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**Experimental Construction 92-34 : Field Trial of Gravel
Stabilization Methods, Route 1, Cyr-Van Buren, Maine, 6th Interim
Report, September 2000**

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STATE OF MAINE
DEPARTMENT OF TRANSPORTATION



TRANSPORTATION RESEARCH DIVISION
BUREAU OF PLANNING, RESEARCH & COMMUNITY SERVICES



September 2000

EXPERIMENTAL CONSTRUCTION 92-34

FIELD TRIAL OF GRAVEL STABILIZATION METHODS
ROUTE 1, CYR-VAN BUREN, MAINE

6TH INTERIM REPORT

INTRODUCTION

This experimental construction project was developed, designed, and inspected by personnel from the University of Maine, Civil Engineering Staff. The experimental project was constructed on and as a part of Project #2586 00. This was a complete reconstruction project 3.54 km (2.2 mi) in length. The experimental section contains 6 experimental base types and is 310 m (1020 ft) in length. The experimental section began at Station 1028+00 and ended at Station 1038+20. The test section consisted of 60 m (200 ft) segments of soil cement, asphalt, calcium chloride, modified, standard and one 6 m (20 ft) untreated section. The stabilized and control sections were located as follows:

Soil-Cement Stabilized	STA 1028+00 to 1030+00
Modified Subbase Control	STA 1030+00 to 1032+00
Asphalt Stabilized Section	STA 1032+00 to 1034+00
Untreated Section	STA 1034+00 to 1034+20
Calcium Chloride Stab Section	STA 1034+20 to 1036+20
Standard Subbase Control	STA 1036+20 to 1038+20

The Soil Cement Stabilized section is a mixture of Modified Subbase (mentioned later) and 6 percent by weight of Type I Portland Cement.

The Modified Subbase Control section is standard subbase aggregate MDOT specification 703.06b Type D with a 5.1 cm (2 in) maximum aggregate size. This aggregate was used on all stabilized sections to facilitate blending of each treatment.

The Asphalt Stabilized section is a mixture of modified subbase and 4.5 percent of MS-4 Emulsified Asphalt

The Untreated section consists of Modified Subbase

The Calcium Chloride Stabilized section is a mixture of Modified Subbase and 2.8 l/m² (0.75 gal/yd²) of 35 percent liquid calcium chloride solution

The Standard Subbase Control section consists of standard subbase aggregate MDOT specification 703.06b Type D with a 15.2 cm (6 in) maximum aggregate size

Construction on this project started in September 1990 and was completed in the summer of 1991. A background of the stabilization agents, their uses, advantages and disadvantages is explained in the construction report titled "Experimental Construction 92-34" written in December 1991. This report also provided preliminary design results as well as test results obtained during construction. In addition to the test results a plan for long term monitoring was also included in Appendix G and reproduced for this report in Table I. Some of the features to be monitored are rutting and serviceability, such as roughness and overall performance. Strength measurements using pavement deflection was also suggested. Most of the evaluations can be performed with the Automatic Road Analyzer (ARAN) and Falling Weight Deflectometer test vehicles. Long term monitoring of the calcium chloride is specifically mentioned. For this phase they recommend boring test holes and sampling the base every 5th year to monitor the possibility of leaching calcium chloride.

RESULTS

This report covers the period of time from January 1998 thru December 1999. According to the test schedule in Table I, roughness, rut depths, pavement deflections and crack survey data were obtained.

ROUGHNESS MEASUREMENTS

The ARAN test vehicle was replaced in 1998. The new ARAN was used to measure roughness, this is an ASTM Class II profiler using lasers to measure the vehicle's height above the road surface and accelerometers to measure vertical forces caused by surface deformities. Measurements are recorded every two inches in each wheel path. Data was collected on May 17, 2000 and results are presented in Table II using International Roughness Index (IRI) values. Roughness values have increased in all sections with the exception of the south bound Soil Cement section which decreased nearly 31% since 1997.

