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Paper :- Steel structure

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Dated :- 25-08-2020.

Q1:-

ANS:-

Design Philosophies:-

A general Statment assuming Safety in engineering design

Resistance (of material & X- Section) ≥ Effect of applied loads. — (1)

In equation (1) it is essential that both sides are evaluated for some condition eg if effect of load is to produced compressive stress on soil, then it should be compared with bearing capacity of soil.

⇒ When particular loading reaches its limits, failure is the assumed result, i-e the loading conditions become failure modes, such a condition is referred to as limit state and it can can be define as

" A limit state is a condition beyond which a structural system or a structural component cease to fullfill the function for which it is designed"

=) ASD:-

Safety in design is obtained by specifing that the effects of the loads should produced stressess that is a friction of the yield stress f_y say one half.

This is equivalent to

f_{os} = Resistance, R/Effect of load

$= f_y / 0.3 f_y$

$= 2$

Mathematical Description of ASD

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

R_n = Resistance or strenght of the component being designed

ϕ = Resistance factor or strenght Reduction factor

γ = over load or load factor

γ/ϕ = factor of saftey fs.

Q_i - Effects of applied loads

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

- ASD does not give resonable measure

of strenght which is more fundamental measure of resistance than is allowable stress.

(LRFD):

- To over come the deficiencies of ASD, the LRFD method is based on strenght of material.
- It consider the variability not only in resistance but also in the effects of load.
- It provides measure of saftey related to probability of failure.

Saftey in the design is obtained by specifying that the reduced Nominal strength of deighned 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 strenght of the component being designed

Q_i = Effects of applied loads

n = Take into accounts ductility, redundacy & operational imp.

ϕ = Resistance factor or strenght reduction factor.

γ = over load or load factor.

γ/ϕ = factor of saftey.

Merits of LRFD :-

* LRFD accounts for both variability in resistance & load.

* It achieves fairly uniform levels of saftey for differents limits states.

Demerits of LRFD :-

* elastic behaviour considered for load analysis & ultimate plastic behaviour for material strenght are not compatible

* Engineers are experienied in ASD have to be come familiar with ~~th~~ this ~~tec~~ technique.

Merits of ASD:-

The Following of ASD merit are:-

(1) Elastic analysis for loads become compatible for design.

2) Experienced engineers are used to this methods.

3) In past it was the only method for design purpose.

⇒ Demerits of ASD

(1) latest research and literature is very limited.

(2) Failure mode is not directly predicted

(3) Result cannot be compared with experiment test up to collapse.

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Q02:-

ANS:- Type of Bolt Connections:-

There are three basic joint type That we will dissciused.

① Snug tight
② pre tensioned
③ Slip critical

The difference among these joint type are essentially the amount of clamping force That is achived when tightening the bolts and The degree to which The connect part Can move while Service.

⇒ In any project The engineer must indicate The joint type and The faying.

① Snug - Tight Connection:-

- A Snug-tight connection occurs when The bolts are in direct bearing and The piles of a connection are in firm contact.

- This Can be accomplished by

The full effort of a worker using a Spud Wrench.

- Snug - tight joints are not permitted for connection Supporting non Static.

(2) Pretensioned Connection :-

A pretensioned joint has a greater amount of clamping force then The Snug tight condition and Then force provides a greater of Slip - resistance in The joint.

- They are also requied for joints with A490 bolts in Tension.

- Some Specific example of Connection where prentiond joint should be Specied are

- Column Splice in building with high height to - width ration

- Connection with in The load path of The lateral force System.

(3) Slip- critical Connection:-

- This type of joints is similar to a pretension joint ~~exp~~ except that failure is assumed to: occure when the applied load is greater then the fraction force and thus slip does not occure b/w the faying surface.

- As with pretensioned joints. Slip critical joints are used for joints subjected to cyclical loads or fatigue loads.

- They should also be used for joints subjected to cyclical loads are used for joints subjected to cycled loads.

- They should be used in connection that have slotted hole paralel to the direction of the load or in connections that use a combination of welds and bolts along the same faying surface.

- The amount of pretension for a slip-critical bolt is the same that was used for pretension joints.

