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SUBJECT: STEEL STRUCTUR.

QNo1

Ans: When particular Loading reaches its limits failiur is the assumed result i.e the loading condition become failure modes, such a condition ~~become failure modes~~ is reffered to as limits state and it can be defined as:

"A limit state is a condition beyond which a structural system or a structural component ceases to full fill the functional for which it is design"

A general statment assumed saftely in engineering design.

"Resistance of material and x-section > effect of applied load"

↓

eq 1

In eq 1 it is essential that both sides are evaluated for same conditions e.g if effect of load is to produce compressive stress on soil then it should be compared with bearing capacity of soil.

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CONSIDERATION FOR A DESIGN APPROACH.

- In steel design AISC manuals for ASD and LRFD guide line can be accepted as reflectio of openions of experlanced and qualified group of engineer such as to determine the acceptable margin of safty

- To facilitate the analysis of load effect and strengut of materials the two distuing procedures employeed by designers are allowable stress design (ASD) and load and Resistance Factor design (LRFD)

ALLOWABLE STRESS DESIGN (ASD)

- Safety in the design is obtained by specifying that the effect of load should produced stresses that is a fraction of the yeild stress f_y, say one half.

- This is equalent to:

$$FOS = \text{Resistance}, R / \text{Load effect}, Q$$
$$= f_y / 0.5 f_y$$
$$= 2.$$

Mathematical:

$$\frac{\phi R_n}{\gamma} \geq \Sigma Q_i$$

R_n = Resistance of design component
ϕ = Resistance factor
γ = Load factor

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$\frac{\gamma}{\phi}$ = Factor of safety

Q_i = Effect of applied load.

DRAW BACKS

- ASD does not give reasonable measurement of strenght, which is more fundamental measures of resistance than is allowable stress.

- Another drawback is ASD is that safty is applied only to stress level, loads are consider to be deterministic (with out variability)

LRFD

- To over come the defecencies of ASD the LRFD method is based on Strenght of material"
- It consider the variebility not only in resistance but also in effects of load.
- It provides measure of safety related to probability of falure.
- Safety in the design is obtained by specifying that the reduced Nominal strength of a designed structure is less than the effect of factored loads acting on the structure.

$$\phi R_n \geq n \sum \gamma Q_i$$

R_n = Resistance or strength of the component

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being designed.

Q_i = Effect of Applied loads.

η = Takes into account ductility, redunda
and operational imp.

ϕ = Resistance factor or Strength Reduction
factor.

γ = Overload or load factors.

$$\frac{\gamma}{\phi} = \text{Factor of Safety}$$

Advantages:

- LRFD accounts for both variability in resistance and load.
- It achieves fairly uniform levels of safety for different limit states.

Disadvantages:

- It's disadvantage is change in design philosphy from previous method.

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QNo : 2

Types of Bolted connections:

Types of connections.

Slip-criticle connections.

- Connection transmits the force by friction produced between the faying surfaces by the clamping action of the bolts.
- Slip-critical connections are recommended for joints subjected to stress reversal, severe stress fluctuation, impact, vibration ore where slip is objectional.

Structural Bolts:-

- Two commonly used bolts are:
  - Unfinished (A307)
  - High strength bolts (A325, A449, A490)
- A307 is known by names unfinished, rough common, ordinary and machine.
- They are made of low carbon steel having tensile strength of 60ksi
- ~~High strength bolt can be tightened~~
- A325 is made of medium carbon steel whose tensile strength decreases with increase in dia.
- High strength bolts can be tightened to to large tensions.

The greater the diameter of bolt greater are residual stresses.

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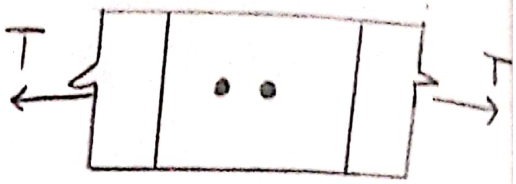
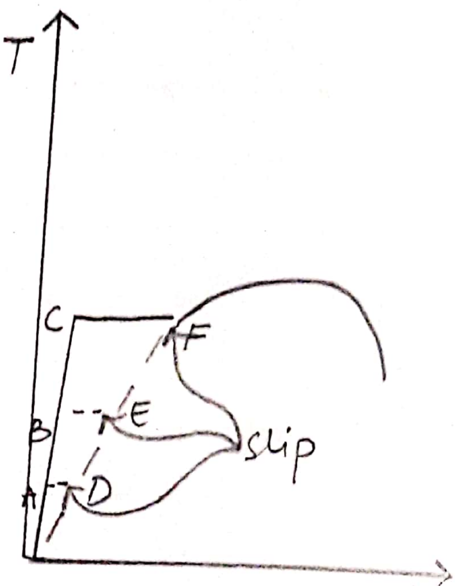
Behavior of Bolted & Riveted Connecti

T = Tensile for on Connection.