In the Northbound lane, the Standard Subbase continues to be the smoothest section followed by Calcium Chloride, Soil Cement, Modified Subbase and Asphalt Stabilized Base sections

In the Southbound lane, the Soil Cement section is the smoothest followed by Asphalt Stabilized, Standard Subbase, Modified Subbase and Calcium Chloride sections

Overall the Standard Subbase section continues to be the smoothest with an IRI of 76.43 in/mi but this years data increased nearly 67% from 1997. Second smoothest with an IRI of 78.54 in/mi and the smallest increase of 14.54 % is the Soil Cement section followed by the Calcium Chloride section with an IRI of 92.93 in/mi an increase of 65.61%, Asphalt Stabilized with an IRI of 94.55 in/mi an increase of 17.24% and the Modified Subbase with an IRI of 101.53 in/mi an increase of 33.01%. Even though the IRI has increased for all sections they are still within the smooth rating of 0-3 m/km (0-190 in/mi)

Some roughness data collected between 1991 and 1997 contradicts itself, one sample year high readings the next year lower readings. This could be due to the short length of each test section and the capabilities of the ARAN test vehicle at that time. Data was collected between 1991 and 1997 using an older version of ARAN that had a Class III type profiler. Class III profilers measure the dynamic response of the vehicle as it travels across the roadway using axle/body accelerometers or other measurement devices. This type of roughness measurement is not as accurate or repeatable as the current Class II type ARAN test vehicle. Future roughness readings should represent a truer longitudinal profile of each section.

RUT DEPTH MEASUREMENTS

The ARAN was also used to measure rut depths. Ultrasonic sensors are spaced 10 cm (4 in) apart on a 3.7 m (12 ft) wide smartbar (front bumper). These sensors record distance from the smartbar to the pavement surface. Gyroscopes are used to record pitch and roll of the vehicle at each station to determine the pavement slope. Depths are measured to the nearest 0.25 cm (0.1 in). Average values for inner and outer wheelpaths per lane per test section are presented in Table III. Tests have revealed the following:

Rut depths have increased in the inner wheelpath and decreased or remained the same in the outer wheelpath.

Calcium Chloride stabilized base has consistently had the least amount of rutting among the stabilized base sections.

There is very little change in rut depths throughout the project and these changes are normal for a project of this age.

STRUCTURAL MEASUREMENTS

In previous years, MDOT used the Road Rater to record structural measurements. In 1997 MDOT purchased a Falling Weight Deflectometer (FWD) to replace the Road Rater. Measurements from the Road Rater and FWD are reported in Table IV.

Road Rater results are displayed as an overlay required. This is the depth of overlay necessary to restore each section to a 20 year design life using 61 cm (24 in) of subbase and 15 cm (6 in) of pavement, the lower the number the stronger the section. All readings are negative suggesting no overlay is necessary.

The FWD calculates an effective existing pavement structural number. This number is calculated using measurements from the first sensor and represents the existing structural number for 61 cm (24 in) of subbase and 15 cm (6 in) of pavement combined, the higher the number the stronger the section. Similar roads of this design in the state of Maine have a structural number between 5 and 6. Deflections have revealed the following:

The Soil Cement section continues to outperform all sections.

The Asphalt Stabilized section is also structurally stronger than all sections with the exception of Soil Cement.

Calcium Chloride section had stronger readings than previous tests.

The Modified Subbase section is structurally weaker than the other sections closely followed by the Standard Subbase section.

A Comparison of Population Means using the F and T test comparing 1997 and 1999 structural data within the same section was performed. Data revealed that we cannot reject the null hypothesis at the 95.0% confidence level within each section and that Mean 1997 data equals mean 1999 data for each section.

Table V contains results of a multiple comparison test to determine which section(s) is significantly different from each other. In 1997 the Soil-Cement Section was significantly different than the Modified, Asphalt, Calcium Chloride and Standard sections. In 1999 the Soil Cement section was significantly different than the Modified, Calcium Chloride and Standard sections.

