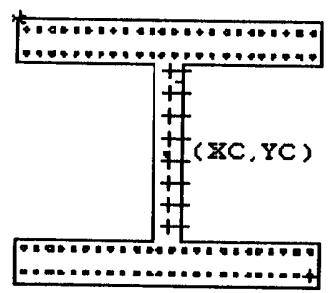
ACTUAL STRAINS
VS. BALANCED
(BALANCED = ...)



* MAX. CONC. STR.=.00043

\+ MAX. STEEL STR.=.00137

MEMBER CHAMBASE SECTION CENTER

```
1000 GONSKI
1010 MEMBER, CHAMBASE
1020 SECTION, CENTER
1030 MATERIALS, 6000.0000, 60000.0000
  40 DIMENSION, IN
1050 POINTS, 13
1060 0.0000, 0.0000
1070 0.0000, 24.0000
1080 75.0000, 24.0000
1090 75.0000, 120.0000
1100 0.0000, 120.0000
1110 0.0000, 144.0000
1120 168.0000, 144.0000
1130 168.0000, 120.0000
1140 93.0000, 120.0000
1150 93.0000, 24.0000
1160 168.0000, 24.0000
1170 168.0000, 0.0000
1180 0.0000, 0.0000
1190 REINFORCE, 12
1195 24, 3.1200, 4.50000, 138.0000, 163.5000, 138.0000
1196 24, 3.12, 4.5, 125.1, 163.5, 125.1
1200 2, 1.56, 79.8, 114.0, 88.2, 114.00
1201 2, 1.56, 79.8, 102.0, 88.2, 102.00
1202 2, 1.56, 79.8, 90.0, 88.2, 90.00
1203 2, 1.56, 79.8, 78.0, 88.2, 78.00
1204 2, 1.56, 79.8, 66.0, 88.2, 66.00
1205 2, 1.56, 79.8, 54.0, 88.2, 54.00
1206 2, 1.56, 79.8, 42.0, 88.2, 42.00
1207 2, 1.56, 79.8, 30.0, 88.2, 30.00
  13 24, 3.12, 4.5, 18.90, 163.5, 18.90
1214 24, 3.12, 4.5, 6.1, 163.5, 6.1
1240 USE, 0.9000, 0.0030, 4410000.0000, 0.7500, 0.80
1250 LOAD, SHIPCMAX, 1
1260 -66411.0000, 0.0000, 00000.00, 84.0000, 72.0000
1270 EXIT
```

