SHAWNEE

Dry Fly Ash
Bottom Ash - From Pond
Spent Bed Material (SBM)
Char

SHAWNEE

Dry Fly Ash

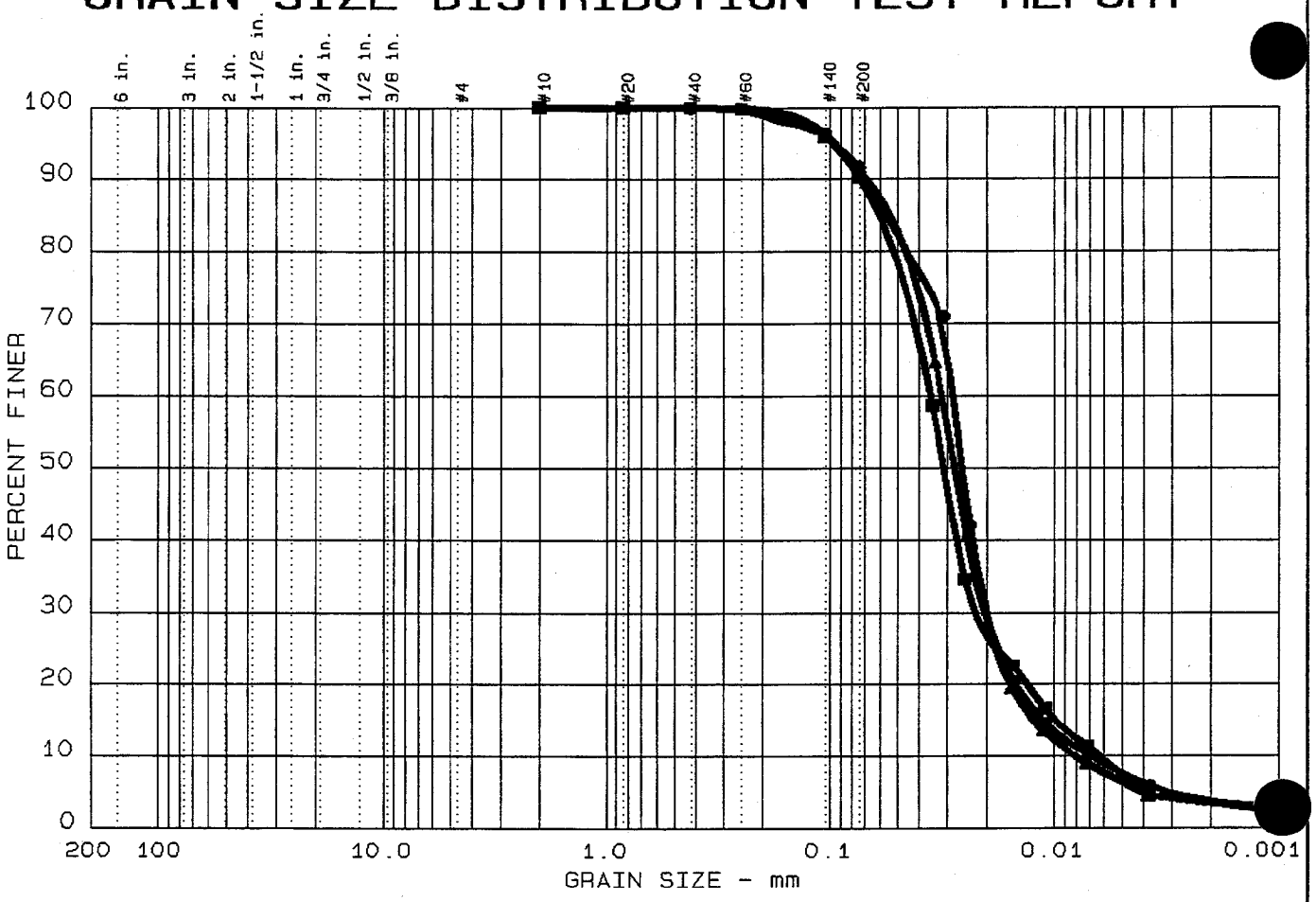
Grain Size Distribution Test Report
Moisture-Density Relationship (Standard Proctor)
Moisture-Density Relationship (Modified Proctor)
Consolidation Test Report
Hydraulic Conductivity - Falling Head (2 Pages)
Triaxial Compression Test (2 Pages)
Direct Shear Test
California Bearing Ratio
Resilient Modulus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

TVA - SHAWNEE
DRY FLY ASH

Description	Test Method	Property	Sample 1	Sample 2	Sample 3
Grain Size	ASTM D 422	Percent Retained on the #4 Sieve Percent Passing the #200 Sieve Percent Passing the 0.005 mm Sieve	0.0 91.6 7.6	0.0 91.2 6.4	0.0 90.1 7.5
Atterberg Limits	ASTM D 4318	Liquid Limit Plastic Limit Plasticity Index	NL NP N/A	NL NP N/A	NL NP N/A
Specific Gravity	ASTM D 854	Specific Gravity at 20°C	2.14	2.09	2.11
Classification	ASTM D 2487 AASHTO M 145	Unified Soil Classification System (USCS) AASHTO Classification	ML A-4(0.0)	ML A-4(0.0)	ML A-4(0.0)
				Composite Sample	
Moisture-Density Relations (Standard Effort)	ASTM D 698	Maximum Dry Density, pcf Optimum Moisture Content, %		72.4 28.3	
Moisture-Density Relations (Modified Effort)	ASTM D 1557	Maximum Dry Density, pcf Optimum Moisture Content, %		77.2 24.4	
			Result	Dry Density, pcf	Moisture Content, %
Consolidation	ASTM D2435	Compression Index C_c	0.04	66.9	28.1
Hydraulic Conductivity	ASTM D 5084	Hydraulic Conductivity, cm/sec	9.2E-5	68.9	27.4
Triaxial Shear Strength Consolidated-Undrained (CU)	ASTM D4767	Effective Stress, Cohesion, c', ksf Effective Stress, Internal Friction Angle, ϕ', degrees	1.24 22.4	68.9	27.5
		Total Stress, Cohesion, c, ksf Total Stress, Internal Friction Angle, ϕ, degrees	1.79 14.7	68.9	27.5
Direct Shear Strength	ASTM D 3080	Cohesion, c, ksf Internal Friction Angle, ϕ, degrees	1.10 39.8	60.1	27.9
California Bearing Ratio	ASTM D 1883	CBR, %	9	68.8	28.2
Resilient Modulus (Standard Compactive Effort)	SHRP P46	Resilient Modulus at 4psi axial stress and 4psi confining pressure	4,222	67.7	27.6
Resilient Modulus (Modified Compactive Effort)	SHRP P46	Resilient Modulus at 4psi axial stress and 4psi confining pressure	4,731	73.9	24.5
Soil Resistivity	AASHTO T 288	Minimum Resistivity, Ohm-cm		1,000	
pH of Soil	AASHTO T 289	pH		11.5	
Water Soluble Sulfate Ion	AASHTO T 290	Sulfate Ion Content, mg/kg		2270	
Water Soluble Chloride Ion	AASHTO T 290	Chloride Ion Content, mg/kg		<10	

shf-fa.xls

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	9	0.0	0.0	8.4	84.0	7.6
▲	10	0.0	0.0	8.8	84.8	6.4
■	11	0.0	0.0	9.9	82.6	7.5

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NL	NP			0.03	0.020	0.0112	0.0068	2.06	4.1
▲	NL	NP			0.03	0.020	0.0123	0.0079	1.66	4.0
■	NL	NP			0.03	0.022	0.0099	0.0062	2.28	5.7

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

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

GRAIN SIZE DISTRIBUTION TEST REPORT

LAW ENGINEERING, INC.

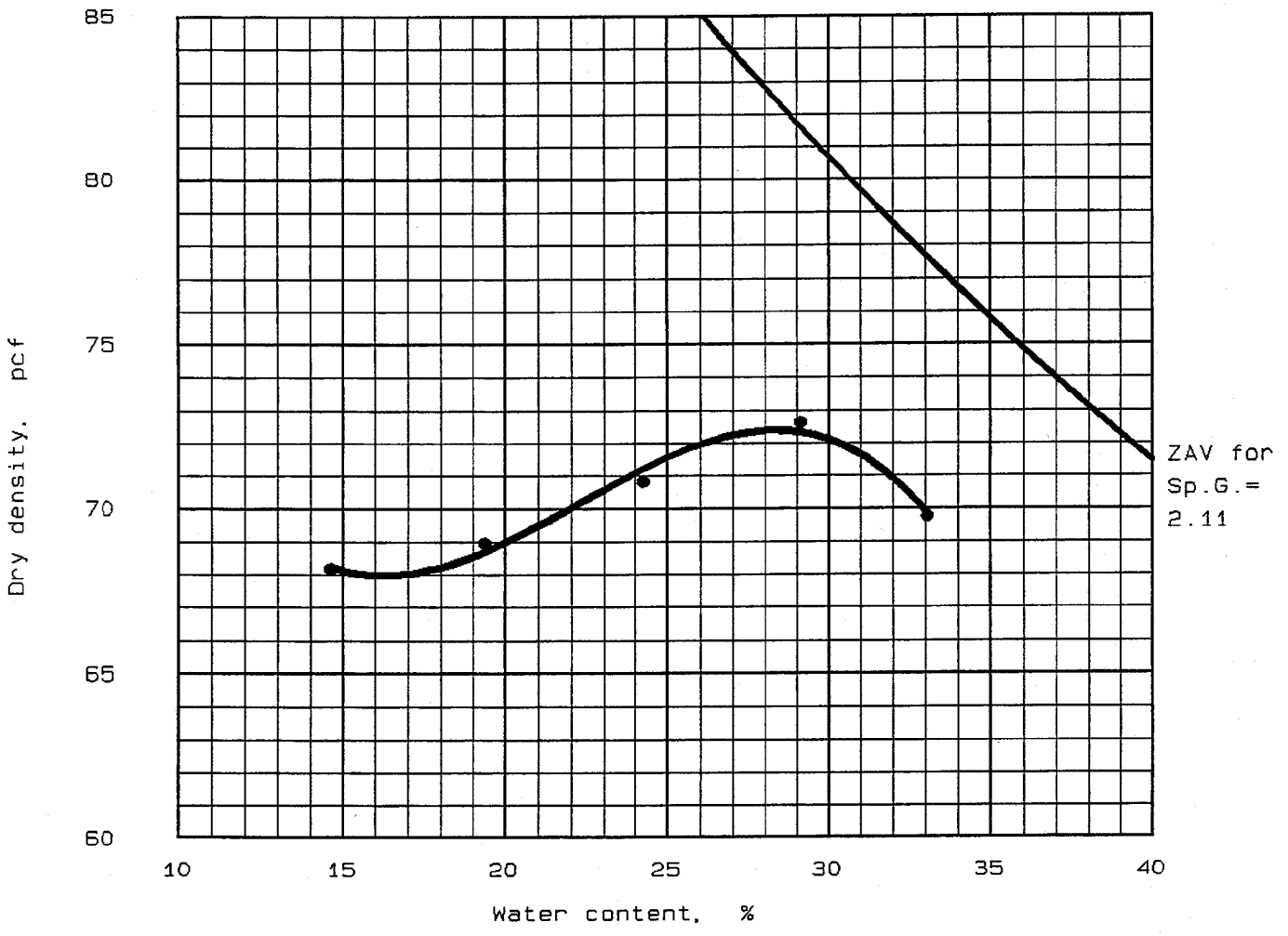
Remarks:

Tested by: JCR

Reviewed by: HS

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	A-4(0.0)	0.14 %	2.11	NL	NP	0 %	91.0 %

TEST RESULTS	MATERIAL DESCRIPTION
Optimum moisture = 28.3 % Maximum dry density = 72.4 pcf	

Project No.: 5810860101
Project: TVA - Shawnee
Location: Dry Fly Ash

Date: July 25, 1995

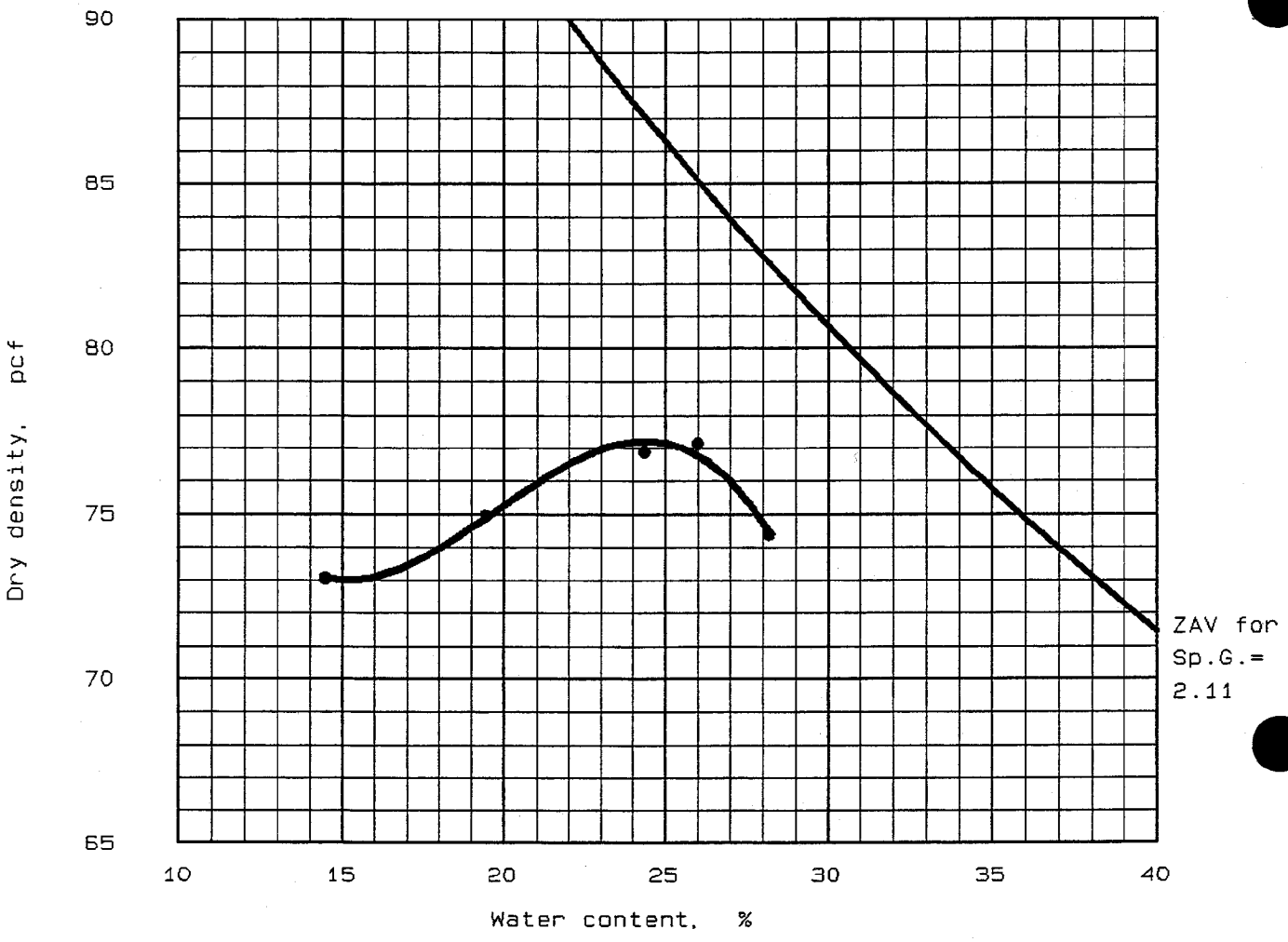
Remarks:
Tested by: JCR
Reviewed by: REB

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)	0.14 %	2.11	NL	NP	0 %	91.0 %

TEST RESULTS	MATERIAL DESCRIPTION
Optimum moisture = 24.4 % Maximum dry density = 77.2 pcf	

Project No.: 5810860101
Project: TVA - Shawnee
Location: Dry Fly Ash

Date: July 25, 1995

Remarks:

Tested by: JCR

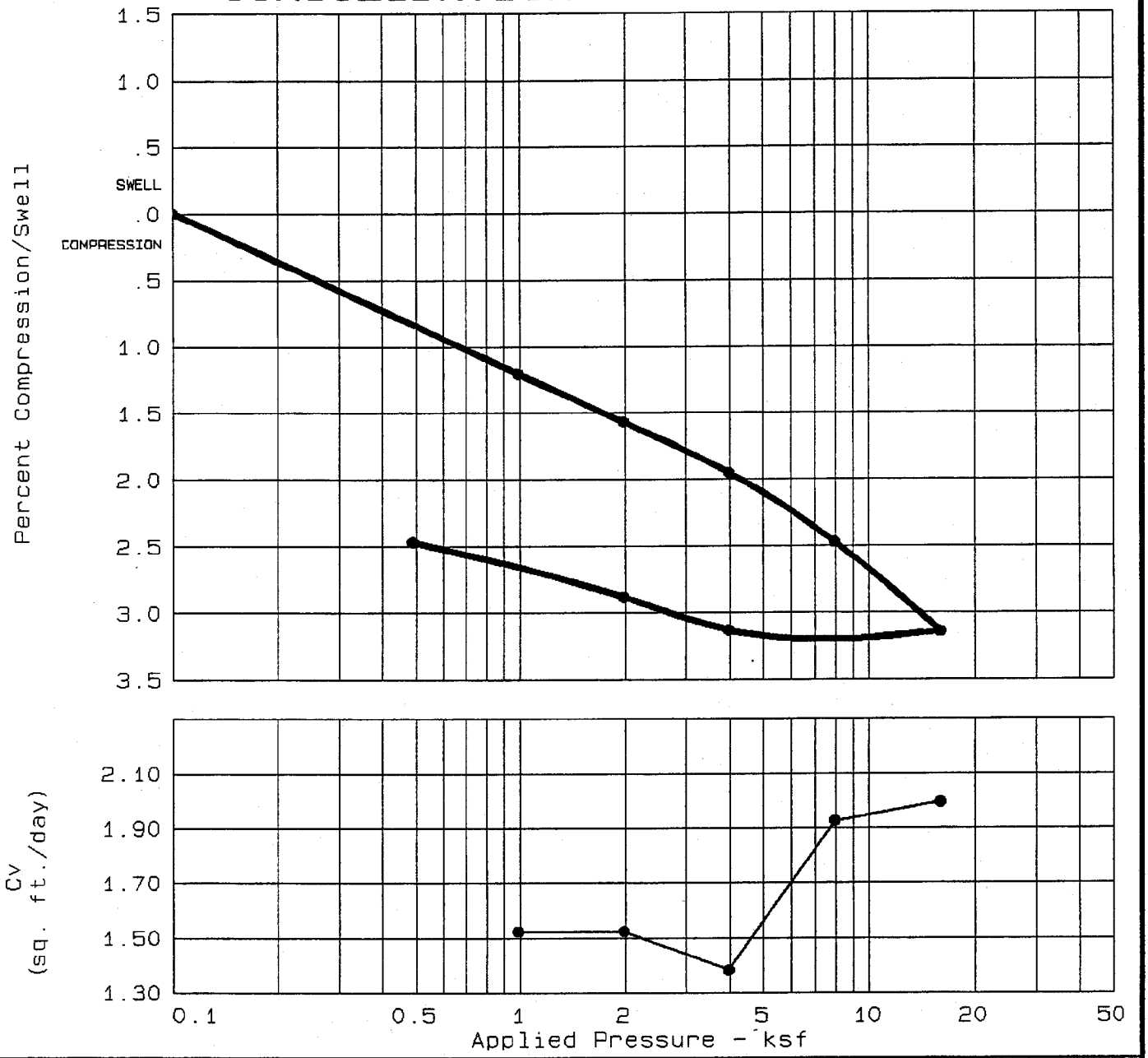
Reviewed by: RWB

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
63.5 %	28.1	66.9	NL	NP	2.113	7.27	0.04	0.9342

TEST RESULTS	MATERIAL DESCRIPTION
Compression Index = 0.04	
Project No.: 5810860101 Project: TVA - Shawnee Location: Dry Fly Ash Date: July 25, 1995	Class: USCS: ML Remarks: Tested by: ASK Reviewed by: HS
CONSOLIDATION TEST REPORT LAW ENGINEERING, INC.	Fig. No. _____

