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55-F-207C

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Hwy 2 AT

COOTES PARADISE

HAMILTON

Bridge culvert and TO foundation data

FILE No. 23-60-269-L

File No.

Ontario Department of Highways

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File # 23
23-60-249-2

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REPORT NO. 8-500/55/7-151-1

310 Odeon Building,
20 Carlton Street,
Toronto, Ontario.

Department of Highways of Ontario,
Parliament Building,
Toronto, Ontario.

9 November 1955.

RE: FUNDAMENTAL INVESTIGATION BY
NO. 2 HIGHWAY BRIDGE, COUNTY
PARADISE, WEST OF HAMILTON,
ONTARIO.

Dear Sirs:

Our subsurface investigation at the above noted site has been completed and our field observations and comments are presented under the following headings:-

SITE HISTORY AND FIELD OBSERVATIONS.

The site of this investigation is in a deep ravine extending approximately 100 feet below the grade of the present No. 2 Highway Bridge, located near the C.P.R. Railway stop of Bayview and about one mile north east of the traffic circle leading to Hamilton. The ravine extends roughly in a east-west direction at this point and is blocked by a railway fill approximately 70 feet high, occurring a few hundred yards to the east.

This fill has slopes of approximately 45 degrees and appears to be in a stable condition. Workmen indicated that the tracks across it were lifted every one or two years, an observation which may not be too significant since this type of maintenance, according to Mr. Dove of the C.P.R. Bridge Office, has been required at numerous other locations along the line. This embankment was first placed during the construction of the Great Western Railway in 1853 and was widened on the west side for double tracks in 1904.

The fill for the embankment was obtained from the adjacent railway cuts and, therefore, probably contains a considerable quantity of the conglomerate and shale rock observed to the south and north respectively. Mr. Dove could not find nor recall any record of embankment failures during or after construction of this railway fill.

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The banks of the ravine themselves have slopes of approximately 45 degrees and surface water erosion at the north west corner of the No.2 Highway Bridge indicates the presence of shale bedrock, very close to the ravine banks and extending up to about elevation 325. Further to the north west, the ground rises sharply and is composed of deep deposits of weathered very lean clay-shale, containing harder green interbeds. The natural moisture of this deposit was well below its liquid and plastic limits of approximately 28.5 and 15.5 percent respectively. The green shale interbeds show no signs of breaking down, after immersion for one month in distilled water.

The bottom of the ravine is covered by approximately 6 feet of water and is underlain by wet highly organic silt, as described in the engineering data sheets. *that material is not a structural layer*

DRILLING WORK

The drill was transferred to the project on September 14th and the following two days were required to get the raft, drill and other equipment down to the bottom of the ravine. During the period from 12th September to 3rd October, three borings and 17 soundings were made in the area, in order to determine the depth and condition of bedrock and of the organic silt overlying rock. The equipment was recovered from the ravine on October 5th and 6th.

DISCUSSION OF RESULTS

1. The subsoil overlying rock in this ravine consists for the most part, of a highly organic silt which has a maximum thickness of approximately 6 1/2 feet and extends to a depth of 70 feet below the water surface in the centre of the valley. Some interbedding of the silt with eroded material from the ravine banks was noted near the south bank. Information from the borings and soundings indicates that a thin layer of fine sand underlies the organic silt immediately over bedrock in the deeper portions of the ravine.

The profile of the bedrock is indicated in enclosure No.2. Although excellent core recovery was obtained from corehole No.3, at the south end of the present bridge, competent samples of the rock were not obtainable from corehole No.1, even though it was carried to elevation 194, or to a depth of 17 feet into bedrock. This bedrock was identified as a red clay-shale with hard green shale interbeds and, therefore, is probably of the same origin as the deposits of weathered material occurring above elevation 325 to the north of the bridge. Since the fill supporting the present Highway bridge appears to be founded on this clay-shale, it should provide a satisfactory support for any future structure. However, some penetration of steel piles into the soft bedrock should be anticipated.

