65-F-273M

FAIRCHILD BRIDGE

MOIRA RIVER

THURLOW

BH 2191

C.C. PARKER & ASSOCIATES LIMITED
688 QUEENSDALE EAST
HAMILTON, ONTARIO

FOUNDATION INVESTIGATION PLANS
PROPOSED REPLACEMENT OF
FAIRCHILD BRIDGE OVER MOIRA RIVER
TOWNSHIP THURLOW, COUNTY HASTINGS, ONTARIO

SITE 11-269
65-F 273M

Project: J2633

October 1965

William Trow Associates Limited

Weston, Ontario
749-1290

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Project: J2633

C.C. Parker & Associates Limited,
688 Queensdale East,
Hamilton, Ontario.

October 28, 1965

Attention: Mr. D.C. Cramm, P.Eng.

Foundation Investigation
Proposed Replacement of
Fairchild Bridge over Moira River
Township Thurlow, County Hastings, Ontario

Dear Sirs:

We have completed the investigation of subsoil and foundation conditions at this bridge site requested in your communication of October 18th, 1965, and herewith report our findings.

Very briefly,

1) A variably thick overburden of fill river alluvial deposits and dense calcareous stoney silt and sand till overlies flat lying limestone bedrock at approximately El 477 to 480 feet.

2) With four feet protection required below the observed maximum scour level, foundations for all the piers will be located directly on the sound bedrock. No serious problems are therefore anticipated. A safe net bearing pressure of 10 tsf may be used.

It is understood that four of the piers will be abutment /retaining wall type structures.

3. Positive anchorage against horizontal forces acting upon the various piers and abutments, can be provided by either

1) keying the footings approximately 2 to 2½ feet into the bedrock to provide passive resistance,

2) dowelling the footing to the bedrock with a 5 feet minimum length grouted reinforcing rod or rock bolt, or

3) using a combination of keying and dowelling.

Sliding resistance between the footing concrete and bedrock limestone should be calculated using a value tan $\phi = 0.7$. An earth pressure coefficient $k = 0.35$ should be used when determining the lateral pressures exerted on the abutments by the retained fill.

4. Dewatering of the foundation excavation should be provided by driving sheet piling caissons to refusal in the dense grey till overlying bedrock or by constructing a zoned earth dyke around the construction area. In the former case rectangular caissons must be braced internally as the excavation proceeds, using an earth pressure coefficient $k = 0.2$ to determine the bracing requirements.

5. Since the foundation soils beneath the two approach embankments and central connecting embankment are essentially compact to dense and granular, no stability problems exist. Settlements will be negligible as only a thin overburden is involved. The movements will occur as the fill loads are being applied, and will cease once construction has been completed.

6. In order to minimize consolidation of embankment material placed below the water level, the base of the central and approach fills should be completed with quarried rock rather than dumped earth. Normal rolled earth embankment techniques can be resumed for the portions of fill above water level, if necessary. A minimum 12 inches of well graded filter material must be incorporated between any rockfill and earth fill section, however, to avoid wash-out of the earth fill during up and down oscillations of the river level.

Our detailed discussion follows.

SITE AND PROJECT

The proposed new bridge and approach structures replacing the existing narrow truss girder township road bridge over the Moira River are to be located immediately upstream from the present bridge, about 1 mile south of the village of Foxboro in the Township of Thurlow, County Hastings. The project involves only minor changes in the horizontal and vertical alignment of the roadway, and has been designed as a combined two span and single span structure separated by approximately 150 feet of embankment fill. Abutments will be of the solid retaining wall type.

River elevation at the site is controlled by the Corbyville Dam about 1½ to 2 miles downstream. A wide level flood plain extends to either side of the stream channel, at El 495 to El 500 feet approximately.

FIELD WORK

Due to the anticipated presence of bedrock at relatively shallow depth, field work was confined to only three small diameter sample borings and an associated series of probings along the proposed centreline. The boreholes were completed using wash bore and rotary diamond core drilling techniques. Half inch diameter solid steel bar forced by hand from a small boat was used for the probings. The work was carried out during the period October 21st to October 26th, 1965.

