US[redacted] BOSTON DISTRICT

SOILS STUDIES

LEND LEASE WHARF SO. BOSTON, MASS.

UNCONFINED COMPR. TESTS
PILE LOADING TESTS
STABILITY ANALYSES

SOILS & GEOLOGY SECTION

COMPILED MARCH 1943

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WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Page

Subject WHARF So. BOSTON

Computation Classification of 2" Shelby Tube Samples.

Computed by W. C. Sayman **Checked by** **Date**

Boring	DD	Soft Silty Blue Clay	785
Sample No.	3		
Depth	50.0'-52.0'		
Date taken			
Boring	D 26	Medium Blue Clay	2790
Sample No.	4		2700
Depth	55.0'-56.7'		
Date taken			
Boring	D I	Silty fine Sand	1228
Sample No.	1		
Depth	19.5'-21.5'		
Date taken			
Boring	—	medium yellow Clay	3536
Sample No.	1		
Depth	16.0'-17.5'		
Date Taken	6/26/42		
Boring	D-I	Fine Sand	no test.
Sample No.	2		D31
Depth	—		
Date taken	6-25-42		
Boring	D-M	stiff yellow Clay	262.6
Sample No.	1		3119
Depth	— Elev.-11		
Date taken	6-26-42		

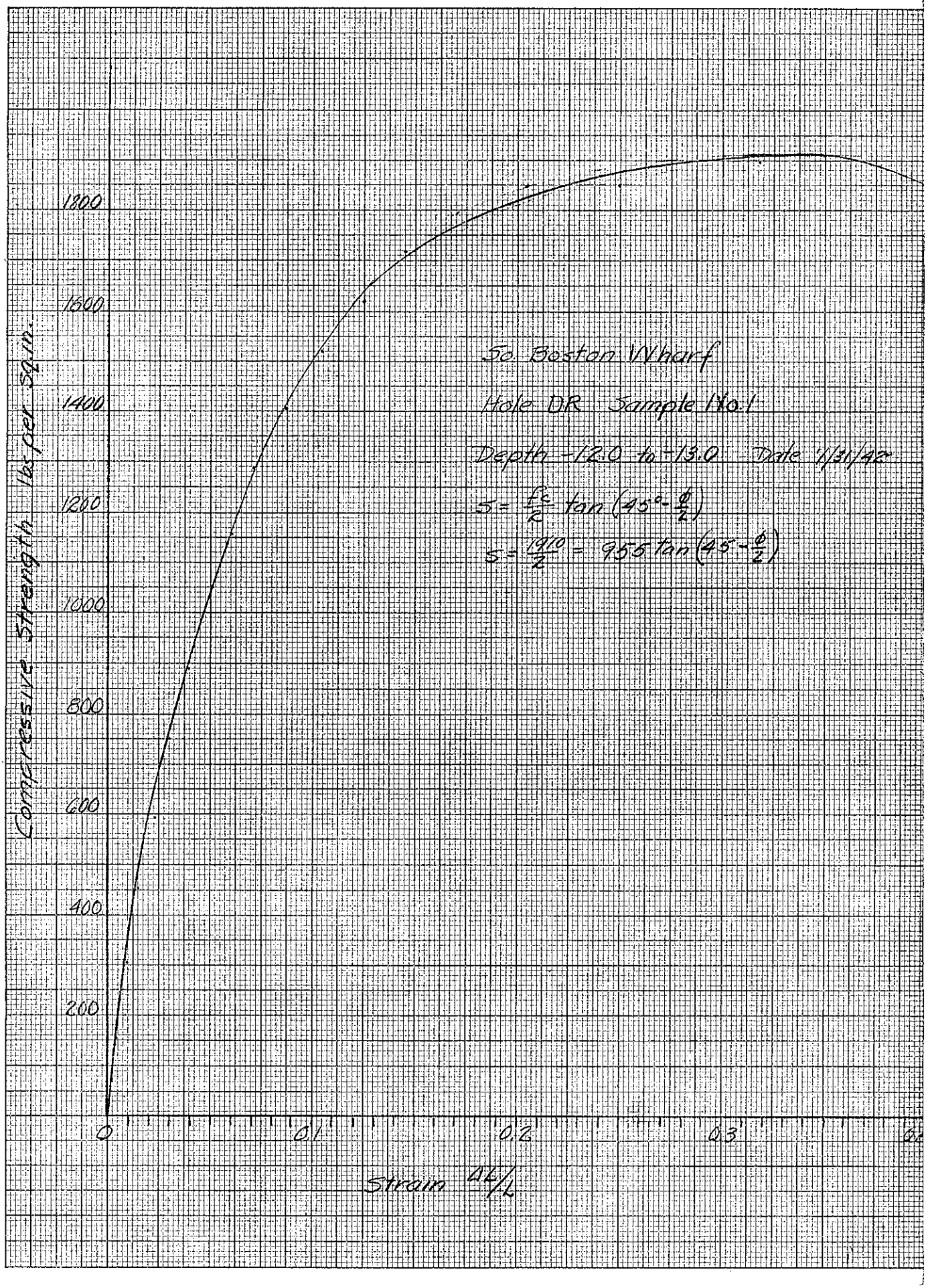
A_f = 8.75 cm² = 3.44 in²

7/31/42

D = T 4.12 cm
M 4.13 cm
B. 4.12 cm. ave D = 4.12 cm = 1.62 = 2.06

50. Boston Wharf Hole No. D-R Sample No 1 Depth -12.0'-13.0'

	Time Min.	Load	Dial	ΔL	ΔL/L	A	P/A Kg/sq.in	P/A Lbs/sq.ft.
	0	0	60	0				
	0.5	.5	66	.006	.002	2.06	.242	77.0
	1.0	1.0	73	.013	.004	2.065	.484	154.0
	1.5	1.5	81	.021	.006	2.07	.725	230.0
	2.0	2.0	90.5	.0305	.009	2.08	.961	306.0
	2.5	3.0	112	.052	.015	2.09	1.435	456.0
	3.0	4.0	138	.078	.023	2.11	1.895	591.0
	3.5	5.0	164	.104	.030	2.12	2.36	750.0
	4.0	6.0	195	.135	.039	2.14	2.80	890.0
	4.5	7.0	230	.170	.049	2.16	3.24	1030.0
	5.0	8.0	268	.208	.061	2.20	3.64	1159.0
	5.5	9.0	312	.252	.073	2.22	4.05	1289.0
	6.0	10.0	359	.299	.087	2.26	4.42	1407.0
	6.5	11.0	418	.358	.104	2.30	4.78	1520.0
S.P.	7.0	12.0	489	.429	.125	2.36	5.09	1620
	7.5	13.0	559	.499	.145	2.41	5.40	1718
	8.0	14.0	648	.588	.171	2.48	5.64	1793
	8.5	15.0	764	.704	.204	2.58	5.81	1848
	9.0	16.0	927	.867	.252	2.76	5.80	1848
	9.5	17.0	1058	.998	.290	2.90	5.86	1863
	10.0	18.0	1151	1.091	.318	3.02	5.96	1895
	10.5	19.0	1264	1.204	.350	3.17	6.00	1910 ←
	11.0	20.0	1450	1.390	.404	3.46	5.78	1840

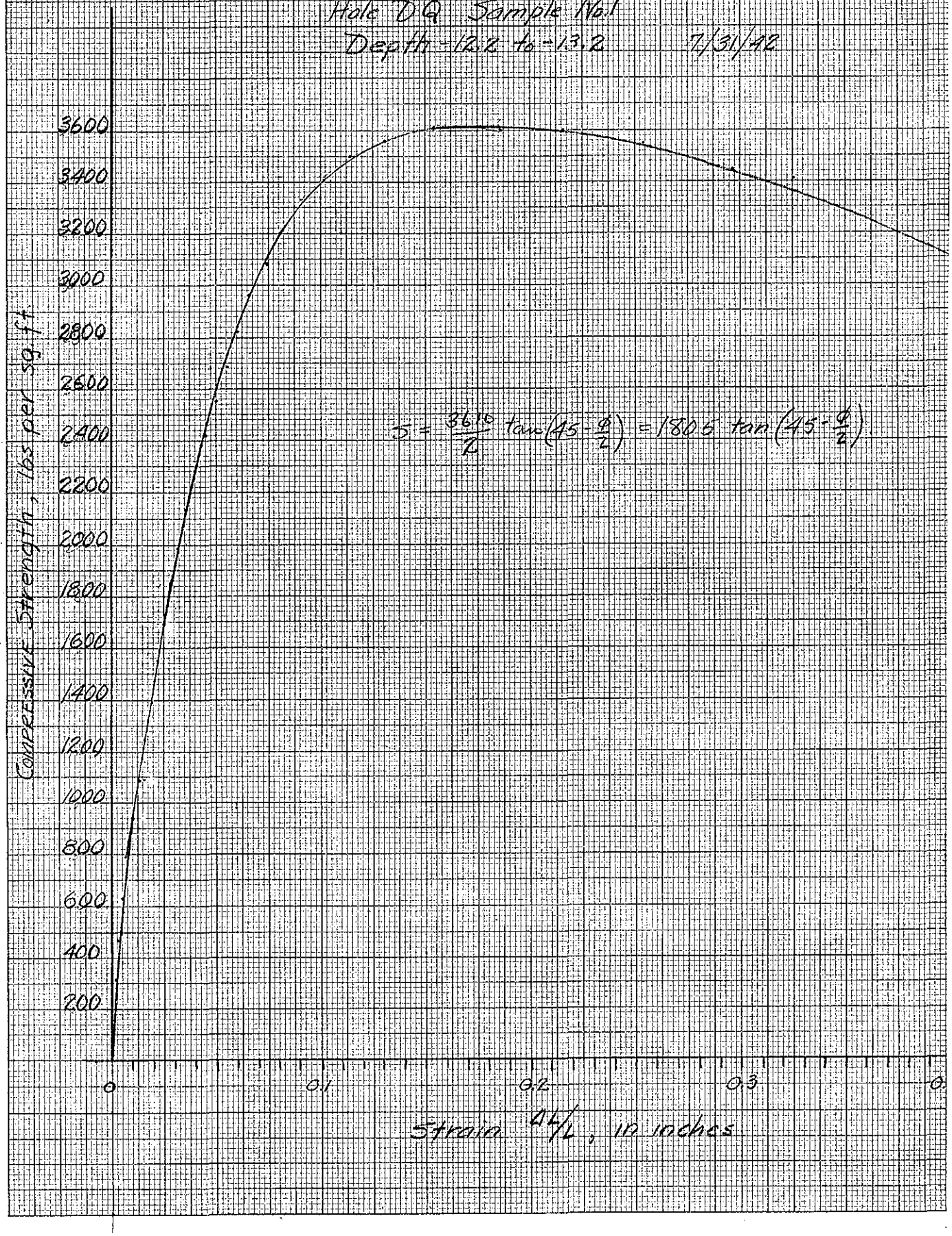


KEUFFEL & ESSER CO., N. Y. NO. 355-14G
Millimeters, 10th lines heavy.
MADE IN U.S.A.

So. Boston Wharf

Hole DQ Sample No. 1

Depth 12.2 to 13.2 7/31/42



KEUFFEL & ESSER CO., N. Y. NO. 359-146
Millimeters, 10th lines heavy.
MADE IN U. S. A.

Ht. 9.3 cm = 3.66 in.

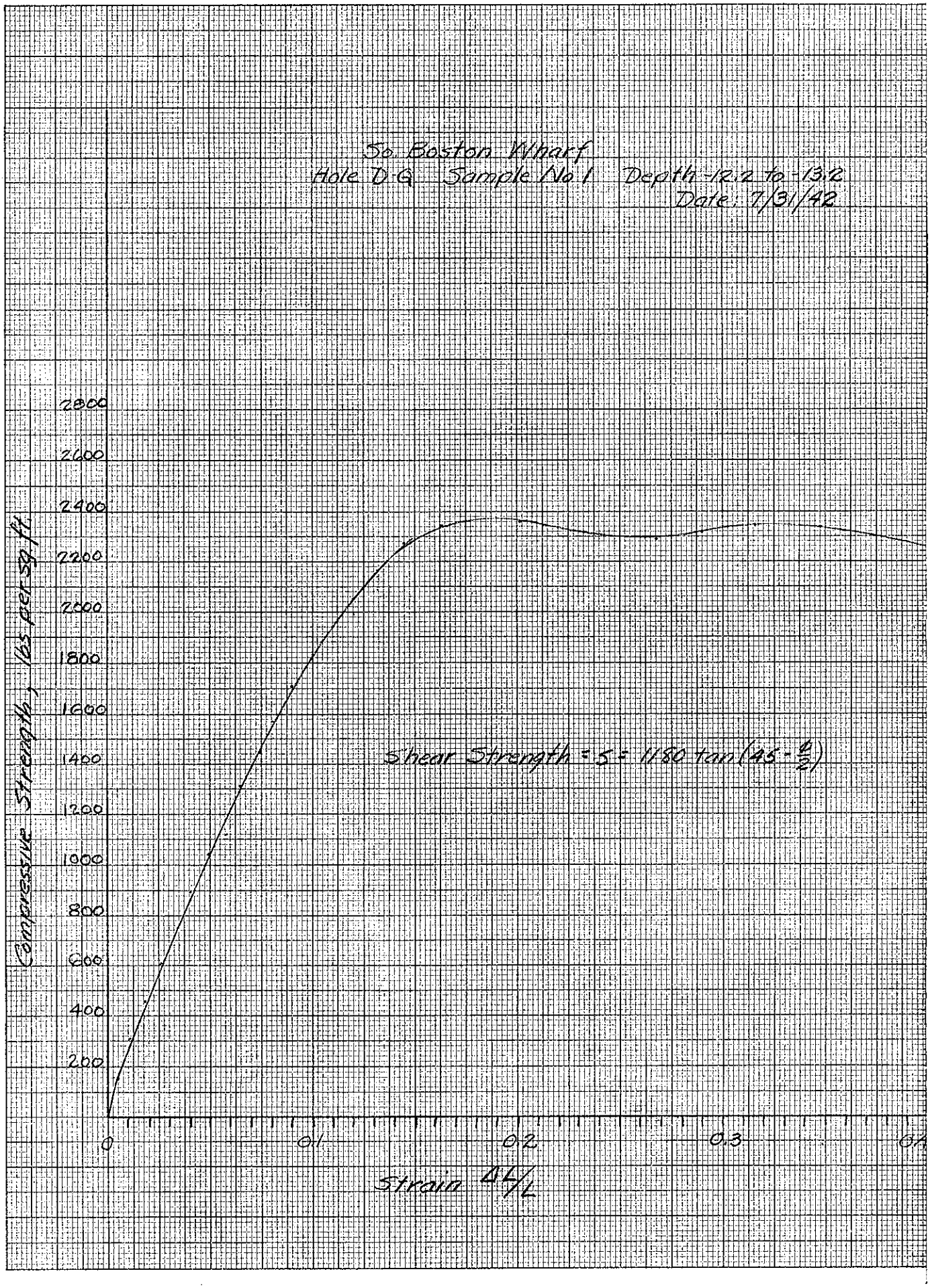
1A

7/31/42.

D-T 4.05
M 4.08
B 4.07 ave D = 4.07 cm = 1.60 in. A = 2.01

So. Boston Wharf. Hole DQ Sample No 1. Depth 12.2 to 13.2

	Time Min	Load	Dial	ΔL	ΔL/L	A	P/A Kg/cm²	P/A #/sq.ft.
	0	0	20	0				
	0.5	1.0	24	.004	.001	2.01	.498	158.3
	1.0	2.0	26	.006	.002	2.015	.994	316.0
	1.5	3.0	32	.012	.003	2.02	1.485	472.0
	2.0	4.0	38	.018	.005	2.02	1.980	630.
	2.5	5.0	47	.027	.007	2.02	2.48	790
	3.0	6.0	57	.037	.010	2.03	2.96	940
	3.5	7.0	68	.048	.013	2.04	3.44	1093
	4.0	8.0	77	.057	.016	2.04	3.92	1247
	4.5	9.0	88	.068	.019	2.05	4.39	1396
	5.0	10.0	99	.079	.022	2.06	4.88	1550.
	5.5	11.0	110	.090	.025	2.065	5.32	1692
	6.0	12.0	123	.103	.028	2.07	5.80	1843
	6.5	13.0	136	.116	.032	2.08	6.25	1988
	7.0	14.0	151	.131	.036	2.085	6.70	2130
	7.5	15.0	166	.146	.040	2.09	7.18	2280
	8.0	16.0	184	.164	.045	2.10	7.61	2420
	8.5	17.0	202	.182	.050	2.12	8.02	2550
	9.0	18.0	221	.201	.055	2.13	8.45	2685
	9.5	19.0	240	.220	.060	2.14	8.88	2820
	10.0	20.0	261	.241	.066	2.15	9.31	2960
	10.5	21.0	289	.269	.074	2.17	9.68	3080
Crack	11.0	22.0	318	.298	.081	2.185	10.07	3200
	11.5	23.0	352	.332	.091	2.21	10.40	3305
	12.0	24.0	392	.372	.102	2.24	10.71	3405
	12.5	25.0	438	.418	.114	2.27	11.00	3500
	13.0	26.0	498	.478	.131	2.32	11.20	3560
	13.5	27.0	582	.562	.154	2.38	11.35	3610 ←
	14.0	28.0	700	.680	.186	2.47	11.32	3600
	14.5	29.0	810	.790	.216	2.56	11.32	3600
	15.0	30.0	946	.926	.254	2.70	11.10	3530
	15.5	31.0	1108	1.088	.297	2.86	10.83	3445
	16.0	32.0	1215	1.195	.326	2.98	10.73	3415
	16 1/2	33.0	1500	1.480	.405	3.38	9.76	3100



KEUFFEL & ESSER CO., N. Y. NO. 359-14G
Millimeters, 10th lines heavy.
MADE IN U. S. A.

Ht = 9.20 = 3.62

D = T - 4.06
M - 4.11
B - 4.07

ave = 4.09cm = 1.61

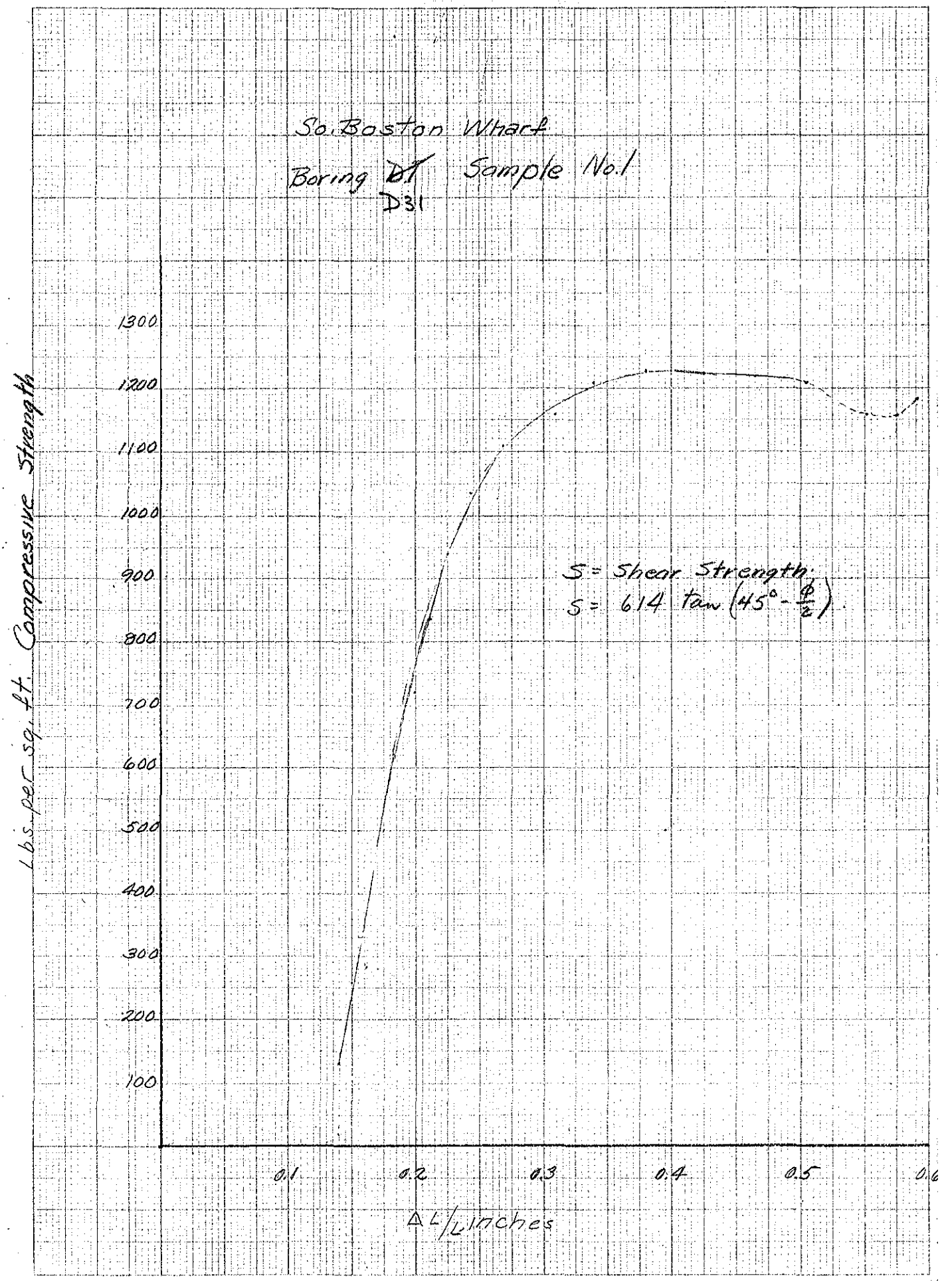
Test 1

7-31-42

A = 2.04

So Boston Wharf Hole DQ Sample No 1 Depth 12.2 to 13.2

	Time	Load	dial	AL	AL/L	A	Kg/sq in P/A	P/A #/sq.ft.
	0	0	20	0				
	.5	1.0	37	.017	.0005	2.05	.488	155
	1.0	2.0	60	.040	.011	2.06	.970	308
	1.5	3.0	85	.065	.018	2.08	1.44	458
	2.0	4.0	114	.094	.026	2.10	1.90	604
	2.5	5.0	142	.122	.034	2.115	2.36	750
	3.0	6.0	169	.149	.041	2.13	2.82	897
	3.5	7.0	198	.179	.049	2.14	3.28	1042
	4.0	8.0	228	.208	.058	2.16	3.70	1177
	4.5	9.0	256	.236	.065	2.18	4.12	1310
	5.0	10.0	288	.268	.074	2.20	4.55	1448
	5.5	11.0	313	.293	.081	2.22	4.95	1573
	6.0	12.0	347	.327	.090	2.24	5.36	1708
	6.5	13.0	380	.360	.100	2.26	5.75	1830
	7.0	14.0	419	.399	.110	2.29	6.11	1942
	7.5	15.0	454	.434	.120	2.32	6.46	2055
	8.0	16.0	498	.478	.132	2.35	6.81	2165
SP.	8.5	17.0	544	.524	.145	2.38	7.15	2275
	9.0	18.0	608	.588	.1163	2.44	7.38	2343
	9.5	19.0	752	.732	.202	2.56	7.42	2360 ←
	10.0	20.0	990	.970	.268	2.78	7.20	2290
	10.5	21.0	1069	1.049	.290	2.88	7.30	2320
	11.0	22.0	1163	1.143	.316	2.98	7.38	2345
	11.5	23.0	1281	1.261	.348	3.13	7.35	2340
	12.0	24.0	1500	1.480	.409	3.45	6.96	2220
	12.5	25.0	1643	1.623	.449	3.70	6.76	2150



THE FREDERICK POST CO. CHICAGO, ILL.
331-20 20X20 PER INCH

Height = 4.45 cm = 1.75 in
dia = 4.24
4.10
4.16
Ave. 4.15 cm = 1.63 in Area = 2.09 sq. in

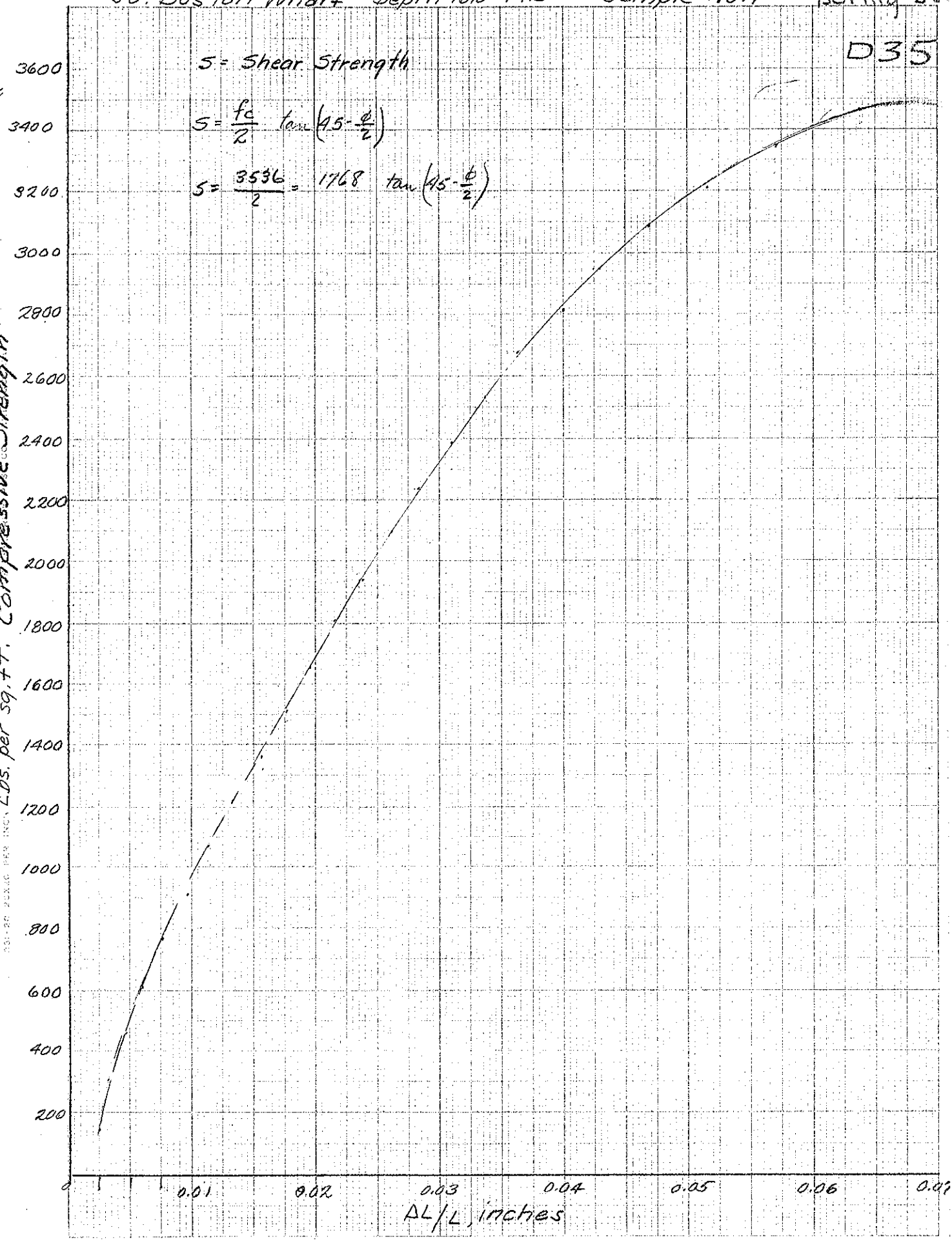
Boring DI
Sample No. 1.

So. Boston Wharf.

Elasped Time - Min.	Load in Kg.	Dial Readings	ΔL	ΔL/L	Corrected Area.	Kg/sq in	Lbs/sq. ft.
	0	140					
	1	383	.243	.139	2.43	.411	130.8
	2	402	.262	.150	2.46	.814	258.5
	3	424	.284	.162	2.50	1.200	282.0
	4	446	.306	.175	2.54	1.575	500.0
	5	459	.319	.182	2.56	1.952	621.0
	6	488	.348	.199	2.61	2.300	732.0
	7	510	.370	.212	2.66	2.63	837.0
	8	534	.394	.225	2.70	2.96	941.0
	9	566	.426	.243	2.76	3.26	1035.0
	10	609	.469	.268	2.86	3.50	1110.2
	11	681	.541	.309	3.02	3.64	1160.0
	12	737	.593	.339	3.16	3.80	1208.0
	13	805	.665	.380	3.37	3.86	1228.0 ←
	14	885	.745	.425	3.64	3.85	1223.0
	15	955	.815	.465	3.91	3.84	1220.0
	16	1025	.885	.505	4.22	3.80	1210.0
	17	1108	.965	.551	4.66	3.65	1160.0
	18	1149	1.009	.576	4.94	3.64	1158.0
	19	1174	1.034	.591	5.11	3.72	1182.0

So. Boston Wharf Depth 16.0-17.5 Sample No. 1 Boring D35

D35



H = 9.2 cm. D = T = 4.11 cm.
H = 3.62 in. M = 4.11
B = 4.14
Ave = 4.12 cm = 1.62 in.

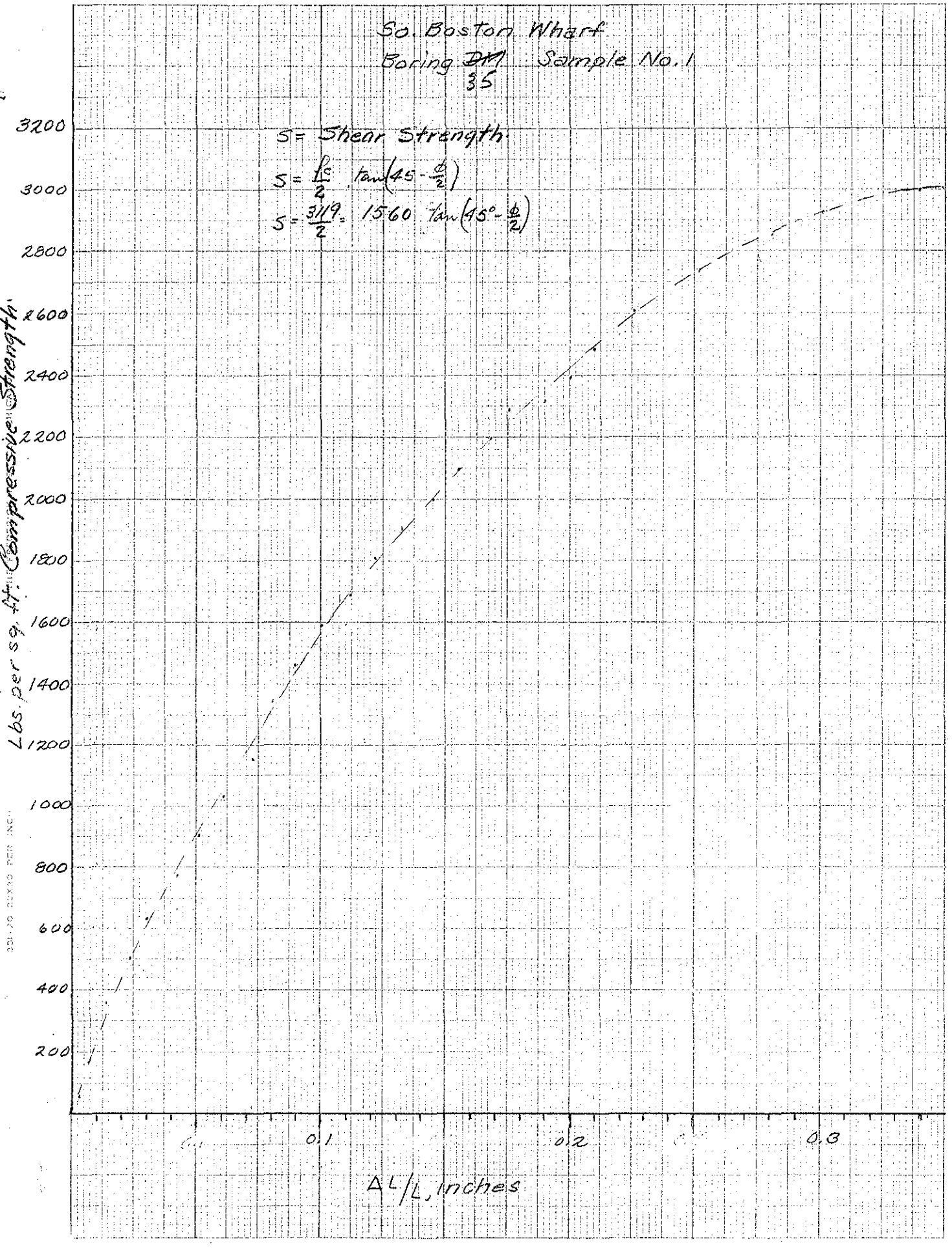
Area = 2.061 in = 13.33 cm.

Sample:- So. Boston Wharf Depth:- 16.0 - 17.5 Sample No 1 Taken 6-26-42 by Honkala

Elasped Time Min.	Load Kg.	Dial/in.	ΔL	ΔL/L	A	Kg/sq. in	~~Kg~~/cm	lbs/sq. ft.
0	0	249			2.061			
0:5	1	258	.009	.00248	2.065	.484	1.067	149.2
1.0	2	261	.012	.00332	2.068	.967	2.139	306.7
1.5	3	266	.017	.00470	2.070	1.445	3.199	459.9
2.0	4	271	.022	.00608	2.075	1.930	4.26	614.0
2.5	5	277	.028	.00774	2.080	2.403	5.31	766.0
3.0	6	284	.035	.00967	2.082	2.878	6.32	910.2
3.5	7	290	.041	.01132	2.084	3.356	7.40	1064.0
4.0	8	297	.048	.01327	2.090	3.827	8.46	1218.0
4.5	9	304	.057	.01575	2.095	4.297	9.46	1360.0
5.0	10	311	.064	.01770	2.10	4.76	10.50	1511.0
5.5	11	318	.071	.01960	2.102	5.23	11.51	1659.0
6.0	12	325	.078	.02160	2.105	5.70	12.59	1810.0
6.5	13	333	.086	.02380	2.110	6.16	13.6	1960.0
7.0	14	342	.095	.0262	2.12	6.609	14.58	2099.0
7.5	15	350	.103	.0284	2.122	7.06	15.59	2240.0
8.0	16	359	.112	.0310	2.130	7.51	16.59	2389.0
8.5	17	369	.122	.0337	2.135	7.97	17.60	2536.0
9.0	18	380	.133	.0368	2.140	8.42	18.60	2680.0
9.5	19	391	.144	.0398	2.145	8.85	19.54	2818.0
10.0	20	403	.156	.0430	2.158	9.28	20.45	2948.0
10.5	21	417	.170	.0470	2.164	9.70	21.40	3083.0
11.0	22	434	.187	.0516	2.178	10.10	22.30	3210.0
11.5	23	454	.207	.0572	2.185	10.51	23.22	3346.0
12.0	24	478	.231	.0638	2.20	10.9	24.03	3462.0
12.5	25	545	.298	.0823	2.25	11.11	24.52	3536.0
13.0								
13.5								
14.0								
14.5								
15.0								

So. Boston Wharf

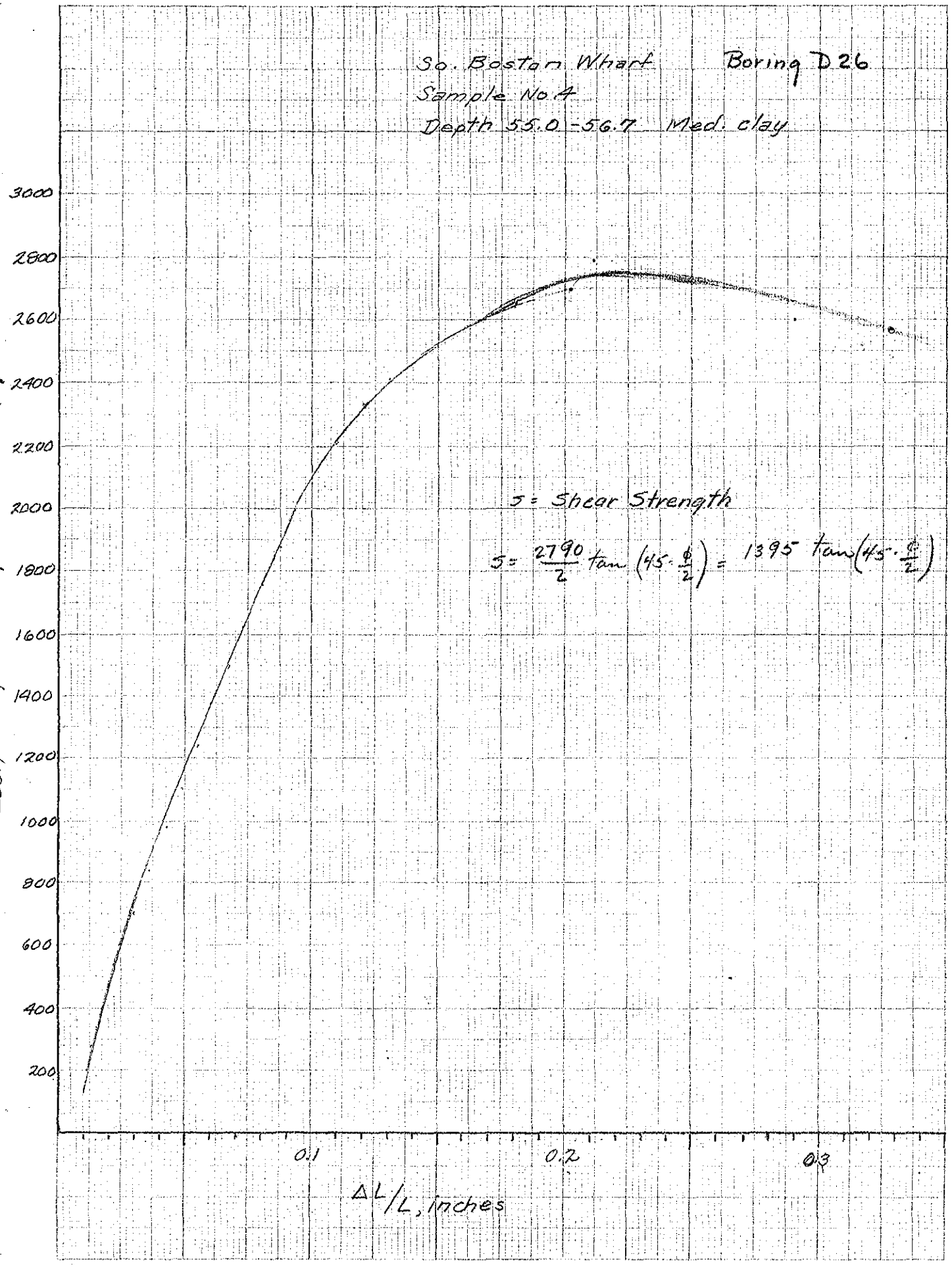
Boring ~~DM~~ 35 Sample No. 1



Height 8.8 cm 3.15 in

So. Boston Wharf Boring DM Sample No 1

Elapsed Time - Min	Load Kg.	DIAL	ΔL	ΔL/L	A	Kg/sq.in	tbs/sq.in	Lbs/sq.ft
0	.0	11						
0.5	.4	21	0.10	.0035	2.18	.1834	.4035	58.0
1.0	.8	23.8	0.128	.00406	2.18	.3669	.8101	
1.5	1.5	32	.0210	.00667	2.185	.526	1.16	167.0
2.0	2.5	57	.0460	.0146	2.20	1.135	2.50	360.0
2.5	3.5	84.5	.0735	.0233	2.22	1.574	3.48	501.0
3.0	4.5	114	.103	.0327	2.24	2.008	4.42	636.0
3.5	5.5	144	.1330	.0422	2.26	2.430	5.37	774.0
4.0	6.5	171	.1600	.0508	2.29	2.84	6.29	904.0
4.5	7.5	203	.1920	.061	2.31	3.247	7.17	1032.0
5.0	8.5	237	.226	.0718	2.34	3.627	8.02	1153.0
5.5	10.0	266	.255	.081	2.36	4.24	9.35	1348.0
6.0	11.0	295	.284	.0902	2.39	4.60	10.16	1461.0
6.5	12	329	.318	.101	2.42	4.96	10.93	1572.0
7.0	13	364	.353	.112	2.44	5.338	11.73	1690.0
7.5	14	395	.384	.122	2.47	5.67	12.51	1809.0
8.0	15	432	.421	.1335	2.50	6.00	13.25	1908.0
8.5	16	467	.456	.145	2.54	6.30	13.90	2001.0
9.0	17	500	.489	.155	2.57	6.61	14.59	2099.0
9.5	18	534	.523	.166	2.60	6.92	15.28	2199.0
10.0	19	567	.556	.176	2.64	7.20	15.90	2290.0
10.5	19.5	607	.596	.189	2.68	7.26	16.02	2309.0
11.0	20.5	643	.632	.201	2.72	7.54	16.61	2396.0
11.5	21.5	674	.663	.210	2.75	7.82	17.26	2486.0
12.0	23.0	722	.711	.226	2.80	8.20	18.12	2608.0
12.5	25.0	804	.793	.252	2.90	8.61	19.01	2740.0
13.0	27.0	897	.886	.281	3.02	8.97	19.81	2853.0
13.5	29.0	986	.975	.309	3.14	9.23	20.37	2923.0
14.0	31.0	1085	1.074	.341	3.29	9.41	20.80	2999.0
14.5	33.0	1165	1.154	.366	3.42	9.65	21.30	3036.0
15.0	35.0	1248	1.237	.3925	3.57	9.80	21.61	3119.0

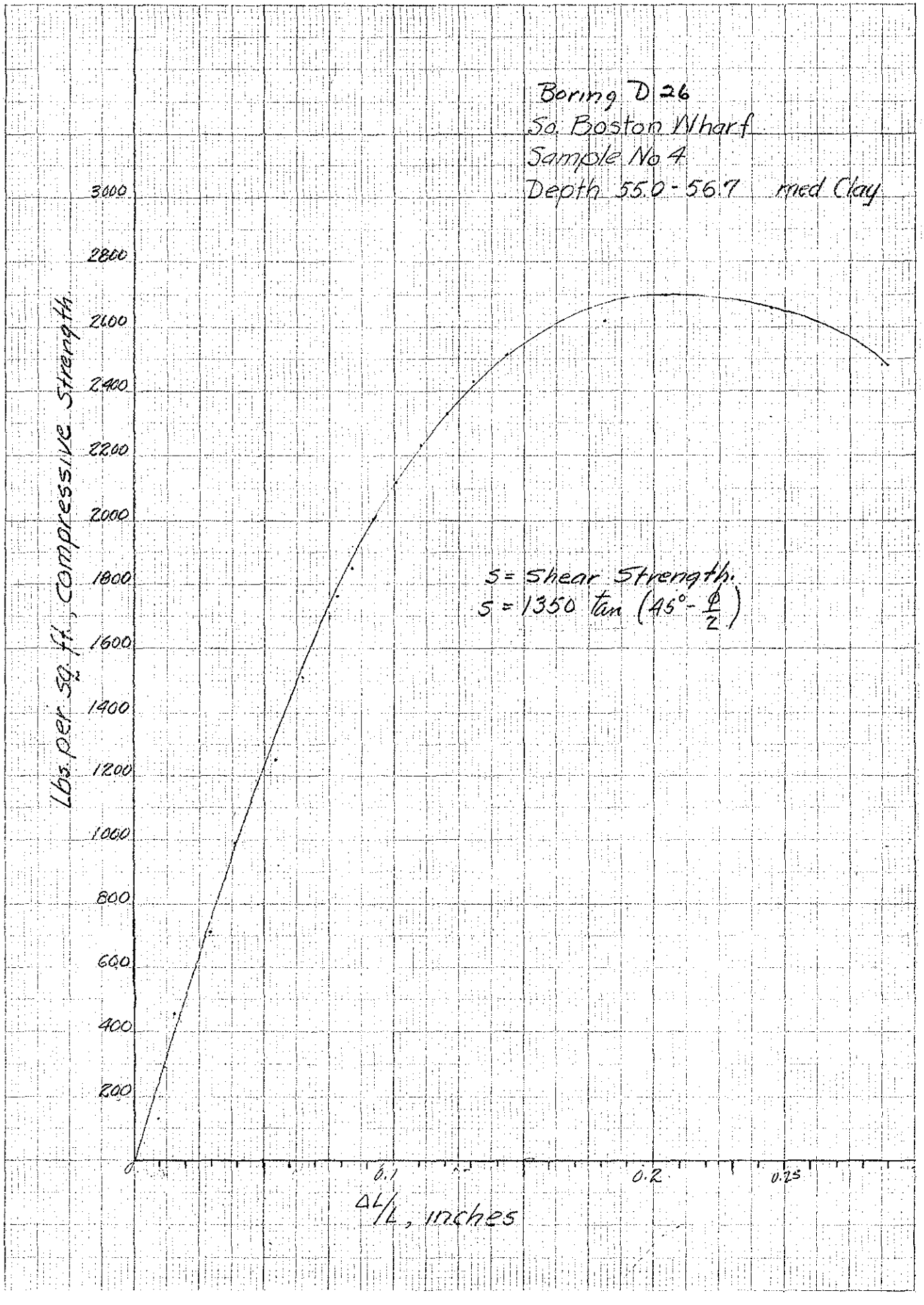

So. Boston Wharf
Boring D26
Sample No 4
Depth 55.0 - 56.7 Med. clay
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
Lbs. per sq. ft. Compressive Strength
s = Shear Strength
s = 2790/2 tan (45 - φ/2) = 1395 tan (45 - φ/2)
0.1
0.2
0.3
ΔL/L, inches

D = 4.25
4.20
4.25
Ave D = 4.22 cm = 1.66 = 2.164

Height = 9.5 cm = 3.74 in.

Sample No 4 Depth 55.0 - 56.7 med Clay So. Boston Wharf.

Elapsed Time - Min.	Load in Kg.	Dial	ΔL	ΔL/L	Corrected Area	Kg/sq. in	Lbs/sq. ft.
	0	137			2.164		
	1	172	.035	0.009	2.183	.458	145.5
	2	181	.044	0.012	2.190	.914	290.0
	3	198	.061	0.016	2.198	1.367	435.0
	4	223	.086	0.023	2.209	1.805	574.0
	5	248	.111	0.029	2.216	2.242	714.0
	6	272	.135	0.036	2.249	2.665	848.0
	7	293	.156	0.042	2.265	3.090	984.0
	8	316	.179	0.048	2.277	3.518	1110.9
	9	341	.204	0.055	2.292	3.921	1248
	10	361	.224	0.060	2.302	4.340	1380
	11	380	.242	0.065	2.319	4.750	1510
	12	405	.268	0.072	2.338	5.140	1633
	13	430	.293	0.078	2.350	5.53	1760
	14	457	.320	0.086	2.371	5.90	1878
	15	483	.346	0.093	2.392	6.27	1992
	16	516	.379	0.101	2.418	6.63	2105
	17	550	.413	0.110	2.438	6.98	2220
	18	589	.452	0.121	2.470	7.36	2340
	19	628	.491	0.131	2.498	7.61	2420
	20	679	.542	0.145	2.535	7.90	2515
	21	739	.602	0.161	2.583	8.12	2580
	22	813	.676	0.181	2.645	8.32	2645
	23	897	.760	0.202	2.714	8.48	2698
	24	918	.781	0.209	2.740	8.76	2790 ←
	25	1220	1.083	0.290	3.05	8.20	2600
	26	1362	1.225	0.328	3.220	8.08	2570
	27	1500	1.363	0.365	3.410	7.93	2520
	28	1712	1.575	0.421	3.74	7.50	2380
	29	1840	1.703	0.456	3.981	7.28	2315
	30						



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331-20 20X20 PER INCH

D T - 4.25 Area - 2.16 in² H = 9.5 cm. = 3.74 in
M - 4.20 Area - 13.99 cm²
B - 4.25

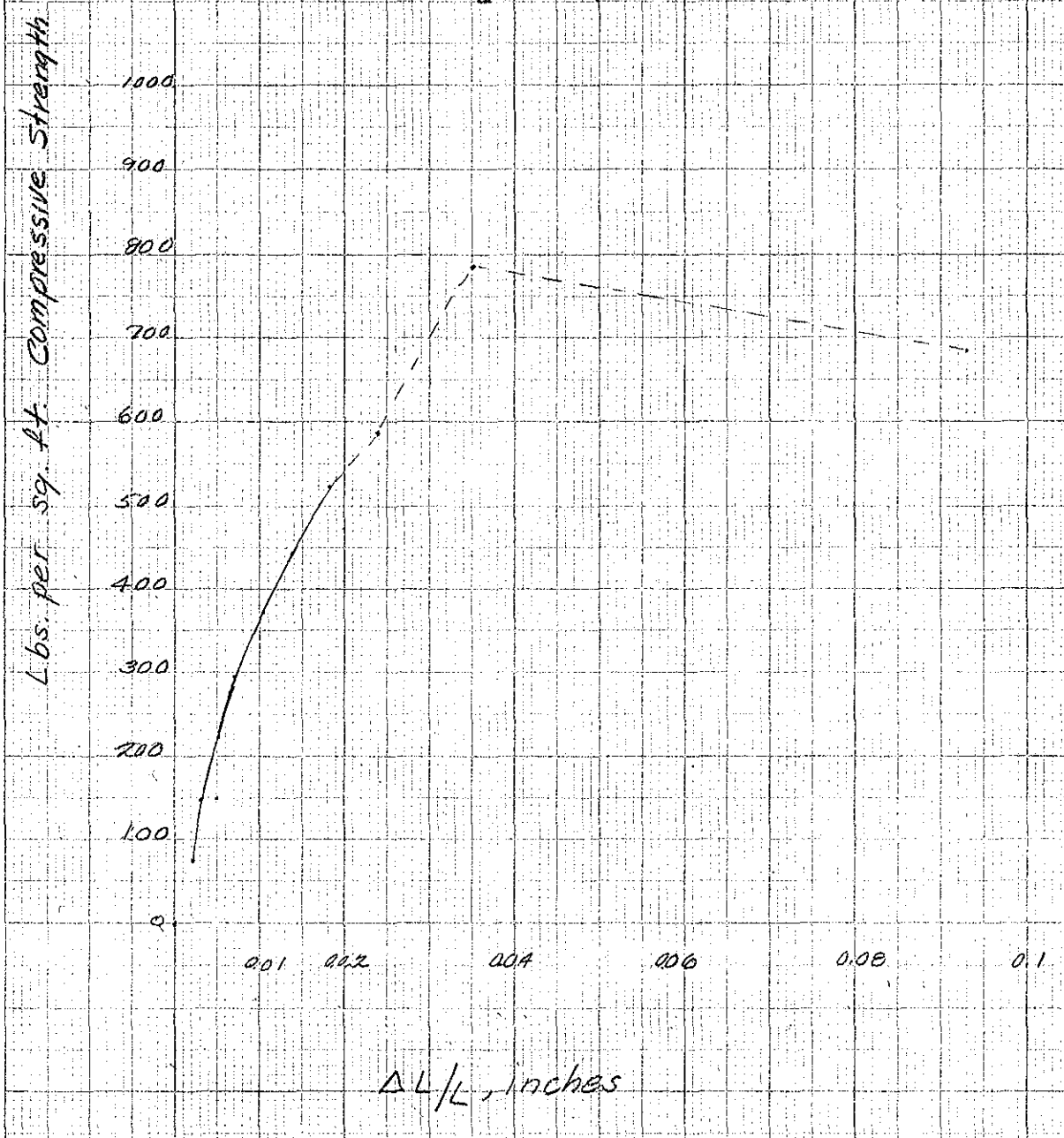
Ave 4.22 cm.
1.66 in.

Project:- So. Boston Wharf Sample No. 4 Depth 55.0-56.7 - med. Clay

Elapsed Time min.	Load Kg.	dial	ΔL	ΔL/L	A	Kg/sq in	Lbs/sq in	Lbs/sq ft
0	0	137	0		2.16			
0.5	1	172	.035	.00936	2.18	.41	.904	130.1
1.0	2	181	.044	.01177	2.185	.914	2.018	289.0
1.5	3	198	.061	.0163	2.195	1.367	3.19	459.0
2.0	4	223	.086	.0230	2.21	1.801	3.98	573.0
2.5	5	248	.111	.0297	2.22	2.226	4.91	707.0
3.0	6	272	.135	.0361	2.241	2.671	5.66	815.0
3.5	7	293	.156	.0417	2.251	3.104	6.86	990.0
4.0	8	316	.179	.0479	2.261	3.522	7.77	1119.0
4.5	9	341	.204	.0545	2.28	3.943	8.69	1250
5.0	10	361	.224	.0599	2.293	4.36	9.61	1382
5.5	11	386	.243	.0650	2.309	4.77	10.51	1515
6.0	12	405	.268	.0717	2.322	5.16	11.39	1640
6.5	13	430	.293	.0784	2.34	5.55	12.23	1762
7.0	14	457	.320	.0856	2.36	5.93	12.82	1850
7.5	15	483	.346	.0925	2.38	6.301	13.91	2001
8.0	16	516	.379	.1012	2.401	6.67	14.70	2120
8.5	17	550	.413	.1104	2.421	7.03	15.5	2230
9.0	18	589	.452	.1210	2.459	7.34	16.19	2330
9.5	19	628	.491	.1313	2.482	7.67	16.89	2430
10.0	20	679	.542	.1450	2.521	7.91	17.44	2515
10.5	21	739	.602	.1610	2.578	8.15	17.99	2590
11.0	22	813	.676	.1810	2.64	8.33	18.35	2620
11.5	23	897	.760	.2030	2.708	8.50	18.73	2700
12.0	24	1055	.918	.2460	2.86	8.39	18.48	2660
12.5	25	1220	1.083	.2900	3.20	7.82	17.23	2480
13.0	26	1362	1.225	.3280	3.213	8.10	17.88	
13.5	27	1500	1.365	.3650	3.40	7.71	17.03	
14.0	28	1712	1.575	.4210	3.738	7.54	16.62	
14.5	29	1840	1.703	.4560	3.979	7.31	16.13	
15.0	30							
15.5								

So. Boston Wharf Boring D 26
Sample No. 3
Depth 5.0-5.2
MED. BLUE CLAY
S = Shear Strength

$$S = \frac{785}{2} \tan\left(45^\circ - \frac{\phi}{2}\right) = 393 \tan\left(45^\circ - \frac{\phi}{2}\right)$$



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331-29 20X20 PER INCH

H	D	A
4.4	4.18	2.11
4.3	4.15	
4.4	4.17	
1.913	"	

So Boston Wharf Sample No 3 Depth 50-52

Elapsed Time	Load in Kg	Dial	ΔL	ΔL/L	Area	Stress	lbs/sq ft
0.5	.5	.423	.003	.00175	2.119	.234	74.01
1.0	1.0	.425	.005	.00291	2.12	.473	149.7
1.5	1.5	.429	.009	.00525	2.123	.704	223.5
2.0	2.0	.432	.012	.00701	2.124	.939	296.9
2.5	2.5	.438	.018	.0105	2.14	1.17	370.9
3.0	3.0	.444	.024	.0140	2.143	1.399	444.0
3.5	3.5	.449	.029	.0169	2.149	1.65	524.0
4.0	4.0	.461	.041	.0239	2.161	1.85	585.0
4.5	4.5	.480	.060	.035	2.183	2.47	785.0
5.0	5.0	.580	.160	.0934	2.328	2.15	684.0
5.5	5.5						
6.0							

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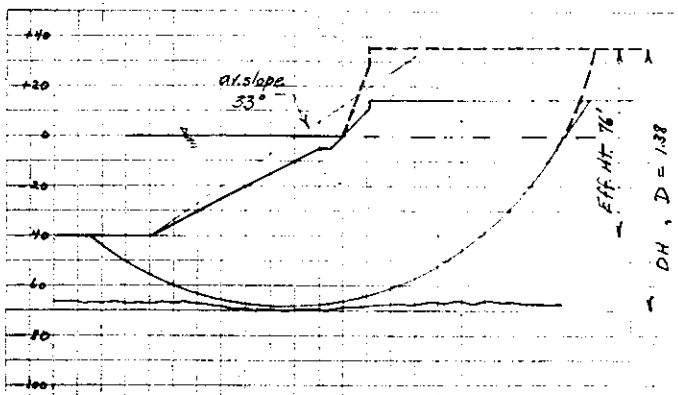
PROJECT WHARF EXT. RESERVED CHANNEL

SUBJECT FOUNDATION INVESTIGATION

FILE NUMBER
SHEET NUMBER 1 of 12
DATE Jul. 1942
COMPUTED BY D. W. Taylor
CHECKED BY



Analysis of Earth Section Alone

Section as per plan, assuming 50 #/CF as submerged unit weight for soil below El. 0 ; 120 #/CF above El. 0 and replacing 120 #/CF material by $\frac{2}{3}$ as much height of 50 #/CF material.

For average shearing strengths along failure arc : assume above El. 0, $\frac{1}{2} \times 15 \times 120 \times .7 = 600$ #/SF, foreshortened 5/12 to 250 #/SF; medium clay 1500 #/SF ; 3 below soft blue clay 700 #/SF. Lengths assumed distributed 15% above El. 0 ; 5% medium clay ; 80% soft clay. Average shearing strength 670 #/SF

From Fig. 8 of "Stability of Earth Slopes"

$$\frac{c}{FwH} = f(33°; D\ 1.38) = \frac{670}{F \times 50 \times 76} = .163$$

c here being the average shearing strength, — whence $F = 1.08$

Allowing for a small amount of seepage force at the low tide condition analyzed, the slope is just about safe if strengths are as assumed. Note: 700 #/SF in soft clay is conservative

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SUBJECT

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Stability of 2:1 slope below water

A slope at inclination i, which is of great extent and has a constant shearing strength s, is stable if depth vertically to ledge or other very strong material parallel to the surface is less than H in —

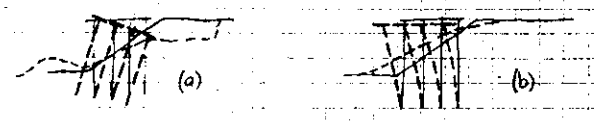
$$\frac{s}{wH} = \frac{1}{2} \sin 2i \quad ; \quad \frac{700}{50\,H} = .4$$

whence $H = 35'$

Here the depth is greater than 35' in some locations but the slope is of such limited extent that an analysis as on the previous page must be used for quantitative results. (To be of unlimited extent the slope length would have to exceed 5 or 10 times the depth of 35', whereas here the slope length is only about 100'.)

Adding a Wharf to the slope

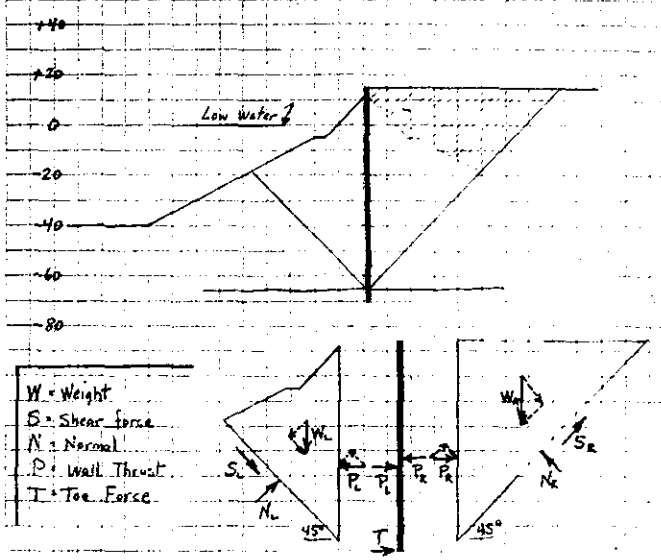
If wharf piles are friction piles in the soft clay the stability is affected very little. Even a large load on the wharf causes only a small effect, as such load cannot be very far to the right of the center of rotation. A failure in such a case is of the type of (a) below.



If many piles go to refusal in strong soil below the clay, failure of type (b) is more likely and the presence of the pile structure is of considerable help to the stability of the section. Here load on the structure does not affect

stability. Of course load on the top of the slope will tax the stability greatly in either case. Load on wharf in case (a) must of course be analyzed relative to pile loading capacity and subsidence conditions also. In case (a) the sliding mass may be essentially undistorted, or may distort to a shape of structure somewhat as in (b), in which case the piles after failure would be more nearly vertical.

The analysis of the case of stability when piles penetrate to refusal is more complex. To show the type of displacements, the case of a simple wall located in the plane of the bulkhead will be considered.



The following is a simple type of failure wedge analysis, not much different in many ways from the setup in retaining wall theory. The wedges and the wall, with all forces which enter are shown in sketch. The assumptions which will be used are chosen to give as simple an analysis as possible.

Assumptions:

Failure planes at 45° to Horizontal
Shearing strength constant
Resultant pressures normal to wall

While these assumptions give a much idealized condition it is surprising how little effect greater refinement has on results.

Equilibrium of components parallel to 45° or failure planes gives

$$\frac{P_R}{\sqrt{2}} + S_R = \frac{W_R}{\sqrt{2}} \qquad \text{or} \qquad P_R = W_R - \sqrt{2}\,S_R$$

$$S_L + \frac{W_L}{\sqrt{2}} = \frac{P_L}{\sqrt{2}} \qquad \text{or} \qquad P_L = W_L + \sqrt{2}\,S_L$$

also $P_R - P_L = T$ and from above $P_R - P_L = W_R - W_L - \sqrt{2}(S_R + S_L)$

$$S_R + S_L = 120\,s + S_P$$

where S_P is shearing strength value per foot, for all piles crossing left side failure plane. Shearing strength required for stability is S and

$$T = W_R - W_L - \sqrt{2}\,(150\,s + S_P)$$

or $$\boxed{W_R - W_L = 255\,s + (1.41\,S_P + T)}$$

On the previous page the weight of the shaded area is $W_R - W_L$

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$$W_R - W_L = 120 \times 1.5 \times 70 + 50 \times 3 \times 27 = 136{,}000 \ \#/\text{ft}$$

Solving for required average shearing strength

$$s = \frac{138{,}000 - (1.41 S_p + T)}{255}$$

and if $1.41 S_p + T$ is neglected $\underline{s = 540 \ \#/\text{sf}}$ (required)

and since the average actual strength per p.1 is 670 #/sf

$$\underline{F = \frac{670}{540} = 1.24}$$

It is known that in the analysis of p.1, surfaces differing quite a lot from the most dangerous circular arc would show safety factors only slightly greater than the value of 1.08. The above case with no $(1.41 S_p + T)$ is just such a case using the 45° lines of p.3 instead of the circle. As the 45° lines differs greatly from the most dangerous circle the factor of safety of 1.24 appears reasonable in line with the 1.08 value. A value somewhat smaller than 1.24 might be found by analyzing lines differing from 45 degrees.

In the actual design there is a wall from El. 15 to El. -10 at the plane of the wall shown on p.3. Below this the piles are closely spaced (3 times as many back-row and batter-piles per bay as is the case for other piles appearing in the cross section). Thus the use of this plane as a pivot-plane in the computations is reasonable.

