Research Report
KTC 92-9

EXPERIMENTAL ROAD BASE CONSTRUCTION UTILIZING ATMOSPHERIC FLUIDIZED BED COMBUSTION RESIDUE

by

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16. Abstract

This report summarizes findings of laboratory and field trial evaluations of two experimental test sections constructed adjacent to one another. One experimental section contained a mixture of pulverized fuel ash, residue from an atmospheric fluidized bed combustion process, and limestone aggregate. The second section contained a similar mixture but included a small amount of Type III cement. Both experimental sections were constructed to a total nominal thickness of nine inches. The typical design section included six inches of the experimental mixtures, used as base materials, beneath three inches asphaltic concrete. A previous report documented construction of the test sections and preliminary performance evaluations of the experimental base mixtures (UKTRP 87-15).

Analyses of additional periodic deflection testing are detailed within this report. The experimental sections were monitored over a three year period. It was concluded, based upon performance observations and evaluation activities, that both experimental mixtures are suitable for use as a road base material. Both test sections performed well with no cracking, rutting or unexpected deterioration observed. Results of the deflection testing activities indicated that the pavement structure containing cement had somewhat higher stiffness values and generally maintained those values over time.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in.	inches	25.40000	millimetres	mm
ft	feet	0.30480	metres	m
yd	yards	0.91440	metres	m
mi	miles	1.60934	kilometres	km
		AREA		
$in.^2$	square inches	645.16000	millimetres squared	mm^2
ft^2	square feet	0.09290	metres squared	m^2
yd^2	square yards	0.83613	metres squared	m^2
ac	acres	0.40469	hectares	ha
mi^2	square miles	2.58999	kilometres squared	km^2
		VOLUME		
fl oz	fluid ounces	29.57353	millilitres	ml
gal.	gallons	3.78541	litres	l
ft^3	cubic feet	0.02832	metres cubed	m^3
yd^3	cubic yards	0.76455	metres cubed	m^3
		MASS		
oz	ounces	28.34952	grams	g
lb	pounds	0.45359	kilograms	kg
T	short tons (2000 lb)	0.90718	megagrams	Mg
		FORCE AND PRESSURE		
lbf	pound-force	4.44822	newtons	N
psi	pound-force per square inch	6.89476	kilopascal	kPa
		ILLUMINATION		
fc	foot-candles	10.76426	lux	lx
fl	foot-Lamberts	3.42583	candela/m^2	cd/m^2
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5(F-32)/9	Celsius temperature	°C

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimetres	0.03937	inches	in.
m	metres	3.28084	feet	ft
m	metres	1.09361	yards	yd
km	kilometres	0.62137	miles	mi
		AREA		
mm^2	millimetres squared	0.00155	square inches	$in.^2$
m^2	metres squared	10.76392	square feet	ft^2
m^2	metres squared	1.19599	square yards	yd^2
ha	hectares	2.47103	acres	ac
km^2	kilometres squared	0.38610	square miles	mi^2
		VOLUME		
ml	millilitres	0.03381	fluid ounces	fl oz
l	litres	0.26417	gallons	gal.
m^3	metres cubed	35.31448	cubic feet	ft^3
m^3	metres cubed	1.30795	cubic yards	yd^3
		MASS		
g	grams	0.03527	ounces	oz
kg	kilograms	2.20462	pounds	lb
Mg	megagrams	1.10231	short tons (2000 lb)	T
		FORCE		
N	newtons	0.22481	pound-force	lbf
kPa	kilopascal	0.14504	pound-force per square inch	psi
		ILLUMINATION		
lx	lux	0.09290	foot-candles	fc
cd/m^2	candela/m^2	0.29190	foot-Lamberts	fl
		TEMPERATURE (exact)		
°C	Celsius temperature	1.8C + 32	Fahrenheit temperature	°F

* SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.

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EXECUTIVE SUMMARY

This report summarizes findings of laboratory and field trial evaluations of two experimental mixtures used in highway road base applications. One experimental section contained a mixture of pulverized fuel ash, atmospheric fluidized bed combustion residue, and limestone aggregate. The second section contained a similar mixture but included a small amount of Type III cement. Both experimental sections were constructed to a nominal thickness of nine inches. The typical design section included six inches of the experimental base materials overlaid with three inches of asphaltic concrete. The two test sections were constructed in November 1985. A previous report documented construction of the test sections and preliminary performance evaluations of the experimental base mixtures [1]. Documentation of periodic deflection testing is included within this report. The experimental sections were monitored over a three year period. Evaluations included strength determinations of the mixture, Road Rater deflection testing and visual observations.

Results of destructive testing of laboratory compacted specimens and field core specimens indicated higher compressive strengths and elastic moduli for the mixture without cement. Results of destructive testing activities generally indicated higher compressive strengths and elastic moduli for specimens compacted in the field during the time of construction than those for laboratory compacted specimens when cured under similar conditions. This may be due to slight differences in mixture proportions, compaction methods, and moisture available for hydration of the mixtures.

