DESIGN PROCEDURE OF ROOF TRUSS

23C15A0105

UNDER THE GUIDENCE OF
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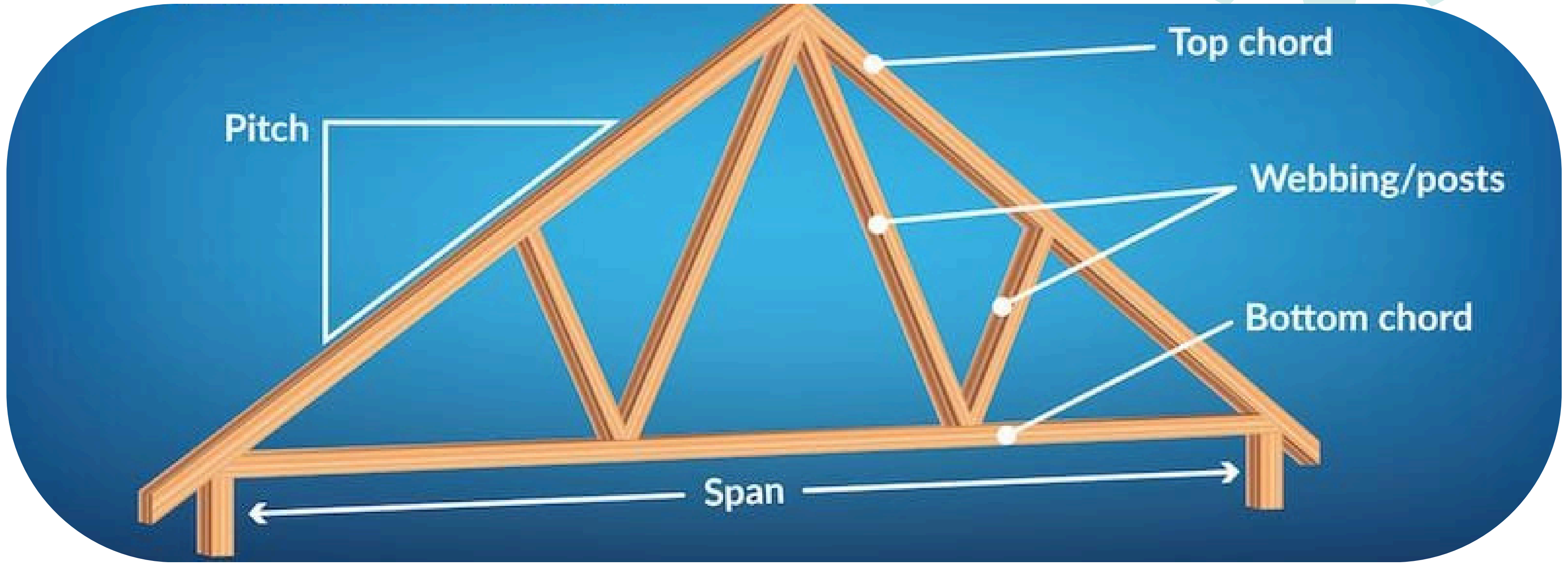
What is a Roof Truss?

- A truss is a framed structure composed of straight members forming triangles.
- Members are connected at joints and lie in the same plane.
- Used primarily in roof structures, bridges, towers, etc



