#65-F-94
W.P. #61-59
HWY #401
OVERPASS
IONA-MELBOURNE
ROAD

PILE LOADING TESTS AT
PROPOSED IONA-MELBOURNE
ROAD AND HWY. #401 OVERPASS
COUNTY OF ALGIN. District #2 (London)
W.O. 65-F-94 W.P. 61-59

Pile Loading Tests at
Proposed Iona-Melbourne
Road and Hwy. #401 Overpass.
County of Elgin. District #2 (London)
W.O. 65-F-94 W.P. 61-59

1. INTRODUCTION

Pile loading tests were carried out at the site of the proposed overpass of Hwy. #401 and the Iona-Melbourne County Road in order to evaluate the load bearing properties of piled foundations. The original foundations investigation, consisting of three sampled boreholes, was carried out by E. N. Peto Associates Ltd. Consulting Engineers in 1960, under W.O. #60-F-2630.

The pile load tests were initiated and supervised by the Foundations Office during 1965-1967, the results of which were kept on file, without being summarized in a report.

In the following paragraphs, the factual information concerning soil properties, pile driving and testing data and estimated loads is given. This summary is being compiled in 1973 as part of an office engineering project, devoted to the collection and critical review of all the pile tests carried out by this office in the past 15 years.

2. SUBSOIL CONDITIONS

The surficial layer at the site of the load test was found to be a brown, mottled silty clay, being somewhat overconsolidated by desiccation. Standard penetration N values, obtained within this stratum, ranged from 16 blows per foot to over 30 blows per foot, indicating very stiff to hard consistency. Laboratory shear strength values were

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estimated to be between 5000 PSF and 6000 PSF. (See figure #1).

Underlying the brown silty clay a greyish brown silty clay was observed extending down to at least 100 feet below ground level. The upper portion of this material is still desiccated, the lower boundary of the crust being ground elevation 715 to 720 feet, some 15 to 16 feet below ground level. Below the desiccated crust, fairly uniform soil properties were noted. Penetration N values varied between 8 and 18 blows per foot and laboratory shear strengths between 1500 PSF and 3000 PSF.

2. PILE DETAILS, DRIVING DATA AND TEST ARRANGEMENT

A total of three test piles and four anchor piles were driven on November 15, 1965. The location of the piles are shown on drawing #65-F-94A. Test pile #1 was a No. 14 timber pile with an embedded length of 10.22 feet. Pile #2 was a 12⅝" x 0.25 tubular steel pile with 9.92 feet embedment. Pile #3 was a 12 BP @ 74 steel H pile with 10.03 feet embedded length. On Figure #1 a graphical presentation of pile details, driving records and corresponding soil properties are given. On the figure, it may be seen that the piles were driven into the crust without penetrating into the weaker zones.

The anchor piles consisted of four 50 foot long timber piles which were attached to a reaction beam as shown on Drawing #65-F-94B, C, and D.

Pile driving was carried out by a Delmag D-12 hammer, having 22,500 ft./lbs. rated energy. The weights of the hammer and the anvil were 1.38 tons and 0.377 tons respectively.

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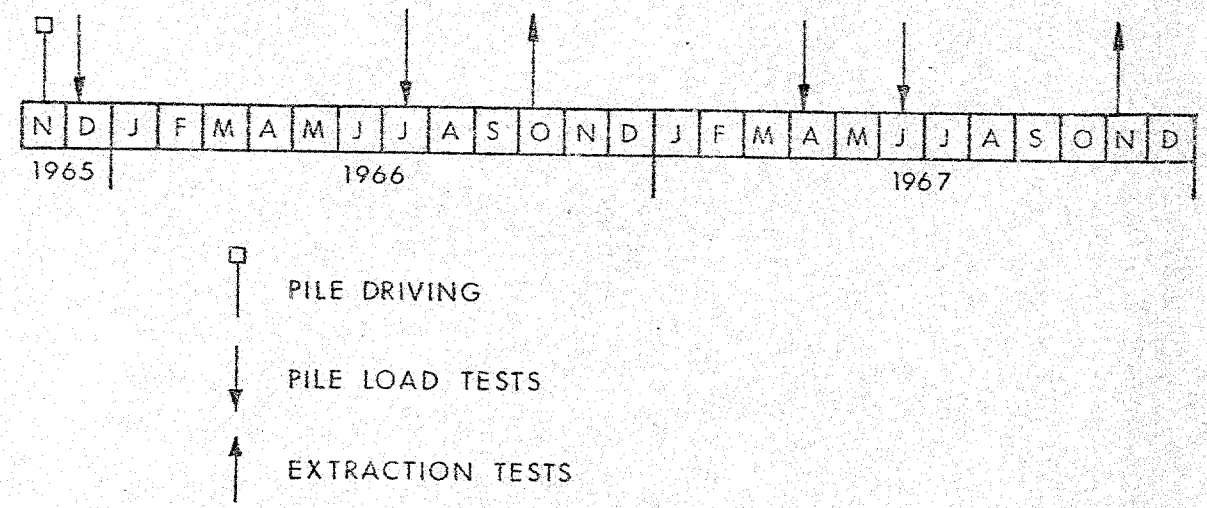
4. PILE LOADING TESTS

Four sets of load tests and two extraction tests were carried out. The first load tests were performed between December 1 and 3, 1965, some 15 to 17 days after driving the piles. The second tests were implemented on July 5, 6 and 7, 1966, approximately 7 months after the first. The third and fourth load tests were carried out in April and June 1967 respectively. Extraction tests took place in October 1966 between the second and third load tests, and again in November 1967.

The results of all the tests are shown graphically in the appendix of this summary. The sketch below shows the time sequence of loading and extraction tests.



5. DISCUSSION AND EVALUATION OF TEST RESULTS

All the load and extraction tests were carried out to failure. To determine the ultimate capacity of a pile is relatively simple in those cases where the pile fails by slipping or plunging under a constant load. However, if a pile begins to experience very large settlements

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under small increases of loads, the ultimate capacity is subject to interpretation. In the latter cases, some arbitrary definition of failure load is necessary. In this summary, the suggestion by Terzaghi is adopted (Terzaghi, K.: Discussion of Pile-Driving Formulas. Proc. A.S.C.E., 1942). According to this procedure, the ultimate load is considered to be that at which the settlement reaches a value equal to 1/10 the top diameter of the pile.

By examining the graphical presentations of the pile load tests, it may be concluded that no noticeable strength increase of the subsoils occurred during the two year testing period. In other words, it appears that the excess pore pressure caused by pile driving fully dissipated within 15 to 17 days after driving.

One clear trend was observed during the April 1967 tests. These tests were carried out immediately after the spring thaw, during a very wet season. All these tests resulted in lower ultimate capacity than the tests earlier or later. The decrease of ultimate load was about 10 to 20%, and believed to be caused by the effect of surface water. Since the piles were all short and embedded only in the crust, the softening of the surficial layers and the lubrication by water along the shafts had a definite, detrimental result on pile capacities.

On table #1 a comparison of the calculated bearing capacities with those obtained by actual load tests is made.

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Tomlinson's static formula was used for the calculations of loads on the piles. The static formula reads:

$$Q_U \text{ end bearing} = N_C \times C_U \times A_B$$

where Q_U = ultimate load on tip of pile

N_C = bearing capacity factor, assumed to be = 9 (Tomlinson)

C_U = undrained shear strength at base

A_B = area of base

and $$Q_{U(\text{adhesion})} = C_A \times L \times A_S$$

where Q_U = ultimate load along the shaft

C_A = adhesion. Full undrained shear strength was used in order to evaluate the % mobilization during load test.

L = embedded length

A_S = circumference of pile

The actual end bearing value on each pile was estimated by deducting the ultimate pull load of the extraction tests from the ultimate value obtained by the loading tests.

The area of base of the 12 BP H pile was taken to be 1 square foot, postulating that the pile and the soil between the flanges act as a block.

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Bearing capacity factors obtained by the loading and extraction tests were evaluated to be as follows:

Timber pile N_C = 16.5

Steel tube N_C = 13.6

Steel H N_C = 8.0

The values of mobilized shear strength along the embedded shafts of piles during the tests are listed below:

Timber pile: C_A = 1240 PSF = 0.21 C_U

Steel tube: C_A = 1670 PSF = 0.28 C_U

Steel H: C_A = 1500 PSF = 0.25 C_U

where C_U = 6000 PSF

While it is understood that dynamic formulae cannot be used to compute loads on piles driven into cohesive materials, for the sake of interest, loads were calculated by the Hiley equation as well. As it was expected, the results of these computations were entirely out of proportion, being some 6 to 10 times larger than the actual loads obtained by the tests.

6. MISCELLANEOUS

The pile load tests were carried out by Messrs. L. Palmer and H. Szymanski. This summary was compiled by Mr. A. K. Barsvary. The entire load test was under the direction of Mr. M. Devata.

A. K. Barsvary

AKB/ds

Aug. 24, 1973.

