

#65-F-280 M

ROAD BRIDGE

LOT 21, CON. 13/14

LONDON TWP.

BA 2061

19-60

R. C. DUNN AND ASSOCIATES LIMITED
CONSULTING ENGINEERS
747 HYDE PARK ROAD
LONDON ONTARIO

Report on
SOIL INVESTIGATION
for
ROAD BRIDGE
LOT 21, CONCESSIONS 13 & 14
TOWNSHIP OF LONDON

65-F-2804

by
DOMINION SOIL INVESTIGATION LIMITED
369 Queens Avenue
LONDON ONTARIO
Reference No. 5-4-L2
April 27th, 1965

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SUMMARY

The two borings showed the following ground succession: sand and gravel fill (5 feet thick), compact to dense sandy silt (5 feet thick), very dense sand and fine gravel (6 feet 6 inches maximum penetrated in borehole 2), and hard silty clay Till (6 feet 6 inches maximum penetrated in borehole 1).

It is recommended that the structure should be supported on spread footings at or below El. 91.0 using a maximum net soil pressure of 7000 pounds per square foot. A well-point system will be necessary in order to construct the footings.

Alternatively it is recommended that a closed box culvert structure be employed with footings placed at El. 94.5 using a maximum net soil pressure of 4000 pounds per square foot.

Special scour requirements are discussed for this type of structure.

I INTRODUCTION

Verbal authorization was received from the office of R.C. Dunn and Associates Limited, Consulting Engineers, to carry out a soil investigation at a site in the Township of London where it is proposed to replace an existing road bridge with a new structure.

The existing steel-beam structure is located on Lot 21, Concessions 13 and 14 of the Township and has a clear span of 20 feet.

It is understood that the new structure will be a 20 foot span concrete culvert and the centre line will be approximately 15 feet east of the centre line of the existing bridge. The requirements of the project were discussed with Mr. N.M. Warner, P. Eng., who supplied the foregoing information.

The purpose of this 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

Two boreholes were put down to a maximum depth of 16 feet 6 inches during the period April 15th to 19th, 1965, using a diamond drill machine equipped for soil sampling. The holes were advanced by washboring methods and were lined with Bx casing.

Standard Penetration Tests using a 2" O.D. split-spoon sampler were performed at frequent intervals of depth to determine the relative density or consistency of the soil and to recover representative samples. The results are plotted as 'N' values on the Geotechnical Data Sheet for each borehole and are also given on the Subsurface Profile, Enclosure 2.

A dynamic cone penetration test was performed adjacent to borehole 1 location. This test gives a profile of the soil density changes with depth.

The locations of the boreholes are shown on the site plan, Enclosure 2, and elevations have been referred to a Bench Mark which was established by the client (Nail in base of tree on west side of bridge, El. 100.0 feet).

III SUBSURFACE CONDITIONS

Detailed descriptions of the strata encountered in each borehole are given on the data sheet comprising Enclosure 3, and a general picture of the soil stratigraphy is given in the form of a subsurface profile on Enclosure 2.

Both boreholes penetrated a deposit of fill which is associated with the construction of the approaches to the existing bridge. The fill consists of sand and gravel, and from the results of the cone penetration test it would appear that it is generally in a 'loose' condition.

Underlying the fill both boreholes penetrated a stratum of sandy silt which was found to be clayey at borehole 2 location, and was found to contain seams of silty fine sand at borehole 1 location. The relative density of this stratum is described as 'compact' to 'dense' as estimated from Standard Penetration Test Results ranging from 21 to 38 blows per foot.

Borehole 1 encountered a stratum of grey silty clay till at 10 feet depth which was penetrated a distance of 6 feet 6 inches. The consistency of this stratum is described as 'hard' as estimated from Standard Penetration Test Results ranging from 34 to 42 blows per foot. Borehole 2 encountered a stratum of silty fine to coarse sand with fine gravel at 10 feet depth, which was penetrated a distance of 6 feet 6 inches. The relative density of this stratum is described as 'very dense' as estimated from Standard Penetration Test Values ranging from 43 to 109 blows per foot.

