63-F-48

MIDDLESEX CO.

RD. NO. #12

BRIDGE NO. #1

Mr. A. M. Toye,
Bridge Engineer,
Bridge Division.

Attn: Mr. K.L. Kleinsteiber,
Mun. Bridge Liaison Engr.

Mr. A. G. Stermac,
Principal Foundation Engr.,
Foundation Section,
Materials & Research Division.
May 21, 1963

FOUNDATION INVESTIGATION REPORT BY D.H.O. -
Middlesex County Bridge No. 1, County Road 12,
Station 78+50, Lot 6 and 10, Con. IV and VII,
Twp. of Adelaide and West Williams, Dist. No.2.
W.J. 63-F-48 -- Cont. No. 5868-1

Attached, we are forwarding to you, the results of our foundation investigation at the above structure site.

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

If any additional information is required, please feel free to call on our Office.

KYL/MdeF
Attach.
cc: Messrs. A. M. Toye (4)
J. P. Howard
T. S. Caldwell
J. Roy
A. Watt

Foundations Office
Gen. Files ✓

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

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FOUNDATION INVESTIGATION

For

Middlesex County Bridge No. 1, County Road 12,
Station 78+50, Lot 6 and 10, Con. IV and VII,
Twp. of Adelaide and West Williams, Dist. No.2.
W.J. 63-F-48 -- Cont. No. 5868-1

1. INTRODUCTION:

It is proposed to construct a new bridge to carry Middlesex County Road No. 12 over a proposed creek diversion.

A foundation investigation at this site was requested by the Direct Expenditures Engineer, Mr. P. D. Patterson, Municipal Roads Branch, in his memorandum dated May 8, 1963, to determine the subsoil conditions.

An investigation comprised of two sampled boreholes and dynamic cone penetration tests, was commenced on May 13, 1963. The results of this investigation and the exact borehole locations, are attached to this report.

2. SUBSOIL CONDITIONS:

The ground is underlain by an approx. 5-ft. layer of loose, silty sand, followed by a deep layer of clayey silt.

Clayey Silt: This layer of cohesive material was encountered at an approximate elevation 705'. It is of low plasticity and contains traces of sand particles throughout the entire depth explored. The consistency of this layer is, in general, stiff to very stiff, becoming hard below elevation 649'. The thickness of this layer is undetermined, but is at least 56 feet.

cont'd. /2 ...

2. SUBSOIL CONDITIONS: (cont'd.) ...

The average values of Atterberg limits are 32% and 18.5%, respectively: moisture content is 20%, and the density is 131 p.c.f. The colour of the material is brownish-grey.

From field vane and laboratory unconfined compression and quick triaxial tests, an undrained shear strength of 1,800 p.s.f. may be used for design.

3. RECOMMENDATIONS:

The proposed channel diversion necessitates the excavation to be carried down to elevation 700.0' - that is, approximately 11 feet below the ground surface. Spread footings provided at or below this elevation, can support a safe load of 2 t.s.f. The exact footing elevation will, however, depend on the amount of scour protection required. Care must be taken not to place concrete on disturbed or reworked material. No settlement problems are expected to be encountered at this bearing load.

No stability problems are expected to occur during the channel excavations.

As the water table is close to the ground surface, a de-watering scheme will have to be adopted. If sheet piles are required for scour protection, they may be incorporated into the dewatering scheme.

As an alternative for spread footings, a pile-supported foundation may be adopted. Timber displacement piles are recommended. It is estimated that 12" diameter timber piles driven down to elevation 655', can support a load of 20 tons per pile.

cont'd. /3 ...

3. RECOMMENDATIONS: (cont'd.) ...

As the existing grade of the road is planned to be raised by four feet, no slope stability problems are anticipated.

4. MISCELLANEOUS:

Field work was carried out on May 13 and 14, 1963, under the supervision of Mr. B. Ghadiali of the Foundation Section.

Equipment was owned and operated by a two-man crew of Dominion Soil Investigation Co. of London and Toronto.

May 1963

APPENDIX I.

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 :-

CONSISTENCY	'N' BLOWS / FT.	c LB. / SQ. FT.	DENSENESS	'N' BLOWS / FT.
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		
	P.H. SAMPLE ADVANCED HYDRAULICALLY		
	P.M. SAMPLE ADVANCED MANUALLY		

SOIL TESTS

Qu	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V.	FIELD VANE
Qcu	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Qd	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
	IN TERMS OF EFFECTIVE STRESS $\tau_f = c' + \sigma' \tan \phi'$
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
	IN TERMS OF TOTAL STRESS $\tau_f = c_u + \sigma \tan \phi$
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
σ'	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 (YOUNGS 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_o	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
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 1

FOUNDATION SECTION

JOB 63-F-48 LOCATION Stn. 78/80 and 23' to right of ℄ of County Rd. #12. ORIGINATED BY B.M.G.

