REINFORCED CONCRETE DESIGN 1

Analysis of Section (Flange)

by
Dr. Sharifah Maszura Syed Mohsin
Faculty of Civil Engineering and Earth Resources
maszura@ump.edu.my

Lesson Outcome

At the end of this lesson, students should be able to:

- Understand the definition of flanged beam.
- Determine the effective width of the flange.
- Understand the differences between various types of flanged beam.

Introduction

- Flanged beams – when reinforced concrete slabs are cast integrally with the supporting beams
- The slabs may contribute to the compressive strength of the beams during flexure.
- There are two types of flanged beam:

  a) T-beam

  b) L-beam

where the slab portion is called the flange of the T or L beam. The beam portion below the flange is term the web.

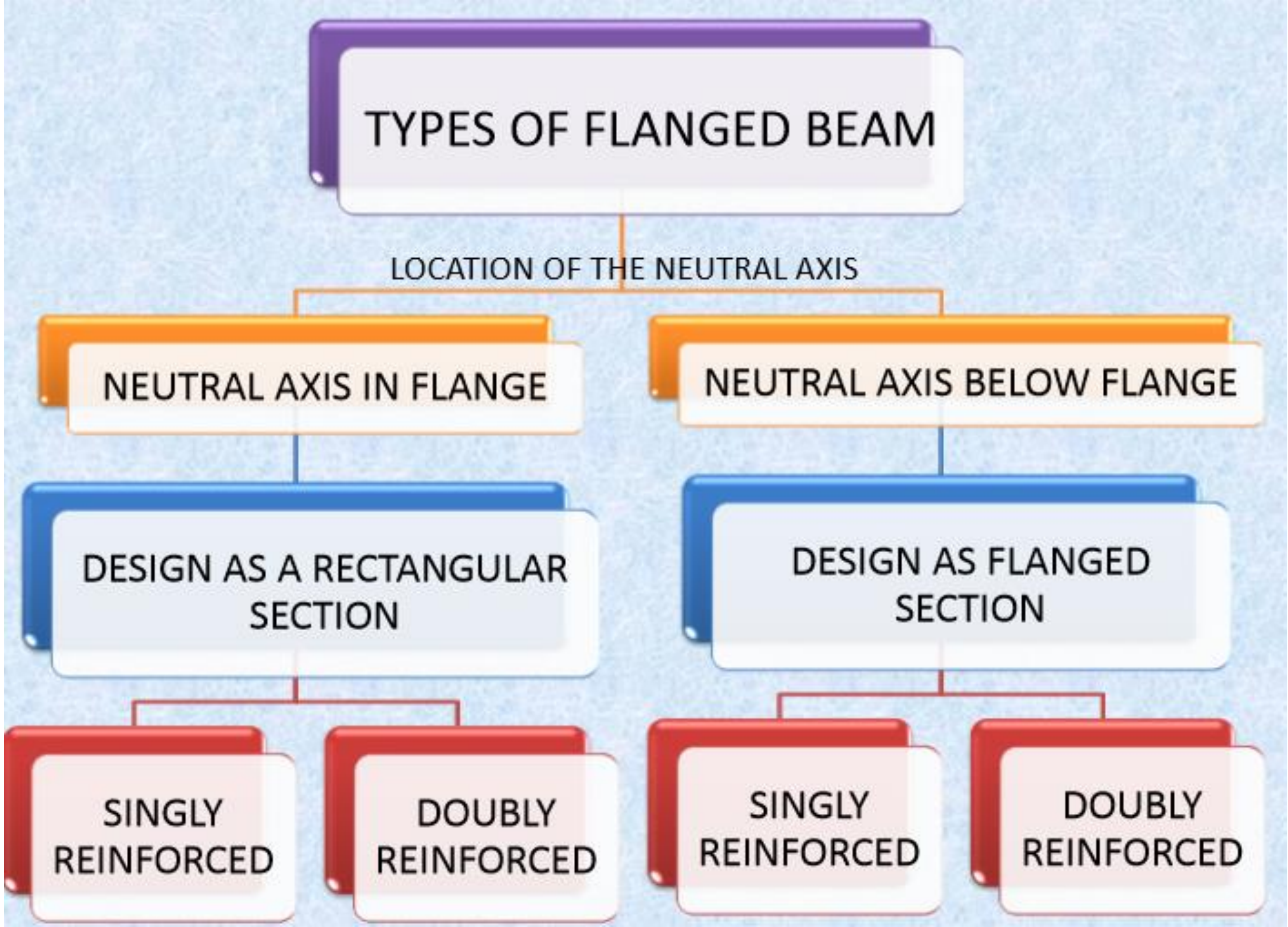
T - Beam

- Concrete beams are often cast integrally with slab forming a much stronger “T” shaped beam.
- These beams are very efficient as the slab portion carries the compressive loads & the reinforcing bars placed at the bottom of the stem carry the tension.

L - Beam

- The end beams which have slabs on one side only, acts as L-beams.
- In bending, the beams take tension forces while slab take compression forces.
- L-beams receive their loads from one side only, they are subjected to considerable amount of torsional moments.
- L-beams are subjected to bending moment, shear force and torsional moment.

