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LIME SLURRY IN COLD INPLACE RECYCLE

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Kansas Department of Transportation

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16 Abstract

In 1997, a cold inplace recycle (CIR) project using fly ash additive in one half, and a lime slurry additive in the other half, was built on US-283 in Ford County, Kansas. Test sections were established and monitored through periodic inspections, crack surveys, and FWD measurements for approximately 5 to 6 years. The lime slurry section contained less cracking during the early years of the monitoring period. Toward the end of the 5 year period both sections contained approximately the same amount of cracking. Wheel path rutting was not a major distress using both additives.

A laboratory study was conducted on field cores from the project, and also on lab molded samples using various additives. Some of the tests were permeability, modified T283, resilient modulus, asphalt pavement analyzer and density measurements. The laboratory data showed that both additives improved the engineering mix properties with the fly ash showing the best results.

Cost data was also collected from a summary of several CIR projects using the two different additives, and it was determined that the lime slurry was approximately 25 percent more expensive. Based on the field surveys, it is expected that the life of the lime slurry section will be at least 1 to 2 years longer than the fly ash section. The report concluded that the life cycle cost of the lime slurry section is about equal to the fly ash section.

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Final Report

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A Report on Research Sponsored By

THE KANSAS DEPARTMENT OF TRANSPORTATION
TOPEKA, KANSAS

FEDERAL HIGHWAY ADMINISTRATION
Topeka, Kansas

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ABSTRACT

In 1997, a cold inplace recycle (CIR) project using fly ash additive in one half, and a lime slurry additive in the other half, was built on US-283 in Ford County, Kansas. Test sections were established and monitored through periodic inspections, crack surveys, and FWD measurements for approximately 5 to 6 years. The lime slurry section contained less cracking during the early years of the monitoring period. Toward the end of the 5 year period both sections contained approximately the same amount of cracking. Wheel path rutting was not a major distress using both additives.

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ACKNOWLEDGEMENTS

The research documented in this report was conducted by the Kansas Department of Transportation (KDOT), and was coordinated through the local Federal Highway Administration (FHWA) division Office.

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1.1 Background

When first used in Kansas in 1977 cold inplace recycling (CIR) was a very slow process that required closing the roadway. The large cold milling machines were just being developed to make reclaiming of old asphalt pavement more feasible. By 1985, the process had evolved to where approximately three kilometers could be recycled daily with traffic carried through construction during the day and with the road open to the public during the night.

From 1985 to approximately 1991, the Kansas Department of Transportation (KDOT) reconstructed approximately 160 to 240 kms of roadway every year. Most of the time, a thin overlay (20-40 mm) overlay was placed over the CIR, but on several occasions a double conventional seal was also used. This construction procedure was confined to mainly lower volume roads and was considered a minor modification to the roadway or a "1R" project. During this period either an HFMS-1 or CMS-1 asphalt emulsion was used as a liquid additive.

Most of the projects were successfully constructed; however, a few experienced premature failure due to rutting and moisture damage. This was especially true if the CIR was constructed during a rainy period. There was no official life expectancy of the complete projects, but a CIR with overlay was generally accepted to have a service life of three to five years. There are no formal published reports delineating the problems with CIR (with emulsion), but several internal letter reports calling attention to the problem were written. At this time there was a general frustration within KDOT that the CIR process was not working satisfactorily and that improvements or changes were necessary.

To address the premature failures, in 1991 KDOT performed laboratory testing on a variety of additives and additive combinations, and determined that the Class C fly ash provided the best stabilization benefits. That same year experimental test sections were constructed using Class C fly ash as an additive instead of an emulsion. The construction benefits were excellent and the next year (1992) almost all of the minor construction projects were constructed using fly ash as the additive to the CIR process. With the 40 mm overlay, a pavement that would last over five years resulted. Other than raveling due to traffic while under construction, the problems with premature rutting and moisture damage was essentially eliminated. The only major concern was that the pavement was experiencing early cracking, but the pavement still performed satisfactory for approximately six years (two to three years longer than with emulsion).

In 1997, use of lime slurry in lieu of fly ash as an additive in cold inplace recycling process was proposed by industry to potentially address the performance problems with the current process. The concern with CIR stabilized fly ash was whether it led to increased cracking due to thermal effects and/or fatigue loading. Possible equal or better performance characteristics could be obtained through the use of the lime slurry additive. Also, industry preferred use of this product due to less wear and tear on their equipment.

