

NORMAN HANSON & ASSOCIATES  
Consulting Civil Engineers  
105 Berry Drive  
Madera, California 93637  
(209) 674-2297

Bomanite Corporation  
3765 N. Goldenrod Ave.  
Kerman, CA 93630

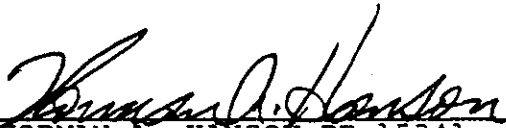
Attention: Vaughan Chamness Jr.  
Chief Engineer

RE: STRUCTURAL LOAD TEST, GRASSCRETE,  
REUSABLE FORMER SYSTEM

On September 4, 1986, a loading test was performed on the test section of Grasscrete that was constructed at Roeding Park, Fresno, California, on July 15, 1986. A City of Fresno Grumman ladder truck, Grumman Model No. 4310-84, Serial No. 1091L43F4D1008313, with a G.V.W. of 66,000 pounds, a GAWR Front 20,000 pounds and a GAWR Rear 46,000 pounds. Objective of test was to determine if Grasscrete as constructed on this site provided suitable support for a deployment of this heavy equipment under worst case conditions. These conditions were stipulated by Grumman Corporation and included extending the ladder 100 feet in the horizontal 90° to the longitudinal axis of the truck with 800 pounds in the basket, and the truck fully elevated off the ground by the outriggers.

The deflection of the concrete was measured with a dial indicator. The results measured by B.S.K. & Associates, the Geotechnical Consultants showed the maximum deflection observed was 0.065 inches with the soil saturated.

The complete report by Norman Hanson & Associates and B.S.K. & Associates is available on request.

  
NORMAN A. HANSON, RE 15341  
President & Chief Engineer



GRASSCRETE PERFORMANCE TESTS

**NORMAN HANSON & ASSOCIATES**

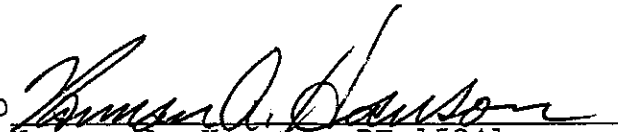
CONDUCTED BY:

**Consulting Civil Engineers  
105 Berry Drive  
Madera, California 93637  
(209) 674-2297**

CONDUCTED FOR:

**BOMANITE CORPORATION  
81 Encina Avenue  
Palo Alto, CA 94301**

APPROVED

  
Norman A. Hanson, RE 15341  
President & Chief Engineer

Date: September 29, 1986



## INTRODUCTION

BOMANITE CORPORATION has a product called GRASSCRETE. It is a monolithic slab of concrete five and a half inches thick. A uniform pattern of holes are achieved in the concrete with the use of a specific form placed on the prepared base prior to the pour.

When completed the holes are filled with dirt or sand and grass is often planted in the holes. The result is an attractive surface capable of carrying heavy vehicular loads at slow speeds.

The firm of NORMAN A. HANSON & ASSOCIATES monitored the entire process and retained the firm of B.S.K. & ASSOCIATES to take appropriate samples and measurements to determine the results contained in the attached report.

The test is to evaluate a recent improvement in the formers used to create GRASSCRETE as described in BOMANITE CORPORATION'S bulletin #504 GRASSCRETE. BOMANITE CORPORATION'S specification bulletin #505 was used to determine the concrete mix. This new system allows the formers to be reused, reducing the cost of the installation. The formers used up to this time were consumed in the casting process. The new system is sufficiently different to require retesting.

Load bearing properties need to be established for various private and public agencies that utilize GRASSCRETE. The vehicles having the highest concentrated load are the outriggers of fire fighting ladder trucks.

The Grumman Corporation of Roanoke, Virginia, informed us that one of those trucks is owned by the Fresno Fire Department. The tests were conducted at Roeding Park in Fresno, California.

## TEST RESULTS

Three separate tests were conducted on a GRASSCRETE test sample twenty five feet by thirty seven feet. The outriggers were placed in the center of each test pad, see Figure A. for details of the test pad. The outriggers were deployed for maximum loading conditions as stated in "Test Methods".

