IS code 800 for Steel structure design

IS 800 : 2007 based on LSM

IS 800 : 1984 based on WSM

Rivetted joints:

Steel structure joints are of two types

1. Permanent joint : Easily dissambled नहीं कर सकते
   1. Riveted joint
   2. Welded joint

2. Temporary joint : Easily dissamble कर सकते है।
   1. Bolted joint
   2. Pin joint

Rivet joint is used in IS 800:1984.

Rivetted joint :- Joint that is made using rivets. made up of cast iron or wrought iron.

Head : work as lock.

Shank : provide grip length.

Tail : used for making another head.

Types of rivet :

1. According to shape of head

   Snap head mostly used.

2. Driving force required to insert the rivet

   1. Hot rivet : गर्म करके
   2. Cold rivet : atmospheric temp. पर ही।

   3. Shop rivet
   4. Field rivet

   5. Power driven
   6. Hand driven

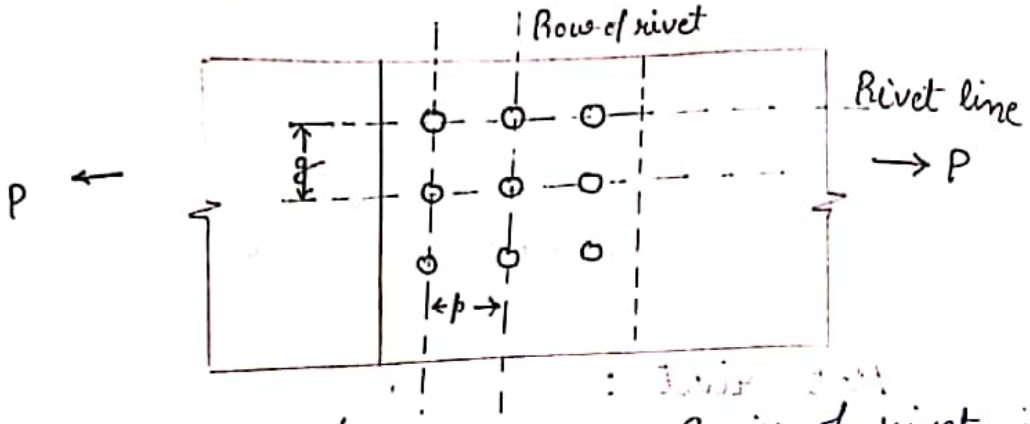
Some technical terms :-

1. Nominal dia. of rivet : it is the dia. of shank, before rivet gets used in riveting. Denoted by 'D'.

2. Gross / Effective dia. of rivet :- it is the dia. of rivet after it gets used in riveting.

⇒ When, $D \leq 25\,mm$, $d = D + 1.5\,mm$

$D > 25\,mm$, $d = D + 2\,mm$



3. Rivet line / Gauge line :- Series of rivet in direction parallel to force. is Rivet line.

4. Row of rivet :- Series of rivet in direction perpendicular to force, is row of rivet.

5- Gauge distance :- centre to centre distance between two consecutive gauge line. (g)

6- Edge distance :- nearest distance of rivet from the edge of member in rivetted joint is known as edge distance.

Minimum edge distance :-

* $e = 1.7\,d$ (for plate, hand cut or sheared off section)
* $e = 1.5\,d$ (for angle. channel or machine cut edge)

7. Pitch :- centre to centre distance between two consecutive rivet in direction parallel to force. Denoted by 'p'.

8. Staggered pitch :- In zig-zag rivetting centre to centre distance between two consecutive rivet in direction parallel to force.

