Solver Input Values for S10 x 35 Door Analysis

Blast Load = 152 psi t_d = 24.6 ms

Use S10 x 35 Stiffener Beams with ½" Cover PL on Outside and ¼" Cover PL on Inside

Mass of Door: Weight (lb/In) ½ + ¼ PL's = $\frac{.75 \times 15(490)}{1728}$ = 3.19

S10 x 35 = $\frac{35}{12}$ = 2.92

6.11 lbs/In

Weight per Square Inch, $W = \frac{6.11}{15} = 0.407$ psi.

Mass, $M = \frac{.407}{32.2 \times 12} = 1{,}054 \frac{psi\text{-}ms^2}{In}$ ✓

Elastic Load Mass Factor = 0.78 ✓
Plastic Load Mass Factor = 0.66 ✓

A) Initial Conditions

Stiffness: $K_E = \frac{384EI}{5L^4} = \frac{384(29 \times 10^6)(433.54)}{5(14 \times 12)^4} \cdot \frac{1{,}212}{15} = 80.8 \frac{psi}{In}$

(163)

Ultimate Unit Resistance: r_u = 1,204 lbs/In of 15" Wide Section (See Door Calcs Pg 31)

$r_u = \frac{1{,}204}{15} = 80.3$ PSI

```
$ SOLVE    P298DOOR : P-298, PT. HADLOCK DOOR
     1     1        0.01          35                                        -1

     2     2        1054          .04
     1        80.8         80.3                    .78         1.0
     3         0.0                      20.0       .66         0.0
     1        67.6        -64.0                    .78         1.0
     3         0.0                     -20.0       .66         0.0
     1     3
         0.0          152        24.6          0.0         40.0          0.0
$ STOP
```

1 NE DEGREE OF FREEDOM SOLVER INPUT
VERSION 2.2 FEB 1989

ROBLEM DESCRIPTION
SOLVE P298DOOR : P-298, PT. HADLOCK DOOR

ANALYSIS CONTROL CARD

YPE OF SOLUTION..... 1
EQ. 0, DEFAULTS TO 1
EQ. 1, NEWMARK-BETA METHOD
EQ. 2, WILSON-THETA METHOD
NUMBER OF LOAD CASES..... 1
TIME STEP..... 0.0100
IME LIMIT..... 35.0000
EWMARK*S GAMMA..... 0.0000
EQ. 0.0, DEFAULTS TO 0.5
EWMARK*S BETA..... 0.0000
EQ. 0.0, DEFAULTS TO 0.25
WILSON*S THETA..... 0.0000
EQ. 0.0, DEFAULTS TO 1.4
RINT OPTION..... -1
EQ. 0, DEFAULTS TO 1
EQ. 1, PRINT EVERY STEP
EQ. N, PRINT EVERY N-TH STEP
EQ. -1, PRINT SIGNIFICANT CHANGES

NITIAL CONDITIONS

INITIAL DEFLECTION..... 0.0000
NITIAL VELOCITY..... 0.0000
NITIAL ACCELERATION..... 0.0000

TIFFNESS CONTROL CARD

NUMBER OF STIFFNESSES..... 2
UMBER OF REBOUND STIFFNESSES..... 2
MASS..... 1054.0000
PERCENT OF CRITICAL DAMPING..... 0.0400

INITIAL RESISTANCE-DEFLECTION CURVE

UMBER	MODE	STIFFNESS	RESISTANCE	YLD DEFL	MASS FACT	DAMP FRAC
1	1	0.80800E+02	0.80300E+02	0.00000E+00	0.78	1.00
2	3	0.00000E+00	0.00000E+00	0.20000E+02	0.66	0.00

EBOUND RESISTANCE-DEFLECTION CURVE

NUMBER	MODE	STIFFNESS	RESISTANCE	YLD DEFL	MASS FACT	DAMP FRAC
3	1	0.67600E+02	-0.64000E+02	0.00000E+00	0.78	1.00
4	3	0.00000E+00	0.00000E+00	-0.20000E+02	0.66	0.00

```
LOAD DATA

LOAD CASE NUMBER.....                    1
NUMBER OF LOAD POINTS.....               3


POINT                TIME                LOAD
    1              0.0000            152.0000
    2             24.6000              0.0000
    3             40.0000              0.0000


GENERATED RESISTANCE - DEFLECTION CURVES

NATURAL PERIOD.....                  20.0420

NUMBER  MODE   STIFFNESS  RESISTANCE    YLD DEFL   MASS FACT   DAMP FRAC
     1     1 0.80800E+02 0.80300E+02 0.99381E+00        0.78        1.00
     2     3 0.00000E+00 0.80300E+02 0.20000E+02        0.66        0.00
     3     1 0.67600E+02-0.64000E+02-0.94675E+00        0.78        1.00
     4     3 0.00000E+00-0.64000E+02-0.20000E+02        0.66        0.00
* * * * NEWMARK-BETA SOLUTION * * * * *
LOAD CASE.....                           1
TIME STEP.....                           0.0100


* * * * * SOLUTION RESULTS  * * * * * *
        STEP   TIME STIF DEFLECTION   VELOCITY       ACC RESISTANCE       LOAD

ELAS     0    0.0000    1      0.000     0.0000     0.1849       0.00     152.00
*CHG   361    3.6048    2      0.994     0.4674     0.0484      80.30     129.73
REB   2462   24.6200    1     12.766    -0.0007    -0.0977      80.30       0.00
*CHG 2976   29.7546    3     11.772    -0.2921     0.0073       0.00       0.00
*CHG 3470   34.6924    4     10.825    -0.0309     0.0786     -64.00       0.00


***** TIME LIMIT REACHED

MAXIMUM DEFLECTION IN SOLUTION
STEP NUMBER..........................  2461
TIME AT MAXIMUM.....................      24.6100
MAXIMUM DEFLECTION..................      12.766

MINIMUM DEFLECTION IN SOLUTION
STEP NUMBER..........................  3499
TIME AT MINIMUM.....................      34.9900
MINIMUM DEFLECTION..................      10.820


SOLUTION TIME LOG
   ASSEMBLY.....................          0.33
   SDOF SOLUTION.(LOAD CASE  1)...        1.98

   TOTAL TIME.....................        2.31
ONE DEGREE OF FREEDOM SOLVER INPUT
VERSION 2.2  FEB 1989

PROBLEM DESCRIPTION
STOP
```

Door Analysis: Using 510 x 35 Internal Stiffeners @ 15" Center to Center
1/2" Exterior Cover Plate
1/4" Interior Cover Plate

All Steel to be A-36

From SOLVER Output:

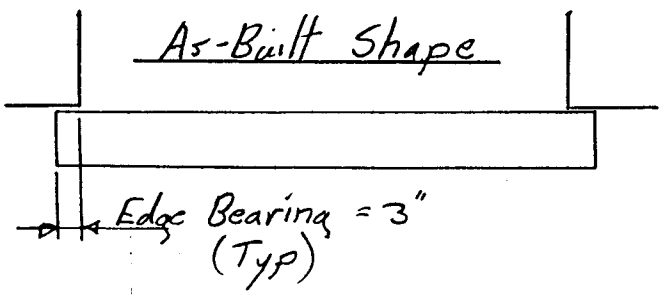
Yield Point: Time: 3.60 ms ✓
Deflection: 0.99 inches ✓
Resistance: 80.3 PSI ✓

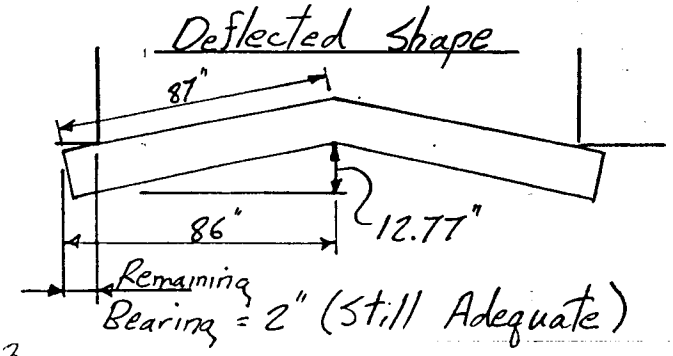
Maximum Deflection
Time: 24.61 ms ✓
Deflection: 12.77 Inches ✓
Resistance: 80.3 PSI ✓

Allowable 12° Support Rotation, $\Delta_{max} = \tan 12° \left(\frac{14 \times 12}{2}\right)$
$= 17.85"$ ✓

Actual Deflection = 12.77" < 17.85" OK

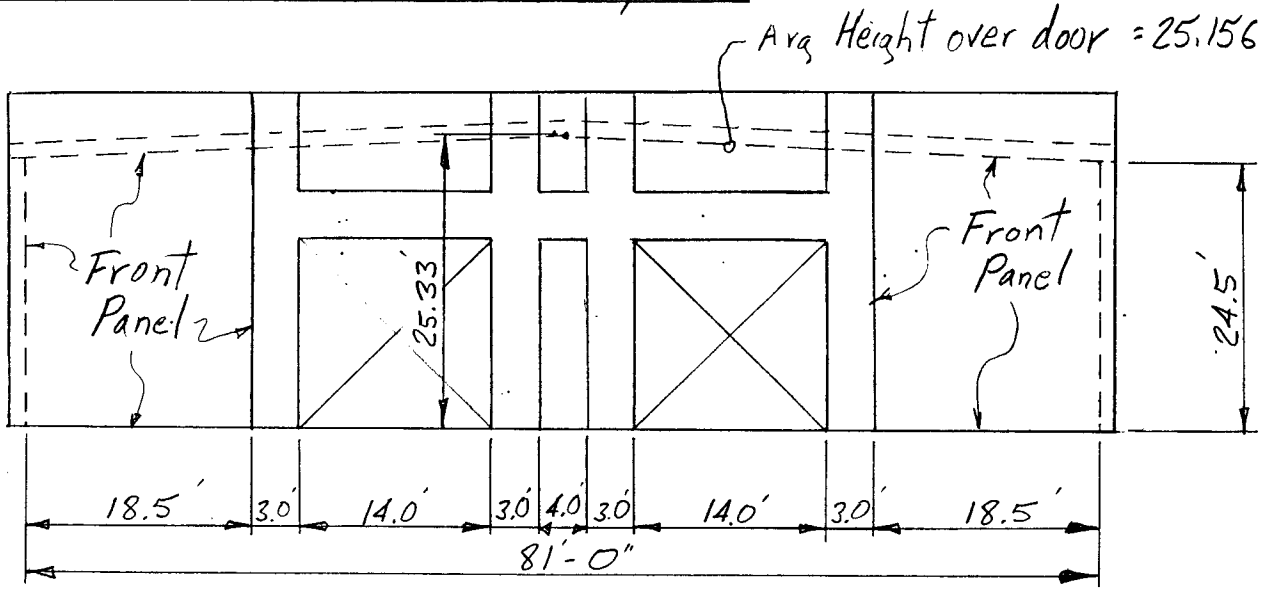
Check Door Support Widths to Insure Door Doesn't Blow thru Opening





FRONT HEADWALL PANEL

Front Wall Panel Analysis



Front Headwall Elevation

Blast Loads on Front Headwall

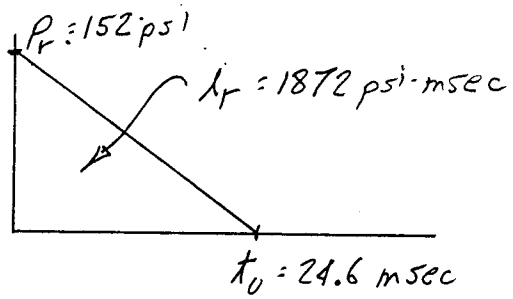
$i_{r\alpha} = 1872$ psi-msec

$P_{r\alpha} = 152$ psi

$t_o = 24.6$ msec

From: Design Blast Loads for Headwall and Door MILCON P-137 9 April, 1992

By: Phil Wager & Bill Keenan



Material Strengths

Concrete

$f'c = 4,000$

$f'dc = 1.19 \times 4000 = 4,760$ psi

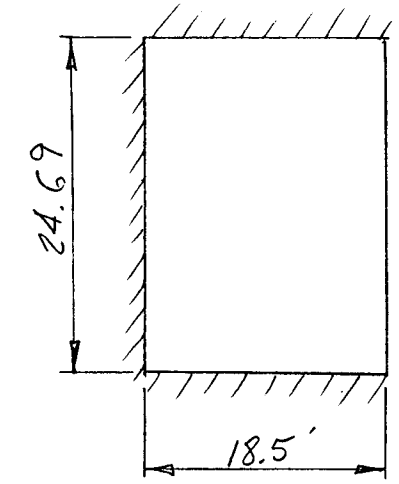
Reinforcing Steel

$fy = 66,000$

$fdy = 1.17 \times 66,000 = 77,220$ psi

Front Wall Panel Analysis

Design Front Wall Panel, Far Side of Door Pilasters



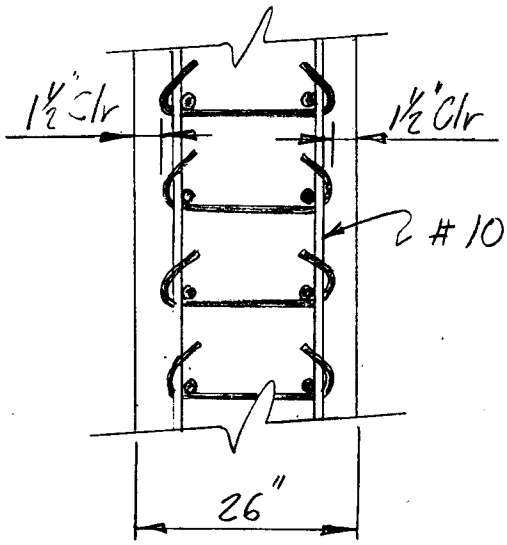
Avg Height = $24.5 + .02083(\frac{18.5}{2}) = 24.69$ ft.