HYDRAULIC CONDUCTIVITY

LAW ENGINEERING

Project No.	*5810860101*	Tested By	*HEJ*
Project Name	*TVA - Shawnee*	Test Date	*07/22/95*
Material (Source)	*Dry Fly Ash*	Reviewed By	*RLB*
		Review Date	*09/06/95*

ASTM D5084 - Falling Head

Sample Type:	*Remolded*
Sample Orientation:	*Vertical*
Initial Water Content, %:	*27.4*
Wet Unit Weight, pcf:	*87.8*
Dry Unit Weight, pcf:	*68.9*
Compaction, %:	*95.2*
Hydraulic Conductivity, cm/sec. @20 °C:	***9.2E-05***

PERMEABILITY TEST - FALLING HEAD
(ASTM D5084 - 90)

LAW ENGINEERING

Job Number	5810860101	Tested By	HEJ
Project Name	TVA - Shawnee	Test Date	07/22/95
Material (Source)	Dry Fly Ash	Reviewed By	RLB
		Review Date	09/06/95

Sample Data

Length, in		Diameter, in		Pan No.	
Location 1	6.000	Location 1	2.830	Dry Soil+Pan, grams	682.79
Location 2	6.000	Location 2	2.830	Pan Weight, grams	0.00
Location3	6.000	Location 3	2.830		
Average	6.000	Average	2.830	Moisture Content, %	27.4
		Wet Soil + Tare, grams	870.15	Wet Unit Wt, pcf	87.8
		Tare Weight, grams	0.00	Dry Unit Wt, pcf	68.9

Chamber Pressure, psi	37
Back Pressure, psi	23
Confining Pressure, psi	14

Date Start	Date Finish	Time Start	Time Finish	Time (sec)	Division Start	Division Finish	H0 (cm)	Hf (cm)	k cm/sec	Temp (°C)	k cm/sec at 20 °C
				1074	50.0	0.0	92.16	42.16	9.3E-05	21	9.1E-05
				1065	50.0	0.0	92.16	42.16	9.4E-05	21	9.2E-05
				1067	50.0	0.0	92.16	42.16	9.4E-05	21	9.2E-05

No. of Trial	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
3	Remolded	72.4	95.2	Vertical

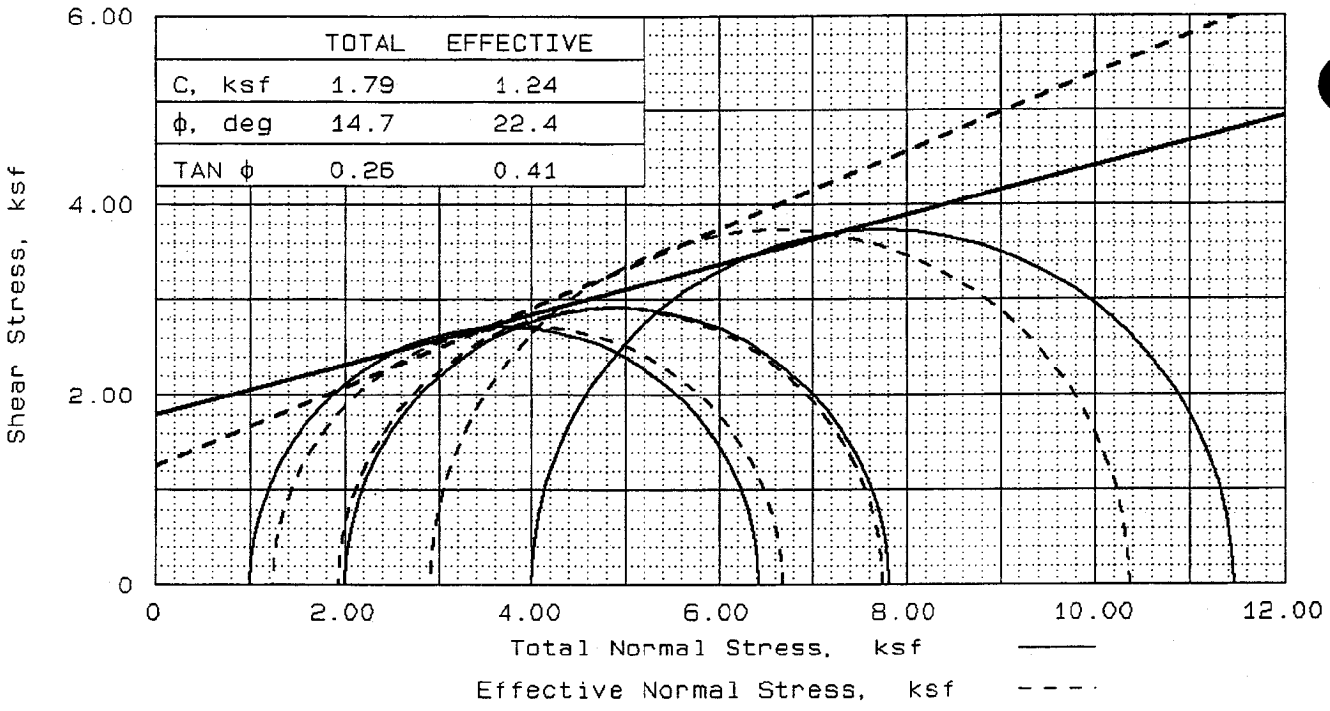
Avg. k at 20 °C 9.2E-05 cm/sec

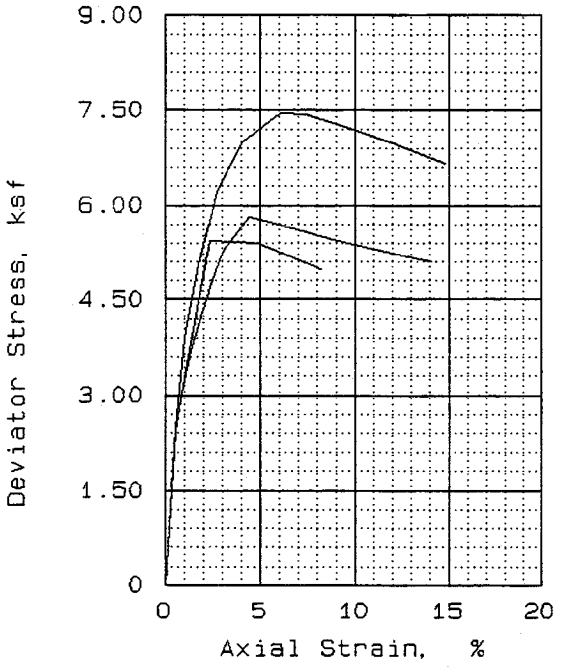
a = area of burette in cm²
L = length of sample in cm
A = area of sample in cm²

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

a = 0.34 cm²
A = 40.582 cm²
L = 15.24 cm

TVA-00012416





SAMPLE NO.		1	2	3
INITIAL	WATER CONTENT, %	27.6	27.4	27.4
	DRY DENSITY, pcf	68.8	68.9	69.0
	SATURATION, %	63.7	63.5	63.6
	VOID RATIO	0.915	0.911	0.910
	DIAMETER, in	2.83	2.83	2.83
	HEIGHT, in	6.00	6.00	6.00
AT TEST	WATER CONTENT, %	40.8	41.6	42.3
	DRY DENSITY, pcf	70.8	70.2	69.6
	SATURATION, %	100.0	100.0	100.0
	VOID RATIO	0.861	0.878	0.893
	DIAMETER, in	2.80	2.81	2.82
	HEIGHT, in	5.96	5.97	5.99
BACK PRESSURE, ksf		3.28	3.27	3.28
CELL PRESSURE, ksf		7.29	5.27	4.28
FAILURE STRESS, ksf		7.45	5.82	5.44
PORE PRESSURE, ksf		4.38	3.34	3.04
STRAIN RATE, %/min.		0.100	0.100	0.100
ULTIMATE STRESS, ksf				
PORE PRESSURE, ksf				
$\bar{\sigma}_1$ FAILURE, ksf		10.36	7.75	6.68
$\bar{\sigma}_3$ FAILURE, ksf		2.91	1.93	1.24

TYPE OF TEST:
CU with pore pressures
SAMPLE TYPE: Remolded
DESCRIPTION:

LL= NL PL= NP PI=
SPECIFIC GRAVITY= 2.11
REMARKS: Tested by: HS

Reviewed by: RWB

FIG. NO.

CLIENT:

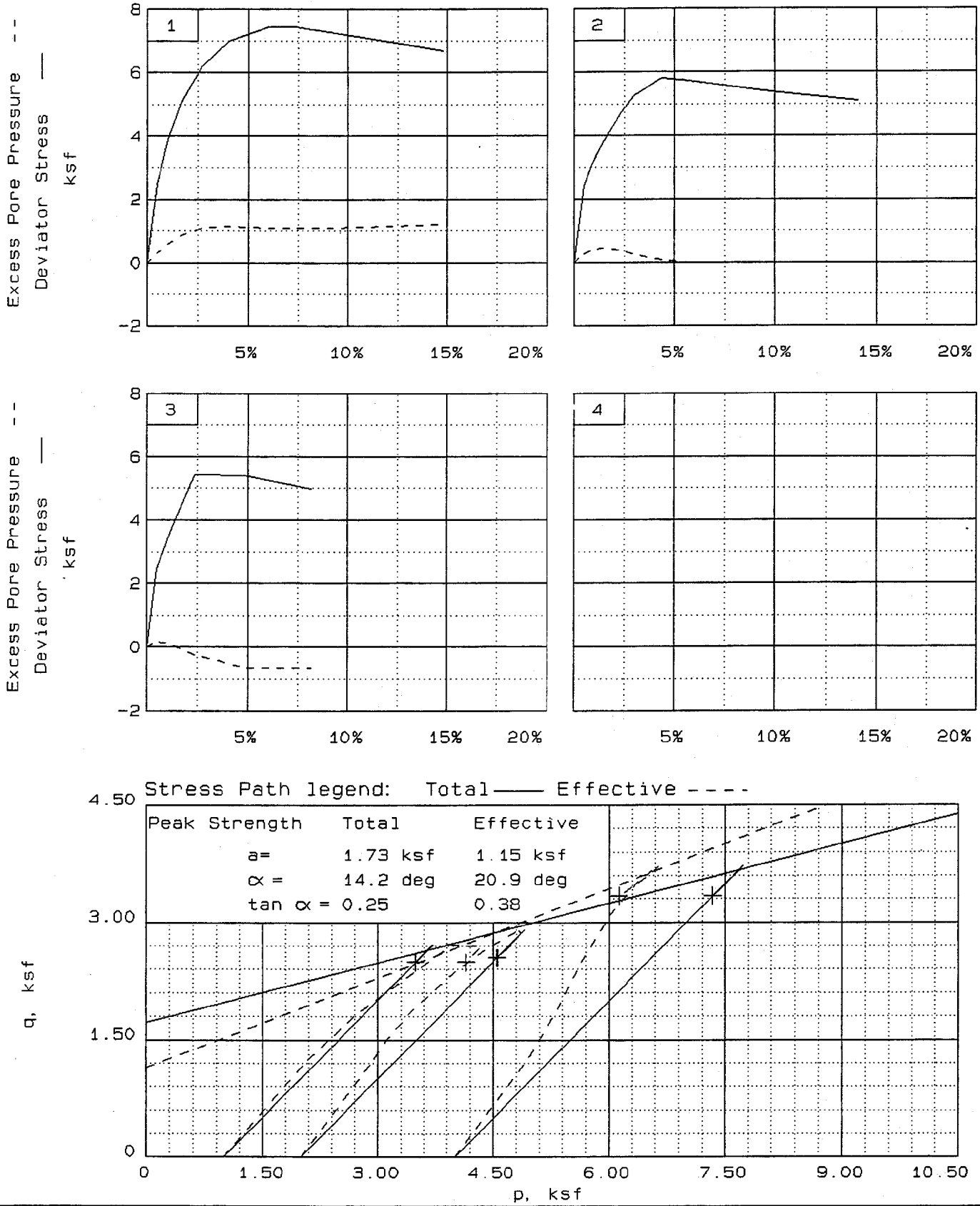
PROJECT: TVA - Shawnee

SAMPLE LOCATION: Dry Fly Ash

PROJ. NO.: 5810860101 DATE: August 23, 1995

TRIAXIAL COMPRESSION TEST

LAW ENGINEERING, INC.

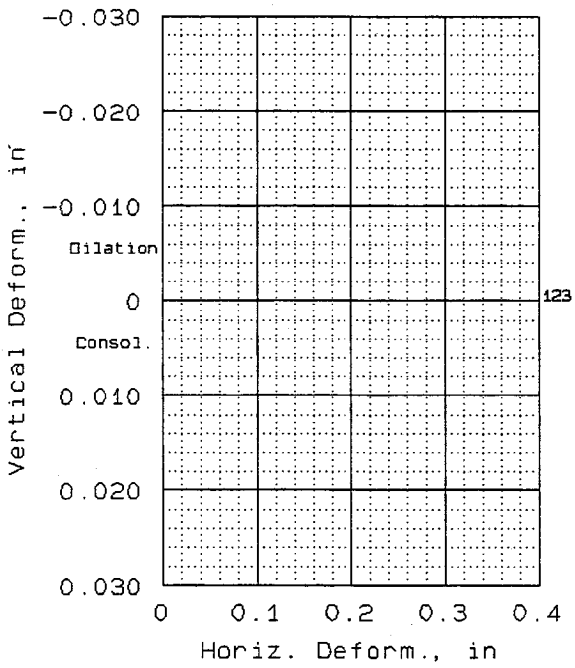


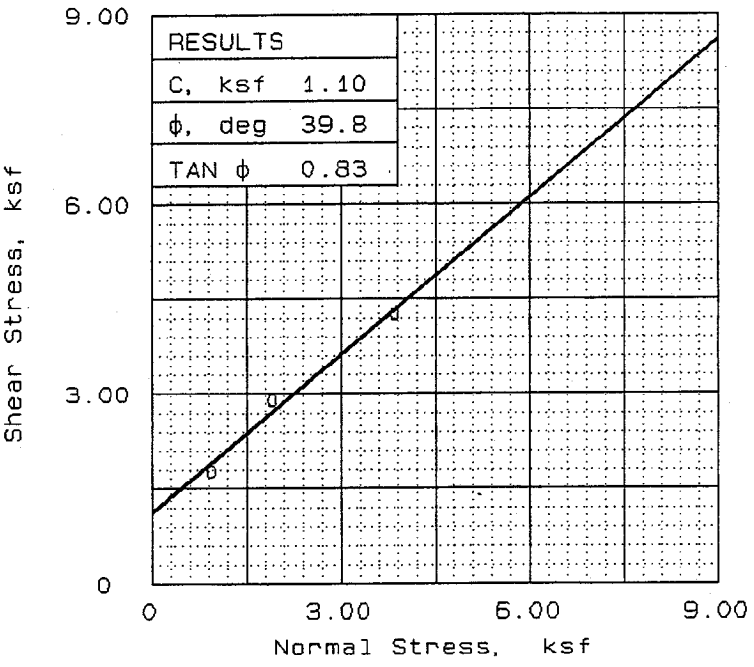
Client:

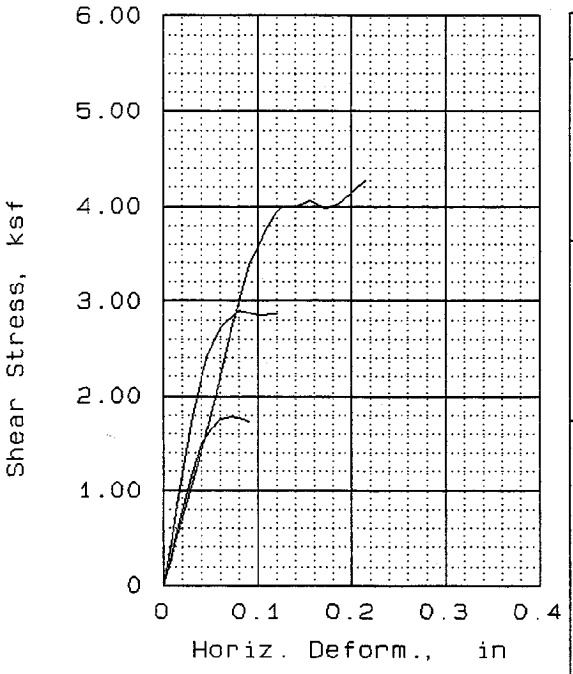
Project: TVA - Shawnee

Location: Dry Fly Ash

File: 8601J Project No.: 5810860101 Page 2/2 Fig. No. ____







SAMPLE NO.		1	2	3
INITIAL	WATER CONTENT, %	27.7	28.0	28.0
	DRY DENSITY, pcf	59.8	59.8	60.7
	SATURATION, %	48.6	49.0	50.6
	VOID RATIO	1.202	1.204	1.170
	DIAMETER, in	2.50	2.50	2.50
	HEIGHT, in	0.81	0.81	0.81
AT TEST	WATER CONTENT, %	27.7	28.0	28.0
	DRY DENSITY, pcf	59.8	59.8	60.7
	SATURATION, %	48.6	49.0	50.6
	VOID RATIO	1.202	1.204	1.170
	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		1.78	2.91	4.27
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= 2.11

REMARKS: Tested by: HJ

Reviewed by: RWB

FIG. NO.

CLIENT:

PROJECT: TVA - Shawnee

SAMPLE LOCATION: Dry Fly Ash

PROJ. NO.: 5810860101 DATE: 9/5/95

DIRECT SHEAR TEST

LAW ENGINEERING, INC.

