

63-F-230M

LOT 25, CON. VIII

BA 1751

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STRUCTURE SITE No. 12-333

Report on
SOIL INVESTIGATION
for
ROAD BRIDGE
LOT 25, CONCESSION VIII
TOWNSHIP OF GREY

63-F-2304

by
DOMINION SOIL INVESTIGATION LIMITED
363 Queens Avenue
LONDON ONTARIO
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SUMMARY

Loose to compact deposits of sand and silt extend to El.1137 (\pm). A very stiff to hard cohesive till exists between El.1137 and the limestone bedrock which was encountered at El.1125.4 \pm 1 feet.

It is proposed that the structure should be supported on spread footings, bearing in the till below El.1135 feet. A gross soil pressure of 5000 p.s.f. is recommended.

The dewatering and restraining of the pervious upper strata may present some problems. It is proposed that the construction should be carried out within an enclosure of sheet piling driven into the till.

I INTRODUCTION

Verbal authorization was received from the office of Mr. B. M. Ross to carry out a soil investigation at a site in the Township of Grey, where it is proposed to construct a new road bridge. The new structure will carry a realigned road across the Maitland River, and will replace two other structures which presently support the road about 350 feet upstream.

A plan of the site was supplied showing the outlines of the existing bridges and the proposed new structure which will probably consist of two 50-foot spans. The requirements of the project were discussed with Mr. K. G. Dunn.

The purpose of this investigation has been to reveal the subsurface conditions and to determine the necessary soil properties for the design and construction of foundations.

II PHYSIOGRAPHY

The site is located approximately 10 miles west of the town of Listowel in the extensive physiographic region known as the Stratford Till Plain. The characteristic soil formation is a dense ground moraine deposited by the advancing glaciers. Meltwaters have created a system of drainage channels running north and west to the Huron Basin. These channels or spillways are now occupied by smaller streams such as the Maitland River on which this site lies.

The bedrock which was encountered at relatively shallow depth is Norfolk limestone.

III FIELD WORK

Field work was carried out during the period 4th to 9th of December 1963, and consisted of 2 boreholes at the locations shown on enclosure 2. Dynamic cone penetration tests were performed adjacent to each borehole. The holes were advanced by wash boring and lined with Bx (3-inch) casing. Rock core was extracted from the bedrock by diamond drilling using an Axt core barrel.

Standard Penetration tests were performed at frequent intervals of depth to determine the relative density or consistency of the soil, and to recover disturbed samples. The dynamic cone penetration tests provide a continuous record of penetration resistance and reveal abrupt changes in stratification.

The results of the field tests are recorded on geotechnical data sheets comprising enclosures 3 and 4. Elevations have been referred to a local geodetic datum (deck of existing 90-foot truss, assumed El.1158.3 feet).

IV SUBSURFACE CONDITIONS

Details of the stratification at each borehole are shown in the data sheets and a general picture of the subsurface conditions is given by the profile on enclosure 2.

Above El.1137 (\pm) the strata are *loose* or *compact* deposits of sand and silt containing varying proportions of organics and clay. These strata appear to be of alluvial origin and have probably been deposited by the original glacial river.

Below El.1137 feet the soil is a *very stiff* to *hard* till. The upper 3 feet of this material at borehole 1 is predominantly clayey and contains about 10% of fine gravel particles. The remainder of the deposit is a dense cohesive silt of low permeability, containing up to 25% of subangular gravel particles generally less than one inch in diameter. The gravel content increases with depth towards the bedrock.

The bedrock was encountered at an average elevation of 1125.4 feet. It consists of Norfolk limestone and is highly porous and fossilized. The percentage of core recovery in the upper layers was very low (25 to 33%) indicating that the deposit is shattered or contains soft or soluble seams. Artesian water was encountered within the rock at El.1115 feet (\pm). Water flowed from the casing at an estimated rate of 4 to 5 gallons per minute, and the excess head of water was approximately 13 feet.

