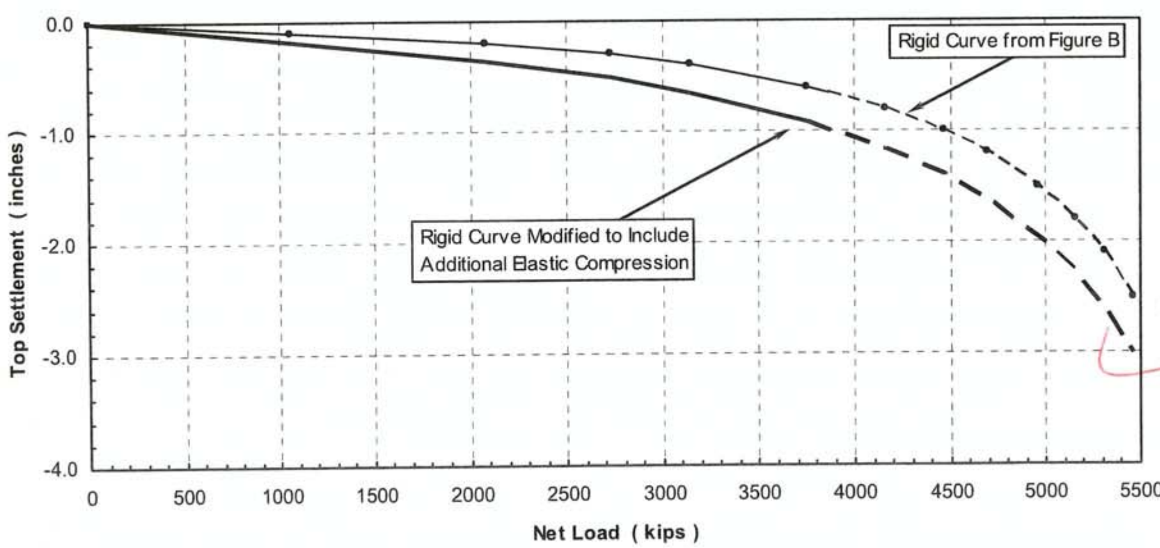
Example Calculation for the Additional Elastic Compression Correction For Single Level Test (English Units)

Given:

C_1	=	0.441	
AE	=	3,820,000	kips (assumed constant throughout test)
I_0	=	5.9	ft
I_1	=	30.0	ft (embedded length of shaft above O-cell)
I_2	=	0.00	ft
I_3	=	0.0	ft
Shear reduction factor	=	1.00	(cohesive soil)

Δ_{OLT} (in)	$Q'_{\downarrow A}$ (kips)	$Q'_{\uparrow A}$ (kips)	P (kips)	δ_{TLT} (in)	δ_{OLT} (in)	Δ_δ (in)	$\Delta_{OLT} + \Delta_\delta$ (in)
0.000	0	0	0	0.000	0.000	0.000	0.000
0.100	352	706	1058	0.133	0.047	0.086	0.186
0.200	635	1445	2080	0.257	0.096	0.160	0.360
0.300	867	1858	2725	0.339	0.124	0.215	0.515
0.400	1061	2088	3149	0.396	0.139	0.256	0.656
0.600	1367	2382	3749	0.478	0.159	0.319	0.919
0.800	1597	2563	4160	0.536	0.171	0.365	1.165
1.000	1777	2685	4462	0.579	0.179	0.400	1.400
1.200	1921	2773	4694	0.613	0.185	0.427	1.627
1.500	2091	2867	4958	0.651	0.191	0.460	1.960
1.800	2221	2933	5155	0.680	0.196	0.484	2.284
2.100	2325	2983	5308	0.703	0.199	0.504	2.604
2.500	2434	3032	5466	0.726	0.202	0.524	3.024

Figure C



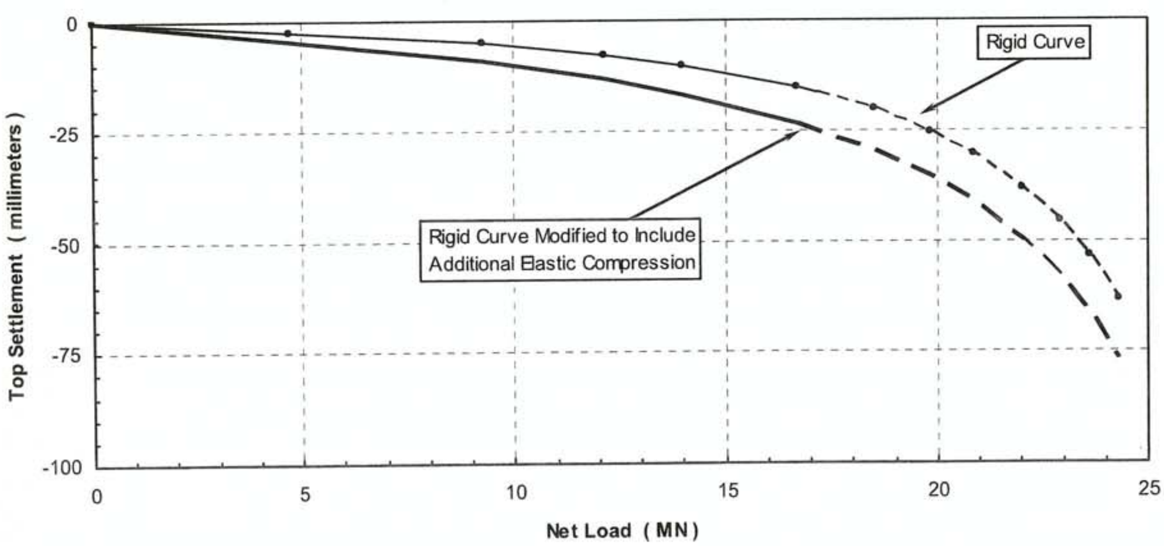
Load at Top w/ elastic shorting.

