

# 62-F-125

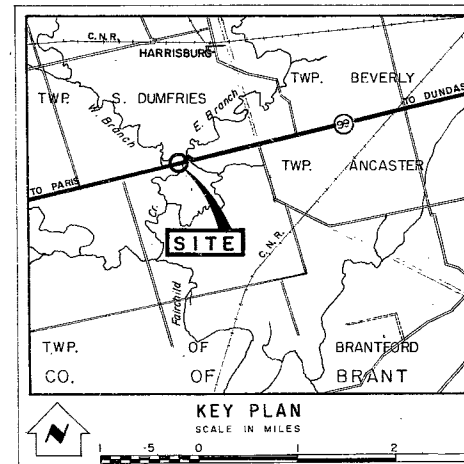
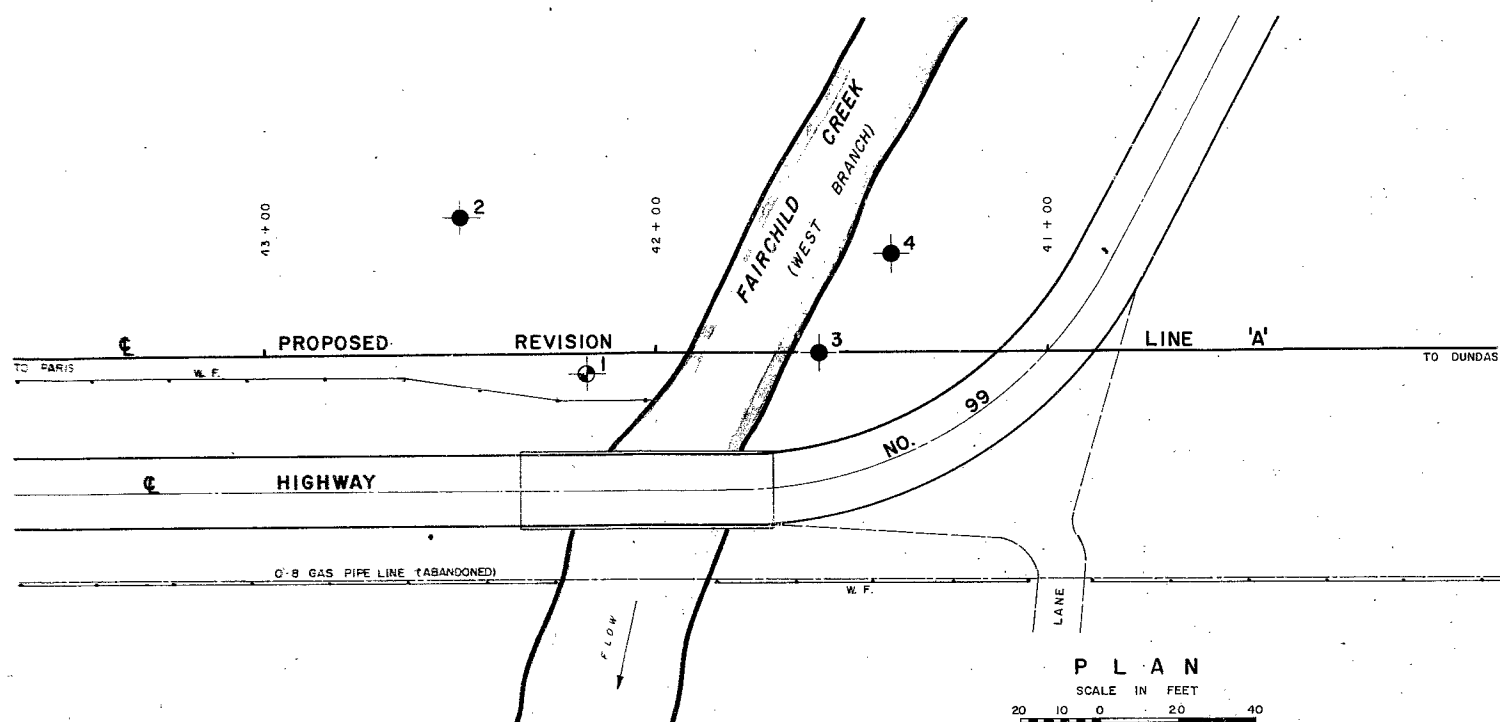
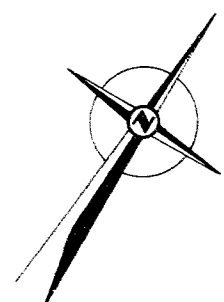
W.P. # 184-62

Hwy. # 99

CROSSING

FAIRCHILD CR.

