

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: May 11, 1966

Our File Ref.

IN REPLY TO

MAY 15 1966

SUBJECT:

FOUNDATION INVESTIGATION REPORT
For
The Proposed Humber River Bridge,
North of Palgrave, Hwy. #50,
District #6 (Toronto).

W.J. 66-P-29

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W.P. 3-66

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

We believe that you will find the factual data and recommendations contained therein, adequate for your design requirements.

Should additional information be required, please do not hesitate to contact our Office.

AGS/WdeP

Attach.

cc: Messrs. B. R. Davis (2)
H. A. Tregaskes
D. W. Farren
G. K. Hunter (2)
J. C. Thatcher
T. J. Kovich
A. Watt

A. G. Stermac

A. G. Stermac,
PRINCIPAL FOUNDATION ENGINEER

Foundations Office
Gen. Files

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FOUNDATION INVESTIGATION REPORT
For
The Proposed Humber River Bridge,
North of Palgrave, Hwy. #50,
District #6 (Toronto).
W.J. 66-P-29 -- W.P. 3-66

1. INTRODUCTION:

The Foundation Section was requested to carry out a foundation investigation where Hwy. #50 crosses Humber River. At this location the old centre portion of this bridge has now deteriorated so badly that it has been decided to replace the centre section of the existing structure. A request was received in a memo dated March 4, 1966, from the Bridge Location Section (Mr. W. Melinyshyn, Regional Bridge Location Engineer). An investigation was carried out by this Section to determine the subsoil conditions existing at the site. This report contains the results of this investigation, together with our recommendations.

2. DESCRIPTION OF SITE:

The site is about half a mile north of Palgrave on Hwy. #50. The area is hilly with a rolling "knob-and-basin" relief. The terrain is covered with a thick forest of pine and swamp cedar trees. Physiographically, the area is referred to as "Oak Ridges".

3. DESCRIPTION OF FIELD WORK:

The field investigation was carried out by means of a core drill machine adapted for soil sampling. The investigation comprised of two boreholes with adjacent dynamic cone penetration tests. The boreholes were driven down to 71.5' and 135', respectively.

In granular soils sampling was carried out with a split-spoon sampler whose dimensions and driving energy used, comply with the requirements of the Standard Penetration Test.

cont'd. /2

3. DESCRIPTION OF FIELD WORK: (cont'd.) ...

In the laboratory, samples were visually examined and on selected representative ones, tests were performed for moisture content, organic content, and grain size distribution. The laboratory test results and the borehole elevations are shown on the attached Drawing No. 66-P-29A.

4. SUBSOIL CONDITIONS:

4.1) General:

The subsoil at the site is quite uniform. The upper layer of silty sand with organics is underlain by a deposit of sandy silt to silt material.

4.2) Silty Sand with Organics:

In both boreholes the upper 15 ft. is made up of a recent deposit of silty sand and gravel with some organics. The range of the "N" values was found to be 2 - 13 blows per foot, indicating that the material is generally very loose to compact. The moisture content was found to be 15% - 63%.

4.3) Sandy Silt to Silt (layered):

Underlying the stratum of silty sand with organics, the deposit of sandy silt to silt was encountered. This layer is essentially silt with variable amounts of fine sand decreasing with depth. Below 55 ft. within the silt deposit, random layers of silty fine sand approximately 1/4" to 1/2" were observed. The moisture content of the material ranges from 15% to 24%. The "N" values range from 7 - 56 blows per foot, indicating a loose to very dense relative density, generally increasing with depth.

5. GROUND WATER:

The measured ground water level, during the investigation, was found to be at elevation 896.5 ft., which corresponds to the water level in the river.

cont'd. /3

6. DISCUSSION AND RECOMMENDATIONS:

The centre portion of the existing single-span structure at the crossing of Hwy. #50 and the Humber River, is to be replaced.

Subsoil at the site consists of a 15-ft. surface stratum of very loose to compact silty sand with gravel and organics, followed by an extensive deposit of compact to dense sandy silt to silt.

