

#58-F-18

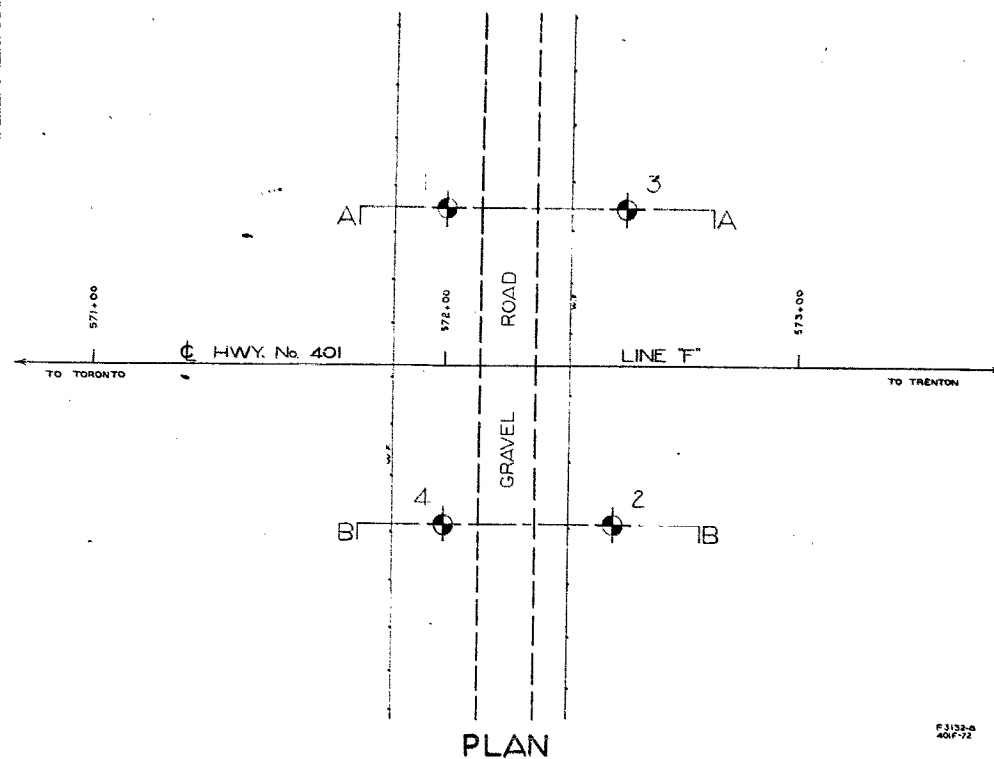
WP# 55-58

HWY# 401 CROSSING
GRAVEL ROAD BETWEEN

LOTS #28 & #29 (CON#1)

3 MI. W. OF COBourg

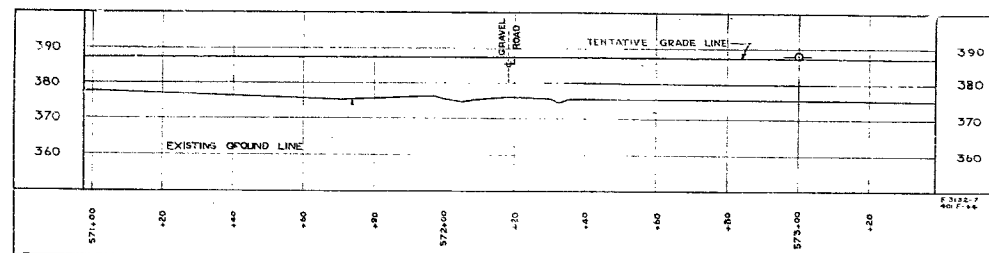




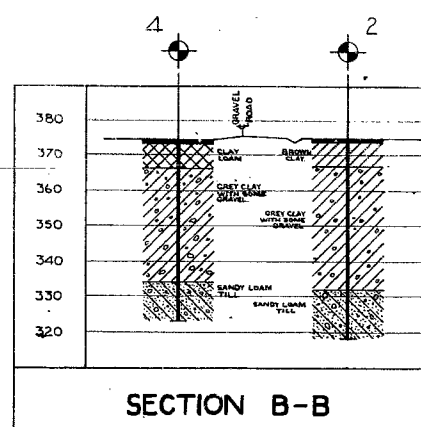
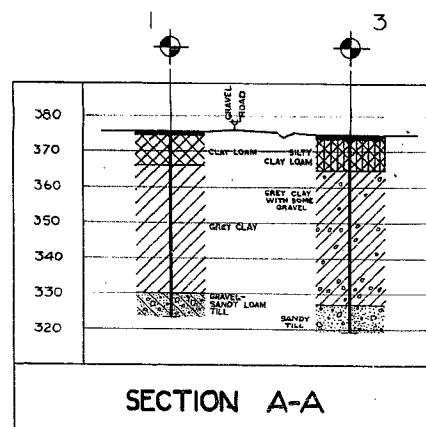
F3132-B
401-F-72



— 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.



LEGEND			
BORE HOLE			
BORE & PENETRATION HOLE			
PENETRATION HOLE			
HOLE No.	ELEVATION	STATION	DISTANCE FROM E.
1	376'	572+00	45' L.
2	375'	572+48	45' RT.
3	375'	572+81	45' LT.
4	374.5'	572+00	45' RT.



DEPARTMENT OF HIGHWAYS - ONTARIO.
MATERIALS & RESEARCH SECTION DOWNSVIEW.

**GRAVEL ROAD
PROPOSED CROSSING
3 MILES WEST OF COBOURG**

SHOWING POSITION & ELEVATION OF HOLES.

HWY. No. 401. W.P. 55-58. DIV. No. 7.
CO. NORTHUMBERLAND
TWP. HAMILTON LOT. 28 & 29 CON. 1.

SCALE 1 IN = 20 FT. SUBMITTED BY DATE 25 AUG. 1958.
DRAWN BY D. N. APPROVED BY DRAWING No. F-58-18A

Foundation Report

on

New overpass bridge at Highway 401 line
"F" and gravel road between lots 26 and
27 (Con. 1) crossing, about 3 miles west
of Cobourg, Township of Hamilton.

Plan no. F-318

Station: 572+20

Distribution:

Mr. A. Toye
Bridge Engineer (2)

Mr. H. Trogaskes
Construction Engineer (1)

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

Mr. H. D. Duff
District Engineer, Port Hope (1)

Mr. V. Watt
Water Resources Commission (1)

Mr. J. Karow
Department of Mines (1)

Foundation Section (1)

File (1)

D.P. 55-58
-J. F-58-18

Introduction:

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

The site is about 3 miles west of Cobourg where the new Highway #401 line "F" crosses the existing gravel road between lots 28 & 29 (con. 1) Township of Hamilton (station 572+20, profile no. F-3132-7).

The job started on June 7, 1958 and was completed on June 27, 1958.

Description of Site and Field Work:

The site is located in an area which is believed to be formerly within the shoreline of late Iroquois Lake. The physiography is gently curved drumlins and the land is cultivated. The terrain is lacustrine clay deposited on basically glacial till.

The subsoil investigations were carried out by means of skid mounted core drill machine. In the course of investigations four boreholes were made two on each side of the Centre line (probable locations of piers). By driving 2" diameter cone down to refusal the dynamic cone penetration profile of the site was established. To obtain in situ shear values of the subsoil some vane tests were made in the boreholes. The boreholes were made by alternately washing and driving the casing. Samples were extracted at regular intervals and standard penetration resistance was measured,

The boreholes were explored some 50 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-58-18 A and their elevations on log sheets under Appendix I.

Field and Laboratory Findings:

The subsoil stratigraphy revealed by explorations consists of 8-10 feet brown silty clay loam under the topsoil. This layer is underlain by some 35 feet of grey clay. This clay layer is spotted with gravel and is soft to medium in consistency. The grey clay layer is underlain by very stiff gravelly sandy loam till.

The samples extracted from the boreholes were tested in the laboratory. From the test results the top brown clay layer is inorganic and of low plasticity. The unconfined compression tests indicated average value of 3000 p.s.f. Its density is about 130 p.c.f. and moisture content about 17%.

The grey clay layer was found to be inorganic and of low plasticity with average density of 140 p.s.f. and average moisture content of 13%. The average unconfined compression values obtained in this layer were 500-800 p.s.f. A number of in situ vane tests were also performed in this layer. The results of these tests also varied within the same range as the values obtained from unconfined compression tests.

The support of Abutment footings:

According to the proposed grade line the new highway 401 is overpassing the existing gravel road at this intersection.. The gravel road will be cut and lowered to elevation 368 ft. The foundations of the new structure will be placed below this elevation possibly at about 361 ft. Judging from the measured unconfined comp-

ression and in situ vane tests the grey clay layer could not provide more than 0.7 T.s.f. bearing value to support spread footing type foundations.

It will be convenient to consider the support of the foundations on end bearing piles. Judging from the standard penetration resistance and blows per foot penetration of the BK casing, it would be seen that the piles will probably reach refusal at about elevation 325 feet.

Conclusions and Recommendations:

From the above discussion it will follow that:

1. The terrain is very probably lacustrine clay deposit on glacial till.
2. To support the structure on spread footing type foundations would imply to place the footings at about elevation 361 ft. Judging from the unconfined compression tests and in situ vane tests at this elevation the grey clay layer can not provide more than 0.7 T.s.f. bearing value to support the footings.
3. It will be convenient to support the footings by means of end bearing piles. These piles when driven into the layer, will probably meet refusal at about elevation 325 feet.
4. There is no approach fill stability problem at this site.

APPENDIX I

DRILL RIG 54-6 OPERATION BORE & PENETN JOB F-58-18 WP 55-58 BORING 1 STA. 572.00(45' LT)
CASING BX (standard samplers to fit unless noted) DATUM GEODETIC DATE REPORT JULY 1958
SAMPLER HAMMER WT. 250 LBS DROP 16 INCHES COMPILED BY H.S. CHECKED BY AL DATE BORING 9 JUNE 1958

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

S.S. - SLEEVE SAMPLE
PS - PISTON SAMPLE
WS - WASHED SAMPLE
RC - ROCK CORE

- DISTURBED
- FAIR
- GOOD
- LOST

[illegible]

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH BRANCH - FOUNDATIONS SECTION - DOWNSVIEW
OFFICE REPORT ON SOIL EXPLORATION

DRILL RIG 54-6 OPERATION BORE & PENET JOB F-58-18 WP 35-58 BORING 2 STA 512+48(45RT)
CASING BX (standard samplers to fit unless noted) DATUM GEODETIC DATE REPORT JULY 1958
SAMPLER HAMMER WT. 250 LBS. DROP 19 INCHES COMPILED BY H.S. CHECKED BY AL DATE BORING 16 JUNE 1958

ABBREVIATIONS

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

SAMPLE TYPES

CS - CHUNK SS - SLEEVE SAMPLE
DO - DRIVE OPEN PS - PISTON SAMPLE
DF - DRIVE FOOT VALVE WS - WASHED SAMPLE
T.O. - THIN WALLED OPEN R.C. - ROCK CORE

SAMPLE CONDITION



- DISTURBED
- FAIR
- GOOD
- LOST

SOIL PROFILE

SHEAR STRENGTH IN LBS. PER SQ. FT. & VANE TEST & UNCONFINED COMPRESSION SAMPLES

1000 2000 3000 4000

WATER CONTENT W% 20 30 40 50

0 - NAT □ - PW Δ - LW

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

CASING BLOWS (ACTUAL)

OTHER TESTS

CONDITION

TYPE

NO.

PENETRATION RESISTANCE

%

ELEV. RECOV.

