

#68-F-40

W.P. #165-65

Hwy #41

RANKIN NORTHERLY

DEPARTMENT OF HIGHWAYS ONTARIO

MEMORANDUM

TO: Mr. J. E. Gruspier,
Regional Materials Engineer,
Materials and Testing Div.,
Regional Office,
KINGSTON, Ont.

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

DATE: June 21, 1968
JUL - 3 1968

OUR FILE REF.

IN REPLY TO

SUBJECT:

FOUNDATION INVESTIGATION REPORT
For
Embankment Reconstruction Between
Station 874+00 and Station 886+00
Highway #41, Rankin Northerly
District No. 9 (Ottawa)
W.J. 68-F-40 -- W.P. 165-65

1. INTRODUCTION:

It is proposed to reconstruct a portion of Hwy. #41 located approximately 6 miles north of Rankin. The existing embankment in this area will be increased in height and widened. A preliminary investigation was carried out in 1967, by the Kingston Region Soil Section, to determine the existing site conditions. Subsequently the Foundation Section was requested to carry out a detailed subsurface investigation at the above mentioned site. The request was contained in a memo from Mr. J. E. Gruspier, Regional Materials Engineer, dated April, 1968. A detailed boring was thus put down by a conventional diamond drill rig adapted for soil sampling purposes.

This memo presents the factual results of the above investigation, together with our comments and recommendations pertaining to the stability and settlement of the proposed reconstructed embankment.

cont'd. /2 ...

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2. EXISTING SITE CONDITIONS:

The area investigated is located on Hwy. #41 (between Sta. 874+00 and 886+00) some 6 miles north of Rankin, Ontario. Hwy. #41 traverses a valley whose floor is a maximum of 35 feet below the top of the bank; the valley banks are standing with side slopes of 2:1. The valley floor varies in width from about 60 feet on the east side to 40 feet on the west side of the highway. A creek, approximately 6 to 8 feet wide and 3 feet deep, meanders along the valley floor. The surrounding terrain is undulating in relief and supports heavy brush growth.

Hwy. #41 is presently carried over the valley by means of an embankment, the crest of which is a maximum of 26 feet above the valley floor. The crest width of this embankment is approximately 26 feet with the side slopes being of the order of 2:1. Available information indicates that a glacial till composed primarily of clayey silt was used as embankment fill. The creek is carried through the embankment by means of a concrete culvert 11'-6" x 9' by 139 feet long. There are no visual signs that the embankment is unstable.

3. SUBSOIL CONDITIONS:

Borehole #1 was put down at Sta. 880+78, O/S 25' Lt. of centre-line of Hwy. #41. The subsoil strata encountered are shown on the borelog sheet as well as on Figure 1, both appended to this report. A brief subsoil resume' follows:

cont'd. /3 ...

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

Depth	Soil Description	Undrained Shear Strength Field Vane	Lab. Tests	Standard Penetration Resistance - ('N' Values)
0' - 9.5'	Stiff Clayey Silt with a trace of Sand.	2,000 p.s.f.	-	-
9.5' - 21.0'	Compact Sandy Silt to Silty Fine Sand.	-	-	16 - 18 Blows/ft.
21.0' - 109.0'	Stiff to very Stiff Clay to Silty Clay.	1,250 - 2,500 p.s.f.	1,000 - 1,850 p.s.f.	4 Blows/ft.

A water level observation, taken in the open borehole at the time of the investigation, indicated that the groundwater level was at a depth of about 12 feet below ground surface - i.e., at about elevation 431.

4. DISCUSSION AND RECOMMENDATIONS:

4.1) General:

The embankment, between Sta. 874+00 and 886+00, will be increased in height and widened. The maximum increase will be in the vicinity of the existing culvert (Sta. 880+79) where 11 feet of fill will be added - i.e., proposed height is 37 feet above culvert invert. The proposed crest width is 40 feet an increase of approximately 14 feet; the finalized side slopes are to be of the order of 1-1/4:1. Rock fill will be used to reconstruct the embankment. Extensions to the existing culvert may be required; corrugated iron pipe (C.I.P.) founded on a 2-foot thick granular pad will be used for this purpose.

cont'd. /4 ...

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4. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

4.1) General: (cont'd.) ...

A typical cross-section of the existing and proposed embankment is shown on the attached figure.

