

1850 Jane Street
Weston, Ontario
241-4644

William A. Trow

Project: J1599

Soil Mechanics
Consultants
W. A. Trow
MSc. MEIC. P. Eng.
K. Peaker
PhD. MEIC. P. Eng.
D. H. Shields
PhD. MEIC. P. Eng.



Associates Ltd.

Mr. A. Rutka,
Chief Materials and Research Engineer,
Materials and Research Section,
Department of Highways of Ontario,
Parliament Buildings,
Toronto, Ontario

September 23, 1964

Attention: Mr. A.G. Stermac, P.Eng.

Re: Foundation Investigation - Proposed Bridge Overpass
County Road 23 and Highway 406
Township of Thorold, County of Welland, Ontario
W.P. No. 93-63

Dear Sirs:

In conformance with your authorization of mid July, we have carried out a foundation investigation at the above county road overpass of Highway 406. The field work consisted of 3 borings made in September of this year.

Our observations and recommendations arising from this work are summarized below.

1. The borings made along the shoulder of existing county road 23 showed that the soil is a very dense silt till underlain by limestone bedrock at a depth of from 13 to 20 feet.
2. The three centrapiers may be placed at a minimum depth below present ground level of 4 feet to avoid frost action, with a safe bearing pressure of 4 t/ft.².

3. The end piers may be safely founded on piles driven through the approach fill and underlying soil to bedrock.
4. The settlement of the piers and the underlying soil due to weight of the approach fill will be small and will occur during construction, while the settlement of the approach abutments will be negligible.
5. As the water table exists at a minimum depth of 8 feet, and the entire depth of subsoil is essentially impermeable, no difficulty with water should arise during excavation.

These recommendations are based upon the information presented in the sections that follow.

PROJECT

The intersection of County Road 23 with Highway 406 requires a bridge overpass to carry County Road 23 over Highway 406. A four span structure is proposed.

FIELD WORK

Three continuous flight auger boreholes uncased to bedrock were made on the existing shoulder of County Road 23; two holes under the proposed eastern and western abutments and the third under the central pier of the proposed bridge. The central hole was continued into the underlying bedrock and AX core recovered over a depth of 2 feet 9 inches. Bedrock was confirmed at two other locations on the site by angering to refusal. .

SOIL CONDITIONS

Beneath a 2 foot layer of crushed stone fill, (the shoulder of County Road 23), the soil consists of a dense brown silt till being more a dense clay till near the surface. The till has little plasticity, - the plasticity index is about 10.

The high resistance to penetration indicates the density and strength of the existing soil; at a depth of 5 feet the resistance to penetration is somewhat over 30 blows/ft. Consistent with these field measurements are the laboratory bulk density determinations of between 131 - 139 lb./ft.³ and the low moisture contents of about 20 percent or below. Three undrained shear strength tests gave values of between 5800 and 8200 lb./ft.².

Bedrock consisting of brown limestone was cored in the central hole at a depth of 17 feet. The other four flight auger holes met refusal, (assumed to be bedrock) at a depth of between 12 feet and 20 feet.

WATER CONDITIONS

The water table was found at a depth of about 8 feet under the proposed western abutment sloping to a depth of about 14 feet under the proposed eastern abutment. The soil has a low permeability.

Details of the drilling logs are given in Dwg. 2 to 4 inclusive, while the subsoil profile is shown on the site plan, Dwg. 1.

FOUNDATIONS

Piers: The load from the 3 central piers may be safely transmitted to the ground by means of footings at a minimum depth of 4 feet to prevent frost action.

Assuming the material to be cohesionless, the safe bearing pressure for a footing may be obtained from the following expression:

$$q_a = \frac{\gamma'}{F} \left(\frac{B}{2} N_\gamma + D N_q \right)^*$$

where: γ' = submerged unit weight of the soil (68 pcf)
 D = depth of footing below surface (ft.)
 B = width of footing (ft.)
 N_q & N_γ = bearing capacity factors which depend on the angle of shearing resistance of the soil

Taking a width of 5 feet, the factors N_q and N_γ may be obtained from the average penetration resistance at depth $B/2$ below the footing elevation. N_q and N_γ are conservatively taken as 80 and 100 respectively, based on a blow count of 40 blows/ft.**

$$\begin{aligned} q_a &= \frac{68}{3} \left(\frac{5}{2} \times 100 + 4 \times 80 \right) \\ &= \frac{68}{3} (250 + 320) = 13 \text{ K/ft.}^2 \end{aligned}$$

The safe bearing capacity may also be calculated assuming the material to be cohesive, using the results of undrained triaxial tests according to the following expression:

* Terzaghi, K. & Peck, R.; 1948. 'Soil Mechanics in Engineering Practice' Wiley.

