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Section = B

Subject = Steel Structure.

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QNO(1):

Ans: In eq(1) it is essential that both side are evaluated for same conditions eg: if effect of load is to produce compressive stress on soil, then it should be compared with bearing capacity of soil.

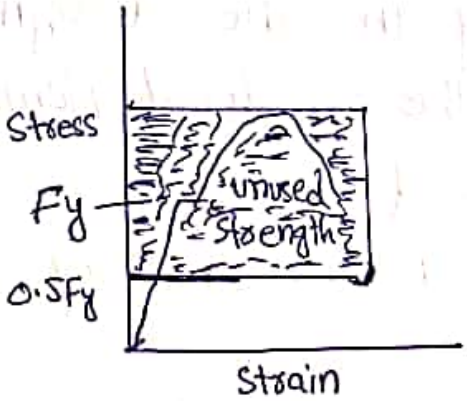
* Allowable stress Design(ASD):-

- 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.

$\frac{\gamma}{\Phi}$ = factor of safety Fs.

Q_i = Effect of applied loads.

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

Strength Materials

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

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

R_n = Resistance or strength of the component being designed.

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.

* Advantages of using Allowable Stress design method:-

- Following are some advantages of Allowable Stress design method.

i- Elastic analysis for loads become compatible for design.

ii- Old famous books are according to this method.

iii- Experienced engineers are used to this method.

iv- In past it was the only method for design purpose.

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

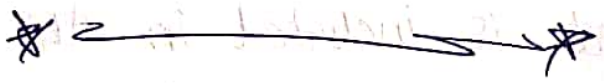
* Advantages:- . LRFD accounts for both variability in resistance and load.

- It achieves fairly uniform levels of safety for different limit states.

* Disadvantages:- Its disadvantages is change in design philosophy from previous method.

* Drawbacks :- implied in the ASD method is the assumption that the stress in the member is zero before any loads are applied, ie, 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).



Q NO (3).

Given data:

Dead load = 130 k

Live load = 265 k

Two plates (10x30)

$\frac{1}{2}$" gusset plate

All material is A136 steel

Bolt are A325 with 3/4 in dia bearing type connection.

Threads excluded from shea plane

Use three lines of bolts

ASD Method.

Required:

A number of bolts required = ?,

Appropriate, layout.

Solution:

Design force = D.L + L.L

= 130 + 265

= 395 k

⇒ Bolt Design:

For $\frac{3}{4}$" dia bolts

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

Area = 0.4418 in^2

Shear Design

Shear ~~Design~~ strength of bolts when threads are excluded from shear plane, from taste

$F_V = 30$ Ksi

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

$= 0.4418 \times 30$

$= 13.25$ k per shear surface

→ As there are two shear surfaces 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, $F_p = 1.2 F_u$

$F_u = 58$

$F_p = 1.2 \times 58$

$F_p = 69.6$ Ksi

⇒ For channel, $R_p = d \cdot t F_p$

$t_w = 0.673$

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

$R_p = 35.13$ K for single bearing surface

∴ there are 15 bolts so 30 surfaces

Capacity :

30×35.13

$= 1053.9\ K > 395\ K$

OK

$\Rightarrow$ For gasset plate

$R_p = d + F_p$

$= \frac{3}{4} \times 1 \times 69.6 \quad R_p = 52.2$

Capacity

$15 \times 52.2 = 783K > 395K$

OK

Spacing :

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

Also, End distance $= 1\frac{1}{2}d = 1\frac{1}{2}\left(\frac{3}{4}\right)$

$= 1.13$ in 21.25

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

$\Rightarrow$ Centre to centre distance

$L = 3d$

$= 3(3/4)$

$= 2.25$"

