PSA

SLOTTED INSERTS

FOR PRE-CAST CONCRETE PANEL CONNECTIONS

PERFORMANCE REPORTS

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Peto MacCallum Ltd.
CONSULTING ENGINEERS

TEST REPORT NO. 1

LOAD TESTS ON

PSA SLOTTED INSERTS

September, 1993

NOTICE

45 Burford Road, Hamilton, Ontario L8E 3C6
Tel: (905) 561-2231 Fax: (905) 561-6363
AURORA, BARRIE, BRAMPTON, HAMILTON, KITCHENER, OSHAWA, TORONTO

PetoMacCallum Ltd.
CONSULTING ENGINEERS

September, 1993

LOAD TESTS ON PSA SLOTTED INSERTS
TEST REPORT NO. 1

INTRODUCTION

The purpose of this test program is to establish the ultimate pull-out capacity of the various inserts developed by Paton Steenson Associates Inc., known as PSA Inserts, for use in precast concrete panel applications.

TEST PANEL

A concrete test panel was constructed into which several different PSA inserts were cast. The details of the test panel are shown on drawing no. 1001, included in Appendix A. This panel was manufactured at the Tri-Krete Plant in Toronto, Ontario as part of a normal days production. Load tests were conducted on the inserts when the test panel was twenty eight days old. The average concrete strength, as determined by concrete test cylinders, was 5249 psi at 14 days and 6279 psi at 28 days. The test panel was not prestressed but was reinforced for handling purposes by a nominal layer of welded wire fabric. No additional reinforcing steel was provided and the wire fabric did not affect the anchorage of the insert in any way. The concrete was cured in a normal manner (not accelerated). Details of the concrete quality control data are included in Appendix A.

TEST METHOD

The test load, in all cases, was applied to the inserts through their normal connection devices using a 30 ton hydraulic ram and hand operated pump. A load cell with a digital readout gauge was used to obtain an accurate direct load measurement. Recent calibration data for the load cell is included in Appendix A.

Figures 1 and 2 illustrate the conventional test arrangement used. A high strength bolt in the load transfer bracket was attached to the heavy duty nut built-into in the insert. In all cases, the load was applied when the nut was located in the center of the insert. All inserts were tested for ultimate pull-out capacity.

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A visual inspection of the pattern of failure cracking was made throughout the tests. The mode of failure was determined, photographed and recorded.

TEST PROGRAM

Inserts were both 4 1/2" and 6" long and either 2 1/2", 3 1/2" or 4 1/2" deep. Heavy duty square nuts are contained within the inserts and a 3/4" high strength bolt, located at the center of each insert, was used for these tests.

All inserts were located away from the edges and corners of the panel as shown on drawing no. 1001, in order to determine the true unreinforced capacity of these inserts.

TEST RESULTS

A table of test results is given in Appendix A.

DISCUSSION

1. In the case of the 2 1/2" deep inserts, the mode of failure was a typical concrete failure cone extending to the full depth of the insert. The average failure load was 13,475 lbs.

2. In the case of the 3 1/2" deep inserts, the mode of failure for two tests was a typical concrete failure cone extending to the full depth of the anchors. The other two tests, produced a typical mechanical failure of the insert lips along the slot.

3. In the case of the 4 1/2" deep inserts, the mode of failure was typically a concrete failure cone type, extending to the full depth of the anchors, except for test No. 9 which cracked the panel due to improper support. In all cases the concrete failure was initiated by the ductile yielding of the insert legs. The average failure load was 21,566 lbs.

CONCLUSIONS AND RECOMMENDATIONS

1. The recommended design ultimate capacity of these inserts is governed by the strength of the concrete failure cone which is a function of the embedded depth of the insert and its anchors when applicable.

2. When used in minimum 5,000 psi concrete with appropriate edge distances, the recommended design ultimate pull-out capacities of these inserts are as follows:

INSERT TYPE	ANCHORAGE DEPTH	AVERAGE FAILURE LOAD	RECOMMENDED DESIGN ULT. CAPACITY
4525	2 1/2"	13,475 lb.	12,000 lb.
6025	2 1/2"	13,475 lb.	12,000 lb.
4535	3 1/2"	18,850 lb.	16,000 lb.
6035	3 1/2"	18,850 lb.	16,000 lb.
4545	4 1/2"	21,566 lb.	20,000 lb.
6045	4 1/2"	21,566 lb.	20,000 lb.

Peto MacCallum Ltd.

Gerry Pacitti, P. Eng.

September 31, 1993

APPENDIX A

1. Table of Test Results.

2. Load Cell Calibration Report.

3. Concrete Cylinder Test Report.

4. Photographs - Figs. 1 through 6 incl.

5. Test Set Up - Fig. 7.

6. Drawing No. 1001 - Test Panels.

7. Data Sheet for PSA Inserts.

TEST RESULTS

PSA SLOTTED INSERTS - TEST REPORT NO. 1

INSERT TYPE	TEST NUMBER	INSERT LOCATION	EXTRA REINF.	BOLT LOCATION	FAILURE LOAD (lbs)	REMARKS
2 1/2" INSERTS (Rated - 12 Kips Ultimate)						
6025	1	Internal	None	Center	12,500	Typ.concrete cone Insert Intact
6025	3	Internal	None	Center	14,400	Typ. concrete cone Insert Intact
4525	2	Internal	None	Center	12,600	Typ. concrete cone Insert Intact
4525	4	Internal	None	Center	14,400	Typ. concrete cone Insert Intact
3 1/2" INSERTS (Rated - 16 Kips Ultimate)						
6035	5	Internal	None	Center	18,800	Typ. concrete cone Insert wings bent
6035	7	Internal	None	Center	18,800	Insert lips failed
4535	6	Internal	None	Center	18,900	Insert lips failed
4535	8	Internal	None	Center	18,900	Typ. concrete cone Insert wings bent
4 1/2" INSERTS (Rated - 20 Kips Ultimate)						
6045	9	Internal	None	Center	19,900*	Cracked test panel
6045	11	Internal	None	Center	23,200	Test bolt failed
4545	10	Internal	None	Center	21,600	Typ. concrete cone Insert wings bent
4545	12	Internal	None	Center	19,900	Typ. concrete cone Insert wings bent

* Disregard this test result (cracked panel)

CALIBRATION CHART

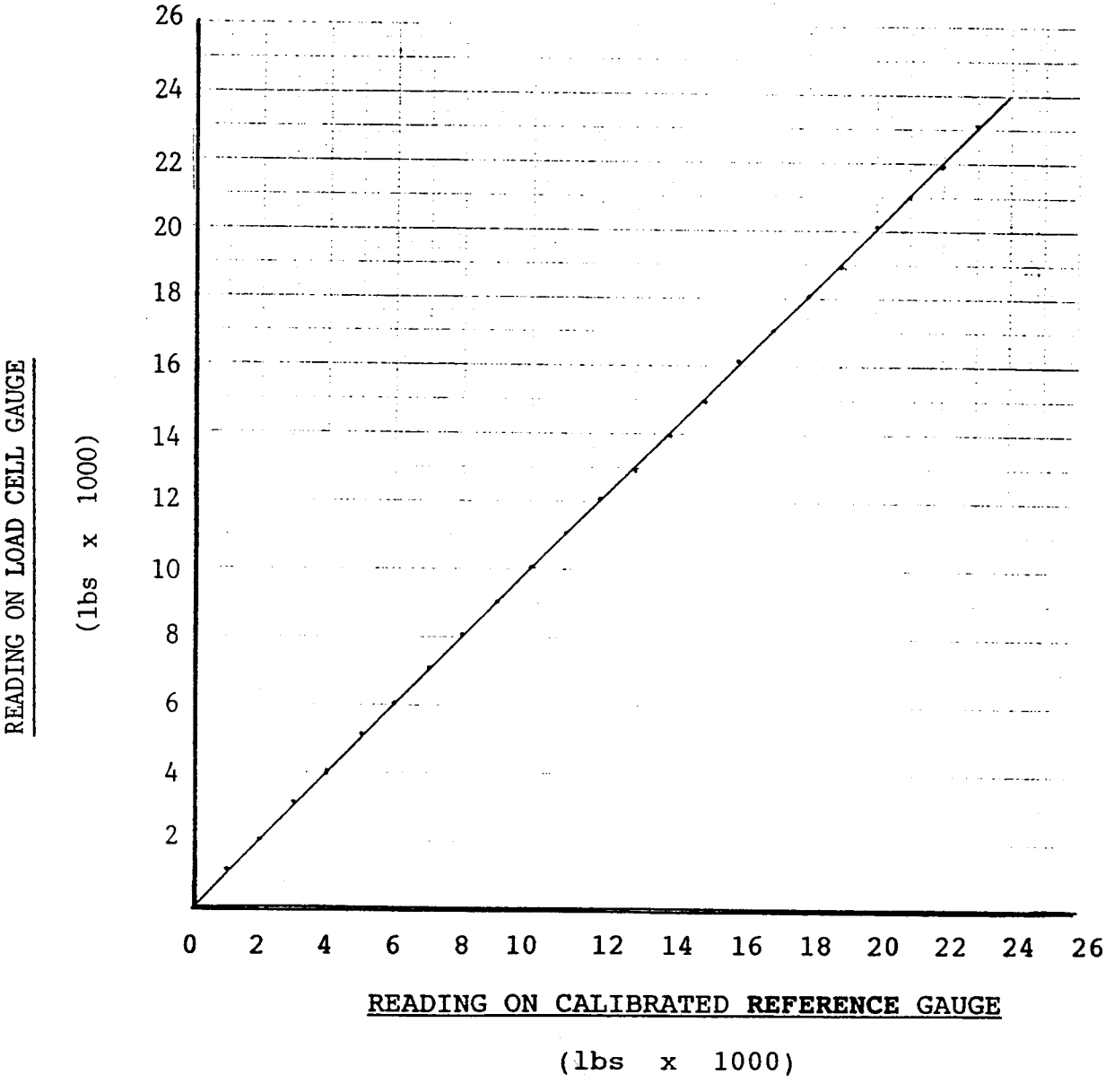
For

- STRAINSERT UNIVERSAL FLAT LOAD CELL
  MODEL FL25U(C) S/N 08908-2

Coupled with

- DORIC TRANSDUCER INDICATOR S/N 400236

DATE: September 3, 1993



CONSTRUCTION CONTROL GROUP
CONSULTING ENGINEERS

CONCRETE CYLINDER COMPRESSIVE STRENGTH TEST REPORT

Job Code: 8021 Project No.: Laboratory Job: 2634

Cylinder No.	Date Cast	Date Received in Lab	Date Tested	Curing	Density (kg / m³)	Specified 28 Day Strength (MPa)	7 Day Strength (MPa)	28 Day Strength (MPa)	Day Strength (MPa)
A	21JUL93	26JUL93	28JUL93	LAB	189	5000	4394		
B	21JUL93	26JUL93	04AUG93	LAB	190	5000		14 DAY	5249
C	21JUL93	26JUL93	18AUG93	LAB	190	5000		6279	

Contractor: N/A

Project: PSA

Location on Structure: N/A

Concrete Supplier: Tri-Krete **Plant:**

Cylinders Cast By: F. Bertolo **Representing:** Tri-Krete

Time Mixer Charged: 11:00 **Time Cylinders Cast:** 11:15

Specified Slump (mm): N/R **Measured Slump (mm):** see below

Temp. of Concrete (°C): see below **Air Temperature (°C):** see below

Specified Air (%): 5.0 **Measured Air (%):** 5.6

Water Added on the Job (litres): None **By What Authority:** N/A

Type of Mould Used: Plastic **Load No.:** N/R

Nom. Size of Agg. (mm): see below **Truck No.:** N/R

Type of Admixture: MBVR Rheobuild **Ordered 28 Day Strength (MPa):** see specified

Initial 24 Hour Curing Temp. (°C): **Maximum:** N/A **Minimum:** N/A

REMARKS:

Nominal size of aggregate = 3/8 ins.
Measured Slump = 3.3 ins.
Air Temp. (F°) = 75
Temp of Concrete (F°) = 70

All strengths are in psi.
All densities are in lb/ft^3

We hereby certify testing in accordance with CAN 3-A23. 2-M90 for that portion of the test performed by this company

DISTRIBUTION:

2 Tri-Krete Attn: Mr. E. Romanin
1 Paton, Steenson & Assoc. Attn: Mr. Don Paton, P.Eng.

Construction Control Group

CONSTRUCTION CONTROL (1987) LIMITED
100 SPY COURT, MARKHAM, ONTARIO L3R 5H6 TEL: (416) 479-9770 FAX: (416) 479-7579

PHOTOGRAPHS

Fig. 1 Test Panel - Test Apparatus

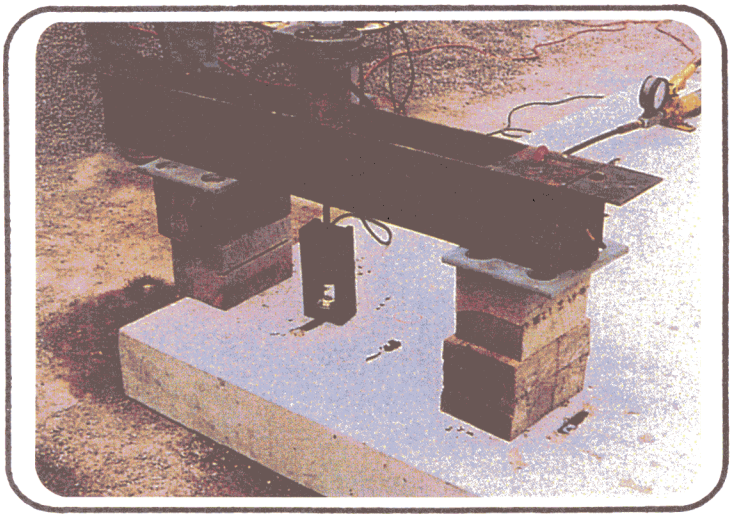


Fig. 2 Test Set Up - Test No. 1

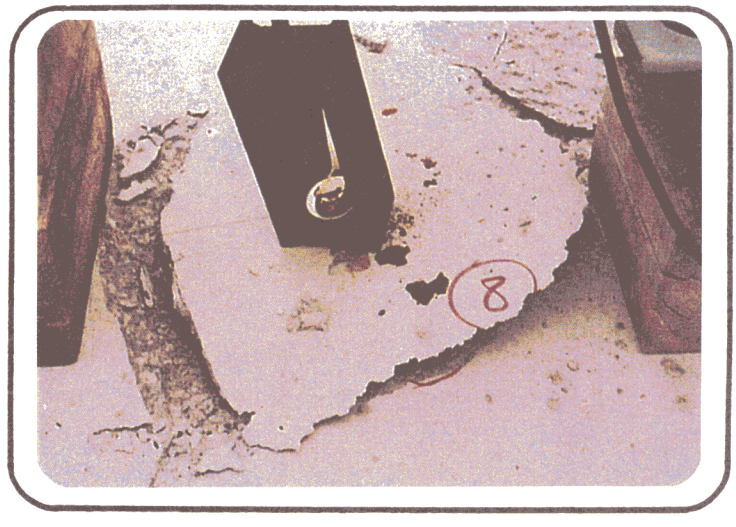


Fig. 3 4 1/2" x 3 1/2" Insert - 18,900 lbs.
Typical concrete cone failure.

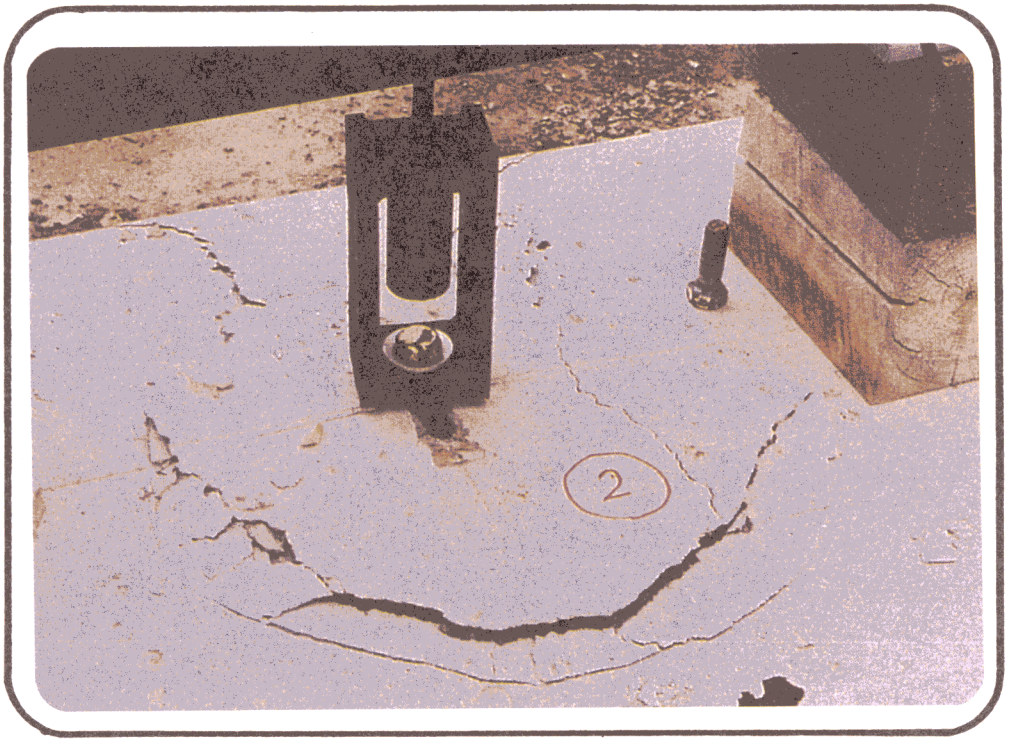


Fig. 4 4 1/2" x 2 1/2" Insert - 14,400 lbs.
Typical concrete cone failure.

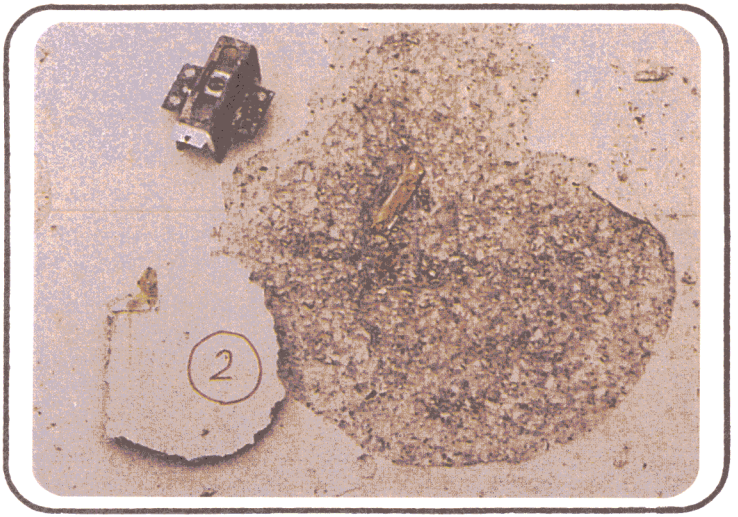
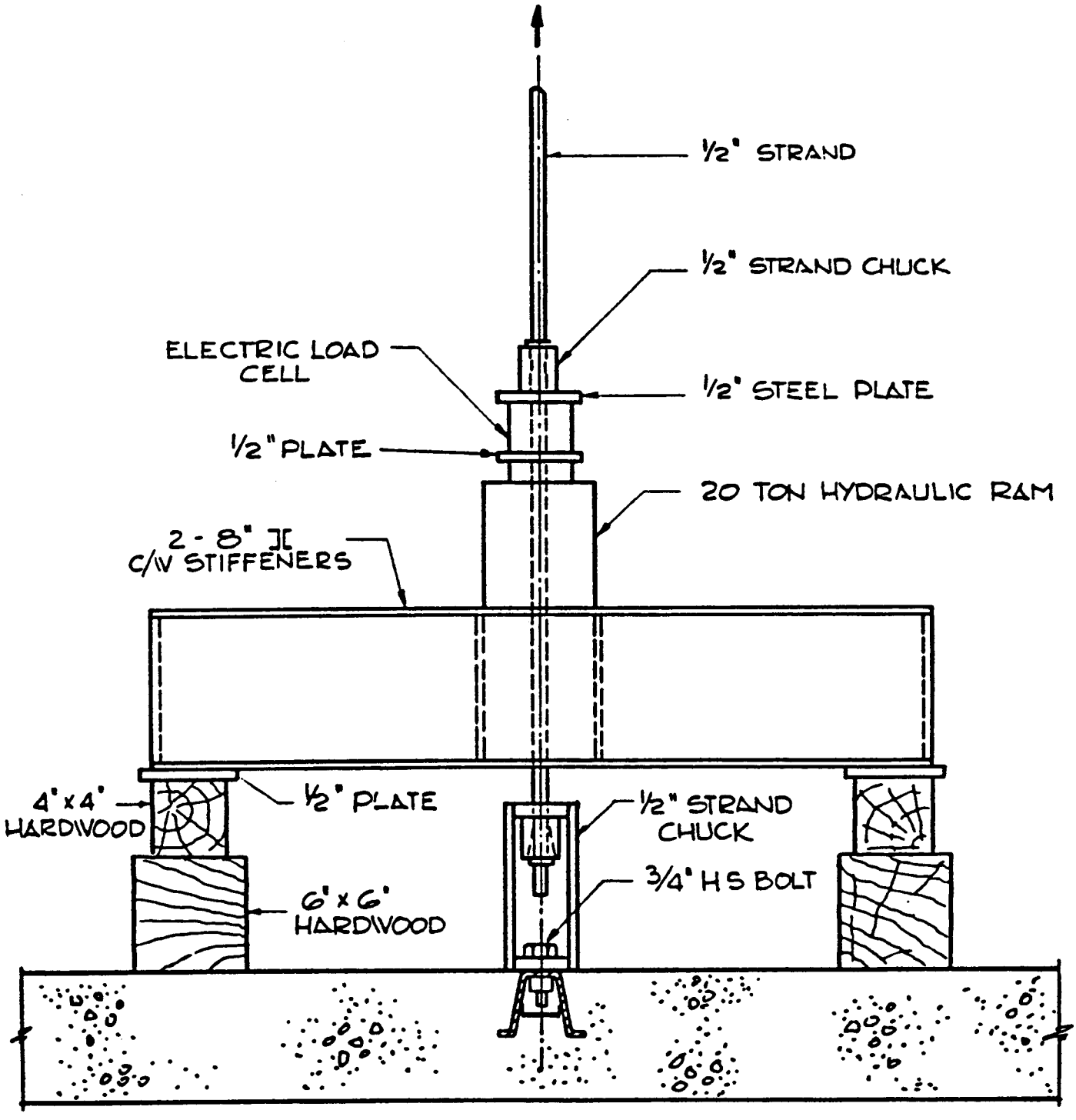


Fig. 5 4 1/2" x 2 1/2" Insert - 14,400 lbs.
Concrete cone extends to base of insert

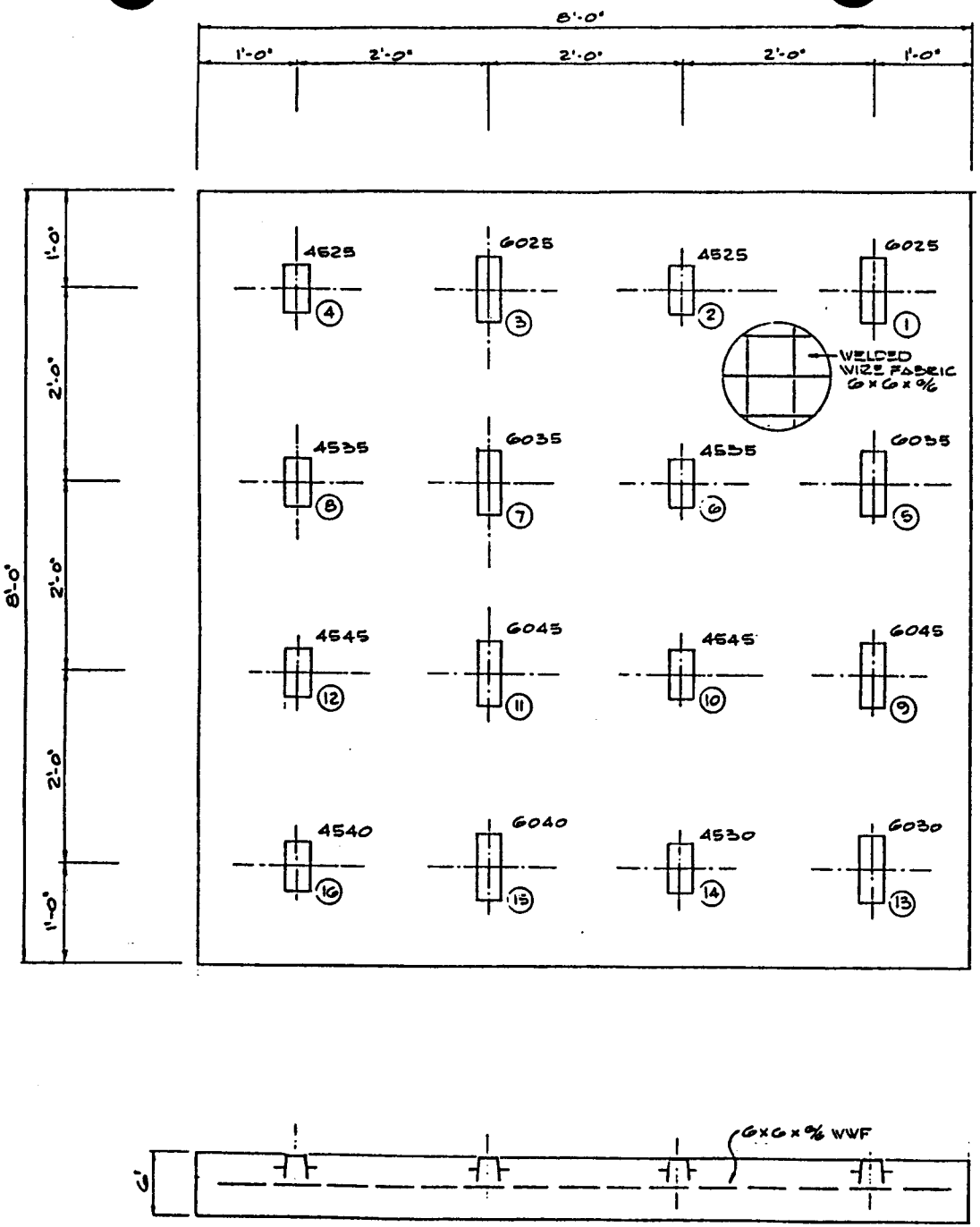
Fig. 6 6" x 3 1/2" Insert - Lips
deformed at 18,800 lbs.



TEST SET-UP

FOR PULLOUT TESTS

FIG. 7



INSERT DESCRIPTION

TEST PANEL NO. 1

1	6025	6" x 2½"	
2	4525	4½" x 2½"	
3	6025	6" x 2½"	
4	4525	4½" x 2½"	
5	6035	6" x 3½"	
6	4535	4½" x 3½"	
7	6035	6" x 3½"	
8	4535	4½" x 3½"	
9	6045	6" x 4½"	
10	4545	4½" x 4½"	
11	6045	6" x 4½"	
12	4545	4½" x 4½"	
13	6030	6" x 3"	
14	4530	4½" x 3"	
15	6040	6" x 4"	
16	4540	4½" x 4"	

NOTES.

CONCRETE STRENGTH AT TIME OF TEST = 6270 psi

TESTED AT TRIKRETE PLANT TORONTO, ONTARIO

DATE	ISSUE	REV.No.	DESCRIPTION	CHECK

PSA PATON STEENSON ASSOCIATES INC
10 Royal Orchard Blvd.
P.O. Box #53000
THORNHILL, ONT. L3T 7N9

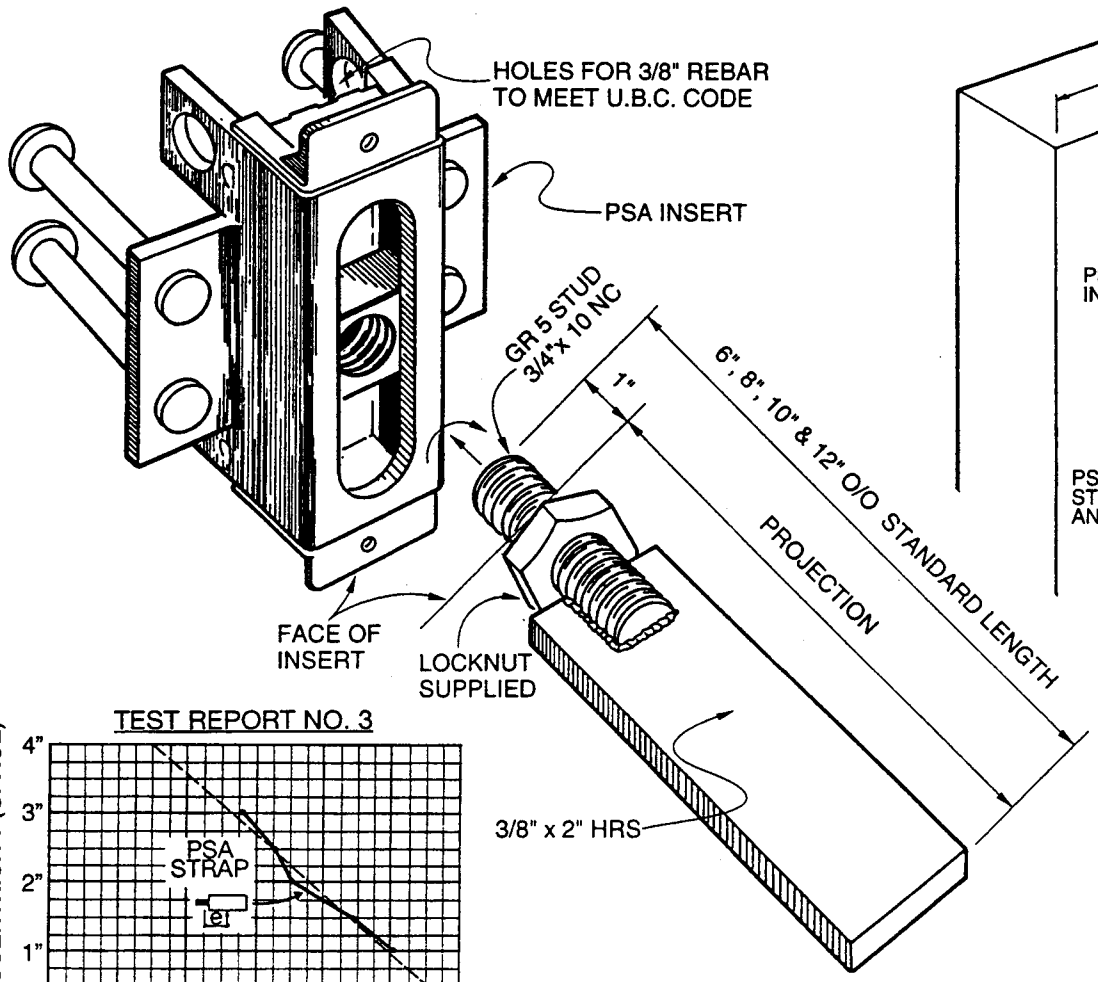
JOB

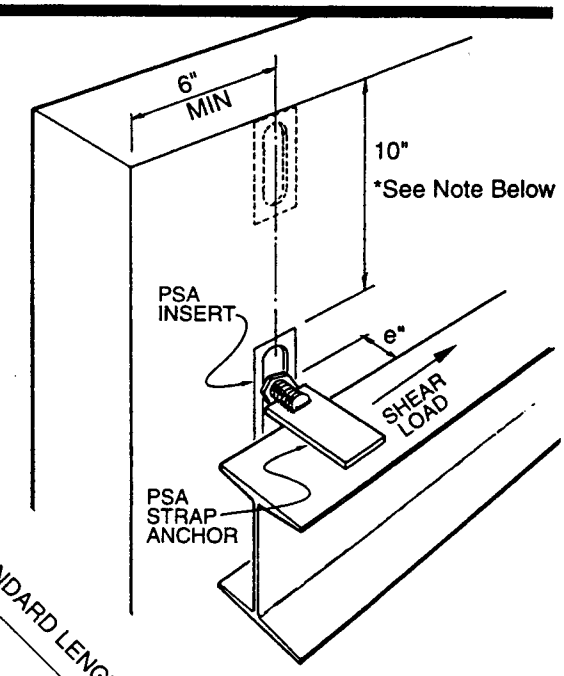
DETAIL

PSA TEST PANEL NO. 1

DETAIL No.	DRAWN BY ER.	DATE SEPT. 93
DET. REF.	CHECKED BY	REVISION
	DRAWING No. 1001	

PSA STRAP ANCHORS





Note:
* Reduce Ultimate Load by 25% if Insert Placed at Top Edge of Panel. (Test Report No. 2)

FEATURES:

• Ultimate Pull-out Capacity

Strap Anchors Develop full Ultimate Capacity of the insert

Insert Type	Depth	Length	Ult. Pull-Out Capacity
4525	2 1/2"	4 1/2"	12,000 lbs
6025		6"	
4535	3 1/2"	4 1/2"	16,000 lbs
6035		6"	
4545	4 1/2"	4 1/2"	20,000 lbs
6045		6"	

Ultimate Pull-Out Capacity Based on Tests Performed in 5,000 psi Normal Weight Concrete (Refer to PSA Test Report No.1)

• Ultimate Shear Capacity

20,350 lbs. at 1" Eccentricity (See Graph Above)
Ult. Shear Capacity based on Tests Performed in 6,000 psi Normal Weight Concrete (Refer to PSA Test Report No. 3)

• Standard Strap Anchor Lengths

6", 8", 10" & 12" Out/Out

• **Available Finishes** – Epoxy or Hot Dipped Galvanized. (Stainless Steel available on Special Order)

• **Material** – High Strength weldable grade HRS Steel

• **Lock Nut** – Ensures Positive Connection in Both Directions

In the U.S.A. JVI In Canada PSA

ACCESSORIES, INC.
7550 North Linder Avenue
Skokie, Illinois 60077 USA
705/675-1560 Fax: 708/675-0083

PATON STEENSON ASSOC. INC.
10 Royal Orchard Blvd. P.O. Box #53009
Thornhill, Ontario L3T 7R9
905/889-7357 Fax: 905/889-7648

Peto MacCallum Ltd.
CONSULTING ENGINEERS

TEST REPORT NO. 2

LOAD TESTS ON

PSA SLOTTED INSERTS

Inserts Located at Edge of Panel

September, 1993

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Peto MacCallum Ltd.
CONSULTING ENGINEERS

September, 1993

LOAD TESTS ON PSA SLOTTED INSERTS
TEST REPORT NO. 2

Introduction

The purpose of this limited test program is to determine how the ultimate pull-out capacity of various PSA Slotted Inserts is affected when the inserts are placed at the edge of a precast concrete panel without any additional steel reinforcement.

