MATHEWS KESSLER & ASSOCIATES, INC.
4045 E. McDOWELL RD.
PHOENIX, ARIZONA 85008-4405
PHONE: 602/244-2664
FAX: 602/275-3220

TO:	Cyrous Vahidnia Civil Engineer Flood Control District of Maricopa County 3335 West Durango Street Phoenix, Arizona 85009
FROM:	Robert T. Herz, P.E., R.L.S. Robert T. Herz
SUBJECT:	51st Avenue Bridge at Skunk Creek (BR-885806)
MKA PROJECT NO:	6068
DATE:	December 24, 1990
Transmitted Via:	Hand Delivered

As requested:

1 Copy	Soils report by Thomas-Hartig & Associates dated December 26, 1989 (Project No. 90-0012)
1 Copy	Design Criteria from RGA Engineering Corp's Flood Plain Study, dated June 14,1989

ENGINEERING DIVISION
LIBRARY

Property of
Flood Control District of MC Library
Please Return to
2801 W. Durango
Phoenix, AZ 85009

THOMAS-HARTIG & ASSOCIATES, INC.

TOM W. THOMAS, P.E. • HARRY E. HARTIG, P.E.
Geotechnical, Materials Testing, and Environmental Consultants
7031 West Oakland Street • Chandler, Arizona 85226

James R. Morrow
John P. Boyd, P.E.
Charles H. Atkinson, P.E.
Glen K. Copeland, P.E.

James M. Willson, P.E.
Frank M. Guerra, P.E.
Steven A. Haire, P.E.

Kenneth L. Ricker, P.E.
Judith A. McBee
Dale V. Bedenkop, P.E.
John C. Patton

RGA
2633 East Indian School Road, Suite 401
Phoenix, Arizona 85016-6741

26 December 1989

Attention: Robert T. Herz

Project: 51st Avenue Bridge at Skunk Creek
South of Beardsley
Phoenix, Arizona

Project No. 90-0012

This report presents the results of the geotechnical engineering services authorized for the 51st Avenue Bridge at Skunk Creek located south of Beardsley, Phoenix, Arizona. The purpose of these services is to determine the soil conditions at the locations indicated which thereby provide a basis for the design discussions and recommendations presented herein. This firm should be notified for evaluation if conditions other than described herein are encountered during construction.

Our field services have not included exploration for underlying geologic conditions or evaluation of potential geologic hazards such as seismic activity, faulting, and ground subsidence/cracking potential due to groundwater withdrawal, or the presence of contamination.

The recommendations presented in this report are based upon the project information received and described in "Scope" Part I. This firm should be contacted for review if the design conditions are changed substantially.

If requested, we will be available to review project plans and specifications relative to compliance to the intent of this report.

Respectfully submitted,

THOMAS-HARTIG & ASSOCIATES, INC.

By: Steven A. Haire, P.E.

Reviewed by: Kenneth L. Ricker, P.E.

/sb

Copies to: Addressee (5)

TABLE OF CONTENTS

PART I - REPORT

Introduction..... 1
Site Description..... 1
Investigation..... 1
Soil Conditions..... 2
Discussion and Recommendations:
General..... 2
Foundations..... 2
Figure 1 - Allowable Pile Capacity..... 4
Lateral Design Parameters..... 5
Lateral Pile Capacity..... 5
Structural Fill..... 5
Corrosion..... 6

APPENDIX A - FIELD RESULTS

Site Plans..... 7
Legend..... 8
Legend of Soil Types..... 9
Graphical Boring Logs.....10

APPENDIX B - LABORATORY RESULTS

Direct Shear Test.....12
Percent Passing No. 200 Sieve and Plasticity Index.....16
pH, Soluble Salts, Sulfates.....17

INTRODUCTION

The proposed 51st Avenue Bridge over Skunk Creek will be 6-lane, two-span structure utilizing pre-stressed concrete girders. Based on preliminary design information provided by the structural engineer, RGA, maximum center support foundation loads will be about 600 kips per columns. Abutment loads will be about 150 kips per foot.

SITE DESCRIPTION

The proposed bridge will be constructed in an area that is undeveloped, open desert land just south of the existing low flow channel of Skunk Creek. The existing ground surface is relatively flat, sloping down toward the north with about 4 feet of elevation differential across the proposed bridge structure. Scattered trash, construction debris, and rubble were present across the site area. Surface vegetation consists of scattered desert shrubs.

INVESTIGATION

The field investigation included a site review, a site reconnaissance, and subsurface explorations. The subsurface explorations consisted of drilling 4 tests borings at locations shown on the attached site plan. Test Borings 1, 2, and 3 were advanced using a 7-inch diameter hollow-stem auger CME 55 drill rig. The auger borings were advanced to the depth of refusal at 10 to 15.5 feet. In order to achieve the required depth of exploration, a fourth boring (Test Boring 2A) was advanced using 9-inch O.D. double-wall drive casing driven by a diesel percussion hammer rig to a depth of about 69 feet. Standard Penetration Test (SPT) sampling was conducted in all the borings at selected depths. During the field investigation, the soils encountered were visually classified by our field engineer. The results of the test drilling are presented on the boring logs in Appendix A, "Field Results."

Laboratory testing was conducted on representative soil samples obtained during the test drilling. The testing was conducted to obtain the data necessary to develop design parameters for this project. The following tests were conducted:

Test	Sample(s)	Purpose
Direct Shear	Remolded soil samples (4)	Strength characteristics of site soils
Sieve Analysis and Atterberg Limits	Soil (5)	Soil classification and correlation to engineering properties
pH, Soluble Salts, Sulfates	Soil (2)	Corrosion potential of site soils

The results of laboratory testing are presented in Appendix A.

SOIL CONDITIONS

Detailed soil descriptions are presented on the graphical boring logs in Appendix A. Soils encountered in the upper 39 feet consisted primarily of dense gravelly sand and gravelly clayey sands. Soils encountered below a depth of about 39 feet were primarily very stiff to hard sandy clays of medium plasticity with scattered lenses of gravelly silty to clayey sand. Soil moisture contents at the time of test drilling were described as damp to moist, and no free groundwater surface was observed in any of the test borings during drilling.

DISCUSSION AND RECOMMENDATIONS

General: Soil engineering recommendations for support of the new bridge are presented in the following sections. These recommendations of based upon the results of the field and laboratory testing. Alternative recommendations may be possible and will be considered upon request.

Foundations: Based on preliminary calculations by RGA, there is a potential for approximately 23 feet of scour at the bridge foundations. Based on a planned bottom of channel of elevation of 1287 feet, the resulting scour line would be at about Elevation 1264 feet. All foundation depths shown in this section are based on depths below this scour level. When the final design scour elevation has been determined, we should be contacted for review and possibly supplemental recommendations.

Although under reamed drilled piles might be feasible in the more clayey soils, we recommend the use of straight-shaft drilled piles because scattered gravelly lenses and/or non-plastic silty sand lenses may result in excessive caving. This possibility could best be evaluated in a test excavation. Recommendatons for both

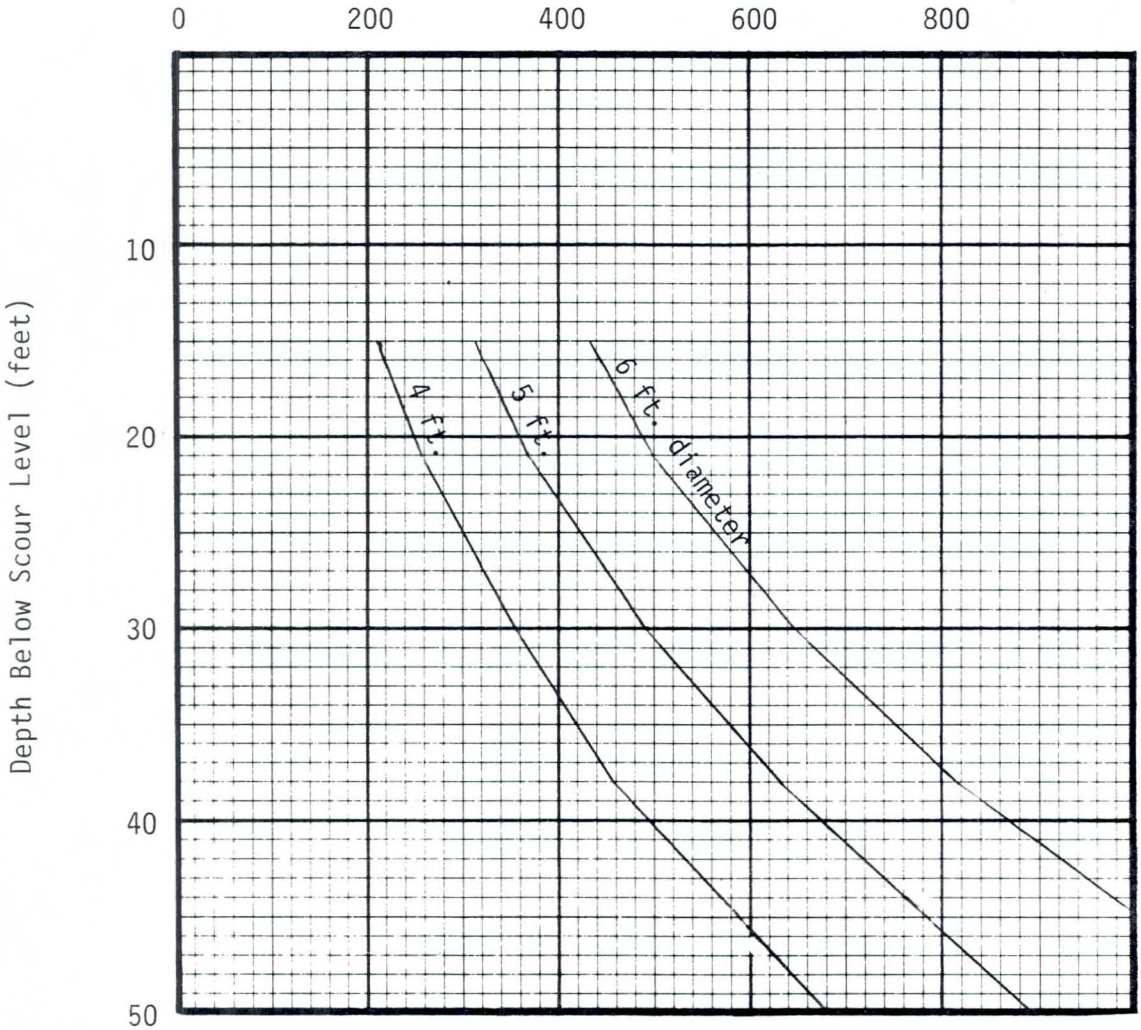
under reamed and straight-shaft piles are presented below for comparison.

I. Drilled C.I.P. Straight Shaft Piles: The allowable downward capacities of straight-shaft, cast-in-place drilled piles for support of foundation loads are presented in Figure 1 on the following page. The presented allowable drilled pile capacities should be considered allowable maximums for dead plus design live loads, and may be increased by one-third when considering total loads including transient wind or seismic forces. The weight of the foundation concrete below-grade (below the scour line during scour) may be neglected in dead load computations. Settlements for the anticipated foundations loads are less than about 1/2 inch.

II. Drilled C.I.P. Undereamed Piles: Undereamed (belled) piles may be designed using an allowable end bearing pressure of 12000 psf, bearing in undisturbed sandy clay and/or clayey sand soils at least 20 feet below the anticipated scour depth. The allowable bearing pressure may be increased by 1/3 when considering total loads including transient wind and seismic forces. The weight of foundation concrete below-grade may be neglected in dead load computations. Settlements for the anticipated foundation loads are less than about 3/4 inch.

Drilling spoil must be removed form the bottom of drilled pile excavations before concrete is placed and will normally require personnel entry and manual cleaning if piles are under-reamed. In some instances, disturbed materials can be adequately removed (less than about 3" disturbed material remaining) from the bottom of straight-shaft footings by machine cleaning. Applicable safety codes will require safety casing for protection of personnel entering shafts for cleaning and observation. A minimum shaft diameter of 2.5 feet is recommended for shafts which are entered for cleaning or observation purposes. Moderate to severe raveling or caving may be experienced in the non-cohesive granular soil in the upper 10 feet±, particularly if soils dry out prior to or during drilled pile installation. Some caving may also occur in random deeper lenses of non-plastic sands and/or gravel.

ALLOWABLE DOWNWARD C.I.P. STRAIGHT
SHAFT PILE CAPACITY (kips)



ALLOWABLE PILE CAPACITY
Figure 1
THOMAS-HARTIG & ASSOCIATES, INC.

Lateral Design Parameters: The following tabulation presents recommendations for lateral stability analyses:

[1]Foundation Toe Pressures----------1.33 x allowable
[2]Lateral Backfill Pressures:
Unrestrained walls---------- 30 psf/ft.
Restrained walls---------- 45 psf/ft.
Lateral Passive Pressures:
Continuous walls/footings----------250 psf/ft.
Spread columns/footings----------350 psf/ft.
Coefficient of Base Friction:
Independent of passive resistance--------0.40
In conjunction with passive resistance---0.30

[1]Increase in allowable foundation bearing pressure (previously tabulated) for foundation toe pressures due to eccentric or lateral loading. The entire footing bearing surface should remain in compression.

[2]Equivalent fluid pressures for vertical walls and horizontal backfill surfaces (maximum 12-foot height). Pressures do not include temporary forces imposed during compaction of the backfill, swelling pressures developed by over-compacted clayey backfill, hydrostatic pressures from inundation of backfill, or surcharge loads. Walls should be suitably braced during backfilling to prevent damage and excessive deflection.

Compaction of the backfill soils against embedded footings or walls designed to provide passive resistance should be accomplished to a minimum 95 percent of the maximum ASTM D698 density to develop this resistance with low strains.

Lateral Pile Capacity: Drilled center pier support piles will be subjected to lateral loads caused by flowing water. Abutment piles will sustain lateral loading from backfill pressure on the abutment retaining walls and pile cap, and may also be subjected to lateral loads caused by creep or shrinkage of the pre-stressed girders. When the pile geometry and depth of scour have been finalized, a lateral pile analysis can be performed. At your request, we will perform a lateral pile analysis using a computer-based finite difference model (COM 624G).

Structural Fill: All structural fill materials should be inorganic soils free of vegetation, debris, organic contaminants, and fragments larger than 6 inches in size. All structural fill materials should meet the following recommendations:

Maximum particle size----------6 inches*
Maximum percent expansion----------1.5 **

*Maximum size may be reduced at engineer's direction to satisfy trenching and landscaping requirements, etc.

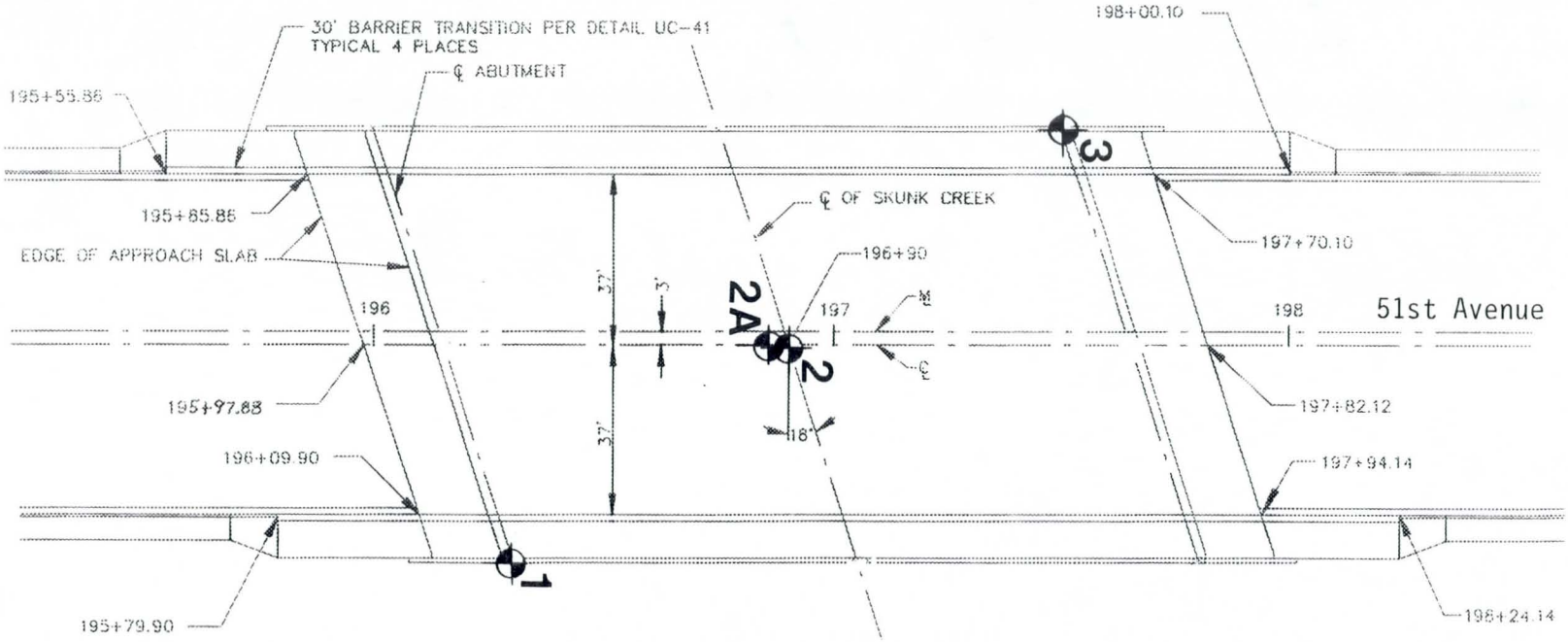
**Performed on sample remolded to 95 percent of the maximum ASTM D698 density and 2 percent below optimum moisture under a 100 psf surcharge pressure.

Site surface soils (0 to 10 feet) should meet the above requirements provided all rubble, trash, or boulders are removed.

All structural fill placed behind the abutment walls should be compacted to a minimum or 95 percent of the maximum ASTM D698 dry density at a moisture content of optimum ±3 percent to help reduce the settlement of the compacted fill.

All abutment walls should be adequately braced to provide lateral support of the walls during the backfilling operations. Compaction of all structural fill behind the walls should be done by mechanical methods, preferrably utilizing hand operated equipment within 3 feet of the wall. The compacted fill behind the walls will tend to settle differentially relative to the walls and should be expected to settle about 1/4 to 1/2 percent of the total height of the compacted backfill. The approach roadways/slabs should be constructed to allow and compensate for this differential settlements.

Corrosion: Laboratory tests were performed on selected soil samples to determine pH, soluble salts, and soluble sulfates content. The results are presented in Appendix B. The soulble sulfate contents of the tested soil samples were to 0.018 to 0.021 percent. Therefore, the corrosion potentional to concrete is considered negligible based on American Concrete Institute guidelines, and no special requirements for concrete in contact with native soils are indicated.



LEGEND

Test Boring

THOMAS-HARTIG & ASSOCIATES, INC.

Project No. 90-0012

LEGEND

SOIL CLASSIFICATION

COARSE-GRAINED SOIL

More than 50% larger than 200 sieve size

SYMBOL	LETTER	DESCRIPTION	MAJOR DIVISIONS
	GW	WELL-GRADED GRAVELS OR GRAVEL-SAND MIXTURES. LESS THAN 5% - #200 FINES	GRAVELS More than half of coarse fraction is larger than No. 4 sieve size
	GP	POORLY-GRADED GRAVELS OR GRAVEL-SAND MIXTURES. LESS THAN 5% - #200 FINES	
	GM	SILTY GRAVELS. GRAVEL-SAND-SILT MIXTURES. MORE THAN 12% - #200 FINES	
	GC	CLAYEY GRAVELS. GRAVEL-SAND-CLAY MIXTURES. MORE THAN 12% - #200 FINES	
	SW	WELL-GRADED SANDS OR GRAVELLY SANDS. LESS THAN 5% - #200 FINES	SANDS More than half of coarse fraction is smaller than No. 4 sieve size
	SP	POORLY-GRADED SANDS OR GRAVELLY SANDS. LESS THAN 5% - #200 FINES	
	SM	SILTY SANDS. SAND-SILT MIXTURES MORE THAN 12% - #200 FINES	
	SC	CLAYEY SANDS. SAND-CLAY MIXTURES MORE THAN 12% - #200 FINES	

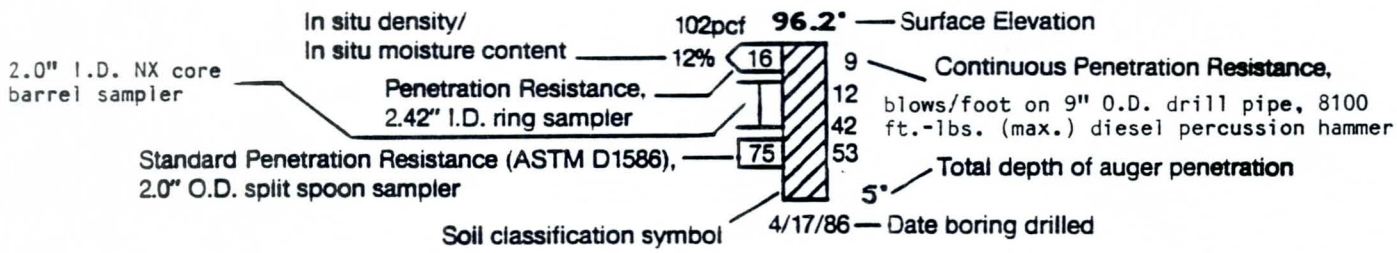
FINE-GRAINED SOIL

More than 50% smaller than 200 sieve size

SYMBOL	LETTER	DESCRIPTION	MAJOR DIVISIONS
	ML	INORGANIC SILTS. ROCK FLOUR. AND FINE SANDY OR CLAYEY SILTS OF LOW TO MEDIUM PLASTICITY	SILTS AND CLAYS Liquid limit less than 50
	CL	INORGANIC CLAYS. GRAVELLY CLAYS. SANDY CLAYS. SILTY CLAYS. AND LEAN CLAYS OF LOW TO MEDIUM PLASTICITY	
	OL	ORGANIC SILTS AND ORGANIC SILT-CLAY MIXTURES OF LOW TO MEDIUM PLASTICITY	
	MH	INORGANIC SILTS. MICACEOUS OR DIATOMACEOUS. AND FINE SANDY OR CLAYEY SILTS OF HIGH PLASTICITY	SILTS AND CLAYS Liquid limit greater than 50
	CH	INORGANIC CLAYS. FAT CLAYS. AND SILTY CLAYS OF HIGH PLASTICITY	
	OH	ORGANIC CLAYS AND ORGANIC SILTS OF MEDIUM TO HIGH PLASTICITY	
	PT	PEAT AND OTHER HIGHLY ORGANIC SOILS	

LEGEND FOR GRAPHICAL BORING LOGS:

Log denotes visual approximation unless accompanied by mechanical analysis and Atterberg limits.



GRAIN SIZES

U.S. STANDARD SERIES SIEVE: 200, 40, 10, 4

CLEAR SQUARE SIEVE OPENINGS: 3/4", 3", 12"

SILTS & CLAYS DISTINGUISHED ON BASIS OF PLASTICITY	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE		

MOISTURE CONDITION (INCREASING MOISTURE →)

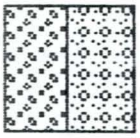
DRY — SLIGHTLY DAMP — DAMP (Plastic Limit) — MOIST — VERY MOIST — WET (SATURATED) (Liquid Limit)

CONSISTENCY CORRELATION		RELATIVE DENSITY CORRELATION	
CLAYS & SILTS	BLOWS/FOOT*	SANDS & GRAVELS	BLOWS/FOOT*
VERY SOFT	0-2	VERY LOOSE	0-4
SOFT	2-4	LOOSE	4-10
FIRM	4-8	MEDIUM DENSE	10-30
STIFF	8-16	DENSE	30-50
VERY STIFF	16-32	VERY DENSE	OVER 50
HARD	OVER 32		

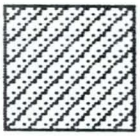
*Number of blows of 140 lb. hammer falling 30" to drive a 2" O.D. (1-3/8" I.D.) split-spoon sampler (ASTM D1586).

Project No. 90-0012

LEGEND OF SOIL TYPES

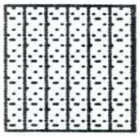


GRAVELLY SAND TO SANDY GRAVEL AND COBBLES; (SW,GW, SW- SM,GW- GM); brown; stratified; fine to coarse sand size; generally non-plastic; medium dense to dense ; damp; scattered boulders possible.



GRAVELLY CLAYEY SAND; (SC); dark brown to red-brown; stratified, fine to coarse sand size, low to medium plasticity; dense; damp; scattered cobbles and boulders possible.

