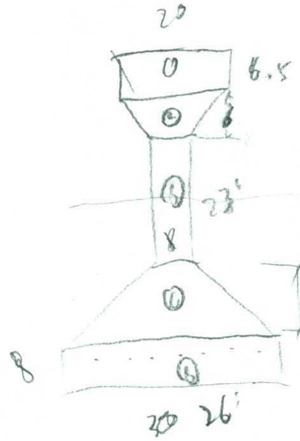
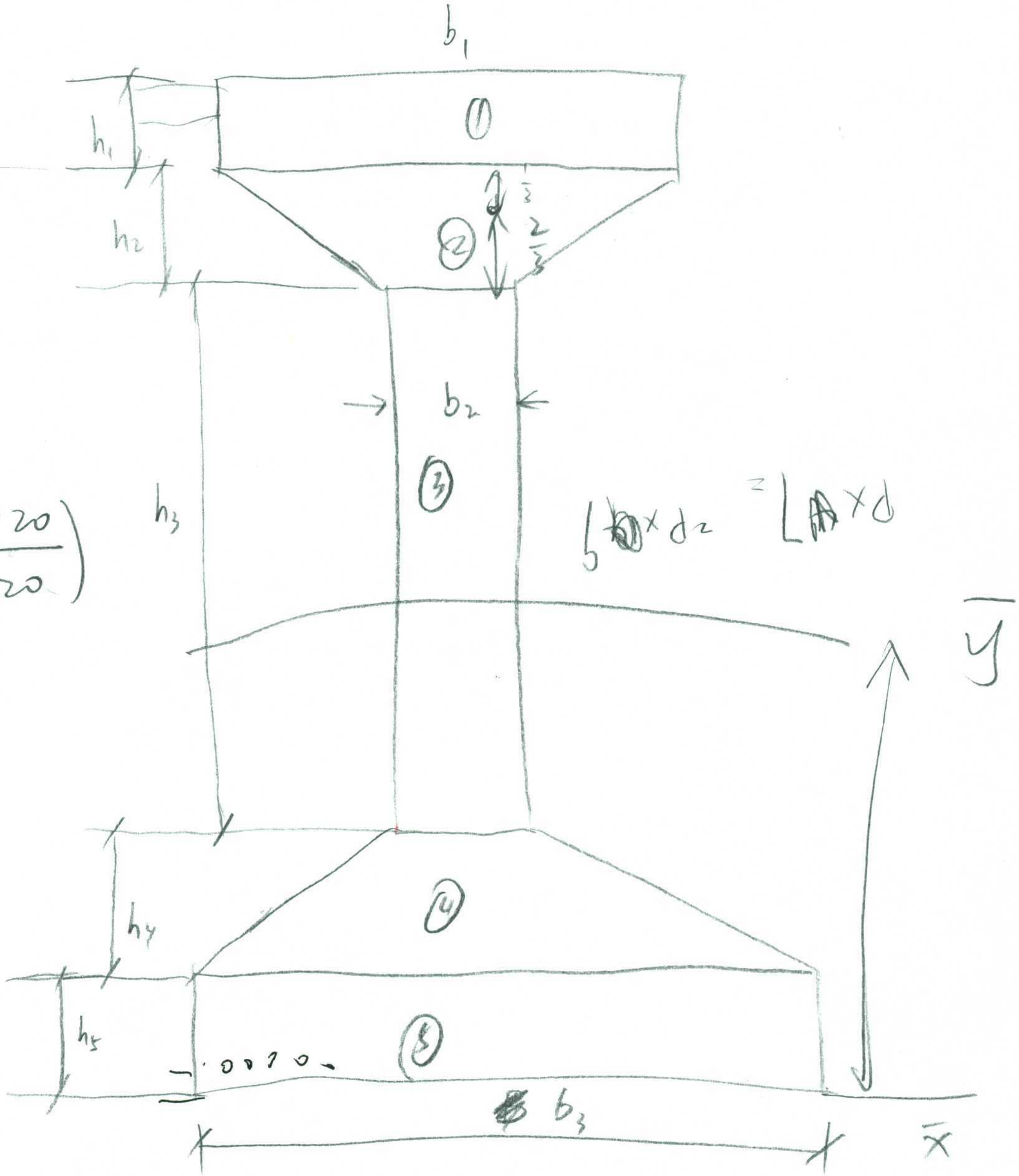
0.2 12