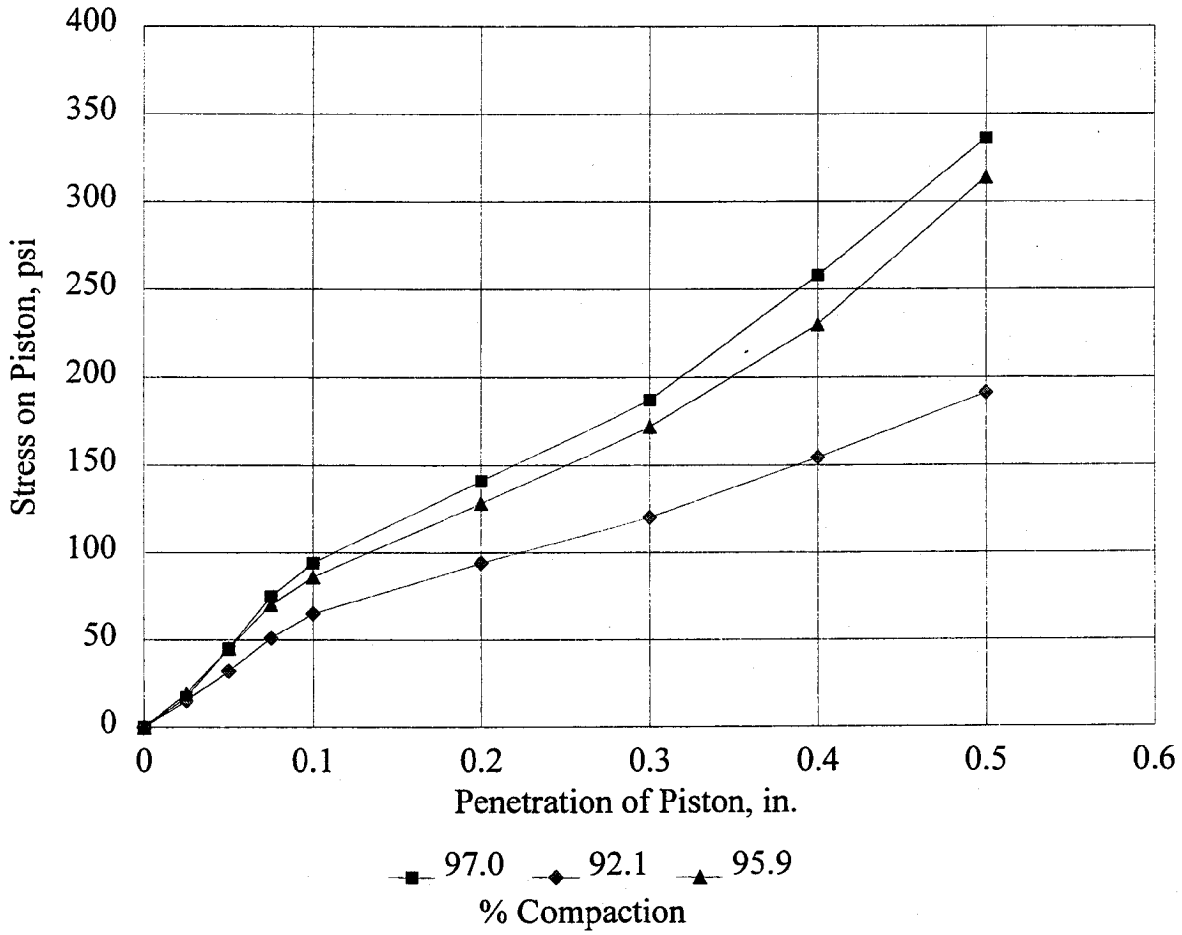
California Bearing Ratio

(ASTM D1883-92)

LAW ENGINEERING

Project No.	5810860101	**Tested By**	EM
Project Name	TVA - Shawnee	**Test Date**	08/08/95
Material (Source)	Dry Fly Ash	**Reviewed By**	RLB
		Review Date	08/30/95

Compaction, %	97.0	92.1	95.9
Before Soak Dry Density, pcf	70.2	66.7	69.5
Before Soak Moisture Content,	28.6	27.4	28.6
After Soak Dry Density, pcf	68.0	64.2	67.1
After Soak Moisture Content, %	43.9	47.2	45.2
CBR @ 0.1 in.	9.4	6.5	8.6
CBR @ 0.2 in.	9.4	6.3	8.5



LABORATORY MATERIAL HANDLING AND TESTING SHEET NO 1 OF 2

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:*	Shawnee
2.	*MATERIAL DESCRIPTION:*	Dry Fly Ash
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	2.86
	MIDDLE	2.86
	BOTTOM	2.86
	AVERAGE	2.86
	MEMBRANE THICKNESS (1), inch	0.01
	MEMBRANE THICKNESS (2), inch	0.01
	NET DIAM., inch	2.84
	HEIGHT OF SPECIMEN, CAP AND BASE, inch	6.17
	HEIGHT OF CAP AND BASE, inch	0.00
	INITIAL LENGTH, L_0, inch	6.17
	INITIAL AREA, A_0, in^2	6.32
	INITIAL VOLUME A_0L_0, in^3	39.05
7.	*SOIL SPECIMEN WEIGHT*:	
	INITIAL WEIGHT OF CONTAINER AND WET SOIL, grams	885.70
	FINAL WEIGHT OF CONTAINER AND WET SOIL, grams	0.00
	WEIGHT OF WET SOIL USED, grams	885.70
8.	*SOIL PROPERTIES*.:	
	IN SITU MOISTURE CONTENT (NUCLEAR), %	N/A
	IN SITU WET DENSITY (NUCLEAR), pcf	N/A
	or	
	OPTIMUM MOISTURE CONTENT, %	28.3
	MAX. DRY DENSITY, pcf	72.4
	95 % MAX. DRY DENSITY, pcf	68.8
9.	*SPECIMEN PROPERTIES:*	
	COMPACTION MOISTURE CONTENT, %	27.6
	MOISTURE CONTENT AFTER RESILIENT MODULUS TESTING, %	27.7
	COMPACTION DRY DENSITY, γ_d pcf	67.7
10.	*QUICK SHEAR TEST*	
	STRESS - STRAIN PLOT ATTACHED (Y = YES, N = NO)	Y
	TRIAXIAL SHEAR MAXIMUM STRENGTH (MAX. LOAD/X-SECTION AREA), psi	32.5
	SPECIMEN FAIL DURING TRIAXIAL SHEAR? (Y = YES, N = NO)	Y
11.	*COMMENTS* (Section 10.4 of Protocol P46)	
	(a) *CODE*	0 0 0 0 0 0
	(b) *NOTE*	
12.	*TEST DATE*	07-06-1995

GENERAL REMARKS:

SUBMITTED BY, DATE

R S Boudreau 9/6/95

LABORATORY MANAGER

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study
LAW PROJECT NO.: 5810860101
1. *MATERIAL SOURCE:* Shawnee
2. *MATERIAL DESCRIPTION:* Dry Fly Ash
3. *REMOLDING TARGETS:* 95% Standard Dry Density at Optimum Moisture Content
4. *MATERIAL TYPE* 2
5. *TEST DATE* 07-06-1995
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	11.6	1.3	2.0	1.8	0.2	0.00186	0.00188	0.00187	0.00030	6,039
			2	12.8	11.6	1.2	2.0	1.8	0.2	0.00187	0.00189	0.00188	0.00030	6,016
			3	12.8	11.6	1.2	2.0	1.8	0.2	0.00188	0.00189	0.00188	0.00031	6,016
			4	12.8	11.6	1.2	2.0	1.8	0.2	0.00189	0.00192	0.00191	0.00031	5,914
			5	12.9	11.6	1.2	2.0	1.8	0.2	0.00190	0.00190	0.00190	0.00031	5,956
	COLUMN AVERAGE			12.8	11.6	1.2	2.0	1.8	0.2	0.00188	0.00190	0.00189	0.00031	5,988
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00002	0.00001	0.00002	0.00000	51

Source: Shawnee Description: Dry Fly Ash 95% Standard Dry Density at Optimum Moisture Content

SEQUENCE 2	6.0	4.0	1	25.4	23.0	2.4	4.0	3.6	0.4	0.00398	0.00399	0.00398	0.00065	5,637
			2	25.3	22.9	2.4	4.0	3.6	0.4	0.00399	0.00398	0.00399	0.00065	5,618
			3	25.4	23.0	2.4	4.0	3.6	0.4	0.00399	0.00399	0.00399	0.00065	5,623
			4	25.3	22.9	2.4	4.0	3.6	0.4	0.00398	0.00399	0.00398	0.00065	5,615
			5	25.3	22.9	2.4	4.0	3.6	0.4	0.00398	0.00399	0.00398	0.00065	5,604
	COLUMN AVERAGE			25.3	22.9	2.4	4.0	3.6	0.4	0.00398	0.00399	0.00398	0.00065	5,619
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00000	0.00000	0.00000	12
SEQUENCE 3	6.0	6.0	1	38.0	34.4	3.7	6.0	5.4	0.6	0.00634	0.00633	0.00633	0.00103	5,297
			2	38.1	34.4	3.7	6.0	5.4	0.6	0.00627	0.00630	0.00629	0.00102	5,347
			3	38.1	34.4	3.7	6.0	5.4	0.6	0.00632	0.00634	0.00633	0.00103	5,312
			4	38.2	34.5	3.7	6.0	5.5	0.6	0.00632	0.00633	0.00632	0.00102	5,325
			5	38.2	34.5	3.7	6.0	5.5	0.6	0.00630	0.00632	0.00631	0.00102	5,345
	COLUMN AVERAGE			38.1	34.5	3.7	6.0	5.4	0.6	0.00631	0.00633	0.00632	0.00102	5,325
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00002	0.00001	0.00002	0.00000	21
SEQUENCE 4	6.0	8.0	1	51.1	46.1	5.0	8.1	7.3	0.8	0.00856	0.00858	0.00857	0.00139	5,256
			2	51.1	46.1	4.9	8.1	7.3	0.8	0.00856	0.00857	0.00857	0.00139	5,257
			3	51.1	46.1	4.9	8.1	7.3	0.8	0.00858	0.00860	0.00859	0.00139	5,245
			4	51.0	46.1	4.9	8.1	7.3	0.8	0.00857	0.00859	0.00858	0.00139	5,241
			5	51.0	46.1	4.9	8.1	7.3	0.8	0.00857	0.00859	0.00858	0.00139	5,242
	COLUMN AVERAGE			51.1	46.1	4.9	8.1	7.3	0.8	0.00857	0.00859	0.00858	0.00139	5,248
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	8

Source: Shawnee Description: Dry Fly Ash 95% Standard Dry Density at Optimum Moisture Content

SEQUENCE 5	6.0	10.0	1	63.7	57.5	6.2	10.1	9.1	1.0	0.01058	0.01060	0.01059	0.00172	5,304
			2	63.8	57.6	6.2	10.1	9.1	1.0	0.01058	0.01061	0.01059	0.00172	5,305
			3	63.8	57.6	6.2	10.1	9.1	1.0	0.01063	0.01065	0.01064	0.00172	5,284
			4	63.8	57.6	6.2	10.1	9.1	1.0	0.01058	0.01058	0.01058	0.00171	5,317
			5	63.8	57.6	6.2	10.1	9.1	1.0	0.01059	0.01060	0.01059	0.00172	5,312
	COLUMN AVERAGE			63.8	57.6	6.2	10.1	9.1	1.0	0.01059	0.01061	0.01060	0.00172	5,304
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00002	0.00002	0.00002	0.00000	13
SEQUENCE 6	4.0	2.0	1	13.1	11.4	1.7	2.1	1.8	0.3	0.00227	0.00231	0.00229	0.00037	4,863
			2	13.1	11.4	1.7	2.1	1.8	0.3	0.00226	0.00229	0.00227	0.00037	4,904
			3	13.1	11.4	1.7	2.1	1.8	0.3	0.00223	0.00228	0.00225	0.00037	4,936
			4	13.1	11.4	1.7	2.1	1.8	0.3	0.00226	0.00229	0.00228	0.00037	4,895
			5	13.0	11.4	1.7	2.1	1.8	0.3	0.00226	0.00230	0.00228	0.00037	4,867
	COLUMN AVERAGE			13.1	11.4	1.7	2.1	1.8	0.3	0.00226	0.00229	0.00228	0.00037	4,893
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00002	0.00001	0.00001	0.00000	30
SEQUENCE 7	4.0	4.0	1	25.4	23.0	2.4	4.0	3.6	0.4	0.00508	0.00511	0.00510	0.00083	4,404
			2	25.3	22.9	2.4	4.0	3.6	0.4	0.00507	0.00511	0.00509	0.00082	4,398
			3	25.4	23.0	2.4	4.0	3.6	0.4	0.00510	0.00512	0.00511	0.00083	4,385
			4	25.3	22.9	2.4	4.0	3.6	0.4	0.00507	0.00510	0.00509	0.00082	4,402
			5	25.4	23.0	2.4	4.0	3.6	0.4	0.00508	0.00512	0.00510	0.00083	4,403
	COLUMN AVERAGE			25.3	23.0	2.4	4.0	3.6	0.4	0.00508	0.00511	0.00510	0.00083	4,398
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	8

Source: Shawnee Description: Dry Fly Ash 95% Standard Dry Density at Optimum Moisture Content

SEQUENCE 8	4.0	6.0	1	38.2	34.7	3.4	6.0	5.5	0.5	0.00790	0.00794	0.00792	0.00128	4,283
			2	38.1	34.7	3.4	6.0	5.5	0.5	0.00788	0.00792	0.00790	0.00128	4,290
			3	38.1	34.7	3.4	6.0	5.5	0.5	0.00785	0.00787	0.00786	0.00127	4,306
			4	37.9	34.5	3.4	6.0	5.5	0.5	0.00787	0.00789	0.00788	0.00128	4,279
			5	38.0	34.6	3.5	6.0	5.5	0.5	0.00787	0.00790	0.00789	0.00128	4,279
	COLUMN AVERAGE			38.1	34.6	3.4	6.0	5.5	0.5	0.00787	0.00790	0.00789	0.00128	4,287
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00002	0.00003	0.00002	0.00000	11
SEQUENCE 9	4.0	8.0	1	50.9	46.0	4.9	8.0	7.3	0.8	0.01018	0.01022	0.01020	0.00165	4,404
			2	51.0	46.1	4.9	8.1	7.3	0.8	0.01022	0.01025	0.01024	0.00166	4,397
			3	51.0	46.1	4.9	8.1	7.3	0.8	0.01020	0.01022	0.01021	0.00165	4,412
			4	50.9	46.1	4.9	8.1	7.3	0.8	0.01022	0.01025	0.01024	0.00166	4,395
			5	51.0	46.1	4.9	8.1	7.3	0.8	0.01019	0.01023	0.01021	0.00165	4,410
	COLUMN AVERAGE			50.9	46.1	4.9	8.1	7.3	0.8	0.01020	0.01023	0.01022	0.00165	4,403
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00002	0.00002	0.00002	0.00000	8
SEQUENCE 10	4.0	10.0	1	63.9	57.7	6.2	10.1	9.1	1.0	0.01222	0.01223	0.01222	0.00198	4,611
			2	63.9	57.8	6.2	10.1	9.1	1.0	0.01222	0.01222	0.01222	0.00198	4,616
			3	63.8	57.7	6.1	10.1	9.1	1.0	0.01223	0.01225	0.01224	0.00198	4,599
			4	63.8	57.6	6.2	10.1	9.1	1.0	0.01221	0.01222	0.01221	0.00198	4,608
			5	63.8	57.7	6.2	10.1	9.1	1.0	0.01224	0.01221	0.01222	0.00198	4,604
	COLUMN AVERAGE			63.9	57.7	6.2	10.1	9.1	1.0	0.01222	0.01223	0.01222	0.00198	4,608
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00002	0.00001	0.00000	6

Source: Shawnee Description: Dry Fly Ash 95% Standard Dry Density at Optimum Moisture Content

SEQUENCE 11	2.0	2.0	1	13.6	11.5	2.0	2.1	1.8	0.3	0.00284	0.00287	0.00285	0.00046	3,942
			2	13.6	11.5	2.0	2.1	1.8	0.3	0.00281	0.00285	0.00283	0.00046	3,980
			3	13.5	11.4	2.0	2.1	1.8	0.3	0.00283	0.00287	0.00285	0.00046	3,914
			4	13.5	11.5	2.1	2.1	1.8	0.3	0.00282	0.00287	0.00285	0.00046	3,935
			5	13.5	11.5	2.0	2.1	1.8	0.3	0.00279	0.00284	0.00282	0.00046	3,973
	COLUMN AVERAGE			13.5	11.5	2.0	2.1	1.8	0.3	0.00282	0.00286	0.00284	0.00046	3,949
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00002	0.00001	0.00002	0.00000	27
SEQUENCE 12	2.0	4.0	1	25.0	22.6	2.4	3.9	3.6	0.4	0.00634	0.00639	0.00636	0.00103	3,464
			2	25.0	22.6	2.4	3.9	3.6	0.4	0.00636	0.00641	0.00638	0.00103	3,449
			3	25.0	22.6	2.4	3.9	3.6	0.4	0.00634	0.00640	0.00637	0.00103	3,459
			4	25.0	22.6	2.4	4.0	3.6	0.4	0.00636	0.00641	0.00638	0.00103	3,462
			5	25.0	22.6	2.4	4.0	3.6	0.4	0.00637	0.00642	0.00640	0.00104	3,450
	COLUMN AVERAGE			25.0	22.6	2.4	3.9	3.6	0.4	0.00635	0.00641	0.00638	0.00103	3,457
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00002	0.00001	0.00001	0.00000	7
SEQUENCE 13	2.0	6.0	1	38.0	34.4	3.7	6.0	5.4	0.6	0.00957	0.00960	0.00959	0.00155	3,501
			2	38.0	34.4	3.6	6.0	5.4	0.6	0.00952	0.00958	0.00955	0.00155	3,514
			3	37.9	34.3	3.7	6.0	5.4	0.6	0.00956	0.00960	0.00958	0.00155	3,493
			4	38.0	34.3	3.6	6.0	5.4	0.6	0.00953	0.00960	0.00956	0.00155	3,506
			5	38.1	34.4	3.7	6.0	5.4	0.6	0.00953	0.00956	0.00954	0.00155	3,519
	COLUMN AVERAGE			38.0	34.4	3.7	6.0	5.4	0.6	0.00954	0.00959	0.00957	0.00155	3,507
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00002	0.00002	0.00002	0.00000	10

Source: Shawnee Description: Dry Fly Ash 95% Standard Dry Density at Optimum Moisture Content

SEQUENCE 14	2.0	8.0	1	51.0	46.1	4.9	8.1	7.3	0.8	0.01201	0.01206	0.01204	0.00195	3,736
			2	51.0	46.1	4.9	8.1	7.3	0.8	0.01198	0.01201	0.01200	0.00194	3,753
			3	51.0	46.1	4.9	8.1	7.3	0.8	0.01201	0.01203	0.01202	0.00195	3,743
			4	51.0	46.1	4.9	8.1	7.3	0.8	0.01200	0.01205	0.01203	0.00195	3,744
			5	51.1	46.1	4.9	8.1	7.3	0.8	0.01197	0.01200	0.01199	0.00194	3,759
	COLUMN AVERAGE			51.0	46.1	4.9	8.1	7.3	0.8	0.01200	0.01203	0.01201	0.00195	3,747
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00002	0.00003	0.00002	0.00000	9
SEQUENCE 15	2.0	10.0	1	63.6	57.5	6.2	10.1	9.1	1.0	0.01415	0.01419	0.01417	0.00229	3,959
			2	63.6	57.4	6.2	10.1	9.1	1.0	0.01418	0.01421	0.01420	0.00230	3,950
			3	63.6	57.4	6.2	10.1	9.1	1.0	0.01415	0.01420	0.01418	0.00230	3,955
			4	63.7	57.5	6.2	10.1	9.1	1.0	0.01415	0.01417	0.01416	0.00229	3,962
			5	63.7	57.5	6.2	10.1	9.1	1.0	0.01411	0.01415	0.01413	0.00229	3,973
	COLUMN AVERAGE			63.6	57.5	6.2	10.1	9.1	1.0	0.01415	0.01418	0.01417	0.00229	3,960
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00003	0.00003	0.00003	0.00000	9

SUBMITTED BY, DATE

RJ Boudreau 9/6/95

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:*	Shawnee
2.	*MATERIAL DESCRIPTION:*	Dry Fly Ash
3.	*REMOLDING TARGETS:*	95% Standard Dry Density at Optimum Moisture Content
4.	*MATERIAL TYPE*	2
5.	*TEST DATE*	07-06-1995

