Q1)

Ans) Design philosophies:-

A general statement assuming safety in engineering design

Resistance (of material & X-section) ≥ Effect of Applied load (1)

In eq(1) It is essential that both sides are evaluated for same conditions e.g:- if effects of loads is to produce compressive stress on soil, then it should be compared with bearing capacity of soil.

*) when particular loading reaches its limit, failure is the assumed result, i-e the loading condition become failure modes, such a condition is referred to as limit state and it can be defined as;

" A limit state is condition beyond which a structural system or a structural component ceases to fulfill the function for which it is designed."

(b) brief note on ASD and LRFD:-

a) ASD:-

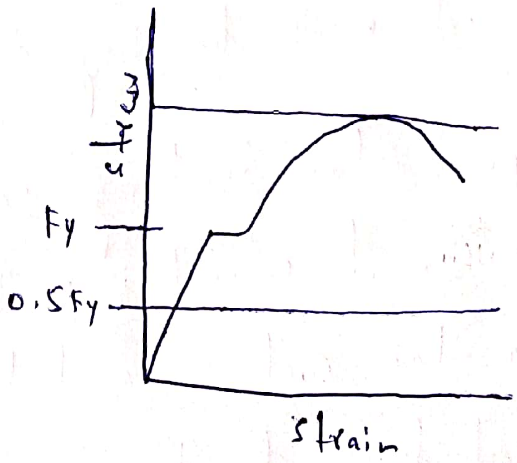
Safety in the design is obtained by specifying that the effect of the loads should produce stresses that is a fraction of the yield stress Fy, say one half.

*) This is equivalent to:

FOS = Resistance R / Effect of load Q

$= F_y / 0.5 F_y$

$= 2$



*) ASD (contd.):-

Mathematical description of ASD

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

R_n = resistance or strength of the component being designed.

ϕ = Resistance factor or strength reduction factor

γ = overload or load factors

γ/ϕ = Factor of safety F_s

Q_i = Effect of applied loads.

(b) LRFD :-

To overcome the defeciencies of ASD, the LRFD method is based on

strength of materials

+) It consider the variability not only in resistance but also in the effect of loads.

+) It provides measure of safety related to probability of failure.

+) 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 being designed.

Q_i = effect of Applied loads

n = taken into account ductility, redundancy and operational imp.

ϕ = Resistance factor or strength reduction factor.

γ = over load or load factors.

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

c) what are merits and demerits?

a) ASD advantages:-

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 purpose.

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

***) ASD disadvantages / demerits / draw back :-**

(1) Implied in the ASD method is the assumption that the stress in the member is zero (0) before any loads are applied, i.e:- no residual stresses exist from forming the members.

(2) ASD does not give reasonable measure of strength, which is more fundamental method measure of resistance than is allowable stress.

(3) Another draw back in ASD is that safety is applied only to stress level. Loads are considered to be deterministic (without variation).

(b) LRFD Advantages :-

(1) LRFD accounts for both variability in resistance and load.

(2) It achieves fairly uniform levels of safety for different limit states.

***) LRFD disadvantages / demerits / draw back :-**

1) Its disadvantage is change in design philosophy from previous method.

Q2)

Ans) Types of bolted Connections:-

1) Slip-critical connection:-

connection transmits the force by friction produced between the faying surfaces by the clamping action of the bolts.

*) Slip-critical Connection are recommended for joints subjected to stress reversal, severe stress fluctuation impact, vibration or where slip is objectionable.

*) Types of bolted connection (contd.):-

slip critical connections becomes bearing type connection after the slip occurs so every slip critical connection is essentially a bearing type connection also.

2) Bearing type connections:-

load is transferred by shearing and bearing on the bolt.

*) Capacity in shear depends on whether shear plane intersects the body of bolts or threaded portion.

*) Bearing type connection is the most widely used general type of connection in which the load is resisted by

the bolt body without any friction between faying surfaces.

