

GEOCRES No. 31G-164DIST. 9 REGION W.P. No. CONT. No. W. O. No. 73-11206MSTR. SITE No. 27-136HWY. No. TRLOCATION BUTTERNUT CREEK
BRIDGENo. of PAGES - 1

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. REMARKS:

Geoc. No 31G-164

REPORT ON FOUNDATION CONDITIONS

FOR

73-F-206M

BUTTERNUT CREEK BRIDGE

CASSELMAN, TOWNSHIP OF CAMBRIDGE

RUSSELL COUNTY, ONTARIO

STRUCTURE SITE No.

27-136

REPORT ON FOUNDATION CONDITIONS
FOR
BUTTERNUT CREEK BRIDGE .
CASSELMAN, TOWNSHIP OF CAMBRIDGE
RUSSELL COUNTY, ONTARIO

TO

THE CORPORATION OF THE TOWNSHIP OF CAMBRIDGE

BY

FONDEX LIMITED

OTTAWA, NOVEMBER 10, 1970

3007-S

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REPORT ON FOUNDATION CONDITIONS

FOR

BUTTERNUT CREEK BRIDGE

TOWNSHIP OF CAMBRIDGE, RUSSELL COUNTY

ONTARIO

TO

CAMBRIDGE TOWNSHIP COUNCIL

1. INTRODUCTION

This report presents an appraisal of the foundation conditions at the site of a proposed bridge over Butternut Creek at its' intersection with the South Nation River, near Casselman, Ontario. The appraisal and report were requested by McNeely, Lecompte & Associates Ltd., Consulting Engineers, Rockland, Ontario.

2. SITE LOCATION AND GEOLOGY

The location of the proposed construction is about four miles west of Casselman, Ontario, at the intersection of Butternut Creek and the South Nation River.

This site is on a Pleistocene marine clay plain which is between 25 and 32 feet in thickness. The water content of the clay material is high and in the remoulded state the material exhibits a very low strength. Furthermore, if loads great enough to break down the structure of the clay are applied, large settlements can occur.

The clay deposit is known as the Leda marine clay deposit. The engineering properties of this material are not easily determined from standard laboratory tests; hence, reliance is only placed on such tests together with the research reports of the National Research Council in order to more reliably evaluate the shear strength and compressibility characteristics of clays in this region.

3. FIELD AND LABORATORY INVESTIGATIONS

Two boreholes were made at the site between November 3rd and 5th, 1970, using a conventional diamond drill rig adapted to soil sampling purposes. Both boreholes were sampled at prescribed intervals throughout their depth.

Samples of the dessicated silty clay crust, the silty sand stratum, and the underlying glacial till were obtained using a standard split spoon sampler. Penetration tests were also made in these strata in accordance with the specifications for the Standard Penetration Test.

Samples of the cohesive silty clay stratum were taken in two inch I.D. Shelby tubes - Field vane shear tests were also made in this stratum to determine the undrained shear strength of the material.

An attempt was made to sample the till material below a depth of 40 feet in borehole no. 1 by taking a core sample. However, the material encountered consisted of cobble sized material in a sand, silt, clay, stone matrix which made successful coring impossible.

The locations of the boreholes are shown on the site plan in the appendix. The elevations on the borehole logs and in the report are referred to assumed elevation 100.00 on top of the south west corner of the south west abutment of the existing bridge.

All samples were visually examined in the field and more closely examined and classified in the laboratory. A few laboratory tests were performed to determine the following index properties of the soils so that their engineering characteristics

could be assessed.

- natural water contents
- liquid limits
- plastic limits
- grain size distribution

The results of these tests are shown on the borehole logs and soil classification graph in the appendix.

4. SOIL CONDITIONS

4.1 GENERAL

The area is generally covered by a deposit of silty sand and clay to depths up to 11 feet 6 inches under which there is a stratum of silty clay extending to a depth of between 25 and 32 feet. The clay is underlain by a stratum of fine silty sand about 5 to 7 feet in thickness which in turn is underlain by glacial till. Bedrock was not positively proven in either of the borings; however, it is known that limestone and/or shale bedrock underlies the glacial till.

