

**LIME, AGGREGATE, CEMENT, EMULSION (L.A.C.E.):
AN INNOVATIVE SURFACE TREATMENT**

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AN INNOVATIVE SURFACE TREATMENT**

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ABSTRACT

This report describes an innovative method for treating flushed or slick wheel paths. A maintenance team from Abilene District developed and placed an experimental mix on U.S. 80 and found that the treatment represented a cost-effective, durable, nontoxic procedure for repairing flushed asphalt (or other) surfaces. Because its fundamental ingredients consisted of lime, aggregate, cement, and emulsion, the process was termed "L.A.C.E." friction course.

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There was no invention or discovery conceived or first actually reduced to practice in the course of this contract, including any art, method, process, machine, manufacture, design or composition of matter, or any new and useful improvement thereof, or any variety of plant, which is or may be patentable under the patent laws of the United States of America or any foreign country.

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BIDDING, OR PERMIT PURPOSES**

PROBLEM

In addition to posing a hazard for motorists, slick (or flushed) wheel paths represent a significant maintenance problem. For example, since this condition is most often caused by too much asphalt on the surface, conventional maintenance remedies—such as treating the area with a skid-resistant aggregate seal—can compound the problem, since such treatment involves the application of even more asphalt.

Adding to the maintenance problem is the fact that slick wheel paths develop quickly, with deterioration setting in so rapidly that repair work becomes difficult to schedule effectively. Because the distressed areas are usually small, a large accumulation of these types of problems would be required before the letting of a maintenance contract could be justified.

When slick wheel paths threaten public safety, however, the department cannot afford to wait for formal or even emergency project programming. What maintenance crews need is a procedure for treating these distressed areas quickly and cost effectively.

OBJECTIVE

The objective of this experiment was to develop a repair procedure that allows highway maintenance personnel to place a skid-resistant surface on flushed asphalt (or other) surfaces that have lost their skid resistance for any reason. This procedure would be designed so that the surface could be placed when needed (i.e., not necessarily during the hot asphalt season). In approaching this objective, we sought a surface treatment whose material ingredients were as follows:

- readily available from local sources;
- nontoxic;
- capable of easily handling (not difficult to place);
- capable of placement by standard, easily operated equipment;
- quick setting, so that the roadway can be reopened to traffic as soon as possible;
- durable; and
- cost effective.

Thus, we required a process in which a thin layer of inexpensive material could be placed at any time of the year using readily available equipment—in other words, an alternative to the asphalt surface treatment that, as indicated earlier, frequently aggravates the problem.

DEVELOPMENT

After reviewing current methods and every available design, we initially identified microsurfacing (also called slurry seal) as the best candidate procedure for development. This surface treatment can be applied in thin layers and, as evidenced by the microsurfacing projects placed in the Abilene District, performs extremely well. The problem, however, is

that this process requires expensive, specialized equipment to which TxDOT crews do not have access. The material ingredients used in microsurfacing are also specialized and not locally available. In those projects undertaken in our district, for example, we had to transport the aggregate and emulsion over 400 miles to the construction site (the CSSI-P asphalt used in this procedure was not even available for our experiments).

These shortcomings led us to look to other available methods. In our pursuit of a durable, nontoxic, easily placed surface treatment, we determined that we needed the following key ingredients:

- First, we needed a washed, crushed aggregate that was widely available and about the size of a standard grade 6 rock. In addition, we needed a stone having sharp faces and a relatively high polish value. (In most cases the polish value was not too important because what we were developing was, in effect, a moderately short-term cure.)
- Also required for the total aggregate was a washed screening that matched the engineering qualities of the grade 6 rock. Because such screenings are routinely produced along with the grade 6 rock, we considered them similarly available.
- We needed an emulsion in which to suspend the material. Here, our experiments in the lab verified that the various emulsions differed significantly. For example, the MS-1 emulsion set up much too quickly, with the material also failing to stay suspended (it tended to separate from the aggregate and would not mix). On the other hand, the regular SS-1 emulsion performed well, with its overall performance similar to that of the CSS-1P emulsion required in the microsurfacing material.
- An antistripping agent was required. In our prototype mix, we used a small percentage of lime to deter the possibility of stripping and to toughen the mix (and to offset brittleness as well). While we were unable to measure toughness precisely, our observations confirmed that the inclusion of one-half percent lime yields a much stronger mix.
- Two-and-one-half to 3 percent portland cement was needed to provide strength, durability, good workability, and consistency. (We believe there is little difference between 2- and 3-percent cement.)

