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Subject : Steel Structure

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Q.No 1

Ans:- Design philosophies:-

A general statement assuming safety in engineering design:

Resistance (of material and x-section) >> effect of applied loads .... (1)

In equation (1) it is essential that both slides are evaluated for some conditions e.g if effect of load is to produce compressive stress on soil, then it should be compared with bearing capacity of soil.

→ ASD:- Allowable stress design

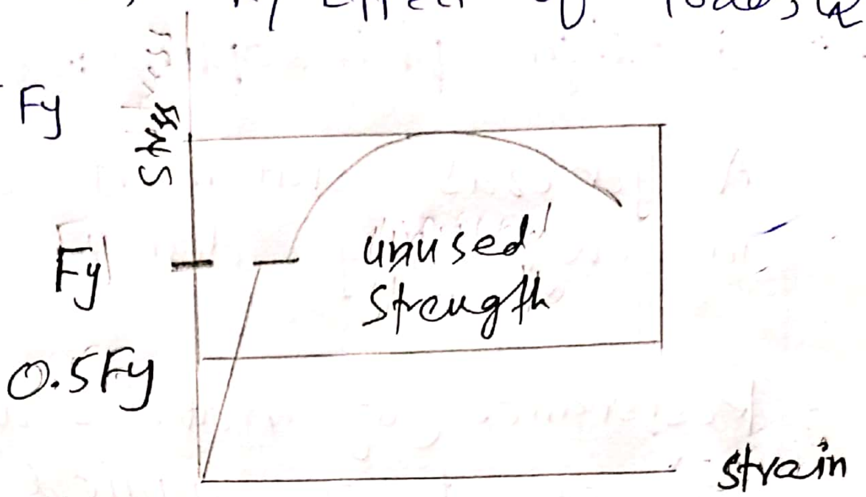
• Safety is the design is obtained by specifying, that the effect of the loads should produced stresses that is a friction of the yield stress Fy, say one half

• This is equivalent to

FOS = Resistance, R / Effect of load, Q

$= Fy / 0.5 Fy$

$= 2$



Mathematical Description of ASD

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

R_n = Resistance of strength of the component being design

ϕ = Resistance Factor or strength Reduction Factor

γ = load Factor or over loaded

γ/ϕ = Factor of safety

Q_i = effect of applied load.

LRFD :

- To overcome the deficiencies of ASD, the LRFD method is based on

  ⇒ Strength of Material

- It consider the variability not only in resistance but also in the effects of load.

- It provides measure of safety related to probability ~~in the effects~~ of failure.

- Safety is the design is obtained by specifying that the reduce Nominal strength of a designed structure is less than the effect of Factored loads acting on the structure.

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

R_n = Resistance

Q_i = Effect of Applied loads

η = Takes into account ductility, redundancy and operational Imp

ϕ = Resistance Factor or strength Reduction factor

γ = overload or load factors

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

Merits of ASD

1) Elastic analysis For loads become Compatible For design.

2) old Famous books are according to this method

3) Experienced engineers are used to this method.

4) In past it was the only method for design purposes.

5) This method is included in AISC-05 specifications as an alternate method.

Demerits of ASD

- Implied in the ASD method is the assumption that the stress in the member is zero before any loads are applied, i.e, no residual stresses exist from forming the members.

- ASD does not give reasonable measure of strength, which is more fundamental measure of resistance than is allowable stress.

- Another drawback in ASD is that safety is applied only to stress level. loads are considered to be deterministic (without variation).

→ Advantages of LRFD:

- LRFD accounts For both variability in resistance and load.
- It achieves Fairly uniform levels of Safety For different limit states.

→ Dis advantages:

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

QNo 2

Ans Types of bolted connection in steel structure:

① Slip-critical 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 or where slip is objectionable

② Bearing type connection:-

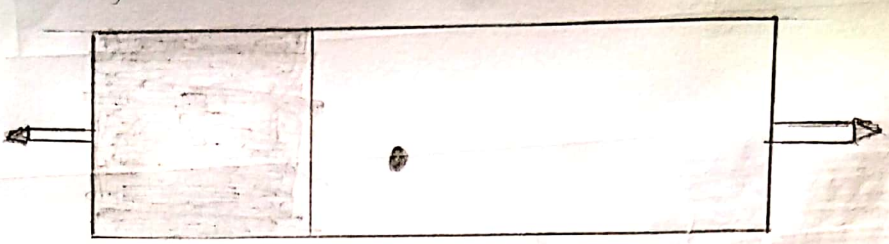
- Loads is transferred by shearing and bearing on the bolt.