1.2 Objective

The objective of this research project was to compare the performance of lime slurry and fly ash additives in cold recycle pavements.

1.3 Introduction

A project, using a fly ash additive in one half of the CIR, and a lime slurry additive in the other half, was built on US-283 south of Dodge City in 1997. Formal test sections of 300 meters were established on the project and monitored for 5 years with periodic field inspections, falling weight deflectometer measurements, and crack/rut surveys. In addition to the field performance, a laboratory study by Dr. Steve Cross at KU was completed at the beginning stages of the project monitoring period. His results were published in KDOT Report No. KS-99-4 in August 2000 (1). This report used the construction material and actual cores from the US-283 project. With verbal permission from Dr. Cross, a summary of his laboratory results will be presented at appropriate locations in this report.

1.4 Construction

Brown and Brown Construction Co. was the contractor for the project and used one of their standard recycling trains to construct the CIR portion of the project. A milling machine was used to pulverize the top 100mm of pavement. The material was then resized through a crushing screening unit, and a pug mill was used to mix the additive. For the fly ash operation, water was added to the mixture through both the cutting head and at the pug mill. For the lime-slurry operation, the pug mill was used for mixing the lime slurry and emulsion. Tankers filled with hot lime slurry were located at the front of the recycling train, and fed the additive directly into the unit's cutting head.

The hydrated lime slurry was produced by tank-slaking pebble quick lime. Tanks were located close to the project. A measured amount of water wass added to the mixing tank. Approximately 1.14% quick lime (based on wt. of RAP) has air blown into approximately 3.76% water (based on wt of RAP), agitated, and slaked into a hot (210 to 220° F) slurry. Tanker trucks delivered the slurry to the job site where it was pumped into the pug mixer and mixed further with the RAP. A CSS-1 asphalt emulsion, at a rate of 1.5% (based on wt. of RAP) was also added to the mixture at the same time and location. An asphalt paver with a windrow pickup device then placed the material at the desired pavement depth. Heavy rollers (27 mG) were used to compact the mat to a uniform density. A final steel-wheel roller was used to obtain a smooth surface finish. Later that same year a 40mm hot mix overlay was placed over all of the test sections. The mix percentages for each section are as follows:

FLY ASH

8-10% Class C Fly Ash
5.19% Water
2.1% Retarder

LIME SLURRY

1.5% Lime-Solids [Hydrated- $Ca(OH)_2$]
3.76% Water
1.5% CSS-1 Emulsion

1.5 Laboratory Study

Summary data from Dr. Cross' report(1) is presented in Table 1 (page 16). The top portion of Table 1 presents the tensile strength ratios (TSR's), and the bottom portion presents the modulus ratios (IRRM) for conditioned and unconditioned specimens. As can be seen from Table 1 and from the conclusions in the report(1), lime with emulsion test results are better than those for emulsion by itself. The test results with fly ash are mixed when compared to the various emulsion with lime combinations. The TSR of the fly ash additive was higher than any of the emulsion with lime combinations, but the IRRM for the fly ash was lower than the emulsions. The general conclusion is that any dry additive (lime or fly ash) is better than any of the liquid emulsion additives alone.

Laboratory samples were compacted and tested in the Asphalt Pavement Analyzer (APA) at KU. The procedures for this testing were in accordance with GDT-115, Method A (test at dry conditions), and also Method B (test at wet conditions). The results of this laboratory study are presented in Table 2. The results indicated that that the samples treated with hot lime slurry (HLS) performed better than the samples without the lime in all cases. Both the testing under dry and wet conditions showed that lime improved the CIR mixes.

The fly ash test results also show excellent results. The lowest rut depths were obtained from these fly ash specimens. There is no universal rut depth limits, but for KDOT purposes rut depths less that 4 mm under wet conditions are generally considered an acceptable criteria. Wet rut depths from 4 to 7 mm are considered marginal or in the caution zone. Fly Ash, CSS-1(W/lime) & CMS-1(w/lime) samples all yielded wet condition test results in the caution zone (4-7 mm).

The second part of the laboratory study was completed by the Kansas Department of Transportation (KDOT). A typical RAP gradation was used in this laboratory study. Specimens were compacted at room temperature using 50 blows per side of a Marshall hammer. Both the lime-slurry and the fly ash mixes were evaluated for moisture susceptibility using the KT-56 method. The KT-56 method is a KDOT modification to the AASHTO T283 method or Lottman method. Each mix was also evaluated for density, air and water permeability. The results of these tests are presented in Table 3.

