Lecture # 11

Riveted Joints - Lozenge Joint

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Riveted Joint for Structural Use–Joints of Uniform Strength (Lozenge Joint)

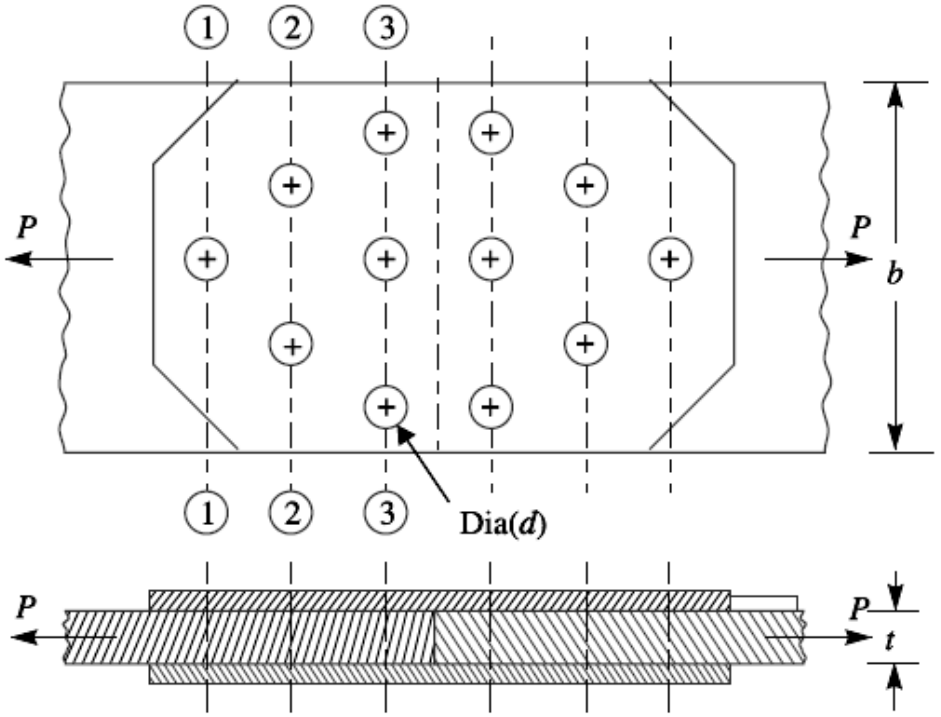
A riveted joint known as ***Lozenge joint is used for roof, bridge work or girders*** etc.

In such a joint, diamond riveting is employed so that the joint is made of uniform strength.

b = Width of the plate,

t = Thickness of the plate, and

d = Diameter of the rivet hole.



In diamond riveting, the number of rivets increases as we proceed from the outermost row to the innermost row.

Riveted Joints - Lozenge Joint

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In designing a Lozenge joint, the following procedure is adopted.

1. Diameter of rivet

The diameter of the rivet hole is obtained by using Unwin's formula,

i.e. $d = 6\sqrt{t}$

According to IS : 1929–1982 (Reaffirmed 1996), the sizes of rivets for general purposes are given in the following table.

Diameter of rivet hole (mm)	Diameter of hole (mm)	Diameter of rivet hole (mm)	Diameter of hole (mm)	Diameter of rivet hole (mm)	Diameter of hole (mm)	Diameter of rivet hole (mm)	Diameter of hole (mm)	Diameter of rivet hole (mm)	Diameter of hole (mm)
13.50	12.00	19.50	18.00	25.50	24.00	35.00	33.00	44.00	42.00
15.50	14.00	21.50	20.00	29.00	27.00	38.00	36.00	50.00	48.00
17.50	16.00	23.50	22.00	32.00	30.00	41.00	39.00		

Riveted Joints - Lozenge Joint

Riveted Joint for Structural Use–Joints of Uniform Strength (Lozenge Joint)

2. Number of rivets

The number of rivets required for the joint may be obtained by the shearing or crushing resistance of the rivets.

Let P_t = Maximum pull acting on the joint = (b – d) t × σ_t

This is the tearing resistance of the plate at the outer row which has only one rivet.

$$\text{Shearing resistance of one rivet, } P_s = 1.75 \times \frac{\pi}{4} \times d^2 \times \tau$$

$$\text{Crushing resistance of one rivet } P_c = d \times t \times \sigma_c$$

$$\therefore \text{Number of rivets, } n = \frac{P_t}{\text{Least of } P_s \text{ or } P_c}$$

Riveted Joints - Lozenge Joint

Riveted Joint for Structural Use–Joints of Uniform Strength (Lozenge Joint)

2. Number of rivets

Since the joint is double strap butt joint, therefore the rivets are in double shear. It is assumed that resistance of a rivet in double shear is 1.75 times than in single shear in order to allow for possible eccentricity of load and defective workmanship.