Working Principle

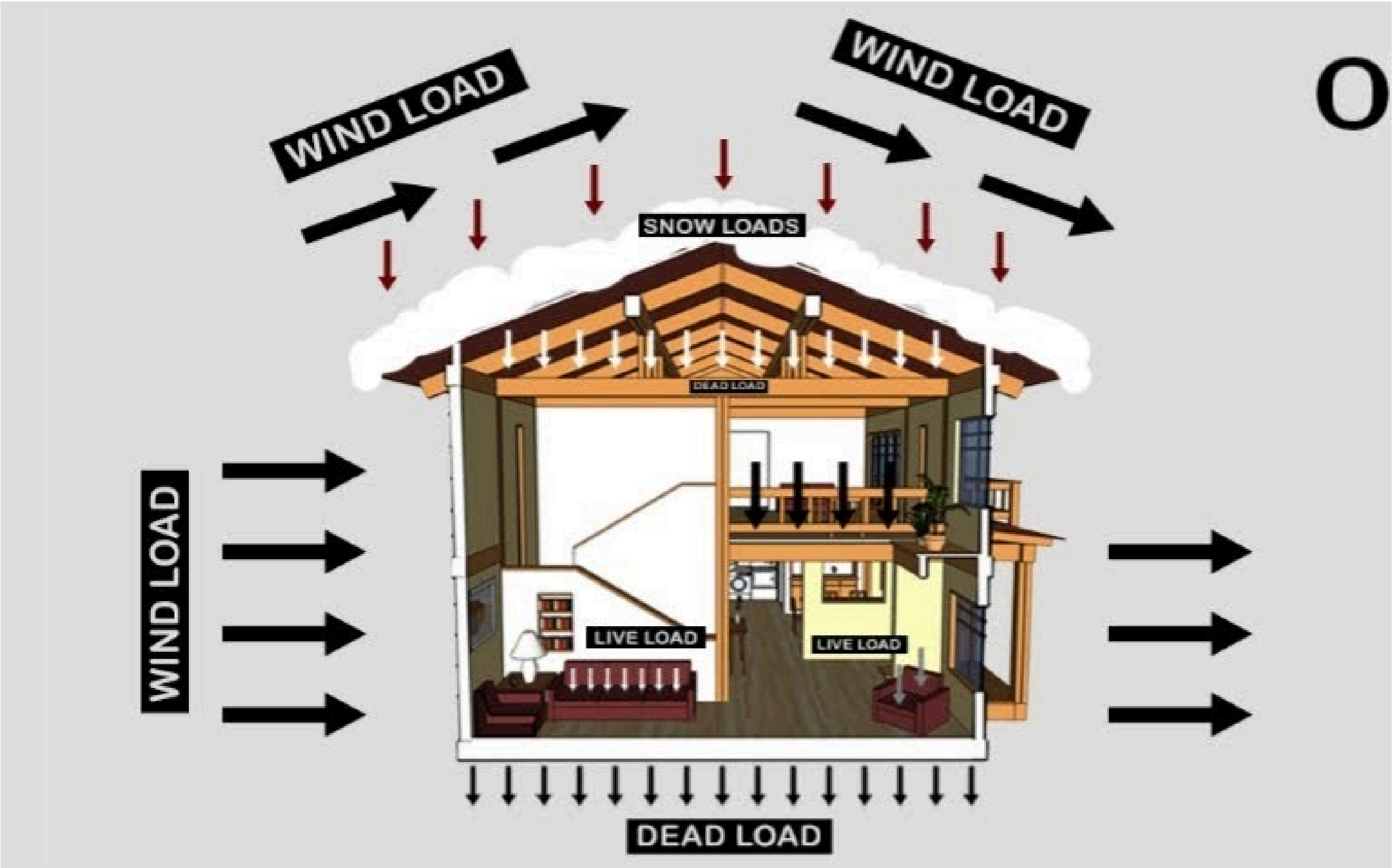
- Trusses distribute loads through axial forces (tension/compression).
- Triangle geometry gives rigidity.
- Transfers load from roof covering to supporting columns/walls.

Truss Spacing

- Usually $\frac{1}{3}$ to $\frac{1}{5}$ of span
- Common range: 3 m to 5 m
- Affects cost and structural behavior

Design Procedure of Roof Truss

- Load Calculations
- Dead Load
- Live Load
- Wind Load
- Member Calculations
- Bolted/Welded Connections
- Strength Characteristics



Load calculations

🧱 Dead Load (DL):

Formula:

$$\mathrm{DL} = w_r + w_p + w_t$$

Where:

- w_r = Load due to **roofing material** (e.g., CGI sheets, tiles) in kN/m²
- w_p = Load due to **purlins** (based on spacing and section)
- w_t = Self-weight of the **truss itself** (typically taken as 0.1 to 0.15 kN/m² if not precisely known)

> **Total DL per meter run = (Sum of above) × spacing between trusses**

Load calculations

🧍 Live Load (LL):

As per IS 875 Part 2:

Formula:

$$\text{LL} = \text{Design Live Load} = \min\left(\text{Live Load from IS 875 Table}, 0.75\,\text{kN/m}^2\right)$$

- For **roof slope** ≤ 10°:

$$\text{LL} = 0.75\,\text{kN/m}^2$$

- For **roof slope** > 10°:

$$\text{LL} = 0.75 - \left(\frac{\theta - 10}{20}\right)\,\text{kN/m}^2 \quad (\text{minimum } 0.4\,\text{kN/m}^2)$$

Where θ = roof slope in degrees.