4.2 SILTY SAND WITH CLAY

Under a thin cover of organic topsoil is a layer of loose to compact silty sand with clay. This material has been oxidized and desiccated to depths up to about 11 feet.

4.3 SILTY CLAY

Underlying the silty sand and clay material is a stratum of sensitive to extra sensitive gray silty clay. The thickness of this stratum at the site varies between 25 and 32 feet. Occassional silt seams were encountered throughout the stratum. Atterberg limit tests as plotted on the consistency chart serve to categorize the material as a highly compressible organic clay and/or inorganic silt.

4.3.1. STRENGTH AND COMPRESSIBILITY CHARACTERISTICS OF THE SILTY CLAY

A number of field vane shear tests were carried out during the drilling operation. Beneath the dessicated crust the undrained shear strength varied between 780 and 880 p.s.f. indicating a consistency of firm for the material.

No laboratory consolidation tests were carried out on this material. However, the natural void ratios of the material indicates that it is highly compressible. If it is loaded in excess of its preconsolidation pressure large settlements can be expected. Although no tests were done it is probable that the preconsolidation pressure of the material is in the order of 1500 to 2500 p.s.f.

4.4 SILTY FINE SAND

A layer of loose to compact silty fine sand was encountered beneath the silty clay stratum. A grain size distribution curve for this material is included in the appendix.

4.5 GLACIAL TILL

A deposit of dense glacial till underlies the silty sand stratum. This material is composed of sand with silt and clay, gravel and cobbles.

5. CONCLUSION RECOMMENDATIONS

- 5.1 The site is underlain by a firm, sensitive to extra-sensitive stratum of silty clay. The shear strength which should be used for design purposes is 780 p.s.f.
- 5.2 The clay has a high voids ratio and the water contents are of the same order as the liquid limits. It is probable that this material is overconsolidated by about 1500 to 2500 p.s.f.; hence, settlements of the bridge structure, if it is supported by this material, and of fill construction will be a factor in design.

5.3 In view of the above considerations and if loads are to exceed 1500 p.s.f. it is recommended that the bridge abutments bear on pile foundations: timber, Steel H, tube or precast concrete piles driven to practical refusal in the till stratum; or expanded base piles bearing in the uppermost region of the till stratum. A cost study should be done to determine the most economical pile type.

5.4 If piles are used, negative skin friction can be calculated with the assumption that a fully developed shear force acts only along the upper half of the pile in the clay strata (Fellenius, B.H., "Report on Drag Forces on Piles in Clay - a Literature Study", December, 1965). It can be assumed that the average mobilized shear strength of the clay in the vicinity of each pile will be 350 p.s.f.

The largest value of negative skin friction as found from the following equation should be used for pile design (Terzaghi & Peck - Soils Mechanics & Engineering Practice - 2nd edition 1967):

$$F_N = \frac{C}{N} H \uparrow$$

where:

F = negative skin friction

C = individual pile circumference or pile group circumference


N = 1 if individual pile circumference is used
 = number of piles in the group if the group circumference is used.

H = one-half the length of the pile in clay

\uparrow = shear strength of the clay = 350 p.s.f.

- 5.5 Piles should be designed for the larger of:-
a) full dead load plus full live
load of the bridge
or b) full dead load plus full negative
skin friction.
- 5.6 Fill required to complete the approach to the
bridge and to widen the existing road should
be properly compacted in order to achieve as
much shear strength as possible.
- 5.7 Those portions of the construction where fill
is placed should have side slopes no steeper
than 1 vertical to 1½ horizontal. It is noted
that the existing fill slopes towards the South
Nation River at slightly steeper than this
recommendation and that there is no apparent
movement of the fill due to sliding.
- 5.8 Maintenance of approach fills at the level to
which they are constructed will be a question
of annual maintenance since some consolidation
is inevitable. Evidence of this phenomenon is
available at the site.
- 5.9 Because of the extra-sensitive nature of the
clay, care should be taken during construction to
avoid excessive disturbance.