IV GROUNDWATER CONDITIONS

The water level of the stream at the time the field work was carried out was observed to be El. 97.9. The water levels recorded in the boreholes after the drilling was completed was El. 98.2 in borehole 1, and El. 98.3 in borehole 2. It can be assumed, therefore, that the ground water table is the same elevation as the water level in the stream at any particular time.

V DISCUSSION

The general soil profile below the fill consists of compact to very dense granular strata except in borehole 1 which encountered a stratum of hard silty clay till at 10 feet depth.

The bed of the stream extends to El. 95.6, and because of the susceptibility of the underlying silt stratum to scour it is recommended that the footings should bear at or below El. 91. This level lies within the stratum of hard silty clay till at borehole 1 location and within the stratum of very dense silty fine to coarse sand with fine gravel at borehole 2 location, and on the basis of the borehole results a maximum net soil pressure of 7000 pounds per square foot would be appropriate for the design of the footings. It is estimated that total settlement will not exceed 1 inch. It will occur immediately for footings placed in the sand and gravel stratum at borehole 2 location, but it will take place over a period of several months for footings placed in the clay till encountered at borehole 1 location. It can be anticipated therefore that differential settlement of $3/4$ inch will take place over a period of several months. The footings will have a factor of safety of at least 3 against shear failure of the underlying soil.

The lateral stability of the abutments should be checked and the minimum factor of safety against forward sliding should not be less than 1.5. The coefficient of friction between the footings and the silty clay till may be taken as 0.35, and in the case of the very dense silty fine to coarse sand and gravel the coefficient of friction may be taken as 0.45.

The proposed structure is located to the east of the existing bridge therefore it is probable that the footings will bear in the silty sand and gravel stratum. Excavations in this stratum will require control of the ground water to prevent an excessive flow of water and soil into the excavations. It is therefore recommended that a well-point system be used to lower the water table below the level of the proposed footings.

As an alternative method a closed box-culvert structure should be considered with the footings placed at about El. 94.5. Excessive flow of water and soil into the excavation can then be prevented by carrying out the excavations for the footings inside continuous timber sheeting which should be driven to at least El. 91. Excavation below El. 94.5 is not advisable because of the 'heave' which would take place in the bottom of the excavation due to the excess hydrostatic pressure in the underlying sand and gravel stratum. Seepage will be controlled by pumping from sumps. This type of

construction will necessitate positive means of scour protection such as steel sheet piling placed across the upstream end of the culvert to prevent erosion of the silt stratum.

A maximum net soil pressure of 4,000 pounds per square foot is recommended for footings placed at El. 94.5.

Yours very truly,

DOMINION SOIL INVESTIGATION LIMITED



A handwritten signature in cursive script, reading 'C.J.W. Atkinson'.

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

CA:sg

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"	4.76mm	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	OBSERVATIONS	Steady pressure
"	"	pressure :	p	MADE WHILE CORING	No pressure
"	"	tapping :	t		intermittent pressure

	Washwater returns
	Washwater lost

PENETRATION RESISTANCES.

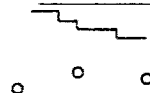
DYNAMIC PENETRATION RESISTANCE : to drive a 2" ϕ , 60° cone attached to the end of the drilling rods into the ground, expressed in blows per foot.

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 :



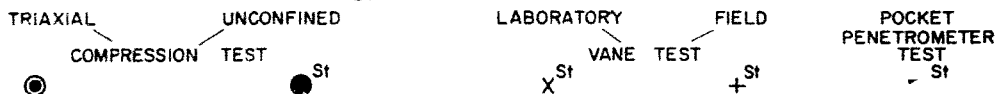
322

SOIL PROPERTIES.

