

CONT. 72-119

HAMILTON ENTRANCE

BR. 1+3 VIDEO

INSP. OF CASSONS

30MS-96

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GLORES No.



VIDEO INSPECTION OF CAISSONS
AT HAMILTON ENTRANCE BRIDGES NOS. 1 & 3
HIGHWAY NO. 2 AND YORK BOULEVARD
HAMILTON, ONTARIO

Prepared for:
THE MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

WILLIAM TROW ASSOCIATES (HAMILTON) LTD.
Project: H1569/H1533 1870 Barton Street East
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Telephone: 547-6385
Direct Toronto Line: 368-6293



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CAISSON INSTALLATION REPORTS FOR BRIDGE NOS. 1 AND 3



Video Inspection of Caissons
at Hamilton Entrance Bridges Nos. 1 & 3
Highway No. 2 and York Boulevard
Hamilton, Ontario

SUMMARY

Underwater video inspection of the caissons at Pier 4, Hamilton Entrance Bridge No. 3 was undertaken, as direct visual examination of the bedrock was not possible, and detailed inspection was required to confirm the design bearing capacity of 500 tons on 3 feet diameter by 8 feet long rock sockets. Inspection of holes cored through the caissons was also performed to determine the condition of the concrete and the underlying rock.

The inspection involved flushing of clear water through the caissons and core holes, and subsequent examination of rock and concrete with radial and axial view lenses. From previous direct visual experience of caissons for the Hamilton Entrance Bridges and other sites and by adjustment of the focusing, lighting, contrast, etc., soils engineers were able to establish the level of the lowest seam in each caisson, the general condition of the bedrock, and the presence of ground up soil and rock on the bottom of the caissons. The level to found the caissons to obtain the design bearing loads could therefore be determined.

The cored boreholes through the caissons were viewed by video techniques. The causes of poor core recovery in three of the caissons

were established, and the required remedial measures could therefore be recommended.

The video inspection techniques proved successful in examining the founding conditions at Hamilton Entrance Bridge No. 3, and could be used on other projects where direct visual inspection is not possible. These include sites where the caissons cannot be dewatered and where the diameter is too small to allow direct visual inspection. The inspection of the cored holes by video techniques is considered to be the most positive available method of determining the reasons for poor core recovery, and therefore establishing the required remedial measures. Without it, at least three caissons at this site may have been rejected because of doubts about the competence of the concrete to support the design loads.



INTRODUCTION

The high design bearing pressures (i.e., 75 tsf) of the caissons at Hamilton Entrance Bridges 1 and 3, required that a thorough inspection of the exposed rock in each caisson socket be undertaken. Although direct visual inspection of the caissons was possible at Bridge 1, Pier E, it could not be carried out at Bridge 3, Pier 4, due to severe groundwater seepage into the open holes. As a result, an examination of the exposed bedrock in each caisson at Bridge 3 was undertaken by video inspection procedures.

At both bridge sites, the degree of groundwater seepage was such that the concrete had to be placed by tremie methods. One caisson was selected at each bridge and cored to determine the concrete quality, the conditions at the concrete to rock interface and the soundness of the underlying bedrock. Subsequently, three additional caissons were cored when either the previous caisson had indicated unsatisfactory concrete or the concrete quality was doubtful due to the tremie procedures. Each cored hole was examined by means of closed-circuit television.

Appendix "C" presents copies of the caisson inspection reports for Bridges 1 and 3, and notes on the inspection requirements for caissons are provided in Appendix "B".

PROCEDURE

The video inspection involved three phases: (a) provision of suitably clear water in the caisson or borehole to allow inspection;

(b) inspection of the caissons and reinspection where the caisson was initially unacceptable; and (c) inspection of the cored holes. The radial view lens, capable of being rotated through 360 degrees from the monitor, was used primarily for inspection, although the axial view (103 degrees) lens was also used to assess the diameter of the churned hole in comparison to the liner and also to inspect the bottom of the caisson.

The water in the caissons and boreholes after the installation was initially so turbid that closed-circuit television pictures did not clearly show the rock or concrete. Attempts were made to clear the water with flocculating agents. Three chemicals were used: aluminum sulphate, an organic polymer and a combination of soda ash and aluminum sulphate. They were ineffective at Bridge 3, due to a constant agitation of the water in the caissons by flow through bedrock fissures. As an alternative to the chemical flocculant, it was decided to flush out the caissons with clear water.

The caissons were not sealed due to bedrock fissures. If it was possible to continuously add clean water to the top of the caisson without overflowing the sides of the steel liner, the caisson was flushed by allowing the underlying cloudy water to be displaced out through the bedrock fissures. If, however, this procedure was not possible (i.e., in a fairly tight caisson), a submersible pump was

installed at the bottom of the caisson to draw water out as clear water was added to the top. During the flushing of each caisson, and the subsequent video inspection, the water was maintained above the water level in adjacent caissons to ensure that any flow of water was outward from the caisson. In most cases, 3000 to 4000 gallons of water were required to flush out each caisson. Video inspection was undertaken immediately after each flushing operation was completed. If the inspection was significantly delayed, the constant agitation of the water in the caisson would have produced turbid conditions. Since the caissons were interconnected by means of the bedrock fissures, it was also necessary to flush and inspect each caisson separately.

Video inspection of the cored holes was carried out with a radial view lens. The camera was lowered slowly from the concrete surface, and the lens was rotated periodically to examine the concrete around the complete circumference of the cored hole. Since the cored holes were well sealed, they were flushed with clear water from the bottom.

During the video inspection of the caissons the well defined occurrence of an interface between clean and cloudy water was frequently observed. Occasionally, the light source on the front of the camera was extinguished if it became embedded in silt or fine shale on the bottom of the caisson. Photographs of bedrock and concrete conditions



encountered in the caissons and boreholes are presented in Appendix "A".

INSPECTION RESULTS

Each caisson at Bridge 3, Pier 4, was inspected by closed-circuit television to primarily examine the exposed bedrock and determine the level of sound shale. The inspection results are summarized in Table 1. Photographs of typical bedrock conditions were obtained during the video inspection and are included in Appendix "A".

The cored holes which were put down in Caissons 5 and 8 at Bridge 1, Pier E, and in Caissons 1, 4 and 6 at Bridge 3, Pier 4, were inspected by closed-circuit television to examine the tremie concrete and the concrete to rock interface. The holes in Caissons 4 and 6 at Bridge 3 and at Caisson 5 at Bridge 1 were terminated on reinforcing steel above the concrete to rock interface. The other holes were advanced several feet into shale bedrock. Video inspection results for the cored holes at both bridge sites are presented in Table 2.

DISCUSSION

Video inspection was undertaken at the caissons at Pier 4, Hamilton Entrance Bridge 3, because it was not possible to visually inspect them in a dewatered condition. Additionally, core holes drilled through the tremie concrete in the caissons for Bridges 1 and 3 were examined with the closed-circuit television to determine the condition



of the concrete, rock and concrete-rock interface. The use of the video inspection of the caissons generally proved successful, although direct visual inspection of the caissons by an engineer or experienced technician is considered to be both preferable and more economical wherever possible. However, the video inspection is itself probably preferable and more economical than using a diver to examine the rock.

Detailed inspection of the rock conditions for the caissons at this site was necessary because of the heavy design loads to be applied. These loads represented a design bearing pressure of 75 tsf on the base of the caisson. The bedrock had to be sound and without seams or fissures to support the applied pressures without excessive distortion. When direct visual inspection of the rock proved to be impractical, because of the large volume of flow into the caissons at Bridge 3, the use of either a diver or closed-circuit television was examined. It was decided that the latter should be employed, as: (a) it had been difficult to obtain a diver for cleaning services at Bridge 1; (b) the diver would be fairly expensive but would probably be unable to make a good judgment of the rock conditions; and (c) the video unit could be watched by the same engineer who had inspected the caissons at Bridge 3, and the experience gained from it and previous projects applied to the interpretation. The caissons were therefore inspected by closed-circuit television techniques.



There are advantages and disadvantages of video techniques when compared to direct visual inspection. The major comparative disadvantages are that direct visual inspection can be reinforced by probing of the rock or soil to assess its condition, and that inspection of the base is possible by the video only if the water is very clear, which is infrequent. Measurements of the socket size were not possible on the project, although a rough comparison was made between the liner and socket diameters. Only half of each socket could be inspected because the camera rested against the low side of the battered caissons. Also, the observed picture is in black and white, and the rock generally provided little contrast, with the result that considerable experience was required to distinguish between seams and fissures and rock broken by the churning operations. However, after about 3 days of viewing, engineers with considerable general or some specific experience in the area, could quickly determine the general condition of the bedrock and establish the level of the lowest seam. Depth perception on the 2 dimensional picture could be aided by use of the sensitive focusing characteristics of the equipment. This enabled depth scanning of depressions, the continuity of which could be examined by rotating the radial lens. Additionally, flow of water in and out of the fissures could be frequently observed by watching the movement of suspended particles. A badly fractured and irregular rock surface was also found to indicate the presence of seams. Finally, the sudden occurrence of cloudy water below a specific depth in a caisson, which had been flushed from the top without pumping from the bottom, was a sign that

the lower rock did not contain water bearing seams and blackout of the lighting showed that there was ground up soil and rock on the base of the caisson. Consequently, it was concluded that the video inspection conservatively but satisfactorily established the presence of seams and the condition of the bedrock, as reported on January 8, 1973 (Appendix "C"), but that if direct visual inspection had been possible, it would have been preferable.

Video inspection techniques of caisson inspection are therefore recommended in the following conditions for heavily loaded caissons:

- (a) The caisson diameter is too small for direct visual inspection;
- (b) The caisson cannot be dewatered sufficiently for direct visual inspection; and
- (c) If video inspection is required because dewatering is not practical, the caisson should be designed to obtain its support from bond or skin friction between the concrete and the sides of the rock socket, rather than by end bearing.

The inspection itself should be carried out by an engineer familiar with direct visual caisson inspection and with video techniques. The reason for this is that the engineer must be able to adjust the focus, contrast, lighting, angle of view etc., to obtain the maximum possible visual information. For this reason, the photographs presented in Appendix "A" cannot be used solely for establishing the

sound rock level, and are only an instantaneous, two-dimensional record of a specific location in the caisson.

The video inspection of the core drill holes was very valuable in assessing the concrete and rock conditions adjacent to the hole. When 100 per cent recovery was not obtained, the concrete or rock at the intermediate levels could be examined. On this project this established: (a) a zone of washed out concrete in Caisson 5, Bridge 1 what was subsequently pressure grouted; (b) the presence of an unsuitable mixture of concrete aggregate, shale fragments and grinding in the base of Caisson 1, Bridge 3; and (c) that the lack of core at one level in Caisson 6, Bridge 3, was the result of honeycombing with the honeycombed concrete being capable of supporting the design loads. This positive assessment of the conditions was reported on November 23, 1972 and January 8, 1973 (Appendix "C"), and would not have been possible without the video unit. Consequently, it is considered to be a very useful tool to examine the condition of caissons and rock, as it views what remains adjacent to the hole, rather than the core, the most important section of which is frequently washed out.

