

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO

MEMORANDUM

TO: Mr. A. P. Watt. (2)
Regional Structural Planning Eng.,
Southwestern Region,
London, Ontario.

FROM: Foundations Office,
Design Services Branch,
West Bldg., Downsview.

ATTENTION:

DATE: November 1, 1973.

OUR FILE REF.

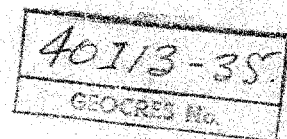
IN REPLY TO NOV - 6 1973

SUBJECT:

FOUNDATION INVESTIGATION REPORT

The Proposed Cul. Replacement at
Sta. 117+68, E. 3, Twp. of Mosa
District #3 (London, Ont.)
W.O. 73-11081 -- W.P. 811-65-00

CONT. 73-515



tached we are forwarding to you our detailed foundation investigation report on the subsoil conditions existing at the above-mentioned site.

We believe that the factual data and recommendations contained therein will prove adequate for your design requirements. Should additional information be required, please do not hesitate to contact our Office.

AGS/ao
Attch.

A. G. Stermac
A. G. Stermac,
PRINCIPAL FOUNDATIONS ENGINEER.

c.c. E. J. Orr
B. R. Davis
A. Rutka
A. Wittenberg
L. E. Walker
B. J. Giroux
J. R. Roy
G. A. Wrong
B. A. Singh

Foundations Files
Documents

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FOUNDATION INVESTIGATION REPORT
For
The Proposed Culvert Replacement at
Sta. 117+62, Hwy. 80, Twp. of Mosa
District #2 (London, Ont.)
W.O. 73-11081 -- W.P. 811-65-00

1. INTRODUCTION:

A foundation investigation was undertaken at the location of a 14'-1" x 8'-9" SPSA currently showing signs of distress. This culvert is located along Hwy. 80 at approximate S. 117+62. A request for this investigation was received from Mr. A. P. Watt, Regional Structural Planning Engineer, for the Southwestern Region dated September 20, 1973. This report contains the results of both the field and laboratory investigation pertaining to this site, as well as our recommendations pertaining to the structure foundations.

2. DESCRIPTION OF SITE:

At the site the land is relatively flat except where rivers and streams have created valleys. The land use is mainly for pasture. The stream at the time of the investigation contained ponded water.

The existing culvert is a 14'-1" x 8'-9" SPSA and for the last several years has showed signs of distress in the form of heaved up bottom plates (12 - 18 inches). Attempts were made to rectify this by placing struts at the affected locations and also by grouting below the pipe. None of these remedies worked since the cause of the heaving was frost action in the highly frost susceptible subsoil (fine sand & silt) below the pipe.

It should be noted that during the winter this culvert is dry and the bottom plates have little or no earth cover, thus allowing a frost penetration of 3 - 4 ft. into the fine sand and silt subsoil. Progressive heaving of the bottom plates will, of course, eventually cause structural collapse of the very highly stressed corner radius plates. At the present time it is difficult to predict how long the culvert will still function as an arch.

Geologically the site is part of the Elfrid Clay Plain. In the area south of Alvinston this region consists of silt beds superimposed on the clay.

3. FIELD AND LABORATORY INVESTIGATIONS:

The field work consisted of two sampled boreholes and three dynamic cone tests, one of the cones being adjacent to B.H. #2. The drilling was done using a Bombardier mounted C.M.E. 55 equipped with hollow stem augers. Split spoon samples were taken at regular intervals.

Thin walled 2-inch I.D. Shelby tube soil samples were obtained by advancing the Shelby hydraulically. All field and laboratory test results are recorded on the accompanying Borelog sheets.

Soil samples were examined in the field and again upon arrival in the laboratory. Laboratory tests to determine moisture content, grain size and Atterberg limits were carried out on representative samples. The soil samples obtained from the Shelby tubes were subjected to unconfined compression tests.

The groundwater levels across the site were determined by recording the water levels in the open boreholes over the period of the investigation.

The locations and elevations of the boreholes as well as a stratigraphical profile are plotted on Drawing 73-11081A attached at the end of this report.

4. SUBSOIL CONDITIONS:

4.1) General:

The subsoil at the site varies in general, in both the vertical and horizontal directions. Basically non-cohesive fine grained soils are found from the ground surface down to depths of 6 - 11 ft. followed by a layer of clayey silt which overlies a hard till deposit.

The boundaries between the various soil types and soil layers are shown on the Record of Borehole sheets which are contained in the Appendix. Based on the information contained in these sheets an estimated stratigraphical profile has been developed and is shown on Drawing No. 73-11081A.

Some detail with respect to soil types and properties is given as follows:

4.2) Silt to Clayey Silt, Some Gravel, Traces of Sand:

A deposit of silt to clayey silt with some gravel and traces of sand and organic material was encountered in Borehole #2, extending from the ground level to a depth of 7 feet.