Δ = Joint Displacement.





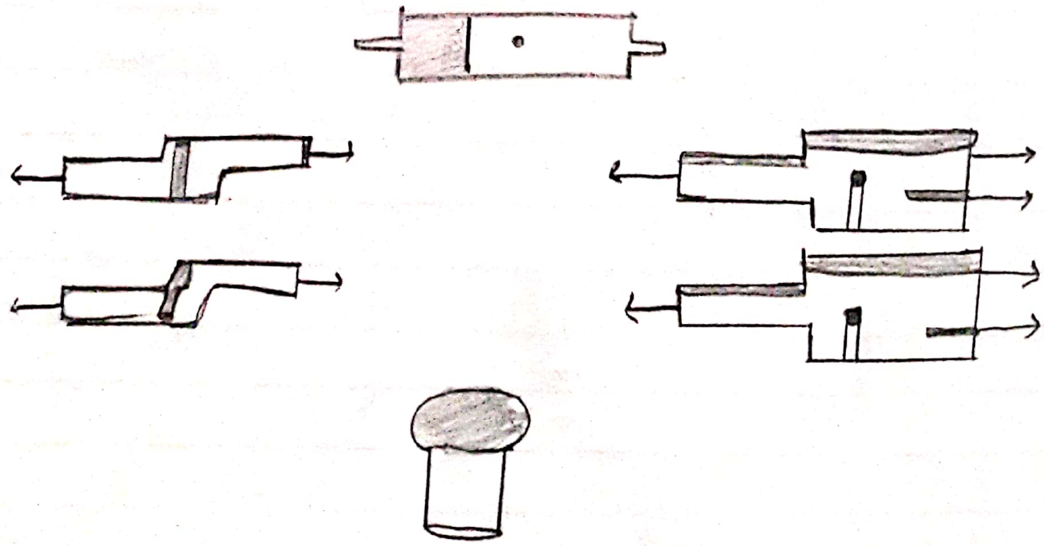
Behaviour of mechanically connected joints.

Types of failure:

- Shearing failure of bolts.
- Bearing failure of ~~bolts~~. plates
- Tearing failure at edge of plate.

Types of failure:-

Shearing failure of bolts.



Types of Bolted Connections:

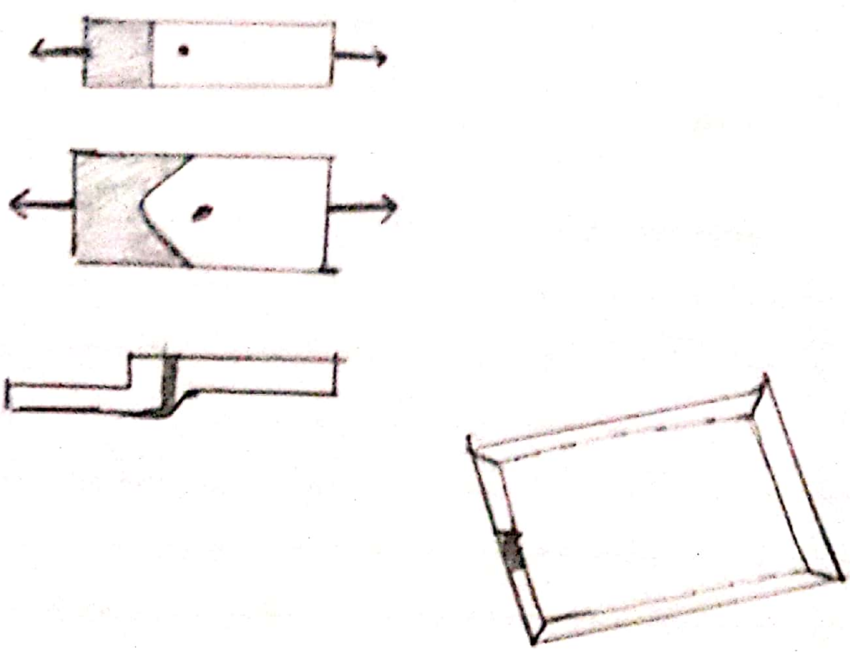
- Bearing type connections
  - load is transfered by shearing and bearing on the bolt
- Capacity in shear depends on whether shear plane intersects the body of bolt or threaded portion.

