CIHAN UNIVERSITY

COLLEGE OF ENGINEERING

ARCHITECTURAL ENGINEERING DEP.

CONCRETE DESIGN I

CHAPTER 4

T – Beams

and Flanged Sections

Diyari B. Hussein

M.Sc. Structural Engineering

CHAPTER 3 T-BEAMS AND FLANGED SECTIONS

3.1 Introduction

Reinforced concrete floor systems normally consist of slabs and beams that are placed monolithically. As a result, the two parts act together to resist loads. In effect, the beams have extra widths at their tops, called *flanges*, and the resulting T-shaped beams are called *T beams*. The part of a T beam below the slab is referred to as the *web* or *stem*.

There is a problem involved in estimating how much of the slab acts as part of the beam. Should the flanges of a T beam be rather stocky and compact in cross section, bending stresses will be fairly uniformly distributed across the compression zone. If, however, the flanges are wide and thin, bending stresses will vary quite a bit across the flange due to shear deformations. The farther a particular part of the slab or flange is away from the stem, the smaller will be its bending stress.

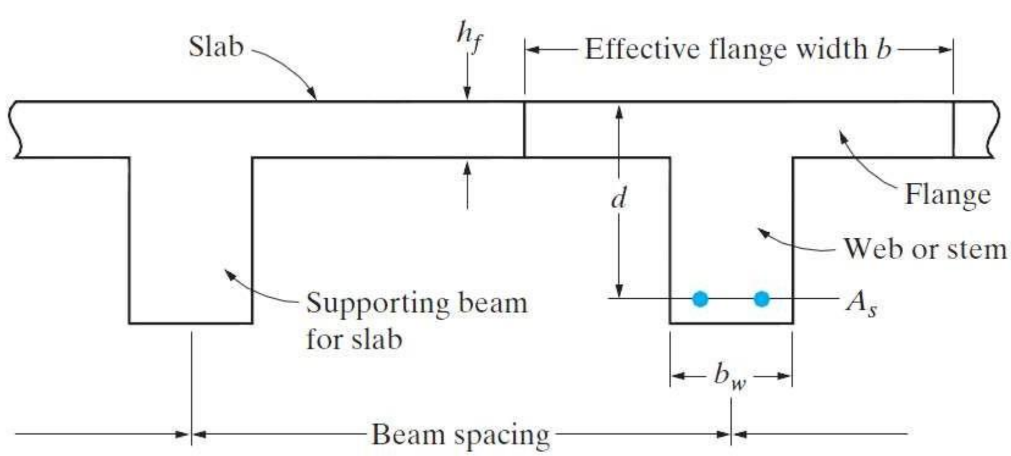
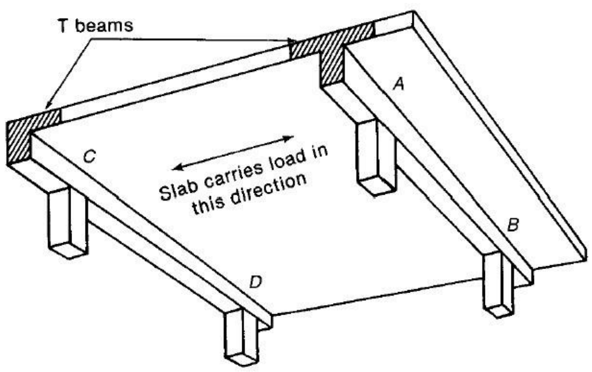
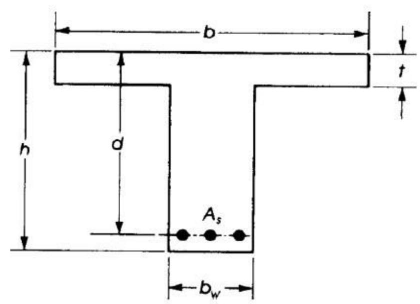