Because of the low estimated bearing capacity of the upper subsoil ("N" values 2 - 13 blows/ft.), it is recommended that the structure be supported on a piled foundation.

The use of timber piles would seem to provide a practical solution. For example, 45-ft. long, #14 timber piles, driven to an estimated tip elevation of 845, would provide a safe load of 25 tons/pile. However, the driving of piles in the field should be controlled by the use of the Hiley formula as per current D.H.O. standards DD 1218 and DD 1219.

A dewatering scheme will be necessary, as excavations for pile caps will be carried out in fine-grained granular material below the prevailing ground water or river water level.

Care should be exercised in the design to ensure that the centre portion of the structure which has to be replaced, is so articulated that any possible differential settlements can take place without impairing the overall performance of the bridge.

No fill stability problems are anticipated since the existing grade will not be changed.

7. SUMMARY:

Subsoil at the site consists mainly of a loose to dense silty fine sand to silt deposit extending at least 120 ft. below ground surface.

cont'd. /4

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

The centre portion of the existing bridge over the Humber River on Hwy. #50 will be replaced by a new structure. The new structure can be supported on large displacement piles driven into the silty sand to silt stratum. A design load of 25 tons per pile may be used for #14 timber piles driven to 45' below ground surface (estimated tip elev. 845).

A dewatering scheme may be required if pile caps are formed below water level.

No stability problems are anticipated for the proposed 2:1 standard slopes.

8. MISCELLANEOUS:

The field work, performed in March 1966, together with the preparation of this report, was performed by Mr. V. Korlu, Project Foundation Engineer. The investigation was carried out under the general supervision of Mr. M. Devata, Senior Foundation Engineer, who also reviewed this report.

Equipment was owned and operated by Johnston Drilling Co. of Ottawa.