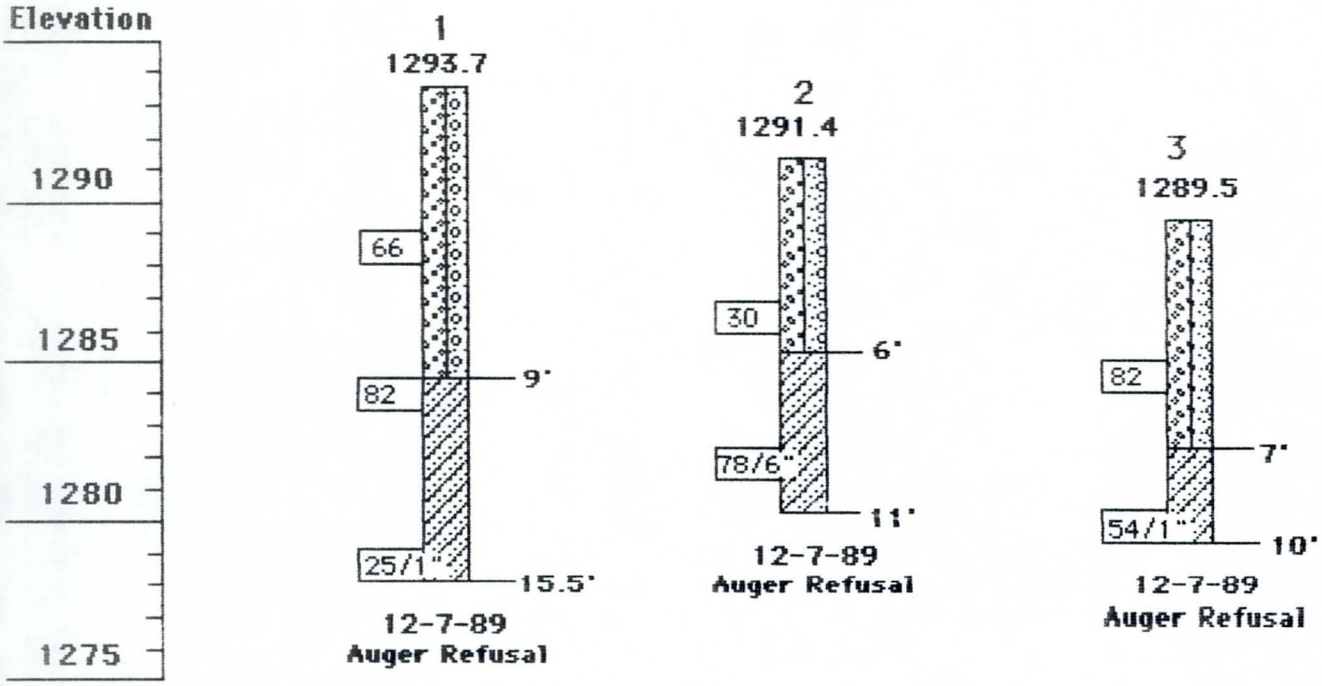
SANDY CLAY; (CL); brown; medium plasticity; very stiff to hard; damp to moist; scattered lenses of gravelly silty to clayey sand; (SM & SC).



GRAVELLY SILTY SAND; (SM); brown; fine to coarse; medium dense; non-plastic, damp.

Project No. 90-0012

Thomas - Hartig & Associates



NOTE: Boring elevations are approximate, based on interpolation from contours on site survey.

No free groundwater was encountered in any of the borings during drilling.

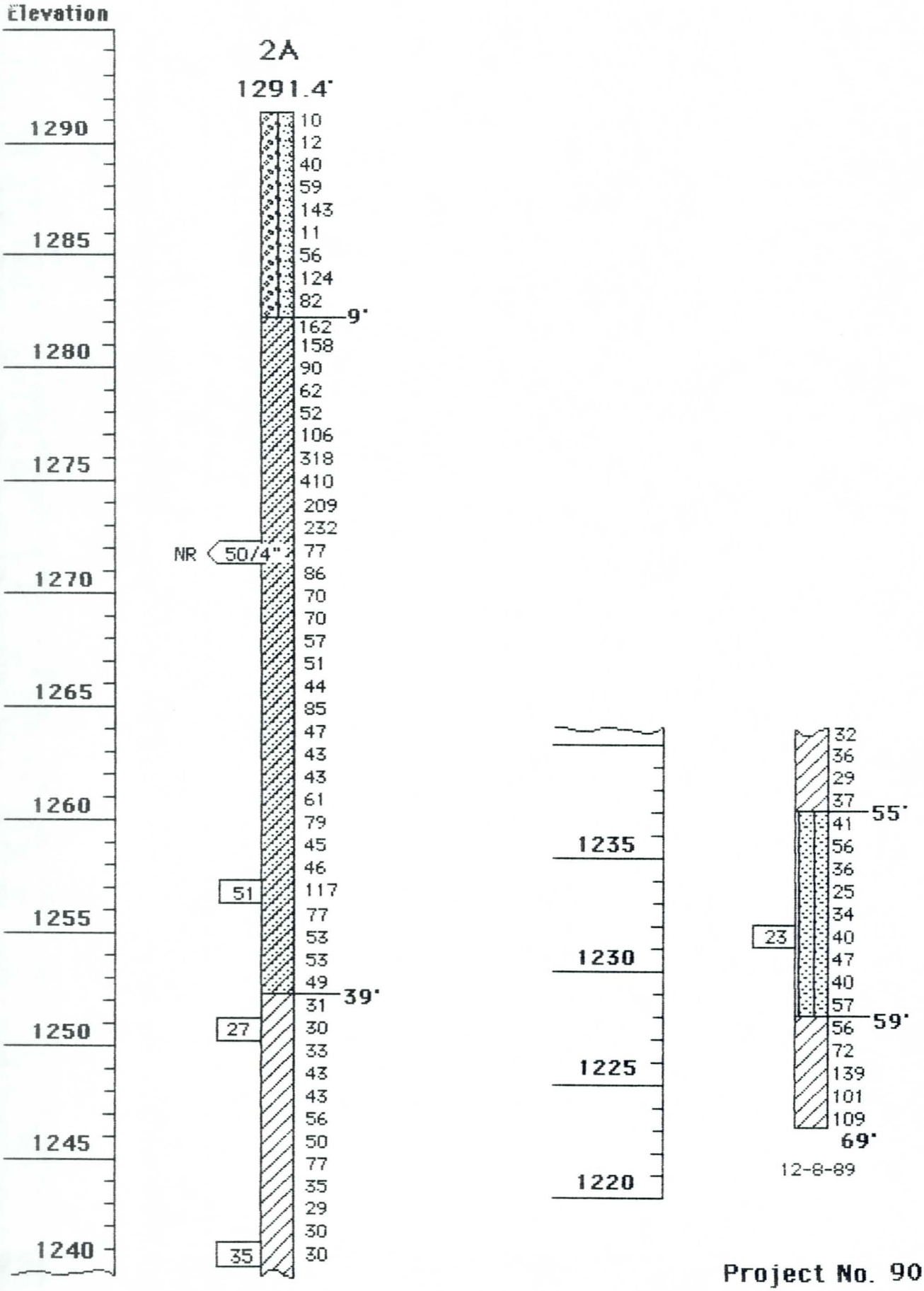
Borings 1, 2, and 3 drilled with 7" hollow stem auger.

Boring 2A drilled with percussion hammer driven 9" O.D. casing.

Project No. 90-0012

Thomas - Hartig & Associates

NOTE: The data presented on the boring logs represents subsurface conditions only at the specific locations and at the time designated. This data may not represent conditions at other locations and/or times. Contacts between soil strata are approximate and changes between soil types may be gradual rather than abrupt. This boring data was compiled primarily for design purposes and should not be construed as part of the plans governing construction or defining construction techniques. Bidders are fully responsible for interpretations or conclusions they draw from the boring log.



Project No. 90-0012
Thomas-Hartig & Associates, Inc

REPORT ON LABORATORY TESTS

SAMPLE: Date 12-15-89

Source Test Boring 1; 0 - 10'

Type Drill cuttings remolded to 115 pcf dry density

Material Sandy Gravel (GW)

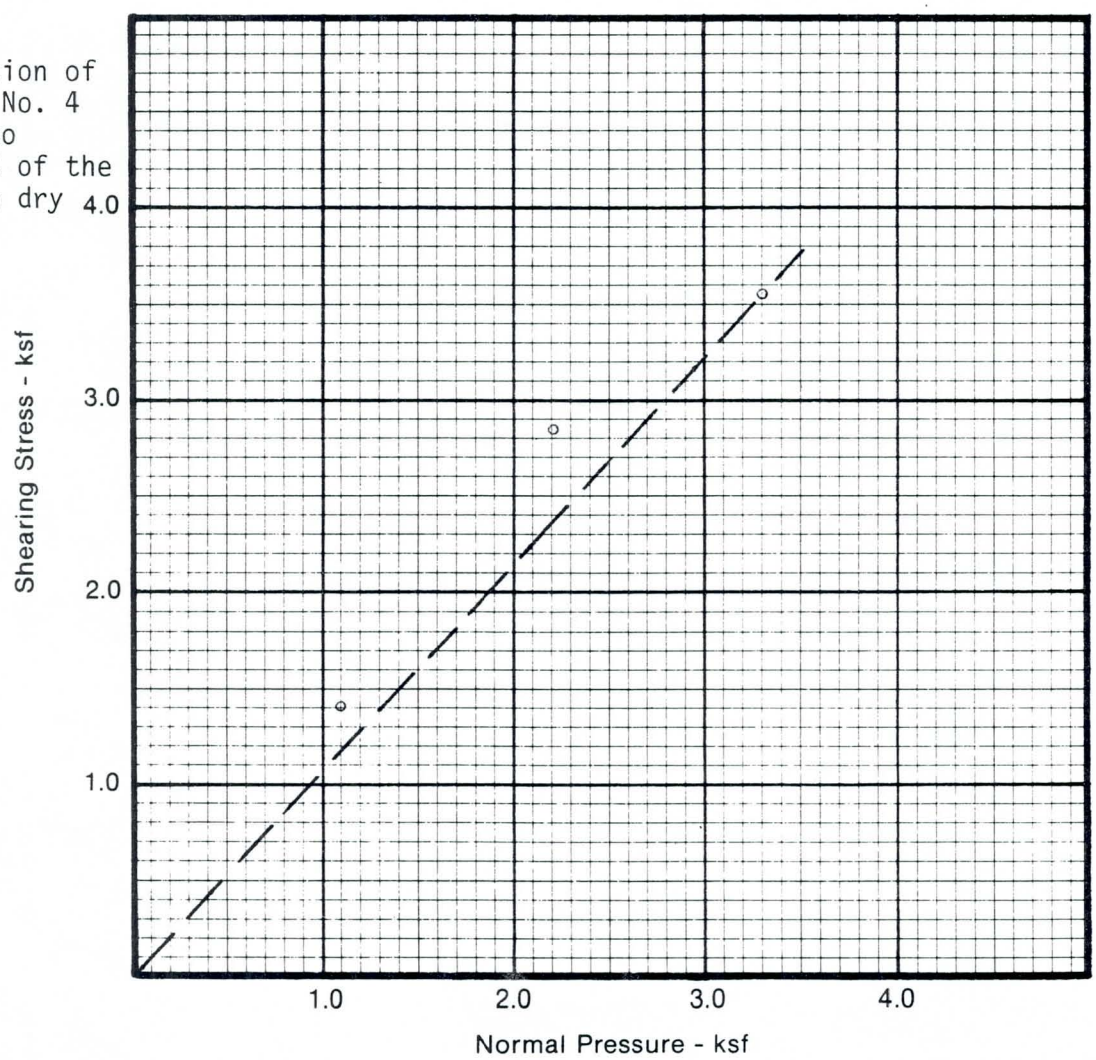
Sampled By TH/Thompson

TESTED: Direct Shear, sample submerged and consolidated prior to shearing at a deformation rate of 0.06 in./min.

RESULTS:

Friction Angle (Ø) = 47° Cohesion (c) = 0 ksf

Note: Shear test performed on portion of sample passing a No. 4 sieve, remolded to approximately 95% of the ASTM D698 maximum dry density.



Project No. 90-0012

REPORT ON LABORATORY TESTS

SAMPLE: Date 12-18-89

Source: Test Boring 2A; 24 - 34'

Type: Hammer drill cuttings remolded to 107 pcf dry density

Material: Clayey Gravelly Sand (SC)

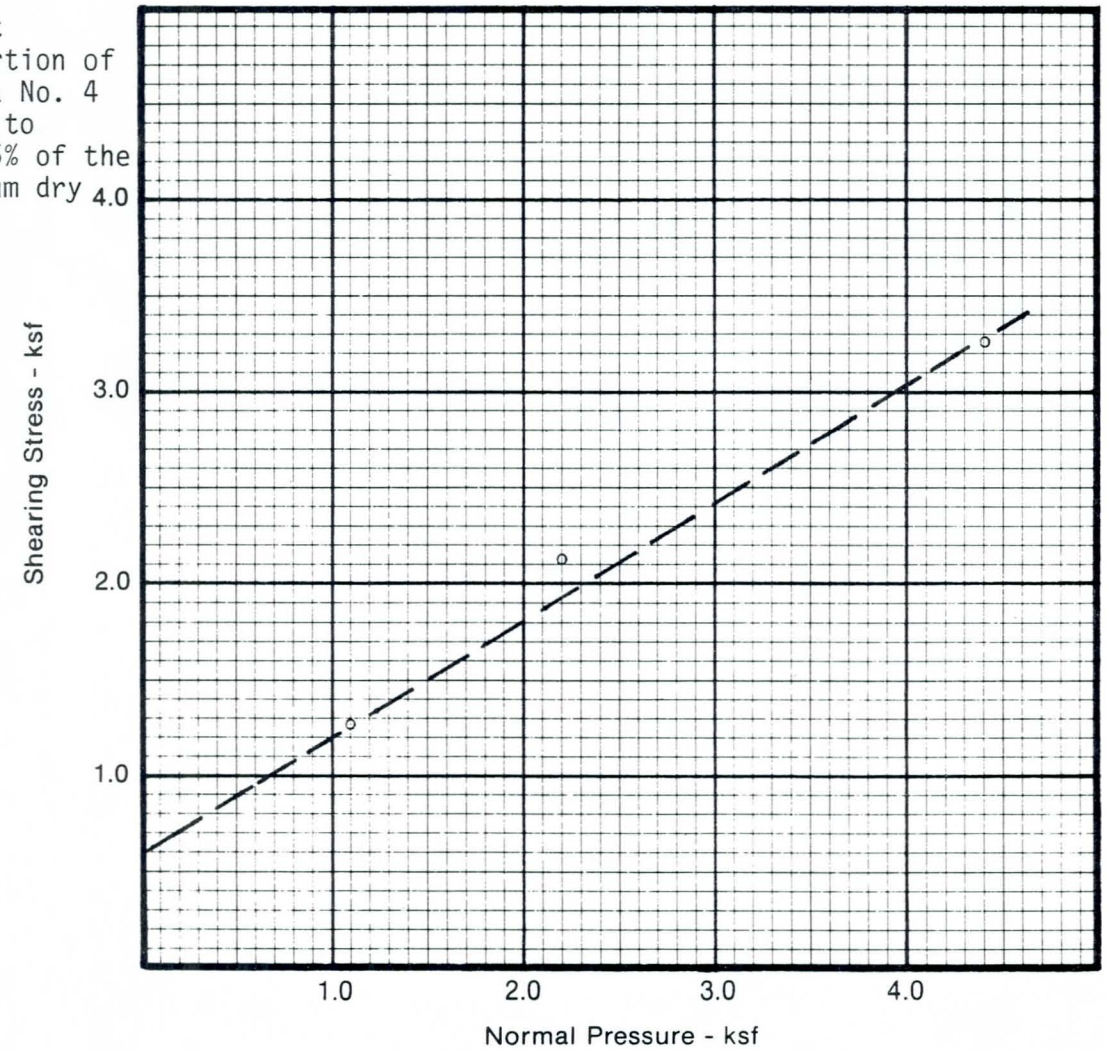
Sampled By: TH/Perry

TESTED: Direct Shear, smaple submerged and consolidated prior to shearing at a deformation rate of 0.06 in./min.

RESULTS:

Friction Angle (Ø) = 31° Cohesion (c) = 0.6 ksf

Note: Shear test performed on portion of sample passing a No. 4 sieve, remolded to approximately 95% of the ASTM D698 maximum dry density.



Project No. 90-0012

REPORT ON LABORATORY TESTS

SAMPLE: Date 12-15-89

Source: Test Boring 2A; 64 - 69'

Type: Drill cuttings remolded to 95 pcf dry density

Material: Sandy Clay (CL)

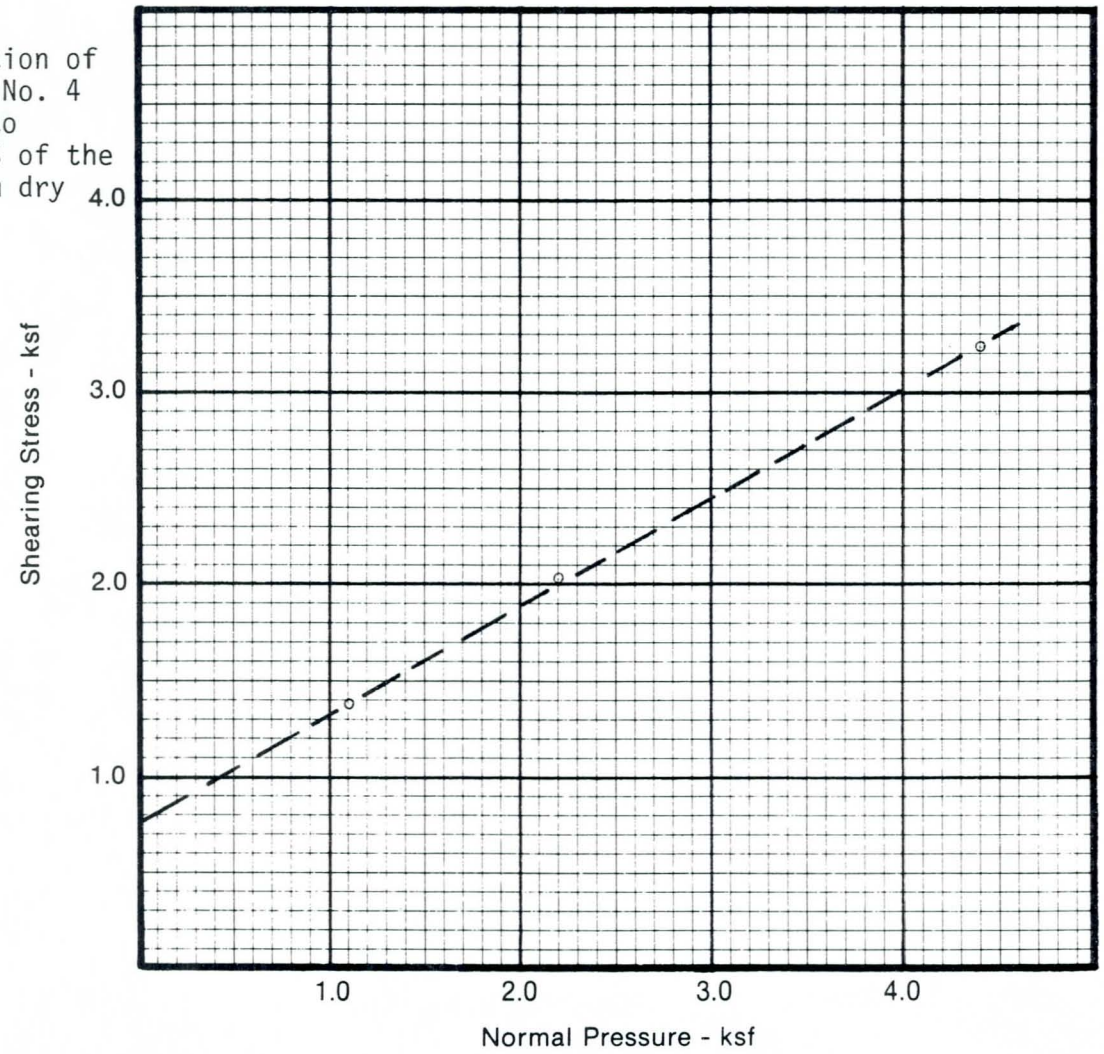
Sampled By: TH/Perry

TESTED: Direct Shear, sample submerged and consildated prior to shearing at a deformation rate of 0.06 in./min.

RESULTS:

Friction Angle (Ø) = 29° Cohesion (c) = 0.75 ksf

Note: Shear test performed on portion of sample passing a No. 4 sieve, remolded to approximately 95% of the ASTM D698 maximum dry density.



Project No. 90-0012

TH-105

THOMAS-HARTIG & ASSOCIATES, INC.

REPORT ON LABORATORY TESTS

SAMPLE: Date 12-15-89

Source Test Boring 2A; 34 - 39'

Type Drill cuttings remolded to 116 pcf dry density

Material Clayey Gravelly Sand (SC)

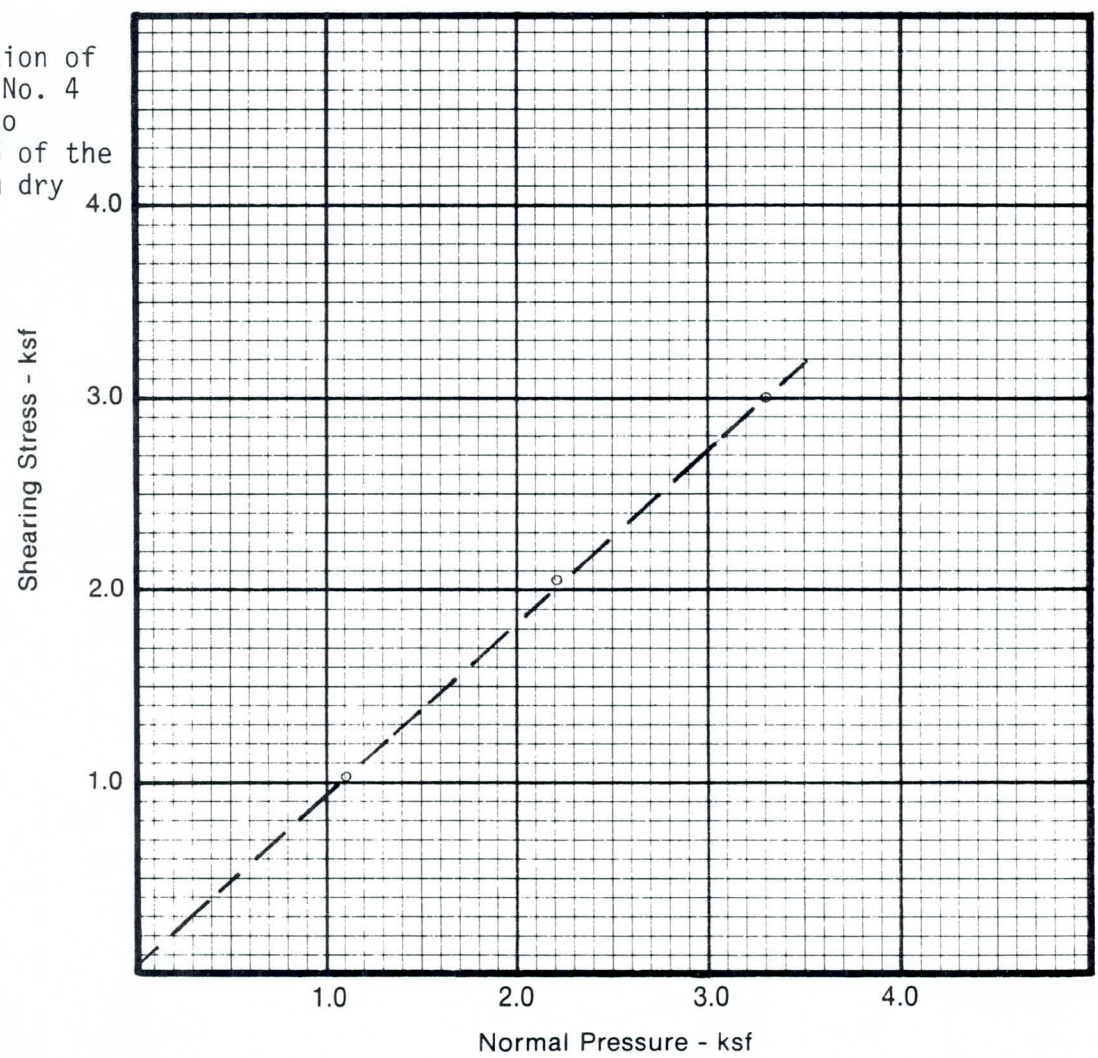
Sampled By TH/Perry

TESTED: Direct Shear, sample submerged and consolidated prior to shearing at a deformation rate of 0.06 in./min.

RESULTS:

Friction Angle (Ø) = 42° Cohesion (c) = 0 ksf

Note: Shear test performed on portion of sample passing a No. 4 sieve, remolded to approximately 95% of the ASTM D698 maximum dry density.



Project No. 90-0012

TH-105

THOMAS-HARTIG & ASSOCIATES, INC.

REPORT ON LABORATORY TESTS

SAMPLE: Date 12-18-89

Source Noted Below

Type Bulk Sample

Material Soil

Sampled By TH/Perry

TESTED: Sieve Analysis and Atterberg Limits

RESULTS:

Sample	LL	PI	Sieve Size - Accum. % Passing 200	100	50	30	16	8	4	3/4"	1"	2"	3"	* Class	
1; 0 - 10'	--	NP**	4	5	7	12	19	33	4.75 51	86	91	100		GW	4.75
2; 4 - 9'	21	4	5	8	11	16	27	47	66	93	96	100		SW-SM-SC	2
2A; 24 - 34'	47	22	31	40	47	58	68	77	85	96	96	100		SC	.3
2A; 34 - 39'	44	20	13	16	20	28	37	51	72	96	98	100		SC	2
2A; 64 - 69'	47	19	65	75	84	91	97	99	100					CL	

* Unified Soil Classification

Project No. 90-0012

THOMAS-HARTIG & ASSOCIATES, INC.