375' GROUND LEVEL

374' TOPSOIL

1" BROWN CLAY

5

10

15

20

25

30

35

40

45

50

55

60

65

70

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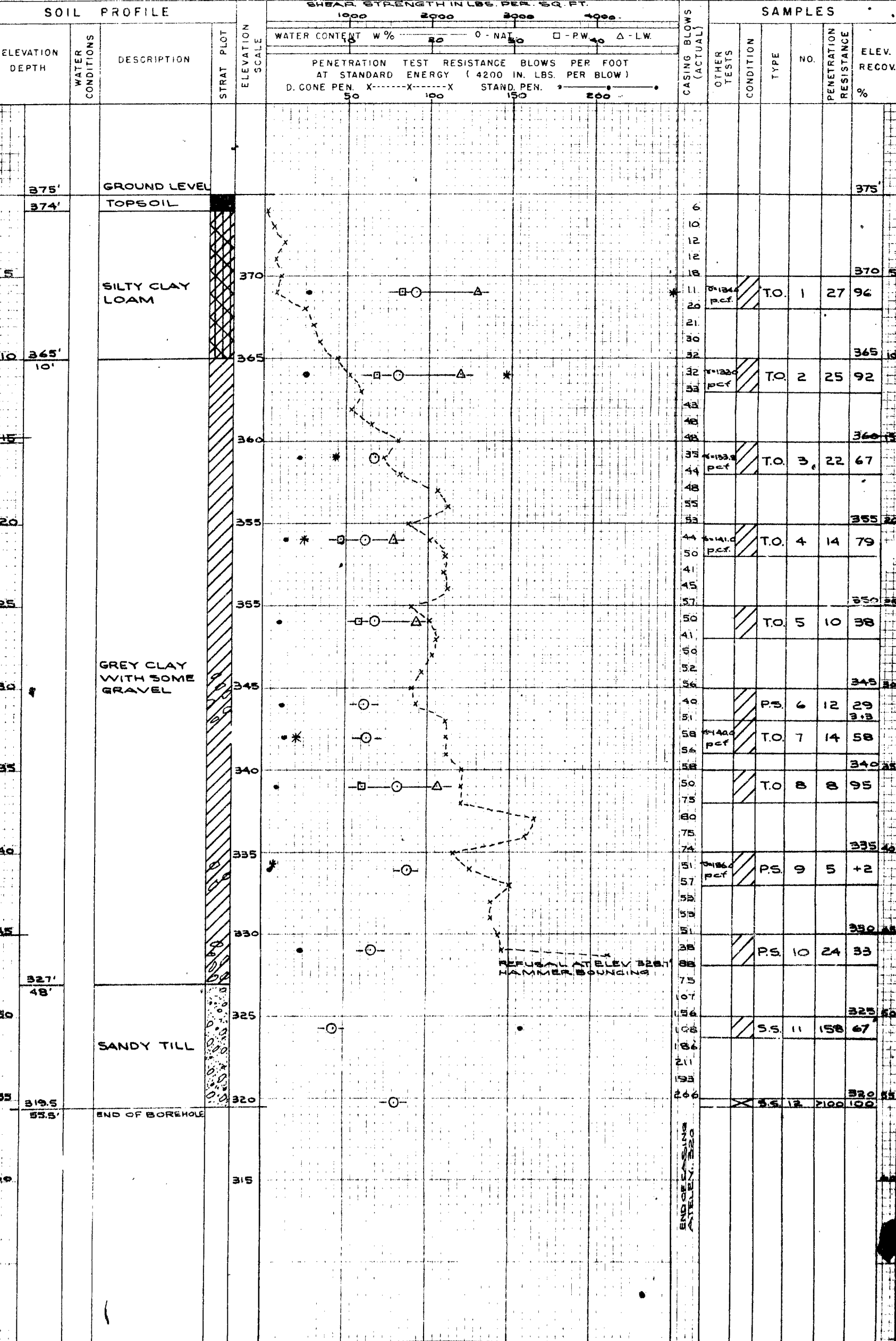
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DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH BRANCH - FOUNDATIONS SECTION - DOWNSVIEW
OFFICE REPORT ON SOIL EXPLORATION

DRILL RIG 54-6 OPERATION BORE & PENET'N JOB F-58-18 WP 55-58 BORING 3 STA. 572+51 (45' LT)
CASING EX (standard samplers to fit unless noted) DATUM GEODETIC DATE REPORT JULY 1958
SAMPLER HAMMER WT. 250 LBS. DROP 19 INCHES COMPILED BY H.S. CHECKED BY AL DATE BORING 20 JUNE 1958