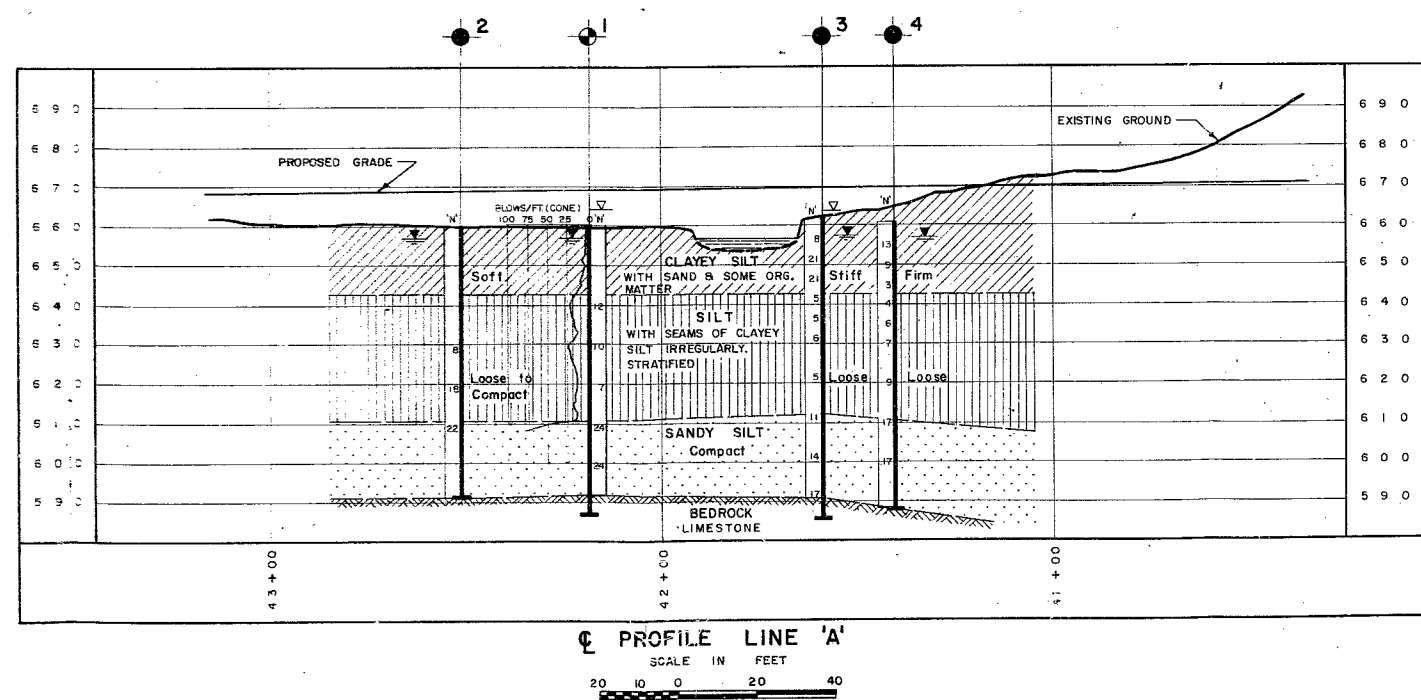
WEST BRANCH



- LEGEND**
- Bore Hole
  - Cone Penetration Hole
  - Bore & Cone Penetration Hole
  - Water Levels established at time of field investigation
  - Artesian Head

NO.	ELEVATION	STATION	OFFSET
1	660.2	42+18	5' LT.
2	660.2	42+50	35' RT.
3	662.7	41+58	E
4	660.7	41+40	25' RT.

