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Subject : STEEL Structure

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Question No # 01

"General Statement Of Design Philosphies"

* A General Statement assuming Safety in engineering design.

Resistance (of material & X-section) ≥ effect of applied load → (1)

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

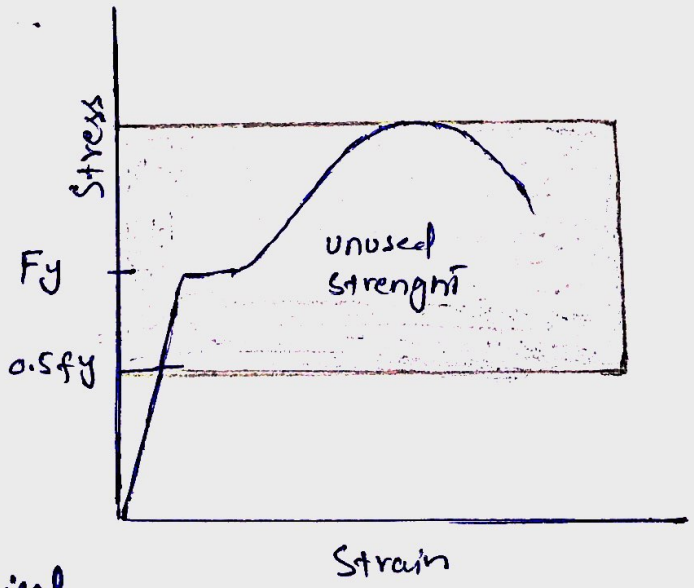
Allowable Stress Design ASD :-

* 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

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

$$= f_y / 0.5 f_y$$

$$= 2$$



Mathematical of ASD :-

$$\frac{\phi R_n}{\gamma} \geq \sum Q_1$$

"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 effect 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.

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

R_n = Resistance
Q = effect of Applied load.
n = Takes into account ductility
ϕ = Strength Reduction factor
γ = overload or load factor $\frac{\gamma}{\phi}$ = factor of Safety.

Advantages of ASD :-

* Elastic analysis for loads become compatible for design.
* Old famous books are according to the method.
* Experienced engineers are used to this method
* In past, It was the only method for design purpose
* This method is included in AISC-05 Specification as an alternate method.

Disadvantages of ASD :-

* Implied the ASD method is the assumption that the stress in the member is Zero before any loads 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 drawback is ASD is that safety is applied only to stress level. load are considered to be deterministic (without variation).

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 :-

★ It's disadvantages is change in design philosphy from previous method.

Question NO #02

TYPES OF Bolt Connection

Types of bolt Connection are as under;

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 recomended for joints subjected to stress reversal, Severe stress fluctuation, Impact, vibration or where slip is objectionable.

★ Slip Critical becomes bearing type Connection after the slip occours so every Slip Critical Connection is essentially a bearing type Connection also.

Bearing type Connection :-

→ Load is transferred by Shearing and bearing on the bolt.

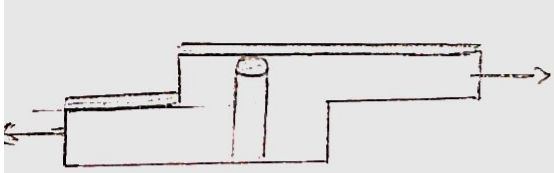
→ Capacity is Shear depends on whether Shear plane intersects the body of bolt or threaded portion.

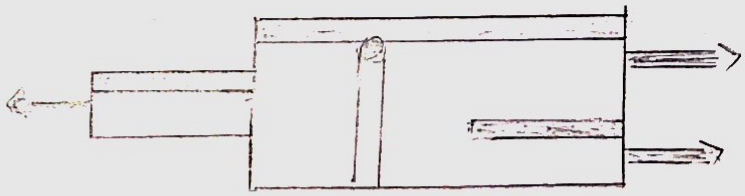
→ Bearing type Connection is the most widely used general type Connection in which the load is resisted by the bolt body without any friction btw faying surface.

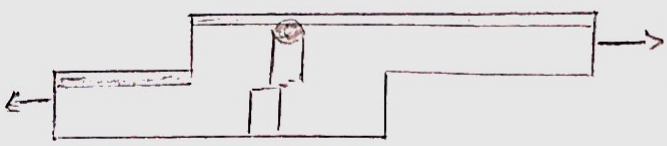
" TYPES OF FAILURE "

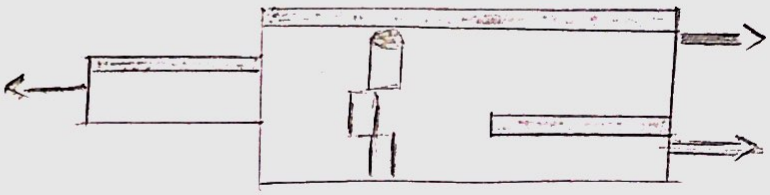
★ Shearing Failure of Bolts :—

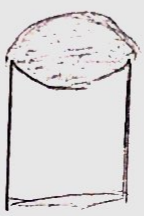
The shear stress in the bolt may exceed the working shear stress in the bolt. Shear stresses are generated because the plates slip due to applied force.





