

Mr. A. Toye

Oct. 13th, 1935

Bridge Engineer, Dept. of Highways.

Highways Lab., 1200 Sheppard Ave.

Re: Foundation Report, Intersection Hwy. 401 & 42 at Lancaster Line "D", Sta. 568+40, Site Plan - E 2932-1, Project F55-15

We are forwarding herewith the foundation report for the above noted structure.

The soil overlying bedrock is of marine clay origin and has a very low bearing value. Steel H-piles are recommended for the structure foundation. However, for the approach fills, 3 alternatives are proposed.

1. bents
2. sand drains
3. trestle structure

The final design for the approach fills will likely depend upon economic considerations. It is pointed out that when reviewing cost analysis the closest borrow source will be in the neighbourhood of 3 to 4 miles.

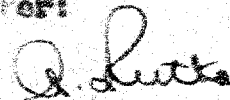
The site plan does not indicate a cloverleaf for this intersection. If such is proposed, it will be necessary to review the leg and loop foundations and to make the necessary recommendations for stability.

This structure is not shown on any preparation list and is not proposed for immediate construction to our knowledge.

F.C. Brownridge
Materials & Research Engineer

Copies to: A. Toye
J. Walter
H. Fregaskes
J.B. Wilkes
C. Parantatos ✓

For:



(A. Rutka)

AR:SH

REPORT OF FOUNDATION INVESTIGATION

FOR PROPOSED UNDERPASS BRIDGE

HWY. # 401 and HWY. # 2

AT LANCASTER

SITE PLAN E-2932-1

Copies to -

Mr. A. Toya, Bridge Engineer (1)

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INTRODUCTION:

A bridge is to be built for Hwy. # 2 overpassing Hwy. # 401 at Lancaster.

Subsoil investigation was therefore required to be made on the site of the proposed bridge to determine the best method of foundation for the overpass structure. The fills on the approach were also investigated with regards to stability.

PROCEDURE:

The field exploration on the foundation site was carried out since 19th June, and completed on the 23th June 1955.

Altogether four boreholes were made, two on each abutments.

Preliminary tests were made by dynamic cone penetration, then followed by the boring tests.

The locations and logs of the boreholes are shown in drawing E-55-15a and Appendix I respectively.

SOIL CONDITION:

The subsoil consists of a layer of soft gray clay extending from ground surface to a depth from 33 ft. to 40 ft. with bedrock immediately underlying it. This soil profile occurs in all the four boreholes.

The clay is of marine deposit having a liquid limit almost as high as its water content which averages about 70%. It has a void ratio of about 2.0. For such soil characteristics the clay can be described as fully saturated, clay in a state of flowing, and has high compressibility.

WATER CONDITION:

The water table as observed from the various boreholes was found to occur at about 3 ft. to 4 ft. below the present ground surface at the time of exploration. This water was obviously the result of the inflow of the water from the excessively saturated marine clay.

ANALYSIS OF TEST RESULTS AND DISCUSSIONS:

Bridge Foundation:

According to the four boreholes the general profile of the subsoil in the region of the bridge foundation consists of soft clay extending from ground surface to depths varying from 33 ft. to 40 ft. with bedrock immediately underlying it.

Due to the great depth of the clay and the low shearing strength of its material, it is not possible to provide a spread footing foundation for a bridge on such a site. Pile foundation is considered the most suitable for this kind of soil condition.

Piles should be brought down to top of bedrock. Steel H-piles bearing on bedrock can easily support 50 tons or more per pile.

STABILITY OF APPROACH FILL:

The approaches to both the abutments require about 25 ft. of fill to bring the level of the roadway over the deck of the bridge.

Critical Height of Fill:

Assuming that the soil conditions under both the approaches to be the same as those under the abutments it has been estimated from Theory of slope stability that the critical height of fill on a slope of 1:2 is only 15 ft. The stable height is 15 ft. giving a safety factor of about 1:2. These analyses are based on cohesion of 400 lbs./square foot.

allowing effect due to disturbance during the process of sampling the clay. (The high sensitivity of the clay made it impossible to perform any unconfined compression tests on remolded samples.) Any instability would most probably result from a base failure with the slip circle tangent to the surface of bedrock.