Use Panel fixed on 3-Sides.

"d" Distances: (Same for both Sides)

Vert = $26 - 1\frac{1}{2} - \frac{5}{8} - \frac{1.27}{2} = 23.24$"

Horiz = $23.24 - 1.27 = 21.97$"



Try Using 26" Thick Wall

w/ #10's @ 8" EWEF

$A_s = 1.27 \times \frac{12}{8} = 1.91$ in²

Run CBARCS to Determine Dynamic Design Properties

Input File: Frtwall5.In
Output File: Frtwall5.Out

From Output File: Mass = 3649.84 lbs-ms

K_E = 83.65 psi

r_u = 82.88 psi

Using Dynamic Design Properties from CBARCS (Frtwall5.Out)

Run SOLVER to determine Dynamic Deflections
Input File: Frtwall5
Output File: Frtwall5.out

From Output File, Max Deflection, $\Delta_x = 4.015$ Inches

Allowable Max Deflection, $\Delta_A = \frac{24.62 \times 12 \times \tan 2^\circ}{2} = 5.16''$

Since $\Delta_A = 5.16'' > \Delta_x = 4.015''$ Deflect is OK

Check Shear Design

Diagonal Shear $\rho = \frac{A_s}{bd} = \frac{1.91}{12(23.24)} = .0068$

$v_c = [1.9(f'_{dc})^{1/2} + 2500\rho] \leq 3.5(f'_{dc})^{1/2}$ $f'_{dc} = 4000 \times 1.0$

$[1.9(4000)^{1/2} + 2500(.0068)] \leq 3.5(4000)^{1/2}$

$= 137.2 \text{ psi} \leq 221.4 \text{ psi}$

(From CBARCS)
$v_{u\,ed} = 335.59 \text{ psi} > 137.2 \text{ psi}$ Shear Reinf Required

Area of Stirrups Required

$A_V = [(v_u - v_c) b_s s_s] / \phi f_{ds}$

$= \frac{(335.59 - 137.2) \times 8 \times 8}{.85 \times 66{,}000} = 0.23 \text{ in}^2$

Use #5 Stirrups @ 8" on Center, EW

Mason & Hanger Engineering, Inc.
Lexington, Kentucky

File	2446.01 Page
Sheet	of Sheets
Date	9/98
Computed By	TA
Checked By	

Project P-501 ADCAP Magazine Location NWS Yorktown, VA

Subject Front Wall Panel

Check Direct Shear Capacity

Max Support Shear, $V_u = 8829.93$ lbs /Inch

Concrete Capacity $V_c = 0.18 f'_c b d$

$= 0.18 (4400)(1)(23.24)$

$= 18,406.08$ lbs /In

Therefore, $V_c = 18,406.08 > V_u = 8829.93$ lbs/In OK

No Diagonal Steel will be Required

Use SOLVER to Check Panel Deflections

Input File: Frtwall5
Output File: Frtwall5.out

From SOLVER Output: Max Deflection = 4.015"

2° Allowable Deflection, $\Delta_x = \frac{24.5 \times 12}{2} \times \tan 2° = 5.13"$
Use 2° to Eliminate Diagonal Bars

Since Allowable $\Delta_x >$ Actual Δ_x 5.13" > 4.015"

Use 26" Front Panel with #10 @ 8 EWEF
with #5 Stirrups @ 8" EW

Frtwall5. In
cBARCS Program

```
100  0,0,0,0,1.17
110  P298 MAGAZINE - 18.5 X 24.92 FRONT WALL PANEL, 26" THICK
120  0,1,0,0,0,0
130  350000,1,0,0,0,0,0,0
140  1872,18.5,24.92,152.0,24.6,0,0,0,0,0,0
150  4760,66000,26,2,3,0,0,0
160  1.89,1.89,1.89,1.89,3.26,2.76,4.53,4.03•
```

Mass = 3649.84

K_e = 83.65

r_u = 82.88

For Raising Wall Height 4'-0"
Using 26" Wall

Frtwall5.out
CBARCS Output

P298 MAGAZINE - 18.5 X 24.92 FRONT WALL PANEL, 26" THICK

BLAST WALL HEIGHT	18.50 FT
BLAST WALL LENGTH	24.92 FT
DURATION OF LOAD	24.60000 MSEC
FICTITIOUS PEAK PRESSURE	152.00000 PSI
EFFECTIVE IMPULSE	1872.00 PSI MS

HEIGHT 222.00 IN . LENGTH 299.04 IN

DYNAMIC CONCRETE STRENGTH	4760.00
DYNAMIC STEEL STRESS	77220.00
THICKNESS CONCRETE INCHES	26.0000
THICKNESS OF SAND INCHES	.0000
THETA ALLOWABLE DEGREES	2.0000

AREA VERT TOP STEEL/FT	1.8900	COVER	3.2600
AREA VERT BOT STEEL/FT	1.8900	COVER	2.7600
AREA HORIZ TOP STEEL/FT	1.8900	COVER	4.5300
AREA HORIZ BOT STEEL/FT	1.8900	COVER	4.0300

TYPE 1 CONSTRUCTION

CONCRETE MODULUS PSI	3555611.
RATIO MOD STEEL/CONCRETE	8.16
GROSS MOMENT INERTIA	1464.67
AVE CRACKED MOM INERTIA	422.92
AVE MOMENT INERTIA	943.80
AVERAGE PERCENT STEEL	.0071
D FACTOR MU=1/6	3451727886.
D FACTOR MU= 0.3	3687658981.

ALLOW SHEAR UNREINFORCED WEB 114.65 PSI 2562.90 LBS/IN WIDTH

ALLOW SHEAR AT SUPPORT 753.98 PSI 16855.31 LBS/IN WIDTH

UNREINFORCED CONCRETE THETA LE 2 DEG

POSITIVE VERTICAL MOMENT	264368.84
NEGATIVE VERTICAL MOMENT	258287.77
POSITIVE HORIZONTAL MOMENT	248922.91
NEGATIVE HORIZONTAL MOMENT	242841.84

SUPPORT ON 3 SIDES

YIELD LINE Y ABOVE FLOOR

LOCATION YIELD LINE LENGTH 149.52

LOCATION YIELD LINE HEIGHT	177.57	
ULTIMATE LOAD CAPACITY RU	82.8753	
SHEAR LOAD AT VERTICAL SUPPORT	8579.38	LB/IN WIDTH
SHEAR LOAD AT HORIZONTAL SUPPORT	8829.93	LB/IN WIDTH
SHEAR AT DISTANCE FROM VERTICAL SUPPORT	323.65	PSI
SHEAR AT DISTANCE FROM HORIZONTAL SUPPORT	335.59	PSI
ALLOWABLE MAX DEFLECTION	5.2301	

SHEAR CAPACITY(VC) EXCEEDED

LOAD MASS FACTOR	.6248
MASS CONCRETE ONLY	3649.84

FIRST YIELD POINT AT PT 2	
ELASTIC LIMIT RE PSI	33.32
ELASTIC DEFLECTION XE	.2349
SECOND YIELD AT PT 3	
ELASTO PLASTIC LIMIT	44.54
ELASTO-PLASTIC DEFLECTION	.4140
ULTIMATE RESISTANCE	82.88
PLASTIC DEFLECTION	1.3338

ULTIMATE RESISTANCE RU	82.88
ELASTIC DEFLECTION LIMIT XE	.9908
STIFFNESS KE	83.65

MASS	3649.842
LOAD	152.000
DURATION	24.600
RESISTANCE	82.875
STIFFNESS	83.648

GAS PRESSURE	.00	DURATION	.00
NATURAL PERIOD			41.503806
MAXIMUM DEFLECTION			4.042972
TIME TO MAXIMUM DEFLECTION			27.378648
DURATION/NATURAL PERIOD			.592717
LOAD/RESISTANCE			1.834080
ELASTIC DEFLECTION LIMIT			.990759

MAX FRAGMENT SPALL VELOCITY FT/SEC 18.077955

Frtwall5
SOLVER Program

```
SOLVE    FRTWALL5: ANALYSIS OF 26" WALL: 24.9167' x 18.5' W/ #10 @ 8"
EWEF
    1     1        .05        200                                    -1

    2     2     3649.8       0.01
    1      83.65      82.88                    1.0        1.0
    3        0.0                        10      1.0        0.0
    1      83.65     -82.88                    1.0        1.0
    3        0.0                       -10      1.0        0.0
    1     3
        0.0        152       24.6        0.0         40        0.0
STOP
```