V FOUNDATIONS

It is assumed that the level of the river bed is at or near El.1138 feet indicating that footings should bear at El.1133 or 1134 feet, allowing for erosion. This level lies within the till which is an adequate foundation material.

Below El.1135 the minimum 'N' value is 16 with an average value of 25. In a clay, the value $N = 16$ corresponds to an allowable soil pressure of 4000 p.s.f. whereas in a sand at this depth, it indicates a relative density of about 55% and an allowable soil pressure of 6000 p.s.f. The till combines the properties of both cohesive and granular materials, and in the present case a gross soil pressure of 5000 p.s.f. is proposed for the design of

the footings. Provided that the footings are poured on a clean undisturbed grade, the total settlement is not expected to exceed one inch nor differential settlement to exceed 3/4-inch. Most of the settlement will occur immediately as the loads are applied.

It will be necessary to provide bracing for vertical excavations through the sand and silt strata above El.1137 feet. The material below the water table (El.1141) will flow horizontally if it is not restrained. Seepage through the till will be small, but through the sand and silt strata it will be considerable unless the river can be diverted some distance from the site. To overcome the dewatering problem it is recommended that steel sheet piling should be driven into the till to form a more or less watertight enclosure around each abutment or pier. Seepage water should be collected in sumps dug below the footing grade, and removed by pumping.

It is unlikely that any advantage would be gained by extending the construction to bedrock, but for information the following notes are given. The conditions for driving piles would be hard, and steel H-piles would be the most suitable. These might penetrate as much as 3 feet below the rock surface. For footings or caissons bearing on the rock a pressure of 20,000 p.s.f. may be used.

VI REFERENCES

1. The Physiography of Southern Ontario by L. J. Chapman and D. F. Putnam of the Ontario Research Foundation - University of Toronto Press 1951.
2. Procedures for Testing Soils, ASTM, April 1958. pp. 186 to 198. (Unified Soil Classification System - by A. A. Wagner).
3. Proceedings of the 4th International Conference on Soil Mechanics and Foundation Engineering (Research on Determining the Density of Sands by Spoon Penetration Testing - by H. J. Gibbs and W. G. Holtz of the United States Bureau of Reclamation.) London, 1957.
4. Terzaghi and Peck: Soil Mechanics in Engineering Practice. John Wiley and Sons, New York 1948.
5. National Building Code of Canada, 1960, Part 4, Design, Section 4.2 Foundations.



DOMINION SOIL INVESTIGATION LIMITED

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LIST OF SYMBOLS, ABBREVIATIONS AND NOMENCLATURE.

SOIL COMPONENTS AND GROUND WATER CONDITIONS.

BOULDER	COBBLE	GRAVEL		SAND			SILT	CLAY	ORGANICS	BEDROCK	GROUND WATER LEVEL	DEPTH OF CAVE-IN
		COARSE	FINE	COARSE	MEDIUM	FINE						
Ø	> 8"	3"	¾"	4.75mm	2.0	0.42	0.074	0.002	>	NO SIZE LIMIT		
U.S. Standard Sieve Size :				No. 4	No. 10	No. 40	No. 200					

SAMPLE TYPES.

AS Auger sample	RC Rock core	TP Piston, thin walled tube sample
CS Sample from casing	% Recovery	TW Open, thin walled tube sample
ChS Chunk sample	SS Split spoon sample	WS Wash sample

SAMPLER ADVANCED BY	static weight : w	OBSERVATIONS MADE WHILE CORING	Steady pressure
"	pressure : p		No pressure
"	tapping : t		Intermittent pressure

Washwater returns
Washwater lost

PENETRATION RESISTANCES.

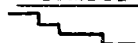
DYNAMIC PENETRATION RESISTANCE : to drive a 2" ϕ , 60° cone attached to the end of the drilling rods into the ground, expressed in blows per foot.

STANDARD PENETRATION RESISTANCE, -N- : to drive a 2" outside dia, split spoon sampler 1 foot into the ground, expressed in blows per foot.