None of the three test areas failed. Failure was defined as deflection without the appropriate rebound. See attached Lab Report by B.S.K. & ASSOCIATES.

Following the tests, we excavated around each of the above test areas and observed no visible evidence of structural degradation as a result of the tests. There were no visible cracks in the concrete as the result of the tests.

### TEST METHOD

A GRASSCRETE test pavement twenty five feet by thirty seven feet was placed with two sub-grade conditions. One section had one inch of sand over native soil. The other had the native soil, five inches of class 2 aggregate base and one inch of sand below the GRASSCRETE.

The analysis of the soil shows a Hanford series with some coarser aggregates than are normally found. See B.S.K. & ASSOCIATES report.

The concrete was a mix of Portland cement conforming to ASTM-C-150 type II. Aggregate used conformed to ASTM-C-33 and were minus 3/8 inch.

The GRASSCRETE openings were filled with dirt then sod placed on top. Following a 30 day cure, a Grumman Model No. 9310-84 ladder truck was brought to the test site.

The park sprinkler system was operated for 5 days prior to the test to fully saturate the ground at the test site. Soil moisture was measured to assure saturation below the level of the base of the GRASSCRETE.

The truck was positioned so the outriggers carrying the stated load could be placed over the load center. The hydraulic system on the truck was operated to lift the truck completely off the ground by the outriggers. See Figure B for elevation of the ladder truck. The truck was left in that position for ten minutes. At the end of the ten minutes the deflection was measured, see B.S.K. & ASSOCIATES report.

### REINFORCEMENT

Figure A displays the reinforcing Schedule for each of the test load centers. The mesh used was 6" x 6"-#10 x 10, 6" x 6"-#6x6, and 6" x 6 "-#4x4. All mesh ends were overlapped at least 12 inches. The steel was chaired off subgrade two inches.

### TEST APPARATUS

The load vehicle used is a Grumman Model #4310-84 ladder truck. It is serial No. 109oL43F4D1008313. It has a gross weight of 66,000 pounds. 20,000 pounds is on the front axle. 46,000 pounds are shared by the rear axles. The ladder when fully extended reaches 100 feet. With the outriggers in use, the entire weight of the truck is carried by the outriggers, see Figure B.

The test was conducted deploying the ladder the full 100 feet in a horizontal position  $90^{\circ}$  to the axis of the truck with 800 pounds in the basket. This (per the attached) letter from the Grumman Corporation states 218,800 pounds force is transmitted over an area two feet by two feet, see B.S.K. & ASSOCIATES report.

The letter states that the outrigger load is 218,800 pounds with 1,000 pounds in the basket. The fire captain felt this load was excessive for the equipment and wanted the load limited to 800 pounds. Eight hundred pounds results in an outrigger load of 208,700 pounds.