4.2) Proposed Embankment:

Computations were carried out to determine the stability of the proposed embankment. These computations indicated that the embankment could be built on the cohesive subsoil without danger of an overall base failure, provided the reconstructed portion of the embankment consists of the proposed rock fill material.

Settlement of the foundation subsoil will occur due to the surcharge loading of the additional fill. This settlement will be of a consolidation type and thus take place over an extended period of time. The subsoil has been consolidating under the weight of the existing fill for a considerable period of time and, therefore, no appreciable settlements are expected to take place. It is recommended however, that if C.I.P. extensions are required, a construction joint be provided at the junction with the existing concrete culvert. This joint will allow for any differential settlement that may occur between the proposed and existing embankment sections.

cont'd. /5 ...

Mr. J. E. Gruspier,
Regional Materials Engineer,
Regional Office,
Kingston, Ont.

5.

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5. MISCELLANEOUS:

The field work for this project was carried out on May 8 and 9, 1968, under the supervision of Mr. W. Hutton, Project Foundation Engineer. The equipment used was owned and operated by Master Soil Investigation Ltd.

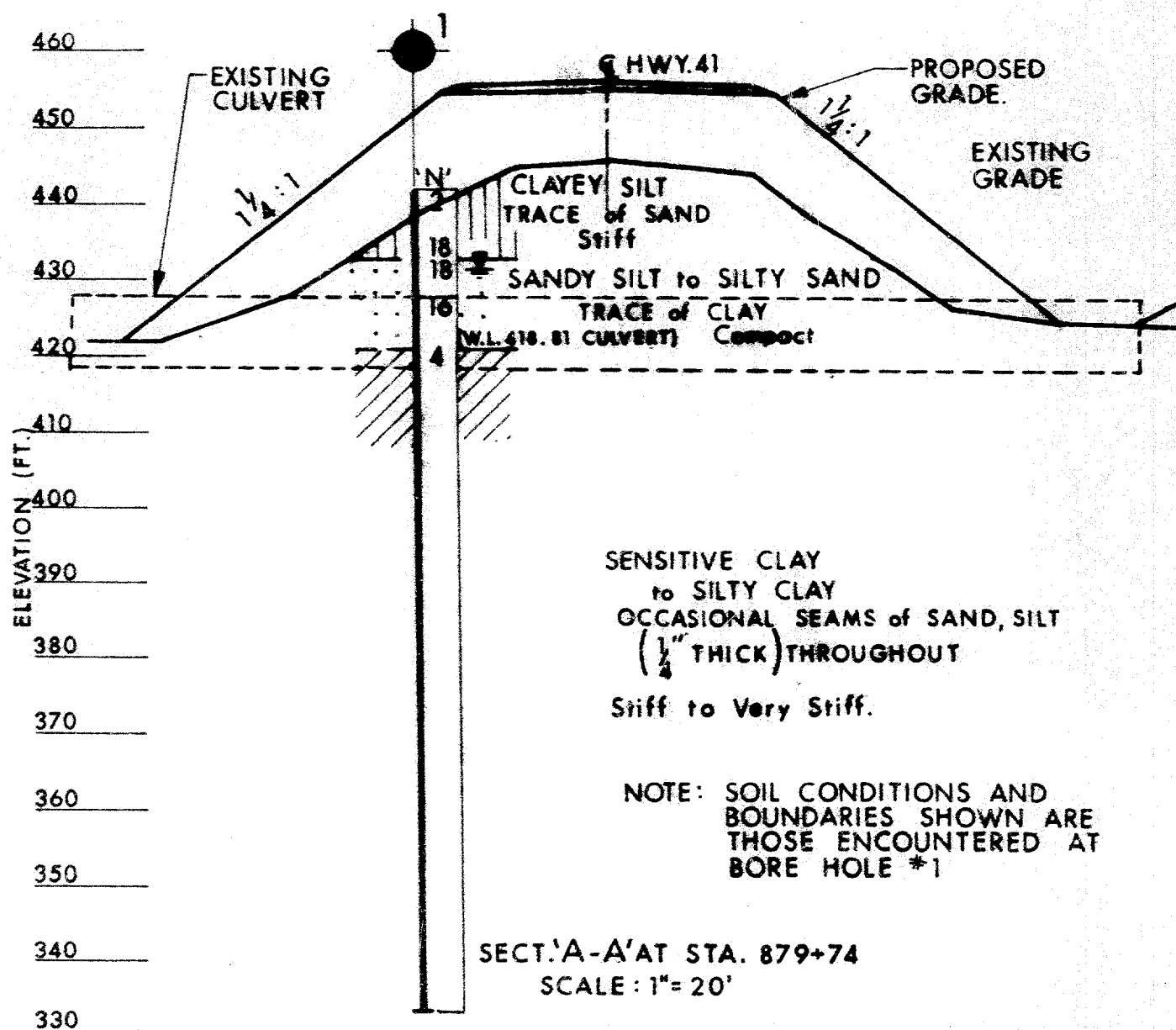
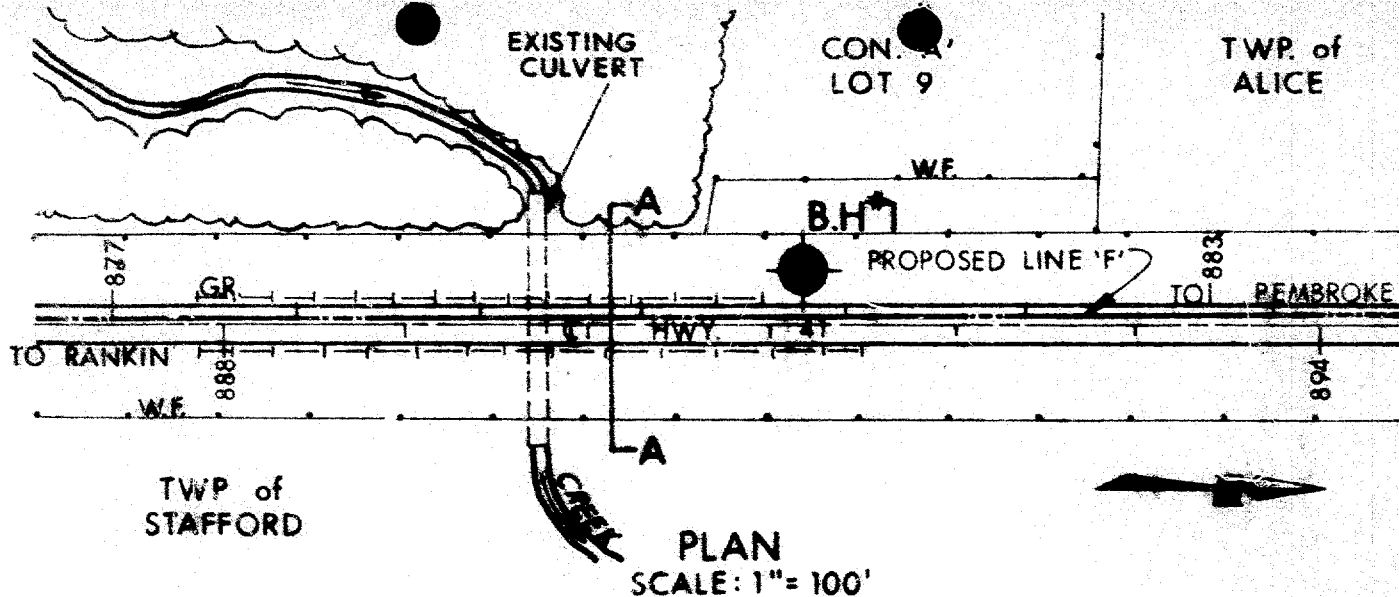
This memo was prepared by Mr. B. T. Darch, Senior Foundation Engineer, and reviewed by Mr. M. Devata, Supervising Foundation Engineer.

BTD/MdeF
Attach.

cc: Messrs. J. E. Gruspier (2)
B. R. Davis
H. A. Tregaskes
D. W. Farren
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S. J. Markiewicz
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Foundations Files ✓
Gen. Files