** Peck, R.B. Hanson, W.E., and Thornburn, T.H., 'Foundation Engineering', Wiley

$$q_a = \frac{C_u}{F} N_c +$$

N_c = bearing capacity factor (6)

C_u = average undrained shear strength below footing level 7000 lb.(ft.²)

F = factor of safety (3)

Substituting,

$$q_a = 14 \text{ k/ft.}^2$$

ABUTMENTS

It is understood that the two abutments will be placed on H piles driven through the approach fill. With assumed bedrock being at a depth of 12 feet under the proposed eastern abutment, and 20 feet under the western abutment, the H piles should be taken to bear on bedrock. Piles sufficiently strong to remain intact after driving to bedrock will have adequate strength to carry the abutment load and negative skin friction due to the possible fill settlement. Based on load test experience on Dundas Shale in the Port Credit area, a bearing stress of 7000 psi is considered to be permissible for direct support on bedrock.

SETTLEMENT

Settlement of the 3 piers will occur during construction and by experience will be less than one inch. Settlement of the abutments on piles will be negligible, provided the piles are adequately driven to bedrock. The settlement of the subsoil due to the weight of the added fill will be immediate and of no significance as the soil is so dense. Most of the settlement of the approach surface will be due to the settlement of the fill.

Yours very truly,


William A. Trow, P.Eng.

BPW:GC
ENCLOS.

⁺Skempton, A.W., 1951 - 'The Bearing Capacity of Clays, Building Research Congress, London.

LEGEND

BOREHOLE NO. 1
PROJECT Proposed Bridge Overpass, W.P. 93-63
LOCATION County Road 23 & N.J. 406
HOLE LOCATION See Dwg. 1.
HOLE ELEVATION 589.00 ft.
DATUM Geodetic

PENETRATION RESISTANCE

2" O.D. SPLIT TUBE —●—●—●—
2" I.D. SHELBY TUBE —*—*—*—*—
2" DIA. CONE —————

SHEAR STRENGTH

UNDRAINED TRIAXIAL
AT OVERBURDEN PRESSURE
UNCONFINED COMPRESSION
VANE TEST AND SENSITIVITY (S)

NATURAL MOISTURE CONTENT AND LIQUIDITY INDEX

X²

ATTERBERG LIMITS

LIQUID LIMIT _____
PLASTIC LIMIT _____

SAMPLE TYPE



2" O.D. SPLIT TUBE
2" I.D. SHELBY TUBE
3" O.D. SHELBY TUBE

SYMBOL	SOIL DESCRIPTION	ELEV FEET	DEPTH FEET	PENETRATION RESISTANCE				550 FT. LB BLOWS/FT 60	NATURAL MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT				SAMPLE TYPE AND NO	NATURAL UNIT WEIGHT P.C.F.
				SHEAR STRENGTH										
				20	40	60	80							
		589.0	0	2000 4000 6000 8000					10 20 30 40					
	FILL-crushed stone, clayey silt, roots.	587											1	
	CLAY TILL-silty, hard, brown.	584.0											2	132
	SILT TILL-brown, cohesive, hard, moist near top becoming drier near base with occasional fine gravel, laminated with silt partings; a hard silt till 2' thick located at 11'.		10										3	131
													4	
	Refusal to augers - assumed bedrock.												5	
	End of Bore	569.3	20										6	
Notes:	1) Continuous flight auger, uncased to full depth.													
	2) Hole dry at 19 ft., 1½ hrs. after completion; water level at 13.6' after 3 days.		30											
			40											

