#58-F-10

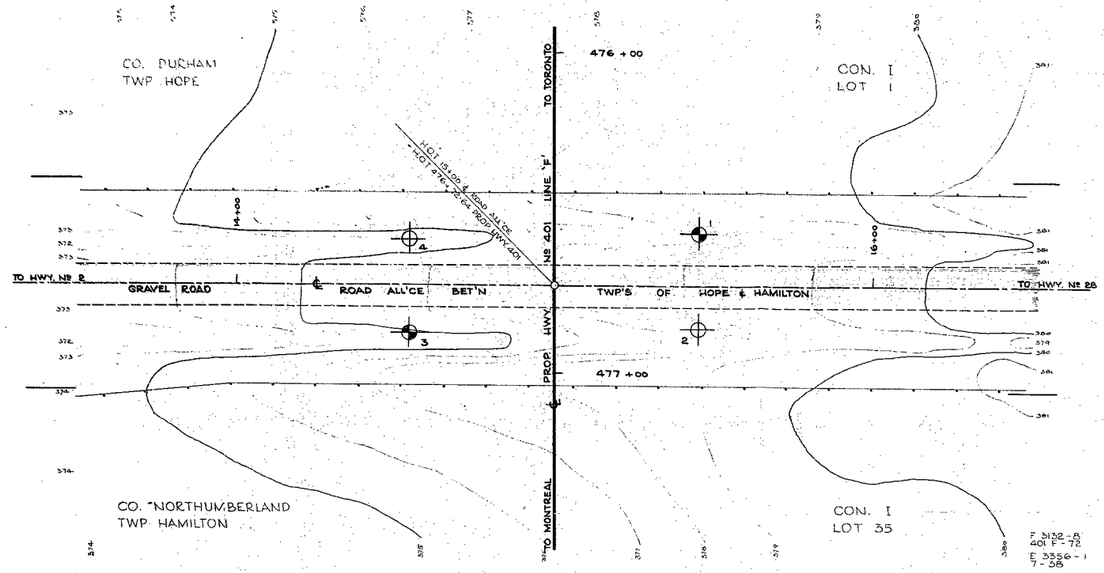
WP.#54-58

HWY #401

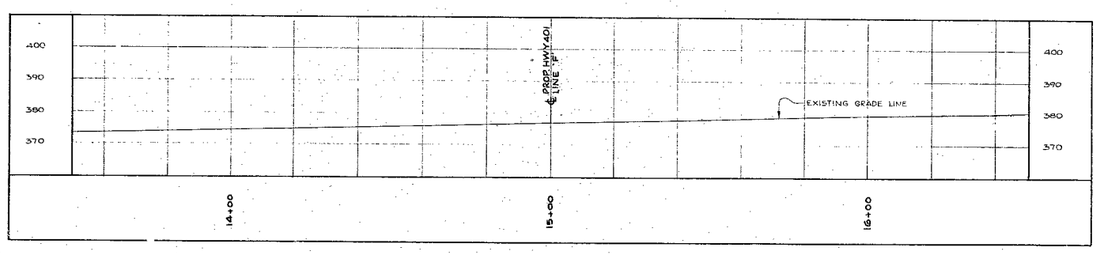
CROSSING THE TWP.