Frtwall5.out
SOLVER Output

```
1ONE DEGREE OF FREEDOM SOLVER INPUT
 VERSION 2.2  FEB 1989

 PROBLEM DESCRIPTION
 SOLVE   FRTWALL5: ANALYSIS OF 26" WALL: 24.9167' x 18.5' W/ #10 @ 8"
EWEF


 ANALYSIS CONTROL CARD

 TYPE OF SOLUTION.....................    1
   EQ. 0,  DEFAULTS TO 1
   EQ. 1,  NEWMARK-BETA METHOD
   EQ. 2,  WILSON-THETA METHOD
 NUMBER OF LOAD CASES.................    1
 TIME STEP............................    0.0500
 TIME LIMIT...........................  200.0000
 NEWMARK*S GAMMA......................    0.0000
   EQ. 0.0, DEFAULTS TO 0.5
 NEWMARK*S BETA.......................    0.0000
   EQ. 0.0, DEFAULTS TO 0.25
 WILSON*S THETA.......................    0.0000
   EQ. 0.0, DEFAULTS TO 1.4
 PRINT OPTION.........................   -1
   EQ. 0, DEFAULTS TO 1
   EQ. 1, PRINT EVERY STEP
   EQ. N, PRINT EVERY N-TH STEP
   EQ. -1, PRINT SIGNIFICANT CHANGES


 INITIAL CONDITIONS

 INITIAL DEFLECTION...................    0.0000
 INITIAL VELOCITY.....................    0.0000
 INITIAL ACCELERATION.................    0.0000


 STIFFNESS CONTROL CARD

 NUMBER OF STIFFNESSES................    2
 NUMBER OF REBOUND STIFFNESSES........    2
 MASS.................................    3649.8000
 PERCENT OF CRITICAL DAMPING..........       0.0100


 INITIAL RESISTANCE-DEFLECTION CURVE

 NUMBER  MODE   STIFFNESS  RESISTANCE    YLD DEFL   MASS FACT   DAMP
FRAC

      1     1 0.83650E+02 0.82880E+02 0.00000E+00        1.00
1.00
      2     3 0.00000E+00 0.00000E+00 0.10000E+02        1.00
0.00


 REBOUND RESISTANCE-DEFLECTION CURVE

 NUMBER  MODE   STIFFNESS  RESISTANCE    YLD DEFL   MASS FACT   DAMP
FRAC
```

```
      3      1 0.83650E+02-0.82880E+02 0.00000E+00         1.00
1.00
      4      3 0.00000E+00 0.00000E+00-0.10000E+02         1.00
0.00


 LOAD DATA

 LOAD CASE NUMBER.....................    1
 NUMBER OF LOAD POINTS................    3


 POINT              TIME              LOAD
     1            0.0000          152.0000
     2           24.6000            0.0000
     3           40.0000            0.0000


 GENERATED RESISTANCE - DEFLECTION CURVES

 NATURAL PERIOD.......................   41.5032

 NUMBER  MODE   STIFFNESS  RESISTANCE    YLD DEFL   MASS FACT   DAMP
FRAC
      1      1 0.83650E+02 0.82880E+02 0.99079E+00         1.00
1.00
      2      3 0.00000E+00 0.82880E+02 0.10000E+02         1.00
0.00
      3      1 0.83650E+02-0.82880E+02-0.99079E+00         1.00
1.00
      4      3 0.00000E+00-0.82880E+02-0.10000E+02         1.00
0.00
1* * * * NEWMARK-BETA SOLUTION * * * * *
 LOAD CASE.............................    1
 TIME STEP.............................    0.0500


 * * * * * SOLUTION RESULTS  * * * * * *
          STEP   TIME STIF DEFLECTION   VELOCITY        ACC RESISTANCE
LOAD

 ELAS     0    0.0000    1      0.000     0.0000     0.0416       0.00
152.00
 *CHG   156    7.7865    2      0.991     0.2060     0.0051      82.88
103.89
 REB    548   27.4000    1      4.015    -0.0001    -0.0227      82.88
0.00
 *CHG   757   37.8360    3      3.024    -0.1476     0.0004       0.00
0.00
 RLOD   963   48.1500    3      2.064     0.0001     0.0220     -80.32
0.00
 *CHG  1172   58.5888    1      3.024     0.1431    -0.0004       0.00
0.00
 REB   1378   68.9000    1      3.954     0.0000    -0.0213      77.83
0.00
 *CHG  1587   79.3415    3      3.024    -0.1387     0.0004       0.00
0.00
 RLOD  1794   89.7000    3      2.122     0.0010     0.0207     -75.42
0.00
 *CHG  2002  100.0942    1      3.024     0.1344    -0.0004       0.00
0.00
```

```
 REB  2209   110.4500     1       3.898     -0.0009     -0.0200       73.09
0.00
 *CHG 2417   120.8470     3       3.024     -0.1302      0.0004        0.00
0.00
 RLOD 2624   131.2000     3       2.177      0.0008      0.0194      -70.83
0.00
 *CHG 2832   141.5997     1       3.024      0.1262     -0.0004        0.00
0.00
 REB  3039   151.9500     1       3.844     -0.0008     -0.0188       68.64
0.00
 *CHG 3248   162.3524     3       3.024     -0.1223      0.0004        0.00
0.00
 RLOD 3454   172.7000     3       2.229      0.0007      0.0182      -66.52
0.00
 *CHG 3663   183.1051     1       3.024      0.1185     -0.0004        0.00
0.00
 REB  3869   193.4500     1       3.794     -0.0006     -0.0177       64.46
0.00

 ***** TIME LIMIT REACHED

 MAXIMUM DEFLECTION IN SOLUTION
 STEP NUMBER.............................  547
 TIME AT MAXIMUM.........................      27.3500
 MAXIMUM DEFLECTION......................       4.015

 MINIMUM DEFLECTION IN SOLUTION
 STEP NUMBER.............................  962
 TIME AT MINIMUM.........................      48.1000
 MINIMUM DEFLECTION......................       2.064


SOLUTION TIME LOG
   ASSEMBLY.....................          0.06
   SDOF SOLUTION.(LOAD CASE  1)...        0.05

   TOTAL TIME.....................        0.11
1ONE DEGREE OF FREEDOM SOLVER INPUT
 VERSION 2.2  FEB 1989

 PROBLEM DESCRIPTION
 STOP


 ***** END SOLVER RUNS *****
```

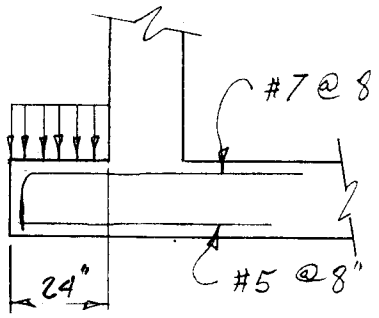
Mason & Hanger Engineering, Inc.
Lexington, Kentucky

File	Page
Sheet	of Sheets
Date	
Computed By	
Checked By	

Project P-298 Location Port Hadlock

Subject Wingwall Design

Design Wall Cantilever - Next to Magazine Headwall



Soil Pressure @ Base of Wall

$P = 2 \times 60\ pcf \times 27.25 = 3.3$

$\frac{1}{2} \times 60 \times (27.25)^2 = 22.3$

25.6 Kips

$M_n = \frac{wl^2}{2} = \frac{25.6(1.92)^2}{2} = 47.2$ ft-Kips

$M_u = 1.7 \times 47.2 = 80.24$ ft-Kips

$d = 23 - 1\frac{1}{2} - \frac{1}{2}\left(\frac{10}{8}\right) = 20.875"$

$\frac{M_u}{\phi b d^2} = \frac{80.24 \times 12{,}000}{0.9 \times 12 \times (20.875)^2} = 205$ $\quad \rho_{req'd} = .00352$

$A_{s\ req'd} = .00352 \times 12 \times 20.875 = 0.88\ in^2$

Use #7 @ 8" $\quad A_s = 0.60 \times \frac{12}{8} = 0.9\ in^2$

Wall Cantilever @ Mechanical Rm

Soil Pressure: $P = 2 \times 60\ pcf \times 19.75 = 2.37$

$\frac{1}{2} \times 60 \times (19.75)^2 = 11.70$

14.07 Kips

$M_n = \frac{wl^2}{2} = \frac{14.07(2)^2}{2} = 28.14$ ft-Kips

$M_u = 1.7 \times 28.14 = 47.84$ $\quad d = 18 - 1\frac{1}{2} - \frac{1}{2}\left(\frac{8}{8}\right) = 16.0$

$\frac{M_u}{\phi b d^2} = \frac{47.84 \times 12{,}000}{.9 \times 12 \times (16.0)^2} = 208$ $\quad \rho = .00357$

$A_{s\ req'd} = .00357 \times 12 \times 16 = 0.69\ in^2$

Use #7 @ 8" $\quad A_s = 0.6 \times \frac{12}{8} = 0.90\ in^2$

Front Wall Extension
& Wingwall

```
100  0,0,0,0,1.17
110  P298 MAGAZINE - 18.583 X 20.92 FRONT WALL PANEL
120  0,1,0,0,0,0
130  350000,1,0,0,0,0,0,0
140  1872,1.25,20.92,152.0,24.6,0,0,0,0,0,0
150  4760,66000,23,2,3,0,0,0
160  1.89,1.89,1.89,1.89,3.26,2.76,4.53,4.03•
```

P298 MAGAZINE - 18.583 X 20.92 FRONT WALL PANEL

BLAST WALL HEIGHT	1.25 FT
BLAST WALL LENGTH	20.92 FT
DURATION OF LOAD	24.60000 MSEC
FICTITIOUS PEAK PRESSURE	152.00000 PSI
EFFECTIVE IMPULSE	1872.00 PSI MS

HEIGHT 15.00 IN LENGTH 251.04 IN

DYNAMIC CONCRETE STRENGTH	4760.00
DYNAMIC STEEL STRESS	77220.00
THICKNESS CONCRETE INCHES	23.0000
THICKNESS OF SAND INCHES	.0000
THETA ALLOWABLE DEGREES	2.0000

AREA VERT TOP STEEL/FT	1.8900	COVER	3.2600
AREA VERT BOT STEEL/FT	1.8900	COVER	2.7600
AREA HORIZ TOP STEEL/FT	1.8900	COVER	4.5300
AREA HORIZ BOT STEEL/FT	1.8900	COVER	4.0300

TYPE 1 CONSTRUCTION

CONCRETE MODULUS PSI	3555611.
RATIO MOD STEEL/CONCRETE	8.16
GROSS MOMENT INERTIA	1013.92
AVE CRACKED MOM INERTIA	306.96
AVE MOMENT INERTIA	660.44
AVERAGE PERCENT STEEL	.0081
D FACTOR MU=1/6	2415412666.
D FACTOR MU= 0.3	2580509967.

ALLOW SHEAR UNREINFORCED WEB 116.97 PSI 2264.02 LBS/IN WIDTH

ALLOW SHEAR AT SUPPORT 753.98 PSI 14593.36 LBS/IN WIDTH

UNREINFORCED CONCRETE THETA LE 2 DEG

POSITIVE VERTICAL MOMENT	227882.39
NEGATIVE VERTICAL MOMENT	221801.32
POSITIVE HORIZONTAL MOMENT	212436.46
NEGATIVE HORIZONTAL MOMENT	206355.39

SUPPORT ON 3 SIDES

YIELD LINE X FROM SIDE

LOCATION YIELD LINE LENGTH 27.49

LOCATION YIELD LINE HEIGHT	15.00	
ULTIMATE LOAD CAPACITY RU	2769.9255	
SHEAR LOAD AT VERTICAL SUPPORT	45695.08	LB/IN WIDTH
SHEAR LOAD AT HORIZONTAL SUPPORT	38400.21	LB/IN WIDTH
SHEAR AT DISTANCE FROM VERTICAL SUPPORT	582.45	PSI
SHEAR AT DISTANCE FROM HORIZONTAL SUPPORT	-650.88	PSI
ALLOWABLE MAX DEFLECTION	.5247	

SHEAR CAPACITY(VC) EXCEEDED

LOAD MASS FACTOR	.6435
MASS CONCRETE ONLY	3325.39

FIRST YIELD POINT AT PT 2	
ELASTIC LIMIT RE PSI	1274.08
ELASTIC DEFLECTION XE	.0031
SECOND YIELD AT PT 3	
ELASTO PLASTIC LIMIT	2032.20
ELASTO-PLASTIC DEFLECTION	.0049
ULTIMATE RESISTANCE	2769.93
PLASTIC DEFLECTION	.0372

ULTIMATE RESISTANCE RU	2769.93
ELASTIC DEFLECTION LIMIT XE	.0148
STIFFNESS KE	186611.35

MASS	3325.394
LOAD	152.000
DURATION	24.600
RESISTANCE	2769.925
STIFFNESS	186611.352

GAS PRESSURE	.00	DURATION	.00
NATURAL PERIOD			.838749
MAXIMUM DEFLECTION			.001605
TIME TO MAXIMUM DEFLECTION			.416834
DURATION/NATURAL PERIOD			29.329392
LOAD/RESISTANCE			.054875
ELASTIC DEFLECTION LIMIT			.014843

MAX FRAGMENT SPALL VELOCITY FT/SEC .502451

Front Wall Panel & Sidewall Capacities

Since Front Wall Panel is 26" Thick Increase Moment Capacity of 24" Sidewall Panel to Match Front Wall.

Calculate Horiz Moment Capacity of 26" Wall

$d = 26 - 2 - 1.27 - \frac{1.27}{2} = 22.1"$ Reinf = #10 @ 8"

$A_s = 1.27 \times \frac{12}{8} = 1.91 \text{ in}^2$ $\rho = \frac{A_s}{bd} = \frac{1.91}{12(22.1)} = .0072$

From $\frac{Mu}{\phi b d^2}$ Chart, for $\rho = .0072$

$\frac{Mu}{\phi b d^2} = 406$ Solve for Mu

$Mu = 406 \times .9 \times 12 \times (22.1)^2 = 2,141,580 \text{ in-lbs}$

Determine A_s Required for 24" Wall

$d = 24 - 2 - 1.27 - \frac{1.27}{2} = 20.1$

$\frac{Mu}{\phi b d^2} = \frac{2,141,580}{.9(12)(20.1)^2} = 491$ $\rho_{Req'd} = .00883$

A_s Req'd $= .00883 \times 12 \times 20.1 = 2.13$

A_s Prov'd = #10 @ 8, $A_s = 1.27 \times \frac{12}{8} = 1.91$

Additional Stl. Required $= 2.13 - 1.91 = 0.22 \text{ in}^2/\text{ft}$.