A. K. Barsvary, P. Eng.

REGISTERED PROFESSIONAL ENGINEER
CIVIL
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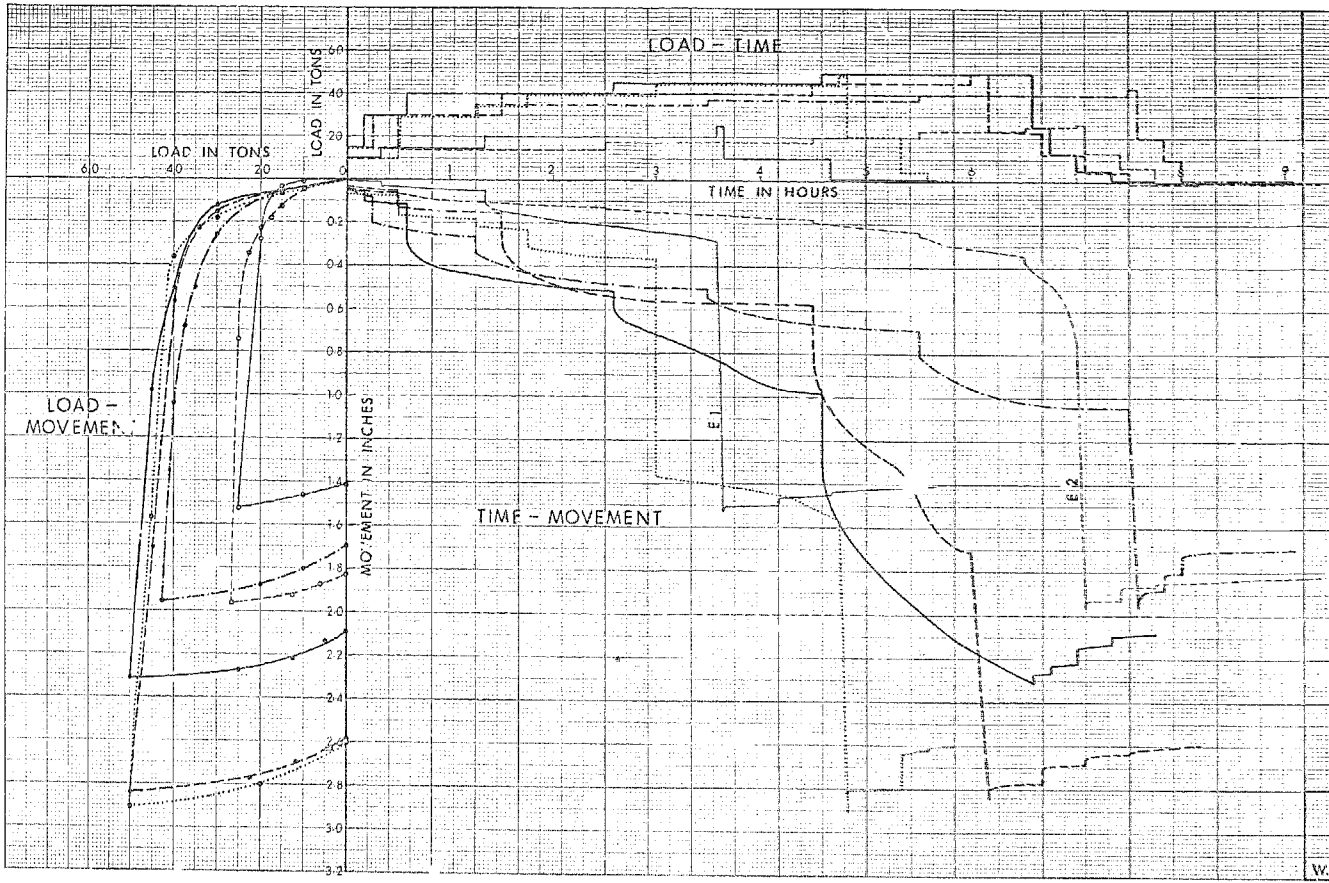
PROVINCE OF ONTARIO



PILE DATA

PILE TYPE	*TIMBER No 14 (14" – 10") UNTREATED*
DATE DRIVEN	*15 November 1965*
LENGTH IN GROUND	*10·217*
CUT OFF ELEV.	*739·0*
TIP ELEVATION	*726.57*

LOAD TEST DATA

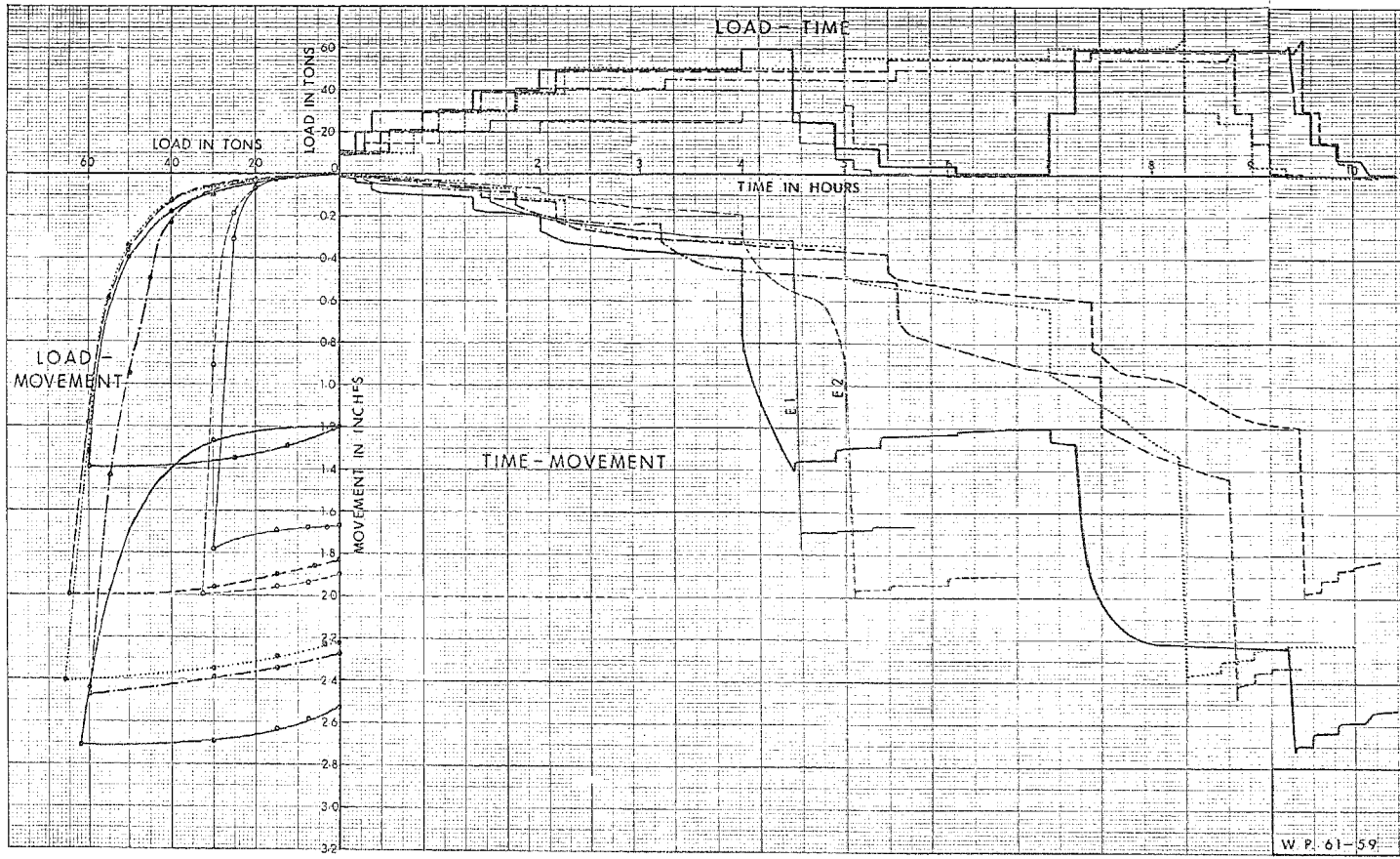
TEST No	SYMBOL	DATE	MAXIMUM LOAD APPLIED	ESTIMATED FAILURE
1	———	*3 Dec. 1965*	*50 Tons*	
2	– – – –	*5 July 1966*	*50 Tons*	
3	— — —	*7 Apr. 1967*	*42.5 Tons*	
4	·····	*14 June 1967*	*50 Tons*	