May 1966

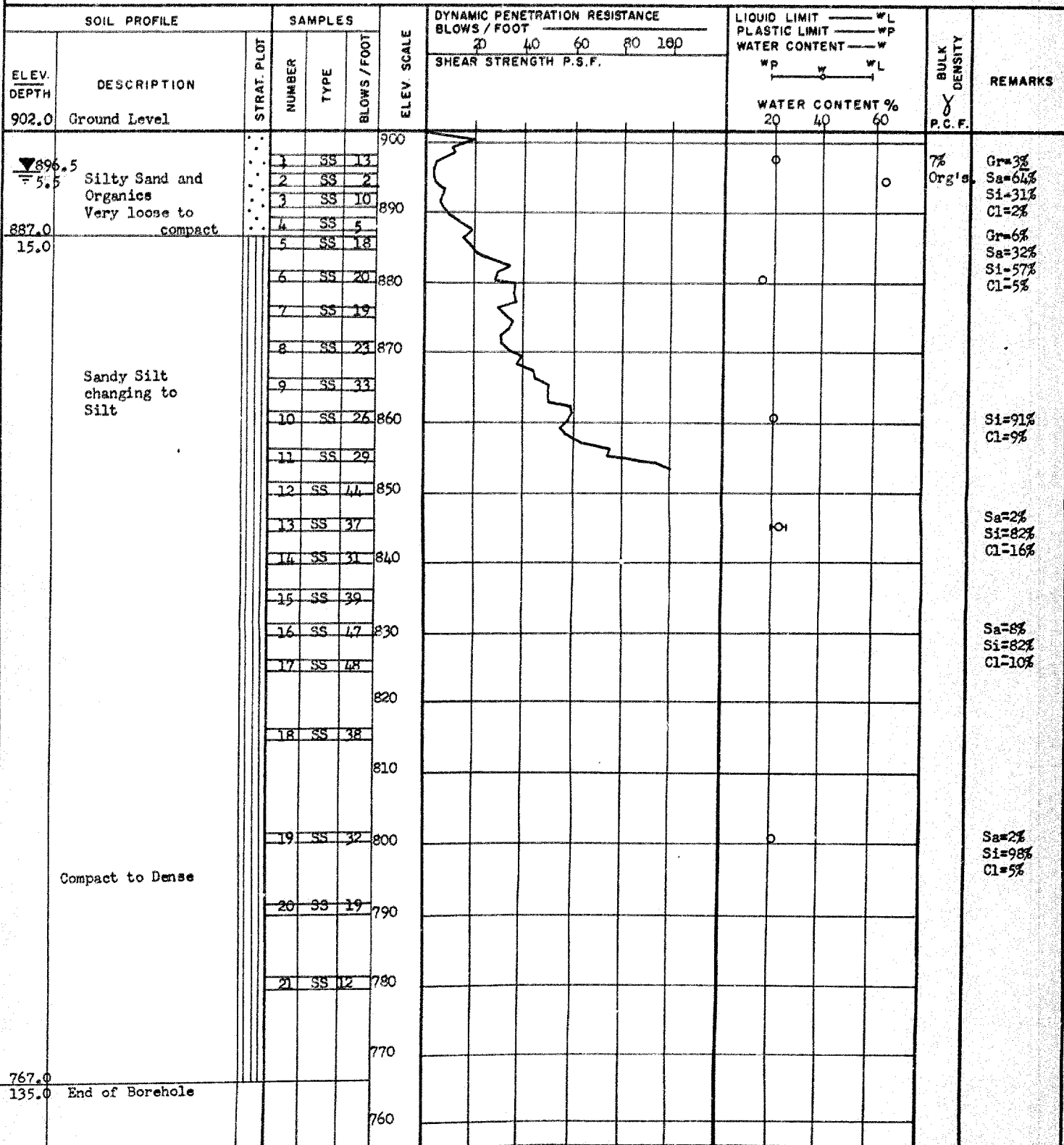
APPENDIX I

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 1

FOUNDATION SECTION

JOB 66-F-29LOCATION Hwy. 50 & Humber River 552/81 26' Rt.ORIGINATED BY V.K.W.P. 3-66BORING DATE March 21, 1966COMPILED BY V.K.DATUM GeodeticBOREHOLE TYPE Drive BX Casing & WashCHECKED BY dl