2. The organic deposit overlying the bedrock exists in a extremely

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compressible condition and considerable settlement should be anticipated under a 100 foot embankment load. Partially decomposed leaves and wood were readily discernable, even in samples taken 30 feet below the surface in borehole No.1. Visual inspection of the samples and reference to the results from borehole No.1 indicate that the peaty deposit becomes drier with depth.

It will be observed that the moisture content of the soil is, for the most part, at or slightly above its liquid limit, which suggests a slightly unstable structure in the material. The rapid consolidation of sample 5, enclosure No.3, under pressures below 5000 p.s.f., confirms this view. The extreme variations in the driving resistance to the 3 inch pipe shown in enclosure No.4, are typical of a loose silt. The rapid reduction in penetration resistance once pipe driving has begun, indicates a partial liquifaction of the soil; with the temporary cessation of this disturbance, the silt quickly stabilizes and becomes stiffer.

3. The rapid adjustment to load during the two consolidation tests made on this material, also illustrated the relatively free-draining character of the organic silt. The results of these consolidation tests are presented in enclosure No.3. It will be observed that the compression index for the two samples varies between 0.27 and 0.45 and the coefficient of consolidation under pressures corresponding to the weight of a 100 foot embankment, is approximately 0.02 square inches per minute. The approximate estimate of the magnitude and rate of settlement under the weight of the proposed 100 ft. high embankment across the ravine, was made on the assumption that the organic silt contains no continuous seams or layers of fine sand, that it will drain only toward the surface and to the fine sand overlying bedrock, that secondary time effects can be neglected and that the silt has been consolidated under its own weight only up to the present time. The maximum settlement under the portions of the embankment overlying the full 64 feet of organic silt was computed, using Terzaghi's formula for normally loaded clays.

$$S = H \frac{C_c}{1+e} \log_{10} \frac{P}{P_0} *$$

Where H = 64 feet

C_c = 0.36 the average value for the compression index.

e = 1.65 = the present void ratio of the soil.

P = 8250 p.s.f. = the total pressure acting at mid depth on the stratum, following the application of the embankment load.

P_0 = 700 p.s.f. = the pressure at mid depth prior to the application of the embankment load.

* Soils Mechanics in Engineering Practice - Terzaghi & Peck
Page 55.

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4. Because of the very low cohesive resistance of the organic silt, it is reasonable to be concerned for the stability of any embankment constructed upon it. However, evidence of the apparent capability of this marsh deposit for supporting load, exists in the railroad embankment to the east. Although it is possible that the weight of this embankment was sufficient to displace the underlying silt and therefore to cause it to rest on or near bedrock below, it is also possible that the rate of construction 100 years ago was sufficiently slow to allow the underlying silt, which basically derives its strength from internal friction, to consolidate sufficiently to support the load applied to it.

In order to appraise the potential supporting power of the organic silt, it would be necessary to make stability analyses of the embankment, in which the slow-drained strength of the embankment materials and the underlying silt are used and various assumptions regarding the excess pore pressure in the subsoil are made. It would then be possible to predict what reduction in pore pressure was necessary for embankment safety and, on the basis of the consolidation tests, to determine the approximate duration of time elapsing before the pore pressure is reduced to this required value. If the answer seemed reasonable from a construction point of view, piezometers could be installed in the silt to measure the rate of pore pressure dissipation and thereby to exert a control on the rate of load application.

SUMMARY OF CONCEPTS AND RECOMMENDATIONS

1. The subsoil in Coates Paradise ravine consists of a deposit of very organic loose silt extending to approximate elevation 175. Bedrock begins near elevation 170 in the deepest part of the ravine and consists of red clay-shale with hard green shale interbeds. Although cores could not be obtained in this portion of the ravine, it is apparently strong enough to support the piles of the present bridge.

2. The loose organic silt above bedrock is in a very compressible condition and should prove very unstable if loaded too quickly. The maximum settlement under a fill 100 feet high will be approximately 3 feet, half of which should be accomplished in about two and three quarter years and the balance within fourteen years. If it is proposed to found a highway fill on this material, the organic silt should first be covered by a layer of pit-run gravel, in order to encourage consolidation. This measure will also protect the overlying clay-shale fill, which it is proposed to recover from the borrow area to the north. Although this fill should be satisfactory for compaction above the water level, it will probably become too soft and weak to support load if placed directly on to the water covered silt-muck.