VISUAL EVALUATION

Visual inspection and a crack survey of the project were conducted on September 14, 1999. The results are as follows:

All cracks were sealed with a rubber sealant since the last evaluation

Asphalt flushing has increased in all sections excluding the Calcium Chloride section which has none

The Modified Subbase, Asphalt Stabilized and Calcium Chloride stabilized sections have full length centerline joint separation. Soil Cement centerline separation increased from 21 m (70 ft) to 28 m (92 ft) and the Standard Subbase section has remained the same with a total of 52 m (170 ft) of cracking

All sections have shoulder joint separation. The Soil Cement, Modified Subbase and Asphalt Stabilized sections have no additional shoulder joint separation and remain at 33 m (110 ft), 55m (182 ft) and 85 m (280 ft) respectively. Calcium Chloride stabilized base increased from 46 m (150 ft) to 47 m (153 ft) and the Standard Subbase section increased from 11 m (35 ft) to 58 m (192 ft)

The Modified Subbase and Calcium Chloride sections have one full width transverse crack with no additional cracking since the 1997 evaluation. The Soil cement section has two full width cracks, a 1 m (4 ft) crack at centerline and a new 1 m (4 ft) crack at centerline at station 1029+12. The Asphalt Stabilized area has three transverse cracks, one full width, one three quarters across lanes and a new half width crack in the northbound lane. The Standard Subbase section has one full width transverse crack and a new three quarter crack at station 1038+12

The Calcium Chloride section has an additional 6 m (20 ft) of longitudinal cracking between wheel paths bringing the total to 49 m (160 ft) and the Soil Cement section has 1.5 m (5 ft) of cracking between wheelpaths. No other sections are experiencing cracking of this type

Load associated cracking has not occurred within the experimental project

RECOMMENDATIONS

The Soil Cement and Asphalt Stabilized sections continue to outperform the other sections structurally and are recommended for use as a soil stabilizer

Calcium Chloride has shown an increase in structural numbers but the pavement is still showing signs of deterioration and roughness has increased suggesting instability. Perhaps further evaluation will determine if Calcium Chloride can stabilize the soil in this area

A significant decrease in structural number and increase in rutting of the Standard Subbase section suggests the base material may be beginning to degrade

The Modified Subbase section also has low structural numbers and high roughness readings suggesting degradation of the base and is not recommended as an alternative to our standard subbase material

Prepared by



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Reviewed by.



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Distribution B

Other Available Documents

Construction Report December 1991
1st Interim Report May 1993
2nd Interim Report February 1995