Use Additional #5 @ 8 / Between #10's $A_s = .47 \text{ in}^2/\text{ft}$

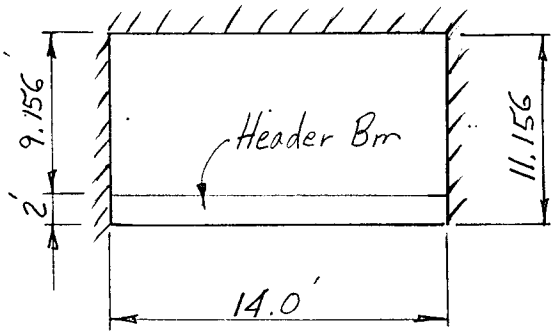
PANEL OVER DOOR

Mason & Hanger Engineering, Inc.
Lexington, Kentucky

Project P-501 ADCAP Magazines Location NWS Yorktown, VA
Subject Front Headwall

File 2446.01 Page
Sheet of Sheets
Date 9/98
Computed By TA
Checked By Faj.

Design Wall Panel Over Doors Fixed 3 Sides
Combine Header Beam with Wall Panel
To Determine Panel Reactions + Deflections



Try 26" Thick Panel
with #7 @ 8 EWEF

$Clr_{vert} = 2 + \frac{1}{2} + \frac{.875}{2} = 2.94$

$Clr_{Horiz} = 2.94 + .875 = 3.82$

Run CBARCS to determine Panel Dynamic Properties

From Output File: Topwal43.out

$M_E = 3685.95$ psi-ms
$K_E = 735.32$ psi
$r_u = 109.22$ psi

Determine Reactions From Panel to Pilaster

From CBARCS, Horizontal Support Reaction = 6768.77 lbs/In

Reaction on Roof Slab $= \frac{6768.77}{24} = 282.0$ psi

From CBARCS, Vertical Support Reaction = 6466.66 lbs/In

Reaction on Pilaster $= \frac{6466.66}{36} = 179.63$ psi

Use #7 @ 8" EWEF

Determine Reactions from Header Bm to Pilaster

From CBARCS, End Support Reaction = 12,368 lbs/In

Reaction on Pilaster = $\frac{12,368}{36}$ = 343.56 psi

Check Shear Design

Diagonal Shear $\rho = \frac{A_s}{bd} = \frac{.875 \times 1\frac{7}{8}}{12(22.18)} = .0049$

$v_c = [1.9(f'dc)^{1/2} + 2500\rho] \leq 3.5(f'dc)^{1/2}$

$= [1.9(4000)^{1/2} + 2500(.0049)] \leq 3.5(4000)^{1/2}$

132.4 psi $\leq$ 221.4 psi

(From CBARCS: Topwal43.Out)(@ d distance)

v_u = 221.30 psi > 132.4 psi Stirrups Required

Area of Stirrups Required

$A_v = (v_u - v_c) b_s S_s] / \phi f_{ds}$

$= \frac{(221.3 - 132.4) \times 8 \times 8}{.85 \times 66,000} = 0.101\ in^2$

Use #4 (min) Stirrups @ 8" on Center, EW

Check Direct Shear Capacity

Max Support Shear, $V_u = 6,768.77$ lbs/In.

Concrete Capacity, $V_c = 0.18 f'_c b d$

$= .0.18(4400)(1)(22.18)$

$= 17,566.56$ lbs/In.

Since $V_c = 17,566.56 > V_u = 6,768.77$ lbs/In.

No Diagonal Steel will be Required

Use SOLVER to Check Panel Deflections

Input File: Topwal20
Output File: Topwal20.out

From SOLVER: Max. Deflection = 1.184".

Max Allowable $\Delta_x = \frac{14 \times 12}{2} \times \tan 2^\circ = 2.93" > 1.18"$ OK

Use 26" Panel with #7 @ 8" EWEF

Use #4 Stirrups @ 8" EW

For Panel Above Door

Topwal43.in

CBARCS Program

```
100  0,0,0,0,1.17
110  P501 - 11.156 X 14.0 X 26" ABOVE DOOR PANEL, FIXED 3 SIDES, #7@8
120  0,1,0,0,0,0
130  350000,1,0,0,0,0,0,0
140  1872,11.156,14.00,152.0,24.6,0,0,0,0,0,0
150  4760,66000,26,4,3,0,0,0
160  0.90,0.90,0.90,0.90,2.94,2.94,3.82,3.82
```

#7 @ 8" $A_s = 0.60 \times \frac{12}{8} = 0.90\ in^2$

$M_E = 3685.95$ psi-ms

$K_E = 735.32$ psi

$f_u = 109.22$ psi

Topwal43.out
CBARCS

P501 - 11.156 X 14.0 X 26" ABOVE DOOR PANEL, FIXED 3 SIDES, #7@8

BLAST WALL HEIGHT	11.16 FT
BLAST WALL LENGTH	14.00 FT
DURATION OF LOAD	24.60000 MSEC
FICTITIOUS PEAK PRESSURE	152.00000 PSI
EFFECTIVE IMPULSE	1872.00 PSI MS

HEIGHT 133.87 IN LENGTH 168.00 IN

DYNAMIC CONCRETE STRENGTH	4760.00
DYNAMIC STEEL STRESS	77220.00
THICKNESS CONCRETE INCHES	26.0000
THICKNESS OF SAND INCHES	.0000
THETA ALLOWABLE DEGREES	4.0000

AREA VERT TOP STEEL/FT	.9000	COVER	2.9400
AREA VERT BOT STEEL/FT	.9000	COVER	2.9400
AREA HORIZ TOP STEEL/FT	.9000	COVER	3.8200
AREA HORIZ BOT STEEL/FT	.9000	COVER	3.8200

TYPE 3 CONSTRUCTION

CONCRETE MODULUS PSI	3555611.
RATIO MOD STEEL/CONCRETE	8.16
GROSS MOMENT INERTIA	1464.67
AVE CRACKED MOM INERTIA	232.09
AVE MOMENT INERTIA	848.38
AVERAGE PERCENT STEEL	.0033
D FACTOR MU=1/6	3102765198.
D FACTOR MU= 0.3	3314844138.

ALLOW SHEAR UNREINFORCED WEB 106.71 PSI 2413.75 LBS/IN WIDTH

ALLOW SHEAR AT SUPPORT 753.98 PSI 17055.12 LBS/IN WIDTH

UNREINFORCED CONCRETE THETA LE 2 DEG

POSITIVE VERTICAL MOMENT	116524.98
NEGATIVE VERTICAL MOMENT	116524.98
POSITIVE HORIZONTAL MOMENT	106331.94
NEGATIVE HORIZONTAL MOMENT	106331.94

SUPPORT ON 3 SIDES

YIELD LINE Y ABOVE FLOOR

LOCATION YIELD LINE LENGTH 84.00

LOCATION YIELD LINE HEIGHT	103.29	
ULTIMATE LOAD CAPACITY RU	109.2190	
SHEAR LOAD AT VERTICAL SUPPORT	6466.66	LB/IN WIDTH
SHEAR LOAD AT HORIZONTAL SUPPORT	6768.77	LB/IN WIDTH
SHEAR AT DISTANCE FROM VERTICAL SUPPORT	206.37	PSI
SHEAR AT DISTANCE FROM HORIZONTAL SUPPORT	221.30	PSI
ALLOWABLE MAX DEFLECTION	5.8837	

SHEAR CAPACITY(VC) EXCEEDED

LOAD MASS FACTOR	.6310
MASS CONCRETE ONLY	3685.95

FIRST YIELD POINT AT PT 2	
ELASTIC LIMIT RE PSI	45.82
ELASTIC DEFLECTION XE	.0375
SECOND YIELD AT PT 3	
ELASTO PLASTIC LIMIT	62.47
ELASTO-PLASTIC DEFLECTION	.0700
ULTIMATE RESISTANCE	109.22
PLASTIC DEFLECTION	.2020

ULTIMATE RESISTANCE RU	109.22
ELASTIC DEFLECTION LIMIT XE	.1485
STIFFNESS KE	735.32

MASS	3685.945
LOAD	152.000
DURATION	24.600
RESISTANCE	109.219
STIFFNESS	735.319

GAS PRESSURE	.00	DURATION	.00
NATURAL PERIOD			14.067468
MAXIMUM DEFLECTION			1.183150
TIME TO MAXIMUM DEFLECTION			17.575435
DURATION/NATURAL PERIOD			1.748715
LOAD/RESISTANCE			1.391699
ELASTIC DEFLECTION LIMIT			.148533

MAX FRAGMENT SPALL VELOCITY FT/SEC 7.926536

Topwal20
SOLVER Program

```
SOLVE    TOPWAL20: ANALYSIS OF 11.156 x 14.0 x 26" ABOVE DR PANEL, FIXED
3S
    1    1        .05        200                                        -1

    2    2   3685.95       0.01
    1    735.32    109.22                      1.0        1.0
    3       0.0                    10         1.0        0.0
    1    735.32   -109.22                      1.0        1.0
    3       0.0                   -10         1.0        0.0
    1    3
       0.0        152       24.6        0.0         40         0.0
STOP
```

Topwal20.out
SOLVER Output

```
1ONE DEGREE OF FREEDOM SOLVER INPUT
 VERSION 2.2  FEB 1989

 PROBLEM DESCRIPTION
 SOLVE    TOPWAL20: ANALYSIS OF 11.156 x 14.0 x 26" ABOVE DR PANEL, FIXED
3S


 ANALYSIS CONTROL CARD

 TYPE OF SOLUTION.....                    1
   EQ. 0,  DEFAULTS TO 1
   EQ. 1,  NEWMARK-BETA METHOD
   EQ. 2,  WILSON-THETA METHOD
 NUMBER OF LOAD CASES.....                1
 TIME STEP.....                      0.0500
 TIME LIMIT.....                   200.0000
 NEWMARK*S GAMMA.....                0.0000
   EQ. 0.0, DEFAULTS TO 0.5
 NEWMARK*S BETA.....                 0.0000
   EQ. 0.0, DEFAULTS TO 0.25
 WILSON*S THETA.....                 0.0000
   EQ. 0.0, DEFAULTS TO 1.4
 PRINT OPTION.....                        -1
   EQ. 0, DEFAULTS TO 1
   EQ. 1, PRINT EVERY STEP
   EQ. N, PRINT EVERY N-TH STEP
   EQ. -1, PRINT SIGNIFICANT CHANGES


 INITIAL CONDITIONS

 INITIAL DEFLECTION.....             0.0000
 INITIAL VELOCITY.....               0.0000
 INITIAL ACCELERATION.....           0.0000


 STIFFNESS CONTROL CARD

 NUMBER OF STIFFNESSES.....               2
 NUMBER OF REBOUND STIFFNESSES.....       2
 MASS.....                         3685.9500
 PERCENT OF CRITICAL DAMPING.....     0.0100


 INITIAL RESISTANCE-DEFLECTION CURVE

 NUMBER  MODE   STIFFNESS  RESISTANCE   YLD DEFL   MASS FACT   DAMP.
FRAC

      1     1 0.73532E+03 0.10922E+03 0.00000E+00        1.00
1.00
      2     3 0.00000E+00 0.00000E+00 0.10000E+02        1.00
0.00


 REBOUND RESISTANCE-DEFLECTION CURVE

 NUMBER  MODE   STIFFNESS  RESISTANCE    YLD DEFL   MASS FACT   DAMP
FRAC
```

```
      3      1 0.73532E+03-0.10922E+03 0.00000E+00        1.00
1.00
      4      3 0.00000E+00 0.00000E+00-0.10000E+02        1.00
0.00
```