3. If stability analyses indicate that the weight of the highway fill will displace much or all of the organic silt, or if the amount of settlement indicated above cannot be tolerated, consideration should be given to the use of a rock fill mass, carried through the full depth of

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the silt. The silt could be displaced either by overloading, blasting or dredging. In this type of proposal, some thought should be given to the safety of the present bridge, the piles of which may be shifted by any earth movement. In the search for rockfill, consideration could be given to the use of the rock existing almost to the surface in the north and south banks of the ravine. This material probably conforms to that used in the construction of the railway embankment to the east. It could be readily blasted into the ravine and then replaced by the more weathered red clay-shale overlying it to the north. Some re-alignment of the highway might be necessary with this proposal.

b. An analysis of the water in the ravine should be made, to determine its acid content and possible effect on concrete piers or piles.

We shall be pleased to discuss any other matters regarding this foundation investigation, which may occur to you after reading this report.

Yours very truly,

HACEY, MACGILLIVRAY AND ASSOCIATES LTD.

H. T. MacGillivray

HAT/ED

H. T. MacGillivray, Eng.

Original and 2 copies - Department of Highways of Ontario, Toronto.

1 - Hacey, MacGillivray and Associates Ltd., Montreal.

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RESULTS OF THE SOUNDING INVESTIGATIONS

SOUNDING

APPARENT ROCK DEPTH
FOOT BELOW WATER SURFACE

REMARKS

1	73
2	66
3	36
4	24
5	64-67
6	69
7	62
8	57
9	71
10	71
11	50
12	70
13	65
14	64
15	71
16	44
17	65
18	63

Stop ed to 60 feet

Proposed Bridge Pier

To Hwy No 6

Approx position
Proposed
Highway Centre Line

325

300

275

250

To Toronto

Shoreline

Top of slope

Top of slope



SCALE 1" = 100'