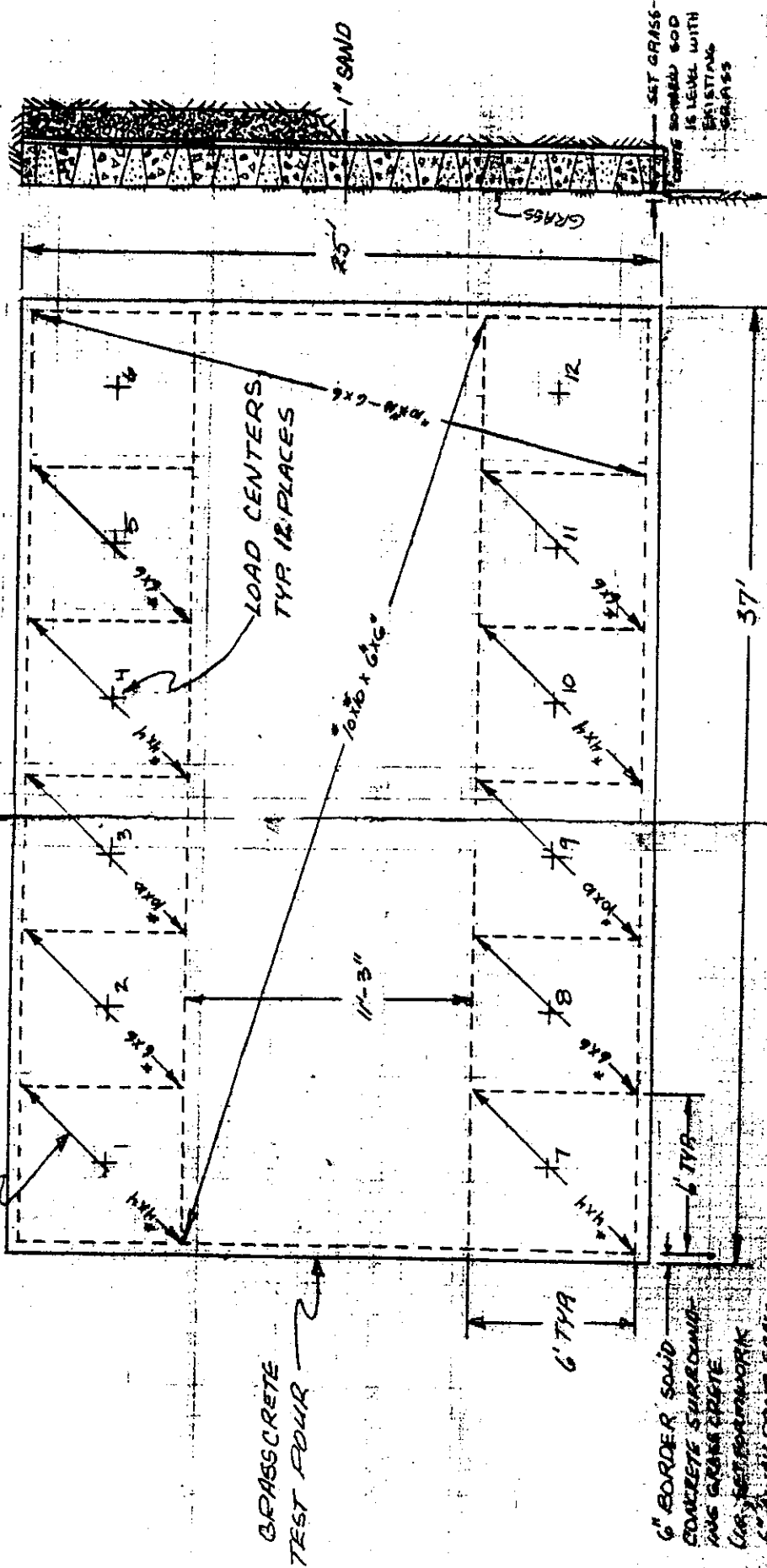
# GRASSCRETE LOAD TEST

(216 GRASSCRETE FORMERS)

$$2 \times 11 \times 11 = 242 \text{ sq ft}$$

LOCATION OF WELDED WIRE FABRIC  
ALL WIRE ON 6" x 6" CENTERS, TYR

5" TYPE 2 BASE  
(CRUSH GROUND BASE)  
W/BEAR-PLATE COMPACTION



GRASSCRETE  
TEST FOUR

6" BORDER SOLID  
CONCRETE SURROUNDING  
THIS GRASSCRETE  
(W/ REINFORCEMENT)  
6" (W/ 1" FROM GRASS-  
CRET FORMERS)