After various mixtures of crushed gravel, gravel screenings, concrete, crushed stone, and washed screenings were tried, we finally established what we considered to be the optimum mixture: One part grade 6 crushed stone and three parts washed screenings (from Vulcan Materials in Brownwood). The proportions of all ingredients included:

Grade 6 crushed gravel: 25%

Washed screenings: 75%

Cement: 3%

Lime: 0.5%

Water: 6.4%

SS-1: 9.6%

We found the above mix (essentially a modified slurry seal) to meet our needs for a durable, nontoxic, and easily handled surface treatment. (Alternative mixes are listed in Appendix A.) Because its fundamental ingredients consisted of lime, aggregate, cement, and emulsion, the new process was dubbed "L.A.C.E." friction course.

EQUIPMENT

In identifying the laydown equipment needed, we started by reviewing earlier (1950s) technology that made use of drag brooms to place a slurry-type seal in lieu of a regular penetration-type seal. These drag brooms, which were pulled behind tractors, had a series of angled brushes that kicked and mixed the sand and emulsion. For various reasons, the department later found this method to be unsatisfactory and therefore discontinued its use. In the mid-1970s, the department tried this method again, this time rigging three-point hookups for tractors and brooming all excess material off the road (so that only the cracks filled). Using this system of mixing for our experiment, we added a screed to the back of the broom-box assembly. A 50-gallon water tank (with pressure) was also added so that a fog spray of water could be applied when needed. Figure 1 shows a lab prototype of the laydown machine, while Figures 2 and 3 show the equipment as developed for final testing.

The screed is split in the middle and at quarter points, with screws added, so that the screed may be adjusted. Following a test run, we decided to add another broom mixer so that only one pass of the screed assembly would be required.



Figure 1. Mixture being placed with a lab prototype of the laydown machine

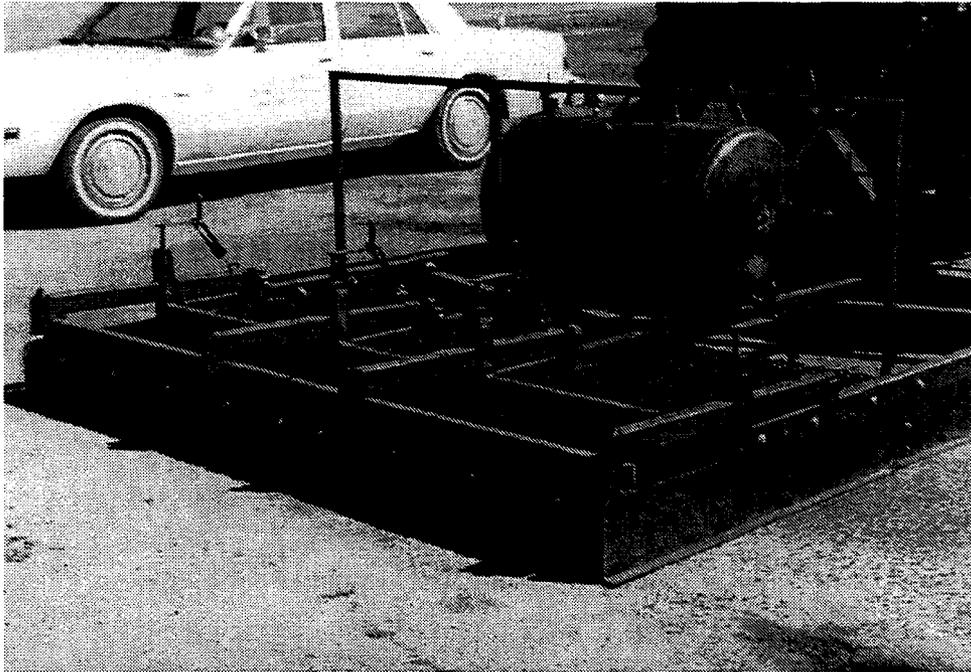


Figure 2. Shop-made laydown machine (note the pressure water storage tank and screed adjustment handles)

