Day. M T W T F S

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IQRA NATIONAL UNIVERSITY

Mid Term Paper / summar 2020

STeel Structures

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Q1:. What is the general statement of design philosophies? Write brief notes on ASD and LRFD. Write merits and demerits.

Design philosophies:

- When particular loading reaches its limit, failure is the assumed result, i.e. the loading condition become failure modes, such a condition is referred to as limit state and its can be defined as

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

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 f_y, say one half.
- This is equivalent to:

$$FOS = \text{Resistance, } R / \text{Effect of load, } Q$$
$$= f_y / 0.5 f_y$$
$$= 2$$

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 of 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

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

R_n = Resistance or strength of the component being designed

Q_i = Effect of Applied Loads
n = Takes into account ductility, redundancy and operational imp.
ϕ = Resistance factor or Strength Reduction factor
γ = Overload or Load factors.

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

Advantages

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

Disadvantages:

- It's disadvantage is change in design philosophy from previous method.

Q2:- Write brief note on types of bolted connections in steel structures? Also explain failures in bolted connections, with the help of figures.

Types of bolted 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.

Bearing type connections

- Load is transferred by shearing and bearing on the bolt.

→ Capacity in shear depends on whether shear plane intersects the body of bolt or threaded portion.

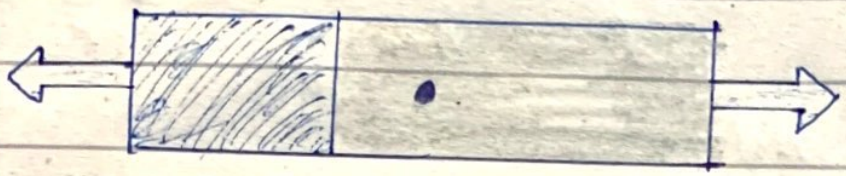
Bearing type connection is the most widely used general type connection in which the load is resisted by the bolt body without any friction btw faying surfaces.

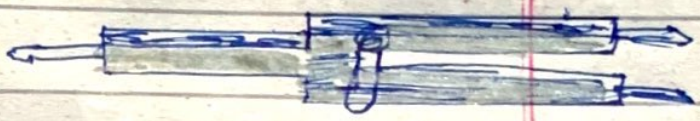
Failures in bolted connections:

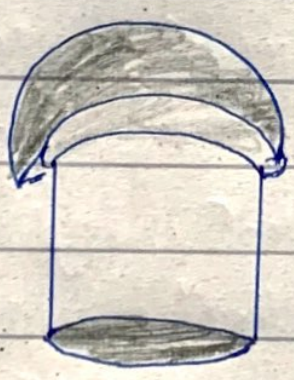
Types of failures:

=> Shearing Failure of bolts.
=> Bearing Failure of Plate.
=> Tearing Failure at edge of Plate.

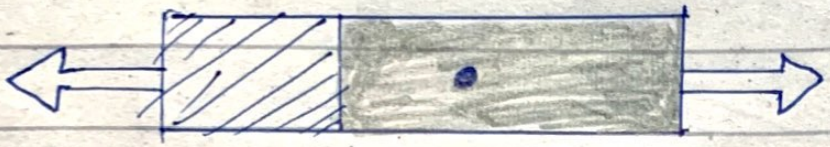
Shearing Failure of bolts:

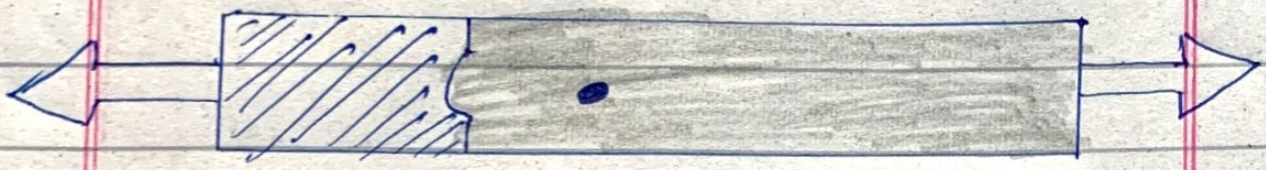


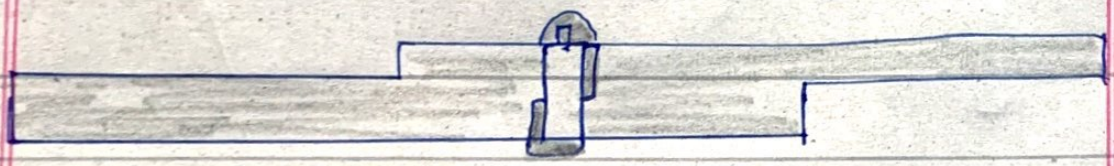


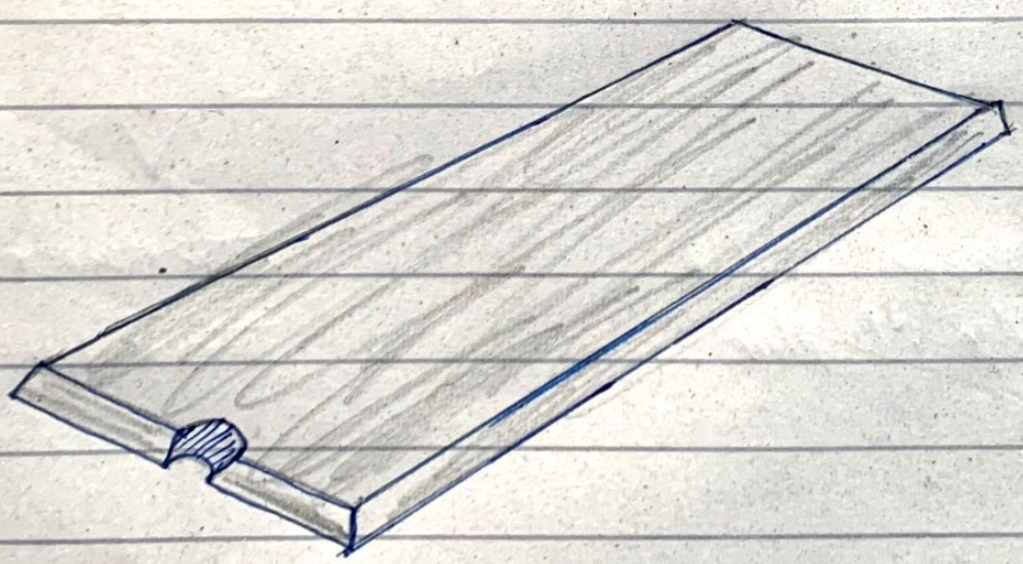


Bearing Failure of plate

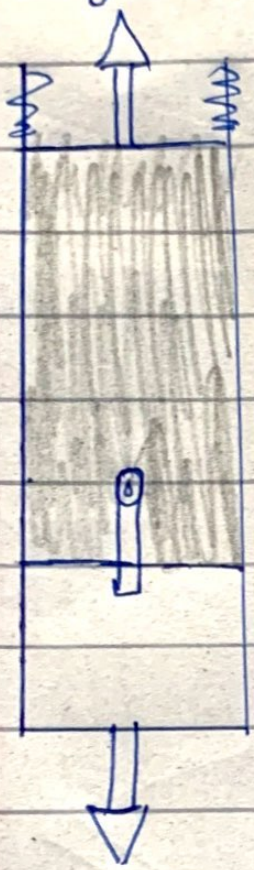








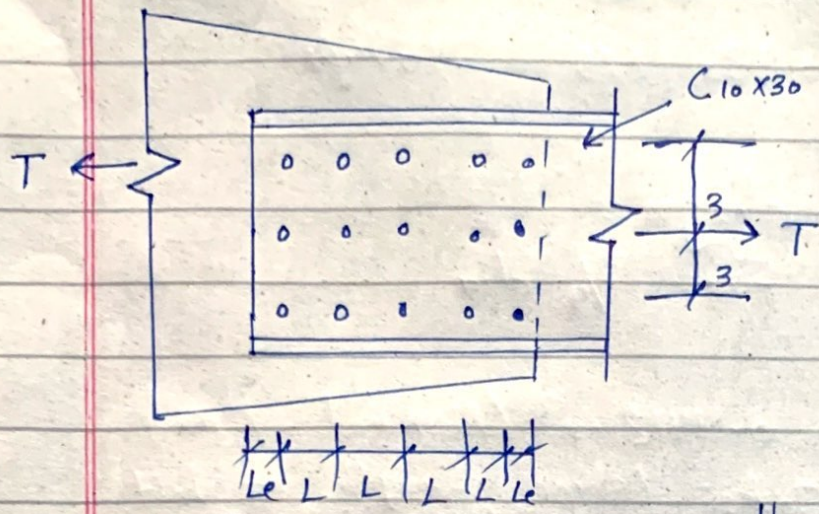
Tearing Failure at the edge of plate.

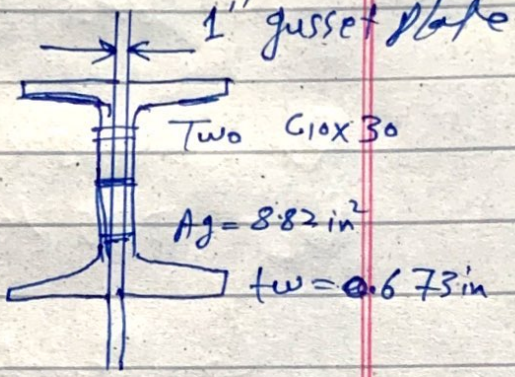


Shearing Failure edge of Plate

Transverse Tension Failure

Q3:- Determine the number _ _ _ _ _ _ _ _ _ _ _ method.





Given data:

Dead load = 130K

Live load = 265k

Section = C10x30

Gusset plate = 1 in

Bolts diameter = 3/4 in

A325, A36

three bolts lines.

Required:

No of bolts = ?

Capacity using ASD = ?

Sol:-

1) Finding total service load
= 130 + 265 = 395 kips

2) Bolts design:
For 3/4 dia

Area = 0.4418 in^2 (Nominal Area)
Fv = 30 ksi (shear strength of bolt in single shear Table 2-11)

Rv = 0.4418 X 30
Rv = 13.25 kips/shear surface

↳ Resistance offered by a single in shear.

As there are two shear surface per bolt

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

3) Bearing:

$F_p = 1.2 F_u$ (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 surfaces So,

Capacity $= 30 \times 35.13$

$= 1053.9 > 395$ kips

Gusset plate:

$R_p = d t F_p$

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

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

For gusset plate these are 16 bearing surfaces So,

Capacity $= 15 \times 52.2$

$= 783 > 395$ kips

4) Spacing:

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

End distaue $= 1\frac{1}{2}d = 1.13 \text{ in} \leq \frac{1}{4}$ in } Table 2-8 and 2-9

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

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

$L_e = \frac{2p}{Fut} = 1.25$ { $t = 0.673$ From table 1-5 AISC Manual

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

$p = 24.4$ kips

$$L = \frac{2P}{F_{ut}} + \frac{d}{2}$$

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

$$P = 31.7 \text{ kips}$$

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

$$\text{Capacity} = 907.2 > 395 \text{ kips}$$

Gusset

$$L_c = \frac{2P}{F_{ut}} \Rightarrow 1.25 = \frac{2P}{58 \times 1}$$

$$P = 36.25 \text{ kips}$$

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

$$P = 47.13 \text{ kips}$$

$$\text{Capacity} = (3 \times (36.25) + 12(47.13))$$

$$\text{Capacity} = 674.31 > 395 \text{ kips}$$

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

END