Destructive testing of field core specimens validated results of the laboratory study. Compressive strengths and moduli values were higher for the field core specimens obtained from the mixture not having cement. Results of the deflection testing activities indicated the pavement structure containing the experimental mixture with cement generally had higher stiffness values than the mixture without cement. Although the compressive strength and elastic modulus values of specimen without cement exceeded those with cement in both laboratory and field samples, differences in the stiffnesses of the overall pavement structure were attributed to a weakened subgrade below the experimental base material without cement in the mixture. It was estimated from the deflection analyses that the stiffness of the overall pavement structure where cement was used in the mixture was approximately 44 percent greater than that of the pavement structure constructed of the mixture without cement. There were no appreciable differences in the overall dynamic stiffness of either section during the evaluation period.

It may be concluded, based upon performance observations and evaluation activities, that both experimental mixtures would be suitable for use as road base materials. The test sections performed well with no cracking, rutting or deterioration observed. The road base materials were marginally as strong as typical concrete but had lower elastic moduli than typical concrete. The pulverized fuel ash, atmospheric fluidized bed combustion residue, and limestone aggregate mixture could serve as an alternative road base material. Evaluation of the use of the experimental mixtures as a road base material has provided valuable insight into its use. However, further experience with the use of the material must be gained before widespread use is recommended.

INTRODUCTION

Kentucky has traditionally been among the leading producers of coal. Kentucky has two coal producing regions; the eastern Kentucky coalfields contain low-sulfur bituminous coal and the western Kentucky coalfields contain bituminous coal which is higher in sulfur content. Coal-fired electric generating facilities are abundant in Kentucky and as a result, by-products in the form of fly ash, flue gas desulfurization sludge, boiler slag, and bottom ash are generated in large quantities. More than three million tons of fly ash are produced annually from Kentucky power plants. Additionally, approximately 1-million tons of bottom ash and boiler slag are produced annually. Production of flue gas desulfurization sludge (scrubber sludge) also is increasing with increasing use of scrubbers for pollution control for power plants burning high-sulfur coal. Fly ash has been used with lime (and by-product lime) for modification of soil and aggregate bases. Fly ash is used in portland cement for a variety of purposes. Scrubber sludge and bottom ash also have been used to construct roadway subbases [2].

The fluidized bed combustion process has been refined to permit cleaner burning of high-sulfur coal. Atmospheric Fluidized Bed Combustion (AFBC) is an advanced combustion process that provides a method of burning high-sulfur coal economically and in an environmentally acceptable manner. AFBC is a process wherein coal is burned in a fluidized bed of fine limestone particles. Air is passed through the bed from below and a fire, fed by oil or other fuel, is injected into the bed to heat the coal to ignition temperature. Sulfur dioxide, an undesirable by-product, is captured by calcium oxide formed from the limestone to produce calcium sulfate as a by-product. Coal ash and spent limestone are removed from the bottom of the bed. The dry lime and calcium sulfate by-product may be disposed of by conventional means.

Studies have examined the potential of the AFBC by-product as a soil amendment and plant nutrient source for revegetation of disturbed mine lands, cement additive, and road base filler [3, 4, and 5]. The AFBC residue contains appreciable amounts of unreacted calcium oxide, CaO. Because of this available free lime, residue from the AFBC process, when mixed with fly ash from conventional coal-burning plants, has cement-like properties. Those mixtures have the potential to be used in a variety of applications where a lower strength concrete is suitable, including use as a road base material.

BACKGROUND

In July 1985, representatives of the Kentucky Transportation Research Program (KTRP) and Civil Engineering Department of the University of Kentucky, and the Kentucky Transportation Cabinet met with representatives of the Tennessee Valley Authority (TVA) to discuss potential applications of the AFBC residue in highway construction. TVA representatives expressed an interest in providing a trial installation for construction demonstration and evaluation of two base course mixtures. The first mixture would be comprised of cement, fly ash, AFBC residue, and limestone aggregate. The second mixture would contain a greater amount of limestone aggregate and exclude the small proportion of cement contained in the first mixture. The proposed site of the base course was a construction access road at TVA's Shawnee Power Plant off KY 996 near Paducah, Kentucky.

Prior investigations of potential applications for residue from the fluidized bed combustion processes were used to estimate the expected structural properties of the proposed experimental base section [5]. Virtually no information was available regarding traffic volumes or vehicle loadings expected on the construction access road. However, previous experience with the use of fly ash-hydrated lime-aggregate bases had demonstrated general satisfactory performance for stabilized base thicknesses between six and ten inches beneath two to four inches of asphaltic concrete. Analyses of previously constructed stabilized aggregate base sections formed the basis for the thickness design of these experimental base mixtures. A thickness design of six inches AFBC concrete base overlaid by three inches quality asphaltic concrete was proposed. The component proportions per cubic yard presented in Table 1 for the two AFBC concrete base mixtures were developed and optimized by Dr. Jerry G. Rose, professor of Civil Engineering at the University of Kentucky. Laboratory studies during development of the mixture design involved determining the optimum moisture content and maximum dry density of the mixtures, and compressive strength development and elastic moduli of molded and cured specimens. Field studies involved monitoring construction, performing road rater deflection surveys, visual surveys, and taking core specimens for laboratory evaluation.

