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Section C

Paper Steel Structure

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Q1 :- What is the general Statement of design Philosphies ? Write brief notes on ASD and LRED. Write merits and demerits.

Ans Design philosophies :- A general Statement assuming Safety in engineering design.

Resistance (of materials and x-Section) ≥ Effect of applied load — ①

In eqn 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.

ASD and LRFD

To facilitate the analysis of load effects and strength of the materials. The two distinct procedure employed by designers are **Allowable Stress design (ASD) and load and Resistance Factor design (LRFD)**

ASD (Allowable Stress design)

- Safety in the design is obtained by specifying, that the effect of the load should produced stresses that is a fraction of the yield stress fy, say one half!

- This is equivalent to

$$FoS = \text{Resistance, } R / \text{Effect of load, } Q$$

$$= Fy / 0.5fy$$

$$= 2$$

Mathematical Description of ASD

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

R_n = Resistance or strength of the Component

ϕ = Resistance Factor or Strength Reduction factor

γ = overload or load factors

$\frac{\gamma}{\phi}$ = factor of Safety Fs

Q_i = Effect of applied load

Disadvantages of ASD

- Implied in the ASD Method is the assumption that the Stress in the member is zero before any load are applied i.e 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 draw back in ASD is that Safety is applied only to Stress level. loads are considered to be determistics.

Advantage:- The design is quite Simple.

LRDF

- 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.

Mathematical Description

$$\phi R_n \geq \eta \sum \gamma Q_i$$

Advantages of LRFD

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

Disadvantages of LRFD

There is no specific disadvantages of LRFD. its disadvantage is change in design philosophy from previous method.

Q2 :-

Ans Types of Bolt Connection

There are Three basic joint Types that we will Consider:

(1) Snug Tight.
(2) pretensioned.
(3) Slip Critical.

The difference among these joint Types are essentially the amount of clamping force that it achieved When Tightening the bolts and The degree To Which the Connected parts can move while in Service.

(1) Snug-Tight Connection :-

The Snug-Tight Condition occure When the bolts are in direct bearing and The plies of the Connection are firm

Contact.

- This can be accomplished by the full effort of a worker using a "Spud" Wench. Which is an open-ended Wench approximately 16 inches long.
- A Snug-tight joint can be Specified for most Simple Shear Connections as Well as Tension only Connections.
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- Snug-Tight joints are not permitted for Connections Supporting non static loads. nor are they permitted With A490 bolts loaded in Tension.

(2) Pretensioned Connection :-

- A pretensioned joint has a greater amount of clamping forces than the Snug Tight Condition and therefore provides a greater degree of Slip-resistance in the joint.
- Pretensioned joints are used for joints that are subject to cyclical load or fatigue load.
- They are also required for joints with A490 bolts in Tension.
- Some Specific examples of connection where pretensioned joints should be Specified are
- Column Splices in building with high height to width ratios.

(3) Slip - Critical Connection :-

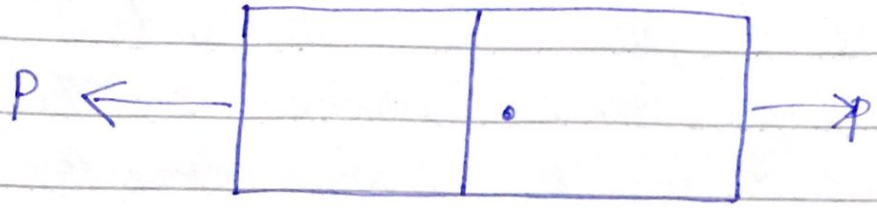
This Type of joint is Similar To a pretensioned joint expect That failure is assumed To occur When The applied load is greater than The friction force and Thus Slip does not occure blw The paying Surfaces.

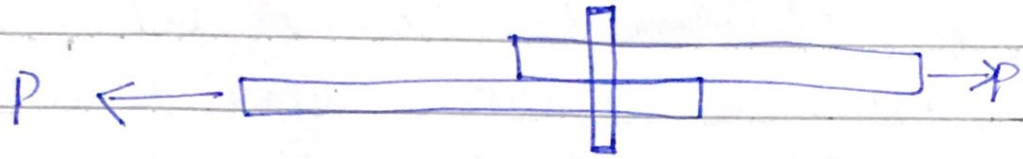
- As With pre tensioned joints, Slip - critical joints are used for joints Subjected To Cyclical loads or fatigue load.

