

JOHNSONVILLE

Ponded Fly Ash (New Dredge Cell)

Ponded Fly Ash (Old Dredge Cell)

Ponded Fly Ash (Active Ash Pond)

Bottom Ash - From Pond



JOHNSONVILLE

Ponded Fly Ash (New Dredge Cell)

Grain Size Distribution Test Report
Moisture-Density Relationship (Standard Proctor)
Moisture-Density Relationship (Modified Proctor)
Consolidation Test Report
Hydraulic Conductivity - Falling Head (2 Pages)
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Direct Shear Test
California Bearing Ratio
Resilient Modulus (Standard Proctor) (9 Pages)
Resilient Modulus (Modified Proctor) (9 Pages)

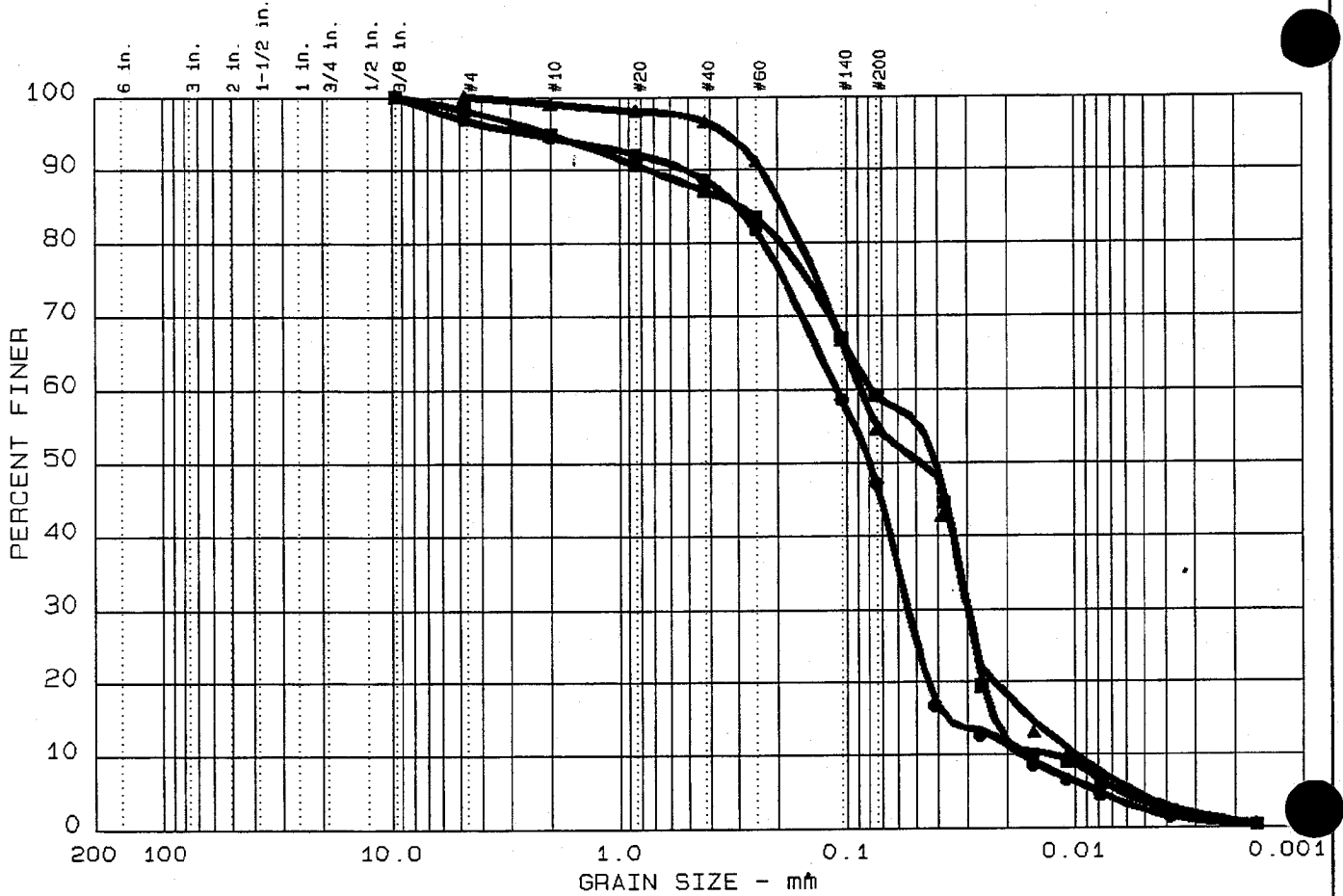


TVA - JOHNSONVILLE
PONDED FLY ASH (NEW DREDGE CELL) - DuPont

Description	Test Method	Property	Sample 1	Sample 2	Sample 3
Grain Size	ASTM D 422	Percent Retained on the #4 Sieve	3.2	0.0	1.8
		Percent Passing the #200 Sieve	47.1	54.4	59.2
		Percent Passing the 0.005 mm Sieve	2.4	4.2	3.5
Atterberg Limits	ASTM D 4318	Liquid Limit	NL	NL	NL
		Plastic Limit	NP	NP	NP
		Plasticity Index	N/A	N/A	N/A
Specific Gravity	ASTM D 854	Specific Gravity at 20°C	2.36	2.56	2.31
Classification	ASTM D 2487	Unified Soil Classification System (USCS)	SM	ML	ML
	AASHTO M 145	AASHTO Classification	A-4(0.0)	A-4(0.0)	A-4(0.0)
Composite Sample					
Moisture-Density Relations (Standard Effort)	ASTM D 698	Maximum Dry Density, pcf	75.8		
		Optimum Moisture Content, %	31.4		
Moisture-Density Relations (Modified Effort)	ASTM D 1557	Maximum Dry Density, pcf	92.5		
		Optimum Moisture Content, %	20.6		
			Result	Dry Density, pcf	Moisture Content, %
Consolidation	ASTM D2435	Compression Index C_c	0.06	68.3	31.3
Hydraulic Conductivity	ASTM D 5084	Hydraulic Conductivity, cm/sec	5.0E-4	71.0	33.9
Triaxial Shear Strength Consolidated-Undrained (CU)	ASTM D4767	Effective Stress, Cohesion, c' , ksf	0.23	70.7	34.5
		Effective Stress, Internal Friction Angle, ϕ' , degrees	32.4		
		Total Stress, Cohesion, c , ksf	1.26	70.7	34.5
		Total Stress, Internal Friction Angle, ϕ , degrees	25.8		
Direct Shear Strength	ASTM D 3080	Cohesion, c , ksf	1.29	68.4	30.4
		Internal Friction Angle, ϕ , degrees	32.4		
California Bearing Ratio	ASTM D 1883	CBR, %	12	69.5	33.3
Resilient Modulus (Standard Compactive Effort)	SHRP P46	Resilient Modulus at 4psi axial stress and 4psi confining pressure	3,769	69.9	32.9
Resilient Modulus (Modified Compactive Effort)	SHRP P46	Resilient Modulus at 4psi axial stress and 4psi confining pressure	4,917	83.1	21.6
Soil Resistivity	AASHTO T 288	Minimum Resistivity, Ohm-cm	2,800		
pH of Soil	AASHTO T 289	pH	8.1		
Water Soluble Sulfate Ion	AASHTO T 290	Sulfate Ion Content, mg/kg	83		
Water Soluble Chloride Ion	AASHTO T 290	Chloride Ion Content, mg/kg	<10		

jof-fan.xls

GRAIN SIZE DISTRIBUTION TEST REPORT



Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
● 18	0.0	3.2	49.7	44.7	2.4
▲ 19	0.0	0.0	45.6	50.2	4.2
■ 20	0.0	1.8	39.0	55.7	3.5

	LL	PI	D ₈₅	D ₆₀	D ₅₀	D ₃₀	D ₁₅	D ₁₀	C _c	C _u
●	NL	NP	0.30	0.11	0.08	0.054	0.0364	0.0170	1.54	6.5
▲	NL	NP	0.19	0.09	0.05	0.029	0.0156	0.0098	1.01	8.8
■	NL	NP	0.30	0.08	0.04	0.030	0.0228	0.0121	0.94	6.4

MATERIAL DESCRIPTION	USCS	AASHTO
● New Dredge Cell	SM	A-4 (0.0)
▲ New Dredge Cell	ML	A-4 (0.0)
■ New Dredge Cell	ML	A-4 (0.0)

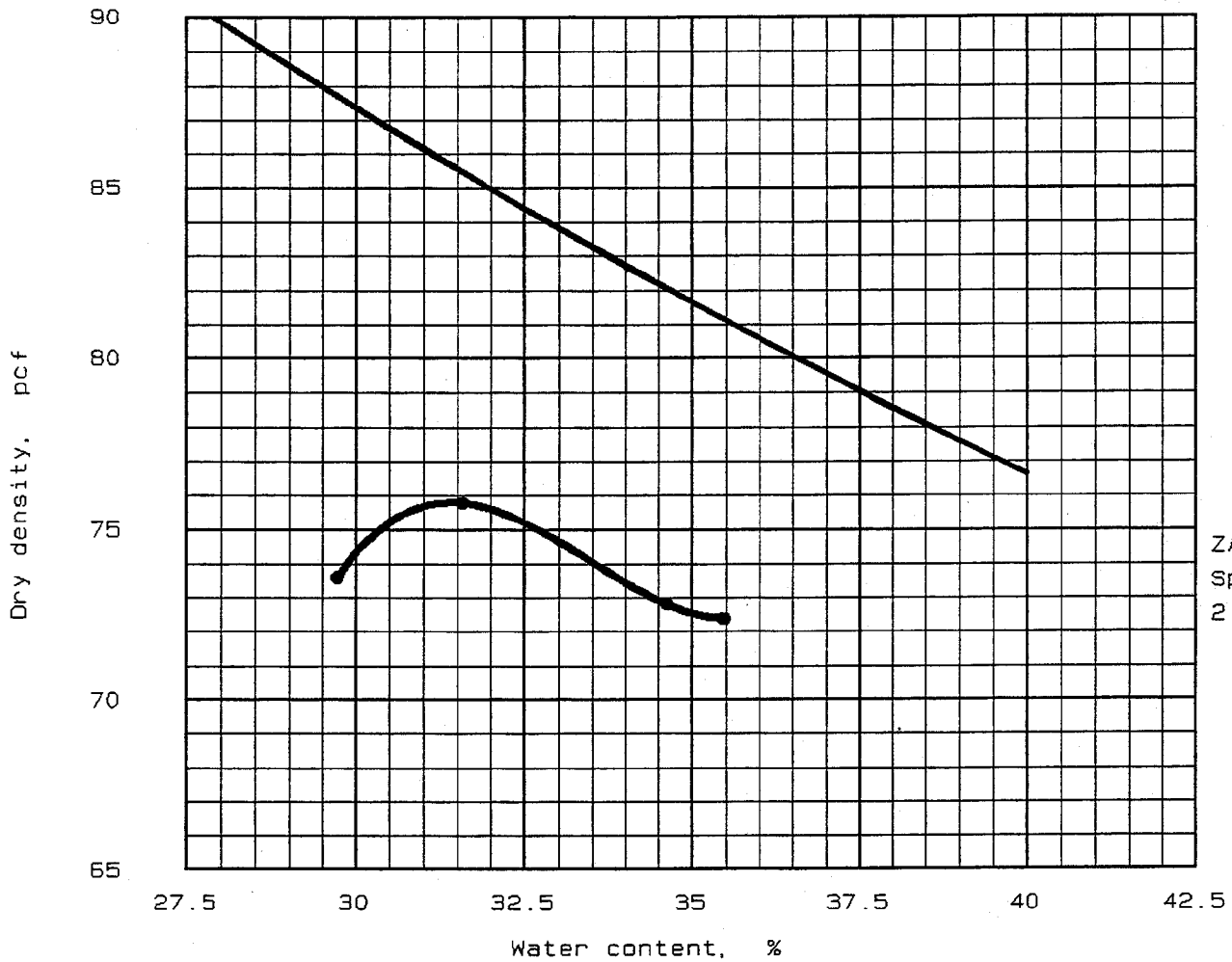
Project No.: 5810860101
 Project: TVA - Johnsonville
 ● Location: Poned Fly Ash A & B
 ▲ Location: Poned Fly Ash C & D
 ■ Location: Poned Fly Ash E & F
 Date: July 18, 1995

Remarks:
 Tested by: *JCR*
 Reviewed by: *HS*

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Figure No.

MOISTURE-DENSITY RELATIONSHIP



"Standard" Proctor, ASTM D 698, Method A

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No. 4	% < No. 200
	USCS	AASHTO						
	ML (SM)	A-4 (0.0)	33.0 %	2.41	.NL	NP	1.67 %	53.6 %

TEST RESULTS	MATERIAL DESCRIPTION
Optimum moisture = 31.4 % Maximum dry density = 75.8 pcf	

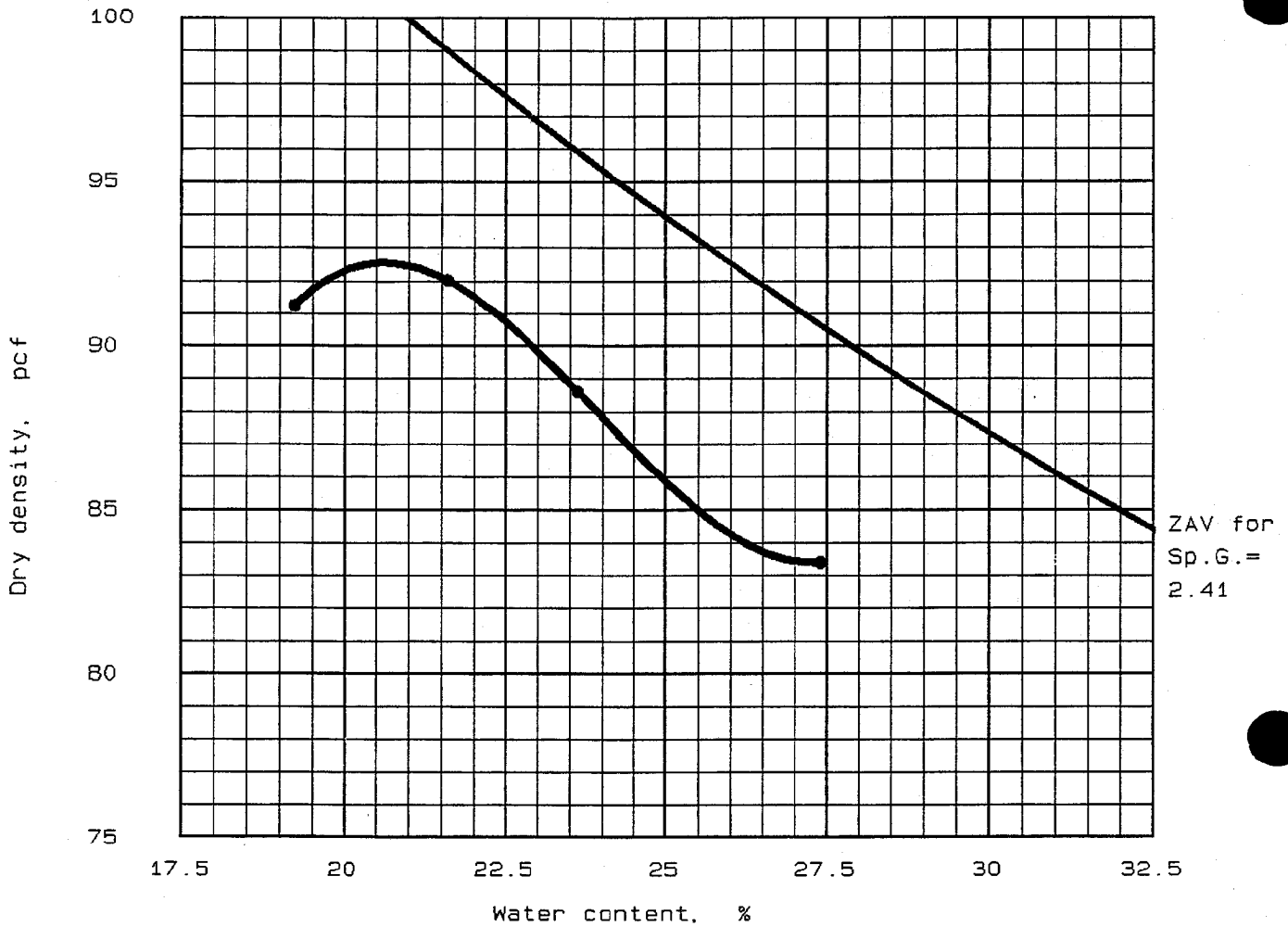
Project No.: 5810860101
 Project: TVA - Johnsonville
 Location: Ponded Fly Ash
 New Dredge Cell
 Date: July 25, 1995

Remarks:
 Tested by: *JCR*
 Reviewed by: *HS*

MOISTURE-DENSITY RELATIONSHIP
LAW ENGINEERING, INC.

Figure No. _____

MOISTURE-DENSITY RELATIONSHIP



"Modified" Proctor, ASTM D 1557, Method A

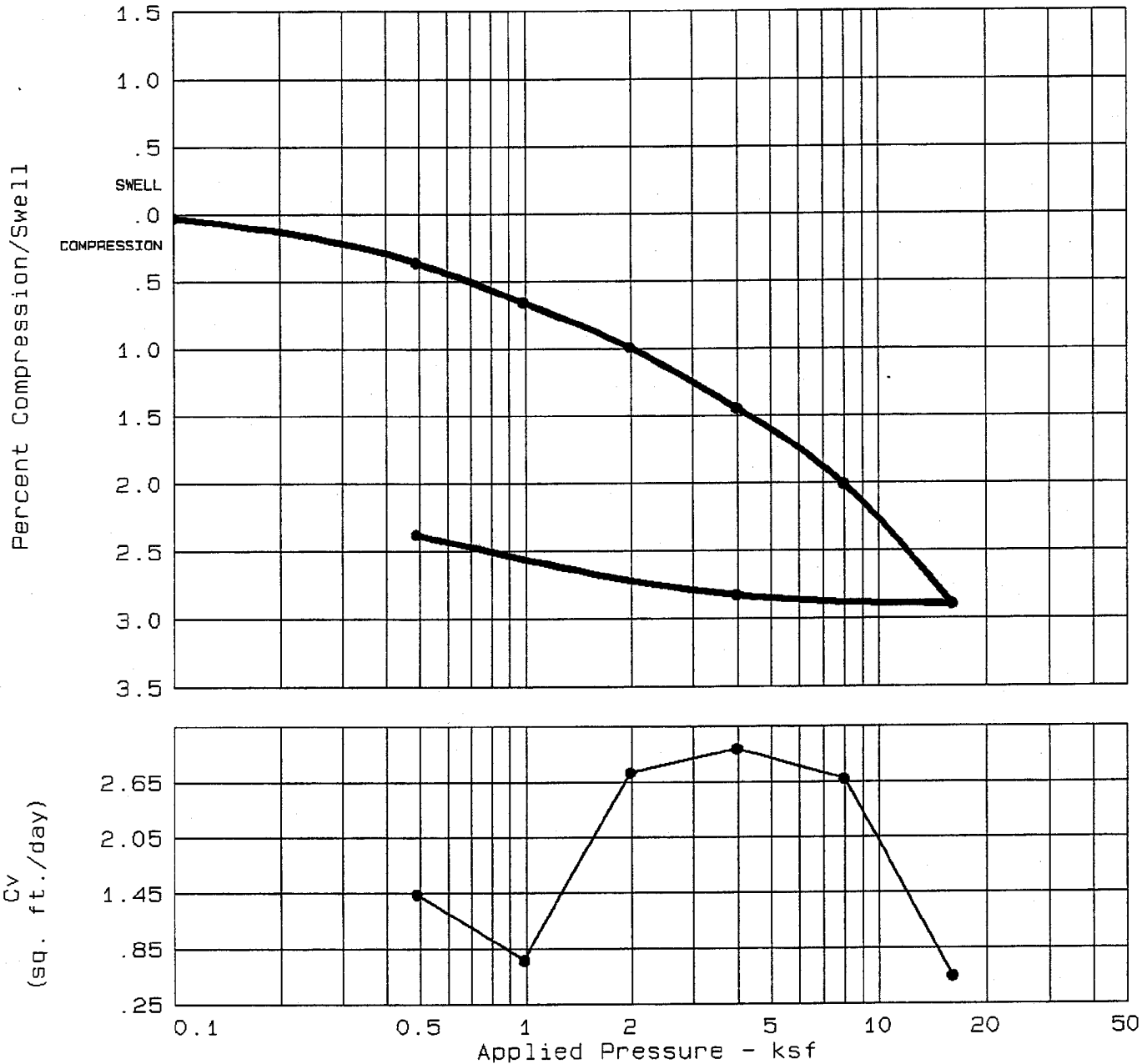
Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No. 4	% < No. 200
	USCS	AASHTO						
	ML (SM)	A-4 (0.0)	33.0 %	2.41	NL	NP	1.67 %	53.6 %

TEST RESULTS	MATERIAL DESCRIPTION
Optimum moisture = 20.6 % Maximum dry density = 92.5 pcf	

Project No.: 5810850101 Project: TVA - Johnsonville Location: Poned Fly Ash New Dredge Cell Date: July 25, 1995	Remarks: Tested by: <i>JCR</i> Reviewed by: <i>HS</i>
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MOISTURE-DENSITY RELATIONSHIP LAW ENGINEERING, INC.	Figure No. _____
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CONSOLIDATION TEST REPORT



Natural Saturation	Natural Moisture	Dry Density	LL	PI	Sp. Gr.	Precons. press.	C _c	e ₀
62.7 %	31.3	68.3	NL	NP	2.410	8.00	0.06	1.2020

TEST RESULTS	MATERIAL DESCRIPTION
Compression Index = 0.06 Project No.: 5810860101 Project: TVA - Johnsonville Location: Poned Fly Ash New Dredge Cell Date: July 24, 1995	Class: USCS: SM, ML Remarks: Tested by: <i>ASR</i> Reviewed by: <i>HS</i>
CONSOLIDATION TEST REPORT LAW ENGINEERING, INC.	Fig. No. _____

HYDRAULIC CONDUCTIVITY



LAW ENGINEERING

Project No. **5810860101**
Project Name **TVA - Johnsonville**
Material (Source) **Ponded Fly Ash**
(New Dredge Cell)

Tested By **HEJ**
Test Date **08/04/95**
Reviewed By **RLB**
Review Date **09/06/95**

ASTM D5084 - Falling Head

Sample Type:	<i>Remolded</i>
Sample Orientation:	<i>Vertical</i>
Initial Water Content, %:	<i>33.9</i>
Wet Unit Weight, pcf:	<i>95.1</i>
Dry Unit Weight, pcf:	<i>71.0</i>
Compaction, %:	<i>93.7</i>
Hydraulic Conductivity, cm/sec. @20 °C:	5.0E-04

PERMEABILITY TEST - FALLING HEAD
(ASTM D5084 - 90)

LAW ENGINEERING

Job Number 5810860101 Tested By HEJ
 Project Name TVA - Johnsonville Test Date 08/04/95
 Material (Source) Ponded Fly Ash Reviewed By RLB
 (New Dredge Cell) Review Date 09/06/95

Chamber Pressure, psi 39
 Back Pressure, psi 25
 Confining Pressure, psi 14

Sample Data

Length, in	Diameter, in		Pan No.	
	Location 1	Location 2	Dry Soil+Pan, grams	Dry Soil+Pan, grams
6.000	2.830	2.830	703.55	703.55
6.000	2.830	2.830	0.00	0.00
6.000	2.830	2.830		
Average	2.830	2.830	Moisture Content, %	33.9
	Wet Soil + Tare, grams	941.76	Wet Unit Wt, pcf	95.1
	Tare Weight, grams	0.00	Dry Unit Wt, pcf	71.0

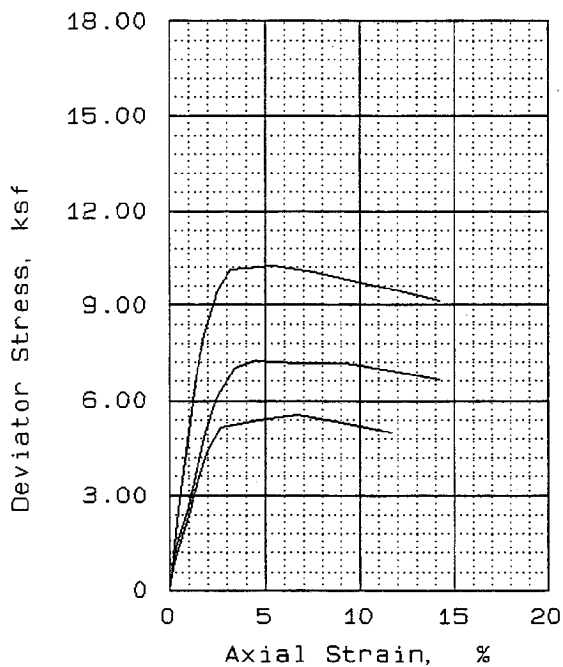
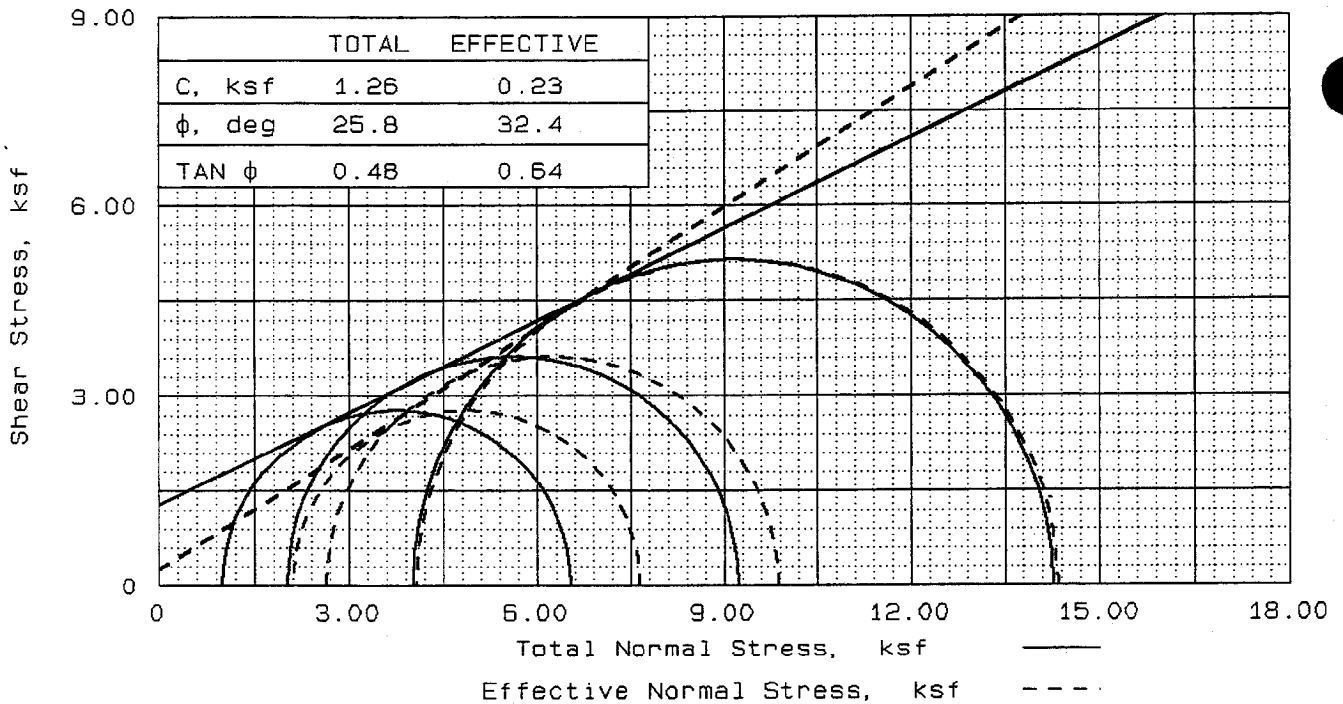
Date	Date	Time	Time	Time	Division	Division	H ₀	H _f	k	Temp	k
Start	Finish	Start	Finish	(sec)	Start	Finish	(cm)	(cm)	cm/sec	(°C)	cm/sec
				141	50.0	10.0	91.91	51.91	5.2E-04	21	5.1E-04
				142	50.0	10.0	91.91	51.91	5.1E-04	21	5.0E-04
				142	50.0	10.0	91.91	51.91	5.1E-04	21	5.0E-04

No. of Trial	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
3	Remolded	75.8	93.7	Vertical

Avg. k at 20 °C 5.0E-04 cm/sec

a = area of burette in cm² a = 0.34 cm²
 L = length of sample in cm A = 40.582 cm²
 A = area of sample in cm² L = 15.24 cm

H₀ = initial head in cm
 H_f = final head in cm
 t = time in seconds



SAMPLE NO.		1	2	3
INITIAL	WATER CONTENT, %	34.2	35.3	33.9
	DRY DENSITY, pcf	70.8	70.3	71.0
	SATURATION, %	73.2	74.5	73.0
	VOID RATIO	1.126	1.141	1.119
	DIAMETER, in	2.83	2.83	2.83
	HEIGHT, in	6.00	6.00	6.00
AT TEST	WATER CONTENT, %	46.1	45.9	44.9
	DRY DENSITY, pcf	71.2	71.4	72.2
	SATURATION, %	100.0	100.0	100.0
	VOID RATIO	1.112	1.106	1.083
	DIAMETER, in	2.82	2.81	2.81
	HEIGHT, in	6.00	5.99	5.98
BACK PRESSURE, ksf		3.59	3.61	3.60
CELL PRESSURE, ksf		4.58	7.62	5.60
FAILURE STRESS, ksf		5.55	10.26	7.24
PORE PRESSURE, ksf		2.48	3.54	2.97
STRAIN RATE, %/min.		0.100	0.100	0.100
ULTIMATE STRESS, ksf				
PORE PRESSURE, ksf				
$\bar{\sigma}_1$ FAILURE, ksf		7.65	14.34	9.87
$\bar{\sigma}_3$ FAILURE, ksf		2.1	4.08	2.64

TYPE OF TEST:
 CU with pore pressures
 SAMPLE TYPE: Remolded
 DESCRIPTION:
 LL= NL PL= NP PI=
 SPECIFIC GRAVITY= 2.41
 REMARKS: Tested by: *HS*

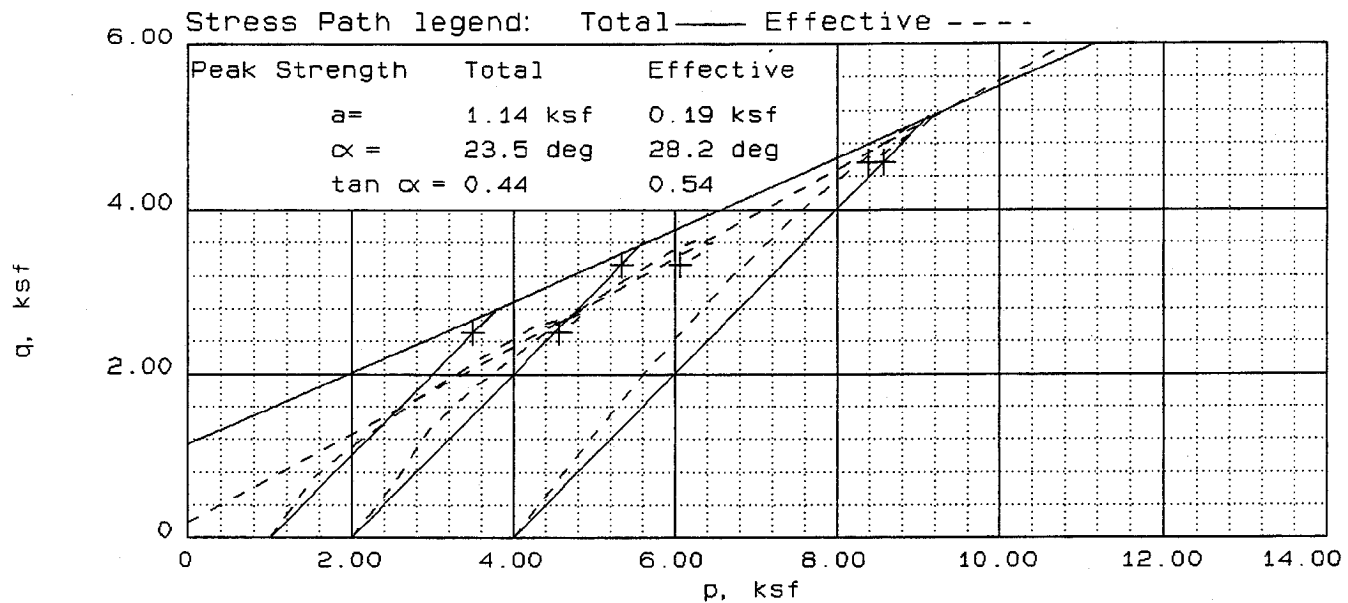
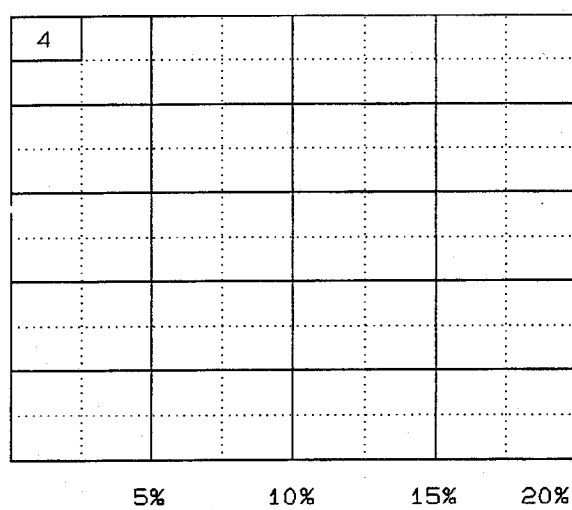
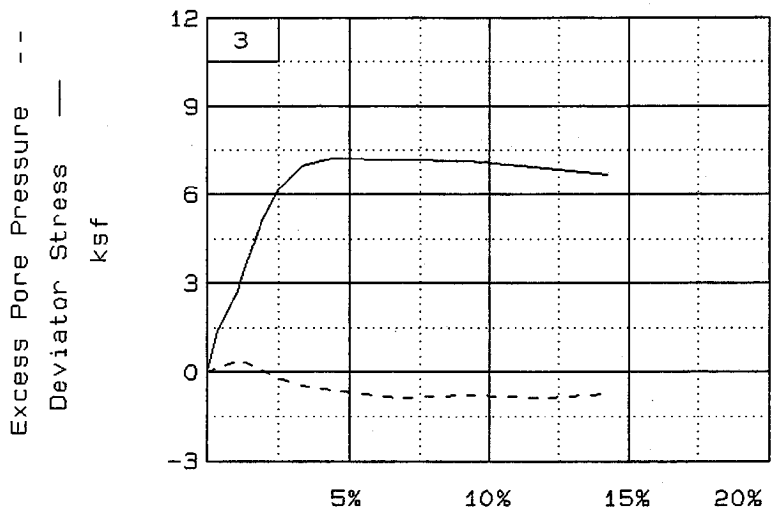
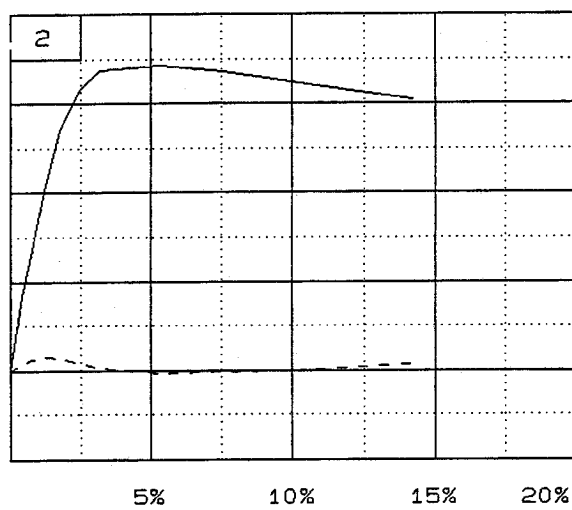
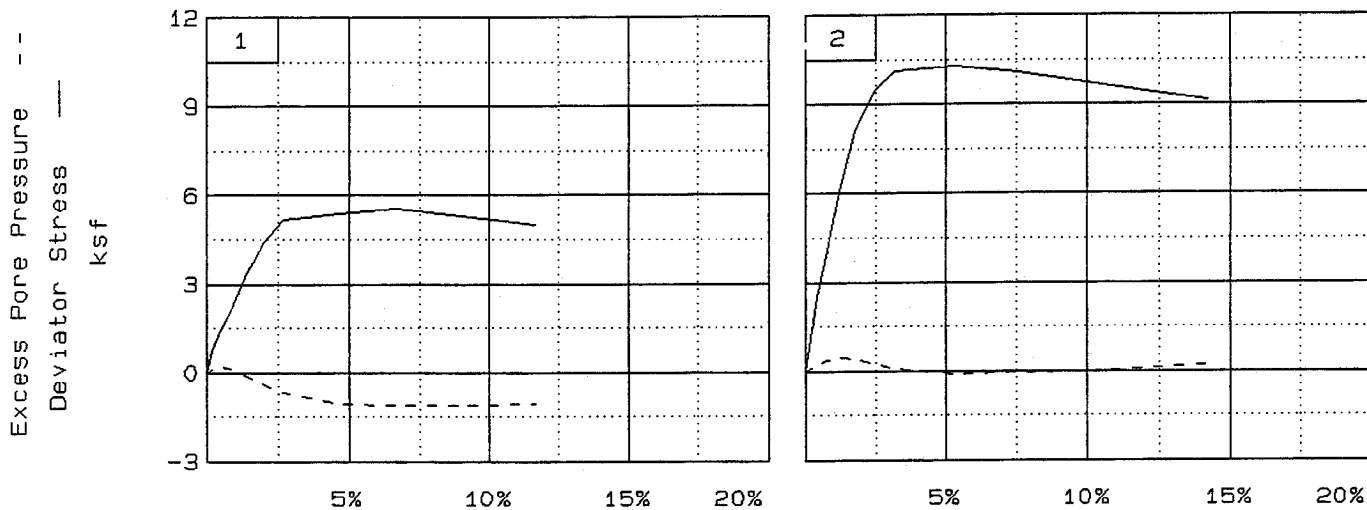
Reviewed by: *RIB*

CLIENT:
 PROJECT: TVA -- Johnsonville
 SAMPLE LOCATION: Poned Fly Ash
 New Dredge Cell
 PROJ. NO.: 5810860101 DATE: August 24, 1995

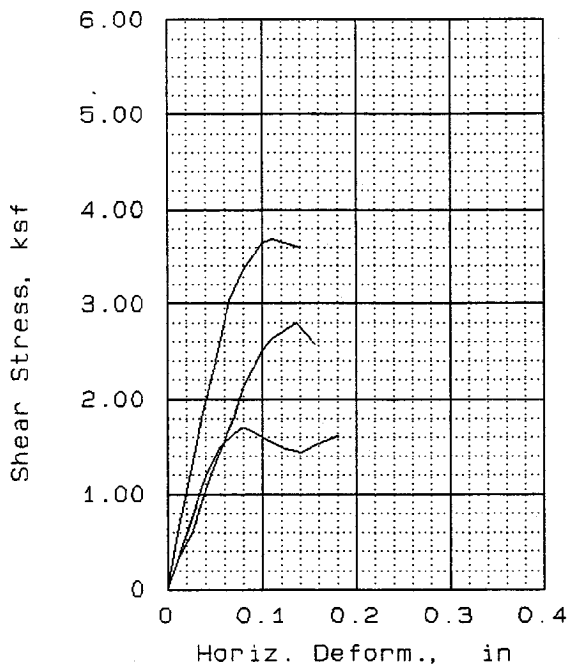
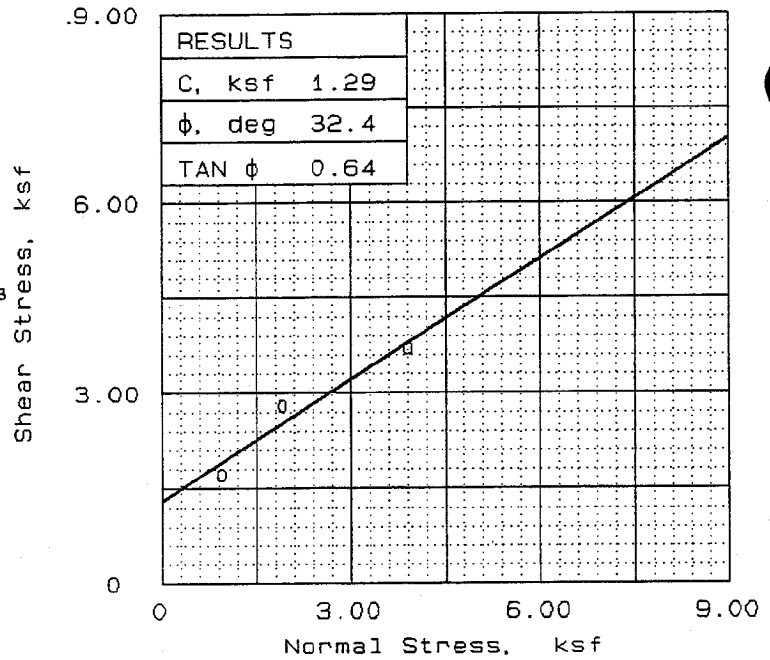
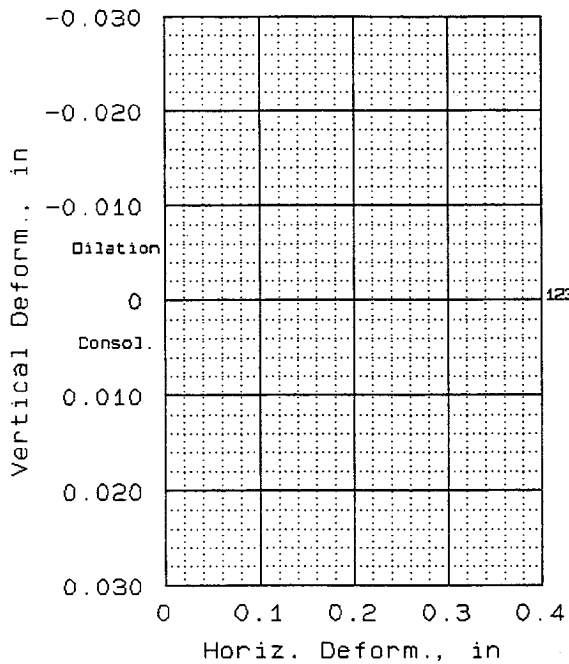
TRIAxIAL COMPRESSION TEST

LAW ENGINEERING, INC.

FIG. NO.



Client:
 Project: TVA - Johnsonville
 Location: Poned Fly Ash New Dredge Cell
 File: 8601K Project No.: 5810860101



SAMPLE NO.		1	2	3
INITIAL	WATER CONTENT, %	30.2	30.4	30.7
	DRY DENSITY, pcf	68.6	68.7	67.9
	SATURATION, %	61.0	61.6	60.8
	VOID RATIO	1.193	1.189	1.217
	DIAMETER, in	2.50	2.50	2.50
	HEIGHT, in	0.81	0.81	0.81
AT TEST	WATER CONTENT, %	30.2	30.4	30.7
	DRY DENSITY, pcf	68.6	68.7	67.9
	SATURATION, %	61.0	61.6	60.8
	VOID RATIO	1.193	1.189	1.217
	DIAMETER, in	2.50	2.50	2.50
	HEIGHT, in	0.81	0.81	0.81
NORMAL STRESS, ksf		0.97	1.94	3.94
MAX. SHEAR, ksf		1.71	2.80	3.70
STRAIN RATE, %/min.		0.500	0.500	0.500
ULT. SHEAR, ksf				

SAMPLE DATA
 SAMPLE TYPE: Remolded
 DESCRIPTION:
 LL= NL PL= NP PI=
 SPECIFIC GRAVITY= 2.41
 REMARKS: Tested by: *HJ*
 Reviewed by: *RUB*

CLIENT:
 PROJECT: TVA - Johnsonville
 SAMPLE LOCATION: Poned Fly Ash
 New Dredge Cell
 PROJ. NO.: 5810860101 DATE: August 28, 1995

DIRECT SHEAR TEST
LAW ENGINEERING, INC.

FIG. NO.

California Bearing Ratio

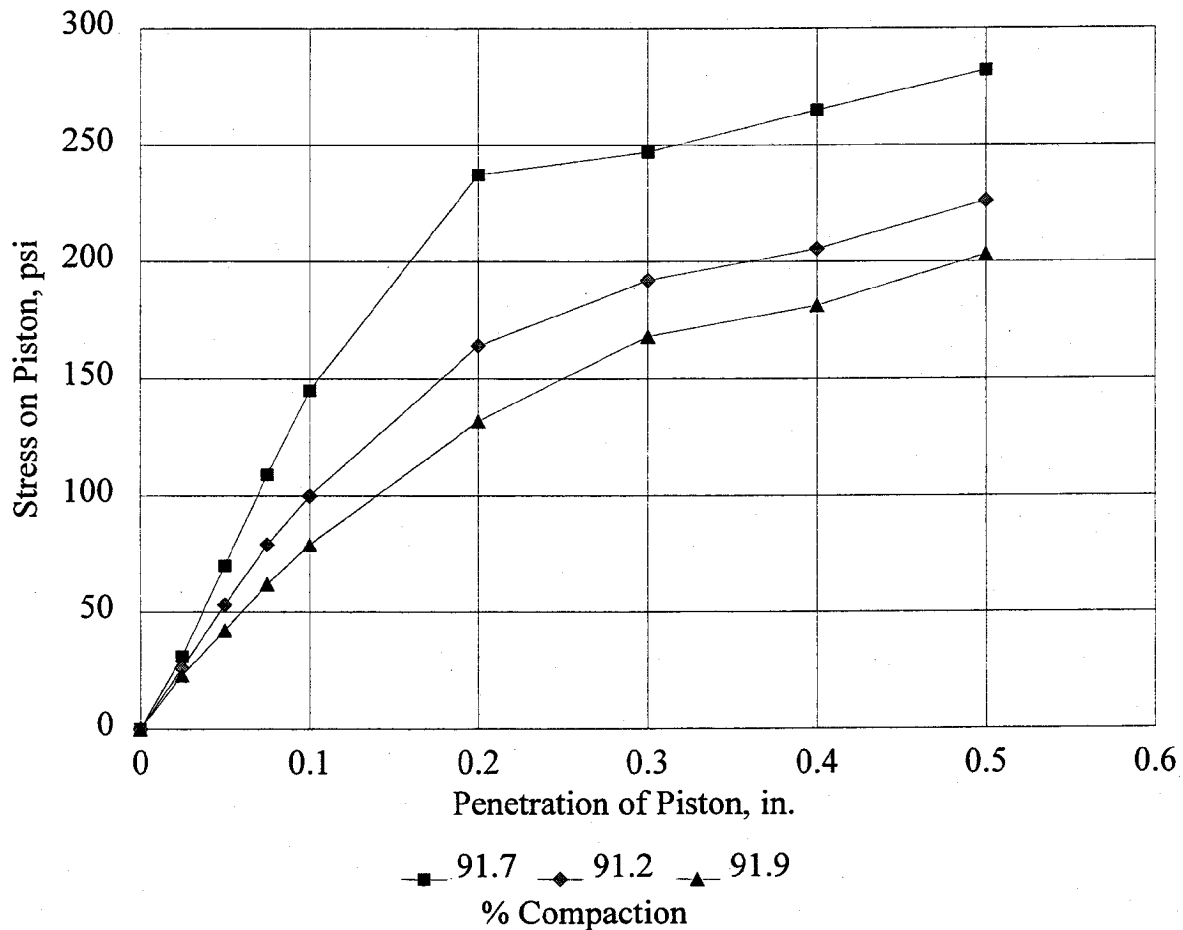
(ASTM D1883-92)



LAW ENGINEERING

Project No.	<u>5810860101</u>	Tested By	<u>EM</u>
Project Name	<u>TVA - Johnsonville</u>	Test Date	<u>07/27/95</u>
Material (Source)	<u>Ponded Fly Ash (New Dredge Cell)</u>	Reviewed By	<u>RLB</u>
		Review Date	<u>08/16/95</u>

Compaction, %	91.7	91.2	91.9
Before Soak Dry Density, pcf	69.5	69.2	69.7
Before Soak Moisture Content,	34.2	35.4	30.4
After Soak Dry Density, pcf	69.8	69.4	69.9
After Soak Moisture Content, %	37.3	38.0	39.6
CBR @ 0.1 in.	14.5	10.0	7.9
CBR @ 0.2 in.	15.8	10.9	8.8



LABORATORY MATERIAL HANDLING AND TESTING
 LABORATORY MATERIAL TEST DATA
 RESILIENT MODULUS OF UNBOUND GRANULAR BASE/SUBBASE
 MATERIALS AND SUBGRADE SOILS
 LAB DATA SHEET T46 - RECOMPACTED SAMPLES

SHEET NO 1 OF 2

UNBOUND GRANULAR BASE/SUBBASE LAYERS AND SUBGRADE SOILS
 SHRP TEST DESIGNATION UG07, SS07/SHRP PROTOCOL P46

LABORATORY PERFORMING TEST: LAW ENGINEERING, INC. - ATLANTA, GEORGIA

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study

LAW PROJECT NO.: 5810860101

1.	MATERIAL SOURCE:	Johnsonville		
2.	MATERIAL DESCRIPTION:	Ponded Fly Ash (New Dredge Cell)		
3.	REMODELING TARGETS:	95% Standard Dry Density at Optimum Moisture Content		
4.	MATERIAL TYPE (Type 1 or Type 2)			2
5.	TEST INFORMATION			
	PRECONDITIONING - GREATER THAN 5% PERM. STRAIN? (Y = YES OR N = NO)			N
	TESTING - GREATER THAN 5% PERM. STRAIN? (Y = YES OR N = NO)			N
	TESTING - NUMBER OF LOAD SEQUENCES COMPLETED (0 - 15)			15
6.	SPECIMEN INFO.:			
	SPECIMEN DIAM., inch			
	TOP			2.85
	MIDDLE			2.86
	BOTTOM			2.85
	AVERAGE			2.85
	MEMBRANE THICKNESS (1), inch			0.01
	MEMBRANE THICKNESS (2), inch			0.01
	NET DIAM., inch			2.83
	HEIGHT OF SPECIMEN, CAP AND BASE, inch			6.12
	HEIGHT OF CAP AND BASE, inch			0.00
	INITIAL LENGTH, L ₀ , inch			6.12
	INITIAL AREA, A ₀ , in ²			6.31
	INITIAL VOLUME A ₀ L ₀ , in ³			38.57
7.	SOIL SPECIMEN WEIGHT:			
	INITIAL WEIGHT OF CONTAINER AND WET SOIL, grams			940.88
	FINAL WEIGHT OF CONTAINER AND WET SOIL, grams			0.00
	WEIGHT OF WET SOIL USED, grams			940.88
8.	SOIL PROPERTIES.:			
	IN SITU MOISTURE CONTENT (NUCLEAR), %			N/A
	IN SITU WET DENSITY (NUCLEAR), pcf			N/A
	or			
	OPTIMUM MOISTURE CONTENT, %			31.4
	MAX. DRY DENSITY, pcf			75.8
	95 % MAX. DRY DENSITY, pcf			72.0
9.	SPECIMEN PROPERTIES:			
	COMPACTION MOISTURE CONTENT, %			32.9
	MOISTURE CONTENT AFTER RESILIENT MODULUS TESTING, %			32.9
	COMPACTION DRY DENSITY, γ _d pcf			69.9
10.	QUICK SHEAR TEST			
	STRESS - STRAIN PLOT ATTACHED (Y = YES, N = NO)			Y
	TRIAxIAL SHEAR MAXIMUM STRENGTH (MAX. LOAD/X-SECTION AREA), psi			23.1
	SPECIMEN FAIL DURING TRIAXIAL SHEAR? (Y = YES, N = NO)			Y
11.	COMMENTS (Section 10.4 of Protocol P46)			
	(a) CODE	0	0	0
	(b) NOTE	0	0	0
12.	TEST DATE			07-31-1995

GENERAL REMARKS:

SUBMITTED BY, DATE

R. J. Boudreau 9/5/95
 LABORATORY MANAGER

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study
LAW PROJECT NO.: 5810860101
1. MATERIAL SOURCE: Johnsonville
2. MATERIAL DESCRIPTION: Ponded Fly Ash (New Dredge Cell)
3. REMOLDING TARGETS: 95% Standard Dry Density at Optimum Moisture Content
4. MATERIAL TYPE: 2
5. TEST DATE: 07-31-1995
6. RESILIENT MODULUS TESTING

COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
PARAMETER	Chamber Confining Pressure	Nominal Maximum Axial Stress	Cycle No.	Actual Applied Max. Axial Load	Actual Applied Cyclic Load	Actual Applied Contact Load	Actual Applied Max. Axial Stress	Actual Applied Cyclic Stress	Actual Applied Contact Stress	Recov. Def. LVDT #1 Reading	Recov. Def. LVDT #2 Reading	Average Recov Def. LVDT 1 and 2	Resilient Strain	Resilient Modulus
DESIGNATION	S_3	S_{cyclic}	C_1	P_{max}	P_{cyclic}	$P_{contact}$	S_{max}	S_{cyclic}	$S_{contact}$	H_1	H_2	H_{avg}	ϵ	
UNIT	psi	psi	---	lbs	lbs	lbs	psi	psi	psi	in.	in.	in.	in/in	psi
PRECISION														
SEQUENCE 1	6.0	2.0	1	12.8	11.5	1.3	2.0	1.8	0.2	0.00195	0.00203	0.00199	0.00032	5,596
			2	12.6	11.4	1.3	2.0	1.8	0.2	0.00195	0.00202	0.00199	0.00032	5,552
			3	12.7	11.4	1.3	2.0	1.8	0.2	0.00197	0.00203	0.00200	0.00033	5,533
			4	12.6	11.3	1.3	2.0	1.8	0.2	0.00197	0.00203	0.00200	0.00033	5,492
			5	12.6	11.4	1.3	2.0	1.8	0.2	0.00199	0.00202	0.00200	0.00033	5,511
	COLUMN AVERAGE			12.7	11.4	1.3	2.0	1.8	0.2	0.00197	0.00203	0.00200	0.00033	5,537
	STANDARD DEV.			0.1	0.0	0.0	0.0	0.0	0.0	0.00002	0.00001	0.00001	0.00000	40

Source: Johnsonville		Description: Ponded Fly Ash (New Dredge Cell)										95% Standard Dry Density at Optimum Moisture Content				
SEQUENCE 2	6.0	4.0	1	25.3	22.9	2.4	4.0	3.6	0.4	0.00393	0.00392	0.00393	0.00064	5,663		
			2	25.3	22.9	2.4	4.0	3.6	0.4	0.00391	0.00392	0.00391	0.00064	5,665		
			3	25.2	22.8	2.4	4.0	3.6	0.4	0.00390	0.00391	0.00391	0.00064	5,669		
			4	25.2	22.8	2.4	4.0	3.6	0.4	0.00392	0.00392	0.00392	0.00064	5,640		
			5	25.2	22.8	2.4	4.0	3.6	0.4	0.00391	0.00393	0.00392	0.00064	5,640		
	COLUMN AVERAGE		25.2	22.8	2.4	4.0	3.6	0.4	0.00392	0.00392	0.00392	0.00064	5,655			
	STANDARD DEV.		0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	14		
SEQUENCE 3	6.0	6.0	1	37.8	34.2	3.6	6.0	5.4	0.6	0.00594	0.00596	0.00595	0.00097	5,576		
			2	37.7	34.1	3.6	6.0	5.4	0.6	0.00596	0.00594	0.00595	0.00097	5,560		
			3	37.8	34.2	3.6	6.0	5.4	0.6	0.00597	0.00595	0.00596	0.00097	5,560		
			4	37.8	34.2	3.6	6.0	5.4	0.6	0.00598	0.00596	0.00597	0.00098	5,553		
			5	37.9	34.3	3.6	6.0	5.4	0.6	0.00596	0.00596	0.00596	0.00097	5,576		
	COLUMN AVERAGE		37.8	34.2	3.6	6.0	5.4	0.6	0.00596	0.00595	0.00596	0.00097	5,565			
	STANDARD DEV.		0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.00002	0.00001	0.00001	0.00000	11		
SEQUENCE 4	6.0	8.0	1	50.0	45.6	4.4	7.9	7.2	0.7	0.00815	0.00815	0.00815	0.00133	5,427		
			2	50.1	45.7	4.4	7.9	7.2	0.7	0.00815	0.00813	0.00814	0.00133	5,443		
			3	50.0	45.6	4.4	7.9	7.2	0.7	0.00817	0.00815	0.00816	0.00133	5,417		
			4	50.0	45.6	4.4	7.9	7.2	0.7	0.00815	0.00815	0.00815	0.00133	5,429		
			5	50.0	45.5	4.4	7.9	7.2	0.7	0.00817	0.00815	0.00816	0.00133	5,410		
	COLUMN AVERAGE		50.0	45.6	4.4	7.9	7.2	0.7	0.00816	0.00815	0.00815	0.00133	5,425			
	STANDARD DEV.		0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	13		

Source: Johnsonville		Description: Ponded Fly Ash (New Dredge Cell)					95% Standard Dry Density at Optimum Moisture Content							
SEQUENCE 5	6.0	10.0	1	63.0	56.9	6.0	10.0	9.0	1.0	0.01013	0.01008	0.01010	0.00165	5,468
			2	63.0	57.0	6.0	10.0	9.0	1.0	0.01009	0.01007	0.01008	0.00165	5,485
			3	63.1	57.0	6.0	10.0	9.0	1.0	0.01011	0.01007	0.01009	0.00165	5,484
			4	63.1	57.1	6.0	10.0	9.1	1.0	0.01011	0.01007	0.01009	0.00165	5,489
			5	63.2	57.1	6.0	10.0	9.1	1.0	0.01013	0.01007	0.01010	0.00165	5,488
	COLUMN AVERAGE			63.1	57.0	6.0	10.0	9.0	1.0	0.01011	0.01007	0.01009	0.00165	5,483
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00000	0.00001	0.00000	9
SEQUENCE 6	4.0	2.0	1	13.1	11.4	1.7	2.1	1.8	0.3	0.00252	0.00260	0.00256	0.00042	4,305
			2	13.0	11.3	1.7	2.1	1.8	0.3	0.00252	0.00260	0.00256	0.00042	4,273
			3	13.1	11.4	1.7	2.1	1.8	0.3	0.00254	0.00261	0.00258	0.00042	4,299
			4	13.0	11.3	1.7	2.1	1.8	0.3	0.00254	0.00261	0.00258	0.00042	4,244
			5	13.0	11.3	1.7	2.1	1.8	0.3	0.00254	0.00258	0.00256	0.00042	4,284
	COLUMN AVERAGE			13.0	11.3	1.7	2.1	1.8	0.3	0.00253	0.00260	0.00257	0.00042	4,281
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	24
SEQUENCE 7	4.0	4.0	1	24.9	22.5	2.4	3.9	3.6	0.4	0.00545	0.00552	0.00548	0.00090	3,974
			2	24.8	22.3	2.4	3.9	3.5	0.4	0.00546	0.00552	0.00549	0.00090	3,946
			3	24.8	22.3	2.4	3.9	3.5	0.4	0.00547	0.00550	0.00548	0.00090	3,953
			4	24.8	22.4	2.4	3.9	3.5	0.4	0.00543	0.00550	0.00547	0.00089	3,968
			5	24.8	22.3	2.4	3.9	3.5	0.4	0.00545	0.00551	0.00548	0.00090	3,958
	COLUMN AVERAGE			24.8	22.4	2.4	3.9	3.5	0.4	0.00545	0.00551	0.00548	0.00090	3,960
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	11

Source: Johnsonville Description: Pondered Fly Ash (New Dredge Cell) 95% Standard Dry Density at Optimum Moisture Content

SEQUENCE 11	2.0	1	13.0	10.8	2.2	2.1	1.7	0.3	0.00334	0.00345	0.00340	0.00056	3,091
		2	13.1	10.9	2.2	2.1	1.7	0.3	0.00333	0.00343	0.00338	0.00055	3,119
		3	13.0	10.8	2.2	2.1	1.7	0.3	0.00334	0.00344	0.00339	0.00055	3,096
		4	13.1	10.9	2.2	2.1	1.7	0.3	0.00335	0.00343	0.00339	0.00055	3,103
		5	13.0	10.8	2.2	2.1	1.7	0.3	0.00336	0.00345	0.00341	0.00056	3,083
	COLUMN AVERAGE		13.0	10.8	2.2	2.1	1.7	0.3	0.00334	0.00344	0.00339	0.00055	3,098
	STANDARD DEV.		0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	13
SEQUENCE 12	2.0	1	24.5	22.1	2.4	3.9	3.5	0.4	0.00738	0.00748	0.00743	0.00122	2,889
		2	24.6	22.2	2.4	3.9	3.5	0.4	0.00741	0.00748	0.00745	0.00122	2,890
		3	24.6	22.2	2.4	3.9	3.5	0.4	0.00738	0.00749	0.00743	0.00122	2,897
		4	24.6	22.2	2.4	3.9	3.5	0.4	0.00739	0.00750	0.00744	0.00122	2,888
		5	24.6	22.1	2.4	3.9	3.5	0.4	0.00738	0.00750	0.00744	0.00122	2,885
	COLUMN AVERAGE		24.6	22.2	2.4	3.9	3.5	0.4	0.00739	0.00749	0.00744	0.00122	2,890
	STANDARD DEV.		0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00001	0.00000	4
SEQUENCE 13	2.0	1	37.4	33.7	3.7	5.9	5.3	0.6	0.01038	0.01043	0.01041	0.00170	3,143
		2	37.4	33.7	3.7	5.9	5.3	0.6	0.01039	0.01040	0.01040	0.00170	3,145
		3	37.4	33.8	3.7	5.9	5.4	0.6	0.01039	0.01040	0.01039	0.00170	3,151
		4	37.4	33.8	3.7	5.9	5.4	0.6	0.01039	0.01041	0.01040	0.00170	3,148
		5	37.4	33.7	3.7	5.9	5.4	0.6	0.01041	0.01042	0.01041	0.00170	3,145
	COLUMN AVERAGE		37.4	33.7	3.7	5.9	5.4	0.6	0.01039	0.01041	0.01040	0.00170	3,146
	STANDARD DEV.		0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00001	0.00000	3

Source: Johnsonville		Description: Ponded Fly Ash (New Dredge Cell)					95% Standard Dry Density at Optimum Moisture Content							
SEQUENCE 14	2.0	8.0	1	49.9	45.0	4.9	7.9	7.1	0.8	0.01297	0.01290	0.01293	0.00211	3,379
			2	49.9	45.0	4.9	7.9	7.1	0.8	0.01297	0.01291	0.01294	0.00212	3,375
			3	50.0	45.1	4.9	7.9	7.1	0.8	0.01296	0.01291	0.01294	0.00211	3,380
			4	50.0	45.2	4.9	7.9	7.2	0.8	0.01297	0.01291	0.01294	0.00212	3,387
			5	50.0	45.1	4.9	7.9	7.1	0.8	0.01296	0.01291	0.01293	0.00211	3,381
			COLUMN AVERAGE	50.0	45.1	4.9	7.9	7.1	0.8	0.01297	0.01291	0.01294	0.00211	3,381
			STANDARD DEV.	0.0	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00000	0.00000	4
SEQUENCE 15	2.0	10.0	1	62.3	56.2	6.2	9.9	8.9	1.0	0.01560	0.01546	0.01553	0.00254	3,508
			2	62.3	56.1	6.2	9.9	8.9	1.0	0.01556	0.01546	0.01551	0.00254	3,513
			3	62.5	56.3	6.2	9.9	8.9	1.0	0.01556	0.01546	0.01551	0.00254	3,521
			4	62.2	56.1	6.1	9.9	8.9	1.0	0.01557	0.01545	0.01551	0.00254	3,506
			5	62.3	56.1	6.2	9.9	8.9	1.0	0.01559	0.01544	0.01552	0.00254	3,509
			COLUMN AVERAGE	62.3	56.2	6.2	9.9	8.9	1.0	0.01558	0.01545	0.01552	0.00254	3,511
			STANDARD DEV.	0.1	0.1	0.0	0.0	0.0	0.0	0.00002	0.00001	0.00001	0.00000	6

SUBMITTED BY, DATE

RJ Brubaker 9/5/95

LABORATORY MANAGER

FIGURE 1 - Logarithmic Plot of Resilient Modulus (M_R) vs Cyclic Stress (S_C)

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study
 LAW PROJECT NO.: 5810860101
 1. MATERIAL SOURCE: Johnsonville
 2. MATERIAL DESCRIPTION: Ponded Fly Ash (New Dredge Cell)
 3. REMOLDING TARGETS: 95% Standard Dry Density at Optimum Moisture Content
 4. MATERIAL TYPE: 2
 5. TEST DATE: 07-31-1995

$$M_R = K1 (S_C)^{K2} (1+S_3)^{K5}$$

K1 = 1,487
 K2 = 0.03358
 K5 = 0.63725
 R² = 0.95

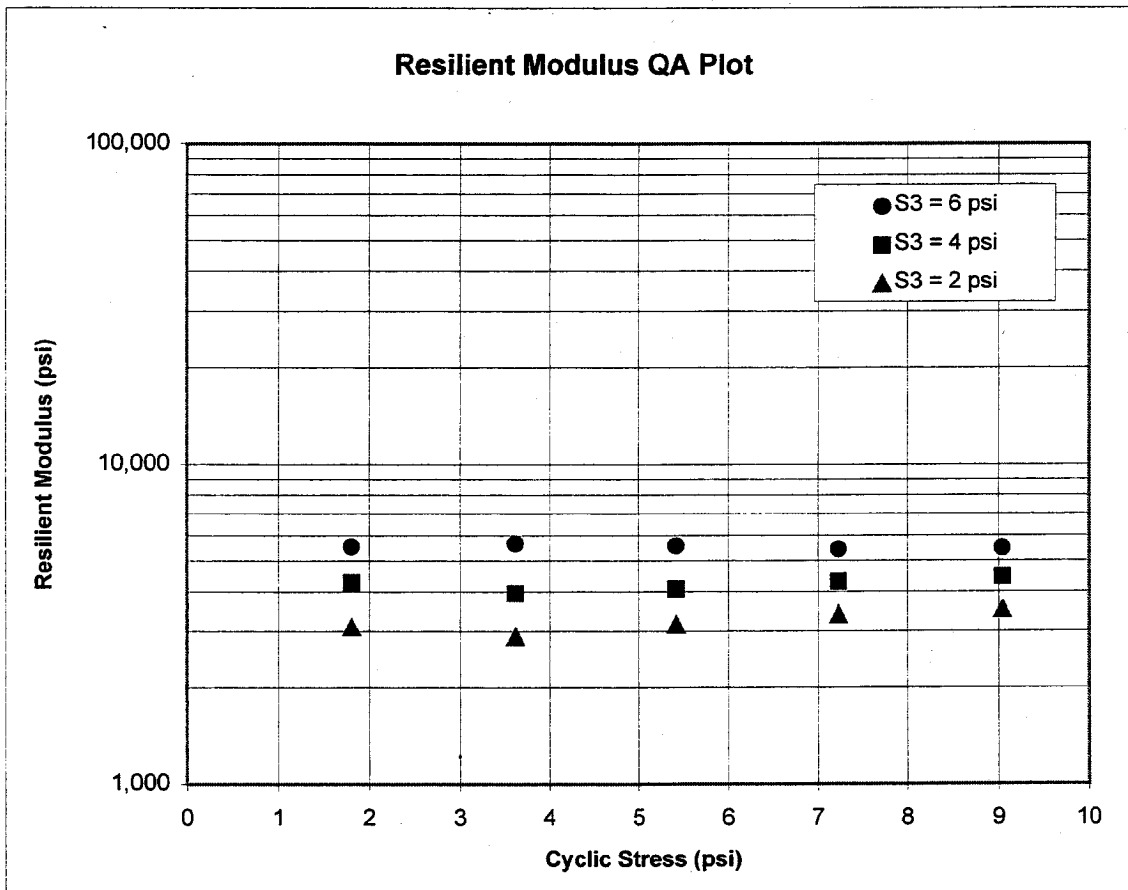
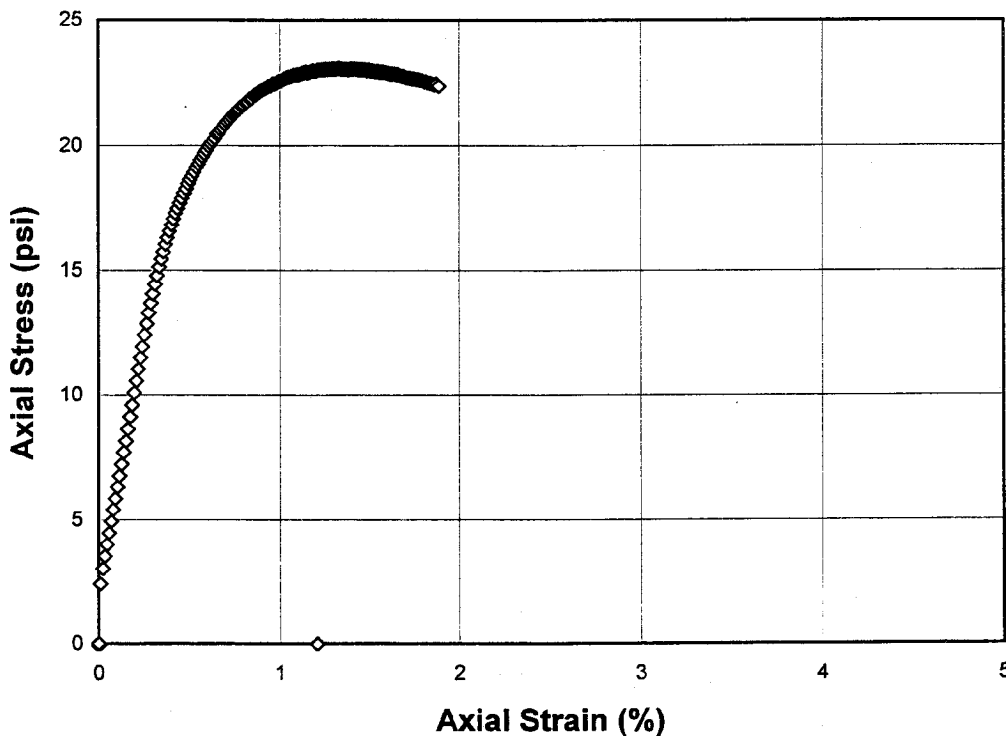


FIGURE 2 - Quick Shear Stress vs Strain

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study
LAW PROJECT NO.: 5810860101
1. *MATERIAL SOURCE:* Johnsonville
2. *MATERIAL DESCRIPTION:* Ponded Fly Ash (New Dredge Cell)
3. *REMOLDING TARGETS:* 95% Standard Dry Density at Optimum Moisture Content
4. *MATERIAL TYPE* 2
5. *TEST DATE* 07-31-1995



**LABORATORY MATERIAL HANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
RESILIENT MODULUS OF UNBOUND GRANULAR BASE/SUBBASE
MATERIALS AND SUBGRADE SOILS
LAB DATA SHEET T46 - RECOMPACTED SAMPLES**

SHEET NO 1 OF 2

**UNBOUND GRANULAR BASE/SUBBASE LAYERS AND SUBGRADE SOILS
SHRP TEST DESIGNATION UG07, SS07/SHRP PROTOCOL P46**

LABORATORY PERFORMING TEST:

LAW ENGINEERING, INC. - ATLANTA, GEORGIA

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study

LAW PROJECT NO.: 5810860101

- | | | | | |
|-----|---|--|---|------------|
| 1. | MATERIAL SOURCE: | Johnsonville | | |
| 2. | MATERIAL DESCRIPTION: | Ponded Fly Ash (New Dredge Cell) | | |
| 3. | REMOLDING TARGETS: | 95% Modified Dry Density at Optimum Moisture Content | | |
| 4. | MATERIAL TYPE (Type 1 or Type 2) | | | 2 |
| 5. | TEST INFORMATION | | | |
| | PRECONDITIONING - GREATER THAN 5% PERM. STRAIN? (Y = YES OR N = NO) | | | N |
| | TESTING - GREATER THAN 5% PERM. STRAIN? (Y = YES OR N = NO) | | | N |
| | TESTING - NUMBER OF LOAD SEQUENCES COMPLETED (0 - 15) | | | 15 |
| 6. | SPECIMEN INFO.: | | | |
| | SPECIMEN DIAM., inch | | | |
| | TOP | | | 2.86 |
| | MIDDLE | | | 2.86 |
| | BOTTOM | | | 2.86 |
| | AVERAGE | | | 2.86 |
| | MEMBRANE THICKNESS (1), inch | | | 0.01 |
| | MEMBRANE THICKNESS (2), inch | | | 0.01 |
| | NET DIAM., inch | | | 2.83 |
| | HEIGHT OF SPECIMEN, CAP AND BASE, inch | | | 6.20 |
| | HEIGHT OF CAP AND BASE, inch | | | 0.00 |
| | INITIAL LENGTH, L ₀ , inch | | | 6.20 |
| | INITIAL AREA, A ₀ , in ² | | | 6.30 |
| | INITIAL VOLUME A ₀ L ₀ , in ³ | | | 39.09 |
| 7. | SOIL SPECIMEN WEIGHT: | | | |
| | INITIAL WEIGHT OF CONTAINER AND WET SOIL, grams | | | 1037.97 |
| | FINAL WEIGHT OF CONTAINER AND WET SOIL, grams | | | 0.00 |
| | WEIGHT OF WET SOIL USED, grams | | | 1037.97 |
| 8. | SOIL PROPERTIES.: | | | |
| | IN SITU MOISTURE CONTENT (NUCLEAR), % | | | N/A |
| | IN SITU WET DENSITY (NUCLEAR), pcf | | | N/A |
| | or | | | |
| | OPTIMUM MOISTURE CONTENT, % | | | 20.6 |
| | MAX. DRY DENSITY, pcf | | | 92.5 |
| | 95 % MAX. DRY DENSITY, pcf | | | 87.9 |
| 9. | SPECIMEN PROPERTIES: | | | |
| | COMPACTION MOISTURE CONTENT, % | | | 21.6 |
| | MOISTURE CONTENT AFTER RESILIENT MODULUS TESTING, % | | | 21.6 |
| | COMPACTION DRY DENSITY, γ _d pcf | | | 83.1 |
| 10. | QUICK SHEAR TEST | | | |
| | STRESS - STRAIN PLOT ATTACHED (Y = YES, N = NO) | | | Y |
| | TRIAXIAL SHEAR MAXIMUM STRENGTH (MAX. LOAD/X-SECTION AREA), psi | | | 38.7 |
| | SPECIMEN FAIL DURING TRIAXIAL SHEAR? (Y = YES, N = NO) | | | Y |
| 11. | COMMENTS (Section 10.4 of Protocol P46) | | | |
| | (a) CODE | 0 | 0 | 0 |
| | (b) NOTE | 0 | 0 | 0 |
| 12. | TEST DATE | | | 08-01-1995 |

GENERAL REMARKS:

SUBMITTED BY, DATE

RS Bondman 9/5/95
LABORATORY MANAGER

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study
 LAW PROJECT NO.: 5810860101
 Johnsonville
 1. MATERIAL SOURCE: Ponded Fly Ash (New Dredge Cell)
 2. MATERIAL DESCRIPTION: 95% Modified Dry Density at Optimum Moisture Content
 3. REMOLDING TARGETS: 2
 4. MATERIAL TYPE: 2
 5. TEST DATE: 08-01-1995
 6. RESILIENT MODULUS TESTING

COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
PARAMETER	Chamber Confining Pressure	Nominal Maximum Axial Stress	Cycle No.	Actual Applied Max. Axial Load	Actual Applied Cyclic Load	Actual Applied Contact Load	Actual Applied Max. Axial Stress	Actual Applied Cyclic Stress	Actual Applied Contact Stress	Recov. Def. LVDT #1 Reading	Recov. Def. LVDT #2 Reading	Average Recov Def. LVDT 1 and 2	Resilient Strain	Resilient Modulus
DESIGNATION	S ₃	S _{axial}	c ₁	P _{max}	P _{cyclic}	P _{contact}	S _{max}	S _{cyclic}	S _{contact}	H ₁	H ₂	H _{avg}	ε	
UNIT	psi	psi	---	lbs	lbs	lbs	psi	psi	psi	in.	in.	in.	in/in	psi
PRECISION														
SEQUENCE 1	6.0	2.0	1	12.6	11.4	1.3	2.0	1.8	0.2	0.00167	0.00161	0.00164	0.00026	6.821
			2	12.5	11.3	1.3	2.0	1.8	0.2	0.00167	0.00159	0.00163	0.00026	6.797
			3	12.6	11.4	1.2	2.0	1.8	0.2	0.00167	0.00160	0.00164	0.00026	6.832
			4	12.6	11.3	1.3	2.0	1.8	0.2	0.00168	0.00160	0.00164	0.00026	6.790
			5	12.6	11.4	1.3	2.0	1.8	0.2	0.00167	0.00160	0.00163	0.00026	6.837
COLUMN AVERAGE				12.6	11.3	1.3	2.0	1.8	0.2	0.00167	0.00160	0.00164	0.00026	6.815
STANDARD DEV.				0.0	0.0	0.0	0.0	0.0	0.0	0.00000	0.00001	0.00000	0.00000	21

Source: Johnsonville Description: Ponded Fly Ash (New Dredge Cell) 95% Modified Dry Density at Optimum Moisture Content

SEQUENCE 2	6.0	4.0	1	25.0	22.7	2.3	4.0	3.6	0.4	0.00331	0.00331	0.00331	0.00053	6,740
			2	25.0	22.7	2.3	4.0	3.6	0.4	0.00331	0.00330	0.00331	0.00053	6,752
			3	25.0	22.7	2.4	4.0	3.6	0.4	0.00331	0.00331	0.00331	0.00053	6,750
			4	25.0	22.7	2.4	4.0	3.6	0.4	0.00330	0.00331	0.00331	0.00053	6,750
			5	25.0	22.7	2.4	4.0	3.6	0.4	0.00330	0.00329	0.00330	0.00053	6,771
	COLUMN AVERAGE		25.0	22.7	2.3	4.0	3.6	0.4	0.00331	0.00331	0.00331	0.00053	6,753	
	STANDARD DEV.		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00000	12	
SEQUENCE 3	6.0	6.0	1	37.6	33.9	3.7	6.0	5.4	0.6	0.00511	0.00516	0.00513	0.00083	6,501
			2	37.6	33.8	3.7	6.0	5.4	0.6	0.00510	0.00516	0.00513	0.00083	6,489
			3	37.6	33.8	3.7	6.0	5.4	0.6	0.00512	0.00517	0.00515	0.00083	6,472
			4	37.6	33.9	3.7	6.0	5.4	0.6	0.00510	0.00515	0.00512	0.00083	6,505
			5	37.6	33.9	3.7	6.0	5.4	0.6	0.00511	0.00515	0.00513	0.00083	6,497
	COLUMN AVERAGE		37.6	33.9	3.7	6.0	5.4	0.6	0.00511	0.00516	0.00513	0.00083	6,493	
	STANDARD DEV.		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00000	13	
SEQUENCE 4	6.0	8.0	1	50.2	45.3	4.9	8.0	7.2	0.8	0.00693	0.00703	0.00698	0.00113	6,388
			2	50.4	45.5	4.9	8.0	7.2	0.8	0.00694	0.00701	0.00697	0.00112	6,420
			3	50.3	45.4	4.9	8.0	7.2	0.8	0.00692	0.00702	0.00697	0.00112	6,412
			4	50.3	45.4	4.9	8.0	7.2	0.8	0.00693	0.00702	0.00698	0.00112	6,405
			5	50.3	45.5	4.9	8.0	7.2	0.8	0.00694	0.00703	0.00698	0.00113	6,404
	COLUMN AVERAGE		50.3	45.4	4.9	8.0	7.2	0.8	0.00693	0.00702	0.00698	0.00112	6,406	
	STANDARD DEV.		0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00000	12	

Source:	Johnsonville	Description:	Ponded Fly Ash (New Dredge Cell)	95% Modified Dry Density at Optimum Moisture Content										
SEQUENCE 5	6.0	10.0	1	62.9	56.8	6.1	10.0	9.0	1.0	0.00856	0.00868	0.00862	0.00139	6,485
			2	63.1	56.9	6.1	10.0	9.0	1.0	0.00859	0.00868	0.00864	0.00139	6,485
			3	63.0	56.9	6.1	10.0	9.0	1.0	0.00856	0.00869	0.00863	0.00139	6,486
			4	63.2	57.0	6.2	10.0	9.0	1.0	0.00858	0.00868	0.00863	0.00139	6,500
			5	63.1	57.0	6.1	10.0	9.0	1.0	0.00857	0.00870	0.00864	0.00139	6,493
	COLUMN AVERAGE		63.1	56.9	6.1	10.0	9.0	1.0	0.00857	0.00869	0.00863	0.00139	6,490	
	STANDARD DEV.		0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	7	
SEQUENCE 6	4.0	2.0	1	13.2	11.6	1.5	2.1	1.8	0.2	0.00201	0.00194	0.00197	0.00032	5,809
			2	13.2	11.6	1.6	2.1	1.8	0.3	0.00203	0.00194	0.00199	0.00032	5,753
			3	13.2	11.6	1.6	2.1	1.8	0.3	0.00202	0.00194	0.00198	0.00032	5,773
			4	13.3	12.0	1.3	2.1	1.9	0.2	0.00209	0.00199	0.00204	0.00033	5,796
			5	13.1	11.8	1.3	2.1	1.9	0.2	0.00205	0.00195	0.00200	0.00032	5,787
	COLUMN AVERAGE		13.2	11.7	1.5	2.1	1.9	0.2	0.00204	0.00195	0.00199	0.00032	5,783	
	STANDARD DEV.		0.1	0.2	0.2	0.0	0.0	0.0	0.00003	0.00002	0.00003	0.00000	21	
SEQUENCE 7	4.0	4.0	1	24.7	22.7	2.0	3.9	3.6	0.3	0.00449	0.00450	0.00449	0.00072	4,972
			2	24.5	22.4	2.0	3.9	3.6	0.3	0.00448	0.00449	0.00448	0.00072	4,922
			3	24.5	22.4	2.0	3.9	3.6	0.3	0.00447	0.00447	0.00447	0.00072	4,941
			4	24.4	22.4	2.0	3.9	3.6	0.3	0.00447	0.00447	0.00447	0.00072	4,926
			5	24.5	22.5	2.0	3.9	3.6	0.3	0.00447	0.00448	0.00448	0.00072	4,936
	COLUMN AVERAGE		24.5	22.5	2.0	3.9	3.6	0.3	0.00448	0.00448	0.00448	0.00072	4,939	
	STANDARD DEV.		0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	20	

Source: Johnsonville		Description: Ponded Fly Ash (New Dredge Cell)					95% Modified Dry Density at Optimum Moisture Content							
SEQUENCE 8	4.0	6.0	1	37.3	33.7	3.6	5.9	5.3	0.6	0.00669	0.00677	0.00673	0.00109	4.922
			2	37.6	34.0	3.6	6.0	5.4	0.6	0.00667	0.00677	0.00672	0.00108	4.978
			3	37.5	33.9	3.6	5.9	5.4	0.6	0.00668	0.00677	0.00672	0.00108	4.960
			4	37.6	34.0	3.6	6.0	5.4	0.6	0.00669	0.00677	0.00673	0.00109	4.975
			5	37.6	34.0	3.6	6.0	5.4	0.6	0.00668	0.00678	0.00673	0.00109	4.970
	COLUMN AVERAGE			37.5	33.9	3.6	6.0	5.4	0.6	0.00668	0.00677	0.00673	0.00108	4.961
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	23
SEQUENCE 9	4.0	8.0	1	50.2	45.4	4.9	8.0	7.2	0.8	0.00849	0.00860	0.00854	0.00138	5.226
			2	50.2	45.4	4.8	8.0	7.2	0.8	0.00848	0.00858	0.00853	0.00138	5.235
			3	50.4	45.5	4.9	8.0	7.2	0.8	0.00847	0.00859	0.00853	0.00137	5.253
			4	50.4	45.5	4.8	8.0	7.2	0.8	0.00849	0.00861	0.00855	0.00138	5.242
			5	50.4	45.6	4.8	8.0	7.2	0.8	0.00847	0.00859	0.00853	0.00138	5.254
	COLUMN AVERAGE			50.3	45.5	4.9	8.0	7.2	0.8	0.00848	0.00859	0.00854	0.00138	5.242
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	12
SEQUENCE 10	4.0	10.0	1	62.8	56.7	6.2	10.0	9.0	1.0	0.01006	0.01019	0.01013	0.00163	5.505
			2	63.1	57.0	6.1	10.0	9.0	1.0	0.01006	0.01020	0.01013	0.00163	5.532
			3	63.0	56.9	6.1	10.0	9.0	1.0	0.01007	0.01019	0.01013	0.00163	5.524
			4	63.0	56.9	6.1	10.0	9.0	1.0	0.01005	0.01019	0.01012	0.00163	5.529
			5	63.2	57.0	6.2	10.0	9.0	1.0	0.01005	0.01020	0.01013	0.00163	5.542
	COLUMN AVERAGE			63.0	56.9	6.1	10.0	9.0	1.0	0.01006	0.01020	0.01013	0.00163	5.527
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00000	0.00000	14

Source: Johnsonville	Description: Pondered Fly Ash (New Dredge Cell)	95% Modified Dry Density at Optimum Moisture Content												
SEQUENCE 14	2.0	8.0	1	50.3	45.4	4.9	8.0	7.2	0.8	0.00997	0.01014	0.01005	0.00162	4,443
			2	50.2	45.3	4.9	8.0	7.2	0.8	0.00997	0.01012	0.01005	0.00162	4,435
			3	50.3	45.4	4.9	8.0	7.2	0.8	0.00997	0.01014	0.01005	0.00162	4,441
			4	50.3	45.4	4.9	8.0	7.2	0.8	0.00999	0.01012	0.01005	0.00162	4,444
			5	50.4	45.5	4.9	8.0	7.2	0.8	0.01000	0.01012	0.01006	0.00162	4,450
	COLUMN AVERAGE		50.3	45.4	4.9	8.0	7.2	0.8	0.00998	0.01013	0.01005	0.00162	4,443	
	STANDARD DEV.		0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	5	
SEQUENCE 15	2.0	10.0	1	62.9	56.8	6.1	10.0	9.0	1.0	0.01163	0.01180	0.01171	0.00189	4,773
			2	62.8	56.7	6.2	10.0	9.0	1.0	0.01162	0.01179	0.01170	0.00189	4,766
			3	62.8	56.7	6.1	10.0	9.0	1.0	0.01163	0.01180	0.01172	0.00189	4,763
			4	63.0	56.8	6.2	10.0	9.0	1.0	0.01159	0.01180	0.01169	0.00189	4,781
			5	63.0	56.8	6.1	10.0	9.0	1.0	0.01159	0.01178	0.01169	0.00188	4,785
	COLUMN AVERAGE		62.9	56.8	6.1	10.0	9.0	1.0	0.01161	0.01180	0.01170	0.00189	4,774	
	STANDARD DEV.		0.1	0.1	0.0	0.0	0.0	0.0	0.00002	0.00001	0.00001	0.00000	9	

