

Mr. A. M. Toye,
Bridge Engineer.
Materials & Research Division,
(Foundation Section)

January 19, 1962.

D.H.O. FOUNDATION INVESTIGATION
REPORT
W.J. 61-F-113 -- W.P. 85-59-3.

Attention: Mr. S. McCombie.

Re: Proposed Extension of Bridge at Black Creek
and Hwy. No. 401, North York, County of York,
District No. 6.

Attached, we are forwarding to you, our detailed report on the subsoil conditions existing at the above structure site.

We believe the factual data and recommendations contained therein, should prove adequate for your future design work. If clarification, or additional information is required, please do not hesitate to contact our Office.

AGS/MdeF
Attach.

cc: Messrs. A. M. Toye (2)
H. A. Tregaskes
H. D. McMillan
I. C. Campbell
C. Fraser
T. J. Kovich
J. Roy
J. E. Gruspier
E. B. Saint
F. Norman
A. Watt
Foundations Office
Gen. Files.

A. G. Stermac
A. G. Stermac,
PRINCIPAL FOUNDATION ENGINEER

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FOUNDATION INVESTIGATION

For

Proposed Extension of Bridge at Black Creek
and Hwy. No. 401, North York, County of York,
District #6.

W.J. 61-F-113

W.P. 85-59-3

1. INTRODUCTION:

In conjunction with the future widening of Hwy. #401, on the Toronto Bypass, it is proposed to widen the existing bridge at the Black Creek crossing. This bridge is a barrel arch structure of 40' span and is located just East of the Jane St. interchange. It is proposed to construct additional lengths of 50' at each end.

A field investigation was carried out by this Section to determine the subsoil conditions existing at the site. This report contains the results of the field and subsequent laboratory investigations, together with conclusions and recommendations pertaining to the design and performance of the proposed structure.

2. DESCRIPTION OF THE SITE:

The site is contained within the limits of the right-of-way of Hwy. #401. The surrounding area has a generally rolling topography. The highway embankment is about 20' in height and crosses a small stream known as Black Creek, which flows in a southerly direction and joins the Humber River some four miles away.

cont'd. /2 ...

2. DESCRIPTION OF THE SITE: (cont'd.) ...

Physiographically, the site lies in the so-called South Slope Region, being the south slope of an interlobate moraine. This moraine consists of a clay till deposited during the Pleistocene Ice Epoch.

3. FIELD INVESTIGATION PROCEDURE:

A total of three sampled boreholes and four dynamic cone penetration tests were carried out during the field investigation. Undisturbed samples were obtained by means of 2-inch I.D. Shelby Tubes. These were pushed into the soil by hand. Disturbed samples were obtained by means of a standard Split Spoon Sampler driven into the soil with an energy of 350 ft. lbs. per blow. In-situ vane tests were carried out wherever possible, at elevations 12" below the various sample depths. A measure of the relative density of the predominantly granular deposits was obtained by means of the Standard Penetration Tests.

Ground water levels were recorded throughout the duration of the investigation.

The locations and elevations of all boreholes are shown on Drawing #61-F-113A, which accompanies this report.

4. LABORATORY INVESTIGATION:

Samples were visually examined and classified at the site as well as in the laboratory.

cont'd. /3 ...

4. LABORATORY INVESTIGATION: (Cont'd.) ...

Laboratory tests were carried out on various representative samples to determine:-

- (a) Natural Moisture Content
- (b) Atterberg Limits.
- (c) Undrained Shear Strength.
- (d) Grain Size Distribution.
- (e) Consolidation Properties.

Laboratory and field test results are summarized and included under Appendix I of this report.

5. SUBSOIL CONDITIONS:

5.1) General:

The stratigraphy of the subsoil at the site was found to be generally uniform. Detailed descriptions of the various strata encountered, are shown in Appendix I of this report. The estimated stratigraphical profile of Drawing No. 61-F-113A is based on this information.

The subsoil consists of the following strata:-

- (i) Sand, Gravel & Clay (Fill Material).
- (ii) Silty Clay with Sand & Gravel.
- (iii) Clayey Silt with Sand & Gravel.

cont'd. /4 ...

5. SUBSOIL CONDITIONS: (cont'd.) ...

5.2) Sand, Gravel & Clay (Fill Material):

This material immediately underlies the topsoil and extends for depths varying from two to ten feet. It consists generally, of loosely compacted sand with traces of gravel and clay. The average 'N' value obtained for this layer was 8 blows per ft.

5.3) Silty Clay, with traces of Sand & Gravel:

This deposit extends for about fifty feet to approximate elev. 348.0, and consists of silty clay with occasional traces of fine to coarse sand and fine gravel.

In boreholes #1 and #2, located some 25' from the embankment toe, the shear strength as obtained by the field vane tests, varied randomly from 560 p.s.f. to more than 2000 p.s.f. Fair agreement was obtained between field vane and laboratory triaxial tests. In B.H. #3, located at the toe of the embankment, the influence of the fill was reflected in the higher shear strengths measured by the field vane, these being in the order of 2000 p.s.f. down to a depth of 30.0'. A comparison of some physical properties of the material is given below:-

	<u>25' from Embankment</u>	<u>Close to Embankment</u>
Liquid Limit	24 - 41%	23 - 44%
Plastic Limit	17 - 25%	17 - 24%
Undrained Shear Strength	560 - 2000 p.s.f.	2000 p.s.f.
Moisture Content	20 - 37%	20 - 21%
Bulk Density	114 - 130 p.c.f.	124 - 131 p.c.f.

cont'd. /5 ...

5. SUBSOIL CONDITIONS: (cont'd.) ...

5.4) Clayey Silt with Sand & Gravel:

This material was observed in B.H. #1 at a depth of 60'. It extended to the full depth of the borehole which was 81'. The deposit consists of a mixture of clayey silt, fine to coarse sand, and fine gravel. Occasional seams of sandy silt 1/2" to 3" in thickness, were observed during sampling operations. The relative density of the material may be classified as compact to very dense with 'N' values ranging from 13 to 52 blows per foot.

6. GROUND WATER CONDITIONS:

Ground water observations carried out during the investigation, indicate that the ground water table is at approx. elev. 400. The exact water levels observed at the of investigation, are shown on boreholes logs (Appendix I).

7. DISCUSSION & RECOMMENDATIONS:

It is proposed to widen the existing bridge over Black Creek by an amount of 50' at each side. Subsoil consists of about 10' of sandy fill, followed by about 40' of stiff to very stiff silty clay. The existing footings are founded in the silty clay deposit at elev. 394.0. According to the information obtained from the Bridge Division, a design load of 5500 p.s.f. was used in this case. Our investigation has shown that the shear strength of the subsoil at elev. 394.0 is about 1000 p.s.f. at the location of the proposed extensions, and about 2000 p.s.f. at the existing bridge. Consolidation during the past 10 years,

cont'd. /6 ...

7. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

has no doubt increased the shear strength at the latter location, but it is not possible to say with certainty that the increase would be as much as 1000 p.s.f. We estimate that the factor of safety against a bearing capacity type failure at the existing bridge, is about 2.0. For the new extensions, the safe bearing capacity at elev. 394.0 is 2000 p.s.f. using a factor of safety of 3.0. In view of the fact that conditions will improve with time, however, we would be prepared to use a factor of safety of 2.0 for the end of construction case, and therefore recommend a design load of 3000 p.s.f. for footings founded at or below elev. 394.0.

It is probable that some settlements will occur due to consolidation, but a close examination of the existing structure which has been built for some ten years, indicates that they are likely to be of a small order. However, in view of the fact that some differential settlements must be anticipated, it is proposed that the extensions be constructed so as to be independent of the existing structure. The situation is somewhat complicated due to the fact that the sides of the existing arch are sloping to conform with the embankment. These should therefore, be reconstructed so as to have vertical ends. The new units may then be built with vertical ends butting against the existing arch. Dewatering should present no major problems as the subsoil is relatively impermeable.

No stability problems are anticipated with regard to the proposed approach embankments.

cont'd. /7 ...

8. SUMMARY:

At the site of the proposed bridge extensions, subsoil consists of about 10' of sandy fill material followed by about 40' of silty clay with occasional traces of fine to coarse sand and fine gravel. The consistency of this deposit may be described as medium stiff to very stiff. Spread footings with an allowable loading of 1.5 t.s.f. may be placed at or below elev. 394.0. The extensions should be constructed as independent units. The sloping sides of the existing bridge should be reconstructed to the vertical so that all three sections may butt against each other in a vertical plane.

No dewatering problems are anticipated.

No stability problems with regard to the approach fills are anticipated.

9. MISCELLANEOUS:

The field work was carried out from November 14 to November 20, 1961, by F. E. Johnston Drilling Co., Ltd. The work was supervised by I. Holubec for the Ontario Department of Highways.

January 1962.

REPORT PREPARED BY:

I. Holubec
.....
I. Holubec,
PROJECT FOUNDATION ENGINEER

REPORT APPROVED BY:

K. G. Selby
.....
K. G. Selby,
SR. PROJECT FOUNDATION ENGINEER.

APPENDIX I.

SUMMARY OF FIELD & LABORATORY TESTS

JOB 61-F-113

W.P. 85-57-3

HOLE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENETIN RESIST BLOWS/FT	MOIST CONT %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH p.s.f.	UNIT WEIGHT p.c.f.	REMARKS
1	1	5.0-6.5	Sand, fine to medium, with traces of gravel, medium dense, oxidized brown Fill.	11	-	-	-	-	-	
	2	10-10.5	As above.							
		10.5-11.5	Silty Clay with some fine to coarse sand and traces of fine gravel, medium dense, grey.	12	-	-	-	-	-	
	3	15-16.5	Silty Clay of low to intermediate plasticity with traces of rounded gravel ($\frac{3}{4}$ " max. diam.), stiff, grey.	9	-	-	-	-	-	
	4	16.5-18.0	- " -	Pushed	31.2	24.6	40.7	720	121.2	
		18-19.5	Large Field Vane	-	-	-	-	920	-	Sens: 2.4
	5	20-21.5	Silty Clay of low to intermediate plasticity with traces of fine to coarse sand, firm, grey.	Pushed	37.3	-	-	-	-	
		21.5-23.0	Large Field Vane.	-	-	-	-	1,120	-	Sens: 2.5
	6	25-26.5	Same as above.	Pushed	35.5	20.8	41.7	740	114.1	
		26.5-28.0	Large Field Vane.	-	-	-	-	840	-	Sens: 2.5
	7	30-31.5	Same as above.	Pushed	20.8	17.8	29.0	530	124.8	
		31.5-33.0	Large Field Vane.	-	-	-	-	920	-	Sens: 2.2
	8	35-36.5	Same as above.	-	-	-	-	-	-	
		36.5-38.0		-	-	-	-	920	-	Sens: 1.9

