Q No. 1

"Design philosophies"

General Statment.

when a particular loading reaches its limit failure is the assume result the loading condition become failure modes. Such a condition is reffered to as limit state and define as

"A limit state is condition beyond which structural system or a structural component ceases to full fill the function for which it design."

A general Statment assuming Safety in engineering design

Resistence (Material & x-Section) ≥ effect of applied load ①

In eq (1) it assential that both Sides are valuable for Same Condition e.g. if effect of load is to produce Comprehensive Stress on Soil then it Should with Bearing capacity of Soil.

⇒ Consideration for Design load.

In Steel design AISC manuals for ASD & LRFD

guidline can be accepted as reflection of opinions of experienced and qualified group of engineers such as to determine the acceptable margin of safety.
To facilitate the analysis of load effect and strength of materials the two distinct procedure employed by designers are Allowed Stress Design (ASD) + load + resistence factor Design (LRFD).

⇒ Allowable Stress Design (ASD)

* Safety in the Design is obtain by Specifying that the effect of the loads Should produce Stress that is a ~~function~~ fraction of the yield Stress fy, Say on half.

this is equivalent

$$FOS = \text{Resistance. } R / \text{effect of load. } Q$$

$$= Fy / 0.5 Fy$$

$$= 2$$

Mathematical Description of ASD

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

R = Resistence or Strength of component bug design.

ϕ = Resistence factor or Strength reduction factor

γ = over load or load factor

γ/ϕ = factor of Safety FS

Q_i = Effect of applied loads.

⇒ **LRFD;** to overcome the deficiencies of ASD, the LRFD method is based on

Strength material

* it Consider the variability not only in resistence but also in the effects of load.
* it provides measure of Safety related to probability of failure.
* Safety in the design is obtain by Specifying That the reduce nominal Strength of a design Structure is less than the effect of factor load acting on

Structure

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

R_n = Resistence or Strength of the Component being design

Q_i = effect of applied loads

n = takes into acount ductality redundency and operational Imp.

ϕ = Resistence factor or Strength reduction factor

γ = over load or load factor.

γ/ϕ = factor of Safety

⇒ Disadvantages (ASD)

* Implied in the ASD method is the assumption that the 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 reasonable measure of Strength which is more fundamental measure of resistence than is allowed Stress.

* Another Draw Back in ASD is that Safety is applied only to Stress level.

⇒ Disadvantages (LRFD)

* its disadvantages is change in design philosphy from previous method.

⇒ Advantage (LRFD)

* LRFD accounts for both variability in resistence and load.

* it achieves fairly uniform levels of Safety for differient limit states.

ANS 02:

Structural Bolts

two Comonly used types are:

⇒ (1) Unfinished (A 307)

⇒ (2) High Strength bolt (A 325, A 490)

* A 307 is known by names unfinished, rough Common, ordinary and machine

* They are made of low Carbon Steel having tensile Strength of 60 ksi

* A 325 is made of medium Carbon Steel whose tensile Strength decrease with Increase in dia.

⇒ Types of Bolt Connections.

(i) Slip-Critical Connections.

* Connection transmit the force by fraction produced between the faying surface by the clamping action of bolts.

* Slip Critical Connection are recommended for Joints subjected to stress reversal sever, stress fluctuation, impact, vibration or where slip is objectionable.

⇒ Bearing type Connection.

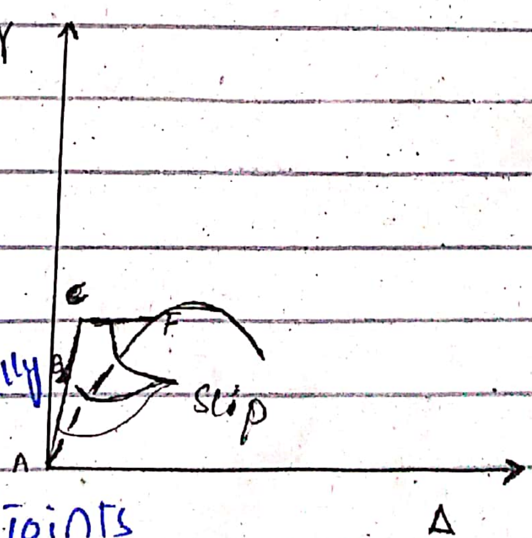
* Load is transferred by shering and bearing on bolt.