- x SOUNDING (WASH PILES)
- C BORING HOLE
- + PRESENT BRIDGE PIERS

Hwy No 2

To Hamilton

ENGINEERING CONSULTANTS
AND ARCHITECTS

Elevation in feet

- 250
- 225
- 300
- 275
- 250
- 225
- 200
- 175

Assumed slopes of
highway fill 1/4

Present Bridge

Approx. 1925 to 1935

Bridge Area

section A A

A

Approx. Highway Bridge

To HANWICK

- 350
- 325
- 300
- 275
- 250
- 225
- 200
- 175

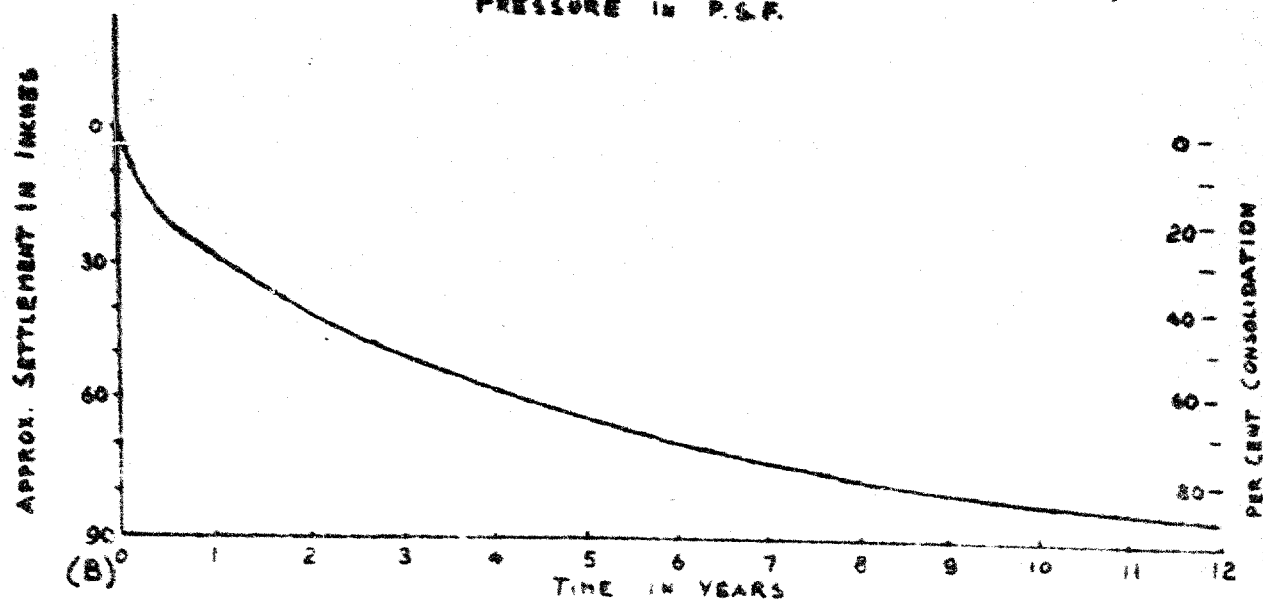
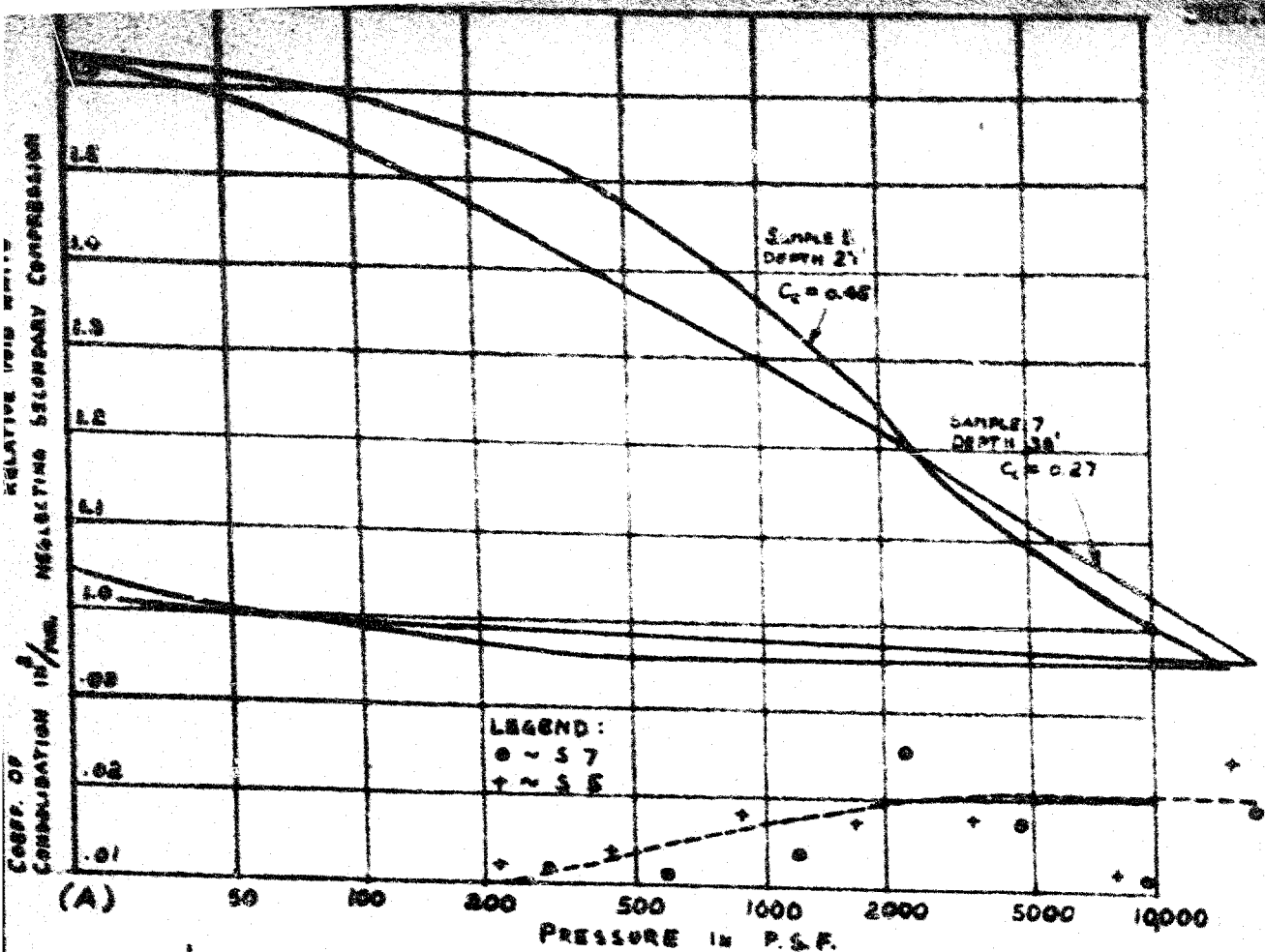
very loose
highly organic
silt

Bedrock

Red clay shale

with hard green shale interbeds

Scale 100 ft = 1 inch







- (A) Void-Ratio and Coefficient of Consolidation vs. pressure curves for two samples from test cell 1.
- (B) Computed magnitude and rate of settlement at station AA of the proposed highway as shown, assuming drainage at bedrock and at the surface.

Year

Blows/ft. Natural weight p.c.

Core recovery

Zero


 standard distribution

 test 2" split water

 unconfined compression
 strength, t.s.f.

 natural soil weight
 p.c.f.

LACEY, MacCALLUM AND ASSOCIATES LIMITED

J. Marykuta
Driller

Foundation Engineering Division

R. Morrisette
Helper

Job No. 27.9.55.

Engineering Data Sheet for Borehole: 2

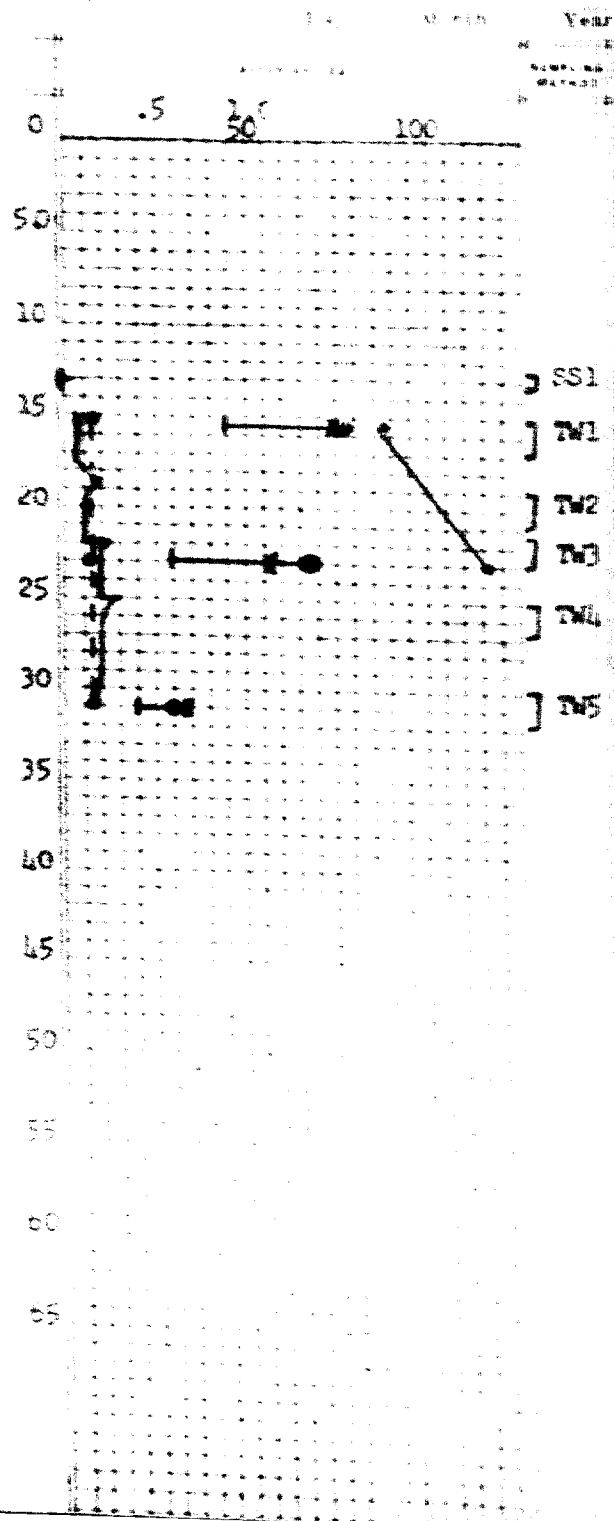
W.A.T.