3. From the number of rivets, the number of rows and the number of rivets in each row is decided.

4. Thickness of the butt straps

The thickness of the butt strap, t_1 = 1.25 t, for single cover strap

= 0.75 t, for double cover strap

Riveted Joints - Lozenge Joint

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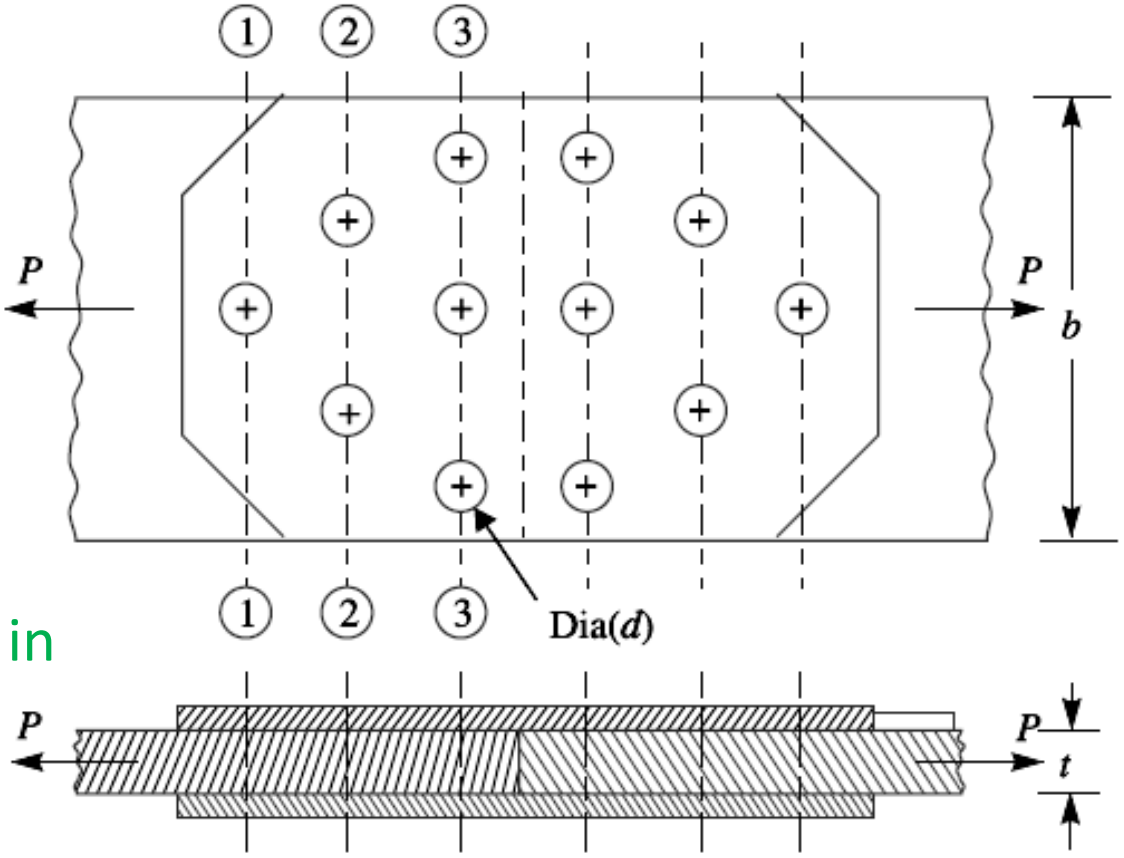
5. Efficiency of the joint

First of all, calculate the resistances along the sections 1-1, 2-2 and 3-3.

At section 1-1, there is only one rivet hole.