Borehole and probe locations and ground elevations were referenced in accordance with the details given in your site plan and profile drawing, Dwg. 1, Contract 2317 dated October 13, 1965. River level during the field work period was also confirmed.

SOIL AND GEOLOGY

All five pier or pier-abutment foundations will be located within the wide channel of the Moira River, which at the bridge site forms part of the head pond held back by the Corbyville Distillery Dam. Maximum water level in the head pond/river is recorded as El 492.49 feet, or approximately 2 to 4 feet below the level of the bordering flood plain.

Along the east bank of the river a former low area flooded during peak storage of the Corbyville Dam has been reclaimed with a silt sand clay and concrete rubble fill obtained from roadway reconstruction and repair elsewhere in the Township. This fill now forms the river bank for about 500 to 600 feet north of the existing road bridge. Slightly organic silty material at the base of the fill overlies natural silt till at El 484.6 feet.

To the west of the river, the uppermost soils consist of stratified silty and sandy alluvial deposits down to approximately the same erosional level at El 485 feet.

The central embankment section of the new river crossing will be located immediately upstream from the existing "Fox's Island". Borehole 2 indicates that this island is covered with compact glacial silt till to a higher level than in either of the main river banks, or El 492 feet. However, the greater portion of the new fill will extend out into the water where the till surface has been eroded down to approximately El 485 feet and covered with an irregular layer of cobbles, boulders, river bottom mud and rip-rap.

The grey calcareous silt till rest directly upon a smooth gently sloping surface of hard grey crystalline Trenton Limestone, at El 480 feet in Hole 1 to El. 477 feet in Hole 3. The limestone is regularly stratified into thin 2 inch to 6 inch beds, with the bedding planes occasionally open sufficiently to allow the loss of drilling water. However, no clay or weathered calcareous shale seams were detected, and the rock appears very sound. Core recovery varied between 95 and 100 percent.

FOUNDATIONS

1. Bearing Capacity: - It is recommended that the five piers and abutments be founded directly upon the sound Trenton Limestone bedrock, with a minimum 4 feet of scour protection provided below the present river bed. Founding level will be approximately El 477 feet, requiring possibly 1 to 2 feet of bedrock excavation for the two eastern piers. A safe net bearing pressure of 10 tsf may be utilized.

If higher bearing pressures could be used or are required, the allowable capacity of footings on the rock may be increased to 25 tsf as long as the five feet of limestone immediately beneath founding level is explored for clay seams or cavities by star drill holes.

2. Sliding Resistance and Horizontal Forces: - As outlined in our opening paragraphs, anchorage of the pier and abutment foundations will be required to resist horizontal forces developed by water, ice and retained earth fill. This may be provided by either keying the footings into bedrock in order to develop passive resistance additional to the sliding resistance between concrete base and limestone surface, or by dowelling the footing to the bedrock. A key depth of 2 to 3 feet, or a minimum dowel length of 5 feet is suggested, though these values are very arbitrary since the effective shear strength of the rock could vary from as little as 1000 psf in the case of thin near-surface horizontal beds sliding over one another, to 6,000 or 7,000 psi for a direct

fracture across sound unweathered limestone. Horizontal shear strength values of 1 tsf for the uppermost 2 feet and 10 tsf for the next 3 feet are tentatively suggested as a basis for calculation. Below 5 feet the horizontal strength may be increased to 100 tsf, since any horizontal shear would require vertical or angular shear across the overlying 5 feet. The suggested values would be very conservative for the flat lying tightly bedded Trenton Limestone.

A value of tan $\phi = 0.7$ may be used in computing the sliding resistance between concrete and rock. This is believed to be conservative.

3. Earth Pressures: - The four abutments supporting approach embankments must be designed to resist the earth pressures developed by the retained fill. The pressure at any depth, h, can be determined from the expression:

$$p = k\ (\gamma h_1 + \gamma^1 h_2) + \gamma_w h_2$$

where: $k = 0.35$, a compromise between the active and at rest condition believed to be applicable for the case of a slightly settling granular fill acting upon a very slightly yielding abutment.