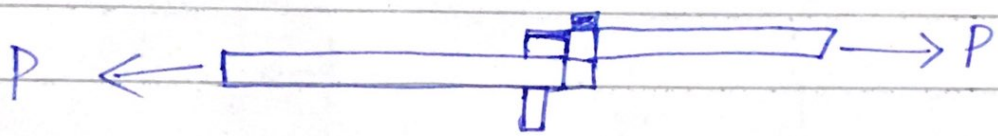
Types of Connection failures

(1) Shearing failure of bolt
(2) Bearing failure of bolt
(3) Tearing failure of bolt

(1) Shearing failure of bolt :-



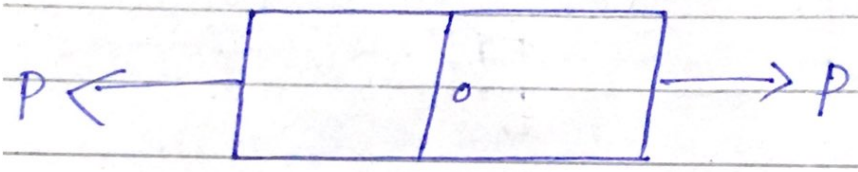


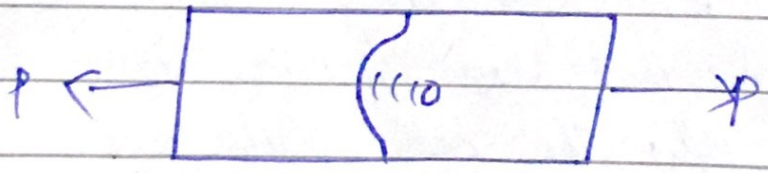


Here the load is transfer by the shearing of bolts and here shearing stress exceeds the shear strength of bolts. That's why the bolts fails in shear. It may be single or double shear.

(2) Bearing failure of plates :-

This is a failure of plate and the bearing stresses induced on the plate exceeds the bearing strength of the plate and hence failure of the connection occure and known as bearing failure of plate as shown.

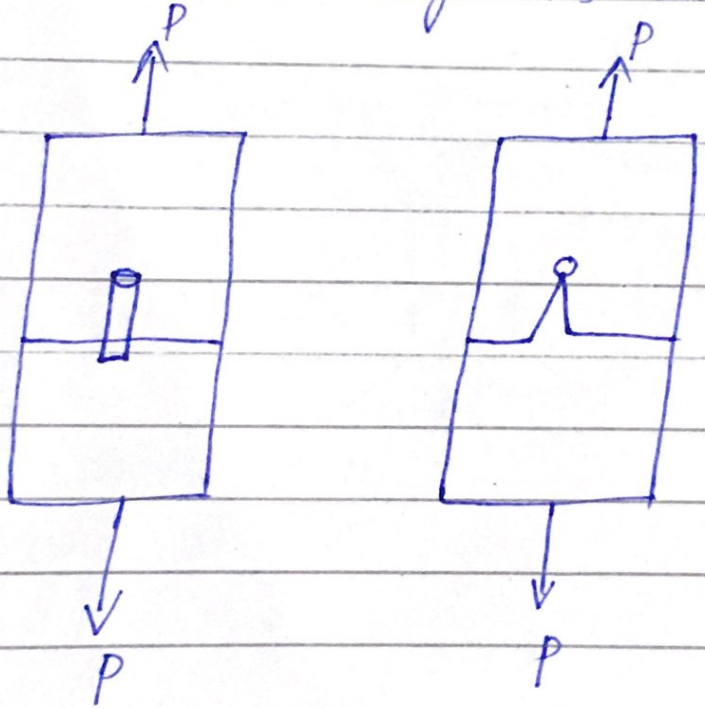




due to this failure a gap is produced b/w the bolt and the surface of plate.