EXTRAPOLATED -N- VALUE

The energy for the penetration resistances is supplied by a 140 lb. hammer falling 30 inches

SYMBOL :



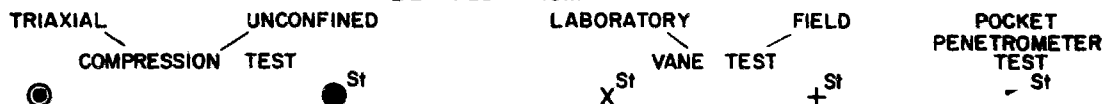
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SOIL PROPERTIES.

W % Water content	γ Natural bulk density (unit weight)	k Coeff. of permeability
LL % Liquid limit	e Void ratio	C Shear strength in terms of total stress
PL % Plastic limit	RD Relative density	ϕ Angle of int. friction in terms of effective stress
PI % Plasticity index	C _v Coeff. of consolidation	C' Cohesion
LI Liquidity index	m _v Coeff. of volume compressibility	ϕ' Angle of int. friction

UNDRAINED SHEAR STRENGTH.

- DERIVED FROM -



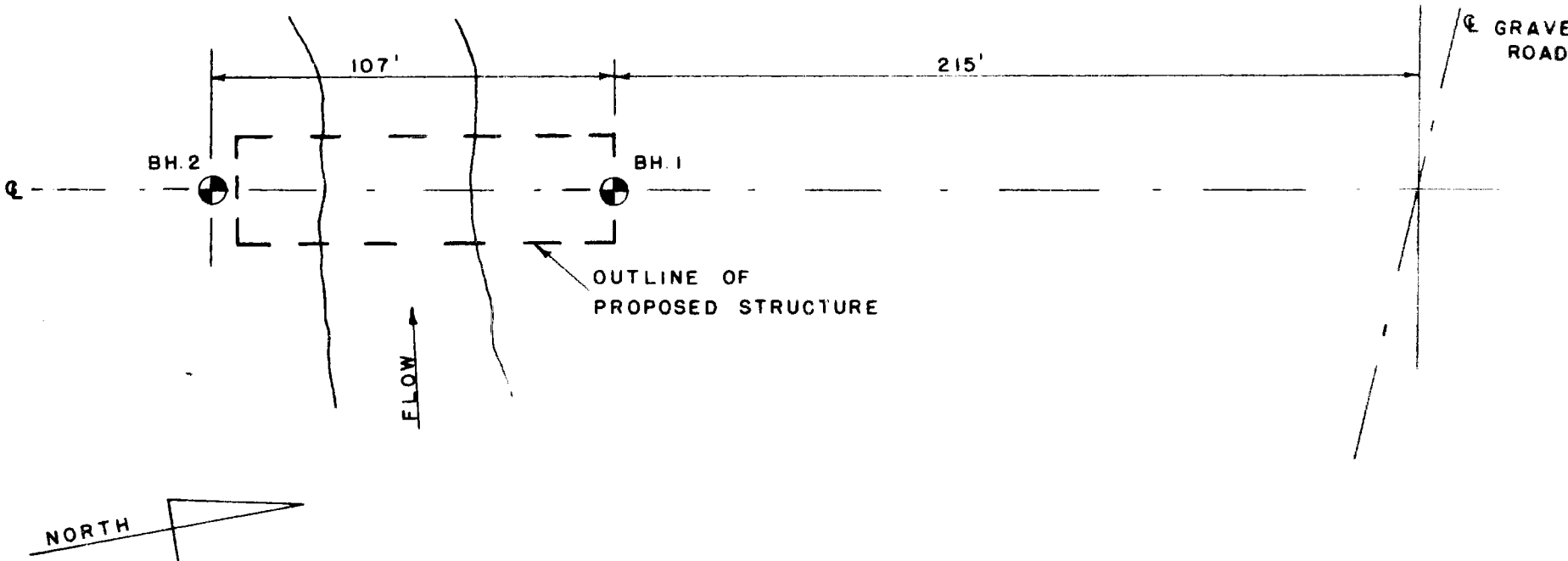
Strain at failure is represented by direction of stem

