

MEMORANDUM

23-65-263

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

FROM: Foundation Section,
Materials & Research Div.,
Room 107, Lab. Bldg.

Attention: Mr. S. McCombie

DATE: June 30, 1964

OUR FILE REF.

IN REPLY TO

SUBJECT:

FOUNDATION INVESTIGATION REPORT

For

A Proposed Structure at E.-W. 401
over W.B. Collector Road (Islington
Avenue Interchange), District No. 6

W.J. 64-F-35

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W.P. 243-63

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

We believe that you will find the factual data and recommendations contained therein, adequate for your future design work. Should you require additional information, please do not hesitate to contact our Office.

KYL/MdeF
Attach.

cc: Messrs. A. M. Toye
H. A. Tregaskes
H. D. McMillan
G. K. Hunter (2)
C. Fraser
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for A. G. Stermac,
PRINCIPAL FOUNDATION ENGINEER

Foundations Office
Gen. Files

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FOUNDATION INVESTIGATION REPORT

For

A Proposed Structure at E.-W. 401
over W.B. Collector Road (Islington
Avenue Interchange), District No. 6
W.J. 64-F-35 -- W.P. 243-63

1. INTRODUCTION:

As requested by Mr. J. B. Curtis, Regional Bridge Location Engineer, on April 28, 1964, a foundation investigation at the above-noted site was carried out by this Section during the period from May 26 to May 28, 1964. This report contains the results of the field investigation and the laboratory tests, together with the recommendations pertaining to the design of the structure foundations and approach embankments.

2. DESCRIPTION OF THE SITE:

The site is located about a quarter of a mile east of the existing interchange of Hwy. 401 and Islington Avenue of Metropolitan Toronto and is on the north side of the same highway. The area is in general, fairly flat and is covered by grass lawn.

3. DESCRIPTION OF FIELD AND LABORATORY WORK:

The field work was carried out by means of a Pennsylvania type drillrig machine adapted for soil sampling.

During the investigation, four sampled boreholes were driven. Samples were recovered at required depths by means of a

cont'd. /2 ...

3. DESCRIPTION OF FIELD AND LABORATORY WORK: (cont'd.) ...

2" O.D. split-spoon sampler. The dimensions of the split-spoon sampler and the energy used in driving it, conform to the requirements of the Standard Penetration Test.

The locations and elevations of all boreholes are shown on Drawing #64-F-35A which accompanies this report.

Samples were visually examined and identified in the field as well as in the laboratory. Atterberg limits and moisture content tests were determined on a selection of samples in order to classify the material according to Casagrande's Plasticity Chart.

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

4. SUBSOIL CONDITIONS:

Subsoil conditions in the area are fairly uniform and favourable. It was found to consist mainly of a deposit of glacial till consisting of clayey silt, sand and traces of fine gravel. The consistency of the material is in general, hard.

Underlying a thin layer of topsoil, the desiccated layer of oxidized, brown clayey silt with sand and fine gravel was observed in all the boreholes. The thickness of this layer ranges from 12 to 15 feet. The same material is grey in colour under this oxidized zone.

Atterberg limit determinations of the soil indicate that the moisture content ranges from 10% to 20%, the plastic limit is between 12% to 22% and the liquid limit is between 17% to 32%. According to the Unified Soils Classification System, the soil is classified as inorganic clayey silt.

cont'd. /3 ...

5. GROUND WATER CONDITIONS:

No attempt was made to establish an accurate ground water level by means of piezometers. Observations carried out during the time of the investigation showed that the water level in the ground was quite close to the ground surface. The ground water level observed in another job site (64-F-37) about 1/2 mile east of this job site, is approximately 2 to 4 ft. below the natural ground. Reviewing the water level at equilibrium condition in B.H. #4, which is 3.4 ft., we could assume that the ground water level at this job site is about 2 to 4 ft. below the natural ground.

6. DISCUSSION AND RECOMMENDATIONS:

It is proposed to construct a three-span bridge at E.-W. 401 over W.B. collector road at the future Islington Avenue interchange.