REPORT ON LABORATORY TESTS

SAMPLE: Date 12-22-89

Source Notes Below

Type Bulk samples of auger cuttings

Material Soil

Sampled By TH/Perry and Thompson

TESTED: pH, Soluble Salts, Sulfates

RESULTS:

Sample	pH	Soluble Salts	Soluble Sulfates
1; 0 - 10'	8.1	0.056	0.021
2; 34 - 39'	8.6	0.028	0.018

FLOOD PLAIN STUDY

FOR

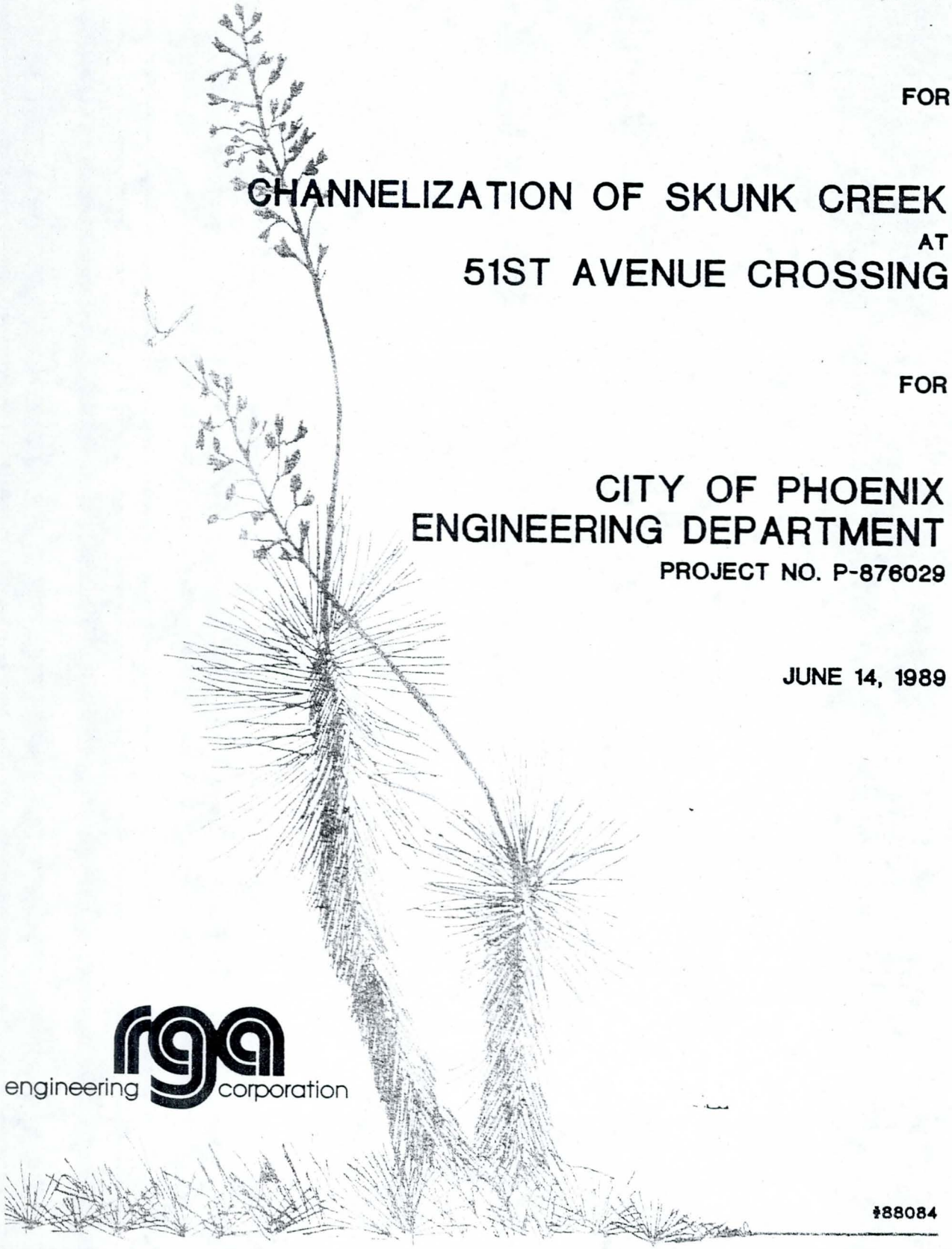
CHANNELIZATION OF SKUNK CREEK
AT
51ST AVENUE CROSSING

FOR

CITY OF PHOENIX
ENGINEERING DEPARTMENT

PROJECT NO. P-876029

JUNE 14, 1989



engineering corporation

#88084

2141 E. Indian School Road, Ste. 101 • Phoenix, Arizona 85016-4741 • (602) 957-6191

FLOOD PLAIN STUDY
FOR
CHANNELIZATION OF SKUNK CREEK
AT
51ST AVENUE CROSSING

1.0 INTRODUCTION

1.1 Purpose of Study

To obtain, develop and evaluate pertinent hydrologic studies for the project area and to provide recommendations for the roadway crossing of Skunk Creek.

2.0 AREA STUDIED AND DOWNSTREAM CONDITIONS

2.1 Site Description

The study concerns the portion of Skunk Creek at 51st Avenue located in Section 28 and 29, Township 4 North Range 2 East of the Gila and Salt River Base and Meridian, Maricopa County, Arizona which is from the FEMA Study Section 280.4 to Section 310.55. The centerline of 51st Avenue is approximately Section 291.9.

2.2 Scope of Study

Establish a roadway crossing of Skunk Creek at 51st Avenue which will not constrict flows above that permitted by FEMA regulations.

2.3 Background Data

The City of Phoenix has contracted for design of paving improvements of 51st Avenue from Union Hills Drive to Beardsley Road (Index No. P-876029, Work Order No. 57989). Within the past several years, the hydrologic conditions of the watershed upstream of the study reach have changed significantly. Major flood control improvements influencing the Skunk Creek hydrology include: Adobe Dam, Central Arizona Project Levee and Skunk Creek Channelizations near Interstate 17.

Adobe Dam, a flood retarding structure on Skunk Creek located approximately 1.5 miles upstream from the site was completed in 1982 by the U.S. Army Corps of Engineers (COE). The Central Arizona Canal Levee has also been recently completed by the Bureau of Reclamation. Both have reduced the potential magnitude of floods on the Skunk Creek Watershed. Due to these improvements, the COE has re-established discharge-frequency relationships on Skunk Creek. Additionally, COE has re-delineated the Skunk Creek flood plain.

3.0 ENGINEERING METHODS

3.1 Assumed Flows

The hydrologic data obtained from COE and the Maricopa County Flood Control District is summarized in Table 1 below:

Table 1. Summary of Discharges

Skunk Creek at 51st Avenue
100 year Flood-Present Development: 8,750 cfs
100 year Flood-Future Development: 10,400 cfs

The discharges established by the COE for the FEMA flood plain delineation are based on the present hydrologic conditions (Exhibit 1 A). In addition, the COE has developed discharges based on projected future hydrologic conditions which assumes urbanization (complete development) of the watershed (Exhibit 1 B).

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of Skunk Creek were carried out to determine the effects of the proposed roadway crossing of the existing flood plain.

Water surface elevations for floods of the selected recurrence intervals were computed through the use of the U.S. Army Corps of Engineers HEC-2 Step Backwater Computer Program (Reference 2). Structural geometry and elevation data for the proposed bridge at 51st Avenue were obtained from a preliminary design plan (Exhibit 2). Locations of selected cross sections used in the hydraulic analysis are shown on Exhibits 1A, and 1B, and Figure 1.

Hydraulic roughness coefficients (Manning's "n") were selected on the basis of field inspection and engineering judgement. These values are shown in Table 2.

Table 2 - Summary of Manning's "n" Values

Existing Condition	Left Over Bank	Channel	Right Over Bank
Sec. 280.4 to 296.3	0.045	0.035	0.045
Sec. 306.55 to 310.53 (Overland Hills)	0.030	0.030	0.030
Proposed Channelized Condition			
Sec. 288.1 to 299.4	0.045	0.030	0.045

Why is overbank considered when channelized

The starting water surface elevations for the backwater analysis through the study reach were obtained by the slope area method. The energy grade line slope is estimated and an initial water surface elevation is used. The resulting water surface elevation was then compared to published data from Flood Insurance Study for Maricopa County (Reference 1).

3.2.2 Present Condition Modelling

The hydraulic analysis presented in this study (Computer Printout 1) is duplicated from the work performed by the COE (Reference 1). Another analysis was made incorporating cross section data at Sections 285.7, 291.1, 296.3 and 299.4 using additional survey information obtained for this project, and cross section data of Overland Hills Subdivision Sections 306.55 to 310.55 (Computer Printout 2).

3.2.3 Modelling with Proposed Channelized Condition

The present development hydraulic model (computer printout 2) was modified within the study reach, by adding six sections (Section 288.1 to 299.1) to describe proposed channelization and bridge geometry (Computer Printout 3).

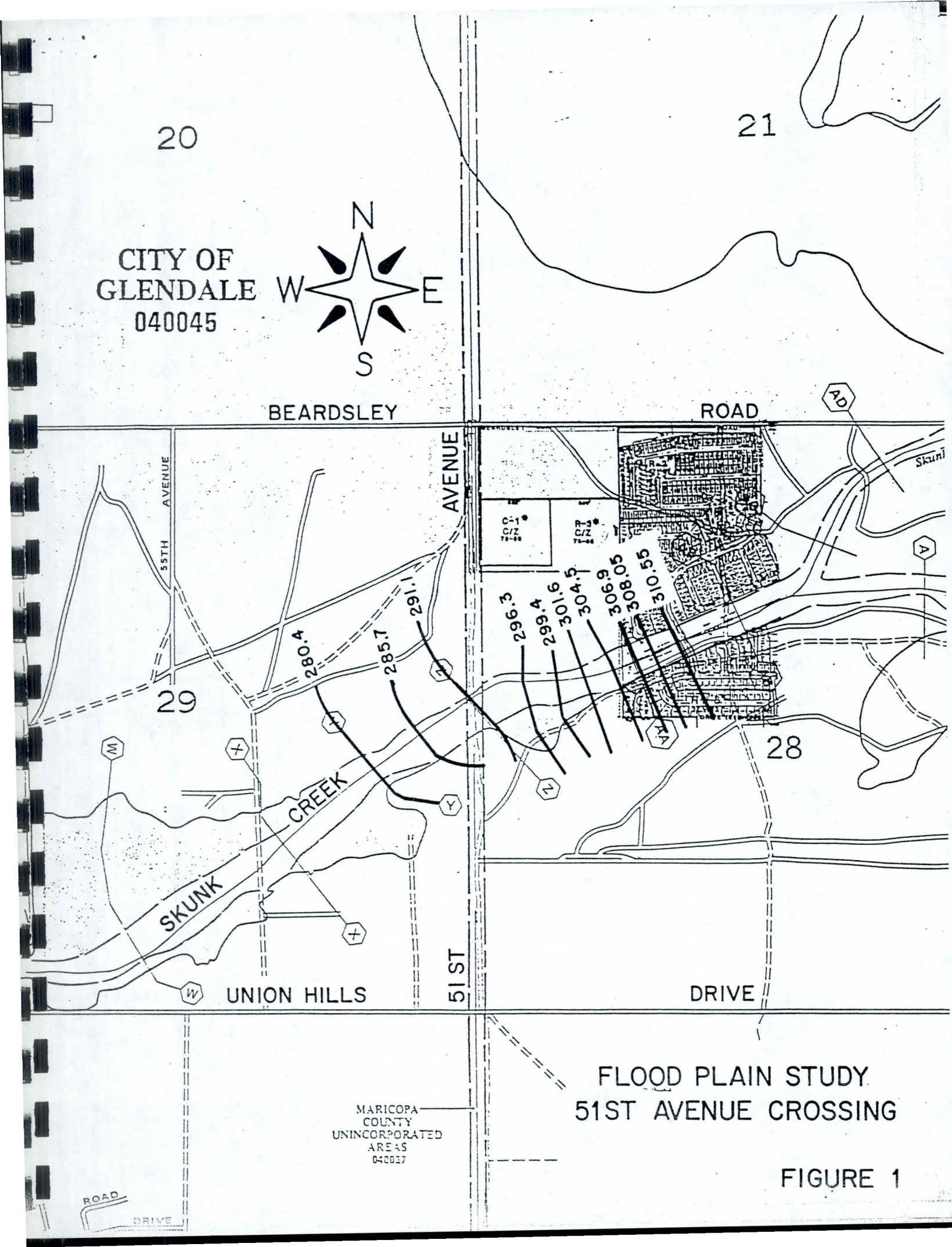
The design of the channel and bridge improvements shall be based upon the following parameters established by the MCFCD and Flood Plain Management Division of the City of Phoenix.

(a) The channel to be designed for the present development 100-year discharge with a minimum of one (1) foot of freeboard.
(b) The bridge to be designed for the present development 100-year discharge with a minimum of two (2) feet of freeboard.
(c) The channel to provide a minimum of 0.5 feet freeboard for the future development 100-year discharge.
(d) The bridge to provide a minimum of 1.5 feet freeboard for the future development 100-year discharge.

An additional HEC-2 Analysis was performed for the proposed channelization condition modelling the future development 100-year discharge (Computer Printout 4).

A Floodway Data Table, Table 3, is presented to show the difference between the natural (existing floodway) and proposed channelization water surface elevations (WSELS). The proposed channelization has not increased the WSELS for the 100-year flood (base-flood).

The flood plain profiles for the 100-year discharge for the present development is presented in this study (Exhibit 1 A). Floodway Data is also presented (See Table 4) to show the base-flood WSELS for present and future development flows and minimum channel and low chord bridge elevations.



FLOOD PLAIN STUDY
51ST AVENUE CROSSING

FIGURE 1

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

INTEROFFICE MEMORANDUM

Subject: 51st Avenue Bridge across Skunk Creek Normal Bridge versus Special Bridge **File:**

To: Joe Tram **From:** Tim Murphy **Date:** 1-21-91

I have made a HEC-2 model for the proposed 51st Avenue bridge using the special bridge method. For cross section 1043.0, the upstream face of the bridge, the computed water surface elevation is 0.7 of a foot higher using the special bridge method. At cross section 1075.0, 32 feet upstream of the bridge, the difference in computed water surface elevation is only 0.2 of a foot.

Even with the higher water surfaces the minimum freeboard requirements are still met. For the present condition peak discharge the minimum amount of freeboard required is 2.0 feet. On sheet S-7 the elevation of the bridge abutments on which the girders will rest is 1295.93. This elevation results in a freeboard of 2.8 feet for the special bridge method water surface elevation. For the future condition peak discharge the minimum amount of freeboard required is 1.5 feet. The freeboard using the special bridge method is 2.0 feet.

The higher water surface elevations resulting from the use of the special bridge method do not cause any problems as all flows are contained and fit under the bridge. It should be noted that the use of the normal bridge method results in slightly higher velocities.

	NORMAL BRIDGE METHOD		SPECIAL BRIDGE METHOD	
CROSS SECTION	WATER SURFACE	VELOCITY CHANNEL	WATER SURFACE	VELOCITY CHANNEL
925.0	1290.9	11.6	1290.9	11.6
957.0	1291.0	12.9	1291.0	12.9
1043.0	1292.4	11.9	1293.1	10.5
1075.0	1293.4	10.0	1293.6	9.6
1100.0	1293.6	9.8	1293.8	9.6
1200.0	1294.5	8.6	1294.6	8.4
1300.0	1295.4	6.3	1295.4	6.3
1400.0	1295.7	5.9	1295.7	5.8
1500.0	1295.8	6.3	1295.9	6.3
1545.0	1295.9	6.5	1295.9	6.5

Water surface elevations calculated using the present condition discharge
Cross section 957.0 is the downstream face of the bridge
Cross section 1043.0 is the upstream face of the bridge
Cross section 1545.0 is the upstream limit of the proposed channel

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

Interoffice Memorandum

Subject: Hydraulic & Scour Analysis, 51st Avenue Bridge at Skunk Creek

File:

To: Ed Raleigh

From: Dick Perreault

Date: December 19, 1990

Please review the attached plans and design study report, "Hydraulic & Scour Analysis, 51st Avenue Bridge at Skunk Creek", by MKA.

We should anticipate that we will become involved as a cost-sharing partner, construction agency and will be responsible for operation and maintenance for a Skunk Creek Channel from 49th Avenue to 55th Avenue.

Please provide your comments and recommendations by January 10, 1991.

RGP/jnk

Thanks, Dick

Attachments

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

INTEROFFICE MEMORANDUM

Subject: 51st Avenue Bridge across Skunk Creek **File:**

To: Joe Tram **From:** Tim Murphy **Date:** 12-18-90

JET RGP 12/19
EAR.

1) Their channel improvements are being done within the existing FEMA floodplain. The Coe & Van Loo study shows that the floodplain has migrated to the north in this area. Portions of the ponding areas upstream and downstream of the bridge are outside of the current FEMA floodplain. If the design of the channel improvements is altered slightly these ponding areas could be eliminated and potential problems avoided.

   Consideration should be given to extending the channel banks to eliminate the ponding areas, stop the channel migration, and return the floodplain to within the existing FEMA limits. See attached red lined plans for possible locations of bank extensions.

2) The alignment of the channel on the downstream side could cause some problems. The channel is pointed directly at an area that is outside of the current FEMA floodplain. The Coe & Van Loo study does show this area as being in their floodplain.

   The engineer should look closely at the downstream channel alignment and consider directing flows so that they stay closer within the FEMA floodplain.

3) There are no problems with the peak discharges they are using.

	Existing Condition	Future Condition	
FEMA	8,800 cfs	N/A	(Approximated using velocity & depth)
CVL	8,400	10,410 cfs	(Coe & Van Loo, Skunk Creek Study)
This Study	8,750	10,400	(Mathews Kessler & Associates)

4) There are no problems with the new water surface elevations. I could only make a direct comparison with the FEMA elevations at the bridge. The Mathews Kessler study does not extend far enough to take in the next upstream and downstream FEMA cross sections. I did interpolate the FEMA water surface elevations upstream and downstream of the bridge. See the attached 11x17 sheet for the location of cross sections.

		Cross Section	CWSEL	
Downstream of Bridge	FEMA		1294.7	(interpolated value)
	CVL	5.579	1289.7	(40 ft. upstream of MKA)
	MKA	835	1284.0	
At the Bridge	FEMA	Z	1295.9	(20 ft. upstream)
	CVL		1291.2	(interpolated value)
	MKA	1000	1291.0	(at center of bridge)
Upstream of Bridge	FEMA		1297.2	(interpolated value)
	CVL	5.679	1295.3	(40 ft. upstream of MKA)
	MKA	1300	1295.4	

On page three of the report they state that their elevation datum is the same as Coe & Van Loo's Skunk Creek study. I could only find one common elevation reference mark for the Coe & Van Loo study and the existing FEMA delineations. This is at the intersection of 71st Avenue and Judy Lynn Lane. The FEMA elevation reference mark is 0.313 ft. higher then the Coe & Van Loo reference mark. I did not make any adjustments to the water surface elevations for the difference in elevation datum.

71st Ave. & Judy Lynn Ln.	C&VL	1220.857
	FEMA	1221.17

Recommend:

1) Meeting between Phoenix, Glendale + PPM to assure continuity + compatibility with existing + proposed projects

2) Recommend Edgr assess local + long term scour if are one involved in project.

P&PM INTEROFFICE MEMO AND ROUTING SLIP

Originator: Dick Perreault

Topic: 51st Ave. Bridge @ Skunk Crk Hydraulic/Scour Analysis by MKA

Date Sent: 12/19/90 Reply Required By: 01/10/91 Follow: 01/04/91

X	Initial	Date Received	Date Returned	Reviewers
X	JMK	12/19/90		P&PM Adm. Coord.(All Memos for Logging)
X		12/19/90		Division Chief, Engineering Division
				Division Chief, _____ Division
				Division Chief, _____ Division
				_____, _____ Division
				_____, _____ Division

Remarks: _____

INTEROFFICE MEMORANDUM

TO: Dick Perreault FROM: Cyrous Vahidnia CV DATE: Jan. 10, 1991
VIA: Ed Raleigh

SUBJECT: Scour Analysis, 51st Avenue Bridge at Skunk Creek

The referenced subject was reviewed and the following comments should be addressed:

1. The soils report submitted with the scour analysis appears to have been conducted for bridge bearing capacity and not for scour analysis. Additional soils analysis should be done to determine the median size of river-bed native materials. Samples should be taken at multiple cross-sections at different locations along the cross-sections and at different depths. The method of sampling and analysis should be explained in the soils report. The soils report should provide a recommendation as to what size of d_{50} should be used for scour analysis.

2. General scour considerations:

   The depth of general scour should be computed by analytical methods such as the principle of tractive shear. The procedures used should include velocity, depth of flow, and the median size of river-bed native materials.

   In calculating the depth of general scour, the final value of general scour depth should not be increased by a factor of safety, because the depth of general scour is not linear with tractive shear. The force that is causing the scour should be increased by factor of 1.5 to account for the safety factor. Detail calculations should be provided to support the final recommended value for design.

   Based on information conservatively interpolated from the soils report results, I looked at three analytical methods (utilizing the size of d_{50}) for the determination of the depth of general scour. The results indicate high values for general scour depths, which do not seem to be realistic. The calculated general scour depth would likely be reduced if the conservative interpolated assumptions were replaced by adequate soils information.

3. Pier considerations:

The calculation provided for local scour due to the pier was based on twice the pier width (debris plus pier) which resulted in 2.5 feet of debris on each side of the pier. The District generally uses three or more times the pier width for these calculations. In this case, analysis of scour due to the pier should consider 5 feet of debris on each side of the pier. This 15 feet diameter pier width should be used with both sub-critical and supercritical flow assumptions for Q = 10,400 cfs in the HEC II model to provide proper information for analysis of scour due to the pier.

A 1.3 factor of safety was used in this analysis. We would normally require a minimum factor of safety of 1.5.

Also, the debris that can hang up on the piers and on the bridge can cause lateral forces that should be considered in the structural design of the bridge.

Equation 4.3 on page 19 has been copied incorrectly.

The report does not include calculations to support of the values listed in the tables.

When the final value of scour depth due to the pier is obtained, the diameter of the "zone of influence" of a pier should be discussed and any hydraulic design element such as toe downs for the bank protection or abutments that fall within the "zone of influence" must consider the added effect of local scour at the bridge piers. The report does not provide explanation regarding this issue.

4. Abutment considerations:

For a more objective analysis of scour due to the bridge abutments, it is necessary to determine the flow distribution of the natural channel cross section upstream of the bridge (such as discharges and depths in the main channel and overbanks).

Based on the geometry of the bridge and other considerations, different methods of calculations should be used and compared to obtain a reasonable value of scour depth. Detailed calculations should be provided to support the final value recommended. The report does not provide sufficient explanation and analysis as to why the final value recommended for design is adequate.

6. As per usual procedure, we recommend that all calculations be independently checked in the consultant's office before they are submitted to the permitting agency and that both the designer and the checker initial and date each page. Having the designer merely check his/her own work does not, in our opinion, lead to the discovery and correction of all errors.

INTEROFFICE MEMORANDUM

TO: Dick Perreault

FROM: Cyrous Vahidnia
VIA: Ed Raleigh

DATE: Jan. 10, 1991

SUBJECT: Scour Analysis, 51st AVenue Bridge at Skunk Creek

The referenced subject was reviewed and the following comments should be addressed:

1. Soil analysis is required to determine the median size of riverbed native materials. Samples should be taken at all cross-sections at different locations along the cross-sections and at different depths. The method of sampling and analysis should be explained in the soil report. The soil report should provide a recommendation as to what size of d_{50} should be used for scour analysis. The soil analysis for the purpose of scour is not a part of the submitted soil report.

2. Several analytical methods, with respect to the size of d_{50} provided in the soil report, were used for determination of the depth of general scour. The results indicate very high values of scour depths, which do not seem to be realistic.

   Due to lack of proper information regarding riverbed native material (see comment #1) determination of depth of general scour was not possible. The depth of general scour should be computed by analytical methods such as principle of tractive shear. The procedures used should include velocity, depth of flow, and the median size of riverbed native materials.

   In calculation of depth of general scour, the final value of scour depth should not be increased by factor of safety because the depth of general scour is not linear with tractive shear. The force that is causing the scour should be increased by a factor of 1.5 to account for safety factor. Detail calculations should be provided to support the final recommended value for design.

3. Analysis of scour due to the pier should consider 5 feet of debris on each side of the pier. Debris can hang up on the piers and on the bridge which could create a large lateral force. In that case the bridge can be literally pushed over. Resistance to a large lateral force should be considered in the design of the bridge structure. This 15 feet diameter pier width should be used with sub-critical and supercritical at Q=10,400 cfs in Hec II model to provide proper information for analysis of scour due to the pier. A minimum 1.5 safety factor should be considered for this analysis.

?

were

The report indicates that 2.5' of debris on each side of the pier and 1.3 as a factor of safety was used for the scour analysis. Equation 4.3 on page 19 is incorrect. The report does not provide detail calculations to support the proposed values listed on the tables.

4. For more objective analysis of scour due to the bridge abatements, it is necessary to provide flow distribution of natural channel upstream of the bridge, to obtain hydraulic data such as discharges and depths in the main channel and ~~out banks~~ over. overbanks.

   Based on the geometry of the bridge and other considerations, different methods of calculations should be used to obtain a reasonable value of scour depth. Detailed calculations should be provided to support the final value recommended for design. The report does not provide sufficient explanation and analysis as to why the final value recommended for design is adequate.

5. When the final value of scour depth due to pier is obtained, the diameter of the "zone of influence" of a pier should be discussed and any hydraulic design element such as toe downs for the bank protection or abutments that fall within the "zone of influence" must consider the added effect of local scour at the bridge piers. The report does not provide explanation regarding this issue.

6. As per ususal procedure, we recommend that all calculations be independently checked in the consultant's office before they are submitted to the permitting agency and that both the designer and the checker initial and date each page. Having the designer merely check his/her own work does not, in our opinion, lead to the discovery and correction of all errors. There is no evidence that the design of this project has been checked.