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

K1 =	2,390
K2 =	-0.04340
K5 =	0.45385
R^2 =	0.91

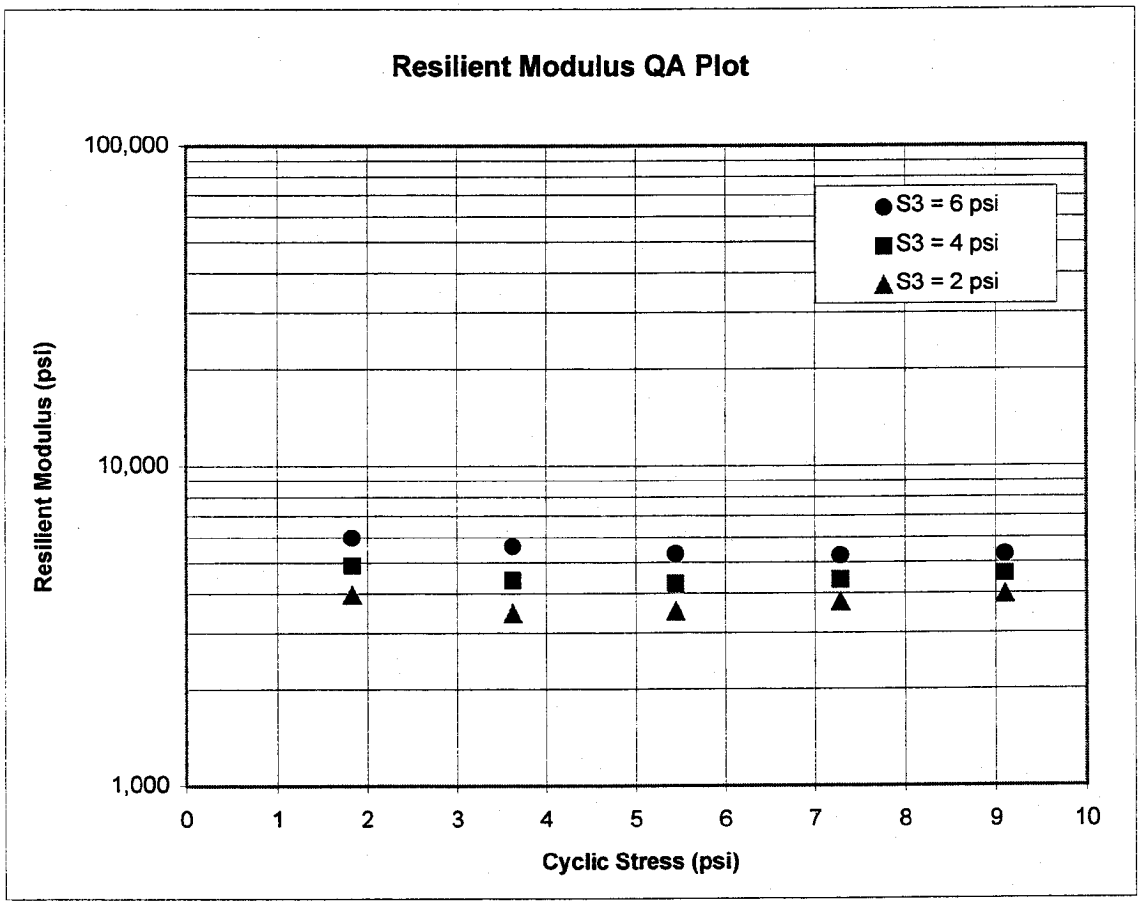
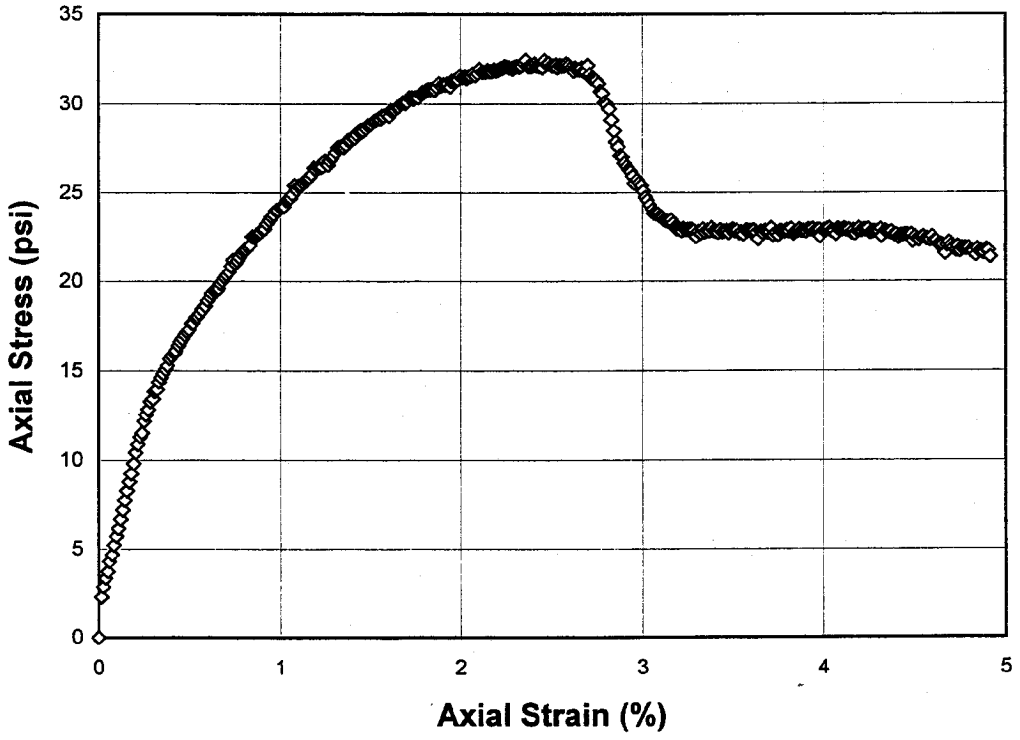


FIGURE 2 - Quick Shear Stress vs Strain

PROJECT NAME:		TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study
LAW PROJECT NO.:		5810860101
1.	*MATERIAL SOURCE:*	Shawnee
2.	*MATERIAL DESCRIPTION:*	Dry Fly Ash
3.	*REMOLDING TARGETS:*	95% Standard Dry Density at Optimum Moisture Content
4.	*MATERIAL TYPE*	2
5.	*TEST DATE*	07-06-1995



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:*	Shawnee
2.	*MATERIAL DESCRIPTION:*	Dry Fly 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	2.87
	MIDDLE	2.87
	BOTTOM	2.87
	AVERAGE	2.87
	MEMBRANE THICKNESS (1), inch	0.02
	MEMBRANE THICKNESS (2), inch	0.02
	NET DIAM., inch	2.84
	HEIGHT OF SPECIMEN, CAP AND BASE, inch	5.99
	HEIGHT OF CAP AND BASE, inch	0.00
	INITIAL LENGTH, L_0 , inch	5.99
	INITIAL AREA, A_0 , in^2	6.32
	INITIAL VOLUME $A_0 L_0$, in^3	37.83
7.	*SOIL SPECIMEN WEIGHT*:	
	INITIAL WEIGHT OF CONTAINER AND WET SOIL, grams	1887.50
	FINAL WEIGHT OF CONTAINER AND WET SOIL, grams	973.40
	WEIGHT OF WET SOIL USED, grams	914.10
8.	*SOIL PROPERTIES*.:	
	IN SITU MOISTURE CONTENT (NUCLEAR), %	N/A
	IN SITU WET DENSITY (NUCLEAR), pcf	N/A
	or	
	OPTIMUM MOISTURE CONTENT, %	24.4
	MAX. DRY DENSITY, pcf	77.2
	95 % MAX. DRY DENSITY, pcf	73.3
9.	*SPECIMEN PROPERTIES:*	
	COMPACTION MOISTURE CONTENT, %	24.5
	MOISTURE CONTENT AFTER RESILIENT MODULUS TESTING, %	24.5
	COMPACTION DRY DENSITY, γ_d pcf	73.9
10.	*QUICK SHEAR TEST*	
	STRESS - STRAIN PLOT ATTACHED (Y = YES, N = NO)	Y
	TRIAXIAL SHEAR MAXIMUM STRENGTH (MAX. LOAD/X-SECTION AREA), psi	40.4
	SPECIMEN FAIL DURING TRIAXIAL SHEAR? (Y = YES, N = NO)	Y
11.	*COMMENTS* (Section 10.4 of Protocol P46)	
	(a) *CODE*	0 0 0 0 0 0
	(b) *NOTE*	
12.	*TEST DATE*	07-06-1995

GENERAL REMARKS:

SUBMITTED BY, DATE

RS Bachman 9/6/95

LABORATORY MANAGER

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

LAW PROJECT NO.: 5810860101

1. *MATERIAL SOURCE:* Shawnee
2. *MATERIAL DESCRIPTION:* Dry Fly Ash
3. *REMOLDING TARGETS:* 95% Modified Dry Density at Optimum Moisture Content
4. *MATERIAL TYPE* 2
5. *TEST DATE* 07-06-1995
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	12.7	11.7	1.0	2.0	1.8	0.2	0.00174	0.00166	0.00170	0.00028	6,502
			2	12.8	11.7	1.1	2.0	1.9	0.2	0.00175	0.00169	0.00172	0.00029	6,460
			3	12.8	11.7	1.1	2.0	1.9	0.2	0.00174	0.00167	0.00170	0.00028	6,503
			4	12.8	11.7	1.1	2.0	1.9	0.2	0.00175	0.00168	0.00171	0.00029	6,468
			5	12.7	11.7	1.0	2.0	1.9	0.2	0.00173	0.00168	0.00170	0.00028	6,500
	COLUMN AVERAGE			12.8	11.7	1.1	2.0	1.9	0.2	0.00174	0.00167	0.00171	0.00029	6,486
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	21

Source: Shawnee Description: Dry Fly Ash 95% Modified 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	0.00354	0.00348	0.00351	0.00059	6,165
			2	25.3	22.9	2.4	4.0	3.6	0.4	0.00354	0.00345	0.00350	0.00058	6,203
			3	25.2	22.8	2.4	4.0	3.6	0.4	0.00352	0.00344	0.00348	0.00058	6,205
			4	25.3	22.9	2.4	4.0	3.6	0.4	0.00356	0.00348	0.00352	0.00059	6,158
			5	25.2	22.8	2.4	4.0	3.6	0.4	0.00352	0.00344	0.00348	0.00058	6,209
	COLUMN AVERAGE			25.3	22.9	2.4	4.0	3.6	0.4	0.00354	0.00346	0.00350	0.00058	6,188
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00002	0.00002	0.00002	0.00000	25
SEQUENCE 3	6.0	6.0	1	38.0	34.3	3.7	6.0	5.4	0.6	0.00556	0.00548	0.00552	0.00092	5,888
			2	38.0	34.3	3.7	6.0	5.4	0.6	0.00555	0.00547	0.00551	0.00092	5,889
			3	37.9	34.2	3.7	6.0	5.4	0.6	0.00557	0.00548	0.00552	0.00092	5,865
			4	38.0	34.3	3.7	6.0	5.4	0.6	0.00559	0.00550	0.00555	0.00093	5,859
			5	38.0	34.3	3.7	6.0	5.4	0.6	0.00559	0.00549	0.00554	0.00093	5,871
	COLUMN AVERAGE			38.0	34.3	3.7	6.0	5.4	0.6	0.00557	0.00549	0.00553	0.00092	5,874
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00002	0.00001	0.00001	0.00000	13
SEQUENCE 4	6.0	8.0	1	50.5	45.6	4.9	8.0	7.2	0.8	0.00750	0.00740	0.00745	0.00125	5,791
			2	50.5	45.5	4.9	8.0	7.2	0.8	0.00748	0.00738	0.00743	0.00124	5,802
			3	50.5	45.6	4.9	8.0	7.2	0.8	0.00750	0.00737	0.00744	0.00124	5,799
			4	50.5	45.5	4.9	8.0	7.2	0.8	0.00750	0.00741	0.00746	0.00125	5,783
			5	50.5	45.5	4.9	8.0	7.2	0.8	0.00749	0.00735	0.00742	0.00124	5,809
	COLUMN AVERAGE			50.5	45.6	4.9	8.0	7.2	0.8	0.00749	0.00739	0.00744	0.00124	5,797
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00002	0.00001	0.00000	10

Source: Shawnee Description: Dry Fly Ash 95% Modified Dry Density at Optimum Moisture Content

SEQUENCE 5	6.0	10.0	1	63.5	57.3	6.2	10.0	9.1	1.0	0.00923	0.00914	0.00918	0.00153	5,907
			2	63.6	57.3	6.2	10.1	9.1	1.0	0.00925	0.00916	0.00921	0.00154	5,896
			3	63.5	57.3	6.2	10.0	9.1	1.0	0.00924	0.00915	0.00919	0.00154	5,900
			4	63.5	57.3	6.2	10.0	9.1	1.0	0.00918	0.00911	0.00915	0.00153	5,926
			5	63.5	57.2	6.2	10.0	9.1	1.0	0.00921	0.00910	0.00915	0.00153	5,921
	COLUMN AVERAGE			63.5	57.3	6.2	10.0	9.1	1.0	0.00922	0.00913	0.00918	0.00153	5,910
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00003	0.00003	0.00003	0.00000	13
SEQUENCE 6	4.0	2.0	1	13.1	11.7	1.4	2.1	1.8	0.2	0.00207	0.00201	0.00204	0.00034	5,420
			2	13.1	11.7	1.4	2.1	1.8	0.2	0.00207	0.00201	0.00204	0.00034	5,423
			3	13.2	11.8	1.4	2.1	1.9	0.2	0.00207	0.00202	0.00204	0.00034	5,445
			4	13.2	11.8	1.4	2.1	1.9	0.2	0.00207	0.00200	0.00204	0.00034	5,470
			5	13.2	11.8	1.4	2.1	1.9	0.2	0.00207	0.00202	0.00204	0.00034	5,456
	COLUMN AVERAGE			13.2	11.7	1.4	2.1	1.9	0.2	0.00207	0.00201	0.00204	0.00034	5,443
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00000	0.00001	0.00000	0.00000	22
SEQUENCE 7	4.0	4.0	1	25.2	22.9	2.3	4.0	3.6	0.4	0.00450	0.00443	0.00447	0.00075	4,842
			2	25.1	22.8	2.3	4.0	3.6	0.4	0.00452	0.00442	0.00447	0.00075	4,832
			3	25.2	22.8	2.3	4.0	3.6	0.4	0.00452	0.00444	0.00448	0.00075	4,827
			4	25.1	22.8	2.3	4.0	3.6	0.4	0.00451	0.00444	0.00447	0.00075	4,827
			5	25.2	22.9	2.3	4.0	3.6	0.4	0.00450	0.00442	0.00446	0.00074	4,870
	COLUMN AVERAGE			25.2	22.8	2.3	4.0	3.6	0.4	0.00451	0.00443	0.00447	0.00075	4,840
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	18

Source: Shawnee Description: Dry Fly Ash 95% Modified Dry Density at Optimum Moisture Content

SEQUENCE 8	4.0	6.0	1	37.9	34.2	3.7	6.0	5.4	0.6	0.00682	0.00670	0.00676	0.00113	4,785
			2	37.8	34.1	3.7	6.0	5.4	0.6	0.00683	0.00673	0.00678	0.00113	4,767
			3	37.9	34.3	3.7	6.0	5.4	0.6	0.00684	0.00675	0.00680	0.00114	4,773
			4	37.9	34.2	3.7	6.0	5.4	0.6	0.00680	0.00670	0.00675	0.00113	4,804
			5	37.9	34.2	3.7	6.0	5.4	0.6	0.00683	0.00674	0.00679	0.00113	4,768
	COLUMN AVERAGE			37.9	34.2	3.7	6.0	5.4	0.6	0.00683	0.00673	0.00678	0.00113	4,779
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00002	0.00002	0.00002	0.00000	16
SEQUENCE 9	4.0	8.0	1	50.9	46.0	4.9	8.0	7.3	0.8	0.00885	0.00876	0.00881	0.00147	4,941
			2	50.8	45.9	4.9	8.0	7.3	0.8	0.00885	0.00876	0.00881	0.00147	4,934
			3	50.8	45.9	4.9	8.0	7.3	0.8	0.00886	0.00874	0.00880	0.00147	4,935
			4	50.8	45.9	4.9	8.0	7.3	0.8	0.00886	0.00876	0.00881	0.00147	4,933
			5	50.7	45.8	4.9	8.0	7.2	0.8	0.00884	0.00873	0.00879	0.00147	4,933
	COLUMN AVERAGE			50.8	45.9	4.9	8.0	7.3	0.8	0.00885	0.00875	0.00880	0.00147	4,935
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	4
SEQUENCE 10	4.0	10.0	1	63.3	57.1	6.2	10.0	9.0	1.0	0.01054	0.01041	0.01048	0.00175	5,163
			2	63.4	57.2	6.2	10.0	9.0	1.0	0.01054	0.01043	0.01049	0.00175	5,165
			3	63.5	57.4	6.2	10.1	9.1	1.0	0.01055	0.01042	0.01049	0.00175	5,178
			4	63.8	57.6	6.2	10.1	9.1	1.0	0.01055	0.01044	0.01050	0.00175	5,192
			5	63.7	57.5	6.2	10.1	9.1	1.0	0.01052	0.01042	0.01047	0.00175	5,200
	COLUMN AVERAGE			63.5	57.4	6.2	10.1	9.1	1.0	0.01054	0.01042	0.01048	0.00175	5,180
	STANDARD DEV.			0.2	0.2	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	16

Source: Shawnee Description: Dry Fly Ash 95% Modified Dry Density at Optimum Moisture Content

SEQUENCE 11	2.0	2.0	1	13.6	11.8	1.8	2.2	1.9	0.3	0.00250	0.00249	0.00249	0.00042	4,473
			2	13.5	11.7	1.8	2.1	1.9	0.3	0.00250	0.00247	0.00248	0.00042	4,459
			3	13.4	11.6	1.8	2.1	1.8	0.3	0.00252	0.00249	0.00250	0.00042	4,399
			4	13.5	11.6	1.8	2.1	1.8	0.3	0.00251	0.00249	0.00250	0.00042	4,411
			5	13.6	11.7	1.8	2.1	1.9	0.3	0.00252	0.00249	0.00251	0.00042	4,433
	COLUMN AVERAGE			13.5	11.7	1.8	2.1	1.9	0.3	0.00251	0.00248	0.00250	0.00042	4,435
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	31
SEQUENCE 12	2.0	4.0	1	25.2	23.0	2.2	4.0	3.6	0.3	0.00556	0.00547	0.00551	0.00092	3,945
			2	25.2	23.0	2.2	4.0	3.6	0.3	0.00555	0.00548	0.00551	0.00092	3,947
			3	25.3	23.1	2.2	4.0	3.6	0.3	0.00556	0.00547	0.00551	0.00092	3,961
			4	25.3	23.1	2.2	4.0	3.7	0.3	0.00555	0.00547	0.00551	0.00092	3,977
			5	25.4	23.2	2.2	4.0	3.7	0.3	0.00553	0.00546	0.00549	0.00092	3,992
	COLUMN AVERAGE			25.3	23.1	2.2	4.0	3.6	0.3	0.00555	0.00547	0.00551	0.00092	3,964
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	20
SEQUENCE 13	2.0	6.0	1	37.9	34.2	3.6	6.0	5.4	0.6	0.00825	0.00814	0.00820	0.00137	3,955
			2	38.0	34.3	3.6	6.0	5.4	0.6	0.00825	0.00814	0.00820	0.00137	3,966
			3	37.9	34.3	3.6	6.0	5.4	0.6	0.00824	0.00813	0.00819	0.00137	3,968
			4	38.0	34.4	3.6	6.0	5.4	0.6	0.00825	0.00814	0.00820	0.00137	3,972
			5	37.9	34.3	3.6	6.0	5.4	0.6	0.00824	0.00813	0.00819	0.00137	3,962
	COLUMN AVERAGE			37.9	34.3	3.6	6.0	5.4	0.6	0.00825	0.00814	0.00819	0.00137	3,964
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	7

Source: Shawnee Description: Dry Fly Ash 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	0.01034	0.01025	0.01029	0.00172	4,191
			2	50.6	45.7	4.9	8.0	7.2	0.8	0.01033	0.01024	0.01028	0.00172	4,212
			3	50.8	45.9	4.9	8.0	7.3	0.8	0.01031	0.01020	0.01025	0.00171	4,235
			4	50.8	45.9	4.9	8.0	7.3	0.8	0.01033	0.01021	0.01027	0.00172	4,235
			5	51.0	46.1	4.9	8.1	7.3	0.8	0.01036	0.01023	0.01029	0.00172	4,238
	COLUMN AVERAGE			50.7	45.8	4.9	8.0	7.3	0.8	0.01033	0.01022	0.01028	0.00172	4,222
	STANDARD DEV.			0.2	0.2	0.0	0.0	0.0	0.0	0.00002	0.00002	0.00002	0.00000	20
SEQUENCE 15	2.0	10.0	1	63.8	57.7	6.1	10.1	9.1	1.0	0.01211	0.01201	0.01206	0.00201	4,528
			2	63.8	57.6	6.2	10.1	9.1	1.0	0.01214	0.01203	0.01208	0.00202	4,515
			3	63.8	57.7	6.2	10.1	9.1	1.0	0.01213	0.01203	0.01208	0.00202	4,521
			4	63.4	57.3	6.2	10.0	9.1	1.0	0.01211	0.01203	0.01207	0.00202	4,491
			5	63.1	57.0	6.2	10.0	9.0	1.0	0.01212	0.01196	0.01204	0.00201	4,481
	COLUMN AVERAGE			63.6	57.4	6.2	10.1	9.1	1.0	0.01212	0.01201	0.01207	0.00202	4,507
	STANDARD DEV.			0.3	0.3	0.0	0.0	0.0	0.0	0.00001	0.00003	0.00002	0.00000	20

SUBMITTED BY, DATE

RJ Burdeen 9/6/95

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:*	Shawnee
2.	*MATERIAL DESCRIPTION:*	Dry Fly Ash
3.	*REMOLDING TARGETS:*	95% Modified Dry Density at Optimum Moisture Content
4.	*MATERIAL TYPE*	2
5.	*TEST DATE*	07-06-1995