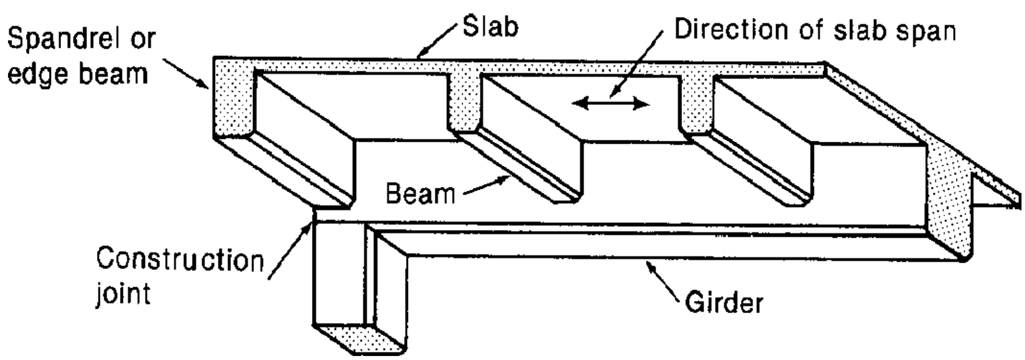
Figure 13 T-beams [4]

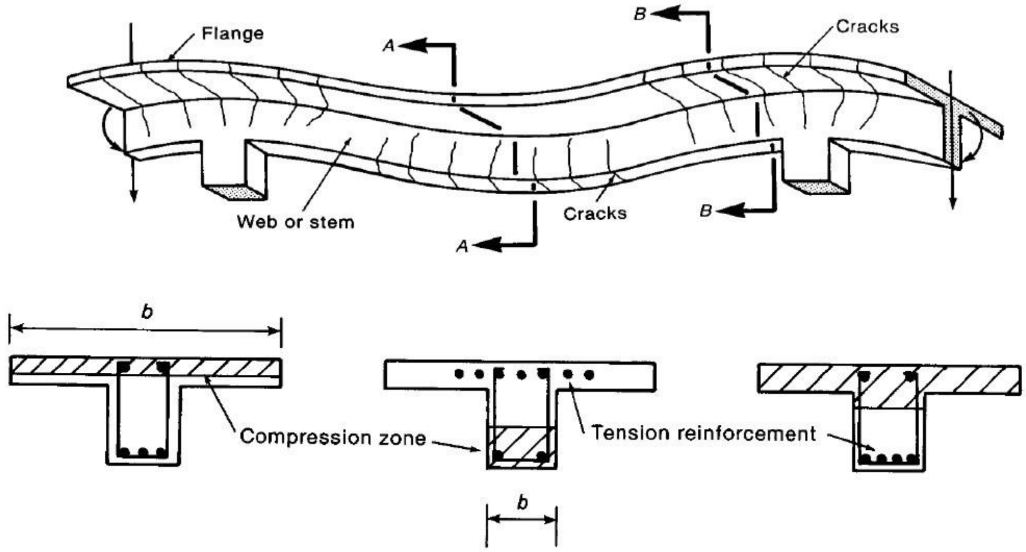
Instead of considering a varying stress distribution across the full width of the flange, the ACI Code (8.12.2) calls for a smaller width with an assumed uniform stress distribution for design purposes. The objective is to have the same total compression force in the reduced width that actually occurs in the full width with its varying stresses.

Real figure of T- beams









(b) Section A-A (rectangular compression zone).

(c) Section B-B (negative moment).

(d) Section A-A (T-shaped compression zone).

3.2 Effective Flange Width ACI318M-14:6.3.2.1

Flange location	**Effective overhanging flange width, beyond face of web**	
Each side of web	Least of:	$8h$
		$s_w/2$
		$\ell_n/8$
One side of web	Least of:	$6h$
		$s_w/2$
		$\ell_n/12$

Figures

3.3 Verification of T-beams

To check whether a T-shaped beam should be analyzed and designed as a T-beam or rectangular beam.

