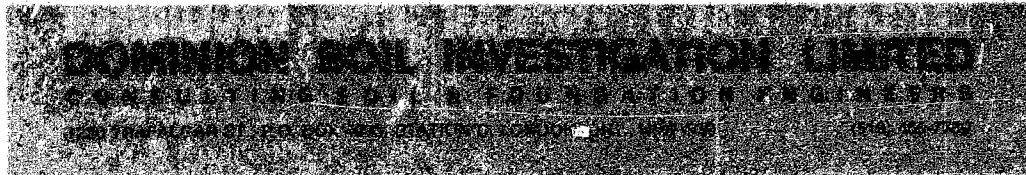


NEW BRIDGE.

LOT 20/21, CON. 2

HIBBERT TWP.

40P11-12



B.M. ROSS & ASSOCIATES LIMITED
CONSULTING ENGINEERS
41 West Street
GODERICH ONTARIO

4DP11-12
GEOCRES No.

Report On
SOIL INVESTIGATION
for
PROPOSED NEW BRIDGE
LOTS 20/21, CONCESSION 2
TOWNSHIP OF HIBBERT

by

Dominion Soil Investigation Limited
1220 Trafalgar Street
London Ontario

Ref: 74-2-L7
April 16, 1974

§

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I

INTRODUCTION

In accordance with a letter of authorization dated February 27, 1974, from B.M. Ross & Associates Limited, Consulting Engineers, a soil investigation has been carried out in the Township of Hibbert, where it is proposed to replace an existing bridge with a new structure.

The existing 47 foot span steel truss structure is located at Lots 20-21, Concession 2 of the Township, where the sideroad crosses the Bayfield River.

It is understood that the proposed structure is a 60 foot span reinforced concrete rigid frame bridge on a 30 degree skew, and the centre line of the new structure will be located 200 feet to the south of the existing south abutment face. The requirements of the project were discussed with Mr. K.G. Dunn, P.Eng., who supplied the foregoing information.

The purpose of the investigation was to reveal the subsurface conditions at the site, and to determine the relevant soil properties for the design and construction of the new foundations.

II

FIELD WORK

The field work, consisting of two boreholes, was carried out on March 25, 1974, at the locations shown on Enclosure 2. The holes were advanced to the sampling depths by a continuous flight power auger machine, which was equipped with hollow-stem augers for soil sampling.

Standard penetration tests were performed at frequent intervals of depth, as detailed in Appendix 'A', and the results are recorded on the borehole logs as 'N' values. The split-spoon samples were stored in air-tight containers and transferred to our London laboratory for classification, testing and storage.

The field work was supervised by a soils engineer, who also related the ground surface elevations to a Geodetic benchmark. The benchmark was taken as a nail in the west face of a hydro pole at Station 13+07, and it was given a value El. 1071.56 feet. The benchmark was established by the client.

III

SUBSURFACE CONDITIONS

Detailed descriptions of the strata, which were encountered in each borehole, are given on the borehole logs comprising Enclosures 3 and 4. The following notes are intended only to amplify this data.

Both boreholes encountered surface layers of sand and gravel which form the existing road surface, overlying a topsoil layer which is presumably the original ground surface. The natural subsoil consists of a stratum of 'stiff' to 'hard' silty clay which contains seams and layers of sand and gravel, overlying 'compact' to 'dense' silt and silty fine sand material. At borehole 1 location the silty fine sand is underlain by a layer of 'very stiff' sandy silty clay and the borehole was terminated in a 'very dense' glacial sandy silt till, which was also encountered in borehole 2.

The relative density of the silt stratum, which was encountered in borehole 2, is described as 'dense' based on 'N' values of 40 and 47 blows per foot, and the relative density of the silty fine sand which was encountered in borehole 1 is described as

'compact' based on an 'N' value of 21 blows per foot. An unconfined compression test was performed on a sample of the 'very stiff' to 'hard' silty clay taken at El. 1057 in borehole 1, which resulted in an undrained shear strength value of 9100 p.s.f.

Moisture content tests were performed on two samples of the sandy silt till stratum in which both the boreholes were terminated, resulting in values of 7.8% and 8.7%. Due to the very dense nature of the sandy silt till, it exhibited some cementation.

IV

GROUNDWATER CONDITIONS

Equilibrium water levels were observed at El. 1058.7 and El. 1059.9 in boreholes 1 and 2 respectively, and the ice level in the adjacent river was observed at El. 1062.5. Due to the impervious nature of the silty clay and sandy silt till materials, it is possible that insufficient time was available during the short drilling period for the groundwater table to reach an equilibrium state in the boreholes, and for construction purposes it may be assumed that the prevailing groundwater table will be located slightly above the river level at any particular time.

