

G.I.-30 SEPT. 1976

GEOCRES No. 40J16-40DIST. 1 REGION W.P. No. 122-65-03/04CONT. No. 75-027W. O. No. STR. SITE No. 14-338HWY. No. 402LOCATION Modeland Rd.OverpassNo. of PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.REMARKS:

MEMORANDUM

CRM 110 LAB. (P. 108)
~~40J-108~~
 GEOCRES No.

To: Mr. B. R. Davis,
 Bridge Engineer,
 Bridge Office,
 Admin. Bldg.

From: Foundation Section,
 Materials & Testing Office,
 Room 107, Lab. Bldg.

ATTENTION: Mr. S. McCombie

DATE: July 8, 1970

OUR FILE REF.

IN REPLY TO

JUL 14 1970

SUBJECT:

40J16-40
 GEOCRES No.

FOUNDATION INVESTIGATION REPORT
 For
 The Proposed Hwy. #402 Overpass
 At Modeland Road
 District No. 1 (Chatham)
 W.O. 70-11046 -- W.P. 122-65-03 & 04

CONT. 75-27

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

AGS/MdeF
 Attach.

Afterman
 A. G. Stermac
 PRINCIPAL FOUNDATION ENGINEER

cc: Messrs. B. R. Davis
 H. A. Tregaskes
 D. W. Farren
 W. Zonnenberg
 F. C. Brown
 A. P. Watt (2)
 J. Roy
 B. A. Singh

Foundations Files
 Gen. Files

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FOUNDATION INVESTIGATION REPORT
For
The Proposed Hwy. #402 Overpass
At Modeland Road
District No. 1 (Chatham)
W.O. 70-11046 -- W.P. 122-65-03 & 04

1. INTRODUCTION:

A foundation investigation was requested by Mr. A. P. Watt regional bridge planning eng. Southwestern Region, at the site of the proposed Hwy. #402 overpass at Modeland Rd., east of Sarnia. The memo containing the request was dated May 22, 1970.

The originally proposed Hwy. #402 line "C" ran some 200 ft. north of the present line and it has been shifted on account of unfavourable subsoil conditions. A soils investigation for the original line "C" was carried out in Dec. 1969, the results of which were compiled in our report numbered W.J. 69-F-119. During this previous investigation a fairly thick, soft organic deposit was revealed to underlie the site. The thickness of this deposit was found to diminish southward, consequently it was pointed out, that by adjusting the proposed line the deeper organic deposit might be avoided. Since the general soil conditions were discussed at some length in the above mentioned report, only a summary is given here, together with recommendations covering structure foundations.

2. DESCRIPTION OF THE SITE:

The proposed crossing is situated in the eastern outskirts of the city of Sarnia, appr. 0.3 mi. north of the existing Hwy. #402 along Modeland Rd. The general area is flat, the east side of the existing Modeland Rd. is a residential development, the area west of the road is occupied by farmlands.

Geologically the area belongs to the physiographic region known as the HURON FRINGE. At this southerly portion of the region, behind the sandy beaches of Lake Huron some marshy lagoons may be found. These marshlands are usually underlain by marl or marly silt and clay.

3. FIELD AND LABORATORY INVESTIGATIONS:

Some 15 boreholes were drilled during the course of the new foundation investigation at the proposed footing locations and under the proposed approach fills. Borehole #2 carried out during the previous investigation falls very near a proposed footing, thus it was also incorporated in this report.

The boreholes were carried out by means of a continuous flight auger and a C.M.E. hollow stem auger. Bedrock was proved by means of diamond drilling in BH.'s #7 and 9. Standard sampling techniques were followed, taking split spoons and "undisturbed" shelby tube samples at regular intervals. Split spoon samples were advanced by performing

3. FIELD AND LABORATORY INVESTIGATIONS: (cont'd.)...

Standard penetration tests, while the thin walled Shelby tubes were pushed either manually or hydraulically 18" into the soils. Undrained field vane shear tests were implemented in the boreholes where soil conditions permitted. The shear strengths of the remoulded soils were also determined by turning the vane apparatus six full rotations and again measuring the torque. The locations and elevations of the boreholes as well as the estimated soil stratigraphy at the proposed footing locations are shown on Drawing # 70-11046A & B in the appendix. All the laboratory and field tests are compiled on the borelogs accompanying this report.