Subsoil at the site consists of a deposit of hard clayey silt with sand and fine gravels (glacial till).

Subsoil conditions are favourable for spread footing type of foundations at this location. The proposed structure should therefore be supported on spread footings with a net bearing pressure of 3 T.S.F. A minimum of 6 ft. of cover for frost protection is recommended for the footings.

It is suggested that care should be taken to prevent softening of the foundation material by surface water during construction.

No slope stability problems will be encountered if standard side slopes horizontal to 1 vertical are used.

cont'd. /4 ...

7. SUMMARY:

The site is underlain by a deposit of hard glacial till consisting of clayey silt, sand and fine gravels.

It is recommended that the structure be supported on spread footings founded in the hard clayey silt till stratum. A minimum of 6.0' cover for frost protection should be provided. A safe design load of 3 T.S.F. may be used. No major dewatering and stability problems are anticipated.

8. MISCELLANEOUS:

The field work, performed during the period from May 26, 1946 to May 28, 1964, was undertaken by Mr. T. Chan, Project Foundation Engineer, who also wrote this report. The investigation was carried out under the general supervision of Mr. M. Devata, Senior Foundation Engineer, who also reviewed this report.

June 1964.


APPENDIX I

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 1

FOUNDATION SECTION

JOB 64-F-35 LOCATION Hwy. 401, Sta. 410/44, 255' Rt. ORIGINATED BY T.C.
W.P. 243-63 BORING DATE May 27, 1964. COMPILED BY T.C.
DATUM G.S.C. BOREHOLE TYPE Pennsylvania Type Auger CHECKED BY M.D.

SOIL PROFILE			SAMPLES			ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT			LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W			BULK DENSITY POUNDS PER CUBIC FOOT	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.			WATER CONTENT % WD — W — WL					
488.3	Groundlevel					485									
0.0	Topsoil														
	Clayey silt with sand and fine gravel, hard, brown, oxidized (Glacial till)		1	SS	43										
			2	SS	50										
			3	SS	69										
475.3	Brown changing to grey at El. 475.3 approximately.		4	SS	41	475									
13.0			5	SS	39										
			6	SS	33										
						465									
		7	SS	42											
457.3	A sand layer (7") at El. 457.9 approx.	8	SS	63/6"	455										
31.0															

▼ W.L.
at El. 464.
W.L. observed
one day after
the borehole
was
completed.




W.L. at El. 464.7
W.L. observed one day after the borehole was completed.

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 2

FOUNDATION SECTION

JOB 64-P-35 LOCATION Hwy. 401, Sta. 409+60, 188' Rt. ORIGINATED BY T.C.
 W.P. 243-63 BORING DATE May 27, 1964. COMPILED BY T.C.
 DATUM G.S.C. BOREHOLE TYPE Pennsylvania Type Auger CHECKED BY M.D.

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 % 10 20 30			
487.2	Groundlevel											
0.0	Topsoil											
	Clayey silt with sand and fine gravel, hard, brown, oxidized, (Glacial till) soil very silty between 12'-16'.					485						
			1	SS	28							
			2	SS	39							
			3	SS	68							
			4	SS	103	475						
471.2	Brown changing to grey at El. 471.2 approximately.		5	SS	35							
16.0			6	SS	33							
						465						
			7	SS	27							
			8	SS	54							
	Soil is very hard from 31' (El. 456.2) downward.					455						
			9	SS	67 1/4"							
448.2			10	SS	62 1/5"							
39.0	End of borehole.					445						

W.L.
at El. 473.8
W.L. observed one day after the borehole was completed.

W.L.
at El. 473.8
W.L. observe one day after the borehole was completed.

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 4

FOUNDATION SECTION

JOB 64-F-35 LOCATION Hwy. 401, Sta. 406+00, 104' Rt. ORIGINATED BY T.C.
W.P. 243-63 BORING DATE May 26, 1964. COMPILED BY T.C.
DATE G.S.C. BOREHOLE TYPE Pennsylvania Type Auger CHECKED BY M.D.