SITE INVESTIGATIONS · SOIL MECHANICS CONSULTATION

DRAWING NO. 3
PROJECT NO. J1599

PENETRATION RESISTANCE

2" O.D. SPLIT TUBE
2" I.D. SHELBY TUBE 
2" DIA. CONE 

SHEAR STRENGTH

UNDRAINED TRIAXIAL AT OVERBURDEN PRESSURE (3)
UNCONFINED COMPRESSION (2)
VANE TEST AND SENSITIVITY (5) +

NATURAL MOISTURE CONTENT AND LIQUIDITY INDEX

ATTERBERG LIMITS

LIQUID LIMIT

PLASTIC LIMIT

SAMPLE TYPE

2" O.D. SPLIT TUBE

2" I.D. SHELBY TUBE

3" O.D. SHELBY TUBE

BOREHOLE NO. 2
PROJECT Proposed Bridge Overpass, W.P. 93-63
LOCATION County Road 23 & Hwy. 406
HOLE LOCATION See Dwg. 1.
HOLE ELEVATION 591.60 ft.
DATUM Geodetic

[illegible]

SITE INVESTIGATIONS SOIL MECHANICS CONSULTATION

BOREHOLE NO. 3
PROJECT Proposed Bridge Overpass, W.P. 93-63
LOCATION County Road 23 & Hwy. 426
HOLE LOCATION See Dwg. 1.
HOLE ELEVATION 590.04 ft.
DATUM Geodetic

2" O.D. SPLIT TUBE 

2" I.D. SHELBY TUBE 

2" DIA. CONE 

UNDRAINED TRIAXIAL AT OVERBURDEN PRESSURE
UNCONFINED COMPRESSION
VANE TEST AND SENSITIVITY (S)

