

# **COLBERT**

*Dry Fly Ash (Units 1-4)  
Bottom Ash - From Pond*



# COLBERT

## *Dry Fly Ash (Units 1-4)*

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)



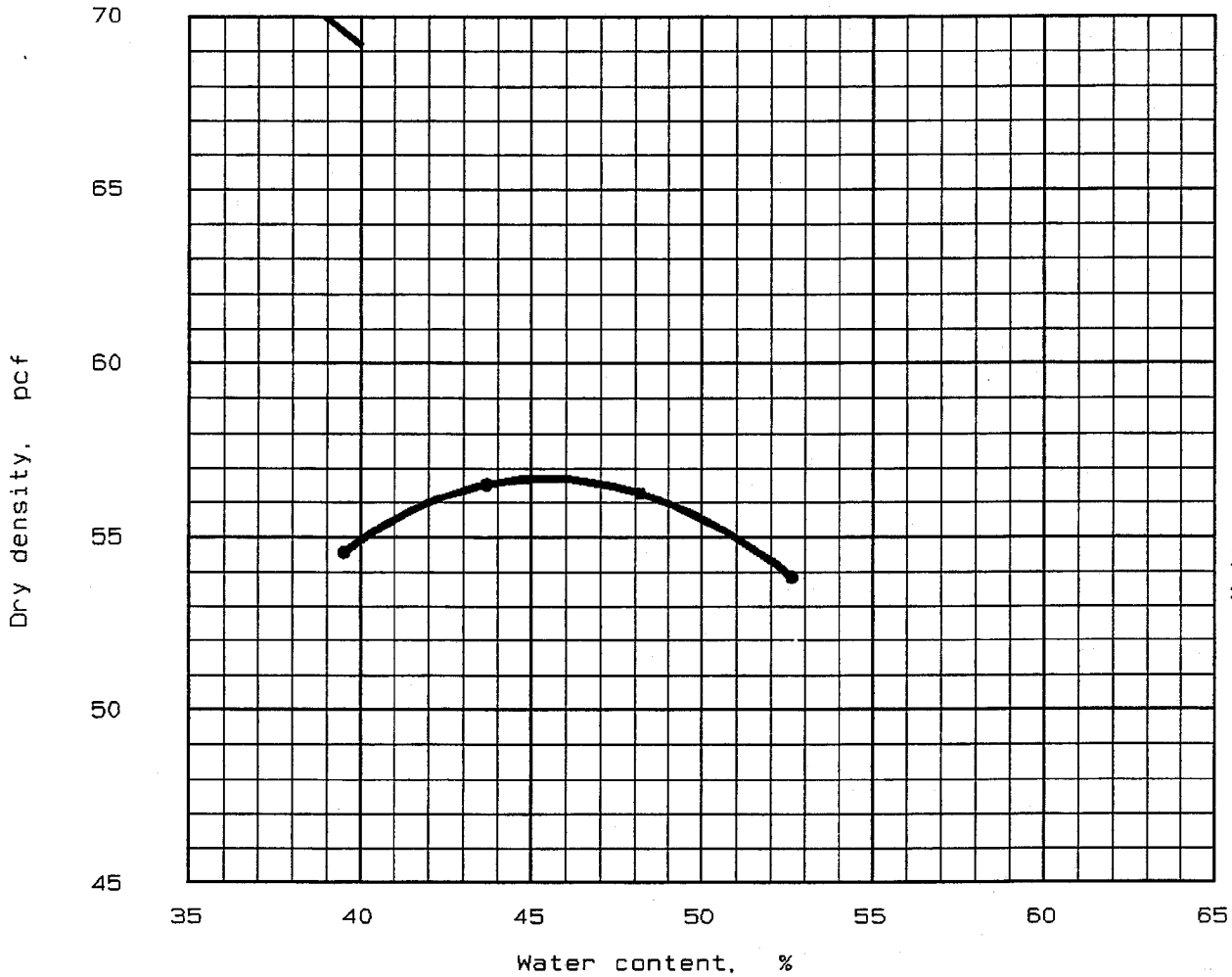
**TVA - COLBERT  
DRY FLY ASH (UNITS 1-4)**

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	81.6	69.9	83.6
		Percent Passing the 0.005 mm Sieve	14.9	11.5	3.9
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	2.02	2.00	1.95
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)
<b>Composite Sample</b>					
Moisture-Density Relations (Standard Effort)	ASTM D 698	Maximum Dry Density, pcf	56.7		
		Optimum Moisture Content, %	45.4		
Moisture-Density Relations (Modified Effort)	ASTM D 1557	Maximum Dry Density, pcf	62.9		
		Optimum Moisture Content, %	40.3		
			<b>Result</b>	<b>Dry Density, pcf</b>	<b>Moisture Content, %</b>
Consolidation	ASTM D2435	Compression Index $C_c$	0.08	52.5	45.6
Hydraulic Conductivity	ASTM D 5084	Hydraulic Conductivity, cm/sec	2.8E-4	54.0	44.2
Triaxial Shear Strength Consolidated-Undrained (CU)	ASTM D4767	Effective Stress, Cohesion, $c'$ , ksf	0.34	54.0	44.2
		Effective Stress, Internal Friction Angle, $\phi'$ , degrees	27.6		
		Total Stress, Cohesion, $c$ , ksf	0.69	54.0	44.2
		Total Stress, Internal Friction Angle, $\phi$ , degrees	19.9		
Direct Shear Strength	ASTM D 3080	Cohesion, $c$ , ksf	1.31	53.3	47.8
		Internal Friction Angle, $\phi$ , degrees	28.6		
California Bearing Ratio	ASTM D 1883	CBR, %	9	56.6	45.4
Resilient Modulus (Standard Compactive Effort)	SHRP P46	Resilient Modulus at 4psi axial stress and 4psi confining pressure	2,918	52.2	44.8
Resilient Modulus (Modified Compactive Effort)	SHRP P46	Resilient Modulus at 4psi axial stress and 4psi confining pressure	3,480	55.9	39.5
Soil Resistivity	AASHTO T 288	Minimum Resistivity, Ohm-cm	850		
pH of Soil	AASHTO T 289	pH	9.4		
Water Soluble Sulfate Ion	AASHTO T 290	Sulfate Ion Content, mg/kg	1660		
Water Soluble Chloride Ion	AASHTO T 290	Chloride Ion Content, mg/kg	<10		

cof-fa.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						
	ML	A-4 (0.0)	.050 %	1.99	NL	NP	0 %	78.4 %

TEST RESULTS	MATERIAL DESCRIPTION
Optimum moisture = 45.4 % Maximum dry density = 56.7 pcf	

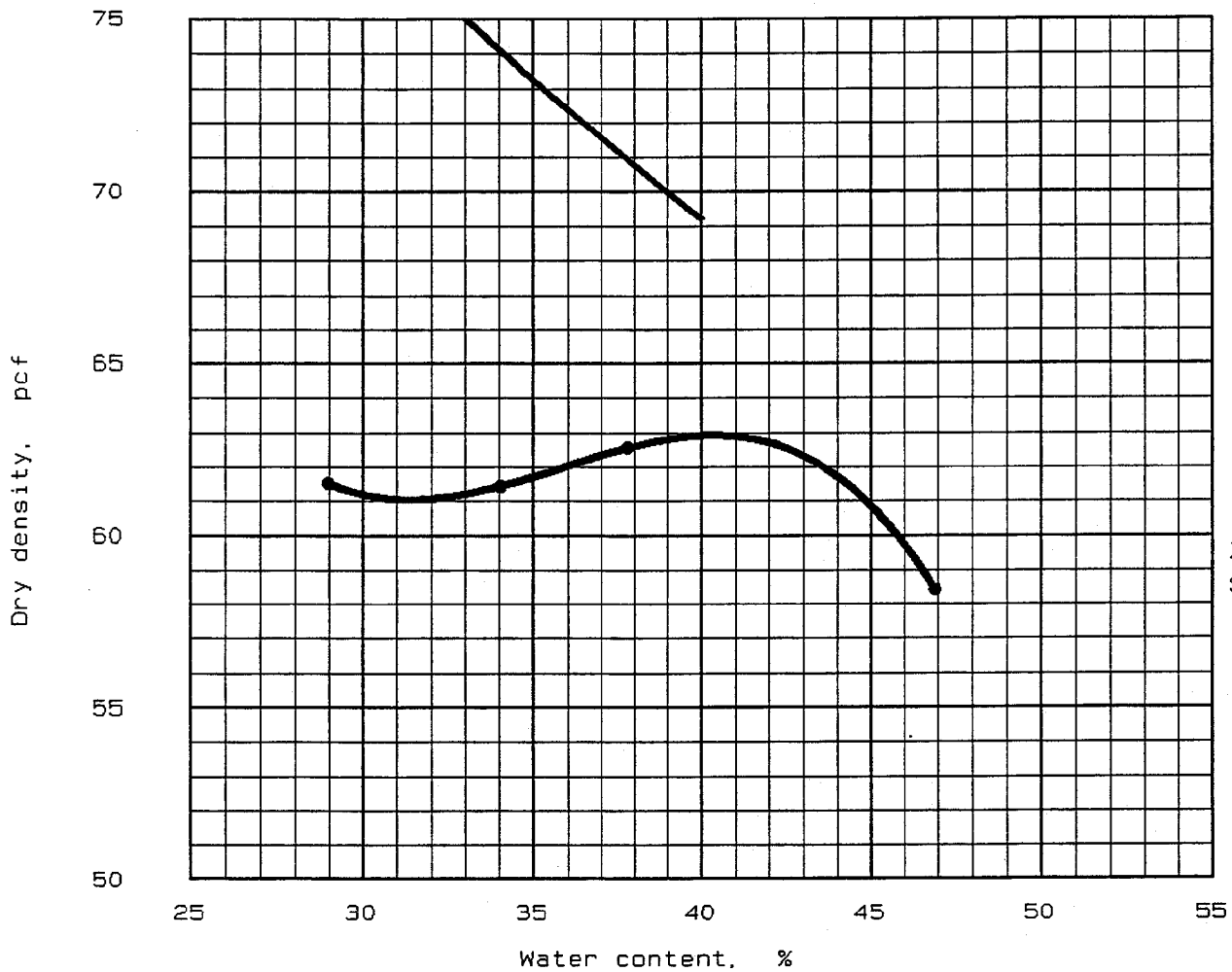
Project No.: 5810860101  
 Project: TVA - Colbert  
 Location: Dry Fly Ash  
 Units 1-4  
 Date: July 25, 1995

Remarks:  
 Tested by: *Joe*  
 Reviewed by: *HS/RB*

MOISTURE-DENSITY RELATIONSHIP  
**LAW ENGINEERING, INC.**

Figure No. \_\_\_\_\_

# MOISTURE-DENSITY RELATIONSHIP



ZAV for  
Sp.G. =  
1.99

"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)	.050 %	1.99	.NL	NP	0 %	78.4 %

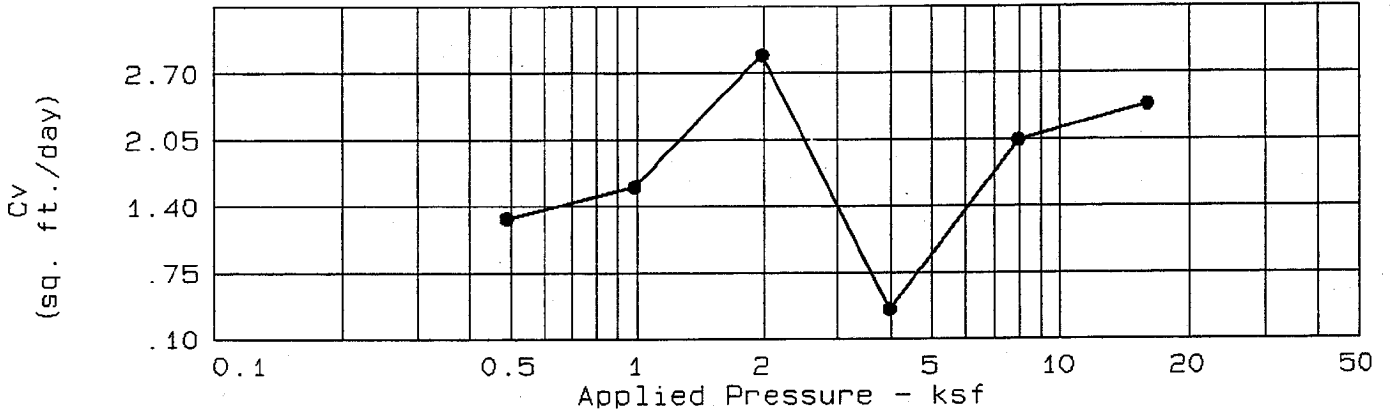
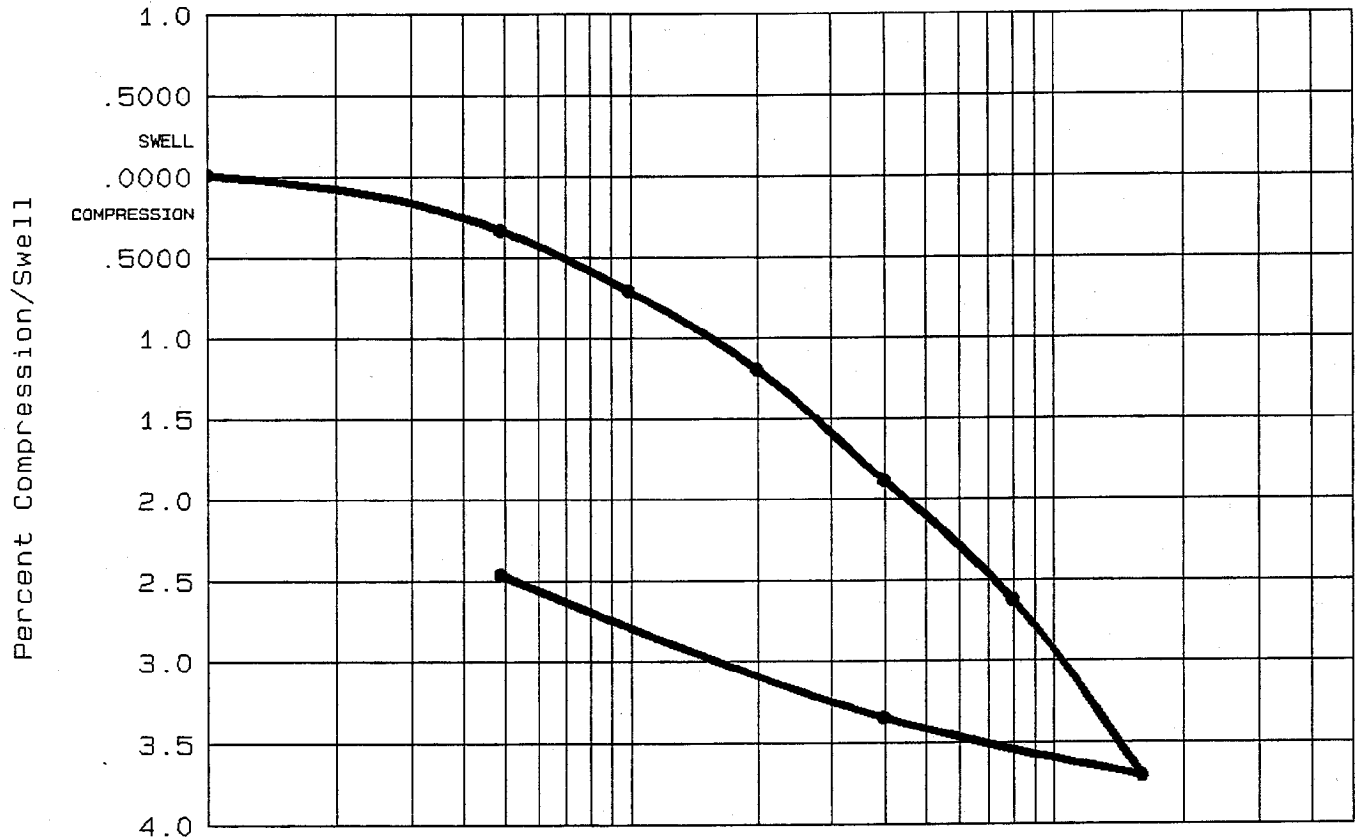
TEST RESULTS	MATERIAL DESCRIPTION
Optimum moisture = 40.3 % Maximum dry density = 62.9 pcf	

Project No.: 5810860101 Project: TVA - Colbert Location: Dry Fly Ash Units 1-4 Date: July 25, 1995	Remarks: Tested by: <i>JCR</i> Reviewed by: <i>RUB</i>
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MOISTURE-DENSITY RELATIONSHIP <b>LAW ENGINEERING, INC.</b>	Figure No. _____
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# CONSOLIDATION TEST REPORT



Natural Saturation	Natural Moisture	Dry Density	LL	PI	Sp. Gr.	Precons. press.	C <sub>c</sub>	e <sub>0</sub>
66.6 %	45.6	52.5	NL	NP	1.990	8.00	0.08	1.3640

TEST RESULTS	MATERIAL DESCRIPTION
<p>Compression Index = 0.08</p> <p>Project No.: 5810860101                      Project: TVA - Colbert                      Location: Dry Fly Ash                      Units 1-4                      Date: July 17, 1995</p> <p style="text-align: center;">CONSOLIDATION TEST REPORT</p> <p style="text-align: center;"><b>LAW ENGINEERING, INC.</b></p>	<p>Class: USCS: ML</p> <p>Remarks:</p> <p>Tested by: <i>Adk</i>                      Reviewed by: <i>IB</i></p> <p>Fig. No. _____</p>

# HYDRAULIC CONDUCTIVITY



Project No. **5810860101**  
Project Name **TVA - Colbert**  
Material (Source) **Dry Fly Ash**  
**(Units 1-4)**

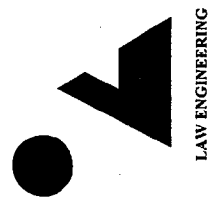
Tested By **HEJ**  
Test Date **05/19/95**  
Reviewed By **RLB**  
Review Date **09/06/95**

## *ASTM D5084 - Falling Head*

Sample Type:	<i>Remolded</i>
Sample Orientation:	<i>Vertical</i>
Initial Water Content, %:	44.2
Wet Unit Weight, pcf:	77.9
Dry Unit Weight, pcf:	54.0
Compaction, %:	95.3
Hydraulic Conductivity, cm/sec. @20 °C:	<b>2.8E-04</b>