EXTRACTION TEST DATA

TEST No	SYMBOL	DATE	MAXIMUM PULL APPLIED	ESTIMATED FAILURE
E1	———	*12 Oct. 1966*	*25 Tons*	
E2	– – – –	*7 Nov. 1967*	*26.57 Tons*	

PILE NO. 1 – TIMBER
LOAD & EXTRACTION TESTS
HWY. 401 & IONA STATION

W.P. 61-59 DIST. 2 W.O. 65-F-94



PILE DATA

PILE TYPE *TUBULAR STEEL (Concrete filled) 12¾"×0.25"*

DATE DRIVEN *15, November 1965*

LENGTH IN GROUND *9·9'*

CUT OFF ELEV *739·0* TIP ELEVATION *727·0*

LOAD TEST DATA

TEST Nº	SYMBOL	DATE	MAXIMUM LOAD APPLIED	ESTIMATED FAILURE
1	———	2 Dec. 1965	60 Tons	
2	– – – –	6 July 1966	65 Tons	
3	—·—·—	10 Apr. 1967	60 Tons	
4	·····	13 June 1967	66·25 Tons	

EXTRACTION TEST DATA

TEST Nº	SYMBOL	DATE	MAXIMUM PULL APPLIED	ESTIMATED FAILURE
E1	———	7 Oct. 1966	30 Tons	
E2	– – – –	9 Nov. 1967	32·5 Tons	

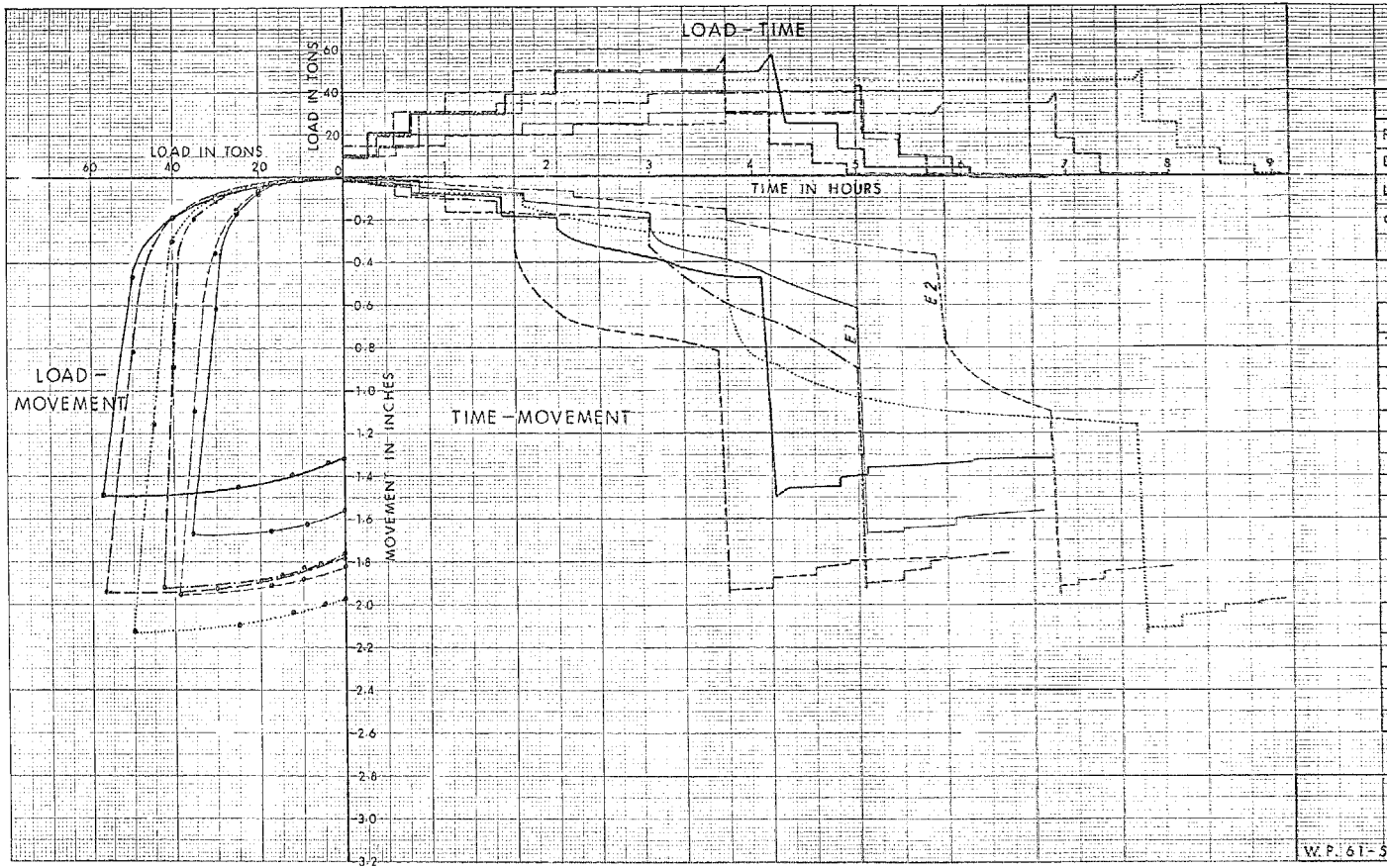