FOUNDATION SECTION

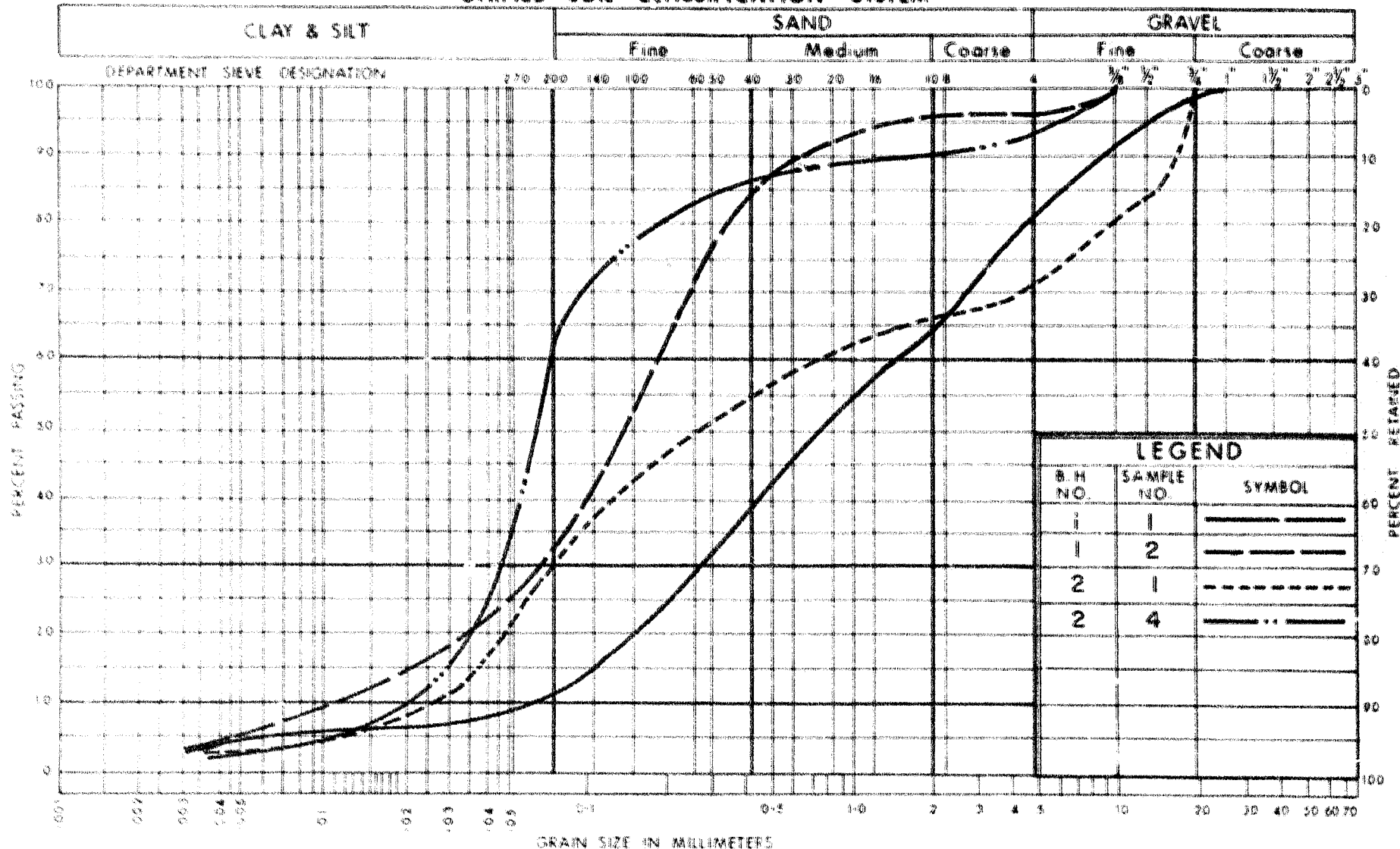
ORIGINATED BY V.K.

COMPILED BY V.K.

CHECKED BY SK

[illegible]