**PERMEABILITY TEST - FALLING HEAD**  
**(ASTM D5084 - 90)**

Job Number 5810860101 Tested By HEJ  
 Project Name TVA - Colbert Test Date 05/19/95  
 Material (Source) Dry Fly Ash Reviewed By RLB  
 (Units 1-4) Review Date 09/06/95



Chamber Pressure, psi 47  
 Back Pressure, psi 33  
 Confining Pressure, psi 14

**Sample Data**

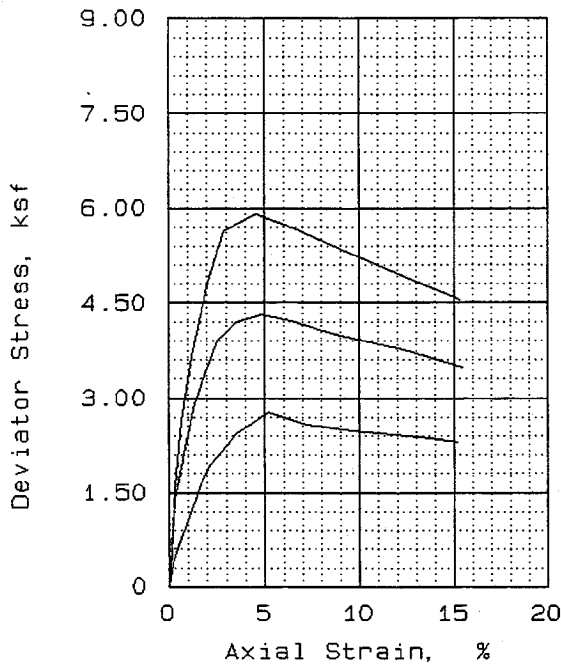
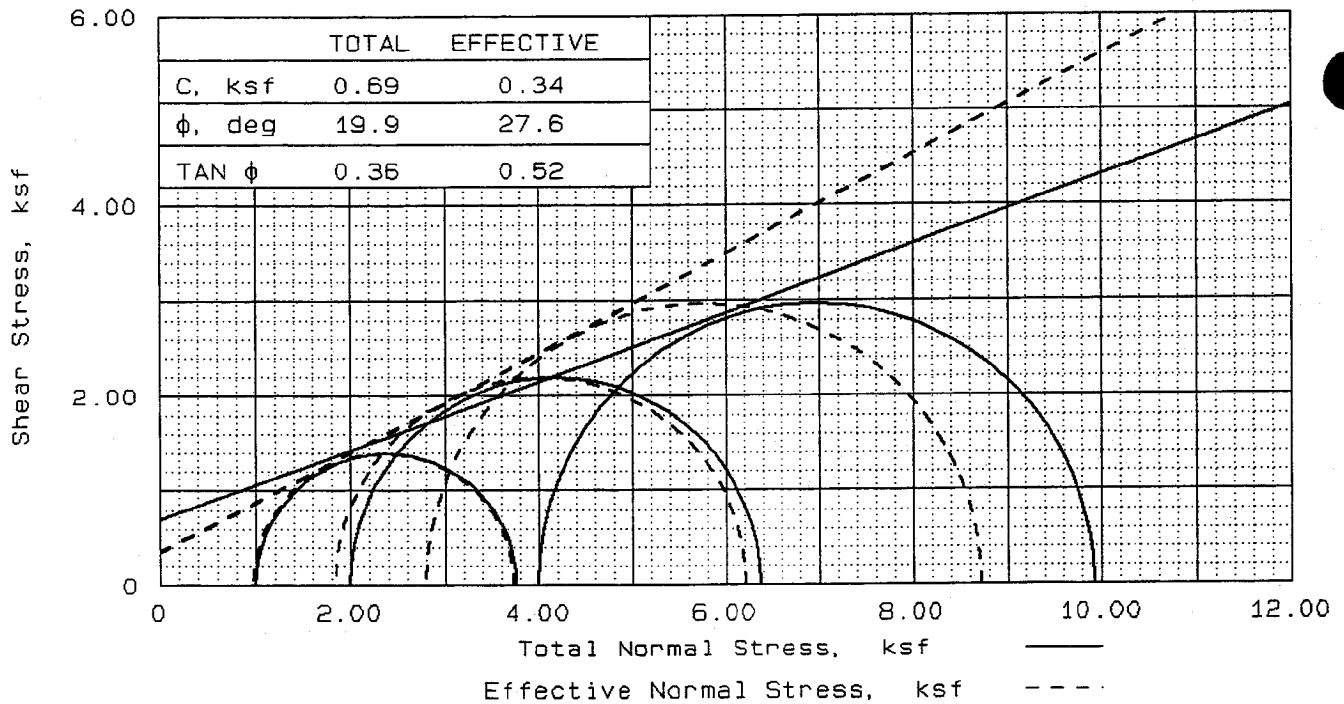
Length, in	Diameter, in	Pan No.
Location 1	Location 1	Dry Soil+Pan, grams
Location 2	Location 2	Pan Weight, grams
Location 3	Location 3	
Average	Average	Moisture Content, %
	Wet Soil + Tare, grams	Wet Unit Wt, pcf
	Tare Weight, grams	Dry Unit Wt, pcf

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
				697	0.0	22.0	54.34	32.34	2.8E-04	21	2.7E-04
				684	0.0	22.0	54.34	32.34	2.9E-04	21	2.8E-04
				692	0.0	22.0	54.34	32.34	2.8E-04	21	2.8E-04

No. of Trial	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
3	Remolded	56.7	95.3	Vertical

**Avg. k at 20 °C 2.8E-04 cm/sec**

a = area of burette in cm<sup>2</sup>      a = 1.00 cm<sup>2</sup>  
 L = length of sample in cm      A = 40.582 cm<sup>2</sup>  
 A = area of sample in cm<sup>2</sup>      L = 15.24 cm  
 H<sub>0</sub> = initial head in cm  
 H<sub>f</sub> = final head in cm  
 t = time in seconds



SAMPLE NO.		1	2	3
INITIAL	WATER CONTENT, %	44.2	44.4	44.1
	DRY DENSITY, pcf	54.0	53.9	54.1
	SATURATION, %	67.7	67.7	67.6
	VOID RATIO	1.299	1.304	1.298
	DIAMETER, in	2.83	2.83	2.83
	HEIGHT, in	6.00	6.00	6.00
AT TEST	WATER CONTENT, %	64.3	64.9	62.2
	DRY DENSITY, pcf	54.5	54.2	55.5
	SATURATION, %	100.0	100.0	100.0
	VOID RATIO	1.279	1.292	1.239
	DIAMETER, in	2.83	2.82	2.81
	HEIGHT, in	5.96	5.99	5.94
BACK PRESSURE, ksf		3.50	3.34	3.79
CELL PRESSURE, ksf		5.50	4.34	7.78
FAILURE STRESS, ksf		4.37	2.77	5.93
PORE PRESSURE, ksf		3.66	3.37	4.98
STRAIN RATE, %/min.		0.100	0.100	0.100
ULTIMATE STRESS, ksf				
PORE PRESSURE, ksf				
$\bar{\sigma}_1$ FAILURE, ksf		6.21	3.74	8.73
$\bar{\sigma}_3$ FAILURE, ksf		1.84	0.97	2.8

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

LL= NL      PL= NP      PI=

SPECIFIC GRAVITY= 1.99

REMARKS: Tested by: *HS*

Reviewed by: *RUB*

FIG. NO.

CLIENT:

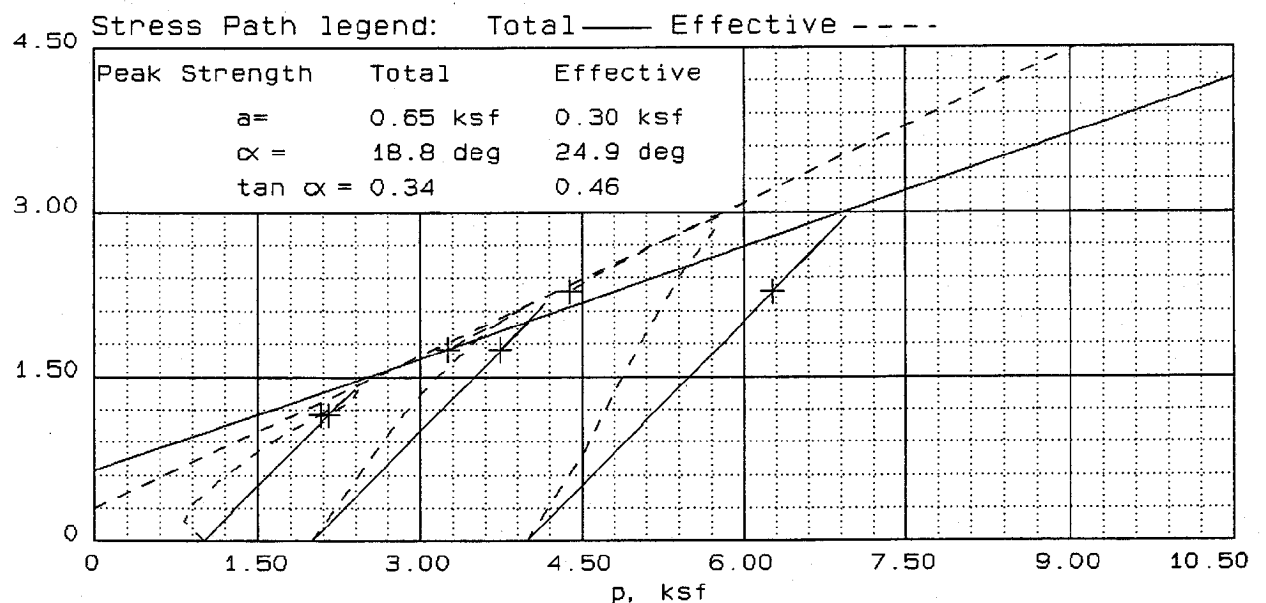
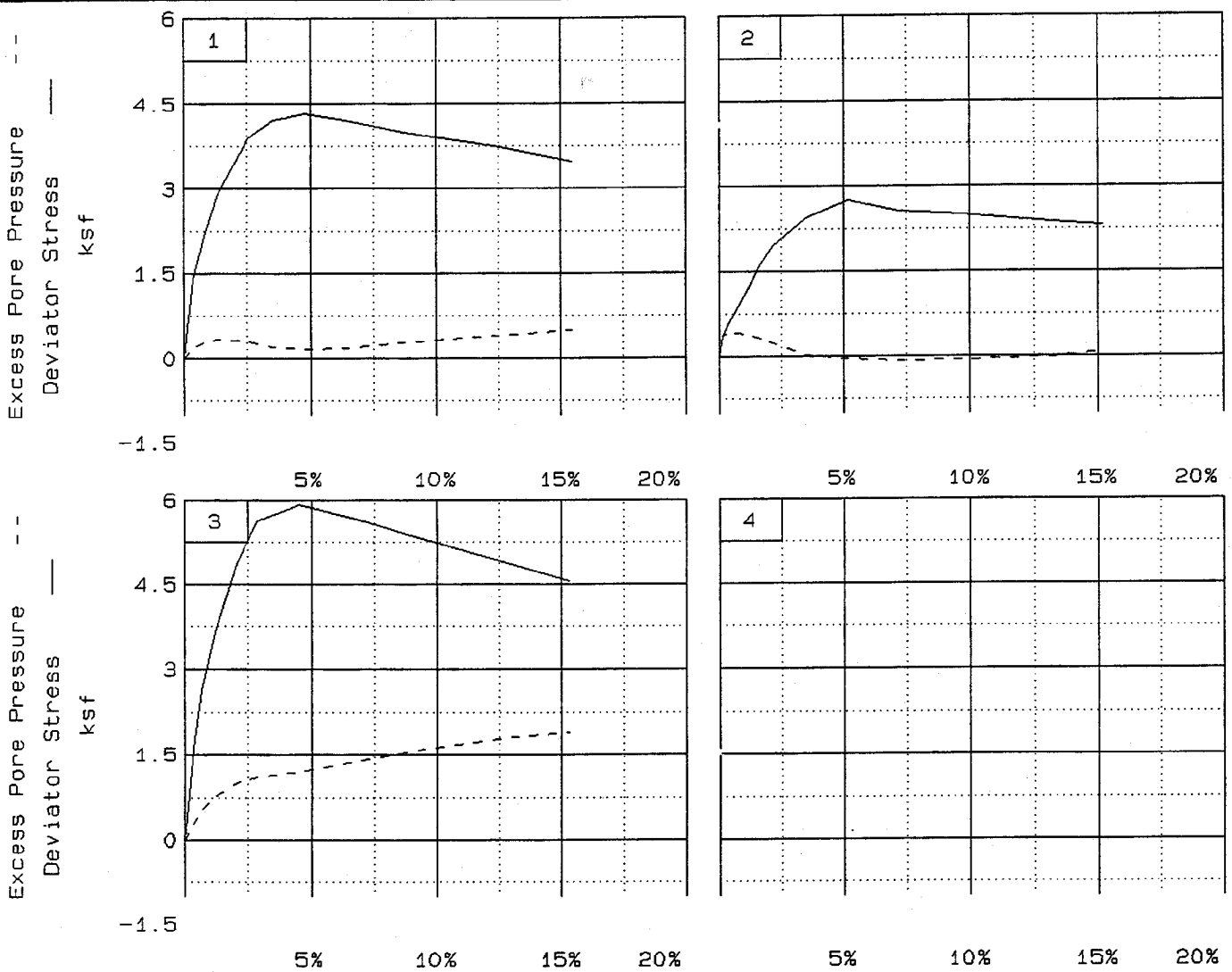
PROJECT: TVA - Colbert

SAMPLE LOCATION: Dry Fly Ash  
Units 1-4

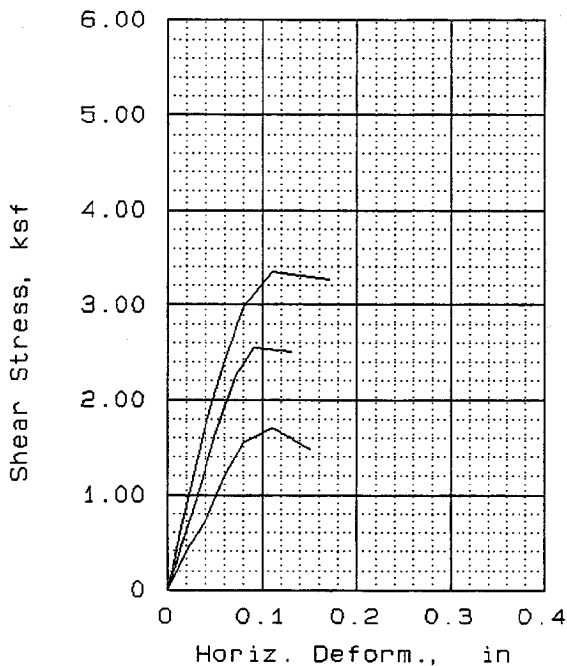
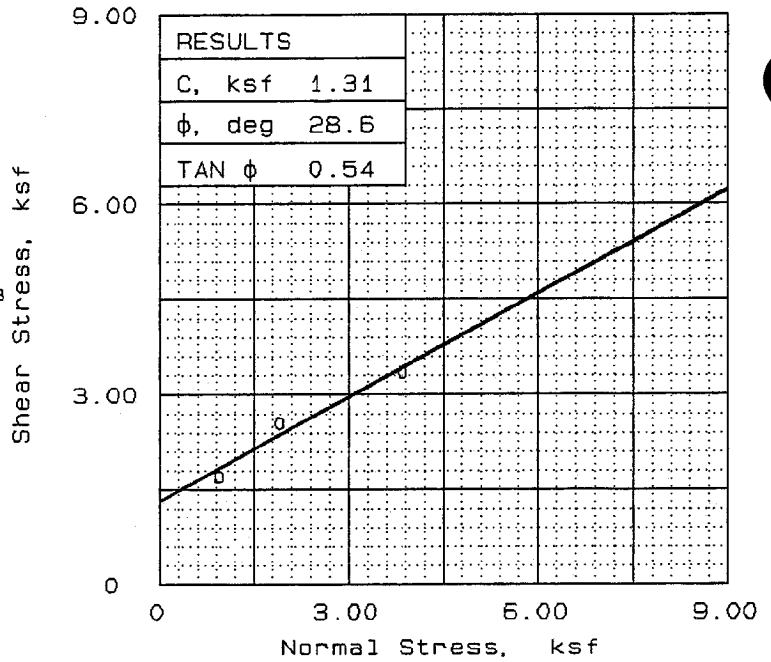
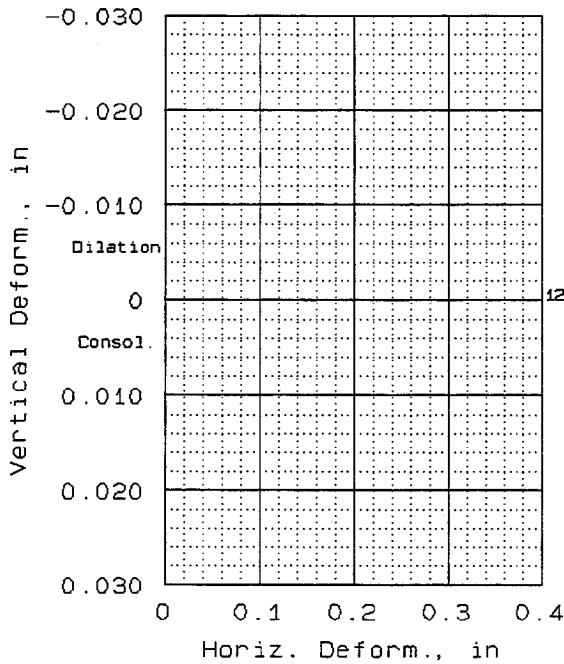
PROJ. NO.: 5810850101      DATE: July 27, 1995

TRIAxIAL COMPRESSION TEST

**LAW ENGINEERING, INC.**



Client:  
 Project: TVA - Colbert  
 Location: Dry Fly Ash Units 1-4  
 File: 8601B      Project No.: 5810860101      Page 2/2      Fig. No. \_\_\_\_\_



SAMPLE NO.	1	2	3
INITIAL			
WATER CONTENT, %	46.9	48.4	48.2
DRY DENSITY, pcf	52.9	53.5	53.6
SATURATION, %	69.2	72.8	72.8
VOID RATIO	1.349	1.323	1.320
DIAMETER, in	2.50	2.50	2.50
HEIGHT, in	0.81	0.81	0.81
AT TEST			
WATER CONTENT, %	46.9	48.4	48.2
DRY DENSITY, pcf	52.9	53.5	53.6
SATURATION, %	69.2	72.8	72.8
VOID RATIO	1.349	1.323	1.320
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	1.71	2.55	3.36
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= 1.99  
 REMARKS: Tested by: *HD*  
 Reviewed by: *RUB*  
 FIG. NO.

