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LOCKS (WATERWAYS)
INLAND WATERWAYS
MISSISSIPPI RIVER
STRUCTURAL ENGINEERING

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

It is recommended that both the landward lock, the riverward lock and the dam at Lock & Dam no. 1, Minneapolis, Minnesota be completely rehabilitated. Based on studies completed to the date of this report, more detailed studies are required to firmly establish cost estimates, environmental effects, and the construction scheduling necessary to insure the work can be completed in the proposed two year construction period without delaying navigation.

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DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
1210 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

MISSISSIPPI RIVER
STUDY OF ALTERNATIVES FOR REHABILITATION OF LOCK AND DAM NO. 1
MINNEAPOLIS, MINNESOTA

SUPPORTING DATA
FOR
APPENDIX C
STRUCTURAL INVESTIGATIONS

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STRUCTURAL INVESTIGATIONS COMPUTATIONS COMPUTED R.V.M. CHECKED	PROJECT LOCK & DAM No. 1 FILE NO. 800A DATE 4/21/75 PAGE 1 OF PAGES

COMPUTATIONS

TABLE OF CONTENTS

MONOLITH Nos	LOADING CONDITION	ELEV. OF BACKFILL, FT	W.S. ELEV. AT LANDSIDE, FT	W.S. ELEV. AT RIVER-SIDE, FT	LOCATION OF RES ECCENTRICITY FROM e, FT	±(L/6
					UPPER GUIDE WA	
1-7 (L=14.0')	NORMAL OPERATING	732.7	725.2	725.2	3.72	+1
1-6	CONSTRUCTION	732.7	719.7	(EMPTY)	4.22	-1
8-13 (L=18.0')	NORMAL OPERATING	732.7	725.2	725.2	3.40	-0

NOTES:

(1) SUMMATION OF HORIZONTAL FORCES ONE FOOT STRIP ACROSS EACH

(2) FACTOR OF SAFETY AGAINST SLIDING TO COEFFICIENT OF FRICTION f = 0.

(3) NEGATIVE SIGN INDICATES LOCATIO

(4) ALL WATER SURFACE (W.S.) ELEVATIONS CONSTRUCTION CONDITION FOR MON

(5) FOR 3-DIMENSIONAL ANALYSES e

...CK AND DAM Nº 1
SUMMARY OF STRUCTURAL INVESTIGATIONS

V. LOCATION OF RESULTANT - ECCENTRICITY FROM MIDDLE ⅓ e, FT	±(⅙-e) FT ③	FOUNDATION PRESSURE, KSF f_{MAX}	f_{MIN}	F.S.O.	ΣH KIPS	ΣV KIPS	SLIDING FACTOR, ΣH/ΣV	F.S.S. ②
PER GUIDE WALL								
3.72	-1.39	7.46	0.00	1.43	13	37	.35	1.80
4.22	-1.89	11.34	0.00	1.59	21	47	.44	1.42
3.40	-0.40	4.13	0.00	2.06	11	35	.33	1.90

ONTAL FORCES (ΣH) AND VERTICAL FORCES (ΣV) ARE FOR AN AVERAGE ACROSS EACH MONOLITH.

AINST SLIDING (F.S.S.) IS BASED ON $\phi \approx 32°$ CORRESPONDING RICTION $f = 0.625$ (FOR DAM; $\phi = 33°$, $f = 0.649$)

CATES LOCATION OF RESULTANT OUTSIDE OF MIDDLE THIRD

(W.S.) ELEVATIONS FOR INTERMEDIATE WALL ARE INTERCHANGEABLE EXCEPT TION FOR MONOLITHS 4 & 5

ANALYSES e_x IS ACROSS THE WALL AND e_y ALONG THE WALL

MONOLITH Nos	LOADING CONDITION	ELEV. OF BACKFILL, FT	W.S. ELEV. AT LAND-SIDE, FT	W.S. ELEV. AT RIVER-SIDE, FT	LOCATION OF RESULTANT ECCENTRICITY FROM e, FT ±(+ LAND W
3 (L=32.0')	NORMAL OPERATING (PRESENT)	732.7	704.0	687.2	9.06
3	CONSTRUCTION — ALL REHABILITATION PLANS. CONDUIT LOWERED, NO CONC. FILL	724.7	704.0	(EMPTY)	7.47
3	NORMAL OPERATING — AFTER HYDRAULIC IMPROVEMENTS COMPLETED	732.7	704.0	687.2	7.70
3	IMPROVED NORMAL OPERATING — BACKFILL LOWERED BY 8'	724.7	704.0	687.2	5.61
4 (L=32.0')	CONSTRUCTION — ALL REHABILITATION PLANS, CONDUIT LOWERED, NO CONC. FILL	722.7	704.0	(EMPTY)	7.44
4	NORMAL OPERATING — AFTER HYDRAULIC IMPROVEMENTS COMPLETED	732.7	704.0	687.2	8.04
4	IMPROVED NORMAL OPERATING — BACKFILL LOWERED BY 10'	722.7	704.0	687.2	5.38

LOCK & DAM No 1

SUMMARY OF STRUCTURAL INVESTIGATION

V. ER- T	LOCATION OF RESULTANT ECCENTRICITY FROM MIDDLE ⅓ e, FT	±(⅓-e) FT ③	FOUNDATION PRESSURE, KIPS/SQ FT fMAX.	fMIN	M.S.F.	ΣH KIPS	ΣV KIPS	SLIDING FACTOR, ΣH/ΣV	F.S.S. ②
	9.06	+3.73	13.41	0.00	1.54	85	184	.46	1.36
Y)	7.47	+2.14	13.39	0.00	1.57	75	171	.44	1.49
2	7.70	+2.40	16.10	0.00	1.67	85	201	.42	1.48
	5.61	+0.28	12.60	0.00	2.05	66	196	.34	1.85
Y)	7.44	+2.11	13.40	0.0	1.79	71	172	.41	1.52
2	8.04	+2.63	16.00	0.0	1.62	85	191	.45	1.40
2	5.38	+0.05	11.58	0.00	2.06	62	184	.34	1.86

LAND WALL

MONOLITH NOS	LOADING CONDITION	ELEV. OF BACKFILL, FT	W.S. ELEV. AT LAND-SIDE, FT	W.S. ELEV. AT RIVER-SIDE, FT	LOCATION OF RESULTANT ECCENTRICITY FROM CENTER, e, FT	±(L/6 - e
						LAND WA
5-15 (L=32.0')	NORMAL OPERATING	732.7	700.0	687.2	7.85	
5-15	NORMAL OPERATING	732.7	704.0	687.2	8.56	
5-15	CONSTRUCTION AND MAINTENANCE	732.7	704.0	(EMPTY)	8.50	
5-15	IMPROVED NORMAL OPERATING 1-1 3/8" Ø BAR TENDON PER ANCHOR SPACED 10 FT	732.7	704.0	687.2	4.86	
5-15	IMPROVED NORMAL OPERATING 2-1 1/4" Ø BAR TENDONS PER ANCHOR SPACED 15 FT	732.7	704.0	687.2	4.30	
5-15	IMPROVED NORMAL OPERATING 3-1 1/8" Ø BAR TENDONS PER ANCHOR SPACED 15 FT	732.7	704.0	687.2	2.50	
5-15	IMPROVED NORMAL OPERATING BACKFILL LOWERED BY 10'	722.7	704.0	687.2	6.59	

LOCK AND DAM NO. 1
SUMMARY OF STRUCTURAL INVESTIGATIONS

EV. RE- SULT	LOCATION OF RESULTANT ECCENTRICITY e, FT	FROM MIDDLE $\frac{1}{3}$ $\pm(\frac{L}{6}-e)$ FT (3)	FOUNDATION PRESSURE, KSF f_{MAX}	f_{MIN}	F.S.O.T.	ΣH KIPS	ΣV KIPS	SLIDING FACTOR $\Sigma H/\Sigma V$	F.S.S. (2)
LAND WALL (CONT'D)									
2	7.85	-2.52	16.50	0.00	1.68	85	202	.42	1.49
2	8.56	-3.23	17.74	0.00	1.57	86	198	.43	1.44
T)	8.50	-3.20	18.84	0.00	1.50	98	212	.46	1.35
2	4.86	0.47	12.10	0.60	2.37	72	203	.36	1.76
2	4.30	1.00	12.00	1.30	2.45	70	212	.33	1.89
.2	2.50	2.83	9.80	3.60	3.27	63	215	.29	2.16
.2	6.59	-1.26	12.33	0.00	1.87	63	174	.36	1.74

2

MONOLITH NOS	LOADING CONDITION	ELEV. OF BACKFILL, FT	W.S. ELEV. AT LAND-SIDE, FT	W.S. ELEV. AT RIVER-SIDE, FT	LOCATION OF ECCENTRICITY e, FT
					LAND WALL (CONT
17 (GATE) (L=30.0')	NORMAL OPERATING	732.7	700.0	687.2	9.70
17	IMPROVED NORMAL OPERATING BACKFILL LOWERED BY 10 FT	722.7	700.0	687.2	6.90
17	IMPROVED NORMAL OPERATING STABILIZED BY 1 3/8" Ø ANCHORS SPACED 10 FT.	732.7	700.0	687.2	6.00
17	IMPROVED NORMAL OPERATING STABILIZED BY 1 3/8" Ø ANCHORS SPACED 10 FT, BACKFILL LOWERED BY 10 FT.	722.7	700.0	687.2	3.20
					LOWER G
1 (L=18.0')	NORMAL OPERATING	VARIES FROM 709.7 TO 732.7	687.2	687.2	7.00
3-13 (L=20.0')	NORMAL OPERATING	697.6	687.2	687.2	2.70
6-12	CONSTRUCTION (CANNOT [illegible] AT [illegible] POINTS)	699.6 (PLUS 3' OF SURCHARGE)	681.0	(EMPTY)	3.22

LOCK AND DAM N? 1
SUMMARY OF STRUCTURAL INVESTIGATIONS

...V. ...ER. ...FT	LOCATION OF RESULTANT ECCENTRICITY e, FT	RESULTANT FROM MIDDLE $\frac{1}{3}$ $\pm(\frac{L}{6}-e)$ FT	FOUNDATION PRESSURE, KSF f_{MAX}	f_{MIN}	F.S.O.T.	ΣH KIPS	ΣV KIPS	SLIDING FACTOR $\Sigma H/\Sigma V$	F.S.S.
WALL (CONT'D)									
2	9.70	-4.70	26.00	0.0	1.41	94	207	.46	1.38
2	6.90	-1.90	16.44	0.00	1.81	70	200	.35	1.79
2	6.00	-1.0	18.70	0.00	1.71	79	212	.37	1.67
2	3.20	+1.8	11.10	2.50	2.23	55	205	.27	2.34
LOWER GUIDE WALL									
2	7.00	-4.00	33.60	0.00	1.26	45	98	.46	1.35
2	2.70	+.63	5.39	0.55	5.75	9	59	.15	4.07
2	3.22	+0.11	6.95	0.12	3.78	16	71	.22	2.84

MONOLITH Nos	LOADING CONDITION	W.S. ELEVATIONS, FT (4) LANDWARD LOCK	RIVERWARD LOCK	LOCATION OF RESULTANT ECCENTRICITY (5) FT e OR e_x	e'_y
4-16 (L=40.0')	NORMAL OPERATING	687.2	725.2	7.26	—
4	CONSTRUCTION — REHABILITATION PLAN 2, LANDWARD LOCK REBUILT	(EMPTY)	725.2	6.10	0.20
5	CONSTRUCTION — REHABILITATION PLAN 2 RIVERWARD LOCK REBUILT	(EMPTY)	725.2	7.60	0.51
6-16	CONSTRUCTION AND MAINTENANCE	(EMPTY)	725.2	7.23	—
18 (GATE) (L=35.0')	NORMAL OPERATING	725.2	687.2	12.40	7.90
18	IMPROVED NORMAL OPERATING STABILIZED BY 12 ROCK ANCHORS OF 3-1¼"Ø BAR TENDONS PER ANCHOR	725.2	687.2	7.30	5.80
18	IMPROVED NORMAL OPERATING INTERCONNECTION OF MONOLITHS 18 & 19 BY SHEAR KEYS	725.2	687.2	8.75	3.25
18	IMPROVED NORMAL OPERATING INTERCONNECTION OF MONOLITHS 18 & 19 BY SHEAR KEYS	725.2	687.2	8.30	—

LOCK AND DAM No 1
SUMMARY OF STRUCTURAL INVESTIGATIONS

RESULTANT WEIGHT ③ Ex	e'y	FT FROM MIDDLE 1/3 ±(1/6 − e) FT ③	FOUNTATION PRESSURE, K.S.F. f MAX.	f MIN	F.S.O.	ΣH KIPS	ΣV KIPS	SLIDING FACTOR ΣH/ΣV	F.S.S. ②
INTERMEDIATE WALL									
6	—	−0.59	10.90	0.00	1.94	73	209	.35	1.80
0	0.20	0.57	8.66	0.00	1.89	76	197	.39	1.81
0	0.51	−0.9	11.30	0.00	1.90	76	188	.41	1.57
3	—	0.56	11.32	0.00	2.02	77	217	.35	1.77
0	7.90	—	74.50	0.00	1.03	130	217	.60	1.04
0	5.80	—	47.54	0.00	—	130	370	.35	1.77
5	3.25	—	20.10	0.00	1.75	84	189	.45	1.41
	—	−2.46	13.80	0.00	1.74	72	193	.37	1.68

1 2

MONOLITH NOS	LOADING CONDITION	ELEV. OF BACKFILL FT	W.S. ELEV AT LAND-SIDE, FT	W.S. ELEV. AT RIVER-SIDE, FT	LOCATION OF RESULTA ECCENTRICITI, FT e OR e_x	e_y	FRO ±(
					RIVER WA		
1 (OLD RIVER WALL) (L=25.0')	CONSTRUCTION (INVESTIGATION OF OLD RIVER WALL MONOLITH)	709.0	705.0	731.7	6.42	—	
6-16 (L=26.0')	NORMAL OPERATING (I) NEW MONOLITH	690.0	725.2	707.7	9.70	—	
6-16 (L=28.0')	NORMAL OPERATING (II) OLD MONOLITH	690.0	707.7	687.2	3.80	—	
6-16	NORMAL OPERATING COMBINED NEW (I) AND OLD (II) MONOLITHS	690.0	725.2	687.2	2.58	—	
6-16	CONSTRUCTION & MAINTENANCE COMBINED NEW (I) & OLD (II) MONOLITHS	690.0	(EMPTY)	690.0	—	—	
19 (L=32.0')	NORMAL OPERATING "LOCK SIDE AVERAGE" UPLIFT PRESSURE	698.0	725.2	687.2	5.84	—	

LOCK AND DAM N 2 1
SUMMARY OF STRUCTURAL INVESTIGATIONS

ATION OF RESULTANT ENTRICITY, FT e_x	e_y	FROM MIDDLE $\frac{1}{3}$ $\pm(\frac{L}{6}-e)$ FT ③	FOUNDATION PRESSURE, KSF f_{MAX}	f_{MIN}	PILE LOAD KIPS/PILE	F.S.O.T.	ΣH / ΣV KIPS	SLIDING FACTOR, $\Sigma H/\Sigma V$	F.S.S. ②
RIVER WALL									
2	—	+2.26	9.50	0.00	—	1.40	38 / 86	.44	1.25
70	—	-5.70	35.60	0.00	—	—	64 / 123	.52	1.05
30	—	+0.86	7.12	0.72	—	—	1 / 109	—	—
58	—	+6.42	5.54	3.07	P_{MAX} = 50 P_{MIN} = 42 P_H = 13	—	64 / 232	.273	2.01
—	—	—	—	—	P_{MAX} = 98 P_{MIN} = 21 P_H = 2	—	— / —	—	—
84	—	-0.51	11.86	0.00	P_{MAX} = 130 P_{MIN} = -10 P_H = 21	1.84	63 / 181	.35	1.57

MONOLITH NOS	LOADING CONDITION	ELEV. OF BACKFILL, FT	W.S. ELEV. AT LAND-SIDE, FT	W.S. ELEV. AT RIVER-SIDE, FT	LOCATION OF R ECCENTRICITY OFT e OR e_x	e_y
19	NORMAL OPERATING "LOCKSIDE MAXIMUM" UPLIFT PRESSURE	698.0	725.2	687.2	7.14	—
19	IMPROVED NORMAL OPERATING-BACKFILL BEHIND MONOLITH "LOCKSIDE AVERAGE" UPLIFT PRESSURE	710.0	725.2	687.2	4.70	—
19	IMPROVED NORMAL OPERATING - BACKFILL BEHIND MONOLITH "LOCKSIDE MAXIMUM" UPLIFT PRESSURE	710.0	725.2	687.2	5.87	—
20 (L=20.0')	NORMAL OPERATING "LOCKSIDE AVERAGE" UPLIFT PRESSURE	690.0	725.2	687.2	8.62	7.25
20	NORMAL OPERATING "LOCKSIDE MAXIMUM" UPLIFT PRESSURE	690.0	725.2	687.2	9.29	7.95
20	IMPROVEDNORMAL OPERATING BACKFILL "LOCKSIDE AVERAGE" UPLIFT PRESSURE	710.0	725.2	687.2	7.55	6.95

LOCK AND DAM N?1
SUMMARY OF STRUCTURAL INVESTIGATIONS

TION OF RESULTANT LICITY OFT x e_y	RESULTANT FROM MIDDLE $\frac{1}{3}$ $\pm(\frac{1}{6}-e)$, FT	FOUNDATION PRESSURE, KSF f_{MAX}	 f_{MIN}	PILE LOAD KIPS/PILE	F.S.O.T.	$\frac{\Sigma H}{\Sigma V}$ KIPS	SLIDING FACTOR $\Sigma H/\Sigma V$	② F.S.S.
				RIVER WALL (CONT'D)				
—	−1.80	12.17	0.00	$P_{MAX.}$ = 131 $P_{MIN.}$ = -23 P_H = 21	1.55	63/162	.39	1.41
—	+0.63	10.61	0.68	$P_{MAX.}$ = 117 $P_{MIN.}$ = 3 P_H = 16	1.93	49/181	.27	2.04
—	−0.53	10.70	0.00	$P_{MAX.}$ = 117 $P_{MIN.}$ = -9 P_H = 16	1.63	49/162	.30	1.83
7.25	—	53.50	0.00	$P_{MAX.}$ = 290 P_{MIN} = -151 P_H = 40	—	116/202	.59	0.95
1.95	—	64.20	0.00	$P_{MAX.}$ = 234 $P_{MIN.}$ = -162 P_H = 48	—	116/192	.61	0.90
6.95	—	45.50	0.00	P_{MAX} = 283 P_{MIN} = -139 P_H = 33	—	96/210	.44	1.20

MONOLITH Nos	LOADING CONDITION	ELEV. OF BACK FILL, FT	W.S. ELEV. AT LAND-SIDE, FT.	W.S. ELEV AT RIVER-SIDE, FT	LOCATION OF RESU ECCENTRICITY (5) FT e OR e_x	FR e_y ±
						RIVER WALL
	IMPROVED NORMAL OPERATING					
20	BACKFILL "LOCKSIDE MAXIMUM" UPLIFT PRESSURE	710.0	725.2	687.2	8.18	7.60
20	SHEAR KEYS (6) "LOCKSIDE AVERAGE" UPLIFT PRESSURE	690.0	725.2	687.2	5.04	3.89
20	SHEAR KEYS (6) "LOCKSIDE MAXIMUM" UPLIFT PRESSURE	690.0	725.2	687.2	5.60	5.10
20	BACKFILL & SHEAR KEYS (6) "LOCKSIDE AVERAGE" UPLIFT PRESSURE	710.0	725.2	687.2	3.90	5.21
20	BACKFILL & SHEAR KEYS (6) "LOCKSIDE MAXIMUM" UPLIFT PRESSURE	710.0	725.2	687.2	4.49	6.40

(6) MONOLITHS 19, 20 & 21 INTERCONNECT

LOCK [illegible]
SUMMARY OF [illegible] INVESTIGATIONS

CATION OF RESULTANT ECCENTRICITY ⑤ FT e_x	e_y	③ FROM MIDDLE $\frac{1}{3}$ FT $\pm(\frac{L}{6}-e)$	FOUNDATION PRESSURE, KSF f_{MAX}	f_{MIN}	PILE LOAD KIPS/PILE	F.S.O.T.	ΣH / ΣV KIPS	SLIDING FACTOR $\Sigma H/\Sigma V$	F.S.S. ②
RIVER WALL (CONT'D)									
	7.60	—	52.40	0.00	P_{MAX} = 287 P_{MIN} = -149 P_H = 33	—	96 / 200	.48	1.15
4	3.89	—	14.15	0.00	P_{MAX} = 172 P_{MIN} = -34 P_H = 30	—	79 / 205	.39	1.42
0	5.10	—	14.88	0.00	P_{MAX} = 179 P_{MIN} = -47 P_H = 30	—	79 / 200	.40	1.39
0	5.21	—	13.70	0.00	P_{MAX} = 164 P_{MIN} = -22 P_H = 23	—	66 / 209	.32	1.74
	6.40	—	13.80	0.00	P_{MAX} = 173 P_{MIN} = -37 P_H = 23	—	66 / 204	.32	1.70

INTERCONNECTED WITH SHEAR KEYS

1

2

BUTTRESS

LOADING CONDITIONS	WATER SURFACE ELEV, FT			LOCATION OF RESULTANT	
	UPPER POOL	TAIL - WATER	LOWER POOL	ECCENTRICITY e, FT	FROM MIDDLE $\frac{1}{3}$ $\pm(\frac{L}{6}-e)$ (B)
NORMAL OPERATING 10K/FT OF CREST ICE PRESSURE	723.2	(EMPTY)	(EMPTY)	4.32	+ 5.81
FLOOD DISCHARGE 1965 FLOOD DAM CAVITY FULL OF WATER	734.7	719.0	719.0	0.96	+ 9.19
FLOOD DISCHARGE 1951 FLOOD WATER IN CAVITY @ RELIEF HOLES LEVEL	731.0	695.5	709.0	0.72	+ 9.41
EARTHQUAKE NORMAL OPERATING WITH EARTHQUAKE BUT WITHOUT ICE PRESSURE	723.2	(EMPTY)	(EMPTY)	2.81	+ 7.32
IMPROVED NORMAL OPERATING 1951 FLOOD ADDITIONAL SAND FILL UP TO EL. 701.25±	731.0 "	695.5	709.0	0.69	9.44

(6) INTERNAL HYDROSTATIC PRESSURE EXCEPT NORMAL OPERATING

LOCK AND DAM N21
SUMMARY OF STRUCTURAL INVESTIGATIONS

OF RESULTANT FROM MIDDLE 1/3 ±(L/6 - e) (3)	BEARING ΣH KIPS	BEARING ΣV KIPS	FOUNDATION PRESSURES $f_{MAX.}$, KSF	FOUNDATION PRESSURES $f_{MIN.}$, KSF	SLIDING R_T KIPS	SLIDING R_T KIPS	SLIDING FACTOR R_T/R_N	F.S.S.
BUTTRESS DAM								
+ 5.81	725	1726	2.53	1.02	530	1903	0.279	2.33
+ 9.19	536	1215	1.36	1.13	297	1366	0.217	2.98
+ 9.41	807	1335	1.47	1.27	669	1525	0.439	1.48
+ 7.32	804	1726	2.27	1.29	609	1941	0.319	2.03
9.44	807	1557	1.48	1.30	667	1542	0.439	1.50

ATIC PRESSURE (UPLIFT) DETERMINED BY FLOW NET METHOD
OPERATING CONDITIONS.

2

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT INVESTIGATION OF STABILITY FOR LOCK WALLS	PROJECT L & D #1
		FILE NO 800A
	COMPUTED M.J. CHECKED R.N.M.	DATE 8.74 PAGE 1 OF ____ PAGES

BACK FILL BEHIND WALLS

NUMBER OF BLOWS FOR 12" PENETRATION

HOLE NO / DEPTH IN FT.	74-22		74-14		74-8	
1	6		20			
2	16		14	SAND	100	
3	28	SAND ROUNDED	12	BACKFILL	40	
4		FINE TO COARSE	20	FINE TO MEDIUM	46	SANDY GRAVEL
5	50		20		36	
6			90	SANDSTONE	42	
7			140		46	GRAVELLY SAND
8						
9	4				80	
10	28				90	SAND
11	88				100	
12						
13						
14					16	
15	12				16	
16	16				14	
17	26					
18						
19					10	
20					20	
					26	
25					10 16 16	
30					16 20 30	
35					110 42 32	

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT LATERAL EARTH PRESSURES
COMPUTED R.H.M. CHECKED V.T.

PROJECT LOCK AND DAM No. 1
FILE No. 800 A
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The land and guide wall monoliths have been considered to behave essentially as rigid structures. Therefore at-rest earth pressure coefficients have been utilized for calculating lateral forces, modified by reduction factors considering the deformation history of the monoliths and the nature of the granular backfill materials. For monoliths founded directly upon the sandstone (sand) a reduction factor of 0.95 was used. For monoliths bearing upon timber cribs a reduction factor of 0.85 was applied.

LAND WALL, MONOLITHS 1-7 UPPER GUIDE WALL AND MONOLITHS 1-2 LOWER GUIDE WALL

These monoliths are founded directly on sandstone

$\gamma_{moist} = 115$ pcf
$\gamma_{saturated} = 130$ pcf
$\gamma_{submerged} = 68$ pcf

$\phi = 38°$

$K_o = 1 - \sin\phi = 0.384$
$K = 0.95\, K_o = 0.365$

$K\gamma_{moist} = 0.365 \times 115 = 42$ psf

$K\gamma_{sub.} = 0.365 \times 68 = 25$ psf

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LATERAL EARTH PRESSURES COMPUTED R.N.M. CHECKED VT	PROJECT LOCK AND DAM No. 1 FILE NO. 800 A DATE OCT. 1, 75 PAGE 2A OF ____ PAGES

MONOLITHS 8-13 UPPER GUIDE WALL AND MONOLITHS 3-13 LOWER GUIDE WALL

These monoliths are bearing upon timber cribs

$\gamma_{moist} = 115$ pcf
$\gamma_{saturated} = 125$ pcf
$\gamma_{submerged} = 63$ pcf

$\phi = 35°$

$K_o = 1 - \sin\phi = 0.426$
$K = 0.85\, K_o = 0.362$

$K\gamma_{moist} = 0.362 \times 115 = 42$ psf

$K\gamma_{subm.} = 0.362 \times 63 = 23$ psf

EQUIVALENT FLUID PRESSURES USED IN THE ANALYSES

Because of small variations in calculated values the following equivalent fluid weights were used for calculating earth pressures acting on the land and guide wall monoliths

$K\gamma_{moist} = 42$ psf

$K\gamma_{submerged} = 26$ psf

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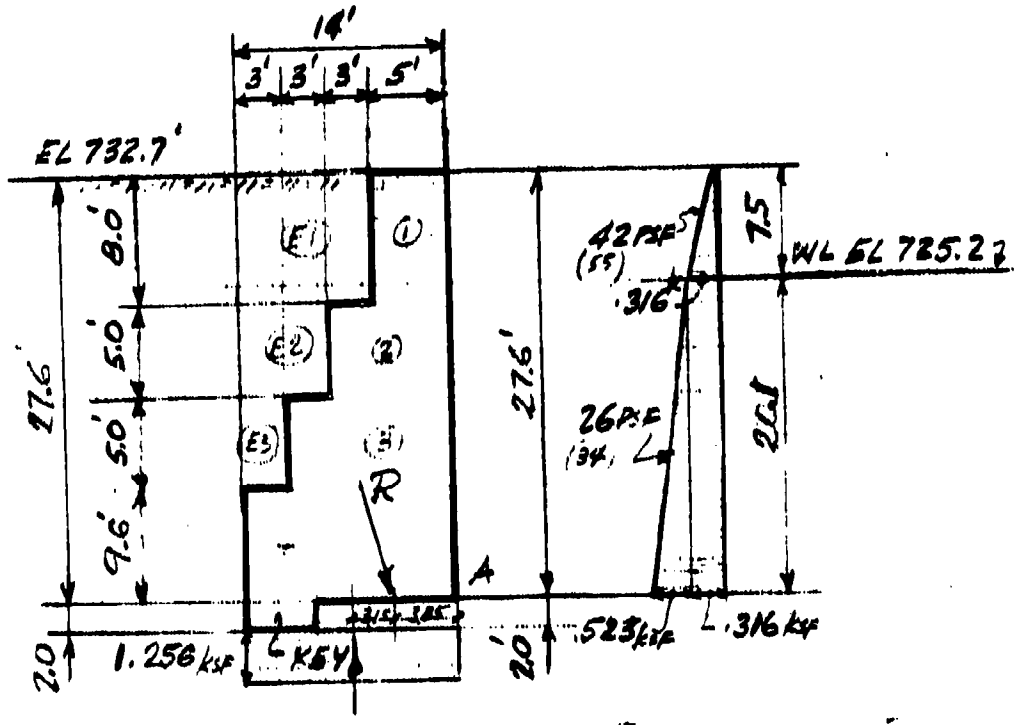
HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILITY OF UPPER LAND GUIDE WALL MONO #1-7	PROJECT L & D #1
	COMPUTED M.J. CHECKED K.N.M. 4/2/75	FILE NO. 900A
		DATE 8-74 PAGE 3 OF ____ PAGES

UPPER (LAND) GUIDE WALL MONOLITHS #1-7



$\Sigma V = 36.7^{k}$ $\Sigma H = 12.76^{k}$ $M_A = 120.3^{ft\text{-}k}$ $a = \frac{120.3}{36.7} = 3.28'$

1) $e = 3.72'$ $R = 38.9'$ OUTSIDE MOD. E 3 BY 1.39'

2) $\frac{\Sigma H}{\Sigma V} = \frac{12.76}{36.7} = 0.348$ ✓

3) $f_{soil} = 7.46$ KSF (max.) ✓

4) $FSS = \frac{36.7 \times 0.625}{12.76} = 1.80$ ✓

5) $FSOT = \frac{362.1}{248.6} = 1.48$ ✓

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT STABILITY OF UPPER LAKE GUIDE WALL

COMPUTED M.J. CHECKED R.N.M.

PROJECT L&D #1

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4/2/74

UPPER LAKE GUIDE WALL - MONOLITHS #1 - #7

WATER LEVEL @ EL 725.2

LOADS IN KIPS		VERT ↓	VERT ↑	HORIZ →	HORIZ ←	ARM	MOM_A ↻	MOM_A ↺
C_1	8.0 × 5.0 × .15	6.0				2.5		15.0
C_2	5.0 × 8.0 × .15	6.0				4.0		24.0
C_3	11.0 × 5.0 × .15	8.3				5.5		45.6
C_4	14.0 × 9.6 × .15 ✓	20.2 ✓				7.0 ✓		141.1 ✓
E_1	.11 × 9.0 × 8.0	7.9				9.5		75.2
E_2	.13 × 6.0 × 5.0	3.9				11.0		43.0
E_3	.13 × 3.0 × 5.0	2.0				12.5		25.0
W_1	20.1 × .0625 × 14	✓	17.6 ✓			7.0	123.1 ✓	
Σ		54.3	17.6				123.1	368.9 ✓ 1k
H_{E_1}	.042 × 7.5²/2			1.18		22.60	26.7	
H_{E_2}	.042 × 7.5 × 20.1			6.33		10.05	63.6	
H_{E_3}	.028 × 20.1²/2			5.25		6.70	35.2 ✓	
		36.7 ✓		12.76 ✓			248.8	2 1k
							ΣM = 120.3 ↺ 1k ✓	

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT STABILITY OF UPPER LAND GUIDE WALL
COMPUTED M.J. CHECKED R.N.M. 4/2/75

PROJECT LED #1
FILE NO. 800 A
DATE 8.74 PAGE 5 OF ____ PAGES

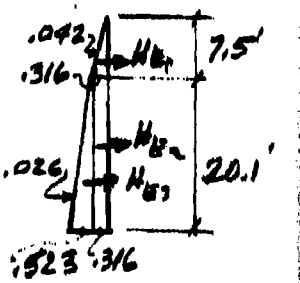
UPPER LAND GUIDE WALL - MONOLITHS #1 - #7 (CONTD)

$H_{E_1} = .042 \times 7.5^2/2 = 1.18^{k} \times 22.60$

$H_{E_2} = .042 \times 7.5 \times 20.1 = 6.33 \times 10.05$

$H_{E_3} = .026 \times 20.1^2/2 = 5.25 \times 6.70$

$\Sigma H = 12.76^{k}$



$M_{E_1} = 26.7^{k}$

$M_{E_2} = 63.6$

$M_{E_3} = 35.2 / 125.5^{k}$

$\Sigma M = 368.9 - 125.5 - 123.1 = 120.3^{k}$

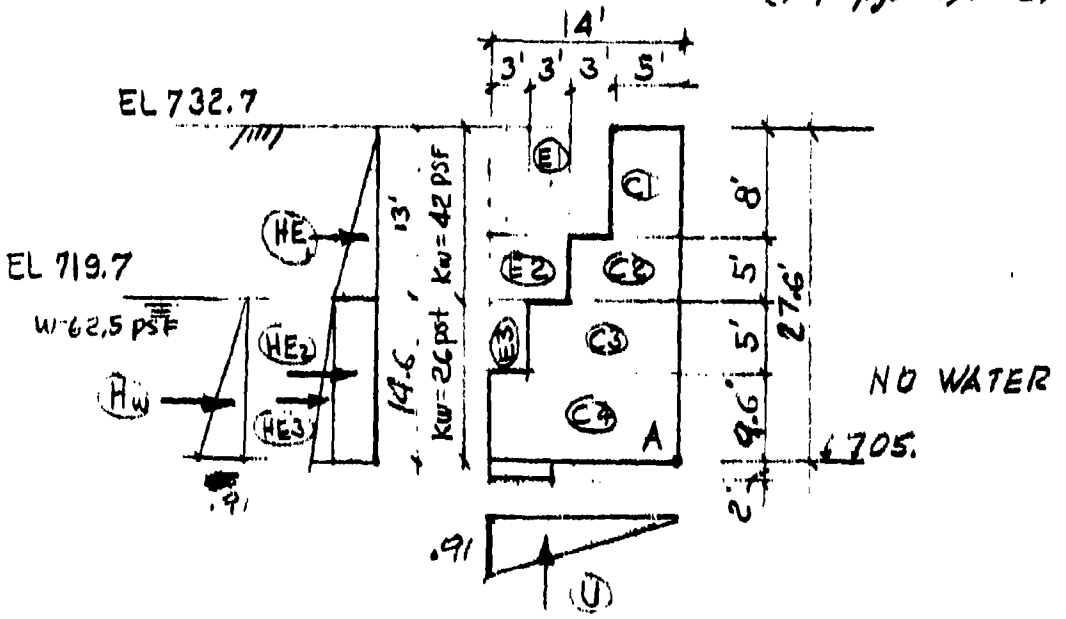
$a = \frac{120.3}{36.7} = 3.28$ $\qquad f_{soil} = \frac{2}{3}\left(\frac{36.7}{3.28}\right) = 7.4$

$e = 7.0 - 3.28 = 3.72$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT UPPER GUIDE WALL STABILITY, CONSTRUCTION CONDITION COMPUTED R.N.M CHECKED JJ	PROJECT LOCK & DAM N 21 FILE NO. 800 A DATE 2/'75 PAGE 5a OF ____ PAGES

(16). STABILITY OF UPPER GUIDEWALL MONOLITHS 1-5 DURING CONSTRUCTION PERIOD.

Riverward side empty (Inside cofferdain enclosure)
Landward side W.S. EL. 719.7 (Ref. pgs 3, 4 & 5)



1) "R" outside middle 1/3 [redacted] by [redacted] 1.89 ft

2) $\frac{\Sigma H}{\Sigma V}$ = 0.44

3) f_{soil} = 11.34 KSF

4) FSS = 1.41

5) FSOT = 1.57

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT UPPER GUIDE WALL MONOLITHS 3 & 5 (CONSTRUCTION)

COMPUTED R.N.M. CHECKED VV

PROJECT LOCK & DAM NO. 1

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CONSTRUCTION CONDITION (cont'd

FORCES		H → ⊕	V ↓ ⊕	ARM	$\overrightarrow{M_A}$	$\overleftarrow{M_A}$
C1			+ 6.0			15.0
C2			+ 6.0			24.0
C3			+ 8.3			45.6
C4			+ 20.2			141.1
E1			+ 7.9			75.2
E2	0.11 × 6 × 5.0		+ 3.3	11.0		36.3
E3			+ 2.0			25.0
U	14.6 × .0625 × 14 × ½		− 6.4	9.3	59.5	
HE1	0.042(13)² × ½	+ 3.5		18.9	66.2	
HE2	0.042(13) × 14.6	+ 8.0		7.3	58.4	
HE3	0.026(14.6)² × ½	+ 2.8		4.9	13.7	
HW	0.0625(14.6)² × ½	+ 6.7		4.9	32.8	
		ΣH = + 21.0	ΣV = 47.3		230.6	362.2
					ΣM_A =	131.6 ↑

$\bar{X} = \frac{131.6}{47.3} = 2.78$ $\quad e = 7 - \bar{X} = 4.22'$ $\quad \frac{L}{6} = 2.33$

(1) Resultant outside middle $\frac{1}{3}$ " 1.89 ft

(2) $f_{soil} = \frac{2}{3}\frac{\Sigma V}{X} = \frac{2}{3} \times \frac{47.3}{2.78} = 11.34$ KSF

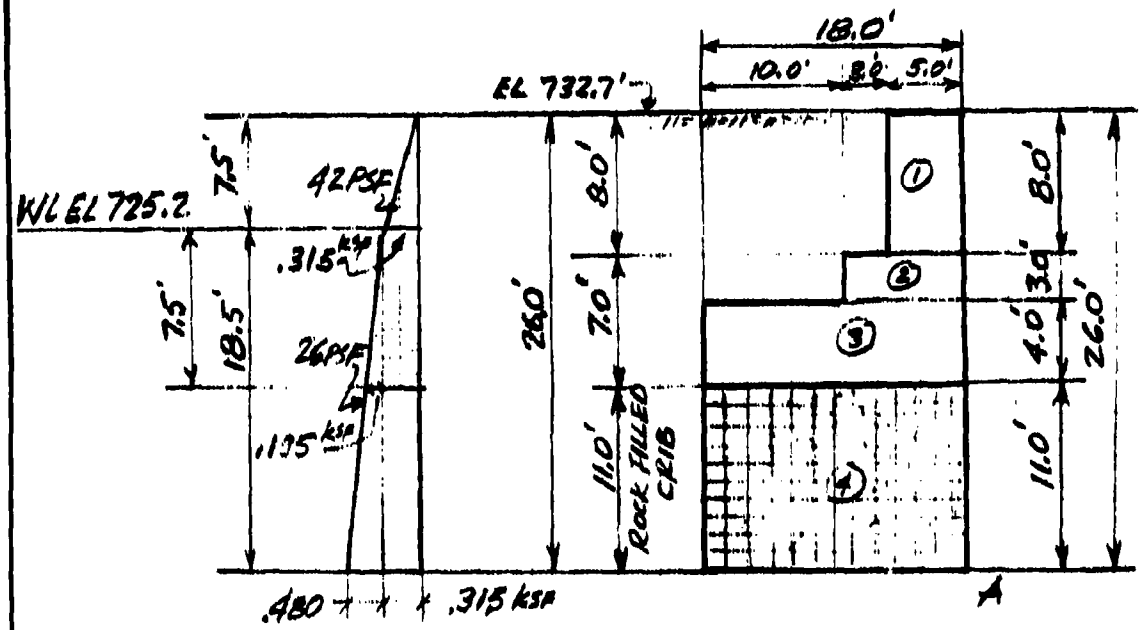
(3) $\frac{\Sigma H}{\Sigma V} = \frac{21.0}{47.3} = 0.44$

(4) FSS = 1.41

(5) FSOT = $\frac{362.2}{230.6} = 1.57$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILITY OF UPPER LAND GUIDE WALL	PROJECT L&D #1
	COMPUTED M.J. CHECKED R.N.M.	FILE NO. 800A
		DATE 8.74 PAGE 6 OF ____ PAGES

UPPER (LAND) GUIDE WALL - MONOLITHS #8-13



$\Sigma V = 34.70^k \quad \Sigma H = 11.40^k$

$M_A = 194.0^{ft\text{-}k} \quad a = \frac{194.0}{34.70} = 5.60' \quad e = 3.4'$

1/. $R = 37.8^k$ OUTSIDE MIDDLE ⅓ BY 0.4'

2/. $\frac{\Sigma H}{\Sigma V} = .33 (< .417\ ok)$

3/. $FSS = \frac{34.1 \times .625}{11.40} = 1.90$

4/. $f_{SOIL} = 4.13\ ksf$

5/. $FSOT = 2.06$

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT STABILITY OF UPPER LAND GUIDE WALLS

PROJECT L&D #1

FILE NO 800A

COMPUTED M.J. CHECKED R.N.M.

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UPPER LAND GUIDE WALL - MONOLITHS #8-13

	LOADS IN KIPS	VERT ↓	VERT ↑	HORIZ. →	HORIZ. ←	ARM	MOM$_A$ ↻	MOM$_A$ ↺
C_1	8.0×5.0×.15	6.0				2.5		15.0
C_2	8.0×3.0×.15	3.6				4.0		14.6
C_3	18.0×4.0×.15	10.8				9.0		97.2
C_4	18.0×11.0×(.10-.063)	7.4				9.0		66.6
E_1	13.0×8.0×.11	11.5				11.5		132.3
E_2	3.0×10.0×.13	2.9				13.0		50.8
W_1	7.5×.0625×18.0		8.5			9.0	76.5	
H_{E1}	.315×3.75			1.2		21.0	25.3	
H_{E2}	.315×18.5			5.8		9.25	53.6	
H_{E3}	.48×18.5/2			4.4		6.17	27.2	
		43.2	8.5	11.4			182.6	376.5

$\Sigma V = 43.2 - 8.5 = 34.7^k$

$\Sigma M = 376.5 - 182.6 = 194.0^{'k}$

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT STABILITY OF UPPER GUIDE WALLS

COMPUTED M.T. CHECKED R.N.M.

PROJECT LFD #1

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UPPER LAND GUIDE WALL - MONOLITHS #8 - #13

$\Sigma V = 34.70^k$

$\Sigma H = 11.40^k$

$\Sigma M = 194.0$ ↺

$a = \frac{194.0}{34.70} = 5.60$

$e = 9.0 - 5.6 = 3.4$

$Me = 34.70 \times 3.4 = 118.0^{tk}$

1. RESULTANT OUTSIDE MIDDLE THIRD BY 0.4'

2. $\frac{\Sigma H}{\Sigma V} = \frac{11.90}{34.70} = .33$

3. $FSS = \frac{34.70 \times .625}{11.40} = 1.90$

4. $f_{SOIL} = \frac{2}{3} \times 34.70/5.6 = 4.13\ KSF$

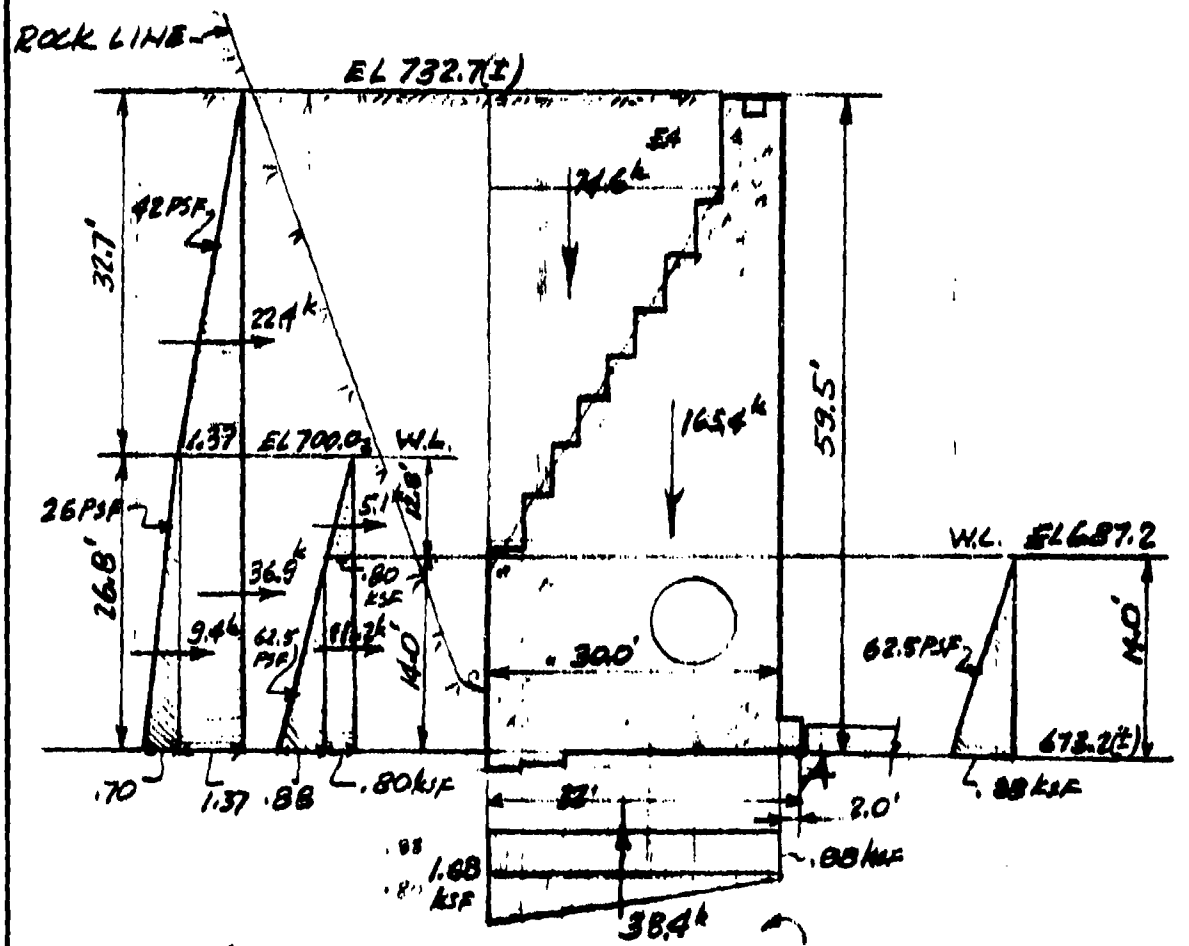
5. $FSOT = \frac{376.5}{182.6} = 2.06$

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL MONOLITHS	PROJECT L & D #1
		FILE NO 900A
	COMPUTED M.J. CHECKED R.N.M.	DATE 1974 PAGE 9 OF ____ PAGES

W.S. EL. 700' (LANDWARD)

LANDWALL MONOLITHS #5-15 - EXISTING CONDITION



$\Sigma V = 202.0^k$ $\Sigma H = 85.0^k$ $\Sigma M_A = 1647.0^{ft\text{-}k}$

1). $R = 218.0^k$ OUTSIDE MIDDLE ⅓ BY 2.52

2). $\frac{\Sigma H}{\Sigma V} = .422$

3). $f_{SOIL} = 16.5$ ksf

4). $FSS = \frac{202.0 \times .625}{85.0} = 1.49$

5). $FSOT = 1.68$

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT LANDWALL 5-15
EXISTING - NORMAL
COMPUTED R.N.M. CHECKED JJ

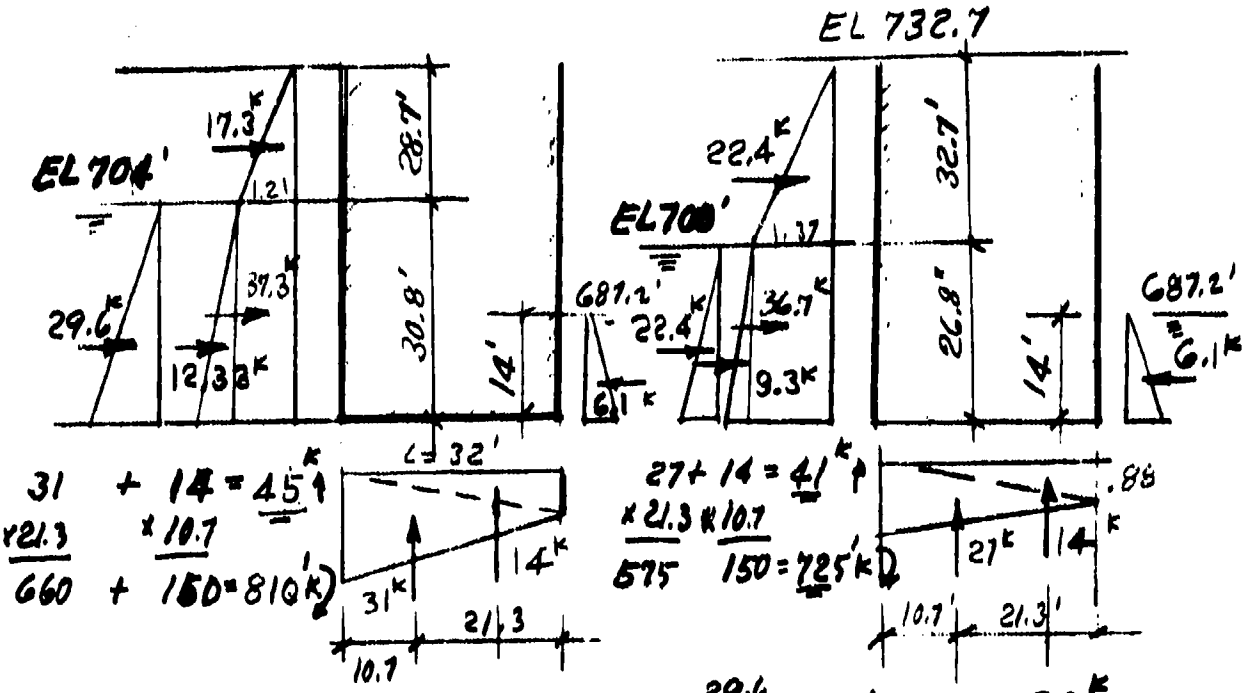
PROJECT L & D #1
FILE NO 800 A
DATE 1/'75 PAGE 10 OF ____ PAGES

W.S. EL 704' (LANDWARD)

LANDWALL MONOLITHS 5 -15
NORMAL OPERATING, EXISTING CONDITION

Added hor. force — friction from w.b. of submerged slab, $P_R = 2 \times 56 \times .088 \times .55 = 5^K \leftarrow$

Compute difference in earth + hydrostatic pressures:



31 + 14 = 45K ↑
×21.3 ×10.7
660 + 150 = 810'K ↻

27 + 14 = 41K ↑
×21.3 ×10.7
575 + 150 = 725'K ↻

$\Sigma H_{704} = 17.3 + 37.3 + 12.3 + 29.6 - 6.1 = 90.4^K \rightarrow$

$\Sigma M_{A\,704} = 700 + 574 + 127 + 305 - .29 + 810 = 2487'K \circlearrowright$

$\Sigma H_{700} = 22.4 + 36.7 + 9.3 + 22.4 - 6.8 = 84.7^K \rightarrow$

$\Sigma M_{A\,700} = 844 + 492 + 83 + [illegible] - 29 + 725 = 2314'K \circlearrowright$

$\Delta H = 90.4 - 84.7 - 5 = 0.7^K \rightarrow$

$\Delta V = 45 - 41 = 4^K \uparrow$

$\Delta M_A = 2487 - 2314 = 173'K \circlearrowright$

Cont'd on Pg 10 a

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL SM-15 EXISTING - NORMAL	PROJECT L & D #1
	COMPUTED R.N.M. CHECKED JI	FILE NO. 800A
		DATE 1/'75 PAGE 104 OF ____ PAGES

W.S. EL. 704'

LANDWALL MONOLITHS SM-15
NORMAL OPERATING, EXISTING CONDITION (CONT'D)

From page 11, $\Sigma H' = 85^k \rightarrow$, $\Sigma V' = 202^k \downarrow$, $\Sigma M_A' = 1647'^k$) For W.S. EL 704, without Pr

$\Sigma H = 85 + .7 = 85.7^k$

$\Sigma V = 202 + (-4) = 198^k$

$\Sigma M_A = -1647 + 173 = -1474^k$

(1) $a = \frac{1474}{198} = 7.44'$ $e = \frac{L}{2} - a = 8.56$
-5.33 ... 4/L

Location of Resultant 3.23' Outside middle 3rd.

(2) $\frac{\Sigma H}{\Sigma V} = \frac{85.7}{198} = 0.43$

(3) $FSS = \frac{198 \times .625}{85.7} = 1.44$

(4) $f_{soil} = \frac{2}{3} \times \frac{198}{7.44} = 17.74$ KSF

(5) $FSOT = \frac{4051}{2404 + 173} = 1.57$

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT LANDWALL MONOLITHS | PROJECT LED #1

FILE NO. 800A

COMPUTED M. T. CHECKED R.N.M. | DATE 11.74 PAGE 11 OF ____ PAGES

W.S. EL. 700' (LANDWARD)

LANDWALL MONOLITHS #5-15 - EXISTING CONDITION

$E_4 = 24.0 \times 7.5 \times .13 = 23.40^k$ (REF: CASE FOR LOWERING BACK FILL BY 10.0')

$\Sigma V = 202.0^k$ (222.8 - 44.6 + 23.4)

$\Sigma H = 85.0$

$\Sigma M_A = 3583.5 - 808.0 + 2340 \times 20.0 - 1596 = 4051 - 2404$

$\Sigma M_A = 1647.0^{ft}$

$a = \frac{1647.0}{202.0} = 8.15'$

$e = 16.0 - 8.15 = 7.85'$

1). RESULTANT $R = 218.0^k$ OUTSIDE MIDDLE $\frac{1}{3}$ BY 2.52'

2). $\frac{\Sigma H}{\Sigma V} = \frac{85.0}{202.0} = 0.422$

3). $f_{SOIL} = \frac{2}{3} \times 202.0 / 8.15 = 16.60\ ksf$

4). $FSS = \frac{202.0 \times .625}{85.0} = 1.49$

5). $FSOT = \frac{4051}{2404} = 1.68$

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT LANDWALL 5-15
EXISTING - MAINTENANCE
COMPUTED R.N.H CHECKED JI

PROJECT LOCK & DAM #1
FILE NO 800 A
DATE 3/1/75 PAGE 12 OF ____ PAGES

W.S. EL 704 (LANDWARD)

LANDWALL MONOLITHS 5-15

MAINTENANCE LOADING — LOCK EMPTY
— EXISTING BACKFILL @ EL 732.7
— (REFER TO NORMAL LOADING)
— FRICTION BETWEEN SLAB & ROCK

REFERENCE PAGES 10 & 10a

$\Sigma H = 91 + 6.8 = \underline{97.8}$ kips →

$\Sigma V = 198 + 14 = \underline{212.0}$ kips ↓

$\Sigma M_A = -1473 + (-150) + 33 \} = -\underline{1590}$ 'K }

(1) $a = \frac{1590}{212} = 7.5'$ · $\frac{L}{2} - a = e = \underline{8.5'}$

· "R" OUTSIDE M 1/3 ; 3.2 H.

(2) $\frac{\Sigma H}{\Sigma V} = \frac{97.8}{212} = \underline{0.46}$

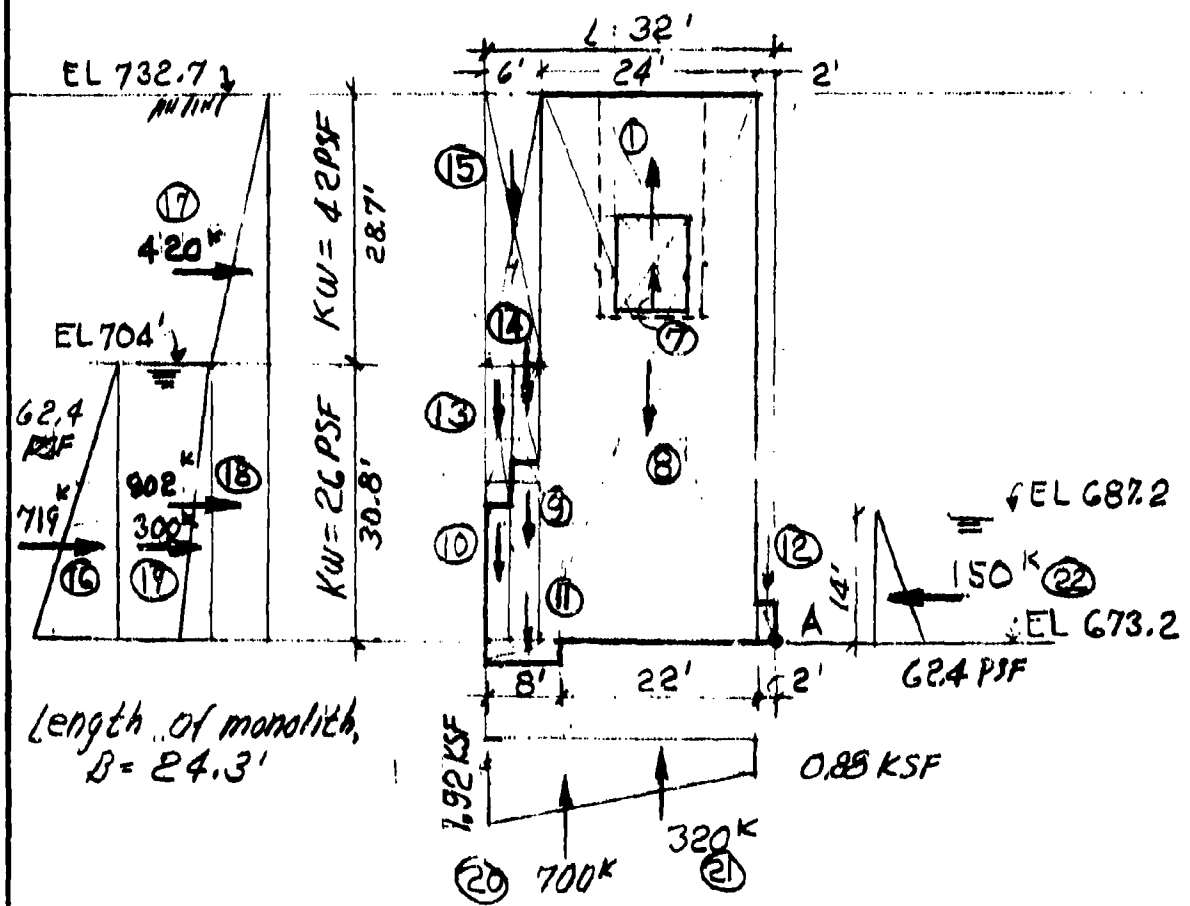
(3) FSS = 1.35

(4) $f_{soil} = \frac{2}{3} \times \frac{212}{7.5} = \underline{18.84}$ KSF

(5) $FSOT = \frac{4051}{2578 + 150 - 33} = \underline{1.5}$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL STABILITY- EXISTING CONDITION COMPUTED R. N. M. CHECKED J.L.	PROJECT LOCK & DAM NO. 1 FILE NO 800 A DATE 2/1/75 PAGE 104 OF ____ PAGES

MONOLITH NO. 3, NORMAL LOADING CASE (PRESENT)



(1) Resultant 3.73 ft. outside middle 1/3

(2) f_{soil} = 13.41 KSF

(3) $\frac{\Sigma H}{\Sigma V}$ = 0.461

(4) FSS = 1.36

(5) F.S.O.T. = 1.54

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT LANDWALL STABILITY - EXISTING CONDITION
COMPUTED R.N.M. CHECKED J.L.

PROJECT LOCK & DAM NO. 1
FILE NO 800 A
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MONOLITH NO. 3, NORMAL LOADING CASE (CONT'D)

	H →⊕	V ↓ ⊕	ARM	M_{Y-Y}
(17) (28.7²/₂) .042 (24.3)	1420		40.4	+16981
(18) 28.7 x .042 x 30.8 x 24.3	902		15.4	+13893
(1) 14 x 14 x 24 (-0.15)		-706	2	+ 1412
(7) 11.5 x 11 x 9 (-0.15)		-170	2	- 340
		-876		
(8) TO (12) "FR. TEMP. CONST."		+5641	(0.93)	+5237
(15) 6 x 28.7 x 24.3 x 0.11		+ 460	13'	- 5980
(13) & (14) FROM TEMP. CONST.		+ 261		- 3463
(16) and (19) FR. TEMP. CONST.	+ 1019			+10496
(Pp) 2 x 56 x 0.088 x 24.3 x .55	- 132	—	—	—
(20) 1.92 x 30 x ½ x 24.3		-700	6'	+4200
(21) 0.88 x 30 x ½ x 24.3		-320	4	- 1280
(22) 14² x ½ x 0.0625 x 24.3	- 150		4.67	- 700

$\Sigma H = +2059$ $\Sigma M_{Y-1} = +40456$

$\Sigma V = 4466^K$

$\leftarrow = \frac{40456}{4466} = 9.04 > \frac{L}{6}, \quad 5.33, \quad 9.06 \quad \bar{X} = 6.94$

(1) RESULTANT IS 3.73 OUTSIDE MIDDLE 3rd

(2) $f = \frac{2}{3}\frac{\Sigma V}{A} = \frac{2}{3}\frac{4466}{6.94 \times 32} = 13.41$ KSF

(3) $\frac{\Sigma H}{\Sigma V} = \frac{2059}{4466} = 0.461$ $40456 - 43590 = -3134$

$\frac{3134}{5486} = 0.57$ $\frac{16.0}{16.57}$

(4) FSS = $\frac{.625}{.461} = 1.36$ RESIST $M = 5486 \times 16.57 = 90903$

(5) F.S.O.T. = 1.54 OVERT. $M_A = 43590 - 2980 + 320 \times \frac{2}{3} \times 32 + 200 \times \frac{2}{3} \times 32 = 59017$ 'K

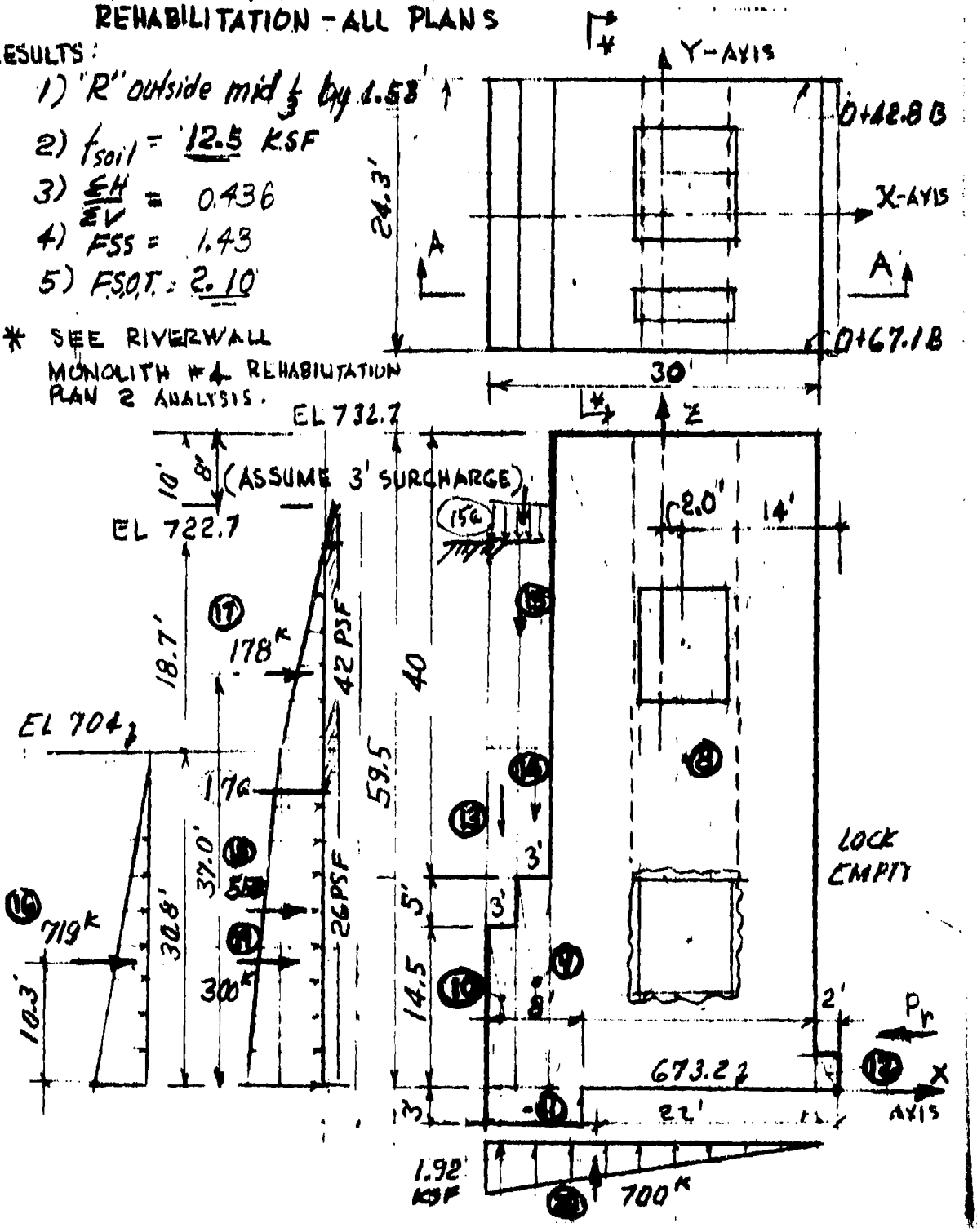
HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LAND WALL STABILITY – TEMPORARY CONSTRUCTION COMPUTED R.N.M. CHECKED JJ	PROJECT LOCK & DAM #1 FILE NO 800 A DATE 2/'75 PAGE 10C OF ____ PAGES

LANDWALL MONOLITH NO. 3 REHABILITATION - ALL PLANS

RESULTS:

1) "R" outside mid ⅓ by 1.58'
2) f_{soil} = 12.5 KSF
3) $\frac{\Sigma H}{\Sigma V}$ = 0.436
4) FSS = 1.43
5) FS.O.T. = 2.10

* SEE RIVERWALL MONOLITH #4 REHABILITATION PLAN 2 ANALYSIS.



HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL STABILITY - TEMPORARY CONSTRUCTION COMPUTED R.N.M. CHECKED JJ	PROJECT LOCK & DAM NO. 1 FILE NO 800 A DATE 2/'75 PAGE 10d OF ____ PAGES

LANDWALL MONOLITH NO. 3

REHABILITATION - ALL PLANS (con'd)

		H → (+)	V ↓ (+)	ARM	M_Y (+)
(1) To (7)	See intermediate wall monolith No. 3, Rehabilitation Plan 2 Analysis		-1386	2.0	- 2772
(8)	59.5 x 24 x 24.3 x 0.15		5205	2.0	+ 10410
(9)	19.5 x 3 x 24.3 x 0.15		213	11.5	- 2450
(10)	14.5 x 3 x 24.3 x 0.15		159	14.5	- 2306
(11)	8 x 3 x 24.3 x .088		51	12.0	612
(12)	2 x 3 x 24.3 x .088		13	15.0	+ 195
(13)	16.3 x 3 x 24.3 x .13		154	14.5	- 2233
(14)	11.3 x 3 x 24.3 x .13		107	11.5	- 1230
15	18.7 x 6 x 24.3 x .11		300	13.0	- 3900
(15a)	3.0 x 6.0 x 24.3 x 0.11		48	13.0	- 625
			(4864)	1.14	(5523)
(17a)	2 x .042 x 50 x 24.3	+ 102	1	25	+ 2552
(16)	$30.8^2 \times \frac{1}{2} \times .0624 \times 24.3$	+ 719		10.3	+ 7406
(17)	$18.7^2 \times \frac{1}{2} \times .042 \times 24.3$	+ 178		37.0	+ 6586
(18)	18.7 x .042 x 30.8 x 24.3	+ 588		15.4	+ 9055
(19)	$30.8^2 \times \frac{1}{2} \times .026 \times 24.3$	+ 300		10.3	+ 3010
H_S	.042 x 3 x 49.5 x 24.3	+ 152		24.8	+ 3770
P_h*	2 x 56 x 0.15 x 24.3 x .55	- 224		—	—
20	1.92 x 30 x ½ x 24.3		- 700	6.0	+ 4200
		+ 1815 K			31136
		+ ~~1913~~	+ 4164		+ ~~28504~~

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL STABILITY - TEMPORARY CONSTRUCTION COMPUTED R.N.M. CHECKED JJ	PROJECT LOCK & DAM NO. 1 FILE NO 800 A DATE 2/'75 PAGE 10e OF PAGES

LANDWALL MONOLITH NO. 3
REHABILITATION - ALL PLANS (CONT'D)

$\Sigma H = \cancel{1718}\ 1815^{k}$ $\quad \Sigma V = 4164^{k}$ $\quad \Sigma M_y = \cancel{29594}\ 31136^{'k}$

(1) $e_x = \dfrac{\cancel{29594}\ 31136}{4164} = \cancel{7.11'}\ 7.47'$

$\dfrac{L}{6} = \dfrac{5.33}{2.14}$

Resultant, $\cancel{1.53}$ outside middle $\frac{1}{3}$

(2) $\bar{X} = \dfrac{L}{2} - e = \cancel{2.14'}\ 8.53'$

$f_{soil} = \dfrac{2}{3} \times \dfrac{4164}{24.3 \times \cancel{9.14}\ 8.53} = \cancel{18.5}\ 13.39\ KSF$

(3) $\dfrac{\Sigma H}{\Sigma V} = \dfrac{\cancel{1718}\ 1815}{4164} = 0.436$

(4) $FSS = 1.43$

(5) ΣM_A (Resisting) $= 4864\ (7.14 + 16) = 83369\ 'k$

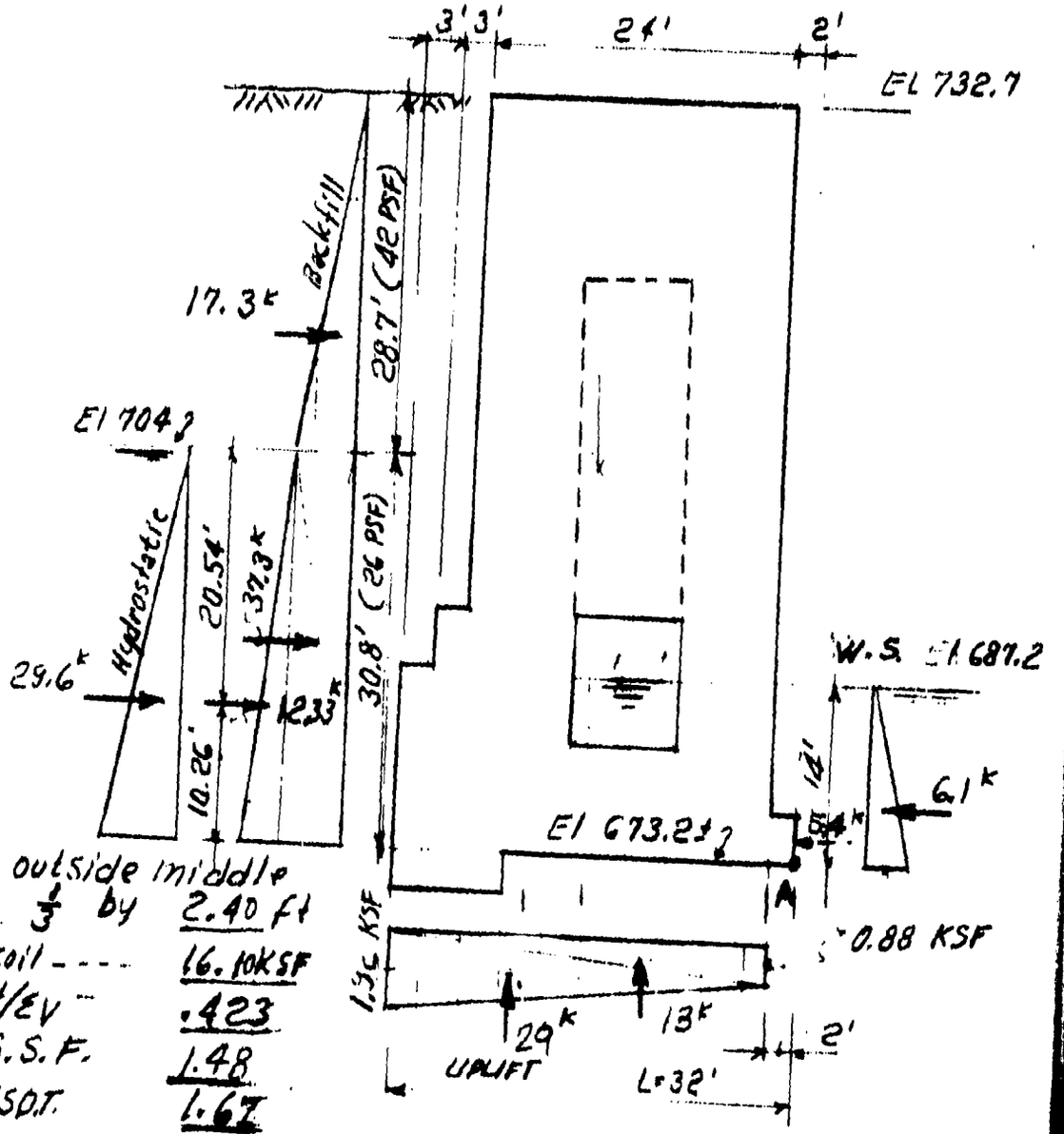
ΣM_A (Overturning) $= \cancel{24384}\ 24384 \times 1.03 \times (7.14 + 16) + 2552 = \cancel{39784}\ 42336\ 'k$

$FSOT = \dfrac{83369}{\cancel{39784}\ 42336} = \cancel{2.10}\ 1.97$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL STABILITY - EXISTING CONDITION COMPUTED R. N. M. CHECKED JJ	PROJECT LOCK & DAM No 1 FILE NO. 800A DATE 3/'75 PAGE 10K OF ____ PAGES

MONOLITH No 3
NORMAL LOADING
(WITHOUT STABILIZATION)

CONDUIT IS LOWERED AND 2 GATE SHAFTS ARE FILLED WITH CONCRETE



1) R outside middle 3/4 by 2.40 ft
2) f_{soil} ---- 16.10 KSF
3) EH/EV -- .423
4) S.S.F. 1.48
5) F.S.O.T. 1.67

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL STABILITY - EXISTING CONDITION COMPUTED R.N.M. CHECKED JJ	PROJECT LOCK & DAM #1 FILE NO 800 A DATE 3/'75 PAGE 10 2 OF ____ PAGES

MONOLITH NO. 3
NORMAL LOADING (CONT'D)

This page is refered to: a) P_g 10a, for Hydrostatic and earth pressures
b) P_g 35c, for completed 8'x10' conduit geometry.
c) P_g 10c, for Dead load

(Analyzed per foot strip of wall)

Forces	H (+→)	V (+↓)	ARM	M_A (+↻)
Net horizontal	90.4 k			
Uplift		-29 k	22.0	2468 k
Water in lower conduit: $10 \times 6 \times 8 \times .0625 \times \frac{1}{24.3}$		-13 k	12.0	
		+ 2 k	14.0	- 28 k
10'x8' Conduit space: Approx. length = 37' $80 \times 37 \times (-0.15) = 444^k$ Equiv. per foot = $\frac{444}{24.3}$ =		- 19 k	14.0'	+ 266'k
Dead load: ⑧ to ⑭ = $\frac{5641+261}{24.3}$		+ 243 k	15.7' *	- 3815 'k
⑮ $28.7 \times 6 \times .11$		+ 19 k	29.0'	- 551 'k
P_R	- 5.4 k			
Σ's	85 k	201 k		M_{Re} = -4128'k
				M_{ov} = 2468
				ΣM_A = -1660'k

* $\frac{M_4}{\downarrow} \frac{1774}{5902}$ = 0.3' from ℄
Arm = 16 - .3 = 15.7

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT LANDWALL STABILITY- EXISTING CONDITION
COMPUTED R.N.M. CHECKED JJ

PROJECT LOCK & DAM No 1
FILE NO. 800 A
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MONOLIT Nº 3

NORMAL LOADING (CONT'D)

$\Sigma H = 85$ K →
$\Sigma V = 201$ K ↓
$\Sigma M_A = 1660$ 'K)

$L = 32'$ $\frac{L}{6} = 5.33'$

$B = 1'$

$a = \frac{\Sigma M_A}{\Sigma V} = 8.30'$; $e = \frac{L}{2} - a = 7.70$

(1) Resultant is outside the middle 1/3 by 2.40 feet

(2) $f_{soil} = \frac{2}{3}\frac{\Sigma V}{a} = \frac{2}{3}\frac{201}{8.3} = 16.10$ KSF

(3) $\frac{\Sigma H}{\Sigma V} = \frac{85}{201} = 0.423$

(4) $SSF = \frac{0.625}{\Sigma H/\Sigma V} = 1.48$

(5) $F.S.O.T. = \frac{M_{Re}}{M_{ov}} = \frac{4128}{2468} = 1.67$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL STABILITY TEMPORARY CONSTRUCTION	PROJECT LOCK & DAM #1
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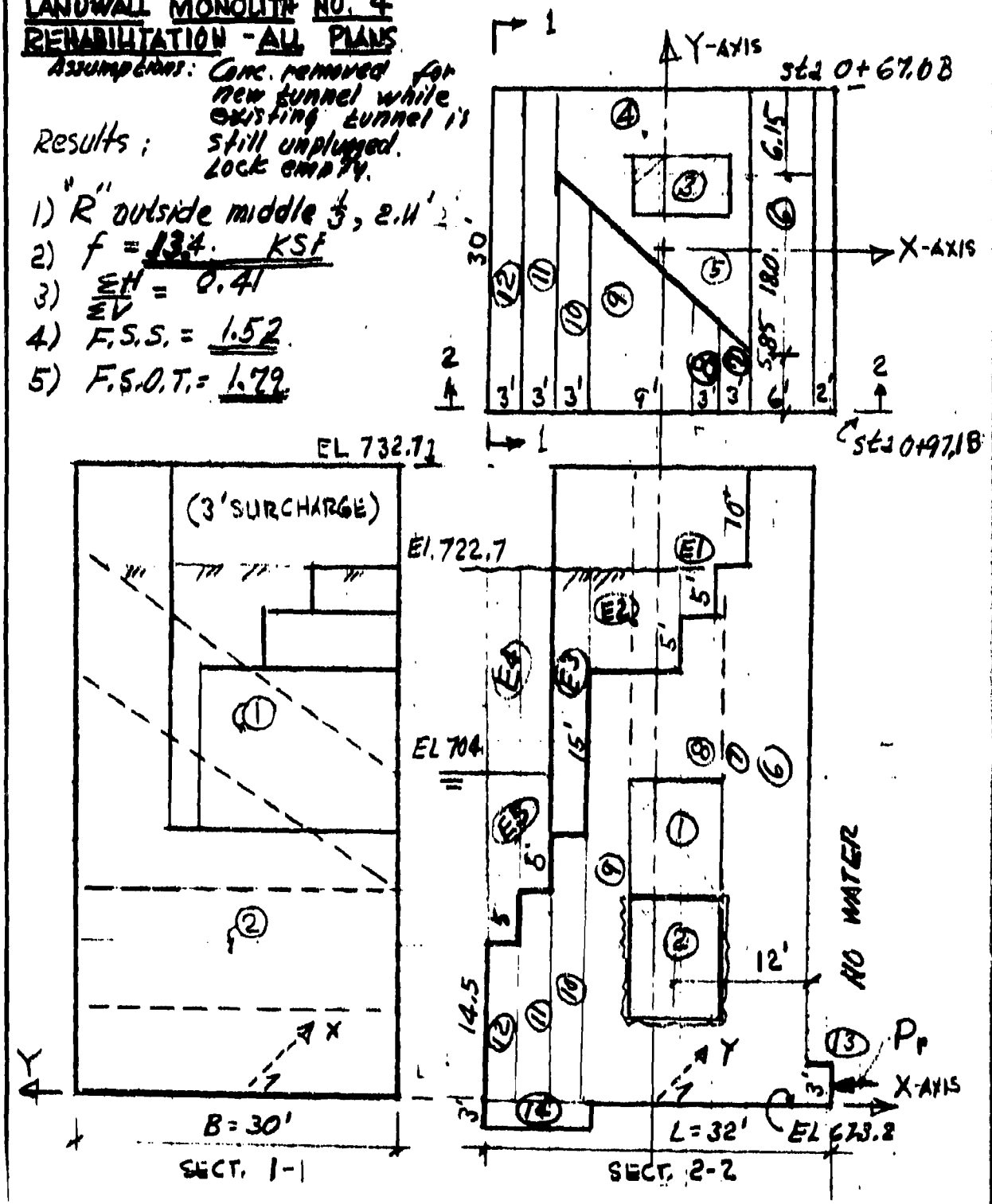
LANDWALL MONOLITH NO. 4 REHABILITATION - ALL PLANS

Assumptions: Conc. removed for new tunnel while existing tunnel is still unplugged. Lock empty.

Results;

1) "R" outside middle ⅓, 2.11'
2) f = 134. KSF
3) $\frac{\Sigma H}{\Sigma V}$ = 0.41
4) F.S.S. = 1.52
5) F.S.O.T. = 1.79



HARZA ENGINEERING COMPANY CHICAGO

SUBJECT LANDWALL STABILITY - TEMPORARY CONSTRUCTION

COMPUTED R.N.M. CHECKED JJ

PROJECT LOCK & DAM #1

FILE NO. 800 A

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LANDWALL MONOLITH NO. 4 REHABILITATION -- ALL PLANS (CONT'D)

	Concrete and soil	H	V	Y	X	M_x (+)	M_y (+)
(1)	11 x 9 x 35 x (-0.15)		-520	0	+2.0	—	-1040
(2)	11 x 9 x 30 (-0.15)		-446	0	+2.0		-892
(3)	10 x 5 x 40 (-0.15)		-800	+5.5	+2.0	+1650	-600
			(1266)			(1650)	(2532)
(4)	18 x 6.15 x 59.5 x 0.15		+988	+12.0	-1.0	-11856	-988
(5)	18 x 18 x ½ x 59.5 (0.15		+1446	+2.85	+2.0	-4121	+2892
(6)	6 x 30 x 59.5 (0.15		+1607	0	+11.0	-0	+17677
(7)	3 x 7.35 x 49.5 x 0.15		+164	-11.3	+6.5	+1853	+1066
(8)	3 x 10.35 x 44.5 x 0.15		+207	-10.-	+3.5	+1925	+725
(9)	9 x 16.35 x 39.5 x 0.15		+872	-7.5	-2.5	+6540	-2180
(10)	3 x 22.35 x 24.5 x 0.15		+246	-4.0	-8.5	+984	-2091
(11)	3 x 30 x 19.5 x 0.15		+263	0	-11.5	—	-3025
(12)	3 x 30 x 14.5 x 0.15		+196	0	-14.5	—	-2842
(13)	2 x 3 x 30 x (0.08.9)		+16	0	+15.0	—	+240
(14)	8 x 3 x 30 (0.08.9)		+64	0	-12.0	—	-768
			(2069			(2478)	(10706)
(E1)	3 x 5 x 10.35 x 0.11		+17	-10.0	+3.5	+167	+60
(E2)	9 x 10 x 16.35 x 0.11		+162	-7.5	-2.5	+1215	-405
(E3)	3 x 25 x 22.35 x 0.11		+184	-4.0	-8.5	+936	-1564
(E4)	6 x 30 x 18.7 x 0.11		+370	0	-13.0	—	-810
(E5)	6 x 18.8 x 30 x 0.13		+328	0	-13.0	—	-199
			(1056)			(2118)	(-1918)
(S1)	30 x 6.0 x 30. x .11		+59	0	-13.-	—	-767
(S2)	30 x 18 x 18 x ½ x .11		+53	-3.15	-4.-	+167	-212
(S3)	3 x 6 x 24. x .11		+46	-12.08	-1.0	+556	-46
			(+158)			(+723)	(-1025)
			+6017			-184	-3769

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HARZA ENGINEERING COMPANY CHICAGO

SUBJECT LANDWALL STABILITY - TEMPORARY CONSTRUCTION
COMPUTED R.N.M. CHECKED JI

PROJECT LOCK & DAM #1
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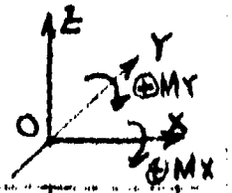
LANDWALL MONOLITH NO. 4
REHABILITATION - ALL PLANS (Cont'd)



Soil pressure, Hydrostatic Uplift and Surcharge	H	V ↓⊕	ARM	Mx	My
Carried fr. preceeding pg.		+6017		-184	-3769
(16) $719 \times \frac{30}{24.3}$	+888		10.3	—	+9146
(17) $178 \times \frac{30}{24.3}$	+220		37.0	—	+8140
(18) $588 \times \frac{30}{24.3}$	+726		15.4	—	+11180
(19) $300 \times \frac{30}{24.3}$	+370		10.3	—	+3811
(20) $700 \times \frac{30}{24.3}$		-864	6.0	—	+5184
(21) $152 \times \frac{30}{24.3}$	+188		24.8	—	+4662
(22) Reaction in 2' slab (See page ——)	-277	—	—	—	—
	ΣH 2115	ΣV = 5153		Σ Mx = -184	Σ My = +38354

(16)–(21): See Rehabilitation, all plans, Mon. #3

32277

$e_x = \frac{38354}{5153} = 7.44'$

$\frac{5153 - 5.33}{4/6} = 2.11'$

R = 2.11' outside the middle third

$e_y = \frac{-184}{5153} = +0.04''$

$f_{soil} = \frac{2.5 \times 5753}{30 \times 32} = 13.4$ KSF

$\frac{2x}{32} = 0.23$

$\frac{2x}{30} = 0.601$

} K = 2.5

$\frac{\Sigma H}{\Sigma V} = \frac{2115}{5153} = 0.41$

SSF = 1.52

$\Sigma M_R = \left(\frac{3761}{6017} + 1C\right)\frac{6017}{5573} = 100047$

$\Sigma M_{pert} = 32277 + 864 \times 22 + 4662 = 55947$

FSOT = 1.79

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT LANDWALL STABILITY - TEMPORARY CONSTRUCTION
COMPUTED R.N.M. CHECKED JJ

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LANDWALL MONOLITH NO. 4 - REHABILITATION, ALL PLANS (Cont'd)

FRICTION RESISTANCE FROM WEIGHT OF LANDLOCK SLAB

It is assumed that the 2' thick slab in landward lock is capable of supporting a transverse load, P_r, equal to the force of friction between slab and foundation derived from its own weight.

$$P_r = 2 \times 56 \times 0.15 \times 0.625 = 10.5^{K} \text{ per foot}$$

P_r is resisted by uniformly distributed frictional force and becomes zero at end of 56' slab. Actually, buckling is not possible because any moment developed from eccentricity between P_r & friction is overcomed by wt. of slab.

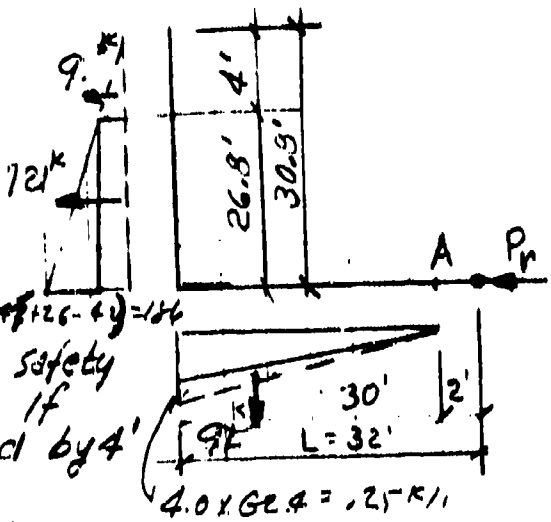
SSF FOR GROUND WATER BEHIND WALL @ El 700.

2165 − 9 − 121 = ΣH +1985^{K}

5153 + 91 = ΣV = 5244^{K}

$\frac{\Sigma H}{\Sigma V} = 0.38$

SSF = 1.64 ← Factor of safety against sliding if W.S. is lowered by 4'



HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL STABILITY- EXISTING CONDITION	PROJECT LOCK & DAM #1
	COMPUTED R.N.M. CHECKED JJ	FILE NO 800A
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MONOLITH Nº 4
NORMAL LOADING
(WITHOUT STABILIZATION)

CONDUIT IS LOWERED
2 NEW GATE SHAFTS
FULL OR UNIFORM CONCRETE SECTION (24' TOP WIDTH)

This case is referred to monolith 3, Lowered conduits existing, normal loading condition on pages 10K to 10 m.
The same outside geometry and loading prevails except that now, conduit is shorter and that, 2 gate shafts are added. Another assumption is that, the monolith is filled with concrete to the shape of monolith 3

Wt. of conduit space removed for monolith 3 (+)
plus water → = +19 − 2 = +17 K ↓

Wt. of conduit space for monolith 4
Void = −8 × 4 × 1 × .15 ..... −12. K
Water = +8 × 10 × 1 × .0625 = +3.0

Service gate shaft :
$\frac{7 \times 9 \times 40 \times (-0.15)}{30}$ (See 35 f) ... −12.6 K

Maintenance gate shaft
$\frac{3 \times 9 \times 40 \times (-0.15)}{30}$ ..... −5.4 K

$\Sigma H = 85^{K} \rightarrow$
$\Sigma V = 201 - 10 = 191.5^{K} \downarrow$
$\Sigma M_A = -1660 + 140 = 1520'^{K}$)

$\Delta V = -10.0 \uparrow$
$\times 14$
$\Delta M_A = 140'K$)+

$a = \frac{1520}{191.0} = 7.96$ $e = 16 - 7.96 = 8.04'$
(1) Resultant outside middle $\frac{1}{3}$. by 2.63
(2) $\frac{2}{3}\frac{\Sigma V}{7.96}$ = 16.0 KSF (3) $\frac{\Sigma M}{\Sigma V} = 0.445$
(4) SSF = 1.40 (5) FSOT = $(\frac{4128 - 140}{2468})\frac{1}{1.62}$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITIONS OF STABILITY OF LAND WALL	PROJECT LED #1
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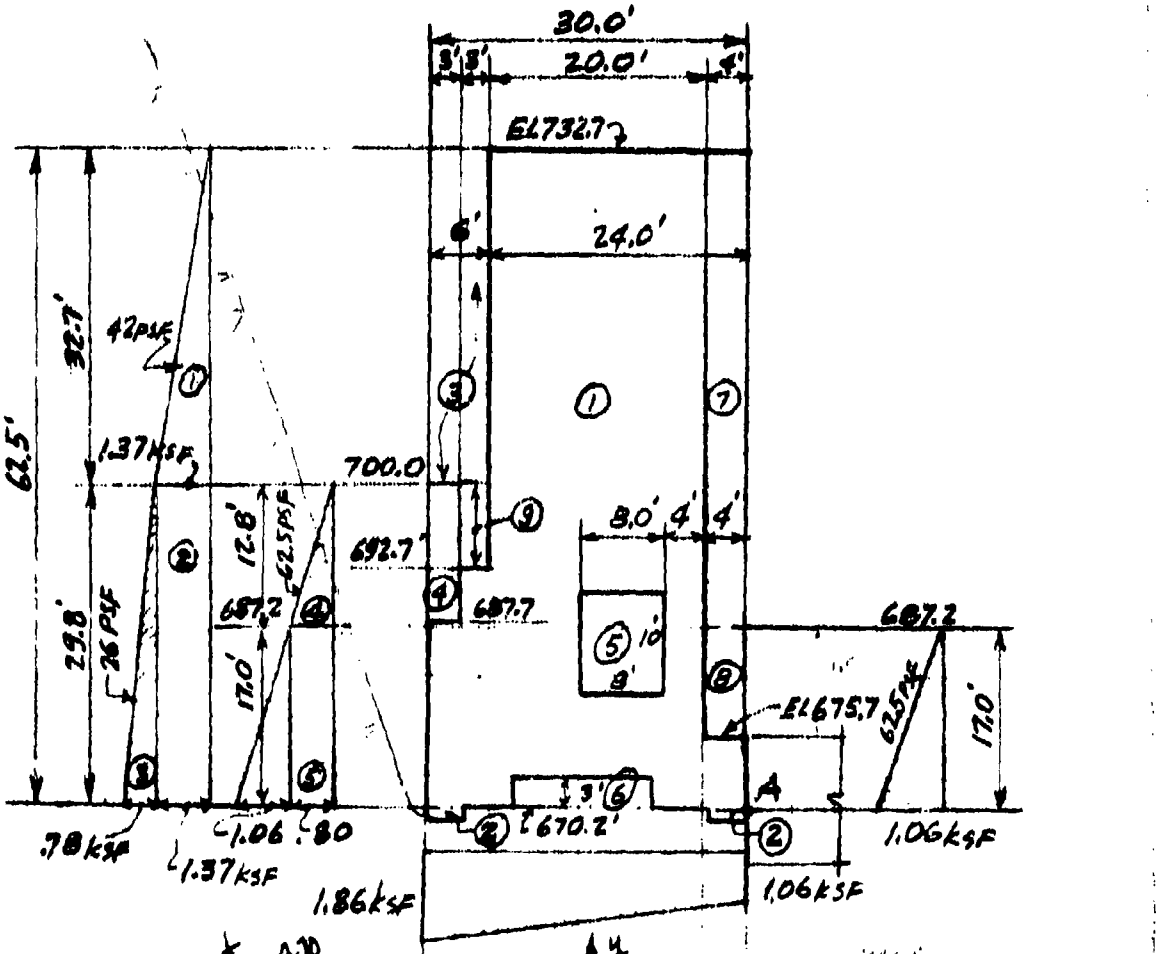
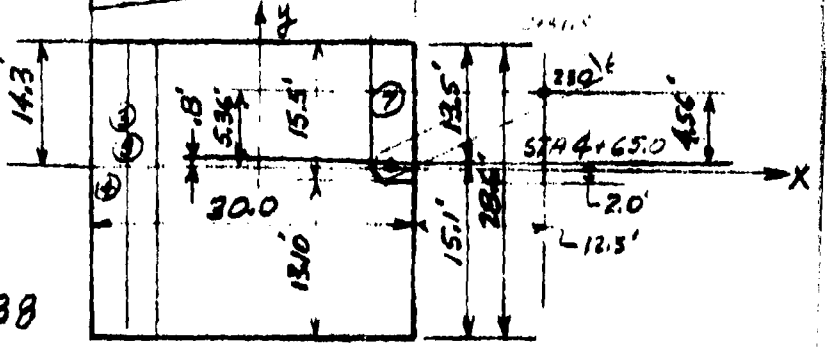
LANDWALL GATE MONOLITH #17 - EXISTING CONDITION





1. $E = 6500^{k}_{0LOPS} \sqrt{\frac{4.78}{2.2}} = 9685$

2. $\frac{\Sigma H}{\Sigma V} = \frac{2685}{5890} = .455$

3. $f_{SOIL} = 26.00 ksf$

4. $FSS = \frac{5810 + 625}{2685} = 1.38$

5. $FSOT = \frac{100690}{76920} = 1.41$

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT: EXISTING CONDITIONS OF STABILITY @ LAND WALL

COMPUTED M.J. CHECKED RNM

PROJECT LED #1

FILE NO 800A

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LANDWALL GATE MONOLITH #17 (CONTD)

	LOADS IN KIPS	V ↓	V ↑	H ←	H →	ARM	$M_{A_{yy}}$ ↺	$M_{A_{yy}}$ ↻
①	30×62.5×28.6×.15	8050				15.0		120,750
②	5×2×28.6×.087	25				15.0		375
③	32.7×6×28.6×.035		196			27.0	5300	
④	5×3×28.6×.020		9			28.5	257	
⑤	80×28.6×.6×.088		120			12.0	1440	
	80×28.6×.4×.150		137			12.0	1650	
⑥	13×3×28.6×.15		168			15.0	2530	
⑦	45.5×15.5×4×.15		423			2.0	846	
⑧	11.5×15.5×4×.087		62			2.0	124	
⑨	7.3×6.0×28.6×.020		25			27.0	675	
	Σ	8075	1140				12.821	121.125 ^k/_ft
		ΣV = 6935 ↓					ΣM = 108.304 ^k/_ft	

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT EXISTING CONDITIONS OF STABILITY OF LAND WALL

PROJECT L&D #1

FILE NO. 800A

COMPUTED M.J. CHECKED R.N.M.

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LANDWALL GATE MONOLITH #17 (CONT'D)

	LOADS IN KIPS	V ↓	V ↑	H ←	H →	ARM	M_A ↻	M_A ↺
W_1	30.0×28.6×1.06		912			15.0	13700	
W_2	30.0×28.6×.80×½		344			20.0	6880	
	GATE CLOSED, LOW WATER IN LOCK	230				12.5	2880	
							Σ 23,460	
H_1	1.37×16.35×28.6				643	40.7	26200	
H_2	1.37×29.8×28.6				1170	14.9	17500	
H_3	.39×29.8×28.6				338	9.9	3350	53,460
H_4	.40×17.8×28.6				145	21.27	3100	
H_5	.80×17.0×28.6				389	8.5	3310	
		Σ 230	1256		2685		76920	

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HARZA ENGINEERING COMPANY CHICAGO

SUBJECT EXISTING CONDITIONS OF STABILITY C LAND WALL

COMPUTED M.J. CHECKED R.N.M.

PROJECT LFD #1

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LANDWALL GATE MONOLITH #17 (CONT'D)

	LOAD IN KIPS	V ↓	V ↑	H ←	H →	ARM	M_{xx}
	GATE	230.0				5.36	-1230
(7)			423			6.55	+2780
		230	423				1550

SUMMARY OF LOADS

$\Sigma V = 8075 - 1140 + 230 - 1256 = 5910^{k}$

$\Sigma H_x = 2685^{k} \qquad R = 6500^{k}$

$\Sigma M_A = 121.125 - 12821 - 76920 = 31.384^{ik}$

$\Sigma M_{xx} = 1550^{ik}$

$a_x = \frac{31384}{5910} = 5.30 \qquad e = 15.0 - 5.30 = 9.70$

$e_y = \frac{1550}{5910} = 0.26'$

$A = 28.6 \times 30.0 = 858\ FT^2$

MAXIMUM SOIL PRESSURE

$f = \frac{2}{3}\frac{5910}{28.6 \times 5.50} = 26.00\ KSF$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITIONS OF STABILITY OF LANDWALL	PROJECT LED #1
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LANDWALL GATE MONOLITH #17 (CONT'D)

$\Sigma V = 6910^k \quad \Sigma H_x = 2685^k$

$\Sigma M_{yy} = 5910 \times 9.70 = 57,200^{ik}$

1. SOIL PRESSURE $f = 26.00$ KSF
2. $R = 6500.0^k$ OUTSIDE MIDDLE $\frac{1}{3}$ BY $\frac{4.10}{2} = 2.20'$
3. $\frac{\Sigma H}{\Sigma V} = \frac{2685}{5910} = .455$
4. $FSS = \frac{5910 \times .625}{2685} = 1.38$
5. $FSOT = \frac{108,304}{76920} = 1.41$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITIONS OF STABILITY C LAND WALL	PROJECT L & D #1
	COMPUTED M.J. CHECKED R.V.M.	FILE NO. 800A
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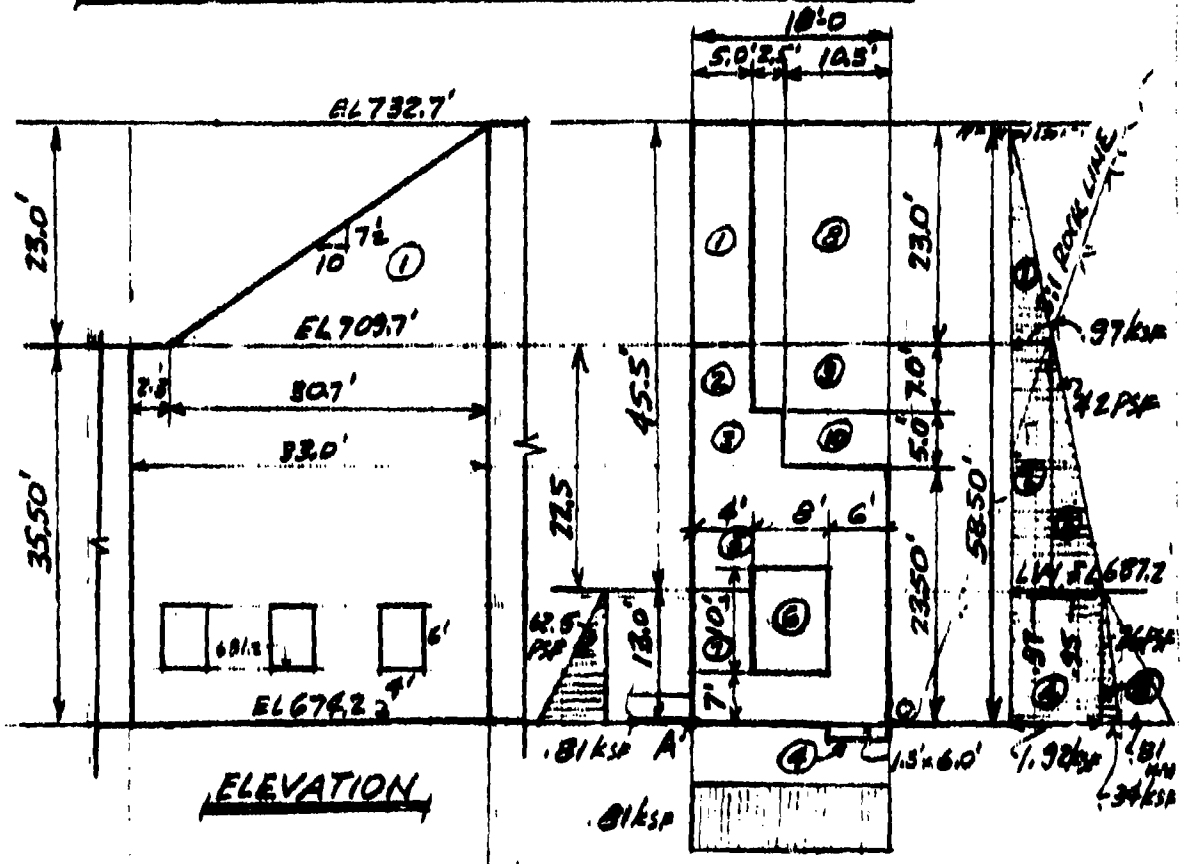
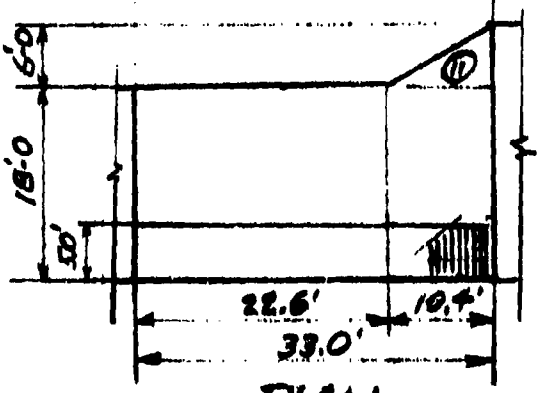
LOWER LAND GUIDE WALL MONOLITH #1





1. $R = 3560^k$ OUTS. MIDDLE ⅓ BY 4'
2. $\frac{\Sigma H}{\Sigma V} = \frac{1400}{3222} = 0.463$
3. $FSS = \frac{3222 \times .625}{1490} = 1.35$
4. $FSOT = \frac{31053}{24616} = 1.26$
5. $f_{soil} = 33.6$ ksf

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT EXISTING CONDITIONS OF STABILITY C LAND WALL

COMPUTED M.J. CHECKED R.N.M.

PROJECT L&D #1

FILE NO. 800A

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LOWER LAND GUIDE WALL MONOLITH #1 (CONT'ED)

	LOADS IN KIPS	$V_\downarrow$	$V_\uparrow$	$H_\leftarrow$	$H_\rightarrow$	ARM	$M_A\circlearrowright$	$M_A\circlearrowleft$
C_1	23.0×30.7×2.5×.15	266				2.5	667	
C_2	7.0×5×33×.15	173				2.5	435	
C_3	7.5×5×33×.15	185				3.75	697	
C_4	9.0×33×.088	26				15.0	390	
C_5	23.5×18.0×33×.15	2090				9.0	18,800	
C_6	80.0×33×.6×.088		139			8.0		1113
	80.0×33×.4×.150		158			8.0		1263
C_7	3×96×.088		25			2.0		50
C_{11}	10.4×3×23.5×.15	110				20.0	2200	
E_8	13.0×30.7×11.5×.115	530				11.5	6100	
E_9	13×7×33×.115	345				11.5	3970	
E_{10}	10.5×5×33×.115	200				12.75	2550	
E_{11}	10.4×3×35×.115	126				20.0	2520	
W_1	.81×18×33.0		482			9.0		4350
W_N	.81×3×10.4		25			20.0		500
		Σ 4051	829			Σ 38,329		7276

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITIONS OF STABILITY CLAND WALL COMPUTED M.J. CHECKED R.M.M.	PROJECT LED #1 FILE NO. 800A DATE 11-74 PAGE 20 OF ____ PAGES

LOWER LAND GUIDE WALL MONOLITH #1 (CONTEO)

$H_{E1} = 4 \times .97 \times \frac{30.7}{2} \times \frac{23.0}{3} \times \frac{1}{2}$	= 114.0	43.17	4950 ^k
$H_{E2} = .97 \times 22.5 \times 30.7 \times \frac{1}{2}$	= 335.0	24.25	8,120
$H_{E3} = .95 \times \frac{1}{2} \times 22.5 \times 33.0$	= 352.0	20.50	7,220
H_{E4} { $.95 \times 13.0 \times 33.0$	= 408.0	6.50	2,660
H_{E4} { $.97 \times 13.0 \times 33.0 \times 0.5$	= 208.0	6.50	1,350
$H_{E5} = .34 \times 13.0 \times 33.0 \times \frac{1}{2}$	= 73.0	4.33	316
	1490.0 k		24616 ^k

RESULTANT $H = 1490.0^k$

$\frac{24,616}{1490.0} = 16.50$

$\Sigma V = 4051 - 829 = 3222^k$

$\Sigma M_A = 38329 - 7276 - 24616 = -6437^{1k}$ (31053)

$\frac{6437}{3222} = 2.0'$

1. $R = 3560^k$ OUTSIDE MIDDLE $\frac{1}{3}$
2. $\frac{\Sigma H}{\Sigma V} = \frac{1490}{3222} = 0.463$
3. $FSS = \frac{3222 \times .625}{1490.0} = 1.35$
4. $FSOT = \frac{31.053}{24616} = 1.26$

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT EXISTING CONDITIONS OF STABILITY C LANDWALL

COMPUTED M.J. CHECKED

PROJECT LSD #1

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LOWER LAND GUIDE WALL MONOLITH #1 (CONT'ED)

SOIL PRESSURE VALUE

$V = 3222^k \quad M_A = 6437^{fk} \quad a = 2.0' \quad e = 7.0'$

$$f = \frac{2}{3} \times \frac{3222}{33 \times 2} = 33.6 \text{ ksf}$$

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT EXISTING CONDITIONS OF STABILITY FOR LOWER GUIDE WALL

COMPUTED M.J. CHECKED R.N.M.

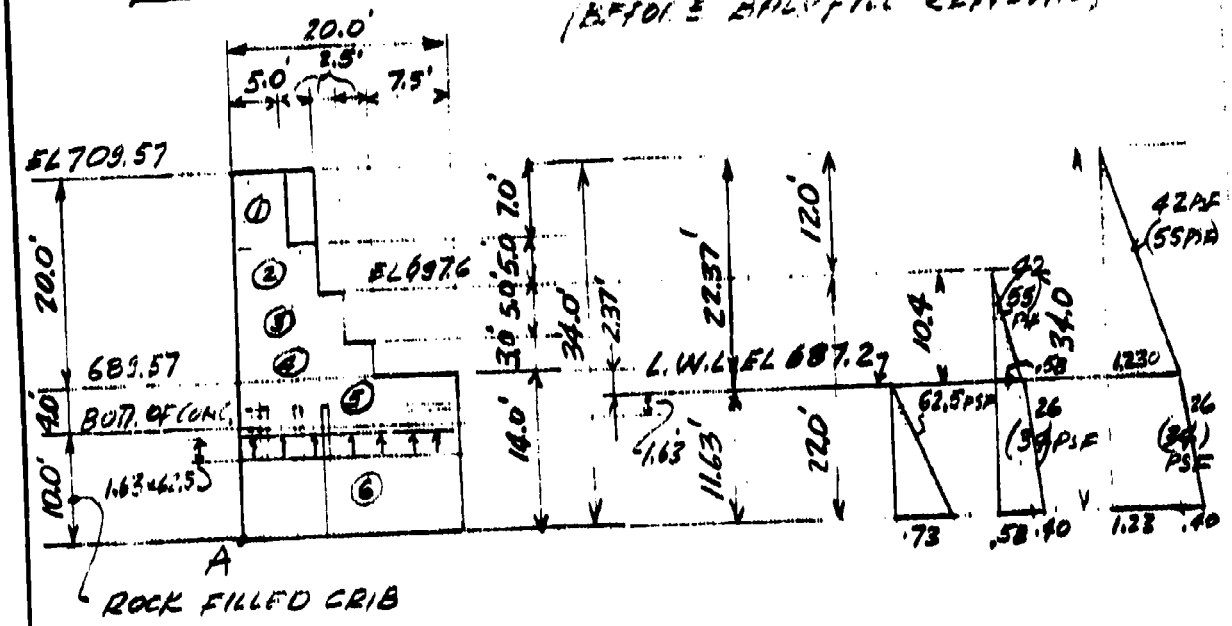
PROJECT L&D #1

FILE NO 800A

DATE 9.74 PAGE 22 OF ____ PAGES

TYPICAL SECTION @ LOWER LAND GUIDE WALLS

(BEFORE BACKFILL REMOVAL)



I. CHECK STABILITY FOR BACKFILL @ TOP OF WALL

	CONCRETE		BACKFILL	
①	5.0 × 7.0 × .15	= 5.3 k	15.0 × 7.0 × .11	= 11.6 k
②	7.5 × 5.0 × .15	= 5.6	12.5 × 5.0 × .11	= 6.9
③	10.0 × 5.0 × .15	= 7.5	10.0 × 5.0 × .11	= 5.5
④	12.5 × 3.0 × .15	= 5.6	7.5 × 3.0 × .11	= 2.5
⑤	20.0 × 4.0 × .15	= 12.0		
		36.0 k		26.5 k

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT LOWER GUIDE WALL BACKFILL TO TOP OF WALL

PROJECT L & D #1

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COMPUTED M.J. CHECKED R.N.M.

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LOWER LAND GUIDE WALL (CONT'ED)

LOADS IN KIPS		VERT. ↓	VERT. ↑	HORIZ. →	HORIZ. ←	ARM	MOM$_A$ ↻	MOM$_A$ ↺
C_1		5.3				2.5	13.2	
C_2		5.6				3.8	21.3	
C_3		7.5				5.0	37.5	
C_4		5.6				6.25	35.0	
C_5		12.0				10.00	120.0	
E_1		11.6				12.50	146.0	
E_2		6.9				13.75	95.0	
E_3		5.5				15.00	82.5	
E_4		2.5				16.25	40.7	
W_1	1.63×.063×20		2.1			10.00		21.0
Σ		62.5	2.1				591.2	21.0
H_W	.73×11.63/2			4.3	4.3			
H_{E_1}	1.23×22.32/2				13.7	19.1		262.0
H_{E_2}	1.23×11.63				14.4	5.3		83.6
H_{E_4}	.40×11.63/2				2.3	3.3		9.0
ΣH					30.4	k		354.6 ft-k

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT LOWER GUIDE WALL BACKFILL TO TOP OF WALL

COMPUTED M.J. CHECKED R.N.M.

PROJECT L. & D. #1

FILE NO 800A

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LOWER LAND GUIDE WALL, (CONT'ED)

CHECK STABILITY INCLUDING ROCK FILLED CRIB

$10.0 \times 20.0 \times (.10 - .063) = 7.3^{k}$

$M_A' = 7.30 \times 10.0 = 73.0^{1k}$ $\quad \Sigma V = 62.5 - 2.1 + 7.3 = 67.7^{k}$

$\Sigma M_A = 591.2 - 21.0 - 354.6 + 73.0 = 288.6^{1k}$

$a = \frac{288.6}{67.7} = 4.26'$

1. RESULTANT OUTSIDE MIDDLE 2' BY .74'

2. $\frac{\Sigma H}{\Sigma V} = \frac{30.4}{67.7} = 0.45$ (SEE BELOW)

MAXIMUM SOIL PRESSURE

3. $f_{SOIL} = \frac{2 \times 67.70}{3 \times 4.26} = 10.6$ KSF

IF $\frac{\Sigma V \times .625}{\Sigma H} = 1.5$, $\frac{\Sigma V}{\Sigma H} = 2.73$ OR $\frac{\Sigma H}{\Sigma V} = .417$ MAX

$F_{SL} = \frac{67.7 \times .625}{30.4} = 1.39$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LOWER GLIDE WALL BACKFILL TO TOP OF WALL	PROJECT L. & D. #1
	COMPUTED M.J. CHECKED R.N.M.	FILE NO. 800A
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LOWER LAND GLIDE WALL (CONT'D)

CHECK STABILITY @ TOP OF CRIB

$\Sigma V = 36.0 + 26.5 - 2.1 = 60.4^{k}$

$\Sigma H = 1.23 \times 22.37/2 + 1.23 \times 1.63 + 1.67 \times .034/2$

$\Sigma H = 13.70 + 2.06 + .05 = 15.81^{k}$

$\Sigma M = 591.2 - 21.0 - 13.7 \times 9.1 - 2.06 \times .815 - .05 \times .54$

$\Sigma M = 591.2 - 148.0 = 443.2$

$e = \frac{443.2}{60.4} = 7.34$

1. $e = 2.66'$ WITHIN MIDDLE $\frac{1}{3}$

2. $\frac{\Sigma H}{\Sigma V} = \frac{15.81}{60.4} = .263 < .367$ OK

3. $\int_{BTM\,RG} = \frac{60.4}{20.0} \pm \frac{60.4 \times 2.66}{66.7} = 3.02 \pm 2.40 \begin{cases} MAX\ 5.42\ KSF \\ MIN\ 0.62\ KSF \end{cases}$

$S = \frac{20.0^2}{6} = 66.7$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LOWER GUIDE WALL BACKFILL TO TOP OF WALL	PROJECT L. & D. #1
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LOWER LAND GUIDE WALL (CONT'D)

CHECK STABILITY ASSUMING CRIBS FILLED IN WITH CONCRETE

CRIB WT $10 \times 20 \times (.15 + .063) = 17.4^{k}/_{FT}$

$M_A' = 17.4 \times 10 = 174.0^{'k}$ ↻ $\quad 174 - 73 = 101^{'k}$ ↺

$\Sigma M_A = 288.6 + 101 = 389.6^{'k}$ ↻

$\Sigma V = 67.7 + (17.4 - 7.3) = 77.8^{k}$

$$a = \frac{389.6}{77.8} = 5.0'$$

1. RESULTANT AT MIDDLE ½ (BY 0.0')
2. $\frac{\Sigma H}{\Sigma V} = \frac{30.4}{77.8} = .391$ [.417 (MAX) FOR $f_{FRICTION} = .625$ AND F.S.S. = 1.5]
3. $f_{SOIL} = \frac{2}{3}\frac{77.8}{5.0} = 10.4$ KSF

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITIONS OF STABILITY	PROJECT L & D #1
	COMPUTED M.J. CHECKED R.N.M.	FILE NO 800A
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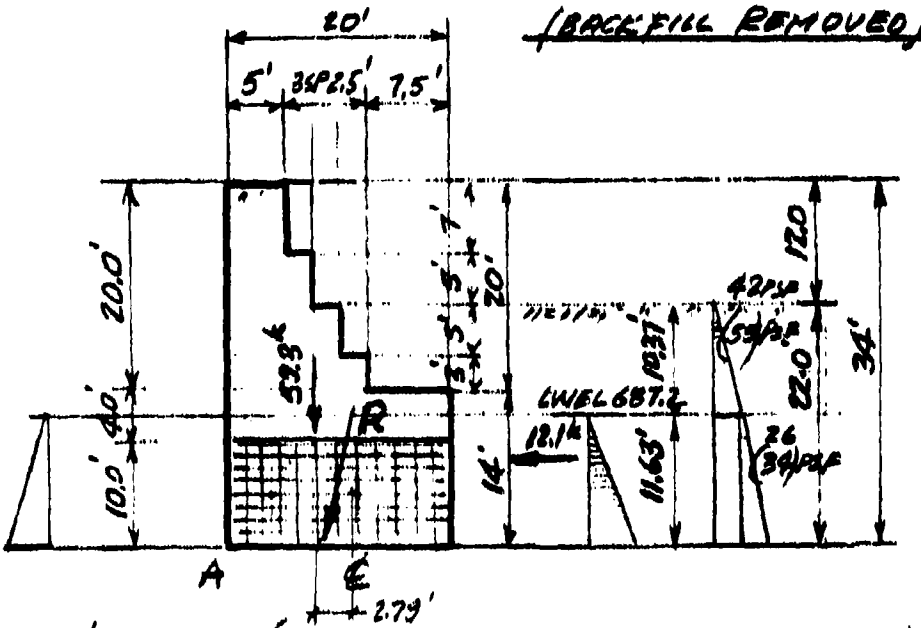
LOWER LAND GUIDE WALLS - CRIBS FILLED WITH GROUT (BACKFILL REMOVED)



$K = 0.50$ (SOIL PRESSURE AT REST CONDITION)

$\Sigma V = 59.3^k$

$\Sigma H = 12.1^k$

$\Sigma M_A = 409.4^{ft\text{-}k}$ $\quad a = \frac{409.4}{59.3} = 6.9'$ $\quad e = 3.10' < \frac{20.0}{6} = 3.33$

$R = 61.2^k$ INSIDE MIDDLE $\frac{1}{3}$

$\frac{\Sigma H}{\Sigma V} = 0.205 < .417$ ($\tan\phi = .625$ FSS = 1.5)

$FSS = \frac{59.3 \times .625}{12.1} = 3.06$

f_{SOIL} = MAX 5.73 KSF, MIN .21 KSF

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT LOWER GUIDE WALL BACKFILL REMOVED TO EL 697.6

COMPUTED M.J. CHECKED R.N.M.

PROJECT L&D #1

FILE NO 800A

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LOWER LAND GUIDE WALL WITH BACKFILL REMOVED TO EL 697.6 (CONCRETE FILLED CRIB)

	LOADS IN KIPS	VERT. ↓	VERT. ↑	HORIZ. →	HORIZ. ←	ARM	M_A ↻	M_A ↺
C_1		5.3					13.2	
C_2		5.6					21.3	
C_3		7.5					37.5	
C_4		5.6					35.0	
C_5		12.0					120.0	
C_6	10.0×20.0×.087	17.4				10.	174.0	
E_3		5.5					82.5	
E_4		2.5					40.7	
W_1			2.1			10.		21.0
Σ		61.4	2.1				524.2	21.0
H_{E3}	10.4×.58/2				3.0	15.1		45.3
H_{E4}	11.63×.58				6.8	5.8		39.5
H_{E5}	11.63×.20				2.3	3.9		9.0
Σ		61.4	2.1		12.1		524.2	114.8

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT LOWER GUIDE WALL BACKFILL REMOVED TOE EL 697.6

COMPUTED M.J. CHECKED R.N.M.

PROJECT L. & D. #1

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LOWER LAND GUIDE WALL WITH BACKFILL REMOVED (CONTD)

$\Sigma V = 61.9 - 2.1 = 59.3^{k}$

$\Sigma H = 12.1^{k}$

$\Sigma M_A = 524.2^{\curvearrowright} - 114.8^{\curvearrowleft} = 409.4^{\curvearrowright k}$

$a = \frac{409.4}{59.3} = 6.9$

1). $e = 10.0 - 6.9 = 3.1$ RESULTANT WITHIN MIDDLE 1/3

$M = 59.3 \times 3.1 = 183.8^{\curvearrowright k}$

2). $\frac{\Sigma H}{\Sigma V} = \frac{12.1}{59.3} = 0.205$

3). $f_{soil} = \frac{59.3}{20.0} \pm \frac{183.8}{66.7} = 2.97 \pm 2.76$ { MAX 5.73 KSF; MIN 0.21 KSF

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITION OF STABILITY	PROJECT L&D #1
	COMPUTED M.I. CHECKED R.N.M.	FILE NO. 800A
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LOWER LAND GUIDE WALLS - BACK FILL REMOVED (CONT'D)

(SOIL PRESS. 42 PSF & 26 PSF)

		M_A
$H_{E1} = .042 \times 10.37^2/2 = 2.25^k$	$\times$ 15.10	34.00 $^{ft-k}$
$H_{E2} = .435 \times 11.63 = 5.07^k$	$\times$ 5.80	29.40
$H_{SB} = .304 \times 11.63/2 = 1.77^k$	$\times$ 3.90	6.92
$\Sigma H = 9.09^k$		70.32 $^{ft-k}$

$\Sigma M_A = 524.2 - 21.0 - 70.3 = 432.9^{ft-k}$

$\Sigma V = 61.4 - 2.1 = 59.3^k$

$\Sigma H = 9.1^k$

$a = \frac{432.9}{59.3} = 7.3'$

$e = 2.7' < 3.33'$ (USED)

1). $R = 59.3^k$ INSIDE MIDDLE $\frac{1}{3}$ BY 0.63'

2). $\frac{\Sigma H}{\Sigma V} = \frac{9.10}{59.3} = .154$

3). $f_{SOIL} = \frac{59.3}{20.0} \pm \frac{59.3 \times 2.7}{66.70}$ $\quad S = \frac{20.0^2}{6} = 66.70\ FT^3$

$f_{SOIL} = 2.97 \pm 2.42$

$f_{MAX} = 5.39\ KSF$ $\quad f_{MIN} = .55\ KSF$

4). $FSS = \frac{59.3 \times .625}{9.10} = 4.07$

5). $FSOT = 5.75$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITION OF STABILITY	PROJECT L & D #1
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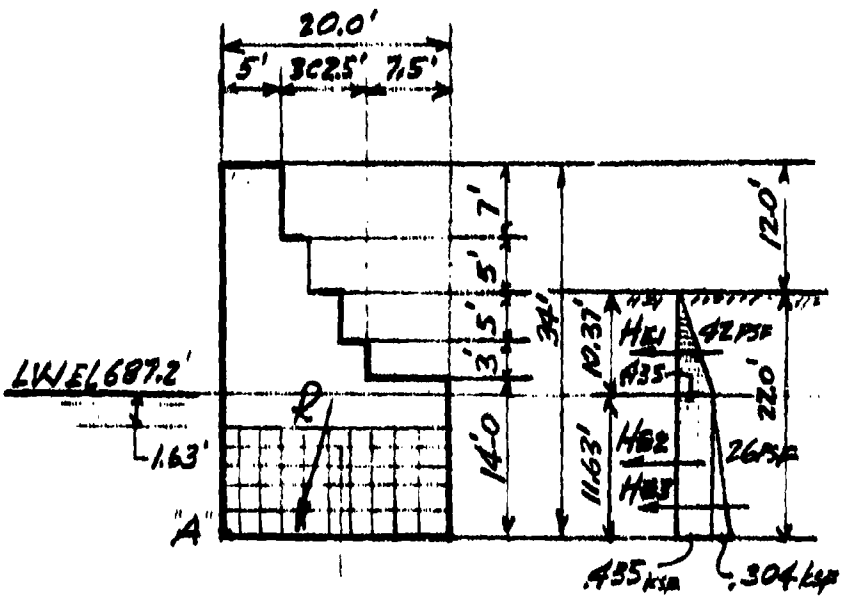
LOWER LAND GUIDE WALLS - BACKFILL REMOVED



1). $R = 59.3^{4}$ INSIDE MIDDLE $\frac{1}{3}$ BY 0.63

2). $\frac{\Sigma H}{\Sigma V} = \frac{9.10}{59.3} = .153$

3). f_{SOIL} = MAX 5.89 ksf, MIN 0.55 ksf

4). $FSS = \frac{59.3 \times .625}{9.10} = 4.07$

5). $F_{SOT} = 5.75$

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LOWER GUIDE WALL STABILITY, CONSTRUCTION CONDITION COMPUTED R.N.M. CHECKED JJ	PROJECT LOCK & DAM NO. 1 FILE NO. 800A DATE 2/'75 PAGE 31a OF ____ PAGES

16/6 STABILITY OF LOWER GUIDE WALL MONOLITHS 6-12 DURING CONSTRUCTION PERIOD (Backfill removed) Ref. page 27

According to water level readings in borehole No. 74-8U and downstream of the lock chamber the difference in hydraulic grade line was about 7' on Sept. 10, 1974. Using the same difference, assume that the hydraulic grade line behind the lower guide wall monoliths is approximately, 674 + 7 = 681' when the construction area is dewatered.
Assume 3' of surcharge

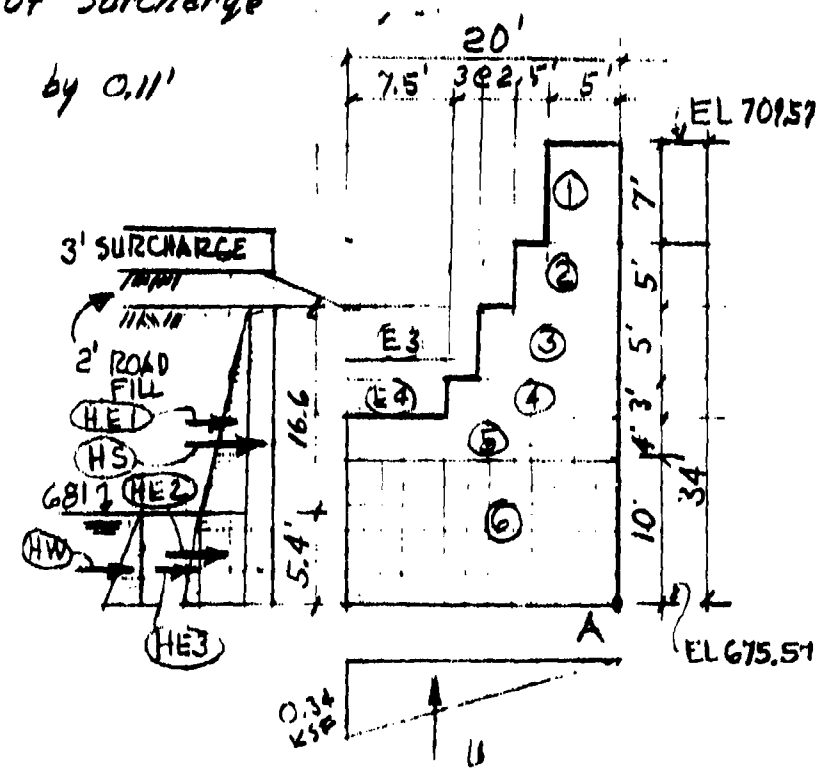
(1) "R" inside middle 1/3 by 0.11'

(2) $\frac{\Sigma H}{\Sigma V}$ = 0.22

(3) FSS = 2.84

(4) f_{soil} = 6.95 KSF max
0.12 KSF min

(5) FSOT = 3.78



HARZA ENGINEERING COMPANY CHICAGO

SUBJECT LOWER GUIDE WALL STABILITY, CONSTRUCTION CONDITION

COMPUTED P.N.M. CHECKED JJ

PROJECT LOCK & DAM #1

FILE NO. 800 A

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CONSTRUCTION CONDITION

		H →⊕	V ⊕↓	ARM	⊕↻ MA	↺ MA
①-⑤	See page 28		+36.0			227
E3			+ 5.5	15.0		83
E4			+ 2.5	16.25		41
⑥	10 x 20 x 0.15		30.0	10		300
U	0.0625 x 5.4 x 20 x ½		- 3.4	13.3	45	
HS	5 x 0.042 x 22	+4.6		11.0	51	
HE1	0.042 x (16.6)² x ½	+ 5.8		10.9	63	
HE2	0.042 (16.6) x 5.4	+ 3.8		2.7	10	
HE3	0.026 (5.4)² x ½	+ 0.4		1.8	1	
HW	0.0625 (5.4)² x ½	+0.9	___	1.8	2	___
		ΣH = 15.5ᴷ	ΣV = 70.6ᴷ		172'ᴷ	651'ᴷ
					ΣM_A = -479'ᴷ	

1) $\bar{X} = \frac{479}{70.6} = 6.78'$ $e = 3.22'$

Resultant inside middle $\frac{1}{3}$, 0.11 ft

2) $\frac{\Sigma H}{\Sigma V} = \frac{15.5}{70.6} = 0.22$ (3) FSS = 2.84

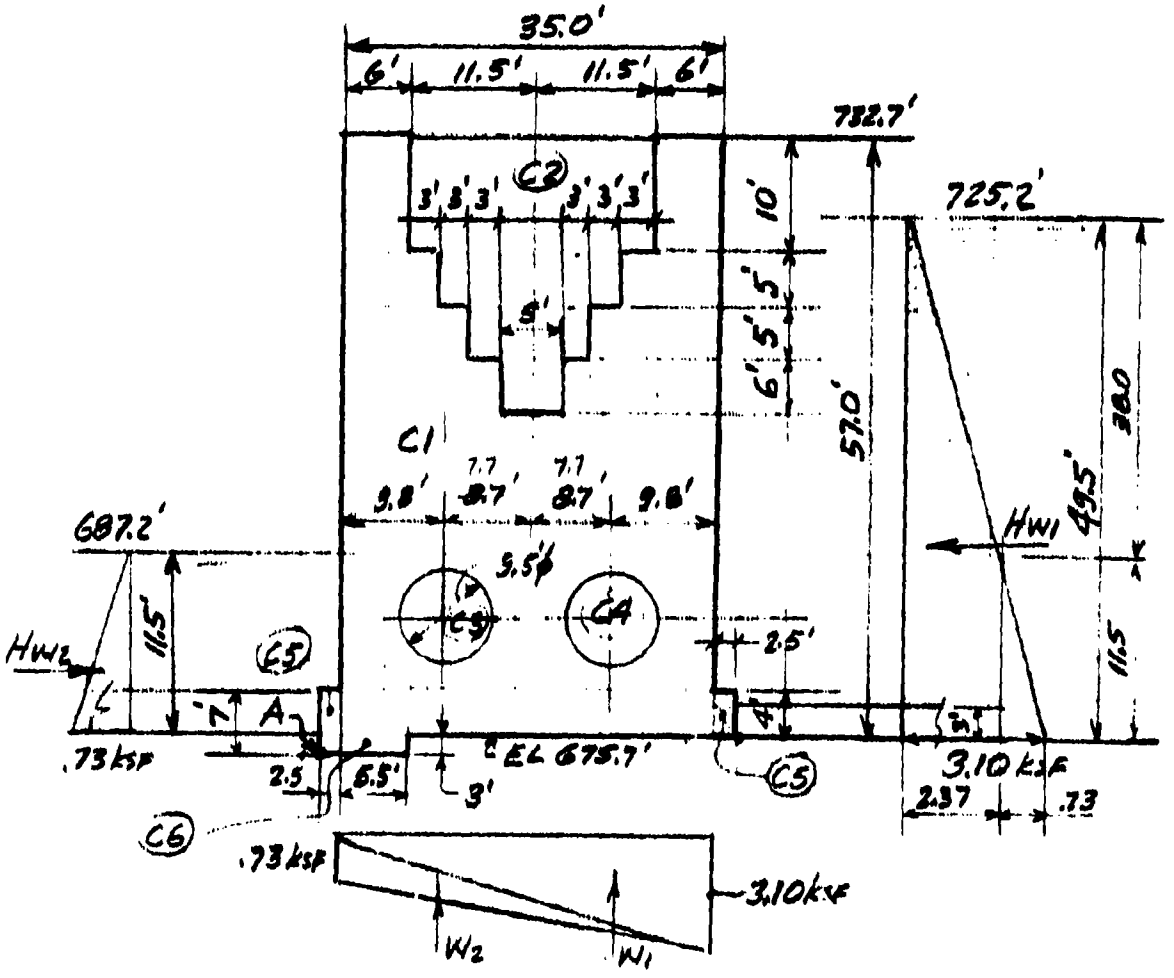
4) $f_{soil} = \frac{70.6}{20}\left(1 \pm \frac{6 \times 3.22}{20}\right)$ = 6.95 KSF max.
- 0.12 KSF min.