ABBREVIATIONS			SAMPLE TYPES		SAMPLE CONDITION	
V - INSITU VANE SHEAR TEST	Q - TRIAXIAL QUICK	K - PERMIABILITY	C.S. - CHUNK	S.S. - SLEEVE SAMPLE		- DISTURBED - FAIR - GOOD - LOST
M - MECHANICAL ANALYSIS	S - TRIAXIAL SLOW	C - CONSOLIDATION	D.O. - DRIVE OPEN	PS - PISTON SAMPLE		
U - UNCONFINED COMPRESSION	WL - WATER LEVEL IN CASING	CA - CASING	D.F. - DRIVE FOOT VALVE	WS - WASHED SAMPLE		
Qc - TRIAXIAL CONSOLIDATED QUICK	WT - WATER TABLE IN SOIL	γ - UNIT WEIGHT	T.O. - THIN WALLED OPEN	R.C. - ROCK GORE		







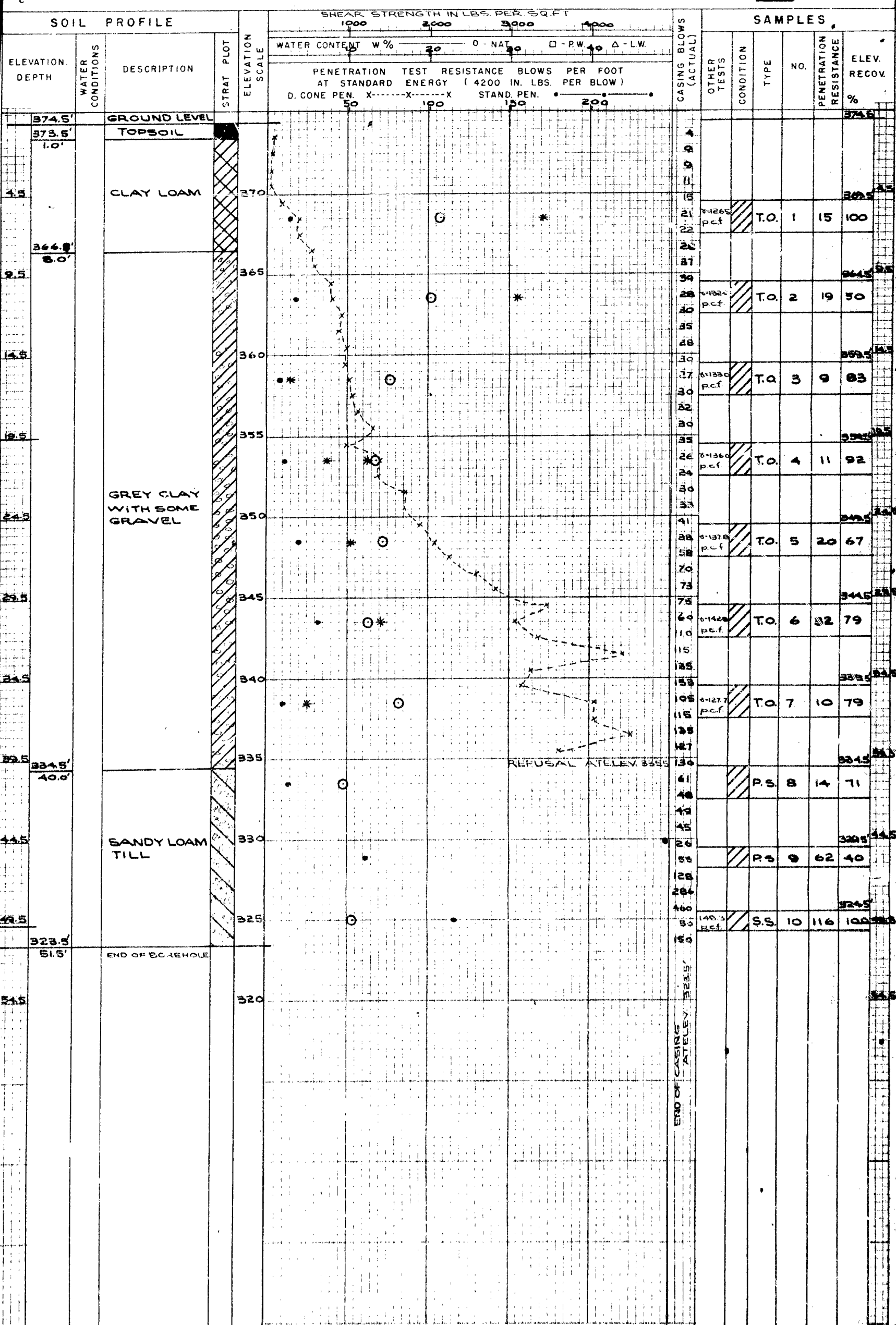
DRILL RIG 54-6 OPERATION BORE & PENET'N JOB F-58-18 W.P. 53-58 BORING 4 STA. 572+00(45'RT)
CASING BX (standard samplers to fit unless noted) DATUM GEODETIC DATE REPORT JULY 1958
SAMPLER HAMMER WT. 250 LBS. DROP 19 INCHES COMPILED BY H.S. CHECKED BY A.L. DATE BORING 25 JUNE 1958