CLIENT:  
 PROJECT: TVA - Colbert  
 SAMPLE LOCATION: Dry Fly Ash  
 Units 1-4  
 PROJ. NO.: 5810860101      DATE: August 23, 1995  
 DIRECT SHEAR TEST  
**LAW ENGINEERING, INC.**

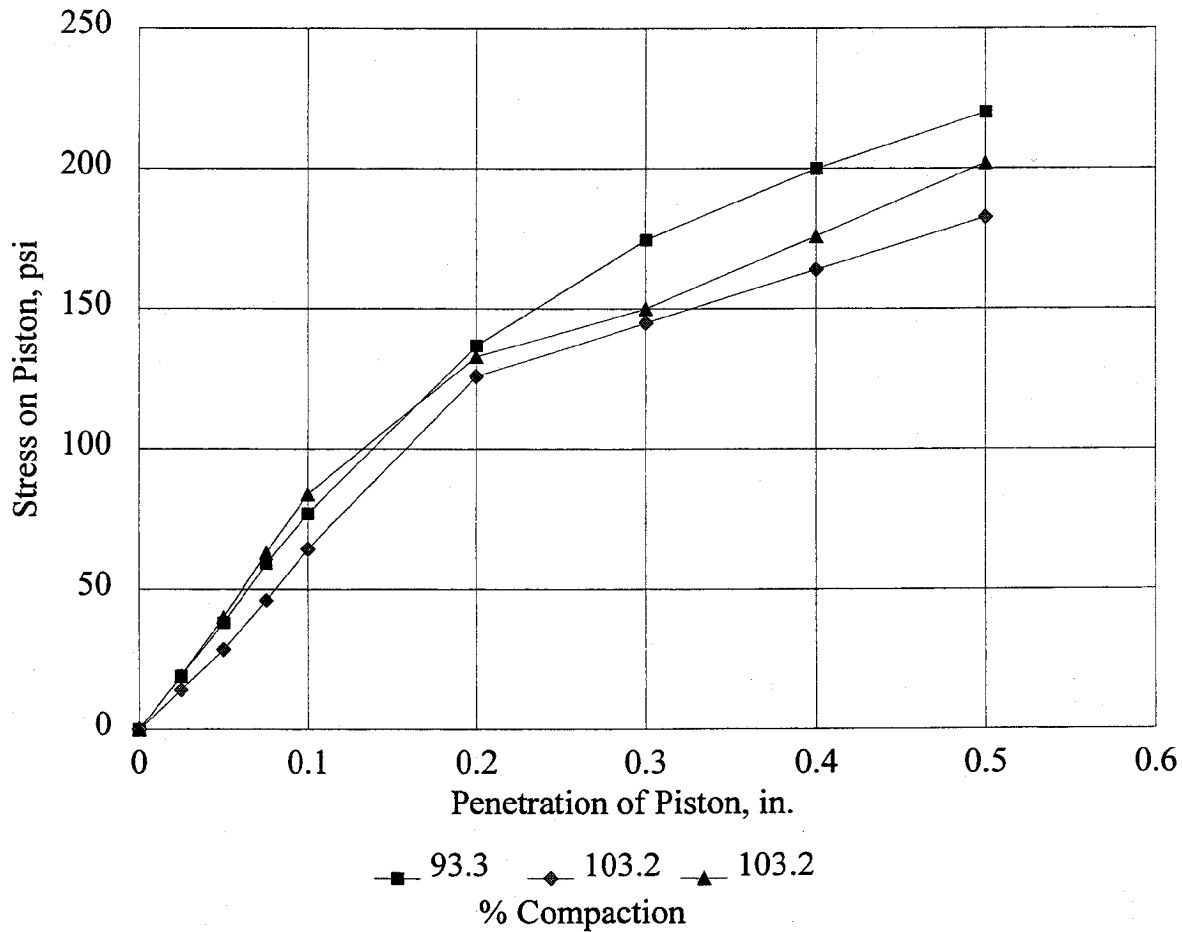
**California Bearing Ratio**  
(ASTM D1883-92)



Project No. 5810860101  
 Project Name TVA - Colbert  
 Material (Source) Dry Fly Ash (Units 1-4)

Tested By EM  
 Test Date 07/17/95  
 Reviewed By RLB  
 Review Date 08/11/95

Compaction, %	93.3	103.2	103.2
Before Soak Dry Density, pcf	52.9	58.5	58.5
Before Soak Moisture Content,	46.9	43.5	45.8
After Soak Dry Density, pcf	52.1	57.6	57.7
After Soak Moisture Content, %	60.7	54.0	57.0
CBR @ 0.1 in.	7.7	6.4	8.4
CBR @ 0.2 in.	9.1	8.4	8.9



**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:	<u>Colbert</u>		
2.	MATERIAL DESCRIPTION:	<u>Dry Fly Ash (Units 1-4)</u>		
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			6.13
	HEIGHT OF CAP AND BASE, inch			0.00
	INITIAL LENGTH, L <sub>0</sub> , inch			6.13
	INITIAL AREA, A <sub>0</sub> , in <sup>2</sup>			6.33
	INITIAL VOLUME A <sub>0</sub> L <sub>0</sub> , in <sup>3</sup>			38.81
7.	SOIL SPECIMEN WEIGHT:			
	INITIAL WEIGHT OF CONTAINER AND WET SOIL, grams			771.10
	FINAL WEIGHT OF CONTAINER AND WET SOIL, grams			0.00
	WEIGHT OF WET SOIL USED, grams			771.10
8.	SOIL PROPERTIES.:			
	IN SITU MOISTURE CONTENT (NUCLEAR), %			N/A
	IN SITU WET DENSITY (NUCLEAR), pcf			N/A
	or			
	OPTIMUM MOISTURE CONTENT, %			45.4
	MAX. DRY DENSITY, pcf			56.7
	95 % MAX. DRY DENSITY, pcf			53.9
9.	SPECIMEN PROPERTIES:			
	COMPACTION MOISTURE CONTENT, %			44.8
	MOISTURE CONTENT AFTER RESILIENT MODULUS TESTING, %			44.1
	COMPACTION DRY DENSITY, γ <sub>d</sub> pcf			52.2
10.	QUICK SHEAR TEST			
	STRESS - STRAIN PLOT ATTACHED (Y = YES, N = NO)			Y
	TRIAXIAL SHEAR MAXIMUM STRENGTH (MAX. LOAD/X-SECTION AREA), psi			22.0
	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			07-18-1995

GENERAL REMARKS:

SUBMITTED BY, DATE

RS Baandren 9/5/95  
LABORATORY MANAGER



PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study  
 LAW PROJECT NO.: 5810860101  
 MATERIAL SOURCE: Colbert  
 MATERIAL DESCRIPTION: Dry Fly Ash (Units 1-4)  
 REMOLDING TARGETS: 95% Standard Dry Density at Optimum Moisture Content  
 MATERIAL TYPE: 2  
 TEST DATE: 07-18-1995  
 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 <sub>3</sub>	S <sub>cyclic</sub>	c <sub>1</sub>	P <sub>max</sub>	P <sub>cyclic</sub>	P <sub>contact</sub>	S <sub>max</sub>	S <sub>cyclic</sub>	S <sub>contact</sub>	H <sub>1</sub>	H <sub>2</sub>	H <sub>avg</sub>	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	11.3	1.3	2.0	1.8	0.2	0.00259	0.00267	0.00263	0.00043	4,172
			2	12.7	11.4	1.3	2.0	1.8	0.2	0.00258	0.00268	0.00263	0.00043	4,195
			3	12.7	11.4	1.3	2.0	1.8	0.2	0.00260	0.00266	0.00263	0.00043	4,196
			4	12.8	11.4	1.3	2.0	1.8	0.2	0.00258	0.00266	0.00262	0.00043	4,224
			5	12.7	11.4	1.3	2.0	1.8	0.2	0.00258	0.00265	0.00261	0.00043	4,231
	COLUMN AVERAGE			12.7	11.4	1.3	2.0	1.8	0.2	0.00259	0.00266	0.00263	0.00043	4,204
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	24

Source: Colbert Description: Dry Fly Ash (Units 1-4) 95% Standard Dry Density at Optimum Moisture Content

SEQUENCE 2	6.0	1	25.1	22.7	2.4	4.0	3.6	0.4	0.00532	0.00536	0.00534	0.00087	4,123
		2	25.1	22.7	2.4	4.0	3.6	0.4	0.00533	0.00537	0.00535	0.00087	4,105
		3	25.0	22.6	2.4	4.0	3.6	0.4	0.00533	0.00537	0.00535	0.00087	4,097
		4	25.1	22.7	2.4	4.0	3.6	0.4	0.00532	0.00537	0.00535	0.00087	4,102
		5	25.1	22.7	2.4	4.0	3.6	0.4	0.00533	0.00536	0.00534	0.00087	4,108
	COLUMN AVERAGE	25.1	22.7	2.4	4.0	3.6	0.4	0.00533	0.00536	0.00535	0.00087	4,107	
	STANDARD DEV.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00000	0.00000	10	
SEQUENCE 3	6.0	1	37.6	33.9	3.7	5.9	5.4	0.6	0.00814	0.00815	0.00815	0.00133	4,029
		2	37.6	33.9	3.7	5.9	5.4	0.6	0.00813	0.00815	0.00814	0.00133	4,034
		3	37.6	33.9	3.7	5.9	5.4	0.6	0.00816	0.00819	0.00817	0.00133	4,012
		4	37.5	33.8	3.7	5.9	5.3	0.6	0.00815	0.00816	0.00816	0.00133	4,010
		5	37.6	33.9	3.7	5.9	5.4	0.6	0.00815	0.00817	0.00816	0.00133	4,017
	COLUMN AVERAGE	37.6	33.9	3.7	5.9	5.4	0.6	0.00815	0.00816	0.00816	0.00133	4,021	
	STANDARD DEV.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00002	0.00001	11	
SEQUENCE 4	6.0	1	50.0	45.4	4.6	7.9	7.2	0.7	0.01105	0.01104	0.01104	0.00180	3,982
		2	49.9	45.4	4.5	7.9	7.2	0.7	0.01104	0.01106	0.01105	0.00180	3,974
		3	49.9	45.3	4.6	7.9	7.2	0.7	0.01107	0.01105	0.01106	0.00180	3,969
		4	49.9	45.3	4.6	7.9	7.2	0.7	0.01110	0.01108	0.01109	0.00181	3,957
		5	49.8	45.3	4.6	7.9	7.2	0.7	0.01107	0.01107	0.01107	0.00181	3,957
	COLUMN AVERAGE	49.9	45.4	4.6	7.9	7.2	0.7	0.01107	0.01106	0.01106	0.00181	3,968	
	STANDARD DEV.	0.1	0.1	0.0	0.0	0.0	0.0	0.00002	0.00002	0.00002	0.00000	11	



Source: Colbert		Description: Dry Fly Ash (Units 1-4)					95% Standard Dry Density at Optimum Moisture Content							
SEQUENCE 8	4.0	6.0	1	37.1	33.5	3.6	5.9	5.3	0.6	0.01037	0.01037	0.01037	0.00169	3,125
			2	37.2	33.6	3.7	5.9	5.3	0.6	0.01038	0.01037	0.01038	0.00169	3,130
			3	37.1	33.5	3.6	5.9	5.3	0.6	0.01038	0.01038	0.01038	0.00169	3,121
			4	37.2	33.6	3.6	5.9	5.3	0.6	0.01037	0.01036	0.01036	0.00169	3,137
			5	37.2	33.5	3.7	5.9	5.3	0.6	0.01039	0.01039	0.01039	0.00169	3,121
				37.2	33.5	3.7	5.9	5.3	0.6	0.01038	0.01037	0.01038	0.00169	3,127
			0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	7
SEQUENCE 9	4.0	8.0	1	49.7	44.7	4.9	7.8	7.1	0.8	0.01345	0.01343	0.01344	0.00219	3,223
			2	49.7	44.8	4.9	7.8	7.1	0.8	0.01346	0.01346	0.01346	0.00220	3,220
			3	49.7	44.8	4.9	7.9	7.1	0.8	0.01344	0.01340	0.01342	0.00219	3,234
			4	49.8	44.9	4.9	7.9	7.1	0.8	0.01345	0.01343	0.01344	0.00219	3,231
			5	49.7	44.8	4.9	7.8	7.1	0.8	0.01347	0.01346	0.01346	0.00220	3,221
				49.7	44.8	4.9	7.8	7.1	0.8	0.01345	0.01344	0.01344	0.00219	3,226
			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00003	0.00002	0.00000	6
SEQUENCE 10	4.0	10.0	1	62.1	56.0	6.2	9.8	8.8	1.0	0.01650	0.01649	0.01649	0.00269	3,285
			2	62.0	55.9	6.1	9.8	8.8	1.0	0.01651	0.01646	0.01648	0.00269	3,281
			3	62.1	56.0	6.1	9.8	8.8	1.0	0.01649	0.01647	0.01648	0.00269	3,289
			4	61.9	55.8	6.1	9.8	8.8	1.0	0.01648	0.01650	0.01649	0.00269	3,274
			5	62.1	55.9	6.2	9.8	8.8	1.0	0.01649	0.01648	0.01649	0.00269	3,284
				62.1	55.9	6.1	9.8	8.8	1.0	0.01649	0.01648	0.01648	0.00269	3,282
			0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.00001	0.00002	0.00001	0.00000	5

Source:	Colbert	Description:	Dry Fly Ash (Units 1-4)	95% Standard Dry Density at Optimum Moisture Content										
SEQUENCE 11	2.0	1	13.1	11.1	2.0	2.1	1.7	0.3	0.00415	0.00415	0.00415	0.00415	0.00068	2,580
		2	13.0	11.0	2.0	2.1	1.7	0.3	0.00415	0.00415	0.00415	0.00415	0.00068	2,557
		3	13.0	11.0	2.0	2.1	1.7	0.3	0.00413	0.00413	0.00413	0.00413	0.00067	2,573
		4	12.9	10.9	2.0	2.0	1.7	0.3	0.00413	0.00413	0.00414	0.00414	0.00067	2,552
		5	12.9	10.9	2.0	2.0	1.7	0.3	0.00415	0.00413	0.00414	0.00414	0.00068	2,549
		COLUMN AVERAGE	13.0	11.0	2.0	2.1	1.7	0.3	0.00414	0.00414	0.00414	0.00414	0.00068	2,562
		STANDARD DEV.	0.1	0.1	0.0	0.0	0.0	0.0	0.00001	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	0.00911	0.00913	0.00912	0.00912	0.00149	2,351
		2	24.5	22.1	2.4	3.9	3.5	0.4	0.00914	0.00915	0.00915	0.00915	0.00149	2,339
		3	24.6	22.2	2.4	3.9	3.5	0.4	0.00912	0.00911	0.00912	0.00912	0.00149	2,361
		4	24.4	22.1	2.4	3.9	3.5	0.4	0.00914	0.00914	0.00914	0.00914	0.00149	2,338
		5	24.6	22.2	2.4	3.9	3.5	0.4	0.00912	0.00912	0.00912	0.00912	0.00149	2,357
		COLUMN AVERAGE	24.5	22.2	2.4	3.9	3.5	0.4	0.00913	0.00913	0.00913	0.00913	0.00149	2,349
		STANDARD DEV.	0.1	0.1	0.0	0.0	0.0	0.0	0.00002	0.00002	0.00002	0.00001	0.00000	10
SEQUENCE 13	2.0	1	36.9	33.3	3.7	5.8	5.3	0.6	0.01324	0.01327	0.01326	0.01326	0.00216	2,430
		2	36.9	33.2	3.7	5.8	5.2	0.6	0.01328	0.01330	0.01329	0.01329	0.00217	2,418
		3	37.0	33.3	3.7	5.8	5.3	0.6	0.01325	0.01327	0.01326	0.01326	0.00216	2,433
		4	36.9	33.3	3.7	5.8	5.3	0.6	0.01328	0.01326	0.01327	0.01327	0.00217	2,428
		5	36.9	33.3	3.7	5.8	5.3	0.6	0.01326	0.01327	0.01327	0.01327	0.00216	2,428
		COLUMN AVERAGE	36.9	33.3	3.7	5.8	5.3	0.6	0.01326	0.01328	0.01328	0.01327	0.00217	2,427
		STANDARD DEV.	0.0	0.0	0.0	0.0	0.0	0.0	0.00002	0.00001	0.00001	0.00001	0.00000	5

Source: Colbert		Description: Dry Fly Ash (Units 1-4)										95% Standard Dry Density at Optimum Moisture Content				
SEQUENCE 14	2.0	8.0	1	49.8	44.9	4.9	7.9	7.1	0.8	0.01688	0.01689	0.01689	0.00276	2,576		
			2	49.7	44.9	4.9	7.9	7.1	0.8	0.01690	0.01688	0.01689	0.00276	2,571		
			3	49.8	44.9	4.9	7.9	7.1	0.8	0.01693	0.01690	0.01691	0.00276	2,569		
			4	49.9	45.0	4.9	7.9	7.1	0.8	0.01690	0.01690	0.01690	0.00276	2,576		
			5	49.8	44.9	4.9	7.9	7.1	0.8	0.01686	0.01687	0.01687	0.00275	2,577		
				49.8	44.9	4.9	7.9	7.1	0.8	0.01689	0.01689	0.01689	0.00276	2,574		
				0.0	0.0	0.0	0.0	0.0	0.0	0.00002	0.00001	0.00002	0.00000	4		
SEQUENCE 15	2.0	10.0	1	62.2	56.1	6.2	9.8	8.9	1.0	0.02068	0.02069	0.02068	0.00337	2,623		
			2	62.1	56.0	6.2	9.8	8.8	1.0	0.02069	0.02070	0.02069	0.00338	2,618		
			3	62.2	56.0	6.2	9.8	8.9	1.0	0.02074	0.02064	0.02069	0.00338	2,622		
			4	62.3	56.2	6.2	9.8	8.9	1.0	0.02068	0.02064	0.02066	0.00337	2,631		
			5	62.3	56.1	6.2	9.8	8.9	1.0	0.02069	0.02069	0.02069	0.00338	2,626		
				62.2	56.1	6.2	9.8	8.9	1.0	0.02070	0.02067	0.02068	0.00337	2,624		
				0.1	0.1	0.0	0.0	0.0	0.0	0.00002	0.00003	0.00001	0.00000	5		