Example Calculation for the Additional Elastic Compression Correction For Single Level Test (SI Units)

Given:	C_1	=	0.441
	AE	=	17,000 MN (assumed constant throughout test)
	I_0	=	1.80 m
	I_1	=	14.69 m (embedded length of shaft above mid-cell)
	I_2	=	0.00 m
	I_3	=	0.0 m
Shear reduction factor		=	1.00 (cohesive soil)

Δ_{OLT} (mm)	$Q'_{\downarrow A}$ (MN)	$Q'_{\uparrow A}$ (mm)	P (MN)	δ_{TLT} (mm)	δ_{OLT} (mm)	Δ_δ (mm)	$\Delta_{OLT} + \Delta_\delta$ (mm)
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.54	1.57	3.14	4.71	3.37	1.20	2.17	4.71
5.08	2.82	6.43	9.25	6.52	2.45	4.07	9.15
7.62	3.86	8.27	12.12	8.61	3.15	5.46	13.08
10.16	4.72	9.29	14.01	10.05	3.54	6.51	16.67
15.24	6.08	10.60	16.68	12.14	4.04	8.10	23.34
20.32	7.11	11.40	18.50	13.60	4.34	9.26	29.58
25.40	7.90	11.94	19.85	14.70	4.55	10.15	35.55
30.48	8.55	12.33	20.88	15.55	4.70	10.85	41.33
38.10	9.30	12.75	22.05	16.53	4.86	11.67	49.77
45.72	9.88	13.05	22.93	17.27	4.97	12.29	58.01
53.34	10.34	13.27	23.61	17.84	5.06	12.79	66.13
63.50	10.83	13.48	24.31	18.44	5.14	13.30	76.80

Figure D



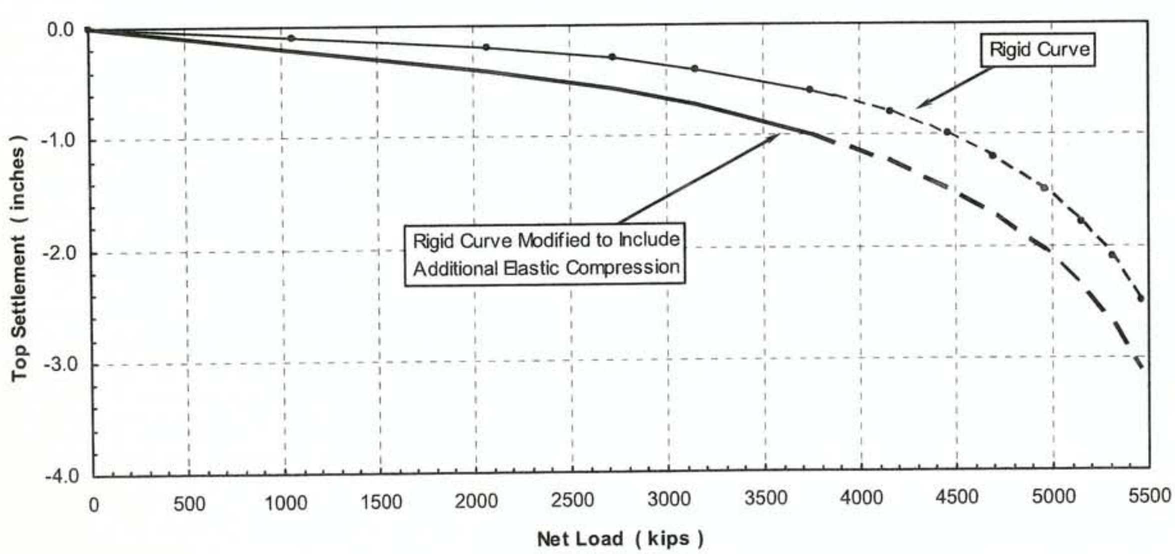
Example Calculation for the Additional Elastic Compression Correction For Multi Level Test (English Units)

Given:

	C_1	=	0.441
	C_2	=	0.579
	C_3	=	0.396
	AE	=	3,820,000 kips (assumed constant throughout test)
	I_0	=	5.9 ft
	I_1	=	30.0 ft (embedded length of shaft above mid-cell)
	I_2	=	18.2 ft (embedded length of shaft between O-cells)
	I_3	=	0.0 ft
Shear reduction factor		=	1.00 (cohesive soil)

Δ_{OLT} (in)	$Q'_{\downarrow A}$ (kips)	$Q'_{\downarrow B}$ (kips)	$Q'_{\uparrow A}$ (kips)	P (kips)	δ_{TLT} (in)	δ_{OLT} (in)	Δ_δ (in)	$\Delta_{OLT} + \Delta_\delta$ (in)
0.000	0	0	0	0	0.000	0.000	0.000	0.000
0.100	352	247	459	1058	0.133	0.025	0.107	0.207
0.200	635	506	939	2080	0.257	0.052	0.205	0.405
0.300	867	650	1208	2725	0.339	0.067	0.272	0.572
0.400	1061	731	1357	3149	0.396	0.075	0.321	0.721
0.600	1367	834	1548	3749	0.478	0.085	0.393	0.993
0.800	1597	897	1666	4160	0.536	0.092	0.444	1.244
1.000	1777	940	1745	4462	0.579	0.096	0.483	1.483
1.200	1921	971	1802	4694	0.613	0.099	0.513	1.713
1.500	2091	1003	1864	4958	0.651	0.103	0.548	2.048
1.800	2221	1027	1907	5155	0.680	0.105	0.575	2.375
2.100	2325	1044	1939	5308	0.703	0.107	0.596	2.696
2.500	2434	1061	1971	5466	0.726	0.109	0.618	3.118

Figure E



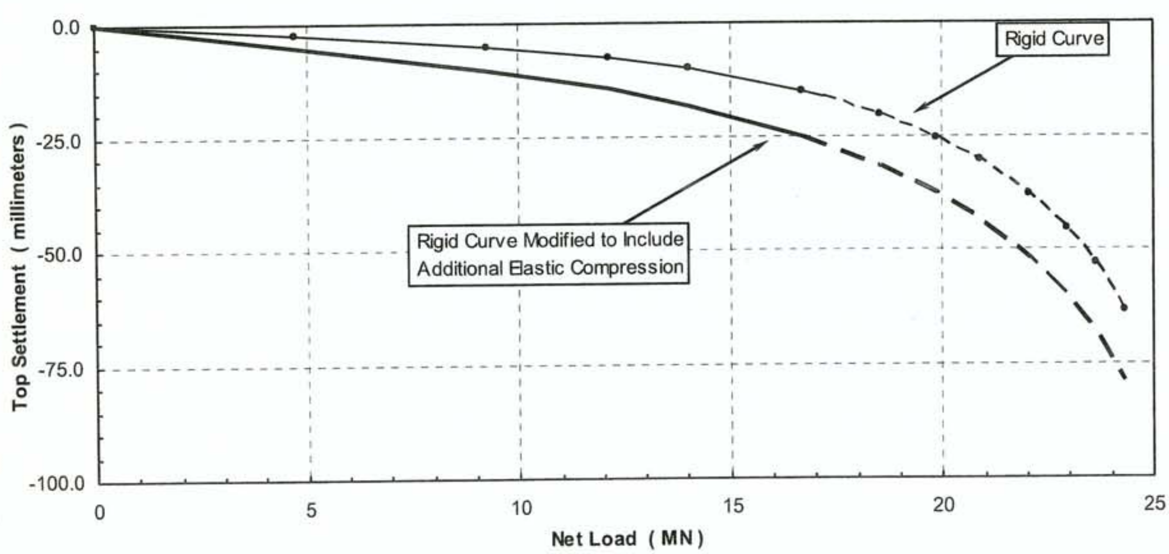
Example Calculation for the Additional Elastic Compression Correction For Multi Level Test (SI Units)

Given:

C_1	=	0.441	
C_2	=	0.579	
C_3	=	0.396	
AE	=	17,000	MN (assumed constant throughout test)
I_0	=	1.80	m
I_1	=	9.14	m (embedded length of shaft above mid-cell)
I_2	=	5.55	m (embedded length of shaft between O-cells)
I_3	=	0.00	m
Shear reduction factor	=	1.00	(cohesive soil)

Δ_{OLT} (mm)	$Q'_{\downarrow A}$ (MN)	$Q'_{\downarrow B}$ (MN)	$Q'_{\uparrow B}$ (mm)	P (MN)	δ_{TLT} (mm)	δ_{OLT} (mm)	Δ_δ (mm)	$\Delta_{OLT} + \Delta_\delta$ (mm)
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.54	1.57	1.10	2.04	4.71	3.37	0.64	2.73	5.27
5.08	2.82	2.25	4.18	9.25	6.52	1.31	5.21	10.29
7.62	3.86	2.89	5.37	12.12	8.61	1.69	6.92	14.54
10.16	4.72	3.25	6.04	14.01	10.05	1.90	8.15	18.31
15.24	6.08	3.71	6.89	16.68	12.14	2.17	9.97	25.21
20.32	7.11	3.99	7.41	18.50	13.60	2.33	11.27	31.59
25.40	7.90	4.18	7.76	19.85	14.70	2.44	12.26	37.66
30.48	8.55	4.32	8.02	20.88	15.55	2.52	13.03	43.51
38.10	9.30	4.46	8.29	22.05	16.53	2.61	13.92	52.02
45.72	9.88	4.57	8.48	22.93	17.27	2.67	14.60	60.32
53.34	10.34	4.64	8.62	23.61	17.84	2.71	15.13	68.47
63.50	10.83	4.72	8.76	24.31	18.44	2.76	15.68	79.18

Figure F



APPENDIX D

O-CELL METHOD FOR DETERMINING CREEP LIMIT LOADING

O-CELL METHOD FOR DETERMINING A CREEP LIMIT LOADING ON THE EQUIVALENT TOP-LOADED SHAFT (September, 2000)

Background: O-cell testing provides a sometimes useful method for evaluating that load beyond which a top-loaded drilled shaft might experience significant unwanted creep behavior. We refer to this load as the "creep limit," also sometimes known as the "yield limit" or "yield load".

To our knowledge, Housel (1959) first proposed the method described below for determining the creep limit. Stoll (1961), Bourges and Levillian (1988), and Fellenius (1996) provide additional references. This method also follows from long experience with the pressuremeter test (PMT). Figure 8 and section 9.4 from ASTM D4719-94, reproduced below, show and describe the creep curve routinely determined from the PMT. The creep curve shows how the movement or strain obtained over a fixed time interval, 30 to 60 seconds, changes versus the applied pressure. One can often detect a distinct break in the curve at the pressure P_e in Figure 8. Plastic deformations may become significant beyond this break loading and progressively more severe creep can occur.

Definition: Similarly with O-cell testing using the ASTM Quick Method, one can conveniently measure the additional movement occurring over the final time interval at each constant load step, typically 2 to 4 minutes. A break in the curve of load vs. movement (as at P_e with the PMT) indicates the creep limit.

We usually indicate such a creep limit in the O-cell test for either one, or both, of the side shear and end bearing components, and herein designate the corresponding movements as M_{CL1} and M_{CL2}. We then combine the creep limit data to predict a creep limit load for the equivalent top loaded shaft.

Procedure if both M_{CL1} and M_{CL2} available: Creep cannot begin until the shaft movement exceeds the M_{CL} values. A conservative approach would assume that creep begins when movements exceed the lesser of the M_{CL} values. However, creep can occur freely only when the shaft has moved the greater of the two M_{CL} values. Although less conservative, we believe the latter to match behavior better and therefore set the creep limit as that load on the equivalent top-loaded movement curve that matches the greater M_{CL}.

Procedure if only M_{CL1} available: If we cannot determine a creep limit in the second component before it reaches its maximum movement M_x, we treat M_x as M_{CL2}. From the above method one can say that the creep limit load exceeds, by some unknown amount, that obtained when using $M_{CL2} = M_x$.

Procedure if no creep limit observed: Then, according to the above, the creep limit for the equivalent top-loaded shaft will exceed, again by some unknown amount, that load on the equivalent curve that matches the movement of the component with the maximum movement.

Limitations: The accuracy in estimating creep limits depends, in part, on the scatter of the data in the creep limit plots. The more scatter, the more difficult to define a limit. The user should make his or her own interpretation if he or she intends to make important use of the creep limit interpretations. Sometimes we obtain excessive scatter of the data and do not attempt an interpretation for a creep limit and will indicate this in the report.

Excerpts from ASTM D4719
"Standard Test Method for Pressuremeter Testing in Soils"

9.4 For Procedure A, plot the volume increase readings (V_{60}) between the 30 s and 60 s reading on a separate graph. Generally, a part of the same graph is used, see Fig. 8. For Procedure B, plot the pressure decrease reading between the 30 s and 60 s reading on a separate graph. The test curve shows an almost straight line section within the range of either low volume increase readings (V_{60}) for Procedure A or low pressure decrease for Procedure B. In this range, a constant soil deformation modulus can be measured. Past the so-called creep pressure, plastic deformations become prevalent.

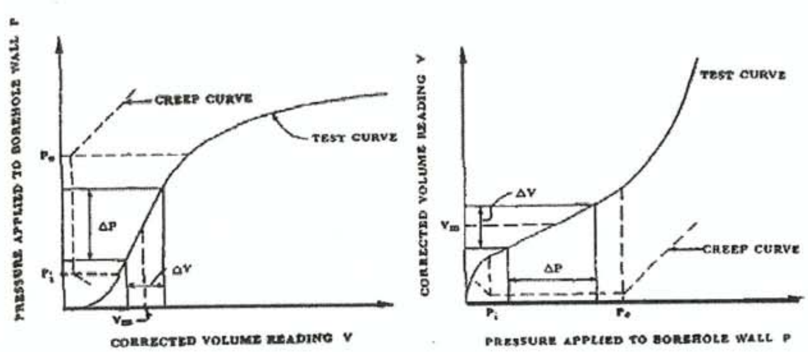


FIG. 8 Pressuremeter Test Curves for Procedure A

References

Housel, W.S. (1959), "Dynamic & Static Resistance of Cohesive Soils", ASTM STP 254, pp. 22-23.

Stoll, M.U.W. (1961, Discussion, Proc. 5th ICSMFE, Paris, Vol. III, pp. 279-281.

Bourges, F. and Levillian, J-P (1988), "force portante des rideaux plans metalliques charges verticalmement," Bull. No. 158, Nov.-Dec., des laboratoires des ponts et chaussees, p. 24.

Fellenius, Bengt H. (1996), Basics of Foundation Design, BiTech Publishers Ltd., p.79.

APPENDIX E

SOIL BORING LOG

LOG OF BORING NO. 7

BOREHOLE LOCATION	ELEVATION DATUM	DRILLER	LOGGER
See Location Plan	Survey	Abel Monarrez	Bruce Birge
BORING STARTED	BORING COMPLETED	DRILL RIG	DRILLING METHOD
3-13-04	3-14-04	CME-55	3 1/4" HSA/RWB
		SURFACE TYPE	TOTAL DEPTH (FT.)
		Sandy Flood Plain	85

WATER LEVEL OBSERVATIONS (FT.)

- ∇ 4.0 ATD
- ▼ AD
- 4.9

SAMPLE NO.	SAMPLE TYPE	RECOVERY, in.	PENETRATION RESISTANCE - BLOWS/FT.	POCKET PENETROMETER - TSF	UNCONFINED COMPRESSION - TSF	MOISTURE CONTENT - %	DRY DENSITY - PCF	OTHER	GRAPHIC LOG	DEPTH, FT.	DESCRIPTION Surface Elevation: 1157.0
											Loose, Moist, Brown, Poorly Graded Sand, Fine-Grained with Some Medium and Coarse Sand (SP) (Alluvium)
1	2S	18	7								
2	2S	12	9								Becomes Slightly Moist, Pale Brown with a Trace of Gravel
										5	Becomes Wet, Dark Gray to Grayish Brown, and Very Fine- to Fine-Grained
3	2S	13	12								
											Becomes Medium Dense
4	2S	16	10								
										10	
5	2S	18	23								Becomes Light Brownish Gray
										15	
6	2S	18	4								Becomes Loose, Medium to Dark Brownish Gray, and Fine- to Medium-Grained with Scattered Fine Gravel
										20	
										21.0	1136.0
											Medium Dense, Wet, Medium to Dark Brownish Gray, Poorly Graded, Fine-Grained Sand (SP) (Alluvium)
7	2S	17	17								Becomes Very Fine-Grained
										25	

The stratification lines represent the approximate boundary lines between soil and rock types. In situ the transition may be gradual.