V

DISCUSSION AND RECOMMENDATIONS

The existing river bed extends down to El. 1059.7, therefore it is recommended that spread footing foundations be located at or below El. 1055.5 to provide sufficient cover for protection against frost heave. The investigation has shown that the proposed footing elevation is at the interface between the 'hard' silty clay and the 'compact' silty fine sand at borehole 1 location, and lies within the silt stratum (slightly above the 'very dense' sandy silt) at borehole 2 location. To minimize problems associated with excavation and dewatering of the granular sand and silt materials, it would be advisable to maintain the footing grade within the 'hard' grey silty clay at borehole 1 location, and to lower the footing grade slightly at borehole 2 location to bear directly on the 'very dense' sandy silt till material. This latter measure would preclude difficulties in maintaining a stable subgrade within the silt stratum.

On the basis of the borehole results a maximum allowable soil pressure of 5000 p.s.f. is appropriate for the design of spread footing foundations at the recommended levels, and this soil pressure incorporates a factor of safety of 3 against shear failure of the underlying soil. Total settlement of footings 5 to 10 feet in width is estimated to be in the range 0.3 to 0.6 inch.

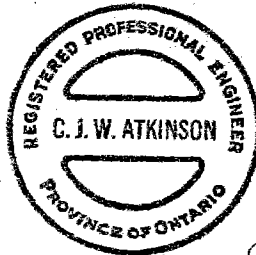
The coefficient of friction between the footings and the underlying soil may be taken as 0.35, and the factor of safety against horizontal sliding of the abutments must be at least 1.5.

In carrying out excavations, some problems may be encountered in excavating through the saturated silt and silty fine sand materials, however it is anticipated that sloughing of the sides of the excavation will be prevented by excavating to slopes of 1:1, or carrying out the excavations inside timber sheeting. It is possible that the sheeting may be placed after the excavation has been carried out.

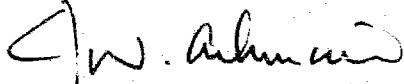
The native materials are not suitable for backfill behind abutments, therefore approved free-draining granular material should be used to prevent an out-of-balance hydrostatic pressure being exerted on the abutment by entrapped water.

Yours very truly,

DOMINION SOIL INVESTIGATION LIMITED



CJWA:eg


C.J.W. Atkinson, M.Sc., P.Eng.
Branch Manager

APPENDIX 'A'

THE STANDARD PENETRATION TEST

In order to determine the relative density of non-cohesive soils, such as sands and gravels, the standard penetration test has been adopted. The test also gives an indication of the consistency of cohesive soils.

A two inch external diameter thick-walled sample tube is driven into the ground at the bottom of the borehole by means of a 140 lb. hammer falling freely through 30 inches. The tube is first driven an initial 6 inches to allow for the presence of disturbed material at the bottom of the borehole. The number of standard blows (N) required to drive the sampler a further 12 inches is recorded. The sample tube is one originally developed by Raymond Concrete Pile Company in the United States, where a sufficient number of tests have been made in conjunction with field investigations to show that the results, although essentially empirical, may be applied to foundation design.

For Sands:-

Values of 'N'	Density
Less than 10	Loose
Between 10 and 30	Compact
Between 30 and 50	Dense
Greater than 50	Very Dense

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						
3"	> 8"	3"	3/4"	4.76mm	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
 " pressure : p
 " tapping : t

OBSERVATIONS
 MADE WHILE
 CORING

Steady pressure
 No pressure
 Intermittent pressure

Washwater returns
 Washwater lost

PENETRATION RESISTANCES.

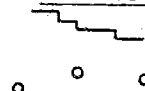
DYNAMIC PENETRATION RESISTANCE : to drive a 2" ϕ , 60° cone attached to the end of the drilling rods into the ground, expressed in blows per foot.

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 :



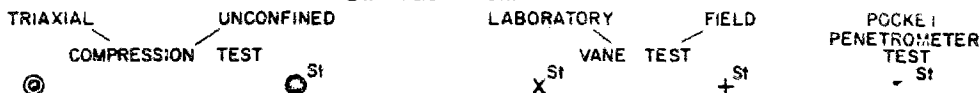
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SOIL PROPERTIES.

W % Water content	γ_s 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	ϕ' Cohesion
LI Liquidity index	m_v Coeff. of volume compressibility	ϕ' Angle of int. friction

UNDRAINED SHEAR STRENGTH.