4. SOIL CONDITIONS:

4.1) General:

Three soil strata were discerned in the boreholes, underlain by shale bedrock. The surficial layer in most holes were observed to be recent organic deposits, followed by clayey silts with traces of sand and gravel which in turn were underlain by silty clays with traces of sand and gravel. A brief description of each layer is as follows:

..... 4

4. SOIL CONDITIONS: (cont'd.)...

4.2) Organic Deposits:

The depth of the organic deposit was found to vary between 1.5 ft. and 16 ft. The thickest deposits were observed at the locations of the proposed west pier and west abutment, diminishing towards both the east and west directions. The organic material consists of seams and pockets of black peat, sand and organic silts and clays. The black peat is a typically fibrous deposit, formed by partially and entirely decomposed vegetable matter. The organic silts and clays are grey in colour, containing a large number of shells and having very light bulk density. Such calcareous organic clays are commonly known as marls. The organic content of the samples were as high as 25-29%, the Atterberg limits and natural moisture contents exceeding 100-200%. The average bulk density of the organic deposit may be taken to be 80 PCF. Standard penetration "N" values usually range from 1 to 5 blows per ft. indicating very soft to firm consistency and very loose to loose relative density. Undrained shear strength values were measured to be 150-600 PSF, averaging 400 PSF.

4.3) Clayey silt with traces of sand and gravel:

Underlying the organic deposit, clayey silts with traces of sand and gravel were encountered, extending down to apprx. 45 ft. below ground level. This material is considered to be a portion of the deposit known as the St. Clair

4. SOIL CONDITIONS: (cont'd.)...

4.3) Clayey silt with traces of sand and gravel: (cont'd.)...
clay till. Several publications are available describing these soils, so that their physical and engineering properties are fairly well known. The upper zone of the clayey silt is overconsolidated by desiccation and it appears that the overconsolidation is more pronounced at locations where the overlying organic deposit is thin. There is a great variation of the measured shear strengths of the stratum, ranging from 500-600 PSF around elevations 545-550 ft. up to much in excess of 2000 PSF within the upper desiccated layers. The clayey silts have slight plasticity, the plastic limits averaging about 15%, the liquid limits about 26% with a natural moisture content of 20%. (see plasticity chart attached as Fig. #1.) The bulk density of the material may be taken to be 130-132 PCF.

4.4) Silty clay with traces of sand and gravel:

Around el. 542-546 ft. some 45 ft. below ground level, silty clays with traces of sand and gravel were found, extending down to bedrock, having an overall thickness of 60 ft. By visual examination the clayey silts and silty clays appear to be very similar, having the same colour, comparable consistencies, and similar amount of coarse sand and gravel particles. The silty clay however is a different geological deposit as was indicated by some investigators. The shear strength characteristics of this material suggest that the deposit is normally consolidated or slightly over-

4. SOIL CONDITIONS: (cont'd.)...

4.4) Silty clay with traces of sand and gravel: (cont'd.)... consolidated. The average plastic limit of the silty clay was estimated to be 20%, the liquid limit 38%, with natural moisture contents of apprx. 25%. The layer has an average bulk density of 127-128 PCF. Standard penetration tests carried out within the stratum resulted in "N" values between 5 blows per ft. and 28 blows per ft. The corresponding undrained shear strengths were 400 PSF and over 2000 PSF.

4.5) Bedrock:

In order to establish bedrock elevations at the locations of the proposed footings, diamond drilling was carried out in BH's #7 and 9. Some 4-5 ft. thickness of the rock was proved by this method. Another 5 borings were augered down to the bottom of the overburden, where the probable bedrock elevations were estimated by the refusal of further penetration. The bedrock was found to dip slightly westward, being at el. 484-485 ft. under the future east abutment, and el. 482-482.5 ft. beneath the west. The rock was classified to be sound, black shale of the Kettle point formation. The drilling yielded 95% recovery in the AXT size core barrels.

4.6) Ground water conditions:

Groundwater observations were carried out in the boreholes for period of 3-5 days. The water levels were found to lie some 1.5-3 ft. below ground elevation, within the organic deposit. It is assumed that the pore water distribution is hydrostatic within the entire overburden.

5. DISCUSSION AND RECOMMENDATIONS:

5.1) General:

The proposal for this crossing calls for a multiple span structure to carry the future Hwy. #402 over Modeland Rd. The grade of Hwy. # 402 at the crossing is proposed to be at el. 613.6 ft. necessitating approach fills of 20-23 ft. height. Modeland Rd. will be improved to a four lane road, the grade of which at the crossing will be at el. 593.0 ft., practically unchanged.