KLEINFELDER

9312 G Court, Omaha, Nebraska 68127 (402) 331-2260

PROJECT NAME	Highway 81 Bridge
LOCATION	U.S. Highway 81 at the Missouri River Yankton, South Dakota
PROJECT NUMBER	41298

LOG OF BORING NO. 7

BOREHOLE LOCATION	ELEVATION DATUM	DRILLER	LOGGER
See Location Plan	Survey	Abel Monarrez	Bruce Birge
BORING STARTED	BORING COMPLETED	DRILL RIG	DRILLING METHOD
3-13-04	3-14-04	CME-55	3 1/4" HSA/RWB
		SURFACE TYPE	TOTAL DEPTH (FT.)
		Sandy Flood Plain	85

WATER LEVEL OBSERVATIONS (FT.)

- ▽ 4.0 ATD
- ▼ AD
- 4.9

SAMPLE NO.	SAMPLE TYPE	RECOVERY, in.	PENETRATION RESISTANCE - BLOWS/FT.	POCKET PENETROMETER - TSF	UNCONFINED COMPRESSION - TSF	MOISTURE CONTENT - %	DRY DENSITY - PCF	OTHER	DEPTH, FT.	DESCRIPTION
										Continued: Medium Dense, Wet, Medium to Dark Brownish Gray, Poorly Graded, Very Fine-Grained Sand (SP) (Alluvium)
8	2S	18	23						30	
									32.5	1124.5
										Hard, Very Moist, Dark to Very Dark Gray, Shale, Slightly to Non-Calcareous, Massive Structure, Unfossiliferous, Partially Silty (SH) (Carlile Shale)
9	2S	18	34			22		LL=53 PI=32	35	Calcite-Filled Fracture at 34-34.3'
										Switched to Drilling with Mud-Rotary System @ 35'
										PMT @ 38 - Tricone
10	2S	3	50/3"			28			40	Sampler Refusal - Septarian (Lime) Nodule
11	2S	15	41			20			45	
12	2S	18	34			23			50	Occasional Small Lime Nodules - Otherwise Non-Calcareous

The stratification lines represent the approximate boundary lines between soil and rock types. In situ the transition may be gradual.

KLEINFELDER

9312 G Court, Omaha, Nebraska 68127 (402) 331-2260

PROJECT NAME	Highway 81 Bridge
LOCATION	U.S. Highway 81 at the Missouri River Yankton, South Dakota
PROJECT NUMBER	41298

LOG OF BORING NO. 7

BOREHOLE LOCATION	ELEVATION DATUM	DRILLER	LOGGER
See Location Plan	Survey	Abel Monarrez	Bruce Birge
BORING STARTED	BORING COMPLETED	DRILL RIG	DRILLING METHOD
3-13-04	3-14-04	CME-55	3 1/4" HSA/RWB
		SURFACE TYPE	TOTAL DEPTH (FT.)
		Sandy Flood Plain	85

WATER LEVEL OBSERVATIONS (FT.)

- ▽ 4.0 ATD
- ▼ AD
- 4.9

SAMPLE NO.	SAMPLE TYPE	RECOVERY, in.	PENETRATION RESISTANCE - BLOWS/FT.	POCKET PENETROMETER - TSF	UNCONFINED COMPRESSION - TSF	MOISTURE CONTENT - %	DRY DENSITY - PCF	OTHER	GRAPHIC LOG	DEPTH, FT.	DESCRIPTION
											Continued: Hard, Very Moist, Dark to Very Dark Gray, Shale, Massive Structure, Non-Calcareous, Partially Silty (SH) (Carlile Shale)
13	2S	18	42			21					With Abundant Silt Partings & Laminae, Becoming Slightly Fissile, Mostly Dark Gray
										55	
14	2S	10	50/4"								Sampler Refusal @ 59.3' - Septarian (Lime) Nodule
										60	
15	2S	18	50			23					
										65	
16	2S	18	60			21					
										70	Suspended Drilling 03/13/04 @ 70' Resumed Drilling 03/14/04
											Becomes more Fissile & Chaley, with Disseminated Pyrites & Several Small Lime Nodules @ 73-77'
17	2S	18	60			22					
										75	

The stratification lines represent the approximate boundary lines between soil and rock types. In situ the transition may be gradual.

KLEINFELDER

9312 G Court, Omaha, Nebraska 68127 (402) 331-2260

PROJECT NAME	Highway 81 Bridge
LOCATION	U.S. Highway 81 at the Missouri River Yankton, South Dakota
PROJECT NUMBER	41298

LOG OF BORING NO. 7

BOREHOLE LOCATION	ELEVATION DATUM	DRILLER	LOGGER
See Location Plan	Survey	Abel Monarrez	Bruce Birge
BORING STARTED	BORING COMPLETED	DRILL RIG	DRILLING METHOD
3-13-04	3-14-04	CME-55	3 1/4" HSA/RWB
		SURFACE TYPE	TOTAL DEPTH (FT.)
		Sandy Flood Plain	85

WATER LEVEL OBSERVATIONS (FT.)