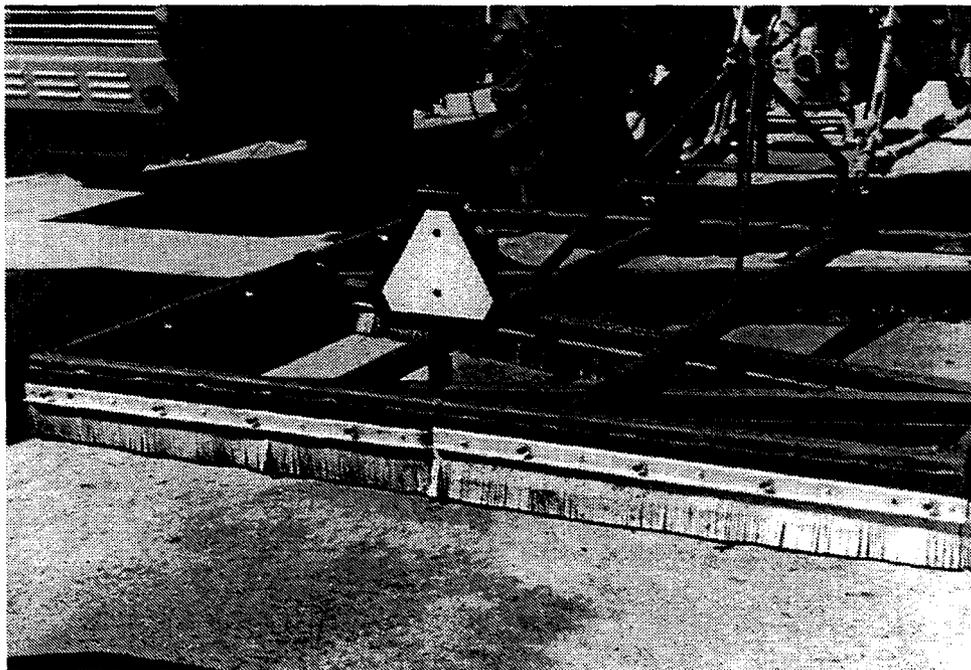


Figure 3. Mixing unit without screed or water storage

TEST REPORT

The Abilene District test site was a 1,500-foot section on U.S. 80 characterized by flushing problems. Using the two-section adjustable screed with flared wings (angled brushes) on front, the test crew performed the following procedure:

1. The pavement was sprayed with water.
2. A moderate amount of emulsion was applied on the pavement.
3. A spreader truck distributed the mix.
4. A second portion of emulsion was applied.
5. More gravel mix was spread.
6. Three passes were made with the drag box/brush mixer.
7. Two passes were made with the laydown machine with variable screed.
8. The mix was watered while the screed was adjusted (the adjustable screed was binding and required some machining before it could be adjusted properly).
9. Another pass was made with the screed at a lower position.
10. Half of the test section (500 feet on the south end and 200 feet on the north end) was rolled with a pneumatic roller after 4 to 4 1/2 hours.

We applied our surface treatment on a dry and windy day, with the temperature around 38° F. Hardening rapidly under these conditions, the treatment was dry after 4 hours. Figures 4 through 8 show the laydown operation and the final mat in place before curing.