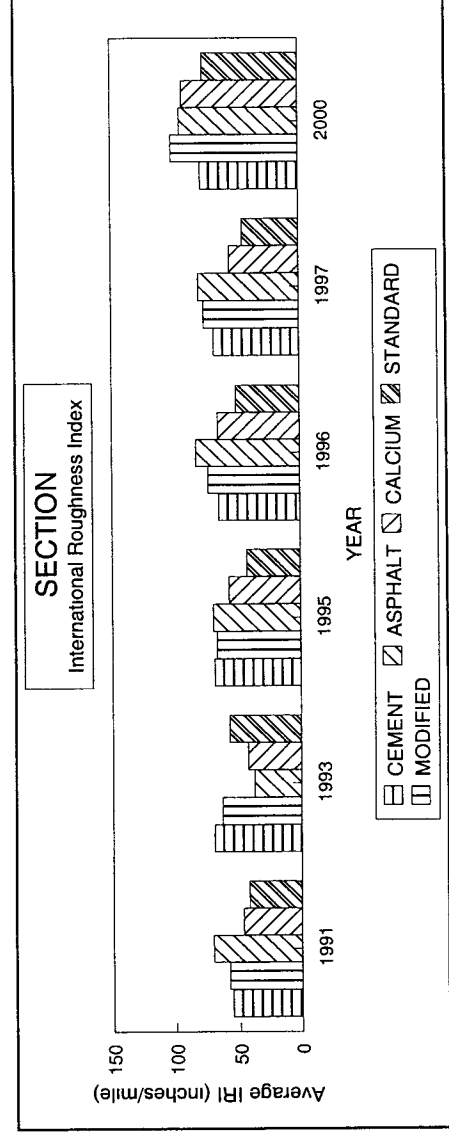
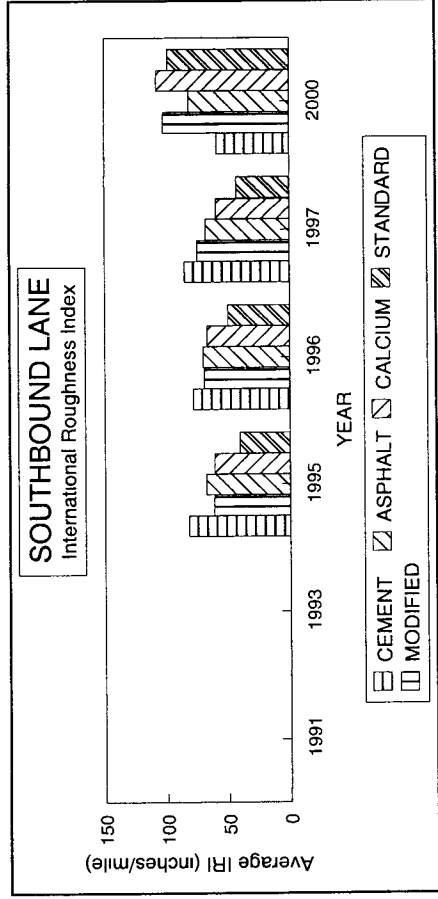
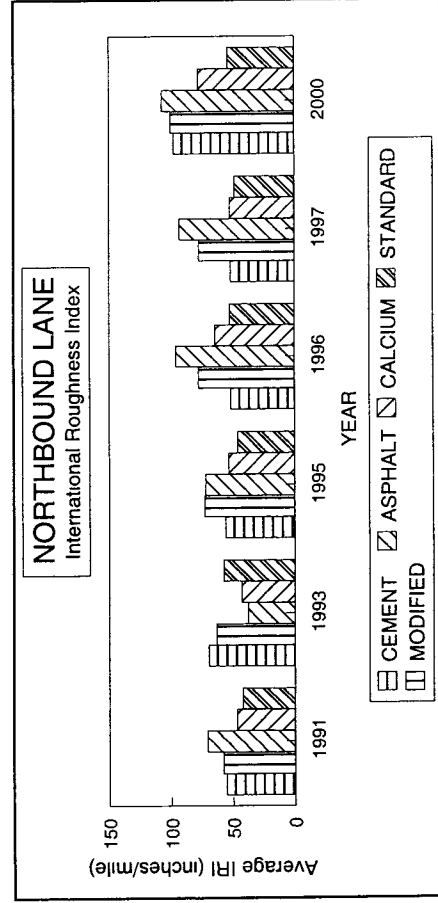
3rd Interim Report January 1996
4th Interim Report January 1997
5th Interim Report May 1998

TABLE I
 TESTING SCHEDULE FOR CYR - VAN BUREN
 FIELD TRIAL OF
 GRAVEL STABILIZATION METHODS

<u>YEAR</u>	ARAN	<u>ARAN</u> <u>Rut</u>	<u>Pavement</u> <u>Deflections</u>	<u>Elev</u> <u>X-sections</u>	<u>Elev</u> <u>Profile</u>	<u>Crack</u> <u>Survey</u>	<u>CaCl2</u> <u>Leach</u>
	<u>Roughness</u> <u>IRI</u>						
1991	*	*	*				
1992	*	*	*	*	*	*	
1993	*	*	*	*	*	*	
1994	*	*	*				
1995	*	*	*	*	*	*	*
1996	*	*	*				
1997	*	*	*	*	*	*	
1998						*	
1999	*	*	*			*	
2000						*	
2001	*	*	*			*	
2002						*	
2003	*	*	*			*	
2004						*	
2005	*	*	*			*	
2006						*	

TABLE II
 PHYSICAL PROPERTIES
 INTERNATIONAL ROUGHNESS INDEX (Inches / Mile)