In conclusion, heavily loaded caissons at Bridge 3 were installed without dewatering and by placing the concrete using tremie methods. The use of the large design loads of 500 tons each required

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11. 

detailed inspection of the caissons and this was successfully accomplished by video inspection techniques (Appendix "C"). Additionally, the same techniques proved very effective in examining the concrete and rock in the caissons after they had been cored drilled. It is therefore considered that similar video inspection techniques could be employed to inspect caissons at other sites, if it is not possible to examine them by direct visual methods.

WILLIAM TROW ASSOCIATES (HAMILTON) LTD.

P.D. Anderson

P. D. Anderson, B. Sc.

C.D. Thompson

C. D. Thompson, P. Eng

PDA/yg

Dist:

Ministry of Transportation
& Communications (1)

TABLE 1

VIDEO INSPECTION OF CAISSONS AT BRIDGE 3, PIER 4

Caisson No.	Date		Elevation (ft.)			Dia. of Socket (inches)	Remarks
	Initial Insp. 1972	Re-Insp. 1972	Bottom of Liner	Lowest Seam	Bottom of Caisson		
1	Nov. 12		226.07	224.13	215.24	34½-35	Bottom of caisson at time of inspection was El. 221.95, subsequently churned an additional 7ft. approx., to provide 8ft. of sound rock. (See Photographs 1, 2 & 3)
2	Nov. 20		209.82	207.00	198.99	34½-35	Bottom of caisson at time of inspection was El. 201.46, subsequently churned an additional 2½ft. to provide 8ft. of sound rock. (See Photograph 4)
3	Nov. 12		228.69	223.61	215.39	34½-35	Bottom of caisson at time of inspection was El. 223.11, subsequently churned an additional 8ft. to provide 8ft. of sound rock.
4	Nov. 20		214.41	207.00	199.16	34½-35	Bottom of caisson at time of inspection was El. 205 approx., subsequently churned an additional 6ft. to provide 8ft. of sound rock.
5	Nov. 12	Nov. 22	232.36	225.97	217.76	34½-35	Bottom of caisson at time of inspection was El. 218.36, subsequently churned an additional 1 ft. to provide 8ft. of sound rock.



TABLE 1 (continued...)

VIDEO INSPECTION OF CAISSONS AT BRIDGE 3, PIER 4

Caisson No.	Date		Elevation (ft.)			Dia. of Socket (inches)	Remarks
	Initial Insp. 1972	Re-Insp. 1972	Bottom of Liner	Lowest Seam	Bottom of Caisson		
6	Nov. 21		213.84	208.50	200.34	34½-35	Bottom of caisson at time of inspection was El. 206.65, subsequently churned an additional 6ft. approx., to provide 8ft. of sound rock. (See Photograph 5)
7	Nov. 13		235.28	230.28	222.28	34½-35	Bottom of caisson at time of inspection was El. 228 approx. subsequently churned an additional 6ft. to provide 8ft. of sound rock.
8	Nov. 21		217.91	212.91	205.18	34½-35	Bottom of caisson at time of inspection was El. 210.90, subsequently churned an additional 6ft. to provide 8ft. of sound rock. (See Photographs 6, 7 & 8)
9	Nov. 15		235.73	-	227.26	34½-35	Seams were not encountered below liner, elevation of sound rock established as approx. the bottom of the liner. (See Photograph 9)
10	Nov. 16		222.30	-	214.13	34½-35	- as above -

TABLE 1 (continued...)

VIDEO INSPECTION OF CAISSONS AT BRIDGE 3, PIER 4

Caisson No.	Date		Elevation (ft.)			Dia. of Socket (inches)	Remarks
	Initial Insp. 1972	Re-Insp. 1972	Bottom of Liner	Lowest Seam	Bottom of Caisson		
11	Nov. 15		235.95	-	227.45	34½-35	Seams were not encountered below liner, elevation of sound rock established as approx. the bottom of the liner.
12	Nov. 15	Nov. 22	223.54	-	215.54	34½-35	- as above - (See Photograph 11)



TABLE 2

VIDEO INSPECTION RESULTS OF CORED HOLES

Location of Cored Hole	Date of Inspection 1972	Elevation (ft.)		Remarks
		Top of Concrete	Concrete to Rock Inter face	
Bridge 1, Pier E Caisson 5	October 27	Approx. 242	183.55	Good quality concrete above & below the joint in tremie concrete, voids & loose aggregate from El.225 to 222ft. approx. (See Photographs 12, 13, 14 & 15)
Caisson 8	November 11	241.33	195.52	Good quality concrete to El.195.2, small voids at this level, adjacent to steel plate, flow of particles from voids observed. (See Photographs 16 & 17)
Bridge 3, Pier 4 Caisson 1	November 28	Approx. 252	215.24	Good quality concrete & bond with reinforcing to El.214ft. approx. large voids observed from El.215 to 216, frayed reinforcing bars visible, washed concrete with small shale pieces. (See Photographs 18, 19, 20 & 21)
Caisson 6	December 28	Approx. 252	200.34	Cored hole terminated at El.215 approx., on reinforcing steel; washed concrete encountered from 22 to 27 ft, compressive strength test results on core samples from depths of 22, 25 & 27 ft., were 5040, 4560 and 4230 psi respectively. (See Photographs 22, 23 & 24)

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APPENDIX "A"

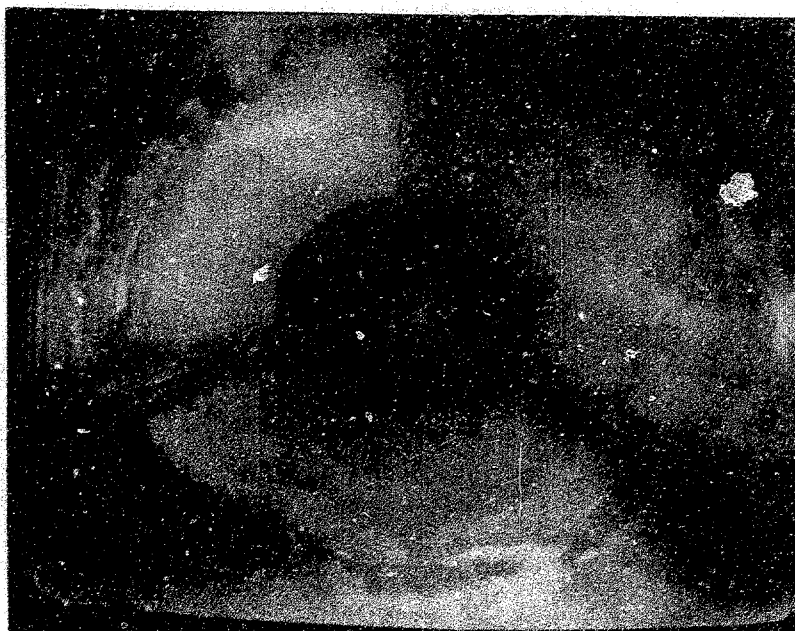
VIDEO INSPECTION OF CAISSONS IN BRIDGE NO.3 AND CORED HOLES

APPENDIX "A"

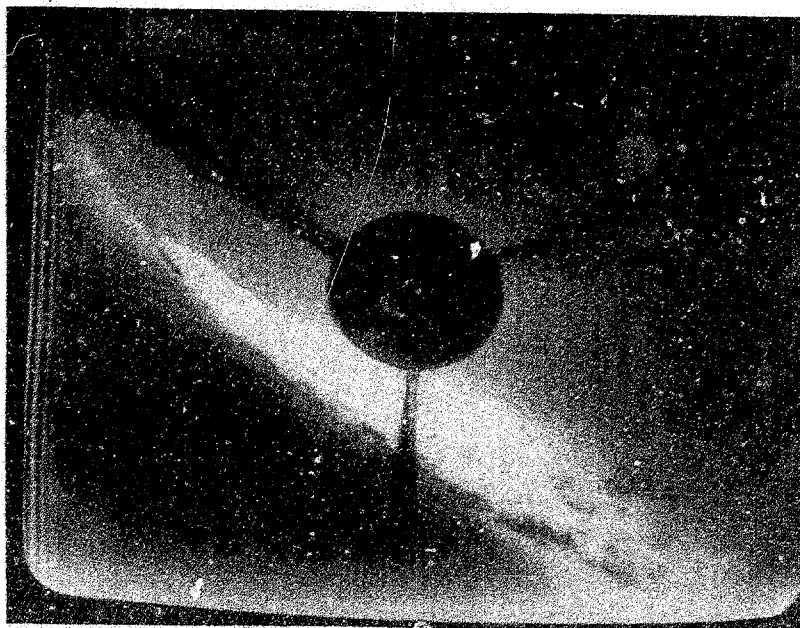
VIDEO INSPECTION OF CAISSONS IN BRIDGE NO. 3 AND CORE HOLES

1. Caissons at Bridge No. 3, Pier No. 4

Photograph #1 Caisson 1, El. 225.5 feet
Axial view of exposed bedrock seam just
below liner.

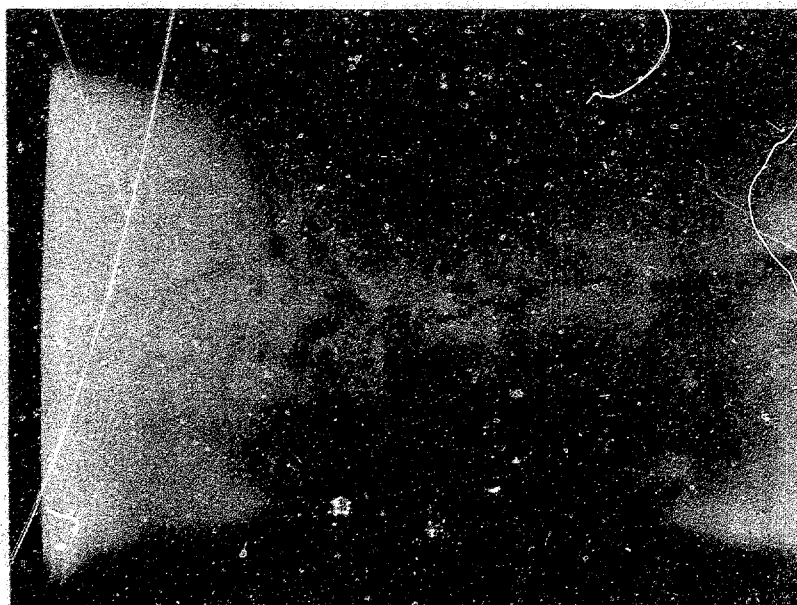
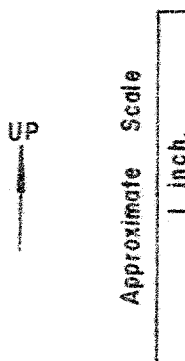


Photograph #2 Caisson 1, El. 225.5 feet
Axial view of rock at bottom of liner indicating
liner virtually flush with socket