20%
15% + 5%
10%

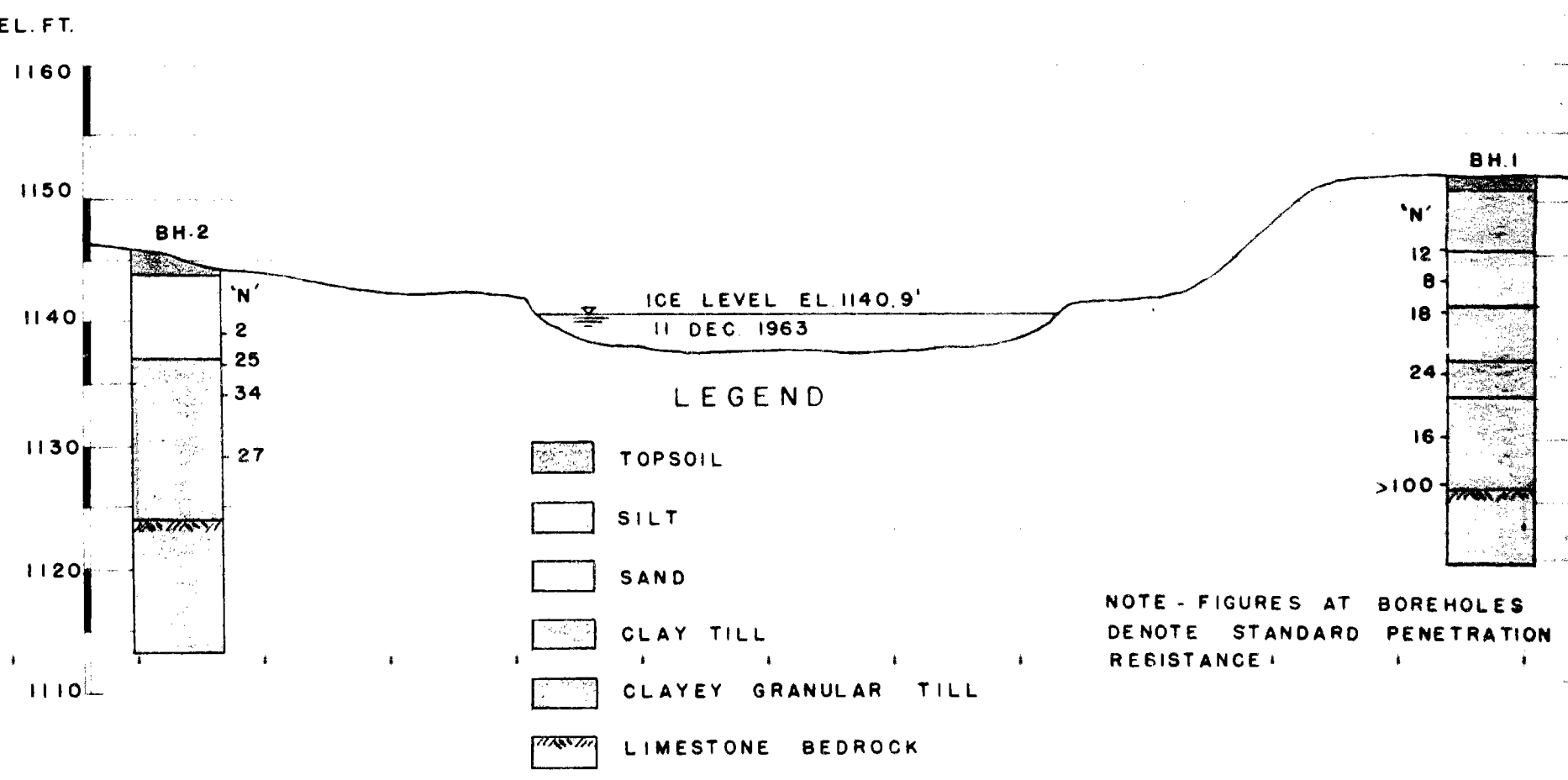
St : sensitivity = $\frac{\text{shear strength in undisturbed state}}{\text{shear strength in remoulded state}}$

SOIL DESCRIPTION.

