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Subject :- Steel Structure

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Q no1
What is the general statement of design philosiphies ? Write brief notes on ASD and LRFD. Write merits and demerits

Ans:-
A general statement assuming safty in engineering design
Resistance of (material & X- section) ≥ Effect of applied loads —— (1)

In Eq (1) it is essential that both sides are evaluated for same conditions e.g if effect of load 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 ie the loading condition become failure modes, such a condition is refered to as limit state and it can be defined as:

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

=> ASD & LRFD

ASD:-

ASD is based on the convectional Stress calculation of structure with respect to the allowable stress limit is known as ASD. ASD indirectly incaporates the F.O.S by limiting the stress

LRFD:-

LRFD defines the actual strength required against the required strength. LRFD is more rational as different factors of safty can be assigned to different loadings such as Dead load, Live load, Earthquake load etc.

=> Merits & Demerits

Merits:-

- LRFD accounts for both variability in resistance and load.
- It achieves fairley uniform levels of safty for different limit states

&

Demerits:-

- Its disadvantage is change in design philosophy from previous method.

ASD:- Merits:-

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 only method for design purposes
5. This method is included in AISC-05 Specification as a alternate method.

ASD:- Demerits:-

1. Latest research and literature is very limited.
2. Same factor of safety is used for different loads
3. failure mode is not directly predicted
4. With some overloading, the material stresses increases but donot go to collapse
5. Failure mode can not be observed.

Qno2

Write brief note on types of bolted connections in steel structures? Also explain failures in bolted connections with half of figures.

Ans

Types of connection

(a) Slip-Critical connections:-

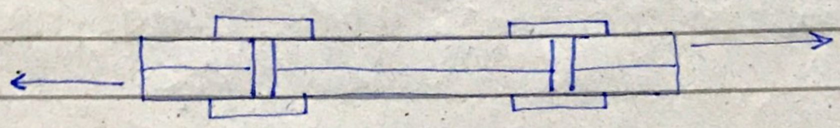
Connection transimits the force by friction produced between the faying surfaces by the clamping action of the bolts. Slip-critical connections are recomended for joints subjected to stress reversal, severe stress fluctuation impact, vibration or where slip is objectionable

The clamping force applied to the bolt brings the two members close enough so that appreciable friction is produced between them which is then responsible for resisting the load The more the clamping force ~~applied~~ the more is the friction and strong is the connection but the clamping force need not to be greater than tensile strength of the bolt.

Slip critical connection becomes bearing type connection after the slip occures so every slip critical connection is essentrally a bearing type connection also

(b) Bearing Type :-

Shear resistance is attained by bolt Shaft butting against the metal plates The holes should not be over sized for bearing type bolts.



Bolts donot need to be tightened to a pre-specified tension. Bolts are typically snug fitted.

Snug fitted bolts :- Snug fitting is achieved by the force of an average worker using a spud. wrench. Snug fitting is done to make sure that the bolts will not fall of.