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

K1 =	2,774
K2 =	-0.03472
K5 =	0.41978
R^2 =	0.90

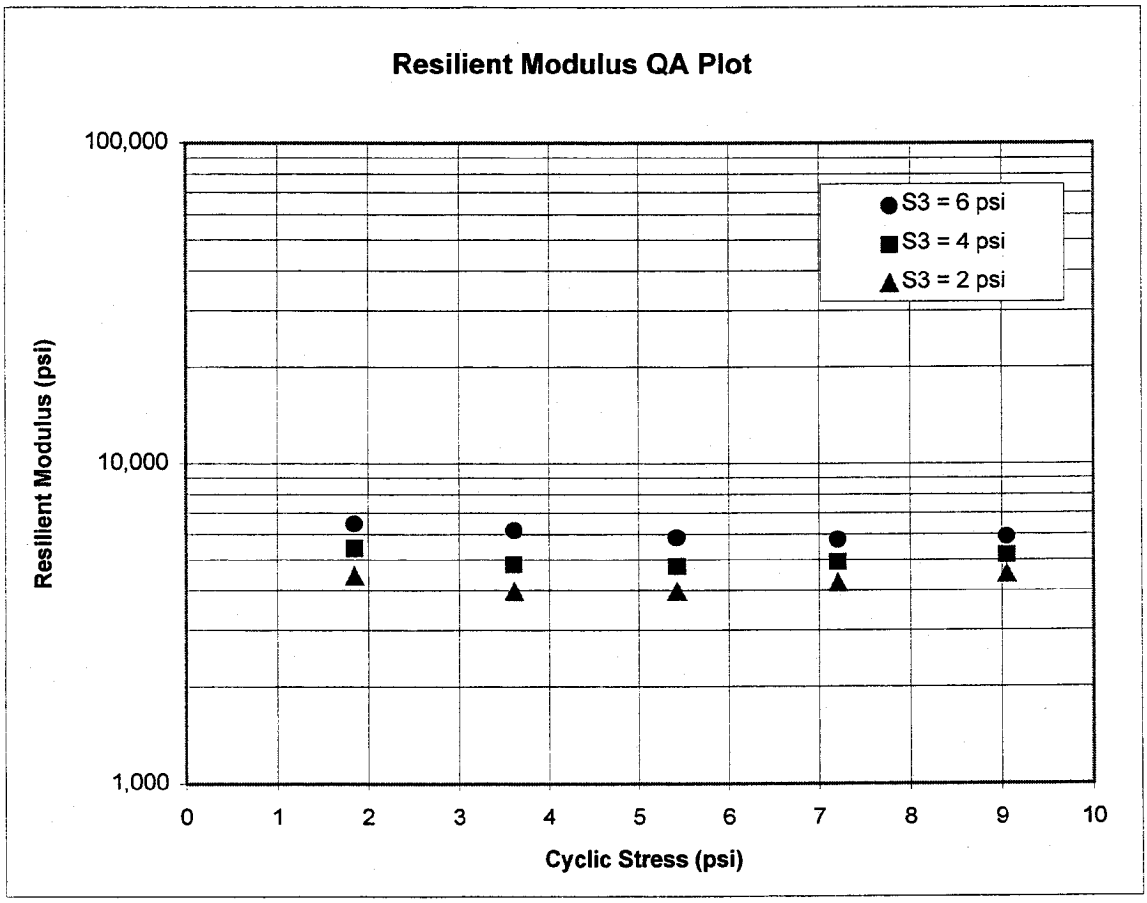
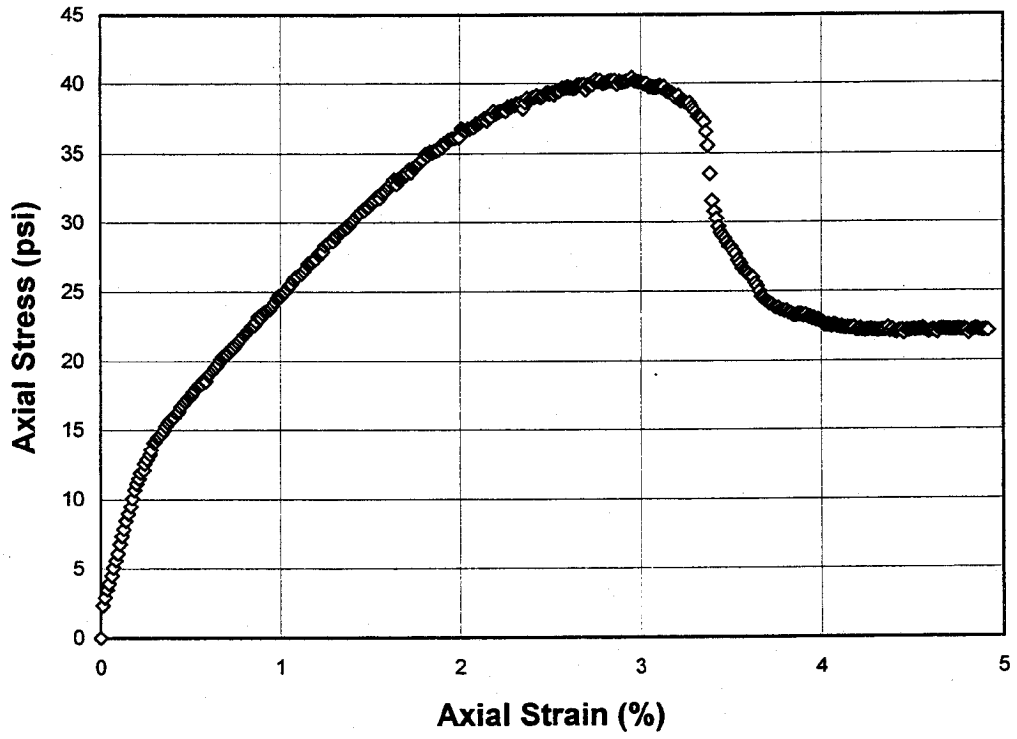


FIGURE 2 - Quick Shear Stress vs Strain

PROJECT NAME:		TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study
LAW PROJECT NO.:		5810860101
1.	*MATERIAL SOURCE:*	Shawnee
2.	*MATERIAL DESCRIPTION:*	Dry Fly Ash
3.	*REMOLDING TARGETS:*	95% Modified Dry Density at Optimum Moisture Content
4.	*MATERIAL TYPE*	2
5.	*TEST DATE*	07-06-1995



SHAWNEE

Bottom Ash - From Pond

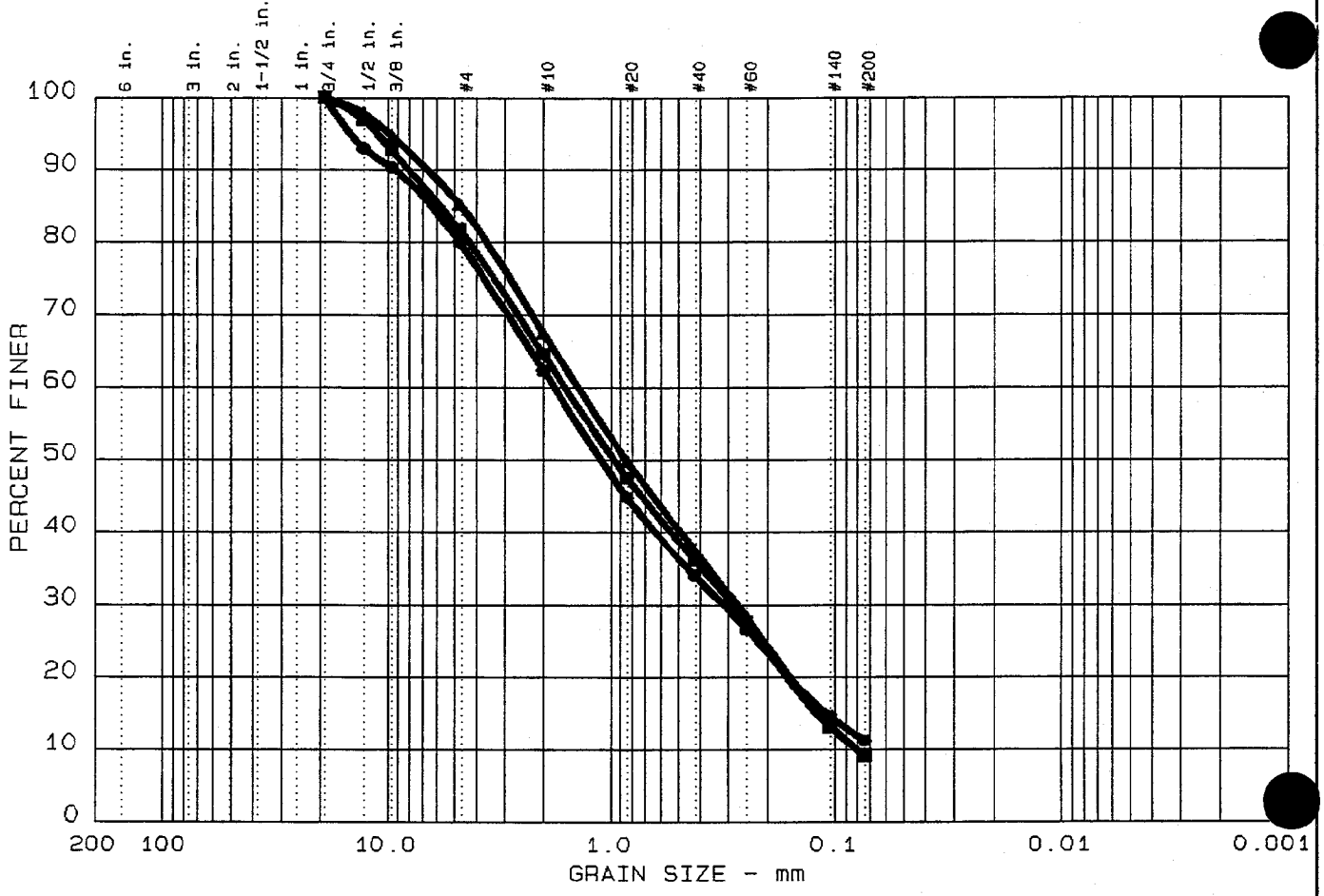
Grain Size Distribution Test Report
Moisture-Density Relationship (Standard Proctor)
Moisture-Density Relationship (Modified Proctor)
Relative Density Test
Hydraulic Conductivity - Constant Head (2 Pages)
California Bearing Ratio
Resilient Modulus (Standard Proctor) (9 Pages)
Resilient Modulus (Modified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

TVA - SHAWNEE
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 Percent Passing the #200 Sieve	20.0 11.2	14.7 9.1	18.3 9.3
Atterberg Limits	ASTM D 4318	Liquid Limit Plastic Limit Plasticity Index	NL NP N/A	NL NP N/A	NL NP N/A
Specific Gravity	ASTM D 854	Specific Gravity at 20°C	2.14	2.14	2.09
Classification	ASTM D 2487 AASHTO M 145	Unified Soil Classification System (USCS) AASHTO Classification	SP-SM A-1-b	SP-SM A-1-b	SP-SM A-1-b
			Composite Sample		
Moisture-Density Relations (Standard Effort)	ASTM D 698	Maximum Dry Density, pcf Optimum Moisture Content, %	71.7 30.5		
Moisture-Density Relations (Modified Effort)	ASTM D 1557	Maximum Dry Density, pcf Optimum Moisture Content, %	81.4 26.1		
Relative Density	ASTM D 4254 ASTM D 4253	Minimum Dry Density, pcf Maximum Dry Density (Dry Method), pcf	57.4 74.0		
			Result	Dry Density, pcf	Moisture Content, %
Hydraulic Conductivity	ASTM D 2434	Hydraulic Conductivity, cm/sec	8.9E-3	67.6	0.0
Angle of Repose	LAW TP6	Angle of Repose, degrees	31.6	57.4	0.0
California Bearing Ratio	ASTM D 1883	CBR, %	25	67.9	33.6
Resilient Modulus (Standard Compactive Effort)	SHRP P46	Resilient Modulus at 4psi axial stress and 4psi confining pressure	6,244	67.6	30.5
Resilient Modulus (Modified Compactive Effort)	SHRP P46	Resilient Modulus at 4psi axial stress and 4psi confining pressure	5,030	75.2	26.8
Soil Resistivity	AASHTO T 288	Minimum Resistivity, Ohm-cm	3,000		
pH of Soil	AASHTO T 289	pH	8.1		
Water Soluble Sulfate Ion	AASHTO T 290	Sulfate Ion Content, mg/kg	4200		
Water Soluble Chloride Ion	AASHTO T 290	Chloride Ion Content, mg/kg	10		

shf-ba.xls

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	12	0.0	20.0	68.8	11.2	
▲	13	0.0	14.7	76.2	9.1	
■	14	0.0	18.3	72.4	9.3	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	NL	NP	6.31	1.78	1.11	0.316	0.1083			
▲	NL	NP	4.68	1.40	0.84	0.272	0.1175	0.0794	0.67	17.6
■	NL	NP	5.75	1.60	0.96	0.288	0.1201	0.0784	0.66	20.4

	MATERIAL DESCRIPTION	USCS	AASHTO
●		SP-SM	A-1-b
▲		SP-SM	A-1-b
■		SP-SM	A-1-b

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

GRAIN SIZE DISTRIBUTION TEST REPORT

LAW ENGINEERING, INC.

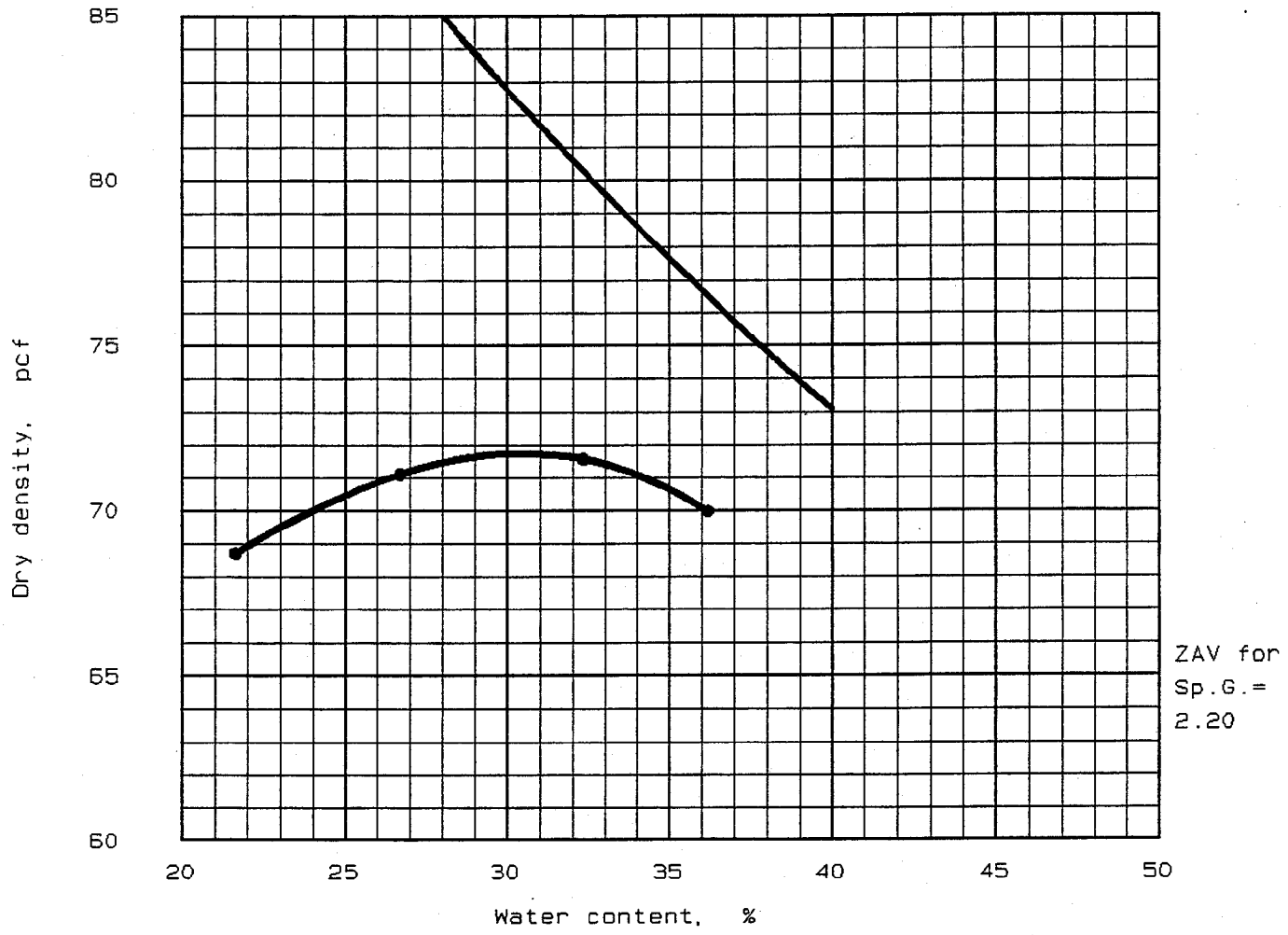
Remarks:

Tested by: JCR

Reviewed by: HS

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						
	SP-SM	A-1-b	22.9 %	2.14	NL	NP	17.7 %	9.87 %

TEST RESULTS	MATERIAL DESCRIPTION
Optimum moisture = 30.5 % Maximum dry density = 71.7 pcf	

Project No.: 5810860101
Project: TVA - Shawnee
Location: Bottom Ash

Date: July 25, 1995

MOISTURE-DENSITY RELATIONSHIP

LAW ENGINEERING, INC.

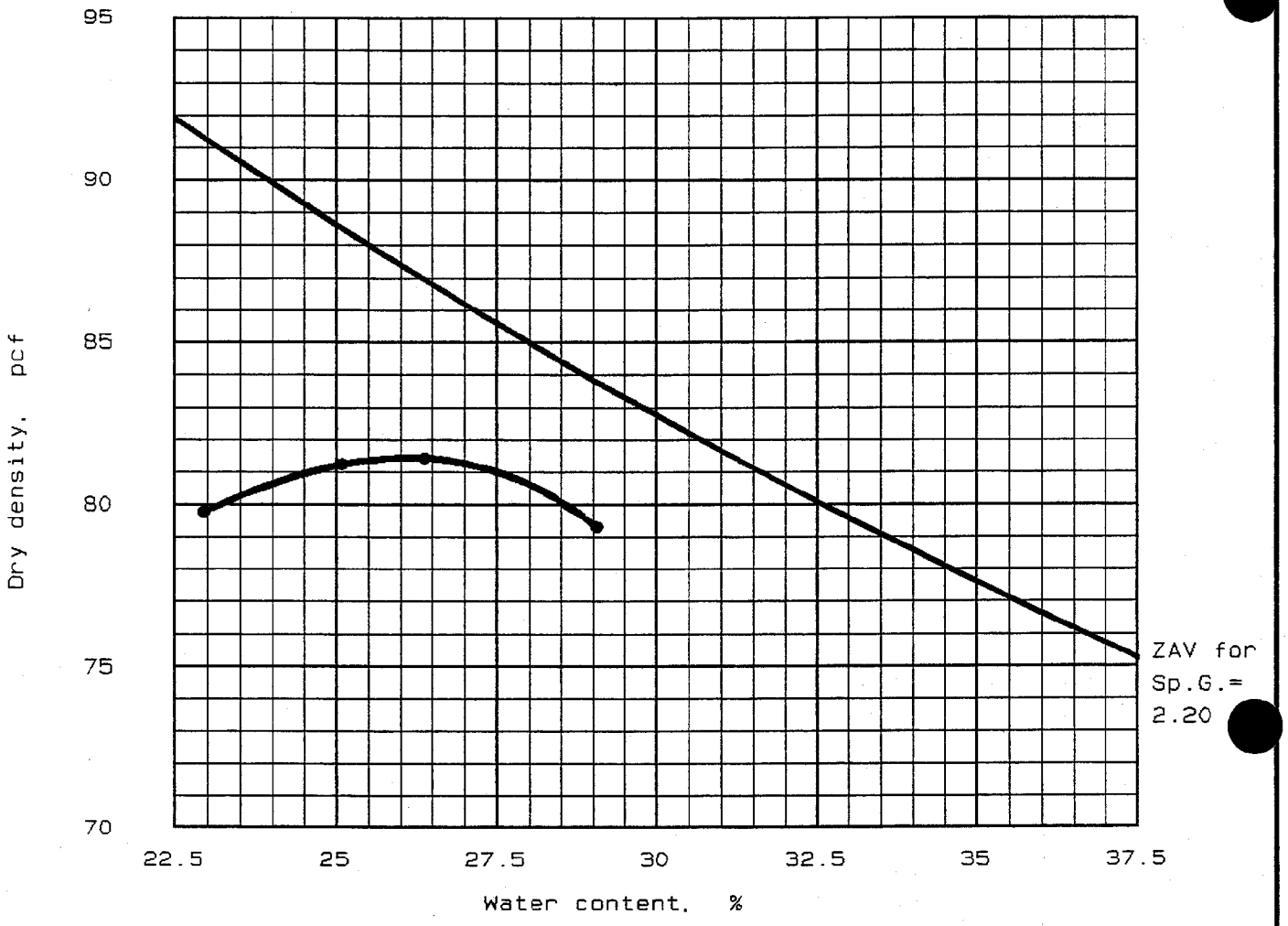
Remarks:

Tested by: JCR

Reviewed by: HJ/RLB

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						
	SP-SM	A-1-b	22.9 %	2.14	NL	NP	17.7 %	9.87 %

TEST RESULTS	MATERIAL DESCRIPTION
Optimum moisture = 26.1 % Maximum dry density = 81.4 pcf	

Project No.: 5810860101
Project: TVA - Shawnee
Location: Bottom Ash

Date: July 25, 1995

Remarks:

Tested by: JCR

Reviewed by: RWB

MOISTURE-DENSITY RELATIONSHIP

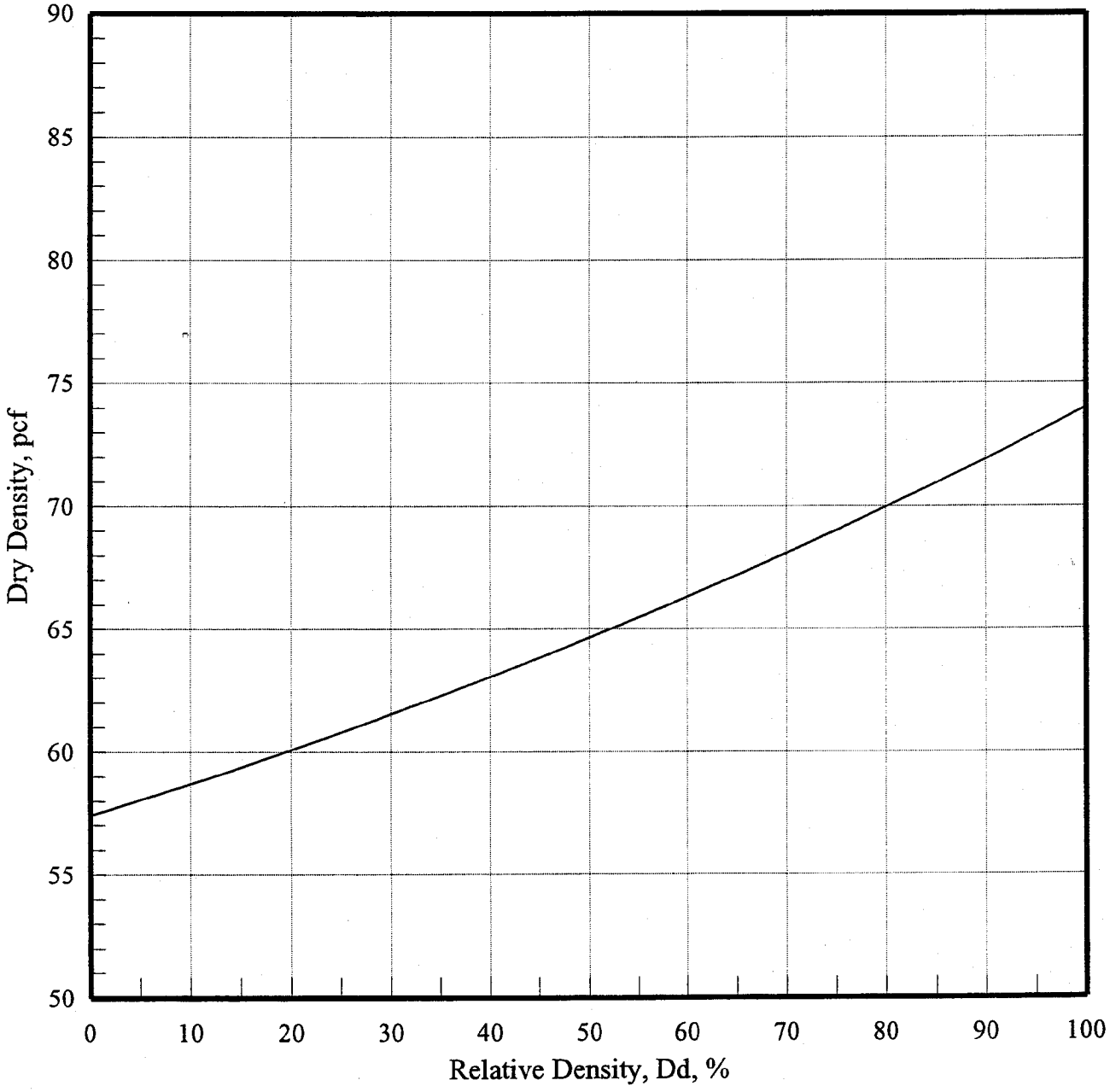
LAW ENGINEERING, INC.

Figure No. _____

Relative Density Test

TVA - Shawnee, Bottom Ash

Law Project No. 5810860101



HYDRAULIC CONDUCTIVITY

LAW ENGINEERING

Project No.	*5810860101*	Tested By	*JCR*
Project Name	*TVA - Shawnee*	Test Date	*08/17/95*
Material	*Bottom Ash*	Reviewed By	*RLB*
		Review Date	*09/06/95*

ASTM D2434-68 Constant Head Permeability

Sample Type:	*Remolded*
Sample Orientation:	*Vertical*
Initial Water Content, %:	*0.0*
Wet Unit Weight, pcf:	*67.6*
Dry Unit Weight, pcf:	*67.6*
Compaction, %:	*94.3*
Hydraulic Conductivity, cm/sec. @20° C:	***8.9E-03***

PERMEABILITY TEST - Constant Head
(ASTM D2434 - 68)

LAW ENGINEERING

Project No. 5810860101
Project Name TVA - Shawnee
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	4.991	Location 1	2.858	Wet Soil + Pan, grams	578.36
Location 2	5.104	Location 2	2.875	Dry Soil+Pan, grams	578.36
Location3	5.050	Location 3	2.868	Pan Weight, grams	0.00
Average	5.048	Average	2.867	Moisture Content, %	0.0
		Sample wet weight, grams	578.36	Wet Unit Wt, pcf	67.6
		Membrane, Cap weight, grams	0.00	Dry Unit Wt, pcf	67.6

Time (sec)	Q (cm^3)	H (cm)	k (cm/sec)	Temp ° C	k (cm/sec at 20° C)	i (cm/cm)
600	75.00	5.08	7.6E-03	20.0	7.6E-03	0.40
1200	175.00	5.08	8.8E-03	20.0	8.9E-03	0.40

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
2	Remolded	71.7	94.3	Vertical

L = length of sample in cm
A = area of sample in cm^2
H = constant head in cm
t = time in seconds

A = 41.65 cm^2
L = 12.823 cm

Avg. k at 20° C 8.9E-03 cm/sec

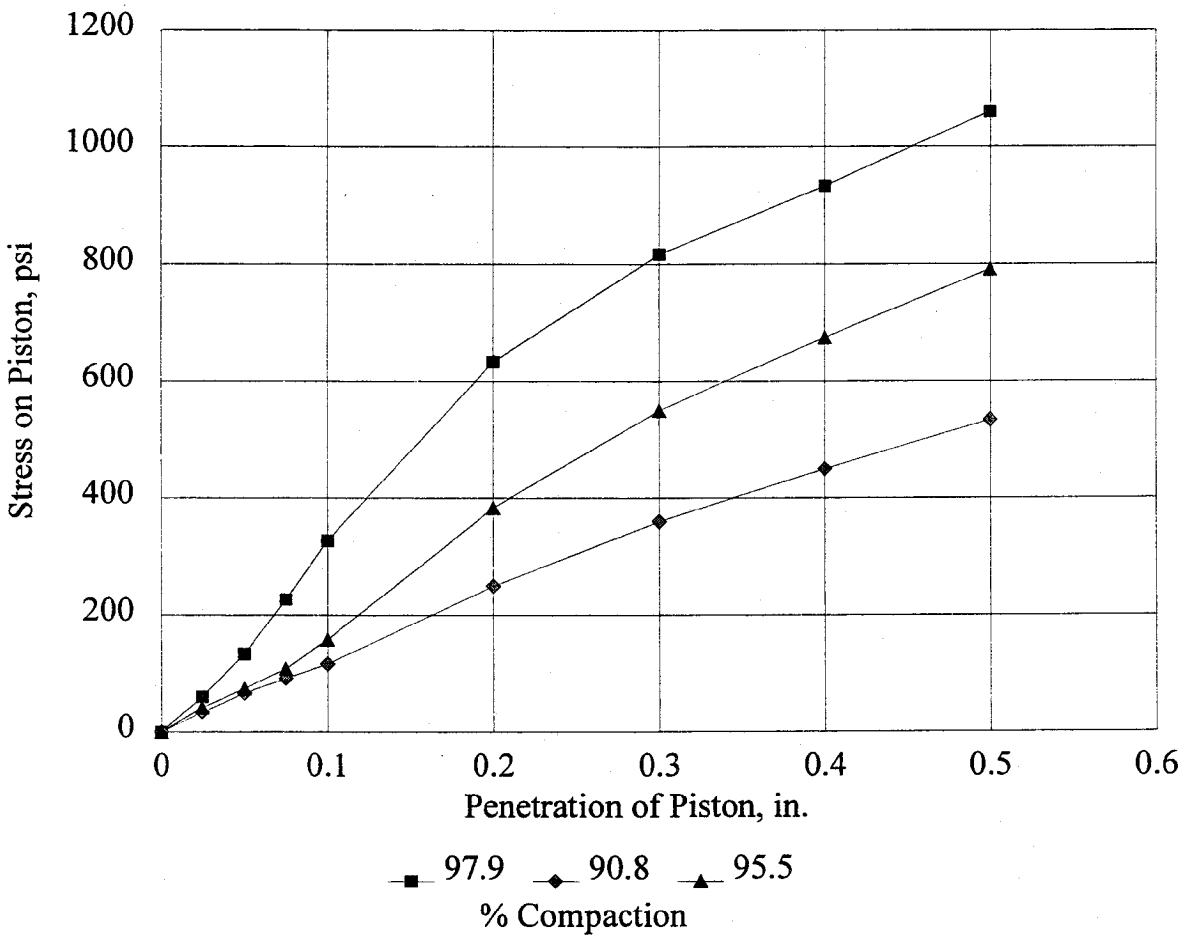
California Bearing Ratio

(ASTM D1883-92)

LAW ENGINEERING

Project No.	5810860101	**Tested By**	EM
Project Name	TVA - Shawnee	**Test Date**	08/08/95
Material (Source)	Bottom Ash	**Reviewed By**	RLB
		Review Date	08/30/95

Compaction, %	97.9	90.8	95.5
Before Soak Dry Density, pcf	70.2	65.1	68.5
Before Soak Moisture Content,	33.9	33.8	33.1
After Soak Dry Density, pcf	70.5	65.3	69.0
After Soak Moisture Content, %	33.8	36.7	35.5
CBR @ 0.1 in.	32.7	11.7	15.8
CBR @ 0.2 in.	42.2	16.7	25.6



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:*	Shawnee
2.	*MATERIAL DESCRIPTION:*	Bottom Ash
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	2.86
	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	6.06
	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	38.16
7.	*SOIL SPECIMEN WEIGHT*:	
	INITIAL WEIGHT OF CONTAINER AND WET SOIL, grams	1303.20
	FINAL WEIGHT OF CONTAINER AND WET SOIL, grams	418.60
	WEIGHT OF WET SOIL USED , grams	884.60
8.	*SOIL PROPERTIES .:*	
	IN SITU MOISTURE CONTENT (NUCLEAR), %	N/A
	IN SITU WET DENSITY (NUCLEAR), pcf	N/A
	or	
	OPTIMUM MOISTURE CONTENT, %	30.5
	MAX. DRY DENSITY, pcf	71.7
	95 % MAX. DRY DENSITY, pcf	68.1
9.	*SPECIMEN PROPERTIES:*	
	COMPACTION MOISTURE CONTENT, %	30.5
	MOISTURE CONTENT AFTER RESILIENT MODULUS TESTING, %	30.5
	COMPACTION DRY DENSITY, γ_d pcf	67.6
10.	*QUICK SHEAR TEST*	
	STRESS - STRAIN PLOT ATTACHED (Y = YES, N = NO)	Y
	TRIAXIAL SHEAR MAXIMUM STRENGTH (MAX. LOAD/X-SECTION AREA), psi	35.1
	SPECIMEN FAIL DURING TRIAXIAL SHEAR? (Y = YES, N = NO)	Y
11.	*COMMENTS* (Section 10.4 of Protocol P46)	
	(a) *CODE*	0 0 0 0 0 0
	(b) *NOTE*	
12.	*TEST DATE*	08-18-1995

GENERAL REMARKS:

SUBMITTED BY, DATE

R S Burchum 9/10/95

LABORATORY MANAGER

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study
LAW PROJECT NO.: 5810860101
1. *MATERIAL SOURCE:* Shawnee
2. *MATERIAL DESCRIPTION:* Bottom Ash
3. *REMOLDING TARGETS:* 95% Standard Dry Density at Optimum Moisture Content
4. *MATERIAL TYPE* 2
5. *TEST DATE* 08-18-1995
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	12.8	11.5	1.2	2.0	1.8	0.2	0.00117	0.00115	0.00116	0.00019	9,571
			2	12.7	11.5	1.2	2.0	1.8	0.2	0.00118	0.00114	0.00116	0.00019	9,543
			3	12.8	11.5	1.2	2.0	1.8	0.2	0.00117	0.00114	0.00115	0.00019	9,627
			4	12.8	11.6	1.2	2.0	1.8	0.2	0.00117	0.00113	0.00115	0.00019	9,654
			5	12.8	11.6	1.2	2.0	1.8	0.2	0.00118	0.00114	0.00116	0.00019	9,626
	COLUMN AVERAGE			12.8	11.5	1.2	2.0	1.8	0.2	0.00117	0.00114	0.00116	0.00019	9,604
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00000	0.00000	46

Source: Shawnee Description: Bottom Ash 95% Standard Dry Density at Optimum Moisture Content

SEQUENCE 2	6.0	4.0	1	25.4	23.1	2.2	4.0	3.7	0.4	0.00218	0.00216	0.00217	0.00036	10,263
			2	25.2	22.9	2.3	4.0	3.6	0.4	0.00217	0.00216	0.00216	0.00036	10,207
			3	25.0	22.8	2.3	4.0	3.6	0.4	0.00216	0.00215	0.00216	0.00036	10,164
			4	25.2	22.9	2.3	4.0	3.6	0.4	0.00217	0.00217	0.00217	0.00036	10,153
			5	25.2	22.9	2.3	4.0	3.6	0.4	0.00218	0.00217	0.00217	0.00036	10,135
	COLUMN AVERAGE			25.2	22.9	2.3	4.0	3.6	0.4	0.00217	0.00216	0.00217	0.00036	10,184
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	52
SEQUENCE 3	6.0	6.0	1	37.7	34.2	3.5	6.0	5.4	0.6	0.00324	0.00324	0.00324	0.00054	10,150
			2	38.0	34.4	3.6	6.0	5.5	0.6	0.00324	0.00325	0.00325	0.00054	10,198
			3	37.9	34.3	3.5	6.0	5.5	0.6	0.00324	0.00326	0.00325	0.00054	10,161
			4	37.8	34.2	3.6	6.0	5.4	0.6	0.00325	0.00325	0.00325	0.00054	10,138
			5	38.0	34.5	3.5	6.0	5.5	0.6	0.00325	0.00326	0.00326	0.00054	10,190
	COLUMN AVERAGE			37.9	34.3	3.5	6.0	5.5	0.6	0.00324	0.00325	0.00325	0.00054	10,167
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00000	0.00001	0.00001	0.00000	26
SEQUENCE 4	6.0	8.0	1	51.1	46.2	4.9	8.1	7.3	0.8	0.00440	0.00445	0.00443	0.00073	10,039
			2	50.8	46.0	4.8	8.1	7.3	0.8	0.00437	0.00445	0.00441	0.00073	10,030
			3	50.9	46.0	4.9	8.1	7.3	0.8	0.00439	0.00444	0.00442	0.00073	10,029
			4	50.7	45.9	4.8	8.0	7.3	0.8	0.00438	0.00444	0.00441	0.00073	10,003
			5	51.0	46.1	4.9	8.1	7.3	0.8	0.00440	0.00445	0.00442	0.00073	10,028
	COLUMN AVERAGE			50.9	46.0	4.9	8.1	7.3	0.8	0.00439	0.00445	0.00442	0.00073	10,026
	STANDARD DEV.			0.2	0.1	0.0	0.0	0.0	0.0	0.00001	0.00000	0.00001	0.00000	14

Source: Shawnee Description: Bottom Ash 95% Standard Dry Density at Optimum Moisture Content

SEQUENCE 5	6.0	10.0	1	63.4	57.4	6.1	10.1	9.1	1.0	0.00543	0.00558	0.00551	0.00091	10,021
			2	63.7	57.6	6.1	10.1	9.1	1.0	0.00548	0.00561	0.00554	0.00091	9,995
			3	63.4	57.3	6.1	10.1	9.1	1.0	0.00545	0.00558	0.00551	0.00091	10,002
			4	63.5	57.4	6.1	10.1	9.1	1.0	0.00546	0.00558	0.00552	0.00091	10,000
			5	63.6	57.5	6.1	10.1	9.1	1.0	0.00548	0.00561	0.00554	0.00091	9,992
	COLUMN AVERAGE			63.5	57.4	6.1	10.1	9.1	1.0	0.00546	0.00559	0.00553	0.00091	10,002
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00002	0.00002	0.00002	0.00000	11
SEQUENCE 6	4.0	2.0	1	13.2	11.6	1.6	2.1	1.8	0.3	0.00167	0.00166	0.00167	0.00028	6,688
			2	13.1	11.5	1.6	2.1	1.8	0.3	0.00169	0.00166	0.00167	0.00028	6,599
			3	13.0	11.4	1.6	2.1	1.8	0.3	0.00167	0.00164	0.00166	0.00027	6,626
			4	13.2	11.5	1.6	2.1	1.8	0.3	0.00169	0.00166	0.00167	0.00028	6,626
			5	13.1	11.4	1.7	2.1	1.8	0.3	0.00169	0.00167	0.00168	0.00028	6,559
	COLUMN AVERAGE			13.1	11.5	1.6	2.1	1.8	0.3	0.00168	0.00166	0.00167	0.00028	6,620
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	47
SEQUENCE 7	4.0	4.0	1	25.1	22.8	2.3	4.0	3.6	0.4	0.00340	0.00340	0.00340	0.00056	6,457
			2	25.3	23.0	2.3	4.0	3.6	0.4	0.00341	0.00337	0.00339	0.00056	6,515
			3	25.2	22.9	2.3	4.0	3.6	0.4	0.00340	0.00340	0.00340	0.00056	6,484
			4	25.1	22.8	2.3	4.0	3.6	0.4	0.00340	0.00337	0.00339	0.00056	6,478
			5	25.2	22.9	2.3	4.0	3.6	0.4	0.00339	0.00339	0.00339	0.00056	6,502
	COLUMN AVERAGE			25.2	22.9	2.3	4.0	3.6	0.4	0.00340	0.00339	0.00339	0.00056	6,487
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	23

Source: Shawnee Description: Bottom Ash 95% Standard Dry Density at Optimum Moisture Content