TEST PANEL

A concrete test panel was constructed into which several PSA inserts were cast. The details of the test panel are shown on Drawing No.1002, included in Appendix A. This panel was manufactured at the Tri-Krete plant in Toronto as part of a normal days production. Load tests were conducted on the inserts when the panel was twenty eight days old. The average concrete strength, as determined by concrete test cylinders, was 5017 psi at 14 days and 5351 psi at 28 days. The test panel was not prestressed but was reinforced for handling purposes with a nominal layer of welded wire fabric. The inserts were placed at, and perpendicular to the edges of the panel. No additional reinforcing steel was placed in or around these inserts. The concrete was cured in a normal manner (not accelerated). Details of the concrete quality control data are included in Appendix A.

TEST METHOD

The test load, in all cases, was applied to the inserts through their normal connection devices using a 30 ton hydraulic ram and hand operated pump. A load cell with a digital readout gauge was used to obtain an accurate direct load measurement. Recent calibration data for the load cell is included in Appendix A.

Figure 6 illustrates the conventional test arrangement used. A high strength bolt in the load transfer bracket was attached to the heavy duty nut built-into the insert. In all cases the load was applied when the nut was located in the center of the insert. All inserts were tested for ultimate pull-out capacity.

A visual inspection of the pattern of failure cracking was made throughout the tests. The mode of failure was determined, photographed and recorded.

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TEST PROGRAM

Inserts were both 4 1/2" and 6" long and either 2 1/2", 3 1/2" or 4 1/2" deep. Heavy duty square nuts were contained within the inserts and a 3/4" high strength bolt, located at the center of each insert, was used for these tests.

All of these inserts were located along the sides of the panel, away from the corners, but at, and perpendicular to the edges of the panel as shown on Drawing No.1002. No additional reinforcing steel was provided around or through the inserts so that the true unreinforced pull-out capacity of these edge-placed inserts could be determined.

TEST RESULTS

A table of test results is given in Appendix A.

DISCUSSION

1. In all cases, the mode of failure was a typical concrete failure cone extending to the full depth of the insert (and/or anchor) except that the diameter of the cone was somewhat reduced since the inserts were placed at the edge of the panel.

2. All inserts remained intact within the concrete cone. None of these inserts yielded.

3. The pull-out capacity of these edge-located inserts was reduced because of the reduced size of the failure cone. For the 2 1/2" inserts, the capacity was reduced about 20%, for the 3 1/2" inserts, about 25% and for the 4 1/2" inserts, about 27% below the capacities achieved in Test Report No. 1. where recommended edge distances were maintained.

CONCLUSIONS AND RECOMMENDATIONS

1. The capacity of these inserts is governed by the strength of the concrete failure cone which in turn is a function of the embedded depth of the insert, the tensile strength of the insert and the diameter of the failure cone.

2. The diameter of the failure cone is substantially reduced when inserts are placed at the edge of a panel. Other test programs may show that the full capacity of these inserts can be developed if additional reinforcing steel is used to compensate for the reduced size of the shear cone.

3. We do not recommend installing the inserts at edge distances less than recommended. These tests were conducted only to illustrate the consequences of not providing adequate edge distances or additional reinforcing steel to strengthen the smaller shear cone.

4. When compared to the results from Test Report No.1, it can be seen that the ultimate pull-out capacities of the same inserts are reduced by 20% to 27% when the inserts are located at the edge of a panel as follows:

INSERT DEPTH	AVE.TEST RESULTS INSERTS NOT LOCATED AT EDGE OF PANEL (TEST REPORT NO.1)	AVE.TEST RESULTS INSERTS LOCATED AT EDGE OF PANEL (TEST REPORT NO.2)
2 1/2"	13,475 lbs.	10,850 lbs.
3 1/2"	18,850 lbs.	14,150 lbs.
4 1/2"	21,566 lbs.	15,800 lbs.

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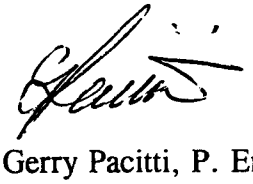


Gerry Pacitti, P. Eng.

September 31, 1993

APPENDIX A

1. Table of Test Results.

2. Load Cell Calibration Report.

3. Concrete Cylinder Test Report.

4. Photographs - Figs. 1 through 5 incl.

5. Test Set Up - Fig. 6.

6. Drawing No. 1002 - Test Panels.

7. Data Sheet for PSA Inserts

TEST RESULTS

PSA INSERTS - TEST REPORT NO. 2

ALL INSERTS LOCATED AT EDGE OF PANEL

INSERT TYPE	TEST NUMBER	INSERT TYPE	EXTRA REINF.	BOLT LOCATION	FAILURE LOAD (lbs)	REMARKS
2 1/2" INSERTS - (Rated 12 Kips Ultimate)						
6025	1	Perp to edge	None	Center	12,200	Concrete failed Insert intact
4525	2	Perp to edge	None	Center	11,500	Concrete failed Insert intact
3 1/2" INSERTS - (Rated 16 Kips Ultimate)						
6035	12	Perp to edge	None	Center	14,500	Concrete failed Insert intact
4535	5	Perp to edge	None	Center	13,800	Concrete failed Insert intact
4 1/2" INSERTS - (Rated 20 Kips Ultimate)						
6045	14	Perp to edge	None	Center	17,500	Concrete failed Insert intact
4545	15	Perp to edge	None	Center	14,100	Concrete failed Insert intact

CALIBRATION CHART

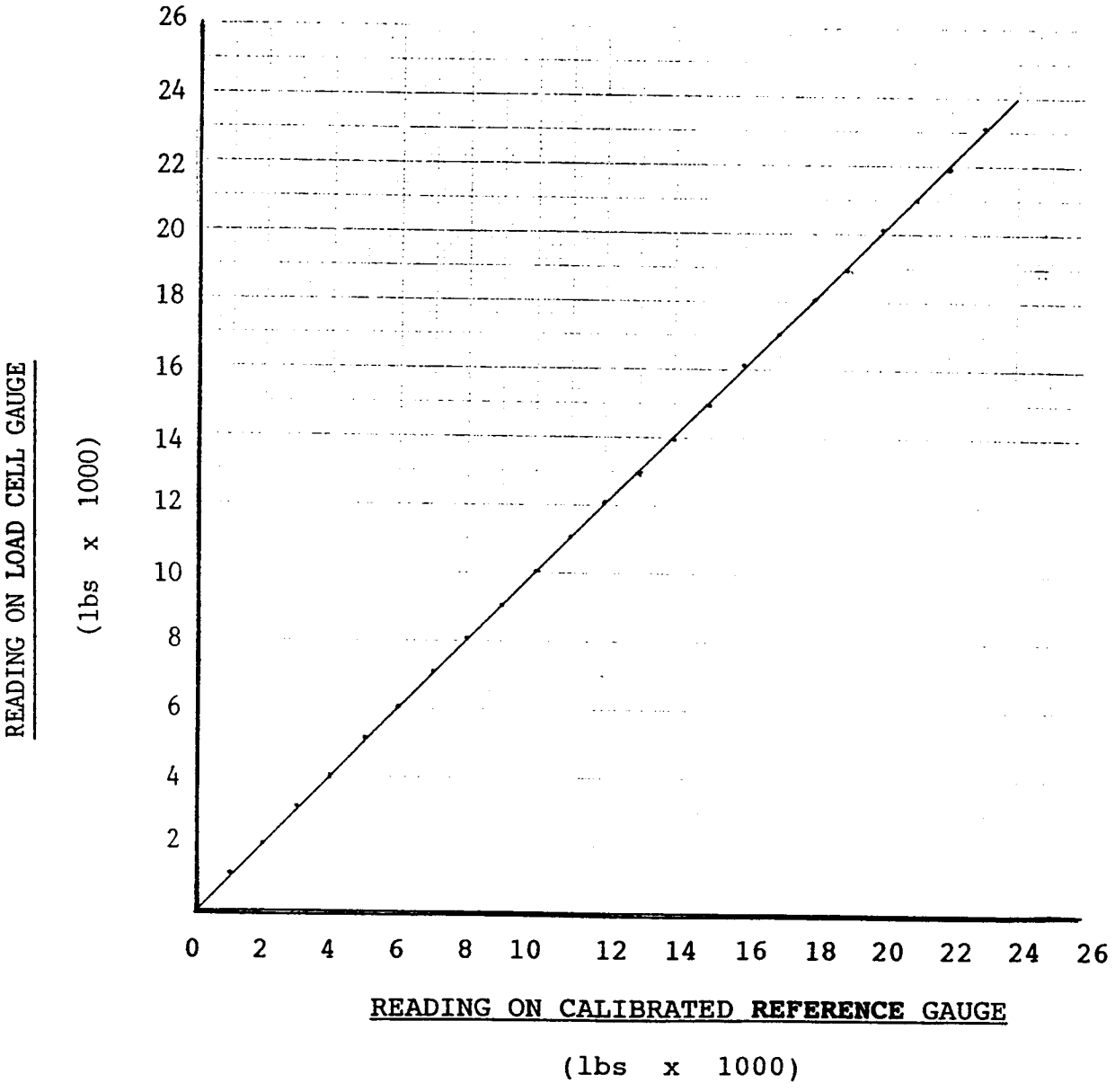
For

- STRAINSERT UNIVERSAL FLAT LOAD CELL
  MODEL FL25U(C) S/N 08908-2

Coupled with

- DORIC TRANSDUCER INDICATOR S/N 400236

DATE: September 3, 1993



CONSTRUCTION CONTROL GROUP
CONSULTING ENGINEERS

CONCRETE CYLINDER COMPRESSIVE STRENGTH TEST REPORT

Job Code: 8021 Project No.: Laboratory Job: 2635

Cylinder No.	Date Cast	Date Received in Lab	Date Tested	Curing	Density (kg / m³)	Specified 28 Day Strength (MPa)	7 Day Strength (MPa)	28 Day Strength (MPa)	Day Strength (MPa)
A	22JUL93	26JUL93	29JUL93	LAB	183	5000	4713		
B	22JUL93	26JUL93	05AUG93	LAB	183	5000		14 DAY	5017
C	22JUL93	26JUL93	19AUG93	LAB	183	5000		5351	

Contractor: N/A

Project: PSA

Location on Structure: N/A

Concrete Supplier: Tri-Krete

Plant:

Cylinders Cast By: F. Bertolo

Representing: Tri-Krete

Time Mixer Charged: 10:30

Time Cylinders Cast: 10:40

Specified Slump (mm): N/R

Measured Slump (mm): see below

Temp. of Concrete (°C): 21

Air Temperature (°C): see below

Specified Air (%): 5.0

Measured Air (%): 5.0

Water Added on the Job (litres): None

By What Authority: N/A

Type of Mould Used: Plastic

Load No.: N/R

Nom. Size of Agg. (mm): see below

Truck No.: N/R

Type of Admixture: MBVR RHEOBUILD

Ordered 28 Day Strength (MPa): see specified

Initial 24 Hour Curing Temp. (°C):

Maximum: N/A **Minimum:** N/A

REMARKS:

Nominal size of aggregate = 3/8 inch
Measured slump = 3.0 ins.
Temperature of concrete (F°) = 70
Air temp. (F°) = 75

All strengths are in psi.
All densities are in lb/ft^3.

We hereby certify testing in accordance with CAN 3-A23. 2-M90 for that portion of the test performed by this company

DISTRIBUTION:

2 Tri-Krete Mr. E. Romanin
1 Paton, Steenson & Associates Attn: Mr. Don Paton, P. Eng.

Construction Control Group

CONSTRUCTION CONTROL (1987) LIMITED
100 SPY COURT, MARKHAM, ONTARIO L3R 5H6 TEL: (416) 479-9770 FAX: (416) 479-7579

PHOTOGRAPHS

Fig. 1 6" x 2 1/2" Insert at edge - 10,200 lbs.
Typical reduced concrete cone failure.

Fig. 3 4 1/2" x 3 1/2" Insert at edge, 13,800 lbs.
Cone extends to base of anchors.

Fig. 2 4 1/2" x 2 1/2" Insert at edge, 11,500 lbs.
Typical concrete cone failure.
Cone extends to base of anchors.

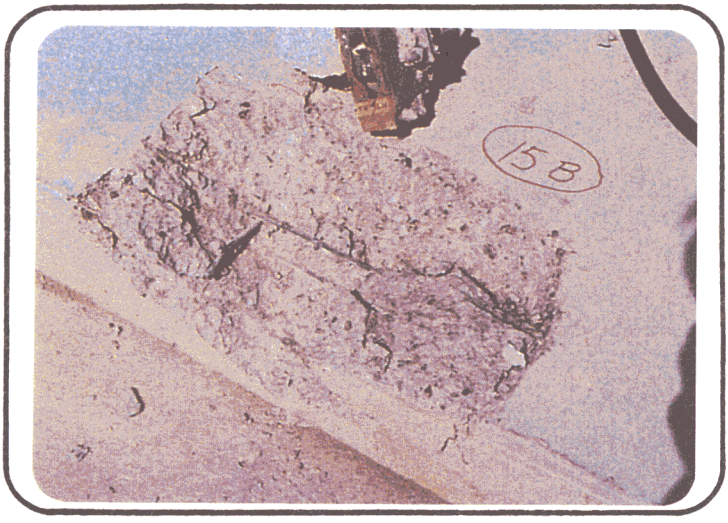
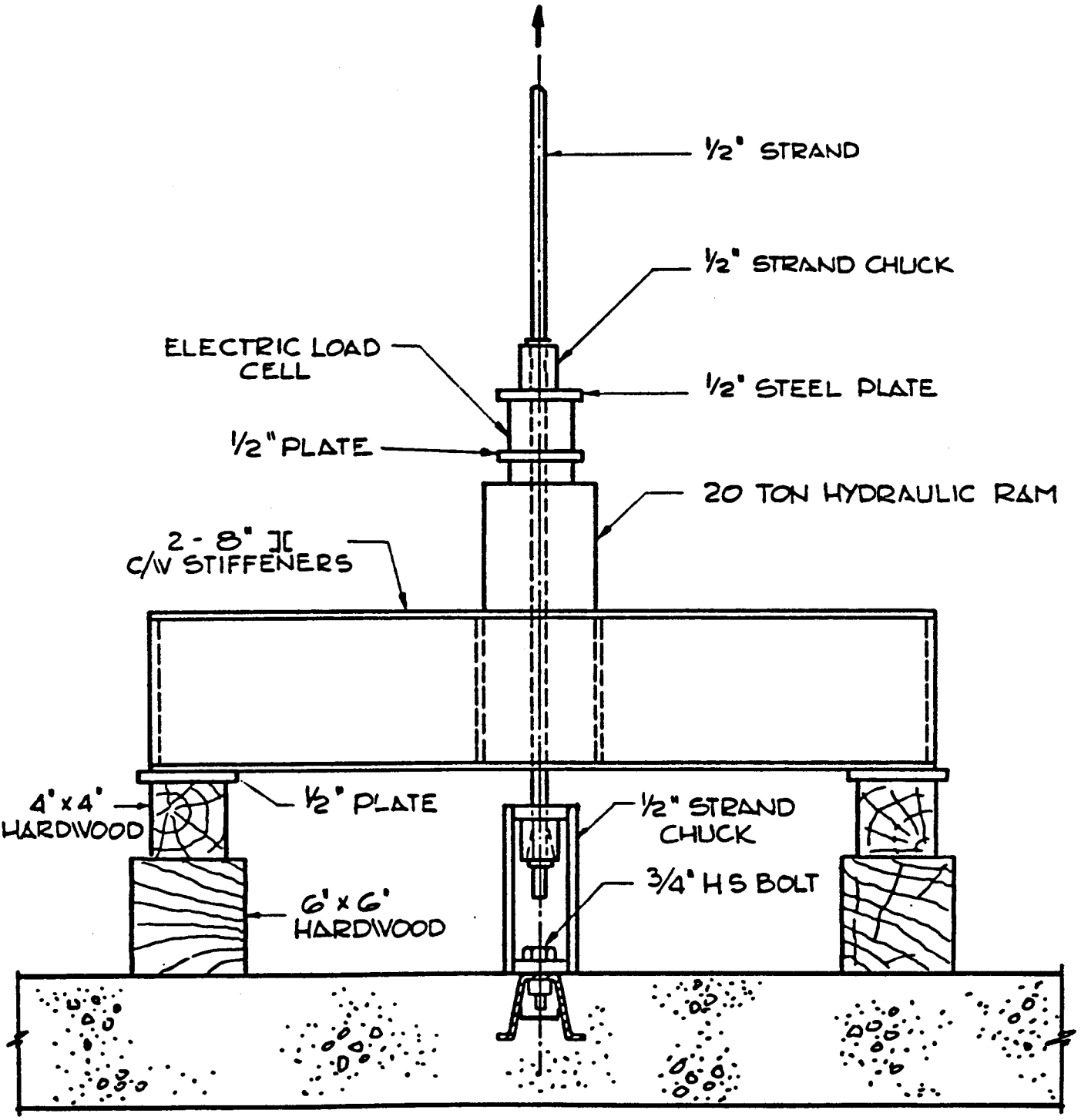


Fig. 4 4 1/2" x 4 1/2" Insert at edge, 14,100 lbs. Cone extends to base of anchors.

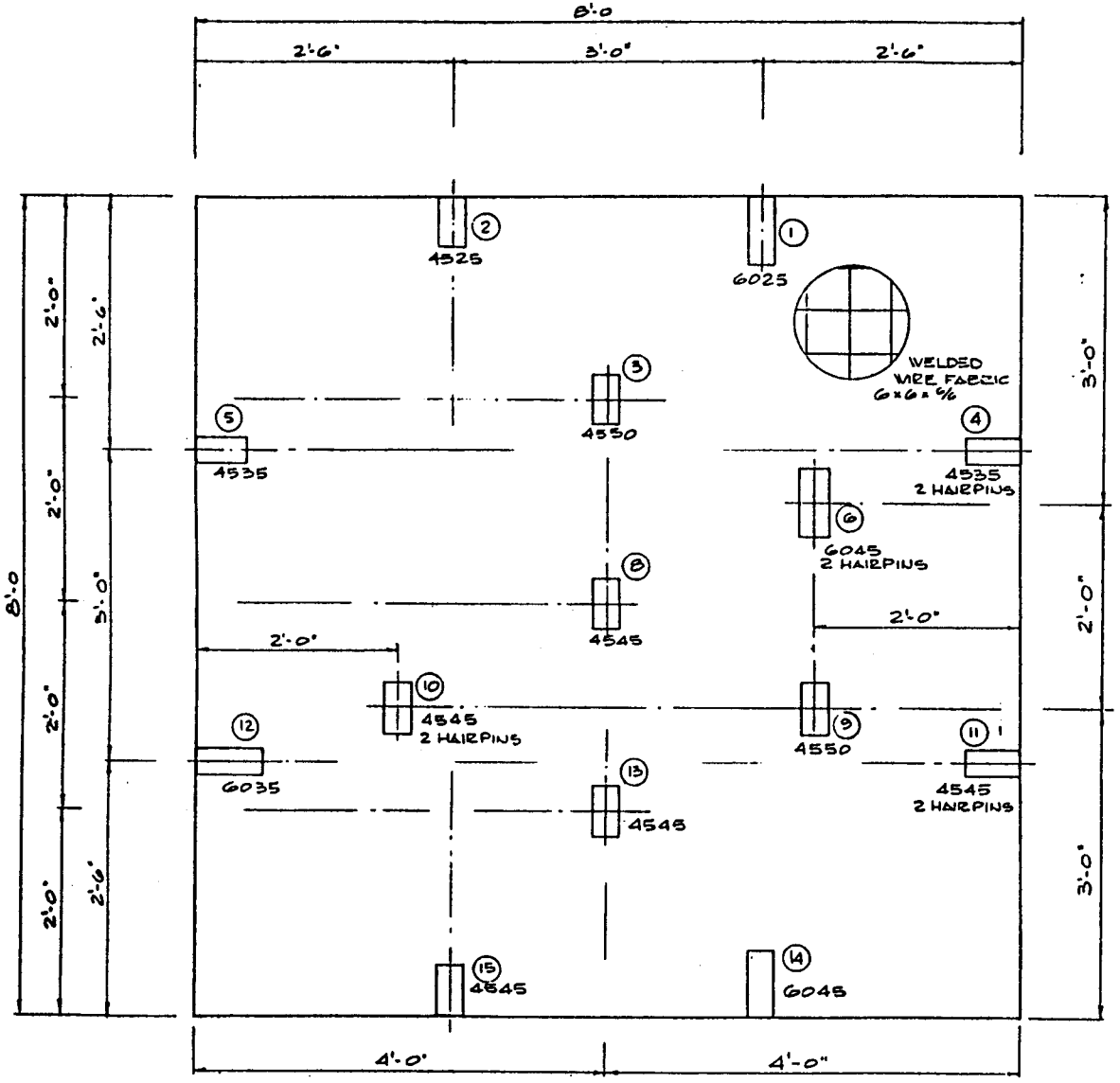
Fig. 5 4 1/2" x 4 1/2" Insert at edge. 14,100 lbs. Typical concrete failure. Insert intact.

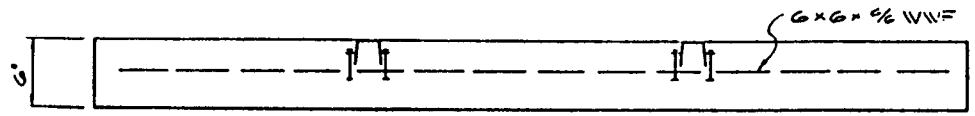


TEST SET-UP

FOR PULLOUT TESTS

FIG. 6





INSERT DESCRIPTION

TEST PANEL NO. 2

1	6025	6" x 2½"	
2	4525	4½" x 2½"	
3	4550	4½" x 5	SPECIAL BOLTS
4	4545	4½" x 4½	2-HAIRPINS
5	4535	4½" x 3½"	
6	6045	6" x 4½"	2-HAIRPINS
7	NOT CAST		
8	4545	4½" x 4½"	SPEC. BOLTS & NUT
9	4550	4½" x 5"	SPECIAL NUT
10	4545	4½" x 4½"	2-HAIRPINS
11	4545	4½" x 4½"	2-HAIRPINS SPEC. NUT
12	6035	6" x 3½"	
13	4545	4½" x 4½"	SPECIAL BOLTS
14	6045	6" x 4½"	
15	4545	4½" x 4½"	

NOTES.

CONCRETE STRENGTH AT TIME OF TEST = 5351 psi

TESTED AT TRIKRETE PLANT TORONTO, ONTARIO

DATE	ISSUE	REV.No.	DESCRIPTION	CHECK

PSA PATON STEENSON ASSOCIATES INC
10 Royal Orchard Blvd.
P.O. Box P53009
THORNHILL, ONT. L3T 7N9

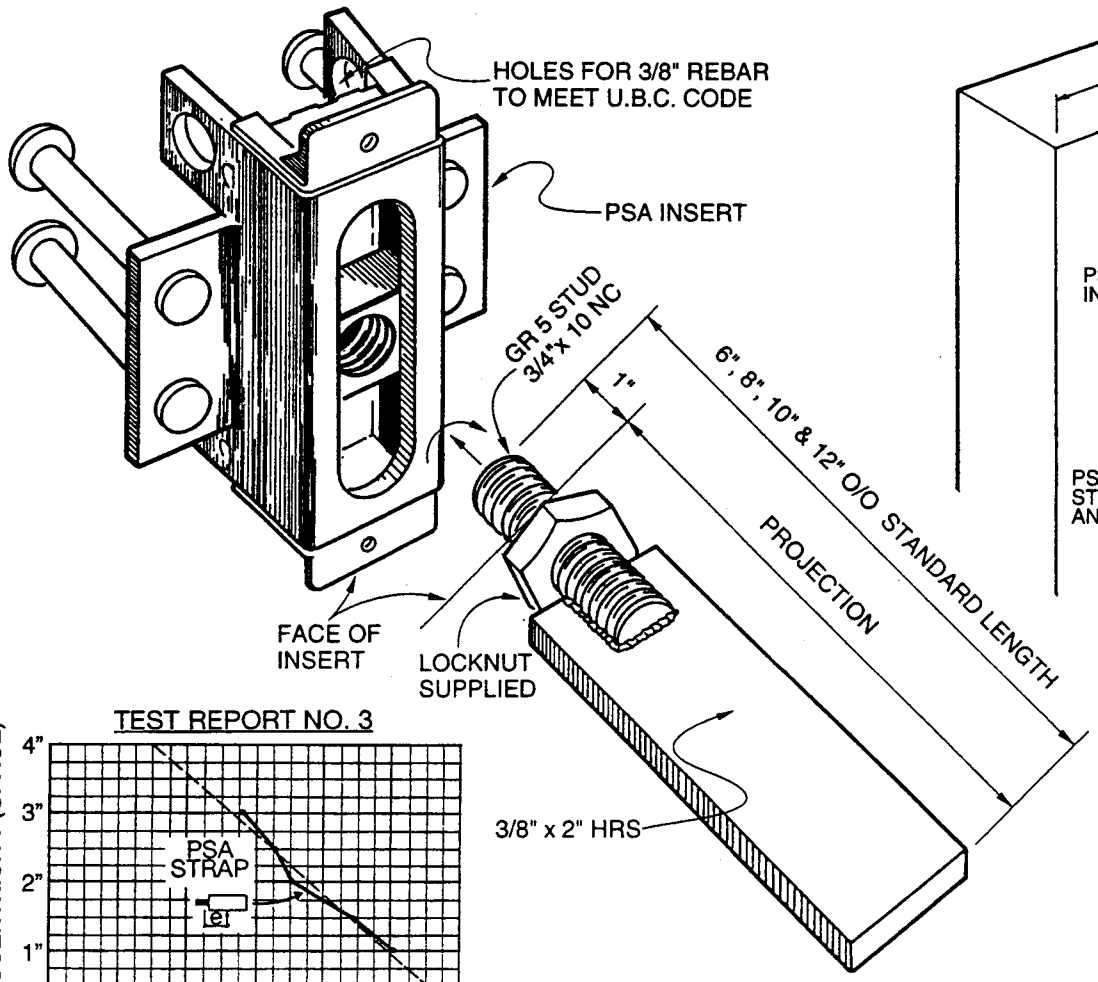
JOB

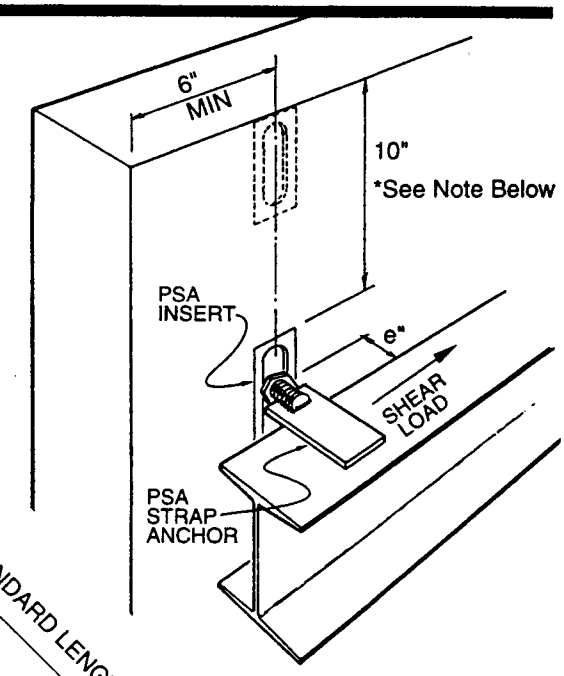
DETAIL

PSA TEST PANEL No. 2

DETAIL No.	DRAWN BY	DATE
DET. REF.	EC.	SEPT. 95
	CHECKED BY	REVISION
	DRAWING No.	1002

PSA STRAP ANCHORS





Note:
* Reduce Ultimate Load by 25% if Insert Placed at Top Edge of Panel. (Test Report No. 2)

FEATURES:

• Ultimate Pull-out Capacity

Strap Anchors Develop full Ultimate Capacity of the insert

Insert Type	Depth	Length	Ult. Pull-Out Capacity
4525	2 1/2"	4 1/2"	12,000 lbs
6025		6"	
4535	3 1/2"	4 1/2"	16,000 lbs
6035		6"	
4545	4 1/2"	4 1/2"	20,000 lbs
6045		6"	

Ultimate Pull-Out Capacity Based on Tests Performed in 5,000 psi Normal Weight Concrete (Refer to PSA Test Report No.1)

• Ultimate Shear Capacity

20,350 lbs. at 1" Eccentricity (See Graph Above)
Ult. Shear Capacity based on Tests Performed in 6,000 psi Normal Weight Concrete (Refer to PSA Test Report No. 3)

• Standard Strap Anchor Lengths

6", 8", 10" & 12" Out/Out

• **Available Finishes** – Epoxy or Hot Dipped Galvanized. (Stainless Steel available on Special Order)

• **Material** – High Strength weldable grade HRS Steel

• **Lock Nut** – Ensures Positive Connection in Both Directions

In the U.S.A. JVI In Canada PSA

ACCESSORIES, INC.
7550 North Linder Avenue
Skokie, Illinois 60077 USA
705/675-1560 Fax: 708/675-0083

PATON STEENSON ASSOC. INC.
10 Royal Orchard Blvd. P.O. Box #53009
Thornhill, Ontario L3T 7R9
905/889-7357 Fax: 905/889-7648

PSA PATON STEENSON ASSOCIATES INC

10 ROYAL ORCHARD BOULEVARD • P.O. BOX 53009 • THORNHILL, ONTARIO L3T 7R9
TEL 905-889-7357 • FAX 905-889-7648

TEST REPORT NO. 3

SHEAR TESTS ON

PSA SLOTTED INSERTS

At Metromont Materials Plant

MAY, 1994

ACKNOWLEDGEMENT

Special thanks to HARRY GLEICH AND JIM JUSTUS of Metromont Materials Corp. for their help and advice in making this test program possible.

NOTICE

PSA PATON STEENSON ASSOCIATES INC

10 ROYAL ORCHARD BOULEVARD • P.O. BOX 53009 • THORNHILL, ONTARIO L3T 7R9
TEL 905-889-7357 • FAX 905-889-7648

March, 1994

SHEAR TESTS ON PSA SLOTTED INSERTS
TEST REPORT NO. 3

INTRODUCTION

The purpose of this test program was to determine the lateral shear capacity of welded strap anchor connections using PSA slotted inserts and strap anchors. The shear force was applied at various eccentricities from 1" to 3" away from the face of the insert so as to simulate actual construction conditions. The "fixed-end" effect of the weld on the strap anchor was taken into consideration.

TEST PANEL

The details of the test panel are shown on Drawing No. 1003 included in Appendix A. The panel was manufactured in the Metromont Materials plant in Greenville, S.C., as part of a normal days production. Inserts were "plunged" into the wet concrete in order to simulate actual production proceedures for this type of prestressed concrete wall panel. The concrete was cured using normal accelerated curing proceedures. The load test was made on January 11, 1994 when the panel was 7 days old. The average concrete strength at time of testing was 6,200 psi. as determined by two concrete test cylinders. An 8" x 8" steel box beam, welded to embedded weld plates served as a reaction beam to resist the design load of 30 kips at 4" eccentricity.

TEST METHOD

The test load was applied to the connection through a special test beam using a 20 ton hydrailic ram and hand operated pump. Recent calibration data for the pump and pressure gauge is included in Appendix A. The test beam was specially fabricated to rigidly restrain the ends of the strap anchors so as to simulate the fixed-end effect of a 2" weld on the strap anchor. This is the minimum length of weld usually used with this type of connection. Each strap anchor was tested individually. In all cases the jam nut was just finger tight (not torqued down). The eccentricity of the applied load was measured from the face of the insert to the bottom of the test beam to simulate the usual clearance between the back of a panel and the edge of the roof beam, all as shown on on Drawing No. 1003 in Appendix A. Tests were made at five different eccentricities - 1", 1 1/2", 2", 2 1/2" and 3".

TEST RESULTS

A Table of Test Results is given in Appendix A.

DISCUSSION

(1) The test beam effectively transmitted the axial load along the centre line of the jack. The levelling screws on the test beam maintained the alignment of the jack such that no secondary moments were introduced.

(2) The test beam effectively simulated the fixed-end condition of the welded strap anchor as illustrated in Figs. 2 and 4.

(3) Initial failure in all cases resulted from the ductile yielding of the steel strap as the load translated. Final failure occurred as the lips of the insert failed and the nut rotated out of the insert. Minor concrete spalling occurred as shown in Fig. 3.

(4) It would appear that the shear capacity of these connections could be increased by using a wider (stiffer) steel strap, 2 1/2" or 3" wide to delay initial yielding. However it may be more cost effective for unusual loading conditions to weld extension plates onto the structural frame at connection points in order to reduce the eccentricity and utilize standard strap anchors.

(5) In no case was there any bending or yielding of the high strength studs in the strap anchor. The exposed length of the stud was minimal and it would appear that the stud was effectively fixed-ended in both the insert and the strap anchor.

CONCLUSIONS AND RECOMMENDATIONS

(1) The 2" x 3/8" standard steel strap anchor provides adequate shear resistance for normal loading conditions.

(2) Although a wider strap (2 1/2" or 3") would increase shear resistance it is recommended that for unusual loading conditions, an extension plate be welded onto the structural frame at connection points so that standard strap anchors can be used. The shear load is then transferred to the strap anchors at the eccentricity of the extension plate rather than the structural frame.

January 11, 1994

TEST RESULTS

PSA INSERTS - TEST REPORT NO.3

LATERAL SHEAR TESTS ON STRAP ANCHORS

METROMONT MATERIALS PLANT - GREENVILLE, SC.

INSERT TYPE	TEST NUMBER	INSERT DESC.	LOAD ECCENT.	GAUGE READING	FAILURE LOAD (lbs)	REMARKS
6025	2	6" x 2 1/2"	1"	4300 psi.	20,253	Concrete spalled Insert lips failed
6025	1	6" x 2 1/2"	1 1/2"	3800 psi.	17,900	Nut rotated out Insert lips failed
6025	3	6" x 2 1/2"	2"	3000 psi.	14,200	Insert lips failed Min. spalling (washer)
6025	4	6" x 2 1/2"	2 1/2"	2800 psi.	13,200	Same
6025	5	6" x 2 1/2"	3"	2400 psi	11,300	Same

NOTES

(1) Ram area = 4.71 sq. in.
(2) Refer to Drawing No. 1004 in Appendix A for a graph if Test Results.

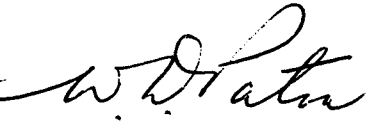
(3) The test results of standard PSA Strap Anchors when tested in lateral shear in 6000 psi. concrete are summarized in the following table:

INSERT TYPE	STRAP TYPE	LOAD ECCENTRICITY	FAILURE LOAD
6" x 2 1/2"	3/8" X 2"	1"	20,253 lb.
6" x 2 1/2"	3/8" X 2"	1 1/2"	17,900 lb.
6" x 2 1/2"	3/8" X 2"	2"	14,200 lb.
6" x 2 1/2"	3/8" X 2"	2 1/2"	13,200 lb.
6" x 2 1/2"	3/8" X 2"	3"	11,300 lb.

NOTE:

Please refer to Drawing No. 1004 in Appendix A for a graphical presentation of these test results.

PATON STEENSON ASSOCIATES INC



Don Paton, P. Eng.