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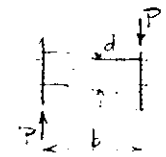

Little is known of the exact action of a pile in transverse shear. Looking at it from the viewpoint of bending the case at the 13ft. according to ordinary beam theory gives

$$M = \frac{Pb}{2} = \frac{fI}{c} = \frac{f\pi d^3}{32} \quad \text{or} \quad P = \frac{f\pi d^3}{16b}$$

using $f = 5{,}000$ #/sq.in., $d = 8$ in., and using $b = 2d$ gives

$$P = 16 \text{ Tons}$$

In true transverse shear wedges strain, but transverse shear and also the above moment conditions are not the types of failure occurring. diagonal compression and longitudinal shear are the true limiting factors. If the transverse shear strength is taken as 400 #/sq.in. which is approximately the longitudinal shearing strength

$$P = 400 \ \#/\text{in}^2 \times 8^2 \frac{\pi}{4} = 10 \text{ Tons} \quad \left(\begin{matrix}\text{over} \\ \text{conservative}\end{matrix}\right.$$

The ultimate strength of a pile in transverse shear is probably large than the values above and perhaps of the order of 20 Tons, giving the value of 5 Tons at a factor of safety of 4.

With 32 piles per 10 ft. bent or 2.2 piles per foot, the shearing resistance offered by piles if they act in unison is

$$3.2 \times 20 = \underline{64 \text{ T per ft.}}$$

The shearing strength of the soil on the arc used on p.1 is

$$\frac{670}{2000} \times 265 = \underline{88 \text{ T per ft.}}$$

This strength of piles is large enough so that, even though it must not be expected that strength of individual piles will ~~not~~ act together and piles and soil will not act in unison, it appears safe to assume there can be

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no failure on deep seated circles and the action will be of the type illustrated by sketch (b), p. 2.

Even if the shearing strengths in the soft clay are considerably higher than values assumed on p. 1, the stresses there obtained will cause slow plastic flow even though there is no danger of rupture. This plastic flow giving distortions of the type shown in (b), p. 2. A certain amount of distortion is inevitible, but the lower the shear stresses, the slower the flow. As time goes on the shear stresses are relieved somewhat, - thus slowing the distortions, - by the increasing resistance to distortion offered by the structure and by consolidation.

Thus the real question here is one of lowering shears so as to give smaller outward movements. The factors of safety thus are not so much a measure of safety against failure as of the degree to which shear stresses and thus speeds of plastic flow are restricted.

The carrying of piles thru the clay prevents appreciable settlement of the wharf, adds a small degree of safety against failure, but most important, restricts plastic flow to the upper regions of the soft clay thus diminishing the outward movement the wharf undergoes

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SUBJECT

FILE NUMBER
SHEET NUMBER 8
DATE Jul. 1942
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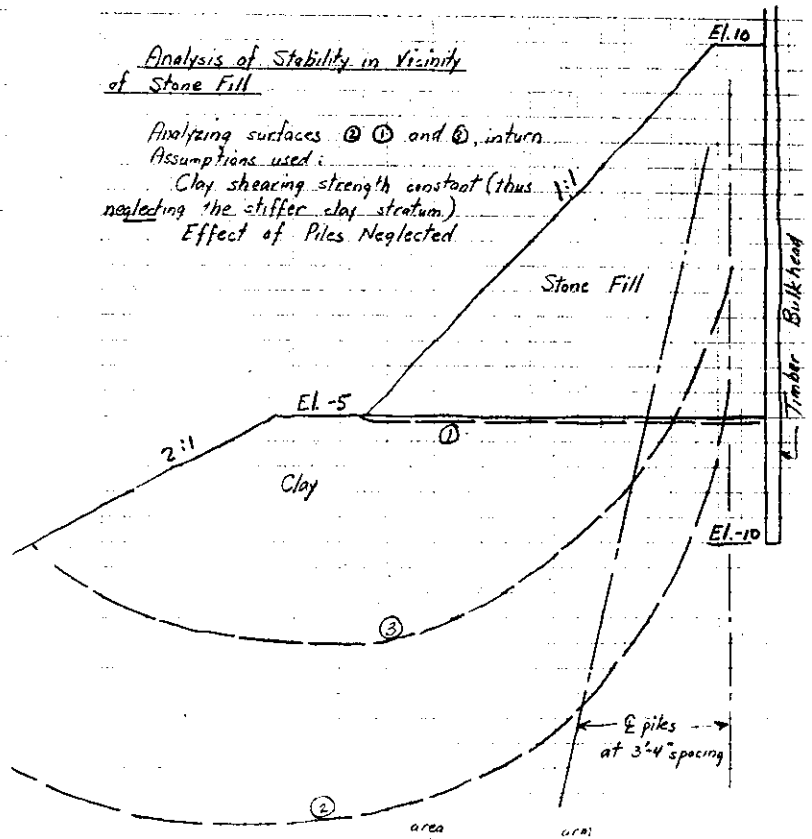
Analysis of Stability in Vicinity of Stone Fill

Analyzing surfaces ② ① and ③, in turn
Assumptions used:
Clay shearing strength constant (thus neglecting the stiffer clay stratum)
Effect of Piles Neglected



Surface ② Actuating: $\overbrace{\tfrac{1}{2} \times 16 \times 15}^{\text{area}} \times 120 \times \overbrace{17}^{\text{arm}} = 244{,}800$ (stone)
$\tfrac{1}{2} \times 20 \times 12 \times 50 \times 12 = 72{,}800$ (clay)

Tot. 316,800 ft#/ft.

Resisting $\frac{1}{2}K\gamma H^2 f = \frac{1}{2} \cdot \frac{1}{4} \cdot 120 \cdot (15)^2 \times .6 = 2,000$ (stone)

$17 \times 50 \times 700 = 595,000$ (clay)

Tot. 597,000 ft.#/ft.

On Surface ② Safety Factor $= \frac{597}{316.8} = 1.88$

Surface ①

$\frac{1}{2} K\gamma H^2 = \frac{1}{2} \cdot \frac{1}{4} \cdot 120 \cdot (19)^2 = 4,860$ (H. thrust)

$17 \cdot 700 = 11,900$ (H. strength)

On Surface ① Safety Factor $\frac{11.9}{4.86} = 2.4$

Surface ③

$\frac{1}{2} \cdot 16 \cdot 15 \cdot 120 \cdot 13 = 187,200$

$\frac{1}{2} \cdot 14 \cdot 15 \cdot 50 \cdot 9 = 15,800$

203,000

Resisting in stone 2,000

$16 \cdot 30 \cdot 700$ 336,000

338,000

On Surface ③ Safety Factor $\frac{338}{203} = 1.67$

Surface ③ is probably close to the most dangerous circle. As the assumptions were very conservative there is no danger of failure of the type giving a mud wave high on the clay slope.

There can be no danger of failure from flow below the sheeting with the heavy stone fill shown. This heavy fill probably will settle considerably and this should be allowed for. If it settles to El.-10, arching between the piles gives much strength against flow below piles.

With section as shown but with timber bulkhead omitted + with cinder fill behind the stone fill, the section has nearly as high a safety factor as shown by computations on the previous page where the bulkhead exists. The bulkhead gives added safety, however, and the settlements in the fill behind are smaller if the bulkhead is used. It also removes all danger of small local failures at soft spots.

Effects of Various Factors Not Yet Considered

For the sake of simplicity a number of important factors and possible alternates have not been considered in the above computations. Such factors which will now be analyzed are the following

A. Surcharge Loads on Fill behind wharf
B. Effect of Loading platform or Cinder Backfill
C. Effect of Differential Water Level
D. Effect of Spur Piles
E. Effect of Wider wharf thus giving higher fill at left of bulkhead.

Each of the above will be analyzed as a difference relative to the case, given on p.5, using 45° slopes and showing a Safety Factor of 1.24.

A. A surcharge load of 300 #/SF above the backfill increses W_R by $300 \times 80 = 24,000$. $W_R + W_h$ is increased from 138,200 to 162,200 #/ft., an increase of 17%. The factor of safety of 1.24 is correspondingly reduced to 1.05. This surcharge of 300 #/SF is not likely to occur and considering the numerous other conservative assumptions, the margin of safety is much larger than the value 1.05 tends to indicate.

B. Relief of weight of fill behind the bulkhead, whether by some type of platform or open crib or by the use of cinders for backfill material.

Any desired amount of load relief, up to the following, could be accomplished.

CRIB EL. 0 to 13, extending back average of 50 ft

$13 \times 50 \times 120 = 78{,}000$

decreasing $W_R - W_L$ from 132,000 to 50,000 and giving a factor of safety of 3.4

CINDER FILL - Same extent as Crib above. Assuming cinder fill weighs 50 #/CF less than granular soil

$13 \times 50 \times 50 = 32{,}500$

decreasing $W_R - W_L$ to 106,000 and raising safety factor to 1.6

The crib or loading platform scheme is not likely to be economically feasible but the cinder fill should be adopted if possible. The large degree with which relief of load adds to the safety, as compared to the degree in other cases given below, is worthy of careful note.

C. Assuming the water table 2' higher on the right than on the left is sometimes resorted to to allow for tidal differential, and will serve here to indicate the order of magnitude of this factor.

The computations of p.5 were based on submerged weights and thus the P values were earth thrusts, the water pressures being balanced. For a 2' differential

$2 \times 62.5 \times 66 = 8{,}250$ #/ft

and $P_R + 8{,}250 = P_L + T$

It is seen that this increased pressure on the wall has the same effect as increasing W_R an equal amount would have. The increase of 8,200 is 6% of $W_R - W_L$ and 2' differential head reduces the Safety factor from 1.24 to 1.16.

D. Effect of Spur Piles

A spur pile giving horizontal support to the wooden bulkhead in effect relieves $W_L - W_R$ by the amount of horizontal support it gives. Three spur piles per 10 ft. with piles at 1:4 slope and thus good for about a 2000 # horizontal reaction furnishes

$3/10 \times 8000 = 2{,}400$ #/ft

This relatively small relieving force is but 2% of $W_R - W_L$ and raises the factor of safety from 1.24 to 1.26.

There are 3 spur piles per 10 ft of wharf and 32 piles in all per 10 ft. of wharf, only 15 of which cross the 45° lines of the analysis being used.

$15/10 \times 8000 = 12{,}000$ #/ft ; 9% of $W_R - W_L$

Thus all the piles, assuming strength of 4 T each, give only a minor amount of strength in the 45° degree plane analysis.

No Danger of Failure

Feasible ways to cut down shears, thus decreasing outward movement, are spur piles and cinder fill.

160 SF of Cinder Cross section is equal to 3 spur piles per bent.

Use of as large as large amounts of cinder as possible recommended

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Computation: Stability Study During Construction
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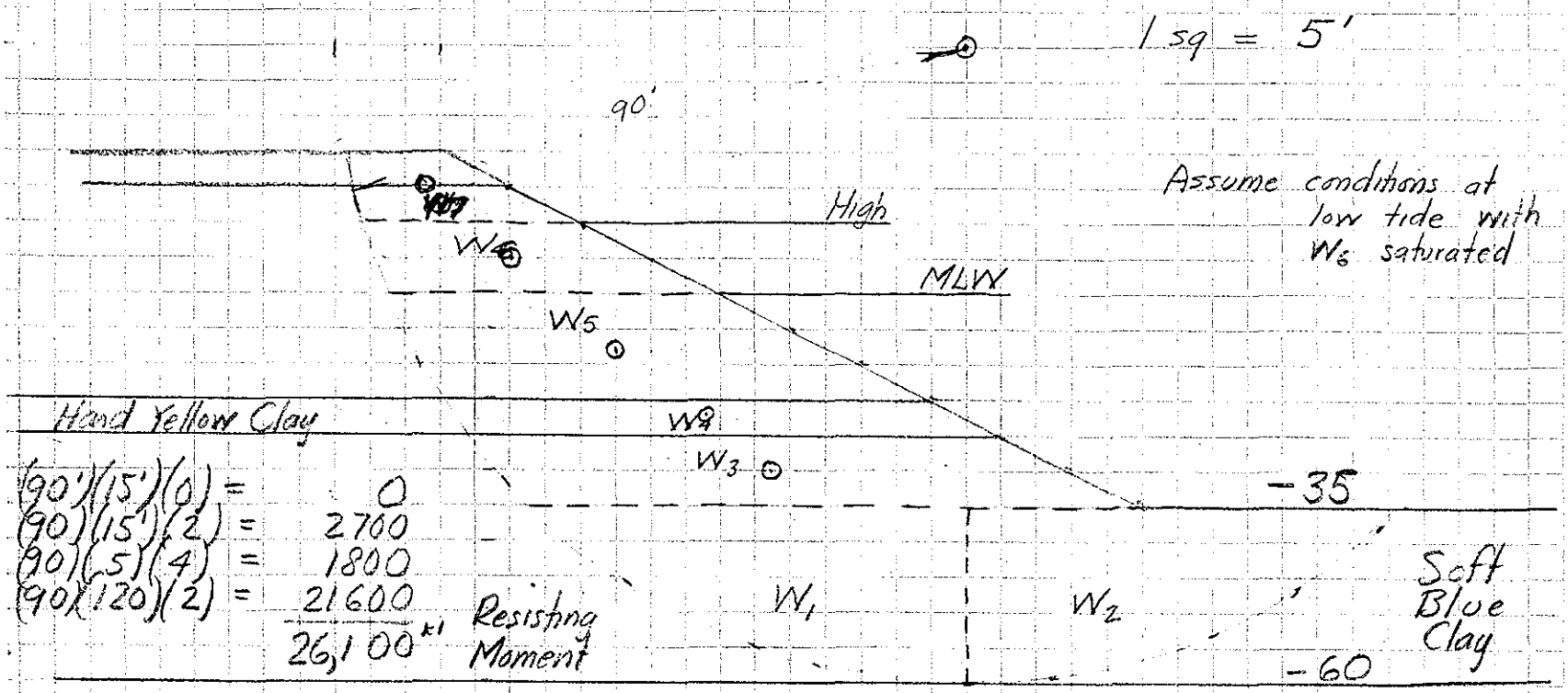

Assume conditions at low tide with W_6 saturated

(90')(15')(0) = 0
(90')(15')(2) = 2700
(90')(5')(4) = 1800
(90')(120')(2) = 21600
26,100 k' Resisting Moment

$W_1 = W_2$

W_3 = (80')(10')(1')(50)	= 40k	(40)(27') =	1080 k'
W_4 = (70')(5')(1')(60#/cf)	= 21k	(21)(37') =	777
W_5 = (60')(15')(1')(70#/cf)	= 63k	(63)(50') =	3150
W_6 = (40')(10')(1')(130#/cf)	= 52k	(65')(52)	3380
W_7 = (23')(10')(1')(100#/cf)	= 23.0k	(23.0)(75)	1925
			9324 k' Overturning Moment

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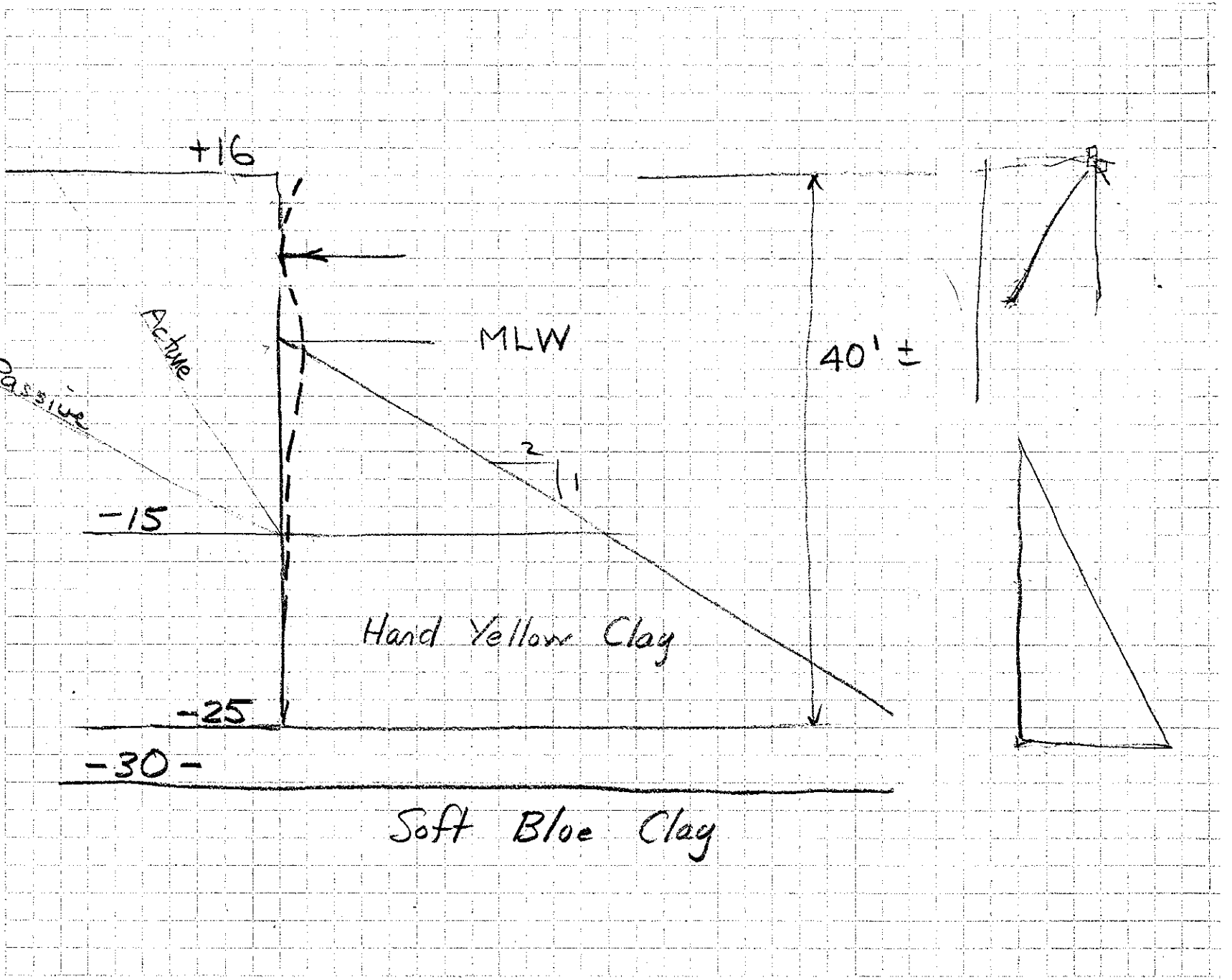

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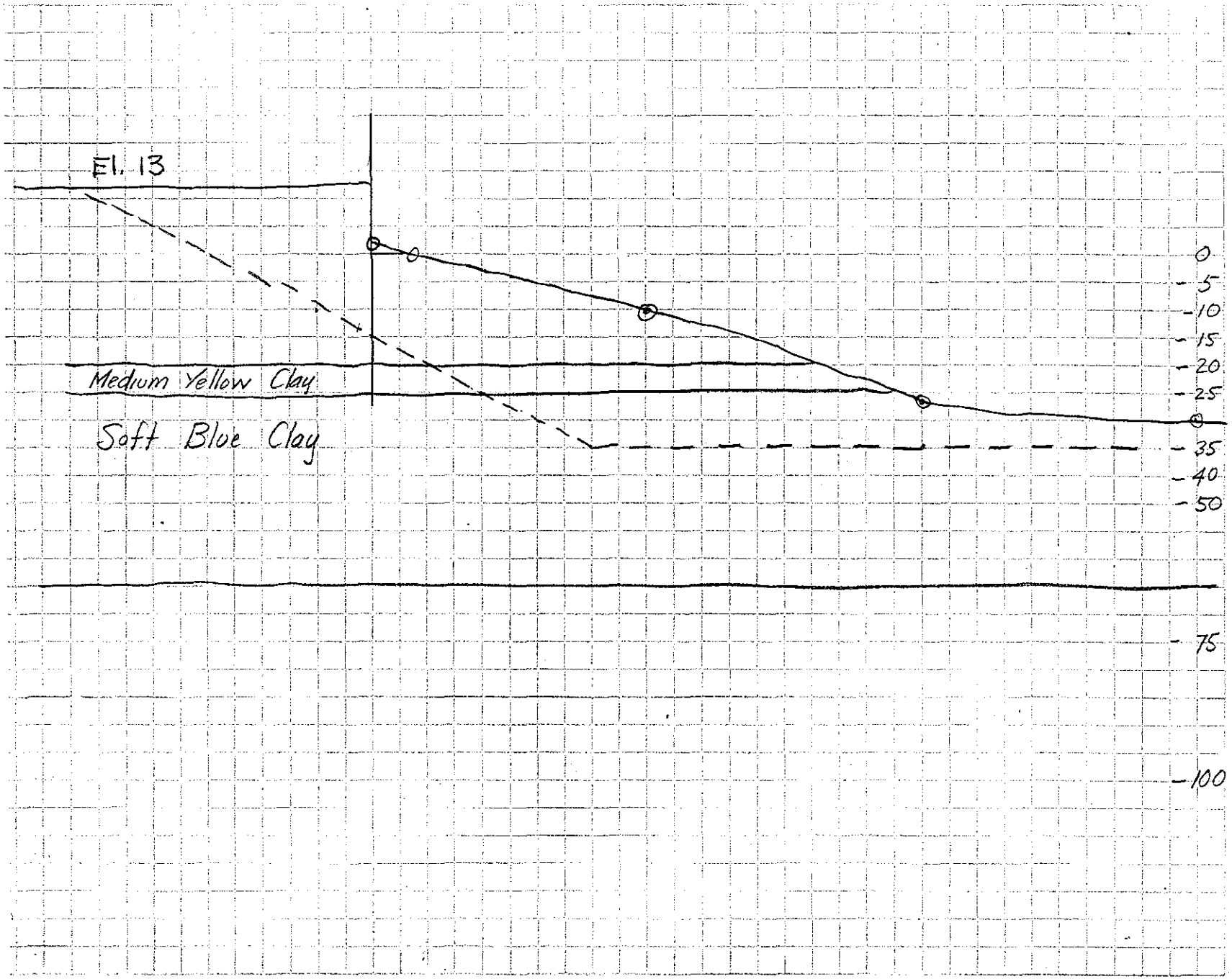

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Load from wharf: Assume at 250 lbs/sq. ft.

Assume:

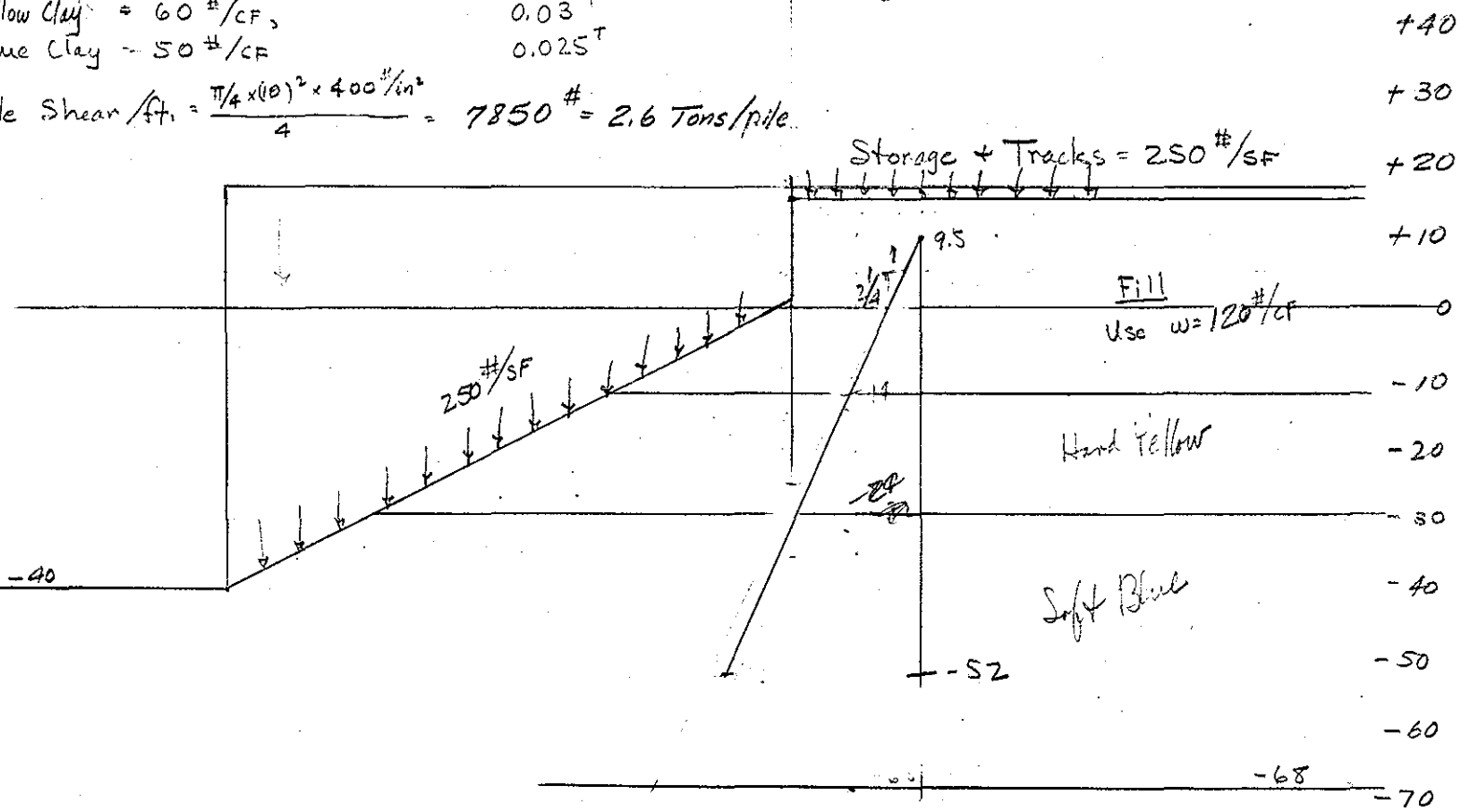
Load on wharf and storage area = 250 #/SF 0.125 T
Fill wgt. = 120 #/CF, above MLW 0.06 T
50 #/CF, below MLW 0.025 T
Yellow Clay = 60 #/CF, 0.03 T
Blue Clay = 50 #/CF 0.025 T

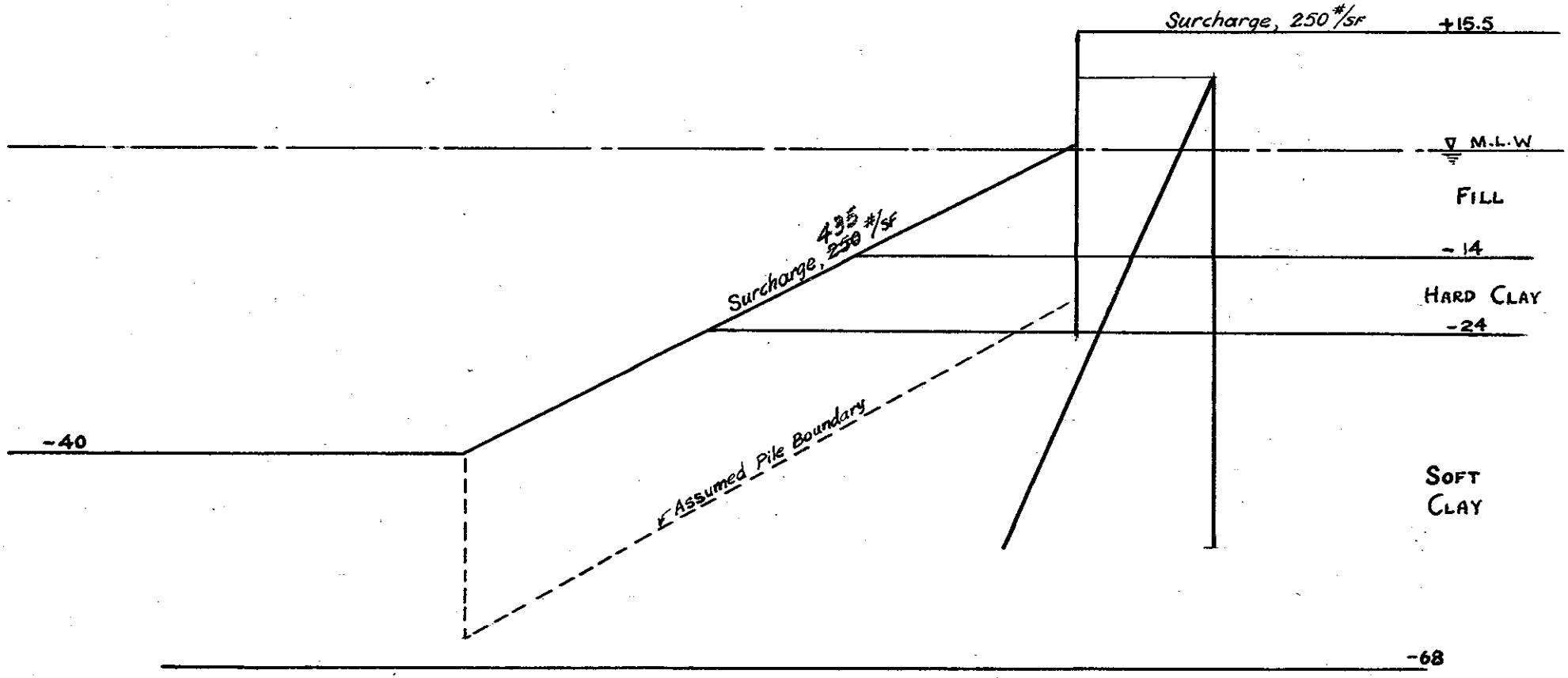
Pile Shear/ft. = $\frac{\pi/4 \times (10)^2 \times 400\ \#/in^2}{4}$ = 7850 # = 2.6 Tons/pile

Blue Clay (40%) Yellow Clay, 30% H_2O

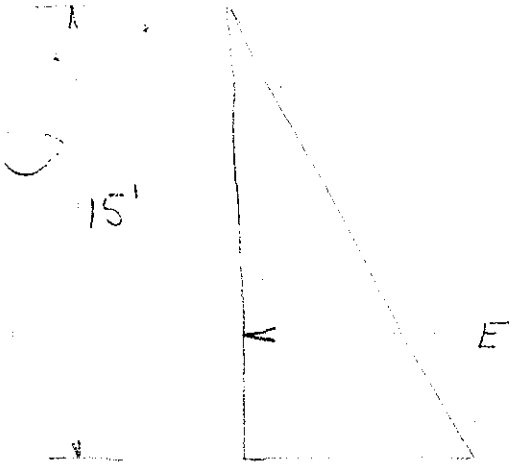
1.12 1.12 / 1 2.78 — V 0.84 W 0.84 / 1 2.78

$\frac{2.78-1}{2.11} \times 62.4 = 52.6\ \#/CF$ $\frac{2.78-1}{1.84} \times 62.4 = 60.5\ \#/CF$





WHARF
SOUTH BOSTON



$$E = (80\#/cf)(15')(1')(15')(\tfrac{1}{2})$$

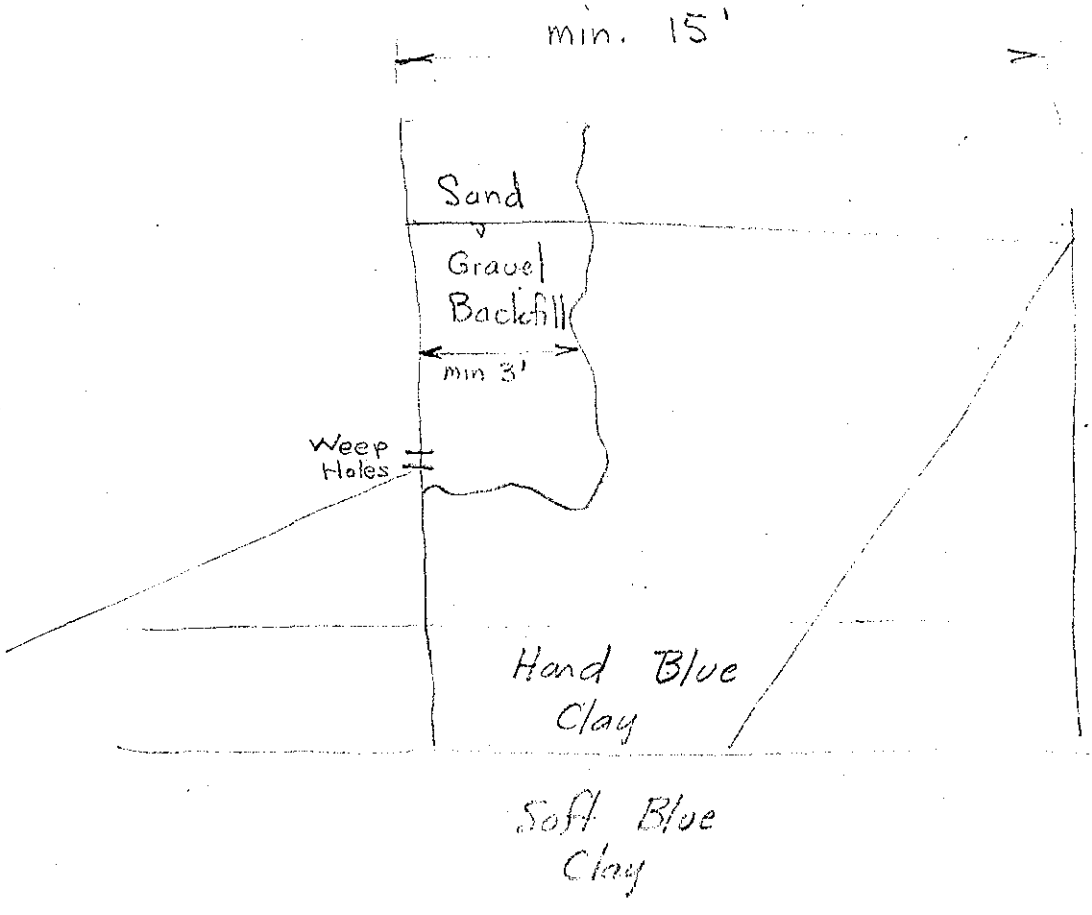
$$E = 9000\# = 9^k$$

$$4{,}300 = (x)(225)\tfrac{1}{2}$$

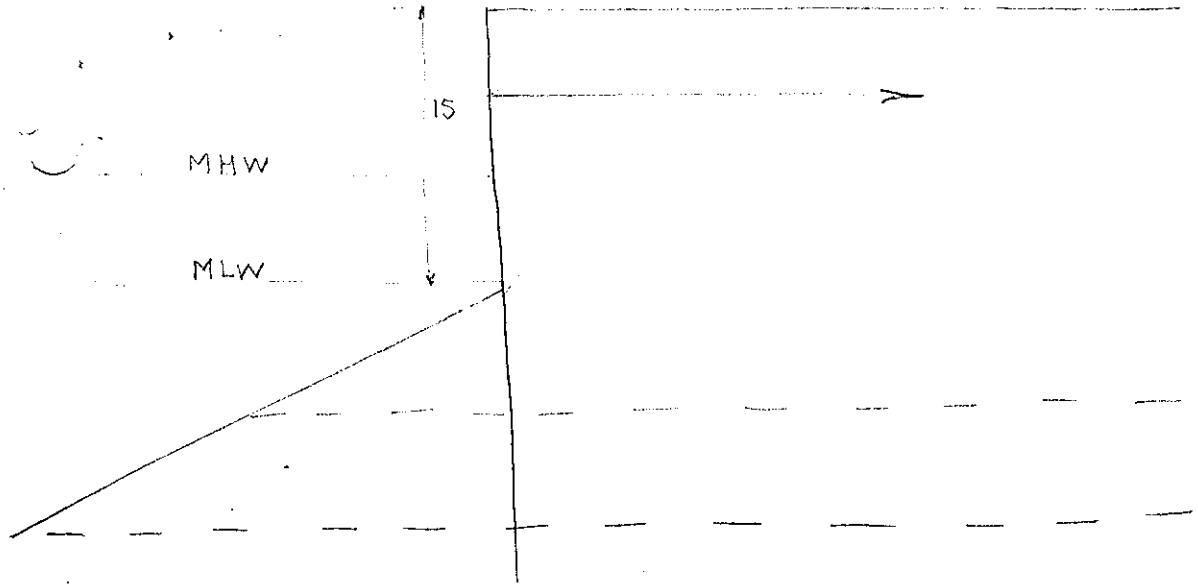
$$225 \overline{)8600} = 38$$
675
1850

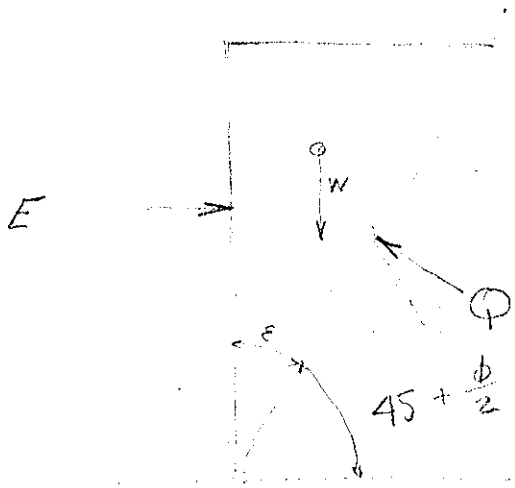
$$x = \frac{(4300)(2)}{225} = 38\#/cf$$

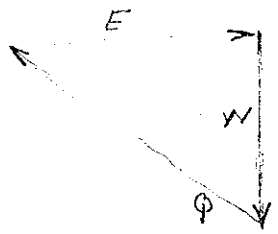
Suggested Design



Use equiv. fluid pressure of 40#/cu.ft. with such a design.







$\phi = 0$

Unit wt. soil = 115 #/cf (saturated)

$\varepsilon = 30°$ (Assumed)

(a) $E = \sqrt{3} \times W$ (b) $E = \frac{W}{\sqrt{3}}$

$$W = \left(\frac{1}{2}\right)(15')\left(\frac{15'}{\sqrt{3}}\right)(1')(115\#/cf)$$

$$= \frac{(225)(115)}{2\sqrt{3}}$$

(a) $E = \sqrt{3} \times \frac{\overset{112.5}{\cancel{(225)}}(115)}{\cancel{2}\sqrt{3}} = 12937\#$

$E = 12.9^k/_1$

(b) $E = \frac{(225)(115)}{(2)\sqrt{3}\sqrt{3}}$

$= \frac{(225)(115)}{(2)(3)}$

$= 4309$

$= 4.3^k$

(Not computing surcharges)

Computation of wgts.

1) $(15.5 \times 13.9 \times 0.06) + (\frac{14}{2} \times 9.7 \times 0.025) = 24.9$ Tons

2) $(15.5 \times 50.9 \times 0.06) + (14 \times 50.9 \times .025) + (10 \times 46.5 \times .03) + (18.5 \times 42.2 \times .025) = 98.5$

3) $(\frac{1}{2} \times 14.7 \times 29.0 \times 0.025) + (10 \times 38.3 \times 0.03) + (48.5 \times 39.6 \times 0.025) = 64.8$

4) $(27.4 \times 36.3 \times 0.025) = 24.8$

5) $(\frac{1}{2} \times 62.9 \times 26.5 + \frac{2}{3} \times 68.1 \times 4.1)\ 0.025 = 25.4$

Tangential Forces +	−
4.8	−0.5
6.1	−7.5
1.8	
7.7	−8.0

7 tons net Driving T
2 T from Fill Res.
5 T to be resisted by clay

Resisting Forces

Fill { Assume c = 0.15 T/sf
Res. F = 0.15 × 84.8 = 5.2 tons

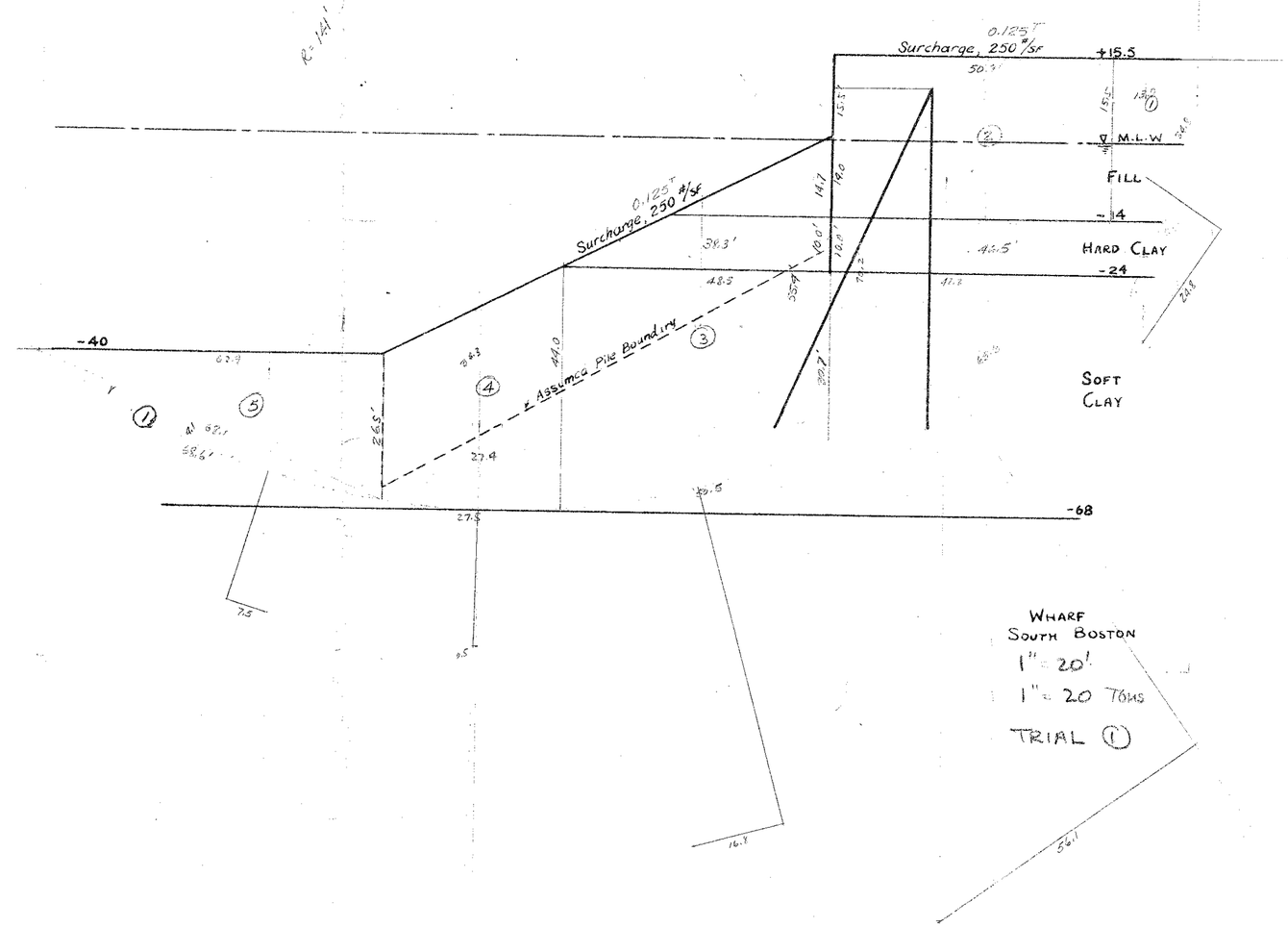
Clay: Arc L.
65.6
50.5
27.5
68.6
212.2

Req'd c of clay $= \frac{84.5}{212.2} = 0.40$ T/sf

Actual c of clay = 900 T/sf ±

$F = \frac{900}{677} = 1.3$

(No Surcharge)
Stability Analysis
Wharf, South Boston



Weights of Slices

Slice ①

0.125 × 13.8 = 1.7
0.060 × 10.4 × 16.0 = 10.0
0.025 × 4.0 × 14.0 = 1.4
13.1

Slice ②

0.125 × 22.1 = 2.8
0.060 × 22.1 × 15.5 = 20.6
0.025 × 22.1 × 14.0 = 8.6
0.030 × 18.9 × 10.0 = 5.7
0.025 × 8.1 × 15.5 = 3.1
40.8

Slice ③

0.218 × 48.2 = 10.5
0.025 × 14.8 × 14.8 = 5.5
0.030 × 38.9 × 10.0 = 11.7
0.025 × 43.2 × 34.7 = 38.2
65.9

Slice ④

0.218 × 32.5 = 7.1
0.025 × 32.5 × 35.8 = 29.1
36.2

Slice ⑤

0.025 × 14 × 73.5 = 25.7
0.025 × 2/3 × 78.7 × 6.6 = 8.7
34.4

Driving Forces

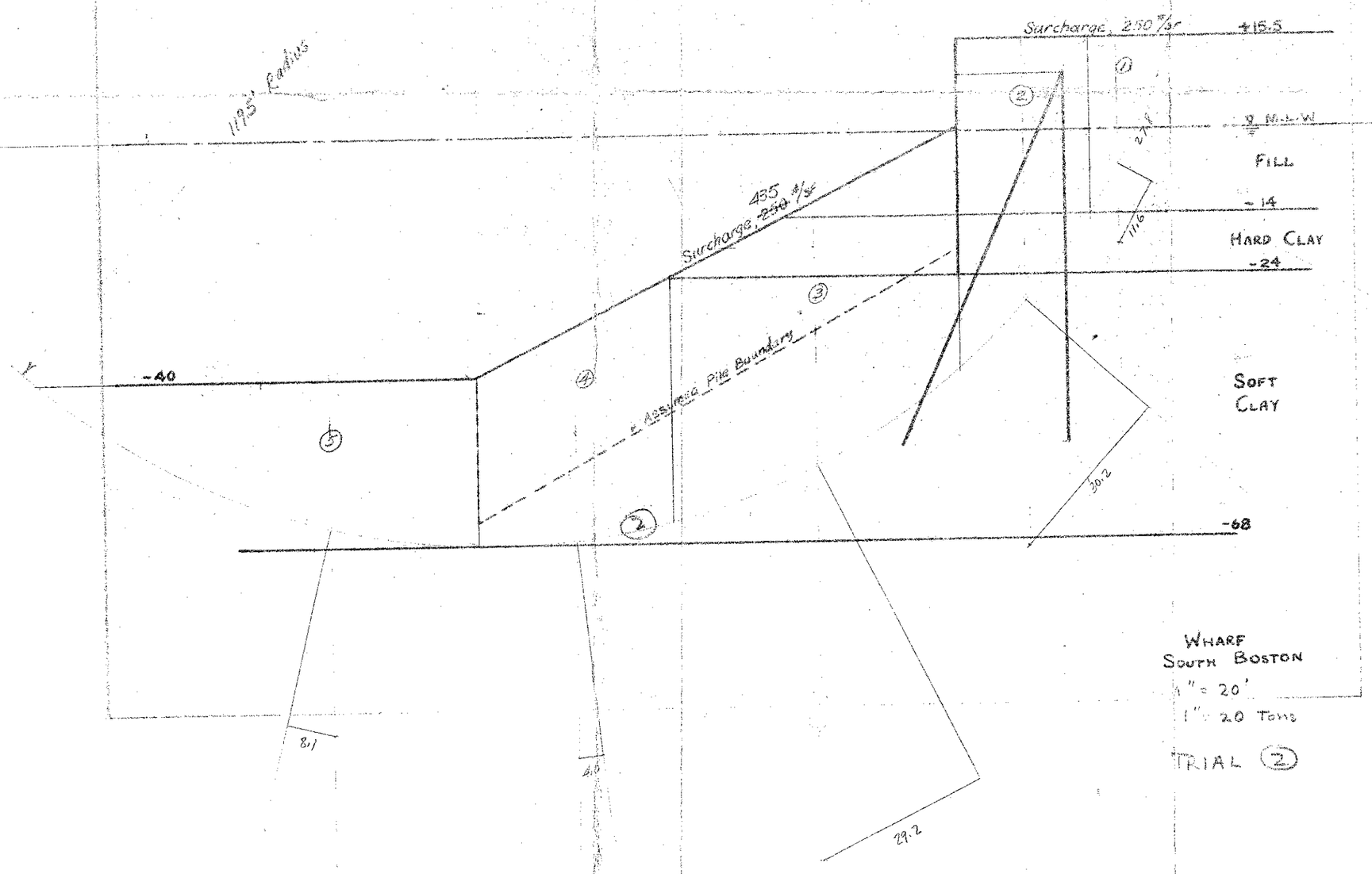
+
11.6
30.2
29.2
4.0
75.0
− 8.1
+ 67.9 Net Driving Force

Resistance in Fill = 27.8' × 0.15 T/SF
= 4.2 Tons

Resistance Req'd from Clay
= 67.9 − 4.2 = 63.7 Tons

Arc length, clay = 202.3'

Req'd. Shearing Strength
= 63.7 / 202.3 = 0.315 T/SF
= 630 #/SF



WHARF
SOUTH BOSTON
1" = 20'
1" = 20 Tons
TRIAL ②

Slice ①

0.125 × 27.0 = 3.4
0.060 × 31.2 × ½ × 20.3 = 19.0
0.025 × 7.0 × 7.2 = 1.3
23.7

Slice ②

0.125 × 39.1 = 4.9
0.060 × 39.1 × 15.5 = 36.4
0.025 × 39.1 × 14.0 = 13.7
0.030 × 33.0 × 10.0 = 9.9
0.025 × 26.5 × 9.5 = 6.3
71.2

Slice ③

0.125 × 39.1 = 4.9
0.060 × 39.1 × 15.5 = 36.4
0.025 × 39.1 × 14.0 = 13.7
0.030 × 39.1 × 10.0 = 11.7
0.025 × 39.1 × 27.1 = 26.4
93.1

Slice ④

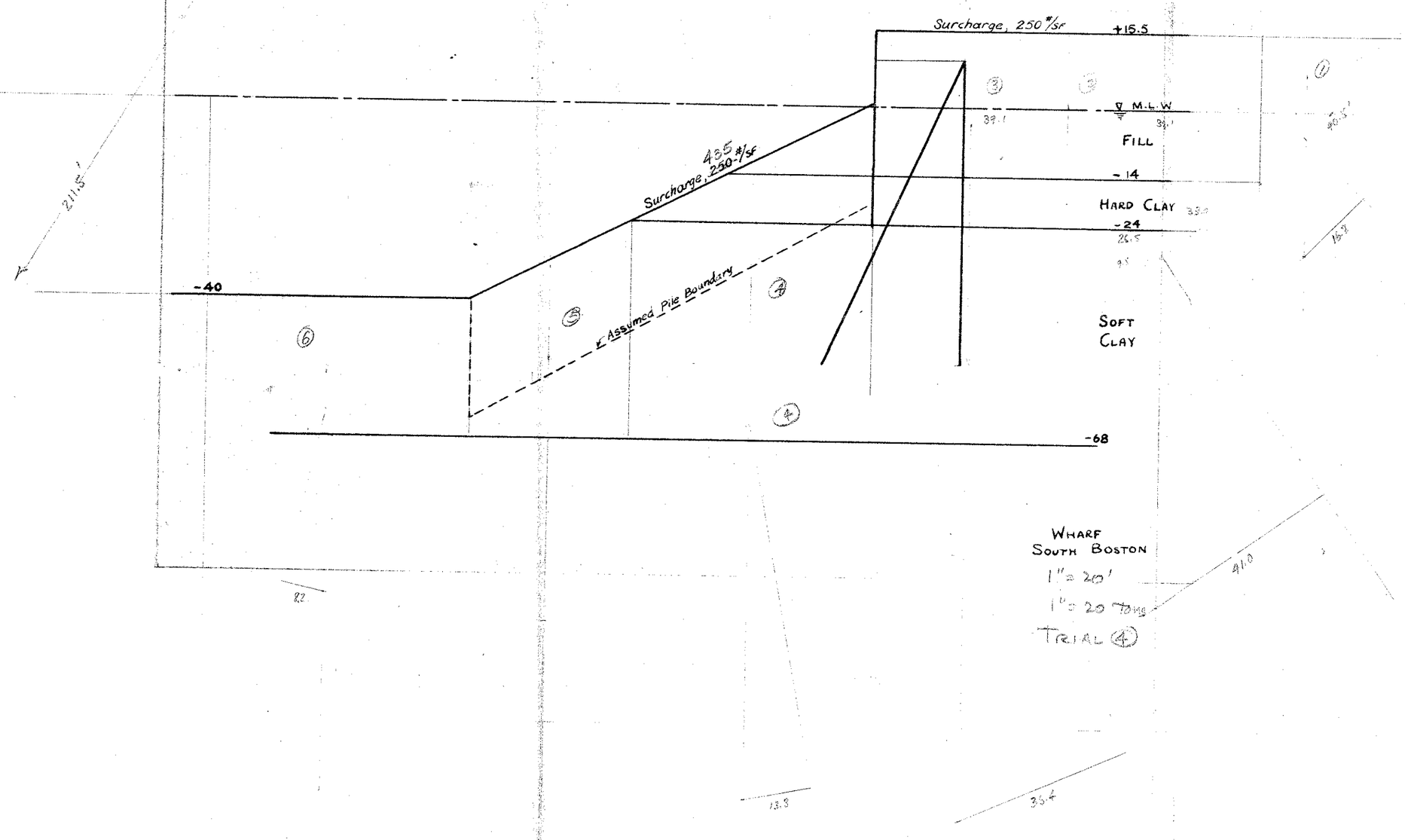
Previous Analyses 10.5
5.4
11.7
0.025 × 48.2 × 40.4 = 48.6
76.2

Slice ⑤

(No tangential)

Slice ⑥

0.025 × $\frac{87.0}{2}$ × 27.2 = 29.6
0.025 × ⅔ × 91.0 × 4.9 = 7.4
37.0



Driving Forces

+16.8
+41.0
+36.4
+13.8
108.0
− 8.2
+ 99.8 Net Driving Force

Resistance in Fill = 40.5' × 0.15 = 6.1 Tons

Resistance to be supplied by clay

= 99.8 − 6.1 = 93.7 Tons

Frictional Unit Resistance Reqd.

= $\frac{93.7 \text{ Tons}}{264'}$ = 0.355 Tons/SF

= 710 #/SF

WHARF
SOUTH BOSTON
1" = 20'
1" = 20 Tons
TRIAL ④

Computation of Weights

Slice ①

Surcharge = 0.125 × 17.7 = 2.2
Wet Fill = 0.060 × 15.5 × 14.0 = 13.0
Sub. " = 0.025 × ½ × 9.7 × 14.0 = 1.7
16.9

②

0.125 × 50.1 = 6.3
0.060 × 50.1 × 15.5 = 46.6
0.025 × 50.1 × 14 = 17.5
0.03 × 10.0 × 45.5 = 13.7
0.025 × 18.2 × 41.5 = 18.9
103.0

③

Sn. 0.125 × 48.5 = 6.1
0.025 × $\frac{29.0}{2}$ × 14.7 = 5.3
0.030 × 10 × 38.8 = 11.6
0.025 × 48.5 × 39.2 = 47.5
70.5

④

0.125 × 32.2 = 4.0
0.025 × 32.2 × 36.2 = 29.2
33.2

⑤

0.025 × 18 × 64 = 28.8

Driving Forces

+T	−T
+14.0	−0.8
62.8	8.2
17.9	
+94.7	9.0
−9.0	
+85.7 T	Total Driving Force, Tons.
−5.2	Resisted by Fill
80.5 T	Resisted by clay

Resisting Force

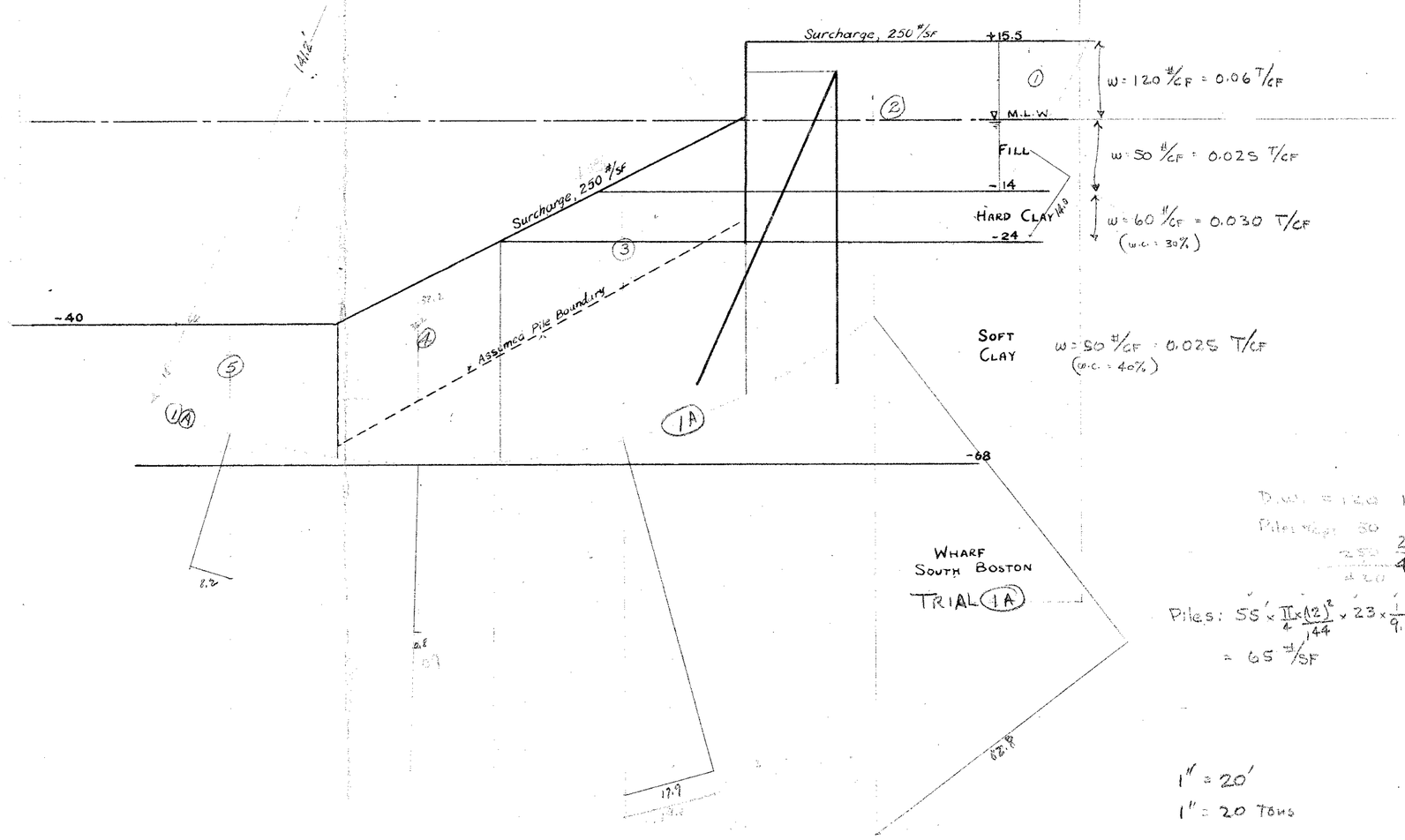
Fill, 34.8' × 0.15 T/SF = 5.2 Tons
Clay, = 218.2'C

$C = \frac{80.5^T}{218.2} = 0.368$ T/SF = 737 T/SF Required Shearing Strength (Surcharge)

Actual Shearing Strength = 900 T/SF

Factor of Safety = $\frac{900}{737}$ = 1.2

Stability Analysis
Wharf, South Boston



D.W. = 120 120
Piles Top 50 65
250
435

Piles: $55' \times \frac{\pi \times (12)^2}{144} \times 23 \times \frac{1}{9.5} \times \frac{50}{81}$
= 65 #/SF

1" = 20'
1" = 20 Tons

Computation of Weights of Slices

Slice ①

0.125 × 13.2 = 1.6
0.06 × 10 × 15.5 = 9.3
0.025 × 7.2 × 14.0/2 = 1.3
12.2

Slice ②

0.125 × 28.0 = 3.5
0.06 × 28.0 × 15.5 = 26.0
0.025 × 28.0 × 14.0 = 9.8
0.030 × 25.2 × 10 = 7.6
0.025 × 22.0 × 13.8 = 7.6
54.5

Slice ③

0.218 × 48.1 = 10.5
0.025 × 28.8 × 14.8/2 = 5.3
0.030 × 38.8 × 10 = 11.6
0.025 × 48.1 × 38.2 = 46.0
73.4

Slice ④

0.218 × 32.5 = 7.1
0.025 × 35.9 × 32.5 = 29.2
36.3

Slice ⑤

0.025 × 16.2 × 60.9 = 24.6

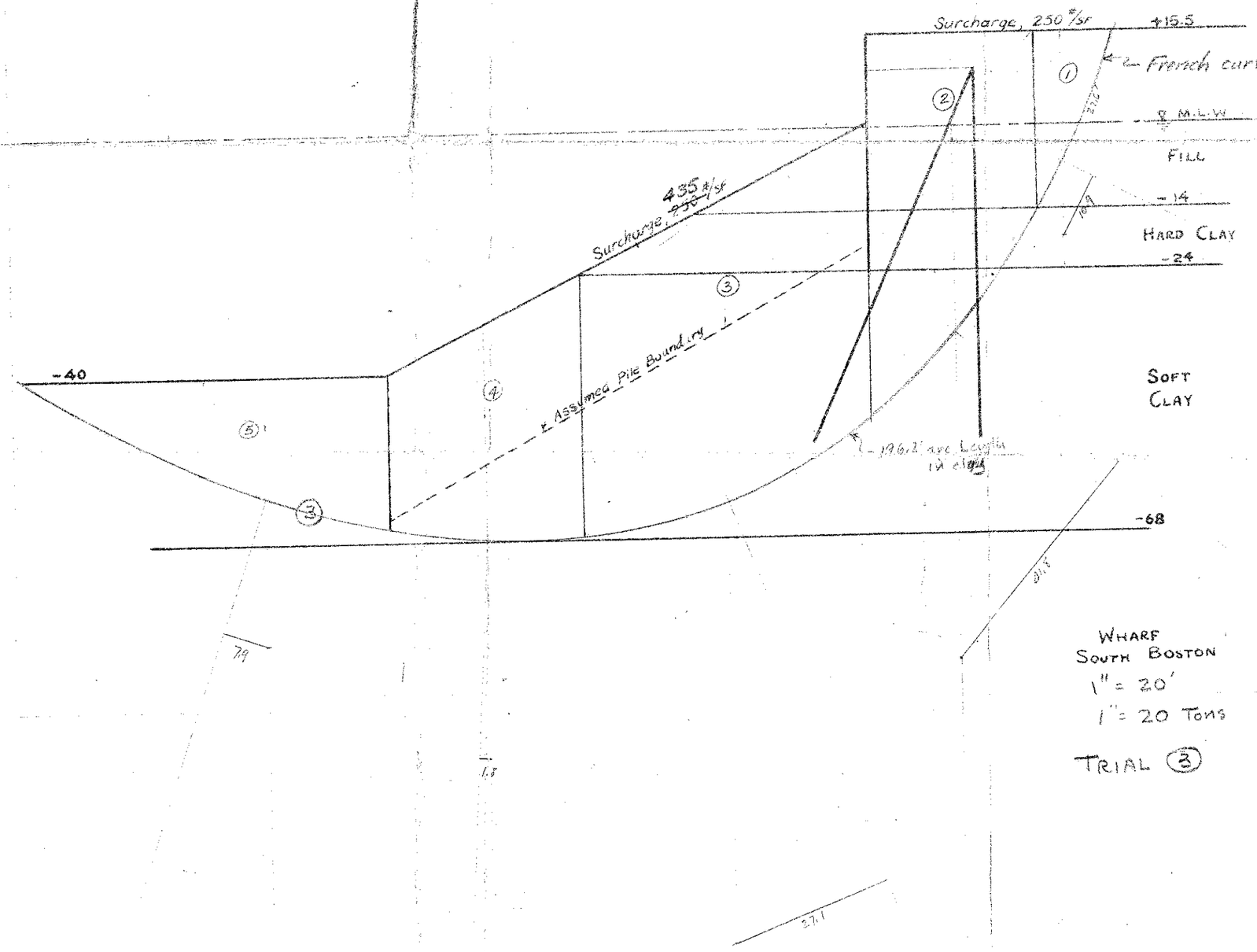
Driving Forces

+	−
10.9	1.8
41.8	7.9
27.1	9.7
79.8	
− 9.7	
70.1 Tons, Net Driving Force	

Resistance in Fill = 22.0' × 0.15 T/SF = 3.3 T

70.1 − 3.3 = 66.8 Tons to be resisted by clay

Req'd. Shearing Strength = 66.8 / 196.2' = 0.340 T/SF = 680 #/SF



ACTUAL SHEARING STRENGTH = 900 PSF
REQ'D " " = 680 PSF

SAFETY FACTOR = G_s = 900/680 = 1.3

GEORGE B. SOWERS
Consulting Engineer
1836 Euclid Avenue
Cleveland

1220

COPY

January 10, 1942

Mr. John E. Allen
Chief Engineer
U. S. District Engineer Office
Park Square Bldg.
Boston, Mass.