Field investigations revealed that the roughly 106 ft. thick overburden consisted of organic deposits, followed by clayey silt and silty clay glacial tills. Around el. 482-285 ft. black shale bedrock was established.

5.2) Removal of organic materials:

In our report, numbered 69-F-119 recommendations concerning the excavations of organic deposits at the proposed crossing were given. Since along the present line "C" the organic deposit was nowhere found deeper than 16 ft. below ground level, the recommendations under paragraph (5.1) of the above report should be followed. Paragraph (5.1) is quoted as follows:

"Excavate all organic soil and replace with suitable granular up to about 3 ft. above water level, and suitable earth fill above that level. If this treatment is carried out, there should be no stability or settlement problems." (for approach embankments, constructed with 2 horizontal to 1 vertical slopes.)

Quite shallow organic deposits were found under the

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

5.2) Removal of organic materials: (cont'd.)...

proposed four lanes of Modeland Rd., therefore it is recommended that all organics be removed from under the future roadbed and replaced by suitable granular backfill.

5.3) Structure Foundations:

It is believed that the proposed multiple span structure can most economically be supported on piled foundations. In order to eliminate differential settlements between abutments and piers, steel H piles should be driven to refusal on bedrock. As was mentioned earlier the bedrock surface is around el. 482-482.5 ft. under the west abutment and pier, and around el. 484-485 ft. under the east portion of the crossing.

Design loads equal to the maximum allowable for the steel 'H' section used may be employed on piles driven to sound bedrock. For perched abutments piles may be driven through the approach fills, which in the location of the piles should be devoid of bouldery material. Pile caps should be placed at four ft. below finished ground for frost protection. The groundwater level was found to lie very near the ground level, it is surmised therefore that footing excavations will be carried out a few ft. below water level. In such a case, even a well graded granular backfill may be loosened up under the upward pressure of the unbalanced hydrostatic head.

5. DISUCSSION AND RECOMMENDATIONS: (cont'd.)...

5.3) Structure Foundations: (cont'd.)...

If the material used for the backfill is a poorly graded fine sand, it will certainly "boil" at the excavation bottoms. To overcome such problems a dewatering scheme will be necessary.

6. MISCELLANEOUS:

The field investigations, carried out during the period June 4-19, 1970 were supervised by Mr. A. K. Barsvary, Senior Foundation Engineer & Mr. T. Preston, Student Technician. Equipment used was owned and operated by P.V.K. Drilling Company, Burford, Ontario.

This report was prepared by Mr. A. K. Barsvary & reviewed by Mr. K. G. Selby, Supervising Foundation Engineer.

JULY 1970

APPENDIX

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 1

FOUNDATION SECTION

JOB 70-11046

LOCATION STA. 62 + 88, 33 Ft. Lt. of C

ORIGINATED BY A.K.B.

W.P. 122-65-0304

BORING DATE June 17-18, 1970

COMPILED BY A.K.B.

DATUM Geodetic

BOREHOLE TYPE Auger

CHECKED BY

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT			LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY γ P.C.F. GR. SA. SI. CL.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE 1000 2000		WATER CONTENT % 10 20 30				
591.3	Ground Level												
0.0	Black peat, seams of organic sand, silt		1	SS	5	590							
588.8	Sand clay, firm.		2	TW	PM								
5.5			3	SS	21								
			4	SS	19								
	Clayey silt, Traces of sand & gravel		5	SS	24	580							
			6	SS	10								
	stiff to hard grey		7	TW	PM	570							
			8	SS	46	560							
			9	SS	22	550							
546.3			10	SS	15	540							
45.0	Silty clay, traces of sand and gravel		11	TW	PM	530							
	stiff to hard grey		12	SS	36	520							
			13	SS	25	510							
484.2	Probable bedrock					490							
107.1	End of borehole												

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No.2 (69-F-104)

FOUNDATION SECTION

JOB 70-11046

LOCATION STA 62+ 94 105' Lt

ORIGINATED BY A.P.

W.P. 122-65-03604

BORING DATE Nov. 18-20, 1969

COMPILED BY A.K.B.

