reduce inventory cost etc. (ease → absence of difficulty)

(viii) Safety of operation - while operating machine at high speed, high temp zone etc, there may be every possibility of an accident/hazard (a danger or risk) within the zone of a worker. it is therefore necessary that a designer should always provide safety devices for the safety of worker. The safety appliances should in no way interfere with operation of the machine.

other factors which also affect the designing of machine elements are -

danger or risk.

- Availability of workshop facilities.
- Number of components to be manufactured.
- cost of production.
- Assembling of the machine or structure

Describe design procedure:-

-> understand the requirements.

-> Analyse and Evaluate the Design Mechanism

-> Analysis of forces.

-> Design of elements.

-> Material Analysis and selection

Design of Fastening elements:-

- state nomenclature, form of threads & specification
- Design of screw thread (Nut and Bolt).
- state types of welded joints.
- state advantages of welded joints over other joints.
- Determine strength of welded joints for eccentric load
- state types of riveted joints.
- Describe failure of riveted joints.
- Determine strength & efficiency of riveted joints.
- Design riveted joints for pressure vessel.
- Solve numerical on screw thread, welded joint and Riveted joints.

→ state types of welded joints.

Following types of welded joints are basically used.

(1) lap joint or fillet joint:

(a) single transverse joint.

(b) Double transverse "

(c) parallel fillet joint.

(2) Butt joint:-

(a) square butt joint

(b) single v-butt joint.

(c) single u-butt joint.

(d) Double v-butt joint.

other types of welded joints are:

(a) corner joint.

(b) Edge "

(c) T- joint

(b) what is the advantage of welded joint over riveted joint?

(i) A welded joint has a great strength often a welded joint has the strength of the parent metal itself.

(ii) welded joints can be made more than 100% strong i.e, the joint will never fail.

(iii) The welded joints provide max efficiency which is not possible in case of riveted joints.

iv) with adoption of welding

moulds etc.

v) As the welded structure is smooth in appearance. therefore it looks pleasing.

vi) Fabrication by welding results in lighter construction and there is saving in material.

vii) Alternations and additions can be easily made in the existing structures.

viii) with welding techniques it is possible to add the specific material with desired characteristics to any portion of the machine part.

ix) The welding provides very rigid joints. This is in line with the modern trend of providing rigid frames.

x) in welded connections, the tension members are not weakened as in case of riveted joints.

xi) The process of welding takes less time than the riveting.

xii) sometimes the members are of such a shape that they afford difficulty for riveting. But they can easily welded.

xiii) it is possible to weld any part of a structure at any point but riveting requires enough clearance.

help of a rivet.

Types of Riveted joints:- Following are the two types of riveted joints, depending upon the way in which the plates are connected.

1. Lap joint

2. Butt joint.

1. lap joint - A lap joint is that in which one plate overlaps the other and the two plates are then riveted together.

2. Butt joint - A butt joint is that in which the main plates are kept in touching each other and a cover plate is placed either on one side or on both sides of the main plates.

The cover plate is then riveted together with the main plates. Butt joints are of the following types:-

1. single strap butt joint

2. Double " " "

in a single strap butt joint, the edges of the main plates butt against each other and only one cover plate is placed on one side of the main plates and then riveted together.

→ in a double strap butt joint, the edges of the main plates butt against each other and two cover plates are placed on both sides of the main plates and then riveted together

in addition to the above, following are the types of riveted joints depending upon the number of rows

of the rivets.

1. single riveted joint.

2. Double " "

A single riveted joint is that in which there is a single row of rivets in a lap joint.

A double riveted joint is that in which there are two rows of rivets in a lap joint.

→ strength of a Riveted joint:- The strength of a joint may be defined as the max force, which it can transmit, without causing it to fail.

→ if the joint is continuous as in case of boilers, the strength is calculated per pitch length, But if the joint is small, the strength is calculated for the whole length of the plate.

→ Efficiency of a Riveted joint:- The efficiency of a riveted joint is defined as the ratio of the strength of riveted joint to the strength of the un-riveted or solid plate.

we have already discussed that strength of the riveted joint

$= \text{least of } P_t, P_s \text{ and } P_c$

strength of the un-riveted or solid plate per pitch length.

$P = p \times t \times \sigma_t.$

∴ Efficiency of the riveted joint.

$$\eta = \frac{\text{least of } P_t, P_s \text{ and } P_c}{p \times t \times \sigma_t}$$

p = pitch of the ...

t = Thickness of the plate and

σ_t = permissible tensile stress of the plate material.

Q Find the efficiency of the following riveted joints

1 Single riveted lap joint of 6mm plates with 20mm diameter rivets having a pitch of 50mm

2 Double riveted lap joint of 6mm plates with 20mm diameter rivets having a pitch of 65mm

permissible tensile stress in plate = 120 Mpa (σ_t)

" shearing " in rivets = 90 Mpa (τ)

" crushing " " rivets = 180 Mpa (σ_c)

Solⁿ:- Given: t = 6mm, d = 20mm; σ_t = 120 Mpa = 120 N/mm²;

τ = 90Mpa = 90 N/mm², σ_c = 180 Mpa = 180 N/mm².

pitch, p = 50mm.

1. efficiency of the 1st joint

tearing, shearing & crushing resistances.

(i) Tearing resistance of the plate

we know that tearing resistance of the plate per pitch length.

$$P_t = (p-d)t \times \sigma_t = (50-20) \times 6 \times 120$$

$$= 30 \times 6 \times 120 = 180 \times 120 = 21600 N$$

(ii) shearing resistance of the rivet

we know that shearing resistance of one rivet.

$$P_s = \frac{\pi}{4} \times d^2 \times \tau = \frac{\pi}{4} \times (20)^2 \times 90 = 28275 N = 28080$$

$$= \frac{3.141}{4} \times 400 \times 90$$

(iii) crushing resistance of the rivet - since the joint is a single riveted, therefore strength of one rivet is taken, we know that crushing resistance of one rivet,

$$P_s = \frac{\pi}{4} \times d^2 \times \tau = P_c = d \times t \times \sigma_c = 20 \times 6 \times 180 = 21600N.$$

strength of the joint -

= least of P_t, P_s and P_c = 21600N.

we know that strength of unriveted or solid plate,

$P = p \times t \times \sigma_t = 50 \times 6 \times 120$

$= 300 \times 120 = 36000N.$

300
120
000
600
300

efficiency of the joint,

$$\eta = \frac{\text{least of } P_t, P_s \text{ and } P_c}{P} = \frac{21600}{36000} = 0.60$$

or 60%.

1 pascal [pa] = 1 N/square meter² [N/m²] = 1kg:

Given data

Pt

t = 8mm, d = 30mm, p = 40mm

σ_t = 110 Mpa, τ = 80 Mpa, σ_c = 180

η

35,200 = 2.318

t = 6 σ_t = 120
d = 20 τ = 90
p = 65 σ_c = 180