Loading Fill in Stages:

The allowable fill of 15 ft. could be first loaded. Under the weight of this fill the clay will consolidate and gain strength.

However, by interpolating the results obtained from several consolidated-quick tests in relationship to the soil condition as existed in the field, it has been roughly estimated that the procedure of loading the fills in stages would require at least 9 to 12 years before an increase of about 50% of the present shearing strength can be attained. Obviously this great length of time involved cannot warrant the use of this method.

Use of Loading Berms:

The construction of berms to counter-balance the instability of the fill is the more feasible method but could be expensive.

It can now be seen that the procedures of securing stability of the 26 ft. of fill as outlined above may prove to be either impractical or time consuming and too expensive unless appropriate measures are provided, whereby, the strength of the clay can be considerably increased within a given short time. On the other hand, the possibility of building a different type of bridge structure should be examined. Such a structure should require only 15 ft. of fill on its approaches.

CONCLUSIONS:

Bridge Foundation:

The footings or piers that may form the foundation of a bridge at the site should be supported on piles.

Steel H-piles driven down to bedrock should be capable of providing 50 tons or more per pile. The length of piles would be between 39 ft. to 44 ft. depending on the elevation of the footings.

STABILITY OF THE APPROACH FILLS:

The stability of the 26 ft. of fill can be secured by the various ways already outlined in the foregoing discussions. Attention has been specially drawn to the following method which we believe, can be successfully employed. They should be economically compared when making the final choice.

Use of the Landing Berms:

The berms required to stabilize the 26 ft. of fill should not be less than 50 ft. long and 15 ft. high, to be installed on both sides of the approaches on a slope of 1:3. However, if the section of the road to be approach is built on a 4% grade, the size of berm can be reduced in accordance with the over-all height of the fill, as shown by Fig.I.

For a road surface 40 ft. wide, the average quantity of earth required per yard-run is approximately 412 cu. yds. If backfill material is available in a nearby site this procedure can be economically employed. However, the discrepancy here will be that due to continued settlements during the first 10 to 20 years.

Use of Sand-filled Drain-wells:

Sand-filled drain wells of diameter 20 inches installed through the clay layer with spacing varied from 10 ft. to 12 ft. would increase the strength of the clay within a considerably short time. By this process 90% consolidation of the clay could be attained within a period of 9 to 12 months.

The undersigned would be pleased to discuss in details in the event that this method is contemplated.

Use of a Different Form of Bridge Structure:

Since the ground can safely support 15 ft. of fill, a trestle-type of structure may be used to advantage. This bridge would have to be long enough so that both its approaches could be located on 15 ft. of fill and at the same time provide enough overhead clearance for through traffic. Piers in the intermediate positions could be likewise be founded on piles driven down to bedrock.

G.N. Farantatos,
Foundation Engineer.