- ∇ 4.0 ATD
- ▼ AD
- 4.9

SAMPLE NO.	SAMPLE TYPE	RECOVERY, in.	PENETRATION RESISTANCE - BLOWS/FT.	POCKET PENETROMETER - TSF	UNCONFINED COMPRESSION - TSF	MOISTURE CONTENT - %	DRY DENSITY - PCF	OTHER	GRAPHIC LOG	DEPTH, FT.	DESCRIPTION
											Continued: Hard, Very Moist, Dark Gray, Shale, Massive to Fissile, Non-Calcareous, Partially Silty (SH) (Carlile Shale)
											Less Silty & Less Fissile @ 78-82'
18	2S	18	50			23				80	
19	2S		62			22		LL=56 PI=35		85	85.0 / 1072.0
											Bottom of Boring at 85'

The stratification lines represent the approximate boundary lines between soil and rock types. In situ the transition may be gradual.

KLEINFELDER

9312 G Court, Omaha, Nebraska 68127 (402) 331-2260

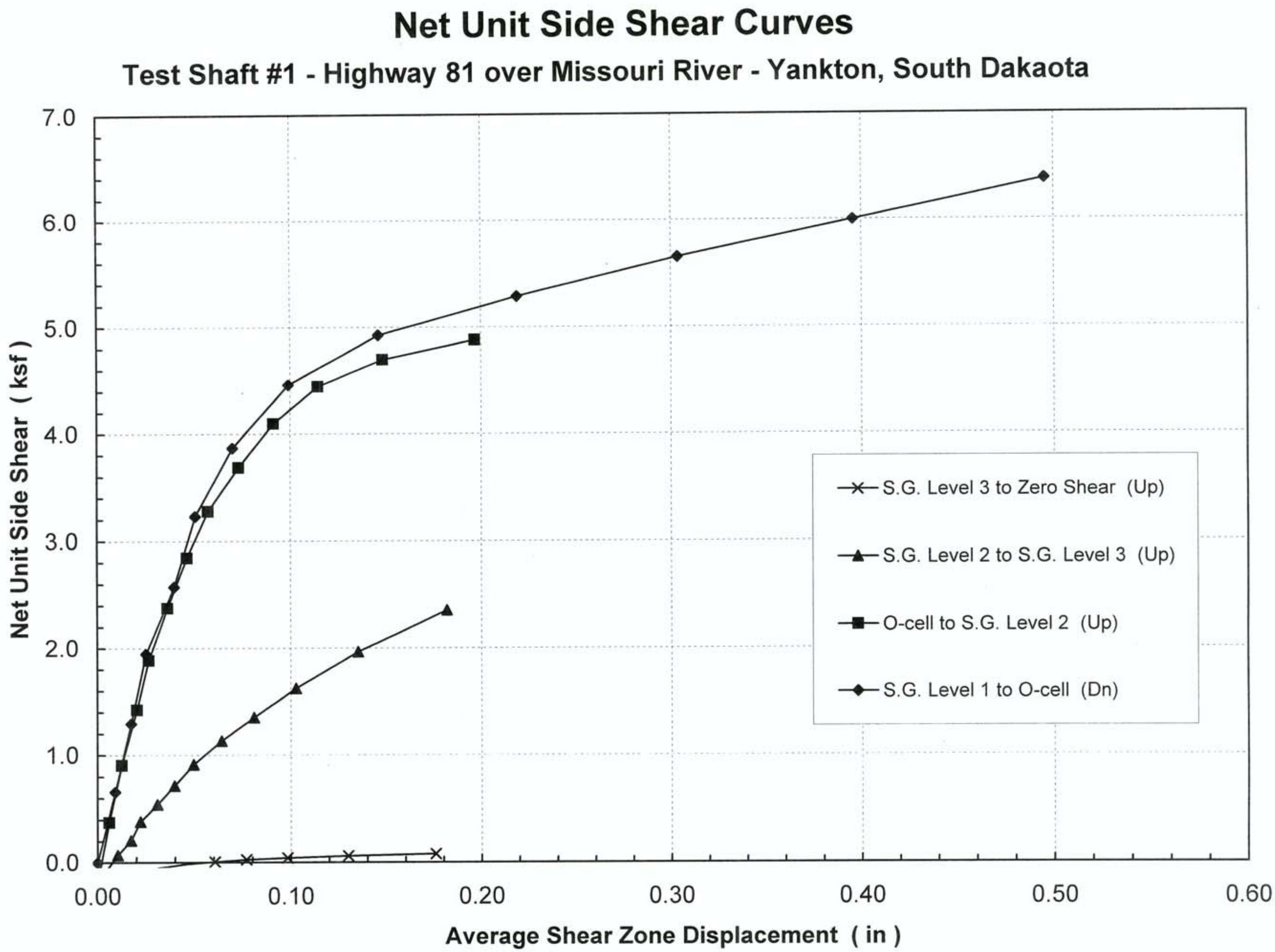
PROJECT NAME: Highway 81 Bridge

LOCATION: U.S. Highway 81 at the Missouri River, Yankton, South Dakota

PROJECT NUMBER: 41298

APPENDIX F

NET UNIT SHEAR CURVES



Net Unit Side Shear Curves
Test Shaft #1 - Highway 81 over Missouri River - Yankton, South Dakaota
Net Unit Side Shear (ksf)
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0.00
0.10
0.20
0.30
0.40
0.50
0.60
Average Shear Zone Displacement (in)
S.G. Level 3 to Zero Shear (Up)
S.G. Level 2 to S.G. Level 3 (Up)
O-cell to S.G. Level 2 (Up)
S.G. Level 1 to O-cell (Dn)