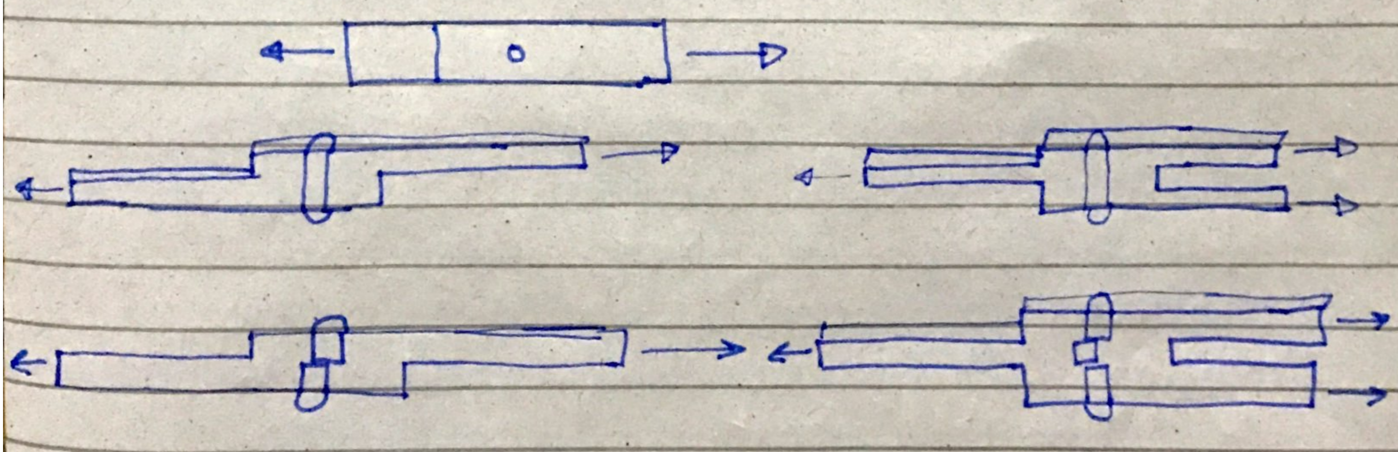
⇒ failure in bolted connection :-

The types of failure in bolted connection are as described bellow

ⓐ Shearing failure of Bolts
ⓑ Bearing failure of plate
ⓒ Tearing failure at Edge of plate

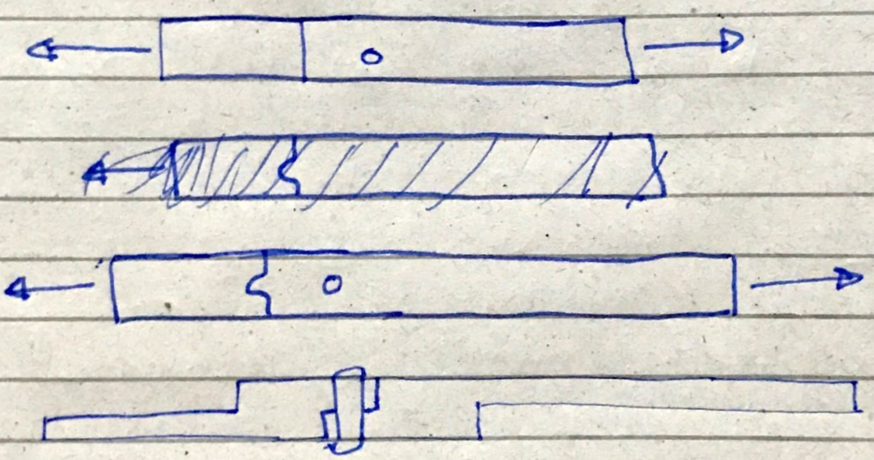
(a Shearing failure of Bolts :-

When two sheets are connected by bolt and are loaded by oppositely directed forces, bolt cross-section withstand shear failure. Acting stress in the bolt is assumed to be distributed uniformly over the cross-section and is determined dividing force over section area of bolt. Bolt shear failure takes place when acting stress exceeds shear strength of material (approx half of tension strength)



(b) Bearing failure of plate

~~is weaker~~ If the plate material is weaker than the bolt material, then failure will occour by bearing of the bolt on the plate and the hole will elongate. If the connected plates are made of high strength steel than failure of bolt can take place by bearing of the plate on the bolts.



(c) Tearing failure at Edge of plate:-

Tests showed, failure by tearing through free edge of material will not occur if Le measured parrallel to line of applied force is not less than product of bolt dia and ratio of bearing stress to tensile strength of connected part

Force transmitted by bolt.

$$P = f_p D t \quad \text{—— (A)}$$

force to cause failure along two shear planes

$$P = 2(L_e - D/2)\, t\, u$$

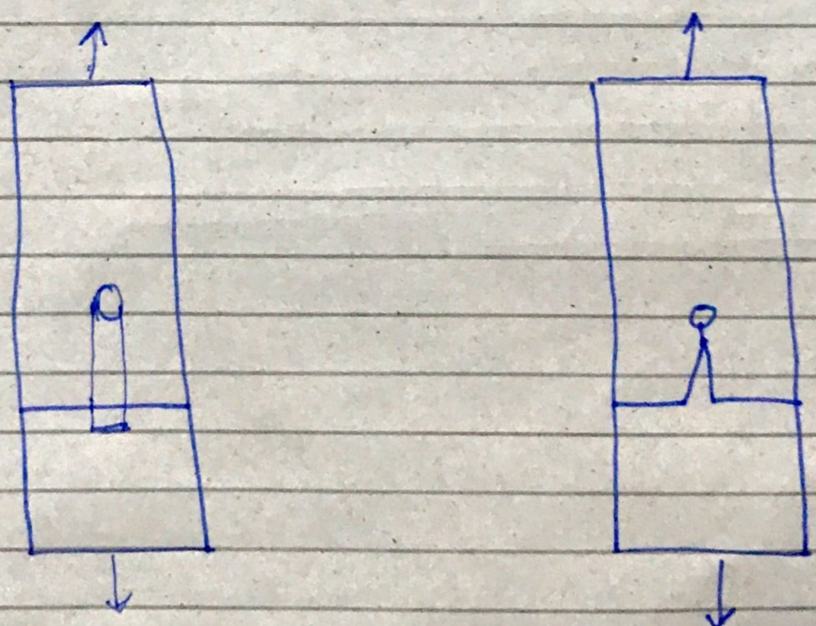
$$u = 0.7\, f_u$$

$$P = 1.4\, D t\, f_u\, (L_e/D - 1/2) \quad \text{— (B)}$$

Equating (A) & (B)