X⁴

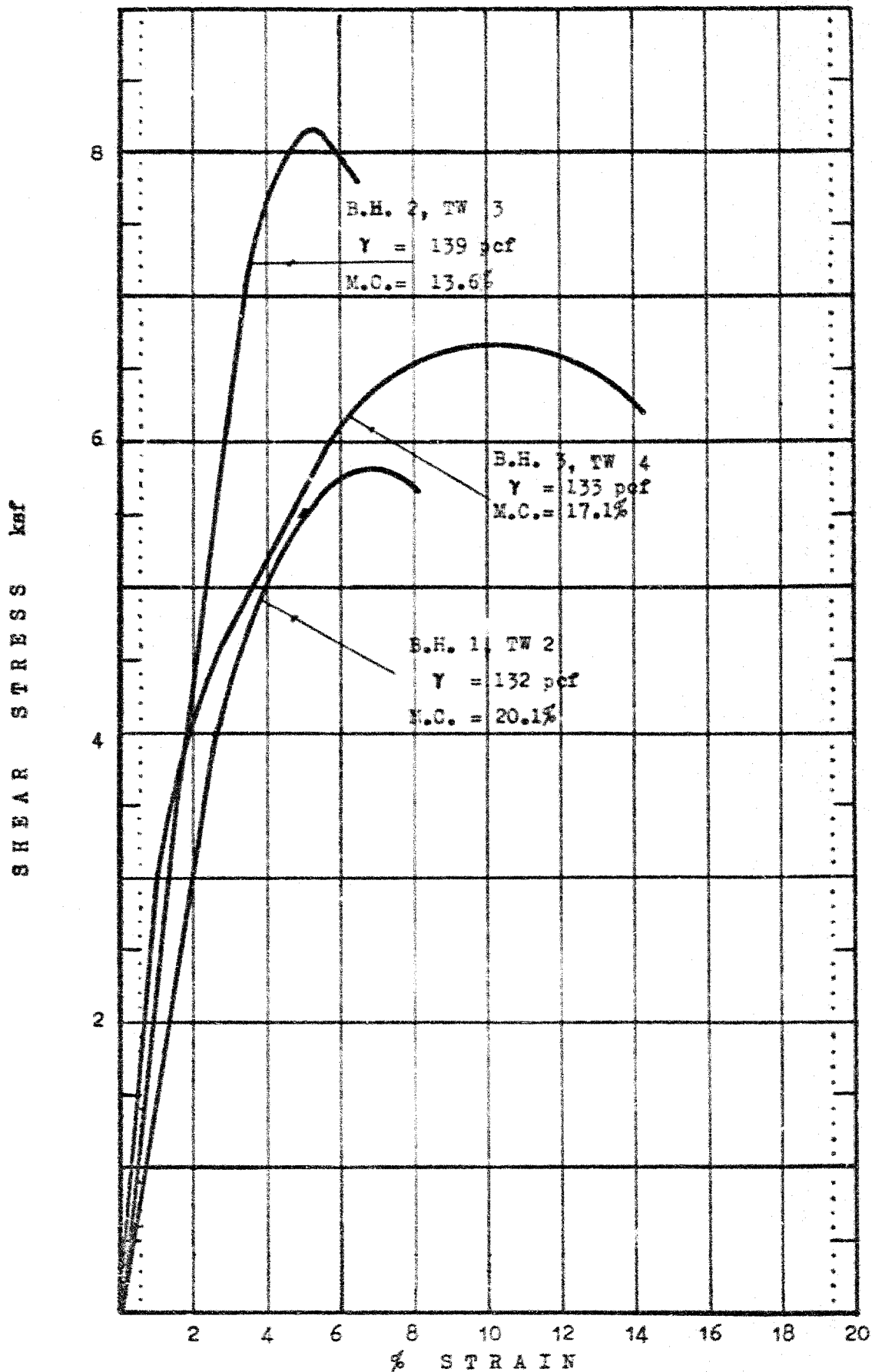
LIQUID LIMIT

PLASTIC LIMIT

SAMPLE TYPE

2" O.D. SPLIT TUBE
2" I.D. SHELBY TUBE
3" O.D. SHELBY TUBE

SYMBOL	SOIL DESCRIPTION	ELEV FEET	DEPTH FEET	PENETRATION RESISTANCE	350 FT. LB. BLOWS/FT.	NATURAL MOISTURE CONTENT AND ATTERBERG LIMITS	SAMPLE TYPE AND NO	NATURAL UNIT WEIGHT P.C.F.
				SHEAR STRENGTH		% DRY WEIGHT		
				20 40 60 80		10 20 30 40		
	FILL-crushed stone,brown silt.	590.0	0	2000 4000 6000 8000				
	CLAY TILL-silty,brown, hard.	588.		X			1	
		582.		*			2	
	SILT TILL-brown,cohesive, a hard silt till layer 2' thick located at 15'.		10	(X)			3	
	Refusal to augers and split spoon.			(X)			4	133
	BEDROCK-grey limestone, solution cavities. End of Bore	572.5	20				5	
		568.					AX Core Recovery	80%
Notes:	1) Continuous flight auger, uncased to bdrock.							
	2) Hole dry on completion; water level at 7.4 ft. after 3 days.		30					
			40					



REPRESENTATIVE UNDRAINED TRIAXIAL TEST, BOREHOLES 1, 2 AND 3.

WILLIAM A. TROW AND ASSOCIATES

Originally, jobs given to E. M. Peto (Letter Aug. 19/64) - It was decided that Peto should work in Kitchener area instead - hence, the reason for Trow doing this work.

Hwy. 401 & Keele St.,
Scarborough, Ontario.

Materials and Testing Division

August 31, 1964

William L. Trow & Associates Ltd.,
1890 Jane Street,
Weston, Ontario.

Attention: Mr. W. L. Trow

Re: H.P. 294-60, Hwy. 406, Gibson Lake Crossing,

Z.P. 92-63, Hwy. 406, Beaver Road Underpass.

✓ H.P. 93-63, Hwy. 406, Beaver Dam Road Underpass.
District No. 4, Hamilton

Dear Sir:

Please consider this your authority to carry out foundation investigations at the above sites. Plans and profiles were provided to your representative on August 25, 1964.

It is understood that a qualified Soils Engineer will be in charge of the field work at all times.

Eleven (11) copies of each completed foundation reports, with one additional copy of each subsail profile, should be submitted to the Foundation Section prior to October 9, 1964. Previous requirements as to preliminary borehole information and laboratory testing program, should be followed.

Because the drawings accompanying the foundation reports, showing the location of borings, the inferred subsail conditions, etc., are to become contract drawings, you are requested to prepare them in accordance with the D.M.C. standards. To enable you to do this, we are supplying you with sample drawings with all the necessary explanations, together with linen sheets for your drawings. You are also requested to provide the D.M.C. with Crenaflex copies of the drawings.

Charges for the work performed will be in accordance with your Schedule of Rates, dated November 19, 1962, and invoices to be addressed to the attention of the undersigned.