SUBMITTED BY, DATE

*RJ Anderson* 9/5/95

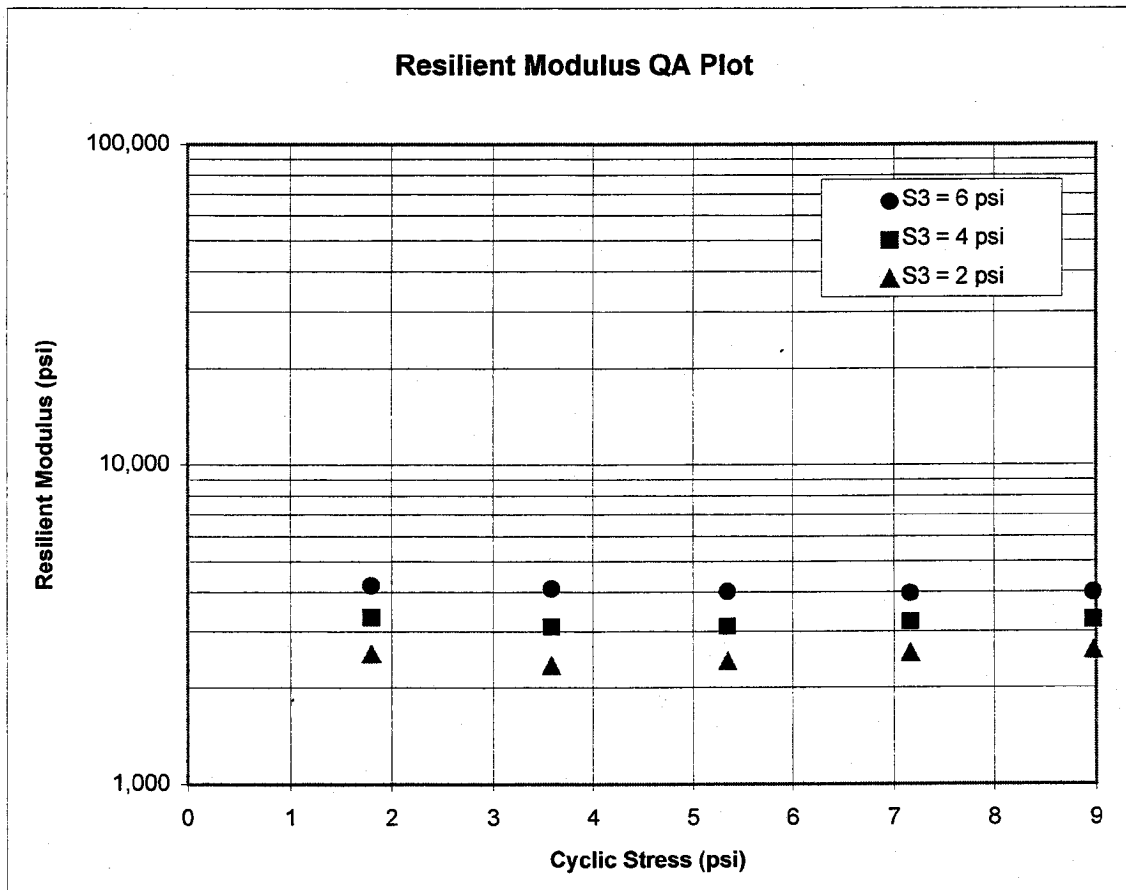
LABORATORY MANAGER

**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: Colbert  
 2. MATERIAL DESCRIPTION: Dry Fly Ash (Units 1-4)  
 3. REMOLDING TARGETS: 95% Standard Dry Density at Optimum Moisture Content  
 4. MATERIAL TYPE: 2  
 5. TEST DATE: 07-18-1995

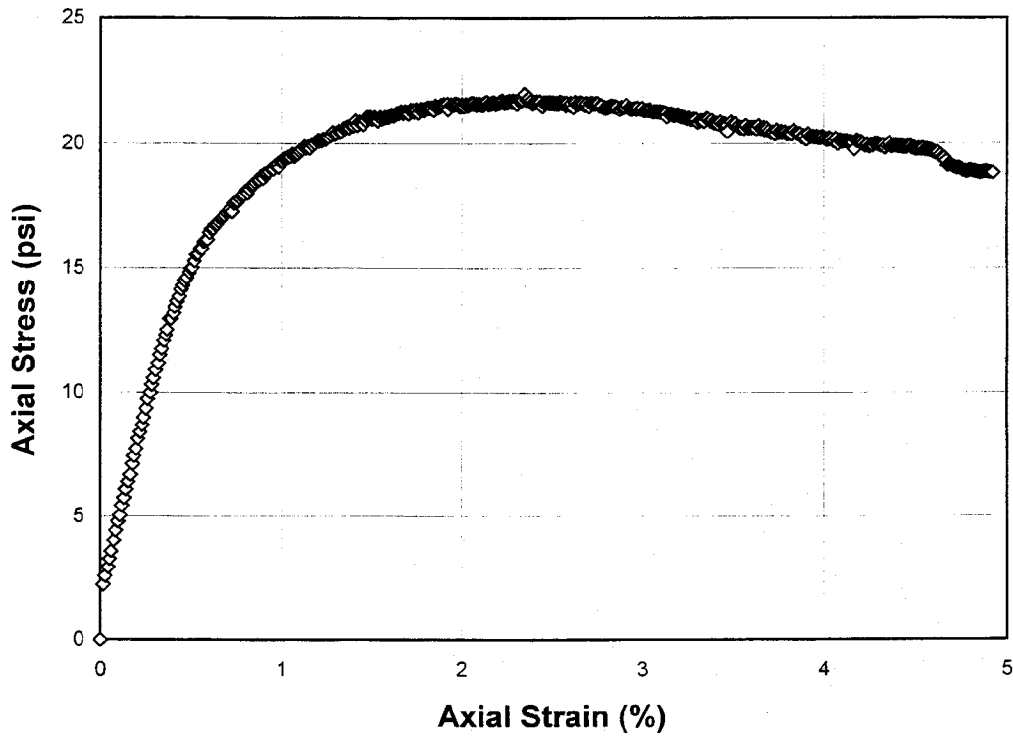
$$M_R = K1 (S_C)^{K2} (1+S_3)^{K5}$$

K1 = 1,353  
 K2 = -0.00868  
 K5 = 0.56321  
 R<sup>2</sup> = 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:* Colbert  
2. *MATERIAL DESCRIPTION:* Dry Fly Ash (Units 1-4)  
3. *REMOLDING TARGETS:* 95% Standard Dry Density at Optimum Moisture Content  
4. *MATERIAL TYPE:* 2  
5. *TEST DATE:* 07-18-1995





**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:	Colbert		
2.	MATERIAL DESCRIPTION:	Dry Fly Ash (Units 1-4)		
3.	REMODELING 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			2.84
	HEIGHT OF SPECIMEN, CAP AND BASE, inch			6.19
	HEIGHT OF CAP AND BASE, inch			0.00
	INITIAL LENGTH, L <sub>0</sub> , inch			6.19
	INITIAL AREA, A <sub>0</sub> , in <sup>2</sup>			6.32
	INITIAL VOLUME A <sub>0</sub> L <sub>0</sub> , in <sup>3</sup>			39.14
7.	SOIL SPECIMEN WEIGHT:			
	INITIAL WEIGHT OF CONTAINER AND WET SOIL, grams			802.10
	FINAL WEIGHT OF CONTAINER AND WET SOIL, grams			0.00
	WEIGHT OF WET SOIL USED, grams			802.10
8.	SOIL PROPERTIES.:			
	IN SITU MOISTURE CONTENT (NUCLEAR), %			N/A
	IN SITU WET DENSITY (NUCLEAR), pcf			N/A
	or			
	OPTIMUM MOISTURE CONTENT, %			40.3
	MAX. DRY DENSITY, pcf			62.9
	95 % MAX. DRY DENSITY, pcf			59.8
9.	SPECIMEN PROPERTIES:			
	COMPACTION MOISTURE CONTENT, %			39.5
	MOISTURE CONTENT AFTER RESILIENT MODULUS TESTING, %			38.6
	COMPACTION DRY DENSITY, γ <sub>d</sub> pcf			55.9
10.	QUICK SHEAR TEST			
	STRESS - STRAIN PLOT ATTACHED (Y = YES, N = NO)			Y
	TRIAXIAL SHEAR MAXIMUM STRENGTH (MAX. LOAD/X-SECTION AREA), psi			29.3
	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			07-19-1995

GENERAL REMARKS:

SUBMITTED BY, DATE

RS Brubum      9/5/95  
LABORATORY MANAGER

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study  
 LAW PROJECT NO.: 5810860101  
 1. MATERIAL SOURCE: Colbert  
 2. MATERIAL DESCRIPTION: Dry Fly Ash (Units 1-4)  
 3. REMOLDING TARGETS: 95% Modified Dry Density at Optimum Moisture Content  
 4. MATERIAL TYPE: 2  
 5. TEST DATE: 07-19-1995  
 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	$S_3$	$S_{cyclic}$	$C_1$	$P_{max}$	$P_{cyclic}$	$P_{contact}$	$S_{max}$	$S_{cyclic}$	$S_{contact}$	$H_1$	$H_2$	$H_{avg}$	$\epsilon$	
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	0.00230	0.00233	0.00231	0.00037	4,889
			2	12.9	11.6	1.3	2.0	1.8	0.2	0.00228	0.00233	0.00231	0.00037	4,946
			3	12.9	11.6	1.3	2.0	1.8	0.2	0.00229	0.00236	0.00233	0.00038	4,892
			4	12.9	11.6	1.3	2.0	1.8	0.2	0.00231	0.00237	0.00234	0.00038	4,838
			5	12.9	11.6	1.3	2.0	1.8	0.2	0.00230	0.00236	0.00233	0.00038	4,891
	COLUMN AVERAGE			12.9	11.6	1.3	2.0	1.8	0.2	0.00230	0.00235	0.00232	0.00038	4,891
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00002	0.00001	0.00000	38

Source: Colbert		Description: Dry Fly Ash (Units 1-4)										95% Modified Dry Density at Optimum Moisture Content									
SEQUENCE 2	6.0	4.0	1	25.5	23.1	2.4	4.0	3.7	0.4	0.00467	0.00470	0.00468	0.00076	4.837							
			2	25.5	23.1	2.4	4.0	3.7	0.4	0.00470	0.00474	0.00472	0.00076	4.793							
			3	25.5	23.1	2.4	4.0	3.7	0.4	0.00468	0.00473	0.00470	0.00076	4.824							
			4	25.6	23.2	2.4	4.0	3.7	0.4	0.00468	0.00474	0.00471	0.00076	4.816							
			5	25.5	23.1	2.4	4.0	3.7	0.4	0.00470	0.00474	0.00472	0.00076	4.793							
	COLUMN AVERAGE			25.5	23.1	2.4	4.0	3.7	0.4	0.00469	0.00473	0.00471	0.00076	4.813							
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00002	0.00002	0.00000	19							
SEQUENCE 3	6.0	6.0	1	38.2	34.5	3.7	6.0	5.5	0.6	0.00718	0.00721	0.00720	0.00116	4.694							
			2	38.3	34.6	3.7	6.1	5.5	0.6	0.00714	0.00717	0.00716	0.00116	4.734							
			3	38.2	34.5	3.7	6.1	5.5	0.6	0.00716	0.00720	0.00718	0.00116	4.714							
			4	38.2	34.5	3.7	6.0	5.5	0.6	0.00718	0.00720	0.00719	0.00116	4.699							
			5	38.2	34.5	3.7	6.0	5.5	0.6	0.00717	0.00717	0.00717	0.00116	4.711							
	COLUMN AVERAGE			38.2	34.5	3.7	6.0	5.5	0.6	0.00717	0.00719	0.00718	0.00116	4.710							
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00002	0.00002	0.00002	0.00000	15							
SEQUENCE 4	6.0	8.0	1	50.9	46.0	4.9	8.1	7.3	0.8	0.00959	0.00966	0.00962	0.00155	4.689							
			2	50.9	46.1	4.9	8.1	7.3	0.8	0.00960	0.00966	0.00963	0.00155	4.689							
			3	51.0	46.0	4.9	8.1	7.3	0.8	0.00960	0.00966	0.00963	0.00155	4.688							
			4	51.0	46.0	4.9	8.1	7.3	0.8	0.00960	0.00966	0.00963	0.00155	4.687							
			5	50.9	46.0	4.9	8.1	7.3	0.8	0.00961	0.00966	0.00963	0.00156	4.681							
	COLUMN AVERAGE			50.9	46.0	4.9	8.1	7.3	0.8	0.00960	0.00966	0.00963	0.00155	4.687							
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00000	0.00000	0.00000	3							

Source: Colbert Description: Dry Fly Ash (Units 1-4) 95% Modified Dry Density at Optimum Moisture Content

SEQUENCE 5	6.0	10.0	1	63.7	57.6	6.2	10.1	9.1	1.0	0.01187	0.01194	0.01191	0.00192	4,739
			2	63.7	57.5	6.2	10.1	9.1	1.0	0.01189	0.01196	0.01193	0.00193	4,727
			3	63.8	57.6	6.2	10.1	9.1	1.0	0.01187	0.01191	0.01189	0.00192	4,750
			4	63.8	57.6	6.2	10.1	9.1	1.0	0.01190	0.01195	0.01192	0.00193	4,736
			5	63.7	57.5	6.2	10.1	9.1	1.0	0.01189	0.01194	0.01191	0.00192	4,731
	COLUMN AVERAGE		63.7	57.6	6.2	10.1	9.1	1.0	0.01188	0.01194	0.01191	0.00192	4,737	
	STANDARD DEV.		0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00002	0.00001	0.00000	9	
SEQUENCE 6	4.0	2.0	1	12.8	11.2	1.7	2.0	1.8	0.3	0.00275	0.00276	0.00276	0.00045	3,962
			2	12.9	11.4	1.5	2.0	1.8	0.2	0.00281	0.00282	0.00281	0.00045	3,973
			3	13.1	11.4	1.7	2.1	1.8	0.3	0.00281	0.00283	0.00282	0.00045	3,969
			4	13.1	11.6	1.5	2.1	1.8	0.2	0.00284	0.00288	0.00286	0.00046	3,990
			5	13.0	11.3	1.7	2.1	1.8	0.3	0.00282	0.00284	0.00283	0.00046	3,921
	COLUMN AVERAGE		13.0	11.4	1.6	2.1	1.8	0.3	0.00281	0.00282	0.00282	0.00045	3,963	
	STANDARD DEV.		0.1	0.2	0.1	0.0	0.0	0.0	0.00003	0.00004	0.00004	0.00001	26	
SEQUENCE 7	4.0	4.0	1	25.3	23.2	2.1	4.0	3.7	0.3	0.00614	0.00618	0.00616	0.00099	3,693
			2	25.3	23.2	2.1	4.0	3.7	0.3	0.00614	0.00617	0.00616	0.00099	3,697
			3	25.4	23.3	2.1	4.0	3.7	0.3	0.00613	0.00616	0.00615	0.00099	3,712
			4	25.6	23.5	2.1	4.0	3.7	0.3	0.00617	0.00620	0.00619	0.00100	3,718
			5	25.3	23.2	2.1	4.0	3.7	0.3	0.00613	0.00618	0.00616	0.00099	3,690
	COLUMN AVERAGE		25.4	23.3	2.1	4.0	3.7	0.3	0.00614	0.00618	0.00616	0.00099	3,702	
	STANDARD DEV.		0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	12	



Source: Colbert

Description: Dry Fly Ash (Units 1-4)

95% Modified Dry Density at Optimum Moisture Content

SEQUENCE 11	2.0	1	13.6	11.5	2.1	2.1	1.8	0.3	0.00372	0.00376	0.00374	0.00060	3.007
		2	13.5	11.5	2.1	2.1	1.8	0.3	0.00372	0.00375	0.00374	0.00060	3.011
		3	13.6	11.5	2.1	2.2	1.8	0.3	0.00373	0.00377	0.00375	0.00061	3.015
		4	13.6	11.5	2.1	2.1	1.8	0.3	0.00373	0.00376	0.00374	0.00060	3.019
		5	13.6	11.5	2.1	2.2	1.8	0.3	0.00374	0.00377	0.00375	0.00061	3.009
	COLUMN AVERAGE		13.6	11.5	2.1	2.1	1.8	0.3	0.00373	0.00376	0.00374	0.00060	3.012
	STANDARD DEV.		0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	5

SEQUENCE 12	2.0	1	25.1	22.7	2.4	4.0	3.6	0.4	0.00799	0.00802	0.00801	0.00129	2.775
		2	25.1	22.7	2.4	4.0	3.6	0.4	0.00798	0.00803	0.00801	0.00129	2.783
		3	25.1	22.7	2.4	4.0	3.6	0.4	0.00798	0.00801	0.00800	0.00129	2.787
		4	25.2	22.8	2.4	4.0	3.6	0.4	0.00800	0.00802	0.00801	0.00129	2.786
		5	25.2	22.8	2.4	4.0	3.6	0.4	0.00797	0.00804	0.00800	0.00129	2.792
	COLUMN AVERAGE		25.1	22.7	2.4	4.0	3.6	0.4	0.00798	0.00803	0.00800	0.00129	2.785
	STANDARD DEV.		0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00000	0.00000	6

SEQUENCE 13	2.0	1	37.9	34.3	3.6	6.0	5.4	0.6	0.01158	0.01163	0.01161	0.00187	2.892
		2	37.9	34.2	3.6	6.0	5.4	0.6	0.01157	0.01161	0.01159	0.00187	2.896
		3	37.9	34.3	3.6	6.0	5.4	0.6	0.01155	0.01160	0.01158	0.00187	2.900
		4	38.0	34.3	3.6	6.0	5.4	0.6	0.01158	0.01161	0.01160	0.00187	2.901
		5	38.0	34.3	3.6	6.0	5.4	0.6	0.01154	0.01158	0.01156	0.00187	2.909
	COLUMN AVERAGE		37.9	34.3	3.6	6.0	5.4	0.6	0.01157	0.01161	0.01159	0.00187	2.900
	STANDARD DEV.		0.0	0.0	0.0	0.0	0.0	0.0	0.00002	0.00002	0.00002	0.00000	6