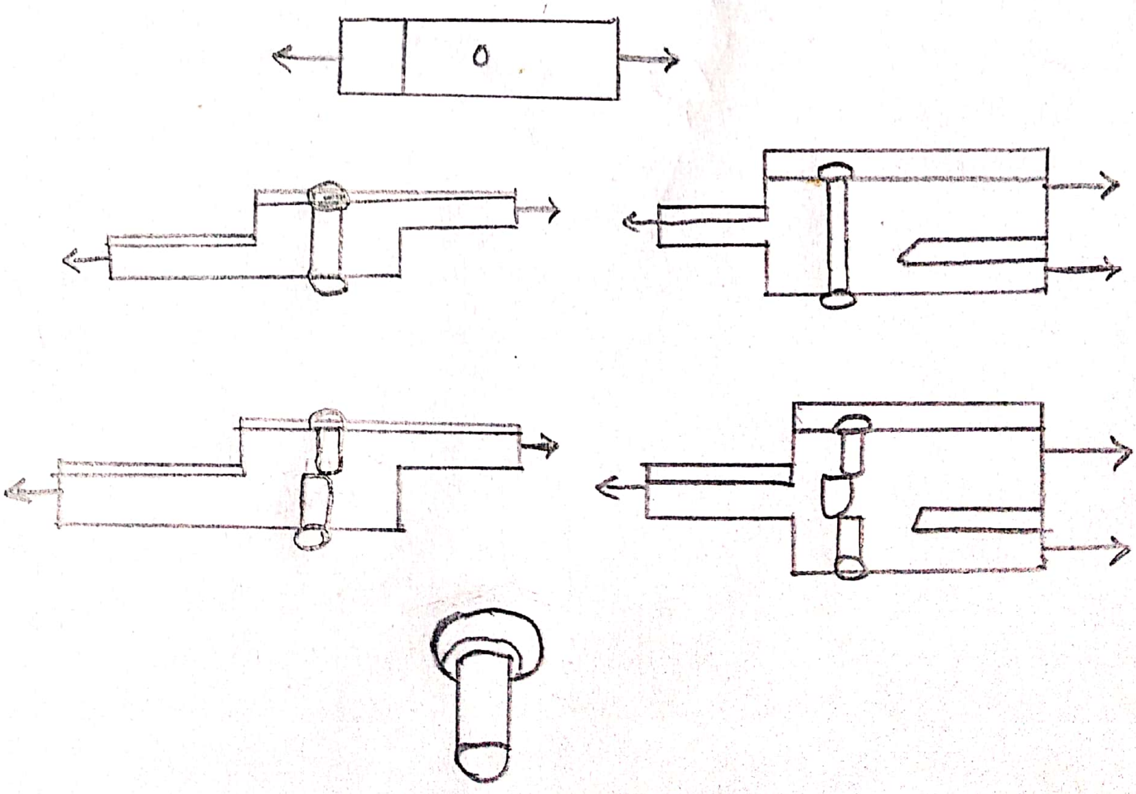
(b) Types of failure :-

Following are the types of failure.

1) Shearing failure of bolts
2) Bearing failure of plate
3) Tearing failure at the edge of plate.

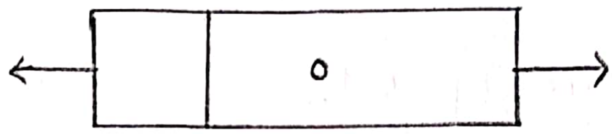
1) Shearing failure of bolts :-

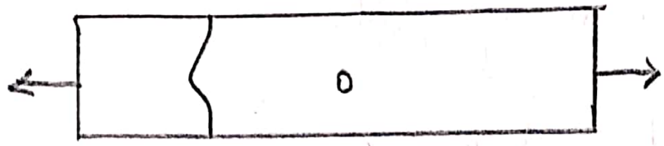
The shear stress in the bolt may exceed the working shear stress in the bolt generated because the plates slip due to applied forces.