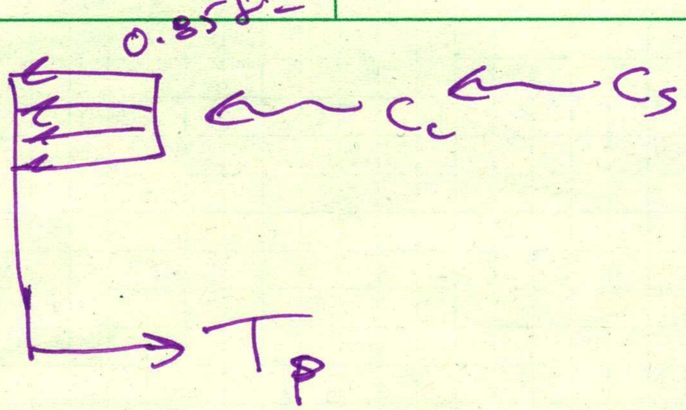


$\int A \times d_2 = \int A \times d$

2. $6 - \frac{6}{3}\left(\frac{2\times 8+20}{8+20}\right)$

$\frac{1}{2}$

$\frac{9}{3}\left(\frac{2\times 8+26}{8+26}\right)$



$$C_c + C_s - T_p = 0$$

$$C_c = 0.85 f'_c \cdot \beta \cdot c \cdot b$$

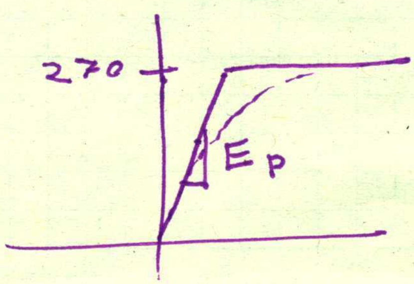
$$\cancel{C_s =}$$

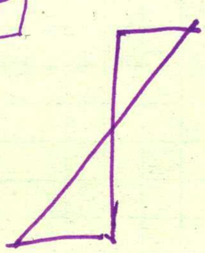
$$0.85 f'_c \beta \cdot c \cdot b + C_s - T_p = 0$$

$$c = \frac{T_p - C_s}{0.85 f'_c \cdot \beta \cdot b}$$

$$f_p = E_p \cdot \varepsilon_p$$

$$T_p = f_p \cdot A_p = \overset{f_p \cdot A_p}{\boxed{E_p \cdot \varepsilon_p \cdot A_p}} \le 270\,\text{ksi}\,(A_p)$$

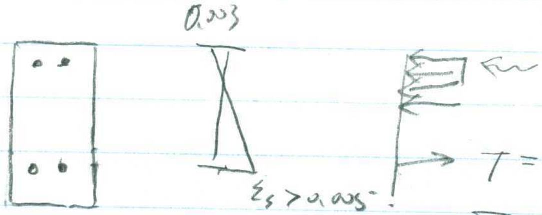




$\boxed{M_n > M_u}$

2 kip.

Ultimate



$T = f_{pu} \cdot A_p$

$T = C_c + C_s$

$M = C_c \cdot\cdot\cdot\ C_s$

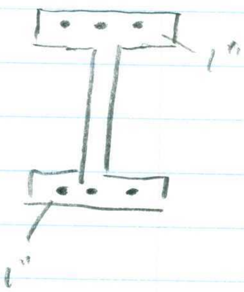
release $< \sigma_{top} \le 7.5\sqrt{f_c'}$

cracking $< \sigma_{bot} \le 7.5\sqrt{f_c'}$

$M_{cr} > 120$ kip ft

ultimate $\leftarrow$ $M_u < 273$ k ft.

f'c from mixture



$f_{ci}' =$

$f_c' =$ 9 4000 − 12000 psi

$f_p = 270$ ksi.