γ is the bulk density of the retained soil or rock, assumed as 130 pcf for soil, and ranging from 120 to 140 pcf for quarried rock.

γ^1 is the submerged density of the retained soil or rock

γ_w is the density of water

h_1 is the depth of soil above the water table

h_2 is the depth of soil below the water table, such that $h_1+h_2 = h$.

EMBANKMENT AND ROADWAY SUBGRADE

No problems relating to the stability and settlement of the approach and central connecting fills are anticipated as long as the following general techniques and procedures are observed. All fill below high water level should be completed with quarried rock, dumped into the water and spread out and compacted with a D8 dozer or equivalent. Smaller equipment should be used with caution because of the lighter weight and lower vibratory impact force. Above the high water level the embankments may be completed as rolled earth fills, constructed in accordance with the Department of Highways of Ontario placement and compaction requirements.

If the four embankments are completed above the water level with rolled earth, an 18 inch transitional blanket of well graded sand and gravel must be provided to prevent leaching of the earth fill into the larger voids and cavities of the rock fill, by up and down oscillation of the river level. Gradational requirements of the gravel will depend upon the character of the quarried rock used for the base of the fill, and on the type of soil placed above.

Coarse sandy gravels may be used as an alternative to the quarried rock, as long as the side slopes below water level are increased to approximately 4 horizontal to 1 vertical. By comparison, 2:1 slopes should be readily obtained with the shot rock.

All embankment slopes constructed of gravel or earth must be protected with rip-rap to a height of at least 2 feet above maximum water level.

We trust you will find the foregoing report and recommendations in order. If additional queries should arise please do not hesitate to contact us.

Yours very truly,

JDM/gh
Encls.

J.D. Morton,

W.A. Trow, P.Eng.

WILLIAM TROW ASSOCIATES LTD.

SITE INVESTIGATIONS · SOIL MECHANICS CONSULTATION

DRAWING No 2.

PROJECT No J2633.

LEGEND

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 X^LI

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 1.

PROJECT Fairfield Bridge over Moira River.

LOCATION Twp. Thurlow, County Hastings, Ontario.

HOLE LOCATION E. River Bank, Sta. 15+00 approx.

HOLE ELEVATION 493.06 ft.

DATUM C.G., Parker Project Bench Mark.

SYMBOL	SOIL DESCRIPTION	ELEV FEET	DEPTH FEET	PENETRATION RESISTANCE 350 FT. LB. BLOWS/FT. (20, 40, 60, 80) / SHEAR STRENGTH P.S.F	NATURAL MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT	SAMPLE TYPE AND No	NATURAL UNIT WEIGHT P.C.F.
	FILL-sand, silt, clay, concrete blocks, asphalt; dense to compact; trace black organics at base.	493.1	0			1 2	
	SAND & SILT (TILL)-very dense, grey brown to grey, limestone fragments.	484.6	10			3	
	LIMESTONE BEDROCK-light grey, crystalline, well bedded, sound. No clay seams noted. (Trent Limestone Fm)	480.4	20			AX Cone	96% Recovery
	Terminated	470.0	30				
	1)Hole advanced by wash boring and rotary diamond core drilling. BX casing to 13 feet. Hole relocated twice due to refusal on boulders or concrete block in fill. 2)Drill water level at 5.3 ft. after drilling casing, with hole open to 7.9 ft. Caved and dry at 3.5 ft. 3½ hrs. later. Adjacent river level at El 490.5' October 26, 1965.		40				

BOREHOLE 1 - J2633.

WILLIAM TROW ASSOCIATES LTD.

SITE INVESTIGATIONS · SOIL MECHANICS CONSULTATION

DRAWING No 3.

PROJECT No J2633.

LEGEND

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 X^LI

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 Fairfield Bridge over Moira River.

LOCATION Twp. Thurlow, County Hastings, Ontario.

HOLE LOCATION Centre Island, Sta. 12+30 approx.