W.P - BORING DATE May 13, 1963. COMPILED BY B.M.G.

DATUM Geodetic BOREHOLE TYPE Washboring using NX Casing. CHECKED BY K.Y.L.

ELEV. / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/FOOT	ELEV SCALE
711.5	Groundlevel					
	Topsoil					710
1.6	Silty sand and trace of clayey silt.		1	SS	6	
704.5	Loose brown.		2	SS	13	
7.0			3	TW	P	700
			4	TW	15	
	Clayey silt with trace of sand.		5	SS	21	690
	Stiff to very stiff.		6	SS	22	
						680
	Brownish grey.		7	SS	20	
						670
665.0			8	SS	25	
46.6	End of sampling.					660
	(Dynamic cone test taken to El. 656.5)					650

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT 20 40 60 80 100

SHEAR STRENGTH P.S.F.
Unconfined Compression Test ○
Quick Triaxial Test +
400 800 1200 1600 2000

+ 2455

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_P
WATER CONTENT —— w
w_P w w_L
WATER CONTENT % 15 30 45

BULK DENSITY P.C.F.
132
131

REMARKS
W.L.at 710'

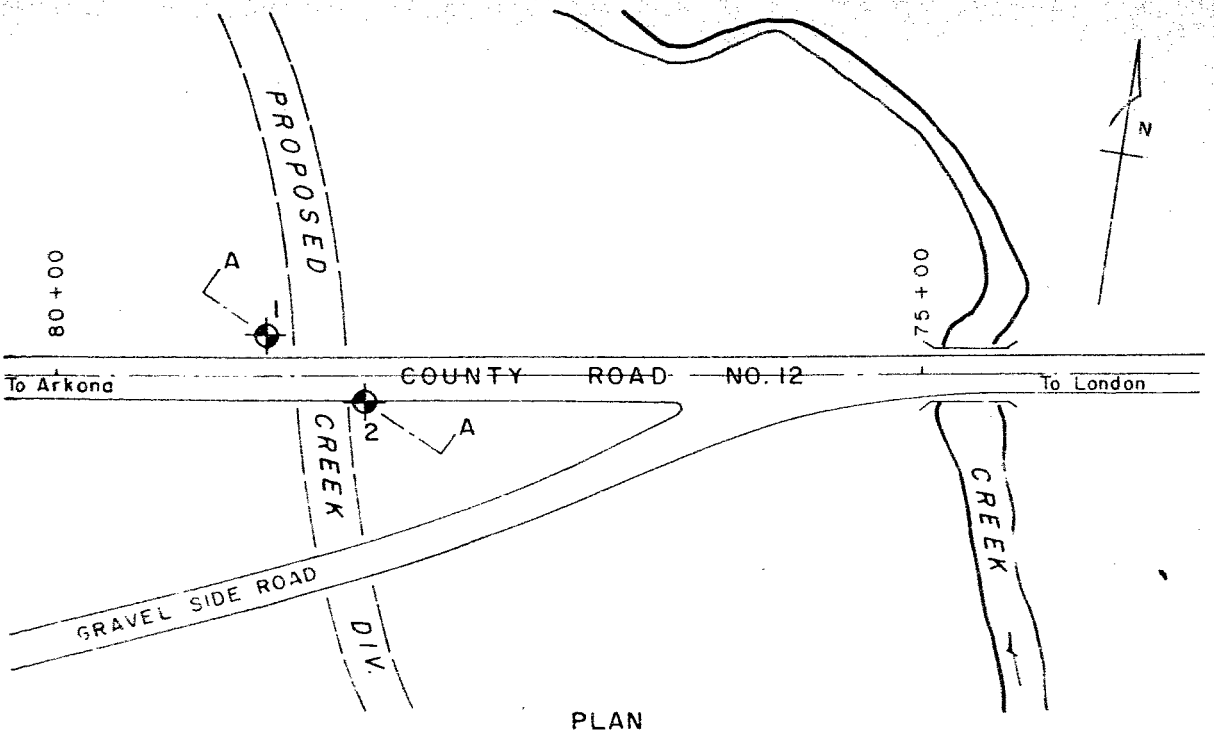
DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 2