- DERIVED FROM -

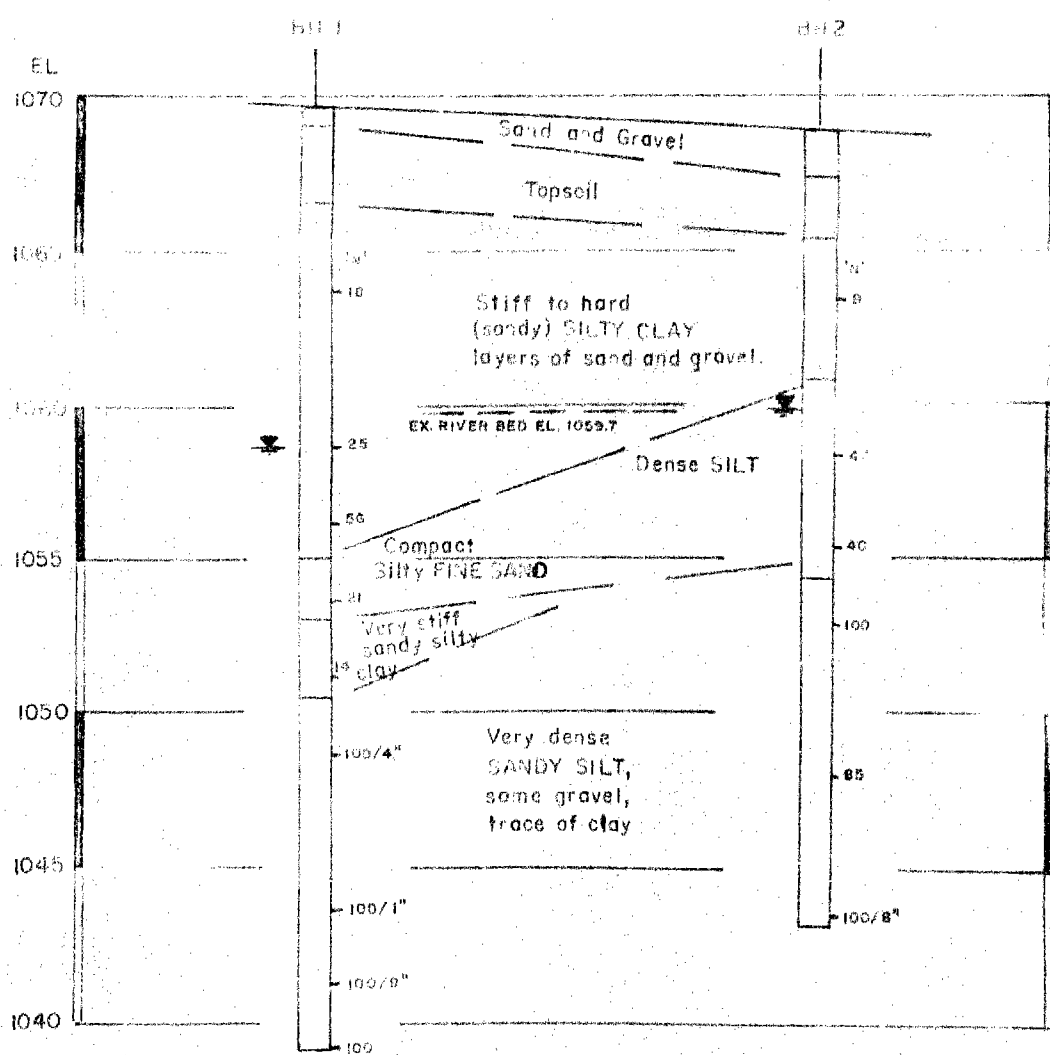
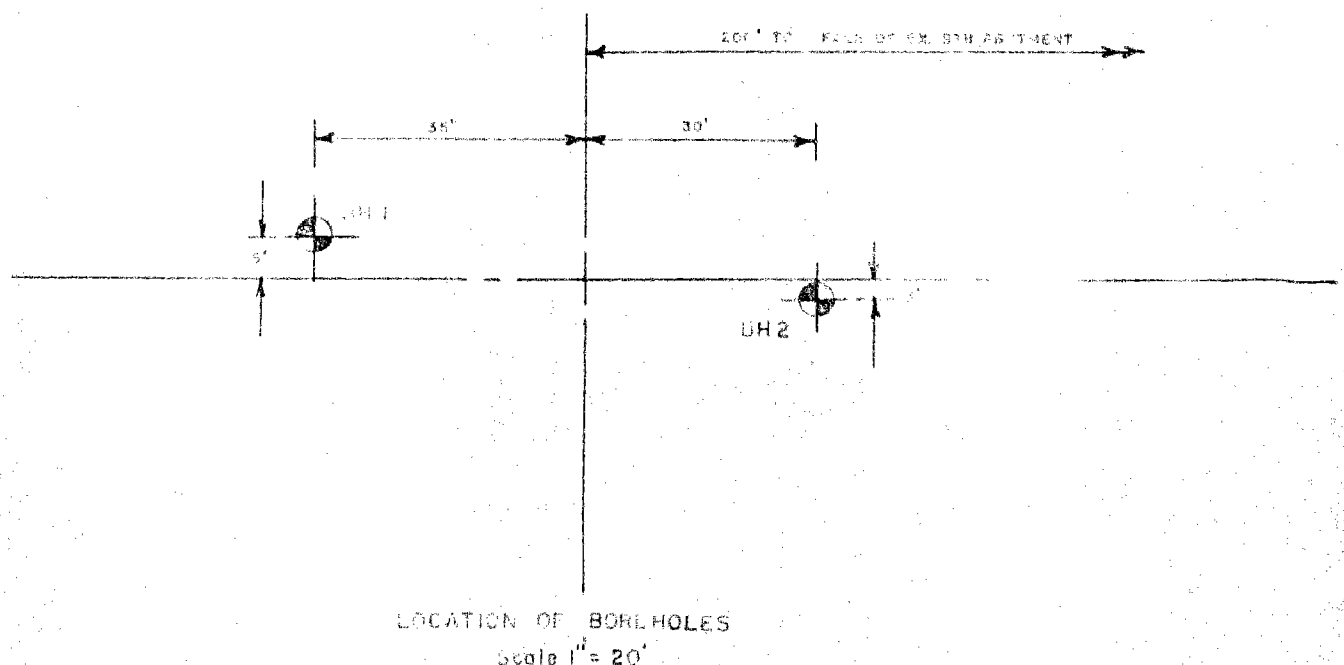