Channel

$L_e = \frac{2P}{F_{ut}}$

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

$P = 24.4k$

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

$2 = \frac{2P}{58 \cdot 0.673} + \frac{3/4}{2}$ $\quad P = 31.7k$

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

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

$1.25 = \frac{2P}{58 \times 1}$ $\quad P = 36.25k$

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

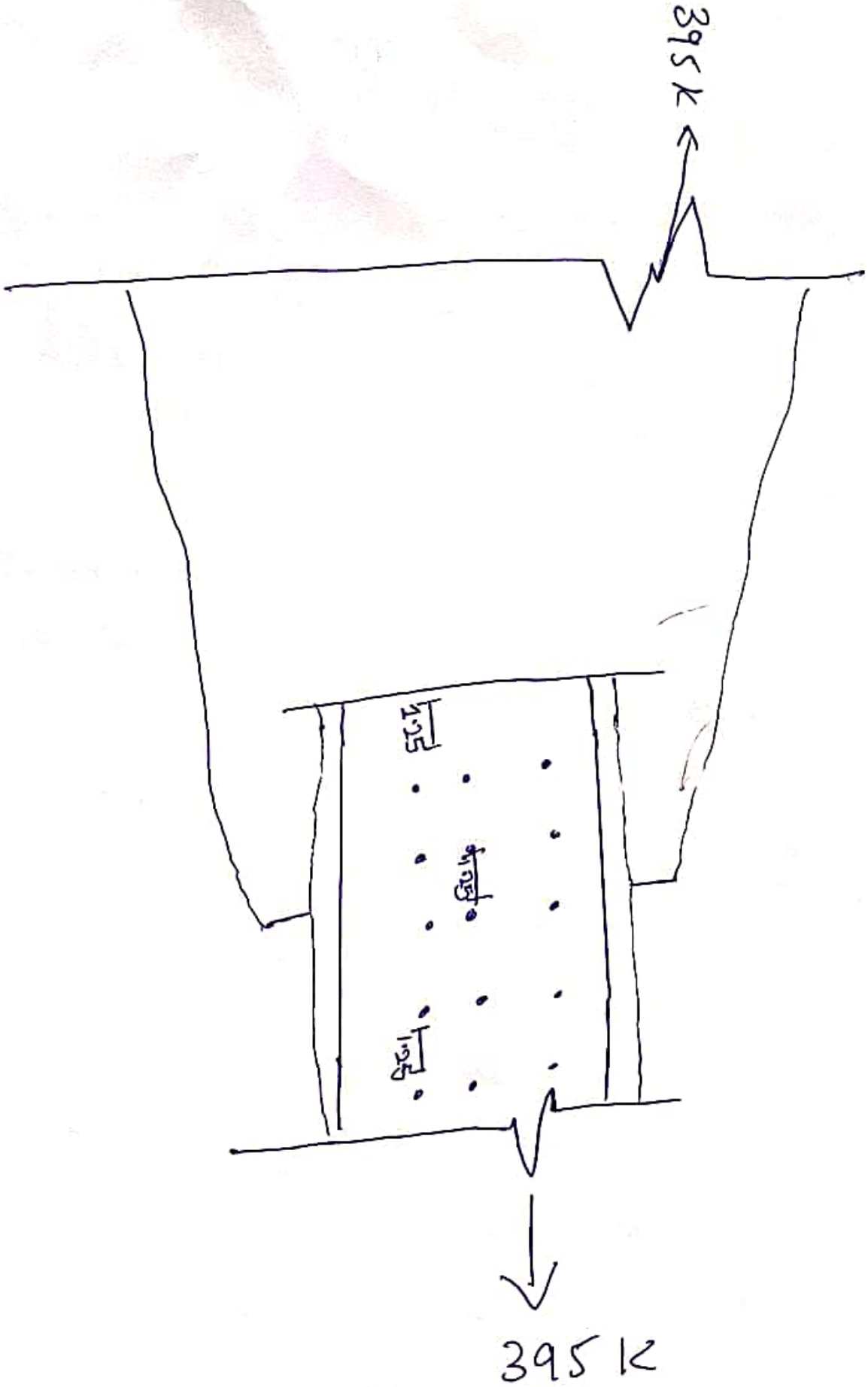
$P = 47.134$

Capacity

$3 \times 36,25 + 12 \times 47.134$

$674.358k > 395k$

OK



Ans:

Q NO (2):- Types of Connections:-

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.

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

* 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 applied forces.

* Bearing failure of plates:- The plate may be crushed when the bearing stress in the plate exceeds the working bearing stress.

* Tension or tearing failure of plates:-

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