Load calculations

Wind Load (WL):

As per IS 875 Part 3:

Formula for design wind pressure:

$$P_z = 0.6 \times V_z^2$$

Where:

- P_z = Wind pressure in N/m²
- V_z = Design wind speed in m/s
- 0.6 is a constant (air density factor)

- **Design wind speed:**

$$V_z = V_b \times k_1 \times k_2 \times k_3 = 4$$

- Coefficients:

$$k_1 = 1.0, \quad k_2 = 0.85, \quad k_3 = 1.0$$

Load Combinations (As per IS Code)

- DL + LL
- DL + WL
- LL + WL
- Consider maximum of uplift or downward pressure for critical design

Section Selection

- Use bending equation:
  $M = \frac{wL^2}{10}$ (for purlins)
- Section modulus:
  $Z = \frac{M}{f_y}$
- Choose angle sections or built-up sections accordingly

Design of Connections (Bolted/Welded)

1. Shear Strength of Bolt (V_{dsb})

$$V_{dsb} = \frac{V_{nsb}}{\gamma_{m1}} = \frac{f_{ub}}{\sqrt{3} \cdot \gamma_{m1}} \cdot (n_n A_{nb} + n_s A_{sb})$$

Where:

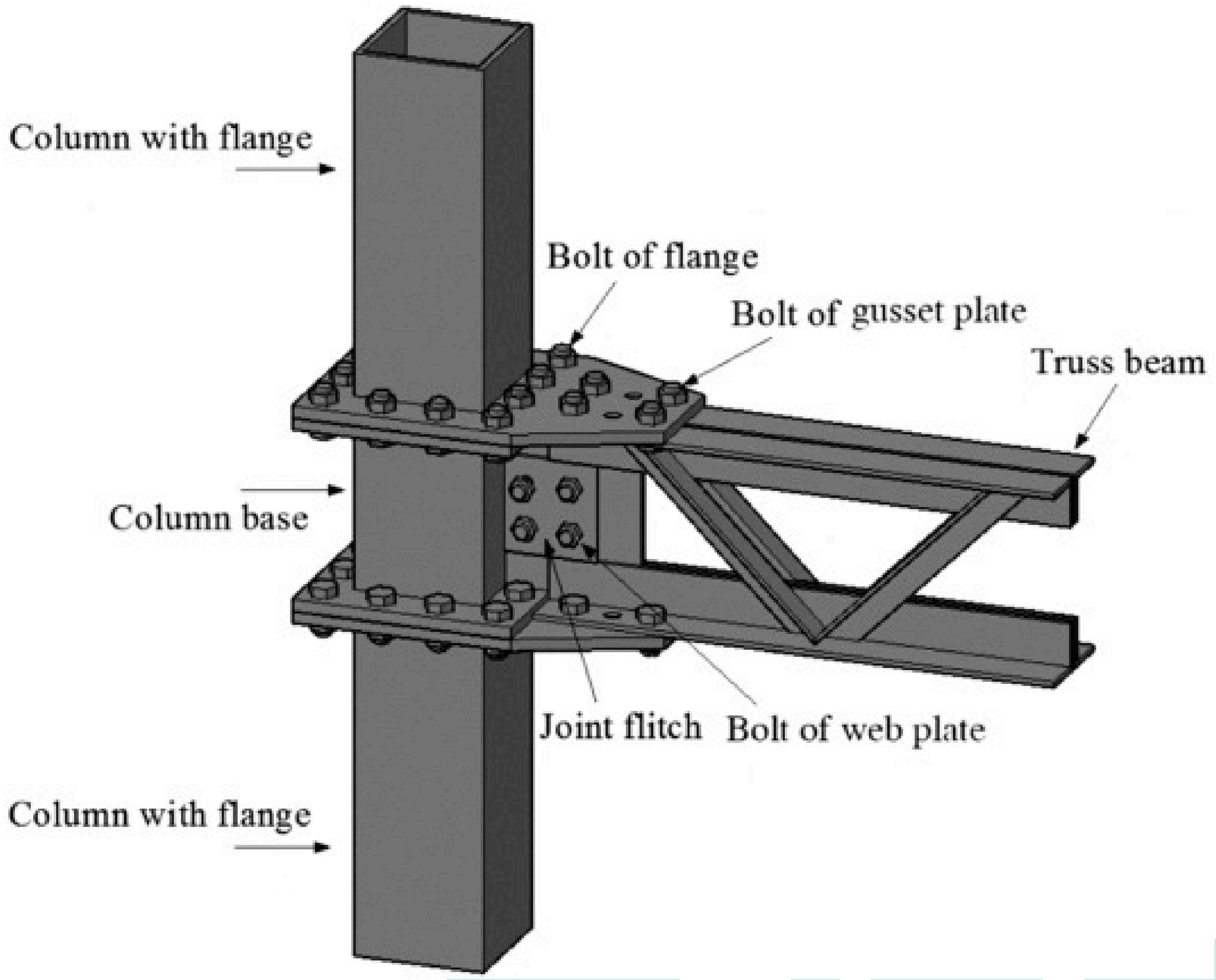
- f_{ub} = ultimate tensile strength of bolt
- γ_{m1} = partial safety factor for bolt (typically 1.25)
- n_n, n_s = number of shear planes with threads and without threads
- A_{nb}, A_{sb} = net and shear area of the bolt