DATUM Geodetic

BOREHOLE TYPE Auger

CHECKED BY

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT ——— w_L			BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE	SHEAR STRENGTH P.S.F.	PLASTIC LIMIT ——— w_p	WATER CONTENT ——— w	WATER CONTENT %		
590.3	Ground Level						1000 2000			10 20 30	P.C.F.	GR.SA.SI.CL.
585.3	Clayey silt		1	TW	PH	590						
5.0	Traces of organics		2	SS	13							
			3	SS	32	580						2-20-47-30
			4	TW	PH							
	Clayey silt		5	SS	14							
	with some sand		6	TW	PH	570					129	2-16-48-34
	&		7	TW	PH							
	traces of gravel		8	TW	PH	560						
			9	TW	PH							
	firm to very stiff		10	TW	PH	550					134	1-16-47-36
			11	TW	PH	540						
			12	SS	20	530						
515.3												
75.0	Silty clay with					520						
	some sand traces											
	of gravel											
	very stiff		13	TW	PH	510					127	1-9-50-40
			14	SS	30	490						
484.3	Prob. Bedrock											
106.0	End of borehole											

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 3

FOUNDATION SECTION

JOB 70-11046

LOCATION STA 62 + 46, 33Ft. Lt of 8

ORIGINATED BY A.K.B.

W.P. 122-85-03-04

BORING DATE June 19, 1970

COMPILED BY A.K.B.

DATUM Geodetic

BOREHOLE TYPE Auger

CHECKED BY *AKB*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT — W_L PLASTIC LIMIT — W_P WATER CONTENT — W			BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.		W_P — W — W_L WATER CONTENT %				
							1000	2000					
592.5	Ground Level												
0.0	Gravelly sand					590							
586.5	(Road Base)		1	SS	6								
6.0	Clayey silt with traces of sand & gravel Hard to stiff		2	SS	32								
			3	SS	39	580							
			4	SS	28								
570.0		5	SS	13	570								
22.5	End of borehole												

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 4

FOUNDATION SECTION

JOB 70-11046

LOCATION Sta. 61 + 11 34 FT. Lt. of 8

ORIGINATED BY A.K.B.

W.P. 122-65-03404

BORING DATE June 4-8, 1970

COMPILED BY A.K.B.

DATUM Geodetic

BOREHOLE TYPE C.M.E. Auger

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT ——— W _L PLASTIC LIMIT ——— W _P WATER CONTENT ——— W			BULK DENSITY γ	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	W _P	W	W _L		
588.6	Ground Level															
0.0	Seams of black peat, organic sand silt and clay. numerous shells very soft		1	SS	1											0-90-(10)
			2	TW	Pm										118	
			3	SS	1											
			4	TW	PH											
573.6			5	SS	11											
15.0	Clayey silt, traces of sand & gravel, stiff to very stiff		6	TW	PH											
			7	SS	11											
	Brown and Grey		8A	TW	PH											
			8	SS	28											
			9	TW	PH											
543.6																
45.0	Silty clay, traces of sand and gravel stiff, grey		10	SS	5											
			11	TW	PH											
527.6																
61.0	End of borehole															

DEPARTMENT OF HIGHWAYS- ONTARIO

MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 5

FOUNDATION SECTION

JOB 70-11046

LOCATION STA 61 + 87 100 Ft. Lt of ϕ

ORIGINATED BY T.P.

W.P. 122-65-03404

BORING DATE June 9-10, 1970

COMPILED BY A.K.B.

DATUM Geodetic

BOREHOLE TYPE C.M.E. Auger

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_p WATER CONTENT ——— w			BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.		w_p ——— w ——— w_L				
							\circ UNCONFINED \bullet QUICK TRIAXIAL	+ FIELD VANE x LAB. VANE	WATER CONTENT % 10 20 30				
587.4	Ground Level					1000	2000						
0.0	Organic Clay, Pockets of black Peat seams of sand		1	TW	PM								7-85-(8)
579.9	V. Soft		2	TW	PM	580	a						
7.5	Clayey silt with traces of sand & Gravel--hard to firm Brown and Grey		3	SS	13			+					
			4	TW	PH								
			5	SS	28	570							
			6	TW	PH								
			7	SS	14								
			8	TW	PH	560							
			9	TW	PH								
			10	TW	PH	550							
			11	SS	8								
542.4													
45.0						540							
	Silty clay with traces of sand & gravel very stiff grey		12	TW	PH								
						530							
			13	SS	24								
						520							
						510							
			14	TW	PH								
						490							
482.9	Probably bedrock												
104.5	End of borehole												

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 6

FOUNDATION SECTION

JOB 70-11046

LOCATION STA 60 + 80, 34 Ft. Lt. of 8

ORIGINATED BY T.P.