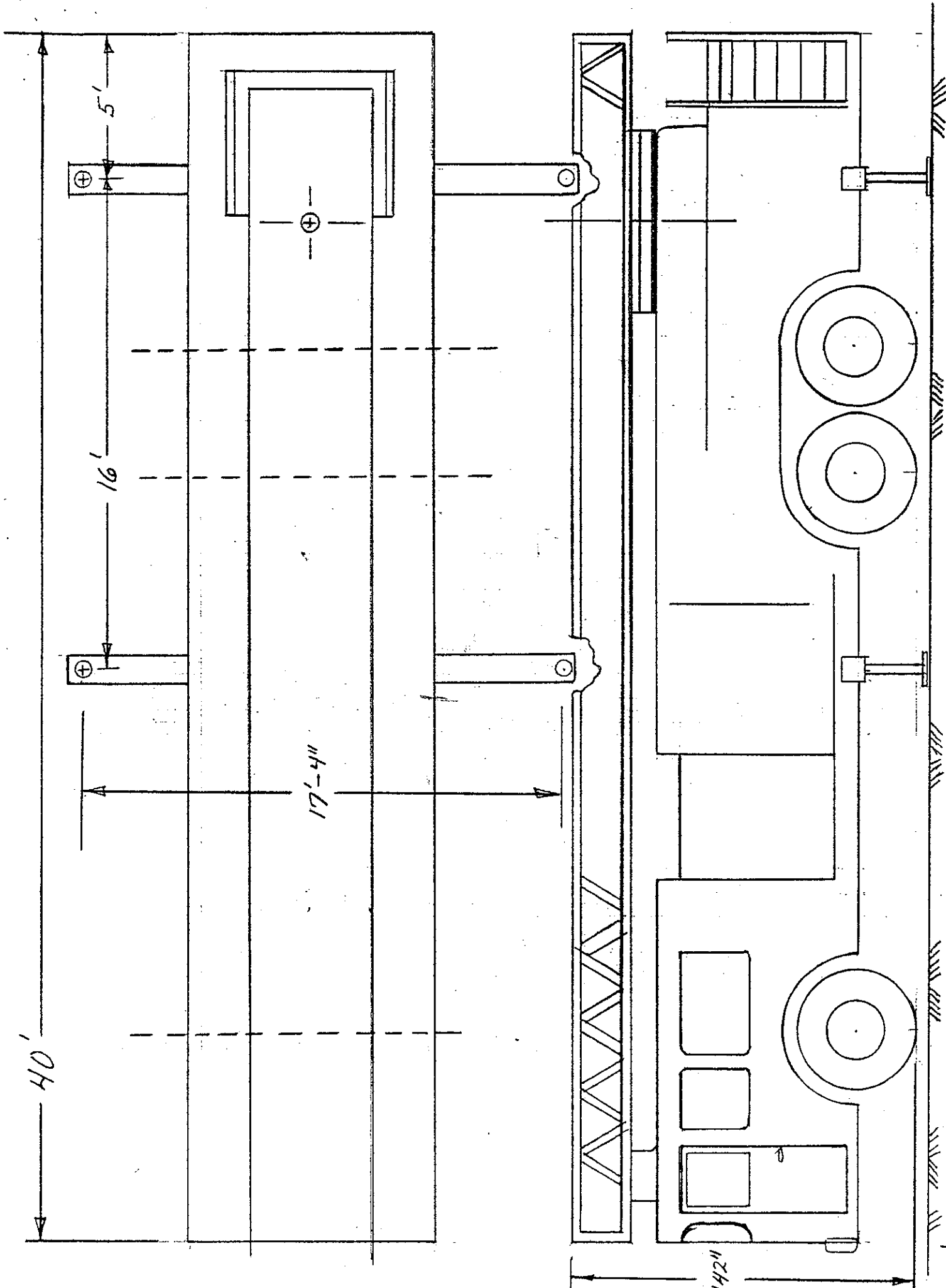
FIGURE

A

**Somanite**  
CORPORATION

MAIN OFFICE  
2100 E. 12th Avenue  
Alto, CA 94001  
PH: 415-761-0776

ENGINEERING DIVISION  
2200 North Golden Gate  
Marina, CA 94028  
PH: 415-393-3448



GRUMMAN  
FIGURE B

# Grumman Emergency Products, Inc.

1723 Seibel Drive, NE, Roanoke, Virginia 24012  
A Subsidiary of Grumman Allied Industries, Inc.  
703-982-6666

August 26, 1986

Mr. Vaughan Chamness  
Solarpave Division  
Bomanite Corporation  
3765 North Goldenrod Ave.  
Kerman, CA 93630

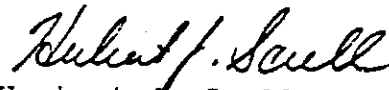
Dear Sir:

I have researched your question as to what is the greatest vertical load that is exerted through the outriggers of a 102 ft. Aerialcat and have found this to be 380 PSI. This is for a 2 ft. by 2 ft. area. The following conditions would apply:

- The ladder would be fully extended.
- It would be rotated 90 degrees to the central axis of the vehicle.
- It would have a 1000 lb. basket load.

