CAPWAPC DEVELOPMENTS AND RECOMMENDATIONS

By

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Cleveland, Ohio

CAPWAPC DEVELOPMENTS AND RECOMMENDATIONS

INTRODUCTION

The improved speed and capacity of PC compatibles has made the Capwapper's life a lot more agreeable. With a 386-type machine, 20 MHz clock rate and co-processor, a 5 s analysis cycle is typical for short land piles. The new CAPWAPC utilizes the availability of graphics capabilities to fully take advantage of the higher computational speed. The "thinking" interruption is therefore more time consuming than the analysis itself. In fact, input preparation and output plotting may now cost as much time as the analysis itself. A total analysis time of 2 hours seems to be the upper limit with good equipment. A one-hour analysis duration can be achieved.

As hardware and software yield greater and greater time savings, it becomes even more important to approach the final result as directly as possible without many repeat trials. In order to accomplish an optimal analysis procedure the following three steps must be taken.

- o Preparation: Data Check, Pile Model Check
- o Record Classification
- o Matching

PREPARATIONS

The CAPWAP procedure has not changed much, but the availability of screen graphics allows for a very thorough and systematic record investigation before the actual matching process starts. Thus, as a first step, the time scale should be made large and the final analysis time set to maximum. Then a force, velocity, wave (FW) plot should be made and the following be checked.

- o 2L/c reflection. Verify wave speed and/or length.

- Proportionality considering friction and pile non-uniformities.

- Diesel hammer precompression phase, again considering resistance of pile. For example, velocity may be higher than force in <u>very</u> easy driving. Use AA12 if absolutely needed.

- Final displacement. Use ACAS if needed. However, consider whether significant displacement/velocity changes occur at the end of the record. Then an adjustment to permanent set is not necessarily reasonable.

The pile model also may require adjustments. For nonuniform piles, real impedance changes may need to be more gradual than real. Splices are most easily modeled with impedance reductions. Use of the splice model may not be a very attractive alternative because of its transitionless open-closed behavior. Often, pile model adjustments must be made during the matching process. This is particularly true for drilled shafts with outgrowth and/or necking.

<u>Record Classification</u>

Depending on the record appearance and blow count, a classification can be made. Important categories are: low, normal and high blow count and friction, end bearing or mixed resistance piles.

<u>Resistance Matching</u>

(I) Very low blow count records (up to 50 bpm)

They are usually easily matched but they may yield unreliable capacity results since the linear damping assumption may produce errors. High velocity returns make it important that the exact wave speed is found. In the case of cracks, the first effort must be directed at a proper pile model.

(ii) Normal blow count records (50 to 300 bpm)

(a) Friction

Most end bearing parameters need not be tried and this leads to a rather significant simplification of the matching process. Results are reliable in most soil types. Of course, it is important that restrike records be used for capacity predictions. Starting with low damping (.15 s/m) and alternatingly increasing damping and redistributing will quickly lead to satisfactory results. The automatic procedure often produces usable results.

(b) End Bearing - Non-Displacement Piles

This pile type usually does not present unusual problems since it is probably driven into a rock. For very low friction a gap may be necessary. Again starting with minimal damping and replacing resistance with damping until a best match is found produces the solution most efficiently. However, the quakes are usually small. The unloading portion may be matched with quake, unloading quake or bottom dashpot adjustments (in that order).

(c) End Bearing - Displacement Piles

This pile type poses difficult problems. It is often used in fine sands where the difficulties are compounded by temporary, negative pore water pressure increases. Problems primarily occur because of the non-linear nature of the end bearing. Often differentiation between damping and static resistance is difficult. The PEBWAP plot is a smooth round curve which reaches a force peak when the displacements are still increasing. Thus, with further increasing displacements, the resistance decreases. This curve is typical regardless of damping, i.e., the dampened resistance displacements curves are similar to the J = 0 curve.

Apparently, the elasto-plastic model then poorly represents the actual soil behavior. In order to solve these problems it may be necessary to decide on a reasonable range of damping factors (may be from experience) and then attempt a match within these bounds. Naturally, toe quakes will be high and unloading quakes are often very low. Blow count matching may not be successful since rebounding may occur over a long time after impact and after the static resistance has dropped to low values.

In this category of records practically all toe model parameters are usually tried. Toe gap and/or quake adjustments are quickly solved for from the loading cycle. If a large quake or a toe gap is needed then the Smith type toe damping should be tried in order to delay the damping forces. Damping parameters must then be chosen rather high (damping will only be active late when pile velocities have become small). For unloading ,the CRto or the Soil support dashpot may be tried. Note that the latter parameter causes slow activation and the full capacity may not be mobilized even though the pile toe has moved a distance exceeding the sum of gap and quake.

(d) Friction plus End Bearing

This is the most common pile type with friction accounting for 15 to 85% of total capacity. Higher friction percentages usually make the matching process easier. The most critical part of the matching process is the assignment of the proper skin and toe damping parameters. Often distinction between these two parameters is difficult at best. Here is a case where knowledge about soil types may be helpful allowing the establishment of certain bounds on damping constants. It is again recommended to start the matching process with low damping values to reduce capacity on skin and toe simultaneously as needed. If it is apparent that more damping is needed and that toe damping increases would destroy the match at 2L/c, then the damping choices are simplified.

(iii) Very high blow count records (higher than 300 bpm)

Regardless of the type of soil resistance the matching process becomes more complex as pile penetrations become small. The main reason is the non-linear soil resistance behavior within the displacement range of the test. Even the ground motion has an effect on the static resistance. Pile velocities may be very low and multiplication with common damping factors yields a low dynamic resistance and thus little damping effect. Damping factors therefore may be higher than usual. Predicted quakes may be lower than usual near the bottom of the pile. (Of course, these quakes are only lower bounds like the corresponding capacity). Finally, for mixed end bearing and friction piles, a residual soil resistance may develop.

It is sometimes indicated that unloading quakes are higher than loading quakes and the analyzing engineer is tempted to use CRto>1. Such an energy producing device may only be allowable (a) when using a gap (toe quake + gap are "really" the correct loading quake), (b) when the real soil motion (assumed to be zero) is negative (upwards) during the pile rebound period.