The tensile strength ratios (TSR) for both the lime-slurry and the fly ash specimens are quite acceptable with the fly ash mix performing the best. The TSR for the fly ash mix was 134.2%, which indicates that moisture probably helps the mix. The TSR for the lime-slurry mix is 100.4%, which is also very good. For reference, the Superpave hot mix specification has a minimum TSR requirement of 80%.

The permeabilities of these mixes are also indicated at the bottom of Table 3. Laboratory test results show that the permeability of the lime slurry mix is quite high and very low for the fly ash mix. Later in this report, test results on field cores will show that the permeability of the field lime slurry mix was considerably lower than that of the laboratory compacted samples.

1.6 Field Study

The field study was also completed in two parts. Cores were obtained from the pavement just after construction. Laboratory test were completed by Cross(1) and by the Kansas Department of Transportation. A final report by Cross was published and a summary of the data is presented in this report. Credit is extended to Dr. Cross for his testing program and the data summary in this report. The second part was a follow up field monitoring study for five years through the use of crack/rut surveys and FWD data collection.

1.6.1 Part One

Just before construction was started, two 300 meter test sections were laid out by KDOT in 1997. One section (at approximately M.P. 43 or Station 14+691 to 14+996) was in the lime slurry section, and the other section (at approximately M.P. 40 or Stat. 10+245 to 10+550) was in the fly ash section. These test sections were scheduled to be monitored for a minimum of five years.

The following year (1998) cores were obtained from several locations in both test sections. The cores were first shipped to and tested at the Materials and Research Center in Topeka, and later transported to the University of Kansas for further testing and analysis. These cores were tested for density and permeabilities at the Topeka Laboratory. A summary of those test results are presented in Table 4.

The hot mix surface was included in the testing protocol to asertain as to whether it would allow an excessive amount of moisture to penetrate into the base material. It was a concern because a previous CIR research project was overlaid with hot mix that was permeable and did allow water to penetrate and cause the underlying CIR to deteriorate at an accelerated rate. This “leaky” surface virtually destroyed any meaningful field surveys because the pavement failures were now probably more of a direct result of the hot mix and not the cold inplace recycle additives.

Table 4 reveals that the permeability of the surface course is very low. The type of hot mix is a BM-2A, which is a fine mix, and tends to be very impermeable. This tight surface course will work very well with the CIR process and prevent premature base failure. This in turn will allow both CIR additives to be given the full potential of achieving their maximum life. As would be expected, the densities of the surface cores from the wheel paths are greater than the densities of the cores in between the wheel paths. Also, the permeabilities of the wheel path surface cores are less that the cores from in between the wheel path.

Probably the most interesting and more important test results were the permeability testing of the lime slurry cores. Preliminary laboratory testing (Table 3) indicated that the lime slurry laboratory-compacted specimens had a high permeability. But when the actual lime slurry field cores were tested they revealed a low to very low permeability. These results were unexpected and in direct contrast to each other, and obviously very encouraging.

The cores were then shipped to the University of Kansas and further testing was accomplished under the direction of Cross(1). The cores were tested in accordance to AASHTO T283 for moisture susceptibility, resilient modulus (along with the index of Retained Resilient Modulus), and in the Asphalt Pavement Analyzer (APA). The results of this testing is published elsewhere (1), but a summary of the results are presented in Tables 5 and 6.

The T283 testing revealed that the fly ash cores had the highest dry (unconditioned) strength and highest wet (conditioned) tensile strength. The tensile strength ratio (TSR) for the fly ash cores was slightly lower than the lime slurry cores. However, the reader should be cautioned about drawing conclusion about performance using TSR's exclusively. The wet or conditioned strengths also reveal useful insight about the nature of the fly ash material and should be considered when looking at all of the T283 test results. For example, a high wet strength divided by an extremely high dry strength will give a low TSR.

The resilient modulus testing of the conditioned and unconditioned specimens was conducted in a manner similar to that of the tensile strength testing. Instead of a TSR, an Index Retained Modulus (IRRM) was obtained, which is the average modulus of the conditioned specimens divided by the average modulus of the unconditioned specimens. As indicated at the bottom of Table 5, the lime-slurry mix appeared to have higher modulus and IRRM values than the fly ash specimens.