SUMMARY OF FIELD & LABORATORY TESTS

JOB 61-F-113

W.P. 85-59-3

HOLE NO	SAMP NO	SAMPLE DEPTH FEET	MATERIAL DESCRIPTION	PENET'N RESIST. BLOWS/FT	MOIST. CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH p.s.f.	UNIT WEIGHT p.c.f.	REMARKS
1	9	40-41.0	Large Field Vane.	Pushed.	-	-	-	-	-	
		41.0-41.1	Silty clay with fine and coarse sand and traces of fine gravel stiff, grey.	-	-	-	-	-	-	
		41-42.5	Large Field Vane.	-	-	-	-	1920	-	Sens: 6.0
10	45-46.5	Same as above.		Pushed.						
				A	13.9	18.7	30.5	-	-	
				L	25.8	19.2	24.3	-	-	
		46.5-48.0	Large Field Vane.	-	-	-	-	760	-	Sens: 2.7
11	55-56.5	Same as above.		Pushed.	-	-	-	-	-	
	56.5-57.5	Large Field Vane.		-	-	-	-	2,000 plus	-	Impossible to turn vane.
12	60-60.5	Large Field Vane.		Pushed	-	-	-	-	-	
	60.5-61.5	Clayey silt with fine sand.		-	-	-	-	-	-	
13	62-63.5	Clayey silt with fine sand and with a 6" seam of silty clay with fine gravel and sand, dense, grey.		40	17.3	-	-	-	-	
14	65-66.5	Silty clay with fine to coarse sand and fine gravel and two 3" seams of clayey silt with fine sand, stiff, grey.		13	-	-	-	-	-	
15	75-76.5	Silty clay with fine to coarse sand and traces of fine gravel with occasional seams (1-1") of clayey silt with fine sand. Stiff, grey.		13	-	-	-	-	-	

SUMMARY OF FIELD & LABORATORY TESTS

JOB 61-F-113

W.P. 85-59-3

HOLE NO.	SAMP NO.	SAMPLE DEPTH FEET:	MATERIAL DESCRIPTION	PENEY-N RESIST BLOWS/FT.	MOIST CONT %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH p.s.f.	UNIT WEIGHT p.c.f.	REMARKS
1	16	80-81.5	Fine gravel, well graded, very dense, grey.	52	7.8	-	-	-	-	
2	1	3.0-3.5	Sand, fine to coarse, oxidized, loose, brown.	-	-	-	-	-	-	
		3.5-4.5	Silty Clay with some coarse sand, firm, grey.	6	-	-	-	-	-	
	2	6.0-7.5	Silty Clay of low to intermediate plasticity with traces of coarse to medium sand, firm grey.	Pushed	-	-	-	-	-	
		7.5-9.0	Large Field Vane.	-	-	-	-	1080	-	Sens: 2.2
	3	10-11.5	Same as above.	Pushed	34.3	19.7	32.9	785	117.6	
		11.5-13.0	Large Field Vane.	-	-	-	-	920	-	Sens: 2.9
	4	15.0-16.5	Same as above with traces of fine gravel ($\frac{1}{2}$ " max.).	Pushed	-	-	-	-	-	
		16.5-18.0	Large Field Vane.	-	-	-	-	760	-	Sens: 2.4
	5	20-21.5	Same as above.	Pushed	-	-	-	-	-	
		21.5-23.0	Large Field Vane.	-	-	-	-	560	-	Sens: 1.8
6		25-26.5	Silty Clay of low plasticity with some fine sand, firm grey.	Pushed	27.3	17.2	26.4	720	130.2	
		26.5-28.0	Large Field Vane.	-	-	-	-	880	-	Sens: 3.1

SUMMARY OF FIELD & LABORATORY TESTS

JOB 61-F-113

W.P. 85-59-3

BOREHOLE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENETRATION RESIST. BLOWS/FT	MOIST. CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH p.s.f.	UNIT WEIGHT p.c.f.	REMARKS
2	7	30-31.5	Silty clay of low plasticity with traces of fine to coarse sand, firm, grey.	Pushed	25.0	-	-	650	125.5	
		31.5-33.0	Large Field Vane.	-	-	-	-	960	-	Sens: 1.7
	8	35-36.5	Same as above.	Pushed	-	-	-	-	-	
		36.5-38.0	Large Field Vane.	-	-	-	-	640	-	Sens: 3.2
	9	40-41.5	Same as above.	Pushed	31.4	20.8	33.8	-	-	
		41.5-43.0	Large Field Vane.	-	-	-	-	1080	-	Sens: 2.3
	10	50-51.0	Same as above, but with traces of fine gravel.	Pushed	-	-	-	-	-	
3	11	60-61.5	Silty clay of low plasticity with traces of fine to coarse sand, stiff, grey.	Pushed	-	-	-	-	-	
	1	10-11.5	Silty clay of low plasticity with traces of fine to coarse sand and fine gravel, hard, grey.	Push 6" Hammer 12"	-	-	-	-	-	
	2	15-16.5	Silty clay of low plasticity with traces of fine to coarse sand, very stiff, grey.	29	20.8	24.0	43.5	-	124.0	
	3	20-21.5	Silty clay of low plasticity, firm, grey.	11	-	-	-	-	-	
		21.5-23.0	Large Field Vane.	-	-	-	-	1840	-	Sens: 1.6

SUMMARY OF FIELD & LABORATORY TESTS

JOB 61-F-113

W.P. 85-59-3

SAMP. NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENET'N RESIST. BLOWS/FT.	MOIST. CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH p.s.f.	UNIT WEIGHT p.c.f.	REMARKS
4	25-26.5	Silty clay of low plasticity with traces of fine to coarse sand, firm grey.	Pushed	20.5	16.6	26.4	940	131.4	Sens: 2.3
	26.5-28.0	Large Field Vane.	-	-	-	-	2000	-	
5	30-31.5	As above.	Pushed	20.9	18.4	23.3	4320 2000 plus	131.6	
	31.5-33.0	Large Field Vane.	-	-	-	-	-	-	
6	40-41.5	As above.	Pushed	-	-	-	-	-	
		Cone penetration only.							

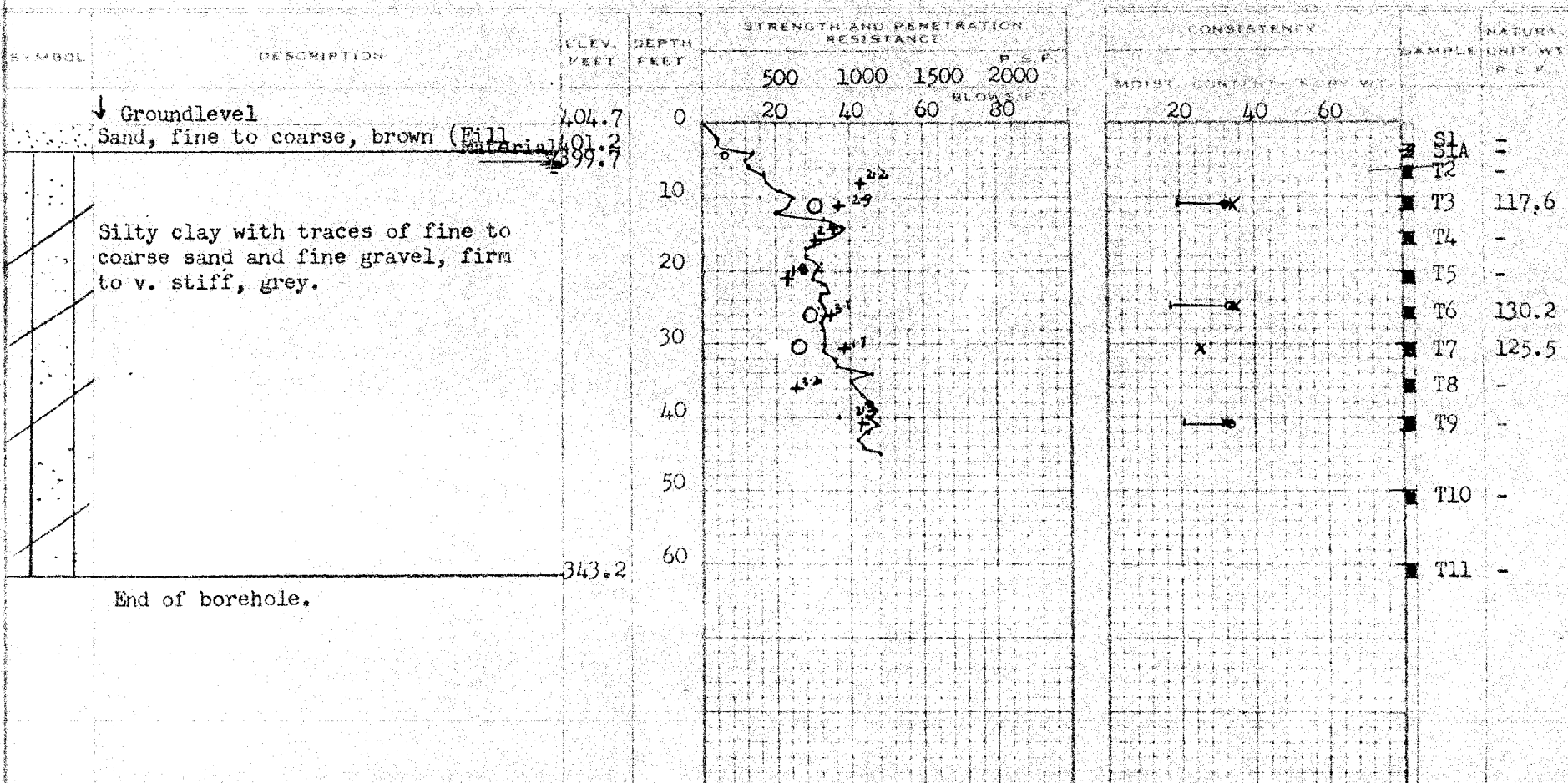
DEPARTMENT OF HIGHWAYS - ONTARIO MATERIALS AND RESEARCH SECTION

W.P. 85-59-3 BORE HOLE NO. 2
 JOB 61-F-113 STATION 85+46 (120' Rt.)
 DATUM 404.7 COMPILED BY I.H.
 BORING DATE Nov. 16/61 CHECKED BY K.S.

2" DIA. SPLIT TUBE
 2" SHELBY TUBE
 2" SPLIT TUBE
 2" DIA. CONE
 2" SHELBY
 CASING

LEGEND

1/2 UNCONFINED COMPRESSION (Q_u)
 VANE TEST (C) AND SENSITIVITY (S)
 NATURAL MOISTURE AND
 LIQUIDITY INDEX
 LIQUID LIMIT
 PLASTIC LIMIT



DEPARTMENT OF HIGHWAYS - ONTARIO MATERIALS AND RESEARCH SECTION

W.P. 85-59-3

BORE HOLE NO. 3

JOB 61-F-113

STATION 85/44 (102' It.)

DATUM 406.0

COMPILED BY I.H.

BORING DATE Nov. 20/61.

CHECKED BY K.S.