∴ Resistance of the joint in tearing along 1-1,

$P_{t1} = (b - d)\, t \times \sigma_t$



Riveted Joints - Lozenge Joint

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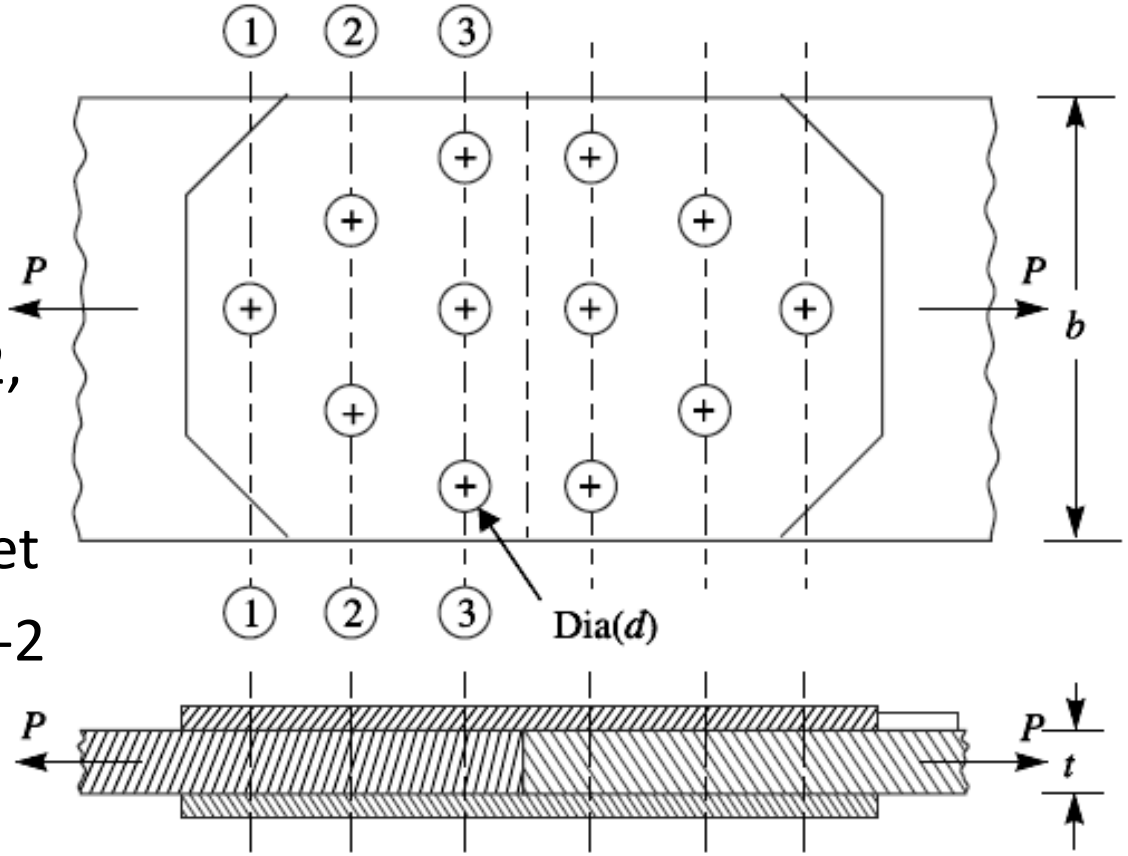
5. Efficiency of the joint

At section 2-2, there are two rivet holes.