?

OK
cv.

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

Interoffice Memorandum

SUBJECT: Scatter Wash Channel **FILE:**

TO: Dick Perreault **FROM:** Ed Raleigh **DATE:** 12/11/90

Dick,

Attached is a copy of design criteria used by the Flood Control District for the design of improvements, including levees, in the Salt River, Mill Avenue to McClintock Drive. These criteria should be utilized for the design of improvements constructed within Scatter Wash, to meet Flood Control District requirements. I have also attached applicable excerpts from the FEMA requirements for levee construction that must be met in order to receive federal approval.

Please feel free to forward these attachments and this memo to ADOT or to their consultant.

Ed Raleigh

Ed Raleigh

Flood Control District of Maricopa County, Scatter Wash Channel

Design Criteria:

1. General Scour depth should be computed by using the principles of tractive shear and velocity, depth of flow and native riverbed median size material parameters.

2. The velocity used in the scour analysis should be based on the velocity associated with the maximum design flow depth in the thalwag.

3. Scaled cross sections should be provided showing velocity, depth, and energy slope for the two design flows. The depth of scour should be determined from the thalwag invert elevation to determine the toe-down elevations for bank protection and grade control structures. The tabulated scour data must also be provided.

4. Water surface profiles for the two design flows must be presented showing top of levee protection, freeboard for each, and low chords for all bridges in the project.

5. Bank slope stability analysis calculations need to be submitted for District review. The analysis should consider pore pressures caused by rapid draw down. Minimum factor of safety should be 1.5.

6. Scour due to bend should be analyzed by using the principles of tractive shear. This analysis should include both of the design velocities and depths of flow and the d_{50} for the native materials.

7. All geotechnical testing and analyses should be provided for District review.

8. Degradation and aggradation analyses should include the factors for dunes and antidunes.

9. All calculations performed for the design using riprap and filter materials for slope stabilization need to be provided for District review.

10. All calculations should be independently checked by a person at least as competent as the designer before submitting them to the District. Both the designer and checker must initial and date each page of the calculations before submittal.

City of Phoenix
ENGINEERING & ARCHITECTURAL SERVICES DEPARTMENT

RECEIVED
DEC 26 1990

ALL-AMERICA CITY
1989

December 21, 1990

MARICOPA COUNTY FLOOD CONTROL DISTRICT
3335 West Durango
Phoenix, Arizona 85009

Attention: Mr. Ed Raleigh
Chief Engineering Division

Gentlemen:

51ST AVENUE FROM BELL ROAD TO UNION HILLS DRIVE
INDEX NO. P-865907, W.O. #41880
INDEX NO. ST-882662, W.O. #59327
******* C.A.C.C. STEP 20 *******

Enclosed are pre-final plans (95%) completed for the projects listed above. A design presentation meeting (P.S.&E.) will be held on Wednesday, January 9, 1991 at 9:00 A.M. in Conference Room 200, located at 125 East Washington Street, Phoenix, Arizona. Representatives to discuss conflicts, dates of utility clearance and schedules.

The purpose of this meeting will be to discuss these plans with representatives from the City, the design consultant, other agencies and the Utility companies.

This meeting will focus on Steps 16, 17, 18, and 19 of the C.A.C.C. Public Improvement Project Guide. Please plan to attend or send a representative to discuss conflicts, commitment dates, schedules, permits, application, etc.

We would appreciate you expediting your review on a timely matter in order to remain on schedule. Projects are schedule to bid April of 1991.

If you have any questions, please feel free to contact Cato Esquivel at 256-3516.

Very ~~truly~~ yours,

PATRICK D. GRIFFIN
Utility Coordinator

RAA/aff

Attachments

c: Mr. Rink
Mr. Ely
Mr. Esquivel
Mr. Almaraz

YOUR PRESENT IS REQUESTED TO DISCUSS BR-885806 (51ST AVENUE BRIDGE OVER SKUNK CREEK)
THANKS

City of Phoenix
STREET TRANSPORTATION DEPARTMENT
DESIGN AND CONSTRUCTION MANAGEMENT DIVISION

ALL-AMERICA CITY
1989

FLOOD CONTROL DISTRICT
RECEIVED
JAN 22 1991

	CH ENG	3	P & PM
	DEP		HYDRO
	ADMIN		LMGT
	FINANCE		FILE
	C & O		
1	LMGT	2	BGR

REMARKS

January 16, 1991

Mr. Ed Raleigh, P.E.
FLOOD CONTROL DISTRICT OF
MARICOPA COUNTY
3335 West Durango Street
Phoenix, Arizona 85009

Attention: Mr. Ed Raleigh, P.E.

Gentlemen:

RE: 51ST AVENUE BRIDGE OVER THE SKUNK CREEK WASH, BR-885806

Submitted for your information and records are Thomas-Hartig & Associates, Inc.'s supplemental analysis for 51st Avenue Bridge project dated January 2 and January 4.

The 51st Avenue project is tentatively schedule to bid in April, 1991. If additional information is required, please contact our Project Manager, Cato Esquivel at 495-2050.

Sincerely,

Andrew O. Almaraz, P.E.
Engineering Supervisor

Don Chie Wong

Don Chie Wong, P.E.
Civil Engineer III

CE:rl:CE6

Enclosures

c: Central Records
Mr. Moody
Mr. Park
Mr. Esquivel

1034 East Madison Street, Phoenix, Arizona 85034 602-495-2050 / FAX: 602-495-3670

THOMAS-HARTIG & ASSOCIATES, INC.

TOM W. THOMAS, P.E. • HARRY E. HARTIG, P.E.
Geotechnical, Materials Testing, and Environmental Consultants
7031 West Oakland Street • Chandler, Arizona 85226

James R. Morrow
John P. Boyd, P.E.
Charles H. Atkinson, P.E.
James M. Willson, P.E.

Frank M. Guerra, P.E.
Steven A. Haire, P.E.
Kenneth L. Ricker, P.E.
Judith A. McBee

Dale V. Bedenkop, P.E.
John C. Patton
Kenneth D. Walsh, P.E.
Lynn Olson

Mathews Kessler & Associates
4045 East McDonald Road
Phoenix, AZ 85008

2 January 1991

Attention: Bob Herz

Project: Supplemental Analyses
51st Avenue Bridge
At Skunk Creek
Phoenix, Arizona

Project No. 91-0190
(Supplement to Project No. 90-0012)

As you requested, we have performed supplemental analyses for design of pile foundations at the subject bridge. The results are attached.

Lateral Analyses: Lateral pile analyses were performed using a computer-based finite difference model (COM 624G). The lateral loads on the pile heads are presented in the following tabulation:

Location	Load Case*	Applied Shear (kips)	Applied Moment (kip-ft.)	Applied Axial Load (kips)
Abutment	1L	86	454	538
Abutment	1T	4	509	538
Abutment	2L	82	380	388
Abutment	2T	3.5	503	538
Pier	1T	40	514	546
Pier	2T	43	448	920
Pier	3T	45	11	904
Pier	3L	12	0	904

* L = longitudinal load direction
T = transverse load direction

The above loads were provided by the structural engineer. For the abutment piles, we have added the shear and moment due to active soil pressure on the abutment wall and pile cap, multiplied by a load factor of 1.3. Output for the COM 624G computer program is presented in Appendix A.

Center Pier Axial Pile Capacity: A revised axial capacity chart for center pier drilled piles is presented in Figure 1. The presented axial capacity chart is based on an assumed scour level at Elevation 1252 feet.

A copy of this supplemental letter should be attached to the original geotechnical report (Project No. 90-0012, dated 26 December 1989) for the subject bridge.

Please call if you have any questions or if we may be of further service.

Respectfully submitted,
THOMAS-HARTIG & ASSOCIATES, INC.

By: _____ Reviewed by: _____

Steven A. Haire, P.E. Kenneth L. Ricker, P.E.

/dkl-s
Copies to Addressee (5)
Inca Engineers, Inc./C. Gnanasambanthan, P.E. (1)

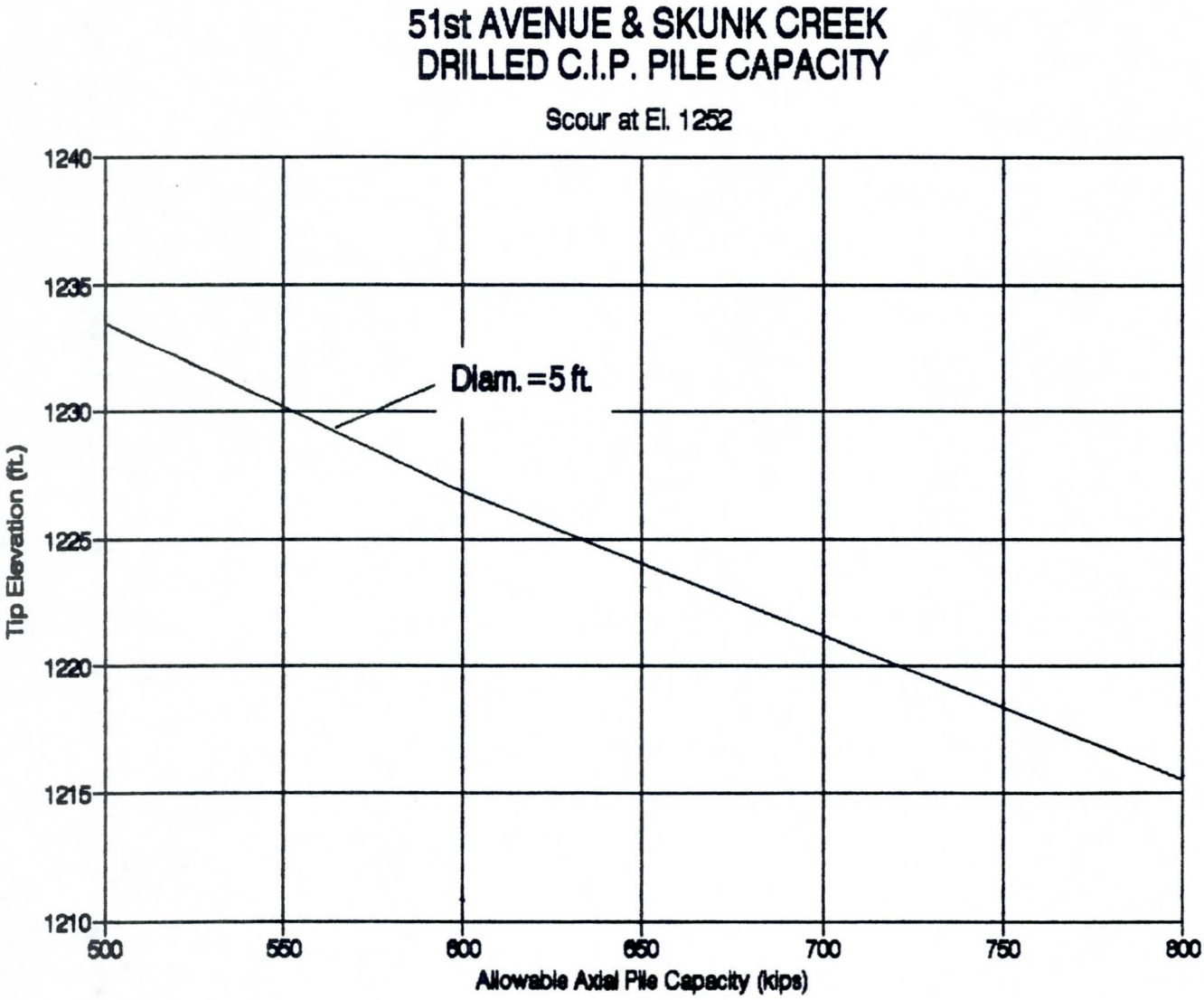


Figure 1
Center Pier Axial Pile Capacity
Project No. 90-0190

THOMAS-HARTIG & ASSOCIATES, INC.

APPENDIX A

LATERAL PILE ANALYSES
COM 624G
OUTPUT

```
*************************************************************
*                                                           *
*     LATERALLY LOADED PILE ANALYSIS   -  COM624G           *
*                                                           *
*     PC ADAPTATION OF COM624                               *
*                                                           *
*     ORIGINALLY WRITTEN BY REESE AND SULLIVAN AT           *
*     UNIVERSITY OF TEXAS AT AUSTIN                         *
*                                                           *
*     ADAPTED FOR PC USE BY                                 *


*                                                           *
*     GEOSOFT                                               *
*     1442 LINCOIN AVE., SUITE 146                          *
*     ORANGE, CA 92665  (714) 998-4030                      *
*                                                           *
*                                                           *
*     PORTIONS (C) COPYRIGHT 1984 GEOSOFT                   *
*                                                           *
*                                                           *
*************************************************************
```

1

90-0012,SKUNK CREEK ABUTMENT,STRUT LOAD = 0,ABUT1.DAT

UNITS--ENGL

I N P U T I N F O R M A T I O N
****

THE LOADING IS STATIC

PILE GEOMETRY AND PROPERTIES

PILE LENGTH = 396.00 IN
MODULUS OF ELASTICITY OF PILE = .300D+07 LBS/IN**2
1 SECTION(S)

X IN	DIAMETER IN	MOMENT OF INERTIA IN**4	AREA IN**2
.00	48.000	.261D+06	.181D+04
396.00			

```
SOILS INFORMATION

    X AT THE GROUND SURFACE              =       24.00 IN

    1 LAYER(S) OF SOIL

    LAYER  1
    THE SOIL IS A SAND
    X AT THE TOP OF THE LAYER            =       24.00 IN
    X AT THE BOTTOM OF THE LAYER         =      600.00 IN
    MODULUS OF SUBGRADE REACTION         =    .225D+03 LBS/IN**3


    DISTRIBUTION OF EFFECTIVE UNIT WEIGHT WITH DEPTH
                         2 POINTS
                 X,IN      WEIGHT,LBS/IN**3
                24.00          .75D-01
               600.00          .75D-01

    DISTRIBUTION OF STRENGTH PARAMETERS WITH DEPTH
                         2 POINTS
                 X,IN        C,LBS/IN**2      PHI,DEGREES      E50
                24.00        .000D+00          40.000        *****
               600.00        .000D+00          40.000        *****


FINITE DIFFERENCE PARAMETERS
    NUMBER OF PILE INCREMENTS                                  =          66
    TOLERANCE ON DETERMINATION OF DEFLECTIONS                  =    .100D-04 IN
    MAXIMUM NUMBER OF ITERATIONS ALLOWED FOR PILE ANALYSIS =          100
    MAXIMUM ALLOWABLE DEFLECTION                               =     .48D+03 IN


INPUT CODES
    OUTPT  =  1
    KCYCL  =  1
    KBC    =  1
    KPYOP  =  0
    INC    =  2
1   90-0012,SKUNK CREEK ABUTMENT,STRUT LOAD = 0,ABUT1.DAT


UNITS--ENGL


                    O U T P U T   I N F O R M A T I O N
                    ***********************************


PILE LOADING CONDITION

    APPLIED MOMENT AT PILE HEAD          =    .545D+07 LBS-IN
    LATERAL LOAD AT PILE HEAD            =    .860D+05 LBS
    AXIAL LOAD AT PILE HEAD              =    .538D+06 LBS
```

X IN	DEFLECTION IN	MOMENT LBS-IN	TOTAL STRESS LBS/IN**2	DISTR. LOAD LBS/IN	SOIL MODULUS LBS/IN**2	FLEXURAL RIGIDITY LBS-IN**2
*****	**********	**********	**********	**********	**********	**********
.00	.331D+00	.545D+07	.799D+03	.000D+00	.000D+00	.782D+12
12.00	.297D+00	.650D+07	.896D+03	.000D+00	.000D+00	.782D+12
24.00	.264D+00	.755D+07	.992D+03	.000D+00	.000D+00	.782D+12
36.00	.232D+00	.859D+07	.109D+04	.000D+00	.147D+04	.782D+12
48.00	.203D+00	.958D+07	.118D+04	.000D+00	.355D+04	.782D+12
60.00	.174D+00	.105D+08	.126D+04	.000D+00	.634D+04	.782D+12
72.00	.148D+00	.112D+08	.133D+04	.000D+00	.984D+04	.782D+12
84.00	.124D+00	.117D+08	.138D+04	.000D+00	.135D+05	.782D+12
96.00	.102D+00	.120D+08	.140D+04	.000D+00	.162D+05	.782D+12
108.00	.825D-01	.120D+08	.141D+04	.000D+00	.189D+05	.782D+12
120.00	.649D-01	.118D+08	.139D+04	.000D+00	.216D+05	.782D+12
132.00	.496D-01	.115D+08	.135D+04	.000D+00	.243D+05	.782D+12
144.00	.363D-01	.109D+08	.130D+04	.000D+00	.270D+05	.782D+12
156.00	.251D-01	.102D+08	.124D+04	.000D+00	.297D+05	.782D+12
168.00	.157D-01	.937D+07	.116D+04	.000D+00	.324D+05	.782D+12
180.00	.804D-02	.848D+07	.108D+04	.000D+00	.351D+05	.782D+12
192.00	.196D-02	.755D+07	.993D+03	.000D+00	.378D+05	.782D+12
204.00	-.274D-02	.661D+07	.906D+03	.000D+00	.405D+05	.782D+12
216.00	-.621D-02	.568D+07	.821D+03	.000D+00	.432D+05	.782D+12
228.00	-.864D-02	.479D+07	.739D+03	.000D+00	.459D+05	.782D+12
240.00	-.102D-01	.396D+07	.662D+03	.000D+00	.486D+05	.782D+12
252.00	-.110D-01	.320D+07	.592D+03	.000D+00	.513D+05	.782D+12
264.00	-.112D-01	.252D+07	.529D+03	.000D+00	.540D+05	.782D+12
276.00	-.110D-01	.192D+07	.474D+03	.000D+00	.567D+05	.782D+12
288.00	-.104D-01	.142D+07	.428D+03	.000D+00	.594D+05	.782D+12
300.00	-.952D-02	.100D+07	.389D+03	.000D+00	.621D+05	.782D+12
312.00	-.848D-02	.669D+06	.359D+03	.000D+00	.648D+05	.782D+12
324.00	-.731D-02	.416D+06	.336D+03	.000D+00	.675D+05	.782D+12
336.00	-.606D-02	.234D+06	.319D+03	.000D+00	.702D+05	.782D+12
348.00	-.477D-02	.113D+06	.308D+03	.000D+00	.729D+05	.782D+12
360.00	-.346D-02	.422D+05	.301D+03	.000D+00	.756D+05	.782D+12
372.00	-.214D-02	.888D+04	.298D+03	.000D+00	.783D+05	.782D+12
384.00	-.822D-03	-.319D+03	.297D+03	.000D+00	.810D+05	.782D+12
396.00	.500D-03	.000D+00	.297D+03	.000D+00	.837D+05	.782D+12

OUTPUT VERIFICATION

```
THE MAXIMUM MOMENT IMBALANCE FOR ANY ELEMENT      =  -.105D-05 IN-LBS
THE MAX. LATERAL FORCE IMBALANCE FOR ANY ELEMENT  =  -.149D-06 LBS

COMPUTED LATERAL FORCE AT PILE HEAD               =   .86000D+05 LBS
COMPUTED MOMENT AT PILE HEAD                      =   .54480D+07 IN-LBS
COMPUTED SLOPE AT PILE HEAD                       =  -.28802D-02

THE OVERALL MOMENT IMBALANCE                      =   .289D-04 IN-LBS
THE OVERALL LATERAL FORCE IMBALANCE               =  -.288D-06 LBS
```

OUTPUT SUMMARY

```
PILE HEAD DEFLECTION    =   .331D+00 IN
MAXIMUM BENDING MOMENT  =   .120D+08 IN-LBS
MAXIMUM TOTAL STRESS    =   .141D+04 LBS/IN**2
MAXIMUM SHEAR FORCE     =   .875D+05 LBS
NO. OF ITERATIONS       =          7
MAXIMUM DEFLECTION ERROR =  .364D-05 IN
```

PILE LOADING CONDITION

APPLIED MOMENT AT PILE HEAD = .611D+07 LBS-IN
LATERAL LOAD AT PILE HEAD = .400D+04 LBS
AXIAL LOAD AT PILE HEAD = .538D+06 LBS

X IN	DEFLECTION IN	MOMENT LBS-IN	TOTAL STRESS LBS/IN**2	DISTR. LOAD LBS/IN	SOIL MODULUS LBS/IN**2	FLEXURAL RIGIDITY LBS-IN**2
*****	**********	**********	**********	**********	**********	**********
.00	.123D+00	.611D+07	.860D+03	.000D+00	.000D+00	.782D+12
12.00	.107D+00	.616D+07	.865D+03	.000D+00	.000D+00	.782D+12
24.00	.918D-01	.622D+07	.870D+03	.000D+00	.000D+00	.782D+12
36.00	.781D-01	.627D+07	.875D+03	.000D+00	.270D+04	.782D+12
48.00	.656D-01	.629D+07	.877D+03	.000D+00	.540D+04	.782D+12
60.00	.542D-01	.626D+07	.874D+03	.000D+00	.810D+04	.782D+12
72.00	.440D-01	.617D+07	.865D+03	.000D+00	.108D+05	.782D+12
84.00	.349D-01	.601D+07	.850D+03	.000D+00	.135D+05	.782D+12
96.00	.269D-01	.578D+07	.829D+03	.000D+00	.162D+05	.782D+12
108.00	.200D-01	.548D+07	.802D+03	.000D+00	.189D+05	.782D+12
120.00	.141D-01	.513D+07	.770D+03	.000D+00	.216D+05	.782D+12
132.00	.915D-02	.474D+07	.734D+03	.000D+00	.243D+05	.782D+12
144.00	.506D-02	.431D+07	.695D+03	.000D+00	.270D+05	.782D+12
156.00	.177D-02	.387D+07	.654D+03	.000D+00	.297D+05	.782D+12
168.00	-.817D-03	.342D+07	.612D+03	.000D+00	.324D+05	.782D+12
180.00	-.277D-02	.297D+07	.570D+03	.000D+00	.351D+05	.782D+12
192.00	-.418D-02	.253D+07	.530D+03	.000D+00	.378D+05	.782D+12
204.00	-.512D-02	.211D+07	.492D+03	.000D+00	.405D+05	.782D+12
216.00	-.567D-02	.173D+07	.457D+03	.000D+00	.432D+05	.782D+12
228.00	-.590D-02	.138D+07	.424D+03	.000D+00	.459D+05	.782D+12
240.00	-.588D-02	.107D+07	.396D+03	.000D+00	.486D+05	.782D+12
252.00	-.566D-02	.799D+06	.371D+03	.000D+00	.513D+05	.782D+12
264.00	-.530D-02	.571D+06	.350D+03	.000D+00	.540D+05	.782D+12
276.00	-.482D-02	.384D+06	.333D+03	.000D+00	.567D+05	.782D+12
288.00	-.428D-02	.236D+06	.319D+03	.000D+00	.594D+05	.782D+12
300.00	-.369D-02	.124D+06	.309D+03	.000D+00	.621D+05	.782D+12
312.00	-.308D-02	.461D+05	.301D+03	.000D+00	.648D+05	.782D+12
324.00	-.246D-02	-.360D+04	.298D+03	.000D+00	.675D+05	.782D+12
336.00	-.184D-02	-.294D+05	.300D+03	.000D+00	.702D+05	.782D+12
348.00	-.123D-02	-.366D+05	.301D+03	.000D+00	.729D+05	.782D+12
360.00	-.621D-03	-.309D+05	.300D+03	.000D+00	.756D+05	.782D+12
372.00	-.189D-04	-.184D+05	.299D+03	.000D+00	.783D+05	.782D+12
384.00	.580D-03	-.583D+04	.298D+03	.000D+00	.810D+05	.782D+12
396.00	.118D-02	.000D+00	.297D+03	.000D+00	.837D+05	.782D+12

OUTPUT VERIFICATION

THE MAXIMUM MOMENT IMBALANCE FOR ANY ELEMENT = .315D-06 IN-LBS
THE MAX. LATERAL FORCE IMBALANCE FOR ANY ELEMENT = .893D-07 LBS

COMPUTED LATERAL FORCE AT PILE HEAD = .40000D+04 LBS
COMPUTED MOMENT AT PILE HEAD = .61080D+07 IN-LBS
COMPUTED SLOPE AT PILE HEAD = -.13778D-02

THE OVERALL MOMENT IMBALANCE = -.408D-05 IN-LBS
THE OVERALL LATERAL FORCE IMBALANCE = .110D-06 LBS

OUTPUT SUMMARY

```
PILE HEAD DEFLECTION    =    .123D+00 IN
MAXIMUM BENDING MOMENT  =    .629D+07 IN-LBS
MAXIMUM TOTAL STRESS    =    .877D+03 LBS/IN**2
MAXIMUM SHEAR FORCE     =    .474D+04 LBS
NO. OF ITERATIONS       =          3
MAXIMUM DEFLECTION ERROR =   .000D+00 IN
```

PILE LOADING CONDITION

```
APPLIED MOMENT AT PILE HEAD     =    .456D+07 LBS-IN
LATERAL LOAD AT PILE HEAD       =    .820D+05 LBS
AXIAL LOAD AT PILE HEAD         =    .388D+06 LBS
```

