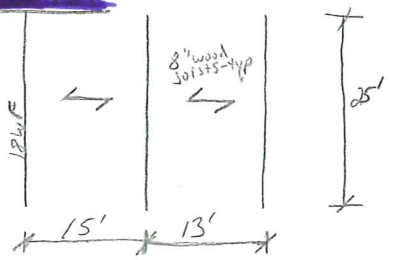
Determine Reinforcing for 18WF in [redacted]

DL = 50 psf
LL = 100 psf

$W_D = (7.5+6.5)(0.05) = 0.700\ K/ft$

$W_L = (7.5+6.5)(0.10) = 1.4\ K/ft$

$F_y = 30\ ksi$
$E = 29000\ ksi$
$I_x = 795.6$; $S_x = 88.4$
$I_y = 21.9$; $S_y = 7.1$

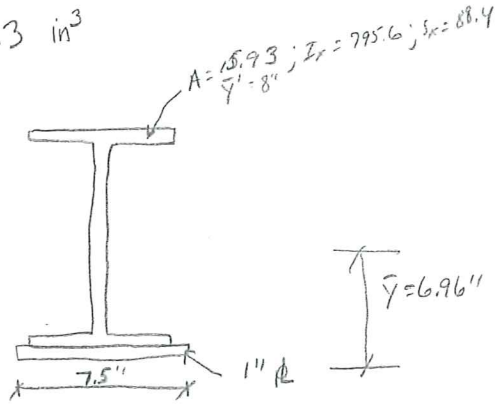


New Design Moment $= (1.4+0.7+0.055)\frac{(25.75)^2}{8} = 179\ K\text{-}ft = M_{new}$

Allowable M for old section $= 121.55\ K\text{-}ft = M_{allow}$

DL Moment $= (0.7+0.055)\frac{(25.75^2)}{8} = 63\ K\text{-}ft$ (cons. say that All DL is applied before Reinforcing)

$$\text{Req'd } S_{new,top} \geq \frac{(M_{pos,max} - M_{DL\,max})}{18 - \frac{[63(12)]}{88.4}} = 147.3\ in^3$$

