

Geotechnical Software Update

**Mark McClelland
Bridge Division
Geotechnical Branch**

What program do you guys use for...

- ...slope stability?
- ...laterally loaded foundations?
- ...soil nail wall design?
- ...foundation design?
- ...pile driving analysis?

Slope Stability





Slope Stability

Two major “families” of programs-

- UTEXAS
 - Developed at University of Texas at Austin
- STABL
 - Developed at Purdue University

UTEXAS

- Original version developed on a TxDOT research project.
- Current version is UTEXAS3, with UTEXAS4 being developed.
- Has an “intelligent” search routine to seek out the most critical failure planes.

STABL

- Early versions were widely distributed in the public domain.
- Last major distribution was PCSTABL by FHWA.
- Has been the basis for many commercial software packages.
- Utilizes a random search technique and then reports lowest factors of safety.

Slope Stability

- Bridge Division is currently using GSTABL7 w/ STEDwin v. 2.004.
- Pharr District using WINSTABL.
- Still some old versions of UTEXAS and STABL in use.

Laterally Loaded Foundations



03/10/2004

WEST
290 TEXAS 71
Johnson City
Llano

LOOP 360
Capital of Tx Hwy

LOOP 343
Lamar Blvd
West Gate
Blvd

TH 1/4
1
Brook Lane
Southwest Pkwy

WEST
290 TEXAS 71
Johnson City
Llano

Capital of Tx Hwy

EAST
290
71 TEXAS
LEFT

EAST
290
71 TEXAS
RIGHT

MARKHAM



Laterally Loaded Foundations

- COM622, COM623, COM624
- COM624P (Still available at FHWA)
- LPILE
- FB-Pier

Name	Size	Type	Date Modified
AUTOEXEC.BAT	1 KB	MS-DOS Batch File	9/6/1995 11:23 AM
BANNER.EXE	15 KB	Application	4/30/1992 11:10 PM
C624EDIT.CFG	1 KB	CFG File	8/23/1996 1:26 PM
C624EDIT.EXE	98 KB	Application	12/15/1995 1:35 PM
C624EDIT.HLP	18 KB	Help File	3/30/1994 2:58 AM
C624VIEW.EXE	197 KB	Application	10/8/1993 3:41 PM
COM624P.EXE	209 KB	Application	12/14/1995 3:47 PM
			6/21/2002 10:59 AM
			6/22/1995 10:47 AM
			8/8/2007 1:09 PM
			2/11/1993 10:17 PM
			10/29/1992 2:15 AM
			5/6/1992 12:51 AM
			2/11/1993 10:15 PM
			4/25/1992 3:01 AM
			3/5/1993 11:54 PM
			8/8/2007 1:09 PM
			9/7/1993 3:20 AM
			5/6/1992 3:56 AM
			4/30/1992 10:54 PM
			5/9/1994 10:28 PM
			3/30/1994 2:50 AM
			12/14/1995 11:55 AM
			11/29/1989 8:37 PM
			12/14/1995 11:55 AM
			6/21/2002 10:59 AM

U:\COM624P\OPENMENU.EXE

File Input Run Graphics

This program is developed especially for Design and analysis of piles under lateral loading. The current version is 2.0

The selection of the FILE menu allows the user to access a pull-down menu for file operations such as assigning input file, output file, and graphics file, reading in an existing file, creating a new data file, checking files in the directory, and similar operations.

The selection of INPUT menu allows the user to access Program C624EDIT to create a data file or to edit an existing data file.

The selection of the RUN menu allows the user to execute the program with the specified input and output files.

The selection of the GRAPHICS menu allows the user to view the soil and pile response curves directly on the screen. The system must have graphics adapters such as CGA, EGA, VGA, or monographics adapter in order to view the graphics.

F1-Help Alt-X-Exit

PLOTDATA	6 KB	File	
UP1001.JUK	1 KB	JUK File	

L-Pile Plus 5.0.24 for Networks - Traffic 48 inch

File Data Options Plot Computation Graphics Tools Window Help



Pile Properties

Total: Pile-Head Boundary Conditions & Load...

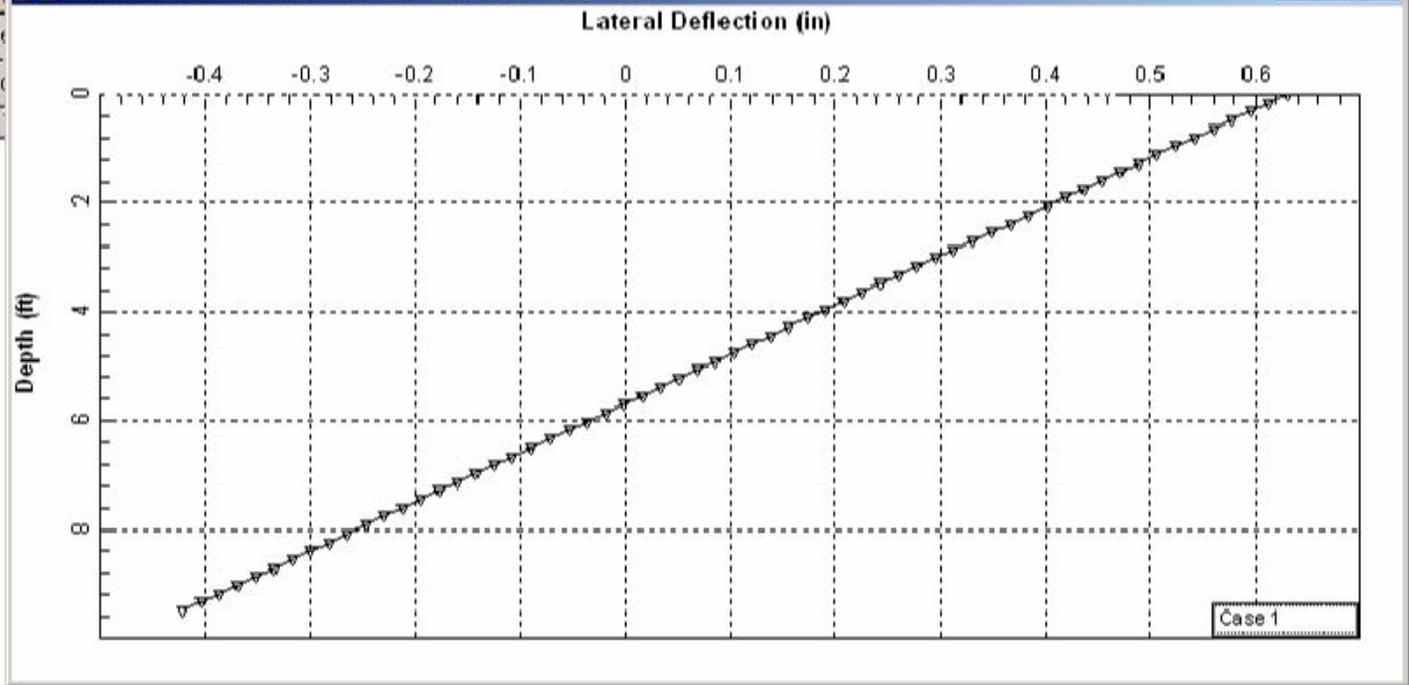
Num	Pile-Head Conditions	Condition 1	Condition 2	Axial Load (lbs)
1				