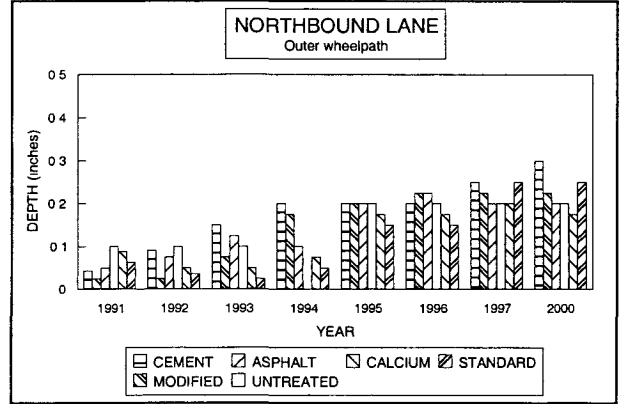
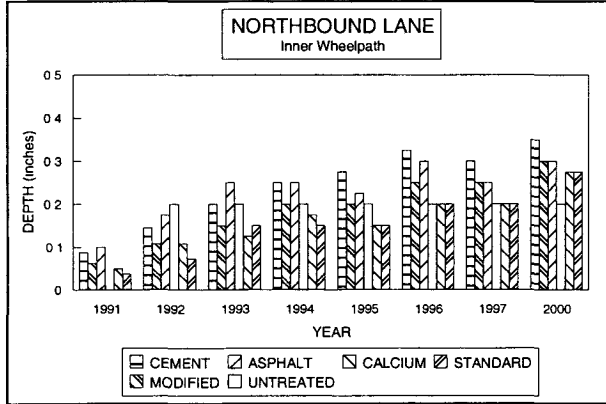
Date	Soil Cement			Modified Subbase			Asphalt Stabilized			Calcium Chloride			Standard Subbase		
	NBL Ave	SBL Ave	Section Ave	NBL Ave	SBL Ave	Section Ave	NBL Ave	SBL Ave	Section Ave	NBL Ave	SBL Ave	Section Ave	NBL Ave	SBL Ave	Section Ave
1991	55.67	M	55.67	58.09	M	58.09	70.97	M	70.97	47.09	M	47.09	42.23	M	42.23
1993	69.98	M	69.98	63.40	M	63.4	37.88	M	37.88	43.07	M	43.07	57.66	M	57.66
1995	56.03	M	69.04	73.09	M	67.31	72.18	M	70.20	53.61	M	57.48	46.11	M	43.39
1996	51.65	M	65.11	77.89	M	73.67	96.14	M	83.32	64.55	M	65.90	52.50	M	51.33
1997	51.75	M	68.57	77.62	M	76.33	93.30	M	80.65	52.48	M	56.12	48.64	M	45.82
2000	98.09	M	78.54	100.48	M	101.53	107.44	M	94.55	78.00	M	92.93	54.12	M	76.43
% Increase	89.55%	-30.92%	14.54%	29.45%	36.70%	33.01%	15.16%	20.09%	17.24%	48.63%	80.52%	65.61%	11.27%	129.68%	66.82%