W.P. 122-65-03404

BORING DATE June 8-9, 1970

COMPILED BY A.K.B.

DATUM Geodetic

BOREHOLE TYPE C.M.E. Auger

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT — W _L PLASTIC LIMIT — W _P WATER CONTENT — W			BULK DENSITY γ	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.		W _P — W — W _L				
							○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE x LAB. VANE	WATER CONTENT % 10 20 30				
						1000	2000				P.C.F.	GR. SA. SI. CL.	
588.8	Ground Level												
0.0	Organic Silt & Clay with pockets of black peat & sand numerous shells very soft to stiff		1	SS		580							0-89-(11)
			2	SS	5								
			3	SS	3								
			4	TW	PH								
572.8			5	SS	11								
16.0	Clayey silt with traces of sand & gravel stiff to very stiff brown & grey		6	SS	17	570							38-53-(9)
			7	SS	16								
			8	TW	PH								
			9	SS	17	560							
			10	TW	PH								
			11	SS	29	550							
543.8													
45.0	Silty clay with traces of sand & gravel. Firm to very stiff grey		12	TW	PM	540							
529.3			13	SS	28	530							
59.5	End of borehole												

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 7

FOUNDATION SECTION

JOB 70-11046

LOCATION STA 60 +.83, 100 FT Lt. of \varnothing

ORIGINATED BY A.K.B.

W.P. 122-65-03404

BORING DATE June 4-5, 1970

COMPILED BY A.K.B.

DATUM Geodetic

BOREHOLE TYPE Pendrill & Washboring BX casing

CHECKED BY *AKB*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY γ P.C.F.	REMARKS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT					SHEAR STRENGTH P.S.F.					WATER CONTENT %																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
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DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 8

FOUNDATION SECTION

JOB 70-11046

LOCATION STA. 62 & 85, 34Ft. RT. of 0

ORIGINATED BY A.K.B.

W.P. 122-65-03-04

BORING DATE June 19, 1970

COMPILED BY A.K.B.

DATUM Geodetic

BOREHOLE TYPE Auger

CHECKED BY *AK*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.		WATER CONTENT %				
							\circ UNCONFINED \bullet QUICK TRIAXIAL	$+$ FIELD VANE \times LAB. VANE	10	20	30		
590.8	Ground Level						1000	2000					
0.0	Sand with some black peat		1	SS	15	590							
586.8			2	SS	34								
4.0	Clayey silt with Traces of sand & Gravel.		3	SS	39	580							
	Hard to stiff		4	SS	12								
	Brown & Grey		5	SS	13	570							
567.8													
23.0	End of borehole												

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 9

FOUNDATION SECTION

JOB 70-11046

LOCATION STA 62 + 82, 101 Ft. Rt of Ø

ORIGINATED BY A.K.B.

W.P. 122-65-03404

BORING DATE June 10-11, 1970

COMPILED BY A.K.B.

DATUM Geodetic

BOREHOLE TYPE Washboring, BX and AX casings

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT — W _L PLASTIC LIMIT — W _P WATER CONTENT — W			BULK DENSITY γ P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.		W _P — W — W _L				
							○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE x LAB. VANE	WATER CONTENT % 10 20 30				
590.8	Ground Level						1000	2000					
0.0	Oxidized					590							
			1	SS	15								
			2	SS	27								
	clayey silt with		3	SS	23	580							
	traces of sand &		4	SS	10								
	gravel												
	very stiff to firm		5	TW	Pm	570						129	
	brown and grey		6	SS	7							128	
			7	SS	29	560							
			8	TW	PM	550						136	
545.8													
45.0			9	SS	6	540							
	Silty clay with												
	traces of sand &		10	TW	PM	530						128	
	gravel												
	firm to very stiff		11	SS	20	520							
	grey												
			12	TW	PM	510							
			13	SS	21	490							
485.1													
105.7	Shale bedrock		14	RC	REC.								
481.1					95%								
109.7	End of borehole												

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 10

FOUNDATION SECTION

JOB 70-11046

LOCATION STA 62 +45 117 Ft. Rt of ϕ

ORIGINATED BY T.P.