TWO EXAMPLES OF UNUSUAL SITUATIONS

Example 1: "Incorrect" Pile Length

A CAPWAP analysis was performed for a PDA user. He submitted the usual data sheet (Appendix A) which indicated a pile length of 7.2 m below gages. The pile was a closed end pipe and inspection revealed that it was undamaged at the end of driving. The pile was driven through silt into glacial till. It did not reach bedrock. For those unfamiliar with glacial till it may be mentioned that this material may contain all types of grain size from clay to boulder.

The data submitted was from a restrike with a 7 ton drop hammer. A 5 mm/blow penetration was measured. Records of force and velocity (sheet 2, App. A) indicated a very high friction near the toe or a high end bearing. Matching produced a good agreement over the first part of the record, however, after the resistance peak (at about 2L/c) it was not possible to bring the computed force curve as far down as the measured one (see matches).

A more thorough inspection of the record revealed a very clear tensile reflection at approximately 3L/c. It was therefore argued that the pile had contacted a relatively large boulder which moved with the pile. A model was then constructed (sheets 8, 9) with a "concrete pile bottom" added underneath the steel pipe. This new model was easily matched and produced reasonable capacity results. Note that the total CAPWAP capacity prediction (1860 vs 1810 kN) did not significantly change, however, the RSP Case Method was strongly affected.

Example 2: Smith Toe Damping

Traditionally, CAPWAPC uses a viscous soil damping model. Thus, the damping resistance, R_d, can be calculated from pile velocity, v, and the viscous damping factor, J_v, as

$$R_d = J_v v$$

The Smith definition, on the other hand, calculates

$$R_d = J_s v R_s$$

where J_s is the Smith damping factor [s/m] and R_s is the temporary static resistance force. In CAPWAPC a conversion is done at the end of the analysis from viscous to Smith damping factors, using R_u, the ultimate resistance, instead of R_s. Then

$$J_s = J_v / R_u$$

For most CAPWAPC problems the viscous approach is superior to the Smith definition since the Smith definition produces a phase shift between static and dynamic resistance and higher damping values at low static resistance values. The former reason allows for a relatively clear distinction between static and dynamic resistance, the latter simulates the typically heavily dampened records.

There is one instance when the Smith approach is superior to the viscous one and that is when a toe gap exists. Then a damping force cannot exist before the static one, a situation which is correctly represented by Smith's approach.

In the case of a 20x20 inch prestressed concrete pile of 83 ft length below gages, the Smith toe damping option was particularly helpful when the best match with normal viscous damping was really not bad (MQ 4.5, see sheets 2 through 4 in Appendix B). However, the computed blow count was only 36 instead of 80 blows/ft. The total capacity could not exceed 480 kips or the match after 2L/c would be bad. On the other hand, with Smith damping, high damping plus high static resistance could be chosen for a good match and a perfect blow count agreement (App. B, sheets 5 through 8). Note that high Smith damping factors do not necessarily mean high damping forces when a gap is present. With Smith damping the total predicted capacity was then 590 kips which was in good agreement with bearing capacities of other piles at the same site driven similarly.

HELPFUL HINTS FOR CAPWAPC USERS

- o Data files can now be referenced across directories.
- o File 18 are now shorter and data plus results can be stored at relative ease with different job related names. Use .18 extension to distinguish this file type from others.
- o At end of analysis do a test on capacity by trying 10% higher and lower capacity values.

WARNINGS

- o Unit skin friction results only correct for uniform piles.
- o The match quality should not be overrated, after all, we are working with an imperfect soil model. Blow count and realism of soil parameters must be considered as well.
- o Going back to best match (option in "Best Match" display) is only valid for quantities listed on screen. Data adjustments or pile model changes would not be included.
- o When using a soil support dashpot, full activation of toe resistance may not be achieved even though the maximum toe displacement is greater than the sum of toe quake and toe gap.

FUTURE SOFTWARE IMPROVEMENTS

- o Improved auto-resistance distribution in the presence of high skin damping.
- o Static resistance (R_u) increases/decreases during blow.
- o Residual stress?
- o Improved automatic matching for end bearing piles.