9. Diagonal pitch :- In zig-zag rivetting :: centre to centre distance between two consecutive rivet.

* Min. pitch = 2.5 D
* Max. pitch ⇒ a) for compression : should not be greater than min. of
  12 t or 200 mm

  b) for tension : should not be greater than min. of
  16 t or 200 mm

c) if tacking / stitching rivet is used : should not be greater than min. of
32 t or 300 mm

where, 't' is thickness of thinner member

Types of rivetted joint :-

1. Lap joint
2. Butt joint

1. Lap joint :- When two members are joined by giving lap over each other.

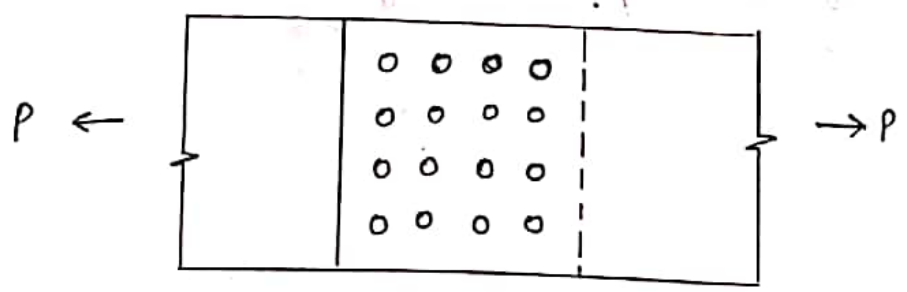
   a) Single rivetted
   b) Double rivetted
   c) Multi rivetted

Bending stress are also induced in rivet in lap joint.

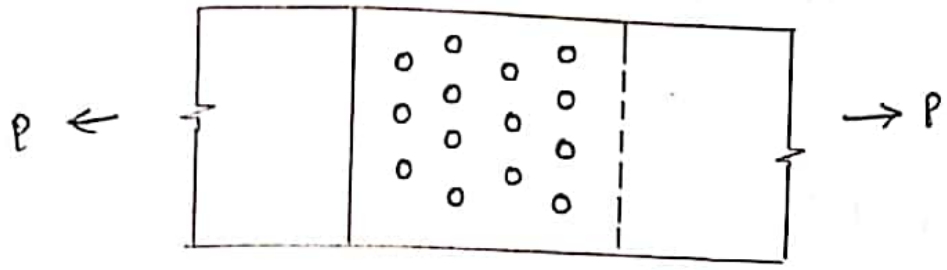
2- Butt joint :- When two members are joined by using cover plate.

Arrangement of rivet :-

1- Chain rivetting :-

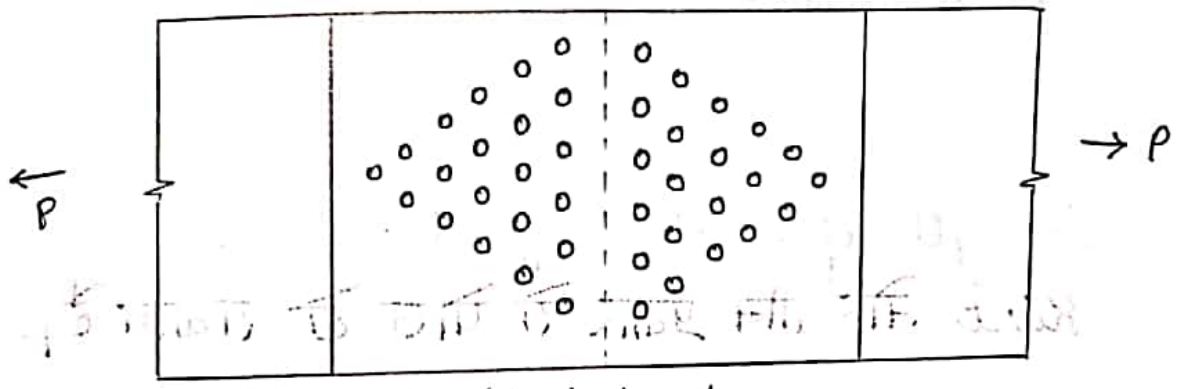


2- Zig-zag riveting :- • its efficiency is more.



3- Diamond riveting :- In this arrangement in each row of rivet, no. of rivet gets decreased by one, and only one rivet left in last row of rivet.

• It is most efficient.



Failure in rivetted joint :-

1. Plate / Member failure :- due to tensile stresses, member will shear off from minimum cross-sectional area. (a) Tensile failure

(b) Edge failure : due to tensile stresses, plate can shear off from edge, it can be avoided by providing proper edge distance

(c) Bearing failure : due to compressive stress. rivet hole can get teared or ovalised.