UNIFIED SOIL CLASSIFICATION SYSTEM



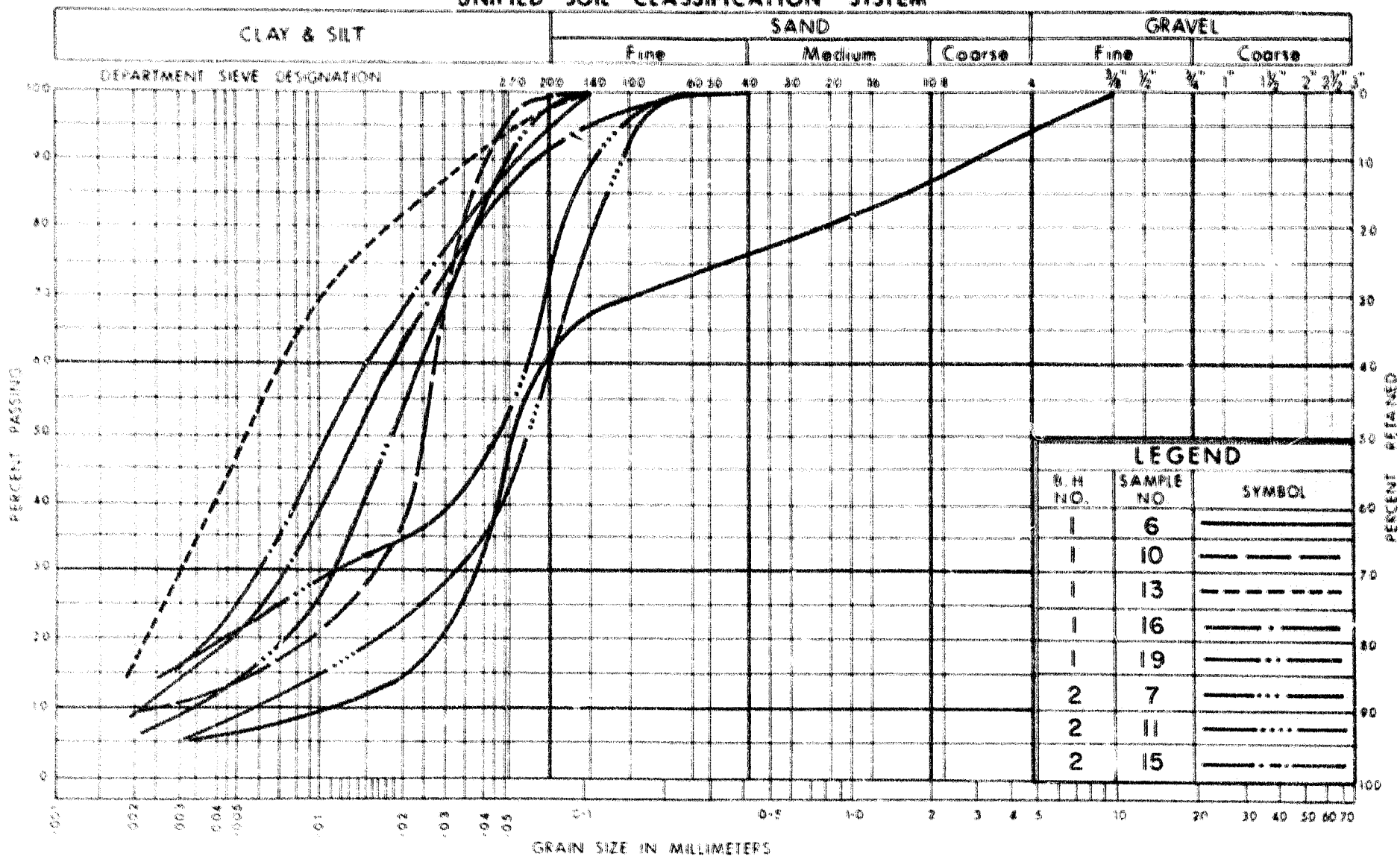
DEPARTMENT OF HIGHWAYS
MATERIALS and
TESTING
DIVISION

GRAIN SIZE DISTRIBUTION
SILTY SAND with GRAVEL

W.P. No. 3-66

JOB No. 66-F-29

UNIFIED SOIL CLASSIFICATION SYSTEM



ONTARIO

DEPARTMENT OF HIGHWAYS
MATERIALS and
TESTING
DIVISION

GRAIN SIZE DISTRIBUTION
SANDY SILT to SILT

W.P. No. 3-66

JOB No. 66-F-29

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 / 50 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	WASHER 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		
	P 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

MEMORANDUM

To: Mr. A. C. Sternac,
Principal Foundation Engineer,
Room 107, Lab. Building.

From: Bridge Division,
Downsview, Ontario

Date: November 1, 1966

Our File Ref.

In Reply To

SUBJECT:

W.P. 3-66, Site No. 24-205,
Humber River Bridge,
Highway 50, District 6

Herewith one print of our drawing D-5955-1P
for your approval and comments.



RNC/pr
Encl.

J. C. McAllister,
for W. S. Melinshyn,
Regional Bridge Location
Engineer

Mr. J. L. Keen,
Senior Bridge Project Engineer,
Bridge Division,
Main Bldg.

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

October 26, 1966

Your Memo -- Oct. 25/66

Knabner River Bridge - Hwy. 50,
1.4 Miles South of Jct. Hwy. No. 9,
W. P. 3 - 66, Site 24 - 205,
District No. 5 (Toronto).