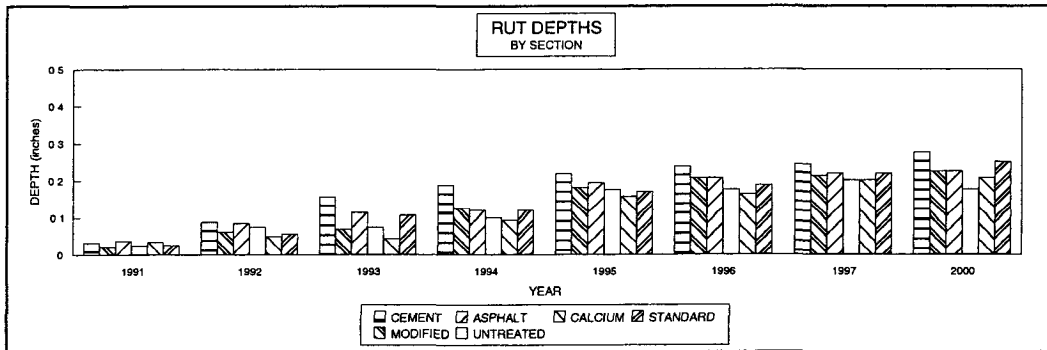
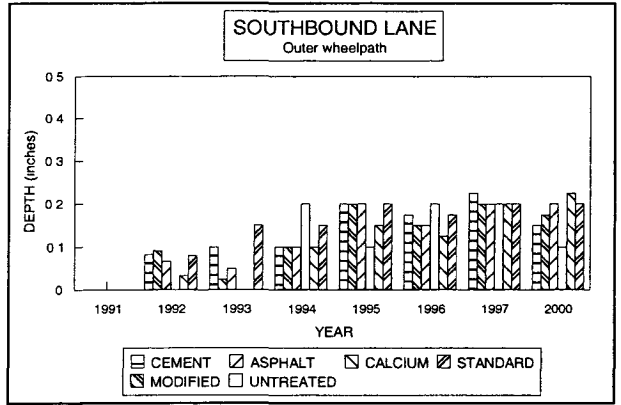
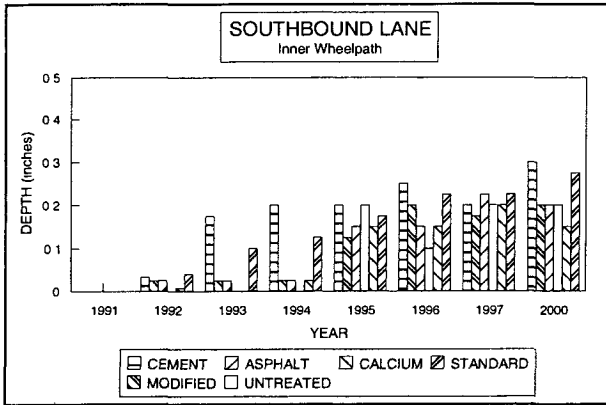
M represents missing data

TABLE III
PHYSICAL PROPERTIES
AVERAGE RUT DEPTHS (Inches)

DATE	NORTHBOUND LANE Inner Wheelpath						NORTHBOUND LANE Outer wheelpath					
	SOIL CEMENT	MODIFIED SUBBASE	ASPHALT SUBBASE	UN TREATED	CALCIUM CHLORIDE	STANDARD SUBBASE	SOIL CEMENT	MODIFIED SUBBASE	ASPHALT SUBBASE	UN TREATED	CALCIUM CHLORIDE	STANDARD SUBBASE
1991	0 088	0 063	0 100	0 000	0 050	0 038	0 043	0 025	0 050	0 100	0 088	0 063
1992	0 145	0 108	0 175	0 200	0 108	0 073	0 091	0 025	0 075	0 100	0 050	0 036
1993	0 200	0 150	0 250	0 200	0 125	0 150	0 150	0 075	0 125	0 100	0 050	0 025
1994	0 250	0 200	0 250	0 200	0 175	0 150	0 200	0 175	0 100	0 000	0 075	0 050
1995	0 275	0 200	0 225	0 200	0 150	0 150	0 200	0 200	0 200	0 200	0 175	0 150
1996	0 325	0 250	0 300	0 200	0 200	0 200	0 200	0 225	0 225	0 200	0 175	0 150
1997	0 300	0 250	0 250	0 200	0 200	0 200	0 250	0 225	0 200	0 200	0 200	0 250
2000	0 350	0 300	0 300	0 200	0 275	0 275	0 300	0 225	0 200	0 200	0 175	0 250



DATE	SOUTHBOUND LANE Inner Wheelpath						SOUTHBOUND LANE Outer wheelpath					
	SOIL CEMENT	MODIFIED SUBBASE	ASPHALT SUBBASE	UN TREATED	CALCIUM CHLORIDE	STANDARD SUBBASE	SOIL CEMENT	MODIFIED SUBBASE	ASPHALT SUBBASE	UN TREATED	CALCIUM CHLORIDE	STANDARD SUBBASE
1991	M	M	M	M	M	M	M	M	M	M	M	M
1992	0 033	0 025	0 025	0 000	0 008	0 040	0 083	0 092	0 067	0 000	0 033	0 080
1993	0 175	0 025	0 025	0 000	0 000	0 100	0 100	0 025	0 050	0 000	0 000	0 150
1994	0 200	0 025	0 025	0 000	0 025	0 125	0 100	0 100	0 100	0 200	0 100	0 150
1995	0 200	0 125	0 150	0 200	0 150	0 175	0 200	0 200	0 200	0 100	0 150	0 200
1996	0 250	0 200	0 150	0 100	0 150	0 225	0 175	0 150	0 150	0 200	0 125	0 175
1997	0 200	0 175	0 225	0 200	0 200	0 225	0 225	0 200	0 200	0 200	0 200	0 200
2000	0 300	0 200	0 200	0 200	0 150	0 275	0 150	0 175	0 200	0 100	0 225	0 200