5) $FSUT = \frac{651}{172} = 3.78$

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILITY CONDITIONS AT INTERMEDIATE WALL COMPUTED M.J. CHECKED R.N.M.	PROJECT LED #1 FILE NO. 800 A DATE 11.74 PAGE 92 OF ____ PAGES

INTERMEDIATE WALL MONOLITHS #4-16



NORMAL OPERATING CONDITION

1). RESULTANT OUTS. $\frac{1}{3}$ BY 0.59

2). $\frac{\Sigma M}{\Sigma V} = \frac{2031}{5844} = .348$

3). $f_{SOIL} = 10.90$ ksf

4). FSS = 1.80

5). FSOT = 1.94

CONSTRUCTION CONDITION (ONE LOCK EMPTY)

1). RESULTANT OUTS. $\frac{1}{3}$ BY 0.56

2). $\frac{\Sigma M}{\Sigma V} = .354$

3). $f_{SOIL} = 11.32$ ksf

4). FSS = 1.77

5). FSOT = 2.02

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT STABILITY CONDITIONS AT INTERMEDIATE WALL

COMPUTED M.J. CHECKED R.N.M.

PROJECT LEO #1

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INTERMEDIATE WALL MONOLITHS #4-16

		$V\downarrow_k$	$V\uparrow_k$	$H\rightarrow_k$	$H\leftarrow_k$	ARM	$M_{\circlearrowleft}$	$M_{\circlearrowright}$
C1	35.0×57.0×28×.15	8380				0.		
C2	(10×23+170)×28×.035		392			0.		
C3	π×4.8²×28×.088		178			0.		
C4	π×4.8²×28×.088		178			0.		
C5	2×2.5×4.0×28×.088	49				0.		
C6	5.5×3.0×28×.088	41				16.0		660
		Σ 8470	748					
HW_1	3.10×20.75×28				2148	16.5		35,500
HW_2	.73×11.5/2×28			117		3.84	450	
W_1	3.10×17.5×28		1520			5.83		8860
W_2	.73×17.5×28		358			5.83	2090	
				117 ←	2148 ←	Σ 2540		45,020

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT STABILITY CONDITIONS AT INTERMEDIATE WALL

COMPUTED M.J. CHECKED R.N.M.

PROJECT L & D #1

FILE NO. 800A

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INTERMEDIATE WALL MONOLITHS #4-16 (CONT'D)

NORMAL OPERATING CONDITION (W.L @ 725.2' & 687.2')

$\Sigma V = 8470 - 748 - 1520 - 358 = 5844^k$ (1520 = 1616 − 96)

$\Sigma H = 2148 - 117 = 2031^k$

$\Sigma M_E = 45020 - 2540 = 42480^{'k}$

$e = \frac{42480}{5844} = 7.26'$ $\quad \frac{40.0}{6} = 6.67'$ $\quad a = 12.74'$

1). RESULTANT OUTSIDE MIDDLE ⅓ BY 0.59'

2). $\frac{\Sigma H}{\Sigma V} = \frac{2031}{5844} = .348$

3). $f_{soil} = \frac{2}{3} \times \frac{5844}{29 \times 12.74} = 10.90^{k/sf}$

4). $FSS = \frac{5884 \times .625}{2031} = 1.80$

5). $FSOT = \frac{7722 \times 20}{79550} = 1.94$ $\quad 8470 - 748 = 7722^k$

$M_A = 35500 + .73 \times 35.0 \times 28.0 \times 20 + \frac{2.37}{2} \times 35.0 \times 28 \times 25.84$

$-450 = 35500 + 14300 + 30200 - 450 = 79550$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILITY CONDITIONS AT INTERMEDIATE WALL COMPUTED M.J. CHECKED R.N.M.	PROJECT LED #1 FILE NO. 800A DATE 11.74 PAGE 35 OF ____ PAGES

INTERMEDIATE WALL MONOLITHS #4-16

REHABILITATION CONDITION - ONE LOCK EMPTY (CONSTRUCTION)

2268

$\Sigma V = 8470 - 748 - 1520 - 126 = 6076^k$

$\Sigma H = 2148^k$ $\quad C_3 = \pi \times 4.8^2 \times 28 \times .15 = 304^k$ (304 − 178 = 126)

$\Sigma M_{\mathcal{L}} = 45.020 - 126 \times 8.7 = 43.920^{'k}$

$e = \frac{43920}{6076} = 7.23'$

$a = 12.77$

1). RESULTANT OUTSIDE MIDDLE ⅓ BY .56'

2). $\frac{\Sigma H}{\Sigma V} = \frac{2148}{6076} = .354$

3). $f_{soil} = \frac{2}{3} \times \frac{6076}{28 \times 12.77} = 11.32$ ksf

4). $FSS = \frac{6076 \times .625}{2148} = 1.77$

5). $FSOT = \frac{7722 \times 30}{76450} = 2.02$

$M_A = 35.500 + \frac{3.10}{2} \times 350 \times 29.0 \times 25.84 + 126 \times 12.3 =$

$= 35.500 + 39400 + 1550 = 76450^{'k}$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT INTERMEDIATE WALL STABILITY - TEMPORARY CONSTRUCTION	PROJECT LOCK & DAM #1
	COMPUTED R.N.M. CHECKED JJ	FILE NO 800 A
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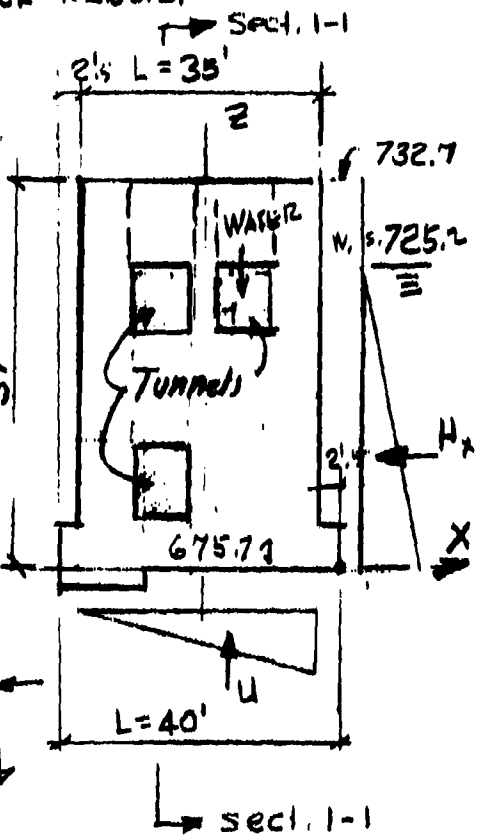
REHABILITATION PLAN 2 — MONOLITH NO. 4
INTERMEDIATE WALL, LANDWARD LOCK REBUILT
RIVERLOCK — NO CHANGE



1) Resultant inside middle ⅓ by .57

2) Factor of sliding = .39

3) Sliding safety factor = 1.61

4) Bearing pressure = 9.66 ksf

5) F.S.O.T. = 1.89

ΣH_x = ——— 1858 K ←

ΣV = ——— 4789 K ↓

ΣM_x ——— + 923'k

ΣM_y ——— −29343'k

$\frac{\Sigma H_x}{\Sigma V} = \frac{1858}{4789} = .39$ SSF = 1.61

$e_x = \frac{\Sigma M_y}{\Sigma V} = \frac{29343}{4789} = 6.1$ $\frac{e_x}{40} = 0.15$

$e_y = \frac{\Sigma M_x}{\Sigma V} = \frac{923}{4789} = .2$ $\frac{e_y}{243} = 0.01$ } K = 1.96

$f_s = \frac{1.96 \times 4789}{972} = 9.66$ ksf

8862 − 816 + 936 = 8982
7272 − 1386 + 51 + 93 + 172 = 6102

F.S.O.T. = $\frac{6102\,(17.5 + 1.47)}{1393 \times 23.33 + 30657} = 1.89$ $\frac{8982}{6102} = 1.47$

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT INTERMEDIATE WALL STABILITY-TEMPORARY CONSTRUCTION
COMPUTED R.N.M. CHECKED JJ

PROJECT LOCK & DAM #1
FILE NO 800.6
DATE 2/'75 PAGE 35b OF ____ PAGES

REHABILITATION PLAN 2 – MONOLITH NO 4 (CONT'D)

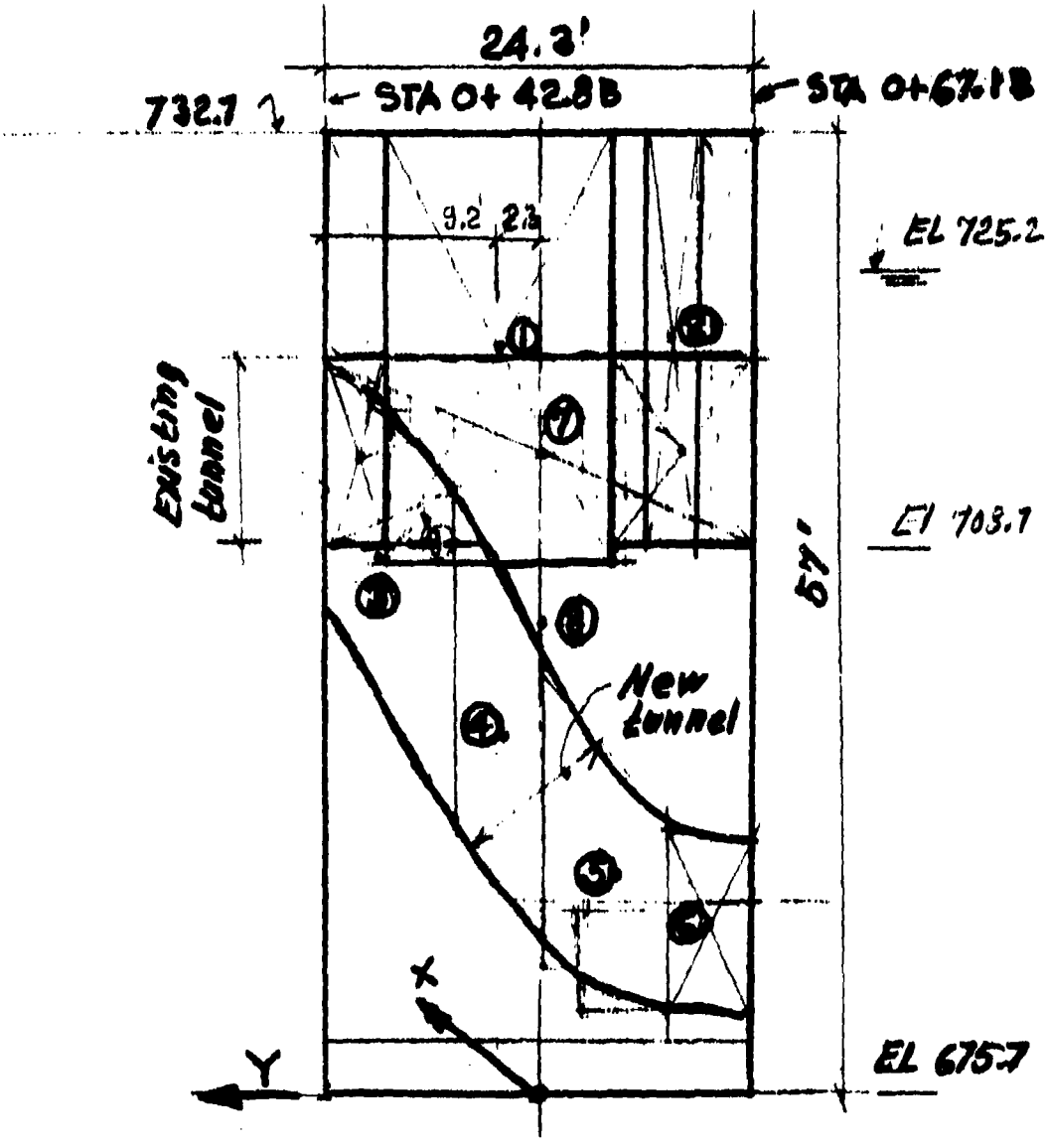
CONCRETE

		V	Y	X	M_x	M_y
①	14 x 14 x 24 (-0.15)	- 706	2.95	-7.67	+2083	+5415
	$\frac{1}{2}$ x 8.0 x 7.0 x 9 (.15)	+ 38	+6.5	-7.67	- 247	- 291
②	3 x 10 x 24 (-0.15)	- 108	- 8.0	-7.67	- 864	+ 828
③	$\frac{15.5+21}{2}$ (7.8)(9)(-0.15)	- 192	+8.5	-7.67	+1632	+ 1473
④	$\frac{21+17}{2}$ (4.35)(9)(-0.15)	- 110	+ 2.2	-7.67	+ 242	+ 844
⑤	$\frac{17+12}{2}$ (7.2)(-0.15)(9)	- 141	- 3.6	-7.67	- 508	+ 1081
⑥	$\frac{12+11}{2}$ (5)(9)(-0.15)	- 78	-9.65	-7.67	- 753	+ 598
⑦	24.3x11x9(-0.15)	- 361	0	+7.67	0.	-2769
	3.5x11x9(-0.15)	- 52	+10.5	-7.67	+546	+ 399
	2.0x11x9(-0.15)	- 30	- 6.1	-7.67	- 183	+ 230
	3.5x3.0x$\frac{1}{2}$x9 (-.15)	- 7	+9.8	-7.67	+67	+ 54
		V_1 = 1386 K			M = +923'K	+8862'K
GROSS CONC.	57 x 24.3 x 35 x 0.15 =	+7272	0	0	0	0
	3 x 8 x 24.3 x .088 =	+ 51	0	16	0	-816
	4 x 5 x 24.3 x .099 =	+ 43	0	0	0	0
Water: 8x10x24.3x.0625		+122	0	7.67	0	+936
I_1 = 49.5x.0624x35x24.3x$\frac{1}{2}$ =		- 1313	0	5.84	0	-7668
$\Sigma H_x = \frac{49.5^2}{2} \times .0624 \times 24.3$ = 1856 K						-30657
	ΣV =	4789 K			ΣM_y = +923'K	

ΣM_y = -29343'K

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT INTERMEDIATE WALL STABILITY - TEMPORARY CONSTRUCTION COMPUTED R.N.M. CHECKED	PROJECT LOCK & DAM #1 FILE NO 800 A DATE 2/'75 PAGE 35C OF ____ PAGES

REHABILITATION PLAN 2 - MONOLITH #4 (CONT'D)



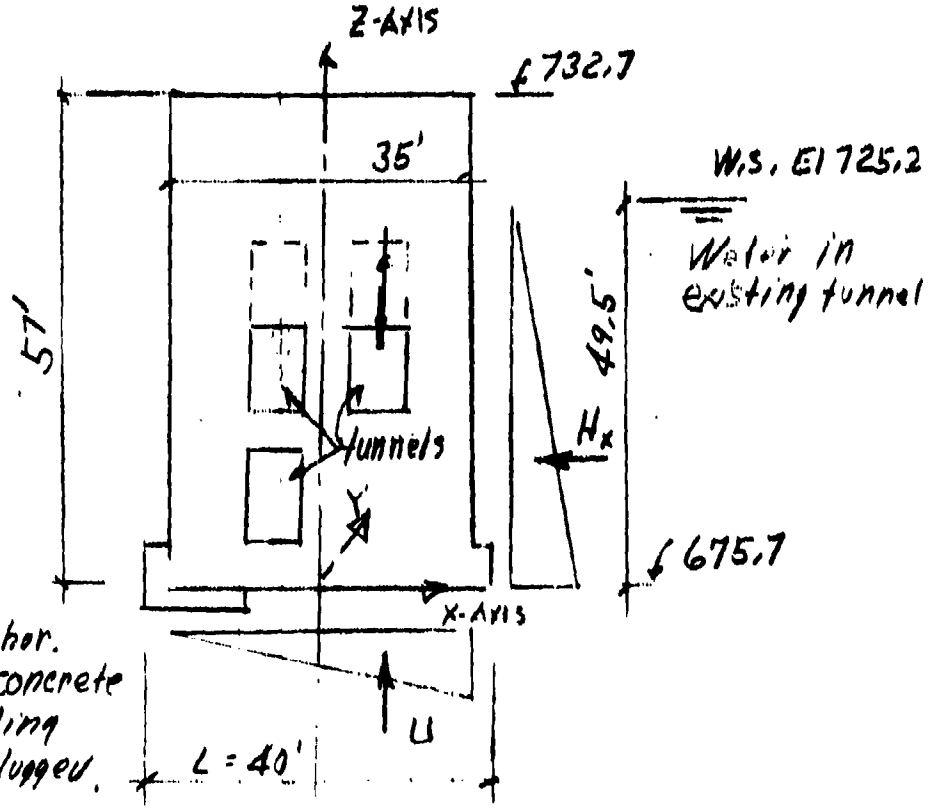
Sect. 1-1

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT INTERMEDIATE WALL STABILITY - TEMPORARY CONSTRUCTION	PROJECT LOCK & DAM No. 1
	COMPUTED R.N.M. CHECKED	FILE NO 800 A
		DATE 2/1/75 PAGE 35d OF ____ PAGES

REHABILITATION PLAN 2 - MONOLITH NO. 5

INTERMEDIATE WALL LANDWARD LOCK CULVERT REBUILT*

NO CHANGE IN RIVER LOCK



* New vertical & hor. opening cut, concrete removed, existing opening not plugged.

1) Resultant outside middle 1/3 by 0.9'
2) Factor of sliding = .41
3) Factor of safety against sliding = 1.54
4) Bearing pressure = 11.30 KSF
5) F.S.O.T. = 1.90

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT INTERMEDIATE WALL STABILITY-TEMPORARY CONSTRUCTION
COMPUTED R. N. M. CHECKED JJ

PROJECT LOCK & DAM #1
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DATE 2/'75 PAGE 35C OF ____ PAGES

REHABILITATION PLAN 2 - MONOLITH #5 (CONT'D)

CONCRETE		ARM Y	ARM X	MOMENT M_x ↻	MOMENT M_y ↻
① $7 \times 13.5 \times 9 \times (-0.15)$	$= -128$	+6.5	-7.67	+832	981
② $\frac{15+13}{2} \times 4.8 \times 8 (-0.15) \times 2$	$= -161$	-12.5	0.0	-2013	0
③ $\frac{13+12}{2} \times 5.1 \times 8 (-0.15) \times 2$	$= -153$	-7.5	0.0	-1148	0
④ $\frac{12+11.5}{2} \times 5 \times 8 (-0.15) \times 2$	$= -141$	-2.5	0.0	-353	0
⑤ $10 \times 15.1 \times 8 (-0.15) \times 2$	$= -362$	+7.5	0.0	+2715	0
⑥ $10 \times 7 \times (9-8)(-0.15)$	$= -11$	+6.0	-7.67	+66	+84
⑦ $8 \times 12.5 \times 9 (-0.15)$	$= -135$	+6.5	-7.67	+878	+1035
⑧ $5.5 \times 5 \times 9 (-0.15)$	$= -37$	+6.5	-7.67	+241	+284
⑨ $30 \times 9 \times 11 (-0.15)$	$= -446$	0	-7.67	0	+3419
⑩ $10^2 (-0.15) \times 13$	$= -195$ ~~-150~~	+8.0	+7.67	+1560	-1495
⑪ $3 \times 9 \times 13 (-0.15)$	$= -53$	-1.5	+7.67	-80	-406
	-1822				
Pass (a) $35 \times 57 \times 30 \times 0.15$	$= +8978$	0	0	0	0
Pass (b) $3 \times 3 \times 36 \times 0.092$	$= +64$	0	-16.0	0	-1024
Pass (b) $4 \times 5 \times 30 \times 0.088$	$= +53$	0	0	0	0
	$V_1 = +$ ~~[illegible]~~ 7273			$M_{x_1} =$ 2698 ↻	
				$\Sigma M_{y_1} =$	12878 ↻

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT INTERMEDIATE WALL STABILITY - TEMPORARY CONSTRUCTION	PROJECT LOCK & DAM #1
	COMPUTED R.N.M. CHECKED JJ	FILE NO 800 A
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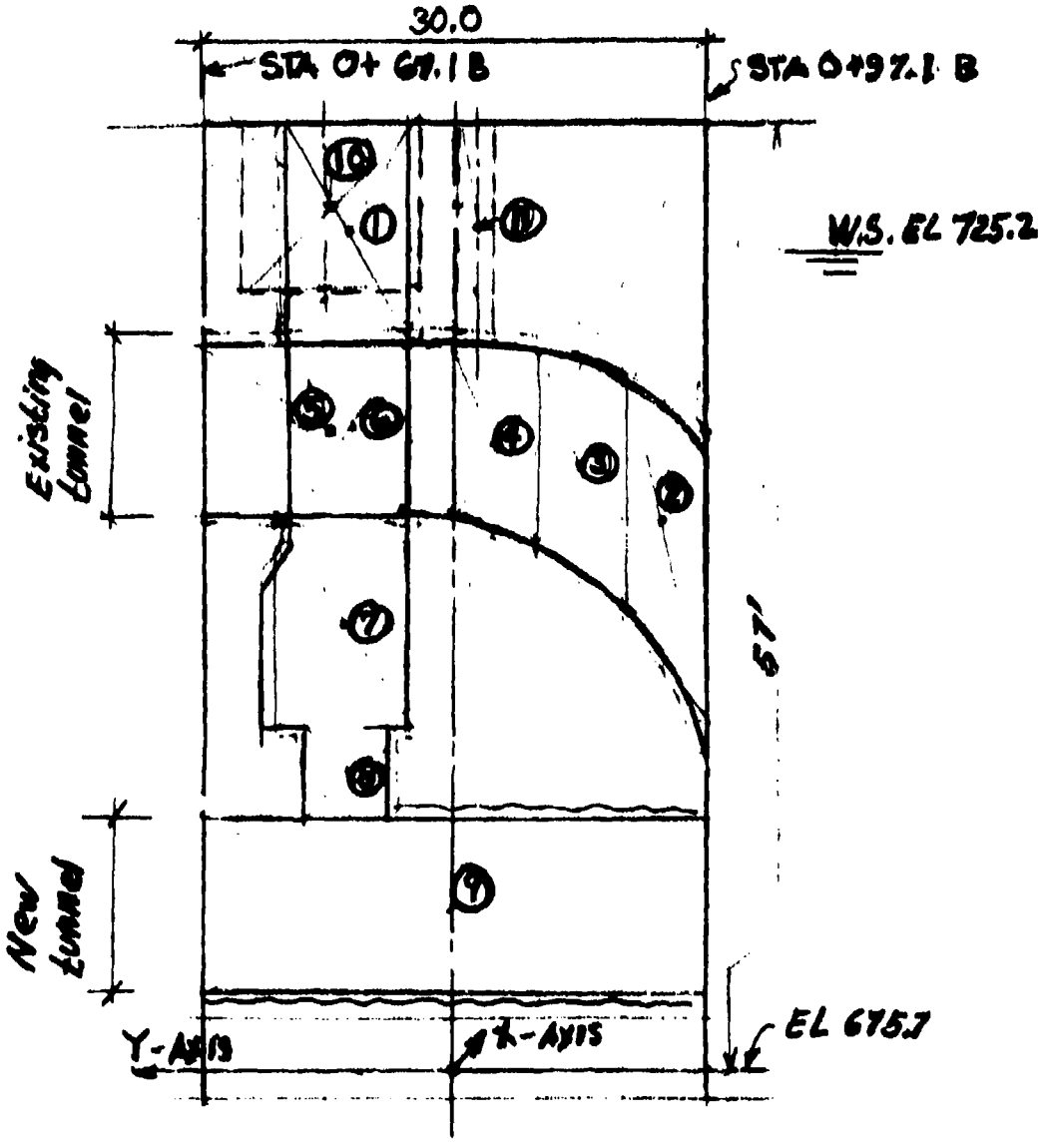
REHABILITATION PLAN 2 - MONOLITH #5 (CONT'D)



HARZA ENGINEERING COMPANY CHICAGO

SUBJECT INTERMEDIATE WALL STABILITY-TEMPORARY CONSTRUCTION

COMPUTED R.N.M CHECKED JI

PROJECT LOCK & DAM NO. 1

FILE NO 800A

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REHABILITATION PLAN 2 - MONOLITH NO. 5 (CONT'D)

	H	V	Y	X	M_x	M_y
		+~~7318~~ +7273	.4	~~0.28~~ .37	+2698	+2878
Water in riverward tunnel						
② 80 x 0.0625/0.15		+33	-12.5	+7.67	+413	+253
③ 77 x 0.0625/0.15		+32	-7.5	+7.67	+240	+245
④ 70 x 0.0625/0.15		+29	-2.5	+7.67	+73	+222
⑤ 181 x 0.0625/0.15		+75	+7.5	+7.67	-563	+575
		+164		1.1	+163	(1291)
H_x $\frac{49.5^2}{2}$ x .0624 x 30	-2293		z = 16.5	—	—	-37835
U 49.5 x .0624 x 35 x 30		-162^2		+5.84	—	-9472
	~~2293~~					

$\Sigma H = -2293^K$

$\Sigma V = 5651^K$

$\Sigma M_x = +2861^K$

$\Sigma M_y = -43134'^K$

$e_x = \frac{43134}{5651} = 7.6$ $\quad \frac{e_x}{40} = 0.19$

$e_y = \frac{2861}{5651} = .51$ $\quad \frac{e_y}{30} = 0.02$

$k = 2.4$

$e > \frac{1}{6}$ by 0.9

$f = \frac{2.4 \times 5651}{1200} = 11.30$ KSF

$\frac{\Sigma H}{\Sigma V} = \frac{~~2300~~ 2293}{5651} = .406$ SSF = ~~1.54~~

$F.S.O.T. = \frac{7273 \times 20.~~28~~^{37} + 164 \times 21}{~~37950~~ 37835 + 162^2 \times ~~6.7~~ 25.34} = \frac{~~151700~~ 151700}{~~81415~~ 79147} = ~~1.87~~ 1.90$

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT INTERMEDIATE WALL DOWNSTREAM GATE MONOLITH #1B

COMPUTED M.J. CHECKED R.N.M

PROJECT L. & D. #1

FILE NO. 800A

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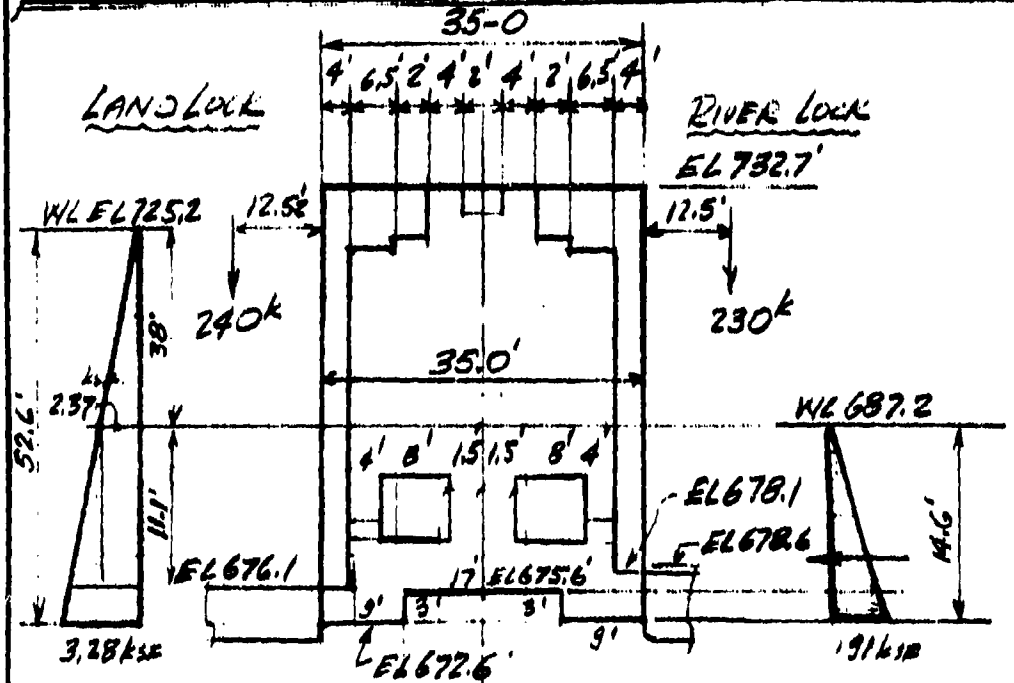
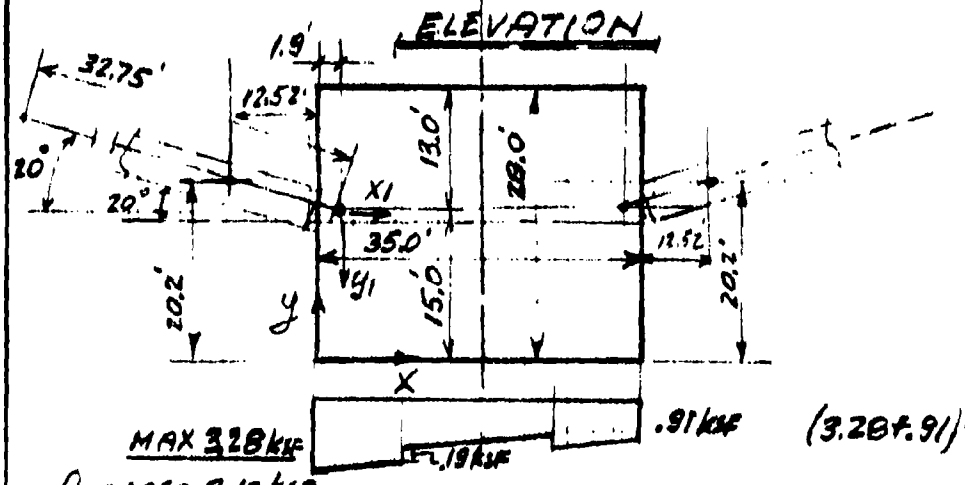
INTERMEDIATE WALL GATE MONOLITH #1B-EXISTING CONDITIONS





MAX 3.28 ksf

AVERAGE 2.10 ksf

$(3.28 + .91)\frac{1}{2} = 2.10$ ksf

$\Sigma V = 6081^k$ $\Sigma M_{xx} = 37.606^{1k}$ $\Sigma M_{yy} = 181.105^{1k}$ $\Sigma H = 3650^k$

1). $e_x = 12.4'$; $e_y = 7.9'$

2). $f_{soil} = 74.5$ KSF

3). $\frac{\Sigma H}{\Sigma V} = \frac{3650}{6081} = 0.60$

4). $FSS = \frac{6081 \times .625}{3650} = 1.04$

5) $FSOT = 1.03$

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT INTERM. WALL DOWNSTR. GATE MONO. #18

COMPUTED M.J. CHECKED R.N.M

PROJECT L.G.O. #1

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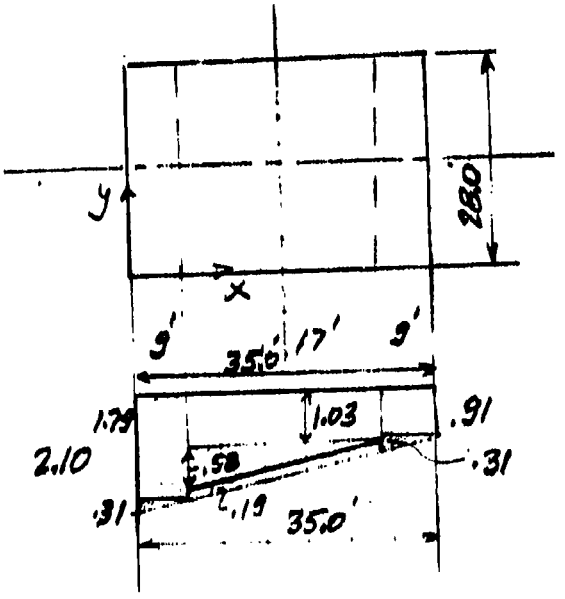
INTERMEDIATE WALL MONOLITH #18 (CONTED)

HYDROSTATIC LOAD



2.10 − .91 = 1.19

1.35 / 0.0341

.15 × 9.0	=	1.35	× 6.0	8.12
.910 × 9.0	=	8.20	× 4.5	37.00
1.03 × 17.0	=	17.50	× 17.5	307.00
1.79 × 9.0	=	16.10	× 30.5	492.00
.15 × 9.0	=	1.35	× 32.0	43.30
.29 × 17.0	=	4.92	× 20.3	100.00
		49.42 k		987.42

49.42 × 28.0 = 1380.0 k

987.4 / 49.42 = 20.0'

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT INTERMEDIATE WALL DOWNSTREAM GATE MONO. #18	PROJECT L&D #1
	COMPUTED M.J. CHECKED RNM	FILE NO. 300 A
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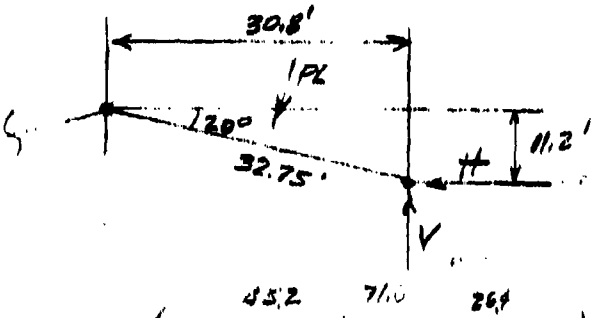
INTERMEDIATE WALL MONOLITH #18 (CONT'D)



Sin 20 = .342

Cos 20 = .940

$PL = (2.37 \times 38.0/2 + 2.37 \times 11.1)\ 32.75 = 2350^{k}$

$V = 2350^{k} \cdot .940 = \underline{2210^{k}} = Y1$

$2350 \times 16.37' + 11.2\,H' = 2210 \times 30.8'$

$38{,}500 - 68200 = -11.2H$

$H = X1 = \underline{2650^{k}}$

$45.2 \times 23.7 = 1070.0$

$\underline{26.4 \times 5.5} = \underline{145.0}$

$71.6 \qquad\qquad 1215.0^{k}$

$q = \frac{1215.0}{71.60} = 17.0$ (ABOVE EL 676.10)

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT INTERMEDIATE WALL DOWNSTREAM GATE MONO. #18

COMPUTED M. J. CHECKED BNM

PROJECT L&D #1

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INTERMEDIATE WALL DOWNSTREAM GATE MONO. #18

	VERT ↓ K.	VERT ↑ K.	HORIZ. →	HORIZ. ←	ARM	±M_{xx}	M_{yy}
MONOLITH	6.634					+87.100	116.980
GATES L.L.	240					+ 4.920	- 3.360
R.L.	230					+ 4.635	10.725
WATER IN UPSTREAM CULVERT	357					+ 5.651	2,560
HYDROSTATIC, " ↑	-1380				14.00 15.00	-19.400	-20.800
GATE THRUST X1 →			2650				54.300
" " Y1 ↓			↓ 2210		20.5	-45.300	
HYDROSTATIC →			→ 1.000				20.500
	6081					37.606	181.105

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT INTERMEDIATE WALL DOWNSTREAM GATE MONO. #18

COMPUTED M.J. CHECKED R.N.M

PROJECT L & D #1

FILE NO. 800A

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INTERMEDIATE WALL MONOLITH #18 (CONT'D)

HYDROSTATIC LOAD ON LAND LOCK SIDE

$2.37 \times 38.0/2 + 2.37 \times 11.1 = 71.6$ (45.2, 26.4)

$71.6 \times 14.0 = 1000^k$ @ 17.0' ABOVE SILL EL 676.1

$M_{yy} = 1000 \times [17.0 + (676.1 - 672.6)] = 20500^{lk}$ (8.05, 3.5)

SOIL PRESSURE AND LOCATION OF RESULTANT

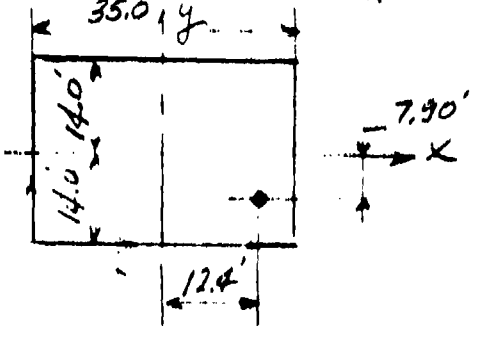
$\Sigma V = 6031^k$

$\Sigma M_{xx} = 37,626^{lk}$ $\quad a_{yy} = 6.10'$

$\Sigma M_{yy} = 181,105^{lk}$ $\quad a_{xx} = 29.90'$

$e_{yy} = 14.0 - 6.10 = 7.90'$ OUTSIDE MIDDLE BY 0.90'

$e_{xx} = 29.9 - 17.5 = 12.4'$ OUTSIDE MIDDLE BY 3.65'



$A = 28.0 \times 35.0 = 980.0\ FT^2$

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT INTERMEDIATE WALL DOWNSTREAM GATE MONO #18

COMPUTED M.J. CHECKED PNM

PROJECT L.E.O #1

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INTERMEDIATE WALL MONOLITH #18 (CONT'D)

SOIL PRESSURE AT EDGE

$$\frac{C_{xx}}{d} = \frac{12.40}{35.0} = .356$$

$$\frac{C_{yy}}{b} = \frac{7.90}{28.0} = .282$$

$$C \simeq 12.0$$

$$f = 12 \cdot \frac{6081.0}{980} = 74.5 \text{ ksf}$$

$$FSOT = \frac{6081 \times 17.5}{2650 \times 20.5 + 1000 \times 20.5 + 1380 \times 20.0} = \frac{106.000}{102.600} = 1.03$$

$$\Sigma H = 2650 + 1.000 = 3650^{k}$$

$$\Sigma V = 6081^{k}$$

$$FSS = \frac{6081 \times .625}{3650} = 1.04^{*}$$

*ACTUAL SLIDING WILL BE RESISTED BY SILL SLAB

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT STABILITY OF RIVER WALL MONOLITH #1 DURING CONSTRUCTION

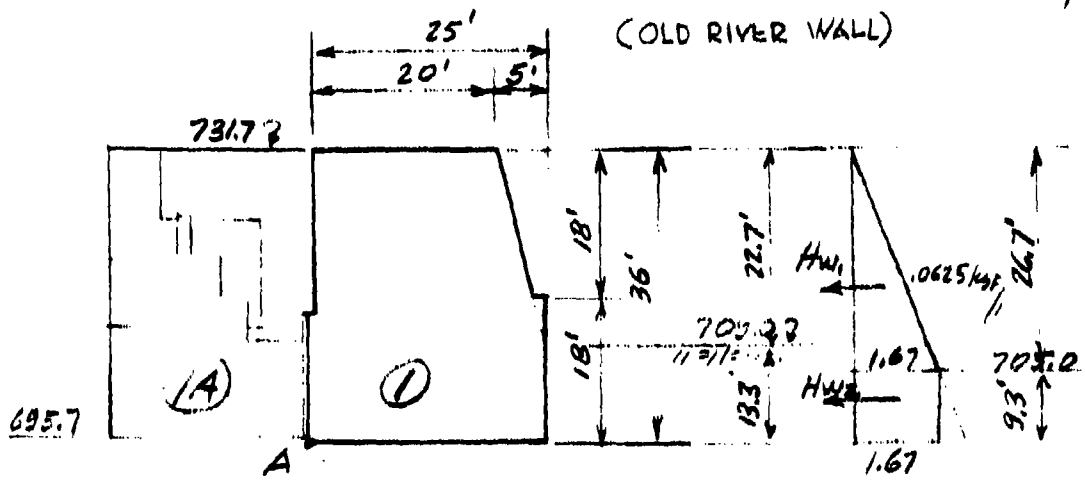
PROJECT L&D #1

FILE NO 800A

COMPUTED M.T. CHECKED R.N.M.

DATE 1.75 PAGE 41a OF ____ PAGES

STABILITY OF MONOLITH #1 DURING CONSTRUCTION



$(25 \times 36 - 3.5 \times 18) \times .15 = 125^k$

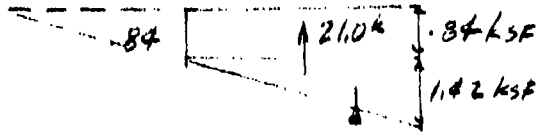
$-13.3 \times .0625 \times 25 = -21.$

$\Sigma Y = 104^k$

$900 \times .15 = 135 \times 12.5 = 1688$

$63 \times .15 = -10 \times 23.5 = 235$

$125^k \downarrow$ $M_{12} = 1453$



$22.7 \times .0625 = 1.42$

$1.42 \times 25/2 = 17.8^k$ $\quad 17.8^k$

$H_{W1} = 1.67 \times 26.7 \times \frac{1}{2} = 22.2^k$ $\times 18.20 = 405^k$

$H_{W2} = 1.67 \times 9.3 = 15.6$ $\times 4.05 = 73$

$\Sigma H = 37.8^k$ $\quad 479^k$

$\Sigma M_2 = 479 \times 17.8 \times 4.17 = 554.0$

$21 \times 12.5 = 263$

$17.8 \times 16.75 = 298$

$M_{OVERT.} = 1040$

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT RIVER WALL MONOLITH #1, STABILITY DURING CONSTRUCTION

COMPUTED M.T. CHECKED R.N.M.

PROJECT LEO #1

FILE NO 800.42

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STABILITY OF MONOLITH #1 DURING CONSTRUCTION (CONT'D)

$\Sigma V = 125.0 - 21.0 - 17.8 = 86.2^k$

$\Sigma M_E = 554.0^{tk}$ $\quad \Sigma H = 37.8^k$

$e = \frac{554}{86.2} = 6.42'$ $\quad a = 6.08'$ $\quad \left(\frac{L}{6} - e\right) = 4.16 - 6.42 = -2.26'$

1). $R = 95.0$ OUTSIDE MIDDLE $\frac{1}{3}$ BY $2.26'$

2) $\frac{\Sigma H}{\Sigma V} = \frac{37.8}{86.2} = .438$

3). $f_{SOIL} = \frac{2 \times 86.2}{3 \times 6.08} = 9.50\ ksf$

4). $FSS = \frac{86.2 \times .55}{37.8} = 1.25$ *

$M_A = 47 \times 17.5 \times 16.67 + 21 \times 12.5 = 776^{tk} = 1040$

5). $F_{SOT} = \frac{\cancel{1453 \times 12.5}}{\cancel{776}} = \cancel{1.87} = \frac{1453}{1040} = 1.40$

* A SLIDING WILL BE IMPROVED, IF EXISTING PIPE [illegible] MONOLITH 1A UNDER CONSTRUCTION WOULD BE COUNTED.

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT EXISTING CONDITIONS OF STABILITY C TYPICAL RIVER WALL

COMPUTED M.J. CHECKED R.N.M.

PROJECT L & D #1

FILE NO 800A

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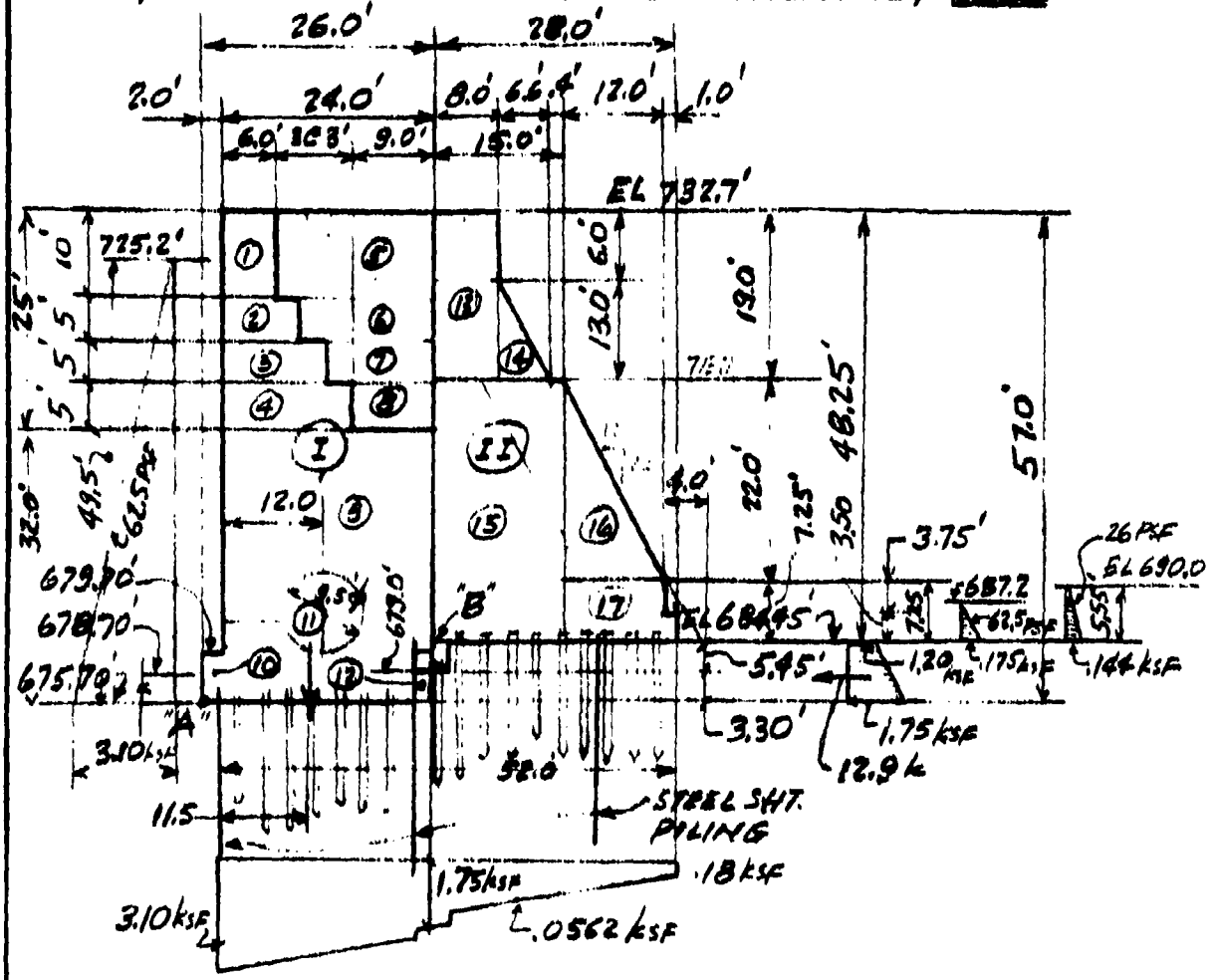
TYPICAL RIVER WALL MONOLITHS 6-16



FOR FOUNDATION PRESSURES SEE p 50 g

FOR PILE LOADS SEE p: 50 a and p 50 b

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT EXISTING CONDITIONS OF STABILITY

COMPUTED M.J. CHECKED R.N.M.

PROJECT L&D #1

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TYPICAL RIVER WALL MONOLITH

	LOADS IN KIPS	V ↓	V ↑	H ←	H →	ARM	MA ↻	MA ↺
C_1	6.0×10×.15	9.0				5.0	45.0	
C_2	5.0×9.0×.15	6.8				6.5	44.2	
C_3	5.0×12.0×.15	9.0				8.0	72.0	
C_4	5.0×15.0×.15	11.3				9.5	107.3	
C_9	32.0×24.0×.15	115.0				14.0	1615.0	
C_{10}	2.0×4.0×.15	1.2				1.0	1.2	
C_{11}	$\pi \times 4.8^2 \times .15$		↑ 10.8			14.0		↺ 151.5
C_{12}	4.0×3.0×.15		↑ 1.8			24.5		↺ 45.2
E_5	10.0×18.0×.115	20.8				17.0	354.0	
E_6	5.0×15.0×.115	8.6				18.5	159.0	
E_7	5.0×12.0×.115	6.9				20.0	138.0	
E_8	5.0×9.0×.115	5.2				21.5	111.5	
		Σ 193.8	12.6				2647.2	196.7 ↺

$\Sigma V = 181.2^{k}\downarrow$

$\Sigma M = 2450.5^{'k}\circlearrowleft$

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT EXISTING CONDITIONS OF STABILITY

COMPUTED M.J. CHECKED R.N.M.

PROJECT LED #1

FILE NO 800 A

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TYPICAL RIVER WALL MONOLITH (CONT'D)

	LOAD IN KIPS	V ↓	V ↑	H ←	H →	ARM	M_B ↻	M_B ↺
C_{13}	8.0 × 19.0 × .15	22.8				4.0	91.4	
C_{14}	6.6 × 6.5 × .15	6.4				10.2	65.3	
C_{15}	15.0 × 29.25 × .15	66.0				7.5	496.0	
C_{16}	12.0 × 11.0 × .15	19.8				19.0	377.0	
C_{17}	12.5 × 7.25 × .15	13.6				21.25	290.0	
		Σ 128.6	k				1319.7	ik
H_{W_2}	3.10 × 49.5/2				77.0	16.5	M_{B_2} 1270.0	

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITIONS OF STABILITY COMPUTED M.J. CHECKED R.N.M.	PROJECT L&D #1 FILE NO. 800A DATE 11.74 PAGE 45 OF ____ PAGES

TYPICAL RIVER WALL MONOLITH (CONT'ED)

MONOLITH (I) (SHT #5)

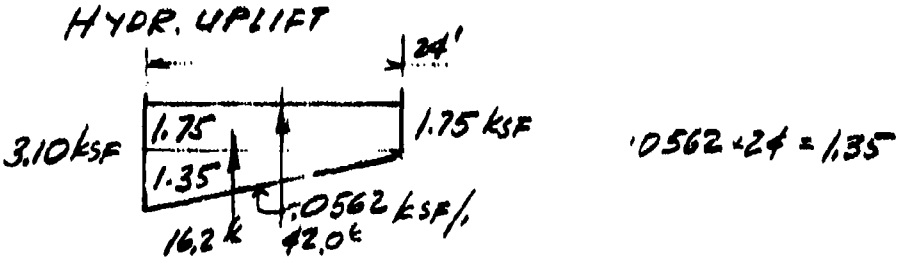
$\Sigma V = 181.2^k$ (WITHOUT UPLIFT)

$\Sigma M_A = 2450.5$

LOCATION OF RESULTANT (DIST.)

$\frac{2450.5}{181.2} = 13.50'$ (DISTANCE FROM "A")

HYDR. UPLIFT



.0562 × 24 = 1.35

$1.75 \times 24.0 = 42.0^k$

$1.35 \times 24.0/2 = 16.2^k$ } 58.2^k

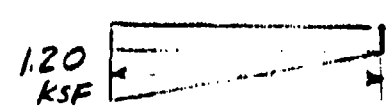
MONOLITH (II) (SHT #5)

$\Sigma V = 128.6^k$ (WITHOUT UPLIFT)

$\Sigma M_B = 1319.7^{lk}$

LOCATION OF RESULTANT $\frac{1319.7}{128.6} = 10.3'$ (DIST. FROM "B")

HYDROST. UPLIFT



$.18 \times 28 = 5.0^k$

$1.02 \times 14 = 14.3^k$ } 19.3^k

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITIONS OF STABILITY	PROJECT L&D #1
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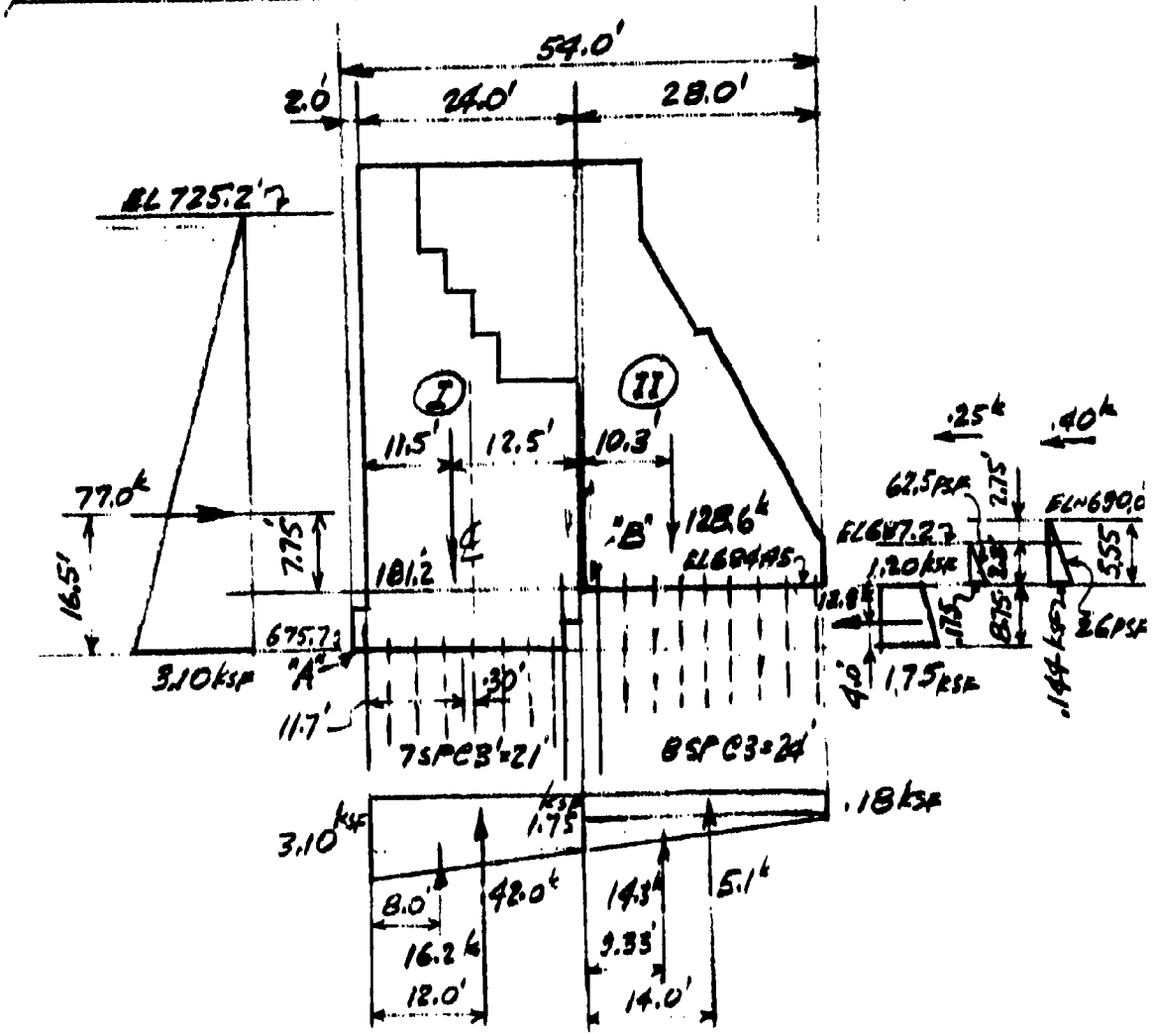
TYPICAL RIVER WALL MONOLITH (CONT'D)



$$\text{W.S. EL. @ "B"} = 675.7 + \frac{1}{.0625}\left[\frac{(3.10 - .18)}{52}28 + .18\right] = 703.7'$$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITIONS OF STABILITY	PROJECT LED #1
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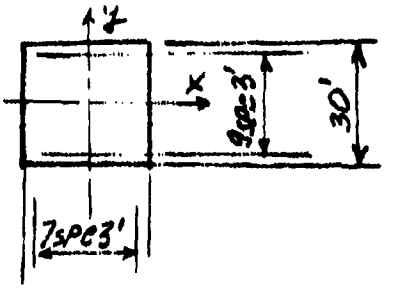
TYPICAL RIVER WALL MONOLITH (CONT'D)

MONOLITH (I) FOUNDATION PROPERTIES

PILES @ 3.0' SPACING 7 RODS @ 3' = 21.0'

FOR 30' WIDE MONOLITH × 24' DEEP



$I_{yy} = 20 \times 10.5^2 + 20 \times 7.5^2 + 20 \times 4.5^2 + 20 \times 1.5^2 = 3793$

$S_{yy} = \frac{3793}{10.5} = 362$ FOR 1-0 WIDTH $S = 12.0$

MONOLITH (II) FOUNDATION PROPERTIES

FOR 30' WIDE × 28.0' DEEP MONO.

$I_{yy} = 20 \times 12.0^2 + 20 \times 9.0^2 + 20 \times 6.0^2 + 20 \times 3.0^2 = 5400$

$S_{yy} = \frac{5400}{12} = 450$ FOR 1-0 WIDTH $S = 15.0$

MONO'S (I) & (II) COMBINED

$I_{yy} = 20 \times 3.0^2 + 20 \times 6.0^2 + 20 \times 9.0^2 + 20 \times 12.0^2 + 20 \times 15.0^2 + 20 \times 18.0^2$

$+ 20 \times 21.0^2 + 20 \times 24.0^2 = 36670$

$S_{yy} = \frac{36670}{24} = 1550$ FOR 1-0 WIDTH $S = 51.7$

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT EXISTING CONDITIONS OF STABILITY
COMPUTED M.I. CHECKED R.N.M.

PROJECT L&D #1
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TYPICAL RIVER WALL MONOLITH (CONT'D)

MONOLITH (I), FOUNDATION LOADING

$181.2 \times 11.5 = 2084$

$-16.2 \times 8.0 = -130$

$-42.0 \times 12.0 = -504$

127.6^{k} (123.0) $\qquad 1450$

$x_1 = \frac{1450.0}{123.0} = 11.80'$ (13.7' FROM "A")

$M_{\frac{L}{2}} = 77.0 \times 16.5 - 123.0 \times 0.2 - 12.9 \times 4.0 = 1194.4^{1k}$

$e = \frac{1194.4}{123.0} = 9.70'$ $\qquad a = 2.30'$ $\qquad \frac{L}{2} - e = -5.7'$

$\frac{\Sigma H}{\Sigma V} = \frac{64.1}{123} = .52$

FSS = 1.05

ARFM LOADING,

$A = 24.0\ FT^2$

SOIL PRESSURE $f = \frac{2}{3} \times \frac{127.6\ (123)}{2.30} = 37.1\ (35.6)\ KSF$

PILE LOADING,

$P = \frac{123.0}{80/30} \pm \frac{1194.4}{12} = 46.0 \pm 99.0$

$P_{MAX} = 145.0^{k}$

$P_{MIN} = -53.0^{k}$

FOR COMBINED PILE LOADING, SEE SHT # 2

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITIONS OF STABILITY COMPUTED M.J. CHECKED R.V.M.	PROJECT LED #1 FILE NO 800A DATE 11.74 PAGE 49 OF ____ PAGES

TYPICAL RIVER WALL MONOLITH (CONT'D)

MONOLITH (II), FOUNDATION LOADING

$128.6 \times 10.30 = 1325.0^{k}$

$-14.3 \times 9.33 = -134.0$

$-\underset{109.2^{k}}{5.1} \times 14.00 = -\underset{1120.0^{k'}\ (M_2)}{71.3}$

$X_2 = \frac{1120.0}{109.2} = 10.25'$ $\quad 14.0 - 10.25 = 3.75'$

$M_{\mathcal{L}} = 109.2 \times 3.75 + .175 \times \frac{2.8^2}{2} + .144 \times \frac{5.55^2}{2} = 415.0^{k'}$

$e = \frac{415.0}{109.2} = 3.80'$ $\quad S = \frac{10 \times 28.0^2}{6} = 130.0$ $\quad \frac{L}{6} - e = -.86'$

$\frac{.175 \times 2.8}{2} = .24$

$\frac{.144 \times 5.55}{2} = .4$

AREA LOADING

$f = \frac{109.2}{28} \pm \frac{415.0}{130.0} = 3.92 \pm 3.20$

$f_{MAX} = 7.12^{KSF}$ $\quad f_{MIN} = 0.72^{KSF}$

PILE LOADING

$P = \frac{109.20}{80/30} \pm \frac{415}{15.0} = 41.2 \pm 27.7$

$P_{MAX} = 68.9^{k}$

$P_{MIN} = 13.5^{k}$

FOR COMBINED PILE LOADING, SEE SHT # 9

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITIONS OF STABILITY	PROJECT 250 #1
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TYPICAL RIVER WALL MONOLITH (CONT'D)

COMBINED PILE LOADING FOR MONO'S (I) & (II)

$M'_{(II)} = 415.0^{1k}$

$77.0 \times 16.5 = 1270$

$-12.9 \times 4.0 = -51.6$

$64.1^{k} \qquad 1218.4$

$y = \frac{1218.4}{64.1} = 19.1'$

MOMENT @ EL 684.45

$64.1 \times (19.0 - 8.75) - 415.0 = 243.3^{1k}$ $\qquad \Sigma H = 64.1$

PILE LOADING

$P = \frac{127.6}{8/3} - \frac{243.0}{51.7} = 48.0 - 4.7$

$P_{MAX} = 43.30^{k}/\text{PILE}$

$P = \frac{107.1}{9/3} + 4.7$

$P_{MIN} = 35.7 + 4.7 = 40.4^{k}/\text{PILE}$

FOR PILE LOADS WHERE STEEL SHEET PILING IS NOT CONSIDERED, SEE P/50a

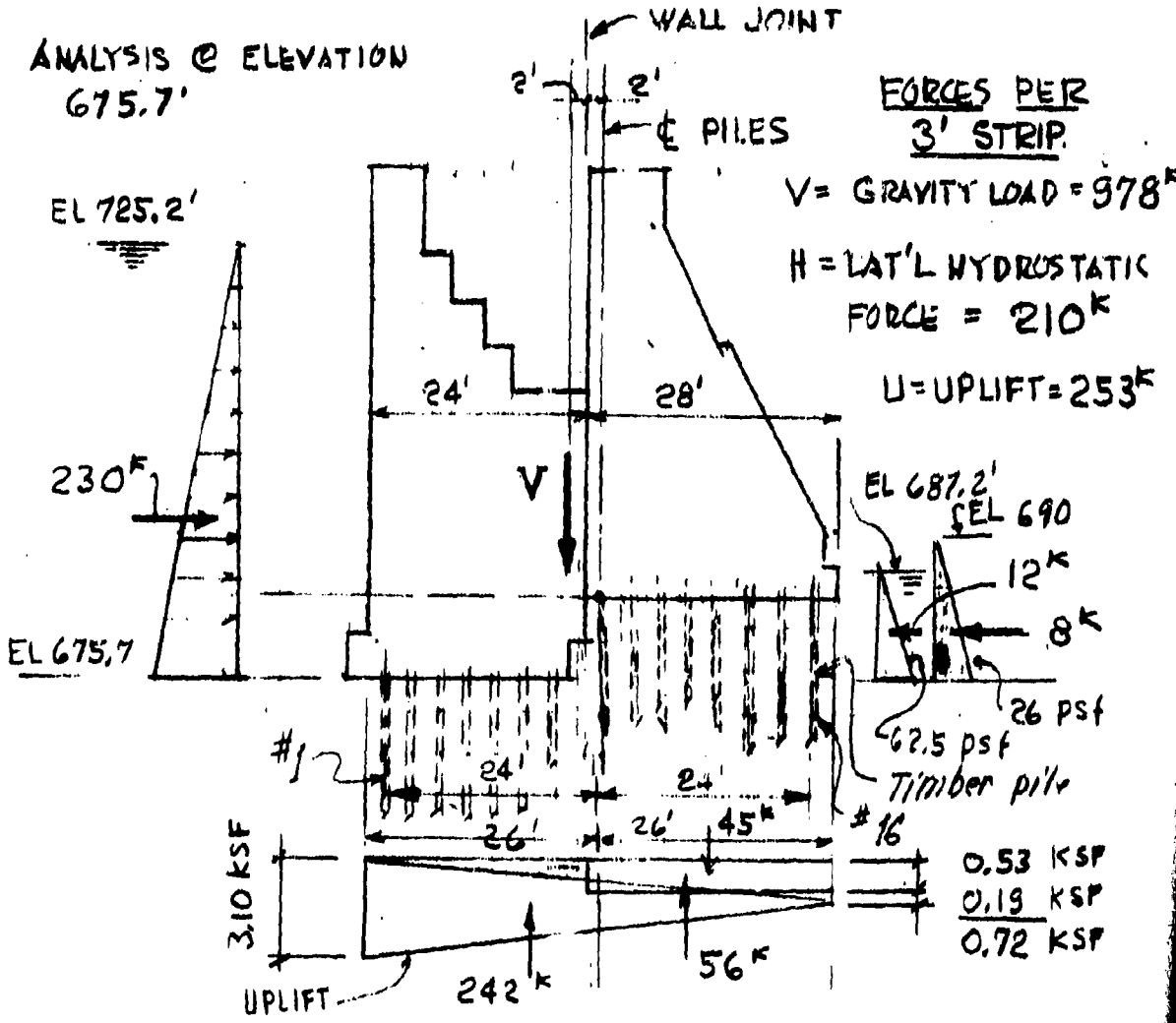
HARZA ENGINEERING COMPANY CHICAGO

SUBJECT TYPICAL RIVERWALL - EXISTING - NORMAL CONDITION
COMPUTED R.N.M. CHECKED JI

PROJECT LOCK & DAM
FILE NO 800 A
DATE 3/1/75 PAGE 50a OF PAGES

TYPICAL RIVERWALL MONOLITH
EXISTING CONDITION
NORMAL LOADING

ANALYSIS @ ELEVATION 675.7'



FORCES PER 3' STRIP

V = GRAVITY LOAD = 978K

H = LAT'L HYDROSTATIC FORCE = 210K

U = UPLIFT = 253K

1) MAX BEARING ON PILES = 50K (PILE #16)

2) HORIZONTAL PILE LOAD = 13K

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT TYPICAL RIVERWALL - EXISTING - NORMAL LOADING
COMPUTED P.N.M. CHECKED VI

PROJECT L & D DAM #1
FILE NO 800 A
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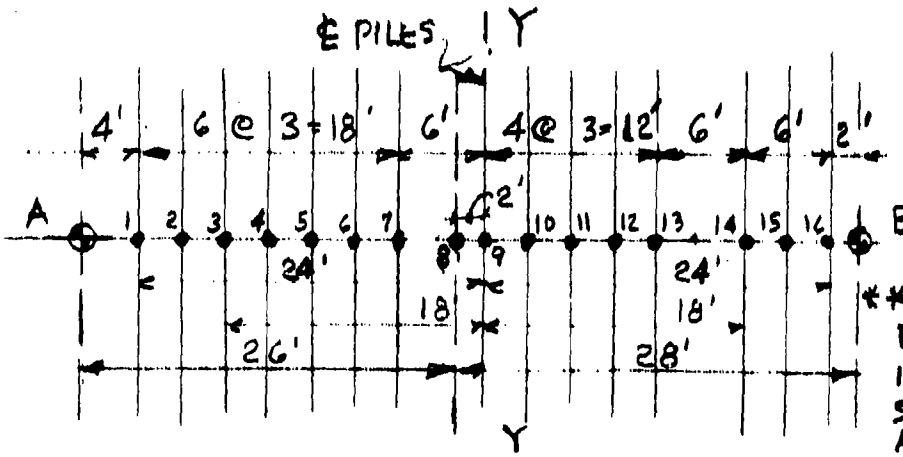
TYPICAL RIVERWALL
EXISTING CONDITION
NORMAL LOADING

PILE FOUNDATION PROPERTIES**



** C.G. OF PILE IS APPROXIMATE BUT WITH SUFFICIENT ACCURACY.

$$I_{Y-Y} = 2(24)^2 + 2(21)^2 + 2(18)^2 + 15^2 + 2(12)^2 + 2(9)^2 + 2(6)^2 + 3^2 + 2^2$$

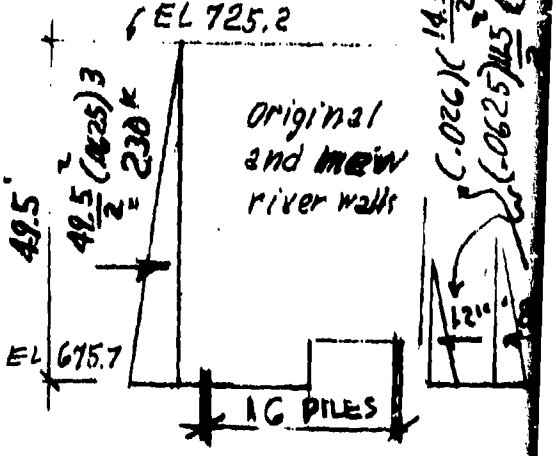
$$I_{Y-Y} = 3442'^4$$

$$S = \frac{3442}{24} = 143'^3 \text{ PER 3 FEET LONGITUDINAL}$$

Number of piles = 16

HORIZONTAL LOAD PER PILE

$$P_H = \frac{230 - 30}{16} = 13^K \text{ (Approx)}$$



HARZA ENGINEERING COMPANY CHICAGO	SUBJECT TYPICAL RIVERWALL — EXISTING, — NORMAL LOADING	PROJECT L & D #1
	COMPUTED B.N.M. CHECKED VI	FILE NO 800 A
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TYP. RIVERWALL MONOLITH, EXISTING CONDITION, NORMAL LOADING

GRAVITY LOAD, V & M_{Y-Y}

REFERENCE Pg 42

TAKEN AT ELEVATION 684.45'

	GRAVITY LOAD	H	V ↓ ⊕	ARM A	ARM Y-Y	M_A ↻	M_{Y-Y} ⊕↻
①	6 x 10 x .15		9.0	5.0		45.0	
②	5 x 9 x .15		6.8	6.5		44.2	
③	5 x 12 x .15		9.0	8.0		72.0	
④	5 x 15 x .15		11.3	9.5		107.3	
⑤	10 x 18 x .115	192.8	20.8	17.0	2644	354.0	
⑥	5 x 15 x .115		8.6	18.5		159.0	
⑦	5 x 12 x .115		6.9	20.0		138.0	
⑧	5 x 9 x .115		5.2	21.5		111.5	
⑨	32 x 24 x .15		115.2	14.0		1613.	
⑩a	24 x 8.75 x (-.063)		- 13	13.0		- 169	
⑪	π(4.8)² x (.15)		- 10.8	14.0		- 151	
⑫	4 x 3 x (.15)		- 1.8	24.5		- 44	
⑬			122.8	30.0		684	
⑭			6.4	36.2		398	232
⑮		128.6	66.0	33.5	4461	2211	
⑯			19.8	45.0		891	
⑰			13.6	47.3		643	
	TOTAL =		295.8	(23.47) 24.0	-4.53'	6941	1340 - 1186
	ARM Y-Y = ARM A - 28'		x 3	ft. strip of wall			x 3
			887.K				- 4020'K
	CONC. BELOW EL 684.5:		91.3	x 14'			
	ΔV = 24 x 8.45 x 3 x .15		978.3 K SAY	ΔM_{Y-Y} =			- 1278

$\Sigma V_{GRAVITY}$ = 978 K $\Sigma M_{Y-Y\ GRAVITY}$ = 5298 'K

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT TYPICAL RIVER WALL EXISTING – NORMAL LOADING COMPUTED P.N.M. CHECKED JJ	PROJECT L & D #1 FILE NO. 800 A DATE 3/1/75 PAGE 50d OF ____ PAGES

TYPICAL RIVER WALL MONOLITHS
EXISTING, NORMAL LOADING CONDITION

MAX. LOAD ON PILES @ EL. 675.7

LATERAL PRESSURES: $M_{GRAVITY} = 5298'^K$

$\frac{(725.2 - 675.7)^2}{2} \times .0625 \times 3 = +230^K$ (49.5) $\times 16.5 = 3795'^K$ ↻

$\frac{(687.2 - 675.7)^2}{2} \times .0625 \times 3 = -12^K$ (11.5) $\times 3.8 = -46'^K$ ↺

$\frac{(690 - 675.7)^2}{2} \times .026 \times 3 = -8^K$ (14.3) $\times 4.8 = -38'^K$ ↺

$\Sigma H = 210^K$ $M_{\Sigma H} = 3711'^K$ ↻

UPLIFT:

$\frac{3.10 \times 52}{2} \times 3 = +242^K$ $\times 8.7 = +2105'^K$ ↻

$\frac{0.72 \times 52}{2} \times 3 = +56^K$ $\times 8.7 = -487'^K$ ↺

$0.53 \times 28 \times 3 = -45^K$ $\times 12 = +540'^K$ ↻

$U = 253^K \downarrow$ $M_U = 2158'^K$ ↺

PILE LOAD:

$\Sigma V = 978 - 253 = 725^K$ $\Sigma M_{\ell} = +571'^K$ ↻

$\frac{725}{16} - \frac{571}{143} = 41.3$ SAY 42^K – P VERT ON PILE # 1

$\frac{725}{16} + \frac{571}{143} = 49.3$ SAY 50^K – P VERT. ON PILE # 16

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT TYPICAL RIVER WALL EXISTING - NORMAL LOADING

PROJECT L & D #1

FILE NO 600A

COMPUTED JL CHECKED R.N.M.

