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Subject : Steel structure

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Question # 1 (1)

Ans:- Design philosophies :-

A general statement assuming safety in engineering design

Resistance (of marterial and X-Section) ≥ effect of applied load ..... (1)

In equation (1) it is essential that both side are evalnated for some condition e.g if effect of load is to produce compressive stress on soil them 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 load should produced stress that is a Friction of the yield stress fy say one half.

This is equivalant to

Fos = Resistance R / effect of load

Q = Fy / 0.5 y

= 2

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Mathematical Description (2) of ASD

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

R_n = Resistance of strength of the component being design.

φ = Resistance factor or strength Reduction factor

γ = load Factor

γ/Q = 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 effect of load.

it provide measure of safety related to probability of Failure.

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

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

R_n = Resistance

Q_i = effect of Applied load

n = Taking into account ducitility

Q = Resistance Factor

V = overload or load Factor.

$\frac{r}{Q}$ = Factor of safety.

Merits of ASD :-

1) elastic of Analysis for load become compatible for design.
2) old Famous book are accourdin to this method.
3) experienced ensineer are used to this method
4) In past it was only method For Design load.

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Demerits of ASD :- (4)

Implied in the ASD method is the assumption that the stress in the member is zero. before any load are applied i-e no residual stress exist from Forming the member.

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 load are considered to be deterministic (without ~~vibr~~ variation)

→ Advantage of LRFD:-

LRFD account For both variability in resistance and load.
it achieves Fairly uniform level of safety for different limit state.

→ Dis @dvantage :-

it disadvantage is change in Design philospley from Perivious method.

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Question #2 (5)

Ans:- Types of bolted Connection in steel structure :-

1) Slip-critical connection :-
Connection transmit the force by Friction produced blw the Faying surface by the clamping action of the bolts.
Slip-critical connection are recommended for joint subjected to stress reversal, severe stress fluctuation impact vibration or where slip is objectionable.

2) Bearing type connection :-
load is transfered by shearing and bearing on the bolt.
capacity is shear depends on wheater shear plan Interesct 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 blw Faying surface.

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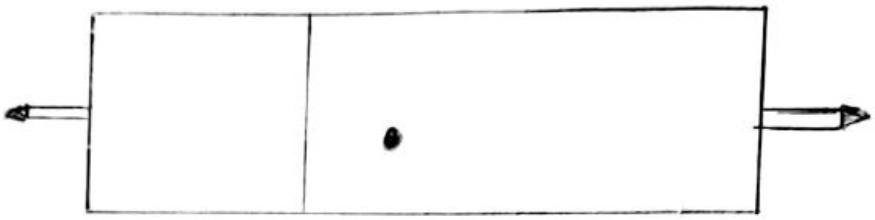
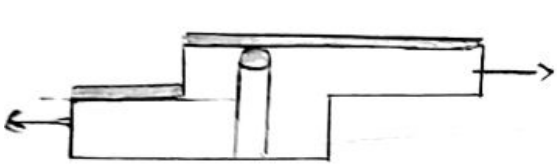
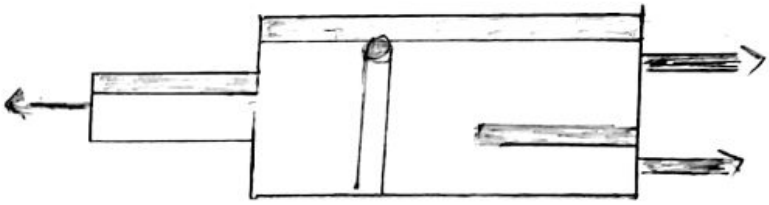
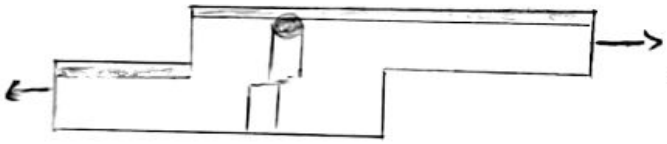
.. Type of Failure

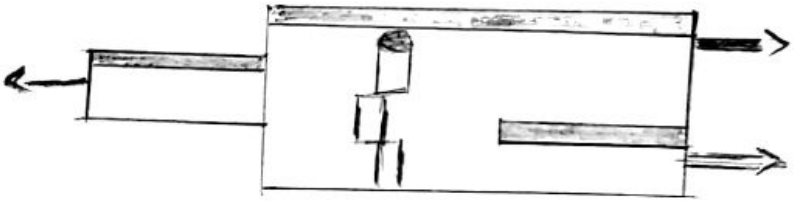
① shearing failure of Bolts:











⇒ 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.