2. Rivet failure :

(a) Shearing failure : due to tensile or compressive force, rivet can fail in shear in single or double plane.

(b) Bearing failure : due to compressive stresses rivet can get crushed.

Strength of rivetted joint :
Rivet जोड़ तीन प्रकार से फेल हो सकता है।

1. Tensile failure of plate
2. Shear failure of ~~plate~~ rivet
3. Bearing failure of rivet

} इनमें से जो Strength कम होगी वही Rivet joint की strength कहलाएगा

1- Tensile strength of plate :

solid plate, $P_t = b \times t \times \sigma_{at}$

holed plate, $P_t = (b - nd) \times t \times \sigma_{at}$

holed, per pitch length, $P_t = (p - d) \times t \times \sigma_{at}$

p = pitch
d = gross dia
σ_{at} = permissible tensile stress of member
t = thickness { thinner plate for lap joint / thinner main plate in butt joint

2- Shear strength of rivet:

$$P_s = n \times \frac{\pi d^2}{4} \times \tau_{vf}$$

{ In lap joint and in single cover butt joint rivet fail in single shear plane.

$$P_s = n \times \frac{2\pi d^2}{4} \times \tau_{vf}$$

{ In double cover butt joint, rivet fail in double shear plane.

d = gross dia. of rivet.
τ_{vf} = Permissible shear stress in rivet.

3- Bearing strength:

$$P_b = n.d.t.\sigma_{pf}$$

n = no. of rivet
d = gross dia of rivet
t = thickness { thinner plate for lap joint / smaller of thinner main plate or combined thickness of cover plate for butt joint.

σ_{pf} = permissible bearing stress of rivet.

⇒ Strength of rivetted joint per pitch length

$P_t = (p-d) \times t \times \sigma_{at}$

$P_s = n \cdot \frac{\pi d^2}{4} \cdot \tau_{vf}$, single shear

$2n \cdot \frac{\pi d^2}{4} \cdot \tau_{vf}$, double shear

$P_b = n.d.t.\sigma_{pf}$

n = no. of rivet in rivet line.

⇒ Strength of rivetted joint in full width

$P_t = (b - nd).t.\sigma_{at}$

n = no. of rivet in one ~~gauge line~~ row of rivet.

$P_s = n\left(\frac{\pi d^2}{4} \cdot \tau_{vf}\right)$ single shear

$= 2n\left(\frac{\pi d^2}{4} \cdot \tau_{vf}\right)$ double shear

$P_b = n.d.t.\sigma_{pf}$

n = total no. of rivets.

Permissible stresses:-

Steel grade, fe 410, fe 420

$f_y = 250 \text{ N/mm}^2$

- Permissible tensile stresses in plate $\Rightarrow \sigma_{at} = 0.6 f_y$

$\sigma_{at} = 150 \text{ N/mm}^2$

Types of rivet	Shear stress τ_{vf} N/mm²	Bearing stress σ_{pf} N/mm²
PDSR	100	300
PDFR	90	270
Hand rivet	80	250

- Rivet value :- Minimum of P_b or P_s of one rivet.

$$P_s = \frac{\pi d^2}{4} \cdot \tau_{vf} \text{ or } \frac{2\pi d^2}{4} \cdot \tau_{vf}$$

$$P_b = d \cdot t \cdot \sigma_{pf}$$

- No. of rivet = $\frac{\text{Total load}}{\text{Rivet value}}$

- Efficiency of rivetted joint $\Rightarrow$

$$\eta\% = \frac{\text{Strength of rivetted joint}}{\text{Strength of solid plate}} \times 100$$

Strength of rivetted joint

= least of P_t, P_b, P_s

⇒ Strength of solid plate = $\sigma_{at} \times t \times \text{width}$

$$\eta = \frac{p-d}{p} \times 100\ \%$$

⇒ In full width,

$$\eta = \frac{(b - nd)}{b} \times 100\ \%$$

⇒ At min. pitch,

$$\eta = \frac{2.5D - D}{2.5D} \times 100$$

$$\eta = 60\ \%$$

Unwin's formula :- for nominal dia of rivet

$$D = 6.01 \sqrt{t}\ mm$$

$$D = 1.91 \sqrt{t}\ cm$$

Thickness of coverplate

$\frac{5}{8}$ × thickness of thinner main plate

Welded joints

When two members are joined by heating them to their melting point. using filler material, by help of with pressure or without pressure, is called welded joint.