ABBREVIATIONS

SAMPLE TYPES

SAMPLE CONDITION

V - INSITU VANE SHEAR TEST	Q - TRIAXIAL QUICK	K - PERMIABILITY	C.S. - CHUNK	S.S. - SLEEVE SAMPLE		- DISTURBED
M - MECHANICAL ANALYSIS	S - TRIAXIAL SLOW	C - CONSOLIDATION	D.O. - DRIVE OPEN	P.S. - PISTON SAMPLE		- FAIR
U - UNCONFINED COMPRESSION	WL - WATER LEVEL IN CASING	CA - CASING	D.F. - DRIVE FOOT VALVE	WS - WASHED SAMPLE		- GOOD
Q - TRIAXIAL CONSOLIDATED QUICK	WT - WATER TABLE IN SOIL	γ - UNIT WEIGHT	T.O. - THIN WALLED OPEN	R.C. - ROCK CORE		- LOST



Department of Highways

COPY

For the Information of:

Mr. Korlu,
Foundation Engineer,
Department of Highways,
Downsview, Ontario.

Toronto 5,
October 16, 1958.

MEMORANDUM TO:

Mr. A. M. Toye,
Bridge Engineer.

RE: W.P. 55-58,
Soils F58-18.

The case No. III is taken as most convenient with the following considerations:

1. Use of Piles: In this case, as recommended in our submitted report, the piles will be driven down to the hard till layer, and as end bearing piles are capable to provide sufficient support for the foundations. The lateral pressure will be overcome by batter piles.
2. Use of spread footings: It is understood that a bearing value of $\frac{23.1}{6.5} = 3.5$ k.s.f. is needed to support the spread footings. A convenient elevation to place the footings will be elevation 361 ft.
 - (1) The footing is 3.5 ft. high and from the design there is a 1.6 K/lin. ft. horizontal pressure which has to be ^{counteracted} ~~contracted~~ by the soil on the inside surface. The minimum shear value of 500 p.s.f. will provide $3.5 \times 500 = 1.75$ k/lin. ft., this gives a safety factor of $\frac{1.75}{1.6} = 1.1$. If maximum shear value of

-2-

800 p.s.f. is used then the safety factor will be

$$\frac{2.8}{1.6} = 1.75. \text{ If an average can be taken then a}$$

safety factor of 1.4 is available.

- (2) The footing will exert about 3.5 k.s.f. vertical pressure on the soil. The soil measured from laboratory tests has shear value ranging from 500 to 800 p.s.f. This, calculated from Meyerhof's formula, can provide a bearing value of 3 to 4.8 k.s.f. If an average value were taken it will be 3.9 k.s.f. and with a safety factor of 3 (as recommended by Terzaghi) the safe allowable bearing value will be 1.3 k.s.f.

