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PAPER : STEEL STRUCTURE.

QUESTION # 1

GENERAL STATEMENT OF DESIGN PHILOSPHY:

- a general statement assuming safety in engineering design

Resistance (of materials & x-sections) ≥ effect of applied load.

it is essential that both side are evaluted for same condition e.g if effect of load is produce compressive stress on soil then it should be compared with bearing capacity of soil.

ASD:

safety in the design is obtained by specifying that the effect of load should produce stresses that is
a f

is a fraction of the yeild stress f_y. ~~sau~~

This is equivilent to

$$= f_y / 0.5 f_y$$

$$= 2$$

Mathematically:

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

R_n = Resistance of component being designed.

ϕ = Resistance factor

γ = load factor

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

Q_i = effect of applied load.

LRFD:

to overcome the deficiencies of ASD the LRFD method is based on strength of materials.

it consider variability not only in resistance but also in the effect of load.

it provide measure of safety related to probability of failures.

Mathematically:

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

R_n = resistance of component being designed.

Q_i = effect of loads.

n = redundancy

ϕ = Resistance factor.

γ = load factor.

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

Advantages 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 desingn.
5. This includes in AISC-05 specification as an alternate method.

Disadvantages of ASD:

1. ASD does not give reasonab-le measure of strength which is more fundamental measure of resistance than is allowiable stress.
2. safety is applied only to stress level. load are considered to be deter-ministic.

Advantages of LRFD:

★ LRFD account for both variability in resistance and load.

★ it achieves fairly uniform level of safety for different limit states.

Disadvantages of LRFD:

★ the chang in design philosophy from previous method.

Q: QUESTION # 2:

Types of bolted connections.

Slip-Critical Connection:

Connection transmit the force by friction produced between the fying surface by the clamping action of bolts.

slip-crrictical connections are recomended for joint subjected to stress reversal severe stress fluctuation, impact vibration or where slip is objectionable.

slip-critical connections become bearing type connection after the slip occurs so essentialy every slip-critical connection is a bearing type connection.

Bearing type Connections.

load is transferred by shearing and bearing on the bolt.

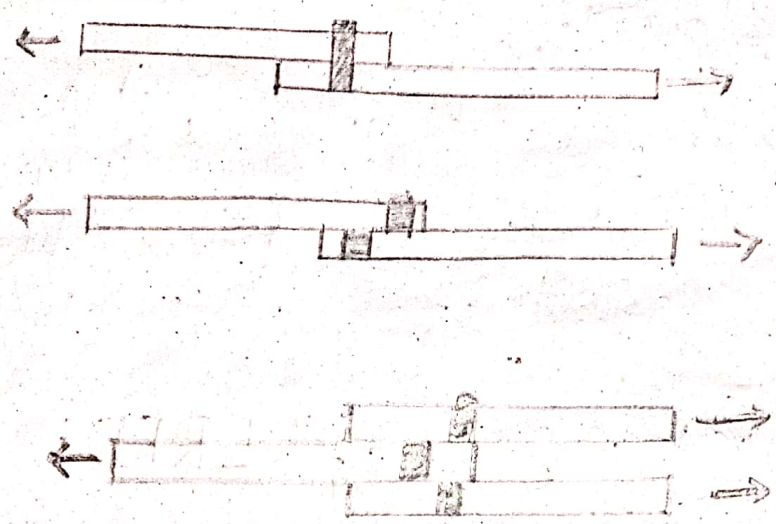
capacity in shear depend on whether shear plane intersect the body of bolt or threaded portion.

bearing type connection is most widely used general type connection in which the load is ~~already~~ resisted by bolts body without any friction b/w faying surfaces.

Types of failure:

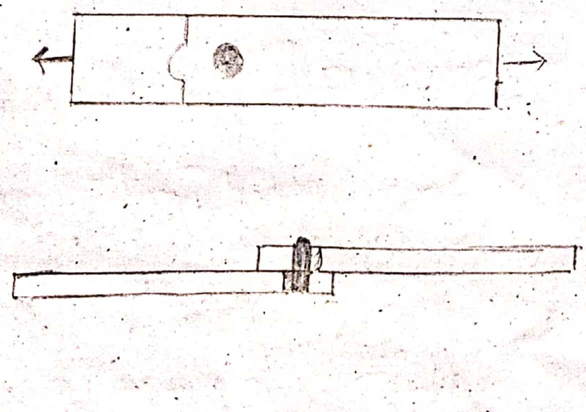
Shear failure of bolts: the shear stress in the bolt may exceed the working shear stress in the bolt shear stresses are generated because the plates slip due to force.

Shearing failure of bolts.



Bearing failure of plates:

the plate may be crushed when the bearing stress exceeds.



Tension or tearing failure of plates.

the tensile stress in the plate at the net cross-section may enceed the working tensile stress. tearing failure occurs when the bolts are stronger then plate.

QUESTION # 3.

Given Data:

Dead load = 130 k
live load = 265 k

Two plates C10×30
1" gusset plate
all material is A36 steel.

Bolts are A325 with 3/4 in dia.
Bearing connection
threads excluded from shear plane use three lines for bolt.
ASD method.

Required Data:

number of bolts required?
Appropriate layout.