Service = 20k

factored = 1.6 × 20k = 32k < 39 k

$M_n \le 19.5 \times 7 = 137$ k·ft

8 β

4 $C_c = 0.85 f'_c \cdot \beta \cdot c \cdot b$

5 $C_s = \underbrace{\varepsilon'_s \cdot E_s}_{f_s} \cdot A'_s \le f_y \cdot A'_s$

7 $T_p = \phi\, \cancel{f_{pu}\, A_{ps}}$ → assume tension control

Create column. ← $T = \boxed{f_{ps}} A_{ps}$

Ramberg-Os good relationship.

$T_p = C_s + C_c$

$\frac{c}{d} = \frac{0.003}{\varepsilon_{ps} + 0.003}$

$M_n = T \cdot (d - \frac{a}{2})$

iteration

3 ✓ $\cancel{c = d \cdot \left(\frac{0.003}{\varepsilon_{ps} + 0.003}\right)}$ = $\boxed{\frac{T_p - C_s}{0.85 f'_c \beta \cdot b}}$ = C.

$\frac{\varepsilon'_s}{c - d'} = \frac{0.003}{c}$

1 ✓ $\varepsilon'_s = 0.003 \left(\frac{c - d'}{c}\right)$

2 ✓ $\varepsilon_{ps} = 0.003 \left(\frac{d - c}{c}\right)$

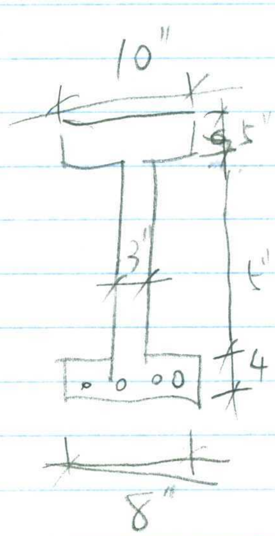
$M_n =$

Dec 2: spreedsheets 100%

Dec 8: Decision 6-8 options

Dec 10: response verify

Dec 15: Final Design



start point

~~A_{ps}~~ ~~ϕ~~ area of strand

A_{ps}

~~$f_r = 7.5\sqrt{f'_c}$~~

11/15 $d_s = 0$. do it at the end.

#5 as many as ~~we can~~ possible in compression

$f'_c > f'_{ci}$ but $9 \le f'_c \le 12$

~~200 ksi~~ $\rightarrow f_{pi}$ = ~~187 ksi~~ ~~200 small~~ ~~195 - 200~~

174 ksi

L = 18'

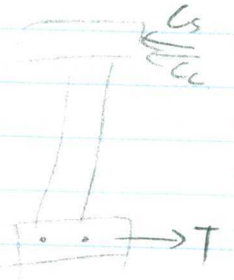
don't need S_v & S_h.

$f_{p,cr} = 200\,ksi$ $f_{pu} = 270\,ksi$

losses = 18 ✓

response: bot: (4)

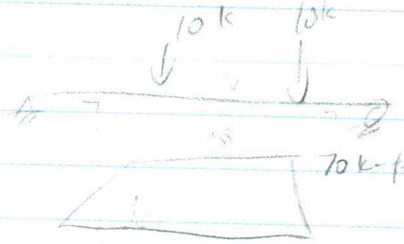
Top: (4)



~~stress at release~~:

$F_0 = F_p = f_{pi} = \underline{174\ ksi} \times A'_{ps} \times \#$ of strand

service

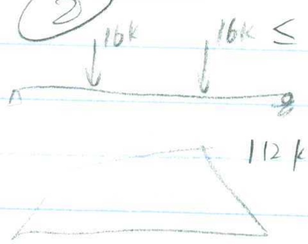


70 k-ft = $M_{service}$ (1)

Req. no cracking ≤ service

factor ~~factored~~

(2)



$\le P \le \underline{19.5^k}$

112 k-ft $M_{factored}$

Req: no fail ≤ factored

$\phi = 1.0$

~~LL~~ DL = 1.0

$$(23.508-1.08) \qquad (52.5-26.508)$$

$$M_{cr} = \left(750 + \frac{P_{cr}\ (\text{kip})}{A_{tr}\ (\text{in}^2)} + \frac{f_p \times e \times c\ (\text{kip-in}^2)}{I_{tr}} - \frac{M_D \times c\ (\text{kip-in}^2)}{I_{tr}} \right) \times \frac{I_{tr}}{c}$$

11/29 cover letter. ~~for~~ To PCI.

labor work 18x27 = ~~27~~

20 ft. $3

Concret $80 / yd³.