LINE BETWEEN

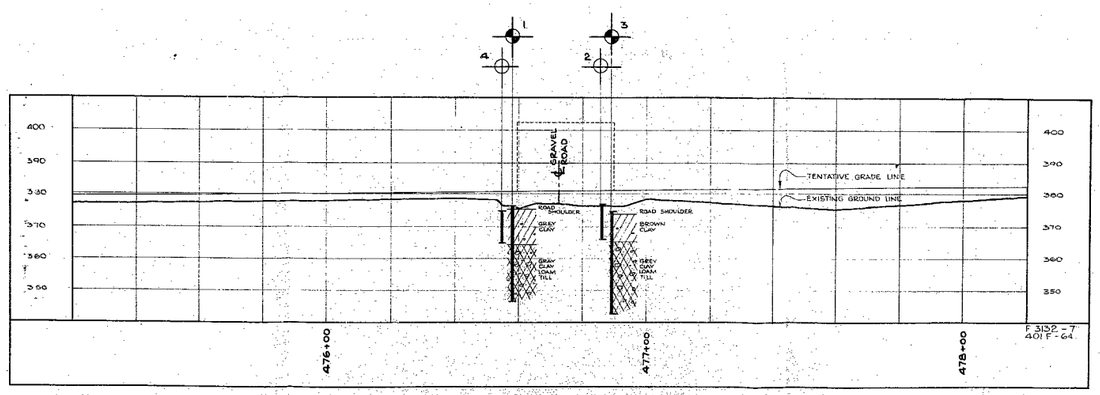
HOPE & HAMILTON



PLAN



PROFILE OF GRAVEL ROAD



PROFILE OF HWY. Nº 401

LEGEND

- AUGER HOLE
- BORE HOLE
- PENETRATION HOLE
- BORE & PENETRATION HOLE

HOLE Nº	ELEVATION	STATION	DISTANCE FROM ℄
1	376.5 '	476+57'	45' LT
2	377.0 '	476+57'	45' LT
3	374.5 '	476+57'	45' RT
4	375.0 '	476+58'	45' 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.

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH SECTION - DOWNSVIEW

GRAVEL ROAD PROPOSED CROSSING 1 MILE N. OF PORT HOPE

SHOWING POSITION & ELEVATION OF HOLES

HWY. Nº 401	W.P. 54 - 58	DIV. Nº 7
CO. DURHAM & NORTHUMBERLAND		
TWP. HOPE & HAMILTON	LOTS 35 & 1	CON. I

SCALE: 1 IN = 20 FT	SUBMITTED BY:	DATE: 16 MAY 1958
DRAWN BY: R.E.F.	APPROVED BY:	DRAWING Nº: F - 58 - 10A

Mr. A. Toye,

Bridge Engineer.

Materials & Research Section.

July 7, 1958.

Re: Foundation Report- Hwy. 401 crossing Nip. line between Hop & Hamilton, about one mi. N. of Por Hope. W.P. 54-58 W.J. F-58-10

Attached please find two copies of the above mentioned report.

It will be seen that a freely supported structure can be founded on spread footing type foundations placed at elevation 370 ft.

For a rigid type of structure, if placed at this elevation, it is believed the differential settlement will be in excess of allowable limit. However, this can be avoided by placing the foundations at elevation 365 ft.

End bearing piles would also be considered. It is believed end bearing piles will meet refusal in the vicinity of elevation 360 ft.

VK/jy.

C.C. Mr. A. Toye
H. Treyvaskes
D. G. Mansay
H. E. Duff
A. Watt
Dr. P. Karrow
Foundation Section
File.

A. Rutka,
Acting Materials & Research Engineer.

Per: V. Korlu.

Foundation Report

on

New Bridge at Highway 401
crossing the township line
between Hope and Hamilton, about
one mile north of Port Hope.

Plan no. F-3132-8

Station: 476+80

Distribution:

Mr. A. Toye,
Bridge Engineer. (2)

Mr. H. Tregaskes,
Construction Engineer. (1)

Mr. D. G. Ramsay,
Design Engineer. (1)

Mr. H. D. Duff,
Dist. Eng. Port Hope. (1)

Mr. A. Watt,
Water Resources Commission (1)

Dr. P. Karrow,
Department of Mines (1)

Foundation Section (1)

File (1)

W.P. 54-58

W.J. F-58-10

Introduction:

A subsoil investigation was carried out to determine the bearing values of the layers for supporting the foundations of the proposed structure.

The site is about one mile north of Port Hope, where the new highway 401 crosses the township line between Hope and Hamilton, (station 476/80 profile no. F-3132-7).

The work started on April 14, 1958 and was completed on April 21, 1958.

Description of Site and Field work:

The location of the site is within the shoreline of late Iroquois Lake. The terrain is probably lacustrine deposit formed on basically glacial till.

The subsoil investigations were carried out by means of a skid mounted coredrill machine. In the course of investigations two boreholes were made one on the north-west and the other on the south-east side of the centre line (assumed locations for piers). Four dynamic cone penetrations were made by driving 2" diameter cone from ground surface down to refusal.

The boreholes were made by alternately washing and driving the casing. At five feet intervals samples were taken and Standard penetration resistence measured.

The boreholes were explored some 30 ft. below the ground surface and due to the nature of the subsoil encountered were stopped at this depth.

The location of the boreholes is shown on the drawing no. F-58-108, and their elevations on log sheets under Appendix I.