2" DIA. SPLIT TUBE

2" SHELBY TUBE

2" SPLIT TUBE

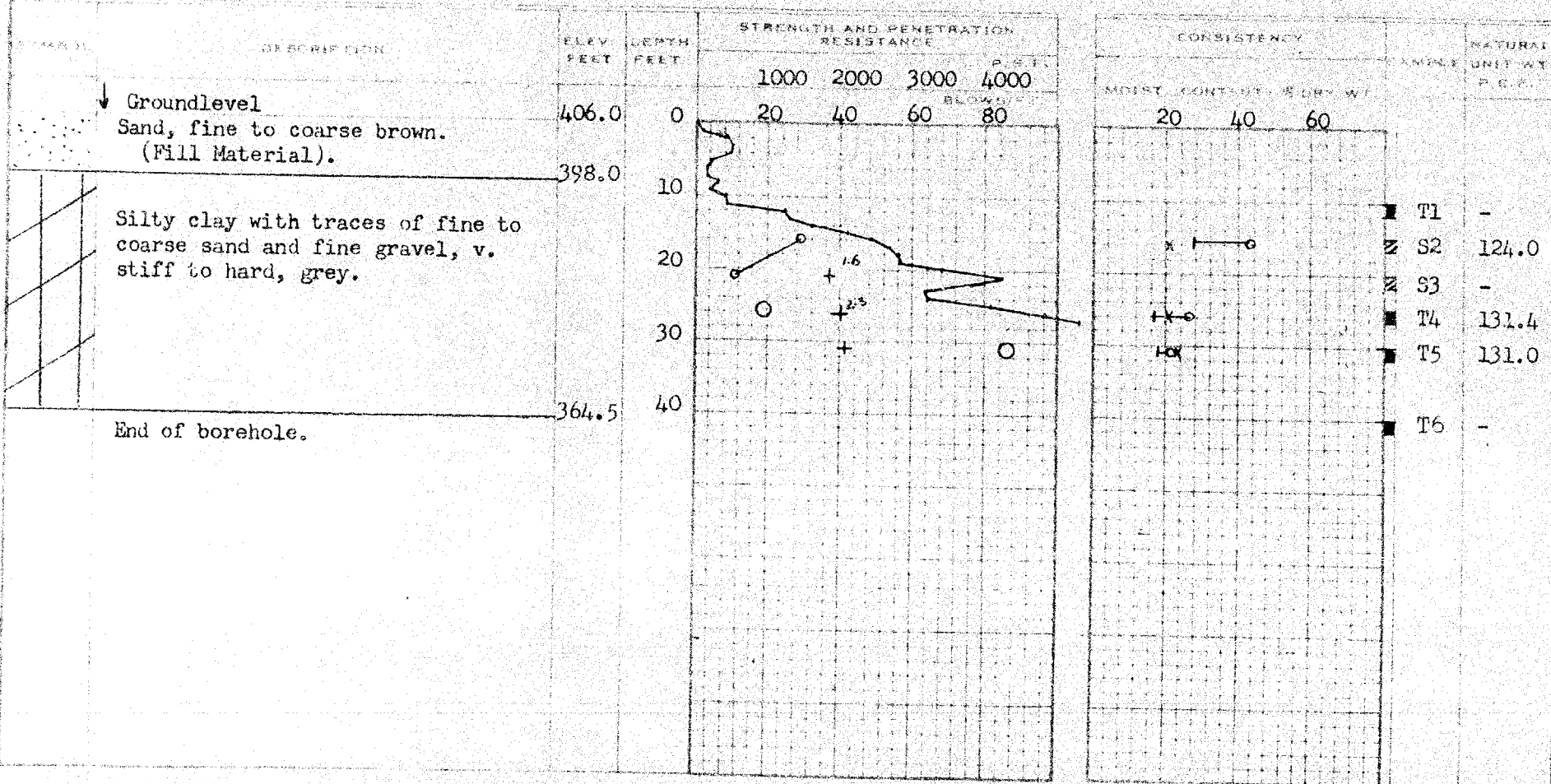
2" DIA. CONE

2" SHELBY

CASING

LEGEND

1/2 UNCONFINED COMPRESSION (QU) O
 VANE TEST (C) AND SENSITIVITY (S) +
 NATURAL MOISTURE AND LIQUIDITY INDEX X
 LIQUID LIMIT —
 PLASTIC LIMIT —



OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS AND RESEARCH SECTION

W.P. 85-59-3 BORE HOLE NO. 4

JOB 61-F-113 STATION 85+44 (120' Lt.)

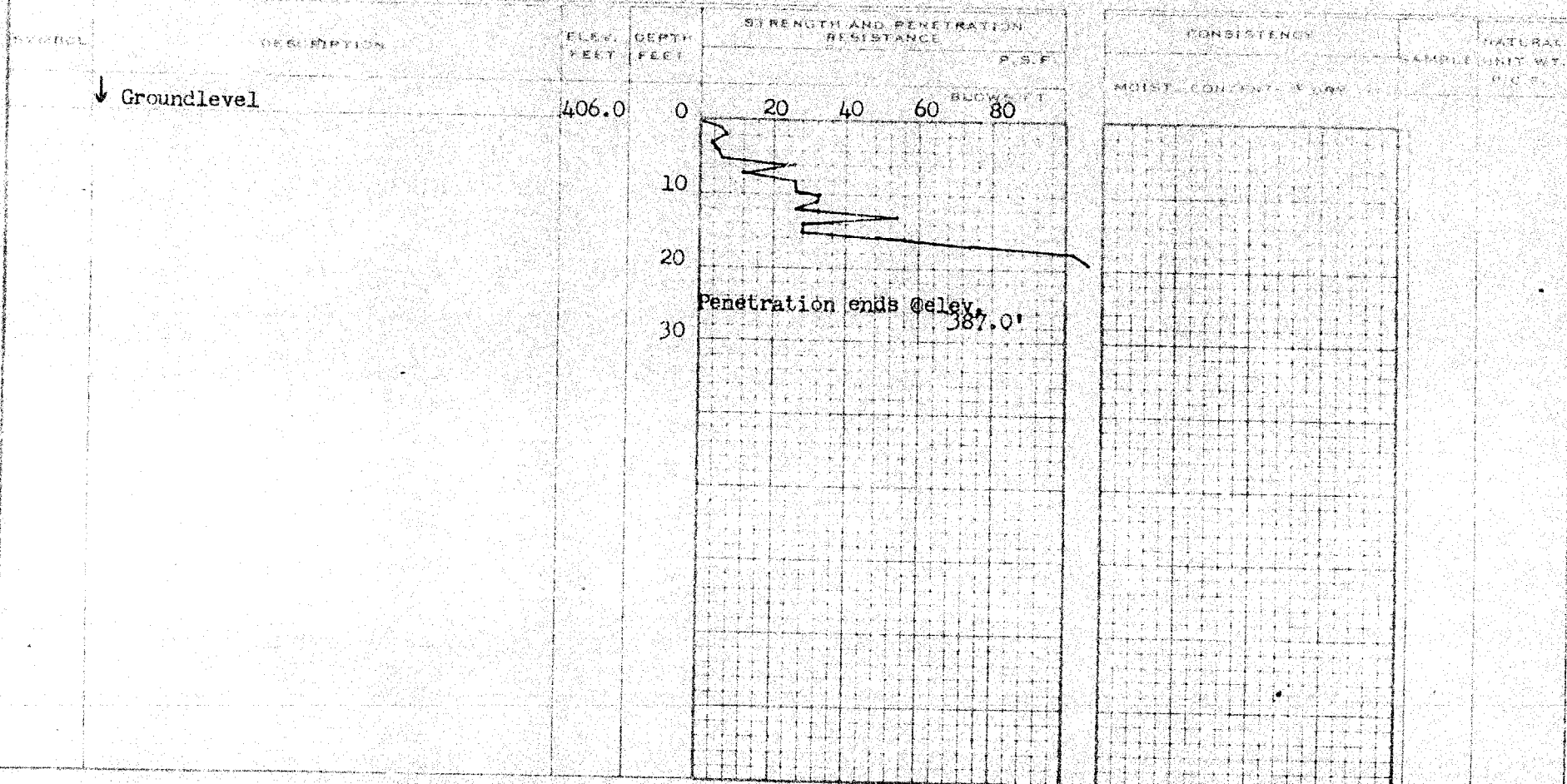
DATUM 406.0 COMPILED BY I.H.

BORING DATE Nov. 20/61. CHECKED BY K.S.

2" DIA SPLIT TUBE
2" SHELBY TUBE
2" SPLIT TUBE
2" DIA CONE
2" SHELBY
CASING

LEGEND

1/2 UNCONFINED COMPRESSION (QU) 0
VANE TEST (C) AND SENSITIVITY (S) +5
NATURAL MOISTURE AND
LIQUIDITY INDEX 11
LIQUID LIMIT 0
PLASTIC LIMIT 0



DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 5

FOUNDATION SECTION

JOB 61-F-113LOCATION Sta. 86+14 (139' Rt. & Hwy. 401)ORIGINATED BY H.S.W P 85-59-3BORING DATE March 13, 1963.COMPILED BY H.S.DATUM GeodeticBOREHOLE TYPE Washboring using NX casing.CHECKED BY B.K.

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W			BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.					WATER CONTENT %				
							+ Unconfined Shear Strength					WP	W	WL		
						400	800	1200	1600	2000						
408.0	Groundlevel															
0.0	Fine sand Loose brown.		1	SS	6											
						400										
398.0																
397.0	Sand and gravel.		2	SS	12											
11.0			3	SS	18											
			4	SS	12	390										
	Grey silty clay - Firm to stiff.		5	SS	7				1.4							
			6	SS	12	380			2.9							
			7	SS	12											
			8	SS	12	370										
370.0										5.7						
38.0	Clayey silt to silt- stiff.		9	SS	11				3.6							
366.0			10	SS	28	360				1.9						
42.0	Grey silty clay Stiff		11	SS	21											
360.0						350				4.2						
48.0	Grey silt Very stiff.															
350.5						340										
37.5	End of borehole.															

W.L. in
borehole
= 397.7
10.3

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 7

FOUNDATION SECTION

JOB 61-F-113 LOCATION Stn. 84+70 (112' to left of E Hwy. 401) ORIGINATED BY B.M.G.
W.P. 85-59-3 BORING DATE March 29, 1963. COMPILED BY B.M.G.
DATUM Geodetic BOREHOLE TYPE Washboring using NX casing. CHECKED BY B.K.

SOIL PROFILE		SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	LIQUID LIMIT ——— WL PLASTIC LIMIT ——— WP WATER CONTENT ——— W *P ——— W ——— L WATER CONTENT % 20 40 60	BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE					
					SHEAR STRENGTH P.S.F. ⊗ Field Vane Test ○ Remoulded Strength + Unconf. Shear Strength 400 800 1200 1600 2000			
411.7	Groundlevel							
0.6	Clayey silt with traces of sand and gravel. (Fill Material) Stiff brown	1	SS	8	410			
399.7		2	SS	16	400			
12.0		3	SS	14				
	Clayey silt with traces of sand. Stiff to firm Grey.	4	TW	P	390	+		121
		5	TW	P		○ ⊗		
		6	TW	P	380	+		124
378.7						○ ⊗		Sens=4.3
33.0	End of borshole.							Sens=2.5
								Sens=4.0

Re: Extension of Bridge at Black Creek

Mr. B. R. Davis,
Bridge Design Engr.,
Bridge Division.

