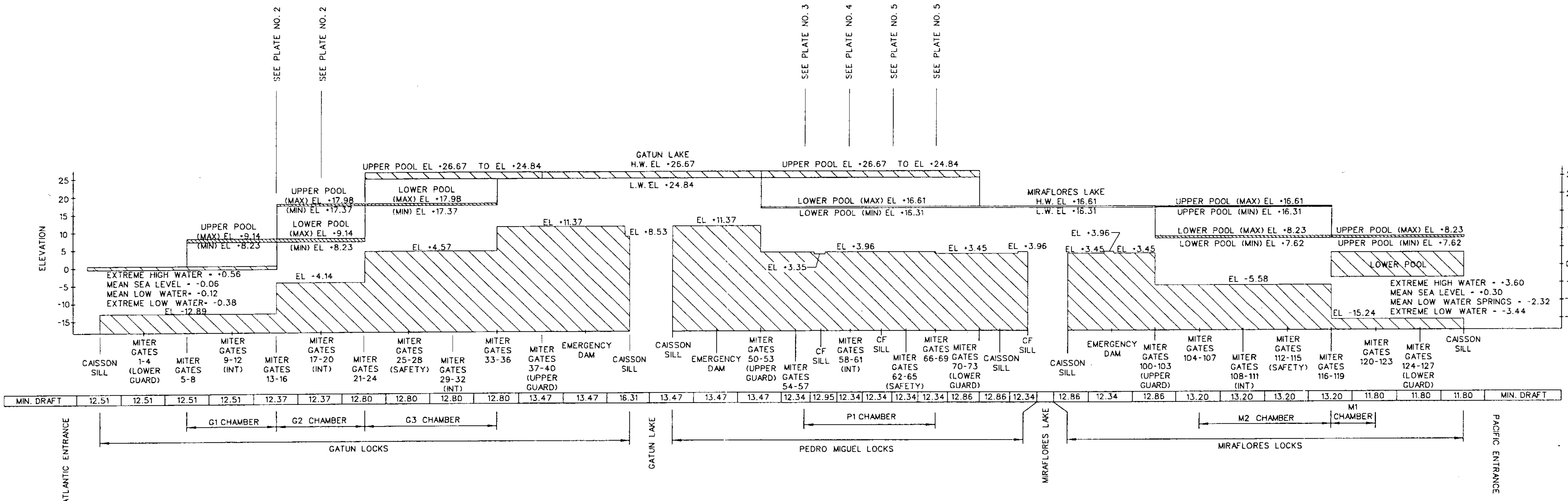
Appendix 1. – Plates



ALL DIMENSIONS AND/OR DIMENSIONS SHOWN IN CALLOUTS/NOTES ARE IN METERS UNLESS OTHERWISE NOTED.

JOB SAFETY DEPENDS ON YOU

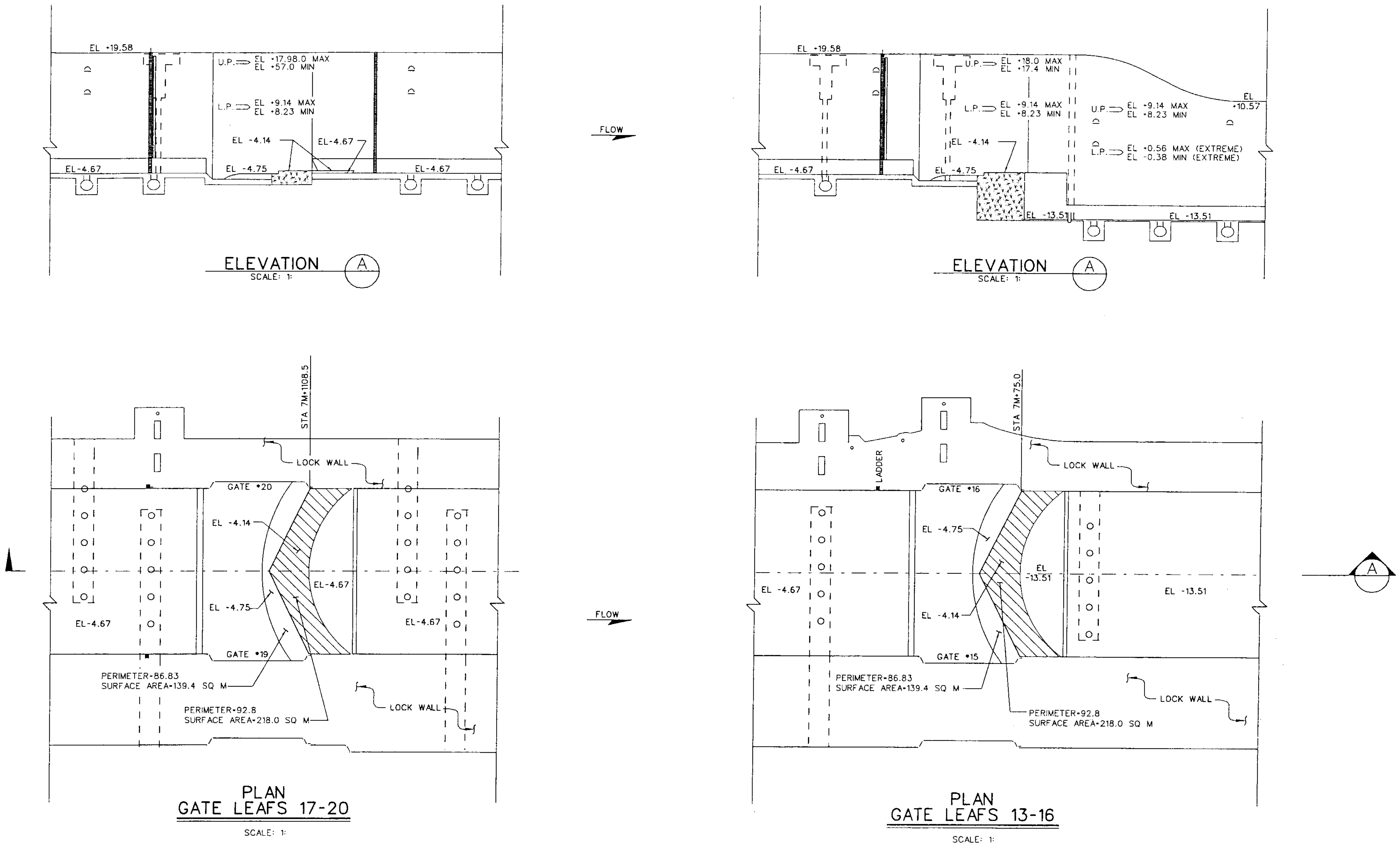
PANAMA CANAL COMMISSION

ENGINEERING AND CONSTRUCTION BUREAU

MITER GATE STUDY

MINIMUM DRAFT

PLATE NO. 1



ALL DIMENSIONS AND/OR DIMENSIONS SHOWN IN CALLOUTS/NOTES ARE IN METERS UNLESS OTHERWISE NOTED.

JOB SAFETY DEPENDS ON YOU

REV.	DATE	DESCRIPTION	BY		

PANAMA CANAL COMMISSION

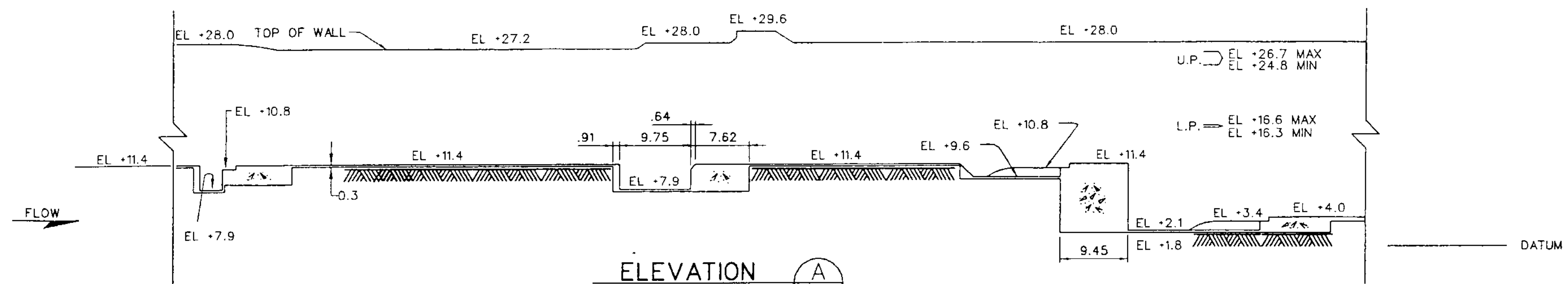
ENGINEERING AND CONSTRUCTION BUREAU
ENGINEERING DIVISION
BALBOA HEIGHTS, REPUBLIC OF PANAMA

MITER GATE STUDY

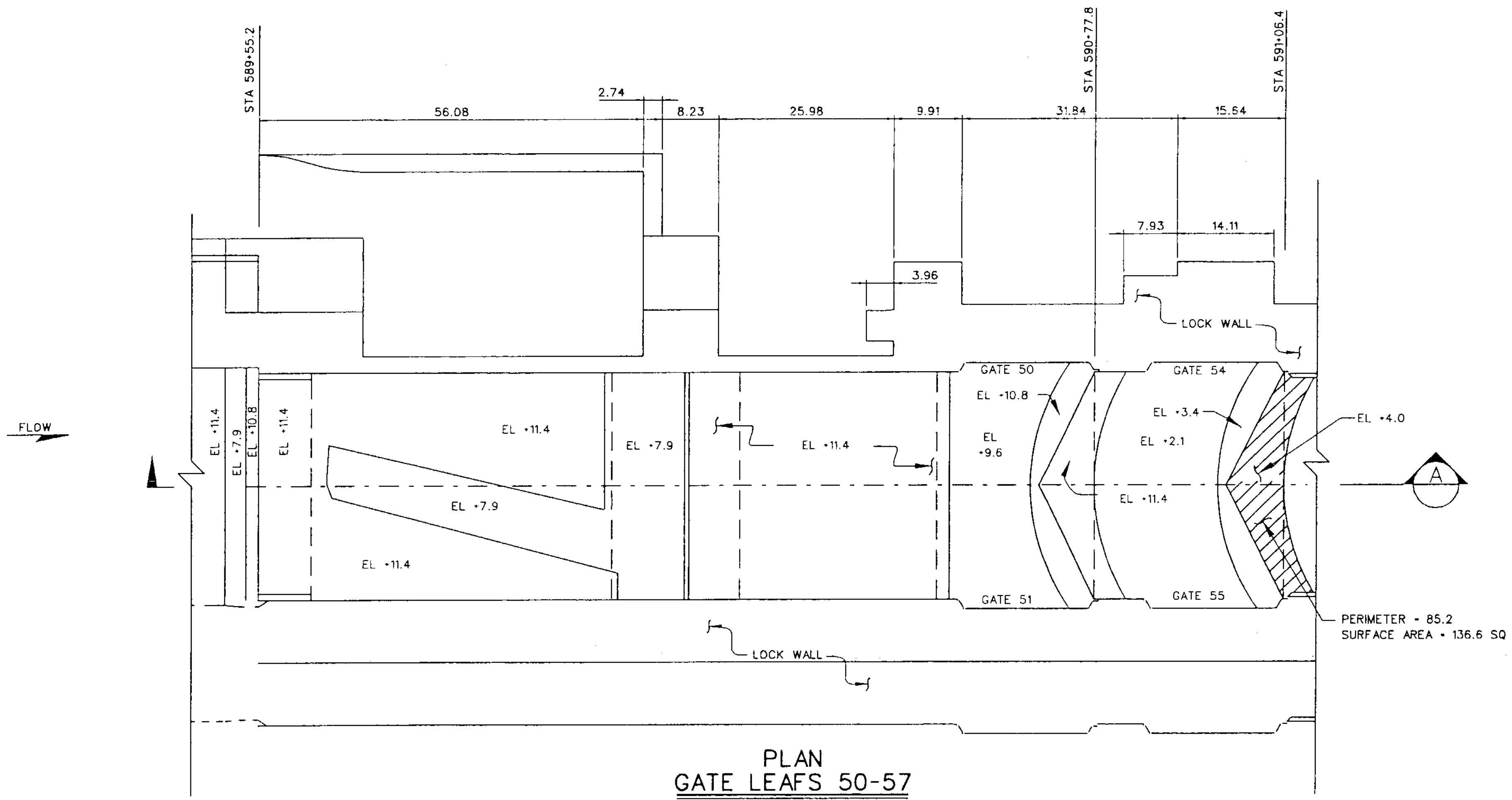
GATUN LOCKS
GATE LEAFS 13 - 20

SCALE: 1: DATE: XXX
DESIGNED: R. A. ALLWES
DRAWN: CDC
CHECKED: XXX
SUBMITTED: CHIEF STRUCTURAL BRANCH
APPROVED: CHIEF, ENGINEERING DIVISION

PLATE NO. 2



ELEVATION (A)
SCALE: 1:



PLAN
GATE LEAFS 50-57
SCALE: 1:

ALL DIMENSIONS AND/OR DIMENSIONS SHOWN IN CALLOUTS/NOTES ARE IN METERS UNLESS OTHERWISE NOTED.

JOB SAFETY DEPENDS ON YOU

REV.	DATE	DESCRIPTION	BY	REVIEWED	APPROVED

PANAMA CANAL COMMISSION

ENGINEERING AND CONSTRUCTION BUREAU
ENGINEERING DIVISION
BALBOA HEIGHTS, REPUBLIC OF PANAMA

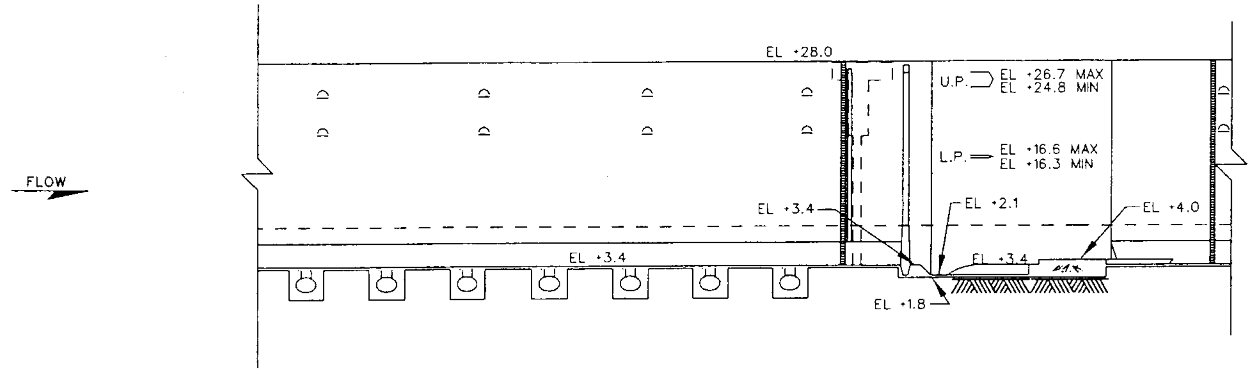
MITER GATE STUDY

PEDRO MIGUEL LOCKS
GATE LEAFS 50-57

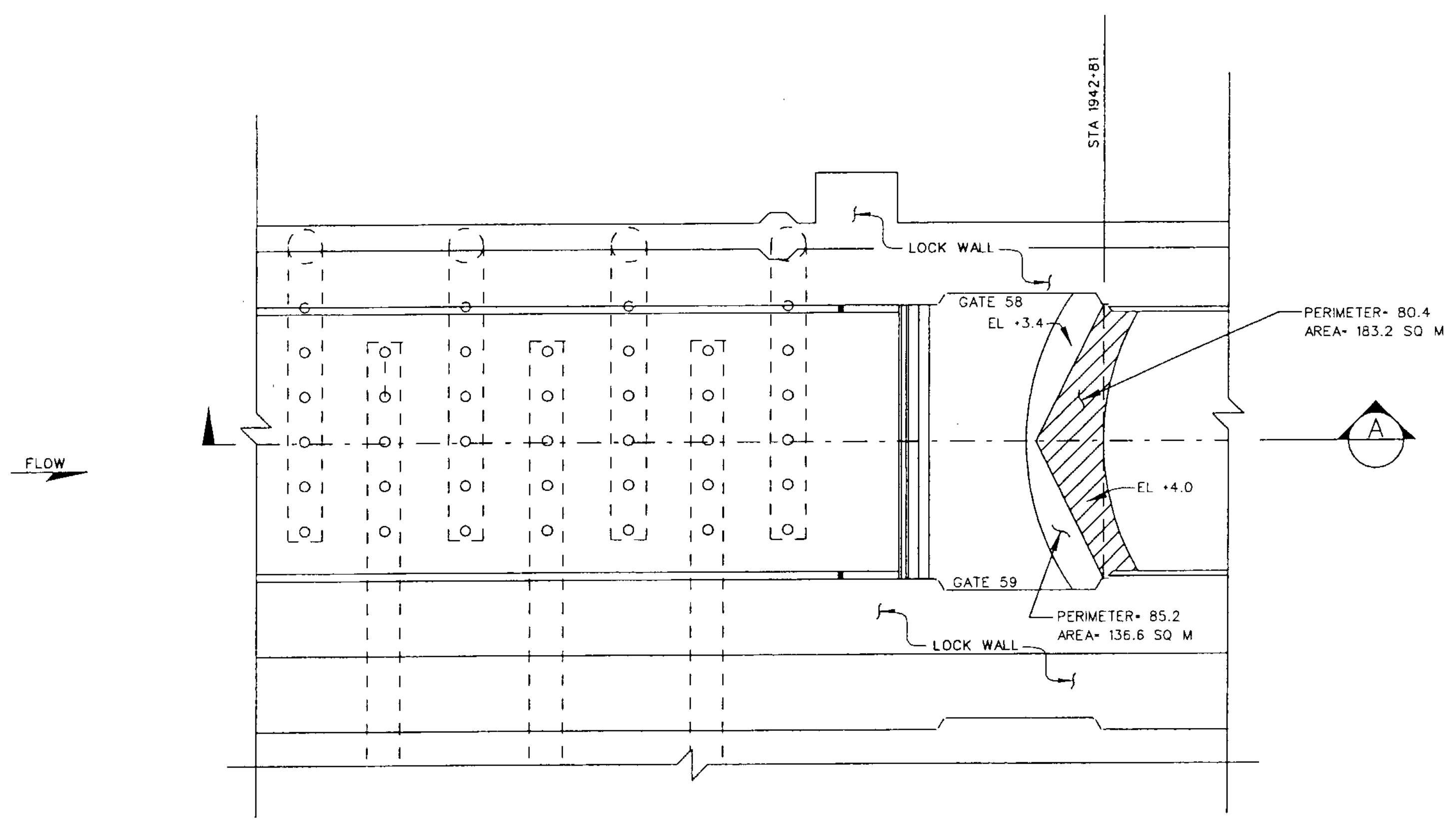
SCALE: 1: | DATE: XXX

DESIGNED: R. A. ALLWES
DRAWN: CDC
CHECKED: XXX
SUBMITTED: CHIEF, STRUCTURAL BRANCH
APPROVED: CHIEF, ENGINEERING DIVISION

PLATE NO. 3



ELEVATION (A)
SCALE: 1:



PLAN
GATE LEAFS 58-61
SCALE: 1:

ALL DIMENSIONS AND/OR DIMENSIONS SHOWN IN CALLOUTS/NOTES ARE IN METERS UNLESS OTHERWISE NOTED.

JOB SAFETY DEPENDS ON YOU

REV.	DATE	DESCRIPTION	BY	REVWD.	APPVD.

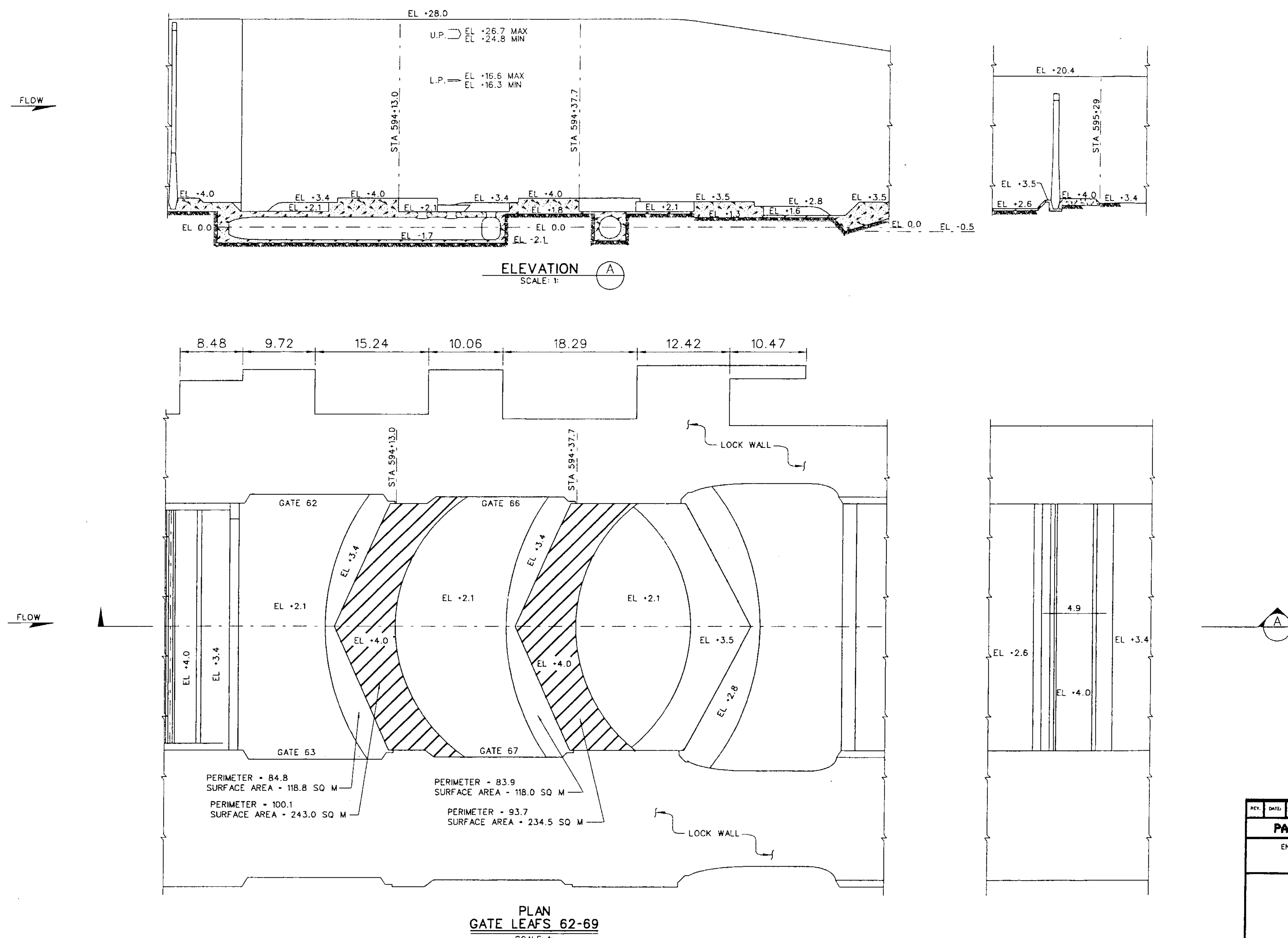
PANAMA CANAL COMMISSION
ENGINEERING AND CONSTRUCTION BUREAU
ENGINEERING DIVISION
BALBOA HEIGHTS, REPUBLIC OF PANAMA

MITER GATE STUDY

PEDRO MIGUEL LOCKS
GATE LEAFS 58-61

SCALE: 1: | DATE: XXX
DESIGNED: R. A. ALLWES
DRAWN: CDC
CHECKED: XXX
SUBMITTED: CHIEF STRUCTURAL BRANCH
APPROVED: CHIEF, ENGINEERING DIVISION

PLATE NO. 4



ALL DIMENSIONS AND/OR DIMENSIONS SHOWN IN CALLOUTS/NOTES ARE IN METERS UNLESS OTHERWISE NOTED.

JOB SAFETY DEPENDS ON YOU

REV.	DATE	DESCRIPTION	BY / CHKD.	REVWD.	APPVD.

PANAMA CANAL COMMISSION

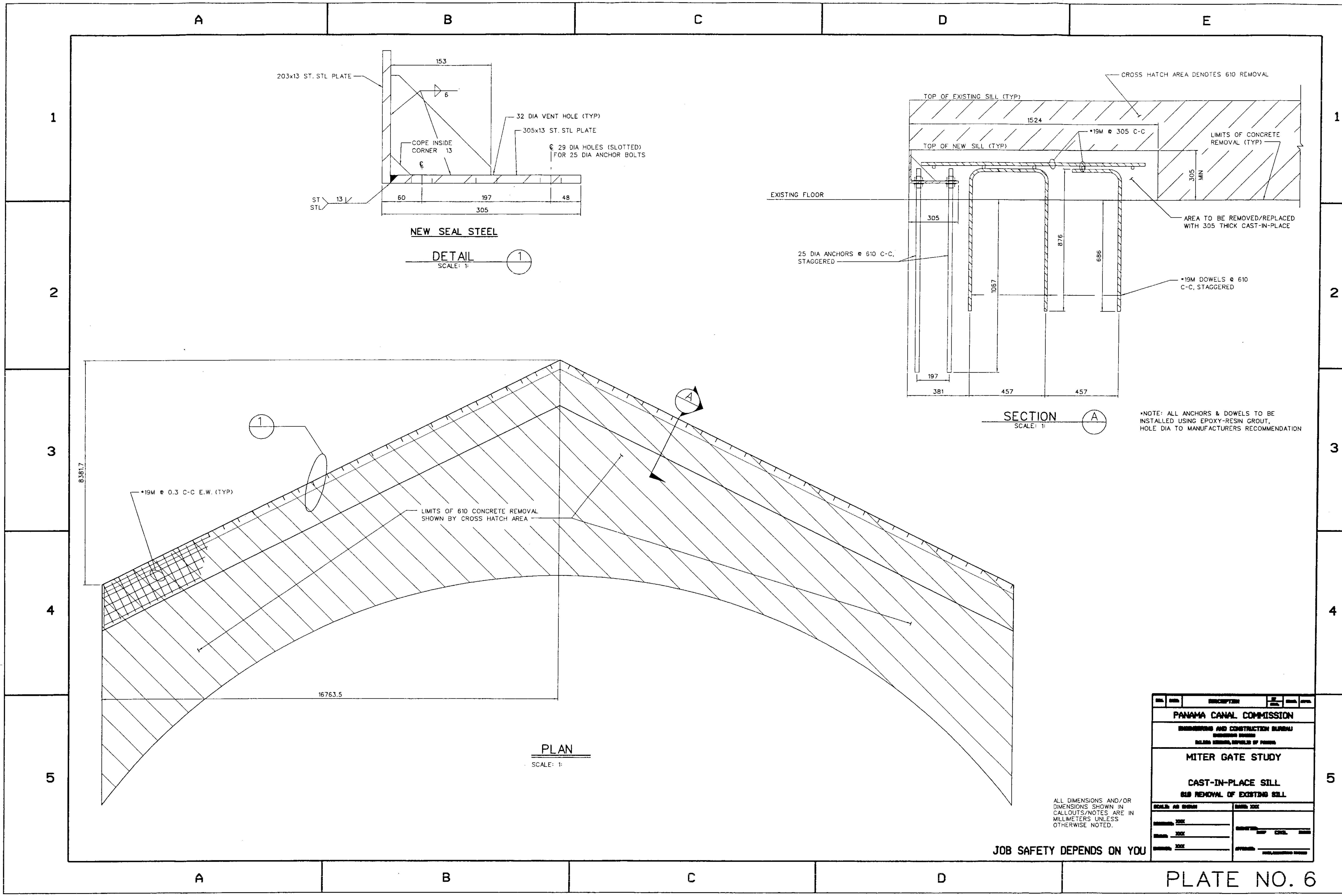
ENGINEERING AND CONSTRUCTION BUREAU
ENGINEERING DIVISION
BALBOA HEIGHTS, REPUBLIC OF PANAMA

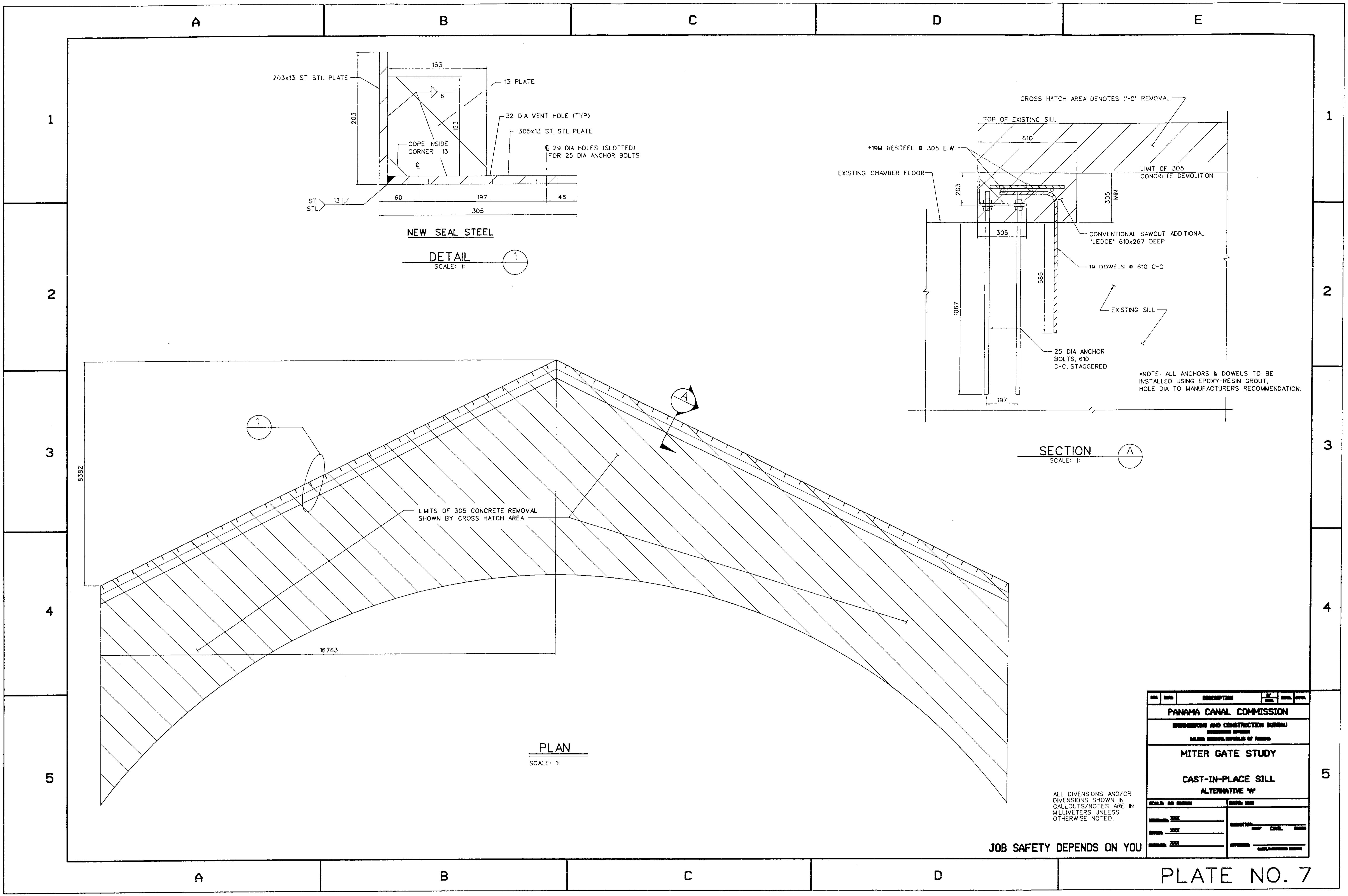
MITER GATE STUDY

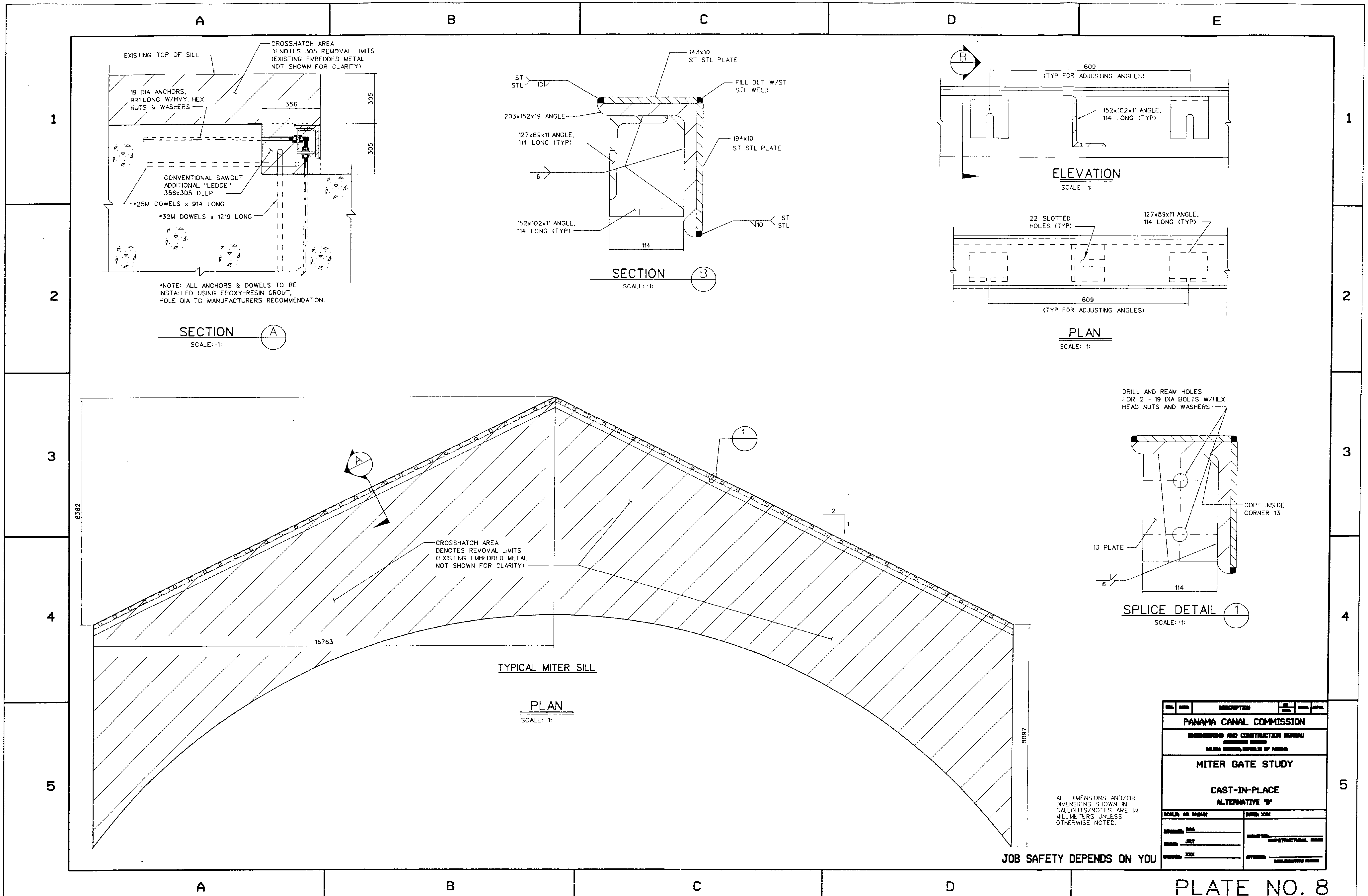
PEDRO MIGUEL LOCKS
GATE LEAFS 62-69

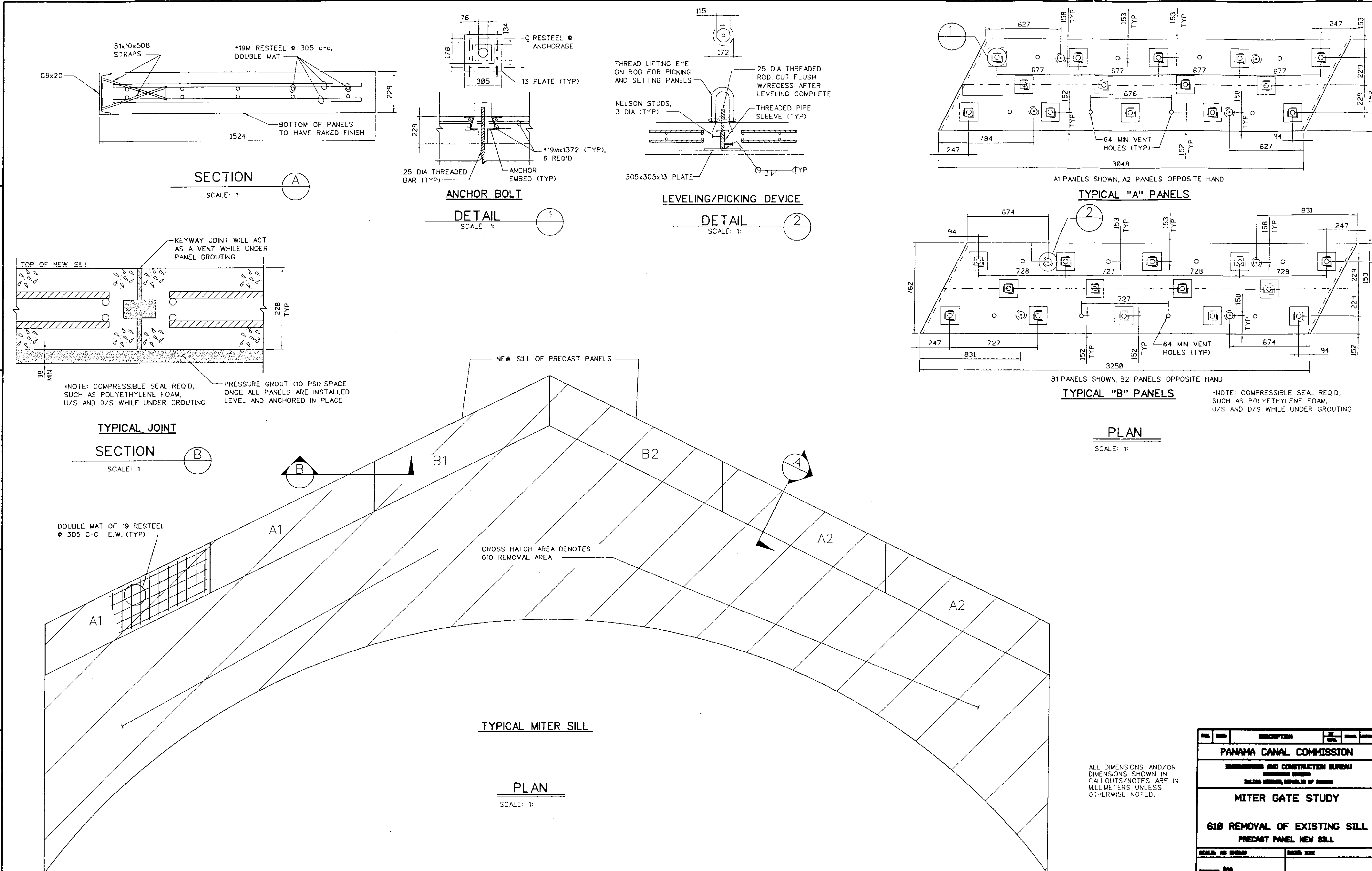
SCALE: 1:
DATE: XXX
DESIGNED: R. A. ALLWES
DRAWN: EAT
CHECKED: XXX
SUBMITTED: CHIEF, STRUCTURAL BRANCH
APPROVED: CHIEF, ENGINEERING DIVISION

PLATE NO. 5


203x13 ST. STL PLATE
153
6
32 DIA VENT HOLE (TYP)
305x13 ST. STL PLATE
COPE INSIDE CORNER 13
℄ 29 DIA HOLES (SLOTTED) FOR 25 DIA ANCHOR BOLTS
ST STL 13
60
197
48
305
NEW SEAL STEEL
DETAIL 1
SCALE: 1:
CROSS HATCH AREA DENOTES 610 REMOVAL
TOP OF EXISTING SILL (TYP)
1524
*19M @ 305 C-C
TOP OF NEW SILL (TYP)
LIMITS OF CONCRETE REMOVAL (TYP)
305 MIN
EXISTING FLOOR
AREA TO BE REMOVED/REPLACED WITH 305 THICK CAST-IN-PLACE
305
876
686
1067
25 DIA ANCHORS @ 610 C-C, STAGGERED
*19M DOWELS @ 610 C-C, STAGGERED
197
381
457
457
SECTION A
SCALE: 1:
*NOTE: ALL ANCHORS & DOWELS TO BE INSTALLED USING EPOXY-RESIN GROUT, HOLE DIA TO MANUFACTURERS RECOMMENDATION
8381.7
*19M @ 0.3 C-C E.W. (TYP)
LIMITS OF 610 CONCRETE REMOVAL SHOWN BY CROSS HATCH AREA
16763.5
PLAN
SCALE: 1:
ALL DIMENSIONS AND/OR DIMENSIONS SHOWN IN CALLOUTS/NOTES ARE IN MILLIMETERS UNLESS OTHERWISE NOTED.
JOB SAFETY DEPENDS ON YOU
PANAMA CANAL COMMISSION
ENGINEERING AND CONSTRUCTION BUREAU
MITER GATE STUDY
CAST-IN-PLACE SILL
610 REMOVAL OF EXISTING SILL
PLATE NO. 6


203x13 ST. STL PLATE
153
13 PLATE
6
203
153
32 DIA VENT HOLE (TYP)
305x13 ST. STL PLATE
COPE INSIDE CORNER 13
℄ 29 DIA HOLES (SLOTTED) FOR 25 DIA ANCHOR BOLTS
ST STL
13
60
197
48
305
NEW SEAL STEEL
DETAIL 1
SCALE: 1:
CROSS HATCH AREA DENOTES 1'-0" REMOVAL
TOP OF EXISTING SILL
610
*19M RESTEEL @ 305 E.W.
LIMIT OF 305 CONCRETE DEMOLITION
EXISTING CHAMBER FLOOR
203
305 MIN
305
CONVENTIONAL SAWCUT ADDITIONAL "LEDGE" 610x267 DEEP
19 DOWELS @ 610 C-C
586
1067
EXISTING SILL
25 DIA ANCHOR BOLTS, 610 C-C, STAGGERED
*NOTE: ALL ANCHORS & DOWELS TO BE INSTALLED USING EPOXY-RESIN GROUT, HOLE DIA TO MANUFACTURERS RECOMMENDATION.
197
SECTION A
SCALE: 1:
A
1
8382
LIMITS OF 305 CONCRETE REMOVAL SHOWN BY CROSS HATCH AREA
16763
PLAN
SCALE: 1:
ALL DIMENSIONS AND/OR DIMENSIONS SHOWN IN CALLOUTS/NOTES ARE IN MILLIMETERS UNLESS OTHERWISE NOTED.
JOB SAFETY DEPENDS ON YOU
PANAMA CANAL COMMISSION
MITER GATE STUDY
CAST-IN-PLACE SILL
ALTERNATIVE "A"
PLATE NO. 7


EXISTING TOP OF SILL
CROSSHATCH AREA DENOTES 305 REMOVAL LIMITS (EXISTING EMBEDDED METAL NOT SHOWN FOR CLARITY)
19 DIA ANCHORS, 991 LONG W/HVY. HEX NUTS & WASHERS
356
305
305
CONVENTIONAL SAWCUT ADDITIONAL "LEDGE" 356x305 DEEP
*25M DOWELS x 914 LONG
*32M DOWELS x 1219 LONG
*NOTE: ALL ANCHORS & DOWELS TO BE INSTALLED USING EPOXY-RESIN GROUT, HOLE DIA TO MANUFACTURERS RECOMMENDATION.
SECTION A
SCALE: 1:
143x10 ST STL PLATE
ST STL 10
FILL OUT W/ST STL WELD
203x152x19 ANGLE
127x89x11 ANGLE, 114 LONG (TYP)
194x10 ST STL PLATE
6
152x102x11 ANGLE, 114 LONG (TYP)
10 ST STL
114
SECTION B
SCALE: 1:
B
609 (TYP FOR ADJUSTING ANGLES)
152x102x11 ANGLE, 114 LONG (TYP)
ELEVATION
SCALE: 1:
22 SLOTTED HOLES (TYP)
127x89x11 ANGLE, 114 LONG (TYP)
609 (TYP FOR ADJUSTING ANGLES)
PLAN
SCALE: 1:
DRILL AND REAM HOLES FOR 2 - 19 DIA BOLTS W/HEX HEAD NUTS AND WASHERS
COPE INSIDE CORNER 13
13 PLATE
6
114
SPLICE DETAIL 1
SCALE: 1:
A
1
8382
2
1
CROSSHATCH AREA DENOTES REMOVAL LIMITS (EXISTING EMBEDDED METAL NOT SHOWN FOR CLARITY)
15763
8097
TYPICAL MITER SILL
PLAN
SCALE: 1:
ALL DIMENSIONS AND/OR DIMENSIONS SHOWN IN CALLOUTS/NOTES ARE IN MILLIMETERS UNLESS OTHERWISE NOTED.
JOB SAFETY DEPENDS ON YOU
PANAMA CANAL COMMISSION
MITER GATE STUDY
CAST-IN-PLACE
PLATE NO. 8



ALL DIMENSIONS AND/OR DIMENSIONS SHOWN IN CALLOUTS/NOTES ARE IN MILLIMETERS UNLESS OTHERWISE NOTED.

JOB SAFETY DEPENDS ON YOU

PANAMA CANAL COMMISSION

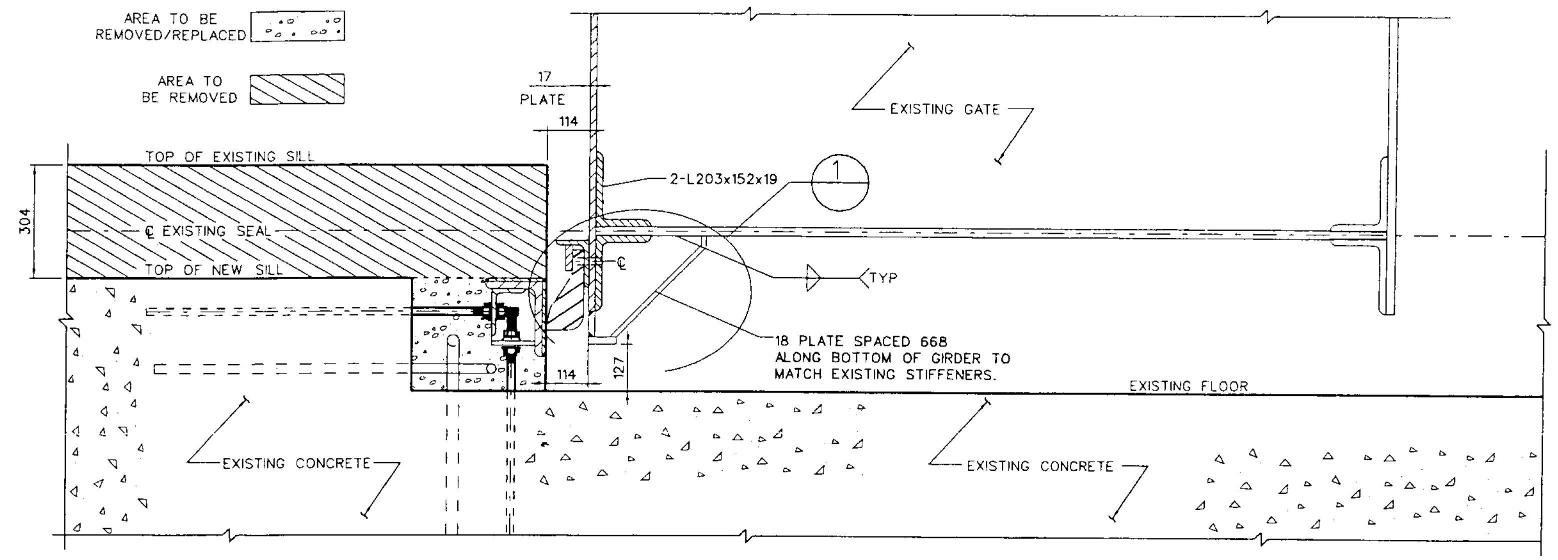
ENGINEERING AND CONSTRUCTION BUREAU

MITER GATE STUDY

610 REMOVAL OF EXISTING SILL

PRECAST PANEL NEW SILL

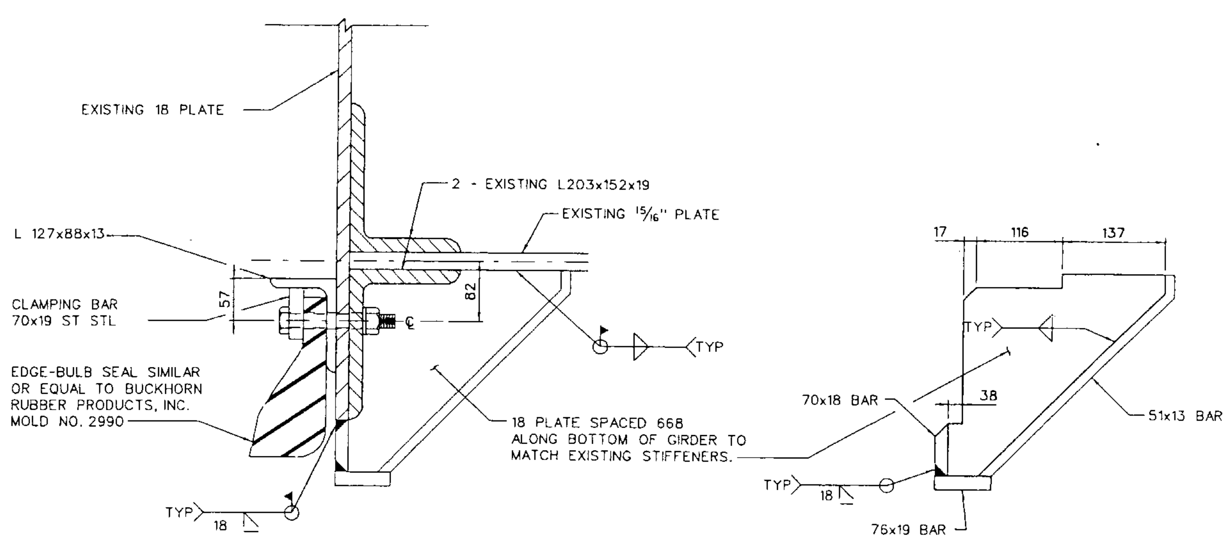
PLATE NO. 9



MITER GATES TO BE MODIFIED
GATUN - M.G. NO'S 13-16 AND 17-20
PEDRO MIGUEL - M.G. NO'S 54-69

TYPICAL MITER GATE EXTENSION

SCALE: 1:



DETAIL (1)

SCALE: 1:

Table 1. - Miter Gate and Miter Gate Sill Information for Existing Condition

Lock	Miter Gates			Existing Condition					
	No.	Type	Height m	M G Sill EL m	Chamber Floor EL m	Low Water EL m	M G Seal EL m	Minimum Draft m	M G-Chamber FL Clearance mm
Gatun	13-16	Main	23.72	-4.14	-4.75	8.23	-4.32	12.37	216
	17-20	Intermediate	23.72	-4.14	-4.75	8.23	-4.32	12.37	216
Pedro Miguel	54-57	Main	24.08	3.96	3.35	16.31	3.79	12.34	216
	58-61	Intermediate	24.08	3.96	3.35	16.31	3.79	12.34	216
	62-65	Main	24.08	3.96	3.35	16.31	3.79	12.34	216
	66-69	Main	24.08	3.96	3.35	16.31	3.79	12.34	216

Table 2. - Miter Gate and Miter Gate Sill Information for Future Modification.

Lock	Miter Gates			Future Modification					
	No.	Type	Height m	M G Sill EL m	Chamber Floor EL m	Low Water EL m	M G Seal EL m	Minimum Draft m	M G-Chamber FL Clearance mm
Gatun	13-16	Main	23.81	-4.44	-4.75	8.23	-4.57	12.67	128
	17-20	Intermediate	23.81	-4.44	-4.75	8.23	-4.57	12.67	128
Pedro Miguel	54-57	Main	24.17	3.66	3.35	16.31	3.54	12.65	128
	58-61	Intermediate	24.17	3.66	3.35	16.31	3.54	12.65	128
	62-65	Main	24.17	3.66	3. 35	16.31	3.54	12.65	128
	66-69	Main	24.17	3.66	3.35	16.31	3.54	12.65	128

GENERAL NOTES:

1. ALL STEEL ASTM A36.
2. RUBBER SEAL MODEL NO. 2990 FROM BUCKHORN RUBBER PRODUCTS, INC.
3. ALL BOLTS SHALL BE ASTM A325 TYPE 3.

