

Chapter 3 Tension Members

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Chapter 3.8 – Roof Trusses

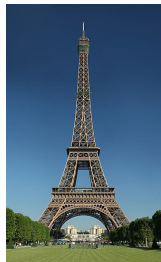
- Trusses usually function as the main supporting elements of roof systems where long spans are required.
- They are used when the cost and weight of a beam would be prohibitive.



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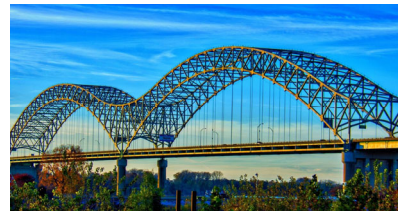
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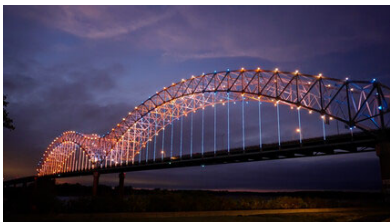
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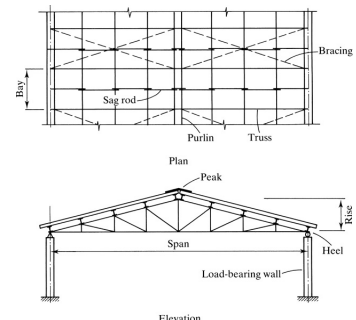
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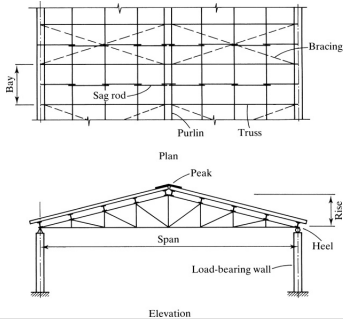
- Typical roof construction with trusses supported by load-bearing walls.



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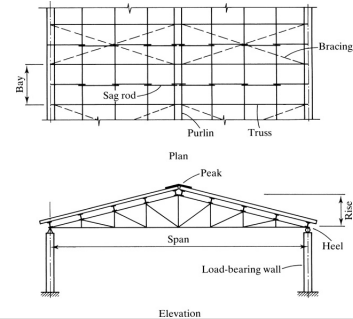
- The connection of the truss to the walls can usually be considered as pinned, and the other as roller-supported



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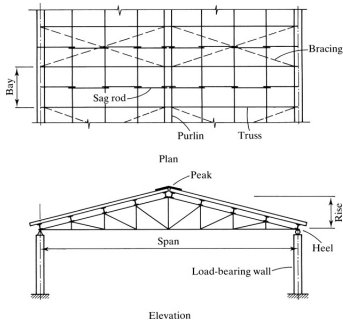
- The truss can be analyzed as an externally statically determinate structure.



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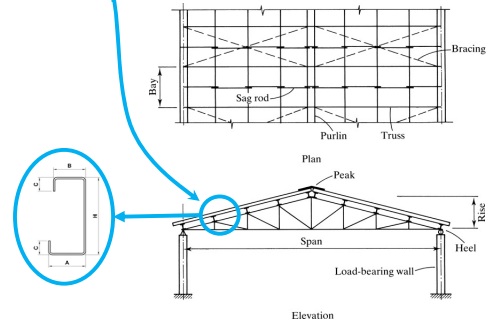
- The supporting walls can be reinforced concrete, concrete block, brick, or a combination of these materials.



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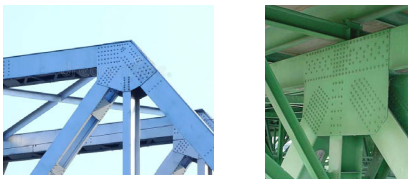
- The *purlins* transfer loads to the top chord of the truss, but they can also act as part of the bracing system.



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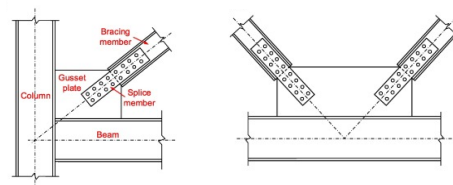
- Since chord members are continuous and joints are bolted or welded, it would seem to invalidate the usual assumption that the truss is pin-connected.
- Joint rigidity does introduce some bending moment into the members, but it is usually small and considered to be a secondary effect.



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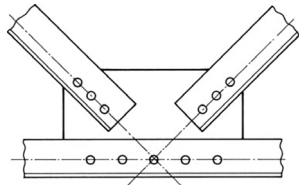
- The line of action of truss members in a properly detailed truss intersects at the *working point* at each joint.
- For a bolted truss, the *bolt lines* are the *working lines*, and in welded trusses, the *centroidal axes of the welds* are the working lines.



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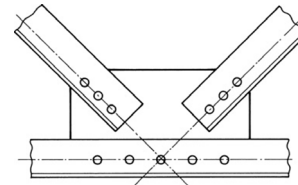
- In bolted trusses, **double-angle sections** are frequently used for both chord and web members.
- This design facilitates the connection of members meeting at a joint by permitting the use of a **single gusset plate**.