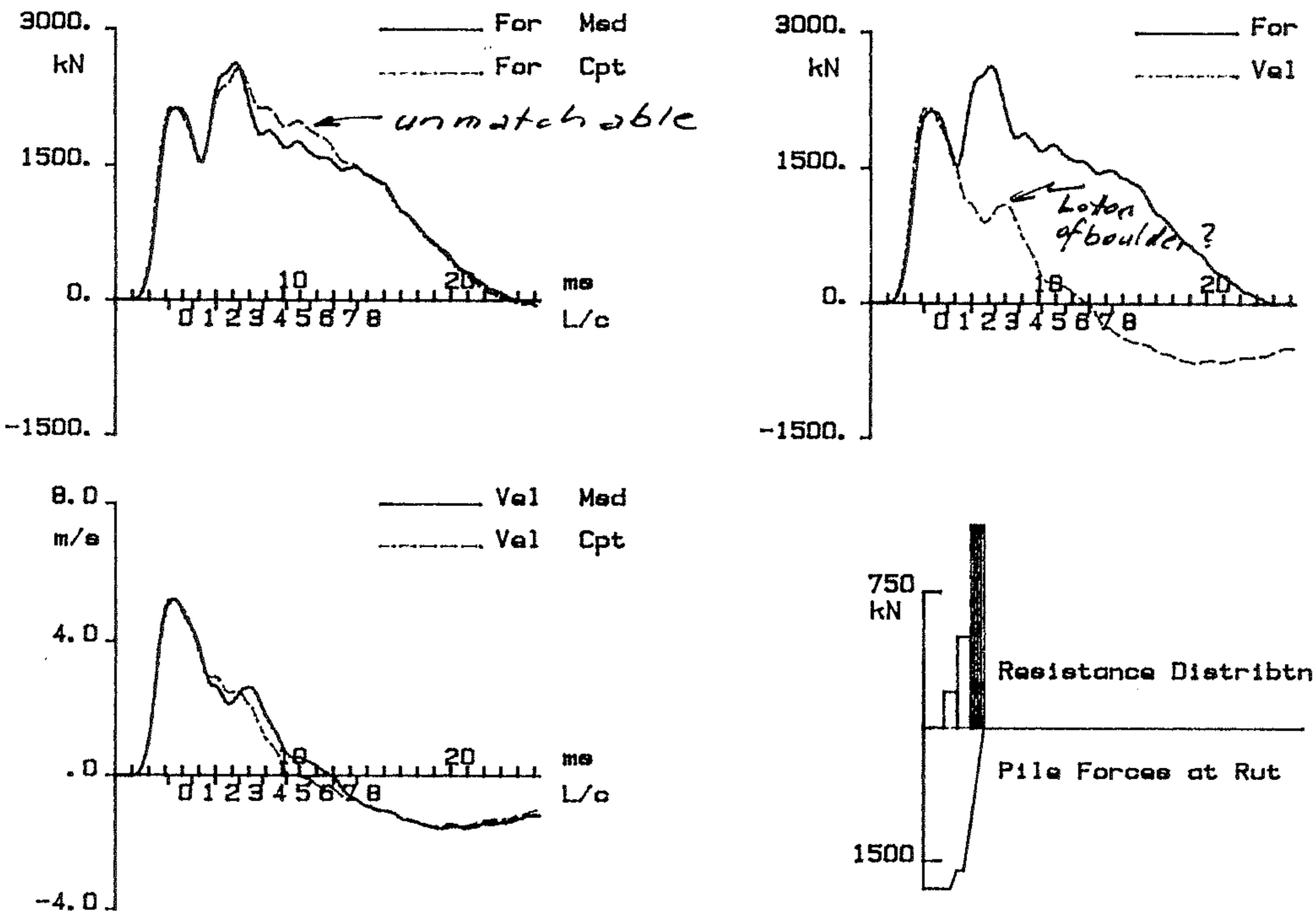
APPENDIX A

EXAMPLE 1

Demo

CAPWAPC - GRL & Associates, Inc.

Blow 5 10-Dec-87



Just as a demo!
Regular Model

CAPWAPC - GRL & Associates, Inc.

Blow No 5 10-Dec-87

Final CAPWAPC Capacity: Ru 1810.5, Skin 704.1, Toe 1106.4 kN

Soil Sgmnt No.	Depth Below Gages m	Depth Below Grade m	Quake mm	Soil Damping Case	Viscs kN /m/s	Smith s/m	Ru kN	Sum of Ru kN	Unit Skin Frctn kN /m2
								1810.5	
1	3.1	1.2	3.500	.000	.0	.235	.0	1810.5	.00
2	5.2	3.2	3.500	.114	47.3	.235	201.2	1609.3	126.82
3	7.2	5.3	3.500	.286	118.2	.235	502.9	1106.4	317.06
Sum				.400	165.4		704.1		
Avrge			3.500			.235	234.7		147.96
Toe			12.000	1.000	413.6	.374	1106.4		23293.01

Soil Model Extensions		Skin	Toe
Unloading Level	(% of Ru)	0	
Resistance Gap	(mm)		4.00

Regular Model

Demo

CAPWAPC - GRL & Associates, Inc.

Blow No 5 10-Dec-87

PILE PROFILE AND PILE MODEL

	Depth	Area cm2	E-Modulus kN /cm2	Spec. Weight kN / m3
1	.00	100.90	21000.0	78.500
2	7.21	100.90	21000.0	78.500

Segmnt No.	Depth B.G. m	Impedance kN /m/s	Tensn Slack mm	Compr. Slack mm
1	1.03	413.6	.0000	.0000
7	7.21	213.6	10.0000	.0000

Pile Damping (%) 2.0, Time Incr (ms) .201, Wave Speed m/s 5122.8

EXTREMA TABLE

Pile Sgmnt No.	Depth below Gages m	max. Force kN	min. Force kN	max. Comp. Stress kN /cm2	max. Tension Stress kN /cm2	max. trnsfd. Energy kN - m	max. Veloc. m/s	max. Displmt cm
1	1.0	2639.7	-9.5	26.16	-.09	50.33	5.2	2.609
2	2.1	2551.2	-78.8	25.28	-.78	45.32	5.2	2.170
3	3.1	2577.8	-85.9	25.55	-.85	44.34	5.2	2.070
4	4.1	2577.8	-85.9	25.55	-.85	44.34	5.2	2.070
5	5.2	2652.4	-93.6	26.29	-.93	43.41	5.1	1.980
6	6.2	2676.1	-83.2	26.52	-.82	42.57	4.9	1.890
7	7.2	2449.2	-36.9	24.27	-.37	23.56	3.5	1.653
Absolute	5.2			26.52		(T=	26.3 ms)	
	4.1				-.93	(T=	42.4 ms)	