March 31, 1994

APPENDIX A

1. Table of Test Results.

2. Calibration Report.

3. Photographs - Figs. 1 through 4 incl.

4. Drawing No. 1003 - Test Set Up
   - Test Panel

5. Drawing No. 1004 - Graph of Test Results
   - Strap Anchor Assembly

6. Drawing No. 1005 - PSA Strap Anchors

7. Tensile Test on Strap Anchors

8. Data Sheet for PSA Strap Anchors

9. Data Sheet for PSA Inserts.

January 11, 1994

TEST RESULTS

PSA INSERTS - TEST REPORT NO.3

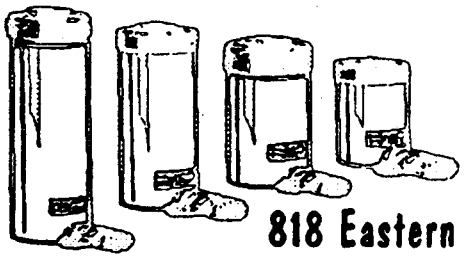
LATERAL SHEAR TESTS ON STRAP ANCHORS

METROMONT MATERIALS PLANT - GREENVILLE, SC.

INSERT TYPE	TEST NUMBER	INSERT DESC.	LOAD ECCENT.	GAUGE READING	FAILURE LOAD (lbs)	REMARKS
6025	2	6" x 2 1/2"	1"	4300 psi.	20,253	Concrete spalled Insert lips failed
6025	1	6" x 2 1/2"	1 1/2"	3800 psi.	17,900	Nut rotated out Insert lips failed
6025	3	6" x 2 1/2"	2"	3000 psi.	14,200	Insert lips failed Min. spalling (washer)
6025	4	6" x 2 1/2"	2 1/2"	2800 psi.	13,200	Same
6025	5	6" x 2 1/2"	3"	2400 psi	11,300	Same

NOTES

(1) Ram area = 4.71 sq. in.
(2) Refer to Drawing No. 1004 in Appendix A for a graph if Test Results.



Hydraquip
Sales & Service

818 Eastern Avenue, Unit 2, Toronto, ON, M4L 1A1

Calibration Test Certificate

==========

Customer: Paton Steenson Associates
Gauge Description: Enerpac Gauge 0-10,000 psi, serial G93-496

==========

Standard Used: Mansfield & Green, Type #R-50
Dead Weight Serial #: 1315
Dead Weight Accuracy: 0.1%

==========

**Note: Instruments have been tested against a dead weight tester serial # as above, which is traceable to the National Research Council in Ottawa, as per their report # 722.0329, dated August 18,1989.

Hydraquip Sales & Service Ltd. certifies that the below item(s) have been tested to comply in every way with the requirements of the above purchase order.

==========

Master Test Gauge D.W.	Above Gauge
1000 PSI	1000 PSI
3000	3000
5000	5000
7000	7025
9000	9025

Date Tested: Dec 6, 1993
Technician: Pat Mahon

Phone 416-461-3573 Fax 416-461-2979
Out of town callers 1-800-463-4168

PHOTOGRAPHS

Fig. 1 Jack & Test Beam (Test # 2)
e = 1" 20,253 lbs.

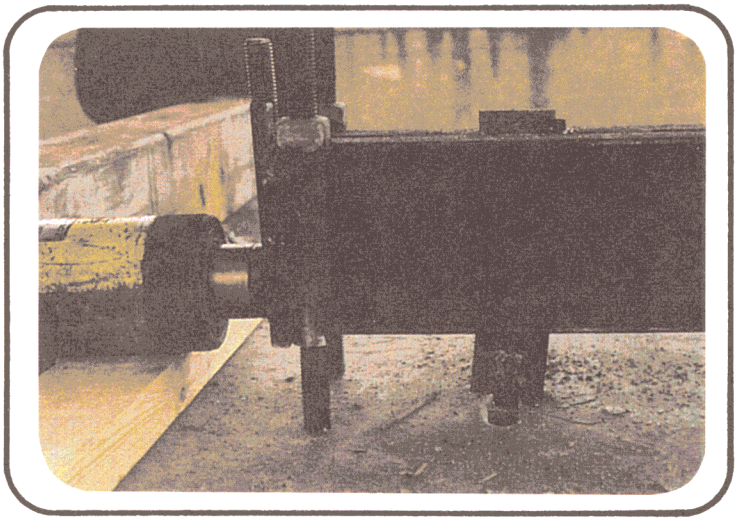


Fig. 2 Jack & Test Beam (Test # 4)
e = 2 1/2" 13,200 lbs.

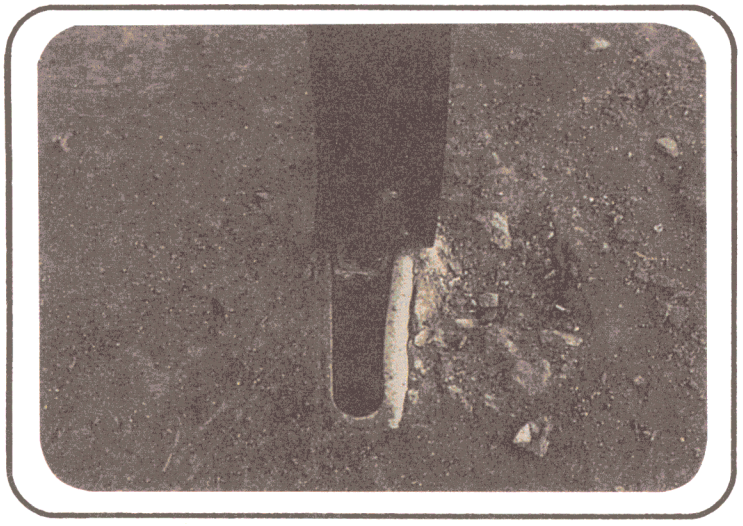


Fig. 3 Typical failure (Test # 1)
e = 1 1/2" 17,900 lbs.

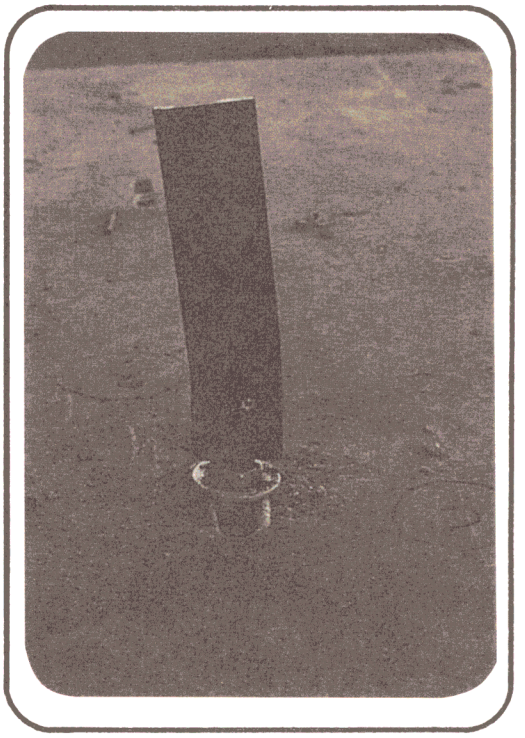
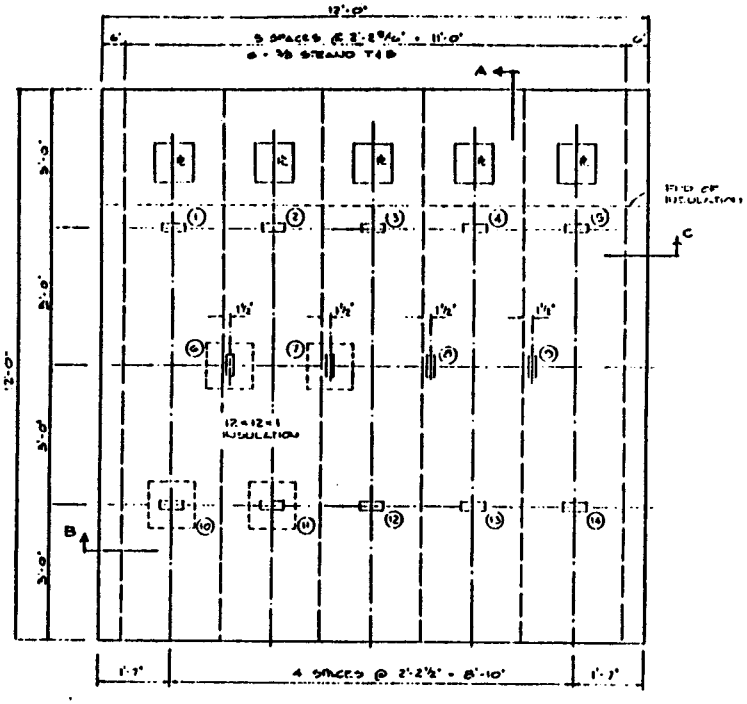
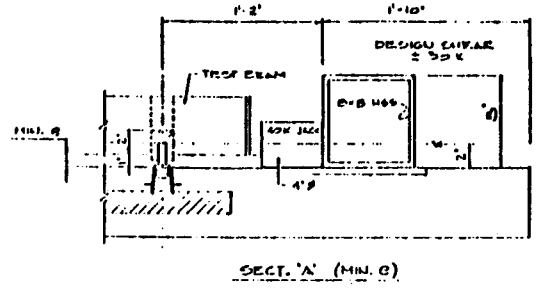
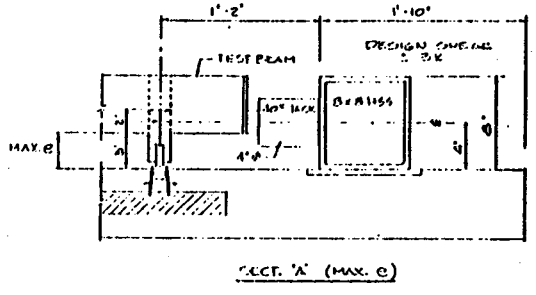
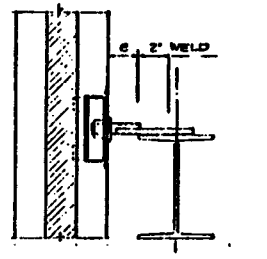


Fig. 4 Effective fixed-end of strap. (Test # 3)
e = 2" 14,200 lbs.

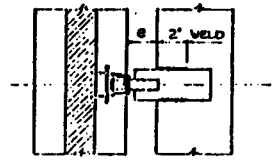




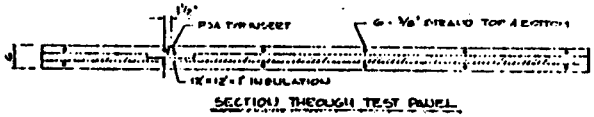




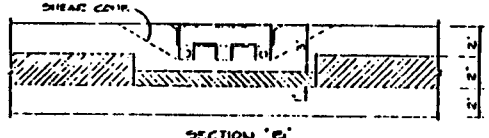
TYPICAL TOP CONNECTION



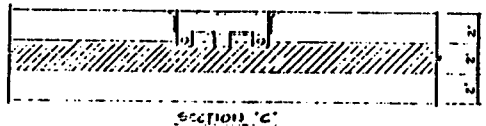
TOP VIEW



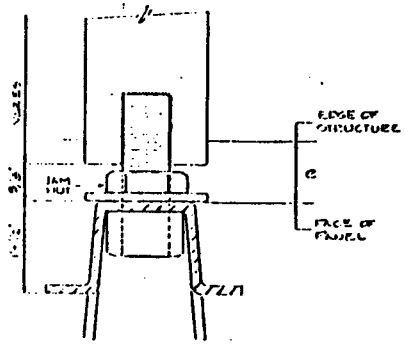
SECTION THROUGH TEST PANEL



SECTION 'B'
12"x12"x1" REDUCED INSULATION



SECTION 'C'
FULL INSULATION



STRAP ANCHOR
WITH DOUBLER

INSERT DESCRIPTION

1	G025	6" x 5½"	SHEAR TEST
2	G025	6" x 3½"	SHEAR TEST
3	G025	6" x 4½"	SHEAR TEST
4	G025	6" x 5½"	SHEAR TEST
5	G025	6" x 2½"	SHEAR TEST
6	G025	6" x 2½"	3" CONCRETE
7	G025	6" x 2½"	3" CONCRETE
8	G025	6" x 2½"	2" CONCRETE
9	G025	6" x 2½"	2" CONCRETE
10	G025	6" x 2½"	2" CONCRETE
11	G025	6" x 2½"	3" CONCRETE
12	G025	6" x 2½"	2" CONCRETE
13	G025	6" x 2½"	2" CONCRETE
14	G025	6" x 2½"	2" CONCRETE

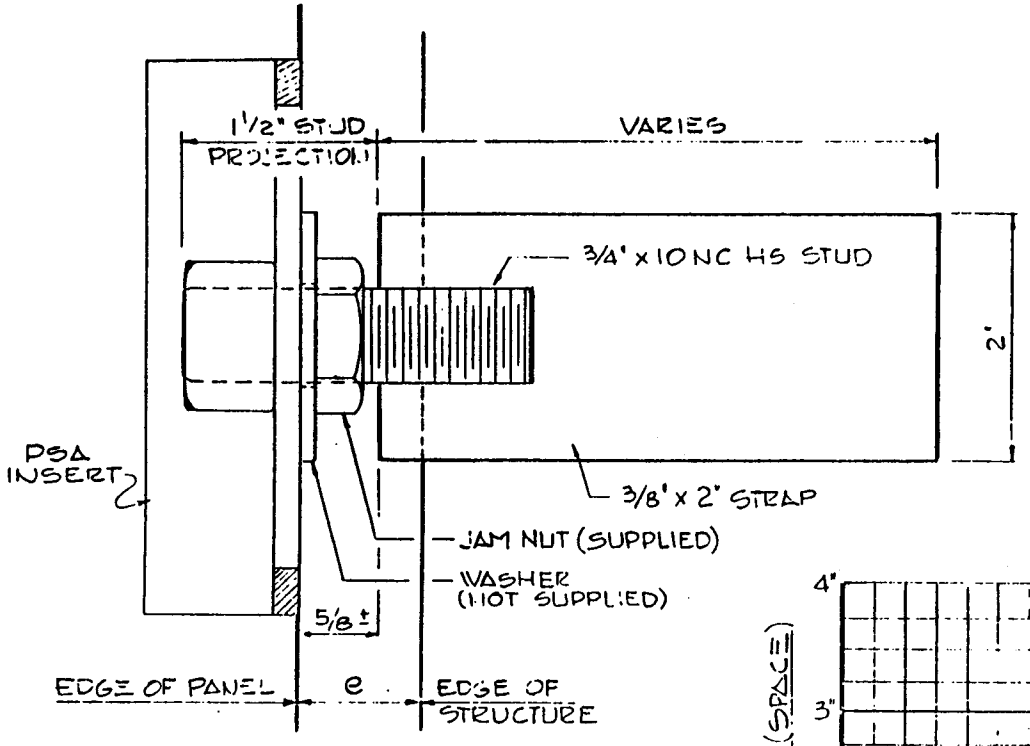
DATE	ISSUE	REVIS.	DESCRIPTION	CHECK

PSA PATCH STEPHENSON ASSOCIATES INC

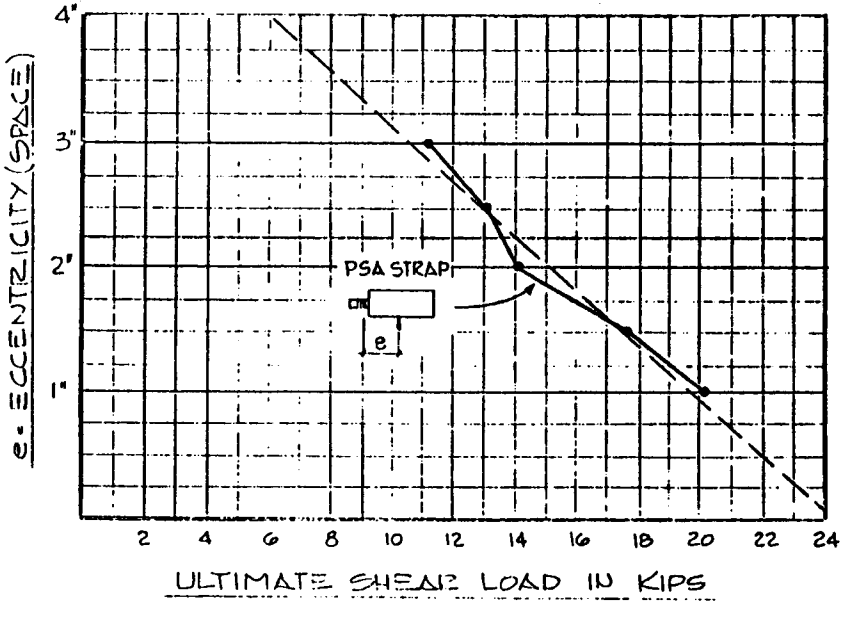
JOB: STRAP ANCHOR SHEAR TEST

DETAIL: TEST PANEL SET-UP

DETAIL No.	DRAWN BY: MC.	DATE: MAR. '94
	CHECKED BY	REVISION
DET. REF.	DRAWING No. 1003	



PSA STRAP ANCHOR



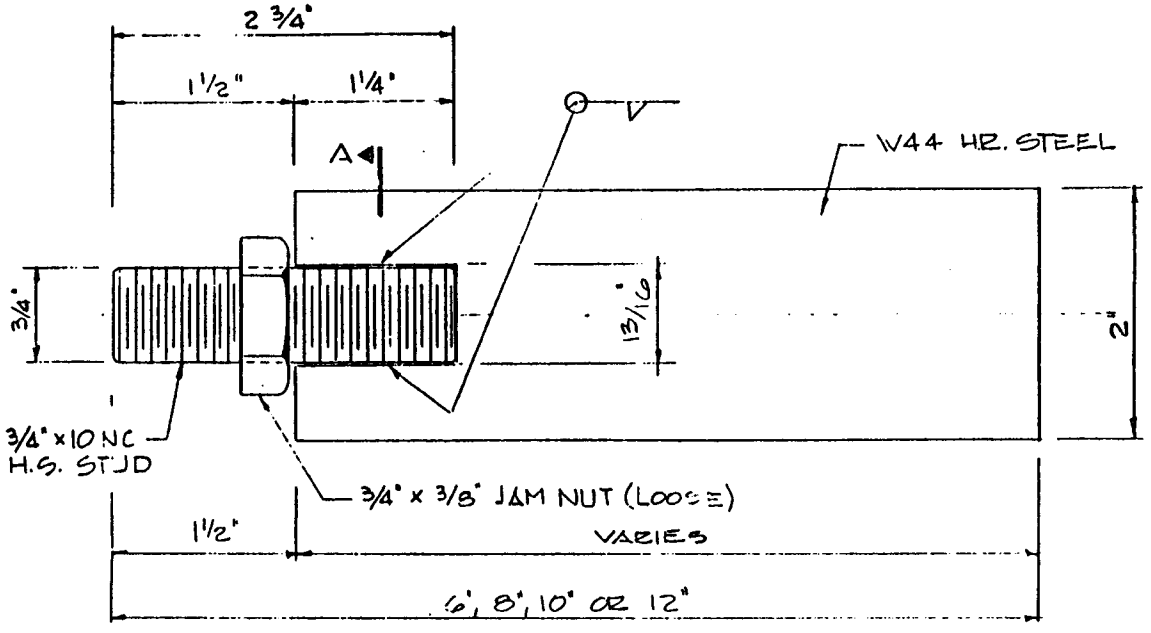
DATE	ISSUE	REV.No.	DESCRIPTION	CHECK

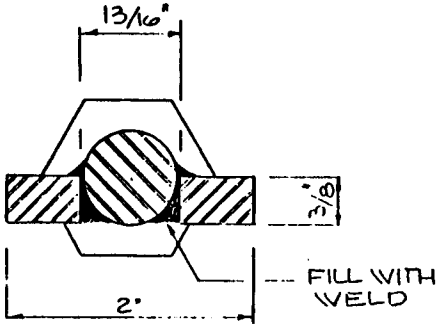
PATON STEENSON ASSOCIATES INC

JOB: STRAP ANCHOR SHEAR TEST

DETAIL: ULTIMATE SHEAR LOAD

DETAIL No.	DRAWN BY	DATE
DET. REF.	E.P.	MAR/94
	CHECKED BY	REVISION
	DRAWING No. 1004	





SECT. 'A'

DATE	ISSUE	REV.No.	DESCRIPTION	CHECK

PSA PATON STEENSON ASSOCIATES INC

JOB

DETAIL

THREADED STRAP ANCHOR

DETAIL No.	DRAWN BY	DATE
DET. REF.	ER.	MAR. 94
	CHECKED BY	REVISION
	DRAWING No.	1005

TELEPHONE 519-621-8191
FAX 519-621-7700

The Galt Testing Laboratories Limited

ESTABLISHED 1929

Chemical Analysis of Malleable, Meehanite, Ductile and Cast Irons; Plain, Alloyed and Stainless Steels; Zinc and Aluminum Alloys; Brass and Bronze; Coal, Coke, Limestone Slags, Etc.

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CAMBRIDGE, ONTARIO
N1R 7L3

Paton Steenson Associates Inc.
10 Royal Orchard Blvd.
P.O. Box #53009
Thornhill, Ontario
L3T 7R9
Attention: Don Paton

Customer P.O.: 1077

Laboratory Sample I.D. #: 40561

Report Date: April 12, 1994

4 Strap Anchors

Four strap anchors were placed in a direct tensile load and pulled to failure. Specimens were tested as received. In all cases, the specimen fractured outside of the weld in the threaded area. The following results were obtained: 48,300 lbf, 45,700 lbf, 44,400 lbf, and 44,100 lbf. Test were conducted in accordance with The Galt Testing Laboratories' in house testing procedures.

Samples returned at customer's request and expense; otherwise samples retained one year from date of test.

The Galt Testing Laboratories

Per Bill Bartlett
Senior Technician

Per Graham Payne
P. Eng.

TELEPHONE 519-621-8191
FAX 519-621-7700

The Galt Testing Laboratories Limited

ESTABLISHED 1929

Chemical Analysis of Malleable, Meehanite, Ductile and Cast Irons; Plain, Alloyed and Stainless Steels; Zinc and Aluminum Alloys; Brass and Bronze; Coal, Coke, Limestone Slags, Etc.

CHEMISTS and METALLURGISTS

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Notched Bar Impact
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Reports

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CAMBRIDGE, ONTARIO
N1R 7L3

Paton Steenson Associates Inc.
10 Royal Orchard Blvd.
P.O. Box #53009
Thornhill, Ontario
L3T 7R9
Attention: Don Paton

Laboratory Sample I.D. #: 71189 Report Date: July 25, 1994

Strap Anchor Sample, Marked #2 by Galt Testing Laboratories

One PSA Strap Anchor was placed in a direct tensile load and pulled to failure using a crosshead rate of 0.100"/min. Specimen fractured in the threads of the 3/4 x 10 stud at a maximum load of 40,200 lbf.

Specimen was tested as received.

Test conducted in accordance with the Galt Testing Laboratories' in house testing procedures.

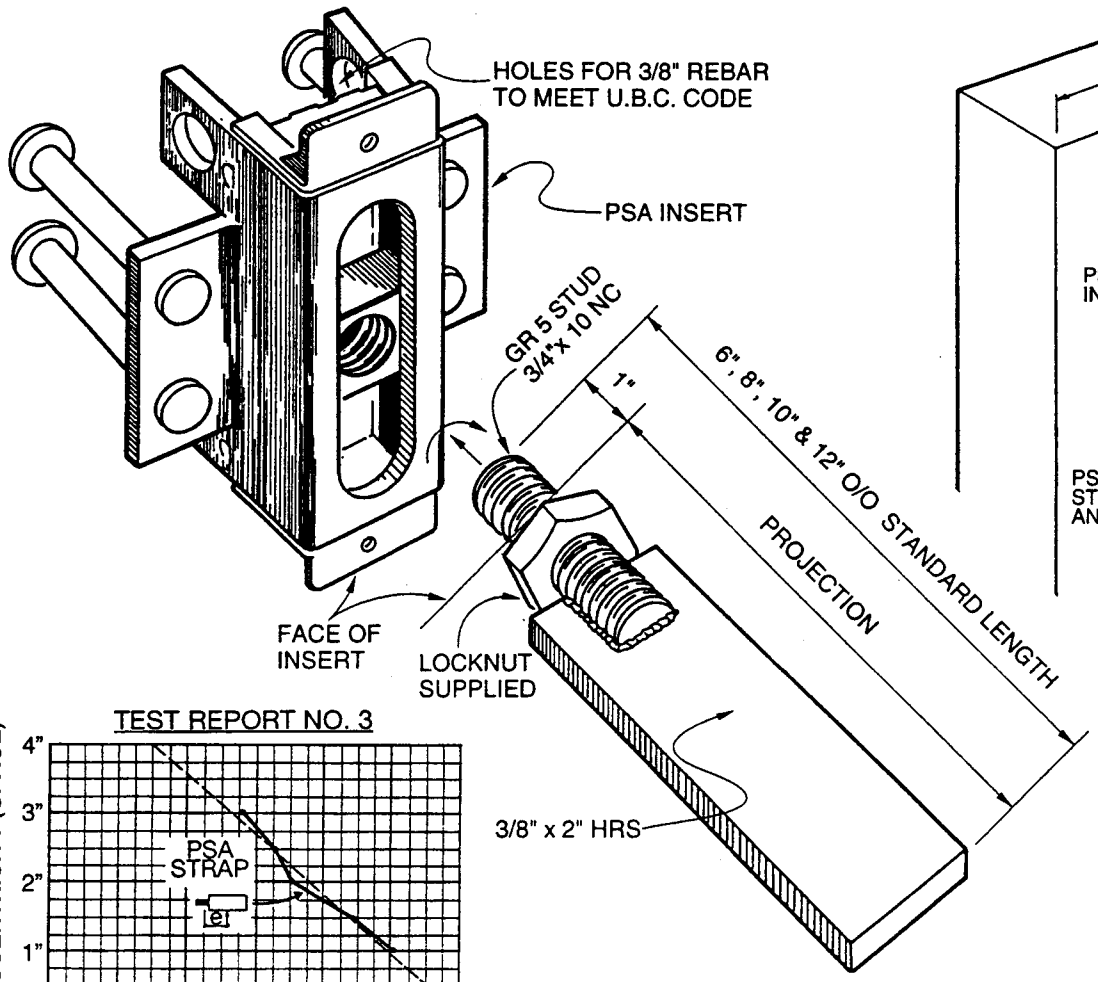
Samples returned at customer's request and expense; otherwise samples retained one year from date of test.

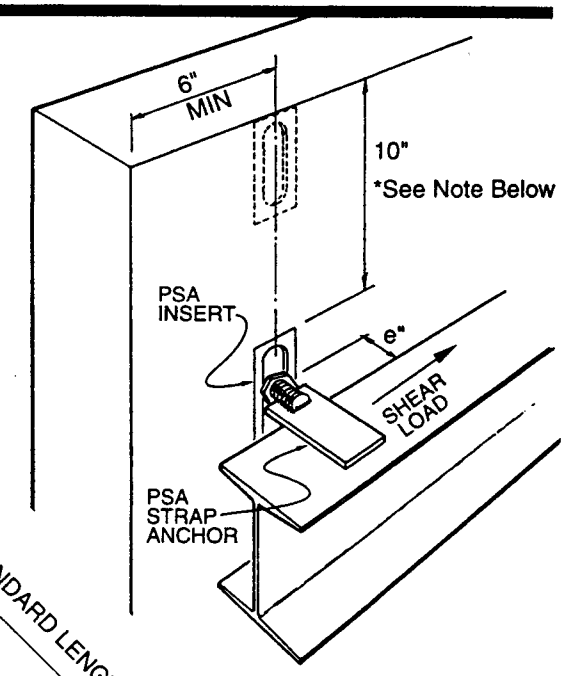
The Galt Testing Laboratories

Per Bill Bartlett
Senior Technician

Per Roger Trefzger
P. Eng.

PSA STRAP ANCHORS





Note:
* Reduce Ultimate Load by 25% if Insert Placed at Top Edge of Panel. (Test Report No. 2)

FEATURES:

• Ultimate Pull-out Capacity

Strap Anchors Develop full Ultimate Capacity of the insert

Insert Type	Depth	Length	Ult. Pull-Out Capacity
4525	2 1/2"	4 1/2"	12,000 lbs
6025		6"	
4535	3 1/2"	4 1/2"	16,000 lbs
6035		6"	
4545	4 1/2"	4 1/2"	20,000 lbs
6045		6"	

Ultimate Pull-Out Capacity Based on Tests Performed in 5,000 psi Normal Weight Concrete (Refer to PSA Test Report No.1)

• Ultimate Shear Capacity

20,350 lbs. at 1" Eccentricity (See Graph Above)
Ult. Shear Capacity based on Tests Performed in 6,000 psi Normal Weight Concrete (Refer to PSA Test Report No. 3)

• Standard Strap Anchor Lengths

6", 8", 10" & 12" Out/Out

• **Available Finishes** – Epoxy or Hot Dipped Galvanized. (Stainless Steel available on Special Order)

• **Material** – High Strength weldable grade HRS Steel

• **Lock Nut** – Ensures Positive Connection in Both Directions

In the U.S.A. JVI In Canada PSA

ACCESSORIES, INC.
7550 North Linder Avenue
Skokie, Illinois 60077 USA
705/675-1560 Fax: 708/675-0083

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10 Royal Orchard Blvd. P.O. Box #53009
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PSA PATON STEENSON ASSOCIATES INC

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TEL 905-889-7357 • FAX 905-889-7648

TEST REPORT NO. 4

PULL-OUT TESTS ON

PSA SLOTTED INSERTS

At Metromont Materials Plant

MARCH, 1994

ACKNOWLEDGEMENT

Special thanks to HARRY GLEICH AND JIM JUSTUS of Metromont Materials Corp. for their help and advice in making this test program possible.

NOTICE

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TEL 905-889-7357 • FAX 905-889-7648

March, 1994

LOAD TESTS ON PSA SLOTTED INSERTS
TEST REPORT NO. 4

INTRODUCTION

The purpose of this test program was to establish the ultimate pull-out capacity of PSA Inserts in the 2" concrete wythe of a 6" prestressed concrete sandwich panel. The effect of increasing the concrete thickness to 3" (by reducing the insulation thickness directly underneath some inserts), was also studied.

TEST PANEL

The details of the test panel are shown on Drawing No. 1003 included in Appendix A. The panel was manufactured in the Metromont Materials plant in Greenville S.C. as part of a normal days production of 6" prestressed concrete sandwich panels (2/2/2 sandwich). Inserts were "plunged" into the top surface of the wet concrete in order to simulate actual production procedures. The top wythe of concrete was only 2" thick but was thickened to 3" in a 12" x 12" area directly underneath some inserts, by reducing the thickness of insulation by 1". For other inserts, the 2" concrete thickness was maintained and legs of these inserts (which are 2 1/2" deep) were pushed 1/2" into the insulation. The panel was prestressed to a standard P/A of 225 psi. The panel was cured using normal accelerated curing procedures. The load tests were made on January 11, 1994 when the panel was 7 days old. The average strength of concrete at time of testing was approximately 6200 psi. as determined by two concrete test cylinders.

TEST METHOD

The test load in all cases was applied to the inserts through their normal connection devices using a 20 ton hydraulic ram and hand operated pump. Recent calibration data for the pump and pressure gauge is included in Appendix A.

Figure 1 illustrates the conventional test arrangement used. A high strength bolt in the load transfer bracket was attached to the heavy duty nut built into the insert. In all cases, the load was applied with the bolt located in the centre of the insert. All inserts were tested for ultimate pull-out capacity. A visual inspection of the pattern of failure cracking was made throughout the tests. The mode of failure was determined, photographed and recorded.

TEST PROGRAM

All inserts were 6" long and 2 1/2" deep (Type 6025). Four inserts were placed near a prestressing strand. Two of these inserts were in 2" of concrete and two were in 3" of concrete.

Five other inserts were placed at least 12" clear of any prestressing strands. Three of these inserts were in 2" of concrete and two were in 3" of concrete.

All inserts were located away from the edges and corners of the panel as shown on Drawing No. 1003 in order to determine the true unreinforced capacity of these inserts.

TEST RESULTS

A table of Test Results is given in Appendix A.

DISCUSSION

1. For inserts in 3" of concrete, the mode of failure was a typical concrete failure cone extending to the full depth of the insert. A large failure cone as shown in Fig. 4, was developed even though the 3" concrete thickness was localized in a 12" x 12" area under the insert. The average failure load was 14,000 lbs. for inserts clear of a prestressing strand, and 16,500 lbs for inserts adjacent to a prestressing strand. Fig. 3 illustrates the large failure cone developed when a prestressing strand was located adjacent to an insert.

2. For inserts in 2" of concrete, the mode of failure was a typical concrete failure cone extending to the full 2" depth of the concrete as shown in Fig. 2. The failure cone was somewhat smaller than for other inserts in 3" of concrete. The average failure load was 9,930 lbs. for inserts clear of a prestressing strand, and 12,950 lbs. for inserts adjacent to a prestressing strand.

CONCLUSIONS AND RECOMMENDATIONS

1. The tests on inserts located adjacent to a prestressing strand were included for general information only. It is <u>not</u> recommended that such test results be used for design purposes.

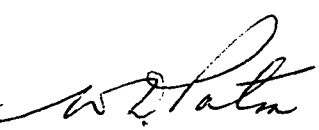
2. The test results for inserts in 3" of concrete compare closely with the results of previous tests on these inserts. (Refer to PSA Test Report No. 1). It is recommended that an appropriate ϕ factor be applied to these test results for ultimate design purposes.

3. It is <u>not</u> recommended that PSA inserts be used in a 2" wythe of concrete unless it is thickened to at least 3" in the vicinity of the insert.

4. When tested in minimum 6,000 psi. prestressed concrete with appropriate edge distances, the average ultimate pull-out capacitities of these inserts were as follows:

INSERT TYPE	ANCHORAGE DEPTH	LOCATION	AV. FAILURE LOAD IN 2" CONCRETE	AV. FAILURE LOAD IN 3" CONCRETE
6025	2 1/2"	Clear of strand	9,950 lbs.	14,000 lbs.
6025	2 1/2"	Adjacent to strand	12,950 lbs.	16,500 lbs.

PATON STEENSON ASSOCIATES INC



W. D. Paton P. Eng.

March 31, 1994

APPENDIX A

1. Table of Test Results.
2. Calibration Report.
3. Photographs - Figs. 1 through 4 incl.
4. Fig. 5 Test Setup.
5. Drawing No. 1003 - Test Panel
6. Data Sheet for PSA Inserts.