TABLE 1. MIXTURE PROPORTIONS FOR EXPERIMENTAL ROAD BASE

MATERIAL	MIX No. 1 (%)a	MIX No. 1 (lbs)	MIX No. 2 (%)a	MIX No. 2 (lbs)
Type III Cement	1.6	60	0.0	0
Class F Fly Ash	8.9	340	12.3	470
AFBC Residue	35.4	1,350	33.2	1,265
Crushed Stone(b)	54.1	2,060	54.5	2,075
Water	6-10	250	6-10	250

(a) Percent by dry weight
(b) No. 57 limestone aggregate

EVALUATIONS

Construction Monitoring

The proposed demonstration was a road base to be constructed on an existing gravel road. The entire experimental test section extended from Station 18+50 to Station 20+00. The existing gravel roadway was excavated an average of eight inches between Stations 18+50 and 19+00 to achieve proper grade. In that area, particularly nearer Station 18+50, the existing traffic bound stone was excavated completely down to the soil subgrade. The remaining length of the section was scarified slightly with a road grader and recompacted with a smooth-wheel vibratory roller. A four foot wide shoulder having a six inch compacted thickness of dense-graded aggregate was placed on each side of the existing roadway making the experimental section approximately 20 feet in width.

Residue from the AFBC process was preconditioned, or prehydrated to prevent detrimental expansion of the mixtures, one week prior to construction at the Federal Materials Corporation's concrete batch plant located in Paducah. The prehydration step was accomplished by adding approximately 12 percent water, by weight, to the AFBC residue and mixing in a central batching unit for five to seven minutes. Temperatures of the residue reached approximately 250°F during the prehydration process. The AFBC residue was stockpiled and covered by heavy tarpaulins after the prehydration process.

Construction of the demonstration project began Tuesday morning, November 5, 1985. The materials were blended at the Federal Materials Corporation's concrete batch plant and placed in a dump trucks. The trip time of the covered dump trucks to the jobsite was approximately 30 minutes. Sixty-four cubic yards, about 8 truck loads, of Mixture No. 1 were placed from Station 20+00 to Station 19+00. Thirty-two cubic yards, about four truck loads, of Mixture No. 2 were placed from Station 19+00 to Station 18+50. The first truck load to arrive was end dumped into a Blaw-Knox asphalt paver. However, the mix did not flow through the paver as expected and a backhoe was used to dig the material out of the paver's hopper. Subsequent loads were end dumped directly onto the prepared subbase. A Galion 503, Series A road grader was used to spread the plastic material, although without much success. Finally, TVA construction personnel opted to use a Case 450 bulldozer to spread the material. Initial loads were slightly dry while each succeeding load appeared wetter than the previous load. Three of the last six loads were not well mixed and segregation of the component materials was apparent. A large portion of the base material appeared to be wet of the optimum moisture content. An attempt was made to compact the plastic base material using a smooth-wheel vibratory roller. However, the compactor became bogged down and had to be pulled aside by the bulldozer. A decision was made by construction personnel to delay compaction until the following day and to cut the material to grade.

On Wednesday morning, construction personnel discovered that the experimental base had hardened such that any further compaction was impossible. The construction crew placed a bituminous curing seal on the experimental base and returned Thursday to place the asphaltic concrete leveling course and surface course.

Post-Construction Laboratory

During construction activities, KTRP personnel molded 6-inch by 12-inch cylindrical specimens from the first and third loads (Mixture No. 1) and the ninth and tenth loads (Mixture No. 2) for laboratory evaluations relative to compressive strength and elastic modulus. Compressive strength testing was in accordance with ASTM C-39 [6]. Tests for elastic moduli were performed in accordance with ASTM C-469 [7]. Field compacted specimens were sealed in plastic bags to prevent loss of moisture. The field specimens were cured for 28 days at room temperature. Average 28-day compressive strength and elastic modulus of field specimen prepared from Mixture No. 1 were 2,570 psi and 830,000 psi, respectively. Field specimens prepared from Mixture No. 2 had average 28-day compressive strength and elastic modulus values of 1,480 psi and 510,000 psi, respectively. Three specimens containing cement (Mixture No. 1) were cured for 28 days in a 100°F oven. Those specimens had an average compressive strength of 3,500 psi and an average elastic modulus of 1,030,000 psi.

Several tests for optimum moisture content and maximum dry density, for each mix design, were completed in accordance with ASTM D 1557, Method C, [8]. Deviations from that method involved the use of a 5.5-lb. hammer having a 12-inch free fall and five lifts were replaced with three lifts to better simulate construction compactive efforts. Optimum moisture content and maximum dry density were determined using a polynomial curve fitting procedure. A smoothing technique was used to eliminate localized changes in concavity. Results were variable for both mixtures. The average optimum moisture content and maximum dry density were 8.9% and 131.5 pcf, respectively, for Mixture No. 1 and 8.7% and 131.8 pcf, respectively, for Mixture No. 2. A typical optimum moisture content and maximum dry density relationship for Mixture No. 1 is shown in Figure 1.