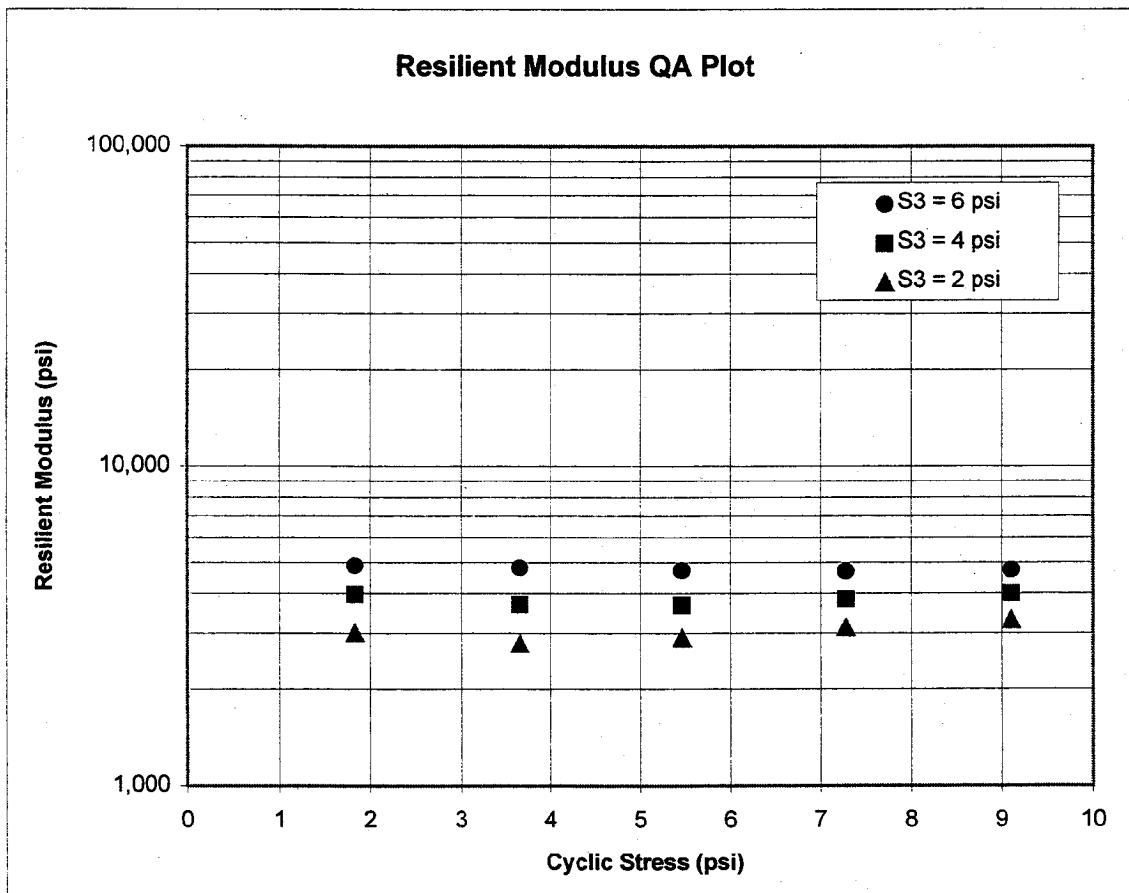


**FIGURE 1 - Logarithmic Plot of Resilient Modulus ( $M_R$ ) vs Cyclic Stress ( $S_C$ )**

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study  
 LAW PROJECT NO.: 5810860101  
 1. MATERIAL SOURCE: Colbert  
 2. MATERIAL DESCRIPTION: Dry Fly Ash (Units 1-4)  
 3. REMOLDING TARGETS: 95% Modified Dry Density at Optimum Moisture Content  
 4. MATERIAL TYPE: 2  
 5. TEST DATE: 07-19-1995

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

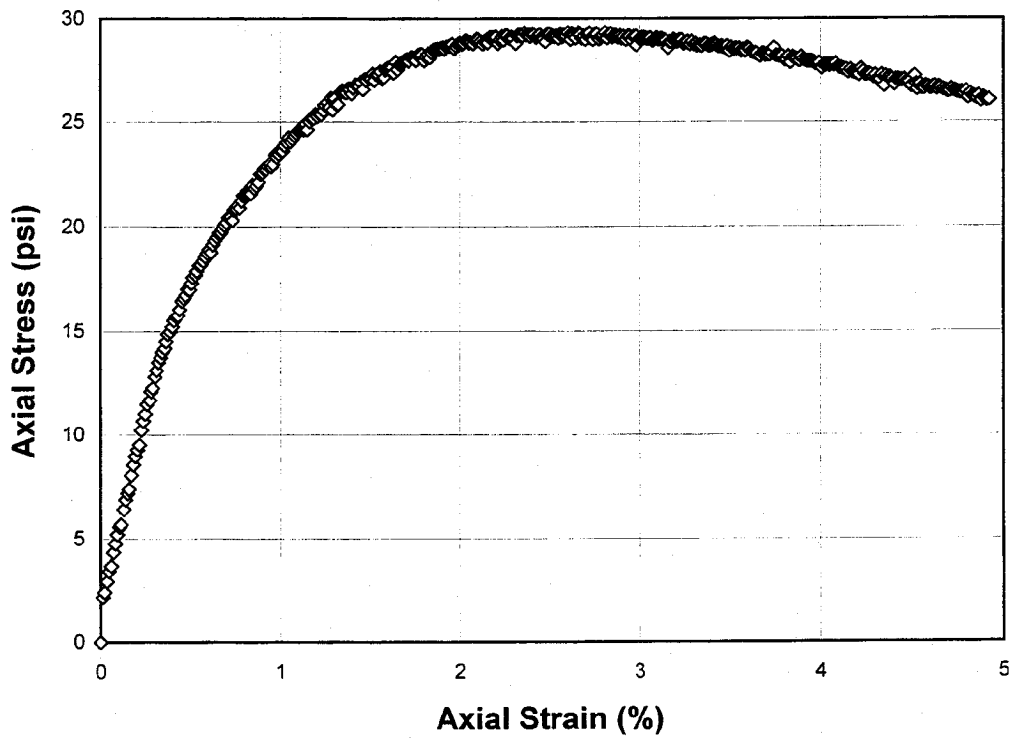
K1 = 1,639  
 K2 = 0.01011  
 K5 = 0.53301  
 R<sup>2</sup> = 0.95





**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:* Colbert  
2. *MATERIAL DESCRIPTION:* Dry Fly Ash (Units 1-4)  
3. *REMOLDING TARGETS:* 95% Modified Dry Density at Optimum Moisture Content  
4. *MATERIAL TYPE* 2  
5. *TEST DATE* 07-19-1995





# COLBERT

## *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)

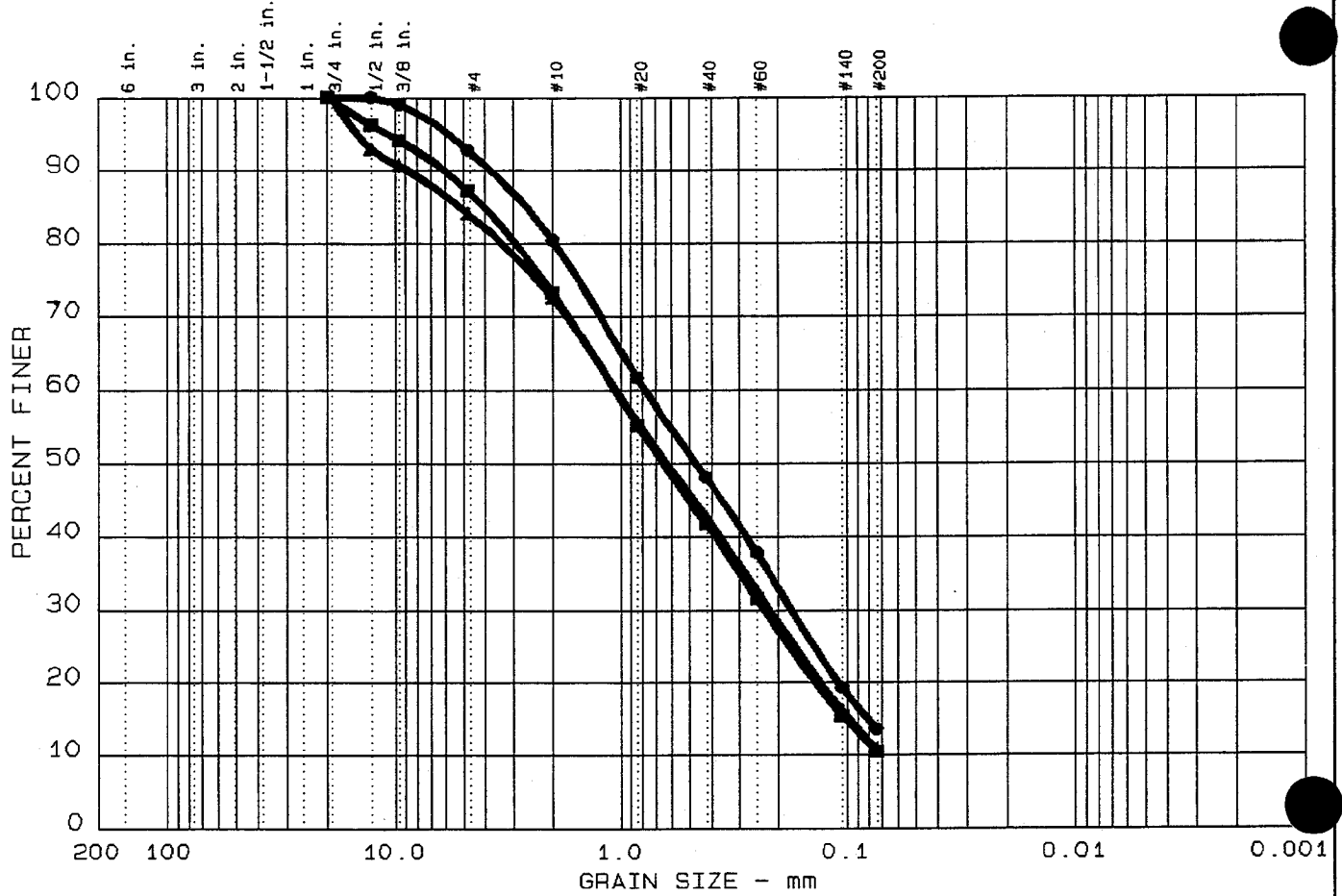


**TVA - COLBERT  
BOTTOM ASH - FROM POND**

Description	Test Method	Property	Sample 1	Sample 2	Sample 3
Grain Size	ASTM D 422	Percent Retained on the #4 Sieve	7.2	15.9	12.8
		Percent Passing the #200 Sieve	13.6	10.8	10.5
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	2.15	2.08	2.10
Classification	ASTM D 2487	Unified Soil Classification System (USCS)	SM	SP-SM	SP-SM
	AASHTO M 145	AASHTO Classification	A-1-b	A-1-b	A-1-b
<b>Composite Sample</b>					
Moisture-Density Relations (Standard Effort)	ASTM D 698	Maximum Dry Density, pcf	64.2		
		Optimum Moisture Content, %	27.4		
Moisture-Density Relations (Modified Effort)	ASTM D 1557	Maximum Dry Density, pcf	73.2		
		Optimum Moisture Content, %	17.2		
Relative Density	ASTM D 4254	Minimum Dry Density, pcf	55.7		
	ASTM D 4253	Maximum Dry Density (Dry Method), pcf	71.2		
Hydraulic Conductivity	ASTM D 2434	Hydraulic Conductivity, cm/sec	Result	Dry Density, pcf	Moisture Content, %
			1.6E-2	61.1	0.0
Angle of Repose	LAW TP6	Angle of Repose, degrees	30.9	55.7	0.0
California Bearing Ratio	ASTM D 1883	CBR, %	24	61.2	27.4
Resilient Modulus (Standard Compactive Effort)	SHRP P46	Resilient Modulus at 4psi axial stress and 4psi confining pressure	6,264	60.5	25.9
Resilient Modulus (Modified Compactive Effort)	SHRP P46	Resilient Modulus at 4psi axial stress and 4psi confining pressure	6,372	67.8	17.8
Soil Resistivity	AASHTO T 288	Minimum Resistivity, Ohm-cm	4,500		
pH of Soil	AASHTO T 289	pH	5.4		
Water Soluble Sulfate Ion	AASHTO T 290	Sulfate Ion Content, mg/kg	215		
Water Soluble Chloride Ion	AASHTO T 290	Chloride Ion Content, mg/kg	<10		

cof-ba.xls

# GRAIN SIZE DISTRIBUTION TEST REPORT



Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
● 12	0.0	7.2	79.2	13.6	
▲ 13	0.0	15.9	73.3	10.8	
■ 14	0.0	12.8	76.7	10.5	

	LL	PI	D <sub>85</sub>	D <sub>60</sub>	D <sub>50</sub>	D <sub>30</sub>	D <sub>15</sub>	D <sub>10</sub>	C <sub>c</sub>	C <sub>u</sub>
●	NL	NP	2.60	0.78	0.46	0.176	0.0804			
▲	NL	NP	5.13	1.04	0.62	0.219	0.0966			
■	NL	NP	4.03	1.05	0.65	0.232	0.1012			

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

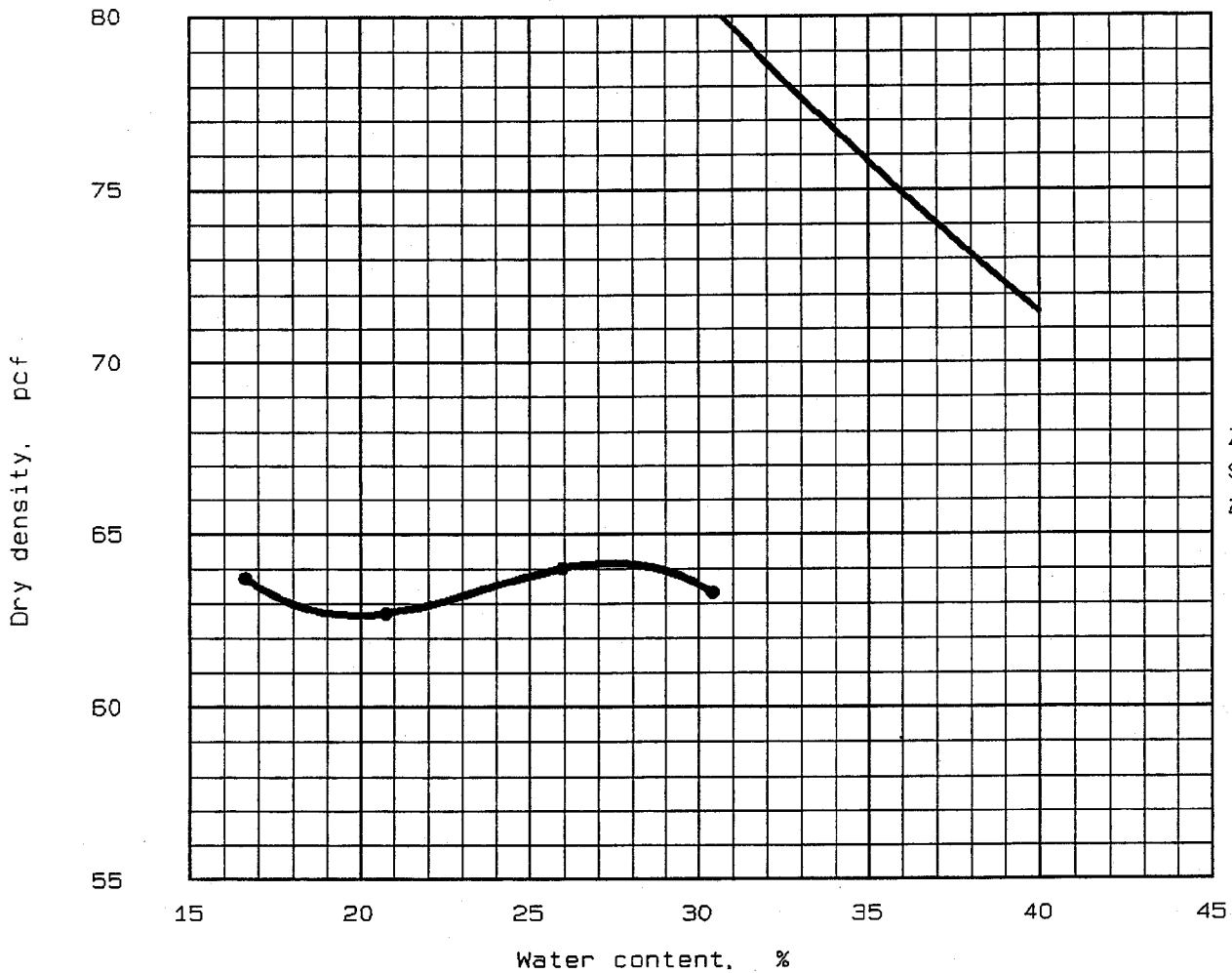
Project No.: 5810860101  
 Project: TVA - Colbert  
 ● Location: Bottom Ash A & B  
 ▲ Location: Bottom Ash C & D  
 ■ Location: Bottom Ash E & F  
 Date: July 18, 1995

Remarks:  
 Tested by: *JOP*  
 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						
	SP-SM (SM)	A-1-b	7.60 %	2.11	NL	NP	12.0 %	11.6 %

TEST RESULTS	MATERIAL DESCRIPTION
Optimum moisture = 27.4 % Maximum dry density = 64.2 pcf	