A grain-size analysis done on a sample taken from this deposit gave the following distribution: gravel - 15%, sand - 8%, silt - 50%, clay - 27%. The natural moisture content of the material is approximately 17%.

Based on SPT 'N' values ranging from 12 - 14 blows/foot, the deposit may be described as having a compact relative density.

4.3) Silt, Some Clay and Traces of Sand:

A deposit of silt with some clay and traces of sand was encountered in Borehole #1. This deposit extends from ground level to a depth of 6 ft. at this location.

A grain size analysis performed on a sample taken from the deposit indicated the following distribution: gravel - 0%, sand - 1%, silt - 81%, clay - 18%. The water content of the material is approximately 20%.

SPT 'N' values obtained within the stratum varied from 14 - 19 blows/ft. indicating a compact relative density.

4.4) Silty Sand With Traces of Clay:

This deposit was encountered in Borehole #2 only. It underlies the silt to clayey silt surficial layer previously described. The stratum is some 4 ft. thick and consists of a silty sand with traces of clay.

The natural water content of the deposit is about 21%. A simple grain size analysis indicated the composition of the deposit to be 53% sand and 47% silt and clay. 'N' values varied between 10 and 20 blows/foot suggesting a compact relative density.

4.5) Clayey Silt, Some Sand and Gravel:

A 6 - 9 ft. thick layer of clayey silt containing some sand and gravel was encountered at both boring locations. It is believed that this stratum is continuous across the site area. It underlies the silt layer at the location of Borehole #1 and the silty sand layer at Borehole #2. The layer consists of clayey silt with some sand and gravel.

Physical properties of the material as determined by laboratory tests are as follows:

	<u>Range of Values</u>	<u>Average</u>
Natural Moisture Content (%)	18 - 30	24
Liquid Limit (%)	31 - 48	39
Plastic Limit (%)	19 - 23	22
Field Vane (p.s.f.)	2000	
Unconfined Shear Strength (p.s.f.)	795	

SPT 'N' values ranged from 7 - 21 blows/foot suggesting a firm to very stiff consistency but on the average very stiff. It appears that the softer material is confined to an approximately 1 - 2 ft. thick zone between elevations 650 and 654.

4.6) Heterogeneous Mixture of Sand Gravel Silt and Clay (Till):

This deposit was encountered at each boring location beneath the clayey silt stratum. The extent of the deposit is not known since both boreholes were terminated within it, but the deposit has a minimum thickness of 5 feet.

Laboratory tests indicate an average water content of 8% and liquid and plastic limits of 25 and 15%, respectively.

Based on 'N' values of from 93 to greater than 100 blows/foot, the deposit may be described as very hard.

5. GROUNDWATER CONDITIONS:

During the course of the field work groundwater levels were determined by measuring the water levels in the open boreholes. The following levels were recorded:

<u>Borehole No.</u>	<u>Water Level Elev.</u>
1	661.0
2	661.0

The stream bed at either end of the existing culvert was dry; however, some ponded water was observed at other places along the stream channel. Due to the pervious nature of the surficial soils at the site the groundwater levels can be expected to undergo constant fluctuations in step with the seasonal variation of water levels in the stream.

6. DISCUSSION AND RECOMMENDATIONS:

6.1) General:

It is proposed to replace the existing SPSPA culvert showing signs of distress with a 10'- 0" SPSCP culvert some 172 ft. long at a skew angle of approximately 58°. The new culvert may have concrete head walls at both the upstream and downstream ends placed at 45° to the flow or rip-rapped slopes as a means of protection. It is reported that the culvert invert elevation

will be some 2 feet below the stream bed level (i.e., approximate invert elevation 660). Some 18 inches of coarse material will be placed inside the pipe.

The subsoil at the site consists of a 6 - 11 ft. surficial deposit of fine grained cohesionless soil underlain by a deposit of clayey silt which in turn is underlain by a hard glacial till deposit.

6.2) SPSPA Culvert Foundation:

The culvert should be designed and placed according to the appropriate Ministry standards. At the time of construction, any soft material beneath the existing culvert should be excavated and replaced with a suitable free draining granular material. A minimum 2 ft. thick Granular 'B' bedding should be placed beneath the culvert. The maximum thickness of bedding will be governed by the availability of cover inside the pipe. The bottom of the bedding should extend below the maximum frost penetration depth (i.e., 4 ft.).

Backfill for the pipe should also consist of Granular 'B' and should extend to a minimum height of 2 ft. above the pipe. Above this level native backfill may be used.

To prevent piping through the bedding and backfill, 3 ft. thick clay seal should be provided at the upstream end of the culvert and a suitable filter blanket 3 ft. thick placed at the downstream end. If slopes are rip rapped the rip rap material should be placed so as to cover both seal and filter.