Laboratory evaluations of the two mixtures also included tests for compressive strength and elastic modulus of laboratory prepared specimen. Specimens were prepared in general accordance with ASTM C 593 [9] in 4.0-inch by 4.6-inch molds using the average optimum moisture content obtained previously. The specimens were cured in accordance with ASTM C 593. All specimens were placed in sealed paint cans after molding and extrusion from the molds. Some specimens were cured in a 100°F oven for seven and 28 days. Others were cured at ambient (room) temperatures for 28 days. All samples were submerged in water for four hours prior to testing as recommended by ASTM C 593. Samples were not vacuum saturated however.

The average compressive strengths and elastic moduli were 500 psi and 35,000 psi, and 960 psi and 245,000 psi, respectively, for specimens prepared from Mixture No. 1 and cured in a 100°F oven for seven days and 28 days. The average compressive strength and elastic modulus for specimens cured at room temperature for 28 days were 1,025 psi and 385,000 psi, respectively. The average compressive strengths and elastic moduli were 1,070 psi and 265,000 psi, and 2,275 psi and 750,000 psi, respectively, for specimens prepared from Mixture No. 2 and cured in a 100°F oven for seven days and cured

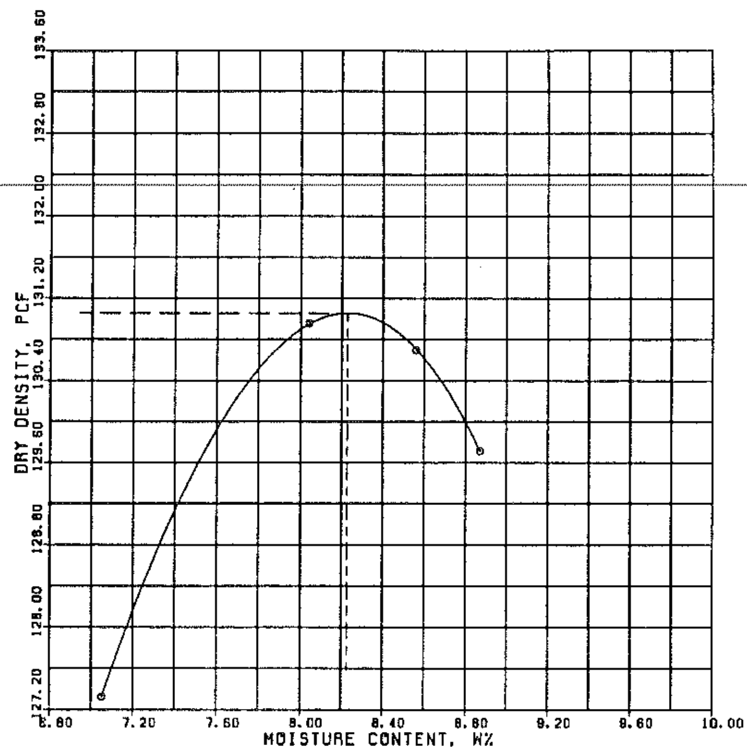

Figure 1. Typical Optimum Moisture Content - Maximum Dry Density Determination for Mixture No. 1.

ambiently for 28 days. There were no specimens evaluated from Mixture No. 2 which were cured in an oven for 28 days.

Post-Construction Field

Deflection tests were conducted using the Model 400B Road Rater, in April 1986, July 1987, and July 1988. The Road Rater is a dynamic pavement testing device capable of applying variable dynamic loads between 600 lbf and 1,200 lbf. Responses of the pavement structure are then measured at radial distances of 5.25, 13.10, 24.57, and 36.38 inches from the center of the applied load.

The deflection measurements were obtained at 10-foot intervals along the centerline of each lane and along the centerline of the pavement. Average deflections for both the section containing base material with cement and the section without cement added to the mixture were determined for a 1,200-lb load. The dynamic stiffness was then determined for the pavement structure. The dynamic stiffness is calculated by dividing the applied dynamic load by the deflection directly beneath the load. It may be represented in terms of pounds-force per inch. The dynamic stiffness is a measure of the structural capacity of the pavement structure.

Results of this testing activity for each year are given in Figures 2 through 4, for 1986, 1987, and 1988 respectively. It may be seen from these figures that the pavement structure of the section of road base material containing cement maintains a higher strength, or greater stiffness, than the section of road base without cement added to the mixture throughout the evaluation period. The average percent difference in stiffness for the pavement section of Mixture No. 1 was about 44 percent greater than the pavement section of Mixture No. 2.

The change in stiffness of the pavement structure with time is shown in Figures 5 and 6, for the cement added and no cement added sections, respectively. It may be seen in these figures that there are apparently no significant uniform differences in the pavement structure over time in either experimental section. The apparent variability of the stiffness measurements with time may be attributed to the changing condition of the subgrade.