Field and Laboratory Findings:

The explorations carried out at the site revealed the following stratigraphy:

Under the topsoil the layer, down to elevation about 365 ft., is clay. Below this elevation down to the end of the boreholes the subsoil is pebbly clay loam till.

The textural analysis indicated that the top clay layer is made up of about 70% binder material and 30% fine aggregate. The soil in this layer has average 26% liquid limit, 17% plastic limit, natural moisture content of 16% and 140 p.c.f. density. The soil is inorganic and of low to medium plasticity. The unconfined compression tests indicated minimum 3500 p.s.f. The Standard Penetration tests registered about 40 blows per foot penetration.

The layer below elevation 365 ft. is clay loam till with 40% binder material, 38% fine aggregate, and 22% coarse aggregate. Its liquid or plastic limits could not be established. Its average natural moisture content is 7.5% and density 145 p.c.f. Some unconfined compression tests gave values of the order of 3400 p.s.f. and the very hard state of the layer was confirmed by Standard penetration tests registering average 60 blows per foot penetration.

Support of Abutments;

The tentative grade line at this crossing indicates some 6 ft. of fill over the existing ground surface.

From laboratory measurements the topclay layer has unconfined compression values of 3500 - 5500 p.s.f. It will be convenient to consider spread footing, type of foundations. Using the least unconfined compression value 3500 p.s.f. in Meyerhaf's formula, and assuming 7 ft. wide footings placed at elevation 370 ft., the bearing value available at this elevation will be:

$$q = \frac{CNc}{FS} + \gamma D \quad ; \quad Nc = 5\left(1+\frac{B}{L}\right)\left(1+\frac{D}{5B}\right)$$

$$= 5\left(1+\frac{2}{30}\right)\left(1+\frac{5}{5\times7}\right)$$

$$= \frac{3500\times7}{3} + 140\times5 \qquad = 5 \times 1.4 = 7$$

$$= 6800 \text{ p.s.f. or } 4.4 \text{ T.s.f.}$$

However, this will not prevent some settlement due to the remaining 5 ft. of clay layer under the footing. Basing the compression index (Cc) on 26% liquid limit and assuming a design load of 3 T.s.f. the calculated total settlement is found to be 3.8 inches. Also, it will need some 520 days for 90% of this settlement to take place.

It is also possible to support the footings on piles. In this case piles are believed to be driven to refusal at about 360 ft. and will provide sufficient end bearing and friction to support the foundations.

Conclusions and Recommendations:

From the above discussion it will follow that:

1. The subsoil stratigraphy at the site is clay down to elevation 365 ft. and below this the layer is very hard pebbly clay loam till.
2. It will be convenient to support the structure on spread footing type foundations. When the footings are placed at elevation 370 ft. the layer can provide more than 3 t.s.f. bearing value. However, the remaining 5 ft. clay layer under the footings with its 26% liquid limit and 3 t.s.f. design load is calculated to settle about 3.8" in some 520 days (90%). Hazards due to this amount of settlement can be overcome by constructing a freely supported structure. A rigid type structure will necessitate placing the foundations at elevation 365 ft. This will avoid any hazards due to differential settlement.
3. It is also possible to support the foundations on piles. It is very probable that piles will be driven to refusal at about elevation 360 ft. (This elevation is observed from dynamic cone penetration refusal profile, and it would be preferrable to have it tested and confirmed by some previous pile test). In this case the piles, both as end bearing and friction, will provide sufficient support for the foundations. This will make possible to place the footings at higher elevation than 370 ft. and eliminate the excessive settlement hazards.

The choice of types of foundation support remains to be decided according to different considerations and their relative economy.

4. The existing gravel road is overpassing the new highway. The approach fills to the new structure do not present any stability problem.

VK/jy.

V. Korlu,
Foundation Engineer.

APPENDIX I.

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & RESEARCH BRANCH - FOUNDATIONS SECTION - DOWNSVIEW

OFFICE REPORT ON SOIL EXPLORATION

DRILL RIG 54-1 OPERATION BORE & PENET'N JOB F-58-10 W.P. 54-58 BORING 1 STA. 476+57 (45' LT.)