Figure 4. Emulsion being placed and aggregate spreader following the asphalt distributor

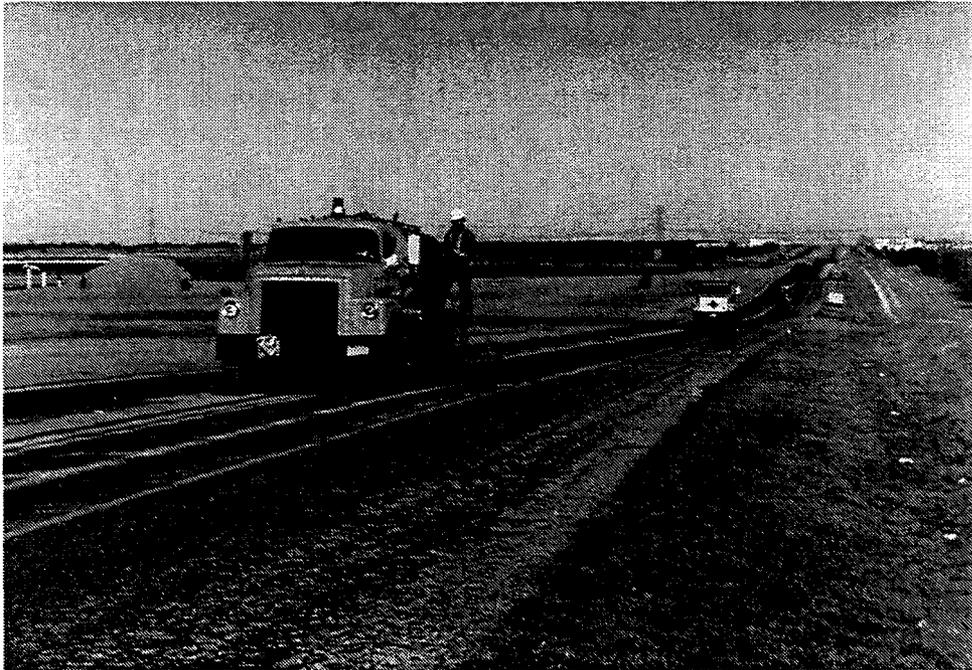


Figure 5. Another view of maintenance crew placing emulsion

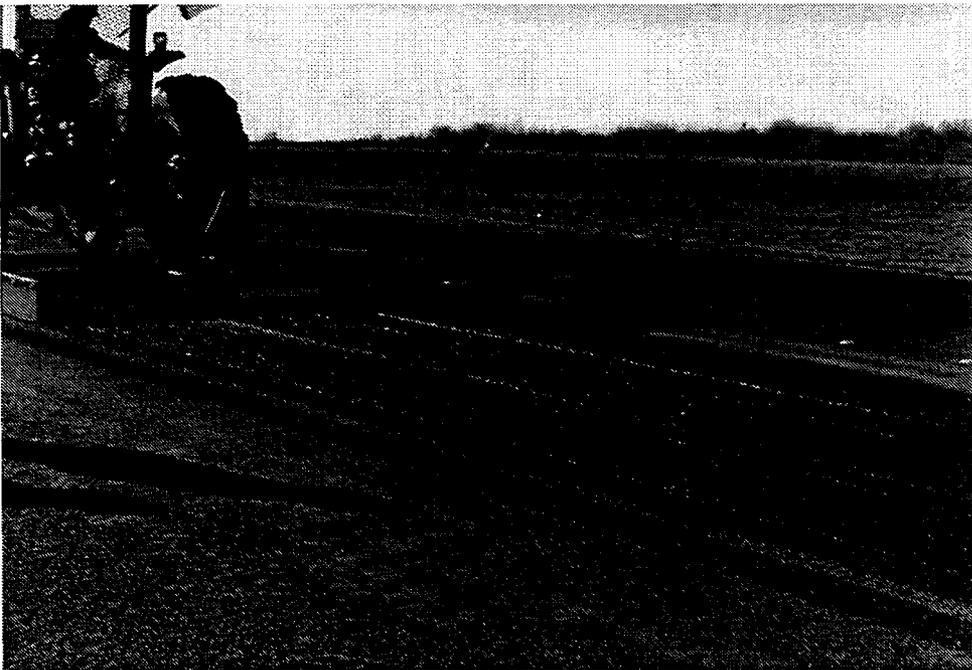


Figure 6. Closer view of mixer equipment in operation

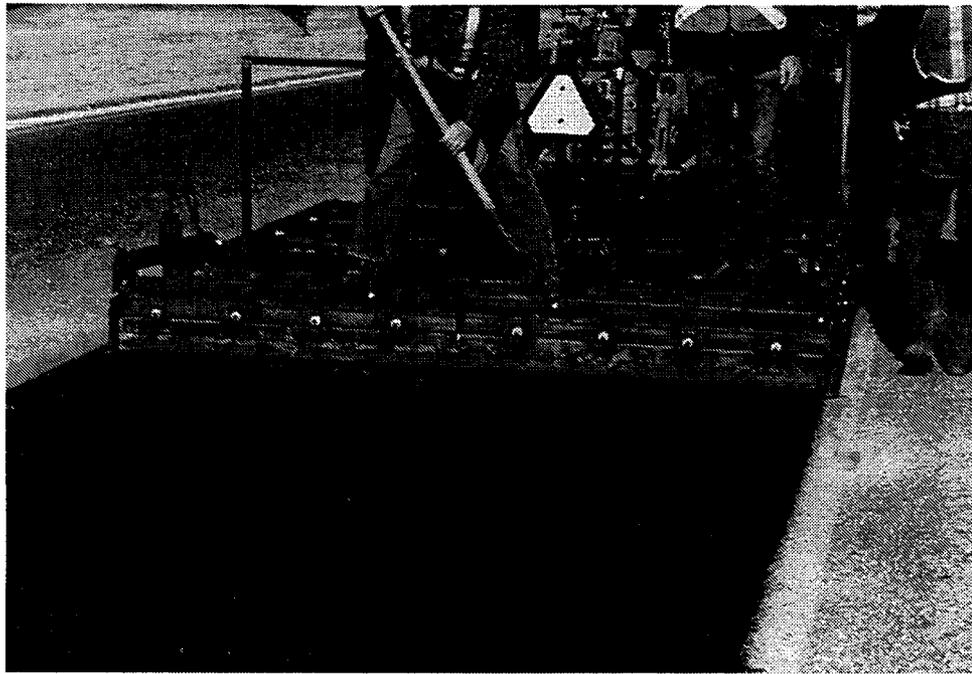


Figure 7. View of final laydown operation



Figure 8. Final mat in place before it was cured out

CONCLUSIONS

Our tests indicate that this procedure is an effective surface treatment. It does a very good job of filling cracks, curing bleeding surfaces, providing good skid numbers for polished surfaces, filling slight wheel path depressions, and smoothing small areas of rough-textured surfaces. It also can be used to cover existing striping so that changes may be made.

When placing this surface treatment, the weather should be clear and the pavement dry. It should be neither extremely cold nor extremely hot. The colder it is, the longer it takes for the emulsion to break and the material to dry. The hotter it is, the faster the emulsion breaks (reducing the time available to work the material to a desirable finish). And, of course, the mix must be completely dry before the roadway is reopened to traffic.

Our experiments indicated that the L.A.C.E. surface treatment should ideally be placed on dry, clear days, with temperatures ranging between 50° to 80° F. On such dry, clear days, the roadway can be reopened to traffic after 2 to 4 hours at 50° F, and after 1 to 2 hours at 75° F (with actual times affected by the presence of high wind and high relative humidity). L.A.C.E. should not be used on cloudy days when the temperature is below 38° F—the surface will not dry adequately, necessitating overnight road closures.

We should also point out that a thin surface course is all that is needed. If there are wheel paths that need filling, we suggest either using more than one pass with this material or using some other means of filling ruts. Aggregate larger than grade 6 will not lay smoothly in this mix, resulting in an undesirable finish (this mix is very wet and requires a small aggregate that tends to stay in the solution).

Finally, because the timing of each sequence and the proportioning of each ingredient are critical, we suggest that the District Special Job Crew perform this process. The Abilene District office has a videotape of this procedure available for viewing.

APPENDIX A

As was noted earlier, we found that MS-1 did not provide a homogeneous mixture, owing to its inability to hold the material in suspension. Better results were obtained with SS-1. (Note: These ingredients can also be mixed in a concrete mix truck. The dry ingredients should be weighed and placed in the mixer at the plant and the emulsion and water [50-50 solution] added on the road. We do not recommend this method because mixer trucks are not readily available in rural areas and because the use of these trucks would add appreciably to the cost.)