LOAD DATA

LOAD CASE NUMBER..... 1
NUMBER OF LOAD POINTS..... 3

POINT	TIME	LOAD
1	0.0000	152.0000
2	24.6000	0.0000
3	40.0000	0.0000

GENERATED RESISTANCE - DEFLECTION CURVES

NATURAL PERIOD..... 14.0675

```
 NUMBER  MODE   STIFFNESS  RESISTANCE    YLD DEFL   MASS FACT   DAMP
FRAC
      1      1 0.73532E+03 0.10922E+03 0.14853E+00        1.00
1.00
      2      3 0.00000E+00 0.10922E+03 0.10000E+02        1.00
0.00
      3      1 0.73532E+03-0.10922E+03-0.14853E+00        1.00
1.00
      4      3 0.00000E+00-0.10922E+03-0.10000E+02        1.00
0.00
1* * * * NEWMARK-BETA SOLUTION * * * * *
 LOAD CASE.....                1
 TIME STEP.....                0.0500
```

```
 * * * * * SOLUTION RESULTS  * * * * * *
          STEP   TIME STIF DEFLECTION   VELOCITY        ACC RESISTANCE
LOAD

 ELAS     0    0.0000    1      0.000     0.0000     0.0412       0.00
152.00
 *CHG    60    2.9677    2      0.149     0.0821     0.0059     109.22
133.66
 REB    352   17.6000    1      1.184    -0.0004    -0.0179     109.22
43.25
 *CHG   443   22.1204    3      1.035    -0.0471     0.0046       0.00
15.32
 RLOD   511   25.5500    3      0.942     0.0006     0.0187     -68.93
0.00
 *CHG   582   29.0600    1      1.035     0.0412    -0.0004       0.00
0.00
 REB    652   32.6000    1      1.126    -0.0008    -0.0181      66.79
0.00
 *CHG   722   36.0944    3      1.035    -0.0399     0.0004       0.00
0.00
 RLOD   792   39.6000    3      0.947     0.0002     0.0176     -64.74
0.00
 *CHG   863   43.1287    1      1.035     0.0387    -0.0003       0.00
0.00
```

REB	933	46.6500	1	1.121	-0.0005	-0.0170	62.73
0.00							
*CHG	1004	50.1631	3	1.035	-0.0375	0.0003	0.00
0.00							
RLOD	1074	53.7000	3	0.953	0.0007	0.0165	-60.79
0.00							
*CHG	1144	57.1975	1	1.035	0.0364	-0.0003	0.00
0.00							
REB	1214	60.7000	1	1.116	-0.0001	-0.0160	58.92
0.00							
*CHG	1285	64.2319	3	1.035	-0.0352	0.0003	0.00
0.00							
RLOD	1355	67.7500	3	0.958	0.0004	0.0155	-57.09
0.00							
*CHG	1426	71.2663	1	1.035	0.0341	-0.0003	0.00
0.00							
REB	1496	74.8000	1	1.111	-0.0006	-0.0150	55.32
0.00							
*CHG	1567	78.3007	3	1.035	-0.0331	0.0003	0.00
0.00							
RLOD	1636	81.8000	3	0.963	0.0001	0.0145	-53.62
0.00							
*CHG	1707	85.3350	1	1.035	0.0321	-0.0003	0.00
0.00							
REB	1777	88.8500	1	1.106	-0.0003	-0.0141	51.96
0.00							
*CHG	1848	92.3694	3	1.035	-0.0311	0.0003	0.00
0.00							
RLOD	1918	95.9000	3	0.967	0.0005	0.0137	-50.35
0.00							
*CHG	1989	99.4038	1	1.035	0.0301	-0.0003	0.00
0.00							
REB	2058	102.9000	1	1.102	0.0000	-0.0132	48.80
0.00							
*CHG	2129	106.4382	3	1.035	-0.0292	0.0003	0.00
0.00							
RLOD	2199	109.9500	3	0.971	0.0002	0.0128	-47.29
0.00							
*CHG	2270	113.4726	1	1.035	0.0283	-0.0003	0.00
0.00							
REB	2340	117.0000	1	1.098	-0.0004	-0.0124	45.82
0.00							
*CHG	2411	120.5070	3	1.035	-0.0274	0.0002	0.00
0.00							
RLOD	2481	124.0500	3	0.975	0.0006	0.0120	-44.40
0.00							
*CHG	2551	127.5414	1	1.035	0.0266	-0.0002	0.00
0.00							
REB	2621	131.0500	1	1.094	-0.0002	-0.0117	43.03
0.00							
*CHG	2692	134.5757	3	1.035	-0.0257	0.0002	0.00
0.00							
RLOD	2762	138.1000	3	0.979	0.0003	0.0113	-41.70
0.00							
*CHG	2833	141.6101	1	1.035	0.0249	-0.0002	0.00
0.00							
REB	2903	145.1500	1	1.090	-0.0005	-0.0110	40.41
0.00							
*CHG	2973	148.6445	3	1.035	-0.0242	0.0002	0.00
0.00							
RLOD	3043	152.1500	3	0.982	0.0001	0.0106	-39.16

```
0.00
 *CHG 3114   155.6789     1       1.035      0.0234     -0.0002        0.00
0.00
 REB  3184   159.2000     1       1.087     -0.0003     -0.0103       37.95
0.00
 *CHG 3255   162.7133     3       1.035     -0.0227      0.0002        0.00
0.00
 RLOD 3325   166.2500     3       0.985      0.0004      0.0100      -36.77
0.00
 *CHG 3395   169.7477     1       1.035      0.0220     -0.0002        0.00
0.00
 REB  3465   173.2500     1       1.084     -0.0001     -0.0097       35.64
0.00
 *CHG 3536   176.7820     3       1.035     -0.0213      0.0002        0.00
0.00
 RLOD 3606   180.3000     3       0.989      0.0002      0.0094      -34.54
0.00
 *CHG 3677   183.8164     1       1.035      0.0207     -0.0002        0.00
0.00
 REB  3747   187.3500     1       1.081     -0.0004     -0.0091       33.47
0.00
 *CHG 3818   190.8508     3       1.035     -0.0200      0.0002        0.00
0.00
 RLOD 3887   194.3500     3       0.991      0.0000      0.0088      -32.44
0.00
 *CHG 3958   197.8852     1       1.035      0.0194     -0.0002        0.00
0.00

 ***** TIME LIMIT REACHED

 MAXIMUM DEFLECTION IN SOLUTION
 STEP NUMBER.............................  351
 TIME AT MAXIMUM.........................      17.5500
 MAXIMUM DEFLECTION......................       1.184

 MINIMUM DEFLECTION IN SOLUTION
 STEP NUMBER.............................  510
 TIME AT MINIMUM.........................      25.5000
 MINIMUM DEFLECTION......................       0.942


SOLUTION TIME LOG
   ASSEMBLY.....................          0.06
   SDOF SOLUTION.(LOAD CASE  1)...        0.11

   TOTAL TIME.....................        0.17
1ONE DEGREE OF FREEDOM SOLVER INPUT
 VERSION 2.2  FEB 1989

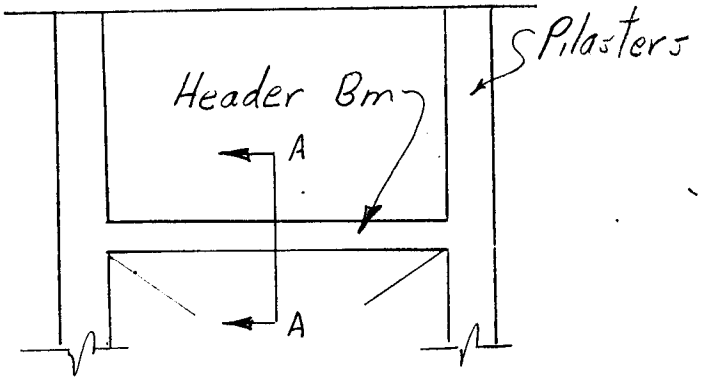
 PROBLEM DESCRIPTION
 STOP


 ***** END SOLVER RUNS *****
```

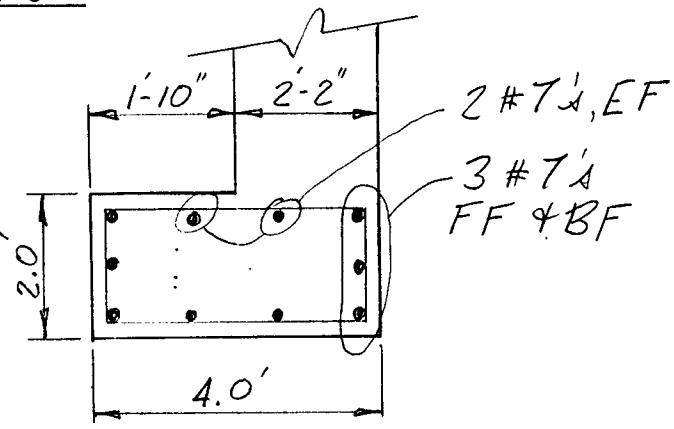
HEADER

BEAM

Header Beam Analysis



Headwall Above Doors



Section A-A

Use 2 ft wide x 4 ft deep Header Beam
w/ 3 #7's Front & Back Face

Run cBARCS to Determine Dynamic Properties
Input File: Header1.in
Output File: Header1.out

From Output File: $M_E = 7764.48$ psi-ms
$K_E = 7027.17$ psi
$r_u = 147.24$ psi

Reaction to Pilaster, $W_H = \frac{12,367.97 \text{ lbs/in}}{36 \text{ (Width of Pilaster)}}$

$W_H = 343.56$ psi

Check Beam Deflections, SOLVE Output: Header25.out

From Solver, Max Deflection = .096"

Max Allowable $\Delta_x = \frac{14 \times 12}{2} \times \tan 2^\circ = 2.93" > .096"$ OK
Header Beam Size is Adequate

Mason & Hanger Engineering, Inc.
Lexington, Kentucky

File 2246.01 Page
Sheet of Sheets
Date 9/98
Computed By TA
Checked By

Project P-501 ADCAP Magazines Location NWS Yorktown, VA

Subject Header Beam

$d = 48 - 1\frac{1}{2} - \frac{1}{2} - \frac{.875}{2} = 45.56"$

Diagonal Shear Design

$\rho = \frac{3 \times .875}{12 \times 45.56} = .0048$

$v_c = [1.9(4000)^{1/2} + 2500(.0048)]$

$v_c = 132.2$ psi

(From CBARCS)
$v_u = 124.22$ psi < 132.2 psi No Stirrups Required for Shear

Use Minimum #4 Stirrups @ 8"

Check Direct Shear Capacity

Max Support Shear, $V_u = 12,367.97$ lbs/In

Concrete Capacity, $V_c = 0.18 f'_c b d$

$= 0.18(4400)(1)(45.56)$
$= 36,083.52$ lbs/In

Since $V_c = 36,084 > V_u = 12,368$ lbs/In No Diagonal Steel Required

Use 24" x 48" Header Beam w/ 3 #7's Frt & Bck
2 #7's Top & Bott
#4 Stirrups @ 8"

Header 1. in
CBARCS Program

```
100  0,0,0,0,1.17
110  P501 MAGAZINE - 24" x 48" x 14' HEADER BEAM
120  0,1,0,0,0,0
130  350000,1,0,0,0,0,0,0
140  1872,14.00,2.00,152.0,24.6,0,0,0,0,0,0
150  4760,66000,48,2,6,0,0,0
160  0.90,0.90,0.30,0.30,2.438,2.438,1.75,1.75
```

$M_E = 7764.48$

$K_E = 7027.17$

$r_u = 147.24$

Header1.out
CBARCS Output

P501 MAGAZINE - 24" x 48" x 14' HEADER BEAM

BLAST WALL HEIGHT	14.00 FT
BLAST WALL LENGTH	2.00 FT
DURATION OF LOAD	24.60000 MSEC
FICTITIOUS PEAK PRESSURE	152.00000 PSI
EFFECTIVE IMPULSE	1872.00 PSI MS

HEIGHT 168.00 IN LENGTH 24.00 IN

DYNAMIC CONCRETE STRENGTH	4760.00
DYNAMIC STEEL STRESS	77220.00
THICKNESS CONCRETE INCHES	48.0000
THICKNESS OF SAND INCHES	.0000
THETA ALLOWABLE DEGREES	2.0000

AREA VERT TOP STEEL/FT	.9000	COVER	2.4380
AREA VERT BOT STEEL/FT	.9000	COVER	2.4380
AREA HORIZ TOP STEEL/FT	.3000	COVER	1.7500
AREA HORIZ BOT STEEL/FT	.3000	COVER	1.7500

TYPE 1 CONSTRUCTION

CONCRETE MODULUS PSI	3555611.
RATIO MOD STEEL/CONCRETE	8.16
GROSS MOMENT INERTIA	9216.00
AVE CRACKED MOM INERTIA	1033.72
AVE MOMENT INERTIA	5124.86
AVERAGE PERCENT STEEL	.0016
D FACTOR MU=1/6	18743068325.
D FACTOR MU= 0.3	20024186878.