CASING BX (standard samplers to fit unless noted) DATUM GEODETIC DATE REPORT MAY 1958

SAMPLER HAMMER WT. 250 LBS. DROP 19 INCHES COMPILED BY W.G. CHECKED BY A.L. DATE BORING 15 APRIL 1958

ABBREVIATIONS

V - INSITU VANE SHEAR TEST; M - MECHANICAL ANALYSIS; U - UNCONFINED COMPRESSION; Q_c - TRIAXIAL CONSOLIDATED QUICK; Q - TRIAXIAL QUICK; S - TRIAXIAL SLOW; W.L. - WATER LEVEL IN CASING; W.T. - WATER TABLE IN SOIL; K - PERMIABILITY; C - CONSOLIDATION; CA. - CASING; γ - UNIT WEIGHT

SAMPLE TYPES

C.S. - CHUNK; D.O. - DRIVE OPEN; D.F. - DRIVE FOOT VALVE; T.O. - THIN WALLED OPEN; S.S. - SLEEVE SAMPLE; P.S. - PISTON SAMPLE; W.S. - WASHED SAMPLE; R.C. - ROCK CORE

SAMPLE CONDITION

- DISTURBED
- FAIR
- GOOD
- LOST

SOIL PROFILE

ELEVATION / DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT PLOT
376.5'		GROUND LEVEL	
375.5' / 1.0'		ROAD SHOULDER	
		GREY CLAY	
364.5' / 12.0'		GREY CLAY LOAM TILL	
346.5' / 30.0'		END OF BOREHOLE	

ELEVATION SCALE: 375, 370, 365, 360, 355, 350, 345

SHEAR STRENGTH IN LBS. PER SQ. FT. * — 2000, 4000, 6000, 8000

WATER CONTENT W % — 10, 20, 30, 40 — O - NAT. □ - P.W. Δ - L.W.

PENETRATION TEST RESISTANCE BLOWS PER FOOT AT STANDARD ENERGY (4200 IN. LBS. PER BLOW)

D. CONE PEN. X------X------X STAND. PEN. •——•——• — 50, 100, 150, 200

REFUSAL AT ELEV. 359.5'

END OF CASING AT ELEV. 346.5'

CASING BLOWS (ACTUAL): 3, 8, 15, 20, 23, 18, 26, 31, 85, 78, 94, 138, 133, 124, 141, 97, 112, 157, 174, 149, 148, 186, 216, 252, 81, 176, 217, 288, 216

SAMPLES

OTHER TESTS	CONDITION	TYPE	NO.	PENETRATION RESISTANCE	ELEV. / RECOV. %
					376.5'
f' 131.8 p.c.f.		T.O.	1	48	371.5' 78
					366.5'
f' 133.0		S.S.	2	86	78
					361.5'
		S.S.	3	56	33
					356.5'
		D.S.	4	75	50
					351.5'
		T.O.	5		351.0'
		S.S.	6	92	40

FORM OB-ML-1

H.D.R.

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & RESEARCH BRANCH - FOUNDATIONS SECTION - DOWNSVIEW

OFFICE REPORT ON SOIL EXPLORATION

DRILL RIG 54-1 OPERATION PENETRATION JOB F-58-10 W.P. 54-58 BORING 2 STA. 476+87 (45' LT.)

CASING BX (standard samplers to fit unless noted) DATUM GEODETIC DATE REPORT MAY 1958

SAMPLER HAMMER WT. 250 LBS. DROP 19 INCHES COMPILED BY HS CHECKED BY A.L. DATE BORING 18 APRIL 1958

ABBREVIATIONS

V - INSITU VANE SHEAR TEST
M - MECHANICAL ANALYSIS
U - UNCONFINED COMPRESSION
Q_c - TRIAXIAL CONSOLIDATED QUICK
Q - TRIAXIAL QUICK
S - TRIAXIAL SLOW
W.L. - WATER LEVEL IN CASING
W.T. - WATER TABLE IN SOIL
K - PERMIABILITY
C - CONSOLIDATION
CA. - CASING
γ - UNIT WEIGHT

SAMPLE TYPES

C.S. - CHUNK
D.O. - DRIVE OPEN
D.F. - DRIVE FOOT VALVE
T.O. - THIN WALLED OPEN
S.S. - SLEEVE SAMPLE
P.S. - PISTON SAMPLE
W.S. - WASHED SAMPLE
R.C. - ROCK CORE