Soil Layers

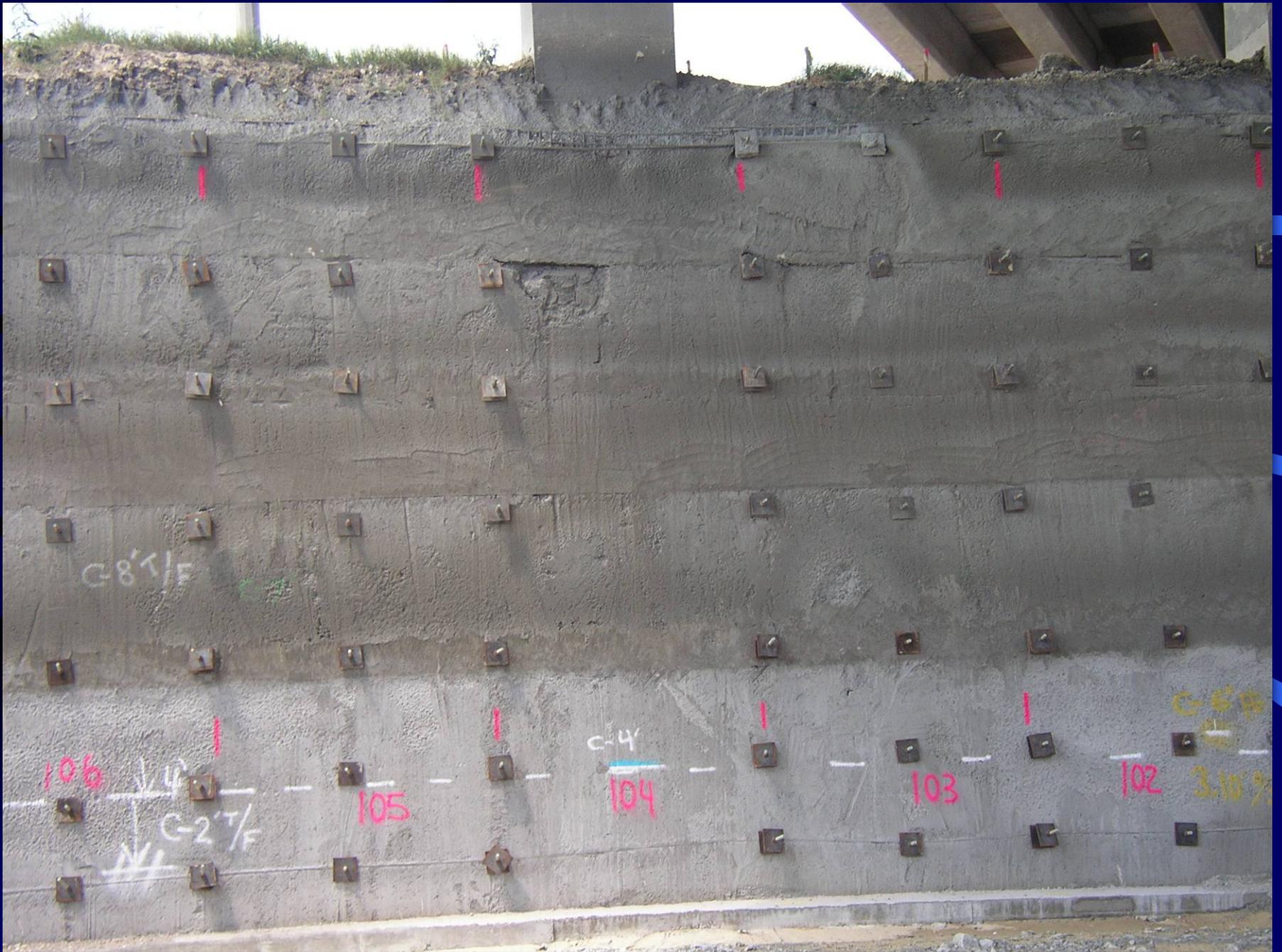
Layer	Soil Type (p-y curve model)	Top of Layer, (in)	Bottom of Layer, (in)	Properties of Layer
1	Stiff Clay w/o Free Water (Reese)	0	250	1: Stiff Clay w/o Free Water

Select a Condition
Condition
The Axial
Add R
To specif
To specif
All positive
If the pile-
negative c

Deflection Curves X: -0.31337, Y: 0



Soil Nail Wall Design



G-8 1/2

106

G-2 1/2

105

C-4

104

103

102

G-6 1/2

3.10



GoldNail is loaded.