ALLOW SHEAR UNREINFORCED WEB 103.16 PSI 4700.09 LBS/IN WIDTH

ALLOW SHEAR AT SUPPORT 753:98 PSI 34353.02 LBS/IN WIDTH

UNREINFORCED CONCRETE THETA LE 2 DEG

POSITIVE VERTICAL MOMENT	259727.31
NEGATIVE VERTICAL MOMENT	259727.31
POSITIVE HORIZONTAL MOMENT	88825.07
NEGATIVE HORIZONTAL MOMENT	88825.07

FIXED END BEAM

LOCATION YIELD LINE LENGTH	.00	
LOCATION YIELD LINE HEIGHT	84.00	
ULTIMATE LOAD CAPACITY RU	147.2377	
SHEAR LOAD AT VERTICAL SUPPORT	.00	LB/IN WIDTH
SHEAR LOAD AT HORIZONTAL SUPPORT	12367.97	LB/IN WIDTH

SHEAR AT DISTANCE FROM VERTICAL SUPPORT	.00 PSI
SHEAR AT DISTANCE FROM HORIZONTAL SUPPORT	124.22 PSI
ALLOWABLE MAX DEFLECTION	2.9383

LOAD MASS FACTOR	.7200
MASS CONCRETE ONLY	7764.48

SHEAR CAPACITY(VC) EXCEEDED

ELASTIC LIMIT RE PSI	110.43
ELASTIC DEFLECTION XE	.0126
ULTIMATE RESISTANCE	147.24
PLASTIC DEFLECTION	.0335

ULTIMATE RESISTANCE RU	147.24
ELASTIC DEFLECTION LIMIT XE	.0210
STIFFNESS KE	7027.17

MASS	7764.480
LOAD	152.000
DURATION	24.600
RESISTANCE	147.238
STIFFNESS	7027.169

GAS PRESSURE	.00	DURATION	.00
NATURAL PERIOD			6.604585
MAXIMUM DEFLECTION			.096061
TIME TO MAXIMUM DEFLECTION			7.789466
DURATION/NATURAL PERIOD			3.724685
LOAD/RESISTANCE			1.032344
ELASTIC DEFLECTION LIMIT			.020953

MAX FRAGMENT SPALL VELOCITY FT/SEC	1.616973

Header 25
SOLVER Program

```
SOLVE   HEADER25: ANALYSIS OF 24" x 48" x 14' HEADER BM, FIXED EA END
    1    1        .05        200                                      -1

    2    2    7764.48        0.01
    1  7027.17    147.24                        1.0         1.0
    3      0.0                        10        1.0         0.0
    1  7027.17   -147.24                        1.0         1.0
    3      0.0                       -10        1.0         0.0
    1    3
       0.0         152       24.6         0.0         40         0.0
STOP
```

Header 25
SOLVER Output

```
1ONE DEGREE OF FREEDOM SOLVER INPUT
 VERSION 2.2  FEB 1989

 PROBLEM DESCRIPTION
 SOLVE   HEADER25: ANALYSIS OF 24" x 48" x 14' HEADER BM, FIXED EA END


 ANALYSIS CONTROL CARD

 TYPE OF SOLUTION.....                    1
   EQ. 0,  DEFAULTS TO 1
   EQ. 1,  NEWMARK-BETA METHOD
   EQ. 2,  WILSON-THETA METHOD
 NUMBER OF LOAD CASES.....                1
 TIME STEP.....                      0.0500
 TIME LIMIT.....                   200.0000
 NEWMARK*S GAMMA.....                0.0000
   EQ. 0.0, DEFAULTS TO 0.5
 NEWMARK*S BETA.....                 0.0000
   EQ. 0.0, DEFAULTS TO 0.25
 WILSON*S THETA.....                 0.0000
   EQ. 0.0, DEFAULTS TO 1.4
 PRINT OPTION.....                     -1
   EQ. 0, DEFAULTS TO 1
   EQ. 1, PRINT EVERY STEP
   EQ. N, PRINT EVERY N-TH STEP
   EQ. -1, PRINT SIGNIFICANT CHANGES


 INITIAL CONDITIONS

 INITIAL DEFLECTION.....             0.0000
 INITIAL VELOCITY.....               0.0000
 INITIAL ACCELERATION.....           0.0000


 STIFFNESS CONTROL CARD

 NUMBER OF STIFFNESSES.....               2
 NUMBER OF REBOUND STIFFNESSES.....       2
 MASS.....                         7764.4800
 PERCENT OF CRITICAL DAMPING.....     0.0100


 INITIAL RESISTANCE-DEFLECTION CURVE

 NUMBER  MODE   STIFFNESS  RESISTANCE   YLD DEFL   MASS FACT   DAMP
FRAC

      1     1 0.70272E+04 0.14724E+03 0.00000E+00        1.00
1.00
      2     3 0.00000E+00 0.00000E+00 0.10000E+02        1.00
0.00


 REBOUND RESISTANCE-DEFLECTION CURVE

 NUMBER  MODE   STIFFNESS  RESISTANCE   YLD DEFL   MASS FACT   DAMP
FRAC

      3     1 0.70272E+04-0.14724E+03 0.00000E+00        1.00
```

```
1.00
      4      3 0.00000E+00 0.00000E+00-0.10000E+02         1.00
0.00


 LOAD DATA

 LOAD CASE NUMBER.....................    1
 NUMBER OF LOAD POINTS................    3


 POINT                TIME                LOAD
     1              0.0000            152.0000
     2             24.6000              0.0000
     3             40.0000              0.0000


 GENERATED RESISTANCE - DEFLECTION CURVES

 NATURAL PERIOD.....................    6.6046

 NUMBER  MODE   STIFFNESS  RESISTANCE    YLD DEFL   MASS FACT   DAMP
FRAC
      1      1 0.70272E+04 0.14724E+03 0.20953E-01         1.00
1.00
      2      3 0.00000E+00 0.14724E+03 0.10000E+02         1.00
0.00
      3      1 0.70272E+04-0.14724E+03-0.20953E-01         1.00
1.00
      4      3 0.00000E+00-0.14724E+03-0.10000E+02         1.00
0.00
1* * * * NEWMARK-BETA SOLUTION * * * * *
 LOAD CASE.............................    1
 TIME STEP.............................    0.0500


 * * * * * SOLUTION RESULTS  * * * * * *
          STEP   TIME STIF DEFLECTION   VELOCITY        ACC RESISTANCE
LOAD

 ELAS     0    0.0000    1       0.000      0.0000      0.0196        0.00
152.00
 *CHG    34    1.6546    2       0.021      0.0194     -0.0011      147.24
141.78
 REB    157    7.8500    1       0.096     -0.0003     -0.0056      147.20
103.50
 RLOD   229   11.4500    1       0.081      0.0001      0.0054       39.59
81.25
 REB    289   14.4500    1       0.090     -0.0003     -0.0053      103.74
62.72
 RLOD   361   18.0500    1       0.075      0.0000      0.0050        1.31
40.47
 REB    420   21.0000    1       0.084      0.0000     -0.0049       60.50
22.24
 *CHG   462   23.0983    3       0.075     -0.0058      0.0013        0.00
9.28
 RLOD   494   24.7000    3       0.070      0.0002      0.0048      -37.09
0.00
 *CHG   527   26.3212    1       0.075      0.0049     -0.0001        0.00
0.00
 REB    560   28.0000    1       0.080     -0.0002     -0.0046       35.95
```

0.00							
*CHG	593	29.6243	3	0.075	-0.0048	0.0001	0.00
0.00							
RLOD	626	31.3000	3	0.070	0.0002	0.0045	-34.84
0.00							
*CHG	659	32.9274	1	0.075	0.0046	-0.0001	0.00
0.00							
REB	692	34.6000	1	0.080	-0.0001	-0.0043	33.76
0.00							
*CHG	725	36.2305	3	0.075	-0.0045	0.0001	0.00
0.00							
RLOD	758	37.9000	3	0.070	0.0001	0.0042	-32.72
0.00							
*CHG	791	39.5335	1	0.075	0.0044	-0.0001	0.00
0.00							
REB	824	41.2000	1	0.080	-0.0001	-0.0041	31.71
0.00							
*CHG	857	42.8366	3	0.075	-0.0042	0.0001	0.00
0.00							
RLOD	890	44.5000	3	0.071	0.0001	0.0040	-30.74
0.00							
*CHG	923	46.1397	1	0.075	0.0041	-0.0001	0.00
0.00							
REB	956	47.8000	1	0.079	-0.0001	-0.0038	29.79
0.00							
*CHG	989	49.4428	3	0.075	-0.0040	0.0001	0.00
0.00							
RLOD	1022	51.1000	3	0.071	0.0001	0.0037	-28.87
0.00							
*CHG	1055	52.7458	1	0.075	0.0038	-0.0001	0.00
0.00							
REB	1088	54.4000	1	0.079	0.0000	-0.0036	27.98
0.00							
*CHG	1121	56.0489	3	0.075	-0.0037	0.0001	0.00
0.00							
RLOD	1154	57.7000	3	0.071	0.0000	0.0035	-27.11
0.00							
*CHG	1188	59.3520	1	0.075	0.0036	-0.0001	0.00
0.00							
REB	1220	61.0000	1	0.079	0.0000	-0.0034	26.27
0.00							
*CHG	1254	62.6551	3	0.075	-0.0035	0.0001	0.00
0.00							
RLOD	1286	64.3000	3	0.071	0.0000	0.0033	-25.46
0.00							
*CHG	1320	65.9582	1	0.075	0.0034	-0.0001	0.00
0.00							
REB	1352	67.6000	1	0.079	0.0000	-0.0032	24.68
0.00							
*CHG	1386	69.2613	3	0.075	-0.0033	0.0001	0.00
0.00							
RLOD	1419	70.9500	3	0.072	0.0001	0.0031	-23.89
0.00							
*CHG	1452	72.5643	1	0.075	0.0032	-0.0001	0.00
0.00							
REB	1485	74.2500	1	0.078	-0.0001	-0.0030	23.15
0.00							
*CHG	1518	75.8674	3	0.075	-0.0031	0.0001	0.00
0.00							
RLOD	1551	77.5500	3	0.072	0.0001	0.0029	-22.44
0.00							