PILE NO. 2 – TUBULAR STEEL

LOAD & EXTRACTION TESTS

HWY. 401 & IONA STATION

DIST. 2

W.P. 61–59 W.O. 65–F–94



PILE DATA

PILE TYPE	STEEL H-PILE (12BP74)
DATE DRIVEN	15 November 1965
LENGTH IN GROUND	10.0'
CUT OFF ELEV.	739.0 — TIP ELEVATION 726.88

LOAD TEST DATA

TEST Nº	SYMBOL	DATE	MAXIMUM LOAD APPLIED	ESTIMATED FAILURE
1	———	1 Dec. 1965	57 Tons	
2	– – – –	7 July 1966	57 Tons	
3	——·——	6 Apr. 1967	42.5 Tons	
4	·····	12 June 1967	50 Tons	

EXTRACTION TEST DATA

TEST Nº	SYMBOL	DATE	MAXIMUM PULL APPLIED	ESTIMATED FAILURE
1	———	7 Oct. 1966	35 Tons	
2	– – – –	8 Nov. 1967	39 Tons	

PILE NO. 3 – 'H' STEEL
LOAD & EXTRACTION TESTS
HWY. 401 & IONA STATION

W.P. 61-59 DIST. 2 W.O. 65-F-94

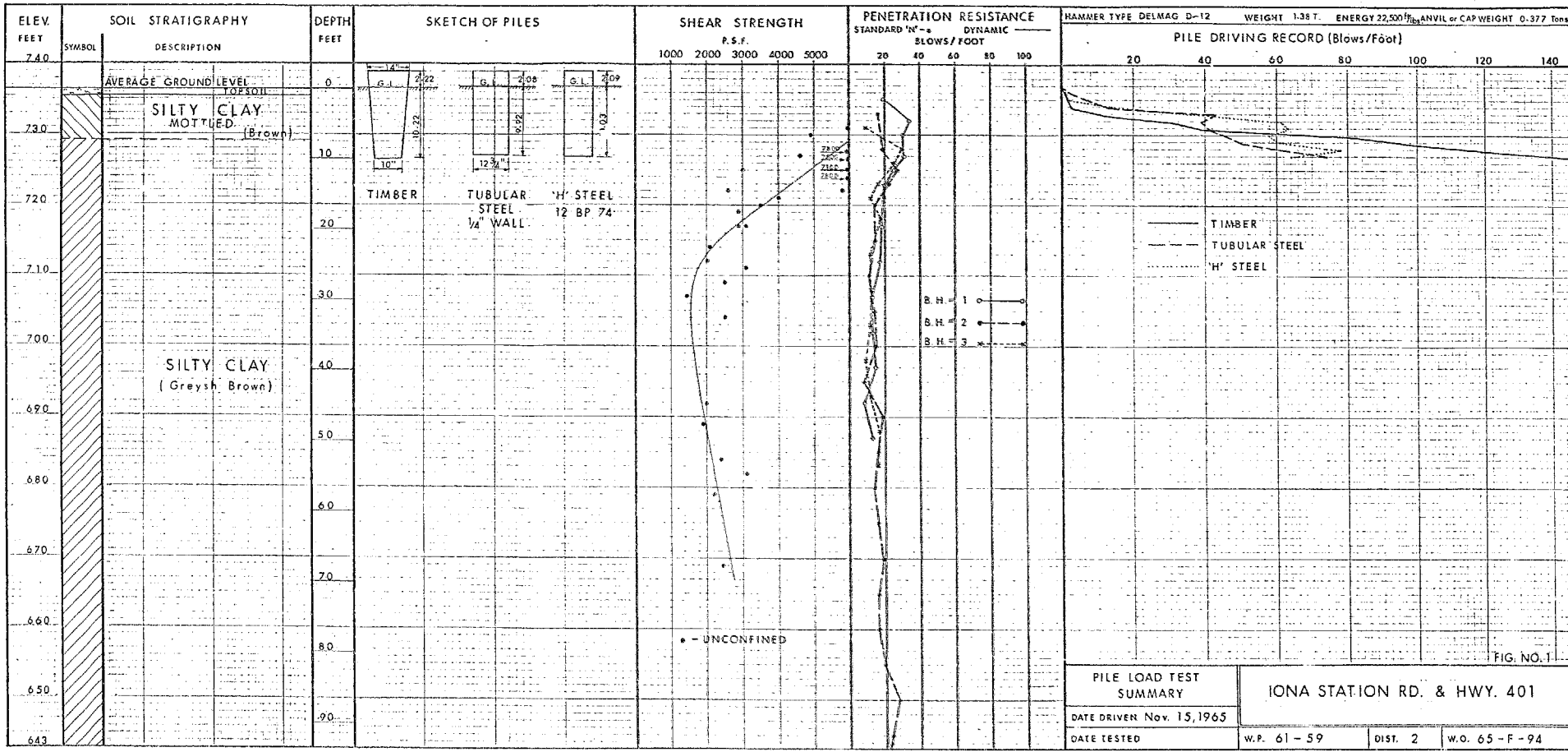
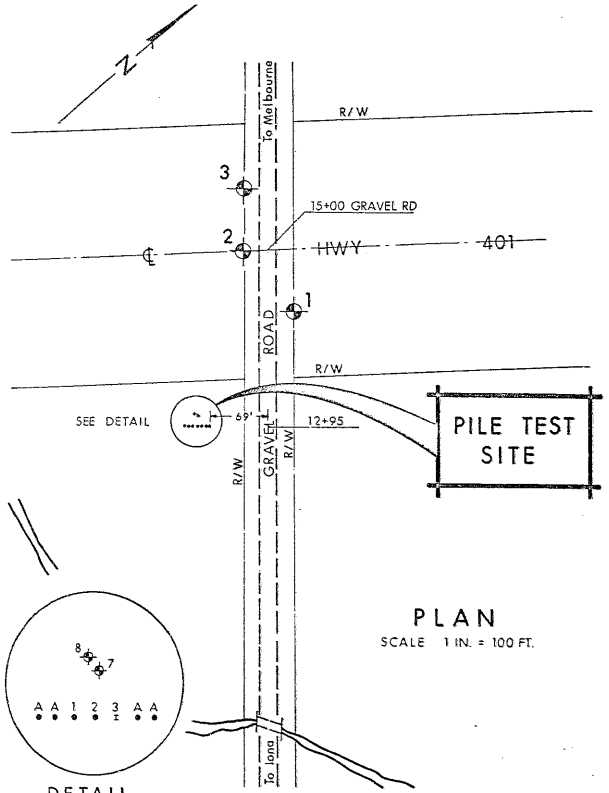