Several of the cores were tested in the Asphalt Pavement Analyzer (APA) under both dry and wet conditions. The results (see Table 6) reveal that the rut depths of all samples in both the dry and wet conditions were very low. When compared with the laboratory compacted samples, the field samples performed significantly better. Hot Mix surface course cores were also tested in the APA. The APA hot mix results indicates that the surface will not leak and allow moisture to penetrate into the underlying CIR material. Based on test results from field cores, we expected that the test sections would perform satisfactorily for several years.

1.6.2 Part Two

As previously mentioned, the second part of the field study was the monitoring of the test sections through crack surveys and FWD data collection. Tables 7 and 8 present the crack/rut surveys and FWD data, respectively. The fly ash section cracked soon after construction and had more cracking overall than the lime slurry test section. Cracking in the lime slurry section occurred much later. There was no significant rutting in any of the test sections, so it was not a factor in determining the performance of either test section.

FWD data indicates that the modulus of the fly ash test section became progressively lower each year. The lime slurry section retained its modulus and showed a slight increase over time. The probable failure mechanism for the fly ash section is due to brittleness and the breaking apart of the cementitious bonds in the CIR matrix under traffic loading and weathering conditions. The lime slurry section has out-performed fly ash test section.

1.7 Cost Data

Table 9 presents the cost data of a typical CIR project rather than actual project data to provide a more reasonable comparison. A typical project would be one located in Western part of Kansas, particularly in District Three or in District Six. In order to determine the cost analysis between the two additives, cost information was obtained from what a typical CIR project in those regions of the state would cost in 2002 dollars. This is possible because both fly ash and lime slurry additives are routinely used in CIR projects in three districts. Prices on both additives have stabilized and more true or accurate cost information can now be obtained.

In 2002, the cost of CIR (Fly Ash) was $18,640.00/Km, and the cost of CIR (Lime-Slurry) was $30,128.00/Km. The lime slurry is 61% more expensive that the fly ash, but makes up only about 49% of the project cost at normal usage rates because a typical project must include pay items such as traffic control, stripping, mobilization, and finally the hot mix overlay.

Costs were determined using a typical CIR project (100 mm CIR with a 40 mm hot mix overlay on a 7.3 m wide roadway), and unit costs was obtained from historical or previous CIR projects. Using this criteria, the cost of the fly ash project was $49,067.00 per kilometer, and the lime-slurry project was $61,129.00 per kilometer. The lime slurry was 25% more expensive than the fly ash project.

Based on conversations with several high-level field and management personnel, the estimated life for a CIR (Fly Ash) project was expected to be six years. Based on analysis of Table 7 (Crack & Rut Survey) data, we estimate that the lime slurry project will last seven to eight years, which is one to two years more than the fly ash test project. This is about 25% longer so on a life-cycle cost basis both additives yield equivalent performance.

1.8 Summary and Conclusions

1. Lime slurry cold inplace recycling is approximately 25 percent more expensive than fly ash CIR.
2. Field performance of a lime-slurry project is about 25 percent better than a fly ash CIR project.
3. On a life cycle cost analysis basis, it appears that the fly ash and lime slurry CIR projects are approximately the same.

REFERENCES

1. Cross, S.A., “Evaluation of Cold In-Place Recycling Mixtures on US-283”, Report No. KS-99-4, Kansas Department of Transportation, Topeka, Kansas August 2000.

TABLE 1: AASHTO T283 Testing Using Different Additives

(Compaction method is Marshall 75 blow/side at 43.3 C or 110 F) (Laboratory Compacted Specimens)

Additive	Average Bulk Sp. G	Average 7-Day Density (Kg/m^3)	Air Voids (%)	Average Tensile Strength		Tensile Strength Ratio (TSR)
				Unconditioned Strength (kPa)	Conditioned Strength (kPa)	
1.5% CMS-1	2.106	2106	12.2	223.1	107.2	48.0
1.5% CMS-1 with 1.5% Lime	2.166	2166	9.7	273.1	210.3	77.0
1.5% CSS-1	2.086	2086	13.1	228.1	101.8	44.7
1.5% CSS-1 with 1.5% Lime	2.131	2131	11.2	345.0	227.0	80.3
1.5% HFE-150	2.096	2096	12.6	222.5	94.3	42.4
1.5% HFE-150 with 1.5%Lime	2.135	2135	11.0	321.1	262.9	81.9
10% Fly Ash	2.214	2214	7.7	418.6	365.7	87.1
10% Fly Ash with 2% Retarder	2.106	2234	6.9	239.7	447.0	186.7