If I can be of any further assistance, please call.

Sincerely,



Herbert J. Scull  
Director of Engineering

HJS/lcj



# BSK & Associates

Geotechnical Consultants, Inc.

Wesley J. Braun, CE  
Robert D. Skaggs, CE  
Hugo Kevorkian, CE

John R. Hedley, CE  
John B. Moore, CE  
John M. Minney, CE

James G. Sutton, CE  
Alex Y. Eskandari, CE

John H. Kirk, CEG  
Thomas E. Vahlstrom, Ch

September 22, 1986

OUR JOB 86234

Bomanite Corporation  
3765 N. Goldenrod Avenue  
Kerman, CA 93630  
Attn: Vaughan Chamness Jr.

SUBJECT: Grasscrete Test Section  
Roeding Park  
Fresno, California

Gentlemen:

At your request, we have made observations and performed tests on the soil and concrete for the recently constructed test section at Roeding Park.

Soils tests have included Compaction Tests of the subgrade soils, "R" Value of the subgrade soils, and Maximum Density of the subgrade soils.

Concrete tests included the preparation of test cylinders on July 15 and Compression Testing of samples cast on July 14 & 15, 1986. Copies of the Compression Test Results are enclosed.

Tests were also performed on a sample of wire mesh obtained from the job site on July 15, 1986.

On September 4, 1986, a loading test was performed on the test section of Grasscrete. A City of Fresno ladder truck was driven over the grass covered Grasscrete with no visible distress. The outriggers were placed on the Grasscrete and the deflection of the underlying concrete measured with a dial indicator supported by a portable bridge, see enclosed photos.

Soil Engineering • Engineering Geology • Engineering Laboratories • Chemical Laboratories


- Fresno, California 93706 • 1414 Stanislaus Street • Telephone (209) 485-8310
- Visalia, California 93278 • 3901 So. Mooney Blvd., P.O. Box 3236 • (209) 732-8857
- Bakersfield, California 93304 • 117 "V" Street • Telephone (805) 327-0671
- Pleasanton, California 94566 • 5729-G Sonoma Drive • Telephone (415) 462-4000

The deflection readings are tabulated on an enclosed Summary of Loading Test.

If you have any questions concerning this report or other projects, please feel free to call.

Respectfully submitted,

BSK & Associates

  
Robert D. Skaggs

RDS:ka

Enclosures: Summary of Test Results  
Summary of Load Tests  
"R" Value  
Concrete Cylinder Tests  
Test Location Map

cc: Norm Hanson

SUMMARY OF TEST RESULTS  
Subgrade Soils, Test Plot

Field Density & Moisture Tests  
ASTM D-2937

Test No.	Date	Location	Depth ft.	Moisture %	Compaction %
1	7-14-86	"Enclosed	0.5	6.2	93.5
2	"	Test	0.5	6.2	86.2
3	"	Location	0.5	6.3	83.3
4	"	Map"	0.5	11.1	88.6

Maximum Density & Optimum Moisture  
ASTM D-1557

Soil Description: Silty SAND: dark olive brown; medium to fine grained

Optimum Moisture: 10.2%

Maximum Dry Density: 128.0 pcf

"R" Value Determination  
Calif. Method 304, ASTM D-2844

Resistance Value at 300 psi,  
Exudation Pressure: 56

(See enclosed "R" Value Data Sheet)

Grasscrete Test Section  
Roeding Park  
Fresno, California

JOB 96234  
September, 1986  
Enclosure 2

SUMMARY OF LOADING TEST

Date of Testing: September 4, 1986

Personnel Present: R. D. Skaggs

Northeast Test Panel - Test No. 1

<u>Condition</u>	<u>Total Deflection*</u>	<u>Notes</u>
Fire Truck in Position, Outriggers Up	0.000"	
Outriggers Down, Fire Truck off Ground	0.025"	
800 lb. load in basket, 100 ft. out	0.045"	= Total
boom rotated 180° Away	0.036"	Deflection