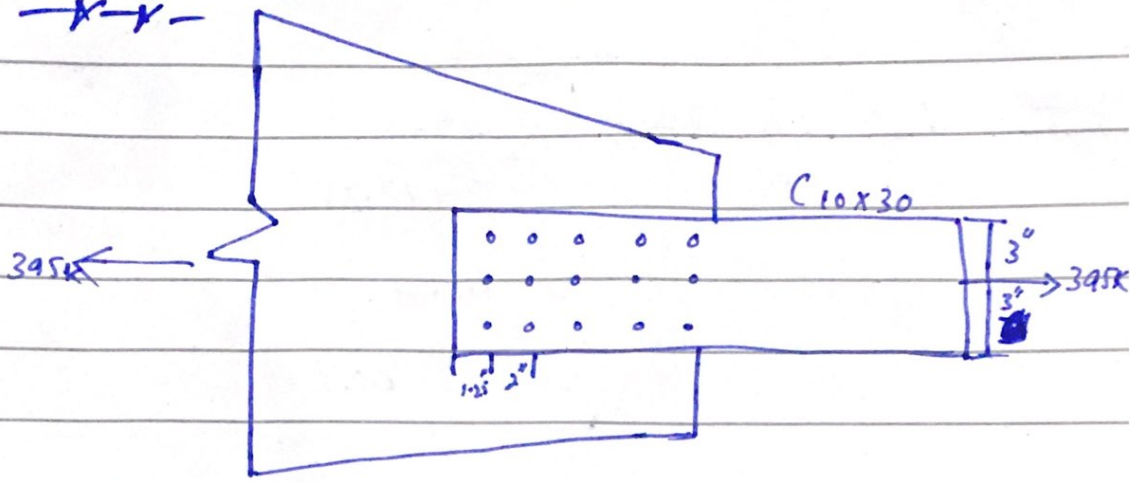
(3) Tearing of plates at the edges:-

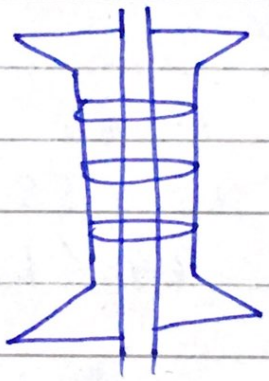
This failure may be due to Shear or Transverse Tension failure of the plate. Here the Stresses exceeds the Shear Strength of the plates and hence the plates are Sheared at the edge as shown



Shearing failure Transverse Tension.

Q03:-





Two C10x30

Ag = 8.82

tw = 0.0673

ASD Method

Sol

Design force

= 130 + 265

= 395 K

Bolt design for 3/4 in dia bolts

A = 0.4418 in² (Area)

Fv = 30 Ksi

Rv = 0.4418 X 30 = 13.25 K/Shear surface

As bolt are in double Shear

$\Rightarrow$ No of bolts $= \frac{395}{2 \times 13.25}$

$= 14.9$

$\boxed{= 15 \text{ bolts}}$

(3) Bearing :-

$F_p = 1.2 F_u$

$= 1.2 \times 58$

$= 69.6 \text{ KSi}$

Also

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

$L = 3d$ (From Table)

Channel :-

$R_p = dt F_p$

$= \frac{3}{4} \times 0.673 \times 69.6 = 35.13 \text{ K}$

For bolts ~~are~~ There are 30 Surfaces

So Capacity $= 30 \times 35.13 = 1053.9 > 395 \text{K}$

Gusset plate :-

$R_p = dt F_p$

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

$= 52.2\ K$

For gusset there are 15 bearing surfaces, So

Capacity $= 15 \times 52.5$

$= 783 > 395\ K$

(4) Spacing

End distance, Sheared edge $= 1\frac{1}{4}$ in min

End distance: $1\frac{1}{2}d = 1.13$ in $\leq 1\frac{1}{4}$ in

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

Since Rp for both Channel and gusset is very larger than required. Conside the min end distance of $1\frac{1}{4}$ in and the min blw Connector Spacing of 2 in.

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

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

$$\Rightarrow P = 24.4\ K$$

$$L = \frac{2p}{Put} + \frac{d}{2}$$

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

$$\Rightarrow P = 31.7$$

$$\text{Capacity} = 2(3 \times 24.4 + 12 \times 31.71)$$

$$= 907.44 > 395\ K$$

Gusset:-

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

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

$$P = 36.25\ K$$

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

* $$2 = \frac{2P}{Fut} + \frac{3/4}{2}$$

$$\Rightarrow P = 47.13$$

Capacity $= 3 \times 36.25 + 12 \times 47.13$

$= 674.31 > 395\,K$

Therefore 15 bolts in three row of five are adequate with end distance of $1 - \frac{1}{4}$ in 8 $2''$ c/c.