Fusion welding → Electric arc welding - using filler rod
Gas welding - oxy-acetylene gas

Pressure welding

Types of welding :-

1. According to position.
   i) Horizontal
   ii) Vertical
   iii) Corner
2. According to formation of weld.
   i) Butt-weld
   ii) Fillet-weld

Butt weld :-

When two members are welded keeping them infront of each other.

They bear only axial compressive or axial tensile stresses.

These welds are specified according to thickness of penetration. Penetration is of two types

Partial penetration / Incomplete penetration.

$$\text{Effective throat thickness} = \frac{5}{8} \times t$$

(t = thickness of thinner plate)

e.g., single-U, single-V.

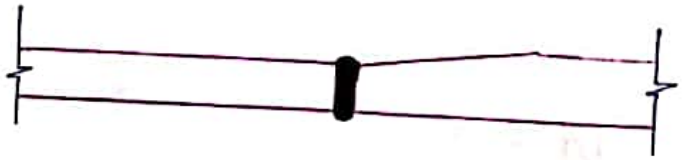
Full penetration / Complete penetration.

Effective throat thickness = t

(thickness of thinner plate)

e.g, double-U, double-V butt.

If the difference of thickness of two members in butt-weld is more than 10% of thinner member, then thicker member is tapered.



Strength of butt-weld

P = length of weld × Effective throat thickness × Permissible axial tensile/comp. stress

For partial penetration,

$$P = \frac{5}{8} t \times l \times \sigma_{at}$$

$\{ \sigma_{at} = 150 \text{ MPa}$

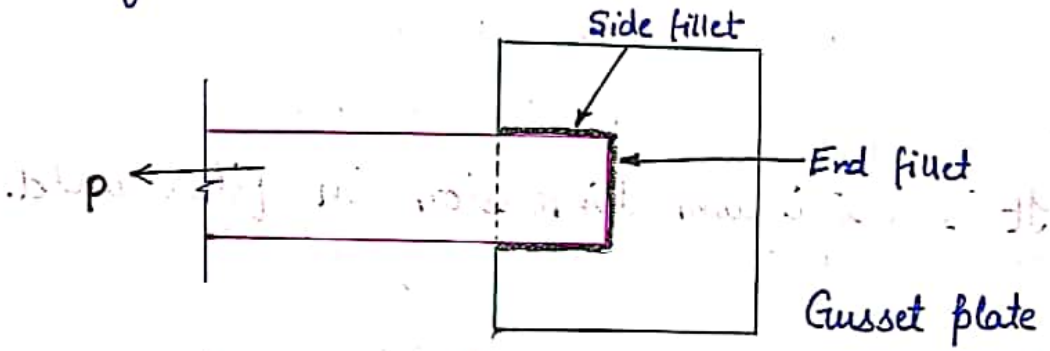
For full penetration,

$$P = l \times t \times \sigma_{at}$$

Fillet weld :-

When two members are joined by welding each other by providing lap, is called fillet weld.

They bear only shear stresses.