GNF:gf

APPENDIX

I

#55-F-15
HWY.# 401 &
HWY.#2 AT
LANCASTER

EDITED
FOR MICROFILMING
BY *KT* DATE *27/10*

<small>PL 125 54-90</small> DRILL RIG --- CORE DRILL --- CASING --- (STANDARD SAMPLERS TO FIT UNLESS NOTED) SAMPLER HAMMER WT --- 250 --- DROPP --- INCHES ---		MATERIALS LABORATORY DEPARTMENT OF HIGHWAYS - ONTARIO OFFICE REPORT ON SOIL EXPLORATION		JOB --- 55 F 15 LANCASTER --- BORING NO --- 3 --- DATUM Sta 367.64 P.A. ST. AL 22-47 --- DATE REPORT JUNE 25, 1955 --- COMPILED BY AH --- CHECKED BY W. H. H. BORING DATE JUNE 21, 1955 ---											
SAMPLE CONDITION		SAMPLE TYPES		ABBREVIATIONS											
<div style="display: flex; align-items: center;"> <div style="width: 20px; height: 20px; border: 1px solid black; background: repeating-linear-gradient(45deg, transparent, transparent 2px, black 2px, black 4px); margin-right: 5px;"></div> <div> DISTURBED S.O.O. LOST </div> </div>		CS - CHUNK DO - DRIVE OPEN D.F. - DRIVE FOOT VALVE VS - VASHEB SAMPLE RC - ROCK CORE TO - THIN WALLED OPEN		V - INSITU VANE SHEAR TEST M - MECHANICAL ANALYSIS U - UNCONFINED COMPRESSION Qc - TRIAXIAL CONSOLIDATED QUICK Q - TRIAXIAL SLOW S - TRIAXIAL SLOW γ - UNIT WEIGHT K - PERMEABILITY C - CONSOLIDATION CA - CASING WLV - WATER LEVEL IN CASING WT - WATER TABLE IN SOIL											
SOIL PROFILE		SHEAR STRENGTH		WATER CONTENT		SAMPLES									
ELEV. DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT. PLOT	TONS/SQ. FT. OR QN/2			%		OTHER TESTS	CONDITION	TYPE	NO.	PENETRATION RESISTANCE	ELEV. RECOVER.	
				0.1	0.2	0.3	40	60							Δ PV
				X CONE PENETRATION TEST											
				RESISTANCE BLOWS PER FOOT											
				20 40 60			40 60								
				STD. ENERGY = 4200 LB. IN.											
125.6		GRAY CLAY (MARINE)		0									STD. ENER.	125.6	
	4													4200 LB. IN.	
	8														
	12														
	16														127.6
	20														100
	24														
	28														
	32														
	36														
122.6		STONES & CLAY (FLOATS)		36										125.6	
59.0				40											121.6
116.3		ROCK LEVEL		40											
59.3				44											
				48											

END OF BOREHOLE AT 34.0 FT. EL. 121.6
 REEL SAID AT 30.3 ROCK
 N.B. Sampler pushed 1.0' and then hit a string & refused to penetrate further

T.L. 150
54-90

MATERIALS LABORATORY - DEPARTMENT OF HIGHWAYS - ONTARIO
OFFICE REPORT ON SOIL EXPLORATION

DRIILL RIG CORE DRILL #
CASING EX (STANDARD SAMPLERS TO FIT UNLESS NOTED)
SAMPLER HAMMER WT 250 # GROPS INCHES

JOB 52 EJS LANCASTER BORING NO. 4
DATUM Sta. 565+38.21 STA. 92' 47" DATE REPORT JUNE 21, 1955
COMPILED BY B.H. CHECKED BY W.WONG BORING DATE JUNE 20-21, 1955

SAMPLE CONDITION SAMPLE TYPES ABBREVIATIONS

DISTURBED C.S. - CHUNK
 GOOD D.O. - DRIVE OPEN
 LOST D.F. - DRIVE FOOT VALVE
TO THIN WALLED OPEN N/S - WASHED SAMPLE
R.C. - ROCK CORE

V - INSITU VANE SHEAR TEST
M - MECHANICAL ANALYSIS
U - UNCONFINED COMPRESSION
Q - TRIAXIAL CONSOLIDATED QUICK
S - TRIAXIAL SLOW
γ - UNIT WEIGHT
K - PERMEABILITY
C - CONSOLIDATION
CA - CASING
WL - WATER LEVEL IN CASING
WT - WATER TABLE IN SOIL