X

Soil Nail Design and Analysis



GoldNail

386 Enhanced Mode
Math Co-processor present
Contiguous free memory: 16320K

Continue

Cancel

General Soils Loads
Geom. FOS Nails

General Data

Soil and Pullout Resistance Properties

Piezometric and Surcharge Pressures

Nail Locations and Properties

Safety Factors

Geometry

Nodal Data

Node	X	Y
1	10	33
2	10.01	20.5
3	21.5	11
4	21.6	10
5	70	10
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		

Segment Data

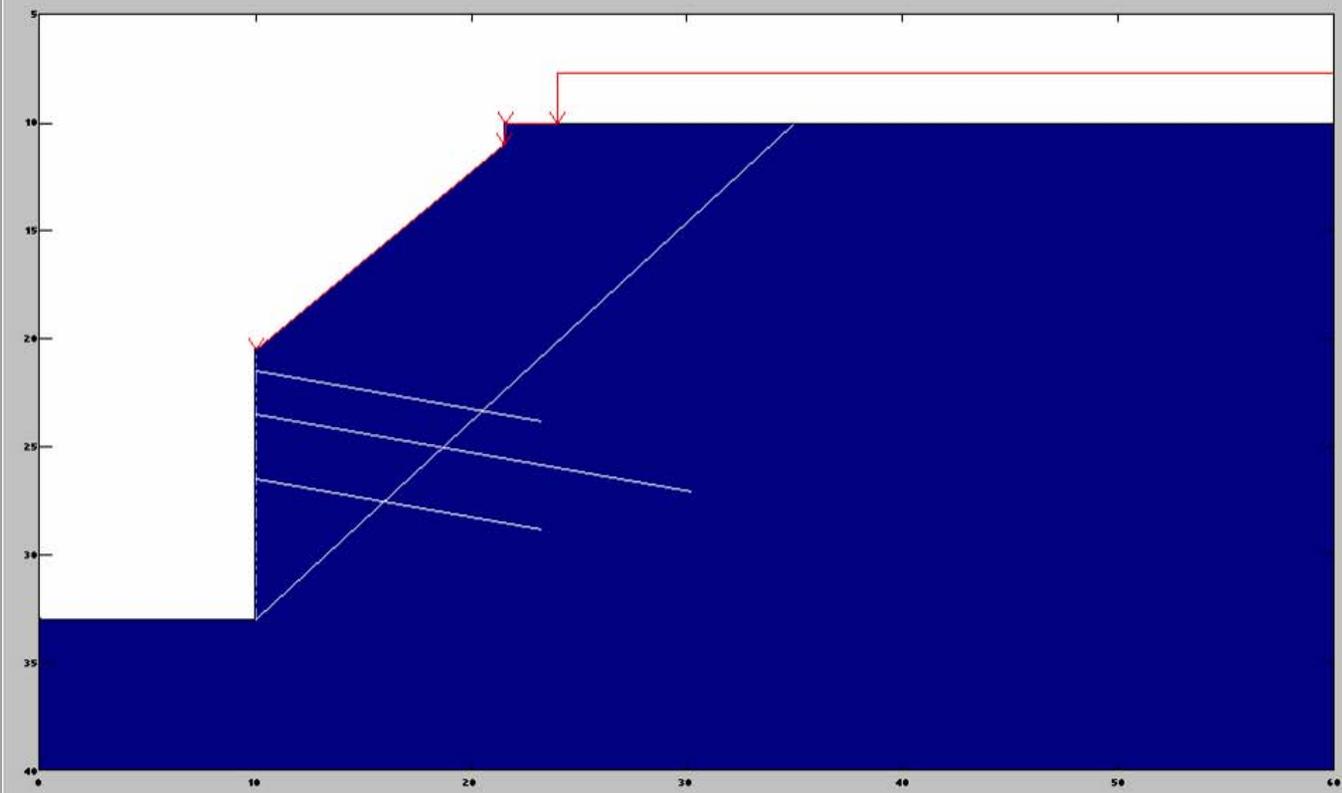
- Wall Segments
- Surface Segments
- Internal Segments

Node 1

Seg	Node 1	Node 2	Soil ID No.
1	1	2	1
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

					General	Soils	Loads
					Geom.	FOS	Nails

Nail pattern from results of GoldNail design analysis





PROJECT TITLE: Soil Nailed Bridge Abutment

Date: 08-08-2007

SnailWin 3.10

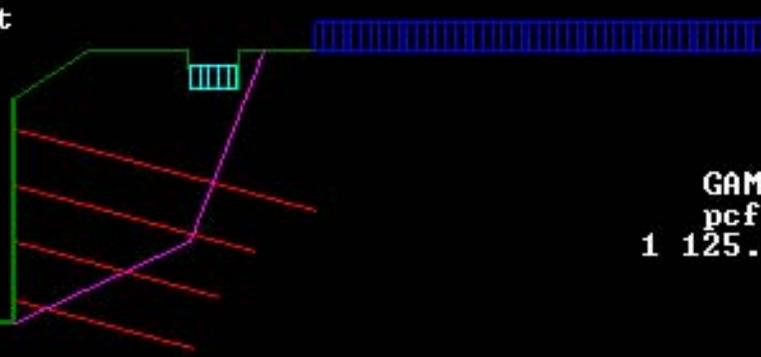
File: SM1

Minimum Factor of Safety = 1.66

20.0 ft Behind Wall Crest

0.0 ft Below Wall Toe

H = 18.0 ft



LEGEND:

PS = 30.0 Kips

FY = 36.0 Ksi

Sh = 5.0 ft

Sv = 4.5 ft

GAM	PHI	COH	SIG
pcf	deg	psf	psi
1	125.0	30	300
			7.0

Scale = 10 ft



Surcharge

100% Complete

Quit

Ioe

B/W

Zoom

Report

Copy

Print Graphics

1:04 PM

Foundation Analysis





WinCore Program



File Design Print Window Help



WinCore Program



Version 3.1



This program was developed by the Texas Department of Transportation. For technical support, call the Bridge Division Geotechnical Section at 512-416-2226 or Email at mmcclell@dot.state.tx.us

Press F1 For Help!



File Design Print Window Help



Project Data



Hole Input

Strata Input

TCP Input

TAT Input

County

Harris

Highway No.

Beltway 8 East

Control - Section -
Job

3256-02-908

District

Houston

Project Description

Structure

Channel Slope

Prepared:

Reviewed:

Input Units

 SI (Metric) English

Output Units

 SI (Metric) English



Project Data

Hole Input Strata Input TCP Input TAT Input

Strata Data

Strata No. _____

Laboratory Data

Hole No. Test No.