Materials were dried 24 hours in a 140° F oven, mixed, and dried again for 14 more hours.

As with HMCL-AC (cold mix), specimens were molded by Test Method Tex-206-F at 100° F. Hveem stabilities were run using Test Method Tex-208-F. The blend of 3 percent cement and 0.5 percent lime was judged to be optimum in terms of consistency, density, and toughness.

Extra portions of mixtures were tested by the boiling test for stripping (Test Method Tex-530-C). The mixture containing neither cement nor lime had approximately 5 percent stripping; all others had none, indicating that both cement and lime have antistripping properties.

Gradation of Combination of Materials

		% Retained
3/8"	—	0.0
#4	—	05.4
#8	—	30.1
#16	—	56.1
#30	—	76.2
#50	—	90.6
#200	—	99.2

State Department of
Highways and Public Transportation
District Laboratory
Abilene, Texas

Asphaltic Concrete Stability Report
Test Method Tex-208-F

Engineer: Bobby C. Satterwhite
County: Taylor

Project: Experimental
Control: Hwy No:

Laboratory Number:
Mixture Spec. and Type:

Date Sampled: 2/13/91
Date Reported: 2/14/91

Specimen Number	Identification Marks	Specimen Height (In.)	Asphalt (% by Weight)	Tex-530 (%) Stripping	Hveem Stability (%) (Average %)	
1 SS-1	1	1.97			52	
2 0 % *	2	1.99	5.80	5.10 %	51	48
3	3	2.02			41	
1 SS-1	4	2.02			42	
2 1 % *	5	2.03	5.80	0 %	46	45
3	6	2.02			47	
1 SS-1	7	2.01			45	
2 2 % *	8	2.01	5.80	0 %	45	45
3	9	2.01			45	
1 SS-1	10	2.00			48	
2 3 % *	11	2.00	5.80	0 %	45	46
3	12	2.01			46	
1 SS-1	13	1.98			48	
2 2 % *	14	1.98	5.80	0 %	53	51
3 .5 % **	15	2.00			51	
1 SS-1	16	2.02			50	
2 2 % *	17	2.02	5.80	0 %	47	48
3 1 % **	18	2.01			47	
1 SS-1	19	2.02			46	
2 3 % *	20	2.01	5.80	0 %	44	46
3 .5 % **	21	1.99			48	
1 SS-1	22	2.00			50	
2 3 % *	23	2.00	5.80	0 %	48	49
3 1 % **	24	2.00			49	

Remarks: * Cement

** Lime

16.0 % SS-1 = 16.0 x 60 % Solution x 60 % Residual = 5.76% Asphalt

In testing the mix, we made molding specimens using the following mixtures:

Stability		
48	25% 75% 16%	Grade 6 Washed screenings SS-1 emulsion solution (60% SS-1, 40% water)
45	25% 75% 16% 1%	Grade 6 Washed screenings SS-1 solution Portland cement (based on dry weight of materials)
45	25% 75% 16% 2%	Grade 6 Washed screenings SS-1 solution Cement
46	25% 75% 16% 3%	Grade 6 Washed screenings SS-1 solution Cement
51	25% 75% 16% 2% 0.5%	Grade 6 Washed screenings SS-1 solution Cement Lime
48	25% 75% 16% 2% 1%	Grade 6 Washed screenings SS-1 solution Cement Lime
46	25% 75% 16% 3% 0.5%	Grade 6 Washed screenings SS-1 solution Cement Lime
49	25% 75% 16% 3% 0.1%	Grade 6 Washed screenings SS-1 solution Cement Lime

APPENDIX B

DISTRICT CONTACT PERSONNEL

General Information:

Glen Bohannon, Construction Manager(915) 676-6890

Placement Information:

Jerry Black, Special Job Crew(915) 676-6959

Martin Turentine, Maintenance Supervisor.....(915) 676-6920