$500 for shipping.

gain chart. start the end 提前排程.

ship. test trouble shoot. buy equipment. final design.

write, the report ; video.

deflection weight cost.

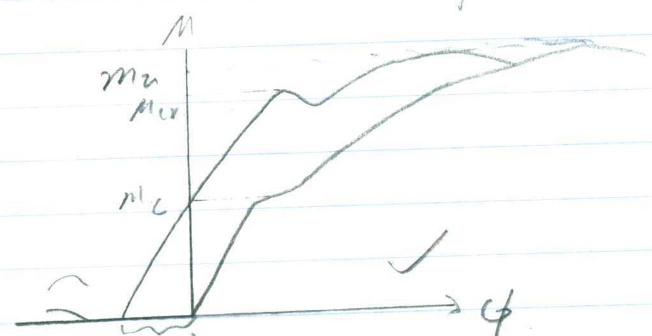
accuracy: $\frac{1}{8}$ in

ACI CH 7

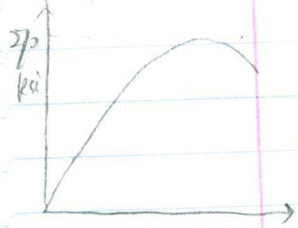
pg4 7.7.2

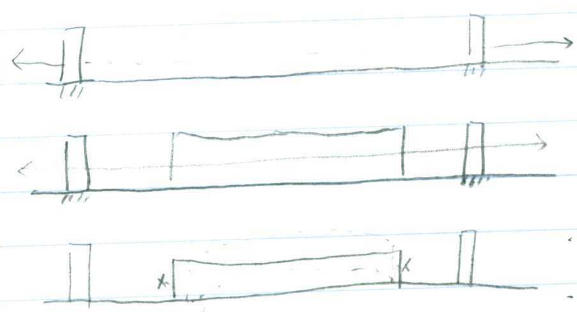
Not too much Comp at bottom

Not too much tension at top



小傾角.
使弯作弧形





· elastic losses.

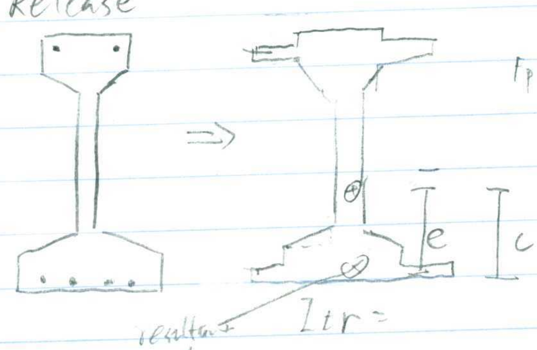
· creep losses.

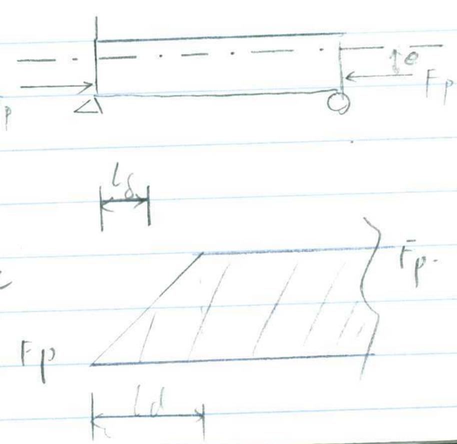
· shrink losses

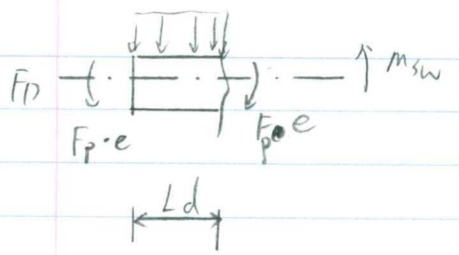
170ksi - 167ksi left in the concrete.