Test Depth	Confining Pressure	Deviator Stress	Moisture Content	Liquid Limit	Plasticity Index	Wet Density
<input type="text" value="4"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="14"/>	<input type="text" value="32"/>	<input type="text" value="18"/>	<input type="text" value="0"/>

Comments:

Depth	Lat. Press.	Dev. Str.	Moi. Cont.	LL	PI	Wet Dens.	Comments
1	0	0	14	32	18	0	% -200 = 64
4	0	0				0	very soft
6	5	18.1	14			135	
8	0	0	14			0	% -200 = 80
9	0	0				0	soft
15	0	0				0	soft
20	0	0				0	stiff
24	20	31.6	23			126	
25	0	0				0	stiff
---	---	---	---	---	---	---	

Hole No. _____

Primary Soil Type _____

Addl. Description _____

Design Type _____

Bottom Depth _____

Strata No.	Depth
1	
2	
3	4
4	9
5	15
6	20
7	25
	30
	35
	40
	45

DRILLING LOG



WinCore
Version 3.1

County Harris
Highway Beltway 8
CSJ N/A

Hole B-10
Structure Sam Houston Tollway
Station N/A
Offset N/A

District N/A
Date 02/17/07
Grnd. Elev. 0.00 ft
GW Elev. -18.00 ft

Boring Log

Elev. (ft)	LOG	Texas Cone Penetrometer	Strata Description	Triaxial Test		Properties				Additional Remarks
				Lateral Press. (psi)	Deviator Stress (psi)	MC	LL	PI	Wet Den. (pcf)	
5		32 (6) 42 (6)	CLAY, sandy, very stiff to hard, brown and gray							54 percent fines w/ sand pockets and roots -penetrometer- 3.0 tsf -penetrometer- 4.5+ tsf -penetrometer- 4.5+ tsf
		41 (6) 49 (6)								w/ sand pockets & partings @ 6' -penetrometer- 4.5+ tsf -penetrometer- 4.5+ tsf
10						8				w/ sand pockets below 10' 24 percent fines -penetrometer- 4.5+ tsf 15 percent fines -penetrometer- 4.5+ tsf
13		33 (6) 29 (6)	SAND, calyey, light gray (SC)							
17										SPT N- 16 9 percent fines
20		15 (6) 12 (6)	SAND, medium dense, light gray and tan, fine grained							SPT N-34 dense below 24'
25										w/ silt seams 37' w/ calcareous nodules below 28' 100 percent fines -penetrometer- 2.5 tsf
26		27 (6) 29 (6)	CLAY, very stiff, red (CL)							w/ silt at 33' -penetrometer- 4.5+ tsf
30										
35		26 (6) 28 (6)								
40										
45		22 (6) 25 (6)								w/ silt pockets at 43' -penetrometer- 4.5+ tsf
45		27 (6) 31 (6)								
50										
50		38 (6) 38 (6)				22				w/ CM layer & calcareous nods -penetrometer- 4.5+ tsf
52										
55										
60										

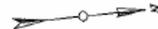
Remarks: Bore Caved to 18'. Upper Sand Layer Fell in, Switched to wet rotary

Any ground water elevation information provided on this boring log is representative of conditions existing on the day and for the specific location where this information was collected. The actual groundwater elevation may fluctuate due to time, climatic conditions, and/or construction activity.

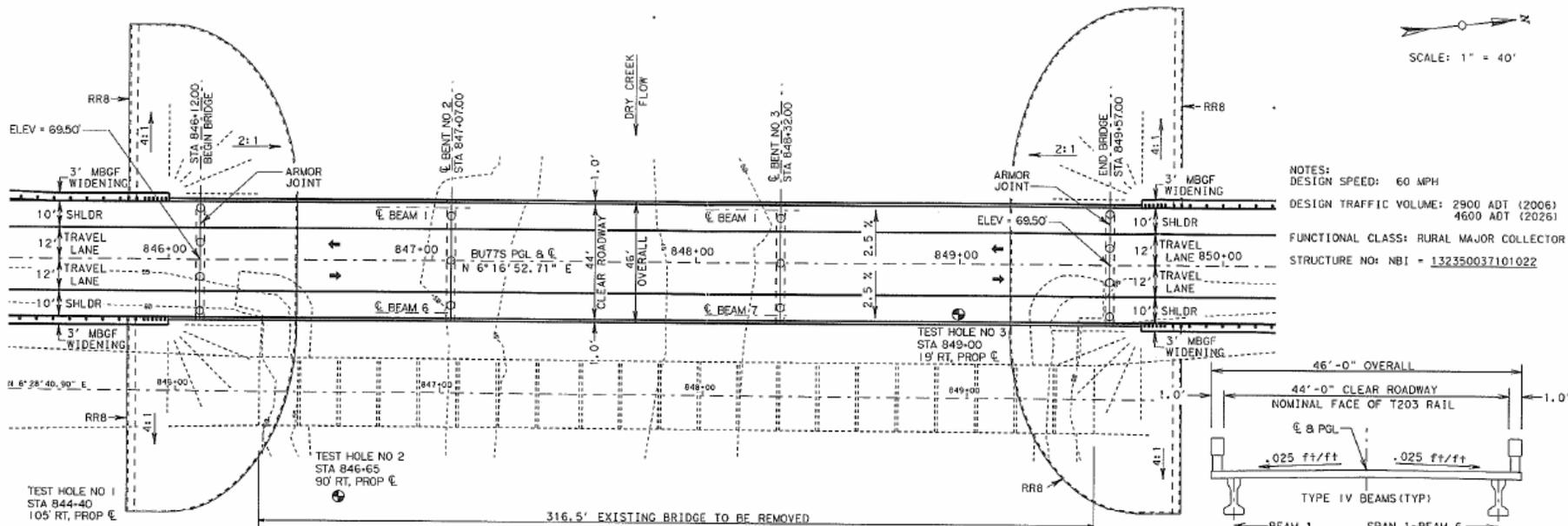
Driller: Gulf Coast Coring

Logger: E. Schulak

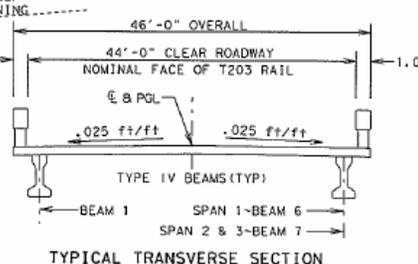
Organization: Fugro Consultants LP



SCALE: 1" = 40'