*CHG	1584	79.1705	1	0.075	0.0030	-0.0001	0.00
0.00							
REB	1617	80.8500	1	0.078	-0.0001	-0.0028	21.75
0.00							
*CHG	1650	82.4736	3	0.075	-0.0029	0.0001	0.00
0.00							
RLOD	1683	84.1500	3	0.072	0.0001	0.0027	-21.08
0.00							
*CHG	1716	85.7766	1	0.075	0.0028	-0.0001	0.00
0.00							
REB	1749	87.4500	1	0.078	-0.0001	-0.0026	20.43
0.00							
*CHG	1782	89.0797	3	0.075	-0.0027	0.0001	0.00
0.00							
RLOD	1815	90.7500	3	0.072	0.0001	0.0025	-19.80
0.00							
*CHG	1848	92.3828	1	0.075	0.0026	-0.0001	0.00
0.00							
REB	1881	94.0500	1	0.078	-0.0001	-0.0025	19.19
0.00							
*CHG	1914	95.6859	3	0.075	-0.0026	0.0000	0.00
0.00							
RLOD	1947	97.3500	3	0.072	0.0001	0.0024	-18.60
0.00							
*CHG	1980	98.9889	1	0.075	0.0025	0.0000	0.00
0.00							
REB	2013	100.6500	1	0.078	0.0000	-0.0023	18.02
0.00							
*CHG	2046	102.2920	3	0.075	-0.0024	0.0000	0.00
0.00							
RLOD	2079	103.9500	3	0.073	0.0000	0.0022	-17.47
0.00							
*CHG	2112	105.5951	1	0.075	0.0023	0.0000	0.00
0.00							
REB	2145	107.2500	1	0.077	0.0000	-0.0022	16.93
0.00							
*CHG	2178	108.8982	3	0.075	-0.0023	0.0000	0.00
0.00							
RLOD	2211	110.5500	3	0.073	0.0000	0.0021	-16.40
0.00							
*CHG	2245	112.2012	1	0.075	0.0022	0.0000	0.00
0.00							
REB	2277	113.8500	1	0.077	0.0000	-0.0020	15.90
0.00							
*CHG	2311	115.5043	3	0.075	-0.0021	0.0000	0.00
0.00							
RLOD	2343	117.1500	3	0.073	0.0000	0.0020	-15.41
0.00							
*CHG	2377	118.8074	1	0.075	0.0021	0.0000	0.00
0.00							
REB	2409	120.4500	1	0.077	0.0000	-0.0019	14.93
0.00							
*CHG	2443	122.1105	3	0.075	-0.0020	0.0000	0.00
0.00							
RLOD	2476	123.8000	3	0.073	0.0001	0.0019	-14.45
0.00							
*CHG	2509	125.4136	1	0.075	0.0019	0.0000	0.00
0.00							
REB	2542	127.1000	1	0.077	-0.0001	-0.0018	14.01
0.00							
*CHG	2575	128.7166	3	0.075	-0.0019	0.0000	0.00

0.00							
RLOD	2608	130.4000	3	0.073	0.0001	0.0017	-13.58
0.00							
*CHG	2641	132.0197	1	0.075	0.0018	0.0000	0.00
0.00							
REB	2674	133.7000	1	0.077	-0.0001	-0.0017	13.16
0.00							
*CHG	2707	135.3228	3	0.075	-0.0018	0.0000	0.00
0.00							
RLOD	2740	137.0000	3	0.073	0.0001	0.0016	-12.75
0.00							
*CHG	2773	138.6259	1	0.075	0.0017	0.0000	0.00
0.00							
REB	2806	140.3000	1	0.077	-0.0001	-0.0016	12.36
0.00							
*CHG	2839	141.9289	3	0.075	-0.0016	0.0000	0.00
0.00							
RLOD	2872	143.6000	3	0.073	0.0000	0.0015	-11.98
0.00							
*CHG	2905	145.2320	1	0.075	0.0016	0.0000	0.00
0.00							
REB	2938	146.9000	1	0.077	0.0000	-0.0015	11.61
0.00							
*CHG	2971	148.5351	3	0.075	-0.0015	0.0000	0.00
0.00							
RLOD	3004	150.2000	3	0.073	0.0000	0.0014	-11.25
0.00							
*CHG	3037	151.8382	1	0.075	0.0015	0.0000	0.00
0.00							
REB	3070	153.5000	1	0.077	0.0000	-0.0014	10.90
0.00							
*CHG	3103	155.1413	3	0.075	-0.0015	0.0000	0.00
0.00							
RLOD	3136	156.8000	3	0.073	0.0000	0.0014	-10.57
0.00							
*CHG	3169	158.4443	1	0.075	0.0014	0.0000	0.00
0.00							
REB	3202	160.1000	1	0.076	0.0000	-0.0013	10.24
0.00							
*CHG	3235	161.7474	3	0.075	-0.0014	0.0000	0.00
0.00							
RLOD	3268	163.4000	3	0.074	0.0000	0.0013	-9.92
0.00							
*CHG	3302	165.0505	1	0.075	0.0013	0.0000	0.00
0.00							
REB	3334	166.7000	1	0.076	0.0000	-0.0012	9.62
0.00							
*CHG	3368	168.3536	3	0.075	-0.0013	0.0000	0.00
0.00							
RLOD	3400	170.0000	3	0.074	0.0000	0.0012	-9.32
0.00							
*CHG	3434	171.6567	1	0.075	0.0012	0.0000	0.00
0.00							
REB	3466	173.3000	1	0.076	0.0000	-0.0012	9.03
0.00							
*CHG	3500	174.9597	3	0.075	-0.0012	0.0000	0.00
0.00							
RLOD	3533	176.6500	3	0.074	0.0001	0.0011	-8.74
0.00							
*CHG	3566	178.2628	1	0.075	0.0012	0.0000	0.00
0.00							

```
 REB  3599  179.9500    1       0.076    -0.0001    -0.0011       8.47
0.00
 *CHG 3632  181.5659    3       0.075    -0.0011     0.0000       0.00
0.00
 RLOD 3665  183.2500    3       0.074     0.0000     0.0011      -8.21
0.00
 *CHG 3698  184.8690    1       0.075     0.0011     0.0000       0.00
0.00
 REB  3731  186.5500    1       0.076     0.0000    -0.0010       7.96
0.00
 *CHG 3764  188.1720    3       0.075    -0.0011     0.0000       0.00
0.00
 RLOD 3797  189.8500    3       0.074     0.0000     0.0010      -7.72
0.00
 *CHG 3830  191.4751    1       0.075     0.0010     0.0000       0.00
0.00
 REB  3863  193.1500    1       0.076     0.0000    -0.0010       7.48
0.00
 *CHG 3896  194.7782    3       0.075    -0.0010     0.0000       0.00
0.00
 RLOD 3929  196.4500    3       0.074     0.0000     0.0009      -7.25
0.00
 *CHG 3962  198.0813    1       0.075     0.0010     0.0000       0.00
0.00
 REB  3995  199.7500    1       0.076     0.0000    -0.0009       7.02
0.00


 ***** TIME LIMIT REACHED

 MAXIMUM DEFLECTION IN SOLUTION
 STEP NUMBER.............................  156
 TIME AT MAXIMUM.........................      7.8000
 MAXIMUM DEFLECTION......................      0.096

 MINIMUM DEFLECTION IN SOLUTION
 STEP NUMBER.............................  493
 TIME AT MINIMUM.........................     24.6500
 MINIMUM DEFLECTION......................      0.070


SOLUTION TIME LOG
   ASSEMBLY.....................        0.06
   SDOF SOLUTION.(LOAD CASE  1)...      0.16

   TOTAL TIME.....................      0.22
1ONE DEGREE OF FREEDOM SOLVER INPUT
 VERSION 2.2  FEB 1989

 PROBLEM DESCRIPTION
 STOP


 ***** END SOLVER RUNS *****
```

FRONT

PILASTER

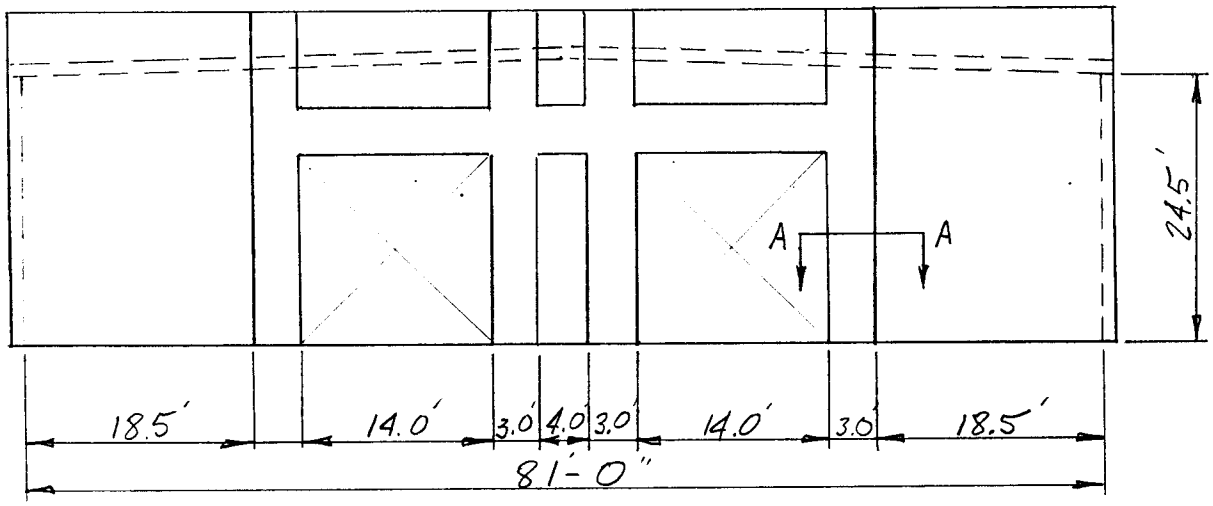
Mason & Hanger Engineering, Inc.
Lexington, Kentucky

File	2446.01 Page
Sheet	of Sheets
Date	9/98
Computed By	TA
Checked By	

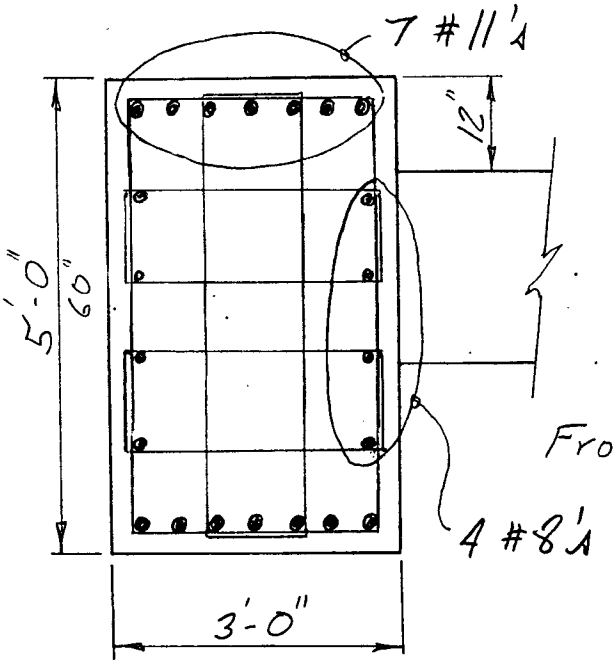
Project P-501, ADCAP Magazines Location NWS Yorktown, VA

Subject Pilaster

Pilaster Analysis



Front Headwall Elevation



Section A-A

Try using 3 ft wide x 6 ft deep Pilaster w/ 7 #11's Frt & Bk

Run CBARCS for Dynamic Properties
Input File: Pilast5.in
Output File: Pilast5.out

From Output File:

M_E = 9705.60 psi-ms
K_E = 1566.34 psi
r_u = 223.73 psi

$d = 60 - 1\frac{1}{2} - \frac{1}{2} - \frac{1.41}{2} = 57.30"$

$A_s = 7 \times 1.56 = 10.92 \text{ in}^2$

$\rho = 10.92/(32 \times 57.30) = .0053$

Vertical Pilaster Design

Design Vertical Pilaster to carry Direct Blast Load plus Blast Load Reactions from Blast Door, Header Beam and Above Door Wall Panel.

Direct Blast Load (On Face of Pilaster)

$P_{rx} = 152$ psi $\quad t_o = 24.6$ ms

Blast Door Reaction

From Blast Door Analysis, Door Reaction = 6,745 lbs/In

Uniform Load on Pilaster, $R_D = \frac{6745}{36} = 187.4$ psi

From SOLVER Output for Door

Time	Ru
0	0
3.6	80.30
24.6	80.30
29.75	0
34.69	0

$R = 80.3 \times \frac{14 \times 12}{2} = 6{,}745$ lbs/In.