Attn: Mr. W. McFarlane

Mr. A. G. Stermac,
Principal Foundation Engr.,
Foundation Section,
Materials & Research Division.

May 23, 1963

Proposed Extension of Bridge at Black Creek
and Hwy. #401 - W.P. 38-63 -- W.J. 61-F-113
District #6

In conjunction with the pile loading test recently carried out at the above site, we have carried out some additional soil borings. These borings confirm our assessment of the subsoil conditions as described in Foundation Report - #61-F-113. The log sheets for the extra borings #5, #6, and Drawing #61-F-113B, are enclosed for your information and should be attached to your copy of the above-mentioned Foundation Report.

For complete details and results of the pile loading test, you are referred to Foundation Report #61-F-113B.

K. G. Selby

KGS/MdeF
Attach.

K. G. Selby
SENIOR FOUNDATION ENGR.
For:
A. G. Stermac,
PRINCIPAL FOUNDATION ENGR.

cc: Messrs. A. M. Toye (2)
H. A. Tregaskes
H. D. McMullan
G. K. Hunter (2)
C. Fraser
T. J. Kovich
A. Watt

Foundations Office
Gen. Files

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Mr. A. M. Toye,
Bridge Engineer,
Bridge Division.

Attention: Mr. B. R. Davis

Mr. A. G. Stermac,
Principal Foundation Engr.,
Foundation Section,
Materials & Research Division.

May 28, 1963

D.H.O. REPORT ON PILE LOADING TESTS AT -
Hwy. #401 and Black Creek, District #6.
W.J. 61-F-113B -- W.P. 85-59-3 WP. 38-63

Attached, we are forwarding to you, our report on the results of pile loading tests carried out at the site of the proposed new bridge over Black Creek and Hwy. 401, Toronto By-Pass, Toronto.

We feel that the information contained in the report will be sufficient for your design purposes. If you have any further queries in connection with this matter, please do not hesitate to call our Office.

AGS/MdeF
Attach.

cc: Messrs. A. M. Toye (2)
H. A. Tregaskes
H. D. McMillan
G. K. Hunter (2)
C. Fraser
T. J. Kovich
A. Watt
Foundations Office ✓
Gen. Files

A. G. Stermac
A. G. Stermac,
PRINCIPAL FOUNDATION ENGINEER

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-

REPORT ON PILE LOADING TESTS AT

Hwy. #401 & Black Creek
W.P.85-59-3 -- W.J.61-F-113B
NEW - WP. 38-63

1. INTRODUCTION:

The Foundation Section was requested by Mr. W. MacFarlane, Senior Bridge Project Engineer, to initiate and subsequently supervise a pile loading test at the site of the proposed extension to the Barrel Arch Bridge over Black Creek on Hwy. #401 just east of Jane St. This request was made verbally on March 1st, 1963.

Following the above request, arrangements were made to test a 45' long Class 'A' Timber Pile at the site. This work was carried out by Franki Pile of Canada Ltd. under W.O. #36332.

The report which follows contains the detailed results of the pile driving records and the pile loading tests together with our recommendations pertaining to the design load to be used for this type of pile.

2. DESCRIPTION OF SITE:

The site is contained within the limits of the right-of-way of Hwy. #401. The surrounding area has a generally rolling topography. The highway embankment is about 20' in height and crosses a small stream known as Black Creek which flows in a southerly direction and joins the Humber River

2. DESCRIPTION OF SITE: (cont'd.)...

some four miles away.

Physiographically, the site lies in the so-called South Slope Region, being the south slope of an interlobate moraine. This moraine consists of a clay till deposited during the Pleistocene Ice Epoch.

3. SUBSOIL CONDITIONS:

Subsoil at the site consists generally of a layer of loose to compact sand about 10' in thickness followed by layers of silty clay, clayey silt and silt, of variable thickness and consistency. For a full description of the subsoil conditions over the entire site the reader is referred to Foundation Report #61-F-113. At the location of the pile test a borehole (B.H.#5) was carried out prior to driving the pile, and the log sheet of this boring, together with Drawing #61-F-113B showing the soil stratigraphy, borehole locations and test pile location are included in the appendix of this report. In-situ vane tests carried out in the cohesive strata in the boring adjacent to the test pile gave undrained shear strength values ranging from 800 p.s.f. to more than 2000 p.s.f.

4. PILE DRIVING:

The pile consisted of a 45' long Class 'A' timber pile, and was driven using Franki Displacement Caisson driving equipment adapted for the purpose. The pile was advanced by

4. PILE DRIVING: (cont'd.)...

means of a 3000 lb. hammer falling 8' through a steel follower attached to the pile butt. Since the proposed footing elevation was some 14' below existing groundlevel the pile was driven through a prebored hole about 14' deep until the butt reached the approximate future cut off elevation. The follower was left in place after being cut off 2' below groundlevel then filled and capped with concrete. Driving took place on March 28th 1963, total time of driving being about 103 minutes. This is regarded as being excessive and entirely due to the fact that the pile driving equipment was not particularly suitable for this purpose. Using proper equipment designed for the job, it is estimated that this particular pile could have been driven in about 20 to 30 minutes. All records pertaining to the driving of this pile are included in the Appendix of this report.

5. PILE TESTING:

In general the load test was carried out in accordance with the National Building Code of Canada. The loads were applied by means of a jack acting between the pile and a reaction beam attached to a box structure containing about 150 tons of sand. Two tests were carried out the first being a slow test carried out to a load of 50 tons over a period of about 30 hours and the second being a quick test carried out to failure of the pile in a period of about 4 hours.

5. PILE TESTING: (cont'd.)...

The exact sequence of events for each test is shown on the Load Test Records given in the Appendix of this report and is summarized as follows:-

The first test commenced at 11:45 A.M. April 10th '63. The pile was loaded in increments of $6\frac{1}{4}$ tons to 50 tons in about 4 hours and this load was maintained for a period of 25 hours. The load was then removed in increments over a period of 30 minutes. Gross and net settlements for the pile were 0.2195" and 0.132" respectively.

The second test commenced at 3:50 P.M. April 11th '63. The pile was loaded rapidly to 50 tons and from then on in increments of 5 tons until the point was reached at which no further load could be applied due to failure of the pile. This occurred after 195 minutes the maximum load achieved being 145 tons. The load was then removed in increments in 30 minutes.

For each test the following curves have been plotted.

- (1) Load versus Time.
- (2) Settlement versus Time.
- (3) Settlement versus Load.

These curves are included in the Appendix of this report.

6. DISCUSSION OF TEST RESULTS:-

The loading tests described in the previous paragraphs were carried out for the purpose of determining an appropriate

6. DISCUSSION OF TEST RESULTS: (cont'd.)...

design load for a 45' long Class 'A' Timber Pile. When load tests have been carried out it is usual to utilize a safety factor of 2.0 for design purposes. The slow test carried out to 50 tons indicated that a safe design load of at least 25 tons per pile may be used according to the provisions of the National Building Code of Canada. The test to failure however, indicated that still higher loadings could be used. An examination of the Load/Settlement curve for the test to failure indicated that the process of failure of the pile probably started in the region of 75 tons. A design load of 35 tons per pile for the future structure foundations is therefore recommended, taking also the variation of subsoil conditions at the site into account.

The theoretical ultimate capacity of the pile has been calculated on the basis of full mobilization of shear strength of the cohesive stratum. This latter has been taken as 1500 p.s.f. and is an average of in-situ vane tests carried out with the stratum. The results of the calculations are as follows:

$$Q = 9A_b C + A_s C_a \text{ where}$$

$$Q = \text{Ultimate capacity of pile}$$

$$A_b = \text{Area of base of pile} = 0.544 \text{ sq. ft.}$$

$$C = \text{Cohesion of soil at base of pile} = 2000 \text{ p.s.f.}$$

$$A_s = \text{Effective area of pile shaft} = 143 \text{ sq. ft.}$$

$$C_a = \text{Adhesion of soil} = 1500 \text{ p.s.f.}$$

$$\begin{aligned} \text{Hence } Q &= \frac{9 \times 0.544 \times 2000}{2000} + \frac{143 \times 1500}{2000} \text{ tons} \\ &= 4.9 + 107 = 112 \text{ tons} \end{aligned}$$

7. CONCLUSIONS:

The results of a pile loading test carried out on a 45' long Class 'A' Timber Pile are reported.

The test was carried out at the site of the proposed extensions to the Barrel Arch Bridge over Black Creek on Hwy. #401 just east of Jane St.

Subsoil at the site consists of about 10' of sand followed by an extensive deposit consisting of layers of silty clay, clayey silt and silt.

The test results are compared with the theoretical ultimate capacity of the pile assuming full mobilization of the shear strength of the cohesive soil. The comparison is reasonably favourable.

As a result of the test a design load of 35 tons for 45' long Class 'A' Timber Pile is recommended. A safety factor of 2.0 has been assumed.

8. MISCELLANEOUS:

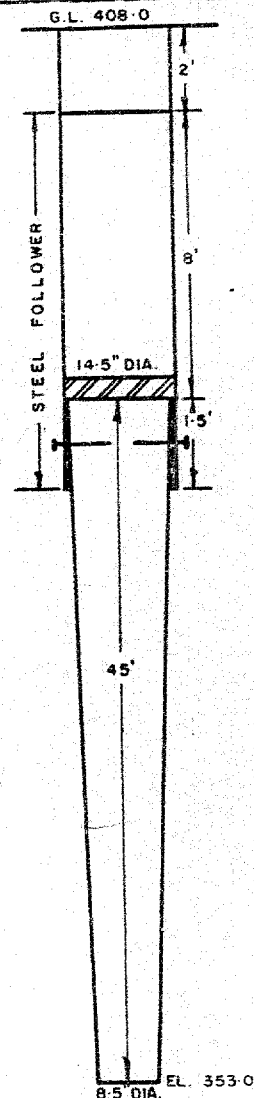
The pile driving and subsequent load tests were carried out during the period March 28th to April 11th '63, by Franki Pile of Canada Ltd., under the supervision of the Department of Highways Foundation Section. This report was prepared by Mr. K. G. Selby.

May 1963.