SOIL PROFILE

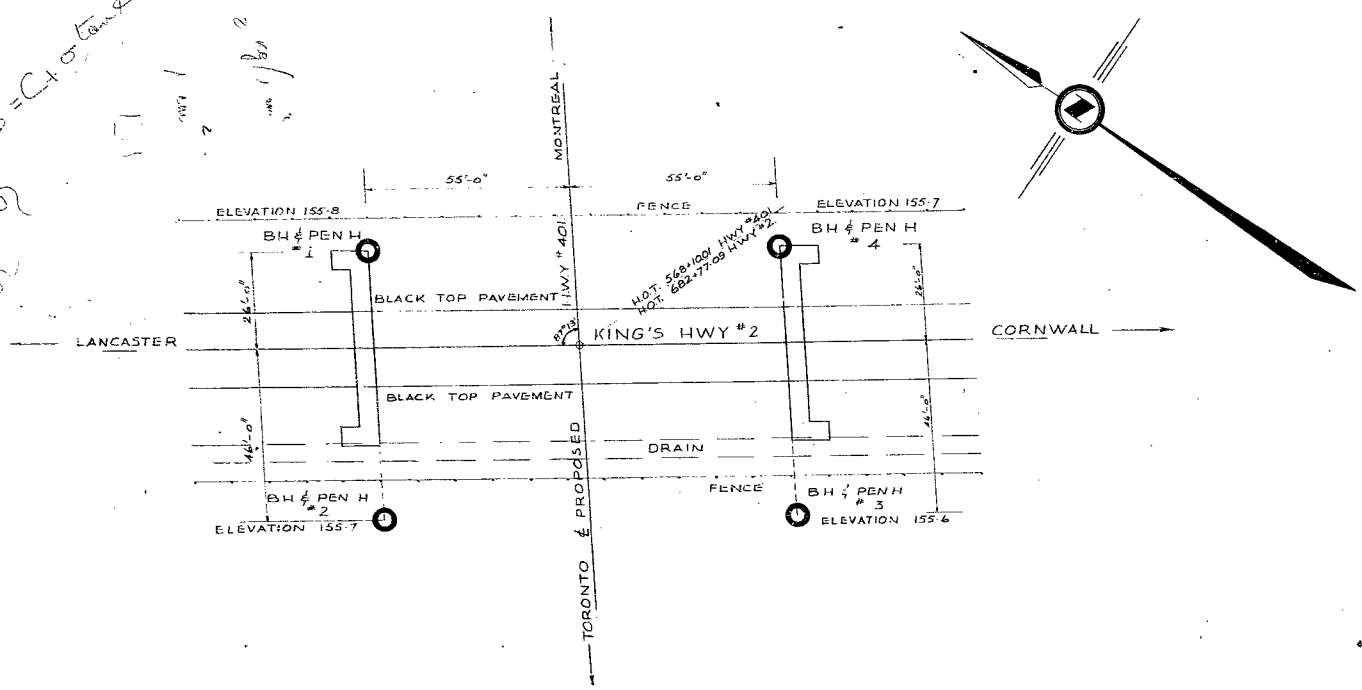
ELEV. DEPTH	WATER CONDITIONS	DESCRIPTION	STRAT. PLCT.	ELEVATION SCALE	σ' SHEAR STRENGTH TONS/SG FT OR Q _{u/2}	WATER CONTENT W %	OTHER TESTS	CONDITION	TYPE	Nº	PENETRATION RESISTANCE	ELEV. RECOV.
					X CONE PENETRATION TEST RESISTANCE BLOWS PER FOOT	Δ PW Δ LV						
					20 40 60	40 60						
					STD. ENERGY 4200 LB-IN/BLOW							
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152.2 3.5	✓	W.L. 23 JUNE		4								
				8								
				12								
				16								
				20								
				24								
				28								
				32								
				36								
117.7 38.0		RAY CLAY (MARINE)		40								
113.4 42.3		STONES & CLAY (FLOATS)		44								
108.7 47.0		ROCK		48								

END OF BORING AT 47'-0"

RC FROM SHOULDER (DISCARDED)

RC (Hx) 10 5 ft of broken rock core recovered

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DEPARTMENT OF HIGHWAYS - ONTARIO			
BRIDGE OFFICE - TORONTO			
SKETCH PLAN SHOWING LOCATIONS OF PENETRATIONS & BORE HOLES			
THE KING'S HIGHWAY NO. 2 #401 DIV. No. 9			
CO.	LOT	CON.	
TWP. LANCASTER			
SCALE - 1" = 20'-0"			
APPROVED			
DESIGN	CHECK	CONTRACT	
D.J.D.	CHECK	NUMBERS	
TRACING	CHECK	LOADING	
DATE		DRAWING NUMBER	55-F-15