ACI code 18.6

Release

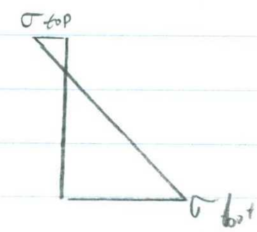






$$\sigma_{top} = \frac{-F_p}{A} + \frac{(F_p \cdot e)\, I}{I} - \frac{M_{sw}\, C_{top}}{I}$$

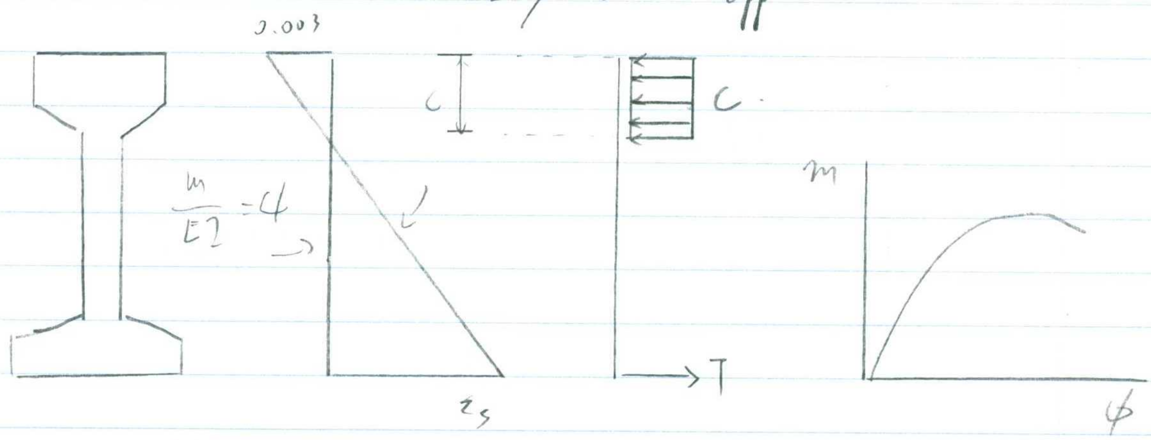
$$\sigma_{bot} = \frac{-F_p}{A} - \frac{F_p \cdot e \cdot I}{I} + \frac{M_{sw} \cdot C_{top}}{I}$$



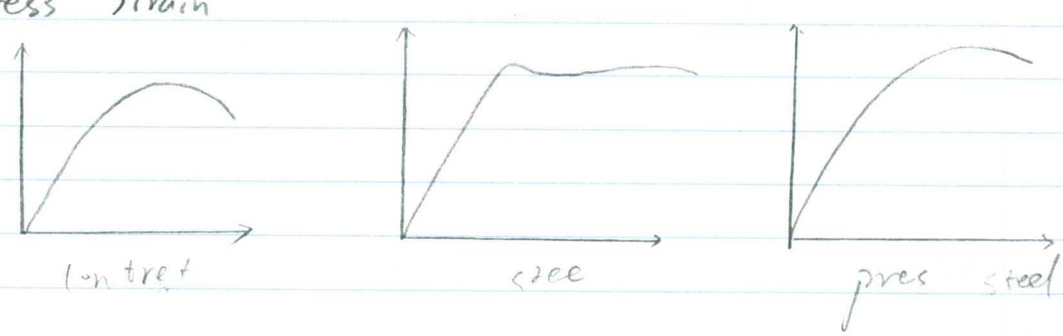
ACI 12.10

ACI p290 18.4.1

Layer section approach.



Stress Strain



Respond 2000 Software

base curve reference

Go

User defined shape (2 first then user).