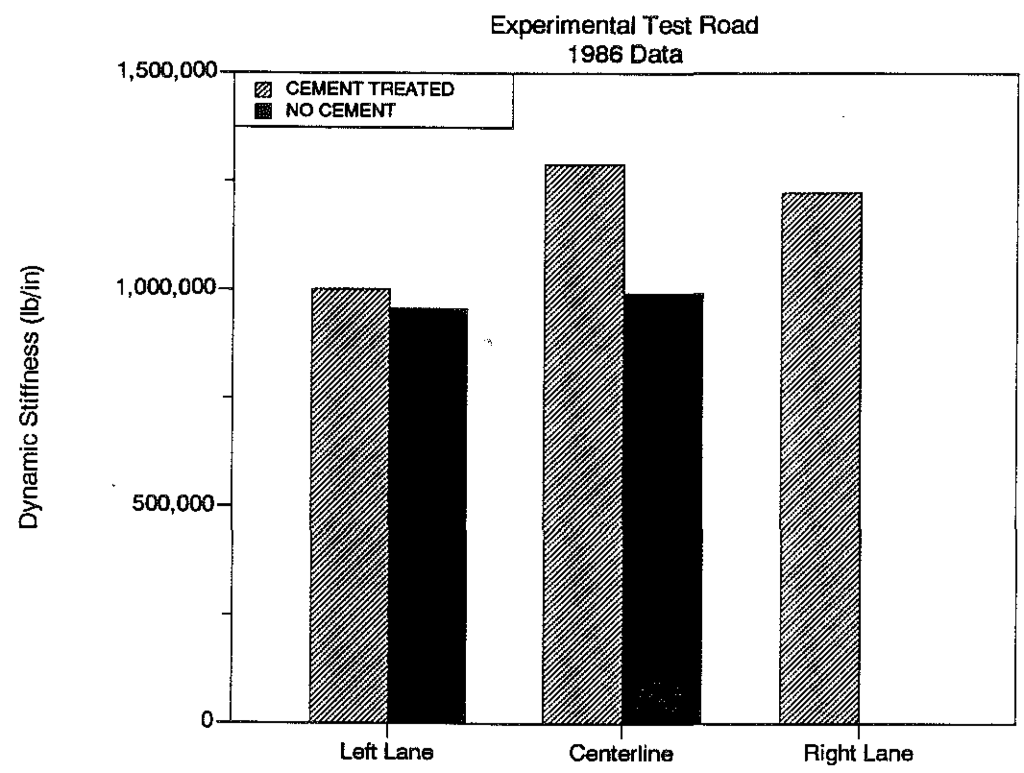

Figure 2. Dynamic Stiffness of the Experimental Pavement, 1986.

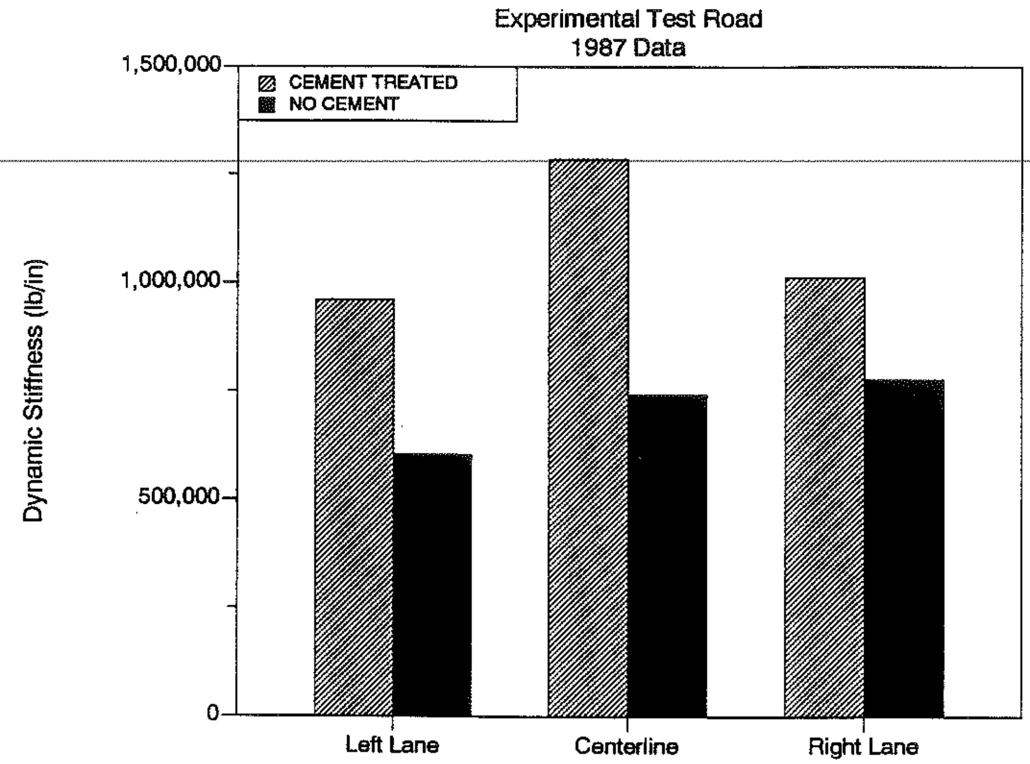

Figure 3. Dynamic Stiffness of the Experimental Pavement, 1987.