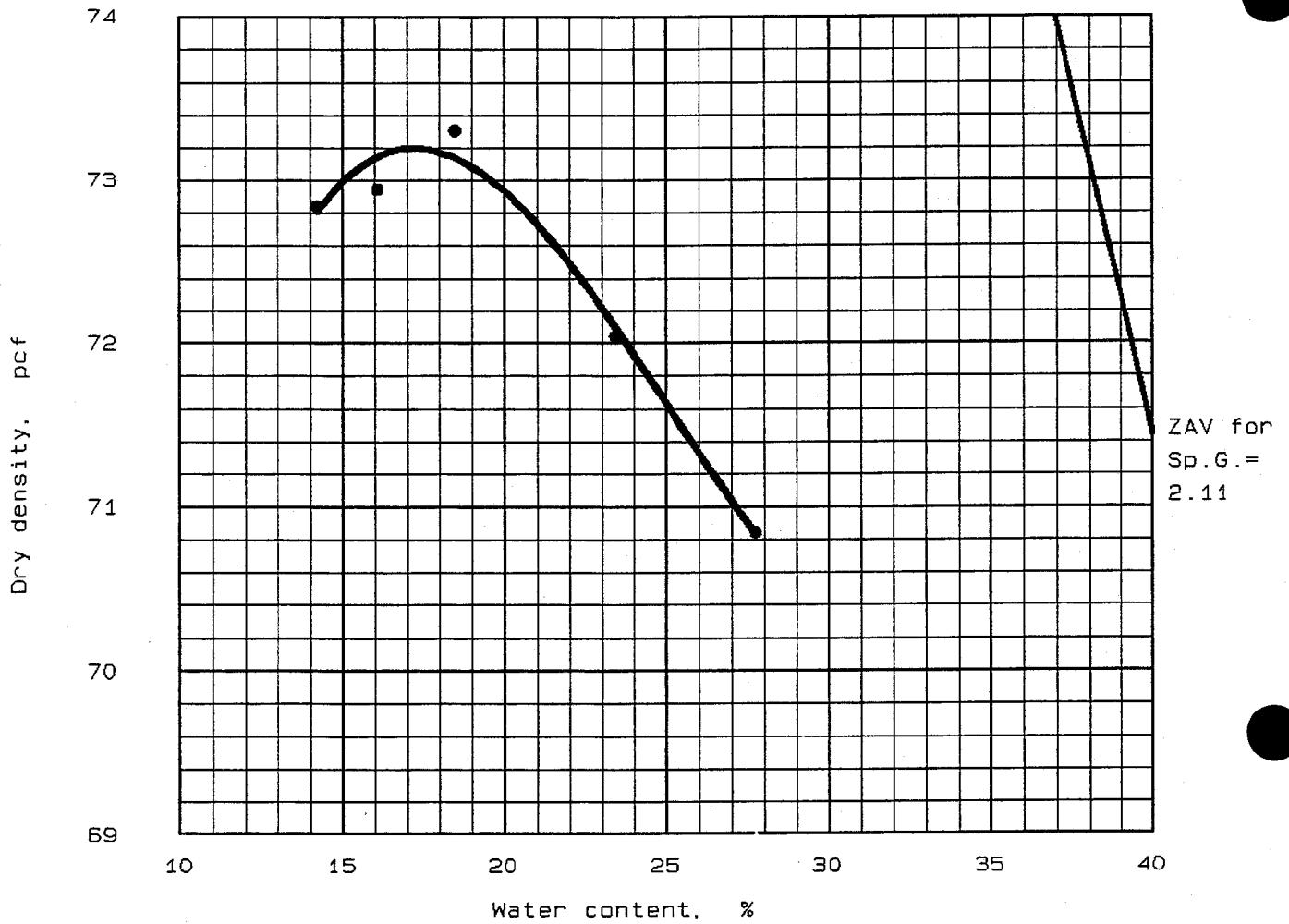
Project No.: 5810860101  
 Project: TVA - Colbert  
 Location: Bottom Ash  
 Date: July 25, 1995

Remarks:  
 Tested by: *JCP*  
 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						
	SP-SM (SM)	A-1-b	7.60 %	2.11	NL	NP	12.0 %	11.6 %

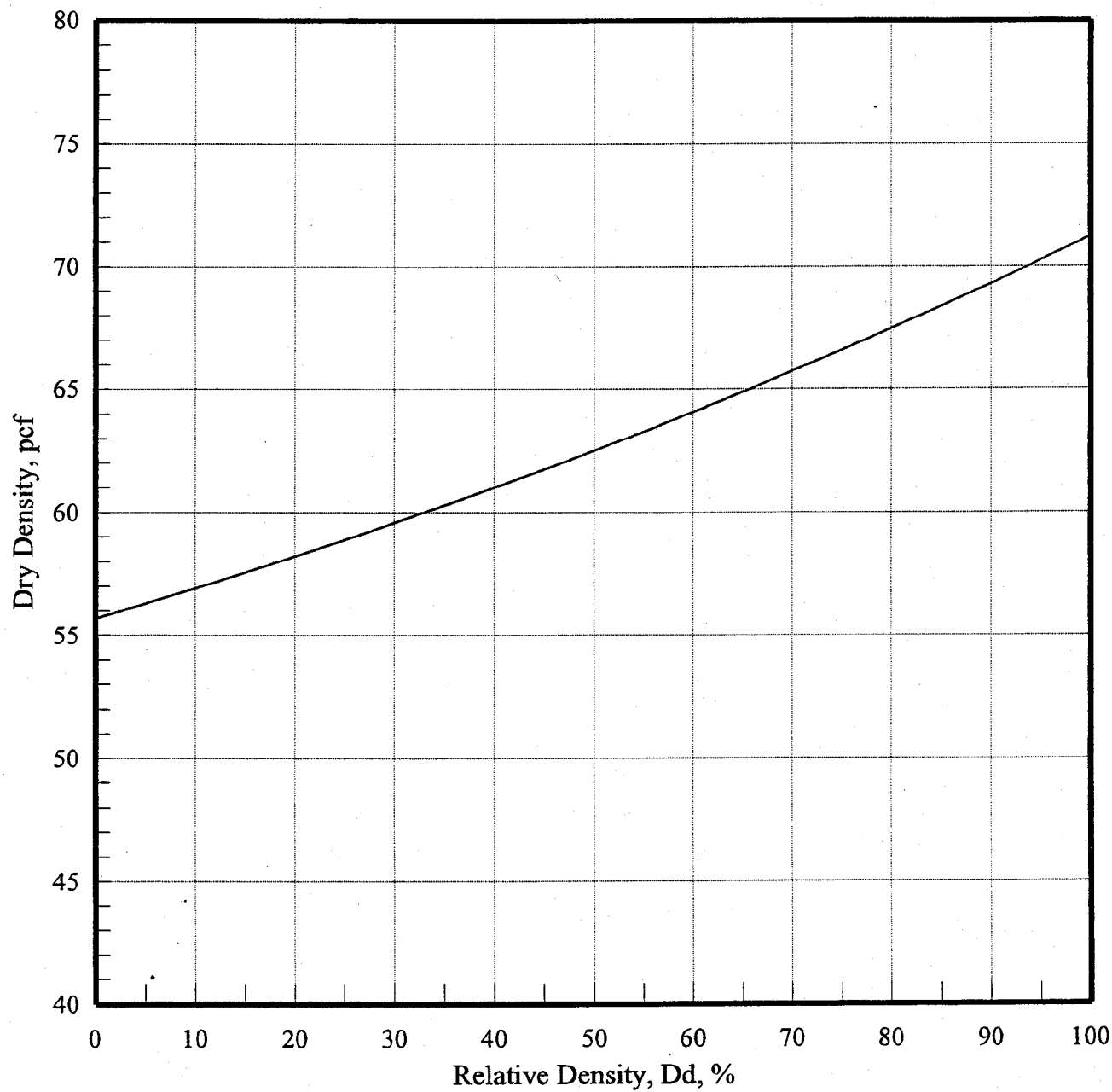
TEST RESULTS	MATERIAL DESCRIPTION
Optimum moisture = 17.2 % Maximum dry density = 73.2 pcf	
Project No.: 5810860101 Project: TVA - Colbert Location: Bottom Ash  Date: July 25, 1995	Remarks: Tested by: JCR/CS Reviewed by: RLB
MOISTURE-DENSITY RELATIONSHIP <b>LAW ENGINEERING, INC.</b>	Figure No. _____



# Relative Density Test

TVA - Colbert, Bottom Ash

Law Project No. 5810860101



# HYDRAULIC CONDUCTIVITY



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

Tested By **DMJ**  
Test Date **08/16/95**  
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>61.1</i>
Dry Unit Weight, pcf:	<i>61.1</i>
Compaction, %:	<i>95.2</i>
Hydraulic Conductivity, cm/sec. @20° C:	<b>1.6E-02</b>

**PERMEABILITY TEST - Constant Head**  
**(ASTM D2434 - 68)**



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

Tested By DMJ  
 Test Date 08/16/95  
 Reviewed By RLB  
 Review Date 09/06/95

**Sample Data**

Length, in		Diameter, in		Pan No.	
Location 1	5.000	Location 1	2.858	Wet Soil + Pan, grams	517.94
Location 2	5.000	Location 2	2.875	Dry Soil+Pan, grams	517.94
Location3	5.000	Location 3	2.868	Pan Weight, grams	0.00
Average	5.000	Average	2.867	Moisture Content, %	0.0
Sample wet weight, grams			517.94	Wet Unit Wt, pcf	61.1
Membrane, Cap weight, grams			0.00	Dry Unit Wt, pcf	61.1

Time (sec)	Q (cm <sup>3</sup> )	H (cm)	k (cm/sec)	Temp ° C	k (cm/sec at 20° C)	i (cm/cm)
600	170.00	5.08	1.7E-02	20.0	1.7E-02	0.40
1200	310.00	5.08	1.6E-02	20.0	1.6E-02	0.40

No. of Trials	Sample Type	Max. Density (pcf)	Compaction %	Sample Orientation
2	Remolded	64.2	95.2	Vertical

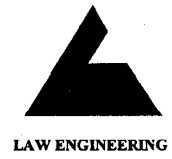
L = length of sample in cm  
 A = area of sample in cm<sup>2</sup>

H = constant head in cm  
 t = time in seconds

A = 41.65 cm<sup>2</sup>  
 L = 12.7 cm

**Avg. k at 20° C 1.6E-02 cm/sec**

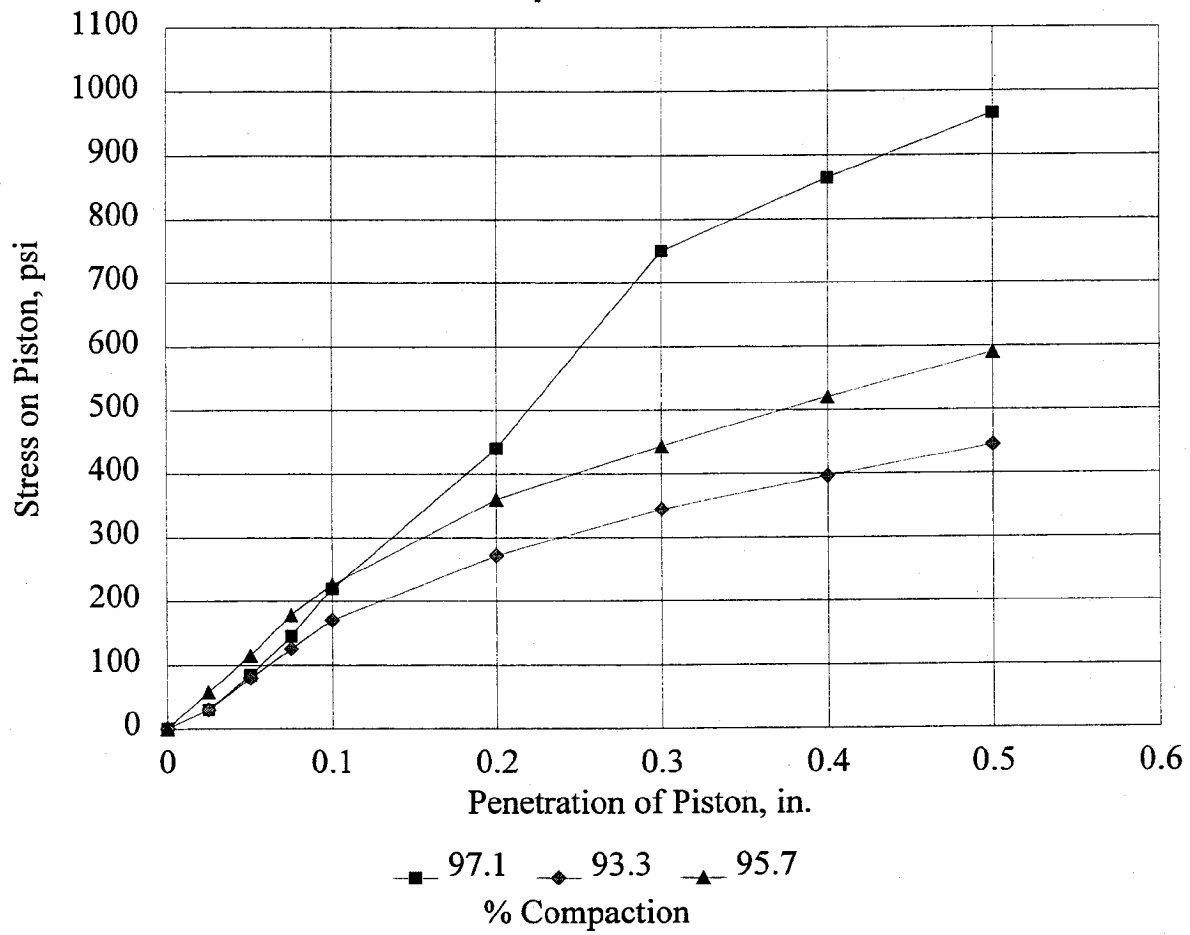
**California Bearing Ratio**  
**(ASTM D1883-92)**



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

Tested By EM  
 Test Date 08/07/95  
 Reviewed By RLB  
 Review Date 08/16/95

Compaction, %	97.1	93.3	95.7
Before Soak Dry Density, pcf	62.3	59.9	61.4
Before Soak Moisture Content, %	28.0	27.0	27.2
After Soak Dry Density, pcf	62.6	60.2	61.6
After Soak Moisture Content, %	40.4	40.3	39.8
CBR @ 0.1 in.	22.0	17.0	22.6
CBR @ 0.2 in.	29.3	18.1	24.0



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:	Colbert							
2.	MATERIAL DESCRIPTION:	Bottom Ash							
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							2.87
		MIDDLE							2.85
		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								6.06
	HEIGHT OF CAP AND BASE, inch								0.00
	INITIAL LENGTH, L <sub>0</sub> , inch								6.06
	INITIAL AREA, A <sub>0</sub> , in <sup>2</sup>								6.32
	INITIAL VOLUME A <sub>0</sub> L <sub>0</sub> , in <sup>3</sup>								38.30
7.	SOIL SPECIMEN WEIGHT:								
	INITIAL WEIGHT OF CONTAINER AND WET SOIL, grams								765.94
	FINAL WEIGHT OF CONTAINER AND WET SOIL, grams								0.00
	WEIGHT OF WET SOIL USED, grams								765.94
8.	SOIL PROPERTIES.:								
	IN SITU MOISTURE CONTENT (NUCLEAR), %								N/A
	IN SITU WET DENSITY (NUCLEAR), pcf								N/A
	or								
	OPTIMUM MOISTURE CONTENT, %								27.4
	MAX. DRY DENSITY, pcf								64.2
	95 % MAX. DRY DENSITY, pcf								61.0
9.	SPECIMEN PROPERTIES:								
	COMPACTION MOISTURE CONTENT, %								25.9
	MOISTURE CONTENT AFTER RESILIENT MODULUS TESTING, %								25.9
	COMPACTION DRY DENSITY, γ <sub>d</sub> pcf								60.5
10.	QUICK SHEAR TEST								
	STRESS - STRAIN PLOT ATTACHED (Y = YES, N = NO)								Y
	TRIAxIAL SHEAR MAXIMUM STRENGTH (MAX. LOAD/X-SECTION AREA), psi								33.8
	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	0
	(b) NOTE								
12.	TEST DATE								08-18-1995

GENERAL REMARKS:

SUBMITTED BY, DATE

R.P. Auwchen 9/10/95  
 LABORATORY MANAGER

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study  
 LAW PROJECT NO.: 5810860101  
 MATERIAL SOURCE: Colbert  
 MATERIAL DESCRIPTION: Bottom Ash  
 REMOLDING TARGETS: 95% Standard Dry Density at Optimum Moisture Content  
 MATERIAL TYPE: 2  
 TEST DATE: 08-18-1995  
 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 <sub>3</sub>	S <sub>cyclic</sub>	C <sub>1</sub>	P <sub>max</sub>	P <sub>cyclic</sub>	P <sub>contact</sub>	S <sub>max</sub>	S <sub>cyclic</sub>	S <sub>contact</sub>	H <sub>1</sub>	H <sub>2</sub>	H <sub>avg</sub>	ε <sub>r</sub>	M <sub>r</sub>
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	1.2	2.0	1.8	0.2	0.00130	0.00131	0.00130	0.00021	8,385
			2	12.5	11.4	1.1	2.0	1.8	0.2	0.00130	0.00130	0.00130	0.00021	8,411
			3	12.6	11.4	1.2	2.0	1.8	0.2	0.00130	0.00131	0.00130	0.00022	8,394
			4	12.6	11.4	1.2	2.0	1.8	0.2	0.00130	0.00132	0.00131	0.00022	8,332
			5	12.5	11.4	1.2	2.0	1.8	0.2	0.00130	0.00131	0.00131	0.00022	8,354
	COLUMN AVERAGE			12.6	11.4	1.2	2.0	1.8	0.2	0.00130	0.00131	0.00130	0.00022	8,375
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00000	0.00000	0.00000	0.00000	32

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

SEQUENCE 2	6.0	4.0	1	25.3	23.1	2.2	4.0	3.7	0.3	0.00243	0.00237	0.00240	0.00040	9,239
			2	25.3	23.1	2.2	4.0	3.7	0.3	0.00243	0.00238	0.00240	0.00040	9,231
			3	25.3	23.1	2.2	4.0	3.7	0.3	0.00242	0.00236	0.00239	0.00039	9,274
			4	25.3	23.1	2.2	4.0	3.7	0.3	0.00244	0.00238	0.00241	0.00040	9,214
			5	25.3	23.1	2.2	4.0	3.6	0.3	0.00244	0.00237	0.00241	0.00040	9,196
	COLUMN AVERAGE			25.3	23.1	2.2	4.0	3.7	0.3	0.00243	0.00237	0.00240	0.00040	9,231
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	29
SEQUENCE 3	6.0	6.0	1	37.8	34.2	3.6	6.0	5.4	0.6	0.00360	0.00347	0.00354	0.00058	9,279
			2	37.8	34.2	3.6	6.0	5.4	0.6	0.00360	0.00349	0.00354	0.00058	9,259
			3	37.8	34.2	3.6	6.0	5.4	0.6	0.00358	0.00348	0.00353	0.00058	9,287
			4	37.8	34.2	3.6	6.0	5.4	0.6	0.00357	0.00347	0.00352	0.00058	9,316
			5	37.8	34.1	3.6	6.0	5.4	0.6	0.00358	0.00348	0.00353	0.00058	9,281
	COLUMN AVERAGE			37.8	34.2	3.6	6.0	5.4	0.6	0.00359	0.00348	0.00353	0.00058	9,284
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	20
SEQUENCE 4	6.0	8.0	1	50.4	45.5	4.9	8.0	7.2	0.8	0.00478	0.00465	0.00471	0.00078	9,258
			2	50.3	45.4	4.9	8.0	7.2	0.8	0.00477	0.00464	0.00471	0.00078	9,252
			3	50.3	45.3	4.9	8.0	7.2	0.8	0.00478	0.00464	0.00471	0.00078	9,230
			4	50.3	45.4	4.9	8.0	7.2	0.8	0.00479	0.00465	0.00472	0.00078	9,235
			5	50.4	45.4	4.9	8.0	7.2	0.8	0.00478	0.00464	0.00471	0.00078	9,250
	COLUMN AVERAGE			50.3	45.4	4.9	8.0	7.2	0.8	0.00478	0.00465	0.00471	0.00078	9,245
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00000	0.00000	0.00000	12