SAMPLE CONDITION

- DISTURBED
- FAIR
- GOOD
- LOST

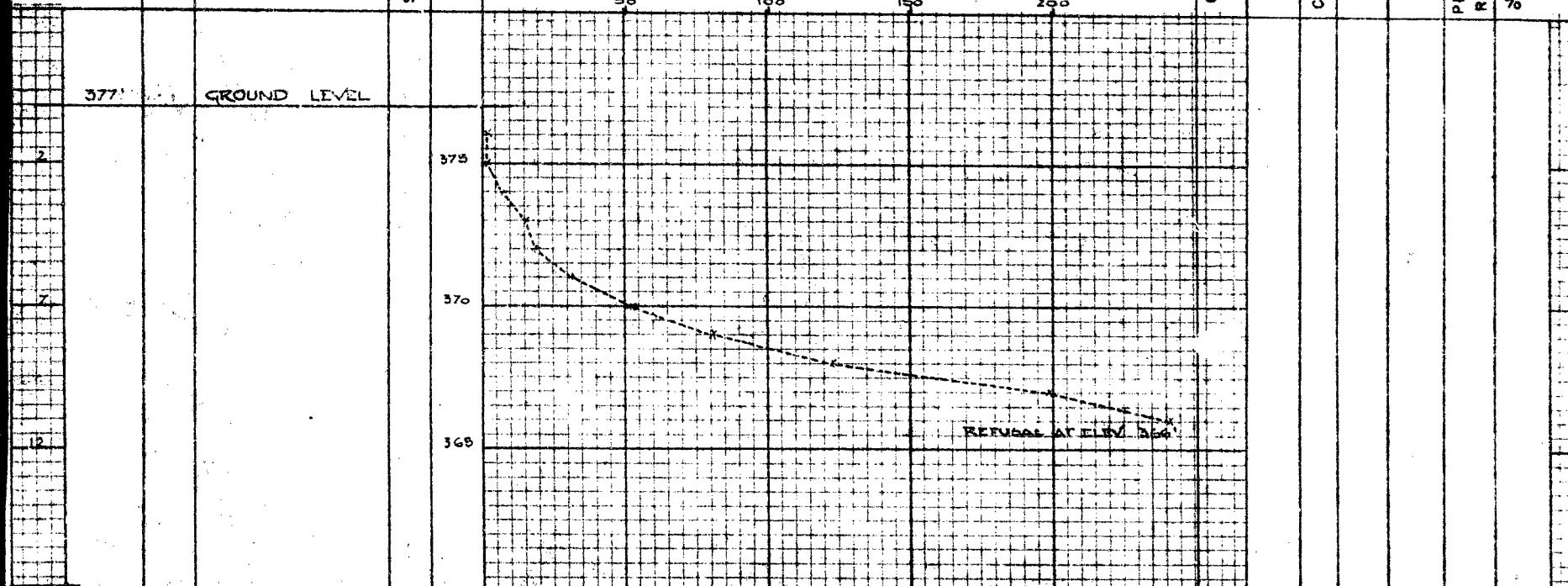
SOIL PROFILE					SAMPLES					
ELEVATION DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT PLOT	ELEVATION SCALE	OTHER TESTS	CONDITION	TYPE	NO.	PENETRATION RESISTANCE	ELEV. RECOV. %
377'		GROUND LEVEL								

WATER CONTENT W % — O - NAT. □ - P.W. Δ - L.W.

PENETRATION TEST RESISTANCE BLOWS PER FOOT AT STANDARD ENERGY (4200 IN. LBS. PER BLOW)

D. CONE PEN. X-------X-------X STAND. PEN. ●——●——●

CASING BLOWS (ACTUAL)



DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & RESEARCH BRANCH - FOUNDATIONS SECTION - DOWNSVIEW

OFFICE REPORT ON SOIL EXPLORATION

DRILL RIG 54-1 OPERATION BORE & PENET'N JOB F-58-10 W.P. 54-58 BORING 3 STA. 476+87 (45' RT.)

CASING BX (standard samplers to fit unless noted) DATUM GEODETIC DATE REPORT MAY 1958

SAMPLER HAMMER WT. 250 LBS. DROP 19 INCHES COMPILED BY A.S. CHECKED BY A.L. DATE BORING 18 APRIL 1958

ABBREVIATIONS

V - INSITU VANE SHEAR TEST; M - MECHANICAL ANALYSIS; U - UNCONFINED COMPRESSION; Q_c TRIAXIAL CONSOLIDATED QUICK; Q - TRIAXIAL QUICK; S - TRIAXIAL SLOW; WL. - WATER LEVEL IN CASING; WT. - WATER TABLE IN SOIL; K - PERMIABILITY; C - CONSOLIDATION; CA. - CASING; γ - UNIT WEIGHT