2. Bearing Strength of Bolt (V_{dpb})

$$V_{dpb} = \frac{V_{npb}}{\gamma_{m1}} = \frac{2.5 \cdot k_b \cdot d \cdot t \cdot f_u}{\gamma_{m1}}$$

Where:

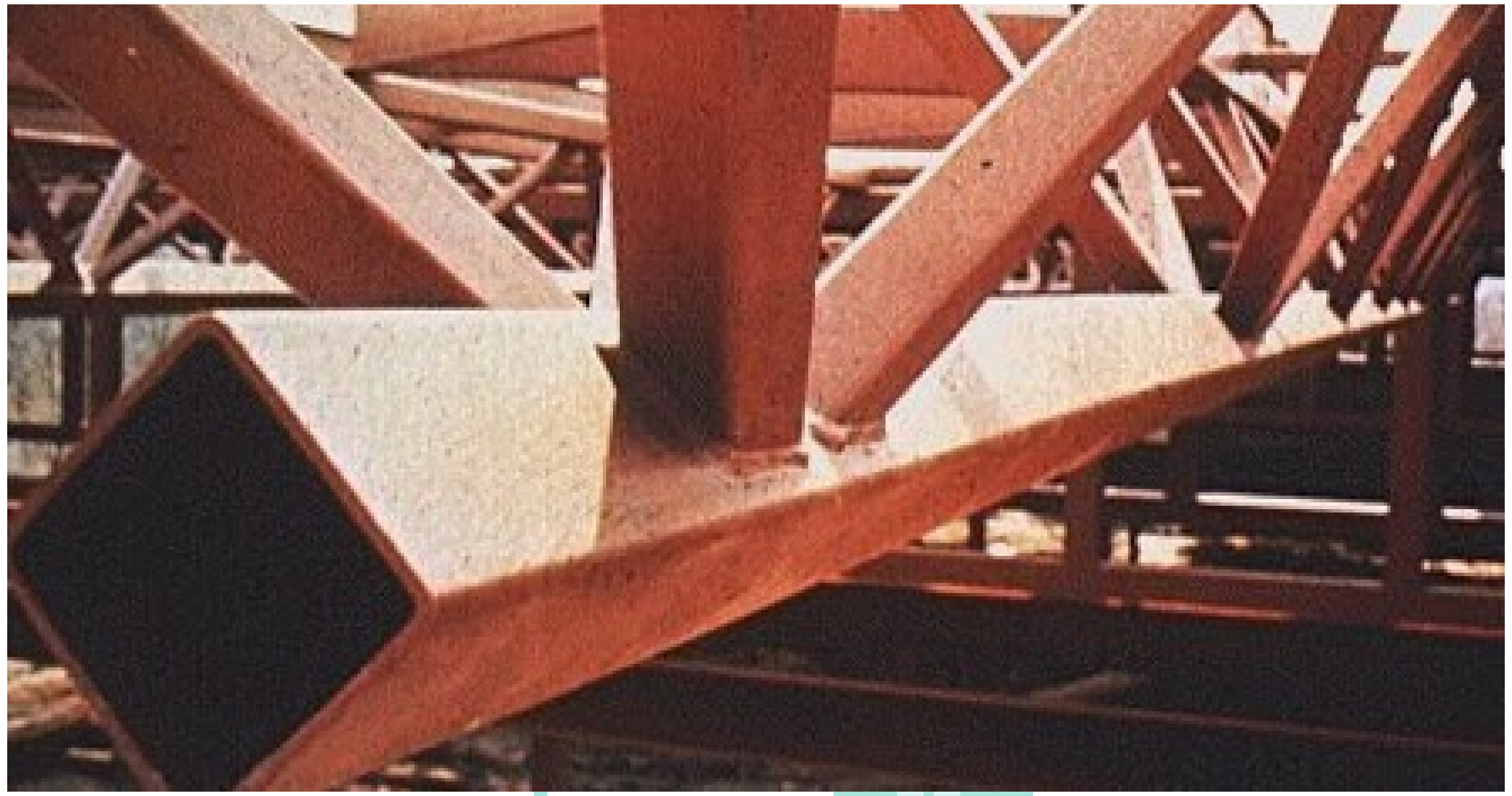
- k_b = minimum of a set of ratios (to be calculated based on edge and pitch distances)
- d = nominal bolt diameter
- t = thickness of the thinner of the connected plates
- f_u = ultimate tensile strength of the plate material