X IN	DEFLECTION IN	MOMENT LBS-IN	TOTAL STRESS LBS/IN**2	DISTR. LOAD LBS/IN	SOIL MODULUS LBS/IN**2	FLEXURAL RIGIDITY LBS-IN**2
*****	**********	**********	**********	**********	**********	**********
.00	.298D+00	.456D+07	.634D+03	.000D+00	.000D+00	.782D+12
12.00	.268D+00	.556D+07	.726D+03	.000D+00	.000D+00	.782D+12
24.00	.238D+00	.655D+07	.818D+03	.000D+00	.000D+00	.782D+12
36.00	.210D+00	.754D+07	.909D+03	.000D+00	.158D+04	.782D+12
48.00	.183D+00	.848D+07	.996D+03	.000D+00	.381D+04	.782D+12
60.00	.158D+00	.932D+07	.107D+04	.000D+00	.681D+04	.782D+12
72.00	.134D+00	.100D+08	.114D+04	.000D+00	.106D+05	.782D+12
84.00	.112D+00	.105D+08	.118D+04	.000D+00	.135D+05	.782D+12
96.00	.927D-01	.108D+08	.120D+04	.000D+00	.162D+05	.782D+12
108.00	.749D-01	.108D+08	.121D+04	.000D+00	.189D+05	.782D+12
120.00	.590D-01	.106D+08	.119D+04	.000D+00	.216D+05	.782D+12
132.00	.451D-01	.103D+08	.116D+04	.000D+00	.243D+05	.782D+12
144.00	.331D-01	.980D+07	.112D+04	.000D+00	.270D+05	.782D+12
156.00	.230D-01	.918D+07	.106D+04	.000D+00	.297D+05	.782D+12
168.00	.145D-01	.845D+07	.993D+03	.000D+00	.324D+05	.782D+12
180.00	.754D-02	.765D+07	.919D+03	.000D+00	.351D+05	.782D+12
192.00	.202D-02	.682D+07	.842D+03	.000D+00	.378D+05	.782D+12
204.00	-.225D-02	.597D+07	.765D+03	.000D+00	.405D+05	.782D+12
216.00	-.542D-02	.514D+07	.688D+03	.000D+00	.432D+05	.782D+12
228.00	-.764D-02	.434D+07	.614D+03	.000D+00	.459D+05	.782D+12
240.00	-.906D-02	.359D+07	.545D+03	.000D+00	.486D+05	.782D+12
252.00	-.982D-02	.290D+07	.482D+03	.000D+00	.513D+05	.782D+12
264.00	-.100D-01	.229D+07	.425D+03	.000D+00	.540D+05	.782D+12
276.00	-.985D-02	.175D+07	.375D+03	.000D+00	.567D+05	.782D+12
288.00	-.933D-02	.129D+07	.333D+03	.000D+00	.594D+05	.782D+12
300.00	-.857D-02	.914D+06	.299D+03	.000D+00	.621D+05	.782D+12
312.00	-.764D-02	.613D+06	.271D+03	.000D+00	.648D+05	.782D+12
324.00	-.660D-02	.383D+06	.250D+03	.000D+00	.675D+05	.782D+12
336.00	-.548D-02	.216D+06	.234D+03	.000D+00	.702D+05	.782D+12
348.00	-.433D-02	.106D+06	.224D+03	.000D+00	.729D+05	.782D+12
360.00	-.316D-02	.401D+05	.218D+03	.000D+00	.756D+05	.782D+12
372.00	-.197D-02	.886D+04	.215D+03	.000D+00	.783D+05	.782D+12
384.00	-.790D-03	-.144D+03	.214D+03	.000D+00	.810D+05	.782D+12
396.00	.395D-03	.000D+00	.214D+03	.000D+00	.837D+05	.782D+12

OUTPUT VERIFICATION

THE MAXIMUM MOMENT IMBALANCE FOR ANY ELEMENT = -.809D-06 IN-LBS
THE MAX. LATERAL FORCE IMBALANCE FOR ANY ELEMENT = .124D-06 LBS

COMPUTED LATERAL FORCE AT PILE HEAD = .82000D+05 LBS
COMPUTED MOMENT AT PILE HEAD = .45600D+07 IN-LBS
COMPUTED SLOPE AT PILE HEAD = -.25759D-02

THE OVERALL MOMENT IMBALANCE = -.106D-04 IN-LBS
THE OVERALL LATERAL FORCE IMBALANCE = .733D-07 LBS

OUTPUT SUMMARY

PILE HEAD DEFLECTION = .298D+00 IN
MAXIMUM BENDING MOMENT = .108D+08 IN-LBS
MAXIMUM TOTAL STRESS = .121D+04 LBS/IN**2
MAXIMUM SHEAR FORCE = .830D+05 LBS
NO. OF ITERATIONS = 6
MAXIMUM DEFLECTION ERROR = .808D-05 IN

PILE LOADING CONDITION

APPLIED MOMENT AT PILE HEAD = .604D+07 LBS-IN
LATERAL LOAD AT PILE HEAD = .350D+04 LBS
AXIAL LOAD AT PILE HEAD = .538D+06 LBS

X IN	DEFLECTION IN	MOMENT LBS-IN	TOTAL STRESS LBS/IN**2	DISTR. LOAD LBS/IN	SOIL MODULUS LBS/IN**2	FLEXURAL RIGIDITY LBS-IN**2
*****	**********	**********	**********	**********	**********	**********
.00	.120D+00	.604D+07	.853D+03	.000D+00	.000D+00	.782D+12
12.00	.104D+00	.609D+07	.858D+03	.000D+00	.000D+00	.782D+12
24.00	.898D-01	.614D+07	.862D+03	.000D+00	.000D+00	.782D+12
36.00	.764D-01	.618D+07	.867D+03	.000D+00	.270D+04	.782D+12
48.00	.641D-01	.620D+07	.868D+03	.000D+00	.540D+04	.782D+12
60.00	.530D-01	.616D+07	.865D+03	.000D+00	.810D+04	.782D+12
72.00	.430D-01	.607D+07	.856D+03	.000D+00	.108D+05	.782D+12
84.00	.341D-01	.590D+07	.841D+03	.000D+00	.135D+05	.782D+12
96.00	.262D-01	.567D+07	.820D+03	.000D+00	.162D+05	.782D+12
108.00	.195D-01	.538D+07	.793D+03	.000D+00	.189D+05	.782D+12
120.00	.137D-01	.504D+07	.761D+03	.000D+00	.216D+05	.782D+12
132.00	.885D-02	.465D+07	.725D+03	.000D+00	.243D+05	.782D+12
144.00	.485D-02	.423D+07	.687D+03	.000D+00	.270D+05	.782D+12
156.00	.163D-02	.379D+07	.646D+03	.000D+00	.297D+05	.782D+12
168.00	-.884D-03	.334D+07	.605D+03	.000D+00	.324D+05	.782D+12
180.00	-.279D-02	.290D+07	.564D+03	.000D+00	.351D+05	.782D+12
192.00	-.415D-02	.247D+07	.525D+03	.000D+00	.378D+05	.782D+12
204.00	-.507D-02	.207D+07	.488D+03	.000D+00	.405D+05	.782D+12
216.00	-.560D-02	.169D+07	.453D+03	.000D+00	.432D+05	.782D+12
228.00	-.582D-02	.135D+07	.421D+03	.000D+00	.459D+05	.782D+12
240.00	-.579D-02	.104D+07	.393D+03	.000D+00	.486D+05	.782D+12
252.00	-.557D-02	.778D+06	.369D+03	.000D+00	.513D+05	.782D+12
264.00	-.520D-02	.554D+06	.348D+03	.000D+00	.540D+05	.782D+12
276.00	-.473D-02	.372D+06	.331D+03	.000D+00	.567D+05	.782D+12
288.00	-.420D-02	.227D+06	.318D+03	.000D+00	.594D+05	.782D+12

300.00	-.362D-02	.119D+06	.308D+03	.000D+00	.621D+05	.782D+12
312.00	-.302D-02	.426D+05	.301D+03	.000D+00	.648D+05	.782D+12
324.00	-.241D-02	-.553D+04	.298D+03	.000D+00	.675D+05	.782D+12
336.00	-.180D-02	-.302D+05	.300D+03	.000D+00	.702D+05	.782D+12
348.00	-.120D-02	-.368D+05	.301D+03	.000D+00	.729D+05	.782D+12
360.00	-.600D-03	-.308D+05	.300D+03	.000D+00	.756D+05	.782D+12
372.00	-.870D-05	-.183D+05	.299D+03	.000D+00	.783D+05	.782D+12
384.00	.579D-03	-.578D+04	.298D+03	.000D+00	.810D+05	.782D+12
396.00	.117D-02	.000D+00	.297D+03	.000D+00	.837D+05	.782D+12

OUTPUT VERIFICATION

THE MAXIMUM MOMENT IMBALANCE FOR ANY ELEMENT = .244D-06 IN-LBS
THE MAX. LATERAL FORCE IMBALANCE FOR ANY ELEMENT = .644D-07 LBS

COMPUTED LATERAL FORCE AT PILE HEAD = .35000D+04 LBS
COMPUTED MOMENT AT PILE HEAD = .60360D+07 IN-LBS
COMPUTED SLOPE AT PILE HEAD = -.13532D-02

THE OVERALL MOMENT IMBALANCE = -.384D-05 IN-LBS
THE OVERALL LATERAL FORCE IMBALANCE = .107D-06 LBS

OUTPUT SUMMARY

PILE HEAD DEFLECTION = .120D+00 IN
MAXIMUM BENDING MOMENT = .620D+07 IN-LBS
MAXIMUM TOTAL STRESS = .868D+03 LBS/IN**2
MAXIMUM SHEAR FORCE = .423D+04 LBS
NO. OF ITERATIONS = 3
MAXIMUM DEFLECTION ERROR = .000D+00 IN

1 90-0012,SKUNK CREEK ABUTMENT,STRUT LOAD = 0,ABUT1.DAT

S U M M A R Y T A B L E
****

LATERAL LOAD (LBS)	BOUNDARY CONDITION BC2	AXIAL LOAD (LBS)	YT (IN)	ST (IN/IN)	MAX. MOMENT (IN-LBS)	MAX. STRESS (LBS/IN**2)
.860D+05	.545D+07	.538D+06	.331D+00	-.288D-02	.120D+08	.141D+04
.400D+04	.611D+07	.538D+06	.123D+00	-.138D-02	.629D+07	.877D+03
.820D+05	.456D+07	.388D+06	.298D+00	-.258D-02	.108D+08	.121D+04
.350D+04	.604D+07	.538D+06	.120D+00	-.135D-02	.620D+07	.868D+03

```
*************************************************************
*                                                           *
*     LATERALLY LOADED PILE ANALYSIS   -  COM624G           *
*                                                           *
*     PC ADAPTATION OF COM624                               *
*                                                           *
*     ORIGINALLY WRITTEN BY REESE AND SULLIVAN AT           *
*     UNIVERSITY OF TEXAS AT AUSTIN                         *
*                                                           *
*     ADAPTED FOR PC USE BY                                 *


*                                                           *
*     GEOSOFT                                               *
*     1442 LINCOLN AVE., SUITE 146                          *
*     ORANGE, CA 92665  (714) 998-4030                      *
*                                                           *
*                                                           *
*     PORTIONS (C) COPYRIGHT 1984 GEOSOFT                   *
*                                                           *
*                                                           *
*************************************************************
```

1

91-0190,CENTER PILE,CPFREE.DAT

UNITS--ENGL

I N P U T I N F O R M A T I O N
****

THE LOADING IS STATIC

PILE GEOMETRY AND PROPERTIES

PILE LENGTH = 888.00 IN
MODULUS OF ELASTICITY OF PILE = .300D+07 LBS/IN**2
1 SECTION(S)

X IN	DIAMETER IN	MOMENT OF INERTIA IN**4	AREA IN**2
.00	60.000	.636D+06	.283D+04
888.00			

SOILS INFORMATION

X AT THE GROUND SURFACE = 468.00 IN

3 LAYER(S) OF SOIL

LAYER 1
THE SOIL IS A STIFF CLAY ABOVE THE WATER TABLE
X AT THE TOP OF THE LAYER = 468.00 IN
X AT THE BOTTOM OF THE LAYER = 660.00 IN
MODULUS OF SUBGRADE REACTION = .150D+04 LBS/IN**3

LAYER 2
THE SOIL IS A SAND
X AT THE TOP OF THE LAYER = 660.00 IN
X AT THE BOTTOM OF THE LAYER = 768.00 IN
MODULUS OF SUBGRADE REACTION = .200D+03 LBS/IN**3

LAYER 3
THE SOIL IS A STIFF CLAY ABOVE THE WATER TABLE
X AT THE TOP OF THE LAYER = 768.00 IN
X AT THE BOTTOM OF THE LAYER = 1000.00 IN
MODULUS OF SUBGRADE REACTION = .150D+04 LBS/IN**3

DISTRIBUTION OF EFFECTIVE UNIT WEIGHT WITH DEPTH
2 POINTS

X,IN	WEIGHT,LBS/IN**3
468.00	.64D-01
1000.00	.64D-01

DISTRIBUTION OF STRENGTH PARAMETERS WITH DEPTH
6 POINTS

X,IN	C,LBS/IN**2	PHI,DEGREES	E50
468.00	.278D+02	.000	.500D-02
660.00	.278D+02	.000	.500D-02
660.00	.000D+00	36.000	*****
768.00	.000D+00	36.000	*****
768.00	.278D+02	.000	.500D-02
1000.00	.278D+02	.000	.500D-02

FINITE DIFFERENCE PARAMETERS
NUMBER OF PILE INCREMENTS = 74
TOLERANCE ON DETERMINATION OF DEFLECTIONS = .100D-04 IN
MAXIMUM NUMBER OF ITERATIONS ALLOWED FOR PILE ANALYSIS = 100
MAXIMUM ALLOWABLE DEFLECTION = .60D+03 IN

INPUT CODES
OUTPT = 1
KCYCL = 1
KBC = 1
KPYOP = 0
INC = 1

1 91-0190,CENTER PILE,CPFREE.DAT

UNITS--ENGL

OUTPUT INFORMATION

****

PILE LOADING CONDITION

APPLIED MOMENT AT PILE HEAD = .617D+07 LBS-IN
LATERAL LOAD AT PILE HEAD = .400D+05 LBS
AXIAL LOAD AT PILE HEAD = .546D+06 LBS

X IN	DEFLECTION IN	MOMENT LBS-IN	TOTAL STRESS LBS/IN**2	DISTR. LOAD LBS/IN	SOIL MODULUS LBS/IN**2	FLEXURAL RIGIDITY LBS-IN**2
*****	**********	**********	**********	**********	**********	**********
.00	.223D+01	.617D+07	.484D+03	.000D+00	.000D+00	.191D+13
12.00	.216D+01	.669D+07	.509D+03	.000D+00	.000D+00	.191D+13
24.00	.208D+01	.721D+07	.533D+03	.000D+00	.000D+00	.191D+13
36.00	.201D+01	.772D+07	.558D+03	.000D+00	.000D+00	.191D+13
48.00	.194D+01	.824D+07	.582D+03	.000D+00	.000D+00	.191D+13
60.00	.187D+01	.876D+07	.606D+03	.000D+00	.000D+00	.191D+13
72.00	.181D+01	.928D+07	.631D+03	.000D+00	.000D+00	.191D+13
84.00	.174D+01	.980D+07	.655D+03	.000D+00	.000D+00	.191D+13
96.00	.167D+01	.103D+08	.680D+03	.000D+00	.000D+00	.191D+13
108.00	.160D+01	.108D+08	.704D+03	.000D+00	.000D+00	.191D+13
120.00	.154D+01	.113D+08	.728D+03	.000D+00	.000D+00	.191D+13
132.00	.147D+01	.119D+08	.753D+03	.000D+00	.000D+00	.191D+13
144.00	.141D+01	.124D+08	.777D+03	.000D+00	.000D+00	.191D+13
156.00	.134D+01	.129D+08	.801D+03	.000D+00	.000D+00	.191D+13
168.00	.128D+01	.134D+08	.825D+03	.000D+00	.000D+00	.191D+13
180.00	.122D+01	.139D+08	.850D+03	.000D+00	.000D+00	.191D+13
192.00	.116D+01	.144D+08	.874D+03	.000D+00	.000D+00	.191D+13
204.00	.110D+01	.149D+08	.898D+03	.000D+00	.000D+00	.191D+13
216.00	.104D+01	.155D+08	.922D+03	.000D+00	.000D+00	.191D+13
228.00	.987D+00	.160D+08	.946D+03	.000D+00	.000D+00	.191D+13
240.00	.932D+00	.165D+08	.970D+03	.000D+00	.000D+00	.191D+13
252.00	.877D+00	.170D+08	.994D+03	.000D+00	.000D+00	.191D+13
264.00	.824D+00	.175D+08	.102D+04	.000D+00	.000D+00	.191D+13
276.00	.773D+00	.180D+08	.104D+04	.000D+00	.000D+00	.191D+13
288.00	.722D+00	.185D+08	.107D+04	.000D+00	.000D+00	.191D+13
300.00	.673D+00	.190D+08	.109D+04	.000D+00	.000D+00	.191D+13
312.00	.626D+00	.195D+08	.111D+04	.000D+00	.000D+00	.191D+13
324.00	.580D+00	.200D+08	.114D+04	.000D+00	.000D+00	.191D+13
336.00	.535D+00	.205D+08	.116D+04	.000D+00	.000D+00	.191D+13
348.00	.492D+00	.210D+08	.119D+04	.000D+00	.000D+00	.191D+13
360.00	.451D+00	.215D+08	.121D+04	.000D+00	.000D+00	.191D+13
372.00	.411D+00	.220D+08	.123D+04	.000D+00	.000D+00	.191D+13
384.00	.373D+00	.225D+08	.126D+04	.000D+00	.000D+00	.191D+13
396.00	.336D+00	.230D+08	.128D+04	.000D+00	.000D+00	.191D+13
408.00	.302D+00	.235D+08	.130D+04	.000D+00	.000D+00	.191D+13
420.00	.269D+00	.240D+08	.133D+04	.000D+00	.000D+00	.191D+13
432.00	.238D+00	.245D+08	.135D+04	.000D+00	.000D+00	.191D+13
444.00	.208D+00	.250D+08	.137D+04	.000D+00	.000D+00	.191D+13
456.00	.181D+00	.255D+08	.140D+04	.000D+00	.000D+00	.191D+13
468.00	.156D+00	.260D+08	.142D+04	.000D+00	.108D+05	.191D+13
480.00	.132D+00	.263D+08	.143D+04	.000D+00	.128D+05	.191D+13
492.00	.111D+00	.263D+08	.143D+04	.000D+00	.152D+05	.191D+13
504.00	.912D-01	.260D+08	.142D+04	.000D+00	.183D+05	.191D+13
516.00	.737D-01	.256D+08	.140D+04	.000D+00	.222D+05	.191D+13
528.00	.581D-01	.248D+08	.136D+04	.000D+00	.276D+05	.191D+13

540.00	.443D-01	.239D+08	.132D+04	.000D+00	.349D+05	.191D+13
552.00	.324D-01	.227D+08	.126D+04	.000D+00	.457D+05	.191D+13
564.00	.222D-01	.213D+08	.120D+04	.000D+00	.626D+05	.191D+13
576.00	.136D-01	.197D+08	.112D+04	.000D+00	.933D+05	.191D+13
588.00	.649D-02	.180D+08	.104D+04	.000D+00	.168D+06	.191D+13
600.00	.729D-03	.161D+08	.950D+03	.000D+00	.891D+06	.191D+13
612.00	-.382D-02	.140D+08	.855D+03	.000D+00	.264D+06	.191D+13
624.00	-.730D-02	.122D+08	.766D+03	.000D+00	.167D+06	.191D+13
636.00	-.987D-02	.104D+08	.686D+03	.000D+00	.137D+06	.191D+13
648.00	-.117D-01	.894D+07	.615D+03	.000D+00	.124D+06	.191D+13
660.00	-.128D-01	.764D+07	.554D+03	.000D+00	.384D+05	.191D+13
672.00	-.133D-01	.641D+07	.496D+03	.000D+00	.408D+05	.191D+13
684.00	-.133D-01	.526D+07	.441D+03	.000D+00	.432D+05	.191D+13
696.00	-.130D-01	.419D+07	.391D+03	.000D+00	.456D+05	.191D+13
708.00	-.123D-01	.321D+07	.344D+03	.000D+00	.480D+05	.191D+13
720.00	-.114D-01	.231D+07	.302D+03	.000D+00	.504D+05	.191D+13
732.00	-.103D-01	.149D+07	.263D+03	.000D+00	.528D+05	.191D+13
744.00	-.913D-02	.752D+06	.229D+03	.000D+00	.552D+05	.191D+13
756.00	-.788D-02	.860D+05	.197D+03	.000D+00	.576D+05	.191D+13
768.00	-.662D-02	-.514D+06	.217D+03	.000D+00	.163D+06	.191D+13
780.00	-.540D-02	-.960D+06	.238D+03	.000D+00	.197D+06	.191D+13
792.00	-.425D-02	-.125D+07	.252D+03	.000D+00	.245D+06	.191D+13
804.00	-.319D-02	-.139D+07	.259D+03	.000D+00	.314D+06	.191D+13
816.00	-.225D-02	-.139D+07	.259D+03	.000D+00	.423D+06	.191D+13
828.00	-.140D-02	-.125D+07	.252D+03	.000D+00	.621D+06	.191D+13
840.00	-.656D-03	-.989D+06	.240D+03	.000D+00	.113D+07	.191D+13
852.00	.181D-04	-.618D+06	.222D+03	.000D+00	.171D+08	.191D+13
864.00	.645D-03	-.291D+06	.207D+03	.000D+00	.121D+07	.191D+13
876.00	.125D-02	-.772D+05	.197D+03	.000D+00	.760D+06	.191D+13
888.00	.185D-02	.000D+00	.193D+03	.000D+00	.582D+06	.191D+13

OUTPUT VERIFICATION

```
THE MAXIMUM MOMENT IMBALANCE FOR ANY ELEMENT      =  -.607D-05 IN-LBS
THE MAX. LATERAL FORCE IMBALANCE FOR ANY ELEMENT =  -.518D-06 LBS

COMPUTED LATERAL FORCE AT PILE HEAD          =   .40000D+05 LBS
COMPUTED MOMENT AT PILE HEAD                 =   .61680D+07 IN-LBS
COMPUTED SLOPE AT PILE HEAD                  =  -.60056D-02

THE OVERALL MOMENT IMBALANCE                 =   .597D-04 IN-LBS
THE OVERALL LATERAL FORCE IMBALANCE          =  -.126D-05 LBS
```

OUTPUT SUMMARY

```
PILE HEAD DEFLECTION    =   .223D+01 IN
MAXIMUM BENDING MOMENT  =   .263D+08 IN-LBS
MAXIMUM TOTAL STRESS    =   .143D+04 LBS/IN**2
MAXIMUM SHEAR FORCE     =   .433D+05 LBS
NO. OF ITERATIONS       =         24
MAXIMUM DEFLECTION ERROR =  .831D-05 IN
```

PILE LOADING CONDITION

```
APPLIED MOMENT AT PILE HEAD      =   .538D+07 LBS-IN
LATERAL LOAD AT PILE HEAD        =   .430D+05 LBS
AXIAL LOAD AT PILE HEAD          =   .920D+06 LBS
```