SEQUENCE 8	4.0	6.0	1	38.4	34.9	3.6	6.1	5.5	0.6	0.00480	0.00482	0.00481	0.00079	6,976
			2	38.2	34.7	3.5	6.1	5.5	0.6	0.00479	0.00482	0.00481	0.00079	6,956
			3	38.1	34.6	3.5	6.1	5.5	0.6	0.00478	0.00480	0.00479	0.00079	6,950
			4	38.3	34.7	3.6	6.1	5.5	0.6	0.00480	0.00482	0.00481	0.00079	6,943
			5	38.2	34.6	3.5	6.1	5.5	0.6	0.00479	0.00480	0.00479	0.00079	6,953
	COLUMN AVERAGE			38.2	34.7	3.5	6.1	5.5	0.6	0.00479	0.00481	0.00480	0.00079	6,956
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	12
SEQUENCE 9	4.0	8.0	1	50.7	45.9	4.8	8.1	7.3	0.8	0.00594	0.00602	0.00598	0.00099	7,393
			2	50.8	46.0	4.8	8.1	7.3	0.8	0.00596	0.00601	0.00598	0.00099	7,394
			3	50.8	46.0	4.8	8.1	7.3	0.8	0.00596	0.00603	0.00599	0.00099	7,391
			4	50.6	45.8	4.8	8.0	7.3	0.8	0.00596	0.00600	0.00598	0.00099	7,377
			5	50.6	45.8	4.8	8.0	7.3	0.8	0.00593	0.00602	0.00597	0.00099	7,378
	COLUMN AVERAGE			50.7	45.9	4.8	8.1	7.3	0.8	0.00595	0.00601	0.00598	0.00099	7,386
	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	57.3	6.1	10.1	9.1	1.0	0.00703	0.00715	0.00709	0.00117	7,784
			2	63.4	57.4	6.1	10.1	9.1	1.0	0.00701	0.00715	0.00708	0.00117	7,794
			3	63.3	57.2	6.1	10.0	9.1	1.0	0.00702	0.00716	0.00709	0.00117	7,765
			4	63.3	57.2	6.1	10.0	9.1	1.0	0.00702	0.00714	0.00708	0.00117	7,772
			5	63.3	57.2	6.1	10.0	9.1	1.0	0.00703	0.00716	0.00710	0.00117	7,751
	COLUMN AVERAGE			63.3	57.2	6.1	10.1	9.1	1.0	0.00702	0.00715	0.00709	0.00117	7,773
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	17

Source: Shawnee Description: Bottom Ash 95% Standard Dry Density at Optimum Moisture Content

SEQUENCE 11	2.0	2.0	1	13.4	11.3	2.1	2.1	1.8	0.3	0.00239	0.00233	0.00236	0.00039	4,628
			2	13.3	11.2	2.1	2.1	1.8	0.3	0.00238	0.00232	0.00235	0.00039	4,583
			3	13.4	11.3	2.1	2.1	1.8	0.3	0.00239	0.00234	0.00236	0.00039	4,602
			4	13.4	11.3	2.1	2.1	1.8	0.3	0.00239	0.00233	0.00236	0.00039	4,631
			5	13.4	11.3	2.1	2.1	1.8	0.3	0.00240	0.00234	0.00237	0.00039	4,592
	COLUMN AVERAGE			13.4	11.3	2.1	2.1	1.8	0.3	0.00239	0.00233	0.00236	0.00039	4,607
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	21
SEQUENCE 12	2.0	4.0	1	25.0	22.7	2.3	4.0	3.6	0.4	0.00480	0.00476	0.00478	0.00079	4,563
			2	25.1	22.7	2.3	4.0	3.6	0.4	0.00477	0.00476	0.00477	0.00079	4,589
			3	25.0	22.6	2.3	4.0	3.6	0.4	0.00479	0.00477	0.00478	0.00079	4,553
			4	25.1	22.7	2.3	4.0	3.6	0.4	0.00480	0.00476	0.00478	0.00079	4,571
			5	25.0	22.6	2.3	4.0	3.6	0.4	0.00480	0.00476	0.00478	0.00079	4,554
	COLUMN AVERAGE			25.0	22.7	2.3	4.0	3.6	0.4	0.00479	0.00476	0.00478	0.00079	4,566
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	15
SEQUENCE 13	2.0	6.0	1	37.8	34.3	3.6	6.0	5.4	0.6	0.00634	0.00637	0.00636	0.00105	5,186
			2	37.8	34.3	3.5	6.0	5.4	0.6	0.00634	0.00638	0.00636	0.00105	5,192
			3	37.9	34.4	3.5	6.0	5.5	0.6	0.00636	0.00637	0.00636	0.00105	5,197
			4	38.1	34.5	3.5	6.0	5.5	0.6	0.00636	0.00639	0.00637	0.00105	5,215
			5	38.1	34.6	3.5	6.1	5.5	0.6	0.00635	0.00639	0.00637	0.00105	5,224
	COLUMN AVERAGE			37.9	34.4	3.5	6.0	5.5	0.6	0.00635	0.00638	0.00636	0.00105	5,203
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	16

Source: Shawnee Description: Bottom Ash 95% Standard Dry Density at Optimum Moisture Content

SEQUENCE 14	2.0	8.0	1	50.3	45.6	4.8	8.0	7.2	0.8	0.00752	0.00758	0.00755	0.00125	5,806
			2	50.5	45.8	4.7	8.0	7.3	0.8	0.00754	0.00761	0.00758	0.00125	5,813
			3	50.5	45.7	4.7	8.0	7.3	0.8	0.00753	0.00761	0.00757	0.00125	5,818
			4	50.4	45.7	4.7	8.0	7.3	0.7	0.00751	0.00762	0.00757	0.00125	5,814
			5	50.6	45.9	4.7	8.0	7.3	0.7	0.00754	0.00761	0.00757	0.00125	5,831
	COLUMN AVERAGE			50.5	45.7	4.7	8.0	7.3	0.8	0.00753	0.00761	0.00757	0.00125	5,816
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	9
SEQUENCE 15	2.0	10.0	1	63.5	57.5	6.0	10.1	9.1	1.0	0.00853	0.00865	0.00859	0.00142	6,439
			2	63.4	57.4	6.0	10.1	9.1	1.0	0.00851	0.00865	0.00858	0.00142	6,441
			3	63.7	57.7	6.0	10.1	9.2	1.0	0.00852	0.00865	0.00859	0.00142	6,461
			4	63.7	57.7	6.0	10.1	9.2	1.0	0.00852	0.00867	0.00860	0.00142	6,461
			5	63.5	57.4	6.0	10.1	9.1	1.0	0.00852	0.00866	0.00859	0.00142	6,432
	COLUMN AVERAGE			63.6	57.5	6.0	10.1	9.1	1.0	0.00852	0.00866	0.00859	0.00142	6,447
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	13

SUBMITTED BY, DATE

RJ Burnham 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:* Shawnee
2. *MATERIAL DESCRIPTION:* Bottom Ash
3. *REMOLDING TARGETS:* 95% Standard Dry Density at Optimum Moisture Content
4. *MATERIAL TYPE* 2
5. *TEST DATE* 08-18-1995

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

K1 =	1,928
K2 =	0.11134
K5 =	0.73640
R^2 =	0.92

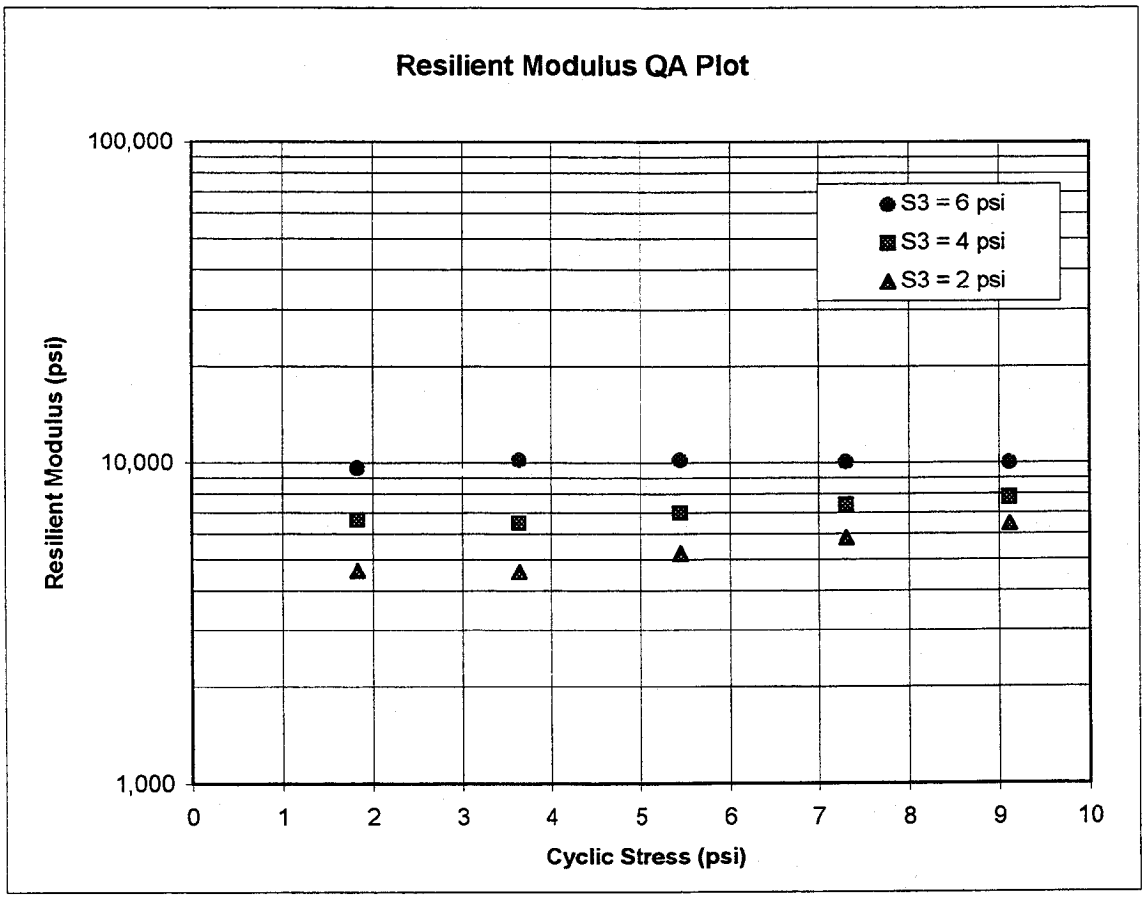
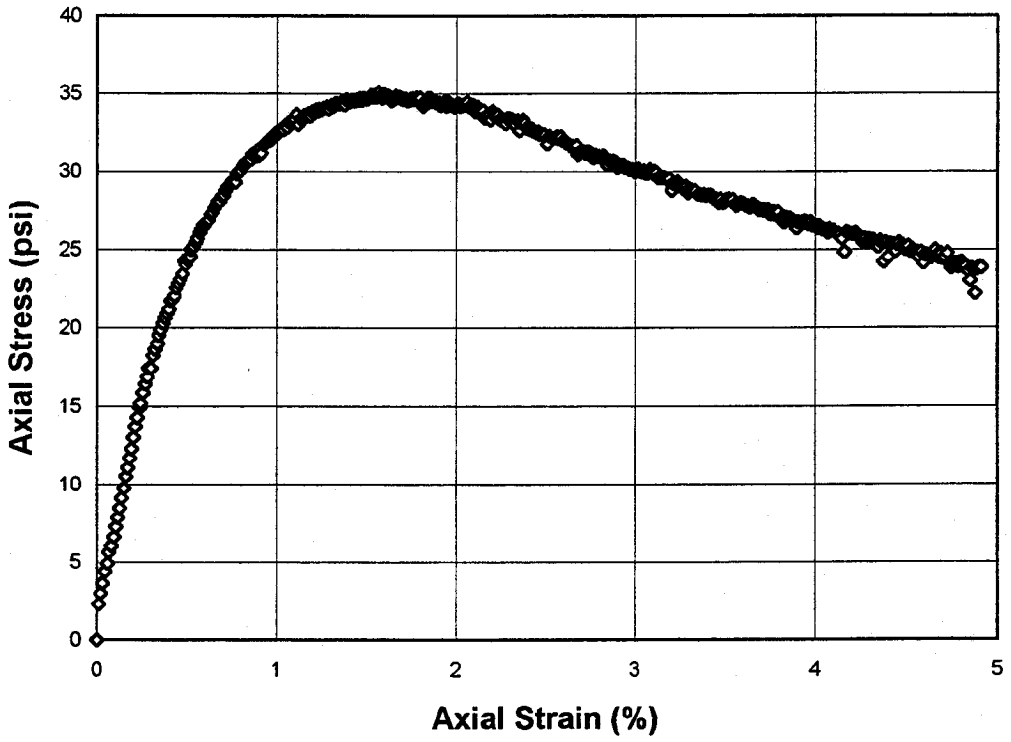


FIGURE 2 - Quick Shear Stress vs Strain

PROJECT NAME:		TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study
LAW PROJECT NO.:		5810860101
1.	*MATERIAL SOURCE:*	Shawnee
2.	*MATERIAL DESCRIPTION:*	Bottom Ash
3.	*REMOLDING TARGETS:*	95% Standard Dry Density at Optimum Moisture Content
4.	*MATERIAL TYPE*	2
5.	*TEST DATE*	08-18-1995



LABORATORY MATERIAL HANDLING AND TESTING SHEET NO 1 OF 2

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:*	Shawnee
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	6.11
	HEIGHT OF CAP AND BASE, inch	0.00
	INITIAL LENGTH, L_0 , inch	6.11
	INITIAL AREA, A_0 , in^2	6.31
	INITIAL VOLUME $A_0 L_0$, in^3	38.53
7.	*SOIL SPECIMEN WEIGHT*:	
	INITIAL WEIGHT OF CONTAINER AND WET SOIL, grams	1268.40
	FINAL WEIGHT OF CONTAINER AND WET SOIL, grams	302.80
	WEIGHT OF WET SOIL USED , grams	965.60
8.	*SOIL PROPERTIES .:*	
	IN SITU MOISTURE CONTENT (NUCLEAR), %	N/A
	IN SITU WET DENSITY (NUCLEAR), pcf	N/A
	or	
	OPTIMUM MOISTURE CONTENT, %	26.1
	MAX. DRY DENSITY, pcf	81.4
	95 % MAX. DRY DENSITY, pcf	77.3
9.	*SPECIMEN PROPERTIES:*	
	COMPACTION MOISTURE CONTENT, %	26.8
	MOISTURE CONTENT AFTER RESILIENT MODULUS TESTING, %	26.8
	COMPACTION DRY DENSITY, γ_d pcf	75.2
10.	*QUICK SHEAR TEST*	
	STRESS - STRAIN PLOT ATTACHED (Y = YES, N = NO)	Y
	TRIAXIAL SHEAR MAXIMUM STRENGTH (MAX. LOAD/X-SECTION AREA), psi	48.7
	SPECIMEN FAIL DURING TRIAXIAL SHEAR? (Y = YES, N = NO)	Y
11.	*COMMENTS* (Section 10.4 of Protocol P46)	
	(a) *CODE*	0 0 0 0 0 0
	(b) *NOTE*	
12.	*TEST DATE*	08-21-1995

GENERAL REMARKS:

SUBMITTED BY, DATE

R S Boncheva 9/10/95

LABORATORY MANAGER

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study
LAW PROJECT NO.: 5810860101
1. *MATERIAL SOURCE:* Shawnee
2. *MATERIAL DESCRIPTION:* Bottom Ash
3. *REMOLDING TARGETS:* 95% Modified Dry Density at Optimum Moisture Content
4. *MATERIAL TYPE* 2
5. *TEST DATE* 08-21-1995
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	12.3	11.1	1.2	1.9	1.8	0.2	0.00141	0.00136	0.00138	0.00023	7,750
			2	12.4	11.2	1.2	2.0	1.8	0.2	0.00139	0.00138	0.00139	0.00023	7,797
			3	12.4	11.2	1.2	2.0	1.8	0.2	0.00141	0.00137	0.00139	0.00023	7,818
			4	12.3	11.1	1.2	2.0	1.8	0.2	0.00141	0.00136	0.00138	0.00023	7,798
			5	12.4	11.2	1.2	2.0	1.8	0.2	0.00139	0.00137	0.00138	0.00023	7,837
	COLUMN AVERAGE			12.3	11.1	1.2	2.0	1.8	0.2	0.00140	0.00137	0.00138	0.00023	7,800
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00000	0.00000	33

Source: Shawnee Description: Bottom Ash 95% Modified Dry Density at Optimum Moisture Content

SEQUENCE 2	6.0	4.0	1	25.3	22.9	2.3	4.0	3.6	0.4	0.00266	0.00263	0.00264	0.00043	8,410
			2	25.3	22.9	2.4	4.0	3.6	0.4	0.00267	0.00264	0.00266	0.00044	8,355
			3	25.3	22.9	2.3	4.0	3.6	0.4	0.00268	0.00263	0.00265	0.00043	8,376
			4	25.3	22.9	2.3	4.0	3.6	0.4	0.00267	0.00264	0.00266	0.00043	8,361
			5	25.3	23.0	2.3	4.0	3.6	0.4	0.00268	0.00264	0.00266	0.00044	8,373
	COLUMN AVERAGE			25.3	22.9	2.3	4.0	3.6	0.4	0.00267	0.00263	0.00265	0.00043	8,375
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	21
SEQUENCE 3	6.0	6.0	1	38.0	34.4	3.5	6.0	5.5	0.6	0.00412	0.00407	0.00409	0.00067	8,144
			2	38.0	34.4	3.5	6.0	5.5	0.6	0.00411	0.00407	0.00409	0.00067	8,158
			3	38.0	34.4	3.6	6.0	5.5	0.6	0.00412	0.00406	0.00409	0.00067	8,161
			4	38.0	34.4	3.6	6.0	5.5	0.6	0.00413	0.00406	0.00409	0.00067	8,151
			5	38.1	34.5	3.6	6.0	5.5	0.6	0.00412	0.00407	0.00409	0.00067	8,174
	COLUMN AVERAGE			38.0	34.5	3.6	6.0	5.5	0.6	0.00412	0.00406	0.00409	0.00067	8,158
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00000	0.00000	11
SEQUENCE 4	6.0	8.0	1	50.7	46.0	4.8	8.0	7.3	0.8	0.00554	0.00555	0.00555	0.00091	8,030
			2	50.6	45.8	4.8	8.0	7.3	0.8	0.00557	0.00555	0.00556	0.00091	7,978
			3	50.7	45.9	4.8	8.0	7.3	0.8	0.00557	0.00556	0.00557	0.00091	7,982
			4	50.7	45.9	4.8	8.0	7.3	0.8	0.00558	0.00557	0.00557	0.00091	7,982
			5	50.7	45.9	4.8	8.0	7.3	0.8	0.00559	0.00554	0.00556	0.00091	7,996
	COLUMN AVERAGE			50.7	45.9	4.8	8.0	7.3	0.8	0.00557	0.00555	0.00556	0.00091	7,994
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00002	0.00001	0.00001	0.00000	21

Source: Shawnee Description: Bottom Ash 95% Modified Dry Density at Optimum Moisture Content

SEQUENCE 5	6.0	10.0	1	63.4	57.4	6.1	10.1	9.1	1.0	0.00697	0.00701	0.00699	0.00114	7,952
			2	63.4	57.4	6.1	10.1	9.1	1.0	0.00698	0.00699	0.00698	0.00114	7,962
			3	63.4	57.3	6.0	10.0	9.1	1.0	0.00697	0.00698	0.00698	0.00114	7,959
			4	63.5	57.4	6.1	10.1	9.1	1.0	0.00696	0.00699	0.00698	0.00114	7,965
			5	63.3	57.3	6.1	10.0	9.1	1.0	0.00697	0.00696	0.00696	0.00114	7,967
	COLUMN AVERAGE			63.4	57.3	6.1	10.1	9.1	1.0	0.00697	0.00699	0.00698	0.00114	7,961
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00002	0.00001	0.00000	6
SEQUENCE 6	4.0	2.0	1	12.6	11.0	1.6	2.0	1.7	0.3	0.00195	0.00191	0.00193	0.00032	5,532
			2	12.6	11.0	1.6	2.0	1.7	0.3	0.00194	0.00192	0.00193	0.00032	5,545
			3	12.6	10.9	1.6	2.0	1.7	0.3	0.00192	0.00190	0.00191	0.00031	5,543
			4	12.7	11.1	1.6	2.0	1.8	0.3	0.00195	0.00192	0.00193	0.00032	5,561
			5	12.7	11.1	1.6	2.0	1.8	0.3	0.00194	0.00193	0.00193	0.00032	5,547
	COLUMN AVERAGE			12.6	11.0	1.6	2.0	1.7	0.3	0.00194	0.00191	0.00193	0.00032	5,546
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	10
SEQUENCE 7	4.0	4.0	1	24.6	22.3	2.3	3.9	3.5	0.4	0.00404	0.00402	0.00403	0.00066	5,357
			2	24.6	22.4	2.2	3.9	3.5	0.4	0.00406	0.00402	0.00404	0.00066	5,363
			3	24.6	22.4	2.2	3.9	3.5	0.4	0.00406	0.00402	0.00404	0.00066	5,370
			4	24.6	22.3	2.3	3.9	3.5	0.4	0.00406	0.00402	0.00404	0.00066	5,338
			5	24.5	22.3	2.3	3.9	3.5	0.4	0.00409	0.00402	0.00406	0.00066	5,317
	COLUMN AVERAGE			24.6	22.3	2.3	3.9	3.5	0.4	0.00406	0.00402	0.00404	0.00066	5,349
	STANDARD DEV.			0.0	0.1	0.0	0.0	0.0	0.0	0.00002	0.00000	0.00001	0.00000	22

