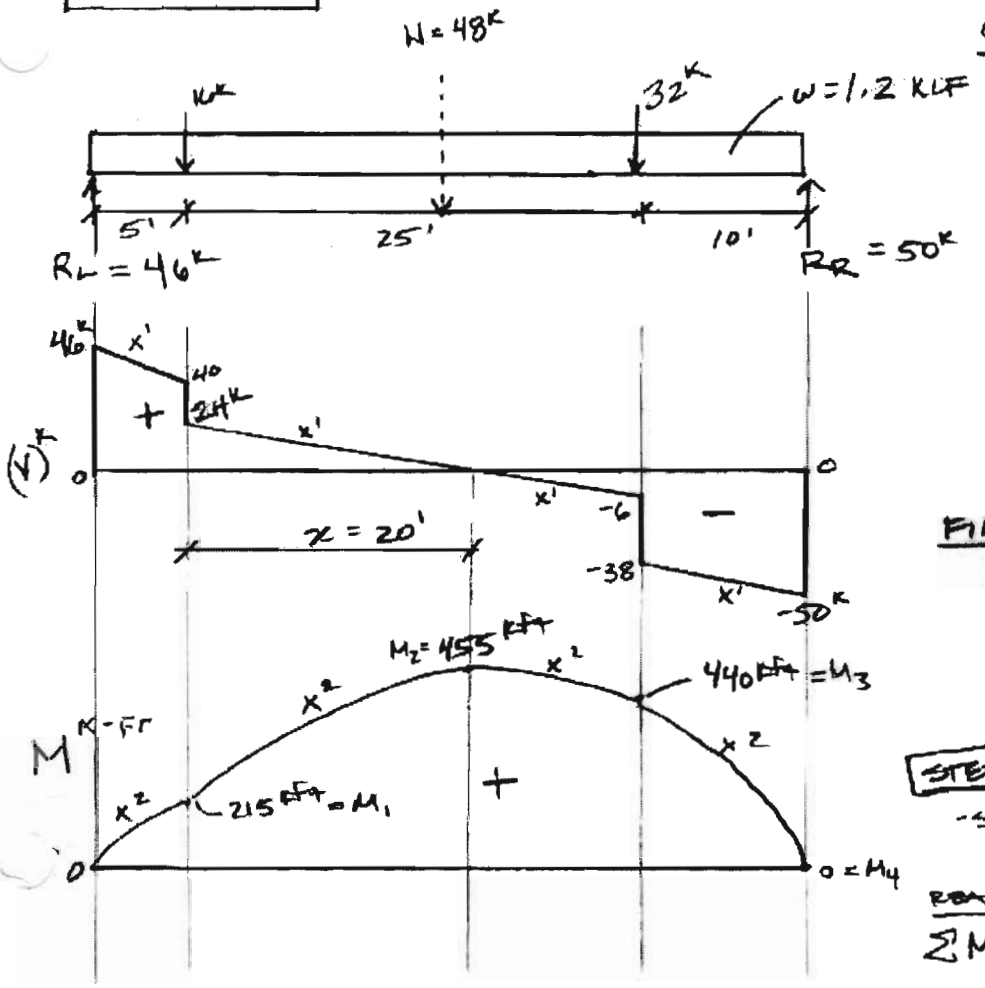
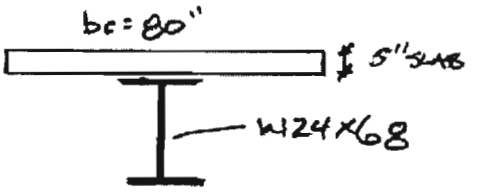
open.michigan

14-2(II)



GIVEN:



$F_b' = 24$ KSI
$F_c' = 1800$ PSI
} ALLOWABLE

$n = 1/8$

FIND:

① CHECK THE SAFETY

$F_b' \geq f_b$
ALLOW. ACTUAL.

STEP 1: FIND M_{MAX}

- SINCE UNSYMMETRICAL LOADING, MUST USE DIAGS.

REACTIONS:

$\sum M_{@L} = 0 = 16^K(5') + 48^K(20) + 32^K(30') - R_R(40')$

$R_R = 50^K$

$\sum F_y = 0 = R_L - 16^K - 48^K - 32^K + 50^K$

$R_L = 46^K$

SHEAR: FIND X - WHERE V = 0

ΔV = AREA LOADING

$24^K - 0 = 1.2\ KLF\ (X)$

$X = 20\ ft$

MOMENT:

$M_1 = \frac{1}{2}(46^K - 40^K)(5') + (40^K)(5') = 215^{K\text{-ft}}$

$M_2 = M_1 + \text{AREA of } V_{DIAG} = 215^{K\text{-ft}} + \frac{1}{2}(24^K)(20') = 455^{K\text{-ft}}$