W.P. 122-65-13 & 04

BORING DATE June 19, 1970

COMPILED BY

DATUM Geodetic

BOREHOLE TYPE C.M.E. Auger

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY γ	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F.		w_p — w — w_L WATER CONTENT %				
							1000	2000	10	20	30		
592.1	Ground level												
0.0	Black Peat & Organic silt—stiff					590							
587.1			1	SS	13								
5.0	clayey silt with trace of sand & gravel		2	SS	22								
			3	SS	26								
	V. Stiff to firm		3A	SS	13	580							
			4	TW	PH							130	
			5	SS	11								
567.6			6	TW	PH	570						130	
24.5	End of borehole												

DEPARTMENT OF HIGHWAYS- ONTARIO

MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 11

FOUNDATION SECTION

JOB 70-11046

LOCATION STA 61 + 81, 34 Ft. Rt of \emptyset

ORIGINATED BY T.P.

W.P. 122-65-03404

BORING DATE June 16-17, 1970

COMPILED BY A.K.B.

DATUM Geodetic

BOREHOLE TYPE C.M.E. Auger

CHECKED BY

SOIL PROFILE		SAMPLES			ELEV SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_p WATER CONTENT ——— w			BULK DENSITY γ P.C.F.	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE		BLOWS/FOOT	SHEAR STRENGTH P.S.F.		WATER CONTENT % 10 20 30			
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE 1000 2000						
587.2	Ground Level											
0.0	Black peat & Org. silt											
583.2			1	SS	13							
4.0			2	TW	PH	580		+ >2000			136	
			3	SS	19							
	Clayey silt		4	TW	PH						131	
	with traces of sand		5	SS	12	570						
	& gravel		6	TW	PH						131	
	very stiff to		7	SS	10							
	firm		8	TW	PH	560					138 140	
	brown & grey		9	SS	31							
						550						
			10	TW	PH						131	
540.2						540						
47.0			11	SS	6							
	Silty clay with					530						
	traces of sand &		12	TW	PH						130 130	
	gravel: firm to					520						
	very stiff, grey					510						
			13	TW	PH							
						490						
481.7	Probable bedrock											
105.5	End of borehole											

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 12

FOUNDATION SECTION

JOB 70-11046

LOCATION STA 61 + 05 100 Ft., RT. of R

ORIGINATED BY T.P.

W.P. 122-65-03-04

BORING DATE June 18, 1970

COMPILED BY

DATUM Geodetic

BOREHOLE TYPE C.M.E. Auger

CHECKED BY

SOIL PROFILE		SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY γ	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE		BLOWS / FOOT		SHEAR STRENGTH P.S.F.		WATER CONTENT %		
588.9	Ground Level											
0.0	Black peat with seams of organic clay, silt & sand		1	SS	3							
			2	SS	5							
	very soft to firm		3	SS	3	580						
575.9			4	TW	PM							
13.0	Clayey silt with traces of sand & gravel		5	TW	PM							
	V. stiff to stiff		6	SS	16	570						
	Brown and grey		7	TW	PM							
			8	SS	20	560						
			9	TW	PH							
549.4			10	SS	20	550						
39.5	End of borehole											

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 13

FOUNDATION SECTION

JOB 70-11046

LOCATION STA 60 + 76, 34 Ft. Rt of \emptyset

ORIGINATED BY T.P.

W.P. 122-65-03-04

BORING DATE June 18, 1970

COMPILED BY

DATUM Geodetic

BOREHOLE TYPE C. M.E. Auger

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY γ	REMARKS			
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		SHEAR STRENGTH P.S.F.		w_p — w — w_L WATER CONTENT %							
							1000	2000	10	20	30					
							\circ UNCONFINED	$+$ FIELD VANE				P.C.F.	GR. SA. SI. CL.			
							\bullet QUICK TRIAXIAL	\times LAB. VANE								
588.7	Ground Level															
0.0	Black peat with seams of organic silt clay and sand very soft to soft		1	SS	3	580							\circ	0-91-6-3		
			2	SS	2											
			3	SS	4											
			4	SS	5											
			5	SS	1											
512.2	Clayey silt with traces of sand & gravel		6	TW	PM	570								134		
16.5			7	TW	PM											
			8	SS	27	560										
			9	TW	PM											
554.2	Hard to stiff													139		
34.5			End of borehole													

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 15

FOUNDATION SECTION

JOB 70-11046

LOCATION STA 64 + 40

ORIGINATED BY A.K.B.

W.P. 122-65-03404

BORING DATE June 18, 1970

COMPILED BY A.K.B.