ALL DIMENSIONS AND/OR DIMENSIONS SHOWN IN CALLOUTS/NOTES ARE IN MILLIMETERS UNLESS OTHERWISE NOTED.

JOB SAFETY DEPENDS ON YOU

REV.	DATE	DESCRIPTION	BY		

PANAMA CANAL COMMISSION
ENGINEERING AND CONSTRUCTION BUREAU
ENGINEERING DIVISION
BALBOA HEIGHTS, REPUBLIC OF PANAMA

MITER GATE STUDY

MITER GATE EXTENSION
SECTION AND DETAIL

SCALE: AS SHOWN | DATE:
DESIGNED: R. ALLWES | SUBMITTED: CHIEF, STRUCTURAL BRANCH
DRAWN: JET | APPROVED: CHIEF, ENGINEERING DIVISION
CHECKED: XXX

PLATE NO. 10

Appendix 2. – Miter Gate Bottom Extension: Calculations

US Army Corps of Engineers
Ohio River Division

COMPUTATION SHEET

Page 1 of Pages

Subject: PANAMA CANAL MITER GATE STUDY

Computed by SRS Date 12/7/99

Checked by [initials] Date 12/11/01

Computation: LOWER SILL OPTION – ASSUMPTIONS

DESIGN ASSUMPTIONS

1.) LOWERING OF 37-40, 50-53, 62-69, 70-73, 100-103, AND 104-107 MITER GATES.
AFTER COMPARING THE LIFT HEIGHTS FOR ALL MITER GATES A LIFT OF 51.17 ft FOR 37-40 AND 50-53 AND A LIFT OF 44.17 ft FOR M.G. 70-73 AND 100-103 ARE CLOSE IN RANGE FOR DESIGN. I WILL DESIGN THE EXTENSION OF THE FOLLOWING MITER GATES FOR A HEAD OF 51.17 ft. THIS ANALYSIS CAN BE FOUND IN PAGE 5 TO 25.

THE DESIGN HEAD FOR M.G. 62-69 AND M.G. 104-107 ARE SIMILAR (75.5 ft AND 73.83 ft) THEREFORE DESIGN EXTENSION FOR A DESIGN HEAD OF 75.5 ft. THIS ANALYSIS CAN BE FOUND ON PAGE 16 OF 25.

2) THE DESIGN ARE BROKEN UP INTO 2 ANALYSIS.
1) 54'-8" GATE FOR A HEAD OF 51.17 ft.
2) 79'-0" GATE FOR A HEAD OF 75.5 ft.

3) SEE DRAWING FOR SEQUENCE OF WORK.

4) FOR EXTENSION OF THE MITER GATE I MOVED THE SEAL LOCATION 1'-0" LOWER FROM THE EXISTING LOCATION. I WILL PUT AN EXTENSION OF THE SKIN PLATE AND PROVIDE STIFFENERS TO SUPPORT THE NEW SKIN PLATE EXTENSION LOCATED AT EVERY EXISTING STIFFENER ON THE LOWER GIRDER OF THE MITER GATES. SEE ATTACHED FOR DRAWING OF BOTTOM GIRDER OF MITER GATE.

THE BOTTOM GIRDER OF MITER GATE WILL HAVE TO BE CHECKED FOR ADDITIONAL BIAXIAL BENDING DUE TO THE EXTENSION. THIS ANALYSIS WAS NOT DONE IN THIS STUDY.

5) THE ONLY LOAD CONDITION USED IN THIS ANALYSIS WAS NORMAL OPERATING. FOR FUTURE DESIGN SUCH AS PLANS & SPECS A FURTHER ANALYSIS OF EXISTING AND EXTREME CONDITION WILL NEED TO BE PERFORMED. EXTREME WOULD CONSIDER DEBRIS LOAD SUCH AS LOG OR MISC. STUCK BETWEEN SILL AND GATE WHICH WOULD INDUCE CONCENTRATED LOAD ON EXTENSION.

US Army Corps of Engineers
Ohio River Division

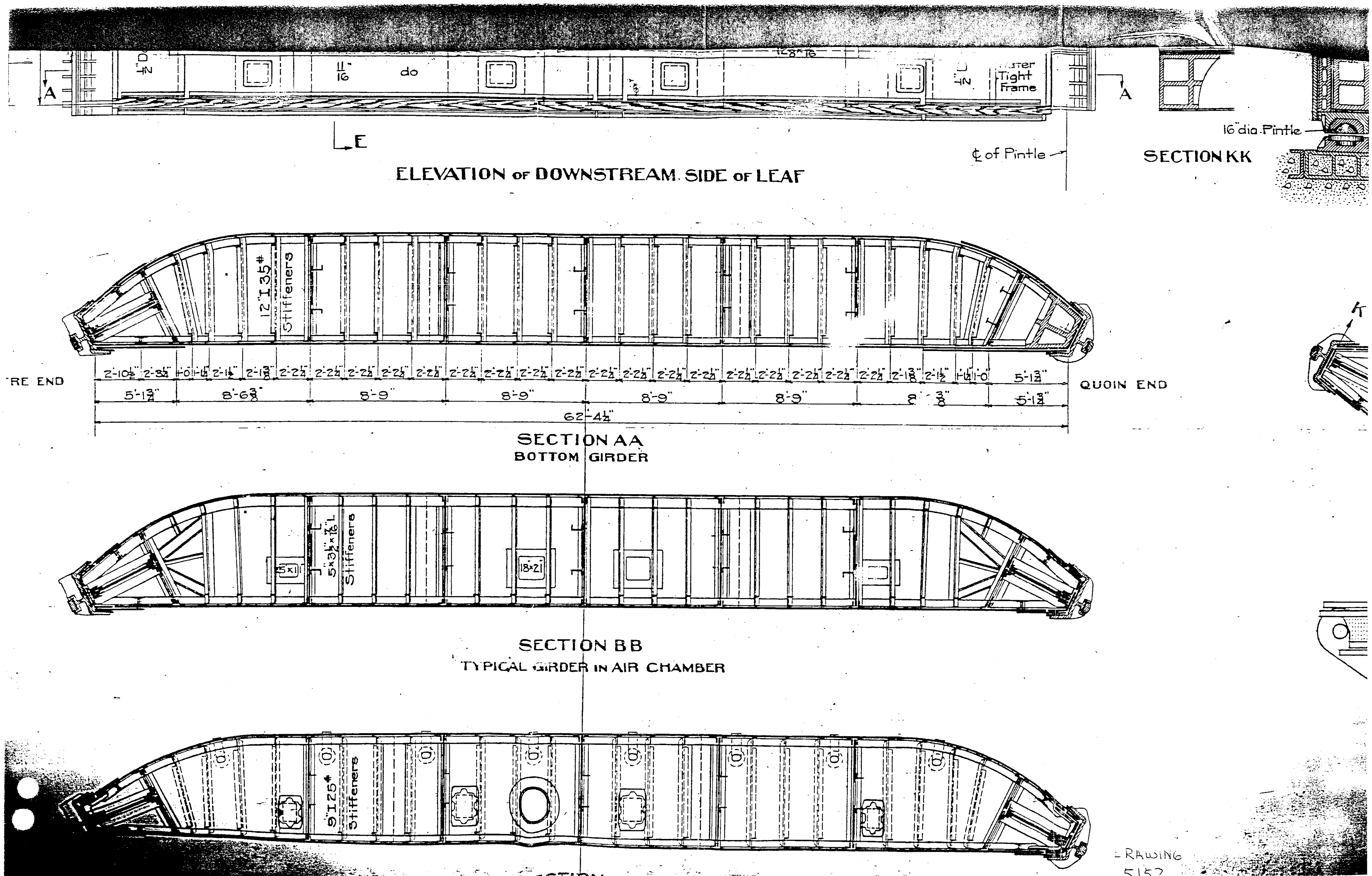
COMPUTATION SHEET

Page 2	of	Pages	
Computed by SRS		Date 12/5/99	
Checked by AH		Date 12/11/01	

Subject: PANAMA CANAL MITER GATE STUDY

Computation: LOWER SILL OPTION - ASSUMPTIONS

6) THE QUIN END OF THE MITER GATE WILL NOT NEED TO BE MODIFIED. THE SEAL ON LEAF WILL NEED A PIECE OF RUBBER TO CONNECT THE QUIN SEAL WITH GATE SEAL. SEE DRAWING FOR DETAILS.


ELEVATION of DOWNSTREAM SIDE of LEAF
A
E
do
11"/16
Tight Frame
¢ of Pintle
16" dia. Pintle
SECTION KK
SECTION AA
BOTTOM GIRDER
12" I 35#
Stiffeners
RE END
QUOIN END
5'-1¾"
8'-6⅜"
8'-9"
62'-4½"
SECTION BB
TYPICAL GIRDER IN AIR CHAMBER
5"x3½"x7/16" L
Stiffeners
5x11
18x21
9" I 25#
Stiffeners
RAWING

US Army Corps of Engineers Ohio River Division Pittsburgh District	COMPUTATION SHEET	Computed by:	SRS
		Date:	11/9/99
		Checked by:	[illegible]
		Date:	[illegible]
		Page:	6
	SUBJECT: Panama Canal Miter Gate Study		
	COMPUTATION: Skin Plate Design		

Lake Elevation		Seal Elevation	Plate Elevation	Design Head
Gatun Highest =	87.5 ft	35.717 ft	35.133	52.367 ft

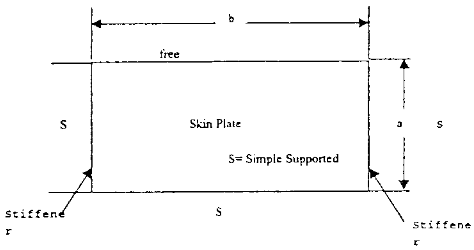
Water Density = 62.5 pcf

WATER PRESSURE q = 22.73 Psi conservative uniform

SKIN PLATE DESIGN

t = 0.6875 inch plate
Steel Fy = 36000 psi
Steel E = 29000000 psi

PANEL a= 18.968 inch a/b = 0.7158
PANEL b= 26.5 inch
Difference = 0.0488



Three edges simple supported and one end free Case 2a

A/B	0.5	0.667	1	1.5	2	4		
β	0.36	0.45	0.67	0.7700	0.79	0.8	0.4822	interpolate
α	0.08	0.106	0.14	0.1600	0.165	0.167	0.1110	interpolate

Max. Bending Stress = $\sigma = \frac{\beta * q * b^2}{t^2}$ = 16284 < 22410 psi **Type B Loading EM 1110-2-2105 allowable stress = .83*.75*Fy** REFERENCE 1

Good

Max. Deflection = $y = \frac{\alpha * q * b^4}{E * t^3}$ = 0.1320 inch

---

PANEL a= 26.5 inch a/b = 1.3971
PANEL b= 18.968 inch
Difference = 0.40

Three edges fixed and one edge free Case 10a:

A/B	0.25	0.5	0.75	1	1.5	2	3	0.5	
β1	0.02	0.081	0.173	0.321	0.727	1.226	2.105	0.6434	interpolate
β2	0.016	0.066	0.148	0.259	0.484	0.605	0.519	0.4377	interpolate
β3	0.031	0.126	0.286	0.511	1.073	1.568	1.982	0.9573	interpolate
γ1	0.114	0.23	0.341	0.457	0.673	0.845	1.012	0.6285	interpolate
γ2	0.125	0.248	0.371	0.51	0.859	1.212	1.0627	0.7872	interpolate

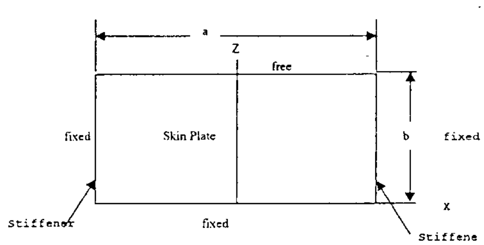
At x=+A/2, z=B):

Max. Bending Stress = $\sigma = \frac{\beta_3 * q * b^2}{t^2}$ = 16563 < 22410 psi **Type B Loading EM 1110-2-2105 allowable stress = .83*.75*Fy** REFERENCE 1

Good

R is the reaction force per unit length normal to the plate surface exerted by the boundary support on the edge of the plate

R at location Z = 0 and X=0 $R = \gamma_1 * q * b$ 270.97 lb/inch



11/16 inch Plate is Good

Job Information

	Engineer	Checked	Approved
Name:	SRS	[signature]	
Date:	10-Nov-99	12-11-01	

Comments

Extension of skin plate due to the LOWER SILL OPTION - 1 ft FOR 54'-8" MITER GATE

Structure Type	SPACE FRAME

Number of Nodes	121	Highest Node	121
Number of Plates	100	Highest Plate	100

Number of Basic Load Cases	1
Number of Combination Load Cases	0

Included in this printout are data for:

All	The Whole Structure

Included in this printout are results for load cases:

Type	L/C	Name
Primary	1	WATER LOAD

Node Displacement Summary

	Node	L/C	X (in)	Y (in)	Z (in)	Resultant (in)	rX (rad)	rY (rad)	rZ (rad)
Max X	1	1:WATER LOA	**0.000**	0.000	0.000	0.000	-0.00001	-0.01653	0.00000
Min X	1	1:WATER LOA	**0.000**	0.000	0.000	0.000	-0.00001	-0.01653	0.00000
Max Y	1	1:WATER LOA	0.000	**0.000**	0.000	0.000	-0.00001	-0.01653	0.00000
Min Y	1	1:WATER LOA	0.000	**0.000**	0.000	0.000	-0.00001	-0.01653	0.00000
Max Z	56	1:WATER LOA	0.000	0.000	**0.138**	0.138	-0.00739	0.00000	0.00000
Min Z	11	1:WATER LOA	0.000	0.000	**-0.000**	0.000	-0.00015	-0.00044	0.00000
Max rX	1	1:WATER LOA	0.000	0.000	0.000	0.000	**-0.00001**	-0.01653	0.00000
Min rX	66	1:WATER LOA	0.000	0.000	0.000	0.000	**-0.00937**	0.00000	0.00000
Max rY	111	1:WATER LOA	0.000	0.000	0.000	0.000	-0.00001	**0.01653**	0.00000
Min rY	1	1:WATER LOA	0.000	0.000	0.000	0.000	-0.00001	**-0.01653**	0.00000
Max rZ	1	1:WATER LOA	0.000	0.000	0.000	0.000	-0.00001	-0.01653	**0.00000**
Min rZ	1	1:WATER LOA	0.000	0.000	0.000	0.000	-0.00001	-0.01653	**0.00000**
Max Rst	56	1:WATER LOA	0.000	0.000	0.138	**0.138**	-0.00739	0.00000	0.00000

Plate Centre Stress Summary

			Shear		Membrane			Bending		
	Plate	L/C	Qx (ksi)	Qy (ksi)	Fx (ksi)	Fy (ksi)	Fxy (ksi)	Mx (kip-in/in)	My (kip-in/in)	Mxy (kip-in/in)
Max Qx	1	1:WATER LOA	**0.692**	0.208	0.000	0.000	0.000	0.367	0.093	0.396
Max Qy	99	1:WATER LOA	-0.220	**0.440**	0.000	0.000	0.000	0.085	0.101	-0.614
Max Fx	1	1:WATER LOA	0.692	0.208	**0.000**	0.000	0.000	0.367	0.093	0.396
Max Fy	1	1:WATER LOA	0.692	0.208	0.000	**0.000**	0.000	0.367	0.093	0.396
Max Fxy	1	1:WATER LOA	0.692	0.208	0.000	0.000	**0.000**	0.367	0.093	0.396

Plate Centre Stress Summary Cont...

			Shear		Membrane			Bending		
	Plate	L/C	Qx (ksi)	Qy (ksi)	Fx (ksi)	Fy (ksi)	Fxy (ksi)	Mx (kip-in/in)	My (kip-in/in)	Mxy (kip-in/in)
Max Mx	51	1:WATER LOA	-0.093	0.059	0.000	0.000	0.000	**1.370**	0.053	-0.059
Max My	56	1:WATER LOA	-0.020	-0.084	0.000	0.000	0.000	0.884	**0.502**	-0.076
Max Mxy	99	1:WATER LOA	-0.220	0.440	0.000	0.000	0.000	0.085	0.101	**-0.614**

Plate Centre Principal Stress Summary

			Principal		Von Mis	
	Plate	L/C	Top (ksi)	Bottom (ksi)	Top (ksi)	Bottom (ksi)
Max (t)	51	1:WATER LOA	**17.424**	17.424	17.111	17.111
Max (b)	51	1:WATER LOA	17.424	**17.424**	17.111	17.111
Max VM (t)	51	1:WATER LOA	17.424	17.424	**17.111**	17.111
Max VM (b)	51	1:WATER LOA	17.424	17.424	17.111	**17.111**

Reaction Summary

			Horizontal	Vertical	Horizontal	Moment		
	Node	L/C	FX (kip)	FY (kip)	FZ (kip)	MX (kip-in)	MY (kip-in)	MZ (kip-in)
Max FX	1	1:WATER LOA	**0.000**	0.000	-0.965	0.000	0.000	0.000
Min FX	1	1:WATER LOA	**0.000**	0.000	-0.965	0.000	0.000	0.000
Max FY	1	1:WATER LOA	0.000	**0.000**	-0.965	0.000	0.000	0.000
Min FY	1	1:WATER LOA	0.000	**0.000**	-0.965	0.000	0.000	0.000
Max FZ	11	1:WATER LOA	0.000	0.000	**0.930**	0.000	0.000	0.000

Reaction Summary Cont...

	Node	L/C	Horizontal FX (kip)	Vertical FY (kip)	Horizontal FZ (kip)	Moment MX (kip-in)	Moment MY (kip-in)	Moment MZ (kip-in)
Min FZ	1	1:WATER LOA	0.000	0.000	**-0.965**	0.000	0.000	0.000
Max MX	1	1:WATER LOA	0.000	0.000	-0.965	**0.000**	0.000	0.000
Min MX	1	1:WATER LOA	0.000	0.000	-0.965	**0.000**	0.000	0.000
Max MY	1	1:WATER LOA	0.000	0.000	-0.965	0.000	**0.000**	0.000
Min MY	1	1:WATER LOA	0.000	0.000	-0.965	0.000	**0.000**	0.000
Max MZ	1	1:WATER LOA	0.000	0.000	-0.965	0.000	0.000	**0.000**
Min MZ	1	1:WATER LOA	0.000	0.000	-0.965	0.000	0.000	**0.000**

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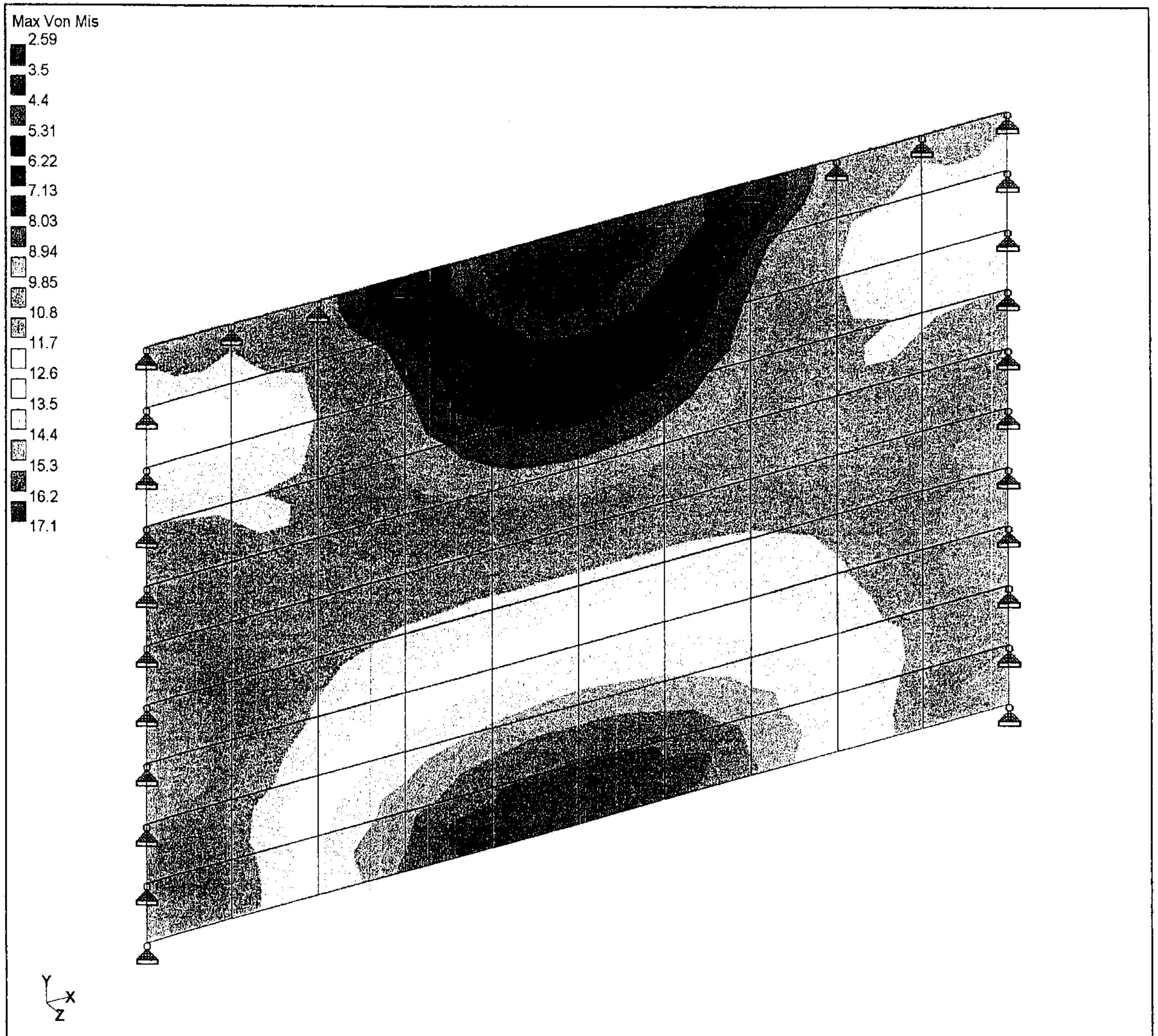
Job No	Sheet No 5	Rev
Part 54'-8" skin plate extension		
Ref		
By SRS	Date 10-Nov-99	Chd
File skin54.std	Date/Time 10-Nov-1999 13:49	

Job Title Panama Canal Miter Gate Study

Client PCC



Whole Structure

```
STAAD SPACE 54'-8" MITER GATE EXTENSION
START JOB INFORMATION
JOB NAME Panama Canal Miter Gate Study
JOB CLIENT PCC
JOB PART 54'-8" skin plate extension
JOB COMMENT Extension of skin plate due to the LOWER SILL OPTION - 1 ft
ENGINEER NAME SRS
ENGINEER DATE 10-Nov-99
END JOB INFORMATION
INPUT WIDTH 79
UNIT FEET KIP
JOINT COORDINATES
1 0 0 0; 2 0 0.158 0; 3 0 0.316 0; 4 0 0.474 0; 5 0 0.632 0; 6 0 0.79 0;
7 0 0.948 0; 8 0 1.106 0; 9 0 1.264 0; 10 0 1.422 0; 11 0 1.58 0; 12 0.221 0 0;
13 0.221 0.158 0; 14 0.221 0.316 0; 15 0.221 0.474 0; 16 0.221 0.632 0;
17 0.221 0.79 0; 18 0.221 0.948 0; 19 0.221 1.106 0; 20 0.221 1.264 0;
21 0.221 1.422 0; 22 0.221 1.58 0; 23 0.442 0 0; 24 0.442 0.158 0;
25 0.442 0.316 0; 26 0.442 0.474 0; 27 0.442 0.632 0; 28 0.442 0.79 0;
29 0.442 0.948 0; 30 0.442 1.106 0; 31 0.442 1.264 0; 32 0.442 1.422 0;
33 0.442 1.58 0; 34 0.663 0 0; 35 0.663 0.158 0; 36 0.663 0.316 0;
37 0.663 0.474 0; 38 0.663 0.632 0; 39 0.663 0.79 0; 40 0.663 0.948 0;
41 0.663 1.106 0; 42 0.663 1.264 0; 43 0.663 1.422 0; 44 0.663 1.58 0;
45 0.884 0 0; 46 0.884 0.158 0; 47 0.884 0.316 0; 48 0.884 0.474 0;
49 0.884 0.632 0; 50 0.884 0.79 0; 51 0.884 0.948 0; 52 0.884 1.106 0;
53 0.884 1.264 0; 54 0.884 1.422 0; 55 0.884 1.58 0; 56 1.105 0 0;
57 1.105 0.158 0; 58 1.105 0.316 0; 59 1.105 0.474 0; 60 1.105 0.632 0;
61 1.105 0.79 0; 62 1.105 0.948 0; 63 1.105 1.106 0; 64 1.105 1.264 0;
65 1.105 1.422 0; 66 1.105 1.58 0; 67 1.326 0 0; 68 1.326 0.158 0;
69 1.326 0.316 0; 70 1.326 0.474 0; 71 1.326 0.632 0; 72 1.326 0.79 0;
73 1.326 0.948 0; 74 1.326 1.106 0; 75 1.326 1.264 0; 76 1.326 1.422 0;
77 1.326 1.58 0; 78 1.547 0 0; 79 1.547 0.158 0; 80 1.547 0.316 0;
81 1.547 0.474 0; 82 1.547 0.632 0; 83 1.547 0.79 0; 84 1.547 0.948 0;
85 1.547 1.106 0; 86 1.547 1.264 0; 87 1.547 1.422 0; 88 1.547 1.58 0;
89 1.768 0 0; 90 1.768 0.158 0; 91 1.768 0.316 0; 92 1.768 0.474 0;
93 1.768 0.632 0; 94 1.768 0.79 0; 95 1.768 0.948 0; 96 1.768 1.106 0;
97 1.768 1.264 0; 98 1.768 1.422 0; 99 1.768 1.58 0; 100 1.989 0 0;
101 1.989 0.158 0; 102 1.989 0.316 0; 103 1.989 0.474 0; 104 1.989 0.632 0;
105 1.989 0.79 0; 106 1.989 0.948 0; 107 1.989 1.106 0; 108 1.989 1.264 0;
109 1.989 1.422 0; 110 1.989 1.58 0; 111 2.21 0 0; 112 2.21 0.158 0;
113 2.21 0.316 0; 114 2.21 0.474 0; 115 2.21 0.632 0; 116 2.21 0.79 0;
117 2.21 0.948 0; 118 2.21 1.106 0; 119 2.21 1.264 0; 120 2.21 1.422 0;
121 2.21 1.58 0;
ELEMENT INCIDENCES SHELL
1 1 12 13 2; 2 2 13 14 3; 3 3 14 15 4; 4 4 15 16 5; 5 5 16 17 6; 6 6 17 18 7;
7 7 18 19 8; 8 8 19 20 9; 9 9 20 21 10; 10 10 21 22 11; 11 12 23 24 13;
12 13 24 25 14; 13 14 25 26 15; 14 15 26 27 16; 15 16 27 28 17; 16 17 28 29 18;
17 18 29 30 19; 18 19 30 31 20; 19 20 31 32 21; 20 21 32 33 22; 21 23 34 35 24;
22 24 35 36 25; 23 25 36 37 26; 24 26 37 38 27; 25 27 38 39 28; 26 28 39 40 29;
27 29 40 41 30; 28 30 41 42 31; 29 31 42 43 32; 30 32 43 44 33; 31 34 45 46 35;
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42 46 57 58 47; 43 47 58 59 48; 44 48 59 60 49; 45 49 60 61 50; 46 50 61 62 51;
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62 68 79 80 69; 63 69 80 81 70; 64 70 81 82 71; 65 71 82 83 72; 66 72 83 84 73;
67 73 84 85 74; 68 74 85 86 75; 69 75 86 87 76; 70 76 87 88 77; 71 78 89 90 79;
```

COMPUTATION SHEET

US Army Corps of Engineers
Ohio River Division

Subject: PANAMA CANAL MITER GATE STUDY

Computed by: SRS Date: 11/9/99

Checked by: AH Date: 12/11/01

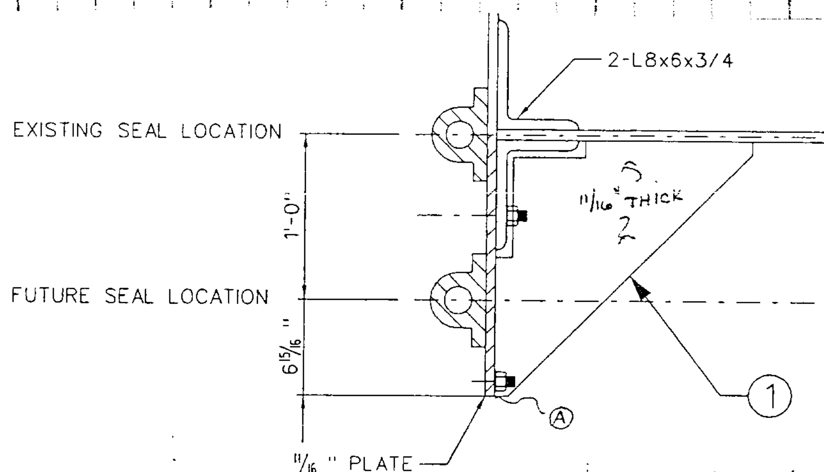
Computation: LOWER SILL OPTION - 54'-8" MITER GATES

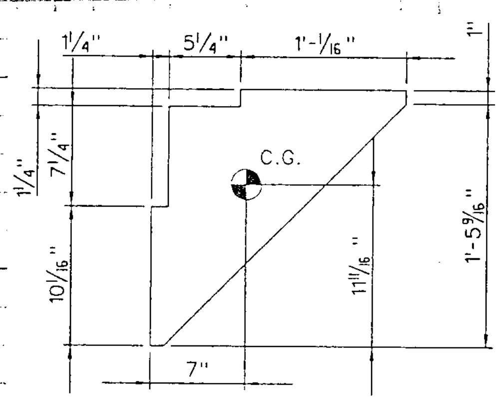
DESIGN STIFFENER

DESIGN STIFFENER FOR BOTTOM OF MITER GATE AS A SEATED BRACKET.

REFERENCE, DESIGN OF WELDED STRUCTURES BY OMER W. BLODGETT, PAGE 5.3-2

ASSUME 11/16" PLATE





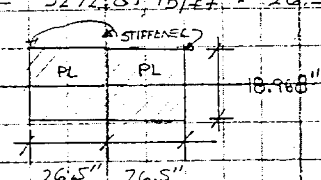
AREA = 1.2066 FT°2

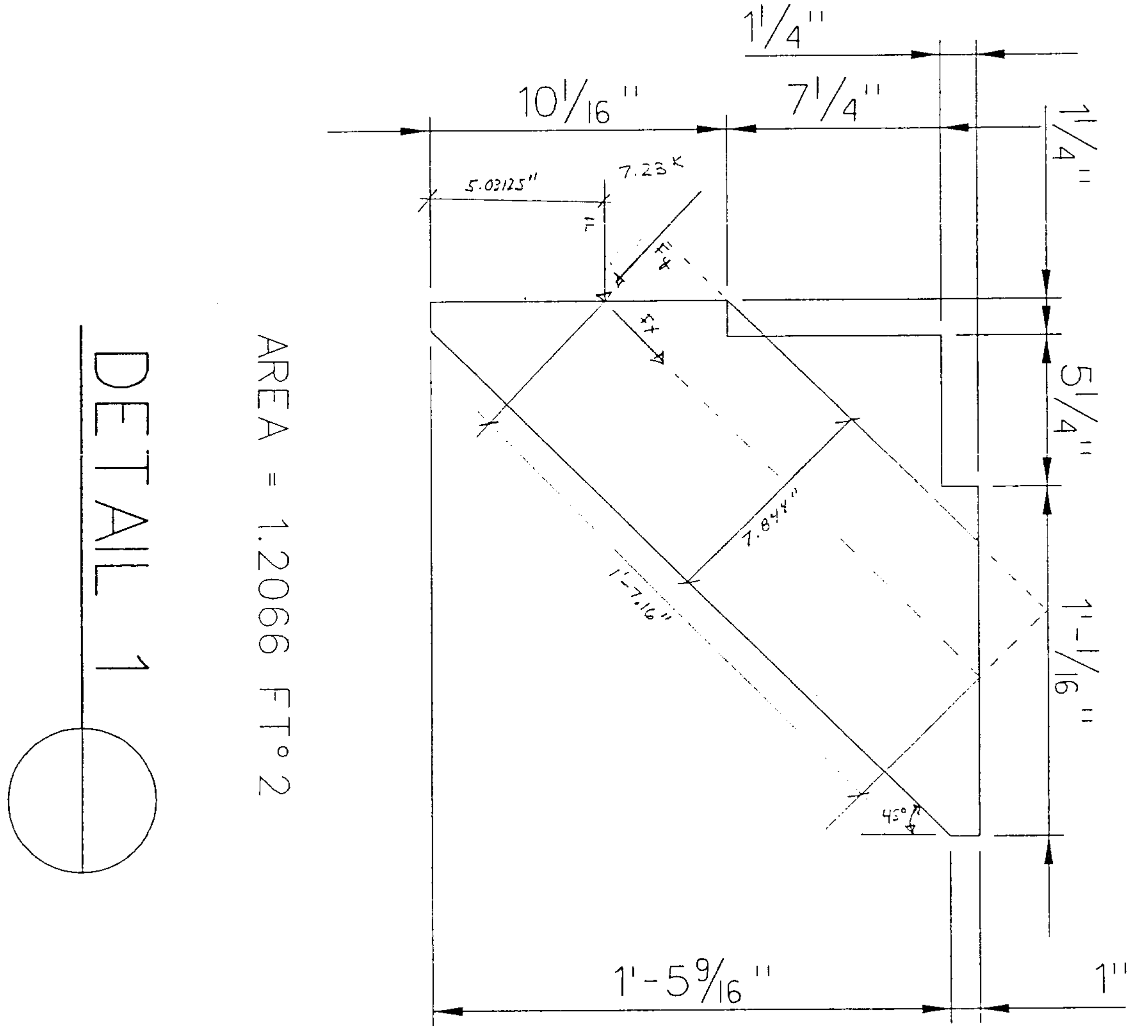
DETAIL 1

A.) USE MAXIMUM FORCE AT (A)

LOAD = (51.783' + .5833') * 62.5 pcf = 3272.89 lb/ft PER LINEAR ft

LOAD = 3272.89 lb/ft * 26.5"/12 ft = 7227 lbs = 7.23 Kip





$\cos\theta = \frac{F_y}{F}$ ∴ $F_y = 7.23^k \cos 45°$

$F_y = 5.11^k = F_x$

US Army Corps of Engineers Ohio River Division	COMPUTATION SHEET	Page 14 of Pages
	Subject *Panama Canal Gate Study*	Computed by SRS Date 12/99
		Checked by AH Date 12/01
	Computation	

B.) AXIAL COMPRESSION

$$f_c = \frac{F}{A} = \frac{5.11^k}{\frac{11}{16}''(7.849'')} = .9476\ ksi$$

AISC, ASD PAGE 5-42 CHAPTER E

$$F_a = \frac{\left[1 - \frac{(Kl/r)^2}{2C_c^2}\right]F_y}{\frac{5}{3} + \frac{3(Kl/r)}{8C_c} - \frac{(Kl/r)^3}{8C_c^3}}$$

$K = 1$

$l = 19.16''$

$r = .577350\ (\frac{11}{16}'') = .397''$

$Kl/r = 48.27$

$$C_c = \sqrt{\frac{2\pi^2 E}{F_y}} = \sqrt{\frac{2\pi^2(29{,}000\ ksi)}{36\ ksi}}$$

$C_c = 126.1$

$Kl/r < C_c$ USE EQUATION E2-1

$$F_a = \frac{\left[1 - \frac{48.27^2}{2(126.1)^2}\right]36\ ksi}{\frac{5}{3} + \frac{3(48.27)}{8(126.1)} - \frac{48.27^3}{8(126.1)^3}}$$

$$= \frac{33.362\ ksi}{1.8032}$$

$F_a = 18.50\ ksi$

FROM EM 1110-2-2105, PAGE 4-1, USE TYPE B STRUCTURE USE .83

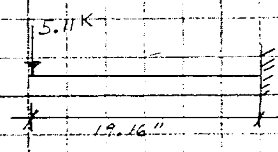
$F_a = .83 * 18.50\ ksi$

$= 15.36\ ksi$

$f_c < F_a$ GOOD

$.9476\ ksi < 15.36\ ksi$

c.) MOMENT ASSUME STIFFENER IS:



$M = P\ell$

$= 5.11^K (19.16")$

$= 97 \text{ k-in}$

$S = \frac{I}{c} = \frac{1/12 (11/16")(7.844")^3}{7.844/2} = \frac{27.651}{3.922} = 7.05 \text{ in}^3$

$f_b = \frac{M}{S} = \frac{97 \text{ k-in}}{7.05 \text{ in}^3} = 13.76 \text{ ksi}$

AISC, ASD PAGE 5-45 CHAPTER F

$F_b = .66 F_y$

$F_b = .66 (36 \text{ ksi})$

$= 23.76 \text{ ksi}$

FROM EM 1110-2-2105, PAGE 4-1, USE TYPE B STRUCTURE USE .83

$F_b = .83 * 23.76 \text{ ksi}$

$= 19.72 \text{ ksi}$

$f_b < F_b$ GOOD

$13.76 \text{ ksi} < 19.72$

FOR COMBINED STRESSES USE AISC, ASD CHAPTER H.

SINCE $f_a / F_a \leq .15$ CAN USE EQUATION H1-3

$\frac{f_a}{F_a} + \frac{f_b}{F_b} \leq 1.0$

$\frac{.9476}{15.36} + \frac{13.76}{19.72} \leq 1.0$

$.76 \leq 1.0$ GOOD FOR COMBINED STRESSES

11/16" PLATE IS SUFFICIENT.

US Army Corps of Engineers
Ohio River Division

COMPUTATION SHEET

Page 16 of Pages	
Computed by SRS	Date 12/99
Checked by AH	Date 12/01

Subject: PANAMA CANAL MITER GATE STUDY

Computation: LOWER SILL OPTION – ANALYSIS AND DESIGN FOR 79' GATES

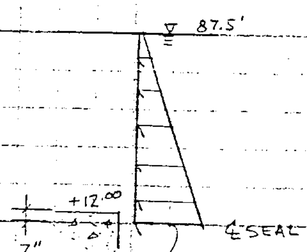
1) THE ANALYSIS ON PAGES _ TO _ ARE FOR THE 79' AND 77' GATES.

2) DESIGN HEAD

a) PEDRO M.G. 62-69
MIRAFLORES M.G. 104-107

b) EXISTING SILL EL. @ PEDRO = +13.00
WATER EL. = 87.5'

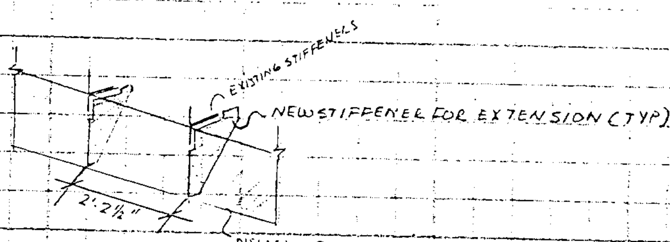
c) NEW SILL EL @ PEDRO = +12.00
WATER EL. = 87.5'



PRESSURE = 76.083' * 62.5 pcf = 4755 lb/ft² = 33 psi
= 4.8 ksf

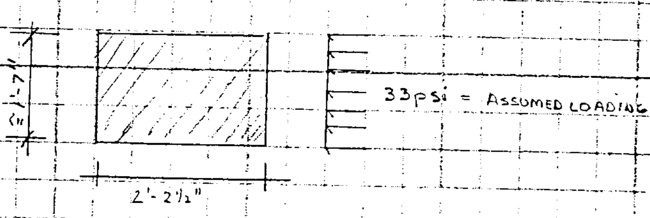
3) SKIN PLATE AND STIFFENERS.

SPACING OF EXISTING STIFFENERS FOR THE BOTTOM GIRDER IS 2'-2½". DRAWING 5155 IS FOR 79' GATES IT REFERENCES 5156 FOR TYPICAL GIRDER. I USED 2'-2½" FROM DWG 5023 FOR 77' GATES.



BOTTOM GIRDER

a) SKIN PLATE



ORD Form 427
1 Feb 87

COMPUTATION SHEET

US Army Corps of Engineers
Ohio River Division

Computed by SRS Date 12/99

Checked by AH Date 12/01

Subject

Computation

FROM ROARK'S FORMULAS FOR STRESS AND STRAIN, SIXTH EDITION, PAGE 461 AND 469
USE CASE 2A AND CASE 10A TO ANALYZE SKIN PLATE

SEE SPREADSHEET FOR ROARK'S ANALYSIS AND SEE STAADPRO ANALYSIS FOR VERIFICATION.

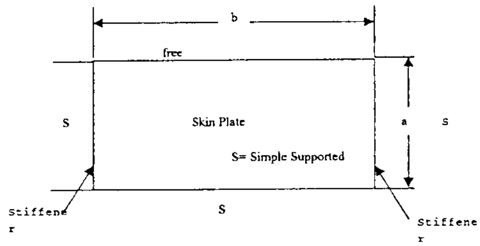
US Army Corps of Engineers Ohio River Division Pittsburgh District	COMPUTATION SHEET	Computed by: SRS Date: 11/9/99 Checked by: HH Date: [illegible] Page: 18

SUBJECT: Panama Canal Miter Gate Study
COMPUTATION: Skin Plate Design for 79' Miter Gate

Lake Elevation		Seal Elevation	Plate Elevation	Design Head
Gatun Highest =	87.5 ft	12.000 ft	11.417	76.083 ft

Water Density = 62.5 pcf

WATER PRESSURE q = 33.02 Psi conservative uniform



SKIN PLATE DESIGN

t = 0.8125 inch plate
Steel Fy = 36000 psi
Steel E = 29000000 psi

PANEL a= 18.968 inch a/b = 0.7158
PANEL b= 26.5 inch
Difference = 0.0488

Three edges simple supported and one end free Case 2a

A/B	0.5	0.667	1	1.5	2	4		
β	0.36	0.45	0.67	0.7700	0.79	0.8	0.4822	interpolate
α	0.08	0.106	0.14	0.1600	0.165	0.167	0.1110	interpolate

Max. Bending Stress = $\sigma = \dfrac{\beta * q * b^2}{t^2}$ = 16939 < 22410 psi

Good

Type B Loading EM 1110-2-2105
allowable stress = .83*.75*Fy

Max. Deflection = $y = \dfrac{\alpha * q * b^4}{E * t^3}$ = 0.1162 inch

PANEL a= 26.5 inch a/b = 1.3971
PANEL b= 18.968 inch
Difference = 0.40

Three edges fixed and one edge free Case 10a:

A/B	0.25	0.5	0.75	1	1.5	2	3	0.5	
β1	0.02	0.081	0.173	0.321	0.727	1.226	2.105	0.6434	interpolate
β2	0.016	0.066	0.148	0.259	0.484	0.605	0.519	0.4377	interpolate
β3	0.031	0.126	0.286	0.511	1.073	1.568	1.982	0.9573	interpolate
γ1	0.114	0.23	0.341	0.457	0.673	0.845	1.012	0.6285	interpolate
γ2	0.125	0.248	0.371	0.51	0.859	1.212	1.0627	0.7872	interpolate

At x=+A/2, y=B):

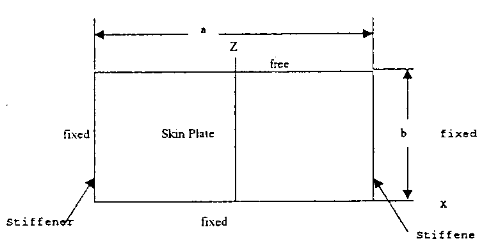
Max. Bending Stress = $\sigma = \dfrac{\beta_3 * q * b^2}{t^2}$ = 17229 < 22410 psi

Good

Type B Loading EM 1110-2-2105
allowable stress = .83*.75*Fy

R is the reaction force per unit length normal to the plate surface exerted by the boundary support on the edge of the plate

R at location Z = 0 and X=0 $R = \gamma_1 * q * b$ 393.70 lb/inch



13/16 inch Plate is Good

Job Information

	Engineer	Checked	Approved
Name:	SRS		
Date:	10-Nov-99		

Comments

Extension of skin plate due to the LOWER SILL OPTION - 1 ft

Structure Type	SPACE FRAME

Number of Nodes	121	Highest Node	121
Number of Plates	100	Highest Plate	100

Number of Basic Load Cases	1
Number of Combination Load Cases	0

Included in this printout are data for:

All	The Whole Structure

Included in this printout are results for load cases:

Type	L/C	Name
Primary	1	WATER LOAD

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Job No	Sheet No 2	Rev	
Job Title Panama Canal Miter Gate Study	Part 79' Miter Gate Skin Plate Extension		
	Ref		
	By SRS	Date 10-Nov-99	Chd
Client PCC	File skin79.std	Date/Time 09-Dec-1999 12:36	

Node Displacement Summary

	Node	L/C	X (in)	Y (in)	Z (in)	Resultant (in)	rX (rad)	rY (rad)	rZ (rad)
Max X	1	1:WATER LOA	**0.000**	0.000	0.000	0.000	-0.00002	-0.01003	0.00000
Min X	1	1:WATER LOA	**0.000**	0.000	0.000	0.000	-0.00002	-0.01003	0.00000
Max Y	1	1:WATER LOA	0.000	**0.000**	0.000	0.000	-0.00002	-0.01003	0.00000
Min Y	1	1:WATER LOA	0.000	**0.000**	0.000	0.000	-0.00002	-0.01003	0.00000
Max Z	56	1:WATER LOA	0.000	0.000	**0.084**	0.084	-0.00449	-0.00000	0.00000
Min Z	11	1:WATER LOA	0.000	0.000	**-0.000**	0.000	-0.00011	-0.00028	0.00000
Max rX	1	1:WATER LOA	0.000	0.000	0.000	0.000	**-0.00002**	-0.01003	0.00000
Min rX	66	1:WATER LOA	0.000	0.000	0.000	0.000	**-0.00569**	0.00000	0.00000
Max rY	111	1:WATER LOA	0.000	0.000	0.000	0.000	-0.00002	**0.01003**	0.00000
Min rY	1	1:WATER LOA	0.000	0.000	0.000	0.000	-0.00002	**-0.01003**	0.00000
Max rZ	1	1:WATER LOA	0.000	0.000	0.000	0.000	-0.00002	-0.01003	**0.00000**
Min rZ	1	1:WATER LOA	0.000	0.000	0.000	0.000	-0.00002	-0.01003	**0.00000**
Max Rst	56	1:WATER LOA	0.000	0.000	0.084	**0.084**	-0.00449	-0.00000	0.00000

Plate Centre Stress Summary

			Shear		Membrane			Bending		
	Plate	L/C	Qx (ksi)	Qy (ksi)	Fx (ksi)	Fy (ksi)	Fxy (ksi)	Mx (kip·in/in)	My (kip·in/in)	Mxy (kip·in/in)
Max Qx	91	1:WATER LOA	**-0.586**	0.177	0.000	0.000	0.000	0.369	0.093	-0.391
Max Qy	99	1:WATER LOA	-0.182	**0.368**	0.000	0.000	0.000	0.085	0.100	-0.610
Max Fx	1	1:WATER LOA	0.586	0.177	**0.000**	0.000	0.000	0.369	0.093	0.391
Max Fy	1	1:WATER LOA	0.586	0.177	0.000	**0.000**	0.000	0.369	0.093	0.391
Max Fxy	1	1:WATER LOA	0.586	0.177	0.000	0.000	**0.000**	0.369	0.093	0.391

Plate Centre Stress Summary Cont...

	Plate	L/C	Shear		Membrane			Bending		
			Qx (ksi)	Qy (ksi)	Fx (ksi)	Fy (ksi)	Fxy (ksi)	Mx (kip-in/in)	My (kip-in/in)	Mxy (kip-in/in)
Max Mx	41	1:WATER LOA	0.078	0.049	0.000	0.000	0.000	**1.371**	0.053	0.058
Max My	46	1:WATER LOA	0.017	-0.071	0.000	0.000	0.000	0.885	**0.502**	0.076
Max Mxy	99	1:WATER LOA	-0.182	0.368	0.000	0.000	0.000	0.085	0.100	**-0.610**

Plate Centre Principal Stress Summary

	Plate	L/C	Principal		Von Mis	
			Top (ksi)	Bottom (ksi)	Top (ksi)	Bottom (ksi)
Max (t)	41	1:WATER LOA	**12.486**	12.486	12.264	12.264
Max (b)	41	1:WATER LOA	12.486	**12.486**	12.264	12.264
Max VM (t)	41	1:WATER LOA	12.486	12.486	**12.264**	12.264
Max VM (b)	41	1:WATER LOA	12.486	12.486	12.264	**12.264**

Reaction Summary

	Node	L/C	Horizontal	Vertical	Horizontal	Moment		
			FX (kip)	FY (kip)	FZ (kip)	MX (kip-in)	MY (kip-in)	MZ (kip-in)
Max FX	1	1:WATER LOA	**0.000**	0.000	-0.959	0.000	0.000	0.000
Min FX	1	1:WATER LOA	**0.000**	0.000	-0.959	0.000	0.000	0.000
Max FY	1	1:WATER LOA	0.000	**0.000**	-0.959	0.000	0.000	0.000
Min FY	1	1:WATER LOA	0.000	**0.000**	-0.959	0.000	0.000	0.000
Max FZ	11	1:WATER LOA	0.000	0.000	**0.916**	0.000	0.000	0.000

Reaction Summary Cont...