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FOUNDATION PRESSURES - VERTICAL LOAD TRANSFER BETWEEN I & II

Combine (I) & (II) Loads per linear foot (Ref. p 42 - 50)

(I)	ΣV	181.2	2451	
(II)	ΣV	128.6	4603	$\left(\frac{1219}{128.6} + 26\right) 128.6$
(I)	Uplift	-16.2	- 162	$\left(\frac{24.0}{2} + 2\right) 16.2$
(I)	"	-42.0	- 588	$\left(\frac{28.0}{2} + 2.0\right) 42$
(II)	"	- 5.0	- 200	$\left(\frac{28.0}{2} + 26.0\right) 5$
(II)	"	- 14.3	- 505	$\left(\frac{28.0}{2} + 26.0\right) 14.3$
ΣV_{resid} =		232.3	5659	$\frac{5634}{232.3} = 24.36$
	Δl	77.0	1871	
	E	- .4	- 4	
	I'	- [illegible]	- [illegible]	
	I'	- 12.0	- 52	
ΣH =		63.5	1912	

$$\bar{X} = \frac{5634 + 1912}{232.3} = 24.59'$$

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT TYPICAL RIVERWALL
EXISTING - NORMAL LOADING

PROJECT L & D #1
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$e = \frac{54.0}{2} - 29.58' = -2.58'$ $\quad \left(\frac{L}{6} - e\right) = 6.42'$

$p = \frac{232.3}{54.0}\left(1 \pm \frac{6 \times 2.58}{54.0}\right) = \begin{cases} \underline{5.54} \text{ ksf max} \\ \underline{3.07} \text{ ksf min} \end{cases}$

$\Sigma H = 63.5$ $\quad \frac{\Sigma H}{\Sigma V} = .273$ $\quad F.S. = 2.01$

$\Sigma V = 232.3$

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT RIVER WALL MONOLITHS #19, #20

COMPUTED M.T. CHECKED

PROJECT LED #1

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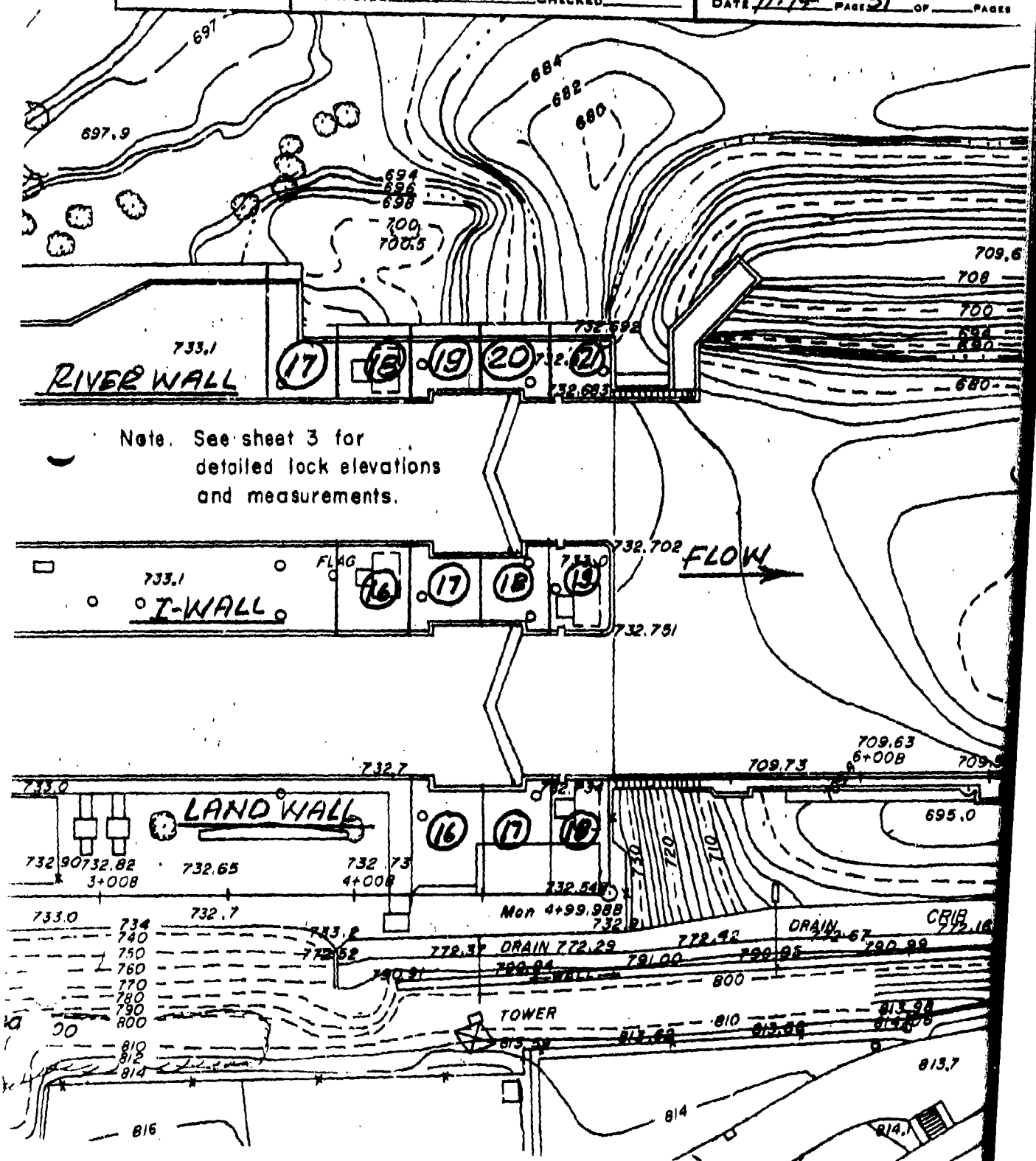

Note. See sheet 3 for detailed lock elevations and measurements.

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SUBJECT TYPICAL RIVERWALL – LOCK EMPTY

COMPUTED R.N.M. CHECKED

PROJECT L & D #1

FILE NO. 800A

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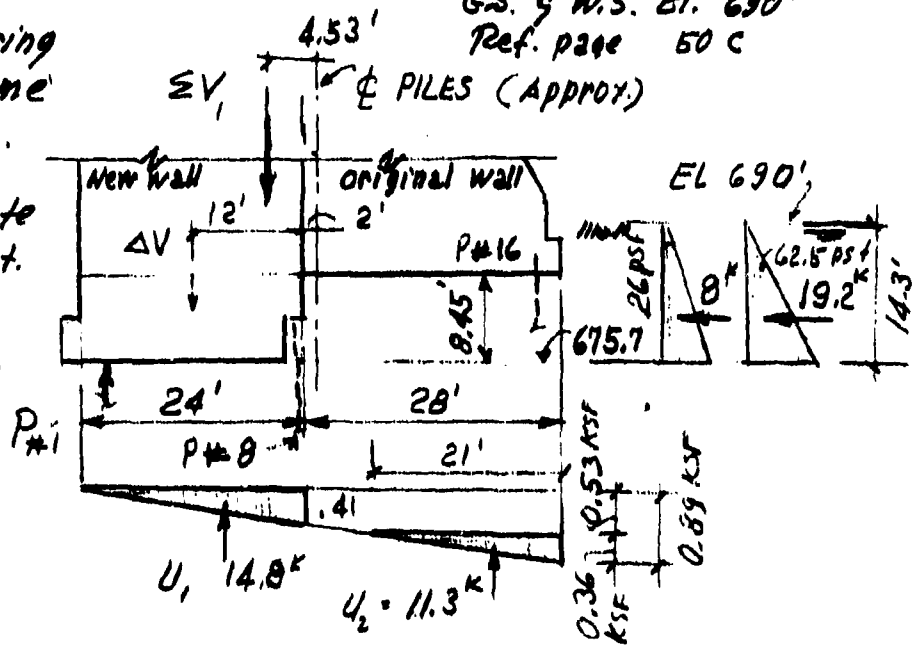
RIVERWALL TYP. MONOLITH CONSTRUCTION/MAINTENANCE

Analysis taken at el. 675.7'
G.S. & W.S. El. 690'
Ref. page 50 C

Maximum bearing load on extreme "lockside" pile.

Assume complete transfer of vert. load between original and new riverwall.



$\Delta V = 24 \times 8.45 \times 3 \times .15 = 91.3^K \quad \times(-14) = -1278$ ↑

$\Sigma V_1 = 887.0^K \quad \times(-4.53) = -4020$ ↓

$U_1 = -14.8^K \quad \times(-10) = +148$ ↑

$U_2 = -11.3^K \quad \times(+19) = -215$ ↑

$\Sigma V = 952.2^K$ ↓

$\Sigma H = 27.2^K$ ← $\quad \times \frac{14.3}{3} = -130$ ↑

$\Sigma M_{\text{℄}} = -5495'^K$ ↻

Force per pile, $P = \frac{\Sigma V}{n} \pm \frac{\Sigma M_{\text{℄}}}{S}$

$= \frac{952.2}{16} + \frac{5495}{143} = 98^K$ Pile #1

$P = 59.5 - \frac{5495}{143} = 21^K$ Pile #16

$P_H = \frac{27.2}{16} = 2^K$

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT EXISTING CONDITION OF STABILITY @ RIVER WALL

COMPUTED M.J. CHECKED R.N.M.

PROJECT LOCK & DAM #1

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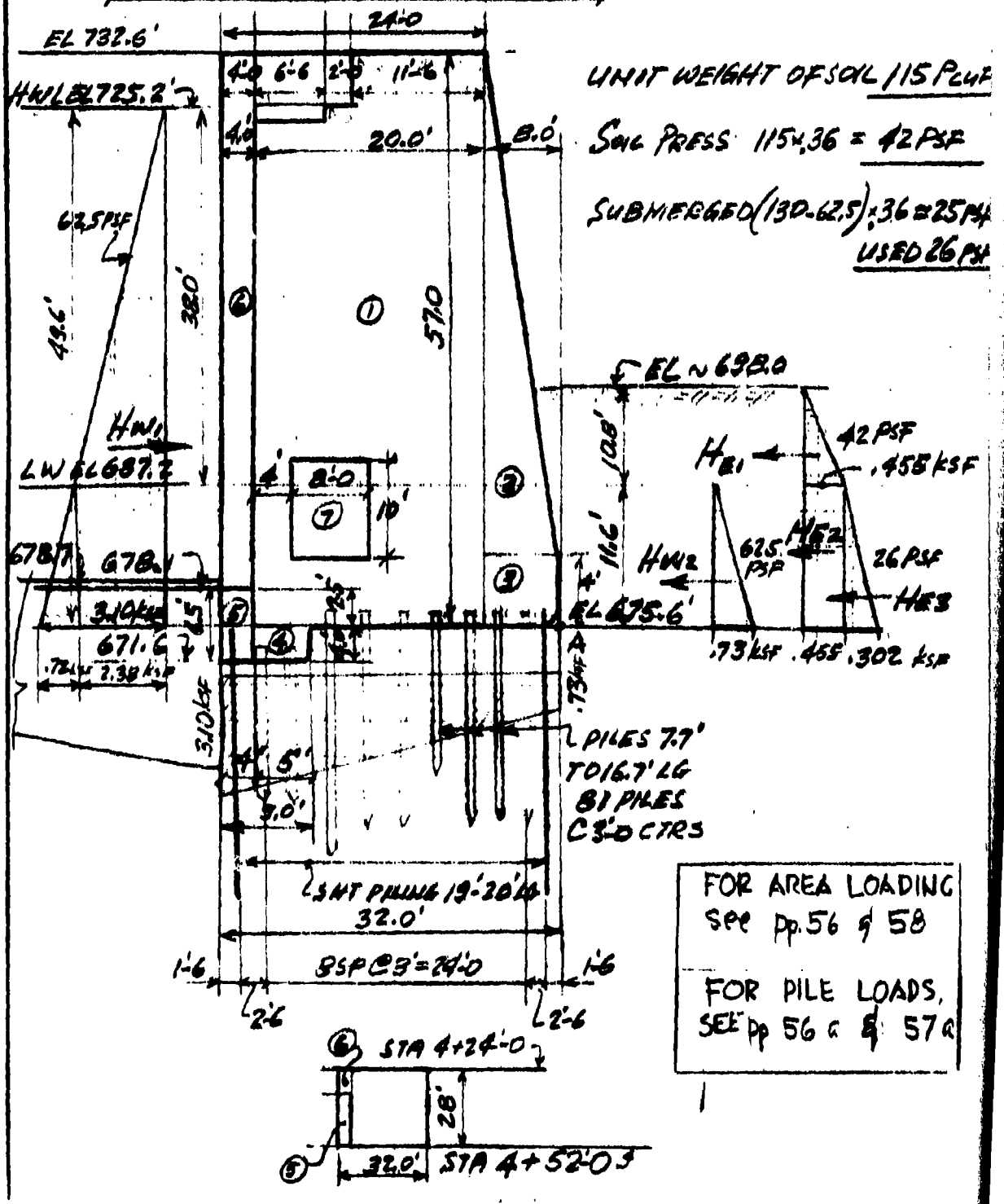
RIVER WALL MONOLITH #19



UNIT WEIGHT OF SOIL 115 PCF

SOIL PRESS 115 × .36 = 42 PSF

SUBMERGED (130 - 62.5) × .36 = 25 PSF

USED 26 PSF

FOR AREA LOADING
See Pp. 56 & 58

FOR PILE LOADS,
SEE Pp 56 a & 57a

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT EXISTING CONDITION OF STABILITY @ RIVER WALL

COMPUTED M.J. CHECKED P.N.M.

PROJECT LEO #1

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RIVER WALL MONOLITH #19 (CONT'D)

(1k)

	LOADS IN KIPS	VERT. ↓	VERT. ↑	HORIZ. →	HORIZ. ←	ARM	MOM'A ↻	MOM'A ↺
C1	57.0×20.0×28×.15	4790				18.0		86,200
C2	53.0×4.0×28×.15	890				5.33		4,740
C3	8.0×4.0×28×.15	134				4.0		538
C4	5.0×4.0×28.0×.087	49				25.5		1250
C5	6.5×4.0×19.5×.087	43				30.0		1290
C8	47.×4×19.5×.0625	230				30.0		6900
C6	61×4.0×8.5×.15	312				30.0		9360
		Σ 6448						Σ 110,280
C7	80.0×28×.088		200			20.0	4,000	
H_{W1}	3.10×24.8×28			2150		16.53	35,600	
H_{W2}	.730×5.8×28				1180	3.88		460
H_{E1}	.328×3.9×28				69.0	17.0		1170
H_{E2}	.328×11.6×28				147.0	5.8		855
H_{E3}	.151×11.6×28				49.0	3.88		190
		Σ 6448	200.0	2150.	383		39,600	112,860.
W_1	AVERAGE PRESS. @ LOCK SIDE		1189.0 k	(SEE NEXT SHT.)			Σ M = 73260 ft-k	
W_2	MAX PRESS. @ LOCK SIDE		1717.0 k	(" ")				

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITION OF STABILITY @ RIVER WALL	PROJECT LED #1
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RIVER WALL MONOLITH #19 (CONTED)

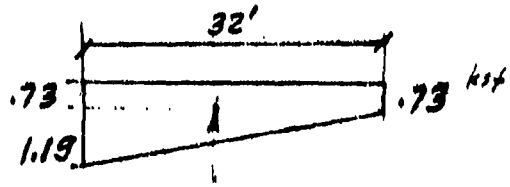
HYDROSTATIC PRESSURE @ BOTTOM

1). LOCKSIDE AVERAGE

$$\frac{3.10+.73}{2} = 1.92 \text{ ksf}$$

$32 \times 28 \times .73 = 655^k$

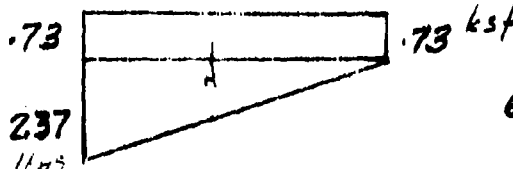
$32 \times 14 \times 1.19 = 534^k$ } 1189^k



$M_A \curvearrowright = 655 \times 16 + 534 \times 21.33 = 10450 + 11390 = 21.840^{1k} \curvearrowright$

$\Sigma M_A = 66360 - 21840 = 44.520^{1k}$

2). LOCKSIDE MAXIMUM



$655 + 1.185 \times 32 \times 28 = 1717^k$ (1062)

$M_A \curvearrowright = 10450 + 1.185 \times 32 \times 28 \times 21.33 = 10450 + 22700$ (1062)

$M_A \curvearrowright = 33.150^{1k} \curvearrowright$

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT EXISTING CONDITIONS OF STABILITY AT RIVERWALL

COMPUTED M.J. CHECKED R.N.M.

PROJECT L&D #1

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RIVER WALL MONOLITH #19 (CONT'D)

PILE LOADING FOR AVERAGE HYDROSTATIC LOAD ↑, (LOCKSIDE AVERAGE LOAD ↑) (AVERAGE UPLIFT)

$V = 6248 - 1189 = 5059^k$

$M_A = 73,260 - 21840 = 51,420^{ft\text{-}k}$

$a = \frac{51420}{5059} = 10.16'$ $\quad e = \frac{32.0}{2} - 10.16 = 5.84'$

$M_e = 5059 \times 5.84 = 29,500^{ft\text{-}k}$

SHEET PILE LOADING

$P_{SP} = \frac{5059}{3 \times 99} \pm \frac{29500}{3 \times 600} = 17.03 \pm 16.4^k/ft \begin{cases} 33.4 \\ 0.6 \end{cases}$

FOR 15" SHT PILES, $P_{MAX} = 41.8^k$ $\quad P_{MIN} = 0.8^k$

MAX LOAD ON TIMBER PILES

$I_{xx} = 8690$

$S = \frac{8690}{12.0} = 725$

$P = \frac{5059}{99} \pm \frac{29,500}{725} = 51.10 \pm 40.7$

$P_{MAX} = 91.8^k$ $\quad P_{MIN} = 10.4^k$

$H = 2150 - 383 = 1767^k$ OR 17.8^k EH. PILE

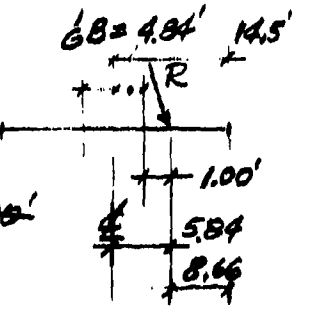
FOR PILE LOADS (WITHOUT STEEL SHT PILING) SEE PAGE 56a

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITIONS OF STABILITY AT RIVER WALL COMPUTED M.J. CHECKED R.N.M.	PROJECT L&D #1 FILE NO. 800A DATE 10.74 PAGE 56 OF ____ PAGES

RIVER WALL MONOLITH #19 (LOCKSIDE AVERAGE), CONTD

CHECK AREA LOADING, ASSUMING AREA BETWEEN SHEET PILES

$A = 29.0 \times 28.0 = 812\ FT^2$



$Q = 10.16'$ $e = 5.84'$

$5.84 - 5.33 = 0.51'$

1). RESULTANT OUTSIDE MIDDLE 1/3 BY ~~1.00'~~

2). $f_{SOIL} = \frac{2}{3}\frac{5059}{28 \times 8.66} = 75.90\ KSF$ (11.86 / 10.16)

3). $\frac{\Sigma H}{\Sigma V} = \frac{1767}{5059} = 0.350$

4) $FSS = \frac{5059 \times .55}{1767} = 1.57$

5). $FSOT = \frac{112860}{61440} = 1.84$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RIVER WALL STABILITY – PILE LOAD	PROJECT L & D #1
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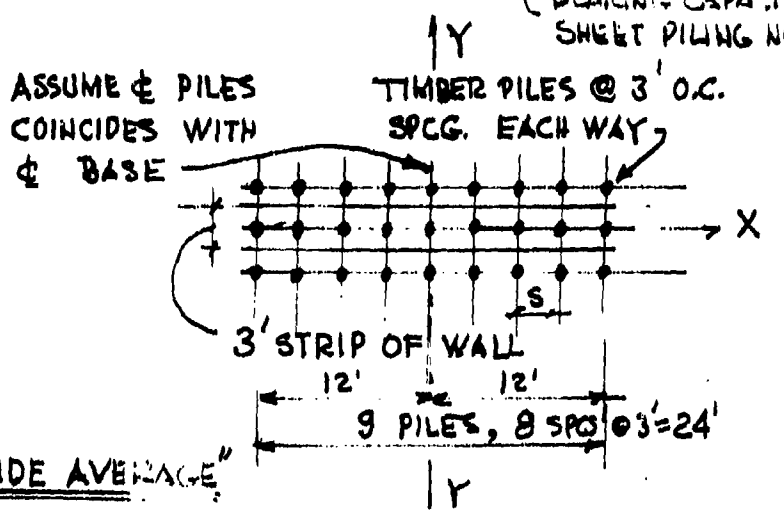
RIVERWALL MONOLITH NO. 19

EXISTING, NORMAL LOADING CONDITION

PILE LOADING, ASSUMING THAT THE TIMBER PILES SUPPORT ALL THE LOAD

(BEARING CAPACITY OF STEEL SHEET PILING NOT CONSIDERED)



$2(12)^2 = 288$
$2(9)^2 = 162$
$2(6)^2 = 72$
$2(3)^2 = 18$
$I_{y-y} = 540\ ft^4$
$\bar{x} = 45\ ft^3$

"LOCK SIDE AVERAGE"

$\Sigma V = 5059 \times \frac{3}{28} = 542^K$ (Incl. Page 55)

$\Sigma M_{℄} = 29{,}500 \times \frac{3}{28} = 3160'^K$ → PER 3' STRIP OF WALL

$\Sigma H = 1767 \times \frac{3}{28} = 189^K \rightarrow$

MAXIMUM LOAD ON TIMPER PILES:

$$P = \frac{542}{9} + \frac{3160}{45} = 60 + 70 = \underline{130^K}\ (MAX)\ /PILE$$

MINIMUM LOAD ON TIMBER PILES = $60 - 70 = \underline{-10^K}$ (MIN)/PILE

HORIZONTAL LOAD PER PILE = $\frac{189}{9} = \underline{21^K}$ /PILE

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT EXISTING CONDITIONS OF STABILITY CRIVER WALL

COMPUTED M.J. CHECKED R.N.N.

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RIVERWALL MONOLITH #19 (CONT'D)

MAXIMUM LOADING ON PILES (LOCKSIDE MAXIMUM)

$\Sigma V = 6248 - 1717 = 4531^{k}$

$M_A = 73260 - 33150 = 40110^{lk}$

$a = \frac{40110}{4531} = 8.85'$ $e = \frac{32.0}{2} - 8.85 = 7.14'$

$M_c = 7.14 \times 4531 = 32350^{lk}$

$I_{xx} =$

18×14.5^2	7/12	3820
18×12.0^2	1/4	2600
18×9.0^2	1/12	1460
18×6.0^2	1/36	648
18×3.0^2	1/108	162
		8690

$I_{xx} = 8690\ FT^4$

$S_{xx} = \frac{8690}{14.50} = 6000\ FT^3$

PAGE 57a FOR PILE LOADS (W/O STEEL SHT. PILING

MAX LOADS ON SHEET PILING

$P = \frac{4531}{99} \pm \frac{32350}{600} = 45.60 \pm 54.00 \begin{cases} 99.60^{k} \\ -8.40^{k} \text{ TENS.} \end{cases}$

FOR 15" SHT. PILES $P_{max} = 41.6^{k}/PILE$ $P_{MIN} = -3.5^{k}/PILE$ (TENS.)

MAX LOAD ON TIMBER PILES

ASS'D MP 101 $A = 10.31\ in^2$ $f_{all.}^{MAX} = 25,000^{\#}$
$P_{MAX} = 75^{k}$

$I_{xx} = 8690\ FT^2$ $S_{xx} = \frac{8690}{12} = 725\ FT^3$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RIVER WALL STABILITY- PILE LOAD	PROJECT L & D #1
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RIVER WALL MONOLITH NO. 19

EXISTING, NORMAL LOADING CONDITION

PILE LOADING

ASSUMPTION THAT PILES SUPPORT ALL LOAD

"LOCK SIDE MAXIMUM." - Reference pgs 56 & 55

$\Sigma V = 4531 \times \frac{3}{28} = 486^{k}$ SECT. MOD., $S = 45\ ft^3$

$\Sigma M_{\ell} = 32,350 \times \frac{3}{28} = 3466\ 'k$

$P_{MAX.} = \frac{486}{9} + \frac{3466}{45} = 54 + 77 = \underline{131}^{k}$

$P_{MIN} = - - - - - - = 54 - 77 = -\underline{23}^{k}$

$P_H = 21^{k}$

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT EXISTING CONDITIONS OF STABILITY AT RIVERWALL
COMPUTED M.S. CHECKED R.N.M.

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RIVERWALL MONOLITH #19 (CONT'ED)

(SEE P. 57a)

MAX LOAD ON TIMBER PILES (LOCKSIDE MINIMUM) (CONT'ED)

$P = 45.6 \pm \frac{32350}{725} = 45.6 \pm 44.6$ $\quad H = 176.7^{k}$

$P_{MAX} = 90.2^{k}\downarrow$ $\quad P_{MIN} = +1.0^{k}\downarrow$ $\quad H/pile = 17.8^{k}\rightarrow$

CHECK FOUNDATION LOADING, ASSUMING FULL AREA ~~(SHEET PILING)~~ SUPPORTING ALL LOADS (AREA LOADING)

$A = 29.0 \times 28 = 810\ FT^2$

$e = 7.14'$ $\quad a = 16 - 7.14 = 8.86'$

1). RESULTANT OUTSIDE MIDDLE $\frac{1}{3}$ BY $7.14 - \frac{32}{6} = 1.80'$

2). $f_{SOIL} = \frac{2 \times 4531}{3 \times 28 \times 8.86} = 12.17\ ksf$

3). $FSS = \frac{4531 \times .55}{1767} = 1.41$

4). $\frac{\Sigma H}{\Sigma V} = \frac{1767}{4531} = .39$ (FOR $f = .55$ & $FSS = 1.5$ $\frac{\Sigma H}{\Sigma V} = .367$)

5). $FSOT = \frac{112,860}{39600 + 33150} = 1.55$

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT EXISTING CONDITIONS OF STABILITY @ RIVERWALL

COMPUTED M. J. CHECKED R.N.M.

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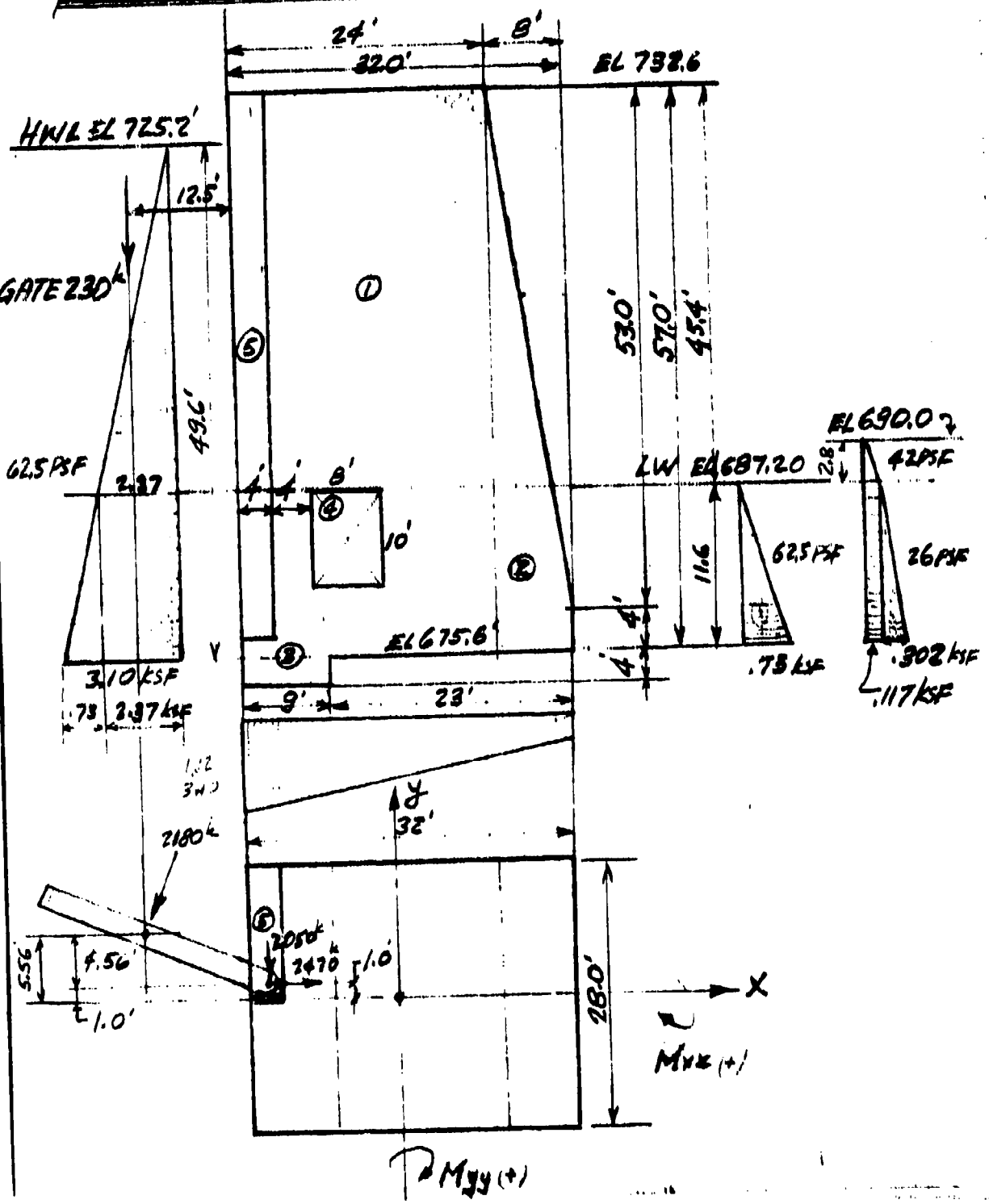
RIVERWALL GATE MONOLITH #20



HARZA ENGINEERING COMPANY CHICAGO

SUBJECT EXISTING CONDITIONS OF STABILITY CLIFF WALL

COMPUTED M.J. CHECKED R.N.M.

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RIVERWALL GATE MONOLITH #20 (CONTED)

ATTENTION

	LOADS IN KIPS	VERT. ↓	VERT. ↑	HORIZ. →	HORIZ. ←	ARM	MOM ↻ about yy	MOM ↺ about yy
C1		5746				4.0		22,984
C2		958				10.7	10,220	
C3	4 × 9 × 28 × .087	88				11.5		1,000
C4			196			4.0	784	
C5			260			14.0	3650	
GATE		230				28.5		6,560
		Σ 7022	456			Σ	14,654	30,544

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT EXISTING CONDITIONS OF STABILITY C RIVER WALL

COMPUTED M.J. CHECKED R.N.M.

PROJECT L&D #1

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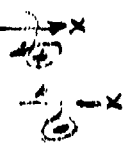
RIVER WALL GATE MONOLITH #20 (CONTD)

	LOAD IN KIPS	V↓	V↑	ARM	MOMENT MxK''	MxK'
	$C_1+C_2+C_3$	6792		0		
C_4			196	0		
C_5			260	7.0		1820
	GATE	230		5.56	1280	
		Σ 7022	456			
W_1	.73 × 32.0 × 14.0		327	7.0		2290
W_2	*1.19 × 32 < 14.0 × ½		267	7.0		1870
						Σ 5980 ↻ 1K
W_3			327	7.0	2290	
	*LOCKSIDE AVERAGE			Σ	3570 ↻ 1K	
W_2'	**2.37 × 32 × 14.0 × ½		532	7.0		3730
	**LOCKSIDE MAXIMUM	Σ 7022	Σ 1642K		Σ 3570K	Σ 7840K ↻



HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITIONS OF STABILITY RIVERWALL	PROJECT LGD #1
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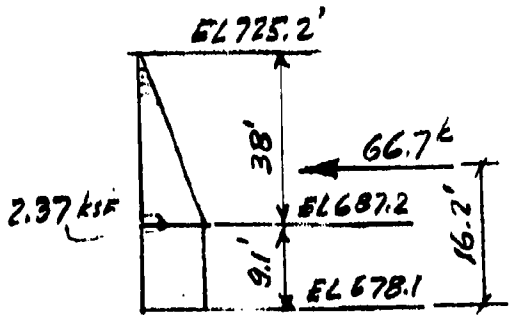
RIVERWALL GATE MONOLITH #20 (CONT'D)

HYDROSTATIC LOAD ON GATES



$2.37 \times 38.0/2 = 45.10^k$

$2.37 \times 9.1 = \underline{21.60}$

66.70^k

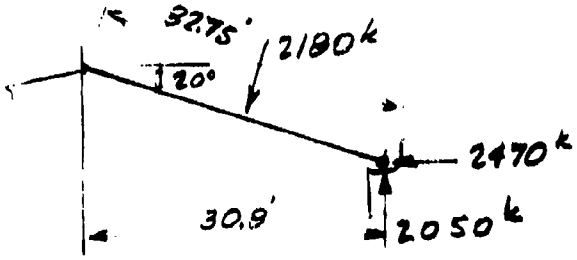
$45.1 \times 21.77 = 980.0$

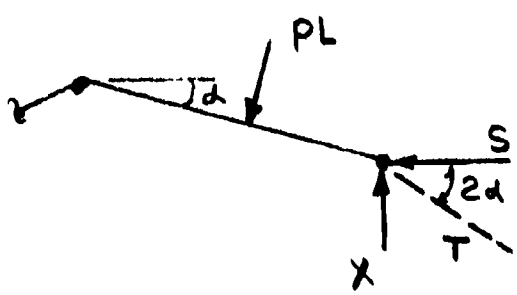
$\frac{21.6 \times 4.55}{66.7^k} = \frac{98.3}{1078.3}$ ft

$y = \frac{1078.3}{66.7} = 16.2' / EL\ 694.3'$

TOTAL GATE THRUST

$66.7 \times 32.75 = 2180^k$





$T = \frac{PL}{2 \sin d}$

$S = T \cos 2d$

$X = T \sin 2d$

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT EXISTING CONDITIONS OF STABILITY CRIVER WALL
COMPUTED M.J. CHECKED R.N.M.
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RIVERWALL GATE MONOLITH #20 (CONTD)

$\Sigma M_{xx} = 5980 - 3570 + 2050 \times (16.2 + 2.5) = 40820^{lk}$ ↷

$\Sigma M_{yy} = 30,544 - 14,654 - 2470 \times 18.7 -$
$- 32 \times 28.0/2 \times 1.19/2 \times (16.0 - 10.67)$ (LOCKSIDE OVERHANG)
$- 3,10 \times 24.8 \times 14 \times 16,55 + 460 + 190$
$+ .117 \times 11.6 \times 28 \times 5.8 + .117/2 \times 11.6 \times 28 \times 5.8$

$\Sigma M_{yy} = 30544 - 14654 - 46200 - 1420 - 17900 + 650$
$+ 221 + 110 = 31,525 - 47,774 = -16,250^{lk}$

"LOCKSIDE AVERAGE" UPLIFT

$\begin{cases} \Sigma M_{xx} = 40.820^{lk} \curvearrowright & e_y = 7.25' \\ \Sigma M_{yy} = 48550^{lk} \curvearrowright & e_x = 8.62' \end{cases}$

$\Sigma V = 7022 - 456 - 2 \times 327 - 267 = 5645^{k}$

$\Sigma H_x = 3260^{k}$

$\Sigma H_y = 2050^{k}$

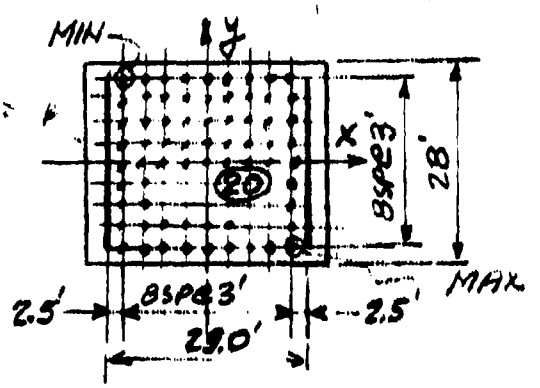
$\Sigma H_R = 3850^{k}$

(CONT'D ON PAGE 65)

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITIONS OF STABILITY C RIVER WALL COMPUTED M.J. CHECKED R.N.M	PROJECT L&D #1 FILE NO 800A DATE 10.74 PAGE 64 OF ___ PAGES

RIVER WALL GATE MONOLITH #20 (CONT'D)

PILE LOADING FOR LOCKSIDE AVERAGE UPLIFT PRESSURE



$I_{yy} = 8690$

$S_{yy} = 600.0$

ANOTHER COMPUTATION FOR PILE LOADS IS ON PAGE 64 b, WHERE SHEET PILING IS NOT INCLUDED

$$I_{xx} = 22 \times 3.0^2 = 198$$
$$22 \times 6.0^2 = 792$$
$$22 \times 9.0^2 = 1783$$
$$22 \times 12.0^2 = 3170$$
$$5943$$

$$S_{xx} = \frac{5943}{12} = 495$$

$$P = \frac{5645}{99} \pm \frac{40820}{495} \pm \frac{48550}{600} = 57.0 \pm 82.5 \pm 81.0$$

(M_{yx} = 40820, M_{yy} = 48550)

MAX $P = 57.0 + 82.5 + 81.0 = \underline{220.5^k}$

MIN $P = \underline{-106.5^k}$ (UPLIFT)

TOTAL $H_x = 3260^k$ OR $\frac{3260}{99} = 33.0^k$/PILE

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT EXISTING ~~UNFACTORED~~ CONDITIONS OF STABILITY @ RIVER WALL

COMPUTED M.T. CHECKED P.N.M.

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RIVER WALL GATE MONOLITH #20 (CONT'D)

EXISTING CONDITIONS - AREA LOADING (LOCKSIDE MAXIMUM)

$\Sigma V = 5380^k$

$\Sigma M_{xx} = 40820 + 1870 = 42690^{1k}$

$\Sigma M_{yy} = 48550 + 1420 = 49970^{1k}$

$\Sigma H_x = 3260^k$ $\quad \Sigma H_R = 3951^k$

$\Sigma H_y = 2050^k$

$A = 912\ FT^2$ (29x29)

$e_y = \frac{42690}{5380} = 7.95$ $\quad e_x = \frac{49970}{5380} = 9.29$

$e_x/b = 7.95/29.0 = .284$; $e_x/L = 3.29/29.0 = .113$

$L = 9.7$

PILE LOADS ON PAGE 64C

1. $F_{SOIL} = 9.7 \cdot \frac{5380}{912} = 64.2\ K/F$

2. L OUTSIDE KERN

3. $\frac{\Sigma H}{\Sigma V} = \frac{3260}{5380} = 0.61$

4. $F.S. = \frac{5380 \cdot .55}{2470} = 0.90$ $\quad F.S._R = \frac{5380 \cdot .55}{3951} = .77$

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT RIVERWALL STABILITY- PILE LOAD
COMPUTED R.N.M. CHECKED JJ

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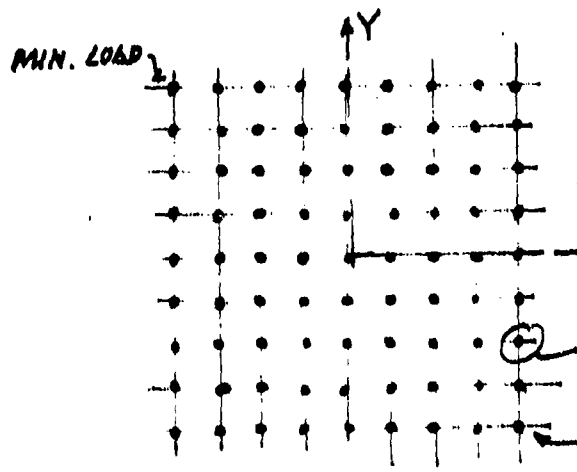
RIVER WALL GATE MONOLITH No. 20
EXISTING, NORMAL LOADING CONDITION



$I_Y = \Sigma X^2 = 4860$

$I_X = \Sigma Y^2 = 4860$

81 Piles @ 3' o.c. E.W.

ASSUME PILE FOUNDATION SUPPORTING ALL LOAD

"LOCK SIDE AVERAGE" Page 64

$\Sigma V = 5645^K$ $\Sigma M_X = 40,820'^K$ $\Sigma M_Y = 48,550'^K$ $\Sigma H_X = 3260^K$

$$P_{MAX.} = \frac{5645}{81} + \frac{48550 \times 12}{4860} + \frac{40820 \times 12}{4860} = 69.7 + 119.9 + 100.8 = 290^K$$

$$P_{MIN.} = 69.7 - 119.9 - 100.8 = -151^K$$

$$P_H = \frac{3260}{81} = 40^K$$

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT RIVER WALL STABILITY PILE LOAD
COMPUTED JJ CHECKED R.W.M.

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RIVER WALL GATE MONOLITH #20
EXISTING, NORMAL LOADING CONDITION
"LOCKSIDE MAXIMUM" (REF. p. 64a)

$\Sigma V = 5380^k$

$\Sigma M_{xx} = 42693^{lk}$ $\Sigma M_{yy} = 49970^{lk}$

$\Sigma H_x = 3260^k$ $\Sigma H_y = 2050^k$ $\Sigma H_R = 3851^k$

$$P_V = \frac{5380}{81} \pm \frac{42693 \times 12.0}{4860} \pm \frac{49970 \times 12.0}{4860} =$$

$$= 66 \pm 105 \pm 123 = \begin{cases} 294^k & \text{max} \\ -162^k & \text{min} \end{cases}$$

$P_{Hx} = \frac{3260}{81} = 40^{k/ft.}$ $P_{HR} = \frac{3851}{81} = 48^{k/ft.}$

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT EXISTING CONDITIONS OF STABILITY @ RIVER WALL

COMPUTED M.J. CHECKED R.N.M.

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RIVERWALL GATE MONOLITH #20 (CONT'D)

CHECK SOIL PRESSURE, ASSUMING AREA LOADING (LOCKSIDE AVERAGE)

$A = 29 \times 28 = 812\ FT^2$

$e_y = \frac{40820}{5645} = 7.25'$

$e_x = \frac{48550}{5645} = 8.62'$

$\frac{e_y}{b} = \frac{7.25}{29.0} = 0.26$

$\frac{e_x}{b} = \frac{8.62}{29.0} = 0.30$

$K = 7.70$

SUMMARY OF RESULTS

1). $f_{MAX} = 7.70 \times \frac{5645}{812} = 53.5\ KSF$

2). RESULTANT OUTSIDE KERN

3). $\frac{\Sigma H}{\Sigma V} = \frac{3260}{5645} = .58$

4). $FSS_{..} = \frac{5645 \times .55}{3260} = 0.95$ $FSS_R = \frac{5645 \times .55}{3850} = .81$

(FROM PAGE 63)

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT SLIDING STABILITY	PROJECT L&D #1
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SLIDING STABILITY

TOP OF IMPERVIOUS LAYER (UNIT B) EL660.00

H.W.L EL 725.2' $.0625 \times 65.2 = 4.08$ KSF

$H_{W_1} = .0625 \times 65.2^2/2 = 133.0^k$ →

$H_{W_2} = .0625 \times 70.2^2/2 = 154.0^k$ ← (TOP OF IMPERVIOUS LAYER @ EL 655.0)

TOTAL VERTICAL LOAD

$\Sigma V' = 6445 - 200 - 1189 = 5056^k$

$5056/28 = 180^k$ /FT OF WIDTH

WEIGHT OF SOIL

$4 \times 23 \times .065 = 6.3$

$11.6 \times 32.0 \times .068 = 25.2$ } 31.5^k (BETWEEN EL 675.6 & 660.0)

$9.5 \times 32.0 \times .115 = 35.0$ (BETWEEN EL 660.0 & 650.5')

$\Sigma V = 130.0 + 31.5 + 35.0 = 246.5^k$

$\phi = 22°$ $\tan\phi = .404$

$246.5 \times .404 = 100.0^k$

$\phi = 23°$ $\tan\phi = .424$

$246.5 \times .424 = 104.5^k$

$\phi = 18°$ $\tan\phi = .325$ $.325 \times 246.5 = 80.5^k$

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT SLIDING STABILITY

COMPUTED M.J. CHECKED R.V.M.

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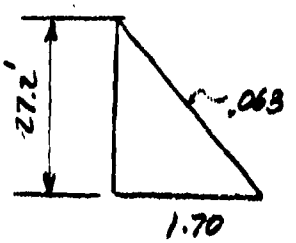
SLIDING STABILITY (CONT'D)

$K_p = 1.5$

$1.5 \times .13 = .195$ KSF/'

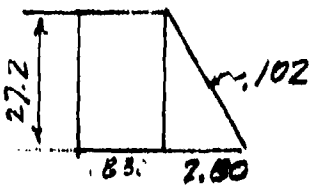
$1.5 \times .068 = .102$ KSF/'

$1.5 \times .115 = .173$ KSF/'



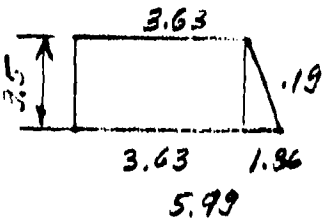
$0.85 \times 27.2 = 23.1^k$

$0.5 \times .173 \times 4.8^2 = 2.0^k$



22.6 38.2

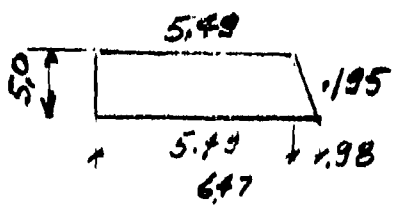
$.832 \times 27.2 + 1.40 \times 27.2 = 60.6^k$



9.2 9.9

$9.5 \times 3.63 + .93 \times 9.5 = 43.1^k$

$\overleftarrow{\Sigma H} = 2.0 + 23.1 + 60.6 + 43.1 = 129.0^k$



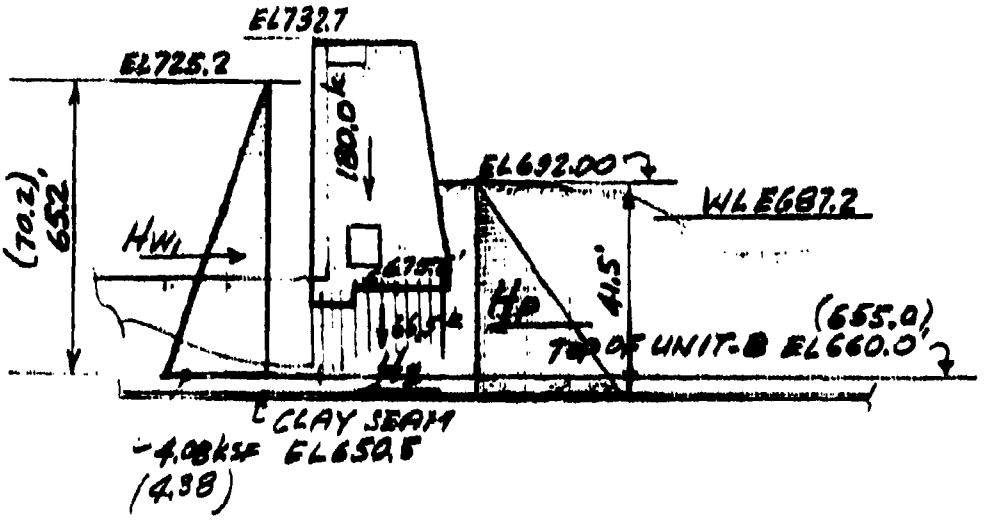
$5.49 \times 5.0 + 2.5 \times .98 = 29.9^k$

$\overleftarrow{\Sigma H} = 129 + 30 = 159^k$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT SLIDING STABILITY OF L&D STRUCTURE COMPUTED M.J. CHECKED R.N.M.	PROJECT L&D #1 FILE NO. 800A DATE 1.75 PAGE 68 OF PAGES

SLIDING STABILITY (CONT'D)

SLIDING STABILITY C CLAY SEAM - SUMMARY



ASSUME NO COHESION IN CLAY SEAM

$H_{W_1} = 4.08 \times 65.2/2 = 133.0^k$ (154^k)

$H_s = 246.5 \times .404 = 100.0^k$ (104.5^k)

$H_p = 129.0^k$

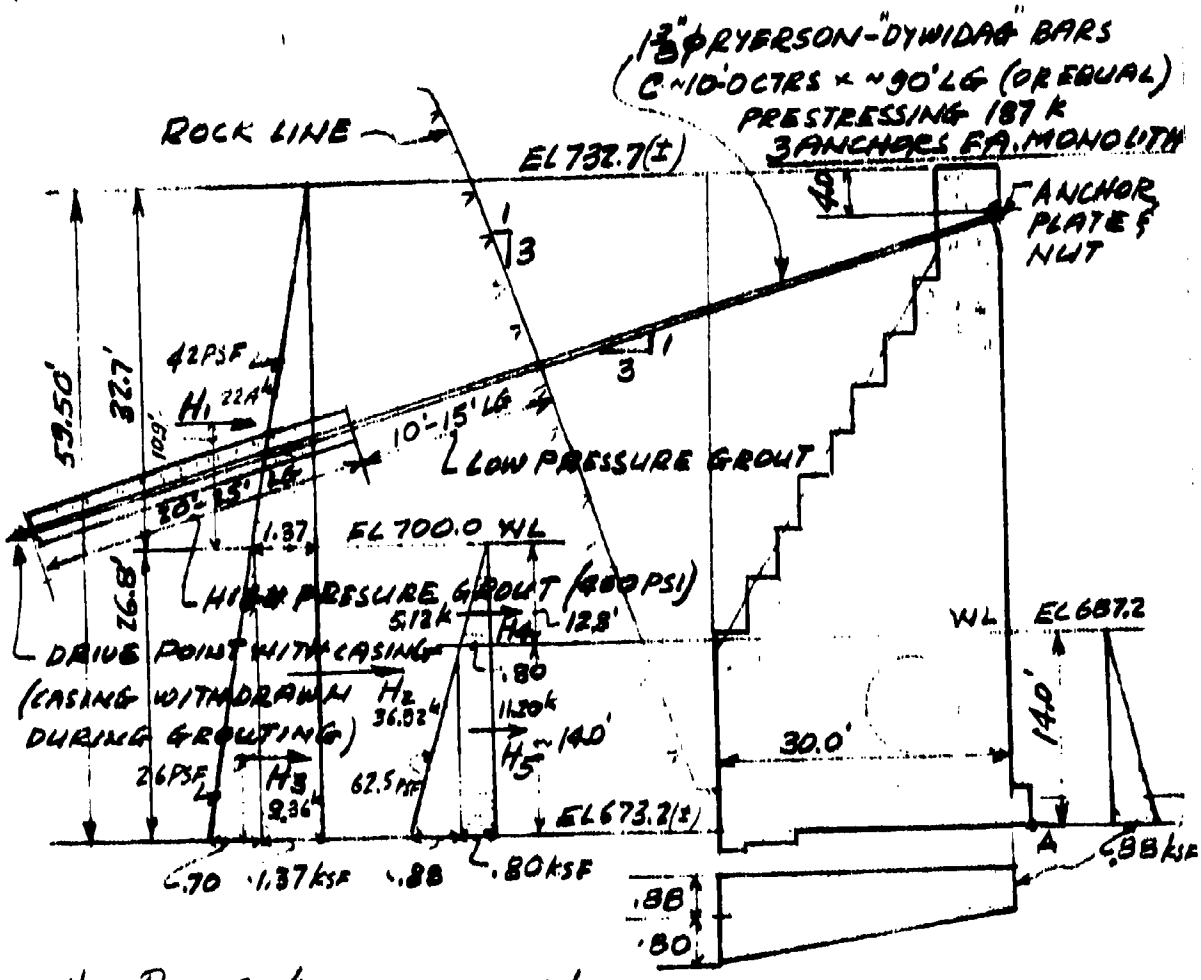
$F_{SS} = \frac{100.0+129}{188.0} = 1.72$ $\phi = 22°$ $\frac{100+159}{154} = 1.68$

$F_{SS} = \frac{104.5+129}{183} = 1.75$ $\phi = 23°$ $\frac{104.5+159}{154} = 1.70$

$F_{SS} = \frac{80.5+129}{183} = 1.58$ $\phi = 18°$ $\frac{80.5+129}{154} = 1.36$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL MONOLITHS	PROJECT LED #1
	COMPUTED M.J. CHECKED R.V.M.	FILE NO 800A
		DATE 11.74 PAGE 69 OF ____ PAGES

LANDWALL MONOLITHS #5-15 - STABILIZING BY ANCHORS



1). $R = 219.0^k$ INSIDE MIDDLE 1/3 key

2). $\frac{\Sigma H}{\Sigma V} = \frac{71.0}{207.0} = 0.343$

3). $f_{SOIL} = 6.5 \pm 5.2$ { MAX 11.7 KSF, MIN 1.3 KSF

4). $FSS = \frac{207 \times .625}{70.0}$ 1.85

5). $FSOT = \frac{4831}{2404} = 2.0$

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT LANDWALL MONOLITHS PROJECT LEO #1

COMPUTED M.S. CHECKED R.N.M. FILE NO 800A

DATE 11.74 PAGE 70 OF ____ PAGES

LANDWALL MONOLITHS #1-5-15-STABILIZING BY ANCHORS (CONT'D)

$H_1 = 1.37 \times 32.7/2 = 22.40^k$

$H_2 = 1.37 \times 26.8 = 36.92$

$H_3 = .70 \times 26.8/2 = 9.36$

$H_4 = .80 \times 12.8/2 = 5.12$

$H_5 = .80 \times 14.0 = 11.20^k$

$\Sigma H = 85.0^k$

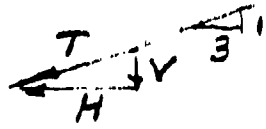
HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL MONOLITHS	PROJECT L&D #1
		FILE NO. 800A
	COMPUTED M.J. CHECKED R.N.M.	DATE 11.74 PAGE 71 OF ____ PAGES

LANDWALL MONOLITHS #4-5-15 STABILIZING BY ANCHORS (CONT'D)

MAXIMUM LOAD ON ANCHORS (ACTIVE PRESS. CONDITION)

22.40 × 37.7	=	846.0
36.92 × 13.4	=	495.0
9.36 × 8.93	=	83.6
5.12 × 18.27	=	93.4
11.20 × 7.00	=	78.4
Σ85.0 k		Σ1596.4 k/ft (MA)

$H = \frac{1596.4}{55.50} = 28.7$ k/ft of wall



$T = \frac{28.7}{3} \times 3.16 = 30.0$ k/ft $V = 9.5$ k/ft

TOTAL (ΣT) ON 30' MONOLITH = 900.0 k

USE 1 3/8" RYERSON "DYWIDAG" BARS, WITH PRESTRESSING

$.80 T_u = 187.2$ k

CHECK STABILITY CONDITIONS USING 3 ANCHORS FOR EACH MONOLITH, SEE NEXT SHT. [$3 \times 187.2 < 900.0$ k OK]

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT LANDWALL MONOLITHS | PROJECT LSD #1

COMPUTED M.J. CHECKED P.N.M. | FILE NO 800A

DATE 11.74 PAGE 72 OF PAGES

LANDWALL MONOLITHS #5-15 - STABILIZING BY ANCHORS (CONT'D)

$1\frac{3}{8}\phi$ BARS; $.80 T_u = 187.2^k$ ("RYERSON" CATALOG 40-1 PG. #5)

LOSS OF PRESTRESS ASSUMED 25 KSI (ACI, 318-71 COMMENT. 18.6.1)

USABLE TENSION $187.2 - 1.56 \times 25.0 = 148.2^k$/BAR

$\frac{3 \times 148.2}{30} \times \frac{3.0}{3.16} = 14.0^k/FT$ $(= H)$ $\quad T = \frac{3.16}{3} H$ (1 V)

EXISTING CONDITIONS

$\Sigma V = 202.0^k \quad \Sigma H = 85.0^k \quad \Sigma M_A = 1647.0^{fk}$

IMPROVED CONDITIONS

$\Sigma V = 202.0 + 5.0 = 207.0^k$

$\Sigma H = 85.0 - 14.0 = 71.0^k \rightarrow$

$\Sigma M_A = 1647.0 + 14.0 \times 55.5 = 2425^{fk}$

$\Sigma R = 219.0^k$

$a = \frac{2425}{207} = \underline{11.7'}$

$e = 16.0 - 11.7 = \underline{4.3'}$

$M_{yy} = 4.3 \times 207 = 890.0^{fk}$ $\qquad 1596.4 + 808 = 2404^{fk}$

$S_{yy} = \frac{32.0^2}{6} = 170.0\ FT^3$ $\qquad 4051 + 14 \times 55.5 = 4831^{fk}$

FOR RESULTS OF IMPROVED CONDITIONS SEE SHT. #1

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT LANDWALL STABILIZATION BY ROCK ANCHORS 1 3/8" ϕ
COMPUTED R.N.M. CHECKED JJ

PROJECT Lock & Dam #1
FILE NO 900 A
DATE Jan '75 PAGE 72a OF ____ PAGES

LANDWALS 5-15

ANALYSIS OF UPPER LANDWALL MONOLITHS FOR ASSUMED WATER SURFACE ON LANDWARD SIDE AT ELEVATION 704

Ref.: pages 69-72, and 75a

* P_f = Friction resistance due to weight of submerged slab = 5^k (Pg 10)

	Σ Forces for W.S @ El 700 (From Pg 72)	Change in hydrostatic and earth pressures, (Pg 75a)	Σ Forces for W.S @ El 704
ΣH → +	$+71^k - P_f^*$	6^k	$77 - 5 = 72^k$
ΣV ↓ +	$+201^k$	-4^k	203^k
ΣM_A ↻ +	$-2425'k$	$163'k$	$2262'k$

$$a = \frac{2262}{203} = 11.14' \quad e = 4.86' < 5.33$$

(1) Resultant, R = 203 inside middle $\frac{1}{3}$ by 0.47'

(2) $f_{soil} = \frac{202}{32}\left(1 + \frac{6 \times 4.86}{32}\right) = 6.34\,(1 \pm 0.91)$

$f_{max} = 12.1$ KSF

$f_{min} = 0.6$ KSF

(3) Factor of sliding = $\frac{72}{203} = 0.355 = \frac{\Sigma H}{\Sigma V}$

(4) Factor of safety against sliding, FS = 1.76

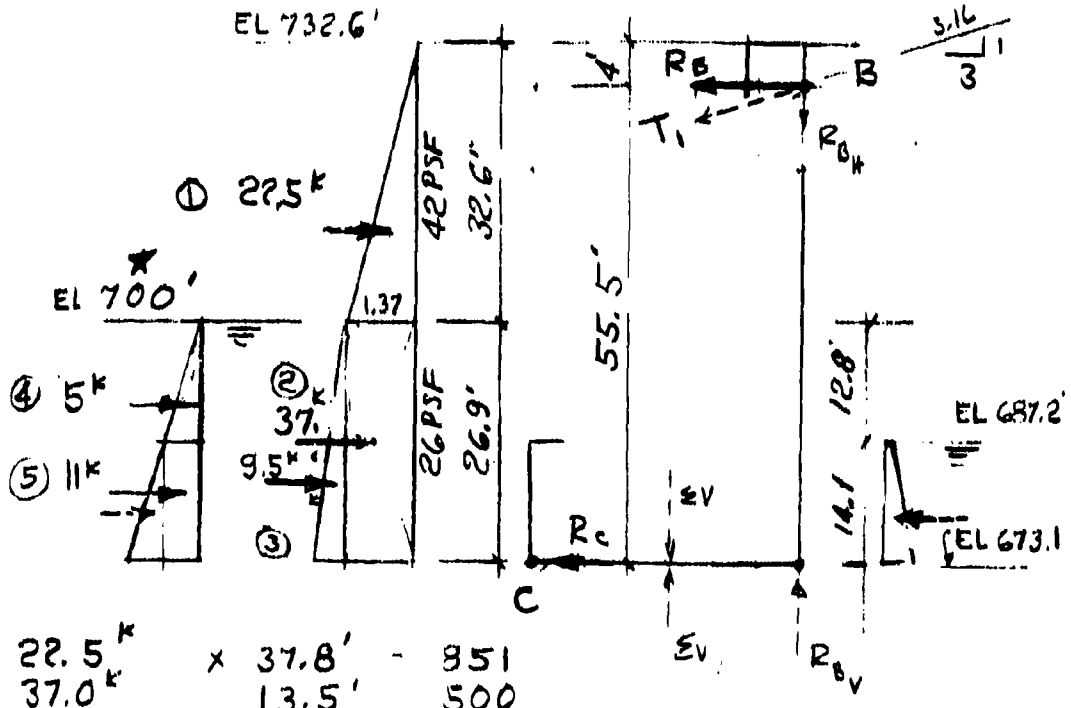
(5) Factor of safety against overturning

F.S.O.T. = $\frac{4051}{2487 - 14.0 \times 55.5} = 2.37$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL STABILIZATION USING LARGER ROCK ANCHORS	PROJECT LOCK & DAM NO. 1
	COMPUTED R.H.M. CHECKED JI	FILE NO. 800 A
		DATE 2/'75 PAGE 72b OF ____ PAGES

LANDWALL MONOLITHS 5-15 IMPROVEMENT & STABILITY, USING LARGER ANCHORS
(ITEM 19 OF GENERAL COMMENTS RECEIVED 2/21/75)

DETERMINATION OF MAXIMUM SIZE OF ROCK ANCHORS IN LANDWALL, UTILIZING ONLY ACTIVE SOIL PRESSURE IN BACKFILL DURING PRESTRESSING.