Welded Connections

Design Shear Strength of Weld

$$\text{Design Shear Strength} = \frac{f_u}{\sqrt{3}\,\gamma_{mw}} \times l_w \times t$$



Where:

- f_u = Ultimate tensile strength of weld material (N/mm²)
- γ_{mw} = Partial safety factor for weld (typically 1.25)
- l_w = Length of weld
- t = Throat thickness of weld = $0.7 \times s$
- s = Size of weld

Determine strength characteristics

1. Yielding of Gross Section

$$T_{dg} = \frac{A_g \cdot f_y}{\gamma_{mo}}$$

- A_g: Gross area of the section
- f_y: Yield strength of material
- γ_{mo}: Partial safety factor for material

2. Failure Due to Rupture of Critical Section

$$T_{dn} = \frac{0.9 \cdot A_{nc} \cdot f_u}{\gamma_{ml}} + \frac{\beta \cdot A_{go} \cdot f_y}{\gamma_{mo}}$$

- A_{nc}: Net area at the critical section
- A_{go}: Gross area of outstanding leg
- f_u: Ultimate tensile strength
- β: Reduction factor

Where:

$$\beta = 1.4 - 0.076 \cdot \left(\frac{w}{t}\right) \cdot \left(\frac{f_y}{f_u}\right) \cdot \left(\frac{b_c}{L_c}\right)$$

- w: Length of outstanding leg
- t: Thickness
- b_c: Width of connection
- L_c: Length of end connection

3. Failure Due to Block Shear

$$T_{db} = \frac{A_{vg} \cdot f_y}{\sqrt{3} \cdot \gamma_{mo}} + \frac{0.9 \cdot A_{tn} \cdot f_u}{\gamma_{ml}}$$

Or

$$T_{db} = \frac{0.9 \cdot A_{vn} \cdot f_u}{\sqrt{3} \cdot \gamma_{ml}} + \frac{A_{tg} \cdot f_y}{\gamma_{mo}}$$

Use the **lesser** of the two values.

- A_{vg}, A_{vn}: Shear area (gross and net)
- A_{tg}, A_{tn}: Tension area (gross and net)

THANK YOU