	Node	L/C	Horizontal FX (kip)	Vertical FY (kip)	Horizontal FZ (kip)	Moment MX (kip in)	MY (kip in)	MZ (kip in)
Min FZ	111	1:WATER LOA	0.000	0.000	**-0.959**	0.000	0.000	0.000
Max MX	1	1:WATER LOA	0.000	0.000	-0.959	**0.000**	0.000	0.000
Min MX	1	1:WATER LOA	0.000	0.000	-0.959	**0.000**	0.000	0.000
Max MY	1	1:WATER LOA	0.000	0.000	-0.959	0.000	**0.000**	0.000
Min MY	1	1:WATER LOA	0.000	0.000	-0.959	0.000	**0.000**	0.000
Max MZ	1	1:WATER LOA	0.000	0.000	-0.959	0.000	0.000	**0.000**
Min MZ	1	1:WATER LOA	0.000	0.000	-0.959	0.000	0.000	**0.000**

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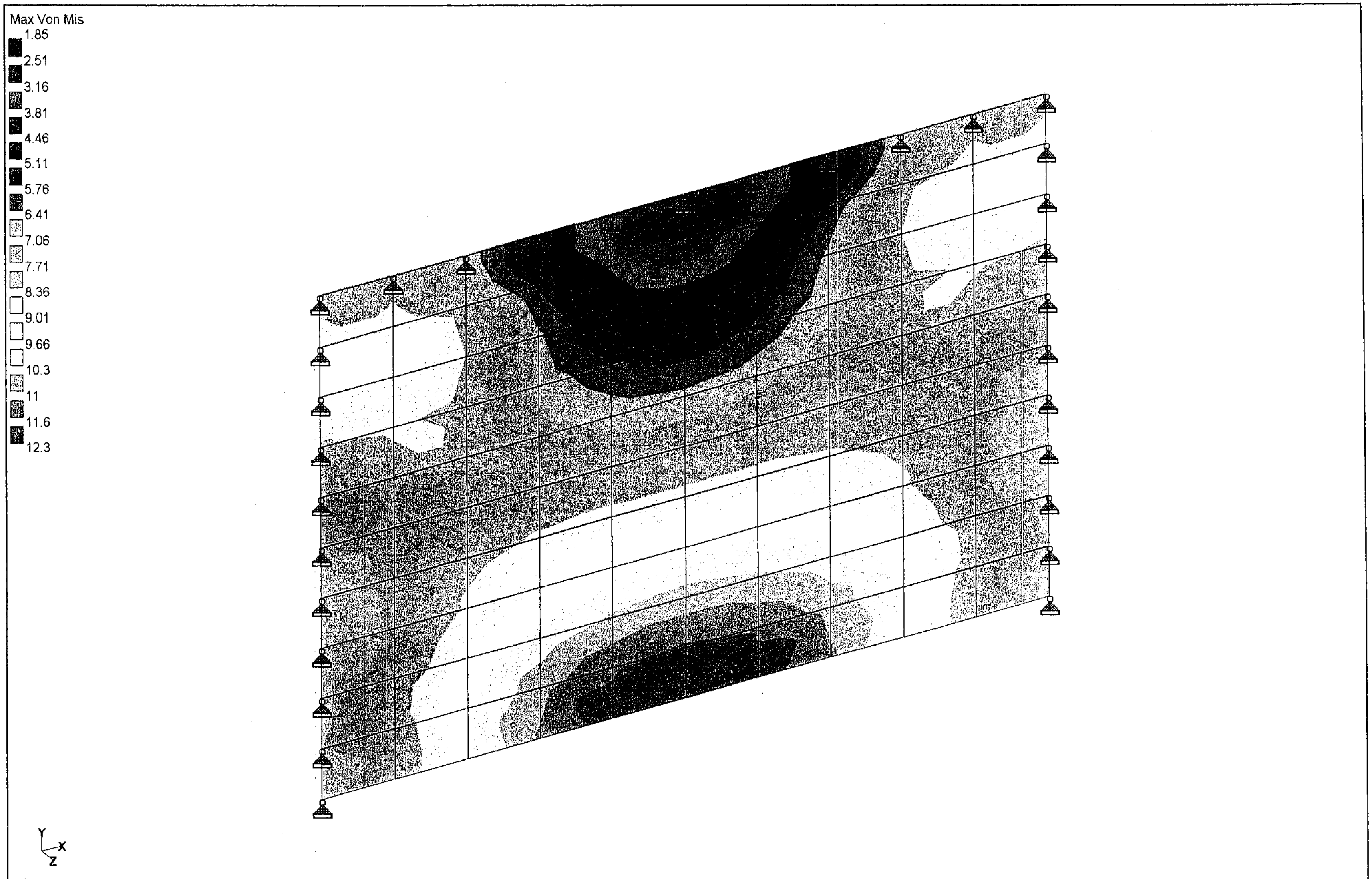
Job Title Panama Canal Miter Gate Study	Job No	Sheet No 5	Rev
	Part 79' Miter Gate Skin Plate Extension		
	Ref		
	By SRS	Date 10-Nov-99	Chd
Client PCC	File skin79.std	Date/Time 09-Dec-1999 12:36	



Whole Structure

```
STAAD SPACE 79' MITER GATE EXTENSION
START JOB INFORMATION
JOB NAME Panama Canal Miter Gate Study
JOB CLIENT PCC
JOB PART 79' Miter Gate Skin Plate Extension
JOB COMMENT Extension of skin plate due to the LOWER SILL OPTION - 1 ft
ENGINEER NAME SRS
ENGINEER DATE 10-Nov-99
END JOB INFORMATION
INPUT WIDTH 79
UNIT FEET KIP
JOINT COORDINATES
1 0 0 0; 2 0 0.158 0; 3 0 0.316 0; 4 0 0.474 0; 5 0 0.632 0; 6 0 0.79 0;
7 0 0.948 0; 8 0 1.106 0; 9 0 1.264 0; 10 0 1.422 0; 11 0 1.58 0; 12 0.221 0 0;
13 0.221 0.158 0; 14 0.221 0.316 0; 15 0.221 0.474 0; 16 0.221 0.632 0;
17 0.221 0.79 0; 18 0.221 0.948 0; 19 0.221 1.106 0; 20 0.221 1.264 0;
21 0.221 1.422 0; 22 0.221 1.58 0; 23 0.442 0 0; 24 0.442 0.158 0;
25 0.442 0.316 0; 26 0.442 0.474 0; 27 0.442 0.632 0; 28 0.442 0.79 0;
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33 0.442 1.58 0; 34 0.663 0 0; 35 0.663 0.158 0; 36 0.663 0.316 0;
37 0.663 0.474 0; 38 0.663 0.632 0; 39 0.663 0.79 0; 40 0.663 0.948 0;
41 0.663 1.106 0; 42 0.663 1.264 0; 43 0.663 1.422 0; 44 0.663 1.58 0;
45 0.884 0 0; 46 0.884 0.158 0; 47 0.884 0.316 0; 48 0.884 0.474 0;
49 0.884 0.632 0; 50 0.884 0.79 0; 51 0.884 0.948 0; 52 0.884 1.106 0;
53 0.884 1.264 0; 54 0.884 1.422 0; 55 0.884 1.58 0; 56 1.105 0 0;
57 1.105 0.158 0; 58 1.105 0.316 0; 59 1.105 0.474 0; 60 1.105 0.632 0;
61 1.105 0.79 0; 62 1.105 0.948 0; 63 1.105 1.106 0; 64 1.105 1.264 0;
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93 1.768 0.632 0; 94 1.768 0.79 0; 95 1.768 0.948 0; 96 1.768 1.106 0;
97 1.768 1.264 0; 98 1.768 1.422 0; 99 1.768 1.58 0; 100 1.989 0 0;
101 1.989 0.158 0; 102 1.989 0.316 0; 103 1.989 0.474 0; 104 1.989 0.632 0;
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109 1.989 1.422 0; 110 1.989 1.58 0; 111 2.21 0 0; 112 2.21 0.158 0;
113 2.21 0.316 0; 114 2.21 0.474 0; 115 2.21 0.632 0; 116 2.21 0.79 0;
117 2.21 0.948 0; 118 2.21 1.106 0; 119 2.21 1.264 0; 120 2.21 1.422 0;
121 2.21 1.58 0;
ELEMENT INCIDENCES SHELL
1 1 12 13 2; 2 2 13 14 3; 3 3 14 15 4; 4 4 15 16 5; 5 5 16 17 6; 6 6 17 18 7;
7 7 18 19 8; 8 8 19 20 9; 9 9 20 21 10; 10 10 21 22 11; 11 12 23 24 13;
12 13 24 25 14; 13 14 25 26 15; 14 15 26 27 16; 15 16 27 28 17; 16 17 28 29 18;
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67 73 84 85 74; 68 74 85 86 75; 69 75 86 87 76; 70 76 87 88 77; 71 78 89 90 79;
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b) STIFFENERS

FOR SAVINGS IN TIME I ASSUMED THE SAME GEOMETERY FOR THE 54'-8" STIFFENER BUT MADE IT 13/16" THICK PLATE.

Appendix 3. – Miter Gate Sill: Precast Panel & CIP Panel and Recess – Calculations

Subject PANAMA CANAL

Computation MITER GATE SILL MODIFICATION

1) PRELIMINARY PRECAST PANEL DESIGN

A) SINCE THE MITER GATES NOS. 13-20 AT GATUN LOCKS AND NOS. 54-69 AT PEDRO MIGUEL ARE HORIZONTALLY FRAMED, THE LATERAL LOAD ON THE SILL IS DUE TO HYDROSTATIC PRESSURE. THE RUBBER SEAL OF THE MITER GATE DOES NOT TRANSFER LOAD TO THE SEAL.

B) TO DESIGN THE ANCHOR BOLTS, THE FOLLOWING DESIGN ASSUMPTIONS ARE MADE:

1) THE UPPER CHAMBER IS AT HIGHEST POOL ELEVATION AND THE LOWER CHAMBER OR OUT SIDE THE CHAMBER IS AT LOWEST POOL ELEVATION OR DEWATERED.

2) THE PRECAST PANEL IS SUBJECT TO FULL UPLIFT

LOW POOL OR DEWATERED	HIGHEST UPPER POOL

3) THE LOWEST GIRDER TRANSFERS ALL OF ITS LOAD INTO THE SILL SEGMENT. THE MAGNITUDE OF THE LOAD IS BASED ON THE TRIBUTARY AREA OF THE HORIZONTAL GIRDER AND THE M.G. EXTENSION FOR THE SEAL.

C) CALCULATE SIZE AND SPACING OF 1-IN DIA THREADBAR

1) 1-IN DIA THREADBAR - $A = 0.85\ in^2$ DYWIDAG[1]

$f_{ULT} = 150$ KSI

$f_y = 0.8 f_{ULT}$ ASTM A722-98 SEC 6.2.2

2) ASSUME LATERAL LOAD APPLIED TO SILL IS EQUAL TO HYDROSTATIC PRESSURE APPLIED TO TRIBUTARY AREA OF LOWEST HORIZONTAL GIRDER. THE HORIZONTAL GIRDERS ARE SPACED ON 3'-9" CENTERS FOR GATUN MG NOS. 13-20 (HEIGHT - 77'-10") AND PEDRO MIGUEL MG NOS. 54-69 (HEIGHT - 79').[2,3] THE SEAL EXTENSION IS 1'-0".

3) THE THREADBAR SIZE AND SPACING WILL BE BASED ON HIGHEST CHAMBER POOL ELEVATION AND ADJACENT CHAMBER AT LOWEST POOL ELEVATION OR DEWATERED.

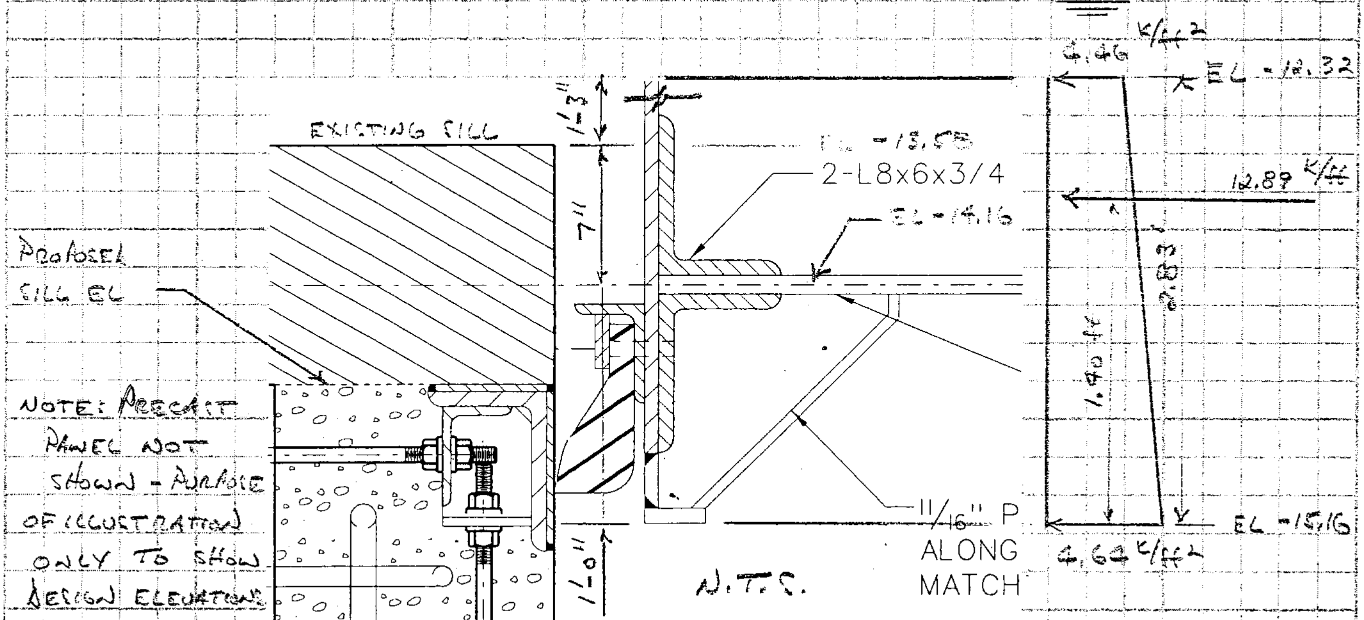
1/ DYWIDAG THREADBAR, ROCK AND SOIL ANCHORS, BROCHURE 4M 4-90, P.3.
2/ ACP, MASTER MG AND VALVE OVERHAUL SCHEDULE, 25 JAN 1994
3/ ACP, DWGS 5154 & 5155, 25 MAR 1914

4) USING HIGHEST CHAMBER POOL ELEVATION FOR ADJACENT CHAMBER DEWATERED:

LOCK	UPPER POOL EL (ft)	NEW M.G. SILL EL (ft)	M.G. EXTENSION PAST NEW SILL (ft)	MAX. HEAD (ft)
GATUN	+59	-14.58	0.58	74.16
PEDRO MIGUEL	+81.5	+12.0	0.58	70.08

∴ GATUN CONTROLS

5) CALCULATE HYDROSTATIC FORCES & PRESSURES FOR LOWEST HORIZONTAL GIRDER



NOTE: 1/2 M.G. HORIZONTAL GIRDER SPACING = 1'-10" (3'-8"/2)

- HYDROSTATIC PRESSURE:

@ EL -12.32 : $4.46\ k/ft^2 = (59' + 12.32')(0.0625\ k/ft^3)$

$4.64\ k/ft^2 = (59' + 15.16)(0.0625\ k/ft^3)$

- FORCE : $H_w = \frac{(4.46\ k/ft^2 + 4.64\ k/ft^2)}{2}(2.83\ ft)$

$H_w = 12.89\ k/ft$

· LOCATION $\bar{y} H_w = \Sigma \bar{y} h_w$

$$\bar{y} = \frac{(4.46)(2.83)^2/2 + \tfrac{1}{2}(4.64 - 4.46)(2.83)^2/3}{12.89}$$

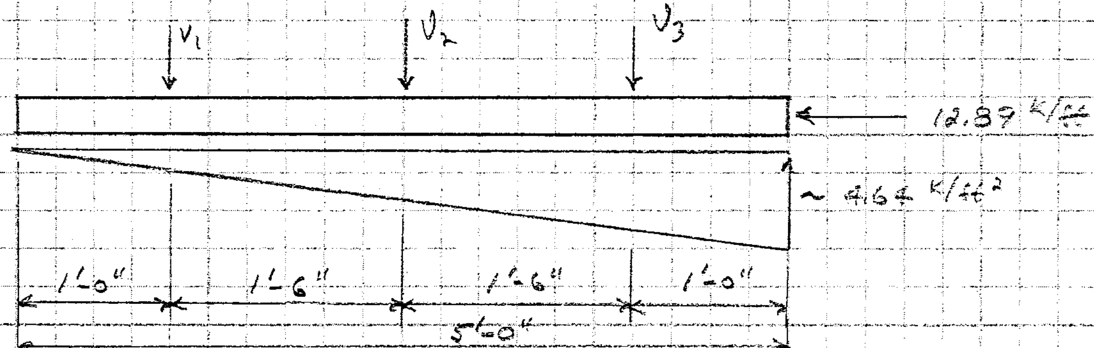
$\bar{y} = 1.40$ ft

D) PRECAST PANEL SIZE & DESIGN DATA (SEE PRECAST PANEL DWG)

1) ASSUMPTIONS / DESIGN DATA

a) PANELS ARE 5'-0" WIDE × 9" THICKNESS × 20'-0" & 21'-9" LENGTH
b) f'_c = 5 KSI
c) 1"-DIA THREADBAR ACTS AS SHEAR-FRICTION STEEL TO RESIST LATERAL THRUST OF LOWEST HORIZONTAL GIRDER AND RESISTS FULL HYDROSTATIC UPLIFT ON PANEL

2) LOADINGS & U/S-D/S ANCHOR LAYOUT (PER UNIT LENGTH OF SLAB)



· PROBLEM IS INDETERMINANT TO 1 DEGREE ∴ USE STAAD/PRO [4] TO FIND REACTIONS:

- USED HYDROSTATIC PRESSURE = 4.66 K/ft², NOT 4.64 K/ft² ∴ STAAD/PRO RESULTS OFF BY ~0.4 % (INSIGNIFICANT)

- STAAD PRO RESULTS: V_1 = 1.32 K/ft
V_2 = 2.53 K/ft
V_3 = 7.80 K/ft

4/ STAAD/PRO, RELEASE 2001, RESEARCH ENGINEERS CORP.

REFERENCES:

1) EM 1110-2-2105 DESIGN OF HYDRAULIC STEEL STRUCTURES
2) EM 1110-2-2703
3) AISC ASD MANUAL

DESIGN LOADS

- HYDROSTATIC
- DEBRIS (LOG OR SOME SORT OF OBSTRUCTION)

STEEL DESIGN CRITERIA

DESIGNED USING THE ALLOWABLE STRESS DESIGN METHOD IN ACCORDANCE WITH THE AISC (ASD) AS MODIFIED BY EM 1110-2-2105.

MATERIAL PROPERTIES:

PLATES & SHAPES: ASTM A36 WITH $F_y = 36,000$ psi
BOLTS: ASTM A325 TYPE 3

COMPUTATION SHEET

US Army Corps of Engineers
Ohio River Division

Computed by SRS Date

Checked by [illegible] Date [illegible]

Subject PANAMA CANAL MITER GATE STUDY

Computation LOWER SILL OPTION – ANALYSIS DESIGN FOR 54'-8" MITER GATES.

1) THE ANALYSIS ON PAGES _ TO _ ARE FOR THE 54'-8" AND 47'-4" MITER GATES.

USED DESIGN HEAD OF 54'-8" GATES FOR 47'-4" GATES.

Subject: PANAMA CANAL MITER GATE STUDY

Computed by: SRS Date: 11/8/99

Checked by: AL Date: 12/11/01

Computation: LOWER SILL OPTION - 54'-8" MITER GATES.

GATUN & PEDRO MIGUEL & MIRAFLORES LOCKS

- MITER GATES 37-40 FOR GATUN LOCKS
- MITER GATES 50-53 FOR PEDRO MIGUEL
- " " 70-73 " ", AND 100-103 FOR MIRAFLORES

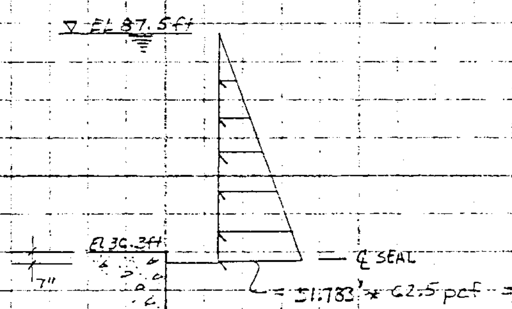
GIVEN:

DESIGN HEAD

HIGHEST LAKE ELEVATION = 87.5 ft

SILL ELEVATION AT GATUN & PEDRO = 37.3 ft (EXISTING)

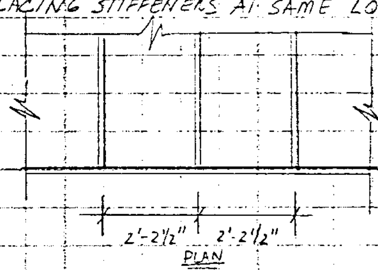
" " = 36.3 ft (FUTURE)



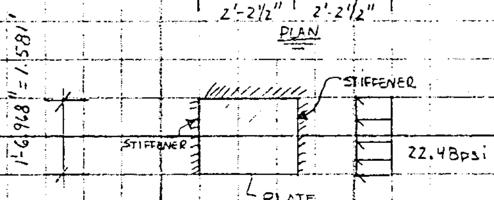
= 51.783' × 62.5 pcf = 3236.46 lb/ft² = 22.48 psi

FROM DWG 5025, SECTION A-A, THE GIRDERS ARE SPACED @ 2'-2½".

∴ TRY PLACING STIFFENERS AT SAME LOCATION. SEE PAGE 4 FOR DWG



SKIN PLATE EXTENSION



FROM ROARK'S FORMULAS FOR STRESS AND STRAIN, SIXTH EDITION, PAGE 461 AND 469.

USE CASE 2A AND CASE 10A TO ANALYZE SKIN PLATE

SEE SPREADSHEET FOR CALCULATIONS OF SKIN PLATE. (NEXT PAGE)

PAGES 7 TO 11 ARE "STAAD PRO" ANALYSIS OF THE SKIN PLATE TO VERIFY SPREADSHEET.

DESIGN ASSUMPTIONS

1.) LOWERING OF 37-40, 50-53, 62-69, 70-73, 100-103, AND 104-107 MITER GATES.
AFTER COMPARING THE LIFT HEIGHTS FOR ALL MITER GATES A LIFT OF 51.17 ft FOR 37-40 AND 50-53 AND A LIFT OF 44.17 ft FOR M.G. 70-73 AND 100-103 ARE CLOSE IN RANGE FOR DESIGN. I WILL DESIGN THE EXTENSION OF THE FOLLOWING MITER GATES FOR A HEAD OF 51.17 ft. THIS ANALYSIS CAN BE FOUND IN PAGE 5 TO 25.

THE DESIGN HEAD FOR M.G. 62-69 AND M.G. 104-107 ARE SIMILAR (75.5 ft AND 73.83 ft) THEREFORE DESIGN EXTENSION FOR A DESIGN HEAD OF 75.5 ft. THIS ANALYSIS CAN BE FOUND ON PAGE 16 OF 25.

2). THE DESIGN ARE BROKEN UP INTO 2 ANALYSIS.
1) 54'-8" GATE FOR A HEAD OF 51.17 ft.
2) 79'-0" GATE FOR A HEAD OF 75.5 ft.

3) SEE DRAWING FOR SEQUENCE OF WORK.

4) FOR EXTENSION OF THE MITER GATE I MOVED THE SEAL LOCATION 1'-0" LOWER FROM THE EXISTING LOCATION. I WILL PUT AN EXTENSION OF THE SKIN PLATE AND PROVIDE STIFFENERS TO SUPPORT THE NEW SKIN PLATE EXTENSION LOCATED AT EVERY EXISTING STIFFENER ON THE LOWER GIRDER OF THE MITER GATES.
SEE ATTACHED FOR DRAWING OF BOTTOM GIRDER OF MITER GATE.

THE BOTTOM GIRDER OF MITER GATE WILL HAVE TO BE CHECKED FOR ADDITIONAL BIAXIAL BENDING DUE TO THE EXTENSION. THIS ANALYSIS WAS NOT DONE IN THIS STUDY.

5) THE ONLY LOAD CONDITION USED IN THIS ANALYSIS WAS NORMAL OPERATING. FOR FUTURE DESIGN SUCH AS PLANS & SPECS A FURTHER ANALYSIS OF EXISTING AND EXTREME CONDITION WILL NEED TO BE PERFORMED. EXTREME WOULD CONSIDER DEBRIS LOAD SUCH AS LOG OR MISC. STUCK BETWEEN SILL AND GATE WHICH WOULD INDUCE CONCENTRATED LOAD ON EXTENSION.

- CHECK STAAD/PRO RESULTS

$U_1 + U_2 + U_3 = 11.65\ k/ft$ (UPLIFT PRESSURE = 4.66 k/ft^2)

UPLIFT = $\frac{1}{2}(4.64\ k/ft^2)(5\ ft) = 11.60\ k/ft$ OK

NOTE - DIFFERENCE IS 0.43% OK

3) CHECK THREAD BAR SPACING (LONGITUDINAL AXIS)

a) CORPS REQUIREMENTS FOR HYDRAULIC CONCRETE STRUCTURES:

$U_u = 1.7\ H_f\ (D + L)$ EM 2104 EQ (3-2)[5]

WHERE $H_f = 1.3$ FOR HYDRAULIC STRUCTURES
$H_f = 1.65$ FOR HYDRAULIC MEMBERS IN DIRECT TENSION
D = DEAD LOAD
L = LIVE LOAD
1.7 = SINGLE LOAD FACTOR - REPLACES ALL ACI 318-99 LOAD FACTORS[6]

b) SHEAR:

$\phi V_s \geq 1.3\ (V_u - \phi V_c)$ EM 2104, p. 3-2

WHERE V_s = STEEL STRENGTH
V_u = ULTIMATE LOAD
V_c = CONCRETE STRENGTH
ϕ = APPROPRIATE ACI STRENGTH REDUCTION

c) THREADBAR ACTS AS SHEAR-FRICTION STEEL FOR LATERAL THRUST

$V_u = A_{vf}\ f_y\ \mu$ ACI (11-25)

A_{vf} = AREA, IN^2 ACI 11.7.4.3
f_y = YIELD STRESS, KSI
$\mu = 1.0\lambda$ (CONCRETE INTENTIONALLY ROUGHENED)
$\lambda = 1.0$ (NORMAL WEIGHT CONCRETE)

5/ EM 1110-2-2104, STRENGTH DESIGN FOR REINFORCED-CONCRETE HYDRAULIC STRUCTURES, 30 JUNE 1992
6/ ACI 318-99, BUILDING CODE REQUIREMENTS FOR STRUCTURAL CONCRETE, AMERICAN CONCRETE INSTITUTE, 1999

d) THREAD BAR RESISTS HYDROSTATIC UPLIFT (LEAD ROW - HIGHEST):

AXIAL TENSION $\phi P_n \geq P_u$ ACI

P_n = AXIAL STRENGTH
P_u = FACTORED AXIAL LOAD

e) COMBINING ACI & CORPS EQUATIONS

TENSION: $0.9\,(f_y A_s) \geq 1.65\,(1.7)\,(P_T)$

SHEAR FRICTION: $0.85\,(f_y A_{vf}) \geq 1.3\,(1.7)\,(V_u)$

– LOADS ON LEAD ANCHOR: TENSION: $P_T = U_2 = 7.80$ K/FT
SHEAR: $P_u = 12.89\text{ K/FT}/3 = 4.30$ K/FT
(3 ROWS)

– 1-IN THREAD BAR: $A_s = 0.85\ in^2$
$f_{ult} = 150$ KSI
$f_y = 0.8\,(150\text{ KSI})$
$f_y = 120$ KSI

f) THREAD BAR SPACING

$$(0.9+0.85)\,(f_y A_s) \geq [1.65(1.7)(P_T) + 1.3(1.7)V_u] \times S$$

WHERE S = LONGITUDINAL SPACING SINCE LOADS ARE EXPRESSED IN TERMS OF LINEAR LENGTH

$$S = \frac{1.75\,(120\text{ KSI})\,(0.85\ in^2)}{1.65\,(1.7)\,(7.80\text{ K/FT}) + 1.3\,(1.7)\,(4.30\text{ K/FT})}$$

ALLOWABLE DESIGN LOAD
1" THREAD BAR = 76.5^K

OK

S = 5.70 FT

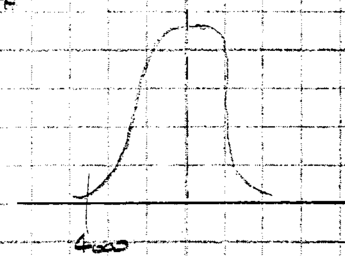
USE S = 4'-9 1/4" OK. NOTE: 2ND ROW ONLY HAS 4 ANCHORS, SEE PRE-CAST DWG.

NOTE: THE ACTUAL MAXIMUM LOAD IN LEAD ANCHORS IS

$57.7^K = (4.77\text{ FT} \times [7.8\text{ K/FT} + 4.3\text{ K/FT}])$
(SPACING) (UPLIFT) (SHEAR)

g) THREADBAR EMBEDMENT

1) ASSUME MINIMUM CONCRETE STRENGTH EQUAL TO 4,000 PSI.



2) THREADBAR: $F_y = 120$ KSI
$A_s = 0.85 \text{ in}^2$

3) DRILL $1\frac{1}{8}$ IN DIA HOLE \6A

4) DEVELOPMENT LENGTH – CONSERVATIVE – BASED ON YIELD

$$l_{db} = \text{MAX}\left\{ \frac{f_y d_b^{3/2}}{2880} \; ; \; \frac{f_y d_b^2}{43\sqrt{f'_c \Delta}} \right\} \text{ in}$$

where Δ = HOLE DIA, IN
d_b = REBAR DIA, IN
f_y = SPECIFIED MIN YIELD STRENGTH, PSI
f'_c = SPECIFIED COMPRESSIVE STRENGTH OF CONCRETE, PSI

$$l_{db} \geq \begin{cases} \dfrac{f_y d_b^{3/2}}{2880} = \dfrac{(120{,}000 \text{ psi})(1 \text{ in})^{3/2}}{2880}\left(\dfrac{ft}{12 in}\right) = 3.50 \text{ FT} \\ \dfrac{f_y d_b^2}{43\sqrt{f'_c \Delta}} = \dfrac{(120{,}000 \text{ PSI})(1 \text{ IN})^2}{43\,(4000 \text{ PSI} \cdot 1.125 \text{ IN})^{1/2}} * \left(\dfrac{ft}{12 in}\right) \end{cases}$$

$= 3.50$ FT

∴ TOTAL LENGTH = 3.5 FT + 8" = **4'-2"**
(3.5 FT = EMBEDMENT; 8" = PRECAST PANEL)

h) EMBEDDED SUBBEARING ANCHOR BASE PLATE – $6\frac{3}{4}" \times 6\frac{3}{4}" \times \frac{1}{2}"$

i) ANCHOR BASE PLATE WITH SPHERICAL SEAT
$5" \times 5" \times 1\frac{1}{4}$

6A/ HILTI REBAR FASTENING GUIDE, FASTENING TECHNOLOGY MANUAL

COMPUTATION SHEET		
US Army Corps of Engineers Ohio River Division	Subject: PANAMA CANAL	Page 5B of Pages 26
		Computed by RAA Date 11/30/01
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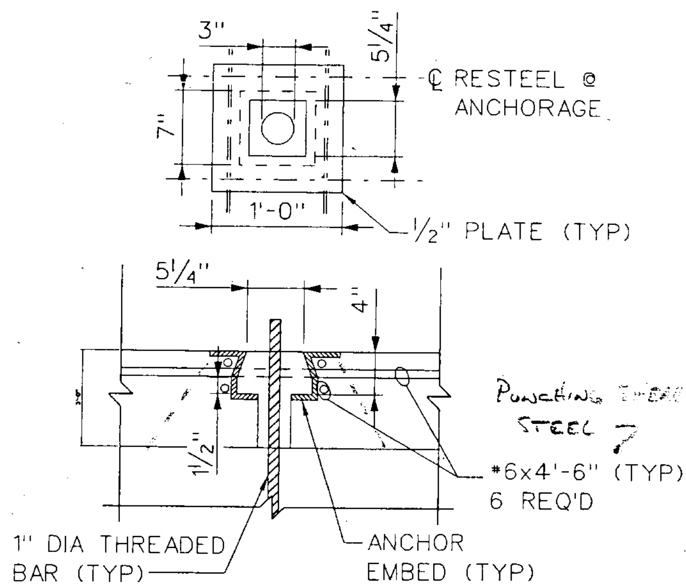
J) CHECK FOR PUNCHING SHEAR STEEL REQUIREMENTS

- 1" THREADBAR: $F_y = 120$ KSI
  $A_s = 0.85 \text{ IN}^2$
  $P_{ULT} = 102^K$

- EVALUATE FOR MAXIMUM ANCHOR FORCE: $P_{ULT} = 102^K$

  NOTE: FROM PAGE 5, THE MAXIMUM ANCHOR LOAD IS 57.7^K. THIS IS A CONSERVATIVE APPROACH.



ANCHOR BOLT

- CHECK BEARING

$P_u = 1.3(1.7)(102^K) = 225.4^K$ — EM 2104, SEC 3.3.a.

$\phi\,(0.85 f'_c A_1)\sqrt{\frac{A_2}{A_1}} \geq P_u$ — ACI 10.17

$\phi = 0.7$ — ACI 9.3.2.4

$\sqrt{A_1/A_2} > 2 \;\therefore$ USE 2

$A_1 \geq P_u / [2\phi(0.85 f'_c)]$

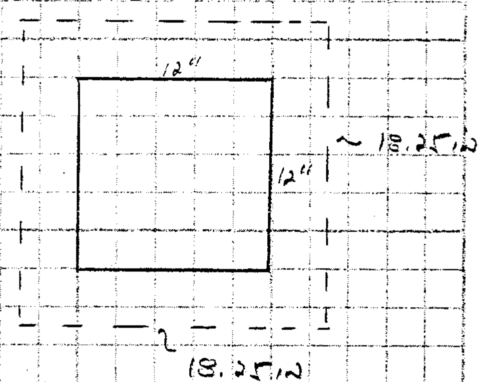
$\geq 225.4^K / [2(0.7)(0.85)(5\text{ KSI})]$

$A_1 \geq 37.9 \text{ IN}^2$

USE ANCHOR INNER BEARING PLATE: 12" x 12" x 1/2"

• PUNCHING SHEAR — ACI 11.12

- d = DISTANCE FROM INBED BEARING PLATE TO PRIMARY REINFORCEMENT



$d = 9'' - \frac{1}{2} - 1\frac{1}{2} - \frac{3}{4}$ (#6)

(½ → PLATE THICKNESS; 1½ → COVER)

$d = 6.25$ in

PERIMETER — $b_o = 4(12 + 6.25\text{ in}) = 73$ in

- ALLOWABLE SHEAR IN CONCRETE

$V_c \le (2 + 4/\beta_c)\sqrt{f'_c}\, b_o d$ — ACI (11-35)

$\le \left(\frac{\alpha_s d}{b_o} + 2\right)\sqrt{f'_c}\, b_o d$ — ACI (11-36)

$\le 4\sqrt{f'_c}\, b_o d$ — ACI (11-37)

$\alpha_s = 40$ {LOADED AREA CONSIDERED AS CENTER COLUMN

$\beta_c = \frac{\text{LONG SIDE OF LOADED AREA}}{\text{SHORT SIDE OF LOADED AREA}} = 1.0$

- DETERMINE CONTROLLING FACTORS

$(2 + 4/\beta_c) = (2 + 4(1)) = 6$

$\left(\frac{\alpha_s d}{b_o} + 2\right) = \left(\frac{40(6.25)}{73} + 2\right) = 5.42$

∴ EQ ACI (11-37) CONTROLS

$V_c \le 4\sqrt{f'_c}\, b_o d$

$\le 4\sqrt{5000}\,(73\text{ in})(6.25\text{ in}) / (1000\text{ lb/k})$

$V_c \le 129.0^k$ NG, NEED

∴ DESIGN SHEAR STEEL BASED ON ACI 11.7.4

- SIZE SHEAR-FRICTION STEEL

$V_u = A_{vf} f_y \mu$ {ACCORDING TO ACI R11.7.4.2, USE EQ (11-25) SHEAR FRICTION IN COMPRESSION}

$\phi V_s \geq 1.3 (V_u - \phi V_c)$ EM 2104, p. 3-2

$V_c = 2\sqrt{f'_c}\, b_o d$ ACI 11.12.3.1

$\phi = 0.85$ ACI 9.3.2.3

$b_o = 4(12\text{ in}) = 48\text{ in}$

$d \simeq 6.25\text{ in}$

$V_c = 2\sqrt{5000}\,(48\text{ in})(6.25\text{ in}) / (1000\text{ lbs/ft})$

$V_c = 42.4\text{ k}$

$V_u = 1.7\, P_{UCT}$

$= 1.7\,(102^k)$

$V_u = 173.4^k$

$V_s \geq 1.3\,(V_u - \phi V_c)/\phi$

$\geq 1.3\,(173.4^k - 0.85[42.4^k])/0.85$

$V_s \geq 210.1^k$

$V_u = A_{vf} f_y \mu \geq V_s$ ACI 11.7.4.3

$A_{vf} = V_s / (f_y \mu)$

$\mu = 1.4\lambda$ CONCRETE PLACED MONOLITHICALLY

$\lambda = 1.0$ FOR NORMAL WT. CONCRETE

$A_{vf} = 210.1^k / (60\text{ KSI} \times 1.4)$

$A_{vf} = 2.5\text{ in}^2$

∴ USE 6 - NO. 6 AS SHEAR FRICTION FOR PUNCHING SHEAR

- Length of #6

· DEVELOPMENT

$$\frac{l_6}{d_6} = \frac{f_y \alpha \beta \lambda}{25\sqrt{f'_c}}$$ ACI 12.2.2

$\alpha = 1.0$ <12" LAYER ACI 12.2.4
$\beta = 1.0$ NO EPOXY
$\lambda = 1.0$ NORMAL WT CONCRETE
$d_6 = 3/4"$ DIA

$$l_6 = \frac{(60{,}000\ PSI)(0.75")}{25\sqrt{5000\ PSI}}$$
$= 25.5"$

$l_6 = 2'-3"$

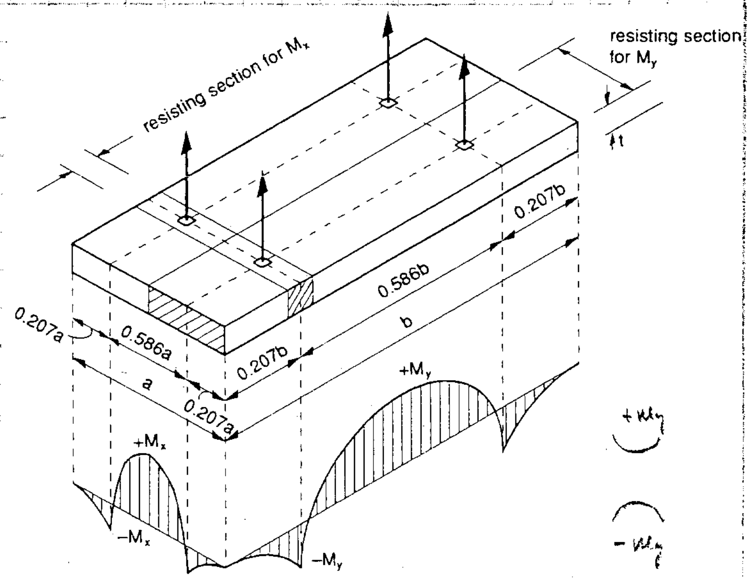
∴ TOTAL LENGTH = 1" + 2 (2'-3")
= 4'-6"

∴ USE 6 - NO. 6 REBAR @ 4'-6" FOR ANCHOR INSERTS

4) DETERMINE PICK AND LEVELING POINTS FOR PRE-CAST PANELS

a) FOUR (4) PICK POINTS AND LEVELING POINTS WILL BE USED (SEE PRECAST PANEL DWG). THE LEVELING/PICKING DEVICE PERFORMS BOTH FUNCTIONS.

b) ACCORDING TO PCI [7], THE PICK POINTS REQUIRED TO BALANCE POSITIVE AND NEGATIVE BENDING MOMENTS ARE AS FOLLOWS:



• THE PICK/LEVELING POINTS ARE LOCATED 0.207 * EDGE LENGTH FROM EDGES.

EDGE DISTANCES

• FOR PANELS 20' x 5' : 1.04' & 4.14' ok

• FOR PANELS 21'-4" x 5' : 1.04' & 4.42' ok

5) ESTIMATE FLEXURAL REINFORCEMENT REQUIREMENTS

a) DUE TO PICK & LEVELING LOADS

i) BOTH FACES: $+M_x = -M_x = 0.0107\, w a^2 b$

$+M_y = -M_y = 0.0107\, w a b^2$

7/ PCI DESIGN HANDBOOK, PRECAST/PRESTRESSED CONCRETE INSTITUTE, 4TH ED., 1992.

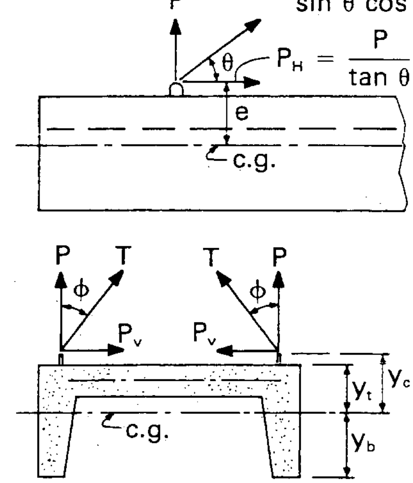
6) Moment: Due to Eccentric Lift

- For lifts, the central lift point should be directly located over the center of gravity of the entire panel (plan view). The typical angles of lift (θ) are greater than 60° to "minimize" the lateral force P_H and the subsequent bending moment.

- For maximum eccentric horizontal force P_H, assume 1 central lift point where the angle is 60°. As a result, there are 1 vertical and 2 orthogonal horizontal reactions.

$$T = \frac{P}{\sin\theta\cos\phi}$$

$$P_H = \frac{P}{\tan\theta}$$



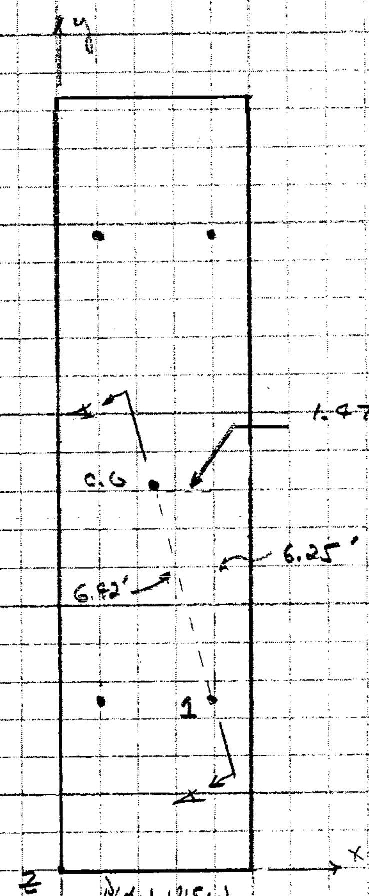
$$M_x = P_H y_c$$

$$M_x = \frac{P y_c}{\tan\theta}$$ PCI, p. 5-9

$$M_z = P_v e$$

$$M_z = Pe\tan\theta$$

Fig 1



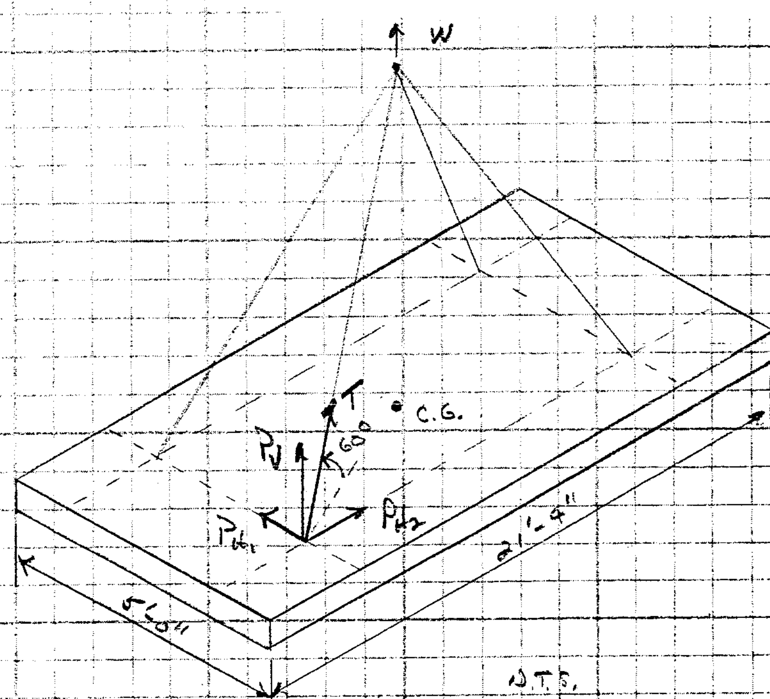
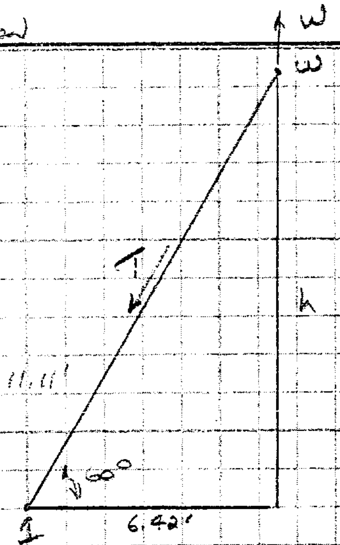


Fig 2



SECTION A-A

- FROM SECTION A, THE CENTRAL PICK POINT W, IS:

$h = 6.42 \tan 60°$

$h = 11.11$ FT

- PT W IS $dx = -1.47'$ $dy = 6.25'$ $dz = 11.11'$ FROM PT 1 (FIG 2).

- FIND P_{H1}, P_{H2}, P_V, & T [FIG 2]

  - FIND PANEL WEIGHT W:

$W = (5')(0.75')(21.33')(0.165\ k/ft^2)$

$W = 13.2^k$

  - FIND CABLE TENSILE FORCE T:

$4T \sin 60° = W$

$T = (13.2^k) / (4 \sin 60°)$

$T = 3.81^k$

  - COMPONENTS OF FORCE HAVE THE SAME COMPONENTS AS DIRECTION

$dx = -1.47'$ $dy = 6.25'$ $dz = 11.11'$

$d = \sqrt{d_x^2 + d_y^2 + d_z^2} = 12.83'$

Check Section A-A $\rightarrow$ $\overrightarrow{1W} = \sqrt{6.42^2 + 11.11^2} = 12.83'$ OK

$$P = \frac{T}{d}\left[-1.47' i + 6.25' j + 11.11' k\right]$$

$$P = \frac{3.81^k}{12.83'}\left[-1.47' i + 6.25' j + 11.11' k\right]$$

$$P = -(0.44k) i + (1.86k) j + (3.30k) z$$

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- COMPONENTS :

$P_{H_1} = 0.44^k$ ↖

$P_{H_2} = 1.86^k$ ↗

$P_V = 3.20^k$ ↑

CHECK: $\sqrt{(0.44)^2 + (1.86)^2 + (3.20)^2} = 3.8$ ok

c) PICK / LEVELING MOMENTS :

$\omega = \gamma_c \, t$ | $\gamma_c = 0.165 \; k/ft^3$ UNIT WT OF CONCRETE; $t = 0.75 \; ft$ PANEL THICKNESS

$\omega = 0.124 \; k/ft^2$

$+M_x = -M_x = 0.0107 \, \omega a^2 b$ | $a = 5'$, $b = 21.33'$

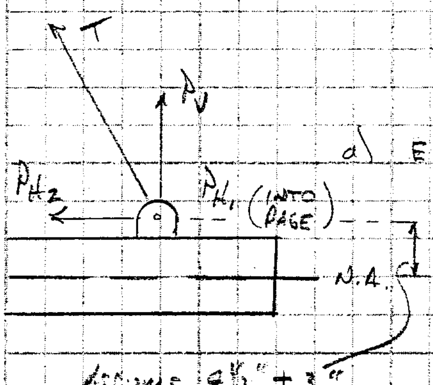
$= 0.0107 (0.124 \; k/ft^2)(5')^2(21.33')$

$+M_x = 0.71 \; k/ft$

$+M_y = -M_y = 0.0107 \, \omega a b^2$

$= 0.0107 (0.124 \; k/ft^2)(5')(21.33')^2$

$+M_y = 3.02 \; k\text{-}ft$



d) ECCENTRIC PICK LOADS

$+M_x = P_{H_1} (7\tfrac{1}{2} \, in)/(12 \, in/ft)$

$= (0.44^k)(7.5 \, in) / (12 \, in/FT)$

$+M_x = 0.28 \; K\text{-}FT$

$+M_y = P_{H_2} (7.5 \, in)/(12 \, in/FT)$

$= (1.86^k)(7.5 \, in)/(12 \, in/FT)$

$+M_y = 1.16 \; K\text{-}FT$

e) SUM PICK / LEVELING & ECCENTRIC

$+M_x = (0.71 + 0.28)^{K\text{-}FT} = 1.0 \; K\text{-}FT$

$+M_y = (3.02 + 1.16) K\text{-}FT = 4.18 \; K\text{-}FT$

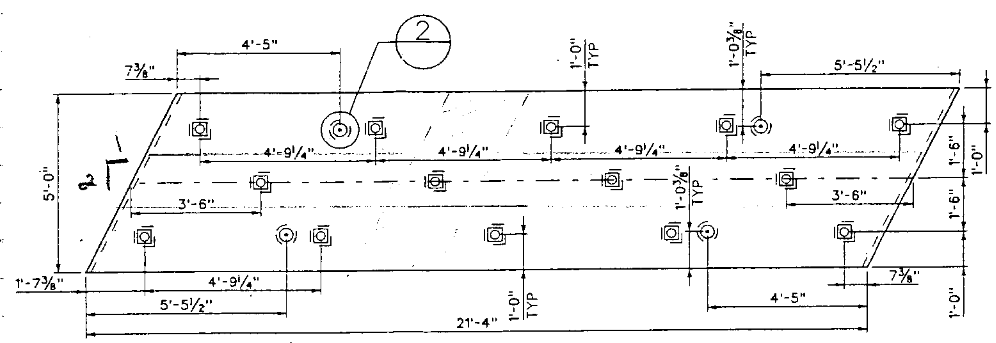
$-M_x = 0.71$ K-FT

$-M_y = 3.02$ K-FT

5) DETERMINE GROUT MOMENTS:

a) GROUT AT 10 PSI WILL BE USED TO FILL THE VOIDS AND JOINTS BETWEEN THE PRECAST PANELS AND EXISTING CONCRETE

b) CALCULATE MOMENTS:

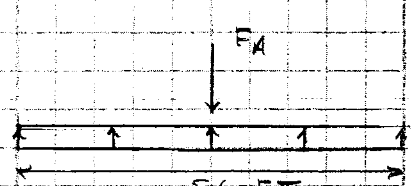


· FOR UPLIFT ON BASE, 2 LOAD CASES WILL BE INVESTIGATED:

1) TRANSVERSE SECTION - UPLIFT WITH 1 SUPPORT
2) LONGITUDINAL SECTION - UPLIFT WITH 4 SUPPORTS

· MAXIMUM MOMENTS WILL BE CALCULATED FOR EACH SECTION.

1) TRANSVERSE SECTION



$\omega = 10\,psi \times (144\,in^2/ft^2) \times \frac{K}{1000\,lbs}$

$\omega = 1.44$ KSF

$+M_x = \frac{\omega L^2}{2}$ AISC, LOAD CASE 2 [3]
p. 2-302

$= 1.44\ KSF\,(5.6\ FT/2)^2/2$

$+M_x = 5.65$ K-FT/FT

3/ AISC, MANUAL OF STEEL CONSTRUCTION, ALLOWABLE STRESS DESIGN, 1989

– Reduce moment ≈ 20 % to account for stiffness of longitudinal reinforcement

$+M_x = 5.65$ K-FT/FT (0.8)

$+M_x = 4.52$ K-FT/FT

2) Longitudinal Section

For longitudinal section, estimate moments from load case 39, AISC p. 2-309. The transverse reinforcement at the panel ends act as "effective" supports. For long span with continuous supports under uniform load, the maximum moments are:

$+M_y = 0.0714\,wl^2$ l = support spacing, FT

$-M_y = 0.0772\,wl^2$

Note: $+M_y$ & $-M_y$ act in opposite direction from the value provided in AISC due to uplift. Due to grouting sequence from one end to the other end, conservatively increase moments by 50 % to account for non uniform span load – refined analysis required to model grout on slab with anchors

$\therefore +M_y = 1.5(0.0714\,wl^2)$

$= 0.1071\,wl^2$ ← Anchor spacing

$= 0.01071(1.44\text{ KSF})(4.77\text{ FT})^2$

$+M_y = 3.51$ K-FT/FT

$-M_y = 1.5(0.0772)(1.44\text{ KSF})(4.77\text{ FT})^2$

$-M_y = 3.79$ K-FT/FT

6) Maximum Design Moments

From a review of the moments due to handling and grouting precast panels, the moments due to grouting will control. The moments due to stripping forms was not investigated since the stripping suction pressure 124 PSF (1.4 × 165 lb/ft³ × 0.75 FT)

(1.4 = load multiplier; 0.75 = panel thickness)

IS SIGNIFICANT LESS THAN THE GROUT PRESSURE 1,440 PSF (10 psi x 144 in²/ft²)

MAXIMUM DESIGN MOMENTS

$+M_x = 4.52$ K-FT/FT { LET $-M_x = 4.52$ K-FT/FT }

$+M_y = 3.51$ K-FT/FT
$-M_y = 3.79$ K-FT/FT

7) SIZE REINFORCEMENT

a) REINFORCEMENT THAT WILL BE USED FOR BOTH FACES

b) FIND BALANCE STEEL CONDITION:

$$\rho_b = \frac{0.85 f'_c \beta_1}{f_y}\left(\frac{\epsilon_c}{\epsilon_c + f_y/E}\right)$$

SEE ATTACHMENT CONCRETE EQ DERIVATION

$\epsilon_c = 0.003$ ACI 10.2.3
$f_y = 60$ ksi
$E = 29,000$ ksi
$\beta_1 = 0.85$ ACI 10.2.7.3
$f'_c = 5$ ksi CONCRETE STRENGTH

$\rho_b = 0.0356$

c) MAXIMUM ALLOWABLE STEEL RATIO

$\rho \leq 0.375\,\rho_b$ EM 2104, SEC 3-5(a)
$\leq 0.375\,(0.0356)$
$\rho \leq 0.0134$

d) REINFORCEMENT REQUIRED

$M_{ux} = 1.7\,M_x\,(max)$
$= 1.7\,(4.52$ k-ft/ft$)$
$M_{ux} = 7.68$ K-FT/FT

$M_{uy} = 1.7\,(3.79$ K-FT/F$)$
$M_{uy} = 6.44$ K-FT/FT

NOTE: CORPS HYDRAULIC LOAD FACTOR NOT USED SINCE GROUTING OPERATION CONDUCTED PRIOR TO USE OF PANELS AS HYDRAULIC STRUCTURE. Hf NOT FOR CONSTRUCTION LOADS.

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$\phi M_n \geq M_u$ — CONCRETE STRENGTH REQUIREMENT

$M_n \geq M_u / \phi$ $\quad \phi = 0.9$ — ACI 9.3.2.1

- $M_{nx} \geq (7.68 \text{ K-FT/FT}) / 0.9$
  $M_{nx} \geq 8.53 \text{ K-FT/FT}$

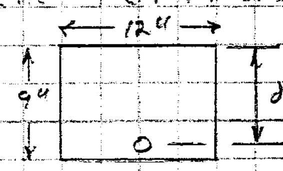
- $M_{ny} \geq (6.44 \text{ K-FT/FT}) / 0.9$
  $M_{ny} \geq 7.16 \text{ K-FT/FT}$

- DETERMINE REINFORCEMENT AREA & SPACING REQUIRED

SEE ATTACHMENT ⇒ FOR DERIVATION OF EQ

$$\frac{f_y^2 A_s^2}{1.7 f'_c b} - f_y d A_s + M_n = 0$$

$f_y = 60$ KSI
$b = 12$ in (1-FT STRIP)



FIND d:

COVER = 1½ in ACI 7.7.2
ASSUME #6 REBAR

$d = 9'' - 1\tfrac{1}{2}'' - \tfrac{3}{8}'' = 7.125$ in

$$\frac{(60)^2 A_s^2}{1.7(5)(12)} - (60)(7.125) A_s + (8.53)(12''/ft) = 0$$

$$35.29 A_s^2 - 427.5 A_s + 102.36 = 0$$

$$A_{s\,REQUIRED} = 0.22 \text{ in}^2/\text{ft}$$

e) SHRINKAGE & TEMPERATURE

$A_{S\&T} = 0.0028 A_g$ — EM 2104 SEC 2-8
$= 0.0028 (12 \text{ in})(9 \text{ in})$
$A_{S\&T} = 0.30 \text{ in}^2/\text{ft}$ TOTAL

$A_{S\&T} = 0.15 \text{ in}^2/\text{ft}$ EACH FACE

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f) FOR $A_{s\,REQUIRED} = 0.22\ in^2/FT$ EACH FACE, BOTH WAYS

$\#6 @ 18\text{-}in = 0.29\ in^2/FT$

TO BE CONSERVATIVE AND ACCOUNT FOR GROUT PRESSURES GREATER THAN 10 PSI, WILL USE #6 @ 12 in

USE #6 @ 12 in BOTH FACES & BOTH WAYS

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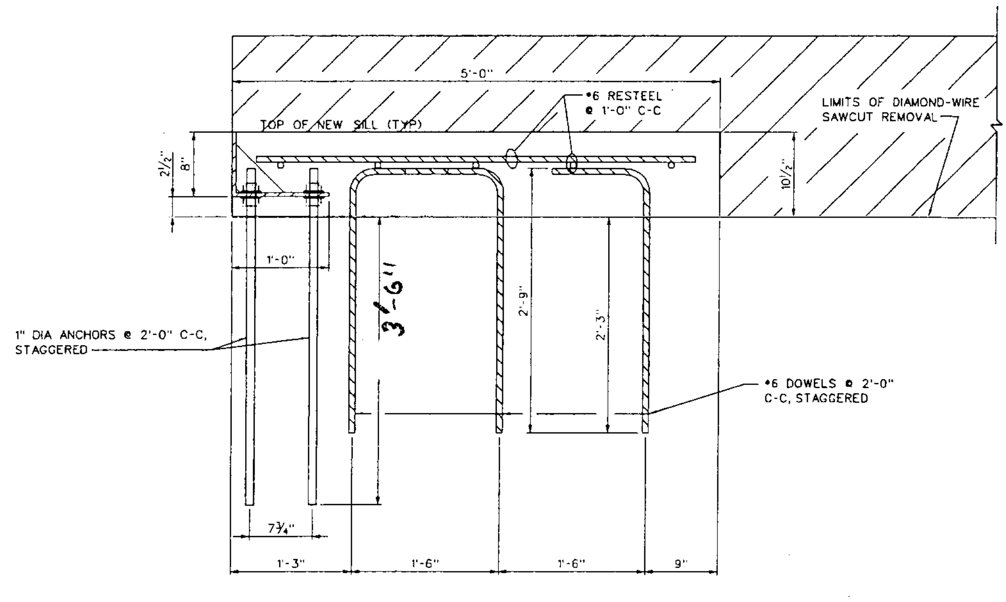
2) PRELIMINARY CIP DESIGN



SECTION (A)
SCALE: 1½" - 1'-0"

A) THREADBAR ANCHORS

1) THE LOADING ON THE CIP SEGMENT IS IDENTICAL TO THE LOADINGS ON THE PRECAST PANEL SEGMENT, AS PRESENTED IN THE DESIGN CALCULATIONS, PAGES 1 THROUGH 3. AS A RESULT, THE 1-IN DIA THREADBAR ANCHORS ARE ADEQUATE SINCE THEIR SPACING IS 2'-0" C-C, AND THE SPACING FOR THE ANCHORS FOR THE PRECAST PANEL WAS 4'-9¼". THE EMBEDMENT FOR THE ANCHORS IS 3'-6", AS SHOWN ON PAGE 54

USE 1-IN DIA THREADBAR, 2'-0" C-C STAGGERED, 4'-0" LENGTH

B) DOWELS

1) NO. 6 DOWELS ARE PLACED ON 2'-0" C-C & STAGGERED

2) FOR NO. 6 DOWELS, GIVEN THE MAXIMUM LOADING FOR THE SILL, PAGE 5, SECTION f; THE SPACING REQUIREMENT IS:

LOAD ≡ K/ft — SPACING

$$(0.9+0.85)(f_y A_s) \geq [1.65(1.7)P_T + 1.3(1.7)V_u] * S$$

$A_s = 0.44\ in^2$ — see page 3
$f_y = 60$ KSI
$P_T \simeq \frac{(7.80\ K/FT + 2.53\ K/ft)}{2} = 5.17\ K/ft$

NOTE: THIS IS APPROXIMATE LOAD ON LEAD DOWELS, CONSIDERING THE FACT THAT THE 2 LEAD ROW ANCHORS CARRY A MAJORITY OF THE UPLIFT.

$V_u = 2.57\ K/ft$ {LATERAL THRUST - PAGE 3; 12.89 K/ft / 5 DOWELS & ANCHORS}

$$S = \frac{1.75(60\ KSI)(0.44\ in^2)}{1.65(1.7)(5.17\ K/ft) + 1.3(1.7)(2.57\ K/ft)}$$

$S = 2.29$ FT

USE #6 DOWELS @ 2'-0" CC

3) EMBEDMENT INTO EXISTING CONCRETE (SEE PAGE 5A)

DEVELOPMENT: $l_{d_b} = MAX \left\{ \frac{f_y d_b^{3/2}}{2880} ; \frac{f_y d_b^2}{43\sqrt{f'_c D}} \right\}$ in

$$l_{d_b} \geq \left\{ \frac{f_y d_b^{3/2}}{2880} = \frac{(60000)(0.75)^{3/2}}{2880} = 13.5\ in \right.$$
↳ CONTROLS

$$\frac{f_y d_b^2}{43\sqrt{f'_c D}} = \frac{(60000)(0.75)^2}{43\sqrt{(4000)(7/8)}} = 13.3\ in$$

USE 2'-3" TO ACCOUNT FOR CONCRETE DAMAGE & TO BE CONSERVATIVE

DOWELS ⇒ #6 @ 2'-0 c-c, STAGGERED, 2'-3" EMBEDMENT

USE CERAMIC EPOXY

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c) SHRINKAGE & TEMPERATURE STEEL

$A_{S\&T} \geq 0.0028 A_g$

$\geq 0.0028 (12 in)(12 in)$

$A_{S\&T} \geq 0.40 \ in^2$

∴ USE #6 @ 1'-0" EACH WAY, ONE FACE

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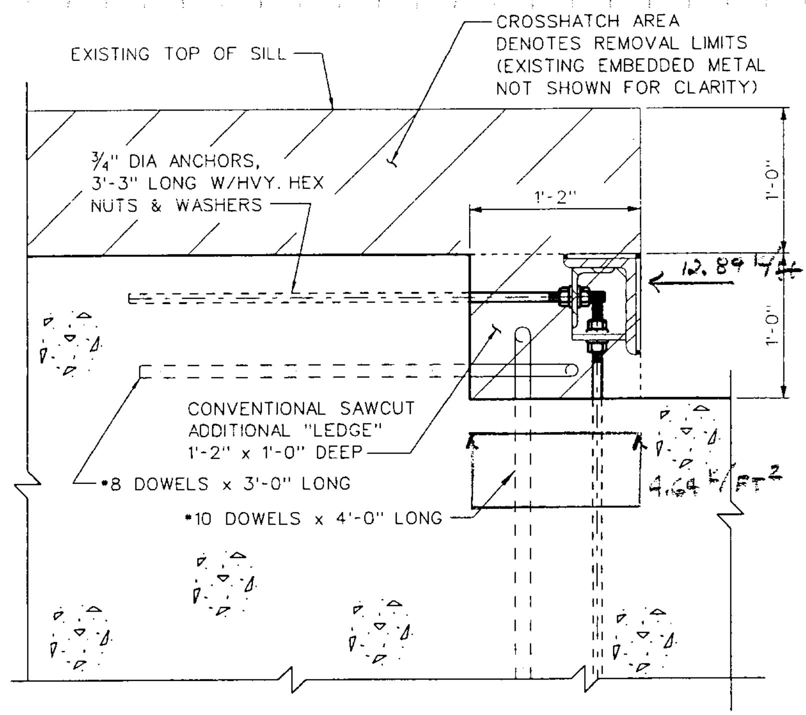
3) PRELIMINARY ALTERNATIVE "B" DESIGN



SECTION A
SCALE: 1½" = 1'-0"

A) 1-IN THREADBAR AND NO. 10 DOWELS

1) ASSUME FULL HYDROSTATIC UPLIFT ON BASE.

$$U = (4.64\ K/FT^2)(1.17\ FT) = 5.43\ K/FT$$

2) THRUST: ASSUME THRUST APPLIED TO SILL IS EQUAL TO HYDROSTATIC PRESSURE APPLIED TO TRIBUTARY AREA OF LOWEST MG HORIZONTAL GIRDER. THE LOAD IS 12.89 K/FT

3) ASSUME THE THREADBAR AND NO. 10 DOWELS CARRY LOADS EQUALLY.

4) DETERMINE SPACING: (SEE PAGE 5)

$$(0.9 + 0.85)(f_y A_s) \geq [1.65(1.7) P_T + 1.3(1.7) V_u] \times S$$

a) 1-IN THREADBAR: $A_s = 0.85 \text{ IN}^2$
$f_y = 120 \text{ KSI}$

$P_T = 5.43 \text{ K/FT} / 2 = 2.72 \text{ K/FT}$
(Σ THREADBAR & DOWEL)
$V_u = 12.89 \text{ K/FT} / 2 = 6.45 \text{ K/FT}$

$$S = \frac{1.75 (120 \text{ KSI})(0.85 \text{ IN}^2)}{1.65(1.7)(2.72 \text{ K/FT}) + 1.3(1.7)(6.45 \text{ K/FT})} = 8.2 \text{ FT}$$

b) NO. 10 REBAR: $A_s = 1.27 \text{ IN}^2$
$f_y = 60 \text{ KSI}$

$P_T = 2.72 \text{ K/FT}$
$V_u = 6.45 \text{ K/FT}$

$$S = \frac{1.75 (60 \text{ KSI})(1.27 \text{ IN}^2)}{1.65(1.7)(2.72 \text{ K/FT}) + 1.3(1.7)(6.45 \text{ K/FT})} = 6.09 \text{ FT}$$

c) 1-IN THREADBAR AND NO. 10 DOWELS ON 2 FT C-C AND STAGGERED 1 FT IS CONSERVATIVE.

d) DEVELOPMENT — USE EPOXY

1) 1-IN THREADBAR - USE 3'-6" (SEE PAGE 5A)

2) NO. 10 DOWELS (SEE PAGE 16)

$$l_{d_b} = \frac{f_y d_b^{3/2}}{2880} = \frac{(60000)(1.27")^{3/2}}{2880} = 29.8 \text{ IN}$$

$$\frac{f_y d_b^2}{43\sqrt{f'_c \Delta}} = \frac{(60000)(1.27")^2}{43\sqrt{4000}(1.40)} = 25.5 \text{ IN}$$

US Army Corps of Engineers
Ohio River Division

Subject: PANAMA CANAL

Computation: MITER GATE SILL MODIFICATION

a) No. 10 90° HOOK:

$$l_{dh} = l_{hb} * \frac{0.7}{\text{ACI 12.5.3.2}} * (A_{S\,REQ} / A_{S\,PROVIDED}) \quad \text{ACI 12.5.1}$$

$$= 0.7 * 1200\, d_b / \sqrt{f'_c} \; * (A_{S\,REQ} / A_{S\,PROVIDED})$$

ACCORDING TO SEC 4(c) OF PAGE 19, USING A SPACING OF 2'-0", $A_{S\,REQ} = 0.42\ in^2$

$$\therefore\ l_{dh} = 0.7\,(0.42/1.27)\,(1200)(1.27)/\sqrt{4000}$$

$$\underline{\underline{l_{dh} = 5.6\ in}}$$

HOOK = $12 d_b = 12(1.27) = 15.24"$

<u>USE 12"</u>

b) No. 10 HOOKS LENGTH:

$$L = \frac{30"}{2} + 6" + 12"$$

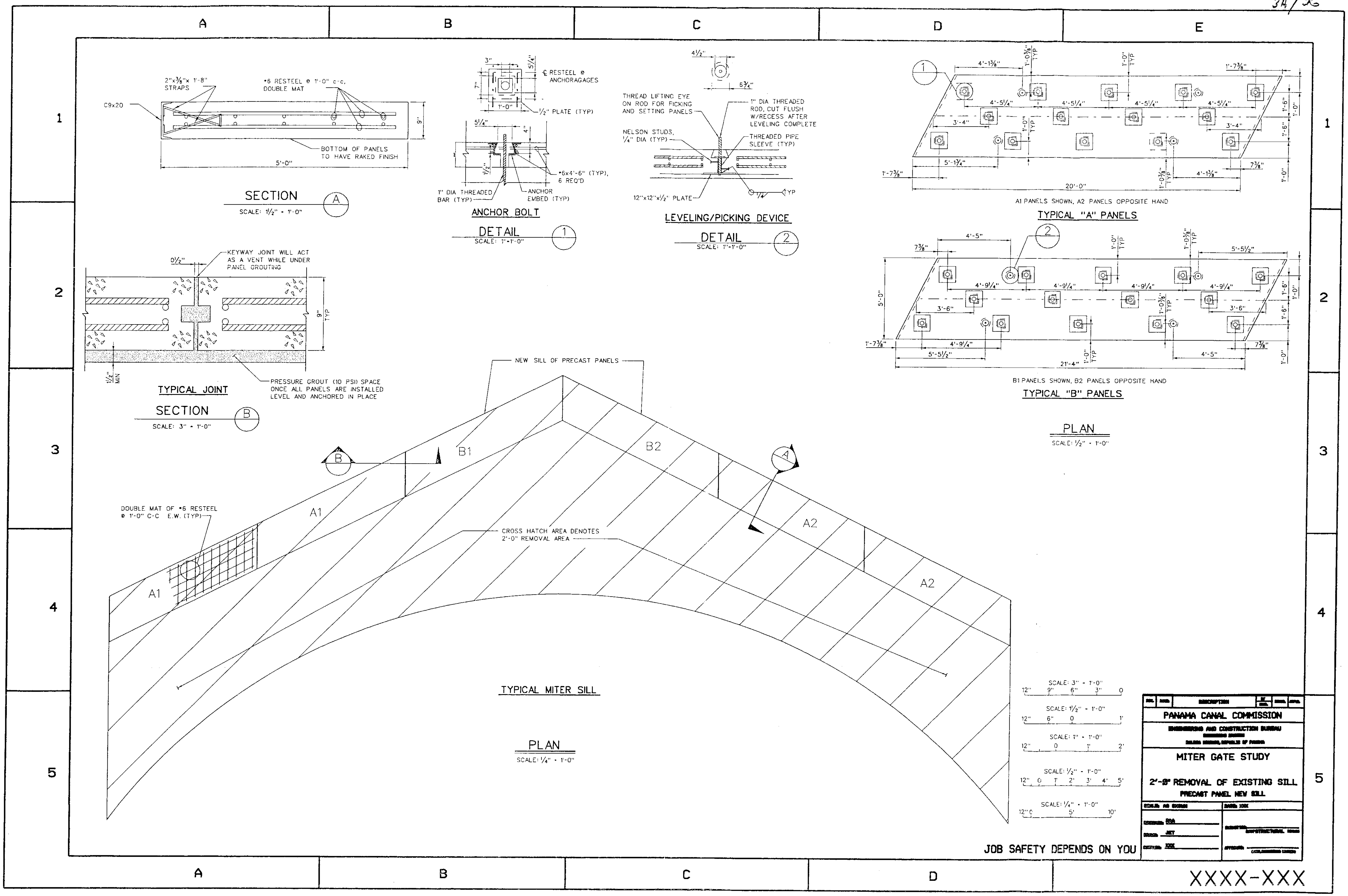
(EMBEDMENT)

$$\underline{\underline{L = 4'\text{-}0"}}$$

US Army Corps of Engineers Ohio River Division	COMPUTATION SHEET	Page of Pages
	Subject PANAMA CANAL	Computed by RAA Date 12/7/01
		Checked by Date
	Computation MITER GATE SILL MODIFICATION	

REFERENCE MATERIAL

ORD Form 427
1 Feb 87

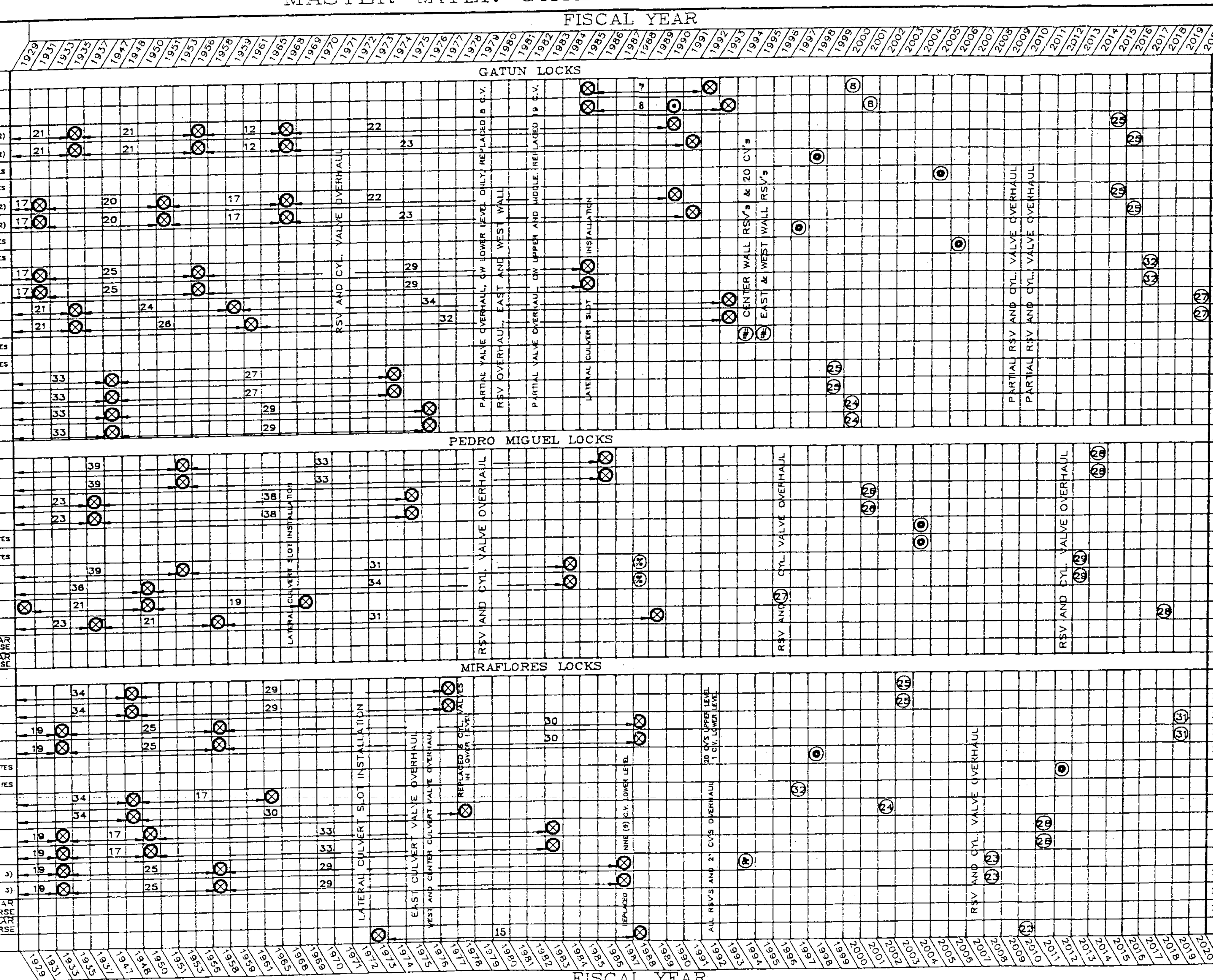


SECTION A
SCALE: 1½" = 1'-0"
2"x⅜"x 1'-8" STRAPS
C9x20
#5 RESTEEL @ 1'-0" c-c, DOUBLE MAT
BOTTOM OF PANELS TO HAVE RAKED FINISH
5'-0"
ANCHOR BOLT DETAIL 1
SCALE: 1"=1'-0"
℄ RESTEEL @ ANCHORAGAGES
½" PLATE (TYP)
1" DIA THREADED BAR (TYP)
ANCHOR EMBED (TYP)
#6x4'-6" (TYP), 6 REQ'D
LEVELING/PICKING DEVICE DETAIL 2
SCALE: 1"=1'-0"
THREAD LIFTING EYE ON ROD FOR PICKING AND SETTING PANELS
1" DIA THREADED ROD, CUT FLUSH W/RECESS AFTER LEVELING COMPLETE
NELSON STUDS, ¼" DIA (TYP)
THREADED PIPE SLEEVE (TYP)
12"x12"x½" PLATE
TYPICAL JOINT SECTION B
SCALE: 3" = 1'-0"
KEYWAY JOINT WILL ACT AS A VENT WHILE UNDER PANEL GROUTING
PRESSURE GROUT (10 PSI) SPACE ONCE ALL PANELS ARE INSTALLED LEVEL AND ANCHORED IN PLACE
A1 PANELS SHOWN, A2 PANELS OPPOSITE HAND
TYPICAL "A" PANELS
B1 PANELS SHOWN, B2 PANELS OPPOSITE HAND
TYPICAL "B" PANELS
PLAN
SCALE: ½" = 1'-0"
NEW SILL OF PRECAST PANELS
DOUBLE MAT OF #6 RESTEEL @ 1'-0" C-C E.W. (TYP)
CROSS HATCH AREA DENOTES 2'-0" REMOVAL AREA
A1
A1
B1
B2
A2
A2
TYPICAL MITER SILL
PLAN
SCALE: ¼" = 1'-0"
SCALE: 3" = 1'-0"
SCALE: 1½" = 1'-0"
SCALE: 1" = 1'-0"
SCALE: ½" = 1'-0"
SCALE: ¼" = 1'-0"
JOB SAFETY DEPENDS ON YOU
PANAMA CANAL COMMISSION
ENGINEERING AND CONSTRUCTION BUREAU
MITER GATE STUDY
2'-0" REMOVAL OF EXISTING SILL
PRECAST PANEL NEW SILL
XXXX-XXX

MASTER MITER GATE AND VALVE OVERHAUL SCHEDULE

MITER GATE

No.	HEIGHT	TYPE
1–2	—	BRIDGE
3–4	—	BRIDGE
5–6	77'	(SEE NOTE 2)
7–8	77'	(SEE NOTE 2)
9–10	77'	INTERMEDIATES
11–12	77'	INTERMEDIATES
13–14	77'–10"	(SEE NOTE 2)
15–16	77'–10"	(SEE NOTE 2)
17–18	77'–10"	INTERMEDIATES
19–20	77'–10"	INTERMEDIATES
21–22	77'	
23–24	77'	
25–26	77'	
27–28	77'	
29–30	77'	INTERMEDIATES
31–32	77'	INTERMEDIATES
33–34	77'	
35–36	77'	
37–38	54'–8"	
39–40	54'–8"	
50–51	54'–8"	
52–53	54'–8"	
54–55	79'	
56–57	79'	
58–59	79'	INTERMEDIATES
60–61	79'	INTERMEDIATES
62–63	79'	
64–65	79'	
66–67	79'	
68–69	79'	
70–71	47'–4"	VEHICULAR OR REVERSE
72–73	47'- 4"	VEHICULAR OR REVERSE
100–101	47'–4"	
102–103	47'–4"	
104–105	77'	
106–107	77'	
108–109	77'	INTERMEDIATES
110–111	77'	INTERMEDIATES
112–113	77'	
114–115	77'	
116–117	77'	
118–119	77'	
120–121	82'	(SEE NOTE 3)
122–123	82'	(SEE NOTE 3)
124–125	66'	VEHICULAR OR REVERSE
126–127	66'	VEHICULAR OR REVERSE
SPARES	82'	



REMARKS

1. The first major Gate overhaul occurred in 1929. Numbers between arrows or in circles indicate years between overhauls.
2. Gates 5, 6, 7, 8, 13, 14, 15, and 16 are single pair operating gates. Removal would restrict the lane to short chamber lockages. Overhaul of these gates requires a special procedure.
3. Gates 120 to 123 are single pair operating gates. Removal would put the lane out of service. Overhaul procedure for these gates requires use the 82 feet spare gates now stored in Gatun Lake.
4. Life-cycle of Miter Gates is approximately 25 years.
5. With the new UHMWPE (Ultra High Molecular Weight Polyethylene) slider Rising Stem Valves, the rehabilitation cycle is approximately 12 to 15 years.
6. Cylindrical valve replacement cycle is approximately 40 to 50 years.

(⊙) Bridge Gate No. 3 replaced as a result of a ship accident.

(◉) Intermediate and Vehicular Gates were not overhauled since their original installation in 1914. They are inspected and evaluated periodically. Depending on the results of the inspections, they are included in the overhaul program.

(#) Gate leaves 29 & 30 will be overhauled at Synchrolift facility in 1994. Dry chamber work will be done in 1995.

(&) MG's 120–121 to be drydocked for touch-up interior grease & exterior painting. Rehang spare gates.

(%) As a result of a ship accident to MG 64, MG 62 replaced MG 64. Once repaired at the Synchrolift, MG 64 was rehung in MG 62 position.

N O T E:

OVERHAUL SCHEDULE IS TENTATIVE AND BASED ON CONDITION OF COMPONENTS DURING PERIODIC INSPECTIONS. IT IS PERIODICALLY UPDATED TO REFLECT ACTUAL CONDITION OF MITER GATES AND VALVES.

REVISED: JAN. 25, 1994

PANAMA CANAL COMMISSION
MARINE BUREAU
LOCKS DIVISION
PANAMA, REPUBLIC OF PANAMA

DESIGNED: CARLOS A. ALVARADO
REVISED: JORGE QUIJANO/FERNANDO SUCRE
DRAWN: NORIS ANDRADE
DATE: FEBRUARY 1988