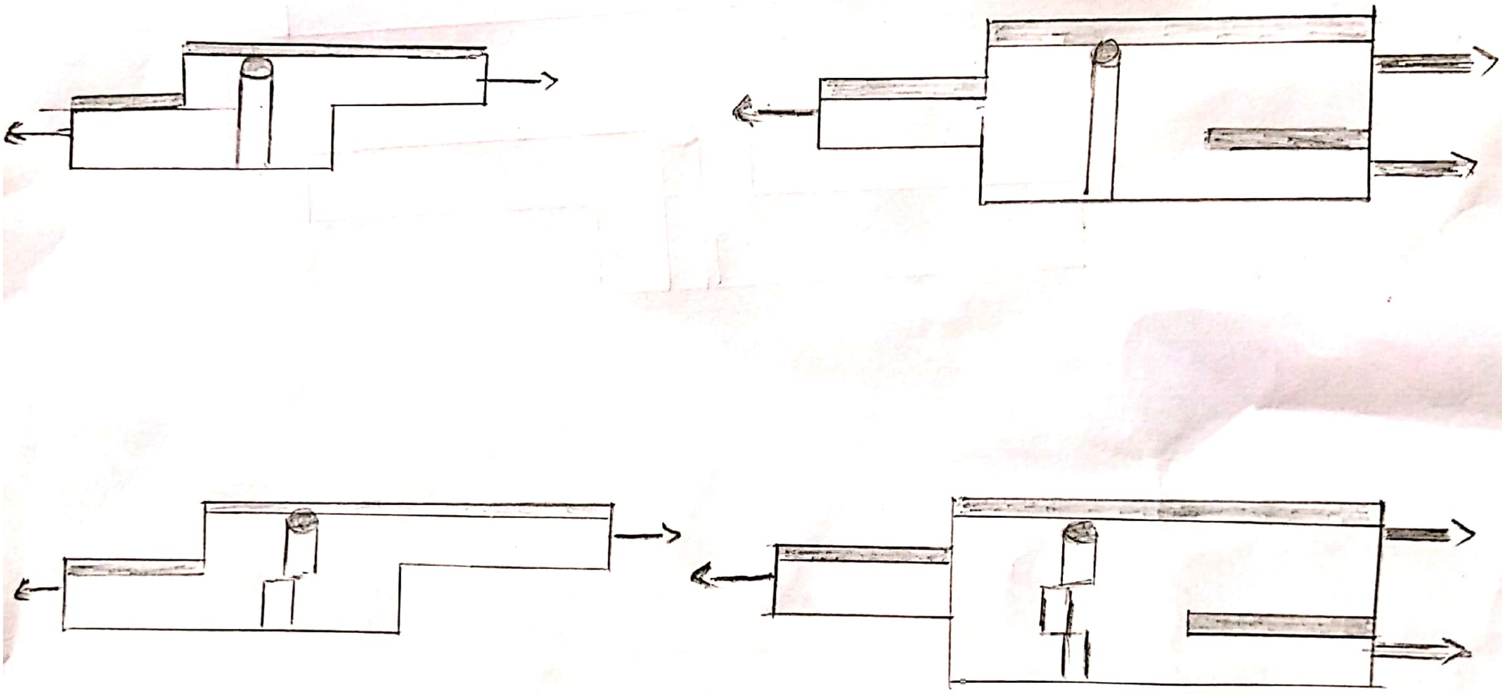
- Capacity in shear depends on wheather shear plane intersects the body of bolt or threaded portion.

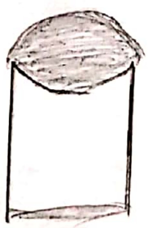
- It is the most widely used general type connection in which the load is resisted by the bolt body without any friction between Faying surfaces.