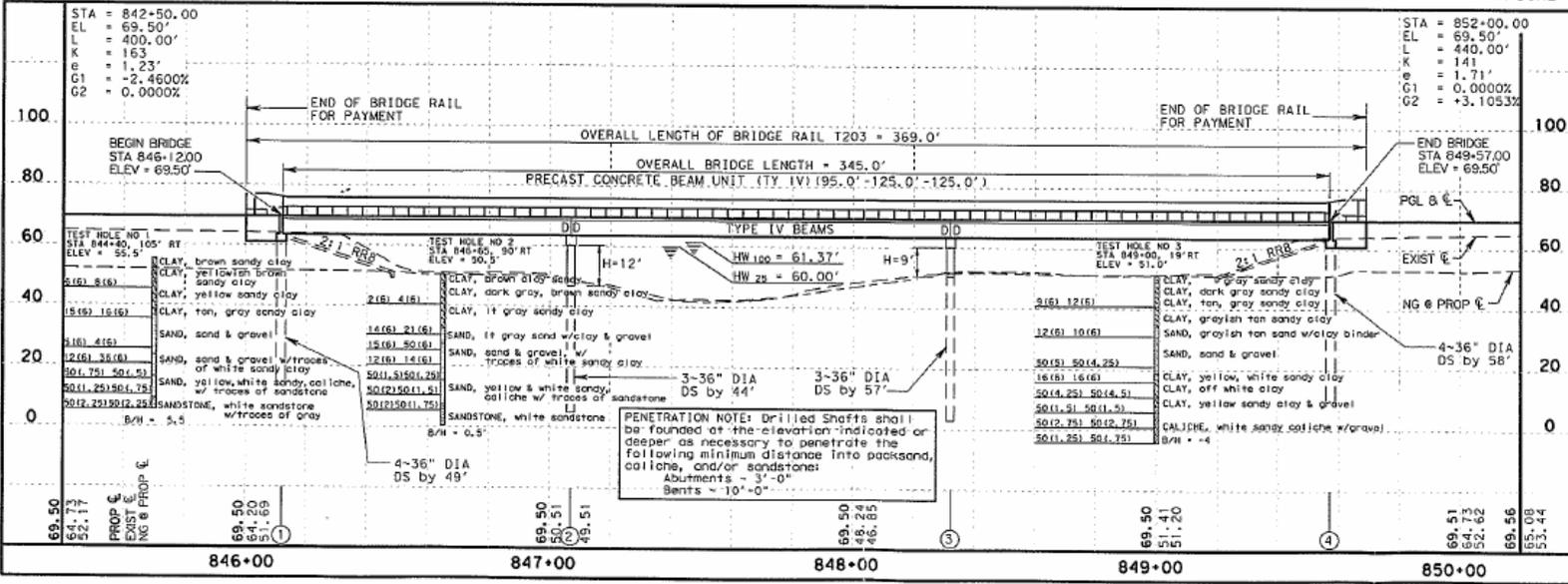


NOTES:
 DESIGN SPEED: 60 MPH
 DESIGN TRAFFIC VOLUME: 2900 ADT (2006)
 4600 ADT (2026)
 FUNCTIONAL CLASS: RURAL MAJOR COLLECTOR
 STRUCTURE NO: NBI = 132350037101022



ALL ABUTMENTS AND BENTS ARE NORMAL TO C/L

TYPICAL TRANSVERSE SECTION



**BRIDGE LAYOUT
 DRY CREEK**



Texas Department of Transportation
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PROJ. NO.	FEDERAL AID PROJECT NO.	SHEET NO.
6		
STATE	DIST.	COUNTY
TEXAS	YKM	VICTORIA
CONV. SECT.	JOB	HIGHWAY NO.
0371	01	079
		BU775

TEST HOLE NO 2
 STA 846+65
 90' RT, PROP C

TEST HOLE NO 1
 STA 844+40
 105' RT, PROP C

316.5' EXISTING BRIDGE TO BE R

ALL ABUTMENTS AND BENTS
 ARE NORMAL TO C

STA = 842+50.00
 EL = 69.50'
 L = 400.00'
 K = 163
 e = 1.23'
 G1 = -2.4600%
 G2 = 0.0000%

END OF BRIDGE RAIL
 FOR PAYMENT

BEGIN BRIDGE
 STA 846+12.00
 ELEV = 69.50'

OVERALL LENGTH OF BRIDGE RAIL T203 = 369.0'

OVERALL BRIDGE LENGTH = 345.0'
 PRECAST CONCRETE BEAM UNIT (TY IV) (95.0'-125.0'-1

TEST HOLE NO 1
 STA 844+40, 105' RT
 ELEV = 55.5'

6(6)	8(6)	CLAY, brown sandy clay
		CLAY, yellowish brown sandy clay
		CLAY, yellow sandy clay
15(6)	16(6)	CLAY, tan, gray sandy clay
5(6)	4(6)	SAND, sand & gravel
12(6)	36(6)	SAND, sand & gravel w/traces of white sandy clay
50(1.25)	50(1.5)	SAND, yellow, white sandy, caliche, w/ traces of sandstone
50(2.25)	50(2.25)	SANDSTONE, white sandstone w/traces of gray

B/H = 5.5

2:1
 PRB

TEST HOLE NO 2
 STA 846+65, 90' RT
 ELEV = 50.5'

2(6)

4(6)

14(6)

21(6)

15(6)

50(6)

12(6)

14(6)

50(1.5)

50(1.25)

50(2)

50(1.5)

50(2)

50(1.75)

B/H = 0.5'

CLAY, brown clay sandy

CLAY, dark gray, brown sandy clay

CLAY, lt gray sandy clay

SAND, lt gray sand w/clay & gravel

SAND, sand & gravel, w/ traces of white sandy clay

SAND, yellow & white sandy, caliche w/ traces of sandstone

SANDSTONE, white sandstone

DD

TYPE IV BEAMS

H=12'

HW 100 = 61.37'

HW 25 = 60.00'

H=9'

3-36" DIA
 DS by 44'

3-36" DIA
 DS by 57'

4-36" DIA
 DS by 49'

PENETRATION NOTE: Drilled Shafts shall be founded at the elevation indicated or deeper as necessary to penetrate the following minimum distance into paksand, caliche, and/or sandstone:
 Abutments ~ 3'-0"
 Bents ~ 10'-0"

69.50
 64.73
 52.17

PROP C
 EXIST C
 NG @ PROP C

69.50
 64.20
 51.69

69.50
 50.51
 49.51

69.50
 48.24
 46.85

Design Options:

- Disregard Depth
- Skin Friction Limit
- TCP / TAT
- Drilling Disturbance Reduction
- Point Bearing Look Ahead
- Disregard Soft Layers Above Hard Layers

Foundation Design

Hole No.