```
**************************************************
*                                                *
*           STAAD.Pro                            *
*           Version  2001    Build 1005          *
*           Proprietary Program of               *
*           RESEARCH ENGINEERS, Intl.            *
*           Date=    DEC  7, 2001                *
*           Time=    15:31:57                    *
*                                                *
*      USER ID: US Army COE - Pittsburgh         *
**************************************************
```

```
 1. STAAD PLANE
 2. START JOB INFORMATION
 3. ENGINEER DATE 07-DEC-01
 4. END JOB INFORMATION
 5. INPUT WIDTH 79
 6. UNIT FEET KIP
 7. JOINT COORDINATES
 8. 1 0 0 0; 2 1 0 0; 3 2.5 0 0; 4 4 0 0; 5 5 0 0
 9. MEMBER INCIDENCES
10. 1 1 2; 2 2 3; 3 3 4; 4 4 5
11. MEMBER PROPERTY AMERICAN
12. 1 TO 4 TABLE ST W6X15
13. SUPPORTS
14. 2 TO 4 PINNED
15. UNIT INCHES KIP
16. CONSTANTS
17. E 29000 MEMB 1 TO 4
18. POISSON 0.3 MEMB 1 TO 4
19. DENSITY 0.000283 MEMB 1 TO 4
20. ALPHA 6E-006 MEMB 1 TO 4
21. UNIT FEET KIP
22. LOAD 1
23. MEMBER LOAD
24. 1 TRAP Y 0 -0.932 0 1
25. 2 TRAP Y -0.932 -2.33 0 1.5
26. 3 TRAP Y -2.33 -3.73 0 1.5
27. 4 TRAP Y -3.73 -4.66 0 1
28. PERFORM ANALYSIS
```

```
         P R O B L E M   S T A T I S T I C S
         -----------------------------------

    NUMBER OF JOINTS/MEMBER+ELEMENTS/SUPPORTS =      5/      4/      3
    ORIGINAL/FINAL BAND-WIDTH=      1/      1/      4 DOF
    TOTAL PRIMARY LOAD CASES =     1, TOTAL DEGREES OF FREEDOM =       9
    SIZE OF STIFFNESS MATRIX =        1 DOUBLE  KILO-WORDS
    REQRD/AVAIL. DISK SPACE  =     12.0/    >2000 MB,  EXMEM =  464.0 MB


 ++ Processing Element Stiffness Matrix.                 15:31:57
 ++ Processing Global Stiffness Matrix.                  15:31:57
 ++ Processing Triangular Factorization.                 15:31:57
 ++ Calculating Joint Displacements.                     15:31:57
 ++ Calculating Member  Forces.                          15:31:57

   29. PRINT SUPPORT REACTION ALL
```

SUPPORT REACTIONS -UNIT KIP FEET STRUCTURE TYPE = PLANE

JOINT	LOAD	FORCE-X	FORCE-Y	FORCE-Z	MOM-X	MOM-Y	MOM Z
2	1	0.00	1.32	0.00	0.00	0.00	0.00
3	1	0.00	2.53	0.00	0.00	0.00	0.00
4	1	0.00	7.80	0.00	0.00	0.00	0.00

************** END OF LATEST ANALYSIS RESULT **************

```
 30. PERFORM ANALYSIS
++ Processing Element Stiffness Matrix.          15:31:57
++ Processing Global Stiffness Matrix.           15:31:57
++ Processing Triangular Factorization.          15:31:57
++ Calculating Joint Displacements.              15:31:57
++ Calculating Member  Forces.                   15:31:57

 31. FINISH
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*********** END OF THE STAAD.Pro RUN ***********

**** DATE= DEC 7,2001 TIME= 15:31:57 ****

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*********************************************************
*     For questions on STAAD.Pro, please contact :      *
*  By Email - North America  : support@ca.reiusa.com    *
*  By Email - International  : support@reiusa.com       *
*  Tel. (USA) : 714-974-2500 ; Fax (USA) : 714-974-4771 *
*********************************************************
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Software licensed to US Army COE - Pittsburgh	Job No	Sheet No 1	Rev
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Job Title	Ref		
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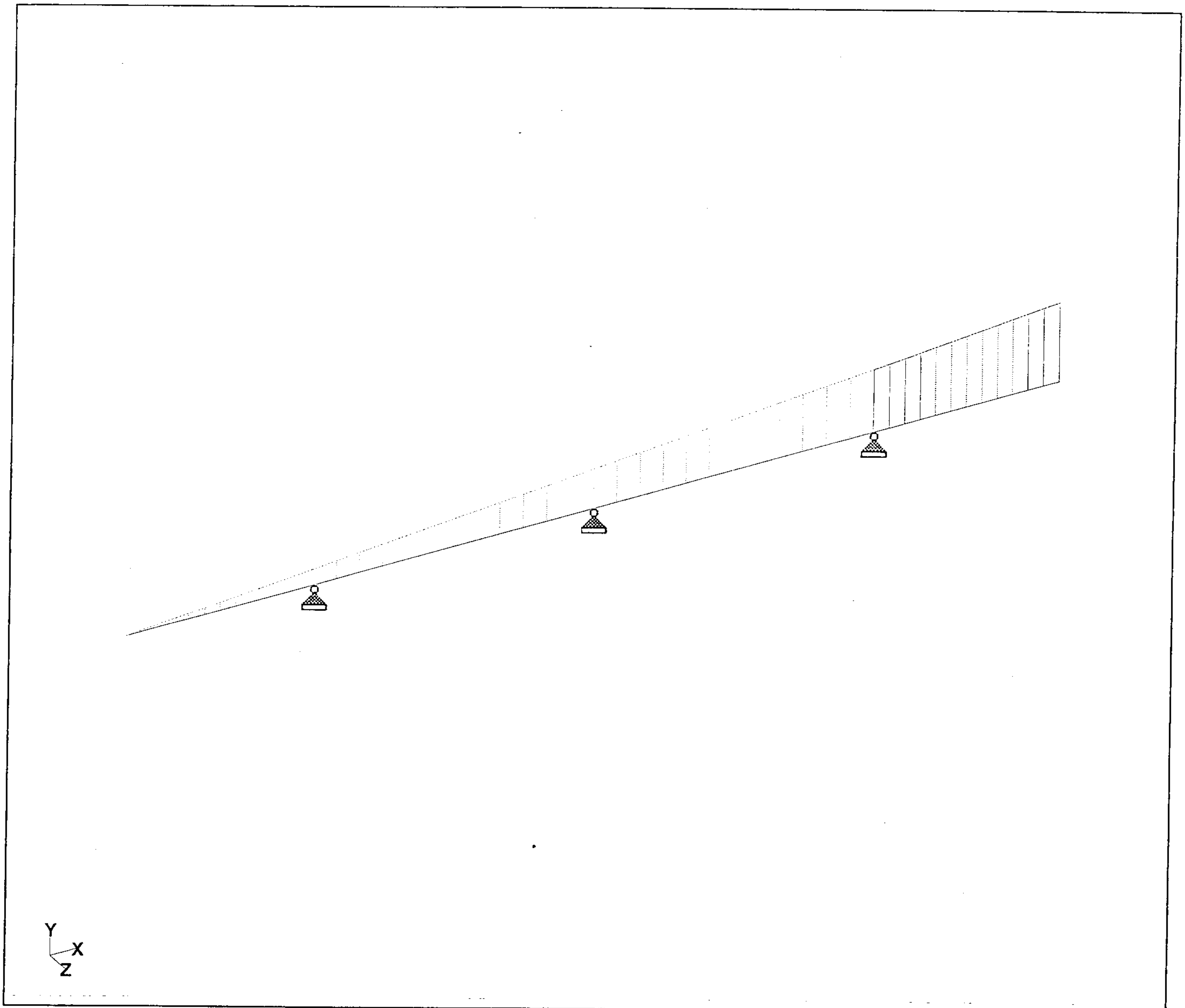
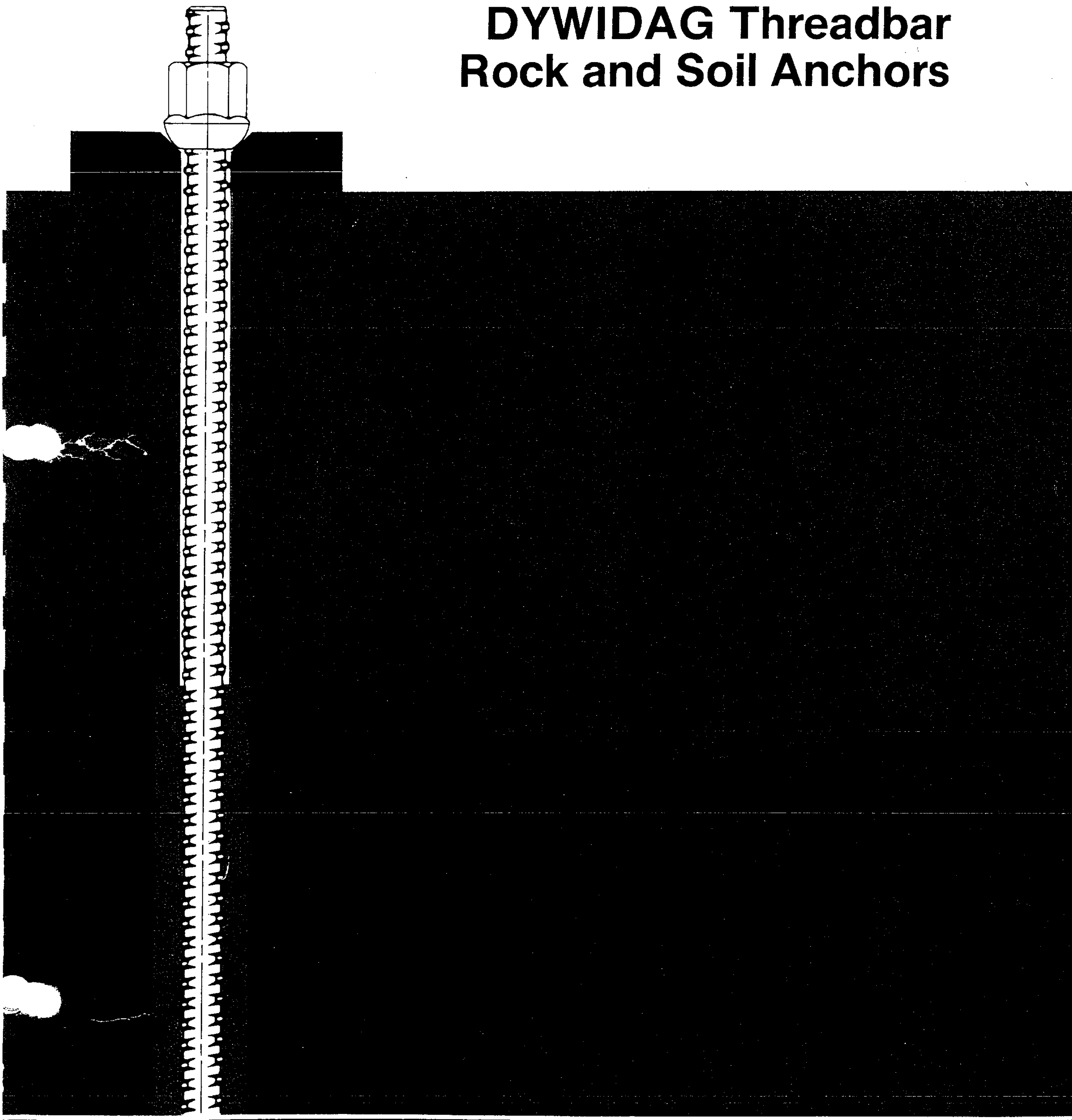
Client	File Rich.std	Date/Time 07-Dec-2001 15:31	



Whole Structure

DYWIDAG Systems International

DYWIDAG Threadbar Rock and Soil Anchors



DYWIDAG

The Dywidag Threadbar System is manufactured in the United States exclusively by Dywidag Systems International. Used worldwide since 1965, the threadbar system provides a simple, rugged method of efficiently applying prestress force to a wide variety of structural systems including posttensioned concrete, rock and soil anchor systems.

Available in ⅝″, 1″, 1¼″ and 1⅜″ nominal diameter, Dywidag Threadbars are hot rolled and proof stressed alloy steel conforming to ASTM A 722.

The Dywidag Threadbar has a continuous rolled-in pattern of threadlike deformations along its entire length. More durable than machine threads, the deformations allow anchorages and couplers to thread onto the threadbar at any point.

The strength of the Dywidag Threadbar anchorages and couplers exceeds the requirements of ACI 318. Test reports are available for the main components of the system.

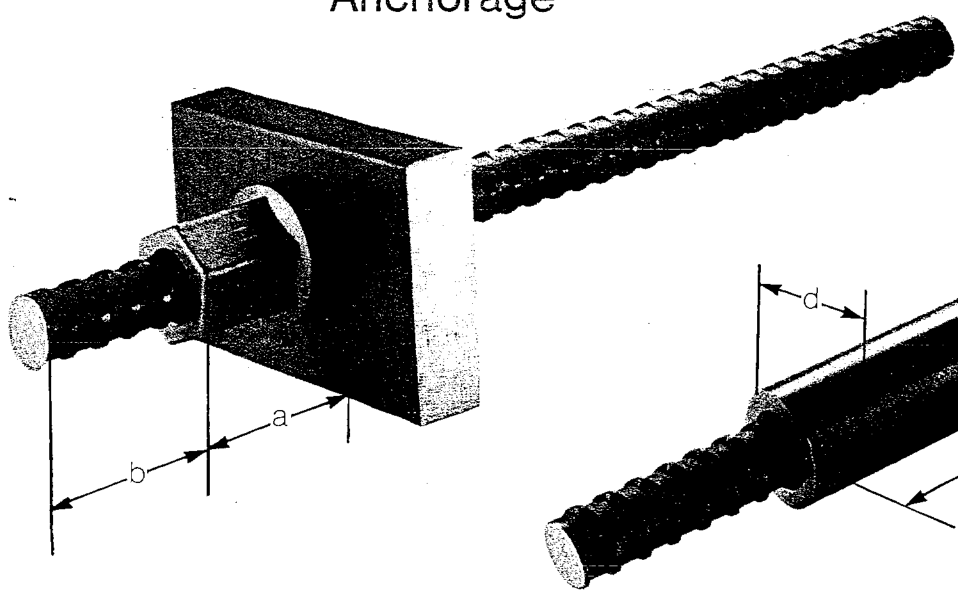
Conforming to the requirements of ASTM A 615, the threadbar deformations develop an effective bond with cement or resin grout. The continuous thread simplifies stressing. Lift off readings may be taken at any time, and the prestress force increased or decreased as required.

The anchor plate need not be perpendicular to the Dywidag Threadbar. The curved surface of the anchor nut accommodates up to 5° misalignment. As much as a 25° misalignment of the threadbar with the bearing plate can be corrected by using a set of wedge washers with the anchor nut.

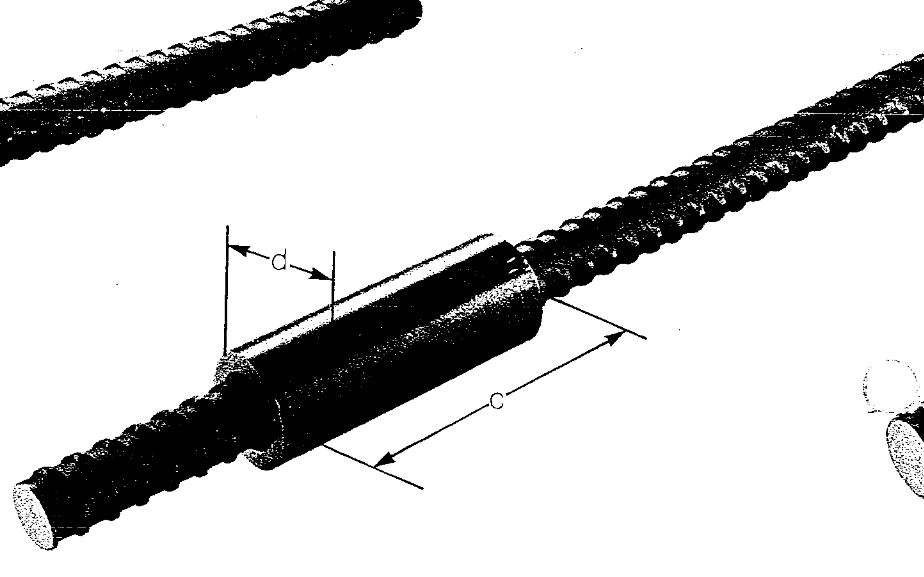
Available in mill lengths to 60′, threadbars may be cut to specified lengths before shipment to the job site. Or where circumstances warrant, the threadbars may be shipped to the job site in mill lengths for field cutting with a portable friction or band saw. Threadbars may be coupled for ease of handling or to extend a previously stressed bar.

The Dywidag Threadbar System is used extensively in rock and soil anchor construction because of its versatility, strength, performance characteristics and off-the-shelf availability of most components.

Anchorage



Coupling



Threadbar Rock and Soil Anchors

Prestressing steel properties

Nominal Threadbar Diameter (inches)	Ultimate Stress (f_{pu}-ksi)	Cross Section Area (Aps-inches^2)	Ultimate Strength (f_{pu} A_{ps})	Prestressing Force — (kips)			Weight (lbs./ft.)	Minimum** Elastic Bending Radius (ft.)	Maximum Threadbar Diameter (inches)
				$0.80 f_{pu} A_{ps}$	$0.70 f_{pu} A_{ps}$	$0.60 f_{pu} A_{ps}$			
⅝	157	0.28	43.5	34.8	30.5	26.1	0.98	26	0.693
1	150	0.85	127.5	102.0	89.3	76.5	3.01	52	1.201
1	160*	0.85	136.0	108.8	95.2	81.6	3.01	49	1.201
1¼	150	1.25	187.5	150.0	131.3	112.5	4.39	64	1.457
1¼	160*	1.25	200.0	160.0	140.0	120.0	4.39	60	1.457
1⅜	150	1.58	237.0	189.6	165.9	142.2	5.56	72	1.630
1⅜	160*	1.58	252.8	202.3	177.0	151.7	5.56	67	1.630

*Grade 160 Dywidag Threadbars available on special order when lead time permits.
**Prebent bars are required for radii less than the minimum elastic radius.

Steel stress levels

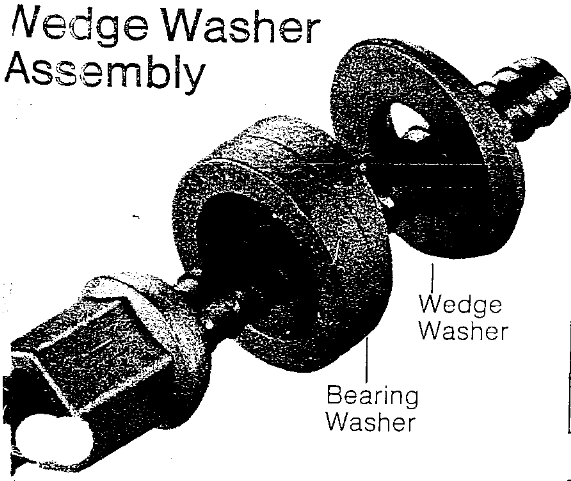
Dywidag Threadbars may be stressed to the allowable limits of ACI 318. The maximum :king stress (temporary) may not exceed 0.80 f_{pu}, and the transfer stress (lockoff) may not exceed 0.70 f_{pu}.

The final effective (working) prestress level depends on the specific application, installation procedure, stressing sequence, and the rigidity of the structural system. In the absence of a detailed analysis of the structural system, 0.60f_{pu} may be used as an approximation of the effective (working) prestress level.

Dywidag Threadbars may be used individually or in multiples depending upon the magnitude of force requirements or upon drilling considerations.

Actual loss calculations require structural design information not normally present on contract documents.

Wedge Washer Assembly



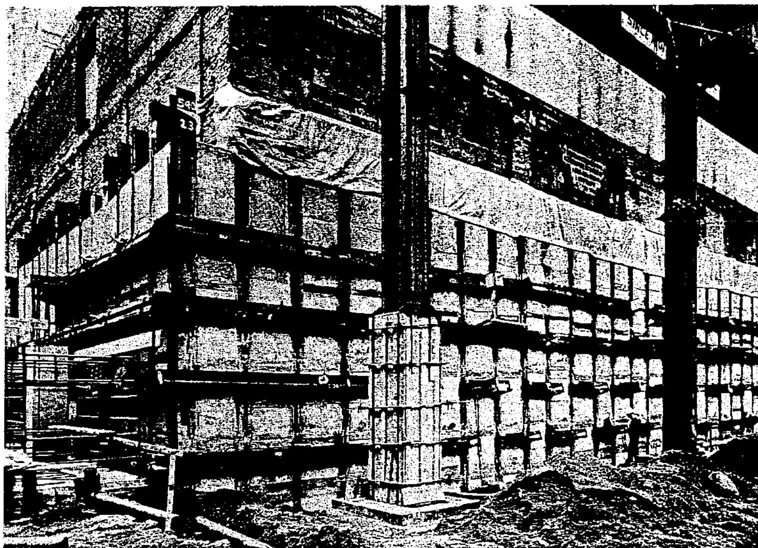
Anchorage Details

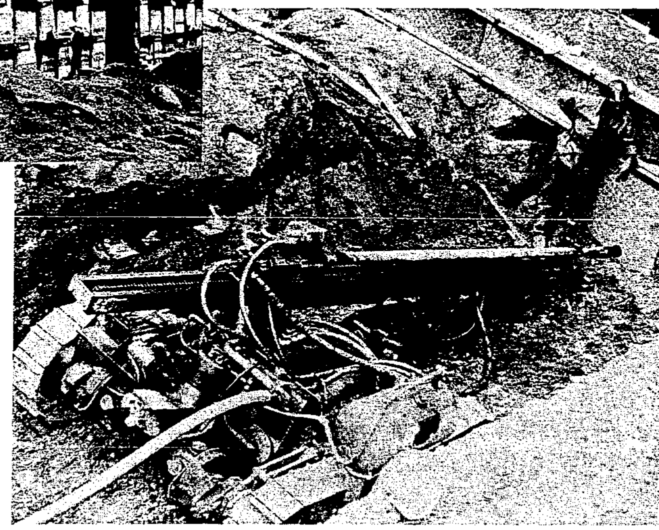
Threadbar Diameter (inches)	⅝	1	1¼	1⅜
Anchor Plate Size (inches)	2 x 5 x 1 3 x 3 x ¾	4 x 6½ x 1¼ 5 x 5 x 1¼	5 x 8 x 1½ 6¼ x 6¼ x 1½	5 x 9½ x 1¾ 7 x 7½ x 1¾
Nut Extension (inches) a	1⁹⁄₁₆**	1⅞	2½	2¾
Min. Bar Protrusion (inches) b	2½	3	3½	4

Coupler Details

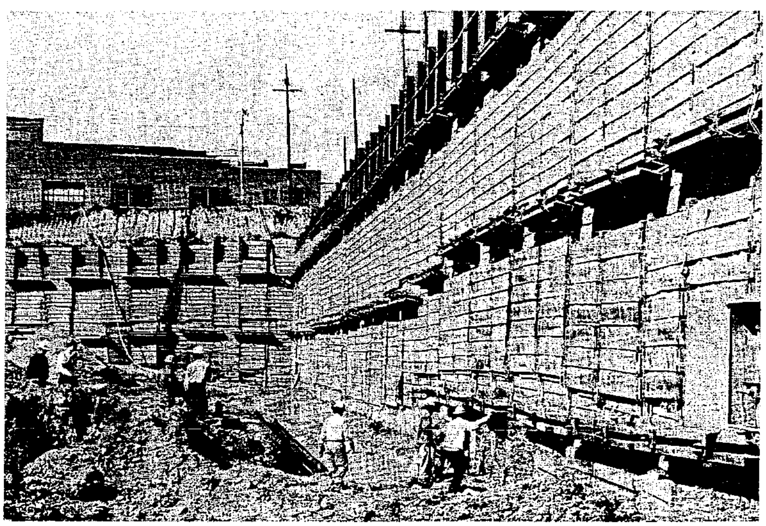
Threadbar Diameter (inches)	⅝	1	1¼	1⅜
Length (inches) c	4½	5½	6¾*	8⅝
Diameter (inches) d	1¼	2	2⅜	2⅝

*7½" long coupler available on special order.