SUBMITTED BY, DATE

RJ Buden 9/15/95

LABORATORY MANAGER

FIGURE 1 - Logarithmic Plot of Resilient Modulus (M_R) vs Cyclic Stress (S_C)

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study
 LAW PROJECT NO.: 5810860101
 1. MATERIAL SOURCE: Johnsonville
 2. MATERIAL DESCRIPTION: Ponded Fly Ash (New Dredge Cell)
 3. REMOLDING TARGETS: 95% Modified Dry Density at Optimum Moisture Content
 4. MATERIAL TYPE: 2
 5. TEST DATE: 08-01-1995

$$M_R = K_1 (S_C)^{K_2} (1+S_3)^{K_5}$$

K1 = 2,541
 K2 = -0.01211
 K5 = 0.48836
 R² = 0.88

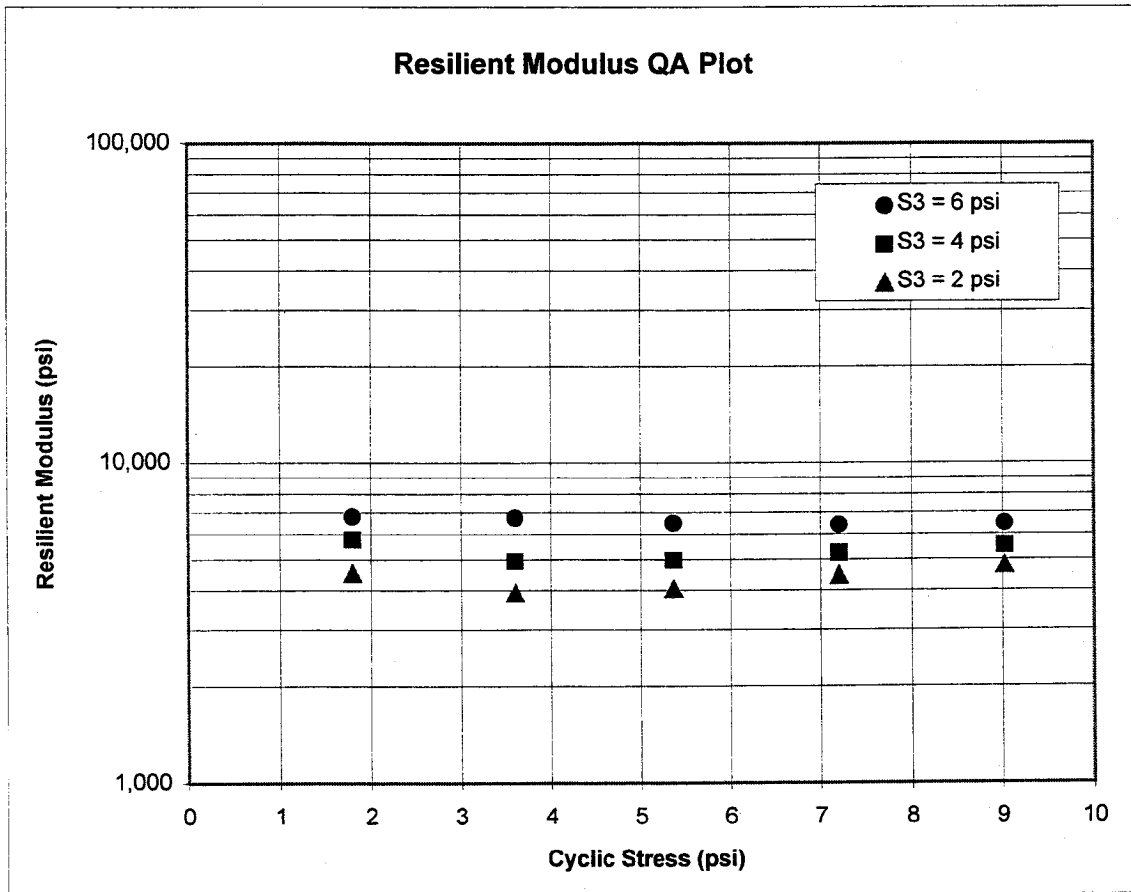
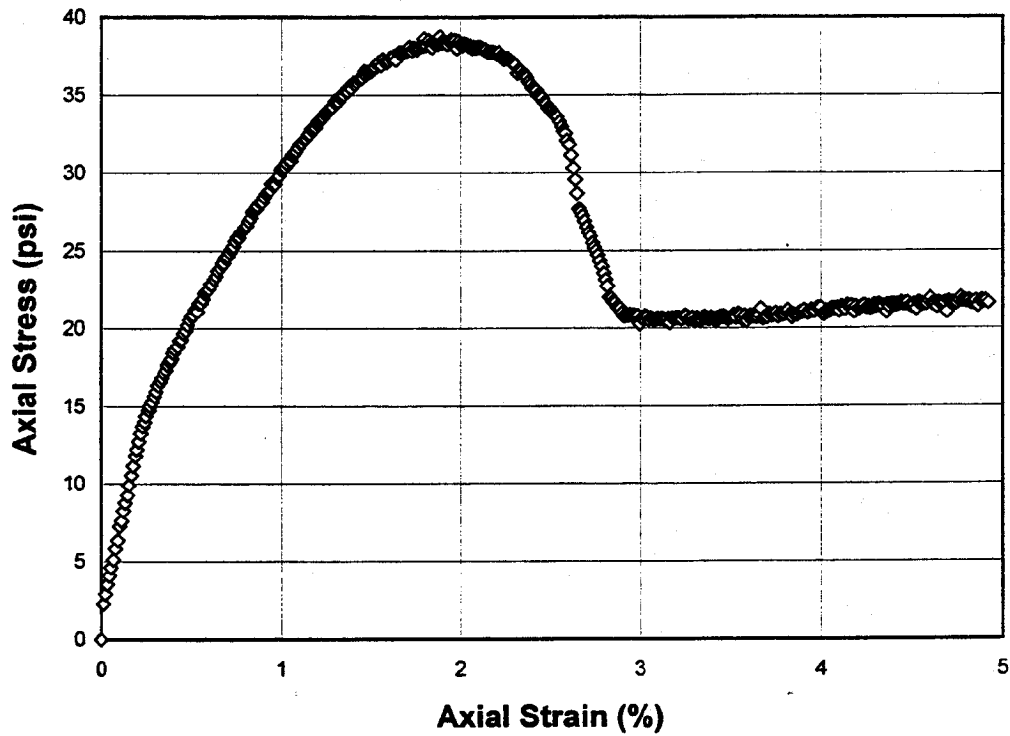


FIGURE 2 - Quick Shear Stress vs Strain

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study
LAW PROJECT NO.: 5810860101
1. *MATERIAL SOURCE:* Johnsonville
2. *MATERIAL DESCRIPTION:* Ponded Fly Ash (New Dredge Cell)
3. *REMODELING TARGETS:* 95% Modified Dry Density at Optimum Moisture Content
4. *MATERIAL TYPE* 2
5. *TEST DATE* 08-01-1995





JOHNSONVILLE

Ponded Fly Ash (Old Dredge Cell)

Grain Size Distribution Test Report
Moisture-Density Relationship (Standard Proctor)
Moisture-Density Relationship (Modified Proctor)
Consolidation Test Report
Hydraulic Conductivity - Falling Head (2 Pages)
Triaxial Compression Test (2 Pages)
Direct Shear Test
California Bearing Ratio
Resilient Modulus (Standard Proctor) (9 Pages)
Resilient Modulus (Modified Proctor) (9 Pages)

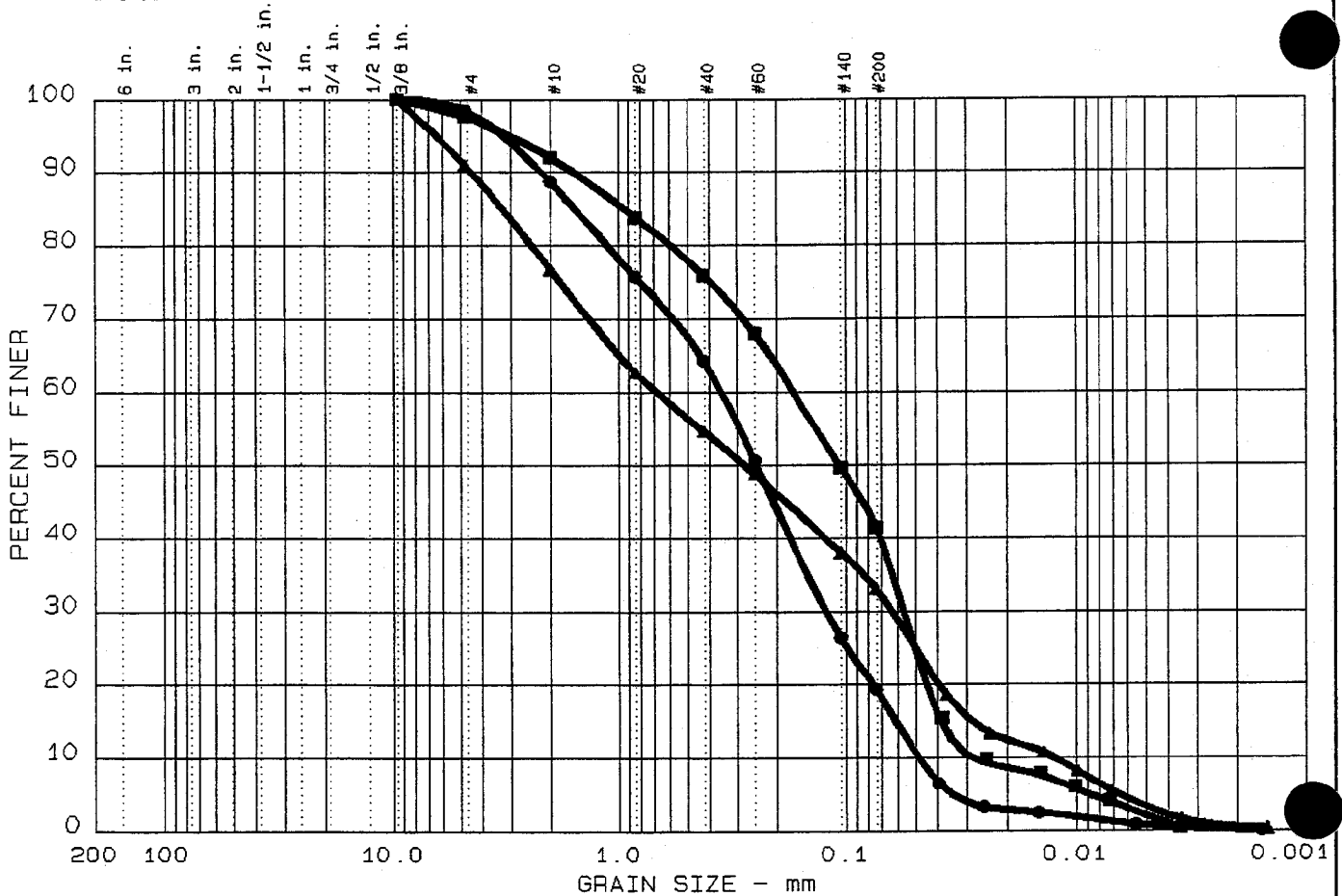


TVA - JOHNSONVILLE
PONDED FLY ASH (OLD DREDGE CELL) - South RR Loop

Description	Test Method	Property	Sample 1	Sample 2	Sample 3
Grain Size	ASTM D 422	Percent Retained on the #4 Sieve	3.6	8.7	2.5
		Percent Passing the #200 Sieve	33.6	42.2	41.4
		Percent Passing the 0.005 mm Sieve	0.0	4.1	2.1
Atterberg Limits	ASTM D 4318	Liquid Limit	NL	NL	NL
		Plastic Limit	NP	NP	NP
		Plasticity Index	N/A	N/A	N/A
Specific Gravity	ASTM D 854	Specific Gravity at 20°C	2.41	2.43	2.23
Classification	ASTM D 2487	Unified Soil Classification System (USCS)	SM	SM	SM
	AASHTO M 145	AASHTO Classification	A-2-4(0.0)	A-2-4(0.0)	A-2-4(0.0)
Composite Sample					
Moisture-Density Relations (Standard Effort)	ASTM D 698	Maximum Dry Density, pcf	89.5		
		Optimum Moisture Content, %	20.5		
Moisture-Density Relations (Modified Effort)	ASTM D 1557	Maximum Dry Density, pcf	96.0		
		Optimum Moisture Content, %	16.1		
			Result	Dry Density, pcf	Moisture Content, %
Consolidation	ASTM D2435	Compression Index C_c	0.1	85.5	19.4
Hydraulic Conductivity	ASTM D 5084	Hydraulic Conductivity, cm/sec	5.8E-4	83.4	18.3
Triaxial Shear Strength Consolidated-Undrained (CU)	ASTM D4767	Effective Stress, Cohesion, c' , ksf	0.12	83.4	18.4
		Effective Stress, Internal Friction Angle, ϕ' , degrees	30.5		
		Total Stress, Cohesion, c , ksf	0.66	83.4	18.4
		Total Stress, Internal Friction Angle, ϕ , degrees	15.2		
Direct Shear Strength	ASTM D 3080	Cohesion, c , ksf	2.14	90.2	19.7
		Internal Friction Angle, ϕ , degrees	39.3		
California Bearing Ratio	ASTM D 1883	CBR, %	28	91.9	21.1
Resilient Modulus (Standard Compactive Effort)	SHRP P46	Resilient Modulus at 4psi axial stress and 4psi confining pressure	4,657	82.0	17.9
Resilient Modulus (Modified Compactive Effort)	SHRP P46	Resilient Modulus at 4psi axial stress and 4psi confining pressure	6,368	88.0	14.4
Soil Resistivity	AASHTO T 288	Minimum Resistivity, Ohm-cm	2,600		
pH of Soil	AASHTO T 289	pH	6.8		
Water Soluble Sulfate Ion	AASHTO T 290	Sulfate Ion Content, mg/kg	1520		
Water Soluble Chloride Ion	AASHTO T 290	Chloride Ion Content, mg/kg	20		

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GRAIN SIZE DISTRIBUTION TEST REPORT



Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
● 3	0.0	1.6	79.1	18.6	0.7
▲ 4	0.0	9.1	58.0	29.7	3.2
■ 5	0.0	2.5	56.1	39.3	2.1

	LL	PI	D ₈₅	D ₆₀	D ₅₀	D ₃₀	D ₁₅	D ₁₀	C _c	C _u
●	NL	NP	1.55	0.35	0.25	0.122	0.0607	0.0483	0.87	7.3
▲	NL	NP	3.24	0.68	0.28	0.063	0.0282	0.0122	0.48	55.6
■	NL	NP	0.93	0.17	0.11	0.056	0.0386	0.0283	0.65	6.0

MATERIAL DESCRIPTION	USCS	AASHTO
● Old Dredge Cell	SM	A-2-4 (0.0)
▲ Old Dredge Cell	SM	A-2-4 (0.0)
■ Old Dredge Cell	SM	A-4 (0.0)

Project No.: 5810860101
 Project: TVA - Johnsonville
 ● Location: Poned Fly Ash A & B
 ▲ Location: Poned Fly Ash C & D
 ■ Location: Poned Fly Ash E & F
 Date: July 18, 1995

Remarks:
 Tested by: *JOR*
 Reviewed by: *HJ*

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Figure No.

JOHNSONVILLE

Ponded Fly Ash (Active Ash Pond)

Grain Size Distribution Test Report
Moisture-Density Relationship (Standard Proctor)
Moisture-Density Relationship (Modified Proctor)
Consolidation Test Report
Hydraulic Conductivity - Falling Head (2 Pages)
Triaxial Compression Test (2 Pages)
Direct Shear Test
California Bearing Ratio
Resilient Modulus (Standard Proctor) (9 Pages)
Resilient Modulus (Modified Proctor) (9 Pages)

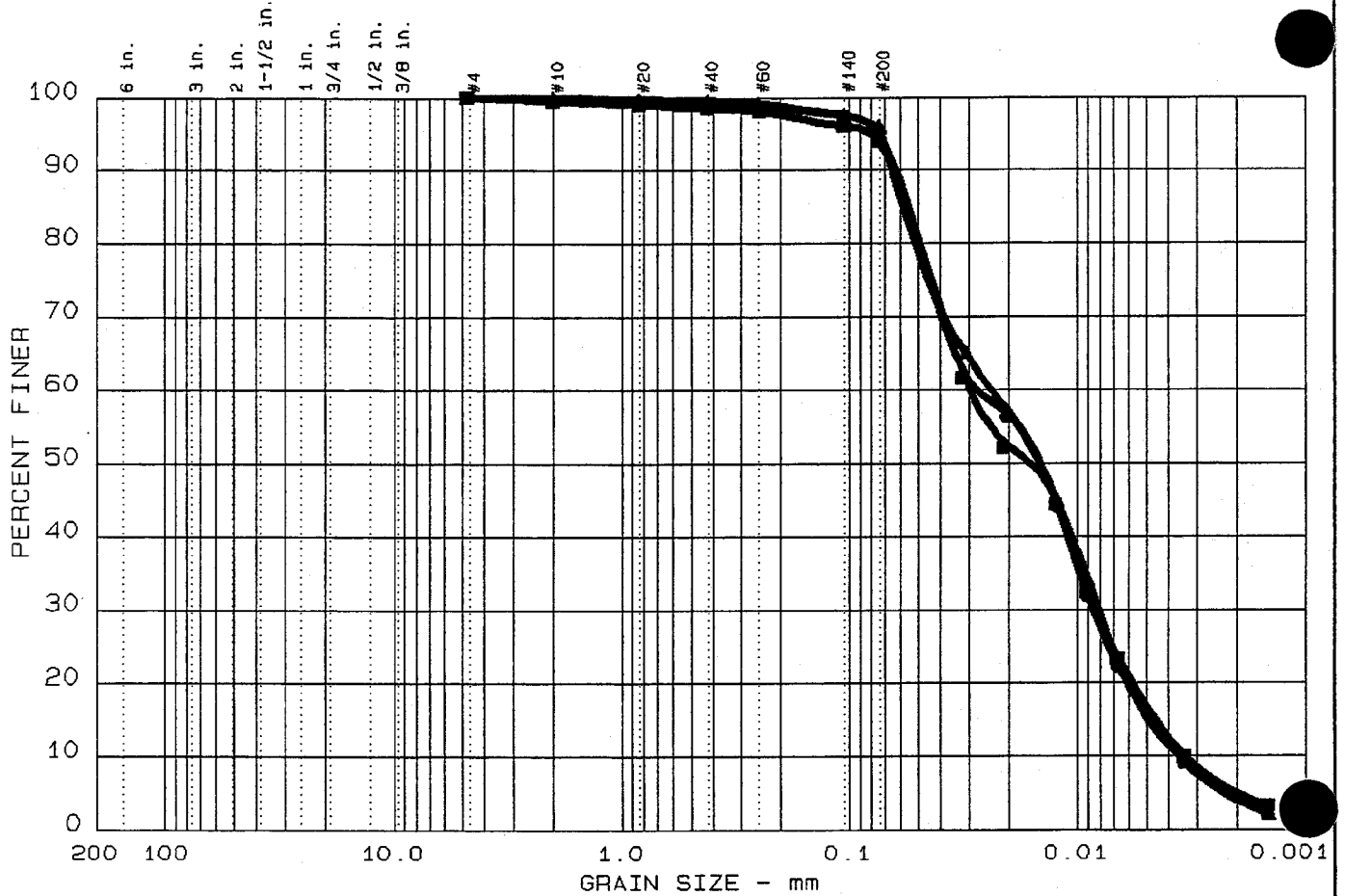


**TVA - JOHNSONVILLE
PONDED FLY ASH (ACTIVE ASH POND)**

Description	Test Method	Property	Sample 1	Sample 2	Sample 3
Grain Size	ASTM D 422	Percent Retained on the #4 Sieve	0.0	0.0	0.0
		Percent Passing the #200 Sieve	95.0	94.8	93.9
		Percent Passing the 0.005 mm Sieve	15.6	14.8	16.8
Atterberg Limits	ASTM D 4318	Liquid Limit	NL	NL	NL
		Plastic Limit	NP	NP	NP
		Plasticity Index	N/A	N/A	N/A
Specific Gravity	ASTM D 854	Specific Gravity at 20°C	2.48	2.48	2.50
Classification	ASTM D 2487	Unified Soil Classification System (USCS)	ML	ML	ML
	AASHTO M 145	AASHTO Classification	A-4(0.0)	A-4(0.0)	A-4(0.0)
Composite Sample					
Moisture-Density Relations (Standard Effort)	ASTM D 698	Maximum Dry Density, pcf	86.6		
		Optimum Moisture Content, %	22.8		
Moisture-Density Relations (Modified Effort)	ASTM D 1557	Maximum Dry Density, pcf	91.7		
		Optimum Moisture Content, %	18.0		
			Result	Dry Density, pcf	Moisture Content, %
Consolidation	ASTM D2435	Compression Index C_c	0.11	81.3	22.1
Hydraulic Conductivity	ASTM D 5084	Hydraulic Conductivity, cm/sec	3.5E-5	79.7	22.2
Triaxial Shear Strength Consolidated-Undrained (CU)	ASTM D4767	Effective Stress, Cohesion, c' , ksf	0.00	79.8	22.2
		Effective Stress, Internal Friction Angle, ϕ' , degrees	22.6		
		Total Stress, Cohesion, c , ksf	0.01	79.8	22.2
		Total Stress, Internal Friction Angle, ϕ , degrees	15.8		
Direct Shear Strength	ASTM D 3080	Cohesion, c , ksf	1.41	81.3	23.1
		Internal Friction Angle, ϕ , degrees	36.6		
California Bearing Ratio	ASTM D 1883	CBR, %	1	85.8	24.0
Resilient Modulus (Standard Compactive Effort)	SHRP P46	Resilient Modulus at 4psi axial stress and 4psi confining pressure	3,844	77.5	24.6
Resilient Modulus (Modified Compactive Effort)	SHRP P46	Resilient Modulus at 4psi axial stress and 4psi confining pressure	5,917	83.2	16.2
Soil Resistivity	AASHTO T 288	Minimum Resistivity, Ohm-cm	690		
pH of Soil	AASHTO T 289	pH	8.4		
Water Soluble Sulfate Ion	AASHTO T 290	Sulfate Ion Content, mg/kg	2960		
Water Soluble Chloride Ion	AASHTO T 290	Chloride Ion Content, mg/kg	60		

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GRAIN SIZE DISTRIBUTION TEST REPORT



Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
● 6	0.0	0.0	5.0	79.4	15.6
▲ 7	0.0	0.0	4.0	80.9	15.1
■ 8	0.0	0.0	6.1	77.1	16.8

	LL	PI	D ₈₅	D ₆₀	D ₅₀	D ₃₀	D ₁₅	D ₁₀	C _c	C _u
●	NL	NP			0.01	0.0009	0.0048	0.0036	0.74	7.6
▲	NL	NP			0.01	0.008	0.0049	0.0036	0.77	6.5
■	NL	NP			0.02	0.008	0.0046	0.0034	0.69	8.7

MATERIAL DESCRIPTION	USCS	AASHTO
● Active Ash Pond	ML	A-4 (0.0)
▲ Active Ash Pond	ML	A-4 (0.0)
■ Active Ash Pond	ML	A-4 (0.0)

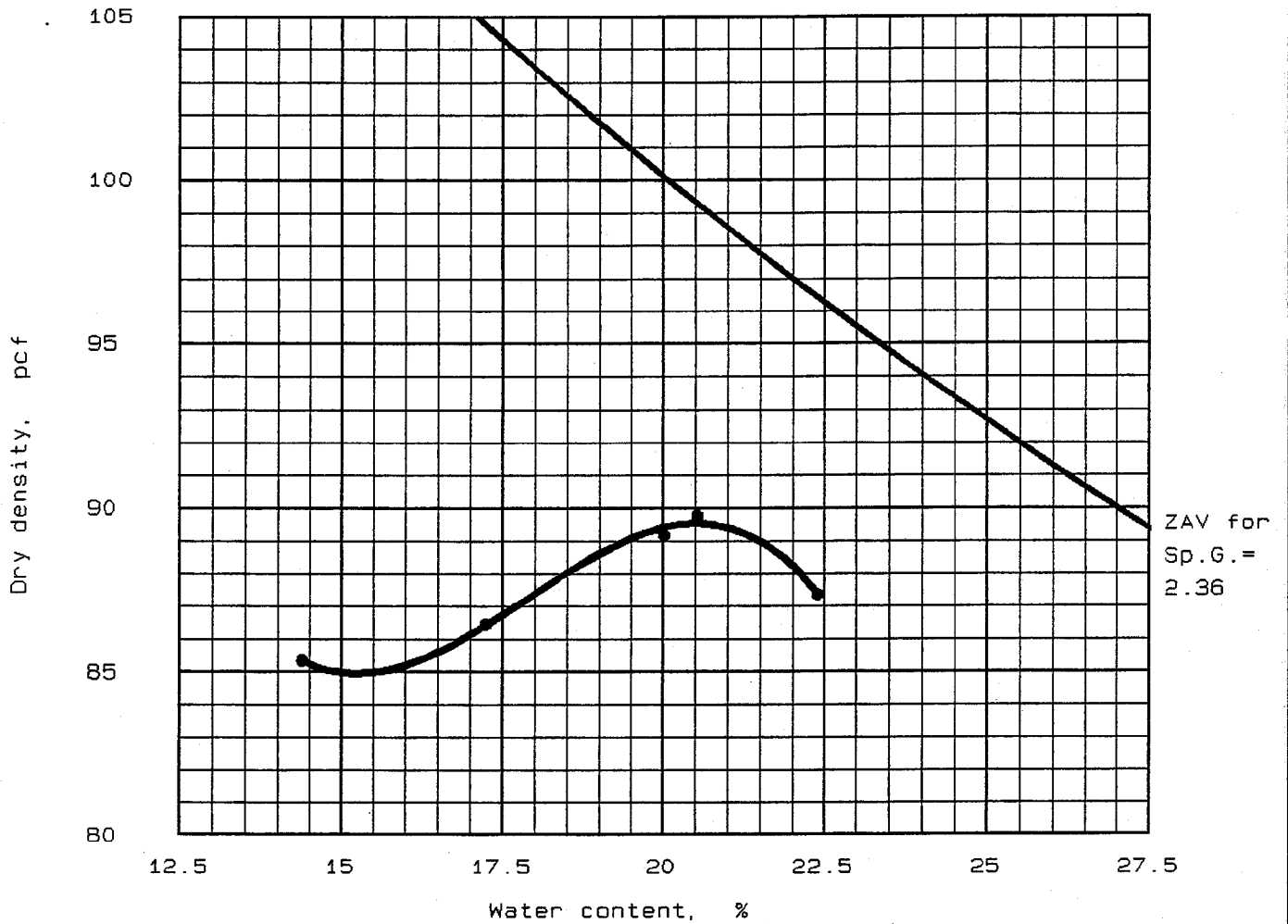
Project No.: 5810860101
 Project: TVA - Johnsonville
 ● Location: Poned Fly Ash A & B
 ▲ Location: Poned Fly Ash C & D
 ■ Location: Poned Fly Ash E & F
 Date: July 18, 1995

Remarks:
 Tested by: JCR
 Reviewed by: HS

GRAIN SIZE DISTRIBUTION TEST REPORT
LAW ENGINEERING, INC.

Figure No.

MOISTURE-DENSITY RELATIONSHIP



"Standard" Proctor, ASTM D 698, Method A

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No. 4	% < No. 200
	USCS	AASHTO						
	SM	A-2-4 (0.0) *	13.2 %	2.36	NL	NP	4.93 %	39.1 %

TEST RESULTS

Optimum moisture = 20.5 %
Maximum dry density = 89.5 pcf

MATERIAL DESCRIPTION

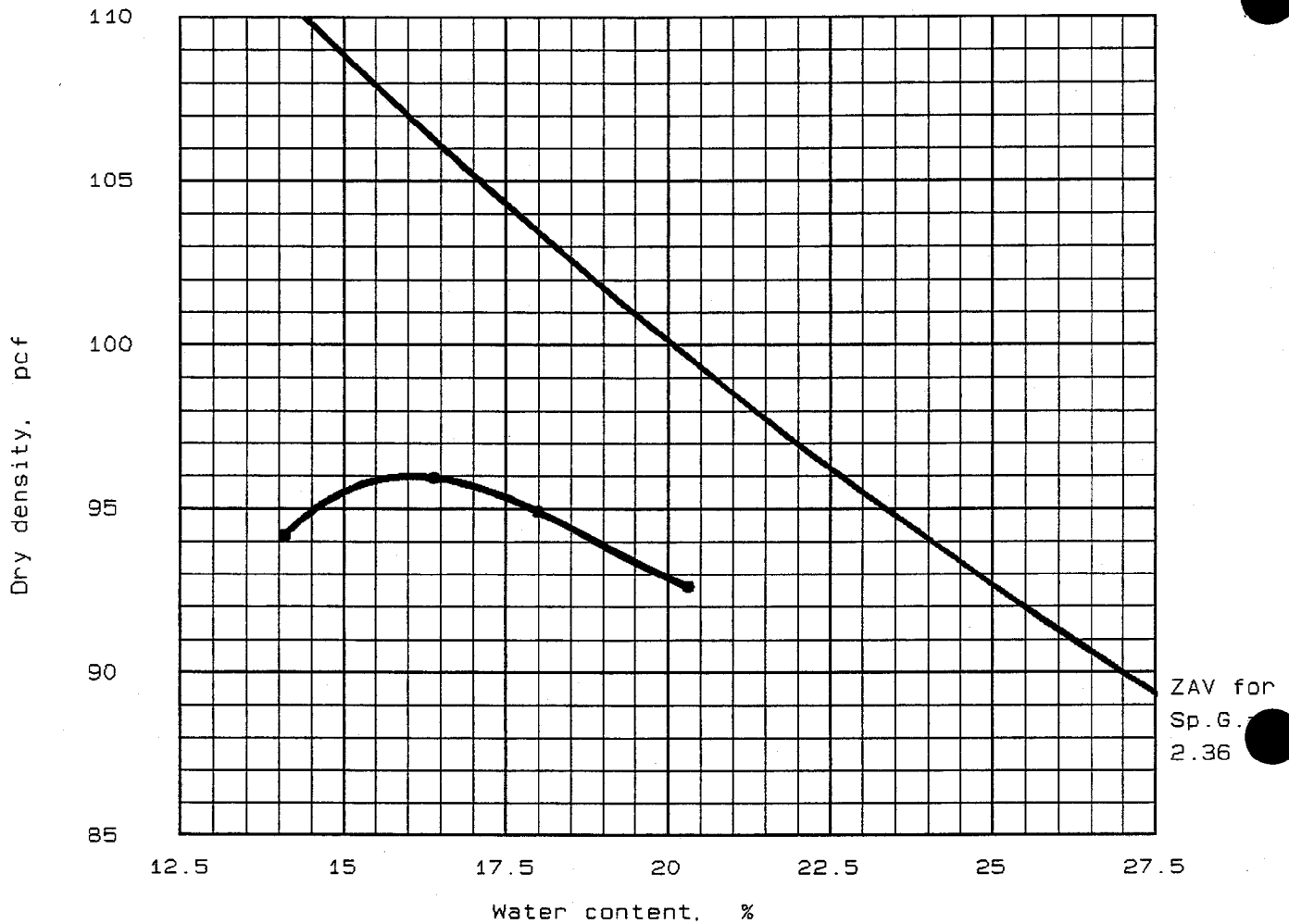
Project No.: 5810860101
Project: TVA - Johnsonville
Location: Ponded Fly Ash
Old Dredge Cell
Date: July 25, 1995

Remarks:
Tested by: *JCR*
Reviewed by: *RUB*

MOISTURE-DENSITY RELATIONSHIP
LAW ENGINEERING, INC.

Figure No. _____

MOISTURE-DENSITY RELATIONSHIP



"Modified" Proctor, ASTM D 1557, Method A

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No. 4	% < No. 200
	USCS	AASHTO						
	SM	A-2-4 (0.0) *	13.2 %	2.36	NL	NP	4.93 %	39.1 %

TEST RESULTS	MATERIAL DESCRIPTION
--------------	----------------------

Optimum moisture = 16.1 %
Maximum dry density = 96.0 pcf

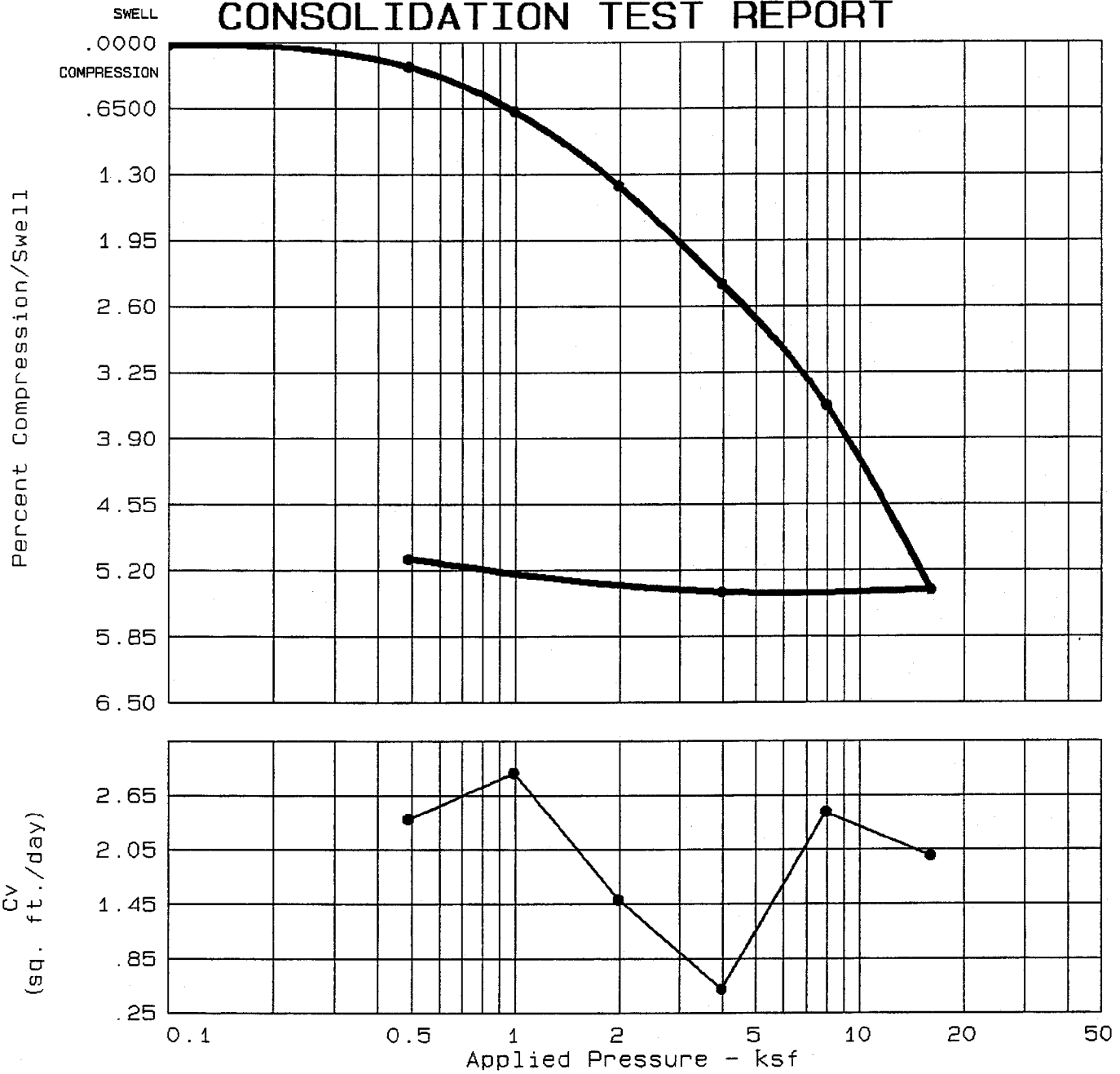
Project No.: 5810860101
Project: TVA - Johnsonville
Location: Poned Fly Ash
 Old Dredge Cell
Date: July 25, 1995

Remarks:
Tested by: *JCN*
Reviewed by: *RUP*

MOISTURE-DENSITY RELATIONSHIP
LAW ENGINEERING, INC.

Figure No. _____

CONSOLIDATION TEST REPORT



Natural Saturation	Natural Moisture	Dry Density	LL	PI	Sp. Gr.	Precons. press.	Cc	e ₀
63.3 %	19.4	85.5	NL	NP	2.360	7.99	0.10	0.7226

TEST RESULTS	MATERIAL DESCRIPTION
Compression Index = 0.10	Class: SM, A-4 (0.0) * Remarks: Tested by: <i>ADK</i> Reviewed by: <i>HS</i>
Project No.: 5810860101 Project: TVA - Johnsonville Location: Poned Fly Ash Old Dredge Cell Date: August 22, 1995	
CONSOLIDATION TEST REPORT LAW ENGINEERING, INC.	
Fig. No. _____	

HYDRAULIC CONDUCTIVITY



LAW ENGINEERING

Project No. **5810860101**
Project Name **TVA - Johnsonville**
Material (Source) **Ponded Fly Ash**
(Old Dredge Cell)

Tested By **HEJ**
Test Date **08/04/95**
Reviewed By **RLB**
Review Date **09/06/95**

ASTM D5084 - Falling Head

Sample Type:	<i>Remolded</i>
Sample Orientation:	<i>Vertical</i>
Initial Water Content, %:	<i>18.3</i>
Wet Unit Weight, pcf:	<i>98.7</i>
Dry Unit Weight, pcf:	<i>83.4</i>
Compaction, %:	<i>93.2</i>
Hydraulic Conductivity, cm/sec. @20 °C:	5.8E-04

PERMEABILITY TEST - FALLING HEAD (ASTM D5084 - 90)

Job Number 5810860101 Tested By HEJ
 Project Name TVA - Johnsonville Test Date 08/04/95
 Material (Source) Ponded Fly Ash Reviewed By RLB
(Old Dredge Cell) Review Date 09/06/95

Sample Data

Length, in	Diameter, in		Pan No.	
	Location 1	Location 2	Dry Soil+Pan, grams	Dry Soil+Pan, grams
Location 1	6.000	2.830	826.64	826.64
Location 2	6.000	2.830	0.00	0.00
Location 3	6.000	2.830		
Average	6.000	2.830	Moisture Content, %	18.3
		977.91	Wet Unit Wt, pcf	98.7
		0.00	Dry Unit Wt, pcf	83.4

Chamber Pressure, psi 34
 Back Pressure, psi 20
 Confining Pressure, psi 14

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	Division Start	Division Finish	H ₀ (cm)	H _f (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				134	0.0	24.0	127.11	103.11	5.9E-04	21	5.7E-04
				134	0.0	24.0	127.11	103.11	5.9E-04	21	5.8E-04
				134	0.0	24.0	127.11	103.11	5.9E-04	21	5.8E-04

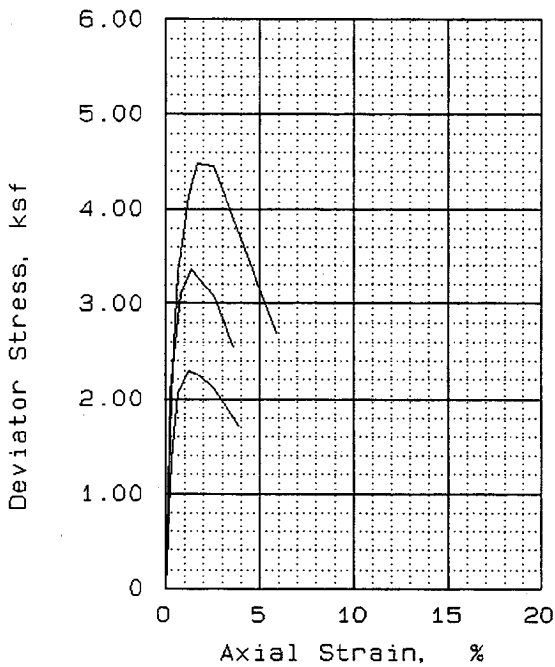
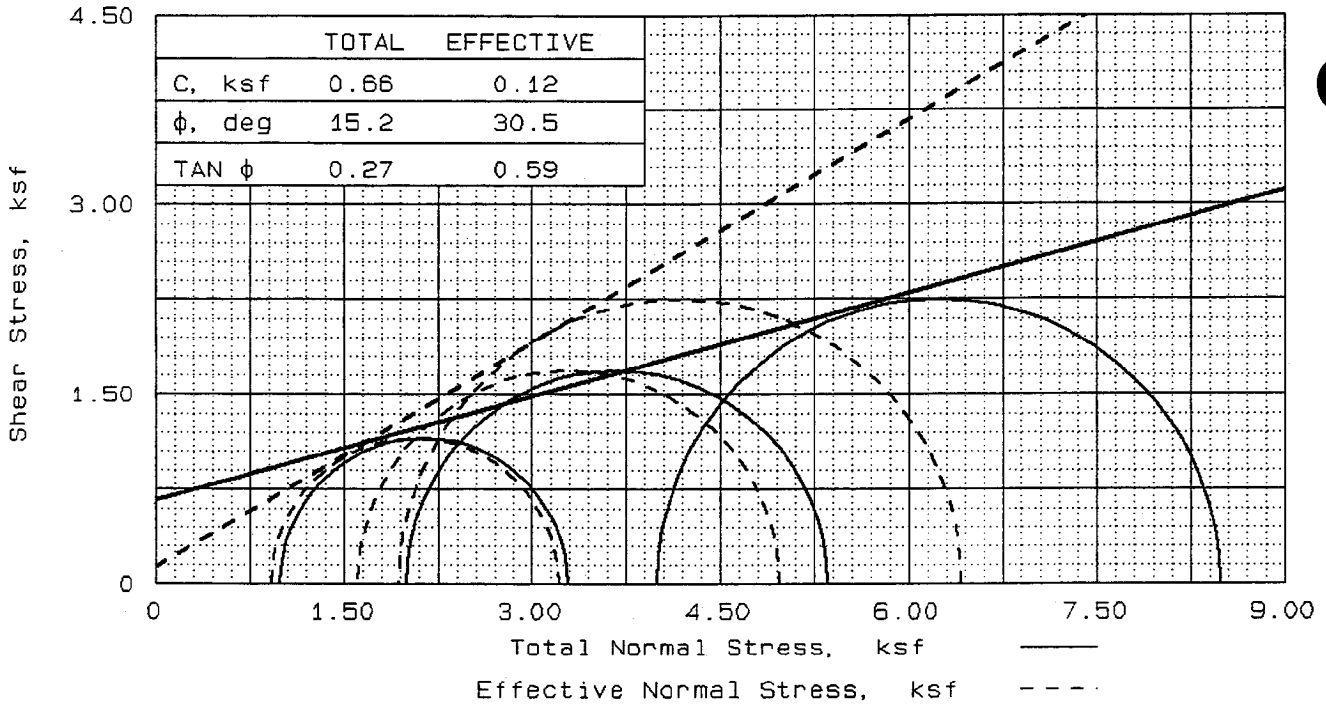
No. of Trial	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
3	Remolded	89.5	93.2	Vertical

Avg. k at 20 °C 5.8E-04 cm/sec

a = area of burette in cm²
 L = length of sample in cm
 A = area of sample in cm²

H₀ = initial head in cm
 H_f = final head in cm
 t = time in seconds

a = 1.00 cm²
 A = 40.582 cm²
 L = 15.24 cm



SAMPLE NO.		1	2	3
INITIAL	WATER CONTENT, %	18.5	18.3	18.3
	DRY DENSITY, pcf	83.4	83.4	83.5
	SATURATION, %	56.9	56.4	56.4
	VOID RATIO	0.767	0.766	0.765
	DIAMETER, in	2.83	2.83	2.83
	HEIGHT, in	6.00	6.00	6.00
AT TEST	WATER CONTENT, %	31.1	31.4	31.9
	DRY DENSITY, pcf	85.0	84.6	84.0
	SATURATION, %	100.0	100.0	100.0
	VOID RATIO	0.734	0.741	0.754
	DIAMETER, in	2.81	2.81	2.82
	HEIGHT, in	5.99	5.99	5.99
BACK PRESSURE, ksf		2.91	2.84	2.88
CELL PRESSURE, ksf		6.91	4.84	3.87
FAILURE STRESS, ksf		4.49	3.36	2.30
PORE PRESSURE, ksf		4.97	3.23	2.95
STRAIN RATE, %/min.		0.100	0.100	0.100
ULTIMATE STRESS, ksf				
PORE PRESSURE, ksf				
$\bar{\sigma}_1$ FAILURE, ksf		6.43	4.97	3.22
$\bar{\sigma}_3$ FAILURE, ksf		1.94	1.61	0.92

TYPE OF TEST:
CU with pore pressures

SAMPLE TYPE: Remolded
DESCRIPTION:

LL= NL PL= NP PI=

SPECIFIC GRAVITY= 2.36

REMARKS: Tested by: *LS*

Reviewed by: *RUB*

FIG. NO.