DATUM Geodetic

BOREHOLE TYPE Auger

CHECKED BY

SOIL PROFILE		SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — W _L PLASTIC LIMIT — W _P WATER CONTENT — W			BULK DENSITY γ	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE		SHEAR STRENGTH P.S.F.		W _P — W — W _L				
						○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE x LAB. VANE	WATER CONTENT %			P.C.F.	GR. SA. SI. CL.
						1000	2000	10	20	30		
589.8	Ground Level											
588.3	Black Organics											
1.5	Clayey silt with traces of sand & gravel		1	SS	46							
	Hard to stiff		2	SS	27							
	Brown to grey		3	SS	32	580						
			4	SS	13							
567.3			5	SS	11	570						
22.5	End of borehole											

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 16

FOUNDATION SECTION

JOB 70-11046

LOCATION STA 60 + 00 Ø

ORIGINATED BY T.P.

W.P. 122-65-03-04

BORING DATE June 19, 1970

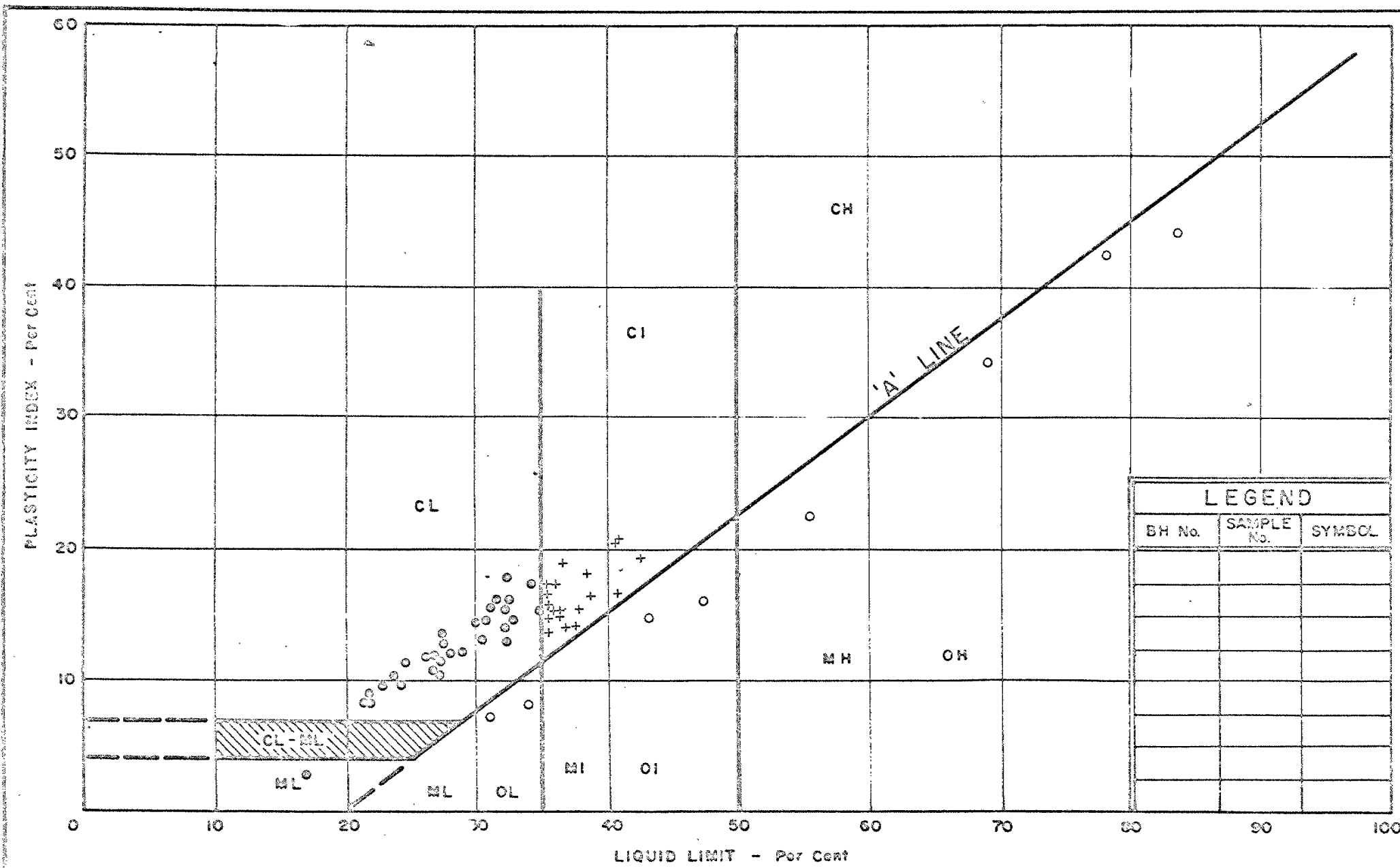
COMPILED BY *AE*

DATUM Geodetic

BOREHOLE TYPE C.M.E. Auger

CHECKED BY *SA*

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE				LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			BULK DENSITY γ P.C.F.	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	SHEAR STRENGTH P.S.F.			WATER CONTENT % 10 20 30					