Type of Failure

① shearing Failure of Bolts:-





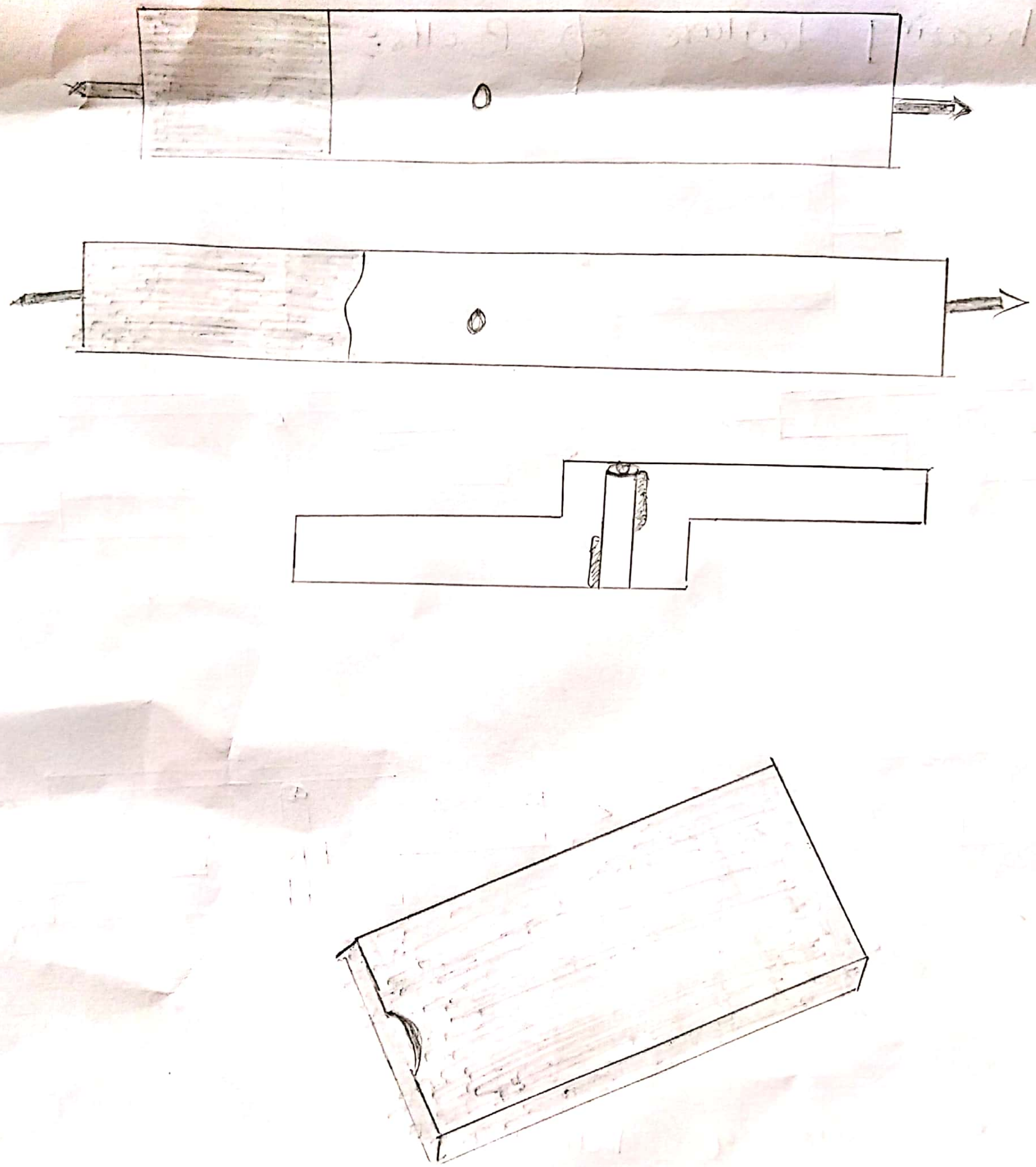


⇒ shear failure of bolt :-

The shear stress in the bolt may exceed the working shear stress in the bolt.

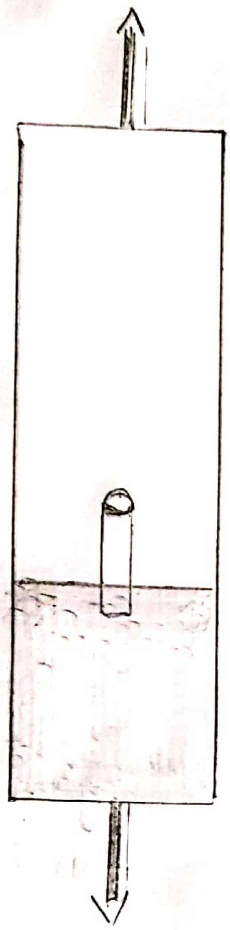
Shear stresses are generated because the plates slip due to applied forces.