∴ Resistance of the joint in tearing along 2-2,

P_{t2} = (b – 2d) t × σ_t

+ Strength of one rivet in front of section 2-2



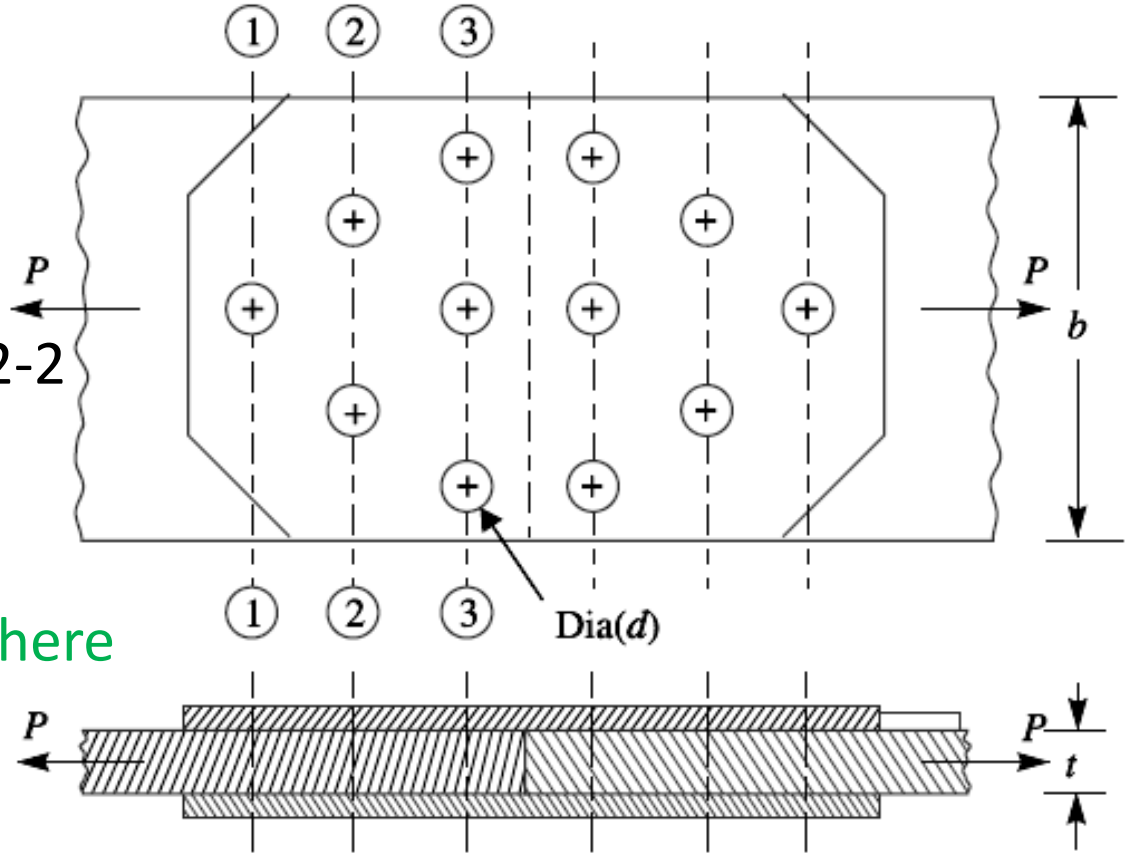
Riveted Joints - Lozenge Joint

Riveted Joint for Structural Use–Joints of Uniform Strength (Lozenge Joint)

5. Efficiency of the joint

This is due to the fact that for tearing off the plate at section 2-2, the rivet in front of section 2-2 i.e. at section 1-1 must first fracture).

Similarly at section 3-3 there are three rivet holes.



Riveted Joints - Lozenge Joint

Riveted Joint for Structural Use–Joints of Uniform Strength (Lozenge Joint)