W %	Water content	γ	Natural bulk density (unit weight)	k	Coeff. of permeability
LL %	Liquid limit	e	Void ratio	ϕ	Shear strength
PL %	Plastic limit	RD	Relative density	ϕ	Angle of int friction
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 —



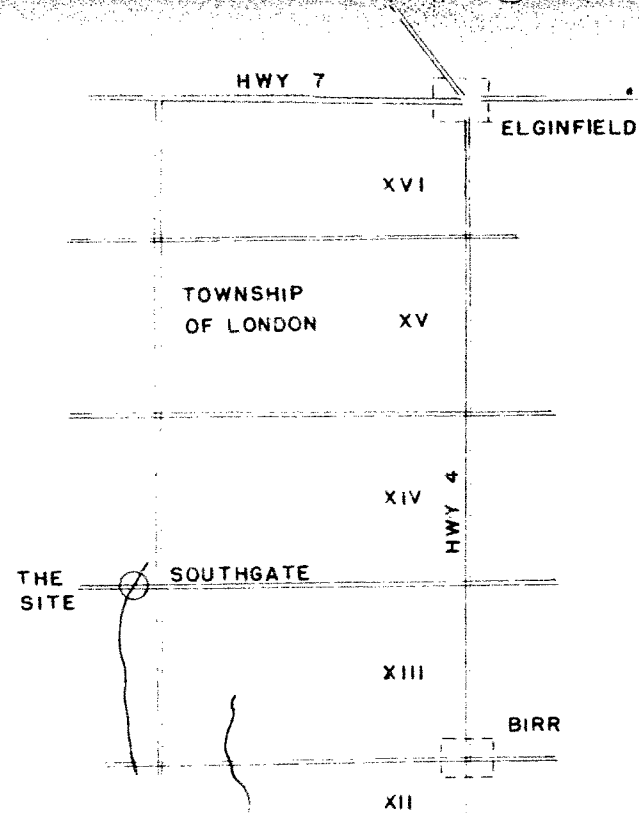
Strain at failure is represented by direction of stem

20%
15% + 5%
10%

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

SOIL DESCRIPTION.

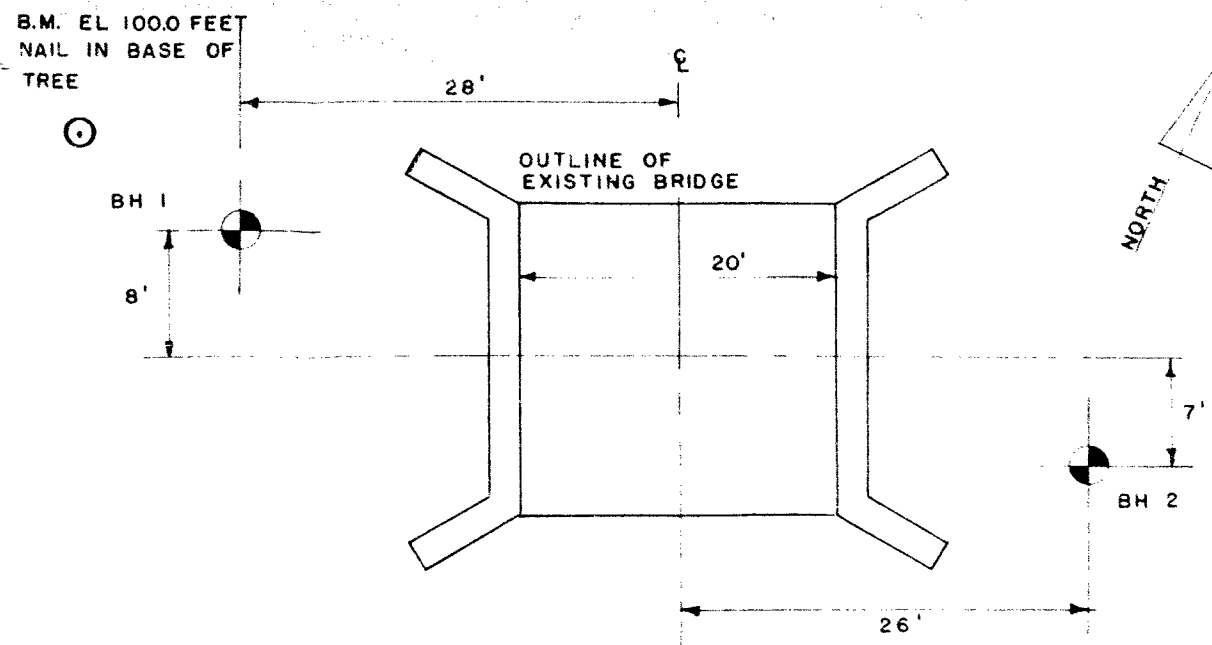
COHESIONLESS SOILS :	RD :	COHESIVE SOILS :	C lbs./sq.ft.
Very loose	0 - 15 %	Very soft	less than 250
Loose	15 - 35 %	Soft	250 - 500
Compact	35 - 65 %	Firm	500 - 1000
Dense	65 - 85 %	Stifi	1000 - 2000
Very dense	85 - 100 %	Very stiff	2000 - 4000
		Hard	over 4000