USD @ MAXIMUM OFFSET

CHAMBER - SHIPLOCK

TRANSVERSE I-BEAM

FLGS - 4 ROWS #11@8

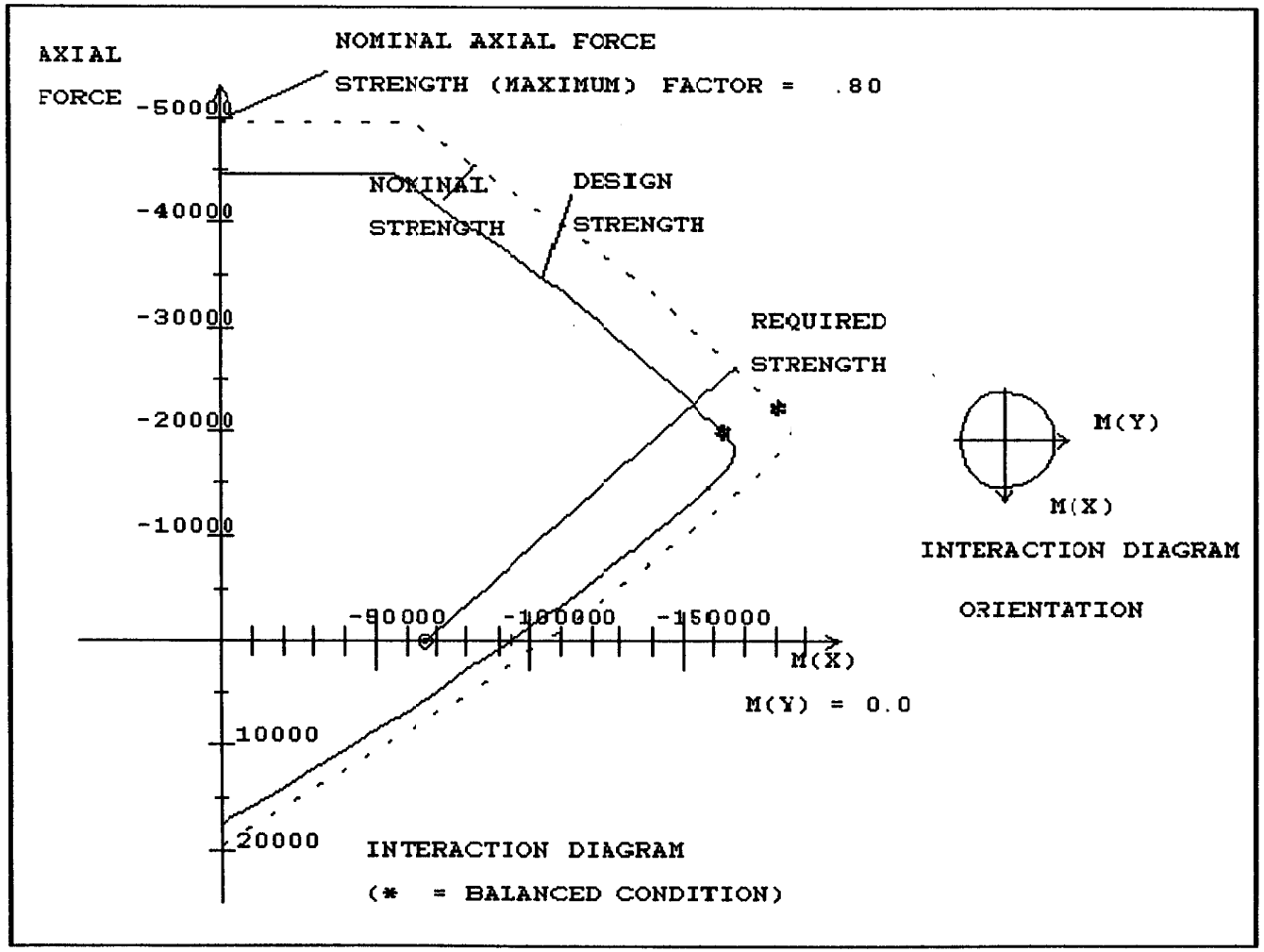
(DUE TO PROGRAM LIMITATIONS, FLG STEL SHOWN AS ONE ROW WITH AS = 2 * 11)

X0061 -- 713-F3-R0061 -- September 1983
Concrete General Strength Investigation

Output - X0061 - File Input Data

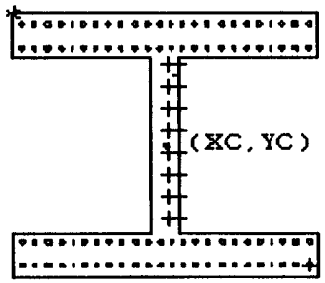
ROW	NO.	AREA (IN2)	X1 (IN)	Y1 (IN)	X2 (IN)	Y2 (IN)
1R	24	3.12	4.500	138.000	163.500	138.000
2R	24	3.12	4.500	125.100	163.500	125.100
3R	2	1.56	79.800	114.000	88.200	114.000
4R	2	1.56	79.800	102.000	88.200	102.000
5R	2	1.56	79.800	90.000	88.200	90.000
6R	2	1.56	79.800	78.000	88.200	78.000
7R	2	1.56	79.800	66.000	88.200	66.000
8R	2	1.56	79.800	54.000	88.200	54.000
9R	2	1.56	79.800	42.000	88.200	42.000
10R	2	1.56	79.800	30.000	88.200	30.000
11R	24	3.12	4.500	18.900	163.500	18.900
12R	24	3.12	4.500	6.100	163.500	6.100

Press Up, Down, PgUp, and PgDn to Scroll, Enter to Continue.


AXIAL
FORCE
NOMINAL AXIAL FORCE
STRENGTH (MAXIMUM) FACTOR = .80
-50000
-40000
-30000
-20000
-10000
NOMINAL
STRENGTH
DESIGN
STRENGTH
REQUIRED
STRENGTH
-50000
-100000
-150000
M(X)
M(Y) = 0.0
10000
20000
INTERACTION DIAGRAM
(* = BALANCED CONDITION)
M(Y)
M(X)
INTERACTION DIAGRAM
ORIENTATION

```
X0061 -- 713-F3-R0061 -- September 1983
        Concrete General Strength Investigation

Output - X0061 - Loads

Fig. 2.    1 .

Strain Analysis and Interaction
Diagram for Load  SHIPCMAX

Required Strength (U)
(Referenced to XC,YC)

  P(U) =                0.000 kips
  M(UX)=           -66411.000 kip-ft
  M(UY)=                0.000 kip-ft

  (XC,YC)=   84.000,  72.000

Percentage of Balanced Reinforcement =    26.83%

Press Up, Down, PgUp, and PgDn to Scroll, Enter to Continue.
```

ACTUAL STRAINS
VS. BALANCED
(BALANCED = ...)



* MAX. CONC. STR.=.00054

\+ MAX. STEEL STR.=.00171

MEMBER CHAMBASE SECTION CENTER

IHNC SHIP LOCK 3 12 8/96

CHAMBER BASE DESIGN - TRANSVERSE

POST TENSION LONG. DIRECTION FOR CONSTR. WAVE LOAD

CONVENTIONAL REBAR IN TRANSVERSE

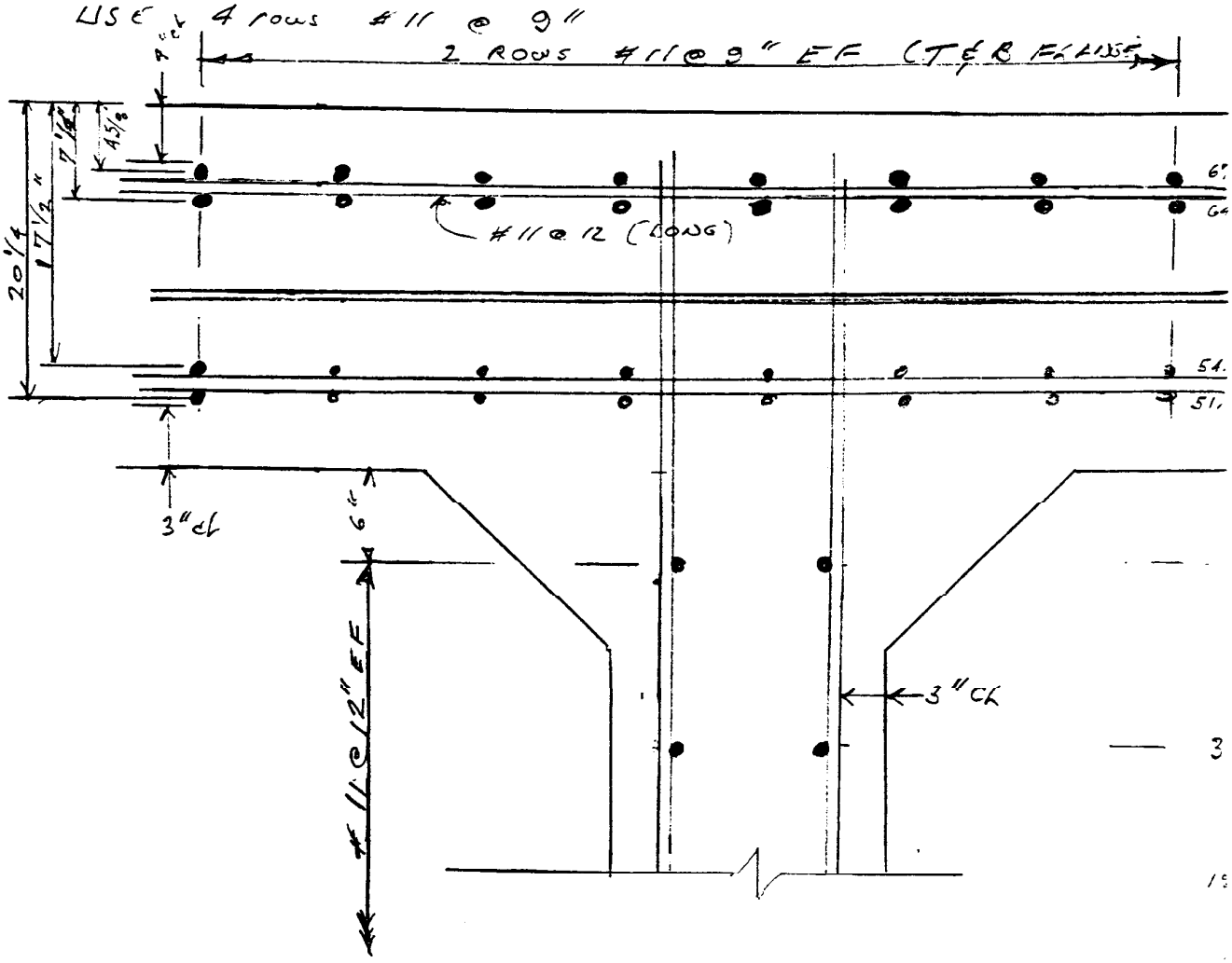
Redesign flange steel to comply w/ S. Moustafa's recommendations to eliminate #18 & #19 as a crack control measure

$$A_{s\,reqd}/12'' = (4 + 2.25)\frac{12}{9''} = 8.33$$

$$8.33/1.56 = 5.34 \quad \#11 \text{ Bars}$$

Try 4 rows #11 $\quad S = \frac{4 \times 1.56}{8.33} = 0.75$

USE 4 rows #11 @ 9"