Source: Colbert		Description: Bottom Ash										95% Standard Dry Density at Optimum Moisture Content									
SEQUENCE 5	6.0	10.0	1	63.1	56.9	6.2	10.0	9.0	1.0	0.00594	0.00579	0.00586	0.00097	9,315							
			2	63.2	57.1	6.2	10.0	9.0	1.0	0.00596	0.00579	0.00588	0.00097	9,321							
			3	63.1	57.0	6.2	10.0	9.0	1.0	0.00596	0.00580	0.00588	0.00097	9,293							
			4	63.2	57.0	6.2	10.0	9.0	1.0	0.00595	0.00582	0.00588	0.00097	9,303							
			5	63.2	57.0	6.2	10.0	9.0	1.0	0.00596	0.00578	0.00587	0.00097	9,318							
	COLUMN AVERAGE			63.2	57.0	6.2	10.0	9.0	1.0	0.00595	0.00579	0.00587	0.00097	9,310							
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	12							
SEQUENCE 6	4.0	2.0	1	12.8	11.1	1.7	2.0	1.8	0.3	0.00171	0.00164	0.00168	0.00028	6,371							
			2	12.8	11.1	1.7	2.0	1.8	0.3	0.00170	0.00164	0.00167	0.00028	6,366							
			3	12.9	11.2	1.7	2.0	1.8	0.3	0.00171	0.00164	0.00168	0.00028	6,433							
			4	12.9	11.1	1.7	2.0	1.8	0.3	0.00170	0.00164	0.00167	0.00028	6,387							
			5	12.8	11.1	1.7	2.0	1.8	0.3	0.00170	0.00163	0.00167	0.00028	6,385							
	COLUMN AVERAGE			12.9	11.1	1.7	2.0	1.8	0.3	0.00170	0.00164	0.00167	0.00028	6,388							
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00000	0.00001	0.00000	0.00000	26							
SEQUENCE 7	4.0	4.0	1	25.0	22.6	2.4	4.0	3.6	0.4	0.00337	0.00328	0.00332	0.00055	6,521							
			2	25.0	22.5	2.5	4.0	3.6	0.4	0.00337	0.00327	0.00332	0.00055	6,511							
			3	25.0	22.6	2.4	4.0	3.6	0.4	0.00337	0.00326	0.00332	0.00055	6,538							
			4	25.0	22.6	2.5	4.0	3.6	0.4	0.00335	0.00326	0.00331	0.00055	6,538							
			5	25.0	22.6	2.4	4.0	3.6	0.4	0.00337	0.00326	0.00332	0.00055	6,529							
	COLUMN AVERAGE			25.0	22.6	2.4	4.0	3.6	0.4	0.00337	0.00327	0.00332	0.00055	6,528							
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	12							



Source: Colbert		Description: Bottom Ash										95% Standard Dry Density at Optimum Moisture Content									
SEQUENCE 8	4.0	6.0	1	37.9	34.4	3.5	6.0	5.4	0.6	0.00478	0.00463	0.00470	0.00078	7,008							
			2	37.9	34.3	3.5	6.0	5.4	0.6	0.00481	0.00463	0.00472	0.00078	6,980							
			3	37.9	34.3	3.6	6.0	5.4	0.6	0.00481	0.00464	0.00473	0.00078	6,962							
			4	37.9	34.4	3.5	6.0	5.4	0.6	0.00480	0.00466	0.00473	0.00078	6,975							
			5	37.9	34.4	3.5	6.0	5.4	0.6	0.00481	0.00465	0.00473	0.00078	6,973							
	COLUMN AVERAGE			37.9	34.4	3.5	6.0	5.4	0.6	0.00480	0.00464	0.00472	0.00078	6,980							
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	17							
SEQUENCE 9	4.0	8.0	1	50.3	46.0	4.3	8.0	7.3	0.7	0.00612	0.00598	0.00605	0.00100	7,304							
			2	50.2	45.9	4.3	7.9	7.3	0.7	0.00614	0.00599	0.00606	0.00100	7,256							
			3	50.2	45.9	4.3	7.9	7.3	0.7	0.00611	0.00597	0.00604	0.00100	7,287							
			4	50.2	45.9	4.3	7.9	7.3	0.7	0.00613	0.00597	0.00605	0.00100	7,276							
			5	50.3	46.0	4.3	8.0	7.3	0.7	0.00613	0.00596	0.00605	0.00100	7,291							
	COLUMN AVERAGE			50.2	45.9	4.3	8.0	7.3	0.7	0.00612	0.00598	0.00605	0.00100	7,283							
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	18							
SEQUENCE 10	4.0	10.0	1	63.2	57.2	6.0	10.0	9.1	1.0	0.00722	0.00703	0.00712	0.00118	7,703							
			2	63.4	57.4	6.1	10.0	9.1	1.0	0.00724	0.00704	0.00714	0.00118	7,705							
			3	63.3	57.3	6.0	10.0	9.1	1.0	0.00722	0.00704	0.00713	0.00118	7,712							
			4	63.3	57.3	6.0	10.0	9.1	1.0	0.00721	0.00703	0.00712	0.00117	7,720							
			5	63.4	57.4	6.1	10.0	9.1	1.0	0.00726	0.00705	0.00715	0.00118	7,695							
	COLUMN AVERAGE			63.4	57.3	6.0	10.0	9.1	1.0	0.00723	0.00704	0.00713	0.00118	7,707							
	STANDARD DEV.			0.1	0.1	0.0	0.0	0.0	0.0	0.00002	0.00001	0.00001	0.00000	9							

Source: Colbert	Description: Bottom Ash					95% Standard Dry Density at Optimum Moisture Content									
SEQUENCE 11	2.0	2.0	1	13.5	11.4	2.0	2.1	1.8	0.3	0.00232	0.00221	0.00226	0.00037	4,842	
			2	13.4	11.3	2.0	2.1	1.8	0.3	0.00231	0.00221	0.00226	0.00037	4,817	
			3	13.3	11.3	2.0	2.1	1.8	0.3	0.00231	0.00221	0.00226	0.00037	4,779	
			4	13.3	11.3	2.0	2.1	1.8	0.3	0.00231	0.00221	0.00226	0.00037	4,788	
			5	13.3	11.2	2.0	2.1	1.8	0.3	0.00231	0.00220	0.00226	0.00037	4,780	
	COLUMN AVERAGE		13.3	11.3	2.0	2.1	1.8	0.3	0.00231	0.00221	0.00226	0.00037	4,802		
	STANDARD DEV.		0.1	0.1	0.0	0.0	0.0	0.0	0.00000	0.00001	0.00000	0.00000	28		
SEQUENCE 12	2.0	4.0	1	25.0	22.6	2.3	4.0	3.6	0.4	0.00451	0.00437	0.00444	0.00073	4,892	
			2	25.0	22.6	2.4	3.9	3.6	0.4	0.00452	0.00436	0.00444	0.00073	4,875	
			3	25.0	22.6	2.4	4.0	3.6	0.4	0.00450	0.00436	0.00443	0.00073	4,899	
			4	25.1	22.7	2.4	4.0	3.6	0.4	0.00451	0.00436	0.00444	0.00073	4,911	
			5	25.1	22.7	2.3	4.0	3.6	0.4	0.00452	0.00436	0.00444	0.00073	4,911	
	COLUMN AVERAGE		25.0	22.7	2.4	4.0	3.6	0.4	0.00451	0.00437	0.00444	0.00073	4,898		
	STANDARD DEV.		0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00000	0.00000	0.00000	15		
SEQUENCE 13	2.0	6.0	1	38.1	34.6	3.6	6.0	5.5	0.6	0.00605	0.00585	0.00595	0.00098	5,572	
			2	38.2	34.6	3.6	6.0	5.5	0.6	0.00606	0.00589	0.00597	0.00099	5,566	
			3	38.1	34.5	3.6	6.0	5.5	0.6	0.00606	0.00587	0.00596	0.00098	5,557	
			4	38.1	34.5	3.6	6.0	5.5	0.6	0.00605	0.00586	0.00595	0.00098	5,562	
			5	38.1	34.6	3.6	6.0	5.5	0.6	0.00603	0.00586	0.00594	0.00098	5,583	
	COLUMN AVERAGE		38.1	34.6	3.6	6.0	5.5	0.6	0.00605	0.00586	0.00596	0.00098	5,566		
	STANDARD DEV.		0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	11		

Source: Colbert		Description: Bottom Ash					95% Standard Dry Density at Optimum Moisture Content									
SEQUENCE 14	2.0	8.0	1	50.4	45.6	4.9	8.0	7.2	0.8	0.00737	0.00721	0.00729	0.00120	6.002		
			2	50.4	45.6	4.8	8.0	7.2	0.8	0.00736	0.00719	0.00728	0.00120	6.014		
			3	50.6	45.8	4.8	8.0	7.2	0.8	0.00740	0.00720	0.00730	0.00120	6.014		
			4	50.6	45.8	4.8	8.0	7.3	0.8	0.00738	0.00721	0.00730	0.00120	6.023		
			5	50.5	45.7	4.8	8.0	7.2	0.8	0.00736	0.00719	0.00728	0.00120	6.020		
			COLUMN AVERAGE		50.5	45.7	4.8	8.0	7.2	0.8	0.00737	0.00720	0.00729	0.00120	6.015	
			STANDARD DEV.		0.1	0.1	0.0	0.0	0.0	0.00002	0.00001	0.00001	0.00000	8		
SEQUENCE 15	2.0	10.0	1	63.3	57.2	6.1	10.0	9.1	1.0	0.00872	0.00853	0.00863	0.00142	6.366		
			2	63.3	57.3	6.1	10.0	9.1	1.0	0.00872	0.00855	0.00863	0.00142	6.365		
			3	63.3	57.2	6.1	10.0	9.1	1.0	0.00874	0.00855	0.00864	0.00143	6.353		
			4	63.5	57.4	6.1	10.1	9.1	1.0	0.00874	0.00856	0.00865	0.00143	6.360		
			5	63.5	57.4	6.1	10.1	9.1	1.0	0.00877	0.00855	0.00866	0.00143	6.360		
			COLUMN AVERAGE		63.4	57.3	6.1	10.0	9.1	1.0	0.00874	0.00855	0.00864	0.00143	6.361	
			STANDARD DEV.		0.1	0.1	0.0	0.0	0.0	0.00002	0.00001	0.00001	0.00000	5		

SUBMITTED BY, DATE

*RS Burchen* 9/10/95

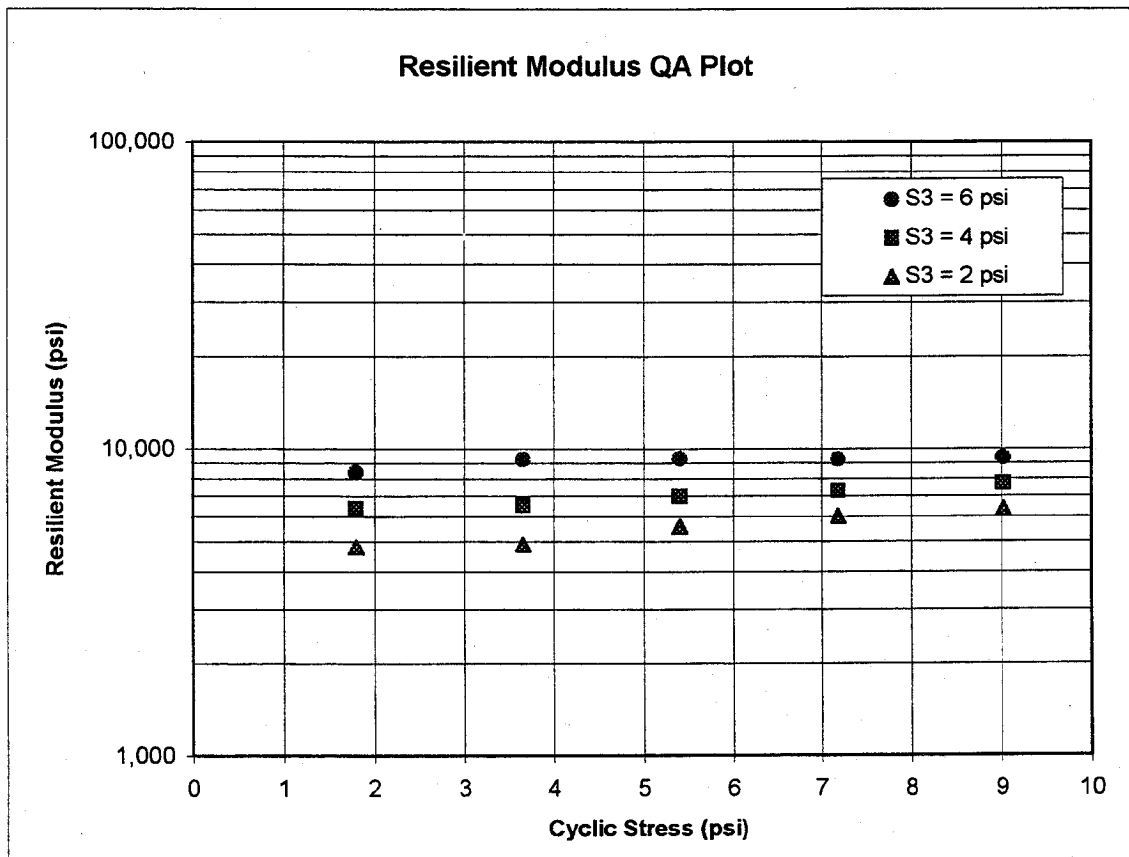
LABORATORY MANAGER

**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: Colbert  
 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

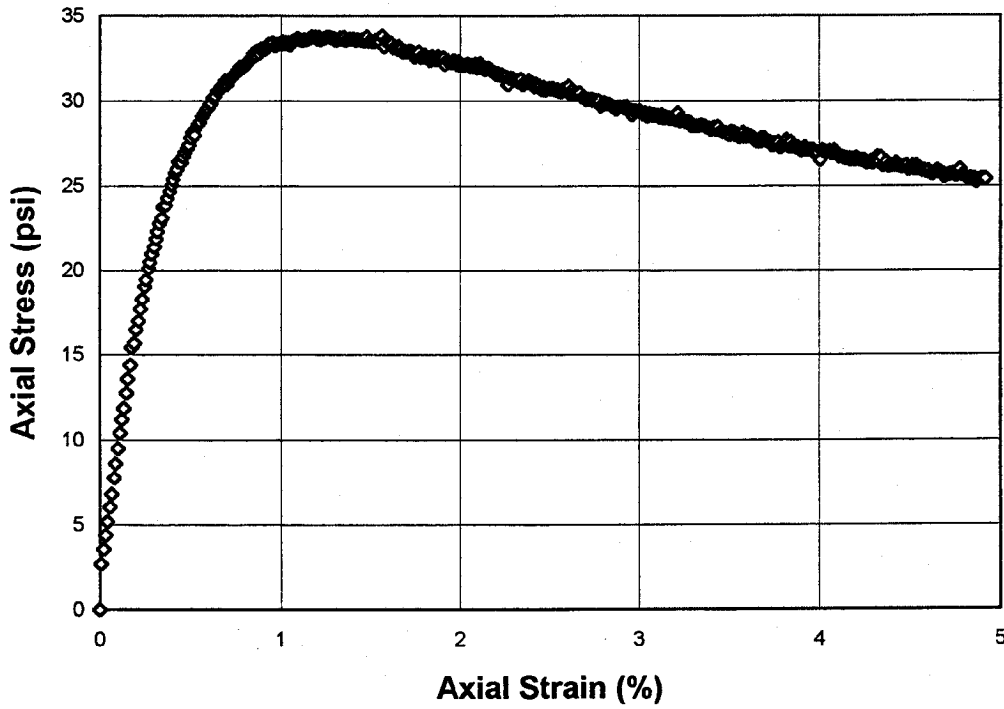
$$M_R = K_1 (S_C)^{K_2} (1+S_3)^{K_5}$$

$K_1 = \underline{\quad 2,368 \quad}$   
 $K_2 = \underline{\quad 0.11934 \quad}$   
 $K_5 = \underline{\quad 0.58242 \quad}$   
 $R^2 = \underline{\quad 0.95 \quad}$



**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:* Colbert  
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  
 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:	Colbert	
2.	MATERIAL DESCRIPTION:	Bottom Ash	
3.	REMODELING 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 <sub>0</sub> , inch		6.07
	INITIAL AREA, A <sub>0</sub> , in <sup>2</sup>		6.31
	INITIAL VOLUME A <sub>0</sub> L <sub>0</sub> , in <sup>3</sup>		38.28
7.	SOIL SPECIMEN WEIGHT:		
	INITIAL WEIGHT OF CONTAINER AND WET SOIL, grams		802.95
	FINAL WEIGHT OF CONTAINER AND WET SOIL, grams		0.00
	WEIGHT OF WET SOIL USED, grams		802.95
8.	SOIL PROPERTIES.:		
	IN SITU MOISTURE CONTENT (NUCLEAR), %		N/A
	IN SITU WET DENSITY (NUCLEAR), pcf		N/A
	or		
	OPTIMUM MOISTURE CONTENT, %		17.2
	MAX. DRY DENSITY, pcf		73.2
	95 % MAX. DRY DENSITY, pcf		69.5
9.	SPECIMEN PROPERTIES:		
	COMPACTION MOISTURE CONTENT, %		17.8
	MOISTURE CONTENT AFTER RESILIENT MODULUS TESTING, %		17.8
	COMPACTION DRY DENSITY, gd pcf		67.8
10.	QUICK SHEAR TEST		
	STRESS - STRAIN PLOT ATTACHED (Y = YES, N = NO)		Y
	TRIAxIAL SHEAR MAXIMUM STRENGTH (MAX. LOAD/X-SECTION AREA), psi		38.0
	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		08-18-1995