Reaction from Above Door Wall Panel

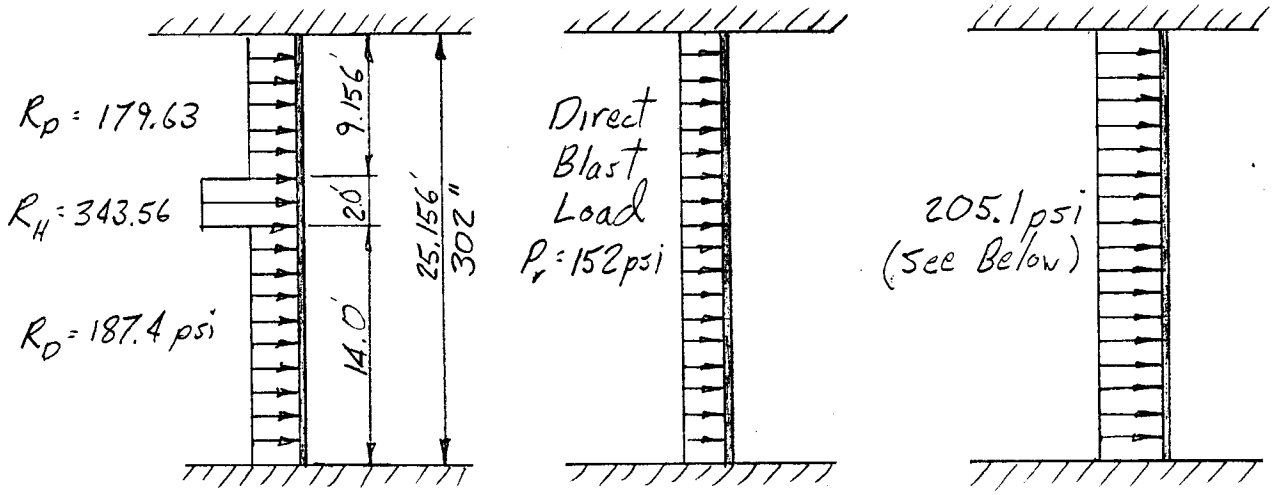
$R_p = 179.63$ psi (See Door Panel Calcs)

Reaction from Header Beam

$R_H = 343.56$ psi (See Header Bm Calcs)

Pilaster Design Cont'd

Apply Loads to Pilaster



Actual Loads | Direct Loads | Equivalent Load

Run Analysis of Pilaster to Determine Maximum Moment
Calculate Equivalent Load

Blast Door Reaction, R_D = 187.4 psi	P_x	0	80.30	80.30	0.0
	t_o	0	3.60	24.62	29.75
Header Bm Reaction, R_H = 343.56 psi	P_x	0	147.2	147.2	1.31
	t_o	0	1.65	14.45	18.05
Wall Panel Reaction, R_p = 179.63 psi	P_x	0	109.22	109.22	0
	t_o	0	2.97	17.60	22.12

From "CAST" Analysis, (See Attached)

Maximum Moment = 1,558,968 in-lbs

Equivalent Uniform Load $W = \frac{1,558,968(12)}{(302)^2}$

W = 205.1 psi

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File 2446 Page
Sheet of Sheets
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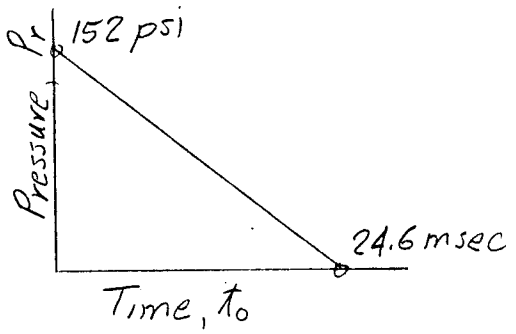
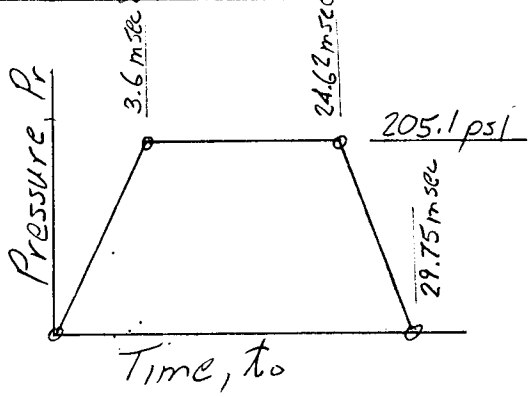
Subject Pilaster

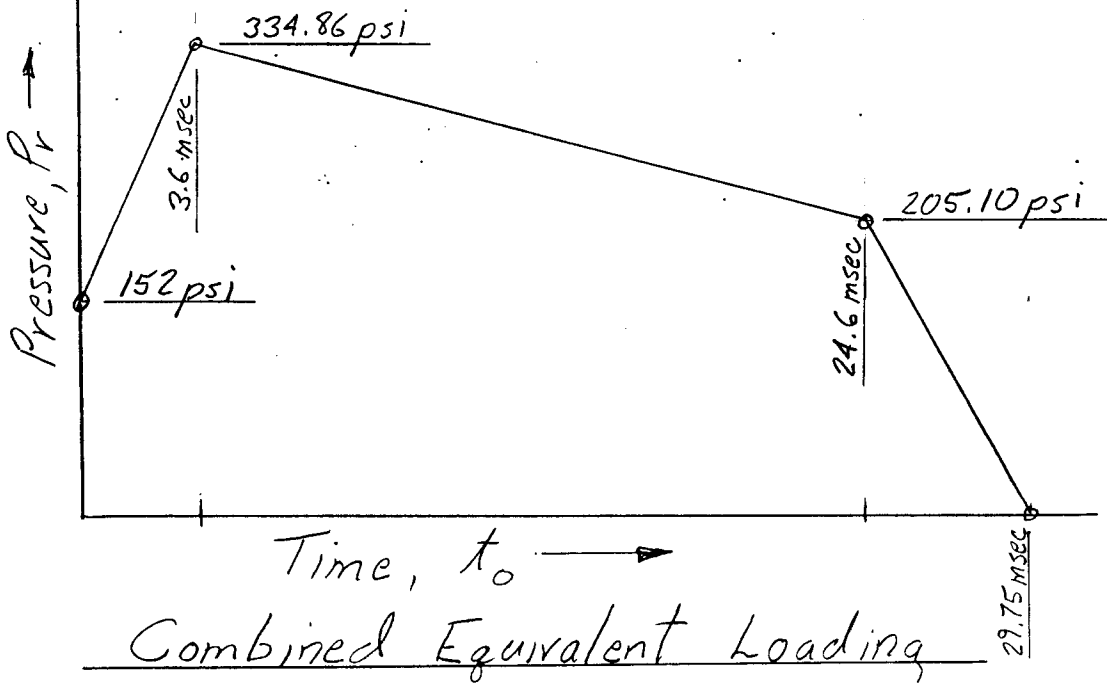
Combine Equivalent Uniform Load & Direct Blast Load





Direct Blast Load + Equivalent Uniform Load
(Use Blast Door Reaction Times)
(These are the longest times & therefore the most conservative)

Time msec	Pressure, psi			
0.0	152	+ 0.0	=	152
3.6	129.76	205.1	=	334.86
24.6	0.0	205.1	=	205.10
29.75	0.0	0.0	=	0.0



Combined Equivalent Loading

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Subject Pilaster

Check Pilaster Deflections

Using SOLVER Output: Pilast5.out (Fixed both Ends)

From SOLVER, Max Defl, $\Delta_x = 4.03"$

Max Allowable $\Delta_x = \frac{25.156 \times 12}{2} \times \tan 2^\circ = 5.27" > 4.03"$ OK

36" x 60" Pilaster is Adequate

Diagonal Shear Design

See previous sht for ρ

$v_c = [1.9(4000)^{1/2} + 2500(.0053)]$

$v_c = 133.4$ psi (From CBARCS)

Shear @ d distance from face of Support

$v_u = 365.66$ psi > 133.4 psi Shear Reinf is Required

Try Using #5 Stirrups - Calculate Spacing Required

$$S_s = \frac{\phi f_{ds} A_v}{(v_u - v_c) b_s} = \frac{.85(66{,}000)(.31 \times 4)}{(365.66 - 133.4)36} = 8.3"$$

Use Dbl. #5 Stirrups @ 8" on Center

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Subject Pilaster

Check Direct Shear Capacity

Max Support Shear, $V_u = 33,769.05$ lbs/In

Concrete Capacity, $V_c = 0.18 f'_c b d$
$= 0.18 (4400)(1)(57.30)$

$V_c = 45,381.6$ lbs/In

Since $V_c = 45,381.6 > V_u = 33,769.05$ lbs/In OK

No Diagonal Steel will be Required

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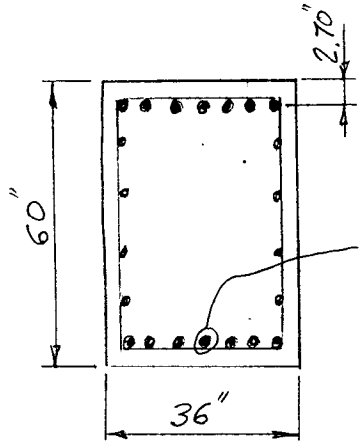
Subject Pilaster

Check Floor Slab to Develop Moment Capacity of Pilaster

Use 36" x 60" Pilaster



$d = 60 - 1\frac{1}{2} - \frac{1}{2} - \frac{1.41}{2} = 57.30"$

Calculate Capacity of Pilaster

7 #11's Front & Back, $A_s = 7 \times 1.56 = 10.92 in^2$

$\rho = \frac{A_s}{bd} = \frac{10.92}{36(57.30)} = .0053$

Using $\rho = .0053$, $\frac{M_N}{\phi b d^2} = 304$

$M_N = 304 (.9 \times 36 \times 57.3^2)$

Pilaster $M_N = 32,339,093$ in-lbs

24" Floor Slab Capacity

$d = 24 - 3 - 1.27 - \frac{1.27}{2} = 19.1"$ #10's @ 8" $A_s = 1.27 \times \frac{12}{8} = 1.91 in^2$

$\rho = \frac{A_s}{bd} = \frac{1.91}{12(19.1)} = .0083$

Using $\rho = .0083$ $\frac{M_N}{\phi b d^2} = 463$

Floor Slab $M_N = 463 (.9 \times 12 \times 19.1^2) = 1,824,197$ in-lbs

Length of Floor Slab Required to Develop Pilaster M_N: $L = \frac{32,339,093}{1,824,197} = 17.7$ ft.

"CAST" Analysis

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**********************************************************************
*       CAST-UTILITY  BY  CAST INC.                                  *
*                                                                    *
*        M A S O N    &    H A N G E R        ENGINEERS              *
*                                                                    *
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Pilaster Analysis

Considering Top & Bottom Supports Fixed

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************************************
* SUMMARY OF THE INPUT INFORMATION *
************************************

TYPE OF THE PROBLEM : CONTINUOUS BEAM CALCULATION

* Types and the locations of the supports are:

   Fixed support at X=     0.0000
   Fixed support at X=   302.0000

* Total number of different materials    :     1

  From X=     0.0000   to X=   302.0000   E= 3605000.0000

* Total number of different sections     :     1

  From X=     0.0000 to X=   302.0000 IX=  6358.0000

* Total number of distributed loads          :     3
  At X=     0.0000  W1=   179.6300   At X=   110.0000  W2=   179.6300
  At X=   110.0000  W1=   343.5600   At X=   134.0000  W2=   343.5600
  At X=   134.0000  W1=   187.4000   At X=   302.0000  W2=   187.4000


***************************
* SUMMARY OF THE RESULTS *
***************************

* MAXIMUM VALUES

   * Max. displacement is     0.19641  at  X=   151.0000
   * Min. displacement is     0.00000  at  X=     0.0000

   * Max. shear force is 29941.42597  at  X=     0.0000
   * Min. shear force is -29546.51403  at  X=   302.0000

   * Max. moment is 1558968.10774  at  X=     0.0000
   * Min. moment is -799097.35400  at  X=   151.0000

 * TOTAL APPLIED LOADS

   * Total applied concentrated load:      0.0000
   * Total applied concentrated moment:     0.0000
   * Total applied distributed load: 59487.9400

 * SUPPORT REACTIONS

   * Reaction at X=     0.0000 : Force= -29941.4260 Moment= -1558968.1077
   * Reaction at X=   302.0000 : Force= -29546.5140 Moment= 1525972.5643
```