HBS/MSR

Yours very truly,

cc: Messrs. J. McConchie
G. R. Hunter
E. Greenland
T. J. Kovich
Mrs. T. Tate
H. D. Smith (2)
Foundations Office
Gen. Files (2)

A. Butke
A. Butke,
Materials & Testing Division

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

Foundation Section,
Materials & Testing Div.,
Room 107, Lab. Bldg.

Attention: Mr. A. McCoskie

October 1, 1964

Proposed Bridge Overpass,
County Rd. 23 and Hwy. 406,
Twp. of Thorold, Co. of Welland, Ont.
S.F. 93-63 -- District No. 4.

FOUNDATION INVESTIGATION REPORT BY:
William A. Trow & Associates, Limited

Attached, please find the foundation report for
the above-mentioned site prepared and submitted by the
Consultant Wm. A. Trow & Associates Ltd.

We have reviewed the report and find the factual
information well presented and the recommendations conclusive.

Should there be any questions in connection with
this job that you would like to discuss, please feel free to
call on our Office.

AGC/MSF

Attach.

cc: Messrs. A. M. Tove (2)
H. A. Fregushen
M. J. McMillan
G. A. Hunter (2)
H. Greenland
T. J. Kovich
A. Watt

afternoon
A. G. Steward,
PRINCIPAL FOUNDATION ENGINEER

Foundations Office
Gen. Files

MEMORANDUM

To: A. Stermac,
Principal Foundation Engineer,
Room 107,
Lab. Building.

From: Bridge Division,
Downsview, Ontario.

Date: January 26th, 1967.

Our File Ref.

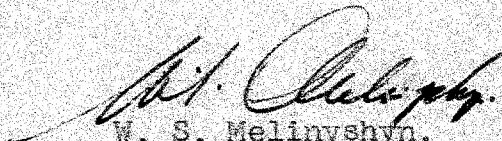
In Reply To

Row/64 ✓ **SUBJECT:** Beaver Dams Road Underpass, — *already submitted our comments to Greboks*
W.P. 93-63,
Structure #8,
Ramp "J" over St. David's Road,
W.P. 30-65-8,
Structure #2, — *submitted comments to Greboks on 4 Jan/67.*
Ramp "Q" and "P" over Hwy. #406,
W.P. 30-65-2,
Hwy. #406, District #4.

Enclosed please find prints of the preliminary bridge plans for each of the above structures.

It is possible that these plans have already been forwarded to your office from our Bridge Design section. We request that when you review our plans a copy of your letter stating your comments and/or approval be sent to this office.

WSM/cew
Encl.


W. S. Melnyshyn,
Regional Bridge Location Engineer.

Trans 69

Mr. C. S. Grebski,
Bridge Design Engineer,
Bridge Division,
Admin. Bldg.

Foundation Section,
Materials & Testing Div.,
Room 107, Lab. Bldg.

January 23, 1967

Your Memo -- Jan. 19/67

Beaver Dams Road Underpass,
W.P. 93-63, Site 34-160,
Highway 406, District No. 4.

We have reviewed the Preliminary Plan No.
D-5576-P1 for the above mentioned structure.

We have no comments pertaining to
structure foundations.

MD/ndef

cc: Foundations Files ✓
Gen. Files

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

Copy for the information of

Mr. A. Stermac, Principal Foundation Engineer,
Room 107, Lab. Building

Mr. W. Melinyshyn,
Regional Bridge Location Engineer,
Bridge Division,
Administration Building

Bridge Division,
Downsview, Ontario

January 19, 1967

Trow/64

Beaver Dams Road Underpass
W.P. 93-63, Site 34-160
Highway 406, District No. 4

Attached herewith are prints of the Preliminary Bridge
Plan Drawing B-5576-P1 for the above-mentioned structure.

The estimated cost of the proposed structure is \$308,000.
This cost includes tender, materials, engineering and sundry
construction.

Any comments or revisions you may have should be submitted
within three weeks.

CSG:rd

C.S. Grebski,
Bridge Design Engineer

Attach.

c.c. S. McCombie
A. Stermac
R. Forrest
E. Cross

*no comments.
M. Devata
Jan 23/67.*

64-F-244C

W.P. 93-63

Hwy # 406+

COUNTY RD.