CLIENT:

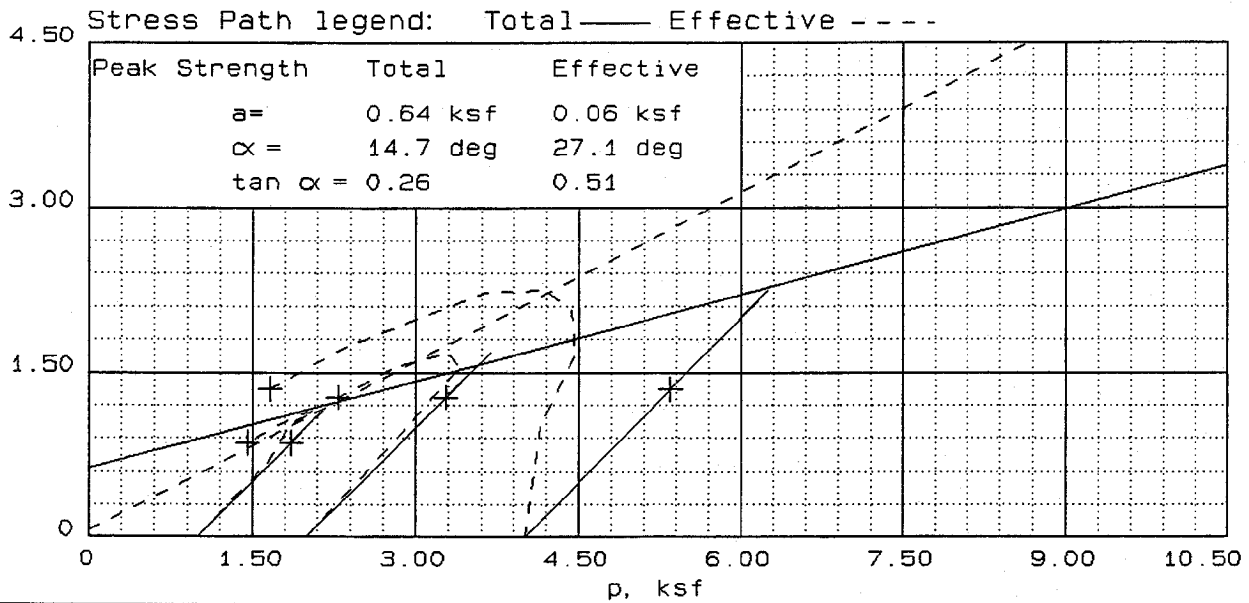
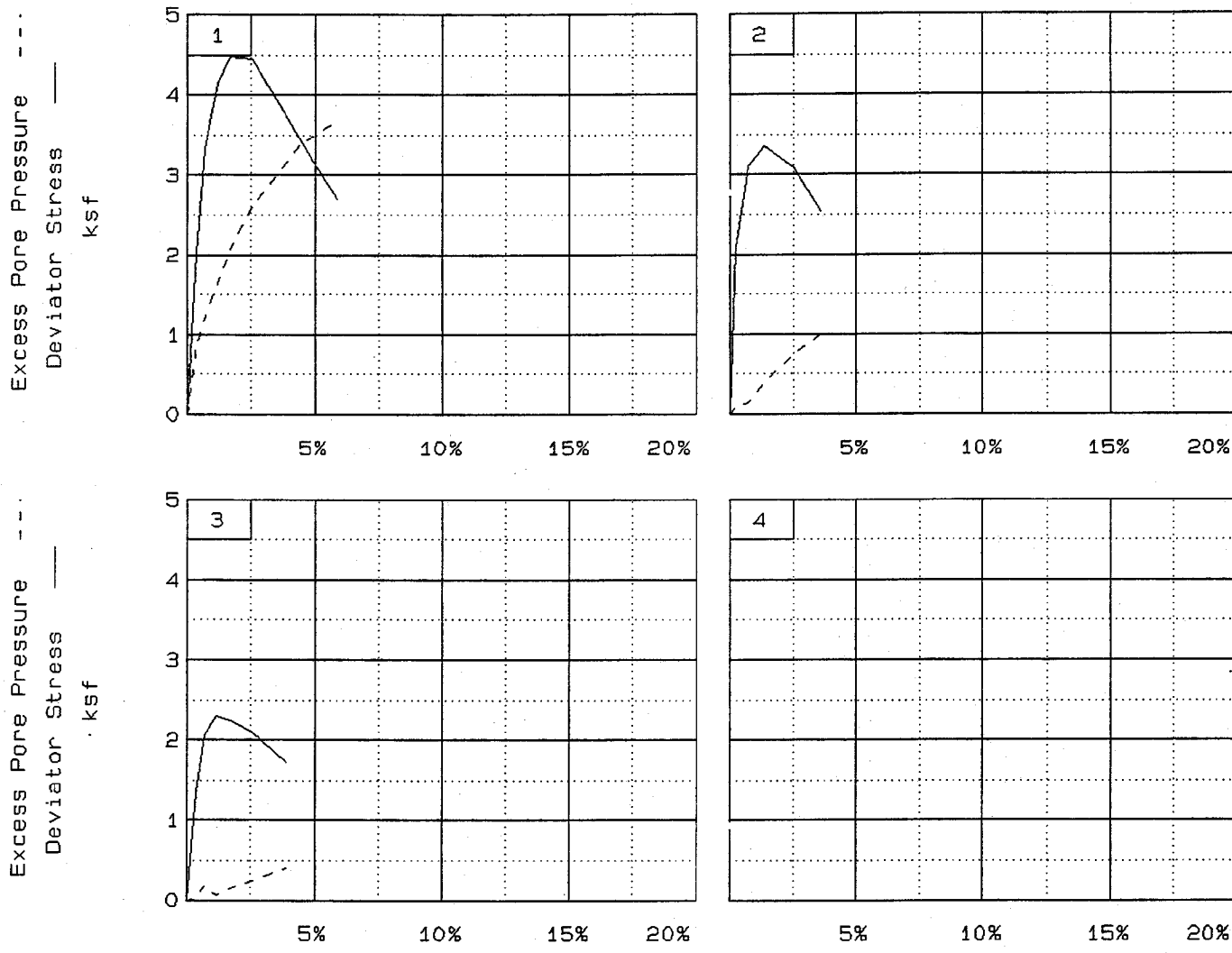
PROJECT: TVA - Johnsonville

SAMPLE LOCATION: Ponded Fly Ash
Old Dredge Cell

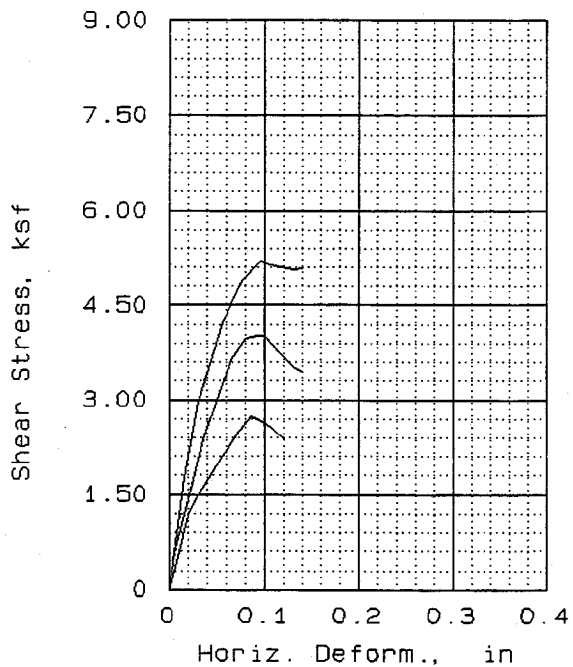
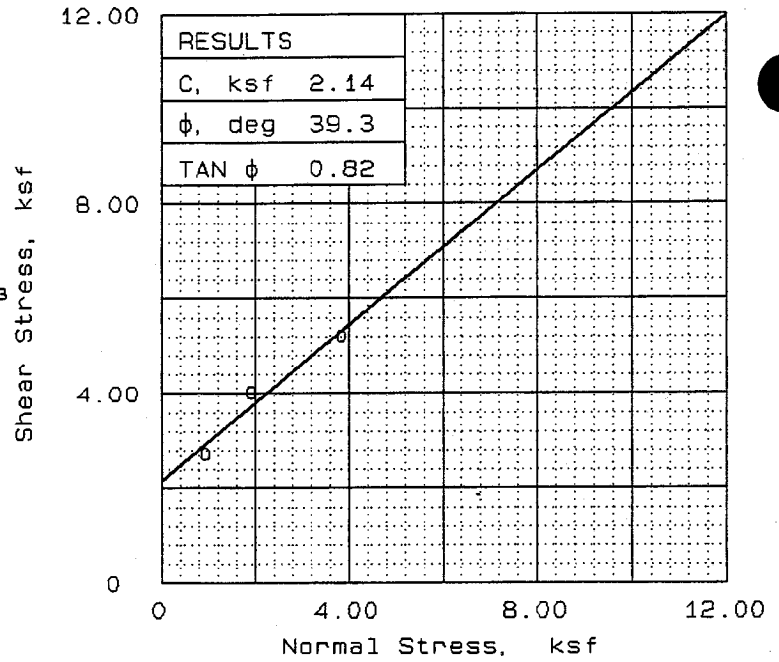
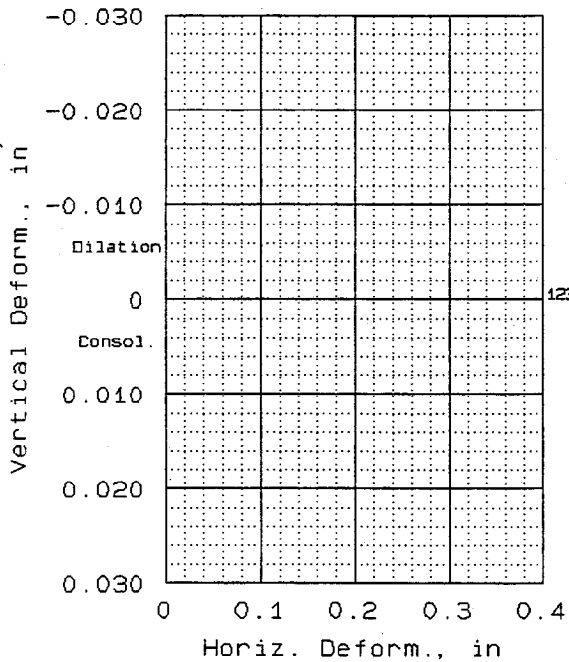
PROJ. NO.: 5810860101 DATE: August 28, 1995

TRIAxIAL COMPRESSION TEST

LAW ENGINEERING, INC.



Client:
 Project: TVA - Johnsonville
 Location: Poned Fly Ash Old Dredge Cell
 File: 8601M Project No.: 5810860101 Page 2/2 Fig. No. _____



SAMPLE NO.		1	2	3
INITIAL	WATER CONTENT, %	19.4	19.9	19.7
	DRY DENSITY, pcf	91.1	89.6	89.9
	SATURATION, %	74.0	72.8	72.6
	VOID RATIO	0.618	0.644	0.639
	DIAMETER, in	2.50	2.50	2.50
	HEIGHT, in	0.81	0.81	0.81
AT TEST	WATER CONTENT, %	19.4	19.9	19.2
	DRY DENSITY, pcf	91.1	89.6	89.9
	SATURATION, %	74.0	72.8	70.8
	VOID RATIO	0.618	0.644	0.639
	DIAMETER, in	2.50	2.50	2.50
	HEIGHT, in	0.81	0.81	0.81
NORMAL STRESS, ksf		0.97	1.94	3.88
MAX. SHEAR, ksf		2.73	4.03	5.21
STRAIN RATE, %/min.		0.500	0.500	0.500
ULT. SHEAR, ksf				

SAMPLE DATA
SAMPLE TYPE: Remolded
DESCRIPTION:
LL= NL PL= NP PI=
SPECIFIC GRAVITY= 2.36
REMARKS: Tested by: *RB*
Reviewed by: *RLB*
FIG. NO.

CLIENT:
PROJECT: TVA - Johnsonville
SAMPLE LOCATION: Poned Fly Ash
Old Dredge Cell
PROJ. NO.: 5810850101 DATE: 29 August, 1995
DIRECT SHEAR TEST
LAW ENGINEERING, INC.

California Bearing Ratio

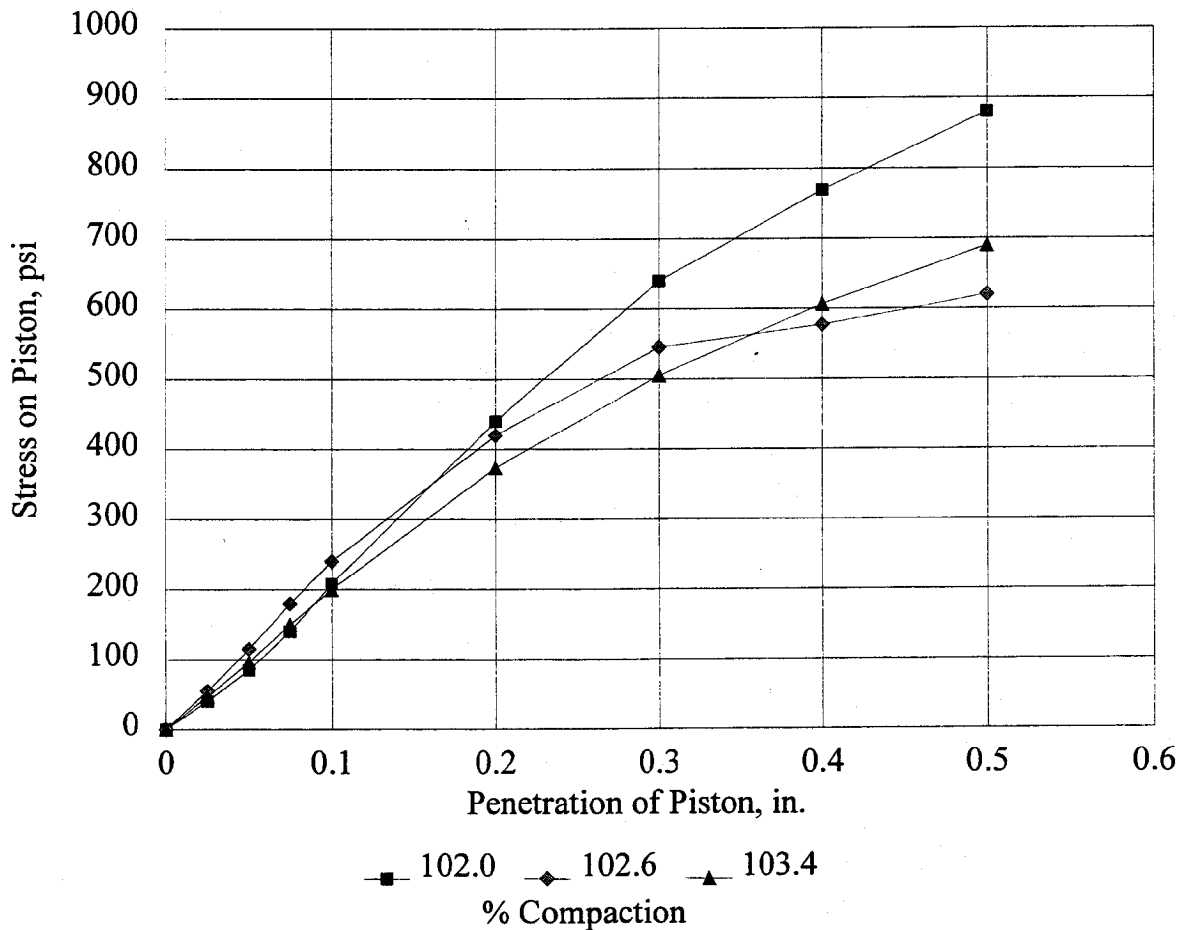
(ASTM D1883-92)



LAW ENGINEERING

Project No.	<u>5810860101</u>	Tested By	<u>EM</u>
Project Name	<u>TVA - Johnsonville</u>	Test Date	<u>08/18/95</u>
Material (Source)	<u>Ponded Fly Ash (Old Dredge Cell)</u>	Reviewed By	<u>RLB</u>
		Review Date	<u>09/01/95</u>

Compaction, %	102.0	102.6	103.4
Before Soak Dry Density, pcf	91.3	91.9	92.6
Before Soak Moisture Content, %	20.7	21.2	21.4
After Soak Dry Density, pcf	92.6	93.2	94.1
After Soak Moisture Content, %	21.4	21.9	21.9
CBR @ 0.1 in.	20.8	24.0	20.0
CBR @ 0.2 in.	29.3	28.0	24.9



LABORATORY MATERIAL HANDLING AND TESTING
 LABORATORY MATERIAL TEST DATA
 RESILIENT MODULUS OF UNBOUND GRANULAR BASE/SUBBASE
 MATERIALS AND SUBGRADE SOILS
 LAB DATA SHEET T46 - RECOMPACTED SAMPLES

SHEET NO 1 OF 2

UNBOUND GRANULAR BASE/SUBBASE LAYERS AND SUBGRADE SOILS
 SHRP TEST DESIGNATION UG07, SS07/SHRP PROTOCOL P46

LABORATORY PERFORMING TEST: LAW ENGINEERING, INC. - ATLANTA, GEORGIA

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study

LAW PROJECT NO.: 5810860101

1.	MATERIAL SOURCE:	Johnsonville	
2.	MATERIAL DESCRIPTION:	Ponded Fly Ash (Old Dredge Cell)	
3.	REMOLDING TARGETS:	95% Standard Dry Density at Optimum Moisture Content	
4.	MATERIAL TYPE (Type 1 or Type 2)		<u>2</u>
5.	TEST INFORMATION		
	PRECONDITIONING - GREATER THAN 5% PERM. STRAIN? (Y = YES OR N = NO)		<u>N</u>
	TESTING - GREATER THAN 5% PERM. STRAIN? (Y = YES OR N = NO)		<u>N</u>
	TESTING - NUMBER OF LOAD SEQUENCES COMPLETED (0 - 15)		<u>15</u>
6.	SPECIMEN INFO :		
	SPECIMEN DIAM., inch		
	TOP		<u>2.85</u>
	MIDDLE		<u>2.85</u>
	BOTTOM		<u>2.87</u>
	AVERAGE		<u>2.86</u>
	MEMBRANE THICKNESS (1), inch		<u>0.01</u>
	MEMBRANE THICKNESS (2), inch		<u>0.01</u>
	NET DIAM., inch		<u>2.84</u>
	HEIGHT OF SPECIMEN, CAP AND BASE, inch		<u>6.03</u>
	HEIGHT OF CAP AND BASE, inch		<u>0.00</u>
	INITIAL LENGTH, L ₀ , inch		<u>6.03</u>
	INITIAL AREA, A ₀ , in ²		<u>6.32</u>
	INITIAL VOLUME A ₀ L ₀ , in ³		<u>38.12</u>
7.	SOIL SPECIMEN WEIGHT:		
	INITIAL WEIGHT OF CONTAINER AND WET SOIL, grams		<u>968.55</u>
	FINAL WEIGHT OF CONTAINER AND WET SOIL, grams		<u>0.00</u>
	WEIGHT OF WET SOIL USED, grams		<u>968.55</u>
8.	SOIL PROPERTIES :		
	IN SITU MOISTURE CONTENT (NUCLEAR), %		<u>N/A</u>
	IN SITU WET DENSITY (NUCLEAR), pcf		<u>N/A</u>
	or		
	OPTIMUM MOISTURE CONTENT, %		<u>20.5</u>
	MAX. DRY DENSITY, pcf		<u>89.5</u>
	95 % MAX. DRY DENSITY, pcf		<u>85.0</u>
9.	SPECIMEN PROPERTIES:		
	COMPACTION MOISTURE CONTENT, %		<u>17.9</u>
	MOISTURE CONTENT AFTER RESILIENT MODULUS TESTING, %		<u>17.9</u>
	COMPACTION DRY DENSITY, γ _d pcf		<u>82.0</u>
10.	QUICK SHEAR TEST		
	STRESS - STRAIN PLOT ATTACHED (Y = YES, N = NO)		<u>Y</u>
	TRIAxIAL SHEAR MAXIMUM STRENGTH (MAX. LOAD/X-SECTION AREA), psi		<u>20.3</u>
	SPECIMEN FAIL DURING TRIAXIAL SHEAR? (Y = YES, N = NO)		<u>Y</u>
11.	COMMENTS (Section 10.4 of Protocol P46)		
	(a) CODE	<u>0</u>	<u>0</u>
	(b) NOTE	<u>0</u>	<u>0</u>
12.	TEST DATE		<u>08-17-1995</u>

GENERAL REMARKS:

SUBMITTED BY, DATE

RS Brubaker
 LABORATORY MANAGER

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study
 LAW PROJECT NO.: 5810860101
 MATERIAL SOURCE: Johnsonville
 MATERIAL DESCRIPTION: Ponded Fly Ash (Old Dredge Cell)
 REMOLDING TARGETS: 95% Standard Dry Density at Optimum Moisture Content
 MATERIAL TYPE: 2
 TEST DATE: 08-17-1995
 RESILIENT MODULUS TESTING

COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
PARAMETER	Chamber Confining Pressure	Nominal Maximum Axial Stress	Cycle No.	Actual Applied Max. Axial Load	Actual Applied Cyclic Load	Actual Applied Contact Load	Actual Applied Max. Axial Stress	Actual Applied Cyclic Stress	Actual Applied Contact Stress	Recov. Def. LVDT #1 Reading	Recov. Def. LVDT #2 Reading	Average Recov Def. LVDT 1 and 2	Resilient Strain	Resilient Modulus
DESIGNATION	S ₃	S _{cyclic}	c ₁	P _{max}	P _{cyclic}	P _{contact}	S _{max}	S _{cyclic}	S _{contact}	H ₁	H ₂	H _{avg}	ε _r	M _r
UNIT	psi	psi	---	lbs	lbs	lbs	psi	psi	psi	in.	in.	in.	in/in	psi
PRECISION														
SEQUENCE 1	6.0	2.0	1	12.7	11.5	1.2	2.0	1.8	0.2	0.00145	0.00146	0.00146	0.00024	7,505
			2	12.7	11.5	1.2	2.0	1.8	0.2	0.00146	0.00147	0.00146	0.00024	7,493
			3	12.7	11.5	1.2	2.0	1.8	0.2	0.00146	0.00146	0.00146	0.00024	7,533
			4	12.7	11.5	1.2	2.0	1.8	0.2	0.00147	0.00147	0.00147	0.00024	7,451
			5	12.7	11.5	1.2	2.0	1.8	0.2	0.00148	0.00147	0.00147	0.00024	7,457
COLUMN AVERAGE				12.7	11.5	1.2	2.0	1.8	0.2	0.00146	0.00147	0.00147	0.00024	7,488
STANDARD DEV.				0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	34

Source:	Johnsonville	Description:	Ponded Fly Ash (Old Dredge Cell)	95% Standard Dry Density at Optimum Moisture Content										
SEQUENCE 2	6.0	4.0	1	25.3	23.0	2.3	4.0	3.6	0.4	0.00282	0.00294	0.00288	0.00048	7,638
			2	25.3	23.0	2.3	4.0	3.6	0.4	0.00282	0.00294	0.00288	0.00048	7,634
			3	25.3	23.0	2.3	4.0	3.6	0.4	0.00281	0.00293	0.00287	0.00048	7,649
			4	25.4	23.1	2.3	4.0	3.7	0.4	0.00281	0.00293	0.00287	0.00048	7,672
			5	25.3	23.0	2.3	4.0	3.6	0.4	0.00282	0.00295	0.00288	0.00048	7,610
SEQUENCE 3	6.0	6.0	1	38.0	34.3	3.6	6.0	5.4	0.6	0.00424	0.00445	0.00435	0.00072	7,540
			2	38.0	34.4	3.6	6.0	5.4	0.6	0.00424	0.00446	0.00435	0.00072	7,547
			3	37.9	34.3	3.6	6.0	5.4	0.6	0.00424	0.00445	0.00435	0.00072	7,521
			4	38.0	34.4	3.6	6.0	5.4	0.6	0.00424	0.00446	0.00435	0.00072	7,544
			5	38.0	34.4	3.6	6.0	5.4	0.6	0.00425	0.00445	0.00435	0.00072	7,545
SEQUENCE 4	6.0	8.0	1	50.3	45.8	4.4	8.0	7.3	0.7	0.00581	0.00612	0.00596	0.00099	7,335
			2	50.2	45.7	4.5	7.9	7.2	0.7	0.00584	0.00611	0.00598	0.00099	7,302
			3	50.3	45.9	4.5	8.0	7.3	0.7	0.00584	0.00614	0.00599	0.00099	7,306
			4	50.5	46.1	4.5	8.0	7.3	0.7	0.00590	0.00619	0.00605	0.00100	7,272
			5	50.3	45.8	4.4	8.0	7.3	0.7	0.00583	0.00613	0.00598	0.00099	7,314

Source:	Johnsonville	Description:	Ponded Fly Ash (Old Dredge Cell)	95% Standard Dry Density at Optimum Moisture Content										
SEQUENCE 8	4.0	6.0	1	38.1	34.5	3.5	6.0	5.5	0.6	0.00607	0.00635	0.00621	0.00103	5,302
			2	38.1	34.5	3.6	6.0	5.5	0.6	0.00607	0.00637	0.00622	0.00103	5,297
			3	38.0	34.4	3.6	6.0	5.4	0.6	0.00605	0.00636	0.00620	0.00103	5,285
			4	38.1	34.5	3.6	6.0	5.5	0.6	0.00607	0.00634	0.00621	0.00103	5,300
			5	38.2	34.5	3.6	6.0	5.5	0.6	0.00607	0.00635	0.00621	0.00103	5,300
	COLUMN AVERAGE			38.1	34.5	3.6	6.0	5.5	0.6	0.00607	0.00635	0.00621	0.00103	5,297
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	7
SEQUENCE 9	4.0	8.0	1	50.9	46.0	4.9	8.0	7.3	0.8	0.00778	0.00815	0.00797	0.00132	5,508
			2	51.0	46.1	4.9	8.1	7.3	0.8	0.00779	0.00815	0.00797	0.00132	5,517
			3	51.0	46.1	4.9	8.1	7.3	0.8	0.00780	0.00815	0.00797	0.00132	5,516
			4	51.0	46.1	4.9	8.1	7.3	0.8	0.00779	0.00815	0.00797	0.00132	5,516
			5	50.9	46.0	4.9	8.0	7.3	0.8	0.00778	0.00816	0.00797	0.00132	5,500
	COLUMN AVERAGE			50.9	46.1	4.9	8.1	7.3	0.8	0.00779	0.00815	0.00797	0.00132	5,511
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00000	0.00000	8
SEQUENCE 10	4.0	10.0	1	63.3	57.1	6.1	10.0	9.0	1.0	0.00945	0.00990	0.00968	0.00160	5,635
			2	63.3	57.1	6.1	10.0	9.0	1.0	0.00945	0.00990	0.00967	0.00160	5,636
			3	63.4	57.2	6.2	10.0	9.1	1.0	0.00946	0.00991	0.00969	0.00161	5,638
			4	63.4	57.2	6.1	10.0	9.1	1.0	0.00947	0.00991	0.00969	0.00161	5,637
			5	63.3	57.2	6.1	10.0	9.0	1.0	0.00942	0.00991	0.00967	0.00160	5,642
	COLUMN AVERAGE			63.3	57.2	6.1	10.0	9.0	1.0	0.00945	0.00991	0.00968	0.00160	5,637
	STANDARD DEV.			0.1	0.0	0.0	0.0	0.0	0.0	0.00002	0.00001	0.00001	0.00000	3

Source: Johnsonville		Description: Ponded Fly Ash (Old Dredge Cell)										95% Standard Dry Density at Optimum Moisture Content				
SEQUENCE 11	2.0	2.0	1	13.3	11.2	2.1	2.1	2.1	1.8	0.3	0.00299	0.00308	0.00304	0.00050	3,524	
			2	13.3	11.2	2.1	2.1	2.1	1.8	0.3	0.00299	0.00307	0.00303	0.00050	3,521	
			3	13.3	11.2	2.1	2.1	2.1	1.8	0.3	0.00299	0.00307	0.00303	0.00050	3,529	
			4	13.3	11.2	2.1	2.1	2.1	1.8	0.3	0.00300	0.00306	0.00303	0.00050	3,539	
			5	13.4	11.3	2.1	2.1	2.1	1.8	0.3	0.00299	0.00308	0.00303	0.00050	3,558	
	COLUMN AVERAGE		13.3	11.2	2.1	2.1	2.1	1.8	0.3	0.00299	0.00307	0.00303	0.00050	3,534		
	STANDARD DEV.		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00000	0.00001	0.00000	0.00000	15		
SEQUENCE 12	2.0	4.0	1	25.3	22.9	2.4	4.0	4.0	3.6	0.4	0.00603	0.00627	0.00615	0.00102	3,553	
			2	25.3	22.9	2.4	4.0	4.0	3.6	0.4	0.00604	0.00627	0.00616	0.00102	3,556	
			3	25.3	22.9	2.4	4.0	4.0	3.6	0.4	0.00604	0.00628	0.00616	0.00102	3,548	
			4	25.2	22.8	2.4	4.0	4.0	3.6	0.4	0.00605	0.00627	0.00616	0.00102	3,539	
			5	25.1	22.8	2.4	4.0	4.0	3.6	0.4	0.00603	0.00626	0.00615	0.00102	3,535	
	COLUMN AVERAGE		25.2	22.9	2.4	4.0	4.0	3.6	0.4	0.00604	0.00627	0.00615	0.00102	3,546		
	STANDARD DEV.		0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	9		
SEQUENCE 13	2.0	6.0	1	37.7	34.2	3.6	6.0	6.0	5.4	0.6	0.00822	0.00858	0.00840	0.00139	3,881	
			2	37.7	34.1	3.6	6.0	6.0	5.4	0.6	0.00821	0.00858	0.00840	0.00139	3,878	
			3	37.7	34.2	3.6	6.0	6.0	5.4	0.6	0.00821	0.00858	0.00840	0.00139	3,882	
			4	37.7	34.1	3.6	6.0	6.0	5.4	0.6	0.00823	0.00860	0.00841	0.00139	3,865	
			5	37.6	34.0	3.6	6.0	6.0	5.4	0.6	0.00820	0.00857	0.00838	0.00139	3,871	
	COLUMN AVERAGE		37.7	34.1	3.6	6.0	6.0	5.4	0.6	0.00821	0.00858	0.00840	0.00139	3,875		
	STANDARD DEV.		0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	7		

Source: Johnsonville		Description: Pondered Fly Ash (Old Dredge Cell)					95% Standard Dry Density at Optimum Moisture Content							
SEQUENCE 14	2.0	8.0	1	50.4	45.6	4.8	8.0	7.2	0.8	0.01048	0.01093	0.01070	0.00177	4,062
			2	50.4	45.5	4.9	8.0	7.2	0.8	0.01048	0.01093	0.01070	0.00177	4,059
			3	50.3	45.5	4.8	8.0	7.2	0.8	0.01051	0.01094	0.01073	0.00178	4,048
			4	50.3	45.5	4.8	8.0	7.2	0.8	0.01050	0.01094	0.01072	0.00178	4,048
			5	50.5	45.6	4.8	8.0	7.2	0.8	0.01049	0.01094	0.01071	0.00178	4,064
	COLUMN AVERAGE			50.4	45.5	4.8	8.0	7.2	0.8	0.01049	0.01093	0.01071	0.00178	4,056
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00002	0.00001	0.00001	0.00000	8
SEQUENCE 15	2.0	10.0	1	62.4	56.2	6.1	9.9	8.9	1.0	0.01312	0.01356	0.01334	0.00221	4,021
			2	62.4	56.2	6.2	9.9	8.9	1.0	0.01312	0.01355	0.01334	0.00221	4,022
			3	62.4	56.4	6.1	9.9	8.9	1.0	0.01312	0.01354	0.01333	0.00221	4,032
			4	62.4	56.3	6.1	9.9	8.9	1.0	0.01316	0.01355	0.01336	0.00221	4,022
			5	62.4	56.3	6.1	9.9	8.9	1.0	0.01313	0.01355	0.01334	0.00221	4,023
	COLUMN AVERAGE			62.4	56.3	6.1	9.9	8.9	1.0	0.01313	0.01355	0.01334	0.00221	4,024
	STANDARD DEV.			0.0	0.1	0.0	0.0	0.0	0.0	0.00002	0.00001	0.00001	0.00000	5

SUBMITTED BY, DATE

R. R. Burchum 9/10/95

LABORATORY MANAGER

FIGURE 1 - Logarithmic Plot of Resilient Modulus (M_R) vs Cyclic Stress (S_C)

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study
 LAW PROJECT NO.: 5810860101
 1. MATERIAL SOURCE: Johnsonville
 2. MATERIAL DESCRIPTION: Ponded Fly Ash (Old Dredge Cell)
 3. REMOLDING TARGETS: 95% Standard Dry Density at Optimum Moisture Content
 4. MATERIAL TYPE: 2
 5. TEST DATE: 08-17-1995

$$M_R = K_1 (S_C)^{K_2} (1+S_3)^{K_5}$$

K1 = 1,495
 K2 = 0.03707
 K5 = 0.78260
 R² = 0.97

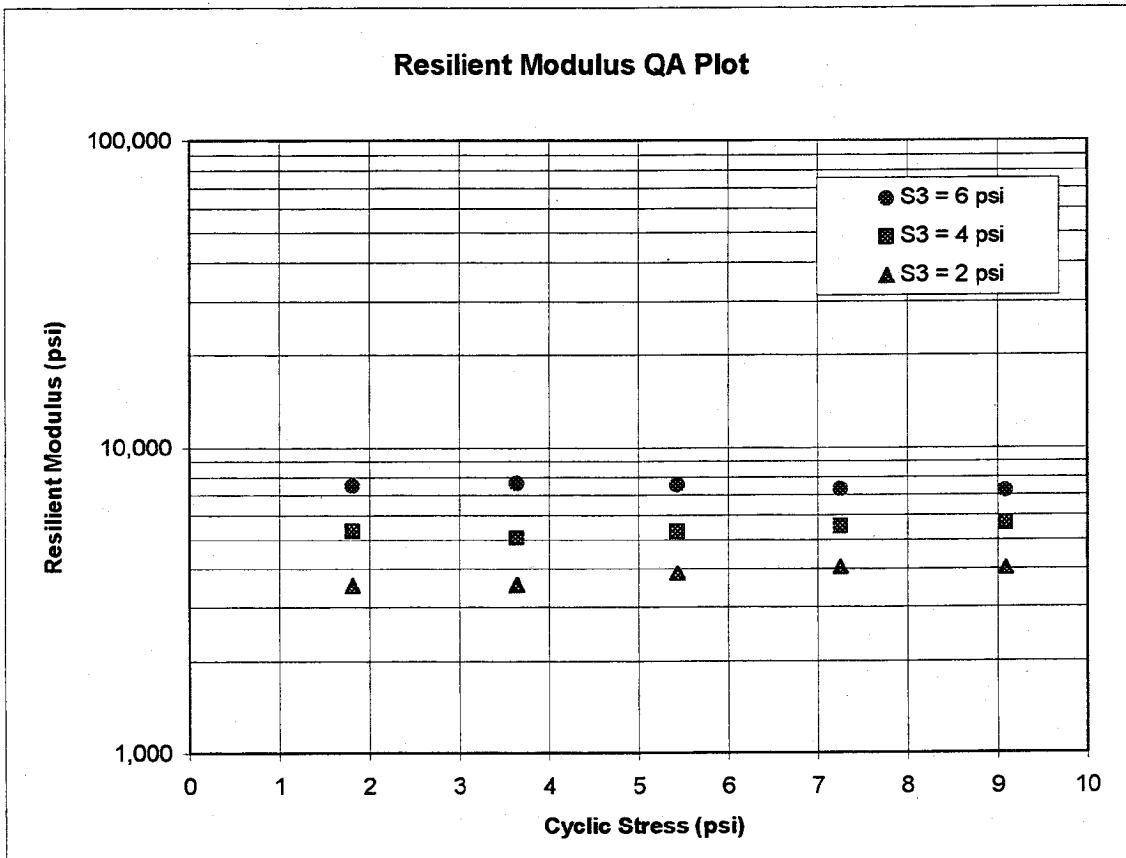
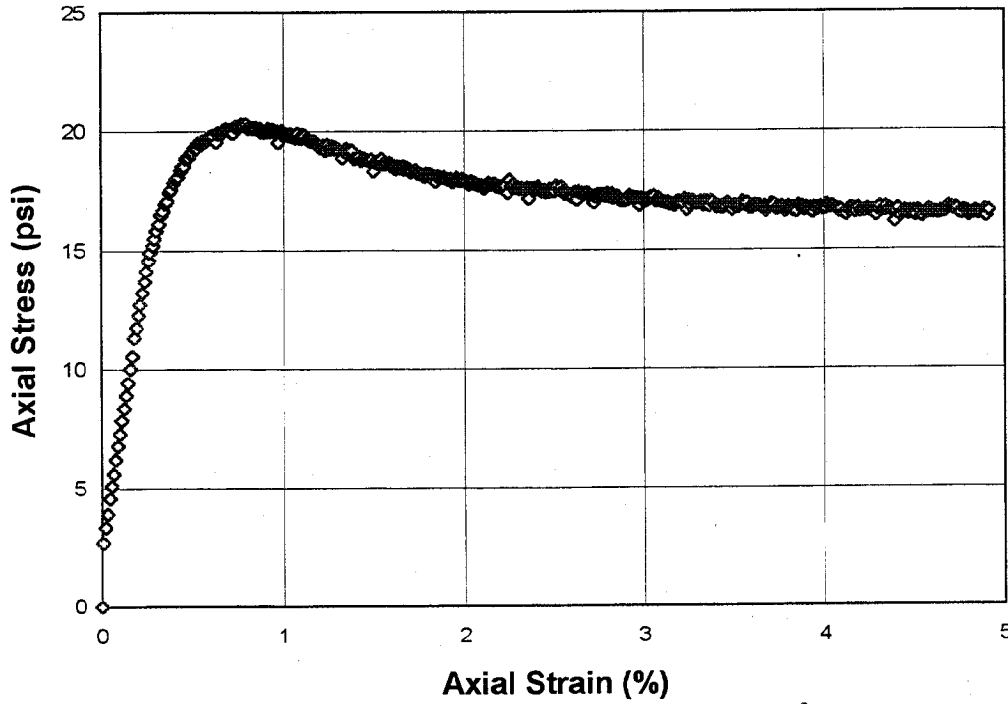


FIGURE 2 - Quick Shear Stress vs Strain

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study
LAW PROJECT NO.: 5810860101
1. MATERIAL SOURCE: Johnsonville
2. MATERIAL DESCRIPTION: Ponded Fly Ash (Old Dredge Cell)
3. REMOLDING TARGETS: 95% Standard Dry Density at Optimum Moisture Content
4. MATERIAL TYPE: 2
5. TEST DATE: 08-17-1995



LABORATORY MATERIAL HANDLING AND TESTING
 LABORATORY MATERIAL TEST DATA
 RESILIENT MODULUS OF UNBOUND GRANULAR BASE/SUBBASE
 MATERIALS AND SUBGRADE SOILS
 LAB DATA SHEET T46 - RECOMPACTED SAMPLES

SHEET NO 1 OF 2

UNBOUND GRANULAR BASE/SUBBASE LAYERS AND SUBGRADE SOILS
 SHRP TEST DESIGNATION UG07, SS07/SHRP PROTOCOL P46

LABORATORY PERFORMING TEST: LAW ENGINEERING, INC. - ATLANTA, GEORGIA

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study

LAW PROJECT NO.: 5810860101

- | | | | | |
|-----|---|--|---|------------|
| 1. | MATERIAL SOURCE: | Johnsonville | | |
| 2. | MATERIAL DESCRIPTION: | Ponded Fly Ash (Old Dredge Cell) | | |
| 3. | REMOLDING TARGETS: | 95% Modified Dry Density at Optimum Moisture Content | | |
| 4. | MATERIAL TYPE (Type 1 or Type 2) | | | 2 |
| 5. | TEST INFORMATION | | | |
| | PRECONDITIONING - GREATER THAN 5% PERM. STRAIN? (Y = YES OR N = NO) | | | N |
| | TESTING - GREATER THAN 5% PERM. STRAIN? (Y = YES OR N = NO) | | | N |
| | TESTING - NUMBER OF LOAD SEQUENCES COMPLETED (0 - 15) | | | 15 |
| 6. | SPECIMEN INFO.: | | | |
| | SPECIMEN DIAM., inch | | | |
| | TOP | | | 2.86 |
| | MIDDLE | | | 2.86 |
| | BOTTOM | | | 2.86 |
| | AVERAGE | | | 2.86 |
| | MEMBRANE THICKNESS (1), inch | | | 0.01 |
| | MEMBRANE THICKNESS (2), inch | | | 0.01 |
| | NET DIAM., inch | | | 2.83 |
| | HEIGHT OF SPECIMEN, CAP AND BASE, inch | | | 6.07 |
| | HEIGHT OF CAP AND BASE, inch | | | 0.00 |
| | INITIAL LENGTH, L ₀ , inch | | | 6.07 |
| | INITIAL AREA, A ₀ , in ² | | | 6.31 |
| | INITIAL VOLUME A ₀ L ₀ , in ³ | | | 38.27 |
| 7. | SOIL SPECIMEN WEIGHT: | | | |
| | INITIAL WEIGHT OF CONTAINER AND WET SOIL, grams | | | 1011.84 |
| | FINAL WEIGHT OF CONTAINER AND WET SOIL, grams | | | 0.00 |
| | WEIGHT OF WET SOIL USED, grams | | | 1011.84 |
| 8. | SOIL PROPERTIES.: | | | |
| | IN SITU MOISTURE CONTENT (NUCLEAR), % | | | N/A |
| | IN SITU WET DENSITY (NUCLEAR), pcf | | | N/A |
| | or | | | |
| | OPTIMUM MOISTURE CONTENT, % | | | 16.1 |
| | MAX. DRY DENSITY, pcf | | | 96.0 |
| | 95 % MAX. DRY DENSITY, pcf | | | 91.2 |
| 9. | SPECIMEN PROPERTIES: | | | |
| | COMPACTION MOISTURE CONTENT, % | | | 14.4 |
| | MOISTURE CONTENT AFTER RESILIENT MODULUS TESTING, % | | | 14.4 |
| | COMPACTION DRY DENSITY, γ _d pcf | | | 88.0 |
| 10. | QUICK SHEAR TEST | | | |
| | STRESS - STRAIN PLOT ATTACHED (Y = YES, N = NO) | | | Y |
| | TRIAXIAL SHEAR MAXIMUM STRENGTH (MAX. LOAD/X-SECTION AREA), psi | | | 31.1 |
| | SPECIMEN FAIL DURING TRIAXIAL SHEAR? (Y = YES, N = NO) | | | Y |
| 11. | COMMENTS (Section 10.4 of Protocol P46) | | | |
| | (a) CODE | 0 | 0 | 0 |
| | (b) NOTE | 0 | 0 | 0 |
| 12. | TEST DATE | | | 08-17-1995 |