* High Strength bolts can be tightened to large tension.

⇒ Behavior of Bolted and Reveted Connection.

T = tensile force on connection

Δ = Joint displacment.



Behavior of Mechanically connected joints

* Capacity in Shear depends on wheather Shear plane Intersect the body of bolt or threaded portion

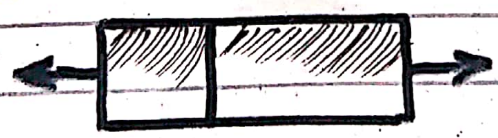
⇒ Types of Failures:→

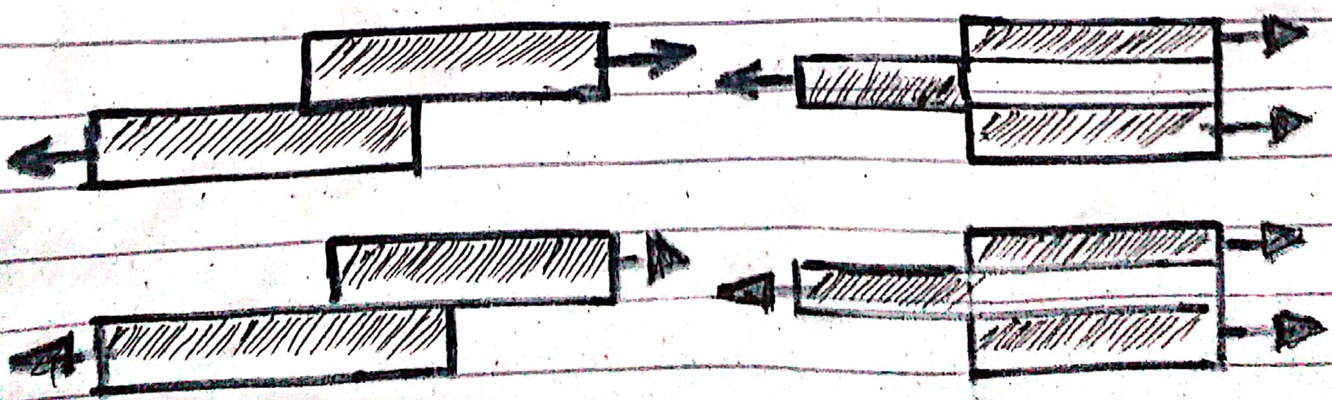
i) Shearing failure of Bolts.

ii) Bearing failure of palate.

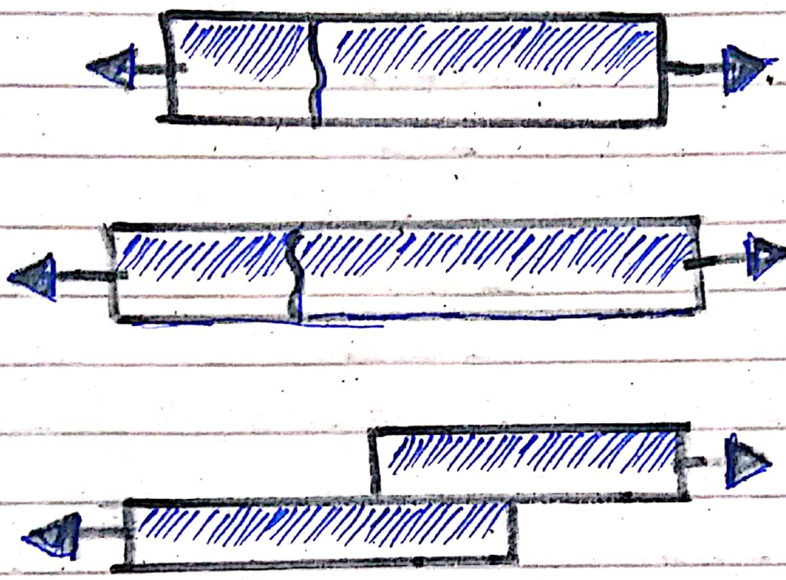
iii) Tearing failure at edge of Palate.