BRIDGE CONSTRUCTION - PILE DRIVING RECORD

DISTRICT NO. 6 CONTRACT NO. W.P. 85-59-3 STRUCTURE HWY. No 401 & BLACK CREEK
CONTRACTOR FRANKI PILE CO. DESIGN LOAD OF PILE TO BE DETERMINED
HAMMER DETAILS: TYPE DROP HAMMER WEIGHT 3,000 HEIGHT OF FALL OR ENERGY 8'
TYPE OF ANVIL OR CAP STEEL FOLLOWER WEIGHT OF ANVIL OR CAP 30 lb/ft. x 12' = 360 lb/ft.
PILE DETAILS CLASS 'A' TIMBER PILE
PILE NO. 3 LOCATION STA. 86+16 144 RT. & HWY. No 401 DATE DRIVEN 28 MAR. 63

TOTAL LENGTH BEING DRIVEN	LENGTH IN GROUND	PENETRATION BLOWS / FT.	TOTAL LENGTH BEING DRIVEN	LENGTH IN GROUND	PENETRATION BLOWS / FT.	TOTAL LENGTH BEING DRIVEN	LENGTH IN GROUND	PENETRATION BLOWS / FT.
92.402	1			26	10	#L.	51	21
	2			27	10		52	22
	3			28			53	22
	4			29			54	23
	5			30		353	55	24
	6			31			56	4:48 PM.
	7			32	43		57	
	8			33			58	
	9			34			59	
	10			35			60	
	11			36			61	
	12			37	36		62	
	13			38			63	
	14			39			64	
3:05 PM.	15			40			65	
	16	9		41			66	
	17	6		42	42		67	
	18	6		43			68	
	19	5		44			69	
	20	5		45			70	
	21	7		46			71	
	22	8		47			72	
	23	7		48	50		73	
	24	10		49	12		74	
	25	8		50	22		75	



DETAILS FOR FINAL SIX INCHES OF PENETRATION	1	2	3	4	5	6
BLOWS PER INCH						
MEASURED REBOUND IN INCHES	NOT RECORDED					
FINAL LENGTH OF PILE <u>45' (+ FOLLOWER = 53')</u>	FINAL CUT OFF ELEVATION <u>TOP OF FOLLOWER - 406.0</u> <u>TOP OF PILE - 398.0</u>					

REPORT TO BE SENT TO: - PRINCIPAL FOUNDATION ENGINEER
MATERIALS & RESEARCH DIVISION
DEPARTMENT OF HIGHWAYS
PARLIAMENT BUILDINGS
TORONTO, ONTARIO

SIGNED H. Szymanski
NAME (PRINT) H. SZYMANSKI
DATE 28 MARCH 1963

ATTACH SKETCH OF PILE NUMBERING SYSTEM

PILE LOAD TEST AT BLACK CREEK

W.P. 38-63

WORK TO BE DONE:

1. Supply and fix reaction beams to anchorage piles as shown in the accompanying sketches to satisfaction of the Engineer. Work to include trimming of all piles necessary.
2. Install reference beams as directed by the Engineer. These to consist of 2 - 2"x6" timbers supported at least 5' from nearest test or anchorage pile or as directed by the Engineer.
3. Supply and install bearing plate for test pile or as directed by the Engineer.
4. Supply and install supports for 4 Dial Guages as directed by the Engineer.
5. Provide one competent workman to assist Department personnel during performance of Load Test.
6. The following materials will be supplied by the Department.
 - a. 1 100 ton jack
 - b. 4 Dial Guages
7. Location of test and anchor piles to be decided by the Department.
8. Contractor should be aware that driving of piles on the site will not be permitted during the actual load test. It is intended to carry out the test after cessation of normal days work and this test should be completed before beginning of next normal working day.

JOE 61-F-113

LOCATION Sta. 8644 (139' R.L. E. Hwy. 401)

ORIGINATED BY H.S.

W P 85-59-3

BORING DATE March 13, 1963.

COMPILED BY: H.S.

DATUM Geodetic

BOREHOLE TYPE Washboring using NX casing.

CHECKED BY: B.K.

SOIL PROFILE		SAMPLES			DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — WL PLASTIC LIMIT — WP		BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	BLows / FOOT	WATER CONTENT — W			
						SHEAR STRENGTH P.S.F. + Unconfined Shear Strength		WATER CONTENT %		
						400 800 1200 1600 2000		20 40 60		
408.0	Groundlevel									
0.0	Fine sand Loose brown.		1	SS	6					
398.0						400				
397.5	Sand and gravel.		2	SS	12					
11.0										
	Grey silty clay - Firm to stiff.		3	SS	18					
			4	SS	12					
			5	SS	7					
			6	SS	12					
			7	SS	12					
370.0						370				
38.0	Clayey silt to silt- stiff.		8	SS	12					
366.0										
42.0	Grey silty clay Stiff		9	SS	11					
360.0										
48.0	Grey silt Very stiff.		10	SS	28					
			11	SS	21					
350.5						350				
37.5	End of borehole.									
347.5										
						340				

RESULTS OF LOAD TEST ON TIMBER PILE

GROSS SETTLEMENT = 21.95

REBOUND = 0.875

NET SETTLEMENT = 13.20

HIGHWAY NO. 401 @ BLACK CREEK

TEST ON TIMBER PILE TO 50 TONS

W.P. 85-59-3 JOB 6-F-113 W.O. 36332

DRIVEN: MARCH 28, 1963 TESTED: APRIL 10, 1963

PILE TYPE: TIMBER PILE - TOP DIA 14.5" BOT DIA 8.5"

LENGTH AFTER CUT OFF = 45.0' (+ FOLLOWER = 53.0')

FINAL CUT OFF EL = TOP OF FOLLOWER = 4061.0

TOP OF PILE = 3981.0 TIP EL = 3531.0

100

75

50

25

0

LOAD IN TONS

LOAD - MOVEMENT

LOAD IN TONS

MOVEMENT IN INCHES

0

2

4

6

8

10

12

14

16

LOAD - TIME

TIME IN HOURS

TIME - MOVEMENT

3:49 P.M. APRIL 11, 1963

RESULTS OF LOAD TEST ON TIMBER PILE

TEST TO FAILURE AFTER 24 HOUR TEST AT 50 TONS.
 HWY. NO. 401 & BLACK CREEK
 WP 85-59-3 JOB 61-F-113 WO 36-332
 DRIVEN MAR 28, 1963 TESTED APR 11, 1963
 PILE TYPE: TIMBER PILE - TOP DIA. 14.5" BOTT. DIA. 8.3"
 LENGTH AFTER CUT OFF 45' (+ FOLLOWER = 53.5')
 FINAL CUT OFF EL. = TOP OF FOLLOWER = 406.0'
 TOP OF PILE = 398.0'

TIP ELEVATION = 353.0'

LOAD IN TONS

LOAD - MOVEMENT

MAX INSTANTANEOUS LOAD

WHICH COULD BE APPLIED WAS 145 TONS

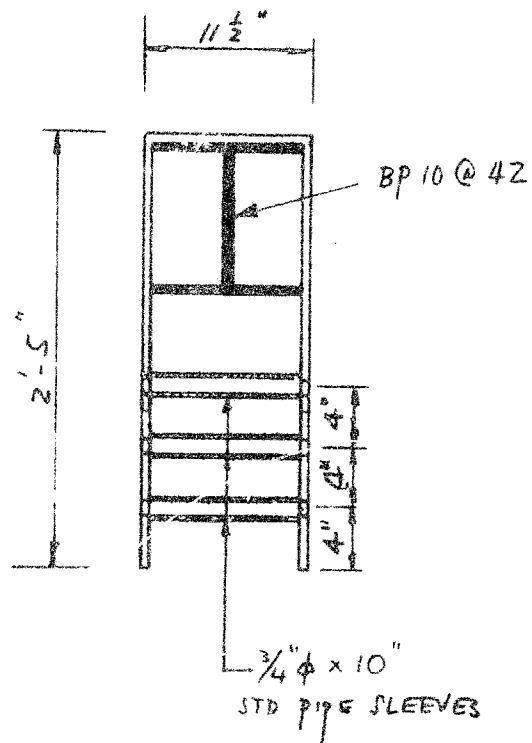
LOAD IN TONS

LOAD - TIME

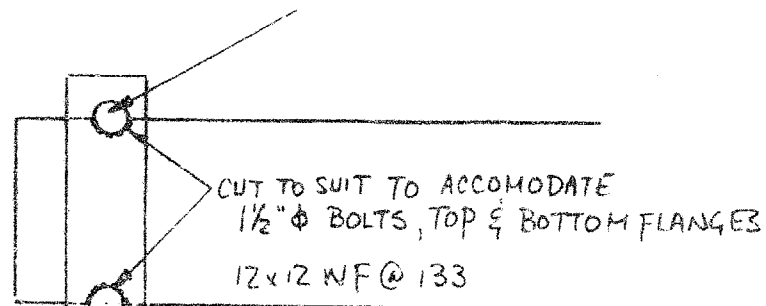
MOVEMENT IN INCHES

TIME - MOVEMENT

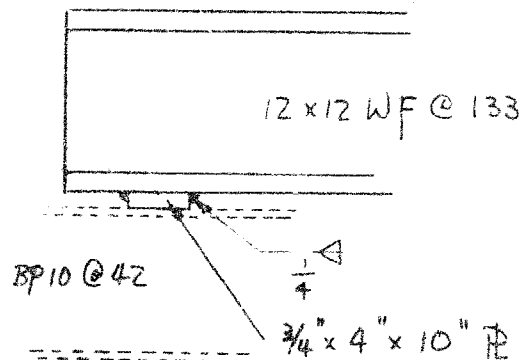
TIME IN MINUTES



2 1/16" ϕ HOLE (FOR USE ON TOP FLANGE)
 1 9/16" ϕ HOLE (FOR USE ON BOTTOM FLANGE)

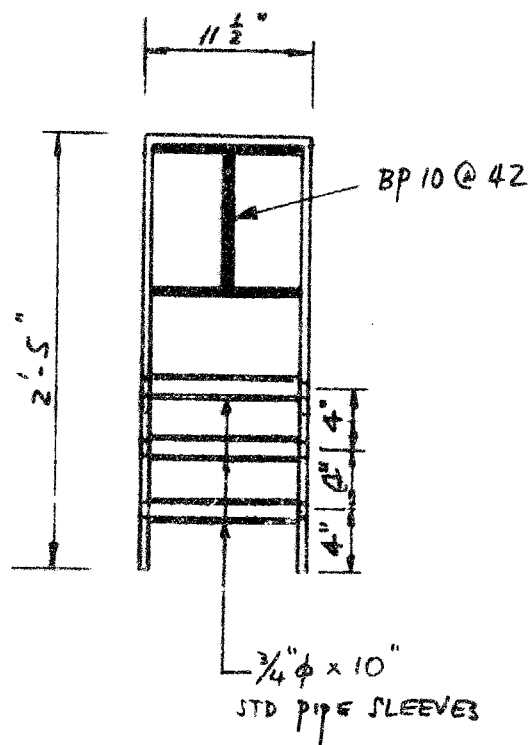


3/4" x 5" x 1'-6" PL 2 REQ'D WITH 2 1/16" ϕ HOLES
 2 " " 1 9/16" ϕ HOLES

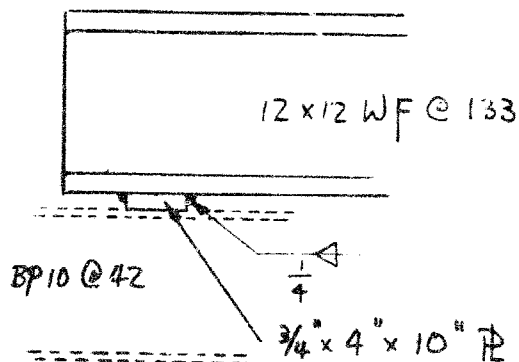
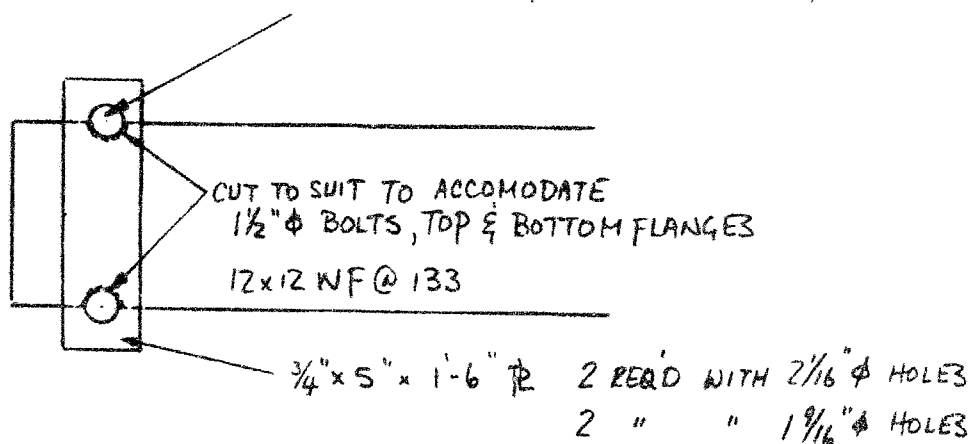