Northwest Test Panel - Test No. 2

Fire Truck in Position, Outriggers Up	0.000"
800 lb. load in basket, 100 ft. out	0.029"
Rebound, ladder Boom to front of Truck	0.009"
Total rebound with Outrigger up	0.061"

West Side Middle Panel - Test No. 3

Fire Truck in Position, Outriggers Up	0.000"
800 lb. load in basket, 100 ft. out	0.009"
Rebound, Ladder parked on Truck, due to Ladder load	0.018"
Total rebound, with Outriggers up	0.065"

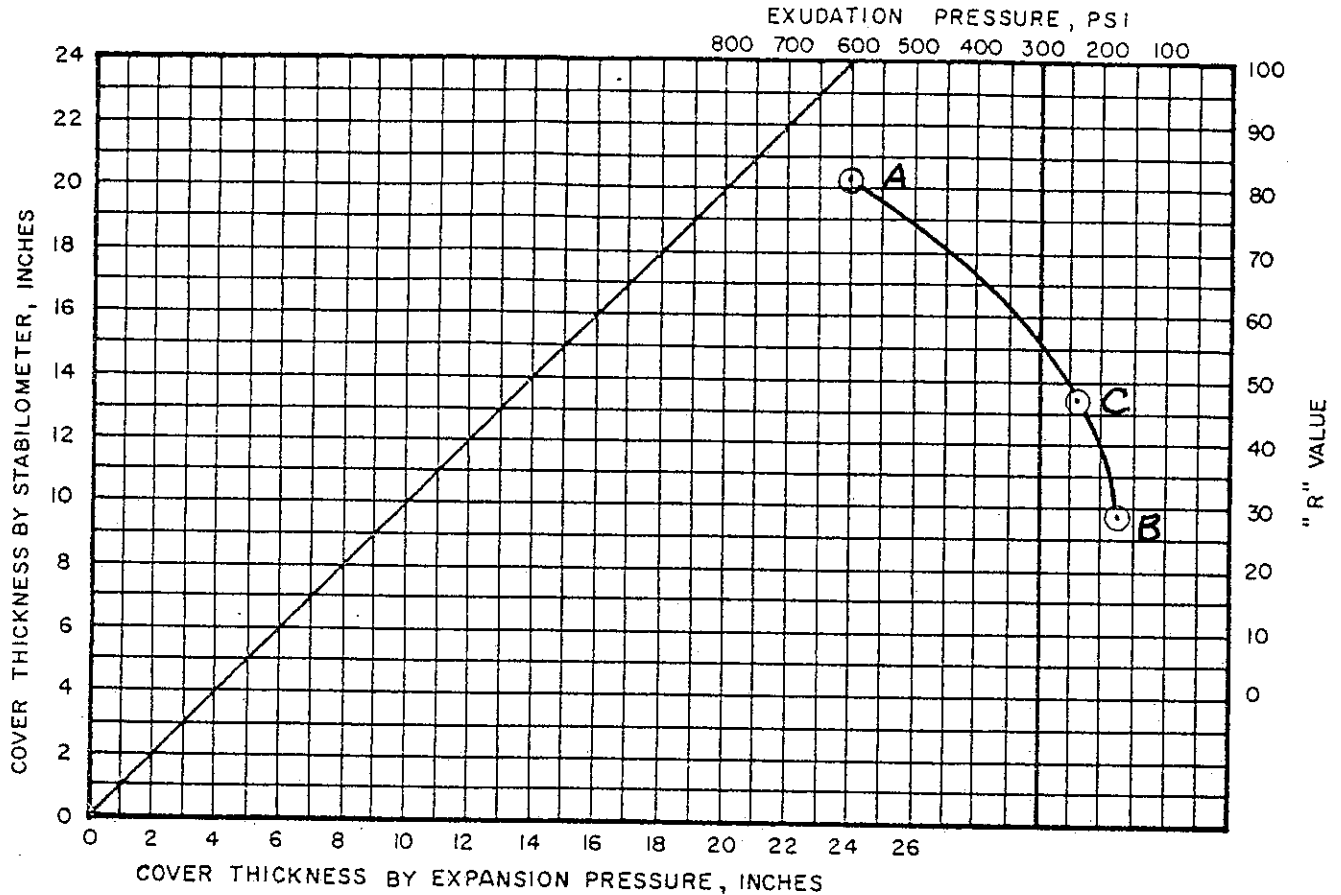
\* Deflection measured on concrete adjacent to Outrigger which is out 10 ft. from  $\phi$  of truck.