January 11, 1994

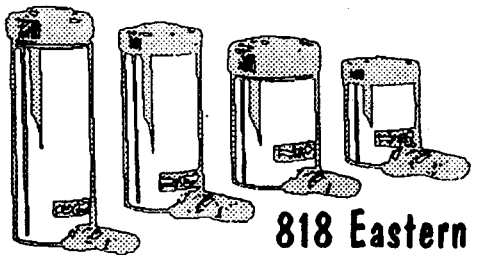
TEST RESULTS

PSA INSERTS - TEST REPORT NO. 4

LOAD TESTS AT METROMONT MATERIALS PLANT

INSERT TYPE	TEST NUMBER	INSERT DESC.	CONC. THICK-NESS	GAUGE READING (psi.)	FAILURE LOAD (Lbs.)	REMARKS
NO STRANDS NEAR INSERT						
6025	10	6" X 2 1/2"	3"	2850 psi	13,400	Honeycomb at insert. Concrete failure
6025	11	6" x 2 1/2"	3"	3100 psi	14,600	Same comments.
NO STRANDS NEAR INSERT						
6025	12	6" X 2 1/2"	2"	2600 psi	12,300	Cracked test panel. Test discontinued.
6025	14	6" x 2 1/2"	2"	1800 psi	8,500	Concrete failure.
6025	13	6" 2 1/2"	2"	9,000 psi	9,000	Same comments
ONE STRAND BESIDE INSERT						
6025	9	6" X 2 1/2"	2"	2300 PSI	10,800	Insert lips failed. Concrete failed
6025	8	6" x 2 1/2"	2"	3200 psi	15,100	Same comments
ONE STRAND BESIDE INSERT						
6025	7	6" X 2 1/2"	3"	3500 PSI	16,500	Large concrete cone. Insert yielded
6025	6	6" x 2 1/2"	3"	3500 psi	16,500	Same comments

NOTE: Ram area = 4.71 sq. in.



Hydraquip
Sales & Service

818 Eastern Avenue, Unit 2, Toronto, ON, M4L 1A1

Calibration Test Certificate

==========

Customer: Paton Steenson Associates
Gauge Description: Enerpac Gauge 0-10,000 psi, serial G93-496

==========

Standard Used: Mansfield & Green, Type #R-50
Dead Weight Serial #: 1315
Dead Weight Accuracy: 0.1%

==========

**Note: Instruments have been tested against a dead weight tester serial # as above, which is traceable to the National Research Council in Ottawa, as per their report # 722.0329, dated August 18,1989.

Hydraquip Sales & Service Ltd. certifies that the below item(s) have been tested to comply in every way with the requirements of the above purchase order.

==========

Master Test Gauge D.W.	Above Gauge
1000 PSI	1000 PSI
3000	3000
5000	5000
7000	7025
9000	9025

Date Tested: Dec 6, 1993
Technician: Pat Mahon

Phone 416-461-3573 Fax 416-461-2979
Out of town callers 1-800-463-4168

PHOTOGRAPHS

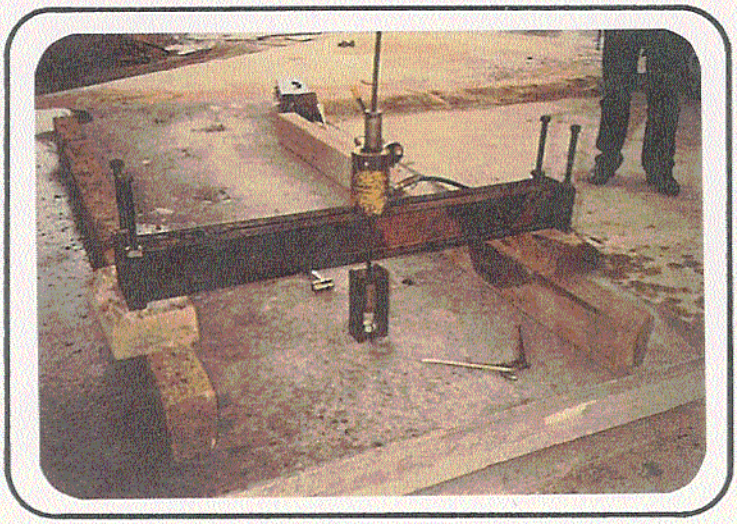


Fig. 1 Test Panel & Set-Up

Fig. 2 Insert in 2" Concrete
(Test # 14) - 9,000 lbs.

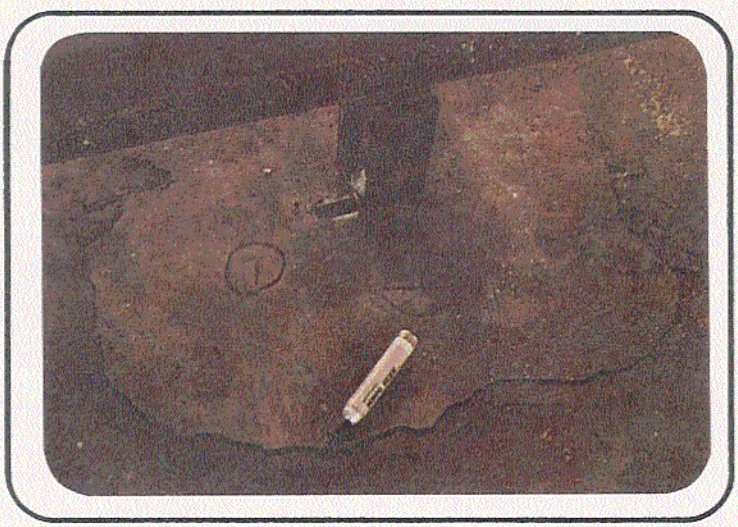
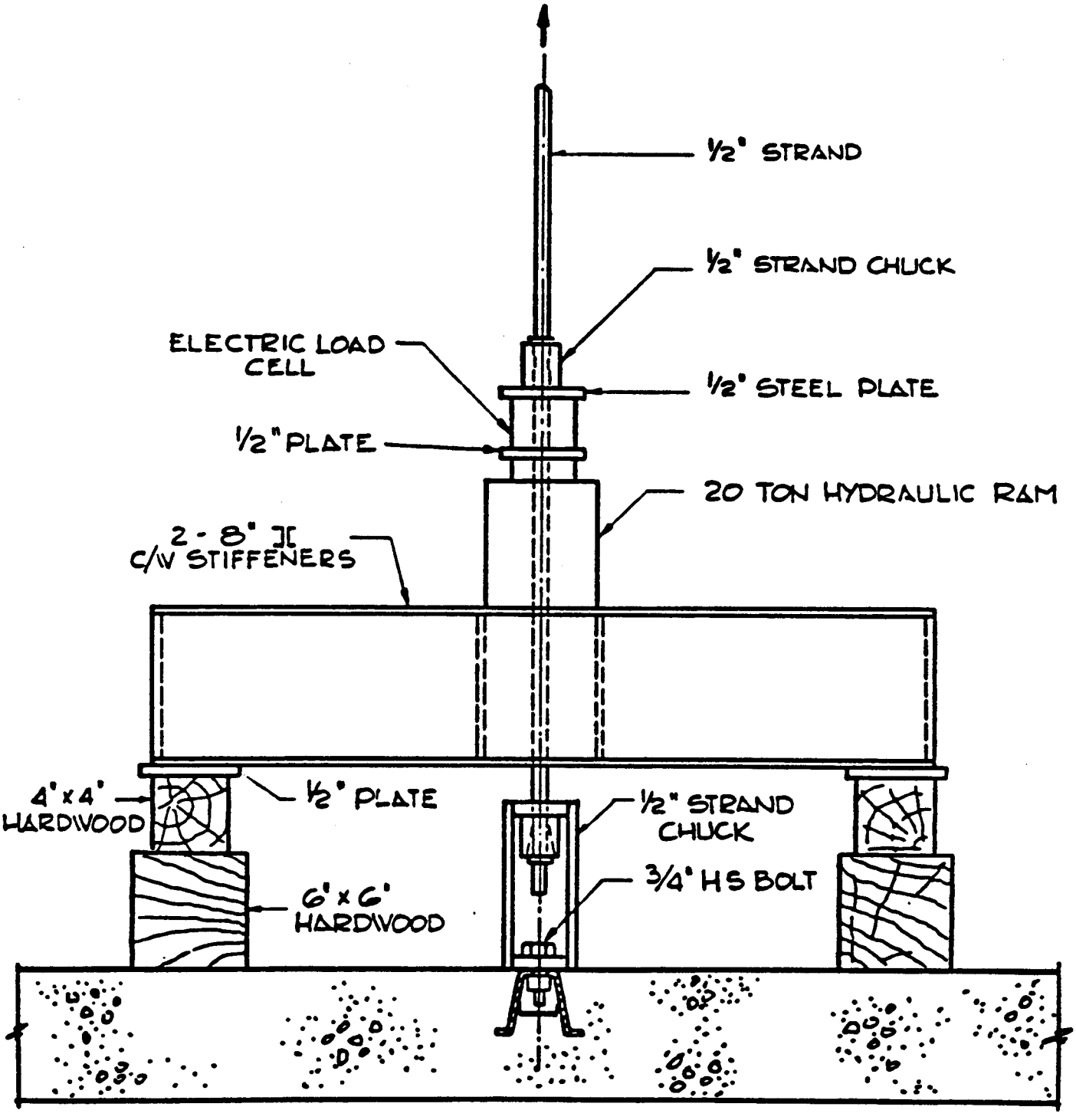


Fig. 3 Insert in 3" Concrete
Near a strand
(Test # 7) - 16,500 lbs.

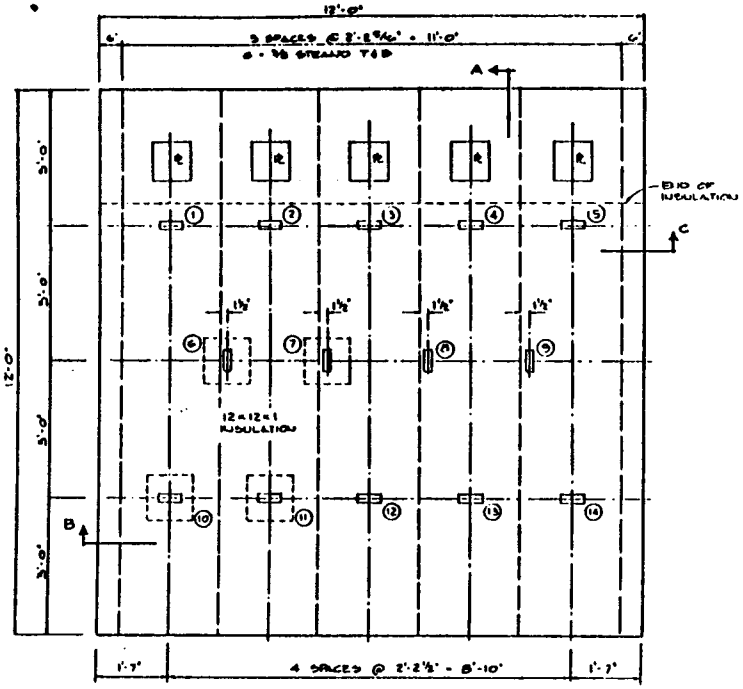
Fig. 4 Insert in 3" Conc.
No strand (Test #11)
14,600 lbs.

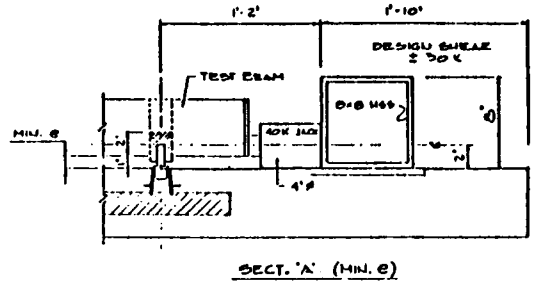


TEST SET-UP

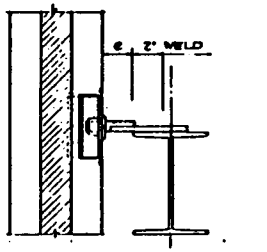
FOR PULLOUT TESTS

FIG. 5

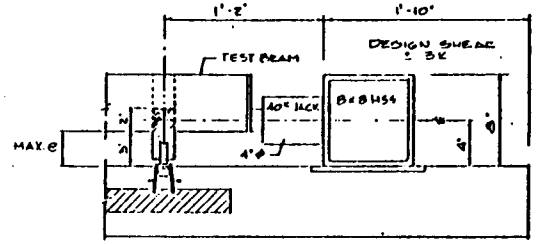




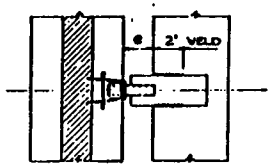
SECT. 'A' (MIN. e)



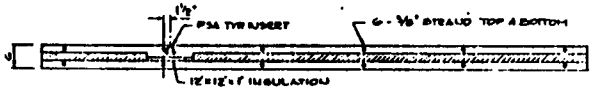
TYPICAL TOP CONNECTION



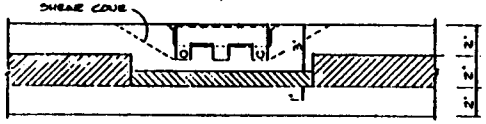
SECT. 'A' (MAX. e)



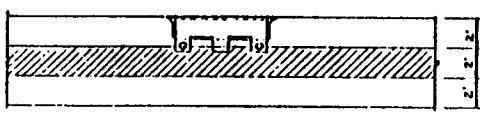
TOP VIEW



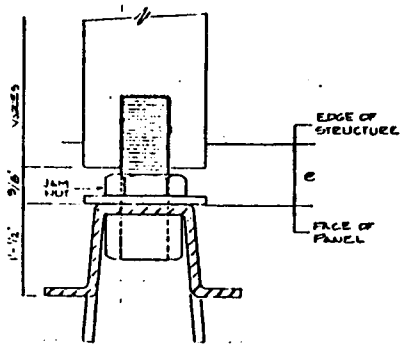
SECTION THROUGH TEST PANEL



SECTION 'B'
12"x12"x1" REDUCED INSULATION



SECTION 'C'
FULL INSULATION



STRAP ANCHOR WITH LOCK NUT

INSERT DESCRIPTION

C	6028	6"x3½"	SHEAR TEST
C	6025	6"x3½"	SHEAR TEST
C	6025	6"x2½"	SHEAR TEST
C	6025	6"x3½"	SHEAR TEST
C	6028	6"x2½"	SHEAR TEST
C	6028	6"x2½"	5" CONCRETE
C	6025	6"x3½"	5" CONCRETE
C	6025	6"x2½"	2" CONCRETE
C	6025	6"x2½"	2" CONCRETE
C	6025	6"x2½"	2" CONCRETE
C	6025	6"x2½"	2" CONCRETE
C	6025	6"x2½"	2" CONCRETE
C	6025	6"x2½"	2" CONCRETE
C	6025	6"x2½"	2" CONCRETE
C	6025	6"x2½"	2" CONCRETE

DATE	ISSUE	REVNS.	DESCRIPTION	CHECK

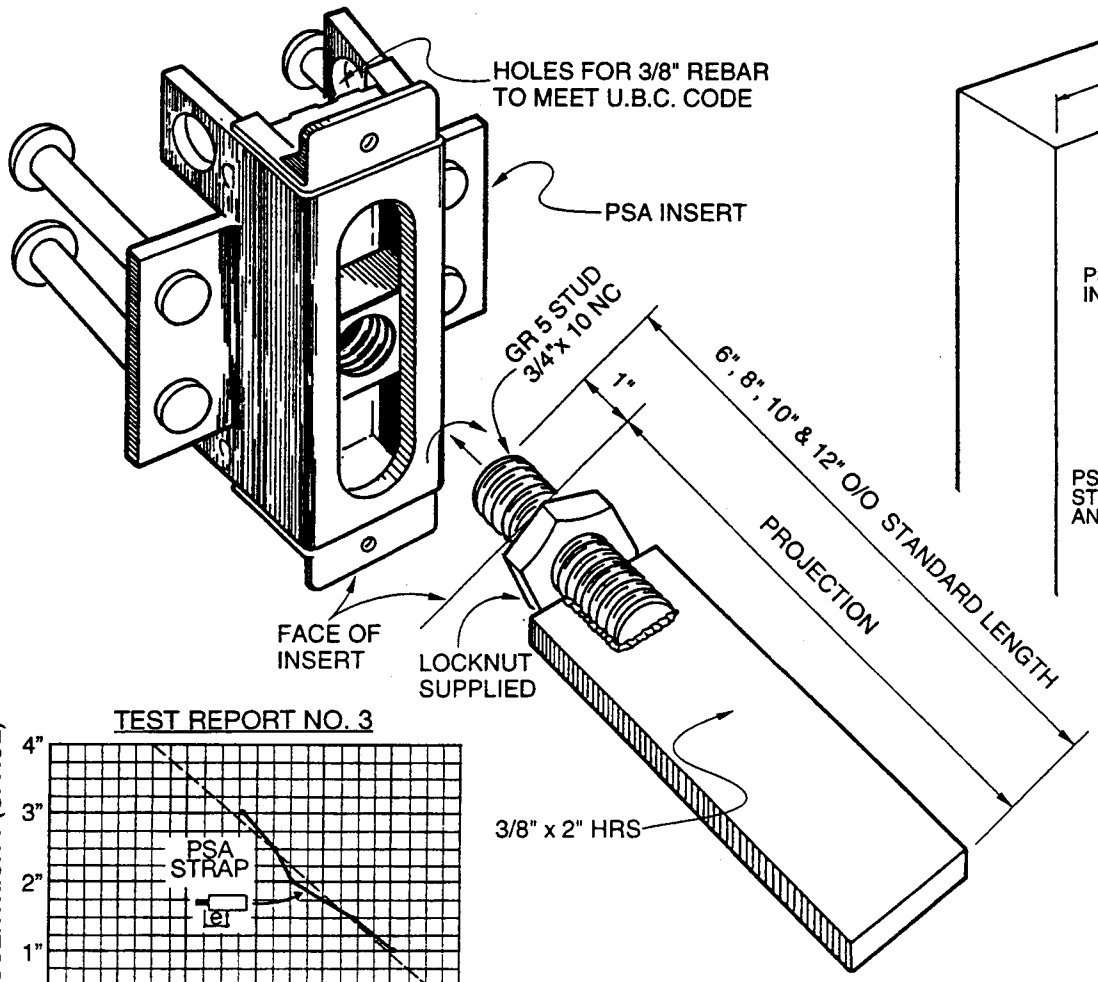
PSA PATON STEPHENSON ASSOCIATES INC

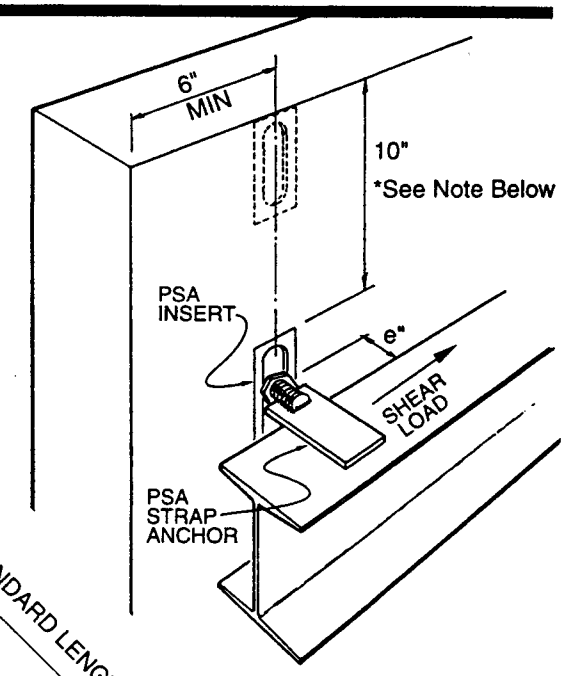
JOB
STRAP ANCHOR SHEAR TEST

DETAIL
TEST PANEL SET-UP

DETAIL No.	DRAWN BY PSA.	DATE MAR. '84
DET. REF.	CHECKED BY	REVISION
	DRAWING No. 1003	

PSA STRAP ANCHORS





Note:
* Reduce Ultimate Load by 25% if Insert Placed at Top Edge of Panel. (Test Report No. 2)

FEATURES:

• Ultimate Pull-out Capacity

Strap Anchors Develop full Ultimate Capacity of the insert

Insert Type	Depth	Length	Ult. Pull-Out Capacity
4525	2 1/2"	4 1/2"	12,000 lbs
6025		6"	
4535	3 1/2"	4 1/2"	16,000 lbs
6035		6"	
4545	4 1/2"	4 1/2"	20,000 lbs
6045		6"	

Ultimate Pull-Out Capacity Based on Tests Performed in 5,000 psi Normal Weight Concrete (Refer to PSA Test Report No.1)

• Ultimate Shear Capacity

20,350 lbs. at 1" Eccentricity (See Graph Above)
Ult. Shear Capacity based on Tests Performed in 6,000 psi Normal Weight Concrete (Refer to PSA Test Report No. 3)

• Standard Strap Anchor Lengths

6", 8", 10" & 12" Out/Out

• **Available Finishes** – Epoxy or Hot Dipped Galvanized. (Stainless Steel available on Special Order)

• **Material** – High Strength weldable grade HRS Steel

• **Lock Nut** – Ensures Positive Connection in Both Directions

In the U.S.A. JVI In Canada PSA

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Peto MacCallum Ltd.
CONSULTING ENGINEERS

TEST REPORT NO. 5

MORE PULL-OUT TESTS ON

PSA SLOTTED INSERTS

At Pre-Con Company Plant

MAY, 1994

ACKNOWLEDGEMENT

Special thanks to BOB MILLER AND ROGER WONG of Pre-Con Company for their help and advice in making this test program possible.

NOTICE

45 Burford Road, Hamilton, Ontario L8E 3C6
Tel: (905) 561-2231 Fax: (905) 561-6363
AURORA, BARRIE, BRAMPTON, HAMILTON, KITCHENER, OSHAWA, TORONTO

Peto MacCallum Ltd.
CONSULTING ENGINEERS

May, 1994

LOAD TESTS ON PSA SLOTTED INSERTS
TEST REPORT NO.5

INTRODUCTION

The purpose of this test program was, (a) to determine the ultimate pull-out capacity of PSA Slotted Inserts when the load is as applied at one end of the insert, (b) to find out if the ultimate pull-out capacity could be increased by adding reinforcing steel through the holes in the legs of the insert, and (c) to reconfirm the ultimate pull-out capacity of PSA Slotted Inserts as previously tested.

TEST PANEL

Two concrete test panels were manufactured at the Pre-Con Plant in Brampton, Ontario on April 22, 1994 as part of a normal day's production. The details of the test panels are shown on Drawing Nos. 1006 & 7, included in Appendix A. Load tests were conducted on May 2nd when the test panels were 10 days old. The average concrete strength, as determined by concrete test cylinders was 5853 psi at the time of the test. The test panels were not prestressed but were reinforced for handling purposes by a nominal layer of welded wire fabric located underneath the inserts. The concrete was cured in a normal manner (not accelerated). Additional reinforcing steel was provided through the legs of specific inserts as shown in detail on the test panel drawings and as noted in the table of test results.

TEST METHOD

The test load, in all cases, was applied to the inserts through their normal connection devices using a 20 ton hydraulic ram and hand operated pump. A load cell with a digital readout gauge was used to obtain an accurate direct load measurement. Recent calibration data for the load cell is included in Appendix A.

Figures 1 and 2 illustrate the conventional test arrangement used. A high strength bolt in the load transfer bracket was attached to the heavy duty nut built into the insert. The load was applied with the nut located either in the center of the insert or at one end of the insert as noted on the drawings and in the table of test results. All inserts were tested for ultimate pull-out capacity.

A visual inspection of the pattern of failure cracking was made throughout the tests. The mode of failure was was determined, photographed and recorded.

45 Burford Road, Hamilton, Ontario L8E 3C6
Tel: (905) 561-2231 Fax: (905) 561-6363
AURORA, BARRIE, BRAMPTON, HAMILTON, KITCHENER, OSHAWA, TORONTO

TEST PROGRAM

Inserts were both 4 1/2" and 6" long and either 2 1/2", 3 1/2" or 4 1/2" deep. Heavy duty square nuts are contained within each insert. The load was applied to the insert using a 3/4" high strength bolt located either at the center or at one end of the insert.

All inserts were positioned away from the edges and corners of the panels, as shown on the drawings, in order to determine the true unreinforced capacity of these inserts.

Additional reinforcing steel was placed through the holes in the legs of specific inserts. This reinforcement consisted of either 2 - 10M (#3) straight bars or one 10 M (#3) hairpin. In all cases, this reinforcement was flat (not stepped).

TEST RESULTS

A table of test results is given in Appendix A.

DISCUSSION

1. In all cases the recommended ultimate capacity of these inserts was developed regardless of whether the bolt was located at the center or at the end of the insert. The minor variation between individual tests results is considered to be insignificant.

2. There was no significant increase in ultimate capacity when additional flat reinforcing steel was placed through the inserts. The individual test results in these cases were inconclusive. However the use of such additional reinforcing steel, as required by the UBC Code is highly recommended.

3. The test results compare closely with similar tests done in September, 1993 as reported in Test Report No. 1.

   (a) In the case of the 2 1/2" deep inserts (12 kip nominal), the average ultimate capacity was 13013 lbs. compared with 13,475 lbs. previously. In all cases the mode of failure was a typical concrete failure cone extending to the full depth of the insert.

(b) In the case of the 3 1/2" inserts (16 kip nominal), the average ultimate capacity was 17,957 lbs. compared with 18,850 lbs. previously. In all cases (except two) the mode of failure was a typical concrete failure cone extending to the full depth of the insert studs. The other two tests produced a typical mechanical failure of the insert lips at 18,700 lbs. compared with 18,800 lbs. previously. This test confirms the balanced design of this insert. The shoulder studs anchored to the insert legs have increased the concrete capacity of the insert up to its mechanical capacity.

(c) In the case of the 4 1/2" inserts (20 kip nominal), the average ultimate capacity was 22,541 lbs. compared with 21,566 lbs. previously. Two tests were stopped prior to failure at approxinately 24,000 lbs. for fear of over loading the load cell. Two other tests were affected by an adjacent crack in the panel caused by a previous test. The mode of failure for the other four tests was a typical concrete failure cone extending to the full depth of the insert studs. These tests confirm the performance of the shoulder studs and represent the highest loads ever achieved with PSA Inserts.

4. Test No. A12 was disregarded because the identification tag for this insert had become embedded in the concrete and caused a smooth shear plane through the concrete failure cone. As A result, the size of the failure cone was reduced to about 2/3 its usual size.

5. Some test results were disregarded because the panel had been cracked near the test insert, by an adjacent test. In future the test inserts should be placed further apart so that one insert failure cannot affect another.

CONCLUSIONS AND RECOMMENDATIONS

1. The ultimate capacity of these inserts is not dependent on the presence of reinforcing steel in the concrete.

2. The ultimate capacity of these inserts can be developed whether the load is applied at the center or at the end of the insert.

3. The ultimate capacity of these inserts is governed by the strength of the concrete failure cone which in turn is a function of the embedded depth of the insert and/or stud anchors.

4. The ultimate capacity of these inserts in <u>not</u> increased by the use of flat reinforcing bars or hairpins inserted through the holes in the insert legs. However this practice is recommended in order to comply with the UBC Code, particularly in seismic areas.

5. When used in minimum 5000 psi. concrete with appropriate edge distances, the ultimate pull-out capacities of these inserts are as follows:

INSERT TYPE	ANCHORAGE DEPTH	AVERAGE FAILURE (PREVIOUS)	AVERAGE FAILURE (CURRENT)	NOMINAL ULTIMATE CAPACITY
4525	2 1/2"	13,475 lb.	12,716 lb.	12,000 lb.
6025	2 1/2"	13,475 lb.	13,260 lb.	12,000 lb.
4535	3 1/2"	18,850 lb.	17,792 lb.	16,000 lb.
6035	3 1/2"	18,850 lb.	18,162 lb.	16,000 lb.
4545	4 1/2"	21,566 lb.	22,467 lb.	20,000 lb.
6045	4 1/2"	21,566 lb.	22,597 lb.	20,000 lb.

Peto MacCallum Ltd.

Gerry Pacitti, P. Eng.

May 15. 1994

APPENDIX A

1. Table of Test Results (2 Pages).

2. Calibration Report.

3. Photographs - Figs. 1 through 10 incl.

4. Fig. 11 - Test Set Up.

5. Drawing No. 1006 - Test Panel "A".

6. Drawing No. 1007 - Test Panel "B".

7. Data Sheet for PSA Strap Anchors.

8. Data Sheet for PSA Inserts.

May 2, 1994

TEST RESULTS

PSA SLOTTED INSERTS - TEST REPORT NO. 5

INSERT TYPE	TEST NUMBER	INSERT LOCATION	EXTRA REINF.	BOLT LOCATION	FAILURE LOAD (Lbs.)	REMARKS
(12 KIP)	6" x 2 1/2" INSERTS - LOAD APPLIED AT CENTER OF INSERT					
6025	A1	Internal	1 hairpin	Center	13,800	Typ. concrete cone
6025	A11	Internal	None	Center	14,550	Typ. concrete cone
6025	B15	Internal	None	Center	13,100	Lge. conctere cone
(12 KIP)	6" x 2 1/2" INSERTS - LOAD APPLIED AT END OF INSERT					
6025	A3	Internal	2 - #3 Str.	End	13,020	Typ. concrete come
6025	A9	Internal	None	End	12,120	Typ. concrete cone
6025	B13	Internal	None	End	12,970	Lge. concrete cone
(12 KIP)	1/2" x 2 1/2" INSERTS - LOAD APPLIED AT CENTER OF INSERT					
4525	A4	Internal	1 Hairpin	Center	12,240	Typ. concrete cone
4525	A10	Internal	None	Center	13,120	Typ. concrete cone
4525	B14	Internal	None	Center	13,400	Lge. concrete cone
(12 KIP)	4 1/2"X 2 1/2" INSERTS - LOAD APPLIED AT END OF INSERT					
4525	A2	Internal	2 - #3 Str.	End	13,120	Typ. concrete cone
4525	A12	Internal	None	End	(10,600)**	Tape fouled cone
4525	B16	Internal	None	End	11,700	Lge. concrete cone
(16 KIP)	6" X 3 1/2" INSERTS - LOAD APPLIED AT CENTER OF INSERT					
6035	A7	Internal	2 - #3 Str.	Center	18,700	Insert lips failed
6035	A15	Internal	None	Center	18,150	Lge. concrete cone
6035	B5	Internal	None	Center	17,100	Typ. concrete cone
(16 KIP)	6" X 3 1/2" INSERTS - LOAD APPLIED AT END OF INSERT					
6035	A5	Internal	1 Hairpin	End	(11,8070)*	Cracked before test
6035	A13	Internal	None	End	(15,850)*	Cracked before test
6035	B7	Internal	None	End	18,700	Insert lips failed

Test Results continued on next page

TEST RESULTS (CONTINUED)

TEST REPORT NO 5

May 2, 1994

INSERT TYPE	TEST NUMBER	INSERT LOCATION	EXTRA REINF.	BOLT LOCATION	FAILURE LOAD (Lbs.)	REMARKS
(16 KIP) 4 1/2" X 3 1/2" INSERTS - LOAD APPLIED AT CENTER OF INSERT						
4535	A6	Internal	2 - #3 Str.	Center	18,900	Lge. concrete cone
4535	A14	Internal	None	Center	16,960	Typ. concrete cone
4535	B8	Internal	None	Center	16,700	Lge. concrete cone
(16 KIP) 4 1/2" X 3 1/2" INSERTS - LOAD APPLIED AT END OF INSERT						
4535	A8	Internal	1 Hairpin	End	17,800	Typ. concrete cone
4535	A16	Internal	None	End	(15,100)*	Cracked before test
4535	B6	Internal	None	End	18,600	Typ. concrete cone
(20 KIP) 6" X 4 1/2" INSERTS - LOAD APPLIED AT CENTER OF INSERT						
6045	B11	Internal	None	Center	24,000***	Test stopped early
6045	B1	Internal	1 Hairpin	Center	22,900	Typ. concrete cone
(20 KIP) 6" X 4 1/2" INSERTS - LOAD APPLIED AT END OF INSERT						
6045	B9	Internal	None	End	22,900	Typ. concrete cone
6045	B3	Internal	2 - #3 Str.	End	20,500	Cracked before test
(20 KIP) 4 1/2" X 4 1/2" INSERTS - LOAD APPLIED AT CENTER OF INSERT						
4545	B10	Internal	None	Center	24,200***	Test stopped early
4545	B4	Internal	1 Hairpin	Center	21,900	Typ. concrete cone
(20 KIP) 4 1/2" X 4 1/2" INSERTS - LOAD APPLIED AT END OF INSERT						
4545	B2	Internal	2 - #3 Str.	End	20,470	Cracked before test
4545	B12	Internal	None	End	21,300	Typ. concrete cone

NOTES

* Panel was cracked from adjacent test.