CHAMBER BASE - TRANSVERSE DESIGN

CRACK WIDTH & FLEXURAL REIN. DIST.

The I-BEAM SECTION, CONSERVATELY ASSUMING THAT BALLAST CONCRETE DOES NOT INCREASE STRUCTURAL CAPACITY, HAS FLANGE COMPONENTS THAT ARE IN TENSION FOR THE COMPLETE DEPTH. CRACK CONTROL SHALL BE PROVIDED BY limiting tensile stress in accordance w/ Table 4.1 of ACI 357. Also rebar shall be distributed to limit crack width to 0.010" @ normal operation.

ACI 10.6.4

$w = 0.076\,\beta \cdot f_s \sqrt{d_c \cdot A}$ where $\beta = 1.16$ (see attached letter from Montalto)

Thousands of inch

CONSIDER 16" (#11 BARS @ 8") width of Tension Flange

$f_{s\,\text{normal oper}} = 16.44\,\text{KSI}$

$d_c = 4\,5/8"$

$d_{ca} = \dfrac{1.56\,(4.625 + 7.5 + 17.5 + 20.25)}{4 \times 1.56} = 12.47$

$A = 12.47 \times 2 \times 16 = 399$

$A/\text{BAR} = \dfrac{399}{8} = 49.88$

$w = 0.076 \times 1.16 \times 16.44 \sqrt[3]{4.625 \times 49.9}$

$= 0.0089 < 0.010$ OK ← CONTROLS

Maximum Operation

$f_s = 20.54\,\text{KSI}$

$w = 0.076 \times 1.16 \times 20.54 \sqrt[3]{4.625 \times 49.9}$

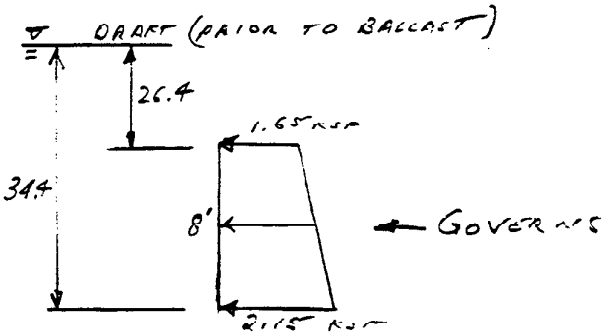
$= 0.011"$ NOT EXCESSIVE CONSIDERING MAX OPERATION IS A RARE EVENT

WEB REINFORCEMENT
HORIZONTAL BARS

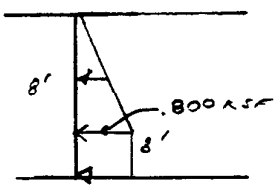
1) ACI 10.6.7 (see pg 1) Need # 11 @ 12

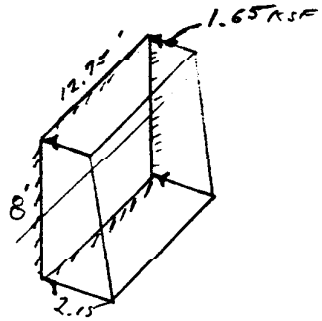
2) Web as a Rectangular Plate fixed @ 4 EDGES, for the largest load created by: 1) Transport Floating
2) Full U-Frame, BASE UNBALANCED
3) Concrete Core

U-FRAME DEPTH > TRANSPORT



CONCRETE FORMING FROM ONE SIDE
rate of pour = 5'/hr





$$M_{HOR.12\ MAX} = \frac{w_u l_n^2}{10} = \frac{1.90 \times 12.75^2}{10} = 30.9'\text{-}K$$

$$= 370''\text{-}K \qquad M_a = 370 \times \frac{2.21}{1.53} = 615''$$

$$M_a/\phi = A_s F_y \left[d - \frac{A_s F_y}{2 \times 0.85 f_c' \times b} \right]$$