The natural groundwater levels at the site are expected to undergo seasonal variations. Depending on the time of the year a dewatering scheme may be required in order to excavate below the groundwater level and place the bedding in the dry.

6.3) Retaining Wall Foundations:

The head walls (if constructed) at the upstream and downstream ends of the culvert may be supported on spread footing type foundations. A safe bearing pressure of 1.0 t.s.f. may be used for design purposes. The spread footings should be

placed so as to achieve a minimum earth cover of 4 ft. for frost protection purposes.

For computations of sliding resistance, a coefficient of friction of 0.3 may be assumed if the spread footings are placed in the cohesionless silt or silty sand layers. If the footings are placed within the clayey silt material, an adhesion of 800 p.s.f. may be assumed between the footings and subsoil.

The backfill to the retaining walls should conform to the appropriate Ministry standard. The coefficient of active earth pressure behind the walls may be assumed to be 0.33.

As an alternative, the wall footings may be supported on short timber piles driven some 5 - 8 ft. into the hard glacial till deposit to approximate elevation 645₊. In this case, the maximum allowable load for the pile section may be assumed. Pile caps should be placed so as to provide a minimum cover of 4 ft. for frost protection purposes. Comments pertaining to dewatering given above are also applicable here.

6.4) Cut Off Wall:

The necessity for a cut off wall at the upstream end of the pipe is dependent on hydrological requirements, and, therefore, this aspect of the design should be discussed with the Hydrology Office.

7. MISCELLANEOUS:

The field work was carried out on September 27, 1973, under the supervision of Mr. P. Korgemagi, Project Foundations Engineer.

This report was prepared by Mr. L. J. Hodge, Project Foundations Engineer and reviewed by Mr. K. G. Selby, Supervising Foundations Engineer.

Equipment used was owned and operated by Master Soils Investigation Limited.

L. J. Hodge

LJH/ao K. G. Selby, P. Eng.
Oct. 30, 1973.

APPENDIX I

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 1

JOB 73-11081 LOCATION Sta. 117 + 35 77.5' Lt. ORIGINATED BY PK
 W.P. 811-65-00 BORING DATE Sept. 27, 1973 COMPILED BY PK
 DATUM Geodetic BOREHOLE TYPE Auger CHECKED BY Q

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w		BULK DENSITY γ	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		SHEAR STRENGTH P.S.F.		WATER CONTENT %			
664.9	Ground Level											
0.0	Silt, some clay, traces of sand.											
658.8	Brown Compact		1	SS	19							0.7 81.18 651.0
6.1	Clayey silt, some sand and gravel. Grey		2	SS	14							
			3	SS	7							
649.5	Firm to Very Stiff		4	SS	21							15 23 38 24
15.4	Het. mix. gravel, sand, silt & clay. (Till)											
644.4	Grey Hard		5	SS	97							
20.5	End of Borehole											

RECORD OF BOREHOLE No 2

JOB 73-11081

LOCATION Sta. 118 + 19 69' Rt.

ORIGINATED BY FK

W.P. 811-65-77

BORING DATE Sept. 27, 1973

COMPILED BY PK

DATUM Geodetic

BOREHOLE TYPE Auger and Cone Test

CHECKED BY

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE			LIQUID LIMIT			BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT	25	50	75	100	125	W _p		
666.4	Ground Level					SHEAR STRENGTH P.S.F.			WATER CONTENT %			γ	P.C.F. GR. SA SI. CL
0.0	Silt to clayey silt, some gravel, sand, traces of organics.		1	SS	12	○ UNCONFINED			+ FIELD VANE				
659.4	Brown Compact		2	SS	14	● QUICK TRIAXIAL			x LAB VANE				
7.0	Silty sand, traces of clay. Grey-Brown		3	SS	26								
655.1	Compact		4	SS	10								
11.3	Clayey silt, some sand and gravel. Grey		5	TN	PH								
649.4	Firm to Very Stiff												
17.0	Het. mix. sand, gravel, silt & clay. (Till)												
644.9	Grey Hard		6	SS	100.8"								
21.5	End of Borehole												

15 ²⁰ 5 % STRAIN AT FAILURE

FOUNDATIONS OFFICE

ORIGINATED BY PK

COMPILED BY FR

CHECKED BY

[illegible]

20
15 ϕ 5 % STRAIN AT FAILURE

RECORD OF BOREHOLE NO 4

FOUNDATIONS OFFICE

LOCATION Sta. 117 + 08 66' Rt.

ORIGINATED BY PK

BORING DATE Sept. 28, 1973

COMPILED BY PK

BCREHOLE TYPE Cone Test

CHECKED BY

[illegible]

20
15 ϕ 5 % STRAIN AT FAILURE
10

CONT. 73-515

HWY. 80.

TWP. OF MOSA

40113-35