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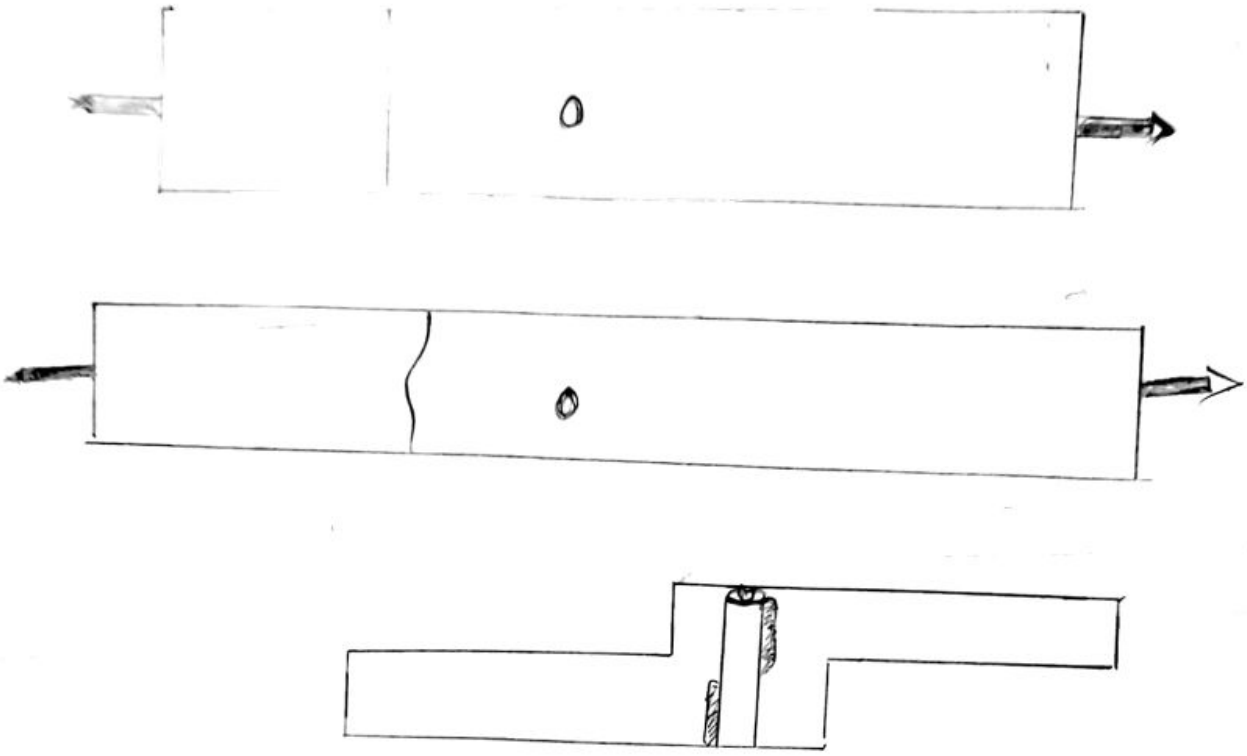
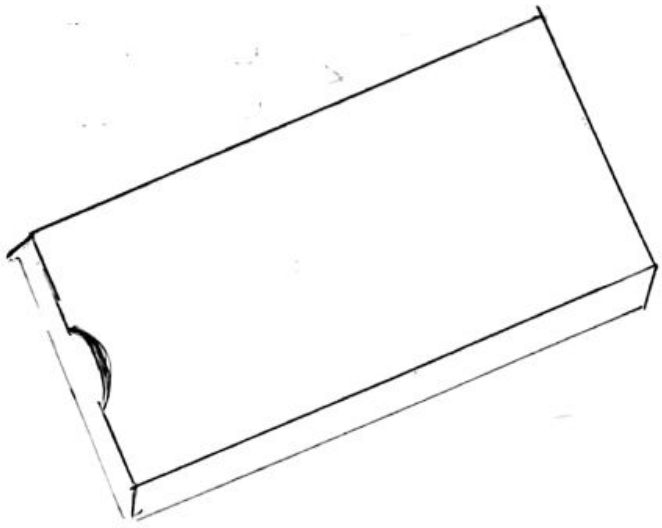
② Bearing Failure of Plate :