GENERAL REMARKS:

SUBMITTED BY, DATE

R J Barkun                      9/10/95  
 LABORATORY MANAGER

PROJECT NAME: TVA - Fly Ash, Bottom Ash and Scrubber Gypsum Study  
 LAW/PROJECT NO.: 5810860101  
 1. MATERIAL SOURCE: Colbert  
 2. MATERIAL DESCRIPTION: Bottom Ash  
 3. REMOLDING TARGETS: 95% Modified 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 <sub>3</sub>	S <sub>cyclic</sub>	c <sub>1</sub>	P <sub>max</sub>	P <sub>cyclic</sub>	P <sub>contact</sub>	S <sub>max</sub>	S <sub>cyclic</sub>	S <sub>contact</sub>	H <sub>1</sub>	H <sub>2</sub>	H <sub>avg</sub>	ε <sub>r</sub>	M <sub>r</sub>
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	1.2	2.0	1.8	0.2	0.00120	0.00127	0.00123	0.00020	8,925
			2	12.6	11.4	1.3	2.0	1.8	0.2	0.00119	0.00127	0.00123	0.00020	8,884
			3	12.6	11.4	1.3	2.0	1.8	0.2	0.00119	0.00126	0.00122	0.00020	8,943
			4	12.7	11.4	1.3	2.0	1.8	0.2	0.00121	0.00126	0.00123	0.00020	8,899
			5	12.6	11.3	1.3	2.0	1.8	0.2	0.00120	0.00126	0.00123	0.00020	8,878
COLUMN AVERAGE				12.6	11.4	1.3	2.0	1.8	0.2	0.00120	0.00126	0.00123	0.00020	8,906
STANDARD DEV.				0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00000	0.00000	28

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

SEQUENCE 2	6.0	4.0	1	25.2	22.8	2.3	4.0	3.6	0.4	0.00238	0.00235	0.00237	0.00039	9,267
			2	25.2	22.9	2.3	4.0	3.6	0.4	0.00237	0.00235	0.00236	0.00039	9,319
			3	25.2	22.9	2.4	4.0	3.6	0.4	0.00237	0.00236	0.00236	0.00039	9,319
			4	25.2	22.8	2.4	4.0	3.6	0.4	0.00236	0.00235	0.00236	0.00039	9,322
			5	25.2	22.9	2.4	4.0	3.6	0.4	0.00238	0.00238	0.00238	0.00039	9,245
	COLUMN AVERAGE		25.2	22.9	2.4	4.0	3.6	0.4	0.00237	0.00236	0.00237	0.00039	9,294	
	STANDARD DEV.		0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	36	

SEQUENCE 3	6.0	6.0	1	37.9	34.2	3.7	6.0	5.4	0.6	0.00356	0.00349	0.00352	0.00058	9,348
			2	37.8	34.1	3.7	6.0	5.4	0.6	0.00357	0.00349	0.00353	0.00058	9,296
			3	37.8	34.2	3.6	6.0	5.4	0.6	0.00357	0.00351	0.00354	0.00058	9,286
			4	37.8	34.1	3.7	6.0	5.4	0.6	0.00354	0.00349	0.00351	0.00058	9,340
			5	37.8	34.1	3.7	6.0	5.4	0.6	0.00356	0.00349	0.00352	0.00058	9,310
	COLUMN AVERAGE		37.8	34.2	3.7	6.0	5.4	0.6	0.00356	0.00349	0.00353	0.00058	9,316	
	STANDARD DEV.		0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	27	

SEQUENCE 4	6.0	8.0	1	50.4	45.5	4.9	8.0	7.2	0.8	0.00477	0.00467	0.00472	0.00078	9,269
			2	50.6	45.7	4.9	8.0	7.2	0.8	0.00476	0.00466	0.00471	0.00078	9,328
			3	50.6	45.6	4.9	8.0	7.2	0.8	0.00476	0.00468	0.00472	0.00078	9,296
			4	50.5	45.6	4.9	8.0	7.2	0.8	0.00478	0.00467	0.00472	0.00078	9,280
			5	50.7	45.7	5.0	8.0	7.2	0.8	0.00475	0.00466	0.00470	0.00078	9,345
	COLUMN AVERAGE		50.5	45.6	4.9	8.0	7.2	0.8	0.00476	0.00467	0.00471	0.00078	9,304	
	STANDARD DEV.		0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	32	



Source: Colbert		Description: Bottom Ash										95% Modified Dry Density at Optimum Moisture Content				
SEQUENCE 5	6.0	10.0	1	63.3	57.0	6.2	10.0	9.0	1.0	0.00592	0.00578	0.00585	0.00096	9,372		
			2	63.3	57.1	6.2	10.0	9.0	1.0	0.00593	0.00582	0.00588	0.00097	9,337		
			3	63.6	57.4	6.2	10.1	9.1	1.0	0.00594	0.00581	0.00587	0.00097	9,392		
			4	63.4	57.2	6.2	10.1	9.1	1.0	0.00594	0.00580	0.00587	0.00097	9,373		
			5	63.1	57.0	6.2	10.0	9.0	1.0	0.00593	0.00579	0.00586	0.00097	9,347		
	COLUMN AVERAGE			63.3	57.1	6.2	10.0	9.1	1.0	0.00593	0.00580	0.00587	0.00097	9,364		
	STANDARD DEV.			0.2	0.2	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	22		
SEQUENCE 6	4.0	2.0	1	13.0	11.3	1.6	2.1	1.8	0.3	0.00157	0.00163	0.00160	0.00026	6,802		
			2	13.0	11.3	1.7	2.1	1.8	0.3	0.00157	0.00163	0.00160	0.00026	6,805		
			3	13.0	11.4	1.6	2.1	1.8	0.3	0.00158	0.00164	0.00161	0.00027	6,790		
			4	13.0	11.3	1.7	2.1	1.8	0.3	0.00157	0.00163	0.00160	0.00026	6,785		
			5	13.1	11.4	1.7	2.1	1.8	0.3	0.00157	0.00162	0.00160	0.00026	6,885		
	COLUMN AVERAGE			13.0	11.4	1.7	2.1	1.8	0.3	0.00157	0.00163	0.00160	0.00026	6,813		
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00000	0.00001	0.00001	0.00000	41		
SEQUENCE 7	4.0	4.0	1	25.1	22.8	2.3	4.0	3.6	0.4	0.00331	0.00330	0.00330	0.00054	6,632		
			2	25.2	22.8	2.3	4.0	3.6	0.4	0.00330	0.00330	0.00330	0.00054	6,653		
			3	25.2	22.9	2.3	4.0	3.6	0.4	0.00330	0.00329	0.00329	0.00054	6,683		
			4	25.2	22.8	2.3	4.0	3.6	0.4	0.00330	0.00330	0.00330	0.00054	6,645		
			5	25.1	22.8	2.3	4.0	3.6	0.4	0.00332	0.00330	0.00331	0.00055	6,617		
	COLUMN AVERAGE			25.2	22.8	2.3	4.0	3.6	0.4	0.00330	0.00330	0.00330	0.00054	6,646		
	STANDARD DEV.			0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	25		

Source: Colbert		Description: Bottom Ash										95% Modified Dry Density at Optimum Moisture Content									
SEQUENCE 8	4.0	6.0	1	37.7	34.0	3.7	6.0	5.4	0.6	0.00473	0.00466	0.00469	0.00077	6,976							
			2	37.5	33.9	3.7	6.0	5.4	0.6	0.00474	0.00464	0.00469	0.00077	6,944							
			3	37.6	33.9	3.6	6.0	5.4	0.6	0.00474	0.00465	0.00469	0.00077	6,949							
			4	37.5	33.9	3.7	6.0	5.4	0.6	0.00474	0.00465	0.00469	0.00077	6,939							
			5	37.7	34.0	3.6	6.0	5.4	0.6	0.00473	0.00466	0.00470	0.00077	6,964							
	COLUMN AVERAGE		37.6	33.9	3.7	6.0	5.4	0.6	0.00473	0.00465	0.00469	0.00077	6,955								
	STANDARD DEV.		0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.00000	0.00001	0.00000	0.00000	15							
SEQUENCE 9	4.0	8.0	1	50.7	45.8	4.9	8.0	7.3	0.8	0.00599	0.00585	0.00592	0.00098	7,441							
			2	50.7	45.8	4.9	8.0	7.3	0.8	0.00600	0.00586	0.00593	0.00098	7,429							
			3	50.7	45.8	4.9	8.0	7.3	0.8	0.00598	0.00586	0.00592	0.00098	7,430							
			4	50.7	45.7	4.9	8.0	7.2	0.8	0.00596	0.00587	0.00592	0.00098	7,433							
			5	50.7	45.8	4.9	8.0	7.3	0.8	0.00596	0.00587	0.00592	0.00098	7,440							
	COLUMN AVERAGE		50.7	45.8	4.9	8.0	7.3	0.8	0.00598	0.00586	0.00592	0.00098	7,435								
	STANDARD DEV.		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00002	0.00001	0.00000	6								
SEQUENCE 10	4.0	10.0	1	62.9	56.7	6.2	10.0	9.0	1.0	0.00712	0.00701	0.00707	0.00116	7,710							
			2	62.7	56.5	6.2	9.9	9.0	1.0	0.00712	0.00699	0.00705	0.00116	7,710							
			3	62.9	56.7	6.2	10.0	9.0	1.0	0.00716	0.00701	0.00708	0.00117	7,696							
			4	62.9	56.7	6.2	10.0	9.0	1.0	0.00713	0.00701	0.00707	0.00116	7,715							
			5	63.0	56.8	6.2	10.0	9.0	1.0	0.00713	0.00697	0.00705	0.00116	7,745							
	COLUMN AVERAGE		62.9	56.7	6.2	10.0	9.0	1.0	0.00713	0.00700	0.00706	0.00116	7,715								
	STANDARD DEV.		0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.00002	0.00002	0.00001	0.00000	18							

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

SEQUENCE 11	2.0	2.0	1	13.3	11.2	2.0	2.1	1.8	0.3	0.00221	0.00219	0.00220	0.00036	4,918
			2	13.3	11.2	2.0	2.1	1.8	0.3	0.00221	0.00219	0.00220	0.00036	4,903
			3	13.3	11.2	2.0	2.1	1.8	0.3	0.00222	0.00220	0.00221	0.00036	4,881
			4	13.2	11.2	2.0	2.1	1.8	0.3	0.00221	0.00219	0.00220	0.00036	4,908
			5	13.4	11.4	2.0	2.1	1.8	0.3	0.00221	0.00220	0.00221	0.00036	4,947
	COLUMN AVERAGE		13.3	11.3	2.0	2.1	1.8	0.3	0.00221	0.00219	0.00220	0.00036	4,912	
	STANDARD DEV.		0.1	0.1	0.0	0.0	0.0	0.0	0.00000	0.00000	0.00000	0.00000	24	
SEQUENCE 12	2.0	4.0	1	24.8	22.5	2.3	3.9	3.6	0.4	0.00444	0.00436	0.00440	0.00073	4,913
			2	24.9	22.6	2.4	4.0	3.6	0.4	0.00445	0.00436	0.00440	0.00073	4,931
			3	24.8	22.4	2.4	3.9	3.5	0.4	0.00443	0.00435	0.00439	0.00072	4,899
			4	24.8	22.5	2.3	3.9	3.6	0.4	0.00444	0.00436	0.00440	0.00073	4,919
			5	24.8	22.5	2.3	3.9	3.6	0.4	0.00444	0.00436	0.00440	0.00073	4,913
	COLUMN AVERAGE		24.8	22.5	2.3	3.9	3.6	0.4	0.00444	0.00436	0.00440	0.00073	4,915	
	STANDARD DEV.		0.1	0.1	0.0	0.0	0.0	0.0	0.00000	0.00001	0.00000	0.00000	11	
SEQUENCE 13	2.0	6.0	1	37.7	34.1	3.6	6.0	5.4	0.6	0.00599	0.00587	0.00593	0.00098	5,523
			2	37.6	34.0	3.6	6.0	5.4	0.6	0.00599	0.00586	0.00592	0.00098	5,516
			3	37.6	34.0	3.6	6.0	5.4	0.6	0.00598	0.00587	0.00593	0.00098	5,521
			4	37.6	34.0	3.6	6.0	5.4	0.6	0.00598	0.00588	0.00593	0.00098	5,523
			5	37.6	33.9	3.6	6.0	5.4	0.6	0.00598	0.00587	0.00593	0.00098	5,508
	COLUMN AVERAGE		37.6	34.0	3.6	6.0	5.4	0.6	0.00598	0.00587	0.00593	0.00098	5,518	
	STANDARD DEV.		0.0	0.0	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00000	0.00000	6	

Source: Colbert		Description: Bottom Ash						95% Modified Dry Density at Optimum Moisture Content					
2.0	8.0	1	50.5	45.7	4.9	8.0	7.2	0.8	0.00731	0.00718	0.00725	0.00119	6,061
SEQUENCE 14		2	50.5	45.6	4.9	8.0	7.2	0.8	0.00731	0.00719	0.00725	0.00120	6,047
		3	50.6	45.7	4.9	8.0	7.2	0.8	0.00734	0.00717	0.00725	0.00120	6,053
		4	50.5	45.6	4.9	8.0	7.2	0.8	0.00731	0.00719	0.00725	0.00120	6,045
		5	50.4	45.5	4.9	8.0	7.2	0.8	0.00729	0.00718	0.00724	0.00119	6,039
				50.5	45.6	4.9	8.0	7.2	0.8	0.00731	0.00718	0.00725	0.00119
			0.1	0.1	0.0	0.0	0.0	0.0	0.00002	0.00001	0.00001	0.00000	8
SEQUENCE 15		1	63.1	57.0	6.1	10.0	9.0	1.0	0.00857	0.00842	0.00850	0.00140	6,452
		2	63.3	57.1	6.2	10.0	9.1	1.0	0.00857	0.00840	0.00849	0.00140	6,475
		3	63.4	57.3	6.1	10.0	9.1	1.0	0.00858	0.00841	0.00849	0.00140	6,482
		4	63.3	57.2	6.1	10.0	9.1	1.0	0.00856	0.00842	0.00849	0.00140	6,480
		5	63.1	57.0	6.2	10.0	9.0	1.0	0.00855	0.00841	0.00848	0.00140	6,463
			63.2	57.1	6.1	10.0	9.1	1.0	0.00856	0.00841	0.00849	0.00140	6,470
			0.1	0.1	0.0	0.0	0.0	0.0	0.00001	0.00001	0.00001	0.00000	13

SUBMITTED BY, DATE

*R.S. Sturchee* 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: Colbert  
 2. MATERIAL DESCRIPTION: Bottom Ash  
 3. REMOLDING TARGETS: 95% Modified Dry Density at Optimum Moisture Content  
 4. MATERIAL TYPE: 2  
 5. TEST DATE: 08-18-1995

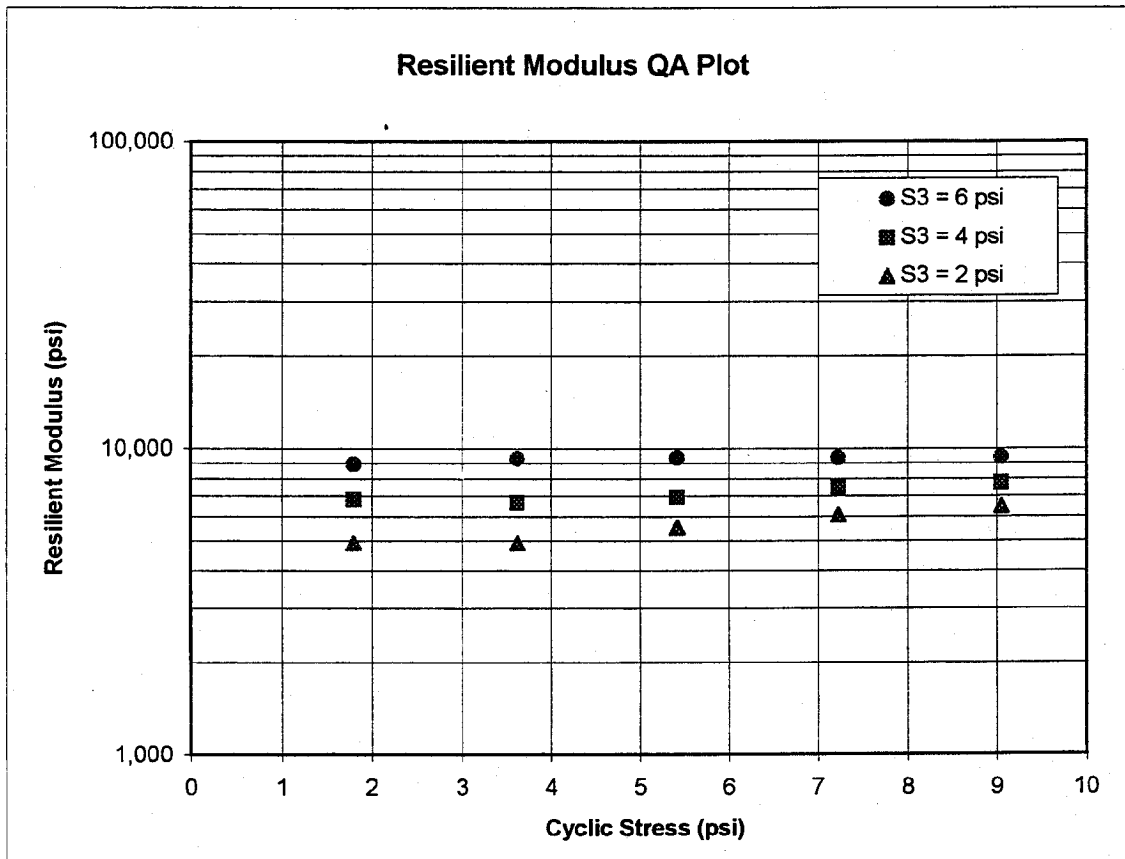
$$M_R = K_1 (S_C)^{K_2} (1+S_3)^{K_5}$$

$$K_1 = \underline{\underline{2,455}}$$

$$K_2 = \underline{\underline{0.09488}}$$

$$K_5 = \underline{\underline{0.59309}}$$

$$R^2 = \underline{\underline{0.94}}$$



**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:* Colbert  
2. *MATERIAL DESCRIPTION:* Bottom Ash  
3. *REMODELING TARGETS:* 95% Modified Dry Density at Optimum Moisture Content  
4. *MATERIAL TYPE* 2  
5. *TEST DATE* 08-18-1995