Regular
Model
Demo

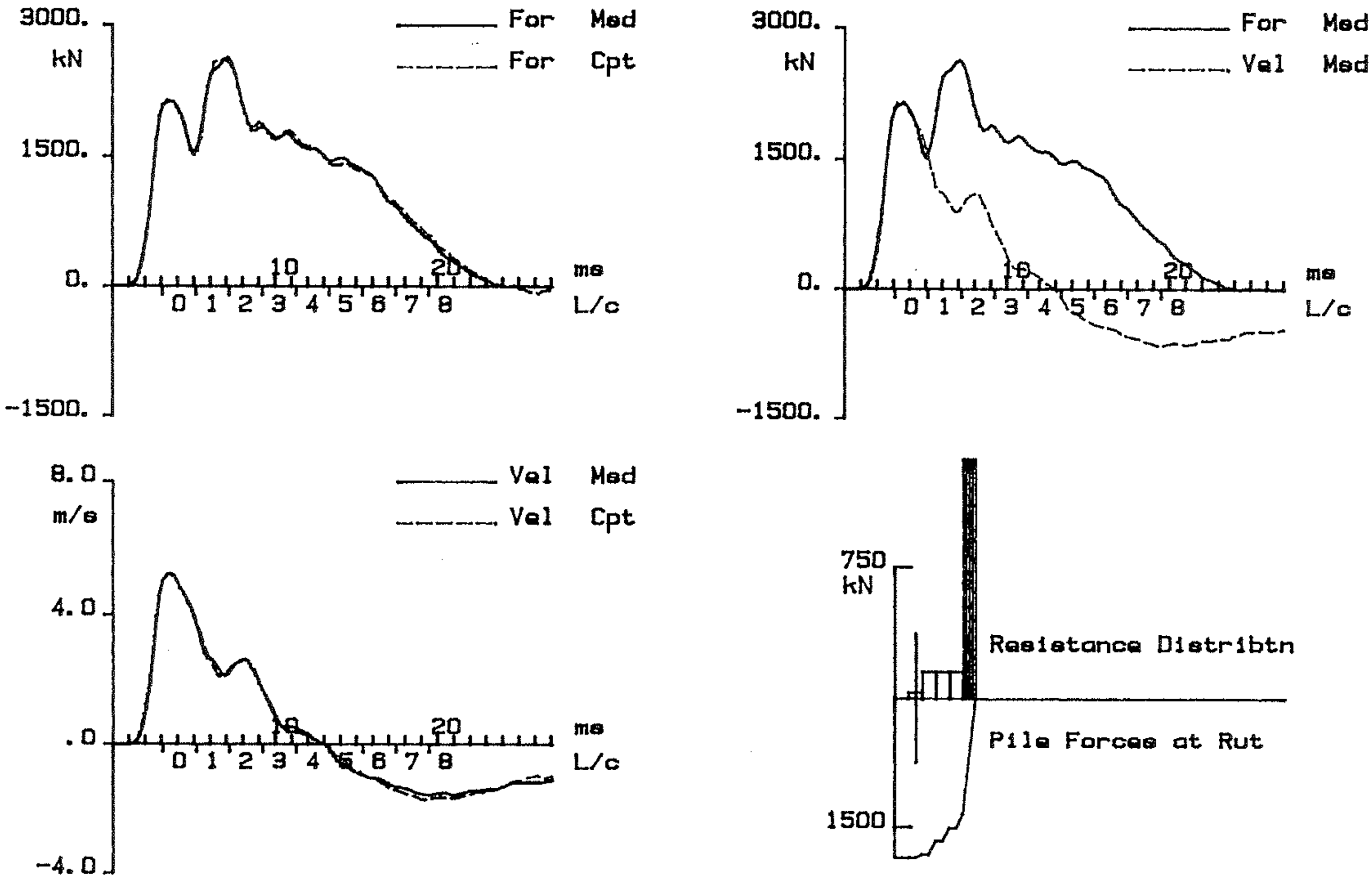
Case Method Capacity Results

	J=0.0	J=0.1	J=0.2	J=0.3	J=0.4	J=0.5	J=0.6	J=0.7	J=0.8	J=0.9
Rs	2565.	2415.	2265.	2115.	1965.	1815.	1665.	1516.	1366.	1216.
Rx	2845.	2719.	2601.	2484.	2376.	2270.	2163.	2064.	1966.	1869.
Ru	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
Ra Ra2	1761.	2161.								

VMAX	VFIN	V1*Z	F1	FMAX	DMAX	DFIN	EMAX	EFIN	R EX	R EF
5.25	-1.15	2147.9	2064.2	2639.7	2.609	.877	50.3	41.4	3237.8	8283.2

CAPWAPC - GRL & Associates, Inc.

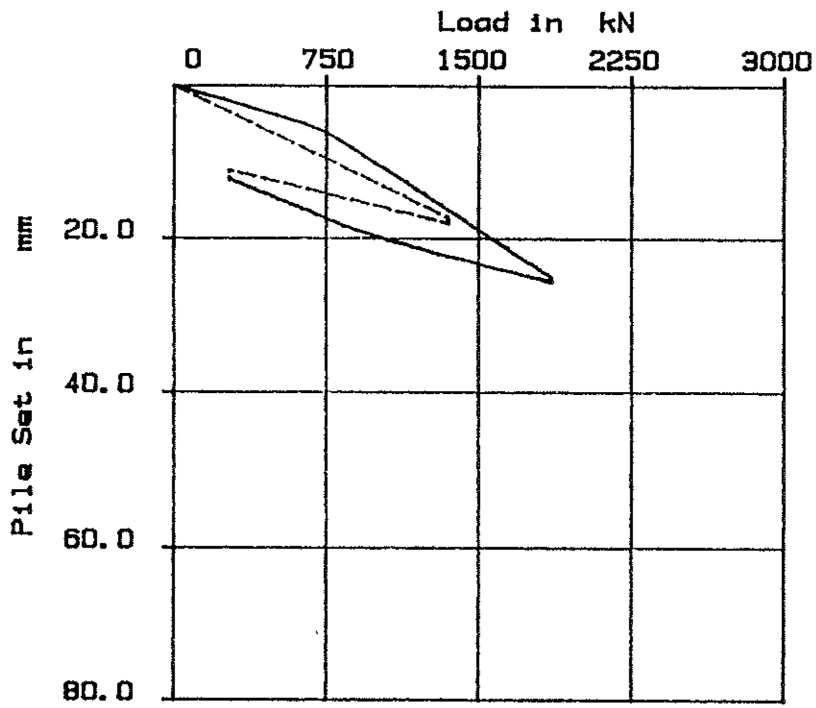
Blow 5 10-Dec-87



CAPWAPC - GRL & Associates, Inc.

Blow 5 DYNAMIC D-TOE, E-P R-TOE

——— Pile Top - - - - - Pile Bottom



CAPWAPC - GRL & Associates, Inc.

Blow No 5 10-Dec-87

Final CAPWAPC Capacity: Ru 1856.8, Skin 501.8, Toe 1355.0 kN

Soil Sgmnt No.	Depth Below Gages m	Depth Below Grade m	Quake mm	Soil Damping Case	Viscs kN /m/s	Smith s/m	Ru kN	Sum of Ru kN	Unit Skin Frctn kN /m2
								1856.8	
1	2.1	.0	2.500	.000	.0	.443	.0	1856.8	.00
2	4.3	.0	2.750	.035	14.6	.443	33.0	1823.8	19.97
3	6.4	1.7	3.000	.167	69.2	.443	156.3	1667.5	94.44
4	8.3	3.8	3.250	.167	69.2	.443	156.3	1511.2	109.29
5	10.0	5.5	3.500	.167	69.2	.443	156.3	1355.0	119.65
Sum				.538	222.4		501.8		
Avrge			3.217			.443	100.4		68.67
Toe			17.500	.700	289.5	.214	1355.0		28525.92

Soil Model Extensions		Skin	Toe
Unloading Quake	(% of loading quake)	100	50
Unloading Level	(% of Ru)	0	

CAPWAPC - GRL & Associates, Inc.