Go through requirement . . . spreadsheet

concrete decision matrix

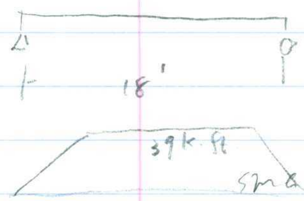
weight strongest / smallest.

more pres – lower deflection

– highest strain concrete (good?)

2000

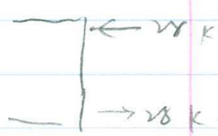
Assume get 12000psi.

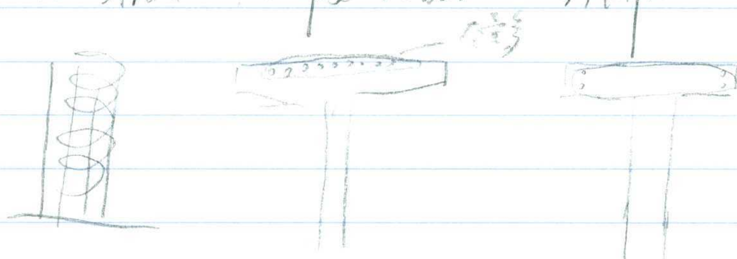


by deflection

smaller depth as possible.

One strain couple rebar → 39 kip.

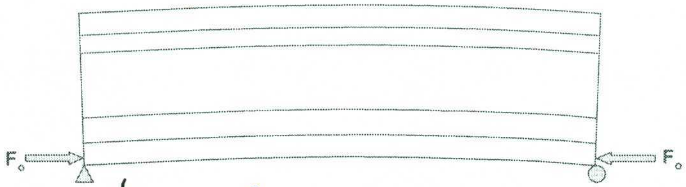


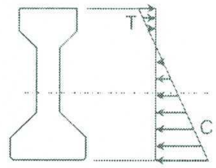


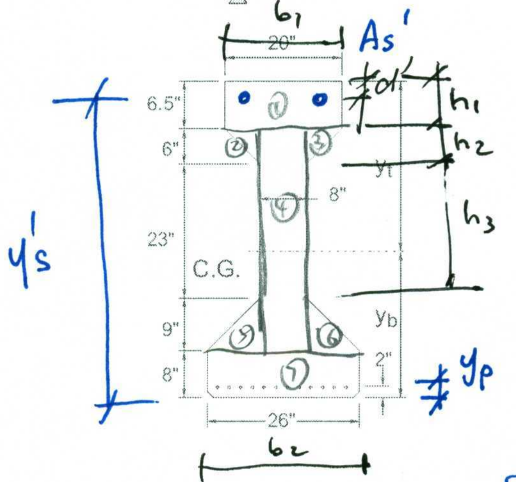
3 design alternative

Matrix

Explain why do we do that.







Material Properties

$f'_{ci} = 8.1\text{ksi}$ ✓

$f_y = 60\text{ksi}$ ✓

$E_s = 29000\text{ksi}$ ✓

$A'_s = 2.38\text{in}^2$

$y'_s := 50\text{in}$

$A_{ps} = 0.153\text{in}^2$ (1 strand)

$y_p := 2\text{in}$

$E_{ci} = 5703\text{ksi}$ (measured)

$$\boxed{E_{ci} = 57\ldots\sqrt{f_{ci}'}}$$

E 57

Section Properties (Block-Out)

$L_o = 20\text{ft}$

$H = 52.5\text{in}$

$y_b = 23.62\text{in}$

$A_g = 758.4\text{in}^2$

$I_g = 235067\text{in}^4$

$F_o = 312\text{kip}$ — ?

$d_b := 0.5\text{in}$

$A_{total} = 759.0$

$A'_{tr} = 767.9$

$= 8.9$

Transfer Length

$$f_{se} := \frac{F_o - 10\text{kip}}{12 \cdot A_{ps}} \qquad f_{se} = 164.5\,\text{ksi}$$

$$l_d := \frac{f_{se}}{3\text{ksi}} \cdot d_b \qquad l_d = 27\,\text{in}$$

f_{ci}' specified compressive strength of concrete @ release

A_{ps} area of prestressing steel in flexural tension zone.