1¼″ Dywidag Threadbar soil anchors installed in a dry sand and gravel to tieback H-beam and concrete underpinning wall in 40 ft. deep excavation. Anchor design and installation by Richard Goettle Inc., Cincinnati, Ohio.



1⅜″ Dywidag Threadbar soil anchors installed in wet sand to tieback H-beam and timber lagging system in 40 ft. excavation. Anchor design and installation by Schnabel Foundation Co., Washington, D. C.

DYWIDAG SYSTEMS INTERNATIONAL, USA, INC.

DSI
DYWIDAG Systems International

Systems and Ideas

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e Tree Place, 360-1002, Route 101, Bedford, NH 03102 (603) 472-7050

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100 Alexis Nihon Boulevard, Suite 216, St. Laurent, Quebec H4M 2N7, Canada (514) 744-6429
2702 Ware Street, Suite 204, Abbotsford, BC V2S 5E6, Canada (604) 852-6466
3701 19th Street, N.E., Calgary, Alberta T2E 6S8, Canada (403) 291-4414

Designation: A 722/A 722M – 98

Standard Specification for Uncoated High-Strength Steel Bars for Prestressing Concrete[1]

This standard is issued under the fixed designation A 722/A 722M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers uncoated high-strength steel bars intended for use in pretensioned and post-tensioned prestressed concrete construction or in prestressed ground anchors. Bars are of a minimum ultimate tensile strength level of 1035 MPa (150 000 psi).

1.2 Two types of bars are provided: Type I bar has a plain surface and Type II bar has surface deformations.

1.3 Supplementary requirements of an optional nature are provided. They shall apply only when specified by the purchaser.

1.4 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

2. Referenced Documents

2.1 *ASTM Standards:*

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products[2]

A 700 Practices for Packaging, Marking, and Loading Methods for Steel Products for Domestic Shipment[3]

E 30 Test Methods for Chemical Analysis of Steel, Cast Iron, Open-Hearth Iron, and Wrought Iron[4]

3. Ordering Information

3.1 Orders for material under this specification should include the following information:

3.1.1 Quantity,

3.1.2 Name of material (uncoated high-strength bars for prestressing concrete),

3.1.3 ASTM designation and year of issue,

3.1.4 Size and length,

3.1.5 Type,

3.1.6 Special inspection requirements, if desired (see Section 12),

3.1.7 Special preparation for delivery, if desired (see Section 11), and

3.1.8 Supplementary requirements, if desired.

NOTE 1—A typical ordering description is as follows: 50 uncoated high-strength steel bars for prestressing concrete to ASTM A 722/A 722M – ; 26 mm diameter, 12.20 m long, Type II; packed in accordance with A 700; meeting supplementary bending properties.

4. Materials and Manufacture

4.1 The bars shall be rolled from properly identified heats of ingot cast or strand cast steel.The standard sizes and dimensions of Type I and II bars shall be those listed in Table 1 and Table 2, respectively.

4.2 The bars shall be subjected to cold-stressing to not less than 80 % of the minimum ultimate strength, and then shall be stress relieved, to produce the prescribed mechanical properties.

5. Chemical Composition

5.1 An analysis of each heat of steel shall be made by the manufacturer from test samples taken during the pouring of each heat.

5.1.1 Choice and use of chemical composition and alloying elements, to produce the mechanical properties of the finished bar prescribed in 6.2, shall be made by the manufacturer, subject to the limitations in 5.1.2.

5.1.2 On heat analysis, phosphorus and sulfur shall not exceed the following:

Phosphorus	0.040 %
Sulfur	0.050 %

5.2 A product analysis may be made by the purchaser from the finished bar representing each cast or heat of steel. The phosphorus and sulfur contents thus determined shall not exceed the limits specified in 5.1.2 by 0.008 %.

5.3 Method E 30 shall be used for referee purposes.

6. Mechanical Properties

6.1 All testing for mechanical properties shall be performed in accordance with the requirements of Methods and Definitions A 370.

6.2 *Tensile Properties*:

6.2.1 Finished bars shall have a minimum ultimate tensile strength of 1035 MPa (150 000 psi).

---

[1] This specification is under the jurisdiction of ASTM Committee A-1 on Steel, Stainless Steel, and Related Alloys and is the direct responsibility of Subcommittee A01.05 on Steel Reinforcement.

Current edition approved April 10, 1998. Published December 1998. Originally published as A 722 – 75. Last previous edition A 722/A 722M – 97a.

[2] *Annual Book of ASTM Standards*, Vol 01.03.

[3] *Annual Book of ASTM Standards*, Vol 01.05.

[4] *Annual Book of ASTM Standards*, Vol 03.05.

TABLE 1 Dimensions for Type I (Plain) Bar

Nominal Diameter		Nominal Mass (Weight)		Nominal Area[A]	
mm	in.	kg/m	lb/ft	mm²	in.²
19	¾	2.23	1.50	284	0.44
22	⅞	3.04	2.04	387	0.60
25	1	3.97	2.67	503	0.78
29	1⅛	5.03	3.38	639	0.99
32	1¼	6.21	4.17	794	1.23
35	1⅜	7.52	5.05	955	1.48

[A]The nominal area is determined from the nominal diameter in inches. Values have been converted from inch-pound units to metric units.

TABLE 2 Dimensions for Type II (Deformed) Bar

Nominal Diameter[A]		Nominal Mass (Weight)		Nominal Area[B]	
mm	in.	kg/m	lb/ft	mm²	in.²
15	⅝	1.46	0.98	181	0.28
20	¾	2.22	1.49	271	0.42
26	1	4.48	3.01	548	0.85
32	1¼	6.54	4.39	806	1.25
36	1⅜	8.28	5.56	1019	1.58
46	1¾	13.54	9.10	1664	2.58
65	2½	27.10	18.20	3331	5.16

[A]Nominal diameters are for identification only. Values have been converted from metric to inch-pound units.
[B]The nominal area is determined from the bar weight less 3.5 % for the ineffective weight of the deformations.

6.2.2 The minimum yield strength of Type I and Type II bars shall be 85 % and 80 %, respectively, of the minimum ultimate tensile strength of the bars. The yield strength shall be determined by either of the methods described in Test Methods and Definitions A 370; however, in the extension under load method, the total strain shall be 0.7 %, and in the offset method the offset shall be 0.2 %.

6.2.3 The minimum elongation after rupture shall be 4.0 % in a gage length equal to 20 bar diameters, or 7.0 % in a gage length equal to 10 bar diameters.

6.3 *Test Specimens*—Tension tests shall be made using full-size bar test specimens. Machined reduced section test specimens are not permitted. All unit stress determinations shall be based on the nominal area shown in Table 1 or the effective area shown in Table 2.

6.4 *Number of Tests*—The number of tensile specimens tested shall be one from each 36 Mg (39 tons) or fraction thereof, of each size of bar rolled from each heat but not less than two from each heat. The specimens shall be randomly selected following the final processing operation.

6.5 *Retests*:

6.5.1 If any tensile property of any tension test specimen is less than that specified, and any part of the fracture is outside the middle third of the gage length, as indicated by scribe scratches marked on the specimen before testing, a retest shall be allowed.

6.5.2 If the results of an original tension test fail to meet specified requirements, two additional tests shall be made on samples of bar from the same heat and bar size, and if failure occurs in either of these tests, the bar size from that heat shall be rejected.

6.5.3 If any test specimen fails because of mechanical reasons such as failure of testing equipment, it shall be discarded and another specimen taken.

6.5.4 If any test specimen develops flaws, it shall be discarded and another specimen of the same size bar from the same heat substituted.

7. Requirements for Deformations

7.1 Material furnished as Type II bar shall have deformations spaced uniformly along the length of the bar. The deformations on opposite sides of the bar shall be similar in size and shape. The average spacing or distance between deformations on both sides of the bar shall not exceed seven tenths of the nominal diameter of the bar.

7.2 The minimum height and minimum projected area of the deformations shall conform to the requirements shown in Table 3.

7.3 *Mechanical Coupling*—For those bars having deformations arranged in a manner to permit coupling of the bars with a screw-on type coupler, it shall be the responsibility of the finished-bar manufacturer to demonstrate that a bar cut at any point along its length may be coupled to any other length of bar and that a coupled joint supports the minimum specified ultimate tensile strength of the coupled bars. The coupler type shall be provided or designed by the finished-bar manufacturer.

8. Measurements of Deformations

8.1 The average spacing of deformations shall be determined by dividing a measured length of the bar specimen by the number of individual deformations and fractional parts of deformations on any one side of the bar specimen. A measured length of the bar specimen shall be considered the distance from a point on a deformation to a corresponding point on any other deformation on the same side of the bar.

8.2 The average height of deformations shall be determined from measurements made on not less than two typical deformations. Determinations shall be based on three measurements per deformation: one at the center of the overall length, and the other two at the quarter points of the overall length.

8.3 To indicate adequately the conformity to the dimensional requirements, measurements shall be taken at random from one bar from each 30 Mg (33 tons) of each lot or fraction thereof.

8.4 Insufficient height, insufficient projected area, or excessive spacing of deformations shall not constitute cause for rejection unless it has been clearly established by determinations on each lot that typical deformation height or spacing

TABLE 3 Deformation Dimensions for Type II Bar

Nominal Diameter		Deformation Dimensions: Maximum Average Spacing		Minimum Average Height		Minimum Projected Area[A]	
mm	in.	mm	in.	mm	in.	mm²/mm	in.²/in.
15	⅝	11.1	0.44	0.7	0.03	2.4	0.09
20	¾	13.3	0.52	1.0	0.04	3.4	0.13
26	1	17.8	0.70	1.3	0.05	4.4	0.17
32	1¼	22.5	0.89	1.6	0.06	5.4	0.21
36	1⅜	25.1	0.99	1.8	0.07	6.1	0.24
46	1¾	30.1	1.19	2.2	0.09	7.3	0.29
65	2½	44.5	1.75	2.9	0.11	9.7	0.38

[A]Calculated from equation, min projected area = $0.75\pi d\ h/s$
where:
d = nominal diameter,
h = minimum average height, and
s = maximum average spacing.

does not conform to the minimum requirements prescribed in Section 7. No rejection shall be made on the basis of measurements if fewer than ten adjacent deformations on each side of the bar are measured.

NOTE 2—The term "lot" shall mean all bars of the same nominal mass (weight) per metre (linear foot) contained in an individual shipping release or shipping order.

9. Permissible Variation in Size or Weight

9.1 For Type I bars, the permissible variation from the nominal diameter specified in Table 1 shall not exceed +0.75, −0.25 mm (+0.030, −0.010 in.).

9.2 For Type II bars, the permissible variation from the nominal weight specified in Table 2 shall not exceed +3 %, −2 %.

10. Finish

10.1 The bars shall be free of defects injurious to the mechanical properties and shall have a workmanlike finish.

11. Delivery

11.1 Unless otherwise specified in the contract or purchase order, bars shall be packed for delivery in accordance with the finished-bar manufacturer's standard commercial practice.

11.2 When specified in the contract or purchase order, bars shall be packed in accordance with Practices A 700.

11.3 *Marking*:

11.3.1 Unless otherwise specified in the contract or purchase order, bars shall be sorted by size and each bundle or lift shall be properly tagged showing heat number, size, specification number (ASTM A 722), and the name of the finished-bar manufacturer in order to assure proper identification. The tags shall display the following statement: "High-Strength Prestressing Bars." The tags shall be made of durable material and marked in a legible manner with waterproof markings; not less than one tag per bundle or lift, attached by wire (see Note 3). In addition, both ends of each bar shall be painted yellow.

NOTE 3—It should be recognized that the legibility of markings on tags has a finite life. When bundles or lifts of bars are stored outdoors for a long period of time, fading of the markings on non-metallic tags, or oxidation of the markings on metal tags, can be expected to occur.

11.3.2 When specified in the contract or purchase order, bars shall be marked in accordance with Practices A 700.

12. Inspection

12.1 The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works that concern the manufacture of the material ordered. The manufacturer shall afford the inspector all reasonable facilities to satisfy him that the material is being furnished in accordance with this specification. All tests (except product analysis) and inspection, shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

12.2 If specified in the purchase order, the purchaser shall reserve the right to perform any of the inspection set forth in the specification where such inspections are deemed necessary to assure that the material furnished conforms to prescribed requirements.

12.3 If outside inspection is waived, the finished-bar manufacturer's certification that the material has been tested in accordance with, and meets the requirements of, this specification, shall be the basis of acceptance of the material.

13. Rejection

13.1 Unless otherwise specified, any rejection based on tests made in accordance with 5.2 shall be reported to the manufacturer within 5 working days from the receipt of samples by the purchaser.

13.2 Material that shows injurious defects subsequent to its acceptance at the manufacturer's works shall be subject to rejection, and the manufacturer shall be notified.

14. Rehearing

14.1 Samples tested in accordance with 5.2 that represent rejected material shall be preserved for two weeks from the date rejection is reported to the manufacturer. In case of dissatisfaction with the results of the tests, the manufacturer shall be permitted to make claim for a rehearing within that time.

15. Certification

15.1 If outside inspection is waived, a manufacturer's certification that the material has been tested in accordance with and meets the requirements of this specification shall be the basis of acceptance of the material. The certification shall include the specification number, year-date of issue, and revision letter, if any.

15.2 The manufacturer shall, when requested in the order, furnish a representative load-elongation curve for each size and grade of bar shipped.

15.3 A modulus of elasticity value of 205 GPa (29 700 000 psi) shall be used for the purpose of elongation calculation for Type II bars.

NOTE 4—Experience has shown that plotted load elongation curves from mill tests on Type II vary excessively and are not sufficiently reliable for use in calculating E-modulus values.

16. Keywords

16.1 high-strength steel bars; prestressed concrete; post-tensioning; deformed bars; plain bars

pci design handbook

Precast and Prestressed Concrete

FOURTH EDITION

MNL 120-92

PRECAST/PRESTRESSED CONCRETE INSTITUTE
175 WEST JACKSON BOULEVARD
CHICAGO, ILLINOIS 60604

312 786-0300 FAX 312 786-0353

First edition, first printing, 1971
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Second edition, first printing, 1978
Second edition, second printing, 1980
Third edition, first printing, 1985
Fourth edition, first printing, 1992

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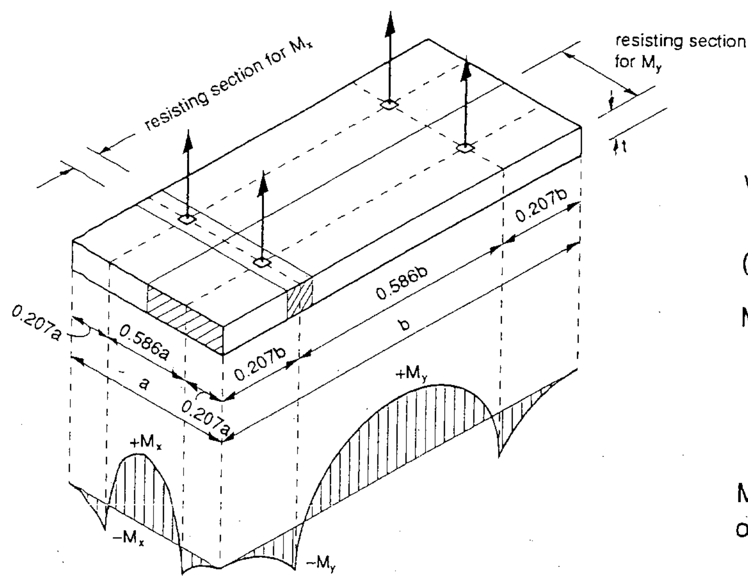
Printed in U.S.A.

Fig. 5.2.5 Moments developed in panels stripped flat



w = weight per unit area

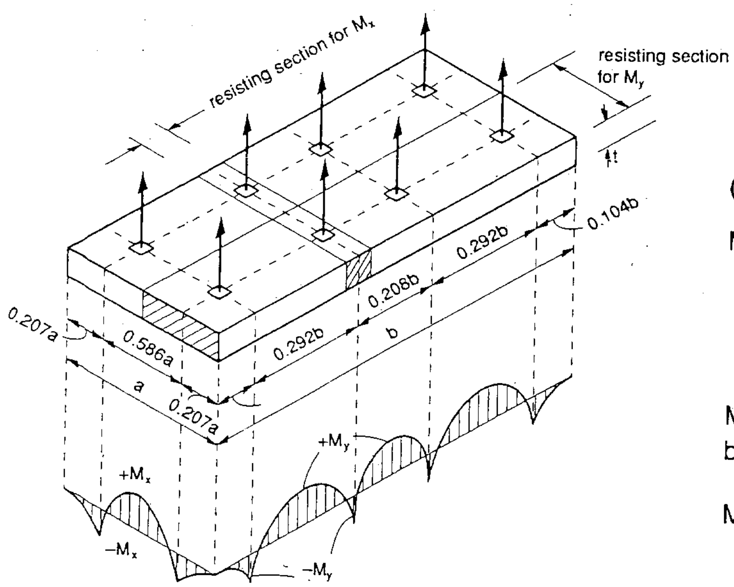
(a) Two point pick-up

Maximum Moments (Approximate)

$$+M_x = -M_x = 0.0107\,wa^2b$$
$$+M_y = -M_y = 0.0107\,wab^2$$

M_x resisted by a section of width 15t or b/2, whichever is less.

M_y resisted by a section of width a/2.



(b) Four point pick-up

Maximum Moments (Approximate)

$$+M_x = -M_x = 0.0054\,wa^2b$$
$$+M_y = -M_y = 0.0027\,wab^2$$

M_x resisted by a section of width 15t or b/4, whichever is less.

M_y resisted by a section of width a/2.

mechanisms to increase the angle of lift. Any such special handling requirements should be clearly shown on the shop drawings.

In addition to longitudinal bending moments, a transverse bending moment may be caused by the orientation of the pick-up points with respect to the transverse dimension (Fig. 5.2.8). For the section shown, a critical moment could occur between the ribs because of the thin cross-section.

The design guidelines listed above apply to elements of constant cross-section. For elements of varying cross-section, the location of lift points is usually determined by trial and error. Rolling blocks can be used on long elements of varying section (Fig. 5.2.10), which makes the forces in the lifting lines equal. The member can then be analyzed as a beam with varying load supported by equal reactions.

The force in inclined lift lines can be determined from Fig. 5.2.7.

5.2.8 Handling Devices

The most common lifting devices are prestressing strand or cable loops projecting from the concrete, threaded inserts, or special proprietary devices.

Since lifting devices are subject to dynamic loads, ductility of the material is part of the design

Fig. 5.2.6 Stripping from a tilt table

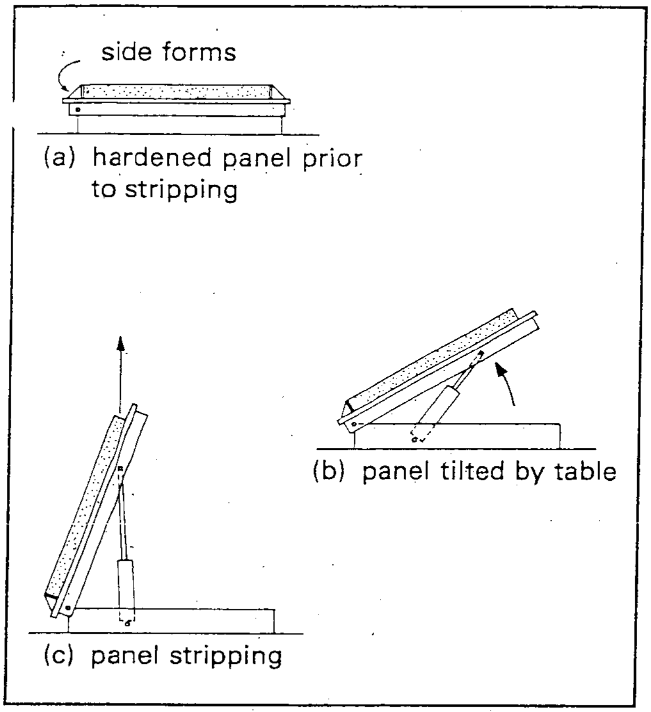
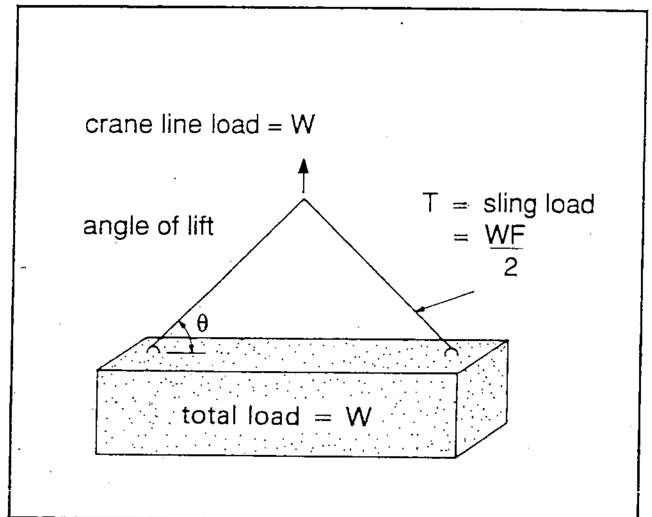


Fig. 5.2.7 Determination of force in inclined lift lines



	Multiplication factor "F" for the total load on hoisting sling with a lift angle of θ					
θ	90°	75°	60°	45°	30°*	15°*
F	1.00	1.04	1.16	1.41	2.00	3.86

Note: θ is usually not less than 60° to 70°
*Not recommended

Fig. 5.2.8 Pick-up points for equal stresses of a ribbed member

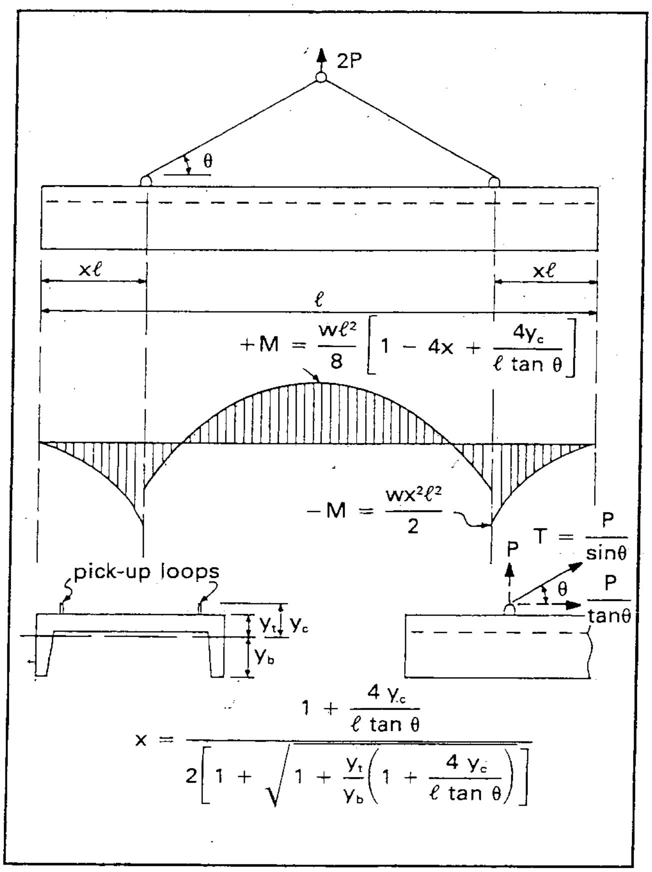
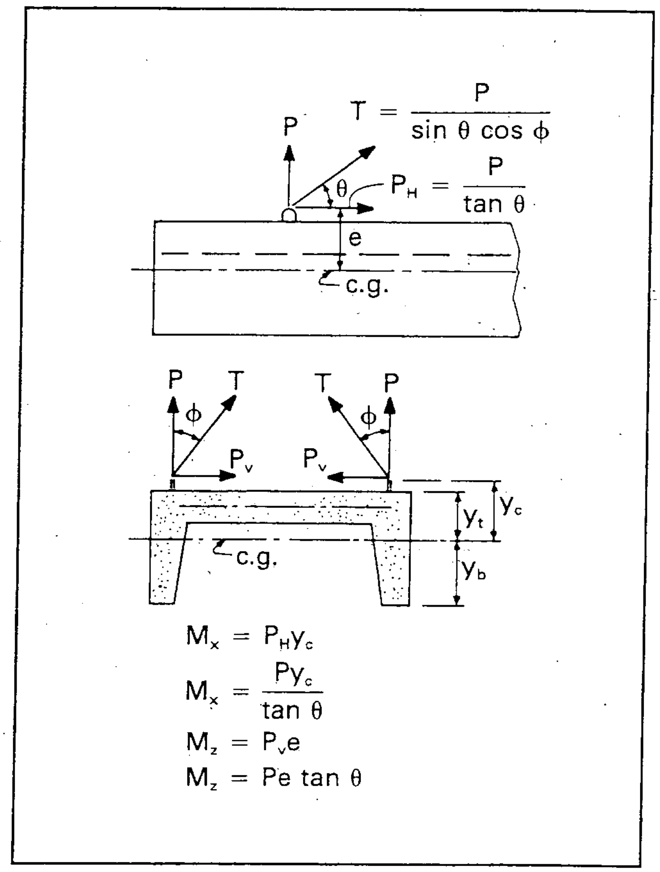
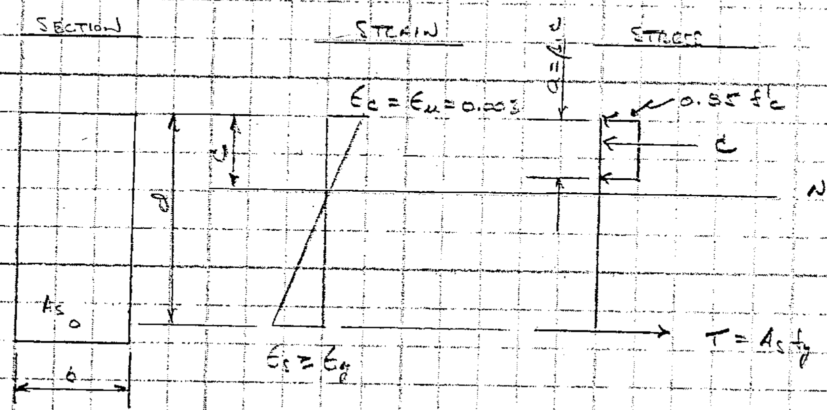


Fig. 5.2.9 Moments caused by eccentric lifting



Derive concrete beam equations



$a = \beta_1 c$ ACI 10.2.7

- Find N.A. from strain compatibility:

$$\frac{\epsilon_c}{c} = \frac{\epsilon_s}{d-c} \qquad c = \frac{d\,\epsilon_c}{\epsilon_c + \epsilon_s} \quad (1)$$

For balance steel condition (ρ_b): $\epsilon_s = f_y / E_s$

$$c_b = \frac{d\,\epsilon_c}{\epsilon_c + f_y/E_s} \quad (2) \quad \text{Balanced N.A.}$$

- Find balance steel condition (ρ_b):

$\rightarrow \Sigma F_x = 0 \quad T - C = 0 \qquad A_s f_y = 0.85 f'_c \beta_1 c\, b \quad (3)$ Let $c = c_b = \frac{d\,\epsilon_c}{\epsilon_c + f_y/E}$

$$\rho_b = \frac{A_s}{bd} = \frac{0.85 f'_c \beta_1}{f_y}\left(\frac{\epsilon_c}{\epsilon_c + f_y/E}\right) \quad (4)$$

Note: For steel to yield: $\rho(\text{actual}) \leq \rho_b$

- Find required depth (d) & steel (A_s) for nominal moment (M_n): Know ρ

$$M_n = A_s f_y \left(d - \frac{a}{2}\right) \qquad a = \beta_1 c = \frac{A_s f_y}{0.85 f'_c b} \quad \text{[see (4)]}$$

$$= \rho b d f_y \left(d - \frac{A_s f_y}{1.7 f'_c b}\right) \qquad \rho = \frac{A_s}{bd}$$

$$M_n = \rho b d^2 f_y \left(1 - \frac{\rho f_y}{1.7 f'_c}\right) \quad (5)$$

Know M_n, ρ, f_y, f'_c, b & solve for "d"

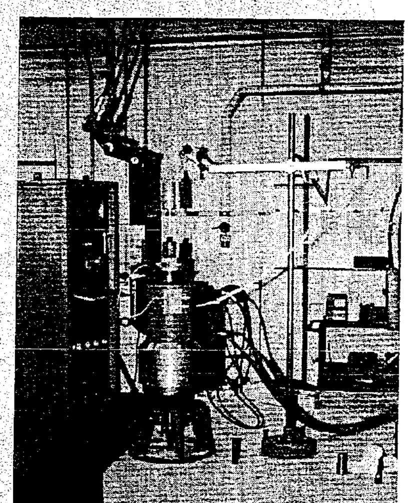
$$M_n = A_s f_y (d - a/2) \qquad a = A_s f_y / (0.85 f'_c b)$$

$$\frac{f_y^2}{1.7 f'_c b} A_s^2 - f_y d A_s + M_n = 0 \quad (6)$$

Know M_n, f_y, d, b & solve for A_s

Fastening Technology Manual

Rebar Fastening Guide



Test Arrangement

HILTI®

TODD PADEZANIN
Regional Field Engineer
Pennsylvania/Upstate New York
(800) 879-8000

Hilti Center: 1301 Beaver Avenue, Pittsburgh, PA
Mailing Address: P.O. Box 21148, Tulsa, OK 74121
Fax (800) 879-7000

ISO 9001 REGISTERED

Curing time

The curing time is dependent on temperature.

Base Material Temperature		Gel Time t_{gel}	Curing Time t_{cure}
23°F	(-5 °C)	25 Minutes	6 Hours
32°F	(0 °C)	18 Minutes	3 Hours
41°F	(5 °C)	13 Minutes	1.5 Hours
68°F	(20 °C)	5 Minutes	50 Minutes
86°F	(30 °C)	4 Minutes	40 Minutes
104°F	(40 °C)	2 Minutes	30 Minutes

Maintain foil pack temperature between 41°F and 104°F (5°C and 40°C).

Drill bit diameter

The correct drill bit diameter is important for the perfomance of the adhesive bond as well as for the economy of the application.

Nominal Rebar Diameter d_b		Maximum Recommended Hole Diameter* D
#3	(3/8")	1/2"
#4	(1/2")	3/4"
#5	(5/8")	7/8"
#6	(3/4")	1"
#7	(7/8")	1 1/8"
#8	(1")	1 1/4"

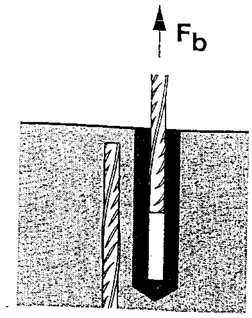
Injection volume

Nominal Rebar Diameter	Drill Bit Diameter* (in.)	Typical Adhesive Volume Required per inch of Embedment (in.³)
#3 or 3/8"	1/2	0.105
#4 or 1/2"	5/8	0.131
#5 or 5/8"	3/4	0.176
#6 or 3/4"	7/8	0.218
#7 or 7/8"	1	0.236
#8 or 1"	1 1/8	0.284
#9 or 1 1/8"	1 5/16	0.466
#10 or 1 1/4"	1 3/8	0.433
#11 or 1 3/8"	1 9/16	0.820

NOTE: Useable volume of HIT HY 150 refill pack is 16.5 in.³ (270 ml)
Useable volume of HIT HY 150 large cartridges is 61.0 in.³ (1000 ml)
*Rebar diameter may vary. Use smallest drill bit which will accomodate rebar.

3.3.2 Bond to Rebar

The force, F_b, which can be transferred in bond between rebar and adhesive increases linearly with the development length, but only with the square root of the rebar diameter.



Adhesive bond failure

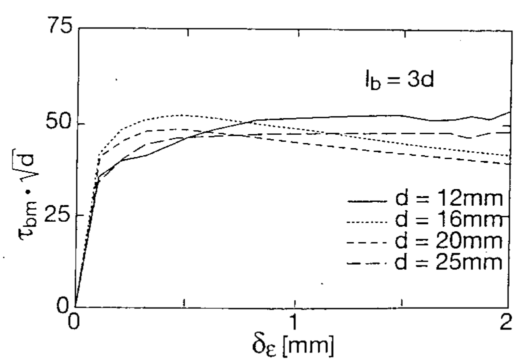
Design Strength of Adhesive:

$$F_b\,[\text{lb}] = 2260 \bullet \ell_d\,[\text{in.}] \bullet \sqrt{d_b}\,[\text{in.}]$$

$$F_b\,[\text{N}] = 78 \bullet \ell_d\,[\text{mm}] \bullet \sqrt{d_b}\,[\text{mm}]$$

The square root takes into consideration that small rebar diameters are typically used in groups, whereas larger diameters occur more often as single anchorage points.

This equation allows for the performance of the adhesive. It was developed by Professor Peter Marti of the Swiss Federal Institute of Technology (ETH), Zurich, based on a review of comprehensive test data.

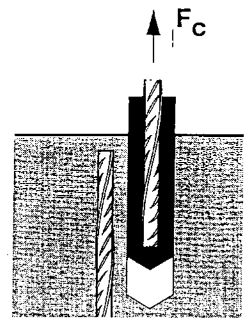


This value controls when the installed development length is smaller than the basic development length and the compressive strength of concrete is greater than 3,000 psi (21 N/mm²).

3.3.3 Bond to Concrete

Concrete Bond Failure

The force, F_C, which can be transferred in the bond interface between adhesive and hole wall increases linearly with embedment depth, as well as in proportion to the square root of the compressive strength times the hole diameter.



Design value of bond strength between HIT-HY 150 and concrete:

$$F_C = 34 \cdot \ell_d \cdot \sqrt{f'_c \cdot D}$$

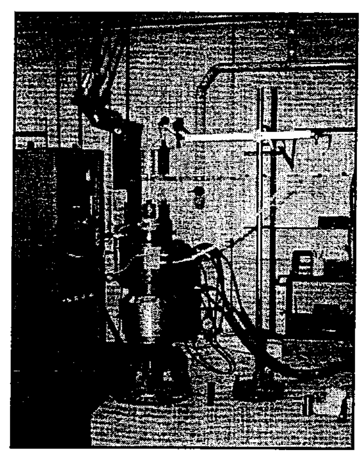
[lb] [in.] [psi] [in.]

$$F_C = 14 \cdot \ell_d \cdot \sqrt{f'_c \cdot D}$$

[N] [mm] [N/mm²] [mm]

D=hole diameter. See 2.3.

This equation allows for the performance of the concrete bond interface. It was developed by Professor Peter Marti of the Swiss Federal Institute of Technology (ETH), Zurich, based on a review of comprehensive test data.



Test Arrangement

This value controls when the installed development length is less than the basic development length and the compressive strength of concrete does not exceed 3,000 psi (21 N/mm^2).

The limit at which the strength of adhesive or strength of concrete controls, is obtained as follows:

Setting $F_b = F_c$:

$$2260 \bullet \underset{[in.]}{\ell_d} \bullet \underset{[in.]}{\sqrt{d_b}} = 34 \bullet \underset{[in.]}{\ell_d} \bullet \underset{[in.]}{\sqrt{f'_c \cdot D}}$$

$$78 \bullet \underset{[mm]}{\ell_d} \bullet \underset{[mm]}{\sqrt{d_b}} = 14 \bullet \underset{[mm]}{\ell_d} \bullet \underset{[mm]}{\sqrt{f'_c \cdot D}}$$

Substituting the typical case in the above equation yields:

$D = 1.2\ \mathbf{d_b}$

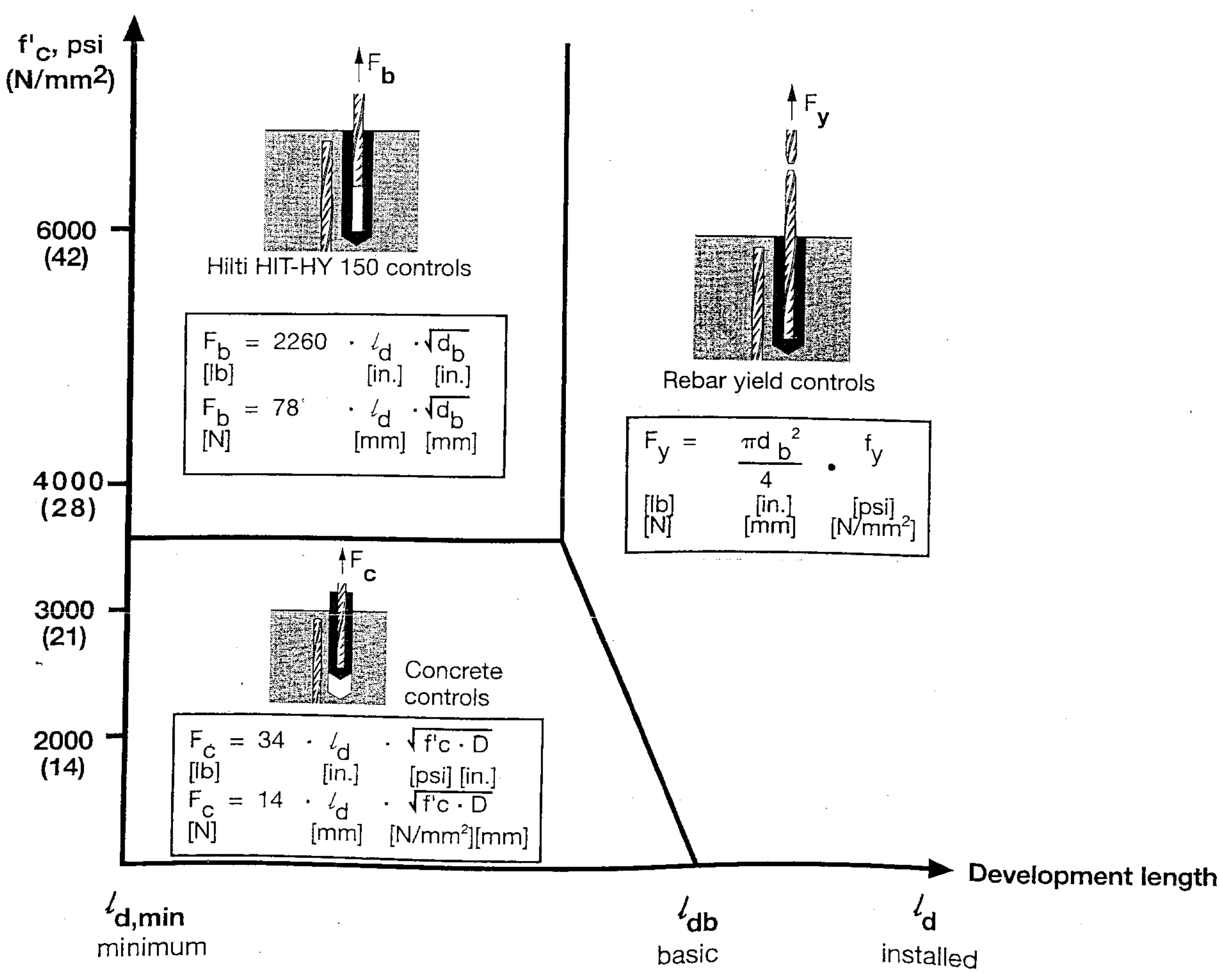
$\mathbf{f'_c} = 3680$ [psi]

$\mathbf{f'_c} = 26$ [N/mm]

Consequently, up to and including f'c = 3000 psi, it is the strength of concrete which controls, but above f'c = 4000 psi, it is the Hilti HIT HY 150 adhesive strength that is decisive.

Schematic presentation of the controlling equation:

Concrete Compressive Strength



3.3.4 Basic Development Length

The basic development length is derived by setting

$F_y \leq F_b$
(rebar strength ≤ adhesive bond strength)

$$\frac{\pi d_b^2}{4} \bullet f_y \leq 2260 \bullet \ell_d \sqrt{d_b}$$
[in.] [psi] [in.] [in.]

$$\ell_d \geq \frac{f_y\, d_b^{3/2}}{2880}$$
[in.] [psi] [in.]

$$\frac{\pi d_b^2}{4} \bullet f_y \leq 78 \bullet \ell_d \sqrt{d_b}$$
[mm] [N/mm²] [mm] [mm]

$$\ell_d \geq \frac{f_y \bullet d_b^{3/2}}{100}$$
[mm] [N/mm²][mm]

and

$F_y \leq F_c$
(rebar strength ≤ concrete bond strength)

$$\frac{\pi d_b^2}{4} \bullet f_y \leq 34 \bullet \ell_d \sqrt{f'_c \bullet D}$$
[in.] [psi] [in.] [psi] [in.]

$$\ell_d \geq \frac{f_y \bullet d_b^2}{43 \bullet \sqrt{f'_c \bullet D}}$$
[in.] [psi] [in.]

$$\frac{\pi d_b^2}{4} \bullet f_y \leq 14 \bullet \ell_d \sqrt{f'_c \bullet D}$$
[mm] [N/mm²] [mm] [N/mm²] [mm]

$$\ell_d \geq \frac{f_y \bullet d_b^2}{18 \bullet \sqrt{f'_c \bullet D}}$$
[mm] [N/mm²] [mm]

As a result, the conservative basic development length useable for all concrete strengths is obtained as the maximum value of the two limiting embedment depths:

Basic Development Length

$$\ell_{db} = \text{MAX}\left\{\frac{f_y \bullet d_b^{3/2}}{2880} \; ; \; \frac{f_y \bullet d_b^2}{43 \bullet \sqrt{f'_c \bullet D}}\right\}$$
[in.] [psi] [in.] [psi] [in.]

$$\ell_{db} = \text{MAX}\left\{\frac{f_y \bullet d_b^{3/2}}{100} \; ; \; \frac{f_y \bullet d_b^2}{18 \bullet \sqrt{f'_c \bullet D}}\right\}$$
[mm] [N/mm²] [mm] [N/mm²] [mm]

Appendix 4. – List of Demolition Contractors Contacted

List of Contractors

Bluegrass Concrete Cutting, Inc
107 Mildred Street
P.O. Box 367
Greenville, AL 36037
800-734-2935

P.C.S. Inc.
P.O. Box 959
Hobe Sound, FL 22475
561-223-7393

Cutting Edge Services Corp.
807 Eight Mile Road
Cincinnati, OH 45255
513-388-0199

Independence Excavating
5720 Schaaf Road
Independence, OH 44131
800 524-DIRT

Kokosing Construction Co., Inc.
17531 Waterford Road
Fredericktown, OH 43019
740-694-6315

Waterjet Tech, Inc.
1803 Beltway Drive
St. Louis, MO 63114
314-428-6900

Tramac
26 Eastmans Road
Parsippany, NJ 07054
800-526-3837

DTI Demolition Technologies Incorporated
P.O. Box 427, 107 Mildred Street
Greenville, AL 36037
800-282-4384

Appendix 5. – Cost Estimates

PROJECT: Panama Canal Miter Gate Study
LOCATION: Panama Canal
COST LEVEL: December 2001

Est By: crc
Checked: pgb
Filename: EV\PANAMA\[sillsup.xls]Chain Fender Sills (2)
Date: 4/10/2002

Precast Panel Sill Replacement (Precision Demo)

Remove 2'-0" of existing sill, replace w/ 9" thick precast panels bolted thru to existing concrete, under grout and grout joints.

Refer to Plate No. 9
Quantities are per Sill

	Item Description	Eng Quantity	Eng Unit	SI Quantity	SI Unit	English Unit Price	SI Unit Price	Amount	Cont	Total Cost
1	Concrete Removal (Precision)	165	cy	126	m3	$1,200.00	$1,570.00	$198,000.00	25%	$247,500.00
2	Precast Concrete Panels									
2a	Concrete	17	cy	13	m3	$800.00	$1,050.00	$13,600.00	25%	$17,000.00
2b	Reinforcing Steel	6,861	lbs	3112	kg	$1.00	$2.20	$6,861.00	25%	$8,576.25
2c	Base Grout	77	cf	2.18	m3	$12.00	$420.00	$924.00	25%	$1,155.00
2d	Joints Grout	2	cf	0.06	m3	$15.00	$500.00	$30.00	25%	$37.50
3	Seal Steel (ss)	2,785	lbs	1263	kg	$12.00	$26.50	$33,423.96	25%	$41,779.95
4	Misc Steel							$0.00	25%	$0.00
4a	1" Dia Anchor Bolts w/ nuts (4'-1.5" Long)	84	ea			$250.00		$21,000.00	25%	$26,250.00
4b	1" Dia Threaded Rods w/ nuts & washers (2'-0" long)	24	ea			$130.00		$3,120.00	25%	$3,900.00
4c	Plates etc.	1,351	lbs	613	kg	$10.00	$22.00	$13,510.00	25%	$16,887.50
	1/4" Dia Headed Concrete Achors (2-11/16" long)	24	ea			$15.00		$360.00	25%	$450.00
								Total/Sill		$363,536.20
								Total/Sill Rounded		$364,000.00
								12 Sills Total		$4,368,000.00
	Dewaterings	4	ea			$30,000.00		$120,000.00	25%	$150,000.00
	Mob/Demob inside Panama	4	ea			$15,000.00		$60,000.00	25%	$75,000.00
								Total		$4,593,000.00

Total Construction Cost, Rounded **$4,590,000**

Construction Duration per Dewatering	
Dewatering	2 days
Demolition	5 days
Steel/Concrete Placement	2 days
Cleanup/Flooding	1 day
Total	10 days

PROJECT: Panama Canal Miter Gate Study
LOCATION: Panama Canal
COST LEVEL: December 2001

Est By: crc
Checked: pgb
Filename: EV\PANAMA\[sillsup.xls]Chain Fender Sills (2)
Date: 4/10/2002

Cast-In-Place Miter Sills (Precision Demo)

Remove 2'-0" of existing sill, install dowels, reinforcing, and seal steel, place 10.5" of 4000 psi concrete.

Refer to Plate No. 6
Quantities are per Sill

	Item Description	Eng Quantity	Eng Unit	SI Quantity	SI Unit	English Unit Price	SI Unit Price	Amount	Cont	Total Cost
1	Concrete Removal (Precision)	165	cy	126	m3	$1,200.00	$1,570.00	$198,000.00	25%	$247,500.00
2	CIP Concrete							$0.00	25%	$0.00
2a	Concrete	20	cy	15	m3	$500.00	$670.00	$10,000.00	25%	$12,500.00
2b	Reinforcing Steel	1,756	lbs	797	kg	$1.00	$2.20	$1,756.00	25%	$2,195.00
3	Dowels									
3a	Drill 7/8" Dia Holes	412	lf	126	m	$45.00	$147.00	$18,540.00	25%	$23,175.00
3b	Dowels (#6 bar)	1,031	lbs	468	kg	$2.50	$5.50	$2,576.88	25%	$3,221.09
4	Seal Steel (SS)	4,481	lbs	2033	kg	$12.00	$26.50	$53,774.40	25%	$67,218.00
5	Misc Steel							$0.00	25%	$0.00
5a	1" Dia Anchor Bolts; Drill and Epoxy Grout - (3'-0" Long)	64	ea			$150.00		$9,600.00	25%	$12,000.00
5b	1" Hvy Hex Nuts & Washers	128	ea			$5.00		$640.00	25%	$800.00
								Total/Sill		$368,609.09
								Total/Sill Rounded		$369,000.00
								12 Sills Total		$4,428,000.00
	Dewaterings	4	ea			$30,000.00		$120,000.00	25%	$150,000.00
	Mob/Demob inside Panama	4	ea			$15,000.00		$60,000.00	25%	$75,000.00
								Total		$4,653,000.00

Total Construction Cost, Rounded **$4,650,000**

Construction Duration per Dewatering

Dewatering	2 days
Demolition	5 days
Steel/Concrete Placement	2-3 days
Cleanup/Flooding	1 day
Total	10 - 11 days

PROJECT:	Panama Canal Miter Gate Study	Est By:	crc
LOCATION:	Panama Canal	Checked:	pgb
COST LEVEL:	December 2001	Filename:	E:\PANAMA\[sillsup.xls]Chain Fender Sills (2)
		Date:	4/10/2002

Cast-In-Place Sills (Alternative "A") (Precision Demo)

Remove 1'-0" from existing sill, sawcut 2'-0" wide x 1'-0" deep across sealing edge of sill, remove concrete and embedded steel, place new steel and concrete.

Refer to Plate No. 7

Quantities are per Sill.

	Item Description	Eng Quantity	Eng Unit	SI Quantity	SI Unit	English Unit Price	SI Unit Price	Amount	Cont	Total Cost
1	Concrete Removal (Precision)									
1a	Precision Removal	88	cy	67	m3	$1,800.00	$2,370.00	$158,760.00	25%	$198,450.00
1b	Concrete Demo	9	cy	7	m3	$1,000.00	$1,300.00	$9,100.00	30%	$11,830.00
2	CIP Concrete									
2a	Concrete	8	cy	6.1	m3	$500.00	$660.00	$4,000.00	25%	$5,000.00
2b	Reinforcing Steel	1,756	lbs	797	kg	$1.00	$2.20	$1,756.00	25%	$2,195.00
3	Dowels									
3a	Drill 7/8" Dia Holes	135	lf	41	m	$45.00	$148.00	$6,075.00	25%	$7,593.75
3b	Dowels (#6 bar)	347	lbs	157	kg	$2.50	$5.50	$867.50	25%	$1,084.38
4	Seal Steel (SS)	4,481	lbs	2033	kg	$12.00	$26.50	$53,774.40	25%	$67,218.00
5	Misc Steel							$0.00	25%	$0.00
5a	1" Dia Anchor Bolts; Drill and Epoxy Grout - (3'-0" Long)	64	ea			$150.00		$9,600.00	25%	$12,000.00
5b	1" Hvy Hex Nuts & Washers	128	ea			$5.00		$640.00	25%	$800.00
								Total/Sill		$306,171.13
								Total/Sill Rounded		$306,000.00
								12 Sills Total		$3,672,000.00
	Dewaterings	4	ea			$30,000.00		$120,000.00	25%	$150,000.00
	Mob/Demob inside Panama	4	ea			$15,000.00		$60,000.00	25%	$75,000.00
								Total		$3,897,000.00

Total Construction Cost, Rounded **$3,900,000**

Construction Duration per Dewatering	
Dewatering	2 days
Demolition	4 days
Steel/Concrete Placement	1-2 days
Cleanup/Flooding	1 day
Total	8-9 days

PROJECT: Panama Canal Miter Gate Study
LOCATION: Panama Canal
COST LEVEL: December 2001

Est By:	crc
Checked:	pgb
Filename:	EV\PANAMA\[sillsup.xls]Chain Fender Sills (2)
Date:	4/10/2002

Cast-In-Place Sills (Alternative "B") (Precision Demo)

Remove from existing sill, sawcut 1'-2" wide x 1'-0" deep across sealing surface edge of sill, remove existing concrete & embedded metals, place new steel and concrete.

Refer to Plate No. 8
Quantities are per Sill.

	Item Description	Eng Quantity	Eng Unit	SI Quantity	SI Unit	English Unit Price	SI Unit Price	Amount	Cont	Total Cost
1	Concrete Removal									
1a	Precision Removal	88	cy	67	m3	$1,800.00	$2,370.00	$158,760.00	25%	$198,450.00
1b	Concrete Demo	5	cy	4	m3	$1,200.00	$1,590.00	$6,360.00	30%	$8,268.00
2	Concrete	5	cy	4	m3	$500.00	$660.00	$2,650.00	25%	$3,312.50
3	Dowels									
3a	Drill 1-1/8" Dia Holes	135	lf	41	m	$50.00	$165.00	$6,750.00	25%	$8,437.50
3b	Drill 1-3/8" Dia Holes	210	lf	64	m	$60.00	$197.00	$12,600.00	25%	$15,750.00
3c	Dowels (#8 bar)	641	lbs	291	kg	$1.00	$2.20	$640.80	25%	$801.00
3d	Dowels (#10 bar)	1,291	lbs	586	kg	$1.00	$2.20	$1,290.90	25%	$1,613.63
4	Seal Steel (SS)	6,930	lbs	3143	kg	$12.00	$26.50	$83,160.00	25%	$103,950.00
5	Misc Steel							$0.00	25%	$0.00
5[illegible]	3/4" Dia Anchor Bolts w/double nut and washers (3.25' ea)	120	ea			$100.00		$12,000.00	25%	$15,000.00
5b	3/4" Dia x 6" Long splice bolts w/ nuts and washers	24	ea			$30.00		$720.00	25%	$900.00

Total/Sill	$356,482.63
Total/Sill Rounded	$360,000.00
12 Sills Total	$4,320,000.00

	Eng Quantity	Eng Unit	English Unit Price	Amount	Cont	Total Cost
Dewaterings	4	ea	$30,000.00	$120,000.00	25%	$150,000.00
Mob/Demob inside Panama	4	ea	$15,000.00	$60,000.00	25%	$75,000.00
				Total		$4,545,000.00

Total Construction Cost, Rounded **$4,550,000**

Construction Duration per Dewatering

Dewatering	2 days
Demolition	4 days
Steel/Concrete Placement	1-2 days
Cleanup/Flooding	1 day
Total	8-9 days

PROJECT:	Panama Canal Miter Gate Study	Est By:	crc
LOCATION:	Panama Canal	Checked:	pgb
COST LEVEL:	December 2001	Filename:	EV\PANAMA\[sillsup.xls]Chain Fender Sills (2)
		Date:	4/10/2002

Precast Panel Sill Replacement (Conventional Concrete Demo)

Remove 2'-0" of existing sill, replace w/ 9" thick precast panels bolted thru to existing concrete, under grout and grout joints.