X IN *****	DEFLECTION IN **********	MOMENT LBS-IN **********	TOTAL STRESS LBS/IN**2 **********	DISTR. LOAD LBS/IN **********	SOIL MODULUS LBS/IN**2 **********	FLEXURAL RIGIDITY LBS-IN**2 **********
.00	.237D+01	.538D+07	.579D+03	.000D+00	.000D+00	.191D+13
12.00	.230D+01	.596D+07	.607D+03	.000D+00	.000D+00	.191D+13
24.00	.222D+01	.655D+07	.634D+03	.000D+00	.000D+00	.191D+13
36.00	.215D+01	.713D+07	.662D+03	.000D+00	.000D+00	.191D+13
48.00	.207D+01	.771D+07	.689D+03	.000D+00	.000D+00	.191D+13
60.00	.200D+01	.830D+07	.717D+03	.000D+00	.000D+00	.191D+13
72.00	.193D+01	.888D+07	.744D+03	.000D+00	.000D+00	.191D+13
84.00	.186D+01	.946D+07	.772D+03	.000D+00	.000D+00	.191D+13
96.00	.178D+01	.100D+08	.799D+03	.000D+00	.000D+00	.191D+13
108.00	.171D+01	.106D+08	.827D+03	.000D+00	.000D+00	.191D+13
120.00	.164D+01	.112D+08	.854D+03	.000D+00	.000D+00	.191D+13
132.00	.158D+01	.118D+08	.881D+03	.000D+00	.000D+00	.191D+13
144.00	.151D+01	.124D+08	.909D+03	.000D+00	.000D+00	.191D+13
156.00	.144D+01	.129D+08	.936D+03	.000D+00	.000D+00	.191D+13
168.00	.138D+01	.135D+08	.963D+03	.000D+00	.000D+00	.191D+13
180.00	.131D+01	.141D+08	.990D+03	.000D+00	.000D+00	.191D+13
192.00	.125D+01	.147D+08	.102D+04	.000D+00	.000D+00	.191D+13
204.00	.118D+01	.152D+08	.104D+04	.000D+00	.000D+00	.191D+13
216.00	.112D+01	.158D+08	.107D+04	.000D+00	.000D+00	.191D+13
228.00	.106D+01	.164D+08	.110D+04	.000D+00	.000D+00	.191D+13
240.00	.100D+01	.170D+08	.113D+04	.000D+00	.000D+00	.191D+13
252.00	.946D+00	.175D+08	.115D+04	.000D+00	.000D+00	.191D+13
264.00	.889D+00	.181D+08	.118D+04	.000D+00	.000D+00	.191D+13
276.00	.834D+00	.187D+08	.121D+04	.000D+00	.000D+00	.191D+13
288.00	.781D+00	.192D+08	.123D+04	.000D+00	.000D+00	.191D+13
300.00	.728D+00	.198D+08	.126D+04	.000D+00	.000D+00	.191D+13
312.00	.678D+00	.203D+08	.129D+04	.000D+00	.000D+00	.191D+13
324.00	.628D+00	.209D+08	.131D+04	.000D+00	.000D+00	.191D+13
336.00	.581D+00	.215D+08	.134D+04	.000D+00	.000D+00	.191D+13
348.00	.535D+00	.220D+08	.136D+04	.000D+00	.000D+00	.191D+13
360.00	.490D+00	.226D+08	.139D+04	.000D+00	.000D+00	.191D+13
372.00	.448D+00	.231D+08	.142D+04	.000D+00	.000D+00	.191D+13
384.00	.407D+00	.237D+08	.144D+04	.000D+00	.000D+00	.191D+13
396.00	.368D+00	.242D+08	.147D+04	.000D+00	.000D+00	.191D+13
408.00	.330D+00	.248D+08	.150D+04	.000D+00	.000D+00	.191D+13
420.00	.295D+00	.253D+08	.152D+04	.000D+00	.000D+00	.191D+13
432.00	.261D+00	.259D+08	.155D+04	.000D+00	.000D+00	.191D+13
444.00	.230D+00	.264D+08	.157D+04	.000D+00	.000D+00	.191D+13
456.00	.200D+00	.270D+08	.160D+04	.000D+00	.000D+00	.191D+13
468.00	.173D+00	.275D+08	.162D+04	.000D+00	.100D+05	.191D+13
480.00	.147D+00	.278D+08	.164D+04	.000D+00	.118D+05	.191D+13
492.00	.124D+00	.278D+08	.164D+04	.000D+00	.140D+05	.191D+13
504.00	.103D+00	.276D+08	.163D+04	.000D+00	.167D+05	.191D+13
516.00	.835D-01	.272D+08	.161D+04	.000D+00	.202D+05	.191D+13
528.00	.664D-01	.265D+08	.157D+04	.000D+00	.249D+05	.191D+13
540.00	.513D-01	.255D+08	.153D+04	.000D+00	.313D+05	.191D+13
552.00	.381D-01	.243D+08	.147D+04	.000D+00	.404D+05	.191D+13
564.00	.268D-01	.229D+08	.141D+04	.000D+00	.544D+05	.191D+13
576.00	.172D-01	.213D+08	.133D+04	.000D+00	.784D+05	.191D+13
588.00	.915D-02	.195D+08	.125D+04	.000D+00	.129D+06	.191D+13
600.00	.262D-02	.175D+08	.115D+04	.000D+00	.341D+06	.191D+13
612.00	-.260D-02	.154D+08	.105D+04	.000D+00	.353D+06	.191D+13
624.00	-.665D-02	.134D+08	.959D+03	.000D+00	.179D+06	.191D+13
636.00	-.968D-02	.116D+08	.873D+03	.000D+00	.139D+06	.191D+13
648.00	-.118D-01	.100D+08	.797D+03	.000D+00	.123D+06	.191D+13
660.00	-.132D-01	.859D+07	.730D+03	.000D+00	.384D+05	.191D+13
672.00	-.140D-01	.725D+07	.667D+03	.000D+00	.408D+05	.191D+13
684.00	-.142D-01	.599D+07	.608D+03	.000D+00	.432D+05	.191D+13

696.00	-.140D-01	.483D+07	.333D+03	.000D+00	.438D+05	.191D+13
708.00	-.134D-01	.375D+07	.502D+03	.000D+00	.480D+05	.191D+13
720.00	-.125D-01	.277D+07	.456D+03	.000D+00	.504D+05	.191D+13
732.00	-.114D-01	.187D+07	.414D+03	.000D+00	.528D+05	.191D+13
744.00	-.101D-01	.106D+07	.376D+03	.000D+00	.552D+05	.191D+13
756.00	-.882D-02	.338D+06	.341D+03	.000D+00	.576D+05	.191D+13
768.00	-.748D-02	-.316D+06	.340D+03	.000D+00	.148D+06	.191D+13
780.00	-.616D-02	-.810D+06	.364D+03	.000D+00	.178D+06	.191D+13
792.00	-.490D-02	-.115D+07	.379D+03	.000D+00	.220D+06	.191D+13
804.00	-.372D-02	-.133D+07	.388D+03	.000D+00	.280D+06	.191D+13
816.00	-.265D-02	-.136D+07	.389D+03	.000D+00	.373D+06	.191D+13
828.00	-.168D-02	-.124D+07	.384D+03	.000D+00	.543D+06	.191D+13
840.00	-.802D-03	-.100D+07	.373D+03	.000D+00	.975D+06	.191D+13
852.00	.282D-06	-.644D+06	.356D+03	.000D+00	.385D+09	.191D+13
864.00	.754D-03	-.304D+06	.340D+03	.000D+00	.108D+07	.191D+13
876.00	.148D-02	-.803D+05	.329D+03	.000D+00	.669D+06	.191D+13
888.00	.221D-02	.000D+00	.325D+03	.000D+00	.509D+06	.191D+13

OUTPUT VERIFICATION

THE MAXIMUM MOMENT IMBALANCE FOR ANY ELEMENT = -.403D-05 IN-LBS
THE MAX. LATERAL FORCE IMBALANCE FOR ANY ELEMENT = -.351D-06 LBS

COMPUTED LATERAL FORCE AT PILE HEAD = .43000D+05 LBS
COMPUTED MOMENT AT PILE HEAD = .53760D+07 IN-LBS
COMPUTED SLOPE AT PILE HEAD = -.62775D-02

THE OVERALL MOMENT IMBALANCE = .183D-04 IN-LBS
THE OVERALL LATERAL FORCE IMBALANCE = -.678D-06 LBS

OUTPUT SUMMARY

PILE HEAD DEFLECTION = .237D+01 IN
MAXIMUM BENDING MOMENT = .278D+08 IN-LBS
MAXIMUM TOTAL STRESS = .164D+04 LBS/IN**2
MAXIMUM SHEAR FORCE = .488D+05 LBS
NO. OF ITERATIONS = 21
MAXIMUM DEFLECTION ERROR = .719D-05 IN

PILE LOADING CONDITION

APPLIED MOMENT AT PILE HEAD = .132D+06 LBS-IN
LATERAL LOAD AT PILE HEAD = .450D+05 LBS
AXIAL LOAD AT PILE HEAD = .904D+06 LBS

X	DEFLECTION	MOMENT	TOTAL STRESS	DISTR. LOAD	SOIL MODULUS	FLEXURAL RIGIDITY
IN	IN	LBS-IN	LBS/IN**2	LBS/IN	LBS/IN**2	LBS-IN**2
*****	**********	**********	**********	**********	**********	**********
.00	.185D+01	.132D+06	.326D+03	.000D+00	.000D+00	.191D+13
12.00	.179D+01	.722D+06	.354D+03	.000D+00	.000D+00	.191D+13
24.00	.174D+01	.131D+07	.382D+03	.000D+00	.000D+00	.191D+13
36.00	.168D+01	.190D+07	.409D+03	.000D+00	.000D+00	.191D+13
48.00	.163D+01	.249D+07	.437D+03	.000D+00	.000D+00	.191D+13

60.00	.157D+01	.308D+07	.483D+03	.000D+00	.000D+00	.191D+13
72.00	.152D+01	.367D+07	.493D+03	.000D+00	.000D+00	.191D+13
84.00	.146D+01	.426D+07	.521D+03	.000D+00	.000D+00	.191D+13
96.00	.141D+01	.485D+07	.548D+03	.000D+00	.000D+00	.191D+13
108.00	.136D+01	.544D+07	.576D+03	.000D+00	.000D+00	.191D+13
120.00	.130D+01	.603D+07	.604D+03	.000D+00	.000D+00	.191D+13
132.00	.125D+01	.661D+07	.632D+03	.000D+00	.000D+00	.191D+13
144.00	.120D+01	.720D+07	.659D+03	.000D+00	.000D+00	.191D+13
156.00	.115D+01	.779D+07	.687D+03	.000D+00	.000D+00	.191D+13
168.00	.110D+01	.837D+07	.715D+03	.000D+00	.000D+00	.191D+13
180.00	.104D+01	.896D+07	.742D+03	.000D+00	.000D+00	.191D+13
192.00	.995D+00	.954D+07	.770D+03	.000D+00	.000D+00	.191D+13
204.00	.946D+00	.101D+08	.798D+03	.000D+00	.000D+00	.191D+13
216.00	.897D+00	.107D+08	.825D+03	.000D+00	.000D+00	.191D+13
228.00	.850D+00	.113D+08	.853D+03	.000D+00	.000D+00	.191D+13
240.00	.803D+00	.119D+08	.880D+03	.000D+00	.000D+00	.191D+13
252.00	.757D+00	.125D+08	.907D+03	.000D+00	.000D+00	.191D+13
264.00	.712D+00	.130D+08	.935D+03	.000D+00	.000D+00	.191D+13
276.00	.668D+00	.136D+08	.962D+03	.000D+00	.000D+00	.191D+13
288.00	.625D+00	.142D+08	.990D+03	.000D+00	.000D+00	.191D+13
300.00	.584D+00	.148D+08	.102D+04	.000D+00	.000D+00	.191D+13
312.00	.543D+00	.154D+08	.104D+04	.000D+00	.000D+00	.191D+13
324.00	.503D+00	.159D+08	.107D+04	.000D+00	.000D+00	.191D+13
336.00	.465D+00	.165D+08	.110D+04	.000D+00	.000D+00	.191D+13
348.00	.428D+00	.171D+08	.113D+04	.000D+00	.000D+00	.191D+13
360.00	.392D+00	.176D+08	.115D+04	.000D+00	.000D+00	.191D+13
372.00	.358D+00	.182D+08	.118D+04	.000D+00	.000D+00	.191D+13
384.00	.325D+00	.188D+08	.121D+04	.000D+00	.000D+00	.191D+13
396.00	.293D+00	.194D+08	.123D+04	.000D+00	.000D+00	.191D+13
408.00	.263D+00	.199D+08	.126D+04	.000D+00	.000D+00	.191D+13
420.00	.234D+00	.205D+08	.129D+04	.000D+00	.000D+00	.191D+13
432.00	.207D+00	.211D+08	.131D+04	.000D+00	.000D+00	.191D+13
444.00	.181D+00	.216D+08	.134D+04	.000D+00	.000D+00	.191D+13
456.00	.157D+00	.222D+08	.137D+04	.000D+00	.000D+00	.191D+13
468.00	.135D+00	.227D+08	.139D+04	.000D+00	.121D+05	.191D+13
480.00	.115D+00	.231D+08	.141D+04	.000D+00	.142D+05	.191D+13
492.00	.957D-01	.232D+08	.141D+04	.000D+00	.169D+05	.191D+13
504.00	.787D-01	.230D+08	.140D+04	.000D+00	.204D+05	.191D+13
516.00	.634D-01	.226D+08	.139D+04	.000D+00	.249D+05	.191D+13
528.00	.497D-01	.220D+08	.136D+04	.000D+00	.310D+05	.191D+13
540.00	.378D-01	.212D+08	.132D+04	.000D+00	.394D+05	.191D+13
552.00	.274D-01	.201D+08	.127D+04	.000D+00	.518D+05	.191D+13
564.00	.186D-01	.189D+08	.121D+04	.000D+00	.716D+05	.191D+13
576.00	.112D-01	.174D+08	.114D+04	.000D+00	.108D+06	.191D+13
588.00	.507D-02	.158D+08	.107D+04	.000D+00	.202D+06	.191D+13
600.00	.161D-03	.140D+08	.982D+03	.000D+00	.275D+07	.191D+13
612.00	-.368D-02	.122D+08	.896D+03	.000D+00	.272D+06	.191D+13
624.00	-.661D-02	.105D+08	.816D+03	.000D+00	.180D+06	.191D+13
636.00	-.874D-02	.900D+07	.744D+03	.000D+00	.150D+06	.191D+13
648.00	-.102D-01	.766D+07	.681D+03	.000D+00	.137D+06	.191D+13
660.00	-.111D-01	.653D+07	.628D+03	.000D+00	.384D+05	.191D+13
672.00	-.114D-01	.546D+07	.577D+03	.000D+00	.408D+05	.191D+13
684.00	-.114D-01	.446D+07	.530D+03	.000D+00	.432D+05	.191D+13
696.00	-.110D-01	.352D+07	.486D+03	.000D+00	.456D+05	.191D+13
708.00	-.104D-01	.266D+07	.445D+03	.000D+00	.480D+05	.191D+13
720.00	-.957D-02	.187D+07	.408D+03	.000D+00	.504D+05	.191D+13
732.00	-.859D-02	.115D+07	.374D+03	.000D+00	.528D+05	.191D+13
744.00	-.753D-02	.499D+06	.343D+03	.000D+00	.552D+05	.191D+13
756.00	-.643D-02	-.957D+05	.324D+03	.000D+00	.576D+05	.191D+13
768.00	-.533D-02	-.637D+06	.350D+03	.000D+00	.191D+06	.191D+13
780.00	-.429D-02	-.103D+07	.368D+03	.000D+00	.234D+06	.191D+13
792.00	-.332D-02	-.128D+07	.380D+03	.000D+00	.294D+06	.191D+13
804.00	-.245D-02	-.139D+07	.385D+03	.000D+00	.383D+06	.191D+13
816.00	-.168D-02	-.137D+07	.384D+03	.000D+00	.525D+06	.191D+13
828.00	-.102D-02	-.121D+07	.377D+03	.000D+00	.790D+06	.191D+13
840.00	-.445D-03	-.943D+06	.364D+03	.000D+00	.151D+07	.191D+13

852.00	.558D-04	-.577D+06	.347D+03	.000D+00	.745D+07	.191D+13
864.00	.513D-03	-.271D+06	.333D+03	.000D+00	.144D+07	.191D+13
876.00	.950D-03	-.717D+05	.323D+03	.000D+00	.935D+06	.191D+13
888.00	.138D-02	.000D+00	.320D+03	.000D+00	.724D+06	.191D+13

OUTPUT VERIFICATION

THE MAXIMUM MOMENT IMBALANCE FOR ANY ELEMENT = -.212D-05 IN-LBS
THE MAX. LATERAL FORCE IMBALANCE FOR ANY ELEMENT = .289D-06 LBS

COMPUTED LATERAL FORCE AT PILE HEAD = .45000D+05 LBS
COMPUTED MOMENT AT PILE HEAD = .13200D+06 IN-LBS
COMPUTED SLOPE AT PILE HEAD = -.46138D-02

THE OVERALL MOMENT IMBALANCE = -.161D-03 IN-LBS
THE OVERALL LATERAL FORCE IMBALANCE = .532D-06 LBS

OUTPUT SUMMARY

PILE HEAD DEFLECTION = .185D+01 IN
MAXIMUM BENDING MOMENT = .232D+08 IN-LBS
MAXIMUM TOTAL STRESS = .141D+04 LBS/IN**2
MAXIMUM SHEAR FORCE = .492D+05 LBS
NO. OF ITERATIONS = 20
MAXIMUM DEFLECTION ERROR = .910D-05 IN

PILE LOADING CONDITION

APPLIED MOMENT AT PILE HEAD = .000D+00 LBS-IN
LATERAL LOAD AT PILE HEAD = .120D+05 LBS
AXIAL LOAD AT PILE HEAD = .904D+06 LBS

X IN	DEFLECTION IN	MOMENT LBS-IN	TOTAL STRESS LBS/IN**2	DISTR. LOAD LBS/IN	SOIL MODULUS LBS/IN**2	FLEXURAL RIGIDITY LBS-IN**2
*****	**********	**********	**********	**********	**********	**********
.00	.376D+00	.000D+00	.320D+03	.000D+00	.000D+00	.191D+13
12.00	.364D+00	.155D+06	.327D+03	.000D+00	.000D+00	.191D+13
24.00	.352D+00	.310D+06	.334D+03	.000D+00	.000D+00	.191D+13
36.00	.340D+00	.465D+06	.342D+03	.000D+00	.000D+00	.191D+13
48.00	.328D+00	.620D+06	.349D+03	.000D+00	.000D+00	.191D+13
60.00	.315D+00	.775D+06	.356D+03	.000D+00	.000D+00	.191D+13
72.00	.303D+00	.930D+06	.364D+03	.000D+00	.000D+00	.191D+13
84.00	.291D+00	.108D+07	.371D+03	.000D+00	.000D+00	.191D+13
96.00	.279D+00	.124D+07	.378D+03	.000D+00	.000D+00	.191D+13
108.00	.268D+00	.139D+07	.386D+03	.000D+00	.000D+00	.191D+13
120.00	.256D+00	.155D+07	.393D+03	.000D+00	.000D+00	.191D+13
132.00	.244D+00	.170D+07	.400D+03	.000D+00	.000D+00	.191D+13
144.00	.233D+00	.186D+07	.407D+03	.000D+00	.000D+00	.191D+13
156.00	.222D+00	.201D+07	.415D+03	.000D+00	.000D+00	.191D+13
168.00	.210D+00	.217D+07	.422D+03	.000D+00	.000D+00	.191D+13
180.00	.199D+00	.232D+07	.429D+03	.000D+00	.000D+00	.191D+13
192.00	.188D+00	.247D+07	.436D+03	.000D+00	.000D+00	.191D+13
204.00	.178D+00	.263D+07	.444D+03	.000D+00	.000D+00	.191D+13

216.00	.167D+00	.278D+07	.451D+03	.000D+00	.000D+00	.191D+13
228.00	.157D+00	.293D+07	.458D+03	.000D+00	.000D+00	.191D+13
240.00	.147D+00	.309D+07	.465D+03	.000D+00	.000D+00	.191D+13
252.00	.137D+00	.324D+07	.473D+03	.000D+00	.000D+00	.191D+13
264.00	.128D+00	.339D+07	.480D+03	.000D+00	.000D+00	.191D+13
276.00	.118D+00	.355D+07	.487D+03	.000D+00	.000D+00	.191D+13
288.00	.109D+00	.370D+07	.494D+03	.000D+00	.000D+00	.191D+13
300.00	.101D+00	.385D+07	.501D+03	.000D+00	.000D+00	.191D+13
312.00	.922D-01	.400D+07	.508D+03	.000D+00	.000D+00	.191D+13
324.00	.841D-01	.415D+07	.516D+03	.000D+00	.000D+00	.191D+13
336.00	.762D-01	.430D+07	.523D+03	.000D+00	.000D+00	.191D+13
348.00	.687D-01	.445D+07	.530D+03	.000D+00	.000D+00	.191D+13
360.00	.615D-01	.460D+07	.537D+03	.000D+00	.000D+00	.191D+13
372.00	.547D-01	.475D+07	.544D+03	.000D+00	.000D+00	.191D+13
384.00	.482D-01	.490D+07	.551D+03	.000D+00	.000D+00	.191D+13
396.00	.421D-01	.505D+07	.558D+03	.000D+00	.000D+00	.191D+13
408.00	.364D-01	.520D+07	.565D+03	.000D+00	.000D+00	.191D+13
420.00	.311D-01	.535D+07	.572D+03	.000D+00	.000D+00	.191D+13
432.00	.262D-01	.550D+07	.579D+03	.000D+00	.000D+00	.191D+13
444.00	.216D-01	.565D+07	.586D+03	.000D+00	.000D+00	.191D+13
456.00	.176D-01	.580D+07	.593D+03	.000D+00	.000D+00	.191D+13
468.00	.139D-01	.594D+07	.600D+03	.000D+00	.663D+05	.191D+13
480.00	.107D-01	.596D+07	.601D+03	.000D+00	.841D+05	.191D+13
492.00	.797D-02	.584D+07	.595D+03	.000D+00	.109D+06	.191D+13
504.00	.566D-02	.560D+07	.584D+03	.000D+00	.147D+06	.191D+13
516.00	.378D-02	.524D+07	.567D+03	.000D+00	.206D+06	.191D+13
528.00	.229D-02	.476D+07	.544D+03	.000D+00	.311D+06	.191D+13
540.00	.116D-02	.418D+07	.517D+03	.000D+00	.535D+06	.191D+13
552.00	.349D-03	.352D+07	.486D+03	.000D+00	.136D+07	.191D+13
564.00	-.199D-03	.278D+07	.451D+03	.000D+00	.217D+07	.191D+13
576.00	-.537D-03	.211D+07	.419D+03	.000D+00	.106D+07	.191D+13
588.00	-.716D-03	.151D+07	.391D+03	.000D+00	.876D+06	.191D+13
600.00	-.782D-03	.101D+07	.367D+03	.000D+00	.845D+06	.191D+13
612.00	-.771D-03	.601D+06	.348D+03	.000D+00	.878D+06	.191D+13
624.00	-.715D-03	.291D+06	.333D+03	.000D+00	.956D+06	.191D+13
636.00	-.637D-03	.785D+05	.323D+03	.000D+00	.107D+07	.191D+13
648.00	-.553D-03	-.355D+05	.321D+03	.000D+00	.122D+07	.191D+13
660.00	-.471D-03	-.521D+05	.322D+03	.000D+00	.384D+05	.191D+13
672.00	-.394D-03	-.662D+05	.323D+03	.000D+00	.408D+05	.191D+13
684.00	-.322D-03	-.779D+05	.323D+03	.000D+00	.432D+05	.191D+13
696.00	-.255D-03	-.876D+05	.324D+03	.000D+00	.456D+05	.191D+13
708.00	-.195D-03	-.956D+05	.324D+03	.000D+00	.480D+05	.191D+13
720.00	-.142D-03	-.102D+06	.325D+03	.000D+00	.504D+05	.191D+13
732.00	-.974D-04	-.108D+06	.325D+03	.000D+00	.528D+05	.191D+13
744.00	-.606D-04	-.113D+06	.325D+03	.000D+00	.552D+05	.191D+13
756.00	-.323D-04	-.117D+06	.325D+03	.000D+00	.576D+05	.191D+13
768.00	-.128D-04	-.121D+06	.325D+03	.000D+00	.176D+08	.191D+13
780.00	-.249D-05	-.930D+05	.324D+03	.000D+00	.624D+08	.191D+13
792.00	.807D-06	-.423D+05	.322D+03	.000D+00	.153D+09	.191D+13
804.00	.904D-06	-.950D+04	.320D+03	.000D+00	.145D+09	.191D+13
816.00	.284D-06	.445D+04	.320D+03	.000D+00	.358D+09	.191D+13
828.00	.546D-09	.374D+04	.320D+03	.000D+00	.382D+11	.191D+13
840.00	-.757D-09	.273D+02	.320D+03	.000D+00	.337D+11	.191D+13
852.00	-.116D-13	-.100D+02	.320D+03	.000D+00	.284D+14	.191D+13
864.00	.239D-14	-.217D-03	.320D+03	.000D+00	.292D+14	.191D+13
876.00	.649D-19	.317D-04	.320D+03	.000D+00	.300D+14	.191D+13
888.00	-.143D-19	.000D+00	.320D+03	.000D+00	.308D+14	.191D+13

OUTPUT VERIFICATION

THE MAXIMUM MOMENT IMBALANCE FOR ANY ELEMENT = -.533D-06 IN-LBS
THE MAX. LATERAL FORCE IMBALANCE FOR ANY ELEMENT = -.598D-07 LBS

COMPUTED LATERAL FORCE AT PILE HEAD = .12000D+05 LBS

```
COMPUTED MOMENT AT PILE HEAD                    =   .00000D+00 IN-LBS
COMPUTED SLOPE AT PILE HEAD                     =  -.10204D-02

THE OVERALL MOMENT IMBALANCE                    =   .218D-04 IN-LBS
THE OVERALL LATERAL FORCE IMBALANCE             =  -.130D-06 LBS


OUTPUT SUMMARY

PILE HEAD DEFLECTION    =    .376D+00 IN
MAXIMUM BENDING MOMENT  =    .596D+07 IN-LBS
MAXIMUM TOTAL STRESS    =    .601D+03 LBS/IN**2
MAXIMUM SHEAR FORCE     =    .129D+05 LBS
NO. OF ITERATIONS       =          19
MAXIMUM DEFLECTION ERROR =   .956D-05 IN


1   91-0190,CENTER PILE,CPFREE.DAT
```

S U M M A R Y T A B L E

****

LATERAL LOAD (LBS)	BOUNDARY CONDITION BC2	AXIAL LOAD (LBS)	YT (IN)	ST (IN/IN)	MAX. MOMENT (IN-LBS)	MAX. STRESS (LBS/IN**2)
.400D+05	.617D+07	.546D+06	.223D+01	-.601D-02	.263D+08	.143D+04
.430D+05	.538D+07	.920D+06	.237D+01	-.628D-02	.278D+08	.164D+04
.450D+05	.132D+06	.904D+06	.185D+01	-.461D-02	.232D+08	.141D+04
.120D+05	.000D+00	.904D+06	.376D+00	-.102D-02	.596D+07	.601D+03

THOMAS-HARTIG & ASSOCIATES, INC.