$\frac{2}{3} \times 6 + 23 + 9 + 8$

~~$6 - \frac{1}{3} \times 6$~~

Transformed Section Properties

$$n := \frac{E_s}{E_{ci}} \qquad n = 5.1$$

$$y_{b.tr} := \frac{A_g \cdot y_b + (n-1)\cdot\left(A'_s \cdot y'_s + 12A_{ps}\cdot y_p\right)}{A_g + (n-1)\cdot\left(A'_s + 12A_{ps}\right)} \qquad y_{b.tr} = 23.742\,\text{in}$$

$$A_{tr} := A_g + (n-1)\cdot\left(A'_s + 12A_{ps}\right) \qquad A_{tr} = 775.6\,\text{in}^2$$

$$I_{tr} := I_g + A_g\cdot\left(y_b - y_{b.tr}\right)^2 + (n-1)\cdot\left[A'_s\cdot\left(y'_s - y_{b.tr}\right)^2 + 12A_{ps}\cdot\left(y_p - y_{b.tr}\right)^2\right] \qquad I_{tr} = 245327\,\text{in}^4$$

Losses due to Elastic Shortening

AASHTO 9.16.2.1.2

losses

187 ksi

$$f_{cir} := \frac{F_o}{A_g} + \frac{F_o\cdot\left(y_b - y_p\right)^2}{I_g} \qquad f_{cir} = 1.03\,\text{ksi}$$

$$\Delta f_{pES} := \frac{E_s}{E_{ci}}\cdot f_{cir} \qquad \Delta f_{pES} = 5.25\,\text{ksi}$$

$$\Delta F_{pES} := \Delta f_{pES}\cdot A_{ps}\cdot 12 \qquad \Delta F_{pES} = 9.6\,\text{kip}$$

Dead Load Moment due to Beam Selfweight

$$\omega_D := 0.145\,\frac{\text{kip}}{\text{ft}^3}\cdot A_g \qquad M_D := \frac{\omega_D \cdot l_d \cdot L_o}{2} - \frac{\omega_D \cdot l_d^{\,2}}{2}$$

KS

$k/in^2/in^2$

$$\omega_D = 0.764\,\frac{\text{kip}}{\text{ft}} \qquad M_D = 185\,\text{kip}\cdot\text{in}$$

Top Fiber Stress at Transfer

$$f_{top} := \frac{-\left(F_o - \Delta F_{pES}\right)}{A_{tr}} + \frac{\left(F_o - \Delta F_{pES}\right)\cdot\left(y_{b.tr} - y_p\right)\cdot\left(H - y_{b.tr}\right)}{I_{tr}} - \frac{M_D\cdot\left(H - y_{b.tr}\right)}{I_{tr}}$$

Tensile Strength Factor, $\quad \text{factor} := \dfrac{f_{top}}{\text{psi}\cdot\sqrt{\dfrac{f'_{ci}}{\text{psi}}}} \qquad \text{factor} = 4.0$