Top Hole Elev. = 477.6

Foundation Size (in)

Foundation Load (tons)

Disregard to Elev. (ft)

Friction Limit (tsf)

Friction Plots Mohr Plots

Point Bearing Capacity

Foundation Type

Piling

Drilled Shaft

Geometry

Round

Square

Analysis Options

TCP Only TAT Preferred

Use Maximum Use Minimum

Use TCP/TAT Average

Soil Reduction Factor

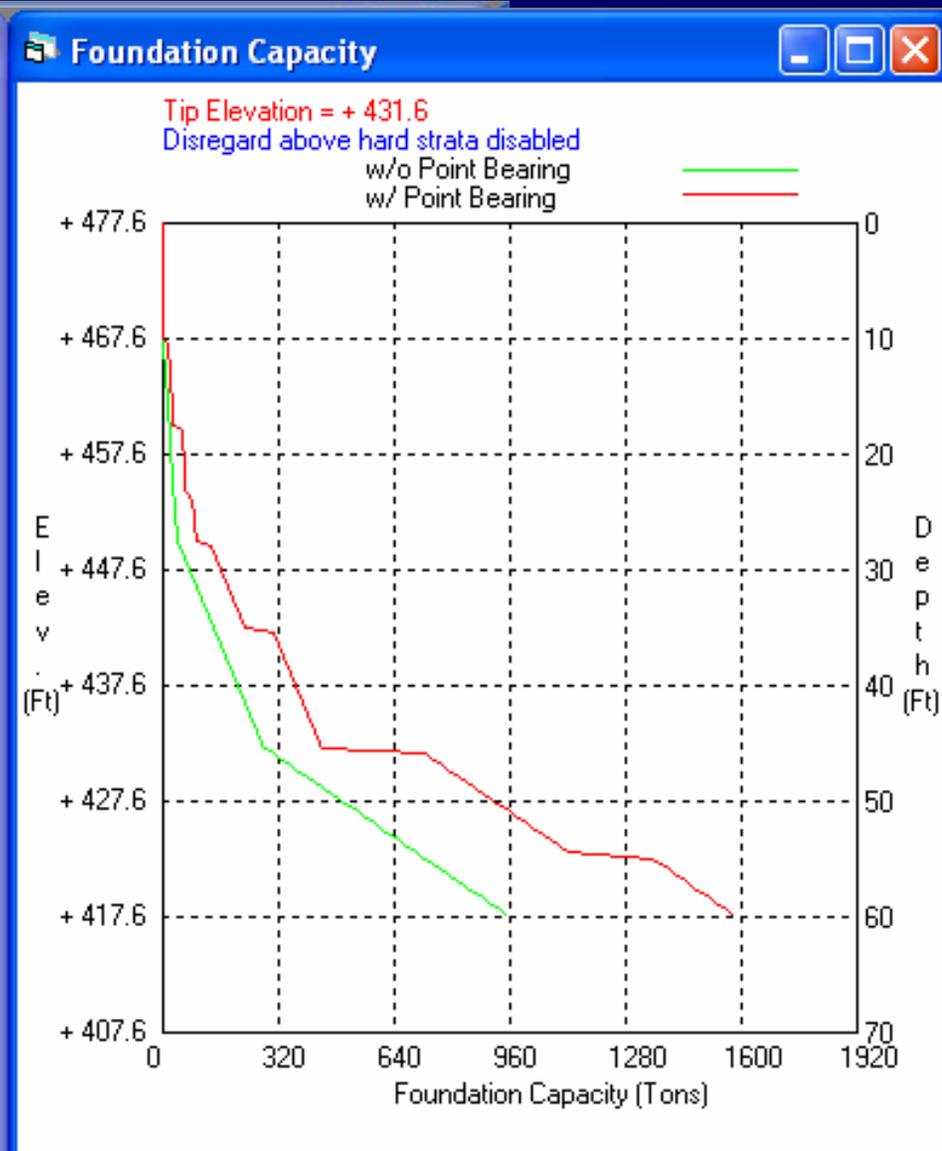
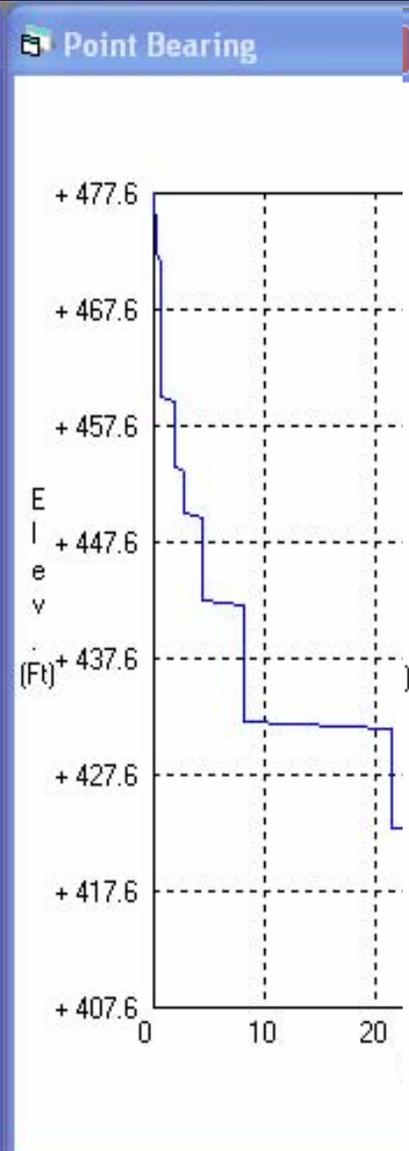
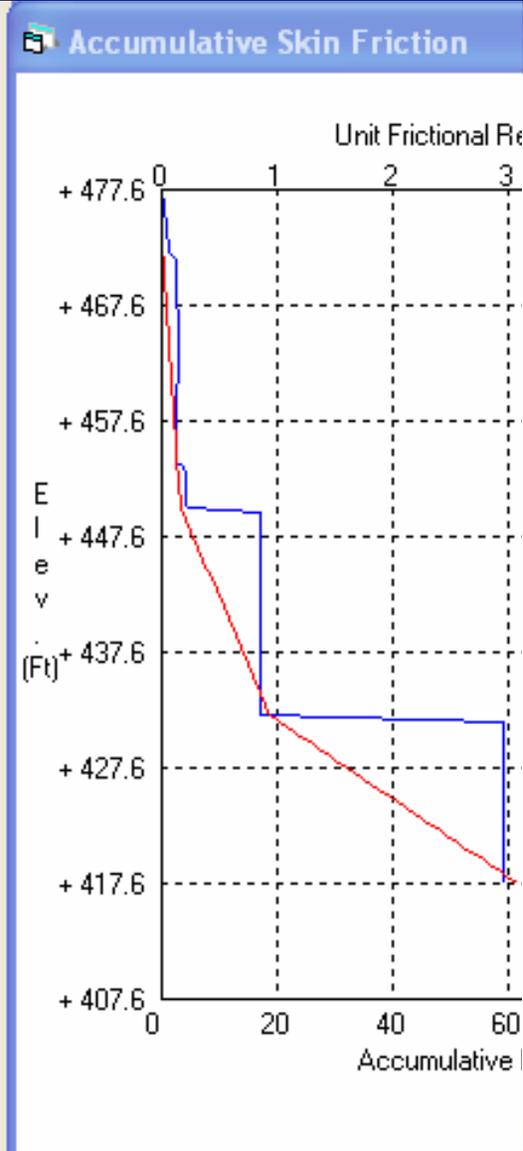
.5 .6 .7 .8