⇒ possible Failure modes:-

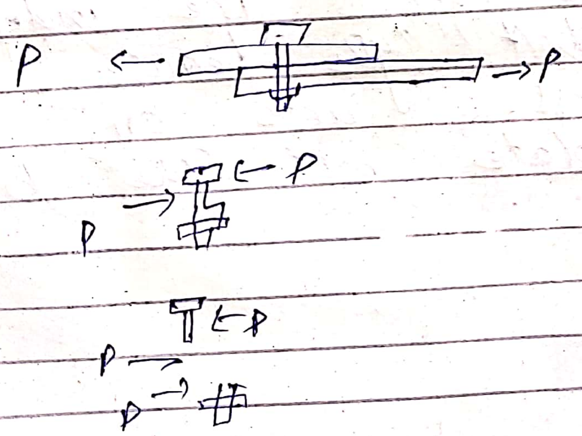
→ Shear failure of the bolts.
→ Failure of member being connected due to fracture
→ Edge tearing or fraction of the connected plate.

→ Excessive bearing deformation at the bolt hole.

⇒ Shear failure of Bolts:-

- Average Shearing Stress in the bolt $= f_v = P/A = P/(\pi d_b^2/4)$.

- Bolts can be in Single shear or double shear.
- When bolts is in double shear. two cross-section are effective in resistance the load.



Failure of Connection Members:-

- Member can fail due to tension fraction failure or block shear.

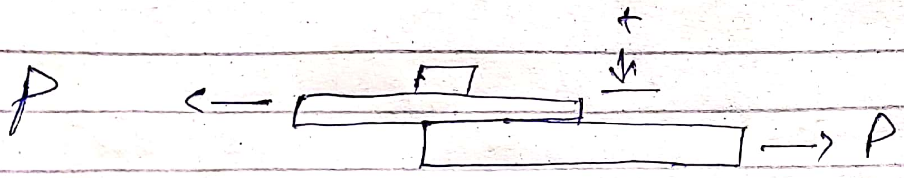
- ~~we~~ ~~have~~

- Bearing Failure of connected due to bearing from bolt hole.

- Hole is slightly larger than the faster and the fasterness is loosely placed in hole of circumference of the fastener.

- As such the stress will be hightest at the radial contact point (A). However, the average stress can be calculated as the applied force divided by the the project area of contact.

- Bearing stress effects are independant of the bolt type beause the bearing stress acts on the connected plate not the bolt.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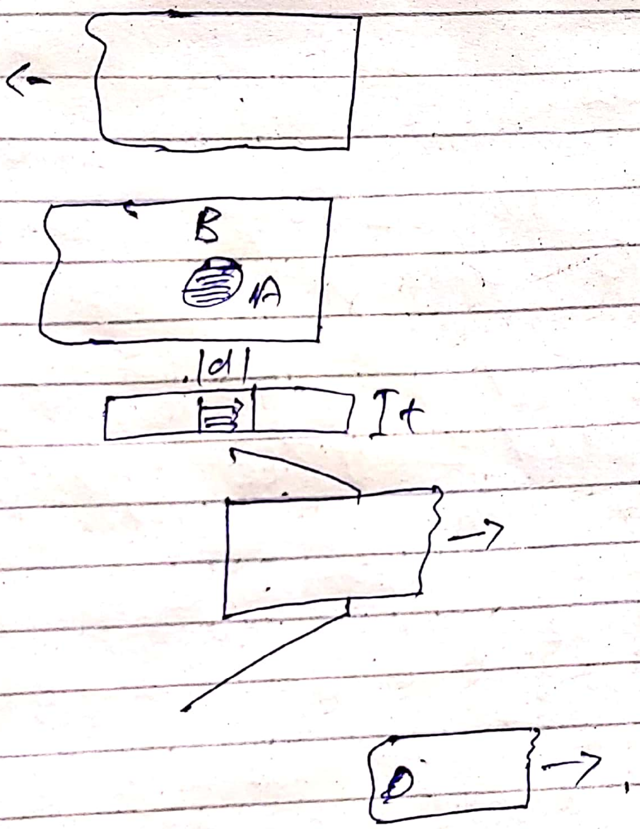
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Q(3)