HOLE ELEVATION 496.18 ft.

DATUM C.C. Parker Project Bench Mark.

SYMBOL	SOIL DESCRIPTION	ELEV FEET	DEPTH FEET
	FILL-silt, sand, gravel, rock fragments, dense.	496.2	0
	SILT & SAND (TILL)-very silty sand or sandy silt, scattered gravel and limestone fragments; very dense, grey, fissured and grey below above 9 feet. Boulders and limestone slabs from 13 ft. to 15½ ft; compact calcareous silt and stones below.	492.2	10
	LIMESTONE BEDROCK-sound, fresh well bedded, crystalline limestone. Narrow open seam at 23 ft. (lost drilling water).	478.2	20
	Terminated	468.2	30
			40

PENETRATION RESISTANCE 350 FT. LB. BLOWS/FT. (20, 40, 60, 80)

SHEAR STRENGTH P.S.F

NATURAL MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT

SAMPLE TYPE AND No	NATURAL UNIT WEIGHT P.C.F.
1	
2	
3	
4	
AX Core	98% Recovery

Notes:
1) Hole advanced by wash boring and rotary diamond core drilling. BX casing to 18 ft. Hole relocated twice due to refusal on boulders or concrete block in fill.
2) Hole filled in on completion due to location in roadway passing area between two existing bridges. W.L. of adjacent river at El490.5'

October 26, 1965.

DRAWING No. 3 - J2633.

WILLIAM TROW ASSOCIATES LTD.

SITE INVESTIGATIONS SOIL MECHANICS CONSULTATION

DRAWING No 4.

PROJECT No J2633.

LEGEND

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 X LI
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. 3.
PROJECT Fairfield Bridge over Moira River.
LOCATION Twp. Thurlow, County Hastings, Ontario.
HOLE LOCATION W. River Bank, Sta. 8+50 approx.
HOLE ELEVATION 493.88 ft.
DATUM C.C. Parker Project Bench Mark.

SYMBOL	SOIL DESCRIPTION	ELEV FEET	DEPTH FEET
		493.9	0
	SILT & SAND-very sandy silt with pockets and lenses of sand, dense, brown. (Alluvial flood plain deposit)	485.0	10
	SILT (TILL)-very sandy and stoney cobble at 15 feet, compact to very dense.	477.6	20
	LIMESTONE BEDROCK-grey, crystalline, well bedded, sound. Partial loss of drill water in open bedding planes at 19 feet and 20 feet.	469.0	30
	Terminated		40

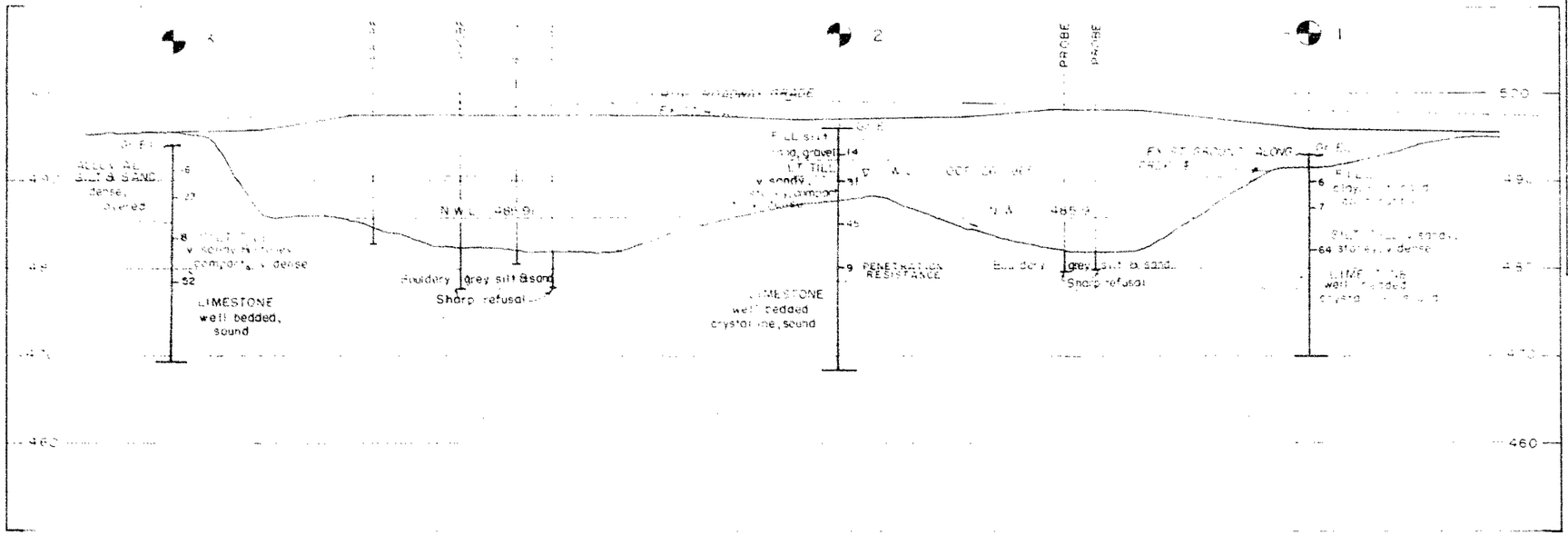
PENETRATION RESISTANCE 350 FT LB. BLOWS/FT. (20, 40, 60, 80)
SHEAR STRENGTH P.S.F