BLACK CREEK ARCH
 PILE TESTING
 CONTRACT 63-182 WP 38-63
 1 OCT 63 W.T.H.

"B"



$2\frac{1}{16}" \phi$ HOLE (FOR USE ON TOP FLANGE)
 $1\frac{9}{16}" \phi$ HOLE (FOR USE ON BOTTOM FLANGE)



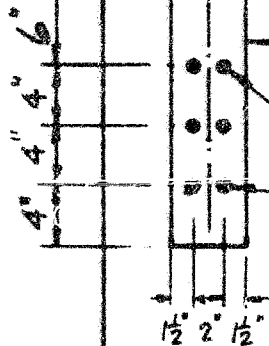
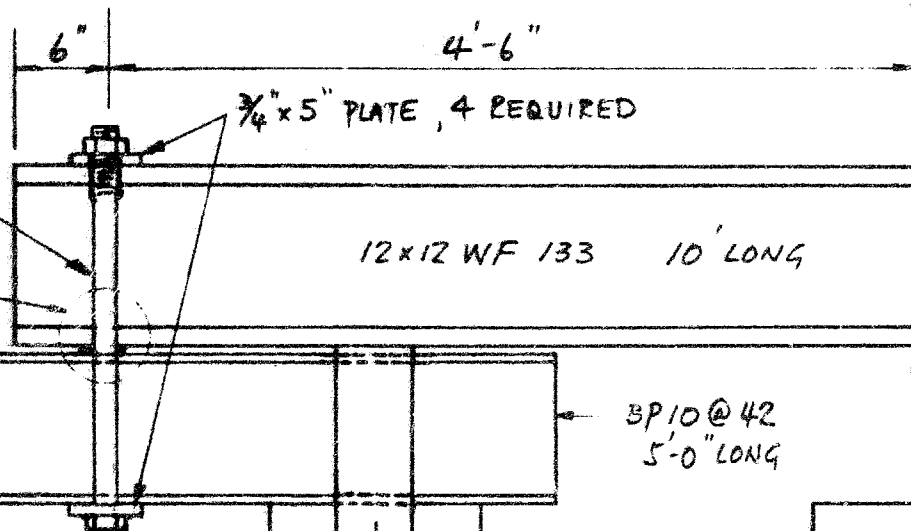
BLACK CREEK ARCH
 PILE TESTING
 CONTRACT 63-182 WSP 38-63
 1 OCT 63 N.T.H.

"B"

SYMMETRICAL
ABOUT
E

$1\frac{1}{2}" \phi \times 2'-3"$ BOLT
WITH $2" \phi$ UPSET THREAD
AND MATCHING NUT
4 REQUIRED

SEE SKETCH "B" FOR DETAILS



$\frac{13}{16}" \phi$ HOLES
FOR $\frac{3}{4}" \phi$ BOLTS
1'-3" LONG
USE $\frac{3}{4}" \phi \times 10"$ STD.
PIPE SLEEVE

$\frac{1}{2}" \times 5"$
STRAP
4 REQUIRED
SEE SKETCH "B"
FOR DETAILS

BLACK CREEK ARCH
PILE TESTING
CONTRACT 63-182, W.P. 38-63
1 OCT 63 W.T.H.

NOT

WILL BE PERMITTED DURING THE ACTUAL LOAD TEST. IT IS INTENDED

TO CARRY OUT THE TEST AFTER CESSATION OF NORMAL DAYS WORK.

AND THIS SHOULD BE COMPLETED BEFORE MORNING
OF NEXT NORMAL WORKING DAY.

PILE LOAD TEST AT BLACK CREEK

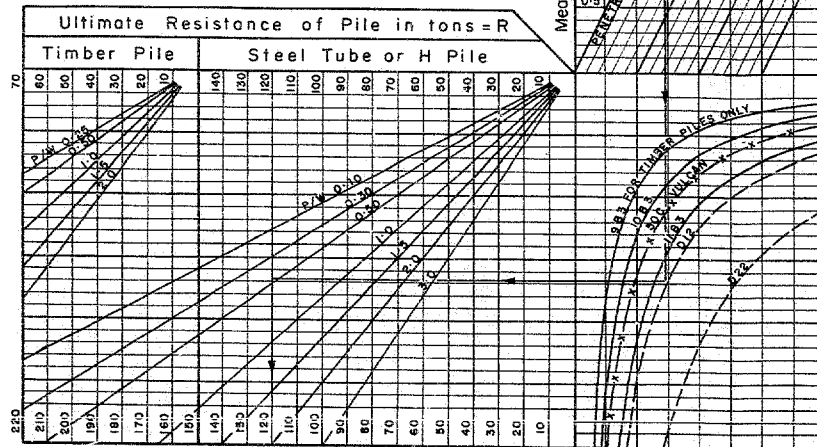
W.P. 38-63

WORK TO BE DONE

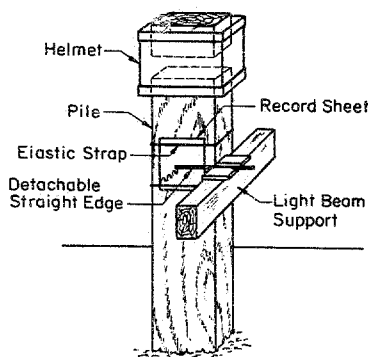
1. SUPPLY AND FIX REINFORCING BEAMS TO PULPWOOD PILES AS SHOWN IN ACCOMPANYING SKETCHES TO SATISFACTION OF THE ENGINEER. WORK TO INCLUDE ^{TRIMMING} ~~CUTTING~~ OF ^{ALL} ~~THE~~ PILES NECESSARY.
AK
2. INSTALL REFERENCE BEAMS AS DIRECTED BY THE ENGR. THESE TO CONSIST OF ² 2"x6" TIMBERS SUPPORTED AT LEAST 5' FROM NEAREST TEST OR ANCHOR PILE OR AS DIRECTED BY THE ENGR.
3. ^{AND INSTALL} SUPPLY BEARING PLATE FOR TEST PILE ($\frac{1}{2}$ " PLATE). ~~=====~~
4. ⁴ SUPPLY AND INSTALL SUPPORTS FOR ~~THE~~ DIAL GAUGES AS DIRECTED BY THE ENGR.
5. PROVIDE 1 COMPETENT WORKMAN TO ASSIST DEPARTMENT PERSONNEL DURING PERFORMANCE OF LOAD TEST.
6. THE FOLLOWING MATERIALS WILL BE SUPPLIED BY THE DEPARTMENT.
 - a. 1 100 TON TACK
 - b. 4 DIAL GAUGES
7. LOCATION OF TEST AND ANCHOR PILES TO BE DECIDED BY THE DEPARTMENT.

HAMMERS

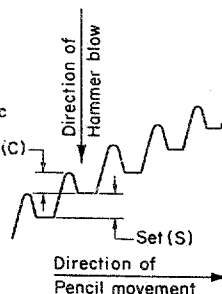
TYPE	WEIGHT W(tons)	PURPOSE
9B	0.8	For Timber Piles
10B3	1.5	For Steel Tube or H Piles
11B3	2.5	
D12	1.38	
D22	2.4	
50C	2.5	



For Steel Tube
or H Piles



Observed Elastic
compression of
Pile and Ground (C)



$$R = \frac{nWh}{S + C/2} \text{ tons (Hiley formula)}$$

where R = Ultimate load in tons.

S = Measured penetration of pile per blow of hammer in inches.

C = Measured rebound of pile per blow of hammer in inches.

Wh = Gross energy of hammer blow with a reduction due to the effect of single action or double action as against a perfect free fall, this reduction is included in plotting of the curves.

$$n = \text{Efficiency of blow} = \frac{W + P_e^2}{W + P}$$

where e = 0.32 for steel (These values of e have been found by experiment.)
= 0.25 for timber

P = Weight of pile + 0.25 ton for helmet.

W = Weight of hammer in tons.

The P/W curves form the required reduction of total energy (Wh) of the hammer blow according to the ratio of P/W.

$$L = R/Q \text{ tons}$$

where L = Working load on pile in tons.

Q = Factor of safety.

Use Q = 3 unless otherwise authorized by the Bridge Engineer.

Example 1:

Observed measured rebound = C = 0.8 in.

Observed measured set per blow = S = 0.33 in.

12 in. steel tube at 28 lb. per ft. 30 ft. long plus helmet weighing 0.25 ton giving P = 0.67 ton. Delmag D12 hammer, W = 1.38 tons, P/W = 0.485

Chart:

With C = 0.8 in. proceed horizontally to the right to cut line S = 0.33 in. and vertically down to cut curve D12 then horizontally to the left to cut P/W = 0.485 and read ultimate load R = 120 tons approximately.

Example 2:

Working load on pile is 20 tons, pile is 12 in. tube, 40 ft. long, D/A Mackiernan Terry hammer 10B3. W = 1.5 tons, P = 0.54 + 0.25 = 0.79 ton, P/W = 0.525. Assume Q = 3, then R = 60.

Chart:

With R = 60 tons trace up to cut P/W = 0.525 and horizontally to the right to cut curve 10B3 then vertically up. The range of reading will now be between C = 0 in. and S = 0.72 in. and C = 1.45 in. and S = 0 (refusal). A test pile must be driven of a length compatible with the soils branch recommendation (if any). The driving must continue until a pair of readings is obtained corresponding to a pair on the chart, the required pair being decided upon by the Bridge Engineer.