$b = 12''$

$d = 18 - 5'' = 13''$

$f_c' = 6000 \qquad f_y = 60{,}000$

$$615/0.9 = A_s \cdot 60 \left[13 - \frac{A_s \cdot 60}{2 \times 0.85 \times 6 \times 12} \right]$$

$$0 = A_s^2 - 26.52 A_s + 23.23$$

$$A_s = \frac{26.52 \pm \sqrt{26.52^2 - (4)(23.23)}}{2}$$

$$= 0.91''^2 < A_{sk}$$

TEMP STEEL $= 0.0014\ A_g$
$= 0.0014 \times 12 \times 18$
$= 0.30\ ''^2 < A_{sk}$

$A_{sk} = 1.31\ ''^2/12\ ''/\text{FACE}$ CONTROLS. ACI 10.6.7 adds web reinforcement to control cracks, this is not an additive bar area.

VERTICAL BARS

Same loading as horizontal, use greater of

$M_{①} = \frac{w l n^2}{10}$ and $M_{②}$ RECT. PLATE per Roark Formula's for Stress and Strain

$M_{①} = \frac{1.90 \times 8^2}{10} = 12.16\ ''\text{-K}$
$= 146\ ''\text{-K}$

ROARK FORMULA'S FOR STRESS & STRAIN 6th Edition pg 465
COMBINE UNIFORM CASE (8A) and LINEARLY VARYING (CASE 8D).

UNIFORM LOAD

$\frac{a}{b} = \frac{12.75}{8} = 1.6$ $\beta_1 = 0.4680$
$q = 1650\ psf$

$\sigma_{max} = \frac{-\beta_1 \cdot q \cdot b^2}{t^2} = \frac{0.468 \times 1.650 \times 8^2}{1.5^2}$
@ Center of bottom edge
$= 21.96\ KSF$

Linearly Varying

$\sigma_m = \frac{-0.3092\,(2.150 - 1.650)\,8^2}{1.5^2}$

$= 4.40\ KSF$

$\Sigma\sigma = 26.36\ KSF$

$M_{②} = \sigma \cdot S_x$ $S_x = \frac{1 \cdot 1.5^2}{6} = 0.375\ Ft^3$

$= 26.36 \times 0.375$
$= 9.89\ ''\text{-K}$
$= 118.6\ ''\text{-K} < M_{①} = 146\ ''\text{-K} \leftarrow$ CONTROLS

$M_u = \frac{2.21}{1.33} \times 146 = 243\ ''\text{-K}$

COMPUTATION SHEET

PROJECT	PAGE 7 OF 17	COMPUTED BY	DATE 8/90
SUBJECT		CHECKED BY	DATE

$243/0.90 = 60A_s\left[d - \frac{60A_s}{2\times0.85\times f'_c\times b}\right]$

$b = 12''$
$d = 18 - 3.68''$
$= 14.31''$

$270 = 858.8A_s - 29.41A_s^2$
$0 = A_s^2 - 29.2A_s + 9.18$

$A_s = \frac{29.2 \pm \sqrt{29.2^2 - (4)(9.18)}}{2} = 0.32'' > A_{s_{TEMP}}$

The tensile stress on the vertical bars is in the same direction as shear stress.

$A_b = A_{s_{FLEXURE\ WEB}} + \frac{A_s}{2}_{web\ shear}$ (REBAR IN ONE FACE)

FOR THE SETTING CONDITION (see pg 10 of 10)

$V_{max_{TRANS}} = 284$ K @ wall face

$V_u = \frac{2.25}{1.33} \times 284 = 472$ K

Recalculate $A_{s_{Flexure}}$ w/ correct web thickness = 27"

$d = 27 - 3.68 = 23.32''$
$b = 12$

$270 = 1399.2A_s - 29.41A_s^2$
$0 = A_s^2 - 47.57A_s + 9.18$

$A_s = \frac{47.57 \pm \sqrt{47.57^2 - 6\times9.18}}{2} = 0.20\ in^2$

$V_u = 472$ K

$V_c = 2\sqrt{f'_c}\ b_w \cdot d$ (ACI 11-3)
$= 2\sqrt{6000} \cdot 27 \cdot 140$
$= 586$ kips

$\phi V_c = 0.85(586) = 498$ kip

$\phi V_c > V_u$ USE Minimum Shear Reinforcement

$A_{v_{min}} = 50\frac{b_w \cdot s}{f_y}$ (ACI 11.5.5)