Blow No 5 10-Dec-87

PILE PROFILE AND PILE MODEL

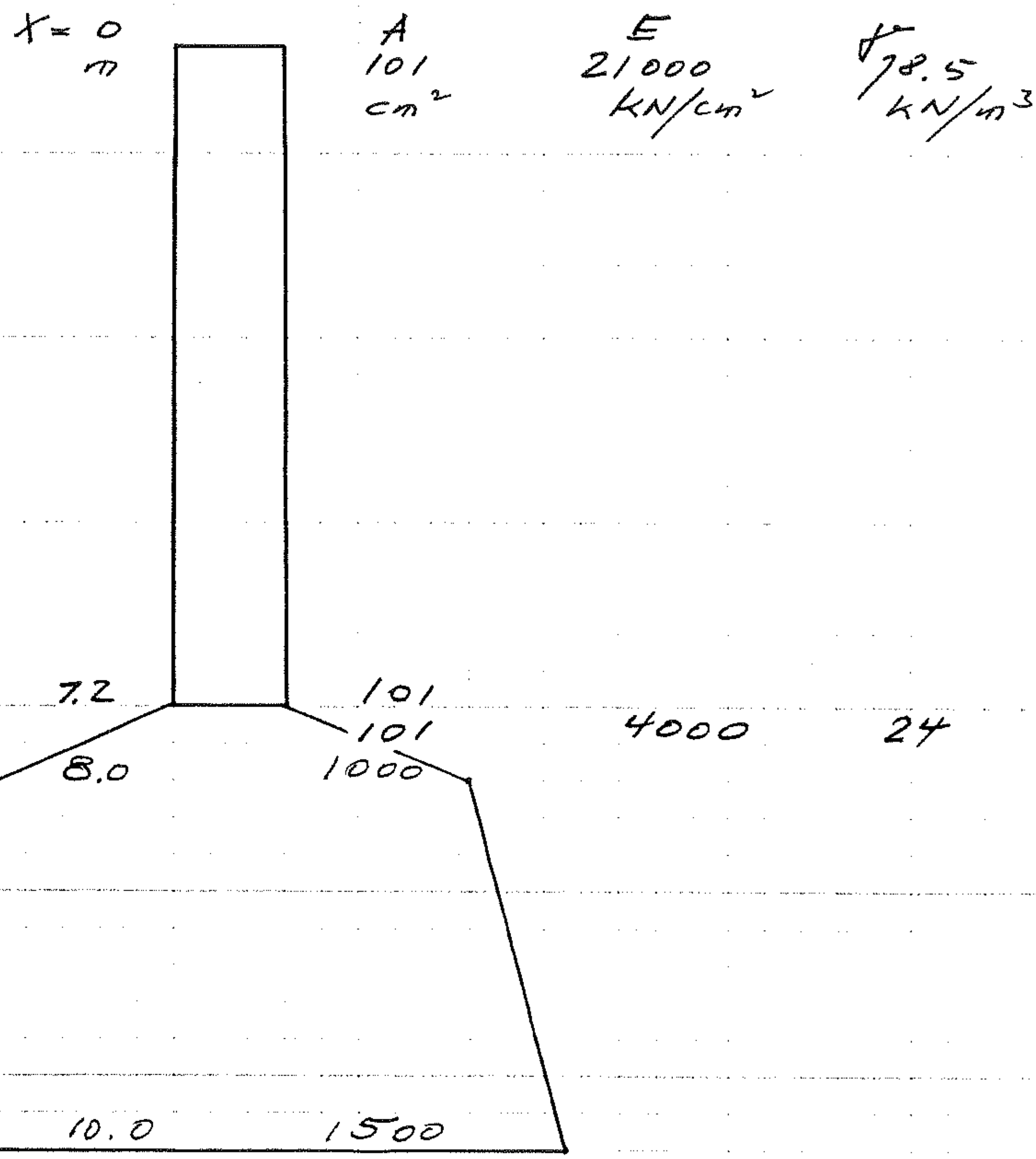
	Depth	Area cm2	E-Modulus kN /cm2	Spec. Weight kN / m3
1	.00	100.90	21000.0	78.500
2	7.21	100.90	21000.0	78.500
3	7.21	100.00	4000.0	24.000
4	8.00	1000.00	4000.0	24.000
5	10.00	1500.00	4000.0	24.000

Segmnt No.	Depth B.G. m	Impedance kN /m/s	Tensn Slack mm	Compr. Slack mm
1	1.07	413.6	.0000	.0000
7	7.46	162.6	10.0000	.0000
8	8.30	605.9	.0000	.0000
9	9.15	1169.2	.0000	.0000
10	10.00	1379.0	.0000	.0000

Pile Damping (%) 2.0, Time Incr (ms) .210, Wave Speed m/s 4767.8

EXTREMA TABLE

Pile Sgmnt No.	Depth below Gages m	max. Force kN	min. Force kN	max. Comp. Stress kN /cm2	max. Tension Stress kN /cm2	max. trnsfd. Energy kN - m	max. Veloc. m/s	max. Displmt cm
1	1.1	2638.1	-10.5	26.15	-.10	51.14	5.2	2.609
2	2.1	2632.5	-92.5	26.09	-.92	49.65	5.3	2.450
3	3.2	2542.9	-91.5	25.20	-.91	49.01	5.3	2.370
4	4.3	2542.9	-91.5	25.20	-.91	49.01	5.3	2.370
5	5.4	2599.2	-102.7	25.76	-1.02	48.32	5.3	2.290
6	6.4	2734.9	-103.5	27.11	-1.03	45.90	5.0	2.200
7	7.5	2734.9	-103.5	19.37	-.73	45.90	5.0	2.200
8	8.3	2878.1	-109.0	3.53	-.13	45.18	4.3	2.120
9	9.2	2878.1	-109.0	2.44	-.09	45.18	4.3	2.120
10	10.0	1991.2	-129.2	1.43	-.09	25.66	3.6	1.815
Absolute	6.4			28.52		(T=	23.3 ms)	
	6.4				-1.08	(T=	43.0 ms)	


X = 0
m
A
101
cm²
E
21000
kN/cm²
γ
78.5
kN/m³
7.2
101
101
4000
24
8.0
1000
10.0
1500

Case Method Capacity Results

	J=0.0	J=0.1	J=0.2	J=0.3	J=0.4	J=0.5	J=0.6	J=0.7	J=0.8	J=0.9
Rs	3121.	2931.	2740.	2550.	2359.	2169.	1978.	1788.	1597.	1406.
Rx	3121.	2931.	2740.	2550.	2359.	2183.	2017.	1955.	1948.	1940.
Ru	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
Ra Ra2	1922.	2646.								