No. DD-1219

Date _____ Rev. _____

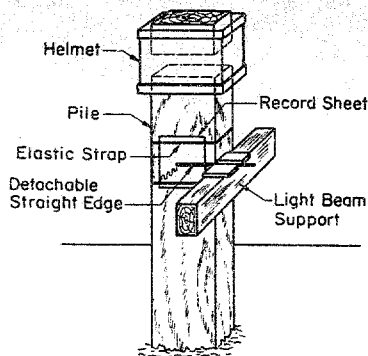
DEPARTMENT OF HIGHWAYS-ONTARIO

PILE DRIVING STEAM AND DIESEL HAMMERS

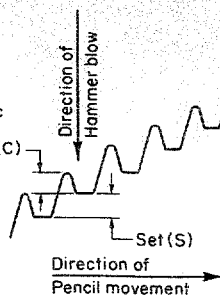
APPROVED

Aug. 4/59
Date

Alvin L. ...
Bridge Engineer



Observed Elastic
compression of
Pile and Ground (C)



$$R = \frac{nWh}{S+C/2} \text{ tons (Hiley formula)}$$

No. DD-1218

Date _____ Rev. _____

where R = Ultimate load in tons.

S = Measured penetration of pile per blow of hammer in inches.

C = Measured rebound of pile per blow of hammer in inches.

W = Gross weight of hammer with a reduction due to the effect of the friction winch as against a perfect free fall. This reduction is included in plotting of the curves.

h = Fall of hammer.

$$n = \text{Efficiency of blow} = \frac{W + P_e}{W + P}$$

where $e = 0.32$ for steel (These values of e have been found by experiment.)
 $= 0.25$ for timber

P = Weight of pile + 0.25 ton for helmet.

W = Weight of hammer in tons.

The P/W curves form the required reduction of total energy (Wh) of the hammer blow according to the ratio of P/W .

$$L = R/Q \text{ tons}$$

where L = Working load on pile in tons.

Q = Factor of safety.

Use $Q=3$ unless otherwise authorized by the Bridge Engineer.

Example 1:

Observed measured rebound = $C = 0.5$ in.

Observed measured set per blow = $S = 0.3$ in.

12 in. steel tube pile 30 ft. long at 28 lbs. per ft. plus helmet weighing 0.25 ton giving $P = 0.67$ ton; 3000 lb. hammer ($W = 1.5$ tons) dropping 6 ft.
 $P/W = \frac{0.67}{1.5} = 0.45$

Chart:

With $C = 0.5$ in. proceed horizontally to the right to cut line $S = 0.3$ and vertically down to cut curve 3000 lbs. then horizontally to the left to cut curve 6 ft. and vertically down to cut $P/W = 0.45$ for steel piles and read $R = 114$ tons approx.

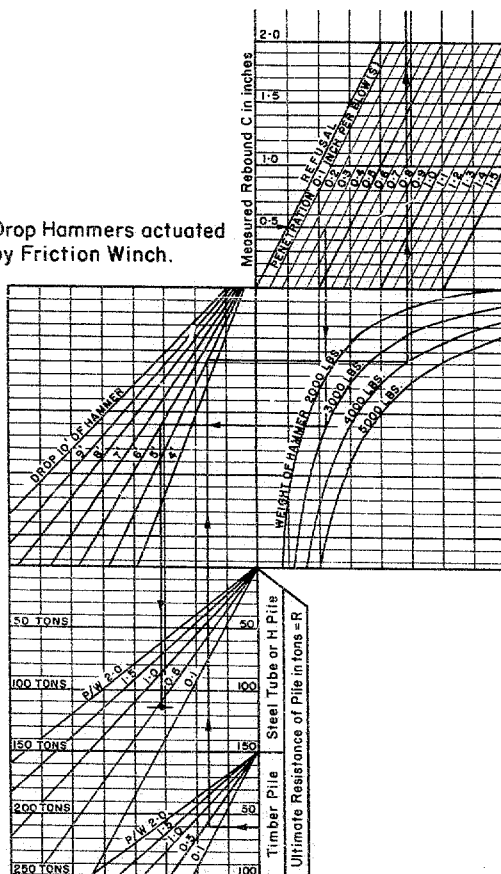
Example 2:

Working load on pile is 20 tons, pile is timber 40 ft. long, hammer 4000 lbs. dropping 5 ft., $W = 2$ tons, P (mean dia. of pile 12 in., timber at 40 lbs. per cu. ft.) = 0.63 + 0.25 = 0.88 ton, $P/W = 0.44$, $Q = 3$, then $R = 60$.

Chart:

With $R = 60$ tons trace horizontally to cut $P/W = 0.44$ and vertically up to cut curve 5 ft. then horizontally to the right to cut curve 4000 lbs. and vertically up. The range of readings will now be between $C = 0$ in. and $S = 1.2$ in. and $C = 2.0$ in. and $S = 0.2$ in. A test pile must be driven of a length compatible with the soils branch recommendation (if any). The driving must continue until a pair of readings is obtained corresponding to a pair on the chart, the required pair being decided upon by the Bridge Engineer.

Drop Hammers actuated
by Friction Winch.



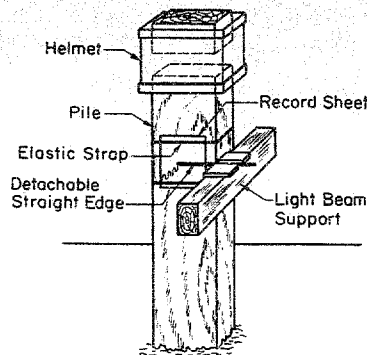
DEPARTMENT OF HIGHWAYS-ONTARIO

PILE DRIVING DROP HAMMERS

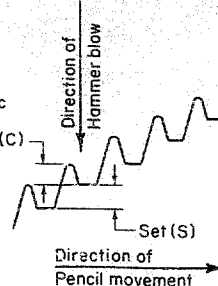
APPROVED

Aug. 4/59
Date

Bridge Engineer



Observed Elastic
compression of
Pile and Ground (C)



$$R = \frac{nWh}{S+C/2} \text{ tons (Hiley formula)}$$

where R = Ultimate load in tons.

S = Measured penetration of pile per blow of hammer in inches.

C = Measured rebound of pile per blow of hammer in inches.

W = Gross weight of hammer with a reduction due to the effect of the friction winch as against a perfect free fall. This reduction is included in plotting of the curves.

h = Fall of hammer.

$$n = \text{Efficiency of blow} = \frac{W + P^2}{W + P}$$

where e = 0.32 for steel (These values of e have been found by experiment.)

P = Weight of pile + 0.25 ton for helmet.

W = Weight of hammer in tons.

The P/W curves form the required reduction of total energy (Wh) of the hammer blow according to the ratio of P/W.

$$L = R/Q \text{ tons}$$

where L = Working load on pile in tons.

Q = Factor of safety.

Use Q=3 unless otherwise authorized by the Bridge Engineer.

Example 1:

Observed measured rebound = C = 0.5 in.

Observed measured set per blow = S = 0.3 in.

12 in. steel tube pile 30 ft. long at 28 lbs. per ft. plus helmet weighing 0.25 ton giving P = 0.67 ton; 3000 lb. hammer (W=1.5 tons) dropping 6 ft.

$$P/W = \frac{0.67}{1.5} = 0.45$$

Chart:

With C=0.5 in. proceed horizontally to the right to cut line S=0.3 and vertically down to cut curve 3000 lbs. then horizontally to the left to cut curve 6 ft. and vertically down to cut P/W=0.45 for steel piles and read R=114 tons approx.

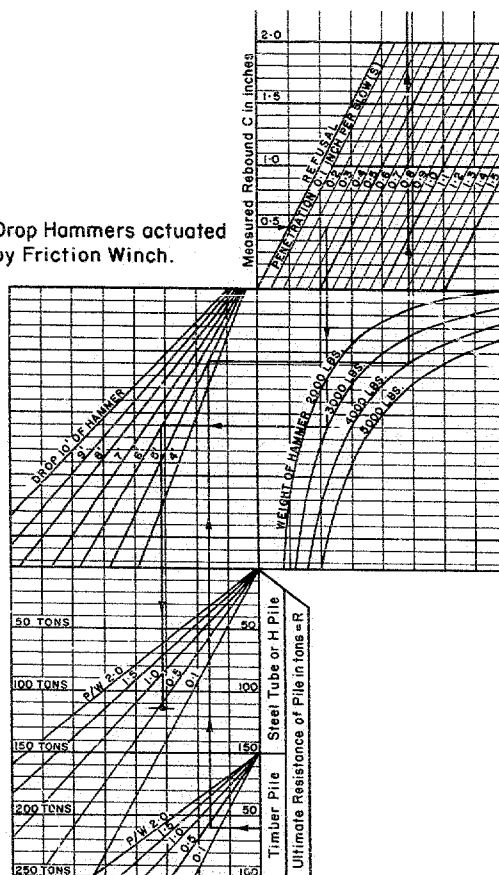
Example 2:

Working load on pile is 20 tons, pile is timber 40 ft. long, hammer 4000 lbs. dropping 5 ft., W=2 tons, P (mean dia. of pile 12 in., timber at 40 lbs. per cu. ft.) = 0.63 + 0.25 = 0.88 ton, P/W=0.44, Q=3, then R=60.

Chart:

With R=60 tons trace horizontally to the right to cut P/W=0.44 and vertically up to cut curve 5 ft. then horizontally to the right to cut curve 4000 lbs. and vertically up. The range of readings will now be between C=0 in. and S=1.2 in. and C=2.0 in. and S=0.2 in. A test pile must be driven of a length compatible with the soils branch recommendation (if any). The driving must continue until a pair of readings is obtained corresponding to a pair on the chart, the required pair being decided upon by the Bridge Engineer.

Drop Hammers actuated
by Friction Winch.