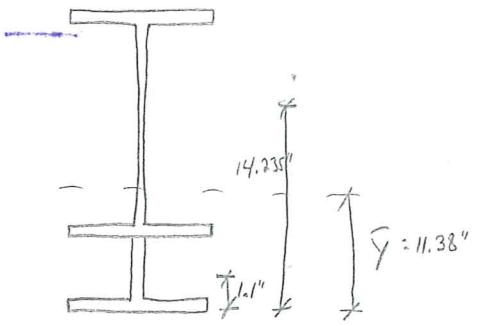


$$\bar{y} = \frac{15.93(10) + 7.5(0.5)}{15.93 + 7.5} = 6.96"$$

$$I_{x,new} = 795.6 + 15.93(3.04^2) + \frac{7.5^3}{12} + 7.5(6.46^2) = 1290.96$$

$$S_{top} = \frac{1290.96}{19 - 6.96} = 107.2\ in^3, \text{ NG!!}$$

-try reinforcing w/a WT 5x15

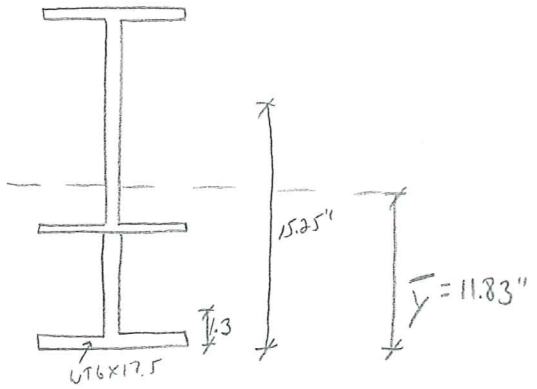


$$\bar{y} = \frac{15.93(14.235) + 1.1(4.42)}{15.93 + 4.42} = 11.38"$$

$$I_{new} = 795.6 + 15.93(2.853^2) + 9.28 + 4.42(10.28^2) = 1401.6 in^4$$

$$S_{top\,new} = \frac{1401.6}{11.86} = 118.18, \text{NG!!}$$

try WT 6x17.5

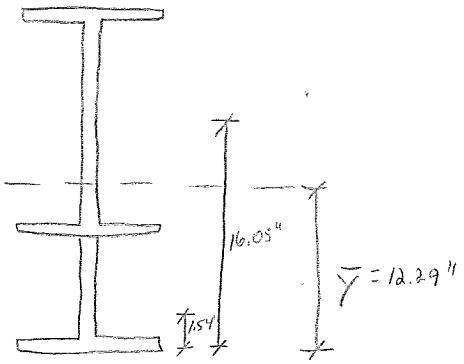


$$\bar{y} = \frac{15.93(15.25) + 5.17(1.3)}{15.93 + 5.17} = 11.83"$$

$$I_{new} = 795.6 + 15.93(3.42^2) + 16 + 5.17(10.53^2) = 1571.2 in^4$$

$$S_{top\,new} = 126.5 \quad \text{NG!!}$$

try WT 7X19

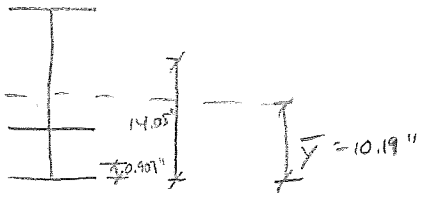


$$\bar{y} = \frac{15.93(16.05) + 5.58(1.54)}{15.93 + 5.58} = 12.29"$$

$$I_{x\,new} = 795.6 + 15.93(3.76^2) + 23.3 + 5.58(10.75^2) = 1689\ in^4$$

$$S_{top,new} = \frac{1689}{25.58 - 12.29} = 127.1\ in^3, NG!!$$

try WT 5X22.5

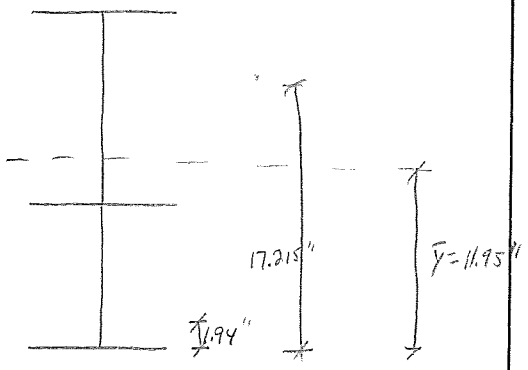


$$\bar{y} = \frac{15.93(14.05) + 0.907(6.63)}{15.93 + 6.63} = 10.19"$$

$$I_{new} = 795.6 + 15.93(3.86^2) + 10.2 + 6.63(9.28^2) = 1614.5\ in^4$$

$$S_{top,new} = \frac{1614.5}{23.05 - 10.19} = 125.5\ in^3, NG!$$

try WT 8X28.5



$$\bar{y} = \frac{15.93(17.215) + 1.94(8.38)}{15.93 + 8.38} = 11.95"$$

$I_{x,new} = 795.6 + 15.93(5.27^2) + 48.7 + 8.38(10.01^2) = 2126.4$

$S_{top,new} = \frac{2126.4}{26.215 - 11.95} = 149.06 in^3$, OK ✓

$S_{bott} = \frac{2126.4}{11.95} = 177.9 in^3$

$f_{dead} = \frac{M_{dead}}{S_{orig}} = \frac{63(12)}{88.4} = 8.55 Ksi$

$f_{top} = \frac{M_{new} - M_{dead}}{S_{top,new}} = \frac{(179-63)12}{149.06} = 9.34 Ksi$

$f_{bott} = \frac{M_{new} - M_{dead}}{S_{bott}} = \frac{(179-63)(12)}{177.9} = 7.82 Ksi$

- $f_{dead} + f_{top} = 8.55 Ksi + 9.34 Ksi = 17.89 Ksi < 18 Ksi = F_b$, OK ✓
- $f_{bott} = 7.82 Ksi < 30 Ksi = F_{b,bott}$, OK ✓

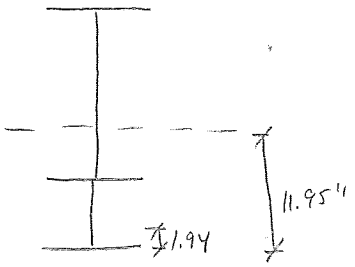
$\frac{wx}{2}(\ell - x) = 121.55$

$25x - x^2 - 112.8 = 0 \quad \therefore x = 19.1' \text{ & } 5.9'$

✳ $V@\ 5.9' = \left[\frac{2.155(25)}{2} - 5.9(2.155)\right] - \left[\frac{0.755(25)}{2} - 5.9(0.755)\right] = 9.24K$

Design weld of WT to Beam

$$q = \frac{VQ}{I}$$



$Q = A'\bar{y}'$ $\Rightarrow A' = 8.38\ in^2$, $\bar{y}' = 11.95 - 1.94 = 10.01\ in$

$Q = 8.38\ in^2 (10.01\ in) = 83.88\ in^3$

$I_{new} = 2126.4\ in^4$

$$q = \frac{VQ}{I} = \frac{9.24K\,(83.88\ in^3)}{2126.4\ in^4} = 0.3645\ K/in$$

try E70, 3/16" weld $\rightarrow$ 2.78 K/in

try 3@12": Capacity $= 2.78\left(\frac{3}{12}\right)(2) = 1.39\ K/in > 0.36\ K/in$, ok ✓

Select 3/16" weld - 3@12 staggered

Anchorage Force

$$f_{anch} = \frac{M_{allow}}{S_{bott,new}} = \frac{(121.55)12}{177.9} = 8.20\,Ksi$$

$$T_{anch} = f_{anch}(A_{wt}) + qa = 8.20Ksi(8.38) + qt\,(a)$$

$$T_{anch} = (2.78)a(2) = 5.55a$$

$$5.55a = 8.20(8.38) + 0.365(a)$$

$$5.185a = 68.716$$

$$\therefore a = 13.25'' \Rightarrow \text{Say } \underline{a = 16''}$$

Length of WT Reinforcement

$$\text{Length} = L - 2(x - a)$$

$$= 25' - 2(5.9' - \tfrac{16}{12}) = 15.87' \Rightarrow \underline{\text{Say } 16'}$$