Additive	Average Bulk Sp. G	Average 7-Day Density (Kg/m^3)	Air Voids (%)	Average Resilient Modulus		Index Retained Modulus (%)
				Unconditioned (MPa)	Conditioned (MPa)	
1.5% CMS-1	2.081	2081.4	13.3	97.3	76.5	78.5
1.5% CMS-1 with 1.5% Lime	2.140	2140.2	10.8	252.0	210.6	83.6
1.5% CSS-1	2.063	2063.2	14.0	185.3	159.9	86.3
1.5% CSS-1 with 1.5% Lime	2.124	2124.2	11.5	308.1	268.3	87.1
1.5% HFE-150	2.085	2085.0	13.1	269.5	119.1	44.2
1.5% HFE-150 with 1.5% Lime	2.117	2116.5	11.8	319.4	239.3	74.9
10% Fly Ash	2.225	2224.9	7.3	134.8	60.2	45.7

27 A:Table-CrossReport-TSR

TABLE 2: APA Test Results of GDT-115 Method A (Dry Test) and Method B (Wet Test)

(Laboratory Compacted Specimens)

	CMS-1		CSS-1		HFE-150		FLY ASH
	w/o HLS (40 C)	HLS (40 C)	w/o HLS (40 C)	HLS (40 C)	w/o HLS (40C)	HLS (40 C)	(40 C)
	RUT DEPTH (mm)						
Final Dry Rut Depths after 8000 cycles	8.0	6.2	7.0	6.1	7.0	5.5	1.2
Final Wet Rut Depths after 8000 cycles	12.0	6.6	8.8	6.3	9.6	7.6	5.0

HLS= Hot Lime Slurry

#27 A:APA-Laboratory-Rut-Depths

TABLE 3: KT-56 and Permeability Laboratory Testing Using Different Additives

(Compaction Method is Marshall 50 blow/side) (Laboratory Compacted Specimens)

Additive	Average 8-Day Sp. G	Air Voids (%)	Saturation (%)	Average Tensile Strength Unconditioned Strength (kPa)	Average Tensile Strength Conditioned Strength (kPa)	Tensile Strength Ratio (TSR)
Lime Slurry	2.042	12.2	58.1	139.5	140.0	100.4
8% Fly Ash	2.098	14.9	44.4	206.2	276.8	134.2

Compaction method is 50 Blow per side with a Marshall Hammer with a 30 minute compaction delay. Vacuum saturation was 17” for 1 minute. Curing time was 8 days.

		Density (Kg/m^3)	Air Permeability (x10E-10 cm^2)	Water Permeability
Lime Slurry	(In the mold)	1.956	1662 High	4410
	(7 day cure)	1.877	9418 High	18
8% Fly Ash	(In the mold)	2.045	1 Very Low	
	(7 day cure)	2.022	99 Very Low	

Mixes:

Lime Slurry	3 %	Water
	1 ½%	CSS-1H
	1 ½%	Lime
Fly Ash	8 %	Fly Ash
	1 %	Retarder (Based on wt. Fly Ash)
	6 %	Water (Based on wt. Fly Ash & Water)

Mixing Procedure:

1. Add lime to water, blend to form a slurry
2. Add emulsion and slurry to RAP sample
3. Add water & lime mix for 2 minutes

1. Add fly ash to RAP and mix 30 sec.
2. Add water & retarder and mix 1½ minutes

#27 A:Table-Glenn-Laboratory-KT-56&Permeability

TABLE 4: Permeability Testing of Field Cores

(Field Cores or Field Compacted Specimens)

	Density (Proc. I) (Kg/m^3)	Density (Proc.IV) (Kg/m^3)	Air Permeability (x10E-10 cm^2)	
Surface Course over Fly Ash (Field Cores)				
(Between Wheel Path)		2.196	60	Very Low
(Outer Wheel Path)		2.211	31	Very Low
Surface Course over Lime-Slurry (Field Cores)				
(Between Wheel Path)		2.145	281	Low
(Outer Wheel Path)		2.195	44	Very Low
Lime Slurry (Field Cores)				
(Between Wheel Path)		2.094	127	Very Low
(Outer Wheel Path)		2.125	90	Very Low
Fly Ash (Field Cores)				
(Between Wheel Path)		2.129	95	Very Low
(Outer Wheel Path)		2.133	90	Very Low