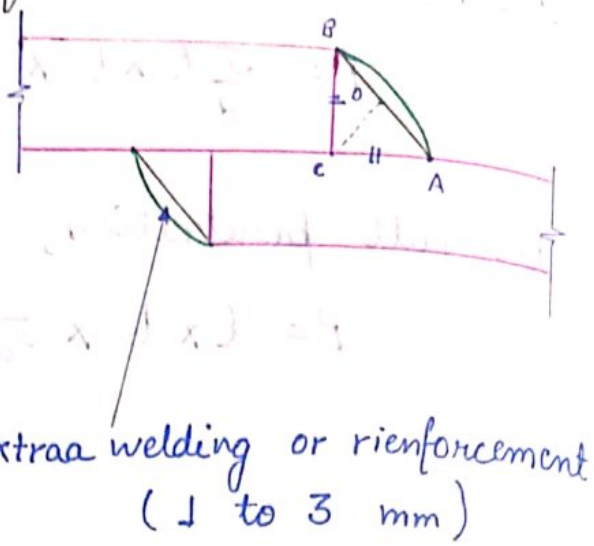


1. Side fillet : When direction of weld is parallel to direction of stress. Longitudnal Shear stress आता है।

2. End fillet : When direction of weld is perpendi-cular to direction of stress. Transverse Shear stress आते है।

3. Diagonal fillet : When direction of weld is inclined to direction of stress.

Cross-section of fillet weld:



toe = A, B

root = C

Extraa welding or rienforcement
(1 to 3 mm)

Effective throat thickness ⇒ Cross-section of fillet weld is isosceles triangle, so the distance between ~~toe~~ root to mid-point of diagonal is effective throat thickness.
It is minimum dimension in fillet weld.
It is weakest plane in fillet weld

AC, BC are size of fillet weld or fusion face denoted by (S).

Effective throat thickness depend upon angle 'θ' between fusion faces,

IS suggest, $60° < \theta < 120°$

Angle b/w fusion faces	Value of 'K'
60° - 90°	0.7
91° - 100°	0.65
101° - 106°	0.60
107° - 113°	0.55
114° - 120	0.50

Generally, $K = 0.7$ or $1/\sqrt{2}$

Effective throat thickness $= K \times S$

or $0.7 \times S$ or $\frac{1 \cdot S}{\sqrt{2}}$

Minimum size of fillet weld is 3 mm.

Size of thicker plate	Min. weld size (mm)
upto & including 10 mm	3 mm
10 - 20 mm	5 mm
20 - 32 mm	6
32 - 50 mm	first run 8 mm min 10 mm

Maximum size of weld :

Sheared off edge / Hand cut edge (e.g., Plate, flat) $= t - 1.5$ mm

Machine cut edge / Rolled steel joist (e.g., angle, channel) $= 3/4\,t$

(Design में Min. की और Suitable size of weld लेते है)

Effective length of fillet weld (to design होती है)

= Drawing length − 2 × Size of weld

(जो drawing में fillet weld की लम्बाई होती है)

(IS suggest)

Minimum effective length of fillet = 4.5

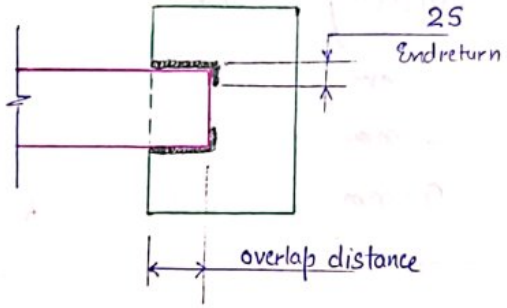
Overlap distance (only in case of end fillet)

Overlap ⩾ 5t

(thickness of thinner plate, t)

End return

End return should not less than = 2.5



Requirement of side fillet weld: (only side fillet)

1. Fillet not provided on single side, it is provided on top and bottom side.
2. Length of side fillet on top and bottom side should be same.
3. Length of each side of side fillet weld

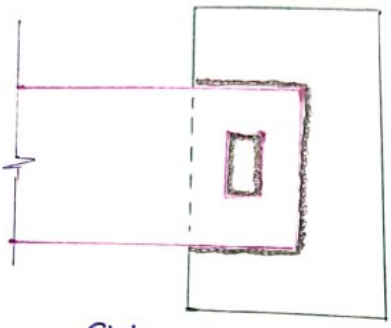
   L ⩾ b (width of member)

4. Width of plate (member) ⩾ 16t (for tension)

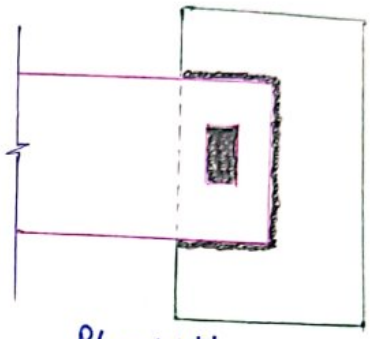
   12t (for compre

Slot welding :- When weld length is more, and to save length of overlap, a slot is cut on one plate and fillet is done on periphery of slot.