NATURAL MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT

SAMPLE TYPE AND No	NATURAL UNIT WEIGHT P.C.F.
1	
2	
3	
4	
AX Core	96% Recovery

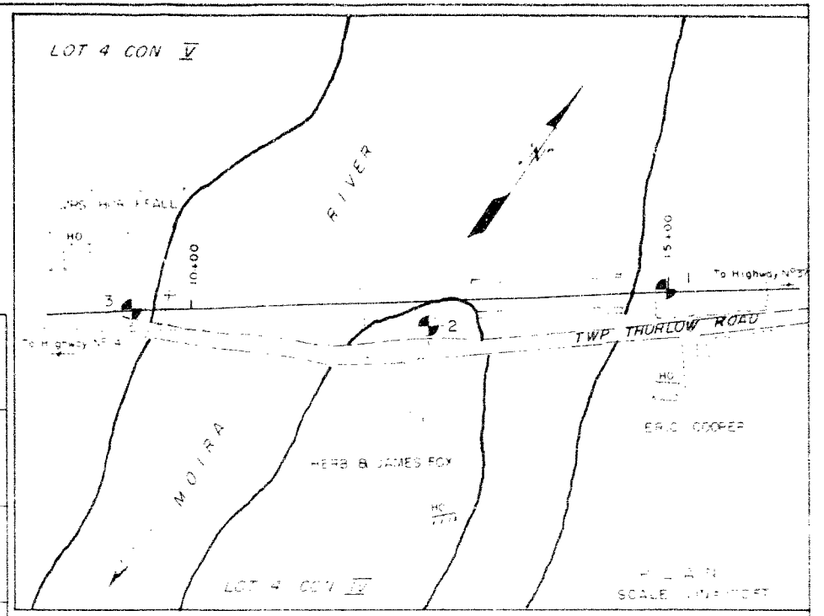
Notes:
1) Hole advanced by wash boring and rotary core drilling. Cased to 61.3 feet.
2) Hole filled in on completion as located closely alongside road. W.L. in adjacent river at El 490.5 ft. October 26, 1965.

BOREHOLE 3 - J2633.



INTERPRETED SUBSOIL STRATIGRAPHY

SCALE: HOR. 1 IN. = 50 FT
VERT. 1 IN. = 10 FT.



— 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.

William Trow ⸸ Associates Ltd.

FOUNDATION INVESTIGATION

FAIRCHILD BRIDGE OVER MOIRA RIVER

TWP. THURLOW CO. HASTINGS ONTARIO

PROJ. 2633	DATE OCT. 1965	DWG. № 1