Mixes:

Lime Slurry	3 % Water
	1 ½% CSS-1H
	1 ½% Lime
Fly Ash	8 % Fly Ash
	1 % Retarder (Based on wt. Fly Ash)
	6 % Water (Based on wt. Fly Ash & Water)

#27 A:Table-Glenn-Field-Permeability

TABLE 5 AASHTO T283 & Resilient Modulus Testing

(Field Compacted Specimens)

Additive	Average Bulk Sp. G (Kg/m^3)	Air Voids (%)	Average Tensile Strength Unconditioned Strength (kPa)	Conditioned Strength (kPa)	Tensile Strength Ratio (TSR) (%)
Lime-Slurry			939	790	82.9
Fly Ash			604	552	92.9

Additive	Average Bulk Sp. G (Kg/m^3)	Air Voids (%)	Average Resilient Modulus Unconditioned (MPa)	Conditioned (MPa)	Index Retained Modulus (IRRM) (%)
Lime-Slurry			444	279	63.6
Fly Ash			294	156	53.1

#27 A:Field-TSR-IRRM

TABLE 6: APA Test Results of GDT-115 Method A (Dry Test) and Method B (Wet Test)
(Field Compacted Specimens)

	Hot Mix Surface Course		CSS-1H with HLS				Fly Ash			
	(40 C)	(50 C)	(40 C)		(50 C)		(40C)		(50 C)	
			WP	IBWP	WP	IBWP	WP	IBWP	WP	IBWP
	RUT DEPTH (mm)									
Final Dry Rut Depths after 8000 cycles	2.3	2.5	0.9	1.9	3.4	3.9	0.4	0.2	0.2	0.2
Final Wet Rut Depths after 8000 cycles			1.7	1.3			0.8	1.0		

HLS= Hot Lime Slurry
WP = Wheel Path
IBWP= Inbetween Wheel path

#27 A:APA-Field-Rut-Depths

TABLE 7: Crack and Rut Survey

	Fly Ash Section			Lime Slurry Section		
Date	Rutting Avg.	Transverse Cracking	Longitudinal Cracking	Rutting Avg	Transverse Cracking	Longitudinal Cracking
	(mm)	(m)	(m)	(mm)	(m)	(m)
1997	9.3	82.1	76.4	11.3	92.5	123.0
(Original/ Before Construction)						
2000		66.5	49.1	2.4	55.0	1.7
2001	0	70.7	67.7	0.1	86.7	3.6
2002	0.5	80.6	83.0	1.5	118.4	19.5
2003		120.5	210.3		160.0	110.6
		(%)	(%)		(%)	(%)
2000		81.0	64.3		59.4	1.4
2001		86.1	88.6		93.7	2.9
2002		98.2	108.6		128.0	15.9
2003		146.8	275.3		173.0	89.9

TABLE 8: Falling Weight Deflectometer (FWD)

	Ep (Adjusted / psi)				
	1998	1999	2000	2001	2002
Fly Ash Section	297,000	270,000	291,000	137,000	259,000
Lime-Slurry Section	236,000	282,000	325,000	285,000	323,000

#27 A:Crack-Rut-FWD-Survey

TABLE 9: Cost Data for a Typical Cold Recycle in Western Kansas

($ per Kilometer) 100 mm CIR / 40 mm Hot Mix Overlay / Roadwidth = 7.3 m

DESCRIPTION	Unit of Measurement	Unit Cost	CIR with Fly Ash ($ per Km)	CIR with Lime Slurry ($ per Km)
Traffic Control	Km	($ 1200)	$ 1,200.00	$ 1,200.00
Striping	m	($1)	$ 1,000.00	$ 1,000.00
Hot Mix Overlay	Megagram	($38)	$ 24,890.00	$ 24,890.00
CIR with Fly Ash	Km	($18,640)	$ 18,640.00	
CIR with Lime Slurry	Km	($30,128)		$ 30,128.00
SUBTOTAL			$ 46,730.00	$ 58,218.00
Mobilization		(5%)	$ 2,337.00	$ 2,911.00
TOTAL			**$ 49,067.00**	**$ 61,129.00**

27 A: Cost-Data