M. Devata
M. Devata,
SUPERVISING FOUNDATION ENGR.
For:
A. G. Stermac,
PRINCIPAL FOUNDATION ENGR.



APPENDIA I

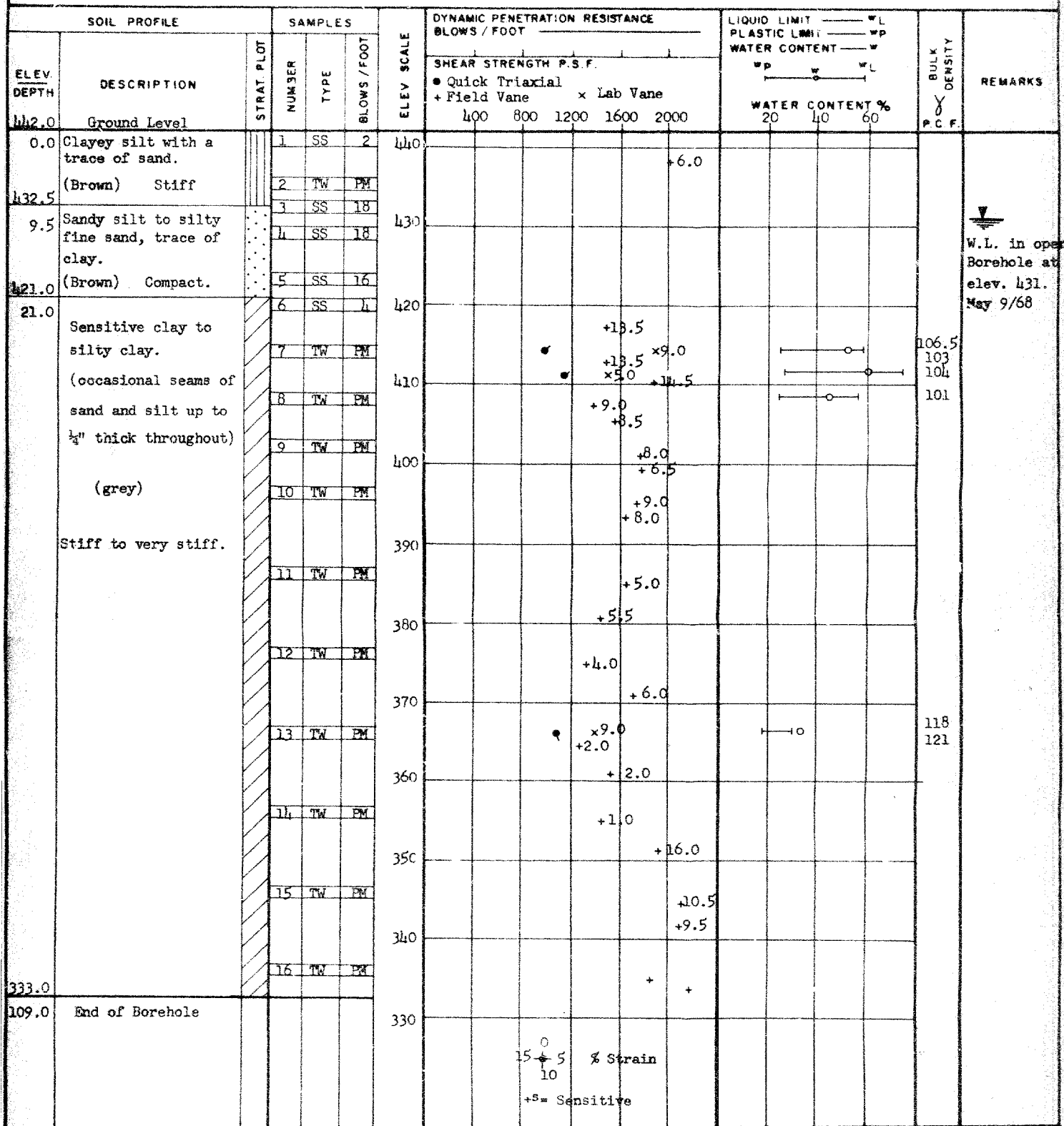
DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 1

FOUNDATION SECTION

JOB 68-F-40 LOCATION Sta. 880 + 78 @ Hwy. #41 o/s 25' Lt. ORIGINATED BY TC
W.P. BORING DATE May 8, 1968 COMPILED BY TC
DATUM Geodetic BOREHOLE TYPE Washboring CHECKED BY



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

SS	SPLIT SPOON	TW	THINWALL OPEN
WS	WASHED SAMPLE	TP	THINWALL PISTON
SB	SCRAPER BUCKET SAMPLE	OS	OESTERBERG SAMPLE
AS	AUGER SAMPLE	FS	FOIL SAMPLE
CS	CHUNK SAMPLE	RC	ROCK CORE
ST	SLOTTED TUBE SAMPLE		
	PH	SAMPLE ADVANCED HYDRAULICALLY	
	PM	SAMPLE ADVANCED MANUALLY	

SOIL TESTS

Qu	UNCONFINED COMPRESSION	LV	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	FV	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
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