COMPUTATION SHEET

PROJECT	PAGE 8 OF 12	COMPUTED BY MRZ	DATE 8/96
SUBJECT		CHECKED BY	DATE

$A_{v_{min}} = \frac{50 \times 27 \cdot 12}{60{,}000}$

$= 0.27''^2$

$\Sigma A_b = \frac{0.27''^2}{2} + 0.20 = 0.34''^2$ @ 12" $< A_{TEMP} = 0.0014 \times 12 \times 27 = 0.45''^2$

USE # 7 @ 12" EF $A_b = 0.60''^2$ ← DOES NOT GOVERN SEE PG 11 - SECTION "A"

Check Wall w/ h = 21" (SECOND PANEL)

$d = 21'' - 3.68 = 17.3''$

$270 = 1038 A_s - 29.41 A_s^2$

$0 = A_s^2 - 35.29 A_s + 9.18$

$A_s = \frac{35.29 \pm \sqrt{35.29^2 - (4)(9.18)}}{2} = 0.26''^2$

$V = 284$ K (use V_{max}. Throughout)

$V_a = 472$ K

$V_c = 2\sqrt{6000} \times 21 \times 140$

$= 455$ K

$\phi V_c = (0.85) V_c = 387$ K

$V_s = 472 - 387 = 85$ K

$A_v = \frac{85 \cdot 12}{60 \cdot 132}$ (ACI 11.5.6)

$= 0.13''^2$

$A_{v_{min}} = \frac{50 \times 21 \times 12}{60{,}000}$

$= 0.21''^2$

$A_b = \frac{0.21}{2} + 0.26$

$= 0.37''^2$ $> A_{TEMP} = 0.0014 \times 12 \times 21 = 0.35''^2$

USE # 6 @ 12" EF $A_b = 0.60''^2$ ← DOES NOT GOVERN SEE PG 12 - SECTION "B"

COMPUTATION SHEET

PROJECT	PAGE 9 OF 12	COMPUTED BY MJL	DATE 8/96
SUBJECT		CHECKED BY	DATE

Check Wall @ h = 18"

$V = 284\ K$

$V_u = 472$

$V_c = 2\sqrt{6000} \times 18 \times 140$
$= 390$

$V_{s_{req'd}} = 472 - 390(0.85) = 140\ K$

$A_V = \frac{140 \times 12}{60 \times 132} = 0.21''^2 > A_{V\,min} = \frac{50 \times 18 \times 12}{60{,}000} = 0.18''^2$

$A_s = 0.32''^2$ (see pg 7)

$A_b = \frac{0.21}{2} + 0.32 = 0.43''^2 > A_{TEMP}$

USE #7 @ 12 EF ← DOES NOT GOVERN SEE PG 12 SECTION "C"

Flange Reinforcement

Long - Prestress 1 3/8" ϕ @ 12"
Rebar #11 @ 12" 2 ROWS/Flange

TRANS - #11 @ 8" 4 ROWS/Flange

Check Shear & Flexure Considering Ballast Concrete not placed

BOTTOM Slab @ 36.4' DRAFT

$w_B = (36.4 \times 0.0625) - (2 \times 0.15) = 1.98\ KSF$

$l_{n\,max} = 14 - 1.25 = 12.75$

$M_{max} = \frac{1.98 \times 12.75^2}{10} = -32.2'\text{-}K$
$= -386''\text{-}K$

Top Slab

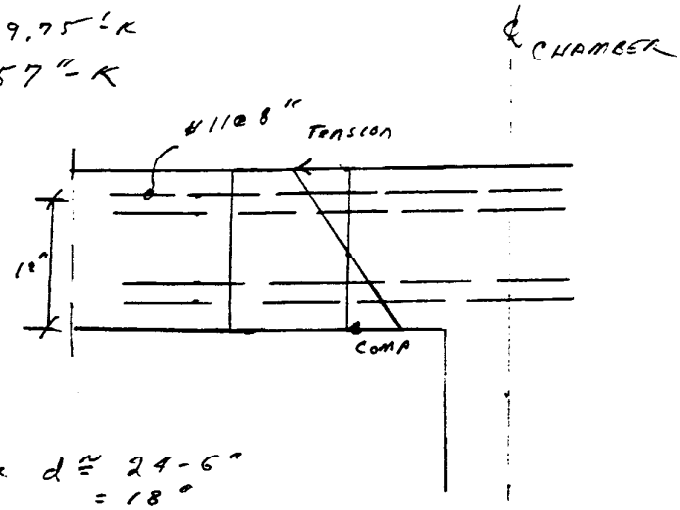
$M_{max} = M_{I\text{-}BEAM} + M_{plate}$