Type of flanged beam

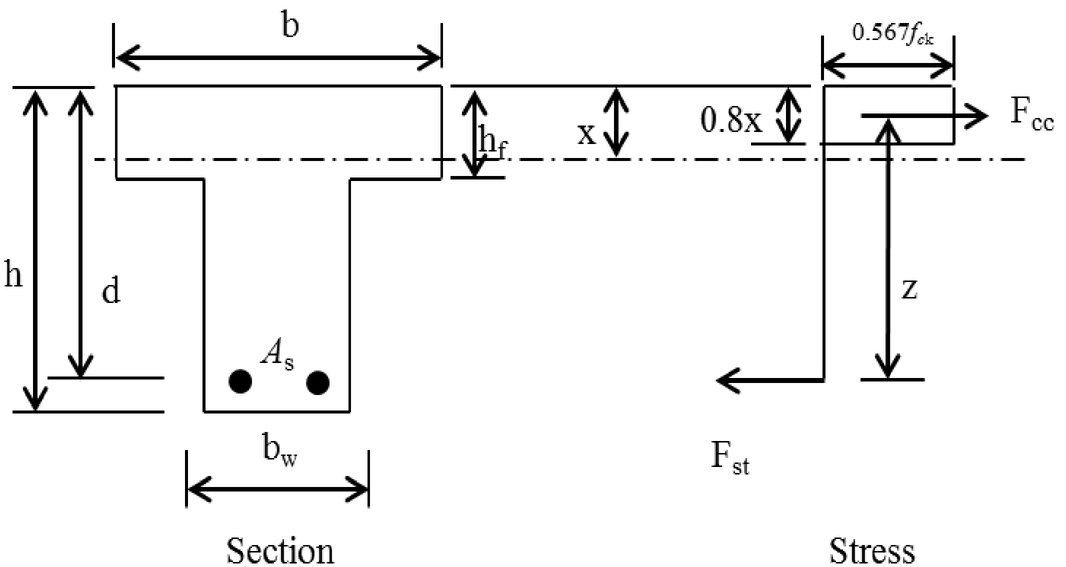


Effective width of flanges

- Effective width of flanges – needed to design the section
- This value is calculated based on the procedure recommended in Section 5.3.2: MS EN 1992-1-1:2010
- l_o – distance between the point of contraflexure along the beam is equal to total span of the beam for simply supported beam

Analysis of section: Neutral axis is within the flange

This section may be treated as a rectangular section of width, b.

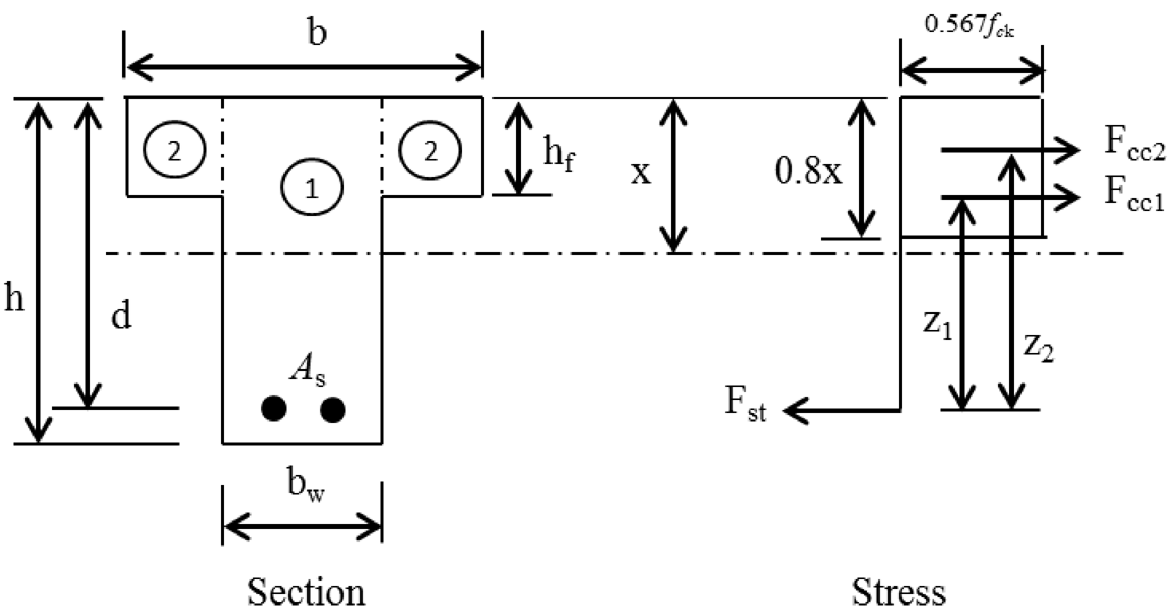


The moment of resistance of the section for the case when 0.8 = h_f is,

$$
\begin{aligned}
Mf &= F_{cc}.z \\
&= 0.567 f_{ck} b(0.8x).(d-0.4x) \\
&= 0.567 f_{ck} b h_f.(d-h_f/2)
\end{aligned}
$$

If $M > M_f$,
the neutral axis
lies in the web.