Dear Mr. Allen:

Travel orders duly received and await your instructions to go to Washington.

In reference to piling specifications I wired you late today as follows:

SUGGEST PILE SPECIFICATION PROVIDE ALL PILES DRIVEN INTO GLACIAL TILL NOT LESS THAN FIVE FEET AT NOT LESS THAN TWENTY BLOWS PER FOOT BUT NO PILE HAVING SEVEN INCH POINT BE HAMMERED MORE THAN THREE BLOWS PER INCH FOR ANY FOUR INCHES OR LARGER POINT MORE THAN 4 BLOWS ALL USING FIVE THOUSAND RAM DELIVERING FIFTEEN THOUSAND ENERGY.

Point, or at best end bearing, timber piles in the very peculiar but not unusual soil conditions at the L.L. wharf are the most economical supporting members that can be provided in a minimum of time for your proposed wharf. Since they must be very long with small sized points (7" or better I hope) there is great danger of their being sheared off or broken if over driven in the layer of hard glacial till or so called "hardpan". (The Bureau of Public Roads describe "hardpan" as a thoroughly cemented indurated, rock-like layer that will not soften when wet.")

Due to the very soft, plastic character of the clay overlying the hard glacial till it is very desirable or even imperative that the piles penetrate the hard layer for at least a few feet.

No dynamic pile driving formulae devised to show the probable safe load for an individual pile has any application to piles driven under the soil conditions obtaining at the L.L. wharf site. Each pile will be an end supported column capable of carrying, without settlement, all of the load that the column structure can itself support as a long column. Failure will not be through further penetration of the pile.

I watched piles driven through identical material across the channel and I studied numerous records of actual piles driven in this soil and tested as well as the records of piles just driven. These and your numerous probings and borings all were given careful consideration in preparing my suggestion for a rule to be followed in driving the 6,000 timber piles.

No dynamic pile formulae is applicable and none should be included in the specifications. You want to secure a pile that is firmly set in the hard glacial till layer and one that has not been over-driven.

Twenty blows per foot for five feet with a 5,000# ram striking a blow of 15,000 foot-pounds is quite adequate to insure a firm seat in the material and hold the pile point against any further penetration under a load of 15 tons. It will also insure penetration of the upper hard clay layer.

Just to indicate what 20 blows per foot means on a 3,000 to 3,500 pound, 85' long timber pile when struck by a 5,000# ram delivering 15,000 foot pounds of energy at the butt I have computed several commonly and even rarely used formulae as follows:

Eytelwein formulae:

Safe load $= \dfrac{2WhH}{S(1+\frac{Wp}{Wh})}$ = 15 + tons

Engineering News formulae of 1888

S.L. $= \dfrac{2WhH}{S + 0.1}$ = 20 tons

A Navy formulae - Bureau of Yards and Docks Bul. 33 p. 46.

S.L. $= \dfrac{2WhH}{S + 0.3\,\frac{Wp}{Wh}}$ = 19 - tons

Chicago Building Code

S.L. $= \dfrac{2WhH}{S(1 + 0.3\,\frac{Wp}{Wh})}$ = 20 + tons

Hiley formulaes - Bookby Russell V. Allen and printed in England

Ultimate resistance (no factor of safety) $= \dfrac{KWH}{S + \frac{C}{2}}$ = 47 tons

While the simplified Hiley formulae given in the A.S.C.E. report gives a safe load of only 10 tons.

Experience has shown that no timber pile with a 6" or 7" diameter point should be driven with the above heavy hammer to a resistance of more than about 3 blows per inch for 4 inches and that an 8" to 10" point should not be driven to more than 4 blows per inch for 4 inches, hence my restriction in the suggested rule.

A 7" diameter point timber pile which has brought up solid on the hard layer of soil will develop compression on the end of the timber grain of less than 800 pounds per square inch. Wet or damp Douglas Fir is usually considered to have a safe unit compressive stress of 800 to 900 pounds per square inch in columns.

If we examine the longest pile as a long column using Euler's formulae for critical load we find that the pile has a critical load value of about 60 tons or a factor of safety of four.

The front rows of piles, as firmly braced, are capable of supporting the design loads used.

Very truly yours,

/s/ George B. Sowers

GBS:R

GEORGE B. SOWERS

2

January 17, 1942

Mr. J. E. Allen, Chief, Defense and Flood Control Subdivision,
U. S. Engineer Office, Boston, Mass.
Pile Driving Criteria, Lend-Lease Wharf, East Boston, Mass.

1. Reference is made to letter dated January 10, 1942, signed by Mr. George B. Sowers, Consulting Engineer, Cleveland, Ohio, concerning pile driving criteria, Lend-Lease Wharf.

The statements made Mr. Sowers are in general concurred with, however there are several considerations which, it is believed, may modify the conclusions reached.

2. It is my opion that piles need not necessarily penetrate to the compact glacial till except where the hard to medium yellow clay is of insufficient thickness to produce the required resistance, or at the front half where this stratum has been dredged. In the back half of the wharf, piles reaching sufficient bearing capacity in the hard to medium yellow clay should be entirely satisfactory.

3. Dynamic pile driving formulas are known to be conservative when applied to piles driven into clay. Hence, piles on the Lend-Lease wharf which develop the required bearing capacity, as measured by the modified Hiley Formula included in the specifications, should be entirely satisfactory from the standpoint of load carrying capacity without slip relative to the soil.

4. The dead load of the wharf including piles is less that 0.1 ton per square foot. This unit pressure is equivalent to about 3 to 4 feet of soil, submerged unit weight. Dredging will remove considerable overburden which will more that compensate for the superimposed loads. Hence, consolidation of the soft blue clay, underlying the hard to medium yellow clay, is not expected due to dead weight. Live loads even if acting continuously for several weeks should not cause consolidation as such periods are exceedingly short compared with the total time required to effect the consolidation.

5. It is true that the hard to medium yellow clay stratum is of variable thickness; however, there may be several areas in which piles may reach sufficient bearing capacity in this stratum. In these areas it is my recommendation that the saving both in time and cost resulting from shorter piles be realized. The determination of bearing capacity of all piles particularly those stopping in the hard to medium clay by the modified Hiley formula in the specifications is recommended.

William L. Shannon
Associate Engineer

D. O. Form 116

WAR DEPARTMENT
United States Engineer Office
3rd Floor, Park Square Building
31 St. James Avenue
Boston, Mass.

May 12, 1942.

MEMORANDUM TO: Mr. J. E. Allen, Principal Engineer, War & Flood Control Subdivision, U. S. Engineer Office, Boston, Mass.
CONCERNING: Pile Loading Test, Wharf, South Boston, Mass., May 9 and 10, 1942.

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1. Purpose of Test. On May 9 and 10, a loading test was performed to check the design bearing value of 15 tons per pile for factor of safety, and to determine the maximum allowable load.

2. Method. The test was performed by using a hydraulic jack to load the pile. Two piles, located 5 feet on each side, were used as reactions. Level readings were taken during the loading to determine the changes in elevation of the loaded pile and the two reaction piles. The maximum load which could safely be applied by the apparatus was 50 tons. Attached is a schematic diagram showing method of loading.

3. Pile Tested. Pile I in bent 17 was selected for test. Selection was based primarily upon ease of installing the loading apparatus and performance of test. Data on the driving of this pile are on the sheet showing the test curve.

4. Description of Test. Loading was begun at 7:00 P.M., May 9, 1942, and completed at 6:00 P.M., May 10, 1942. Generally, increments of 5 tons were applied every two hours. At a load of 35 tons, corresponding to a unit pressure of 420 lbs. per sq. in., a section of cap, which had been left on the pile, failed by crushing perpendicular to the grain. The pile was unloaded, a vertical bearing block substituted, and reloaded in 30 minutes to 35 tons and then to 48 tons as before.

5. Results. Attached is a plot of the load on the pile versus its settlement at end of each load increment. The settlement was only 0.05 inches at the design load of 15 tons, and 3.7 inches at 48 tons. The maximum load corresponds to 0.35 tons per square foot of imbedded surface.

6. Conclusions. Criteria for interpreting loading tests have been suggested by Dr. Casagrande, and appear applicable here. He recommends that the maximum allowable load not exceed either the load at 1/2 inch deformation, one-half the load at failure, or one-half the maximum load reached in the test. This results in a factor of safety of 2. Applying the criterion of 1/2 the total load, the allowable load is 24 tons. This load corresponds to 0.18 tons per square foot of imbedded surface. Applying the criteria of 1/2 inch deflection, the allowable load is 30 tons or 0.23 tons per square foot of imbedded area. Applying this loading test data to predict the results of the loading test to be performed upon

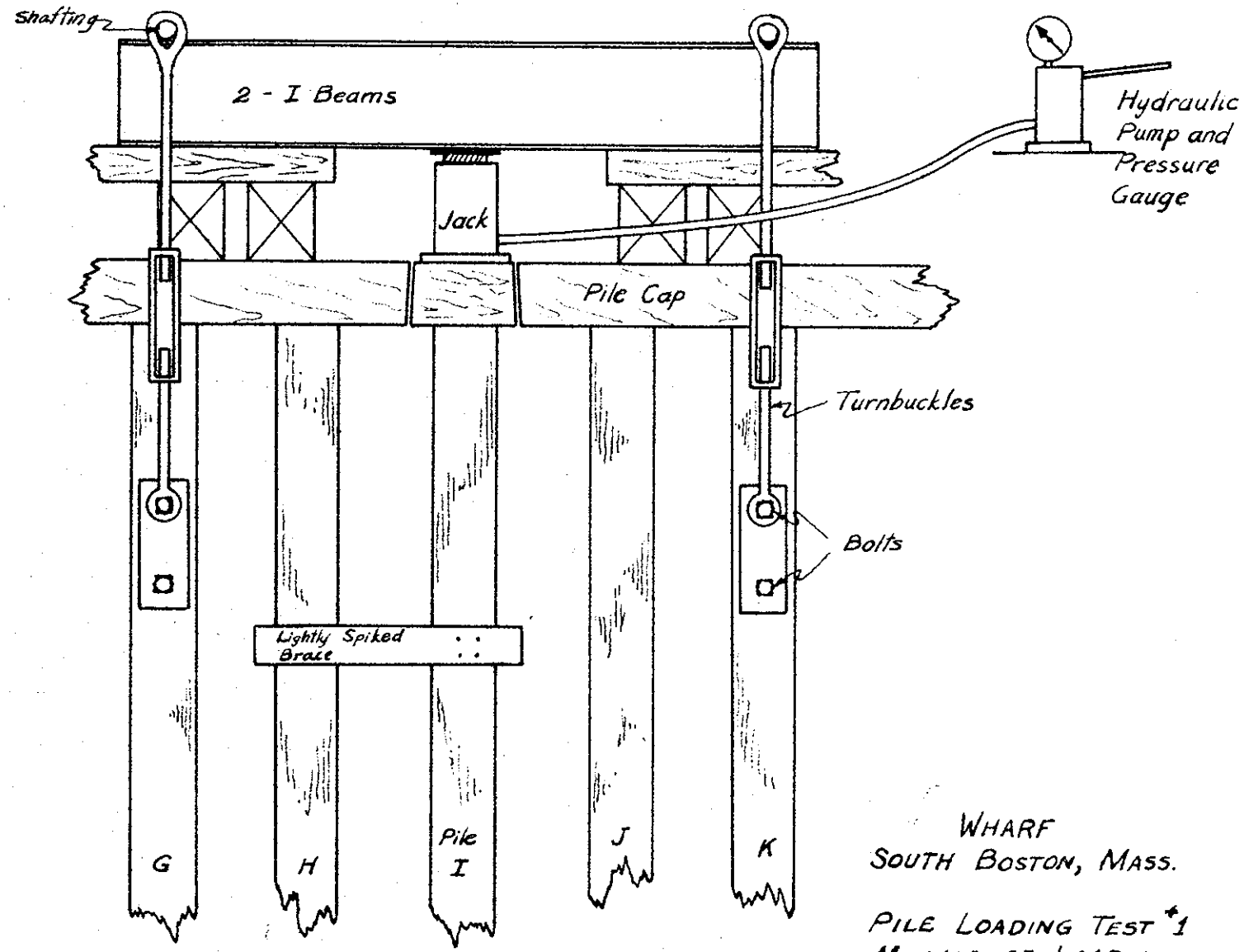
an unlagged pile, it is estimated that failure will result at about 30 tons total load and that the load at 1/2 inch deflection will be about 15 tons.

7. Recommendation. It is recommended that driving of lagged piles continue until the second test, upon an unlagged pile, is completed. If this second test confirms the results of the first, it will be recommended that lagging be reduced in size and number from 2 - 6" x 8" to 3 - 2" x 4". These 2" x 4" may be spiked to the pile in contrast to bolts now used on 6" x 8".

William L. Shannon

William L. Shannon,
Associate Engineer,
Chief, Soils & Geology Section.

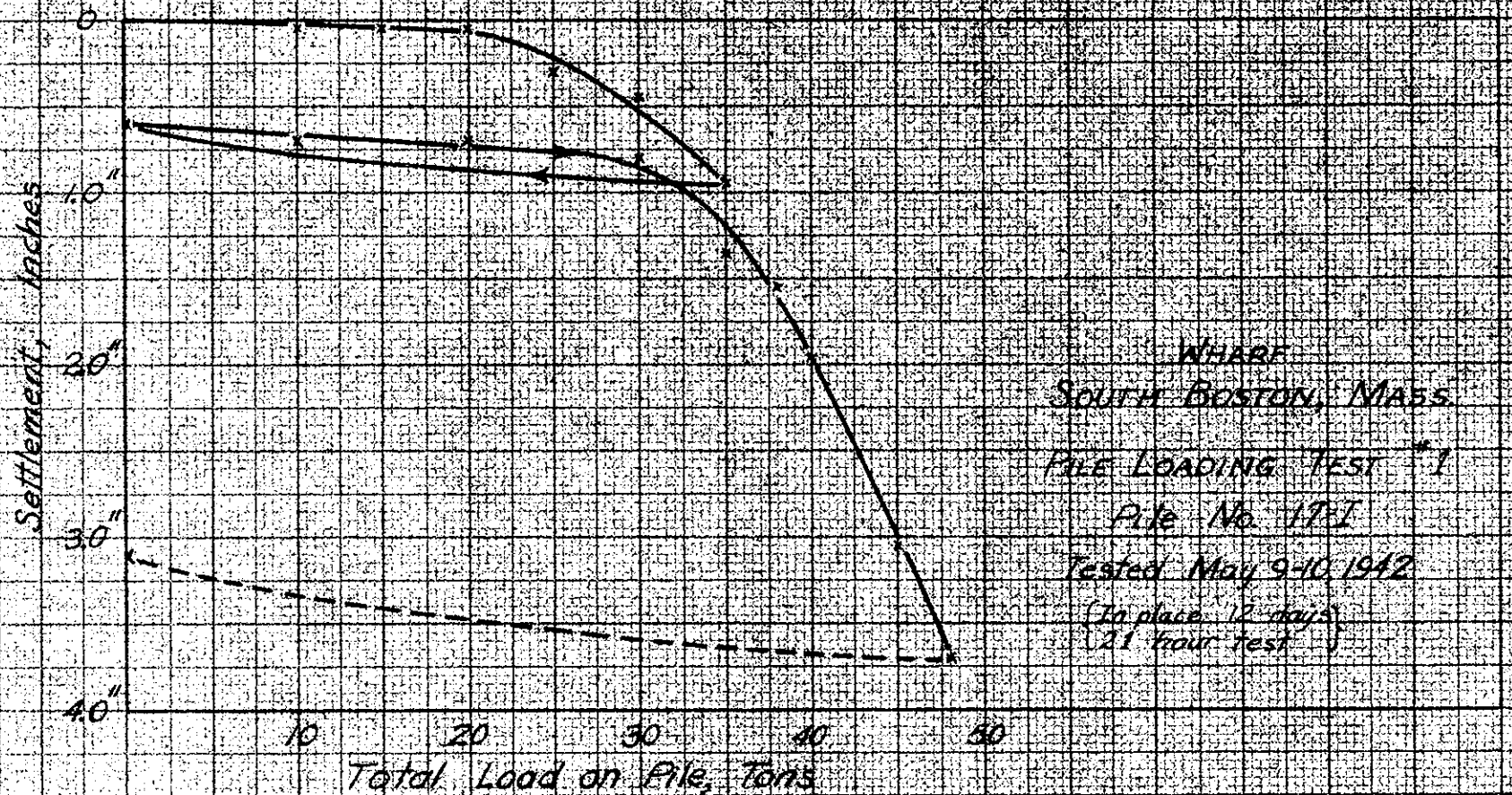
2 Incls.
2 Drawings.



WHARF
SOUTH BOSTON, MASS.

PILE LOADING TEST #1
METHOD OF LOADING

Note: Settlements were read on batter boards attached to piles G, I, K.

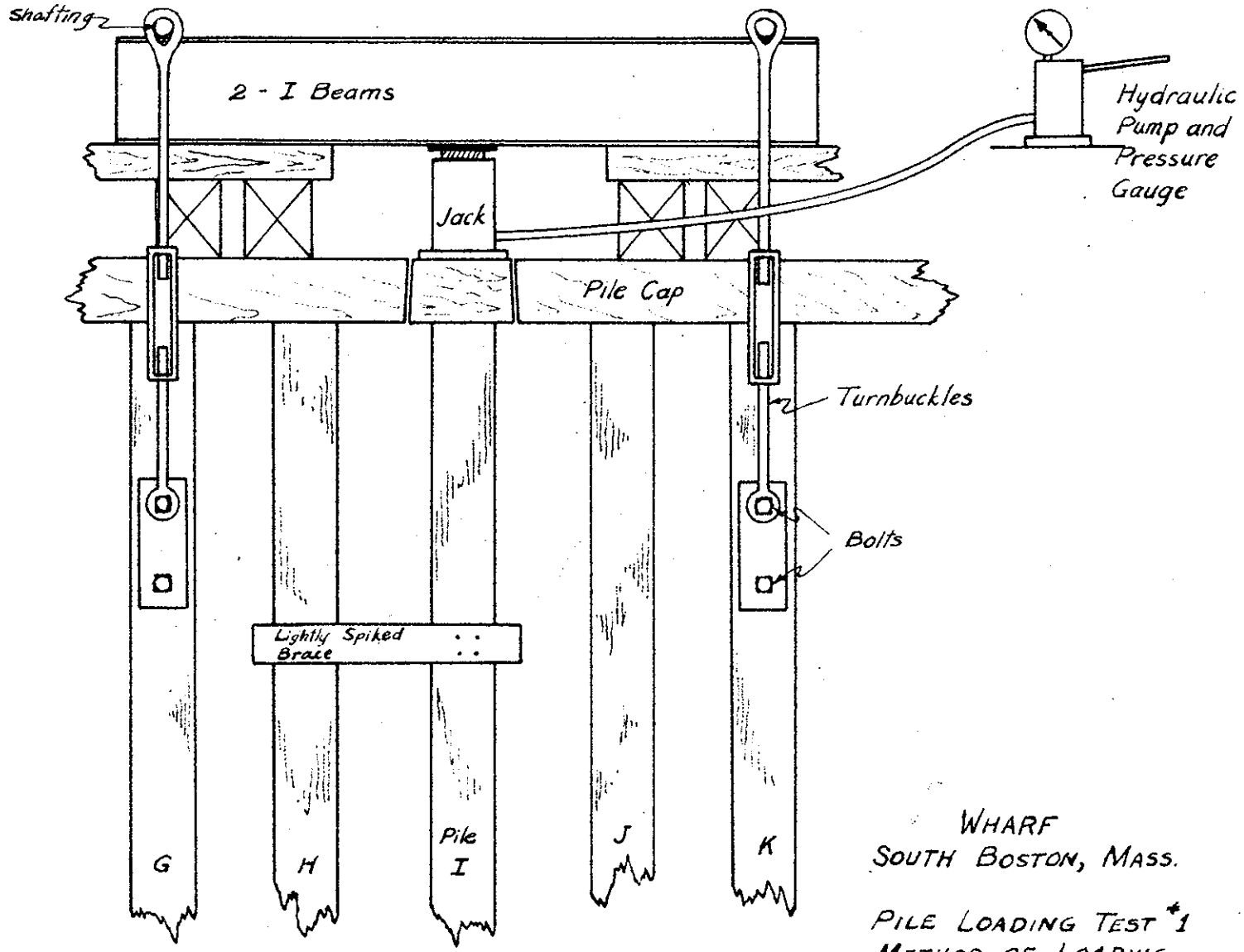


Data on Pile:

Length: 66.4'
Penetration: 25.6' into soft blue clay
Butt Diameter: 16"
Tip Diameter: 9"
Lagging: 3 - 6" x 8" x 20'0"

Data on Driving:

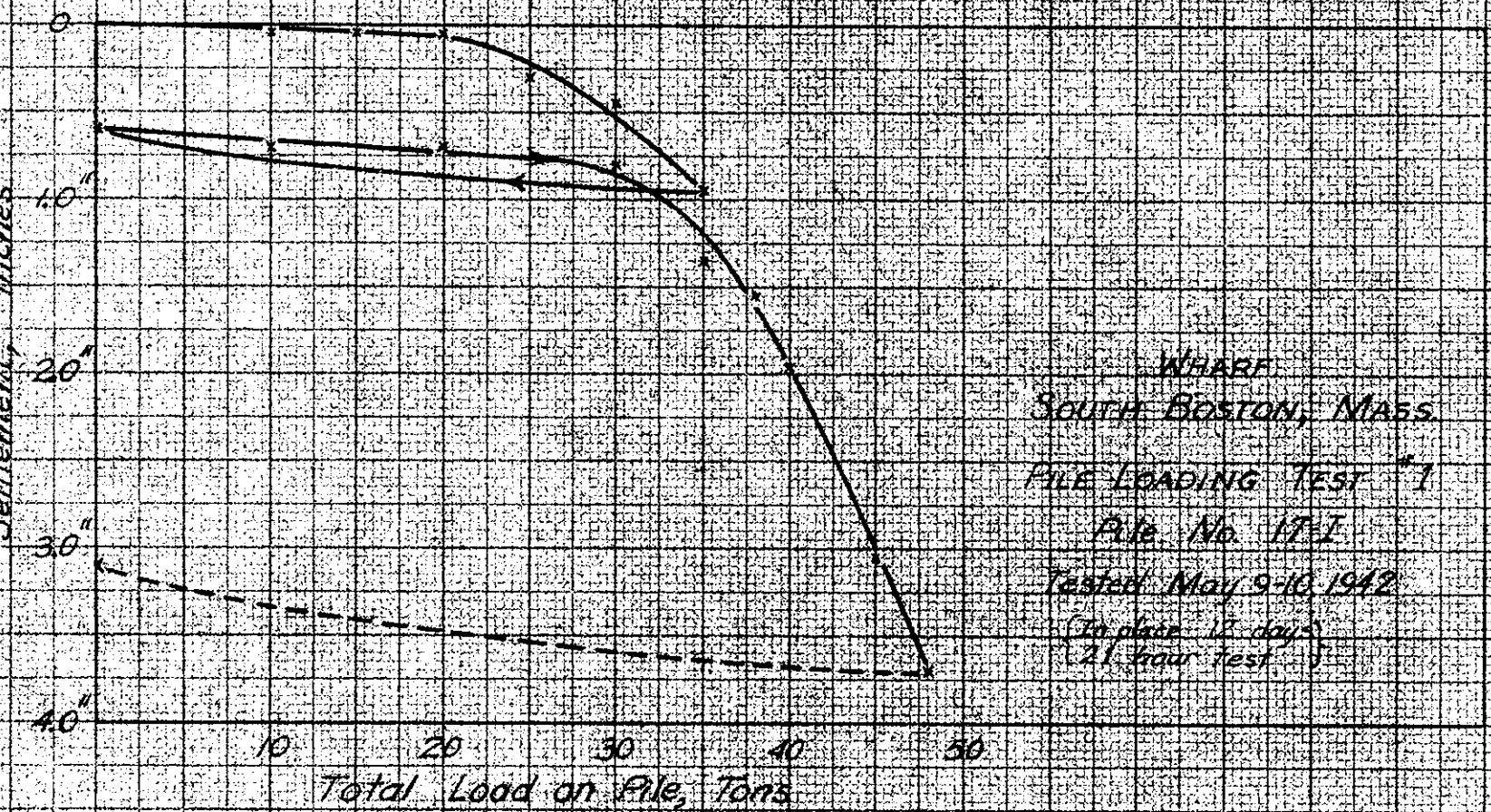
Date driven: April 27 1942
Hammer: 5,000#; 36" drop
Penetration: 1.5' under wgt. of hammer
1" per blow, last 4"
Total blows: 94



WHARF
SOUTH BOSTON, MASS.

PILE LOADING TEST #1
METHOD OF LOADING

Note: Settlements were read on batter boards attached to piles G, I, K.



WHARF
SOUTH BOSTON, MASS.

PILE LOADING TEST #1

Pile No. 17 I

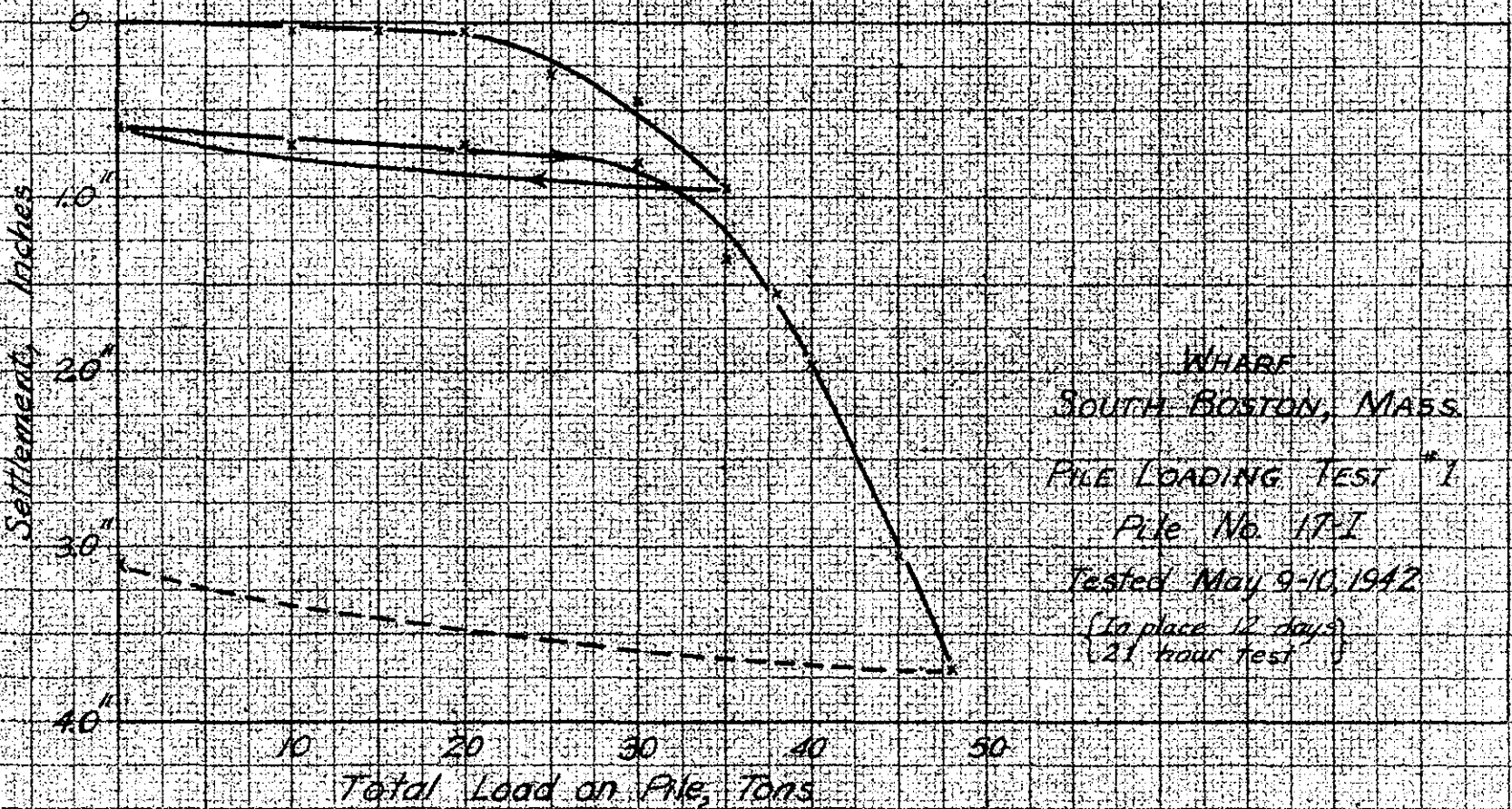
Tested May 9-10, 1942
(In place 17 days
21 hour test)

Data on Pile:

Length: 66.4'
Penetration: 25.6' into soft blue clay
Butt Diameter: 16"
Tip Diameter: 9"
Lagging: 3 - 6" x 8" x 20' 0"

Data on Driving:

Date driven: April 27, 1942
Hammer: 5,000#; 36" drop
Penetration: 1.5" under wgt. of hammer
1" per blow, last 4"
Total blows: 94

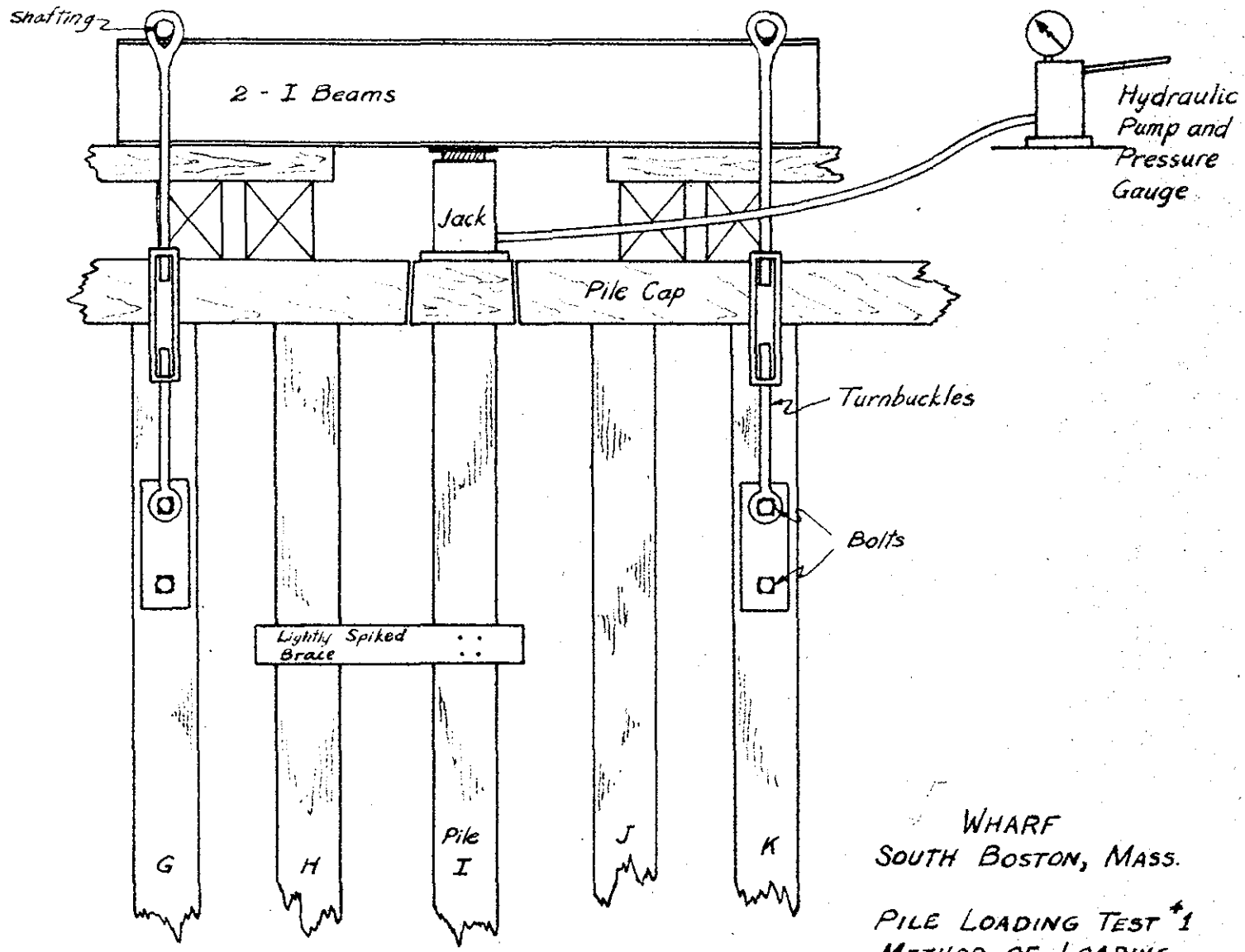


Data on Pile:

Length: 66.4'
Penetration: 25.6' into soft blue clay
Butt Diameter: 16"
Tip Diameter: 9"
Lagging: 3 - 6" x 8" x 20' 0"

Data on Driving:

Date driven: April 27, 1942
Hammer: 5,000# ; 36" drop
Penetration: 1.5' under wgt. of hammer
1" per blow, last 4"
Total blows: 94



WHARF
SOUTH BOSTON, MASS.

PILE LOADING TEST #1
METHOD OF LOADING

Note: Settlements were read on batter boards attached to piles G, I, K.

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject: Hiley Formula for Dynamic Pile Resistance

Computation: Values of k

Compared by: W.L.S. Checked by: Date:

$$k = \frac{3RL}{2AE} + C$$

R = Allowable pile load in lbs
L = Length of pile in inches
A = Av. sect. area of pile sq. in.
E = Mod. of Elas. lbs / sq. in.
C = Constant

Assume: $R = (15^T)(2000) = 30{,}000$ lbs.

$E = 1{,}600{,}000$ lbs / sq. in.

$C = 0.05$

Pile Lengths	Butt Diam in. Min.	Butt Diam in. Max	Min. Tip Diam. In.	Computed Av. Diam. Max.	Computed Av. Diam. Min.
40'	14	18	9	13.5	11.5
60'	14	18	8	13	11
80'	14	18	7	12.5	10.5
100'	14	20	6	13.0	10.0
110'	14	20	6	13.0	10.0

$$\frac{3R}{2E} = \frac{(3)(30{,}000)}{(2)(1{,}600{,}000)} = \frac{9}{320} = 0.0281$$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Page 2

Subject Hiley formula for dynamic pile resistance

Computation

Compared by NLS Checked by Date

Pile ft.	Length (L) inches	Av. Sectional Area □" (A)	$0.0281 \frac{L}{A}$	$\frac{3RL}{2AE} + C$
40	480	143.1	.0945	.14
		123.5	.109	.15
		103.9	.130	.18
60	720	132.7	.153	.20
		113.8	.179	.23
		95.0	.213	.25
80	960	122.7	.220	.27
		104.6	.258	.31
		86.6	.314	.36
100	1200	132.7	.254	.30
		105.6	.320	.37
		78.5	.430	.48
110	1320	132.7	.280	.33
		105.6	.352	.40
		78.5	.473	.52

WAR DEPARTMENT
U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject: Hiley formula for dynamic pile resistance

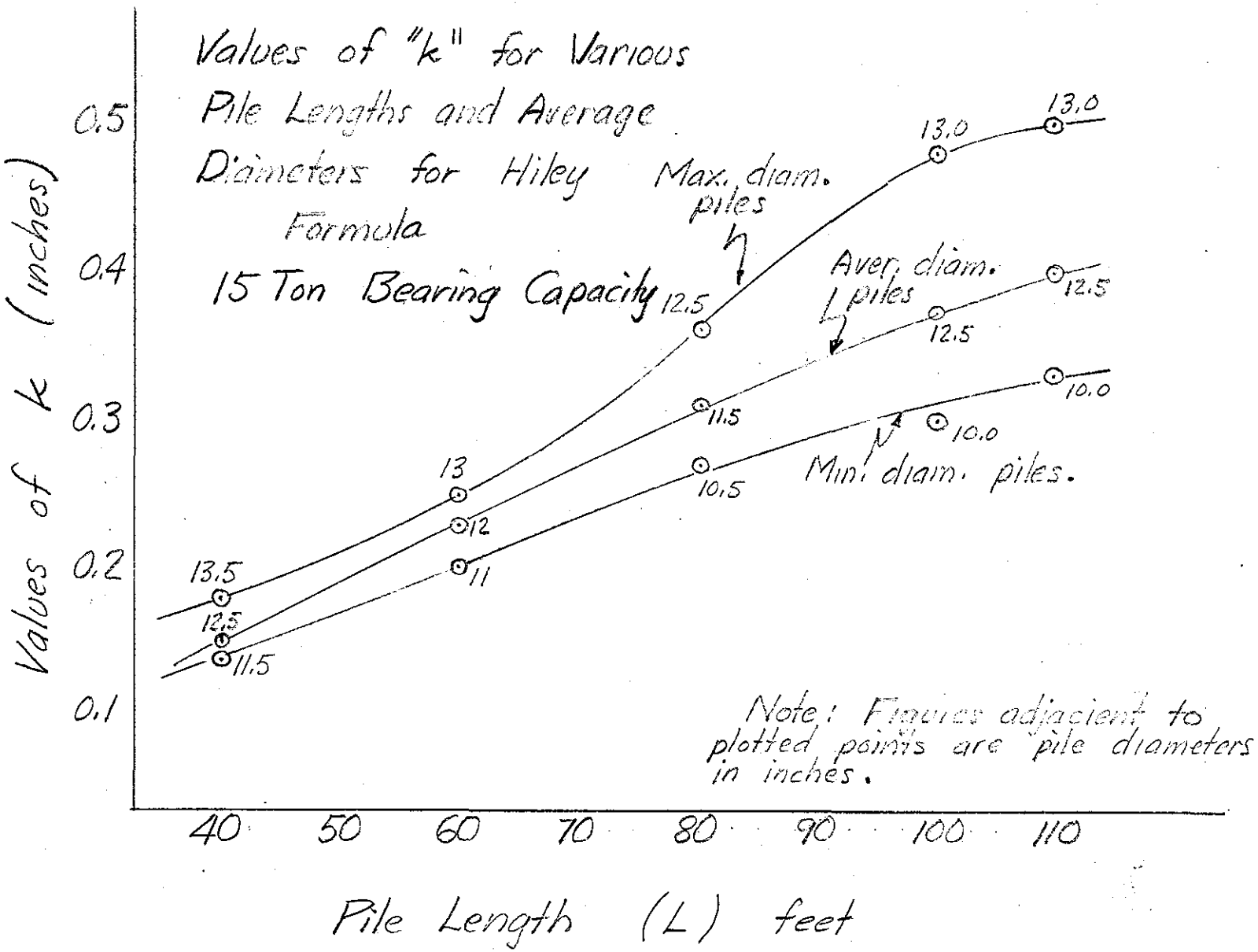
Computation:

Compared by: WLS

Checked by:

Date:

Page 3



WAR DEPARTMENT
U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject: Hiley formula

Computation: WLS

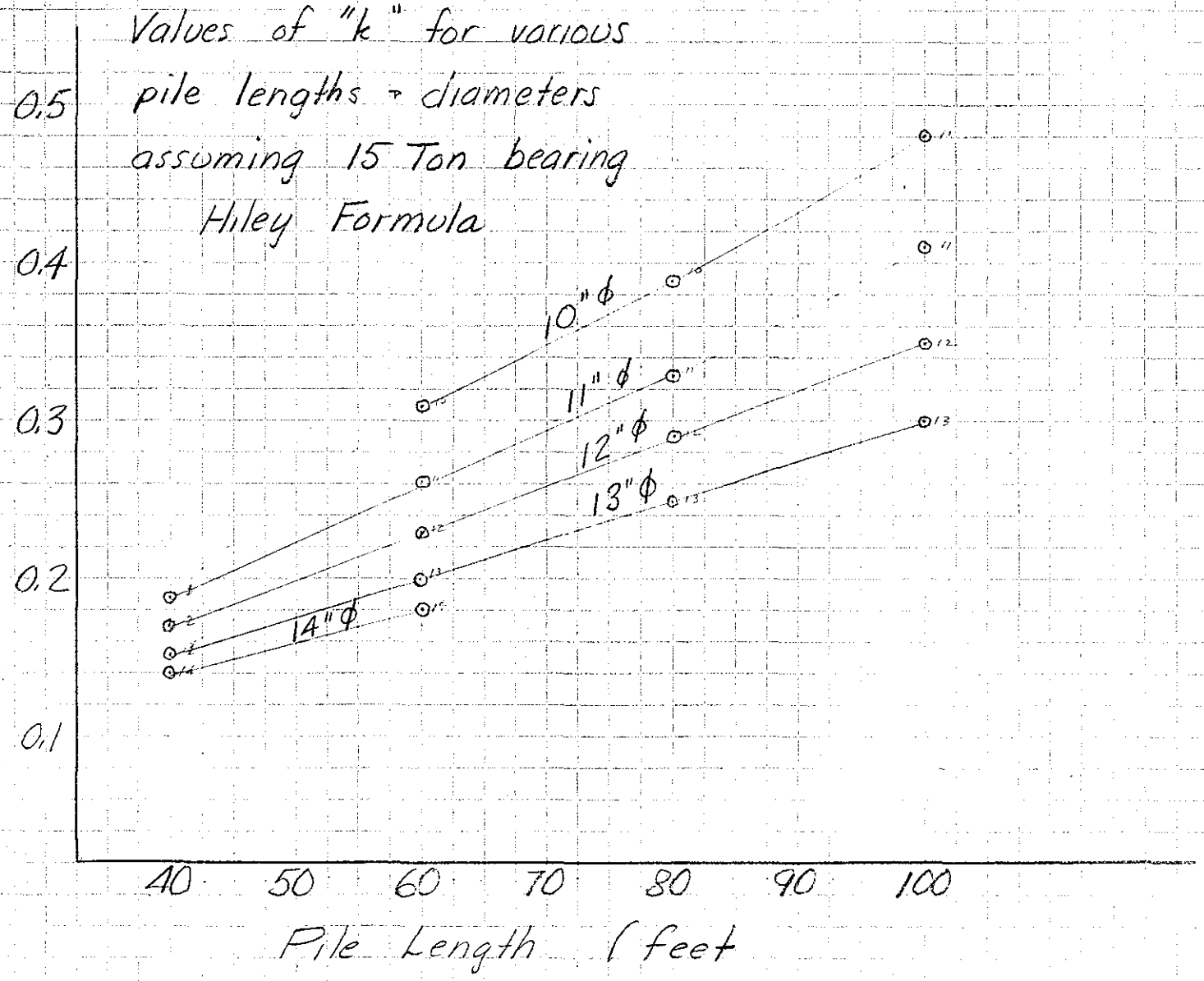
Computed by: ..... Checked by: ..... Date: .....

Page 4

Pile Length ft.	inches (L)	Av. Diam. "	(A) □"	$0.281 \frac{L}{A}$	$k = \frac{3RL}{2AE} + C$
40	480	11	95.0	.142	.19
		12	113	.120	.17
		13	133	.101	.15
		14	154	.088	.14
60	720	10	78.5	.258	.31
		11	95.0	.213	.26
		12	113	.179	.23
		13	133	.152	.20
		14	154	.131	.18
80	960	10	78.5	.344	.39
		11	95.0	.284	.33
		12	113	.239	.29
		13	133	.203	.25
100	1200	10	78.5	.430	.48
		11	95	.355	.41
		12	113	.299	.35
		13	133	.254	.30
110	1320	10	78.5		
		11	95		
		12	113		
		13	133		

WAR DEPARTMENT
U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject: Hiley formula
Computation:
Computed by: WLS
Checked by:
Date:
Page: 5



Subject Hiley formula

Computation

Computed by ..... Checked by ..... Date .....

Computation for Curve Sheet Assuming
5000# single acting steam hammer
3' Drop
Unit Wt. Piling 50#/cf
k for pile alone with no follower
(see page 5 for values used)

$$S = \frac{3.6\ WH}{R} \times \frac{W}{W+P} - k$$

$W = 5000\#$

$H = 3'$

$R = (15\ \text{Tons})(2000) = 30{,}000\#$

$$S = \frac{(\cancel{3.6}^{1.8})(\cancel{5000})(\cancel{3})}{\cancel{30{,}000}\ \cancel{6}\ 2} = 1.8\,\frac{5000}{5000+P} - k$$

$P = (50\#/cf)(A\ sq.ft)(L\ ft)$

WAR DEPARTMENT
U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject: Hiley formula

Computation

Computed by: W.L.S. Checked by: Date:

Page 7

Pile Length ft. L	L/12	Av. Diam in.	A sq. ft	Pile Wt. P lbs	$\frac{W}{W+P}$	$1.8\frac{W}{W+P}$	k	S	$\frac{L}{A12}$	$\frac{L}{12}A$
40		11	0.66	1320	0.78	1.40	.19	1.21	60.5	26.4
		12	0.785	1570	0.76	1.37	.17	1.20	51.0	31.4
		14	1.07	2140	0.70	1.26	.14	1.12	37.4	42.7
		13	0.924	1848	0.73	1.31	.15	1.16	43.4	36.9
60		10	0.545	1635	0.753	1.36	.31	1.05	110	32.7
		12	0.785	2355	0.679	1.22	.23	0.99	76.5	47.1
		14	1.07	3210	0.609	1.09	.18	0.91	56.0	64.2
		13	0.924	2772	0.644	1.16	.20	.96	65.0	55.4
		11	0.66	1980		1.29	.28	1.01	90.9	39.6
80		10	0.545	2180	0.696	1.25	.39	.86	147	43.6
		12	0.785	3140	0.614	1.11	.29	.82	102	62.8
		13	0.924	3696	0.574	1.03	.25	.78	85	75.3
		11	0.66	2640	0.654	1.18	.33	.85	121	52.7
100		10	0.545	2725	0.648	1.12	.48	0.69	183	54.5
		12	0.785	3925	0.561	1.01	.35	.66	127	78.5
		13	0.924	4620	0.519	0.93	.30	.63	108	92.4
		11	0.66	3300	0.600	1.08	.41	.67	151	66.0

WAR DEPARTMENT
U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject

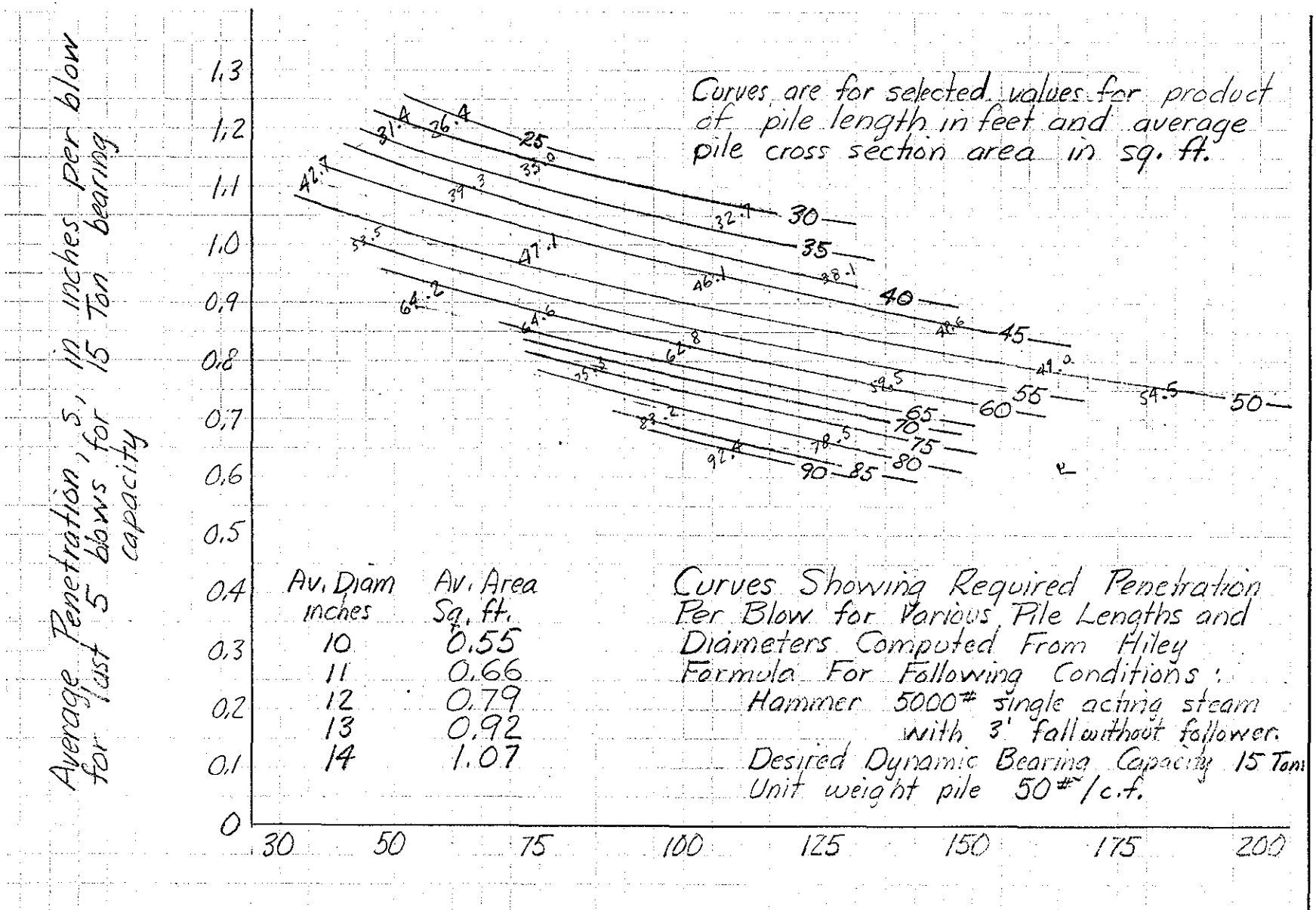
Computation

Computed by ..... Checked by ..... Date .....

Page 8

Pile Length ft.	Av. Diam in.	A Sq. Ft.	Pile Wt. P lbs	$1.8 \frac{W}{W+P}$	k	s	$\frac{L}{A}$	LA
50	11	0.66	1650	1.35	.22	1.13	75.8	33.0
	12	0.785	1940	1.30	.20	1.10	63.8	39.3
	14	1.07	2680	1.17	.16	1.01	46.6	53.5
	13	0.924	2310	1.23	.17	1.06	54.1	46.2
70	10	0.545	1910	1.30	.35	.95	128	38.1
	11	0.660	2310	1.23	.29	.94	106	46.1
	13	0.924	3230	1.09	.22	.87	75.8	69.6
	12	0.785	2747	1.16	.26	.90	83.9	54.9
90	10	0.545	2450	1.21	.43	.78	165	49.0
	11	0.660	2970	1.13	.37	.76	136	59.5
	13	0.924	4150	.98	.28	.70	97.4	83.2
	12	0.785	3532	1.05	.32	.73	114	70.6

WAR DEPARTMENT
U. S. ENGINEER OFFICE, BOSTON, MASS.
Subject Hiley formula
Computation
Computed by WRP
Checked by
Date
Page 9



WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Page.....

Subject .....

Computation .....

Computed by..... Checked by..... Date.....

6	Surf. - 7.4	M.L.W.	0-2.5 Silty Sd 2.5-9.5 Firm Y Sd, little Clay
			9.5-15.7 S&G very little Clay
			15.7-36.0 Hard Sd, very little Gravel
12	" - 5.0	"	0-1.0 Silty Sd & little Gravel
			1.0-18.0 Clay, Sd & Gravel
			18.0-35.0 F. Sd & little Gravel
7	" - 4.1	"	0-0.5 Silt 0.5-2.8 Clay & Gravel
			2.8-5.0 Sd & little Clay
			5.0-7.4 Clay & Gravel
			7.4-9.5 Sd & Gravel
			9.5-17.0 Stiff B. Clay & little Sd
			17.0-36.0 Hard Sd & little Clay
25	" - 6.4	"	0-3.6 Silt & little Sd
			3.6-15.8 Hard blue Clay
			15.8-33.0 Fairly stiff B. Clay
			33.0-34.0 Fine gray Sd, little Clay
3	" - 21.4	"	0-1.0 Soft Silt 1.0-1.7 Silt & Sd
			1.7-11.6 F. yellow Sd
			11.6-15.0 F. Blue Sd
			15.0-20.0 S & V. Sd & Clay
10K	" - 5.7	"	0-1.0 Silt & Gravel
			1.0-19.2 Clay, little Sd & Gravel
			19.2-28.6 Clay & Gravel
			28.6- Boulders or ledge
18	" - 5.8	"	0-1.7 Silt
			1.7-8.5 Very firm Clay, little Gravel
			Sand & Stones
			8.5-13.0 C Sd, little Gr'l. firm
			13.0-23.0 Firm Sd
			23.0-30.0 Firm Sd, very little C. Gravel
			30.0- Stones

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Page.....

Subject .....

Computation .....

Computed by..... Checked by..... Date.....

333 — Surf. -31.2 M.L.W. 0-1.6 silt 1.6-11.6 Stiff Blue Clay
650 — " 8.6 " 0-4.2 " 4.2-31.4
645 — " 6.0 " 0-3.3 " 3.3-34.0
640 — " 2.8 " 0-3.6 "
1.6-13.7 Sd. Gr'l & Clay
13.7-36.2 Stiff Blue Clay
342 — " 5.2 " 0-4.5 Silt 4.5-35.0 Stiff B. Clay
244 — " 6.5 0-2.4 " 2.4-5.6 "
5.6-25.0 Sd, G., Clay
25.0 — Rock
243 " 7.4 " 0-3.3 Silt 3.3-16.0 Stiff B. Clay
16.0-20.6 S, G & Clay 20.6 Rock
208 " 11.6 " 0-4.8 Silt 4.8-25.5 Stiff B. Clay
25.5 Rock
285 " 7.4 " 0-4.3 Silt 4.3-20.5 Stiff B. Clay
20.5-32.5 Hardpan 32.5 Rock
~~X~~ " 27.0 " ~~0-2.3 Silt 2.3-12.0 Med. B Clay~~
~~12.0-27.3 B. Clay 27.3-29.3 Gravel~~
~~X~~ " 27.3 " ~~0-2.7 Silt 2.7-32.0 Med. B. Clay~~
~~32.0-34.2 Gravel~~
~~X~~ " 26.8 " ~~0-2.3 Silt 2.3-12.1 Med. B. Clay~~
~~12.1-27.2 B. Clay 27.2-29.3 Gravel~~
298 " 9.4 " 0-3.0 Silt 3.0-30.6 Stiff B. Clay
643 " 11.8 " 0-1.6 Silt 1.6-25.2 Stiff B. Clay
~~X~~ " 23.0 " ~~0-2.0 " 2.0-14.0 B. Clay~~
~~14.0-28.3 Gravel & Rocks~~
599 " 6.5 " 0-4.7 Silt 4.7-19.3 Stiff B. Clay
19.3-31.5 S, G, & Clay 31.5 Rock
605 " 5.2 " 0-5.0 Silt 5.0-29.5 Stiff B. Clay
29.5-30.0 S, G & Clay 30.0 Rock
~~X~~ " 27.1 " ~~0-4.0 Silt 4.0-24.0 M. B. Clay~~
~~24.0-32.0 B. Clay & Little Gravel~~
32.0 - Rock
0 X " 23.0 " 0-6.0 Silt 6.0-29.0 Med. B. Clay
29.0-34.0 Gravel
● 1 " 3.3 " 0-3.9 Sandy Silt 3.9-16.0 yellow Sd
16.0-28.5 Bl. Sd & Clay 28.5-34.7 Stiff blue
34.7-36.7 Fairly stiff blue Clay
3 " 21.4 " 0-1.0 Soft silt 1.0-1.7 Silt & Sd
1.7-11.6 Fine yellow Sd
11.6-15.0 Fine blue Sd
15.0-20.0 Blue & Yellow Sd & Clay

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Page .....

Subject .....

Computation .....

Computed by ..... Checked by ..... Date .....

Moch

Boston Building Code

John Hancock Building

15 blows

Blows / ft. sampling spoon hard clay

Boston Soc.
1 year ago
by Chellis

-3 Pile cutoff
-31 elev pile tips

Tarner

10,000 piles — 5' in hard clay

2600# 10' drop
4" to 5"

J.R. Worcester
Paper in 1915
Boston Soc

3.75T Ave Bearing — Eng. News.

1/2 to 1" / blows
15T redrive tests

Tests load 15T total load 1/8" settlement
Max load permitted 10T or 11T 24 hrs.

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Page

Subject: Borings at New Ship Loading Wharf

Computation

Computed by: WLS Checked by: Date:

Boring No.	Date Started	Date Completed	Depth Feet	Cumulative Total Depth
D1	12-27-41	12-30-41	62.0	62.0
D2	12-30-41	1-1-42	26.0	88.0
D3	1-1-42	1-1-42	47.5	135.5
D4	1-2-42	1-2-42	77.5	213.0
D5	1-3-42	1-3-42	99.5	312.5
D6	1-3-42	1-3-42	73.0	385.5
D7	1-3-42	1-4-42	74.0	459.5
D8	1-5-42	1-6-42	57.0	516.5
D9	1-6-42	1-6-42	63.5	580.0
D10	1-6-42	1-6-42	71.0	651.0
D11	1-6-42	1-7-42	61.0	712.0
D12	1-7-42	1-8-42	83.0	795.0
D13	1-8-42	1-9-42	62.0 +12°	859.0
D14	1-9-42		64.0	923.0
D15	1-9-42	1-9-42	66.0	989.0
D16	1-10-42	1-10-42	71.5	1060.5
D17	1-11-42	1-14-42	116.0	1176.5
D18	1-12-42	1-12-42	77.0	1253.5
D19	1-12-42	1-13-42	51.5	1305.0

WAR DEPARTMENT

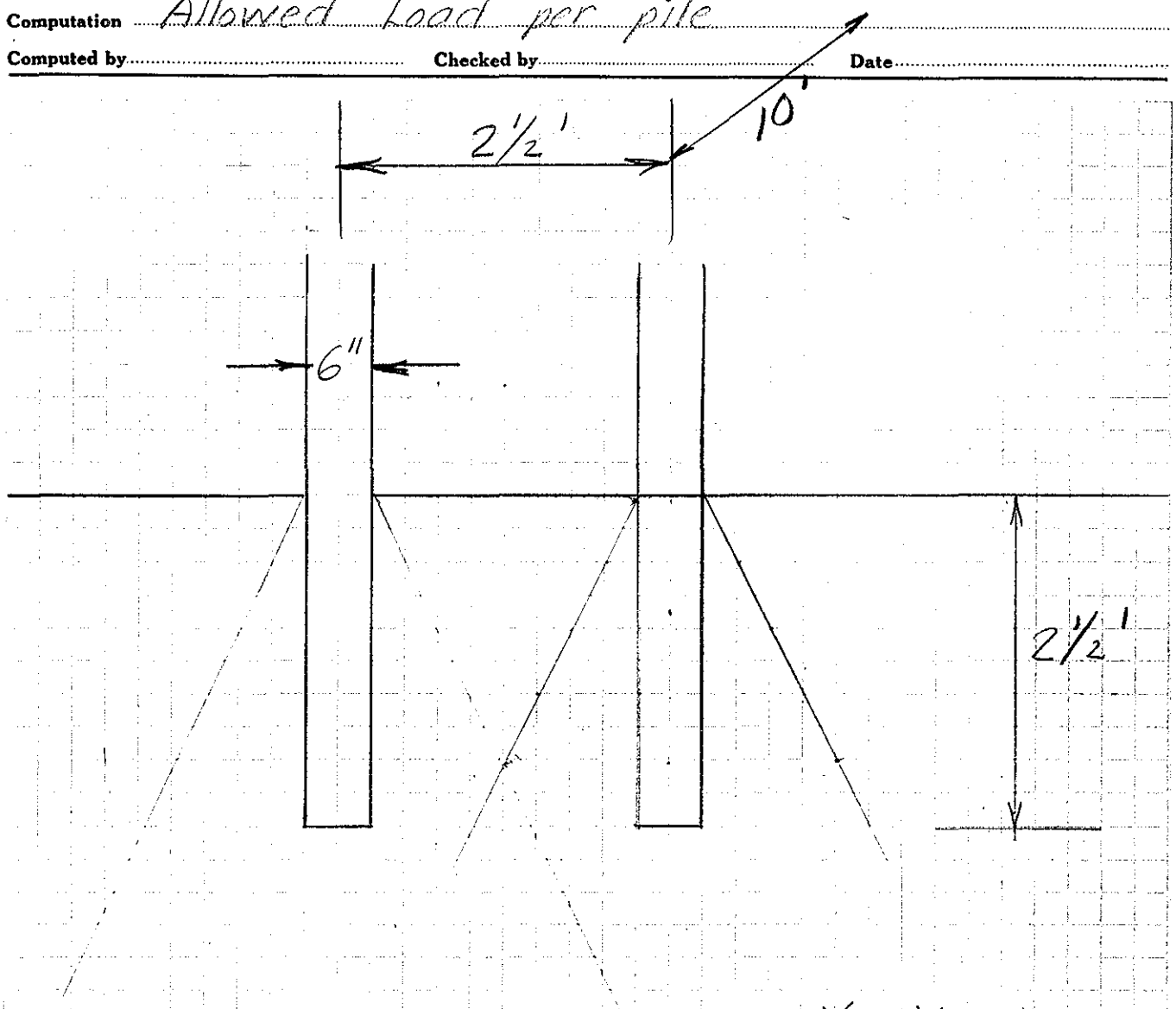
U. S. ENGINEER OFFICE, BOSTON, MASS.

Page .....

Subject: Lend - Lease Wharf

Computation: Allowed Load per pile

Computed by ..... Checked by ..... Date .....