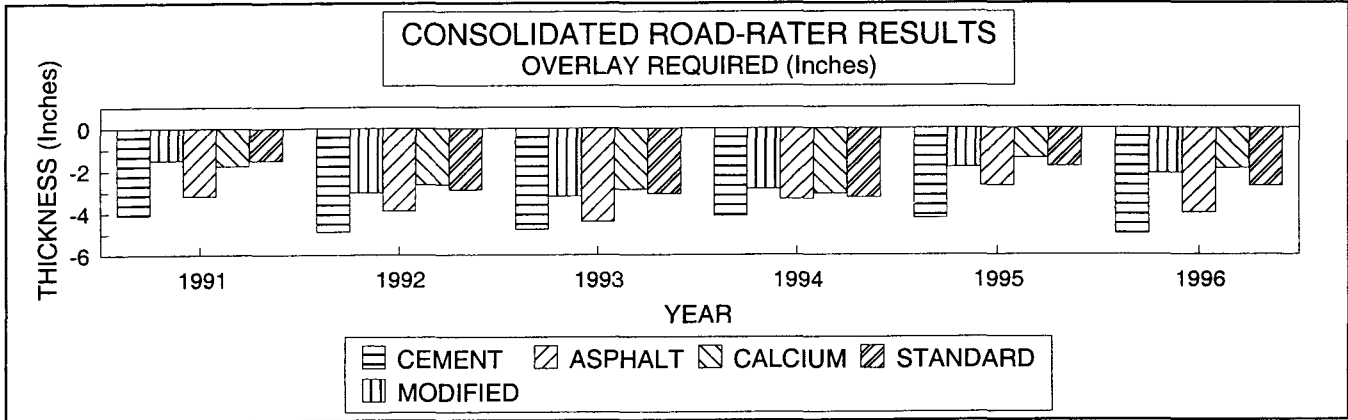


M represents missing data

**TABLE IV
PHYSICAL PROPERTIES
STRUCTURAL EVALUATION**

CONSOLIDATED ROAD-RATER RESULTS

YEAR	OVERLAY REQUIRED (Inches)				
	SOIL CEMENT	MODIFIED SUBBASE	ASPHALT STABILIZED	CALCIUM CHLORIDE	STANDARD SUBBASE
1991	-4 11	-1 50	-3 19	-1 78	-1 52
1992	-4 90	-3 03	-3 90	-2 66	-2 91
1993	-4 78	-3 21	-4 41	-2 89	-3 08
1994	-4 14	-2 85	-3 35	-3 08	-3 27
1995	-4 24	-1 85	-2 72	-1 42	-1 80
1996	-5 00	-2 14	-4 01	-1 92	-2 75



CONSOLIDATED FALLING WEIGHT DEFLECTOMETER RESULTS

YEAR	EFFECTIVE EXISTING PAVEMENT STRUCTURAL NUMBER				
	SOIL CEMENT	MODIFIED SUBBASE	ASPHALT STABILIZED	CALCIUM CHLORIDE	STANDARD SUBBASE
1997	7 32	6 41	6 78	6 46	6 55
1999	7 3	6 39	6 84	6 51	6 45