Point Bearing Influence (Diameters)

0 1 1.5 2 3

Below Design Depth (Ft)	Design Type	Factor	TCP N Value	TCP Unit Friction (TSF)	Accum. Friction (T/F)
0	OTHER	80	16	0.14	0
6	SC	70	22	0.22	0.84
13	SC	70	25	0.25	2.38
17	CH	50	35	0.49	3.38
24	OTHER	80	49	0.43	6.81
28	OTHER	80	80	0.7	8.52
35.5	OTHER	80	150	0.85	13.77
46	OTHER	80	400	2.25	22.7
55	OTHER	80	600	3.25	42.94
60	OTHER	80	600	3.25	59.19

Design Output



Pile Driving Analysis

Pile Driving Analysis

Two major programs developed in the late 1960's and early 1970's-

- TTI Program
 - Developed at University of Texas at Austin
- Wave Equation Analysis of Piling (WEAP)
 - Developed by George Goble and Frank Rausche
- Both programs were distributed by FHWA beginning mid-1970's.

76-13.2

Implementation Package

Volume II – Computer Program and Sample Problems

TTI PROGRAM

USER'S MANUAL

PILE DRIVING ANALYSIS WAVE EQUATION



U.S. DEPARTMENT OF TRANSPORTATION
Federal Highway Administration
Offices of Research and Development
Implementation Division
Washington, D.C. 20590

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76-14.1 Implementation Package

WAVE EQUATION ANALYSIS OF PILE DRIVING

WEAP PROGRAM

Volume I – Background



U.S. DEPARTMENT OF TRANSPORTATION
Federal Highway Administration
Offices of Research and Development
Implementation Division
Washington, D.C. 20590

D-5
TECHNICAL LIBRARY
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VOL I
EXTRA



Pile Driving Analysis

- WEAP program developed more completely to automatically model diesel hammers.
- Evolved into WEAP 86 and PCWEAP87
- Bridge Division is currently using GRLWEAP 2005



OUTPUT.TXT - Notepad

File Edit Format View Help

```

1          ECHO PRINT OF INPUT DATA

    EL PASO ANTHONY 45' PILE
    0 0 6 0 0 0 17 0 0 0 95 0 7 0 1 0 0 0
    2.500 284.000 280.0 2.000 .800 .010 .0
    .000 .0 .000 .500 .010 .0
    45.000 15.500 30000.000 490.000 1.000 .010
DEL MAG D 22 1 3 0
    4.9100 111.6900 15.3300 8.2700 4.0300 .8000
    1.6000 24.7000 15.3300 .9000 .0100
    11.2200 184.5800 197.7000 .0020 .0020 1.3500 .0000 .0000
    14.70 1200.00 .00 .00 .00 .00 1
    .0000 .0000 .0000 .0000 .0000
    .100 .100 .050 .150
    50.0 100.0 150.0 200.0 250.0 300.0 350.0
    400.0 .0 .0
  
```

```

1 WEAP87: WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS
    1987, VERSION 3.00
  
```

EL PASO ANTHONY 45' PILE

HAMMER MODEL OF: D 22 MADE BY: DELMAG

ELEMENT	WEIGHT (KIPS)	STIFFNESS (K/IN)	COEFF. OF RESTITUTION	D-NL. FT	CAP DAMPG (K/FT/S)
1	1.637				
2	1.637	143773.6	1.000	.0100	
3	1.637	143773.6	1.000	.0100	
IMP. BLK	1.600	86431.3	.900	.0100	
CAP/RAM	2.500	39760.0	.800	.0100	9.2

HAMMER OPTIONS:

HAMMER NO.	FUEL SETTG.	STROKE OPT.	HAMMER TYPE	DAMPNG-HAMR
6	1	0	1	2

HAMMER PERFORMANCE DATA

RAM WEIGHT (KIPS)	RAM LENGTH (IN)	MAX STROKE (FT)	STROKE (FT)	EFFICIENCY
4.91	111.69	8.27	4.03	.800

MAX PRESS. (PSI)	ACT PRESS. (PSI)	TIME DELAY (S)	COMP/EXPN V	START INJ. (IN3)
1200.0	1200.0	.00200	1.350/1.350	.0

THE HAMMER DATA INCLUDES ESTIMATED (NON-MEASURED) QUANTITIES

HAMMER CUSHION	AREA (IN2)	E-MODULUS (KSI)	THICKNESS (IN)	STIFFNESS (KIPS/IN)
	284.00	280.0	2.000	39760.0

```

1 PC-WEAP87 REVISED JUNE, 1988 FHWA EL PASO ANTHONY 45' PILE
  