Neutral axis in the web: Singly reinforced



Forces,

$F_{cc1} = 0.56f_{ck}b_w(0.8x) = 0.454f_{ck}b_wx$

$F_{cc2} = 0.567f_{ck}(b-b_w)h_f$

$F_{st} = 0.87f_{yk}A_s$

Lever arms,

$z_1 = (d-0.4x)$

$z_2 = (d-0.5h_f)$

Neutral axis in the web: Singly reinforced

Moment of resistance,

$$M = F_{cc1} \cdot z_1 + F_{cc2} \cdot z_2$$
$$= (0.454 f_{ck} b x).(d-0.4x) + 0.567 f_{ck} (b-b_w) h_f (d-0.5h_f)$$

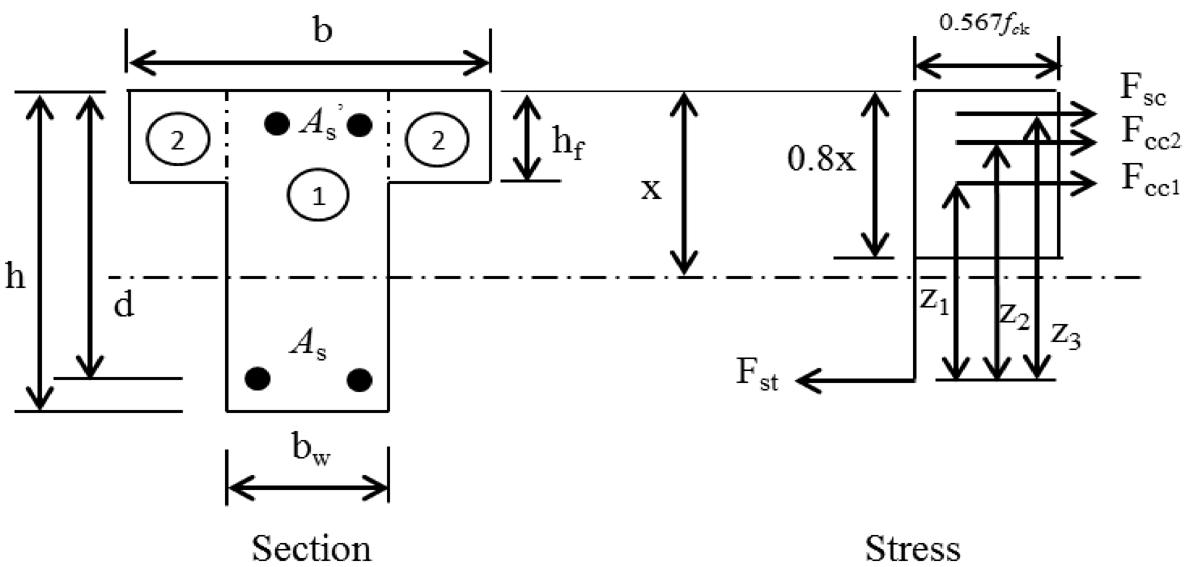
Ultimate moment of resistance of the section when

$$x = x_{bal} = 0.45d$$

$$M_{bal} = 0.454 f_{ck} b_w (0.45d).[d-0.4(0.45d)] + 0.567 f_{ck} (b-b_w) h_f (d-0.5h_f)$$
$$= 0.167 f_{ck} b_w d^2 + 0.567 f_{ck} (b-b_w) h_f (d-0.5h_f)$$

If the applied moment M is less than M_{bal} the compression reinforcement is not required.

Neutral axis in the web: Doubly reinforced



Forces,

$F_{cc1} = 0.567f_{ck}b_w(0.87x) = 0.454f_{ck}b_w x$

$F_{cc2} = 0.567f_{ck}(b-b_w)h_f$

$F_{sc} = 0.87f_{yk}A_s'$

$F_{st} = 0.87f_{yk}A_s$

Lever arms,

$z_1 = (d-0.4x)$

$z_2 = (d-0.5h_f)$

$z_3 = (d-d')$

Communitising Technology

Neutral axis in the web: Doubly reinforced

Moment of resistance

$$M = F_{cc1} \,.\, z_1 + F_{cc2} \,.\, z_2 + F_{sc} \,.\, z_3$$

$$= 0.454 f_{ck} b_w x \,(d-0.4x) + 0.567 f_{ck} \,(b-b_w) h_f \,(d-0.5h_f)$$

$$+ 0.87 f_{yk} A_{s'} \,(d-d')$$

When $x = 0.45d$

$$M = 0.167 f_{ck} b_w d^2 + 0.567 f_{ck} \,(b-b_w)\, h_f \,(d-h_f/2) +$$

$$0.87 f_{yk} A_s'. \,(d-d')$$

$$= M_{bal} + 0.87 f_{yk} As'. \,(d-d')$$

Examples and Tutorials