Note Title 4/17/2007

HW #7 Due Today

HW #8 Due 4/24 3.8, 4.6, 4.10 Conc.

↓

Beam Design ϵ_t, ϕ, ϕM_n

Phone-a-thon Wed 5-7 301 Dupont

Senior Design Mon April 23

6-9 140 Smith

Beam Design

ϕM_n $\phi = 0.90$

$$R_n \geq \frac{M_u}{\phi b d^2}$$

$\rho <$ 0.005

$\epsilon_t = 0.005$ @ failure

$\rho < \rho_b$ $\rho_{0.00207}$

$\rho \leq 0.75 \rho_b$

$\phi M_n \geq M_u$

$M_R = R_n b d^2$ $R_n = f(f'_c, f_y, \rho)$

Practical Sizing Issues

$d/b \approx$ 1.5 to 2.0

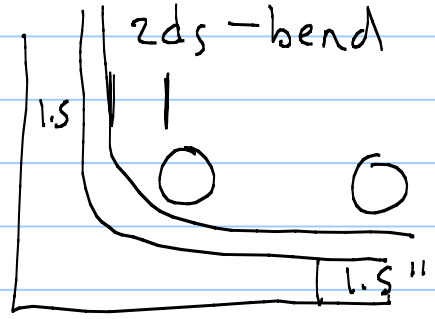
limit deflections $\rightarrow$ h_{min}

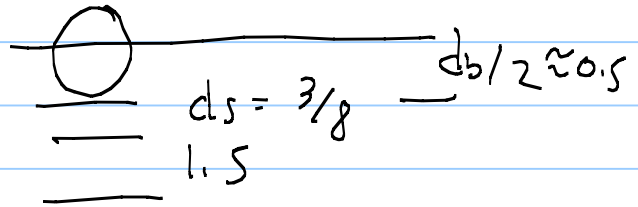
Table 4.1 h_{min} values

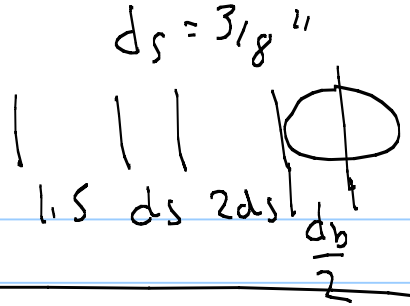
Ex. Beam Simply Supported $h_{min} = \ell/16$

w_{DL} → includes w_{bm} – beam weight

- Selection of Bars #7, 8, 9, 10, 11
- Cover = 1.5"







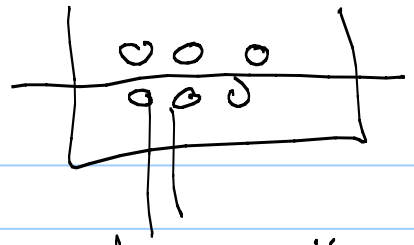


Table B.5 b_{min}

Ex 4.4

$f_y = 60$ ksi
$f'_c = 3$ ksi

$\rho = 0.18 f'_c / f_y \approx \frac{1}{2}(.75\rho_b)$

$\rho = 0.009$

$\rho < \rho_b$

$\rho < \rho_{0.005}$ $\phi = 0.90$

$\ell = 25$ ft

simply supported

$w_{DL} = 2$ k/ft , $w_{LL} = 3$ k/ft

① w_{bm}

$h_{min} = \ell/16 = \frac{12 \times 25'}{16} = 18.75''$

$h/b \approx 1.5 \quad b = 12.5''$

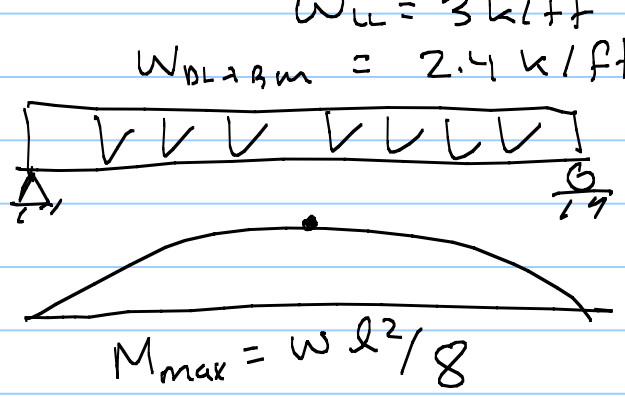
$13'' \times 19''$

$\left(\frac{13}{12}\right)\left(\frac{19}{12}\right)\left(150 \frac{lb}{ft^3}\right)$