"SHEARING FAILURE:"

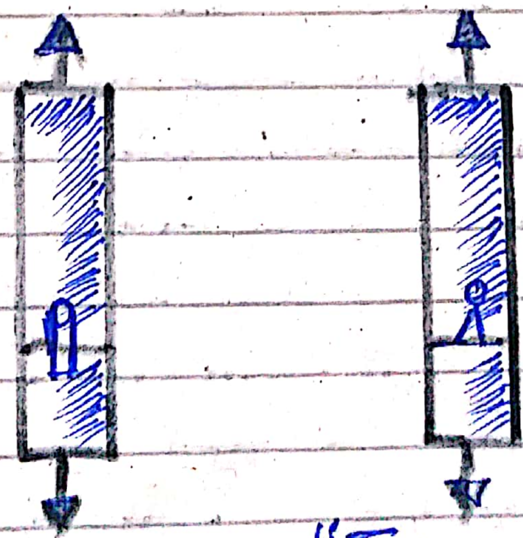




"Bearing Failure of plate";



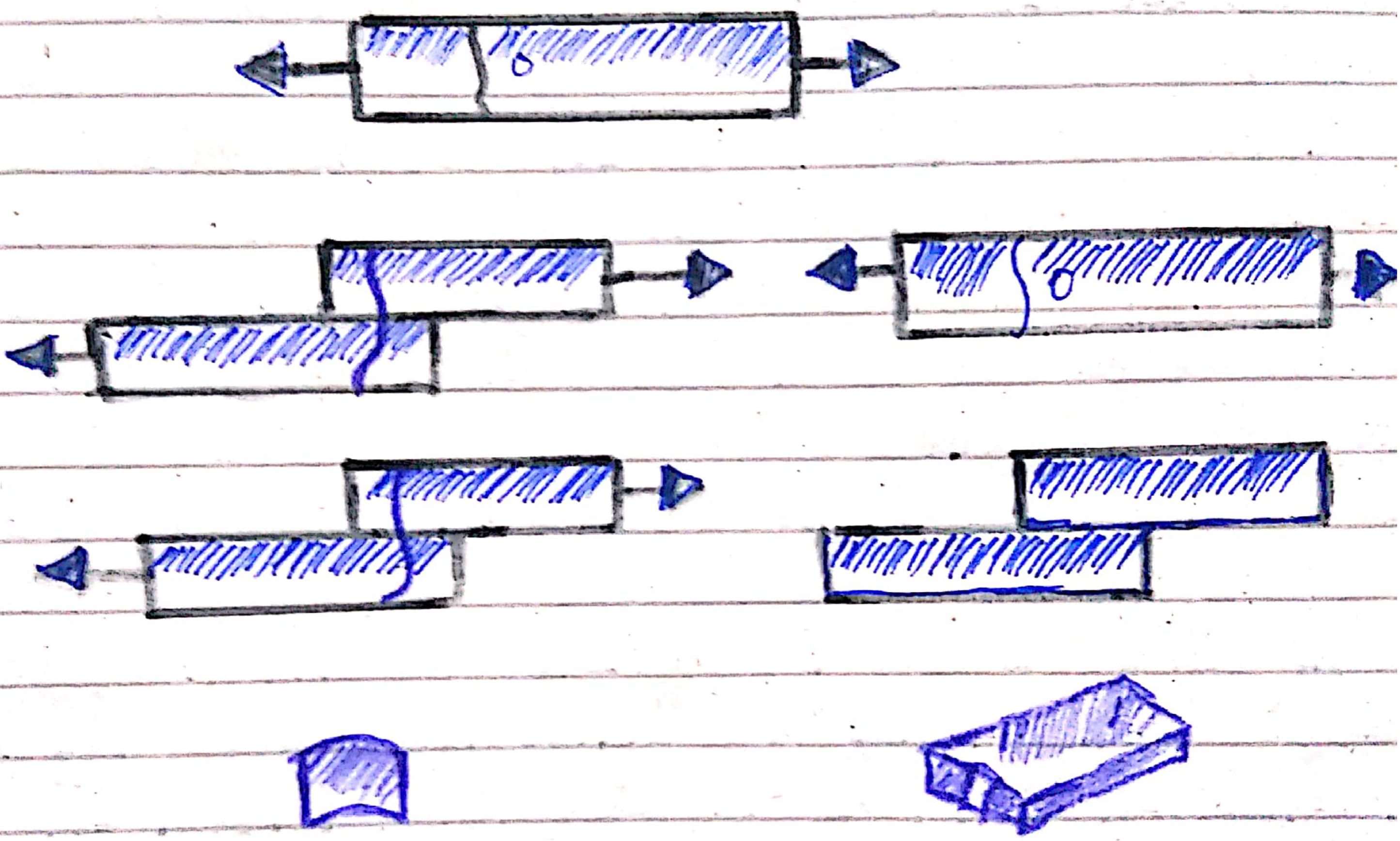
Tearing Failure at the edge of plate;