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

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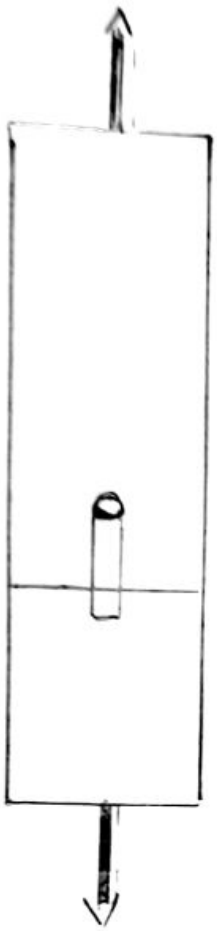
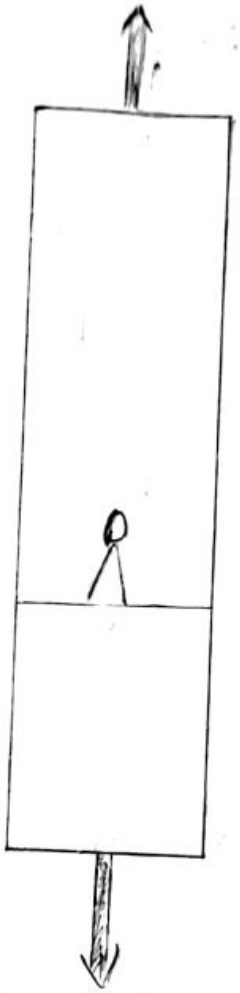
③ Tearing Failure -the edge of plate :-



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. teasing failure occure when bolts are stronger than the plates.

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Q3 Given data:- (9)

Dead load = 130 k
Live load = 265 k
Two plates C10 x 30
1" guset plate
All material is A-36 steel
Bolt are A-35 with 3/4 in dia
Bearing type connection.
Thread excluded brom shear plane
Use three line of bolt.
ASD Method.

Required:-

number of bolt required = ?
Appropriate, layout.

Sol:- Design Force = D.L + L.L
= 130 + 265
= 395 k

⇒ **Bolt Design:-**

For 3/4" dia bolts

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

$$\text{Area} = 0.4418 \text{ in}^2$$

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Shear Design:-

Shear strength of bolts when thread are exclused from shear plane, from table.

$$F_V = 30 \text{ ksi}$$

$$R_V = \text{Area} \times F_V$$

$$= 0.4418 \times 30$$

$$= 13.25k \text{ per shear surface.}$$

→ As there are two shear surface per bolt.

$$\Rightarrow \text{number of bolt} = \frac{\text{Design force}}{2 \times R_V}$$

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

$$= 14.90$$

So 15 bolts.

Bearing:-

Bearing strength $F_p = 1.2\, F_u$

$$F_u = 58$$

$$F_p = 1.2 \times 58$$

$$F_p = 69.6 \text{ ksi}$$

$\Rightarrow$ for channel $R_P = d.t\, F_p$

$$t_w = 0.673$$

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

$$RP = 35.13 \text{ k}$$

for single bearing surface

As there are 15 bolt so 30 surface.

Capacity :-

$$30 \times 35.13$$

$$= 1053.9 \text{ k} > 395 \text{ k} \quad \text{ok}$$

$\Rightarrow$ For Gusset plate

$$RP = d + FP$$

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

$$RP = 52.2$$

Capacity :-

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

ok

Spacing :-

For $\frac{3}{4}$" dia of bolt min edge distance from table $2.8 = 1\ \frac{1}{4}$"

Also End distance $= 1\ \frac{1}{2}(d)$

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

$$= 1.13 \text{ in} < 1.25"$$

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So edge Distance

$le = 1\ 1/4"$ or $1.25"$

⇒ Centre to centre Distance :-

$L = 3d$

$= 3(3/4)$

$l = 2.25"$

Channel:-

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

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

$P = 24.41k$

$\Rightarrow l = \frac{2P}{Fut} + \frac{d}{2}$

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

$P = 31.7k$

As the bolt are arranged in there row and Fire bolt per row

Capacity:-

$2(3 \times 24.47\ 12 \times 31.7)$

$= 907.2k > 395k$

ok

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Gusset plate

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

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

$$P = 36.25$$

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

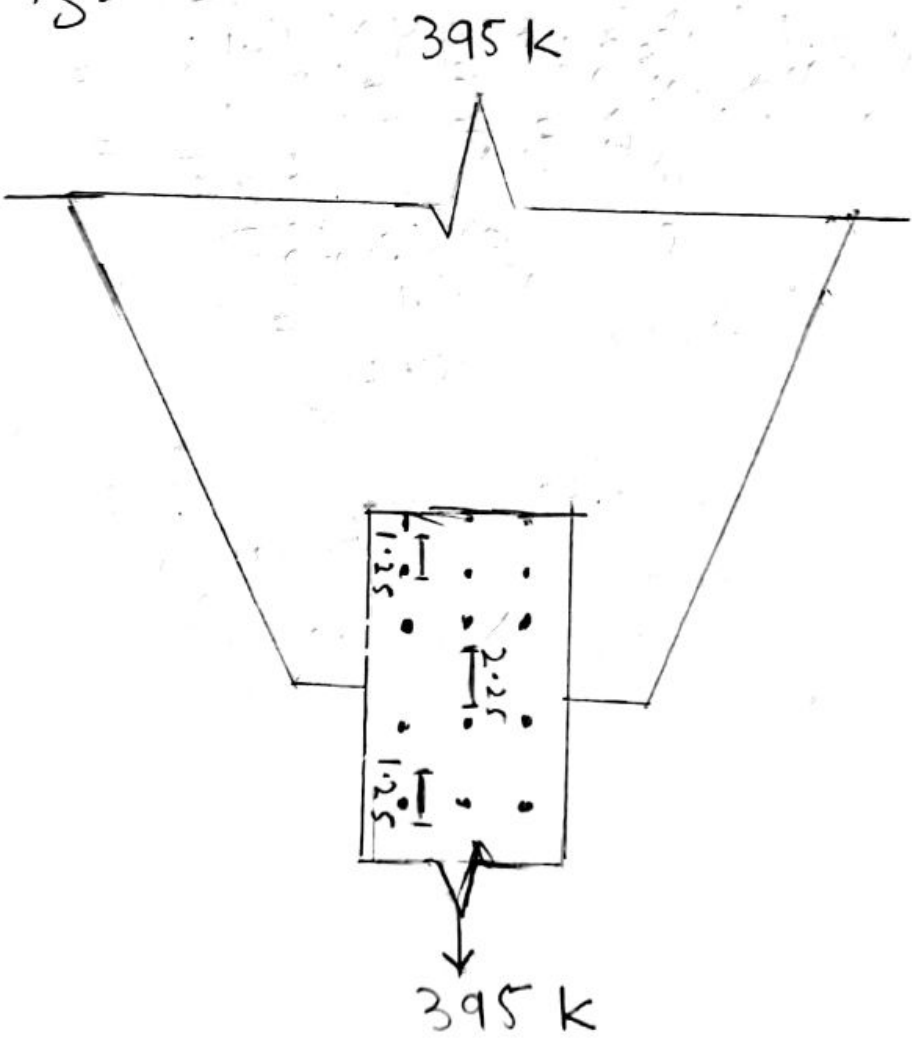
$$P = 47.134$$

capacity

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

$$674.358 k > 395 k \text{ ok}$$

Fig:-



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