** Insert identification tape was embedded in concrete close to insert.

*** Test was stopped at 25 kip capacity of the load cell.

CALIBRATION CHART

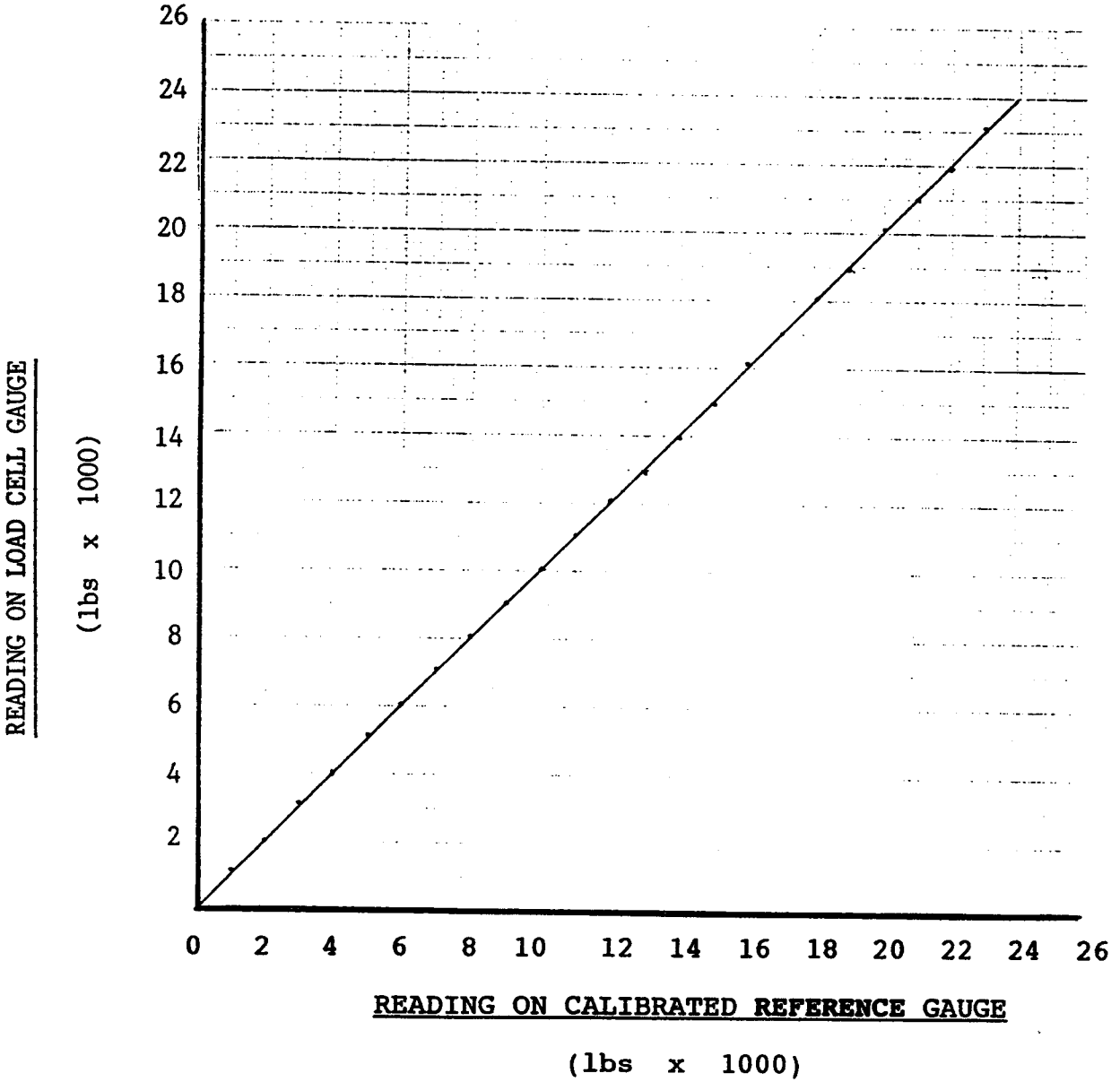
For

- STRAINSERT UNIVERSAL FLAT LOAD CELL
  MODEL FL25U(C) S/N 08908-2

Coupled with

- DORIC TRANSDUCER INDICATOR S/N 400236

DATE: September 3, 1993



PHOTOGRAPHS

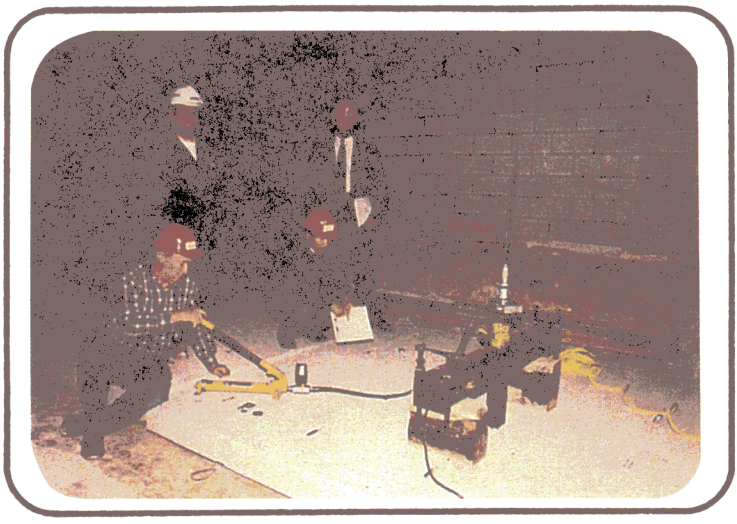


Fig. 1 Test Set-Up
Pre-Con Engineers

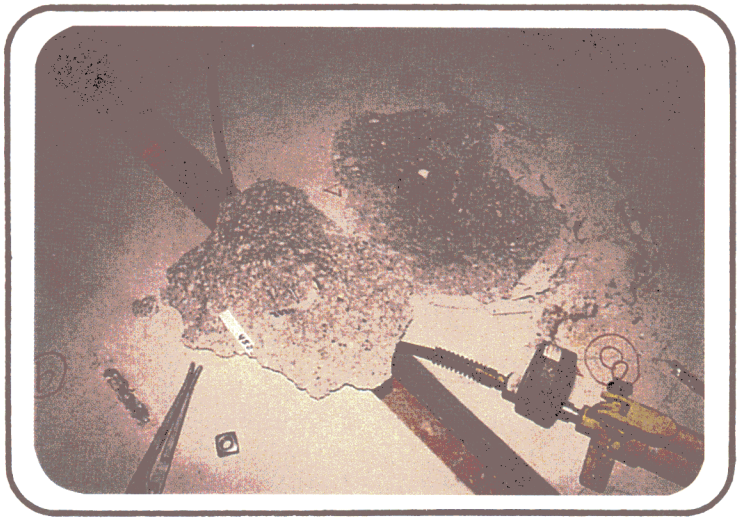


Fig. 2 Identificaion Tape fouled
concrete cone (Test # A12)

Fig. 3 Crack in panel prevented full
development of the failure cone.
Cone extends full depth of studs.

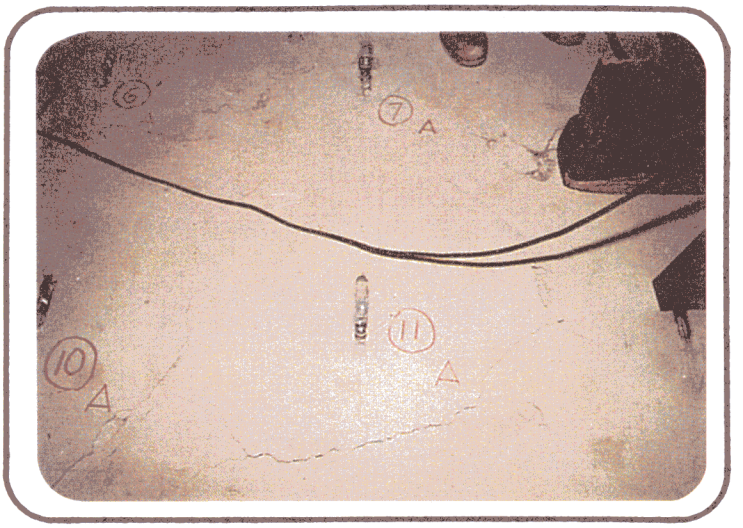


Fig. 4 Typ. 2 1/2" (12 kip) insert (Mk 6025)
Test # A11 - 14,550 lbs. Load at center.

Fig. 5 Typ. 2 1/2" (12 kip) insert (Mk 6025)
Test # B13 - 12,970 lbs. Load at end.

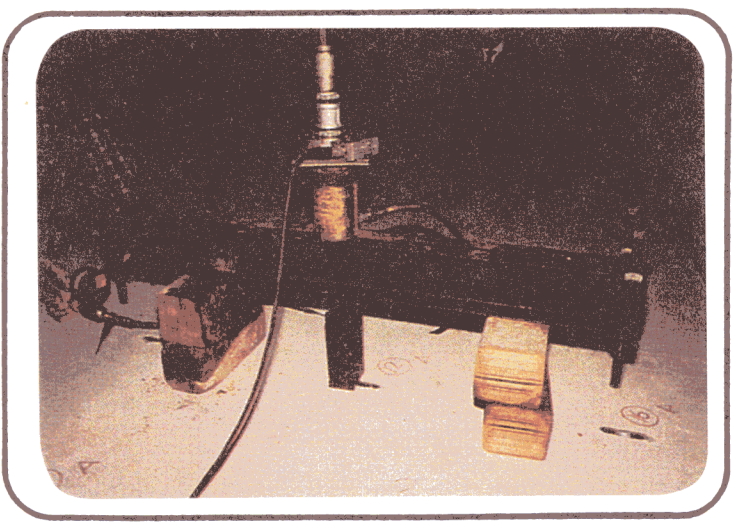


Fig. 6 Test Set-Up showing 20 Ton Jack,
hand pump and digital load cell.
Load located at end of insert.

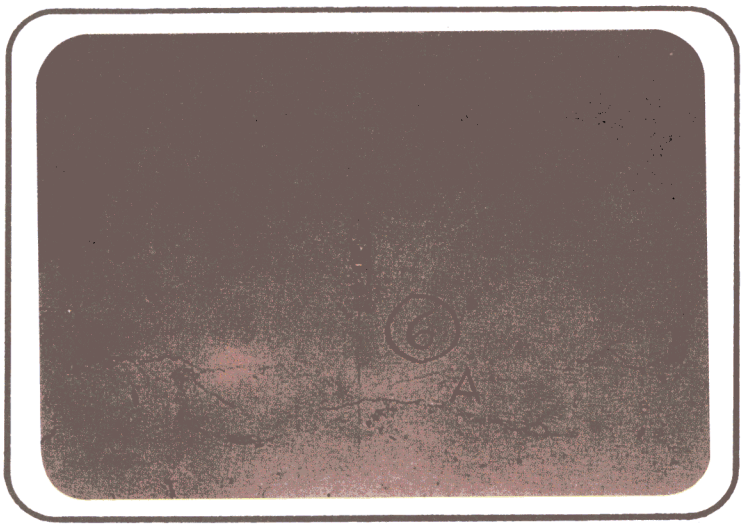


Fig. 7 Typ. 3 1/2" (16 kip) insert (Mk 6035)
Test # A6 - 18,900 lbs.(2 - #3 Bars str)

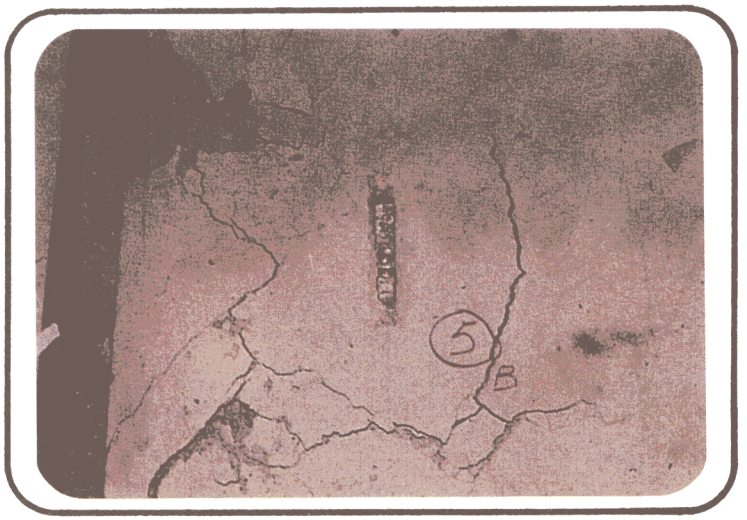


Fig. 8 Typ. 3 1/2" (16 kip) insert (Mk 6035)
Test # B5 - 17,100 lbs. Load at center.

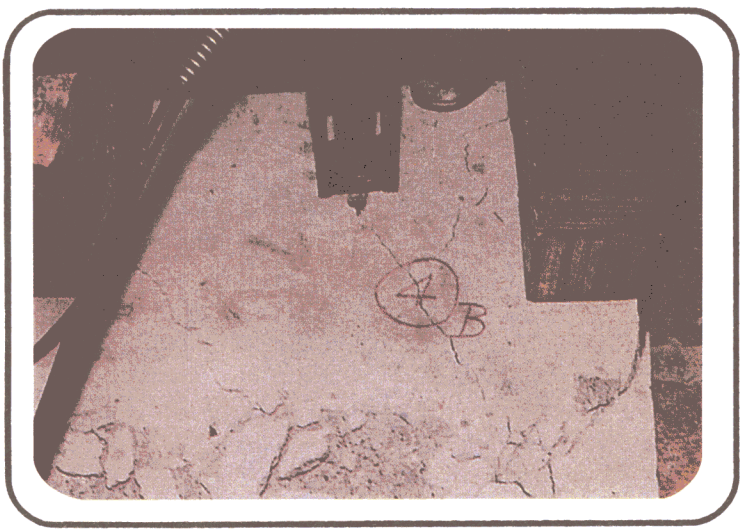


Fig. 9 Typ. 4 1/2" (20 kip) insert (Mk 4525)
Test # B4 - 21,900 lbs. Load at center.

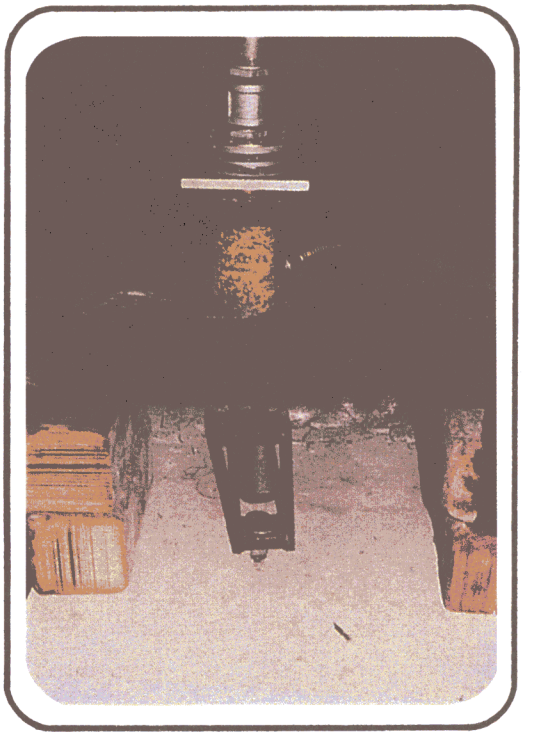
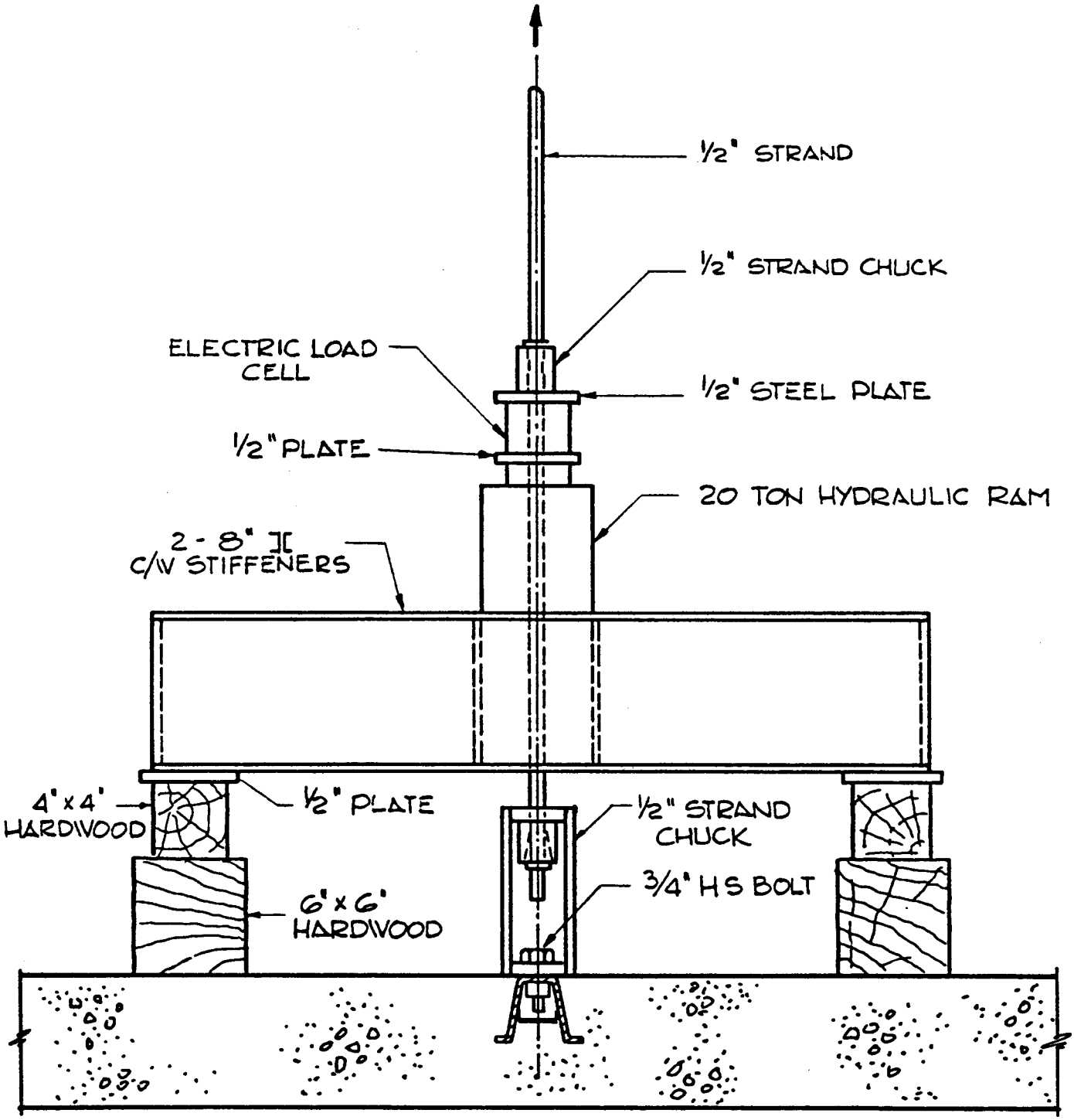


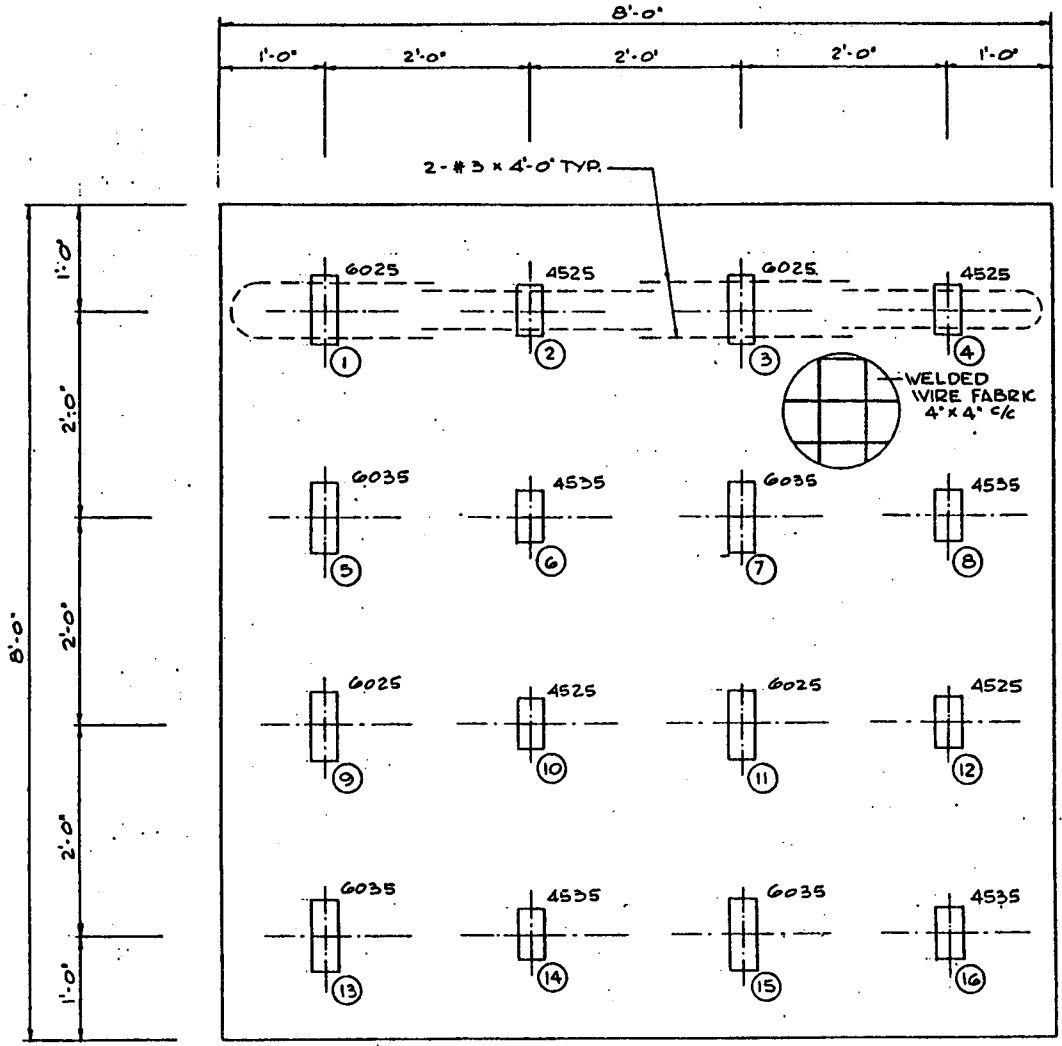
Fig. 10 Test Set-Up.
20 Ton Jack.
Digital Load Cell.
Load Transfer Bracket.

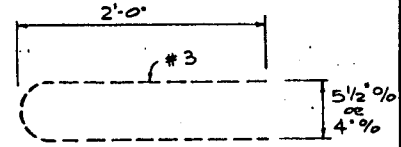


TEST SET-UP

FOR PULLOUT TESTS

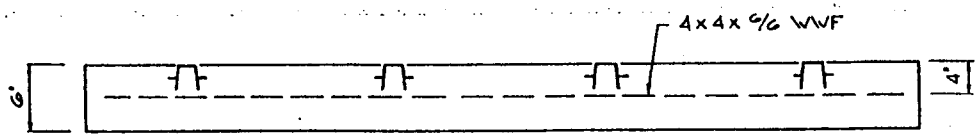
FIG. 11





REBAR

CONCRETE - 5000 psi MIN.
(TYP. FLEXWALL CONCRETE)



INSERT DESCRIPTION

TEST PANEL A

	INSERT	BOLT	REBAR
1	6025	C	HAIRPIN
2	4525	E	2 - 10m
3	6025	E	2 - 10m
4	4525	C	HAIRPIN
5	6035	E	HAIRPIN
6	4535	C	2 - 10m
7	6035	C	2 - 10m
8	4535	E	HAIRPIN
9	6025	E	—
10	4525	C	—
11	6025	C	—
12	4525	E	—
13	6035	E	—
14	4838	C	—
15	6035	C	—
16	4635	E	—

NOTES.

CONCRETE STRENGTH AT TIME OF TEST 5894 psi

TESTED AT PRECON PLANT BRAMPTON

DATE	ISSUE	REV.No.	DESCRIPTION	CHECK

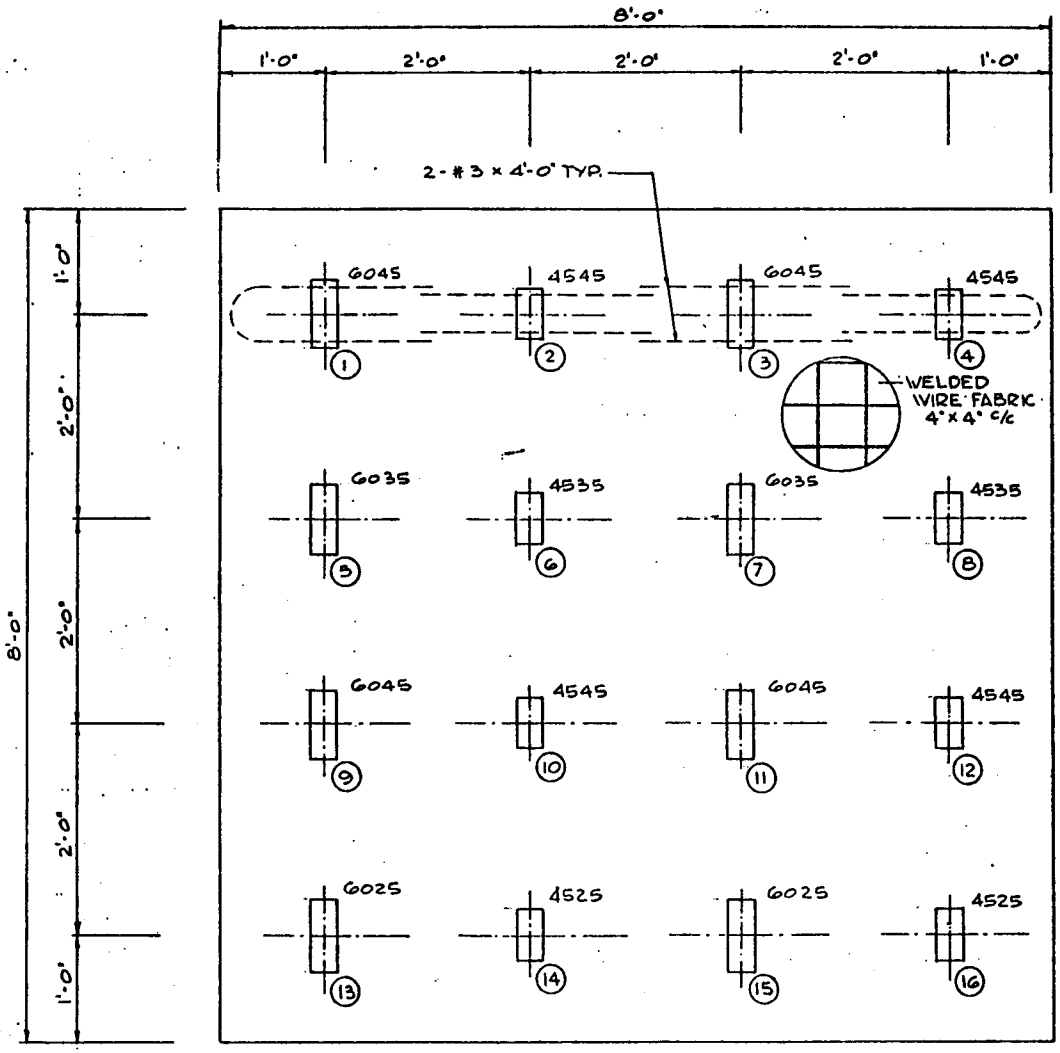
PSA PATON STEENSON ASSOCIATES INC
10 Royal Orchard Blvd.
P.O. Box #53009
THORNHILL, ONT. L3T 7R9

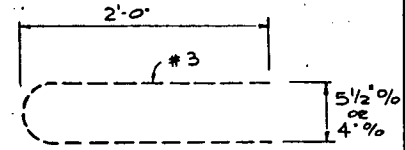
JOB
TEST REPORT No 5

DETAIL
PSA TEST PANEL No A

DETAIL No. / DET. REF.

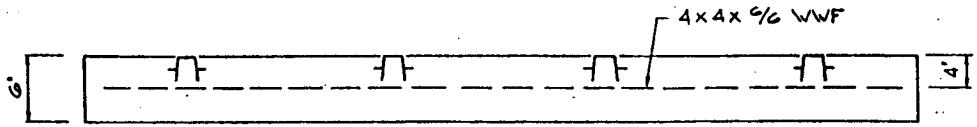
DRAWN BY	DATE
F.R.	MAY / 94
CHECKED BY	REVISION
DRAWING No.	1006





REBAR

CONCRETE - 5000 psi MIN. (TYP. FLEXWALL CONCRETE)



INSERT DESCRIPTION

TEST PANEL B

	INSERT	BOLT	REBAR
1	6045	C	HAIRPIN
2	4545	E	2 - 10m
3	6045	E	2 - 10m
4	4545	C	HAIRPIN
5	6035	C	—
6	4535	E	—
7	6035	E	—
8	4535	C	—
9	6045	E	—
10	4545	C	—
11	6045	C	—
12	4545	E	—
13	6025	E	—
14	4525	C	—
15	6025	C	—
16	4525	E	—

NOTES.

CONCRETE STRENGTH AT TIME OF TEST 5812 psi

TESTED AT PRECON PLANT BRAMPTON

DATE	ISSUE	REV.No.	DESCRIPTION	CHECK

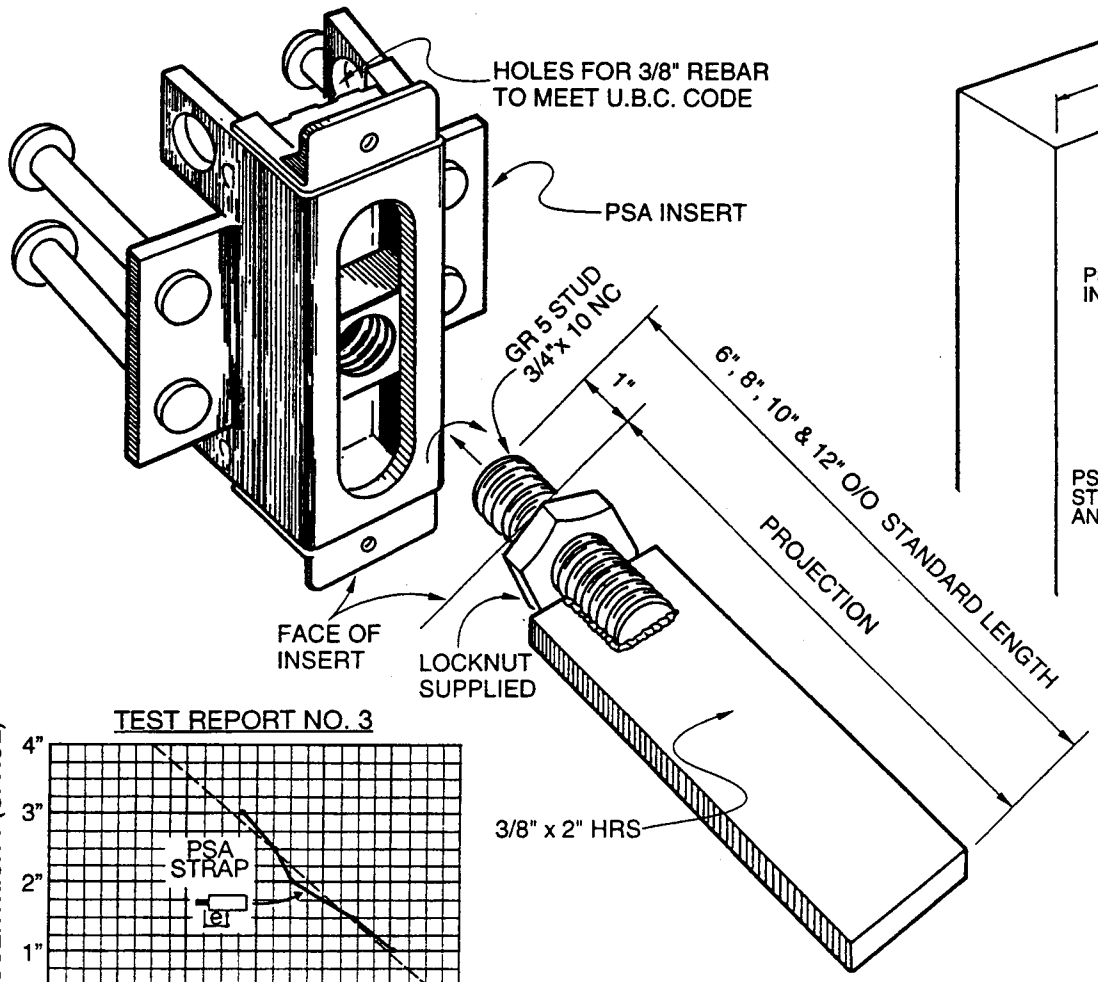
PSA PATON STEENSON ASSOCIATES INC
10 Royal Orchard Blvd.
P.O. Box #53009
THORNHILL, ONT. L3T 7P9

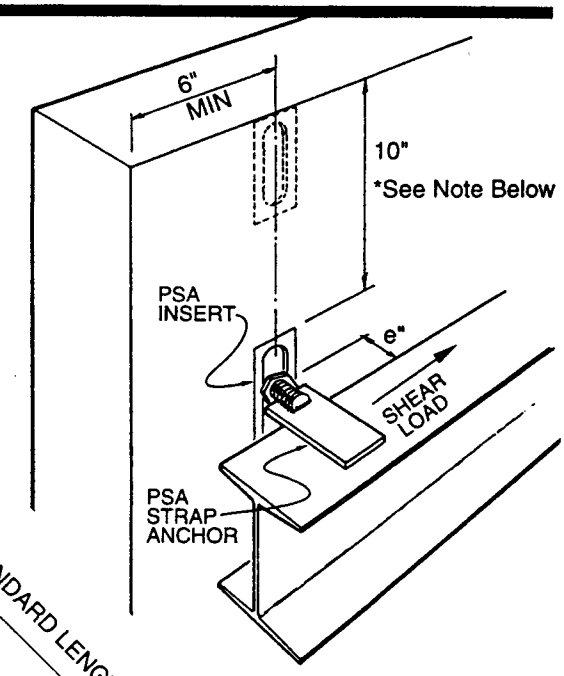
JOB
TEST REPORT No 5

DETAIL
PSA TEST PANEL No B

DETAIL No.	DRAWN BY	DATE
DET. REF.	E.R.	MAY /94
	CHECKED BY	REVISION
	DRAWING No.	1007

PSA STRAP ANCHORS





Note:
* Reduce Ultimate Load by 25% if Insert Placed at Top Edge of Panel. (Test Report No. 2)

FEATURES:

• Ultimate Pull-out Capacity

Strap Anchors Develop full Ultimate Capacity of the insert

Insert Type	Depth	Length	Ult. Pull-Out Capacity
4525	2 1/2"	4 1/2"	12,000 lbs
6025		6"	
4535	3 1/2"	4 1/2"	16,000 lbs
6035		6"	
4545	4 1/2"	4 1/2"	20,000 lbs
6045		6"	

Ultimate Pull-Out Capacity Based on Tests Performed in 5,000 psi Normal Weight Concrete (Refer to PSA Test Report No.1)

• Ultimate Shear Capacity

20,350 lbs. at 1" Eccentricity (See Graph Above)
Ult. Shear Capacity based on Tests Performed in 6,000 psi Normal Weight Concrete (Refer to PSA Test Report No. 3)

• Standard Strap Anchor Lengths

6", 8", 10" & 12" Out/Out

• **Available Finishes** – Epoxy or Hot Dipped Galvanized. (Stainless Steel available on Special Order)

• **Material** – High Strength weldable grade HRS Steel

• **Lock Nut** – Ensures Positive Connection in Both Directions

In the U.S.A. JVI In Canada PSA

ACCESSORIES, INC.
7550 North Linder Avenue
Skokie, Illinois 60077 USA
705/675-1560 Fax: 708/675-0083

PATON STEENSON ASSOC. INC.
10 Royal Orchard Blvd. P.O. Box #53009
Thornhill, Ontario L3T 7R9
905/889-7357 Fax: 905/889-7648

Test Report No. 6 UPDATE

The JVI Gold J-Finish has been updated to a Platinum J-Finish per the specifications below.

The Platinum J-Finish is a 3 step process as defined below.

1. Zinc Plate Per ASTM B633 FE/Zn12 TYPE II, SC3 Severe, (minimum thickness 0.0005")
2. Trivalent Clear Chromate (RoHS and ELV compliant)
3. Sealer

The "PLATINUM J-FINISH" shall meet the following specifications.

PLATINUM J-FINISH SPECIFICATIONS		
1.	Coating Thickness	Minimum .00050" on significant surface.
2.	Appearance	There shall be no evidence of blisters, peeling, pinholes, pits or rough surface on parts.
3.	Adhesion Requirements	There shall be no defects such as peeling, blisters or cracking after heating coated parts to 300 ± 10º C for 30 ± 5 minutes and quenching in water at 15º C to 25º C.
4.	Corrosion Resistance ASTM B 117	Part shall show no evidence of white corrosion after 96-hour exposure. Part shall show no evidence of red rust after 500-hour exposure.

Salt spray testing in accordance with Test Report 6 have been conducted and the results included with this update. The Platinum J-Finish passed all testing the previous gold J-Finish has been subjected to.

The motivation for the change was to have a RoHS/ELV compliant finish, a finish that does not require a hexavalent chromium. While this initiative has been in place since 2003, the trivalent equivalent available until today has not been satisfactory. Recent advances in the trivalent coating have made this a clear change for the better.

Please consider Test Report No. 6 to serve as reference only and consider the latest certificates of compliance to replace Test Report No. 6 for all specification and submittal purposes.