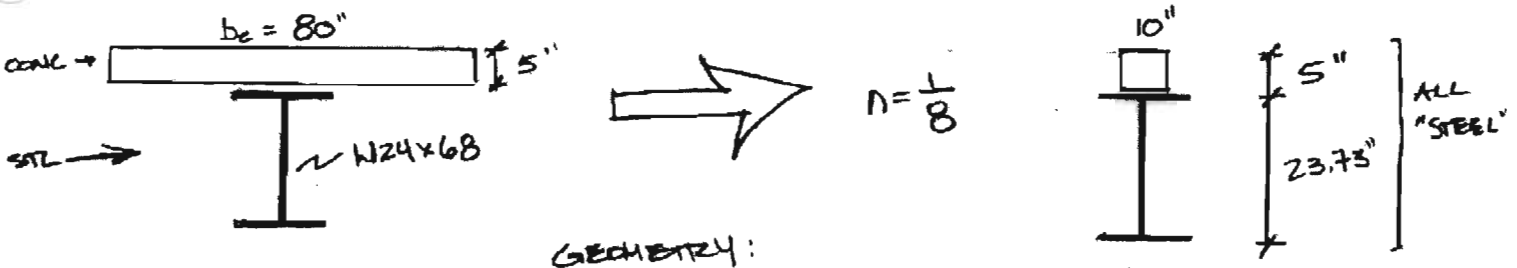
$M_3 = M_2 + \text{AREA } V_{DIAG} = 455^{K\text{-ft}} + \frac{1}{2}(25'-20')(-6^K) = 440^{K\text{-ft}}$

$M_4 = M_3 + \text{AREA } V_{DIAG} = 440^{K\text{-ft}} + \frac{1}{2}(-50^K - -38^K)(10') + (-38^K)(10') = 0^{K\text{-ft}}$ ✓

FROM DIAGS:

$M_{MAX} = 455^{K\text{-ft}}$

STEP 2: TRANSFORM TO "HOMOGENEOUS" SECTION.



GEOMETRY:

STEEL - LOOK UP IN TABLES. (p. 347)

FOR W24 x 68

$b = 8.965"$
$d = 23.73"$
$A = 20.1\ in^2$
$I = 1830\ in^4$
$S = 154\ in^3$

CONCRETE — TRANSFORM TO STEEL

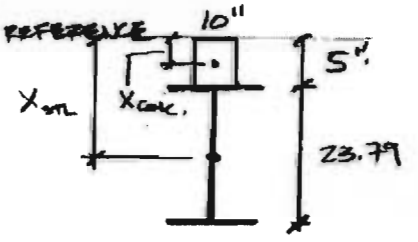
TRANSFORMED $b_e = b_e * n$

$= 80" \left(\frac{1}{8}\right) = \underline{10"}$

STEP 3: FIND N.A.

$\Sigma Ax = A\bar{x}$ (p.40) $\Rightarrow$ $\bar{x} = \frac{\Sigma Ax}{A} = \frac{464\ in^3}{70.1\ in^2} = 6.62\ in$ FROM THE TOP

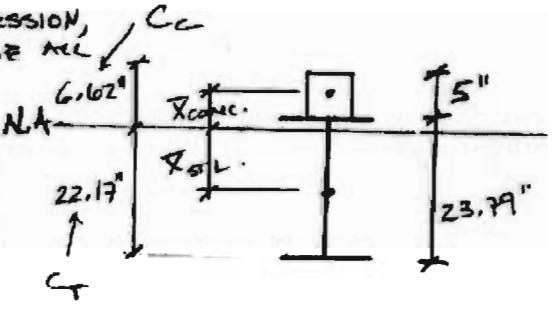
	$A\ (in^2)$	$x\ (in)$	$Ax\ (in^3)$
CONC.	$10" \times 5" = 50$	$\frac{5}{2} = 2.5$	125
STL.	20.1	$\frac{23.73}{2} + 5 = 16.9$	339
	70.1		464



STEP 4: FIND I_{TR}.

$I_{tr} = I + A\bar{x}^2$, $I = \frac{bd^3}{12}$ FOR RECT.

- USE ONLY THE PORTION OF CONCRETE IN COMPRESSION, IGNORE CONC. BELOW N.A. (THIS CASE USE ALL THE CONC.)



	$I\ (in^4)$	$A\ (in^2)$	$\bar{x}\ (in)$	$A\bar{x}^2$	$I + A\bar{x}^2$
CONC.	$10(5)^3/12 = 104.2$	$10 \times 5 = 50$	$6.62" - \frac{5}{2} = 4.12$	848.7	952.9
STL.	1830	20.1	$22.17" - \frac{23.73"}{2} = 10.28$	2122.1	3952.1
			$I_{TR} =$	4905	

$\Rightarrow$ $\underline{I_{TR} = 4905\ in^4}$

STEP 5: FIND F_b

$$F_b = \frac{Mc}{I} \leftarrow \text{GENERAL EQUATION}$$

SINCE WORKING IN "STL" - MUST CONVERT CONC STRESS. →

$$f_{CONC} = \frac{M c_{CT}}{I_{TR}} = \frac{455^{k\text{-ft}}\,(6.62'')\left(\frac{1}{8}\right)\times 12''/1'}{4905\ IN^4} = \underline{921\ PSI}$$

$$f_{STL} = \frac{M c_T}{I_{TR}} = \frac{455^{k\text{-ft}}\,(22.17'')\times 12''/1'}{4905\ IN^4} = \underline{24.7\ KSI}$$

STEP 6: CHECK SAFETY

$$F'_{STL} \geq f_{STL} \Rightarrow 24\ KSI \not\geq 24.7\ KSI$$

(F'_{STL}: ALLOWABLE W/ F.S.; f_{STL}: ACTUAL)

N.G. - STEEL FAILS!!

$$F'_{CONC} \geq f_{CONC} \Rightarrow 1800\ PSI \geq 921\ PSI \checkmark O.K.$$

IN CONCLUSION, THE BEAM IS NOT ADEQUATELY DESIGNED SINCE STEEL FAILS.