VMAX	VFIN	V1*Z	F1	FMAX	DMAX	DFIN	EMAX	EFIN	R EX	R EF
5.25	-1.15	2097.3	2086.2	2638.1	2.609	.873	51.1	42.7	3289.6	8530.3

BAUD RATE: 300

CAPWAPC™ ANALYSIS REQUEST FORM

Title: ______ Date: ______

File Name: ______ Job No.: ______

		1	2	3	4
	Record No.	BOR			
PILE	Number	63, Bl 5			
	Length (total)	7.76			
	(b.g.)	7.21			
	Pile Type	CE Pipe 24.6 cm dia			
	Area	100.9			
	E-Modulus	Steel			
	Specific Wt.				
	Wave Speed				
	Penetration	6.3			
	Blow Count	5 mm/blow			
	FMX (kN)	255t			
	VMX	5.21			
	EMX	4.8			
	RSI (J=)				
	RMX (J=.64) hi damping	208			

HAMMER Drop 7000 kg

DRIVING SYSTEM

SOIL Clay @ top, Till (bearing layer) Bedrock

Data for Non-Uniform Piles

Depth	A	E	W

English ☐

Metric ☐

Client: ______

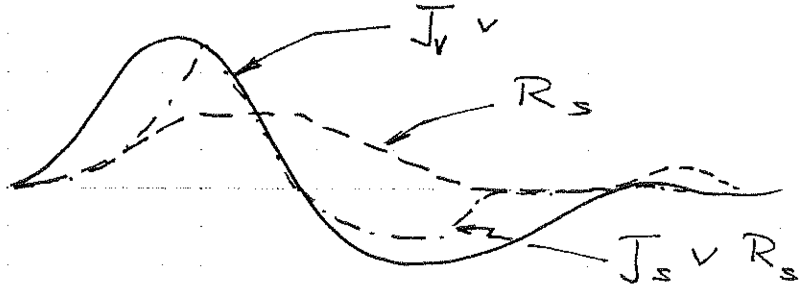
Phone: ______

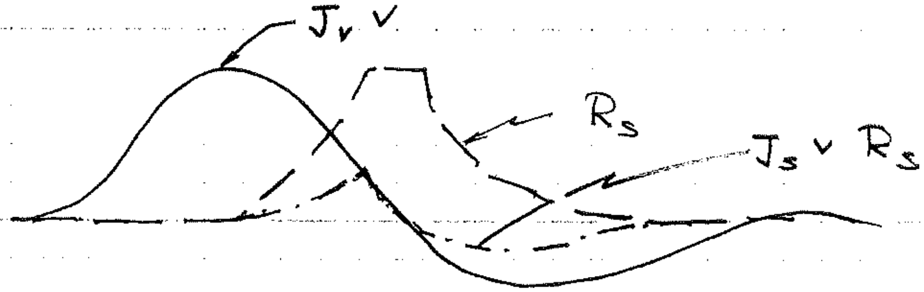
Needed by: ______

APPENDIX B

EXAMPLE 2

Appendix B





================== CAPWAPC - GRL Philadelphia ==================

Trial 55, Rut= 460.0 + 21.8 Kips

NO.	1	2	3	4	5	6	7	8	9
R I	7.9	6.2	17.0	57.8	74.2	45.0	49.1	84.6	118.1
SJ I	1.4	1.1	3.0	10.1	12.9	7.8	8.5	14.7	17.0
QS I	.150	.150	.150	.150	.150	.150	.150	.150	.300

ANAT	PILD	PLUG	JSKN	JTOE	SSKN	STOE	TGAP	UNLD	BTDP	CRSK	CRTO
W->W	.0000	.000	.350	.100	.174	.144	.070	.000	5.000	.80	.40

TIME	F M	F/VC	V TP	D TP	F MD	V MD	D MD	F BT	V BT	D BT	R ST	R D
25.3	1565.	345.	9.1	.65	1570.	9.0	.58	514.	12.4	.54	460.	706.
30.5	0.	-523.	-3.3	.00	-368.	-2.7	.00	-50.	-2.3	.00	0.	-157.
57.0	45.	134.	-1.3	.28	-26.	-1.1	.33	-25.	-1.5	.33	0.	-107.

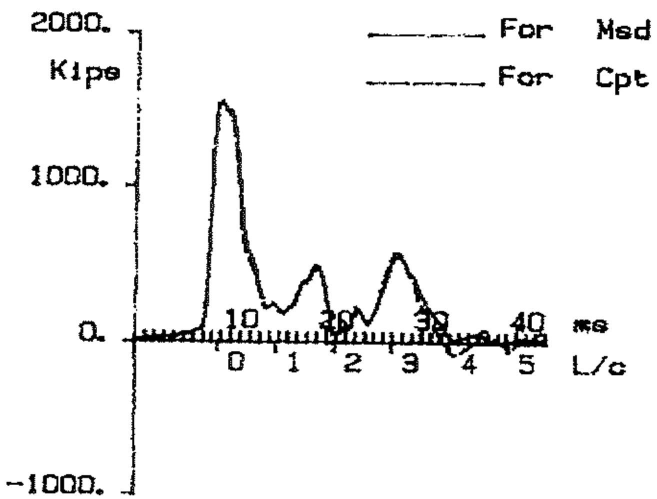
TOTAL ACTIVATED RESISTANCE 460.0 Kips

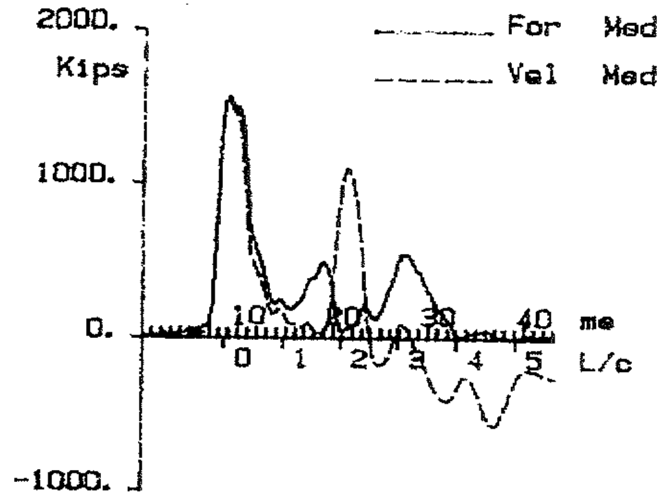
BLCT-Q	BLCT-FN	T1	TVM	T2LC	T2	ENTHRU	MQ-NOW	MQ-BST	No.
36.1	36.6	12.1	20.8	33.2	57.0	41.90	4.50	4.33	51