```

FM 2031 @ GIWW.gww

FM 2031 at GIWW, Bent 3

Hammer Information
Select from following list [4/6/2006-2003]: ID: 26

ID	Name	Type	Ram Wt	Energy/Power
25	DELMAG D 46-23	OED	10.140	107.078
26	DELMAG D 46-32	OED	10.140	122.187
27	DELMAG D 55	OED	11.860	125.004

Hammer parameters
Efficiency: 0.8
Pressure: 1525.0 psi Fixed 100 %
Stroke: 12.05 ft Variable of Max

File material
 Concrete Steel Timber

Cushion Information
Hammer Pile
Area: 415 400 in²
Elastic Modulus: 530 60 ksi
Thickness: 2 6 in
C.O.R.: 0.8 0.5
Stiffness: 0 0 kips/in
Helmet Weight: 3.6 kips

File Information
Length: 75 ft Auto Segments
Penetration: 75 ft Auto S-Length
Section Area: 400 in² Auto S-St. Wt
Elast Modulus: 4000 ksi
Spec Weight: 150.0 lb/ft³
Toe Area: 400 in² 0 Splices
Perimeter: 6.67 ft File Type:
Pile Size: 20 in Unknown

Ultimate Capacities (up to 10) kips

1	100.0	6	600.0
2	200.0	7	700.0
3	300.0	8	800.0
4	400.0	9	900.0
5	500.0	10	1000.0

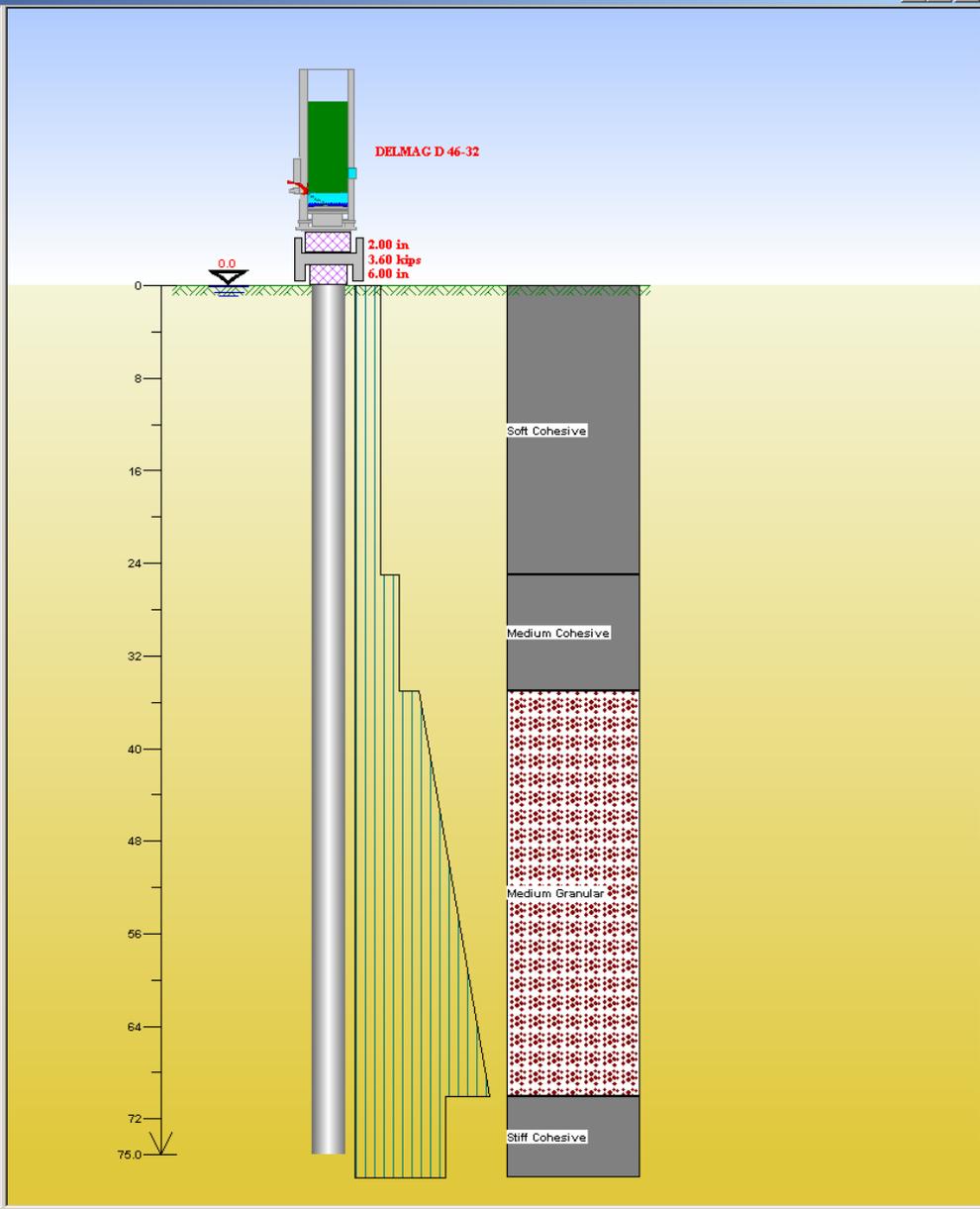
Incr: 0 Action >>

Soil Parameters
Quake
Shaft: 0.1 in Const
Toe: 0.333 in

Damping
Shaft: 0.096 s/ft Const
Toe: 0.15 s/ft Smith

Shaft Resistance Percentage: 89 %
Dist. Shape Num: 0.0

Residual Stress Analysis: No



Bridge Division

Geotechnical Branch

- Mark McClelland 512-416-2226
- Marcus Galvan 512-416-2224
- John Delphia 512-416-2359
- Dina Dewane 512-416-2550
- Scott Walton 512-416-2554
- Fidencio Gonzalez 512-416-2573