TOM W. THOMAS, P.E. • HARRY E. HARTIG, P.E.
Geotechnical, Materials Testing, and Environmental Consultants
7031 West Oakland Street • Chandler, Arizona 85226

James R. Morrow
John P. Boyd, P.E.
Charles H. Atkinson, P.E.
James M. Willson, P.E.
Frank M. Guerra, P.E.
Steven A. Haire, P.E.
Kenneth L. Ricker, P.E.
Judith A. McBee
Dale V. Bedenkop, P.E.
John C. Patton
Kenneth D. Walsh, P.E.
Lynn Olson

Mathews Kessler & Associates
4045 East McDonald Road
Phoenix, AZ 85008

4 January 1991

Attention: Bob Herz

Project: Supplemental Analyses
51st Avenue Bridge
At Skunk Creek
Phoenix, Arizona

Project No. 91-0190
(Supplement to Project No. 90-0012)

As requested by Inca Engineers, we have performed additional lateral pile analyses, using a computer-based finite difference model (COM 624G). The lateral loads on the pile heads are presented in the following tabulation:

Location	Load Case*	Applied Shear (kips)	Applied Moment (kip-ft.)	Applied Axial Load (kips)
Abutment	2T	3.5	503	388
Abutment	3T	1	849	253
Abutment	3L	75	339	253
Pier	3T	45	11	904
Pier	3L	12	0	904
Pier	4T	48	703	433

* L = longitudinal load direction
T = transverse load direction

For the abutment piles, the above loads include the shear and moment due to active soil pressure on the abutment wall and pile cap, multiplied by a load factor of 1.3. Output for the COM 624G computer program is presented in Appendix A.

A copy of this supplemental letter should be attached to the original geotechnical report (Project No. 90-0012, dated 26 December 1989) for the subject bridge.

Please call if you have any questions or if we may be of further service.

Respectfully submitted,
THOMAS-HARTIG & ASSOCIATES, INC.

By: _____ Reviewed by: _____
Steven A. Haire, P.E. Kenneth L. Ricker, P.E.

/dkl-s
Copies to Addressee (5)
Inca Engineers, Inc./C. Gnanasambanthan, P.E. (1)

APPENDIX A

LATERAL PILE ANALYSES
COM 624G
OUTPUT

```
*************************************************************
*                                                           *
*     LATERALLY LOADED PILE ANALYSIS   -   COM624G          *
*                                                           *
*     PC ADAPTATION OF COM624                               *
*                                                           *
*     ORIGINALLY WRITTEN BY REESE AND SULLIVAN AT           *
*     UNIVERSITY OF TEXAS AT AUSTIN                         *
*                                                           *
*     ADAPTED FOR PC USE BY                                 *


*                                                           *
*     GEOSOFT                                               *
*     1442 LINCOlN AVE., SUITE 146                          *
*     ORANGE, CA 92665  (714) 998-4030                      *
*                                                           *
*                                                           *
*     PORTIONS (C) COPYRIGHT 1984 GEOSOFT                   *
*                                                           *
*                                                           *
*************************************************************
```

1

90-0012,SKUNK CREEK ABUTMENT,STRUT LOAD = 0,ABUT1R.DAT

UNITS--ENGL

I N P U T I N F O R M A T I O N
****

THE LOADING IS STATIC

PILE GEOMETRY AND PROPERTIES

PILE LENGTH = 396.00 IN
MODULUS OF ELASTICITY OF PILE = .300D+07 LBS/IN**2
1 SECTION(S)

X IN	DIAMETER IN	MOMENT OF INERTIA IN**4	AREA IN**2
.00	48.000	.261D+06	.181D+04
396.00			

```
SOILS INFORMATION

    X AT THE GROUND SURFACE              =       24.00 IN

    1 LAYER(S) OF SOIL

    LAYER  1
    THE SOIL IS A SAND
    X AT THE TOP OF THE LAYER            =       24.00 IN
    X AT THE BOTTOM OF THE LAYER         =      600.00 IN
    MODULUS OF SUBGRADE REACTION         =    .225D+03 LBS/IN**3


    DISTRIBUTION OF EFFECTIVE UNIT WEIGHT WITH DEPTH
                        2 POINTS
                X,IN      WEIGHT,LBS/IN**3
               24.00          .75D-01
              600.00          .75D-01

    DISTRIBUTION OF STRENGTH PARAMETERS WITH DEPTH
                        2 POINTS
                X,IN        C,LBS/IN**2      PHI,DEGREES      E50
               24.00        .000D+00          40.000        *****
              600.00        .000D+00          40.000        *****


FINITE DIFFERENCE PARAMETERS
    NUMBER OF PILE INCREMENTS                                  =        66
    TOLERANCE ON DETERMINATION OF DEFLECTIONS                  =   .100D-04 IN
    MAXIMUM NUMBER OF ITERATIONS ALLOWED FOR PILE ANALYSIS     =       100
    MAXIMUM ALLOWABLE DEFLECTION                               =    .48D+03 IN


INPUT CODES
    OUTPT  =  1
    KCYCL  =  1
    KBC    =  1
    KPYOP  =  0
    INC    =  2
90-0012,SKUNK CREEK ABUTMENT,STRUT LOAD = 0,ABUT1R.DAT


UNITS--ENGL


                    O U T P U T   I N F O R M A T I O N
                    ***********************************


PILE LOADING CONDITION

    APPLIED MOMENT AT PILE HEAD          =    .604D+07 LBS-IN
    LATERAL LOAD AT PILE HEAD            =    .350D+04 LBS
    AXIAL LOAD AT PILE HEAD              =    .388D+06 LBS
```

X IN *****	DEFLECTION IN **********	MOMENT LBS-IN **********	TOTAL STRESS LBS/IN**2 **********	DISTR. LOAD LBS/IN **********	SOIL MODULUS LBS/IN**2 **********	FLEXURAL RIGIDITY LBS-IN**2 **********
.00	.120D+00	.604D+07	.770D+03	.000D+00	.000D+00	.782D+12
12.00	.104D+00	.608D+07	.775D+03	.000D+00	.000D+00	.782D+12
24.00	.896D-01	.613D+07	.779D+03	.000D+00	.000D+00	.782D+12
36.00	.762D-01	.617D+07	.783D+03	.000D+00	.270D+04	.782D+12
48.00	.640D-01	.619D+07	.784D+03	.000D+00	.540D+04	.782D+12
60.00	.528D-01	.615D+07	.781D+03	.000D+00	.810D+04	.782D+12
72.00	.428D-01	.606D+07	.772D+03	.000D+00	.108D+05	.782D+12
84.00	.340D-01	.589D+07	.757D+03	.000D+00	.135D+05	.782D+12
96.00	.262D-01	.566D+07	.736D+03	.000D+00	.162D+05	.782D+12
108.00	.194D-01	.537D+07	.709D+03	.000D+00	.189D+05	.782D+12
120.00	.137D-01	.502D+07	.677D+03	.000D+00	.216D+05	.782D+12
132.00	.882D-02	.464D+07	.641D+03	.000D+00	.243D+05	.782D+12
144.00	.484D-02	.422D+07	.603D+03	.000D+00	.270D+05	.782D+12
156.00	.163D-02	.378D+07	.562D+03	.000D+00	.297D+05	.782D+12
168.00	-.880D-03	.333D+07	.521D+03	.000D+00	.324D+05	.782D+12
180.00	-.278D-02	.289D+07	.481D+03	.000D+00	.351D+05	.782D+12
192.00	-.414D-02	.247D+07	.441D+03	.000D+00	.378D+05	.782D+12
204.00	-.505D-02	.206D+07	.404D+03	.000D+00	.405D+05	.782D+12
216.00	-.558D-02	.168D+07	.369D+03	.000D+00	.432D+05	.782D+12
228.00	-.580D-02	.134D+07	.338D+03	.000D+00	.459D+05	.782D+12
240.00	-.577D-02	.104D+07	.310D+03	.000D+00	.486D+05	.782D+12
252.00	-.555D-02	.775D+06	.286D+03	.000D+00	.513D+05	.782D+12
264.00	-.518D-02	.553D+06	.265D+03	.000D+00	.540D+05	.782D+12
276.00	-.472D-02	.370D+06	.248D+03	.000D+00	.567D+05	.782D+12
288.00	-.418D-02	.226D+06	.235D+03	.000D+00	.594D+05	.782D+12
300.00	-.361D-02	.118D+06	.225D+03	.000D+00	.621D+05	.782D+12
312.00	-.301D-02	.422D+05	.218D+03	.000D+00	.648D+05	.782D+12
324.00	-.240D-02	-.572D+04	.215D+03	.000D+00	.675D+05	.782D+12
336.00	-.179D-02	-.304D+05	.217D+03	.000D+00	.702D+05	.782D+12
348.00	-.119D-02	-.369D+05	.218D+03	.000D+00	.729D+05	.782D+12
360.00	-.599D-03	-.309D+05	.217D+03	.000D+00	.756D+05	.782D+12
372.00	-.102D-04	-.184D+05	.216D+03	.000D+00	.783D+05	.782D+12
384.00	.575D-03	-.584D+04	.215D+03	.000D+00	.810D+05	.782D+12
396.00	.116D-02	.000D+00	.214D+03	.000D+00	.837D+05	.782D+12

OUTPUT VERIFICATION

THE MAXIMUM MOMENT IMBALANCE FOR ANY ELEMENT = -.340D-06 IN-LBS
THE MAX. LATERAL FORCE IMBALANCE FOR ANY ELEMENT = -.438D-07 LBS

COMPUTED LATERAL FORCE AT PILE HEAD = .35000D+04 LBS
COMPUTED MOMENT AT PILE HEAD = .60360D+07 IN-LBS
COMPUTED SLOPE AT PILE HEAD = -.13506D-02

THE OVERALL MOMENT IMBALANCE = -.711D-05 IN-LBS
THE OVERALL LATERAL FORCE IMBALANCE = -.348D-09 LBS

OUTPUT SUMMARY

PILE HEAD DEFLECTION = .120D+00 IN
MAXIMUM BENDING MOMENT = .619D+07 IN-LBS
MAXIMUM TOTAL STRESS = .784D+03 LBS/IN**2
MAXIMUM SHEAR FORCE = .402D+04 LBS
NO. OF ITERATIONS = 2
MAXIMUM DEFLECTION ERROR = .000D+00 IN

PILE LOADING CONDITION

APPLIED MOMENT AT PILE HEAD = .102D+08 LBS-IN
LATERAL LOAD AT PILE HEAD = .100D+04 LBS
AXIAL LOAD AT PILE HEAD = .253D+06 LBS

X IN	DEFLECTION IN	MOMENT LBS-IN	TOTAL STRESS LBS/IN**2	DISTR. LOAD LBS/IN	SOIL MODULUS LBS/IN**2	FLEXURAL RIGIDITY LBS-IN**2
*****	**********	**********	**********	**********	**********	**********
.00	.191D+00	.102D+08	.108D+04	.000D+00	.000D+00	.782D+12
12.00	.166D+00	.102D+08	.108D+04	.000D+00	.000D+00	.782D+12
24.00	.142D+00	.102D+08	.108D+04	.000D+00	.000D+00	.782D+12
36.00	.120D+00	.102D+08	.108D+04	.000D+00	.237D+04	.782D+12
48.00	.101D+00	.102D+08	.108D+04	.000D+00	.540D+04	.782D+12
60.00	.829D-01	.101D+08	.107D+04	.000D+00	.810D+04	.782D+12
72.00	.669D-01	.990D+07	.105D+04	.000D+00	.108D+05	.782D+12
84.00	.527D-01	.959D+07	.102D+04	.000D+00	.135D+05	.782D+12
96.00	.403D-01	.918D+07	.986D+03	.000D+00	.162D+05	.782D+12
108.00	.296D-01	.868D+07	.939D+03	.000D+00	.189D+05	.782D+12
120.00	.205D-01	.809D+07	.885D+03	.000D+00	.216D+05	.782D+12
132.00	.129D-01	.745D+07	.826D+03	.000D+00	.243D+05	.782D+12
144.00	.667D-02	.675D+07	.762D+03	.000D+00	.270D+05	.782D+12
156.00	.167D-02	.603D+07	.695D+03	.000D+00	.297D+05	.782D+12
168.00	-.222D-02	.530D+07	.628D+03	.000D+00	.324D+05	.782D+12
180.00	-.513D-02	.458D+07	.562D+03	.000D+00	.351D+05	.782D+12
192.00	-.720D-02	.389D+07	.498D+03	.000D+00	.378D+05	.782D+12
204.00	-.854D-02	.324D+07	.438D+03	.000D+00	.405D+05	.782D+12
216.00	-.930D-02	.263D+07	.382D+03	.000D+00	.432D+05	.782D+12
228.00	-.956D-02	.209D+07	.332D+03	.000D+00	.459D+05	.782D+12
240.00	-.944D-02	.160D+07	.287D+03	.000D+00	.486D+05	.782D+12
252.00	-.903D-02	.119D+07	.249D+03	.000D+00	.513D+05	.782D+12
264.00	-.839D-02	.835D+06	.217D+03	.000D+00	.540D+05	.782D+12
276.00	-.760D-02	.548D+06	.190D+03	.000D+00	.567D+05	.782D+12
288.00	-.671D-02	.324D+06	.170D+03	.000D+00	.594D+05	.782D+12
300.00	-.576D-02	.157D+06	.154D+03	.000D+00	.621D+05	.782D+12
312.00	-.478D-02	.420D+05	.144D+03	.000D+00	.648D+05	.782D+12
324.00	-.379D-02	-.289D+05	.142D+03	.000D+00	.675D+05	.782D+12
336.00	-.281D-02	-.629D+05	.146D+03	.000D+00	.702D+05	.782D+12
348.00	-.183D-02	-.687D+05	.146D+03	.000D+00	.729D+05	.782D+12
360.00	-.874D-03	-.551D+05	.145D+03	.000D+00	.756D+05	.782D+12
372.00	.770D-04	-.322D+05	.143D+03	.000D+00	.783D+05	.782D+12
384.00	.102D-02	-.101D+05	.141D+03	.000D+00	.810D+05	.782D+12
396.00	.196D-02	.000D+00	.140D+03	.000D+00	.837D+05	.782D+12

OUTPUT VERIFICATION

THE MAXIMUM MOMENT IMBALANCE FOR ANY ELEMENT = -.872D-06 IN-LBS
THE MAX. LATERAL FORCE IMBALANCE FOR ANY ELEMENT = -.854D-07 LBS

COMPUTED LATERAL FORCE AT PILE HEAD = .10000D+04 LBS
COMPUTED MOMENT AT PILE HEAD = .10190D+08 IN-LBS
COMPUTED SLOPE AT PILE HEAD = -.21923D-02

THE OVERALL MOMENT IMBALANCE = -.328D-05 IN-LBS
THE OVERALL LATERAL FORCE IMBALANCE = -.197D-06 LBS

OUTPUT SUMMARY

PILE HEAD DEFLECTION = .191D+00 IN
MAXIMUM BENDING MOMENT = .102D+08 IN-LBS
MAXIMUM TOTAL STRESS = .108D+04 LBS/IN**2
MAXIMUM SHEAR FORCE = .199D+04 LBS
NO. OF ITERATIONS = 4
MAXIMUM DEFLECTION ERROR = .163D-05 IN

PILE LOADING CONDITION

APPLIED MOMENT AT PILE HEAD = .407D+07 LBS-IN
LATERAL LOAD AT PILE HEAD = .750D+05 LBS
AXIAL LOAD AT PILE HEAD = .253D+06 LBS

X IN	DEFLECTION IN	MOMENT LBS-IN	TOTAL STRESS LBS/IN**2	DISTR. LOAD LBS/IN	SOIL MODULUS LBS/IN**2	FLEXURAL RIGIDITY LBS-IN**2
*****	**********	**********	**********	**********	**********	**********
.00	.266D+00	.407D+07	.514D+03	.000D+00	.000D+00	.782D+12
12.00	.239D+00	.497D+07	.598D+03	.000D+00	.000D+00	.782D+12
24.00	.213D+00	.588D+07	.681D+03	.000D+00	.000D+00	.782D+12
36.00	.187D+00	.678D+07	.764D+03	.000D+00	.172D+04	.782D+12
48.00	.163D+00	.764D+07	.843D+03	.000D+00	.413D+04	.782D+12
60.00	.141D+00	.839D+07	.913D+03	.000D+00	.738D+04	.782D+12
72.00	.120D+00	.900D+07	.969D+03	.000D+00	.108D+05	.782D+12
84.00	.100D+00	.942D+07	.101D+04	.000D+00	.135D+05	.782D+12
96.00	.826D-01	.965D+07	.103D+04	.000D+00	.162D+05	.782D+12
108.00	.667D-01	.968D+07	.103D+04	.000D+00	.189D+05	.782D+12
120.00	.525D-01	.953D+07	.102D+04	.000D+00	.216D+05	.782D+12
132.00	.401D-01	.922D+07	.989D+03	.000D+00	.243D+05	.782D+12
144.00	.294D-01	.877D+07	.948D+03	.000D+00	.270D+05	.782D+12
156.00	.204D-01	.820D+07	.895D+03	.000D+00	.297D+05	.782D+12
168.00	.128D-01	.755D+07	.835D+03	.000D+00	.324D+05	.782D+12
180.00	.662D-02	.684D+07	.769D+03	.000D+00	.351D+05	.782D+12
192.00	.170D-02	.609D+07	.700D+03	.000D+00	.378D+05	.782D+12
204.00	-.210D-02	.533D+07	.631D+03	.000D+00	.405D+05	.782D+12
216.00	-.491D-02	.458D+07	.562D+03	.000D+00	.432D+05	.782D+12
228.00	-.688D-02	.387D+07	.496D+03	.000D+00	.459D+05	.782D+12
240.00	-.814D-02	.320D+07	.434D+03	.000D+00	.486D+05	.782D+12
252.00	-.881D-02	.258D+07	.378D+03	.000D+00	.513D+05	.782D+12
264.00	-.900D-02	.203D+07	.327D+03	.000D+00	.540D+05	.782D+12
276.00	-.882D-02	.156D+07	.283D+03	.000D+00	.567D+05	.782D+12
288.00	-.834D-02	.115D+07	.245D+03	.000D+00	.594D+05	.782D+12
300.00	-.766D-02	.811D+06	.214D+03	.000D+00	.621D+05	.782D+12
312.00	-.682D-02	.543D+06	.190D+03	.000D+00	.648D+05	.782D+12
324.00	-.589D-02	.338D+06	.171D+03	.000D+00	.675D+05	.782D+12
336.00	-.489D-02	.190D+06	.157D+03	.000D+00	.702D+05	.782D+12
348.00	-.386D-02	.923D+05	.148D+03	.000D+00	.729D+05	.782D+12
360.00	-.281D-02	.345D+05	.143D+03	.000D+00	.756D+05	.782D+12
372.00	-.175D-02	.723D+04	.140D+03	.000D+00	.783D+05	.782D+12
384.00	-.689D-03	-.377D+03	.140D+03	.000D+00	.810D+05	.782D+12
396.00	.371D-03	.000D+00	.140D+03	.000D+00	.837D+05	.782D+12

OUTPUT VERIFICATION

```
THE MAXIMUM MOMENT IMBALANCE FOR ANY ELEMENT      =  -.703D-06 IN-LBS
THE MAX. LATERAL FORCE IMBALANCE FOR ANY ELEMENT =  -.114D-06 LBS

COMPUTED LATERAL FORCE AT PILE HEAD          =   .75000D+05 LBS
COMPUTED MOMENT AT PILE HEAD                 =   .40680D+07 IN-LBS
COMPUTED SLOPE AT PILE HEAD                  =  -.23068D-02

THE OVERALL MOMENT IMBALANCE                 =  -.245D-04 IN-LBS
THE OVERALL LATERAL FORCE IMBALANCE          =   .153D-06 LBS
```

OUTPUT SUMMARY

```
PILE HEAD DEFLECTION    =    .266D+00 IN
MAXIMUM BENDING MOMENT  =    .969D+07 IN-LBS
MAXIMUM TOTAL STRESS    =    .103D+04 LBS/IN**2
MAXIMUM SHEAR FORCE     =    .756D+05 LBS
NO. OF ITERATIONS       =          6
MAXIMUM DEFLECTION ERROR =   .238D-05 IN
```

90-0012,SKUNK CREEK ABUTMENT,STRUT LOAD = 0,ABUT1R.DAT

S U M M A R Y T A B L E
****

LATERAL LOAD (LBS)	BOUNDARY CONDITION BC2	AXIAL LOAD (LBS)	YT (IN)	ST (IN/IN)	MAX. MOMENT (IN-LBS)	MAX. STRESS (LBS/IN**2)
.850D+04	.604D+07	.388D+06	.120D+00	-.135D-02	.619D+07	.784D+03
.100D+04	.102D+08	.253D+06	.191D+00	-.219D-02	.102D+08	.108D+04
.750D+05	.407D+07	.253D+06	.266D+00	-.231D-02	.969D+07	.103D+04

```
*********************************************************
*                                                       *
*     LATERALLY LOADED PILE ANALYSIS   -  COM624G       *
*                                                       *
*     PC ADAPTATION OF COM624                           *
*                                                       *
*     ORIGINALLY WRITTEN BY REESE AND SULLIVAN AT       *
*     UNIVERSITY OF TEXAS AT AUSTIN                     *
*                                                       *
*     ADAPTED FOR PC USE BY                             *


*                                                       *
*     GEOSOFT                                           *
*     1442 LINCOlN AVE., SUITE 146                      *
*     ORANGE, CA 92665  (714) 998-4030                  *
*                                                       *
*                                                       *
*     PORTIONS (C) COPYRIGHT 1984 GEOSOFT               *
*                                                       *
*                                                       *
*********************************************************
```

1

91-0190,CENTER PILE,CPFREE.DAT

UNITS--ENGL

```
                    I N P U T   I N F O R M A T I O N
                    *********************************
```

THE LOADING IS STATIC

PILE GEOMETRY AND PROPERTIES

```
PILE LENGTH                          =     888.00 IN
MODULUS OF ELASTICITY OF PILE        =   .300D+07 LBS/IN**2
                1 SECTION(S)

              X            DIAMETER    MOMENT OF        AREA
                                        INERTIA
              IN              IN         IN**4          IN**2
              .00
                           60.000       .636D+06       .283D+04
```

SOILS INFORMATION

X AT THE GROUND SURFACE = 468.00 IN

3 LAYER(S) OF SOIL

LAYER 1
THE SOIL IS A STIFF CLAY ABOVE THE WATER TABLE
X AT THE TOP OF THE LAYER = 468.00 IN
X AT THE BOTTOM OF THE LAYER = 660.00 IN
MODULUS OF SUBGRADE REACTION = .150D+04 LBS/IN**3

LAYER 2
THE SOIL IS A SAND
X AT THE TOP OF THE LAYER = 660.00 IN
X AT THE BOTTOM OF THE LAYER = 768.00 IN
MODULUS OF SUBGRADE REACTION = .200D+03 LBS/IN**3

LAYER 3
THE SOIL IS A STIFF CLAY ABOVE THE WATER TABLE
X AT THE TOP OF THE LAYER = 768.00 IN
X AT THE BOTTOM OF THE LAYER = 1000.00 IN
MODULUS OF SUBGRADE REACTION = .150D+04 LBS/IN**3

DISTRIBUTION OF EFFECTIVE UNIT WEIGHT WITH DEPTH
2 POINTS

X,IN	WEIGHT,LBS/IN**3
468.00	.64D-01
1000.00	.64D-01

DISTRIBUTION OF STRENGTH PARAMETERS WITH DEPTH
6 POINTS

X,IN	C,LBS/IN**2	PHI,DEGREES	E50
468.00	.278D+02	.000	.500D-02
660.00	.278D+02	.000	.500D-02
660.00	.000D+00	36.000	*****
768.00	.000D+00	36.000	*****
768.00	.278D+02	.000	.500D-02
1000.00	.278D+02	.000	.500D-02

FINITE DIFFERENCE PARAMETERS
NUMBER OF PILE INCREMENTS = 74
TOLERANCE ON DETERMINATION OF DEFLECTIONS = .100D-04 IN
MAXIMUM NUMBER OF ITERATIONS ALLOWED FOR PILE ANALYSIS = 100
MAXIMUM ALLOWABLE DEFLECTION = .60D+03 IN

INPUT CODES
OUTPT = 1
KCYCL = 1
KBC = 1
KPYOP = 0
INC = 1
91-0190,CENTER PILE,CPFREE.DAT

UNITS--ENGL

****

PILE LOADING CONDITION

APPLIED MOMENT AT PILE HEAD = .132D+06 LBS-IN
LATERAL LOAD AT PILE HEAD = .450D+05 LBS
AXIAL LOAD AT PILE HEAD = .904D+06 LBS