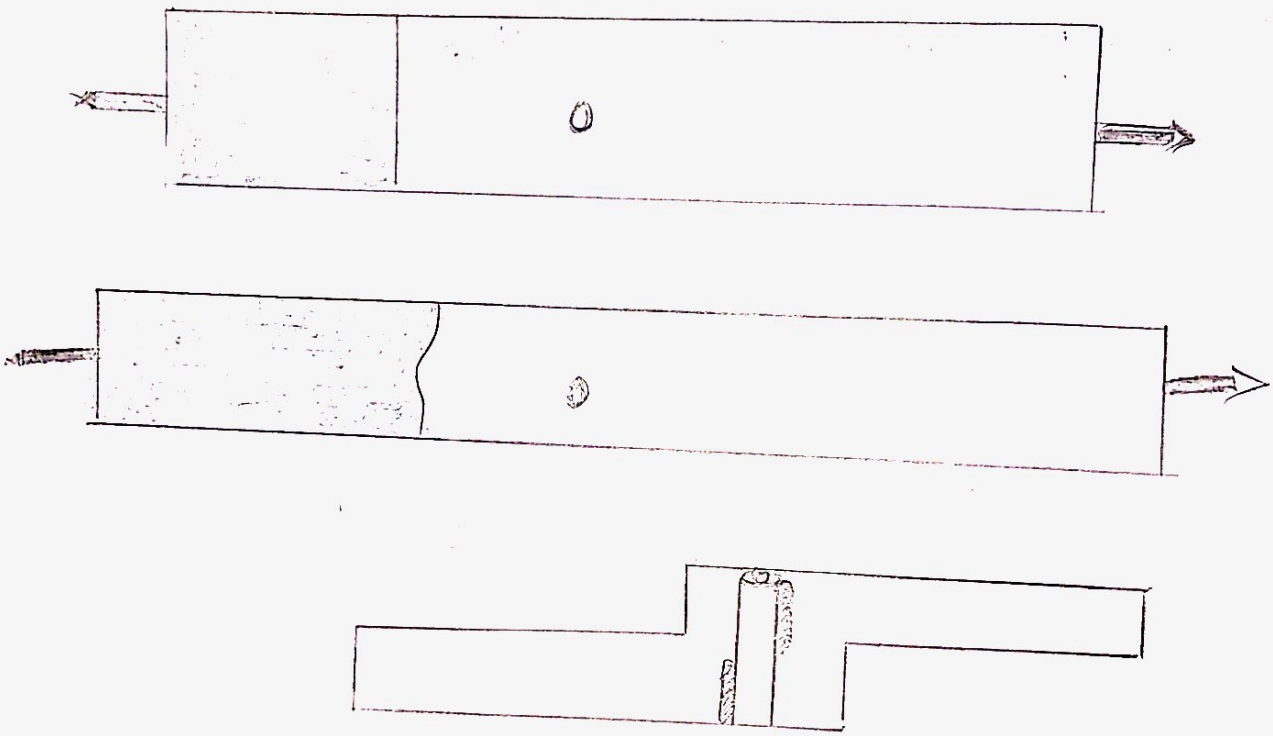


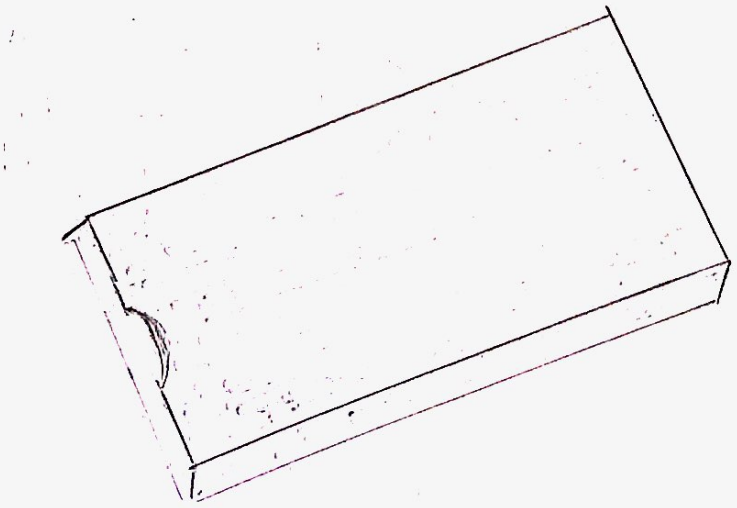




★ Bearing failure of plates :~

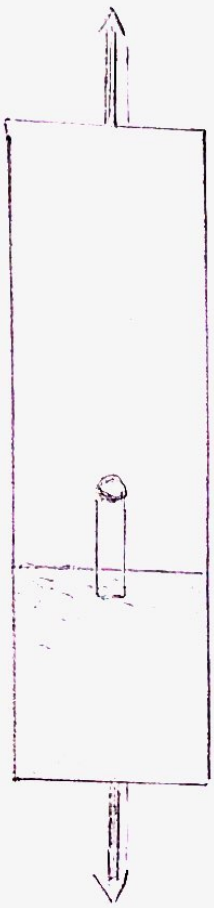
The plate maybe crushed when the bearing stress in the plate exceeds the working bearing stress.