$w_{bm} = 400 \text{ lb/ft}$ $= 257 \text{ lb/ft}$

$= 0.4 \text{ k/ft}$

② M_u



$M_u = w_u \ell^2/8$

$w_u = 7.68$ k/ft

$w_u = (1.2)\left(2.4 \frac{k}{ft}\right) + (1.6)\left(3.0 \frac{k}{ft}\right)$

$$M_u = (7.68\ k/ft)(25\ ft)^2/8 = \underline{600\ ft\text{-}k}$$

$$R_n \geq \frac{M_u}{\phi b d^2} \qquad \phi = 0.90$$

$$R_n = \rho f_y \left[1 - \frac{1}{1.7}\frac{\rho f_y}{f'_c}\right] \qquad \rho = 0.009$$

$$= (0.009)(60)\left[1 - \frac{1}{1.7}\frac{(0.009)(60)}{(3)}\right]$$

$$R_n = 0.4828\ k$$

4821b $\quad 0.4828\ k \geq \dfrac{600\ ft\text{-}k\ (12)(}{(0.9)\ bd^2}$

$$bd^2 = 16,577 \qquad d = 1.5b$$

	b	d	d/b	h ≈ d + 2.5
	16	32.19	2	
→	18	30.35	1.7	32.35
	20	20.79	1	

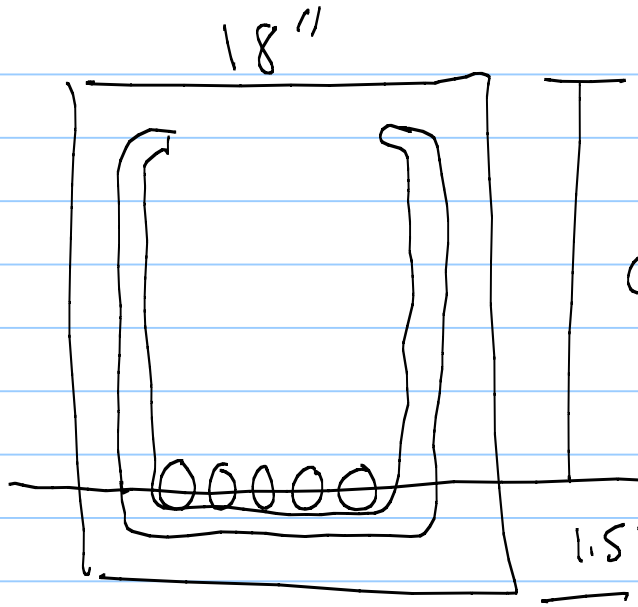
18 × 33 beam $\left(\frac{18}{12}\right)\left(\frac{33}{12}\right)(150) = 619$ lb/ft

$A_s = \rho bd = (0.009)(18)(30.5) = 4.94\ in^2$

5 #9 bars $A_s = 5.0\ in^2 \rightarrow$ $b_{min} = 14.3''$

Check $b_{min} < 18''$ ✓

Sketch



#3 stirrup

5#9

$d = 30.561''$

$1.5'' + 3/8 + \frac{1.128}{2} = 2.439''$

$wl^2/8$

$$\phi M_n \geq M_u = \frac{\left[1.2(2+0.619) + 1.6(3)\right](25)^2}{8}$$

$$M_u = 620.5 \text{ ft-k}$$

ϕM_n $C=T$ solve for a

$$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{(5)(60)}{(.0.85)(3)(18)} = 6.54''$$