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 shear 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 $F_p = 1.2 F_u$

$\because F_u = 58$

$F_p = 1.2 \times 58$

$F_p = 69.6$ ksi

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

$t_w = 0.673$

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

$R_p = 35.13k$

for single bearing surface

As there are 15 bolts so 30 surfaces.

Capacity

$= 30 \times 35.15$

$= 1053.9k > 395k$

OK.

⇒ For Gusset plate

$R_p = d\,t\,F_p$

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

$R_p = 52.2$

Capacity

$= 15 \times 52.2$

$= 783k > 395k$

OK

Spacing:

For 3/4" dia bolt min edge distance from table 2.8 = $1\frac{1}{4}$ = 1.25"

Also

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

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

$= 1.13$ in $< 1.25"$

So
edge distance Le = $1\frac{1}{4}''$ or $1.25''$

⇒ Centre to centre distance

$L = 3d$

$L = 3(3/4)$

$L = 2.25''$

Channel.

$$Le = \frac{2P}{Fu\,t}$$

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

$$P = 24.4k$$

⇒ $$L = \frac{2P}{Fu\,t} + \frac{d}{2}$$

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

$$P = 31.7K.$$

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

Capacity

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

$= 907.2k > 395k$

OK

Gusset plate.

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

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

$P = 36.25k$

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

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

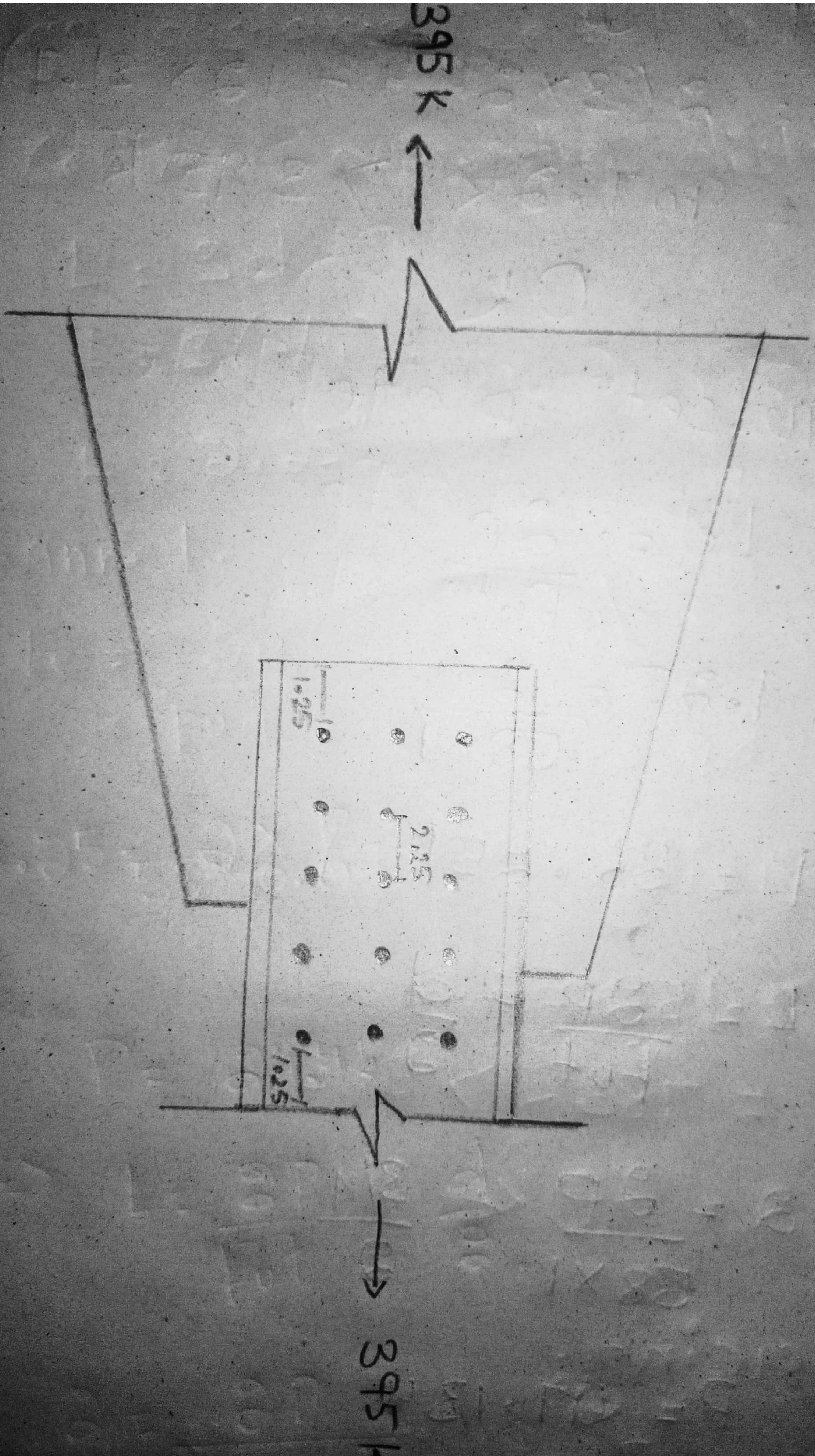
$P = 47.134$

Capacity

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

$= 674.358 K > 395 K$

OK


395 K
1.25
2.25
1.25
395 K