Please contact team JVI with any questions.

info@jvi-inc.com
847-675-1560
1-800-742-8127 (toll free)
www.jvi-inc.com

Coatings 85 Ltd.
6995 Davand Drive, Mississauga, Ontario L5T 1L5
Tel: (905) 564-1711 Fax: (905) 564-2819

CERTIFICATE OF COMPLIANCE

Customer:	**A.B.M. Tool & Die Co. Ltd**	***Processing Location:***	Coatings 85 Ltd.
Part Number:	Sample parts	***Specification:***	**ASTM-B633-FE/ZN12 TYPE11+SEAL**
Type of Finish:	Electroplated Zinc Clear Trivalent +Seal		
Processing Date	August 24,2015	***Prepared Date:***	September 25, 15

.

Actual Parts processed to the above specification have been tested with results as detailed below.

	TEST PERFORMED	RESULT	SPECIFICATION
1.	*Coating Thickness* **ASTM-B633-FE/ZN12** **TYPE11+SEAL** Actual parts tested	.00057 .00060 .00059	Minimum .00050 on significant surface.
2.	*Appearance* **ASTM-B633-FE/ZN12** **TYPE11+SEAL** **Actual parts tested**	No evidence of blisters, peeling, pinholes, pits or rough surface on parts.	There shall be no evidence of blisters, peeling, pinholes, pits or rough surface on parts.
3.	*Adhesion Requirements* **ASTM-B633-FE/ZN12** **TYPE11+SEAL** **Actual part tested**	No evidence of peeling, blisters or cracking after heating coated parts to 300 ± 10º C for 30 ± 5 minutes and quenching in water at 15º C to 25º C.	There shall be no defects such as peeling, blisters or cracking after heating coated parts to 300 ± 10º C for 30 ± 5 minutes and quenching in water at 15º C to 25º C.
4.	*Corrosion Resistance – Neutral* **ASTM-B633-FE/ZN12** **TYPE11+SEAL** **3 Actual parts tested**	**Passed** . **Passed**	Part shall show no evidence of white corrosion after 96-hour exposure. Part shall show no evidence of red rust after 500-hour exposure.

Clifford Allen
Q.C. Supervisor

JAGEMANN PLATING CO.
PH: 920 / 682-6883 • FAX: 682-8003 • 1324 SO. 26th ST. • P.O. BOX 1447 • MANITOWOC, WI 54221-1447
LABORATORY CONTROL • ELECTRO PLATING • METAL FINISHING

ISO 9001:2008 CERTIFIED

In-House Test
Process Verification: Zinc Trivalent Clear Chromate Plate .0005 Minimum Thickness, With Sealer (Rack Process)

Date: **Subject:**	11/16/2015 Salt Spray Test	**Your Ref # :** **Part # :** **Inspection Date:**	25DL/Zincroshield Sample 10/26/2015 - 11/16/2015
Plating Specification:	Zinc Trivalent Clear Chromate Plate .0005 Minimum Thickness With Sealer 1010 Material Pin		
Actual Plating Thickness:	.00051 - .00062		

Salt Spray Test Results
(ASTM B 117)

Hours Of Exposure	Visual Observations	Test Requirements	Pass/Fail
120	After 120 hours of exposure to the below described test conditions, the parts were removed from the test chamber, rinsed with de-ionized water, dried with filtered dry compressed air and inspected. The surface of the test sample shows no visible white rust products in the concern area. After 500 hours of exposure to the below described test conditions, the parts were removed from the test chamber, rinsed with de-ionized water, dried with filtered dry compressed air and inspected. The surface of the test sample shows visible white rust, no visible red rust products.	We were requested to salt fog test the parts according to American Society for Testing and Materials (ASTM) B 117 for 500 hours.	PASS

Solution	5 % NaCl
Chamber Temperature	95 ± 1 ° F
Specific Gravity @ 95 ° F	1.025 to 1.040
PH Of Collected Solution	6.5 to 7.2
Average Collection Rate	1 – 2 ml/hr./80 cm² surf. area

Signed: ***Electronic document Original Contains Signature***

John R. Nelesen
Quality Assurance Manager

PSA PATON STEENSON ASSOCIATES INC

10 ROYAL ORCHARD BOULEVARD • P.O. BOX 53009 • THORNHILL, ONTARIO L3T 7R9
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TEST REPORT NO. 6

CORROSION TESTS ON

PSA STRAP ANCHORS AND INSERTS

Salt Spray Tests - ASTM B117-94

November, 1994

NOTICE

This publication is intended for the use of professional personnel, competent to evaluate the significance and limitations of its contents and who will accept responsibility for the application of the material it contains. Paton Steenson Associates Inc. and JVI Accessories, Inc. disclaim any and all responsibility for the application of the stated principles or for the accuracy of the information contained herein.

APPENDIX A

1. Summary Table of Salt Spray Test Results

2. Individual Salt Spray Test Reports
   - Page 1 J-Type Finish - PSA Strap Anchor
   - Page 2 Zinc Finish - PSA Strap Anchor
   - Page 3 H.D. Galv. Finish - PSA Strap Anchor
   - Page 4 Epoxy Finish - PSA Insert
   - Page 5 H.D. Galv. Finish - PSA Insert
   - Page 6 J-Type Finish - PSA Insert

3. Photographs - Figs. 1 through 6 incl.

4. Fig. 7 - Typical Salt Spray Cabinet

5. Fig 8. - Excerpt from ASTM B117-94 Specification "Standard Practice for Salt Spray Testing Apparatus"

6. PSA Data Sheet for Strap Anchor Connections.

7. PSA Insert Brochure

PSA PATON STEENSON ASSOCIATES INC

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TEL 905-889-7357 • FAX 905-889-7648

November, 1994

ACCELERATED CORROSION TESTS
TEST REPORT NO. 6

INTRODUCTION

The purpose of this report is to compare the corrosion resistance of the new J - TYPE automotive coating used on PSA Strap Anchors and Inserts with the traditional zinc, epoxy and hot dip galvanized coatings used in the construction industry.

TEST SAMPLES

The following insert and strap anchor samples were tested:

Coating	Sample Tested
J - Type	PSA Strap Anchor - Mk. 675
Zinc	PSA Strap Anchor - Mk. 675
Hot Dip Galvanized	PSA Strap Anchor - Mk. 875
Epoxy	PSA Insert - Mk. 6025
Hot Dip Galvanized	PSA Insert - Mk. 6025
J - Type	PSA Insert - Mk. 6025

TEST METHOD

All samples were placed in a commercial Salt Spray Cabinet (Fig. 7) and tested for corrosion resistance in accordance with the ASTM B117-94 Specification "Standard Method of Salt Spray (Fog) Testing" (Fig. 8). A visual inspection was made every 24 hours. The condition of each sample was determined, photographed and recorded.

TEST RESULTS

Detailed test observations for each sample, together with a summary table of Salt Spray Tests are included in Appendix A. Photographs showing the condition of each sample when the particular test was terminated, are also included in Appendix A (Figs. 1 to 6).

DISCUSSION

1. The **J -Type** corrosion resistant finish (guaranteed against red rust for 500 hours), was still intact on both the insert and the strap anchor samples when each test was terminated. There was some white rust but no sign of red rust even after **624** hours (strap anchor) and **648** hours (insert) of test, (see Figs. 2, 4a and 4b in Appendix A). This corrosion resistant finish is being extensively used by the automotive industry for underhood fasteners, brakes and steering parts etc., where salt damage is likely to occur.

2. The **zinc** finish on the PSA strap anchor was 0.00033" thick in accordance with ASTM specification B633 Type II. After **168** hours when the test was terminated, considerable white and red rust had developed on this sample. (Fig. 2). This finish is not used on any PSA products. The test was made for comparative purposes only.

3. The **hot-dip galvanized** finish on the PSA strap anchor was 0.0048" thick, (four times as thick as the insert). This sample was covered with white rust after **360** hours when the test was terminated, but no red rust was observed. (Fig. 1).

4. The **hot-dip galvanized** finish on the PSA insert was completely covered with white rust after **648** hours when the test was terminated. It looked like a Christmas tree. Traces of red rust were observed at termination. (Figs. 5a and 5b)

5. The **epoxy** finish on the PSA insert performed very well. At **168** hours, red rust started along some sharp edges of the sample. At **648** hours when the test was terminated, significant red rust had occurred along sharp edges primarily on the bottom of the sample. (figs. 6a and 6b). It should be noted that 648 hours of salt spray is an extreme exposure for this type of finish. The epoxy finish out-performed the hot-dip galvanized finish.

CONCLUSIONS AND RECOMMENDATIONS

1. Corrosion resistance of the **J - Type** automotive finish is far superior to any other finish tested.

2. The **zinc** finish performed poorly in comparison with the other finishes tested. This finish is not used on any PSA products.

3. The **hot dip galvanized** finish, on both the PSA strap anchor and the Insert performed very well and is recommended as an acceptable construction finish for most applications. Stainless steel inserts are recommended for exposed corrosive conditions.

4. The **epoxy** coating on the PSA insert provides excellent corrosion resistance under normal exposure conditions. Special care must be taken to ensure proper epoxy coverage inside the cavity and at cut edges. The epoxy finish is recommended as an acceptable finish for most building connections.

PATON STEENSON ASSOCIATES INC.

W. D. Paton, P. Eng.

November 15, 1994

SUMMARY OF SALT SPRAY TESTS

HOURS (Av. Thickness)	J-TYPE PSA STRAP ANCHOR (0.00034")	ZINC PSA STRAP ANCHOR (0.00033")	H. D. GALV. PSA STRAP ANCHOR (0.0048")	EPOXY PSA INSERT (0.0023")	H. D. GALV. PSA INSERT (0.00127")	J-TYPE PSA INSERT (0.00037)
24	Nil	Nil	Nil	Nil	Nil	Nil
72	Nil	Nil	Nil	Nil	Nil	Nil
96	Nil	Nil	Nil	Nil	White Started	Nil
168	Nil	White & Red Start Test Terminated	Moderate White	Red Started at Holes & Edges	Moderate White	Nil
336	Nil		Hvy. White-No Red Test Terminated	Same	Moderate White	Nil
432	Slight White			Same	Heavy White	Slight White
648	No Red Test Terminated			Hvy. Red at Edges Test Terminated	Complete White Test Terminated	No Red Test Terminated

NOTE:

(1) Detailed test observations and photographs of all test samples are included in Appendix A.

AUTOTEK ELECTROPLAING INC.

SALT SPRAY TEST RESULTS

Test Method: ASTM B117-94

Customer: Paton Steenson Associates Inc. Part Number: Strap Anchor

Revision Code: Hot Dip Galvanized Cast Day: N/A

Lot Number: N/A Date Plated:

Start Date: 06/13/1994 1300hrs Finish Date: 06/28/1994 1300hrs

Exposure Period: 360 hrs (Test Terminated)

Coating Thickness in Inches:Reading #1 : 0.0048
#2 : 0.0047
#3 : 0.0050
#4 : 0.0047

EVAULATION RESULTS AS PER SPECIFICATION NUMBER: ASTM B117-94

Number of Hours(96): No sign of white corrosion products or red rust.

Number of Hours(120):First sign of white corrosion product .

Number of Hours(360): No sign of base metal corrosion (red rust).
parts exhibited 100 percent white corrosion.Test terminated.

Signature: D. Martin Khan Date: 06/28/1994

AUTOTEK ELECTROPLAING INC.

SALT SPRAY TEST RESULTS

Test Method: ASTM B117-94

Customer: Paton Steenson Associates Inc. Part Number: Strap Anchor

Revision Code: Zinc Finish Cast Day: N/A

Lot Number: N/A Date Plated: 05/11/1994

Start Date: 05/12/1994 1130hrs Finish Date: 05/19/1994 1330hrs

Exposure Period: 168 hrs

Coating Thickness in Inches:Reading #1 : 0.00032
#2 : 0.00034
#3 : 0.00032
#4 : 0.00033

EVAULATION RESULTS AS PER SPECIFICATION NUMBER: ASTM B117-94

Number of Hours(24): No sign of white corrosion products or red rust.

Number of Hours(96): No sign of white corrosion products or red rust.

Number of Hours(168): First sign of white corrosion products and red rust on threaded portion of part.

Signature: T. Matthews Date: 05/19/1994

AUTOTEK ELECTROPLAING INC.

SALT SPRAY TEST RESULTS

Test Method: ASTM B117-94

Customer: Paton Steenson Associates Inc.

Part Number: Strap Anchor

Revision Code: J-Type Corrosion Finish

Cast Day: N/A

Lot Number: N/A

Date Plated: 05/11/1994

Start Date: 06/12/1994 1130hrs

Finish Date: 06/07/1994 1300hrs

Exposure Period: 624 hrs

Coating Thickness in Inches: Reading #1 : 0.00033
#2 : 0.00035
#3 : 0.00033
#4 : 0.00031

EVAULATION RESULTS AS PER SPECIFICATION NUMBER: ASTM B117-94

Number of Hours(96): No sign of white corrosion products or red rust.

Number of Hours(432):First sign of white corrosion product .

Number of Hours(624): No sign of base metal corrosion (red rust).

Test terminated.

Signature: T. Mathew

Date: 06/07/1994

AUTOTEK ELECTROPLAING INC.

SALT SPRAY TEST RESULTS

Test Method: ASTM B117-94

Customer: Paton Steenson Associates Inc.

Part Number: Anchor Bracket

Revision Code: Epoxy Coating

Cast Day: N/A

Lot Number: N/A

Date Plated: N/A

Start Date: 09/21/1994 1300hrs

Finish Date: 10/19/1994 1300hrs

Exposure Period: 648 hrs

Coating Thickness in Inches:Not Available

EVAULATION RESULTS AS PER SPECIFICATION NUMBER: ASTM B117-94

Number of Hours(96): No sign of white corrosion products or red rust.

Number of Hours(168): First sign of red rust along sharp edges.

Number of Hours(648): significant red rust corrosion along all sharp edges

Signature: T. MacPherson

Date: 10/19/1994

AUTOTEK ELECTROPLAING INC.

SALT SPRAY TEST RESULTS

Test Method: ASTM B117-94

Customer: Paton Steenson Associates Inc. Part Number: Anchor Bracket

Revision Code: Galvanized zinc Cast Day: N/A

Lot Number: N/A Date Plated: N/A

Start Date: 09/21/1994 1300hrs Finish Date: 10/19/1994 1300hrs

Exposure Period: 648 hrs

Coating Thickness in Inches:Not Available

EVAULATION RESULTS AS PER SPECIFICATION NUMBER: ASTM B117-94

Number of Hours(96): First sign of white corrosion products ,no red rust.

Number of Hours(168): white corrosion 30-35% , no red rust.

Number of Hours(648): 100% white corrosion no red rust.

Signature: T. Mathew Rana Date: 10/19/1994

AUTOTEK ELECTROPLAING INC.

SALT SPRAY TEST RESULTS

Test Method: ASTM B117-94

Customer: Paton Steenson Associates Inc.

Part Number: Anchor Bracket

Revision Code: J-Type Corrosion Finish

Cast Day: N/A

Lot Number: N/A

Date Plated: 09/27/1994

Start Date: 09/28/1994 1330hrs

Finish Date: 10/25/1994 1300hrs

Exposure Period: 648 hrs

Coating Thickness in Inches:Reading #1 : 0.00038
#2 : 0.00040
#3 : 0.00035
#4 : 0.00034

EVAULATION RESULTS AS PER SPECIFICATION NUMBER: ASTM B117-94

Number of Hours(96): No sign of white corrosion products or red rust.

Number of Hours(408):First sign of white corrosion product .

Number of Hours(648): No sign of base metal corrosion (red rust).

Test terminated.

Signature: T. Matthews

Date: 10/25/1994

PHOTOGRAPHS - 1

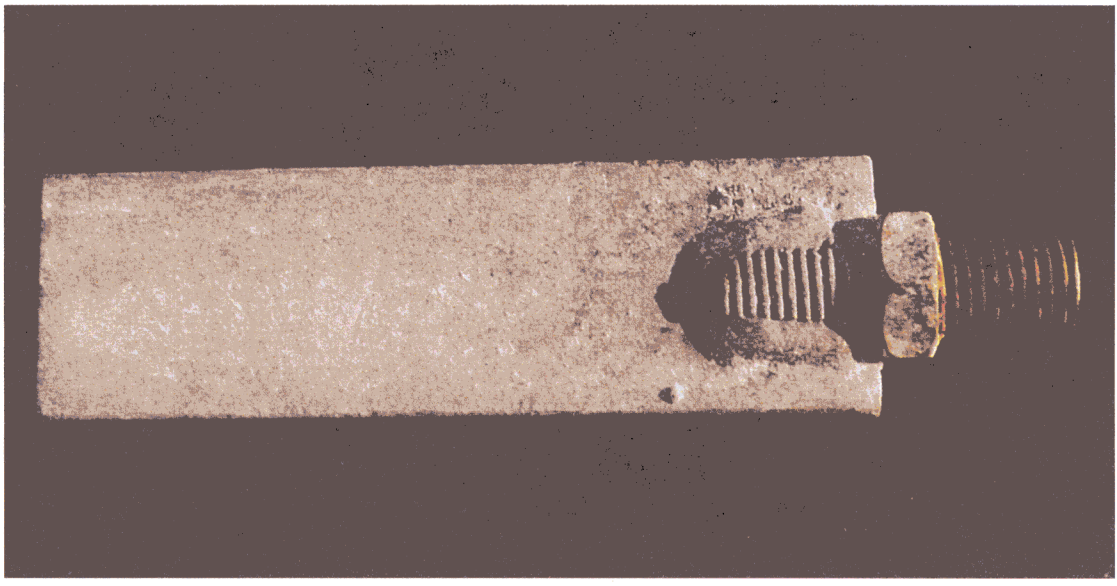


Fig. 1 PSA Strap Anchor Hot Dip Galv. Finish after 360 hours

Fig. 2 PSA Strap Anchor J - Type Finish after 624 hours

Fig. 3 PSA Strap Anchor Zinc Finish after 168 hours

PHOTOGRAPHS - 2

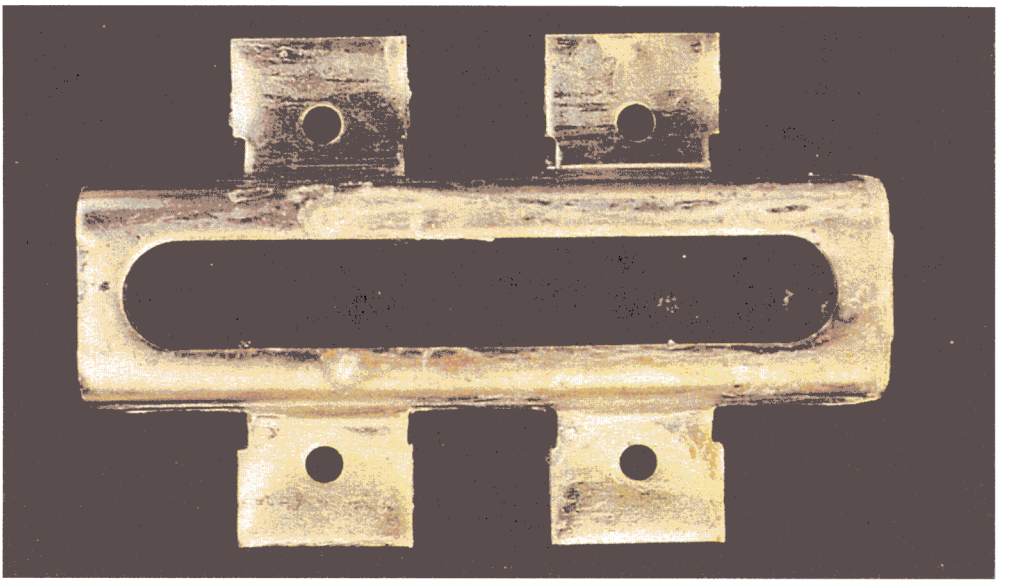


Fig. 4a PSA Insert (Top) J - Type Finish after 648 hours

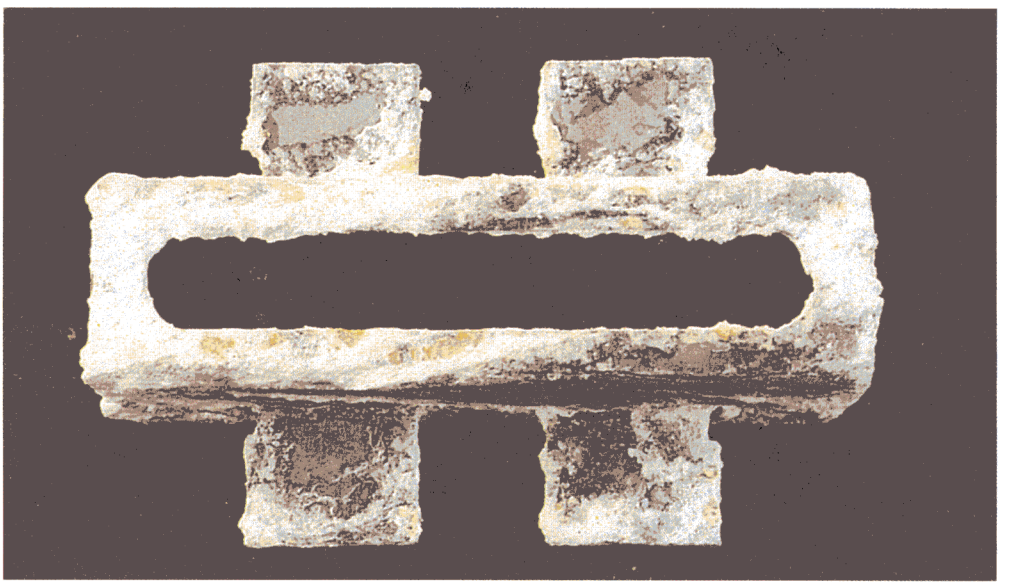


Fig. 5a PSA Insert (Top) Hot Dip Galv. Finish after 648 hours

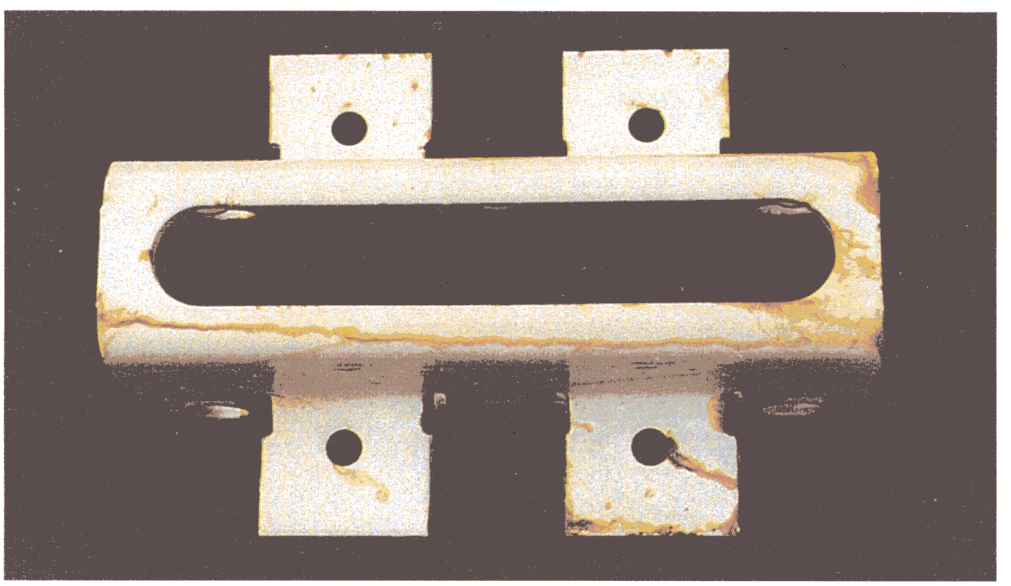


Fig. 6a PSA Insert (Top) Epoxy Finish after 648 hours

PHOTOGRAPHS -3

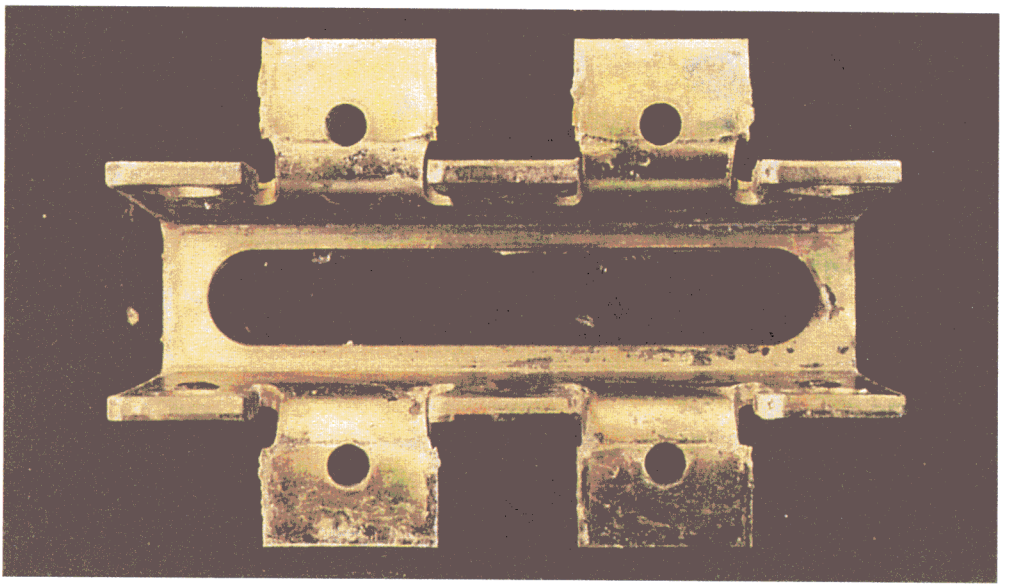


Fig. 4b PSA Insert (Bottom) J - Type Finish after 648 hours

Fig. 5b PSA Insert (Bottom) Hot Dip Galv. Finish after 648 hours

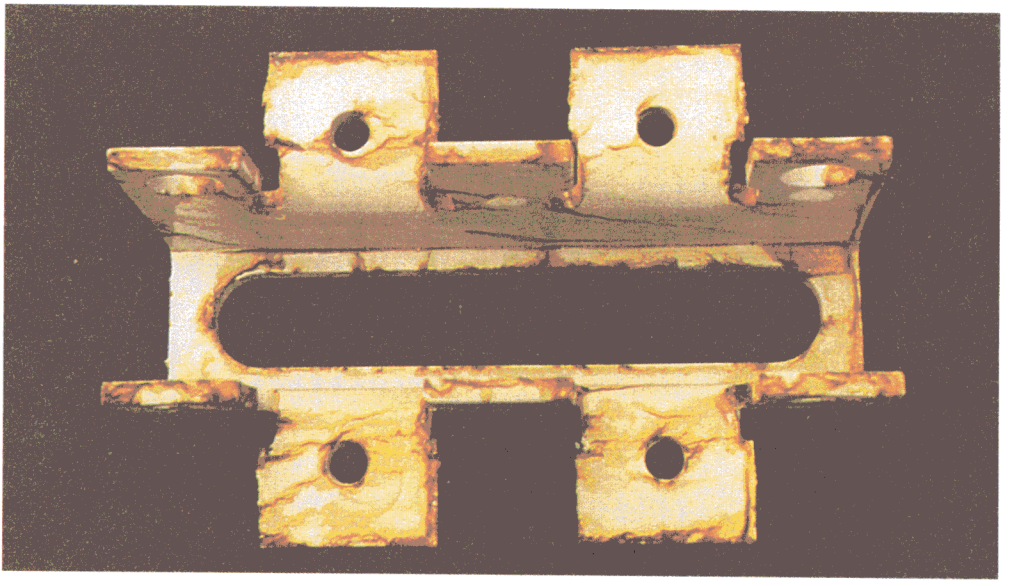
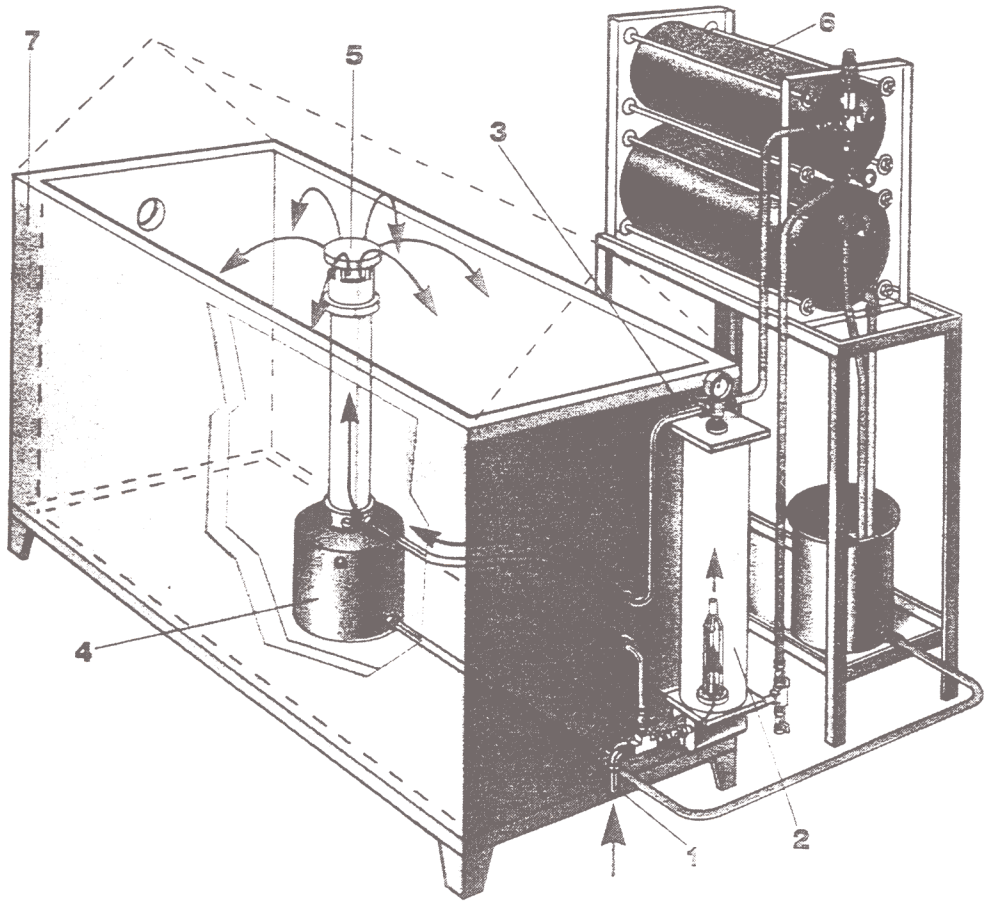


Fig. 6b PSA Insert (Bottom) Epoxy Finish after 648 hours



How a salt fog chamber works.

1. Compressed air enters the humidifying tower via an air line attached to the regulator.

2. Air is forced upward through the tower which contains distilled water that is fed from the level control system.

Once the air is in the tower, it reaches a temperature of approximately 118 degrees Fahrenheit.

3. The air is forced out of the top through an air line tube that continues into the chamber until it reaches the atomizer nozzle in the dispersion tower.

4. Here, the solution of 95 percent distilled water and 5 percent salt is atomized in the tank.

5. The atomized solution rises to the top of the dispersion tower where it baffles off the cone into the chamber, providing a consistent salt fog.

6. To ensure that the saline solution is readily available at the base of the dispersion tower, the nearby level control system automatically feeds the solution as needed.

7. The chamber is heated to 95 degrees Fahrenheit. This is accomplished by a "water jacket," which surrounds the chamber with water. The temperature of the water is maintained by two heaters.

The entire procedure is virtually a "hands-off" operation.

Fig.7 Typical Salt Spray Cabinet

Fig. 8

Designation: B 117 – 94

Standard Practice for Operating Salt Spray (Fog) Testing Apparatus[1]

This standard is issued under the fixed designation B 117; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense to replace Method 811.1 of Federal Test Method Standard No. 151b. Consult the DoD Index of Specifications and Standards for the specific year of issue that has been adopted by the Department of Defense.

1. Scope

1.1 This practice describes the apparatus, procedure, and conditions required to create and maintain the salt spray (fog) test environment. Suitable apparatus which may be used is described in Appendix X1. This practice does not prescribe the type of test specimen or exposure periods to be used for a specific product, nor the interpretation to be given to the results.

1.2 The values stated in SI units are to be regarded as standard. The inch-pound units in parentheses are provided for information.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

B 368 Method for Copper-Accelerated Acetic Acid-Salt Spray (Fog) Testing (CASS Test)[2]

D 609 Practice for Preparation of Cold-Rolled Steel Panels for Testing Paint, Varnish, Conversion Coatings, and Related Coating Products[3]

D 1193 Specification for Reagent Water[4]

D 1654 Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments[3]

E 70 Test Method for pH of Aqueous Solutions with the Glass Electrode[5]

E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method[6]

G 85 Practice for Modified Salt Spray (Fog) Testing[7]

3. Significance and Use

3.1 This practice provides a controlled corrosive environment which has been utilized to produce relative corrosion resistance information for specimens of metals and coated metals exposed in any particular test chamber.

3.2 Correlation and extrapolation of corrosion performance based on exposure to the test environment provided by this practice are not always predictable. Correlation and extrapolation should be considered only in cases where appropriated corroborating long-term atmospheric exposures have been conducted.

3.3 The reproducibility of results in the salt spray exposure is highly dependent on the type of specimens tested and the evaluation criteria selected, as well as the control of the operating variables. In any testing program, sufficient replicates should be included to establish the variability of the results. Variability has been observed when similar specimens are tested in different fog chambers even though the testing conditions are nominally similar and within the ranges specified in this practice.

4. Apparatus

4.1 The apparatus required for salt spray (fog) exposure consists of a fog chamber, a salt solution reservoir, a supply of suitably conditioned compressed air, one or more atomizing nozzles, specimen supports, provision for heating the chamber, and necessary means of control. The size and detailed construction of the apparatus are optional, provided the conditions obtained meet the requirements of this practice.

4.2 Drops of solution which accumulate on the ceiling or cover of the chamber shall not be permitted to fall on the specimens being exposed.

4.3 Drops of solution which fall from the specimens shall not be returned to the solution reservoir for respraying.

4.4 Material of construction shall be such that it will not affect the corrosiveness of the fog.

5. Test Specimens

5.1 The type and number of test specimens to be used, as well as the criteria for the evaluation of the test results, shall be defined in the specifications covering the material or product being tested or shall be mutually agreed upon between the purchaser and the seller.

6. Preparation of Test Specimens

6.1 Specimens shall be suitably cleaned. The cleaning method shall be optional depending on the nature of the surface and the contaminants. Care shall be taken that

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[1] This practice is under the jurisdiction of ASTM Committee G-1 on Corrosion of Metals and is the direct responsibility of Subcommittee G01.05 on Laboratory Corrosion Tests.

Current edition approved Feb. 15, 1994. Published April 1994. Originally published as B 117 – 39 T. Last previous edition B 117 – 90.

[2] *Annual Book of ASTM Standards*, Vol 02.05.

[3] *Annual Book of ASTM Standards*, Vol 06.01.