Shearing Failure at the edge of plate;

"Transverse Tension Failure"

"Shear and Bearing Area";



⇒ Tearing failure - Code requirements

Tearing length or edge distance

$L_e = P/\phi F_{ut}$ $\qquad$ $L_e = 2P/F_{ut}$

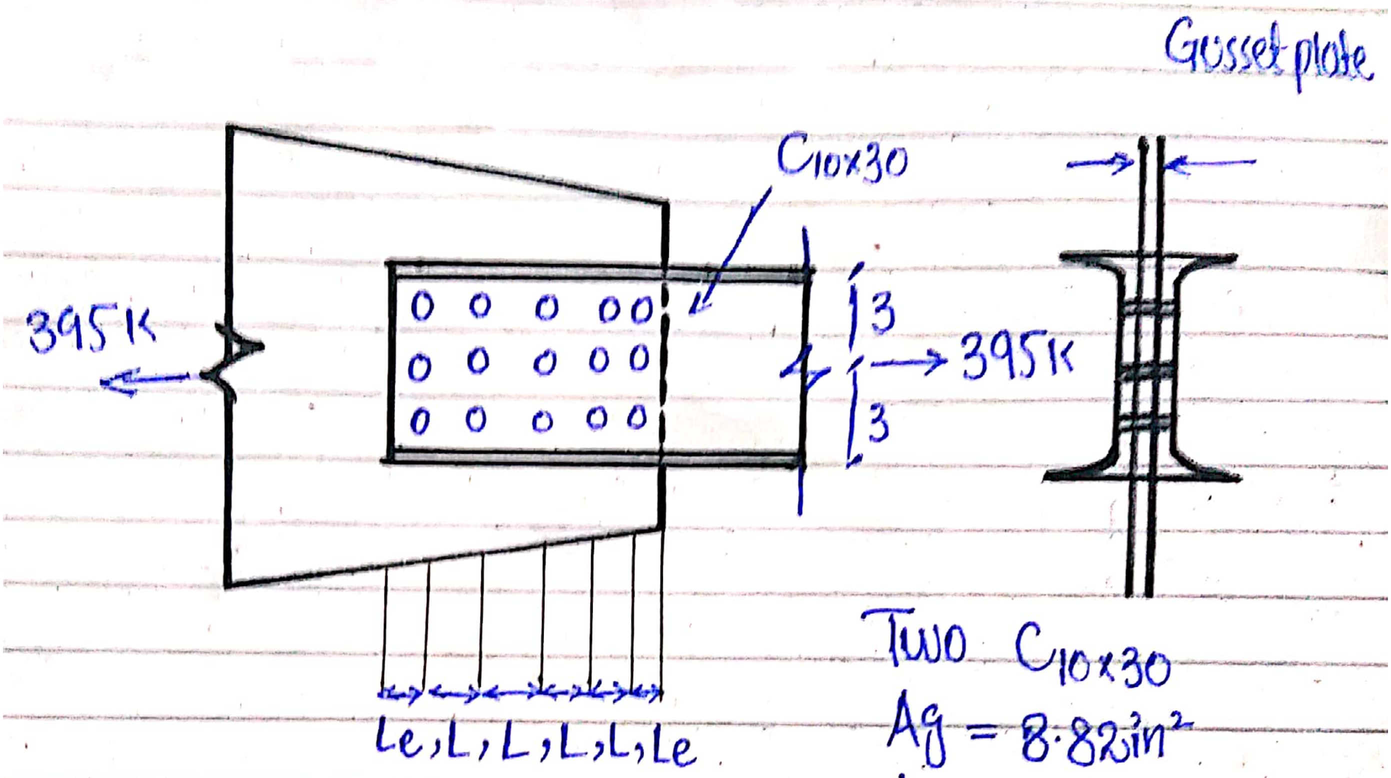
$\phi = 0.75$ $\qquad$ $FOS = 2$

Spacing between holes

$L = \frac{P}{\phi F_{ut}} + \frac{d_h}{2}$ $\qquad$ $L = \frac{2P}{F_{ut}} + \frac{d_h}{2}$

page 11 15

"Ans, 03"; "ASD METHOD"



Two C10x30
$A_g = 8.82 in^2$
$t_w = 0.673$ in

"1"; Number of Bolts required.
"2"; Approporide layout to transmit loads.

"Sol";

Design force = 130+265
= 395K

Bolts Design; For 3/4 dia bolts

$A = 0.4418 in^2$ "Nominal area"
$F_v = 30$ Ksi "Shear strength of a bolt in Single Shear Table 2-11"

"Now";

$$R_v = A \times F_v$$

$$= 0.4418(30)$$

$$= 13.25 \text{ Kips/shear surface}$$

As there are two shear surfaces per Bolt

$$\text{No of Bolts} = \frac{\text{Design force}}{2 \cdot R_v} = \frac{395}{2(13.25)}$$

$$= 14.90$$

$$= 15 \text{ Bolts.}$$

"Bearing";

$$F_p = 1.2 F_u$$

F_p = Specification allowable stresses

$$= 1.2(58)$$

$$= 69.6 \text{ ksi}$$

As; $L_e = 1\frac{1}{2} d$ "From Table 2-9"

$$L = 3d$$

"Channel";

$$R_p = d \cdot t \cdot F_p = \frac{3}{4}(0.673)(69.6)$$

$= 35.14$ Kips "Single Bearing Surface of channel."

For Bolts there are 30 Bearing Surface; so;