$f_{top} = 359\,\text{psi}$ ⇐ ***Max Tensile Stress***

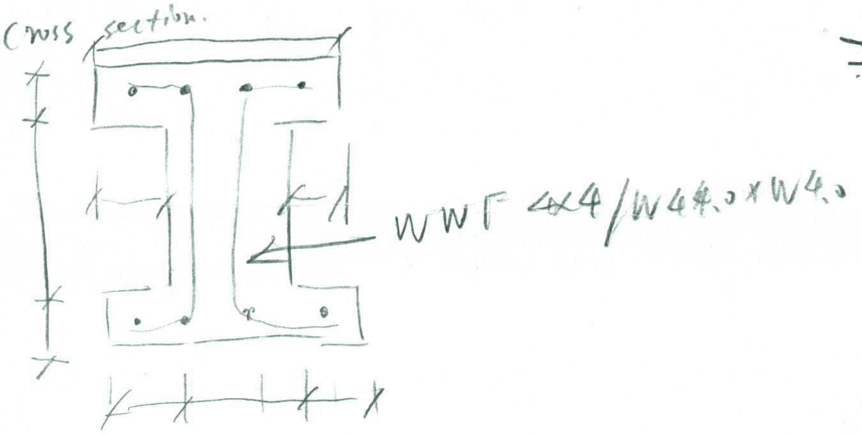
Bottom Fiber Stress at Transfer

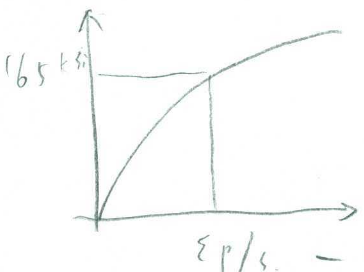
$$f_{bot} := \frac{-\left(F_o - \cancel{\Delta F}_{pES}\right)}{A_{tr}} - \frac{\left(F_o - \cancel{\Delta F}_{pES}\right)\cdot\left(y_{b.tr} - y_p\right)\cdot\left(H - y_{b.tr}\right)}{I_{tr}} + \frac{M_D\cdot\left(H - y_{b.tr}\right)}{I_{tr}} \qquad f_{bot} = -1139\,\text{psi}$$

Final calc

- Cross section
  rebar — check ACI 318 — min spacing // limitations
- → check σ @ release
- → Estimate Mcr
- → Estimate Mult ϕM_n
- → Predict Δult*
- → Response output
- → shear reinforcement / capacity
- → shop drawings
  → Full Elevations

Cross section.





After losses

Material spec
- ▷ concrete
- ▷ Reinforcement
- ▷ strand
- ▷ fabric

ASTM #

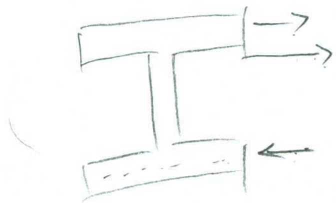
$(x-2)^2+(y-4)^2+(z+5)^2 = (x-2)^2+(y-1)^2+(z-4)^2$

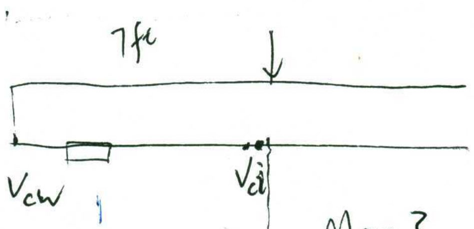
$\frac{x+2}{1} = \frac{y-5}{1} = \frac{z-1}{3} = t$

$\frac{x-1}{1} = \frac{y-2}{1} = \frac{z-1}{3} = t$

$x-1 = t$

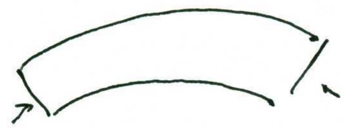
$x = 1 + t$

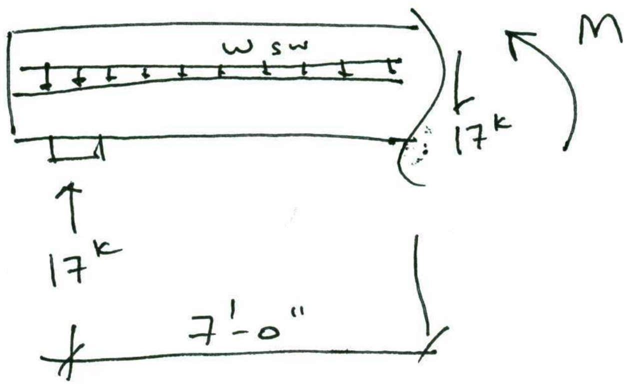




Mcre ?

Mmax ?





$f_{cr} =$

$$V_d = w_{sw} * (7\,ft$$

$$V_i = 17^k - V_d$$

$$M_{cre} = \frac{I_{tr}}{y_t} \cdot \left[6 \cdot \lambda \sqrt{f'_c} + f_{pe} - f_d \right]$$

$$f_{pe} = \left| -\frac{F_{pu}}{A_{tr}} - \frac{(F_{pu} \cdot e) \cdot c_{bot}}{I_{tr}} \right|$$

$$f_d = \frac{M_d \cdot c_{bot}}{I_{tr}}$$