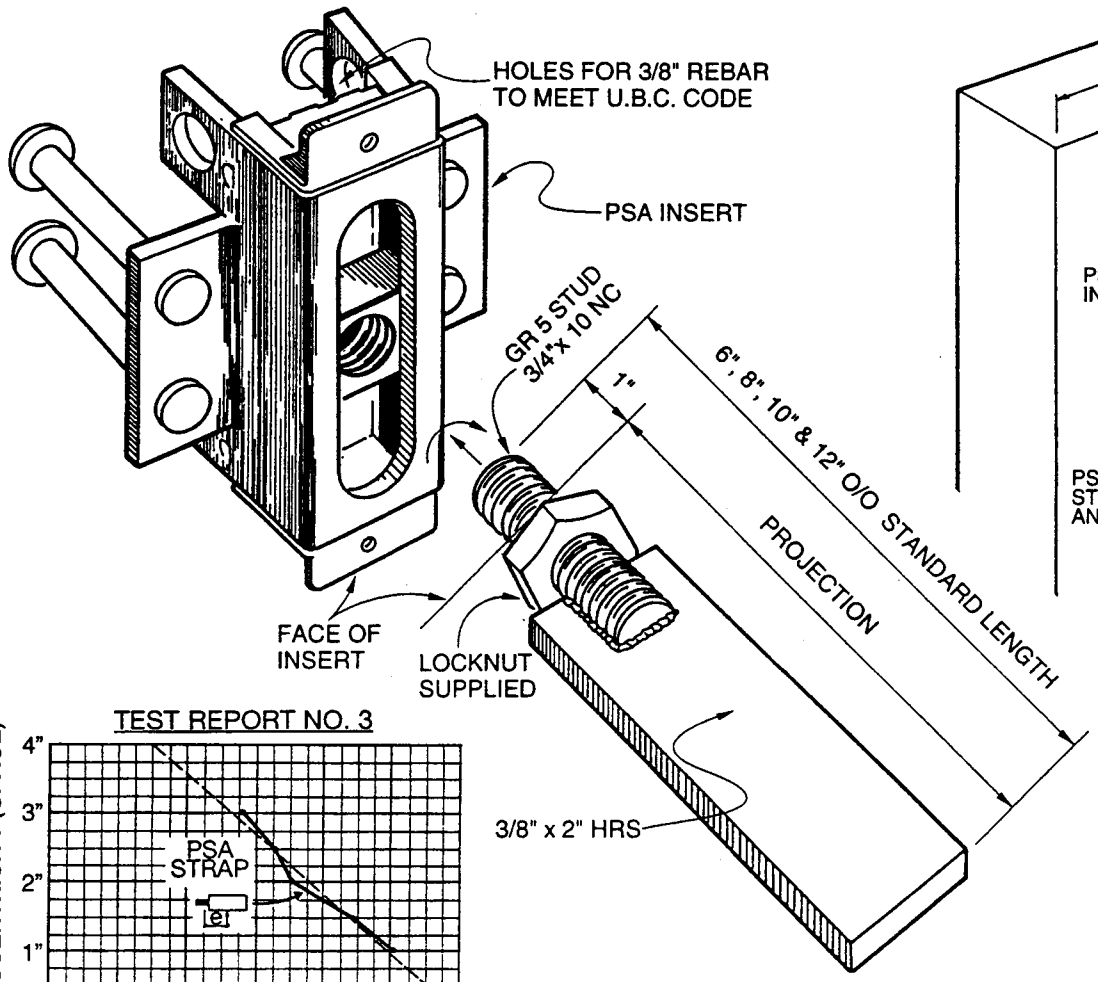
[4] *Annual Book of ASTM Standards*, Vol 11.01.

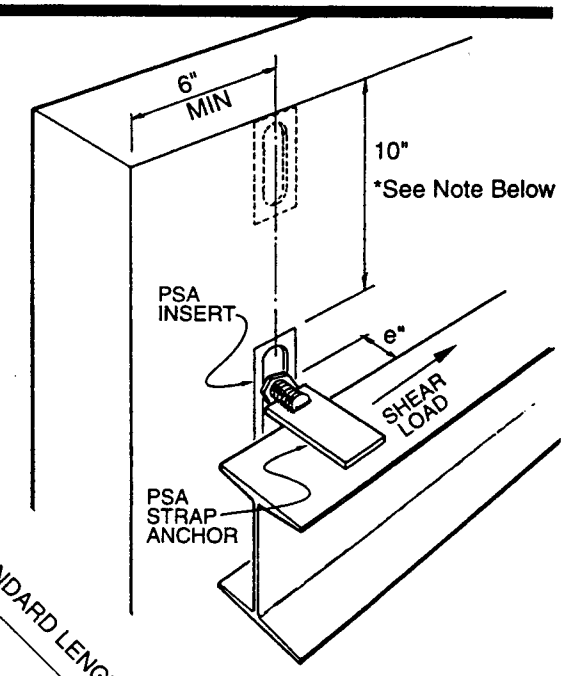
[5] *Annual Book of ASTM Standards*, Vol 15.05.

[6] *Annual Book of ASTM Standards*, Vol 14.02.

[7] *Annual Book of ASTM Standards*, Vol 14.12.

PSA STRAP ANCHORS





Note:
* Reduce Ultimate Load by 25% if Insert Placed at Top Edge of Panel. (Test Report No. 2)

FEATURES:

• Ultimate Pull-out Capacity

Strap Anchors Develop full Ultimate Capacity of the insert

Insert Type	Depth	Length	Ult. Pull-Out Capacity
4525	2 1/2"	4 1/2"	12,000 lbs
6025		6"	
4535	3 1/2"	4 1/2"	16,000 lbs
6035		6"	
4545	4 1/2"	4 1/2"	20,000 lbs
6045		6"	

Ultimate Pull-Out Capacity Based on Tests Performed in 5,000 psi Normal Weight Concrete (Refer to PSA Test Report No.1)

• Ultimate Shear Capacity

20,350 lbs. at 1" Eccentricity (See Graph Above)
Ult. Shear Capacity based on Tests Performed in 6,000 psi Normal Weight Concrete (Refer to PSA Test Report No. 3)

• Standard Strap Anchor Lengths

6", 8", 10" & 12" Out/Out

• **Available Finishes** – Epoxy or Hot Dipped Galvanized. (Stainless Steel available on Special Order)

• **Material** – High Strength weldable grade HRS Steel

• **Lock Nut** – Ensures Positive Connection in Both Directions

In the U.S.A. JVI In Canada PSA

ACCESSORIES, INC.
7550 North Linder Avenue
Skokie, Illinois 60077 USA
705/675-1560 Fax: 708/675-0083

PATON STEENSON ASSOC. INC.
10 Royal Orchard Blvd. P.O. Box #53009
Thornhill, Ontario L3T 7R9
905/889-7357 Fax: 905/889-7648

PSA PATON STEENSON ASSOCIATES INC

10 ROYAL ORCHARD BOULEVARD • P.O. BOX 53009 • THORNHILL, ONTARIO L3T 7R9
TEL 905-889-7357 • FAX 905-889-7648

TEST REPORT NO 7

30 KIP LOAD TESTS ON

PSA SLOTTED INSERTS

At Shockey Brothers Plant

MARCH, 1995

ACKNOWLEDGEMENT

Special thanks to NED CLELAND And DAVID RAY of Shockey Brothers, Inc. for their help and advice in making this test program possible.

NOTICE

This publication is intended for the use of professional personnel, competent to evaluate the significance and limitations of its contents and who will accept responsibility for the application of the material it contains. Shockey Brothers, Inc., JVI Accessories, Inc. and Paton Steenson Associates Inc. disclaim any and all responsibility for the application of the stated principles or for the accuracy of the information contained herein.

PSA PATON STEENSON ASSOCIATES INC

10 ROYAL ORCHARD BOULEVARD • P.O. BOX 53009 • THORNHILL, ONTARIO L3T 7R9
TEL 905-889-7357 • FAX 905-889-7648

September, 1995

30 KIP LOAD TEST ON PSA SLOTTED INSERTS FOR SHOCKEY BROTHERS

INTRODUCTION

The purpose of this load test program was, (a) to find out if a special high capacity PSA Slotted Insert could achieve an ultimate pull-out capacity of 30 kips, and (b) to test some special ferrule and coil type insert details often used in parking deck "spandrel to column" connections.

TEST PANEL

Two concrete test panels were manufactured at Shockey Brothers plant in Winchester, Virginia on March 10th and 16th respectively as part of a normal day's production. The details of the test panels are shown on Sketch 1 for panel (1) and Sketch 4 for panel (2), included in Appendix A. Load tests were conducted on March 29th, 1995 when the test panels were 13 and 19 days old respectively. The estimated concrete strength for panel (1) was 7,900 psi and for panel (2), 7,000 psi at the time of the test. These values were interpolated from the actual 7, 14, and 28 day cylinder test results for this batch of concrete as shown in Appendix A of this report. The test panels were reinforced to simulate a typical "parking deck" spandrel panel and the inserts were located at the edges to model a typical "spandrel to column" connection. Extra reinforcing steel was provided around and through the legs of the PSA inserts as shown in detail on the test panel sketches and as noted in the table of test results.

TEST METHOD

The test load, in all cases was applied to the inserts through their normal connection devices using a 20 ton hydraulic ram and hand operated pump. The pressure gauge reading was multiplied by the ram area (4.71 sq. in.) to determine the applied load. Recent calibration data for the pressure gauge is included in Appendix A.

Figures 1 and 10 illustrate the test set-up for interior inserts and figures 7 and 12 show the cantilever method used for testing the corner inserts. In all cases a high strength bolt in the load transfer bracket was attached to the heavy duty nut in the insert. All inserts were tested for ultimate pull-out capacity.

A visual inspection of the pattern of failure cracking was made throughout the tests. The mode of failure was determined, photographed and recorded.

TEST RESULTS

A table of test results is given in Appendix A

DISCUSSION

1. Standard PSA - 20 kip (6045) inserts, equipped with special high capacity nuts, were used to achieve the desired 30 kip ultimate capacity. Although the special nuts increased the mechanical capacity of these inserts, it was also necessary to use stepped harpins through the inserts (as shown on the detail sheets in Appendix A), to strengthen the concrete cone and so force a ductile mechanical failure. In Test No. 2, where no extra reinforcement was provided, the concrete failed at 24,400 lbs as expected. The insert simply behaved like a 20 kip insert. In this case the extra mechanical capacity of the insert forced a concrete failure. This test confirmed the need to provide extra concrete reinforcement wherever the insert is located, in order to achieve a 30 kip ultimate capacity.

2. Stepped hairpins were used in all other tests to reinforce the concrete cone areas. Even though these inserts were located near the corners of the panel (to simulate the spandrel panel connection), the hairpins effectively strengthened the concrete cone and so forced a slow ductile mechanical failure of the insert lips at an average capacity of 30 kips.

3. Unfortunately the test bolt failed during Test No. 5 which in turn, damaged the threads of the insert nut. Even so a load of 27,700 lbs was reached. The insert was re-tested using a new bolt but the damaged nut failed at 26,800 lbs.

4. The traditional 1" dia. coil/plate type inserts performed very well. In the special Shockey detail (Tests A and D), one of the four struts is cut short and the threaded coil wrapped with pipe insulation. This detail, P8791PA is included in Appendix A. The insulation is intended to relieve any minor misalignment between the threaded rod and the insert. Tests have shown that the capacity of an insert is substantially reduced if the load is **not** applied perpendicular to the insert. This detail requires very close construction tolerances.

   The use of a slotted insert in the "spandrel-to-column" parking deck connection would provide more construction tolerance, and so ensure that the load is applied perpendicular to the insert.

5. The other Shockey detail (Tests B & C) using a heavy hex nut welded to a 1/2" plate does not provide any construction tolerance for misalignment. This detail, P8341PB is included in Appendix A. The capacity of this connection detail was adequate without extra reinforcement when located away from an edge (Test C), but requires additional heavy reinforcement when located in the corner (Test B).

CONCLUSIONS AND RECOMMENDATIONS

1. The PSA 6045 slotted insert when equipped with a special high capacity nut, has a mechanical capacity of approximately 30,000 lbs.

2. This insert has an ultimate pull-out capacity of approximately 30,000 lbs. when reinforced with two stepped hairpins or similar reinforcing steel embedded in 7000 psi concrete, even when the insert is located near the corner of the panel.

3. The ultimate capacity of this insert *without* stepped hairpin type reinforcement is limited to 24,000 lbs. in 7000 psi concrete, when the insert is located well away from the corner or edges of a panel.

4. Straight reinforcing steel around or through the shear cone does not increase the ultimate capacity of the shear cone.

5. Stepped hairpins (#3 weldable grade) or similar reinforcing bars can effectively increase the capacity of the shear cone, *even at the corner of a panel.*

6. The insulated coil/plate type anchorages performed well above the design ultimate capacity of these anchorages.

7. Additional heavy hairpin or stepped hairpin reinforcing steel is needed when these coil/plate type anchorages are located at or near the corner of a panel.

PATON STEENSON ASSOCIATES INC

W. D. Paton, P. Eng

APPENDIX - A

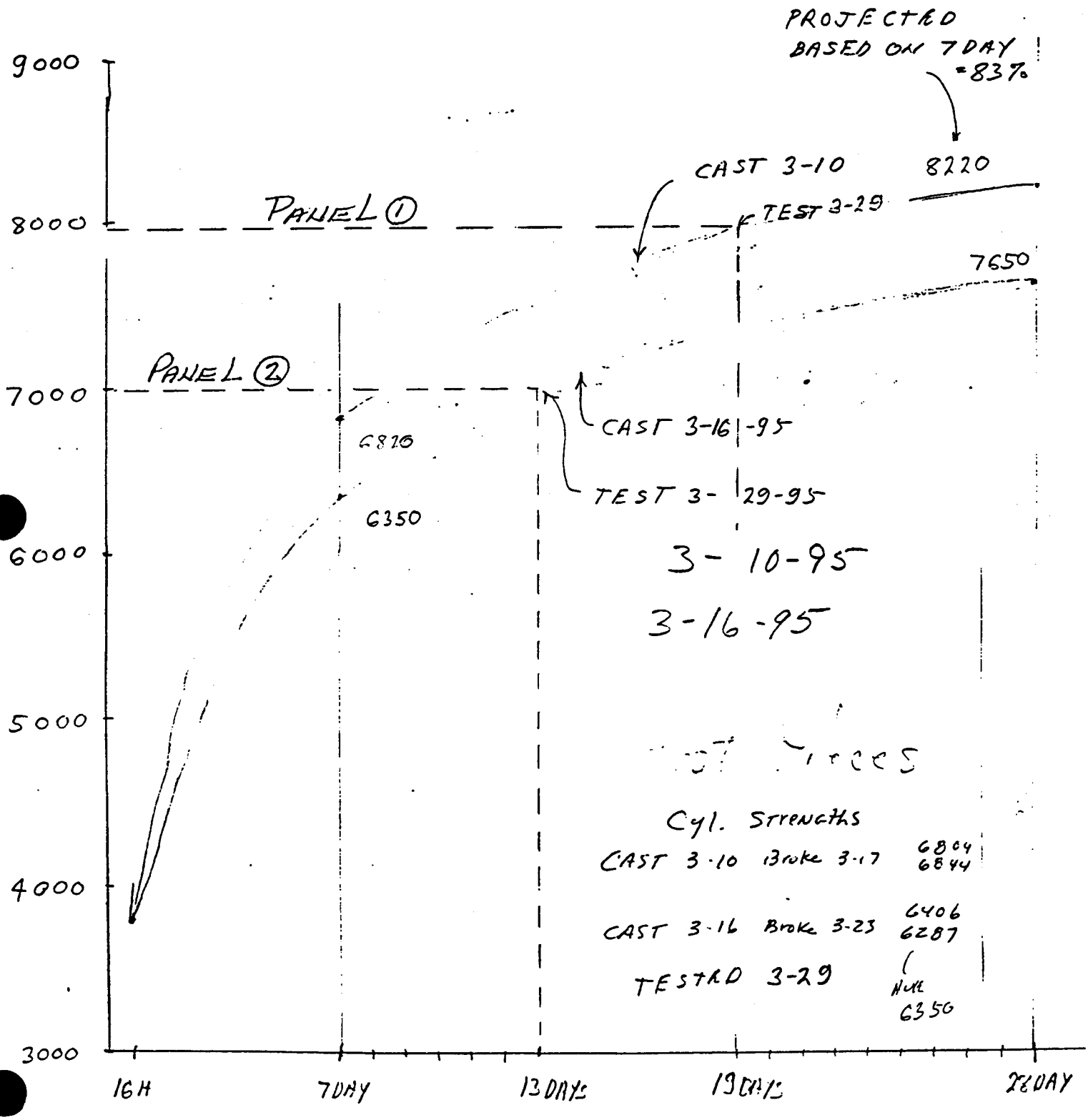
1. Table of Test Results
2. Concrete Strength Graph
3. Calibration Data
4. Photographs - Figs. 1 through 9
5. Fig. 10 - Test Set-Up for Edge Tests
6. Fig. 11 - Test Set-Up for Pull-Out Tests
7. Sketch-1 Test Panel No. 1
8. Sketch-2 Hairpin Reinforcement - 1
9. Sketch-3 Hairpin Reinforcement - 2
10. Sketch-4 Test Panel No. 2
11. Shockey Detail P9603GA - Plate c/w HA Studs
12. Shockey Detail P8341PB - Plate c/w HH Nut
13. Shockey Detail P8791PA - 1" - 4 Strut Coil c/w Insul.
14. Test Block Detail - High Concrete Sleeve

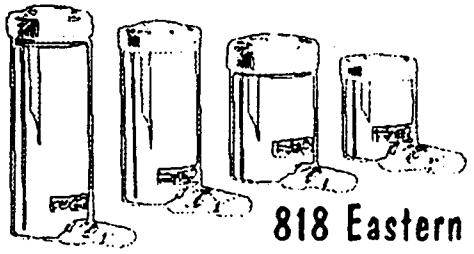
TEST RESULTS
March, 1995

INSERT TYPE	TEST NUMBER	INSERT LOCATION	REINFORCEMENT (In addition to normal panel reinforcement)	FAILURE LOAD		TYPE OF FAILURE	COMMENTS
				Gage (psi)	Lbs.		
PSA 6045 HC	2	Interior	None	5,200	24,400	Slow ductile concrete failure	Lack of stepped hairpins forced a concrete failure. Same as a 20 kip insert.
PSA 6045 HC	3	Corner	2 - Stepped hairpins. 1 - #8 Flat hairpin.	6,500	30,600	Slow ductile failure. Concrete cracked, and lips yielded.	Insert deformed - edge concrete cracked which reduced confinement of insert. The nut then caused lips to fail.
PSA 6045 HC	1	Corner	2 - Stepped hairpins only	NIL	NIL	Not Tested	Concrete around sample was damaged by Test No. 2
PSA 6045 HC	4	Corner	2 - Stepped hairpins. 1 - #8 Flat hairpin.	6,250	29,400	Slow ductile failure. Concrete cracked, and lips yielded.	Same as Test No. 3
PSA 6045 HC	5	Corner	2 - Stepped hairpins only	5,900	27,700	Stripped the threads of the test bolt.	Threads of nut weakened by failed bolt. Retested - but nut failed at 26,800 lbs.
Shockey P9603PA	A	Corner	1" dia.coil insert. c/w pipe insulation. 1/2 x 6 x 6 plate 4 - 1/2 x 6 HA Studs 2- #4 & 1-#8 Hairpin	8,000	37,700	No Failure	Test stopped at jack capacity (20 tons). No distress of either concrete or insert.
Shockey P8341 PB	B	Corner	3/4" HH Nut welded to 1/2 x 6 x 6 plate. No pipe insulation. 4 - 1/2 x 5 HA Studs 2 - #3 Hairpins	6,800	32,000	Slow ductile concrete failure.	No pipe insulation to absorb any load misalignment.
Shockey P8341 PB	C	Interior	Same as B (except no hairpins)	8,100	38,500	No Failure	Test stopped at jack capacity (20 tons)
Shockey P8791PA	D	Corner	1" dia coil insert c/w pipe insulation. 1/2 x 6 x 6 plate. 2 - 1/2 x 6 HA Studs. 2- #4 L & 1 #8 H'pin	7,500	35,300	No Failure	Damaged test beam. (Bent bottom flange) Test was stopped. No distress of sample.
Test Blk.	Special	N/A	3 Standard Washers 3/4, 1 1/8, 1 3/8. High Concrete Sleeve	8,000	37,700	Washers yielded (dished)	Washers held load up to 20 kips. Then kept yielding as load was increased.

SHOCKEY BROS., INC.
Prestressed Precast Concrete
P.O. Box 2530 Winchester, Virginia

SUBJECT INSERT TEST CONC. STRENGTH
SHEET NO. 1 OF 1
JOB NO.
BY GH DATE 3-29-95
CHKD. BY DATE





Hydraquip
Sales & Service

818 Eastern Avenue, Unit 2, Toronto, ON, M4L 1A1

Calibration Test Certificate

==========

Customer: Paton Steenson Associates
Gauge Description: Enerpac Gauge 0-10,000 psi, serial G93-496

==========

Standard Used: Mansfield & Green, Type #R-50
Dead Weight Serial #: 1315
Dead Weight Accuracy: 0.1%

==========

**Note: Instruments have been tested against a dead weight tester serial # as above, which is traceable to the National Research Council in Ottawa, as per their report # 722.0329, dated August 18,1989.

Hydraquip Sales & Service Ltd. certifies that the below item(s) have been tested to comply in every way with the requirements of the above purchase order.

==========

Master Test Gauge D.W.	Above Gauge
1000 PSI	1000 PSI
3000	3000
5000	5000
7000	7025
9000	9025

Date Tested: Dec 6, 1993
Technician: Pat Mahon

Phone 416-461-3573 Fax 416-461-2979
Out of town callers 1-800-463-4168

PHOTOGRAPHS - 1

Fig. 1 Test Set-Up for Interior Test - (Test No. 2)

Fig. 2 Test No. 2 - (24,400 Lbs.) No stepped hairpins

Fig. 3 Test No. 3 - (30,600 Lbs.) Corner with 2 Hairpins

PHOTOGRAPHS - 2

Fig. 4 Test No. 5 - Test Bolt Threads stripped at 27,700 Lbs.

Fig. 5 Test No. B - 3/4" Ferrule at Corner - Concrete failed at 32,000 Lbs.

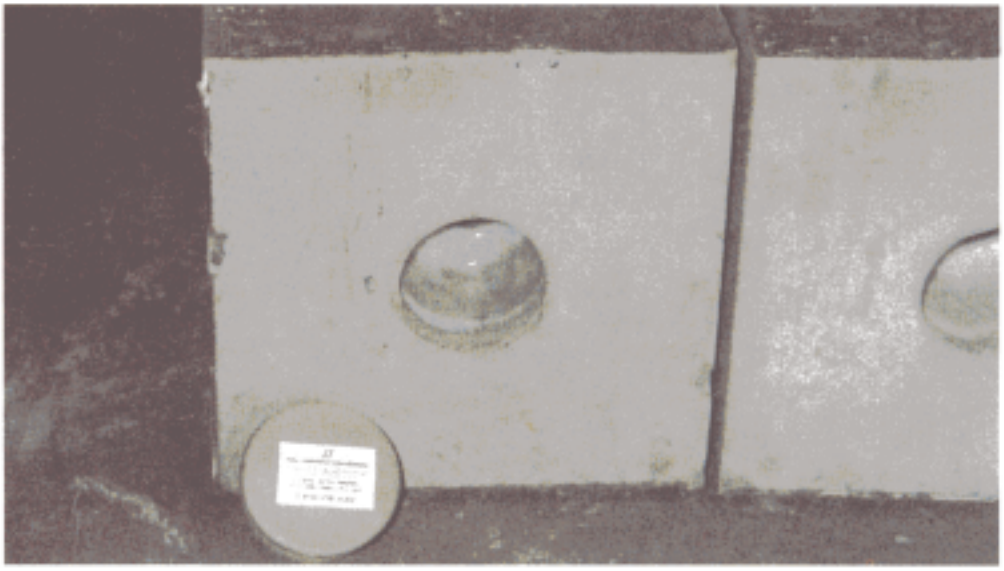


Fig. 6 Test Block with Plastic Connector Sleeve (High Concrete Accessories)

PHOTOGRAPHS -3

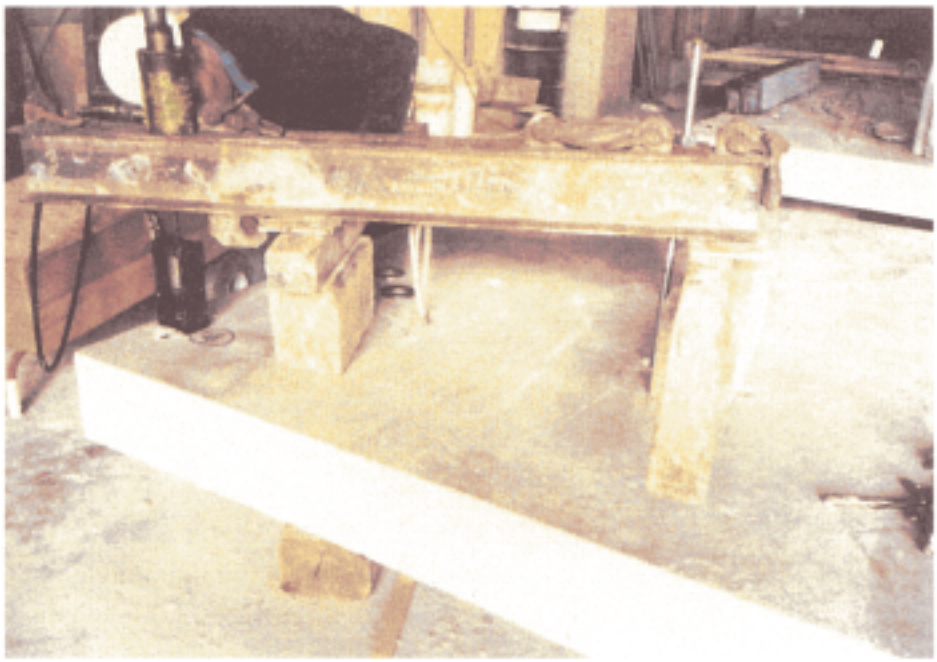


Fig. 7 Test Set-Up for Corner Test

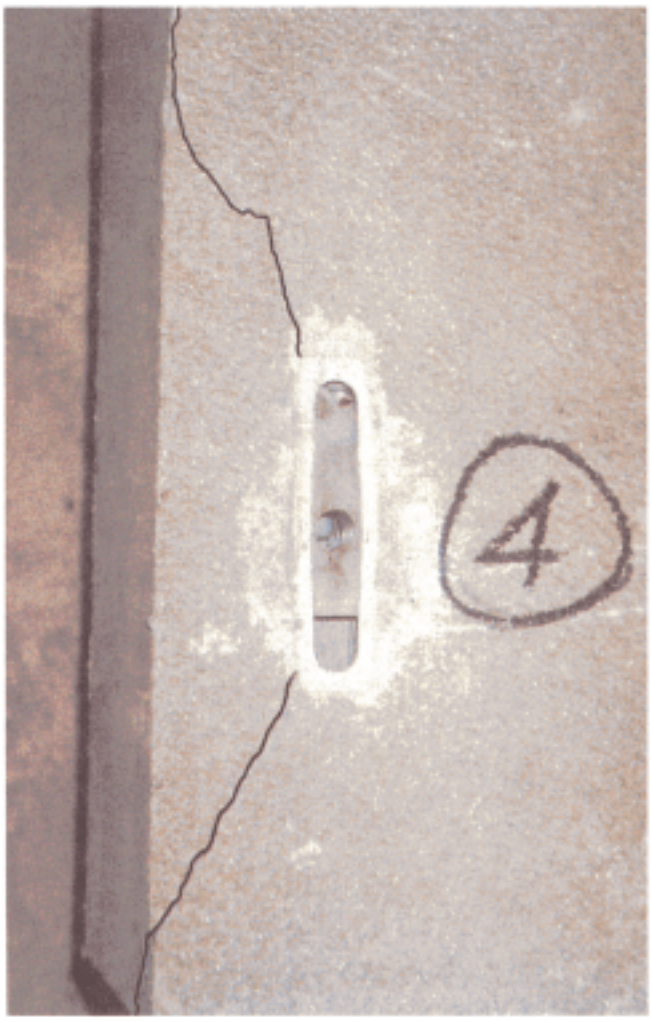


Fig. 8 Test No. 4 - (29,400 Lbs.)
Corner Test with 2 Hairpins

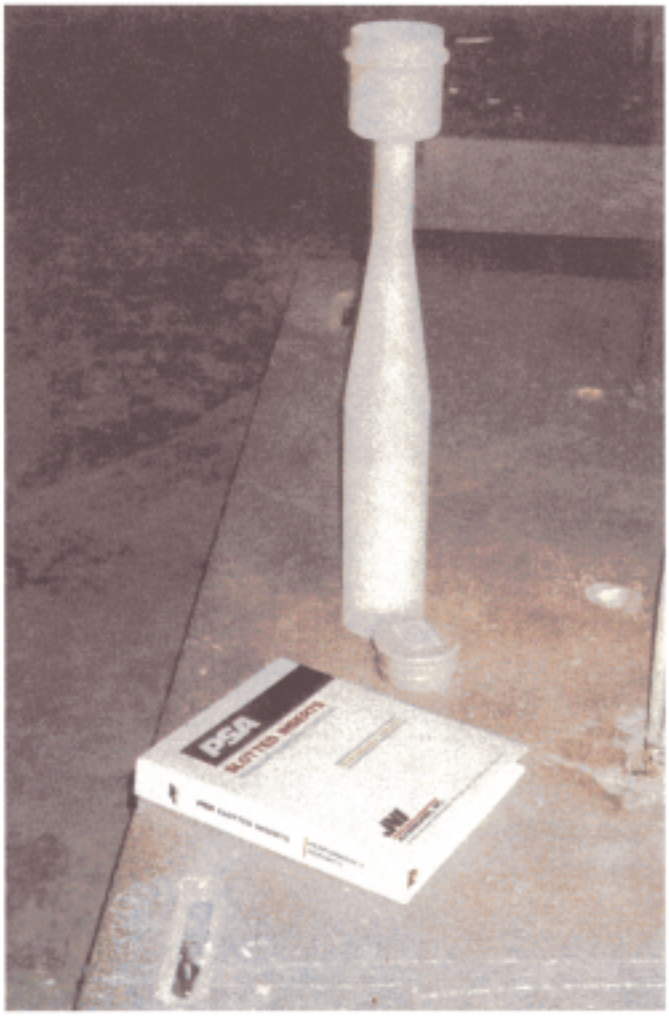
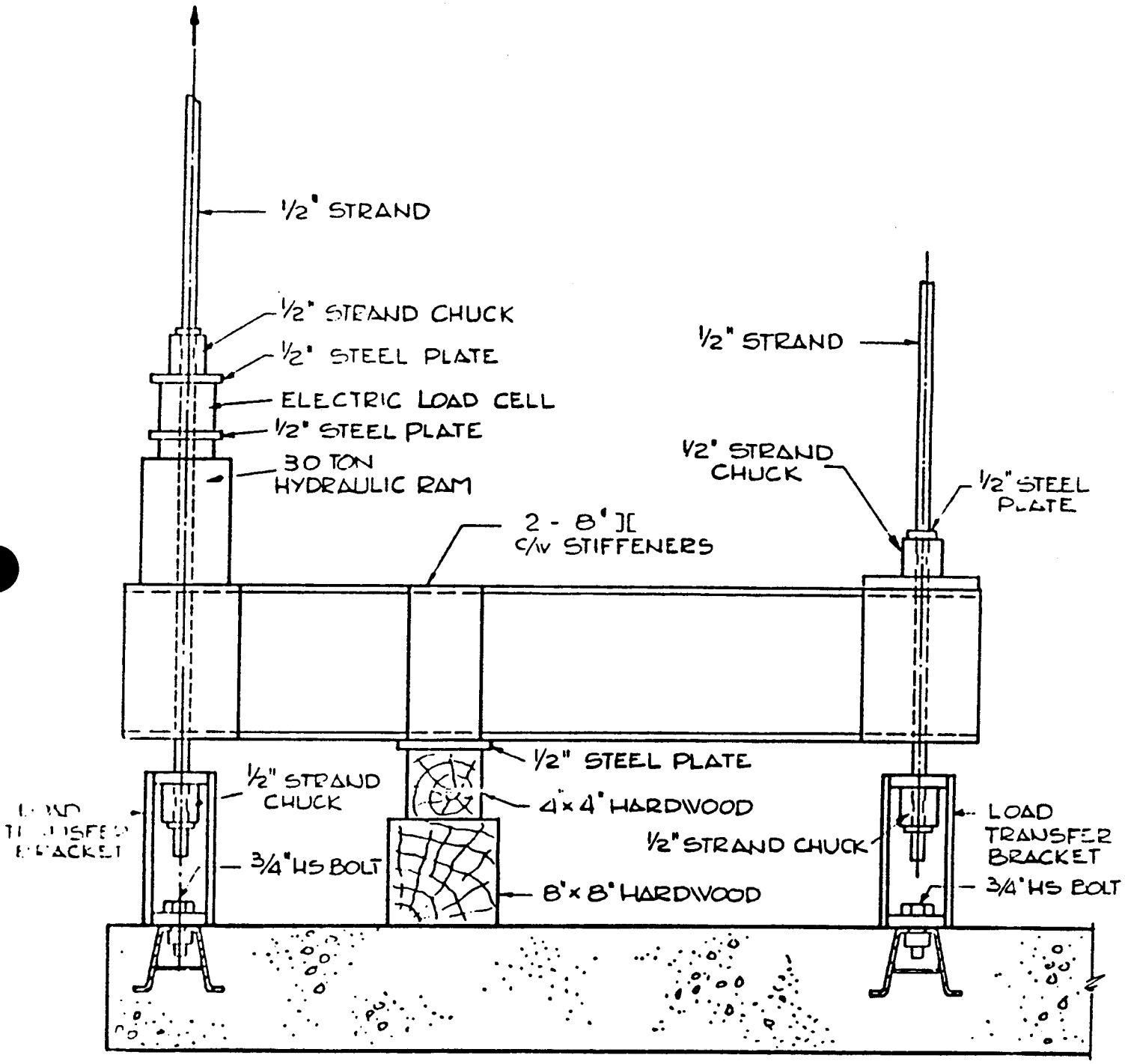


Fig. 9 Connector Sleeve - Column to Spandrel
(High Concrete Accessories)