Load per pile - dead - $= (0.1\ ^T/_{\square'})(10')(2.5') = 2.5^T$

Design Load per pile, dead + live $= 15^T$

Sq. Ft. bearing area $= \dfrac{(3.14)(2.5)(2.5)}{4}$

$= 4.9$ sq. ft.

Allowed load total $= (5)(4.9) = \underline{\underline{24.5^T}}$

per pile, max.

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Page .....

Subject: Lend-Lease Wharf

Computation: Allowed load per pile

Computed by ..... Checked by ..... Date .....

John Hancock Bldg.

Elev. pile tip −31
Elev. pile cutoff −3
Length 28

Hammer 2600#, 10' drop

Penetration / blow driving 4" to 5"
redriving ½" to 1"

Load Test 15 Tons one pile, ⅛" settlement in 24 hrs.

Dynamic Resistance driving

$$R = \frac{3Wh}{s+k} \times \frac{W}{W+P}$$

$$\frac{(3)(2600)(10)}{(5)+0.1} \quad \frac{2600}{2600+476}$$

$$= \frac{(78{,}000)(2600)}{(5.1)(3076)} = 13{,}000\# = 6.5^T$$

redriving

$$= \frac{(78{,}000)(2600)}{(1.2)(3076)} = 55{,}000\# = 27^T$$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Page.....

Subject .....

Computation .....

Computed by..... Checked by..... Date.....

D 20	1-13-42	1-13-42	60.0 + 8°	1373.0
D 21				
D 22				

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Page.....

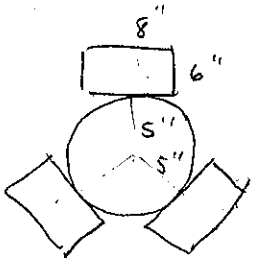
Subject: Wharf, South Boston

Computation: Pile Loading Tests — Frictional Resistance

Compared by: J.G.Z. Checked by: ..... Date: 5-27-42

Pile Loading Test #1 — Lagged - 3 - 6"×8"

Estimated 55 Ton ultimate



Average pile diameter, imbedded = 10"

Circ. = $\frac{11 \times \pi \times 2}{12}$ = 5.75'

Area = 5.75 × 20 = 115 □' lagged

$\pi \times \frac{10}{12} \times 5.6$ = 14.7

Estimated Frictional Resistance = $\frac{55}{129.7}$ = 0.425 T/SF = 850 #/SF

Pile Loading Test #2 — Unlagged

Average pile diam. = 9" Circ. = 2.35' Area = 56.7 □'

Frictional Resistance = $\frac{20}{56.7}$ = 0.353 T/SF = 705 T/SF

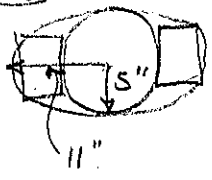
Pile Loading Test #3 — 2 Lags.

$\frac{11-5}{11+5}$ = 0.375

$p = \pi(11+5)\frac{64-3(0.375)^4}{64-16(0.375)^2}$

p = 4.35'

Ave. dia = 10"



Area lagged = 4.35' × 20 = 87

= $\pi \times \frac{10}{12} \times 10.1$ = 26.4

113.4 □'

Frictional Resistance = $\frac{49}{113.4}$ = 0.432 T/SF = 864 #/SF

850
705
864
3) 2419
810

Vulcan #1 Specifications

Style of Base: McDermid
Rated Striking Energy: 15,000 Ft Lbs
Blows per minute: 60
Wt. of Striking Parts: 5,000 Lbs.
Steam Pressure, Lbs per Sq. In. 80
Diameter of Piston, inches: 13½"
Normal Stroke: 3 ft.
Net Wgt., lbs.: 10,200
Length of Hammer, Ft.: 13'3"
Boiler Horse Power: 40
Heating Surface, Sq. Ft.: 480
Volume Free Air, Cu. Ft./Min: 565
Size of Hose, Inches: 2
Distance Between Jaws, Inches: 20
Width of Jaws, Inches: 8¼"
Size of Wire Hoisting Rope, Inches: ¾"
$\sqrt{EW}$ Rating: 8689

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Page.....

Subject....Wharf, South Boston — Pile Loading Tests

Computation....Deflection of Pile

Compared by..... Checked by..... Date.....

Length of pile $= 66.4' - \frac{25.6'}{2} = 66.4 - 12.8 = \underline{53.6'}$

Modulus of Elasticity $= 1{,}600{,}000$ #/□"

Area of section $= \frac{\pi}{4}(13)^2 = 133$ □"

If stress were 1200 #/□"; Load $= \frac{1200}{2000} \times 133 = 79.8$ Tons

(∴ elastic @ 50 Tons)

At 50 Tons, stress $= \frac{50 \times 2000}{133} = 752$ #/□"

Deflection $= \frac{752}{1{,}600{,}000} \times 54' \times 12'' = \underline{0.30''}$ at 50 Tons

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Page

Subject Pile Loading Tests, Land-Lease Wharf

Computation Time spent by contractor's men

Computed by **Checked by** **Date**

Operation	From (time)	To (time)	No. of men
Preparing for test	—	7:00 PM	3 (and foreman)
Run @ 10 Tons	7:00	—	1
Run @ 15 Tons		[illegible]	1
Run @ 20 Tons	10:30 P	1:00 A	1
	[illegible]	12:30	4 [illegible]
Run @ 25 Tons	1:00 AM	[illegible] AM	1 man
Run @ 30 Tons	3:00 AM	[illegible]	1 man
Run @ 35 Tons	5:15 AM	5:20 AM	1 man
Delay	5:20 AM	7:[illegible] AM	2 men replacing broken cap

At 35 Tons pile cap failed in compression. Released load and replaced cap.

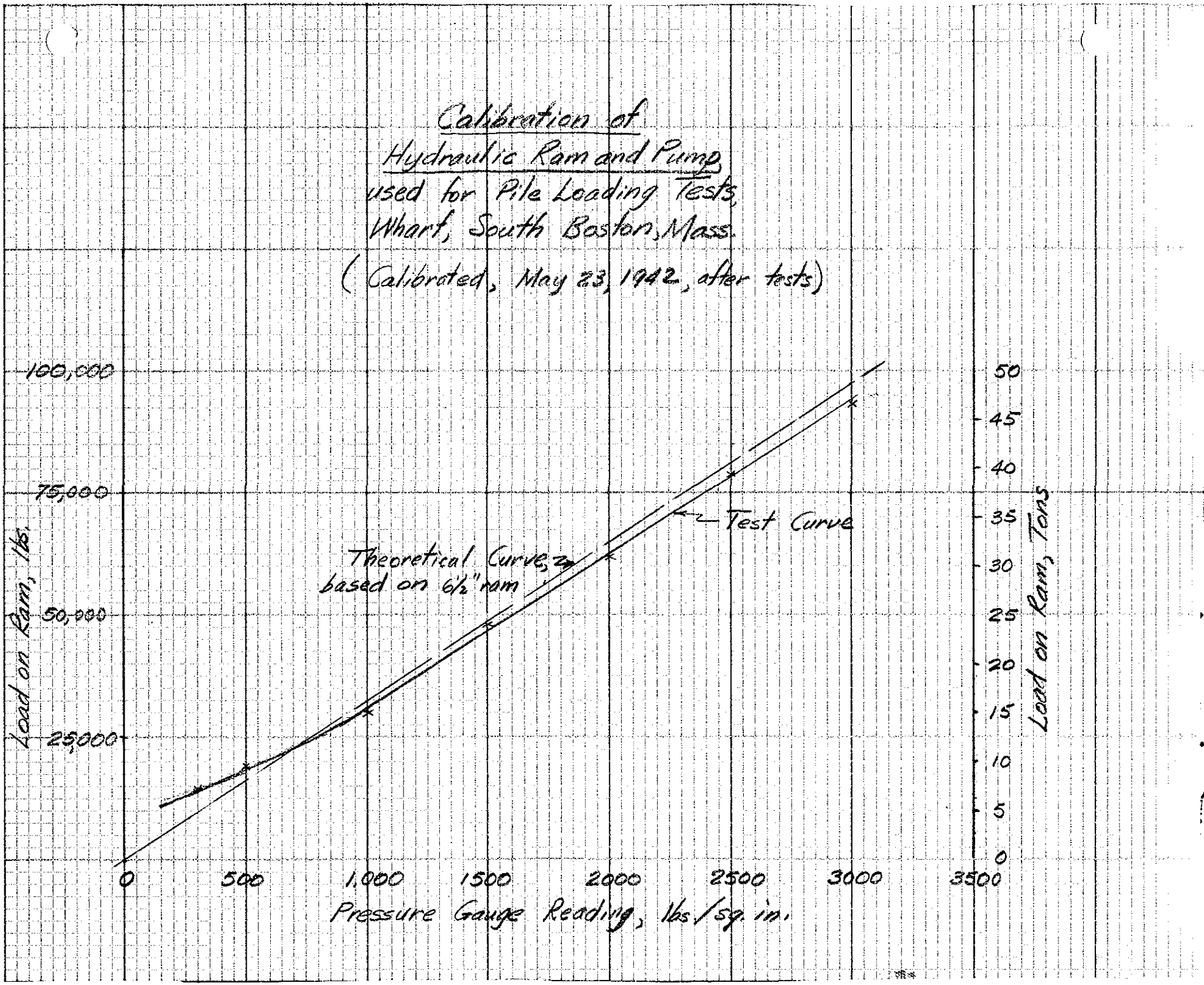
Loading to 10 tons	7:10 AM	7:20 AM	1 man
Run @ 20 Tons	7:20 AM	7:27 AM	1 man
Run @ 30 Tons	7:27 AM	7:45 AM	1 man
Run @ 35 Tons	7:45 AM	10:15 AM	1 man
Run @ 40 "	10:15 AM	12:13 PM	1 man
Run @ 45 "	12:13 PM	2:43 PM	"
Run @ 48 "	2:43 PM	4:53 PM	"
Rebound to 0	4:53 "	6:00 PM	

Calibration Test

Hydraulic Jack used in Pile Loading Tests, Wharf, South Boston.

Pressure Gage Reading	True Load Pounds/sq. in. Load	Unload
0	0	0
300	14,600?	—
500	18,400	19,000
1000	30,000	31,000
1500	48,000	47,000
2000	62,000	61,500
2500	77,400	77,200
"	79,000	80,800
3,000	93,000	93,000
50 T	94,000	—

Tested in Hydraulic Testing Machine, 1st floor, building 2, M.I.T. May 23, 1942.


Calibration of
Hydraulic Ram and Pump
used for Pile Loading Tests,
Wharf, South Boston, Mass.
(Calibrated, May 23, 1942, after tests)
100,000
75,000
50,000
25,000
Load on Ram, lbs.
50
45
40
35
30
25
20
15
10
5
0
Load on Ram, Tons
Test Curve
Theoretical Curve, based on 6½" ram
0
500
1,000
1500
2000
2500
3000
3500
Pressure Gauge Reading, lbs./sq. in.

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Page

Subject: CONVERSION TABLE.

Computation: POUNDS / SQ. IN TO TONS (2000#)

Computed by: A.L.G. Checked by: Date: May 9, 1942

DIAM. OF RAM = 6½" AREA = 33.183 SQ. IN.

PRESSURE #/SQ.IN.	TONS
250	4.15
500	8.29
750	12.44
1000	16.59
1250	20.73
1500	24.89
1750	29.04
2000	33.18
2250	37.33
2500	41.48
2750	45.63
3000	49.77
3250	53.92

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

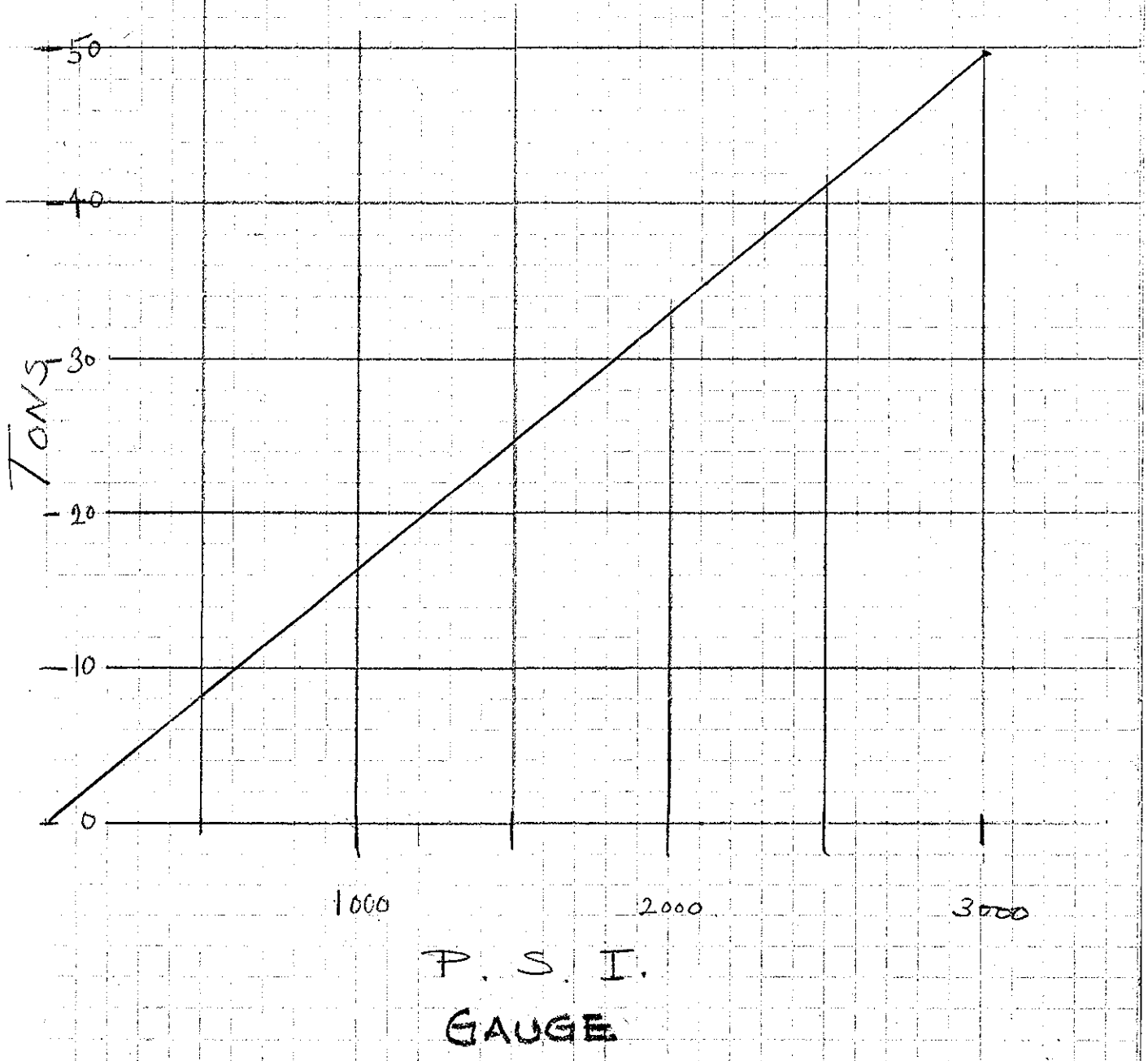
Page

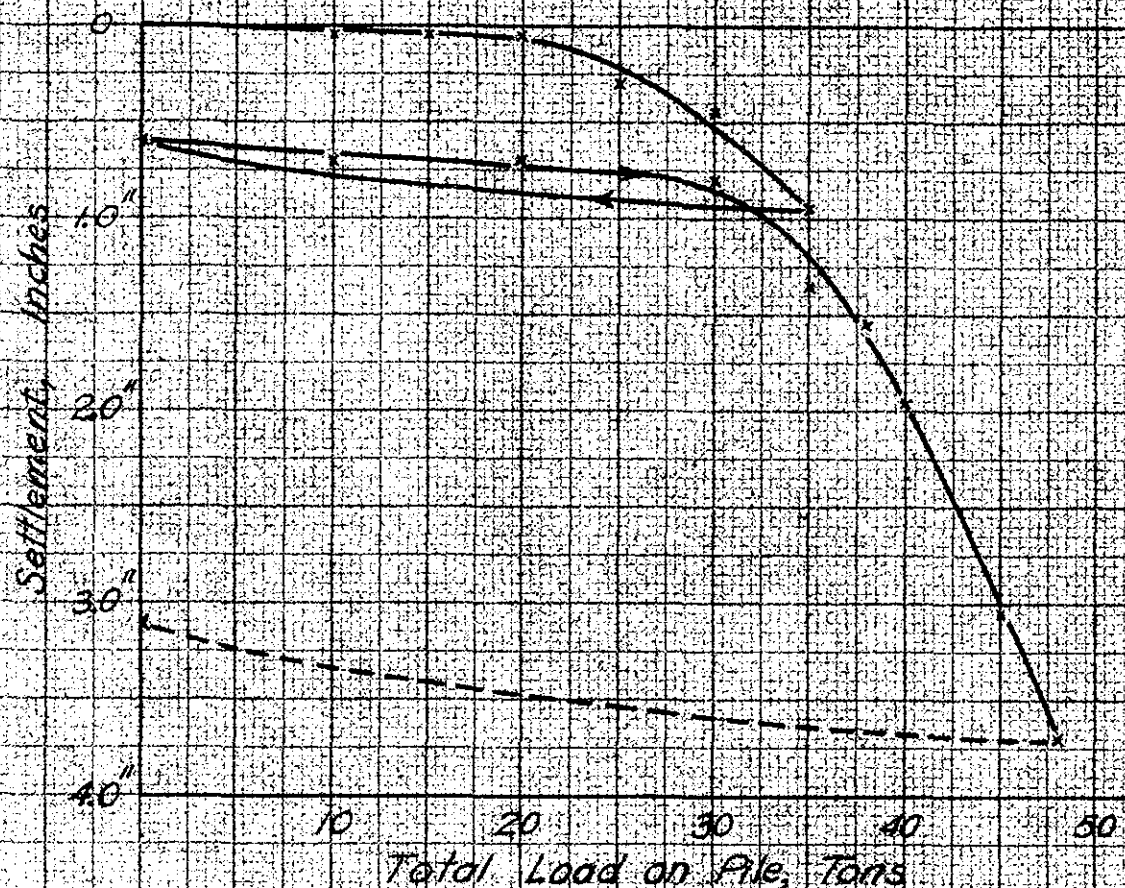
Subject

Computation

Computed by Checked by Date

Total Load on hyd. Jack having 6.5" ram for guage pressures in psi





WHARF
SOUTH BOSTON, MASS.

PILE LOADING TEST #1

Pile No. 17-I

Tested May 9-10, 1942

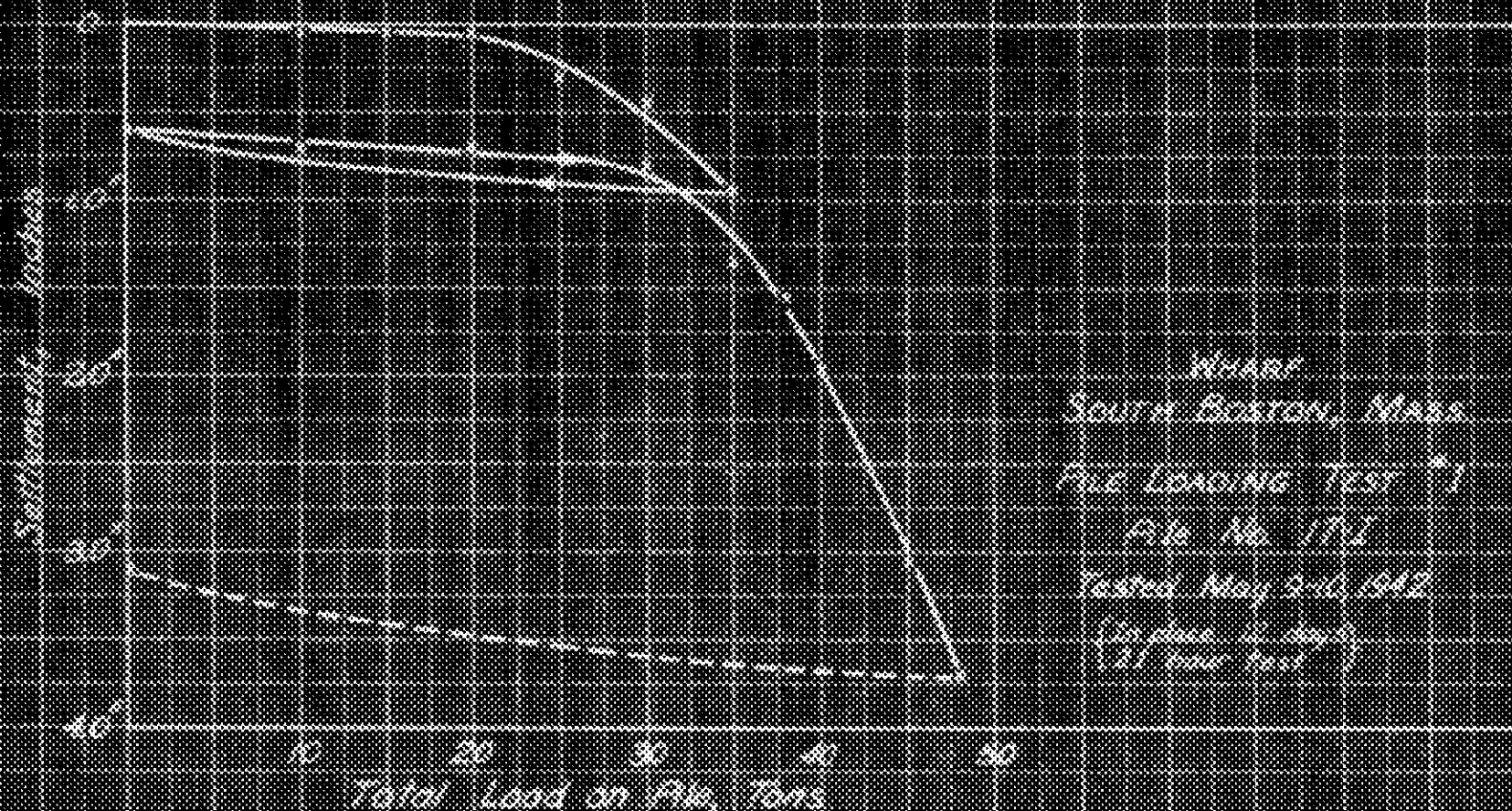
{In place 12 days
21 hour test}

Data on Pile:

Length: 66.4'
Penetration: 25.6' into soft blue clay
Butt Diameter: 16"
Tip Diameter: 9"
Lagging: 3 - 6" x 8" x 20' 0"

Data on Driving:

Date driven: April 27, 1942
Hammer: 5,000# ; 36" drop
Penetration: 1.5' under wgt. of hammer
1" per blow, last 4"
Total blows: 94



Data on Pile:

Length: 66.4'

Penetration: 23.6' into soft blue clay

Butt Diameter: 16"

Tip Diameter: 9"

Logging: 3 - 6", 8", 20' 0"

Data on Driving:

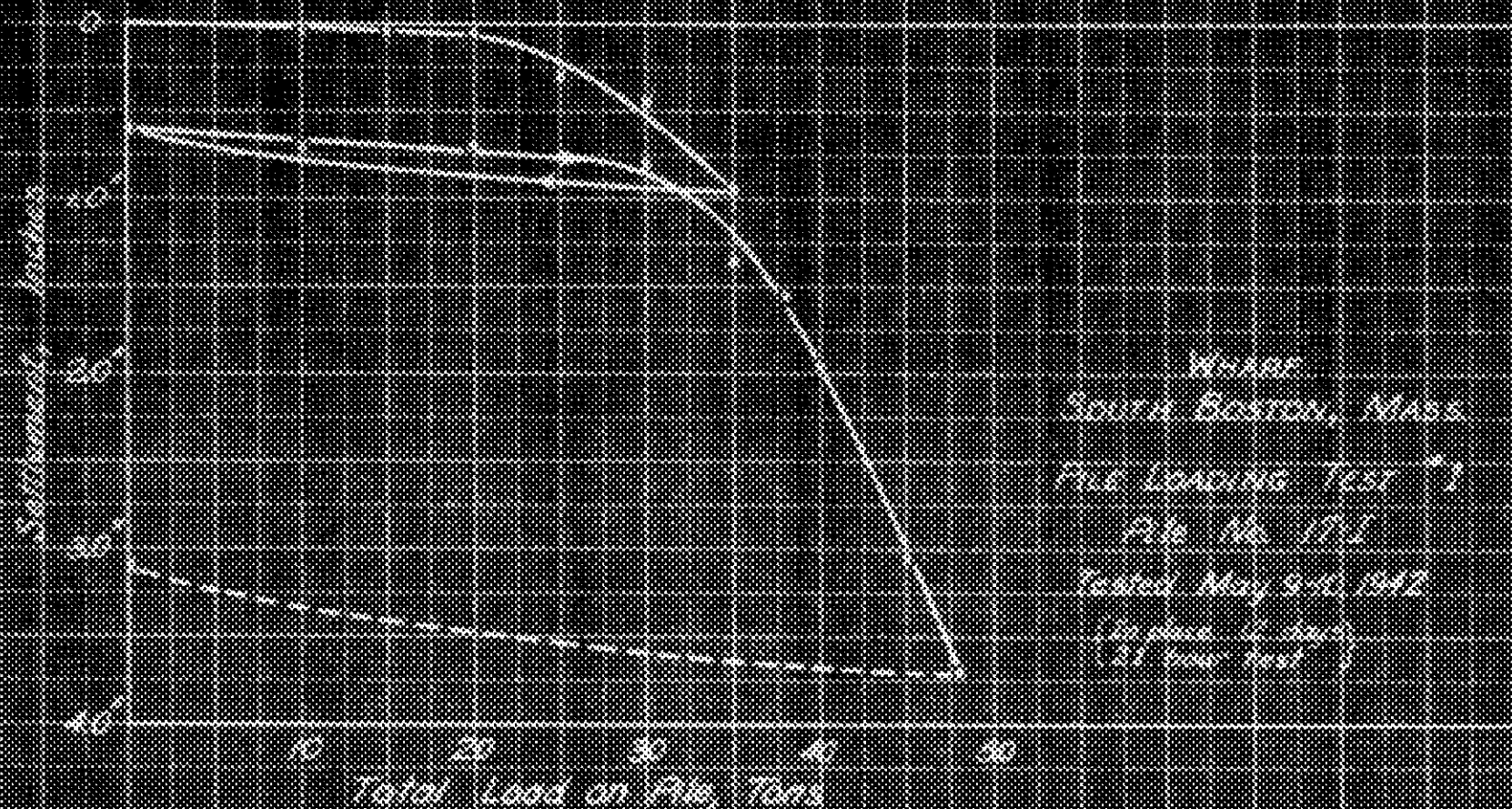
Date driven: April 27, 1942

Hammer: 5,000# ; 36" drop

Penetration: 1.3' under wgt of hammer

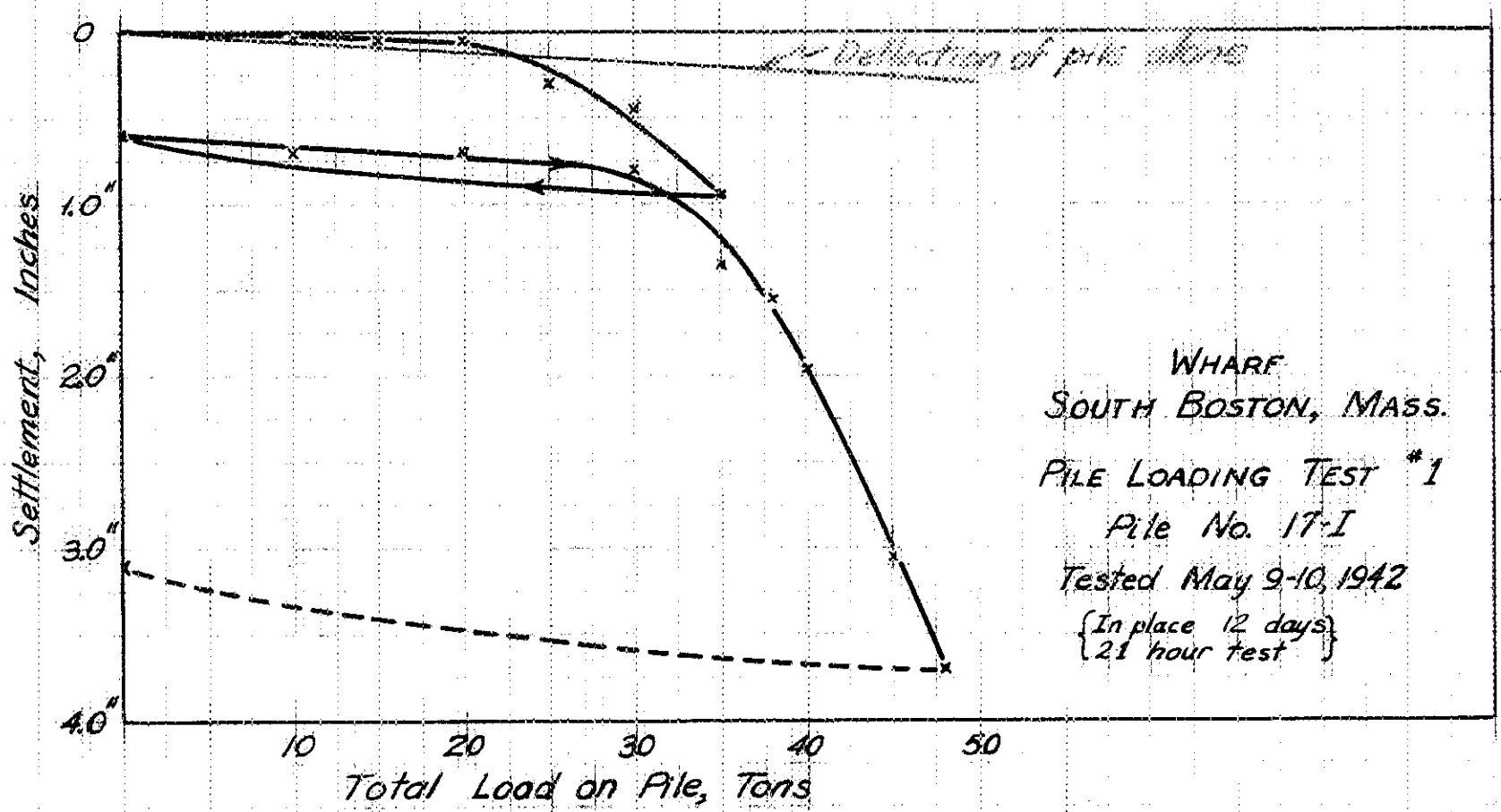
1" per blow last 4"

Total blows: 94



Data on Pile:
Length: 66.4'
Penetration: 25.6' into soft blue clay
Butt Diameter: 16"
Tip Diameter: 9"
Logging: 3 - 6" x 8" - 20'0"

Data on Driving:
Date driven: April 27, 1942
Hammer: 5,000# ; 36" drop
Penetration: 1.5' under wgt of hammer
1" per blow, last 4"
Total blows: 94



Data on Pile:

Length: 66.4'
Penetration: 25.6' into soft blue clay
Butt Diameter: 16"
Tip Diameter: 9"
Lagging: 3 - 6" x 8" x 20' 0"

Data on Driving:

Date driven: April 27, 1942
Hammer: 5,000# ; 36" drop
Penetration: 1.5' under wgt. of hammer
1" per blow, last 4"
Total blows: 94

May 12, 1942.

Mr. J. E. Allen, Principal Engineer, War & Flood Control
Subdivision, U. S. Engineer Office, Boston, Mass.
Pile Loading Test, Wharf, South Boston, Mass., May 9 and 10, 1942.

1. Purpose of Test. On May 9 and 10, a loading test was performed to check the design bearing value of 15 tons per pile for factor of safety, and to determine the maximum allowable load.

2. Method. The test was performed by using a hydraulic jack to load the pile. Two piles, located 5 feet on each side, were used as reactions. Level readings were taken during the loading to determine the changes in elevation of the loaded pile and the two reaction piles. The maximum load which could safely be applied by the apparatus was 50 tons. Attached is a schematic diagram showing method of loading.

3. Pile Tested. Pile I in bent 17 was selected for test. Selection was based primarily upon ease of installing the loading apparatus and performance of test. Data on the driving of this pile, are on the sheet showing the test curve.

4. Description of Test. Loading was begun at 7:00 P.M., May 9, 1942, and completed at 6:00 P.M., May 10, 1942. Generally, increments of 5 tons were applied every two hours. At a load of 35 tons, corresponding to a unit pressure of 420 lbs. per sq. in., a section of cap, which had been left on the pile, failed by crushing perpendicular to the grain. The pile was unloaded, a vertical bearing block substituted, and reloaded in 30 minutes to 35 tons and then to 45 tons as before.

5. Results. Attached is a plot of the load on the pile versus its settlement at end of each load increment. The settlement was only 0.05 inches at the design load of 15 tons, and 3.7 inches at 48 tons. The maximum load corresponds to 0.35 tons per square foot of imbedded surface.

6. Conclusions. Criteria for interpreting loading tests have been suggested by Dr. Casagrande, and appear applicable here. He recommends that the maximum allowable load not exceed either the load at 1/2 inch deformation, one-half the load at failure, or one-half the maximum load reached in the test. This results in a factor of safety of 2. Applying the criterion of 1/2 the total load, the allowable load is 24 tons. This load corresponds to 0.18 tons per square foot of imbedded surface. Applying the criteria of 1/2 inch deflection, the allowable load is 30 tons or 0.23 tons per square foot of imbedded area. Applying this loading test data to predict the results of the loading test to be performed upon

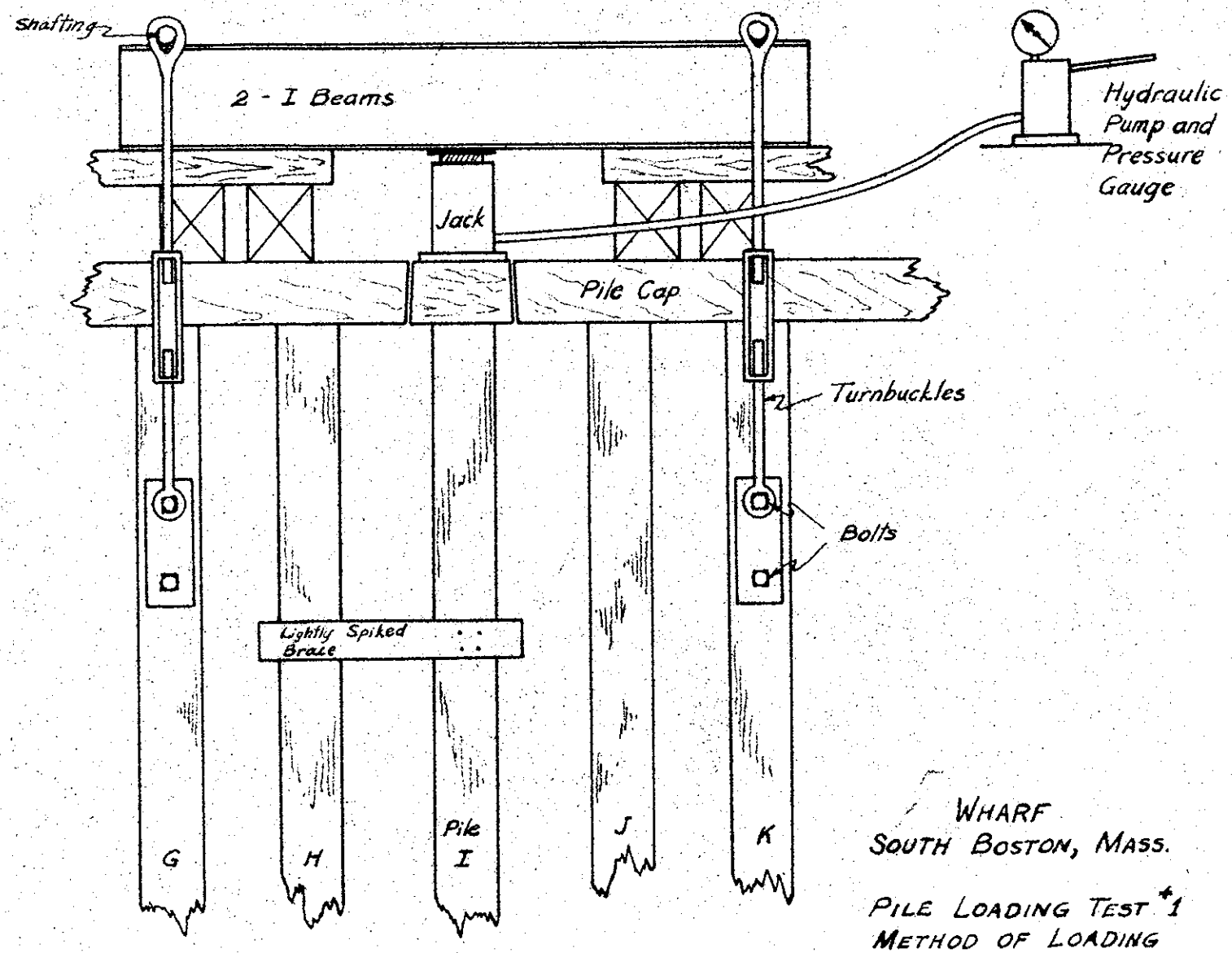
on unlagged pile, it is estimated that failure will result at about 30 tons total load and that the load at 1/2 inch deflection will be about 15 tons.

7. Recommendation. It is recommended that driving of lagged piles continue until the second test, upon an unlagged pile, is completed. If this second test confirms the results of the first, it will be recommended that lagging be reduced in size and number from 2 - 6" x 6" to 3 - 2" x 4". These 2" x 4" may be spiked to the pile in contrast to bolts now used on 6" x 6".

William L. Shannon,
Associate Engineer,
Chief, Soils & Geology Section.

2 Incls.
2 Drawings.

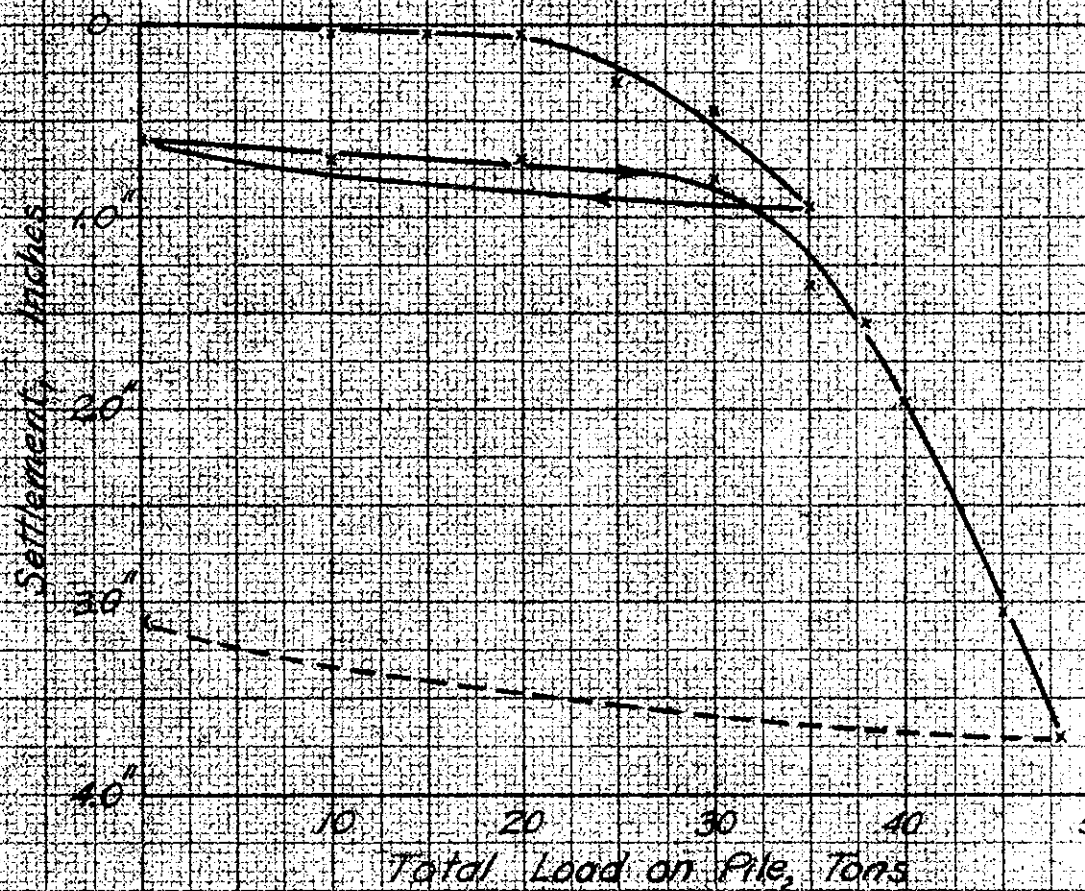
cc: Mr. Shannon (2 copies)
Mr. Dunbar (2 copies)
Mr. Zeitlen



WHARF
SOUTH BOSTON, MASS.

PILE LOADING TEST #1
METHOD OF LOADING

Note: Settlements were read on batter boards attached to piles G, I, K.



WHARF
SOUTH BOSTON, MASS.

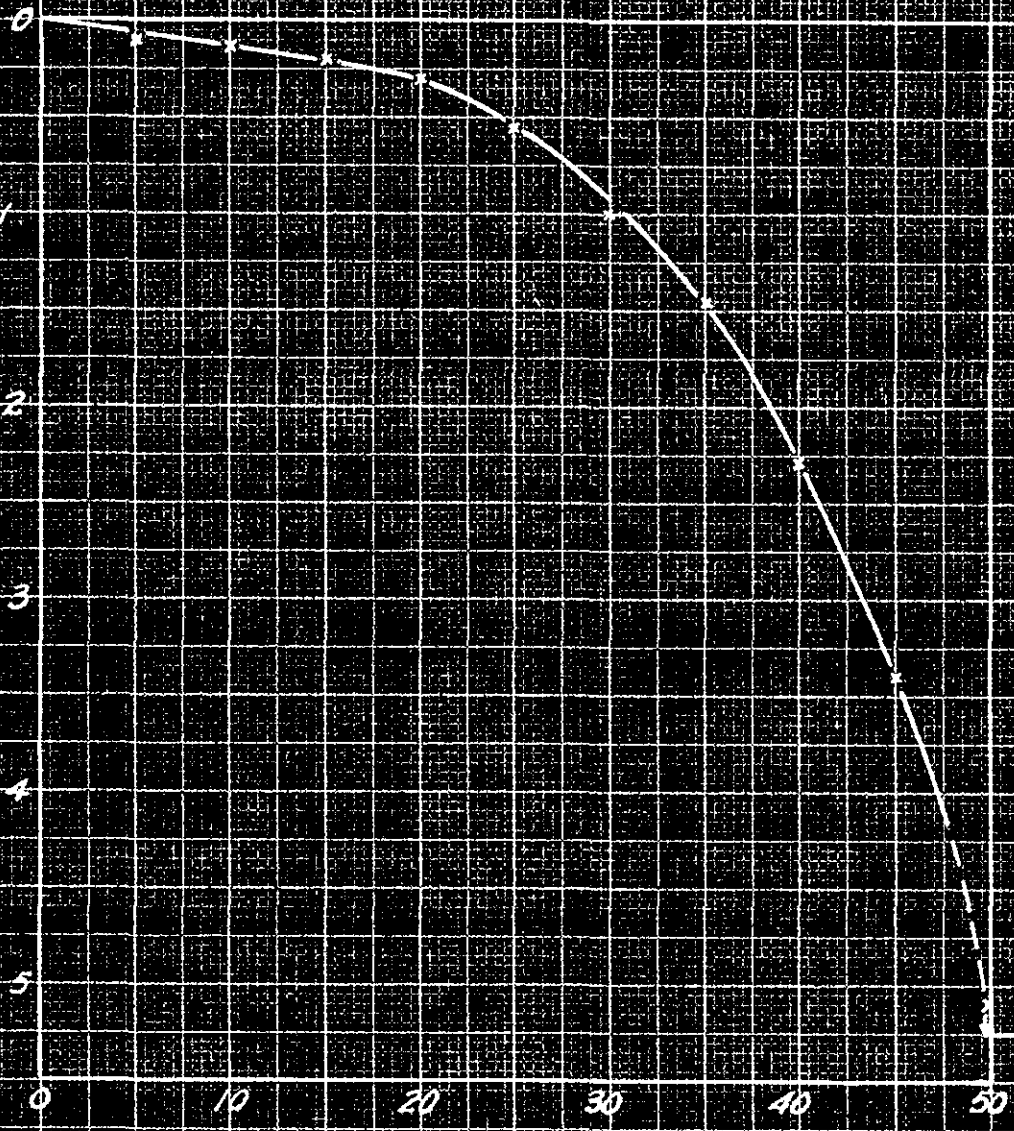
PILE LOADING TEST #1
Pile No. 17-I
Tested May 9-10, 1942
{In place 12 days
21 hour test}

Data on Pile:

Length: 66.4'
Penetration: 25.6' into soft blue clay
Butt Diameter: 16"
Tip Diameter: 9"
Lagging: 3 - 6" x 8" x 20' 0"

Data on Driving:

Date driven: April 27, 1942
Hammer: 5,000# ; 36" drop
Penetration: 1.5' under wgt. of hammer
1" per blow, last 4"
Total blows: 94



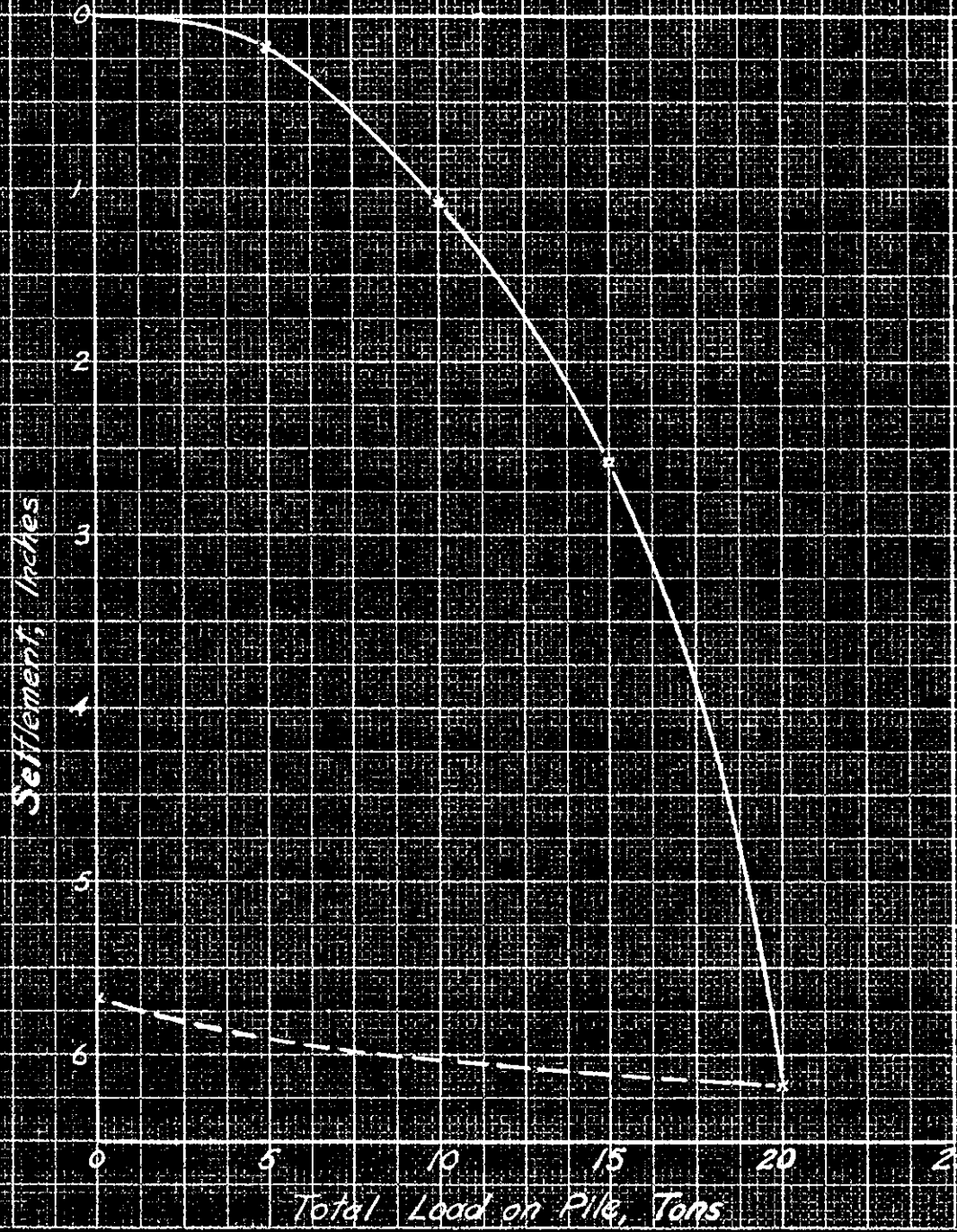
Data on Pile No. 35-I:
Length: 67.3'
Penetration: 30.1'
(into soft blue clay)
Butt Diameter: 17"
Tip Diameter: 8"
Lagging: 2 - 6"-8", 20'0"

Data on Driving:
Date driven: May 8, 1942
Hammer: Vulcan No. 1
Weight: 5000#
Drop: 3 ft.
Set: 1" per blow, last 4"

Data on Test:
Date tested: May 20-21, 1942
Age when tested: 12 days
Testing time: 13 hours
Loaded @ about 1½ hr. intervals

WHARF
SOUTH BOSTON, MASS.

Pile Loading Test #3
(Lagged Pile)

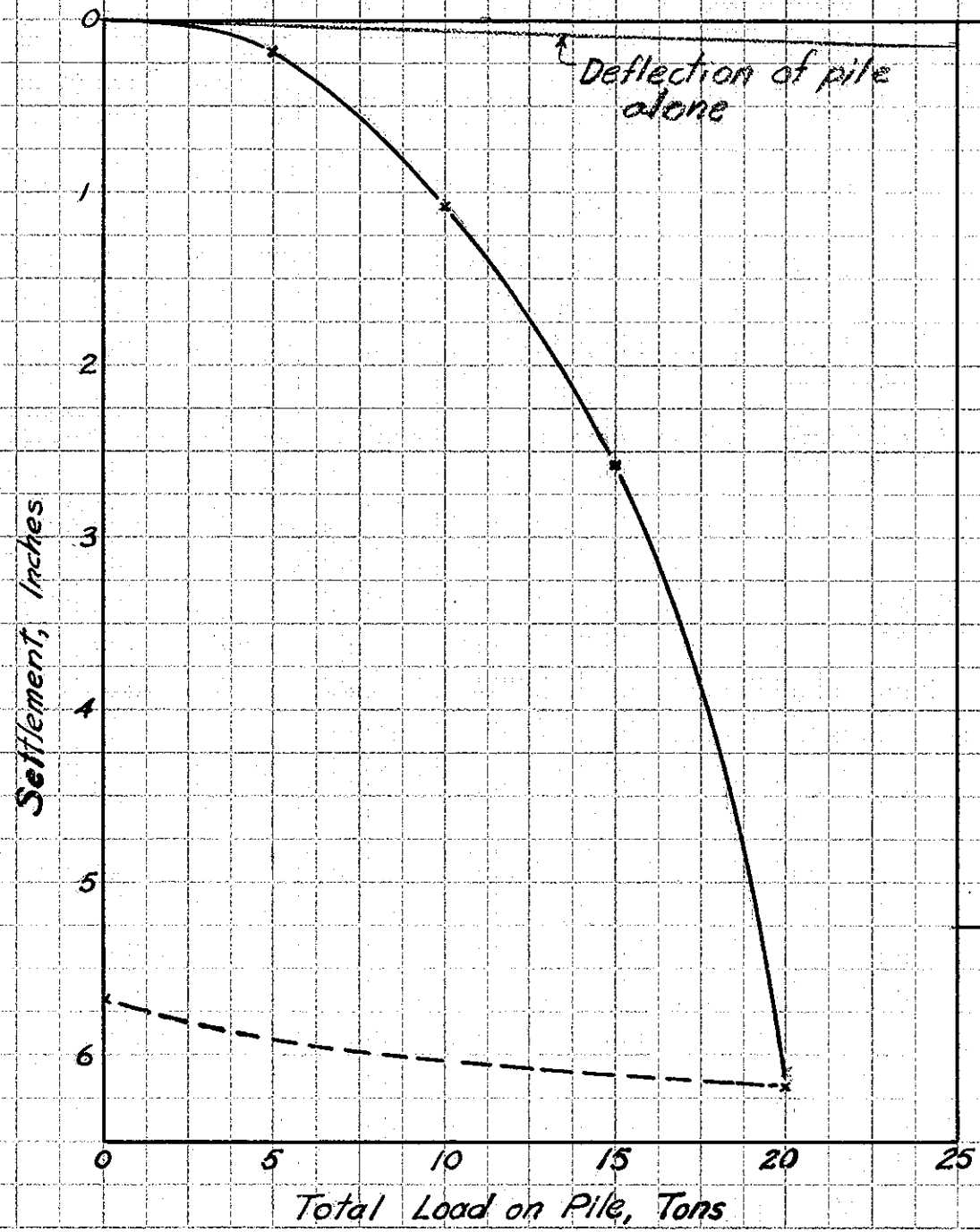


Data on Pile No. 33-N:
Length: 57.3'
Penetration: 24.1'
(into soft blue clay)
Butt Diameter: 17"
Tip Diameter: 7"

Data on Driving:
Date driven: May 6, 1942
Hammer: Vulcan No. 1
Weight: 5000#
Drop: 3 Ft.
Set: 4" per blow last 4"

Data on Test:
Date tested: May 19-20, 1942
Age when tested: 13 days
Testing time: 6½ hrs.
Loaded @ about 2 hr. intervals

WHARF
SOUTH BOSTON, MASS.
PILE LOADING TEST #2
(Unlagged Pile)



Data on Pile No. 33-N:

Length: 57.3'
Penetration: 24.1'
(into soft blue clay)
Butt Diameter: 17"
Tip Diameter: 7"

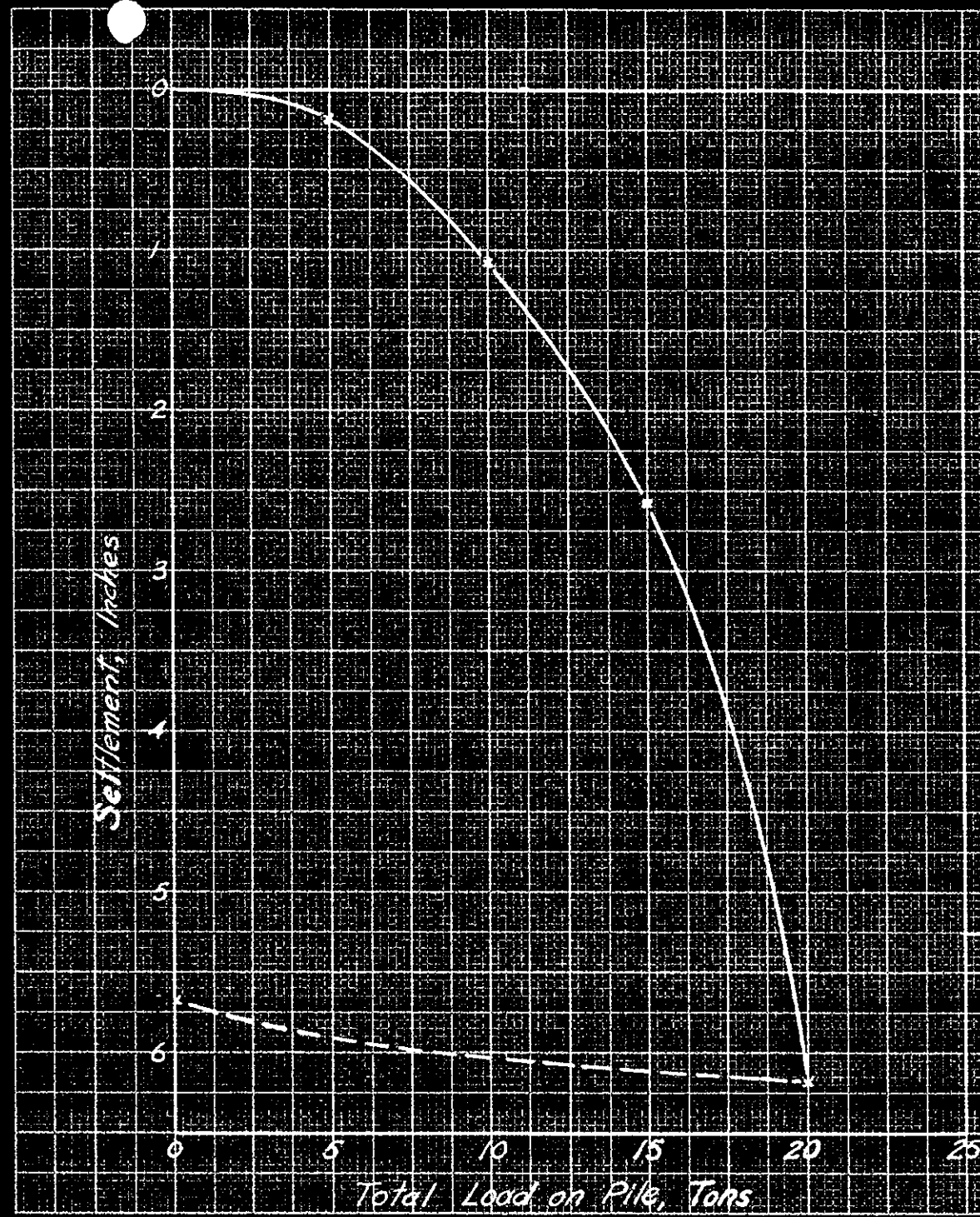
Data on Driving:

Date driven: May 6, 1942
Hammer: Vulcan No. 1
Weight: 5000#
Drop: 3 Ft.
Set: 4" per blow, last 4"

Data on Test:

Date tested: May 19-20, 1942
Age when tested: 13 days
Testing time: 6½ hrs.
Loaded @ about 2 hr. intervals

WHARF
SOUTH BOSTON, MASS.
PILE LOADING TEST #2
(Unlagged Pile)

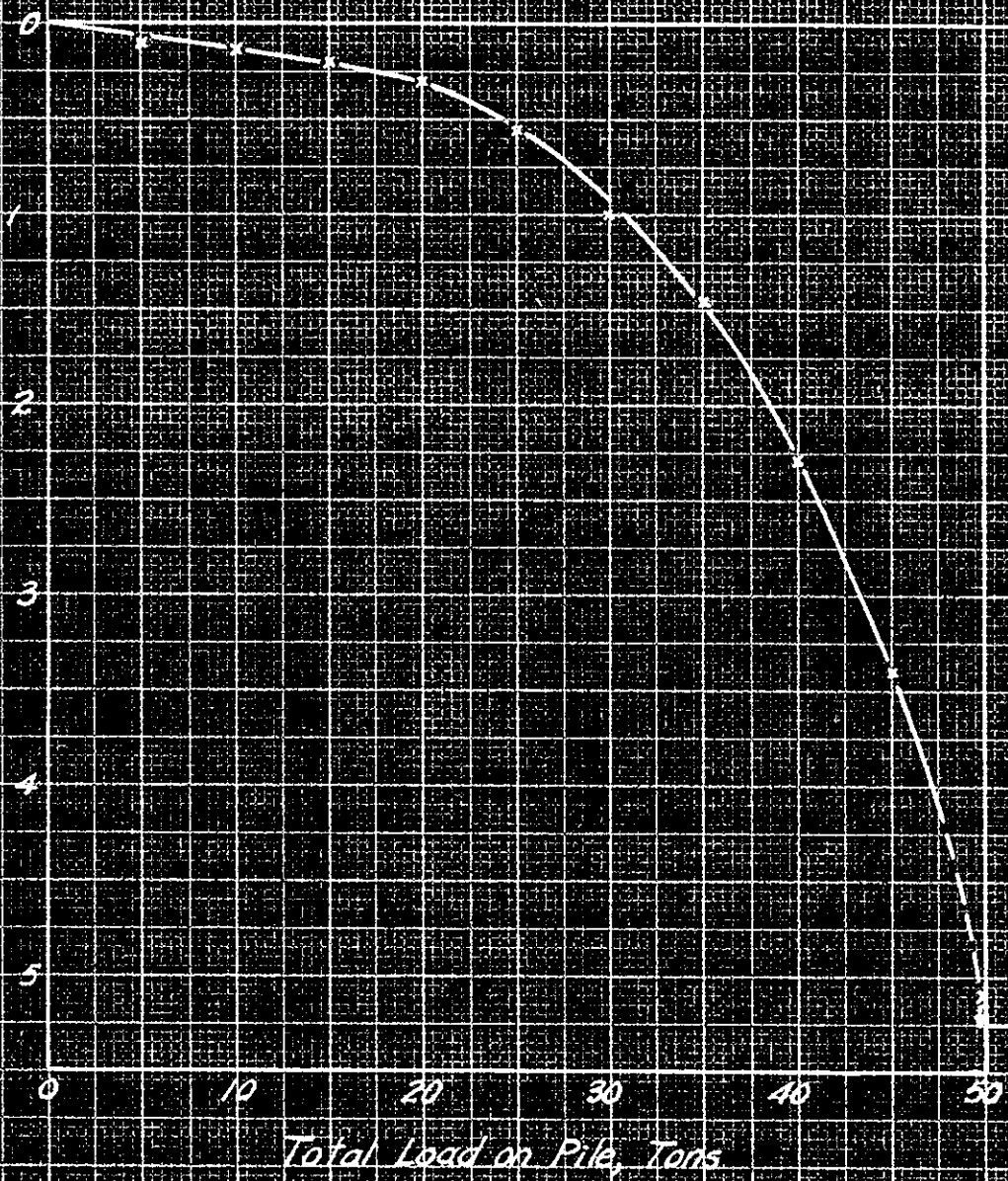


Data on Pile No. 33-N:
Length: 57.3'
Penetration: 24.1'
(into soft blue clay)
Butt Diameter: 17"
Tip Diameter: 7"

Data on Driving:
Date driven: May 6, 1942
Hammer: Vulcan No. 1
Weight: 5000#
Drop: 3 Ft.
Set: 4" per blow, last 4"

Data on Test:
Date tested: May 19-20, 1942
Age when tested: 13 days
Testing time: 6 1/2 hrs
Loaded @ about 2 hr. intervals

WHARF
SOUTH BOSTON, MASS
PILE LOADING TEST #2
(Unlagged Pile)

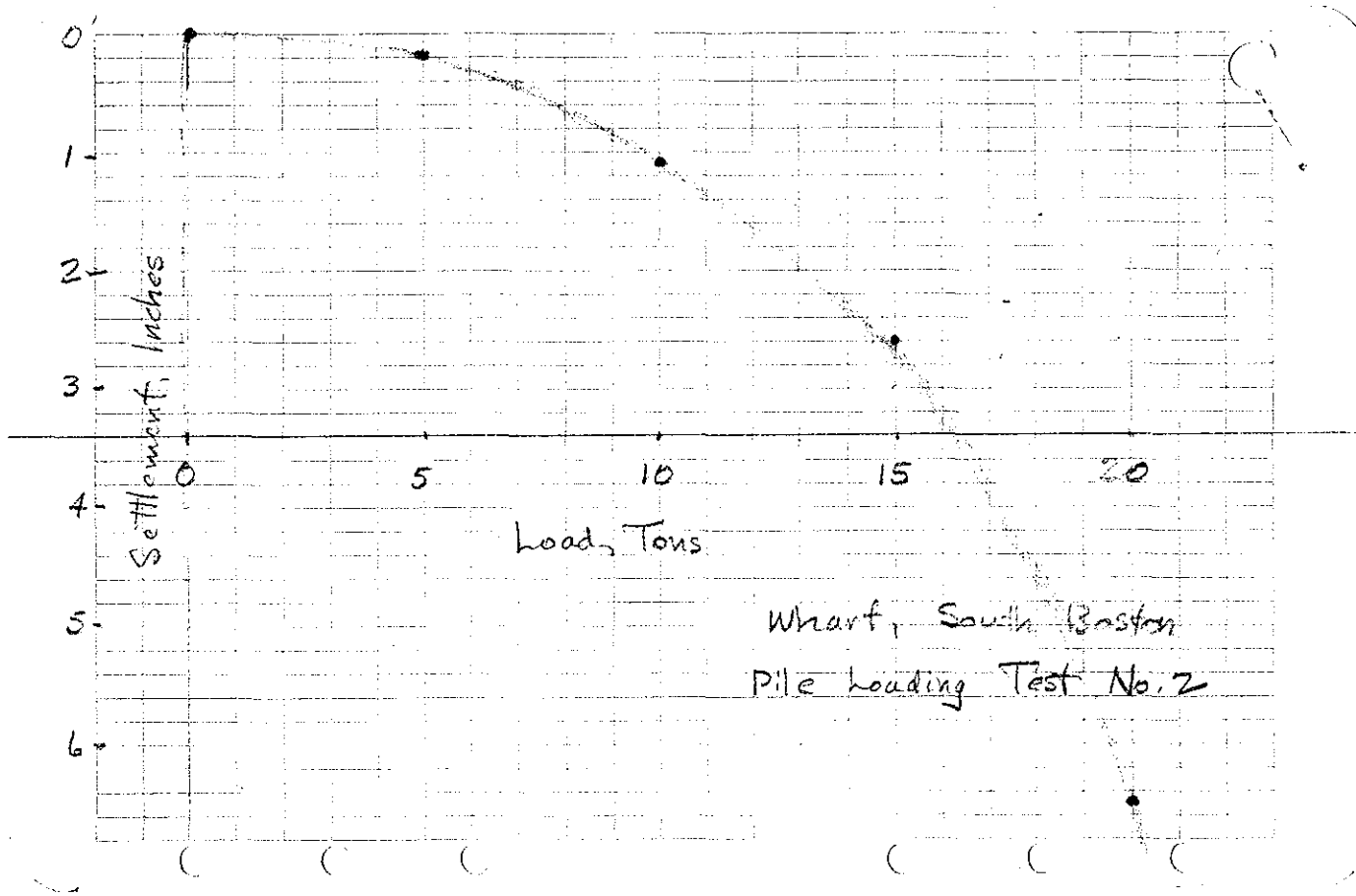


Data on Pile No. 35-T:
Length: 67.3'
Penetration: 30.1'
into soft blue clay
Butt Diameter: 17"
Tip Diameter: 8"
Lagging: 2 - 6" x 8" x 20'0"

Data on Driving:
Date driven: May 8, 1942
Hammer: Vulcan No. 1
Weight: 5000#
Drop: 3 ft.
Set: 1" per blow, last 4"

Data on Test:
Date tested: May 20-21, 1942
Age when tested: 12 days
Testing time: 13 hours
Loaded @ about 1½ hr. intervals

WHARF
SOUTH BOSTON, MASS.
Pile Loading Test #3
(Lagged Pile)


0
1
2
3
4
5
6
Settlement, Inches
0
5
10
15
20
Load, Tons
Wharf, South Boston
Pile Loading Test No. 2

Pile Loading Test No. 2

Pile 33-N. Unlagged

Driven May 6, 1942 17" 7"

Tested May 19, 1942 24.1' Pen.

57.3' long

Load, Tons	Time	Relative Gauge ℄	Level Gauge N	Level Gauge ℄	Level Gauge S
0	6:15 PM	Tel. Pole	Gauge	6.40"	
0	6:28	0	6.02	10.12	6.03
5	6:30	—		—	
"	6:31	0.1	6.02	10.25	6.03
"	6:32	0.1	6.02	10.25	6.03
"	6:34	0.15	6.02	10.25	6.03
"	6:43	0.15	6.00	10.25	6.02
"	6:57	0.15	6.00	10:25	6.00
"	7:15	0.20	6.00	10.30	6.05
"	7:28	0.20	6.03	10.30	6.05
10	7:30	—			
"	7:31	0.40	6.01	10.50	6.00
"	7:34	0.60	6.00	10.70	6.00
	7:44	0.75	6.00	10.85	6.02
	7:58	0.90	6.01	11.00	6.05
	8:13	1.00	6.00	11.08	6.05
	8:33	1.10	6.00	11.20	6.05
	8:58	1.10	6.00	11.20	6.05
	9:30	1.10	6.00	11.20	6.00

Wharf, South Boston
Pile Loading Test No. 2
Data Sheet #2

Load, Tons	Time	Relative Gauge, d	Level G. N	Level G ¢	Level G
15	9:32				
	9:34	1.50			
	9:35	1.60			
	9:37	1.90	6.00	12.00	6.05
	9:43	2.00	6.00	12.10	6.05
	9:49	2.20	6.00	12.44	6.05
	9:59	2.45			
	10:04	2.50	6.03	12.62	6.02
	10:15	2.55	6.00	12.62	6.00
	10:30	2.55	6.00	12.66	6.00
	11:00	2.65	5.95	12.70	6.00
	11:15	2.65	5.98	12.70	6.00
	11:28	2.65	5.98	12.70	6.00
20	11:30				
	11:31		5.96	13.00	6.00
	11:34	3.85	5.98	13.60	6.00
	11:38	4.30	5.95	14.43	6.00
	11:42	4.55	5.92	14.80	6.00
	11:45	5.00	5.90	15.00	6.00
	11:50	5.40	6.00	15.50	6.00
	11:58	5.60	6.00	15.80	6.00

Wharf, South Boston
Pile Loading Test No. 2
Data Sheet #3

Load, Tons	Time	Relative Gauge ℄	Level Gauge N	Level Gauge ℄	Level Gauge S
20	12:05	5.80	—	15.95	—
"	12:15	6.05	5.95	16.12	6.00?
"	12:30 AM	6:25	5.95	16.30	5.95
"	1:00 ±	6.50	Pump unable to keep up pressure - jack all out.		
0	1:05 ±	6.00	Pile Unloaded; blocked up jack		
20	1:40	5.80	5.95	18.50	5.95

Pile 33 N, Driven May 6, 1942

Pile length from plan = 57'
Meas. length before driving = 59'
Diam. of butt = 17"
Diam. of tip = 7"
Last 4 blows = 16"
Length, cut = 57.3'
Penetration = 24.1'

Hammer - Vulcan No. 1

Pile 35 G (Lagged, 3 - 2"x4")

Pile length from plan = 67'
Measured Length before driving = 69'
Diameter of Butt = 16"
Diameter of Tip = 8"
No. of inches in last 4 blows = 12"
Cutoff length of pile = 67.2'
Penetration = 28.6'

Note: Penetration under weight of hammer = 12 feet

Driven — May 12, 1942

WAR DEPARTMENT

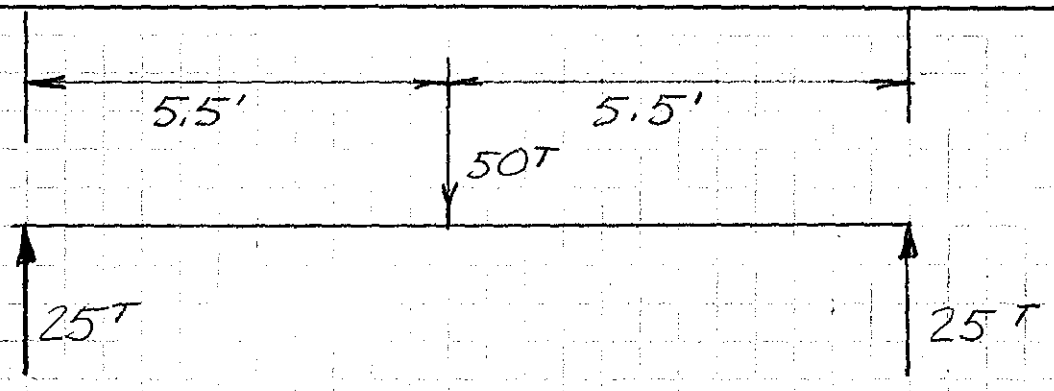
U. S. ENGINEER OFFICE, BOSTON, MASS.

Page 1

Subject Pile Loading Tests

Computation

Computed by ..... Checked by ..... Date .....



$$V_{max} = (25^T)(2) = 50^k$$

$$M_{max} = \frac{Wl}{4} = \frac{(50)(2)(11')}{4} = 275^{k'}$$

Use 2

18" × 4" × 58# Am. Std. Channel

V_{max} - 151^k

M_{max} - $112^{k'}$

$$W = \frac{4\,M_{max}}{l} = \frac{(4)(112)}{2(5.5)}$$

$$= 41.5^T$$

$$W = \frac{(4)(112)}{(2)(4.5)} = 50.5^T$$

Subject
Computation
Computed by Checked by Date

Douglas Fir

Horiz. Shear 72 # /on

Determine No. of bolts assuming 2 sq. ft. shear area per bolt

$$No. = \frac{50{,}000^{\#}}{(2)(144)(72)} = 24$$

No. of 1" ϕ bolts reqd for shear on bolts

$$No = \frac{50{,}000^{\#}}{(2)(12{,}000^{\#}/\square'')(0.785^{\square''})} = 3$$

Pile	Conditions	Driving
J 10	Driven Friday - 30.5' Penetration no lagging	4" last blow
	Redrive Monday	5" last 7 blow
I 1	Driven Saturday - lagged with 2 - 4×8×20' 22.6' penetration	3" last blow
	Redriven Mon.	6 blows 2½
J 2	Driven Sat. lagged 2 - 6×8×20'	3" last blow
	ReDriven Mon.	4 blows 1½"
J 18	Driven Sat. lagged 4 - 6×8×20' 25.2' penetration	½" last blo
	Redriven mon.	16 blows
I 19	Driven Sat. lagged 4 - 4×10×20' 24.0 penetr.	last blow
	Redriven Mon.	16 blows

Test Pile 32 - U

37' Penetration Length 52'

16 blows 7"

Driven April 22

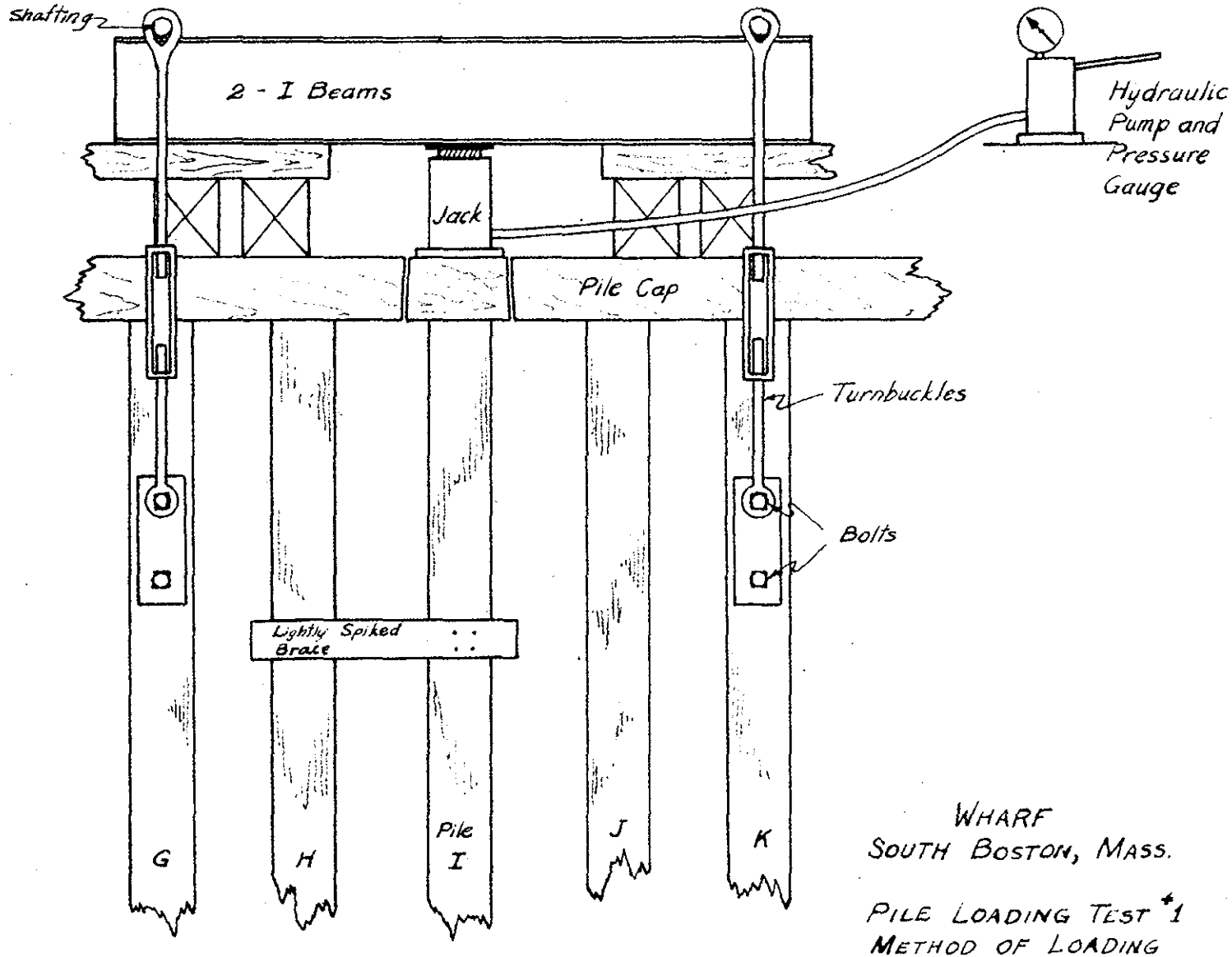
Pile — No. M Bent 36

Driven — May 6th

Pile — No. G Bent 35

Driven — May 12th

No. Blows — 12" for last 4 blows
Init. pen. — 12 feet



WHARF
SOUTH BOSTON, MASS.

PILE LOADING TEST #1
METHOD OF LOADING

Note: Settlements were read on batter boards attached to piles G, I, K.

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject Wharf, South Boston

Computation Pile Loading Test, Settlement of Pile 17-I

Computed by JGZ **Checked by** **Date** 5-10-42

Load Tons	Settlement A	Settlement B	Settlement C	Center Gauge
0	0	0	0	0
10	+0.05	+0.05	+0.10	0.05
15	+0.05	+0.05	+0.10	0.10
20	-0.20	+0.05	0	0.22
25	-0.45	+0.30	-0.10	0.40
30	-0.30	+0.45	-0.15	0.70
35	—	+0.95	—	0.95
0	-0.25	+0.60	-0.05	0.55
10	-0.20	+0.70	0	0.65
20	-0.25	+0.70	-0.15	0.80
30	-0.45	+0.80	+0.05	1.05
35	-0.65	+1.35	-0.15	1.65
38	-0.65	+1.55	-0.15	1.85
40	-0.70	+1.95	-0.20	2.25
45	-0.70	+3.05	+0.05	3.35
48	-0.90	+3.70	-0.15	4.05
0	-0.55	+3.10	-0.20	3.40

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject Lend-Lease Wharf - South Boston, Mass.

Computation Pile Loading Tests - No. 1

~~Computed by~~ Pile 17 I **Checked by** **Date** 8-9-42

Time of Load Application or Reading	Load, Pounds per square inch	Load, Tons	Center Scale Reading	Settlement Readings A (South Support Pile)	B (Loaded Pile)	C (North Support Pile)
6:00	0	0	0	4 11/16	4 11/16	4 5/8
→ 7:00 PM	600	10	0.05	—	—	—
7:05 PM	"	"	"	4 3/4 12/16	4 3/4 12/16	4 5/8
7:45 PM	"	"	"	4 3/4	4 3/4	4 3/4
8:45 PM	900	15	0.07	—	—	—
9:50	"	"	"	4 3/4	4 3/4	4 3/4
[illegible]	"	"	"	[illegible]	[illegible]	[illegible]
0.5" [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10:30	1200	20	0.14	[illegible]	[illegible]	[illegible]
10:40	"	"	[illegible]	[illegible]	[illegible]	[illegible]
11:30	"	"	0.20	[illegible]	[illegible]	[illegible]
12:50	"	"	0.22	4 1/2 8/16	4 3/4 12/16	4 5/8
12:58	1500	25	[illegible]	[illegible]	[illegible]	[illegible]
1:05	"	"	0.30	[illegible]	[illegible]	[illegible]
1:15	"	"	[illegible]	4 1/4 4/16	5 1/2 7/16	4 5/8
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2:[illegible]	"	"	[illegible]	[illegible] 8/16	[illegible]	[illegible]
2:[illegible]	"	"	[illegible]	4 1/4 7/16	5	[illegible]
[illegible]	1200	30	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	"	"	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	"	"	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	"	"	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	1200	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	0	0	[illegible]	[illegible]	[illegible]	[illegible]

At 35 Tons cap failed in compression — Reloaded

[illegible]	0	0	0.55	4 7/16	[illegible] 3/16	4 11/16
[illegible]	600	10	0.65	4 1/2 9/16	[illegible]	4 10/16
7:[illegible]	1200	20	0.80	4 7/16	5 9/16	4 1/2
7:21	1800	30	0.95	4 6/16	5 5/8	4 11/16
7:~~24~~	1800	30	1.00			
7:36	"	"	1.05			

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject .....

Computation .....

Computed by ..... **Checked by** ..... **Date** .....

	Time of Load Applic. or Reading	Load # / □"	Load Tons	Center Scale Reading	Settlement Readings A	B	C
	7:12	1800	30	1.05	4 1/4	5 1/2 9/16	4 11/16
Sunday	7:45 A	2100	35	—	—		
	7:46	"	"	1.15			
	7:54	"	"	1.25			
	8:00	"	"	1.35	4 1/16	5 13/16	4 9/16
	8:20	"	"	1.45	4 1/16	5 7/8	4 1/2
	9:00	"	"	1.60	—	—	—
	9:48	"	"	1.65	4 1/16	6 1/16	4 1/2
	9:55	2300	38	—	—		
	9:57	"	"	1.75			
	9:59	"	"	1.80			
	10:05	"	"	1.85			
	10:14	"	"	1.85	4 1/16	6 4/16	4 1/2
	Loaded at 10:15 10:15	2400 +	40	1.90	—	—	—
	10:19	"	"	1.95	—	—	—
	10:25	"	"	2.10	—	—	—
	11:10	"	"	2.15	4 1/16	6 8/16	4 9/16
	11:15	"	"	2.20	—	—	—
	11:55	"	"	2.25	3 7/8	6 9/16	4 7/16
	12:10	"	"	2.25	4"	6 10/16	4 7/16
	Load @ 12:13	2700 +	45	~~2.1~~			
	12:14	"		2.40	—	—	—
	12:16	"	"	—	—	6 7/8	—
	12:17	"	"	2.55	—	6 15/16	—
	12:21	"	"	2.60	3 3/4	6 15/16	4 1/4
	12:29	"	"	2.65	—	6 15/16	—
	12:35	"	"	2.85	—	—	—
	12:55	"	"	2.95	3 3/4	7 3/16	4 1/4
	1:17	"	"	3.10	3 13/16	7 1/2	4 1/2
	1:38	"	"	3.15	—	—	—
	2:15	"	"	3.30	4	7 11/16	4 9/16
	2:35	"	"	3.35	4	7 12/16	4 11/16
	2:43 PM	Loaded 2900 #/□	48	—	—	—	—
	2:45	"	"	3.45	—	—	—
	2:49	"	"	3.55	4 1/8	8	4 5/8
	2:55	"	"	—	3 13/16	7 15/16	
	3:00		"	3.70	4.00	8 —	4 5/8
	3:15	"	"	3.80	4.00	8 1/16	4 4/8
	3:43	"	"	3.95	3 13/16	8 3/16	4 1/2

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject: Lend-Lease Wharf - South Boston, Mass.

Computation: Pile Loading Test, #1

Computed by: Pile 17 I Checked by: Date: 5-10-42

Time of Load Application or Reading	Load, #/□"	Load, Tons	Center Scale Reading	Settlement Readings A	B	C
4:00 PM	2900	48	4.00	3 15/16	8 6/16	4 11/16
4.20	2900	48	4.00	3 11/16	8 6/16	4 7/16
4:28	"	"	4.00 +	3 14/16	8 6/16	4 9/16
4:44	"	"	4.05	3 13/16	8 6/16	4 8/16
	Note	top of pile	is 4 1/8"	below bottom	of cap.	
4:53	0	0	3.75	4 2/16	8	4
5:00	0	0	3.45	4 1/16	8	4 3/8
5:10	0	0	3.40	4 1/8	7 7/8	4 1/2
5:20	"	"	3.40	4 1/8	7 15/16	4 1/2
5:35	"	"	3.40	4 2/8	7 14/16	4 10/16
5:50	"	"	3.40	4 1/8	7 13/16	4 8/16
6:00	"	"	3.40	4 1/8	7 13/16	4 7/16

Information on Hydraulic Jack -
From Groisson & Schlager
Watson Stillman Co. Hydraulic Jack
Machine No. 3812 — 0 to 8000 #/□"
250 #/□" division, 0 to 1000 #/□"
200 #/□" " 1000 #/□" up
6 1/2" dia. ram

Information on Pile 17-I

Date Driven: 4-27-42, 8:45 AM
By: N. E. Foundation Co.
Driver No: 1 Type No. 1 { 5000 #, 3' drop, 60 blows per min
Hammer: Vulcan No. 732
Length: 67' from plan
69' actual, before driving
Dia. of Butt 16"
Dia. of Tip 9"
No. Blows, last 4" 1.8 - 1"
Length above cutoff = 2.6'
Length below cutoff = 66.4'
Penetration: = 25.6'
Sounding (MLW): = 27.8

Loggings:
3 - 6 × 8" × 20'

Penetration under wgt. of hammer = 1.5'

Total Blows - 94

WAR DEPARTMENT

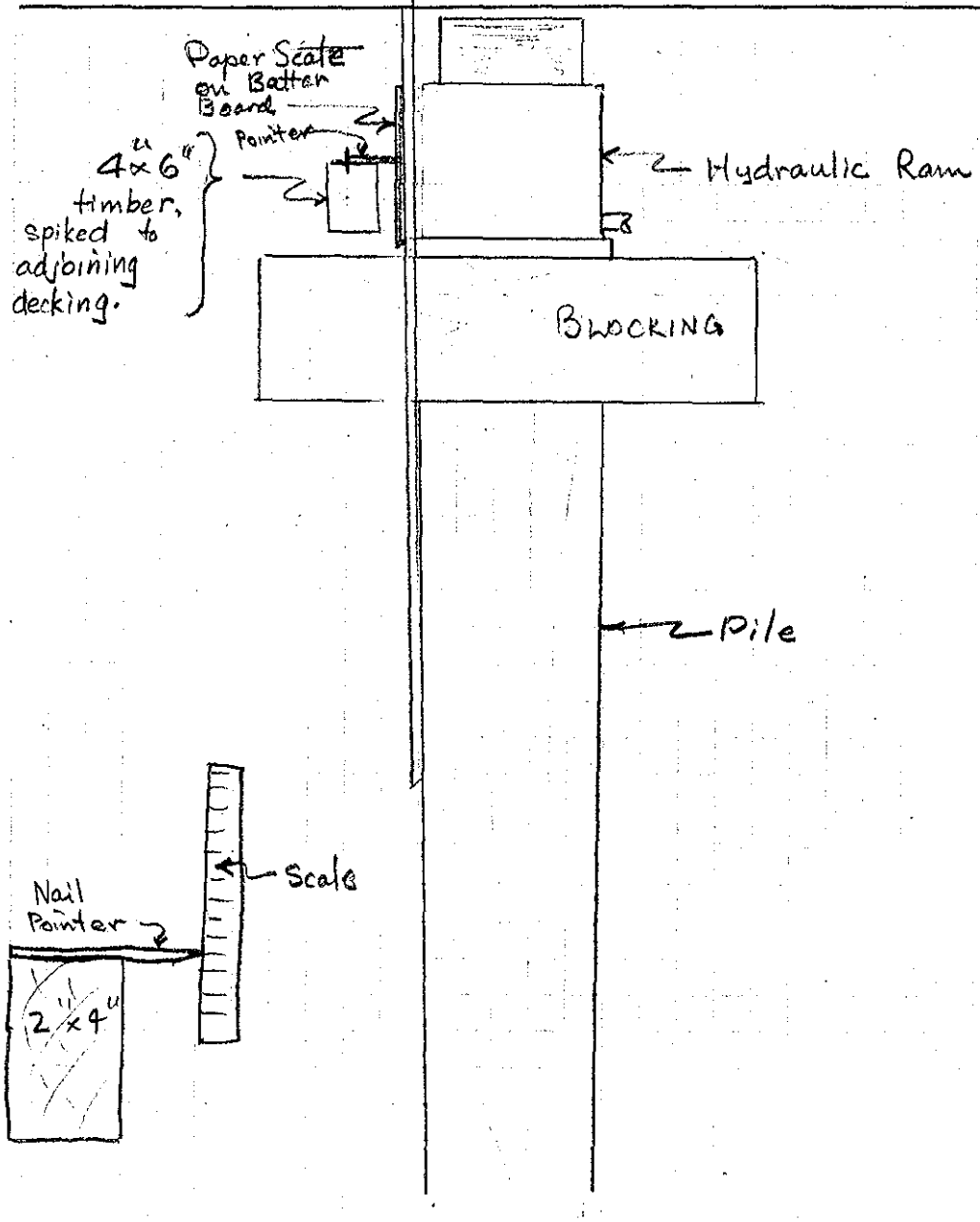
U. S. ENGINEER OFFICE, BOSTON, MASS.

Page

Subject: Lend-Lease Wharf, South Boston, Mass.

Computation: Pile Loading Tests – Arrangement for measuring Settlements – Center Gage

~~Computed by~~ Checked by: Date: 8-9-42



WAR DEPARTMENT

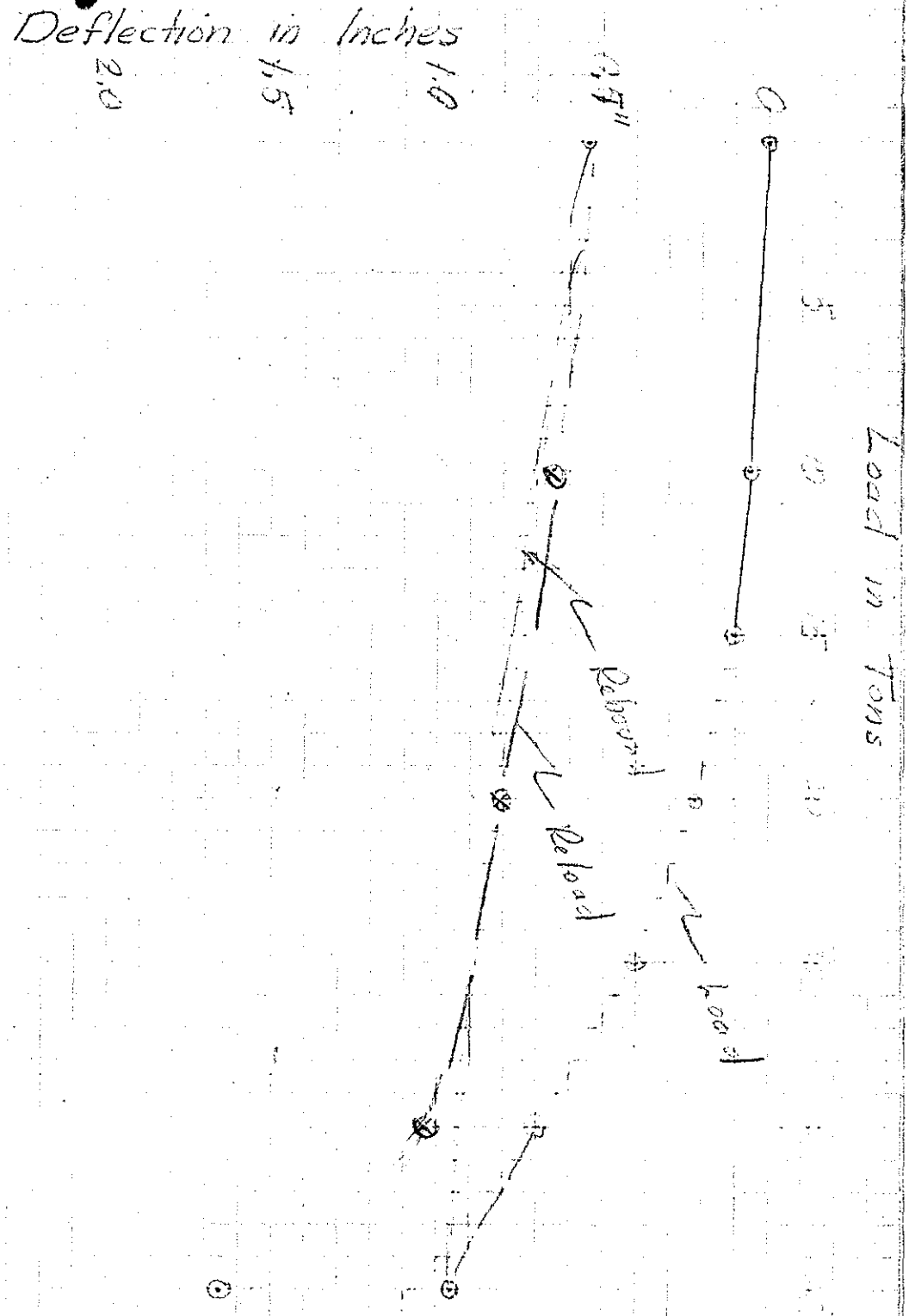
U. S. ENGINEER OFFICE, BOSTON, MASS.

Page.....

Subject .....

Computation .....

Computed by..... **Checked by**..... **Date**.....



WAR DEPARTMENT

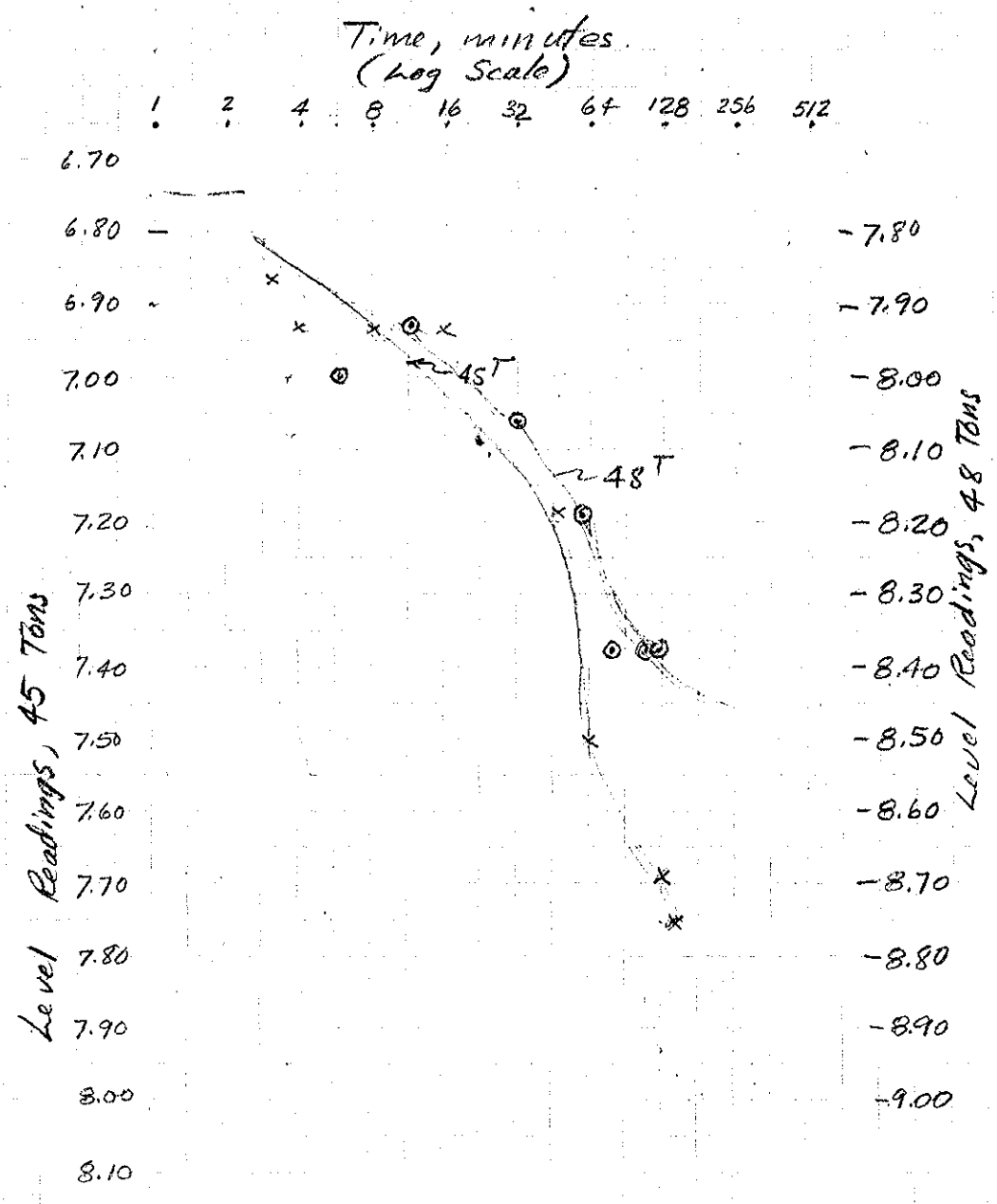
U. S. ENGINEER OFFICE, BOSTON, MASS.

Page .....

Subject .....

Computation .....

Computed by ..... **Checked by** ..... **Date** .....



WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

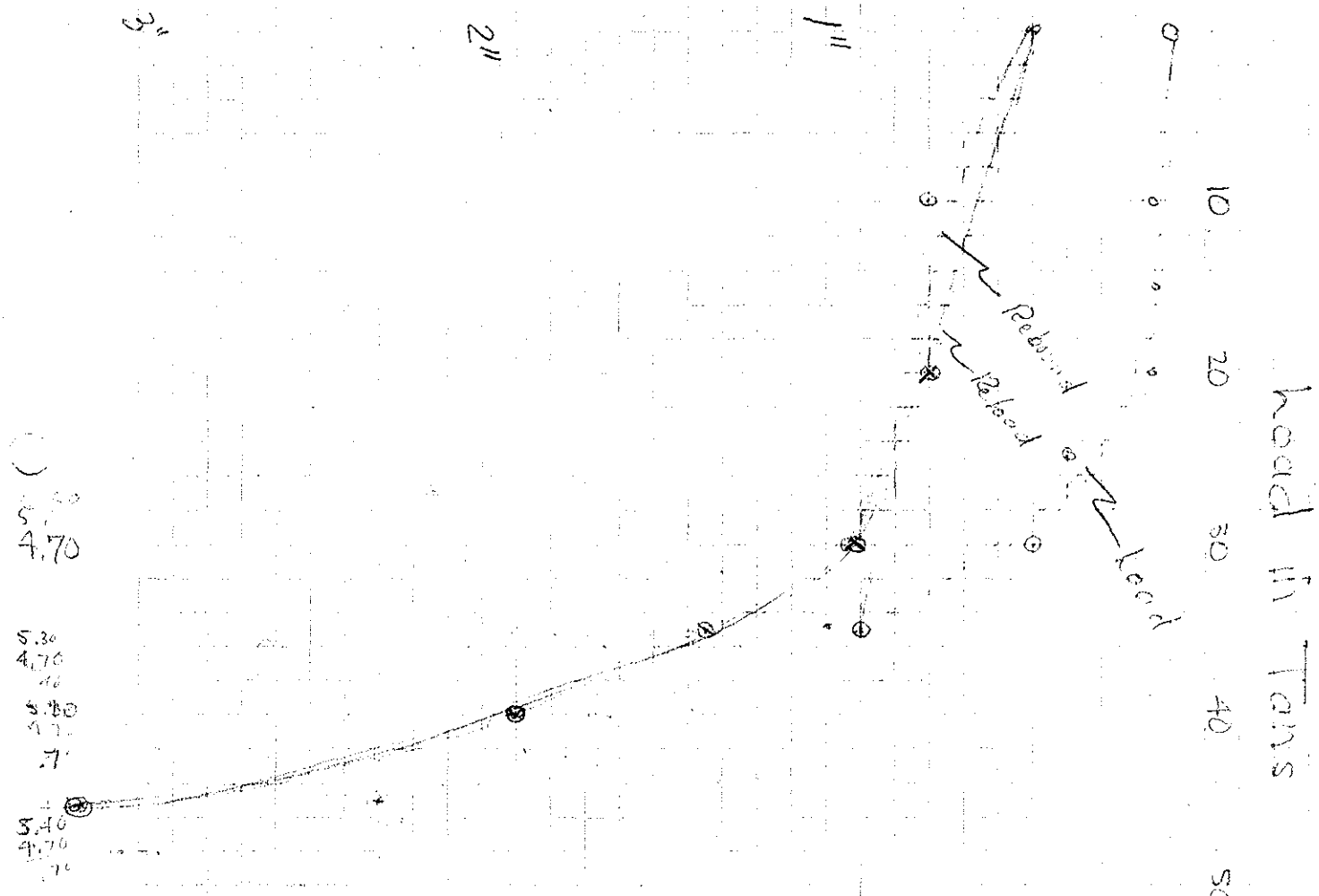
Page.....

Subject .....

Computation .....

Computed by..... Checked by..... Date.....

Settlement of B Gage Meas. by Level



WAR DEPARTMENT

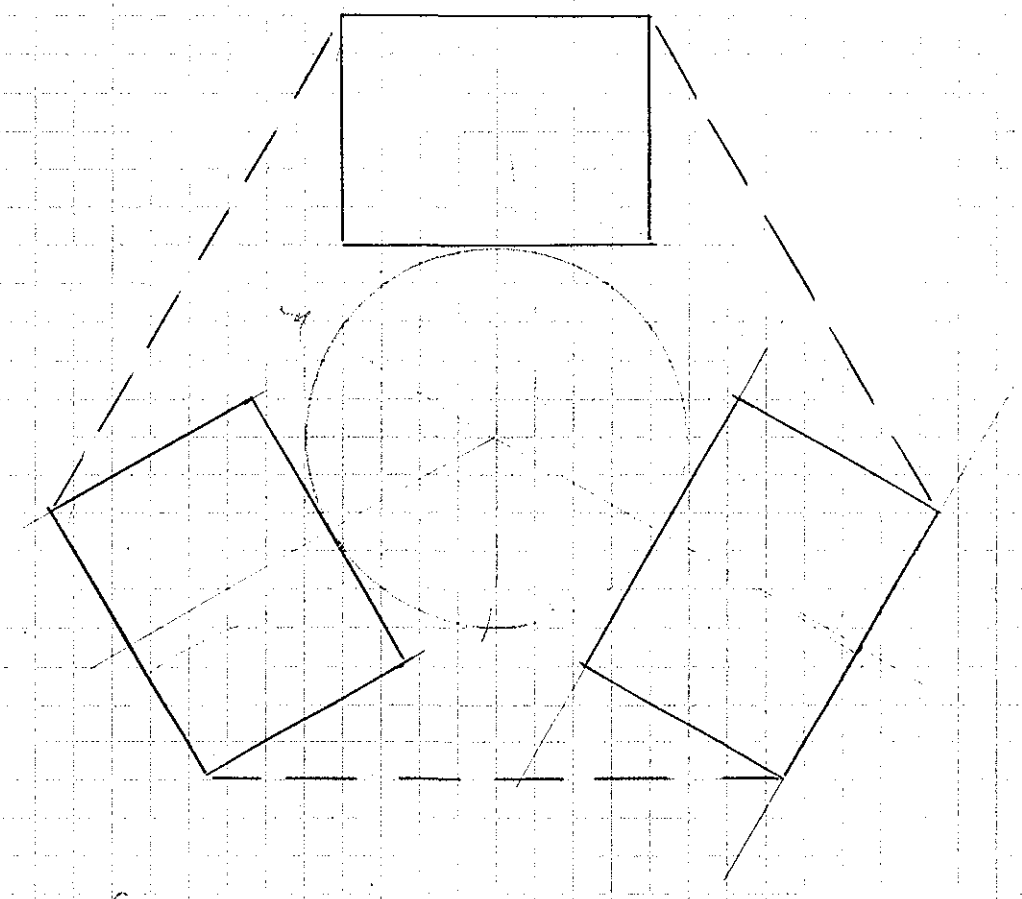
U. S. ENGINEER OFFICE, BOSTON, MASS.

Page

Subject Pile Load Test No. 1

Computation

Computed by **Checked by** **Date**



Circumference

$3 \times 15 = 45''$
$3 \times 8 = 24''$
$69'' = 5.8'$

Surface Area

$20' \times 5.8' = 116$ of

Safe Load from test = 30 Tons

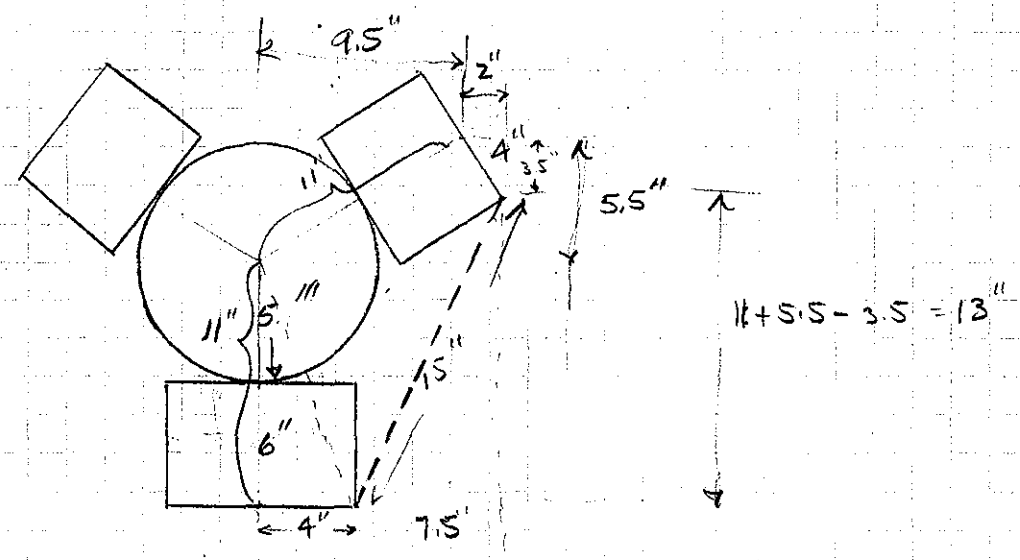
Unit skin friction = 520 #/of

Subject .....

Computation .....

Computed by..... Checked by..... Date.....

3 — 6" × 8" × 20'0"



CIRCUM. 3 × 8" = 24
3 × 15 = 45
69" = 5.75'

Area lagged = 5.75 × 20 = 115 □'

" not lagged = 5.6' × π × 11.5"/12 = 16.9'

Total area = 132 □'

Max. Unit frictional resistance = 48 × 2000 / 132 = 727 #/□"
at ½" def, 30 T/132 = 0.228 T/SF — 0.36 T/SF

10" pile, unlagged, 25' deep in clay,

25' × π × 10/12 × 0.228 = 15 Tons.

WAR DEPARTMENT

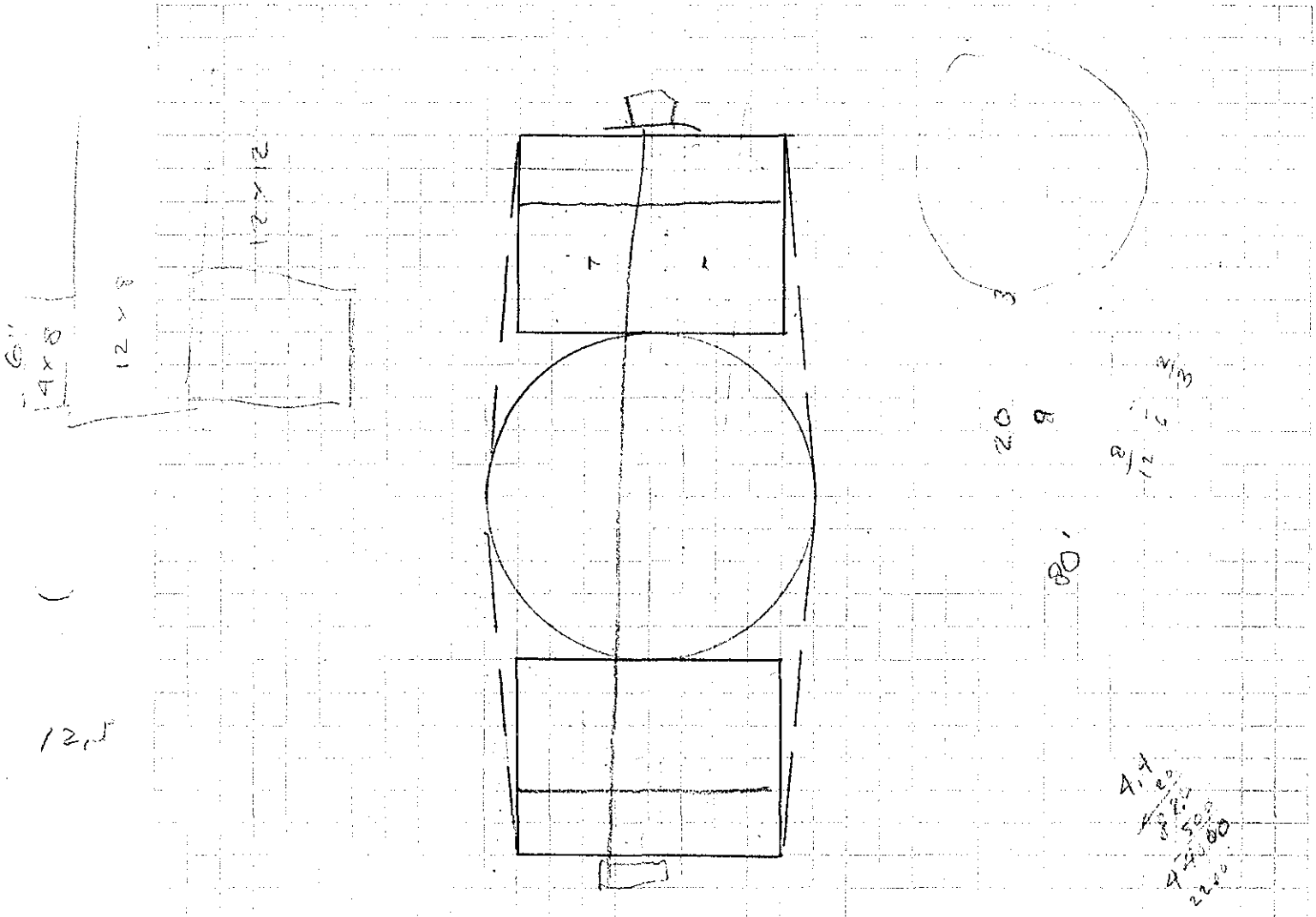
U. S. ENGINEER OFFICE, BOSTON, MASS.

Page.....

Subject: Pile Load Test No. 3

Computation:

Computed by..... Checked by..... Date.....



Circumferance = 4 × 11" = 44
2 × 8" = 16
60 = 5 ft

Surface Area = (5)(20') = 100 sf

Safe Load from test = 24 Tons

Skin friction = 480# /sf

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Page

Subject Pile Load Test No. 2

Computation

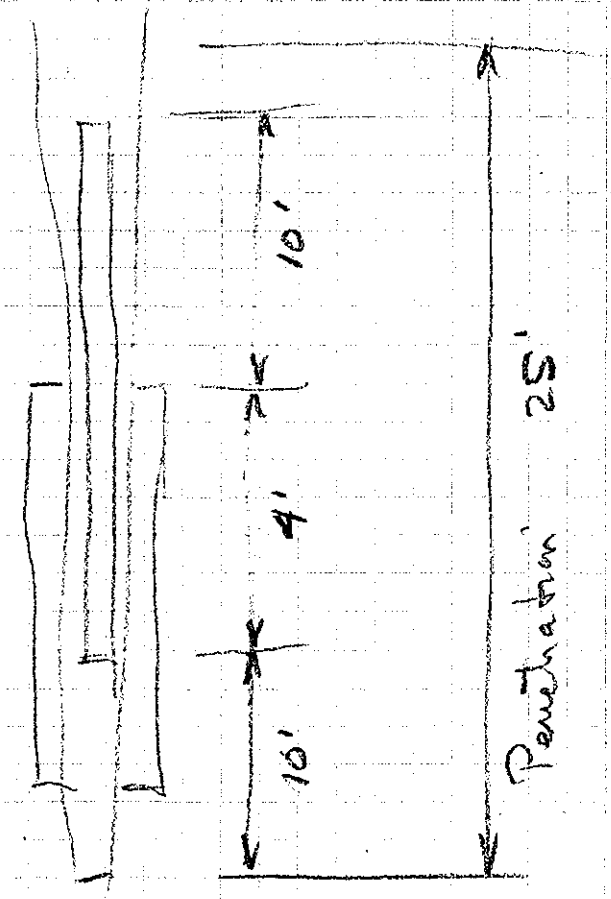
Computed by **Checked by** **Date**

Surface Area

$$\frac{(\pi)(10'')}{12}(25') = 65 \text{ of}$$

Safe Load from test = 7 Tons

Skin Friction = 215 #/of



WLS:hwl

2025
5

D. O. Form 116

WAR DEPARTMENT
United States Engineer Office
3rd Floor, Park Square Building
31 St. James Avenue
Boston, Mass.

August 5, 1942

MEMORANDUM TO: Operations Officer, Rivers and Harbors and Lend Lease Section.

CONCERNING: Pile Loading Tests, Transit Shed, South Boston, Mass.

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1. Confirming telephone conversation of August 1, 1942, it is requested that three (3) piles driven to the upper bearing stratum be tested for bearing capacity. The locations of piles to be tested will be determined jointly in the field by representatives of the Soils and Geology Section, and the Resident Engineer.

2. Loading will be accomplished using a thirty-ton hydraulic jack which will be furnished by the Soils and Geology Section. The reaction for the jack may be most satisfactorily obtained using adjacent piles as anchors and "H" beams to span between anchors. Anchor piles should extend about twenty (20) feet deeper than pile to be tested and may be left in place upon completion of test.

RECEIVED
AUG 6 1942

J. E. Allen
Principal Engineer
Chief, War & Flood Control Subdivision

cc: Mr. Shannon
Mr. Moyer

2005

August 21, 1942

Allston, Massachusetts

Mr. W. L. Shannon, Chief, Soils and Geology Section,
U. S. Engineer Office, Boston, Mass.

Pile Loading Test, Transit Shed, Wharf, South Boston,
Mass., August 18, 1942

1. Purpose of Test. On August 18, a loading test was performed at the Transit Shed, Wharf, South Boston, to determine the maximum allowable load and to check the design bearing value of 10 tons per pile.

2. Method. The test was performed using a hydraulic jack to load the pile as shown on Plate I. Settlements of the test pile and reaction piles were measured by level readings made periodically during the loading.

3. Pile Tested. Pile No. 4 in bent 7Y was selected for testing. Selection of this pile was based upon the ease of installing all equipment and also on the location, since the bearing stratum of hard yellow clay is present at maximum thickness of about 12 feet in this area. Data on the driving of this pile are shown on Plate II.

4. Description of Test. Loading was begun at 5:20 P.M. on August 18, 1942 and unloading completed six hours later at 11:20 P.M. In general, load increments of three (3) tons were applied every twenty (20) minutes. At a load of 32 tons, the testing platform was partially destroyed by a pile being swung to the driver from the fill adjacent to the test pile. Settlement readings taken immediately before and immediately after this occurrence revealed that a negligible amount of disturbance resulted. Loading was continued to a total of 35 tons, or three and one-half times the design load. When equilibrium at this maximum point was reached, unloading was accomplished in sixty minutes at three ten-ton and one 5-ton increments.

5. Results. Plate II shows a plot of the load on the pile versus its settlement at the end of each loading increment when a state of equilibrium had been reached. The settlement at the design load of 10 tons was 0.12 inches, 0.51 inches at 25 tons and 1.4 inches at 35 tons.

6. Conclusions. Many criteria have been examined in interpreting the results of this test. The most restricting of these, namely, that the maximum allowable load not exceed the load at 1/2-inch settlement, one-half the load at failure, or one-half the maximum load reached during the test, and allowable load of 17.5 tons is arrived at, the last

criterion proving the limiting one. It is believed that, had loading been continued, an ultimate total of 36 tons would have been reached, based on characteristics of the load-settlement curve shown on Plate II. Based on Building Code of New York, allowable settlement is limited to 1/100-inch per ton load or 0.1 inches for the design load of ten tons. The settlement at the design load was 0.12 inches, slightly in excess of the allowable according to this criterion.

7. Recommendations. It is recommended that point bearing piles at the Transit Shed be continued as proposed in the areas where the bearing stratum exists at a thickness of twelve (12) feet. These areas lie at the west end of the building site from Sta. 33 to Sta. 35, and at the east end from Sta. 41 to Sta. 42. It is further recommended that driving in other areas be delayed pending the results of a second pile loading test which has been tentatively located near D51 where the bearing stratum exists at a thickness of six and one-half (6.5) feet. It is proposed to make this test within the next four or five days.

MMM

Marshall M. Moyer
Assistant Engineer

D. O. Form 968

UNITED STATES ENGINEER SUBOFFICE
LEND-LEASE WHARF
SOUTH BOSTON, MASS.

PILE DRIVING
INSPECTOR'S SHIFT REPORT

DATE Aug. 13 1946

SHIFT 7:00 A M to 5:30 P M

Sub. Contractor ABERTHAW Co. Driver No. 2 Hammer No. Maker DROP-HAMMER 2600 #

Weather _____ Sea _____

~~Bent No.~~ Line	~~Pile letter~~ Row	Pile Length from plan	Meas. Length before driving	Diameter of Butt	Diameter of Tip	No. blows in last 4"	Tide Reading	~~Sounding~~ Ground Elev.	Sounding Red. to M.L.W.	Cut off elev.	Length above cut-off (meas.)	Length below cut-off	Penetration a - (b+c+d)	Pay length above cut off	Pay length below cut off	Item No.	Under remarks, state reason, pile length used, varied from plan by more than 5 feet over or 2' under.
			(a)						b	c	d	a--d		For	office	use	Remarks:
7Y	4	36	36	10	8	4-5"	–	–	–	17.3	2.7	33.3	23.0			T	Test Pile No. 1 (Driven @ 2:00 P.M.)
8	4	50	50	15	9	4-4"	–	–	–	17.3	3.1	46.9	36.6			T	East Support Pile - Test No. 1
7X	4	50	50	16	8	4-4"	–	–	–	17.3	2.6	47.4	37.1			T	West Support Pile - Test No. 1
																	(All driven with ave. 12' drop)

Signed _____ Inspector-Noted & Approved _____

2025/2

WAR DEPARTMENT
UNITED STATES ENGINEER SUBOFFICE
78 SOUTH MAIN STREET
CONCORD, NEW HAMPSHIRE

xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
xxxxxxxxxxxxxxxxxxx August 27, 1942
xxxxxxxxxxxx

Allston, Massachusetts

Mr. W. L. Shannon, Chief, Soils and Geology Section, U.S. Engineer Office, Boston, Mass.

Pile Loading Test, Transit Shed, Wharf, South Boston, Massachusetts, August 25, 1942.

1. Purpose of Test. Following the completion of Pile Loading Test No. 1, on August 18, which was described by memorandum dated August 21, 1942, an area of very soft driving was encountered at the northwesterly corner of the Transit Shed. Although subsurface conditions in this area were supposedly comparable with those at the initial test pile, it was felt necessary to perform a loading test in this soft area. Choice of the test location was made by personnel of the Field Office.

2. Method. The test was carried out in a manner similar to that employed for the initial test, using a hydraulic jack to load the pile and measuring settlements by level-readings on meter-sticks fastened to the pile. The loading scheme is shown on Plate I.

3. Pile Tested. Pile No. 9Y in row 27 was selected for testing. This pile is located in the soft area as shown on Plate III. Selection was based upon the ease of installing the loading apparatus without interference with construction operations. Although the undersigned was not present during actual driving of the test and reaction piles, information regarding the driving of the former was carefully gathered by the Driving Inspector and is as follows:

(a) Penetration of pile under weight of hammer alone - 17 feet.
(b) Drove pile 1.5 ft. with 6 blows.
(c) Drove pile 11 inches with 4 blows.
(d) Drove pile 2.0 ft. with 9 blows.
(e) Drove pile 13 inches with 4 blows.
(f) Drove pile 11 1/2 inches with 4 blows.
(g) Total number of blows - 27.
(h) Time of driving, 2:40 P.M. August 21, 1942
(i) Additional information on driving is shown on Plate II.

4. Description of Test. Loading was begun at 5:28 P.M. on August 25, 1942, and unloading completed at 12:05 A.M. on August 26. In general, load increments of three (3) tons were applied at intervals of 25 minutes. Settlement readings were made periodically under each load increment until equilibrium was reached. Loading was continued to a total load of 36 tons. When equilibrium was reached at this maximum load, unloading was accomplished in one and one-half (1 1/2) hours.

5. Results. Plate II shows a plot of the total load on the pile versus the maximum settlement under each load increment. The settlement at the design load of ten (10) tons was approximately 0.04 inches, 0.2 inches at 25 tons, and 0.51 inches at 36 tons. Elastic deformation of the pile contributed approximately 0.2 inches to this total maximum settlement.

6. Conclusions. Applying the criteria that the maximum allowable load not exceed one-half the load at failure, one-half the maximum load reached during the test, or the load at 1/2-inch settlement, an allowable load of 18 tons is arrived at, the second restriction being the limiting condition. It is believed that had loading been continued, an ultimate load of 40 tons may have been reached before failure, based upon the load-deformation characteristics of the curve shown on Plate II. Applying the criterion of the New York Building Code that the allowable settlement not exceed 1/100-inch per ton of load or 0.10 inches for the design load of ten (10) tons, it is found that the actual settlement was less than half the allowable. It is concluded by the undersigned that the ease of driving piles in this particular area may be attributed to a general soft condition of the upper strata of the foundation and to the extreme weight of the hammer. This weight, unknown prior to testing of the pile was measured by the undersigned using the hydraulic jack and pressure gauge and found to be approximately 5 1/2 tons.

7. Recommendations. It is recommended that point bearing, unlagged piles be considered safe and that driving be continued in accordance with the Contract Drawings. Recommendations tendered by the memorandum referred to in Paragraph 1 above, regarding pile driving in other areas are still felt justified.

cc. Lt. J. B. Gardner
Inclosures: 3

Marshall M. Moyer
Assistant Engineer

D. ... Form 968

UNITED STATES ENGINEER SUBOFFICE
LEND-LEASE WHARF
SOUTH BOSTON, MASS.

PILE DRIVING
INSPECTOR'S SHIFT REPORT

DATE [illegible] 1942

SHIFT 6 P.M. to 9:30 A.M.

Sub. Contractor Aberthaw Co Driver No. 7 Hammer No. #7 Maker McKiernan-Terry Weather Fair Sea

~~Bent No.~~ Line	~~Pile letter~~ Row	Pile Length from plan	Meas. Length before driving	Diameter of Butt	Diameter of Tip	No. blows in last 4"	Tide Reading	~~Sounding~~ Ground Elev.	Sounding Red. to M.L.W.	Cut off elev.	Length above cut-off (meas.)	Length below cut-off	Penetration a - (b+c+d)	Pay length above cut off	Pay length below cut off	Item No.	Under remarks, state reason, pile length used, varied from plan by more than 5 feet over or 2' under.
			(a)			Last 4 Blows			b	c	d	a--d		For	office	use	Remarks:
22	29	43	43	13	7	1/4"	—	9.0	—	16.5	3.0	40.0	32.5				Test Pile No. 2 (Driven @ 10:00 P.M.)
21Y	29	43	55	16	7	1/4"	—	9.0	—	16.5	8.5	46.5	39.0				West Support Pile
22W	29	43	55	16	7	1/4"	—	9.0	—	16.5	4.5	50.5	43.0				East Support Pile

Signed T. C. Tally Inspector-Noted & Approved

2025/8

September 5, 1942

Allston, Massachusetts

Mr. W. L. Shannon, Chief, Soils and Geology Section,
U.S. Engineer Office, Boston, Massachusetts

Pile Loading Test, Transit Shed for Castle Island
Terminal Project, South Boston, Massachusetts,
September 1 and 2, 1942.

1. Purpose of Test. Following the completion of Pile Loading Test No. 1, on August 18, described by memorandum dated August 21, 1942, a second location representing the minimum thickness of the hard clay bearing stratum was selected for Pile Loading Test No. 2. This area was located at D51 as shown on Plate I attached. Subsurface conditions are shown by the boring log on Plate II attached.

2. Method. The test was carried out using the loading equipment employed for the previous tests. A diagramatic sketch showing the general assembly is shown on Plate III, also attached.

3. Pile Tested. Pile No. 22 in Row 29 was selected for testing since it was located nearest D51. In order that the most critical condition possible might be obtained, a small pile was selected. Information regarding the driving of this pile is presented below:

(a) Penetration of pile under static weight of hammer alone - 3.5 feet.
(b) Total number of blows - 610.
(c) Penetration for last 4 blows - 1/4-inch.
(d) Total penetration - 32.5'.
(e) Time of driving - 10:00 P.M., August 29, 1942.
(f) Additional information shown on Plate IV, attached.

4. Description of Test. Loading was begun at 11:56 A.M. on September 1, 1942, and unloading completed at 10:45 A.M. on September 2, 1942. In general, load increments of three (3) tons were applied at intervals of one hour. Settlement readings were made periodically under each load increment until equilibrium was approached. Loading was continued to a total of 25 tons. Due to the magnitude of settlements it was necessary to completely unload four times during the test so that additional shims might be inserted above the jack, since the maximum allowable travel of the jack-ram was four inches. The maximum load of 25 tons was maintained intermittently on the pile for a period of 18 hours. Since settlement data is incomplete for a great portion of this time, the results are inconclusive and only the initial loading and rebound cycles are presented here.

5. Results. Plate IV shows a plot of the total load on the pile versus the maximum settlement under each load increment. The settlement at the design load of ten (10) tons was approximately 0.17 inches and 3.2 inches at the maximum load of 25 tons. Elastic deformation contributed approximately 0.5 inches to this latter settlement.

6. Conclusions. Applying the criteria that the maximum allowable load not exceed one-half the load at failure, one-half the maximum load reached during the test, or the load at 1/2-inch settlement, an allowable load of approximately ten (10) tons, plus or minus, is arrived at, the first criterion governing. Applying the criterion of the New York Building Code that the allowable settlement not exceed 1/100-inch per ton of load or 0.10 inches for the design load of ten (10) tons, it is found that the actual settlement exceeded the allowable by 0.7 inches.

7. Recommendations. It is believed that the excessive settlements experienced during this test may be attributed to the small 7-inch diameter bearing tip of the pile. It is recommended that from Station 36 to 41, bearing piles with tip diameters of at least 8 inches be used exclusively.

Marshall M. Moyer
Assistant Engineer

cc. Lt. J. B. Gardner
Inclosures: (4)

D. O. Form 968

Sheet 2 of 3

UNITED STATES ENGINEER SUBOFFICE
LEND-LEASE WHARF
SOUTH BOSTON, MASS.

PILE DRIVING
INSPECTOR'S SHIFT REPORT

Date [illegible]

SHIFT 7:00 A.M to 5:00 P.M

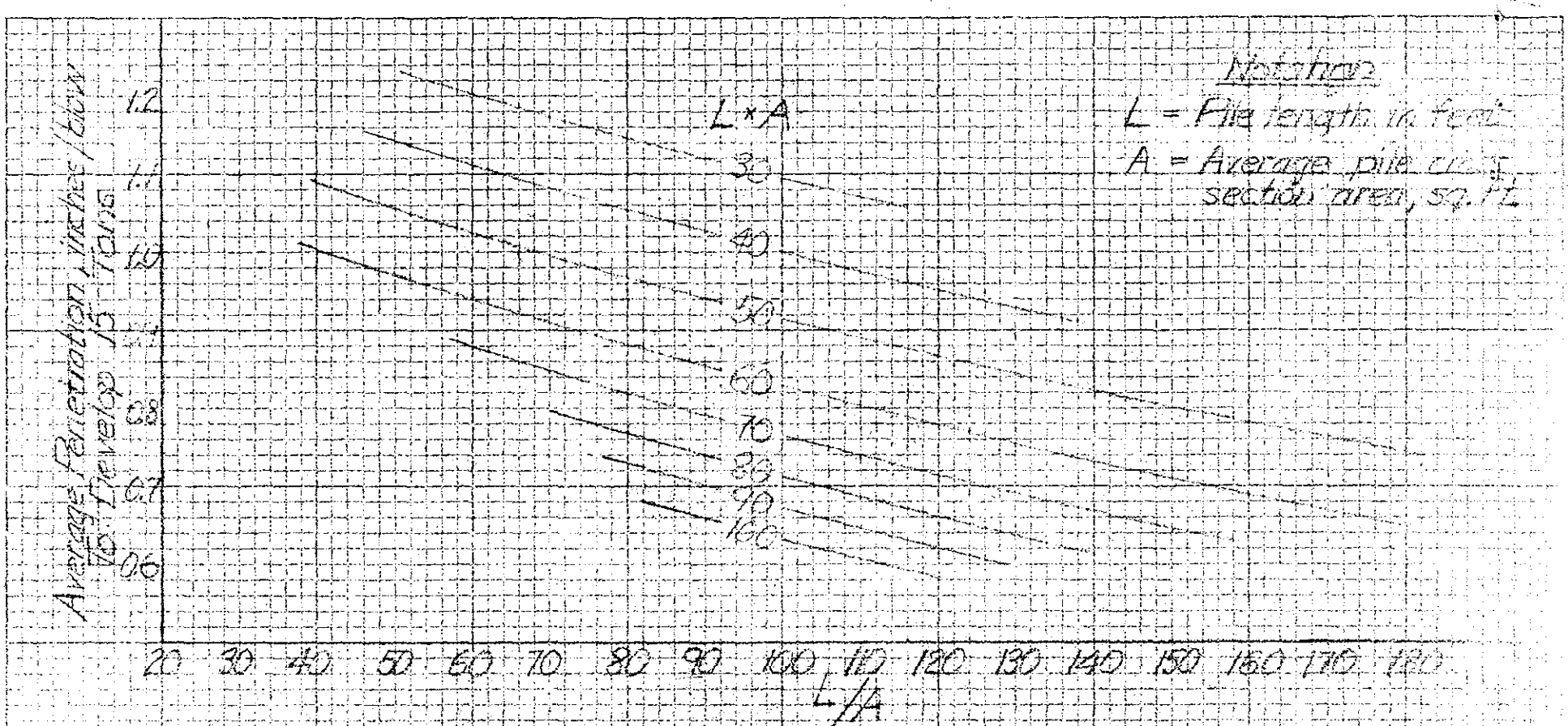
Sub. Contractor Aberthaw Co. Driver No. 3 Hammer No. Maker Vulcan #1

Weather Fair Sea

~~Bent No.~~ Line	~~Pile Letter~~ Row	Pile Length from plan	Meas. Length before driving	Diameter of Butt	Diameter of Tip	No. blows in last 4"	Tide Reading	~~Sounding~~ Ground Elev.	Sounding Red. to M.L.W.	Cut off elev.	Length above cut-off (meas.)	Length below cut-off	Penetration a - (b+c+d)	Pay length above cut off	Pay length below cut off	Item No.	Under remarks, state reason, pile length used, varied from plan by more than 5 feet over or 2' under.
			(a)						b	c	d	a--d		For	office	use	Remarks:
9Y	27	36	40	15	10	4-1½		7.0		16.5	7.0	33.0	23.5			T	Test Pile No.3 (2:40 P.M.)
9X	27	36	50	13	8	4-7		7.0		16.5	2.3	47.7	38.2			T	West Support Pile - Test No.3
10	27	36	50	15	9	4-6½		7.0		16.5	2.5	47.5	38.0			T	East Support Pile - Test No.3

Signed _____ Inspector-Noted & Approved _____

KEUFFEL & ESSER CO., N. Y. NO. 359-S
10 × 10 to the inch.



L	L/A Av. Pile Diam., inches 10	11	12	13	14	L×A Av. Pile Diam., inches 10	11	12	13	14
40		60	51	43	37		26	31	37	43
50		76	64	54	47		33	39	46	54
60	110	91	77	65	56	33	40	47	55	64
70	132	106	89	76		38	46	55	65	
80	147	121	102	85		44	53	63	75	
90	165	136	114	97		49	60	71	83	
100	183	151	127	108		55	66	79	92	

15 TON CHART

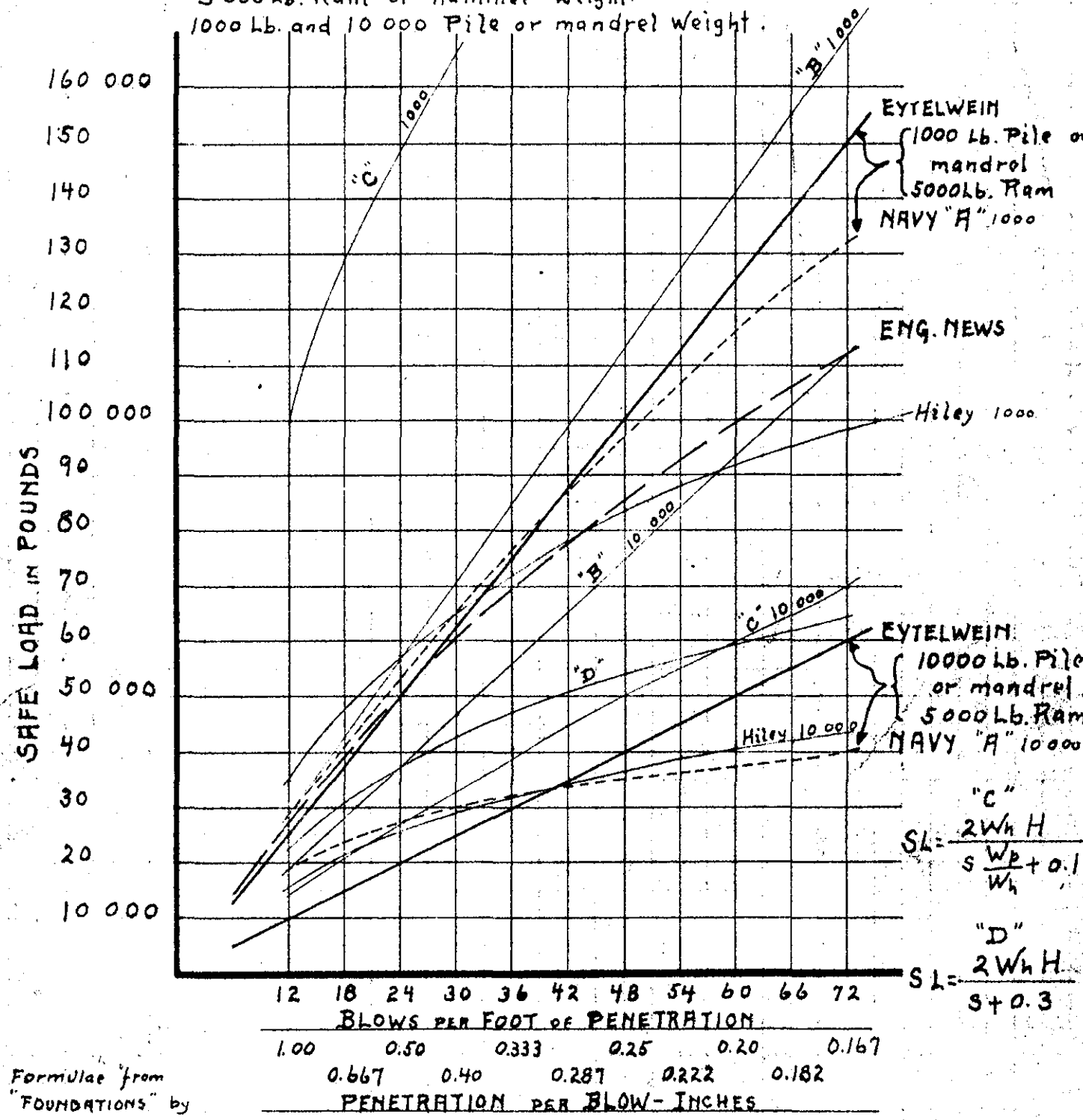
BASED ON HILEY FORMULA

CONDITIONS

5000 lb. single acting steam hammer
3 ft. free fall, no follower
50 lbs./c.f. unit wt. of piling

George B. Sowers
Consulting Engineer
Cleveland Ohio

COMPARISON OF FORMULAE FOR SAFE BEARING POWER OF PILES
5 000 Lb. Ram or hammer weight
1000 Lb. and 10 000 Pile or mandrel Weight.



"C"
$$SL = \frac{2W_h H}{S\frac{W_p}{W_h} + 0.1}$$

"D"
$$SL = \frac{2W_h H}{S + 0.3}$$

Formulae from "FOUNDATIONS" by Jacoby and Davis 1925

EYTELWEIN'S

$$\text{Safe Load} = \frac{2W_h H}{S\left(1 + \frac{W_p}{W_h}\right)}$$

ENG. NEWS

$$\text{Safe Load} = \frac{2W_h H}{S + 0.1}$$

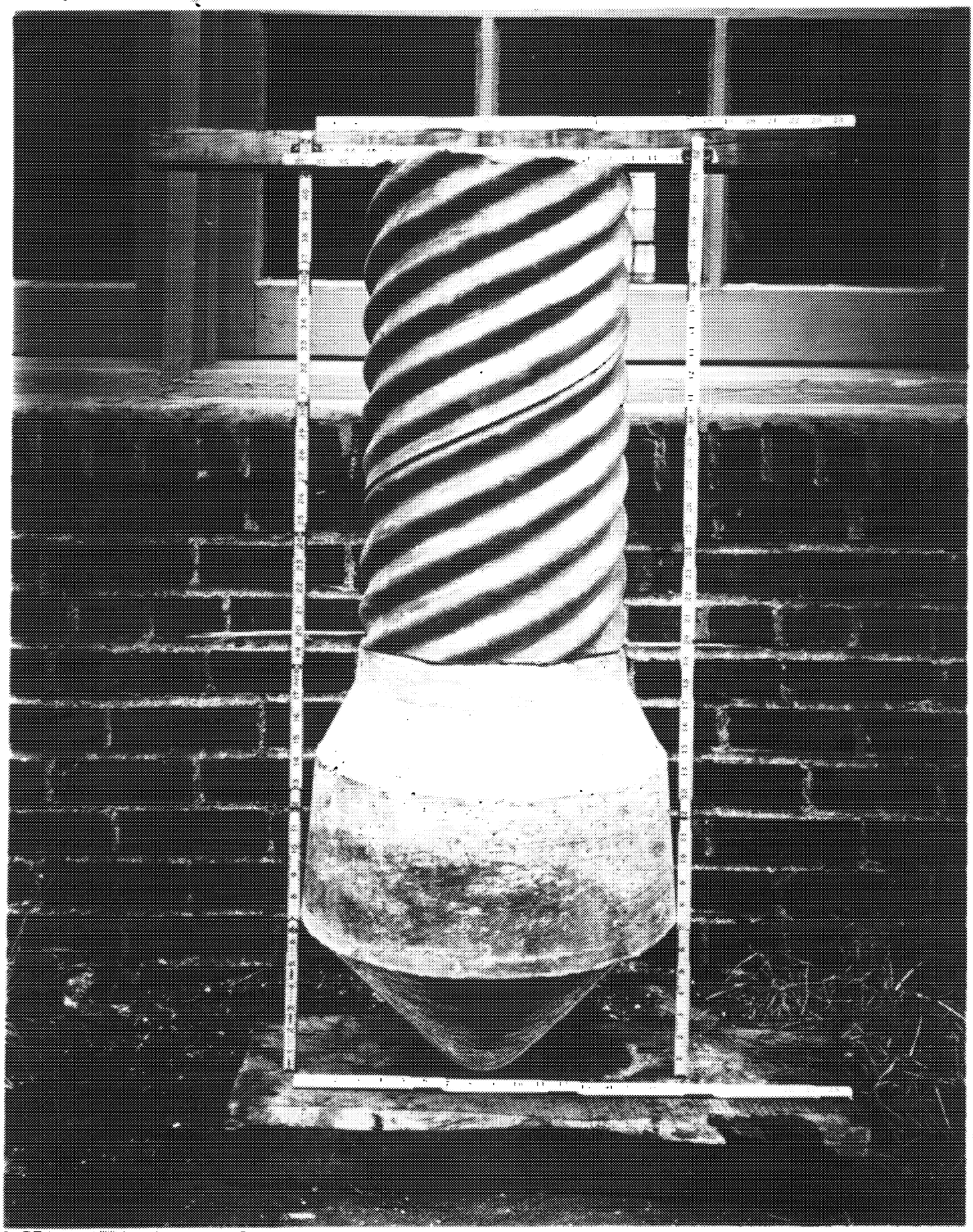
"NAVY" A"

$$\text{Safe Load} = \frac{2W_h H}{S + 0.3\frac{W_p}{W_h}}$$

"B"

$$SL = \frac{2W_h H}{S\left(1 + 0.3\frac{W_p}{W_h}\right)}$$

H = Fall in feet
W_h = Weight of ram = 5 000 Lbs.
W_p = Weight of pile or mandrel = 1000 Lbs. or 10 000 Lbs.



BUTTON-BOTTOM CAST-IN-PLACE CONCRETE PILES

17" diameter pre-cast concrete point.
12" net diameter, steel encased shaft.
Safe load. 45 tons each

Western Foundation Co.
308 West Washington St.
Chicago, Illinois

Western Concrete Pile Corp.
52 Vanderbilt Ave.
New York City, New York

GEORGE B. SOWERS
Consulting Engineer
1836 Euclid Avenue
Cleveland

COPY

January 10, 1942

Mr. John E. Allen
Chief Engineer
U. S. District Engineer Office
Park Square Bldg.
Boston, Mass.

Dear Mr. Allen:

Travel orders duly received and await your instructions to go to Washington.

In reference to piling specifications I wired you late today as follows:

SUGGEST PILE SPECIFICATION PROVIDE ALL PILES DRIVEN INTO GLACIAL TILL NOT LESS THAN FIVE FEET AT NOT LESS THAN TWENTY BLOWS PER FOOT BUT NO PILE HAVING SEVEN INCH POINT BE HAMMERED MORE THAN THREE BLOWS PER INCH FOR ANY FOUR INCHES OR LARGER POINT MORE THAN 4 BLOWS ALL USING FIVE THOUSAND RAM DELIVERING FIFTEEN THOUSAND ENERGY.

Point, or at best end bearing, timber piles in the very peculiar but not unusual soil conditions at the L.L. wharf are the most economical supporting members that can be provided in a minimum of time for your proposed wharf. Since they must be very long with small sized points (7" or better I hope) there is great danger of their being sheared off or broken if over driven in the layer of hard glacial till or so called "hardpan". (The Bureau of Public Roads describe "hardpan" as a thoroughly cemented indurated, rock-like layer that will not soften when wet.")

Due to the very soft, plastic character of the clay overlying the hard glacial till it is very desirable or even imperative that the piles penetrate the hard layer for at least a few feet.

No dynamic pile driving formulae devised to show the probable safe load for an individual pile has any application to piles driven under the soil conditions obtaining at the L.L. wharf site. Each pile will be an end supported column capable of carrying, without settlement, all of the load that the column structure can itself support as a long column. Failure will not be through further penetration of the pile.

I watched piles driven through identical material across the channel and I studied numerous records of actual piles driven in this soil and tested as well as the records of piles just driven. These and your numerous probings and borings all were given careful consideration in preparing my suggestion for a rule to be followed in driving the 6,000 timber piles.

No dynamic pile formulae is applicable and none should be included in the specifications. You want to secure a pile that is firmly set in the hard glacial till layer and one that has not been over-driven.

Twenty blows per foot for five feet with a 5,000# ram striking a blow of 15,000 foot-pounds is quite adequate to insure a firm seat in the material and hold the pile point against any further penetration under a load of 15 tons. It will also insure penetration of the upper hard clay layer.

Just to indicate what 20 blows per foot means on a 3,000 to 3,500 pound, 85' long timber pile when struck by a 5,000# ram delivering 15,000 foot pounds of energy at the butt I have computed several commonly and even rarely used formulae as follows:

Eytelwein formulae:

Safe load $= \frac{2WhH}{S(1+\frac{Wp}{Wh})}$ = 15 + tons

Engineering News formulae of 1888

S.L. $= \frac{2WhH}{S + 0.1}$ = 20 tons

A Navy formulae - Bureau of Yards and Docks Bul. 33 p. 46.

S.L. $= \frac{2WhH}{S + 0.3 \frac{Wp}{Wh}}$ = 19 - tons

Chicago Building Code

S.L. $= \frac{2WhH}{S(1 + 0.3 \frac{Wp}{Wh})}$ = 20 + tons

Hiley formulaes - Bookby Russell V. Allen and printed in England

Ultimate resistance (no factor of safety) $= \frac{KWH}{S + \frac{C}{2}}$ = 47 tons

While the simplified Hiley formulae given in the A.S.C.E. report gives a safe load of only 10 tons.

Experience has shown that no timber pile with a 6" or 7" diameter point should be driven with the above heavy hammer to a resistance of more than about 3 blows per inch for 4 inches and that an 8" to 10" point should not be driven to more than 4 blows per inch for 4 inches, hence my restriction in the suggested rule.

A 7" diameter point timber pile which has brought up solid on the hard layer of soil will develop compression on the end of the timber grain of less than 800 pounds per square inch. Wet or damp Douglas Fir is usually considered to have a safe unit compressive stress of 800 to 900 pounds per square inch in columns.

If we examine the longest pile as a long column using Euler's formulae for critical load we find that the pile has a critical load value of about 60 tons or a factor of safety of four.

The front rows of piles, as firmly braced, are capable of supporting the design loads used.

Very truly yours,

/s/ George B. Sowers

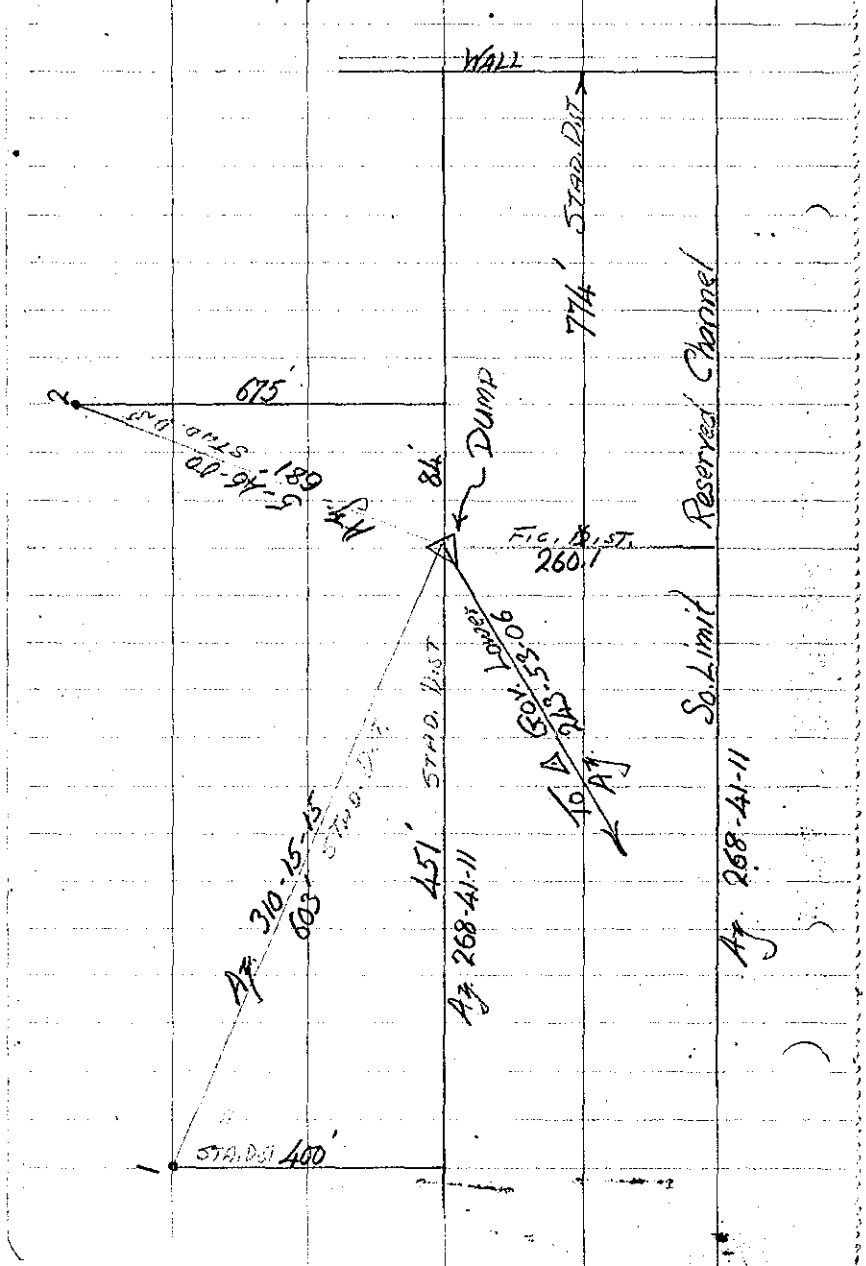
GBS:R

GEORGE B. SOWERS

3 LOCATION BORING HOLES IN S. BOSTON FILL, #1 & #2

Bk. # 388-F

1/13/42



D58 15.0 / -20.0

hard yel clay
top 35'

15

33
15
18

D66

hard [illegible]

17

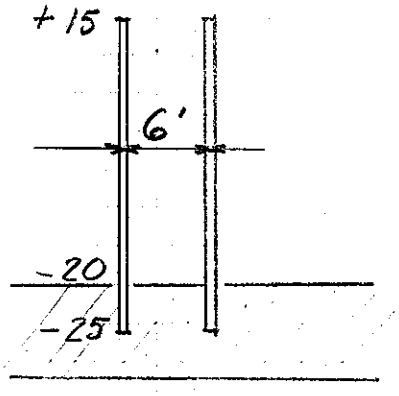
D56

Subject.....

Computation.....

Computed by..... Checked by..... Date.....

C. Uniformly spaced piles, treated, loaded to 10T each



$$\frac{20{,}000^{\#}/\text{pile}}{600^{\#}/\text{lf total load}}$$

$= 34^{\#}/\text{pile}$

$=$ 6' c to c spacing

Pile length = 40'

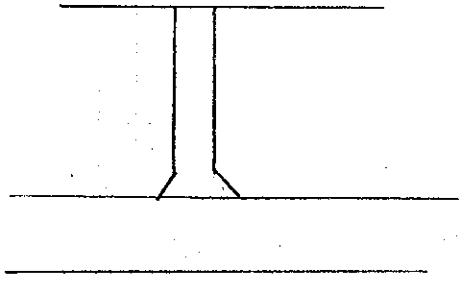
No. of Piles $\frac{(840)(140)}{36} =$

Est. Cost (piles)(40')(1.80) = $295,000

D. Same as C but using untreated composit piles

Est. Cost (piles)(40')(1.30) = $213,000

E Carssons –



WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Page.....

Subject.....

Computation.....

Computed by..... Checked by..... Date.....

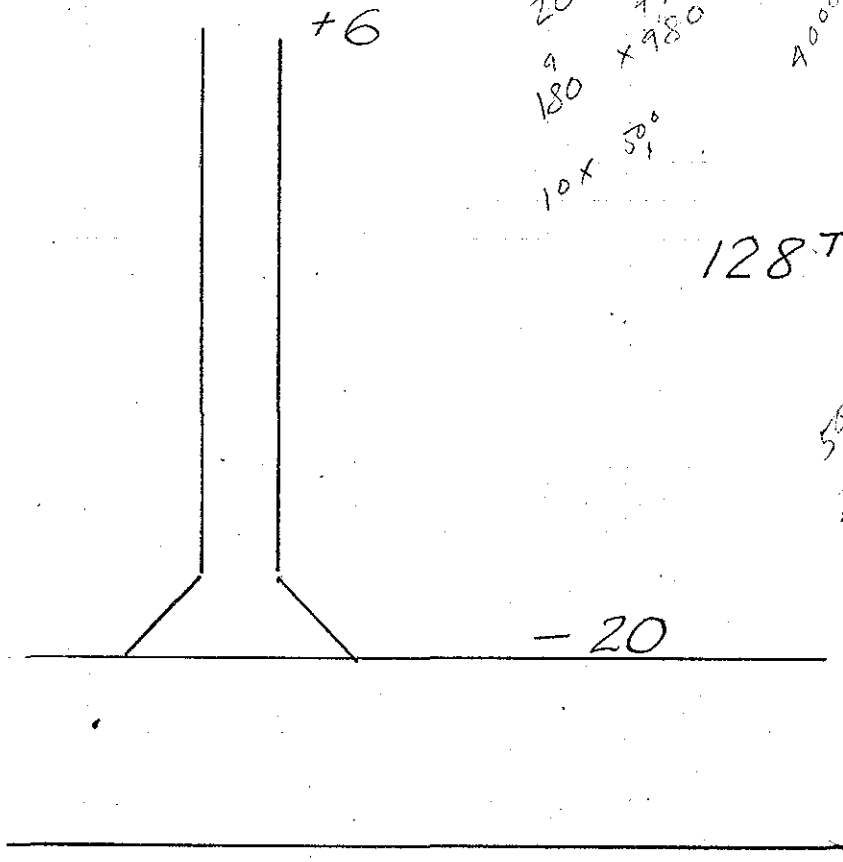
175
180 Tons

20
9
180 × 980
490
10 × 50°

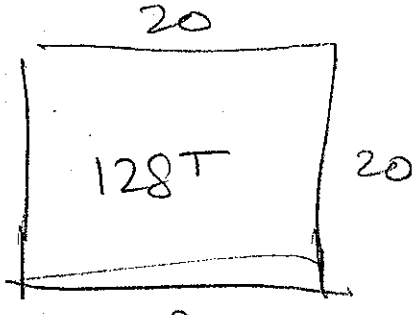
4000
$125,000

128T

500
9
4500
45
200,000



Total Load = 140 Tons
Soil bearing = 4 T/□f



150,000

(980 × 180)

840 × 180

128
400

.32 T/□f

2000
64000

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS. Page.....

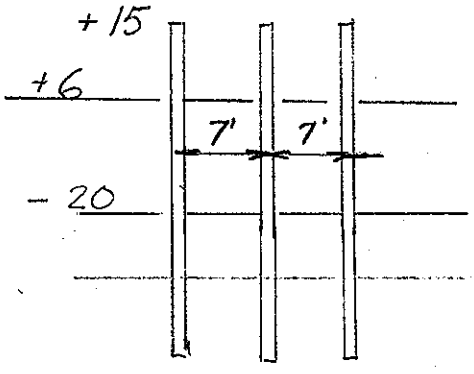
Subject: New Transit Shed

Computation: Foundation

Computed by..... Checked by..... Date.....

The following types of foundations for new Transit Shed are considered

A. Uniformly spaced piles, treated, loaded to 15 T each.



$$\frac{30{,}000\ \#/\text{pile}}{(600\ \#/\text{lf total load})}$$

$= 50\ \text{lf}/\text{pile}$

$= 7'$ c to c Spacing

Pile imbedment below el. -20

$$\frac{30{,}000\ \#/\text{pile}}{(500\ \#/\text{lf})(2'\ \text{circum})} = 30'$$

Total length pile = 65'

Total No. Piles

$$\frac{(\overset{2}{840})(\overset{1}{140})}{49} = 2400 \text{ piles}$$

Est. cost $(2400 \text{ piles})(\overset{1+1}{65'})(\overset{0}{1.80}) = \$280{,}000$

B. Same as above but using untreated piles, composit section

Est. cost (piles)(65')(1.30) = $260,000

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Page.....

Subject.....

Computation.....

Computed by..... Checked by..... Date.....

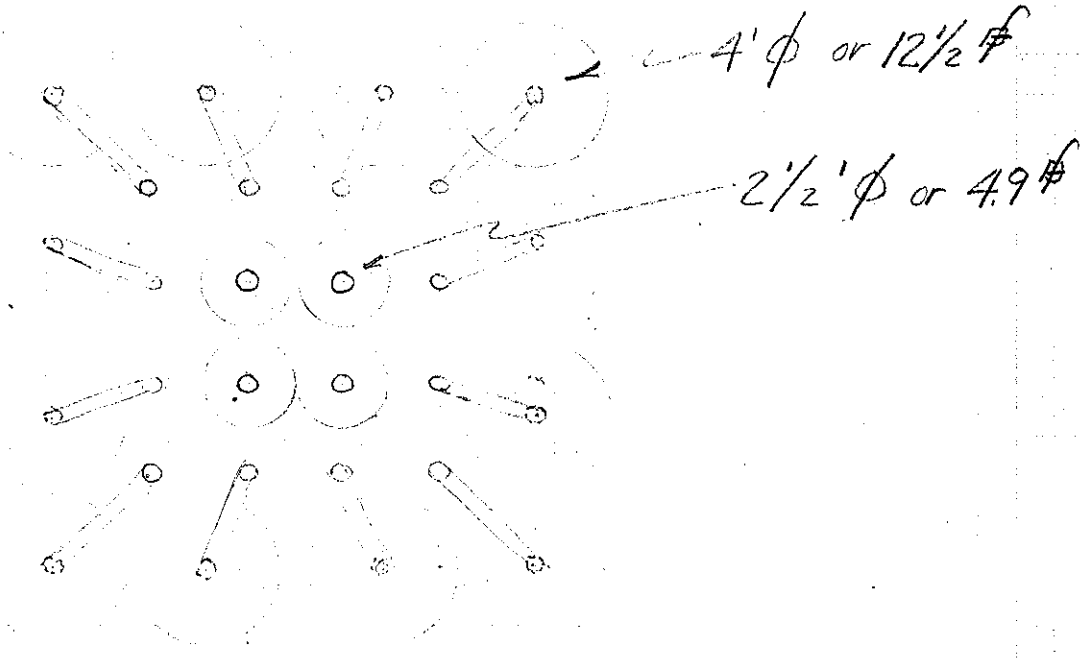
+6

0

12 piles @ 10 tons 120 T
4 piles @ 5 tons = 20 T
140 tons

16 piles @ 8 tons 128 T

-20

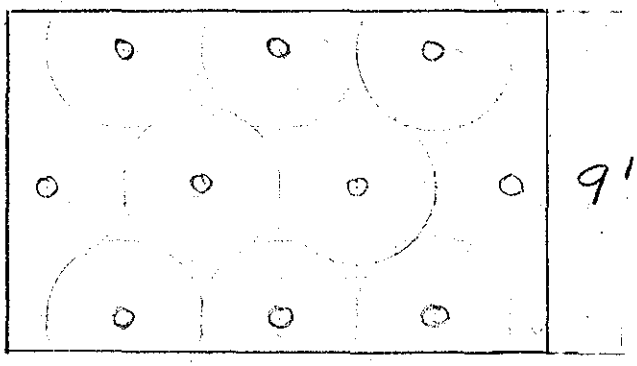


Subject.....

Computation.....

Computed by..... Checked by..... Date.....

Footing for 128^T total load



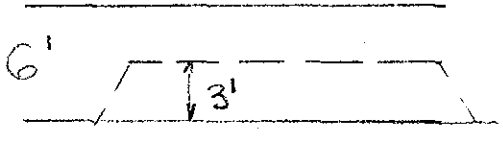
Unit load per pile

$$\frac{128^T}{12 \text{ piles}} = 10.7^T/\text{pile}$$

Unit load on top of hard to medium clay

$$\frac{128^T}{14 \times 9} = 1.02^T/\square f$$

Unit load on top of soft blue clay



$$\frac{128}{17 \times 12} = 0.63^T/\square f$$

WAR DEPARTMENT

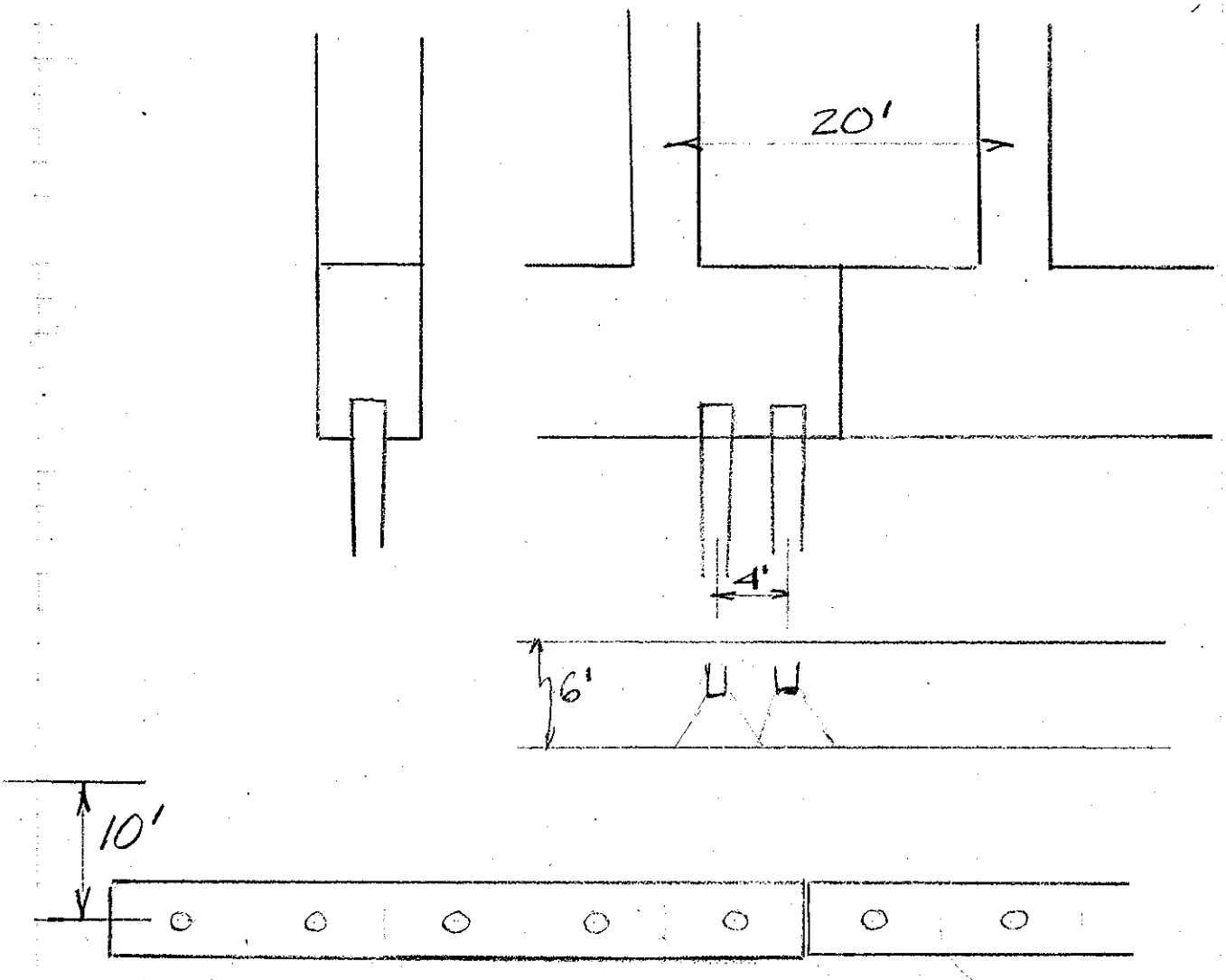
U. S. ENGINEER OFFICE, BOSTON, MASS.

Page.....

Subject.....

Computation.....

Computed by..... Checked by..... Date.....



Allowable load on wall footing

$(5 \text{ piles})(12^{\#}/\text{pile})(1^{T}/^{\#}) = 60^{\text{Tons}}$

Spacing of wall footings = 10' for equiv. unit load

Sept. 28

Mr. Allen:

Jay Spafford & Thorndike, represented by Mr. Williams, make the following recommendations regarding changes in pile schedule, Wharf Extension:

a) If bulkhead piles and piles T to Y cannot be driven to hardpan, jet and drive to get them down.

b) If lengths specified giving less than 25 feet of penetration do not meet approximate refusal, drive piles of sufficient length to result in 25 feet of penetration. Except, that piles A to L should go to approximate refusal.

c) Piles M to S need not be driven to refusal but a minimum penetration of 25 feet should be obtained.

WRS

WAR DEPARTMENT

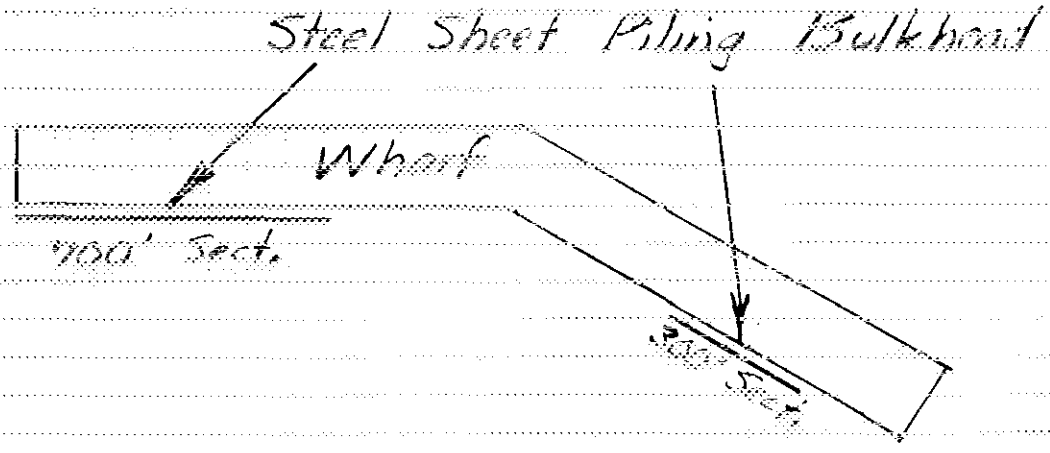
U. S. ENGINEER OFFICE, BOSTON, MASS.

Page

Subject: Wharf at South Boston

Computation: Change Order No. 2

Computed by: WTB Checked by: Date: Mar. 9, 42



Untreated Timber - Item 16

Quantity Total 60.5 MFBM

Quantity 700' Section

$\frac{7}{10}$ 60.5 42.4 MFBM

Item 16 decrease } 18.1 MFBM

Item 13 increase }

Untreated Piles - Items 26, 27, 28

Following tabulation abstracted from pile schedule for untreated piles dated Feb. 21st.

WAR DEPARTMENT
U. S. ENGINEER OFFICE, BOSTON, MASS.
Page 2

Subject
Computation
Computed by Checked by Date

Untreated Piles 59' or less.

0'

Untreated Piles 60' to 89'

11,000
12,000
7,000

25 × 77'
25 × 73
25 × 80
25 × 76
25 × 84
25 × 79
25 × 87
25 × 82
25 × 87

725'

25 × 725' = 18,125'

Cutoff
2' × 225 piles = 450

18,575 or

19,000'

Untreated Piles 90' and over

26,000
15,000
11,000

25 × 92 = 2300
25 × 104 = 2600
25 × 97 = 2425
26 × 109 = 2834
26 × 102 = 2652
127

12,811'

Cutoff
2' × 127

12,811
254
13,065 or
15,000'

Treated Piles - Items 7 and 8

Treated Piles - 45' to 59'

12 × 46 = 552
12 × 45 = 540
9 × 50 = 450
9 × 49 = 441

1983'

Cut off above 2'/pile
2' × 42 = 84
1983
2067 or
2100'

Subject

Computation

Computed by Checked by Date

Treated Piles 44' or less

13 x 39 = 507	Cut off allowance 2' per	
13 x 39 = 507		
12 x 32 = 384	110' x 2' =	220
12 x 32 = 384		3702
30 x 32 = 960		3922 or
30 x 32 = 960		
3702		4000'

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject South Boston Wharf

Computation Untreated Pile Lengths

Computed by WLS Checked by HJG Date Feb 27 1942

Page

Bents Nos.	No. Piles	Elev. Top Hard Mat'l. Average feet	Elev. Pile Cutoff feet: Vertical Pile +12	Elev. Pile Cutoff feet: Batter Pile +9	Penetration into Hard Mat'l. feet	Pile Length w/o allowance for cutoff feet	Batter Piles
0 to 10	52'	-85'			5'	26 @ 102'	26 @ 119
10 to 20	50'	-80'	"		"	28 @ 97'	28 @ 102
20 to 30	50	-70'	"		"	" 87'	28 @ 92
30 to 40	50	-65'	"		"	" 82'	28 @ 87
40 to 50	50	-62'	"		"	" 79'	" @ 84
50 to 60	50	-59'	"		"	" 76'	" @ 80
60 to 70	50	-56'	"		"	" 73'	" @ 77
197 to 200	18	~~-28~~ -32	"	"	"	9 ~~45~~ 39	9 [illegible]
200 to 205	24	-22 -28	"	"		12 @ ~~[illegible]~~ [illegible]	12 @ 46
205 to 210	26	~~-17~~ -22	"	"	"	13 @ ~~32~~ 30	13 @ 39
210 to 215	24	~~-8~~ -15	"	"	"	[illegible] @ ~~30~~ 32	12 @ 31
215 to 227	60	-3	"	"	15	[illegible] @ 30'	30 @ 27

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject: Lead [illegible] Pile Lengths

Computation: Unimproved Pile Lengths

Computed by: [illegible] Checked by: Date: [illegible]

Page

Bents	No. Piles	El. Hard Mat'l. feet	El. Cutoff. feet	Penetration Into Hard Mat'l. feet	Length w/o allowance for cutoff
0-10	52	-85	+12	5'	102'
10-20	50	-80	"	"	97'
20-30	50	-70	"	"	87'
30-40	50	-65	"	"	82'
40-50	50	-62	"	"	79'
50-60	50	-59	"	"	76'
60-70	50	-56	"	"	73'
197-200	17	-28	"	"	45
200-205	25	-22	"	"	39
205-210	25	-17	"	"	32
210-215	25	-8	"	10	30
215-221	60	-3	"	15	30

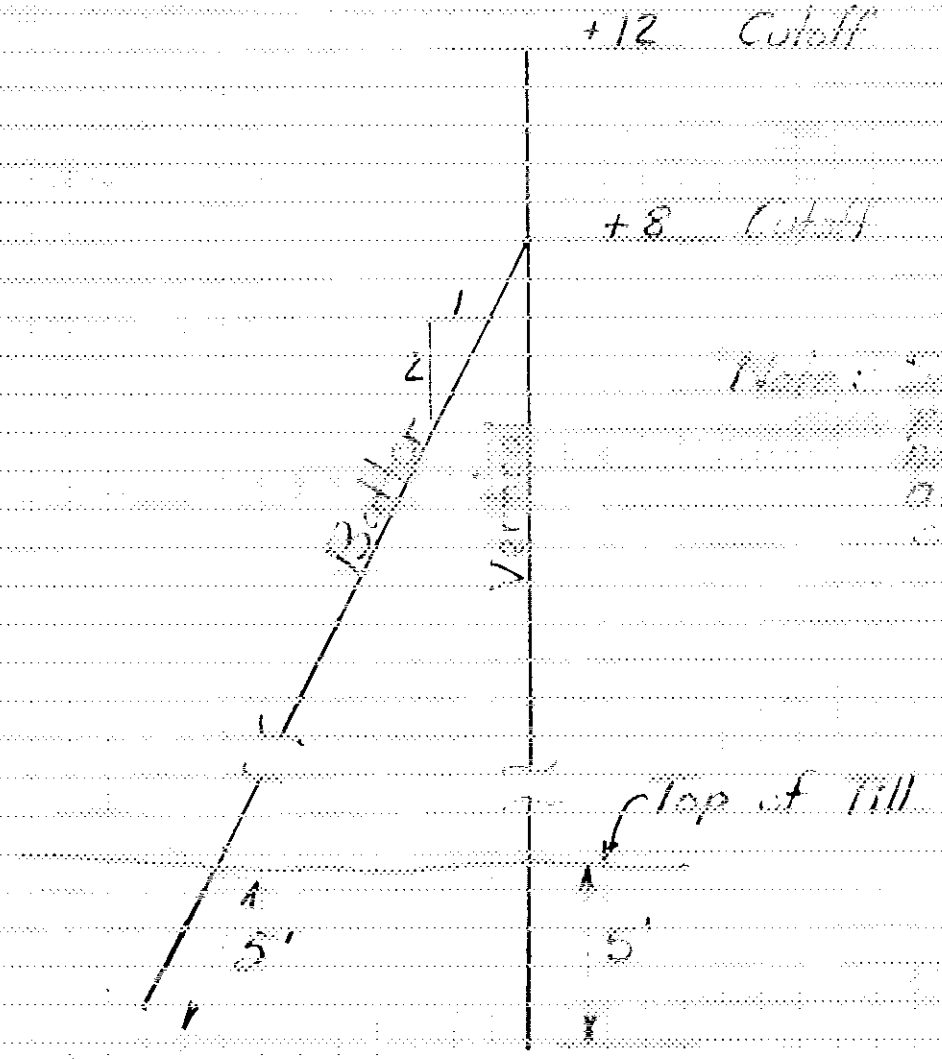
	BEARING PILES																	SPURS				FENDERS	DOLPHINS	TRE
	73	69	63	62	61	58	55	54	53	51	49	48	44	43	40	38	33	70	55	49	45	75	75	52
1 - 19	113	76	76			57			152									57						
20 - 26	42	28	28			21			85									21						
27 - 34	40	32	32			28			94									24						
35 - 49	75	60	60			67			134									45						
50 - 110	305	244	244			183			488									183						
111 - 117	35	26	26			39			57									21						
118 - 124	35	30	11			30			30									21				12		
125 - 131	35	25	26			39			58									21						
132 - 192	305	244	244			183			488									183						
193 - 198	30	24	24			27			48									12	6					
199 - 203	25	20			20			18				48						10	5					
204 - 208		25		20			20				15			50				10		5				
209 - 218		50	40			40				30				30		69		20		10				
219 - 241		115	92			92				69			46		69		69	46			23			
West End																							120	
East End																							40	
Railroad																								20
TOTAL	1040	989	903	20	20	806	20	18	1634	99	15	48	46	80	69	69	69	674	11	15	23	12	160	20

Note: Length of pile is net i.e. no allowance for cutoff
Add 3'-0" for jetting [illegible]

TOTAL No. of PILES 6,860

WAR DEPARTMENT
U. S. ENGINEER OFFICE, BOSTON, MASS.
Page 1/2

Subject: South Boston Wharf
Computation: Bulkhead Pile Schedule
Computed by: DLS Checked by: Date:



Note: Scheduling on page 2 does not include allowance for cutoff.

Assumptions:

a) Cutoff at elevations shown above.

b) Penetration into till: 5' as shown above, assumed except that a minimum penetration, measured from the top of the hard to medium yellow clay, of 15' required.

c) All piles driven in accordance with the specification, paragraph 6.01(g).

WAR DEPARTMENT
U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject: South Boston Wharf
Computation: Bulkhead Pile Schedule
Computed by: WLS
Checked by: MJG
Date: Feb 27, 42
Page: 2/2

Bents Nos.	No Piles		Elev. Top Till - Aver. feet	Elev. Pile Cutoff feet Vert.	Elev. Pile Cutoff feet Batter	Penetration into Till feet	Pile Length w/o Allowance for Cutoff - feet Vert.	Pile Length w/o Allowance for Cutoff - feet Batter
0 to 10	26	UNTREATED	-85	+12	+8	5	102	109
10 to 20	26		-80	"	"	"	97	104
20 to 30	25		-70	"	"	"	87	92
30 to 40	25		-65	"	"	"	82	87
40 to 50	25		-62	"	"	"	79	84
50 to 60	25		-59	"	"	"	76	80
60 to 70	25		-56	"	"	"	73	77
197 to 200	9	TREATED	-32	"	"	"	49	53
200 to 205	12		-28	"	"	"	45	46
205 to 210	13		-22	"	"	"	39	37
210 to 215	12		-15	"	"	"	32	32
215 to 227	12		-3	"	"	17	32	32

NOTE

TRANSIT SHED WHARF, SO. BOSTON, MASS.
PILE LOADING TEST No. 3
PILE No. 9Y-27
DATE 8-25-42

WAR DEPARTMENT
UNITED STATES ENGINEER OFFICE
Boston District
SOILS LABORATORY
Concord, N. H.

Sheet 1 of 2

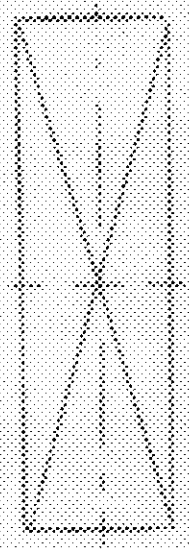
TRIAXIAL COMPRESSION TEST DATA SHEET - (COMMERCIALLY MATERIAL)

9X-27 9Y-27 10-27

SETTLEMENT READINGS

Elapsed Time	Load in Kip Tons	Stub A Reading In. x 10^-3 W Support	Water B Level cm. W Test Pile	C Strain W Support	Actual Corrected W Area Test Pile	Test Pile Stress Kip-cm^-2 lbs. in^-2
5:27 A	0	[illegible]	[illegible]	[illegible]	0	
5:28	5					
5:29	5	[illegible]	[illegible]	[illegible]	0	
5:40	5	[illegible]	[illegible]	[illegible]	0	
5:44	5	[illegible]	[illegible]	[illegible]	0	
5:45	10					
5:46	10	[illegible]	[illegible]	[illegible]	0.1	
5:48	10	[illegible]	[illegible]	[illegible]	0.1	
5:53	10	[illegible]	[illegible]	[illegible]	0.1	
6:00	10	[illegible]	[illegible]	[illegible]	0.1	
6:01	15					
6:02	15	[illegible]	[illegible]	[illegible]	0.1	
6:16	15	[illegible]	[illegible]	[illegible]	0.15	
6:22	15	[illegible]	[illegible]	[illegible]	0.2	
6:30	15	[illegible]	[illegible]	[illegible]	0.2	
6:31	19					
6:32	19	[illegible]	[illegible]	[illegible]	[illegible]	
6:38	19	[illegible]	[illegible]	[illegible]	[illegible]	
6:40	19	[illegible]	[illegible]	[illegible]	[illegible]	
6:54	19	[illegible]	[illegible]	[illegible]	[illegible]	
6:55	22					
6:56	22	[illegible]	[illegible]	[illegible]	0.35	
7:00	22	[illegible]	[illegible]	[illegible]	0.4	
7:03	22	[illegible]	[illegible]	[illegible]	0.4	
7:15	22	[illegible]	[illegible]	[illegible]	0.4	
7:16	22					
7:17	26	[illegible]	[illegible]	[illegible]	0.5	
7:35	26	[illegible]	[illegible]	[illegible]	[illegible]	
7:38	26	[illegible]	[illegible]	[illegible]	0.6	
7:40	26	[illegible]	[illegible]	[illegible]	0.6	
7:43	29					
7:44	29	[illegible]	[illegible]	[illegible]	[illegible]	
7:55	29	[illegible]	[illegible]	[illegible]	0.7	
8:04	29	[illegible]	[illegible]	[illegible]	0.75	
8:11	29	[illegible]	[illegible]	[illegible]	0.75	
8:12	31					
8:14	31	[illegible]	[illegible]	[illegible]	[illegible]	
8:22	31	[illegible]	[illegible]	[illegible]	[illegible]	
8:26	31	[illegible]	[illegible]	[illegible]	0.9	
8:38	31	[illegible]	[illegible]	[illegible]	0.9	

Note: Corrected Area = $\frac{A_1}{1-\text{Strain}}$



Failure Sketch

* Note: all settlement readings in centimeters.

TRANSIT SHED, WHARF, SO. BOSTON, MASS.
PILE LOADING TEST No. 1
PILE No. [illegible]
DATE [illegible]

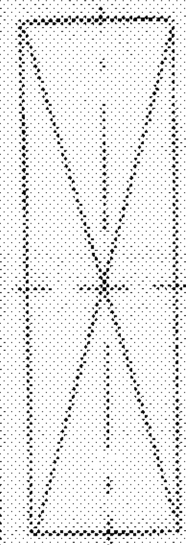
Sheet 2

WAR DEPARTMENT
UNITED STATES ENGINEER OFFICE
Boston District
SOILS LABORATORY
Concord, N. H.

[illegible]

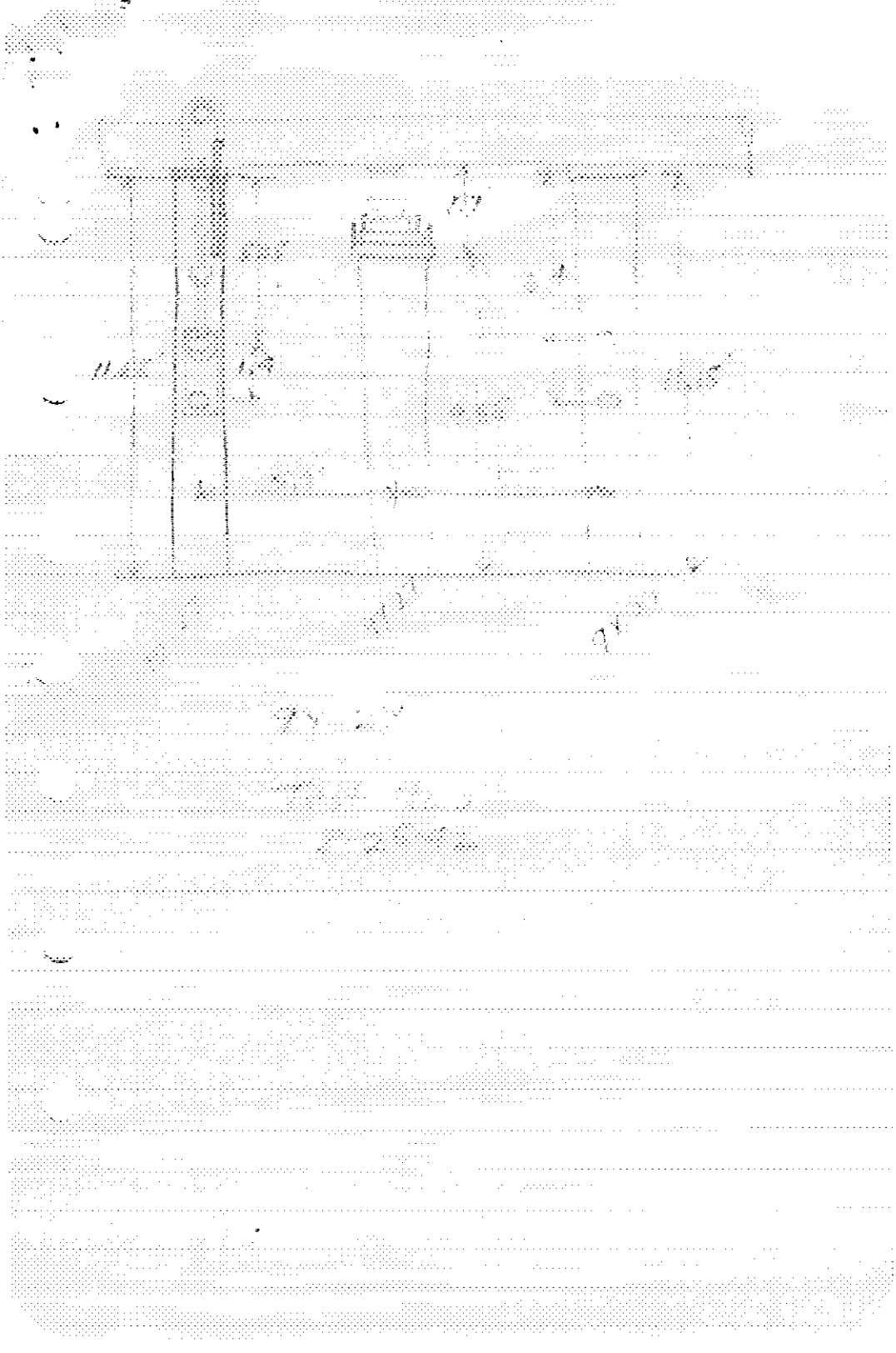
Elapsed Time	Load in Tons	Dial A Reading W Support	Dial B Test Pile	C Support	Actual Corrected Test Pile	Test Pile Stress lbs. in²
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Enter Corrected Area



Failure Sketch

Note: [illegible]



Test Pile #3.

Butt - 15"
Tip - 10"
Pen. on weight of hammer - 17'
Drove pile 1'-6" - then on 4 blows pen. was - 11"
Drove pile 2' more - then on 4 blows pen. was - 13"
Last 4 blows pen. was - 11½"
Total pen. - 23.5'
Total no. of blows - 27

Time of driving - Aug. 21, 1942 - 2:40 P.M.

Line - 9Y Row - 27 - Test Pile No. 3 40' pile

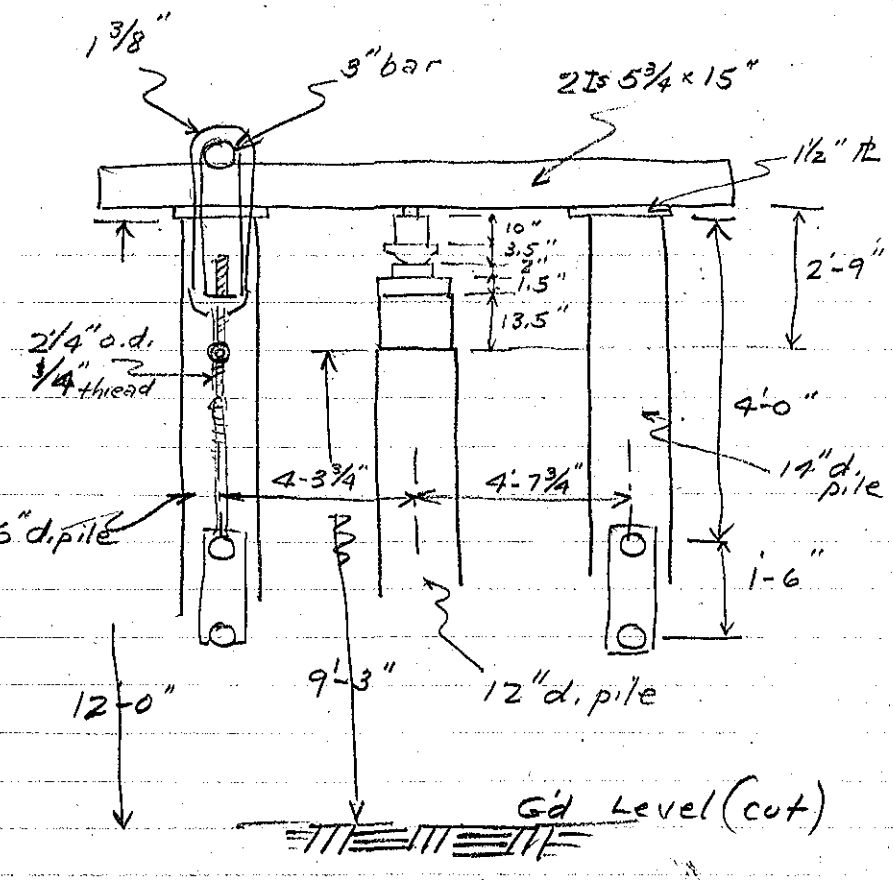
Vulcan No. 1 (Driver No. 3)

W. Support Pile 9x-27 50'
E. Support " 10 - 27 50'

4 | 11.3 / 2

8-18-42

TRANSIT SHED, WHARF, S. BOSTON
PILE LOADING TEST No. 1
Test Pile: 4-7-Y
W. Support: 4-7-X
E. Support: 4-8



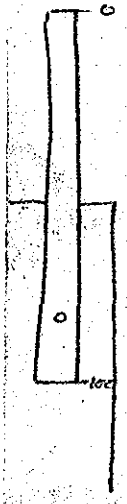
Pile Loading Test #1
Transit Shed
Wharf
So. Boston
8/18/42
M.M.M

TRANSIT SHED - WHARF, SO. BOSTON, MASS.
PILE LOADING TEST
PILE No. 7Y4
DATE 8-18-42

WAR DEPARTMENT
UNITED STATES ENGINEER OFFICE
Boston District
SOILS LABORATORY
Concord, N. H.

Sheet 2

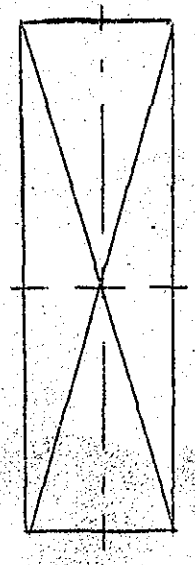
TRIAXIAL COMPRESSION TEST DATA SHEET - (COHESIONLESS MATERIAL)



SETTLEMENT READINGS

Elapsed Time Minutes	Load in ~~kg.~~ Tons	~~Dial Reading In x10^-3~~ A W. Support	~~Water Level cm~~ B Test Pile	~~Strain~~ C E. Support	Actual ~~Corrected Area~~ Test Pile	Test Pile Stress ~~Kg cm^-2~~ lbs. in.^-2
5:20 P.	0	39.0	35.5	33.3	0	
5:25 P	2	39.0	35.5	33.3	0	
5:35 P.	4	—	—	—		
5:38 P	4	39.0	35.5	33.3	0	
5:43 P	4	38.9	35.3	33.2	.2	
6:05 P	4	38.9	35.3	33.2	.2	
6:06 P	7	—	—	—		
6:12 P	7	38.9	35.3	33.2	.2	
6:14 P	7	38.9	35.3	33.2	.2	
6:15 P	10	—	—	—		
6:16 P	10	39.0	35.2	33.4	.3	
6:20	10	39.0	35.2	33.4	.3	
6:21	13	—	—	—		
6:22	13	39.0	35.1	33.4	.4	
6:25	13	39.0	35.1	33.4	.4	
6:27	16	—	—	—		
6:28	16	39.1	35.0	33.4	.5	
6:33	16	39.0	34.9	33.4	.6	
6:35	19	—	—	—		
6:36	19	39.0	34.8	33.4	.7	
6:44	19	39.1	34.7	33.4	.8	
6:45	22	—	—	—		
6:46	22	39.1	34.6	33.4	.9	
6:54	22	39.1	34.5	33.5	1.0	
6:55	25	—	—	—		
6:56	25	39.1	34.4	33.5	1.1	
7:07	25	39.1	34.2	33.5	1.3	
7:14	25	39.1	34.2	33.5	1.3	
7:15	28	—	—	—		
7:16	28	39.1	34.1	33.5	1.4	
7:23	28	39.1	34.0	33.5	1.5	
7:39	28	39.2	33.9	33.5	1.6	
7:40	30	—	—	—		
7:41	30	39.2	33.9	33.6	1.6	
8:08	30	39.2	33.7	33.6	1.8	
8:09	32	—	—	—		
8:10	32	39.2	33.6	33.7	1.9	
8:22	32	39.2	33.5	33.6	2.0	
8:30	Platform damaged by swinging pile					
8:40	32	39.2	33.3	33.6	2.2	
8:57	32	39.2	33.3	33.6	2.2	

Note: Corrected Area = $\frac{A_1}{1-\text{Strain}}$



Failure Sketch

All Settlement Readings in cms.

D. O. Form 374

TRANSIT SHED - WHARF, SO. BOSTON, MASS.
PILE LOADING TEST
PILE No. 7Y4
DATE 8-18-42

WAR DEPARTMENT
UNITED STATES ENGINEER OFFICE
Boston District
SOILS LABORATORY
Concord, N. H.

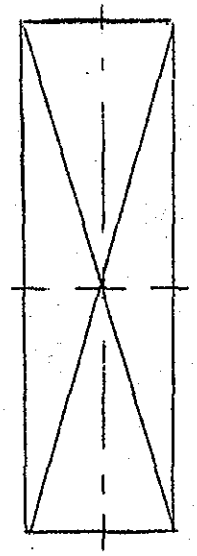
Sheet 2

TRIAXIAL COMPRESSION TEST DATA SHEET - (COHESIONLESS MATERIAL)

SETTLEMENT READINGS

Elapsed Time	Load in ~~kg.~~ TONS	~~Dial~~ A ~~Reading~~ ~~In x 10^-3~~ W. Support	~~Water~~ B ~~Level~~ ~~cm~~ Test Pile	C ~~Strain~~ E Support	Actual ~~Corrected~~ Settlement ~~Area~~ Test Pile	Test Pile Stress ~~kg.cm.^-2~~ lbs. in.^-2
8:58 P.	34	—	—	—		
8:59	34	39.3	33.2	33.6	2.3	
9:01	34	39.2	33.1	33.6	2.4	
9:05	34	39.2	33.0	33.6	2.5	
9:10	34	39.2	32.8	33.6	2.7	
9:17	34	39.2	32.7	33.6	2.8	
9:26	34	39.2	32.6	33.6	2.9	
9:36	34	39.2	32.5	33.6	3.0	
9:46	34	39.2	32.4	33.6	3.1	
9:53	34	39.2	32.4	33.6	3.1	
9:54	35	—	—	—		
9:55	35	39.2	32.3	33.6	3.2	
10:03	35	39.2	32.1	33.6	3.4	
10:11	35	39.2	32.0	33.6	3.5	
10:20	35	39.3	32.0	33.6	3.5	
10:21	25	—	—	—		
10:22	25	39.2	32.0	33.6	3.5	
10:25	15	—	—	—		
10:26	15	39.2	32.3	33.6	3.2	
10:50	15	39.2	32.3	33.6	3.2	
10:51	5	—	—	—		
10:52	5	39.2	32.6	33.5	2.9	
11:07	5	39.2	32.6	33.5	2.9	
11:08	0	—	—	—		
11:09	0	39.2	33.0	33.5	2.5	
11:11	0	39.2	33.1	33.5	2.4	
11:20	0	39.2	33.1	33.5	2.4	

Note: Corrected Area = $\frac{A_1}{1-\text{Strain}}$



Failure Sketch

D. O. Form 374

Akerthaw —

2 1/2 hours

3/4 hour

Type 2 Cement required.

Will use 1/2 doz. brands of cement — Lehigh, Atlas, Glens Falls Pioneer,

T. & L. does not approve of use of blended cements.

Recommend use of a single brand of cement if possible

Concrete pours — concrete has been in transit as long as 3 to 3 1/2 hours.

4 to 4 1/2 hours round trip.

Adding water on job as concrete begins to set.

WAR DEPARTMENT

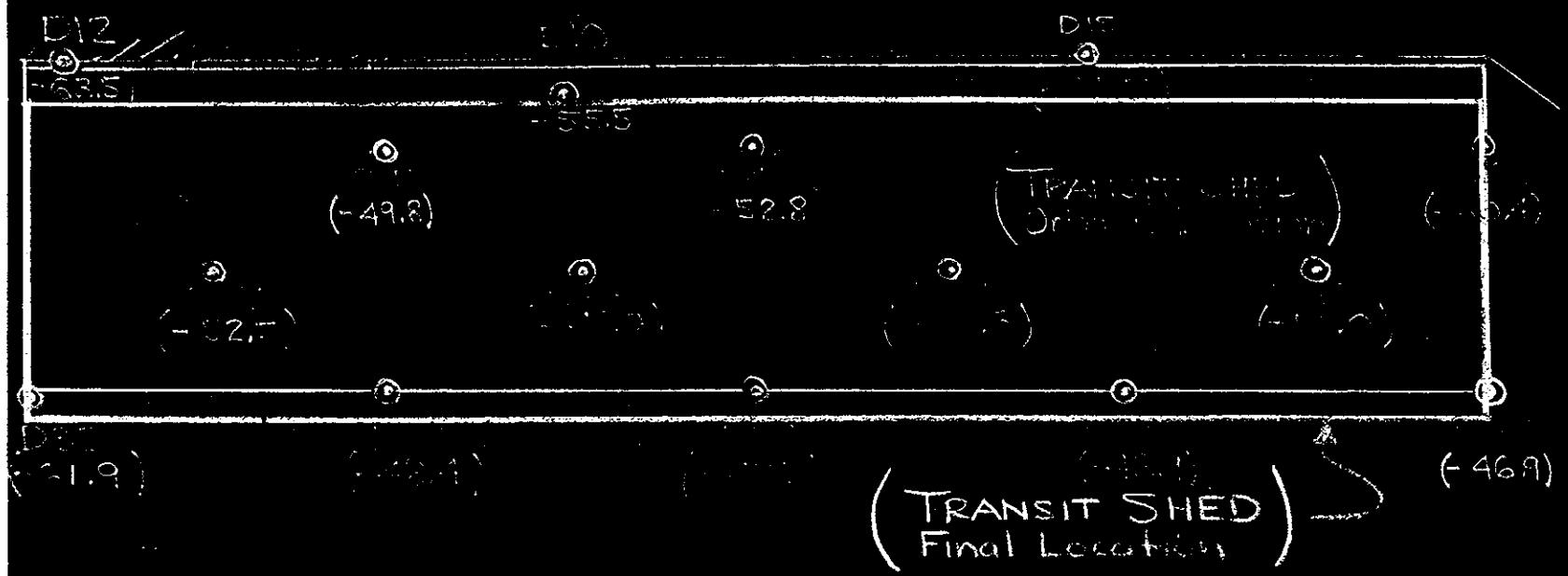
U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject .....

Computation .....

Compared by ..... Checked by ..... Date .....

Page 1



Scale 1" = 100'

For additional adjacent borings
see Plan and Profile of
Exploration, Sheet file No. $\frac{1521}{2}$ F-1-1

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject: [illegible]

Computation: [illegible]

Compared by ..... Checked by ..... Date [illegible]

No	[illegible]	[illegible]	[illegible]
[illegible]	46	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
D 38	[illegible]	10.5	[illegible]
D 39	[illegible]	[illegible]	[illegible]
D 40	[illegible]	[illegible]	[illegible]
D 41	[illegible]	[illegible]	[illegible]
D 42	[illegible]	[illegible]	[illegible]
D 43	[illegible]	[illegible]	[illegible]

WAR DEPARTMENT

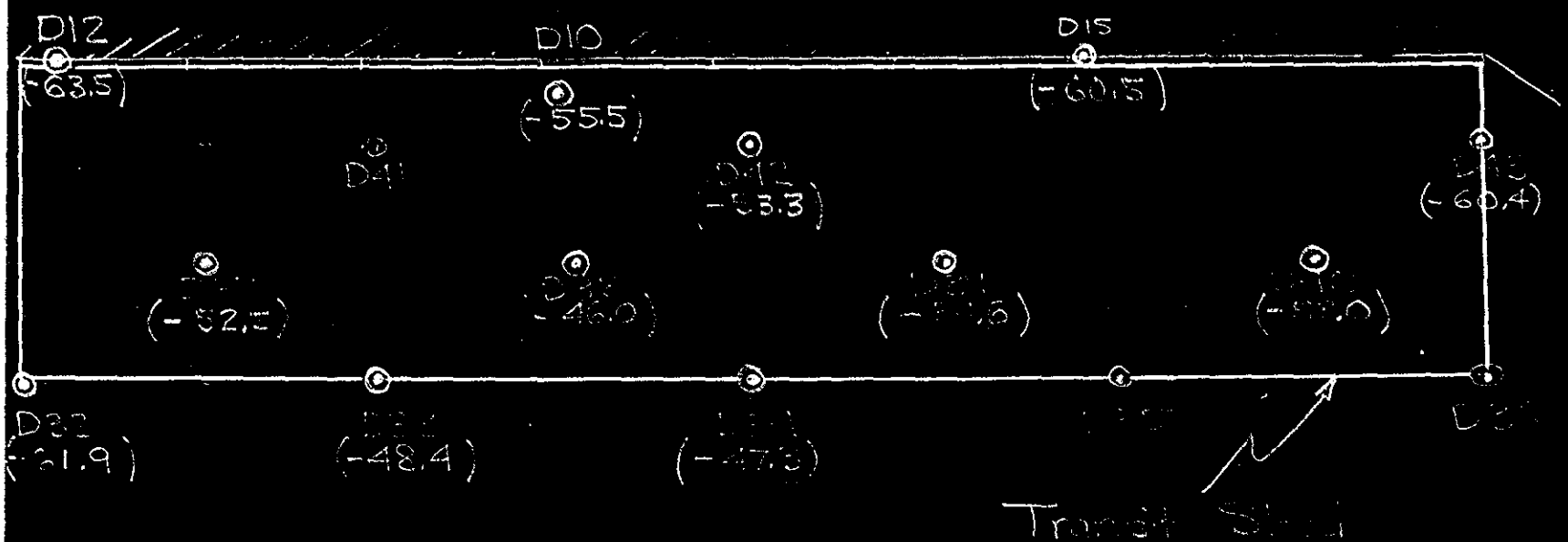
U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject ..... Page .....

Computation ..... Borka - Summary of Results .....

Compared by ..... Checked by ..... Date July 21

Wharf So. Boston



Scale 1" = 100'

Note: Figures in parenthesis are elev. (MLW) of top of hard material [illegible] blue clay.

Preliminary

Revised 7/23/42

WAR DEPARTMENT

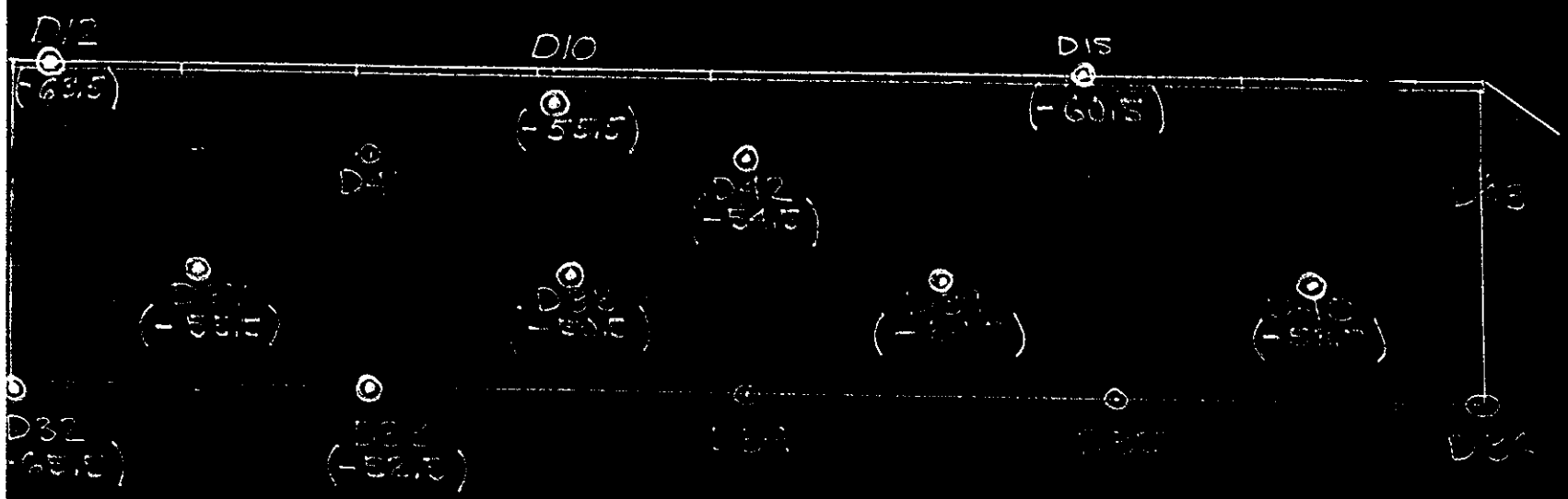
U. S. ENGINEER OFFICE, BOSTON, MASS.

Subject ..... Page .....

Computation ..... Borden

Compared by ..... Checked by ..... Date .....

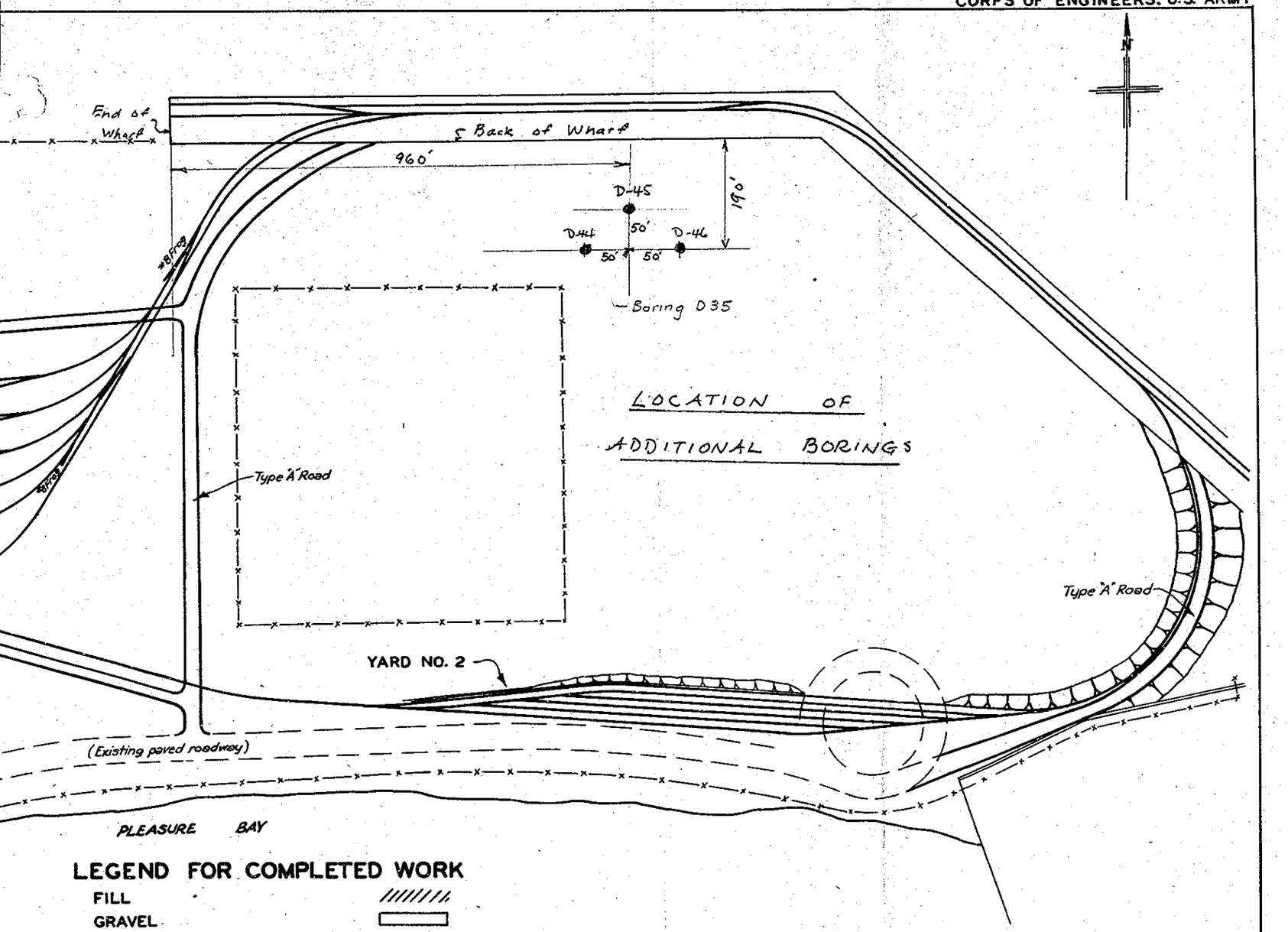
Wharf So. Boston



Borings – Notes [illegible] parenthesis are [illegible] (MLW) of top of hard [illegible] blue clay.

Preliminary

CORPS OF ENGINEERS, U.S. ARMY



LEGEND FOR COMPLETED WORK

FILL	
GRAVEL	
MACADAM SURFACING	
PIPE DRAINAGE	
CATCH BASINS	
RIPRAP	
DERRICK STONE	
TRACK LAID	
TRACK LAID AND BALLASTED	
FENCE	

RESTRICTED

PROGRESS PLAN
WHARF
SOUTH BOSTON, MASS.
ROADS-YARD LAYOUT

PERIOD: _____

SCALE OF FEET

200 0 200 400

U.S. ENGINEER OFFICE BOSTON, MASS.

LT. COL., CORPS OF ENGINEERS

Pile Test No. 2
Transit Shed Sept. 1-2, 1942

DATE Aug 29 1942

SHIFT _____ M to _____ M

Weather _____ Sea _____

Under remarks, state reason, pile length used, varied from plan by more than 5 feet over or 2' under.

For Mr Moyer
L.4B - 1/4"

Pile	No	INITIAL PEN.	TOTAL BLOWS	Remarks:
22	29	3.5'	610.	Pile Driven to 19.5 grade
21W	29	4.0'	2900	" " " 25.0' gr.
22W	29	4.2'	3700	" " " 21.0' gr.
	I noticed a slight easing up on the driving when pen of 36.0' was reached but pile drove very solidly			
	This hammer was not hitting full weight and I left with another pile above grade			

Pile Test No. 2

Line 22
Row 29

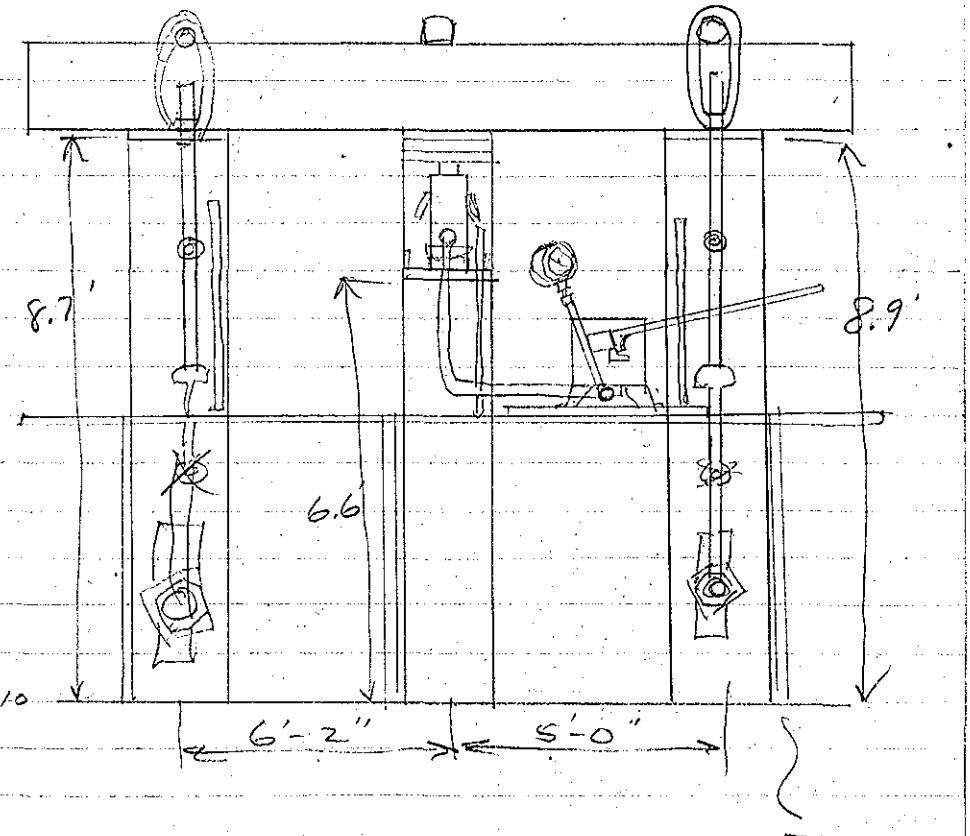
21Y29 West
22W29 East

Lally

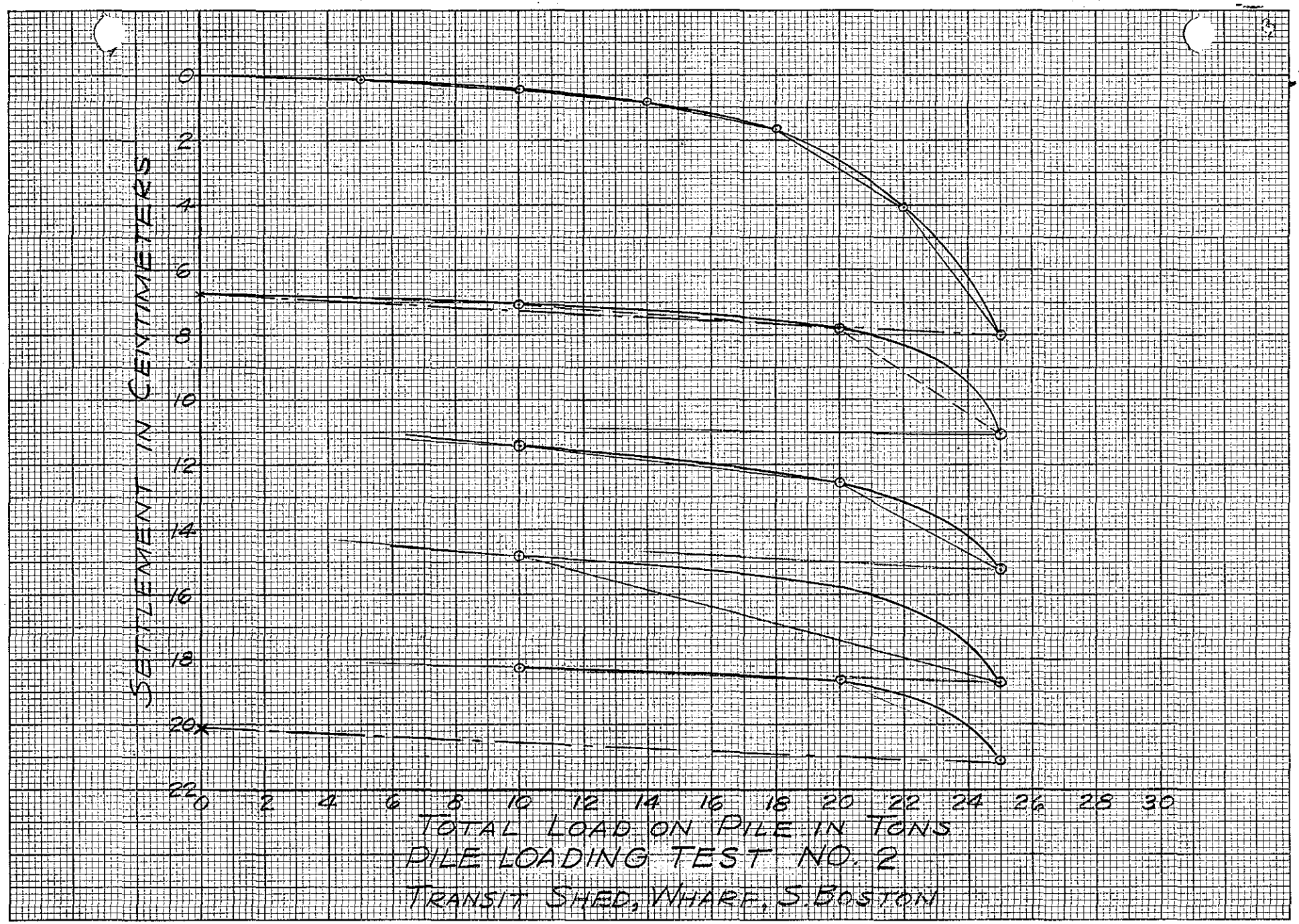
Driver #7
McKiernan & Terry hammer #7

32.5

9-162-42 Test No. 2



32.5
16.5
16.0



PILE LOADING TEST NO. 2

TRANSIT SHED, WHARF, S. BOSTON

KEUFFEL & ESSER CO., N. Y. No. 358-11
20 × 20 to the inch. 10th lines heavy.
MADE IN U.S.A.

TRANSIT SHED, WHARF, SOUTH BOSTON, MASS.
PILE LOADING TEST No. 2
PILE No. 6W-25
DATE: Sept. 1, 1942

WAR DEPARTMENT
UNITED STATES ENGINEER OFFICE
Boston District
SOILS LABORATORY
Concord, N. H.

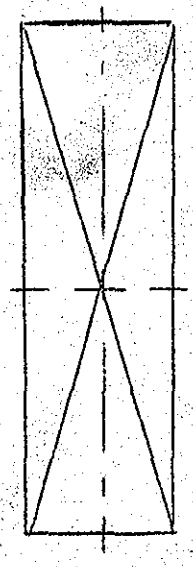
Sheet 1 of

TRIAXIAL COMPRESSION TEST DATA SHEET - (COHESIONLESS MATERIAL)

21Y29 22-29 22W29
SETTLEMENT READINGS

Elapsed Time	Load in ~~kg.~~ Tons	~~Dial Reading In. x 10^-3~~ A W. Support	~~Water Level cm.~~ B Test Pile	~~Strain~~ C East Supt	Actual ~~Corrected Area~~ Test Pile	~~Stress Kg-cm.^-2~~
11:45 A.	0	44.20	39.72	46.68		
11:56 A.	5	—	—	—		
11:57	5	44.25	39.60	46.75		
12:00 N.	5	44.25	39.60	46.75		
12:23 P.	5	44.22	39.58	46.71		
12:29	5	44.20	39.58	46.71	0.14	
12:30	10	—	—	—		
12:31	10	44.26	39.35	46.80		
12:35	10	44.25	39.32	46.81		
12:40	10	44.26	39.30	46.81		
12:49	10	44.27	39.29	46.82		
12:59	10	44.30	39.29	46.84	0.43	
1:00 P.	14	—	—	—		
1:01	14	44.34	39.08	46.90		
1:03	14	44.35	39.02	46.90		
1:06	14	44.35	39.00	46.90		
1:15	14	44.35	38.94	46.90		
1:27	14	44.35	38.90	46.94		
1:35	14	44.35	38.90	46.94	0.82	
1:36	18	—	—	—		
1:37	18	44.40	38.65	47.04		
1:45	18	44.40	38.48	47.05		
1:53	18	44.40	38.38	47.05		
2:13	18	44.40	38.22	47.00		
2:23	18	44.40	38.18	47.00		
2:30	18	44.40	38.15	47.00		
2:50	18	44.40	38.08	47.00		
2:59	18	44.40	38.05	47.00	1.67	
3:00	22	—	—	—		
3:01	22	44.40	37.50	47.02		
3:05	22	44.40	37.30	47.04		
3:10	22	44.40	37.00	47.04	2.72	
3:23	22	44.42	36.60	47.04		
3:30	22	44.40	36.42	47.06		
3:35	22	44.36	36.35	47.06		
3:45	22	44.36	36.20	47.06	3.52	
3:53	22	44.38	36.10	47.02	3.62	
4:03	22	44.38	35.90	47.00		
4:15	22	44.37	35.72	46.98		
4:30	22	44.30	35.65	47.00	4.07	

Note: Corrected Area = $\frac{A_1}{1-\text{Strain}}$



Failure Sketch

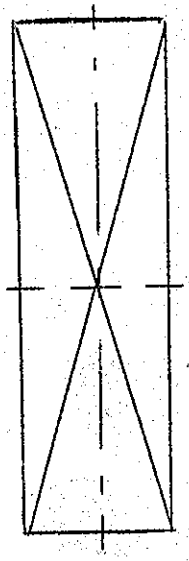
D. O. Form 374

WAR DEPARTMENT
UNITED STATES ENGINEER OFFICE
Boston District
SOILS LABORATORY
Concord, N. H.

TRIAXIAL COMPRESSION TEST DATA SHEET - (COHESIONLESS MATERIAL)

Elapsed Time	Load in kg.	Dial Reading In.x10^{-3}	Water Level cc.	Strain	Corrected Area	Stress Kg.cm.$^{-2}$
4:32	25	–	–	–		
4:35 3	25	44.36	34.40	47.06	5.32	
4:38 6	25	44.38	34.06	47.05	5.66	
4:50 18	25	44.36	32.98	47.07	6.74	
5:12 40	25	44.38	32.70	47.07	7.02	
5:27 55	25	44.38	32.50	47.07	7.22	
5:43 71	25	44.36	31.70	47.04	8.02	
* 5:45	0	–	–	–		
5:52	0	44.12	32.62	46.70		
	* Note: unloaded to insert additional shims in preventing exceeding of max. 4" travel of ram. Gaskets on jack evidently defective as ram would not revert to closed position at zero pressure. Delay to replace gaskets.					
6:06	0	44.18	32.70	46.75		
6:20	0	44.14	32.74	46.75		
6:40	0	44.14	32.77	46.80		
7:00	0	44.20	32.64	46.85		
7:18	0	44.20	32.80	46.80		
7:38	0	44.24	32.80	46.79		
8:04	0	44.10	32.80	46.80		
8:28	0	44.25	32.86	46.84		
8:30	0	Dismantled Pump Jack for repairs				
10:03	0	–	32.98	–	6.74	
10:04	10	–	–	–		
10:05	10	44.48	32.75	47.07		
10:06	10	–	32.65	–	7.07	
10:07	20	–	–	–		
10:08	20	44.60	32.00	47.30		
10:10	20	–	31.90	–	7.82	
10:12	25	–	–	–	–	
10:13 1	25	44.70	31.00	47.40	8.72	
10:14 2	25	–	30.40	–	9.32	
11:07 55	25	–	28.70	–	11.02	
11:43 91	25	44.80	28.65	47.50	11.07	
11:47	Note: Unloaded to insert additional shims. Stopped to repair Jack. Pressure would not diminish to insert additional Shims.					

Note: Corrected Area $= \frac{A_1}{1-\text{Strain}}$



Failure Sketch

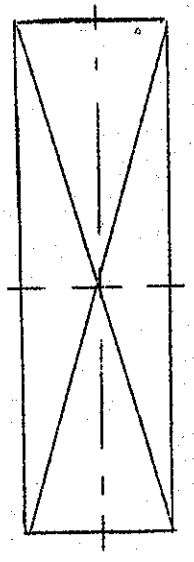
D. O. Form 374

WAR DEPARTMENT
UNITED STATES ENGINEER OFFICE
Boston District
SOILS LABORATORY
Concord, N. H.

TRIAXIAL COMPRESSION TEST DATA SHEET - (COHESIONLESS MATERIAL)

Elapsed Time	Load in kg.	Dial Reading In. x10^{-3}	Water Level cc.	Strain	Corrected Area	Stress Kg.cm.$^{-2}$
9-2-42 1:40 A	10	44.50	28.25	47.30		
1:42	10	—	28.25	—		
1:45	10	—	28.30	—	11.42	
1:47	20	44.65	27.80	47.40		
1:50	20	—	27.56	—		
1:55	20	—	27.15	—	12.57	
1:56 1	25	44.80	26.45	47.47	13.27	
1:59 4	25	—	26.15	—	13.57	
2:00 A 5	25	—	26.06	—	13.66	
2:05 10	25	—	25.85	—	13.87	
2:25 30	25	44.80	24.46	47.54	15.26	
2:26	Note: Unloaded to insert additional shims					
2:35	10	44.54	24.90	47.30		
2:36	10	—	24.90	—		
2:44	10	—	24.90	—	14.82	
2:45 1	25	44.63	24.44	47.38	15.28	
2:47 3	25	—	24.40	—	15.32	
2:50 6	25	—	24.24	—	15.48	
3:20 A 36	25	44.70	22.24	47.48	17.48	
3:44 60	25	44.70	21.25	47.40	18.47	
4:02 A 78	25	44.70	21.20	47.40	18.52	
4:27 103	25	44.73	21.20	47.38	18.52	
5:05 A	25	44.78	21.23	47.50		
5:27	25	44.60	21.00	47.40	18.72	
5:59	25	44.60	21.00	47.40	18.72	
6:21 A	25	44.62	21.00	47.38	18.72	
6:22	Note: Unloaded to insert additional shims.					
6:37	10	44.50	21.20	47.30		
6:40	10	—	21.78	—		
6:51	10	—	21.45	—	18.27	
6:54	20	44.85	21.13	47.30		
6:56	20	—	21.10	—		
7:00 A	20	—	21.10	—	18.62	
7:01 1	25	44.70	21.06	47.25	18.72	
7:02 2	25	—	20.95	—	18.77	
7:04 4	25	—	19.84	—	19.88	
7:07 7	25	44.80	19.70	47.40	20.02	
7:14 14	25	44.72	19.50	47.40	20.22	
7:27 27	25	44.74	19.20	47.40	20.52	
7:50 50	25	44.74	19.00	47.44	20.72	
8:00 60	25	44.80	18.96	47.43	20.76	

Note: Corrected Area $= \frac{A_1}{1-\text{Strain}}$



Failure Sketch

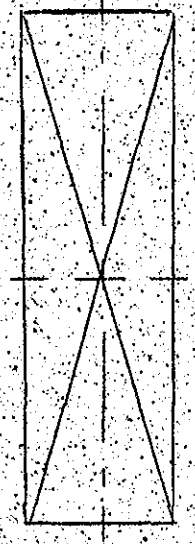
D. O. Form 374

WAR DEPARTMENT
UNITED STATES ENGINEER OFFICE
Boston District
SOILS LABORATORY
Concord, N. H.

TRIAXIAL COMPRESSION TEST DATA SHEET - (COHESIONLESS MATERIAL)

Elapsed Time	Load in kg.	Dial Reading In. x10^{-3}	Water Level cc.	Strain	Corrected Area	Stress Kg.cm.$^{-2}$
9:45 4.105	25	44.80	18.70	47.45	21.02	
9:00 120	25	44.80	18.70	47.44	21.02	
9:17 137	25	44.80	18.62	47.45	21.10	
9:45 165	25	44.80	18.62	47.48	21.10	
9:46	0	—	—	—		
9:55	0	44.53	19.50	47.13	20.22	
10:25	0	44.53	19.68	47.13	20.04	
10:45	0	44.53	19.60	47.13	20.12	

Note: Corrected Area $= \frac{A_1}{1-\text{Strain}}$



Failure Sketch

D. O. Form 374

Photographs

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Page.....

Subject: TRANSIT SHED FOR C.I. Terminal Project

Computation: Pile Test No. 2

Computed by..... Checked by..... Date: Sept. 1-2 1942

A - View toward northwest showing test pile under initial load increment of 5 tons. Time: 12:00 noon, September 1, 1942.

B - Close-up view toward northwest showing test pile under load of 22 tons. Time: 3:15 P.M., September 1, 1942. Note single plate between ram of jack and steel sections.

C - General view toward northeast showing loading assembly, instrument for making settlement readings, and wharf at approximately high tide. Load - 25 tons; time: 4:45 P.M., September 1, 1942.

D - Close-up view toward north showing effect of loading after 21 hours. Load - 25 tons; time: 9:00 A.M., September 2, 1942. Note number of 1-inch plates between ram of jack and steel sections.

~~E~~ F - View showing ~~driving~~ hammer used to drive test pile No. 2 (22-29) — McKiernan and Terry No. 7:

Normal Stroke = 9½ inches
Weight Ram = 800 lbs.
Weight Casing = 3872 lbs.
Weight Flat Anvil = 328 lbs.
Weight Cup Bell Anvil = 342 lbs.

Strokes per Minute	Rated Energy in Ft.-lbs per blow
225	4150
195	3720
170	3280

E - View toward northwest showing driving operations adjacent to location of Test Pile No. 2 using McKiernan and Terry Hammer No. 7, September 2, 1942.

G - General view toward west showing pile foundation of west end of Transit Shed, September 2, 1942.

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Page.....

Subject.....

Computation.....

Computed by..... Checked by..... Date.....

Photo No.	Conditions	Direction	Time	Load
1	Initial before setting-up	NW	10:00 A.M. 9/1	0
2	View under 1st Load	NW	12:00 A.M.	5
3			12:55 P.M.	10
4	Close-up		3:15 P.M.	22
5	Showing Steamship Mana in bgrd.	NE	3:15 P.M.	22
6		NE	4:45 P.M.	25
7		NW	9:00 A.M. 9/2	25
8		N	9:00 A.M.	25
9	McKiernan & Terry Hammer No. 7			
10	Driving adjacent to Test	NW		
11	General View of West Tr. Shed	W		
12	Dismantling during final rebound	N	10:00 A.M.	0

D46 Sta. 34+27 25'.0" - 37'.0" (12')

Sect. 34 — 12' ±

Sect. 35 — 12' ±

D51 Sta. 37+40 25'.0" - 31'.6" (6.5')

D43 " 37+40 38'.6" - 44'.6" (6.5')

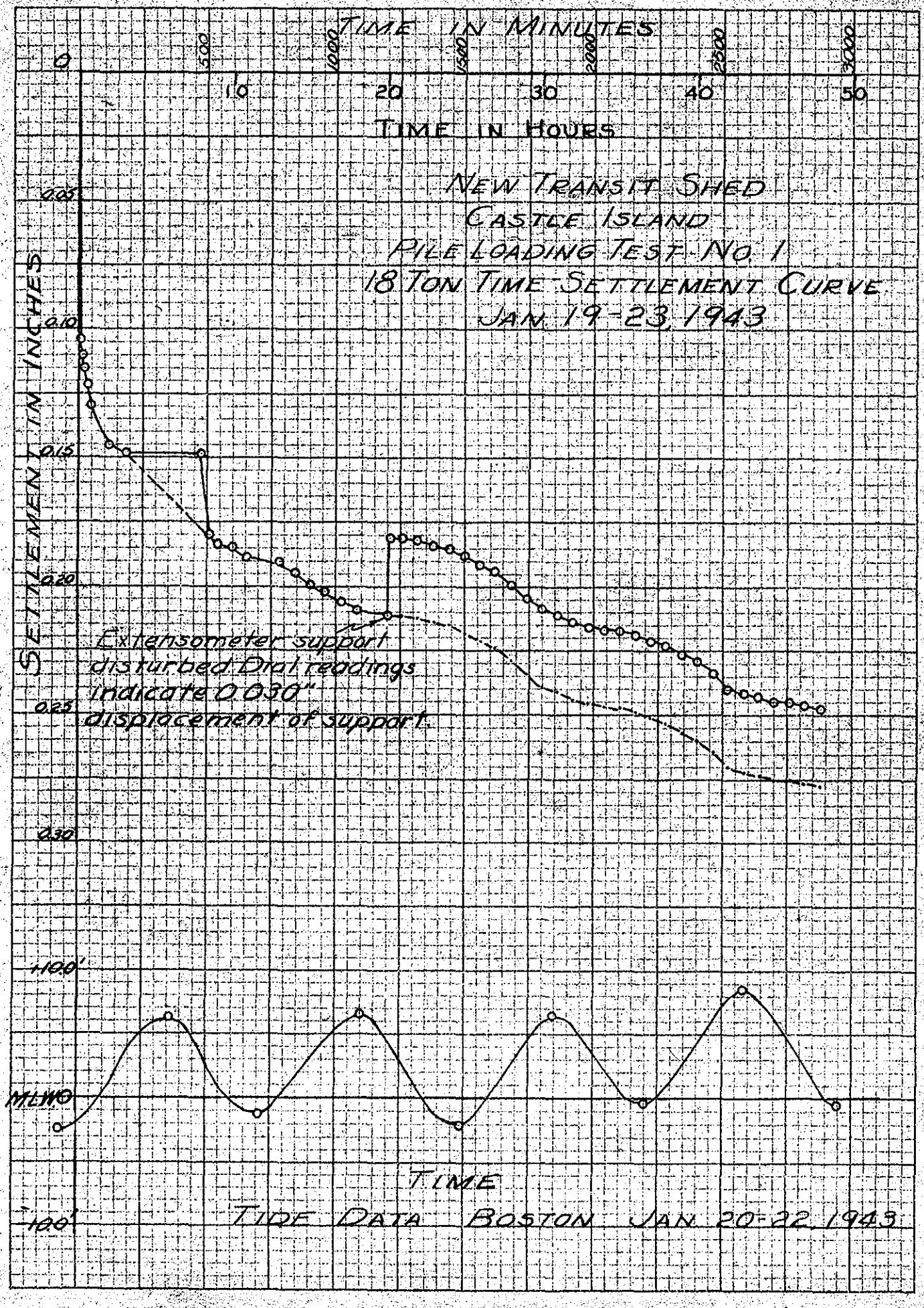
Sect. 37 — 6.5' ±

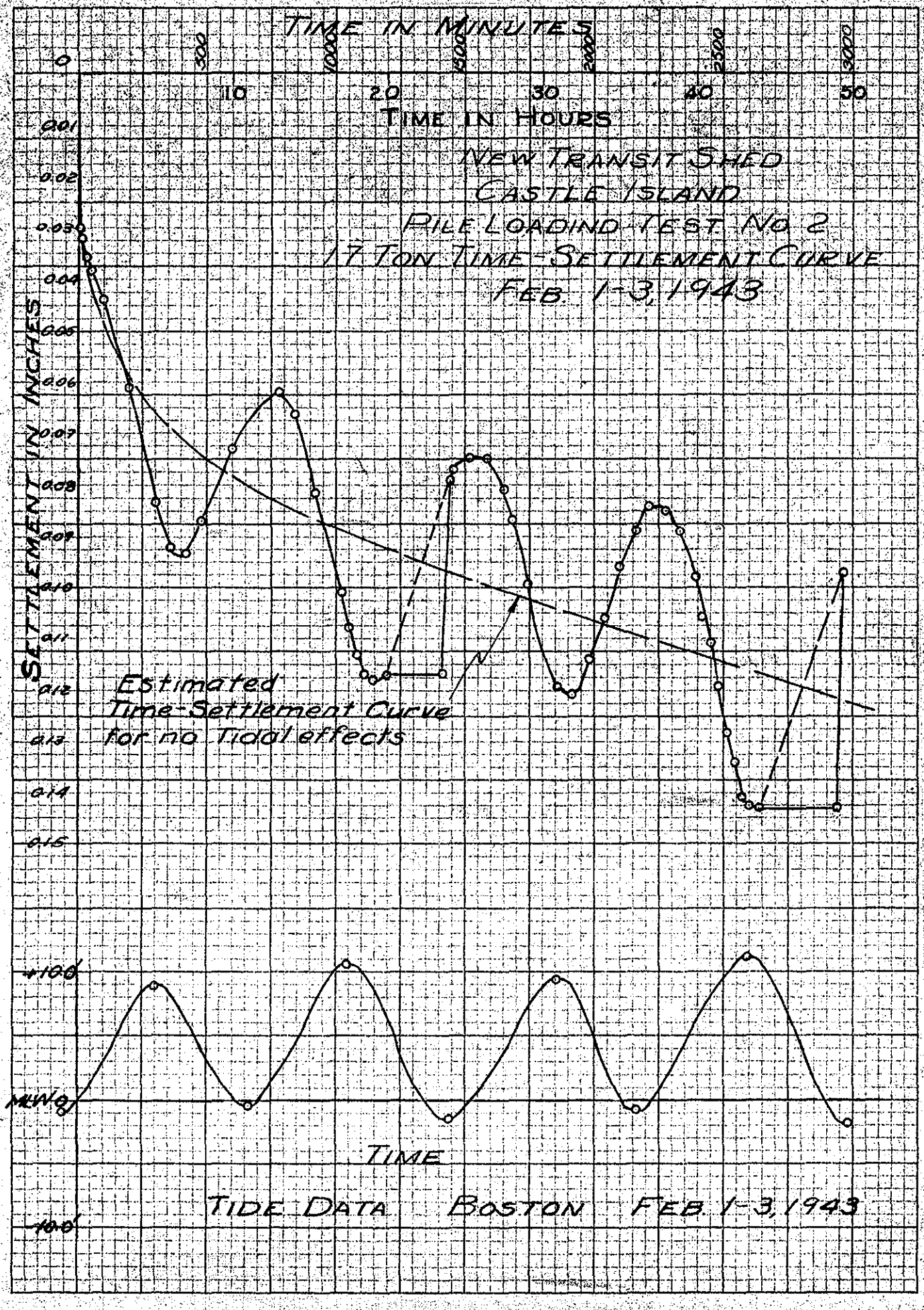
Sect. 38 — 6.5' ±

D42 Sta. 35+25 27'.6" - 38'.6" (11.0')

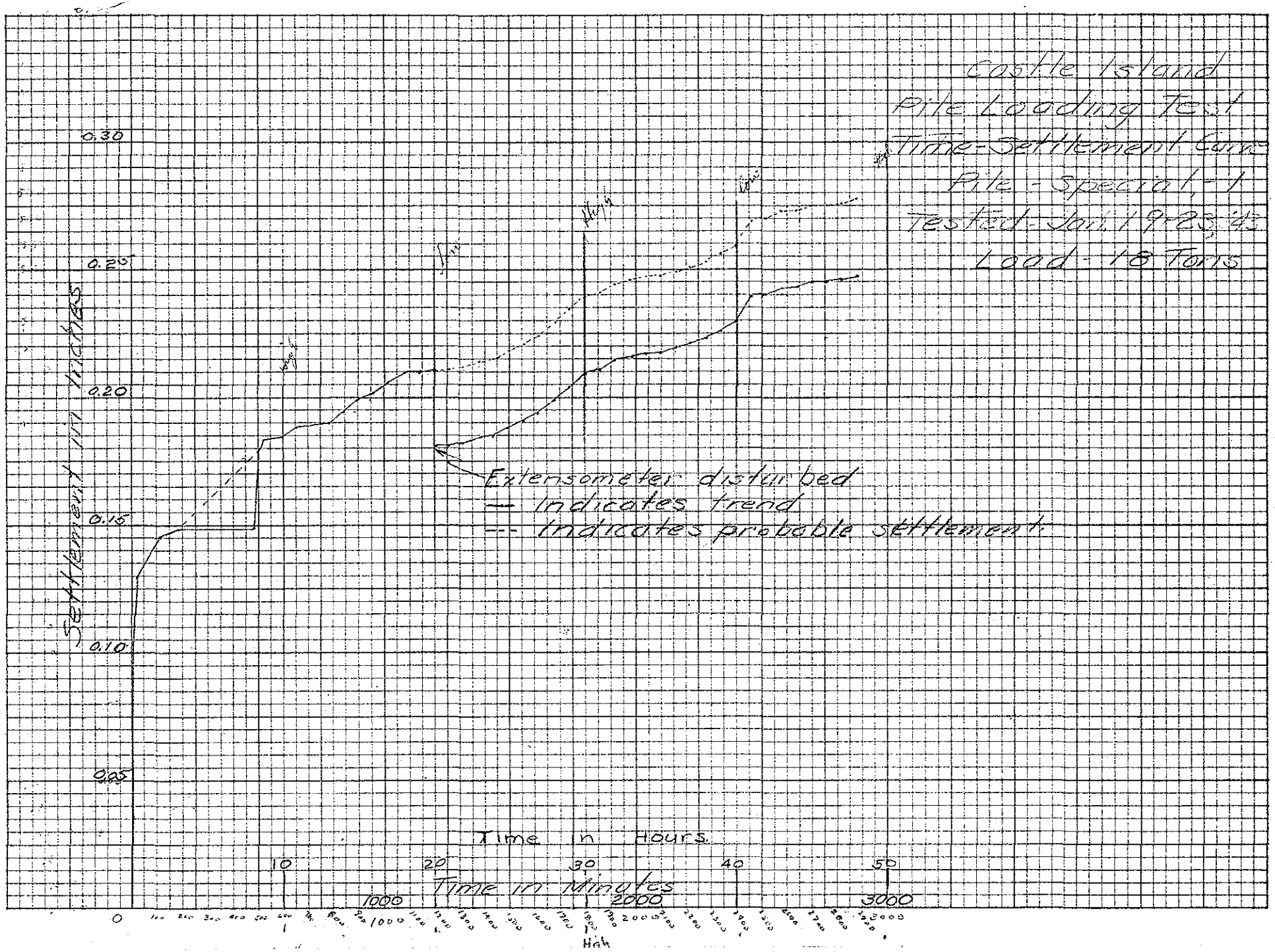
D50 " 35+27 25'.6" - 38'.0" (12.5')

D47 " 36+40 26'.6" - 35'.0" (8.5')

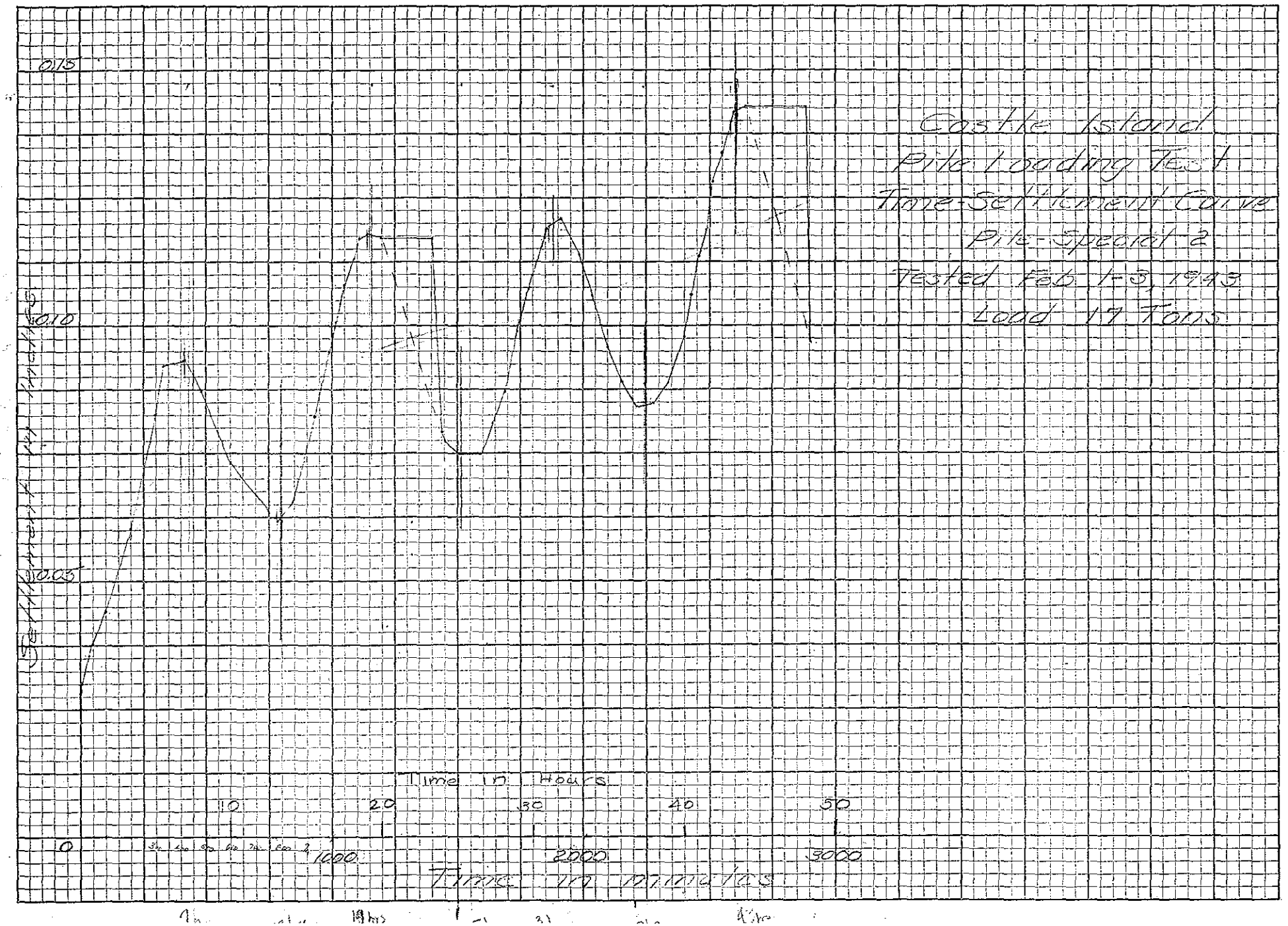

TIME IN MINUTES
0
500
1000
1500
2000
2500
3000
10
20
30
40
50
TIME IN HOURS
NEW TRANSIT SHED
CASTLE ISLAND
PILE LOADING TEST NO. 1
18 TON TIME SETTLEMENT CURVE
JAN. 19-23, 1943
SETTLEMENT IN INCHES
0.05
0.10
0.15
0.20
0.25
0.30
Extensometer support
disturbed. Dial readings
indicate 0.030"
displacement of support
+10.0'
MLWO
-10.0'
TIME
TIDE DATA BOSTON JAN. 20-22, 1943


TIME IN MINUTES
0
300
1000
500
2000
3500
3000
10
20
30
40
50
TIME IN HOURS
NEW TRANSIT SHED
CASTLE ISLAND
PILE LOADING TEST NO 2
17 TON TIME-SETTLEMENT CURVE
FEB 1-3, 1943
SETTLEMENT IN INCHES
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.10
0.11
0.12
0.13
0.14
0.15
Estimated
Time-Settlement Curve
for no Tidal effects
+10.0'
MLW
-10.0'
TIME
TIDE DATA BOSTON FEB 1-3, 1943

No. 330-10 10X10 PER INCH THE FREDERICK POST CO., CHICAGO, ILL.



KEUFFEL & ESSER CO., N. Y. NO. 359-6G
10 × 10 to the inch, 5th lines heavy.
MADE IN U. S. A.



Tide Data - Boston, Mass.

Hancock 1481

Jan. 19-23, 1943

Feb. 1-3, 1943

		High	Low	High	Low				
Jan	19 E.W.T.	10.9 g	~~13.9~~ 10.6	23.4 R	~~10.6~~ 7.3	4.4	~~4.1~~	17.3	~~3.9~~
	20	11.6 a	~~1.0~~ 7.7	24.0 mid.	~~9.5~~ 6.2	5.1	~~2.1~~	17.6	~~1.0~~
	21	–		12.4	~~10.0~~ 6.7	5.8	2.2	18.5	1.2
	22	0.7	~~9.7~~ 6.4	12.9	~~12.0~~ 8.7	6.7	3.0	19.1	2.9
	23	1.5	~~12.2~~ 8.9	13.1	~~13.1~~ 9.8	7.3	4.0	19.8	3.2

		E.S.T.				M.L.W.			
Feb	1	~~7:28a~~ (1)	10.1	8:03p (4)	8.9	Low ~~1:19a~~	0.0	1:56p (2)	−0.9
	2	8:24a (6)	10.6	9:02p (8)	9.3	2:12a (3)	−0.4	2:53p (7)	−1.4
	3	9:23a (10)	11.1	9:59p (12)	9.8	3:08a (9)	−0.8	3:48p (11)	−1.9

WAR DEPARTMENT
UNITED STATES ENGINEER OFFICE
Boston District
SOILS LABORATORY
Concord, N. H.

Sheet 2

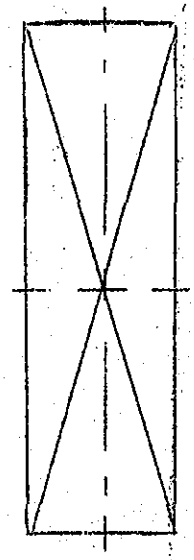
Pile Test No. 1

TRIAXIAL COMPRESSION TEST DATA SHEET - (COHESIONLESS MATERIAL)

Rod on Hydrant Top 2.43

Elapsed Time	Load in kg.	Dial ~~Reading~~ ~~In. x10^-3~~ Load	~~Water Level cc.~~ Δ	Strain Rod Reading	Corrected Area	Stress Kg.cm.^-2 Total Δ
Rod Reading		6.62		6.62'		
1/19/48 0 Load			0.126			
1:53 P	6,000	770				
1:54			0.158			
1:55			0.160			
1:56			0.160			
1:57			0.162			
2:06	6000	770	0.161	6.62'		
	Plate released load;*					
~~2:08~~	~~12,000~~	~~1540~~				
			0.126			
2:09	6,000	770				
2:09:30			0.154			
2:10			0.154			
2:11	6,000	770	0.154			.028"
2:12	12,000	1540	0.154			
2:12:30			0.188			
2:13			0.190			
2:16			0.193			
2:44	12,000		0.195			.069"
	12,000	1540	0.195	6.613		
2:53	17,000	2180				
2:53:30			0.229			
2:54			0.232			
2:55			0.234			
2:57			0.236			
3:02			0.239			
3:12			0.243			.117"
4:15			0.241			
5:30 P			0.234			

Note: Corrected Area = $\frac{A_1}{1-\text{Strain}}$



Failure Sketch

*plate above jack shifted while adding new increment.

67 = 2.23

6 = 3.60

.243
.126
.117

D. O. Form 374

WAR DEPARTMENT
UNITED STATES ENGINEER OFFICE
Boston District
SOILS LABORATORY
Concord, N. H.

Sheet 2

Pile Test No. 1

TRIAXIAL COMPRESSION TEST DATA SHEET - (COHESIONLESS MATERIAL)

Elapsed Time	Load in kg.	Dial Reading In. x10^{-3}	Water Level cc.	Strain	Corrected Area	Stress Kg.cm.$^{-2}$ Total Δ in"
Extensometer Support changed 1/20/43 @ 8:30 AM.						
New Dial Reading at 9:17 A.M 17,000 ± Total Load 0.149.						
Time	Total Load	Dial Reading	Ext. Read. Δ			
1/20/43 9:17A	17,000	2180	0.149			
11:05	17,000	2180	0.154			
12:32P	17,000	2180	0.151			
1:30p	17,000	2180	0.149			
3:03p	17,000	2180	0.146			
Rod 255p	6.95'	Hydraulic	0.72'			
	17,000	2180	0.146			
3:03	22,000	2820	—			
3:03:30	22,000	2820	0.172			
3:04	22,000		0.175			
3:05	22,000	2820	0.177			
3:07	22,000	2820	0.180			
3:14	22,000	2820	0.183			
3:21	22,000	2820	0.183			
3:26	22,000	2820	0.185			
3:38	22,000	2820	0.186			0.157"
			0.186			
3:40p	28,000	3590	—			
3:40:30	28,000	3590	0.242			
3:41	28,000	3590	0.248			
3:42	28,000	3590	0.252			
3:44	28,000	3590	0.257			
3:50	28,000	3590	0.263			
4:01	28,000	3590	0.272			
4:14	28,000	3590	0.275		4:14 P	Rod 6.96'
4:40	28,000	3590	0.280			
5:40	28,000	3590	0.286			
6:45	28,000	3590	0.290			
6:59p	28,000	3590	0.290			0.299"

Note: Corrected Area = $\frac{A_1}{1-\text{Strain}}$

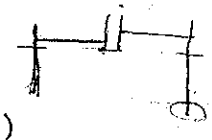
Failure Sketch

D. O. Form 374

WAR DEPARTMENT
UNITED STATES ENGINEER OFFICE
Boston District
SOILS LABORATORY
Concord, N. H.

Sheet 2

Pile Test No 1.

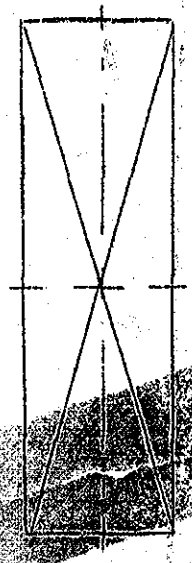


TRIAXIAL COMPRESSION TEST DATA SHEET - (COHESIONLESS MATERIAL)

.299

	~~Elapsed~~ Time	Load ~~in Kg.~~ 28000	Dial ~~Reading In. x10^-3~~	~~Water Level cc.~~ 0.290 Δ	Strain	Corrected Area	Stress Kg.cm.^-2
1/20/43	7:00p	36,000	4630	—			
	7:00:30			0.357			
	7:01			0.368			
	7:02			0.376			
	7:04			0.384			
	7:09			0.394			
	7:16			0.400			
	7:25			0.406			
	7:36			0.412			
	7:49			0.419			
	8:00		4630	—			
	9:00			0.435			
	10:00			0.438			
	11:00			0.438			
	12:00			0.438			
1/21/43	1:00A			0.438			
	2:00			0.438			
	3:00			0.438			
	3:30			0.470	Note: Extensometer support		
	4:00			0.473	not disturbed! ECG		
	5:00			0.474			
	6:00			0.478			
13hrs	8:00			0.480	CWK		
	9:00			0.484	"		
	10:00			0.489	"		
	11:00			0.492	"		
	12:00			0.496	"		
	1:00			0.499	"		
	2:00			0.500	"		
	3:00			0.501	"		
	3:15			0.471	"	Note: Extensometer	
	4:00			0.471		support possibly disturbed	
	5:00			0.472		by laborer. CWK	
	6:00			0.474			
	7:00			0.475			
	8:00			0.478			
	9:00			0.481			
	10:00			0.484			
	11:00			0.489			
	12:00			0.494			
1/22/43	1:00			0.499			

Note: Corrected Area = $\frac{A_1}{1-\text{Strain}}$



Failure Sketch

.510

.258

.501
.290
.211

.258
.211
66
.535

.537
.471
66

.538

D. O. Form 374

WAR DEPARTMENT
UNITED STATES ENGINEER OFFICE
Boston District
SOILS LABORATORY
Concord, N. H.

Sheet 2

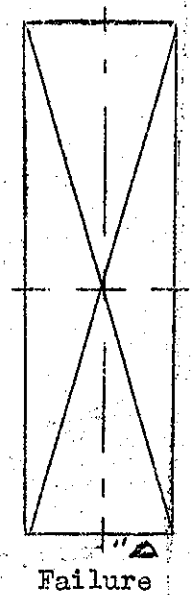
Pile Test No. 1

TRIAXIAL COMPRESSION TEST DATA SHEET - (COHESIONLESS MATERIAL)

~~Elapsed~~ Time	Load ~~in kg.~~	Dial Reading ~~In x10^-3~~	Water Level cc. △	Strain	Corrected Area	Stress Kg.cm.$^{-2}$
1/22/43 2:00a	36,000	4630	.501			
3:00A			0.504			
4:00			0.506			
5:00			0.507			
6:00			0.507			
7:00			0.509			
8:00			0.511			
9:00			0.513			
10:00			0.516			
11:00			0.519	CWK		
12:00			0.524	"		
1:00 P.M.			0.530	"		
2:00 "			0.532	"		
3:00			0.533	"		
4:00			0.535	"		
5:00			0.535	"		
6:00			0.536		Rod 6.74 Hyd 0.645	
7:00			0.537			.574"
7:00	36,000	4630	0.537			
7:00	42,000	5380	—			
7:00:30			0.571			
7:01			0.575			
7:02			0.578			
7:04			0.581			
7:09			0.587			
7:20			0.592			
7:27			0.597			
7:36			0.603			
7:49			0.607			
8:04			0.610			
8:40			0.621			
9:00			0.626			
10:00			0.636			
11:00			0.646			.683

.538

Note: Corrected Area = $\frac{A_1}{1-\text{Strain}}$



Failure Sketch

6.74
65
6.09

D. O. Form 374

.642
.537
105

WAR DEPARTMENT
UNITED STATES ENGINEER OFFICE
Boston District
SOILS LABORATORY
Concord, N. H.

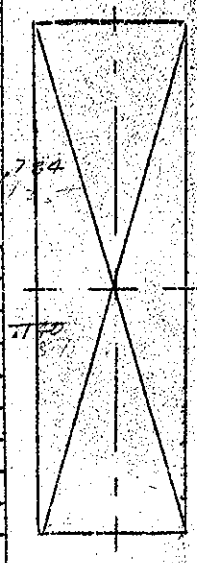
Sheet 2

Pile Test No. 1

TRIAXIAL COMPRESSION TEST DATA SHEET - (COHESIONLESS MATERIAL)

Elapsed Time	Load in kg.	Dial Reading In. x10^{-3}	Water Level cc.	Strain	Corrected Area	Stress Kg.cm.$^{-2}$
			0.646			.683
11:00 P	48,000	6150				
11:00:30			—			
11:01			—			
11:02			0.710			
11:04			0.727			
11:09			0.747	changed extensometer		
11:09			0.611	Pile moving East		
11:16			0.625			
11:25 P			0.637			
11:36			0.650			
11:49			0.665			
12:04 A			0.674			
12:40			0.694			
1:00			0.706			
2:00			0.731			
3:00			0.746			.919
			.746			
3:00	54,000	6920				
3:00:30			.798			
3:01			.817			
3:02			.856			
3:04			.896			
3:09			.961			
3:16			1.050			
3:25			1.107			
3:36			1.145			
3:49			1.181			
4:04			1.218			
5:01			1.270			
6:00			1.392			
7:11			1.491			
8:00			1.525			1.698
8:27			1.549	Rod 6.57 Hyd		0.26
9:02			1.577			

Note: Corrected Area = $\frac{A_1}{1-\text{Strain}}$



Failure Sketch

Elev Top Hyd = B.M + 4.03
1.495
4.29
.26
4.03
Sta Dump

.745

D. O. Form 374

WAR DEPARTMENT
UNITED STATES ENGINEER OFFICE
Boston District
SOILS LABORATORY
Concord, N. H.

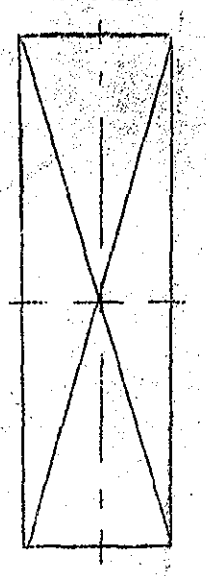
Sheet 2

Pile Test No. 1

TRIAXIAL COMPRESSION TEST DATA SHEET - (COHESIONLESS MATERIAL)

Elapsed Time	Load in kg.	Dial Reading In. x10^{-3}	Water Level cc.	Strain	Corrected Area	Stress Kg.cm.$^{-2}$
9:05	1.578 = 0.793					
9:07	60,000	7690		Pile driven toward		
9:08			0.847	East into frame		
9:09			0.900	cross piece 4"x8"		
9:11			0.976			
9:16			1.058			
9:23			1.120			
9:32			1.184			
9:43			1.224			
10:00			1.267			
11:11			1.383			
12:11			1.441			
12:22			1.452	Rod 6.633	Hyd 0.30	
Rebound-						
		6150	1.428			
		4870	1.385			
		4630	1.375			
		2820	1.253			
		770	1.112			
	0	0	0.954	Rod 6.58		

Note: Corrected Area = $\frac{A_1}{1-\text{Strain}}$



Failure Sketch

TBM on pile 1'7 1/4" Below top of Pile

D. O. Form 374

Pile Test No 1.

WAR DEPARTMENT

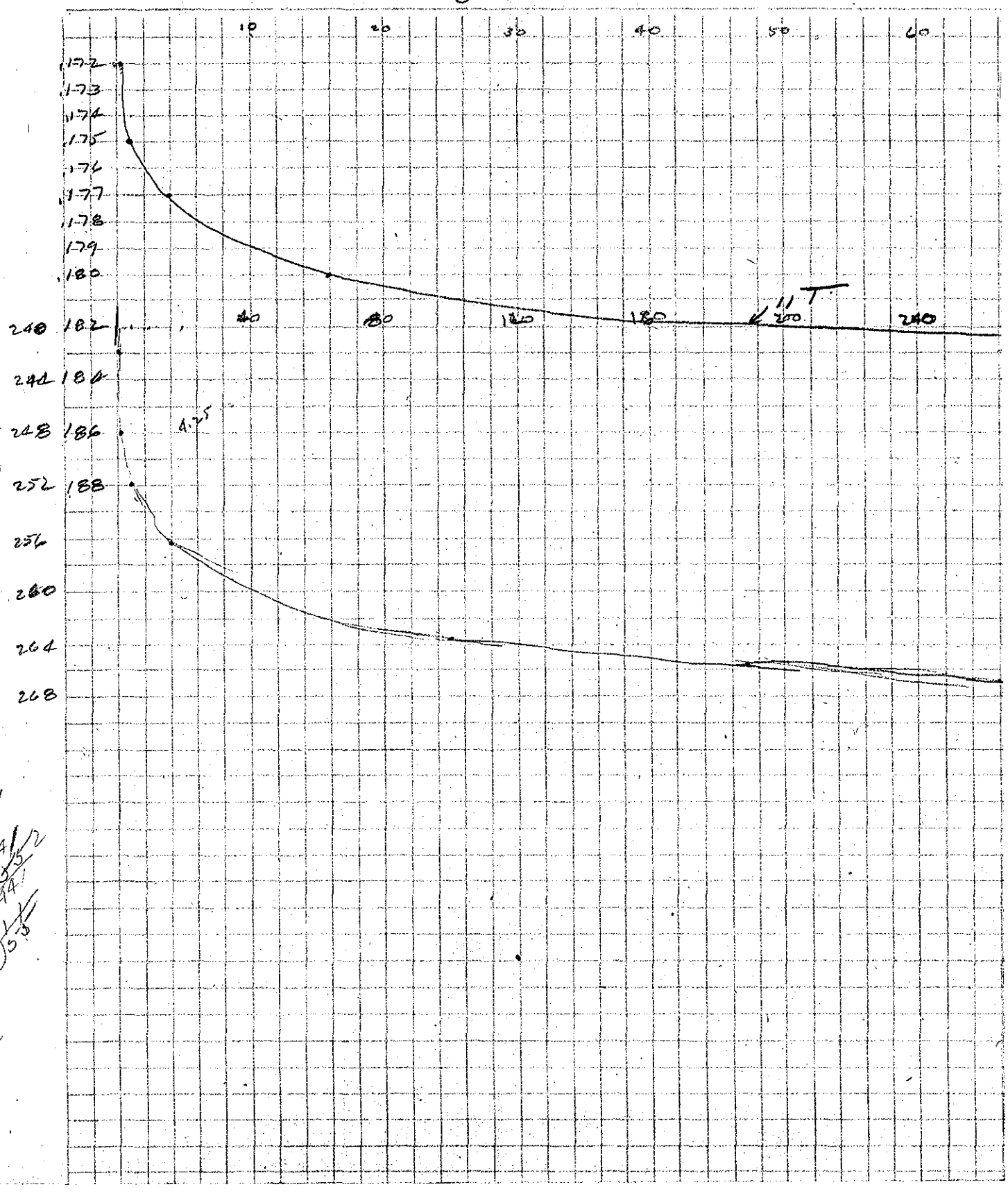
U. S. ENGINEER OFFICE, BOSTON, MASS.

Page.....

Subject.....

Computation.....

Computed by..... Checked by..... Date.....



D.O. Form 971

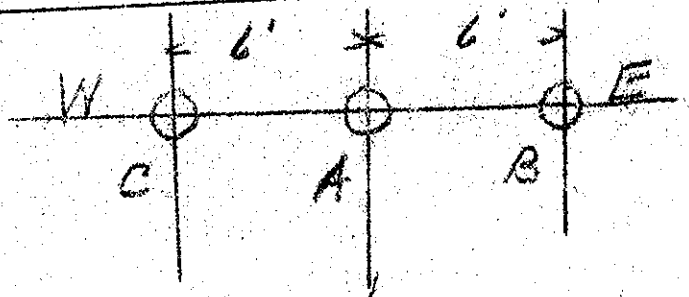
Jan. 12 - 1942
Tuesday
Pile Test No. 1

WAR DEPARTMENT
United States Engineer Suboffice
Castle Island
South Boston, Massachusetts

MEMORANDUM TO: Lt. J. R. Gardner

CONCERNING: Test Pile at Sta 21+60

Hammer:-
Super Vulcan
30 C
120 blows per min



Sta
21+60

"A" 40 ft. Untreated Pile - Butt 12" - Tip 7" - Time 9:30 Am - 9:36 A
Ground Elev. 14.8 - Exca. Elev 6.3 - Tip driven to Elev -

Tip Elev.	+6.3	Start
"	-4.0	6" to 1 blow
"	-10.0	4" " 1 "
"	-15.0	1" " 1 "
"	-25.0	Last 4 blows 1/2"

Total number of blows 289

"B" 50 ft Untreated pile Butt 13" - Tip 8" Time 10:00 - 10:16
Ground Elev. 14.8 - Exca. Elev 6.3 Tip driven to Elev -29.5

Tip Elev.	+6.3	Start
	-5.0	6" to 1 blow
	-10.0	4" " 1 "
	-12.0	1" " 1 "
	-29.5	6" " 68 Blows.

D.O. Form 971

1942-1942

WAR DEPARTMENT
United States Engineer Suboffice
Castle Island
South Boston, Massachusetts

Pile Test No 1

MEMORANDUM TO:

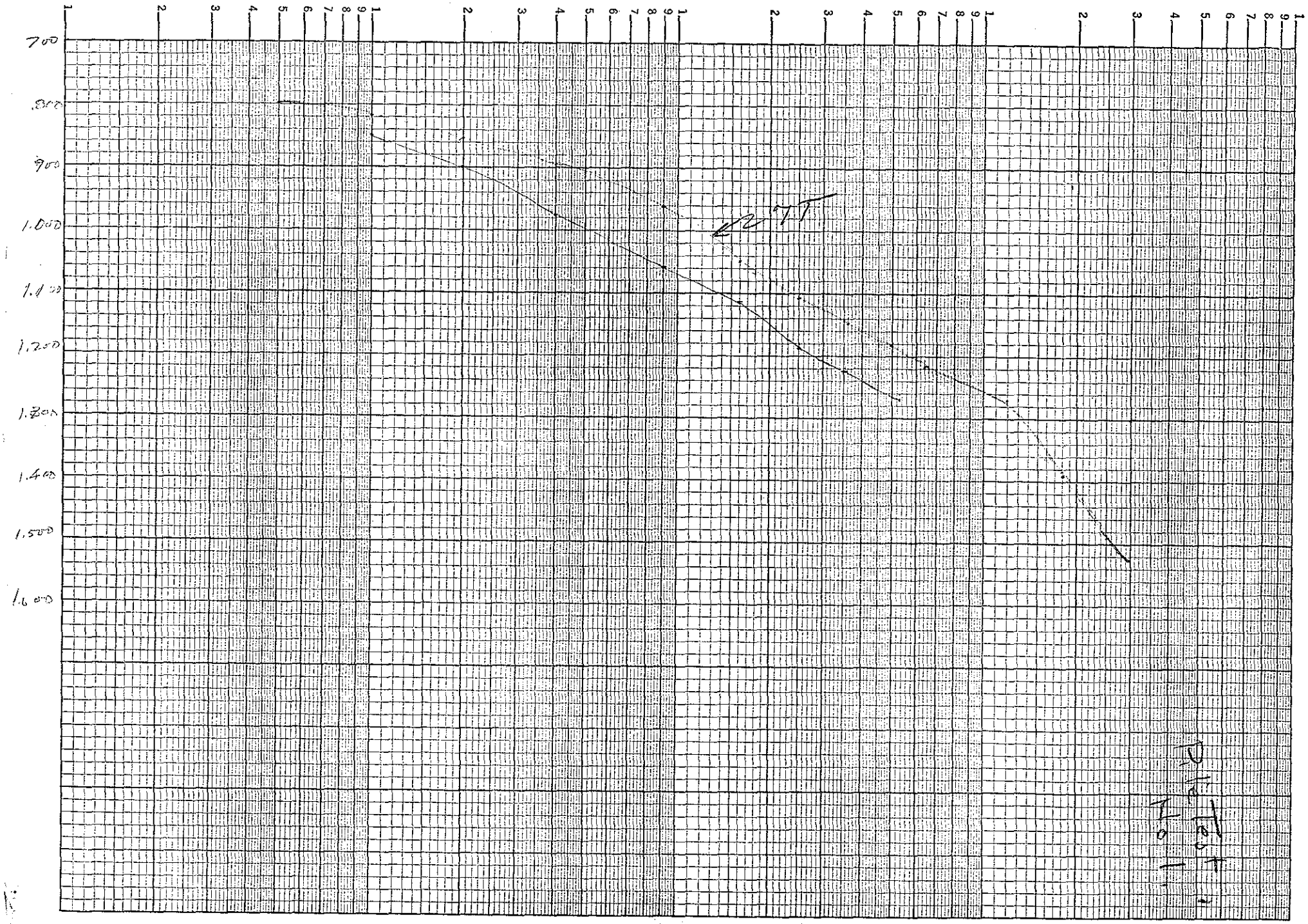
CONCERNING: Test Pile Contu.

"C" 50 ft. Untreated Pile Butt 14" - Tip 8" Tim. 10/25/44.
Ground Elev. 14.5. Exca. Elev 6.3 Tip driven to El -28.

Tip Elev. +6.3 Start
" -4.0 5" to 1 blow
-11.0 4" " 1 "
-13.0 1" " 1 "
-28.7 6" - 74 Blows.

Signed
Walter J. Lynch
Chief Inspector.

KEUFFEL & ESSER CO., N. Y. NO. 359-81G
Semi-Logarithmic, 4 Cycles X 10 to the inch.
MADE IN U. S. A.



Pile Test No 1

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Page.....

Subject: Elastic Deformation of Pile (Test 1/19/43 - 1/23/43)

Computation.....

Computed by: W.A.W. Checked by..... Date.....

Length of Pile = 39.4'

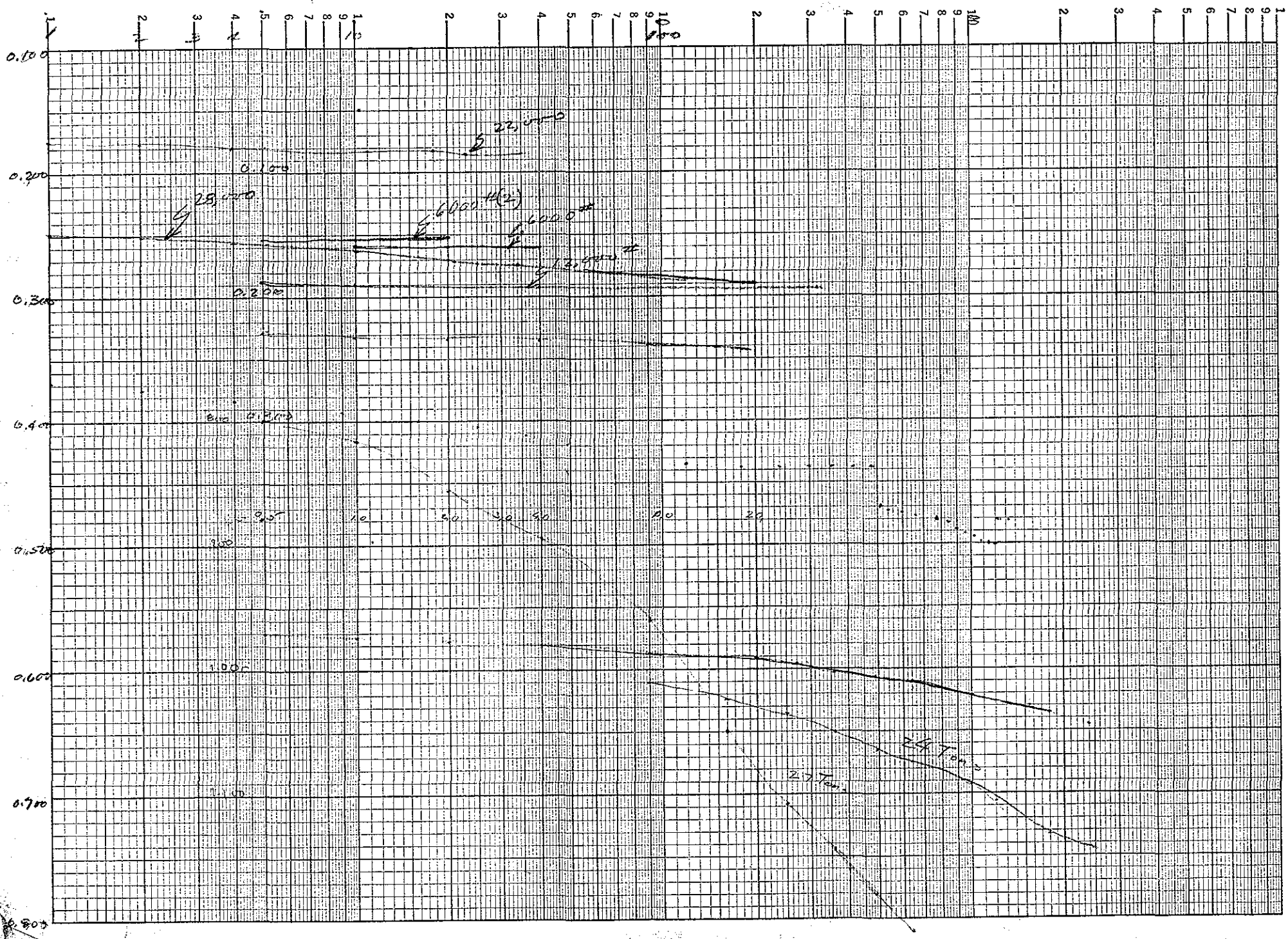
Modulus of elasticity = 1,600,000 #/□"

Area of Section = $\frac{\pi}{4}\left(\frac{7+12}{2}\right)^2$ = 70.9 □"

At 30 Tons stress = $\frac{30 \times 2000}{70.9}$ = 847 #/□"

Defl. = $\frac{847\ \#/\square''}{1600000} \times 39.4' \times 12''$ = 0.25

KEUFFEL & ESSER CO., N.Y. NO. 359-81G
Semi-Logarithmic, 4 Cycles X 10 to the inch.
MADE IN U.S.A.



Pile Test No. 1.

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Pile Test No. 1

Page.....

Subject.....

Computation.....

Computed by..... Checked by..... Date.....

~~TBM #1945~~
Sta Dump 14.95

Loading Schedule

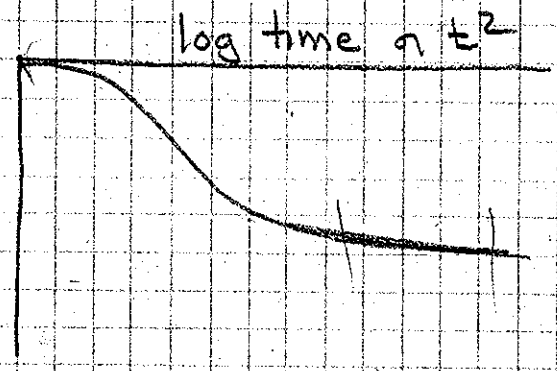
6000 lbs total
6000

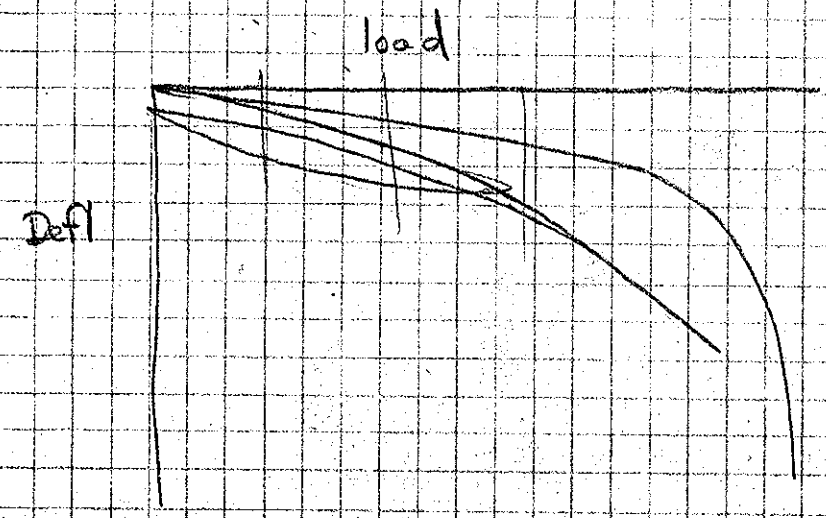
12000 lbs
5000

2180 17,000 lbs total load

Hold Constant for 48 hours
5000

2820 22,000 lbs
3590 28,000 800
3850 30,000 lbs
4630 = 36,000 → 4860 34,000 8000
4870 38,000 lbs
5380 42,000 10000
6150 48,000 lbs
6540 51,000 12000
6920 54,000
7690 60,000 lbs





Measure rise

Clay Fill

6' sand

40' Soft blue clay

Pile Test No. 1.

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Page.....

Subject.....

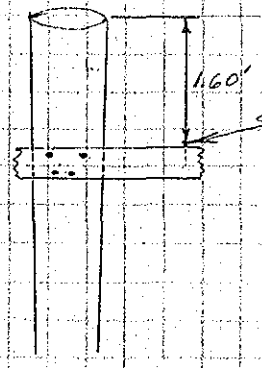
Computation.....

Computed by..... Checked by..... Date.....

Load (after Δ under)	Rod	TBM Hydrant	Rod − T.B.M.	Δ in ft.	Δ in inches	Extensometer Δ
0	6.62	0.43	6.19	0		
6000	6.62	0.43	6.19	0		
12,000	6.61	0.43	6.18	+.01	−0.12	
17,000	6.95	0.72	6.23	−.04	−0.48	
28,000	6.96	0.72	6.24	−.05	−0.60	
(36,000	6.74	0.65	6.09	+.10	+1.20)	
54,000	6.57	0.26	6.31	−.12	−1.44	
60,000	6.63	0.30	6.33	−.14'	−1.68	
0	6.58	0.30	6.28	−.09'		

Elev Top of Hydrant equals Elev BM 1945 plus 4.03'

Elev Top of Pile = +1.60' above Rod reading



Pile Test No. 1

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Page.....

Subject: Castle Island Pile Loading Test.

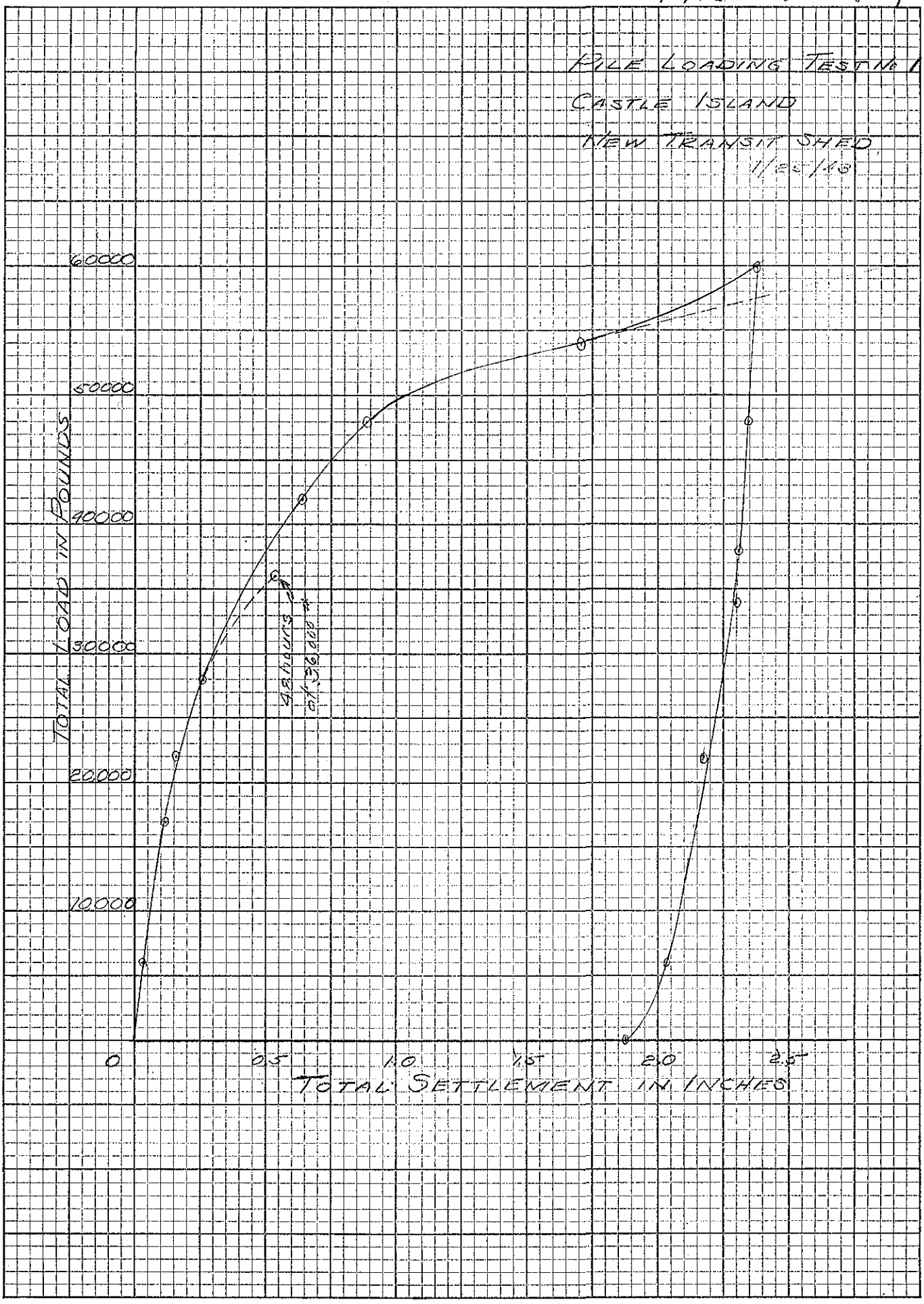
Computation: Summary.

Computed by: W. W. Checked by: Date: 1/25/43

Load	Total Settlement Dial	Total Settlement Rod	
0	0	0	
6000	0.035"		When next increment was added - plates shifted releasing load - reloaded to 6000#
6000	0.028"		
12,000	0.069"	(Total")	
17,000	0.117	0.48	Settlement after 19 min. Dial support shaken by high winds making subsequent dial readings irregular. Dial reset after 17 hrs. Settlement during this period not recorded but believed to be very small. 0.117" Taken as total Δ.
22,000	0.157	—	
28,000	0.261	0.60	
36,000	0.538	(—)	
42,000	0.647		
48,000	0.883		Pile shifting East - Reset Dial to avoid disturbance by jack. Pile being forced into framework to anchor piles at this and all subsequent loads.
54,000	1.714	1.44	
60,000	2.373	1.68	
48,000	2.399		
38,000	2.306		
31,000	2.296		
22,000	2.174		
6,000	2.033		
0	1.875	1.08	

Note: Rod readings were made under great difficulty. Tent covering made it very dark and rod was in very poor condition, half of paint was missing.

Pile Test No. 1



KEUFFEL & ESSER CO., N. Y. NO. 359-6G
10 X 10 to the inch, 5th lines heavy.
MADE IN U. S. A.

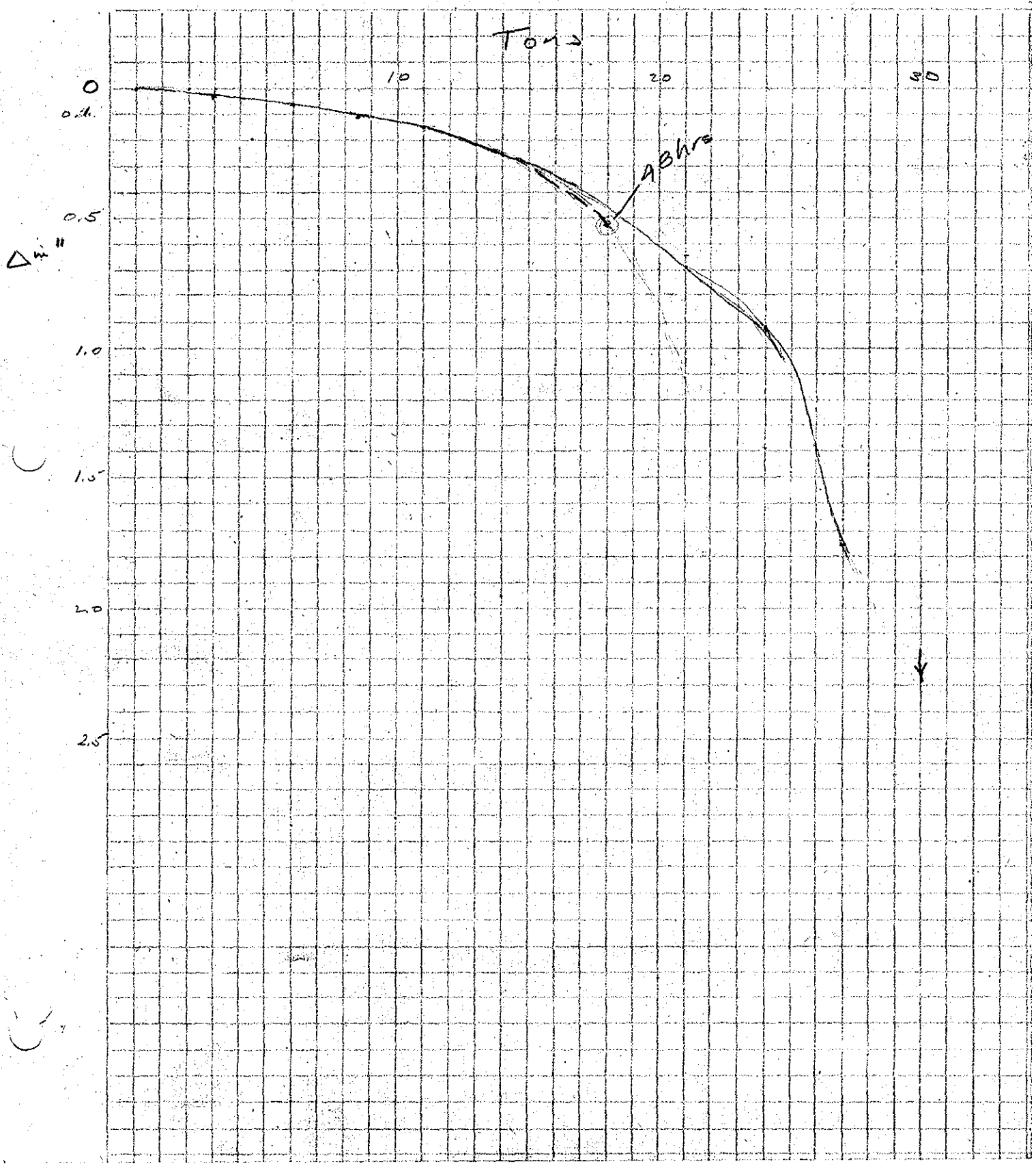
WAR DEPARTMENT Pile Test No. 1.

U. S. ENGINEER OFFICE, BOSTON, MASS. Page.....

Subject.....

Computation.....

Computed by..... Checked by..... Date.....



WAR DEPARTMENT
UNITED STATES ENGINEER OFFICE
Boston District
SOILS LABORATORY
Concord, N. H.

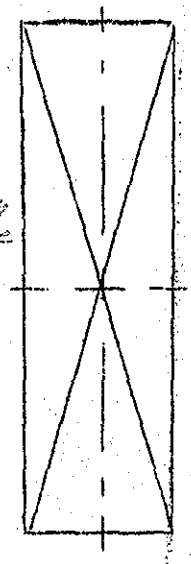
Sheet 2

Pile Test No. 2

TRIAXIAL COMPRESSION TEST DATA SHEET - (COHESIONLESS MATERIAL)

	Elapsed Time	Load in kg.	Dial Reading In.x10^{-3}	Water Level cc.	Strain	Corrected Area	Stress Kg.cm.$^{-2}$
2/1/43	Elev Top of		Pile - +	13.97	MLW	—	
	Time	Extrn Dial	Total Load	Dial Load	Meter Stick (cm	Total Δ	
	10:15	0.118	0	0	94.7		
	10:20		8000	1030			
	10:20:30	0.149					
	10:21	0.150					Oil Leaking
.343	10:22	0.152					around gauge
118	10:24	0.152					
.225	10:29	0.152			94.7-	.034	
		0.152	8000				
	10:30	0.	18000	2310			Oil Leaking
	10:30:30	0.190					
	10:31	0.192					
	10:32	0.193					
	10:34	0.194					
	10:39	0.195					
	10:46	0.195			94.7+	.077	
		0.195	18,000		94.7+		
	10:50	1	28,000	3590		Pile shifted East, 1/4" ±	
	10:50:30	0.244					
	10:51	0.244					
	10:52	0.245					
	10:54	0.246					
	10:59	0.247					
	11:06	0.247			94.7+	.129	
Rebound	12:03	0.243	28,000				
		0.214	18,000			.096	
		0.194	8,000			.076	
		0.138	0		94.9		
		0.136	0				
		0.126	0			.008	

Note: Corrected Area = $\frac{A_1}{1-\text{Strain}}$



Failure Sketch

D. O. Form 374

WAR DEPARTMENT
UNITED STATES ENGINEER OFFICE
Boston District
SOILS LABORATORY
Concord, N. H.

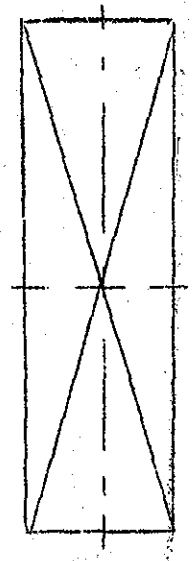
Sheet 2

Pile Test No. 2

TRIAXIAL COMPRESSION TEST DATA SHEET - (COHESIONLESS MATERIAL)

Elapsed Time	Load in kg.	Dial Reading In.x10^{-3}	Water Level cc.	Strain	Corrected Area	Stress Kg.cm.$^{-2}$
				(cm.)		
	Extens.	Total	Dial	Meter	Total	
Time	Dial	load	Load	Stick	Δ	
2/1/43	0.098	0	0	94.9		0
2:52 p		8,000	1030			
2:54 p	0.127				.037	
2:54 p		18,000	2310			
2:56 p	0.157			94.84	.067	.02
2:56 p		28,000	3590			
3:00 p	0.200			94.8	.110	.05
3:00 p		34000	4360			
3:00:30	0.223					
3:01	0.224					
3:02	0.227			94.7		.08
3:04	0.228					
3:09	0.230					
3:16	0.232					
3:30	0.236					
3:50	0.238					
4:40	0.244				.154	
6:20	0.261					
8:00	0.283				.193	
9:00	0.292					
10:00	0.293					
11:00	0.287					
2/2/43 1:00 A	0.273					
4:00	0.262					
5:00	0.266					
6:30	0.282					
7:30	0.295					
WARD. 8:00 AM	0.301					
8:30 AM	0.308					
9:00 "	0.313					
9:30 "	0.317					
10:00	0.318					
10:55	0.317					

Note: Corrected Area $= \frac{A_1}{1-\text{Strain}}$



Failure Sketch

D. O. Form 374

WAR DEPARTMENT
UNITED STATES ENGINEER OFFICE
Boston District
SOILS LABORATORY
Concord, N. H.

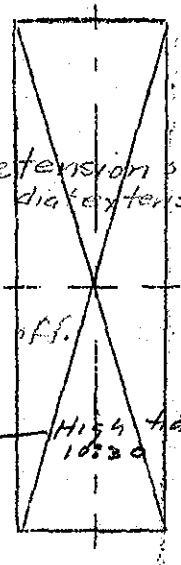
Sheet 2

Pile Test No. 2

TRIAXIAL COMPRESSION TEST DATA SHEET - (COHESIONLESS MATERIAL)

Elapsed Time	Load in kg.	Dial Reading In. x10^{-3}	Water Level cc.	Strain	Corrected Area	Stress Kg.cm.$^{-2}$
		34000	4360			
11:30 AM	0.317					
12:00 "	0.317					
1:00 PM	0.317					
2:00 PM	0.317					
2:30 PM	0.317			94.7cm		
3:00	0.279	Pile shifting, Dial binding released side tension on dial extension				
3:15	0.277	Bull dozer plowing snow -				
4:20	0.275	Heavy trucks passing 16' N of Pile				
5:30	0.275	nearly continuously until 5:30 pm				
6:15	0.281	Trucks started passing again at 6:20 pm				
7:00	0.287	Press. Dial constant 4:20 - 6:15 - then dropping off.				
8:00	0.299					
9:00	0.310					
10:00	0.319			946		.12
CWK 11:00	0.321					
12:00	0.314					
2/3 1:00 AM	0.306					
2:00 "	0.296					
3:00 "	0.289					
4:00 "	0.284					
5:00 "	0.285					
6:00 "	0.289					
7:00 "	0.298					
WaED 7:30 "	0.306					
8:00 AM	0.311	Starting 8:30 AM on Snow truck plying back and forth				
8:30 "	0.319					
9:00 "	0.328					
9:30 "	0.334					
10:00 "	0.340					
10:15	0.342					
10:30 "	0.3425					
11:00	0.343				.253	
11:30	0.343					
12:00	0.343					
12:40	0.343					
1:30	0.343					
2:00	0.343					
2:30	0.343					
3:00	0.3433	Dial binding - released tension -				
3:25	0.297	back to 0.297				

Note: Corrected Area $= \frac{A_1}{1-\text{Strain}}$



Failure Sketch

2 possible explanations for readings.
① pile may be settling first one side & then the other causing one side of top to vary up & down -
② Dial extension on rough steel plate, as pile shifts sideways roughness of plate may be cause of up & down readings
M.A.W.

D. O. Form 374

WAR DEPARTMENT
UNITED STATES ENGINEER OFFICE
Boston District
SOILS LABORATORY
Concord, N. H.

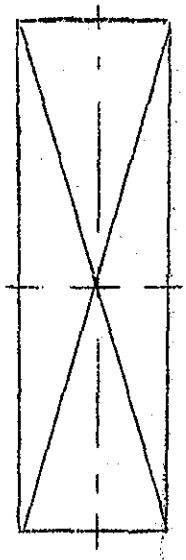
Sheet 2

Pile Test No. 2

TRIAXIAL COMPRESSION TEST DATA SHEET - (COHESIONLESS MATERIAL)

Elapsed Time	Load in kg. Extens.	Dial Reading In. x10^{-3} Total	Water Level cc. Dial	Strain Meter	Corrected Area	Stress Kg.cm.$^{-2}$
7/2/43 Time	Dial.	Load	Load			
3:30	0.297	34,000				
3:00		40,000	5130	94.7		.08
3:30:30	0.313					
3:32	0.313			94.7-		.09
3:32	0.313			94.6+		.10
3:40	0.313			94.6+	.269	.10
	0.313	40,000		94.6+		.10
3:44		46,000	5900			
3:44:30	0.328					
3:45	0.329			94.6		.12
3:46	0.329					
3:48	0.330					
3:53	0.331				0.287	
4:00p						
	0.331	46,000		94.6		.12
4:00p		52,000	6660			
4:00:30	0.347			94.6		.12
4:01	0.348					
4:02	0.349			94.6-		.13
4:04	0.351					
4:09	0.352					
4:16	0.353					
4:25	0.356				0.372	
4:36	0.356			94.6-		.13
	0.356	52,000	6660	94.6-		.13
4:40p		60,000	7690			
4:40:30	0.381	60,000	7690			
4:41	0.385					
4:42	0.389			94.5+		.15
4:44	0.391			94.5-		.17
4:49	0.396					
4:56	0.400					
5:10	0.403					

Note: Corrected Area $= \frac{A_1}{1-\text{Strain}}$



Failure Sketch

D. O. Form 374 356

WAR DEPARTMENT
UNITED STATES ENGINEER OFFICE
Boston District
SOILS LABORATORY
Concord, N. H.

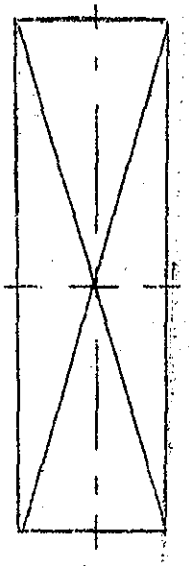
Sheet 2

Pile Test No. 2

TRIAXIAL COMPRESSION TEST DATA SHEET - (COHESIONLESS MATERIAL)

Elapsed Time (Time)	Load in kg. (Proving Ring Dial)	Dial Reading In. x10^{-3} (Total Load)	Water Level cc. (Dial Load)	Strain (Meter Stick)	Corrected Area	Stress Kg.cm.$^{-2}$
5:30	0.411	60000	7690			
6:00	0.415			94.4+		.19
7:00	0.426					
7:40	0.437					
8:00	0.440					
8:40	0.454					
9:00	0.461			94.4-	.417	.21
	0.461					
9:00		70,000	8970			
9:00:30	0.497					
9:01	0.500			94.3-		.24
9:02	0.503					
9:04	0.507					
9:09	0.514					
9:16	0.521	Fluid leaking around				
9:18	0.522	dial connection -				
					.478	
Rebound 9:20p	0.496	52,000	6660			
9:22p	0.496				.452	
9:23p	0.459	40,000	5130			
9:26p	0.458				.414	
9:27p		20,000	2570			
9:28p	0.377					
9:30p		10,000	1280			
9:31	0.329			94.7+		
9:33	0.329					
9:34		0	0			
9:35-	0.267			94.8		
9:56	0.261					
10:00	0.260			94.8+		

Note: Corrected Area = $\frac{A_1}{1-\text{Strain}}$



Failure Sketch

D. O. Form 374

WAR DEPARTMENT

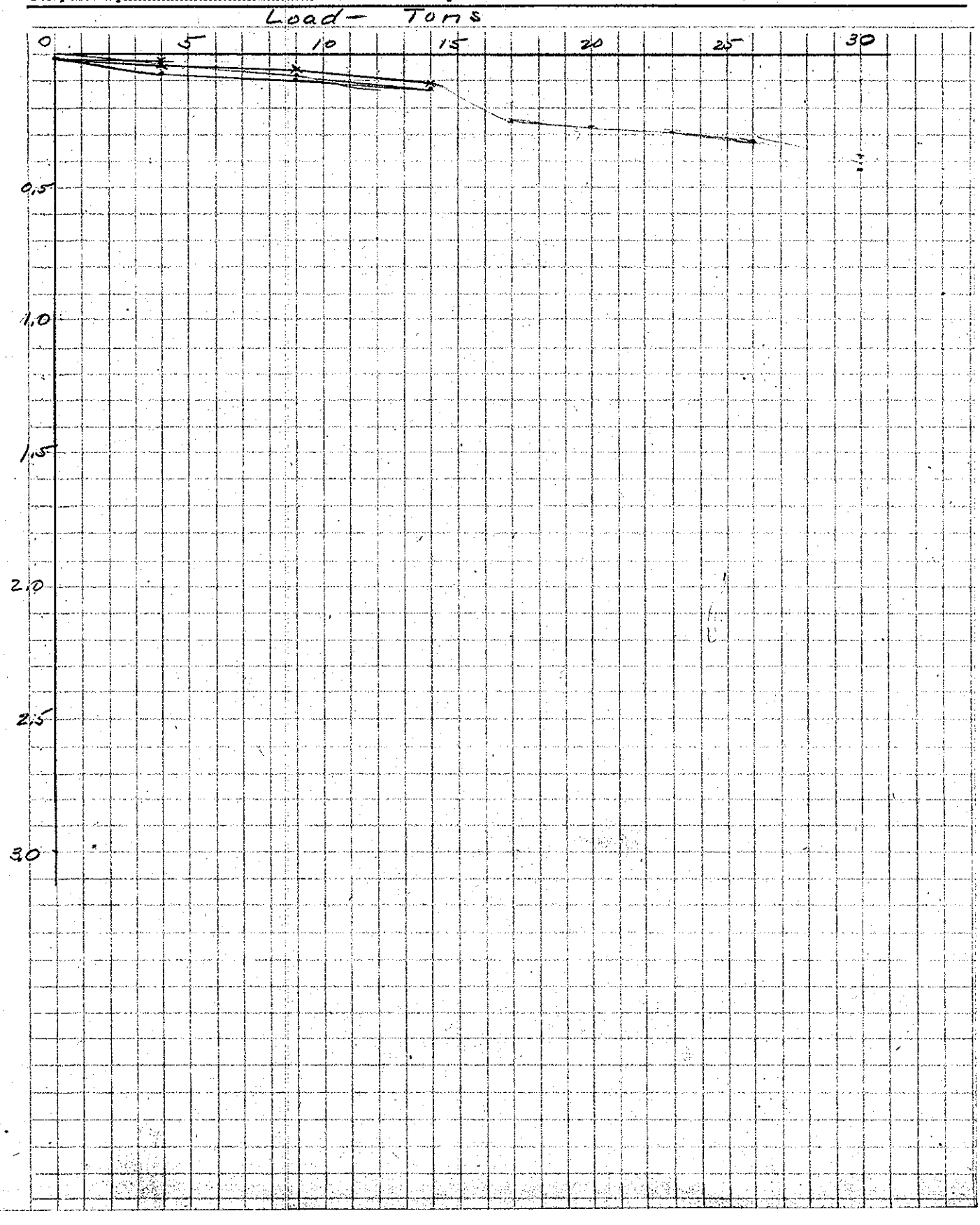
U. S. ENGINEER OFFICE, BOSTON, MASS.

Page

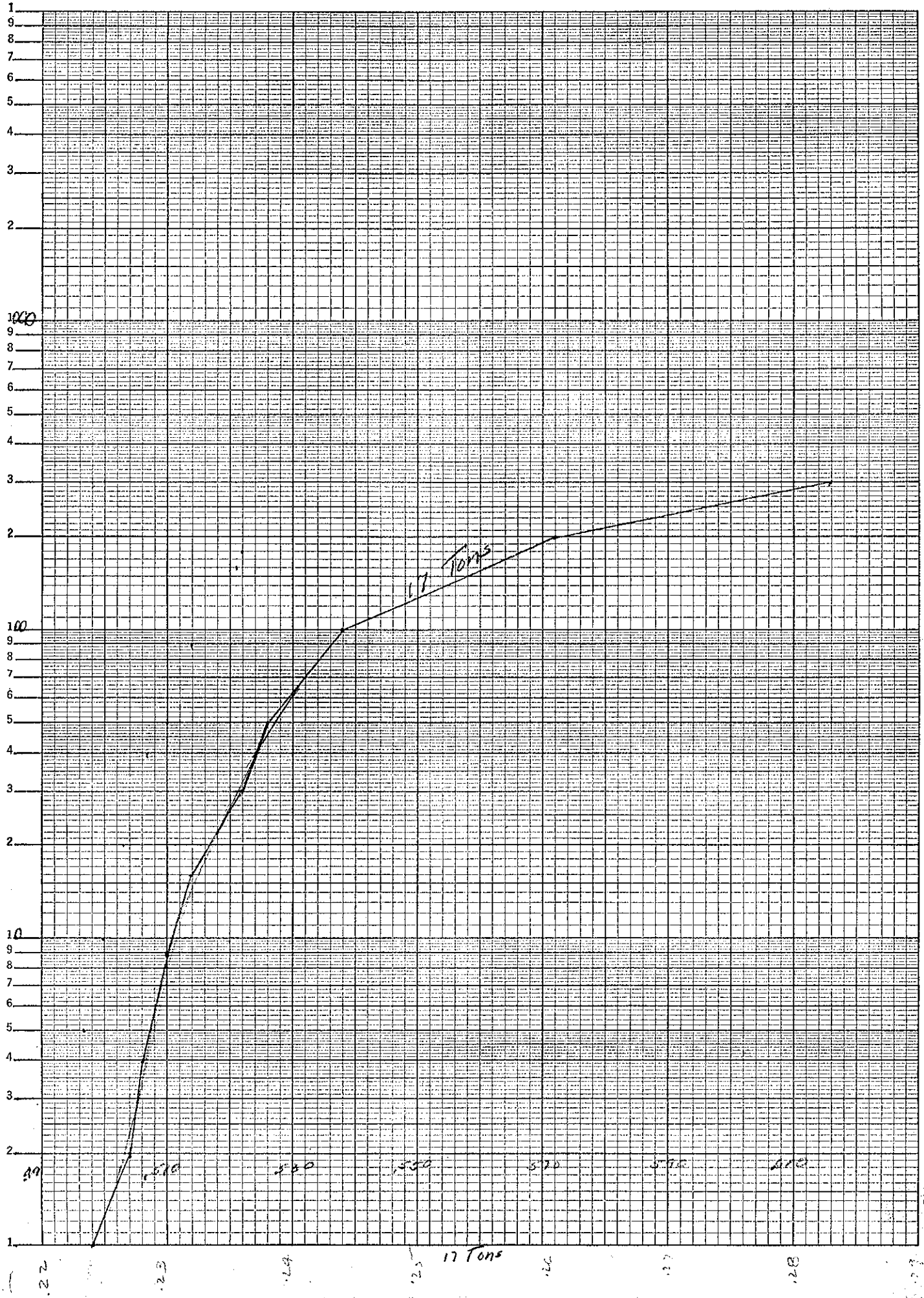
Subject: Pile Test No. 2

Computation

Computed by: Checked by: Date:

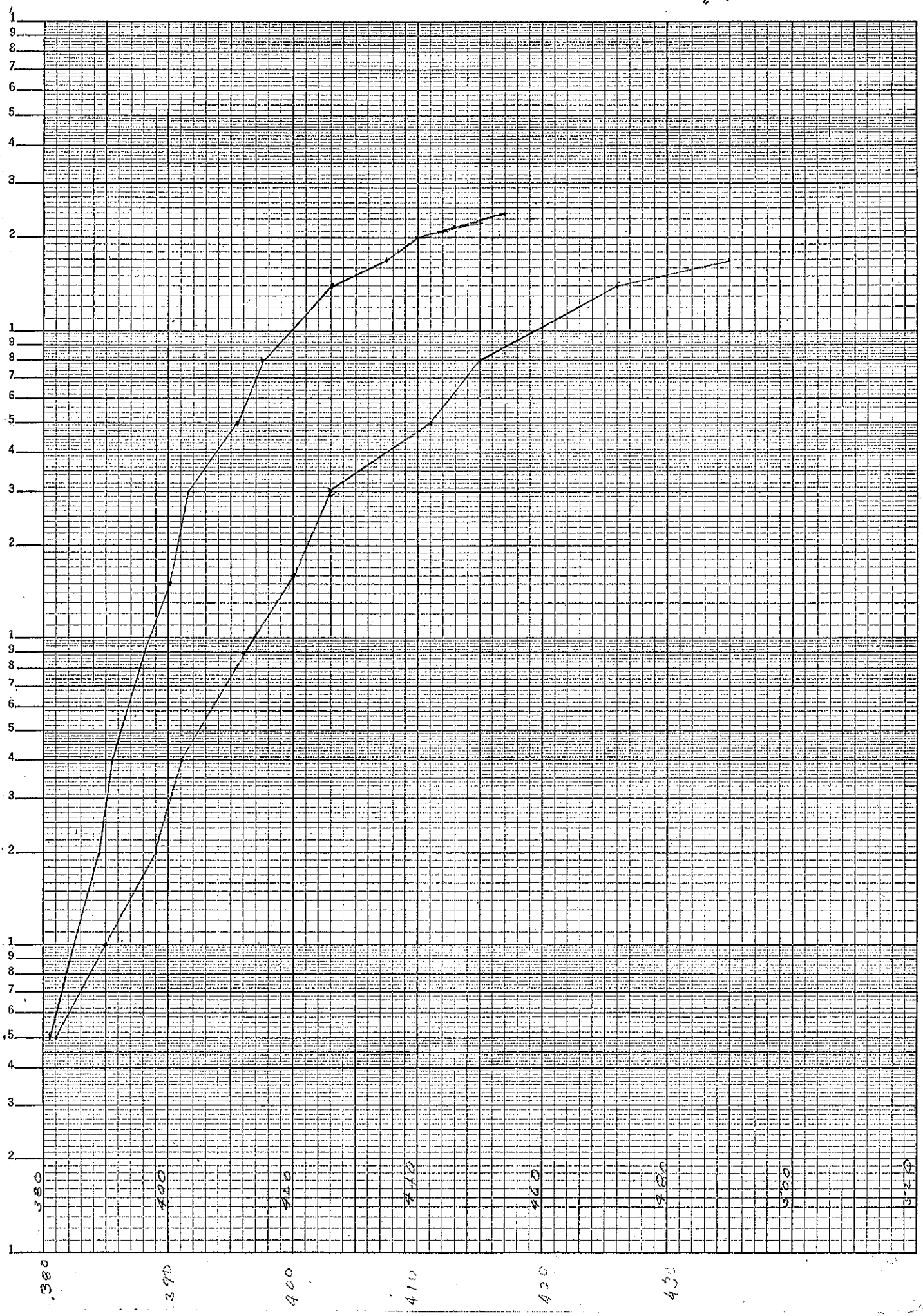


Pile Test No. 2



KEUFFEL & ESSER CO., N.Y. NO. 359-81G
Semi-Logarithmic, 1 Cycles X 10 to the inch.
MADE IN U.S.A.

Pile Test No. 2



WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Pile Test No. 2

Page:

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Computation:

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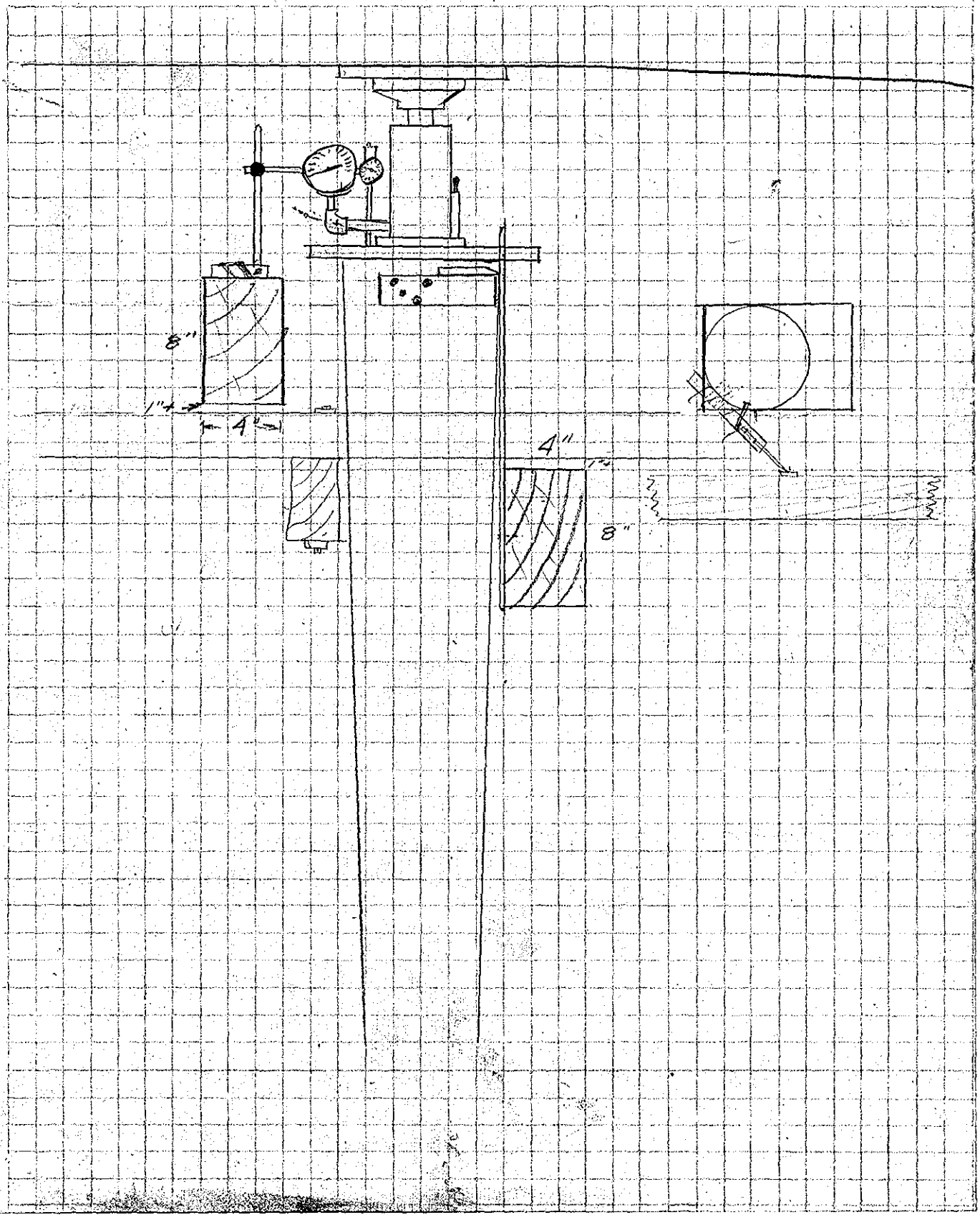


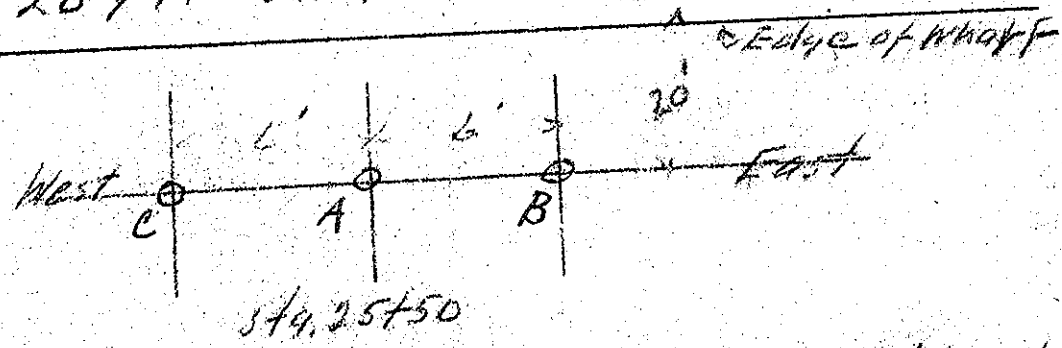
Pile test
Jan. 22 - 1943

D.O. Form 971

WAR DEPARTMENT
United States Engineer Suboffice
Castle Island
South Boston, Massachusetts

MEMORANDUM TO: Lt. Gardner

CONCERNING: Test Pile at Sta. 25+50
20 ft. So. from edge of wharf.



Hammer:- Super Vulcan 30C - 120 blows per min.

"A" - 40 ft. - 12" Butt - 8" Tip untreated
Gr. Elev. 15.0 - Exca. Elev. 6.5, Tip driven to - 25'

Tip Elev.	+ 6.5	Start		
" "	- 7.0	6"	to 1	blow
" "	- 15.0	4"	" 1	"
" "	- 20.0	1"	" 1	"
" "	- 25.0	6"	" 32	"

Note:- Well driven pile

"B" - 55 ft - 14" Butt - 7" Tip untreated.
Gr. Elev. 15.0 - Exca. Elev. 6.5, Tip driven to 34.5

Tip Elev.	+ 6.5	Start		
" "	- 9.0	6"	to 1	Blow
" "	- 16.0	4"	" 1	"
" "	21.0	2"	" 1	"
" "	26.0	1"	" 1	"
" "	30.0	3/4"	" 1	"
" "	34.5	6"	- 50	"

Note:- In my opinion pile over driven

Pile Test No. 2

D.O. Form 971

WAR DEPARTMENT
United States Engineer Suboffice
Castle Island
South Boston, Massachusetts

MEMORANDUM TO:

CONCERNING: Test Pile Sta 25+50 Cont'd.

"C" 55 ft. 14" Butt - 8" Tip Untreated
Gr. Elev. 15.0 - Exca. Elev. 6.5, Tip driven to -34.0
Tip Elev +6.5 Start
" " -8.0 6" to -1- blow
" " -17.0 4" " -1- "
" " -20.0 - 2½ " -1- "
" " -25.0 - 1" " -1- "
" " -29.0 - ½" " 1- "
" " 34.0 - 6" - " 55- "

Note:- In my opinion
pile over driven

Signed
Walter J. Grimsby
Chief Inspector

Pile Test No 2.

WAR DEPARTMENT

U. S. ENGINEER OFFICE, BOSTON, MASS.

Page.....

Subject .....

Computation .....

Computed by..... **Checked by**..... **Date**.....

Elev. Top of pile - +18.95

12" Butt 8" Tip -

Excav. Elev +6.5

Tip Elev - 25.0

Length of pile 38.95'

Ave Dia = 10"

Area of section $\frac{\pi}{4}\left(\frac{12+8}{2}\right)^2 = \frac{314.16}{4} = 78.54$ sq.in.

At 30 Tons Stress = $\frac{30 \times 2000}{78.54} = 764.\#/\square''$

Defl. = $\frac{764}{1,600,000} \times 38.95 \times 12'' = .223$