**NOTE**  
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.



REVISIONS	DATE	BY	DESCRIPTION

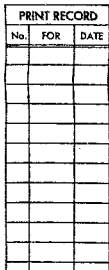
DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & RESEARCH DIVISION - FOUNDATION SECTION

**FAIRCHILD CREEK (WEST BRANCH)**

KING'S HIGHWAY NO. 99 LINE 'A' REVISION DIST. NO. 4  
CO. BRANT  
TWP. S. DUMFRIES LOT 3 CON. 1

**BORE HOLE LOCATIONS & SOIL STRATA**

SUBM'D. G. M. CHECKED	W.P. NO. 184-62	M.S.R. DRAWING NO.
DR. W.N. D. M. CHECKED	JOB NO. 62-F-125	<b>62-F-125 A</b>
DATE 29 NOV. 1962	SITE NO.	BRIDGE DRAWING NO.
APPROVED	CONT. NO.	



REVISIONS			
	DATE	BY	DESCRIPTION

DEPARTMENT OF HIGHWAYS ONTARIO BRIDGE DIVISION				
<u>FAIRCHILD CREEK BRIDGE</u> <u>(WEST BRANCH)</u>				
KING'S HIGHWAY No. 99			DIST. No. 4	
CO. BRANT				
TWP. 5 DUMFRIES/BRANTFORD LOT 3 E 4 S CON. GORE I				
<u>PRELIMINARY</u>				
APPROVED _____ BRIDGE ENGINEER			SITE No. 1-30	
DESIGN L.N.F. CHECK A.K.			W.P. No. 184-62	
DRAWING R.A.S. CHECK A.K.			CONTRACT No.	
DATE _____			DRAWING No. D5315-P	
LOADING H 20 S 16				

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

Attention: Mr. S. McCombie.

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

December 7, 1962.

D.H.G. FOUNDATION INVESTIGATION REPORT -  
West Crossing of Fairchild Creek & Hwy. #99,  
District No. 4, Hamilton, Ontario.  
W.J. 62-F-125 -- W.P. 184-62.

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

We believe you will find the factual data and  
recommendations contained therein, adequate for your future  
design work. If we can be of further assistance, please  
feel free to contact our Office.

KYL/MdeF  
Attach.

cc: Messrs. A. M. Toye (2)  
H. A. Tregaskes  
H. D. McMillan  
G. K. Hunter (2)  
H. Greenland  
T. J. Kovich  
J. Roy  
J. E. Gruspier  
E. R. Saint  
F. Norman  
A. Watt  
Foundations Office  
Gen. Files.

  
K. Y. Lo,  
SUPERVISING FOUNDATION ENGR.  
For:

A. G. Stermac,  
PRINCIPAL FOUNDATION ENGINEER.

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# FOUNDATION INVESTIGATION

For

West Crossing of Fairchild Creek & Hwy. #99,  
District No. 4, Hamilton, Ontario.  
W.J. 62-F-125      --      W. P. 184-62.

## 1. INTRODUCTION:

A request dated October 25, 1962, was received from the Bridge Location Section, to determine the subsoil properties at the site in order to establish the foundation requirements for a new structure.

This report contains the findings of the requested investigation, together with the discussion and recommendations for the foundations of the proposed new bridge.

## 2. DESCRIPTION OF SITE:

The site is located in one of the numerous valleys of the area which is composed of undulating to hilly terrain, mainly under cultivation.

The present structure is a single span steel truss, reinforced by a bailey bridge.

There is evidence of flooding at this location and local information confirmed that at least once, the water came up to bridge grade.

At the time of this investigation, the creek was found to be some 25 feet in width with water 3 to 4 feet deep and flowing rapidly.

cont'd. /2 ...

### 3. FIELD & LABORATORY INVESTIGATION:

Four sampled boreholes, supplemented by one dynamic cone penetration test, were performed at the site, utilizing conventional diamond drilling equipment, adapted for soil sampling procedures.

Undisturbed samples were taken by means of thin-walled Shelby tube samplers pushed manually into the soil. Disturbed samples were recovered in a 2-inch O.D. split-spoon sampler, driven into the soil with an energy of 350 ft.-lbs. per blow.