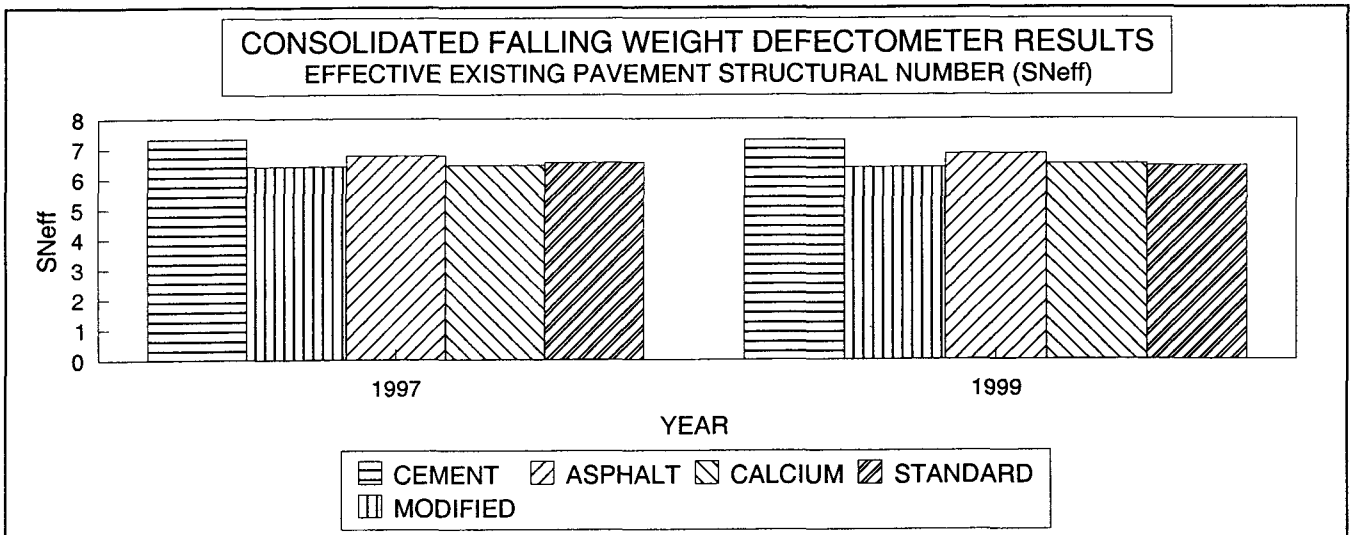


TABLE V
STATISTICAL ANALYSIS of STRUCTURAL MEASUREMENTS

Multiple Range Tests - 1997 Data
Response variable Deflection
Method 95.0 percent Tukey HSD

<u>Treatment</u>	<u>Count</u>	<u>Mean</u>	<u>Homogeneous Groups</u>
Modified	4	6.4125	X
Standard	4	6.4625	X
CaCL2	4	6.5375	X
Asphalt	4	6.7825	X
Soil-Cement	4	7.32	X

<u>Contrast</u>	<u>Difference</u>	<u>+/- Limits</u>
Cement - Modified	*0.9075	0.453788
Cement - Asphalt	*0.5375	0.453788
Cement - CaCL2	*0.8575	0.453788
Cement - Standard	*0.7825	0.453788
Modified - Asphalt	-0.37	0.453788
Modified - CaCL2	-0.05	0.453788
Modified - Standard	-0.125	0.453788
Asphalt - CaCL2	0.32	0.453788
Asphalt - Standard	0.245	0.453788
CaCL2 - Standard	-0.075	0.453788

Multiple Range Tests - 1999 Data
Response variable Deflection
Method 95.0 percent Tukey HSD

<u>Treatment</u>	<u>Count</u>	<u>Mean</u>	<u>Homogeneous Groups</u>
Modified	4	6.3925	X
Standard	4	6.4525	X
CaCL2	4	6.505	X
Asphalt	4	6.8375	X X
Soil-Cement	4	7.3025	X

<u>Contrast</u>	<u>Difference</u>	<u>+/- Limits</u>
Cement - Modified	*0.91	0.498976
Cement - Asphalt	0.465	0.498976
Cement - CaCL2	*0.7975	0.498976
Cement - Standard	*0.85	0.498976
Modified - Asphalt	-0.445	0.498976
Modified - CaCL2	-0.1125	0.498976
Modified - Standard	-0.06	0.498976
Asphalt - CaCL2	0.3325	0.498976
Asphalt - Standard	0.385	0.498976
CaCL2 - Standard	0.0525	0.498976

* Denotes a statistically significant difference