COHESIONLESS SOILS :	RD :	COHESIVE SOILS :	C lbs/sq.ft.
Very loose	0 - 15 %	Very soft	less than 250
Loose	15 - 35 %	Soft	250 - 500
Compact	35 - 65 %	Firm	500 - 1000
Dense	65 - 85 %	Stiff	1000 - 2000
Very dense	85 - 100 %	Very stiff	2000 - 4000
		Hard	over 4000



LOCATION OF BOREHOLES
SCALE: 1 INCH TO 40 FEET



SUBSURFACE PROFILE
SCALE: 1 INCH TO 12 FEET

OUR REFERENCE NO. 5-12-L2

GEOTECHNICAL DATA SHEET FOR BOREHOLE . . . 1 . . .

CLIENT: Mr. B. M. Ross
 PROJECT: Road Bridge
 LOCATION: Township of Grey
 DATUM ELEVATION: Geodetic

METHOD OF BORING: Washboring
 DIAMETER OF BOREHOLE: 8x (3-1/2 inch)
 DATE: December, 1963.

ENCLOSURE NO. 5

ELEVATION ft.	DEPTH ft.	STRATIFICATION DESCRIPTION	STRATIFICATION SYMBOL	SAMPLES			PENETRATION RESISTANCE blows per foot		CONSISTENCY water content %		REMARKS
				NUMBER	TYPE	N or Advancement of Sampler	20	40	60	80	
1151.7		Ground Surface									
50		Organic silty topsoil.									
5		Brown weathered sandy silt, damp, compact, trace of organics. -- clayey		1	SS	12					
45		Fine brown sand, compact, damp.		2	SS	8					
10											
40		Grey silt, compact, trace of clay.		3	SS	18					
15											
35		Very stiff grey clay till.		4	SS	24					
20											
30		Grey clayey, sandy gravelly silt till, moist, very stiff.		5	SS	16					
25				6	SS	100					
25		Limestone bed- rock, shattered, porous.		7	RC Axt 33%						
30											
20		End of borehole									

2" ϕ cone

Ice Level
in river
El. 1140.9'
11 Dec. '63.

VERTICAL SCALE: 1 IN 10 5 FT

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MADE SB CHD JP

OUR REFERENCE NO. 3-12-L2

GEOTECHNICAL DATA SHEET FOR BOREHOLE . 2

CLIENT: Mr. B. M. Ross
 PROJECT: Road Bridge
 LOCATION: Township of Grey
 DATUM ELEVATION: Geodetic

METHOD OF BORING: Washboring
 DIAMETER OF BOREHOLE: 8x (3-inch)
 DATE: December, 1963.

ENCLOSURE NO. 4

ELEVATION ft.	DEPTH ft.	STRATIFICATION DESCRIPTION	STRATIFICATION SYMBOL	SAMPLES			PENETRATION RESISTANCE blows per foot					CONSISTENCY water content %			REMARKS
				NUMBER	TYPE	N- or Advancement of Sampler	20	40	60	80	100	PL	W	LI	
1145.4		Ground Surface													
		Organic sandy topsoil.													
	5	Dark grey silty sand mixed with organics, loose, wet.		1	SS	2									
				2	SS	25									
	10			3	SS	34									
	15	Grey clayey sandy gravelly silt till, moist very stiff to hard.													
	20	very gravelly		4	SS	27									
	25														
	25			5	RC Axt 23%										
	30	Limestone bed-rock, shattered, porous.		6	RC Axt 66%										
				7	RC Axt 70%										
		End of borehole													

2" Ø cone

Ice Level in river
 El. 1140.9'
 11 Dec. '63

Artesian pressure was encountered at 30.0 feet (±). Excess head was 13 feet of water.

VERTICAL SCALE: 1 IN. TO 5 FT.

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MADE: SB

CH'D: JP