With reference to your memorandum of October 25th regarding the above mentioned structure, we wish to make the following comments:

It would be very important to know whether the centre portion of the bridge that is to be replaced is founded on piles or not. Once the contract is let, piles have to be ordered and brought to the site. It would be very embarrassing to discover that piles are already in the ground when the actual pile driving is to commence.

If there are no piles, recommendations given in our report 66-7-29 of May 13, 1966, should be followed. We feel that the pile driving will not adversely affect the existing adjacent exterior parts.

In case the presence of piles is established, we would suggest that consideration be given to adding a few piles to the footing in order to account for the possibly slightly higher load of the new structure.

Since there will be no additional fill placed, we feel that any settlements that will take place, will be negligible. However, to allow for only 1/8" of differential settlement seems to us to be too little. It is very hard, or practically impossible, to predict settlements of this magnitude, but in a case where friction piles are used, differential settlements of the order of 1/4 to 1/2 inch would certainly not be unexpected. We would suggest that the consultant reappraise his design again and assess whether slightly higher settlements would really have very detrimental effects on the structure. It appears to be the experience of your office that very often some of the designs are too conservative in dealing with allowable differential settlements.

cont'd. /2 ...

Mr. J. A. Keen,
Senior Bridge Project Engr.,
Bridge Division.

- 2 -

October 26, 1966

In conclusion, we would express our opinion that there should be no problems with this structure, provided it is built in accordance with the suggestions and recommendations submitted earlier.

AGS/Edg?

A. C. Sterzac
A. C. Sterzac,
PRINCIPAL FOUNDATION ENGINEER

cc: Mr. C. Tilly, P. Eng., Giffels Associates

Foundations Office /
Gen. Files

MEMORANDUM

TO: Mr. A.G. Stermac,
Principal Foundation Engineer,
Room 107, Lab. Building

FROM: Bridge Division,
Downsview, Ontario

DATE: October 25, 1966

OUR FILE REF.

IN REPLY TO

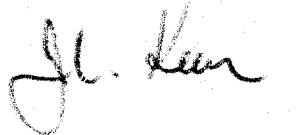
SUBJECT: Humber River Bridge - Hwy. 50
1.4 Miles South of Jct. Hwy. No. 9
W.P. 3-66, Site 24-205
District No. 6

Please find enclosed a copy of D5955-P1, Preliminary Plan, and D5955-P1A, Stream Realignment, accompanying the Preliminary Plan for the above structure. These drawings were prepared by Giffels Associates Limited, the Department's Consultant engaged to carry out design and drawing preparation for the above project.

As this project is somewhat unusual we would be interested in your comments, also if you anticipate any difficulties such as settlement of the previously widened exterior parts from pile driving for the new centre part.

The design will provide for minor differential settlements between the new and existing parts of about 1/8" or slightly more by allowing the connecting dowels to deflect.

Should you require further information please call the writer or Mr. George Tilly, P. Eng., of Giffels Associates Ltd. at 366-3781.



J.L. Keen,
Senior Bridge Project Engineer

JLK:rd

Encls.

c.c. Mr. G. Tilly, P. Eng., Giffels Associates

Mr. J. L. Keen,
Senior Bridge Project Engineer,
Bridge Division,
Admin. Bldg.

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

October 26, 1966

Your Memo -- Oct. 25/66

Humber River Bridge - Hwy. 50,
1.4 Miles South of Jct. Hwy. No. 9,
W. P. 3 - 66, Site 24 - 205,
District No. 6 (Toronto).

with reference to your memorandum of October 25th regarding the above mentioned structure, we wish to make the following comments:

It would be very important to know whether the centre portion of the bridge that is to be replaced is founded on piles or not. Once the contract is let, piles have to be ordered and brought to the site. It would be very embarrassing to discover that piles are already in the ground when the actual pile driving is to commence.