Strain at failure is represented by direction of stem
 20%
 15%
 10%
 5%

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



40 P11-12
GEOLOGICAL No.

LOG OF BOREHOLE 1

Our Reference No. 74-2-17

Enclosure No. 3

CLIENT: B.M. Ross & Associates Limited
PROJECT: Bridge BR-335
LOCATION: Township of Hibbert,
DATUM ELEVATION: Geodetic

DRILLING DATA
Method: Auger
Diameter: Hollow-stem
Date: March 25, 1974

SUBSURFACE PROFILE		SAMPLES			PENETRATION RESISTANCE Blows/Ft.					WATER CONTENT %			REMARKS						
ELEVATION Ft.	DEPTH Ft.	DESCRIPTION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' Blows/Ft.	20	40	60	80	100		PLASTIC LIMIT	NATURAL	LIQUID LIMIT			
								UNDRAINED SHEAR STRENGTH 100 p.s.f.											
								+ FIELD VANE TEST @ COMPRESSION TEST											
								20	40	60	80	100	10	20	30	40	50		

106.97	0.0	Ground Surface																
	0.5	Sand & gravel.																
		Topsoil																
	3.0																	
65		Very stiff to hard silty clay, some brown gravel, grey layers of silty sand and gravel.			1	SS	18											
60																		
					2	SS	25											
					3	SS	56											
55	14.5	Compact silty fine sand.			4	SS	21											
	16.5	Very stiff grey sandy silty clay.																
50	19.0	Very dense grey sandy silt, some gravel, trace of clay.			5	SS	14											
					6	SS	100/4"											
45					7	SS	100/1"											
40					8	SS	100/9"											
					9	SS	100											
	30.5	End of Borehole																

VERTICAL SCALE: 1 inch to 5 ft.

DOMINION SOIL INVESTIGATION LIMITED

DRAWN:

CHECKED:

LOG OF BOREHOLE2.....

Our Reference No. 74-2-1.7

Enclosure No. 4

CLIENT: B.M. Ross & Associates Limited
 PROJECT: Bridge BR-335
 LOCATION: Township of Hibbert
 DATUM ELEVATION: Geodetic

DRILLING DATA
 Method: Auger
 Diameter: Hollow-stem
 Date: March 25, 1974

SUBSURFACE		PROFILE	SAMPLES			PENETRATION RESISTANCE					WATER CONTENT			REMARKS							
ELEVATION Ft.	DEPTH Ft.	DESCRIPTION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' Blows/Ft	Blows/Ft.					PLASTIC LIMIT		NATURAL	LIQUID LIMIT					
								UNDRAINED SHEAR STRENGTH					100 p.s.f.					W _p	W	W _L	
								+ FIELD VANE TEST • COMPRESSION TEST										10 20 30 40 50			
								20	40	60	80	100									

106.89	0.0	Ground Surface																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
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VERTICAL SCALE: 1 inch to 5 ft.

DOMINION SOIL INVESTIGATION LIMITED

DRAWN:

CHECKED: