

#65-F-67

W.P. #189-63

CONCESSION RD.

E. OF HWY. #21

HICKORY

CREEK DIV.

DEPARTMENT OF HIGHWAYS ONTARIO

MEMORANDUM

To: Mr. B. R. Davis,
Bridge Engineer,
Bridge Division.

FROM: Foundation Section,
Materials & Testing Div.,
Room 107, Lab. Bldg.

Attention: Mr. S. McCombie

DATE: September 1, 1965

OUR FILE REF.

IN REPLY TO

SUBJECT:

FOUNDATION INVESTIGATION REPORT

For


Hickory Creek Proposed Diversion,
Lots 2 and 3, Conc's VI and VII,
Twp. of Warwick, Co. of Lambton,
District #1 (Chatham, Ontario).
W.J. 65-F-67 -- W.P. 189-63

Attached, we are forwarding to you, our detailed foundation investigation report on the subsoil conditions existing at the above structure site.

We believe that the factual data and recommendations contained therein, will prove adequate for your design requirements. Should further information be required, please feel free to contact our Office.

KYL/MdeF
Attach.

cc: Messrs. B. R. Davis (2)
H. A. Tregaskes
D. W. Farren
A. Gater
F. C. Brown
J. Foy
A. Watt


K. Y. Lo,
SUPERVISING FOUNDATION ENGR.
For:
A. G. Stermac,
PRINCIPAL FOUNDATION ENGR.

Foundations Office ✓
Gen. Files

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FOUNDATION INVESTIGATION REPORT
For
Hickory Creek Proposed Diversion,
Lots 2 and 3, Conc's VI and VII,
Twp. of Warwick, Co. of Lambton,
District #1 (Chatham, Ontario).

1. INTRODUCTION:

A request for a foundation investigation at the site of the proposed diversion of Hickory Creek in Warwick Twp. was received from Mr. G. Scott, Regional Bridge Location Engineer, in a memo dated May 26, 1965.

A field investigation was subsequently carried out by this Section to determine the subsoil conditions existing at the location of the proposed structure which will cross the creek diversion.

Presented in this report are the results of this investigation and our recommendations pertaining to the design of the proposed structure foundations.

2. DESCRIPTION OF THE SITE:

The proposed bridge site (No. 14-26) is located in the vicinity of the intersection of Hwy. #21 and Rd. Allowance, between Conc's VI and VII, which is approx. 6.8 miles north of the junction of Hwy. #7 and Hwy. #21.

The surrounding area is gently rolling terrain in the immediate vicinity of the site.

Physiographically, the site is located in the region referred to as the St. Clair Clay Plains.

3. FIELD INVESTIGATION PROCEDURE:

A total of two boreholes and four dynamic cone penetration tests was carried out during the course of the field work. Boring was achieved by means of conventional diamond drilling equipment adapted for soil sampling purposes. During the field work, disturbed samples were obtained by means of a standard split-spoon sampler; the energy used in driving it conformed to the requirements of the Standard Penetration Test. Dynamic cone penetration tests were carried out adjacent to each borehole and at two other locations. Driving energy to advance the cone was 350 ft.-lbs. per blow.

The locations and elevations of all boreholes are shown on Dwg. 65-F-67A, which accompanies this report.

4. LABORATORY TESTS:

Samples were visually examined and classified at the site as well as in the laboratory. Tests were carried out in the laboratory for classification purposes. These tests consisted of Atterberg limits, moisture content and grain size distribution determinations. The test results are shown on the Borehole Record sheets which form part of this report.

5. SOIL TYPES AND SOIL CONDITIONS:

5.1) General:

Subsoil at the site was found to consist of a deposit of clayey silt with some sand and gravel, from ground level to the full depth of exploration. In B.H. #2 the continuity of this stratum is interrupted by a 6-ft. thick layer of sandy gravel with some silt and traces of clay.

cont'd. /3 ...

5. SOIL TYPES AND SOIL CONDITIONS: (cont'd.) ...

5.2) Clayey Silt:

This deposit extends from ground level to a minimum depth of 41 ft. (El. 655.0) in all boreholes. The material consists of clayey silt containing sand and some gravel. Between elevation 691.0 and elev. 685.0, a compact layer of sandy gravel with some silt and traces of clay was encountered in borehole #2 only.

The upper portion (approx. 12 ft.) of the main deposit is brown in colour; the rest of the material is grey.

The consistency of the overall stratum ranges from firm to hard. The average 'N' value was found to be 26 blows per foot and the range from 5 to 35 blows per foot. From these results, it is estimated that the undrained shear strength of the deposit ranges from 800 p.s.f. - 3,500 p.s.f.

The average physical properties of the material as determined from laboratory tests, are as follows:

| | | |
|--------------------------|----|-----|
| Natural Moisture Content | -- | 17% |
| Liquid Limit | -- | 26% |
| Plastic Limit | -- | 15% |

The average proportions of the different grain sizes are:

| | | |
|--------|----|-----|
| Gravel | -- | 5% |
| Sand | -- | 9% |
| Silt | -- | 55% |
| Clay | -- | 31% |

The water level in B.H. #1 and #2 was found to be at approximate elev. 590.0.

cont'd. /4 ...

6. DISCUSSION AND RECOMMENDATIONS:

It is proposed to divert Hickory Creek some 400 ft. east from its present location. The traffic on the Township Road will be carried over the creek by means of a 45-ft. long structure, constructed along the centre line of the existing road. It was observed from the bridge site plan that the present grade line of the Township Road will be elevated by 4 feet, and the bed of the diverted creek will be excavated to about elevation 684.0 ft.

The investigation has revealed that the shear strength of the grey, clayey silt deposit is adequate to provide suitable support for spread footing type foundations.

In view of the foregoing, it is recommended that the footings be placed at or below elev. 678.0 in which case, a safe pressure of 2 t.s.f. may be assumed for design purposes. The exact depth of the footings, however, will be determined from hydrological considerations.

No dewatering problems are anticipated since the clayey silt subsoil is relatively impermeable.

No stability problems are anticipated for the structure approaches, provided 2:1 side slopes are constructed.

7. SUMMARY:

A foundation investigation at the proposed Hickory Creek diversion in Warwick Twp. is reported.

Subsoil at the site was found to consist of brown, clayey silt followed by very stiff to hard, grey, clayey silt material.

cont'd. /5 ...

7. SUMMARY: (Cont'd.) ...

The proposed structure is recommended to be founded on spread footings at or below approx. elevation 678.0'. A design load of 2.0 t.s.f. can be achieved at this depth.

Details are given in the foregoing section: "Discussion and Recommendations".

8. MISCELLANEOUS:

The drilling equipment used was owned and operated by Johnston Drilling Co. The field work was carried out during the period of June 14, 15, 16, 1965. The supervision of the field work, together with the preparation of this report, was carried out by Mr. P. Payer, Project Foundation Engineer, under the general supervision of Mr. K. G. Selby, Senior Foundation Engineer.

September 1965

APPENDIX I

MATERIALS & TESTING DIVISION

FOUNDATION SECTION

LOCATION Sta. 4700; 1 1/4' Rt.

ORIGINATED BY P.P.

BORING DATE June 14 & 15, 1965.

COMPILED BY P.P.

BOREHOLE TYPE Washbore - NX Casing.

CHECKED BY AK

| SOIL PROFILE | | | SAMPLES | | | DYNAMIC PENETRATION RESISTANCE | | | | | LIQUID LIMIT ——— WL PLASTIC LIMIT ——— WP WATER CONTENT ——— W | | | BULK DENSITY P.C.F. | REMARKS | |
|----------------|---|-------------|---------|------|--------------|--------------------------------|--------------|----|----|----|--|-----|----|------------------------|---------|----|
| ELEV. DEPTH | DESCRIPTION | STRAT. PLOT | NUMBER | TYPE | BLOWS / FOOT | ELEV SCALE | BLOWS / FOOT | 25 | 50 | 75 | 100 | 125 | WP | | | WL |
| 697.0 | Groundlevel | | | | | | | | | | | | | | | |
| 0.0 | Clayey silt with sand and some gravel. Brown. Firm to v. stiff. | / \ | 1 | SS | 8 | | | | | | | | | | | |
| | | T | 2 | SS | 5 | 690 | | | | | | | | | | |
| | | / \ | 3 | SS | 29 | | | | | | | | | | | |
| | | T | 4 | SS | 20 | | | | | | | | | | | |
| | Clayey silt with some sand. | T | 5 | SS | 23 | 680 | | | | | | | | | | |
| | | T | | | | | | | | | | | | | | |
| | Grey | T | 6 | SS | 27 | | | | | | | | | | | |
| | V. stiff to hard. | T | | | | | | | | | | | | | | |
| | Glacial Till | T | 7 | SS | 24 | 670 | | | | | | | | | | |
| | | T | | | | | | | | | | | | | | |
| | | T | 8 | SS | 21 | | | | | | | | | | | |
| | | T | | | | | | | | | | | | | | |
| | | T | 9 | SS | 33 | 660 | | | | | | | | | | |
| | | T | | | | | | | | | | | | | | |
| | | T | 10 | SS | 35 | | | | | | | | | | | |
| 655.5 | End of borehole. | | | | | | | | | | | | | | | |
| 41.5 | | | | | | | | | | | | | | | | |
| | | | | | | 650 | | | | | | | | | | |

CHECKED BY

FOUNDATION SECTION

[illegible]

CHECKED BY _____

[illegible]

ABBREVIATIONS USED IN THIS REPORT

PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE 'N' :- THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES.

DYNAMIC PENETRATION RESISTANCE :- THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL. THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW.

DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS :-

| <u>CONSISTENCY</u> | <u>'N' BLOWS / FT.</u> | <u>c LB. / SQ FT</u> | <u>DENSENESS</u> | <u>'N' BLOWS / FT.</u> |
|--------------------|------------------------|----------------------|------------------|------------------------|
| VERY SOFT | 0 - 2 | 0 - 250 | VERY LOOSE | 0 - 4 |
| SOFT | 2 - 4 | 250 - 500 | LOOSE | 4 - 10 |
| FIRM | 4 - 8 | 500 - 1000 | COMPACT | 10 - 30 |
| STIFF | 8 - 15 | 1000 - 2000 | DENSE | 30 - 50 |
| VERY STIFF | 15 - 30 | 2000 - 4000 | VERY DENSE | > 50 |
| HARD | > 30 | > 4000 | | |

TYPE OF SAMPLE

| | | | |
|-----|-----------------------------------|-----|-------------------|
| S S | SPLIT SPOON | T W | THINWALL OPEN |
| W S | WASHED SAMPLE | T P | THINWALL PISTON |
| S B | SCRAPER BUCKET SAMPLE | O S | OESTERBERG SAMPLE |
| A S | AUGER SAMPLE | F S | FOIL SAMPLE |
| C S | CHUNK SAMPLE | R C | ROCK CORE |
| S T | SLOTTED TUBE SAMPLE | | |
| | F H SAMPLE ADVANCED HYDRAULICALLY | | |
| | P M SAMPLE ADVANCED MANUALLY | | |

SOIL TESTS

| | | | |
|-----------------|---------------------------------|-----|-----------------|
| Q _u | UNCONFINED COMPRESSION | L V | LABORATORY VANE |
| Q | UNDRAINED TRIAXIAL | F V | FIELD VANE |
| Q _{cu} | CONSOLIDATED UNDRAINED TRIAXIAL | C | CONSOLIDATION |
| Q _d | DRAINED TRIAXIAL | S | SENSITIVITY |

ABBREVIATIONS USED IN THIS REPORT

SOIL PROPERTIES

| | |
|------------|--|
| γ | UNIT WEIGHT OF SOIL (BULK DENSITY) |
| γ_s | UNIT WEIGHT OF SOLID PARTICLES |
| γ_w | UNIT WEIGHT OF WATER |
| γ_d | UNIT DRY WEIGHT OF SOIL (DRY DENSITY) |
| γ' | UNIT WEIGHT OF SUBMERGED SOIL |
| G | SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$ |
| e | VOID RATIO |
| n | POROSITY |
| w | WATER CONTENT |
| S_r | DEGREE OF SATURATION |
| w_L | LIQUID LIMIT |
| w_p | PLASTIC LIMIT |
| I_p | PLASTICITY INDEX |
| s | SHRINKAGE LIMIT |
| I_L | LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$ |
| I_C | CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$ |
| e_{max} | VOID RATIO IN LOOSEST STATE |
| e_{min} | VOID RATIO IN DENSEST STATE |
| I_D | DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$ |
| | RELATIVE DENSITY D_r IS ALSO USED |
| h | HYDRAULIC HEAD OR POTENTIAL |
| Q | RATE OF DISCHARGE |
| v | VELOCITY OF FLOW |
| i | HYDRAULIC GRADIENT |
| k | COEFFICIENT OF PERMEABILITY |
| j | SEEPAGE FORCE PER UNIT VOLUME |
| m_v | COEFFICIENT OF VOLUME CHANGE = $\frac{-\Delta e}{(1+e)\Delta\sigma}$ |
| C_v | COEFFICIENT OF CONSOLIDATION |
| C_c | COMPRESSION INDEX = $\frac{\Delta e}{\Delta \log_{10} \sigma}$ |
| T_v | TIME FACTOR = $\frac{C_v t}{d^2}$ (d, DRAINAGE PATH) |
| U | DEGREE OF CONSOLIDATION |
| τ_f | SHEAR STRENGTH |
| c' | EFFECTIVE COHESION INTERCEPT |
| ϕ' | EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION |
| c_u | APPARENT COHESION |
| ϕ_u | APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION |
| μ | COEFFICIENT OF FRICTION |
| S_t | SENSITIVITY |

GENERAL

| | |
|---------------------------|-----------------------------------|
| π | = 3.1416 |
| e | BASE OF NATURAL LOGARITHMS 2.7183 |
| $\log_e a$ OR $\ln a$ | NATURAL LOGARITHM OF a |
| $\log_{10} a$ OR $\log a$ | LOGARITHM OF a TO BASE 10 |
| t | TIME |
| g | ACCELERATION DUE TO GRAVITY |
| V | VOLUME |
| W | WEIGHT |
| M | MOMENT |
| F | FACTOR OF SAFETY |

STRESS AND STRAIN

| | |
|----------------|--|
| u | PORE PRESSURE |
| σ | NORMAL STRESS |
| $\bar{\sigma}$ | NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED) |
| τ | SHEAR STRESS |
| ϵ | LINEAR STRAIN |
| γ | SHEAR STRAIN |
| ν | POISSON'S RATIO (μ IS ALSO USED) |
| E | MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS) |
| G | MODULUS OF SHEAR DEFORMATION |
| K | MODULUS OF COMPRESSIBILITY |
| η | COEFFICIENT OF VISCOSITY |

EARTH PRESSURE

| | |
|----------|---|
| d | DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE |
| δ | ANGLE OF WALL FRICTION |
| K | DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS |
| K_0 | COEFFICIENT OF EARTH PRESSURE AT REST |

FOUNDATIONS

| | |
|-------|--|
| B | BREADTH OF FOUNDATION |
| L | LENGTH OF FOUNDATION |
| D | DEPTH OF FOUNDATION BENEATH GROUND |
| N | DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY |
| k_s | MODULUS OF SUBGRADE REACTION |

SLOPES

| | |
|---------|--|
| H | VERTICAL HEIGHT OF SLOPE |
| D | DEPTH BELOW TOE OF SLOPE TO HARD STRATUM |
| β | ANGLE OF SLOPE TO HORIZONTAL |

Department of Highways Ontario

Copy for the information of

Mr. K. Selby, Foundation Section, Lab. Bldg., Downsview.

Mr. D. D. Murray,
Sr. Project Design Engineer,
Design Branch,
London Regional Office,
LONDON, Ontario.

Bridge Division,
Downsview, Ontario.

February 4, 1966.

Attention: Mr. M. C. Dodge

Hickory Creek 1 1/2 mls. south of Forest
Site No. 14-26, W.P. 189-63,
BW 1819, District 1, Warwick Twp. Bridge.

In reply to your memorandum of January 25, 1966, the profile of the stream diversion recently supplied by your office will affect both the foundation and the hydrology recommendations.

I have discussed the subject with Mr. K. Selby of the foundation section, and we agreed that in view of the revised invert elevation, the bottom of footings could be raised by 3 feet, to elevation 681.0. This would be satisfactory both for bearing and scour.

JDM/im

cc. K. Selby ✓
M. Zoltay

J. D. Harris,
Bridge Hydrology Engineer.

MEMORANDUM

To: Mr. A. G. Stermac,
Principal Foundation Engineer,
Room 107, Lab. Bldg.

FROM: Bridge Division,
Downsview, Ontario.

DATE: March 21, 1966.

OUR FILE REF.

IN REPLY TO

65-F-67

SUBJECT: W.P. 189-63 Site 14-26,
Hickory Creek Bridge,
6.8 miles north of Jct. Hwy. 7,
On Concession Road East of Hwy. 21,
District 1

Attached please find one copy of the preliminary plan
D 5830-P1 for the above structure.

Would you kindly review the bridge foundations proposed
and inform me if they are satisfactory.

An early reply would be appreciated.



APW/ag

A. P. Watt,
Regional Bridge Location Engineer.

Encl.

Mr. S. McCombie,
Bridge Planning Engr.,
Bridge Division.

Foundation Section,
Materials & Testing Div.,
Room 107, Lab. Bldg.

Attention: Mr. A. P. Watt,
Regional Bridge
Location Engr.

March 23, 1966

W.P. 139-63,
Bridge Site 14-26,
Hickory Creek Bridge,
Hwy. 21, District 1 (Chatham).

We have reviewed the preliminary plan for the
above structure.

The designer appears to have followed the rec-
ommendations of the Foundation Section.

KGS/MieP

K. G. Selby
K. G. Selby,
SENIOR FOUNDATION ENGINEER
For:
A. G. Stermac,
PRINCIPAL FOUNDATION ENGINEER

cc: Foundations Office ✓
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