E.B. Fletcher, Ph.D., P. Eng.

by , C. Eng.

PROJECT Butternut Creek Bridge
LOCATION Casselman, Ontario
DATUM See report BOREHOLE TYPE Wash
SAMPLER HAMMER WEIGHT 140 lb. DROP 30 inches BOREHOLE DIA. Bx

REPORT DATE 10 Nov. 70

DRAWN BY J.C.G

CHECKED BY E.B.F.

[illegible]

RECORD OF BOREHOLE 1

PROJECT _____

DRILLING DATE_____

LOCATION _____

REPORT DATE _____

DATUM _____ BOREHOLE TYPE _____

DRAWN BY

SAMPLER HAMMER WEIGHT _____ lb. DROP _____ inches BOREHOLE DIA. _____

CHECKED BY _____

[illegible]

CHECKED BY E.B.F.

SOILS PROFILE		SAMPLES			DYNAMIC PENETRATION RESISTANCE BLOWS/FT.		CONSISTENCY :	
Elev. Depth	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FT (N)	% RECOVERY	STRENGTH	NATURAL MOISTURE CONTENT (W) ————
							FIELD VANE SHEAR *	LIQUID LIMIT (W _L) ————○
							LAB VANE SHEAR X	PLASTIC LIMIT (W _P) ————
							UNCONF COMP STRENGTH (q _u)	
							0.5 1.0 1.5 2.0 k.s.f.	
88.5' 0'-0"	Ground Surface							
	Organic topsoil		1	SS	4			
83.5' 5'-0"	Silty sand & clay - brown -		2	SS	1			
78.5' 10'-0"			3	SS	1			
73.5' 15'-0"			4	ST				
68.5' 20'-0"	gray silty clay - firm -		5	ST				
63.5' 25'-0"			6	ST				
58.5' 30'-0"			7	ST				
53.5' 35'-0"	Light gray silty sand - compact - loose -							

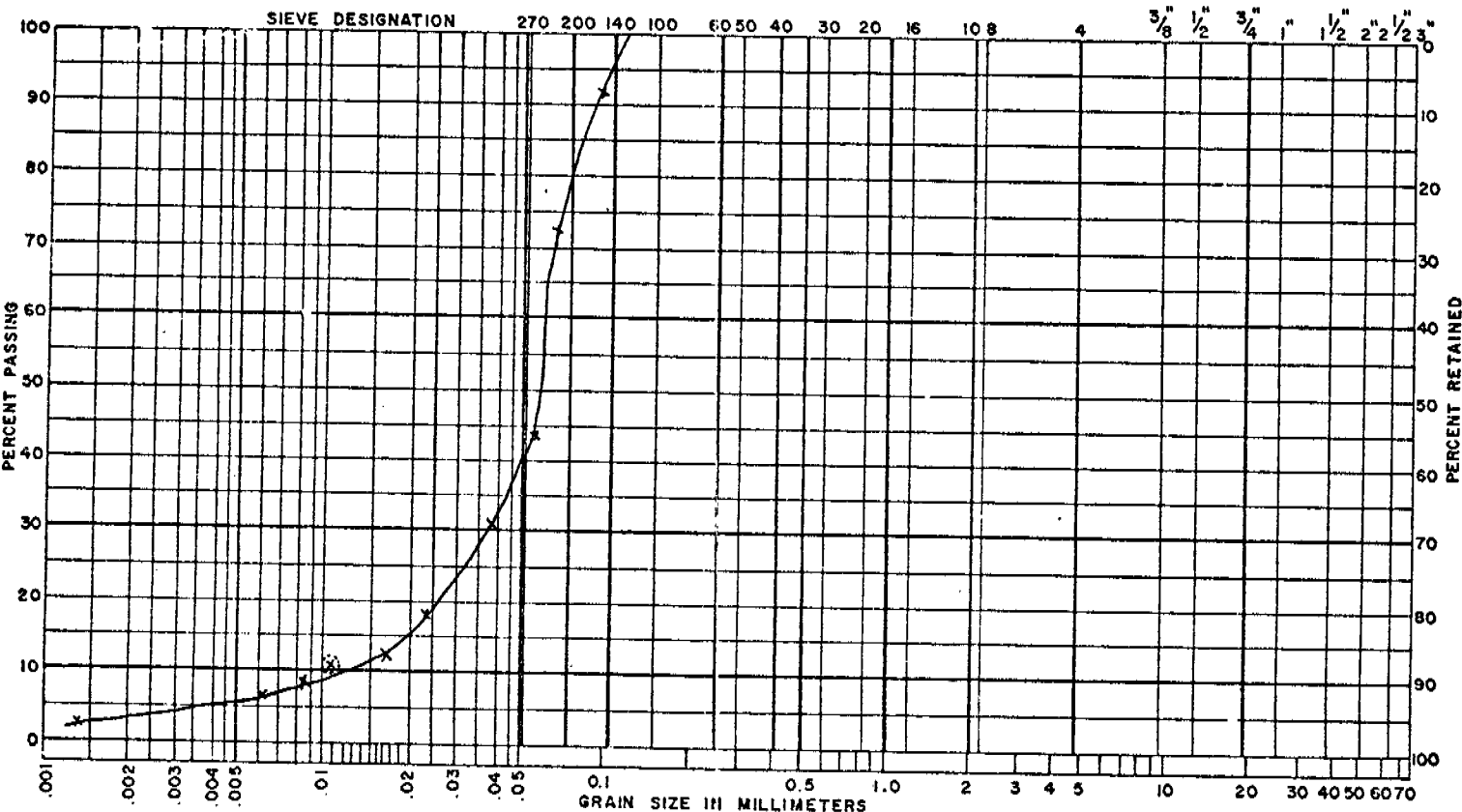
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FONDEX LTD.
FOUNDATION ENGINEERS