①	22.5ᵏ	× 37.8'	= 851	
②	37.0ᵏ	13.5'	500	
③	9.5ᵏ	9.0'	86	R_B = 28.5ᵏ
④	5.0ᵏ	18.4'	92	
⑤	11.0ᵏ	4.7'	52	R_C = 56.5ᵏ
	85ᵏ		$55.5\,R_B$ = 1581	

$T_1 = 28.5 \times \frac{3.16}{3.0} = 30^{k}$ PER FOOT OF WALL

$T = 30.0 \times 15 = 450^{k}$ MAX FOR ROCK ANCHORS SPCD 15' O.C.

★ ASSUMED W.S. ELEV. DURING PRESTRESSING

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT LANDWALL STABILIZATION USING LARGER ROCK ANCHORS

PROJECT LOCK & DAM NO. 1

FILE NO 800 A

COMPUTED R.N.M. CHECKED JJ

DATE 2/1/75 PAGE 72C OF ____ PAGES

LANDWALL MONOLITHS #5-15
IMPROVEMENT OF STABILITY BY LARGER ANCHORS (CONT'D)

MAX PRESTRESSING FORCE FOR ACTIVE SOIL PRESSURE ONLY

ASSUME 2-$1\frac{1}{4}''\phi$ BARS/ANCH. - See sketch attached. "RYERSON"

PRESTRESSING FORCE, $0.80 f_{pu}$ = 150 per rod

$\times 2$

300 K

LOSSES $1.25'' \times 2 \times 25^{ksi}$ = − 63

DESIGN CAPACITY PER ANCHOR = 237 K

ASSUME 3-$1\frac{1}{4}''\phi$ RODS PER ANCHOR $150 \times 3 = 450^{K}$

DESIGN CAPACITY/ANCHOR = $237 \times \frac{3}{2} = 356^{K}$

2-$1\frac{1}{4}''\phi$ (DOUBLE ROD) CAPACITY = $\frac{237}{15} = 15.8^{K}/ft., < 30,^{*}$

3-$1\frac{1}{4}''\phi$ (TRIPLE ROD) CAPACITY = $\frac{356}{15} = 23.7^{K}/ft., < 30,^{*}$

DOUBLE ROD ANCHOR:

$15.8 \times \frac{3.0}{3.16} = 15^{K} \leftarrow$

$15.8 \times \frac{1}{3.16} = 5.0^{K} \downarrow$

TRIPLE ROD ANCHOR.

$23.7 \times \frac{3.0}{3.16} = 22.5^{K} \leftarrow$ PER FOOT OF WALL

$23.7 \times \frac{1}{3.16} = 7.5^{K} \downarrow$

* TENSION DUE TO MAXIMUM ACTIVE SOIL PRESSURE

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT LANDWALL STABILIZATION USING LARGER ROCK ANCHORS
COMPUTED R.N.M. CHECKED JJ

PROJECT LOCK & DAM NO. 1
FILE NO 800A
DATE 2/1/75 PAGE 72d OF ____ PAGES

LANDWALL MONOLITHS 5-15 IMPROVEMENT OF STABILITY USING LARGER ANCHORS
STABILITY ANALYSIS (refer to page 72a)

A. 2 - $1\frac{1}{4}$" Ø STRAND PER ANCHOR, 2 ANCHORS PER MONOLITH

$\Sigma H = 85 - 15 = 70^{K} \rightarrow$

$\Sigma V = 207 + 5 = 212 \downarrow$

$\Sigma M = 1647 + 55.5 \times 15.0 = 2480'K \circlearrowright$

$L = 32'$
$\frac{L}{6} = 5.3'$
$\frac{L}{4} = 8.0'$

(1) $\bar{X} = \frac{2480}{212} = 11.7'$ $e = 4.3$

RESULTANT INSIDE MIDDLE 1/3 BY 1.0

(2) $f = \frac{212}{32}\left(1 \pm \frac{6 \times 4.3}{32}\right) = \begin{cases} 12.0 \text{ KSF MAX.} \\ 1.3 \text{ KSF (MIN)} \end{cases}$

(3) $\frac{\Sigma H}{\Sigma V} = 0.33$ (4) FSS = 1.89

(5) $F.S._{O.T.} = \frac{4051}{2487 - 15.0 \times 55.5} = 2.45$

B. 3 - $1\frac{1}{4}$" Ø STRANDS PER ANCHOR, 2 ANCHORS PER MONOLITH

$\Sigma H = 85 - 22.5 = 62.5^{K}$

$\Sigma V = 207 + 7.5 = 214.5^{K}$

$\Sigma M_A = 1647 + 55.5(22.5) = 2896^{'K}$

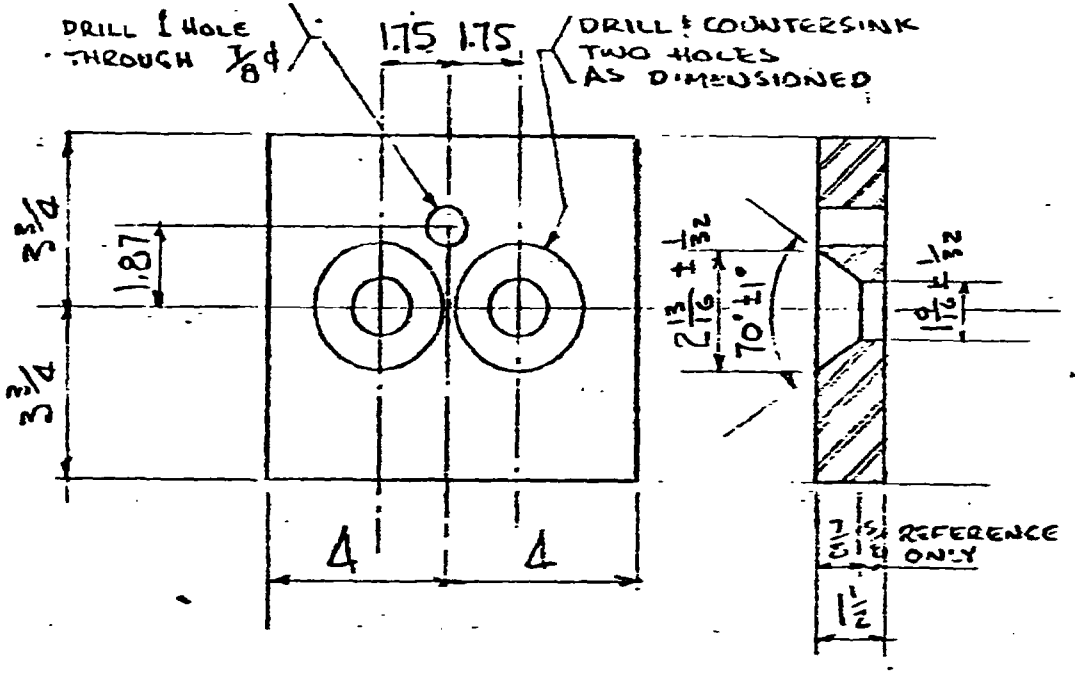
(1) $\bar{X} = 13.5$ $e = 16.0 - 13.5 = 2.5'$

RESULTANT INSIDE MIDDLE 1/3 BY 2.83

(2) $f = \frac{214.5}{32}\left(1 \pm \frac{6 \times 2.5}{32}\right) = \begin{cases} 9.80 \text{ KSF MAX.} \\ 3.60 \text{ KSF MIN.} \end{cases}$

(3) $\frac{\Sigma H}{\Sigma V} = 0.29$ (4) FSS = 2.16

(5) $F.S._{O.T.} = \frac{4051}{2487 - 22.5 \times 55.5} = 3.27$



MATERIAL

1 R 1½ x 7½ x 8 A36

OR Fy min = 33000, CARBON

FOR REFERENCE ONLY.

TOP PLATE FOR TWO BARS - TRUMAN DAM

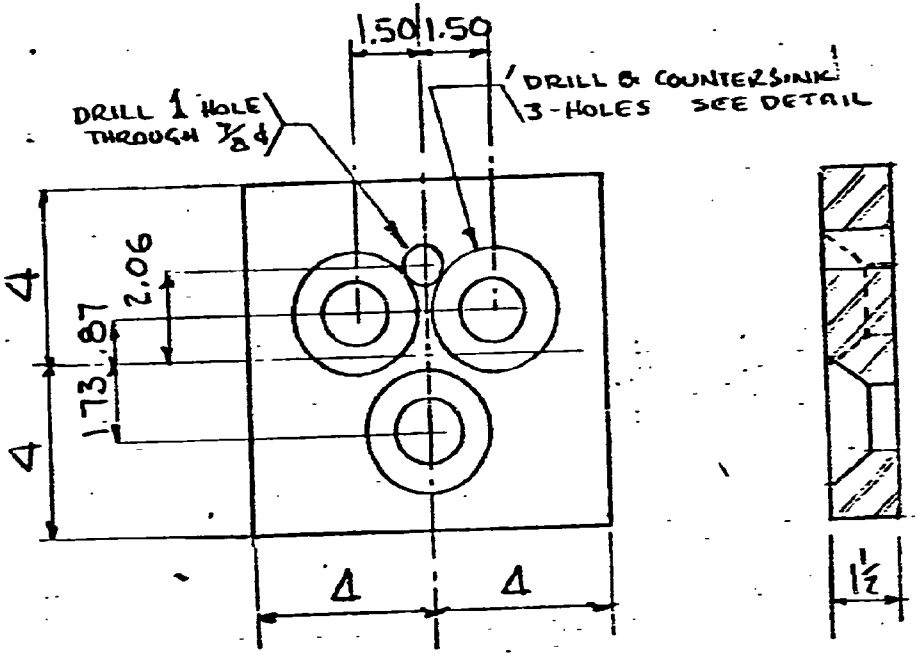
DRAWN BY CLYDE | DATE 10-

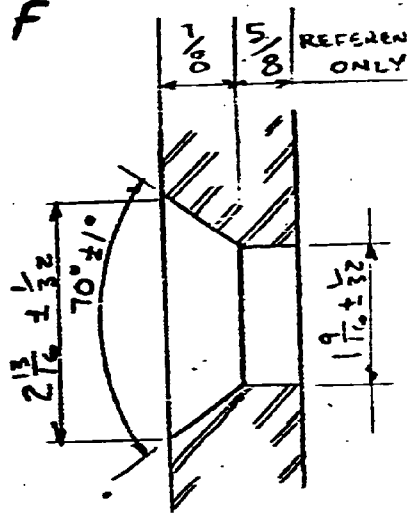
REVISED BY | DATE

APPROVED BY G Chedda | DATE 10-7

CONSTRUCTION PRODUCTS COMPANY

Page 72 F





COUNTERSINK HOLE

MATERIAL

1 pc 1½ x 8 x 8 A36

OR MIN F_y = 33000, MIN CARBON = .15

FOR REFERENCE ONLY.

TOP PLATE FOR THREE BARS TRUMAN DAM

DRAWN BY CLYDE	DATE 10-3-74
REVISED BY	DATE
APPROVED BY G. Chadha	DATE 10-7-74

CONSTRUCTION PRODUCTS COMPANY

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT LANDWALL MONOLITHS

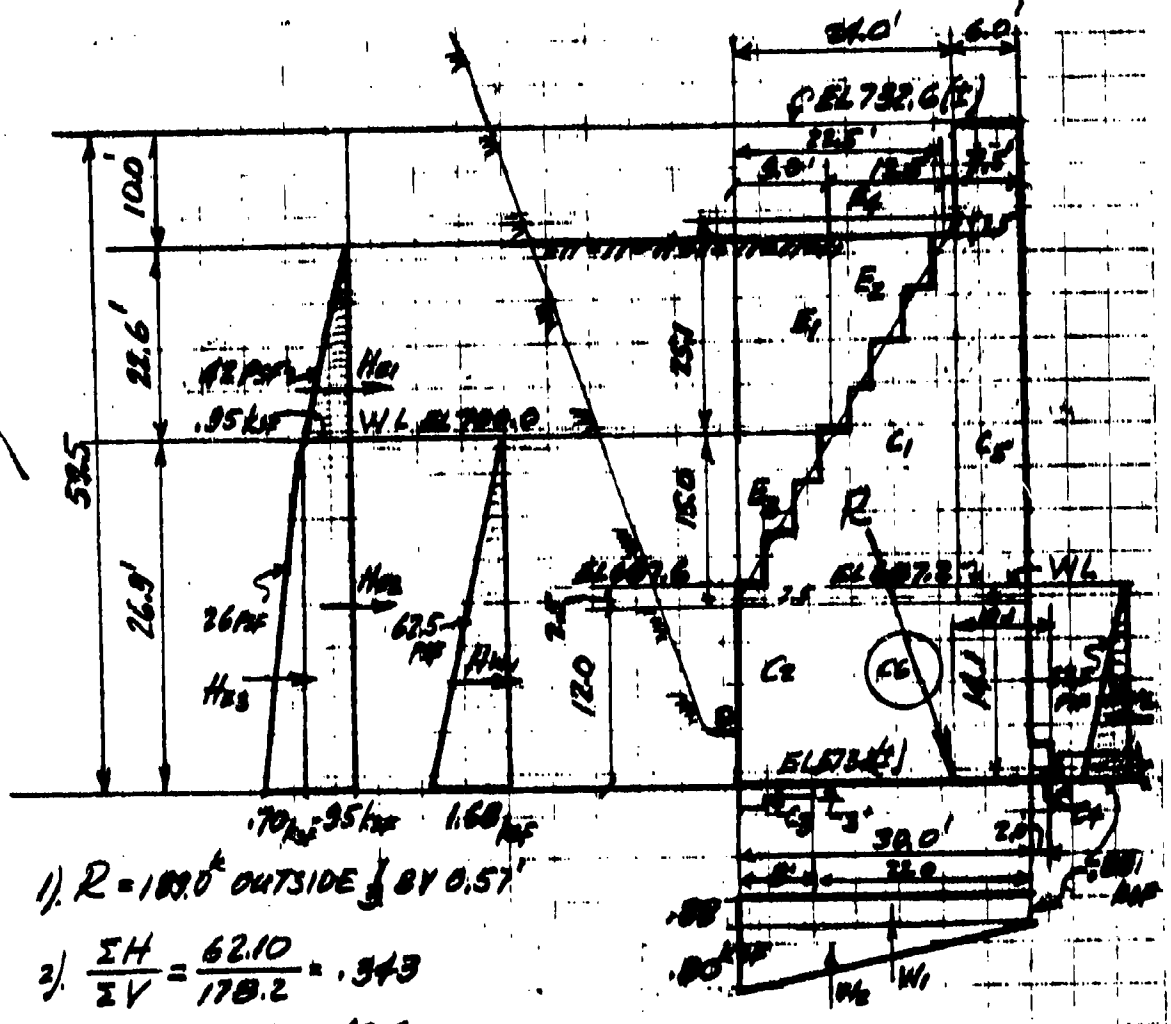
PROJECT LED #1

FILE NO. 800A

COMPUTED M.J. CHECKED P.V.M.

DATE 8.76 PAGE 73 OF ____ PAGES

LANDWALL MONOLITHS #5-15-LOWERING BACKFILL BY 10'-0



1). $R = 180.0^k$ OUTSIDE $\frac{1}{3}$ BY 0.57'

2). $\frac{\Sigma H}{\Sigma V} = \frac{62.10}{178.2} = .343$

3). $FSS = \frac{178.2 \times .625}{62.10} = 1.79$

4). $f_{sen} = \frac{2}{3} \times 178.2/10.1 = 12.0 ksf$

5). $FSOT = \frac{36130}{1812.0} = 2.0$

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT STABILITY OF LAND WALL MONOLITHS

COMPUTED M.J. CHECKED R.N.M.

PROJECT L&O #1

FILE NO. 800A

DATE 8.74 PAGE 74 OF ____ PAGES

LANDWALL MONOLITHS #5 - 15 - LOWERING BACKFILL BY 10'-0

	LOADS IN KIPS	VERT. ↓	VERT ↑	HORIZ →	HORIZ. ←	ARM	MoMA ↻	MoMA ↺
C_1	40.0×24×½×.15	72.0				16.0		1150.0
C_2	12.0×30.0×.15	54.0				17.0		918.0
C_3	8.0×3.0×.088	2.1				28.0		58.8
C_4	2.0×4.0×.088	0.7				1.0		0.7
C_5	47.5×6.0×.150	42.8				5.0		214.0
C_6	π×4.75²×.088		6.2			15.0	94.0	
E_1	22.6×3.0×.110	22.4				27.5		617.0
E_2	16.0×22.6×.055	20.0				18.5		370.0
E_3	9.0×7.5×.130	8.8				29.0		255.0
								Σ3583.5
W_1	.88×30.0		26.4			17.0	450.0	
W_2	.40×30.0		12.0			22.0	264.0	
							Σ808.0	
H_{E1}	.95×11.3			10.7		34.4	370.0	
H_{E2}	.95×26.9			25.6		13.5	345.0	
H_{E3}	.35×26.9			9.4		9.0	84.6	
H_{W1}	.84×26.9			22.6		9.0	204.0	
H_{W2}	.44×14.1				6.2	4.7		29.2
		222.8	44.6	68.3	6.2		1812.0	3613.0

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT STABILITY OF LANDWALL MONOLITHS #9-15

COMPUTED M.J. CHECKED R.M.

PROJECT LED #1

FILE NO. 800A

DATE 8.74 PAGE 75 OF ____ PAGES

LANDWALL MONOLITHS #5-15 - LOWERING BACKFILL BY 10.0 (CANTED)

$\Sigma V = 222.8 - 44.60 = 178.2^k$

$\Sigma M = 3613 - 1812.0 = 1801^{1k}$

$\Sigma H = 62.1^k \qquad R = 189.0^k$

$e = \frac{1801.0}{181.2} = 10.10$

$e = 32.0/3 - 10.10 = 0.57$ (10.67)

1. RESULTANT OUTSIDE MIDDLE ⅓ BY 0.57'

2. $\frac{\Sigma H}{\Sigma V} = \frac{62.10}{178.2} = .343'$

3. $F.S.S. = \frac{178.2 \times .625}{62.1} = 1.79$

4. $f_{SOIL} = \frac{2}{3} \times 181.2 / 10.10 = 12.0\ k.s.f$

5. $F.S.O.T. = \frac{3613.0}{1812} = 2.0$

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT NOT 5-14 LANDWALL STABILIZATION BY LOWERING OF BACKFILL

COMPUTED R.N.M. CHECKED II

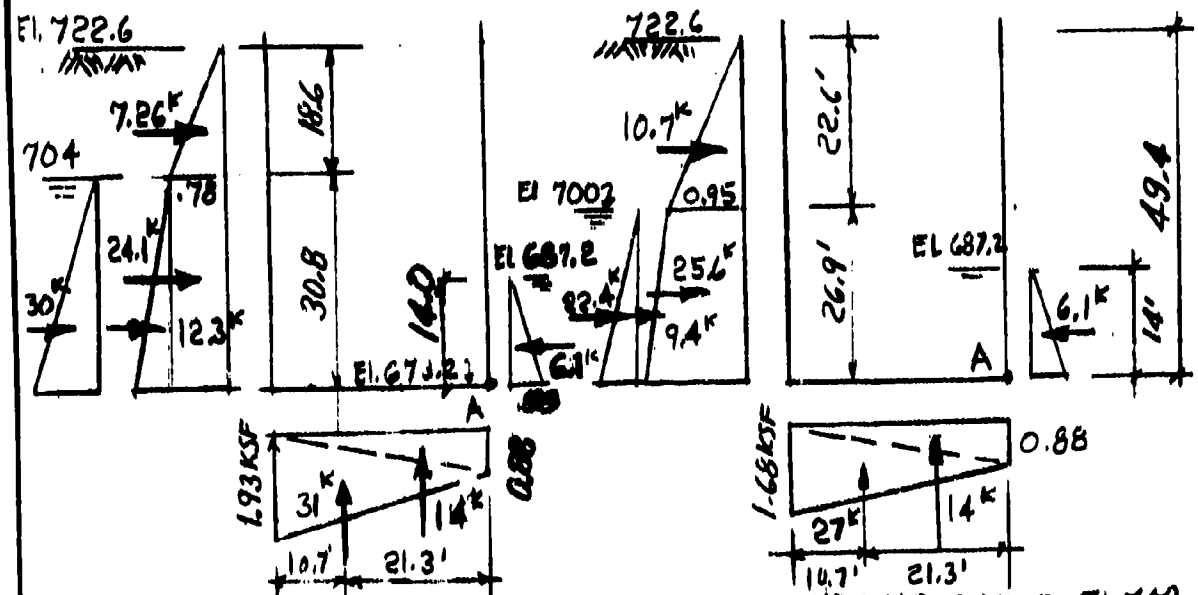
PROJECT LOCK & DAM NO. 1

FILE NO. 900 A

DATE Jan '75 PAGE 75A OF ____ PAGES

ANALYSIS OF UPPER LANDWALL MONOLITHS FOR ASSUMED WATER SURFACE ON LANDWARD SIDE AT ELEVATION 704

Reference: Pgs 73 – 75 of this computation



W.S. LANDWARD SIDE @ EL 704

W.S. LANDWARD SIDE @ EL 700

$30 + 7.26 + 24.1 + 12.3 - 6.1 = 68^K \rightarrow$

$\times 10.3 \quad \times 37 \quad \times 15.4 \quad \times 10.3 \quad \times 4.7$

$309 + 269 + 371 + 127 - 29 = 1047'^K \circlearrowright$

$31 + 1.4 = 45^K \uparrow$

$\times 21.3 \quad \times 10.7$

$660 + 150 = 810'^K \circlearrowright$

$22.4 + 10.7 + 25.6 + 9.4 - 6.1 = 62^K \rightarrow$

$\times 9. \quad \times 34.4 \quad \times 13.4 \quad \times 9 \quad \times 4.7$

$202 + 368 + 343 + 85 - 29 = 969'^K \circlearrowright$

$27 + 14 = 41^K \uparrow$

$\times 21.3 \quad \times 10.7$

$575 + 150 = 725'^K \circlearrowright$

$\Delta H = 68 - 62 = 6^K \rightarrow$

$\Delta V = 45 - 41 = 4^K \uparrow$

$\Delta M_A = 1047 + 810 - 969 - 725 = 163'^K$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL STABILIZATION BY LOWERING OF BACKFILL COMPUTED R.N.M. CHECKED "	PROJECT LOCK and DAM #1 FILE NO 900 A DATE JAN '75 PAGE 756 OF ____ PAGES

Upper Landwall Monoliths, (cont'd)

	ΣFORCES FOR W.S.@ El. 700	CHANGE IN HYDROSTATIC AND EARTH FORCES.	ΣFORCES FOR W.S.@ El. 704
$\Sigma H \rightarrow (+)$	$+62^{K} - P_r^{*}$	$+6^{K}$	$+68 - 5 = 63^{K}$
$\Sigma V \downarrow (+)$	$+178^{K}$	-4^{K}	$+174^{K}$
$\Sigma M_A \circlearrowleft (+)$	-1911^{*}	$+163'K$	$-1638'K$

$a = \frac{1638}{174} = 9.41'$ $\quad e = 16 - 9.41 = 6.59$ $\quad \frac{5.33}{1.26'}$

Resultant $R = 174^{K}$, outside middle $\frac{1}{3}$,

$f_{soil} = \frac{2}{3} \times \frac{174}{9.41} = \underline{12.33}$ KSF

Factor of sliding $= \frac{\Sigma H}{\Sigma V} = 0.35$

Factor of safety against sliding $= \frac{.625}{.35} = \underline{1.74}$

$F.S.O.T. = \frac{3519}{1718+163} = 1.87$

* Friction resistance due to weight of submerged slab.

$P_r = 56 \times 2 \times 0.082 \times 0.55 = 5^{K}$ ←

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LAND WALL - IMPROVED CONDITION	PROJECT LOCK & DAM NO. 1
	COMPUTED RNM CHECKED JJ	FILE NO. 800 A
		DATE 3/'45 PAGE 75C OF ____ PAGES

MONOLITH NO 3
NORMAL LOADING
IMPROVED (OR STABILIZED) CONDITION

BACKFILL IS LOWERED BY 8', GATE SHAFTS ARE FILLED.

The only differences in load between this condition and that of existing (Lowered conduit, shafts filled) condition are the following decreases both in horizontal earth pressure, and weight of backfill

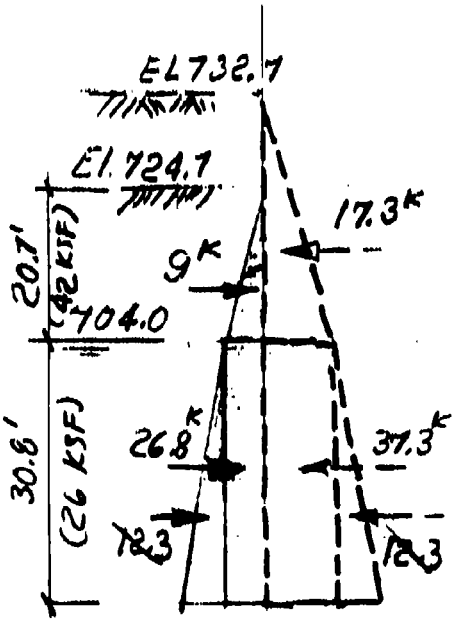
$\frac{20.7^2}{2}(.042) = 9.0^k$

$20.7(.042)(30.8) = 26.8^k$

$\Delta H = (17.3-9) + (37.3-26.8)$
$= 8.3 + 10.5 = \underline{18.8^k}$

$\Delta M_A = -(17.3)40.4 + 9(37.7)$
$+ (-)10.5 \times 15.4 - 5 \times 29$
$= (-699 + 339) - 162 + 145$
$= -377'^k$)

$\Delta V = 8 \times 6 \times 0.11 = 5^k \uparrow$
$\times \frac{29}{145} k$)



$\Sigma H = 85 - 18.8 = 66.2^k \rightarrow$
$\Sigma V = 201 - 5 - 195^k \downarrow$
$\Sigma M_A = 1660 + 377 = 2037 \curvearrowright$)

$a = 10.39$
$e = 5.61 > 5.33$

(1) Resultant outside middle 1/3 by 0.28'
(2) $f_{soil} = \frac{2}{3}\left(\frac{195}{10.39}\right) = 12.6$ KSF
(3) $\Sigma H/\Sigma V = 66.2/195 = 0.338$ (4) SSF = 1.85
(4) FSOT not necessary, resultant is almost at middle 1/3 (.205

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LAND WALL - IMPROVED CONDITION	PROJECT LOCK & DAM NO. 1
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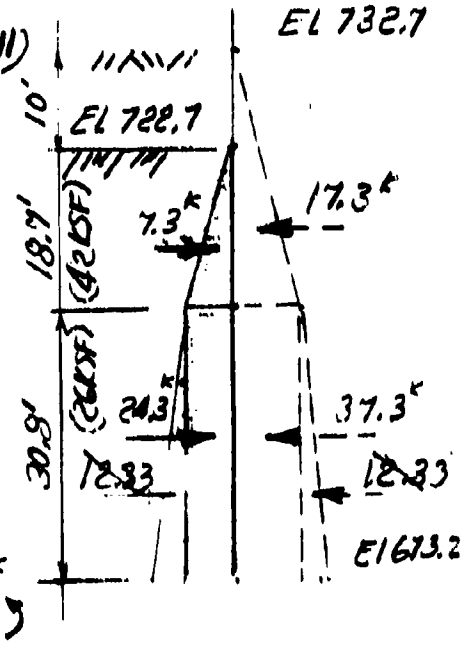
MONOLITH No 4
NORMAL LOADING
IMPROVED (OR STABILIZED) CONDITION

BACKFILL IS LOWERED BY 10 FEET - The only differences in load between this condition and that of existing (lowered conduit, 2 gate shafts full conc. sect.) condition are the following decreases (ΔH, ΔV & ΔM) both in horizontal earth pressure and weight of backfill.



$18.7^2\left(\frac{1}{2}\right)(.042) = 7.3$ kips/(ft of wall)

$18.7\,(.042)(30.8) = 24.2$

	17.3	37.3
	- 7.3	- 24.3
ΔH =	10.0 k	+ 13.0 k = -23.0 k ←

$\Delta V = 10 \times 6 \times .11 = -6.6^k$ ↑

$-17.3 \times (11) 40.4 + 7.3(37.03) = -429$ 'k

$-13.0 \times 15.4 - \ldots = -200$ 'k

-629

$6.6 \times 29.0 - \ldots - = +191.$ 'k

$\Delta M_A = -438$ 'k

$\Sigma H = 85.0 - 23.0 = 62.0^k$ →

$\Sigma V = 191.0 - 6.6 = 184.4^k$ ↓

$\Sigma M_A = -1520 - 438 = -1958$ 'k

$a = 10.62'$

$e = 5.38'$

-5.33 ... $\frac{L}{6}$

0.05 feet

(1) Resultant outside middle $\frac{1}{3}$ by ---

(2) $f_{soil} = (2/3)(184.4)(1/10.6) = 11.58$ KSF

(3) $(\Sigma H/\Sigma V) = C.338$ (4) S.S.F. = 1.86

(5) $\frac{4168 - 146 - 191}{2968 - 629} = \frac{3797}{1839} = [redacted] = 2.06 = F.S.O.T.$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL MONOLITHS	PROJECT LED #1
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LANDWALL GATE MONOLITH #17 - 10'-0 BACKFILL REMOVAL

$H_1 =$	$.95 \times 22.70/2 \times 28.6$	$= 309.0^k$	37.37	11,500
$H_2 =$	$.95 \times 29.80 \times 28.6$	$= 810.0$	14.90	12.030
$H_3 =$		$= 338.0$	9.93	3,350
$H_4 =$		$= 145.0$	21.27	3,100
$H_5 =$		$= 389.0$	8.50	3,310
		1991.0^k		$33,290^{lk}$

$V_3' = 6.0 \times 28.6 \times 10.0 \times .115 = 197.0^k \uparrow$

$\Sigma V = 5910 - 197 = 5713^k \downarrow$

$\Sigma H_x = 1991.0^k$

$\Sigma M_A = 108,304 - 197.0 \times 27.0 - 33,290 - 23460 = 46,234^{lk}$

$\Sigma M_{xx} = 1550^{lk}$ $\Sigma M_{yy} = 5289 \times 6.90 = 39420^{lk}$

$a = \frac{46,234}{5713} = 8.10$

$e = 15.0 - 8.10 = 6.90 > 5.00$ OUTSIDE MIDDLE $\frac{1}{3}$ BY 1.90

MAX SOIL PRESSURE

$f = \frac{2}{3} \times \frac{5713}{28.6 \times 8.10} = 16.44$ KSF

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT LANDWALL MONOLITHS

COMPUTED M.J. CHECKED RNM

PROJECT LEO #1

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LANDWALL GATE MONOLITH #17-10'-0 BACK FILL REMOVAL

$\Sigma V = 5713.0^k \quad \Sigma H_x = 1991.0^k \quad \Sigma M_{yy} = 39.400^{'k}$ (CONTD)

1). $f_{soil} = 16.44 ksf$

2). $R = 6050^k$ ~~INSIDE MIDDLE $\frac{1}{2}$ BY OTT~~ outside middle $\frac{V_3}{2}$ 64 1.9'

3). $\frac{\Sigma H}{\Sigma V} = \frac{1991}{5713} = .350$

4). $FSS = \frac{5713 \tan 6.25}{1991.0} = 1.79$

5). $FSOT = \frac{102.964}{56.750} = 1.81$

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL MONOLITHS	PROJECT L&D #1
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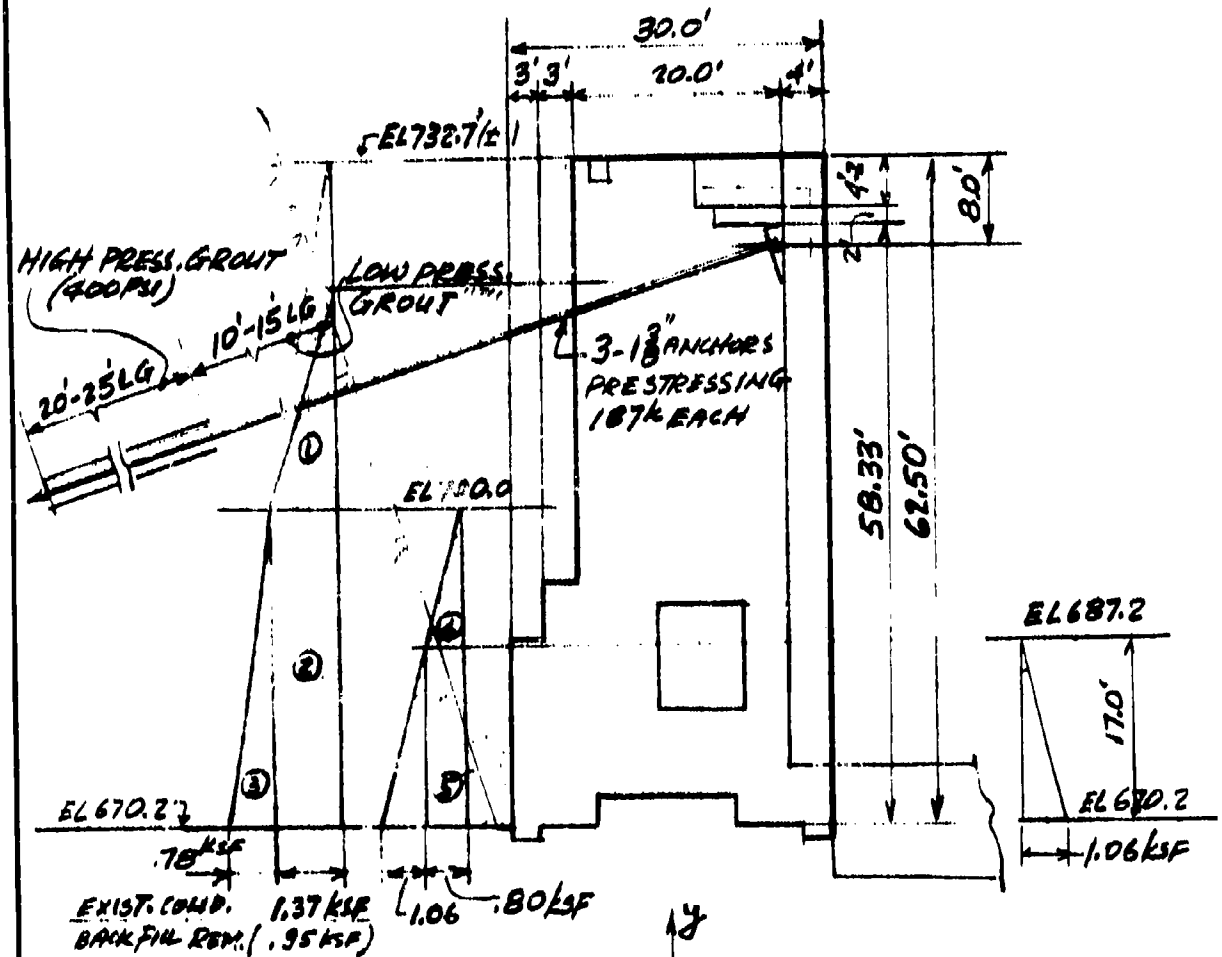
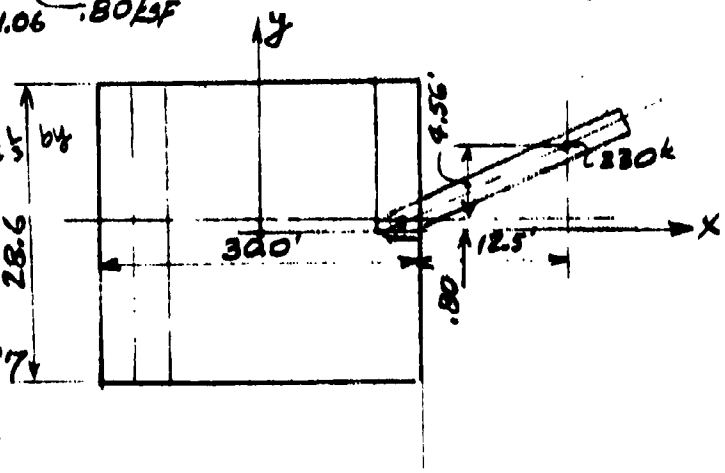
LANDWALL GATE MONOLITH #17 - STABILIZING BY ANCHORS





1. $f_{soil} = 18.70$ KSF
2. $R = 6440$ INSIDE & OUTSIDE MIDDLE ⅓
3. $\frac{\Sigma H}{\Sigma V} = \frac{2260}{6051} = .37$
4. $FSS = \frac{6051 + 625}{2260} = 1.67$
5. $FSOT = \frac{131504}{76920} = 1.71$

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT LANDWALL MONOLITHS

COMPUTED M.J. CHECKED R.V.M.

PROJECT LED #1

FILE NO. 800A

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LAND WALL GATE MONOLITH #17 - STABILIZING BY ANCHORS (CONT'D)

EXISTING CONDITIONS

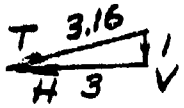
$\Sigma H_{\text{all}} = 2685^k$

$\Sigma V = 5910^k \quad \Sigma M_A = 31.384^{1k} \quad \Sigma M_{\text{all}} = 1550^{1k}$

IMPROVED CONDITIONS USING 3 ANCHORS

3 - 1⅜" ANCHORS, SEE CALCS FOR MONO's #4-15

USEFUL TENSION 140.2^k/BAR



$T = 148.2 \times 3 = 446.0^k \quad H = 425.0^k \quad V = 141.0^k$

$\Sigma V = 5910 + 141 = 6051^k$

$\Sigma H_{\text{bott}} = 2685 - 425 = 2260^k$

$\Sigma M_A = 31384 + 425 \times 54.50 = 31384 + 23200 = 54584^{1k}$

$a = \frac{54584}{6051} = 9.00'$

$e = 6.00'$

$M_{yy} = 6051 \times 6.00 = 36300^{1k}$

$f_{\text{soil}} = \frac{2}{3} \times \frac{6051}{9.00 \times 28.6} = \underline{18.70 \text{ ksf}}$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL MONOLITHS	PROJECT LEO #1
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LANDWALL GATE MONOLITH #17-STABILIZING BY ANCHORS (CONT'ED)

IMPROVED CONDITIONS OF STABILITY BY 3 ANCHORS (CONT'ED)

$$\frac{\Sigma H}{\Sigma V} = \frac{2260}{6051} = .37$$

$f_{SOIL} = 18.70$ KSF

$$F_{SS} = \frac{6051 \times .625}{2260} = 1.67$$

$$M_A = 108.304 + 23.200 = 131.504 \text{ 1k}$$

$$M_A = 76.920 \text{ 1k}$$

$$F_{SOT} = \frac{131.504}{76.920} = 1.71$$

$R = 6440$ k

(4 - $1\frac{3}{8}$ ROCK ANCHORS $F_{SS} = 1.88$)

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT LANDWALL MONOLITHS

COMPUTED M.J. CHECKED RNM

PROJECT LED #1

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LANDWALL GATE MONOLITH #17-STABILIZING BY BACKFILL REMOVAL (10'DEEP) AND ANCHORS (3-1 3/8" ANCHORS)

$\Sigma V = 5713 + 141 = 5854^{k}$

$\Sigma H = 1991 - 425 = 1566^{k}$

$\Sigma M_A = 46.234 + 425 \times 54.50 = 69.434^{1k}$

$a = \frac{69.434}{5854} = 11.80$

1). $e = 3.20'$

$M_{yy} = 5854 \times 3.20 = 18.700^{1k}$

$S_{yy} = \frac{1}{6} \times 30.0^2 \times 28.6 = 4290 FT^3$

$A = 28.6 \times 30.0 = 958 FT^2$

2). $f_{soil} = \frac{5854}{958} \pm \frac{18700}{4290} = 6.8 \pm 4.3$ { MAX 11.10 KSF, MIN 2.50 KSF

3). $\frac{\Sigma H}{\Sigma V} = \frac{1566}{5854} = .269$

4). $FSS = \frac{5854 \times .625}{1566} = 2.34$

$M_A = 109.304 - 5340 + 23200 = 126.164$

$M_A = 33.290 + 23460 = 56.750^{1k}$

5). $FSOT = \frac{126.164}{56750} = 2.23$

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT LANDWALL

COMPUTED M.J. CHECKED RNM

PROJECT LFD #1

FILE NO. 800A

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SUMMARY

LANDWALL GATE MONO #17-STABILIZING BY 10.0 BACKFILL REMOVAL

1. R = 6050k OUTS. MIDDLE ½ BY 1.90'
2. $\frac{\Sigma H}{\Sigma V} = \frac{1991}{5713} = .35$
3. $f_{SOIL} = 16.44$ kSF
4. $FSS = \frac{5713 \times .625}{1991} = 1.79$
5. $FSOT = \frac{102964}{56750} = 1.81$

LANDWALL GATE MONO #17-STABILIZING BY 10'-0 BACKFILL - REMOVAL AND 3-1¾" ANCHORS

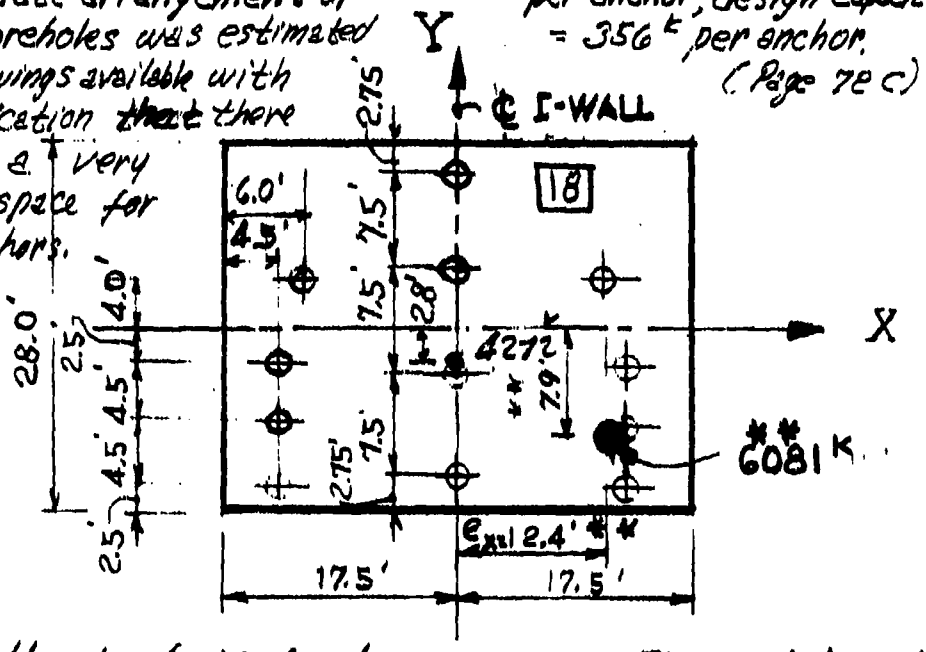
1. R INSIDE MIDDLE ⅓ BY 1.80'
2. $\frac{\Sigma H}{\Sigma V} = .27$
3. $f_{SOIL} = 11.10$ kSF
4. FSS = 2.34
5. FSOT = 2.23

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT I-WALL STABILITY — IMROVED — NORMAL LOADING COMPUTED R.N.M. CHECKED ✓	PROJECT LOCK & DAM #1 FILE NO 800 A DATE 3/'75 PAGE 82a OF ___ PAGES

INTERMEDIATE WALL GATE MONOLITH NO. 18
IMPROVEMENT OF STABILITY BY VERTICAL ROCK ANCHORS
NORMAL LOADING CONDITION

Assume 3-1¼"Ø Bar tendons per anchor, design capacity = 356 ᵏ per anchor. (Page 72 c)

Approximate arrangement of 5"Ø ± boreholes was estimated from drawings available with the indication that there is only a very limited space for rock anchors.



Resultant of 12 Anchors:

** Figures taken from existing - normal loading condition, pg 40

6	x	7	=	42
2	x	18	=	36
4	x	14	=	56
12 h			=	134

$h = 11.2$ $\quad y = -2.8$ ft

$12 \times 356 = 4272$ ↓

From existing condition, pg 40

ΣH = 3650ᵏ $\quad V = 6081^{k}$ $\quad x = 12.4'$ $\quad y = -7.9'$

4267

HARZA ENGINEERING COMPANY CHICAGO | SUBJECT I-WALL STABILITY - IMPROVED - NORMAL LOADING | COMPUTED R.N.M. CHECKED JJ | PROJECT L & D #1 | FILE NO 800 A | DATE 3/1/75 PAGE 82b OF ____ PAGES

I-WALL GATE MONOLITH 18
IMPROVEMENT OF STABILITY BY VERTICAL ANCHORS
NORMAL LOADING CONDITION (Cont'd)

Location of Resultant:

~~4272~~			11962
~~(15268)~~	$\times 2.8$	$=$	~~(42896)~~
6081	$\times 7.9$	$=$	48040

$\Sigma V = (\underset{10353}{\underset{}{\text{~~10401~~}}})^K$ $e_y = 5.8'$ $(\underset{}{\overset{60002}{\text{~~60134~~}}}{}'K) = \Sigma M_x$

~~4272~~			
~~(15268)~~	$\times 0$	$=$	0
6081	$\times 12.4$	$=$	75400 $= \Sigma M_y$
~~(10401)~~ 10353	$e_x = (\overset{7.3}{\text{~~7.2~~}}')$		75400

Bearing pressures: ("Foundation Design")

$\frac{e_x}{35} = 0.208$ $\frac{e_y}{28} = 0.207$ $K = 4.5$

(1) $f_{max} = \frac{K \Sigma V}{A} = \frac{4.5 \times 10\overset{.353}{\text{~~401~~}}}{980} = \overset{.54}{\text{~~47.~~}}$ KSF

(2) Resultant is outside of "KERN"

(3) Sliding factor (along x-axis) $= \frac{3650}{10\text{~~401~~}353} = 0.35\text{~~3~~}$

(4) Sliding factor of safety $= \frac{0.625}{0.35\text{~~3~~}} = 1.77$

Conclusion: Referring to results on page ~~40~~ 41 bearing pressure decreased by 36%, but it's still too high. ∴ Stabilizing by interconnection of 3 monoliths is recommended.

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT INTERMEDIATE WALL DOWNSTREAM GATE MONO #18
COMPUTED M.T. CHECKED
PROJECT LGD #1
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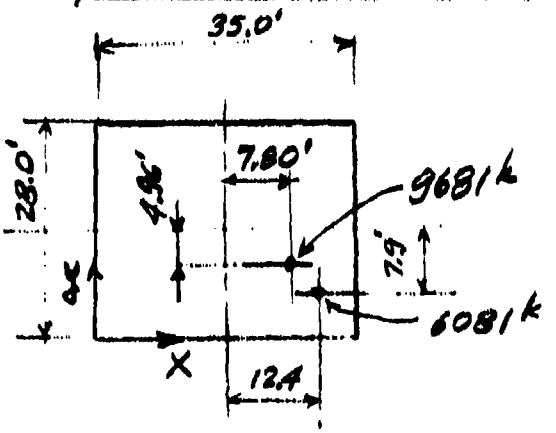
STABILIZATION OF INTERM. WALL GATE MONO. #18

~~12 - ANCHORS WITH 300 kips CAPACITY EACH~~



$M_{xx} = 37.606$ lk $y = 6.1'$

$M_{yy} = 181.105$ lk $x = 29.9'$

$\Sigma V = 6081 + 3600 = 9681k$

$x' = \frac{6081 \times 12.4}{96.81} = 7.8'$

$y' = \frac{6081 \times 7.9}{9681} = 4.96'$

$\frac{e_x}{a} = \frac{7.8}{35.0} = .22$ $\qquad \frac{e_y}{b} = \frac{4.96}{28.0} = .18$

$C = 4.2$ $\qquad f_{soil} = 4.2 \frac{9681}{980} = 41.5 k/F$

$F.S.O.T. = \frac{9681 \times 17.5}{102.600} = 1.65$

$F.S.S. = \frac{9681 \times .625}{3650} = 1.66$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT INTERMEDIATE WALL GATE MONOLITH #18	PROJECT LSD #1
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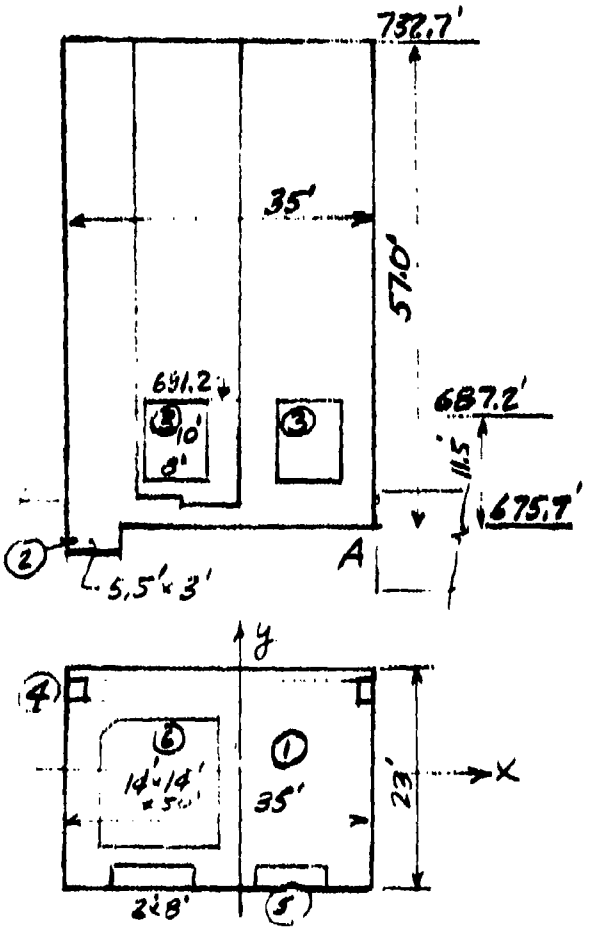
INTERMEDIATE WALL GATE MONOLITH #18

MONO'S #17, 18, 19 INTERCONNECTED

MONOLITH #19



HARZA ENGINEERING COMPANY CHICAGO

SUBJECT INTERMEDIATE WALL GATE MONOLITH #18

COMPUTED M.J. CHECKED R.N.M.

PROJECT LFD #1

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INTERMEDIATE WALL GATE MONOLITH #18 (CONT'D)

MONOLITHS #18 & #19 INTERCONNECTED (CONT'D)

MONOLITH #19

	LOADS KIPS	V↓	V↑	ARM	M_{xx} ↶	M_{xx}^2	M_{yy} ↶	M_{yy}^2
(1)	35×23×57×.15	6883						
(2)	5.5×3×23×.087	33		14.75			487	
(3)	2×80×23×.15		552					
(3)	2×6×8×23×.063	139						
(4)	4.5×3.08×.50		693	8.5		5890		
(5)	4×8×53.5×.15		257	10.5	2698			
(5)	4×8×12.3×.063	25		10.5		263		
(6)	$\left(14^2-\frac{2.5^2}{2}\right)\times 53\times .15$		1533	6.5				9964
(6)	$\left(9^2-\frac{2.5^2}{2}\right)\times 7\times .063$	95		6.5			553	
V↓	11.5×.063×2×.35		583					
		Σ 7166	3618		2698	6153	1040	9964
		ΣV=3548↓			Σ 3455 ↶		Σ 8924 ↶	

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT INTERMEDIATE WALL GATE MONO #18 & MONO #19

COMPUTED M.J. CHECKED R.N.M.

PROJECT LSD #1

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INTERMEDIATE WALL GATE MONO #18 & MONO #19 - INTERCONNECTED (BY SHEAR KEYS)

MONOLITH #18

$M_{yy} = 6081 \times 12.4 = 75500$ 'k

$M_{xx} = 6081 \times 7.90 = 48100$ 'k

$V = 6081$ 'k AREA $35 \times 28 = 980$ FT^2

MONOLITH #19

$M_{yy} = 3548 \times 2.51 = 8920$ 'k

$M_{xx} = 3548 \times 0.97 = 3450$ 'k

$V = 3548$ 'k AREA $23 \times 35 = 805$ FT^2

6081

$3548 \times (12.47 + 6.1)$ (18.57) $= 66{,}000$

9629

$y_1 = \frac{66000}{9629} = 6.85'$

$6081 \times 12.4 = 75400$

$3548 \times 2.51 = 8910$

$84{,}310$ 'k

$x_1 = \frac{84310}{9629} = 8.75'$

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT INTERMEDIATE WALL GATE MONOLITH #18

COMPUTED M.T. CHECKED R.N.M.

PROJECT LGO #1

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INTERMEDIATE WALL GATE MONOLITH #18, INTERCONNECTED WITH MONOLITH #19 (CONT'D)

MONOLITH #19 $\Sigma V = 3548^{k}$

$\Sigma M_{xx} = 3455^{1k}$ ↻

$\Sigma M_{yy} = 8924^{1k}$ ↻

$$e_y = \frac{3455}{3548} = 0.97'$$

$$e_x = \frac{8924}{3548} = 2.51'$$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT INTERMEDIATE WALL GATE MONO #18 & MONO #19	PROJECT L & D #1
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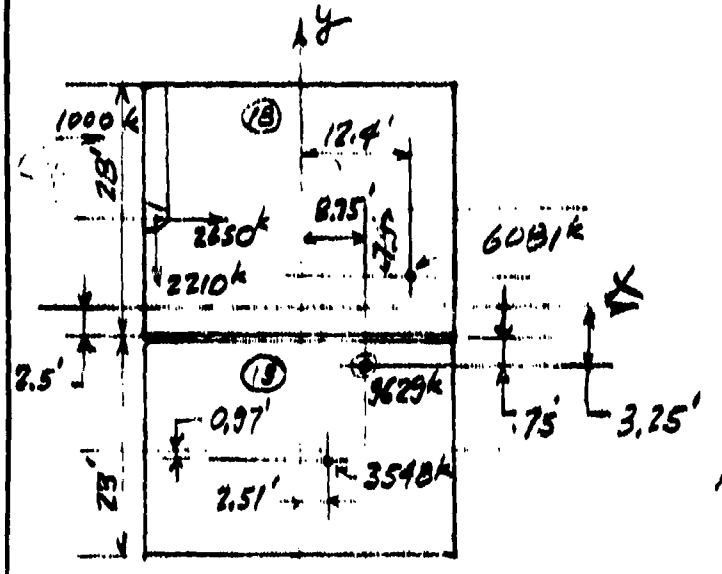
INTERMEDIATE WALL GATE MONO #18 & MONO #19 -

INTERCONNECTED (CANTED)

(BY SHEAR KEYS)



$H_x = 3650^k \rightarrow$

$H_y = 2210^k \downarrow$

RESULTANT $H = 4280^k$

$M_{xx} = 9629 \times 3.25 = 31400'^k$

$M_{yy} = 9629 \times 8.75 = 84200'^k$

1/. LEVER ARM @ MIDDLE 2'

2/. $\frac{\Sigma H}{\Sigma V} = \frac{4280}{9629} = .445$

3/. $FSS = \frac{9629 \times .626}{4280} = 1.41$ (AVAILABLE RESISTANCE BY FLOOR)

4/. $f_{SOIL} = 3.25 \times \frac{6081}{28 \times 35} = 2010 KSF$ $\quad c = 3.25$

$\frac{e_x}{b_1} = \frac{8.75}{35.0} = 0.25$ $\quad \frac{e_y}{b_2} = \frac{3.25}{51.0} = .064$

5/. $FSOT = \frac{134170}{102400} = \frac{1.75}{1.31}$

(97544)

(112640)

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT INTERMEDIATE WALL GATE MONO #18 & MONO #19

COMPUTED M.J. CHECKED R.N.M.

PROJECT LSD #1

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INTERMEDIATE WALL GATE MONO #18 & MONO #19 INTERCONNECTED (CONTD)

(BY SHEAR KEYS)

OVERTURNING STABILITY

MONOLITH WT. 6634 k M_{yy} = 116,900 ft-k a = 17.5' ℄

M^{2} = 1380 × 20.0 + 583 × 17.5 + 56,300 + 20,500 = 102,400 ft-k (112,600 ft-k)

M^{1} = (6634 + 470) × 17.5 + 440 × 17.5 + 4131 × 15.34 + 2470 = 134,170 ft-k (197,540)

(MONO 6634, GATE 470, 124,000; 7740)

WATER IN CULVERTS AND GATE SLOTS

8 × 10 × 28 × .063 = 141 k 141 + 85 = 226 k

8 × 6 × 28 × .063 = 85 k 141 − 85 = 56 k

Gate slots 13.5 × 4.0 + (2×4−2) = 54.0 + 6 = 60.0 ft² (440 k)

60 × 8.5 × .063 = 37 k 176 − 37 = 213 k

60 × 46.5 × .063 = 176 k 176 − 37 = 139 k

M_{yy} = 56 × 5.5 + 139 × 15.5 = 308 + 2160 = 2470 ft-k

$$FSOT = \frac{134{,}170}{102{,}400} = 1.31 \qquad \left(\frac{197{,}540}{112{,}600} = 1.75\right)$$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT INTERMEDIATE WALL GATE MONOLITH #17	PROJECT LOCK & DAM #1
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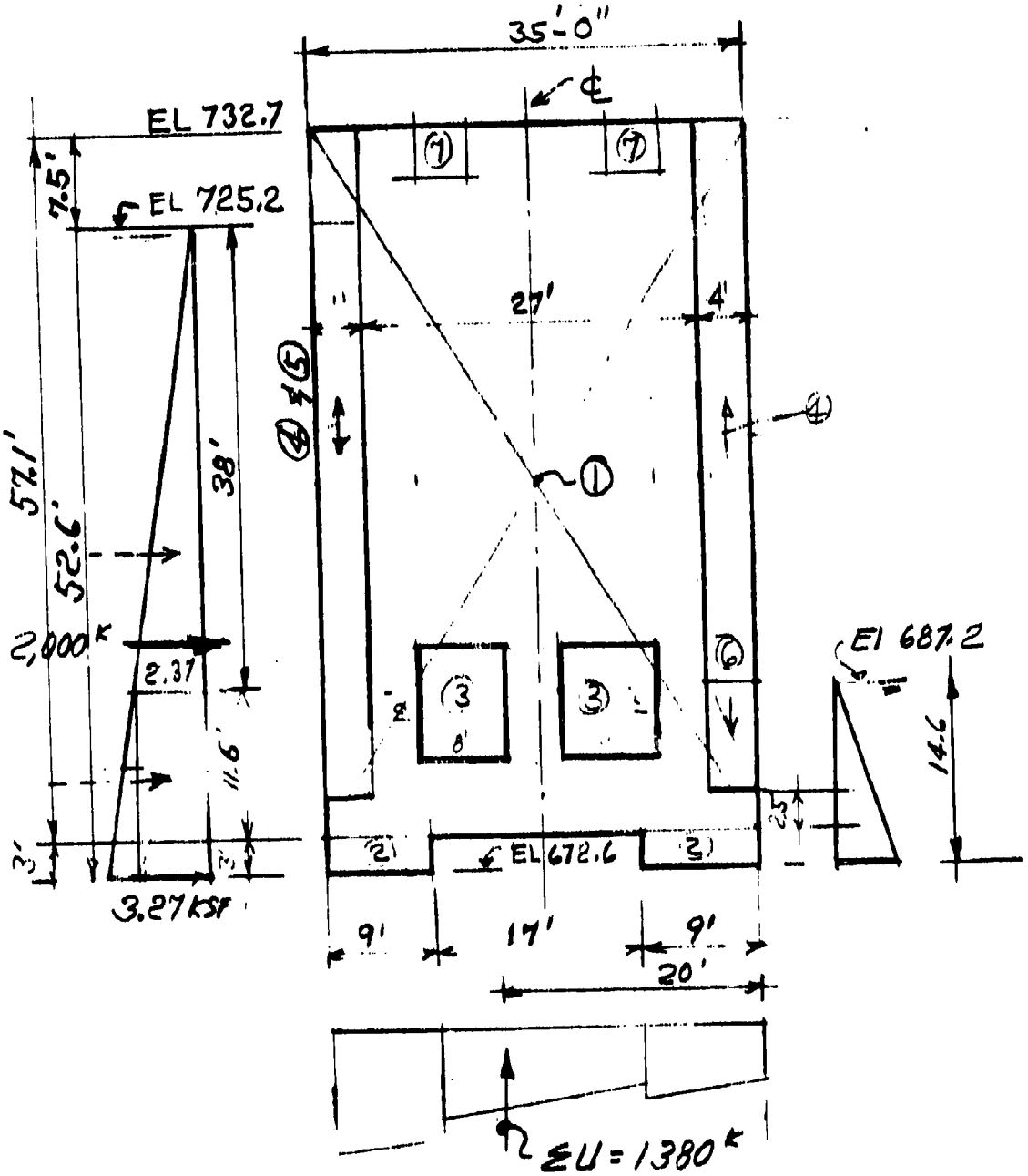
MONOLITH 17



HARZA ENGINEERING COMPANY CHICAGO	SUBJECT INTERMEDIATE WALL GATE MONOLITH #18	PROJECT LOCK & DAM #1
	COMPUTED E.N.N. CHECKED M.J.	FILE NO 80CA
		DATE 12/74 PAGE 91 OF ____ PAGES

FORCES IN MONOLITH #17

		V ↓ (+)	x	y	M_{Y-Y} (+)	M_{X-X} (+)
(1)	35 × 57.1 × 28 × 0.15	+8394 ↓	0	0,	0,	0,
(2)	9 × 3 × 2 × 28 × 0.15	+227 ↓	0	0	0	0
− (3)	80 × 2 × 28 × 0.08 (500) (−80×2×28×.15 = −672; 2.8×8×28×.063/.70 = −500)	−358 ↑	0	0	0	0
− (4)	54.6 × 4 × 2 × 19.5 × 0.15	−1278 ↑	0	4.25	0	−5432
(5)	47.1 × 4 × 19.5 × 0.063	+231 ↓	15.5	4.25	−3581	+982
(6)	12.1 (8,7) × 4 × 19.5 × 0.063	+59 (42) ↓	15.5	4.25	+915	+251
(7)	4.7 × 4 × 2 × 28 × 0.15	−153 ↑	0	0	0	0
	SUB TOTAL =	+7117 (6960)			= −2666 (−2930)	−4199 (−4577)
	UPLIFT =	−1380	2.5	0	+3450	0
	$H_x = \left(\frac{2.37 \times 3^2}{2} + 2.37 \times 11.1\right) = 71.6$					
	H = 71.6 × 28 = 2,000 K				+41,000	

$\Sigma H = 2{,}000^{K} \rightarrow$

$\Sigma V = 5737^{K}$ (5550) ↓

$\Sigma M_{Y-Y} = +41{,}784$ ↻

$\Sigma M_{X-X} = -4199$ ↺

$e_x = \frac{41784}{5737} = 7.28'$ (7.4) $> \frac{L}{2}$

$e_y = \frac{4199}{5737} = 0.73'$ (.757)

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT INTERMEDIATE WALL GATE MONOLITH #18

COMPUTED M.J. CHECKED M.J.