Refer to Plate No. 9

Quantities are per Sill

	Item Description	Eng Quantity	Eng Unit	SI Quantity	SI Unit	English Unit Price	SI Unit Price	Amount	Cont.	Total Cost
1	Concrete Removal	165	cy	126	m3	$850.00	$1,110.00	$140,250.00	30%	$182,325.00
2	Precast Concrete Panels									
2a	Concrete	17	cy	13	m3	$800.00	$1,050.00	$13,600.00	25%	$17,000.00
2b	Reinforcing Steel	6,861	lbs	3112	kg	$1.00	$2.20	$6,861.00	25%	$8,576.25
2c	Base Grout	77	cf	2.18	m3	$12.00	$420.00	$924.00	25%	$1,155.00
2d	Joints Grout	2	cf	0.06	m3	$15.00	$500.00	$30.00	25%	$37.50
3	Seal Steel (ss)	2,785	lbs	1263	kg	$12.00	$26.00	$33,423.96	25%	$41,779.95
4	Misc Steel							$0.00	25%	$0.00
4a	1" Dia Anchor Bolts w/ nuts (4'-1.5" Long)	84	ea			$250.00		$21,000.00	25%	$26,250.00
4b	1" Dia Threaded Rods w/ nuts & washers (2'-0" long)	24	ea			$130.00		$3,120.00	25%	$3,900.00
4c	Plates etc.	1,351	lbs	613	kg	$10.00	$22.00	$13,510.00	25%	$16,887.50
4d	1/4" Dia Headed Concrete Achors (2-11/16" long)	24	ea			$15.00		$360.00	25%	$450.00
								Total/Sill		$298,361.20
								Total/Sill Rounded		$298,000.00
								12 Sills Total		$3,576,000.00
	Dewaterings	4	ea			$30,000.00		$120,000.00	25%	$150,000.00
	Mob/Demob inside Panama	4	ea			$10,000.00		$40,000.00	25%	$50,000.00
								Total		$3,776,000.00

Total Construction Cost, Rounded **$3,780,000**

Construction Duration per Dewatering	
Dewatering	2 days
Demolition	4 days
Steel/Concrete Placement	2 days
Cleanup/Flooding	1 day
Total	9 days

PROJECT:	Panama Canal Miter Gate Study	Est By:	crc
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COST LEVEL:	December 2001	Filename:	EV\PANAMA\[sillsup.xls]Chain Fender Sills (2)
		Date:	4/10/2002

Cast-In-Place Miter Sills (Conventional Concrete Demo)

Remove 2'-0" of existing sill, install dowels, reinforcing, and seal steel, place 10.5" of 4000 psi concrete.

Refer to Plate No. 6

Quantities are per Sill

	Item Description	Eng Quantity	Eng Unit	SI Quantity	Si Unit	English Unit Price	SI Unit Price	Amount	Cont	Total Cost
1	Concrete Removal	165	cy	126	m3	$850.00	$1,110.00	$140,250.00	30%	$182,325.00
2	CIP Concrete							$0.00	25%	$0.00
2a	Concrete	20	cy	15	m3	$500.00	$670.00	$10,000.00	25%	$12,500.00
2b	Reinforcing Steel	1,756	lbs	797	kg	$1.00	$2.20	$1,756.00	25%	$2,195.00
3	Dowels									
3a	Drill 7/8" Dia Holes	412	lf	126	m	$45.00	$147.00	$18,540.00	25%	$23,175.00
3b	Dowels (#6 bar)	1,031	lbs	468	kg	$2.50	$5.50	$2,576.88	25%	$3,221.09
4	Seal Steel (SS)	4,481	lbs	2033	kg	$12.00	$26.50	$53,774.40	25%	$67,218.00
5	Misc Steel							$0.00	25%	$0.00
5a	1" Dia Anchor Bolts; Drill and Epoxy Grout - (3'-0" Long)	64	ea			$150.00		$9,600.00	25%	$12,000.00
5b	1" Hvy Hex Nuts & Washers	128	ea			$5.00		$640.00	25%	$800.00
								Total/Sill		$303,434.09
								Total/Sill Rounded		$303,000.00
								12 Sills Total		$3,636,000.00
	Dewaterings	4	ea			$30,000.00		$120,000.00	25%	$150,000.00
	Mob/Demob inside Panama	4	ea			$10,000.00		$40,000.00	25%	$50,000.00
								Total		$3,836,000.00

Total Construction Cost, Rounded **$3,840,000**

Construction Duration per Dewatering	
Dewatering	2 days
Demolition	4 days
Steel/Concrete Placement	2-3 days
Cleanup/Flooding	1 day
Total	9-10 days

PROJECT: Panama Canal Miter Gate Study
LOCATION: Panama Canal
COST LEVEL: December 2001

Est By: crc
Checked: pgb
Filename: E\PANAMA\[sillsup.xls]Chain Fender Sills (2)
Date: 4/10/2002

Cast-In-Place Sills (Alternative "A") (Conventional Concrete Demo)

Remove 1'-0" from existing sill, sawcut 2'-0" wide x 1'-0" deep across sealing edge of sill, remove concrete and embedded steel, place new steel and concrete.

Refer to Plate No. 7
Quantities are per Sill.

	Item Description	Eng Quantity	Eng Unit	SI Quantity	SI Unit	English Unit Price	SI Unit Price	Amount	Cont	Total Cost
1	Concrete Removal									
1a	Concrete Demo	88	cy	67	m3	$850.00	$1,120.00	$74,970.00	35%	$101,209.50
1b	Concrete Demo	9	cy	7	m3	$1,000.00	$1,300.00	$9,100.00	35%	$12,285.00
2	CIP Concrete									
2a	Concrete	8	cy	6.1	m3	$500.00	$660.00	$4,000.00	25%	$5,000.00
2b	Reinforcing Steel	1,756	lbs	797	kg	$1.00	$2.20	$1,756.00	25%	$2,195.00
3	Dowels									
3a	Drill 7/8" Dia Holes	135	lf	41	m	$45.00	$148.00	$6,075.00	25%	$7,593.75
3b	Dowels (#6 bar)	347	lbs	157	kg	$1.00	$2.20	$347.00	25%	$433.75
4	Seal Steel (SS)	4,481	lbs	2033	kg	$12.00	$26.50	$53,774.40	25%	$67,218.00
5	Misc Steel							$0.00	25%	$0.00
5a	1" Dia Anchor Bolts; Drill and Epoxy Grout - (3'-0" Long)	64	ea			$150.00		$9,600.00	25%	$12,000.00
5b	1" Hvy Hex Nuts & Washers	128	ea			$5.00		$640.00	25%	$800.00
								Total/Sill		$208,735.00
								Total/Sill Rounded		$209,000.00
								12 Sills Total		$2,508,000.00
	Dewaterings	4	ea			$30,000.00		$120,000.00	25%	$150,000.00
	Mob/Demob inside Panama	4	ea			$10,000.00		$40,000.00	25%	$50,000.00
								Total		$2,708,000.00

Total Construction Cost, Rounded **$2,710,000**

Construction Duration per Dewatering

Dewatering	2 days
Demolition	3 days
Steel/Concrete Placement	2 days
Cleanup/Flooding	1 day
Total	8 days

PROJECT:	Panama Canal Miter Gate Study	Est By:	crc
LOCATION:	Panama Canal	Checked:	pgb
COST LEVEL:	December 2001	Filename:	E:\PANAMA\[sillsup.xls]Chain Fender Sills (2)
		Date:	4/10/2002

Cast-In-Place Sills (Alternative "B") (Conventional Concrete Demo)

Remove 1'-0" from existing sill, sawcut 1'-2" wide x 1'-0" deep across sealing surface edge of sill, remove existing concrete & embedded metals, place new steel and concrete.

Refer to Plate No. 8

Quantities are per Sill.

	Item Description	Eng Quantity	Eng Unit	SI Quantity	SI Unit	English Unit Price	SI Unit Price	Amount	Cont	Total Cost
1	Concrete Removal									
1a	Concrete Demo	88	cy	67	m3	$850.00	$1,120.00	$74,970.00	35%	$101,209.50
1b	Concrete Demo	5	cy	4	m3	$1,200.00	$1,590.00	$6,360.00	35%	$8,586.00
2	Concrete	5	cy	4	m3	$500.00	$660.00	$2,650.00	25%	$3,312.50
3	Dowels									
3a	Drill 1-1/8" Dia Holes	135	lf	41	m	$50.00	$165.00	$6,750.00	25%	$8,437.50
3b	Drill 1-3/8" Dia Holes	210	lf	64	m	$60.00	$197.00	$12,600.00	25%	$15,750.00
3c	Dowels (#8 bar)	641	lbs	291	kg	$1.00	$2.20	$640.80	25%	$801.00
3d	Dowels (#10 bar)	1,291	lbs	586	kg	$1.00	$2.20	$1,290.90	25%	$1,613.63
4	Seal Steel (SS)	6,930	lbs	3143	kg	$12.00	$26.50	$83,160.00	25%	$103,950.00
5	Misc Steel							$0.00	25%	$0.00
5a	3/4" Dia Anchor Bolts w/double nut and washers (3.25' ea)	120	ea			$100.00		$12,000.00	25%	$15,000.00
5b	3/4" Dia x 6" Long splice bolts w/ nuts and washers	24	ea			$30.00		$720.00	25%	$900.00
								Total/Sill		$259,560.13
								Total/Sill Rounded		$260,000.00
								12 Sills Total		$3,120,000.00
	Dewaterings	4	ea			$30,000.00		$120,000.00	25%	$150,000.00
	Mob/Demob inside Panama	4	ea			$10,000.00		$40,000.00	25%	$50,000.00
								Total		$3,320,000.00

Total Construction Cost, Rounded **$3,320,000**

Construction Duration per Dewatering	
Dewatering	2 days
Demolition	3 days
Steel/Concrete Placement	2 days
Cleanup/Flooding	1 day
Total	8 days

PROJECT:	Panama Canal Miter Gate Study
LOCATION:	Panama Canal
COST LEVEL:	December 2001

Est By:	crc
Checked:	pgb
Filename:	O:\ED\EC-EV\PANAMA\[sillsup.xls]Chain Fender Sills (2)
Date:	4/10/2002

Miter Gate Bottom Extension

Refer to Plate No. 10
Quantities are per set of gate leafs.

	Item Description	Eng Quantity	Eng Unit	SI Quantity	SI Unit	English Unit Price	SI Unit Price	Amount	Cont	Total Cost
1	Mob/Demob	1	ls			$3,000.00		$3,000.00	25%	$3,750.00
2	Edge Bulb Seal	123	lf	37	m	$25.00	$83.00	$3,075.00	25%	$3,843.75
3	2-3/4" x 3/4" St Stl Clamping Bar	864	lbs	392	kg	$7.00	$15.40	$6,044.50	25%	$7,555.63
4	Angle (5x3.5x.5)	1,673	lbs	759	kg	$4.00	$8.80	$6,692.00	25%	$8,365.00
5	3/4" Dia x 6" long St. Stl Bolts w/ nuts and washers	60	ea			$25.00		$1,500.00	25%	$1,875.00
6	11/16" Single V-Groove (Field Weld	123	lf	37	m	$50.00	$166.00	$6,150.00	25%	$7,687.50
7	11/16" Single V-Groove (Shop Weld	123	lf	37	m	$35.00	$116.00	$4,305.00	25%	$5,381.25
	Bar Stock (2-3/4" x 11/16")	791	lbs	359	kg	$4.00	$8.80	$3,164.00	25%	$3,955.00
9	Bar Stock (3" x 3/4")	942	lbs	427	kg	$4.00	$8.80	$3,768.00	25%	$4,710.00
10	11/16" Plate (.5 SF/plate)	815	lbs	370	kg	$6.00	$13.20	$4,890.00	25%	$6,112.50
11	1/4" Fillet Weld (Field Weld)	84	lbs	38	kg	$12.00	$26.50	$1,008.00	25%	$1,260.00
12	1/4" Fillet Weld (Shop Weld)	24	lbs	11	kg	$8.00	$17.50	$192.00	25%	$240.00
13	2" x 1/2" Bar	247	lbs	112	kg	$4.00	$8.80	$986.00	25%	$1,232.50
14	Metalize	1	ls			$5,000.00		$5,000.00	25%	$6,250.00
15	Misc Field Work (handling/assembling)	1	ls			$8,000.00		$8,000.00	25%	$10,000.00
								Total/Set of leafs		$72,218.13
								Total/Set Rounded		$72,000.00
								12 Sets Total		$864,000.00
								Total		$864,000.00

Total Construction Cost, Rounded **$865,000**

PROJECT:	Panama Canal Miter Gate Study	Est By:	crc
LOCATION:	Panama Canal	Checked:	pgb
COST LEVEL:	December 2001	Filename:	O:\ED\EC-EV\PANAMA\[sillsup.xls]Chain Fender Sills (2)
		Date:	4/10/2002

Emergency Dam Sill Demolition

Miraflores Locks
Quantities are per sill. Total of two sills, one per lane.
A separate dewatering will have to be done to allow this work.

	Item Description	Eng Quantity	Eng Unit	SI Quantity	SI Unit	English Unit Price	SI Unit Price	Amount	Cont	Total Cost
1	Mob/Demob	1	ls			$5,000.00		$5,000.00	25%	$6,250.00
2	Dewater	1	Job			$30,000.00		$30,000.00	25%	$37,500.00
3	Concrete Demolition	178	cy	136	m3	$850.00	$1,110.00	$151,470.00	25%	$189,337.50

Total per sill	$233,087.50
Total per sill rounded	$233,000.00
2 sills total	$466,000.00
Total	$466,000.00

Total Construction Cost, Rounded **$470,000**

PROJECT: Panama Canal Miter Gate Study
LOCATION: Panama Canal
COST LEVEL: December 2001

Est By: crc
Checked: pgb
Filename: O:\ED\EC-EV\PANAMA\[sillsup.xls]Chain Fender Sills (2)
Date: 4/10/2002

Chain Fender Sills

Pedro Miguel - Miraflores Lake Side
Quantities are per sill. Total of two sills, one per lane.
This work will be done in the wet.

	Item Description	Eng Quantity	Eng Unit	SI Quantity	SI Unit	English Unit Price	SI Unit Price	Amount	Cont	Total Cost
1	Mob/Demob	1	ls			$15,000.00		$15,000.00	25%	$18,750.00
2	Concrete Demolition (In the wet)	51	cy	39	m3	$2,200.00	$2,880.00	$112,200.00	25%	$140,250.00

Total per sill	$159,000.00
Total per sill rounded	$159,000.00
2 sills total	$318,000.00
Total	$318,000.00

Total Construction Cost, Rounded **$320,000**

PROJECT:	Panama Canal Miter Gate Study	Est By:	crc
LOCATION:	Panama Canal	Checked:	pgb
COST LEVEL:	December 2001	Filename:	O:\ED\EC-EV\PANAMA\[sillsup.xls]Chain Fender Sills (2)
		Date:	4/10/2002

Chain Fender Sills: Between Miter Gates

Pedro Miguel - Between Miter Gates 54 - 57 and 58 - 61
Quantities are per sill. Total of two sills, one per lane.
Concrete Demolition to be concurrent with other work.
Chamber dewatering covered in the cost of this other lock work.

	Item Description	Eng Quantity	Eng Unit	SI Quantity	SI Unit	English Unit Price	SI Unit Price	Amount	Cont	Total Cost
1	Mob/Demob	1	ls			$5,000.00		$5,000.00	25%	$6,250.00
2	Concrete Demolition	43	cy	33	m3	$850.00	$1,100.00	$36,380.00	25%	$45,475.00

Total per sill	$51,725.00
Total per sill rounded	$52,000.00
2 sills total	$104,000.00
Total	$104,000.00

Total Construction Cost, Rounded **$105,000**

Appendix 6. – Quantities

COMPUTATION SHEET

US Army Corps of Engineers
Ohio River Division

Computed by JET Date 12-9-01

Checked by Date

Subject PANAMA MITER GATE STUDY

Computation MITER GATE EXTENSION (PER SET OF GATE LEAFS)

EDGE BULB SEAL (SIMILAR OR EQUAL TO BUCKHORN RUBBER PRODUCTS, INC., MOLD #2990)

61.5 LF PER GATE LEAF × 2 LEAFS = 123 LF

2 3/4" × 3/4" ST. STL. CLAMPING BAR → 123 LF × 7.02 #/LF = 863.5 LBS

ANGLE → L 5 × 3 1/2 × 1/2" ⇒ 123 LF × 13.6 #/LF = 1,673 LBS

60 – 3/4" ø × 6" LONG ST. STL. BOLTS W/NUTS & WASHERS

123 LF OF 11/16" SINGLE V-GROOVE → FIELD WELD

123 LF " " " " " → SHOP WELD

123 LF OF 2 3/4" × 11/16" BAR STOCK ⇒ 123 × 6.43 #/LF = 791 LBS

123 LF OF 3" × 3/4" " " ⇒ 123 × 7.66 #/LF = 942 LBS

11/16" PLATE → .5 SF/PL × 58 EA (29/LEAF) = 29 SF × 28.1 #/SF

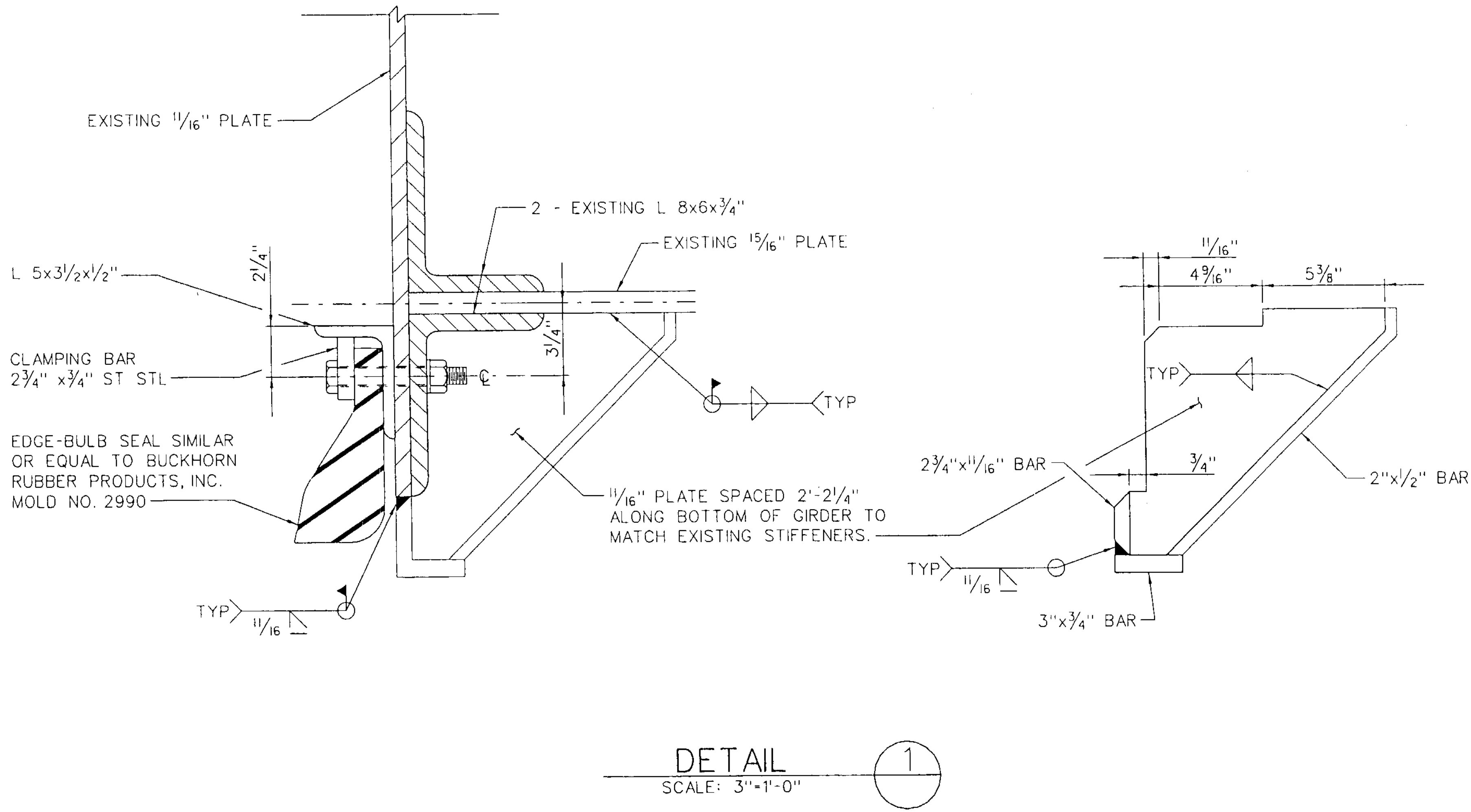
= 815 LBS

1/4" FILLET WELD ⇒ 3.2 LF (SHOP) PER PL × 58 EA = 186 LF

3.2 LF (FIELD) PER PL × 58 EA = 186 LF

2" × 1/2" BAR ⇒ 1.25 LF/PL × 58 PL'S = 72.5 LF × 3.4 #/LF = 246.5 LBS

* METALIZE ALL EXPOSED SURFACES (EXCLUDING ST. ST. & BULB SEAL



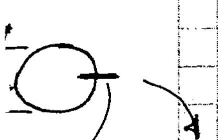
DETAIL

SCALE: 3"=1'-0"

COMPUTATION SHEET	Page 1 of 2 Pages
US Army Corps of Engineers, Ohio River Division	Computed by SET Date 11-29-01
Subject: PANAMA CANAL - MITER GATE STUDY	Checked by Date
Computation: CAST-IN-PLACE MITER SILL (PER SILL QUANTITIES)	

PROCEDURE: REMOVE 2'-0" OF EXISTING SILL, INSTALL DOWELS, REINFORCING, AND SEAL STEEL, PLACE 10½" ± (4,000 PSI) CONCRETE.

—3"ϕ CORE



AMOND
IRE SAW
CENTER OF
℄ (-1½")

REMOVAL: * (SEE REMOVAL BREAKDOWN @ BACK OF PACKAGE)

2346.5131 SF (EXISTING) × 2'-0" = 4,693 CF OR 174 CY/SILL

ACTUAL ⇒ 2346.5131 SF × 1'-10½" = 4400 CF OR 163 CY

DOWELS: #6 BENT BARS — 183 REQUIRED, EPOXY GROUT-IN

DRILL 183 – ⅞"ϕ HOLES @ 2.25 LF EACH = 411.75 LF/SILL

183 – #6 DOWELS @ 5.6325 #/DOWEL = 1,030.75 LBS/SILL

REINFORCING: #6 STEEL @ 1'-0" C-C

2 BARS	@ 3.4'	=	6.8'
2 "	@ 4.2'	=	8.4'
10 "	@ 60.9'	=	609.0'
2 "	@ 4.3'	=	8.6'
2 "	@ 2.2'	=	4.4'
2 "	@ 5.0'	=	10.0'
116 "	@ 4.5'	=	522.0'

1,169.2 LF @ 1.502 #/LF = 1,756 LBS/SILL

SILL SEAL STEEL =

64 – 1"ϕ BOLTS → DRILL & EPOXY GROUT (3'-0" × 1⅛"ϕ) × 64 = 192 LF

128 – 1" HVY. HEX NUTS & WASHERS

122.5 LF – 8" × ½" THICK PL (ST. STL.)
122.5 LF – 12" × ½" THICK PL (ST. STL.)
} SHOP WELD TOGETHER TO FORM 8" ∠ 12" ANGLE – ½" SINGLE BEVEL WELD

122.5 LF × 13.6 #/LF = 1,666 LBS.

122.5 LF × 20.4 #/LF = 2,499 LBS.

US Army Corps of Engineers, Ohio River Division	COMPUTATION SHEET	Page 2 of 2 Pages
	Subject: PANAMA CANAL MITER GATE STUDY	Computed by: GET — Date: 11-29-01
		Checked by: — Date:
	Computation: CAST-IN-PLACE MITER SILL	

SILL SEAL (CONT'D)

62 — 6" x 6" x 1/2" THICK GUSSET PL'S (ST. STL) (.1241 SF EACH)

WELD GUSSET PL'S TO 8" x 12" ANGLE = 2 LF/PL x 62 GUSSET PL'S

= 124 LF OF 5/16" FILLET WELD

→ 31 LF OF 6" x 1/2" PL

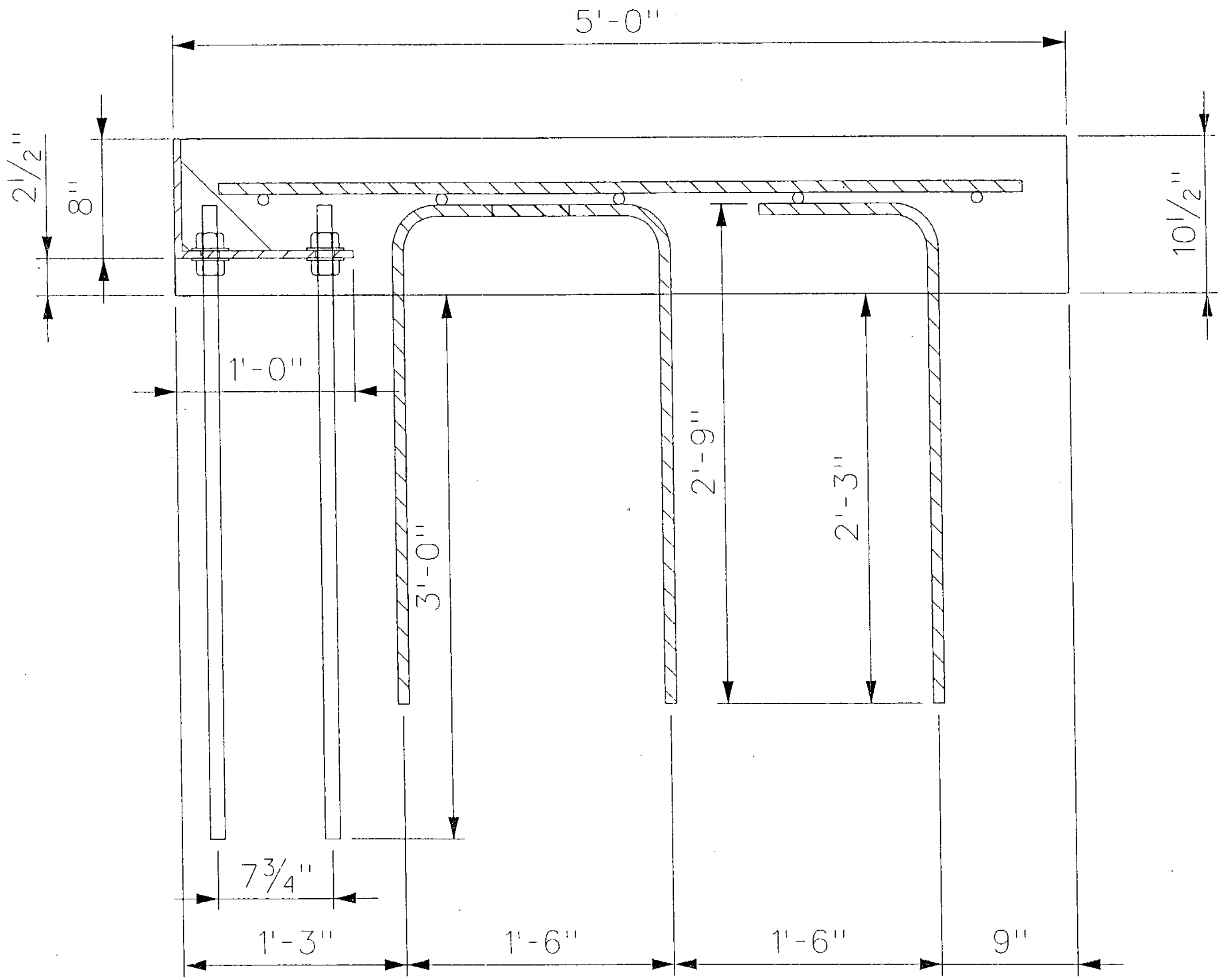
31 LF x 10.2 #/LF = 316.2 LBS

CONCRETE =

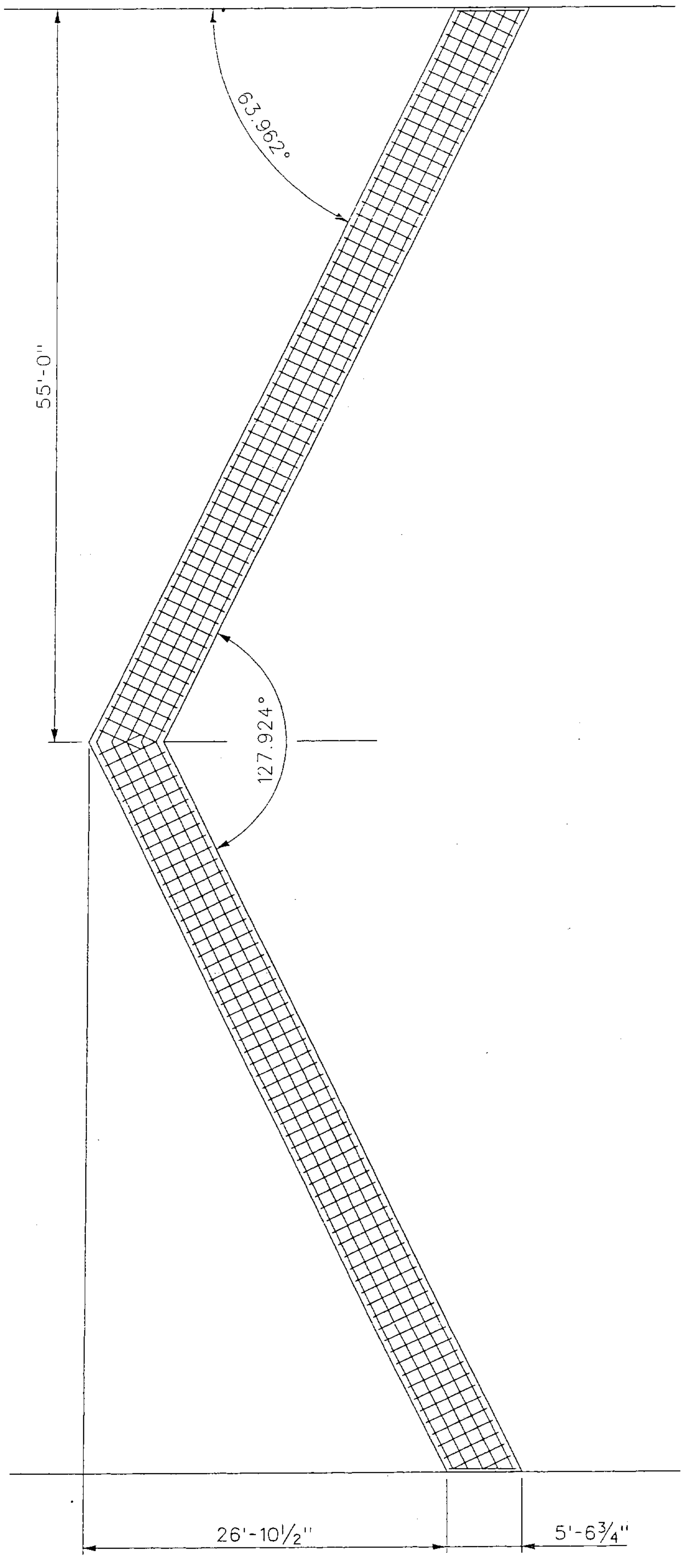
612.1294 SF x 10.5" = 535.61 CF OR 19.84 CY

612.1294 SF x 1'-0" = 612.1294 CF OR 22.67 CY

± 25 CY TOTAL/SILL



TYPICAL SECTION
C.I.P. SILL REPLACEMENT



63.962°
55'-0"
127.924°
26'-10½"
5'-6¾"

12-10-01
JET

Removals (ea sill)

CATION		SF	2'-0"	Alt "A" (+9)	Alt "B" (+5)
SATUN	13-16	2346.5	174 cy	96 cy	92 cy
	17-20	2346.5	174 cy	96 cy	92 cy
?.M.	54-57	1470.17	109 cy	64 cy	60 cy
	58-61	1971.73	146 cy	82 cy	78 cy
2-65	~~6[illegible]~~	2616.14	194 cy	106 cy	102 cy
	66-69	2524.5	187 cy	94 cy	90 cy
		13,275.54	984 cy	538 cy	514 cy
AVG's		2,212.6 sf	164 cy	90 cy	86 cy

US Army Corps of Engineers
Ohio River Division

COMPUTATION SHEET

Computed by JET Date 12-3-01
Checked by Date

Subject: PANAMA MITER GATE STUDY
Computation: CAST-IN-PLACE SILL – ALTERNATIVE "A"

PROCEDURE: DIAMOND-WIRE SAWCUT 1'-0" FROM EXISTING SILL, SAWCUT 2'-0" WIDE × 1'-0" DEEP ACROSS SEALING EDGE OF SILL, REMOVE CONCRETE & EMBEDDED STEEL, PLACE BACK STEEL & CONCRETE

REMOVAL = 2381.14 SF × 1'-0" = 2381.14 CF or 88.2 CY

2'-0" WIDE × 1'-0" DEEP × 123.0 LF = 246 CF = 9.1 CY

*(SEE REMOVAL BREAKDOWN @ BACK OF PACKAGE) 97.3 CY

DOWELS:

60 – #6 BENT BARS @ 3.85 LF EA. × 1.502 #/LF = 347 LBS

DRILL 60 – 7/8" ϕ HOLES, GROUT/EPOXY IN

REINFORCEMENT: #6 @ 12" C-C

124 – 1.5' BARS =
4 @ 61.21' =

22

SILL SEAL STEEL

64 – 1"ϕ BOLTS → DRILL & EPOXY GROUT (3'-0" × 1 1/8"ϕ) × 64 = 192 LF
128 – 1" HVY. HEX NUTS & WASHERS

122.5 LF – 8" × 1/2" THICK PL (ST. STL.)
122.5 LF – 12" × 1/2" THICK PL (" ")
} SHOP WELD TO FORM 8" × 12" ANGLE. USE 1/2" SINGLE BEVEL

→ 122.5 × 13.6 #/LF = 1,666 LBS.

→ 122.5 × 20.4 #/LF = 2,499 LBS.

62 – 6" × 6" × 1/2" GUSSET PL (ST. STL.) – .1241 SF EA
31 LF OF 6" × 1/2" PL ⇒ 31 × 10.2 #/LF = 316.2 LBS.

WELD GUSSET PL TO 8" × 12" ANGLE = 2 LF/PL × 62 PL's = 124 LF OF 5/16" FILLET WELD

ORD Form 427
1 Feb 87

US Army Corps of Engineers
Ohio River Division

COMPUTATION SHEET

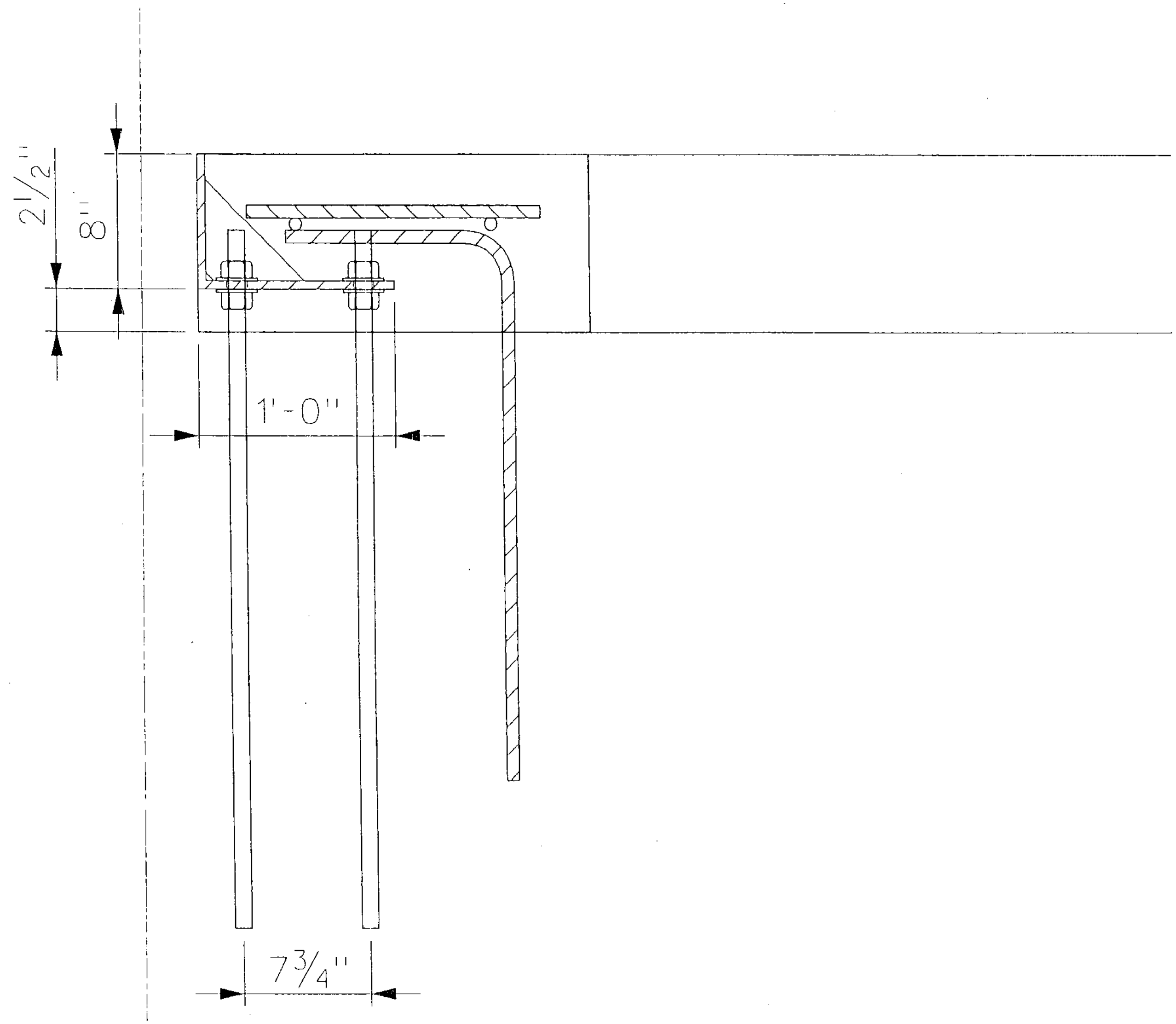
Computed by JET Date 12-4-01
Checked by Date

Subject: Panama Miter Gate Study

Computation: Cast-in-Place Sill – Alternative "A"

Concrete

245.9675 SF × 10 1/2" THICK = 215.22 CF or 8 CY



TYPICAL SECTION
C.I.P. SILL REPLACEMENT,
ALTERNATIVE "A"

12-10-01
JET

REMOVALS (EA SILL)

LOCATION		SF	2'-0"	ALT "A" (+9)	ALT "B" (+5)
SATUN	13-16	2346.5	174 cy	96 cy	92 cy
	17-20	2346.5	174 cy	96 cy	92 cy
P.M.	~~55~~ 54-57	1470.17	109 cy	64 cy	60 cy
	58-61	1971.73	146 cy	82 cy	78 cy
	62-65 ~~[illegible]~~	2616.14	194 cy	106 cy	102 cy
	66-69	2524.5	187 cy	94 cy	90 cy
		13,275.54	984 cy	538 cy	514 cy
AVG'S =		2,212.6 sf	164 cy	90 cy	86 cy

US Army Corps of Engineers, Ohio River Division	COMPUTATION SHEET	Page 1 of 2 Pages
	Subject: PANAMA CANAL - MITER GATE STUDY	Computed by SET Date 12-05-01
		Checked by Date
	Computation: CAST-IN-PLACE MITER SILL - ALTERNATIVE "B"	

PROCEDURE: DIAMOND-WIRE SAWCUT 1'-0" FROM EXISTING SILL, SAWCUT 1'-2" WIDE x 1'-0" DEEP ACROSS SEALING SURFACE EDGE OF SILL, REMOVE EXISTING CONCRETE & EMBEDDED METALS, PLACE BACK STEEL & CONCRETE

REMOVAL: 2381.14 SF x 1'-0" = 2381.14 CF or 88.2 cy

1'-2" WIDE x 1'-0" DEEP x 123 LF = 143.5 CF or 5.3 cy

* (SEE REMOVAL BREAKDOWN @ BACK OF PACKAGE)

94 cy

DOWELS: 60 - #8 DOWELS @ 4'-0" = 240 LF @ 2.67#/FT = 640.8#

60 - #10 DOWELS @ 5'-0" = 300 LF @ 4.303#/FT = 1290.9#

1932 LBS.

DRILL & GROUT { 60 - 1 1/8"ϕ x 2.25 FT = 135 LF
60 - 1 3/8"ϕ x 3.5 FT = 210 LF }

REINFORCING: NONE - DOWELS & ANCHORS ONLY

SILL SEAL STEEL:

ANGLE: (8 x 6 x 3/4") x 33.8#/FT x 123 LF = 4,157 LBS

(6 x 4 x 7/16") x 14.3#/FT x 4 1/2" x 60 = 321.75#

(5 x 3 1/2 x 7/16") x 12.0#/FT x 4 1/2" x 60 = 270.0#

ST. STL. PL ⇒ (5 5/8" x 3/8") x 123 LF x 7.18#/FT = 883.14 LBS

" " " ⇒ (7 5/8" x 3/8") x 123 LF x 9.75#/FT = 1199.25 LBS.

GUSSET PL @ SPLICES ⇒ DEPENDS ON HOW MANY SPLICES; ASSUME EVERY 10' SPLICE = 12 SPLICES

4 1/2" x 6 1/2" x 1/2" PL x 24 PLATES =

(4 1/2 x 1/2")(7.66#/FT)(.5417 FT) x 24 = 99.6 LBS

ORD Form 427
1 Feb 87

US Army Corps of Engineers
Ohio River Division

COMPUTATION SHEET

Computed by GET Date 12-5-01
Checked by Date

Subject PANAMA MITER GATE STUDY

Computation CAST-IN-PLACE SILL — ALTERNATIVE "B"

SILL SEAL STEEL CONT'D

WELD → 123 LF × 3 of 3/8" ST. STL. WELD = 369 LF

12 SPLICES @ 1.3 LF/SPLICE × 1/4" = 15.6 LF OF 1/4" V-GROOVE ST. STL WELD

12 – 1/4" FILLET @ 11" EA = 11 LF

12 – 1/4" SINGLE BEVEL @ 11" EA = 11 LF

1/4" FILLET WELD (7018 ROD) FOR ADJUSTING ANGLES TO SEAL ANGLE

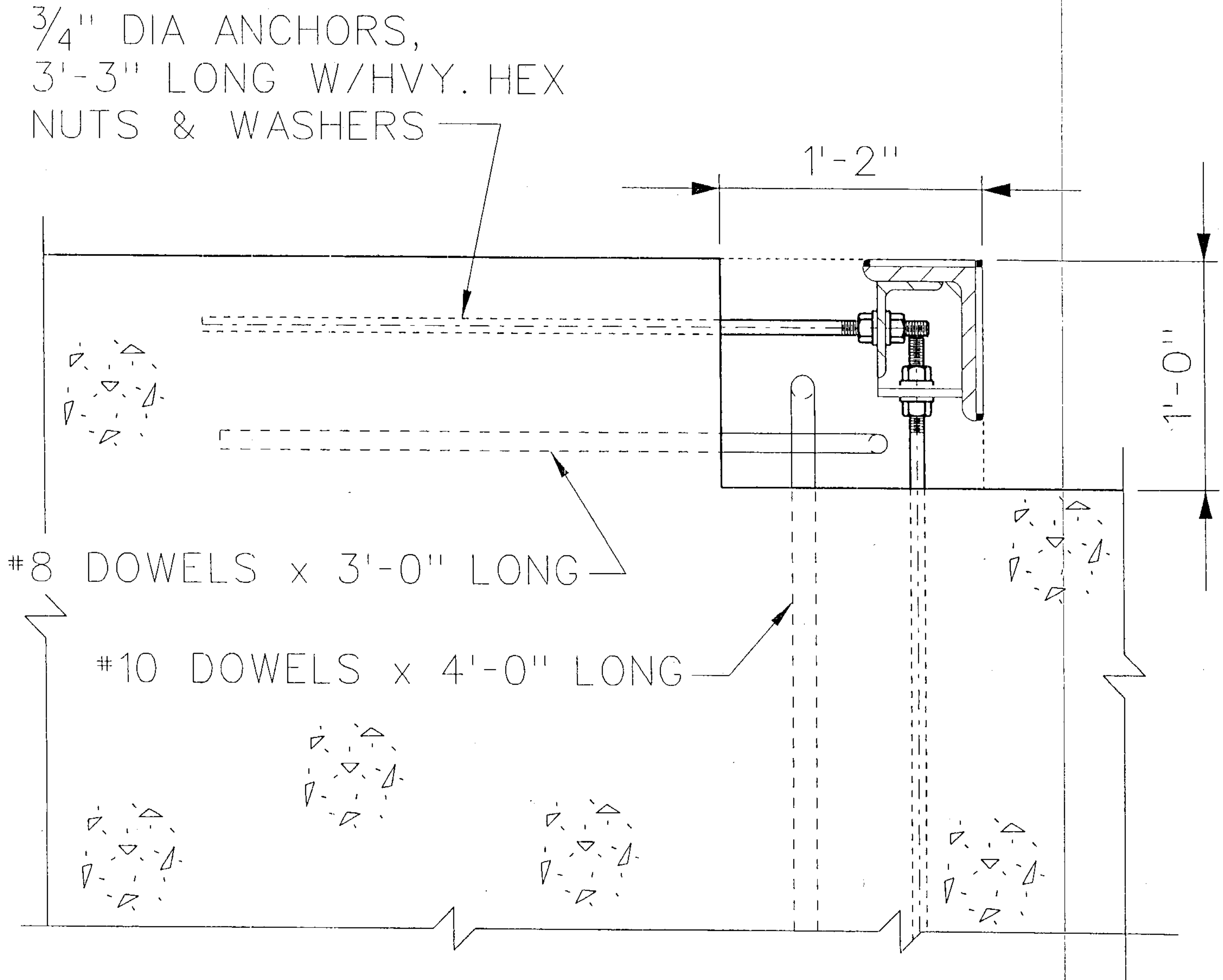
5 × 3 1/2" ∠ = 16" EA × 60 = 80 LF

6" × 4" ∠ = 18" EA × 60 = 90 LF

120 – 3/4" φ ANCHOR BOLTS W/DOUBLE NUT & WASHERS, 3.25' EA

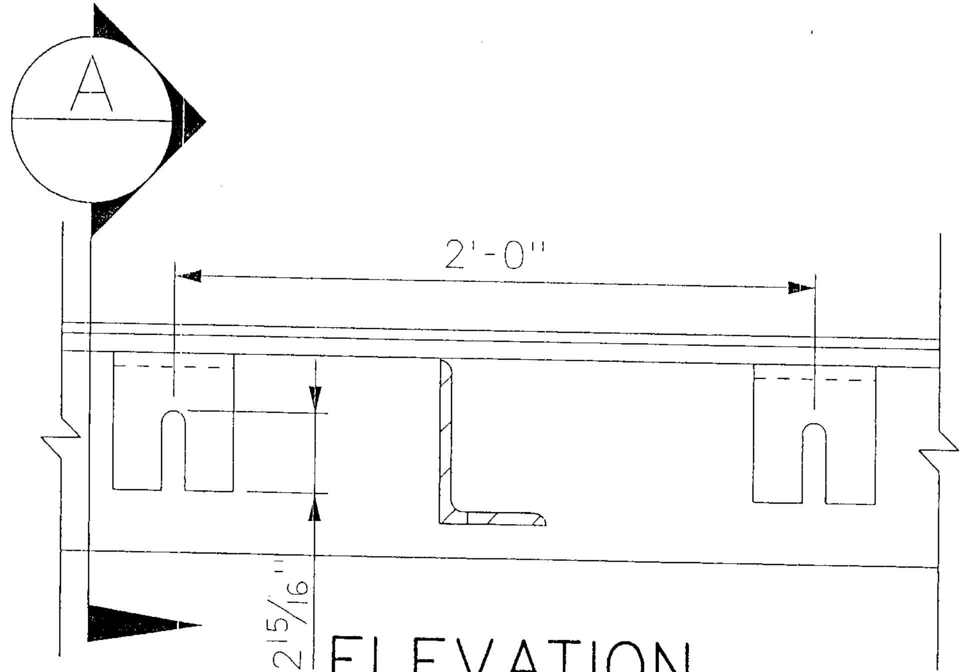
24 – 3/4" φ × 6" LONG SPLICE BOLTS W/NUTS & WASHERS

CONCRETE 143.4 SF × 1'-0" DEEP = 143.4 CF = 5.3 CY



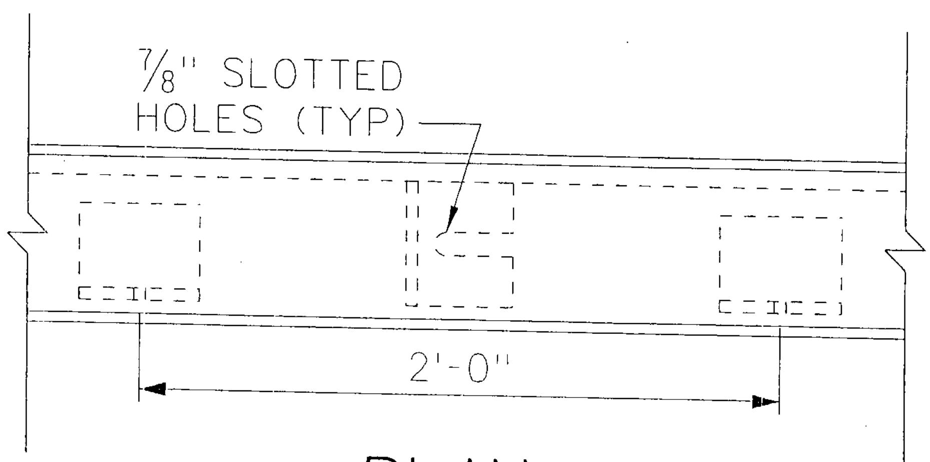
SECTION THRU SILL

SCALE: 1" = 1'-0"



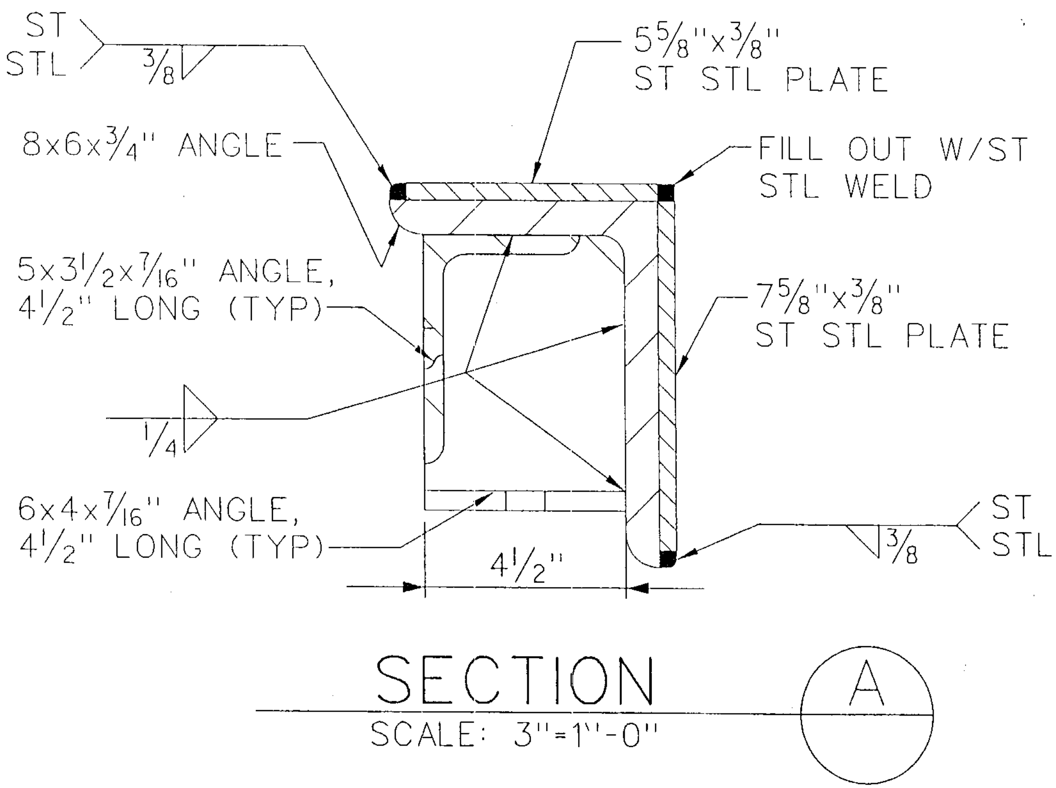
ELEVATION

SCALE: 1½" = 1'-0"



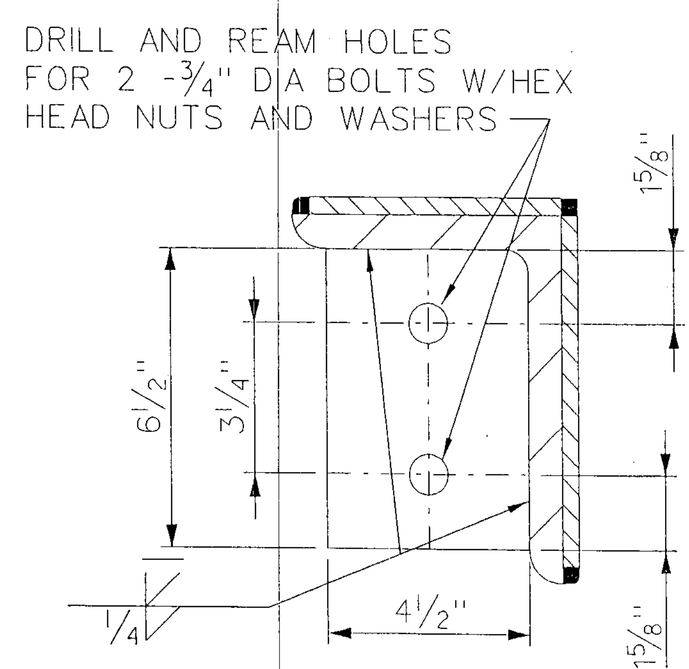
PLAN

SCALE: 1½" = 1'-0"



SECTION

SCALE: 3"=1'-0"



TYPICAL SPLICE

SCALE: 3" = 1'-0"

12-10-01
JET

REMOVALS (EA SILL)

:ATION		SF	2'-0"	ALT "A" (+9)	ALT "B" (+5)
?ATUN	13-16	2346.5	174 cy	96 cy	92 cy
	17-20	2346.5	174 cy	96 cy	92 cy
?.M.	~~5~~ 54-57	1470.17	109 cy	64 cy	60 cy
	58-61	1971.73	146 cy	82 cy	78 cy
	.2-65 ~~6[illegible]~~	2616.14	194 cy	106 cy	102 cy
	66-69	2524.5	187 cy	94 cy	90 cy
		13,275.54	984 cy	538 cy	514 cy
AVG'=		2,212.6 sf	164 cy	90 cy	86 cy

US Army Corps of Engineers
Ohio River Division

COMPUTATION SHEET

Computed by JET Date 12-3-01
Checked by - Date

Subject: PANAMA CANAL MITER GATE STUDY

Computation: PRECAST PANEL SILL REPLACEMENT (PER SILL QUANTITIES)

PROCEDURE: REMOVE 2'-0" OF EXISTING SILL, REPLACE W/ 9" THICK PRECAST PANELS BOLTED THRU TO EXISTING CONCRETE, UNDER GROUT & GROUT JOINTS.