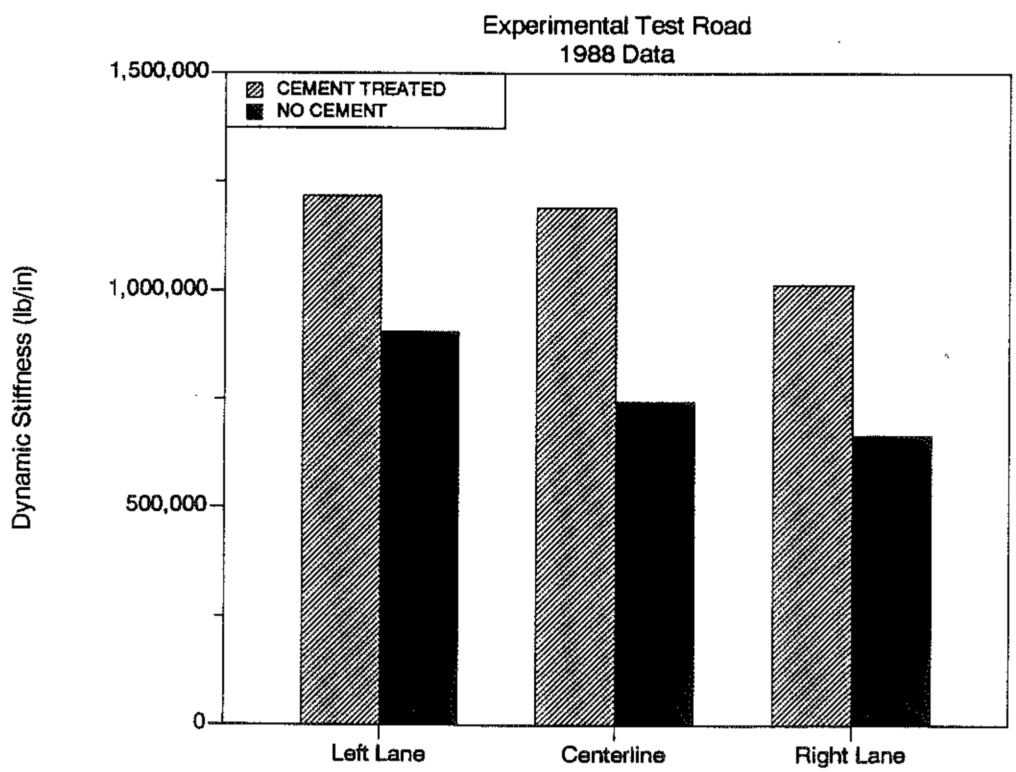

Figure 4. Dynamic Stiffness of the Experimental Pavement, 1988.