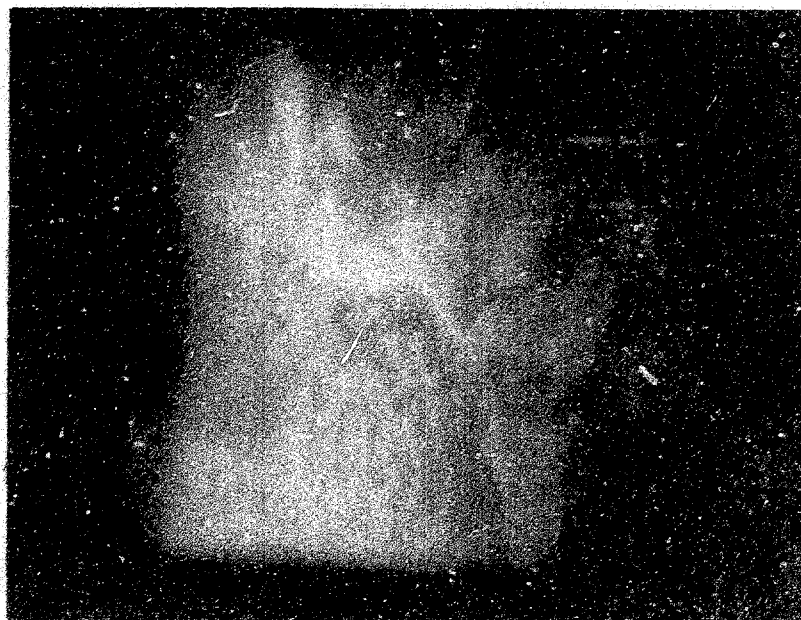
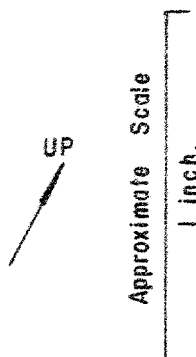
Photograph #3

Caisson 1, El. 225.5 feet
Radial view of seam in bedrock



Photograph #4

Caisson 2, El. 208.46 feet
Radial view of shattered rock





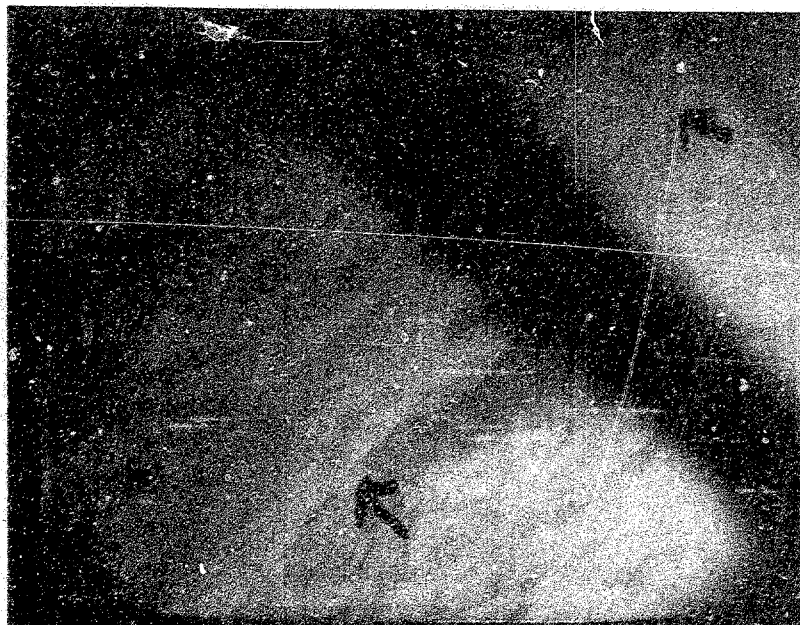
Photograph #5

Caisson 6, El. 209 feet
Radial view of horizontal
crack and seam in bedrock

UP

Approximate Scale

1 inch.



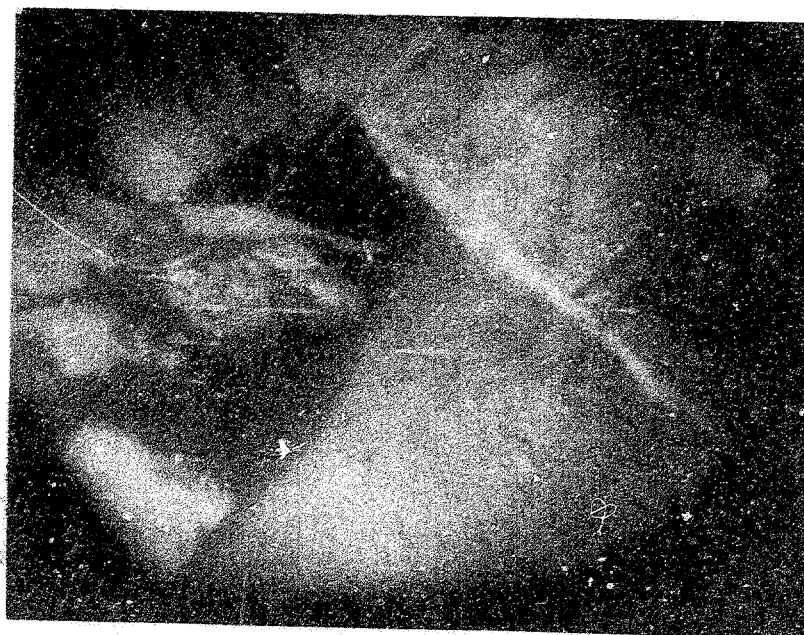
Photograph #6

Caisson 8, El. 217 feet
Broken rock and voids extending
behind the liner

UP

Approximate Scale

1 inch.





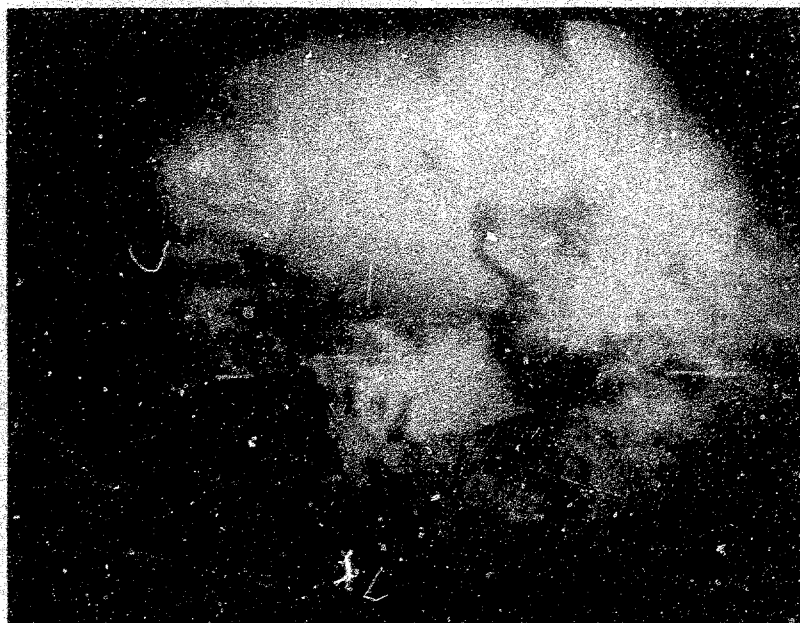
Photograph #7

Caisson 8, El. 216 feet
Radial view of seam filled with soil
and stones (rounded stone visible near
centre of screen)

up

Approximate Scale

1 inch.



Photograph #8,

Caisson 8, El. 215 feet
Radial view of thin soil seam

UP

Approximate Scale

1 inch.



Photograph #9

Caisson 9, El. 236 feet
Radial view at bottom of liner
showing it flush with rock

UP



Approximate Scale

1 inch.



Photograph #10

Caisson 11, El. 236 feet
Radial view of voids behind liner

UP



Approximate Scale

1 inch.





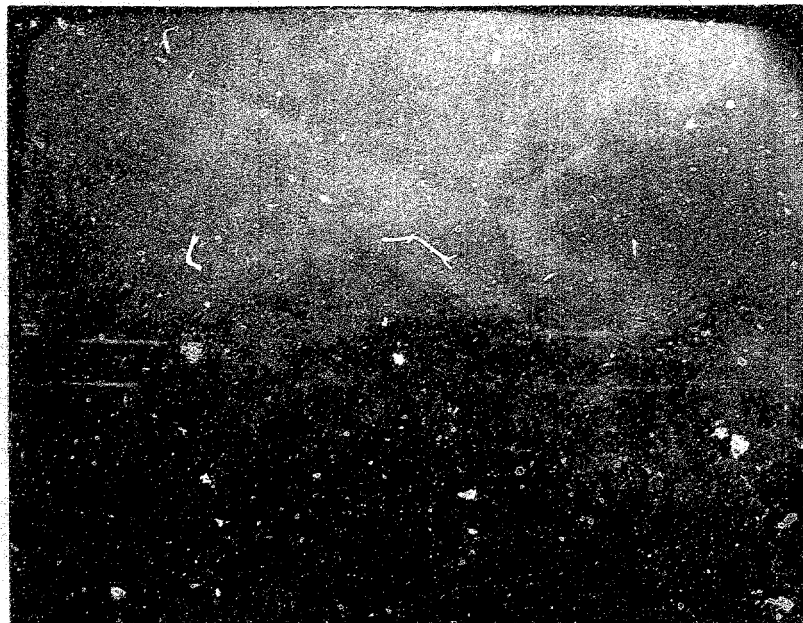
Photograph #11

Caisson 12, El. 215.54 feet
Radial view of sound bedrock at
bottom of caisson



Approximate Scale

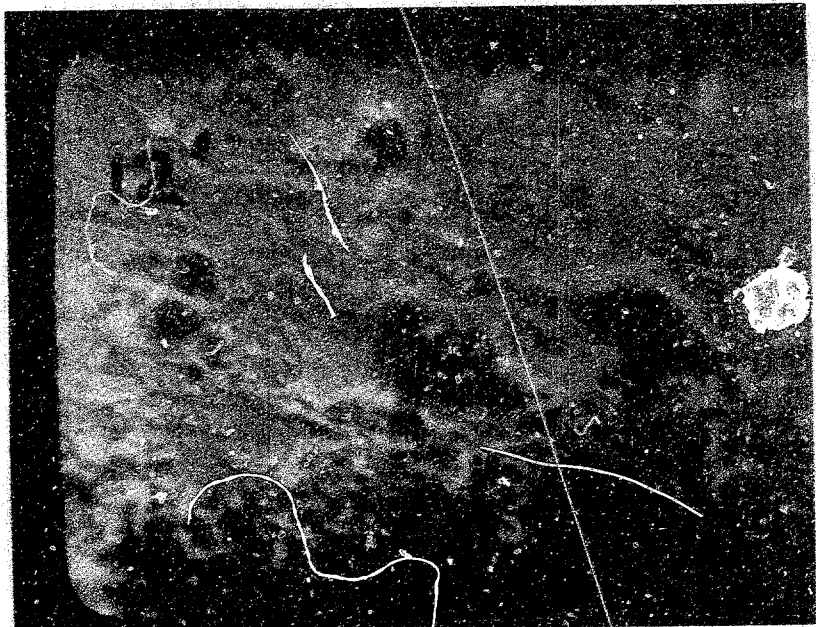
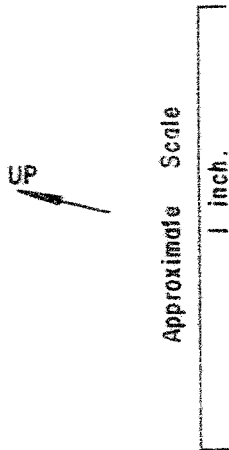
1 inch.