GENERAL REMARKS:

SUBMITTED BY, DATE

RS Bandman 9/10/95
 LABORATORY MANAGER

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study
 LAW PROJECT NO.: 5810860101
 MATERIAL SOURCE: Johnsonville
 MATERIAL DESCRIPTION: Ponded Fly Ash (Old Dredge Cell)
 REMOLDING TARGETS: 95% Modified Dry Density at Optimum Moisture Content
 MATERIAL TYPE: 2
 TEST DATE: 08-17-1995
 RESILIENT MODULUS TESTING

COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
PARAMETER	Chamber Confining Pressure	Nominal Maximum Axial Stress	Cycle No.	Actual Applied Max. Axial Load	Actual Applied Cyclic Load	Actual Applied Contact Load	Actual Applied Max. Axial Stress	Actual Applied Cyclic Stress	Actual Applied Contact Stress	Recov. Def. LVDT #1 Reading	Recov. Def. LVDT #2 Reading	Average Recov Def. LVDT 1 and 2	Resilient Strain	Resilient Modulus
DESIGNATION	S ₃	S _{cyclic}	C ₁	P _{max}	P _{cyclic}	P _{contact}	S _{max}	S _{cyclic}	S _{contact}	H ₁	H ₂	H _{avg}	ε _r	M _r
UNIT	psi	psi	---	lbs	lbs	lbs	psi	psi	psi	in.	in.	in.	in/in	psi
PRECISION														
SEQUENCE 1	6.0	2.0	1	12.7	11.4	1.3	2.0	1.8	0.2	0.00122	0.00115	0.00118	0.00020	9,295
			2	12.7	11.4	1.3	2.0	1.8	0.2	0.00125	0.00112	0.00119	0.00020	9,192
			3	12.6	11.4	1.3	2.0	1.8	0.2	0.00125	0.00113	0.00119	0.00020	9,195
			4	12.7	11.4	1.3	2.0	1.8	0.2	0.00123	0.00115	0.00119	0.00020	9,234
			5	12.7	11.4	1.3	2.0	1.8	0.2	0.00123	0.00114	0.00119	0.00020	9,261
COLUMN AVERAGE				12.7	11.4	1.3	2.0	1.8	0.2	0.00123	0.00114	0.00119	0.00020	9,235
STANDARD DEV.				0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00000	0.00000	44

Source:	Johnsonville	Description:	Ponded Fly Ash (Old Dredge Cell)	95% Modified Dry Density at Optimum Moisture Content										
SEQUENCE 2	6.0	4.0	1	25.2	22.8	2.4	4.0	3.6	0.4	0.00228	0.00220	0.00224	0.00037	9,812
			2	25.2	22.8	2.4	4.0	3.6	0.4	0.00227	0.00221	0.00224	0.00037	9,815
			3	25.2	22.8	2.4	4.0	3.6	0.4	0.00226	0.00220	0.00223	0.00037	9,817
			4	25.4	23.0	2.4	4.0	3.6	0.4	0.00229	0.00222	0.00226	0.00037	9,791
			5	25.3	22.9	2.4	4.0	3.6	0.4	0.00228	0.00222	0.00225	0.00037	9,773
			25.3	22.9	2.4	4.0	3.6	0.4	0.00228	0.00221	0.00224	0.00037	9,802	
			0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00000	19	
SEQUENCE 3	6.0	6.0	1	37.7	34.1	3.6	6.0	5.4	0.6	0.00338	0.00333	0.00336	0.00055	9,751
			2	37.8	34.2	3.6	6.0	5.4	0.6	0.00340	0.00336	0.00338	0.00056	9,724
			3	37.8	34.2	3.6	6.0	5.4	0.6	0.00338	0.00335	0.00336	0.00055	9,769
			4	37.8	34.2	3.6	6.0	5.4	0.6	0.00339	0.00333	0.00336	0.00055	9,775
			5	37.8	34.2	3.6	6.0	5.4	0.6	0.00336	0.00335	0.00336	0.00055	9,784
			37.8	34.2	3.6	6.0	5.4	0.6	0.00338	0.00334	0.00336	0.00055	9,761	
			0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.00002	0.00001	0.00001	24	
SEQUENCE 4	6.0	8.0	1	50.6	45.7	4.9	8.0	7.2	0.8	0.00461	0.00453	0.00457	0.00075	9,616
			2	50.6	45.7	4.9	8.0	7.2	0.8	0.00462	0.00453	0.00458	0.00075	9,605
			3	50.6	45.7	4.9	8.0	7.2	0.8	0.00462	0.00452	0.00457	0.00075	9,605
			4	50.6	45.7	4.9	8.0	7.2	0.8	0.00463	0.00454	0.00458	0.00076	9,592
			5	50.6	45.7	4.9	8.0	7.2	0.8	0.00462	0.00451	0.00457	0.00075	9,621
			50.6	45.7	4.9	8.0	7.2	0.8	0.00462	0.00453	0.00457	0.00075	9,608	
			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00000	11	

Source:	Johnsonville	Description:	Ponded Fly Ash (Old Dredge Cell)	95% Modified Dry Density at Optimum Moisture Content										
SEQUENCE 8	4.0	6.0	1	38.1	34.5	3.6	6.0	5.5	0.6	0.00482	0.00468	0.00475	0.00078	6,985
			2	38.1	34.5	3.6	6.0	5.5	0.6	0.00480	0.00469	0.00474	0.00078	6,990
			3	38.1	34.5	3.6	6.0	5.5	0.6	0.00483	0.00468	0.00475	0.00078	6,984
			4	38.1	34.5	3.6	6.0	5.5	0.6	0.00483	0.00469	0.00476	0.00078	6,972
			5	38.0	34.4	3.6	6.0	5.5	0.6	0.00481	0.00468	0.00475	0.00078	6,970
	COLUMN AVERAGE		38.1	34.5	3.6	6.0	5.5	0.6	0.00482	0.00468	0.00475	0.00078	6,980	
	STANDARD DEV.		0.1	0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	9	
SEQUENCE 9	4.0	8.0	1	50.8	45.9	4.9	8.0	7.3	0.8	0.00597	0.00581	0.00589	0.00097	7,491
			2	50.7	45.9	4.9	8.0	7.3	0.8	0.00595	0.00580	0.00588	0.00097	7,505
			3	50.9	46.0	4.9	8.1	7.3	0.8	0.00596	0.00581	0.00589	0.00097	7,512
			4	50.8	45.9	4.9	8.1	7.3	0.8	0.00595	0.00581	0.00588	0.00097	7,509
			5	51.0	46.1	4.9	8.1	7.3	0.8	0.00597	0.00581	0.00589	0.00097	7,516
	COLUMN AVERAGE		50.8	45.9	4.9	8.1	7.3	0.8	0.00596	0.00581	0.00588	0.00097	7,507	
	STANDARD DEV.		0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00000	0.00001	0.00000	10	
SEQUENCE 10	4.0	10.0	1	63.4	57.3	6.2	10.1	9.1	1.0	0.00714	0.00697	0.00705	0.00116	7,802
			2	63.5	57.4	6.1	10.1	9.1	1.0	0.00714	0.00699	0.00706	0.00116	7,808
			3	63.6	57.5	6.1	10.1	9.1	1.0	0.00713	0.00699	0.00706	0.00116	7,824
			4	63.5	57.4	6.1	10.1	9.1	1.0	0.00712	0.00699	0.00706	0.00116	7,823
			5	63.5	57.4	6.1	10.1	9.1	1.0	0.00713	0.00700	0.00706	0.00116	7,813
	COLUMN AVERAGE		63.5	57.4	6.1	10.1	9.1	1.0	0.00713	0.00699	0.00706	0.00116	7,814	
	STANDARD DEV.		0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00000	0.00000	10	

Source: Johnsonville		Description: Ponded Fly Ash (Old Dredge Cell)					95% Modified Dry Density at Optimum Moisture Content							
SEQUENCE 14	2.0	8.0	1	50.8	46.0	4.9	8.1	7.3	0.8	0.00743	0.00728	0.00735	0.00121	6,007
			2	50.8	45.9	4.9	8.0	7.3	0.8	0.00743	0.00728	0.00736	0.00121	5,997
			3	50.8	46.0	4.8	8.1	7.3	0.8	0.00741	0.00729	0.00735	0.00121	6,010
			4	50.8	45.9	4.9	8.0	7.3	0.8	0.00741	0.00729	0.00735	0.00121	6,003
			5	50.8	45.9	4.9	8.1	7.3	0.8	0.00742	0.00728	0.00735	0.00121	6,005
	COLUMN AVERAGE			50.8	45.9	4.9	8.1	7.3	0.8	0.00742	0.00729	0.00735	0.00121	6,005
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00000	0.00000	0.00000	5
SEQUENCE 15	2.0	10.0	1	63.5	57.3	6.2	10.1	9.1	1.0	0.00860	0.00847	0.00853	0.00141	6,458
			2	63.4	57.3	6.2	10.1	9.1	1.0	0.00862	0.00847	0.00854	0.00141	6,446
			3	63.4	57.2	6.2	10.0	9.1	1.0	0.00858	0.00845	0.00852	0.00140	6,460
			4	63.4	57.2	6.2	10.0	9.1	1.0	0.00857	0.00845	0.00851	0.00140	6,464
			5	63.4	57.2	6.1	10.0	9.1	1.0	0.00856	0.00847	0.00851	0.00140	6,458
	COLUMN AVERAGE			63.4	57.3	6.2	10.1	9.1	1.0	0.00858	0.00846	0.00852	0.00141	6,457
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00002	0.00001	0.00001	0.00000	7

SUBMITTED BY, DATE

R. Buchem 9/10/95

LABORATORY MANAGER

FIGURE 1 - Logarithmic Plot of Resilient Modulus (M_R) vs Cyclic Stress (S_C)

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study
 LAW PROJECT NO.: 5810860101
 1. MATERIAL SOURCE: Johnsonville
 2. MATERIAL DESCRIPTION: Ponded Fly Ash (Old Dredge Cell)
 3. REMOLDING TARGETS: 95% Modified Dry Density at Optimum Moisture Content
 4. MATERIAL TYPE: 2
 5. TEST DATE: 08-17-1995

$$M_R = K_1 (S_C)^{K_2} (1+S_3)^{K_5}$$

$K_1 = \underline{\underline{2,255}}$
 $K_2 = \underline{\underline{0.09559}}$
 $K_5 = \underline{\underline{0.65332}}$
 $R^2 = \underline{\underline{0.93}}$

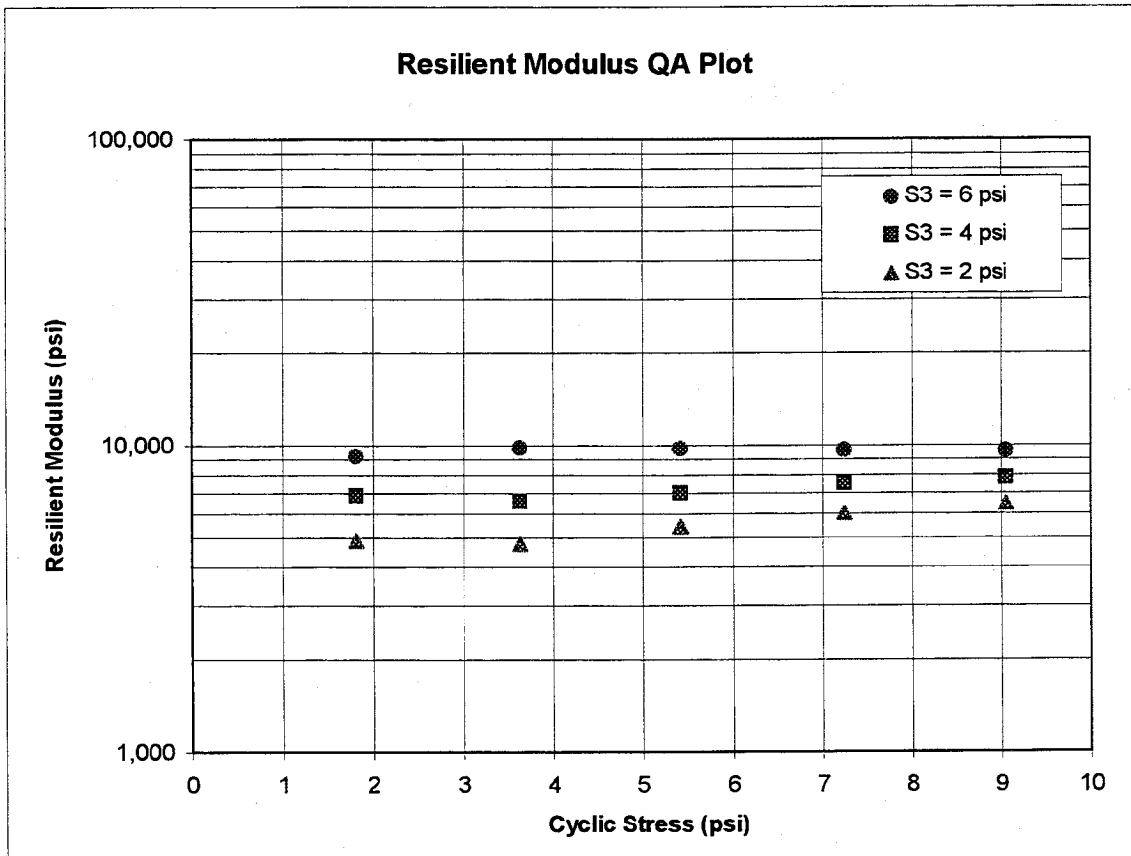
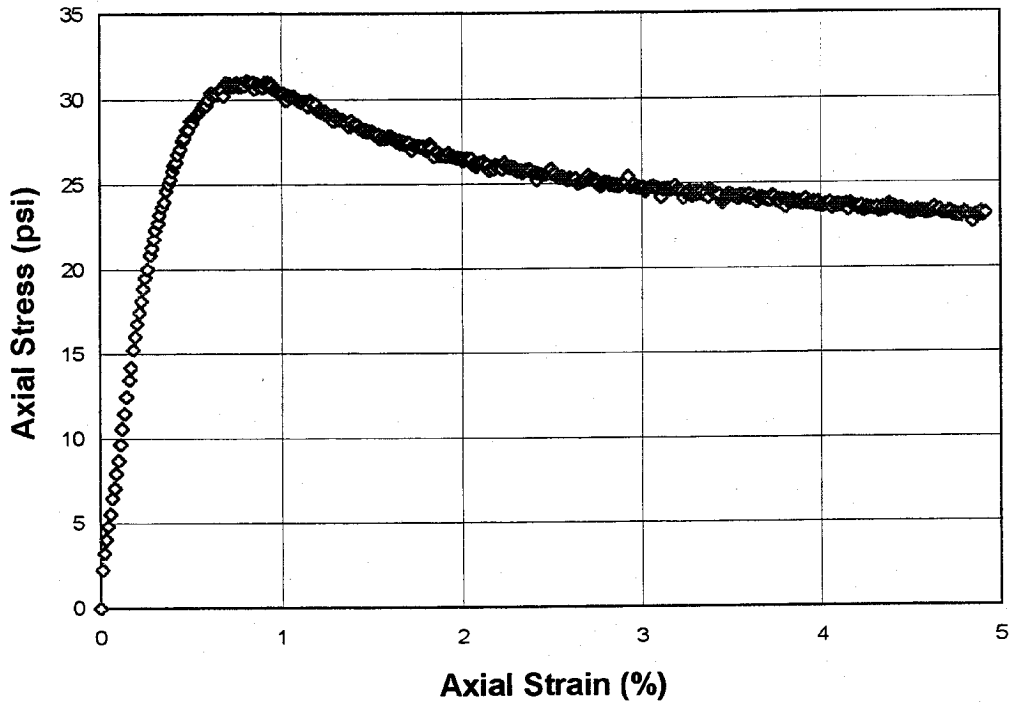


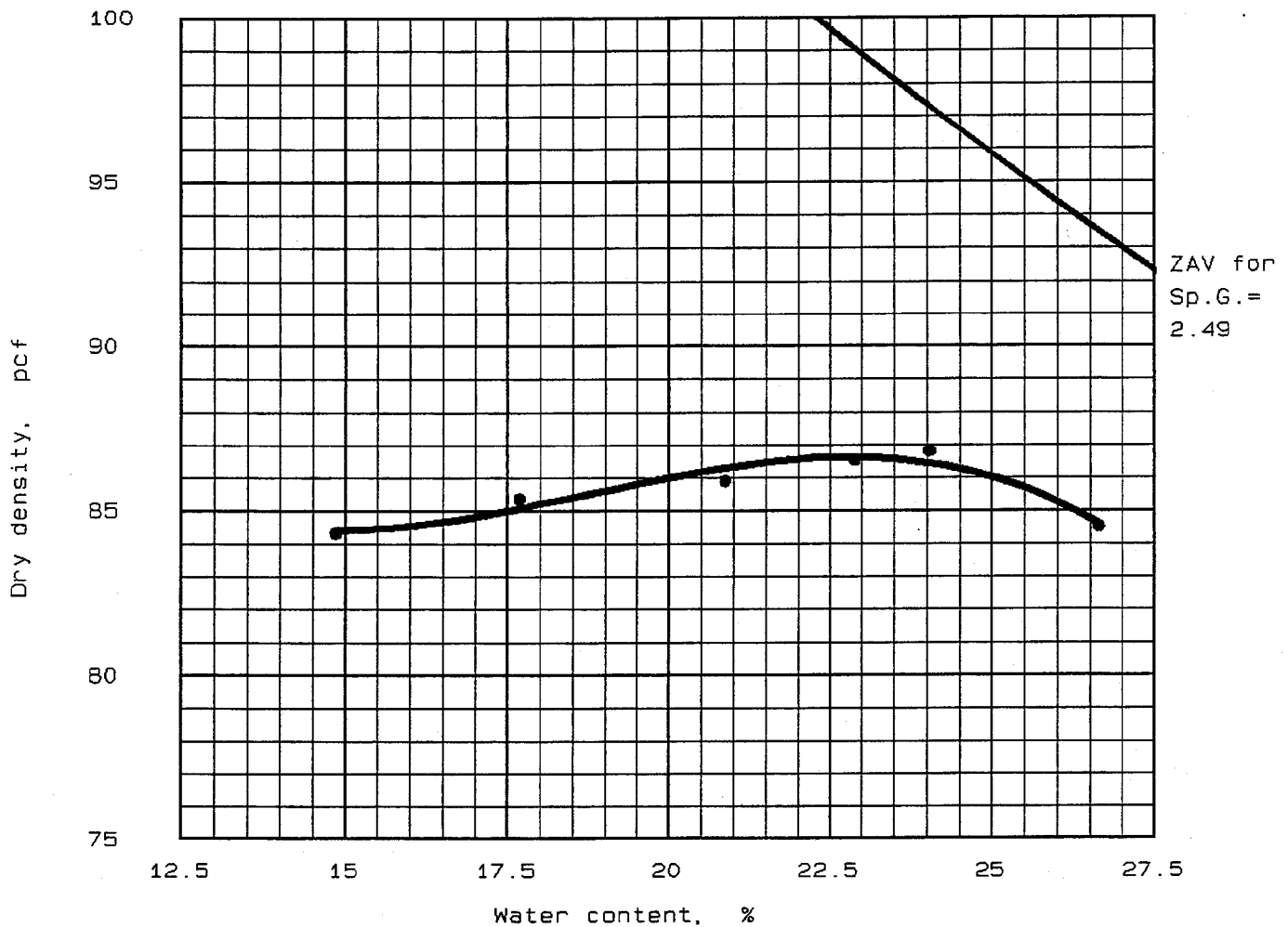
FIGURE 2 - Quick Shear Stress vs Strain

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study
LAW PROJECT NO.: 5810860101
1. MATERIAL SOURCE: Johnsonville
2. MATERIAL DESCRIPTION: Ponded Fly Ash (Old Dredge Cell)
3. REMOLDING TARGETS: 95% Modified Dry Density at Optimum Moisture Content
4. MATERIAL TYPE: 2
5. TEST DATE: 08-17-1995





MOISTURE-DENSITY RELATIONSHIP

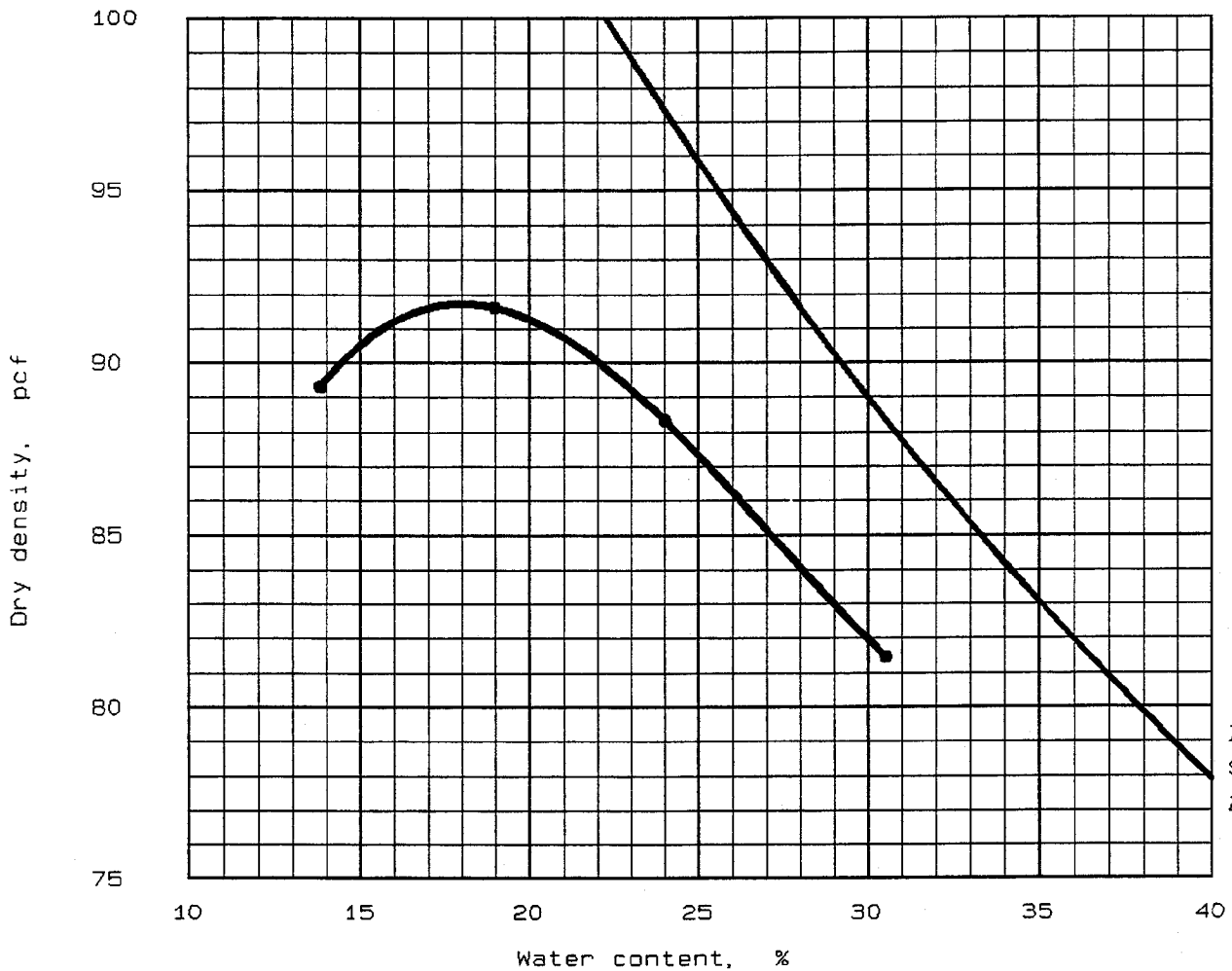


"Standard" Proctor, ASTM D 698, Method A

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No. 4	% < No. 200
	USCS	AASHTO						
	ML	A-4 (0.0)	30.6 %	2.49	NL	NP	0 %	94.6 %

TEST RESULTS	MATERIAL DESCRIPTION
Optimum moisture = 22.8 % Maximum dry density = 86.6 pcf	
Project No.: 5810860101 Project: TVA - Johnsonville Location: Poned Fly Ash Active Ash Pond Date: July 25, 1995	Remarks: Tested by: JCR Reviewed by: HS
MOISTURE-DENSITY RELATIONSHIP LAW ENGINEERING, INC.	Figure No. _____

MOISTURE-DENSITY RELATIONSHIP



"Modified" Proctor, ASTM D 1557, Method A

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No. 4	% < No. 200
	USCS	AASHTO						
	ML	A-4 (0.0)	30.6 %	2.49	NL	NP	0 %	94.6 %

TEST RESULTS	MATERIAL DESCRIPTION
--------------	----------------------

Optimum moisture = 18.0 %
 Maximum dry density = 91.7 pcf

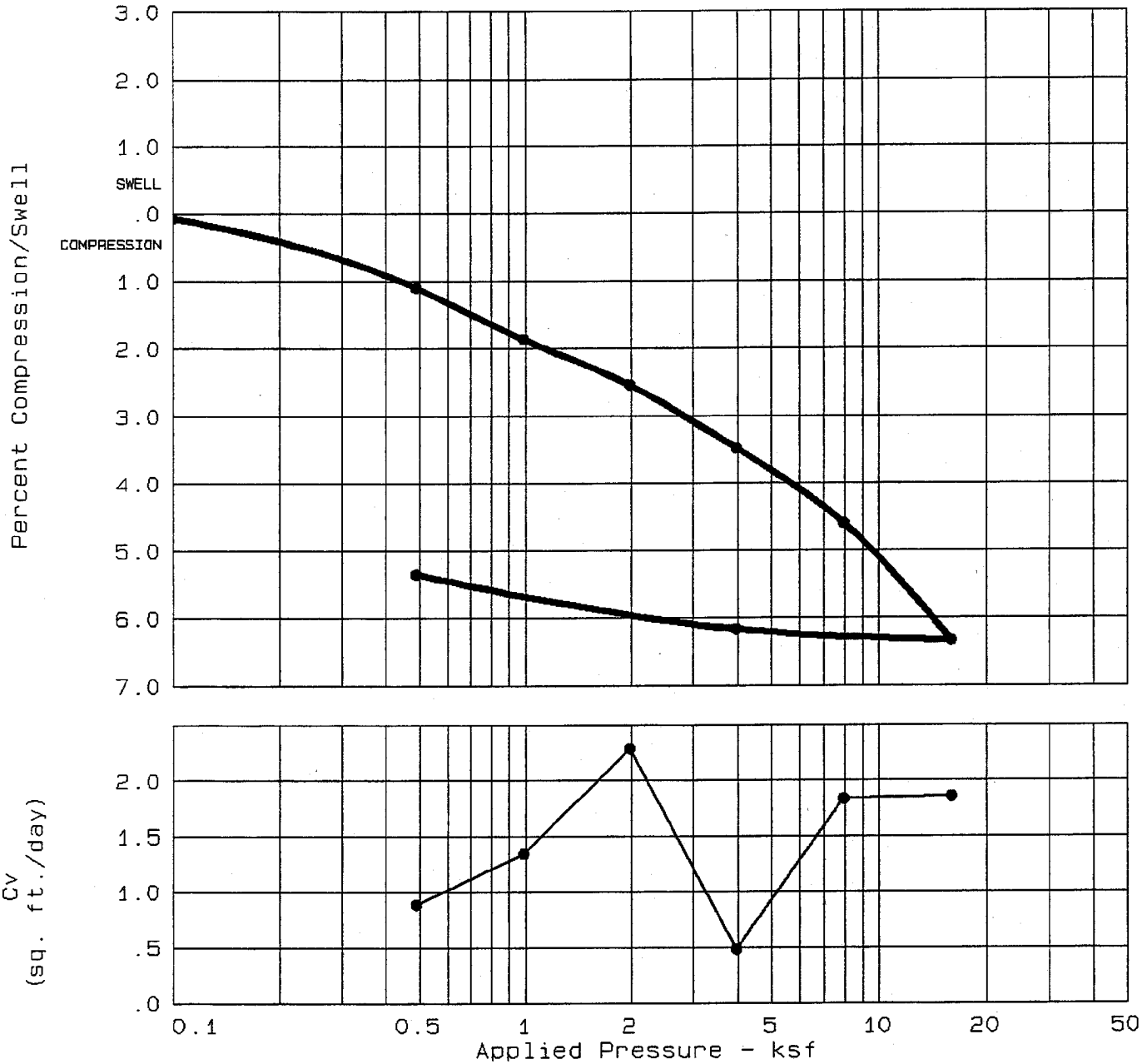
Project No.: 5810860101
 Project: TVA - Johnsonville
 Location: Ponded Fly Ash
 Active Ash Pond
 Date: July 25, 1995

Remarks:
 Tested by: JCN
 Reviewed by: RLB

MOISTURE-DENSITY RELATIONSHIP
LAW ENGINEERING, INC.

Figure No. _____

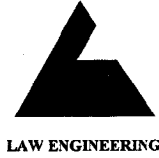
CONSOLIDATION TEST REPORT



Natural Saturation	Natural Moisture	Dry Density	LL	PI	Sp. Gr.	Precons. press.	C _c	e ₀
60.4 %	22.1	81.3	NL	NP	2.487	7.99	0.11	0.9107

TEST RESULTS	MATERIAL DESCRIPTION
Compression Index = 0.11	Class: ML, A-4 (0.0) Remarks: Tested by: <i>ASK</i> Reviewed by: <i>HS</i>
Project No.: 5810860101 Project: TVA - Johnsonville Location: Poned Fly Ash Active Ash Pond Date: August 22, 1995	
CONSOLIDATION TEST REPORT LAW ENGINEERING, INC.	
Fig. No. _____	

HYDRAULIC CONDUCTIVITY



Project No. **5810860101**
Project Name **TVA - Johnsonville**
Material (Source) **Ponded Fly Ash**
(Active Ash Pond)

Tested By **HEJ**
Test Date **08/04/95**
Reviewed By **RLB**
Review Date **09/06/95**

ASTM D5084 - Falling Head

Sample Type:	<i>Remolded</i>
Sample Orientation:	<i>Vertical</i>
Initial Water Content, %:	22.2
Wet Unit Weight, pcf:	97.5
Dry Unit Weight, pcf:	79.7
Compaction, %:	92.1
Hydraulic Conductivity, cm/sec. @20 °C:	3.5E-05

PERMEABILITY TEST - FALLING HEAD
(ASTM D5084 - 90)

LAW ENGINEERING

Job Number 5810860101 Tested By HEJ
 Project Name TVA - Johnsonville Test Date 08/04/95
 Material (Source) Ponded Fly Ash Reviewed By RLB
(Active Ash Pond) Review Date 09/06/95

Sample Data

Length, in	Diameter, in		Pan No.	
	Location 1	Location 1	2.830	Dry Soil+Pan, grams
Location 2	Location 2	2.830	Pan Weight, grams	0.00
Location 3	Location 3	2.830		
Average	Average	2.830	Moisture Content, %	22.2
	Wet Soil + Tare, grams	965.60	Wet Unit Wt, pcf	97.5
	Tare Weight, grams	0.00	Dry Unit Wt, pcf	79.7

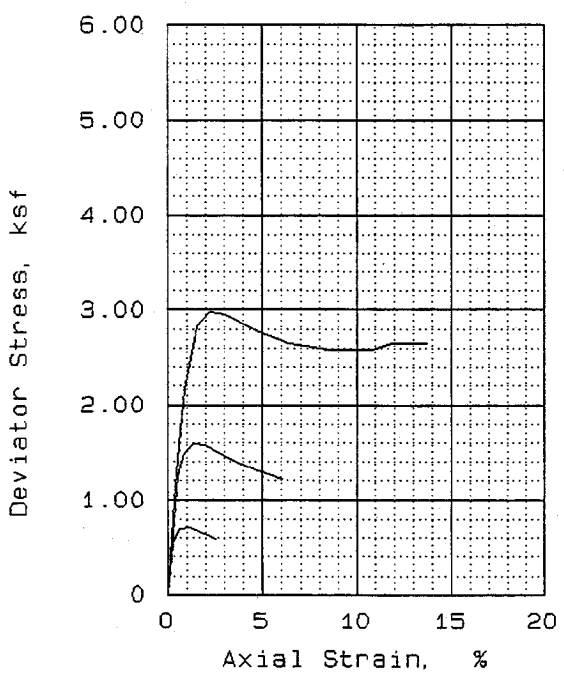
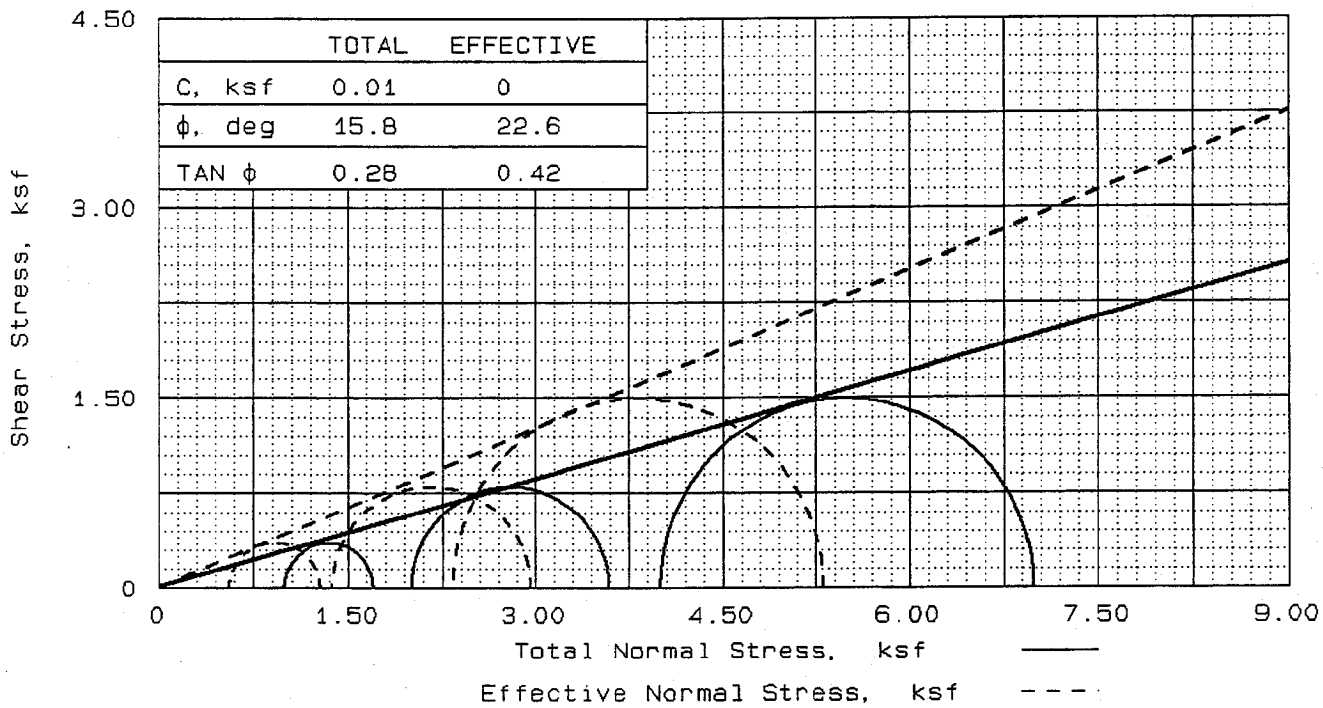
Chamber Pressure, psi 34
 Back Pressure, psi 20
 Confining Pressure, psi 14

Date	Date	Time	Time	Time	Division	H ₀	H _f	k	Temp	k
Start	Finish	Start	Finish	(sec)	Start	(cm)	(cm)	cm/sec	(°C)	cm/sec
				1958	0.0	23.0	104.11	3.8E-05	21	3.8E-05
				2134	0.0	23.0	104.11	3.5E-05	21	3.4E-05
				2143	0.0	23.0	104.11	3.5E-05	21	3.4E-05

No. of Trial	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
3	Remolded	86.6	92.1	Vertical

Avg. k at 20 °C 3.5E-05 cm/sec

a = area of burette in cm² a = 1.00 cm²
 L = length of sample in cm A = 40.582 cm²
 A = area of sample in cm² L = 15.24 cm

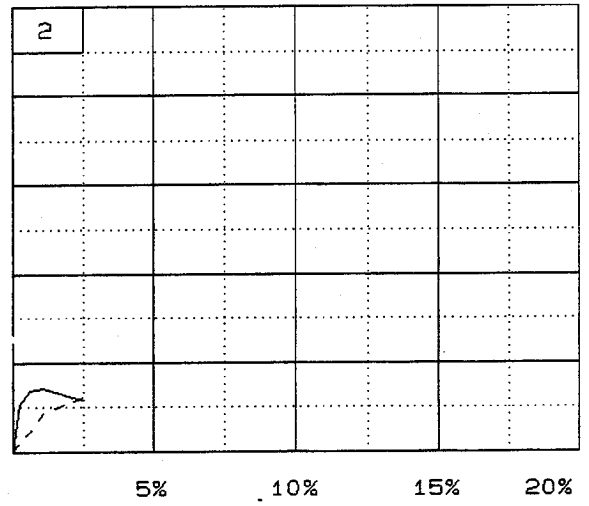
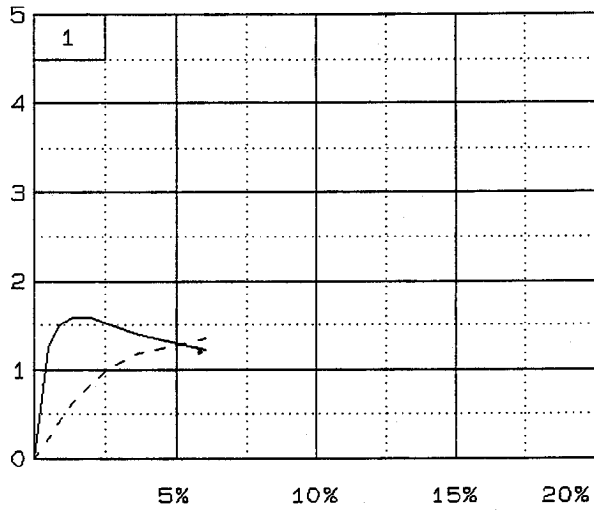


SAMPLE NO.		1	2	3
INITIAL	WATER CONTENT, %	22.2	22.3	22.1
	DRY DENSITY, pcf	79.7	79.7	79.9
	SATURATION, %	58.3	58.3	58.0
	VOID RATIO	0.950	0.950	0.946
	DIAMETER, in	2.83	2.83	2.83
HEIGHT, in	6.00	6.00	6.00	
AT TEST	WATER CONTENT, %	36.3	36.9	34.6
	DRY DENSITY, pcf	81.7	81.0	83.5
	SATURATION, %	100.0	100.0	100.0
	VOID RATIO	0.903	0.919	0.861
	DIAMETER, in	2.80	2.81	2.77
HEIGHT, in	5.98	6.00	5.98	
BACK PRESSURE, ksf	2.81	2.85	2.84	
CELL PRESSURE, ksf	4.81	3.84	6.84	
FAILURE STRESS, ksf	1.59	0.71	2.99	
PORE PRESSURE, ksf	3.44	3.28	4.51	
STRAIN RATE, %/min.	0.100	0.100	0.100	
ULTIMATE STRESS, ksf				
PORE PRESSURE, ksf				
$\bar{\sigma}_1$ FAILURE, ksf	2.96	1.27	5.32	
$\bar{\sigma}_3$ FAILURE, ksf	1.37	0.56	2.33	

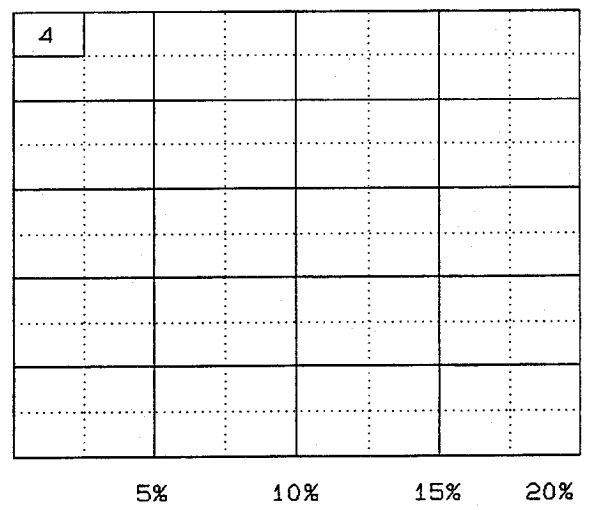
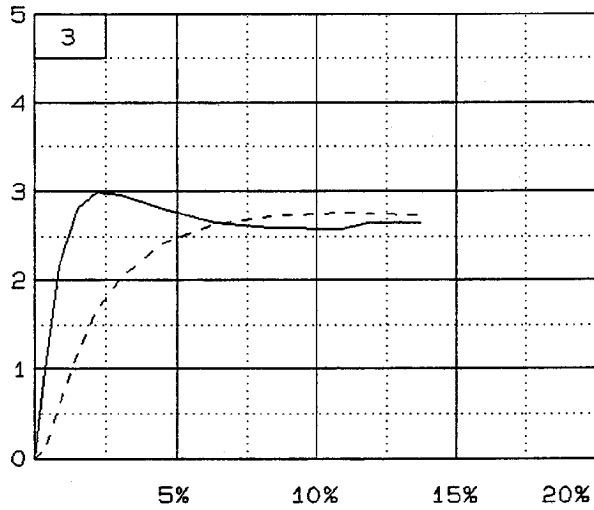
TYPE OF TEST:
 CU with pore pressures
 SAMPLE TYPE: Remolded
 DESCRIPTION:
 LL= NL PL= NP PI=
 SPECIFIC GRAVITY= 2.49
 REMARKS: Tested by: *HS*
 Reviewed by: *RUB*
 FIG. NO.