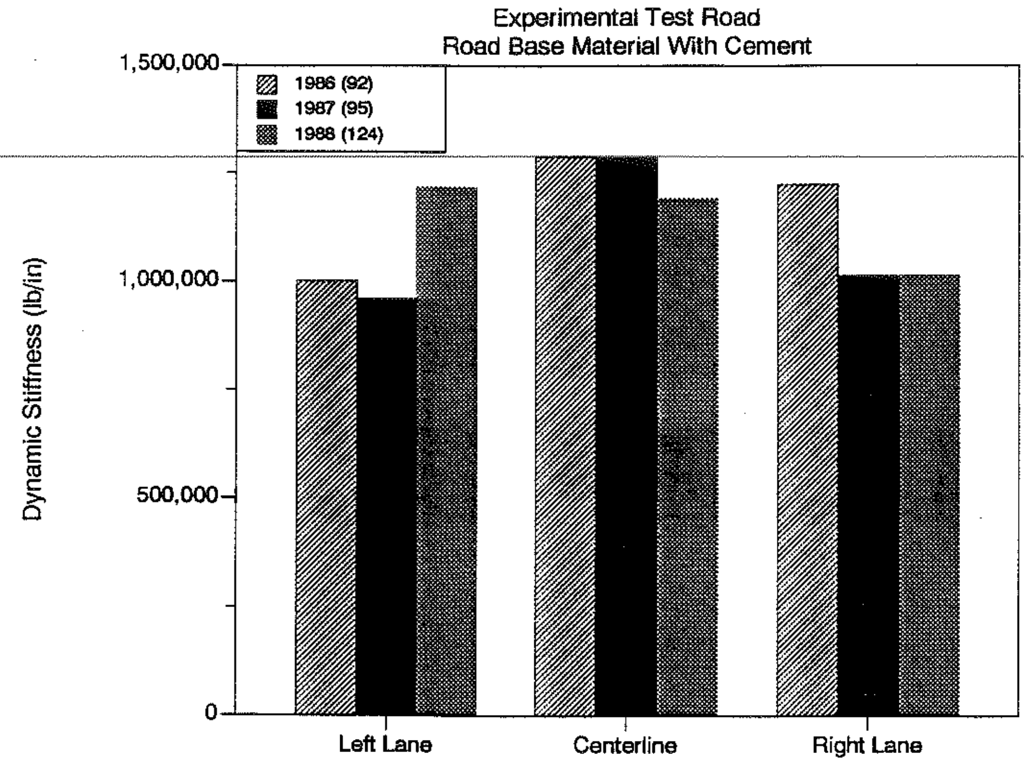

Figure 5. Dynamic Stiffness of the Experimental Pavement Section Containing Cement as a Function of Time.

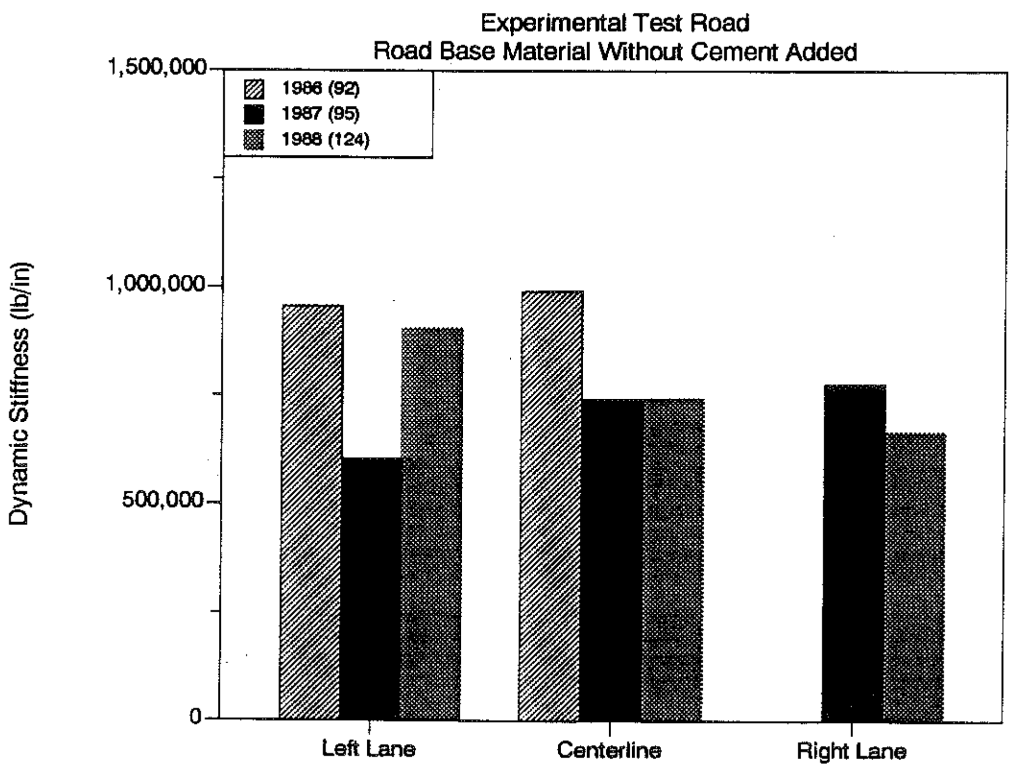

Figure 6. Dynamic Stiffness of the Experimental Pavement Section Without Cement as a Function of Time.

Cores were obtained from the experimental base sections during April and December, 1986. Destructive evaluations included compressive strength and elastic modulus determinations. Core specimens obtained April 28, 1986 were tested at an age of approximately 268 days. The three cores obtained from Mixture No. 1 had an average compressive strength of 3,995 psi and a modulus of elasticity equal to 720,000 psi. The two cores obtained from Mixture No. 2 had an average compressive strength of 5,230 psi and an elastic modulus of 770,000 psi.

Core specimens obtained December 11, 1986 were tested at an age of 563 days. Four core specimens obtained from Mixture No. 1 averaged 3,985 psi and 1,450,000 psi, respectively, for compressive strength and elastic moduli values. Three core specimens obtained from Mixture No. 2 averaged 3,825 psi and 2,170,000 psi, respectively, for compressive strength and elastic modulus values. The compressive strengths and elastic moduli evaluations, relative to Mixture No. 1, indicated fairly uniform compressive strengths while stiffness of the base increased (higher modulus values) during the 295 day time period. Compressive strengths for Mixture No. 2 decreased by about 39% but stiffness had increased 180% during the same time period. Moduli data obtained from laboratory compacted specimen and field cores would tend to contradict the dynamic stiffness values obtained by Road Rater measurements and analyses. The Road Rater deflection analyses indicated a greater stiffness, or modulus value for the pavement structure wherein cement was included in the experimental base mixture. However, the Road Rater deflection analyses performed during this study takes into consideration the entire pavement structure and not just the experimental base layer. Small changes in the subgrade often significantly impact the stiffness of the overall pavement structure. It has been noted previously that the traffic bound stone was largely excavated in the area where Mixture No. 2 was placed (Station 18+50 to Station 19+00). Because of the changing pavement structure from Station 18+50 to Station 20+00, with respect to the traffic bound stone, it is not unreasonable to presume that there is weaker support below the experimental section containing Mixture No. 2, thereby leading to larger deflections and lower overall stiffness values.