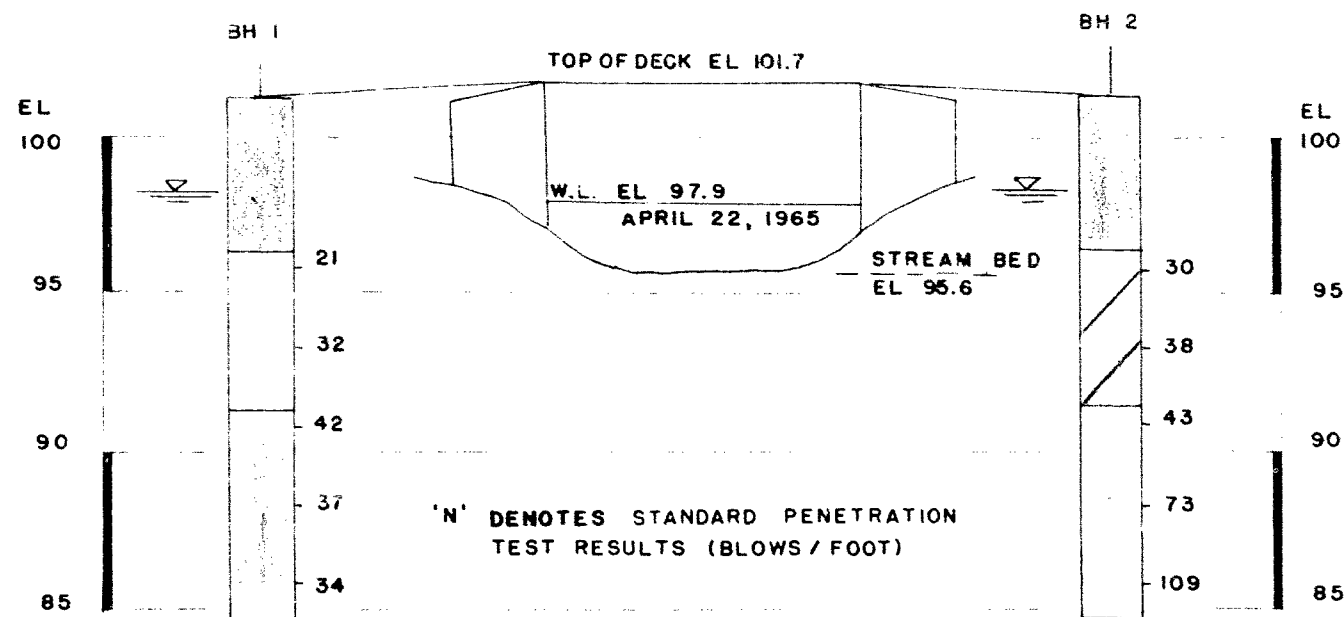
KEY PLAN

LEGEND

- SAND AND GRAVEL FILL
- SILTY FINE SAND AND SANDY SILT
- SANDY CLAYEY SILT
- SILTY CLAY TILL
- SAND AND FINE GRAVEL



LOCATION OF BOREHOLES
SCALE: 1 INCH TO 10 FEET



SUBSURFACE PROFILE

HORIZONTAL SCALE: 1 INCH TO 10 FEET
VERTICAL SCALE: 1 INCH TO 5 FEET