DEPARTMENT OF HIGHWAYS-ONTARIO

PILE DRIVING DROP HAMMERS

APPROVED

Aug. 4/59
Date

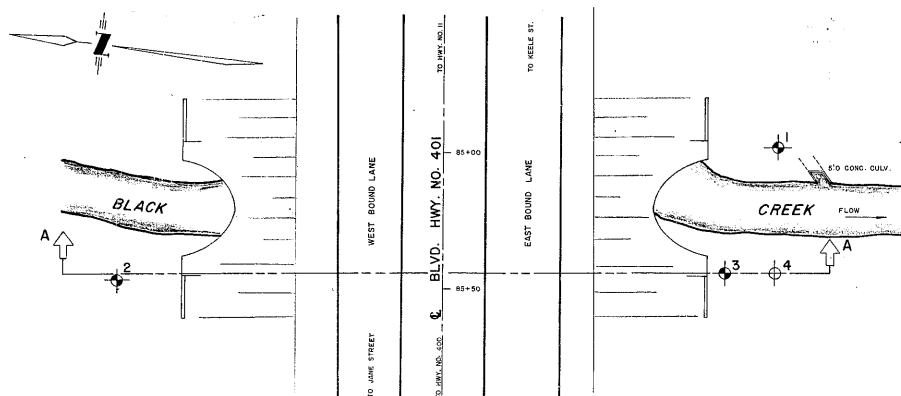
Bridge Engineer

#61-F-113

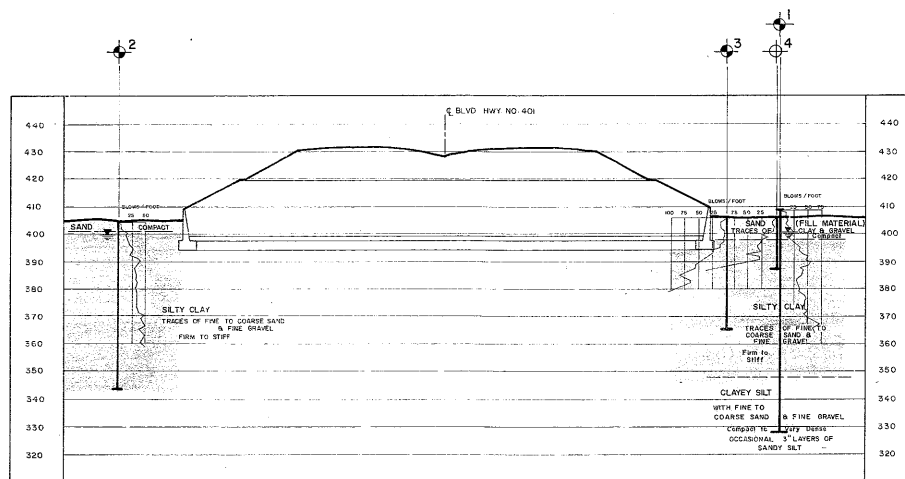
W.P. #38-63

HWY #401

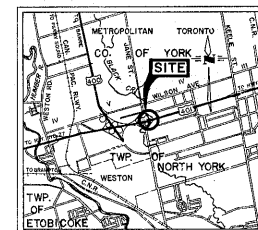
BLACK CREEK



PLAN
SCALE 1 INCH = 20 FEET



A-A
SCALE 1 INCH = 20 FEET



KEY PLAN
SCALE 1 INCH = 0.5 MILES

LEGEND

- BORE & PENETRATION HOLE
- PENETRATION HOLE
- WATER LEVELS Established at the Time of Field Inspection NOV. 15, 1988
- BLOWS / FOOT - CONE PENETRATION

HOLE	ELEVATION	STATION	OFFSET
1	408.5	84+80	121' LT.
2	404.7	85+46	120' RT.
3	406.0	85+44	102' LT.
4	406.0	85+44	120' LT.

6.20100
04/4/750
30M 125
17

NOTE

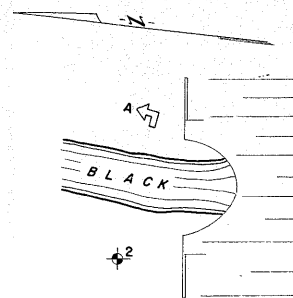
THE BOUNDARIES BETWEEN SOIL STRATA HAVE BEEN ESTABLISHED ONLY AT BORE HOLE LOCATIONS. BETWEEN BORE HOLES THE BOUNDARIES ARE ASSUMED FROM GEOLOGICAL EVIDENCE AND MAY BE SUBJECT TO CONSIDERABLE ERROR.

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH SECTION

BLACK CREEK BRIDGE EXTENSION

AND
HIGHWAY NO. 401

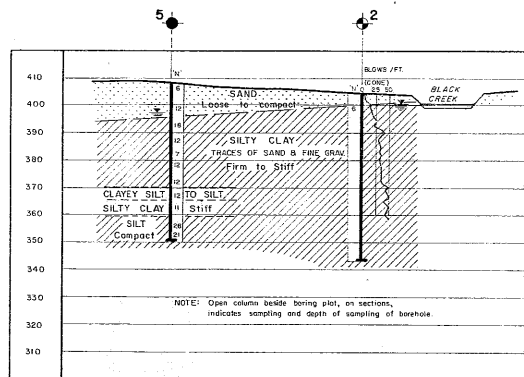
ORIGINATED 12/1/88	DISTRICT NO. 6	DATE DEC 10 1988
DRAWN BY J. CLARK	IN P. NO. 85-39-3	JOB NO. 61-F-113
CHECKED BY [Signature]	SCALE AS SHOWN	DRAWING NO. 61-F-113A
APPROVED BY [Signature]		



CLASS "X" TIMBER PILE

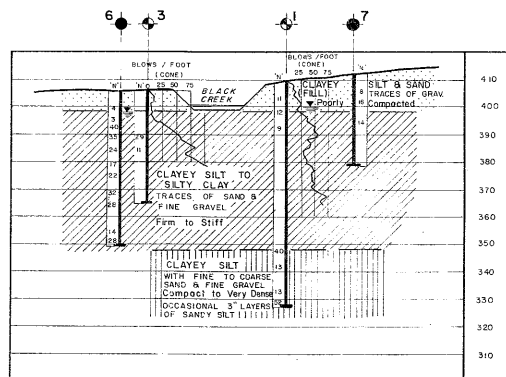


PLAN
SCALE IN FEET
0 20 40 60



A - A

SECTIONS
SCALE IN FEET
0 20 40 60



B - B

NOTE
The complete soil investigation report for this structure may be examined at the Bridge Office and Foundation Office, Downsview and at the TORONTO District Office. The Engineer does not guarantee the accuracy of this report in the abbreviated version shown on these plans.



LEGEND

- Bore Hole
- Cone Penetration Hole
- ⊙ Bore & Cone Penetration Hole
- Water Levels established at time of field investigation.

NO.	ELEVATION	STATION	OFFSET
1	408.5	84+80	121' LT
2	404.7	85+46	120' RT
3	406.0	85+44	102' LT
4	405.0	85+44	120' LT
5	408.0	85+14	139' RT
6	405.2	85+55	100' LT
7	411.7	84+70	112' LT
TIMBER PILE	353.0	BB+16	164' RT

NOTE

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

NO.	DATE	BY	DESCRIPTION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION - FOUNDATION SECTION

BLACK CREEK

KING'S HIGHWAY NO. 401 DIST. NO. 6
CO. YORK
TWP. NORTH YORK LOT 10 CON. IV

PILE TEST LOCATION, BORE HOLES & SOIL STRATA

SUBNO. 63 CHECKED 443 WP. NO. 38-63 N.S.R. DRAWING NO.
DRAWN 222 CHECKED 443 JOB NO. 61-F-113 61-F-113B
DATE MAY 15, 1963 SITE NO. BRIDGE DRAWING NO.
APPROVED [Signature] CONT. NO. 61-F-113A

#

61-F-113 B

#

W.P. 85-59-3

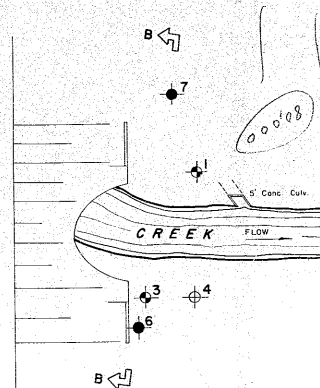
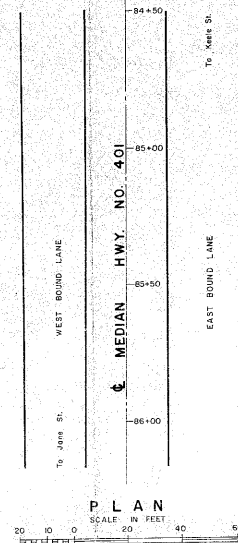
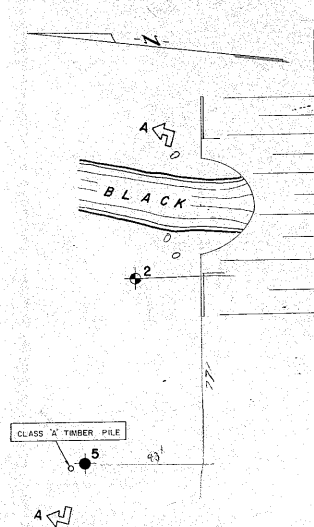
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W.P. 38-63 (NEW)

#

HWY 401

BLACK CREEK



LEGEND			
●	Bore Hole		
⊕	Cone Penetration Hole		
⊕	Bore & Cone Penetration Hole		
⬇	Water Levels established at time of field investigation		

NO.	ELEVATION	STATION	OFFSET
1	406.3	84+80	12' LT
2	404.7	85+46	120' RT
3	405.0	85+44	102' LT
4	406.0	85+42	120' LT
5	408.0	86+14	139' RT
6	405.2	85+55	100' LT
7	411.7	84+70	112' LT
TIMBER PILE	353.0 (TIP EL.)	86+16	144' RT

NOTE
The complete soil investigation report for this structure may be examined at the Bridge Office and Foundation Office, Downsview, and at the TORONTO District Office. The Department does not guarantee the accuracy of this report or the abridged version shown on these plans.

NOTE
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

DATE	BY	DESCRIPTION

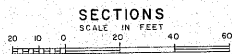
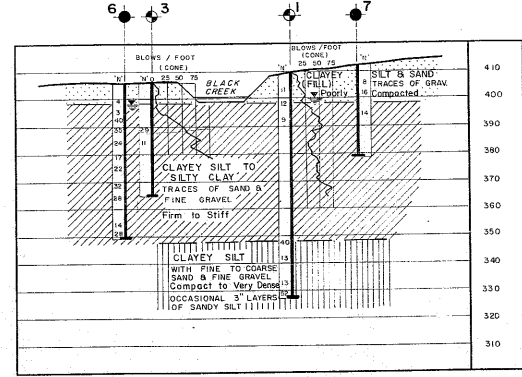
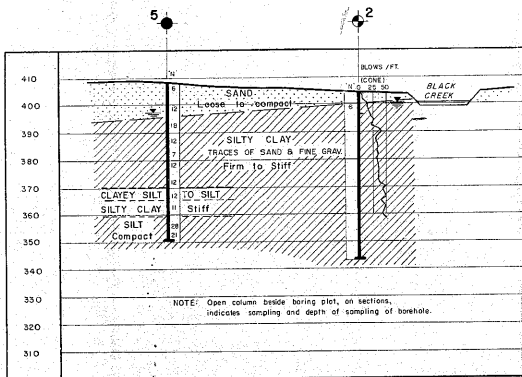
DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION - FOUNDATION SECTION

BLACK CREEK

KING'S HIGHWAY NO. 401 DIST. NO. 6
CO. YORK LOT 10 CON. IV
TWP. NORTH YORK

PILE TEST LOCATION, BORE HOLES & SOIL STRATA

SUB'D. H.S. CHECKED 443 R.P. NO. 38-53 P.B.R. DRAWING NO.
DRAWN 222 CHECKED 222 JOB NO. 61-F-113 61-F-113B
DATE MAY 16, 1963 SITE NO. BRIDGE DRAWING NO.
APPROVED [Signature] CONT. NO. PROJECT ENGINEER



REF. NO. 61-F-113A