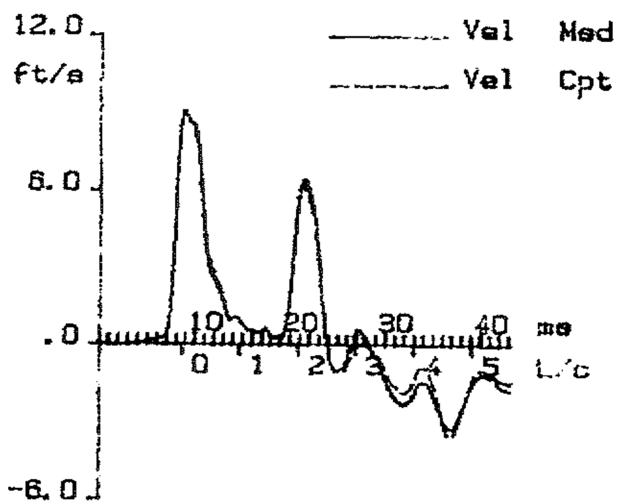
++

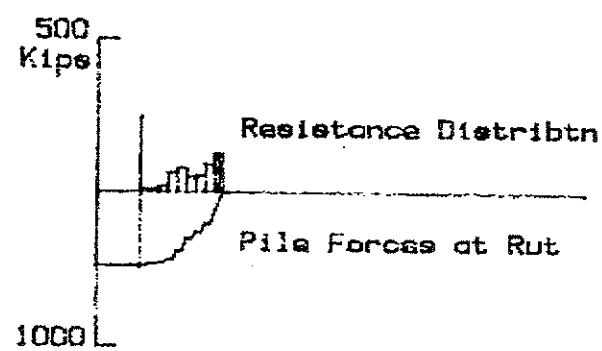
CAPWAPC - GRL Philadelphia

Blow 1 04-Mar-88









CAPWAPC - GRL Philadelphia

Blow No 1 04-Mar-88

Final CAPWAPC Capacity: Ru 481.8, Skin 358.1, Toe 123.7 Kips

Soil Sgmnt No.	Depth Below Gages ft	Depth Below Grade ft	Quake in	Soil Damping Case	Viscs Kips/ft/s	Smith s/ft	Ru Kips	Sum of Ru Kips	Unit Skin Frctn Kips/ft2
								481.8	
1	36.5	.2	.150	.008	1.4	.166	8.3	473.5	.19
2	43.2	6.8	.150	.006	1.1	.166	6.5	467.0	.15
3	49.8	13.5	.150	.017	3.0	.166	17.8	449.2	.40
4	56.4	20.1	.150	.059	10.1	.166	60.6	388.6	1.37
5	63.1	26.8	.150	.076	12.9	.166	77.7	310.9	1.75
6	69.7	33.4	.150	.046	7.8	.166	47.2	263.7	1.07
7	76.4	40.0	.150	.050	8.5	.166	51.4	212.3	1.16
8	83.0	46.7	.150	.087	14.7	.166	88.6	123.7	2.00
Sum				.350	59.5		358.1		
Avrge			.150			.166	44.8		1.01
Toe			.300	.100	17.0	.137	123.7		44.50

Soil Model Extensions

		Skin	Toe
Unloading Quake	(% of loading quake)	80	40
Unloading Level	(% of Ru)	0	
Resistance Gap	(inch)		.07
Soil Support Dashpot	(Kips/ft/s)		849.70

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Trial 35. Rut= 570.0 + 21.9 Kips W->W

.	1	2	3	4	5	6	7	8	9
R I	6.2	19.2	32.2	30.0	58.2	48.0	51.1	55.0	270.0
SJ I	1.7	5.3	8.8	8.2	15.9	13.1	14.0	15.1	69.2
QS I	.150	.150	.150	.150	.150	.150	.150	.150	.180

OPtd	PIld	PLug	JSkn	JToe	SSkn	SToe	TGap	UNld	BTdp	CSkn	CToe
1	.0200	.000	.480	.405	.274	.256	.250	.000	.000	1.00	1.00

TIME	F M	F/VC	V TP	D TP	F MD	V MD	D MD	F BT	V BT	D BT	R ST	R D
24.5	1575.	300.	9.1	.62	1605.	8.7	.51	625.	11.9	.43	555.	788.
29.9	0.	-494.	-3.8	.00	-364.	-2.8	.00	-17.	-2.6	.00	0.	-267.
57.1	45.	151.	-1.9	.14	-62.	-1.4	.17	-5.	-1.8	.17	0.	-139.

Total Activated Resistance 570.0 Kips

BLct-Q	BLct-FN	TBeg	TVpk	T2LC	TEnd	EMAX	MQ-NOW	MQ-BST	No.
81.2	69.3	12.1	20.8	33.1	57.1	41.11	4.99	4.99	35

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Smith Toe Damping

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33

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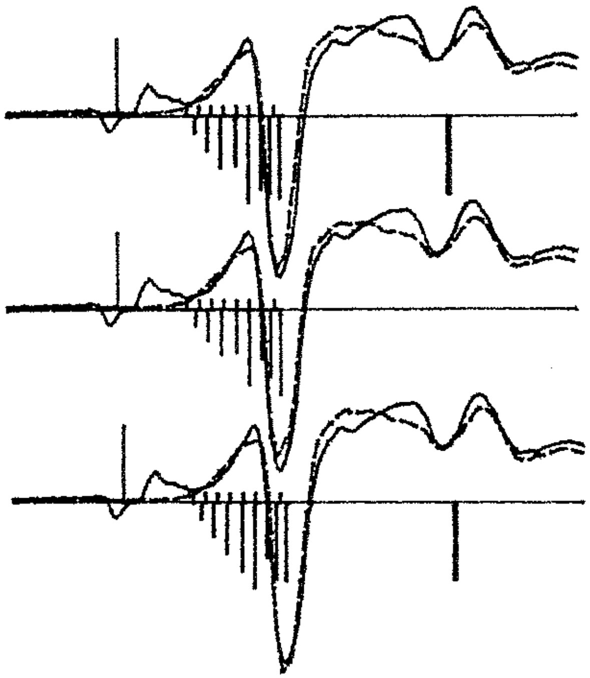

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CAPWAPC - GRL & Associates. Inc.