REMOVAL: 2381.14 SF/SILL × 2'-0" = 4,762.28 CF OR 176 CY

OPTION: DIAMOND WIRE SAW THRU 3" CORES

2381.14 SF/SILL × 1'-10½" = 4,464.64 CF OR 165 CY

* (SEE REMOVAL BREAKDOWN @ BACK OF PACKAGE)

PRECAST PANELS: DOUBLE-MAT OF #6 REINFORCING, LEVELING DEVICES, 1" ϕ ANCHORS, 9" THICK CONCRETE W/KEYS @ ENDS, ST. STEEL CHANNEL SEAL SURFACE

4 - 20'-0" PANELS } PER SILL
2 - 21'-4" PANELS }

REINFORCEMENT

20'-0" PANELS

10 BARS @ 19.441' = 194.41 FT × 1.502 #/FT = 292 LBS
36 BARS @ 5.0312' = 181.12 FT × 1.502 #/FT = 272 LBS

376 FT/PANEL — 564 LBS/PANEL

× 4 PANELS — × 4 PANELS

1,504 FT — 2,256 LBS

21'-4" PANELS

10 BARS @ 20.7696 = 207.70 FT × 1.502 #/FT = 312 LBS
38 BARS @ 5.0312 = 191.19 FT × 1.502 #/FT = 287 LBS

398.89 FT — 599 LBS

× 2 PANELS — × 2 PANELS

798 FT — 1,198 LBS.

2,302 FT/SILL — 3,454 LBS/SILL

12-10-10
JET
ADD RESTEEL @ W/ ANCHORAGES - 6'-4½" EA ANCHOR
× 1.502 #/LF
27 LF × 84 ANCHORS = 3406.54 LBS
= 3,407 LBS

COMPUTATION SHEET

US Army Corps of Engineers
Ohio River Division

Computed by JET Date 12-3-01
Checked by Date

Subject: PANAMA CANAL MITER GATE STUDY

Computation: PRECAST PANEL SILL REPLACEMENT (PER SILL QUANTITIES)

SEAL STEEL: C9x20 STAINLESS STEEL, 3/8" THICK STRAPS

CHANNEL
122'-8" OF C9x20 ST. STL @ 20 #/FT = 2,453.33 #/SILL

ANCHOR STRAPS
2" WIDE x 3/8" THICK x 1'-8" LONG
78 STRAPS x 2.55 LB/LF x 1.6667 FT = 332 LBS/SILL
46 LF OF 1/4" FILLET WELD

MISC. STEEL: 1" φ ANCHORS, 1" φ THREADED BAR, 1/2" THICK PLATE, 1" I.D. THREADED PIPE SLEEVES, 1/4" FILLET WELD, NELSON STUDS

84 - 1" φ ANCHOR BOLTS w/NUTS & WASHERS (4'-1 1/2" LONG EACH)
24 - 1" φ THREADED ROD w/NUTS & WASHERS (2'-0" LONG EACH)
11 LF OF 1 1/4" ID THREADED PIPE (X-STRONG) = 33 LBS
4" φ PLATE x 1/2" x 24 EA = 163 LBS
12" SQUARE PL x 1/2" x 24 EA = 490 LBS
~~6 3/4" SQUARE PL x 1/2" x 84 EA = 966 LBS~~

12-10-01 JET
ANCHOR EMBED DETAIL 1
.3593 x 4 = 1.4372 LF
.2916 x 4 = 1.1664 LF
.2083 x 4 = .8332 LF
} 3.4365 SAY 3.5 LF/embed ~~617~~ LBS OF 1/2" PL (GRADE 50)
x84
294 LF x 20.4 #/LF = 5998 LBS TOTAL = 6651 LBS

24 - 1/4" φ HEADED CONC. ANCHORS (NELSON STUDS), 2 11/16" LONG EA.
125 LF OF 1/4" FILLET WELD

US Army Corps of Engineers
Ohio River Division

Subject: PANAMA MITER GATE STUDY

Computation: PRECAST PANEL SILL REPLACEMENT

Computed by: JET Date: 12-3-01

Checked by: Date:

CONCRETE & GROUT

CONCRETE
4 PANELS @ 20' x 5' x 9" THICK = 300 cf = 11.11 cy
2 PANELS @ 21'-4" x 5' x 9" " = 160 cf = 5.93 cy

17 cy / SILL

BASE GROUT > 614.92 sf x 1½" THICK = 77 cf

JOINTS → 4 JOINTS @ .0729 sf x 5.5625 = 1.62 cf
2 JOINTS @ .03645 sf x 5.5625 = .40 cf
2.0 cf

FILL RECESSES ⇒

LEVELING/PICKING ⇒ 4½" ϕ TO 6¾" ϕ, 3" DEEP

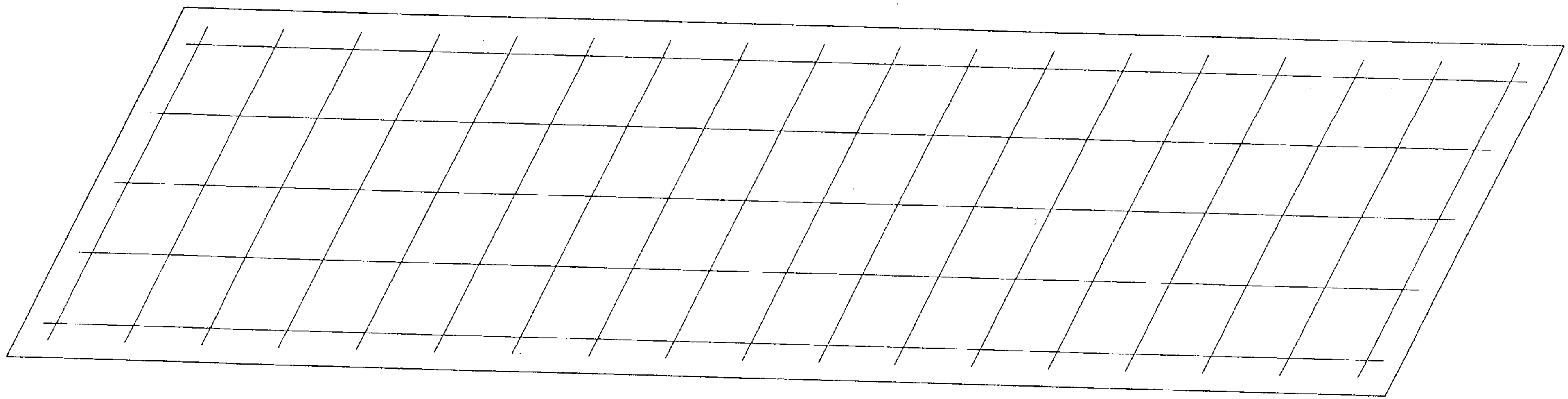
$$\left(\frac{.11045 + .2485}{2}\right) .25 = .04 \text{ cf EA} \times 24 \text{ EA} = 1 \text{ cf}$$

ANCHOR RECESSES ⇒ 4½" SQ. to 6¾" SQ, 3" DEEP

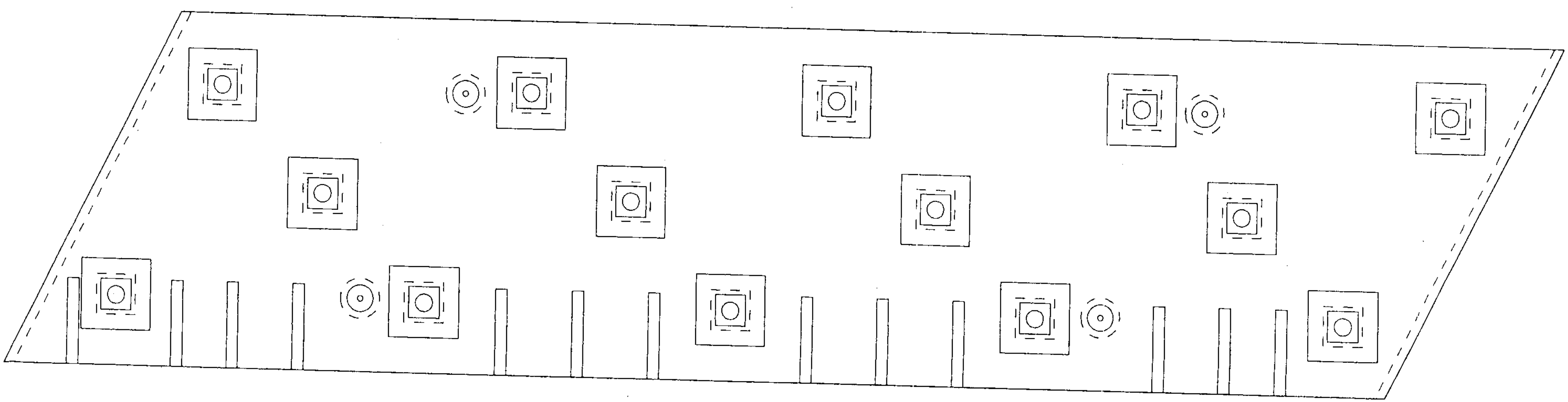
$$\left(\frac{.14063 + .31641}{2}\right) .25 = .06 \text{ cf EA} \times 84 \text{ EA} = 5 \text{ cf}$$

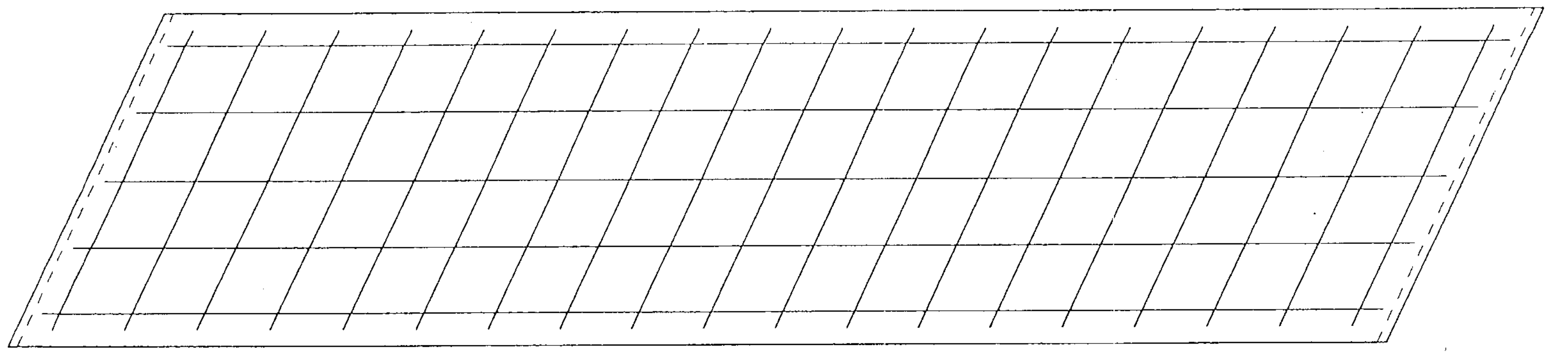
DRILL & EPOXY GROUT ANCHORS 84 – 1⅛" ϕ HOLES x (3' LONG)

$$84(.00690)(3) = 1.74 \text{ cf} = 2 \text{ cf}$$

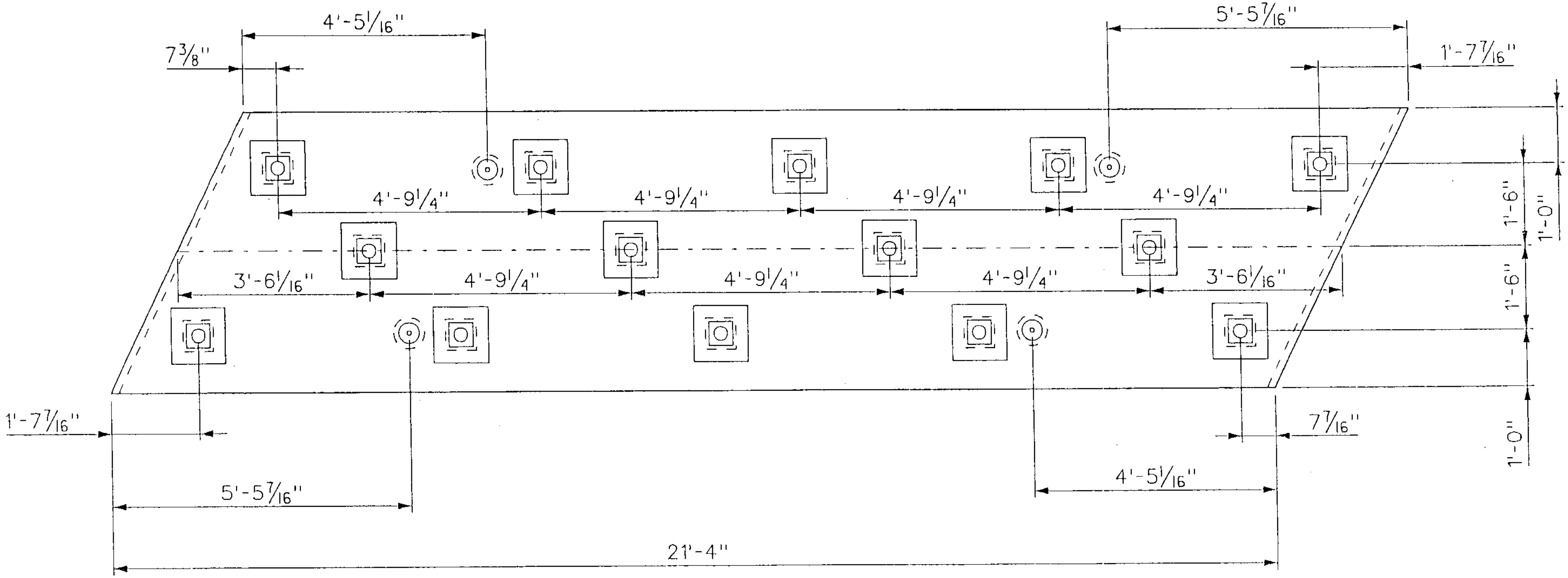


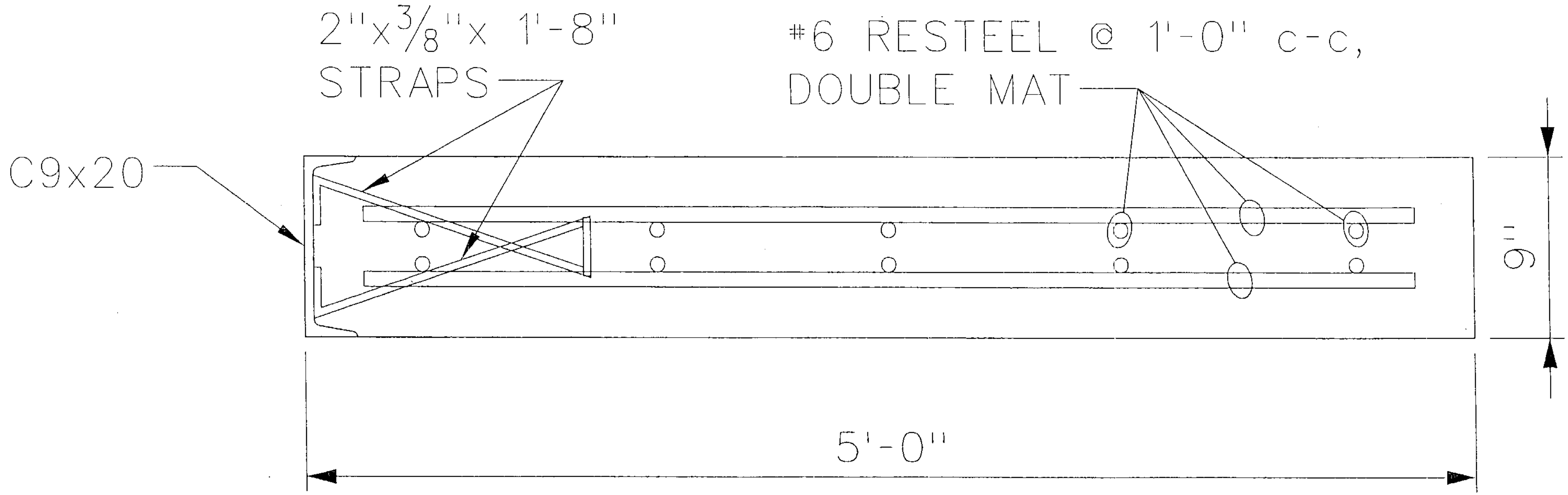
TYPICAL 20' PANEL



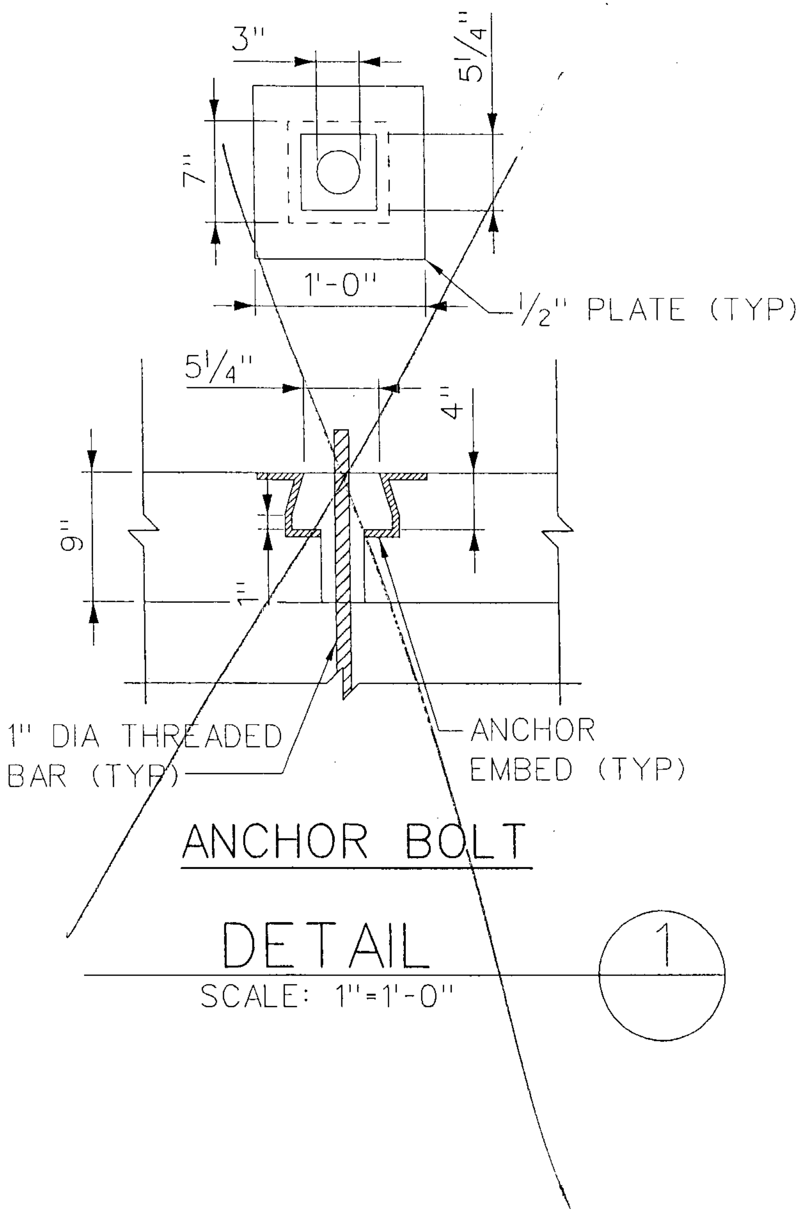


TYPICAL 21'-4" PANEL



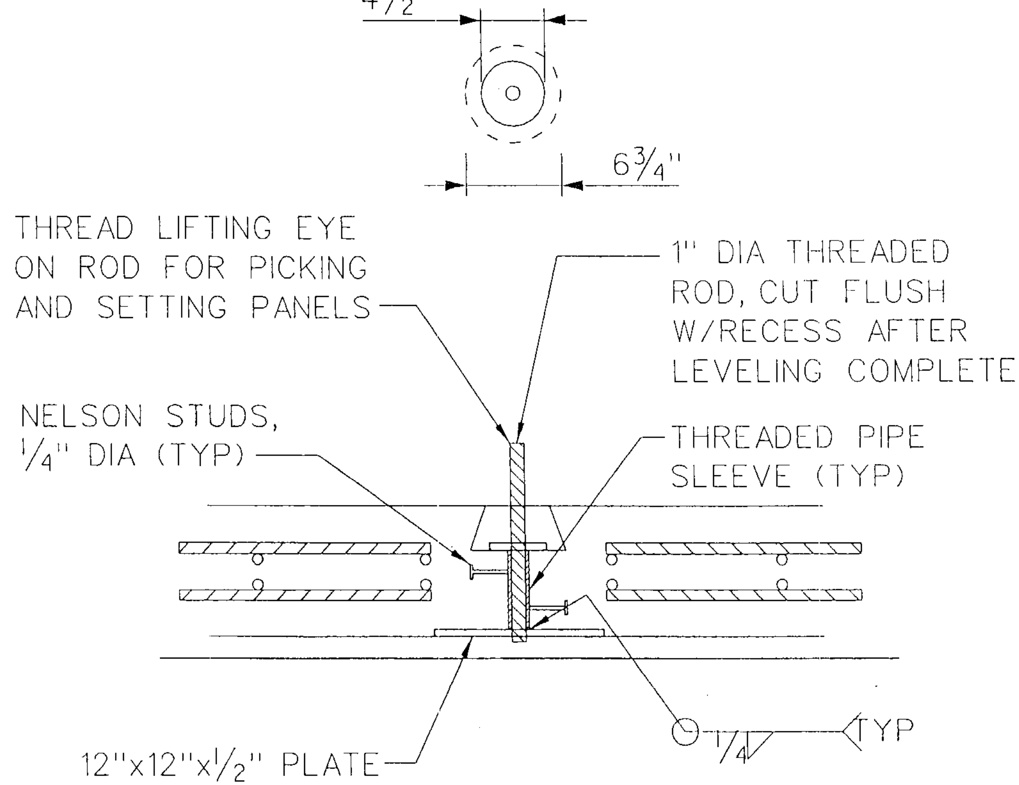


SECTION
TYPICAL PRECAST



ANCHOR BOLT

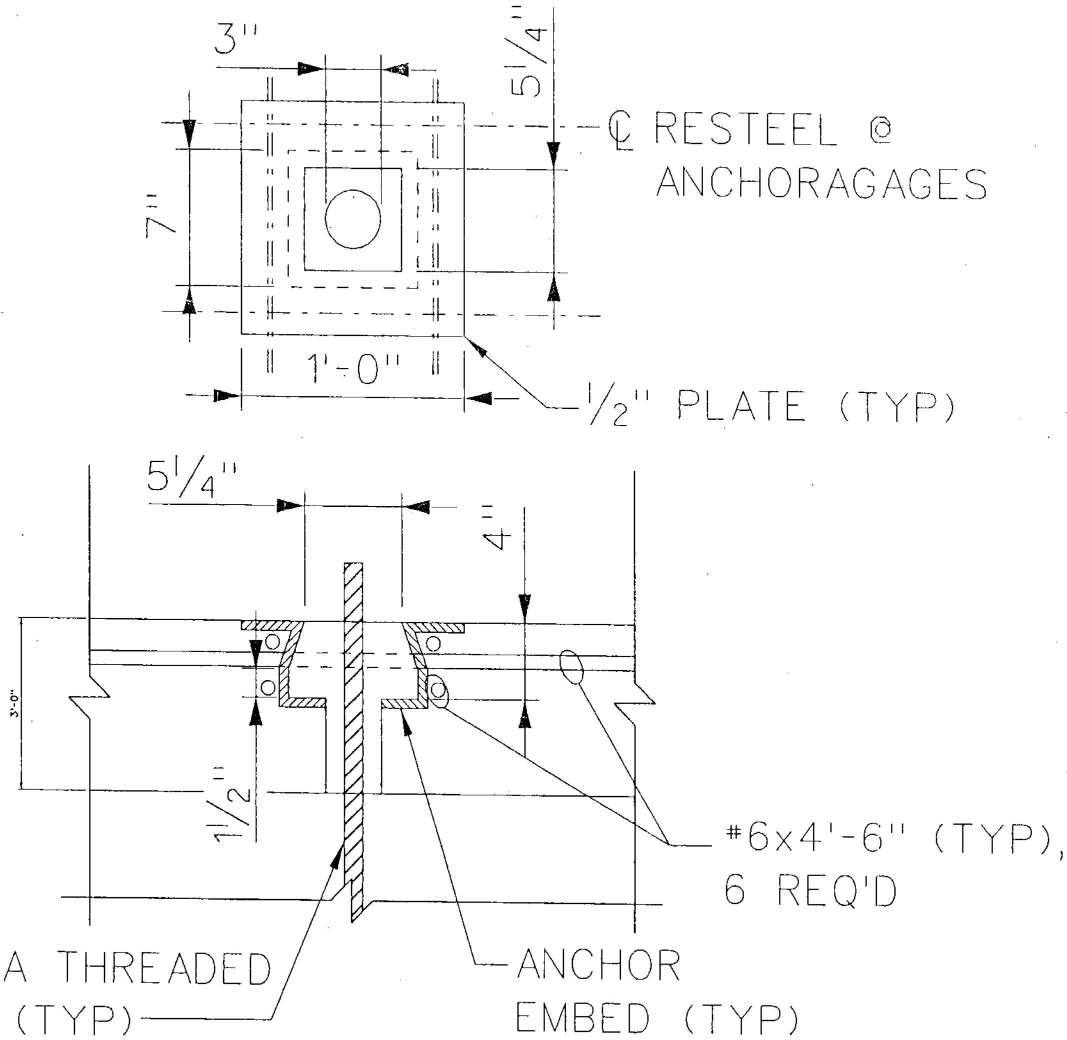
DETAIL 1
SCALE: 1"=1'-0"



LEVELING/PICKING DEVICE

DETAIL 2
SCALE: 1"=1'-0"

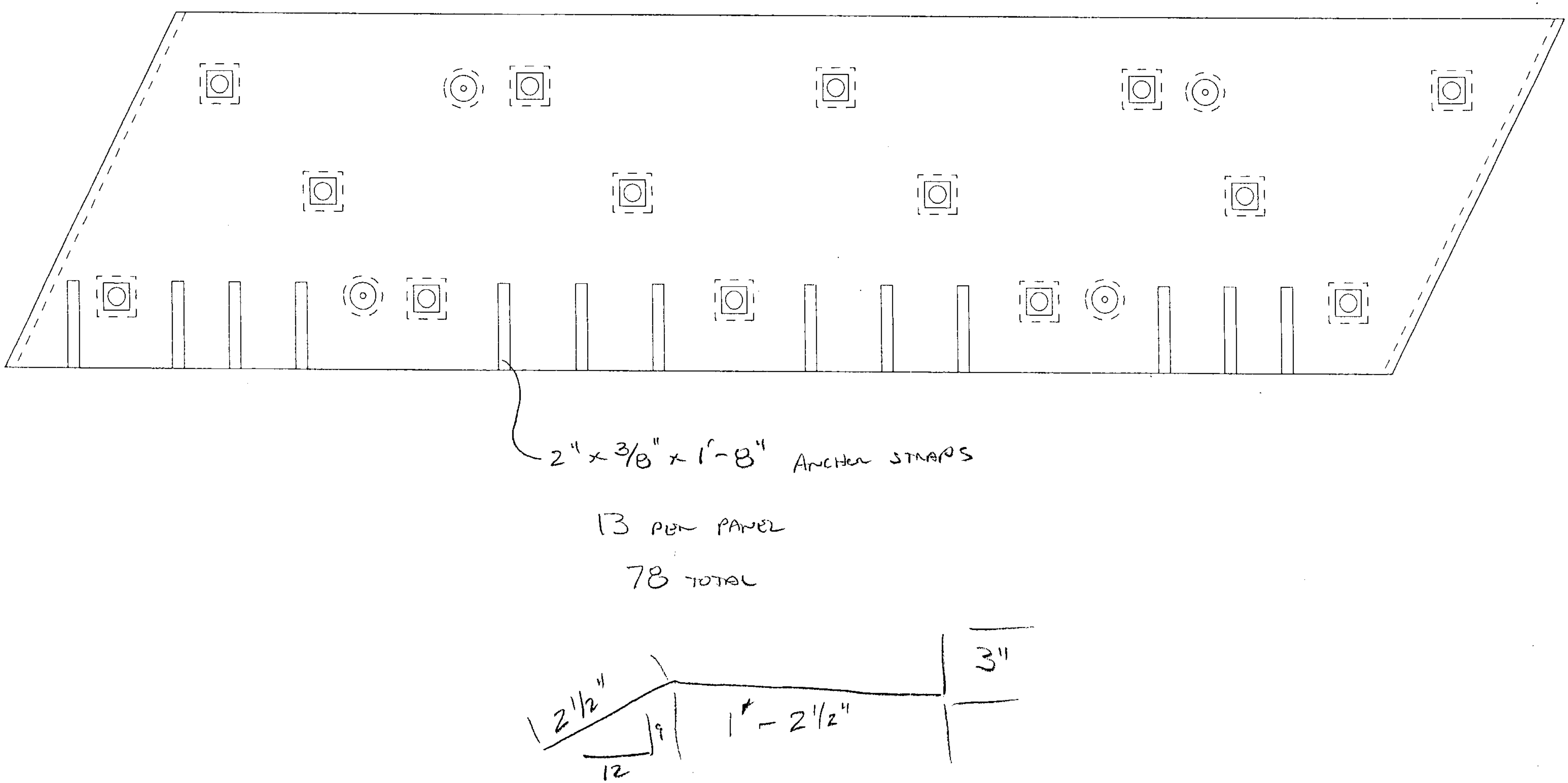
12-10-01



ANCHOR BOLT

DETAIL 1

SCALE: 1"=1'-0"


2" x 3/8" x 1'-8" ANCHOR STRAPS
13 PER PANEL
78 TOTAL
2 1/2"
9
12
1'-2 1/2"
3"

12-10-01
JET

REMOVALS (EA SILL)

ATION		SF	2'-0"	ALT "A" (+9)	ALT "B" (+5)
ATUN	13-16	2346.5	174 cy	96 cy	92 cy
	17-20	2346.5	174 cy	96 cy	92 cy
.M.	~~5~~ 54-57	1470.17	109 cy	64 cy	60 cy
	58-61	1971.73	146 cy	82 cy	78 cy
2-65	6~~[illegible]~~	2616.14	194 cy	106 cy	102 cy
	66-69	2524.5	187 cy	94 cy	90 cy
		13,275.54	984 cy	538 cy	514 cy
AVG's		2,212.6 sf	164 cy	90 cy	86 cy

R. Albers

10 MAR 02

Miraflores Locks

1) Emergency Dam Sill

a) Width – scaled from Dwg A-06

$$\frac{200'}{117} = \frac{x}{14.5} \qquad x = 25'\text{-}0"$$

b) Length – 110'-0"

c) Propose to lower sill 1'-9", since the Emergency Dams are not used.

d) The Emergency Dam Sill will be lowered 1'-9" using slab sawing and pneumatic hammers within the dewatered chamber.

e) Vol of concrete removal: $Vol = (110')(1.75')(25') / (27 ft^3/yd^3)$

Vol = 178.2 yd³

Wt = 361 tons

2) Chain Fender Sills

a) Pedro Miguel – Miraflores Lake Side (Dwg 7048)

1) The S/S chain fender sill must be lowered in-the-wet. No bulkheads are located S/S in which to dewater this portion of the chamber

2) Dimensions: width

$$\text{Scaled: } \frac{110'}{192.5} = \frac{x}{22} \qquad x = 12.57'$$

Say **x = 12'-6"**

3) Propose to lower sill 1'-0"

4) Vol of concrete removal: $Vol = (110')(1')(12.5') / (27 ft^3/yd^3)$

Vol = 51 yd³

Wt = 103 tons

5) In-the-wet removal

a) Saw out & pneumatic hammer w/ hydraulic excavator

b) drill holes & Bristar

c) [illegible]

[illegible]) Pedro Miguel - Between MG [illegible] – [illegible] (Aug [illegible])

1) Sill width - scaled

$$\frac{1[illegible].5}{94.5} = \frac{x}{6.5} \qquad x = 10.6'$$

2) The sill will be lowered with the chamber dewatered

3) Vol of concrete removed:

Vol = (110')(1')(10.5') / (27 ft³/yrd³)

Vol = 42.8 yrd³

Wt = 86.6 TONS

4) Removal - saw cut & pneumatic hammer in-the-dry

Appendix 7. – Scope of Work

MEMORANDUM OF AGREEMENT (MOA)
BETWEEN
THE PANAMA CANAL COMMISSION (PCC)
AND
THE DEPARTMENT OF THE ARMY
OF THE UNITED STATES OF AMERICA

CONTROL No. 97-003

WORK ORDER No. ____

1. Reference enclosed scope of work statement to study and provide a preliminary design to raise miter gate heights and lower the critical miter gate sills to increase allowable vessel draft in the Panama Canal, which shall be performed under this Work Order and MOA 97-003.

2. Schedule: See Scope of Work.

3. The total effort will require $ __,___.__ (_______________ thousand dollars with 00/100). The budget estimate is attached. The Panama Canal Commission (PCC) will provide an Interagency Service Support Agreement (ISSA) indicating the funding level that the U.S. Army Corps of Engineers (USACE) can bill against. Account No. ____________________________.

4. All funds shall be provided to the USACE Mobile District for distribution as required. Mail funding documents to the Commander, U.S. Army Corps of Engineers, Mobile District.

5. The principal representatives for the MOA and Work Order are as listed below:

   5.a. The administrative principal representatives for the MOA and Work Order are:

      5.a.1. For the USACE Mobile District:
      Mr. Billy Brown;
      Phone no. (334) 694-4253; facsimile no. (334) 690-2327;
      E-mail address: Billy.R.Brown@sam02.usace.army.mil;
      Mailing address: U.S. Army Corps of Engineers, Mobile District,
      P.O. Box 2288, Attn.: PM-LA
      Mobile, AL 36628.

      5.a.2. For the PCC Contracting Division:
      Ms. Gloria Gibson;
      Phone no. (507) 272-4075; facsimile (507) 272-3253;
      E-mail address: FMCO-____@ pancanal.com;
      Mailing address: Panama Canal Commission,

Unit 2300 (FMCO)
APO AA 34011-2300.

5.b. The technical principal representatives for the Work Order are:

5.b.1. For the USACE Pittsburgh District
Mr. Allen Remaly;
Phone no. (412) 395-7257; facsimile no. (412) 644-6815;
E-mail address: Allen.T.Remaly@lrp02.usace.army.mil;
Mailing address: USACE, Pittsburgh District;
1000 Liberty Avenue
Pittsburgh, PA 15222

5.b.2. For the PCC Canal Capacity Projects Office:
Mr. Juan Wong H.;
Phone no. (507) 272-5843; facsimile no. (507) 272-6137;
E-mail address: juanwong@pancanal.com;
Mailing address: Panama Canal Commission, CCL,
Unit 2300 (CCL-JW)
APO AA 34011-2300.

6. All communications which may change the terms of this Work Order shall be routed through the USACE Mobile District administrative principal representative (these are generally matters dealing with budget, schedule or additional effort). The communications dealing with the technical aspects of the project shall be addressed to the USACE-Pittsburgh District technical principal representative.

7. The work/services provided under this Work Order shall be provided by the USACE Pittsburgh District in-house labor unless otherwise approved.

8. The USACE Pittsburgh District shall provide the following reports in triplicate to the PCC administrative principal with a copy furnished to the USACE Mobile District administrative principal:

8.a. Monthly progress report.

8.b. Monthly billing with funds status.

9. Intellectual property rights: All information, findings and reports resulting from the execution of this contract shall become property of the Panama Canal Commission. No use nor reproductions of this information is permitted without the previous written authorization from the PCC.

10. Amending or modifying this Work Order: The PCC and USACE Mobile and Pittsburgh Districts shall mutually agree to any change to this Work Order before beginning work. No work shall be executed until the PCC and USACE Mobile District have signed the modification/amendment to the Work Order.

11. Additional coordination of details and responsibilities will be noted in the Scope of Work.

For the Panama Canal Commission:

______________________________ __________________
Date

____
Contracting Officer
Contracting Division
Department of Financial Management

For the Department of the Army:

______________________________ __________________
J. David Norwood
Colonel, Corps of Engineers
District Engineer, Mobile District
Date

PANAMA CANAL COMMISSION (PCC)
CONTRACTING DIVISION

DETERMINATION AND FINDINGS
UNDER ECONOMY ACT

ISSA No. 97-003 (WORK ORDER No. ___)

This determination is made under the authority of the Economy Act, 31, U.S.C. 1535, as implemented by FAR subpart 17.5 and pursuant to FAR 17.504 (a).

1. BACKGROUND INFORMATION

The Panama Canal operates its locks systems continuously on a 24-hour, 365 days a year, passage of deep draft oceangoing vessels. The Panama Canal operates with a series of locks to raise the vessels from the Pacific to the Atlantic Ocean and vice-versa. The vessels are raised to Gatun Lake to a nominal height of 85 feet above sea level by water locks. The locks are twin lane with a total of three lift at Gatun Locks in the Atlantic terminal; at the Pacific terminal, Miraflores Locks provides for two lifts to an intermediate Miraflores Lake, 54 feet above sea level, and Pedro Miguel Locks for a single lift to Gatun Lake.

The lock chambers are 110 feet wide by 1,000 feet long. The maximum allowable vessel draft is of 39.5 feet. The minimum depth over the locks sills is 41 feet and of 45 feet at the navigational channels. The locks operates with eighty (80) miter gates (MGs), double skinned, horizontally braced, riveted design, of different sizes ranging in heights of 54 to 82 feet and approximate weights of 500 to 790 tons.

The Canal Capacity Projects Office was formed in 1998 to develop a long-term strategy for different scenarios for the next 50 years to provide support facilities with the purpose of designing long-range master plan to augment Canal capacity and capability to meet future traffic demand and customer service in a reliable, efficient and competitive way.

These studies include the upgrading of current Canal infrastructure; incorporate modern lock technology and water saving methods to existing facilities; construction of new locks; study alternate systems for raising and lowering vessels; additional sources of water supply, storage and hydropower; making navigational channel improvements; insuring environmental concerns at all phases of study.

The proposals to increase Canal throughput by augmenting vessel draft beyond the existing 39.5 feet limitation by means of raising Gatun Lake level, by increasing lake miter gate heights and by reducing critical sill elevations, require an in-depth study to define the structural modifications, preliminary designs and extent of work involved in order to assess a cost/benefit analysis of the alternative solutions.

2. FINDINGS

The PCC proposes to issue Work Order No. _____, under the subject Interagency Service Support Agreement (ISSA No. 97-003) with the USACE to study and provide preliminary design of proposal to raise the lake miter gates and to reduce the critical miter gate sill elevations to provide for additional vessel draft. The study would provide analysis, preliminary designs, conclusions and recommendations on the results of the gathered information for improvements in structures and operations of existing and future facilities.

This action complies with FAR 6.002, in that it is not being entered into with another agency for the purpose of avoiding competition requirements. Neither the servicing agency or any contractor has commenced work on this acquisition.

This action is considered to be in the best interest of the Government because:

(a) The PCC has not evaluated the structural requirements to increase the height of lake miter gates, nor the structural requirements to lower the critical miter gate sills, in order to increase vessel draft. A limited in-house experience in the structural modification of riveted double skin miter gates requires contracted support. Due to the high impact of the locks structures and equipment in the operating efficiency of the Canal, the PCC requires this critical information based on expert opinion to insure extended and reliable equipment service life.

(b) This contract requires engineers and technicians with experience in structural engineering design. The U.S. Army Corps of Engineers (USACE) Pittsburgh District has performed structural design, modifications, specifications and finite element analysis on a varied range of miter gates, including those with riveted and with double skin designs in continental locks and waterways with similar head and load characteristics.

(c) The USACE Pittsburgh District Structural Design Group and its engineers and technicians are considered highly knowledgeable and with safe and consistent design practices for locks and dams by its peers and other District engineers in the Corps.

(d) The USACE Pittsburgh engineers/technicians are knowledgeable of the PCC mission, structures and operating conditions. They were also involved in different studies for the PCC such as the 1995 USACE Structures Conditions Assessment Report which prompted many actions and projects to upgrade facilites, and the 1999 Water Pressures in Locks Chamber Studies.

(e) The locks miter gates and valves are one of the most critical equipment for the lockages and transit of vessels through the Panama Canal. A delay or failure in its operations affects the throughput capacity of the entire Canal. The efficient operation, reliability, maintenance, repair, and control of the locks miter gates are thus essential for the expeditious and safe operation of the Canal.

(f) The present studies to improve on existing facilities and to consider future capacity expansion requires the consideration of increased permissible draft for Panamax vessels. The alternative to increase water level in Gatun Lake requires to make structural changes to lake miter gates at Gatun and Pedro Miguel Locks. The alternative to lower the critical miter gate sills at Pedro Miguel Locks requires structural modifications to the sills and the miter gates. Proper design and evaluation of modifications at the onset of the contract is critical to successfully comply with all the design, reliability, cost, time and safety parameters.

(g) The PCC will provide plans and information on existing facilities to facilitate study, information and discussions as required. The study by an expert, senior structural engineer in the area of structural designs for miter gates and concrete sills is necessary to insure that the best system and value is obtained as it is in the best interest of the PCC.

(h) The cost of the proposed work order is considered to be fair and reasonable because the USACE Pittsburgh prices are based on GS-9 through GS-13 pay levels, plus overhead, supervisory, office automation, administrative and costs for supplies.

3. DETERMINATION

Based on the above, and in accordance with FAR 17.503, Determination and Findings requirements, I hereby determine that the services described in the Work Order No. ______ cannot be obtained as conveniently and expeditiously by contracting directly with a private source. It is in the best interest of the PCC to issue this work order to the USACE Pittsburgh District.

________________________________ ________________
Date

____
Manager
Contracting Officer
Contracting Division
Financial Management Department

PANAMA CANAL COMMISSION (PCC)

ISSA No. 97-003 (WORK ORDER No. ___)

SCOPE OF WORK FOR THE STUDY AND PRELIMINARY DESIGN TO RAISE MITER GATE HEIGHTS AND LOWER MITER GATE SILLS TO INCREASE ALLOWABLE VESSEL DRAFT

1. BACKGROUND INFORMATION

The Panama Canal operates its locks systems continuously on a 24-hour, 365 days a year, passage of ocean going vessels of up to a maximum allowable draft of 39.5 feet. The Panama Canal operates with a series of locks to raise the vessels from the Pacific to the Atlantic Ocean and vice-versa. The vessels are raised to Gatun Lake at a nominal height of 85 feet above sea level by water locks. The lock chambers are 110 feet wide by 1,000 feet long. The minimum depth is 41 feet over the locks sills and 45 feet in the navigational channels.

The locks operates with eighty (80) miter gates (MGs) of different sizes ranging in heights of 54 to 82 feet and approximate weights of 500 to 790 tons. The miter gates are double skinned, horizontally framed structures with floatation chambers. The miter gates presently operate with an electro-mechanical system consisting of a 40 hp electrical motor going through a series of gear reducers, up to a final bullgear which connects to the miter gate via a strut arm to open/close the gates under 2 minutes.

The lock chambers are fed by one lateral culvert 18 feet in diameter and a shared centerwall culvert of same cross-sectional area. Water from the main culverts is fed to the chamber by 10 lateral culverts with 5 openings each, evenly distributed along the locks chamber floors.

Water movement into and out of the chambers is controlled by rising stem valves (RSVs). The RSVs work in pairs and are 10 ft. wide and 18 ft high and weigh 12 tons. The RSVs are positioned at the beginning and the end of each chamber. There are a total of 116 RSVs in all three locks. Their construction is of welded steel running on sliding bearings.

The centerwall culvert can move water from either the east or west chambers. These are regulated by cast iron 7-foot diameter cylindrical valves (CVs) at the lateral culverts. There are a total of 120 CVs in all three locks.

Present projects to widen the Gaillard Cut are expected to increase the Canal throughput from 38 vessels a day to a sustainable capacity of 43 vessels per day. Work is expected to be completed by the year 2002. Additional capital investment projects to procure additional tugs, towing locomotives, hydraulic miter gate and valve operators, centralized locks control system, rehabilitate locomotive track, and a modern vessel positioning will complement the cut widening project.

Market studies indicate that by the year 2010 the capacity of the Canal will be saturated. The average Canal Waters Times (CWT), an internal efficiency measure, will exceed 24-hours, deteriorating customer service. Restrictions during locks outages for maintenance and upgrading will further add to transit times.

The Canal Capacity Projects Office was formed in 1998 to develop a long-term strategy for different scenarios for the next 50 years to provide support facilities with the purpose of designing long-range master plan to augment Canal capacity and capability to meet future traffic demand and customer service in a reliable, efficient and competitive way.

These studies include the upgrading of current Canal infrastructure; incorporating modern lock technology and water saving methods to existing facilities; studying alternate systems for raising and lowering vessels; constructing new locks; finding additional sources of water supply, storage and hydropower; and making navigational channel improvements.

The proposals to increase Canal throughput by augmenting vessel draft beyond the existing 39.5 feet limitation by means of raising Gatun Lake level, by increasing lake miter gate heights and by reducing critical sill elevations, require an in-depth study to define the structural modifications, preliminary designs and extent of work involved in order to assess a cost/benefit analysis of the alternative solutions.

2. GENERAL INFORMATION

Data analysis and recommendations to improve existing facilities and to consider future capacity expansion requires experienced and accurate structural design calculations to insure structural and equipment reliability and integrity through its expected operating life cycle.

The objectives of this study are for the USACE Pittsburgh District to study and provide preliminary designs to alternatives for raising lake miter gates and to lower critical miter gate sills to allow for increased vessel draft beyond the maximum allowable of 39.5 feet. Design work on effects and means to reduce impact to locks structures and equipment affected by increase of vessel draft is also required.

All information, data, findings, recommendations, conclusions, and reports generated from the execution of this contract shall become sole property of the Panama Canal Commission. No use nor reproductions of this information is permitted without the previous written authorization from the PCC. All major equipment purchased under this contract shall also become property of the PCC.

3. DESCRIPTION OF WORK TO BE PERFORMED

The USACE Pittsburgh District shall provide all labor, materials and services to perform the studies, analysis and preliminary designs to increase allowable draft in the Panama Canal beyond the present vessel limitation of 39.5 feet maximum for the plans described below. The study will consider four major alternatives to be analyzed and evaluated. See attached sketches for miter gate locations and existing sill heights:

a- Increase Height of Gatun Lake Miter Gates: In order to allow increased permissible draft, one option proposed is to raise the height of Gatun Lake over its nominal 85 feet to the extent possible. In order to contain the water, the MGs nos. 21 through 40 at Gatun Locks and MGs 50 through 69 at Pedro Miguel Locks must be raised accordingly. The Contractor shall provide structural calculations and preliminary design on modifications to the miter gates as required. Assessment of impact and proposed solutions to miter gate machinery recess, other openings at the locks, and locks walls shall be considered.

b- Increase Height of Miraflores Lake Miter Gates: In order to allow increased permissible draft, one option proposed is to raise the height of Miraflores Lake over its nominal 54 feet to the extent possible. In order to contain the water, the MGs nos. 100 through 119 at Miraflores Locks must be raised accordingly. The Contractor shall provide structural calculations and preliminary design on modifications to the miter gates as required. Assessment of impact and proposed solutions to miter gate machinery recess, other openings at the locks, and locks walls shall be considered.

c- Lower Gatun Lake Miter Gate Sills: To allow for increased vessel draft, the lake MGs nos. 37 through 40 at Gatun Locks and MGs nos. 50 through 53 at Pedro Miguel Locks sills and upstream emergency dam and caisson seat sills may be lowered accordingly to the extent possible. The Contractor shall provide structural and civil calculations and preliminary designs on modifications to lower miter gate sills and to extend the miter gate seals. The Contractor shall also perform an assessment of the impact and proposed solutions to adjacent underwater structures and operating machinery.

d- Lower Critical Miter Gate Sills: To permit increased draft in transiting vessels, the critical downstream sills of miter gate nos. 54 through 69 may be lowered accordingly to the extent possible. The Contractor shall provide structural and civil calculations and preliminary designs on modifications to lower miter gate sills and to extend the miter gate seals. The Contractor shall also perform an assessment of the impact and proposed solutions to adjacent underwater structures

The USACE Pittsburgh District shall provide knowledgeable senior and junior engineers and technicians for the analysis and preliminary design of study to include assessment of existing structures, consider alternative solutions, evaluate and select best option, prepare preliminary designs, estimate quantities of labor, materials and performance times for modifications, general project guidance, monthly progress, final reports and presentations.