Moisture Content Under Test Section

<u>Depth, ft.</u>	<u>% Moisture</u>
2.0	8.8
3.0	8.3
4.0	8.5

RESISTANCE VALUE TEST RESULTS

Sample No. 1



Sample Description: Silty SAND: dark olive brown; medium to fine grained

Grasscrete Test Plot, Roeding Park - sampled 7-14-86

Specimen	A	B	C
Exudation Pressure, psi	605	175	239
Expansion Dial (.0001")	0	0	0
Expansion Pressure, psf	0	0	0
Resistance Value, 'R'	82	29	48
% Moisture at Test	11.42	14.16	13.16
Dry Density at Test, pcf	121.1	118.9	119.8
'R' Value at 300 psi, Exudation Pressure	56		



CONCRETE TEST CYLINDER DATA

OUR JOB NO. 86234 TEST NO. C86308  
 Project Grasscrete Test Section @ Roeding Park  
 Structure Perforated slab on grade  
 Location North 1/2 of test section  
 Sampled From Clovis Ready Mix Invoice # 17647  
 Resident Engineer or Architect Norm Hanson  
 Contractor Carsten Concrete  
 BILL TO Bomanite Corporation Address \_\_\_\_\_  
 Mix Data Mix #188 w/plasticizer  
 Specified Strength \_\_\_\_\_ Slump \_\_\_\_\_  
 Date Cast 7-15-86 Date Delivered 7-16-86  
 Made By RDS Delivered By Jeff Hannel  
 Number of Cylinders Delivered 3  
 Other Instructions:

LABORATORY TEST DATA

Days	7	X	14	28	X	HOLD	X
Cylinder No.	C86308-1			C86308-2		C86308-3	
Date Tested	7-22-86			8-12-86			
Total Load	119,000			148,500			
PSI	4209			5253			
Type of Break	Conical			Conical			

Copies to: Carsten Concrete  
 Bomanite Corp.

- FRESNO, CALIFORNIA 93706
- VISALIA, CALIFORNIA 93277
- BAKERSFIELD, CALIFORNIA 93304
- PLACANTON, CALIFORNIA 95366

By [Signature]

FORM 118



CONCRETE TEST CYLINDER DATA

OUR JOB NO. 86234 TEST NO. C86307  
 Project Grasscrete Test Section @ Roeding Park  
 Structure Perforated slab on grade  
 Location South 1/2 of test section  
 Sampled From Clovis Ready Mix  
 Resident Engineer or Architect Norm Hanson  
 Contractor Carsten Concrete  
 BILL TO Bomanite Corporation Address \_\_\_\_\_  
 Mix Data Mix No. 488  
 Specified Strength \_\_\_\_\_ Slump \_\_\_\_\_  
 Date Cast 7-15-86 Date Delivered 7-16-86  
 Made By Norm Hanson Delivered By Jeff Hannel  
 Number of Cylinders Delivered 3  
 Other Instructions:

LABORATORY TEST DATA

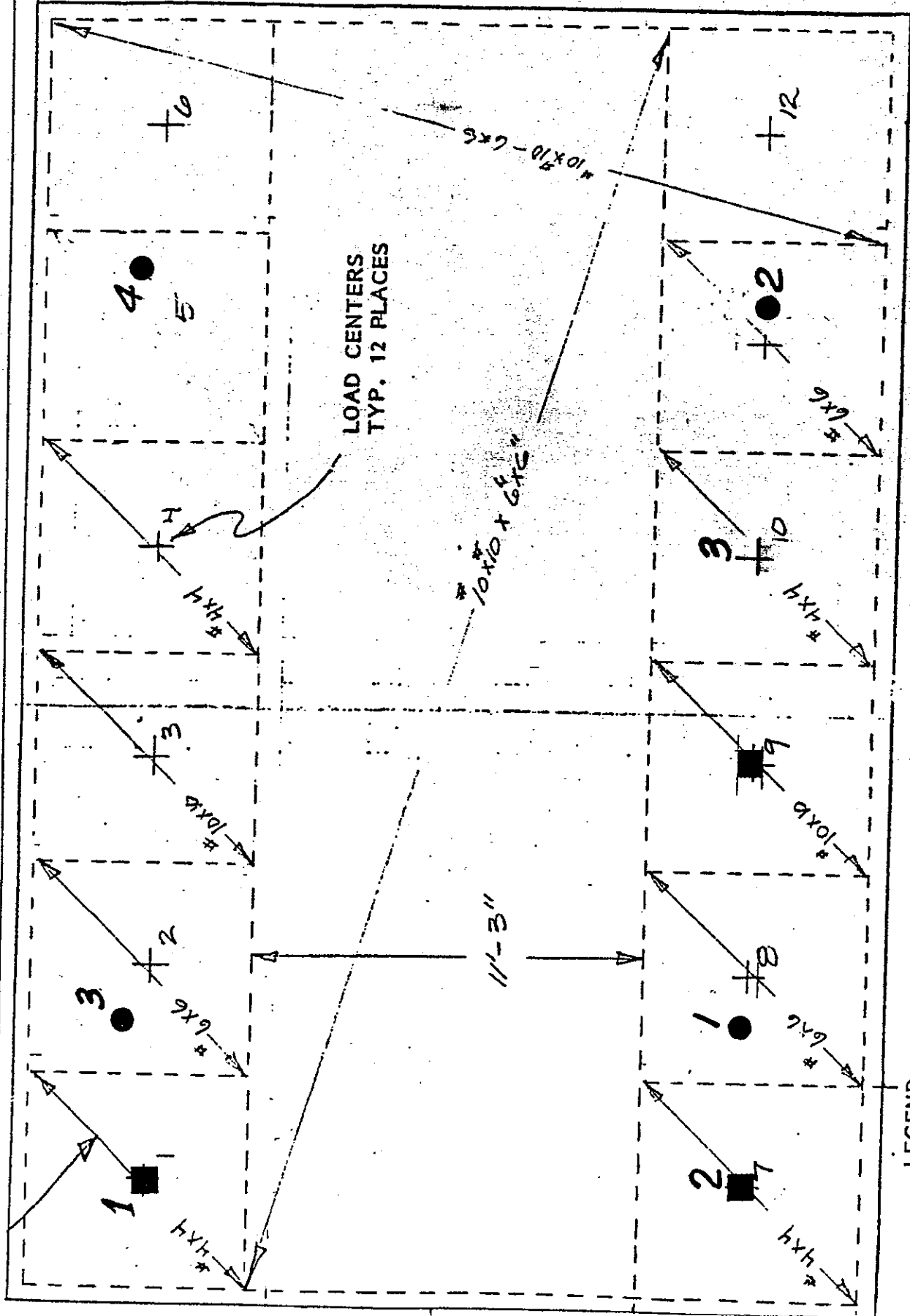
Days	7	X	14	28	X	HOLD	X
Cylinder No.	C86307-1			C86307-2		C86307-3	
Date Tested	7-22-86			8-12-86			
Total Load	108,000			151,000			
PSI	3820			5341			
Type of Break	Conical			Conical			

Copies to: Carsten Concrete  
 Bomanite Corp.

- FRESNO, CALIFORNIA 93706
- VISALIA, CALIFORNIA 93277
- BAKERSFIELD, CALIFORNIA 93304
- PLACANTON, CALIFORNIA 95366

By [Signature]

FORM 118



**LEGEND**

- Approximate Location of Compaction Test No. 1
- Approximate Location of Loading Tests

Subgrade Compaction Testing  
Grasscrete Test Section