Checked by

Job Name: Quotas Paradise Crossing
Job Located: No. 2 Hwy. west of Hamilton
Hole Located: See attached sketch
Hole Elevation: 215 ft. Datum:

DEPTH	EL.	TEST- DEPT	DESCRIPTION
0.0	215		Water surface
			Very loose organic silt with shells, becoming very fine organic silty sand below 20 feet
			Sounded beyond 32 feet
58	187		End of borehole Assumed bedrock. (Red clay shale)

Legend - see Encl. No. 1



RACEY, MACCALLUM AND ASSOCIATES LIMITED

Foundation Engineering Division

J. Marykasa
Driller

R. Morrisette
Helper

W.A.T.
Checked by

Date Bored 1.10.55.

Date Bored 1.10.55.

Engineering Data Sheet for Borehole: 3

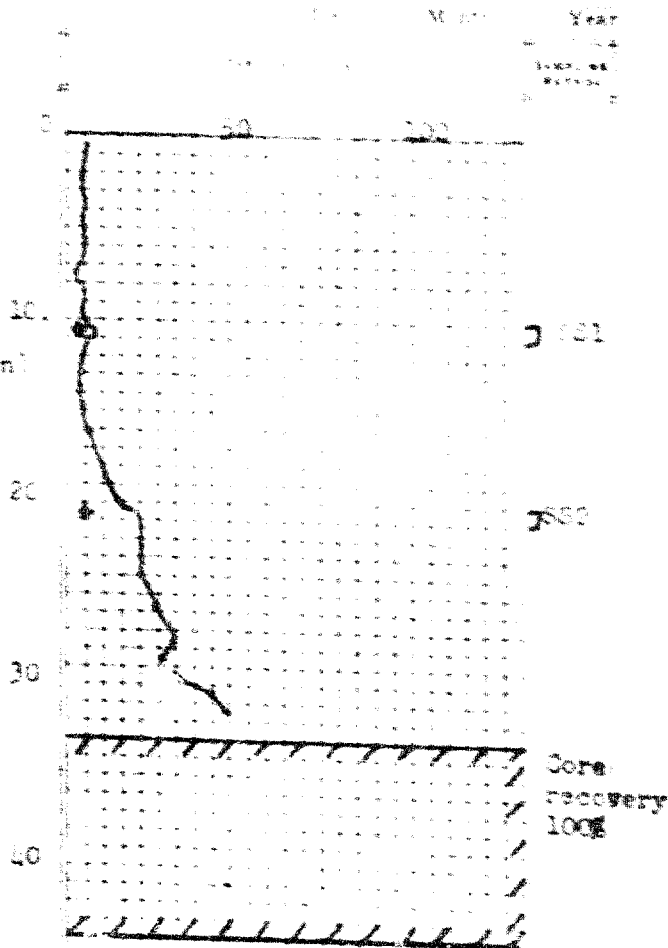
Job Name: Cootes Paradise Crossing

Job Located: No. 2 Hwy, west of Hamilton

Hole Located: See attached sketch

Hole Elevation: 245 feet Datum:

Depth	ft.	Feet - from datum	DESCRIPTION
0	245		Ground Surface
			Loose interbedding of gravelly silt-clay and organic silt. (Result of ravine bank erosion)
33	212		Bedrock
			Greenstone shale: red clay shale with hard greenish interbeds, horizontally layered
44	201		



Legend - see Enclosure No. 1