Visual surveys of the experimental sections were conducted in conjunction with Road Rater testing activities. Pavement rutting measurements were not obtained during the visual surveys because the condition of the road surface did not reveal any excessive rutting during the evaluation period. There were no unusual signs of extensive rutting in either experimental section although extensive heavy truck traffic utilized the construction access road. There was no cracking of the pavement surface observed during the evaluation period. Performance of both experimental sections was considered to be excellent.

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This report summarizes findings of laboratory and field trial evaluations of two experimental test sections constructed contiguously to one another. One experimental section contained a mixture of pulverized fuel ash, atmospheric fluidized bed combustion residue, and conventional limestone aggregate. The second section contained a similar mixture but with a small amount of cement substituted for a portion of the limestone aggregate. Both experimental sections were constructed to a total nominal thickness of nine inches. The designed section included six inches of the experimental base mixture overlaid with three inches of asphaltic concrete.

The test sections containing the experimental mixtures were constructed in November 1985. Construction of the base layer was somewhat difficult as problems did occur. When the materials were blended at the batch plant, some material would invariably stick to the inside of the mixer. Placement of the material with a bulldozer appeared to be satisfactory but there was little control over the depth of the materials. The materials appeared to be placed wet of optimum and the mixtures could not immediately be compacted using the smooth-wheeled vibratory roller. The base mixtures hardened rapidly and proper grade was not attained. It is recommended that the materials be blended in a pug mill, placed slightly dry of optimum with a conventional aggregate spreader and compacted with a smooth-wheeled vibratory roller. Proper grade should be obtained before leaving the jobsite. A bituminous curing seal is necessary to ensure proper curing of the base material.

The sections were monitored for performance over a three year period. Evaluations included strength determinations of the mixtures, Road Rater deflection testing and visual observations. Results of the periodic testing and performance evaluations have been detailed within this report. Results of destructive testing activities generally indicated higher compressive strengths and elastic moduli for field compacted specimens than laboratory compacted specimens when cured under similar conditions. This may be due to slight differences in mixture proportions, compaction methods, and moisture available for hydration of the mixtures.

The average compressive strengths of specimens compacted in the field and cured at room temperatures for 28 days were 2,570 psi for Mixture No. 1 and 1,480 psi for Mixture No. 2. However, specimens of Mixture No. 2 prepared in the laboratory had higher compressive strength values than Mixture No. 1. Those values were 1,025 psi and 2,275 psi, respectively, for Mixture No. 1 and Mixture No. 2. Similar differences between specimens molded in the field and laboratory compacted specimens were noted for values of elastic moduli. The average elastic modulus value of specimens compacted in the field was 830,000 psi for Mixture No. 1 and 510,000 psi for Mixture No. 2. Laboratory prepared specimens had average moduli values of 385,000 for Mixture No. 1 and 750,000 for Mixture No. 2.

Destructive testing of field core specimens validated results of the laboratory study. Compressive strengths and moduli values were higher for the field core specimens obtained from Mixture No. 2. Core specimens tested at 268 days age indicated an average compressive strength and elastic modulus value of 3,995 psi and 720,000 psi, respectively, for Mixture No. 1. Field core specimens from Mixture No. 2 had average compressive strength and elastic modulus values of 5,320 psi and 770,000 psi, respectively, at 268 days. Core specimens from Mixture No. 1, tested at 573 days age, indicated an average compressive strength and elastic modulus of 3,985 psi and 1,450,000 psi, respectively. Field core specimens from Mixture No. 2 had average compressive strength and elastic modulus values of 3,825 psi and 2,170,000 psi, respectively, at 573 days.

Results of the deflection testing activities indicated the pavement structure containing the base material without cement (Mixture No. 2) had a lower stiffness than the section containing cement. It was estimated from the deflection analyses that the stiffness of the pavement structure within the section having the base material containing cement was approximately 44 percent greater than the stiffness of the pavement structure where cement was excluded from the mixture.

It may be concluded, based upon performance observations and evaluation activities, that both experimental mixtures are suitable for use as a road base material. The test sections performed well with no cracking, rutting or deterioration observed. The road base materials were marginally as strong as typical concrete but had lower elastic moduli than typical concrete. The pulverized fuel ash, atmospheric fluidized bed combustion residue, and limestone aggregate mixture could serve well as an alternative road base material. Evaluation of the use of the experimental mixtures as a road base material has provided valuable insight into its use. However, further experience with the use of the material must be gained before widespread use is recommended.

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