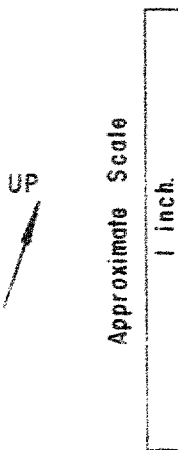


2. Video Inspection Results of Cored Holes at Bridge No. 1, Pier No.E

Photograph #12 Caisson 5, El. 240 feet
Radial view of small voids in concrete

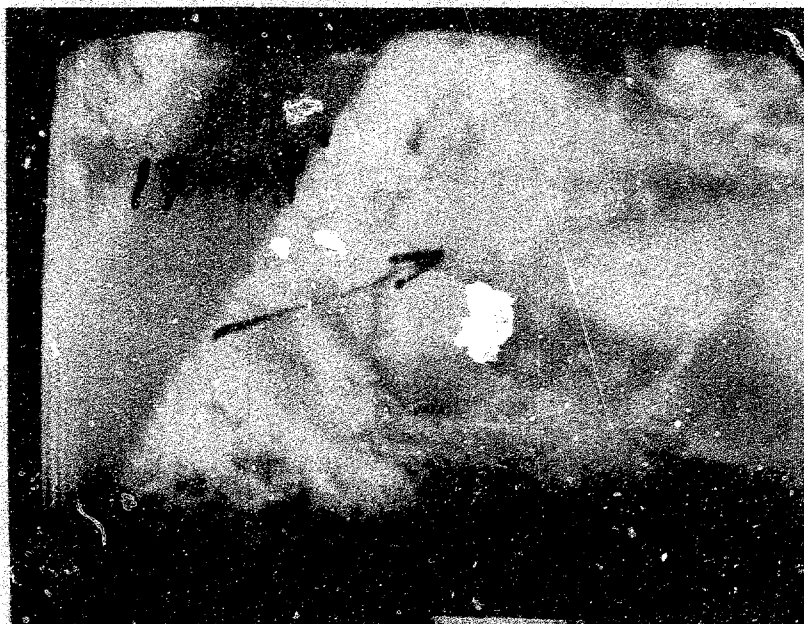
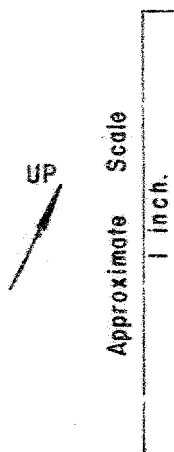


Photograph #13 Caisson 5, El. 234 feet
Radial view of void at top of
tremied concrete



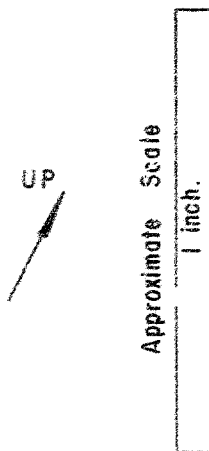
Photograph #14

Caisson 5, El. 234 feet
Radial view of loose aggregate in
void at top of tremied concrete



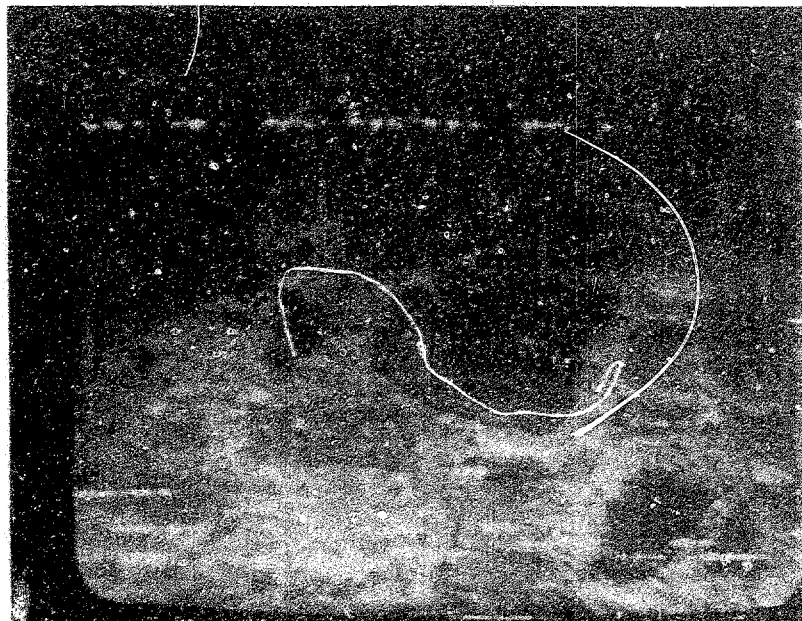
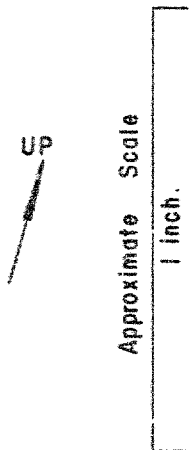
Photograph #15

Caisson 5, El. 232 feet
Radial view of crack in concrete
at edge of void



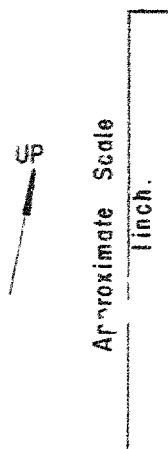
Photographs #16

Caisson 8,
Radial view of typical good quality
concrete



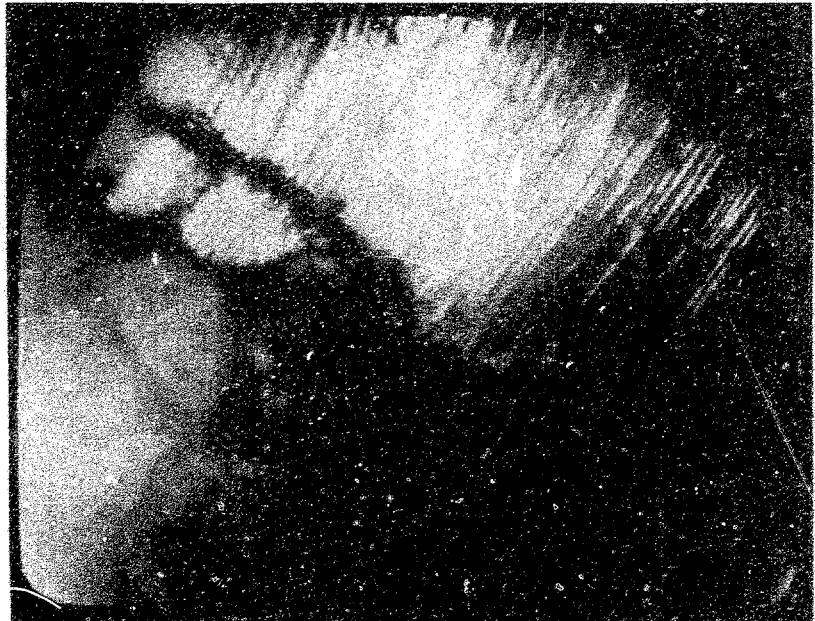
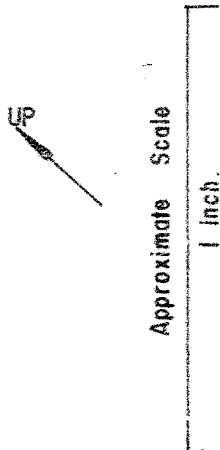
Photograph #17

Caisson 8, El. 195 feet
Radial view of steel plate and plastic
tremie tube cover at concrete to rock
interface

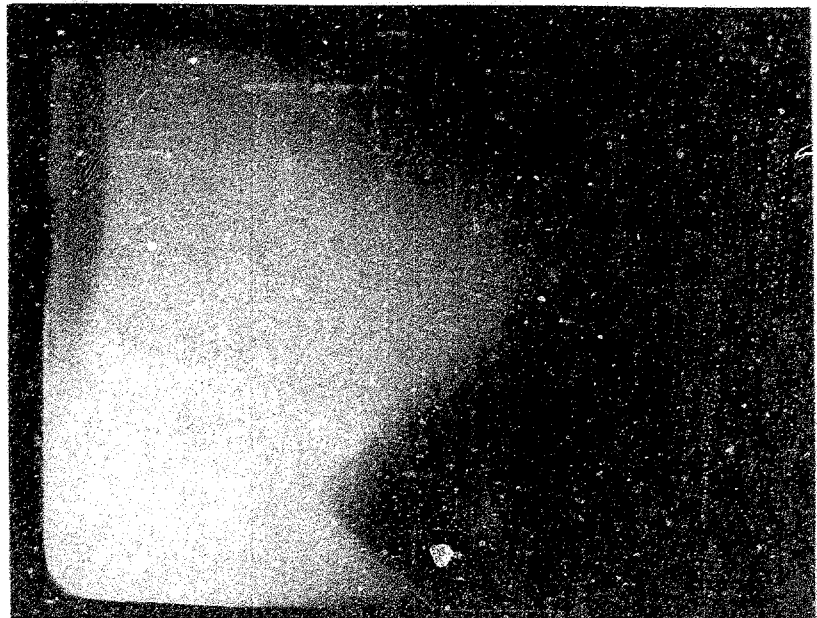
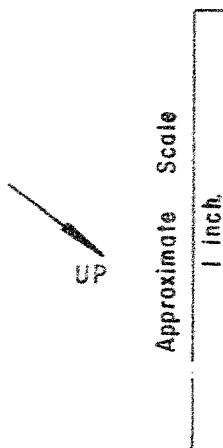


3. Video Inspection Results of Cored Holes at Bridge No. 3 Pier No. 4

Photograph #18 Caisson 1, El. 221 feet
Radial view of reinforcing bar and sound
concrete indicating good bonding



Photograph #19 Caisson 1, El. 215 feet
Radial view of void at concrete to rock
interface focusing on concrete in foreground



Photograph #20

Caisson 1, El. 215 feet
Radial view of loose aggregate in void at
concrete to rock interface

UP 

Approximate Scale

1 inch.



Photograph #21

Caisson 1, El. 215 feet
Radial view of void at concrete to rock
interface focusing on material in foreground

UP 

Approximate Scale

1 inch.



Photograph #22

Caisson 6, 232 feet
Radial view of poorly bonded concrete where
water had gained access to tremie tube

UP

Approximate Scale

1 inch.