FIG. NO. 1

PILE LOAD TEST SUMMARY	IONA STATION RD. & HWY. 401		
DATE DRIVEN Nov. 15, 1965			
DATE TESTED	W.P. 61 - 59	DIST. 2	W.O. 65 - F - 94

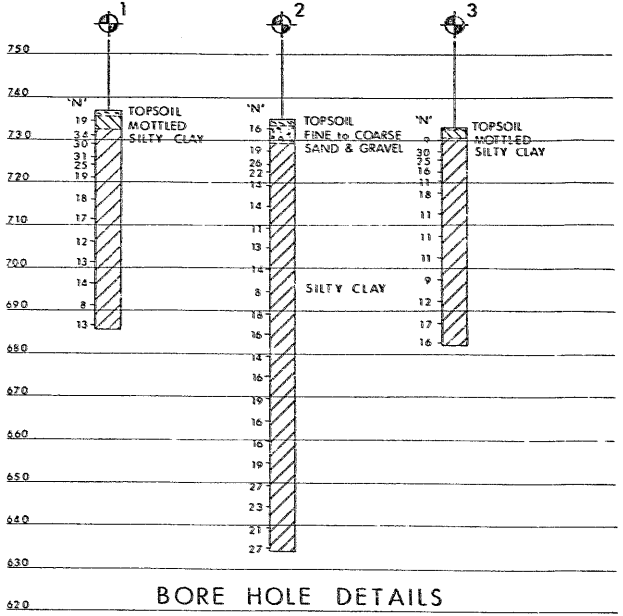


PLAN

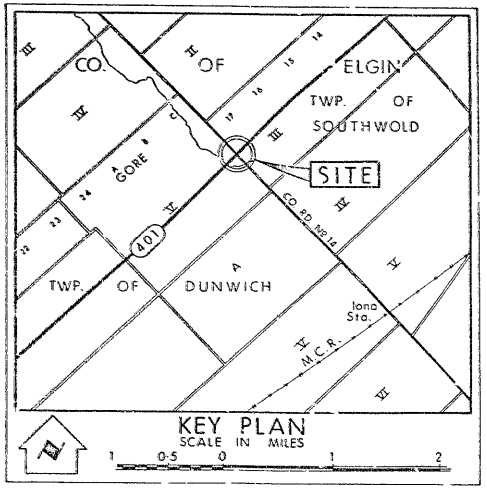
SCALE 1 IN. = 100 FT.

DETAIL

SCALE 1"= 20'