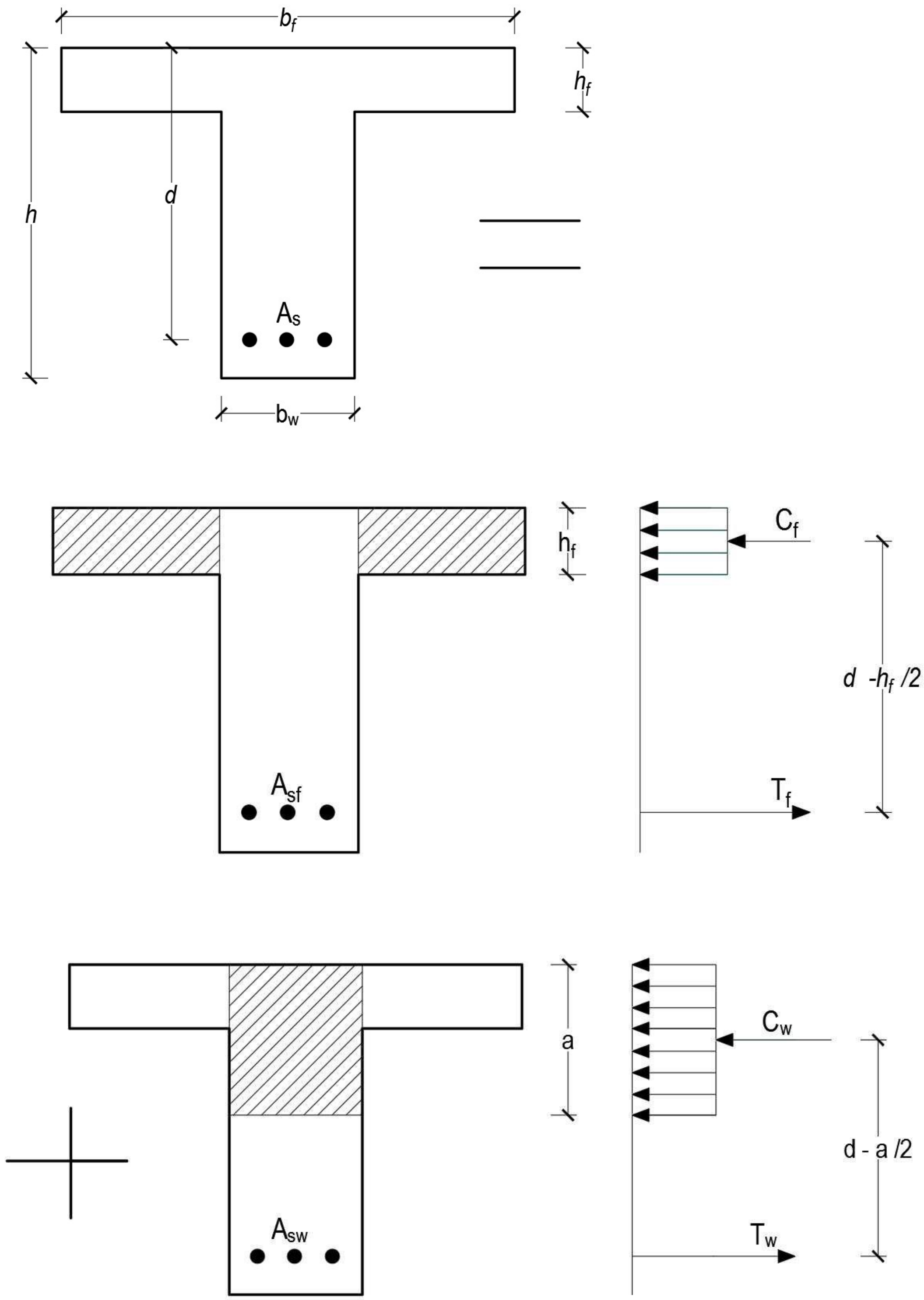
CASE 1: ($a < h_f$)

If depth of compression block is less than the flange depth ($a < h_f$) the beam should be designed as a rectangular beam (as illustrated in Chapter Two).

CASE TWO : ($a > h_f$)

If depth of compression block is more than the flange depth ($a > h_f$) the beam should be designed as a T-beam (The objective of this chapter)

3.4 Analysis of T-Beams (Case 2)



3.4.1 Nominal Moment of T-Beams

Flange Concrete & Reinforcement	Web Concrete and Reinforcement
$C_f = 0.85\, f_c'\, (b - b_w)\, h_f$	$A_s = A_{sf} + A_{sw}$
$T_f = A_{sf}\, f_y$	$A_{sw} = A_s - A_{sf}$
$T_f = C_f$	$T_w = C_w$
$A_{sf}\, f_y = 0.85\, f_c'\, (b - b_w)\, h_f$	$A_{sw}\, f_y = 0.85\, f_c'\, a\, b_w$
$A_{sf} = \dfrac{0.85\, f_c'\, (b - b_w)\, h_f}{f_y}$	$a = \dfrac{A_s\, f_y}{0.85\, f_c'\, b_w}$
$M_{nf} = A_{sf}\, f_y \left(d - \dfrac{h_f}{2}\right)$	$M_{nw} = A_{sw}\, f_y \left(d - \dfrac{a}{2}\right)$