PROJECT LED #1

FILE NO 800A

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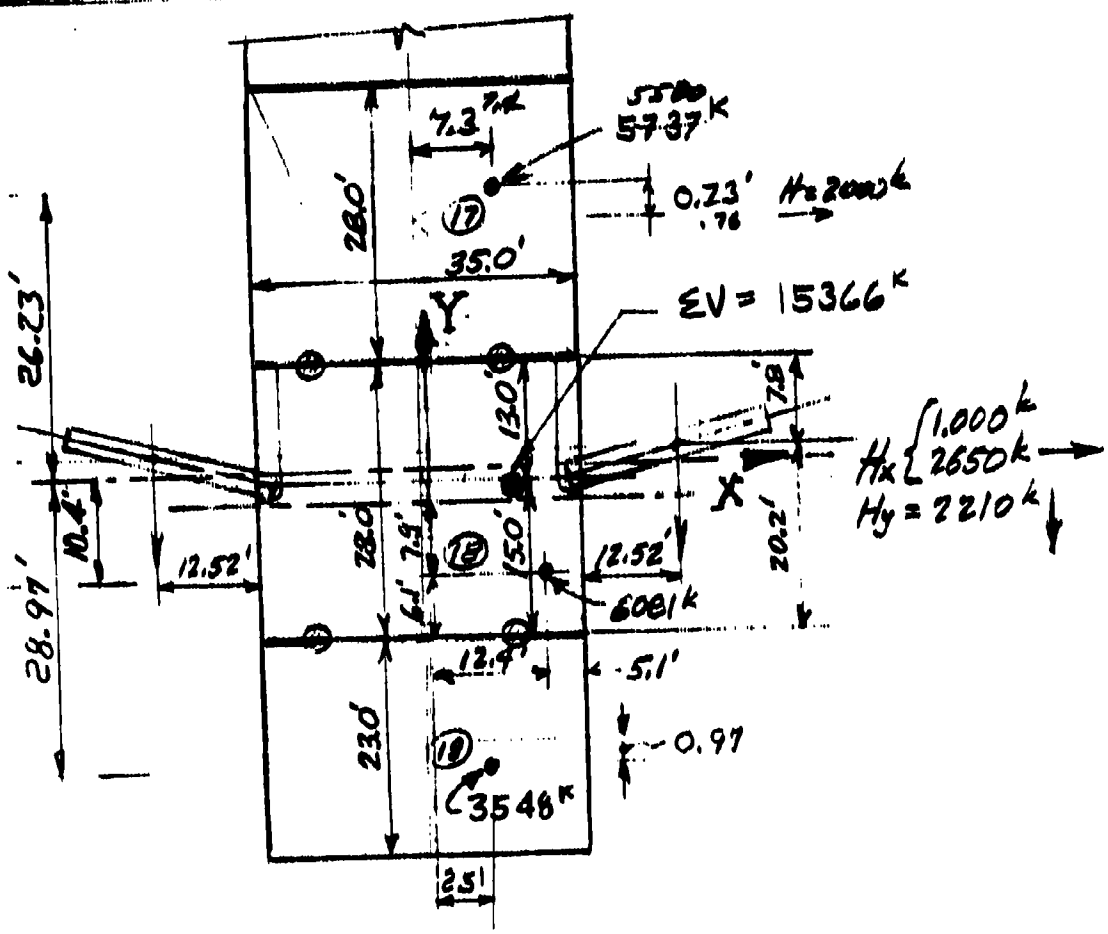
INTERMEDIATE WALL GATE MONOLITH #18-IMPROVED CONDITIONS OF STABILITY BY INTERCONNECTING MONO'S #17, 18 & 19



HARZA ENGINEERING COMPANY CHICAGO	SUBJECT INTERMEDIATE WALL GATE MONOLITH #18 & MONO'S	PROJECT L&D #1
	COMPUTED M.J. CHECKED 17&19 R.N.M.	FILE NO. 900A
		DATE 12.74 PAGE 99 OF ____ PAGES

INTERMEDIATE WALL GATE MONO #18 & MONO'S #17 & 19

INTERCONNECTED BY SHEAR KEYS,

OVERTURNING STABILITY

$$M^{P} = \overset{112,600}{102,400} + 1260 \times 27.27 + 960 \times 7.3 + 1380 \times \overset{20}{2.5} = 147,380$$

$$H = \left(2.37 \times \overset{45}{38.0}/2 + 2.37 \times \overset{34.4}{14.5}\right) \times 28 = 1260 + 960 = 2220^{k}$$

$$F_{SOT} = \frac{6960 \times 17.5 + \overset{197540}{134170}}{\underset{181720}{147380}} = \frac{\overset{319340}{256170}}{\underset{181720}{147380}} = \overset{1.76}{1.74}$$

181,720 ft-k

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT INTERMEDIATE WALL GATE MONOLITH #18 & MONO'S 17 & 19

COMPUTED M.J. CHECKED R.N.M.

PROJECT L & D #1

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INTERMEDIATE WALL GATE MONO #18 & MONO'S #17 & 19

INTERCONNECTION BY SHEAR KEYS (CONT'D)

$M_{yy} = 5580 \times 7.4 + 6081 \times 12.4 + 3548 \times 2.5 = 125.590^{k}$

$e_x = \frac{125.590}{15210} = 8.3'$

$\Sigma V = 5580 + 6081 + 3548 = 15210^{k}$

1). RESULTANT OUTSIDE MIDDLE $\frac{1}{3}$ BY 2.4 − 0.21'

2). $\frac{\Sigma H}{\Sigma V} = \frac{5650}{15210} = .37$

3). $FSS = \frac{15210 \times .625}{50.50} = 1.68$

4). $f_{soil} = 2.60 \times \frac{6081}{35 \times 28} = 16.1 KSF$ OR $\frac{2}{3} \times \frac{6081}{9.2 \times 28} = 15.7 KSF$

$\frac{e}{b} = \frac{8.30}{350} = .238$ $C = 2.60$ $a = 17.5 - 3.3 = 9.2$

5). $FSOT = \frac{256170}{147380} = 1.74$

5580	× 33.7	= 196363
6081	× 11.1	= 67342
3548	× 29	= 102786
15209		19665

$\bar{y} = \frac{19665}{15209} = 1.29$

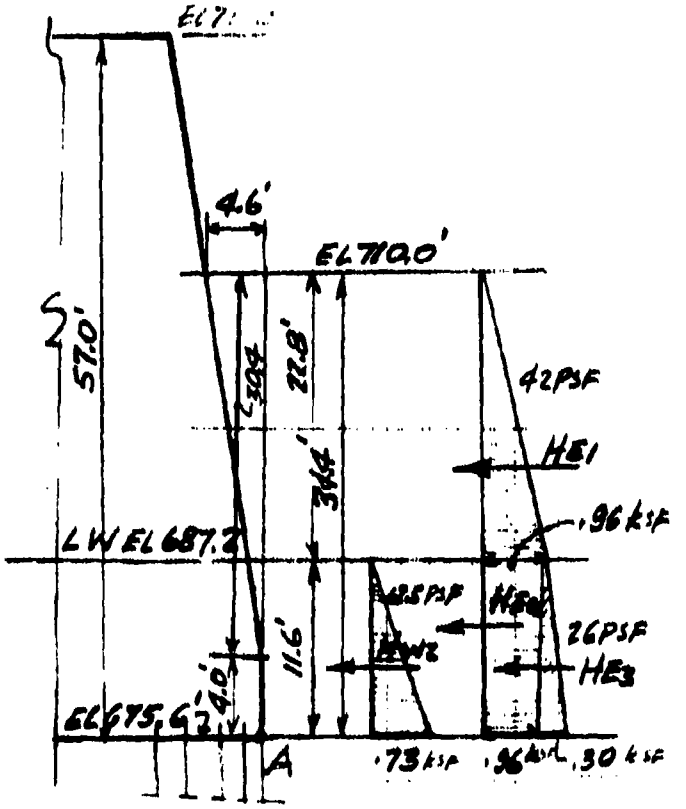
$f_{soil} = 2.5 \times \frac{15209}{35 \times 79} = 13.9 KSF$

$\frac{e_x}{e_b} = \frac{8.3}{35} = .239$ $\frac{e_1}{I} = \frac{1.29}{79.0} = .016$ } $K = 2.5$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT IMPROVING CONDITIONS OF STABILITY @ RIVER WALL COMPUTED M.J. CHECKED R.N.M.	PROJECT LED #1 FILE NO 900A DATE 10.74 PAGE 95 OF ____ PAGES

RIVER WALL MONOLITH #19

BACKFILLING RIVERSIDE UP TO EL 710.0'



	SHEAR	ARM	MOMENT @ "A"
$H_{W2} = .73 \times \frac{11.6}{2} \times 28$	= 118.0 k	3.88	460.0 ft-k
$H_{E1} = .96 \times 11.4 \times 28$	= 307.0 k	19.20	5900.0
$H_{E2} = .96 \times 11.6 \times 28$	= 312.0 k	5.80	1810.0
$H_{E3} = .15 \times 11.6 \times 28$	= 48.8 k	3.88	189.0
	$\Sigma H = 785.8$ k		$\Sigma M_A = 8359.0$ ft-k

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT IMPROVING CONDITIONS OF STABILITY @ RIVER WALL
COMPUTED M.S CHECKED R.N.M.

PROJECT LED #
FILE NO. 800 A
DATE 10.74 PAGE 96 OF ____ PAGES

RIVER WALL MONOLITH #19 (CONT'D)

BACKFILLING RIVERSIDE UP TO EL 710.0' (CONT'D)

$\Sigma H = 2150 - 786 = 1364^k$

$\Sigma M_A = 110\,280 - 39{,}600 + 8360 - 21{,}840 = 57{,}200^{ik}$

$\Sigma V = 5059^k$

LOAD ON TIMBER PILES FROM AVERAGE HYDROSTATIC

LOCKSIDE LOAD

$P = 51.10 \pm \frac{23800}{725} = 51.1 \pm 32.8$

$a = \frac{57.200}{5059} = 11.3'$ $\quad e = 4.7'$

$M_c = 23.800^{ik}$ $\quad H = 1364^k$

$P_{MAX} = 83.9^k$

$P_{MIN} = 18.3^k$ $\quad H_p = \frac{1364}{99} = 13.8^{k/ms}$

SEE LOAD ON TIMBER PILES ON PAGE 96 a WHERE STEEL SHEET PILING IS NEGLECTED

AREA LOADING FOR THE SAME CONDITION

$\frac{32}{6} = 5.33$
4.70
$.63$

1). RESULTANT INSIDE MIDDLE $\frac{1}{3}$ BY $\frac{0.63}{10.61}$ $\frac{0.14}{6'}$

2). $f_{SOIL} = 12.20$ KSF (MAX) ; 0.20 KSF MIN

3). $\frac{\Sigma H}{\Sigma V} = \frac{1364}{5059} = .270$ $(=.367)$

4). $FS.S = \frac{5059 \times .55}{1364} = 2.04$

5). $FSOT = 118640/61440 = 1.93$

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT IMPROVING CONDITIONS OF STABILITY @ RIVER WALL

COMPUTED M.J. CHECKED R.N.M.

PROJECT LSD #1

FILE NO. 300A

DATE 10.74 PAGE 97 OF ____ PAGES

RIVERWALL MONOLITH #19 (CONT'D)

BACKFILLING RIVERSIDE UP TO EL 710.0' (CONT'D)

LOAD ON TIMBER PILES FROM MAX. HYDROST. LOCKSIDE LOAD

$\Sigma H = 2150 - 786 = 1364^k$

$\Sigma V = 4530^k$

$M_A = 110.280 - 39.600 + 8360 - 33.150 = 45900^{lk}$

$a = \frac{45900}{4530} = 10.13 \qquad e = 5.87'$

$M_{\text{¢}} = 26.600^{lk}$

PILE LOAD

$P = 45.6 \pm \frac{26.600}{725} = 45.6 \pm 36.7$

$P_{MAX} = 82.3^k \quad P_{MIN} = 8.9^k$

SEE PAGE 96a FOR TIMBER PILE LOADS WHERE STEEL SHEET PILING IS NEGLECTED

AREA LOADING

1). RESULTANT OUTSIDE MIDDLE ⅓ BY 1.04 (.53)

2). $f_{SOIL} = \frac{2}{3} \times \frac{4531}{\cancel{865}\ 10.13 \times 28.0} = \underline{\cancel{72.50}\ 10.70\ ksf}$

3). $\frac{\Sigma H}{\Sigma V} = \frac{1364}{4531} = .302\ (<.367)$

4). $FSS = \frac{4531 \times .55}{1364} = 1.83$

5). $FSOT = 118640/72750 = \underline{1.63}$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RIVER WALL STABILITY- PILE LOAD	PROJECT L & D #1
	COMPUTED R.N.M. CHECKED JJ	FILE NO 800 A . 98
		DATE 3/'75 PAGE 969 OF ____ PAGES

RIVER WALL MONOLITH No 19
IMPROVE, NORMAL LOADING CONDITIONS FOR PILE LOADING
BACK FILL RIVERSIDE UP TO EL 710'

"LOCK SIDE AVERAGE" *Reference page 96*

For 3' wall

$\Sigma V = 5059 \times \frac{3}{28} = 542^k \downarrow$ $\quad I = 540\ ft^4$, $S = 45\ ft^3$

$\Sigma M_{\ell} = 23{,}800 \times \frac{3}{28} = 2550^k$

$\Sigma H = 1364 \times \frac{3}{28} \quad 146^k \rightarrow \quad P_H = 16^k$

$P_{MAX.} = \frac{542}{9} + \frac{2550}{45} = 60 + 57 = \underline{117}^k$

$P_{MIN.} = \text{- - - - - - - - - - } 60 - 57 = \underline{3}^k$

"LOCK SIDE MAXIMUM" *Reference page 97*

3' strip of wall: $\Sigma V = 4530 \times \frac{3}{28} = 486^k$

$\Sigma M_{\ell} = 26{,}600 \times \frac{3}{28} = 2850^k$

$\Sigma H = 1364^k \times \frac{3}{28} = 146^k \quad P_H = 16^k$

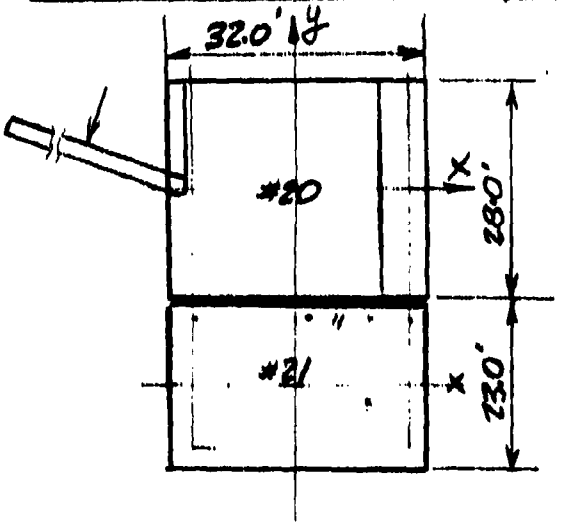
$P_{MAX.} = \frac{486}{9} + \frac{2850}{45} = 54 + 63 = \underline{117}^k$

$P_{MIN.} = \text{- - - - - - } 54 - 63 = \underline{-9}^k$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT IMPROVING CONDITIONS OF STABILITY @ RIVER WALL COMPUTED M.J. CHECKED R.N.M.	PROJECT L & D #1 FILE NO 800 A DATE 10.74 PAGE 99 OF ____ PAGES

RIVER WALL GATE MONOLITH #20

ASSUME MONOLITHS #20 & #21 INTERCONNECTED



WEIGHT OF MONOLITH #21

①	$24.0 \times 57.0 \times 23.0 \times .15$	= 4750
②	$4.0 \times 57.0 \times 23.0 \times .15$	= 788
③	$9.0 \times 4.0 \times 23.0 \times .087$	= 72
④	$-80.0 \times 23.0 \times .15$	= -276
		5334 k

ASSUMED PILING $9 \times 8 = 72 + 2 \times 8$ (ASS'D FOR SHT. PILING) $= 88$

PILE LOADING MONOLITH #21 - EXISTING CONDITION

UPLIFT LOAD $32 \times 23.0 \times .73 = 538$ k

$(5334 - 538) / 88 = 54.5$ k/PILE

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT IMPROVING CONDITIONS OF STABILITY C° RIVER WALL COMPUTED M.J. CHECKED R.N.N.	PROJECT L&D #1 FILE NO. 800A DATE 10.74 PAGE 152 OF ____ PAGES

RIVER WALL GATE MONOLITH #20 (CONT'D)

ASSUME MONOLITHS #20 & #21 INTERCONNECTED

I_{xx} =

22×3.0^2	= 198
22×6.0^2	= 792
22×9.0^2	= 1780
22×12.0^2	= 3180
22×15.0^2	= 4960
22×18.0^2	= 7130
22×21.0^2	= 9700
22×24.0^2	= 12700
	40,440 FT⁴

$S_{xx} = \frac{40440}{24} = 1680$ FT³

I_{yy} =

$2 \times 17 \times 3.0^2$	= 306
$2 \times 17 \times 6.0^2$	= 1220
$2 \times 17 \times 9.0^2$	= 2750
$2 \times 17 \times 12.0^2$	= 4900
$2 \times 17 \times 14.5^2$	= 7150
	16326

$S'_{yy} = \frac{16326}{14.5} = 1133$ C SHEET PILES

$S_{yy} = \frac{16326}{12} = 1360$ C TIMBER PILES

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT IMPROVING CONDITIONS OF STABILITY C RIVER WALL	PROJECT L&D #1
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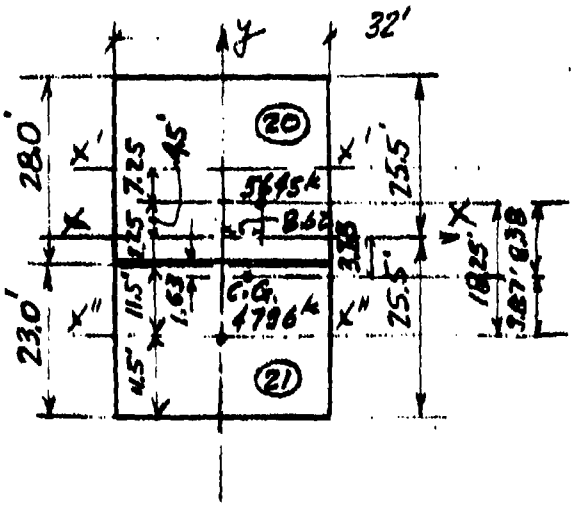
RIVER WALL GATE MONOLITH #20 (CONT'D)

ASSUME MONOLITHS #20 & 21 INTERCONNECTED (CONT'D)



CENTER GRAVITY OF LOADS

$5645 \times 0 = 0$

$\frac{4796}{10441} \times 18.25 = \frac{88.700}{88.700}$

$y = \frac{87.500}{10441} = 8.33'$

$M_{xx} = 10.441 \times 4.13 = 43.300\ ^{1k}$

$P = \frac{10441}{187} \pm \frac{43.300}{1680} \pm \frac{18550}{1360} = 55.83 \pm 25.80 \pm 11.94$

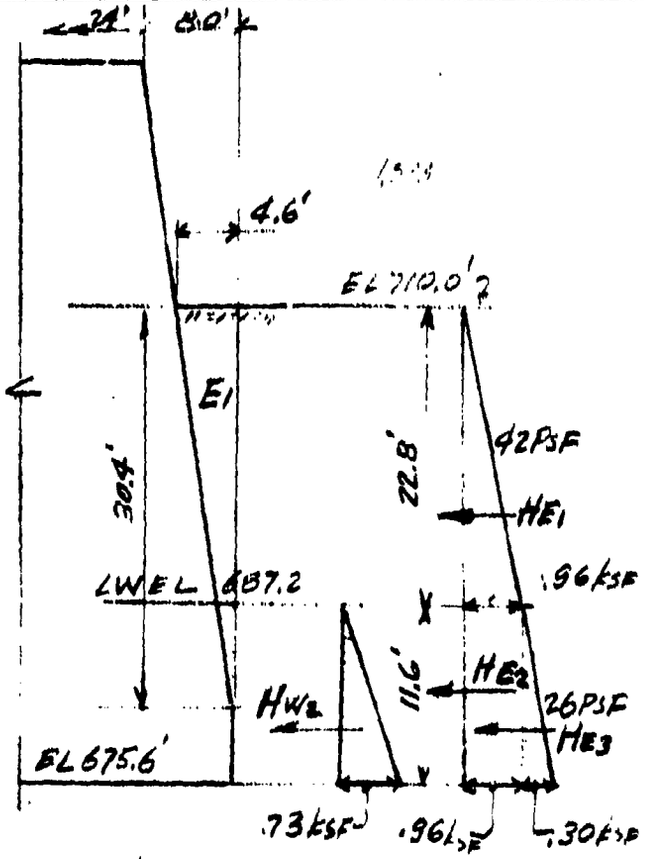
MAX PILE LOAD $P = 117.3\ ^{k}/_{PILE}$

MIN PILE LOAD $P = -57\ ^{k}/_{PILE}$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILITY ANALYSIS C RIVER WALL	PROJECT LED #1
	COMPUTED M.J. CHECKED R.N.M.	FILE NO 800A
		DATE 11.74 PAGE 102 OF ____ PAGES

RIVERWALL GATE MONOLITH #20 (ROUTED)

BACKFILLING RIVERSIDE UP TO EL 710.0'



H_{W2}	118.0^k		× 3.88 = 460.^{k}	8359.0$^{ft\text{-}k}$
H_{E1}	307.0^k	667.8^k ≈ 668	19.20 = 5900.$^{ft\text{-}k}$	
H_{E2}	312.0^k		5.80 = 1810.$^{ft\text{-}k}$	
H_{E3}	48.8		3.88 = 189.$^{ft\text{-}k}$	

E1 $4.6 \times 30.4/2 \times 28 \times .116 = 225 \times 14.67 = 3300.^{ft\text{-}k}$ ↻

$\Sigma M'_{yy} = 8359.0 - 3300. = 5060.^{ft\text{-}k}$ ↻

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT STABILITY ANALYSIS OF RIVER WALL

PROJECT LEO #1

FILE NO 8004

COMPUTED M.I. CHECKED R.N.M.

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RIVER WALL GATE MONOLITH #20 (CONTD)

BACKFILLING RIVERSIDE UP TO EL 710.0' (LAKESIDE AVERAGE)

$\Sigma M'_{yy} = 5060 - .73 \times 5.8 \times 28 \times 3.87 - .117 \times 1.4 \times 28 \times 12.5 - .117 \times 11.6 \times 28 \times 5.8 - .151 \times 11.6 \times 28 \times 3.9 =$

$= 5060 - 930 = 4130^{1k}$

$\Sigma M_{yy} = 48550 - 4130 = 44420^{1k}$

14470

$\Sigma M_{xx} = 40.820^{1k}$

$\Sigma V = 5645 + 228 = 5873^{k}$ ↓

$\Sigma H_x = 2684^{k}$

$\Sigma H = \sqrt{2684^2 + 2050^2} = 3380^{k}$ ↘

PILE LOADING

$P = 5873/99 \pm \frac{40820}{495} \pm \frac{44420}{600} = 59.4 \pm 82.4 \pm 73.8$

$MAX P = 215.6^{k}$

$MIN P = -96.8^{k}$

FOR PILE LOADS WITHOUT SHEET PILING, P. 1034; 105

AREA CONDITIONS FOR THE SAME CONDITIONS

$e_y = \frac{40820}{5873} = 6.95$ $\quad e_x = \frac{44420}{5873} = 7.55$

$\frac{6.95}{28.0} = .25$ $\quad \frac{7.55}{29.0} = .26$ $\quad A = 29 \times 28 = 812\ FT^2$

$L = 6.30$

$f_{soil} = 6.30 \times \frac{5873}{812} = 45.50\ ksf$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RIVER WALL - TRANSV. - SLE LOAD	PROJECT L&D #1
	COMPUTED JJ CHECKED R.N.M.	FILE NO 802A
		DATE 3/75 PAGE 103a OF ___ PAGES

RIVER WALL GATE MONOLITH #20
RIVERSIDE BACKFILLED UP TO EL. 710.0

"LOCKSIDE AVERAGE" (REF. p. 103)

$\Sigma V = 5873^k$

$\Sigma M_{xx} = 40820^{ft\text{-}k}$ $\Sigma M_{yy} = 44420^{ft\text{-}k}$

$\Sigma H_x = 2694^k$ $\Sigma H_y = 2150^k$ $\Sigma H_z = 3329^k$

$P_V = \frac{5873}{81} \pm \frac{4082 \times 10.}{486.} \pm \frac{4442 \times 10.}{4762} =$

$= 72 \pm 161 \pm 110 = \begin{cases} 283^k \text{ max} \\ -134^k \text{ min} \end{cases}$

$P_H = \frac{2694}{81} = 33^k/ft = P_{H_R}$ $\frac{3329}{81} = 41^k/ft$

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT IMPROVED CONDITION OF STABILITY C RIVER WALL

COMPUTED M.J. CHECKED R N M

PROJECT LGO #1

FILE NO 800A

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RIVER WALL GATE MONOLITH #20 (CONTD)

BACKFILLING RIVERSIDE UP TO EL 710.0'

SUMMARY OF RESULTS FOR AREA LOADING

1). $f = 45.50$ KSF

2). $R = 6500^{k}$

3). $\frac{\Sigma H_{\Delta}}{\Sigma V} = \frac{2684}{5873} = 0.44$

4). $FSS_{KH} = \frac{5873 \times .55}{2684} = 1.20$ $\qquad FSS_{R} = \frac{5873 \times .55}{3380} = 0.96$

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT RIVER WALL STABILITY
PILE LOAD
COMPUTED JI CHECKED R.N.M.

PROJECT L&D #1
FILE NO. 802A
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RIVER WALL GATE MONOLITH #20
RIVERSIDE BACKFILLED UP TO EL. 710.5'

"LOCKSIDE MAXIMUM" (REF. p. 106)

$\Sigma V = 5610^k$

$\Sigma M_x = 42690^{ik}$ $\Sigma M_y = 45840^{ik}$

$\Sigma H_x = 2684^k$ $\Sigma H_y = 2050^k$ $\Sigma H_R = 3380^k$

$P_V = \frac{5610}{51} \pm \frac{42690 \times 12.0}{1860} \pm \frac{45840 \times 12.0}{1860} =$

$= 69 \pm 105 \pm 113 = \begin{cases} 287^k \text{ max} \\ -149^k \text{ min.} \end{cases}$

$P_{H_x} = \frac{2684}{51} = 53^k$ / ft $P_{H_R} = \frac{3380}{51} = 42^k$ / ft

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT IMPROVED CONDITIONS OF STABILITY CRIDER WALL

COMPUTED M.J. CHECKED R.N.M.

PROJECT LED #1

FILE NO 800 A

DATE 1.75 PAGE 106 OF ____ PAGES

RIVER WALL GATE MONOLITH #20 (CONT'ED)

BACKFILLING RIVERSIDE UP TO EL 710.0 (LOCKSIDE MAXIMUM)

$\Sigma V = 5380 + 228 = 5610^k$

$\Sigma H_x = 2684^k \qquad \Sigma H_y = 2050^k \qquad \Sigma H = 3380^k$

$\Sigma M_{xx} = 42{,}690\ ^{?}{}^{ik}$

$\Sigma M_{yy} = 49{,}970 - 4130 = 45{,}840\ ^{?}{}^{ik}$

$FSS_{xx} = \frac{5610 \times .55}{2684} = \underline{1.15} \qquad FSS_R = \frac{5610 \times .55}{3380} = 0.92$

$e_y = \frac{42690}{5610} = 7.6'$

$e_x = \frac{45840}{5610} = 8.18$

$e_y/b = 7.6/28.0 = .272$

$K = 7.6$

$e_x/d = 8.18/29.0 = .282$

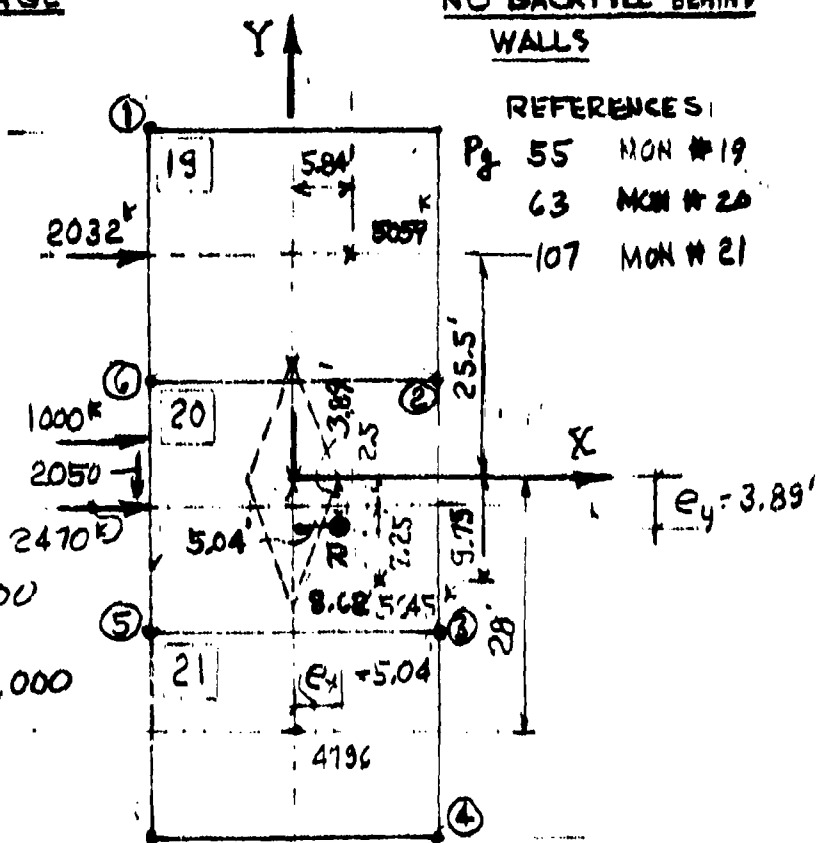
$f_{soil} = 7.6 \frac{5610}{812} = 52.4 ksf$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RIVER WALL STABILITY FOUNDATION PRESSURES	PROJECT L & D No. 1
	COMPUTED R.N.M. CHECKED JJ	FILE NO. 800 A
		DATE 4/1/75 PAGE 1069 OF ____ PAGES

INTERCONNECTION OF RIVERWALL MONOLITHS 20, 19 & 21

"LOCKSIDE AVERAGE" UPLIFT

NO BACKFILL BEHIND WALLS



REFERENCES:
Pg 55 MON # 19
63 MON # 20
107 MON # 21

AREAS

[19] = 896 ft²

[20] = 896 ft²

[21] = 736 ft²

$I_Y = \frac{79(32)^3}{12} = 215{,}700$

$I_X = \frac{32(79)^3}{12} = 1{,}315{,}000$

V	ARM$_X$	M$_Y$	ARM$_Y$	M$_X$
5059	× 5.84	29500	− 25.5	− 129,000
5645	× 8.62	48700	+ 9.75	+ 55,000
4796	× 0	0	+ 28.0	+ 134300
R = 15500#	e_x = 5.04'	ΣM$_Y$ = 78200 'k	e_y = 3.89'	ΣM$_X$ = + 60300

COMPUTE FOUNDATION PRESSURE AT POINTS 1, 2, 3, 4, 5 AND 6, ASSUMING NO TRANSFER OF VERTICAL LOAD BETWEEN MONOLITHS:

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RIVERWALL STABILITY FOUNDATION PRESSURES & SLIDING COMPUTED E.N.M. CHECKED JJ	PROJECT L & D #1 FILE NO 800 A DATE 4/75 PAGE 1066 OF ____ PAGES

INTERCONNECTION OF 20, 19 & 21 (CONT'D) — NO BACKFILLING

"LOCKSIDE AVERAGE" UPLIFT

$$f_{①} = \frac{5059}{896} + \frac{M_x\ Y_1}{60,300(-39.5)} + \frac{M_y\ X_1}{78,200(-16.0)}$$

$$f_{①} = \frac{5059}{896} + \frac{60,300(-39.5)}{1,315,000} + \frac{78,200(-16.0)}{215,700}$$

$$f_{①} = 5.65 - 1.81^{I_x} - 5.82^{I_y}$$

$$f_{①} = -1.98 \text{ KSF}$$

$$f_{②} = \frac{5059}{896} + \frac{60,300(-11.5)}{1,315,000} + 5.82$$

$$f_{②} = 5.65 - 0.53 + 5.82$$

$$f_{②} = 10.94 \text{ KSF}$$

$$f_{③} = \frac{5645}{896}^{6.30} + \frac{60,300(16.5)}{1315000}^{0.76} + 5.82$$

$$f_{③} = 12.88 \text{ KSF}$$

$$f_{④} = \frac{4796}{736}^{6.52} + 1.81 + 5.82 = 14.15 \text{ KSF}$$

$$f_{⑤} = 6.52 + 0.76 - 5.82 = 1.46 \text{ KSF}$$

$$f_{⑥} = 6.30 - 0.53 - 5.82 = -0.05^{*} \text{ KSF}$$

$$\begin{array}{r} 25.5 \\ +\ 14.0 \\ \hline 39.5 = -Y_1 \end{array}$$

$$\begin{array}{r} 28.0 \\ 11.5 \\ \hline \end{array} = -Y_2 = -Y_6$$

$$\begin{array}{r} 28.0 \\ \hline 16.5 = Y_3 = Y_5 \end{array}$$

$$\begin{array}{r} 23 \\ \hline 39.5 = Y_4 \end{array}$$

$$X_2 = X_3 = X_4 = 16'$$

$$X_1 = X_5 = X_6 = -16'$$

* THE TENSION PRESSURES ARE NOT CRITICAL & THEREFORE FURTHER REFINEMENT IS NOT REQUIRED

	FOUNDATION PRESSURE, KSF	
	f_{max}	f_{min}
MON. #19	10.94	-1.98^{*} ◄
MON #20	12.88	-0.05^{*}
MON #21	14.15 ◄	1.46

RESULTANT IS OUTSIDE OF KERN

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RIVERWALL STABILITY FOUNDATION PRESSURE	PROJECT L & D #1
	COMPUTED R.N.M. CHECKED JJ	FILE NO. 800 A
		DATE 4/'75 PAGE 106C OF ____ PAGES

INTER CONNECTION OF RIVER WALL MONOLITHS #20, 19 & 21

LOCKSIDE MAXIMUM UPLIFT

NO BACKFILLING

$I_X = 1,315,000$

$I_Y = 215,700$

$4531 \times 7.14 = 32351$

$5380 \times 9.29 = 49980$

$4796 \times 0 = 0$

$14707^K \times 5.60' = 82331'^K$

$\Sigma V = \quad e_x = \quad \Sigma M_y$

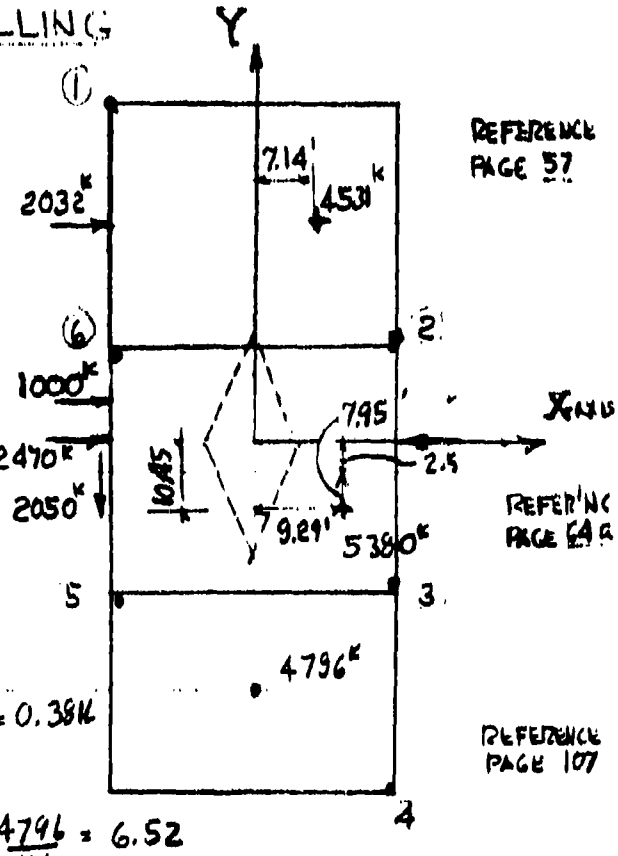
$4531 \times -25.5 = -115540$

$5380 \times 10.45 = +56221$

$4796 \times 28.0 = +134288$

$14707^K \times 5.10' = +74969$

$\Sigma V = \quad e_y \quad \Sigma M_x$



$\frac{M_X}{I_X} = \frac{74969}{1315000} = 0.0570$; $\frac{M_Y}{I_Y} = \frac{82331}{215,700} = 0.381$

$\frac{4531}{896} = 5.06$ $\quad \frac{5380}{896} = 6.00$ $\quad \frac{4796}{736} = 6.52$

$f_1 = 5.06 + 0.0570\,(-39.5) + 0.3816\,(-16) = -3.30$ KSF

$f_2 = 5.06 + 0.0570\,(-11.5) + 0.3816\,(16) = +10.51$ KSF

$f_3 = 6.00 + 0.0570\,(16.5) + 0.3816\,(16) = 13.05$ KSF

$f_6 = 6.00 + 0.0570\,(-11.5) + 0.3816\,(-16) = -.77$ KSF

$f_4 = 6.52 + 0.0570\,(39.5) + 0.3816\,(16) = 14.88$ KSF

$f_5 = 6.52 + 0.0570\,(16.5) + 0.3816\,(-16) = 1.35$ KSF

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT RIVER WALL STABILITY
FOUNDATION PRESSURES & SLIDING
COMPUTED P.N.M. CHECKED JJ

PROJECT L & D #1
FILE NO 800 A
DATE 4/75 PAGE 106d OF PAGES

INTERCONNECTION OF 20, 19 & 21 — NO BACKFILL (CONT'D)

"LOCKSIDE MAX." UPLIFT

	FOUNDATION PRESSURE, KSF f MAX	f MIN
MONOLITH #19	10.51	-3.30 * ←
MONOLITH # 20	13.05	-.77 *
MONOLITH # 21	14.88 ←	1.35

SLIDING FOR MONOLITHS 20 & 21

"LOCK SIDE AVERAGE" UPLIFT

$\Sigma V_{20+21} = 5645 + 4796 = \underline{10441}^{K}$

$\Sigma H_X = 1000 + 2470 = 3470^{K}$

$\Sigma H_Y = -\underline{2050^{K}}$

$\Sigma H_R = \underline{4030^{K}}$ ↘ (HORIZONTAL RESULTANT)

SLIDING FACTOR $= \frac{4030}{10441} = .386$ F.S. = 1.42 < 1.5

"LOCK SIDE MAX." UPLIFT

$\Sigma V_{20+21} = 5380 + 4796 = 10176^{K}$

$\Sigma H_R = 4030^{K}$ ↘

SLIDING FACTOR $= \frac{4030}{10176} = .396$ F.S. = 1.39 < 1.5

* THE TENSION PRESSURES ARE NOT CRITICAL
∴ FURTHER REFINEMENT IS NOT REQUIRED.

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RIVERWALL STABILITY HORIZONTAL PILE LOAD COMPUTED R.H.M. CHECKED JJ	PROJECT L & D #1 FILE NO 800 A DATE 4/75 PAGE 106 OF PAGES

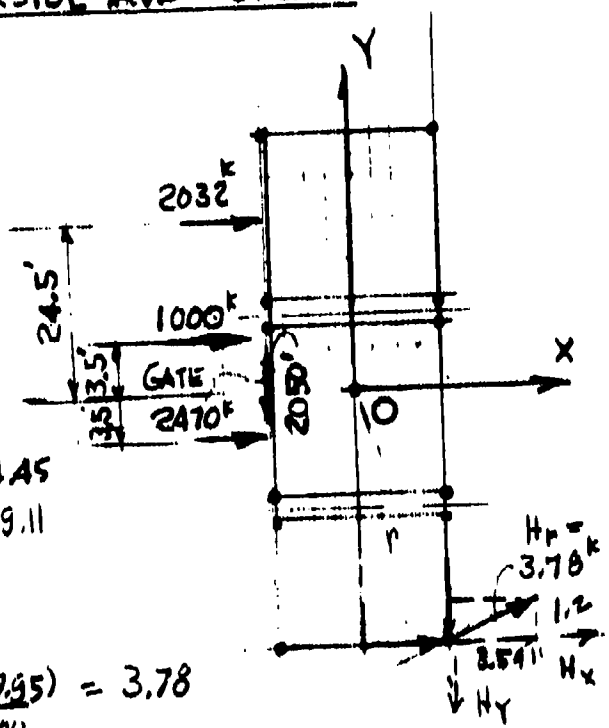
INTERCONNECTION OF RIVERWALL MONOLITHS 20, 19 & 21

"LOCKSIDE MAX." & "LOCKSIDE AVE" UPLIFTS

$2032 \times 24.5 = 49784$ ↑
$1000 \times 3.5 = 3500$ ↓
$53284'^k$ ↻

$2470 \times (-3.5) = -8645$ ↻
$2050 \times (-16) = -32800$ ↻
$41445'^k$

$\Sigma M_H = 11839'^k$ ↻
$\Sigma H_X = 5502^k$ $H_X = \frac{5502}{225} = 24.45$
$\Sigma H_Y = 2050^k$ $H_Y = \frac{2050}{225} = 9.11$



$J = I_X + I_Y = 118,800$
$r = 37.95$ ft
$H_r = \frac{\Sigma M_H (r)}{J} = \frac{11839 (37.95)}{118,800} = 3.78$

H_r (X COMPONENT) $= 3.78 \times \frac{36}{37.9} = 3.59$

H_r (Y COMPONENT) $= 3.78 \times \frac{12}{37.9} = 1.20$

$3.59 + 24.45 = 28.04 \approx 28$ } $P_{H(MAX)} = 30^k$
$1.20 + 9.11 = 10.31 \approx 10^k$ }

$\frac{49.5}{2} \times 0.0625 \times 28 = 2150^k$ →
$\frac{11.6}{2} \times .0625 \times 28 = 118$
2032^k ◀ /2 = $1016 \approx 1000^k$ ◀

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RIVERWALL STABILITY PILE LOADS COMPUTED R.N.M. CHECKED JJ	PROJECT L & D #1 FILE NO. 800 A DATE 4/1/75 PAGE 106 OF ____ PAGES

INTERCONNECTION OF MONOLITHS 19, 20 & 21 — NO BACKFILL

"LOCKSIDE AVERAGE" UPLIFT

ASSUME NO TRANSFER OF VERTICAL LOAD BETWEEN MONOLITHS

ΣM_Y = 78,200 'K ? (Fr. Foundation pressure)

5059	×	24.5	=	123945
5645	×	-10.75		- 60684
4796	×	-2.40		- 13908.4
15500				75823

ΣV = 15500 $\quad \bar{Y}$ = 4.89' $\quad \Sigma M_Y$ = 75823

$\bar{X} = \frac{78200}{15500} = 5.05'$

I_X = 105,300 $\quad I_Y$ = 13,500

$\frac{M_X}{I_X} = 0.72 \quad \frac{M_Y}{I_Y} = 5.79$

$\frac{5059}{81} = 62^K \quad \frac{5645}{81} = 70^K \quad \frac{4796}{63} = 76^K$

$P_1 = 62 + .72(-36) + 5.79(-12)$
$= 62 - 27 - 69$
$= -34^K$

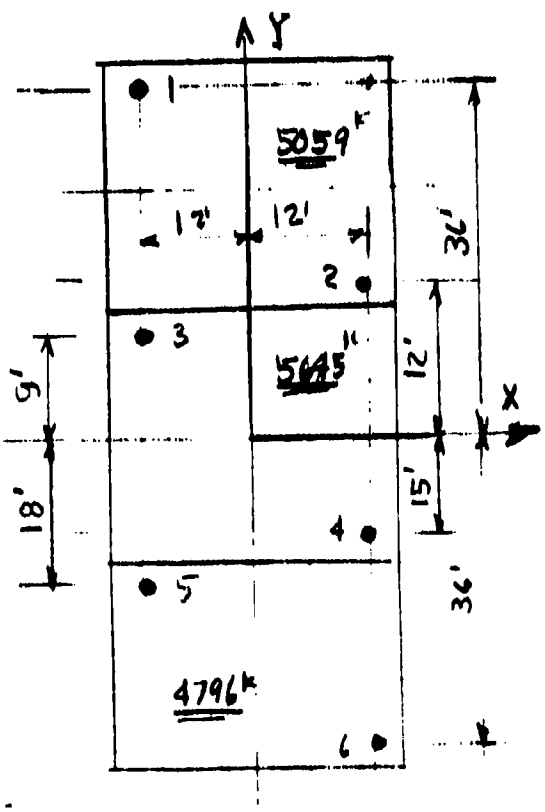
$P_2 = 62 + .72(-12) + 69 = 122^K$

$P_3 = 70 + .72(-9) - 69 = -6^K$

$P_4 = 70 + .72(15) + 69 = 150^K$

$P_5 = 76 + .72(+18) - 69 = 20^K$

$P_6 = 76 + .72(36) + 69 = 172^K$



MONOLITH #	P_{MAX}	M_{MIN}
19	122K	-34K
20	150K	-6K
21	172	20K

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT RIVERWALL STABILITY
PILE LOADS
COMPUTED R.N.M. CHECKED JJ

PROJECT L & D #1
FILE NO. 800 A
DATE 4/'75 PAGE 106 OF PAGES

INTERCONNECTION OF MONOLITHS 19, 20 & 21 — NO BACKFILL

" LOCKSIDE MAXIMUM" UPLIFT

NO TRANSFER OF VERTICAL LOAD BETWEEN MONOLITHS

4531	x 24.5	=	111,000
5380	x -11.45	=	-61,601
4796	x -29	=	-139084
15500		=	89685

ΣV $\quad$ ΣM_x

$$\bar{X} = \frac{M_Y}{\Sigma V} = \frac{82,331'}{15500} = 5.31'$$

$$\frac{M_x}{I_x} = 0.85 \qquad \frac{M_y}{I_y} = 6.10$$

$\frac{4531}{81} = 56^k$ $\quad$ $\frac{5380}{81} = 66^k$ $\quad$ $\frac{4796}{63} = 76^k$

MONOLITH # 19

$P_{MIN} = P_1 = 56 + (.85)(-36) + 6.10(-12)$
$= 56 - 30 - 73 = -47^k$

$P_{MAY} = P_2 = 56 + (.85)(-12) + 73 = 119^k$

MONOLITH # 20

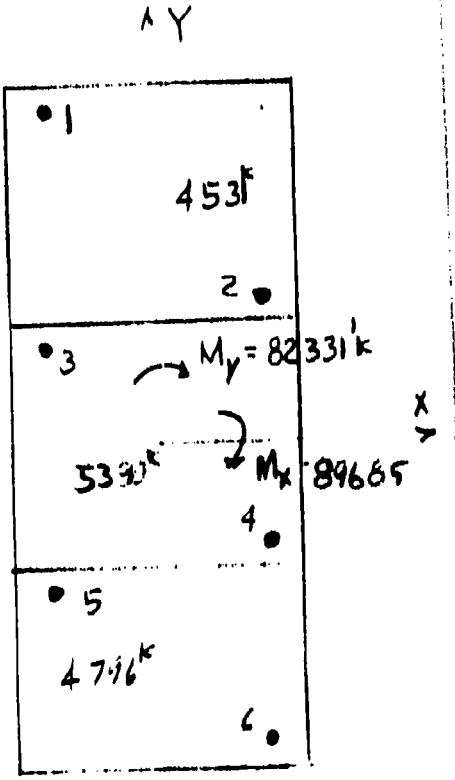
$P_{MIN} = P_3 = 66 + (.85)(-9) - 73 = -14^k$

$P_{MAY} = P_4 = 66 + .85(15) + 73 = 151^k$

MONOLITH # 21

$P_{MIN} = P_5 = 76 + (.85)(18) - 73 = 18^k$

$P_{MAY} = P_6 = 76 + 30 + 73 = 179^k$

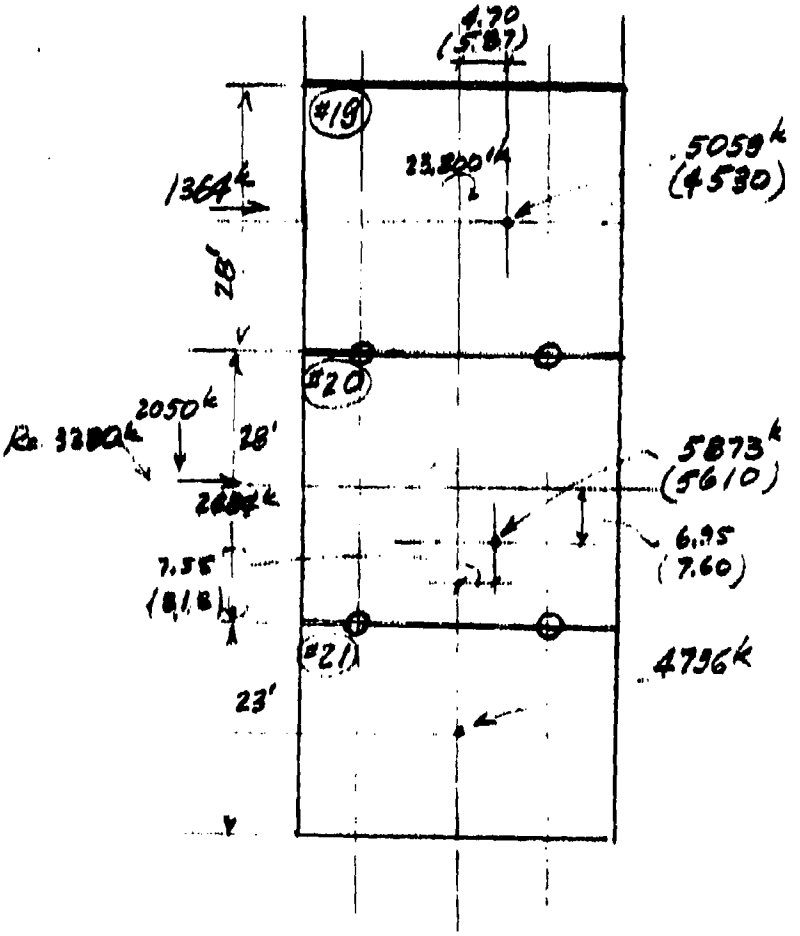


FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT IMPROVED CONDITIONS OF STABILITY C RIVER WALL COMPUTED M.J. CHECKED	PROJECT LEO #1 FILE NO. 200A DATE 1.75 PAGE 107 OF PAGES

RIVER WALL GATE MONOLITH #20 (CONTD)

INTERCONNECTION OF MONOLITHS #19, 20 & 21 & BACKFILLING



HARZA ENGINEERING COMPANY CHICAGO

SUBJECT IMPROVED CONDITIONS OF STABILITY @ RIVER WALL

COMPUTED M.J. CHECKED R.N.M.

PROJECT L&D #1

FILE NO 800A

DATE 1.75 PAGE 108 OF ____ PAGES

RIVER WALL GATE MONOLITH #20 (GROUTED)

INTERCONNECTION OF MONO'S #19, 20, 21 & BACKFILLING

LOCKSIDE AVERAGE

5059	23,800
5873	44,420
4796	0.0
15,728 k	68,220

$X = \frac{68220}{15729} = 4.33$ from e_x

$\frac{5059}{812} \pm \frac{5059 \times 4.33}{3940} = 6.3 \pm 5.6$ 11.9 max

$FSS = \frac{(5873 + 4796) 1.55}{8380} = 1.70$

$S = \frac{28 \times 20^2}{6} = 3940$ in³

$f_{soil} = \frac{5873}{912} \pm \frac{5873 \times 4.33}{3940} = 7.2 \pm 6.5$ { MAX 13.7 KSF, MIN 0.7 KSF

LOCKSIDE MAXIMUM

4530	26,600 lk
5610	45,840 lk
4796	0.0
14936	72,440 lk

$X = \frac{72,440}{14936} = 4.84$ from e_x

$FSS = \frac{5610 + 4796}{3360} \times .55 = 1.70$

11.14 ksf

$\frac{4530}{812} \pm \frac{4530 \times 4.84}{3940} = 5.58 \pm 5.56$ ksf

$f_{soil} = \frac{5610}{812} \pm \frac{5610 \times 4.84}{3940} = 6.9 \pm 6.9$ { MAX 13.8 KSF, MIN 0.0 KSF

(NEXT Pg 108a TO 108e)

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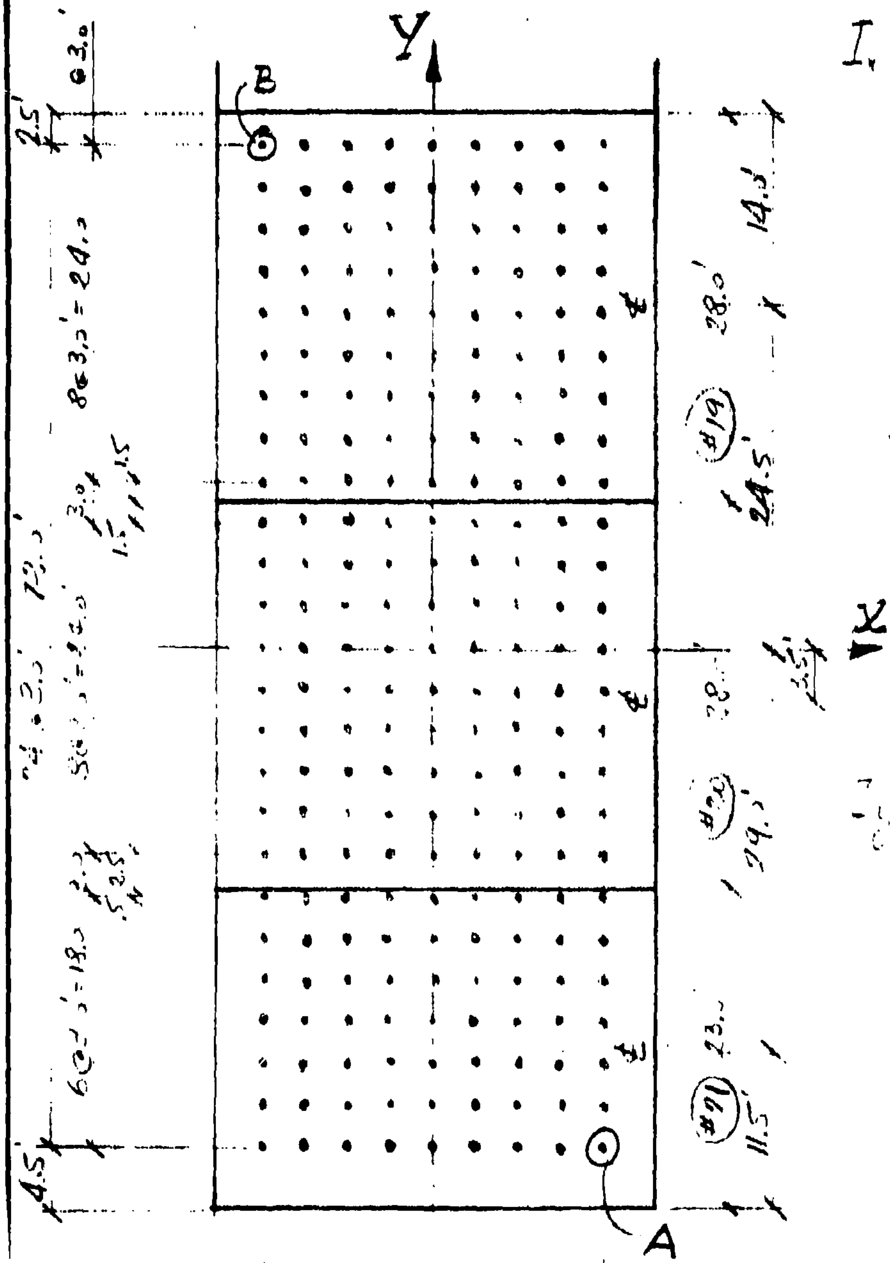
HARZA ENGINEERING COMPANY CHICAGO	Subject: RIVER WALL STABILITY PILE LOAD	Project: L&D #1
	Computed: JI Checked: R.N.H.	File No. 800A
		Date: 3/75 Page: 108a of Pages

RIVER WALL MONOLITHS #19, #20 & #21 INTERCONNECTED

RIVERSIDE BACKFILLED UP TO EL. 710.0'



$I_x = 2 \cdot 9 \cdot 26.5^2$ ... 23.5² ... 20.5² ... 17.5² ... 21.5² ... 9.5² ... 3.5²

= 105300 pile-ft²

I_y ... 12.5² ...

= 13500 pile-ft²

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT PAVED WALL STABILITY
PILE LOAD

COMPUTED JJ CHECKED R.N.M.

PROJECT L&D #1
FILE NO. 600A
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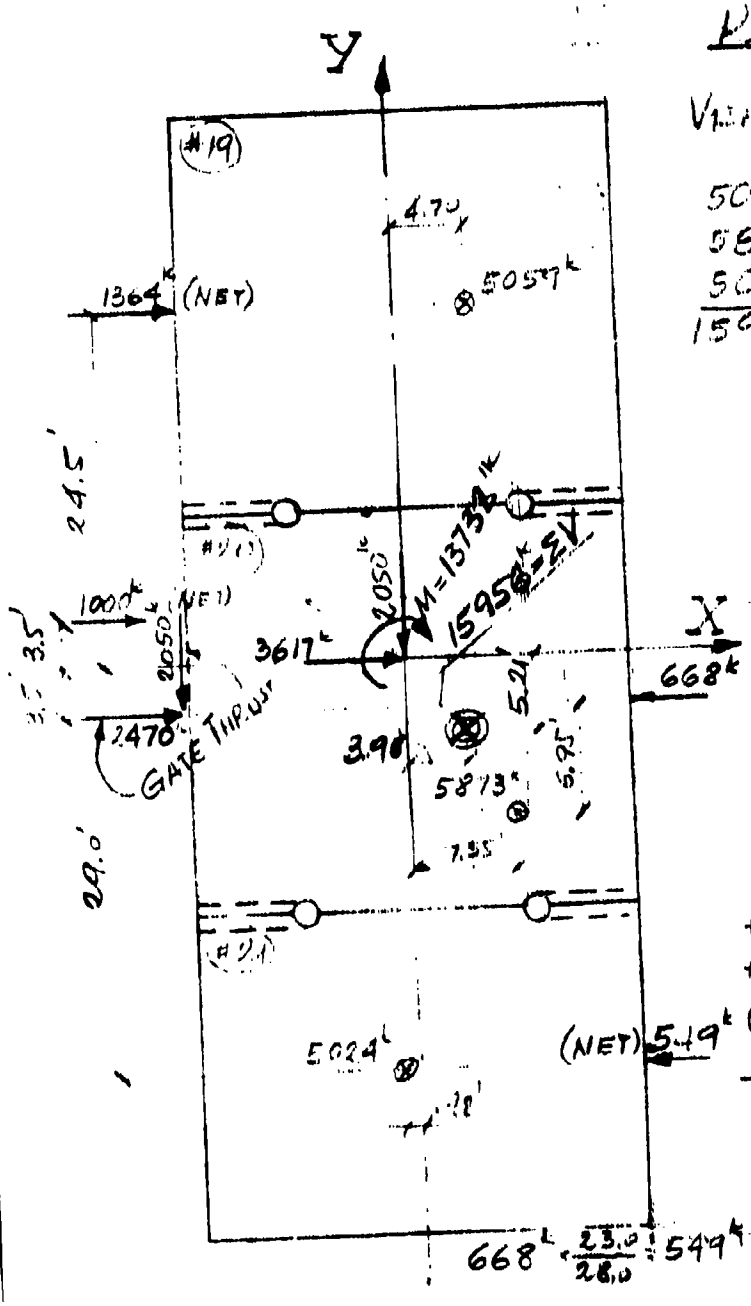
W/O PROJ. PILES.

PAVED WALL MONOLITHS #19, #20 & #21 INTERCONNECTED
RIVERSIDE BACKFILLED UP TO EL. 710.0'

"LOCK AND LOAD" (REF. D. 96, 102 & 107)



RESULTANTS

VERTICALS:

5057 × 4.70 = 23 777
5873 × 7.55 = 44 341
5024 × (-.92) = − 4622
15956 63 496

$\bar{x} = \frac{63496}{15956} = 3.98'$

5057 × 24.5 = 123 896
5873 × (-24.5) = -143 889
5024 × -24.5 = -123 088
15953 -143 081

$\bar{y} = \frac{-143081}{15953} = -8.97'$

HORIZONTALS:

+1364 × 24.5 = +33413
+100 × 2.5 = + 250
(2470 − 2050) × (-2.5) = − 1050
−549 × (−24.5) = +13450
3617
2050 × (−16.0) = −32800

$\Sigma M_H = +13732^{k}$ (?)

(3)

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HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RIVER WALL STABILITY PILE LOAD	PROJECT 6D #1
	COMPUTED JJ CHECKED RNM	FILE NO 600A
		DATE 3/75 PAGE 108C OF ___ PAGES

RIVER WALL MONOLITHS #19, #20 & #21 INTERCONNECTED
RIVERSIDE BACKFILLED UP TO EL. 710.0'

"LOCKSIDE AVERAGE" (CONT'D)

$\Sigma V = 15956^k$

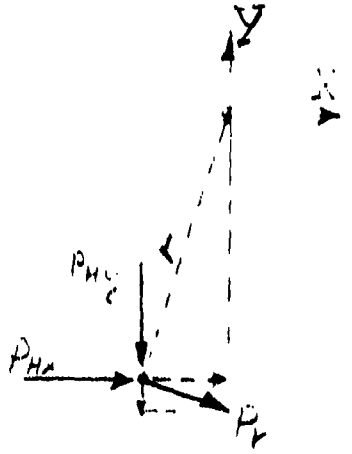
$\Sigma M_x = 83124^{ik}$ $\Sigma M_y = 63496^{ik}$

$\Sigma H_x = \overset{3617}{\cancel{3380}}^k$ $\Sigma H_y = 2050^k$ $\Sigma M_H = \overset{13732}{\cancel{10596}}^{ik}$ (?)

$${}_A P_V = \frac{5024}{9\times7} + \frac{83124\times36.0}{105300} + \frac{63496\times12.0}{13500} = 80+28+56 = 164^k$$

$${}_B P_V = \frac{5059}{9\times9} - \frac{83124\times36.0}{105300} - \frac{63496\times12.0}{13500} = 62-28-56 = -22^k$$

ASSUMING THAT ALL HORIZONTAL LOADS ARE TAKEN BY PILES (NO PASSIVE SOIL PRESSURE):



$r = \sqrt{12.0^2 + 26.0^2} = 28.65'$

$I_p = I_x + I_y = 105300 + 13500 = 118800$

$P_{Hx} = \frac{3617}{9\times9} = 16.07^k$ $P_{Hy} = \frac{2050}{9\times9} = 9.11^k$

$P_r = \frac{13732 \times 28.65}{118800} = 4.38^k$

$P_{rx} = 4.38 \frac{26.0}{28.65} = 4.15^k$

$P_{ry} = 4.38 \frac{12.0}{28.65} = 1.38^k$

$\max P_H = \sqrt{(P_{Hx}+P_{rx})^2 + (P_{Hy}+P_{ry})^2} = \sqrt{(16.07+4.15)^2 + (9.11-1.38)^2} = 22.78^k$

$\min P_H = 14.21^k$ AVE. $P_H = 18.50^k$

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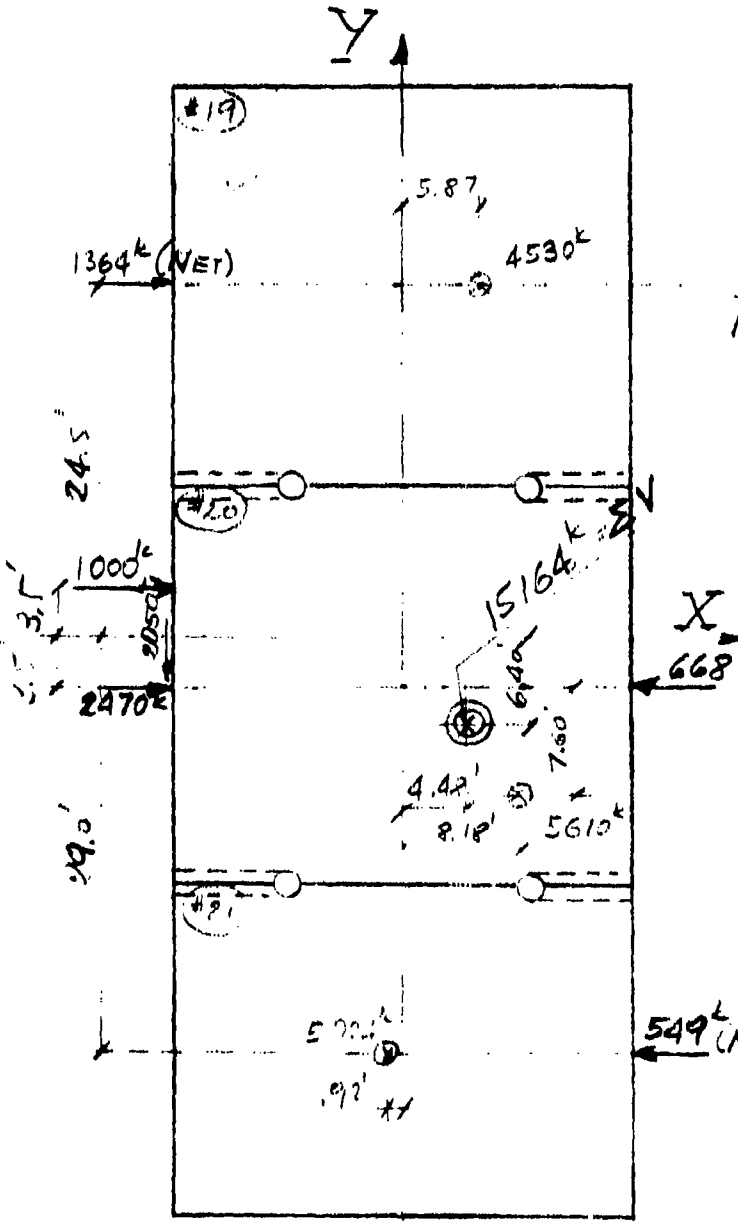
HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RIVER WALL STABILITY PILE LOAD	PROJECT L&D #1
	COMPUTED JJ CHECKED R.N.M.	FILE NO. 800A
		DATE 3/75 PAGE 108d OF ____ PAGES

RIVER WALL MONOLITHS #19, #20 & #21 INTERCONNECTED.
RIVERSIDE BACKFILLED UPTO EL. 710.0'

"LOCKSIDE MAXIMUM" (REF. P. 97, 106 & 107)



RESULTANTS

VERTICAL:

4520 × 1.37 = 6192
5610 × 8.18 = 45890
5024 × (-.92) = -4622
15164 57459

$\bar{X} = \frac{57459}{15164} = 3.79'$

4520 × 24.5 = 110740
5610 × (-11.10) = -62271
5024 × (-28.8) = -144691
15164 -96222

$\bar{Y} = \frac{-96222}{15164} = 6.34'$

HORIZONTAL:

SAME AS [illegible]

(5)

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HARZA ENGINEERING COMPANY CHICAGO

SUBJECT RIVERWALL STABILITY
PILE LOAD
COMPUTED JJ CHECKED R.N.M.