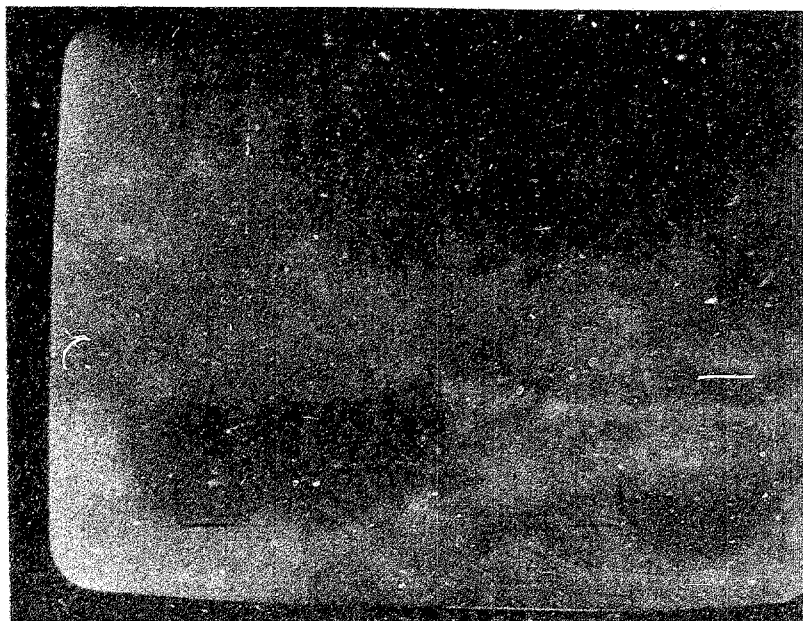
Photograph #23

Caisson 6, El. 231 feet
Radial view of poor quality honeycombed
concrete where water had gained access to
tremie tube

UP

Approximate Scale

1 inch



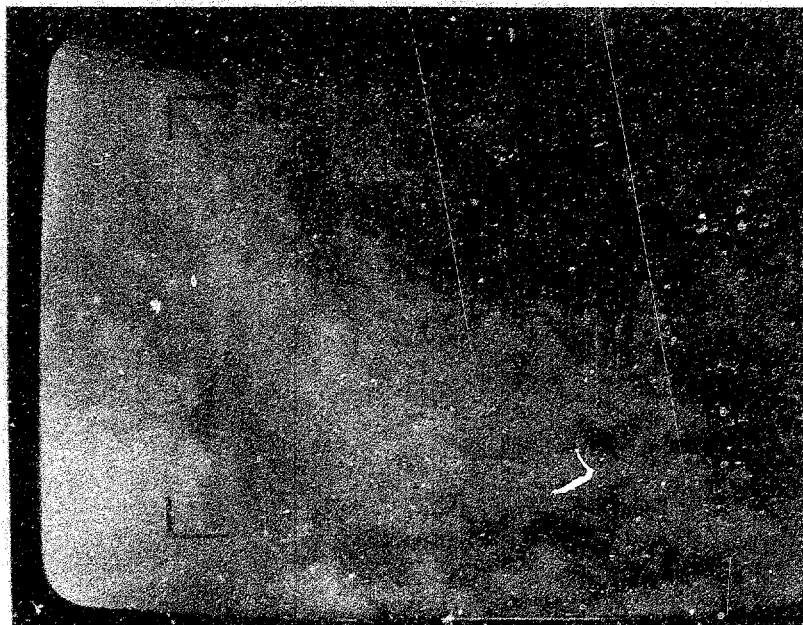
Photograph # 24

Caisson 6, E1.228 feet
Radial view of poor quality honeycombed concrete
where water had gained access to tremie tube
showing tie wire for reinforcing in lower left
hand corner

UP


Approximate Scale

1 inch.





APPENDIX "B"

NOTES ON CAISSON INSPECTION



APPENDIX "B"

NOTES ON CAISSON INSPECTION

Drilled and bored caisson piles are capable of supporting large loads. However, because they are installed by augering or churning techniques, the condition of the bearing stratum should be carefully inspected and tested, if necessary. This is because: (a) unlike the driven pile, there is not a built-in test in the installation procedure; (b) the engineering and churning operations leave ground up and broken soil and rock, which must be cleaned out if intolerable settlements are not to occur; (c) founding in bedrock usually requires that the base of the caisson is out of the range of soft seams; and (d) it can be difficult to place the concrete without cracking, segregation, washing, etc. The degree of inspection and testing is dependent on the intensity of the loading as compared with the ultimate capacity of the bearing stratum, previous experience with the founding material, and installation conditions and procedures. At the least, the caisson should be checked to ensure that all loose or soft material has been removed from it and that the concrete is placed satisfactorily. At the most, it can include extensive load testing and core drilling of the caissons and rock, as well as visual inspection.

The competency of the founding soil or rock must be assessed in relation to the design pressure. If a high bearing pressure is used in comparison with previous design on the same stratum, a load test should be undertaken prior to or during



construction to confirm the capacity of the founding material. The use of high design bearing pressures in bedrock usually requires a thorough examination of the exposed rock in the caisson by direct visual or video techniques, and star drilling below the caisson base and/or extension of selected caissons to determine if compressible seams are present. If more conservative design values are employed, visual examination of the founding material is generally satisfactory, with occasional star drilling to confirm that consistent founding conditions are present.

The base and/or sides of the caisson socket or bell should be inspected to ensure that all the loose soil and rock has been cleaned out. This is generally performed visually, but, if this is not possible, video inspection techniques can be used for the sides of the caisson and probing in the base can indicate the presence of loose material on the base of the caisson. However, if direct visual inspection is not possible, it is preferable to design the caissons for bond or skin friction between the concrete and the sides of the caisson, rather than end-bearing.

The methods of inspection and placement of the concrete are determined by the rate of in-flow of water into the caissons. If there is little flow, the inspection can be visual (assuming that there is sufficient space to lower the inspector) and the concrete can be poured "in the dry". As the flow increases, there becomes a stage at which the inspection can still be visual but the concrete must be poured by "tremie"



methods. Finally, if the caisson cannot be dewatered sufficiently to allow direct visual inspection, video techniques or a diver must be used to examine the bearing stratum and cleanliness of the base and sides.

The concrete must be placed in the caisson to achieve a continuous column of uniform, dense, well compacted material. This can be difficult, as the concrete sometimes has to be dropped to great depths, resulting in segregation, washing of aggregate, etc., unless it is performed with consideration being given to this problem. For instance, the degree of segregation can be minimized by directing the concrete down the centre of the caisson with a short section of tremie tube, so that the concrete will not hit the sides. Tremie pours below water have to be closely supervised to ensure that no water gets into the concrete and that the pour is continuous. If the liner is withdrawn as the concrete is placed, care must be taken that there is neither arching of the concrete nor infiltration of water into it. Additionally, pours should not be stopped at a level at which water pressure on the caissons could cause them to be lifted. For these and other reasons, the placement of the concrete should be supervised closely and the caisson repaired or replaced if not installed satisfactorily.

If there is any doubt about the condition of the concrete, the concrete-bedrock interface or the underlying rock, it may be necessary to load test the caisson and/or core drill it. The main concern about the competency of the caissons is usually caused by the construction



procedure, rather than the competency of the bearing stratum itself. Core drilling can determine whether there might be problems which are indicated by poor recovery at various levels. This can either be taken as proof of unsatisfactory installation, or video inspection techniques can be used to establish the actual conditions, which frequently are not as unacceptable as the core drilling would infer.

There are many potential problems with the installation of caissons, but not all of them are applicable at every site. As a result, the inspection requirements should be determined by the structural and geotechnical engineers at the design stages. They will be controlled by: (a) the pressures on the caissons in relation to the ultimate bearing capacity of the stratum and previous experience with caissons on the particular material; (b) the geotechnical conditions, especially involving the water bearing characteristics of the bearing stratum, the stratigraphy, etc.; (c) the site conditions, including access for equipment; and (d) other related factors. For these reasons it is recommended that the degree and quality of inspection should be determined individually for each project.

Project: H1569/H1533



APPENDIX "C"

CAISSON INSTALLATION REPORTS FOR BRIDGE NOS. 1 AND 3

Project: H1533

1870 Barton Street East
Hamilton 31, Ontario
547-6385
Direct Toronto Line
368-6293

Soil Mechanics
Consultants

W. A. Trow,
M.Sc., M.E.I.C., P.Eng.
K. Peaker,
Ph.D., M.E.I.C., P.Eng.

**William Trow
Associates**



(Hamilton) Ltd.

C. D. Thompson, M.Sc., M.E.I.C., P.Eng.
Manager

Ministry of Transportation and Communications
Box 5020
Burlington, Ontario

November 23, 1972

Caisson Installation
Hamilton Entrance Bridge No. 1, Pier E

Dear Sirs,

The installation of Caissons 1 to 8 inclusive, has been satisfactorily completed. Our inspection of the tremie concrete and the concrete to rock interface in Caissons 5 to 8 is also completed and was carried out using a closed-circuit television camera. The summarized results of the caisson inspection, together with your comments, are presented below.

According to the design concept for the caissons at this site, the load of each caisson was to be carried by end-bearing 5 feet into sound bedrock. The allowable bearing capacity of the sound shale bedrock is 75 tsf. The 5 feet penetration of the socket in the rock provides some additional capacity due to the bond between the rock and the concrete, but this was not allowed for at the design stage, and was to be considered during the inspection only if the allowable load could not be developed in end bearing. Our inspection results have verified that a clean bearing area has been achieved in each caisson and the caisson socket has been extended a

minimum of 5 feet into sound rock. If the measured socket diameter was less than the specified diameter, the socket was extended a few extra feet into sound rock to develop additional bond or skin friction. For instance, in Caisson 3, the diameter of which is 33½ inches, the socket depth was increased to 11 feet to provide 8 feet of sound seamless rock. The upper 3 feet of the socket was fractured and was not considered sound rock. The inspection notes are presented in summarized form on Sheets 1 to 8.

Based upon our inspection of the concrete core samples obtained from Caissons 5 and 8, as well as extensive examination of the concrete in the caissons by means of closed-circuit television, the "tremie" method of placing concrete has apparently been satisfactory for this project and further inspection of the concrete is not warranted.

In Caisson 5, an examination of the interface between the tremie concrete, placed on September 21, 1972, and the upper level of concrete which was placed at a later date, has revealed a significant cavity and washed aggregate in this region. This condition, however, has been rectified by means of pressure grouting. Although very small voids were present at the concrete to rock interface in Caisson 8, they are not significant and are not considered detrimental to the load carrying capability of the caisson.


A detailed report of the closed-circuit television inspection in Caissons 5 and 8 is presently being prepared, and will be forwarded to you as an addendum to this report.


The majority of caissons were poured to approximate Elevation 242 feet, or slightly above the specified cut-off level (i.e., 241.33 feet) to allow for cleaning of the concrete surfaces prior to further construction. In Caissons 1 and 2, a 10 foot length of Number 18 reinforcing bar, which had been spliced to the reinforcing cages for extra length, was evidently pried loose by the tremie pipe during the concrete pour. As a result, eleven Number 18 bars were projecting beyond the concrete, instead of the specified twelve bars. The bridge designer, Mr. F. Gormek was consulted and he requested that one Number 18 reinforcing bar be grouted 3 feet into the concrete in each caisson. This was carried out on November 20, 1972, as required.

Since each caisson is bearing on sound shale bedrock and has 5 feet or more of sound rock in contact with the concrete for additional bearing capacity, it is concluded that each caisson is capable of supporting an applied load of up to 500 tons.

If you have any questions regarding the information contained in this letter, please do not hesitate to contact our office.