Source: Shawnee Description: Bottom Ash 95% Modified Dry Density at Optimum Moisture Content

SEQUENCE 8	4.0	6.0	1	37.5	34.0	3.5	6.0	5.4	0.6	0.00580	0.00580	0.00580	0.00095	5,681
			2	37.5	34.0	3.5	6.0	5.4	0.6	0.00581	0.00578	0.00579	0.00095	5,689
			3	37.6	34.1	3.5	6.0	5.4	0.6	0.00581	0.00578	0.00579	0.00095	5,698
			4	37.5	34.0	3.5	5.9	5.4	0.5	0.00579	0.00578	0.00578	0.00095	5,705
			5	37.5	34.0	3.5	5.9	5.4	0.5	0.00579	0.00578	0.00579	0.00095	5,700
	COLUMN AVERAGE			37.5	34.0	3.5	6.0	5.4	0.6	0.00580	0.00578	0.00579	0.00095	5,695
	STANDARD DEV.			0.0	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	50.1	45.4	4.8	7.9	7.2	0.8	0.00733	0.00733	0.00733	0.00120	5,994
			2	50.3	45.4	4.8	8.0	7.2	0.8	0.00733	0.00735	0.00734	0.00120	5,996
			3	50.3	45.5	4.8	8.0	7.2	0.8	0.00734	0.00735	0.00735	0.00120	6,003
			4	50.2	45.4	4.8	8.0	7.2	0.8	0.00734	0.00733	0.00734	0.00120	5,995
			5	50.3	45.5	4.8	8.0	7.2	0.8	0.00735	0.00736	0.00735	0.00120	5,994
	COLUMN AVERAGE			50.2	45.4	4.8	8.0	7.2	0.8	0.00734	0.00735	0.00734	0.00120	5,996
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	4
SEQUENCE 10	4.0	10.0	1	62.9	56.9	6.0	10.0	9.0	1.0	0.00893	0.00894	0.00894	0.00146	6,170
			2	62.9	56.9	6.0	10.0	9.0	1.0	0.00893	0.00893	0.00893	0.00146	6,169
			3	62.9	56.9	6.0	10.0	9.0	1.0	0.00892	0.00894	0.00893	0.00146	6,173
			4	62.9	56.8	6.0	10.0	9.0	1.0	0.00892	0.00893	0.00893	0.00146	6,169
			5	62.9	56.9	6.0	10.0	9.0	1.0	0.00893	0.00895	0.00894	0.00146	6,166
	COLUMN AVERAGE			62.9	56.9	6.0	10.0	9.0	1.0	0.00893	0.00894	0.00893	0.00146	6,169
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	3

Source: Shawnee Description: Bottom Ash 95% Modified Dry Density at Optimum Moisture Content

SEQUENCE 11	2.0	2.0	1	12.3	10.4	2.0	2.0	1.6	0.3	0.00271	0.00270	0.00271	0.00044	3,709
			2	12.3	10.3	2.0	2.0	1.6	0.3	0.00270	0.00269	0.00269	0.00044	3,707
			3	12.3	10.3	2.0	2.0	1.6	0.3	0.00271	0.00269	0.00270	0.00044	3,704
			4	12.4	10.4	2.0	2.0	1.6	0.3	0.00272	0.00269	0.00270	0.00044	3,728
			5	12.3	10.3	2.0	2.0	1.6	0.3	0.00270	0.00269	0.00270	0.00044	3,698
	COLUMN AVERAGE			12.3	10.3	2.0	2.0	1.6	0.3	0.00271	0.00269	0.00270	0.00044	3,709
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00000	0.00000	0.00000	12
SEQUENCE 12	2.0	4.0	1	25.0	22.7	2.3	4.0	3.6	0.4	0.00598	0.00596	0.00597	0.00098	3,682
			2	25.2	22.9	2.3	4.0	3.6	0.4	0.00599	0.00596	0.00597	0.00098	3,710
			3	25.1	22.8	2.3	4.0	3.6	0.4	0.00597	0.00598	0.00597	0.00098	3,697
			4	25.1	22.7	2.3	4.0	3.6	0.4	0.00596	0.00594	0.00595	0.00097	3,700
			5	25.2	22.8	2.3	4.0	3.6	0.4	0.00596	0.00594	0.00595	0.00097	3,717
	COLUMN AVERAGE			25.1	22.8	2.3	4.0	3.6	0.4	0.00597	0.00595	0.00596	0.00098	3,701
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00002	0.00001	0.00000	13
SEQUENCE 13	2.0	6.0	1	38.2	34.7	3.5	6.1	5.5	0.6	0.00811	0.00811	0.00811	0.00133	4,143
			2	38.2	34.7	3.5	6.1	5.5	0.6	0.00809	0.00809	0.00809	0.00132	4,150
			3	38.2	34.7	3.6	6.1	5.5	0.6	0.00809	0.00809	0.00809	0.00132	4,149
			4	38.4	34.8	3.6	6.1	5.5	0.6	0.00812	0.00811	0.00811	0.00133	4,156
			5	38.4	34.8	3.6	6.1	5.5	0.6	0.00812	0.00811	0.00812	0.00133	4,157
	COLUMN AVERAGE			38.3	34.7	3.5	6.1	5.5	0.6	0.00811	0.00810	0.00810	0.00133	4,151
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00002	0.00001	0.00001	0.00000	6

Source: Shawnee Description: Bottom Ash 95% Modified Dry Density at Optimum Moisture Content

SEQUENCE 14	2.0	8.0	1	51.0	46.2	4.8	8.1	7.3	0.8	0.00984	0.00986	0.00985	0.00161	4,543
			2	51.0	46.2	4.8	8.1	7.3	0.8	0.00985	0.00987	0.00986	0.00161	4,537
			3	51.0	46.2	4.8	8.1	7.3	0.8	0.00986	0.00988	0.00987	0.00162	4,539
			4	50.9	46.2	4.8	8.1	7.3	0.8	0.00985	0.00986	0.00985	0.00161	4,538
			5	51.0	46.3	4.8	8.1	7.3	0.8	0.00985	0.00986	0.00986	0.00161	4,547
	COLUMN AVERAGE			51.0	46.2	4.8	8.1	7.3	0.8	0.00985	0.00987	0.00986	0.00161	4,541
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	4
SEQUENCE 15	2.0	10.0	1	63.8	57.8	6.0	10.1	9.2	1.0	0.01139	0.01139	0.01139	0.00186	4,915
			2	63.8	57.8	6.0	10.1	9.2	1.0	0.01140	0.01139	0.01139	0.00187	4,911
			3	63.6	57.7	6.0	10.1	9.1	0.9	0.01140	0.01138	0.01139	0.00186	4,904
			4	63.5	57.5	6.0	10.1	9.1	0.9	0.01139	0.01141	0.01140	0.00187	4,891
			5	63.6	57.6	6.0	10.1	9.1	1.0	0.01140	0.01142	0.01141	0.00187	4,886
	COLUMN AVERAGE			63.7	57.7	6.0	10.1	9.1	1.0	0.01140	0.01140	0.01140	0.00187	4,902
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00002	0.00001	0.00000	12

SUBMITTED BY, DATE

RY Bachman 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:*	Shawnee
2.	*MATERIAL DESCRIPTION:*	Bottom Ash
3.	*REMOLDING TARGETS:*	95% Modified Dry Density at Optimum Moisture Content
4.	*MATERIAL TYPE*	2
5.	*TEST DATE*	08-21-1995

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

K1 =	1,558
K2 =	0.08323
K5 =	0.76224
R^2 =	0.95

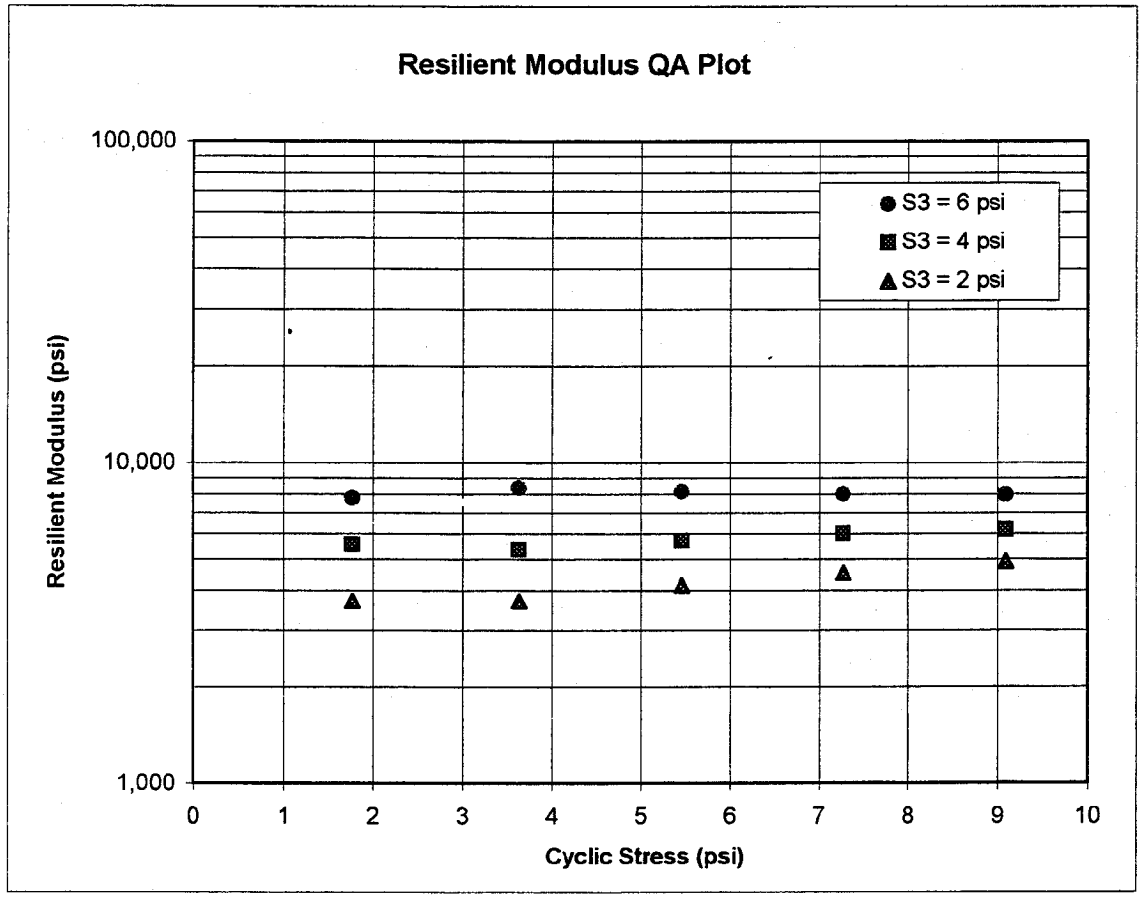
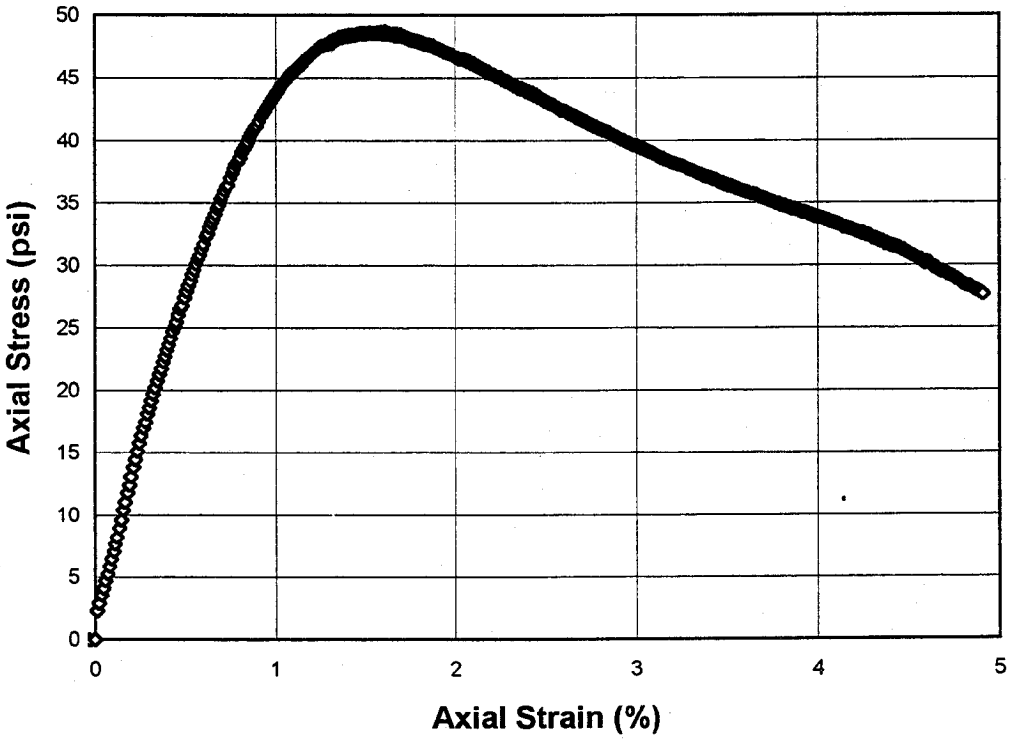


FIGURE 2 - Quick Shear Stress vs Strain

PROJECT NAME:		TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study
LAW PROJECT NO.:		5810860101
1.	*MATERIAL SOURCE:*	Shawnee
2.	*MATERIAL DESCRIPTION:*	Bottom Ash
3.	*REMOLDING TARGETS:*	95% Modified Dry Density at Optimum Moisture Content
4.	*MATERIAL TYPE*	2
5.	*TEST DATE*	08-21-1995



SHAWNEE

Spent Bed Material (SBM)

(Physical Tests Not Performed.)

TVA - SHAWNEE
SPENT BED MATERIAL (SBM)

Description	Test Method	Property	Sample 1	Sample 2	Sample 3
Grain Size	ASTM D 422	Percent Retained on the #4 Sieve Percent Passing the #200 Sieve Percent Passing the 0.005 mm Sieve	t.n.p. t.n.p. t.n.p.	t.n.p. t.n.p. t.n.p.	t.n.p. t.n.p. t.n.p.
Atterberg Limits	ASTM D 4318	Liquid Limit Plastic Limit Plasticity Index	NL NP N/A	NL NP N/A	NL NP N/A
Specific Gravity	ASTM D 854	Specific Gravity at 20°C	t.n.p.	t.n.p.	t.n.p.
Classification	ASTM D 2487 AASHTO M 145	Unified Soil Classification System (USCS) AASHTO Classification	t.n.p. t.n.p.	t.n.p. t.n.p.	t.n.p. t.n.p.
			Composite Sample		
Moisture-Density Relations (Standard Effort)	ASTM D 698	Maximum Dry Density, pcf Optimum Moisture Content, %	t.n.p. t.n.p.		
Moisture-Density Relations (Modified Effort)	ASTM D 1557	Maximum Dry Density, pcf Optimum Moisture Content, %	t.n.p. t.n.p.		
			Result	Dry Density, pcf	Moisture Content, %
Consolidation	ASTM D2435	Compression Index C_c	t.n.p.	t.n.p.	t.n.p.
Hydraulic Conductivity	ASTM D 5084	Hydraulic Conductivity, cm/sec	t.n.p.	t.n.p.	t.n.p.
Triaxial Shear Strength Consolidated-Undrained (CU)	ASTM D4767	Effective Stress, Cohesion, c', ksf Effective Stress, Internal Friction Angle, ϕ', degrees	t.n.p. t.n.p.	t.n.p.	t.n.p.
		Total Stress, Cohesion, c, ksf Total Stress, Internal Friction Angle, ϕ, degrees	t.n.p. t.n.p.	t.n.p.	t.n.p.
Direct Shear Strength	ASTM D 3080	Cohesion, c, ksf Internal Friction Angle, ϕ, degrees	t.n.p. t.n.p.	t.n.p.	t.n.p.
California Bearing Ratio	ASTM D 1883	CBR, %	t.n.p.	t.n.p.	t.n.p.
Resilient Modulus (Standard Compactive Effort)	SHRP P46	Resilient Modulus at 4psi axial stress and 4psi confining pressure	t.n.p.	t.n.p.	t.n.p.
Resilient Modulus (Modified Compactive Effort)	SHRP P46	Resilient Modulus at 4psi axial stress and 4psi confining pressure	t.n.p.	t.n.p.	t.n.p.
Soil Resistivity	AASHTO T 288	Minimum Resistivity, Ohm-cm	t.n.p.		
pH of Soil	AASHTO T 289	pH	12.0		
Water Soluble Sulfate Ion	AASHTO T 290	Sulfate Ion Content, mg/kg	4190		
Water Soluble Chloride Ion	AASHTO T 290	Chloride Ion Content, mg/kg	150		

t.n.p. = test not performed

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SHAWNEE

Char

(Physical Tests Not Performed.)

TVA - SHAWNEE
CHAR

Description	Test Method	Property	Sample 1	Sample 2	Sample 3
Grain Size	ASTM D 422	Percent Retained on the #4 Sieve	t.n.p.	t.n.p.	t.n.p.
		Percent Passing the #200 Sieve	t.n.p.	t.n.p.	t.n.p.
		Percent Passing the 0.005 mm Sieve	t.n.p.	t.n.p.	t.n.p.
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	t.n.p.	t.n.p.	t.n.p.
Classification	ASTM D 2487	Unified Soil Classification System (USCS)	t.n.p.	t.n.p.	t.n.p.
	AASHTO M 145	AASHTO Classification	t.n.p.	t.n.p.	t.n.p.
			Composite Sample		
Moisture-Density Relations (Standard Effort)	ASTM D 698	Maximum Dry Density, pcf	t.n.p.		
		Optimum Moisture Content, %	t.n.p.		
Moisture-Density Relations (Modified Effort)	ASTM D 1557	Maximum Dry Density, pcf	t.n.p.		
		Optimum Moisture Content, %	t.n.p.		
			Result	Dry Density, pcf	Moisture Content, %
Consolidation	ASTM D2435	Compression Index C_c	t.n.p.	t.n.p.	t.n.p.
Hydraulic Conductivity	ASTM D 5084	Hydraulic Conductivity, cm/sec	t.n.p.	t.n.p.	t.n.p.
Triaxial Shear Strength Consolidated-Undrained (CU)	ASTM D4767	Effective Stress, Cohesion, c', ksf	t.n.p.	t.n.p.	t.n.p.
		Effective Stress, Internal Friction Angle, ϕ', degrees	t.n.p.		
		Total Stress, Cohesion, c, ksf	t.n.p.	t.n.p.	t.n.p.
		Total Stress, Internal Friction Angle, ϕ, degrees	t.n.p.		
Direct Shear Strength	ASTM D 3080	Cohesion, c, ksf	t.n.p.	t.n.p.	t.n.p.
		Internal Friction Angle, ϕ, degrees	t.n.p.		
California Bearing Ratio	ASTM D 1883	CBR, %	t.n.p.	t.n.p.	t.n.p.
Resilient Modulus (Standard Compactive Effort)	SHRP P46	Resilient Modulus at 4psi axial stress and 4psi confining pressure	t.n.p.	t.n.p.	t.n.p.
Resilient Modulus (Modified Compactive Effort)	SHRP P46	Resilient Modulus at 4psi axial stress and 4psi confining pressure	t.n.p.	t.n.p.	t.n.p.
Soil Resistivity	AASHTO T 288	Minimum Resistivity, Ohm-cm	190		
pH of Soil	AASHTO T 289	pH	12.0		
Water Soluble Sulfate Ion	AASHTO T 290	Sulfate Ion Content, mg/kg	4130		
Water Soluble Chloride Ion	AASHTO T 290	Chloride Ion Content, mg/kg	980		

t.n.p. = test not performed

shf-char.xls