CLIENT:
 PROJECT: TVA - Johnsonville
 SAMPLE LOCATION: Poned Fly Ash
 Active Ash Pond
 PROJ. NO.: 5810860101 DATE: August 24, 1995
 TRIAXIAL COMPRESSION TEST
LAW ENGINEERING, INC.

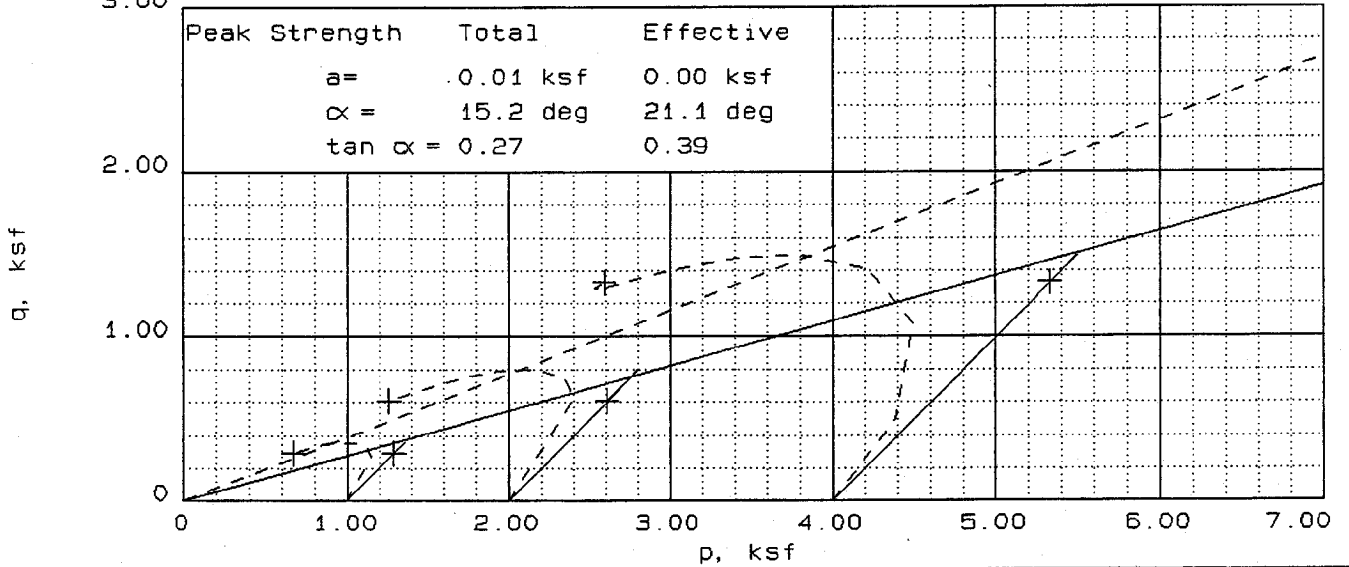
Excess Pore Pressure - - -
 Deviator Stress —
 ksf



Excess Pore Pressure - - -
 Deviator Stress —
 ksf



Stress Path legend: Total — Effective - - -



Client:

Project: TVA - Johnsonville

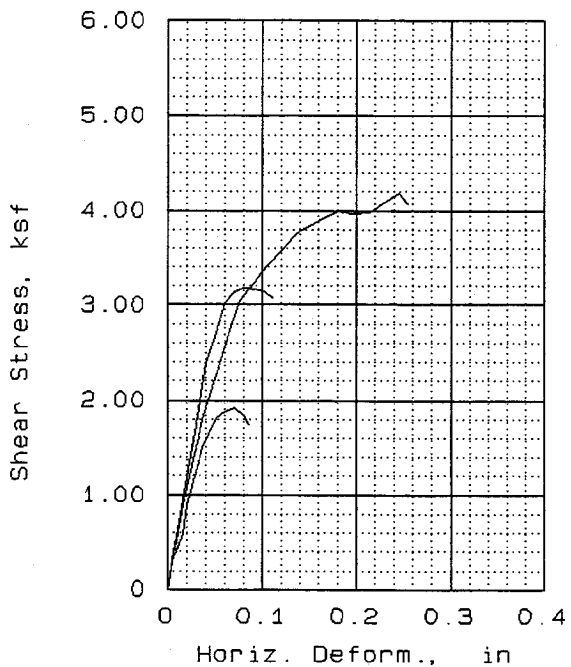
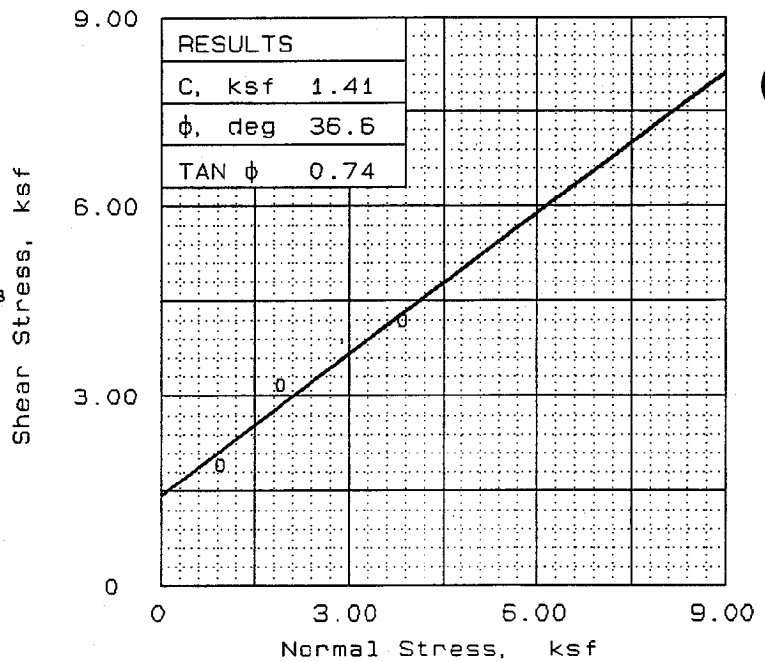
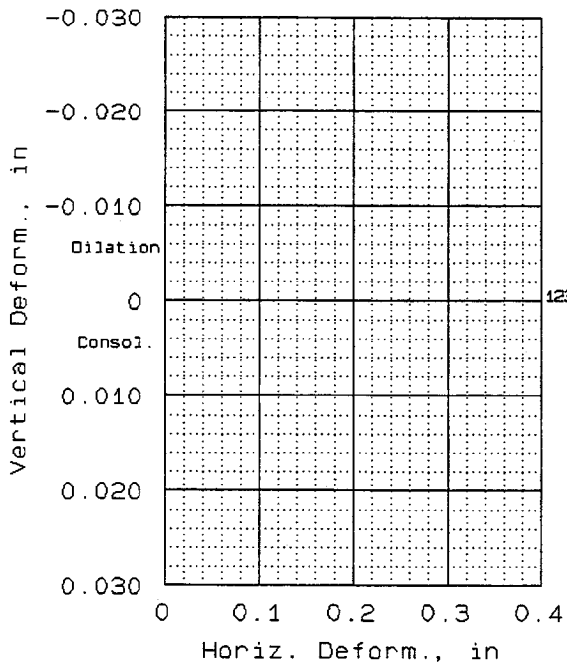
Location: Poned Fly Ash Active Ash Pond

File: 8601L

Project No.: 5810860101

Page 2/2

Fig. No. _____



SAMPLE NO.		1	2	3
INITIAL	WATER CONTENT, %	22.8	23.1	23.3
	DRY DENSITY, pcf	81.2	81.7	79.9
	SATURATION, %	64.6	66.0	63.5
	VOID RATIO	0.853	0.842	0.883
	DIAMETER, in	2.50	2.50	2.50
	HEIGHT, in	0.81	0.81	0.81
AT TEST	WATER CONTENT, %	22.8	23.1	23.3
	DRY DENSITY, pcf	81.2	81.7	79.9
	SATURATION, %	64.6	66.0	63.5
	VOID RATIO	0.853	0.842	0.883
	DIAMETER, in	2.50	2.50	2.50
	HEIGHT, in	0.81	0.81	0.81
NORMAL STRESS, ksf		0.97	1.94	3.88
MAX. SHEAR, ksf		1.92	3.18	4.19
STRAIN RATE, %/min.		0.500	0.500	0.500
ULT. SHEAR, ksf				

SAMPLE DATA
 SAMPLE TYPE: Remolded
 DESCRIPTION:
 LL= NL PL= NP PI=
 SPECIFIC GRAVITY= 2.41
 REMARKS: Tested by: *[Signature]*

Reviewed by: *[Signature]*

FIG. NO.

CLIENT:

PROJECT: TVA - Johnsonville
 Ponded Fly Ash

SAMPLE LOCATION: Active Ash Pond

PROJ. NO.: 5810850101 DATE: August 29, 1995

DIRECT SHEAR TEST

LAW ENGINEERING, INC.

California Bearing Ratio

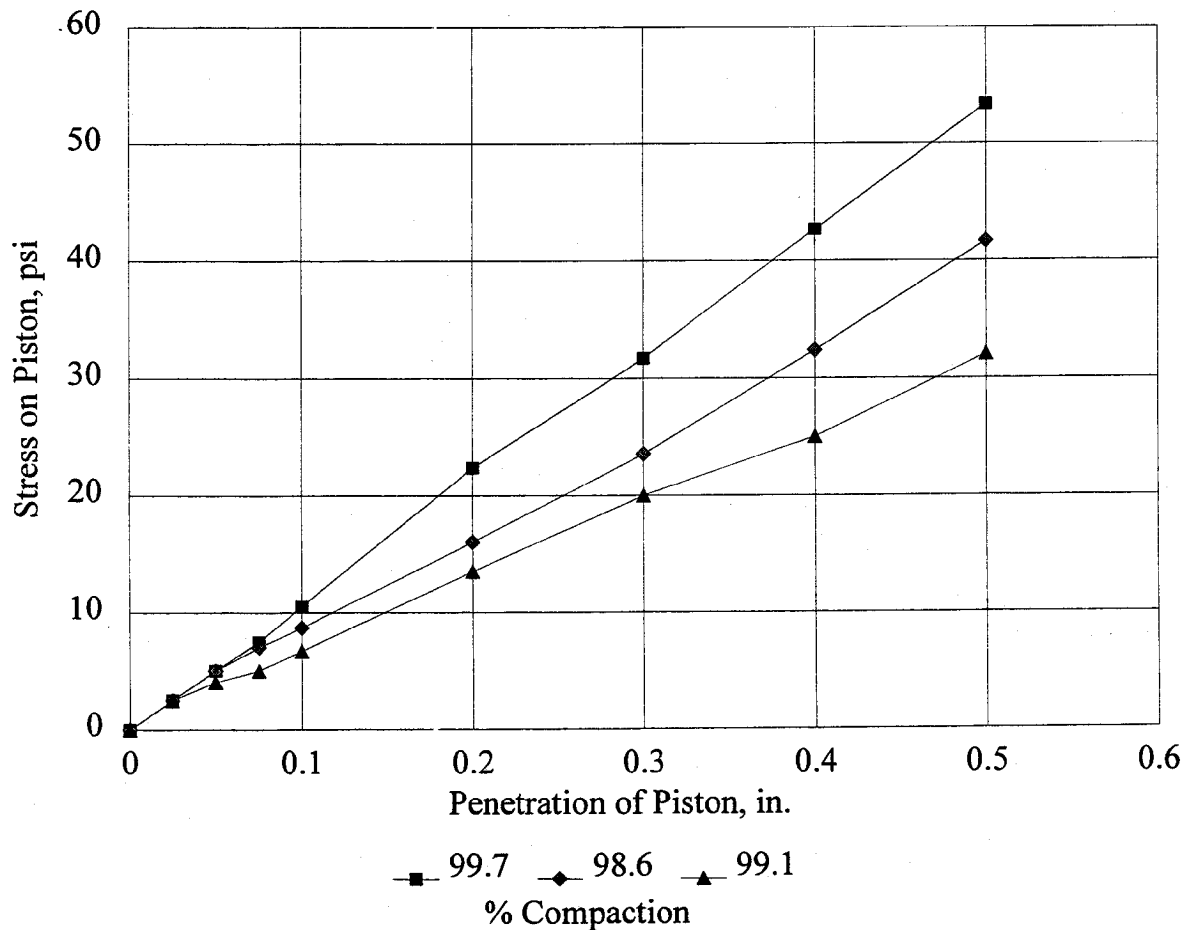
(ASTM D1883-92)



LAW ENGINEERING

Project No.	<u>5810860101</u>	Tested By	<u>EM</u>
Project Name	<u>TVA - Johnsonville</u>	Test Date	<u>08/18/95</u>
Material (Source)	<u>Ponded Fly Ash (Active Ash Pond)</u>	Reviewed By	<u>RLB</u>
		Review Date	<u>08/23/95</u>

Compaction, %	99.7	98.6	99.1
Before Soak Dry Density, pcf	86.3	85.4	85.8
Before Soak Moisture Content,	23.9	25.0	23.0
After Soak Dry Density, pcf	82.0	81.6	81.9
After Soak Moisture Content, %	31.8	32.7	33.1
CBR @ 0.1 in.	1.1	0.9	0.7
CBR @ 0.2 in.	1.5	1.1	0.9



LABORATORY MATERIAL HANDLING AND TESTING
 LABORATORY MATERIAL TEST DATA
 RESILIENT MODULUS OF UNBOUND GRANULAR BASE/SUBBASE
 MATERIALS AND SUBGRADE SOILS
 LAB DATA SHEET T46 - RECOMPACTED SAMPLES

SHEET NO 1 OF 2

UNBOUND GRANULAR BASE/SUBBASE LAYERS AND SUBGRADE SOILS
 SHRP TEST DESIGNATION UG07, SS07/SHRP PROTOCOL P46

LABORATORY PERFORMING TEST: LAW ENGINEERING, INC. - ATLANTA, GEORGIA

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study

LAW PROJECT NO.: 5810860101

1.	MATERIAL SOURCE:	Johnsonville	
2.	MATERIAL DESCRIPTION:	Ponded Fly Ash (Active Ash Pond)	
3.	REMOLDING TARGETS:	95% Standard Dry Density at Optimum Moisture Content	
4.	MATERIAL TYPE (Type 1 or Type 2)		2
5.	TEST INFORMATION		
	PRECONDITIONING - GREATER THAN 5% PERM. STRAIN? (Y = YES OR N = NO)		N
	TESTING - GREATER THAN 5% PERM. STRAIN? (Y = YES OR N = NO)		N
	TESTING - NUMBER OF LOAD SEQUENCES COMPLETED (0 - 15)		15
6.	SPECIMEN INFO.:		
	SPECIMEN DIAM., inch		
	TOP		2.85
	MIDDLE		2.85
	BOTTOM		2.85
	AVERAGE		2.85
	MEMBRANE THICKNESS (1), inch		0.01
	MEMBRANE THICKNESS (2), inch		0.01
	NET DIAM., inch		2.83
	HEIGHT OF SPECIMEN, CAP AND BASE, inch		6.06
	HEIGHT OF CAP AND BASE, inch		0.00
	INITIAL LENGTH, L ₀ , inch		6.06
	INITIAL AREA, A ₀ , in ²		6.29
	INITIAL VOLUME A ₀ L ₀ , in ³		38.10
7.	SOIL SPECIMEN WEIGHT:		
	INITIAL WEIGHT OF CONTAINER AND WET SOIL, grams		966.72
	FINAL WEIGHT OF CONTAINER AND WET SOIL, grams		0.00
	WEIGHT OF WET SOIL USED, grams		966.72
8.	SOIL PROPERTIES.:		
	IN SITU MOISTURE CONTENT (NUCLEAR), %		N/A
	IN SITU WET DENSITY (NUCLEAR), pcf		N/A
	or		
	OPTIMUM MOISTURE CONTENT, %		22.8
	MAX. DRY DENSITY, pcf		86.6
	95 % MAX. DRY DENSITY, pcf		82.3
9.	SPECIMEN PROPERTIES:		
	COMPACTION MOISTURE CONTENT, %		24.6
	MOISTURE CONTENT AFTER RESILIENT MODULUS TESTING, %		24.6
	COMPACTION DRY DENSITY, γ _d pcf		77.5
10.	QUICK SHEAR TEST		
	STRESS - STRAIN PLOT ATTACHED (Y = YES, N = NO)		Y
	TRIAXIAL SHEAR MAXIMUM STRENGTH (MAX. LOAD/X-SECTION AREA), psi		18.7
	SPECIMEN FAIL DURING TRIAXIAL SHEAR? (Y = YES, N = NO)		Y
11.	COMMENTS (Section 10.4 of Protocol P46)		
	(a) CODE	0	0
	(b) NOTE	0	0
12.	TEST DATE		08-17-1995

GENERAL REMARKS:

SUBMITTED BY, DATE

R. J. Boehman 9/10/95
 LABORATORY MANAGER

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study
 LAW PROJECT NO.: 5810860101
 1. MATERIAL SOURCE: Johnsonville
 2. MATERIAL DESCRIPTION: Pondered Fly Ash (Active Ash Pond)
 3. REMOLDING TARGETS: 95% Standard Dry Density at Optimum Moisture Content
 4. MATERIAL TYPE: 2
 5. TEST DATE: 08-17-1995
 6. RESILIENT MODULUS TESTING

COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
PARAMETER	Chamber Confining Pressure	Nominal Maximum Axial Stress	Cycle No.	Actual Applied Max. Axial Load	Actual Applied Cyclic Load	Actual Applied Contact Load	Actual Applied Max. Axial Stress	Actual Applied Cyclic Stress	Actual Applied Contact Stress	Recov. Def. LVDT #1 Reading	Recov. Def. LVDT #2 Reading	Average Recov. Def. LVDT 1 and 2	Resilient Strain	Resilient Modulus
DESIGNATION	S ₃	S _{cyclic}	C ₁	P _{max}	P _{cyclic}	P _{contact}	S _{max}	S _{cyclic}	S _{contact}	H ₁	H ₂	H _{avg}	ε _r	M _r
UNIT	psi	psi	---	lbs	lbs	lbs	psi	psi	psi	in.	in.	in.	in/in	psi
PRECISION														
SEQUENCE 1	6.0	2.0	1	12.4	11.1	1.3	2.0	1.8	0.2	0.00171	0.00186	0.00179	0.00029	5,979
			2	12.4	11.1	1.3	2.0	1.8	0.2	0.00171	0.00186	0.00178	0.00029	6,009
			3	12.4	11.1	1.3	2.0	1.8	0.2	0.00170	0.00185	0.00177	0.00029	6,055
			4	12.4	11.2	1.3	2.0	1.8	0.2	0.00170	0.00187	0.00178	0.00029	6,030
			5	12.5	11.2	1.3	2.0	1.8	0.2	0.00171	0.00186	0.00179	0.00030	6,039
COLUMN AVERAGE														6,023
STANDARD DEV.														29

Source:	Johnsonville	Description:	Ponded Fly Ash (Active Ash Pond)	95% Standard Dry Density at Optimum Moisture Content										
SEQUENCE 2	6.0	4.0	1	25.0	22.7	2.3	4.0	3.6	0.4	0.00376	0.00395	0.00386	0.00064	5,671
			2	25.0	22.6	2.4	4.0	3.6	0.4	0.00377	0.00393	0.00385	0.00063	5,667
			3	25.0	22.7	2.3	4.0	3.6	0.4	0.00375	0.00393	0.00384	0.00063	5,690
			4	25.0	22.6	2.4	4.0	3.6	0.4	0.00376	0.00393	0.00385	0.00063	5,674
			5	25.0	22.7	2.3	4.0	3.6	0.4	0.00376	0.00395	0.00385	0.00064	5,671
				25.0	22.7	2.3	4.0	3.6	0.4	0.00376	0.00394	0.00385	0.00064	5,675
				0.0	0.0	0.0	0.0	0.0	0.0	0.00000	0.00001	0.00001	0.00000	9
SEQUENCE 3	6.0	6.0	1	37.6	33.9	3.6	6.0	5.4	0.6	0.00637	0.00657	0.00647	0.00107	5,059
			2	37.6	33.9	3.6	6.0	5.4	0.6	0.00637	0.00658	0.00648	0.00107	5,052
			3	37.5	33.8	3.7	6.0	5.4	0.6	0.00637	0.00657	0.00647	0.00107	5,038
			4	37.5	33.8	3.6	6.0	5.4	0.6	0.00637	0.00658	0.00647	0.00107	5,036
			5	37.5	33.9	3.6	6.0	5.4	0.6	0.00639	0.00658	0.00648	0.00107	5,040
				37.5	33.9	3.6	6.0	5.4	0.6	0.00637	0.00658	0.00647	0.00107	5,045
				0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	10
SEQUENCE 4	6.0	8.0	1	49.3	44.9	4.4	7.8	7.1	0.7	0.01000	0.01000	0.01000	0.00165	4,326
			2	49.4	45.0	4.4	7.9	7.2	0.7	0.01000	0.01000	0.01000	0.00165	4,337
			3	49.3	44.9	4.4	7.8	7.1	0.7	0.01000	0.01000	0.01000	0.00165	4,331
			4	49.3	44.9	4.4	7.8	7.1	0.7	0.01000	0.01000	0.01000	0.00165	4,328
			5	49.4	44.9	4.4	7.9	7.1	0.7	0.01000	0.01000	0.01000	0.00165	4,330
				49.3	44.9	4.4	7.8	7.1	0.7	0.01000	0.01000	0.01000	0.00165	4,330
				0.0	0.0	0.0	0.0	0.0	0.0	0.00000	0.00000	0.00000	0.00000	4

Source: Johnsonville		Description: Ponded Fly Ash (Active Ash Pond)					95% Standard Dry Density at Optimum Moisture Content									
SEQUENCE 5	6.0	10.0	1	61.6	55.9	5.7	9.8	8.9	0.9	0.01152	0.01171	0.01162	0.00192	4,636		
			2	61.6	55.9	5.7	9.8	8.9	0.9	0.01148	0.01171	0.01160	0.00191	4,642		
			3	61.5	55.9	5.7	9.8	8.9	0.9	0.01148	0.01172	0.01160	0.00191	4,643		
			4	61.6	55.9	5.7	9.8	8.9	0.9	0.01148	0.01172	0.01160	0.00191	4,644		
			5	61.8	56.1	5.7	9.8	8.9	0.9	0.01153	0.01177	0.01165	0.00192	4,641		
	COLUMN AVERAGE		61.6	55.9	5.7	9.8	8.9	0.9	0.01150	0.01173	0.01161	0.00192	4,641			
	STANDARD DEV.		0.1	0.1	0.0	0.0	0.0	0.0	0.00002	0.00002	0.00002	0.00000	3			
SEQUENCE 6	4.0	2.0	1	12.9	11.4	1.6	2.1	1.8	0.3	0.00211	0.00237	0.00224	0.00037	4,892		
			2	12.8	11.2	1.6	2.0	1.8	0.3	0.00212	0.00238	0.00225	0.00037	4,810		
			3	12.8	11.3	1.6	2.0	1.8	0.2	0.00214	0.00238	0.00226	0.00037	4,809		
			4	12.8	11.2	1.6	2.0	1.8	0.2	0.00212	0.00238	0.00225	0.00037	4,817		
			5	12.7	11.2	1.6	2.0	1.8	0.2	0.00210	0.00236	0.00223	0.00037	4,817		
	COLUMN AVERAGE		12.8	11.3	1.6	2.0	1.8	0.2	0.00212	0.00237	0.00225	0.00037	4,829			
	STANDARD DEV.		0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	35			
SEQUENCE 7	4.0	4.0	1	24.6	22.3	2.3	3.9	3.5	0.4	0.00518	0.00546	0.00532	0.00088	4,041		
			2	24.8	22.4	2.3	3.9	3.6	0.4	0.00518	0.00546	0.00532	0.00088	4,061		
			3	24.7	22.3	2.3	3.9	3.6	0.4	0.00517	0.00545	0.00531	0.00088	4,052		
			4	24.7	22.4	2.3	3.9	3.6	0.4	0.00519	0.00546	0.00532	0.00088	4,058		
			5	24.8	22.5	2.3	3.9	3.6	0.4	0.00517	0.00547	0.00532	0.00088	4,068		
	COLUMN AVERAGE		24.7	22.4	2.3	3.9	3.6	0.4	0.00518	0.00546	0.00532	0.00088	4,056			
	STANDARD DEV.		0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	10			

Source:	Johnsonville	Description:	Ponded Fly Ash (Active Ash Pond)	95% Standard Dry Density at Optimum Moisture Content										
SEQUENCE 8	4.0	6.0	1	36.5	33.0	3.6	5.8	5.2	0.6	0.00844	0.00872	0.00858	0.00142	3,702
			2	36.6	33.1	3.6	5.8	5.3	0.6	0.00846	0.00872	0.00859	0.00142	3,713
			3	36.6	33.1	3.5	5.8	5.3	0.6	0.00845	0.00872	0.00858	0.00142	3,713
			4	36.5	33.0	3.6	5.8	5.2	0.6	0.00845	0.00872	0.00858	0.00142	3,701
			5	36.5	32.9	3.5	5.8	5.2	0.6	0.00846	0.00871	0.00858	0.00142	3,699
	COLUMN AVERAGE			36.5	33.0	3.5	5.8	5.2	0.6	0.00845	0.00872	0.00858	0.00142	3,706
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00000	0.00000	0.00000	7
SEQUENCE 9	4.0	8.0	1	49.7	44.9	4.8	7.9	7.1	0.8	0.01126	0.01150	0.01138	0.00188	3,801
			2	49.8	45.0	4.8	7.9	7.2	0.8	0.01128	0.01149	0.01139	0.00188	3,809
			3	49.7	44.9	4.8	7.9	7.1	0.8	0.01126	0.01151	0.01139	0.00188	3,804
			4	49.7	44.9	4.8	7.9	7.1	0.8	0.01127	0.01152	0.01139	0.00188	3,799
			5	49.8	44.9	4.8	7.9	7.1	0.8	0.01127	0.01150	0.01139	0.00188	3,803
	COLUMN AVERAGE			49.7	44.9	4.8	7.9	7.1	0.8	0.01127	0.01150	0.01139	0.00188	3,803
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	4
SEQUENCE 10	4.0	10.0	1	61.8	55.7	6.1	9.8	8.9	1.0	0.01383	0.01407	0.01395	0.00230	3,851
			2	61.7	55.6	6.1	9.8	8.8	1.0	0.01383	0.01408	0.01396	0.00230	3,840
			3	61.7	55.6	6.1	9.8	8.8	1.0	0.01385	0.01407	0.01396	0.00230	3,841
			4	61.7	55.6	6.1	9.8	8.8	1.0	0.01385	0.01410	0.01397	0.00231	3,837
			5	61.6	55.5	6.1	9.8	8.8	1.0	0.01383	0.01409	0.01396	0.00230	3,831
	COLUMN AVERAGE			61.7	55.6	6.1	9.8	8.8	1.0	0.01384	0.01408	0.01396	0.00230	3,840
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	7

Source: Johnsonville		Description: Poned Fly Ash (Active Ash Pond)										95% Standard Dry Density at Optimum Moisture Content				
SEQUENCE 11	2.0	2.0	1	13.2	11.1	2.1	2.1	1.8	0.3	0.00262	0.00288	0.00275	0.00045	3,903		
			2	13.3	11.2	2.1	2.1	1.8	0.3	0.00261	0.00290	0.00276	0.00046	3,915		
			3	13.2	11.1	2.1	2.1	1.8	0.3	0.00261	0.00288	0.00275	0.00045	3,900		
			4	13.3	11.2	2.1	2.1	1.8	0.3	0.00261	0.00290	0.00275	0.00045	3,913		
			5	13.3	11.2	2.1	2.1	1.8	0.3	0.00260	0.00288	0.00274	0.00045	3,935		
			COLUMN AVERAGE		13.3	11.2	2.1	2.1	1.8	0.3	0.00261	0.00289	0.00275	0.00045	3,913	
		STANDARD DEV.		0.0	0.0	0.0	0.0	0.0	0.0	0.00000	0.00001	0.00001	0.00000	13		
SEQUENCE 12	2.0	4.0	1	24.2	21.8	2.4	3.8	3.5	0.4	0.00672	0.00703	0.00687	0.00113	3,058		
			2	24.3	21.9	2.4	3.9	3.5	0.4	0.00671	0.00704	0.00688	0.00113	3,066		
			3	24.3	21.9	2.4	3.9	3.5	0.4	0.00669	0.00703	0.00686	0.00113	3,079		
			4	24.3	21.9	2.4	3.9	3.5	0.4	0.00672	0.00705	0.00689	0.00114	3,071		
			5	24.4	22.0	2.4	3.9	3.5	0.4	0.00672	0.00704	0.00688	0.00114	3,079		
			COLUMN AVERAGE		24.3	21.9	2.4	3.9	3.5	0.4	0.00671	0.00704	0.00687	0.00113	3,071	
		STANDARD DEV.		0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	9		
SEQUENCE 13	2.0	6.0	1	37.2	33.6	3.6	5.9	5.3	0.6	0.01097	0.01125	0.01111	0.00183	2,914		
			2	37.2	33.6	3.6	5.9	5.3	0.6	0.01097	0.01124	0.01110	0.00183	2,915		
			3	37.1	33.5	3.6	5.9	5.3	0.6	0.01098	0.01123	0.01110	0.00183	2,908		
			4	37.1	33.5	3.6	5.9	5.3	0.6	0.01097	0.01123	0.01110	0.00183	2,910		
			5	37.1	33.4	3.6	5.9	5.3	0.6	0.01097	0.01125	0.01111	0.00183	2,902		
			COLUMN AVERAGE		37.1	33.5	3.6	5.9	5.3	0.6	0.01097	0.01124	0.01110	0.00183	2,910	
		STANDARD DEV.		0.1	0.1	0.0	0.0	0.0	0.0	0.00000	0.00001	0.00000	0.00000	5		

Source: Johnsonville		Description: Ponded Fly Ash (Active Ash Pond)					95% Standard Dry Density at Optimum Moisture Content							
SEQUENCE 14	2.0	8.0	1	49.9	45.1	4.8	7.9	7.2	0.8	0.01410	0.01431	0.01421	0.00234	3,056
			2	49.7	44.8	4.9	7.9	7.1	0.8	0.01409	0.01431	0.01420	0.00234	3,045
			3	49.6	44.8	4.8	7.9	7.1	0.8	0.01407	0.01434	0.01421	0.00234	3,040
			4	49.6	44.8	4.8	7.9	7.1	0.8	0.01408	0.01432	0.01420	0.00234	3,039
			5	49.6	44.8	4.8	7.9	7.1	0.8	0.01406	0.01432	0.01419	0.00234	3,040
				49.7	44.8	4.8	7.9	7.1	0.8	0.01408	0.01432	0.01420	0.00234	3,044
				0.1	0.1	0.0	0.0	0.0	0.0	0.00002	0.00001	0.00001	0.00000	7
SEQUENCE 15	2.0	10.0	1	1.2	0.0	1.2	0.2	0.0	0.2	0.00000	0.00000	0.00000	0.00000	#DIV/0!
			2	1.2	0.0	1.2	0.2	0.0	0.2	0.00000	0.00000	0.00000	0.00000	#DIV/0!
			3	1.2	0.0	1.2	0.2	0.0	0.2	0.00000	0.00000	0.00000	0.00000	#DIV/0!
			4	1.2	0.0	1.2	0.2	0.0	0.2	0.00000	0.00000	0.00000	0.00000	#DIV/0!
			5	1.2	0.0	1.2	0.2	0.0	0.2	0.00000	0.00000	0.00000	0.00000	#DIV/0!
				1.2	0.0	1.2	0.2	0.0	0.2	0.00000	0.00000	0.00000	0.00000	#DIV/0!
				0.0	0.0	0.0	0.0	0.0	0.0	0.00000	0.00000	0.00000	0.00000	#DIV/0!

SUBMITTED BY, DATE

RJ Buchan 9/10/95

LABORATORY MANAGER

FIGURE 1 - Logarithmic Plot of Resilient Modulus (M_R) vs Cyclic Stress (S_C)

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study
 LAW PROJECT NO.: 5810860101
 1. MATERIAL SOURCE: Johnsonville
 2. MATERIAL DESCRIPTION: Ponded Fly Ash (Active Ash Pond)
 3. REMOLDING TARGETS: 95% Standard Dry Density at Optimum Moisture Content
 4. MATERIAL TYPE: 2
 5. TEST DATE: 08-17-1995

$$M_R = K_1 (S_C)^{K_2} (1+S_3)^{K_5}$$

K1 = 2,146
 K2 = -0.18159
 K5 = 0.58044
 R² = 0.94

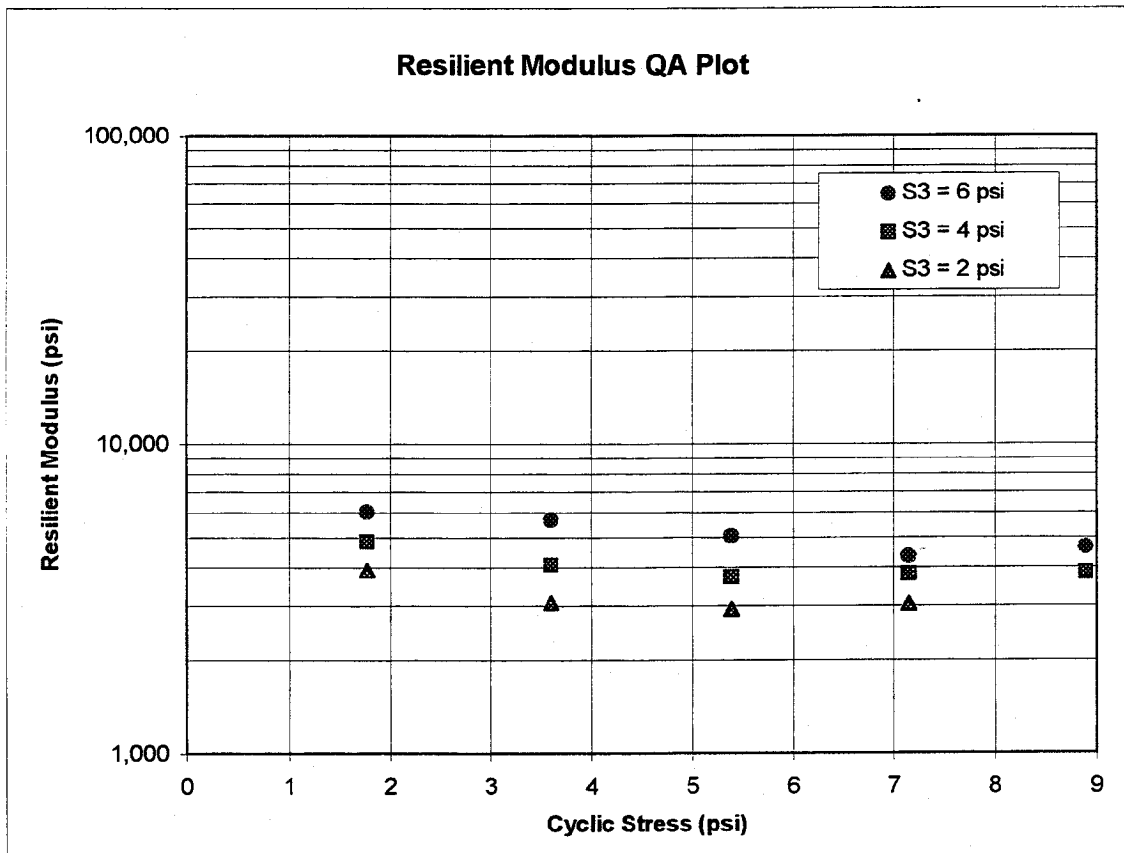
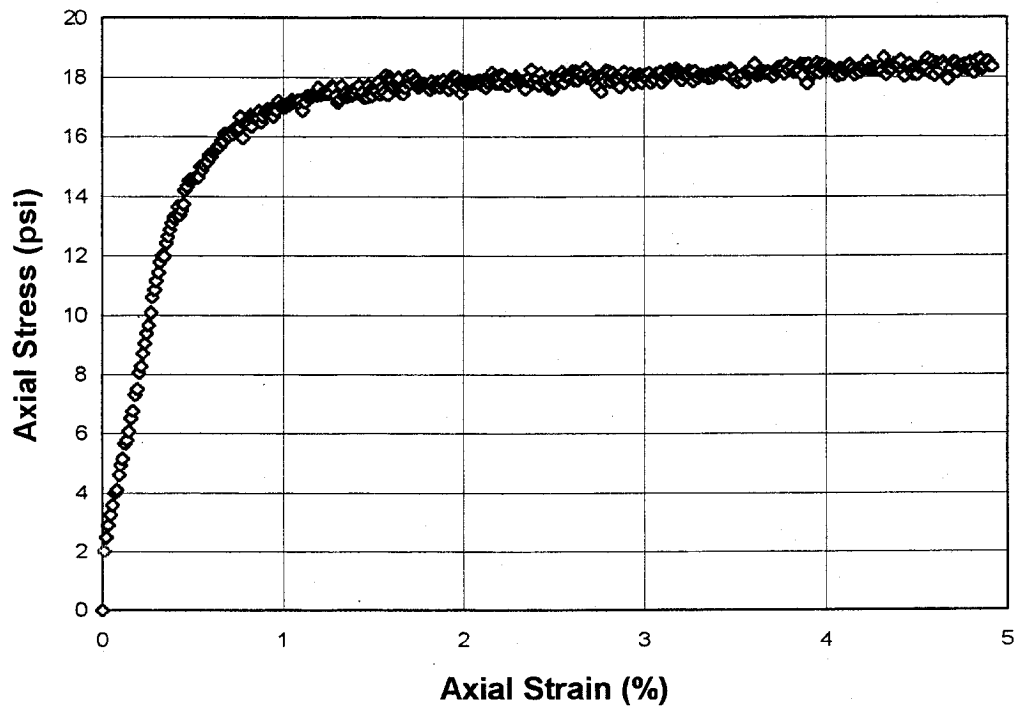


FIGURE 2 - Quick Shear Stress vs Strain

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study
LAW PROJECT NO.: 5810860101
1. MATERIAL SOURCE: Johnsonville
2. MATERIAL DESCRIPTION: Ponded Fly Ash (Active Ash Pond)
3. REMOLDING TARGETS: 95% Standard Dry Density at Optimum Moisture Content
4. MATERIAL TYPE: 2
5. TEST DATE: 08-17-1995



LABORATORY MATERIAL HANDLING AND TESTING
 LABORATORY MATERIAL TEST DATA
 RESILIENT MODULUS OF UNBOUND GRANULAR BASE/SUBBASE
 MATERIALS AND SUBGRADE SOILS
 LAB DATA SHEET T46 - RECOMPACTED SAMPLES

UNBOUND GRANULAR BASE/SUBBASE LAYERS AND SUBGRADE SOILS
 SHRP TEST DESIGNATION UG07, SS07/SHRP PROTOCOL P46

LABORATORY PERFORMING TEST: LAW ENGINEERING, INC. - ATLANTA, GEORGIA

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study

LAW PROJECT NO.: 5810860101

- | | | | | |
|-----|---|--|---|------------|
| 1. | MATERIAL SOURCE: | Johnsonville | | |
| 2. | MATERIAL DESCRIPTION: | Ponded Fly Ash (Active Ash Pond) | | |
| 3. | REMOLDING TARGETS: | 95% Modified Dry Density at Optimum Moisture Content | | |
| 4. | MATERIAL TYPE (Type 1 or Type 2) | | | 2 |
| 5. | TEST INFORMATION | | | |
| | PRECONDITIONING - GREATER THAN 5% PERM. STRAIN? (Y = YES OR N = NO) | | | N |
| | TESTING - GREATER THAN 5% PERM. STRAIN? (Y = YES OR N = NO) | | | N |
| | TESTING - NUMBER OF LOAD SEQUENCES COMPLETED (0 - 15) | | | 15 |
| 6. | SPECIMEN INFO.: | | | |
| | SPECIMEN DIAM., inch | | | |
| | TOP | | | 2.86 |
| | MIDDLE | | | 2.86 |
| | BOTTOM | | | 2.86 |
| | AVERAGE | | | 2.86 |
| | MEMBRANE THICKNESS (1), inch | | | 0.01 |
| | MEMBRANE THICKNESS (2), inch | | | 0.01 |
| | NET DIAM., inch | | | 2.83 |
| | HEIGHT OF SPECIMEN, CAP AND BASE, inch | | | 6.12 |
| | HEIGHT OF CAP AND BASE, inch | | | 0.00 |
| | INITIAL LENGTH, L ₀ , inch | | | 6.12 |
| | INITIAL AREA, A ₀ , in ² | | | 6.31 |
| | INITIAL VOLUME A ₀ L ₀ , in ³ | | | 38.59 |
| 7. | SOIL SPECIMEN WEIGHT: | | | |
| | INITIAL WEIGHT OF CONTAINER AND WET SOIL, grams | | | 980.27 |
| | FINAL WEIGHT OF CONTAINER AND WET SOIL, grams | | | 0.00 |
| | WEIGHT OF WET SOIL USED, grams | | | 980.27 |
| 8. | SOIL PROPERTIES.: | | | |
| | IN SITU MOISTURE CONTENT (NUCLEAR), % | | | N/A |
| | IN SITU WET DENSITY (NUCLEAR), pcf | | | N/A |
| | or | | | |
| | OPTIMUM MOISTURE CONTENT, % | | | 18.0 |
| | MAX. DRY DENSITY, pcf | | | 91.7 |
| | 95 % MAX. DRY DENSITY, pcf | | | 87.1 |
| 9. | SPECIMEN PROPERTIES: | | | |
| | COMPACTION MOISTURE CONTENT, % | | | 16.2 |
| | MOISTURE CONTENT AFTER RESILIENT MODULUS TESTING, % | | | 16.2 |
| | COMPACTION DRY DENSITY, γ _d pcf | | | 83.2 |
| 10. | QUICK SHEAR TEST | | | |
| | STRESS - STRAIN PLOT ATTACHED (Y = YES, N = NO) | | | Y |
| | TRIAXIAL SHEAR MAXIMUM STRENGTH (MAX. LOAD/X-SECTION AREA), psi | | | 34.9 |
| | SPECIMEN FAIL DURING TRIAXIAL SHEAR? (Y = YES, N = NO) | | | Y |
| 11. | COMMENTS (Section 10.4 of Protocol P46) | | | |
| | (a) CODE | 0 | 0 | 0 |
| | (b) NOTE | 0 | 0 | 0 |
| 12. | TEST DATE | | | 08-17-1995 |

GENERAL REMARKS:

SUBMITTED BY, DATE

R. J. Burdman 9/10/95
 LABORATORY MANAGER

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study
 LAW PROJECT NO.: 5810860101
 1. MATERIAL SOURCE: Johnsonville
 2. MATERIAL DESCRIPTION: Ponded Fly Ash (Active Ash Pond)
 3. REMOLDING TARGETS: 95% Modified Dry Density at Optimum Moisture Content
 4. MATERIAL TYPE: 2
 5. TEST DATE: 08-17-1995
 6. RESILIENT MODULUS TESTING

COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
PARAMETER	Chamber Confining Pressure	Nominal Maximum Axial Stress	Cycle No.	Actual Applied Max. Axial Load	Actual Applied Cyclic Load	Actual Applied Contact Load	Actual Applied Max. Axial Stress	Actual Applied Cyclic Stress	Actual Applied Contact Stress	Recov. Def. LVDT #1 Reading	Recov. Def. LVDT #2 Reading	Average Recov Def. LVDT 1 and 2	Resilient Strain	Resilient Modulus
DESIGNATION	S ₃	S _{cyclic}	C ₁	P _{max}	P _{cyclic}	P _{contact}	S _{max}	S _{cyclic}	S _{contact}	H ₁	H ₂	H _{avg}	ε _r	M _r
UNIT	psi	psi	---	lbs	lbs	lbs	psi	psi	psi	in.	in.	in.	in/in	psi
PRECISION														
SEQUENCE 1	6.0	2.0	1	12.7	11.4	1.3	2.0	1.8	0.2	0.00133	0.00130	0.00131	0.00021	8,423
			2	12.6	11.3	1.3	2.0	1.8	0.2	0.00134	0.00128	0.00131	0.00021	8,389
			3	12.6	11.7	1.0	2.0	1.8	0.2	0.00133	0.00131	0.00132	0.00022	8,556
			4	12.7	11.4	1.3	2.0	1.8	0.2	0.00133	0.00128	0.00131	0.00021	8,447
			5	12.8	11.4	1.3	2.0	1.8	0.2	0.00134	0.00129	0.00131	0.00021	8,441
	COLUMN AVERAGE			12.7	11.5	1.2	2.0	1.8	0.2	0.00133	0.00129	0.00131	0.00021	8,451
	STANDARD DEV.			0.0	0.1	0.1	0.0	0.0	0.0	0.00001	0.00001	0.00000	0.00000	63

Source:	Johnsonville	Description:	Ponded Fly Ash (Active Ash Pond)	95% Modified Dry Density at Optimum Moisture Content										
SEQUENCE 2	6.0	4.0	1	24.9	22.9	1.9	3.9	3.6	0.3	0.00279	0.00277	0.00278	0.00045	8,005
			2	24.6	22.7	1.9	3.9	3.6	0.3	0.00278	0.00277	0.00277	0.00045	7,934
			3	24.8	22.9	1.9	3.9	3.6	0.3	0.00278	0.00275	0.00277	0.00045	8,008
			4	24.7	22.8	1.9	3.9	3.6	0.3	0.00279	0.00276	0.00277	0.00045	7,963
			5	24.7	22.8	1.9	3.9	3.6	0.3	0.00278	0.00277	0.00278	0.00045	7,956
		COLUMN AVERAGE	24.7	22.8	1.9	3.9	3.6	0.3	0.00278	0.00276	0.00277	0.00045	7,973	
		STANDARD DEV.	0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00000	0.00000	32	
SEQUENCE 3	6.0	6.0	1	37.8	34.3	3.5	6.0	5.4	0.6	0.00454	0.00462	0.00458	0.00075	7,254
			2	37.8	34.3	3.6	6.0	5.4	0.6	0.00455	0.00462	0.00458	0.00075	7,248
			3	37.9	34.4	3.5	6.0	5.4	0.6	0.00458	0.00463	0.00460	0.00075	7,243
			4	37.8	34.3	3.6	6.0	5.4	0.6	0.00456	0.00461	0.00458	0.00075	7,250
			5	37.9	34.4	3.6	6.0	5.4	0.6	0.00458	0.00462	0.00460	0.00075	7,240
		COLUMN AVERAGE	37.9	34.3	3.6	6.0	5.4	0.6	0.00456	0.00462	0.00459	0.00075	7,247	
		STANDARD DEV.	0.1	0.1	0.0	0.0	0.0	0.00002	0.00001	0.00001	0.00000	6		
SEQUENCE 4	6.0	8.0	1	50.7	45.8	4.9	8.0	7.3	0.8	0.00639	0.00658	0.00649	0.00106	6,847
			2	50.7	45.8	4.9	8.0	7.3	0.8	0.00641	0.00657	0.00649	0.00106	6,847
			3	50.7	45.8	4.9	8.0	7.3	0.8	0.00641	0.00658	0.00649	0.00106	6,843
			4	50.8	45.9	4.9	8.1	7.3	0.8	0.00641	0.00660	0.00651	0.00106	6,843
			5	50.7	45.8	4.9	8.0	7.3	0.8	0.00644	0.00660	0.00652	0.00107	6,817
		COLUMN AVERAGE	50.7	45.8	4.9	8.0	7.3	0.8	0.00641	0.00658	0.00650	0.00106	6,839	
		STANDARD DEV.	0.0	0.0	0.0	0.0	0.0	0.00002	0.00001	0.00001	0.00000	13		

Source:	Johnsonville	Description:	Ponded Fly Ash (Active Ash Pond)	95% Modified Dry Density at Optimum Moisture Content											
SEQUENCE 5	6.0	10.0	1	63.4	57.3	6.1	10.1	9.1	1.0	0.00814	0.00845	0.00830	0.00136	6,694	
			2	63.4	57.2	6.2	10.0	9.1	1.0	0.00812	0.00845	0.00829	0.00135	6,693	
			3	63.4	57.2	6.2	10.0	9.1	1.0	0.00812	0.00846	0.00829	0.00136	6,685	
			4	63.4	57.2	6.2	10.0	9.1	1.0	0.00812	0.00848	0.00830	0.00136	6,684	
			5	63.3	57.2	6.2	10.0	9.1	1.0	0.00814	0.00850	0.00832	0.00136	6,664	
			COLUMN AVERAGE	63.4	57.2	6.2	10.0	9.1	1.0	0.00813	0.00847	0.00830	0.00136	6,684	
			STANDARD DEV.	0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00002	0.00001	0.00000	12	
SEQUENCE 6	4.0	2.0	1	13.2	11.6	1.7	2.1	1.8	0.3	0.00157	0.00157	0.00157	0.00026	7,141	
			2	13.1	11.4	1.7	2.1	1.8	0.3	0.00157	0.00158	0.00157	0.00026	7,052	
			3	13.2	11.6	1.6	2.1	1.8	0.3	0.00157	0.00158	0.00157	0.00026	7,127	
			4	13.2	11.5	1.7	2.1	1.8	0.3	0.00157	0.00158	0.00157	0.00026	7,095	
			5	13.3	11.7	1.7	2.1	1.8	0.3	0.00159	0.00158	0.00158	0.00026	7,143	
			COLUMN AVERAGE	13.2	11.6	1.7	2.1	1.8	0.3	0.00158	0.00158	0.00158	0.00026	7,112	
			STANDARD DEV.	0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00000	0.00000	0.00000	38	
SEQUENCE 7	4.0	4.0	1	25.1	22.7	2.4	4.0	3.6	0.4	0.00325	0.00333	0.00329	0.00054	6,704	
			2	25.2	22.8	2.4	4.0	3.6	0.4	0.00326	0.00333	0.00330	0.00054	6,716	
			3	25.2	22.9	2.4	4.0	3.6	0.4	0.00328	0.00333	0.00330	0.00054	6,714	
			4	25.1	22.8	2.4	4.0	3.6	0.4	0.00326	0.00332	0.00329	0.00054	6,713	
			5	25.1	22.7	2.3	4.0	3.6	0.4	0.00327	0.00332	0.00330	0.00054	6,687	
			COLUMN AVERAGE	25.1	22.8	2.4	4.0	3.6	0.4	0.00327	0.00332	0.00330	0.00054	6,707	
			STANDARD DEV.	0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00000	0.00001	0.00000	12	

Source: Johnsonville		Description: Pondered Fly Ash (Active Ash Pond)										95% Modified Dry Density at Optimum Moisture Content				
SEQUENCE 8	4.0	6.0	1	37.8	34.2	3.7	6.0	5.4	0.6	0.00546	0.00563	0.00555	0.00091	5,976		
			2	37.8	34.1	3.7	6.0	5.4	0.6	0.00548	0.00563	0.00555	0.00091	5,955		
			3	37.7	34.1	3.6	6.0	5.4	0.6	0.00546	0.00563	0.00555	0.00091	5,960		
			4	37.7	34.1	3.6	6.0	5.4	0.6	0.00548	0.00563	0.00555	0.00091	5,954		
			5	37.8	34.1	3.6	6.0	5.4	0.6	0.00546	0.00562	0.00554	0.00091	5,967		
	COLUMN AVERAGE			37.8	34.1	3.6	6.0	5.4	0.6	0.00547	0.00563	0.00555	0.00091	5,962		
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00000	0.00000	0.00000	9		
SEQUENCE 9	4.0	8.0	1	50.8	46.0	4.9	8.1	7.3	0.8	0.00751	0.00778	0.00765	0.00125	5,828		
			2	50.7	45.8	4.9	8.0	7.3	0.8	0.00753	0.00778	0.00765	0.00125	5,802		
			3	50.8	45.9	4.9	8.1	7.3	0.8	0.00752	0.00780	0.00766	0.00125	5,814		
			4	50.8	45.9	4.9	8.0	7.3	0.8	0.00754	0.00778	0.00766	0.00125	5,813		
			5	50.8	45.9	4.9	8.0	7.3	0.8	0.00754	0.00777	0.00766	0.00125	5,812		
	COLUMN AVERAGE			50.8	45.9	4.9	8.0	7.3	0.8	0.00753	0.00778	0.00765	0.00125	5,814		
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	9		
SEQUENCE 10	4.0	10.0	1	63.4	57.2	6.2	10.0	9.1	1.0	0.00930	0.00969	0.00949	0.00155	5,843		
			2	63.4	57.3	6.1	10.0	9.1	1.0	0.00930	0.00968	0.00949	0.00155	5,851		
			3	63.5	57.3	6.2	10.1	9.1	1.0	0.00931	0.00968	0.00949	0.00155	5,855		
			4	63.4	57.2	6.2	10.0	9.1	1.0	0.00932	0.00969	0.00951	0.00155	5,837		
			5	63.5	57.4	6.2	10.1	9.1	1.0	0.00929	0.00967	0.00948	0.00155	5,866		
	COLUMN AVERAGE			63.4	57.3	6.2	10.1	9.1	1.0	0.00931	0.00968	0.00949	0.00155	5,850		
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	11		

Source:	Johnsonville	Description:	Ponded Fly Ash (Active Ash Pond)	95% Modified Dry Density at Optimum Moisture Content											
SEQUENCE 11	2.0	2.0	1	13.5	11.5	2.0	2.1	1.8	0.3	0.00183	0.00183	0.00183	0.00183	0.00030	6,084
			2	13.5	11.4	2.0	2.1	1.8	0.3	0.00182	0.00183	0.00183	0.00183	0.00030	6,075
			3	13.5	11.5	2.0	2.1	1.8	0.3	0.00183	0.00183	0.00183	0.00183	0.00030	6,107
			4	13.5	11.5	2.0	2.1	1.8	0.3	0.00183	0.00184	0.00183	0.00183	0.00030	6,070
			5	13.5	11.5	2.0	2.1	1.8	0.3	0.00183	0.00183	0.00183	0.00183	0.00030	6,081
	COLUMN AVERAGE		13.5	11.5	2.0	2.1	1.8	0.3	0.00183	0.00183	0.00183	0.00183	0.00030	6,083	
	STANDARD DEV.		0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00000	0.00000	0.00000	0.00000	14	
SEQUENCE 12	2.0	4.0	1	24.9	22.5	2.4	3.9	3.6	0.4	0.00424	0.00429	0.00427	0.00070	5,115	
			2	24.9	22.6	2.4	4.0	3.6	0.4	0.00422	0.00430	0.00426	0.00070	5,136	
			3	25.0	22.6	2.4	4.0	3.6	0.4	0.00424	0.00430	0.00427	0.00070	5,134	
			4	25.0	22.6	2.4	4.0	3.6	0.4	0.00423	0.00429	0.00426	0.00070	5,152	
			5	25.1	22.7	2.4	4.0	3.6	0.4	0.00422	0.00431	0.00427	0.00070	5,157	
	COLUMN AVERAGE		25.0	22.6	2.4	4.0	3.6	0.4	0.00423	0.00430	0.00427	0.00070	5,139		
	STANDARD DEV.		0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	17		
SEQUENCE 13	2.0	6.0	1	37.3	33.6	3.6	5.9	5.3	0.6	0.00679	0.00697	0.00688	0.00112	4,741	
			2	37.3	33.7	3.6	5.9	5.3	0.6	0.00678	0.00697	0.00687	0.00112	4,754	
			3	37.5	33.8	3.6	5.9	5.4	0.6	0.00679	0.00698	0.00688	0.00113	4,767	
			4	37.4	33.8	3.6	5.9	5.4	0.6	0.00680	0.00696	0.00688	0.00113	4,755	
			5	37.5	33.9	3.6	5.9	5.4	0.6	0.00679	0.00698	0.00689	0.00113	4,771	
	COLUMN AVERAGE		37.4	33.8	3.6	5.9	5.4	0.6	0.00679	0.00697	0.00688	0.00112	4,758		
	STANDARD DEV.		0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00000	0.00000	12		

Source: Johnsonville		Description: Pondered Fly Ash (Active Ash Pond)					95% Modified Dry Density at Optimum Moisture Content									
SEQUENCE 14	2.0	8.0	1	50.5	45.6	4.9	8.0	7.2	0.8	0.00900	0.00931	0.00916	0.00150	4,831		
			2	50.6	45.7	4.9	8.0	7.2	0.8	0.00900	0.00931	0.00915	0.00150	4,841		
			3	50.5	45.7	4.9	8.0	7.2	0.8	0.00901	0.00933	0.00917	0.00150	4,829		
			4	50.5	45.6	4.9	8.0	7.2	0.8	0.00900	0.00933	0.00916	0.00150	4,825		
			5	50.4	45.5	4.9	8.0	7.2	0.8	0.00901	0.00933	0.00917	0.00150	4,815		
						50.5	45.6	4.9	8.0	7.2	0.8	0.00900	0.00932	0.00916	0.00150	4,828
						0.1	0.1	0.0	0.0	0.00000	0.00001	0.00001	0.00000	9		
SEQUENCE 15	2.0	10.0	1	63.0	56.9	6.1	10.0	9.0	1.0	0.01082	0.01119	0.01101	0.00180	5,008		
			2	63.1	57.0	6.1	10.0	9.0	1.0	0.01079	0.01121	0.01100	0.00180	5,021		
			3	63.0	56.9	6.1	10.0	9.0	1.0	0.01080	0.01120	0.01100	0.00180	5,012		
			4	62.9	56.7	6.1	10.0	9.0	1.0	0.01079	0.01121	0.01100	0.00180	5,002		
			5	63.0	56.9	6.2	10.0	9.0	1.0	0.01079	0.01120	0.01100	0.00180	5,016		
						63.0	56.9	6.1	10.0	9.0	1.0	0.01080	0.01120	0.01100	0.00180	5,012
						0.1	0.1	0.0	0.0	0.00001	0.00001	0.00000	0.00000	7		

SUBMITTED BY, DATE

RS Blum 9/10/95

LABORATORY MANAGER

FIGURE 1 - Logarithmic Plot of Resilient Modulus (M_R) vs Cyclic Stress (S_c)

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study
 LAW PROJECT NO.: 5810860101
 1. MATERIAL SOURCE: Johnsonville
 2. MATERIAL DESCRIPTION: Ponded Fly Ash (Active Ash Pond)
 3. REMOLDING TARGETS: 95% Modified Dry Density at Optimum Moisture Content
 4. MATERIAL TYPE: 2
 5. TEST DATE: 08-17-1995

$$M_R = K_1 (S_c)^{K_2} (1+S_3)^{K_5}$$

$$K_1 = \underline{\quad 3,980 \quad}$$

$$K_2 = \underline{\quad -0.14235 \quad}$$

$$K_5 = \underline{\quad 0.42844 \quad}$$

$$R^2 = \underline{\quad 0.96 \quad}$$

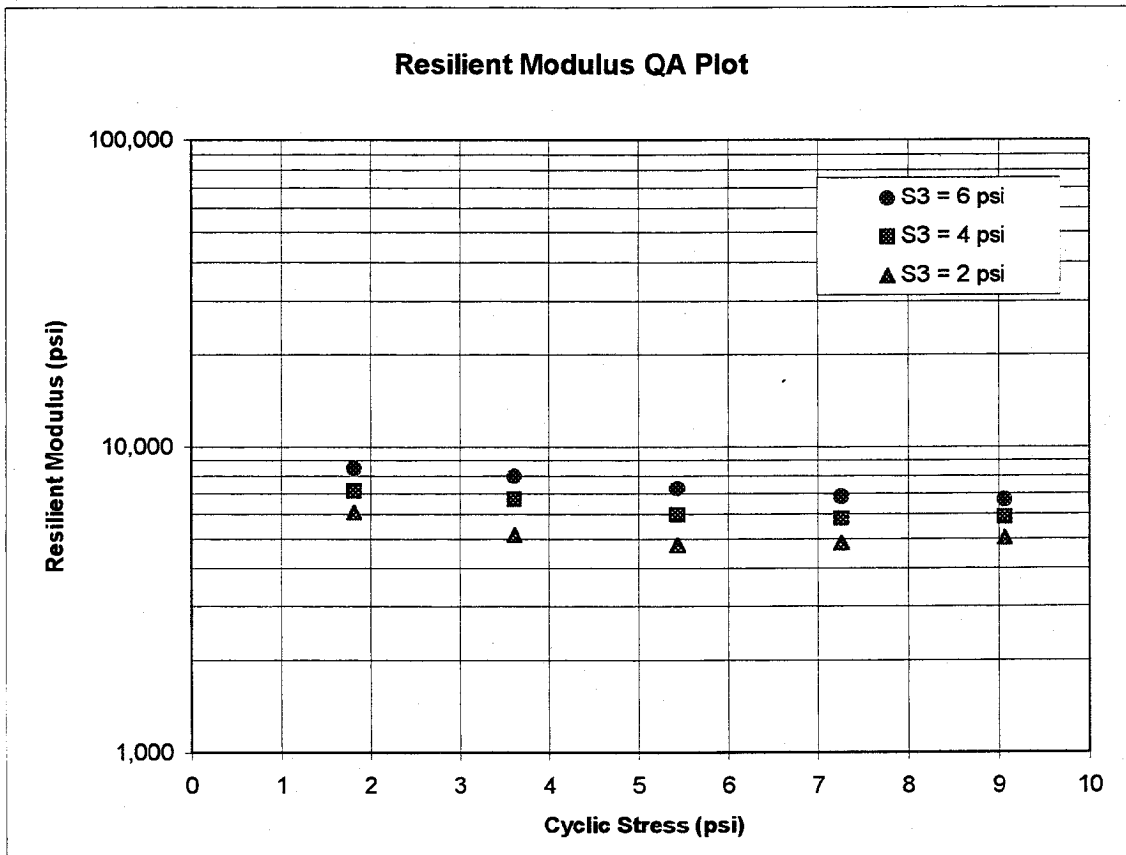
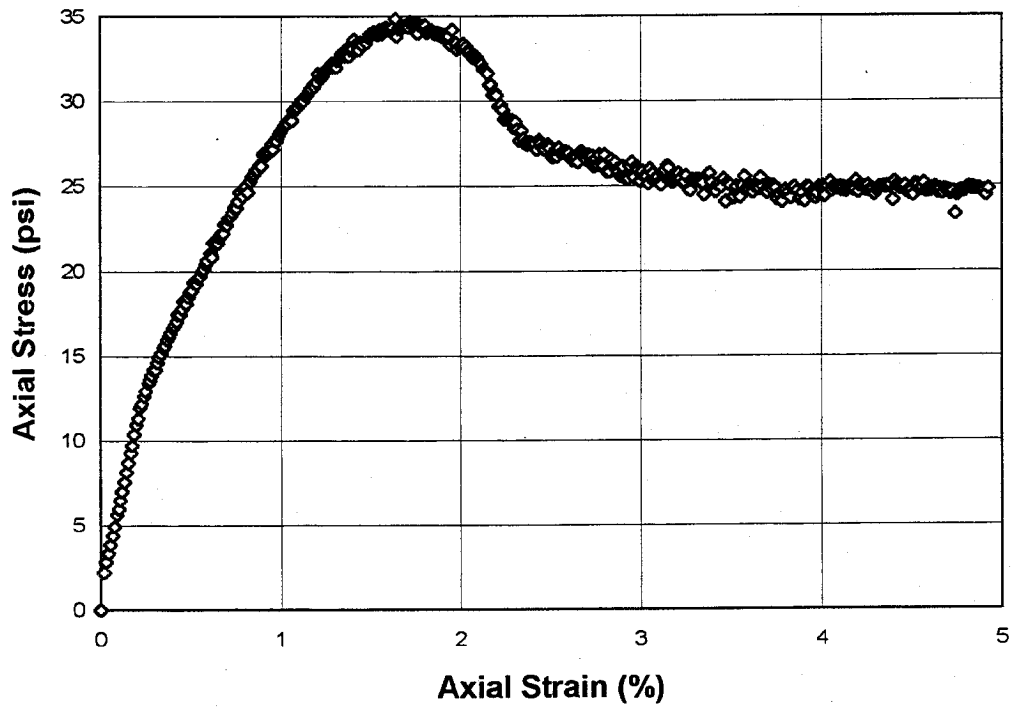


FIGURE 2 - Quick Shear Stress vs Strain

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study
LAW PROJECT NO.: 5810860101
1. *MATERIAL SOURCE:* Johnsonville
2. *MATERIAL DESCRIPTION:* Ponded Fly Ash (Active Ash Pond)
3. *REMOLDING TARGETS:* 95% Modified Dry Density at Optimum Moisture Content
4. *MATERIAL TYPE* 2
5. *TEST DATE* 08-17-1995





JOHNSONVILLE

Bottom Ash - From Pond

Grain Size Distribution Test Report
Moisture-Density Relationship (Standard Proctor)
Moisture-Density Relationship (Modified Proctor)
Relative Density Test
Hydraulic Conductivity - Constant Head (2 Pages)
California Bearing Ratio
Resilient Modulus (Standard Proctor) (9 Pages)
Resilient Modulus (Modified Proctor) (9 Pages)

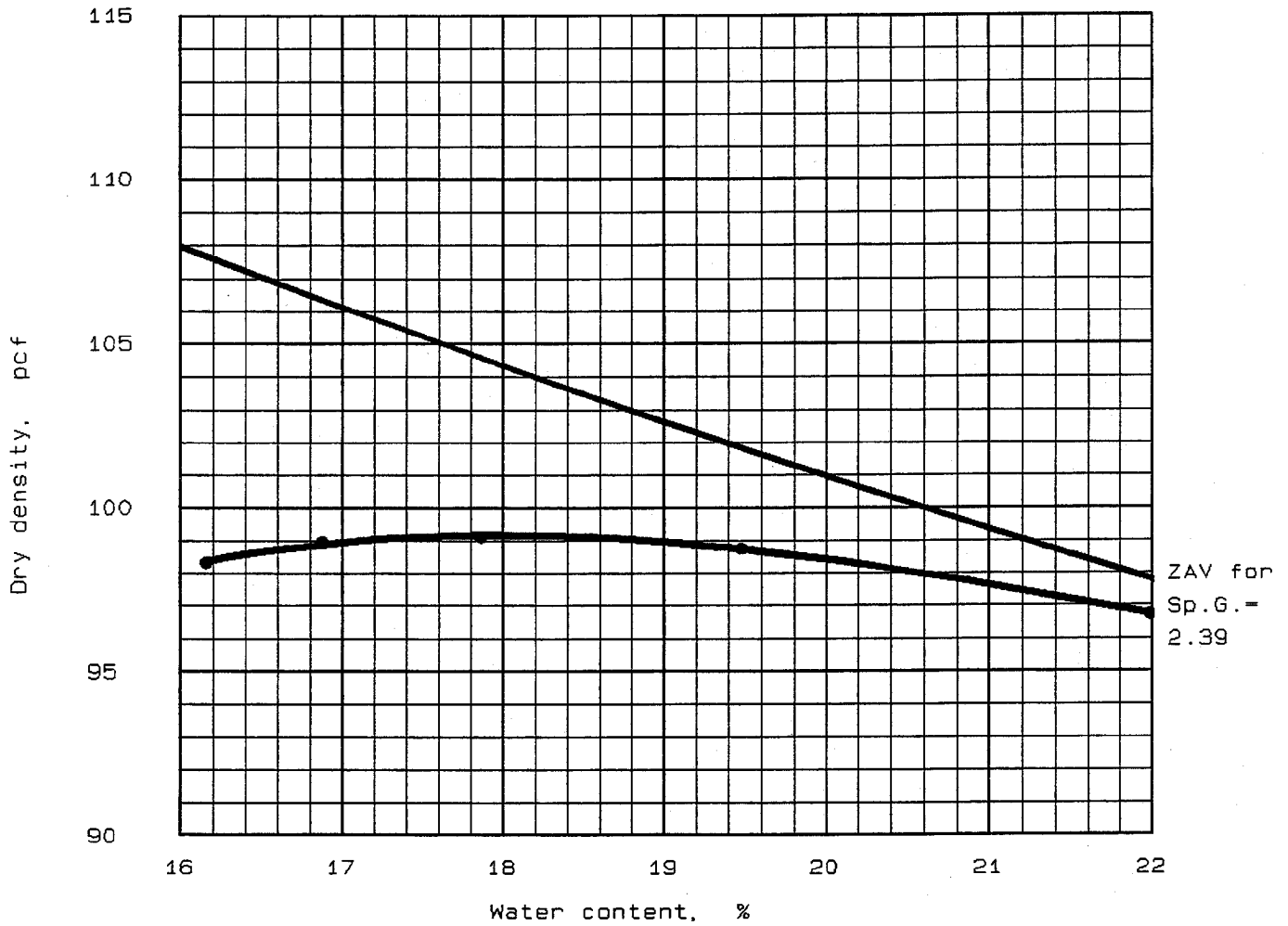


**TVA - JOHNSONVILLE
BOTTOM ASH - FROM POND**

Description	Test Method	Property	Sample 1	Sample 2	Sample 3
Grain Size	ASTM D 422	Percent Retained on the #4 Sieve	15.6	23.0	29.8
		Percent Passing the #200 Sieve	26.3	16.8	18.1
Atterberg Limits	ASTM D 4318	Liquid Limit	NL	NL	NL
		Plastic Limit	NP	NP	NP
		Plasticity Index	N/A	N/A	N/A
Specific Gravity	ASTM D 854	Specific Gravity at 20°C	2.39	2.39	2.39
Classification	ASTM D 2487	Unified Soil Classification System (USCS)	SM	SM	SM
	AASHTO M 145	AASHTO Classification	A-1-b	A-1-b	A-1-b
Composite Sample					
Moisture-Density Relations (Standard Effort)	ASTM D 698	Maximum Dry Density, pcf	99.2		
		Optimum Moisture Content, %	18.0		
Moisture-Density Relations (Modified Effort)	ASTM D 1557	Maximum Dry Density, pcf	104.1		
		Optimum Moisture Content, %	12.0		
Relative Density	ASTM D 4254	Minimum Dry Density, pcf	80.2		
	ASTM D 4253	Maximum Dry Density (Dry Method), pcf	99.2		
Hydraulic Conductivity	ASTM D 2434	Hydraulic Conductivity, cm/sec	Result	Dry Density, pcf	Moisture Content, %
			4.7E-3	91.1	0.0
Angle of Repose	LAW TP6	Angle of Repose, degrees	30.8	80.2	0.0
California Bearing Ratio	ASTM D 1883	CBR, %	50	94.7	18.4
Resilient Modulus (Standard Compactive Effort)	SHRP P46	Resilient Modulus at 4psi axial stress and 4psi confining pressure	6,169	94.6	16.7
Resilient Modulus (Modified Compactive Effort)	SHRP P46	Resilient Modulus at 4psi axial stress and 4psi confining pressure	6,247	97.8	11.3
Soil Resistivity	AASHTO T 288	Minimum Resistivity, Ohm-cm	740		
pH of Soil	AASHTO T 289	pH	6.0		
Water Soluble Sulfate Ion	AASHTO T 290	Sulfate Ion Content, mg/kg	2200		
Water Soluble Chloride Ion	AASHTO T 290	Chloride Ion Content, mg/kg	<10		

jof-ba.xls

MOISTURE-DENSITY RELATIONSHIP



"Standard" Proctor, ASTM D 698, Method A

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No. 4	% < No. 200
	USCS	AASHTO						
	SM	A-1-b	12.2 %	2.39	NL	NP	22.8 %	20.4 %

TEST RESULTS	MATERIAL DESCRIPTION
--------------	----------------------

Optimum moisture = 18.0 %
Maximum dry density = 99.2 pcf

Project No.: 5810850101
Project: TVA - Johnsonville
Location: Bottom Ash

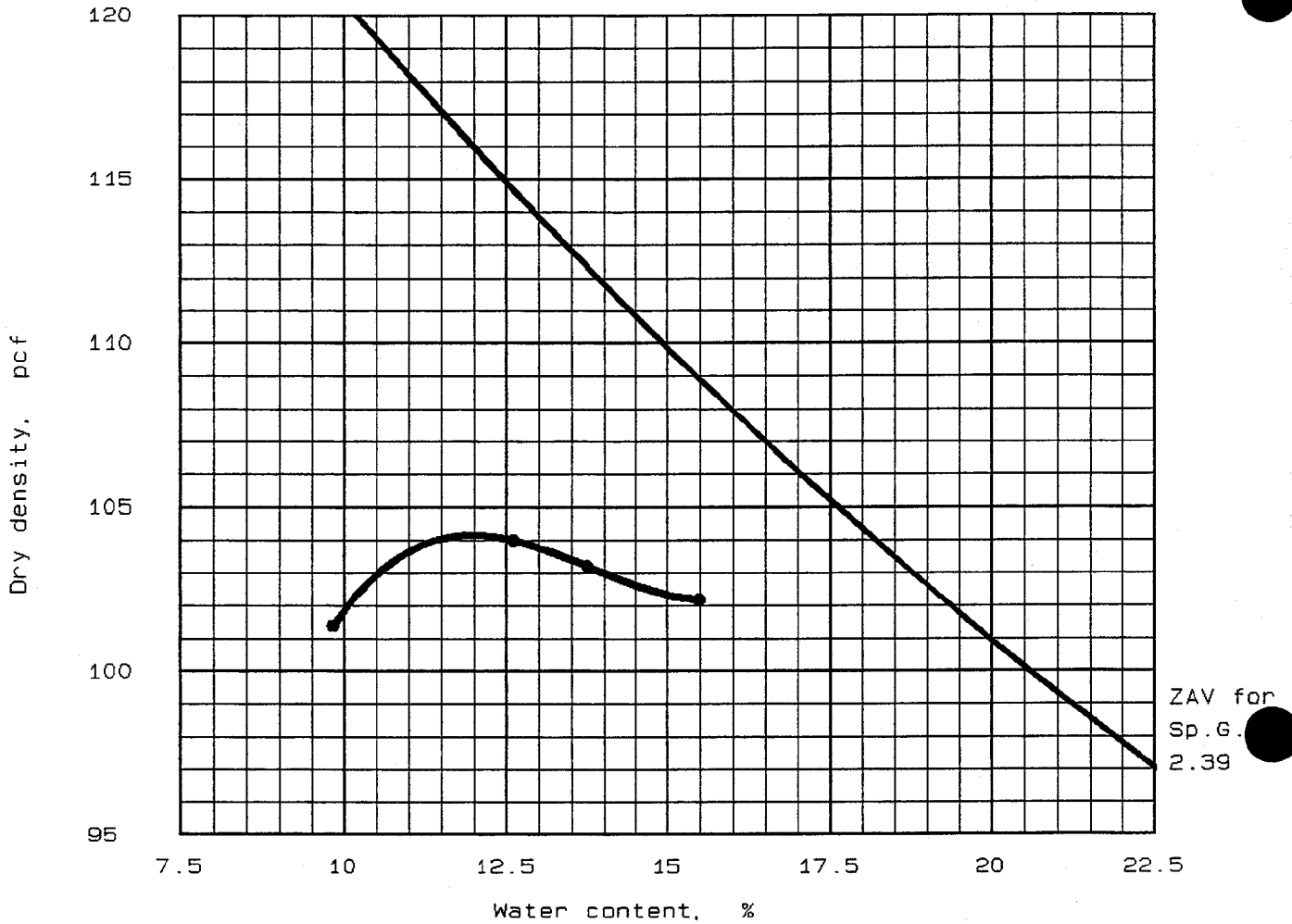
Date: July 25, 1995

Remarks:
Tested by: JCN
Reviewed by: RJB

MOISTURE-DENSITY RELATIONSHIP
LAW ENGINEERING, INC.

Figure No. _____

MOISTURE-DENSITY RELATIONSHIP



"Modified" Proctor, ASTM D 1557, Method A

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No. 4	% < No. 200
	USCS	AASHTO						
	SM	A-1-b	12.2 %	2.39	NL	NP	22.8 %	20.4 %

TEST RESULTS	MATERIAL DESCRIPTION
Optimum moisture = 12.0 % Maximum dry density = 104.1 pcf	

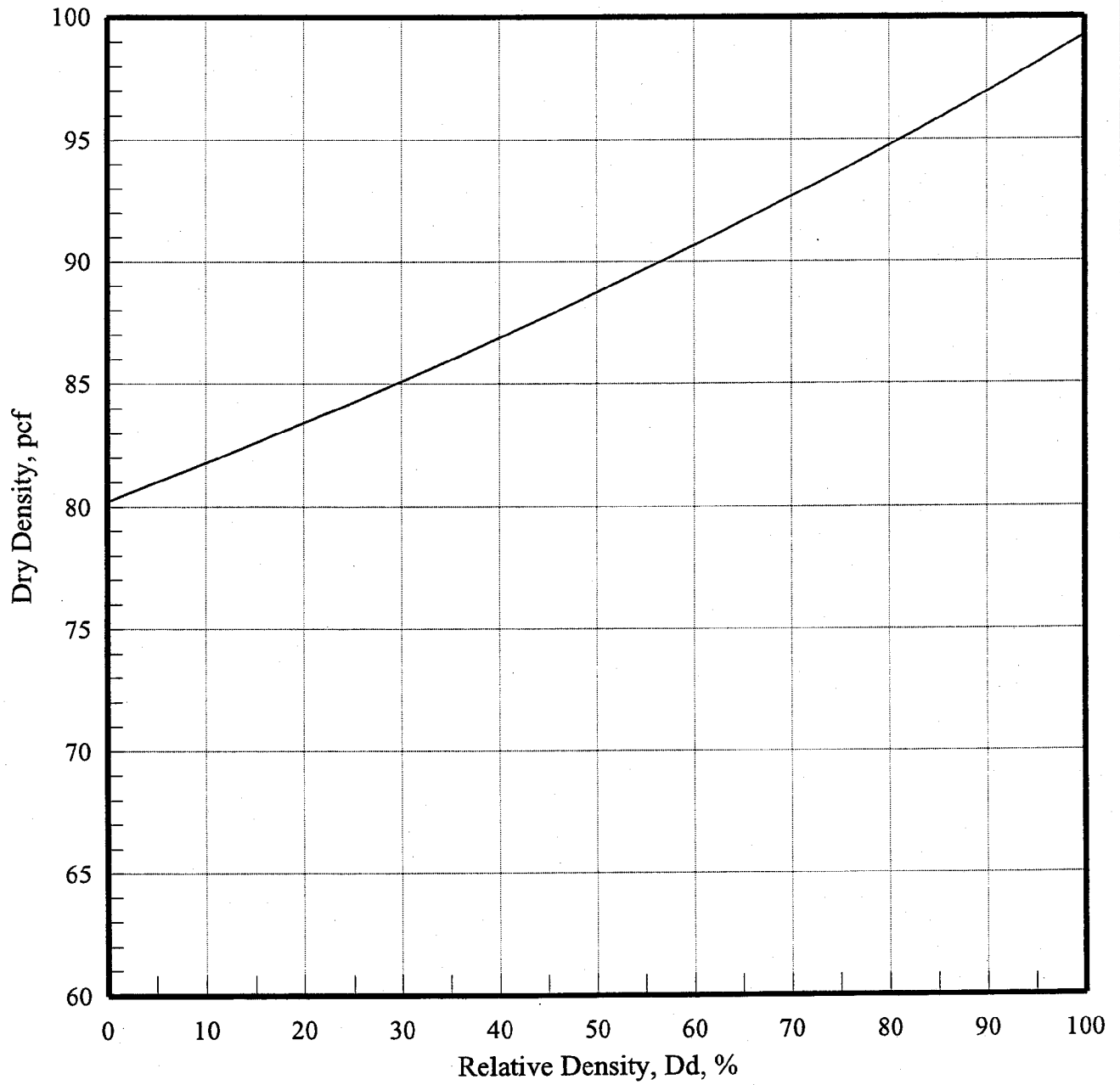
Project No.: 5810860101 Project: TVA - Johnsonville Location: Bottom Ash Date: July 25, 1995	Remarks: Tested by: JCR Reviewed by: RLB
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MOISTURE-DENSITY RELATIONSHIP LAW ENGINEERING, INC.	Figure No. _____
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Relative Density Test

TVA - Johnsonville, Bottom Ash

Law Project No. 5810860101



HYDRAULIC CONDUCTIVITY



Project No. **5810860101**
Project Name **TVA - Johnsonville**
Material **Bottom Ash**

Tested By **JCR**
Test Date **08/17/95**
Reviewed By **RLB**
Review Date **09/06/95**

ASTM D2434-68 Constant Head Permeability

Sample Type:	<i>Remolded</i>
Sample Orientation:	<i>Vertical</i>
Initial Water Content, %:	<i>0.0</i>
Wet Unit Weight, pcf:	<i>91.1</i>
Dry Unit Weight, pcf:	<i>91.1</i>
Compaction, %:	<i>91.8</i>
Hydraulic Conductivity, cm/sec. @20° C:	4.7E-03

PERMEABILITY TEST - Constant Head
(ASTM D2434 - 68)



Project No. 5810860101
 Project Name TVA - Johnsonville
 Material Bottom Ash

Tested By JCR
 Test Date 08/17/95
 Reviewed By RLB
 Review Date 09/06/95

Sample Data

Length, in		Diameter, in		Pan No.		
Location 1	5.163	Location 1	2.858	Wet Soil + Pan, grams	800.18	
Location 2	5.217	Location 2	2.875	Dry Soil+Pan, grams	800.18	
Location 3	5.177	Location 3	2.868	Pan Weight, grams	0.00	
Average	5.186	Average	2.867	Moisture Content, %	0.0	
			Sample wet weight, grams	800.18	Wet Unit Wt, pcf	91.1
			Membrane, Cap weight, grams	0.00	Dry Unit Wt, pcf	91.1

Time (sec)	Q (cm ³)	H (cm)	k (cm/sec)	Temp °C	k (cm/sec at 20° C)	i (cm/cm)
600	70.00	5.08	7.3E-03	20.0	7.3E-03	0.39
1200	90.00	5.08	4.7E-03	20.0	4.7E-03	0.39

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
2	Remolded	99.2	91.8	Vertical

L = length of sample in cm
 A = area of sample in cm²

H = constant head in cm
 t = time in seconds

A = 41.65 cm²
 L = 13.172 cm

Avg. k at 20° C 4.7E-03 cm/sec

California Bearing Ratio

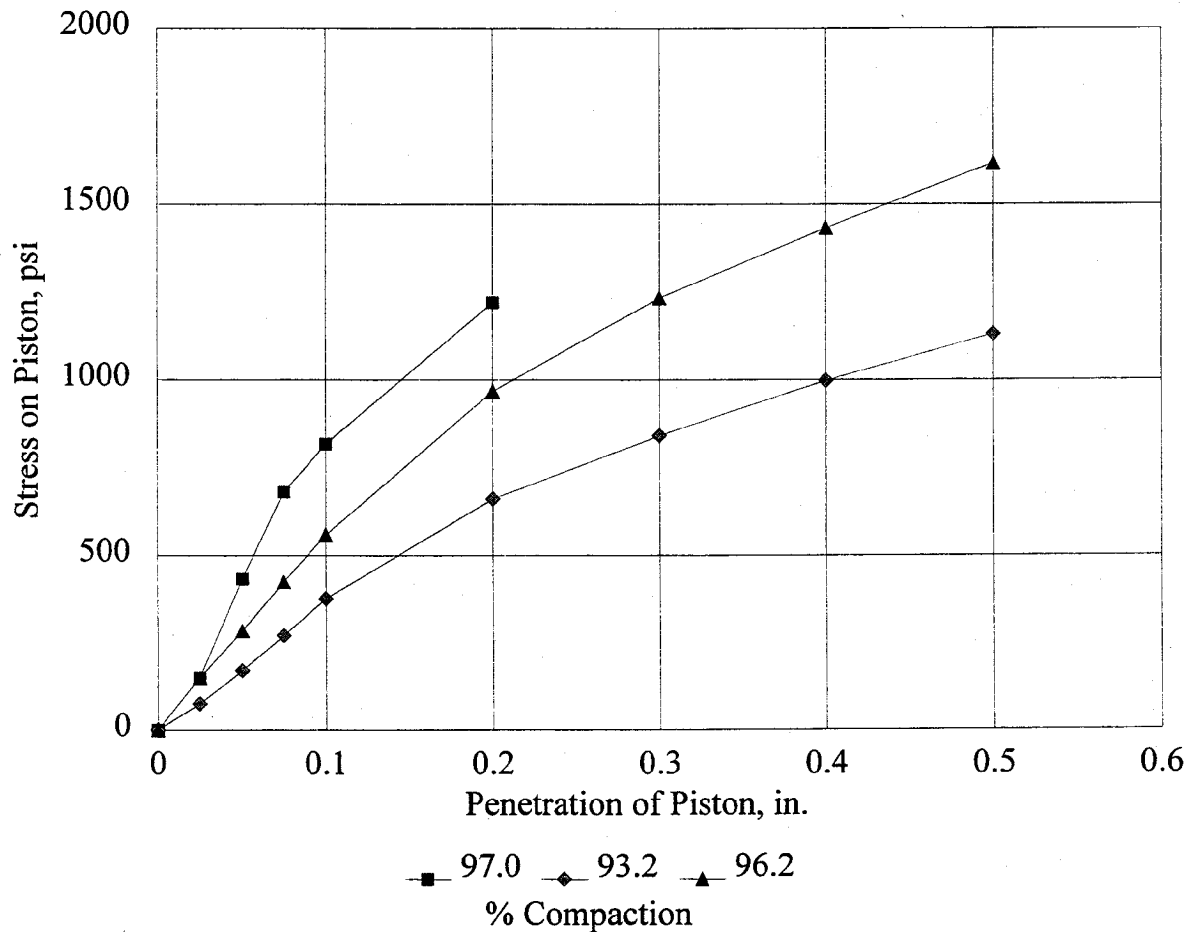
(ASTM D1883-92)



Project No. 5810860101
 Project Name TVA - Johnsonville
 Material (Source) Bottom Ash

Tested By EM
 Test Date 08/03/95
 Reviewed By RLB
 Review Date 09/01/95

Compaction, %	97.0	93.2	96.2
Before Soak Dry Density, pcf	96.2	92.5	95.5
Before Soak Moisture Content, %	18.6	18.5	18.2
After Soak Dry Density, pcf	96.1	92.3	95.0
After Soak Moisture Content, %	18.0	18.7	18.6
CBR @ 0.1 in.	81.6	37.6	55.8
CBR @ 0.2 in.	81.3	44.0	64.4



LABORATORY MATERIAL HANDLING AND TESTING
 LABORATORY MATERIAL TEST DATA
 RESILIENT MODULUS OF UNBOUND GRANULAR BASE/SUBBASE
 MATERIALS AND SUBGRADE SOILS
 LAB DATA SHEET T46 - RECOMPACTED SAMPLES