Yours very truly,
WILLIAM TROW ASSOCIATES (HAMILTON) LTD.


P.D. Anderson, B.Sc.


C.D. Thompson, P.Egg.

PDA/yyg
Encls.

Dist: Ministry of Transportation
& Communications

(3)

PIER E
CAISSON INSPECTION

REPORT NO: 1

DATE: September 21, 1972

CAISSON NO.	GROUND LEVEL EL.	CUT-OFF ELEVATION		LENGTH TIP TO CUT-OFF	EL. OF TIP	Approx. EL. OF ROCK SURFACE	ACTUAL DEPTH INTO ROCK	SOCKET DIAMETER		PLUMB-NESS	LOCATION ERROR	CORE OR STAR CHECK	CONCRETE SLUMP	REMARKS
		ACTUAL	SPECIFIED					ACTUAL	SPECIFIED					
5	Approx. 250	Approx. 242	241.33	37.53	203.80	218.00	14.20	34	36	1:6 Batter	To be checked by MTC	Cored 43ft. Approx.	Tremie concrete spec. 7" slump 5000 psi Load #1 7yds. Truck #221 Charged 1:25 pm On Site 2:00 pm Poured 2:20 pm Off Site 2:35 pm Test Cylinders 7" Slump 2% Air 78° F Load #2 Truck #207 Charged 3:00 pm On Site 3:30 pm Measured Slump 5½"	Exposed rock below liner 11.61 Reinforcing cage placed Elevation of sound rock 210.00 ft.
NOTES: (1) Delay between first and second concrete trucks was approx. 1 hr. 10 minutes, second truck was sent back by Franki superintendent and concrete pour was terminated (i.e. 28.25 feet of concrete was in the caisson at this time). (2) Remainder of caisson was poured on October 20, 1972, using Truck #325, part of which was used in Caisson No. 8.														

PIER E
CAISSON INSPECTION

REPORT NO: 2

DATE: October 17, 1972

MISSION NO.	GROUND LEVEL EL.	CUT-OFF ELEVATION		LENGTH TIP TO CUT-OFF	EL. OF TIP	Approx. EL. OF ROCK SURFACE	ACTUAL DEPTH INTO ROCK	SOCKET DIAMETER		PLUMB-NESS	LOCATION ERROR	CORE OR STAR CHECK	CONCRETE SLUMP	REMARKS
		ACTUAL	SPECIFIED					ACTUAL	SPECIFIED					
2	Approx. 250	Approx. 242	241.33	66.12	175.21	197.60	22.39	34½	36	1:6 Batter	To be checked by MTC	No	<p>Tremie concrete spec. 7" slump 5000 psi</p> <p>Load #1 Truck #3 Charged 8:32 am On Site 8:55 am Poured 9:33 am Finish Pour 9:55 am</p> <p>Slump 4" Franki Added 12 gal. (Vic Slobodian) 9 yds. Slump 6½" Air 1.4 Temp. 59° F</p> <p>Load #2 Truck #328 8½ yds. Slump 6½" Charged 8:45 am On Site 9:25 am Poured 10:00 am Finish Pour 10:35 am</p>	<p>Exposed rock below liner 8.24</p> <p>Elev. bottom of liner 183.45</p> <p>Reinforcing cage placed</p> <p>Elevation of sound bedrock 183.70 ft</p>
<p>NOTES: (1) Concrete poured to 10' below top of liner (to be cleaned to 10.62 below)</p> <p>(2) Cylinders taken by Red-D-Mix & MTC Load 1 off start of load Load 2 taken during pour Air and slump taken by Red-D-Mix</p> <p>(3) One No.18 reinforcing bar, approx. 10' long, which was spliced at the top of the reinforcing cage was knocked loose during the concrete pour. A No.18 bar must be grouted 3' into the concrete to replace the missing steel.</p>														

CAISSON INSPECTION

DATE: October 17, 1972

PISSON NO.	GROUND LEVEL EL.	CUT-OFF ELEVATION		LENGTH TIP TO CUT-OFF	EL. OF TIP	Approx. EL. OF ROCK SURFACE	ACTUAL DEPTH INTO ROCK	SOCKET DIAMETER		PLUMB-NESS	LOCATION ERROR	CORE OR STAR CHECK	CONCRETE SLUMP	REMARKS
		ACTUAL	SPECIFIED					ACTUAL	SPECIFIED					
1	Approx. 250	Approx. 242	241.33	61.33	180.00	199.00	19.00	34	36	1:6 Batter	To be checked by MTC	No	<p>Tremie concrete spec. 7" slump 5000 psi</p> <p>Load #1 9 yds. Truck #352 Charged 12:50 pm On Site 1:22 pm Poured 1:50 pm Off Site 2:40 pm</p> <p>Measured Slump 7¼" Air 2%</p> <p>Load #2 7½ yds. Truck #293 Charged 1:19 pm On Site 1:50 pm Poured 2:45 pm Off Site 3:10 pm</p>	<p>Exposed rock below liner 7.42</p> <p>Reinforcing cage placed</p> <p>Elevation of sound rock 187.47 ft.</p>
NOTES:		<p>(1) One No. 18 reinforcing bar, approx. 10' long, which was spliced at the top of the reinforcing cage, was knocked loose during the concrete pour. A No. 18 bar must be grouted 3' into the concrete to replace the missing steel.</p>												

PIER E

CAISSON INSPECTION

PROJECT NO: H1533

REPORT NO: 4

INSPECTOR: E. McCall

DATE: October 18, 1972

CAISSON NO.	GROUND LEVEL EL.	CUT-OFF ELEVATION		LENGTH TIP TO CUT-OFF	EL. OF TIP	Approx. EL. OF ROCK SURFACE	ACTUAL DEPTH INTO ROCK	SOCKET DIAMETER		PLUMB-NESS	LOCATION ERROR	CORE OR STAR CHECK	CONCRETE SLUMP	REMARKS
		ACTUAL	SPECIFIED					ACTUAL	SPECIFIED					
3	Approx. 250	Approx. 242	241.33	50.43	190.90	208.75	17.85	33½	36	1:6 batter	To be checked by MTC	No	<p>Tremie concrete spec. 7" slump 5000 psi</p> <p>Load #1 Truck #246 Charged 8:55 am On Site 9:30 am Poured 10:15 am Off Site 10:40 am</p> <p>Measured Slump 6¼" Concrete Temp. 64° F Air Temp. 40° F</p> <p>Load #2 Truck #207 Charged 9:20 am On Site 9:55 am Poured 11:00 am Off Site 11:20 am</p> <p>Measured Slump 6½" Concrete Temp. 65° F Air Temp. 40° F Air 1.3%</p>	<p>Exposed rock below liner 11.18</p> <p>Reinforcing cage placed</p> <p>Elevation of sound rock 199.00 ft.</p>

PIER E

CAISSON INSPECTION

PROJECT NO: H1533

REPORT NO: 5

INSPECTOR: E. McColl

DATE: October 18, 1972

CAISSON NO.	GROUND LEVEL EL.	CUT-OFF ELEVATION		LENGTH TIP TO CUT-OFF	EL. OF TIP	Approx. EL. OF ROCK SURFACE	ACTUAL DEPTH INTO ROCK	SOCKET DIAMETER		PLUMB-NESS	LOCATION ERROR	CORE OR STAR CHECK	CONCRETE SLUMP	REMARKS
		ACTUAL	SPECIFIED					ACTUAL	SPECIFIED					
4	Approx. 250	Approx. 242	241.33	57.78	183.55	202.00	18.45	36	36	1:6 batter	To be checked by MTC	No	<p>Tremie concrete spec. 7" slump 5000 psi</p> <p>Load #1 Truck #328 Charged 12:55 pm On Site 1:30 pm Poured 2:15 pm Off Site 2:35 pm</p> <p>Concrete Temp. 64° F Air Temp. 40° F Measured Slump 7"</p> <p>Load #2 Truck #276 Charged 1:30 pm On Site 2:15 pm Poured 4:40 pm Off Site 3:10 pm</p> <p>Concrete Temp. 65° F Air Temp. 40° F Measured Slump 7"</p>	<p>Exposed rock below liner 5.40</p> <p>Reinforcing cage placed</p> <p>Elevation of sound rock 189.00 ft.</p>

PIER B

CAISSON INSPECTION

PROJECT NO: H1533

REPORT NO: 6

INSPECTOR: E. McCall

DATE: October 19, 1972

CAISSON NO.	GROUND LEVEL EL.	CUT-OFF ELEVATION		LENGTH TIP TO CUT-OFF	EL. OF TIP	Approx. EL. OF ROCK SURFACE	ACTUAL DEPTH INTO ROCK	SOCKET DIAMETER		PLUMB-NESS	LOCATION ERROR	CORE OR STAR CHECK	CONCRETE SLUMP	REMARKS
		ACTUAL	SPECIFIED					ACTUAL	SPECIFIED					
7	Approx. 250	Approx. 242	241.33	35.01	206.32	224.60	18.28	35	36	1:6 batter	To be checked by MTC	No	<p>Tremie concrete spec. 7" slump 5000 psi</p> <p>Load #1</p> <p>9 yds. Truck #325</p> <p>Charged 8:50 am</p> <p>On Site 9:25 am</p> <p>Poured 9:35 am</p> <p>Off Site 10:05 am</p> <p>Concrete Temp. 58° F</p> <p>Air Temp. 46° F</p> <p>Measured Slump 7"</p>	<p>Exposed rock below liner 7.0</p> <p>Reinforcing cage placed</p> <p>Elevation of sound rock 213.32 ft.</p>

PIER E

CAISSON INSPECTION

PROJECT NO: H1533

REPORT NO: 7

INSPECTOR: E. McCall

DATE: October 19, 1972

CAISSON NO.	GROUND LEVEL EL.	CUT-OFF ELEVATION		LENGTH TIP TO CUT-OFF	EL. OF TIP	Approx. EL. OF ROCK SURFACE	ACTUAL DEPTH INTO ROCK	SOCKET DIAMETER		PLUMB-NESS	LOCATION ERROR	CORE OR STAR CHECK	CONCRETE SLUMP	REMARKS
		ACTUAL	SPECIFIED					ACTUAL	SPECIFIED					
6	Approx. 250		241.33	49.28	192.05	211.00	18.95	35	36	1:6 batter	To be checked by MTC	No	<p>Tremie concrete spec. 7" slump 5000 psi</p> <p>Load #1 6½ yds. Truck #276 Charged 12:10 pm On Site 12:50 pm Poured 1:00 pm Off Site 1:12 pm</p> <p>Concrete Temp. 62° F Air Temp. 45° F Air 1.5% Measured Slump 7"</p> <p>Load #2 6½ yds. Truck #214 Charged 12:40 pm On Site 1:17 pm Poured 1:22 pm Off Site 1:40 pm</p> <p>Concrete Temp. 62° F Air Temp. 45° F Measured Slump 7"</p>	<p>Exposed rock below liner 6.1</p> <p>Reinforcing cage placed</p> <p>Elevation of sound rock 197.50 ft.</p>

PIER E

CAISSON INSPECTION

PROJECT NO: H1533

REPORT NO: 8

INSPECTOR: E. McCall

DATE: October 20, 1972

CAISSON NO.	GROUND LEVEL EL.	CUT-OFF ELEVATION		LENGTH TIP TO CUT-OFF	EL. OF TIP	Approx. EL. OF ROCK SURFACE	ACTUAL DEPTH INTO ROCK	SOCKET DIAMETER		PLUMB-NESS	LOCATION ERROR	CORE OR STAR CHECK	CONCRETE SLUMP	REMARKS
		ACTUAL	SPECIFIED					ACTUAL	SPECIFIED					
8	Approx. 250	Approx. 242	241.33	45.81	195.52	219.32	23.80	34½	36	1:6 batter	To be checked by MTC	Cored 53½' approx. using NX casing Concrete quality is very good. 7' of rock core indicates sound rock	Tremie concrete spec. 7" slump 5000 psi Load #1 6½ yds. Truck #221 Charged 1:25 pm On Site 2:00 pm Poured 2:05 pm Off Site 2:20 pm Measured Slump 6½" Load #2 9 yds. Truck #325 Charge 1:45 pm On Site 2:30 pm Poured 2:35 pm Off Site 3:25 pm Measured Slump 7"	Exposed rock below liner 683 Reinforcing cage placed Elevation of sound rock 201.00 ft.