Each sample of the subsoil was visually classified in the field before transportation to the laboratory, where a further visual classification was carried out.

In addition, Atterberg limits on cohesive samples, moisture contents on all samples, unconfined compression tests and organic content determinations were performed, where applicable.

The locations and elevations of all boreholes are shown on the attached Plan 62-F-125A, and were established by a D.H.O. survey crew at the time of the investigation.

### 4. GROUND WATER CONDITIONS:

A relatively high water table was found over the area, generally 3 feet below the ground surface at elevation 657.2. The water level in the creek was slightly lower, at elevation 656.4.

In boreholes #1 and #3, where rock core was taken, artesian water was encountered within the rock stratum, rising to elevation 664.2, or 4'.0 and 1'.5 above ground level, respectively.

cont'd. /3 ...

5. SUBSOIL CONDITIONS:

5.1) General:

Fairly uniform conditions were encountered at the site, and from ground level downwards, are as follows:

5.2) Clayey-silt with Organic Matter:

This brown deposit extends from ground level to elevation 643 in all boreholes, and contains varying amounts of organic matter, up to 4.46% in borehole #1. The average thickness of the deposit is 18 feet.

Standard penetration resistance ranged from 3 to 21 blows per foot, and the shear strength from 455 to 1980 p.s.f., indicating the consistency of the deposit to be soft to very stiff.

The liquid limit ranged from 31 to 36%, the plastic limit from 18 to 24% and the moisture content from 22 to 44%.

On the west side of the creek, it is soft and spongy with a higher organic content, whereas on the east side, it is firm to very stiff in places, and contains little or no organics and more sand.

5.3) Silt with Clayey-silt Seams:

Below the clayey-silt, and to a depth of 50 feet in all boreholes, a grey silt irregularly stratified with thin clayey-silt seams, was found over the entire area investigated.

Standard penetration resistance ranged from 4 to 18 blows per foot, indicating that this deposit is loose to compact with the relative density increasing with the depth.

In-situ shear strengths determined by the vane test yielded widely varying results as shown on the attached borehole logs.

cont'd. /4 ...



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

5.3) Silt with Clayey-silt Seams: (cont'd.) ...

The scattering of results can be attributed to the irregular stratification of this deposit and probably depend on whether the vane was in the silty or more clayey part of the stratum.

The average moisture content was found to be 28% and generally decreased with depth from 32% in the upper portion to 22% at the lower limit.

5.4) Sandy-silt:

From a depth of 50 feet below the ground surface, and extending down to bedrock, a sandy-silt deposit was encountered.

Standard penetration resistance ranged from 11 to 24 blows per foot with an average value of 20, indicating the relative density to be compact.

The thickness of this deposit is about 20 feet and the average moisture content 22%.

5.5) Limestone Bedrock:

Below the above deposits, and approximately 70 feet below ground level, bedrock was encountered in all four boreholes.

It is a grey, small grained and massive limestone, horizontally bedded at approximately elevation 590.

Rock samples were recovered in an AXT core barrel in boreholes #1 & #3; in both cases, 100% recovery was achieved. In the other two boreholes, the rock surface was assumed at the refusal depth of the chopping bit.

cont'd. /5 ...

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

5.5) Limestone Bedrock: (cont'd.) ...

As mentioned under article 4, artesian water was encountered within the rock stratum while drilling; in both cases, the artesian water rose to elevation 664.2 or 4'.0 and 1'.5 above ground level in boreholes #1 and #3, respectively.

6. DISCUSSION & RECOMMENDATIONS:

A new single span structure is proposed at the site, to carry Highway #99 over the West Branch of Fairchild Creek.

The subsoil at the site consists of soft to stiff clayey-silt with organic matter for the first 17 feet, followed by loose to compact silt, stratified with irregular thin seams of clayey-silt to a depth of 50 feet, underlain by compact sandy-silt down to limestone bedrock at a depth of approximately 70 feet below the ground surface.

Due to the wide variation in consistency, strength and the organic composition in the upper stratum, adequate bearing capacity for a spread footing foundation cannot be found within it, hence a foundation based on piles is recommended.

For example, a 12 BP 53 steel H-pile driven to bedrock, can support a design load of 60 tons.