Note: Prior to setting the bottom Flange is only in compression ∴ Design of the top Flange will govern

$W_T = (24.4 \times 0.0625) + (2 \times 0.15) = 1.83\ KSF$

$M_{plate} = \frac{1.83 \times 12.75^2}{10} = 29.75'\text{-}K$
$= 357''\text{-}K$

$M_{I\text{-}BEAM} = 17850'\text{-}K$



USE WSD

From CGFAG

$f_{s_{I\text{-}BEAM}} = 12{,}200$ PSI

plate

$357 = A_s f_s j d$ where $d \cong 24 - 6''$
$= 18''$

$f_s = \frac{357}{4.68(0.85 \times 18)}$

$= 4.99$ KSI

$A_s = 1.56 \times 2 \times \frac{12}{8}$
$= 4.68''^2/LF$

$j = 1 - \frac{K}{3}$ $K = \frac{n}{n+r}$

$= 1 - \frac{0.47}{3}$ $n = \frac{E_s}{E_c} = \frac{29{,}000}{4.41} = 6.6$

$= 0.85$

$r = \frac{f_s}{f_c} = \frac{20{,}000}{2700} = 7.4$

$K = 0.47$

$\Sigma f_s = 12{,}200 + 4{,}990$
$= 17{,}190$ KSI

$F_{s_{allow}} = 23$ KSI & f_s ok
Table 4.1

SHEAR - BOTTOM FLANGE

$w = 1.98$

$V_u = \left(1.98 \times \frac{12.75}{2}\right)\frac{2.21}{1.33} = 21\ K$

$V_c = 2\sqrt{6000} \times 12 \times 18 = 33.46\ K$

$\phi V_c = 0.85(33.46) = 28.44\ K > V_u$

```
010 SHIP LOCK CHAMBER TRANS IBEAM ANALYSIS(WSD) ~~NORMAL OPER~~ TRANSPORT. LOAD
020 13 16 1
030 1 -84 72 84 72 84 48
040 1 9 48 9 -48 84 -48
  0 1 84 -72 -84 -72 -84 -48
  0 1 -9 -48 -9 48 -84 48
070 1 -84 72
080 2 1.56 -81 67.4 24 81 67.4
081 2 1.56 -81 64.5 24 81 64.5
082 2 1.56 -81 54.5 24 81 54.5
083 2 1.56 -81 51.75 24 81 51.75
100 2 1.56 -4.5 42 2 4.5 42
110 2 1.56 -4.5 30 2 4.5 30
120 2 1.56 -4.5 18 2 4.5 18
130 2 1.56 -4.5 6 2 4.5 6
140 2 1.56 -4.5 -6 2 4.5 -6
150 2 1.56 -4.5 -18 2 4.5 -18
160 2 1.56 -4.5 -30 2 4.5 -30
170 2 1.56 -4.5 -42 2 4.5 -42
200 2 1.56 -81 -51.75 24 81 -51.75
201 2 1.56 -81 -54.5 24 81 -54.5
202 2 1.56 -81 -64.5 24 81 -64.5
203 2 1.56 -81 -67.4 24 81 -67.4
230 3 0 0 -214200 6.6 0.15 0.01
240
250 0 0 0
```

PROGRAM CORPS/X8008 CONCRETE GENERAL FLEXURE ANALYSIS REV 86
SHIP LOCK CHAMBER TRANS IBEAM ANALYSIS(WSD) NORMAL OPER. LOAD
** I N P U T L O A D I N G A N D P A R A M E T E R S **

LD. CASE	P	Y-AXIS MOM.	X-AXIS MOM.	N	R	ACCURACY
3	.00	.00	-214200.00	6.60	.15	.010

S T R E S S E Q U A T I O N A N D N E U T R A L A X I S:

UNIT STRESS = .00000 X + -.01796 Y + -.63840

AT Y = 0, NEUTRAL AXIS CROSSES X-AXIS AT X = -.10357420E+13
AT X = 0, NEUTRAL AXIS CROSSES Y-AXIS AT Y = -35.543720

MAXIMUM CONCRETE STRESS = .65 AT POINT 7
MAXIMUM STEEL STRESS = 12.20 T
= .57 C

COMPRESSIVE STRESS IS SHOWN PLUS, TENSION MINUS (CONC. & STEEL)

C O N C R E T E S T R E S S E S F O R O U T L I N E 1:

POINT	X-COORD	Y-COORD	COMPRESSIVE STRESS	POINT	X-COORD	Y-COORD	COMP. STRESS
1	-84.00	72.00		2	84.00	72.00	
3	84.00	48.00		4	9.00	48.00	
5	9.00	-48.00	.224	6	84.00	-48.00	.224
7	84.00	-72.00	.655	8	-84.00	-72.00	.655
9	-84.00	-48.00	.224	10	-9.00	-48.00	.224
11	-9.00	48.00		12	-84.00	48.00	
13	-84.00	72.00					

S T E E L S T R E S S E S F O R P A T T E R N NO. 2:

AREA OF ONE BAR	QUAN. OF BARS/ROW	ROW END	X COORDINATE	Y COORDINATE	STRESS IN BAR
1.560	24	1	-81.000	67.400	-12.203
		2	81.000	67.400	-12.203
1.560	24	1	-81.000	64.500	-11.859
		2	81.000	64.500	-11.859
1.560	24	1	-81.000	54.500	-10.674
		2	81.000	54.500	-10.674
1.560	24	1	-81.000	51.750	-10.348
		2	81.000	51.750	-10.348
1.560	2	1	-4.500	42.000	-9.192
		2	4.500	42.000	-9.192
1.560	2	1	-4.500	30.000	-7.770
		2	4.500	30.000	-7.770
1.560	2	1	-4.500	18.000	-6.347
		2	4.500	18.000	-6.347
1.560	2	1	-4.500	6.000	-4.925
		2	4.500	6.000	-4.925
1.560	2	1	-4.500	-6.000	-3.502
		2	4.500	-6.000	-3.502
1.560	2	1	-4.500	-18.000	-2.080
		2	4.500	-18.000	-2.080
1.560	2	1	-4.500	-30.000	-.657
		2	4.500	-30.000	-.657
1.560	2	1	-4.500	-42.000	.115
		2	4.500	-42.000	.115
1.560	24	1	-81.000	-51.750	.288
		2	81.000	-51.750	.288
1.560	24	1	-81.000	-54.500	.337
		2	81.000	-54.500	.337
1.560	24	1	-81.000	-64.500	.515
		2	81.000	-64.500	.515
1.560	24	1	-81.000	-67.400	.566
		2	81.000	-67.400	.566

SHEAR

For the normal of maximum operation the axial loads, induced by lateral loads acting on the W-Frame, are too small to consider axial compression.

SECTION A

$w_{eb} = 27''$

$V_u, = 2336K$

$V_c = 2\sqrt{f_c'}\, b_w \cdot d$

$= 2\sqrt{6000}\ 27 \times 132$

$= 552\ K$

$V_s = V_u/\phi - V_c = 2336/0.85 - 552 = 2196\ K$

$V_{s\,max} = 8\sqrt{f_c'}\, b_w d$ (ACI 11.5.6.8)

$= 2208\ K < V_s$ OK

$V_s = \dfrac{A_v \cdot f_y \cdot d}{S}$ USE Max Permitted #8 BARS

$S = \dfrac{2 \times 0.79 \times 60 \times 132}{2196} = 5.7$ USE 6" SPACING

TRY $b_w = 30''$

$V_c = 2\sqrt{6000} \times 30 \times 132$

$= 613$

$V_s = 2336/0.85 - 613 = 2018$

$S = \dfrac{2 \times 0.79 \times 60 \times 132}{2018} = 6.2''$

USE $b_w = 30''$ w/ 2 - #8" STIRRUP BARS @ 6"

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SECTION B

$b_w = 21''$

$V_{u_{max}} = 800 \times 2.21 = 1768\,K$ (LOAD CASE 1)

$V_c = 2\sqrt{6000} \times 21 \times 132$

$= 429\,K$

$V_s = 1768/0.85 - 429 = 1651\,K$

$V_{s\,max} = 4V_c = 1716 > 1651$ OK

$S_{2-\#8} = \dfrac{2 \times 0.79 \times 60 \times 132}{1650} = 7.5''$ USE 2-#8@3''

SECTION C

$b_w = 18''$

$V_{u_{max}} = 1216$ (LOAD CASE 2A)

$V_c = 2\sqrt{6000} \times 18 \times 132$

$= 368\,K$

$V_s = 1216/0.85 - 368 = 1060\,K$

$V_{s\,max} = 4V_c = 1472\,K > V_s$ OK

$S_{2-\#8} = \dfrac{2 \times 0.79 \times 60 \times 132}{1060} = 16.8''$ USE 2-#8@12''