Types of Bolted connections (Contd)

Bearing type connection is most widely used general type connection in which the load is resisted by the bolt body without any friction btw faying surfaces.

Types of failure:

- Bearing failure of plate.



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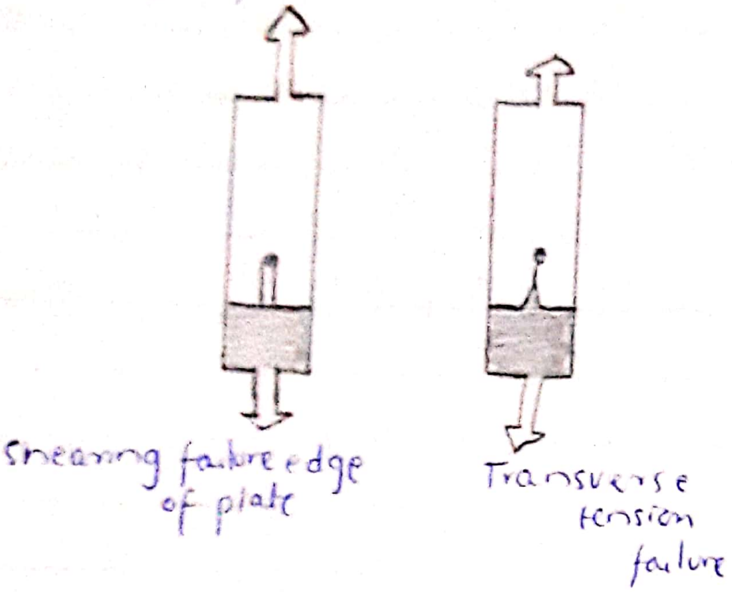
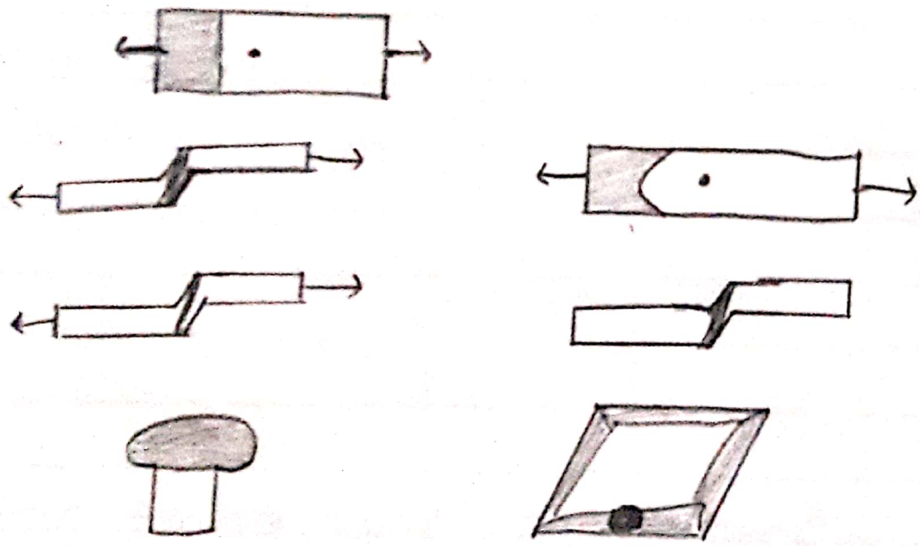
Types of failure in bolts:

Tearing failure at the edge of Plate.



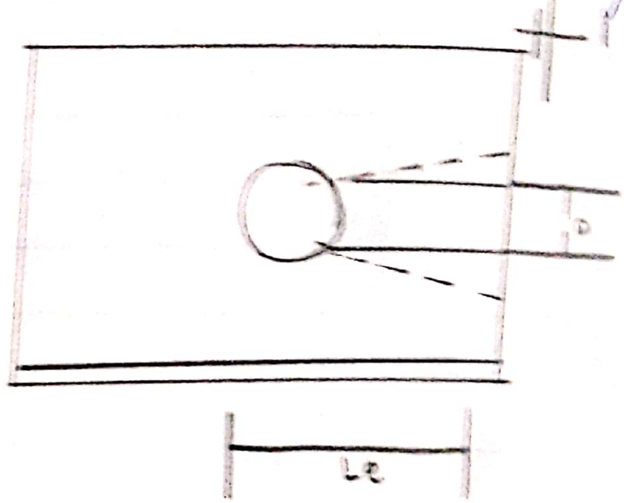
Shearing and bearing Area:



Shear force required = Bolt × Xsectional area × bo
shear strength

Tearing failure:-

- Test showed failure by tearing through free edge of material will not occur if Le measured parallel to line of applied force is not less than product of bolt dia and ratio of bearing stress to tensile strength of connected part



Tearing failure:-

$$\frac{L_e}{D} \simeq \frac{f_p}{F_u}$$

$$L_e = \frac{f_p D}{F_u} = \frac{F_p D t}{t F_u} = \frac{P}{t F_u}$$

Tearing failure code requirement:-

LRFD

Tearing length

$L_e = \frac{P}{\phi F_u t}$, $\phi = 0.75$

or

ASD

Edge distance

$L_e = \frac{2P}{F_u t}$ with FOS = 2

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Spacing between holes

$$L = \frac{P}{\phi F_u t} + \frac{d_h}{2} \qquad L = \frac{2P}{f_u t} + \frac{d_h}{2}.$$

Q No 3 :-

Given data:-

Dead load = 130k

Live load = 265 k

Section = C 10 x 3

Gusset plate = 1 in

Bolts diameter = 3/4 in

A325 , A36

three bolt lines.

Required:-

No of bolts = ?

Capacity of using ASD = ?

Diagram:-

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Solution:-

① Finding total service load.

= 130 + 265 = 395 kips.

② Bolts Design:

For $3/4$ dia

Area = 0.4418 in^2 (Nominal Area).

F_v = 30 ksi (Shear strength of bolt in Single shear table 2-1)

$R_v = 0.4418 \times 30$

R_v = 13.25 kips / shear surface.

↳ Resistance offered by a single in shear.

As there are two shear surfaces per bolt

No of bolts = $\frac{395}{2 \times 13.25}$ = 14.90 ≈ 15 bolts.

③ Bearing:-

$F_p = 1.2 F_u$ (Specification allowable stresses)

$F_p = 1.2 \times 58$

F_p = 69.6 ksi

Channel:-

$R_p = d\,t\,F_p = 3/4 \times 0.673 \times 69.6$

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$R_p = 35.13$ kips (Single bearing surface of channel).

For bolt these are 30 bearing surfaces.

Capacity = 30 x 35.13

= 1053.97395 kips.

③ Gusset plate :-

$R_p = dtF_p$

$R_p = \frac{3}{4} \times 1 \times 69.6$

$R_p = 52.2$ kips. Single bearing surface of gusset plate.

For gussel plate these are 15 bearing surfaces so;

Capacity = 15 x 52.2

= 7837395 kips.

④ Spacing:-

End distance shared. Edge = $1\frac{1}{4}$ minimum.

End distance = $1\frac{1}{2}d = 1.13\text{in} \leq 1\frac{1}{4}$ in

Centre to centre = 3d = $2\frac{1}{4}$ in.

→ As we can see that R_p for both channel and gusset plate is considerably greater than required. Consider minimum end

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distance of $1\frac{1}{4}$ in and the minimum between connection spacing of 2in.

$$l_e = \frac{2P}{F_u t} = 1.25 \quad \left[t = 0.673 \right]$$

$$\frac{2P}{58 \times 0.673} = 1.25$$

$$P = 24.4 \text{ kips.}$$

$$L = \frac{2P}{F_u t} + \frac{d}{2}$$

$$2 = \frac{2P}{58 \times 0.673} + \frac{3/4}{2}.$$

$$P = 31.7 \text{ kips.}$$

$$\text{Capacity} = (2(3 \times (24.4) + 12(31.7)))$$

$$\text{capacity} = 907.2 > 395 \text{ kips.}$$

Gusset:-

$$l_e = \frac{2P}{F_u t} \Rightarrow 1.25 = \frac{2P}{58 \times 1}$$

$$P = 36.25 \text{ kips}$$

$$L = \frac{2P}{F_u t} + \frac{d}{2} \Rightarrow 2 = \frac{2P}{58 \times 1} + \frac{3/4}{2}$$

$$P = 47.13 \text{ kips.}$$

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Capacity = $(3 \times (36.25) + 12(47.13))$

Capacity = 674.31 > 395 kips.

So use 15 bolts. in 3 rows of 5 with end distance $1\frac{1}{4}$ in and centre to centre spacing of 2in.

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