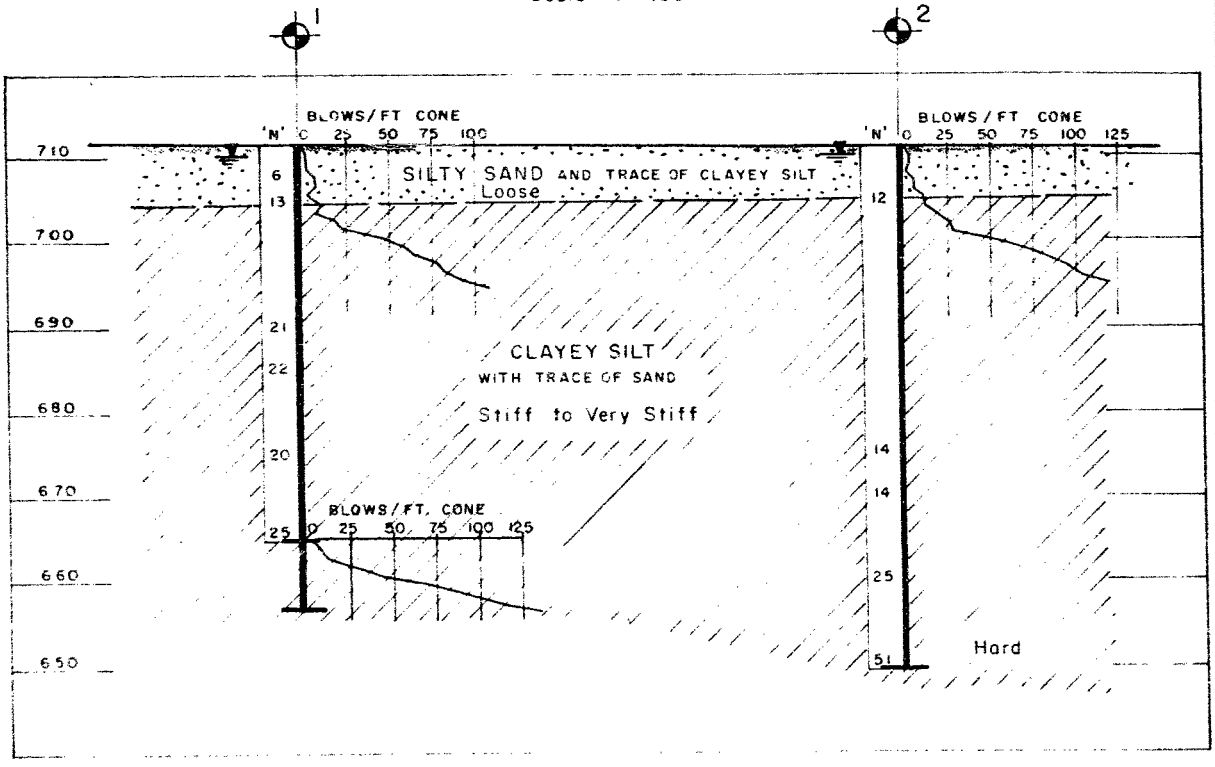
FOUNDATION SECTION

JOB 63-F-48 LOCATION Stn. 78+22 and 15' to ℄ of County Rd. #12 ORIGINATED BY B.M.G.
W.P. - BORING DATE May 14, 1963. COMPILED BY B.M.G.
DATUM Geodetic BOREHOLE TYPE Washboring using NX Casing. CHECKED BY K.Y.L.

ELEV. / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS / FOOT	ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100 / SHEAR STRENGTH P.S.F. Field Vane Test, Unconfined Compression Test o, Quick Triaxial Test + 400 800 1200 1600 2000	LIQUID LIMIT wL, PLASTIC LIMIT wP, WATER CONTENT w, WATER CONTENT % 15 30 45	BULK DENSITY γ P C F.	REMARKS
711	Groundlevel									
	Topsoil					710				W.L. at 710'
1.0	Silty sand,									
705	Loose brown.		1	SS	12					
6.0										
			2	TW	P	700			132	
			3	TW	P				132	
			4	TW	P				131	
	Clayey silt with trace of sand.									Sens:=1.7
			5	TW	P	690			130	
	Stiff to Hard.									Sens:=1.7
			6	TW	P				131	
	Brownish grey.									
			7	TW	8	680			128	
			8	SS	14					
			9	SS	14	670				
			10	SS	25	660				
649.5			11	SS	51	650				
61.6	End of borehole.									



PLAN
Scale - 1" = 100'



A - A
Scale - 1" = 20'

ORIGINATED B G
DRAWN H.D.R
CHECKED
APPROVED
DATE 16 MAY 1963

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH SECTION
BRIDGE NO. 1
MIDDLESEX COUNTY ROAD NO. 12

SCALE AS SHOWN
W.P. NO. MUNICIPAL
JOB NO. 63-F-48
DWG. NO. 63-F-48A