$$\phi M_n = (0.9) A_s f_y \left(d - a/2\right)$$

$$= (0.9)(5.0)(60)\left[30.561 - \frac{6.54}{2}\right]$$

$$= 7,369 \text{ in-k}$$

$$= 614 \text{ ft-k} \not\geq 620.5 \text{ ft-k} \times$$

$18 \times 34''$ $\quad d = 31.561''$ $\quad M_u = 622.3$

$\phi M_n = 636.6$ ✓

$$\rho_{act} = \frac{5}{(18)(31.56)} = 0.0088$$

$$\rho_{min} = \frac{200}{f_y} \approx 0.0033$$

$f'_c = 3$

$f_y = 60$

$\rho_{bal} = 0.0214$

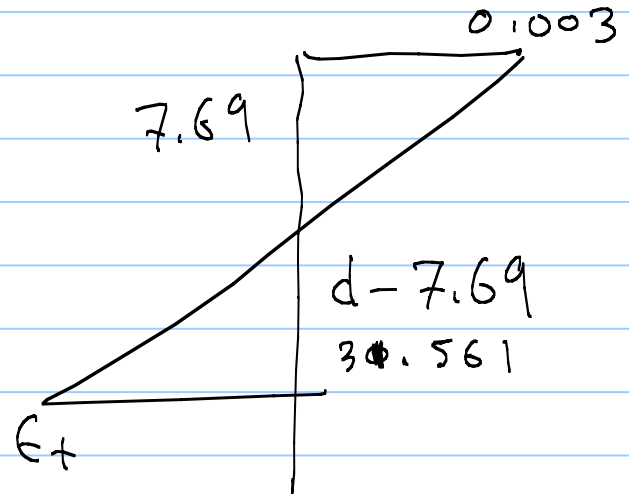
$\rho_{.005} = 0.0136$

$\rho_{min} = 0.0033$ ✓

$\rho_{min} < \rho < \rho_{0.005}$ ✓

$\phi = 0.90$ ✓

find ϵ_t, ϕ

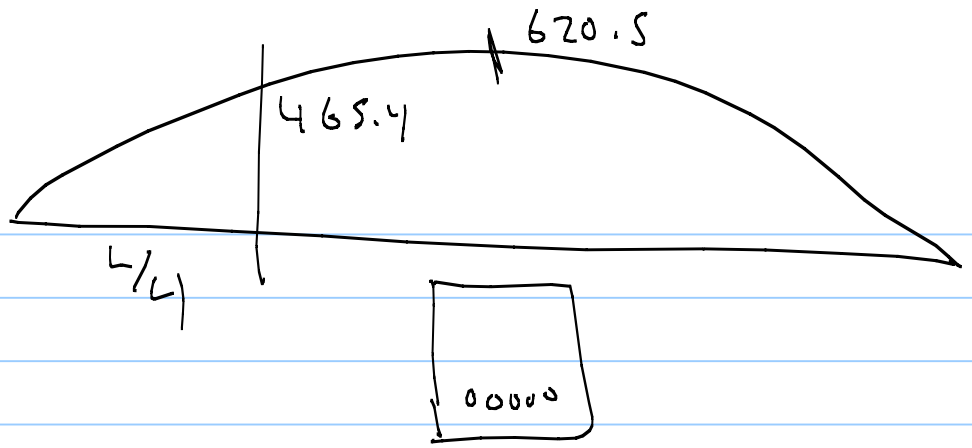


$a = 6.54$ $\quad c = a/\beta_1 = 7.69$ ($\beta_1 = .85$)

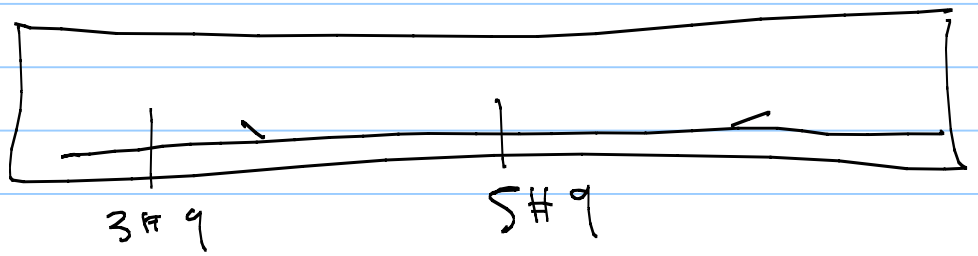
$$\frac{\epsilon_t}{31.561 - 7.69} = \frac{0.003}{7.69}$$

$\epsilon_t = 0.0093 \geq 0.00207 = \epsilon_y$

> 0.005 $\quad \phi = 0.9$



$$\frac{465}{620.5} = 0.75$$



$75\%\,(5.00) = 3.75\,in^2$ 3#9

4#9