Eq C can be approximated as

$$L_e = \frac{f_p D}{f_u} = \frac{f_p D t}{t f_u} = \frac{P}{t f_u}$$



Shearing failure at Edge of plate

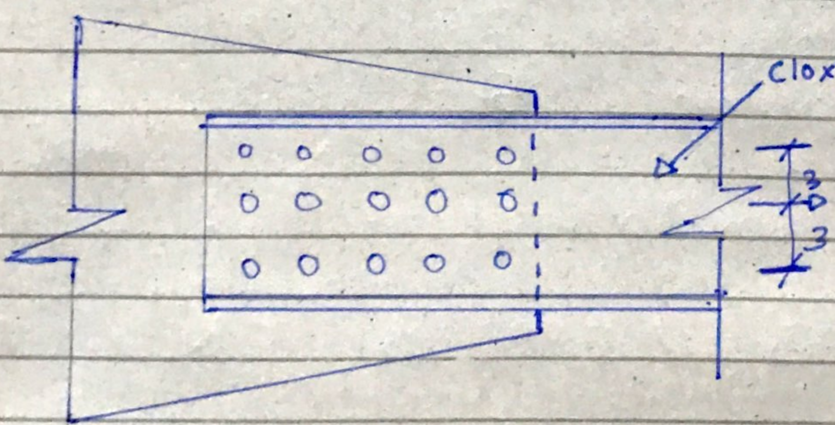
Traverse tension tension failure.

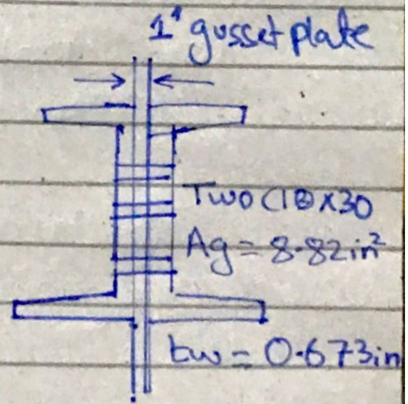
Qno 3:-

Given Data:-

DL = 130K
LL = 265K
Section = C10 x 30
Gusset plate = 1 in
Bolt diameter = 3/4 in
A325, A36
Three bolt lines

Required:-
No of bolts = ?
Capacity using ASD = ?





Solution

① finding total Service load

$= 130 + 265 = 395$ kips

② Bolt Design:

for 3/4 Dia

Area = $0.4418 \, in^2$ (Nominal Area)

$F_v = 30$ ksi (Shear strength of bolt in single table 2-11)

$R_v = 0.4418 \times 30$
$R_v = 13.25$ kips / shear surface

As there are two shear surfaces per bolt

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

③ Bearing

$F_p = 1.2$ (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 $= 30 \times 35.13$

$= 1053.9 > 395$ kips OK ✓

Gusset plate:-

$R_p = d\,t\,F_p$

$R_p = \frac{3}{4} \times 1 \times 69.9$

$R_p = 52.2$ kips (single bearing surface of gusset plate)

For gusset plate these are 15 bearing surfaces so;

Capacity $= 15 \times 52.2$

$= 783 > 395$ kips

④ Spacing :-

End distance sheared Edge $= 1\frac{1}{4}$ (minimum)

End distance $= 1\frac{1}{2}d = 1.13\,in \leq 1\frac{1}{4}\,in$ } Table 2-8 } 2-9

Center to center $= 3d = 2\frac{1}{4}\,in$

As we can see that R_p for both channel and gusset plate is considerably greater than required. Consider minimum end distance of $1\frac{1}{4}$ in and the minimum between connection spacing of 2 in

$$L_e = \frac{2P}{F_u t} = 1.25 \quad \left[\begin{array}{l} t = 0.673 \\ \text{From table 1-5 AISC Manual} \end{array} \right]$$

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

$P = 24.4$ 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

Scanned with CamScanner

Capacity = 2 (3x (24.4) + 12 (31.7))

Capacity = 907.2 > 395 kips

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 x (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 and Center to Center spacing of 2in.