Project: H1569

1870 Barton Street East
Hamilton 31, Ontario
547-6385
Direct Toronto Line
368-6293

Soil Mechanics
Consultants

W. A. Trow,
M.Sc., M.E.I.C., P.Eng.

K. Peaker,
Ph.D., M.E.I.C., P.Eng.

**William Trow
Associates**



(Hamilton) Ltd.

C. D. Thompson, M.Sc., M.E.I.C., P.Eng.
Manager

January 8, 1973

Ministry of Transportation and Communications
Box 5020
Burlington, Ontario

Caisson Installation
Hamilton Entrance Bridge No. 3, Pier 4

Dear Sirs,

The installation of Caissons 1 to 12 inclusive, Hamilton Entrance Bridge No. 3, Pier 4, has been completed. We have inspected the tremie concrete pour for each caisson and have subsequently inspected the quality of the concrete in Caissons 1, 4 and 6, and the concrete to rock interface in Caisson 1, by means of a closed-circuit television camera. The summarized results of the caisson inspection, together with our comments and conclusions, are presented below.

Caissons installed at this site were designed to support an applied load of up to 500 tons by means of an end-bearing pressure on sound shale bedrock. The design bearing pressure of the sound shale bedrock is 75 tsf. In addition, a minimum of 8 feet of sound rock was to be provided below the permanent steel liners. This provided some additional bearing capacity due to the bond between the rock and the concrete. However, for inspection purposes, the full applied load was initially assumed to be carried by means of end bearing, and the additional bearing capacity due to skin friction was to be considered only if the

allowable load could not be developed in end-bearing. Subsequent inspection of the concrete in Caisson 1, which was poured first and cored for general examination purposes, indicated that the effective bearing area in this caisson was reduced to approximately one half, due to poor quality concrete at the outer edge of the concrete to rock interface. Consequently, the bearing pressure on the shale bedrock was approximately 150 tsf. Following discussions with the Bridge Design Office, it was concluded that this caisson and similar caissons could support the design load of 500 tons if the additional bearing capacity due to skin friction between the concrete and sound shale bedrock was considered. The allowable skin friction between the concrete and rock was taken as 100 psi.

The caissons at this site could not be satisfactorily dewatered, due to a high rate of seepage through bedrock fissures. Consequently, hand cleaning of the caisson bases was not possible and inspection of the caissons was carried out by closed-circuit television. Each caisson was also checked for depth and correct batter (i.e., 1 horizontal to 6 vertical) prior to pouring concrete. Our inspection results have indicated that in the centre of each caisson, a reasonably clean bearing surface was achieved by the air-lift method. However, previous experience at Bridge 1 has shown that a 3 to 4 inch wide rim of silt and fine shale pieces remained around the perimeter of each caisson base after air-lifting. At

least 8 feet of sound shale bedrock is exposed below the permanent steel liners in each caisson.

The concrete at this site was placed by the "tremie" method under the supervision of a representative of William Trow Associates (Hamilton) Ltd. A 12 inch diameter pipe with a steel plate at the bottom, fastened and sealed with plastic, was positioned on the base of each caisson. Provided water was not present in the pipe, it was then filled with concrete. A hose attached to the bottom of the tremie pipe supplied a blast of air to send as much of the loose silt material into suspension as possible. The seal on the tremie pipe was then broken to allow the concrete to flow out, displacing water and suspended material. The tremie pipe was embedded at least 5 feet in the concrete at all times and raised gradually as the concrete pour continued. During the pour of Caisson 6, approximately 7 feet of water was found to be in the tremie pipe when the bottom of the pipe was about 12 feet from the ground surface. The pour was completed, although it was decided to core drill the caisson to investigate the possibility of washed concrete. The quantity of concrete for Caisson 4 exceeded by approximately 1-2 yards the amount estimated according to 'mplace measurements. It was decided to core this caisson to investigate the possibility of voids where the concrete may have flowed into large bedrock cavities.

The inspection notes are presented in summarized form on Sheets 1 to 12. In addition, a detailed report of the closed-circuit

television inspection of the caissons is presently being prepared. As requested, general guidelines for caisson inspection will be included with the television report and will be forwarded to you as an Addendum to this letter.

Inspection of the core samples from Caisson 1, at the concrete to rock interface, revealed a red staining of the concrete with shale pieces or washed aggregate. This probably indicates that the concrete mixed with the layer of silt and shale left on the outside of the caisson base. The voids which were visible during the television inspection, was probably the result of the mixture being washed away while diamond drilling. Core samples obtained from Caisson 4 have indicated good quality concrete and the television inspection has confirmed that significant voids are not present in the concrete. In Caisson 6, a slightly washed zone of concrete with partial honeycombing was determined between depths of 21 and 24 feet. Above and below this zone, the concrete was of good quality. Compressive strength tests performed by Construction Testing Services Limited on representative core samples of the washed concrete in this caisson, indicated a strength of 4000 to 5000 psi. Therefore, the concrete is considered capable of carrying the load of the caisson.

Based upon our inspection results, each caisson is considered capable of supporting an applied load of up to 500 tons.

We trust the information contained in this letter is satisfactory for your purposes. If you have any questions about it, please do not hesitate to contact this office.

Yours very truly,
WILLIAM TROW ASSOCIATES (HAMILTON) LTD.



P.D. Anderson, B.Sc.



C.D. Thompson, P.Eng.

PDA/yg

Encls.

Dist: Ministry of Transportation
& Communications

(3)

Site Construction Office
(Attn. Mr. R. Jasper)

(1)

PIER 4

CAISSON INSPECTION

PROJECT NO: H1569

REPORT NO: 1

INSPECTOR: Ed McColl

DATE: November 23, 1972

CAISSON NO.	GROUND LEVEL EL.	CUT-OFF ELEVATION		LENGTH TIP TO CUT-OFF	EL. OF TIP	Approx. EL. OF ROCK SURFACE	ACTUAL DEPTH INTO ROCK	SOCKET DIAMETER		PLUMB-NESS	LOCATION ERROR	CORE OR STAR CHECK	CONCRETE SLUMP	REMARKS
		ACTUAL	SPECIFIED					ACTUAL	SPECIFIED					
1	Approx. 252	Approx. 252	252.0	36.76	215.24	234.94	19.70	34 1/2 - 35"	36	1:6 Batter	To be checked by MTC	Cored approx. 43' using NX casing Concrete quality generally very good Voids at concrete to rock interface Washed aggregate in core Rock is sound	Spec. Tremie Concrete 7" slump, 5000 psi Load 1; 10 yds. Truck #350 Charged: 1:50 On-Site: 2:25 Finished Pour: 3:40 Measured slump 6" Concrete pour approved by V. Slobodian of Franki	Elev. of sound rock 224.13 Reinforcing cage placed Exposed rock below the liner is 10.8

HAMILTON ENTRANCE BRIDGE NO. 3

PIER 4

CAISSON INSPECTION

PROJECT NO: H1569

REPORT NO: 2

INSPECTOR: Ed McGill

DATE: November 30, 1972

CAISSON NO.	GROUND LEVEL EL.	CUT-OFF ELEVATION		LENGTH TIP TO CUT-OFF	EL. OF TIP	Approx. EL. OF ROCK SURFACE	ACTUAL DEPTH INTO ROCK	SOCKET DIAMETER		PLUMB-NESS	LOCATION ERROR	CORE OR STAR CHECK	CONCRETE SLUMP	REMARKS
		ACTUAL	SPECIFIED					ACTUAL	SPECIFIED					
2	Approx. 252	251.96	252.00	52.97	198.99	218.31	19.32	34½"-35"	36	1:6 Batter	To be checked by MTC	No	Spec. Tremie Concrete 7" slump, 5000 psi Load 1; 7 yds. Truck #239 Charged: 9:35 On-Site: 10:30 Finished Pour: 11:00 Estimated Slump 6½" Load 2; 7 yds. Truck #214 Charged: 10:00 On-Site: 10:45 Finished Pour: 11:35 Estimated Slump 6½"	Elev. of sound rock 207.00 Reinforcing cage placed Exposed rock below liner 10.93'

HAMILTON ENTRANCE BRIDGE NO. 3

PIER 4

CAISSON INSPECTION

PROJECT NO: H1569

REPORT NO: 3

INSPECTOR: Ed McColl

DATE: December 1972

CAISSON NO.	GROUND LEVEL EL.	CUT-OFF ELEVATION		LENGTH TIP TO CUT-OFF	EL. OF TIP	Approx. EL. OF ROCK SURFACE	ACTUAL DEPTH INTO ROCK	SOCKET DIAMETER		PLUMB-NESS	LOCATION ERROR	CORE OR STAR CHECK	CONCRETE SLUMP	REMARKS
		ACTUAL	SPECIFIED					ACTUAL	SPECIFIED					
3	Approx. 252	Approx. 252	252.00	36.61	215.39	236.70	21.31	34½-35"	36	1:6 Batter	To be checked by MTC	No	Spec. Tremie Concrete 7" slump, 5000 psi Load 1; 10 yds. Truck #328 Charged: 2:20 On-Site: 3:00 Poured: 3:15 Off-Site: 3:50 Measured slump 6½"	Elev. of sound rock 223.61 Reinforcing cage placed Exposed rock below liner 13.30'

HAMILTON ENTRANCE BRIDGE NO. 3

PIER 4

CAISSON INSPECTION

PROJECT NO: H1569

REPORT NO: 4

INSPECTOR: Ed McCall

DATE: November 30, 1972

CAISSON NO.	GROUND LEVEL EL.	CUT-OFF ELEVATION		LENGTH TIP TO CUT-OFF	EL. OF TIP	Approx. EL. OF ROCK SURFACE	ACTUAL DEPTH INTO ROCK	SOCKET DIAMETER		PLUMB-NESS	LOCATION ERROR	CORE OR STAR CHECK	CONCRETE SLUMP	REMARKS
		ACTUAL	SPECIFIED					ACTUAL	SPECIFIED					
4	Approx. 252	Approx. 252	252.00	52.84	199.16	216.93	17.77	34½-35"	36	1:6 Batter	To be checked by MTC	Cored 46 ft. using NX casing Concrete quality good	Spec. Tremie Concrete 7" slump, 5000 psi Load 1; 7 yds. Truck #317 Charged: 2:35 On-Site: 3:20 Poured: 3:45 Off-Site: 3:55 Estimated slump 6½" Load 2; 7 yds. Truck #239 Charged: 2:59 On-Site: 3:50 Poured: 4:00 Off-Site: 4:15 Measured slump 6 3/4" Load 3, 3 yds. Truck #241 Charged: 4:17 On-Site: 5:00 Off-Site: 5:10 Estimated slump 6½"	Elev. of sound rock 207.00 Reinforcing cage placed Exposed rock below liner 15.25'

- NOTES: 1. Quantity of concrete required, exceeded by approx. 2 yds. The amount estimated according to previous caissons. Caisson was cored, to investigate the possibility of voids where concrete may have flowed into rock fissures.
2. Steel reinforcing encountered at depth 46 feet. Hole terminated at 46 feet on steel reinforcing.