TEST SET-UP

FOR EDGE TESTS

FIG. 10

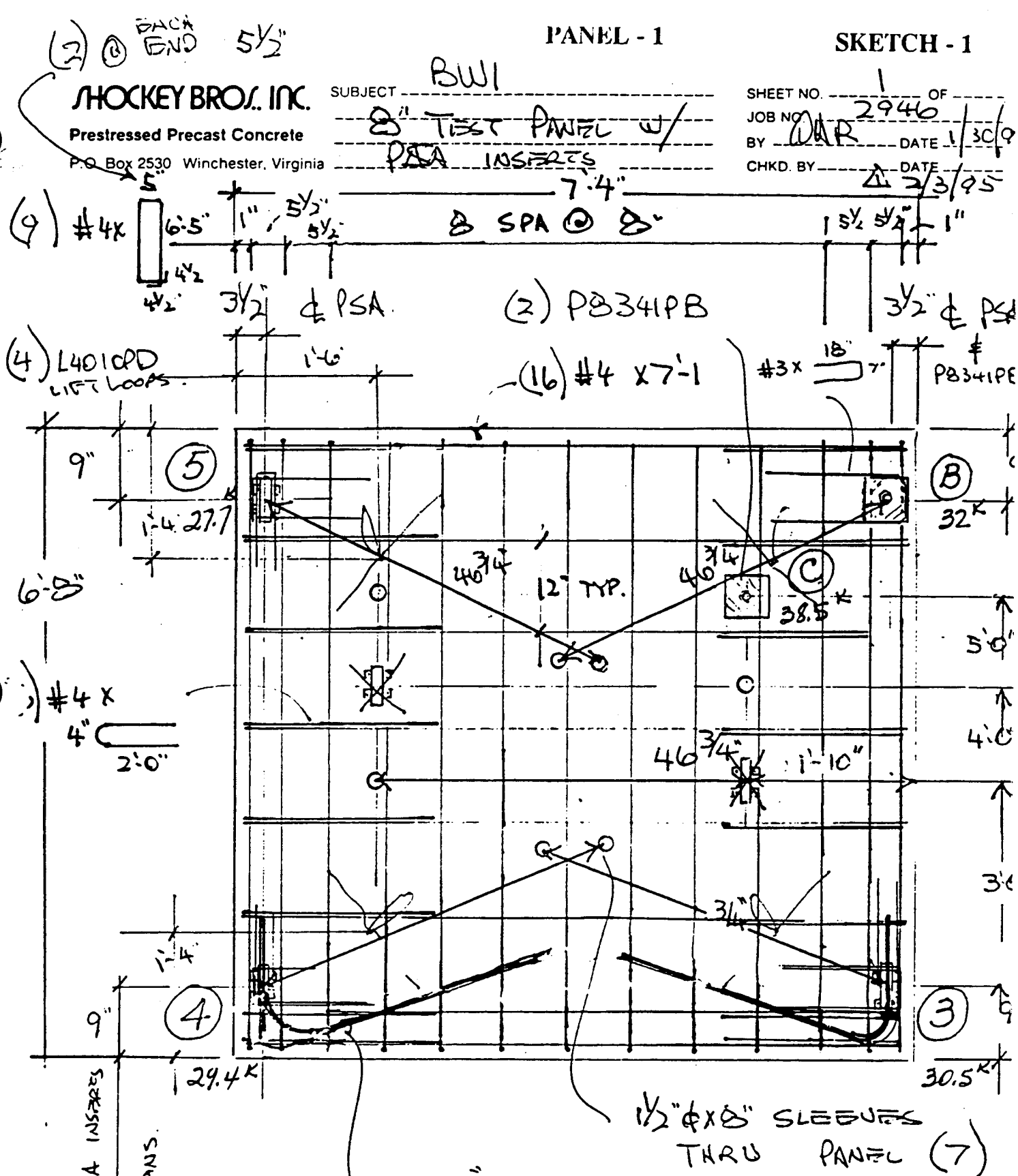
(2) (B) BACK END 5½"

PANEL - 1 **SKETCH - 1**

SHOCKEY BROS. INC.
Prestressed Precast Concrete
P.O. Box 2530 Winchester, Virginia

SUBJECT BWI 8" TEST PANEL W/ PSA INSERTS

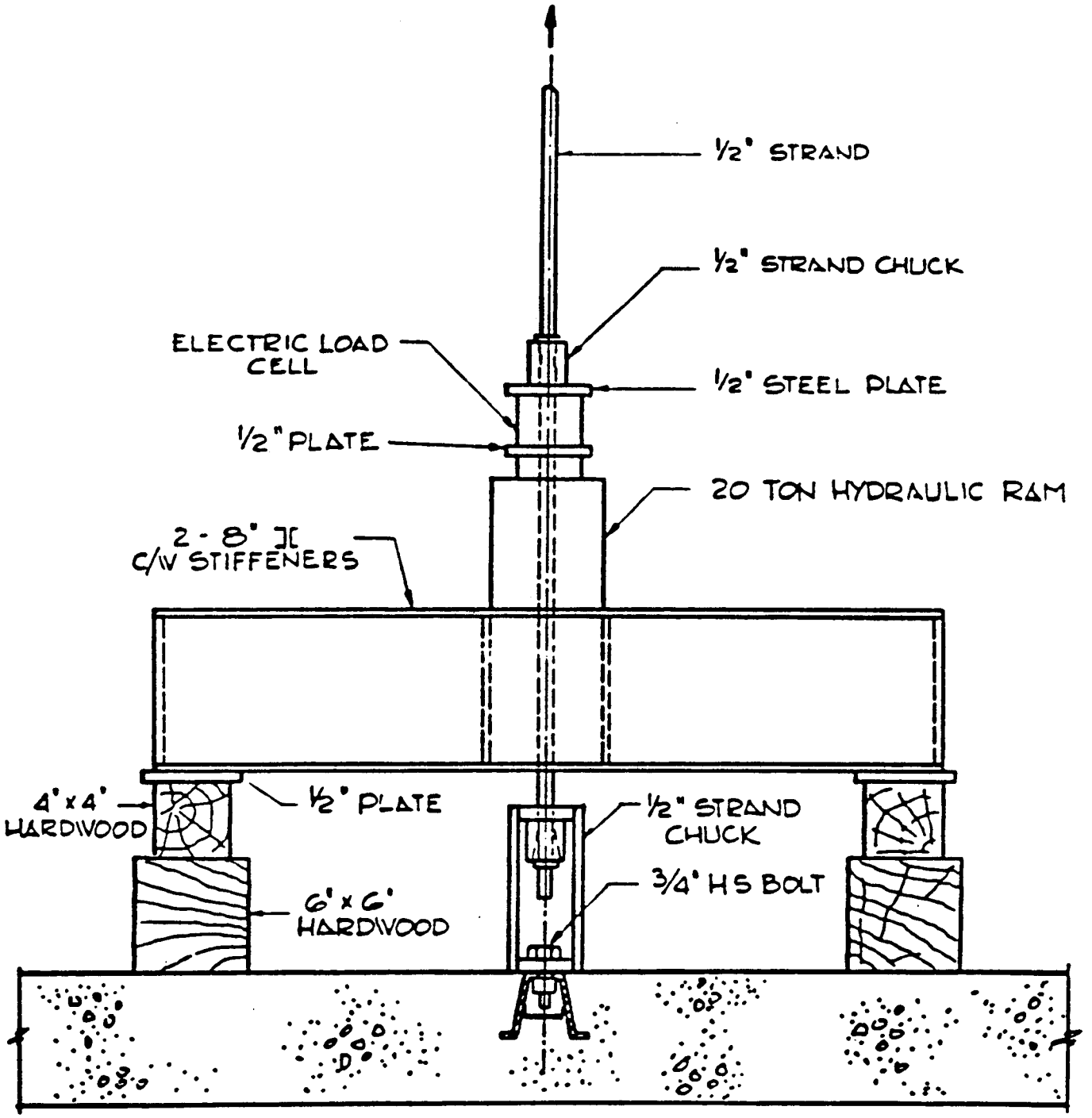
SHEET NO. 1 OF
JOB NO. 2946
BY DAR DATE 1/30/9
CHKD. BY DATE
Δ 2/3/95



TESTED AT 19 DAYS WHEN f'c = 7900 psi

f'c = 3000 psi @ RELEASE

f'c = 5000 psi @ 28



TEST SET-UP

FOR PULLOUT TESTS

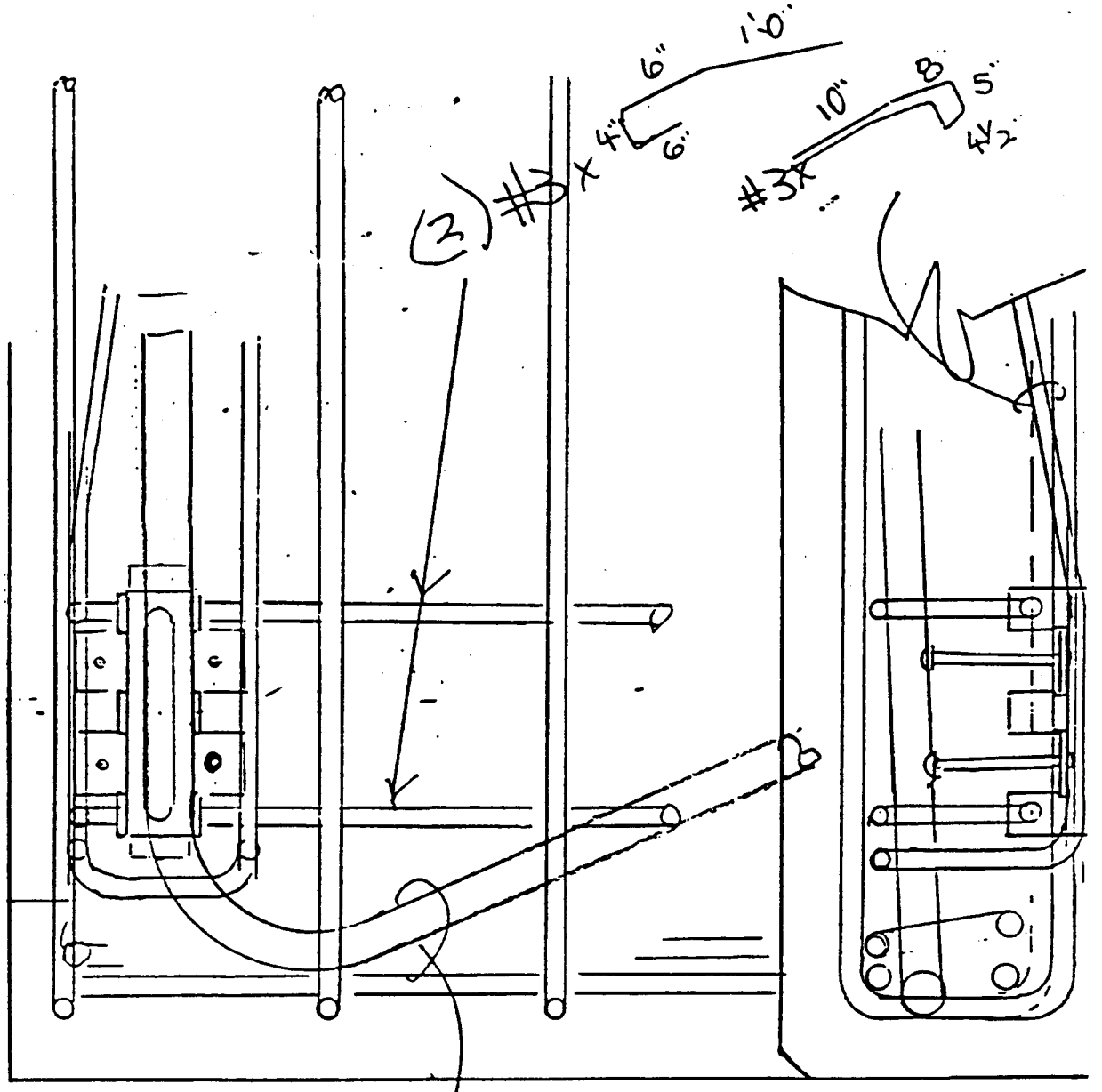
FIG. 11

SKETCH - 2

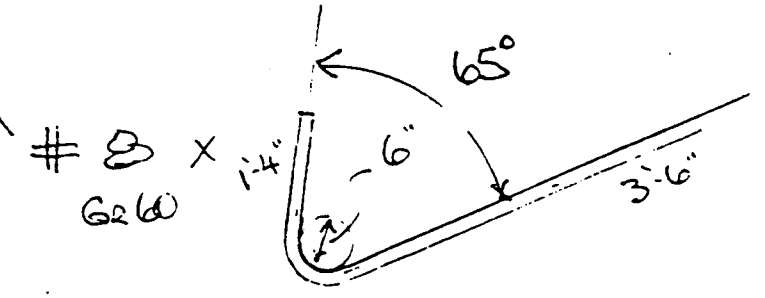
SHOCKEY BROS. INC.
Prestressed Precast Concrete
P.O. Box 2530 Winchester, Virginia

SUBJECT REINFORCEMENT FOR TESTS (3) & (4)

SHEET NO. 1 OF
JOB NO. 2946
BY MAR DATE 3/1
CHKD. BY DATE



TEST (3) & (4)



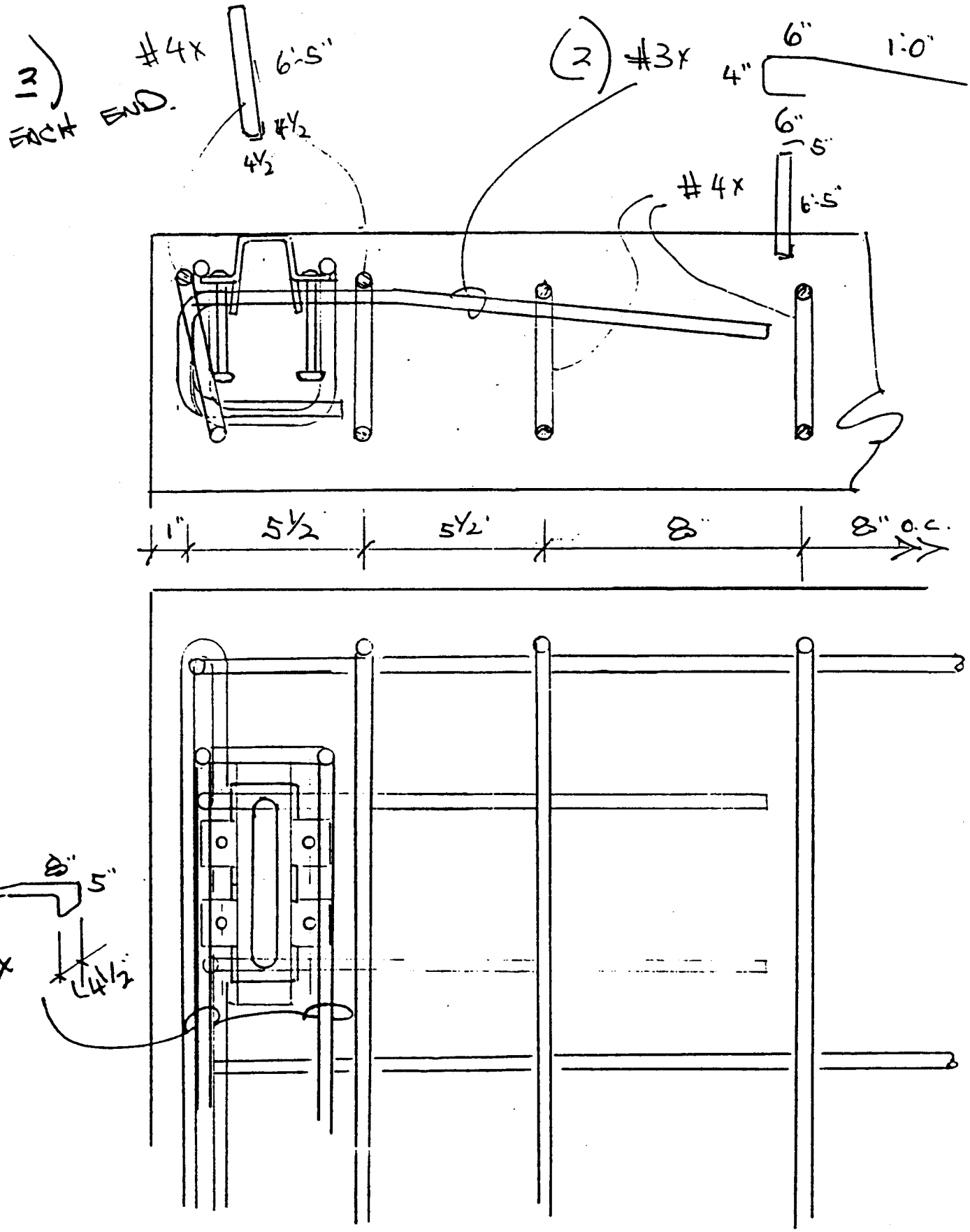
JIM HOSSELROD → (#9 IF BEND ¢ CAN BE HELD) A706

SKETCH - 3

KEY BROS. INC.
sed Precast Concrete
‹ 2530 Winchester, Virgin

SUBJECT KEINFORCEMENT
FOR TESTS (1) & (5)

SHEET NO. 3 OF
JOB NO 2946
BY WAR DATE 3/11/95
CHKD. BY DATE



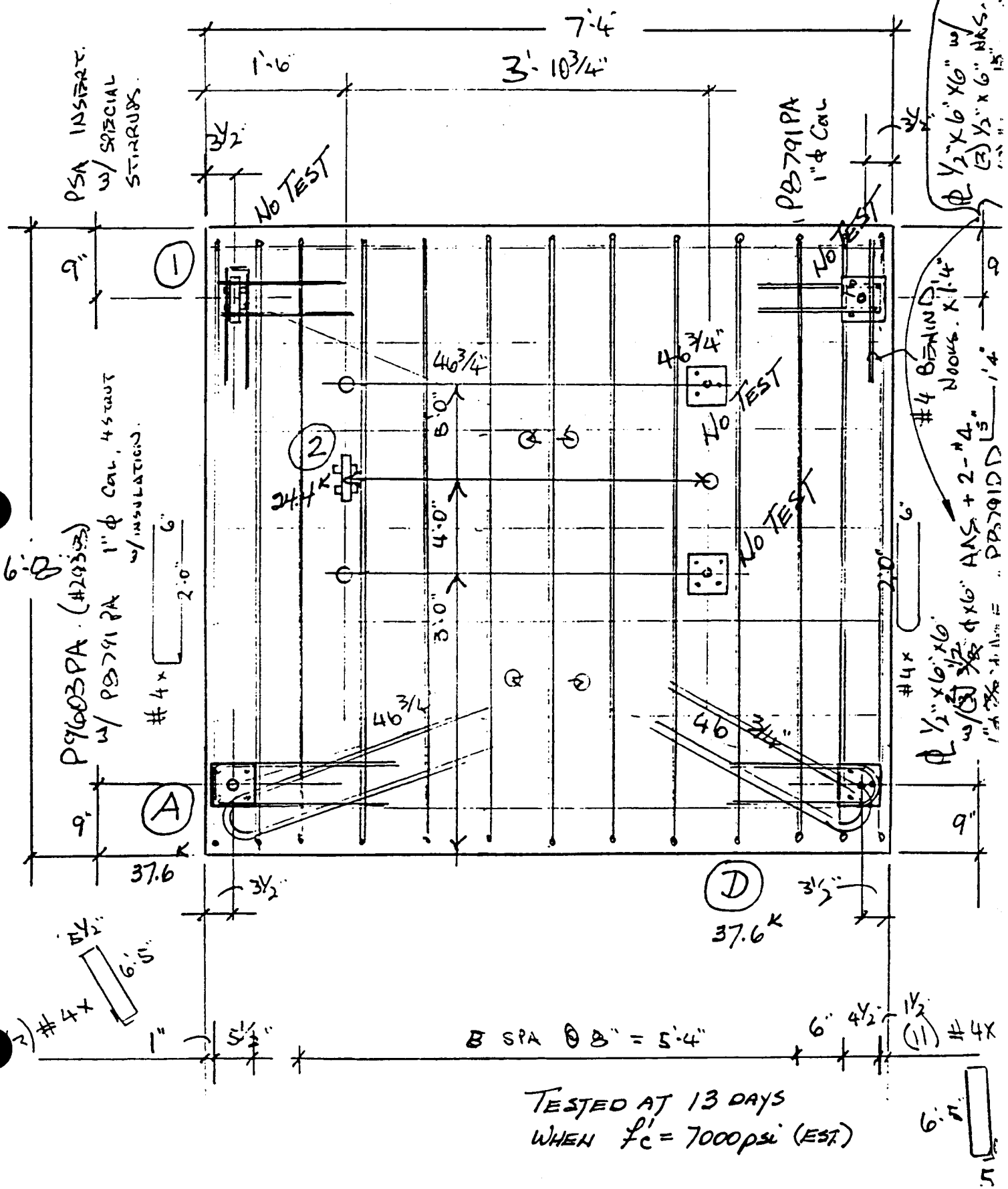
PANEL - 2

SKETCH - 4

SHOCKEY BROS., INC.
Prestressed Precast Concrete
P.O. Box 2530 Winchester, Virginia

SUBJECT 2ND TEST PANEL.

SHEET NO. 4 OF
JOB NO.
BY DAR DATE 3/20
CHKD. BY DATE



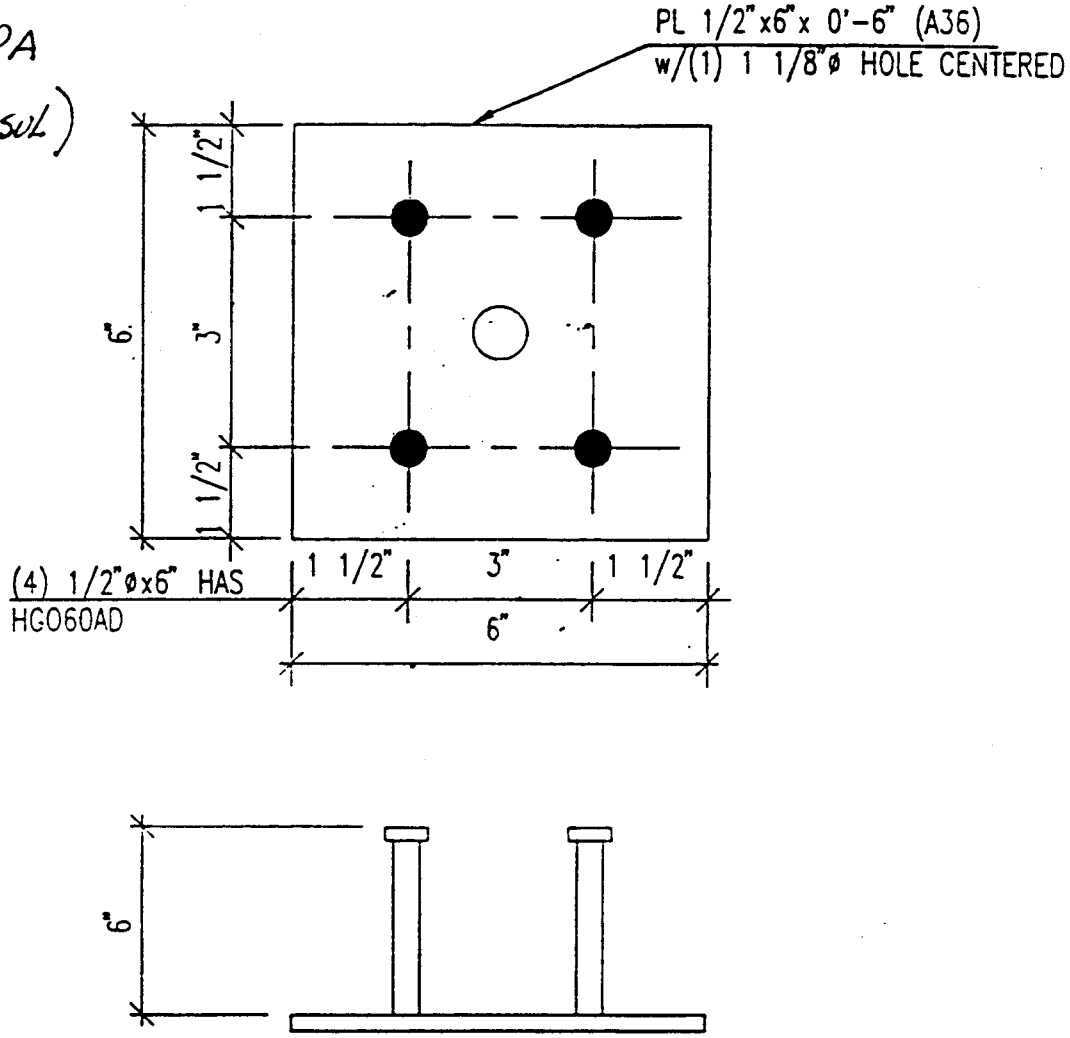
TESTED AT 13 DAYS
WHEN f'_c = 7000psi (EST.)

5

TEST (A) & (D)

w/8791 PA

(1"ϕ COIL + INSUL)



NOTES:

NUMBER REQ'D.	JOB NO. 2938-1245
390	P9603GA
	DRAWN BY JBS / APPROVED BY GH 8-12-94

SHOCKEY BROS., INC.
P.O. BOX 2530 703-667-7700
WINCHESTER, VA.
22604

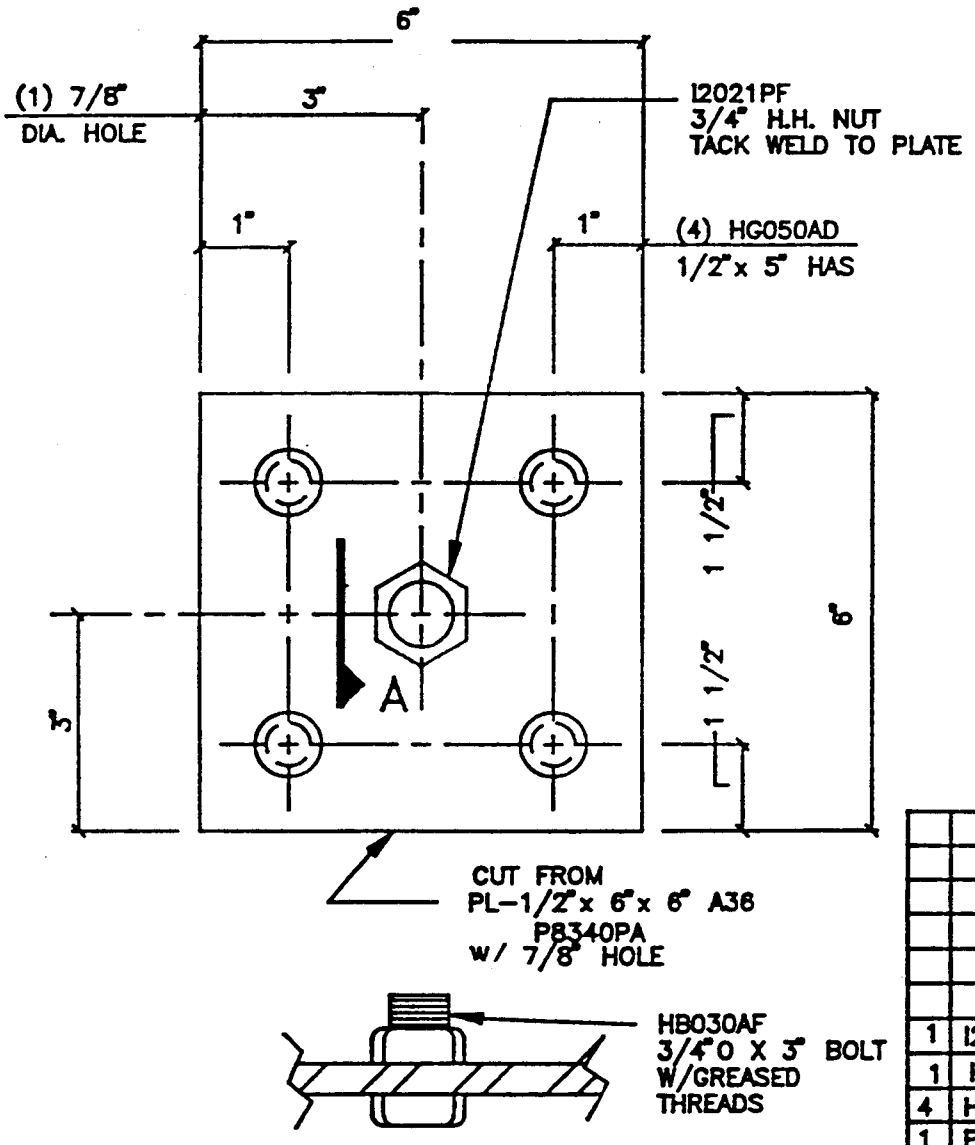
A Hard Hat to Top!

WHERE USED RFA & PFA PANELS

REVISED

CHECKED BY	DATE	CIRCLE ONE
GH	12 8/4/94	A S

RETRIEVAL DESCRIP.	NOTE
P8341PB TESTS (B) & (C)	THIS ITEM USED : SPANDREL TO COLUMN CONNECTION



SECTION A

QTY.	CAT. NO.
1	I2021PF
1	HB030AF
4	HG050AD
1	P8340PA

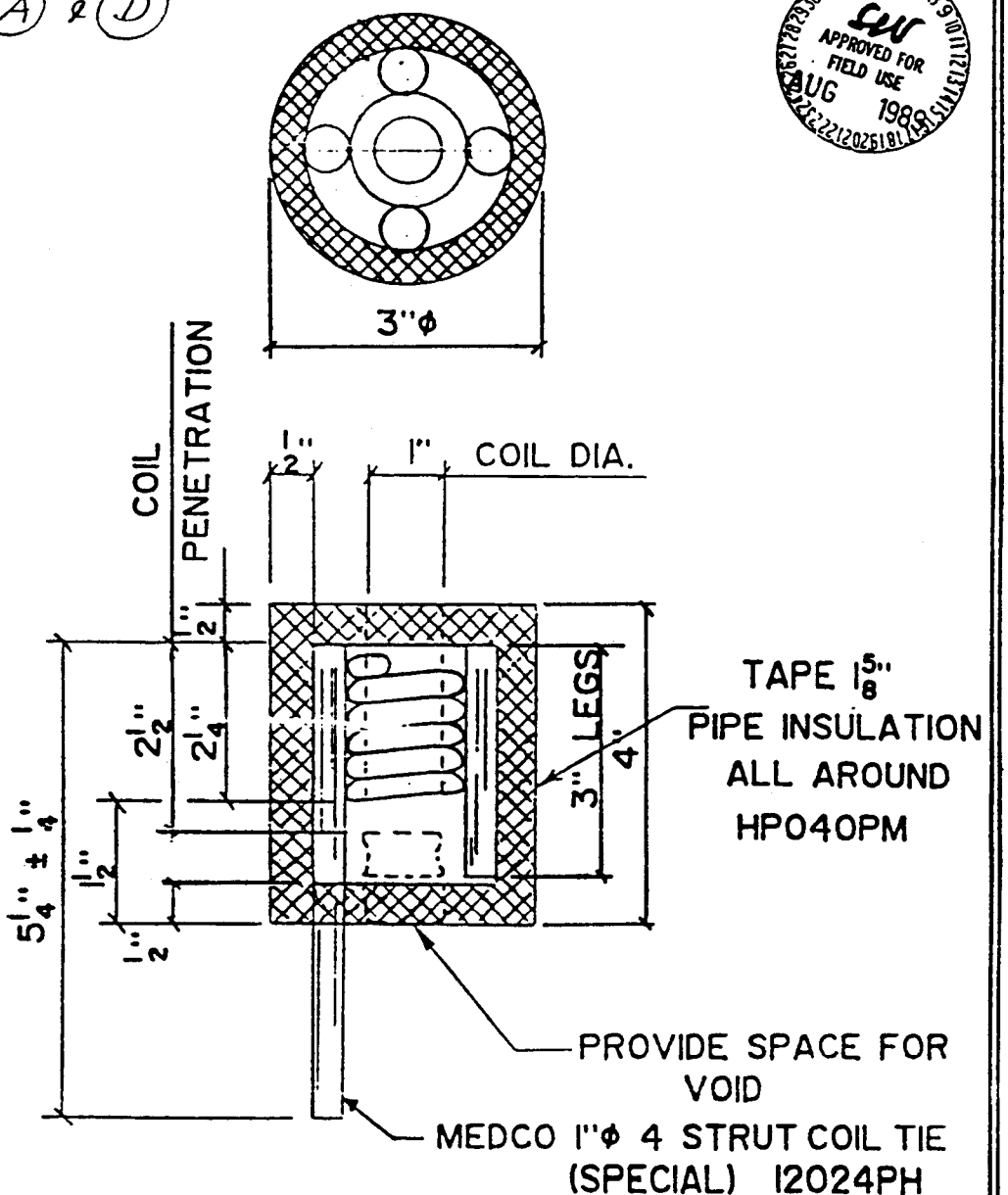
BILL OF MATERIAL

STANDARD MATERIAL DETAIL :
PL 1/2" x 6" x 0'-6"
w/3/4" NUT SPAN'L TO COL

P8341PB

RETRIEVAL DESCRIPT.	NOTE
P879IPA 1"ϕ 4 STRUT COIL INSERT	SERVICE LOADING, TMAX=25.0 K ERECTION LOADING, TMAX=37.5 K

USED IN TESTS (A) & (D)



DETAIL: 1"ϕ 4 STRUT COIL INSERT	P879IPA

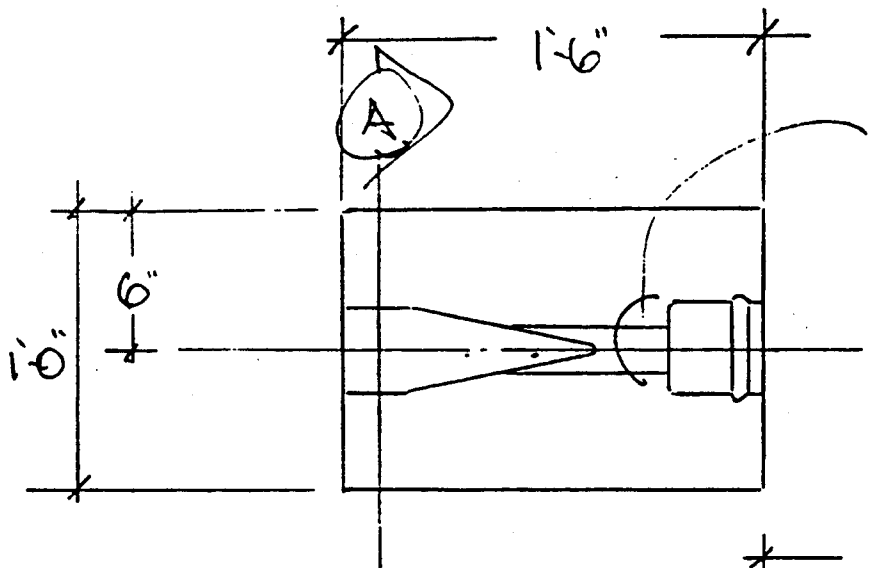
SHOCKEY BROS., INC.
Prestressed Precast Concrete
P.O. Box 2530 Winchester, Virginia

SUBJECT BWI

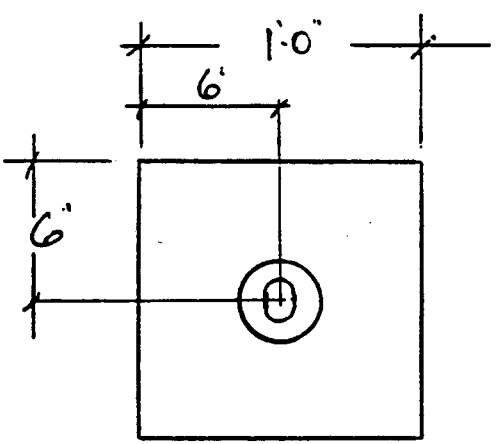
SHEET NO. ____ OF ____
JOB NO 2946
BY ZMR DATE 1/30/95
CHKD. BY ____ DATE ____

LOAD TEST MOCKUP UNITS

COLUMN SLEEVE ANCHORAGE LOAD TEST.



HIGH CONCRETE CONNECTOR SLEEVE



A