$$\boldsymbol{M_n = M_{nf} + M_{nw}}$$

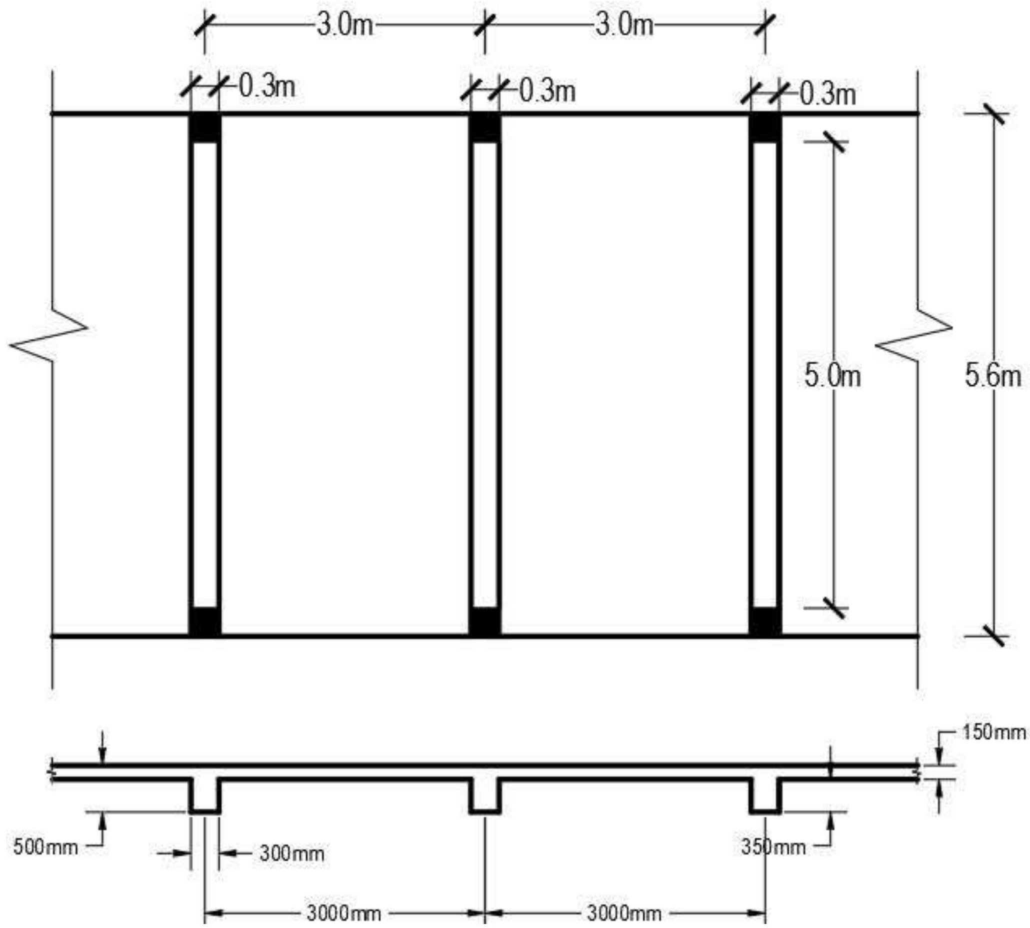
$$\boldsymbol{M_d = \phi\, M_n \geq M_u}$$

3.5 Examples

3.5.1 Example 1

Determine the positive design moment capacity of an interior beam shown in the plan: Reinforcement: 5 Φ20mm, fc'= 35 MPa, fy = 420 MPa.

SOLUTION



3.6 Example 2

Compute the design moment of the beam section shown in the figure.