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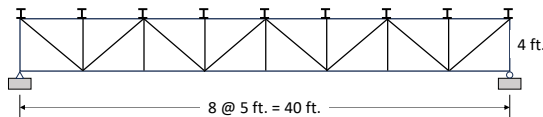
- Joint rigidity does introduce some **bending moment** into the members, but it is usually small and considered to be a secondary effect.
- **The usual practice is to ignore it.**



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- **Example 3.16:** Select a **structural tee** for the bottom chord of the Warren roof truss. The trusses are **welded** and spaced 30 ft apart. Use **A992 steel**.
- Assume that the bottom chord connection is made with **10-inch-long longitudinal welds** at the flange.



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- **Example 3.16:** Select a **structural tee** for the bottom chord of the Warren roof truss. The trusses are welded and spaced 30 ft apart. Use **A992 steel**.
- Assume that the bottom chord connection is made with **10-inch-long longitudinal welds** at the flange.

Purlins	M10 x 8
Snow	15 psf (horizontal projection)
Metal deck	3 psf
Roofing	5 psf
Insulation	2 psf

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Chapter 3.8 – Roof Trusses

- **Example 3.16:** Calculate the loads.

Snow load = 15 psf (40 ft)(30 ft) = 18,000 lb

Dead load = Deck + Roof + Insulation = 10 psf
 = 10 psf (40 ft)(30 ft) = 12,000 lb

Purlin weight = 8 plf (30 ft)(9 purlins) = 2,160 lb

Purlins	M10 x 8
Snow	15 psf (horizontal projection)
Metal deck	3 psf
Roofing	5 psf
Insulation	2 psf

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- **Example 3.16:** Estimate the truss as 10% of the other loads.

Truss Weight = 0.10(18,000 + 12,000 + 2,160)lb = 3,216 lb

Loads at an interior joint are:

$$D = \frac{12,000\text{ lb}}{8} + \frac{3,216\text{ lb}}{8} + 8\text{ plf}(30\text{ ft}) = 2,142\text{ lb}$$

$$S = \frac{18,000\text{ lb}}{8} = 2,250\text{ lb}$$

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➤ **Example 3.16:** Estimate the truss as 10% of the other loads

Truss Weight = $0.10(18,000 + 12,000 + 2,160)/b = 3,216/b$

Loads at an **exterior joint** are:

$$D = \frac{12,000/b}{2(8)} + \frac{3,216/b}{2(8)} + 8plf(30ft) = 1,191/b$$

$$S = \frac{18,000/b}{2(8)} = 1,125/b$$

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➤ **Example 3.16:** LFRD load combination

At an **interior joint**:

$$P_u = 1.2D + 1.0S = 1.2(2.142k) + 1.0(2.25k) = 4.50k$$

At an **exterior joint**:

$$P_u = 1.2D + 1.0S = 1.2(1.191k) + 1.0(1.125k) = 2.554k$$

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➤ **Example 3.16:** The bottom chord is designed by determining the force in each member of the bottom chord and selecting a cross-section to resist the largest force.

$$\sum M_E = 0 = F_u(4ft) + 4.5k(5 + 10 + 15)ft + 2.544(20ft) - 18.304k(20ft)$$

$$F_{IJ} = 45.05k$$

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➤ **Example 3.16:** For the gross section:

$$\text{Required } A_g = \frac{F_u}{0.90F_y} = \frac{45.05k}{0.90(50ksi)} = 1.001in^2$$

For the net section:

$$\text{Required } A_e = \frac{F_u}{0.75F_u} = \frac{45.05k}{0.75(65ksi)} = 0.924in^2$$

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➤ **Example 3.16:** Try an **MT5 x 4**, from **Table 1-9** in the Manual:

$$A = 1.19in^2 > 1.001in^2$$

$$w = \text{flange width} = b_f = 2.69in \quad \bar{x} = 1.52in.$$

$$U = \left(\frac{3l^2}{3l^2 + w^2} \right) \left(1 - \frac{\bar{x}}{l} \right) = \left(\frac{3(10in)^2}{3(10in)^2 + (2.29in)^2} \right) \left(1 - \frac{1.52in}{10in} \right)$$

$$= 0.8334$$

$$A_e = A_g U = 1.19in^2(0.8334) = 0.992in^2$$

$$A_e = 0.992in^2 > \text{required } A_e = 0.924in^2 \quad \text{OK}$$

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➤ **Example 3.16:** Assume that the bottom chord is braced at the panel points ($r_y = r_{min}$).

From **Table 1-9** in the Manual: $r_y = 0.502in$.

$$\frac{L}{r} = \frac{5ft(12in/ft)}{0.502in} = 119.5 < 300 \quad \text{OK}$$

An **MT5 x 4** satisfies all criteria.

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Let's work on some problems



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Any questions?



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