X IN	DEFLECTION IN	MOMENT LBS-IN	TOTAL STRESS LBS/IN**2	DISTR. LOAD LBS/IN	SOIL MODULUS LBS/IN**2	FLEXURAL RIGIDITY LBS-IN**2
*****	**********	**********	**********	**********	**********	**********
.00	.185D+01	.132D+06	.326D+03	.000D+00	.000D+00	.191D+13
12.00	.179D+01	.722D+06	.354D+03	.000D+00	.000D+00	.191D+13
24.00	.174D+01	.131D+07	.382D+03	.000D+00	.000D+00	.191D+13
36.00	.168D+01	.190D+07	.409D+03	.000D+00	.000D+00	.191D+13
48.00	.163D+01	.249D+07	.437D+03	.000D+00	.000D+00	.191D+13
60.00	.157D+01	.308D+07	.465D+03	.000D+00	.000D+00	.191D+13
72.00	.152D+01	.367D+07	.493D+03	.000D+00	.000D+00	.191D+13
84.00	.146D+01	.426D+07	.521D+03	.000D+00	.000D+00	.191D+13
96.00	.141D+01	.485D+07	.548D+03	.000D+00	.000D+00	.191D+13
108.00	.136D+01	.544D+07	.576D+03	.000D+00	.000D+00	.191D+13
120.00	.130D+01	.603D+07	.604D+03	.000D+00	.000D+00	.191D+13
132.00	.125D+01	.661D+07	.632D+03	.000D+00	.000D+00	.191D+13
144.00	.120D+01	.720D+07	.659D+03	.000D+00	.000D+00	.191D+13
156.00	.115D+01	.779D+07	.687D+03	.000D+00	.000D+00	.191D+13
168.00	.110D+01	.837D+07	.715D+03	.000D+00	.000D+00	.191D+13
180.00	.104D+01	.896D+07	.742D+03	.000D+00	.000D+00	.191D+13
192.00	.995D+00	.954D+07	.770D+03	.000D+00	.000D+00	.191D+13
204.00	.946D+00	.101D+08	.798D+03	.000D+00	.000D+00	.191D+13
216.00	.897D+00	.107D+08	.825D+03	.000D+00	.000D+00	.191D+13
228.00	.850D+00	.113D+08	.853D+03	.000D+00	.000D+00	.191D+13
240.00	.803D+00	.119D+08	.880D+03	.000D+00	.000D+00	.191D+13
252.00	.757D+00	.125D+08	.907D+03	.000D+00	.000D+00	.191D+13
264.00	.712D+00	.130D+08	.935D+03	.000D+00	.000D+00	.191D+13
276.00	.668D+00	.136D+08	.962D+03	.000D+00	.000D+00	.191D+13
288.00	.625D+00	.142D+08	.990D+03	.000D+00	.000D+00	.191D+13
300.00	.584D+00	.148D+08	.102D+04	.000D+00	.000D+00	.191D+13
312.00	.543D+00	.154D+08	.104D+04	.000D+00	.000D+00	.191D+13
324.00	.503D+00	.159D+08	.107D+04	.000D+00	.000D+00	.191D+13
336.00	.465D+00	.165D+08	.110D+04	.000D+00	.000D+00	.191D+13
348.00	.428D+00	.171D+08	.113D+04	.000D+00	.000D+00	.191D+13
360.00	.392D+00	.176D+08	.115D+04	.000D+00	.000D+00	.191D+13
372.00	.358D+00	.182D+08	.118D+04	.000D+00	.000D+00	.191D+13
384.00	.325D+00	.188D+08	.121D+04	.000D+00	.000D+00	.191D+13
396.00	.293D+00	.194D+08	.123D+04	.000D+00	.000D+00	.191D+13
408.00	.263D+00	.199D+08	.126D+04	.000D+00	.000D+00	.191D+13
420.00	.234D+00	.205D+08	.129D+04	.000D+00	.000D+00	.191D+13
432.00	.207D+00	.211D+08	.131D+04	.000D+00	.000D+00	.191D+13
444.00	.181D+00	.216D+08	.134D+04	.000D+00	.000D+00	.191D+13
456.00	.157D+00	.222D+08	.137D+04	.000D+00	.000D+00	.191D+13
468.00	.135D+00	.227D+08	.139D+04	.000D+00	.121D+05	.191D+13
480.00	.115D+00	.231D+08	.141D+04	.000D+00	.142D+05	.191D+13
492.00	.957D-01	.232D+08	.141D+04	.000D+00	.170D+05	.191D+13
504.00	.787D-01	.230D+08	.140D+04	.000D+00	.204D+05	.191D+13
516.00	.633D-01	.226D+08	.139D+04	.000D+00	.249D+05	.191D+13
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

540.00	.378D-01	.212D+08	.132D+04	.000D+00	.394D+05	.191D+13
552.00	.274D-01	.201D+08	.127D+04	.000D+00	.518D+05	.191D+13
564.00	.186D-01	.189D+08	.121D+04	.000D+00	.716D+05	.191D+13
576.00	.112D-01	.174D+08	.114D+04	.000D+00	.108D+06	.191D+13
588.00	.506D-02	.158D+08	.107D+04	.000D+00	.202D+06	.191D+13
600.00	.153D-03	.140D+08	.982D+03	.000D+00	.288D+07	.191D+13
612.00	-.369D-02	.122D+08	.896D+03	.000D+00	.271D+06	.191D+13
624.00	-.661D-02	.105D+08	.816D+03	.000D+00	.180D+06	.191D+13
636.00	-.874D-02	.900D+07	.744D+03	.000D+00	.150D+06	.191D+13
648.00	-.102D-01	.766D+07	.681D+03	.000D+00	.137D+06	.191D+13
660.00	-.111D-01	.653D+07	.628D+03	.000D+00	.384D+05	.191D+13
672.00	-.114D-01	.546D+07	.577D+03	.000D+00	.408D+05	.191D+13
684.00	-.114D-01	.446D+07	.530D+03	.000D+00	.432D+05	.191D+13
696.00	-.110D-01	.352D+07	.486D+03	.000D+00	.456D+05	.191D+13
708.00	-.104D-01	.266D+07	.445D+03	.000D+00	.480D+05	.191D+13
720.00	-.957D-02	.187D+07	.408D+03	.000D+00	.504D+05	.191D+13
732.00	-.860D-02	.115D+07	.374D+03	.000D+00	.528D+05	.191D+13
744.00	-.753D-02	.499D+06	.343D+03	.000D+00	.552D+05	.191D+13
756.00	-.643D-02	-.960D+05	.324D+03	.000D+00	.576D+05	.191D+13
768.00	-.533D-02	-.637D+06	.350D+03	.000D+00	.191D+06	.191D+13
780.00	-.429D-02	-.103D+07	.368D+03	.000D+00	.234D+06	.191D+13
792.00	-.332D-02	-.128D+07	.380D+03	.000D+00	.295D+06	.191D+13
804.00	-.245D-02	-.139D+07	.385D+03	.000D+00	.384D+06	.191D+13
816.00	-.168D-02	-.137D+07	.384D+03	.000D+00	.526D+06	.191D+13
828.00	-.101D-02	-.121D+07	.377D+03	.000D+00	.793D+06	.191D+13
840.00	-.442D-03	-.944D+06	.364D+03	.000D+00	.153D+07	.191D+13
852.00	.596D-04	-.577D+06	.347D+03	.000D+00	.698D+07	.191D+13
864.00	.517D-03	-.271D+06	.333D+03	.000D+00	.143D+07	.191D+13
876.00	.955D-03	-.717D+05	.323D+03	.000D+00	.930D+06	.191D+13
888.00	.139D-02	.000D+00	.320D+03	.000D+00	.722D+06	.191D+13

OUTPUT VERIFICATION

```
THE MAXIMUM MOMENT IMBALANCE FOR ANY ELEMENT      =  -.400D-05 IN-LBS
THE MAX. LATERAL FORCE IMBALANCE FOR ANY ELEMENT =   .234D-06 LBS

COMPUTED LATERAL FORCE AT PILE HEAD          =   .45000D+05 LBS
COMPUTED MOMENT AT PILE HEAD                 =   .13200D+06 IN-LBS
COMPUTED SLOPE AT PILE HEAD                  =  -.46138D-02

THE OVERALL MOMENT IMBALANCE                 =  -.173D-03 IN-LBS
THE OVERALL LATERAL FORCE IMBALANCE          =   .692D-06 LBS
```

OUTPUT SUMMARY

```
PILE HEAD DEFLECTION    =   .185D+01 IN
MAXIMUM BENDING MOMENT  =   .232D+08 IN-LBS
MAXIMUM TOTAL STRESS    =   .141D+04 LBS/IN**2
MAXIMUM SHEAR FORCE     =   .492D+05 LBS
NO. OF ITERATIONS       =         20
MAXIMUM DEFLECTION ERROR =  .776D-05 IN
```

PILE LOADING CONDITION

```
APPLIED MOMENT AT PILE HEAD      =   .000D+00 LBS-IN
LATERAL LOAD AT PILE HEAD        =   .120D+05 LBS
AXIAL LOAD AT PILE HEAD          =   .904D+06 LBS
```

X IN *****	DEFLECTION IN **********	MOMENT LBS-IN **********	TOTAL STRESS LBS/IN**2 **********	DISTR. LOAD LBS/IN **********	SOIL MODULUS LBS/IN**2 **********	FLEXURAL RIGIDITY LBS-IN**2 **********
.00	.376D+00	.000D+00	.320D+03	.000D+00	.000D+00	.191D+13
12.00	.364D+00	.155D+06	.327D+03	.000D+00	.000D+00	.191D+13
24.00	.352D+00	.310D+06	.334D+03	.000D+00	.000D+00	.191D+13
36.00	.340D+00	.465D+06	.342D+03	.000D+00	.000D+00	.191D+13
48.00	.328D+00	.620D+06	.349D+03	.000D+00	.000D+00	.191D+13
60.00	.315D+00	.775D+06	.356D+03	.000D+00	.000D+00	.191D+13
72.00	.303D+00	.930D+06	.364D+03	.000D+00	.000D+00	.191D+13
84.00	.291D+00	.108D+07	.371D+03	.000D+00	.000D+00	.191D+13
96.00	.279D+00	.124D+07	.378D+03	.000D+00	.000D+00	.191D+13
108.00	.268D+00	.139D+07	.386D+03	.000D+00	.000D+00	.191D+13
120.00	.256D+00	.155D+07	.393D+03	.000D+00	.000D+00	.191D+13
132.00	.244D+00	.170D+07	.400D+03	.000D+00	.000D+00	.191D+13
144.00	.233D+00	.186D+07	.407D+03	.000D+00	.000D+00	.191D+13
156.00	.222D+00	.201D+07	.415D+03	.000D+00	.000D+00	.191D+13
168.00	.210D+00	.217D+07	.422D+03	.000D+00	.000D+00	.191D+13
180.00	.199D+00	.232D+07	.429D+03	.000D+00	.000D+00	.191D+13
192.00	.188D+00	.247D+07	.436D+03	.000D+00	.000D+00	.191D+13
204.00	.178D+00	.263D+07	.444D+03	.000D+00	.000D+00	.191D+13
216.00	.167D+00	.278D+07	.451D+03	.000D+00	.000D+00	.191D+13
228.00	.157D+00	.293D+07	.458D+03	.000D+00	.000D+00	.191D+13
240.00	.147D+00	.309D+07	.465D+03	.000D+00	.000D+00	.191D+13
252.00	.137D+00	.324D+07	.473D+03	.000D+00	.000D+00	.191D+13
264.00	.128D+00	.339D+07	.480D+03	.000D+00	.000D+00	.191D+13
276.00	.118D+00	.355D+07	.487D+03	.000D+00	.000D+00	.191D+13
288.00	.109D+00	.370D+07	.494D+03	.000D+00	.000D+00	.191D+13
300.00	.101D+00	.385D+07	.501D+03	.000D+00	.000D+00	.191D+13
312.00	.922D-01	.400D+07	.508D+03	.000D+00	.000D+00	.191D+13
324.00	.841D-01	.415D+07	.516D+03	.000D+00	.000D+00	.191D+13
336.00	.762D-01	.430D+07	.523D+03	.000D+00	.000D+00	.191D+13
348.00	.687D-01	.445D+07	.530D+03	.000D+00	.000D+00	.191D+13
360.00	.615D-01	.460D+07	.537D+03	.000D+00	.000D+00	.191D+13
372.00	.547D-01	.475D+07	.544D+03	.000D+00	.000D+00	.191D+13
384.00	.482D-01	.490D+07	.551D+03	.000D+00	.000D+00	.191D+13
396.00	.421D-01	.505D+07	.558D+03	.000D+00	.000D+00	.191D+13
408.00	.364D-01	.520D+07	.565D+03	.000D+00	.000D+00	.191D+13
420.00	.311D-01	.535D+07	.572D+03	.000D+00	.000D+00	.191D+13
432.00	.262D-01	.550D+07	.579D+03	.000D+00	.000D+00	.191D+13
444.00	.216D-01	.565D+07	.586D+03	.000D+00	.000D+00	.191D+13
456.00	.176D-01	.580D+07	.593D+03	.000D+00	.000D+00	.191D+13
468.00	.139D-01	.594D+07	.600D+03	.000D+00	.663D+05	.191D+13
480.00	.107D-01	.596D+07	.601D+03	.000D+00	.841D+05	.191D+13
492.00	.797D-02	.584D+07	.595D+03	.000D+00	.109D+06	.191D+13
504.00	.566D-02	.560D+07	.584D+03	.000D+00	.147D+06	.191D+13
516.00	.378D-02	.524D+07	.567D+03	.000D+00	.206D+06	.191D+13
528.00	.229D-02	.476D+07	.544D+03	.000D+00	.311D+06	.191D+13
540.00	.116D-02	.418D+07	.517D+03	.000D+00	.535D+06	.191D+13
552.00	.349D-03	.352D+07	.486D+03	.000D+00	.136D+07	.191D+13
564.00	-.199D-03	.278D+07	.451D+03	.000D+00	.217D+07	.191D+13
576.00	-.537D-03	.211D+07	.419D+03	.000D+00	.106D+07	.191D+13
588.00	-.716D-03	.151D+07	.391D+03	.000D+00	.876D+06	.191D+13
600.00	-.782D-03	.101D+07	.367D+03	.000D+00	.845D+06	.191D+13
612.00	-.771D-03	.601D+06	.348D+03	.000D+00	.878D+06	.191D+13
624.00	-.715D-03	.291D+06	.333D+03	.000D+00	.956D+06	.191D+13
636.00	-.637D-03	.785D+05	.323D+03	.000D+00	.107D+07	.191D+13
648.00	-.553D-03	-.355D+05	.321D+03	.000D+00	.122D+07	.191D+13
660.00	-.471D-03	-.521D+05	.322D+03	.000D+00	.384D+05	.191D+13
672.00	-.394D-03	-.662D+05	.323D+03	.000D+00	.408D+05	.191D+13
684.00	-.322D-03	-.779D+05	.322D+03	.000D+00	.433D+05	.191D+13

696.00	-.255D-03	-.876D+05	.324D+03	.000D+00	.456D+05	.191D+13
708.00	-.195D-03	-.956D+05	.324D+03	.000D+00	.480D+05	.191D+13
720.00	-.142D-03	-.102D+06	.325D+03	.000D+00	.504D+05	.191D+13
732.00	-.974D-04	-.108D+06	.325D+03	.000D+00	.528D+05	.191D+13
744.00	-.606D-04	-.113D+06	.325D+03	.000D+00	.552D+05	.191D+13
756.00	-.323D-04	-.117D+06	.325D+03	.000D+00	.576D+05	.191D+13
768.00	-.128D-04	-.121D+06	.325D+03	.000D+00	.176D+08	.191D+13
780.00	-.249D-05	-.930D+05	.324D+03	.000D+00	.624D+08	.191D+13
792.00	.807D-06	-.423D+05	.322D+03	.000D+00	.153D+09	.191D+13
804.00	.904D-06	-.950D+04	.320D+03	.000D+00	.145D+09	.191D+13
816.00	.284D-06	.445D+04	.320D+03	.000D+00	.358D+09	.191D+13
828.00	.546D-09	.374D+04	.320D+03	.000D+00	.382D+11	.191D+13
840.00	-.759D-09	.273D+02	.320D+03	.000D+00	.337D+11	.191D+13
852.00	-.116D-13	-.101D+02	.320D+03	.000D+00	.284D+14	.191D+13
864.00	.239D-14	-.217D-03	.320D+03	.000D+00	.292D+14	.191D+13
876.00	.651D-19	.317D-04	.320D+03	.000D+00	.300D+14	.191D+13
888.00	-.143D-19	.000D+00	.320D+03	.000D+00	.308D+14	.191D+13

OUTPUT VERIFICATION

THE MAXIMUM MOMENT IMBALANCE FOR ANY ELEMENT = .808D-06 IN-LBS
THE MAX. LATERAL FORCE IMBALANCE FOR ANY ELEMENT = .497D-07 LBS

COMPUTED LATERAL FORCE AT PILE HEAD = .12000D+05 LBS
COMPUTED MOMENT AT PILE HEAD = .00000D+00 IN-LBS
COMPUTED SLOPE AT PILE HEAD = -.10204D-02

THE OVERALL MOMENT IMBALANCE = -.152D-04 IN-LBS
THE OVERALL LATERAL FORCE IMBALANCE = .793D-07 LBS

OUTPUT SUMMARY

PILE HEAD DEFLECTION = .376D+00 IN
MAXIMUM BENDING MOMENT = .596D+07 IN-LBS
MAXIMUM TOTAL STRESS = .601D+03 LBS/IN**2
MAXIMUM SHEAR FORCE = .129D+05 LBS
NO. OF ITERATIONS = 19
MAXIMUM DEFLECTION ERROR = .956D-05 IN

PILE LOADING CONDITION

APPLIED MOMENT AT PILE HEAD = .844D+07 LBS-IN
LATERAL LOAD AT PILE HEAD = .480D+05 LBS
AXIAL LOAD AT PILE HEAD = .433D+06 LBS

X	DEFLECTION	MOMENT	TOTAL STRESS	DISTR. LOAD	SOIL MODULUS	FLEXURAL RIGIDITY
IN	IN	LBS-IN	LBS/IN**2	LBS/IN	LBS/IN**2	LBS-IN**2
*****	**********	**********	**********	**********	**********	**********
.00	.286D+01	.844D+07	.551D+03	.000D+00	.000D+00	.191D+13
12.00	.277D+01	.905D+07	.580D+03	.000D+00	.000D+00	.191D+13
24.00	.268D+01	.967D+07	.609D+03	.000D+00	.000D+00	.191D+13
36.00	.259D+01	.103D+08	.638D+03	.000D+00	.000D+00	.191D+13

60.00	.241D+01	.115D+08	.696D+03	.000D+00	.000D+00	.191D+13
72.00	.232D+01	.121D+08	.725D+03	.000D+00	.000D+00	.191D+13
84.00	.224D+01	.127D+08	.754D+03	.000D+00	.000D+00	.191D+13
96.00	.215D+01	.134D+08	.783D+03	.000D+00	.000D+00	.191D+13
108.00	.207D+01	.140D+08	.812D+03	.000D+00	.000D+00	.191D+13
120.00	.198D+01	.146D+08	.841D+03	.000D+00	.000D+00	.191D+13
132.00	.190D+01	.152D+08	.870D+03	.000D+00	.000D+00	.191D+13
144.00	.182D+01	.158D+08	.898D+03	.000D+00	.000D+00	.191D+13
156.00	.174D+01	.164D+08	.927D+03	.000D+00	.000D+00	.191D+13
168.00	.166D+01	.170D+08	.956D+03	.000D+00	.000D+00	.191D+13
180.00	.158D+01	.176D+08	.985D+03	.000D+00	.000D+00	.191D+13
192.00	.151D+01	.182D+08	.101D+04	.000D+00	.000D+00	.191D+13
204.00	.143D+01	.188D+08	.104D+04	.000D+00	.000D+00	.191D+13
216.00	.136D+01	.195D+08	.107D+04	.000D+00	.000D+00	.191D+13
228.00	.128D+01	.201D+08	.110D+04	.000D+00	.000D+00	.191D+13
240.00	.121D+01	.207D+08	.113D+04	.000D+00	.000D+00	.191D+13
252.00	.114D+01	.213D+08	.116D+04	.000D+00	.000D+00	.191D+13
264.00	.108D+01	.219D+08	.119D+04	.000D+00	.000D+00	.191D+13
276.00	.101D+01	.225D+08	.121D+04	.000D+00	.000D+00	.191D+13
288.00	.947D+00	.231D+08	.124D+04	.000D+00	.000D+00	.191D+13
300.00	.884D+00	.237D+08	.127D+04	.000D+00	.000D+00	.191D+13
312.00	.824D+00	.243D+08	.130D+04	.000D+00	.000D+00	.191D+13
324.00	.765D+00	.249D+08	.133D+04	.000D+00	.000D+00	.191D+13
336.00	.708D+00	.255D+08	.136D+04	.000D+00	.000D+00	.191D+13
348.00	.653D+00	.261D+08	.138D+04	.000D+00	.000D+00	.191D+13
360.00	.600D+00	.267D+08	.141D+04	.000D+00	.000D+00	.191D+13
372.00	.549D+00	.273D+08	.144D+04	.000D+00	.000D+00	.191D+13
384.00	.500D+00	.279D+08	.147D+04	.000D+00	.000D+00	.191D+13
396.00	.453D+00	.285D+08	.150D+04	.000D+00	.000D+00	.191D+13
408.00	.408D+00	.291D+08	.153D+04	.000D+00	.000D+00	.191D+13
420.00	.365D+00	.297D+08	.155D+04	.000D+00	.000D+00	.191D+13
432.00	.325D+00	.303D+08	.158D+04	.000D+00	.000D+00	.191D+13
444.00	.287D+00	.309D+08	.161D+04	.000D+00	.000D+00	.191D+13
456.00	.252D+00	.315D+08	.164D+04	.000D+00	.000D+00	.191D+13
468.00	.218D+00	.320D+08	.166D+04	.000D+00	.842D+04	.191D+13
480.00	.187D+00	.324D+08	.168D+04	.000D+00	.984D+04	.191D+13
492.00	.159D+00	.324D+08	.168D+04	.000D+00	.116D+05	.191D+13
504.00	.133D+00	.322D+08	.167D+04	.000D+00	.138D+05	.191D+13
516.00	.109D+00	.317D+08	.165D+04	.000D+00	.165D+05	.191D+13
528.00	.881D-01	.310D+08	.162D+04	.000D+00	.202D+05	.191D+13
540.00	.693D-01	.300D+08	.157D+04	.000D+00	.250D+05	.191D+13
552.00	.527D-01	.288D+08	.151D+04	.000D+00	.317D+05	.191D+13
564.00	.383D-01	.273D+08	.144D+04	.000D+00	.416D+05	.191D+13
576.00	.260D-01	.256D+08	.136D+04	.000D+00	.574D+05	.191D+13
588.00	.156D-01	.237D+08	.127D+04	.000D+00	.868D+05	.191D+13
600.00	.699D-02	.215D+08	.117D+04	.000D+00	.163D+06	.191D+13
612.00	.198D-07	.192D+08	.106D+04	.000D+00	.221D+10	.191D+13
624.00	-.554D-02	.169D+08	.952D+03	.000D+00	.206D+06	.191D+13
636.00	-.980D-02	.148D+08	.852D+03	.000D+00	.138D+06	.191D+13
648.00	-.129D-01	.129D+08	.760D+03	.000D+00	.115D+06	.191D+13
660.00	-.151D-01	.111D+08	.679D+03	.000D+00	.384D+05	.191D+13
672.00	-.164D-01	.950D+07	.601D+03	.000D+00	.408D+05	.191D+13
684.00	-.171D-01	.796D+07	.528D+03	.000D+00	.432D+05	.191D+13
696.00	-.171D-01	.652D+07	.460D+03	.000D+00	.456D+05	.191D+13
708.00	-.166D-01	.519D+07	.398D+03	.000D+00	.480D+05	.191D+13
720.00	-.157D-01	.397D+07	.341D+03	.000D+00	.504D+05	.191D+13
732.00	-.145D-01	.287D+07	.289D+03	.000D+00	.528D+05	.191D+13
744.00	-.132D-01	.188D+07	.242D+03	.000D+00	.552D+05	.191D+13
756.00	-.116D-01	.995D+06	.200D+03	.000D+00	.576D+05	.191D+13
768.00	-.100D-01	.206D+06	.163D+03	.000D+00	.119D+06	.191D+13
780.00	-.840D-02	-.411D+06	.173D+03	.000D+00	.141D+06	.191D+13
792.00	-.681D-02	-.857D+06	.194D+03	.000D+00	.172D+06	.191D+13
804.00	-.529D-02	-.114D+07	.207D+03	.000D+00	.215D+06	.191D+13
816.00	-.385D-02	-.125D+07	.212D+03	.000D+00	.282D+06	.191D+13
828.00	-.251D-02	-.121D+07	.210D+03	.000D+00	.401D+06	.191D+13
840.00	-.125D-02	-.102D+07	.201D+03	.000D+00	.694D+06	.191D+13

852.00	-.783D-04	-.708D+06	.187D+03	.000D+00	.543D+07	.191D+13
864.00	.104D-02	-.335D+06	.169D+03	.000D+00	.851D+06	.191D+13
876.00	.214D-02	-.888D+05	.157D+03	.000D+00	.509D+06	.191D+13
888.00	.323D-02	.000D+00	.153D+03	.000D+00	.383D+06	.191D+13

OUTPUT VERIFICATION

THE MAXIMUM MOMENT IMBALANCE FOR ANY ELEMENT = -.527D-05 IN-LBS
THE MAX. LATERAL FORCE IMBALANCE FOR ANY ELEMENT = -.478D-06 LBS

COMPUTED LATERAL FORCE AT PILE HEAD = .48000D+05 LBS
COMPUTED MOMENT AT PILE HEAD = .84360D+07 IN-LBS
COMPUTED SLOPE AT PILE HEAD = -.76602D-02

THE OVERALL MOMENT IMBALANCE = .333D-04 IN-LBS
THE OVERALL LATERAL FORCE IMBALANCE = -.143D-05 LBS

OUTPUT SUMMARY

PILE HEAD DEFLECTION = .286D+01 IN
MAXIMUM BENDING MOMENT = .324D+08 IN-LBS
MAXIMUM TOTAL STRESS = .168D+04 LBS/IN**2
MAXIMUM SHEAR FORCE = .513D+05 LBS
NO. OF ITERATIONS = 22
MAXIMUM DEFLECTION ERROR = .759D-05 IN

1 91-0190,CENTER PILE,CPFREE.DAT

S U M M A R Y T A B L E
****

ATERAL LOAD (LBS)	BOUNDARY CONDITION BC2	AXIAL LOAD (LBS)	YT (IN)	ST (IN/IN)	MAX. MOMENT (IN-LBS)	MAX. STRESS (LBS/IN**2)
.450D+05	.132D+06	.904D+06	.185D+01	-.461D-02	.232D+08	.141D+04
120D+05	.000D+00	.904D+06	.376D+00	-.102D-02	.596D+07	.601D+03
480D+05	.844D+07	.433D+06	.286D+01	-.766D-02	.324D+08	.168D+04