APPENDIX G

HYPERBOLIC CURVE FITTING

uper portion of shaft

Hyperbolic Curve Fit

Test Shaft #1 - Highway 81 over Missouri River - Yankton, South Dakaota

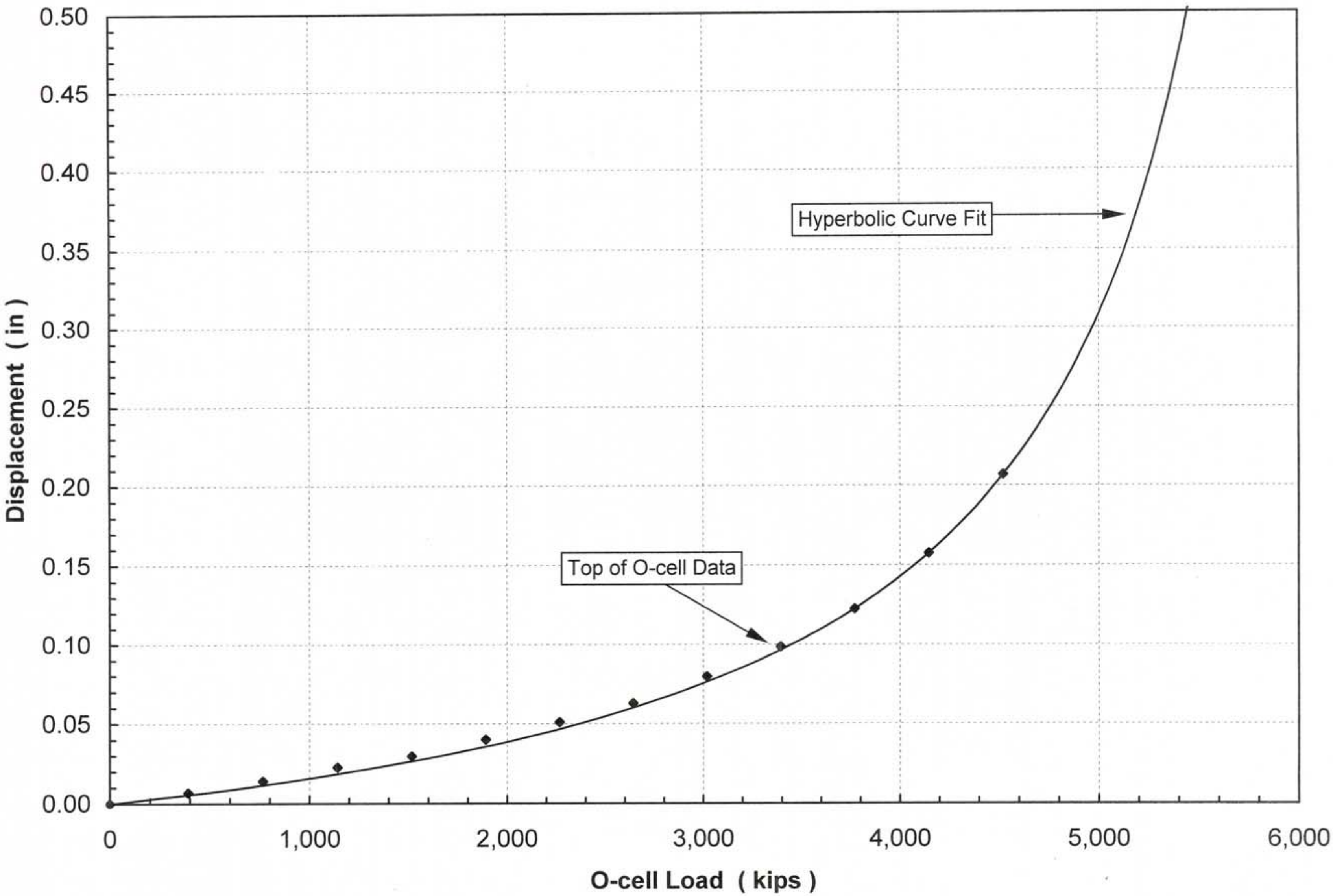
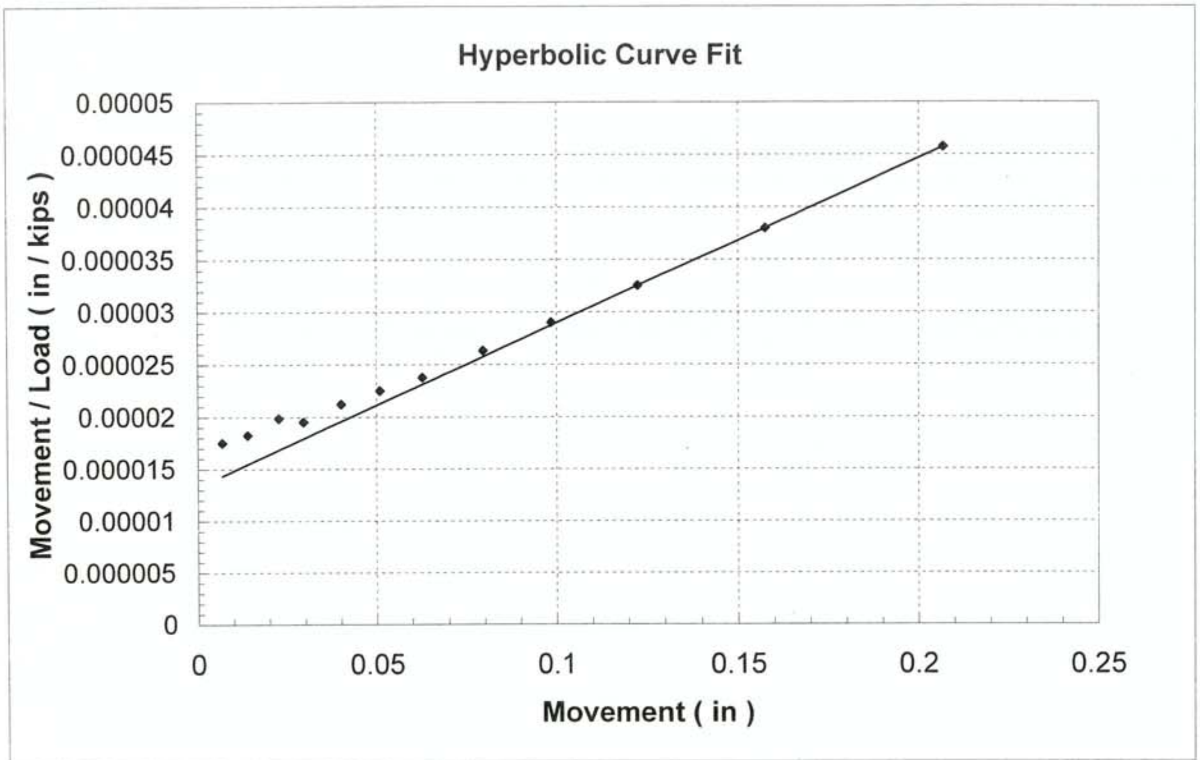