SHEET NO 1 OF 2

UNBOUND GRANULAR BASE/SUBBASE LAYERS AND SUBGRADE SOILS
 SHRP TEST DESIGNATION UG07, SS07/SHRP PROTOCOL P46

LABORATORY PERFORMING TEST: LAW ENGINEERING, INC. - ATLANTA, GEORGIA

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study

LAW PROJECT NO.: 5810860101

1.	MATERIAL SOURCE:	<u>Johnsonville</u>		
2.	MATERIAL DESCRIPTION:	<u>Bottom Ash</u>		
3.	REMOLDING TARGETS:	<u>95% Standard Dry Density at Optimum Moisture Content</u>		
4.	MATERIAL TYPE (Type 1 or Type 2)			<u>2</u>
5.	TEST INFORMATION			
	PRECONDITIONING - GREATER THAN 5% PERM. STRAIN? (Y = YES OR N = NO)			<u>N</u>
	TESTING - GREATER THAN 5% PERM. STRAIN? (Y = YES OR N = NO)			<u>N</u>
	TESTING - NUMBER OF LOAD SEQUENCES COMPLETED (0 - 15)			<u>15</u>
6.	SPECIMEN INFO.:			
	SPECIMEN DIAM., inch			
	TOP			<u>2.85</u>
	MIDDLE			<u>2.85</u>
	BOTTOM			<u>2.85</u>
	AVERAGE			<u>2.85</u>
	MEMBRANE THICKNESS (1), inch			<u>0.01</u>
	MEMBRANE THICKNESS (2), inch			<u>0.01</u>
	NET DIAM., inch			<u>2.83</u>
	HEIGHT OF SPECIMEN, CAP AND BASE, inch			<u>6.04</u>
	HEIGHT OF CAP AND BASE, inch			<u>0.00</u>
	INITIAL LENGTH, L ₀ , inch			<u>6.04</u>
	INITIAL AREA, A ₀ , in ²			<u>6.28</u>
	INITIAL VOLUME A ₀ L ₀ , in ³			<u>37.94</u>
7.	SOIL SPECIMEN WEIGHT:			
	INITIAL WEIGHT OF CONTAINER AND WET SOIL, grams			<u>1100.10</u>
	FINAL WEIGHT OF CONTAINER AND WET SOIL, grams			<u>0.00</u>
	WEIGHT OF WET SOIL USED, grams			<u>1100.10</u>
8.	SOIL PROPERTIES.:			
	IN SITU MOISTURE CONTENT (NUCLEAR), %			<u>N/A</u>
	IN SITU WET DENSITY (NUCLEAR), pcf			<u>N/A</u>
	or			
	OPTIMUM MOISTURE CONTENT, %			<u>18.0</u>
	MAX. DRY DENSITY, pcf			<u>99.2</u>
	95 % MAX. DRY DENSITY, pcf			<u>94.2</u>
9.	SPECIMEN PROPERTIES:			
	COMPACTION MOISTURE CONTENT, %			<u>16.7</u>
	MOISTURE CONTENT AFTER RESILIENT MODULUS TESTING, %			<u>16.7</u>
	COMPACTION DRY DENSITY, γ _d pcf			<u>94.6</u>
10.	QUICK SHEAR TEST			
	STRESS - STRAIN PLOT ATTACHED (Y = YES, N = NO)			<u>Y</u>
	TRIAxIAL SHEAR MAXIMUM STRENGTH (MAX. LOAD/X-SECTION AREA), psi			<u>37.4</u>
	SPECIMEN FAIL DURING TRIAXIAL SHEAR? (Y = YES, N = NO)			<u>Y</u>
11.	COMMENTS (Section 10.4 of Protocol P46)			
	(a) CODE	<u>0</u>	<u>0</u>	<u>0</u>
	(b) NOTE			
12.	TEST DATE			<u>08-28-1995</u>

GENERAL REMARKS:

SUBMITTED BY, DATE

RS Boudreau 9/10/95
 LABORATORY MANAGER

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study
 LAW PROJECT NO.: 5810860101
 1. MATERIAL SOURCE: Johnsonville
 2. MATERIAL DESCRIPTION: Bottom Ash
 3. REMOLDING TARGETS: 95% Standard Dry Density at Optimum Moisture Content
 4. MATERIAL TYPE: 2
 5. TEST DATE: 08-28-1995
 6. RESILIENT MODULUS TESTING

COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
PARAMETER	Chamber Confining Pressure	Nominal Maximum Axial Stress	Cycle No.	Actual Applied Max. Axial Load	Actual Applied Cyclic Load	Actual Applied Contact Load	Actual Applied Max. Axial Stress	Actual Applied Cyclic Stress	Actual Applied Contact Stress	Recov. Def. LVDT #1 Reading	Recov. Def. LVDT #2 Reading	Average Recov Def. LVDT 1 and 2	Resilient Strain	Resilient Modulus
DESIGNATION	S ₃	S _{cyclic}	C ₁	P _{max}	P _{cyclic}	P _{contact}	S _{max}	S _{cyclic}	S _{contact}	H ₁	H ₂	H _{avg}	ε _r	M _r
UNIT	psi	psi	---	lbs	lbs	lbs	psi	psi	psi	in.	in.	in.	in/in	psi
PRECISION														
SEQUENCE 1	6.0	2.0	1	13.0	11.7	1.3	2.1	1.9	0.2	0.00167	0.00144	0.00156	0.00026	7,228
			2	13.1	11.7	1.4	2.1	1.9	0.2	0.00160	0.00143	0.00151	0.00025	7,460
			3	13.1	11.7	1.4	2.1	1.9	0.2	0.00163	0.00149	0.00156	0.00026	7,227
			4	13.1	11.7	1.3	2.1	1.9	0.2	0.00157	0.00144	0.00151	0.00025	7,480
			5	13.0	11.6	1.4	2.1	1.8	0.2	0.00162	0.00149	0.00156	0.00026	7,161
COLUMN AVERAGE				13.0	11.7	1.4	2.1	1.9	0.2	0.00162	0.00146	0.00154	0.00025	7,311
STANDARD DEV.				0.1	0.1	0.0	0.0	0.0	0.0	0.00004	0.00003	0.00003	0.00000	148

Source: Johnsonville Description: Bottom Ash

95% Standard Dry Density at Optimum Moisture Content

SEQUENCE 2	6.0	4.0	1	25.2	23.0	2.2	4.0	3.7	0.4	0.00240	0.00251	0.00245	0.00041	9,019
			2	25.3	23.1	2.2	4.0	3.7	0.3	0.00237	0.00249	0.00243	0.00040	9,158
			3	25.4	23.1	2.3	4.0	3.7	0.4	0.00237	0.00248	0.00242	0.00040	9,176
			4	25.4	23.1	2.3	4.0	3.7	0.4	0.00235	0.00247	0.00241	0.00040	9,230
			5	25.5	23.3	2.2	4.1	3.7	0.4	0.00236	0.00250	0.00243	0.00040	9,231
	COLUMN AVERAGE			25.4	23.1	2.2	4.0	3.7	0.4	0.00237	0.00249	0.00243	0.00040	9,163
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00002	0.00002	0.00002	0.00000	87
SEQUENCE 3	6.0	6.0	1	37.9	34.3	3.6	6.0	5.5	0.6	0.00349	0.00371	0.00360	0.00060	9,165
			2	37.9	34.3	3.6	6.0	5.5	0.6	0.00352	0.00372	0.00362	0.00060	9,097
			3	37.9	34.3	3.6	6.0	5.5	0.6	0.00355	0.00371	0.00363	0.00060	9,099
			4	37.9	34.3	3.6	6.0	5.5	0.6	0.00352	0.00373	0.00362	0.00060	9,106
			5	37.8	34.3	3.5	6.0	5.5	0.6	0.00351	0.00372	0.00361	0.00060	9,131
	COLUMN AVERAGE			37.9	34.3	3.6	6.0	5.5	0.6	0.00352	0.00372	0.00362	0.00060	9,120
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00002	0.00001	0.00001	0.00000	29
SEQUENCE 4	6.0	8.0	1	50.9	46.0	4.8	8.1	7.3	0.8	0.00468	0.00501	0.00484	0.00080	9,141
			2	50.8	46.0	4.9	8.1	7.3	0.8	0.00470	0.00501	0.00485	0.00080	9,109
			3	50.9	46.0	4.8	8.1	7.3	0.8	0.00472	0.00504	0.00488	0.00081	9,073
			4	50.9	46.0	4.9	8.1	7.3	0.8	0.00472	0.00504	0.00488	0.00081	9,075
			5	50.8	46.0	4.8	8.1	7.3	0.8	0.00471	0.00505	0.00488	0.00081	9,073
	COLUMN AVERAGE			50.9	46.0	4.8	8.1	7.3	0.8	0.00470	0.00503	0.00487	0.00081	9,094
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00002	0.00002	0.00002	0.00000	30

Source: Johnsonville		Description: Bottom Ash					95% Standard Dry Density at Optimum Moisture Content									
SEQUENCE 5	6.0	10.0	1	63.8	57.7	6.1	10.2	9.2	1.0	0.00577	0.00623	0.00600	0.00099	9,240		
			2	63.8	57.7	6.1	10.2	9.2	1.0	0.00576	0.00625	0.00600	0.00099	9,244		
			3	63.8	57.7	6.1	10.2	9.2	1.0	0.00578	0.00627	0.00602	0.00100	9,216		
			4	63.8	57.7	6.1	10.2	9.2	1.0	0.00582	0.00629	0.00605	0.00100	9,177		
			5	63.8	57.7	6.1	10.2	9.2	1.0	0.00582	0.00626	0.00604	0.00100	9,190		
	COLUMN AVERAGE			63.8	57.7	6.1	10.2	9.2	1.0	0.00579	0.00626	0.00602	0.00100	9,213		
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00003	0.00002	0.00002	0.00000	30		
SEQUENCE 6	4.0	2.0	1	13.3	11.7	1.7	2.1	1.9	0.3	0.00172	0.00200	0.00186	0.00031	6,052		
			2	13.3	11.7	1.6	2.1	1.9	0.3	0.00169	0.00200	0.00185	0.00031	6,089		
			3	13.3	11.7	1.6	2.1	1.9	0.3	0.00171	0.00199	0.00185	0.00031	6,075		
			4	13.3	11.6	1.6	2.1	1.9	0.3	0.00173	0.00198	0.00185	0.00031	6,037		
			5	13.2	11.6	1.6	2.1	1.8	0.3	0.00172	0.00199	0.00186	0.00031	5,987		
	COLUMN AVERAGE			13.3	11.7	1.6	2.1	1.9	0.3	0.00172	0.00199	0.00185	0.00031	6,048		
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00000	0.00000	40		
SEQUENCE 7	4.0	4.0	1	25.3	23.1	2.2	4.0	3.7	0.4	0.00336	0.00369	0.00353	0.00058	6,293		
			2	25.3	23.0	2.2	4.0	3.7	0.4	0.00335	0.00371	0.00353	0.00058	6,277		
			3	25.3	23.1	2.3	4.0	3.7	0.4	0.00336	0.00369	0.00353	0.00058	6,291		
			4	25.3	23.0	2.2	4.0	3.7	0.4	0.00334	0.00368	0.00351	0.00058	6,310		
			5	25.2	22.9	2.2	4.0	3.6	0.4	0.00333	0.00368	0.00350	0.00058	6,289		
	COLUMN AVERAGE			25.3	23.0	2.2	4.0	3.7	0.4	0.00335	0.00369	0.00352	0.00058	6,292		
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	12		

Source: Johnsonville		Description: Bottom Ash					95% Standard Dry Density at Optimum Moisture Content							
SEQUENCE 8	4.0	6.0	1	38.4	35.0	3.4	6.1	5.6	0.5	0.00472	0.00512	0.00492	0.00081	6,837
			2	38.4	34.9	3.5	6.1	5.6	0.6	0.00470	0.00515	0.00492	0.00082	6,826
			3	38.4	34.9	3.4	6.1	5.6	0.5	0.00470	0.00509	0.00490	0.00081	6,866
			4	38.4	34.9	3.5	6.1	5.6	0.6	0.00470	0.00509	0.00490	0.00081	6,848
			5	38.4	34.9	3.5	6.1	5.6	0.6	0.00468	0.00511	0.00490	0.00081	6,866
	COLUMN AVERAGE			38.4	34.9	3.5	6.1	5.6	0.6	0.00470	0.00511	0.00491	0.00081	6,849
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00002	0.00001	0.00000	18
SEQUENCE 9	4.0	8.0	1	51.1	46.3	4.8	8.1	7.4	0.8	0.00582	0.00631	0.00606	0.00100	7,341
			2	51.2	46.5	4.8	8.2	7.4	0.8	0.00580	0.00632	0.00606	0.00100	7,374
			3	51.2	46.3	4.8	8.1	7.4	0.8	0.00582	0.00631	0.00607	0.00100	7,343
			4	51.1	46.3	4.8	8.1	7.4	0.8	0.00582	0.00632	0.00607	0.00100	7,346
			5	51.1	46.3	4.8	8.1	7.4	0.8	0.00582	0.00630	0.00606	0.00100	7,357
	COLUMN AVERAGE			51.1	46.3	4.8	8.1	7.4	0.8	0.00582	0.00631	0.00606	0.00100	7,352
	STANDARD DEV.			0.0	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00000	0.00000	14
SEQUENCE 10	4.0	10.0	1	63.7	57.6	6.1	10.1	9.2	1.0	0.00689	0.00742	0.00715	0.00118	7,754
			2	63.7	57.6	6.1	10.1	9.2	1.0	0.00691	0.00742	0.00717	0.00119	7,730
			3	63.7	57.6	6.1	10.1	9.2	1.0	0.00691	0.00743	0.00717	0.00119	7,728
			4	63.7	57.6	6.1	10.1	9.2	1.0	0.00689	0.00740	0.00715	0.00118	7,759
			5	63.5	57.4	6.1	10.1	9.1	1.0	0.00689	0.00741	0.00715	0.00118	7,727
	COLUMN AVERAGE			63.7	57.6	6.1	10.1	9.2	1.0	0.00690	0.00742	0.00716	0.00118	7,739
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	15

Source: Johnsonville		Description: Bottom Ash					95% Standard Dry Density at Optimum Moisture Content									
SEQUENCE 11	2.0	2.0	1	13.3	11.2	2.1	2.1	1.8	0.3	0.00215	0.00236	0.00225	0.00037	4,795		
			2	13.4	11.3	2.1	2.1	1.8	0.3	0.00216	0.00235	0.00225	0.00037	4,826		
			3	13.3	11.3	2.1	2.1	1.8	0.3	0.00214	0.00235	0.00225	0.00037	4,827		
			4	13.4	11.3	2.1	2.1	1.8	0.3	0.00216	0.00235	0.00225	0.00037	4,825		
			5	13.4	11.4	2.1	2.1	1.8	0.3	0.00217	0.00235	0.00226	0.00037	4,823		
	COLUMN AVERAGE		13.4	11.3	2.1	2.1	1.8	0.3	0.00216	0.00235	0.00225	0.00037	4,819			
	STANDARD DEV.		0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	13			
SEQUENCE 12	2.0	4.0	1	24.7	22.4	2.4	3.9	3.6	0.4	0.00437	0.00468	0.00453	0.00075	4,757		
			2	24.8	22.4	2.4	3.9	3.6	0.4	0.00436	0.00467	0.00451	0.00075	4,775		
			3	24.8	22.4	2.3	3.9	3.6	0.4	0.00438	0.00469	0.00454	0.00075	4,757		
			4	24.7	22.4	2.3	3.9	3.6	0.4	0.00440	0.00468	0.00454	0.00075	4,748		
			5	24.8	22.5	2.3	3.9	3.6	0.4	0.00435	0.00466	0.00450	0.00075	4,796		
	COLUMN AVERAGE		24.8	22.4	2.4	3.9	3.6	0.4	0.00437	0.00468	0.00452	0.00075	4,766			
	STANDARD DEV.		0.0	0.0	0.0	0.0	0.0	0.0	0.00002	0.00001	0.00001	0.00000	19			
SEQUENCE 13	2.0	6.0	1	38.4	34.9	3.5	6.1	5.5	0.6	0.00580	0.00623	0.00601	0.00100	5,574		
			2	38.3	34.7	3.5	6.1	5.5	0.6	0.00582	0.00623	0.00603	0.00100	5,546		
			3	38.5	35.0	3.5	6.1	5.6	0.6	0.00583	0.00624	0.00603	0.00100	5,573		
			4	38.4	34.9	3.5	6.1	5.6	0.6	0.00582	0.00623	0.00603	0.00100	5,566		
			5	38.3	34.7	3.5	6.1	5.5	0.6	0.00584	0.00623	0.00604	0.00100	5,538		
	COLUMN AVERAGE		38.4	34.8	3.5	6.1	5.5	0.6	0.00582	0.00623	0.00603	0.00100	5,559			
	STANDARD DEV.		0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00000	0.00001	0.00000	16			

FIGURE 1 - Logarithmic Plot of Resilient Modulus (M_R) vs Cyclic Stress (S_C)

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study
 LAW PROJECT NO.: 5810860101
 1. MATERIAL SOURCE: Johnsonville
 2. MATERIAL DESCRIPTION: Bottom Ash
 3. REMOLDING TARGETS: 95% Standard Dry Density at Optimum Moisture Content
 4. MATERIAL TYPE: 2
 5. TEST DATE: 08-28-1995

$$M_R = K_1 (S_C)^{K_2} (1+S_3)^{K_5}$$

$K_1 = \underline{\quad 2,373 \quad}$
 $K_2 = \underline{\quad 0.16927 \quad}$
 $K_5 = \underline{\quad 0.51994 \quad}$
 $R^2 = \underline{\quad 0.92 \quad}$

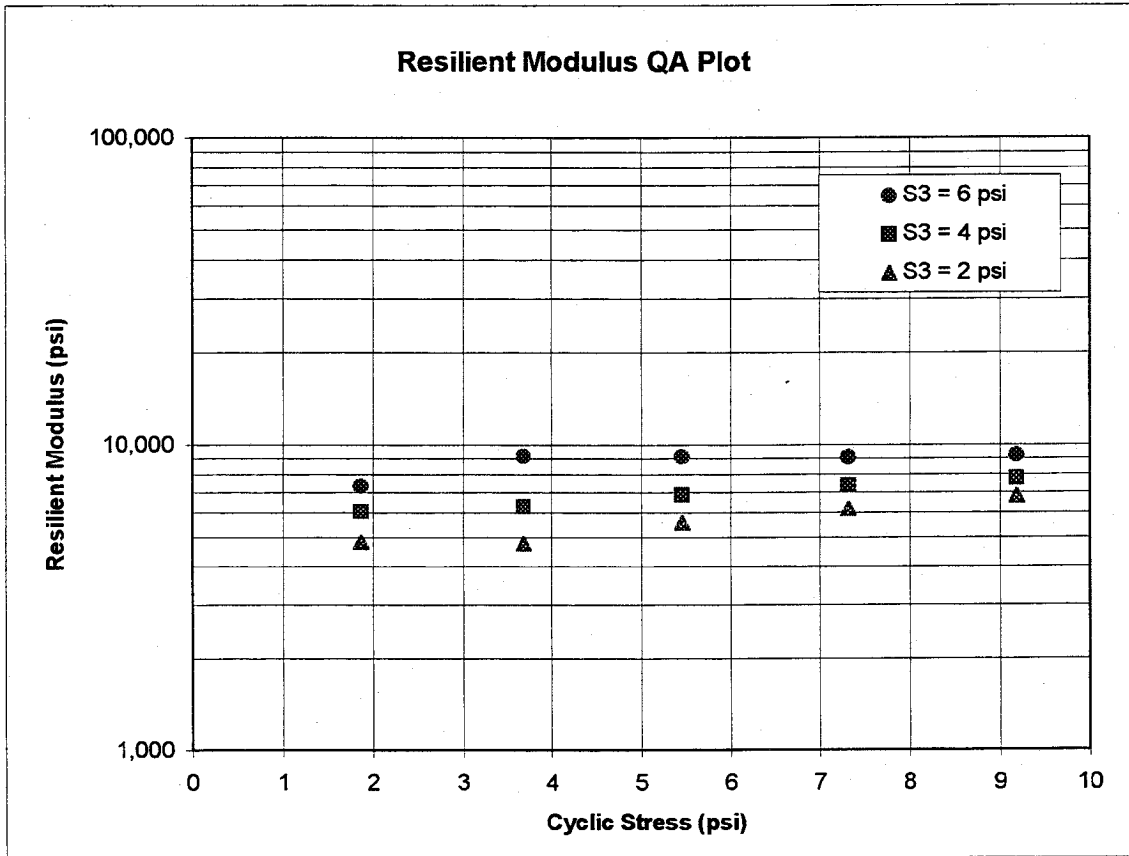
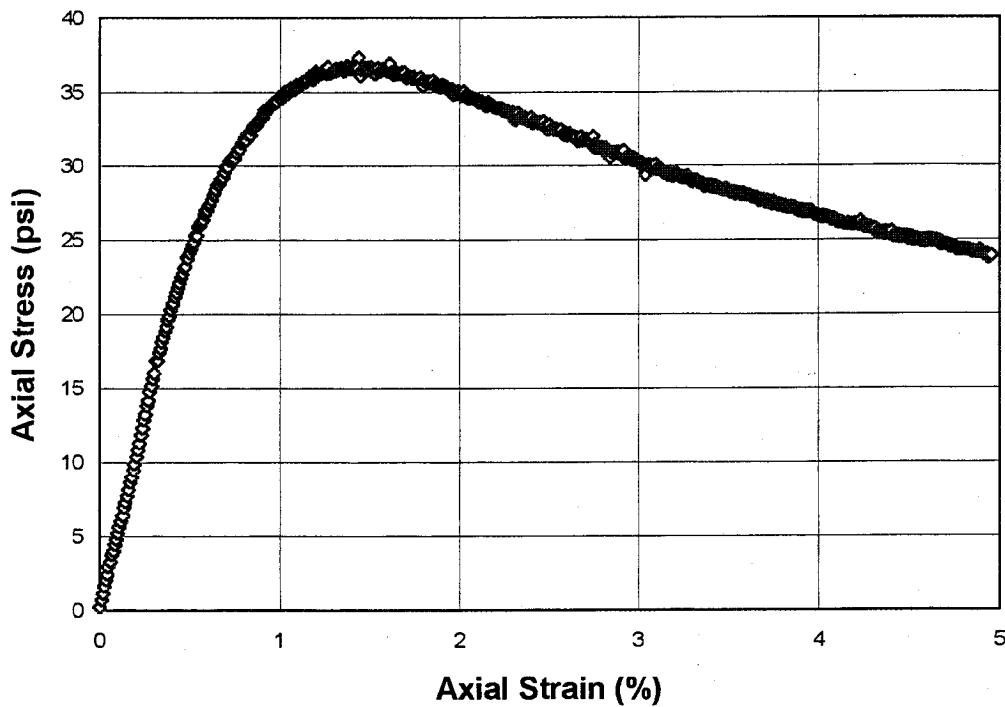


FIGURE 2 - Quick Shear Stress vs Strain

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study
LAW PROJECT NO.: 5810860101
1. *MATERIAL SOURCE:* Johnsonville
2. *MATERIAL DESCRIPTION:* Bottom Ash
3. *REMOLDING TARGETS:* 95% Standard Dry Density at Optimum Moisture Content
4. *MATERIAL TYPE* 2
5. *TEST DATE* 08-28-1995



**LABORATORY MATERIAL HANDLING AND TESTING
LABORATORY MATERIAL TEST DATA
RESILIENT MODULUS OF UNBOUND GRANULAR BASE/SUBBASE
MATERIALS AND SUBGRADE SOILS
LAB DATA SHEET T46 - RECOMPACTED SAMPLES**

**UNBOUND GRANULAR BASE/SUBBASE LAYERS AND SUBGRADE SOILS
SHRP TEST DESIGNATION UG07, SS07/SHRP PROTOCOL P46**

LABORATORY PERFORMING TEST: LAW ENGINEERING, INC. - ATLANTA, GEORGIA

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study

LAW PROJECT NO.: 5810860101

1.	MATERIAL SOURCE:	Johnsonville		
2.	MATERIAL DESCRIPTION:	Bottom Ash		
3.	REMOLDING TARGETS:	95% Modified Dry Density at Optimum Moisture Content		
4.	MATERIAL TYPE (Type 1 or Type 2)			2
5.	TEST INFORMATION			
	PRECONDITIONING - GREATER THAN 5% PERM. STRAIN? (Y = YES OR N = NO)			N
	TESTING - GREATER THAN 5% PERM. STRAIN? (Y = YES OR N = NO)			N
	TESTING - NUMBER OF LOAD SEQUENCES COMPLETED (0 - 15)			15
6.	SPECIMEN INFO.:			
	SPECIMEN DIAM., inch			
	TOP			2.86
	MIDDLE			2.86
	BOTTOM			2.86
	AVERAGE			2.86
	MEMBRANE THICKNESS (1), inch			0.01
	MEMBRANE THICKNESS (2), inch			0.01
	NET DIAM., inch			2.83
	HEIGHT OF SPECIMEN, CAP AND BASE, inch			6.06
	HEIGHT OF CAP AND BASE, inch			0.00
	INITIAL LENGTH, L ₀ , inch			6.06
	INITIAL AREA, A ₀ , in ²			6.30
	INITIAL VOLUME A ₀ L ₀ , in ³			38.22
7.	SOIL SPECIMEN WEIGHT:			
	INITIAL WEIGHT OF CONTAINER AND WET SOIL, grams			1092.64
	FINAL WEIGHT OF CONTAINER AND WET SOIL, grams			0.00
	WEIGHT OF WET SOIL USED, grams			1092.64
8.	SOIL PROPERTIES.:			
	IN SITU MOISTURE CONTENT (NUCLEAR), %			N/A
	IN SITU WET DENSITY (NUCLEAR), pcf			N/A
	or			
	OPTIMUM MOISTURE CONTENT, %			12.0
	MAX. DRY DENSITY, pcf			104.1
	95 % MAX. DRY DENSITY, pcf			98.9
9.	SPECIMEN PROPERTIES:			
	COMPACTION MOISTURE CONTENT, %			11.3
	MOISTURE CONTENT AFTER RESILIENT MODULUS TESTING, %			11.3
	COMPACTION DRY DENSITY, γ _d pcf			97.8
10.	QUICK SHEAR TEST			
	STRESS - STRAIN PLOT ATTACHED (Y = YES, N = NO)			Y
	TRIAXIAL SHEAR MAXIMUM STRENGTH (MAX. LOAD/X-SECTION AREA), psi			53.6
	SPECIMEN FAIL DURING TRIAXIAL SHEAR? (Y = YES, N = NO)			Y
11.	COMMENTS (Section 10.4 of Protocol P46)			
	(a) CODE	0	0	0
	(b) NOTE	0	0	0
12.	TEST DATE			08-28-1995

GENERAL REMARKS:

SUBMITTED BY, DATE

RS Boudreau 9/10/95
LABORATORY MANAGER

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study
 LAW PROJECT NO.: 5810860101
 MATERIAL SOURCE: Johnsonville
 MATERIAL DESCRIPTION: Bottom Ash
 REMOLDING TARGETS: 95% Modified Dry Density at Optimum Moisture Content
 MATERIAL TYPE: 2
 TEST DATE: 08-28-1995
 RESILIENT MODULUS TESTING

COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
PARAMETER	Chamber Confining Pressure	Nominal Maximum Axial Stress	Cycle No.	Actual Applied Max. Axial Load	Actual Applied Cyclic Load	Actual Applied Contact Load	Actual Applied Max. Axial Stress	Actual Applied Cyclic Stress	Actual Applied Contact Stress	Recov. Def. LVDT #1 Reading	Recov. Def. LVDT #2 Reading	Average Recov Def. LVDT 1 and 2	Resilient Strain	Resilient Modulus
DESIGNATION	S ₃	S _{cyclic}	C ₁	P _{max}	P _{cyclic}	P _{contact}	S _{max}	S _{cyclic}	S _{contact}	H ₁	H ₂	H _{avg}	ε _r	M _r
UNIT	psi	psi	---	lbs	lbs	lbs	psi	psi	psi	in.	in.	in.	in/in	psi
PRECISION														
SEQUENCE 1	6.0	2.0	1	12.7	11.6	1.1	2.0	1.8	0.2	0.00124	0.00130	0.00127	0.00021	8,800
			2	12.7	11.5	1.1	2.0	1.8	0.2	0.00122	0.00128	0.00125	0.00021	8,876
			3	12.7	11.6	1.1	2.0	1.8	0.2	0.00123	0.00130	0.00126	0.00021	8,833
			4	12.7	11.6	1.1	2.0	1.8	0.2	0.00126	0.00132	0.00129	0.00021	8,662
			5	12.6	11.4	1.2	2.0	1.8	0.2	0.00123	0.00130	0.00127	0.00021	8,667
COLUMN AVERAGE				12.7	11.5	1.1	2.0	1.8	0.2	0.00124	0.00130	0.00127	0.00021	8,767
STANDARD DEV.				0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	98

Source: Johnsonville

Description: Bottom Ash

95% Modified Dry Density at Optimum Moisture Content

SEQUENCE 2	6.0	4.0	1	25.2	23.0	2.2	4.0	3.7	0.4	0.00240	0.00251	0.00245	0.00040	9,019
			2	25.3	23.1	2.2	4.0	3.7	0.3	0.00237	0.00249	0.00243	0.00040	9,158
			3	25.4	23.1	2.3	4.0	3.7	0.4	0.00237	0.00248	0.00242	0.00040	9,176
			4	25.4	23.1	2.3	4.0	3.7	0.4	0.00235	0.00247	0.00241	0.00040	9,231
			5	25.5	23.3	2.2	4.0	3.7	0.4	0.00236	0.00250	0.00243	0.00040	9,231
	COLUMN AVERAGE			25.4	23.1	2.2	4.0	3.7	0.4	0.00237	0.00249	0.00243	0.00040	9,163
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00002	0.00002	0.00002	0.00000	87
SEQUENCE 3	6.0	6.0	1	37.9	34.3	3.6	6.0	5.4	0.6	0.00349	0.00371	0.00360	0.00059	9,166
			2	37.9	34.3	3.6	6.0	5.4	0.6	0.00352	0.00372	0.00362	0.00060	9,097
			3	37.9	34.3	3.6	6.0	5.4	0.6	0.00355	0.00371	0.00363	0.00060	9,100
			4	37.9	34.3	3.6	6.0	5.4	0.6	0.00352	0.00373	0.00362	0.00060	9,107
			5	37.8	34.3	3.5	6.0	5.4	0.6	0.00351	0.00372	0.00361	0.00060	9,131
	COLUMN AVERAGE			37.9	34.3	3.6	6.0	5.4	0.6	0.00352	0.00372	0.00362	0.00060	9,120
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00002	0.00001	0.00001	0.00000	29
SEQUENCE 4	6.0	8.0	1	50.9	46.0	4.8	8.1	7.3	0.8	0.00468	0.00501	0.00484	0.00080	9,141
			2	50.8	46.0	4.9	8.1	7.3	0.8	0.00470	0.00501	0.00485	0.00080	9,109
			3	50.9	46.0	4.8	8.1	7.3	0.8	0.00472	0.00504	0.00488	0.00080	9,073
			4	50.9	46.0	4.9	8.1	7.3	0.8	0.00472	0.00504	0.00488	0.00080	9,075
			5	50.8	46.0	4.8	8.1	7.3	0.8	0.00471	0.00505	0.00488	0.00080	9,074
	COLUMN AVERAGE			50.9	46.0	4.8	8.1	7.3	0.8	0.00470	0.00503	0.00487	0.00080	9,094
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00002	0.00002	0.00002	0.00000	30

Source: Johnsonville		Description: Bottom Ash					95% Modified Dry Density at Optimum Moisture Content							
SEQUENCE 5	6.0	10.0	1	63.8	57.7	6.1	10.1	9.1	1.0	0.00577	0.00623	0.00600	0.00099	9,240
			2	63.8	57.7	6.1	10.1	9.2	1.0	0.00576	0.00625	0.00600	0.00099	9,244
			3	63.8	57.7	6.1	10.1	9.2	1.0	0.00578	0.00627	0.00602	0.00099	9,216
			4	63.8	57.7	6.1	10.1	9.2	1.0	0.00582	0.00629	0.00605	0.00100	9,178
			5	63.8	57.7	6.1	10.1	9.2	1.0	0.00582	0.00626	0.00604	0.00100	9,190
	COLUMN AVERAGE			63.8	57.7	6.1	10.1	9.2	1.0	0.00579	0.00626	0.00602	0.00099	9,214
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00003	0.00002	0.00002	0.00000	30
SEQUENCE 6	4.0	2.0	1	13.3	11.7	1.7	2.1	1.9	0.3	0.00172	0.00200	0.00186	0.00031	6,052
			2	13.3	11.7	1.6	2.1	1.9	0.3	0.00169	0.00200	0.00185	0.00030	6,089
			3	13.3	11.7	1.6	2.1	1.9	0.3	0.00171	0.00199	0.00185	0.00031	6,075
			4	13.3	11.6	1.6	2.1	1.8	0.3	0.00173	0.00198	0.00185	0.00031	6,037
			5	13.2	11.6	1.6	2.1	1.8	0.3	0.00172	0.00199	0.00186	0.00031	5,987
	COLUMN AVERAGE			13.3	11.7	1.6	2.1	1.8	0.3	0.00172	0.00199	0.00185	0.00031	6,048
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00000	0.00000	40
SEQUENCE 7	4.0	4.0	1	25.3	23.1	2.2	4.0	3.7	0.4	0.00336	0.00369	0.00353	0.00058	6,293
			2	25.3	23.0	2.2	4.0	3.7	0.4	0.00335	0.00371	0.00353	0.00058	6,277
			3	25.3	23.1	2.3	4.0	3.7	0.4	0.00336	0.00369	0.00353	0.00058	6,291
			4	25.3	23.0	2.2	4.0	3.7	0.4	0.00334	0.00368	0.00351	0.00058	6,310
			5	25.2	22.9	2.2	4.0	3.6	0.4	0.00333	0.00368	0.00350	0.00058	6,289
	COLUMN AVERAGE			25.3	23.0	2.2	4.0	3.7	0.4	0.00335	0.00369	0.00352	0.00058	6,292
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	12

Source: Johnsonville

Description: Bottom Ash

95% Modified Dry Density at Optimum Moisture Content

SEQUENCE 8	4.0	6.0	1	38.4	35.0	3.4	6.1	5.5	0.5	0.00472	0.00512	0.00492	0.00081	6,837
			2	38.4	34.9	3.5	6.1	5.5	0.6	0.00470	0.00515	0.00492	0.00081	6,827
			3	38.4	34.9	3.4	6.1	5.5	0.5	0.00470	0.00509	0.00490	0.00081	6,866
			4	38.4	34.9	3.5	6.1	5.5	0.6	0.00470	0.00509	0.00490	0.00081	6,848
			5	38.4	34.9	3.5	6.1	5.5	0.6	0.00468	0.00511	0.00490	0.00081	6,867
	COLUMN AVERAGE			38.4	34.9	3.5	6.1	5.5	0.6	0.00470	0.00511	0.00491	0.00081	6,849
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00002	0.00001	0.00000	18
SEQUENCE 9	4.0	8.0	1	51.1	46.3	4.8	8.1	7.3	0.8	0.00582	0.00631	0.00606	0.00100	7,341
			2	51.2	46.5	4.8	8.1	7.4	0.8	0.00580	0.00632	0.00606	0.00100	7,374
			3	51.2	46.3	4.8	8.1	7.3	0.8	0.00582	0.00631	0.00607	0.00100	7,343
			4	51.1	46.3	4.8	8.1	7.4	0.8	0.00582	0.00632	0.00607	0.00100	7,346
			5	51.1	46.3	4.8	8.1	7.3	0.8	0.00582	0.00630	0.00606	0.00100	7,357
	COLUMN AVERAGE			51.1	46.3	4.8	8.1	7.4	0.8	0.00582	0.00631	0.00606	0.00100	7,352
	STANDARD DEV.			0.0	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00000	0.00000	14
SEQUENCE 10	4.0	10.0	1	63.7	57.6	6.1	10.1	9.1	1.0	0.00689	0.00742	0.00715	0.00118	7,754
			2	63.7	57.6	6.1	10.1	9.1	1.0	0.00691	0.00742	0.00717	0.00118	7,730
			3	63.7	57.6	6.1	10.1	9.1	1.0	0.00691	0.00743	0.00717	0.00118	7,728
			4	63.7	57.6	6.1	10.1	9.1	1.0	0.00689	0.00740	0.00715	0.00118	7,759
			5	63.5	57.4	6.1	10.1	9.1	1.0	0.00689	0.00741	0.00715	0.00118	7,727
	COLUMN AVERAGE			63.7	57.6	6.1	10.1	9.1	1.0	0.00690	0.00742	0.00716	0.00118	7,740
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	15

Source: Johnsonville Description: Bottom Ash

95% Modified Dry Density at Optimum Moisture Content

SEQUENCE 11	2.0	2.0	1	13.3	11.2	2.1	2.1	1.8	0.3	0.00215	0.00236	0.00225	0.00037	4,795
			2	13.4	11.3	2.1	2.1	1.8	0.3	0.00216	0.00235	0.00225	0.00037	4,826
			3	13.3	11.3	2.1	2.1	1.8	0.3	0.00214	0.00235	0.00225	0.00037	4,827
			4	13.4	11.3	2.1	2.1	1.8	0.3	0.00216	0.00235	0.00225	0.00037	4,825
			5	13.4	11.4	2.1	2.1	1.8	0.3	0.00217	0.00235	0.00226	0.00037	4,824
	COLUMN AVERAGE			13.4	11.3	2.1	2.1	1.8	0.3	0.00216	0.00235	0.00225	0.00037	4,820
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	13
SEQUENCE 12	2.0	4.0	1	24.7	22.4	2.4	3.9	3.6	0.4	0.00437	0.00468	0.00453	0.00075	4,757
			2	24.8	22.4	2.4	3.9	3.6	0.4	0.00436	0.00467	0.00451	0.00074	4,775
			3	24.8	22.4	2.3	3.9	3.6	0.4	0.00438	0.00469	0.00454	0.00075	4,757
			4	24.7	22.4	2.3	3.9	3.6	0.4	0.00440	0.00468	0.00454	0.00075	4,748
			5	24.8	22.5	2.3	3.9	3.6	0.4	0.00435	0.00466	0.00450	0.00074	4,797
	COLUMN AVERAGE			24.8	22.4	2.4	3.9	3.6	0.4	0.00437	0.00468	0.00452	0.00075	4,767
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00002	0.00001	0.00001	0.00000	19
SEQUENCE 13	2.0	6.0	1	38.4	34.9	3.5	6.1	5.5	0.6	0.00580	0.00623	0.00601	0.00099	5,574
			2	38.3	34.7	3.5	6.1	5.5	0.6	0.00582	0.00623	0.00603	0.00099	5,546
			3	38.5	35.0	3.5	6.1	5.5	0.6	0.00583	0.00624	0.00603	0.00099	5,574
			4	38.4	34.9	3.5	6.1	5.5	0.6	0.00582	0.00623	0.00603	0.00099	5,566
			5	38.3	34.7	3.5	6.1	5.5	0.6	0.00584	0.00623	0.00604	0.00100	5,539
	COLUMN AVERAGE			38.4	34.8	3.5	6.1	5.5	0.6	0.00582	0.00623	0.00603	0.00099	5,560
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00000	0.00001	0.00000	16

FIGURE 1 - Logarithmic Plot of Resilient Modulus (M_R) vs Cyclic Stress (S_C)

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study
 LAW PROJECT NO.: 5810860101
 1. MATERIAL SOURCE: Johnsonville
 2. MATERIAL DESCRIPTION: Bottom Ash
 3. REMOLDING TARGETS: 95% Modified Dry Density at Optimum Moisture Content
 4. MATERIAL TYPE: 2
 5. TEST DATE: 08-28-1995

$$M_R = K_1 (S_C)^{K_2} (1+S_3)^{K_5}$$

$K_1 = \underline{\quad 2,389 \quad}$
 $K_2 = \underline{\quad 0.13323 \quad}$
 $K_5 = \underline{\quad 0.56010 \quad}$
 $R^2 = \underline{\quad 0.89 \quad}$

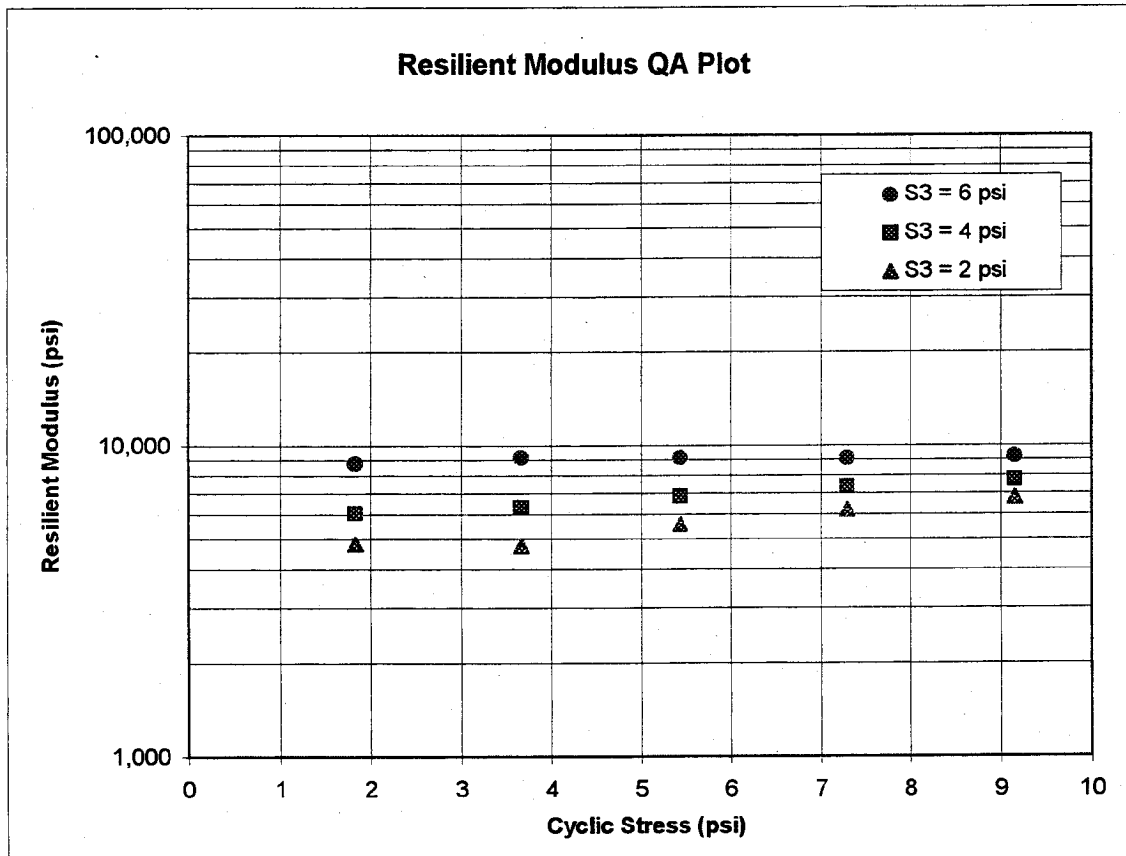


FIGURE 2 - Quick Shear Stress vs Strain

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study
LAW PROJECT NO.: 5810860101
1. MATERIAL SOURCE: Johnsonville
2. MATERIAL DESCRIPTION: Bottom Ash
3. REMOLDING TARGETS: 95% Modified Dry Density at Optimum Moisture Content
4. MATERIAL TYPE: 2
5. TEST DATE: 08-28-1995