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT ——— WL PLASTIC LIMIT ——— WP WATER CONTENT ——— W		BULK DENSITY PCCK T	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.		WP	WL		
469.2	Groundlevel											
0.0	Topsoil											
	Clayey silt with sand and fine gravel, hard brown, oxidized. (Glacial till)		1	SS	13	465						W.L. at El. 465.8
			2	SS	24							W.L. observed one week after the borehole was completed.
458.2	Brown changing to		3	SS	41							
11.0	Grey at El. 458.2, approximately.		4	SS	50	455						
			5	SS	42							
			6	SS	40	445						
			7	SS	20/2"							
			8	SS	60/4"							
30.9	End of borehole.					435						

ABBREVIATIONS USED IN THIS REPORT

PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE 'N' - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES.

DYNAMIC PENETRATION RESISTANCE - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL, THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW.

DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS:-

<u>CONSISTENCY</u>	<u>'N' BLOWS / FT.</u>	<u>c LB. / SQ. FT.</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT.</u>
VERY SOFT	0 - 2	0 - 250	VERY LOOSE	0 - 4
SOFT	2 - 4	250 - 500	LOOSE	4 - 10
FIRM	4 - 8	500 - 1000	COMPACT	10 - 30
STIFF	8 - 15	1000 - 2000	DENSE	30 - 50
VERY STIFF	15 - 30	2000 - 4000	VERY DENSE	> 50
HARD	> 30	> 4000		

TYPE OF SAMPLE

S.S.	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.B.	SCRAPER BUCKET SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE
S.T.	SLOTTED TUBE SAMPLE		
	P.H. SAMPLE ADVANCED HYDRAULICALLY		
	P.M. SAMPLE ADVANCED MANUALLY		

SOIL TESTS

Qu	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V.	FIELD VANE
Qcu	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Qd	DRAINED TRIAXIAL	S	SENSITIVITY

ABBREVIATIONS USED IN THIS REPORT

SOIL PROPERTIES

γ	UNIT WEIGHT OF SOIL (BULK DENSITY)
γ_s	UNIT WEIGHT OF SOLID PARTICLES
γ_w	UNIT WEIGHT OF WATER
γ_d	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
γ'	UNIT WEIGHT OF SUBMERGED SOIL
G	SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$
e	VOID RATIO
n	POROSITY
w	WATER CONTENT
S_r	DEGREE OF SATURATION
w_L	LIQUID LIMIT
w_P	PLASTIC LIMIT
I_P	PLASTICITY INDEX
s	SHRINKAGE LIMIT
I_L	LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
I_c	CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
e_{max}	VOID RATIO IN LOOSEST STATE
e_{min}	VOID RATIO IN DENSEST STATE
I_D	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY D_r IS ALSO USED
h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
k	COEFFICIENT OF PERMEABILITY
j	SEEPAGE FORCE PER UNIT VOLUME
m_v	COEFFICIENT OF VOLUME CHANGE = $\frac{-\Delta e}{(1+e)\Delta\sigma}$
c_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX = $\frac{\Delta e}{\Delta \log_{10} \sigma}$
T_v	TIME FACTOR = $\frac{c_v t}{d^2}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
τ_f	SHEAR STRENGTH
c'	EFFECTIVE COHESION INTERCEPT
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
μ	COEFFICIENT OF FRICTION
S_t	SENSITIVITY

GENERAL

π	= 3.1416
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e \sigma$ OR $\ln \sigma$	NATURAL LOGARITHM OF σ
$\log_{10} \sigma$ OR $\log \sigma$	LOGARITHM OF σ TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

STRESS AND STRAIN

u	PORE PRESSURE
σ	NORMAL STRESS
σ'	NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED)
τ	SHEAR STRESS
ϵ	LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO (μ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
η	COEFFICIENT OF VISCOSITY

EARTH PRESSURE

d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_0	COEFFICIENT OF EARTH PRESSURE AT REST

FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
β	ANGLE OF SLOPE TO HORIZONTAL

#64-F-35

W.P. #243-63

HWY. #401 OVER

W.B. COLLECTOR

RD.