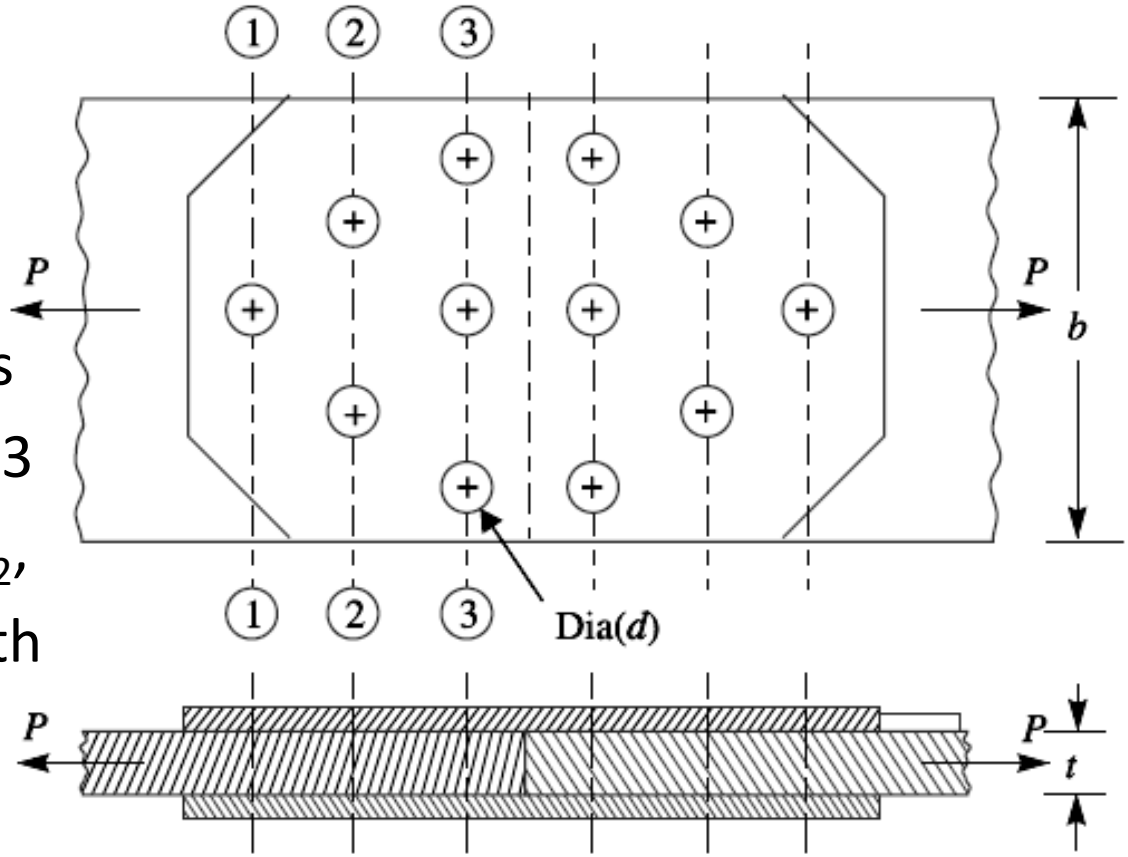
5. Efficiency of the joint

∴ Resistance of the joint in tearing along 3-3,

$P_{t3} = (b - 3d)\, t \times \sigma_t$

+ Strength of 3 rivets in front of section 3-3

The least value of P_{t1}, P_{t2}, P_{t3}, P_s or P_c is the strength of the joint.



Riveted Joints - Lozenge Joint

Riveted Joint for Structural Use–Joints of Uniform Strength (Lozenge Joint)

5. Efficiency of the joint

We know that the strength of unriveted plate, $P = b \times t \times \sigma_t$

$$\therefore \text{Efficiency of the joint, } \eta = \frac{\text{Least of } P_{t1}, P_{t2}, P_{t3}, P_s, or P_c}{P}$$

Note : The permissible stresses employed in structural joints are higher than those used in design of pressure vessels.

The following values are usually adopted.

For plates in tension ... 140 MPa, For rivets in shear ... 105 MPa

For crushing of rivets and plates, Single shear ... 224 MPa

Double shear ... 280 MPa

Riveted Joints - Lozenge Joint

Riveted Joint for Structural Use–Joints of Uniform Strength (Lozenge Joint)

6. The pitch of the rivets is obtained by equating the strength of the joint in tension to the strength of the rivets in shear.

The pitches allowed in structural joints are larger than those of pressure vessels.

The table below shows the values of pitch for the structural joints.

Thickness of Plate (mm)	Diameter of rivet hole (mm)	Diameter of rivet (mm)	Pitch of rivet p=3d+5mm	Marginal pitch (mm)
2	8.4	8	29	16
3	9.5	9	32	17
4	11	10	35	17
5–6	13	12	38	18
6–8	15	14	47	21
8–12	17	16	56	25
11–15	21	20	65	30

Riveted Joints - Lozenge Joint

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7. The marginal pitch (m) should not be less than 1.5 d.

8. The distance between the rows of rivets is 2.5 d to 3 d.

Riveted Joints - Lozenge Joint

Example.1

Two lengths of mild steel tie rod having width 200 mm and thickness 12.5 mm are to be connected by means of a butt joint with double cover plates. Design the joint if the permissible stresses are 80 MPa in tension, 65 MPa in shear and 160 MPa in crushing. Make a sketch of the joint.

Riveted Joints - Lozenge Joint

Example.2

A tie-bar in a bridge consists of flat 350 mm wide and 20 mm thick. It is connected to a gusset plate of the same thickness by a double cover butt joint. Design an economical joint if the permissible stresses are :

σ_t= 90 MPa, τ = 60 MPa and σ_c = 150 MPa

Riveted Joints - Lozenge Joint

Example.3

Design a lap joint for a mild steel flat tie-bar 200 mm × 10 mm thick, using 24 mm diameter rivets. Assume allowable stresses in tension and compression of the plate material as 112 MPa and 200 MPa respectively and shear stress of the rivets as 84 MPa. Show the disposition of the rivets for maximum joint efficiency and determine the joint efficiency. Take diameter of rivet hole as 25.5 mm for a 24 mm diameter rivet.

References

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