PROJECT L & D #1
FILE NO. 800A
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RIVER WALL MONOLITHS #19, #20 & #21 INTERCONNECTED
RIVERSIDE BACKFILLED UP TO EL 710.0'

"LOCKSIDE MAXIMUM" CONT'D

$\Sigma V = 15164^k$

$\Sigma M_x = 96982^{ik}$ $\Sigma M_y = 67859^{ik}$

ΣH – SAME AS "LOCKSIDE AVERAGE"

$${}_A P_V = \frac{5024}{9\times7} + \frac{96982\times36.0}{105300} + \frac{67859\times12.0}{13500} = 80+33+60 = 173^k$$

$${}_B P_V = \frac{4530}{9\times9} - \frac{96982\times36.0}{105300} - \frac{67859\times12.0}{13500} = 56-33-60 = -37^k$$

$$P_H = \left\{ \begin{array}{l} 22.78^k \text{ max.} \\ 18.50^k \text{ ave.} \\ 14.21^k \text{ min.} \end{array} \right\} \text{ same as "Lockside Average"}$$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITION OF STABILITY @ RIVER WALL COMPUTED M.J. CHECKED R.N.M.	PROJECT LSD #1 FILE NO. 800 A DATE 1.75 PAGE 109 OF ____ PAGES

PILE BEARING CAPACITY

ULTIMATE BEARING CAPACITY (EM 1110-2-2906)

$$Q_u' = A_t \bar{\gamma}_2 D_2 N_q + \tfrac{1}{2} A_f K D_2^2 \bar{\gamma}_2 \tan\delta$$

$A_t = .785 \times .83^2 = .558\ ft^2$

$\bar{\gamma}_2 = .034$ TON/cu ft PILE LENGTH ASS'D 13'

$D_2 = 13'$; $N_q = 20$

$A_f = \pi \times .83 = 2.6\ ft^2$

$K = 1.50$

$\tan\delta = \tan 35^\circ = .65$

$Q_u' = .558 \times .034 \times 13 \times 20 + 1.3 \times 1.50 \times 169 \times .034 \times .65$

$Q_u' = 4.9 + 7.3 = 12.2$ TON/PILE

ASSUMING FS = 3

$Q = 12.2/3 = 4.0$ TON/PILE

PILE BEARING CAPACITY Q = 8.0 K/PILE

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILITY ANALYSIS OF DAM - LOADING CONDITIONS	PROJECT LOCK & DAM #1
	COMPUTED R.N.M. CHECKED JJ	FILE NO. 800 A
		DATE Jan '75 PAGE 110 OF ____ PAGES

LOADING CONDITIONS - THE FOLLOWING ARE ASSUMPTIONS AND OTHER GIVEN DATA USED IN THE ANALYSES OF VARIOUS LOADING CONDITIONS. IN ALL CASES, THE HORIZONTAL PILE LOAD OF 4 K PER PILE AND FRICTIONAL RESISTANCE OF 40' ± APRON DUE TO ITS SUBMERGED WEIGHT ARE ASSUMED TO RESIST HORIZONTAL FORCES.

I NORMAL OPERATING CONDITION

1. UPSTREAM WATER SURFACE EL. 723.2
2. EXISTING SAND FILL IN DAM
3. UPSTREAM SEDIMENT EL 710 ±
4. TAILWATER ELEVATION 690.6'
5. ICE PRESSURE 10 KIPS PER FOOT OF CREST HORIZONTAL AT ELEVATION 723.2'
6. TENDENCY OF MONOUTH TO SLIDE TAKEN ALONG CRITICAL PLANE FROM BOTTOM OF CUT-OFF WALL, EL 684.6 TO EL. 690.6 AT THE TOE. (FOR ALL LOADING CONDITIONS)

II FLOOD DISCHARGE CONDITION

A. 1965 FLOOD EXISTING CONDITION

1. MAX. UPSTREAM W.S. EL 734.7
   TAIL WATER AND LOWER POOL EL 719.
2. SPACE INSIDE OF DAM FILLED WITH WATER
3. UPLIFT DETERMINED BY FLOW NET METHOD.

B. 1951 FLOOD EXISTING CONDITION

1. MAX. UPSTREAM W.S. EL. 731
   TAILWATER EL. 695.5 (BEFORE HYDRAULIC JUMP)
   LOWER POOL EL. 709.0
2. UPLIFT DETERMINED BY FLOW NET METHOD.
3. WATER INSIDE DAM SAME LEVEL AS RELIEF HOLE OUTLETS (EL 697.4 ±)

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILITY ANALYSIS OF DAM - LOADING CONDITION COMPUTED R.N.M. CHECKED JJ	PROJECT LOCK & DAM #1 FILE NO. 800 A DATE JAN. '75 PAGE 111 OF ____ PAGES

LOADING CONDITIONS (CONT'D)

III EARTHQUAKE CONDITION

1. EARTHQUAKE INERTIA FORCES AND HYDRO-DYNAMIC FORCES ADDED TO AND ICE PRESSURE REMOVED FROM NORMAL OPERATING CONDITION.

2 EARTHQUAKE ACCELERATION ASSUMED TOWARD UPSTREAM DIRECTION I.E., FORCES ARE OPPOSITE (TOWARD DOWNSTREAM DIRECTION).

$\frac{a}{g} = 0.1$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILITY ANALYSIS OF DAM - IMPROVED CONDITION COMPUTED R.N.M. CHECKED JJ	PROJECT LOCK & DAM #1 FILE NO 800 A DATE JAN. '75 PAGE 112 OF ____ PAGES

LOADING CONDITION

1951 FLOOD IMPROVED CONDITION

1. MAXIMUM UPSTREAM W.S. EL 731
   TAILWATER EL. 695.5
   LOWER POOL EL 709.

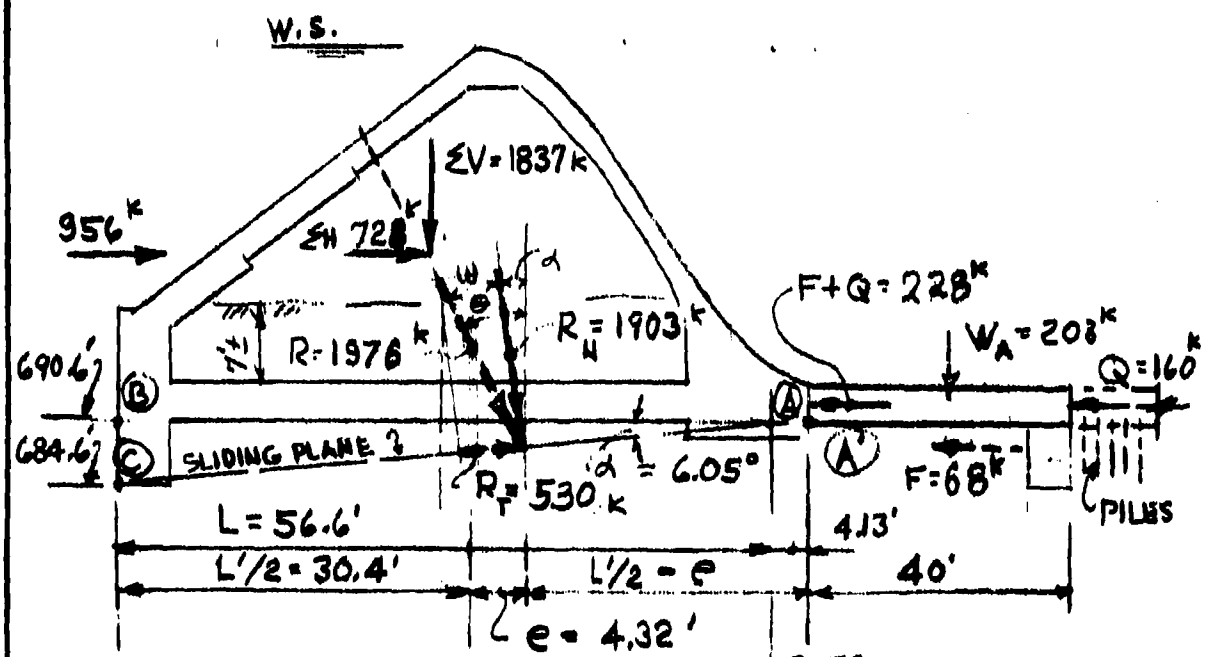
2. UPLIFT DETERMINED BY FLOW NET METHOD

3. WATER IN CAVITY OF DAM SAME LEVEL AS RELIEF HOLE OUTLETS (EL. 697.4 ±)

4. FOR STABILIZATION BY INCREASING THE HEIGHT OF EXISTING SAND FILL, A SLIDING SAFETY FACTOR OF 1.5 WAS SET FOR THE FORCE OF FRICTION TO EQUALIZE THE COMBINED TANGENTIAL COMPONENTS OF [illegible] ON AN INCLINED SLIDING PLANE, AND THE REQUIRED WEIGHT OF ADDITIONAL SAND FILL DETERMINED.

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RESULTS OF BUTTRESS DAM STABILITY ANALYSIS COMPUTED R.N.M. CHECKED JJ	PROJECT LOCK & DAM #1 FILE NO. 800 A DATE JAN '75 PAGE 113 OF ____ PAGES

I NORMAL OPERATING CONDITION (EXISTING)



1. BEARING PRESSURES $f_{A'} = \frac{2.53}{2.34}$ KSF

   $f_B = 1.08$ KSF

2. RESULTANT WITHIN MIDDLE $\frac{1}{3}$, $e = \frac{4.32'}{4.08}$

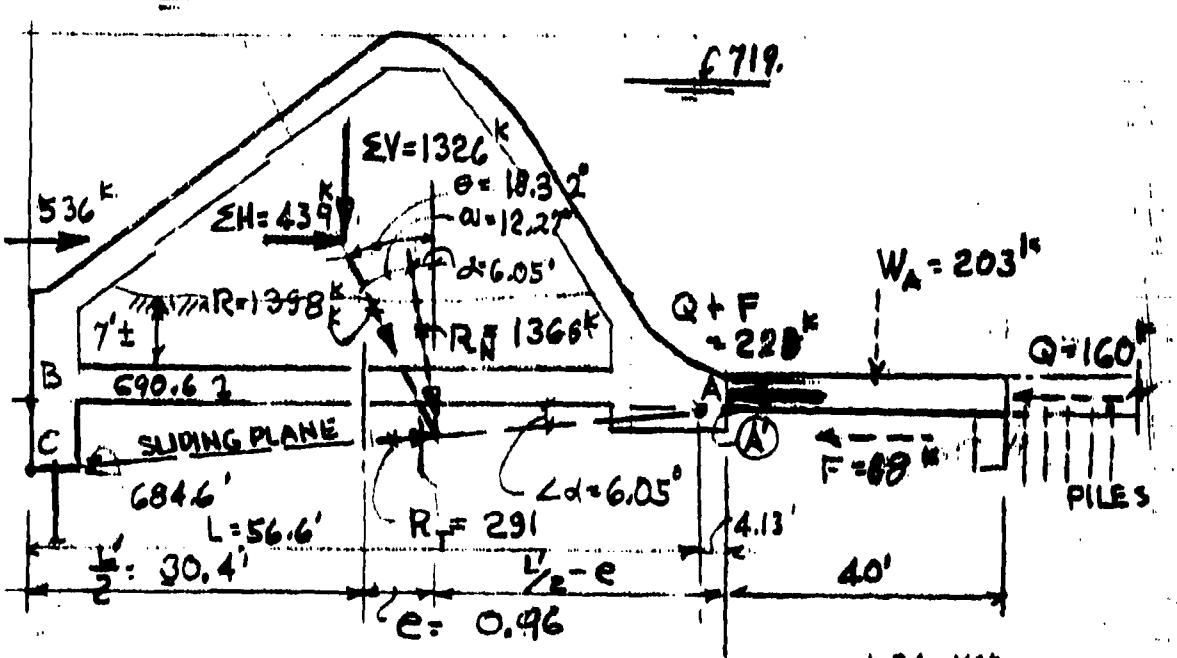
3. SLIDING FACTOR, $\frac{R_T}{R_N} = 0.279$

4. "SLIDING SAFETY FACTOR", SSF = 2.33
   (f 0.649)

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RESULTS OF BUTTRESS DAM STABILITY ANALYSIS COMPUTED RNM CHECKED JJ	PROJECT LOCK AND DAM No. 1 FILE NO. 800 A DATE JAN '75 PAGE 114 OF ____ PAGES

II FLOOD DISCHARGE CONDITION

A. 1965 FLOOD EXISTING CONDITION



1. BEARING PRESSURES: f_A = ~~1.15~~ 1.36 KSF, f_B = ~~1.02~~ 1.13 KSF

2. RESULTANT WITHIN MIDDLE $\frac{1}{3}$; e = ~~0.32~~ 0.96

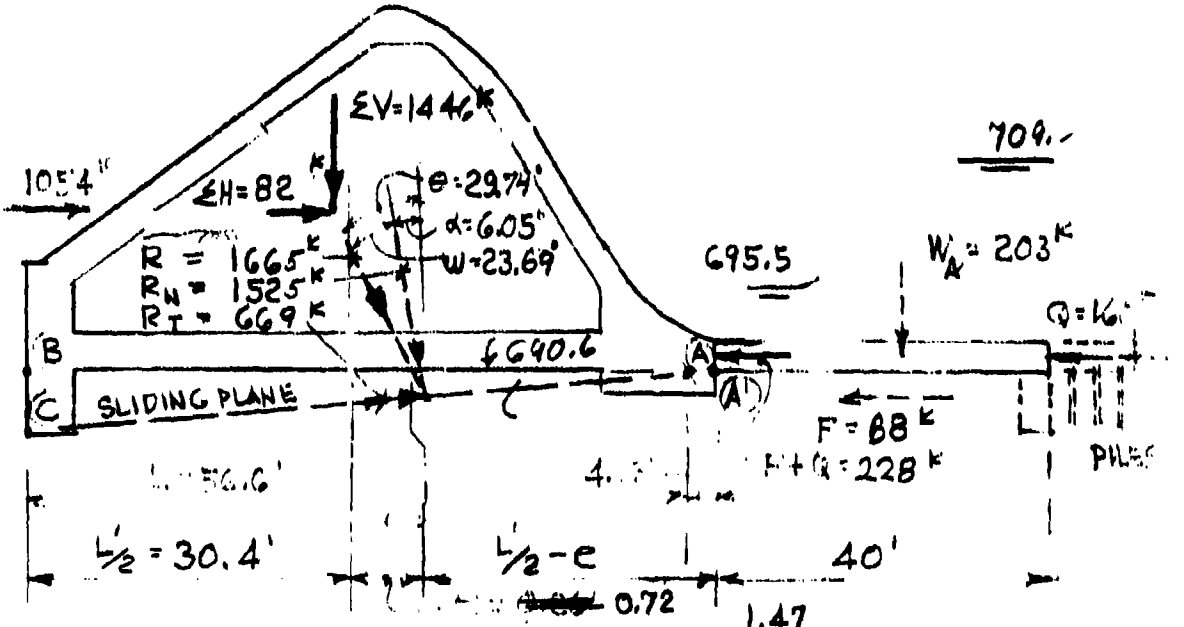
3. SLIDING FACTOR, $\frac{R_T}{R_N} = 0.217$

4. SLIDING SAFETY FACTOR, SSF 2.98
   (f = 0.649)

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RESULTS OF BUTTRESS DAM STABILITY ANALYSIS COMPUTED R.N.M. CHECKED JJ	PROJECT LOCK & DAM No 1 FILE NO 800 A DATE JAN '75 PAGE 115 OF ___ PAGES

II FLOOD DISCHARGE CONDITION

B. 1951' FLOOD EXISTING CONDITION



1. BEARING PRESSURES: $f_{A'}$ ~~1.31~~ 1.47 KSF
   $f_{(B)}$ = ~~1.24~~ 1.27 KSF

2. RESULTANT WITHIN MIDDLE $\frac{1}{3}$. e = ~~0.826~~ 0.72

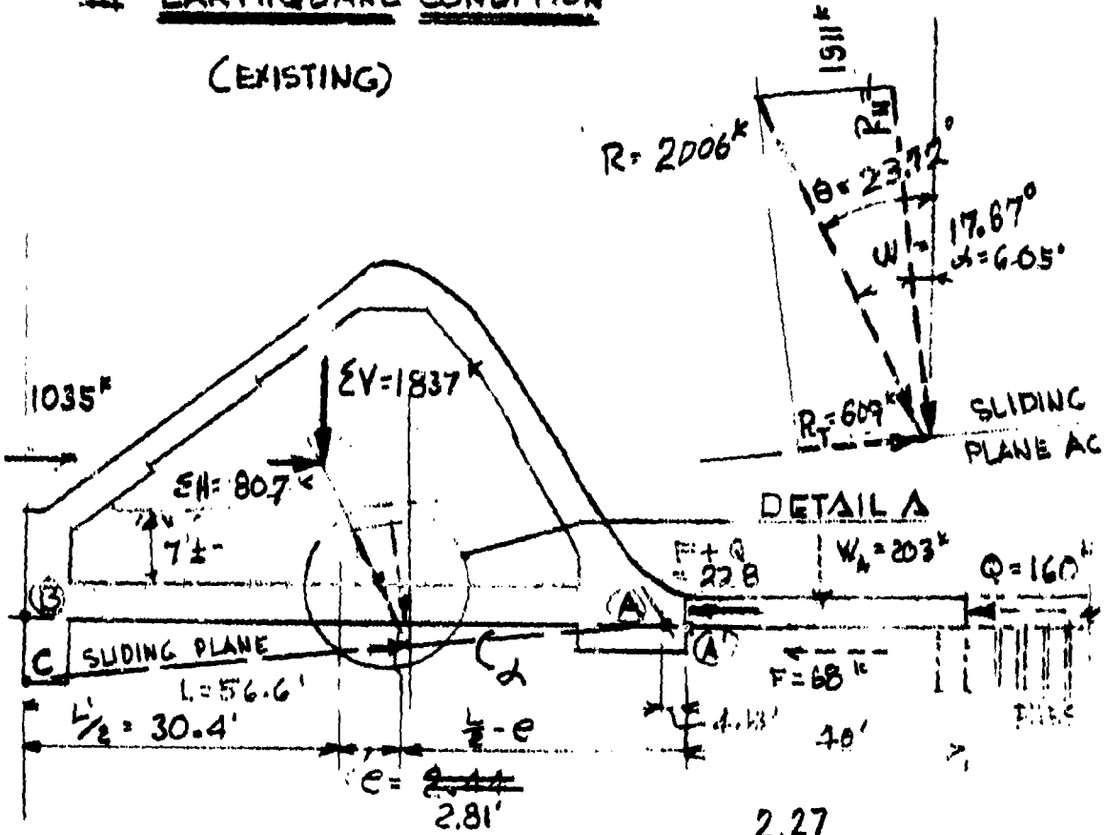
3. SLIDING FACTOR $\frac{R_T}{R_N}$ = 0.439

4. SLIDING SAFETY FACTOR, SSF = 1.48
   (f = 0.649)

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RESULTS OF BUTTRESS DAM STABILITY ANALYSIS COMPUTED R.N.M. CHECKED JI	PROJECT LOCK & DAM #1 FILE NO. 800 A DATE JAN. '75 PAGE 114 OF ____ PAGES

III EARTHQUAKE CONDITION

(EXISTING)



1. BEARING PRESSURES f_A = ~~2.06~~ 2.27 KSF

   f_B = 1.28 KSF

2. RESULTANT WITHIN MIDDLE 1/3, e = ~~2.44~~ 2.81'

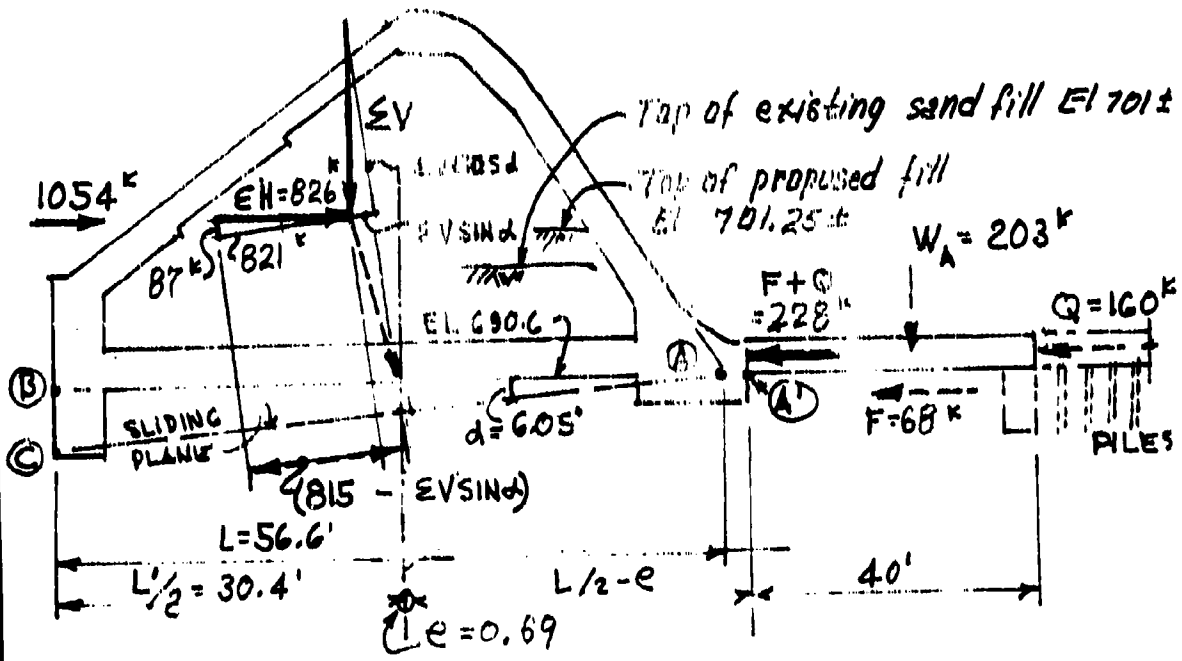
3. SLIDING FACTOR, $\frac{R_T}{R_N}$ = 0.319

4. SLIDING SAFETY FACTOR, SSF = 2.03
   (f = 0.649)

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RESULTS OF BUTTRESS DAM STABILITY ANALYSIS COMPUTED E. N. M. CHECKED N	PROJECT LOCK & DAM #1 FILE NO. 800A DATE 4/'75 PAGE 117 OF ____ PAGES

FLOOD DISCHARGE

1951 FLOOD – IMPROVED CONDITION



$$(87 + \Sigma V \cos 60.5^\circ)\frac{.649}{1.5} = 821 - \Sigma V \sin 60.5^\circ$$

$\Sigma V = 1463^{k}$ IMPROVED

$\Sigma V' = -1446$ WITHOUT IMPROVEMENT

$\Delta V = 17^{k}$ REQUIRED WEIGHT OF ADDITIONAL SAND FILL FOR SSF OF 1.5

1. BEARING PRESSURES:

2. RESULTANT [illegible] MIDDLE THIRD $e = 0.69$

3. SLIDING FACTOR = 0.[illegible]

4. SSF = 1.5

$f_A = 1.48$ ksf

$f_B = 1.30$ ksf

R.N

NORMAL
OPERATING CONDITION

ASSUMPTIONS:

B. A = 16'

1. UPSTREAM WATER SURFACE ELEV. 723.2 -56.6
2. EXISTING SAND FILL 7' HIGH
3. UPSTREAM SEDIMENT HEIGHT 15'
4. TAILWATER ELEV. 690.6'
5. 8" TO 12" CONCRETE RESURFACING @ DOWNSTREAM FACE.
7. 2' OF ICE = 10^{K} PER FOOT OF CREST → (PAGE 5 OF EM 1110-2-2201)

1. 2.75 x 8.75 x 1
2. 2.5 x 12.53 x 1
3. 2.17 x 13.3 x 1
4. 3.5 x 6.6 x ½ x
5. ⅔ x 12.51 x 11.02 x
6. 1.5 x 16.6 x 16
7. 5.9 x 4½ x 1
8. 5.9 x 3.8 x 16
9. 46.9 x 3.0 x 16
10. 10.6 x 4.6 x 16
11. 1.0 x 1.5 x (16 -
12. 6.0 x 1.0 x 0.
13. 5.0 x 1.0 x 0.
14. 8.64 x 42.4
15. 1.7 x 3.5 x 4
16. 2.75 x 3.9 x 4
17. 1.0 x 1.5 (16 -
18. 1.0 x 1.5 (16 -
19. 0.5 x 42.4 x
20. 6.25 x 4.7 x ½
21. 2.7 x 4.7 x ½
22. 33.7 x 4.7 x
23. 1.0 x 1.5 x (16 -
24. 1.0 x 6.0 x
25. 1.0 x 1.5 (16 -

R.N.M. 8/74 J1 3/24/75 118

690.6 (M.S.L.)

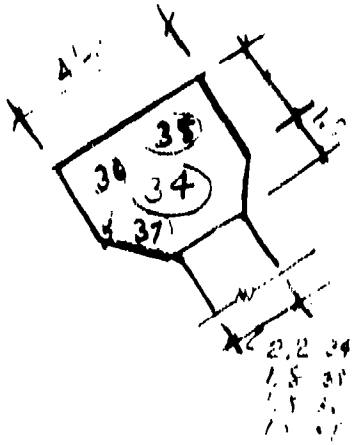
		(KIPS)	(FEET)		(FT-KIPS)
1.	2.75 × 8.[illegible] × 16 × 0.15	57.95	49.8		2886
2	2.5 × 12.58 × 16 × 0.15	75.48	41.2		3110
3	2.11 × 13.3[illegible] × 16 × 0.15	69.42	31.4		2180
4	3.5 × [illegible] × ½ × 16 × 0.15	9.24	25.5		236
5	⅔ × 12.51 × 11.02 × 16 × 0.15	220.57	20.0		4411
6	1.5 × 16.[illegible] × 16 × 0.15	58.32	9.5		554
7	5.9 × 4 × ½ × 16 × 0.15	28.32	4.1		116
8	5.9 × 3.8 × 16 × 0.15	53.31	2.9		156
9	46.8 × 30 × 16 × 0.15	337.00	29.2		9839
10	10.0 × 4.[illegible] × 16 × 0.15	96.00	54.6		5242
11	1.0 × 1.5 × (16 − [illegible]) 0.15	3.15	18.7		59
12	6.0 × 1.0 × 0.33 × 0.15		0.30 18.4	6	
13	5.0 × 1.0 × 0.33 × 0.15		0.25 38.0	10	
14	8.[illegible]4 × 42.4 × 0.15	56.82	28.6		1608
15	1.7 × 3.5 × 4.[illegible] × 0.15	3.57	6.5		23
16	2.75 × 3.9 × 4.[illegible] × 0.15	6.44	51.0		328
17	1.0 × 1.5 (16 − 2[illegible]) × 0.15	3.11	26.7		83
18	1.0 × 1.5 (16 − 2.2) 0.15	3.11	34.3		106
19	0.5 × 42[illegible] × 2.2 × 0.15	7.00	28.5		200
20	6.25 × 4.7 × ½ × [illegible] × 0.15	4.85	45.7		222
21	2.1 × 4.7 × ½ × [illegible] × 0.15	2.09	9.1		19
22	33.7 × 4.7 × [illegible] × 0.15	52.27	26.8		1401
23	1.0 × 1.5 × (1[illegible] − [illegible]) 0.15	3.15	29.2		92
24	1.0 × 6.[illegible] × [illegible] × 0.15		0.30 28.3	8	
25	1.0 × 1.5 (1[illegible] − 1.[illegible]) 0.15	3.20	23.0		74
	Sub-total 1	1154.27	0.85	24	32945

LOCK & DAM #1
STABILITY OF DAM

1

2

NORMAL CONDITION (CONT'D)



2.0' for 34
1.75' for 35
16.7' for 36
1.0' for 37

Areas:

4 x 2 = 8.00

$\frac{4 + 2.2}{2}$ = 3.10

A_{34} = 11.10

4 x 1.75 = 7.0

$\frac{4 + 1.8}{2}$ = 5.9

A_{35} = 12.9

4 x 1.67 = 6.68

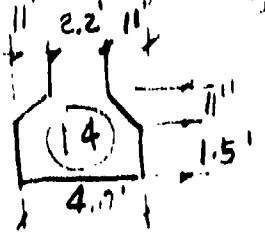
$\frac{4 + 1.1}{2}$ = 5.75

A_{36} = 9.43

4 x 1.0 = 4.0

$\frac{4 + 1.5}{2}$ = 2.75

A_{37} = 7.15



4 x 1.5 = 6

$\frac{2.2 + 4}{2} \times \frac{11}{12} = 2.84$

A_{14} 8.84 ft²

A

-5a 4.0 x 3.0 x 16 x
-5b 6.5 x 7.0 x 16 x
-5c 4.0 x 6.0 x ½ x 1
10a 1.5 x - ½ x 1
26 1.0 x 1.5 x 16
27 10.5 x 8 x ½ x 1.
28 4.4 x 3 x ½ x 1.
29 19.3 x 3 x 1.
30 9.7 x 7.3 x ½ x
31 3.8 x 7.8 x 1.
32 6.0 x 7.8 x 1.
33 3.0 x 6.0 x 1.
34 11.1 x 5.5 x
35 3.9 x 12.5
36 9.4 x 13.33
37 7.15 x 4.0 x
38 5.75 x 5. x
39 5.75 x 6.4 x
40 } 1.0 x 14.6 x
H.

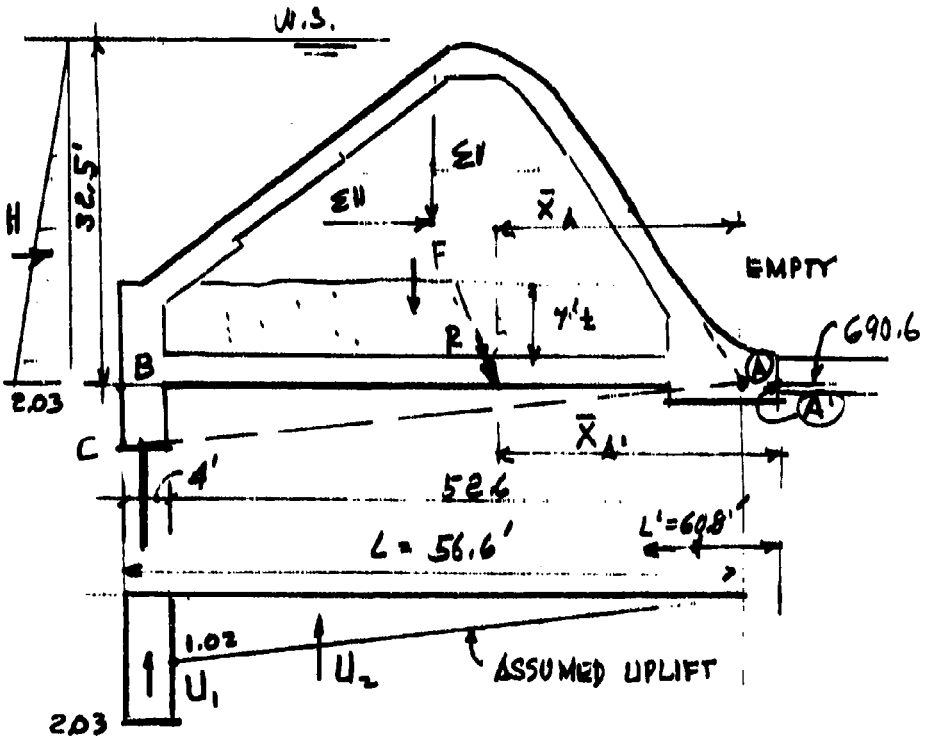
N N 0/14 11 3/24/75 119

EOC.6 CM.S...

4.0 x 3.0 x 16 x 0.15		76.80	22.1	1743		Reduction in Parabolic Area
2.5 x 2.0 x 16 x 0.15		4.80	9.5	819		
4.0 x 1.0 x ½ x 16 x 0.15		4.1	17.0	430		
1.5 x 1.5 x 16 x 0.15		3.60	53.2	192		– Item (3) Reduction
2.0 x 1.5 x 16 x 0.15	3.1		19.4		58	– Beam
1.0 x 3.5 x 1.5 x 0.15	12.60		37.4		471	
4.4 x 2 x 2.0 x 0.15	4.75		13.3		64	
1.0 x 2 x 2.0 x 0.15	4.65		24.3		1130	
9.2 x 2.5 x ½ x 2.0 x 0.15	5.51		21.8		237	
3.5 x 2.0 x 2.0 x 0.15	6.07		22.5		152	
6.0 x 1.5 x 2.5 x 0.15	10.53		18.6		196	
1.0 x 6.0 x 2.5 x 0.15		4.05	21.0	85		Wall opening
11.5 x 2.5 x 2.0 x 0.15	14.15		48.0		679	
4.9 x 2.5 x 2.0 x 0.15	14.63		40.6		747	
3.2 x 2.0 x 2.0 x 0.15	3.76		29.6		558	
2.5 x 1.5 x 2.0 x 0.15	1.91		19.6		37	
3.0 x 2.5 x 2.0 x 0.15	4.13		18.7		191	
3.0 x 1.5 x 2.0 x 0.15	1.40		14.1		66	
2.0 x 2.0 x 2.0 x 0.15	1.20		10.2		202	
sub total	176.38	15.53		3329	4712	
sub total	1176.55	0.55		4	32945	
	1177.1	16.10		3333	37657	
sub total	1176.55		29.10		34304	
	=1177*					

LOCK & DAM N-1
STABILITY OF DAM

NORMAL CONDITION (CONT'D)



42 15.8
43 5.5
44 9.0 K
45 6.0 K

F 45 x 7
Soil

Water
H .062.5
W_1 22.2
W_2 22.23
U_1 32.5 x
U_2 32.5 K

Earth
for
HS_{15} .020.5
WS_{15} 9.0 x

Ice
10 x

Conc.

BEARING PRESSURES:

$\bar{X}_{A'} = \frac{37885}{\cancel{36150}} + 4.13 = \cancel{26.08}$, $e = 30.4 - \bar{X}_{A'} = \cancel{4.32}$

$f_{A'} = \frac{1726}{972.8}\left(1 + \frac{6 \times \cancel{4.32}}{60.8}\right) = \cancel{2.53}$

$f_B = 1.677(1 - 0.\cancel{40}) = \cancel{1.00}$ 1.02

4.0 x 6.0 x 16 x .088 = 34 x 54 = 1045
2.0 x 10 x 16 x .088 = 28 x .87 = 25
3.3 x 4.13 x 16 x .15 = 33 x 2 = +67
Wt. of conc. below El 690.6 = 95 K = 1803 K

R.N.M. 8/74 11 3/24/75 12D

690.6 (M.S.L.

42	15.8 x 1.0 x 16 x 0.15		37.92	7.8	296	}	Resurface
43	5.5 x 1.0 x 16 x 0.15		13.20	2.2	29		
44	9.0 x 0.83 x 16 x 0.15		17.93	14.6	262		
45	6.0 x 0.67 x 16 x 0.15		9.65	19.8	191		
		total 3	78.70		778		
F	45 x 7 x 14 x 0.12 cement-sand fill		526.4	29.0	15266		7' high fill
	Water:						
H	.062.5 x 32.5² x 16 x ½	+528.13		10.83	5,720	}	Hydrostatic
W_1	22.23 x 29.33 x 16 x 0.0625/2		326.00	44.53	14517	}	Weight of
W_2	22.23 x 2.34 x 16 x 0.0625/2		52.02	55.48	2886	}	Water
U_1	32.5 x 0.0625 x 4 x 16		130.00	54.65	7105		
U_2	32.5 x 0.0625/2 x 52.65 x 16 x ½		427.78	35.10	15015		
	Earth and sediment forces:						
HS_{15}	.020 x 5 x 15² x 16 x ½	+37		5.0	185	}	See Flood
WS_{15}	9.0 x 6.0 x ½ x 0.0615 x 16		29.0	53.65	1556	}	condition
	Ice pressure:						
	10 x 16	160		32.5	5200		
	sub-total 4 =	725.1	933.4	557.8	33225		~~33160~~ 34225
	Conc. below el 690.6	=	95				1803
		725.1	2439.8	713.9	36576		74463
				1726			37885

K = 1045
= -25
= +67
1803 k

(A) = 2.53 ~~2.34~~ KSF
(B) = ~~1.80~~ 1.02 KSF

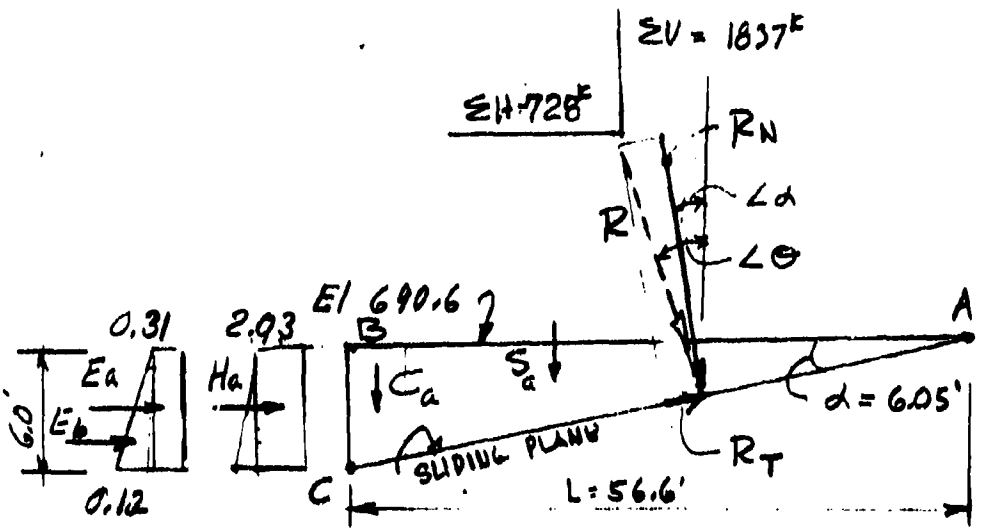
LOCK & DAM #1
STABILITY OF DAM

2

NORMAL OPERATING CONDITION (CONT'D)

SLIDING SAFETY FACTOR (SSF)

ASSUME APRON SLAB & PILE RESISTANCE AS IN Page 125a



$$R = \sqrt{728^2 + 1837^2} = 1976$$

$$\theta = \tan^{-1}\frac{728}{1837} = 21.62^\circ$$

$$\underline{-\ 6.05^\circ}$$

$$R_T = R \sin 15.57^\circ = \frac{530^k}{1903^k} = .279$$

$$R_U = R \cos 15.57^\circ$$

SLIDING FACTOR = .279

$$SSF = \frac{.649}{530/1903} = 2.33$$

Above G
Below

H_a 2.03 x G

E_a 0.31 x G

E_b 0.12 x G / 2

S_a 52.6 x G

C_a G x 4

PILE RESI

APRON SUB
FRICTION
WITH 1.5
Cf = .

R. N. M. 8/74 JI 3/24/75 121

690.6 – 684.6

Above elev. 690.6 → + 725 1631

Below 690.6:

H_a 2.03 x 6 x 16 → 195

E_a 0.31 x 6 x 16 → + 30

E_b $\frac{0.12 \times 6 \times 16}{2}$ → + 6

ΔH = 231

S_a $\frac{52.6 \times 6 \times 16 \times .068}{2}$ → 172

C_a 6 x 4 x 16 x 0.088 → 34

ΔV = 206

PILE RESISTANCE – 160

APRON SUBMERGED WT. FRICTION RESISTANCE WITH 1.5 SAFETY FACTOR (f = .499) – 68

P_g 125a

P_q 135

728[k]

1837

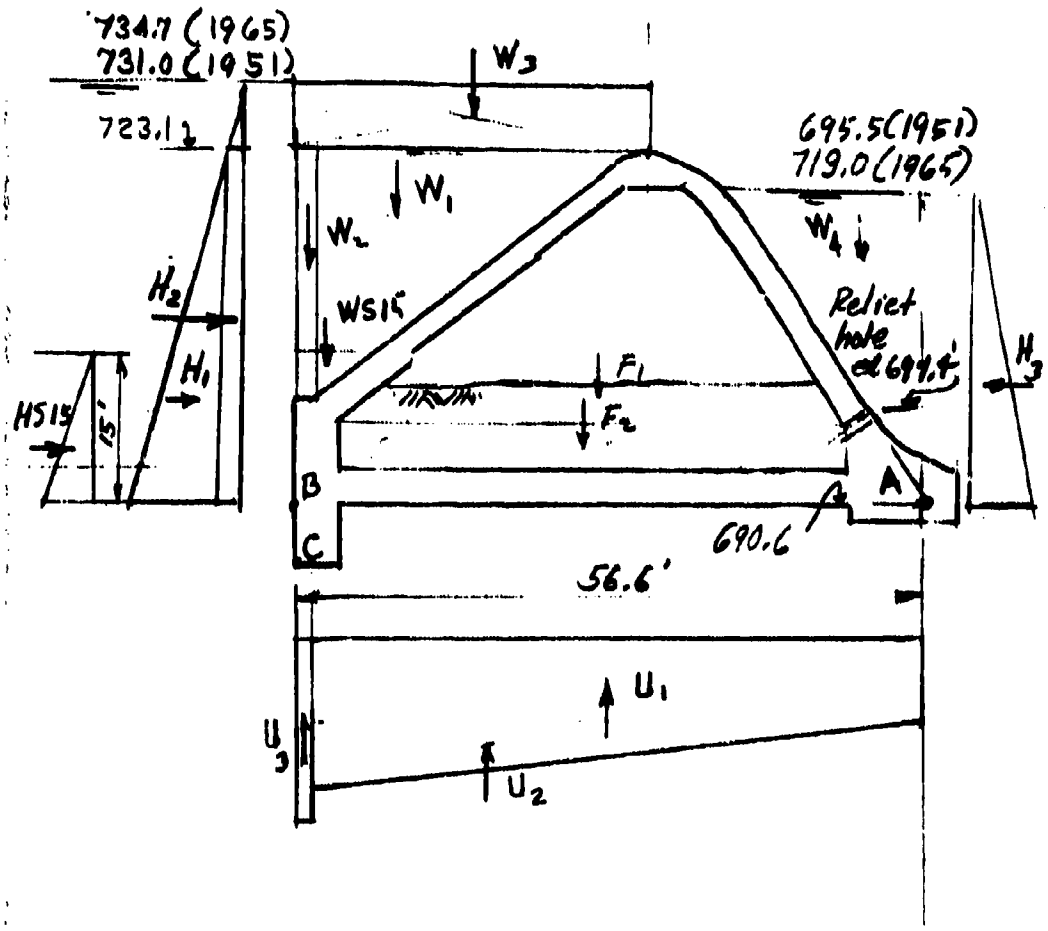
LOCK AND DAM #1
STABILITY OF DAM

2

1

FLOOD DISCHARGE CONDITION

APRIL 1951 FLOOD } FORCES
APRIL 1965 FLOOD }



W_1 22.23x
W_2 22.23x

W_3 (1965) 11.5
W_3 (1951) 7.8

H_1 0.0625x
H_2 (1951) = 7.8x
H_2 (1965) = 11.5x

H_3 (1951) = 0.06
H_3 (1965) = 0.0

U_1 55.6 x 33
U_2 4.5 x 55
U_3 1.0 x 44
U_1 30.6 x 1.5
U_2 30.6 x 6.
U_3 25 x 22
U_4 25 x 3.6
U_5 1.0 x 40.
HS15 0.0205 x
WS15 9 x 6 x $\frac{1}{2}$ x
F_1 (1951) 44 x
F_1 (1965) 44 x
F_2 47 x 3.7x

R.N.M. 1/75 JI 3/24/75 122

→ ⊕

W_1	$22.23 \times 29.33 \times 1.0/2$	326	44.5	14507		
W_2	$22.23 \times 2.34 \times 1.0$	52	55.5	2886		
W_3 (1965)	$11.5 \times 31.7 \times 1.0$	365	40.7	14856		
W_3 (1951)	$7.8 \times 31.7 \times 1.0$	247	40.7	10053		
H_1	$0.0625 \times 32.5^2 \times 16 \times \frac{1}{2}$ +528		10.8	5720		
H_2 (1951)	$= 7.8 \times .0625 \times 32.5 \times 16$ +254		16.3	4140		1951 Flood
H_2 (1965)	$= 11.5 \times .0625 \times 32.5 \times 16$ +374		16.3	6096		1965 Flood
H_3 (1951)	$= 0.0625 \times 4.8^2 \times 16/2$ −12		1.6		19	
H_3 (1965)	$= 0.0625 \times 28.4^2 \times 16/2$ −403		9.5		3820	
U_1	$55.6 \times 33.5 \times 1.0$ (1965)	1863	27.8	51791		Uplift, 1965 Flood
U_2	$4.5 \times 55.6 \times 1.0/2$ (1965)	125	37.0	4625		Uplift, 1965 Flood
U_3	$1.0 \times 44.0 \times 1.0$ (1965)	44	56.1	2468		Uplift, 1965 Flood
U_1	$30.6 \times 15.5 \times 16 \times .0625$	474	15.3	7252		Uplift, 1951 Flood, see uplift diagram
U_2	$30.6 \times 6.5 \times \frac{1}{2} \times 1.0$	99	20.4	2020		Uplift, 1951 Flood, see uplift diagram
U_3	$25 \times 22 \times 1.0$	550	43.1	23705		Uplift, 1951 Flood, see uplift diagram
U_4	$25 \times 3.6 \times \frac{1}{2} \times 1.0$	45	47.3	2129		Uplift, 1951 Flood, see uplift diagram
U_5	$1.0 \times 40.0 \times 1.0$	40	56.1	2244		Uplift, 1951 Flood, see uplift diagram
HS15	$0.0205 \times 15^2 \times 16 \times \frac{1}{2}$ +37		5.0	185		Sediment
WS15	$9 \times 6 \times \frac{1}{2} \times .0675 \times 16$	29	53.7		1556	Sediment $w = 130$, k-a.3
F_1 (1951)	$44 \times 3.3 \times 14 \times 0.12$	244	29.0		7076	Existing Sand fill
F_1 (1965)	$41 \times 3.3 \times 14 \times 0.13$	264	29		7656	Existing Sand fill
F_2	$47 \times 3.7 \times 13 \times 0.13$	294	29		8526	Existing Sand fill

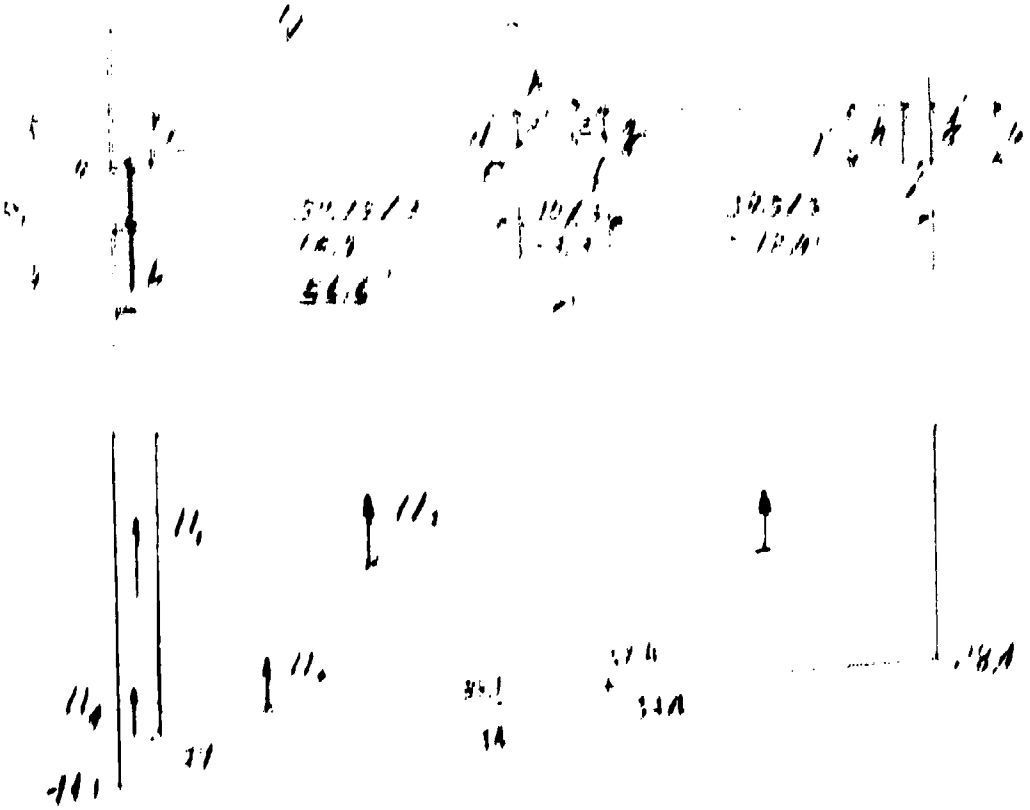
LOCK AND DAM NO. 1
STABILITY OF DAM

2

1965 FLOOD

Purpose

Determination of uplift using weighted creep theory for comparison with flow net Method in design of small dams



T.N.M. 1/'75 11 3/25/75 123

$H = 734.7 - 719 = 15.7'$
$L = 92 \quad r = \frac{L}{H} = 5.85$

Point	Creep length, x	Uplift $(L-x)\frac{1}{n} + 28.4$
a	0	44.1
b	21.	40.5
c	42	36.4
d	58.9	34.0
e	60.9	33.7
f	64.2	33.2
g	66.2	32.8
h	79.0	30.6
i	86.0	29.4
j	92.0	28.4

U_1	37 x 4	148
U_2	3 x 52.6 /2	79
U_3	34 x 52.6	1788
U_4	7.1 x 4/2	14

$\Sigma U = 2029$ kips Creep theory

$\Sigma U = 2032$ kips Flow net method

∴ USE FLOW NET

LOCK AND DAM NO. 1
STABILITY OF DAM

2

R.

FLOOD DISCHARGE CONDITION

1965 FLOOD

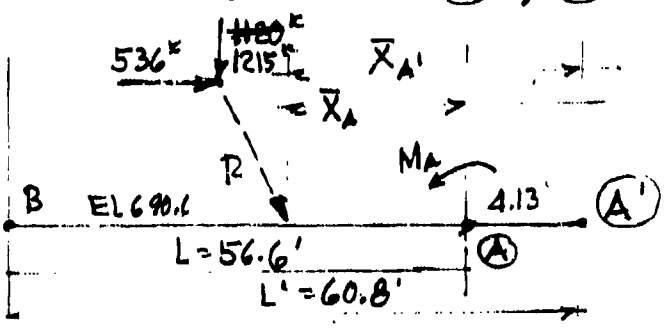
Concrete
Resurfac

Assumptions:

1. Max. flood el. 734.7
   T.W. el. 719.0
   } April 1965
2. Water inside Dam as high as T.W.
3. Uplift by Flow Net Method.

F_1
F_2
W_1
W_2
W_3
W_4 $24 \times 16 \times \frac{1}{2} \times$
W_5 $22 \times 17.3 \times \frac{1}{2}$
W_6 $8.3 \times 17.3 \times$
W_7 $10.7 \times 17.3 \times$

BEARING PRESSURES @ PTS. (A') & (B)



U_1
U_2
U_3
H_1
H_2
H_3
H_{S15}
W_{S15}

$$\bar{X}_{A'} = \frac{30757}{1215} + 4.13 = 29.44 \qquad e = 30.4 - 29.44 = 0.96$$

$$f_{(A')} = \frac{1215}{972.8}\left(1 + \frac{6 \times 0.96}{60.8}\right) = 1.36'$$

Additional s
below

$$f_{(B)} = \frac{1215}{972.8}(1 - .095) = 1.13$$

A'

(A')
(B)

R.N.M. 1-13-75 JI 3/25/75 124

690.6

		→ (+) (Kips)	↓ (Kips) O	(feet) O		
	Concrete D.L.		1177		34304	From Norma
	Resurfacing		79		778	Condition
F_1			264		7656	Sand Fill
F_2			294		8526	
W_1			326		14507	Water, up-
W_2			52		2886	stream
W_3			365		14856	
W_4	$24 \times 16 \times \frac{1}{2} \times .0625 \times 16$		192	5.3	1018	Water, dnstream
W_5	$22 \times 17.3 \times \frac{1}{2} \times 14 \times .0625$		167	35.-	5828	Water
W_6	$8.3 \times 17.3 \times 14 \times .0625$		126	23.-	2889	inside
W_7	$10.7 \times 17.3 \times \frac{1}{2} \times 14 \times .0625$		81	15.-	1215	
U_1				1863	51791	Uplift
U_2				125	4625	
U_3				44	2468	
H_1		+528			5720	Lateral
H_2		+374			6096	hydrostatic
H_3		− 403			3820	
$HS15$		+ 37			185	Sediment
$WS15$			29		1556	
	Additional submerged Concrete below el. 690.6		95		1803	
		536	3247	2032 ~~1120~~ 1215	70885	99839 ~~29050~~ 30757

~~30.1~~ 29.44 ft + [redacted]0.96

A'

1.36

(A') = ~~1.15~~ KSF

(B) = ~~1.12~~ KSF

1.131

LOCK AND DAM NO. 1
STABILITY OF DAM

2

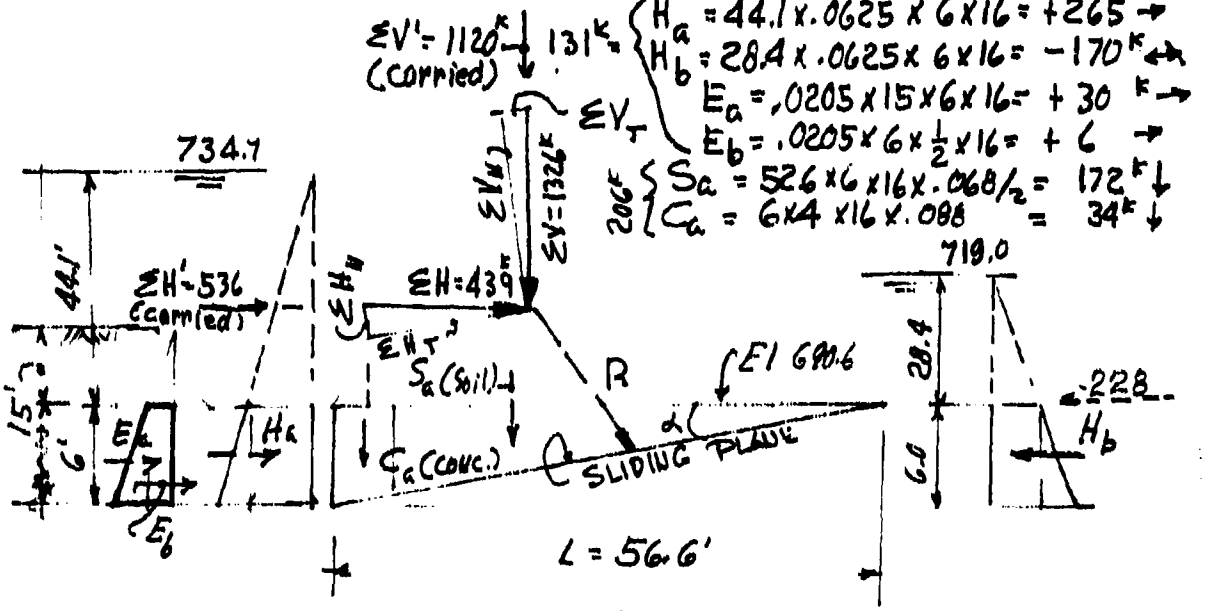
HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILITY OF BUTTRESS DAM	PROJECT L & D #1
	COMPUTED R.H.M. CHECKED JJ	FILE NO 800 A
		DATE 4/'75 PAGE 125 OF ____ PAGES

FLOOD DISCHARGE

1965 FLOOD - EXISTING CONDITION

"SLIDING SAFETY FACTOR" AT PLANE AC
UPLIFT BY FLOW NET METHOD
ADDITIONAL FORCES BELOW EL. 690.6 :

$H_a = 44.1 \times .0625 \times 6 \times 16 = +265^k \rightarrow$
$H_b = 28.4 \times .0625 \times 6 \times 16 = -170^k \leftarrow$
$E_a = .0205 \times 15 \times 6 \times 16 = +30^k \rightarrow$
$E_b = .0205 \times 6 \times \frac{1}{2} \times 16 = +6 \rightarrow$
206# $S_a = 526 \times 6 \times 16 \times .068/2 = 172^k \downarrow$
$C_a = 6 \times 4 \times 16 \times .088 = 34^k \downarrow$



$\Sigma H = 536 + 131 - 228 = \underline{439^k}$ $\quad \Sigma V = 1120 + 206 = \underline{1326^k}$

$\alpha = 6.05°$

$\Sigma H_N = 439 \sin\alpha = 46^k$ $\quad \Sigma H_T = 439 \cos\alpha = 437^k$
$\Sigma V_N = 1326 \cos\alpha = \underline{1319^k}$ $\quad \Sigma V_T = 1326 \sin\alpha = \underline{-140^k}$
$\Sigma H_N + \Sigma V_N = 1365^k$ $\quad \Sigma H_T - \Sigma V_T = 297^k$

$$SSF = \frac{(\Sigma H_N + \Sigma V_N)(.649)}{(\Sigma H_T - \Sigma V_T)} = \frac{1365 \times .649}{297} = \underline{2.98}$$

CHECK: $R = \sqrt{439^2 + 1326^2} = 1398$ $\quad R_T = R \sin W = \frac{297}{1366} = .217$

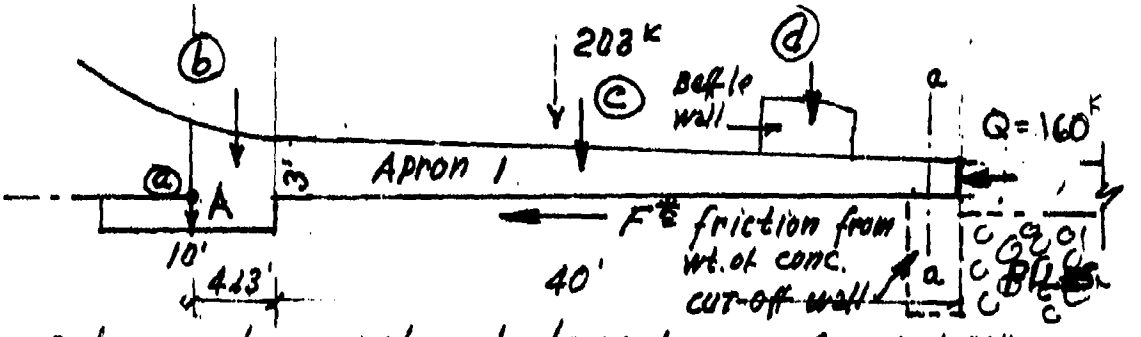
$\theta = \tan^{-1}\frac{43}{1326} = 18.32°$ $\quad R_N = R \cos W = \frac{.55}{29/136} = \underline{2.98}$
$-\ 6.05$
$\angle W = 12.27°$ $\quad SSF =$

(NEXT SHEET IS P. 125a)

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILITY ANALYSIS OF BUTTRESS DAM	PROJECT L & D #1
	COMPUTED R.N.M. CHECKED JJ	FILE NO 800 A
		DATE 4/1/75 PAGE 125a OF ____ PAGES

A. FRICTIONAL RESISTANCE OF SUBMERGED CONCRETE DOWNSTREAM, 44.13 ft. from pt. "A".

B. CRITICAL SHEAR SECTION OF APRON (1) CHECKED FOR ALLOWABLE FORCE REACTION ASSUMING THAT THE CUT-OFF-WALL, APRON (2) & PILES ACT AS A SOLID SUPPORT.



A. Submerged concrete wt downstream of point "A":

ⓐ	2 x 10 x 16 x .088	=	28
ⓑ	3 x 4.13 x 16 x .088	=	17
ⓒ	40 x 3 x 16 x .088	=	141
ⓓ	3 x 4 x 16	= 192	
	- 2 x 2 x 3 x 12	= - 24	x .088 = 17
	3.5 x 4 x 2	= 28	

$F = 203 \times .499 = 101^{K} \leftarrow$ $\quad 203^{K} \downarrow$

* $F = \frac{203 \times .499}{1.5} = 68^{K}$ (With 1.5 Safety Factor)

B. Shearing capacity of slab at section a-a:

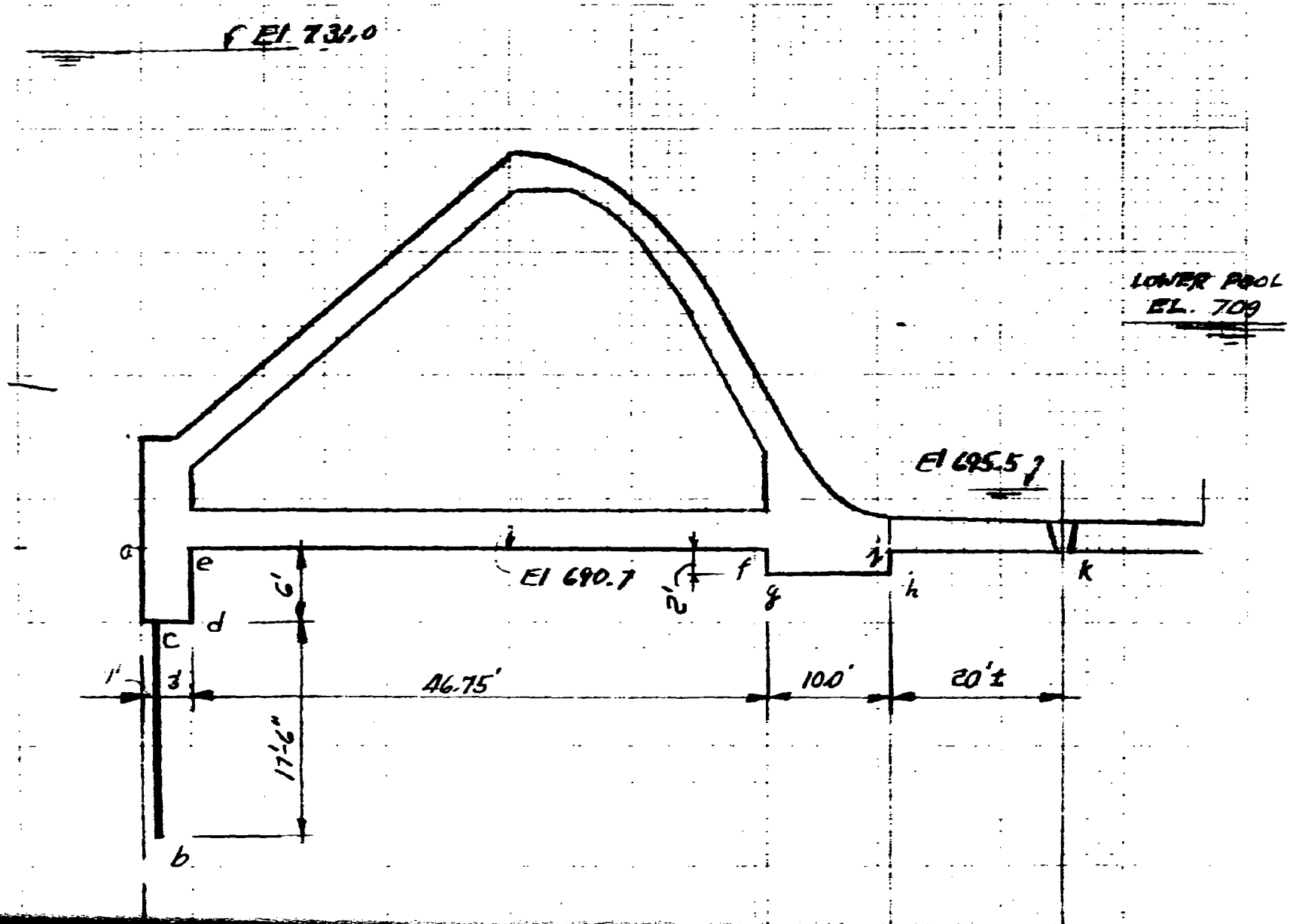
$t = .2'$
$L = 16'$
$t \times L = A = 2 \times 16 \times 144 = 4608\ in^2$

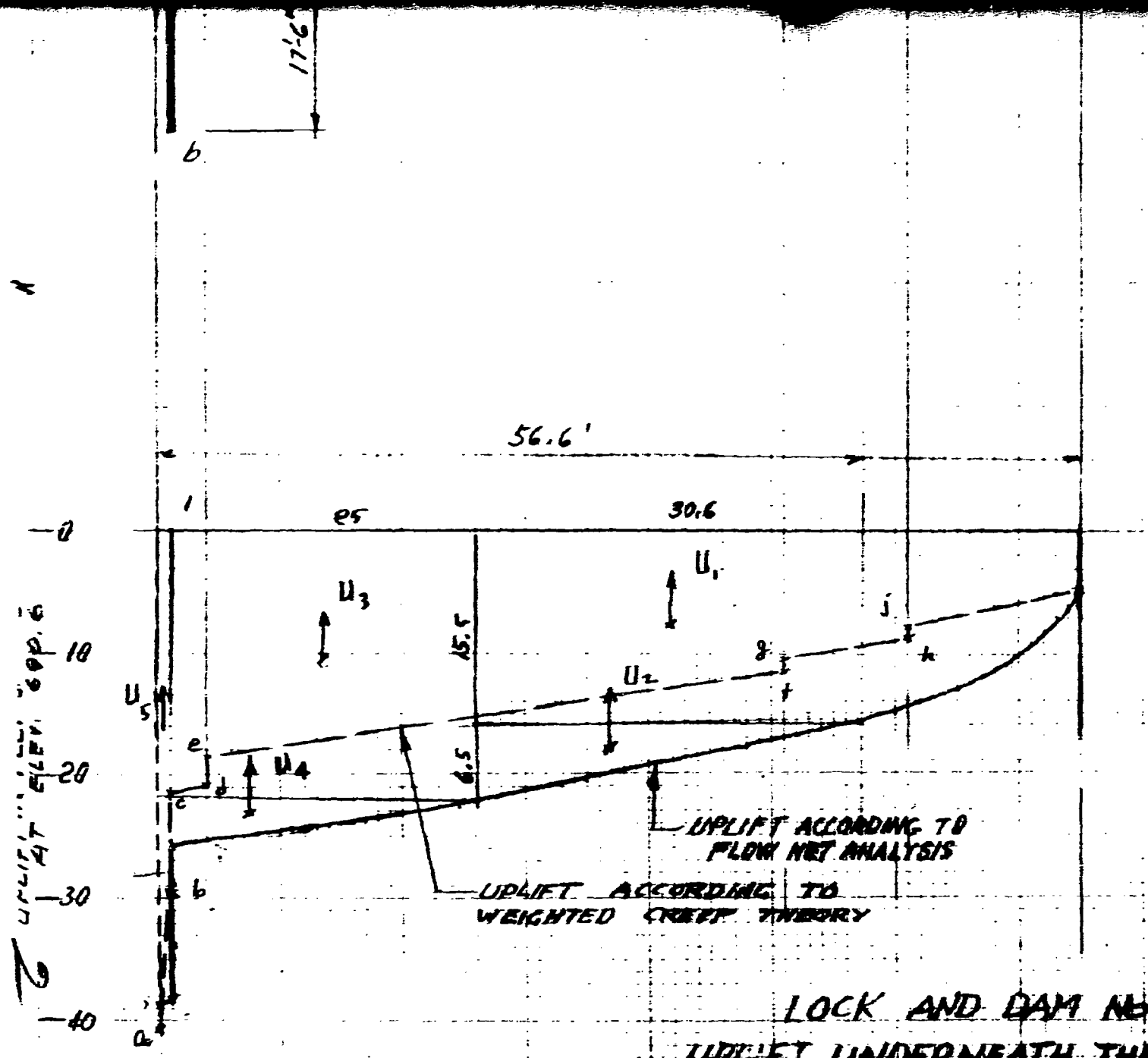
$v_c = \frac{V}{A} = 60$ psi (Very conservative, $f'_c = 3,000$ psi)

$V = 60 \times 4608 = 276^{K}$

276^K shall be governed by pile resistance.
Assume 4' spacing e.w., 40 piles per 16' monolith
40 @ 4^K per pile = 160 kips. ∴ Use $Q = 160^{K}$

(PREVIOUS SHEET IS P. 125)


EL 732.0
LOWER POOL
EL. 709
EL 695.5
EL 690.7
a
b
c
d
e
f
g
h
i
j
k
6'
2'
1'
3
46.75'
10.0'
20'±
17'-6"



LOCK AND DAM No. 1
UPLIFT UNDERNEATH THE DAM

DEC. 9, 1974

PROJECT 402 A

R. N.

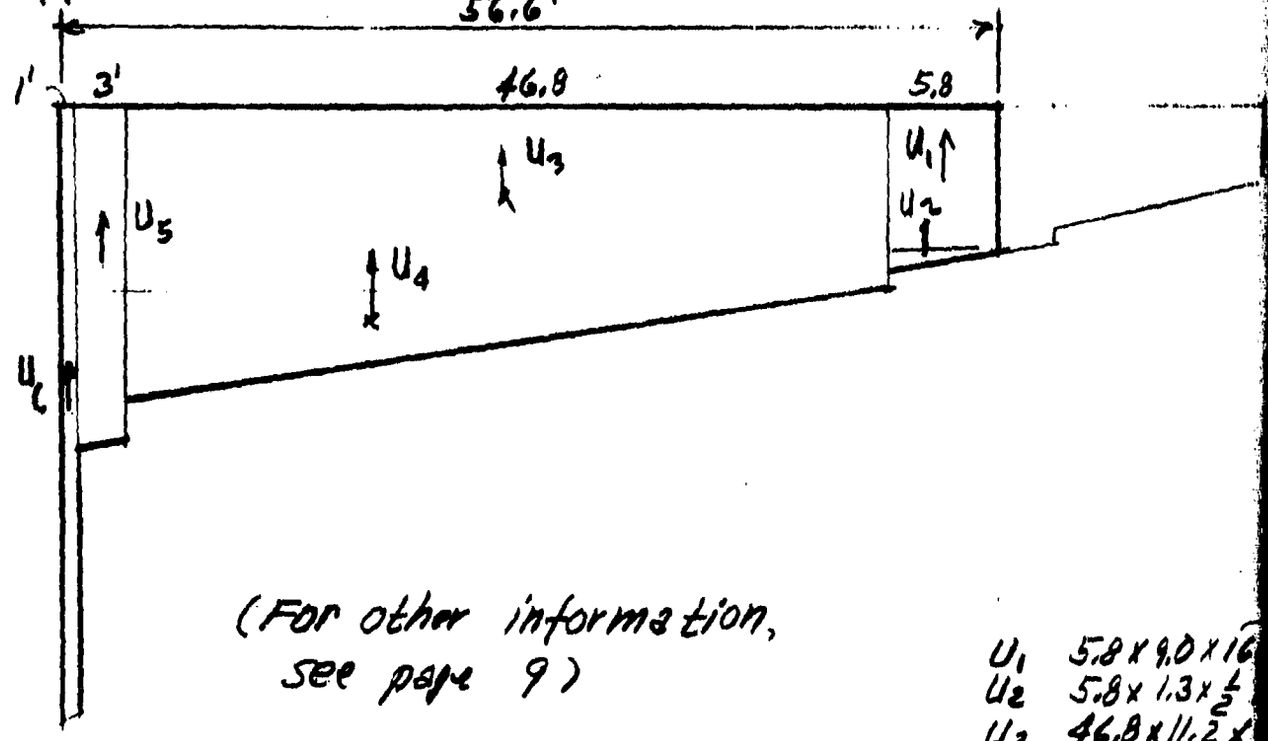
FLOOD DISCHARGE CONDITION

1951 FLOOD

Purpose: Determination of uplift using weighted creep theory for comparision with flow net method.