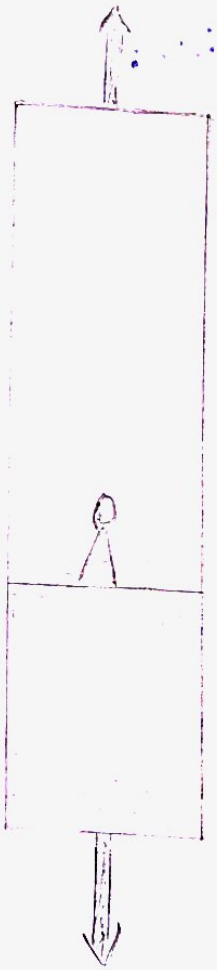


Tearing Failure at the edge of plate :-

The tensile Stress in the plate of the net Cross Section may exceed the working tensile Stress. Tearing failure occurs when bolts are Stronger than the plates.



Shearing Failure edge of plate



Transverse Tension failure.

Question no # 03

Given Data :-

Dead load = 130 k

Live load = 265 k

Two plates $C_{10 \times 30}$

1" gusset plate

→ All material is A36 Steel Bolts are A325 with 3/4 in dia

→ Bearing type connection

→ Thread excluded from Shear plane.

→ Use three line of bolt

* "ASD Method"

Required

Number of bolts required = ?

Appropriate layout

Solution :-

Design force = D.L + L.L

= 130 + 265

$$= 395 \text{ K}$$

⇒ Bolt Design :-

For $3/4''$ dia bolts

$$\text{Area} = \pi/4 \, (D^2) = \pi/4 \, (3/4)^2$$

$$\text{Area} = 0.4418 \text{ in}^2$$

⇒ Shear Design :-

Shear Strength of bolts When threads are excluded from Shear plane,

from table $F_v = 30$ ksi

R_v = Area x F_v

= 0.4418 x 30

$\boxed{= 13.25\ K}$ per Shear Surface

→ As there are two Shear Surfaces per bolt.

⇒ Number of bolts = $\frac{\text{Design force}}{2 \times R_v}$

$= \frac{395}{2 \times 13.25}$

$= 14.90 \approx 15$

"So 15 bolts"

⇒ **Bearing**

Bearing Strength, $F_p = 1.2\ F_u$

$F_u = 58$

$F_p = 1.2 \times 58$

$\boxed{F_p = 69.6\ ksi}$

For Channel, $R_p = d.t\ F_p$

$t_w = 0.673$

$R_p = \frac{3}{4} \times 0.673 \times 69.6$

$\boxed{R_p = 35.13\ K}$ for Single bearing Surface

As there are 15 bolts So "30" Surfaces.

Capacity :~

$= 30 \times 35.13$

$= 1053.9\ K > 395\ K$ Ok

⇒ For Gusset plate

$R_p = d + F_p$

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

$\boxed{R_p = 52.2}$

⇒ Capacity

$15 \times 52.2 = 783K > 395K$

Ok

Spacing

For $\frac{3}{4}$" dia of bolt min edge distance

from table 2.8 $= 1\frac{1}{4}$" $\rightarrow 1.25$"

Also End distance $= 1\frac{1}{2}d$

$= 1\frac{1}{2}(3/4)$

$= 1.13$ in < 1.25"

$\therefore$ edge distance, $Le = 1\frac{1}{4}$" or 1.25"

$\Rightarrow$ Centre to Centre distance

$L = 3d$

$= 3(3/4)$

$L = 2.25$"

$\Rightarrow$ Channel

$$le = \frac{2P}{Fut}$$

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

$$P = 24.4 \text{ k}$$

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

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

$$\boxed{P = 31.7\,k}$$

As the bolts are arranged in three rows and five bolts per row

$\Rightarrow$ Capacity

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

$$= 907.2k > 395\,k$$ Ok

Gusset plate

$$le = 2P/Fut$$

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

$P = 36.25\ K$

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

$$2 = \frac{2P}{58 \times 1} + \frac{3/4}{2}$$

$P = 47.134\ K$

Capacity :-

$3 \times 36.25 + 12 \times 47.134$

$674.358K > 395\ K$

Ok