The USACE Pittsburgh District will study existing conditions and infrastructures in the locks, miter gate machinery operating machinery, gate weight, height, construction, repairs, overhauls, and maintenance, different operating modes, varied vessel configurations, different water level as it effects to transit operations.

The USACE Pittsburgh District will provide for effective technology transfer to PCC Canal Capacity Projects Office personnel to create in-house capabilities for future modification of studies. The completed study shall also address and recommend areas that require further consideration and analysis.

The proposed modifications and designs shall minimize the effect in Canal operations, requiring a minimum number and duration of outages to accomplish the modifications. Ease of installation and maintenance of proposed solutions is very important in this project. The study will also suggest further studies and considerations in the event that the PCC decides to proceed with these modification projects.

An on-site familiarization and recognizance 3-day trip of existing field conditions at the PCC locks and surrounding areas by three performing team members is required and to discuss needs, gather information, view lockage and transit operations, and define design limitations. A second 2-day trip by two performing team members is required to inspect the sill area during the Miraflores Locks MGs 100-101 dry chamber scheduled for August 16-27, 1999.

4. PCC SUPPORT

The PCC will provide plans, drawings, field conditions, operating procedures, mean and range of water levels, and general information to facilitate studies and discussions.

All traveling from Pittsburgh, PA to Panama should have previous approval by the PCC Contracting Officer (CO). The PCC will reimburse to the USACE personnel all air travel, lodging, per diem, and ground transportation according to approved Federal Travel Regulations, prescribed by the General Services Administration, in effect on the dates of performance of this contract and/or any delivery order.

Estimated costs for all travel to be performed under this contract/delivery order must be included in the total cost of services to be performed. Reimbursement of travel expenses will be made separately from the cost of services performed on the basis of each travel occurrence. Reimbursement will be made on the basis of the following:

a- Per diem: Reimbursed based on the established rates ($59 daily in Panama includes meals and incidentals).

b- Lodging: Reimbursed for actual cost incurred up to the stated limits. Lodging will be arranged in PCC quarters to the extent possible.

c- Airfare and Rental Car/Taxi: Reimbursement will be made on the basis of actual costs incurred. Airfare will be reimbursed for coach class, 30-day, non-restricted airline tickets.

d- Miscellaneous expenses: Reimbursement will be made on the basis of actual costs incurred as permissible in accordance with the established guidelines.

Prior to each travel occurrence, PCC will request the official travel order for the Contractor by completing Form No. 504 "Request and Authorization for Official Travel" (pink form) and obtaining the necessary approvals and forward the form to the Contractor.

Upon completion of travel, the Contractor shall complete the reverse side of the "Travel Expenses Report" form and return it to the PCC Contracting Division (FMC) with the original copies of air tickets, receipts and necessary supporting documents on actual expenses incurred. No allowable expenses will be reimbursed proper documentation and verification of costs incurred.

5. SCHEDULE

Within two weeks of contract award, the USACE Pittsburgh District shall provide to the PCC CO for his review and acceptance, a detailed plan with activities, resources, scheduling, time table, and cost estimates for the study and preliminary design of proposed work.

The completed study including plans, design, calculations, reference material, methodology, data gathering and final report presentation shall be completed within four (4) months from date of contract award.

The USACE Pittsburgh District shall provide written monthly reports in triplicate by the fifth day of each month. The USACE Pittsburgh District shall submit five (5) copies of the final report, studies, preliminary design and recommendations with attachments, drawings, calculations, and supporting documents. Additionally, a copy shall also be submitted in electronic form on disc in Word, AutoCAD, Microstation, Excel, Access, and PowerPoint formats, as applicable.

Panama Canal Authority

Contract No. , Delivery Order No. 1

SCOPE OF WORK TO COMPLETE THE STUDY AND PRELIMINARY DESIGN TO RAISE MITER GATE HEIGHTS AND LOWER MITER GATE SILLS TO INCREASE ALLOWABLE VESSEL DRAFT

1. BACKGROUND INFORMATION

The Panama Canal operates its locks systems continuously on a 24-hour, 365 days a year, passage of ocean going vessels of up to a maximum allowable draft of 12.0 m. The Panama Canal operates with a series of locks to raise the vessels from the Pacific to the Atlantic Ocean and vice-versa. The vessels are raised to Gatun Lake at a nominal height of 25.9 m above sea level by water locks. The lock chambers are 33.6 m wide by 305 m long. The minimum depth is 12.5 m over the locks sills and 13.7 m in the navigational channels.

The locks operates with eighty (80) miter gates (MGs) of different sizes ranging in heights of 16.5 to 25.0 m and approximate weights of 230 to 360 metric tons. The miter gates are double skinned, horizontally framed structures with floatation chambers. The miter gates presently operate with an electro-mechanical system consisting of a 40 hp electrical motor going through a series of gear reducers, up to a final bullgear which connects to the miter gate via a strut arm to open/close the gates under 2 minutes.

The lock chambers are fed by one lateral culvert 5.5 m in diameter and a shared centerwall culvert of same cross-sectional area. Water from the main culverts is fed to the chamber by 10 lateral culverts with 5 openings each, evenly distributed along the lock chamber floors.

Water movement into and out of the chambers is controlled by rising stem valves (RSVs). The RSVs work in pairs and are 3.1 m wide and 5.5 m and weigh 5.5 metric tons. The RSV2 are positioned at the beginning and the end of each chamber. There are a total of 116

RSVs in all three locks. Their construction is of welded steel running on sliding bearings.

The centerwall culvert can move water from either the east or west chambers. These are regulated by cast iron 2.1 m diameter cylindrical valves (CVs) at the lateral culverts. There are a total of 120 CVs in all three locks.

Present projects to widen the Gaillard Cut are expected to increase the Canal throughput from 38 vessels a day to a sustainable capacity of 43 vessels per day. Work is expected to be completed by the year 2002. Additional capital investment projects to procure additional tugs, towing locomotives, hydraulic miter gate and valve operators, centralized locks control system, rehabilitate locomotive track, and a modern vessel positioning will complement the cut widening project.

Market studies indicate that by the year 2010 the capacity of the Canal will be saturated. The average Canal Waters Times (CWT), an internal efficiency measure, will exceed 24-hours, deteriorating customer service. Restrictions during locks outages for maintenance and upgrading will further add to transit times.

The Canal Capacity Projects Office was formed in 1998 to develop a long-term strategy for different scenarios for the next 50 years to provide support facilities with the purpose of designing long-range master plan to augment Canal Capacity and capability to meet future traffic demand and customer service in a reliable, efficient and competitive way.

These studies include the upgrading of current Canal infrastructure; incorporating modern lock technology and water saving methods to existing facilities; studying alternate systems for raising and lowering vessels; constructing new locks; finding additional sources of water supply, storage and hydropower; and making navigational channel improvements.

The proposals to increase Canal throughput by augmenting vessel draft the existing 12.0 m limitation by means of raising Gatun Lake level, by increasing lake miter gate heights and by reducing critical sill elevations, require an in-depth study to define the structural modifications, preliminary designs and extent of work involved in order to assess a cost/benefit analysis of the alternative solutions.

2. GENERAL INFORMATION

Data analysis and recommendations to improve existing facilities and to consider future capacity expansion requires experienced and accurate structural design calculations to insure structural and equipment reliability and integrity through its expected operating life cycle.

The objectives of this study are for the Contractor to study and provide preliminary designs and cost estimates for alternatives for raising the locks lake miter gates and to lower critical miter gate sills to allow for increased vessel draft beyond the maximum allowable of 12.0 m. Design work on effects and means to reduce impacts to locks structures and equipment affected by increase of vessel draft is also required. Work under this Scope of Work was initiated in September 1999 under a previous contract but only partially completed. The work under this contract is for the full completion of the work and submission off the required reports.

All information, data, findings, recommendations, conclusions, and reports generated from the execution of this contract shall become sole property of the Panama Canal Authority (ACP). No use or reproductions of this information is permitted without the previous written authorization from the ACP. All major equipment purchased under this contract shall also become property of the ACP.

3. DESCRIPTION OF WORK TO BE PERFORMED

The Contractor shall provide all labor, materials and services to perform the studies, analysis, preliminary designs and cost estimates to increase allowable draft in the Panama Canal beyond the present vessel limitation of 12.0 m maximum for the plans described below. The study will consider four major alternatives to be analyzed and evaluated. The work was originally started under ISSA No. 97-003, Work Order No. 24, and has been completed to about a 50% level of completion. The work required under this Delivery Order shall be for the full completion of the work required for the study and preliminary design with presentation of the required draft and final reports. See sketches previously provided for miter gate locations and existing sill heights:

a- Increase Height of Gatun Lake Miter Gates: In order to allow increased permissible draft, one option proposed is to raise the height of Gatun Lake over its nominal 25.9 m to the extent possible. In order to contain the water, the MGs nos. 21 through 40 at Gatun Locks and MGs nos. 50 through 69 at Pedro Miguel Locks must be raised accordingly. The Contractor shall provide structural calculations and preliminary design on modifications to the miter gates as required. Assessment of impact and proposed solutions to miter gate machinery recess, other openings at the locks, and locks walls shall be considered.

b- Increase Height of Miraflores Lake Miter Gates: In order to allow increased permissible draft, one option proposed is to raise the height of Miraflores Lake over its nominal 16.5 m to the extent possible. In order to contain the water, the MGs nos. 100 through 119 at Miraflores Locks must be raised accordingly. The contractor shall provide structural calculations and preliminary design on modifications to the miter gates as required. Assessment of impact and proposed solutions to miter gate machinery recess, other openings at the locks, and locks walls shall be considered.

c- Lower Gatun Lake Miter Gate Sills: To allow for increased vessel draft, the lake MGs nos. 37 through 40 at Gatun Locks and MGs nos. 50 through 53 at Pedro Miguel Locks sills and upstream emergency dam and caisson seat sills may be lowered accordingly to the extent possible. The contractor shall provide structural and civil calculations and preliminary designs on modifications to lower miter gate sills and to extend the miter gate seals. The contractor shall also perform an assessment of the impact and proposed solutions to adjacent underwater structures and operating machinery.

d- Lower Critical Miter Gate Sills: To permit increased draft in transiting vessels, the critical downstream sills of miter gate nos.

54 through 69 may be lowered accordingly to the extent possible. The Contractor shall provide structural and civil calculations and preliminary designs on modifications to lower miter gate sills and to extend the miter gate seals. The Contractor shall also perform an assessment of the impact and proposed solutions to adjacent underwater structures.

The USACE (Pittsburgh District) shall provide knowledgeable senior and junior engineers and technicians for the analysis and preliminary design of study to include assessment of existing structures, consider alternative solutions, evaluate and select best option, prepare preliminary designs, estimate quantities and costs of labor and materials and estimate performance times for modifications, develop general project guidance, and prepare monthly progress and the final reports and presentations as required.

The Contractor will study existing conditions and infrastructures in the locks, miter gate machinery operating machinery, gate weight, height, construction, repairs, overhauls, and maintenance, different operating modes, varied vessel configurations, different water level as it effects to transit operations.

The Contractor will continue to provide continuous and effective technology transfer to ACP Canal Capacity Projects Office personnel through day-to-day contact to create in-house capabilities for future modifications of studies. The completed study shall also address and recommend areas that require further consideration and analysis.

The proposed modifications and designs shall minimize the effect in Canal operations, requiring a minimum number and duration of outage to accomplish the modifications. Ease of installation and maintenance of proposed solutions is very important in this project. The study will also suggest further studies and considerations in the event that the ACP decides to proceed with these modification projects.

An on-site familiarization and recognizance 3-day trip of existing field conditions at the ACP locks and surrounding areas by three performing team members was performed under the previous contract and no further visits to Panama are required to discuss needs, gather information, view lockage and transit operations, and define design limitations.

3. ACP SUPPORT

The ACP will provide plans, drawings, field conditions, operating procedures, mean and range of water levels, and general information to facilitate studies and discussions.

4. SCHEDULE

Within two weeks of contractor award, the Contractor shall provide to the ACP CO for his review and acceptance, a detailed plan with activities, resources, scheduling, time table, and cost estimates for the completion of the study and preliminary design and cost estimates of proposed work. In accordance with the requirements of the Agreement, no travel to Panama will be needed or accomplished to complete the requirements of this Scope of work.

The submission of the draft report including plans, design, calculations, reference material, methodology and data gathering shall be submitted for review within 10 weeks of receiving the notice to proceed. The final report presentation shall be completed within four (4) weeks from the date of receiving the ACP comments on the draft report. The ACP will furnish comments on the draft report within 30 days of receipt.

The Contractor shall provide written monthly reports in triplicate by the fifth day of each month. The Contractor shall submit five (5) copies of the draft and final report to include studies, preliminary design and recommendations with attachments, drawings, calculations, and supporting documents. Additionally, a copy of the final report shall also be submitted in electronic form on disc in Microsoft Office 2000, AutoCAD, and Microstation, as applicable. All work shall be prepared in the SI units of measure.

ACP-Formulario No. 6 Enero 2000

ACP AUTORIDAD DEL CANAL DE PANAMA
PANAMA CANAL AUTHORITY
ORDEN DE COMPRA/PURCHASE ORDER

CONTRATISTA/CONTRACTOR
US ARMY CORPS OF ENGINEERS
ROOM 630 WANNAMAKER BLD
100 PENN SQ EAST
PHILADELPHIA, PA 17107

ENVIAR A/ SHIP TO
AUTORIDAD DEL CANAL DE PANAMA
PROY CAPACIDAD CANAL
BULDING 714, EL PRADO STREET, BALBOA
PANAMA,
Republica de Panama

FACTURAR A/ BILL TO
AUTORIDAD DEL CANAL DE PANAMA
ACP – CC 010003
P.O. BOX 025413
MIAMI, FL 33102-5413

ORDEN DE COMPRA NO. / PURCHASE ORDER NO.	REVISION NO. / REVISION NO.	PAGINA / PAGE
SAA62000BGP	0	1

FAVOR IDENTIFICAR LOS ENVIOS, DOCUMENTOS Y FACTURAS CON EL NUMERO DE ORDEN DE COMPRA Y LA DIRECCION DESCRITA EN "ENVIAR A". ACOMPAÑAR LOS ENVIOS CON LAS LISTAS DE EMPAQUE.

PLEASE REFER TO OUR P.O. NUMBER AND "SHIP TO" ADDRESS ON INVOICES, DOCUMENTS AND CARTONS. PACKING SLIPS MUST ACCOMPANY ALL SHIPMENTS.

FECHA DE ORDEN / DATE OF ORDER	OFICIAL DE CONTRATACIONES / BUYER
26-APR-2001	L TOALA
FECHA DE REVISION / DATE OF REVISION	OFICIAL DE CONTRATACIONES / BUYER

CODIGO DE CONTRATISTA/ VENDOR NO.	TERMINOS DE PAGO/ PAYMENTS TERMS	TERMINOS DE FLETE/ FREIGHT TERMS	TERMINOS DE ENTREGA/ DELIVERY TERMS	EMBARQUE VIA/ SHIP VIA
0000930725	Neto 30 dias	Pagado por Contratista	DDU PANAMA	

SOLICITANTE/ REQUESTOR BARRERA A, ROSARIO M

LINEA / LINE	NO. DE ARTICULO / DESCRIPCION / ITEM NO / DESCRIPTION	FECHA DE ENTREGA / DELIVERY DATE	CANTIDAD / QUANTITY	UNIDAD / UNIT	PRECIO UNITARIO / UNIT PRICE	MONTO / EXTENDED AMOUNT

– Atención: Leo Cain Tel: 334-690-3440 Fax: 334-690-3754

– ACUSE DE RECIBO Y ACEPTACIÓN DE LA ORDEN:

Mediante fecha y firma de Persona Autorizada en el espacio abajo provisto, (Artículo 49, Numeral 6 del Reglamento de Contrataciones de La ACP), El Contratista tendrá un plazo de hasta tres días una vez recibida la orden, para comunicar su aceptación. Favor remitirlo vía Fax al (507) 272-7661

____________________ Fecha: ______________
Persona autorizada (aceptación)

"CLAUSULAS DEL CONTRATO"
– Son todos los artículos aplicables del Reglamento de Contrataciones de la Autoridad del Canal de Panamá, específicamente: 10, 17, 18, 19, 43, 44, 45, 46, 47, 48, 49, 55, 64, 69, 71, 75, 76, 77, 78, 81, 82, 90, 91, 92, 95, 99, 100, 101, 102, 123, 124, 125, 126, 127, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 144, 152, 153, 154, 155, 156, 158, 162, 165, 166, 169, 170, 172, 173, 175, 176, 214, 217, 218, 219, 220, 221, 222, 223, 225, 226. Para obtener el texto completo, sírvase bajarlo de Internet: – http://www.pancanal.com/esp/procsales/legal.html

– TRIBUTOS, IMPUESTOS, DERECHOS TASAS, CARGOS, O CONTRUBUCIONES DEL PAIS DE ORIGEN:
El proponente o contratista certifica que el precio propuesto incluye todo tributo, impuesto, derecho, tasa cargo o contribución, de carácter nacional, estatal o municipal del país de origen. En virtud de esta certificación no cabe ninguna reclamación.

– CONTROVERSIAS RELACIONADAS CON LOS CONTRATOS:
En referencia a los artículos No. 100 y 101, los procesos administrativos para la resolución de controversias serán los siguientes en el orden que se establecen:
–a. Mediación o Conciliación
–b. Arbitraje de Derecho
La instancia administrativa que se establece para la resolución de controversias será el Centro de Conciliación y Arbitraje de Panamá. Todo arbitraje será de Derecho.

– RESOLUCION ADMINISTRATIVA DEL CONTRATO POR CAUSA IMPUTABLE AL CONTRATISTA,

FIRMA DEL OFICIAL DE CONTRATACIONES / SIGNATURE OF CONTRACTING OFFICER

TOTAL

Continued ...

TERMINOS Y CONDICIONES: Sujeto a los términos y condiciones detallados en los artículos del Reglamento de Contrataciones e incorporados por referencia en esta orden.
Terms and Conditions: Subject to the terms and conditions detailed in the clauses referenced in this order.

FACTURA: Enviar factura, original y copia, a la dirección descrita en "FACTURAR A."
La Autoridad del Canal de Panamá está exenta de todo impuesto nacional o municipal.
INVOICE: Send invoice, original and copy to the "Bill to" address shown above. The Panama Canal Authority is exempt from all national and municipal taxes.

ACP-Forma/Licio No.6 Enero 2000

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PANAMA CANAL AUTHORITY

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US ARMY CORPS OF ENGINEERS
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FACTURAR A/ BILL TO
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ORDEN DE COMPRA NO. / PURCHASE ORDER NO	REVISION NO. / REVISION NO	PAGINA / PAGE
SAA6200BGP	0	2

FAVOR IDENTIFICAR LOS ENVIOS, DOCUMENTOS Y FACTURAS CON EL NUMERO DE ORDEN DE COMPRA Y LA DIRECCION DESCRITA EN "ENVIAR A". ACOMPAÑE LOS ENVIOS CON LAS LISTAS DE EMBARQUE.

PLEASE REFER TO OUR P.O. NUMBER AND "SHIP TO" ADDRESS ON INVOICES, DOCUMENTS AND CARTONS. PACKING SLIPS MUST ACCOMPANY ALL SHIPMENTS.

FECHA DE ORDEN / DATE OF ORDER	OFICIAL DE CONTRATACIONES / BUYER
26–APR–2001	L TOALA
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CODIGO DE CONTRATISTA/ VENDOR NO.	TERMINOS DE PAGO/ PAYMENTS TERMS	TERMINOS DE FLETE/ FREIGHT TERMS	TERMINOS DE ENTREGA/ DELIVERY TERMS	EMBARQUE VIA/ SHIP VIA
0000930725	Neto 30 dias	Pagado por Contratista	DDU PANAMA	

SOLICITANTE/ REQUESTOR BARRERA A, ROSARIO M

LINEA / LINE	NO. DE ARTICULO. / DESCRIPCION / ITEM NO / DESCRIPTION	FECHA DE ENTREGA / DELIVERY DATE	CANTIDAD / QUANTITY	UNIDAD / UNIT	PRECIO UNITARIO / UNIT PRICE	MONTO / EXTENDED AMOUNT
	En referencia el artículo No. 225: "Cuando el contrato no exija fianzas, el oficial de contrataciones podrá exigir que el contratista resuelto indemnice a la Autoridad por los daños ocasionados en el desarrollo o con ocasión del contrato, así como los gastos en que esta incurra para realizar el contrato resuelto."					
1	ESTUDIOS PARA ELEVAR/BAJAR LAS ALTURAS DE LAS COMPUERTAS Y LAS ELEVACIONES DE LOS QUICIOS, VER DOCUMENTOS ADJUNTO.	06–JUL–2001	1	Each	36,844.3400	36,844.34
	FIRMA DEL OFICIAL DE CONTRATACIONES / SIGNATURE OF CONTRACTING OFFICER	**TOTAL**				36,844.34

TERMINOS Y CONDICIONES: Sujeto a los términos y condiciones detallados en los artículos del Reglamento de Contrataciones e incorporados por referencia en esta orden.
Terms and Conditions: Subject to the terms and conditions detailed in the clauses referenced in this order.

FACTURA: Enviar factura, original y copia, a la dirección descrita en "FACTURAR A."
La Autoridad del Canal de Panamá está exenta de todo impuesto nacional o municipal.
INVOICE: Send invoice, original and copy to the "Bill to" address shown above. The Panama Canal Authority is exempt from all national and municipal taxes.

Appendix 8. – Design Manuals and USACE Engineering Manuals

Design Manuals and USACE Manuals

Ref.	Description	Date
AISC ASD	Manual of Steel Construction, 9^{th} Ed.	1989
EM 1110-2-2104	Strength Design for Reinforced-Concrete Hydraulic Structures	30 June 1992
ACI 318-99/ 318R-99	Building Code Requirements for Structural Concrete (318-99)/and Commentary (318R-99)	June 1999
EM 1110-2-2703	Lock Gates and Operating Equipment	29 Feb. 1984
EM 1110-2-2105	Design of Hydraulic Steel Structures	31 Mar. 1993
MNL 120-92	PCI Design Handbook, Precast and Prestressed Concrete	1992
	PCI Design Handbook, Precast and Prestressed Concrete	1971

Appendix 9. – Correspondence

Allwes, Rich LRP

From:	Allwes, Rich LRP
Sent:	Wednesday, November 21, 2001 4:19 PM
To:	'jgribar@pancanal.com'
Cc:	Remaly, Allen T LRP; Zovack, Frank LRP; Harkness, Andy LRP
Subject:	MG Sill and Seal Modification
Importance:	High

Tracking:

Recipient	Delivery	Read
'jgribar@pancanal.com'		
Remaly, Allen T LRP	Delivered: 11/21/2001 4:20 PM	Read: 11/26/2001 8:56 AM
Zovack, Frank LRP	Delivered: 11/21/2001 4:20 PM	
Harkness, Andy LRP	Delivered: 11/21/2001 4:20 PM	Read: 11/23/2001 8:45 AM

John:

I would appreciate if you or your staff would review the attached document and drawing. I believe that some of the miter gate sills do not need to be modified as originally proposed. I would appreciate if you could provide a reply via email or conference call by close of business 27 November. The drawing is in MicroStation format. If you need the drawing in AutoCad format, I can convert it but some information may not port properly.

Respectfully,

Rich Allwes
Structural Engineer
USACE-CELRP-ED-DS
412-395-7294

Panama Canal

Study and Preliminary Design to Raise
Miter Gate Heights and Lower Miter Gate Sills
To Increase Allowable Vessel Draft

Richard A. Allwes, USACE-CELRP-ED-DS
21 November 2001

A. The Scope of Work is to consider the following four (4) alternatives to increase draft:

1. Increase Height of Gatun Lake Miter Gates:

    a. Gatun Locks: raise MGs Nos. 21-40
    b. Pedro Miguel Locks: raise MGs Nos. 50-69

2. Increase Height of Miraflores Lake Miter Gates:

    a. Miraflores Locks: raise MGs Nos. 100-119

3. Lower Gatun Lake Miter Gate Sills:

    a. Gatun Locks: lower MG Sills Nos. 37-40
    b. Pedro Miguel Locks: lower MG Sills Nos. 50-53
    lower upstream emergency dam sill
    lower upstream caisson seat sill

4. Lower Critical Miter Gate Sills:

    a. Pedro Miguel Locks: lower MG Sills Nos. 54-69

B. USACE Current Progress and Request for Clarification:

1. The present plan proposed by the Pittsburgh District is to raise the heights of Gatun Lake and Miraflores Lake by a height of 3 in and not to increase any of the heights of the miter gates in the three (3) locks as proposed in Items 1 and 2 (a. and b. in the Scope of Work). In order to raise the lake elevations by 3 in and not increase the heights of the miter gates, the entrance velocity of the vessels will have to be decreased to prevent overtopping of the miter gates. The reduced vessel velocity study is completed. Boots are required for the direct-connect cylinders to prevent floating lake debris and water from entering the machinery recess areas. In addition, bulkheads are required for the machinery access areas to protect the galleries from flooding.

2. ACP is requested to review the attached Pittsburgh District's Minimum Draft Drawing for concurrence. It was compiled from as-built drawings and plates

provided by ACP. The Minimum Draft Drawing serves as the basis for modifying miter gates sills and seals. The following discrepancy is noted for the record.

a. The upstream emergency dam sill of Miraflores Locks was removed according to Isthmian Canal Commission Dwg 7065 M-28 (revised 2-5-68) and provides a sill elevation EL +11.3. The Panama Canal Elevations Diagram Plate (NIVELES.DGN) provides a sill elevation EL +13.0 for the upstream emergency dam. ACP is requested to verify that the emergency sill elevation is EL +11.3.

3. ACP proposed miter gate sills to be lowered for all three (3) locks. However, a review of the Pittsburgh District's Minimum Draft Drawing reveals that a majority of the proposed sills do not need to be lowered, specifically:

Gatun Locks:	MG Sills Nos. 37-40
Pedro Miguel Locks:	MG Sills Nos. 50-53
	Upstream emergency dam sill
	Upstream caisson seat sill

A review of the Minimum Draft Drawing reveals that drafts above the sills are equal to or greater that 42.2 ft.

4. The miter gate sills planned to be lowered by the Pittsburgh District are MG Sills Nos. 54-69 of Pedro Miguel Locks. The current draft at minimum Gatun Lake Elevation (L.W. EL +81.5) is 40.5 ft. The sills will be lowered 1.0 ft. Accordingly, the miter gate seals of MGs Nos. 54-69 of Pedro Miguel Locks will be extended 1.0 ft.

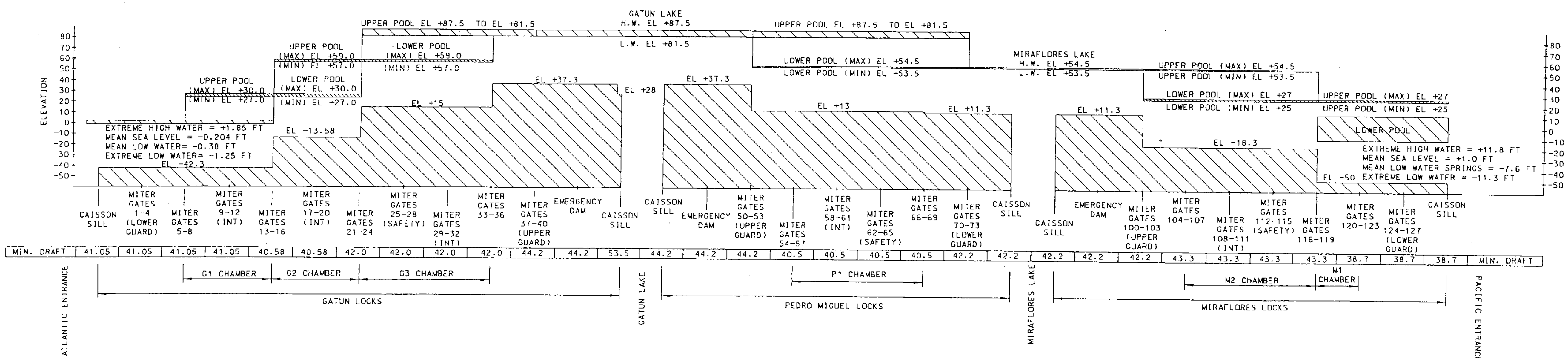
5. The MG Sills Nos. 13-20 of Gatun Locks should be lowered 1.0 ft since they restrict draft to 40.58 ft at the lowest chamber pool (EL +27.0). ACP is requested to provide concurrence to lower these MG sills 1.0 ft and extend the MG seals 1.0 ft.

6. The current proposal is to remove approximately 2.0 ft of each sill and then raise a nominal portion of the sills 1.0 ft. Two methods of concrete removal are being investigated -- hydroblasting and diamond wire concrete cutting.

7. Three MG sill preliminary designs (steel frame, precast panel, and cast-in-place) are being investigated and the preliminary designs will be evaluated in terms of cost and construction time.

8. A mix design is being investigated to achieve a design strength of 4,000 psi within 8 hours to minimize construction time. The time to demobilize and flood the chambers may be incorporated into the cure time of 8 hours to reduce total chamber outage time.

9. Since the miter gates are horizontally framed, the sill extensions will be designed to resist the maximum hydrostatic pressure corresponding to maximum lake or chamber pool elevation.



JOB SAFETY DEPENDS ON YOU

PANAMA CANAL COMMISSION

ENGINEERING AND CONSTRUCTION BUREAU

MITER GATES & SILLS STUDY

MINIMUM DRAFT

XXXX

XXXX-XXX

Allwes, Rich LRP

From: Allwes, Rich LRP
Sent: Wednesday, November 28, 2001 4:17 PM
To: 'jgribar@pancanal.com'
Cc: Zovack, Frank LRP; Harkness, Andy LRP
Subject: USACE Miter Gate Sill Modifications

Tracking:

Recipient	Delivery	Read
'jgribar@pancanal.com'		
Zovack, Frank LRP	Delivered: 11/28/2001 4:17 PM	
Harkness, Andy LRP	Delivered: 11/28/2001 4:17 PM	Read: 11/28/2001 4:23 PM

Dear John:

I sent an email to you on 21 Nov requesting clarification concerning the sills to be modified. I plan on calling you tomorrow morning, 29 Nov at 7:30 am to discuss the email that I sent. Frank Zovack and I tried to call you by phone but you were out of the office.

In addition, I have been speaking with demolition contractors and the following questions have been raised that require input from ACP. I would appreciate if you or someone on your staff could provide a response to the following questions by Monday, 3 Dec:

1. Concrete:
   a. Availability of logs of any concrete cores taken through the years.
   b. Availability of concrete strength data.
   c. Any information on the type of aggregate used at the different sites. We are of the opinion that the basalt was used as aggregate on the Pacific side, the Atlantic side used natural gravel, and we are not sure what type of aggregate was used for the middle locks.
   d. Any information on the original concrete mix designs or any info on the original concrete.
2. Steel reinforcement in the miter gate sills. For Pedro Miguel MG Sills Nos. 54-69, is the steel reinforcement shown in Mitering Lock Gates, Dwg. 5169 present in the sills? When I was there in Sept 1999 at Miraflores Locks dewatering, it appeared that the sills had been modified and the massive steel reinforcement was removed. We need to know if the steel exists at Pedro Miguel since this would have an impact on the method, size, and speed of concrete removal.
3. Cuttings and slurry: are there special requirements (environmental) for collection and/or disposal?
4. Availability of equipment (cranes and sizes) to handle large slabs of concrete? Or must demolition contractor arrange for all equipment?
5. Source of power - from lock, generator, or contractor supplied?
6. Bonding requirements for contractor.
7. Anticipated number of weeks/months for lead time for start of work by contractor - it will take time to schedule equipment, personnel, and arrange for shipping of equipment from Miami, Fl to Panama - this will affect cost.

8. The contractor will work 2 12-hr shifts/day - is this a problem?
9. Housing - supplied by ACP or must contractor arrange for housing.
10. Chamber outage:
    a. What is the chamber outage cost per day?
    b. What is the maximum acceptable time for the chamber closure for the miter sill work?
        i. It is assumed that the period is for dewatering, sill modification, and flooding chamber.

    c. What is the length of time to dewater the Pedro Miguel chambers to have access to MG Sills Nos. 54-69?
    d. What is the length of time to flood the chambers?
10. Water quality - are sulphates a problem for concrete mix?

Respectfully,

Rich Allwes
Structural engineer
USACE - Pittsburgh District 412-395-7294

Allwes, Rich LRP

From: Allwes, Rich LRP
Sent: Thursday, January 24, 2002 11:32 AM
To: 'jgribar@pancanal.com'; 'fhdelgado@pancanal.com'
Cc: Zovack, Frank LRP; Remaly, Allen T LRP; Tankosh, John E LRP
Subject: Panama Canal Study to Increase Draft

Dear John and Rigoberto:

The subject report was sent to your office on 13 Dec 01 for review and was most likely received on 17 Dec 01. I would appreciate if you would let me know when we will receive your comments. In addition, I sent emails to John on 21 Nov 01 and 28 Nov 01 requesting information on the sills and clarification for the study. I appreciate the information provided by Rigoberto on his visit to the Pittsburgh District. However, a majority of the information requested was not received to date. I would appreciate receiving the information, if it is available.

Rigoberto indicated to John Tankosh that the sill elevations are incorrectly shown on the drawing entitled, "Miter Gate Study – Minimum Draft" for the D/S portion of Pedro Miguel Lock. However, on review, the sills elevations are correctly shown (according to PCA Dwg 7046), except that the Chain Fender Sill was not included in the drawing. The Chain Fender Sill was not included in the Scope of Work. Specifically, the sill, sill elevations, and minimum drafts are:

Sill Description	Elevation (ft)	Minimum Draft (ft)
MG 62-65 Sills (Safety)	+13	40.5
MG 66-69	+13	40.5
MG 70-73 (Lower Guard)	+11 $^1/_3$	42.2
Caisson Sill	+11 $^1/_3$	42.2
Chain Fender	**+13**	**40.5**

As a result, we are currently investigating lowering the Chain Fender Sill by 1.0 ft using in-the-wet demolition (hydraulic excavator and a rotary rock cutting head). However, we need to know if the emergency chain is in use or will be used in the future and the impact of lowering the sill by 1 ft on the structure.

Respectfully,

Rich Allwes
Structural Engineer

Appendix 10. – ACP Comments and USACE Responses

Comments on

Panama Canal Study to Increase Draft

Draft Report by USACE, Pittsburgh District

13 December 2001

Cesar Kiamco, Locks Team
March 14, 2002

USACE Responses
10 April 2002

General Response: The Corps appreciates the comments and insight provided by the ACP. Mr. Rigoberto Delgado was particularly helpful in providing concrete material properties and informing us of our omission of the lower chain fender sill during his visit to the Pittsburgh District in December 2001. This information was important and his efforts were appreciated. It should be noted, however, that for several aspects of the project our requests for additional information or clarifications were not addressed (see Appendix 9). In those areas we used the best information we had available and engineering judgment to develop assumptions necessary to complete the study. Some of the comments made concerning the Draft Report are issues originally raised by the Corps and our responses to those comments reflect our belief that the assumptions made are sound and result in an accurate evaluation of the alternatives. Richard Allwes, EC-DS

Page 1

1. Third line: Use caisson instead of bulkhead.

   Response: Revision was made to the report. Richard Allwes, EC-DS

2. Last line of first paragraph: Use ACP instead of PCA.

   Response: Revision was made to the report. Richard Allwes, EC-DS

3. Third line from the bottom: ACP does not have drawings 5158-9 and 5161-5. Are you are referring to drawings 5158 and 5161 of the mitering gates?

   Response: Yes, the miter gate drawings are referenced and revisions were made to the report. Miter gate drawing No.s 5158 and 5161 are referenced. Richard Allwes, EC-DS

Page 2

4. Third paragraph: The statement "Gatun Lake is held at El +87.5 ft when sufficient water is available" is somewhat simplistic. Elevation +87.5 is only a nominal figure used for purposes of communication. Actual elevations may exceed the nominal maximum elevation; they are variable and are not controlled to the millimeter.

Response: Gatun Lake is held at the nominal elevation EL + 26.67 m (+87.5 ft) when sufficient water is available, although actual lake elevations may exceed this nominal level. Richard Allwes, EC-DS

5. Gatun Lake has a Ruling Curve that varies seasonally between elevations 25.75m (84.5') to 26.7m (87.5'). Gatun Lake elevation exceeds 87.5 feet just 5% of the time. Without additional water regulation (new lakes), it will be very difficult to maintain the lake elevation at 87.75 feet.

Response: The operational feasibility of raising and maintaining Gatun Lake to EL +26.75 m (+87.75) is beyond the Scope of Work. Richard Allwes, EC-DS

6. Miraflores Lake is not held at EL +54.5 ft. This elevation is only a nominal figure used for purposes of communication. Actual elevations vary greatly about the nominal elevation and are not controlled to the millimeter. Lake regulation is based on visual observation, experience and judgment. The elevation of the lake varies as a function of lockages at Pedro Miguel (one lift lock) and Miraflores (two lift lock). Every Pedro Miguel chamber spilled to Miraflores Lake increases the Miraflores lake level about 0.15 ft; while, every chamber taken from Miraflores locks from the lake decreases the lake level about 0.11 ft.

Response: The nominal elevation for Miraflores Lake is EL +16.61 (+54.5 ft). It is recognized that the lake elevation is affected by the operation of both Pedro Miguel and Miraflores Locks. However, the operational feasibility of raising and maintaining Miraflores Lake to EL +16.69 m (+54.75) is beyond the Scope of Work. Richard Allwes, EC-DS

Page 3

7. Raising Miraflores Lake 3 inches is something that happens several times every day. For deep draft ships, we let the lake rise to the maximum elevation.

Response: The Corps recommends raising and maintaining Miraflores Lake level to EL +16.61 (+54.75). This will permit Vessels to draft up to 40.75 ft, provided that the critical sills are lowered. Based on this comment, it appears that the recommendation is feasible, provided from an operations standpoint that the level may be maintained or an intermediate lake level may be maintained. Richard Allwes, EC-DS

8. To increase the elevation of Miraflores Lake, we must check Miraflores Dam and the bulkheads used for dewatering.

Response: A statement will be included in the report that ACP needs to assess the impact of raising Miraflores and Gatun Lakes by 76 mm (3 in) on the dams, shoreline structures, miter gates, and other structures. Richard Allwes, EC-DS

9. Raising Miraflores Lake 3 inches seems to entail a high cost since it requires a reduction in the entrance velocity of the ships. This decrease in velocity will result in an increase in the lockage time.

Response: The following points should be considered: 1) while the entrance velocity for the vessels is decreased, it occurs for only two lake chambers per transit, 2) the increase in transit time is very small in comparison o the CWT (24-30 hrs), 3) there is a small cost in terms of the small increase in lockage time for two lake chambers per transit, and 4) there is significant savings associated with the increased tonnage due to the increase in draft and this will more than compensate for the small increase in lockage costs. Richard Allwes, EC-DS

10. The report cites one of the objectives of lowering the miter gate sills as reducing transit times. How is this obtained? Does the reduction in transit time compensate for the increase in lockage time?

Response: The statement made in the report (Sec. 3.2.1) was "...reducing transit times during periods of low lake levels". The transit time during normal periods will slightly increase due to the reduced entrance velocity for a vessel for two lake chambers per transit. The overall transit cost will decrease due to the increase in tonnage. Richard Allwes, EC-DS

Page 4

11. Bottom of first paragraph: The report recommends that entrance velocity from the lakes to the upper chambers be reduced by 0.16 ft/sec at Miraflores and 0.36 ft/sec at Pedro Miguel and Gatún. Although they might be provided with velocity indicators, panamax ships are not this responsive. It is unrealistic to expect that such exact reductions in velocity will be made in practice.

Response: The lake levels may be raised 76 mm and the entrance velocities of the vessels need to be decreased to the theoretical velocities provided in the report to prevent overtopping of the miter gates for a vessel drafting 12.42 (40.75 ft). The velocity recommendations are based on theoretical values established in the 1996 report. Experience will provide the practical data in establishing achievable velocities of vessels and the associated surcharges. The theoretical velocities provide the basis for establishing vessel velocity. It should also be noted that vessels that draft 12.04 m (39.5 ft) may increase their entrance velocity since the surcharge is less due to the increase in draft in the lock chambers if the lakes are *raised and the critical sills are lowered. This will decrease the transit time (CWT) since the entrance velocities may be increased. Richard Allwes, EC-ED*

12. Second paragraph: This year ACP will build two prototypes of rubber boots around the hydraulic pistons to fully watertight these openings. Depending on the results, ACP will implement this change at all gates.

    Response: Acknowledged. Richard Allwes, EC-DS

13. Third paragraph: Your comment is based on the 1996 report. The condition was subsequently investigated. Our findings are different: Overloading due to sliding friction when the valve is lifted under head did not cause problems at some Rising Stem Valves (RSV). The problem occurred in two RSV's at Gatun Locks. Of interest, these valves were not subjected to the greatest operating head.

    Response: Of the representative sampling that was tested in the June 1996 report, all RSV motors were overloading, except for the remaining valve at Miraflores Locks that had the original roller trains. As a result, it is believed that the friction was increased with the new sliding surface and is causing the overloading condition. The additional friction load is proportional to head and is ultimately carried by the H castings. The increased friction load may also contribute to a fatigue loading condition. Frank Zovack, EC-DE & Richard Allwes, EC-DS

14. Plate 1 needs to be modified to reflect chain fender sills elevations at lower Pedro Miguel lock at +13'. These sills are located between miter gates (MG) 58, 59, 60, and 61; and MG's 62, 63, 64, and 65. The other two sills are located downstream of the South caisson sill (East and West).

    Response: This change was made to Plate 1 and is discussed in the report. Richard Allwes, EC-DS.

Page 5

15. First line: Change Table 2 to Table 3.

    Response: Revision was made to the report. Richard Allwes, EC-DS

16. Table 3: Change Meguel to Miguel.

    Response: Revision was made to the report. Richard Allwes, EC-DS

17. Paragraph 3.2.2: USACE recommends lowering the miter gate sills. If the sill is lowered, we must consider the possibility of having the edges rounded (as recommended by the Texas A&M University study) to improve water flow under

deep draft ships. A quarter round of a pipe 10, schedule 80 anchored to the edges would work.

Response: The embedded quarter round of pipe may be incorporated into the sill modification if and when the plans and specifications are developed. However, the Corps is skeptical that the minimal rounding/streamlining will have any beneficial affect to improve the flow of water beneath deep-draft vessels. Richard Allwes, EC-DS

Page 6

18. Change Meguel to Miguel in Tables 5 and 6.

Response: Revisions were made to the report. Richard Allwes, EC-DS

Page 10

19. Bottom of second paragraph: ACP has equipment and trained personnel to do this job.

Response: The costs were changed to reflect that ACP or a contractor is Panama will conduct the work. Richard Allwes, EC-DS

Page 12

20. 3.2.7.1b: Why is a water stop required between existing and new concrete?

Response: A waterstop was initially considered for the cast-in-place sections, but is not necessary and is not provided in any of the details and drawings. The last sentence of the paragraph states that water stops will not be used unless they are absolutely necessary. Waterstop are not necessary. No Revision was made to the report. Richard Allwes, EC-DS

Page 13

21. Construction Scheme for Precast Option: Add a short description of the leveling the precast units.

Response: A short description was provided and the combination lifting/leveling lugs provided in Plate 9, detail 2 was referenced. Richard Allwes, EC-DS

Page 16

22. Bottom of page: The estimate is based on having a contractor from outside of Panamá performing the demolition. Please note, however, that there is expertise within Panama. ACP owns 14 complete units for concrete wire cutting and 2

complete units of hydro-rehabilitation. Trained personnel have removed up to 10,000 tons of concrete in one year

Response: Estimates are changed to reflect the utilization of local contractors, fabricators, as well as the ACP wire saw units. Craig Carney, EC-EV

Page 17

23. Bottom of page: 3" raise of Miraflores pool: see "Page 3" comments above.

Response: The response to Comments No.s 7 through 10 are applicable. Richard Allwes, EC-DS

24. ACP is constructing a prototype with flexible rubber boots to make the strut arm connection to the MG watertight.

Response: Acknowledged. Richard Allwes, EC-DS

Page 18

25. Modification to Miter Gates: ", the additional loading on the girder is insignificant". A finite element modeling (FEM) study should back this statement.

Response: This statement was made for two reasons. The first is that the miter gates at Panama are horizontally framed, not vertically framed. The loads transferred by a vertically-framed miter gate to a sill are significantly higher than the loads transferred by a horizontally-framed miter gate. The second, is that the additional loading on the miter gate is minor when Detail 1 of Plate 10 is closely reviewed. Full hydrostatic pressure acts on both sides of the miter gate extension and a portion of the existing miter gate skin plate. The net load is essentially the same as with the omega-type seal. There is a torsional load applied to the miter gate due to the contact pressure (miter gate deflection) and the offset of the edge-bulb seal, with respect to the centerline of the bottom girder. The bottom girder will not be solely required to carry the torsional load. The torsional load will be distributed through the miter gate by the diaphragms, since the extension stiffeners match the miter gate stiffeners (diaphragms) between the girders. A finite element study is beyond the scope of this study. The purpose of the study was to investigate the feasibility of extending the miter gates and to provide a preliminary design. A finite element study may be used during the final design of the miter gate extension to verify loadings and deflections. The report will be revised to state that the additional loading on the miter gate is minor. Richard Allwes, EC-DS

26. The assumption that the rubber seal does not transmit load to the sill is not correct:

Response: It was not assumed that the miter gate seal does not apply a load to the miter gate sill as a result of miter gate deflection. This issue was discussed with John Gribar on 29 November 2001. The lateral load applied to the sills was made equal to the hydrostatic pressure applied to the tributary area of the lowest girder with the chamber dewatered. This is an extreme loading condition. Richard Allwes, EC-DS

27. Physical evidence in the field shows signs that the sill receives load from the MG seal. There are imprints in concrete made by the seal.

    Response: See comment No.s 26 and 26. Richard Allwes, EC-DS

28. A FEM analysis of the MG would show that the miter point deflects under load after the gates are mitered. At this point, the sill limits the deflection of the seal. The seal deforms, and picks up loads.

    Response: See comment No.s 26 and 26. Richard Allwes, EC-DS

29. Construction and operational variations can cause unintended contact between concrete and seal and, hence, additional loading on the sill.

    Response: The construction and operational variations may be addressed during final design. Richard Allwes, EC-DS

30. Welding of an 11/16" bracket plate to the all riveted, watertight bottom girder of the MG should be recommended with caution. The area is densely populated with rivets. Heat will cause nearby rivets to loosen. Water tightness will be lost.

    Response: The rivets may be ring sealed with weldment or the rivets may also be replaced with structural bolts to eliminate this potential problem. Richard Allwes, EC-DS

31. At the quoin end, you need to provide a detail showing how you will prevent leaks through the intersection of reduced sill and seal of the miter gate extension.

    Response: During the dewatering of the Miraflores Locks, the miter gates, seals, and quoin areas were inspected. It was determined that lowering the sill 1 ft would not interfere nor adversely affect the quoin seal. As a result, no modification is proposed for the quoin seal. Richard Allwes, EC-DS

Page 19

32. Second paragraph: For the purpose of the estimate, it is assumed that fabrication is done in the United States. Please note that the fabrication could be performed in Panama. The estimate would be different.

Response: Cost estimates are amended to reflect that the fabrication along with a majority of the other will be performed by local fabricators, contractors, or the ACP. Craig Carney, EC-EV

33. Third bullet from the bottom: Gates 54 through 69 are located at Pedro Miguel, not at Miraflores.

Response: Change was made to the report. Richard Allwes, EC-DS

Appendix 5

34. An estimate based on costs and construction practices in Panama would be more useful. We cannot make decisions based on estimates based on US costs. As examples of differences, we provide following comparison of US costs to those witnessed in Panama:

Response: Changes are made to the cost estimates to reflect the cost data information furnished through these comments. Craig Carney, EC-EV

35. Page 1/9: \$1,300.00/yd^3 of concrete is too high. \$500.00/yd^3 would be a better figure.

Response: The unit cost for concrete has been changed in the cost estimates. The new values are lower than the original furnished estimate, however, the Corps feels that \$500/cy is too low for precast concrete. Craig Carney, EC-EV

36. \$2/lb for reinforcing steel is also high, \$0.90/lb is better.

Response: Unit cost of reinforcing steel was lowered to \$1.00/lb. Craig Carney, EC-EV

37. Floating plant is not required, we pump concrete from the sidewalls.

Response: Floating plant eliminated from the cost estimates except for the lowering of the Chain Fender Sills for Pedro Miguel Locks (D/S side adjacent to Miraflores Lake). Craig Carney, EC-EV

Page 3/9

38. \$3,600.00/yd^3 is too high. Considering that ACP has equipment and personnel, \$1,200.00/yd^3 is a better estimate.

Response: Precision Demolition unit costs have been lowered. Note that \$1,200/cy has been used for the larger quantity demolition, but a higher unit cost was used for the smaller quantities for precision demolition. This accounts for *the setup and wire cutting, which is essentially the same for the differing quantities. Craig Carney, EC-EV*

Page 4/9

39. $150.00 per bolt can be reduced to half, as ACP can manufacture them.

Response: Estimate is changed to $100 per bolt. Craig Carney, EV-EC

Appendix 6

40. Detail 1: Change 3 ¼", as it is difficult to measure to the middle of plate.

Response: This is a preliminary design drawing, and the dimension provided is with respect to the centerline of the girder. A shop drawing may provide a different dimension. Richard Allwes, EC-DS

Appendix 7

41. Bottom of page 6 asks for SI units for all work. ACP is an international organization. We have agreed to review the draft report in the English system. For the final report, you must use SI for all work.

Response: The original Scope of Work did not require metric units for all work (page 11). This requirement was added to the resubmitted Scope of Work (page 6). The report was changed to provide both SI and English units. The drawings were changed to SI units. The calculations will be provided in English units. Richard Allwes, EC-DS

42. **Plate No. 6**: Demolish 24" thick concrete to rebuild 12" seems unnecessary.

Response: This was one option that was explored but was not proposed as the final concept for the study. Richard Allwes, EC-DS

43. Plate No. 10: The existing seals have to be replaced periodically due to damage. Edge-Bulb Seal proposed looks weaker than the existing Ω'-shaped seal. Sometimes debris is caught under the gate or between the gate and sill. How will the extension, the seal and the bottom girder behave?

Response: The edge-bulb seal (pork chop seal) is commonly used for the horizontally-framed miter gates. The seal is durable. robust, and rarely needs to be replaced according to Operations. If there is a problem with deflection of the miter gates (ACP did not state any problems with excessive deflection of the miter gates during the visit to the locks on 22 September 1999, the edge-bulg seal may be mounted horizontally with respect to the gate and the miter gate sill may be extended so that the edge-bulb seals on the top of the miter gate sill. This was not *explored since ACP did not indicate any problems with deflection of the miter gates. Richard Allwes, EC-DS*

44. What is the expected replacement time for the proposed seal? The proposed seals do no appear to be as strong as the existing seals.

Response: The Corps experience is that they get stiff with age but have lasted more than 50 years. According to Operations, the Corps rarely replaces these seals. Richard Allwes, EC-DS

45. Today, if a trapped log damages the omega seal, a diver unbolts the damaged piece and inserts a new one. If the extension were to be damaged, the miter gate would have to be removed and taken to the Industrial Division for repairs.

Response: The edge-bulb seal may be unbolted and replaced. Richard Allwes, EC-DS