Plug welding :- The weld in which slot is completely filled with filler material.



Slot weld



Plug weld

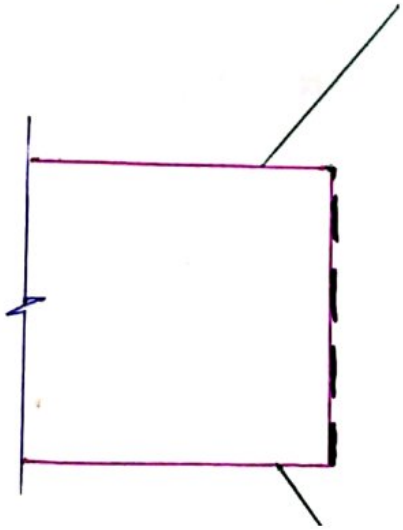
Intermittent weld:

Effective length of intermittent weld (minimum) = 4.5

Clear spacing between intermittent weld

For tension = 16 t से ज्यादा नहीं

For compression = 12 t से ज्यादा नहीं



Tension Member:

Steel truss में वह Member, जिस पर Axially tensile stress आ रहा हो, उसे Tension member कहते हैं tie भी कहते हैं।

e.g. Angle, Channel, plate, flat, wire/rope, rod etc.

Strength of tension member :-

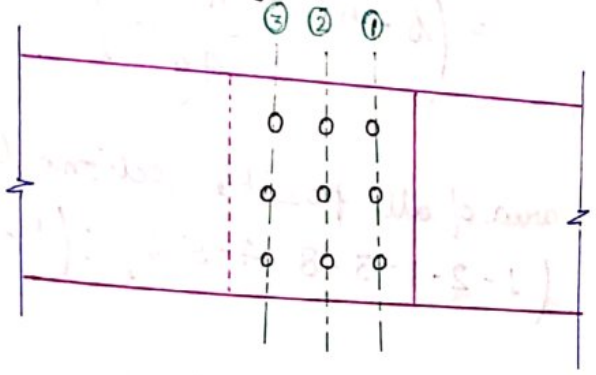
$$P = A_{net} \times \sigma_{at}$$

$\sigma_{at} = 0.6\, f_y$
$= 0.6 \times 250$
$= 150\ N/mm^2$

Calculation of A_{net} for different cases :