Table G-1: Hyperbolic Curve Fit of Upward Top of O-cell Movement

Net Load (kips)	Gross Load (kips)	Up* (in)	Y_u* (in/kip)	$Y_{u\ calc}$ (in/kip)	Gross $Load_{calc}$ (kips)
0	0	0.000	-	-	-
0	389	0.007	0.0000175	0.0000143	476
374	765	0.014	0.0000183	0.0000155	904
749	1141	0.023	0.0000199	0.0000168	1346
1125	1516	0.030	0.0000195	0.0000179	1651
1501	1892	0.040	0.0000212	0.0000196	2050
1877	2268	0.051	0.0000225	0.0000213	2397
2252	2643	0.063	0.0000238	0.0000231	2716
2628	3019	0.080	0.0000264	0.0000258	3088
3004	3395	0.099	0.0000290	0.0000287	3429
3379	**3771**	**0.123**	0.0000325	0.0000325	3771
3755	**4146**	**0.158**	0.0000380	0.0000380	4146
4131	**4522**	**0.207**	0.0000457	0.0000457	4522

* Values in **bold** are used in the curve fit.



SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.999999746
R Square	0.999999491
Adjusted R Squ	0.999998982
Standard Error	6.69829E-09
Observations	3

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	8.81847E-11	8.81847E-11	1965464.586	0.000454096
Residual	1	4.48671E-17	4.48671E-17		
Total	2	8.81848E-11			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	1.32757E-05	1.85839E-08	714.3649105	0.000891168	1.30396E-05	1.35118E-05	1.30396E-05	1.35118E-05
X Variable 1	0.000156957	1.11956E-07	1401.950279	0.000454096	0.000155534	0.000158379	0.000155534	0.000158379

APPENDIX H

POST TEST GROUTING PROCEDURE

POST-TEST GROUTING PROCEDURES FOR PRODUCTION DRILLED SHAFTS TESTED WITH AN OSTERBERG CELL

During the O-cell™ test, the shaft breaks on a horizontal plane separating the upper section above the O-cell™ (upper side shear) from the lower section below (combined end bearing and lower side shear). This creates an annular space, the size of which depends on the shaft/O-cell™ geometry and the expansion of the O-cell™.

When a production shaft has been tested, the Engineer may want to include the end bearing component from the lower section in order to obtain sufficient capacity of the production shaft. In such cases the contractor will be required to grout the O-cell™ and the annular space around the O-cell™ in order to allow load transfer to the lower side shear and end bearing.

POST-TEST GROUTING OF OSTERBERG CELLS

a) The grout shall consist of Portland cement and water only, **NO SAND**. The grout shall be fluid and pumpable. An initial mix consisting of 6 to 7 gallons of water per 95-lb bag of cement is recommended. Adjust water to obtain desired consistency.
b) The mixing shall be thorough to ensure that there are no lumps of dry cement. Pass the grout through a window screen mesh before pumping.
c) Connect the grout pump outlet to one hydraulic line of the O-cell™. Open the other line and establish a flow of water through the system.
d) Pump the grout through the O-cell™ hydraulic line while collecting the effluent from the bleed line. Monitor characteristics of effluent material and when it becomes equivalent to the grout being pumped, stop pumping.
e) Take three samples of the grout for compression testing @ 28 days, if required.

Recommended pre-mixed amount of grout for grouting of O-cell™:				
O-cell Diameter (Inches)	13	21	26	34
Grout Volume (Cubic Feet)	4	7	9	13

POST-TEST GROUTING OF ANNULAR SPACE AROUND OSTERBERG CELLS

a) Prepare a fluid grout mix consisting of Portland cement and water only, **NO SAND**. The mixing procedures should be as outlined for grouting the O-cells™. The quantity of grout should be at least three (3) times the theoretical volume required to fill the annular space and grout pipes.
b) Pump water and establish a flow through the grout pipes (two per shaft).
c) Pump the fluid grout through one of the grout pipes until grout is observed flowing from the second grout pipe or until 1.5 times the theoretical volume has been pumped.
d) If no return of grout is observed from the second grout pipe, transfer the pump to the second pipe and pump grout through it until 1.5 times the theoretical volume has been pumped.
e) If higher strength grout is deemed necessary, immediately proceed with pumping the higher strength grout (which may be a sand mix). The pumping procedures for this grout will be the same as described above for the initial cement-water grout. **The entire grouting operation must be completed before the set time for the initial grout has elapsed.**
f) Take three (3) samples of each type of grout for compression testing @ 28 days.

Recommended pre-mix amount of grout for grouting of annular space:								
Shaft Diameter (Feet)	2	3	4	5	6	7	8	9
Grout Volume (Cubic Feet)	25	30	40	50	65	80	100	125