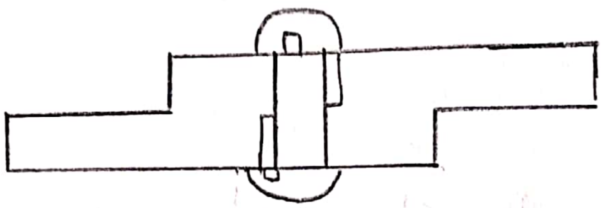


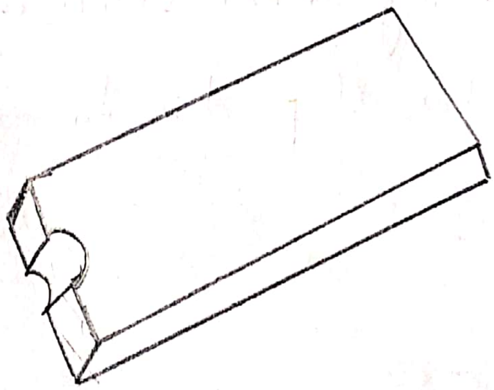
2) Bearing failure of plate :-

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





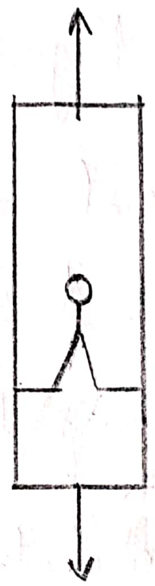




3) Tearing failure :-

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

shearing failure edge of plate



Transverse tension failure

Q3)

+) Given data :-

Dead load = 130 kips

live load = 265 kips

Two plate C10x30

1" gusset plate

All material is A-36 steel

Bolts are A-325 with 3/4 in dia

Bearing type connection

Threads excluded from shear plane

use three lines of bolts

ASD Method

+ Sol :- Required :-

Number of bolts required = ?

Appropriate layout.

Sol:-

Design force = D.L + L.L

= 130 + 265

= 395 kips

+) Bolt design:-

For 3/4" dia bolts

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

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 shear surface per bolt

$$\text{number of bolts} = \frac{\text{design force}}{2 \times R_v}$$

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

$$= 14.90$$

So No. of bolts = 15

+) Bearing :-

Bearing strength, $f_p = 1.2\, F_u$

$F_u = 58$

$F_p = 1.2 \times 58$

$F_p = 69.6$ ksi

=> For channel, $R_p = d.t\, F_p$

$t_w = 0.673$

$R_p = \frac{3}{4} \times 0.673 \times 69.6$

$R_p = 35.13$ k for single bearing surface

As there are 15 bolts so 30 surfaces

+) Capacity:-

$= 30 \times 35.13$

$= \underline{1053.9\,k} > 395\,k$

ok!

For gusset plate

$R_p = d + F_p$

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

$\underline{R_p = 52.2}$

Capacity

$15 \times 52.2 = \underline{783\,k} > 395\,k$

ok!

+) Spacing:-

for 3/4" dia bolts min. edge distance from table 2.8 = $1\frac{1}{4}$" (→ 1.25")

Also

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

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

$= 1.13$ in < 1.25"

So,

Edge distance, $l_e = 1\frac{1}{4}$" or 1.25"