1- For plate –

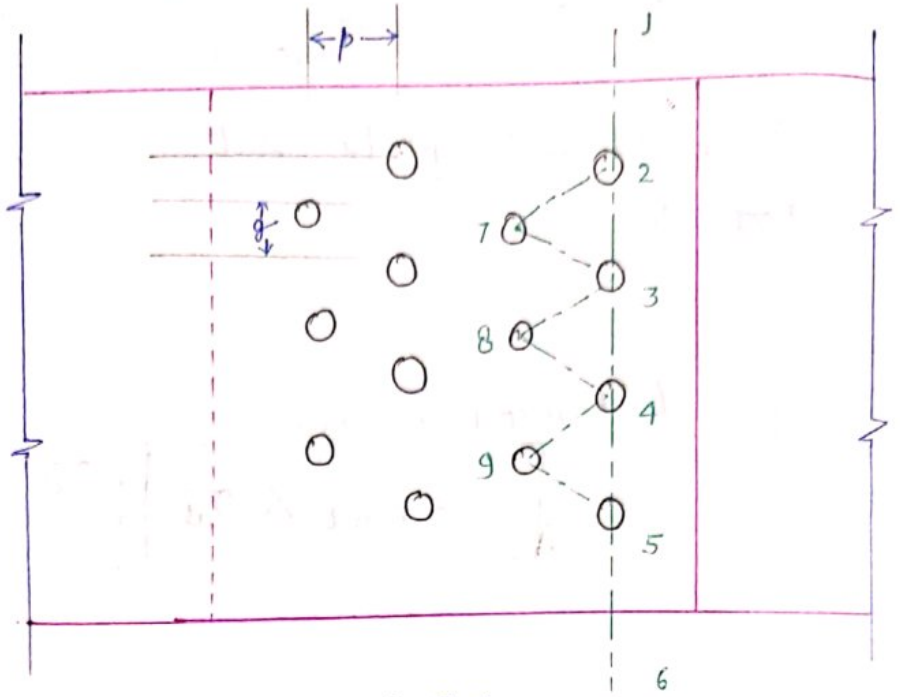
In chain rivetting



$$A_{net} = (b - nd)\, t$$

{ where 'n' is no. of rivets at section of failure

In zig-zag riveting



Area of section: 1-2-3-4-5-6

$$= (b - nd)t$$

Area of section: 1-2-7-3-4-5-6

$$= \left(b - nd + \frac{n' p^2}{4g}\right) \cdot t$$

$\begin{cases} p > g, \text{ Anet} = \text{straig} \\ p < g, \text{ Anet} = \text{zig-za} \\ gg zz \end{cases}$

Similarly, area of all possible sections like:

(1-2-7-3-8-4-5-6) ; (1-2-7-3-8-4-9-5-

$$A_{net} = \text{least of all above area}$$

n = no. of rivet in that particular section

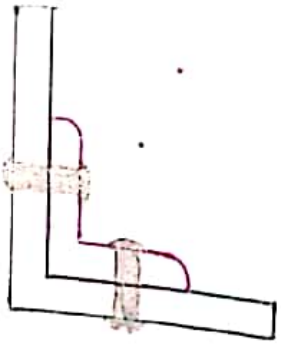
n' = no. of gauge, 6 in case of 1-2-7-3-8-4-9-5-6

p = staggered pitch ; g = gauge distance

2- Single angle section

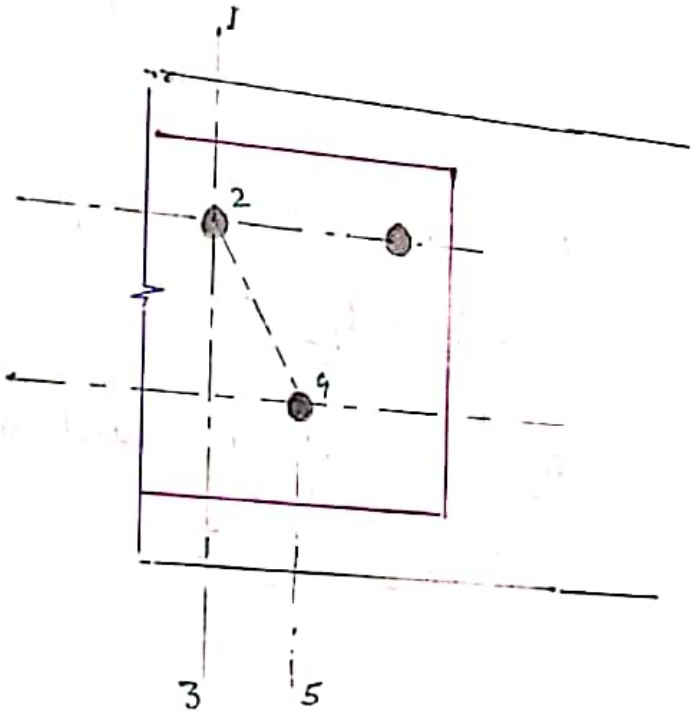
Case I: Both legs connected with gusset plate