SAMPLE TYPES

C.S. - CHUNK; D.O. - DRIVE OPEN; D.F. - DRIVE FOOT VALVE; T.O. - THIN WALLED OPEN; S.S. - SLEEVE SAMPLE; P.S. - PISTON SAMPLE; W.S. - WASHED SAMPLE; R.C. - ROCK CORE

SAMPLE CONDITION

- DISTURBED
- FAIR
- GOOD
- LOST

SOIL PROFILE

ELEVATION DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT PLOT	ELEVATION SCALE
374.5'		GROUND LEVEL		
373.5' 1.0'		ROAD SHOULDER		
4.5		BROWN CLAY		370
365.5' 9.0'				365
14.5		GREY CLAY LOAM TILL		360
24.5				355
29.5				350
343.0 31.5'		END OF BOREHOLE		345
34.5				340

SHEAR STRENGTH IN LBS. PER SQ. FT. * (2000, 4000, 6000, 8000)

WATER CONTENT W % (10, 20, 30, 40) O - NAT. □ - P.W. Δ - L.W.

PENETRATION TEST RESISTANCE BLOWS PER FOOT AT STANDARD ENERGY (4200 IN. LBS. PER BLOW)

D. CONE PEN. X-------X-------X (1.0, 100, 150, 200) STAND. PEN. •——•——• (100, 200)

REFUSAL AT ELEV. 362.7'

END OF CASING AT ELEV. 344.5'

CASING BLOWS (ACTUAL)
2. 5. 5. 9.
13 19 21 37 57
81
58 48 124 145
210
48 49 104 116
119
48 132 128 144
184 139 107 226 217
298

SAMPLES

OTHER TESTS	CONDITION	TYPE	NO.	PENETRATION RESISTANCE	ELEV. RECOV. %
					374.5'
γ-148# p.c.f.		T.O.	1	31	100
					369.5'
					364.5'
	X	T.O.	2	72	72
					359.5'
	X	D.O.	3	107	45
					354.5'
	X	D.O.	4	108	50
					344.5'
γ-142#		S.S.	5	50	100

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & RESEARCH BRANCH - FOUNDATIONS SECTION - DOWNSVIEW

OFFICE REPORT ON SOIL EXPLORATION

DRILL RIG 54-L OPERATION PENETRATION JOB F-58-10 W.P. 54-58 BORING A STA. 476+88 (45' RT.)

CASING BX (standard samplers to fit unless noted) DATUM GEODETIC DATE REPORT MAY 1958.

SAMPLER HAMMER WT. 250 LBS. DROP 19 INCHES COMPILED BY H.S. CHECKED BY A.L. DATE BORING 21 APRIL 1958

ABBREVIATIONS

V - INSITU VANE SHEAR TEST
M - MECHANICAL ANALYSIS
U - UNCONFINED COMPRESSION
Q_c - TRIAXIAL CONSOLIDATED QUICK
Q - TRIAXIAL QUICK
S - TRIAXIAL SLOW
W.L. - WATER LEVEL IN CASING
W.T. - WATER TABLE IN SOIL
K - PERMIABILITY
C - CONSOLIDATION
CA. - CASING
γ - UNIT WEIGHT

SAMPLE TYPES

C.S. - CHUNK
D.O. - DRIVE OPEN
D.F. - DRIVE FOOT VALVE
T.O. - THIN WALLED OPEN
S.S. - SLEEVE SAMPLE
P.S. - PISTON SAMPLE
W.S. - WASHED SAMPLE
R.C. - ROCK CORE

SAMPLE CONDITION

- DISTURBED
- FAIR
- GOOD
- LOST

SOIL PROFILE

ELEVATION DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT PLOT
375'		GROUND LEVEL	

ELEVATION SCALE

WATER CONTENT W % — O - NAT. □ - P.W. Δ - L.W.

PENETRATION TEST RESISTANCE BLOWS PER FOOT AT STANDARD ENERGY (4200 IN. LBS. PER BLOW)

D. CONE PEN. X-------X-------X STAND. PEN. ●——●——● 50 100 150 200

375
370
365

REFUSAL AT ELEV. 365½'

CASING BLOWS (ACTUAL)

SAMPLES

OTHER TESTS	CONDITION	TYPE	NO.	PENETRATION RESISTANCE	ELEV. RECOV. %