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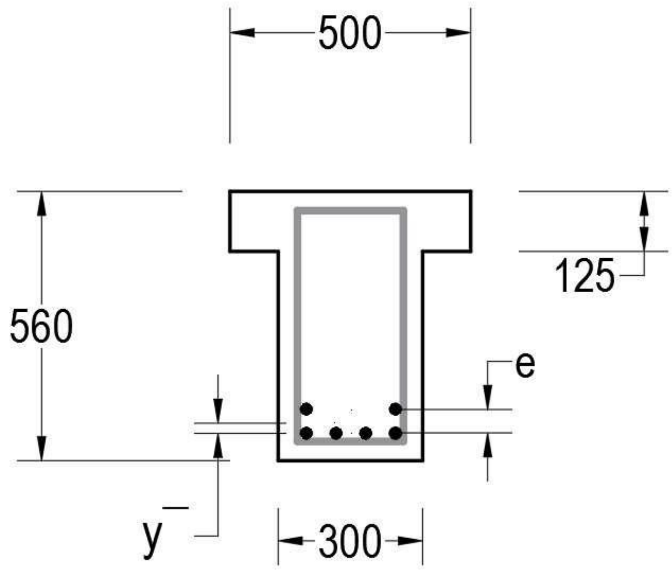
Reinforcement: 6 Φ25mm, fc'= 21 MPa, fy = 420 MPa, 10mm stirrups

SOLUTION

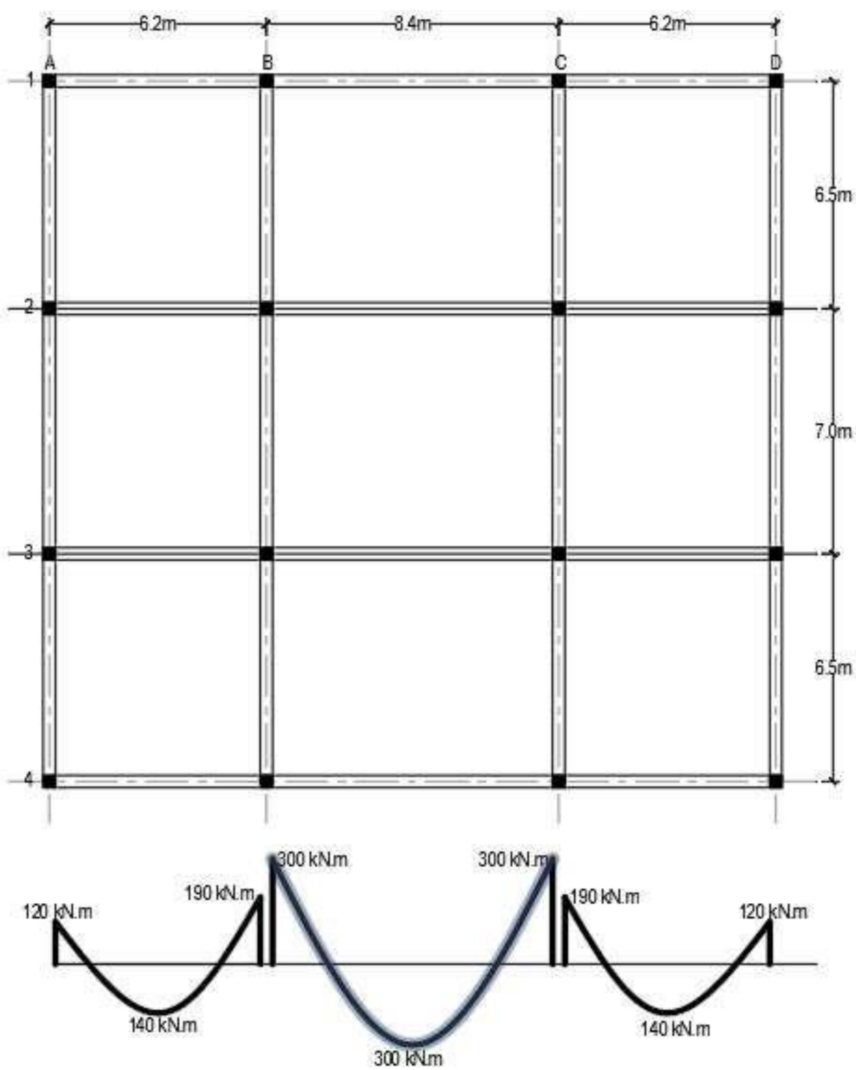


3.7 Example 3

Design beam BC in gridline (2) as shown in the following frame plan .

Given

- Slab thickness: 150mm ; Columns : 350mm x 350mm
- fc'= 25 MPa, fy = 420 MPa
- The moments values shown are at the face of the columns and include the self-weight.
- Assume reasonable values for any missing data



Solution

3.11 References

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