IS say, it behaves like plate section



{ it is assumed as plate with zig-zag riveting

$b = l_1 + l_2 - t$

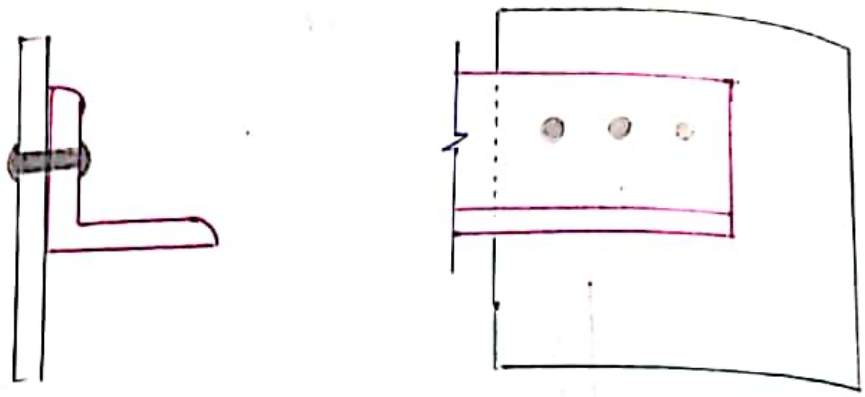


$$A_{net} = \left(b - nd + n' \frac{p^2}{4g} \right) . t$$

या $(b - nd)\, t$

(कम वाला लेंगे)

Case-2- only one leg connected.



$$A_{net} = A_1 + kA_2$$

$$k = \frac{3A_1}{3A_1 + A_2}$$

A_1 = area of connected leg

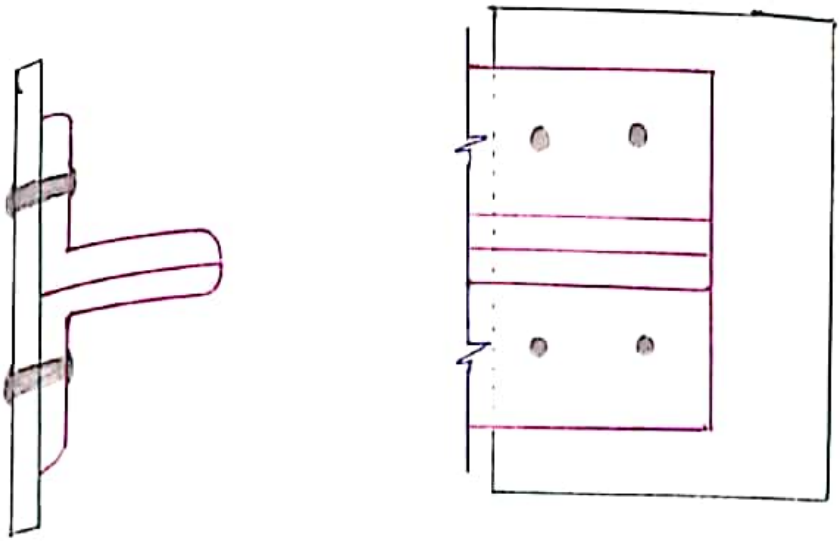
$= (l_1 - t/2 - d)\,t$

A_2 = area of out-standing leg

$= (l_2 - t/2)\,t$

3- Double angle section:

Case-I- Placed back to back and connected on same side.



$$A_{net} = A_1 + KA_2$$

$$K = \frac{5A_1}{5A_1 + A_2}$$

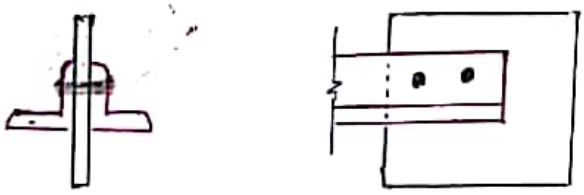
A_1 = area of connected leg

$= 2(l_1 - t/2 - d).t$

A_2 = area of outstanding leg

$= 2(l_2 - t/2).t$

Case-2- Placed back to back and opposite side of gusset plate.



A_{net} = Gross area − deduction for rivet hole

$= 2(A' - ndt)$

A' = gross area of angle section from table

n = no. of rive in row of rivet