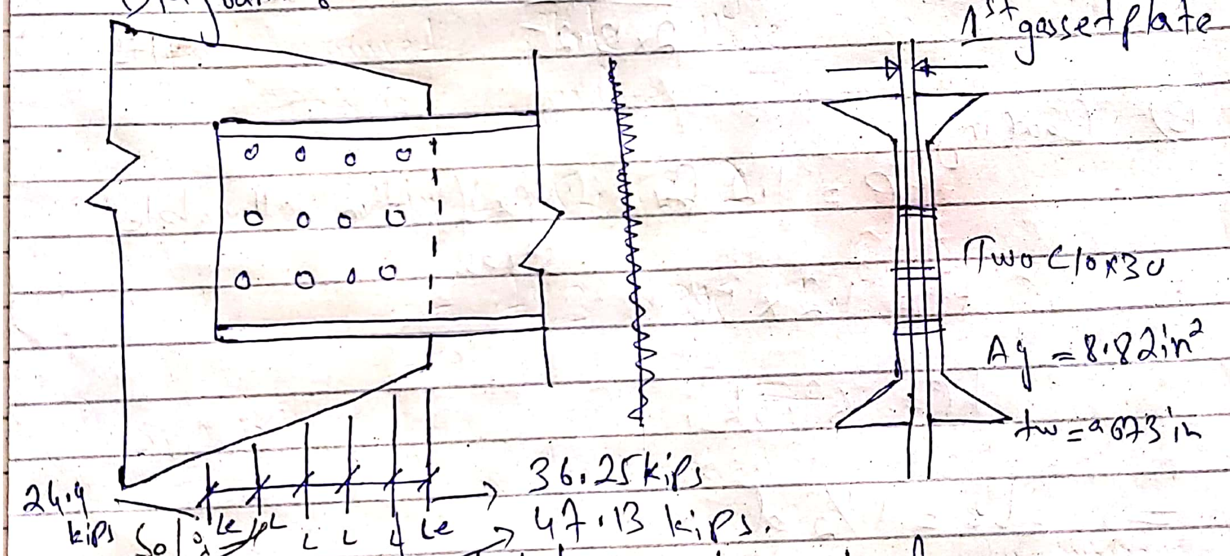
GIVEN Data :-

Dead load = 130 K
Live load = 265 k
Section = C10 x 30
Gusset Plate = 1 in
Bolt diameter = 3/4 in
A325 , A36
three bolts lines

Required :-

No of bolts = ?
Capacity using ASD = ?

Diagram :-



① finding total service load

= 130 + 265 = 395 kips

② Bolts Design :-

for 3/4 dia

Area = 0.4418 in² (Nominal Area)

$F_v = 30$ ksi (shear strength of bolt in single shear Table 2-11)

$R_v = 0.4418 \times 30$

$R_v = 13.25$ kips / shear surface

↳ Resistance offered by a single in shear.

As there are two shear surfaces per bolt

No of bolts $= \frac{395}{2 \times 13.25} = 14.90 \approx 15$ bolts

③ Bearing

$F_P = 1.2\, F_v$ (specification allowable stress)

$F_P = 1.2 \times 58$

$F_P = 69.6$ ksi

$\Rightarrow L_e = 1\frac{1}{2} d$

$L = 3d$ (Table 2-9)

channel

$R_P = d\,t\,F_P = \frac{3}{4} \times 0.673 \times 69.6$

$R_P = 35.13$ kips / (single bearing surface of channel) for bolts these are 30 bearing surface so;

Capacity = 30 × 35.13

= 1053.9 > 395 kip - ok

Gusset Plate

$R_P = d t f_P$

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

$R_P = 52.2$ kips (single bearing surface of gussets plate)

for gusset plate these are 15 bearing surface so,

capacity = 15 × 52.2

= 783 > 395 kips
ok

(4) Spacing

~~+3/4~~

End distance sheared Edge = 1 1/4

End distance = 1 1/2 d = 1.13 in < 1 1/4 in } Table (2-8) (minimum) ~~2-9~~ or 2-9

center to center = 3d = 2 1/4 in

As we can see that R_P for both channel & gusset plate is considerably greater than required

Consider minimum end distance of 1 1/4 in & the minimum between connection spacing of 2 in

$l_e = \frac{2P}{F_u t} = 1.25$ [$t = 0.673$ from Table 1-5 AISC Mannual

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

$P = 24.4$ kips

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

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

$P = 31.7$ kips

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

Capacity $= 907.2 > 395$ kips

ok.

Gusset

$L_c = \frac{2P}{F_u t} \Rightarrow 1.25 = \frac{2P}{58 \times 1}$

$P = 36.25$ kips

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

$P = 47.13$ kips

Capacity = $3 \times (36.25) + 12\,(47.13)$

Capacity = $674.31 > 395$ kips

ok

so use 15 bolts in 3 rows of five with end distance $1\frac{1}{4}$ in & center to center spacing of 2 in.

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