Because of the pervious nature of the organic upper stratum, especially on the west side, and the existence of a high water table, a dewatering scheme will be necessary. Flooding is also prevalent throughout the area. It is therefore suggested that construction be scheduled to take place during the dry season.

cont'd. /6 ...

6. DISCUSSION & RECOMMENDATIONS: (cont'd.) ...

No embankment stability problems are expected, although minor settlements of the embankment fill are probable due to the organic content of the clayey-silt stratum. Paving operations should be therefore, delayed as long as possible after construction of the bridge approaches.

Because of the organic content of the clayey-silt stratum, it is also recommended that the excavation for the pile cap be taken slightly below the footing grade and the removed material replaced with suitable granular borrow or else, sealed with lean concrete.

7. SUMMARY:

Subsoil at the site consists of the following:

- 0' - 17' - Clayey-silt with organics, soft to stiff.
- 17' - 50' - Silt, irregularly stratified with clayey-silt,  
loose to compact.
- 50' - 70' - Sandy-silt, compact.
- 70' - Limestone bedrock.

A foundation based on end-bearing H-piles driven to bedrock, is recommended.

For 12 BP 53 steel H-piles, driven to bedrock, a safe design load of 60 tons per pile, may be used.

A dewatering scheme will be necessary as the water table is relatively high and the upper stratum is highly permeable and contains organic matter.

cont'd. /7 ...

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

No embankment fill stability problems are anticipated, although minor settlements are likely to occur.

8. MISCELLANEOUS:

The field investigation during the period of November 1 - 12, 1962, together with the preparation of this report, was performed by Mr. G. Mierzynski under the general supervision of Mr. M. Devata of the Foundation Section.

Equipment was owned and operated by the D.H.O.

December 1962.

APPENDIX I.

FOUNDATION SECTION

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT						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	20	40	60	80	100	WP	WL	W			
							SHEAR STRENGTH P.S.F. + Field Vane & Sensitivity ○ Unconfined Shear Strength 500 1000 1500 2000 2500						WATER CONTENT % 15 30 45				
660.2	Groundlevel					660											WL from observation in B.H.
0.0	Clayey-silt with sand, pieces of wood and organic matter.		1	TW	P											122	$\bar{v}$ 657.2 3.0
	Soft - Brown.		2	TW	P											105	4.46% Organic
643.2			3	TW	P												1.10% Organic
17.0	Silt with seams of clayey-silt irregularly stratified.		4	SS	12	640											
	Loose to compact - Grey.		5	SS	11												
			6	SS	7	620											
10.2			7	SS	24												
50.0	Sandy - silt Compact - grey.		8	SS	24	600											
592.2			9	RC	-												
68.0	Grey limestone Bedrock		AXT Core Barrel														100% Recovery
587.2																	Artesian Water in Bedrock to 4.0'
73.0	End of borehole.					580											Above G.L.

FOUNDATION SECTION

[illegible]





FOUNDATION SECTION

[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		
	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

$\gamma$	UNIT WEIGHT OF SOIL (BULK DENSITY)
$\gamma_s$	UNIT WEIGHT OF SOLID PARTICLES
$\gamma_w$	UNIT WEIGHT OF WATER
$\gamma_d$	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
$\gamma'$	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
$\tau_f$	SHEAR STRENGTH
$c'$	EFFECTIVE COHESION
$\phi'$	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
$c_u$	APPARENT COHESION
$\phi_u$	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
$\mu$	COEFFICIENT OF FRICTION
$S_t$	SENSITIVITY

## GENERAL

$\pi$	= 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
$\sigma$	NORMAL STRESS
$\sigma'$	NORMAL EFFECTIVE STRESS ( $\bar{\sigma}$ IS ALSO USED)
$\tau$	SHEAR STRESS
$\epsilon$	LINEAR STRAIN
$\gamma$	SHEAR STRAIN
$\nu$	POISSON'S RATIO ( $\mu$ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
$\eta$	COEFFICIENT OF VISCOSITY

## EARTH PRESSURE

d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
$\delta$	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
$\beta$	ANGLE OF SLOPE TO HORIZONTAL