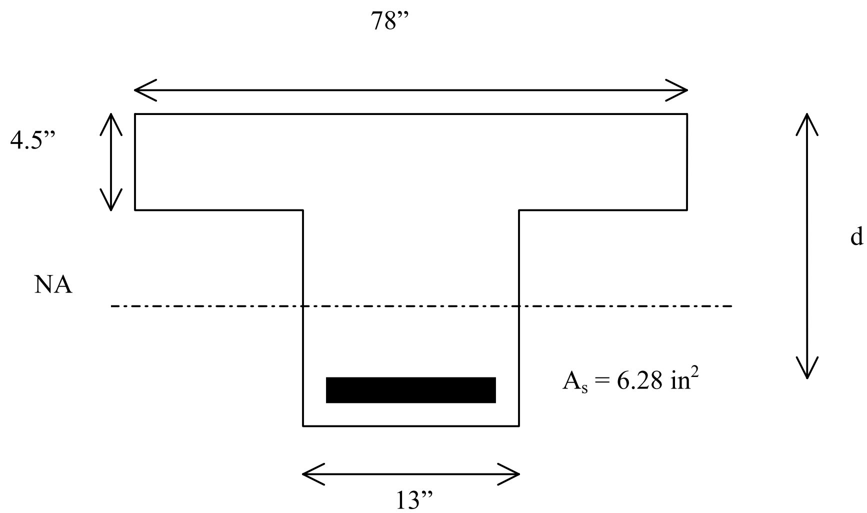
RECITATION 4

Example 1



Determine the M_u for the given section

(a) $b_E = L/4 = 26/4 \times 12 = 78”$
(b) $b_E = b_w + 16t = 13 + 16 \times 4.5 = 85”$
(c) $b_E = 12 \times 13 = 156”$

if a = 4.5” = t
$c = 0.85 \times f_c' \times b_E \times a = 0.85 \times 3000 \times 78 \times 4.5 = 895$ kips

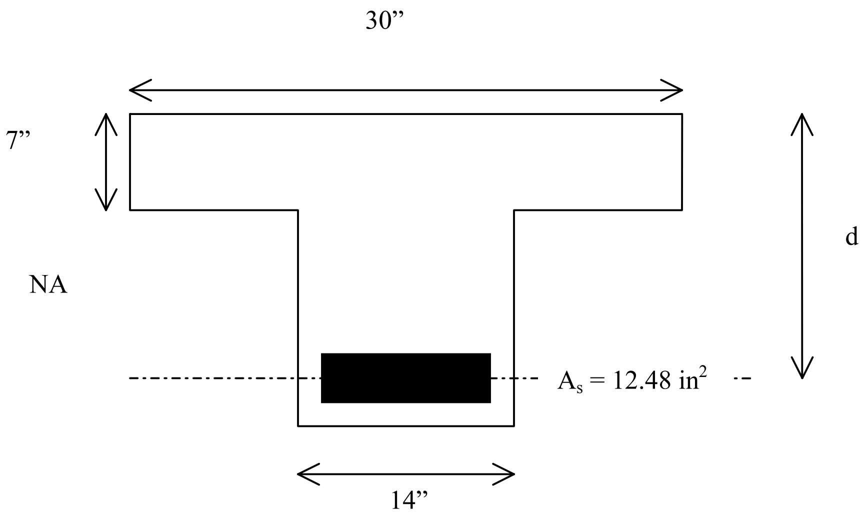
For equilibrium

$C = T = A_s f_y$
$A_s = 895{,}000/50{,}000 = 17.9\ in^2$ (required)

Steel reinforcement provided = $6.28\ in^2 < 17.9\ in^2$; Therefore, $a < t$
This means that we should design according to a rectangular beam (simply reinforced)

$M_n = T \times (d - a/2)$
$T = A_s f_y = 6.28 \times 50 = 314$ kips
$A = T / (0.85 \times f_c' \times b_E) = 314 / (0.85 \times 3 \times 78) = 1.58”$

Example 2 (Determine M_n with the given section (isolated))



$A_s = 12.48$ in^2
$b_E = 30”$
$b_w = 14”$
$d = 36”$
$t = 7’$
$f_c’ = 3000$ psi
$f_y = 50,000$ psi

Check:
$4b_w = 56” > b_E$; **OKAY!**
$½ b_w = 7” > t$; **OKAY!**

If $a = t = 7”$
$C = T \rightarrow 0.85f_c’b_Ea = 0.85\ f_c \times 30 \times 7 = 535.5 = A_sf_y$
$A_s = 10.71 < 12.48$ (provided);
Therefore, $a > t$ (i.e. Neutral axis is below the flange)

$C_1 = 0.85\ f_c’\ b_w\ a = 0.85 \times 3 \times 14 \times a = 35.7a$
$C_2 = 0.85\ f_c’\ (b_E – b_W)\ t = 0.85 \times 3 \times 930\text{-}14) \times 7 = 285.6$

$T = A_sf_y = 12.48 \times 50 = 624$
Therefore, $624 = 35.7a + 285.6$
$a = 9.48”$

$M_n = C_1(d\text{-}a/2) + C_2(d\text{-}t/2) = 35.7 \times 9.48 \times (36 – 9.48/2) + 285.6 \times (36 – 7/2) = 1155$ kips.ft

Example 3 (Design t-Beam with Given Load)

DL = 370 kips.ft b_E = 30"
LL = 520 kips.ft b_W = 14"
f_c' = 3000 psi   d = 36"
f_y = 50,000 psi   t = 7"

$M_u = 1.4DL + 1.7LL = 1.4 \times 370 + 1.7 \times 520 = 1402$ kips.ft
$M_n = M_u/\phi = 1402/0.9 = 1557.8 \approx 1560$ kips.ft

Find position of neutral axis (NA)

If a = t
T = C = 0.85 x 3 x 30 x 7 = 535 kips
$M_n = C(d - a/2) = 535(36 - 7/2) = 1450$ kips.ft < 1560 (required),

Therefore, a>t

$C_1 = 0.85 \times 3 \times 14 \times a = 35.7a$
$C_2 = 0.85 \times 3 \times (30\text{-}14) \times 7 = 285.6$

∴, 1560 x 12 = 35.7.a.(36-a/2) + 285.6(36-35)
$18720 = 1285.2a - 17.85a^2 + 9282$
a = 8.3 in
x = 8.3 / 0.85 = 9.765

$T = 0.85f_c'b_wa + C_2 = 0.85 \times 3 \times 14 \times 8.3 + 285.6 = 582$ kips
$A_s = 582 / f_y = 11.64\ in^2$

$$a_b = 0.85\left(\frac{0.003}{0.003 + \frac{50}{29000}}\right) \times 36 = 19.4 in^2$$

$A_{s1b} = (0.85f_c'b_wa_b) / f_y = 13.85$

$A_{s2b} = (0.85f_c' (b_E - b_w)t) / f_y = 5.71$

Therefore, $A_{s,max} = 0.75 (A_{s1b} + A_{s2b}) = 14.7\ in^2 > 11.64\ in^2$;   **OKAY!!!**