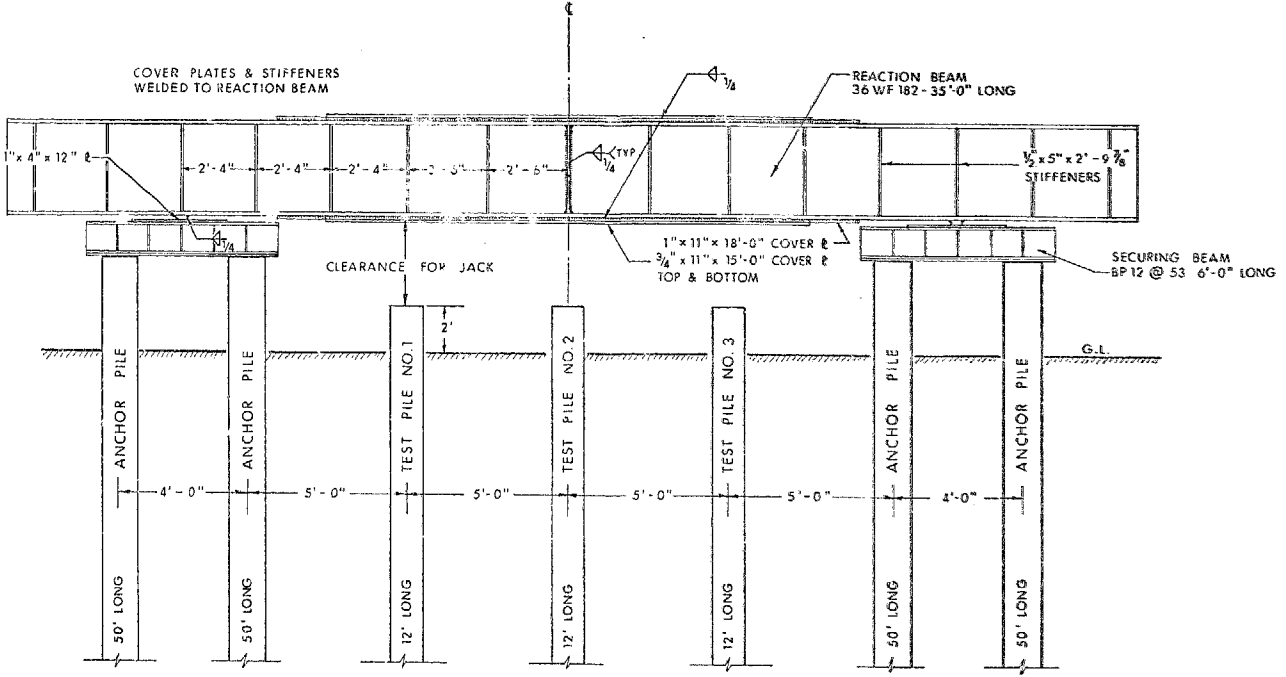
BORE HOLE DETAILS



LEGEND

Bore Hole

ONTARIO — DEPARTMENT OF HIGHWAYS — MATERIALS and TESTING DIVISION	IONA - MELBOURNE RD. & HWY. 401 OVERPASS PILE TEST LOCATION & SOIL STRATA	
DATE 24 AUG. 1965	APPROVED M. Sivola	DRAWING NO. 65-F-94 A



ARRANGEMENT DETAILS

SCALE 3/8" = 1'-0"

PILE DETAILS

TEST PILL NO. 1 – TIMBER (NO. 14)
TEST PILE NO. 2 – TUBULAR (12 3/4" x 0·25")
TEST PILE NO. 3 – STEEL 'H' PILE (12 BP 74)
ANCHOR PILES – TIMBER (NO. 14)