The vertical load of 2 t.s.f. will cause settlement of the footings in about 31 ft. of clay layer which lies between elevations 361 to 330 ft. From the laboratory tests the Compression index (C_c) of the layer was measured to be $C_c = 0.115$ and the coefficient of consolidation $C_v = 0.25$ ~~square~~ ² ft. per day. The measured settlement is 1.75 inch of which the 50% will take place in two years and the 90% in about 10 years.

The exertion of the vertical load by the footing on the subsoil will induce lateral pressures in the subsoil. This lateral stress distribution

is presented by Taylor's chart. According to this chart the maximum shear stress developed due to the vertical pressure (P) of the footing is given

$$S = \frac{P}{3.14} \text{ at a depth equal to half the width of the}$$

footing. In this case it will be $S = \frac{3500}{3.14} = 1100$

p.s.f. This shear will be counteracted by the measured soil shear of the layer at this elevation, which is average 500 p.s.f.

A stability calculation was made for the entire footing by using Wilson's slip circle, which determines the factor of safety by dividing the Resisting moment by the Overturning moment about the calculated slip center, i.e.

$$F_s = \frac{\sum sR}{Wz}$$

In this case a shear value of 650 k.s.f. was used and the F_s was found to be 1.4. The recommended F_s is 2 or 3.

Conclusion: From this discussion it follows that:

1. For the design type III (considered to be the most convenient type) the horizontal earth pressure of 1.6 K/lineal ft.) acting on the footing could be overcome by the shear provided by the soil (2.3 K/lin. ft.) with a safety factor of 1.4 (recommended least $F_s = 2$).

The vertical pressure of $\frac{23.1}{6.5} = 3.5$ k.s.f.

exerted by the footing placed at elevation 361 ft. will give rise to two effects.

First of all it will cause settlement of 1.75 inch (more than allowable one inch). Of this total settlement 50% will take place in 2 years time and 90% in ten years time.

The second effect is the induced shear stress in the subsoil. According to Taylor's chart the maximum induced shear stress will be 1180 k.s.f. at elevation 357 ft. At this elevation the laboratory measured shear strength of the soil is only 500 k.s.f. This situation theoretically will imply the failure of the footing by slip.

By using Wilson's chart the safety factor against circular arc slip was measured and was found to be 1.4 (recommended safety factor is 2 to 3).

(2) It appears that judging from the accepted safety factor standards the subsoil cannot provide sufficient shear value to justify the use of spread footing type foundations for supporting the proposed structure.

(3) End bearing piles appear to be the safest means of support of the foundations.

Department of Highways

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For the Information of:

- 5 -

4. If the vertical reaction on the soil is reduced to 2.5^k/sq. ft. the structure would be safe against horizontal shear slip and Wilson slip circle would provide a S.F. of approx. 2. The vertical settlement would remain approximately the same.

FK:CP

F. Korlu,
Foundation Engineer.

100,000

1st sheet - grey clay layer count 1400 P.S.F.

Key test. line F gravel Rd lot 28 - Dep.
3 miles N of Key.

W.P.F. - 58.

W.J.F. - 58 - 18.

20' below gravel Rd surface.

cc: Foundation Section

Mr. A. Toye

August 29/58.

Bridge Engineer

Materials & Research Section

Re: Foundation Report Hwy. #4
line "F" crossing gravel road
between lots 28 & 29 (Con. I), about
3 miles W. of Cobourg, Twp. of Ham-
on. W.P. 55-58 W.J. F-58-15

Attached please find two copies of the above mentioned report.

The gray clay layer can not provide more than 0.7 T.s.f. bearing value for supporting spread footing type foundations placed at a convenient elevation.

It will be convenient to support the footings by means of end bearing piles driven to refusal at about elevation 325 feet.

A. Rutka
Acting Materials & Research Engr.

cc: Mr. A. Toye
H. Tragaskas
D.G. Ramsay
H.D. Huff
A. Watt
Dr. P. Karrow
Foundation Section /
File

Per: *[Signature]*
V. Korlu
Foundation Engineer

VK/cl