② Bearing Failure of Plate:

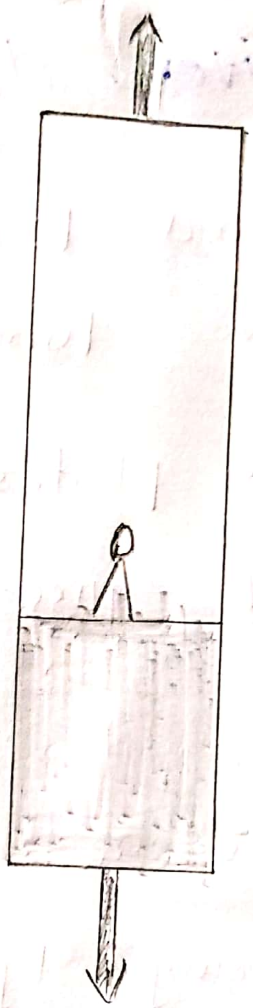


The plate may be crushed when the bearing stress in the plate exceeds the working bearing stress.

③ Tearing Failure the edge of plate:



Shearing Failure edge of plate



Transverse Tension failure.

The tensile stress in the plate at the net cross-section may exceed the working tensile stress. tearing failure occure when bolts are stronger than the plates.

Q NO 3

Ans

Given data:

Dead load = 130 k

Live load = 265 K

Two plates $C_{10} \times 30$

1" gusset plate

All material is A36 steel

Bolts are A 325 with 3/4 in dia

Bearing type connection

Thread excluded

Use three lines of bolts

ASD Method

Required: no of bolts ?

Appropriate layout

Design Force = D.L + L.L

= 130 + 265

= 395K

Solution :

Design Force = D.L + L.L

130 + 265

= 395 K

→ Bolt design :

For 3/4" dia bolts

$$Area = \frac{\pi}{4}(D^2) \Rightarrow \frac{\pi}{4}(3/4)^2$$

$$Area = 0.4418\ in^2$$

→ Shear design :

Shear strength of bolts when threads are excluded from shear plane, from table

F_v = 30 ksi

R_v = Area x F_v

0.4418 x 30

= 13.25 K per shear surface

⇒ As there are two sheer surface per bolt.

Number of bolts:

$$\frac{\text{design Force}}{2 \times R_v}$$

$$\frac{395}{2 \times 13.25}$$

$= 14.90$

So 15 bolts.

Bearing:

Bearing strength,

$F_p = 1.2 F_u$ $F_u = 58$

$= 1.2 (58)$

$F_p = 69.6$ ksi

⇒ For channel, $R_p = d t F_p$

$t_w = 0.673$

$R_p = 3/4 \times 0.673 \times 69.6$

$R_p = 35.13$ K For single bearing surface

As there are 15 bolts so 30 surface.

→ Capacity:

30 × 35.13

= 1053.9 k > 395 k ok

⇒ For gusset plate

$R_p = d\,t\,F_p$

$= 3/4 \times 1 \times 69.6$

$R_p = 52.2$

Capacity = 15 × 52.2 = 783 k > 395 k

ok

→ Spacing:

For 3/4 dia bolts min. edge distance from table

→ 1.25

$2.8 = 1\frac{1}{4}$ "

Also end distance $= 1\frac{1}{2} d$

$= 1\frac{1}{2}(3/4)$

= 1.13 in < 1.25

edge $\frac{3}{30}$ edge distance

$$L_e = 1\frac{1}{4}'' \text{ or } 1.25''$$

-> Centre to Centre distance :-

$$L = 3d$$
$$= 3(3/4)$$
$$L = 2.25''$$

-> Channel :-

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

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

$$P = 24.4k$$

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

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

$$P = 31.7k$$

As the bolt are arranged in three rows and five bolts per row.

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⇒ Capacity :

$2(3 \times 24.1 + 12 \times 31.7)$

$907.2k > 395k$

ok

⇒ Gusset plate.