HAMILTON ENTRANCE BRIDGE NO. 3

PIER 4

CAISSON INSPECTION

PROJECT NO: H1569

REPORT NO: 5

INSPECTOR: E. McColl

DATE: December 5, 1972

CAISSON NO.	GROUND LEVEL EL.	CUT-OFF ELEVATION		LENGTH TIP TO CUT-OFF	EL. OF TIP	Approx. EL. OF ROCK SURFACE	ACTUAL DEPTH INTO ROCK	SOCKET DIAMETER		PLUMB-NESS	LOCATION ERROR	CORE OR STAR CHECK	CONCRETE SLUMP	REMARKS
		ACTUAL	SPECIFIED					ACTUAL	SPECIFIED					
5	Approx. 252	Approx. 252	252.00	34.24	217.76	239.50	21.84	34½-35"	36	1:6 Batter	To be checked by MTC	No	Spec. Tremie Concrete 7" slump; 5000 psi Load 1; 9 yds. Truck #350 Charged: 2:40 On Site: 3:20 Poured: 3:30 Off-Site: 4:00 Measured slump 7"	Elev. of sound rock 225.97 reinforcing cage placed Exposed rock below liner 14.60'

PIER 4
CAISSON INSPECTION

REPORT NO: 6

DATE: December 1, 1972

CAISSON NO.	GROUND LEVEL EL.	CUT-OFF ELEVATION		LENGTH TIP TO CUT-OFF	EL. OF TIP	Approx. EL. OF ROCK SURFACE	ACTUAL DEPTH INTO ROCK	SOCKET DIAMETER		PLUMB-NESS	LOCATION ERROR	CORE OR STAR CHECK	CONCRETE SLUMP	REMARKS
		ACTUAL	SPECIFIED					ACTUAL	SPECIFIED					
6	Approx. 252	Approx. 252	252.00	51.66	200.34	218.13	17.69	34½-35"	36	1:6 Batter	To be checked by MTC	Cored 37 ft. using NX casing	Spec. Tremie Concrete 7" slump; 5000 psi Load 1; 7 yds. Truck #237 Charged: 9:25 On-Site 10:00 Poured: 10:30 Off-Site: 11:00 Estimated slump 6½" Load 2; 7 yds. Truck #277 Charged 9:22 On-Site 10:00 Poured: 11:20 Off-Site: 12:00 Estimated slump 6½"	Elev. of sound rock 208.50 Reinforcing cage placed Exposed rock below liner 13.50'
<p>NOTES: 1. Approximately 7 ft. of water was found to be in the tremie pipe when bottom of pipe was approx. 12 ft., from the top of steel liner. It is unknown at what depth the water was first present in the pipe. The water was pumped off, and the concrete pour was completed. The caisson was cored to investigate the possibility of washed aggregate being present.</p> <p>2. Caisson was cored to approximately 37ft. and terminated on a steel reinforcing bar. The concrete was found to be slightly washed from 21 to 24ft. depth and of good quality above and below this level. The concrete was not considered detrimental to the load carrying capability of the caisson. Compressive strength test results on core samples from depths of 22, 25 and 27 feet, were 5040, 4560 and 4230 psi.</p>														

PIER 4

CAISSON INSPECTION

PROJECT NO: H1569

REPORT NO: 7

INSPECTOR: Ed McCall

DATE: December 7, 1972

CAISSON NO.	GROUND LEVEL EL.	CUT-OFF ELEVATION		LENGTH TIP TO CUT-OFF	EL. OF TIP	Approx. EL. OF ROCK SURFACE	ACTUAL DEPTH INTO ROCK	SOCKET DIAMETER		PLUMB-NESS	LOCATION ERROR	CORE OR STAR CHECK	CONCRETE SLUMP	REMARKS
		ACTUAL	SPECIFIED					ACTUAL	SPECIFIED					
7	Approx. 252	Approx. 252	252.00	29.72	222.28	243.06	20.78	34½-35"	36	1:6 Batter	To be checked by MTC	No	Spec. Tremie Concrete 7" slump, 5000 psi Load 1; 8 yds. Truck #325 Charged: 8:35 On-Site: 9:10 Poured: 9:25 Off-Site: 9:50 Measured slump 7"	Elev. of sound rock 230.28 Reinforcing cage placed Exposed rock below liner 13.00'

PIER 4

CAISSON INSPECTION

PROJECT NO: H1569

REPORT NO: 8

INSPECTOR: Ed McCall

DATE: December 5, 1972

CAISSON NO.	GROUND LEVEL EL.	CUT-OFF ELEVATION		LENGTH TIP TO CUT-OFF	EL. OF TIP	Approx. EL. OF ROCK SURFACE	ACTUAL DEPTH INTO ROCK	SOCKET DIAMETER		PLUMB-NESS	LOCATION ERROR	CORE OR STAR CHECK	CONCRETE SLUMP	REMARKS
		ACTUAL	SPECIFIED					ACTUAL	SPECIFIED					
8	Approx. 252	Approx. 252	252.00	46.82	205.18	221.91	16.73	34½-35"	36	1:6 Batter	To be checked by MTC	No	Spec. Tremie Concrete 7" slump, 5000 psi Load 1; 7 yds. Truck #325 Charged: 9:10 On-Site: 9:50 Poured: 10:10 Off-Site: 10:30 Estimated slump 6½" Load 2; 6 yds. Truck #240 Charged: 9:15 On-Site: 9:55 Poured: 11:00 Off-Site: 11:30 Estimated slump 6 3/4"	Elev. of sound rock 212.91 Reinforcing cage placed Exposed rock below liner 12.73'

HAMILTON ENTRANCE BRIDGE NO. 3

PIER 4

CAISSON INSPECTION

PROJECT NO: H1569

REPORT NO: 9

INSPECTOR: Ed McCall

DATE: December 7, 1972

CAISSON NO.	GROUND LEVEL EL.	CUT-OFF ELEVATION		LENGTH TIP TO CUT-OFF	EL. OF TIP	Approx. EL. OF ROCK SURFACE	ACTUAL DEPTH INTO ROCK	SOCKET DIAMETER		PLUMB-NESS	LOCATION ERROR	CORE OR STAR CHECK	CONCRETE SLUMP	REMARKS
		ACTUAL	SPECIFIED					ACTUAL	SPECIFIED					
9	Approx. 252	Approx. 252	252.00	24.74	227.26	245.47	18.21	34½-35"	36	1:6 Batter	To be checked by MTC	No	Spec. Tremie Concrete 7" Slump, 5000 psi Load 1; 6½ yds. Truck #239 Charged: 2:40 On-Site: 3:15 Poured: 3:30 Off-Site: 3:45 Measured slump 6 3/4"	Elev. of sound rock 235.82 Reinforcing cage placed Exposed rock below liner 8.47'

PIER 4

CAISSON INSPECTION

PROJECT NO: H1569

REPORT NO: 10

INSPECTOR: Ed McCall

DATE: December 7, 1972

CAISSON NO.	GROUND LEVEL EL.	CUT-OFF ELEVATION		LENGTH TIP TO CUT-OFF	EL. OF TIP	Approx. EL. OF ROCK SURFACE	ACTUAL DEPTH INTO ROCK	SOCKET DIAMETER		PLUMB-NESS	LOCATION ERROR	CORE OR STAR CHECK	CONCRETE SLUMP	REMARKS
		ACTUAL	SPECIFIED					ACTUAL	SPECIFIED					
10	Approx. 252	Approx. 252	252.00	37.87	214.13	228.50	14.37	34½-35"	36	1:6 Batter	To be checked by MTC	No	Spec. Tremie Concrete 7" slump, 5000 psi Load 1; 10 yds. Truck #328 Charged: 11:50 On-Site: 12:35 Poured: 12:45 Off-Site: 1:10 Estimated slump 6½"	Elev. of sound rock 222.36 Reinforcing cage placed Exposed rock below liner 8.17'

PIER 4

CAISSON INSPECTION

PROJECT NO: H1569

REPORT NO: 11

INSPECTOR: Ed McCall

DATE: December 8, 1972

CAISSON NO.	GROUND LEVEL EL.	CUT-OFF ELEVATION		LENGTH TIP TO CUT-OFF	EL. OF TIP	Approx. EL. OF ROCK SURFACE	ACTUAL DEPTH INTO ROCK	SOCKET DIAMETER		PLUME-NESS	LOCATION ERROR	CORE OR STAR CHECK	CONCRETE SLUMP	REMARKS
		ACTUAL	SPECIFIED					ACTUAL	SPECIFIED					
11	Approx. 252	Approx. 252	252.00	24.55	227.45	247.89	20.45	34½-35"	36	1:6 Batter	To be checked by MTC	No	Spec. Tremie Concrete 7" slump, 5000 psi Load i; 10 yds. Truck #328 Charged: 7:45 On-Site: 8:30 Poured: 8:50 Off-Site: 9:00 Estimated slump 7"	Elev. of sound rock 235.87' Reinforcing cage placed Exposed rock below liner 8.50

PIER 4

CAISSON INSPECTION

PROJECT NO: H1569

REPORT NO: 12

INSPECTOR: Ed McColl

DATE: December 8, 1972

CAISSON NO.	GROUND LEVEL EL.	CUT-OFF ELEVATION		LENGTH TIP TO CUT-OFF	EL. OF TIP	Approx. EL. OF ROCK SURFACE	ACTUAL DEPTH INTO ROCK	SOCKET DIAMETER		PLUMB-NESS	LOCATION ERROR	CORE OR STAR CHECK	CONCRETE SLUMP	REMARKS
		ACTUAL	SPECIFIED					ACTUAL	SPECIFIED					
12	Approx. 252	Approx. 252	252.00	36.46	215.54	233.51	17.97	34½-35"	36	1:6 Batter	To be checked by MTC	No	Spec. Tremie Concrete 7" slump, 5000 psi Load 1; 10 yds. Truck #328 Charged: 10:25 On-Site: 11:05 Poured: 11:15 Off-Site: 11:35 Estimated slump 6½"	Elev. of sound rock 223.54' Reinforcing cage placed Exposed rock below liner 8.00'