$$\text{Capacity} = 30(35.14)$$

$= 1053.9 > 395$ Kips **Okay**

"Gusset plate"

$$R_p = d t \cdot F_p$$

$$= \frac{3}{4}(1)(69.6)$$

$= 52.2$ Kips; "Single Bearing Surface of gusset plate".

For Gusset plate there are "15" B. Surfaces.

$$\text{Capacity} = 52.2(15)$$

$= 783 > 395$ Kips

Okay

"Spacing";

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

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

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

Table 2-8
2-9

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 between connection spacing of 2 inches.

$$L_e = \frac{2P}{F_u \cdot t_w} = 1.25$$

$$\frac{2P}{58(0.673)} = 1.25$$

$$\boxed{P = 24.4 \text{ Kips}}$$

$$L = \frac{2P}{F_u \cdot t} + \frac{d}{2} \Rightarrow 2 = \frac{2P}{58(0.673)} + \frac{3/4}{2}$$

$$\boxed{P = 31.7 \text{ Kips}}$$

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

$$= 907.2\,K > 395\,K$$

Okay

"Gusset";

$$L_e = \frac{2P}{F_u \cdot t} \Rightarrow 1.25 = \frac{2P}{58(1)}$$

$$P = 36.25 \text{ Kips.}$$

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

$P = 47.13$ Kips

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

$$= 674.31 > 395 \text{ Kips}$$

Okay

So; Finally using 15 Bolts in 3 rows of five with end distance $1\frac{1}{4}$ in and center to center spacing of 2 inches.