$Le = \frac{2P}{Fut}$

$1.25 = \frac{2P}{58 \times 1}$

$P = 36.25k$

$L = \frac{2P}{Fut} + d/2$

$2 = \frac{2P}{58 \times 1} + \frac{3/4}{2}$

$P = 47.134$

Capacity : $3 \times 38.25 + 12 \times 47.134$

$674.358k > 395k$ **OK**

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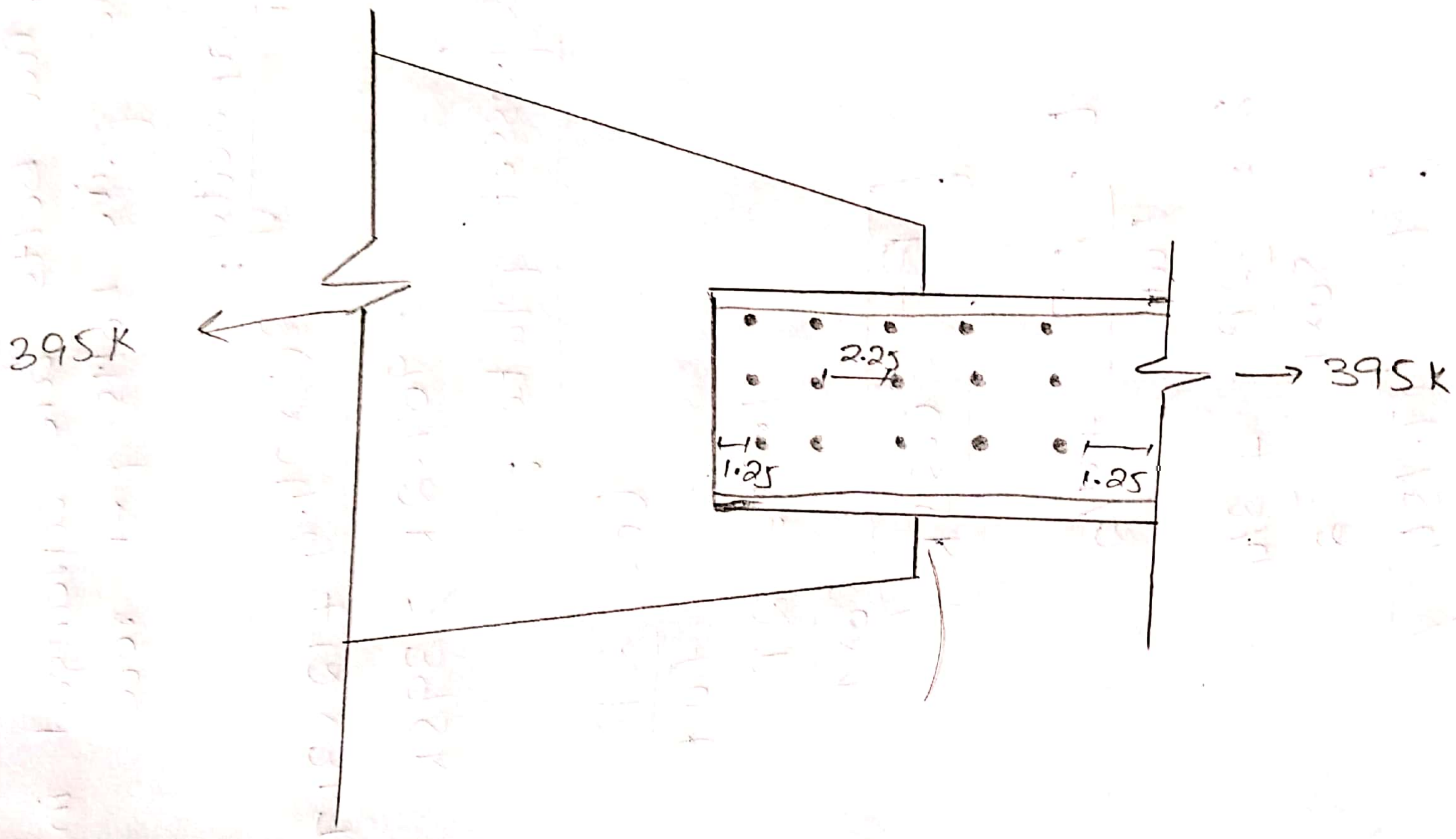
395 K
2.25
1.25
1.25
395 K