NOTE

PILES DRIVEN UNDER W.O. Nº 65-33629 & 65-33630 NOV. 15, 1965

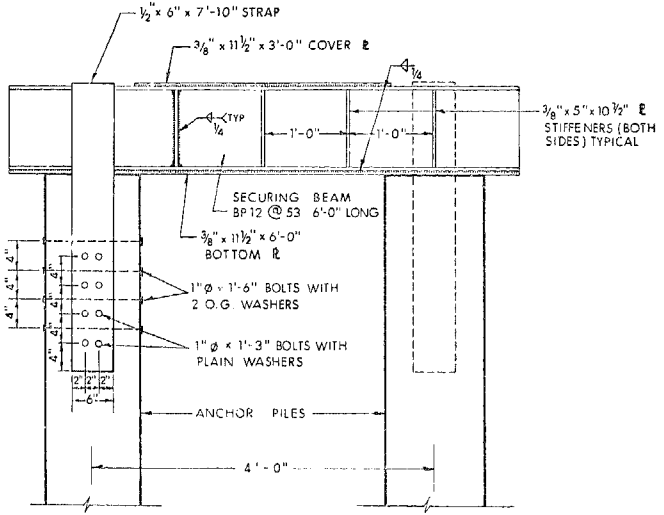
DWG. REVISED MAR. 1968 FEB. 1966

ONTARIO DEPARTMENT OF HIGHWAYS MATERIALS and TESTING DIVISION

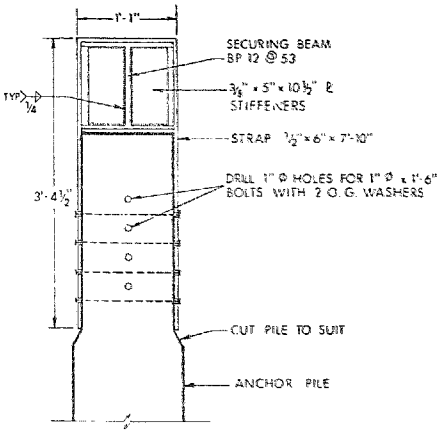
IONA-MELBOURNE RD. & HWY. 401 OVERPASS

TEST PILES, ANCHOR PILES & REACTION BEAM ARRANGEMENT

DATE 24 AUG. 1965 APPROVED [illegible] DRAWING NO. 65-F-94 B



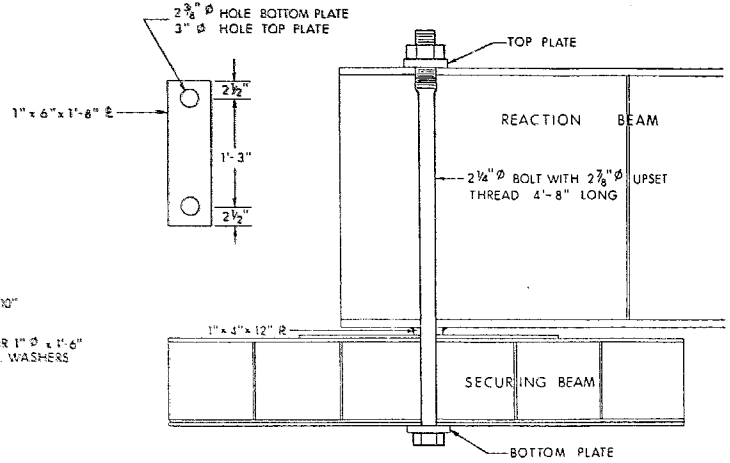
FRONT VIEW



END VIEW

SECURING BEAM & STRAP DETAILS

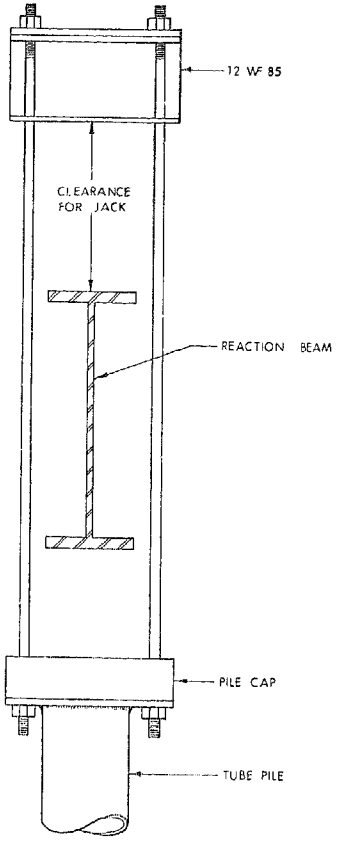
SCALE 1" = 1'-0"



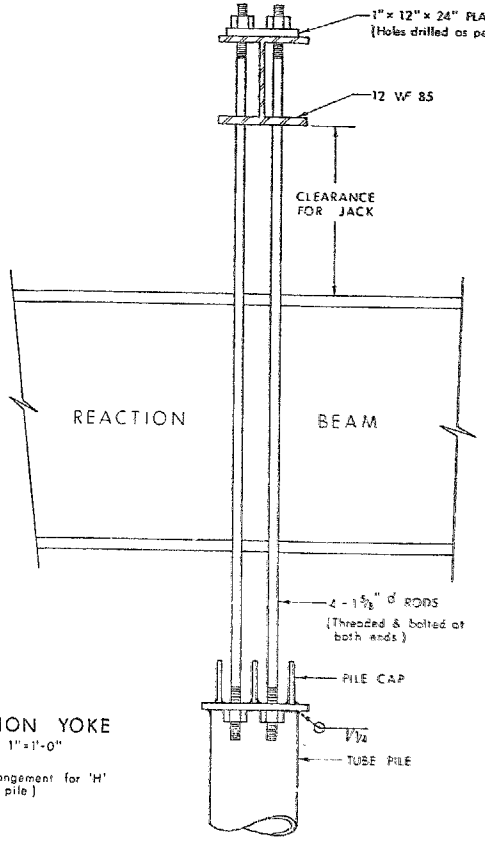
BOLT & PLATE DETAILS

SCALE 1" = 1'-0"

DEPARTMENT OF HIGHWAYS ONTARIO — MATERIALS and TESTING DIVISION	IONA-MELBOURNE RD. & HWY. 401 OVERPASS REACTION BEAM ATTACHMENT DETAILS	
DATE 24 AUG. 1965	APPROVED	DRAWING NO. 65-F-94 C



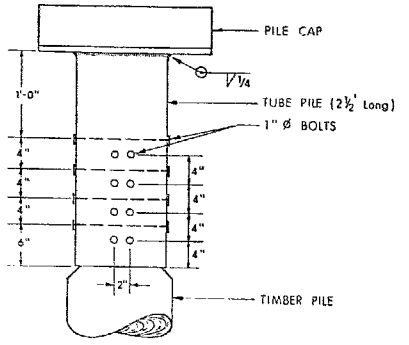
END VIEW



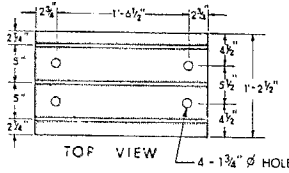
FRONT VIEW

EXTRACTION YOKE
SCALE 1" = 1'-0"

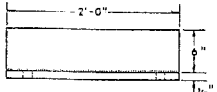
(Use same arrangement for 'H' pile & timber pile)



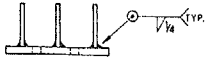
TIMBER PILE
SCALE 1" = 1'-0"



TOP VIEW



FRONT VIEW



END VIEW

PILE CAP DETAILS
SCALE 1" = 1'-0"

1 - ½" x 14½" x 24" BASE PLATE

3 - ⅜" x 6" x 24" ℓ STIFFENERS

ONTARIO DEPARTMENT OF HIGHWAYS MATERIALS and TESTING DIVISION	IONA - MELBOURNE RD. & HWY. 401 OVERPASS EXTRACTION TEST DETAILS	
DATE 1 FEB. 1966	APPROVED	DRAWING NO. 65-F-94 D