Blow No 0 05-Mar-88

Final CAPWAPC Capacity: Ru 591.5. Skin 311.5. Toe 280.4 Kips

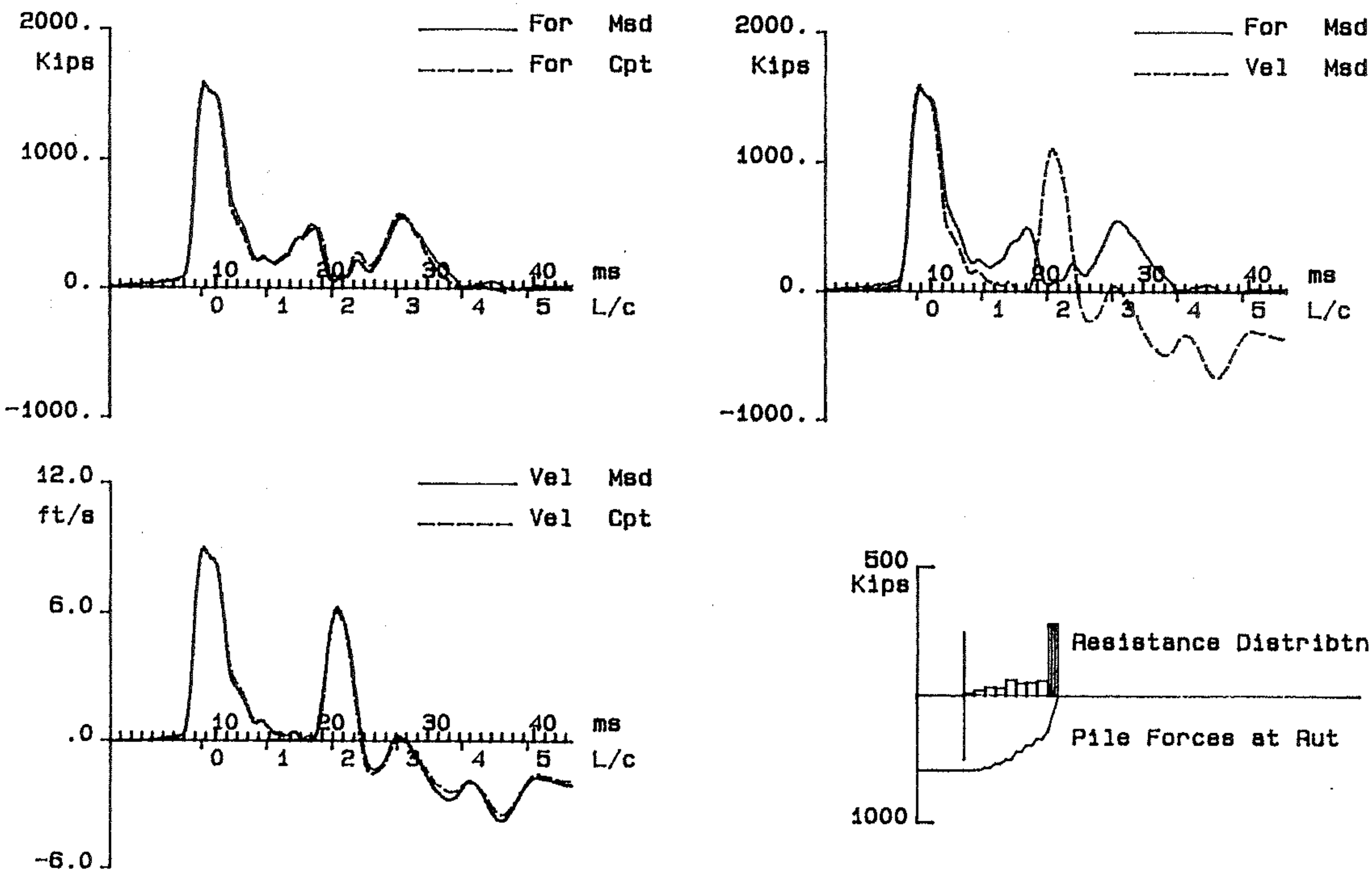
Soil Sgmnt No.	Depth Below Gages ft	Depth Below Grade ft	Quake in	Soil Damping Case	Viscs Kips/ft/s	Smith s/ft	Ru Kips	Sum of Ru Kips	Unit Skin Frctn Kips/ft2
								591.5	
1	36.5	.2	.150	.010	1.7	.264	6.4	585.1	.15
2	43.2	6.8	.150	.031	5.3	.264	19.9	565.2	.45
3	49.8	13.5	.150	.052	8.8	.264	33.4	532.1	.75
4	56.4	20.1	.150	.048	8.2	.264	31.2	500.9	.70
5	63.1	26.8	.150	.093	15.9	.264	60.4	440.5	1.38
6	69.7	33.4	.150	.077	13.1	.264	49.9	390.6	1.13
7	76.4	40.0	.150	.082	14.0	.264	53.1	337.5	1.20
8	83.0	46.7	.150	.088	15.1	.264	57.2	280.4	1.29
Sum				.480	82.1		311.5		
Avrge			.150			.264	38.9		.88
Toe			.180	.405	69.2	.247	280.4		101.22

Soil Model Extensions		Skin	Toe
Unloading Level	(% of Ru)	0	
Resistance Gap	(inch)		.25

Smith Toe Damping

CAPWAPC - GRL & Associates, Inc.

Blow 0 05-Mar-88



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GRL-PDI

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