If there are no piles, recommendations given in our report 66-7-29 of May 13, 1966, should be followed. We feel that the pile driving will not adversely affect the existing adjacent exterior parts.

In case the presence of piles is established, we would suggest that consideration be given to adding a few piles to the footing in order to account for the possibly slightly higher load of the new structure.

CP
Since there will be no additional fill placed, we feel that any settlements that will take place, will be negligible. However, to allow for only 1/8" of differential settlement seems to us to be too little. It is very hard, or practically impossible, to predict settlements of this magnitude, but in a case where friction piles are used, differential settlements of the order of 1/4 to 1/2 inch would certainly not be unexpected. We would suggest that the consultant reappraise his design again and assess whether slightly higher settlements would really have very detrimental effects on the structure. It appears to be the experience of your office that very often some of the designs are too conservative in dealing with allowable differential settlements.

cont'd. /2 ...

Mr. J. L. Keen,
Senior Bridge Project Engr.,
Bridge Division.

- 2 -

October 26, 1966

In conclusion, we would express our opinion that there should be no problems with this structure, provided it is built in accordance with the suggestions and recommendations submitted earlier.

AGS/WdeP

A. G. Sternac
A. G. Sternac,
PRINCIPAL FOUNDATION ENGINEER

cc: Mr. G. Tilly, P. Eng., Giffels Associates

Foundations Office
Gen. Files ✓

MEMORANDUM

To: Mr. A.G. Sternac,
Principal Foundation Engineer,
Room 107, Lab. Building

FROM: Bridge Division,
Downsview, Ontario

DATE: October 25, 1966

Our File Ref.

In reply to

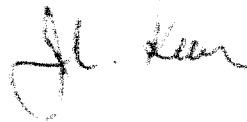
SUBJECT: Humber River Bridge - Hwy. 50
1.4 Miles South of Jct. Hwy. No. 9
W.P. 3-66, Site 24-205
District No. 6

Please find enclosed a copy of D5955-P1, Preliminary Plan, and D5955-P1A, Stream Realignment, accompanying the Preliminary Plan for the above structure. These drawings were prepared by Giffels Associates Limited, the Department's Consultant engaged to carry out design and drawing preparation for the above project.

As this project is somewhat unusual we would be interested in your comments, also if you anticipate any difficulties such as settlement of the previously widened exterior parts from pile driving for the new centre part.

The design will provide for minor differential settlements between the new and existing parts of about $1/8"$ or slightly more by allowing the connecting dowels to deflect.

Should you require further information please call the writer or Mr. George Tilly, P. Eng., of Giffels Associates Ltd. at 366-3781.



J.L. Keen,
Senior Bridge Project Engineer

JLK:rd

Encls.

c.c. Mr. G. Tilly, P. Eng., Giffels Associates

MEMORANDUM

To:

Mr. A. Sternac,
Principal Foundation Engineer,
Room 107, Lab. Building.

FROM:

66-F-29
Bridge Division,
Downsview, Ontario

DATE:

March 4, 1966

Our File Ref.

IN REPLY TO

SUBJECT:

W.P. 3-66 Humber River Bridge N. of Palgrave,
Highway No. 50, District No. 6

In 1953 the above structure was widened on both sides with the addition of 9.5' wide concrete rigid frames. The old centre portion of this bridge has now deteriorated so badly that it has been decided to replace the centre section.

The C.R.F. extensions were founded on 25' long timber piles as indicated on the drawing D-3075-1 which is attached. As there is no actual pile driving record or foundation report available, we feel that the two holes shown on site plan E-4727-1 should be put down.

JCMcA/pr
cc. R. Forrest

J. C. McAllister
J. C. McAllister
for W. Melnyahyn,
Regional Bridge Location Engineer

1966 PROGRAM

TO: SAC, ONT

AT: 5101 DUNDAS ST. W.

MARCH 1966

66-F-29

W.P. # 3-66

Hwy. # 50 E

HUMBER RIVER

BRIDGE