Ref.: "DESIGN OF SMALL DAMS"

L=(6+1



(For other information, see page 9)

U_1 5.8 x 9.0 x 16
U_2 5.8 x 1.3 x $\frac{1}{2}$
U_3 46.8 x 11.2 x
U_4 46.8 x 7.1 x $\frac{1}{2}$
U_5 3.0 x 21.3 x
U_6 4.0 x 1.0 x

$L = (6 + 17.5 + 2)2 + \frac{80.75}{3} = 77.9'$ $H = 731 - 695.5 = 35.5'$

$r = \frac{L}{H} = 2.1943$ $\boxed{U = \frac{L - x}{r} + 4.8}$

Point	Hor. Dist D (Ft)	$\frac{D}{3}$	Vert. Dist. (Ft)	Creep, x	UPLIFT (H. of H_2O)
a					40.4
b	1.0	0.3	23.5	23.8	29.5
c	–	–	17.5	41.3	21.5
d	3.0	1.0		42.3	21.0
e	–	–	6.0	48.3	18.3
f	46.75	15.6		63.9	11.2
g	–	–	2.0	65.9	10.3
h	10.0	3.3		69.2	8.8
j	–	–	2.0	71.2	7.9
k	20.0	6.7		4.8	4.8

$5.8 \times 9.0 \times 16 \times .0625$ = 52
$5.8 \times 1.3 \times \frac{1}{2} \times 1.0$ = 4
$46.8 \times 11.2 \times 1.0$ = 524
$46.8 \times 7.1 \times \frac{1}{2} \times 1.0$ = 166
$3.0 \times 21.3 \times 1.0$ = 64
$40 \times 1.0 \times 1.0$ = 40

$\Sigma U =$ 950 Creep theory
1208 Flow net Method

∴ USE FLOW NET

LOCK AND DAM No. 1
STABILITY OF DAM

2

V

FLOOD DISCHARGE

1951 FLOOD - EXISTING CONDITION

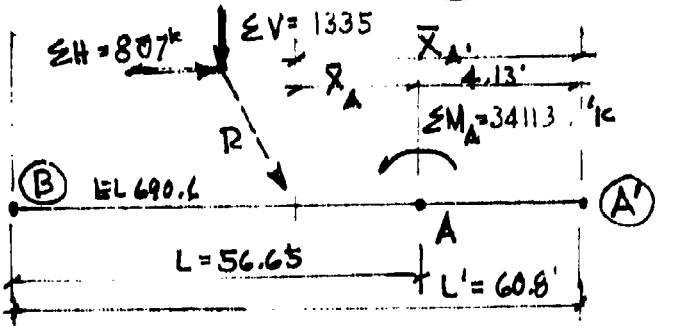
Concr
Resur

Assumptions:

1. Max. flood el. 731.'
   T.W. el. 695.5 (Lower pool el. 709)
2. Water inside Dam same level as relief hole outlets (697.4 ±)
3. Uplift by flow net method.

F1
F2
W1
W2
W3
U1
U2
U3
U4
U5
H1
H2
H3
HS15
WS15

BEARING PRESSURES @ POINTS "A'" AN "B"



$$\bar{X}_{A'} = \frac{34113}{1335} + 4.13 = 29.68 \text{ ft} \qquad e = 30.4 - \bar{X} = 0.72'$$

$$f_{A'} = \frac{1335}{972.8}\left(1 + \frac{6 \times 0.72}{60.8}\right) = 1.47 \text{ KSF}$$

$$f_{B} = 1.37(1 - .071) = 1.27 \text{ KSF}$$

Subm

A'

R. N. M. 12-10-74 JI 3/26/75 128

690.6

Concrete D.L.		1177		34301	From nori
Resurfacing		79		778	condition
F_1		244		7076	Existing
F_2		294		8526	sand fill
W_1		326		14507	Water up
W_2		52		2886	stream.
W_3		247		10053	
U_1			474	7252	Uplift.
U_2			99	2020	
U_3			550	23705	
U_4			45	2129	
U_5			40	2244	
H_1	+528			5720	Lateral
H_2	+254			4140	hydrostati
H_3	−12			19	
HS15	+37			185	Sediment
WS15		29		1556	
Submerged conc. below elev. 690.6		95		1803	
	807	2543 1208		47395 E150E	
		1335 ↓		34113	

29.68 ft

A'

A' = 1.41 ksf

B 1.27 ksf

1

2

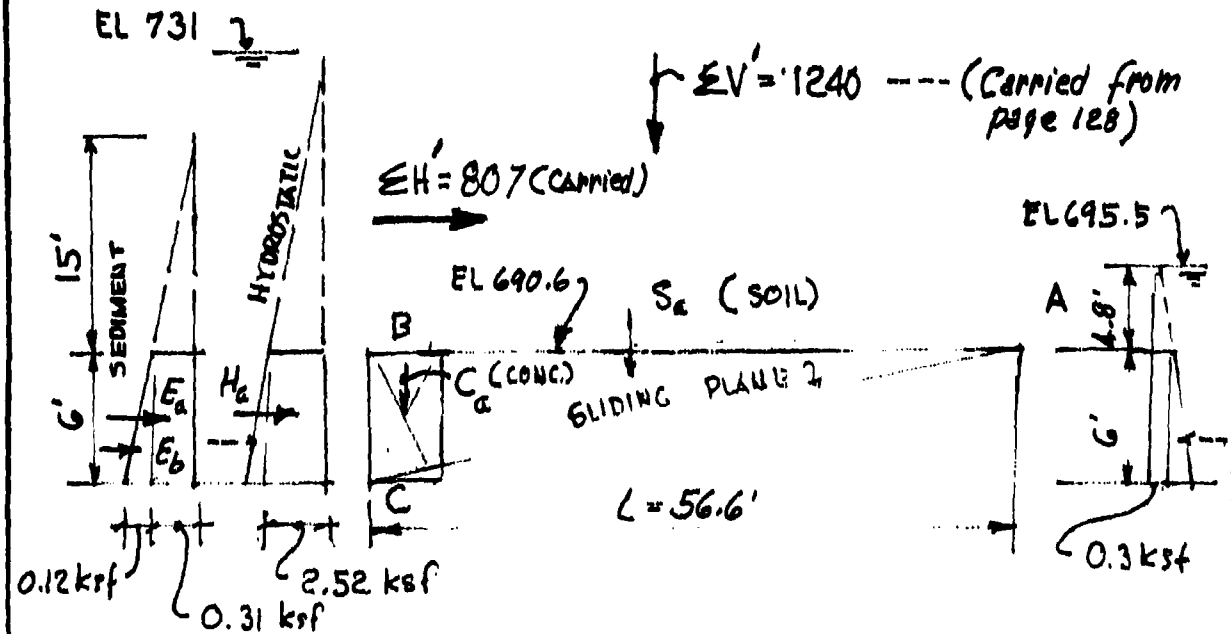
LOCK AND DAM No.1
STABILITY OF DAM

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILITY OF BUTTRESS DAM COMPUTED R.N.M. CHECKED	PROJECT L & D # 1 FILE NO. 800 A DATE 4/'75 PAGE 129 OF PAGES

1951 FLOOD - EXISTING CONDITION

SLIDING SAFETY FACTOR AT PLANE AC

ADDITIONAL FORCES BELOW EL. 690.6 :



$\Sigma H' = 807$

$H_a = (2.52-0.3)(16\times6) = +211$

$E_a = 0.31\times6\times16 = +30$

$E_b = 0.12\times6\times16\times\frac{1}{2} = +6$

$\Sigma H = 1054^{K} \rightarrow$

$\Sigma V' = 1240^{K}$

S_a ---------- 172

C_a ---------- 34

$\Sigma V = 1446^{K}$

SEE CONTINUATION ON PAGE 129 a

(NEXT SHEET IS P. 129 a)

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILITY OF BUTTRESS DAM COMPUTED P.N.M. CHECKED JJ	PROJECT LOCK & DAM NO 1 FILE NO. 800 A DATE 4/'75 PAGE 129a OF ____ PAGES

BUTTRESS DAM
1951 FLOOD — EXISTING CONDITION

DETERMINATION OF FACTOR OF SAFETY AGAINST SLIDING, (S.S.F.)

$$\boxed{(\Sigma H_N + \Sigma V_N)\frac{.649}{SSF.} = \Sigma H_T - \Sigma V_T}$$

$\Sigma H' = 1054$ $\Sigma H = 1054 - 228 = 826^K$ $\Sigma V = 1446^K$

$\Sigma H_N = 826 \sin 6.05^\circ = 87$
$\Sigma V_N = 1446 \cos 6.05^\circ = 1438$ } 1525

$\Sigma H_T = 826 \cos 6.05^\circ = 821$
$-\Sigma V_T = 1446 \sin 6.05 = -152$ } 669

$$SSF = \frac{1524 \times .649}{66} = \underline{1.48}, < 1.5$$

CHECK:

$$R = \sqrt{826^2 + 1446^2} = 1665$$

$$\theta = \tan^{-1}\frac{826}{1446} = 29.74^\circ$$
$$\alpha = -6.05^\circ$$
$$w = 23.69^\circ$$

$$\frac{R_T}{R_N} = \frac{R \sin w}{R \cos w} = \frac{669^K}{1525^K} = .439$$

$$SSF = 1.48$$

PREVIOUS SHEET IS P. 129

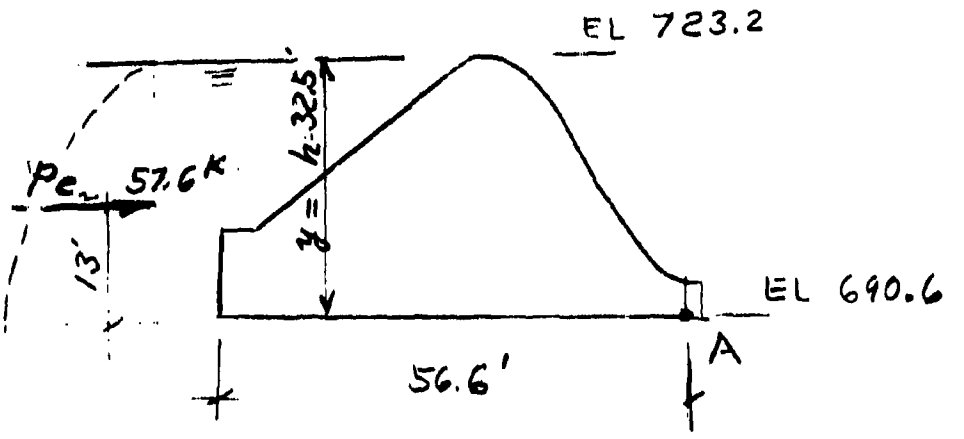
EARTHQUAKE CONDITION

(NORMAL CONDITION WITH EARTHQUAKE)

ASSUMPTIONS:

EARTHQUAKE INERTIA AND HYDRODYNAMIC FORCES ADDED TO AND ICE PRESSURE REMOVED FROM NORMAL OPERATING CONDITION.

ACCELERATION IN UPSTREAM DIRECTION.



Normal c

Less Ice pr

P_{e_2} Hydro d

Inertia

1	59 x
2	75 x
3	67 x
4	9 x
5	221 x
6	58 x
7	28 x
8	54 x
9	337 x
10	96 x
11	3 x
12	0.3
13	0.2
14	56
15	4
16	6 x
17	3 x

R. N. M. 8/74 JI 3/26/75 130 197

690.6

Normal condition - --		+725.	1631	36082
Less Ice pressure		-160.		5200 41282
P_{e_2} Hydrodynamic 3.6x1L		+ 57.6	13.0	749
Inertia forces:				
1	59 x 0.1	+5.8	11.5	68
2	75 x 0.1	+ 7.5	18.3	137
3	67 x 0.1	+ 6.9	26.0	179
4	9 x 0.1	+ 0.9	31.0	28
5	221 x 0.1	+ 22.1	25.0	553
6	58 x 0.1	+ 5.8	14.2	82
7	28 x 0.1	+ 2.8	6.0	17
8	54 x 0.1	+ 5.4	2.0	108
9	337 x 0.1	+ 33.7	1.5	51
10	96 x 0.1	+ 9.6	5.0	48
11	3 x 0.1	+ 0.3	10.0	3
12	0.3 x 0.1	—	—	
13	0.25 x 0.1	—	—	
14	56 x 0.1	+ 5.6	4.0	22
15	4 x 0.1	0.4	4.5	2
16	6 x 0.1	0.6	5.0	3
17	3 x 0.1	0.3	10.0	3
		197.1		2.53

LOCK & DAM #1
STABILITY OF DAM

EARTHQUAKE CONDITION (CONT'D)

Corps of Engineers' Formula

(Pg 5, "SMALL DAM DESIGN")

$$P_{e_2} = \frac{2}{3} C_e \alpha y \sqrt{hy}$$

$$C_e = \frac{51}{\sqrt{1 - 0.72\left(\frac{h}{1000\, t_e}\right)^2}} = 51$$

t_e = Earthquake vibration pd. = 1 sec.

h = total height of dam = 32.5'

y = depth of water = y

$$P_{e_2} = \frac{2}{3} \times 51. \times 0.1 \times 32.5 \sqrt{32.5} = \underline{3.6^{k}/ft.}$$

R.N.M. 8/74 J1 3/26/75 131

15

690.6

18	3 x 0.1	+ 0.3	10.0	3	
19	7 x 0.1	+ 0.7	5.7	4	
20	5 x 0.1	+ 0.5	7.5	4	
21	2 x 0.1	+ 0.2	7.5	2	
22	52 x 0.1	+ 5.2	8.5	44	
23	3 x 0.1	+ 0.3	18.0	5	
-24	0.3 x 0.1	—	—		
25	3 x 0.1	+ 0.3	18.0	5	
-5a	77 x 0.1	- 7.7	25.0		193
-5b	42 x 0.1	- 4.2	23.5		99
-5c	29 x 0.1	- 2.9	22.0		64
-10a	4 x 0.1	- 0.4	9.4		4
26	3 x 0.1	+ 0.3	18.0	5	
27	12 x 0.1	+ 1.2	13.5	16	
28	5 x 0.1	+ 0.5	13.5	7	
29	42 x 0.1	+ 4.2	15.0	63	
30	9 x 0.1	+ 0.9	21.3	19	
31	7 x 0.1	+ 0.7	22.7	16	
32	11 x 0.1	+ 1.1	21.0	23	
33	4 x 0.1	- 0.4	22.0		9 369
34	14 x 0.1	+ 1.4	9.2	13	
35	19 x 0.1	+ 1.9	16.2	31	
36	19 x 0.1	+ 1.9	24.0	46	
37	4 x 0.1	+ 0.4	28.0	11	
38	11 x 0.1	+ 1.1	25.0	28	
39	4 x 0.1	+ 0.4 41	20.4	8 25	

/ft.

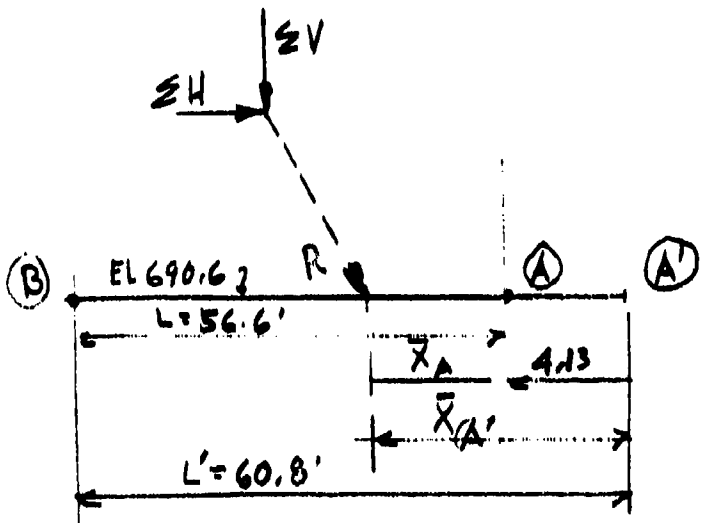
LOCK & DAM #1
STABILITY OF DA

2

1

NORMAL OPERATING CONDITION

WITH EARTH QUAKE (CONT'D)



BEARING PRESSURES:

$\Sigma V = 1726^{k}$ $\Sigma M_A = 4044^{'k}$

$$\bar{X}_{A'} = \frac{4044}{1726} + 4.13 = 27.57'$$

$$f_{(A')} = \frac{1726}{972.8}\left(1 + \frac{6 \times 2.87}{60.8}\right) = 2.27$$

$$f_{(B)} = 1.77\,(1 - C.28) = 1.28$$

40 } 20
41 }

42 3
43 1
44 1
45 1

F 53

WS$_{15}$ 28

Subh

(A')

R N M 8/74 JJ 3/26/75 132
690.6

40 } 41 }	20 x 0.1	+2.0	14.0	28
42	38 x 0.1	+ 3.8	14.7	56
43	13 x 0.1	+ 1.3	6.0	8
44	18 x 0.1	+ 1.8	25.6	46
45	10 x 0.1	+ 1.0 / 1.9	31.2	31 / 169
F	535 x 0.1	+ 53.5	6.5	348
WS_{15}	28 x .1	+2.8	12.4	35

Submerged concrete below el. 690.6 95 1803

804 1726 2958. 43454 40496

(A') + 4.13 = 27.59' e' = 2.81'

LOCK & DAM #1
STABILITY OF DAM

(A') = 2.27 ksf
(B) = 1.28 ksf

2

EARTHQUAKE CONDITION

Below G

Ha
Ea
Eb
Sa
Ca

Sliding Safety Factor @ Plane AC

$R = \sqrt{807^2 + 1837^2} = 2006^k$

$\tan^{-1}\theta \quad \tan^{-1}\frac{807}{1837} = 23.72°$

$\phi = 6.05°$

$17.67°$

$R_T = R \sin w = 609^k$

$R_N = R \cos w = 1911^k$

$\text{Sliding factor} = \frac{609}{1911} = .319$

$SSF = \frac{.649}{.319} = 2.03$

40 piles @ 4

$\frac{203^k \times .65}{1.5}$

200

RNM 174 JI 3/26/75 153

690.6 - 684.6

804 1631

Below el. 690.6 :

Ha
Ec
Eb
Sa
Ca

} 1231

} 206

} From normal condition

40 piles @ 4^{k} per pile -160^{k}

$\frac{203^{k} \times .5}{1.5}$ -68

Friction from Weight of Apron

807 lc

1837

LOCK AND DAM No. 1
STABILITY OF DAM

1

2

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILITY OF BUTTRESS DAM COMPUTED DRB CHECKED RM	PROJECT L&D #1 FILE NO. 800 A DATE 4/76 PAGE 134 OF ____ PAGES

FLOOD DISCHARGE

1951 FLOOD - IMPROVED CONDITION

MAX. FLOOD EL. 731. -
LOWER POOL EL 709. -
TAILWATER ELEVATION @ APRON 695.5'

$\Sigma M_A' = 34113$ (Pg. 128)

$\Sigma V' = 1335^k$ (PAGE 128)
17^k (ADDITIONAL FILL - PAGE 135)
$\Sigma V = 1352^k$ (ABOVE ELEVATION 690.6)
$\Sigma H = 807^k$ (" " ") (PAGE 128)

$M_{A\ FILL} = \frac{17}{2} \times \frac{28}{476}'^k$

$\Sigma M_A = 34113 + 476 = 34589'^k$

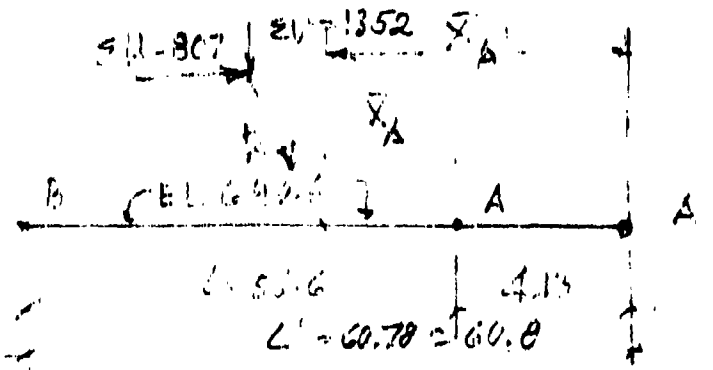
FOR BEARING PRESSURES, $L' = 60.8'$ (from A' to B)
$\bar{X}_{A'} = \bar{X}_A + 4.13'$, AREA = 972.8

$$\bar{X}_{A'} = \frac{34589'^k}{1352^k} + 4.13 = 29.71'$$

$$e_{A'} = 30.4 - 29.71 = 0.69 \text{ ft.}$$

$$f_{H'} = \frac{1352}{972.8}\left(1 + \frac{(6)(0.69)}{60.8}\right) = 1.48 \text{ KSF}$$

$$f_B = \frac{1352}{972.8}\left(1 - \frac{(6)(0.69)}{60.8}\right) = 1.30 \text{ KSF}$$



HARZA ENGINEERING COMPANY CHICAGO

SUBJECT STABILITY OF BUTTRESS DAM
COMPUTED R. N. M. CHECKED JJ

PROJECT LOCK & DAM No. 1
FILE No. 800 A
DATE 4/'75 PAGE 135 OF ____ PAGES

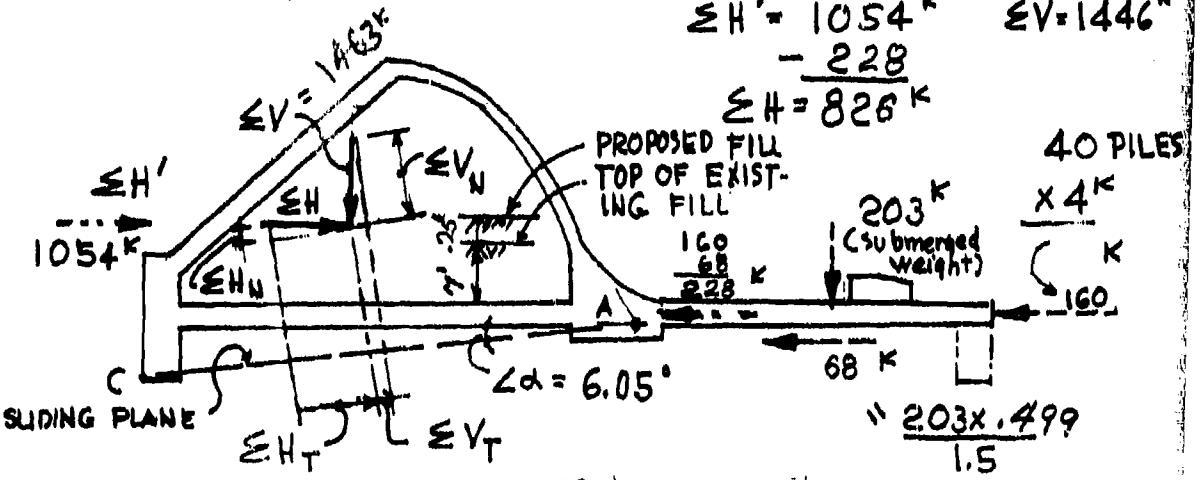
BUTTRESS DAM
1951 FLOOD - IMPROVED CONDITION

DETERMINATION OF REQUIRED HEIGHT OF ADDITIONAL SAND FILL FOR A FACTOR OF SAFETY AGAINST SLIDING OF 1.5 (For other assumptions see page 128)

$\Sigma H' = 1054^K$ $\Sigma V = 1446^K$

$- 228$

$\Sigma H = 826^K$



$$(\Sigma H_N + \Sigma V_N)\left(\frac{0.649}{1.5}\right) = \Sigma H_T - \Sigma V_T$$

$$(826 + 0.1053\Sigma V)(0.4326) = 821 - 0.1053\Sigma V$$

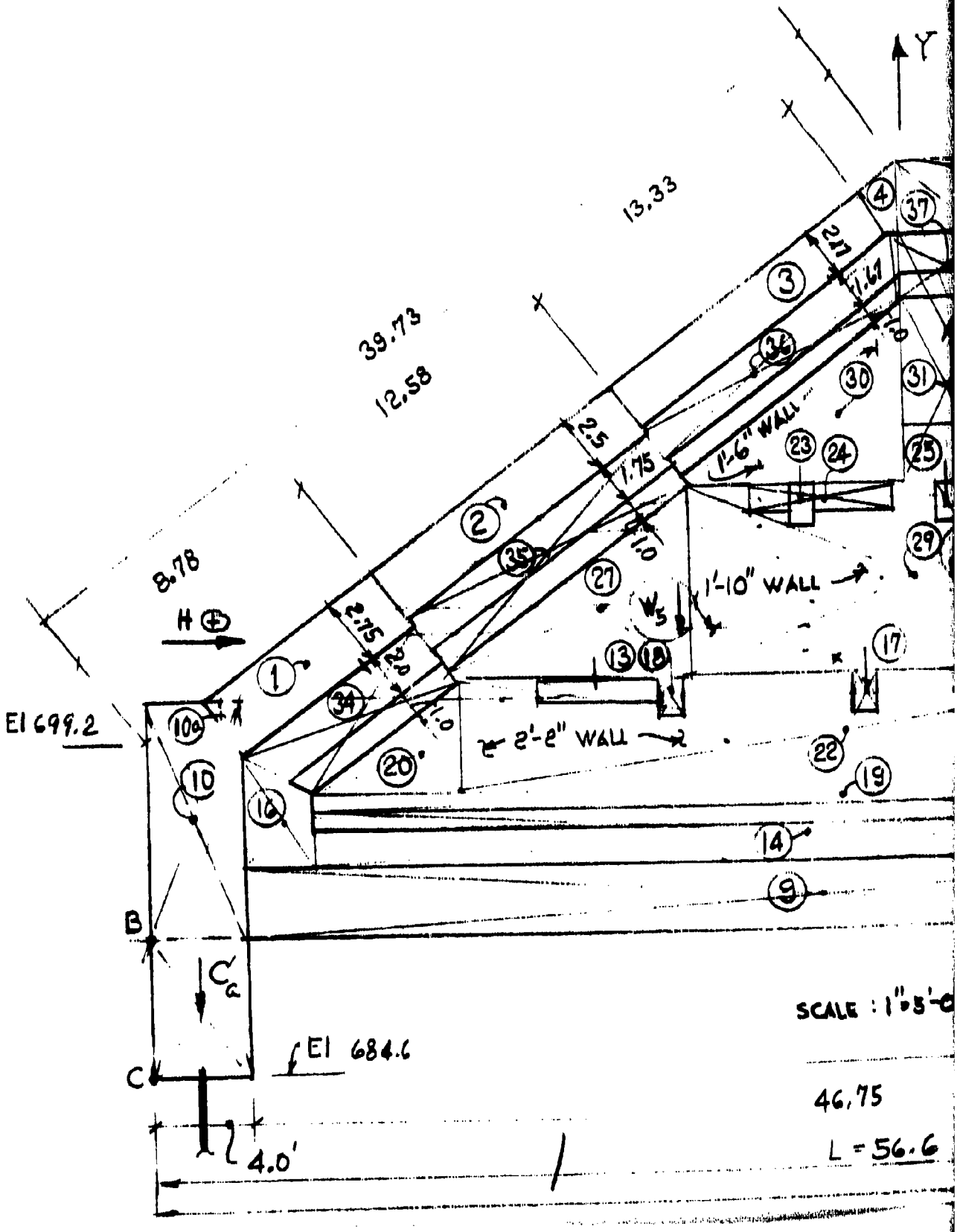
$$37.6 + 0.4302\Sigma V = 821 - 0.1053\Sigma V$$

$$0.535\Sigma V = 783.4$$

$$\therefore \Sigma V = 1463^K$$

ΣV FOR EXISTING CONDITION $= 1446^K$

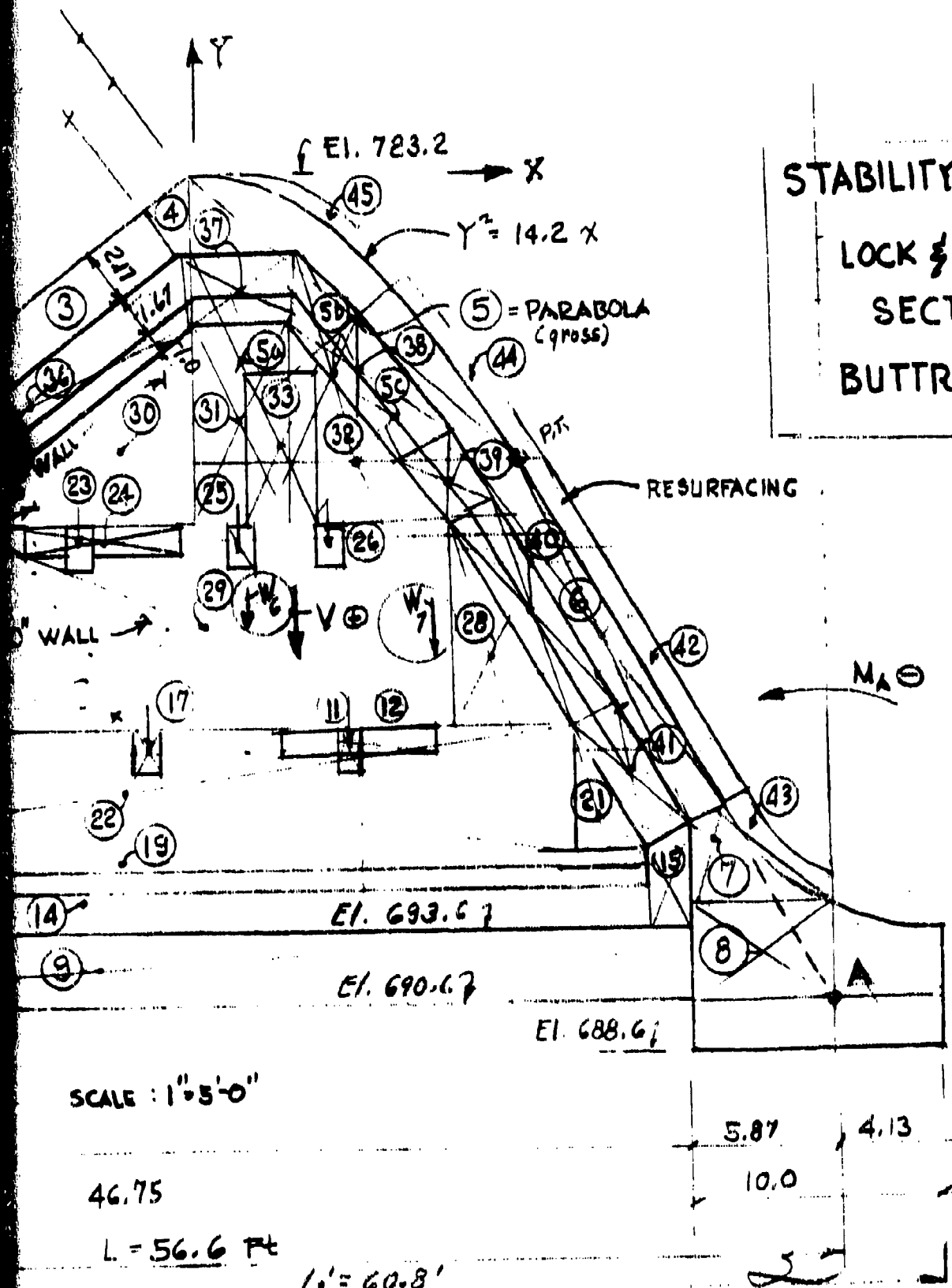
REQUIRED WEIGHT OF ADDITIONAL FILL $= 17^K$
REQUIRED HEIGHT OF ADDITIONAL FILL $= 0.25'+$


Y
13.33
39.73
12.58
8.78
H
2.75
2.5
1.75
2.11
1.67
1'-6" WALL
1'-10" WALL
2'-2" WALL
W5
El 699.2
El 684.6
B
C
Ca
4.0'
SCALE : 1"=5'-0
46.75
L = 56.6

STABILITY ANALYSIS

LOCK & DAM No. 1

SECTION thru BUTTRESS DAM



HARZA ENGINEERING COMPANY CHICAGO | SUBJECT COFFERDAMS | COMPUTED R.N.M. CHECKED JJ | PROJECT LOCK & DAM No 1 | FILE NO 800 A | DATE 4/19/75 PAGE ___ OF ___ PAGES

UPSTREAM & DOWNSTREAM COFFERDAMS

UPSTREAM $H = 733 - 708 = 25$ FT

DOWNSTREAM $H = 705 - 674 = 31$ FT

STABILITY OF DOWNSTREAM COFFERDAM

1. OVERTURNING $w = 130$ PCF

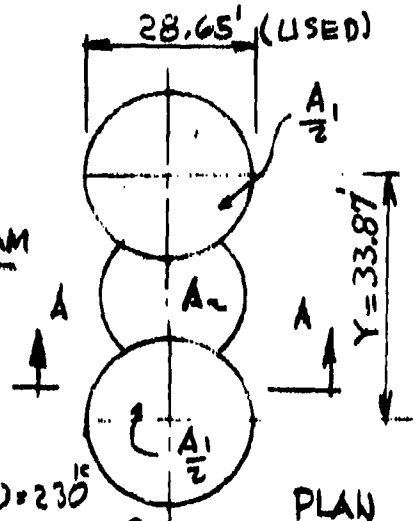
$\Sigma M_c = 0, \quad wh\,B\left(\frac{B}{6}\right) = M$

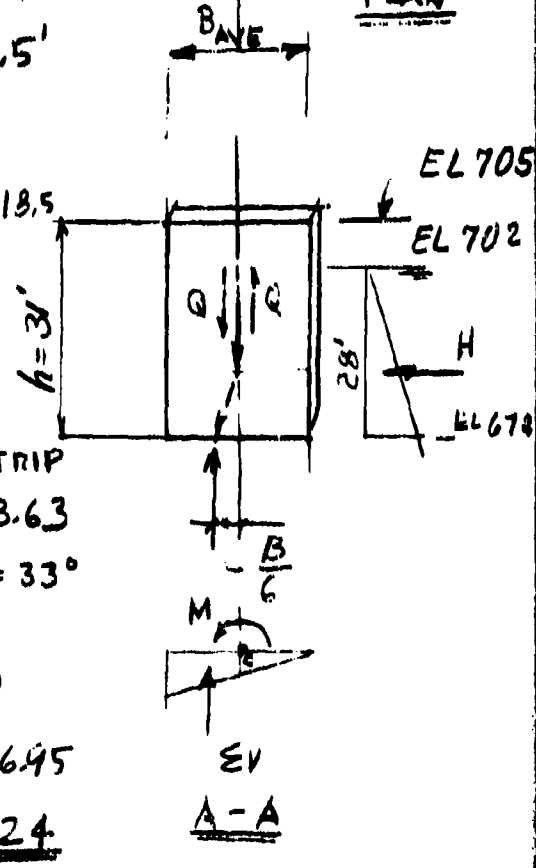
$B_{REQ'D} = \sqrt{\frac{6M}{wh}} \qquad M = \frac{28}{2} \times .062 \times 4.33 = 230^{1c}$

$= \sqrt{\frac{6 \times 230}{.13 \times 31}} = 18.5'$

B_{AVE} (USED) $= \frac{A_1 + A_2}{Y}$

$= \frac{646.9 + 210.4}{33.87} = 25.31' > 18.5$ O.K.





2. VERTICAL SHEAR @ ℄

Q = VERTICAL SHEAR PER FT STRIP

$= \frac{3}{2}\frac{M}{B} = \frac{1.5 \times 230}{25.31} = 13.63$ $\quad \phi = 33°$

R = SHEARING RESISTANCE

$= \frac{kwh^2}{2}(\tan\phi + .30 \times .9)$

$= \frac{.295 \times .13 \times 31^2}{2}(.92) = 16.95$

$F.S. = \frac{R}{Q} = \frac{16.95}{13.63} = \underline{1.24}$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT COFFERDAMS	PROJECT L & D #1
	COMPUTED R.N.M. CHECKED JI	FILE NO 800A
		DATE 4/14/75 PAGE ___ OF ___ PAGES

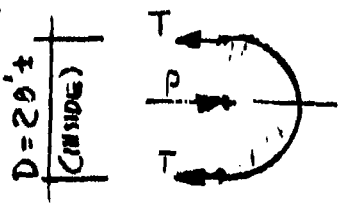
DOWNSTREAM COFFERDAM (CONT'D)

3. INTERLOCK TENSION

UNIT PRESSURE @ BOTTOM

$Kwh = .295 \times 0.13 \times 31 = 1.19\ KSF$

$P = Kwh(D) = 1.19 \times 28 = 33.32^{k}/FT$



$T = \frac{P}{2} = 16.66^{k}/\text{LIN. FT.}$

$= 1.4^{k}/\text{LIN. INCH} < 8^{k}$

RECOMMENDED DESIGN STRESS IN INTERLOCKS OF SECTION MP-101 = 8^{k}/LIN. INCH

UPSTREAM COFFERDAM WILL BE THE SAME AS DOWNSTREAM COFFERDAM

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT CONSTRUCTION ENCLOSURE	PROJECT LED #1
		FILE NO 900A
	COMPUTED M.T. CHECKED RNM	DATE 12-74 PAGE 1 OF 5 PAGES

CONSTRUCTION ENCLOSURE STRUCTURE

DL & LL 30PSF

ASSUME SPACING OF SUPPORTS 10'-0 ON CTRS

LOAD ON TRUSS $10 \times 30 = 300\#/FT$

$.30 \times 64 + .03 \times 64 = 19.20 + 1.92 = 21.12^k$

USE 44 LJ 12, ALLOWABLE LOAD 23.10^k

SPACING OF BMS 7'-4

LOAD ON BMS $7.33 \times .03 = .22^k/$

TOTAL LOAD /BM $.22 \times 10.0 = 2.2^k/BM$

USE M6x4.4, ALLOWABLE LOAD $3.8^k/BM$

USE 2x6 TIMBER @ 2'-0 CTRS FOR ROOF COVER

BEAM @ I-WALL

LOAD $\sim .35^k/FT$

TOTAL LOAD ON BM $.35 \times 29 = 10.2^k$

USE W 16 x 26

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT CONSTRUCTION SHELTER

COMPUTED M.J. CHECKED RNM

PROJECT L&D #1

FILE NO. 800A

DATE 12.5.74 PAGE 2 OF ____ PAGES

ESTIMATE OF MATERIALS FOR CONSTRUCTION SHELTER

ROOF TRUSSES (LJ JOISTS)

64.0 x 30 = 1.92 k/TRUSS

2 x 54 = 1.92 = 208 k

SECONDARY TRUSSES & BRIDGING = 116 k SEE NEXT SHT.

TRUSS STEEL TOTAL = 324.0 k

BEAMS 19 LINES x 532'LG CABT 7'CTRS

MG x 4.4	19 x 532 x .0044	= 45.0 k
WB x 17	4 x 532 x .0170	= 36.2
W16 x 26	29 x .026 x 54	= 40.8

TOTAL = 122.0 k

COLUMNS

	12 x 4 x .017 x 54	= 44.0 k
BASE PL'S	4 x 54 x .025	~= 6.0
		50.0 k

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT CONSTRUCTION SHELTER	PROJECT LED #1
		FILE NO. 800A
	COMPUTED M.J. CHECKED RNM	DATE 12/74 PAGE 3 OF ____ PAGES

ESTIMATE OF MATERIALS FOR CONSTRUCTION SHELTER

ROOF TRUSSES (CONT'D)

BRIDGING FOR TRUSSES

16.0'

8 LINES OF BRIDGING 532' LG

$8 \times 532 \times 2 \times 1.06 \times .005 = 45.2^{k}$

TRUSSES @ BOTTOM OF JOISTS, ~ 100' SPACING, 6 REQ'D

$6 \times 2 \times 640 \times .09$ (KIP/FT) $= 70.0^{k}$

BRIDGING AND SECONDARY TRUSSES TOTAL 116.0^{k}

BRACING FOR COL'S

$2 \times 18.8 \times .010 \times 54 \sim 21.0^{k}$ CENTER BAY

$4 \times 17 \times 25.5 \times .005 = 9.0$ AT 4 ROWS OF COL'S

BRACING TOTAL = 30.0^{k}

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT CONSTRUCTION SHELTER

COMPUTED M.J. CHECKED RNM

PROJECT LSO #1

FILE NO. 200A

DATE 12.74 PAGE 4 OF ____ PAGES

ESTIMATE OF STEEL FOR CONSTRUCTION SHELTER

ROOF TRUSSES	324^k	SAY	164 TON
BEAMS	172^k		86 "
BRACING L^s	100^k		50 "

TOTAL STEEL RFQ'D 300 TON

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT QTO — SHELTER COMPUTED R.N.M. CHECKED JI	PROJECT L & D #1 FILE NO 800 A DATE 4/18/75 PAGE 5 OF ____ PAGES

REHABILITATION OF BOTH LOCKS

LUMBER: 1X6 $160 \times 535 = 86{,}000$ BOARD FT

2X8 $160 \times 266 \times 1.33 = 57{,}000$ " "

TOTAL = 143,000 " "

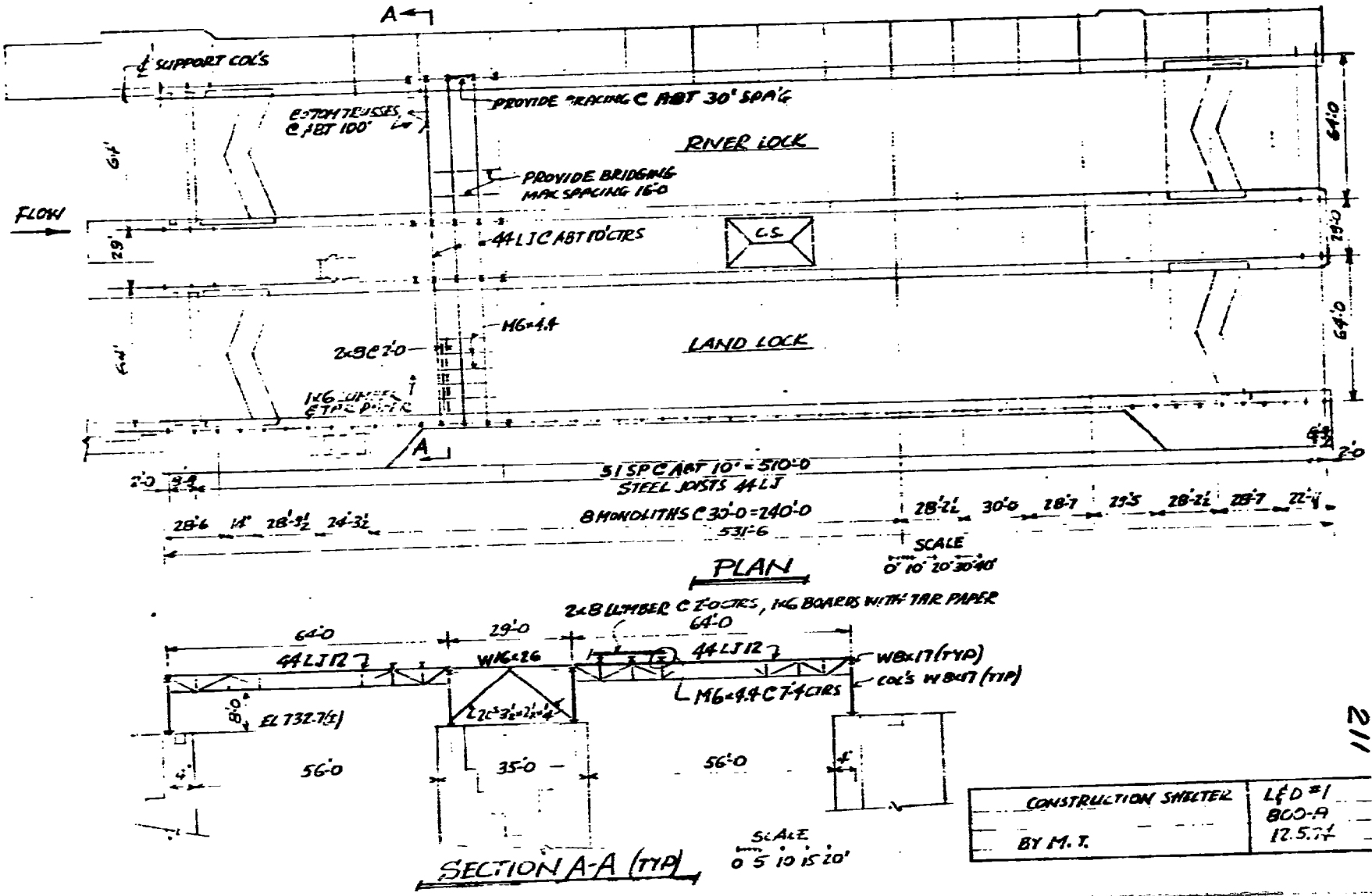
TAR PAPER: $(86{,}000)1.1 =$ 95,000 FT²

CANVASS:

12' HIGH ALL AROUND
$(157 + 532)2 \times 12$ _ _ _ = 17,000

LOCK OPENINGS $56(28+57)2 =$ 10,000

TOTAL 27,000 FT²



CONSTRUCTION SHELTER	L&D #1 800-A 12.5.74
BY M.T.	

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HARZA ENGINEERING COMPANY CHICAGO

SUBJECT QTO — SHELTER REHABILITATION OF LAND LOCK
COMPUTED R.N.M. CHECKED JJ

PROJECT L & DAM #1
FILE NO. 800A
DATE 4/10/75 PAGE 7 OF 9 PAGES

STEEL

① ROOF TRUSS (LJ BAR JOISTS)

1.92 K/TRUSS, 1 X 54 X 1.92 = 104 K

② BRIDGING

4 SETS/BAY,
× 53 BAYS
× 22' LONG/SET
× 5 #/FT
} ------ 23 K

③ SECONDARY TRUSSES @ BOTTOM OF JOISTS SPACED 100' (6 REQ'D / LOCK)

6 X 64 X .09 ---- ----- 35 K

④ M6 X 4.4 BEAMS (SPACED 7'-4")

$(\frac{64}{7.33}+1) \times 530 \times 4.4$ ------ 23 K

⑤ W8 X 17 COLUMNS

12 X 3 X .017 X 54 ------- 33 K

⑥ W16 X 26 29 X .026 X 54 ---- 41 K

⑦ W8 X 17 — 3 X 10 X 54 X 17 ---- 28 K
⑧ BASE PL 3 X 54 X .025 ------ 4 K
⑨ COL. BRACE, CENTER BAY — 2 X 18.5 X .010 X 54 = 21 K
⑩ 3 ROWS COL. — 3 X 17 X 25.5 X .005 = 7

TOTAL FOR STEEL = $\frac{319}{2}$ (1.14) = 180 TONS

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT QTO – SHELTER REHABILITATION OF LAND LOCK COMPUTED R.N.M. CHECKED JJ	PROJECT L&D #1 FILE NO 800A DATE 9/10/75 PAGE 8 OF 9 PAGES

LUMBER

1"x 6"	94 x 535	=	51,000
2"x 8"	94 x 266 x 1.33	=	34,000
	TOTAL	=	85,000 BOARD FEET

TAR PAPER

51,000 +(10%)51,000 = 56,000 FT²

CANVAS

12' HIGH ENCLOSURE

(93 + 532) 2 x 12 = 15,000

LOCK OPENING

56 x (28+57) = 4,760

19,760 Say

TOTAL FOR CANVAS = 20,000 FT²

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT QTO - SHELTOR PLAN 2 & PLAN 4

COMPUTED B.N.M. CHECKED JJ

PROJECT LOCK & DAM #1

FILE NO. 800 A

DATE 4/18/75 PAGE 9 OF 9 PAGES

SUMMARY

MATERIAL	REHABILITATION OF BOTH LOCKS	REHABILITATION OF LAND LOCK ONLY
STRUCTURAL STEEL, TONS	300	180
LUMBER, BF/1000	143	85
TAR PAPER SQ. FT.	95,000	56,000
CANVAS SQ. FT.	27,000	20,000

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT UPPER GUIDE WALL REMEDIAL PRESSURE GROUTING COMPUTED VT CHECKED JJ	PROJECT LOCK AND DAM No. 1 FILE No. 800A DATE APR 9 1975 PAGE 1 OF 1 PAGES

ASSUME THAT CRIBS IN MONOLITHS 9 - 13 NEED REMEDIAL GROUTING

LENGTH OF CRIBS $\Sigma L = 190$ FT
WIDTH OF CRIBS $= 18$ FT
HEIGHT OF ROCK FILL $= 11$ FT

ASSUME THAT HOLES WILL BE DRILLED AT 6 FT SPACING IN 3 RANS

$$n = \frac{190}{6} \times 3 = 95 \text{ holes}$$

DEPTH OF DRILL HOLE = 732.7 - 706.7 = 26 FT

TOTAL LENGTH OF DRILLING

$$\Sigma L = 95 \times 26 = 2470 \text{ LIN FT}$$

DEPTH OF GROUTING - 11 FT EACH HOLE

ASSUME THAT GROUT TAKE IS 2 CU-FT/LIN FT

TOTAL VOLUME OF GROUT

$$11 \times 2 \times 95 / 27 = 77 \cong 80 \text{ CY}$$

COST

		$
SET-UPS	96 × $50	= 4,800
DRILLING	2470 × $10	= 24,700
GROUTING	80 × $160	= 12,800
	TOTAL	$42,300

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT REMOVAL OF BACKFILL BEHIND LAND WALL	PROJECT LOCK AND DAM No. 1
	COMPUTED VT CHECKED JJ	FILE No. 600A
		DATE APR. 7 1938 PAGE ___ OF ___ PAGES

LENGTH FT	WIDTH FT	AREA FT²
90	30	2,700
325	50	16,250
100	40	4,000
		22,950

DEPTH = 10 FT

VOLUME $22{,}950 \times \frac{10}{27} = 8{,}500$

SAY 9000 CY

UNIT COST $ 3.00

COST $9000 \times 3 = \$27{,}000$

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT STABILIZING OF LAND WALL USING INCLINED ROCK ANCHORS
COMPUTED VT CHECKED JJ

PROJECT LOCK AND DAM No. 1
FILE NO. 900 A
DATE Apr. 7 1975 PAGE 1 OF ____ PAGES

ALT. 1 1 3/8" SINGLE ANCHORS

Use 1 3/8" single anchors - 3 per monolith
Total number of anchors = 48
Length of anchor = 90 ft
Diameter of bore hole = 3 in

SET-UP

48 holes @ $ 400.00 = $ 19,200

DRILLING

Total length = 48 × 90 = 4,320 lin ft
Unit cost of 3" bore = $ 10.00 per lin ft
Cost of drilling 4320 × 10.00 = $ 43,200

PLACE, GROUT AND TENSION ANCHOR BARS

Anchor Bars

1 3/8" bars : W = 5.05 lbs/ft
Total length = 48 × 90 = 4 3 2 0 lin ft
Total weight = 4320 × 5.05 = 21,800 lbs

Grout

D = 3" = 0.25 ft
Volume of one hole $V = \frac{\pi}{4} \times 0.25^2 \times 90 = 4.41$ cu ft
Total volume $2V_{tot} = 48 \times 4.41 = 211$ cu ft

Cost	4320 × $ 11.00	47,520
	TOTAL	109,920

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT STABILIZING OF LAND WALL USING INCLINED ROCK ANCHORS
COMPUTED VT CHECKED JJ

PROJECT LOCK AND DAM No. 1
FILE NO 900 A
DATE Apr. 7 1953 PAGE 2 OF ____ PAGES

ALT. 2 1¼" DOUBLE ANCHORS

Use 1¼" double anchors - 2 per monolith
Total number of anchors = 32
Length of anchor = 95 feet
Diameter of bore hole = 4 in

SET-UP

32 holes @ $ 400.00 = $ 12,800

DRILLING

Total length = 32 × 95 = 3,040 lin ft
Unit cost of 4" bore = $ 12.00 per lin ft
Cost of drilling 3040 × 12.00 = $ 36,480

PLACE, GROUT AND TENSION ANCHOR BARS

Anchor Bars

1¼" bars: w = 4.172 lbs/ft
Total length = 32 × 2 × 95 = 6080 lin ft
Total weight = 6080 × 4.172 = 25,400 lbs

Grout

D = 4" = 0.33 ft, L = 95 ft
Volume of one hole $V = \frac{\pi}{4} \cdot 0.33^2 \cdot 95 = 8.3$ cu ft
Total volume $\Sigma V_{net} = 32 \times 8.3 = 265$ cu ft

Cost 3040 × $ 15.00 $ 45,600

$ 94,880

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILIZING OF LAND WALL USING INCLINED ROCK ANCHORS	PROJECT LOCK AND DAM No. 1
	COMPUTED VT CHECKED JJ	FILE NO. 800 A
		DATE Apr. 7, 1970 PAGE 3 OF ____ PAGES

ALT. 3 1¼" TRIPLE ANCHORS

Use 1¼" triple anchors - 2 per monolith
Total number of anchors = 32
Length of anchor = 100 feet
Diameter of bore hole = 5 in

SET-UP

32 holes @ $ 400.00 = $ 12,800

DRILLING

Total length = 32 × 100 = 3,200 lin ft
Unit cost of 5" bore = $ 16.00 per lin ft
Cost of drilling 3200 × 16.00 = $ 51,200

PLACE, GROUT AND TENSION ANCHOR BARS

Anchor Bars

1¼" bars, w = 4.172 lbs/ft
Total length = 32 × 3 × 100 = 9600 lin ft
Total weight = 9600 × 4.172 = 40,050 lbs

Grout

D = 5" = 0.417 ft ; L = 100 ft
Volume of one hole $V = \frac{\pi}{4} \cdot 0.417^2 \cdot 100 = 13.66$ cu-ft
Total volume $\Sigma V_{hole} = 32 \times 13.66 = 437$ cu-ft

Cost 3200 × 20.00 $ 64,000

$ 125,000

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT INTERMEDIATE WALL SHEAR KEYS, LOWER GATE MONO'S. COMPUTED JJ CHECKED VT	PROJECT LOCK AND DAM No1 FILE NO. 800A DATE 4/75 PAGE ___ OF ___ PAGES

VERTICAL KEYS (2.0'Φ)

SET-UP $4 \times \$250.- = 1,000$

DRILLING $L = 4 \times 10.0' = 160.0'$

$160.0' \times \$140.- = 22,400$

CONCRETE $V = \frac{3.14 \times 2.0^2}{4} \times 150.0' \times \frac{1}{27} = 19 \text{ c.y.}$

$19.0 \text{ c.y.} \times \$120.- = 2,280$

25,680

HORIZONTAL KEYS (2.0'Φ) n = 8

SET-UP AND DRILLING

$8 \times \$1,200.- = 9,600$

CONCRETE $V = \frac{3.14 \times 2.0^2}{4} \times 6.0 \times 8 \times \frac{1}{27} = 6 \text{ c.y.}$

$6 \text{ c.y.} \times \$120.- = 720$

10,320

TOTAL 25,680 + 10,320 = $36,000

HANZA ENGINEERING COMPANY CHICAGO	SUBJECT BACKFILL TO STABILIZE DOWNSTREAM MONOLITHS OF RIVER WALL COMPUTED VT CHECKED JJ	PROJECT LOCK AND DAM No. 1 FILE NO 800 A DATE APR. 9 1975 PAGE 1 OF ____ PAGES

FOR COMPUTATION PURPOSES ASSUME 3 DIFFERENT GROUND ELEVATIONS

ELEVATION	DISTANCE FT
700	80
690	40
680	30

EXCAVATION

ASSUME A DEPTH OF 3 FEET

AREA 80 × 160

$V = 80 \cdot 160 \cdot 3 \cdot \frac{1}{27} = 1420$ CY SAY 1500 CY

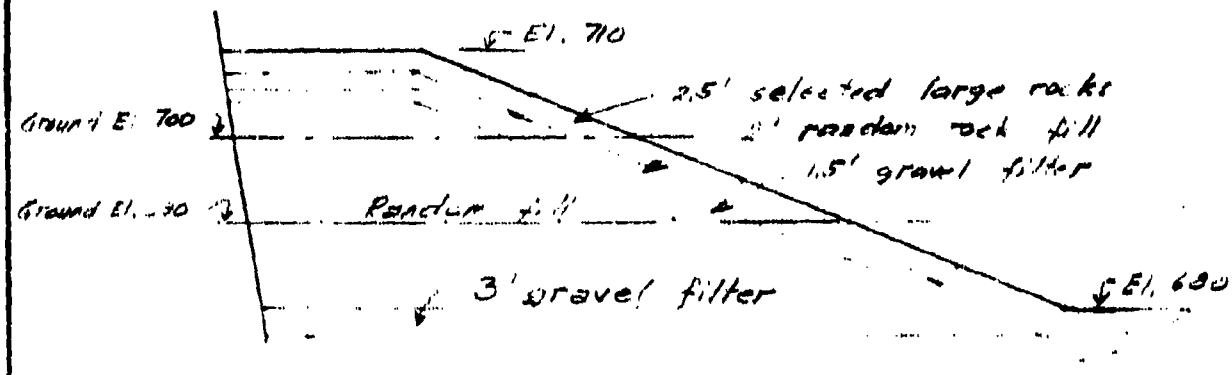
IMPERVIOUS BLANKET

MIN [illegible] FEET

[illegible] (= ESTIMATE)

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT BACKFILL TO STABILIZE DOWNSTREAM MONOLITHS OF RIVER WALL	PROJECT LOCK AND DAM No. 1
	COMPUTED VT CHECKED JJ	FILE NO 800 A
		DATE APR. 8, 1975 PAGE 2 OF ____ PAGES

CROSS-SECTION : GROUND ELEV. 680



SCALE 0 10 20 FEET

Excavation	105 × 3 =	315 ft²
Impervious blanket	85 × 3 =	255 ft²
Random fill	50 × 24 =	1200 ft²
Gravel filter	108 × 15 =	162 ft²
[illegible]	110 × 2 =	220 ft²
Selected large rocks	115 × 2.5 =	287 ft²

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT BACKFILL TO STABILIZE DOWNSTREAM MONOLITHS OF RIVER WALL

COMPUTED VT CHECKED JL

PROJECT LOCK AND DAM NO. 1

FILE NO. 800 A

DATE APR. 8 1957 PAGE 3 OF ____ PAGES

GROUND ELEV. 690

Excavation	80 × 3 =	240 ft²
Impervious blanket	60 × 3 =	180 ft²
Random fill	38 × 14 =	532 ft²
Gravel filter	78 × 1.5 =	117 ft²
Random rock fill	83 × 2 =	166 ft²
Selected large rocks	90 × 2.5 =	225 ft²

GROUND ELEV. 700

Excavation	60 × 3 =	180
Impervious blanket	40 × 3 =	120
Random fill	26 × 4 =	104
Gravel filter	52 × 1.5 =	78
Random rock fill	57 × 2 =	114
Selected large rocks	62 × 2.5 =	155

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT BACKFILL TO STABILIZE DOWN-STREAM MONOLITHS OF RIVER WALL COMPUTED VT CHECKED JJ	PROJECT LOCK AND DAM NO. 1 FILE NO. 800A DATE APR. 8, 1975 PAGE 9 OF ____ PAGES

EXCAVATION

$315 \times 30 = 9450$ ft³
$240 \times 40 = 9600$
$180 \times 80 = 14400$

33450 ft³ = 1238 cy

USE $1.15 \times 1238 = 1424$ cy → 1500 cy

GRAVEL FILTER

$255 \times 30 = 7650$ ft³
$180 \times 40 = 7200$
$120 \times 80 = 9600$

24,450 ft³

USE $24450 \times 1.15 \times \frac{1}{27} = 1041$ cy → 1100 cy

RANDOM FILL

$1200 \times 30 = 36,000$ ft³
$532 \times 40 = 21,280$
$104 \times 80 = 8,320$

65,600 ft³

USE $65600 \times 1.15 \times \frac{1}{27} = 2794$ cy → 3000 cy

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT BACKFILL TO STABILIZE DOWN-STREAM MONOLITHS OF RIVER WALL

COMPUTED VT CHECKED VT

PROJECT LOCK AND DAM 110.1

FILE NO. 800 A

DATE APR. 8 1955 PAGE 5 OF ____ PAGES

GRAVEL FILTER

162 × 20 = 4500 ft²
117 × 40 = 4650
79 × 80 = 6240

15780 ft²

USE 15,780 × 1.15 × 1/27 = 672 cy → 700 cy

RANDOM ROCK FILL

220 × 30 = 6600 ft²
166 × 40 = 6640
114 × 80 = 9120

22360 ft²

USE 22,360 × 45 × 1/27 = 953 cy → 1000 cy

SELECTED LARGE ROCK

28 × 30 = 8550 ft²
225 × 40 = 9000
127 × 80 = 12700

29250

USE 29,250 × 1.5 × 1/27 = 1625 cy → 1700 cy

HARZA ENGINEERING COMPANY CHICAGO

SUBJECT BACKFILL TO STABILIZE DOWN-STREAM MONOLITHS OF RIVER WALL

PROJECT LOCK AND DAM NO. 1

FILE NO. 800 A

COMPUTED VT CHECKED JJ

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COST ESTIMATE

ITEM	QUANTITY	UNIT PRICE	COST
Excavation	1500 c.y.	3.00	4,500
Gravel filter	1100	10.50	11,550
Random fill	3000	6.00	18,000
Gravel filter	700	10.50	7,350
Random rock fill	1000	16.00	16,000
Selected large rocks	1300	25.00	32,500
		TOTAL	$99,900