							1000 2000								
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE								
							1000 2000								
589.5	Ground Level -														
0.0	black peat & or-														
585.5	ganic clay, soft														
4.0	Clayey silt with traces of sand & gravel		1	SS	4		580								
			2	SS	15										
			3	TW	PH										
			4	TW	PH										
			5	SS	11										
	Stiff	6	SS	7		570									
563.5		7	TW	PH											
26.0	End of borehole														



DEPARTMENT OF HIGHWAYS
MATERIALS and
TESTING
DIVISION

PLASTICITY CHART
○-CLAYEY SILTS — — — +-SILTY CLAYS
○-ORGANIC DEPOSITS

WR No. 122-65-03 & 04
JOB No. 70-11046
FIG. 1

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

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
$\log_e \sigma$ OR $\ln \sigma$	NATURAL LOGARITHM OF σ
$\log_{10} \sigma$ OR $\log \sigma$	LOGARITHM OF σ 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 (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

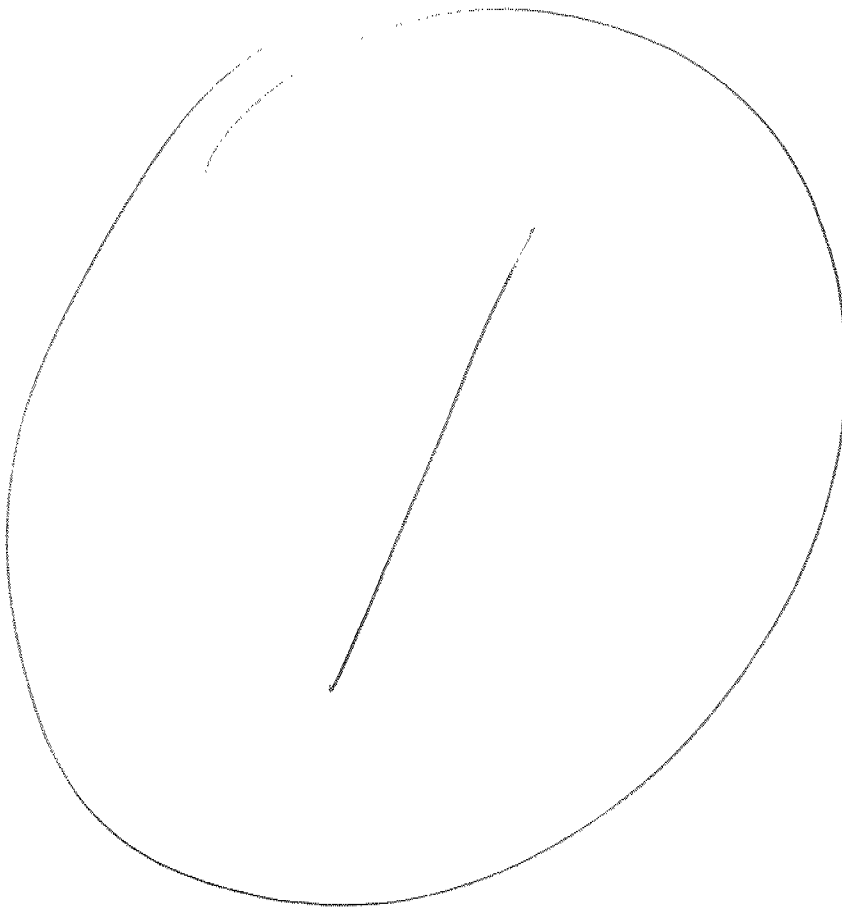
B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

SLOPES

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

35MM

DRAWING



35MM

DRAWING