*) Center to center distance:-

$$l = 3d$$

$$= 3(3/4)$$

$$l = 2.25''$$

+) Channel:-

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

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

$$P = 24.4\,k$$

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

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

$$P = 31.7\,k$$

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

Capacity:-

$$2(3 \times 24.4 + 12 \times 31.7)$$

$$907.2\,k > 395\,k \quad \text{OK!}$$

+) Gusset plate :-

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

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

$$\underline{P = 36.25k}$$

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

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

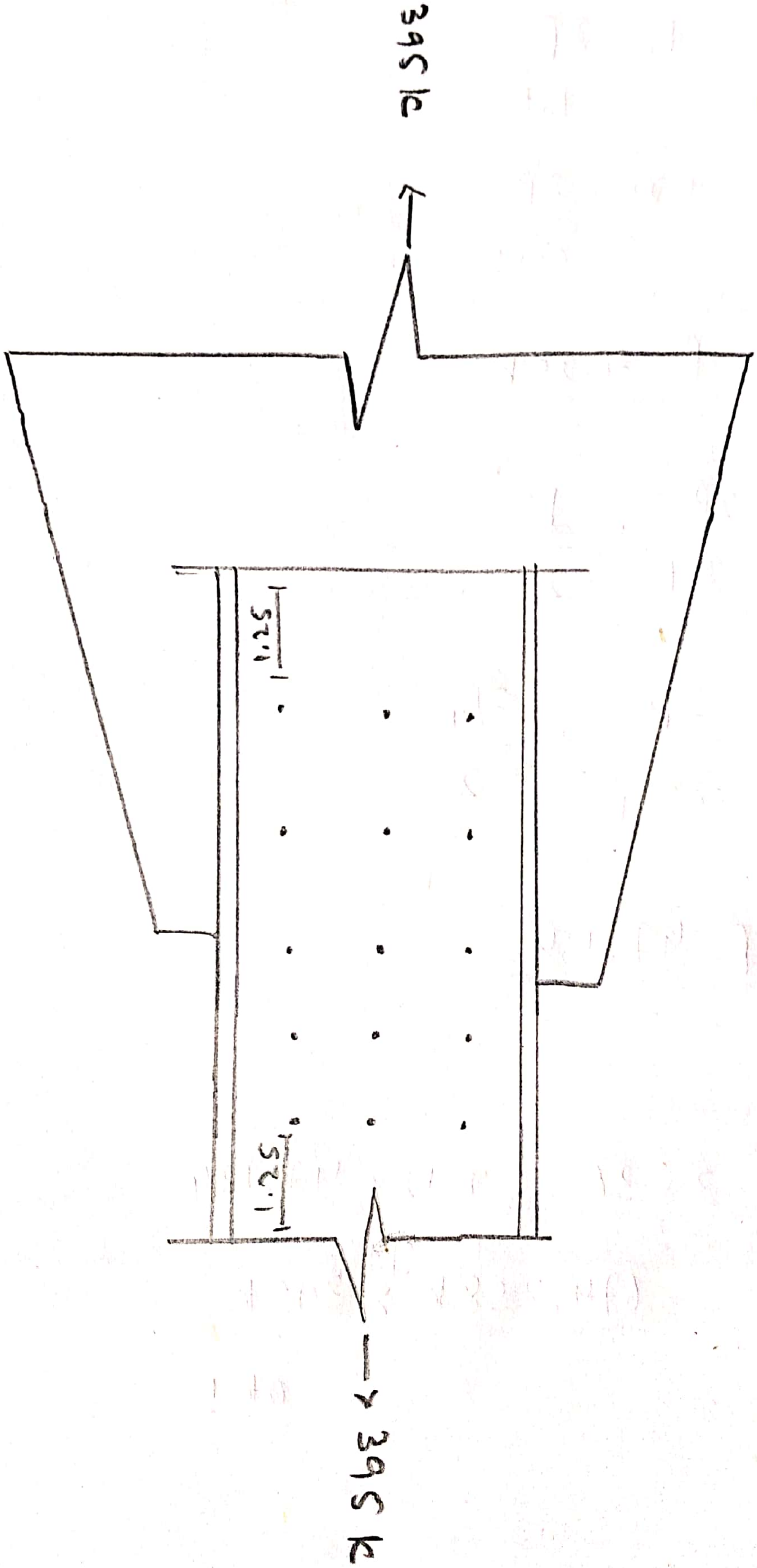
$$\underline{P = 47.134}$$

+ Capacity :-

$$3 \times 36.25 + 12 \times 47.134$$

$$\underline{674.358k} > 395k$$

ok!


395 k
1.25
1.25
395 k