REVISIONS	DATE	BY	DESCRIPTION

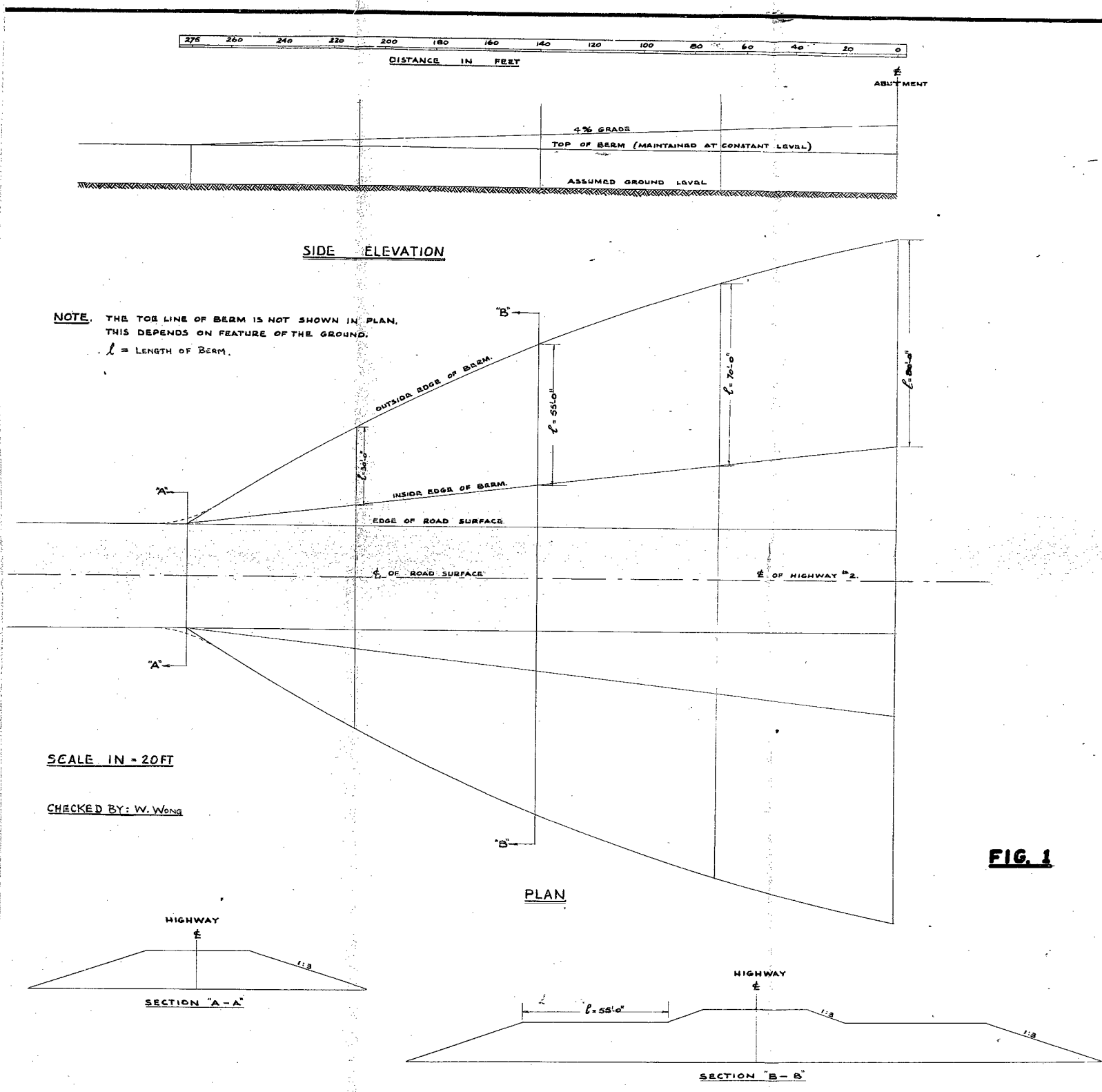


FIG. 1