U. S. BUREAU OF SOILS CLASSIFICATION

CLAY	SILT	VERY FINE SAND	FINE SAND	MEDIUM SAND	COARSE SAND	FINE GRAVEL	GRAVEL
------	------	----------------	-----------	-------------	-------------	-------------	--------



CLAY AND SILT

SAND

GRAVEL

FINE

MEDIUM

COARSE

FINE

COARSE

UNIFIED SOIL CLASSIFICATION SYSTEM

REMARKS: W.S. # 8 B.H. # 1

DATE: Nov. 9th / 1970

John D. Danson

U.S. BUREAU OF SOILS CLASSIFICATION

% FINE GRAVEL _____

% COARSE AND MEDIUM SAND _____

% FINE AND VERY FINE SAND _____

% SILT _____

% CLAY _____

% VERY FINE SAND AND SILT _____

LAB TEXTURAL CLASS _____

FIELD TEXTURAL CLASS _____

DENSITY

SPECIFIC GRAVITY: 2.7 assumed

MAXIMUM WET _____ P.C.F.

MAXIMUM DRY _____ P.C.F.

OPTIMUM MOISTURE CONTENT _____ %

FIELD WET _____ P.C.F.

FIELD DRY _____ P.C.F.

FIELD MOISTURE CONTENT _____ %

% COMPACTION _____

UNIFIED SOIL CLASSIFICATION

% PASSING NO. 4 _____

% PASSING NO. 200 _____

$C_u = \frac{D_{60}}{D_{10}}$ _____

$C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ _____

LIQUID LIMIT _____ %

PLASTIC LIMIT _____ %

PLASTICITY INDEX _____

GROUP SYMBOL _____

FIELD CLASSIFICATION _____

SOUTH NATION RIVER



EXISTING BRIDGE

TO CASSELMAN

B.M.: ASSUMED
ELEV.: 100.0'

ELEV.: 86.5'
B.H. 1

ELEV.: 88.5'
B.H. 2

BUTTERNUT CREEK

CORPORATION OF THE TWP. OF CAMBRIDGE

BUTTERNUT CREEK BRIDGE

FONDEX LTD.

SCALE: 1" = 40'
DATE: NOV. 1970