SLURRY SEAL SYSTEMS

for

PAVEMENT CONSERVATION

presented by

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to the

TOLEDO SECTION
AMERICAN SOCIETY OF CIVIL ENGINEERS/
UNIVERSITY OF TOLEDO
SEMINAR

on

Pavement Rehabilitation and Maintenance Techniques

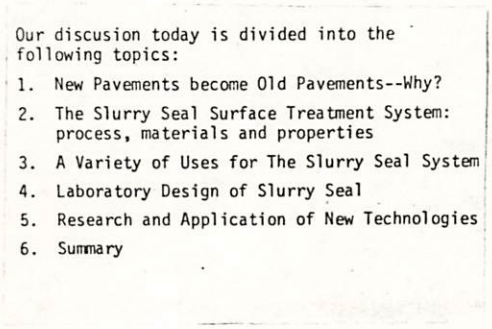
Wednesday, April 21, 1982

INTERNATIONAL SLURRY SEAL ASSOCIATION
1101 Connecticut Ave., N.W., Suite 700
Washington, D.C. 20036
202/857-1160

1.

I am pleased to participate in this American Society of Civil Engineers-University of Toledo Seminar on "Pavement Rehabilitation and Maintenance Techniques" and to represent the slurry seal industry and the International Slurry Seal Association, located in Washington, D.C.

You will find a copy of our script in your workbook which you may wish to follow and make notes as we proceed. If you have questions or comments which cannot be answered because of our time limitations, I invite you to call or write us at the addresses listed on the cover sheet.



2.

Our discussion today is divided into the following topics:

1. New Pavements become Old Pavements---Why?
2. The Slurry Seal Surface Treatment System: process, materials and properties
3. A Variety of Uses for The Slurry Seal System
4. Laboratory Design of Slurry Seal
5. Research and Application of New Technologies
6. Summary

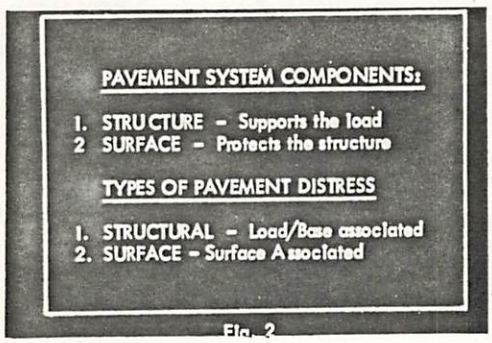


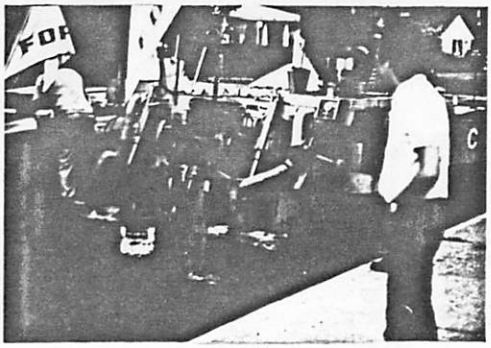
Fig. 2

3.

First, I wish to make a distinction between the structure of a pavement and the surface of a pavement. The structure supports the load; the surface protects the structure. There are then 2 kinds of pavement distress; structural distress and surface distress. Here we are dealing only with surface distresses and the part that slurry can play in treating surface problems or in preventing or delaying their occurance.

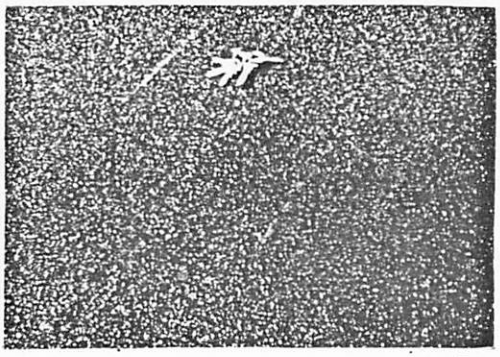
4.

Second, I wish to emphasize that pavement surfaces are not absolutely uniform; nearly all pavement surfaces vary in their composition, thickness, density and texture. Accordingly, their performance will show wide variations from section, both transversely and longitudinally.



5.

Hot Mixed Asphalt Concrete enjoys a world-wide acceptance because it is smooth riding and is acceptable to the user.



6.

We see here a close-up of a newly laid pavement which, if neglected, will look like ---

7.

this.---During the life of this pavement, something happened to this pavement. What caused this disaster to happen?

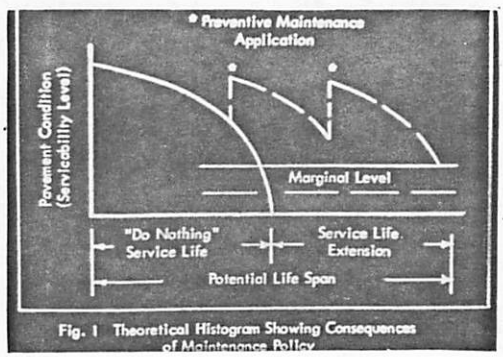
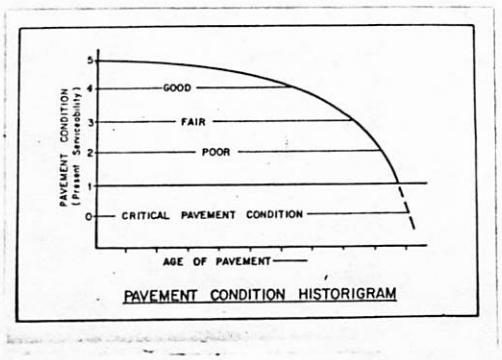


Fig. 1 Theoretical Histogram Showing Consequences of Maintenance Policy

8.

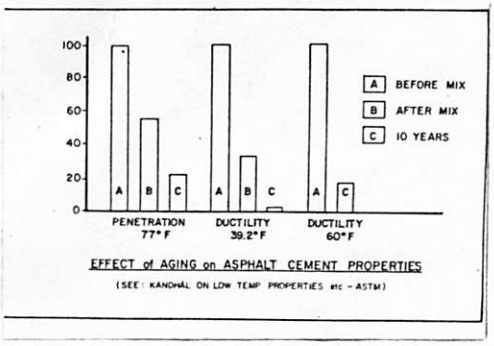
What we're really talking about is illustrated here in this historiogram where a pavement's condition deteriorates at an accelerated rate and some sort of surface maintenance restores the pavement to nearly its original condition, thus, extending the pavements' useful life.



PAVEMENT CONDITION HISTORIGRAM

9.

The question remains, what happened to the condition of this asphalt pavement? Why does it progressively loose fines, ravel, crack and finally go out of service?

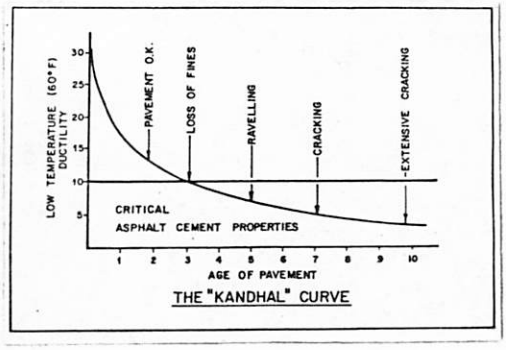


EFFECT of AGING on ASPHALT CEMENT PROPERTIES

(SEE: KANDHAL ON LOW TEMP PROPERTIES etc - ASTM)

10.

In a long term study of the deterioration process sponsored by PennDOT, the investigator, Prithvi Kandhal, reports these findings which I've simplified. First, the asphalt cement loses about 40-50% of its original properties during mixing at the plant. Special attention, however, was given to the rate of change of the ductility at low temperatures, i.e. at 60°F and 39.2°F rather than at the conventional 77°F.

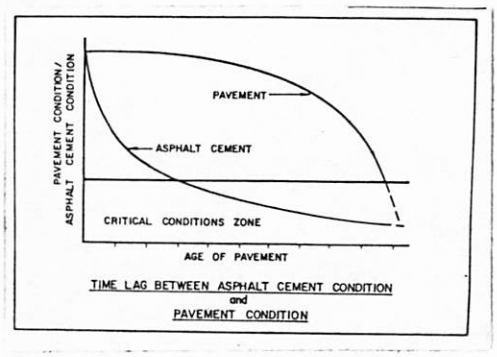


THE "KANDHAL" CURVE

11.

Kandhal found a good correlation between the ductility measured at 60° and the condition of the pavement surface which I also present here for the first time as the "Kandhal Curve".

Note, that as the low temperature ductility crosses the 10 cm. line that a loss of fines occurs; at 5-8 cm., ravelling occurs; at 3-5 cm., cracking occurs and at below 3 cm., extensive cracking occurs.



TIME LAG BETWEEN ASPHALT CEMENT CONDITION and PAVEMENT CONDITION

12.

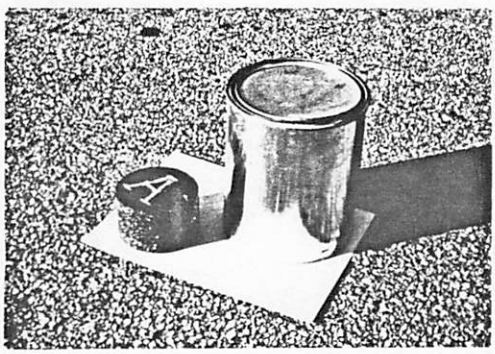
By combining the historiogram and the Kandhal Curve (a historiogram of asphalt cement condition), we find that THE CONDITION OF THE ASPHALT CEMENT PREDICTS THE FUTURE CONDITION OF THE PAVEMENT. In this case the asphalt cement became "critical" 6 or 7 years before the pavement condition became critical.

FACTORS CONTRIBUTING TO THE RATE OF CHANGE OF ASPHALT CEMENT / (CONCRETE) PROPERTIES:

- VOIDS / PERMEABILITY / DENSITY / COMPACTION
- PENETRATION / VISCOSITY / LOW TEMPERATURE DUCTILITY
- STIFFNESS / BRITTLENESS / GLASS TRANSITION
- ADHESION / STRIPPING / ABSORBTION
- MIX DISUNIFORMITY / SEGREGATION / THICKNESS
- QUALITY AND QUANTITY OF FINES
- MIX TIME AND TEMPERATURE
- WEATHER

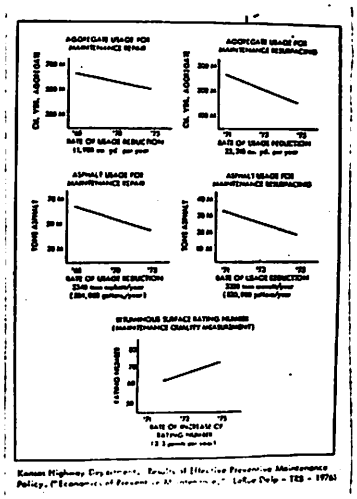
13,

A partial list of the factors that contribute to the rate of change are listed here. Weather, specifically air and water, is the chief culprit.



14.

In fact, there is a large body of evidence to support the notion that if a pavement could be put into a box and protected from the weather that it could last indefinitely.

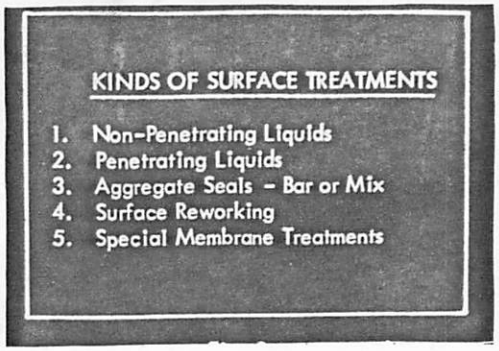


What is suggested by all this is that: if maintenance applications were applied to seal a surface before the need became apparent, then the pavement's useful life could be extended even further.

This may seem to be a radical departure from conventional wisdom or even sanity but, in fact, such a scheme has actually been proven in the field as shown in these graphs. The show the results of a program undertaken by the Kansas DOT in the late 60's & 70's by the then maintenance engineer, LaRue Delp, which treated the pavements in reverse order of the apparent need; i.e., treat the best one's first to keep them best and use the money conserved to reconstruct the worst ones.

Note, that, not only was the expense of maintenance reduced, but the over-all quality of the pavements actually increased.

Well, what can be done about putting our pavements in a box---to isolate the pavement from the destructive forces of weather? A protective surface treatment---Slurry Seal, of course!

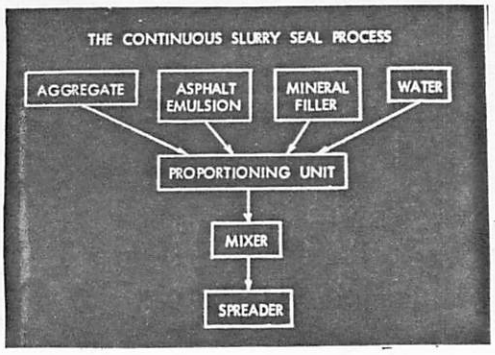


16.

Surface treatments may be classified into 5 broad categories. Slurry Seal is in the aggregate mix-seal category. A more familiar term is "Dense Graded Cold Mix Seal."

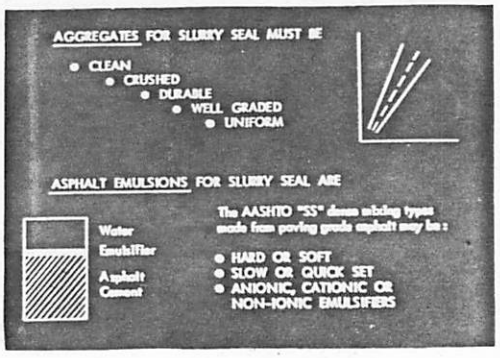
17.

We have come to understand the material called "slurry seal" as a fluid, homogeneous mixture of asphalt emulsion, water, mineral filler and continuously graded fine aggregate which is applied to a pavement surface by means of a bottomless, runner-supported, squeegee-sealed spreader box.



18.

The continuous slurry seal process precisely proportions the materials, mixes and spreads the mixture.



19.

The principle materials of slurry seal are (1) aggregate and (2) asphalt emulsion. The aggregate must be clean, crushed, durable, properly graded and uniform. The emulsion is a three-part system consisting of asphalt cement, water and emulsifier. The asphalt emulsions generally conform to the AASHTO "SS" dense mixing types and are made from paving grade asphalts and may be hard or soft. The emulsions may be of the slow-set or quick-set type made from anionic, cationic, or non-ionic emulsifiers. Sometimes, liquid modifiers are used.

20.

(3) Fillers such as portland cement or hydrated lime are often used in small quantities to stabilize incompatible mixtures or as chemical modifiers of the system. (4) Mix water should be potable and free from harmful salts.

25.

This wheat-drilled chip seal surface shows an extreme example of a variably textured surface. A type II slurry was applied to correct this condition.

26.

---and after 5 years of service, the slurry looked like this.

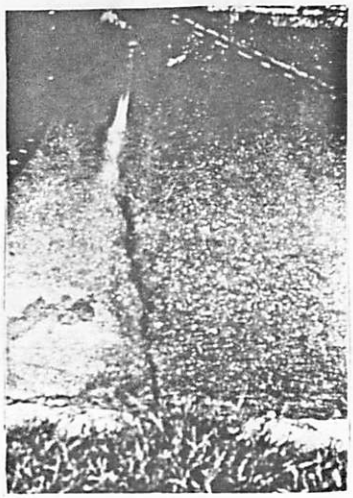
27.

Another extreme example of a variably textured surface is what we call "wet shade erosion"---

28.

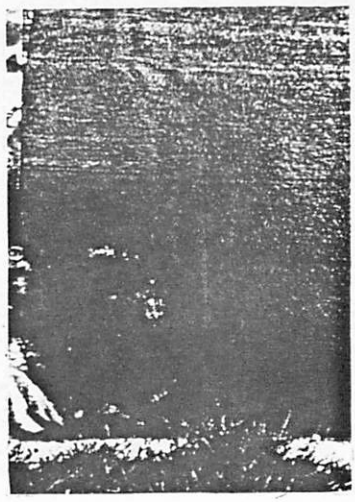
And, its' appearance 2 years after a slurry application.

29.



Regarding cracks, normal slurry seal will not "fix" structural cracks. However, slurry can fill them the quickest and most economical way possible as in the case of this reflective crack.

30.



Now you see it---------Now you don't!

31.

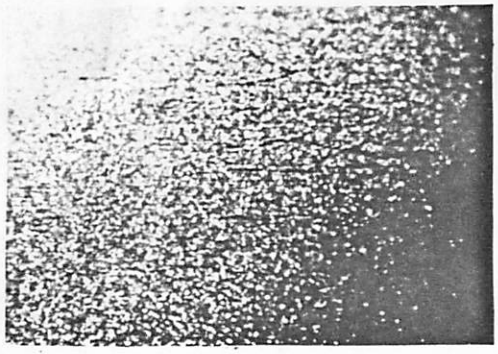
This is an example of a surface-type crack which slurry can effectively repair.

32.

Conventional slurry cannot permanently repair these structurally reflected cracks. The best we can do is to improve the appearance of the pavement and prevent further crack propagation.

33.

Isolation of crack-induced stresses by the construction of a tred-rubber aggregate slurry or strain relieving interlayers have been effective in the reduction of reflective cracking for as many as five years.



34.

When the primary objective is for a crack treatment, then softer, elastic slurries prove beneficial. In this case, the 60/70 penn AC slurry on the right reflected all cracks during the first winter. However, the 170 penn AC used on the left showed no cracking after 4 years of service.

35.

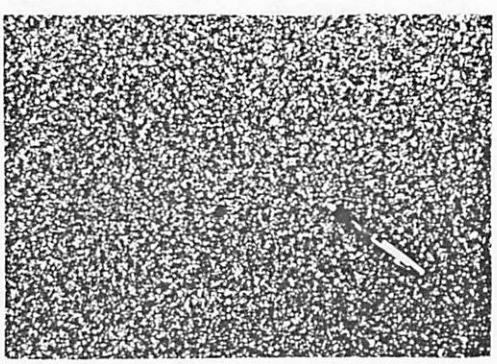
A sad sight---an entire bridge deck surface cracked because the re-bars were placed too close to the surface.

36.

A diluted emulsion "wipe" tack coat was applied to force emulsion into the cracks and ...

37.

Allowed to dry for about one hour.



38.

And then a two-course, 5% latex-modified slurry was applied, shown here after 2 winters. The flexible seal was completely intact in the 3rd year when it then served as a membrane underlayment for a 1½" hot mix surface.

39.

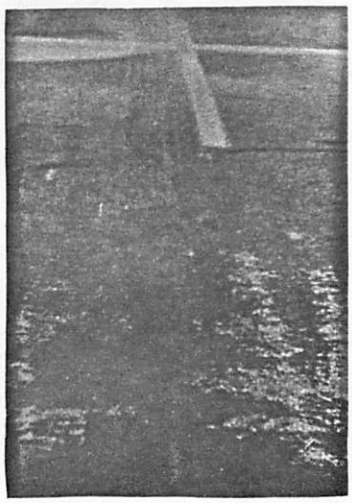
Shown here is an airport overrun in Spain receiving its' second course of a two course slurry.

40.

Then the second application was compacted with a rubber tired roller. It is not normally necessary to roll slurry.

41.

At OSU's Fawcett Center for Tomorrow some parts of the parking area were constructed over a 20 foot fill and topped with a 4" layer of a local coarse black base called "BAM" and---

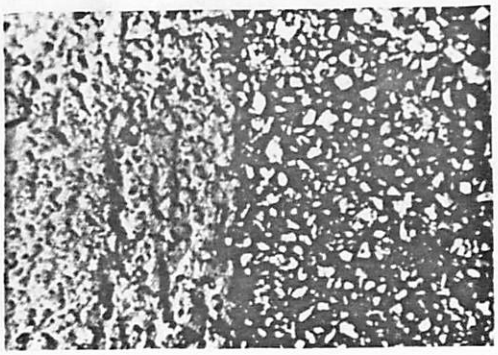


42.

Then sealed with a single course of type II slurry. Note how well the birdbaths caused by base settlement remain effectively sealed.

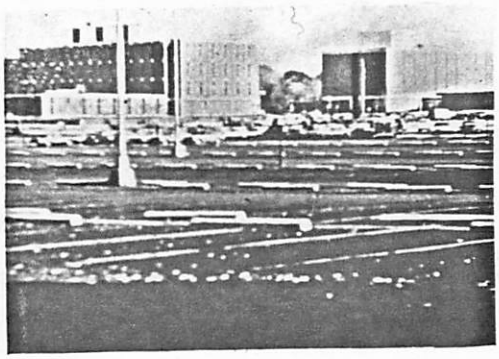
43.

In Central and South Africa a popular bituminous surfacing technique is called a "Cape Seal" after the cape of South Africa. This treatment is a chip seal with slurry applied to prevent loss of the chip seal aggregate. Very long lives (over 10 years) for this type of combination surface treatment are reported.



44.

A temporary chip seal was placed on a parking area at Wright State University. The loose chips created problems of dust and safety. Seventeen triaxle loads of loose chippings were removed by grader and end loaded and the remaining chips rolled and primed with RC-70 and a single 15-pound type II slurry applied.

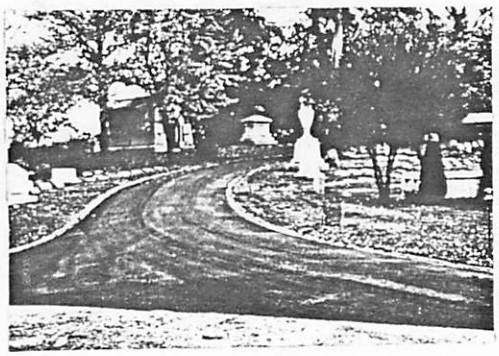


45.

The resulting surface had no dust, no loose chips. stripes could be easily seen and the project was very economical to complete.

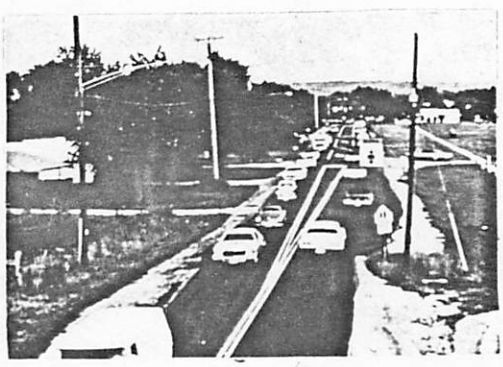
46.

Sometimes, engineers' talents are called upon to help promote community projects. Here, an attractive sign was placed on a background of new slurry. The result was overwhelming approval.



47.

An example of low density traffic application is this cemetery road. In the lower right is a bronze sign pointing to the graves of Orville and Wilbur Wright. I'm sure they're pleased with the nicely slurried pavement.

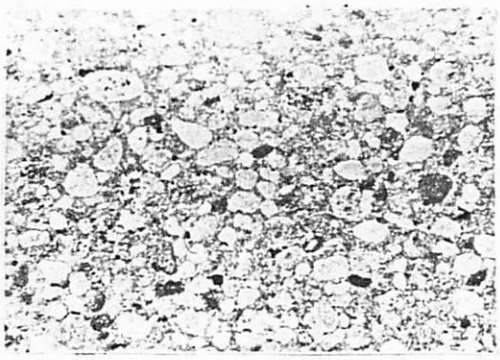


48.

A high density application such as this A-B test road in West Carrollton withstood well over 25 million vehicle passes with entirely satisfactory results. Friction numbers were about 2 points higher at the end of the test period than adjacent hot mix of the same age.

49.

Slurry has a particular use in the prevention of wet pavement accidents with which we are all too familiar.



50.

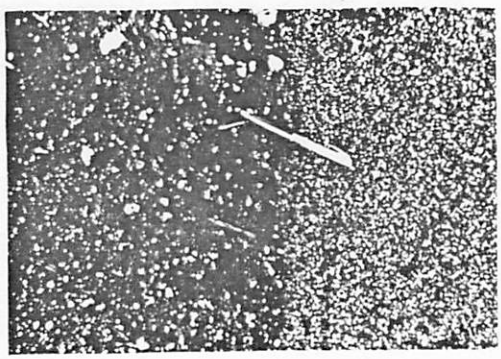
Polished surfaces

51.

Flushed surfaces

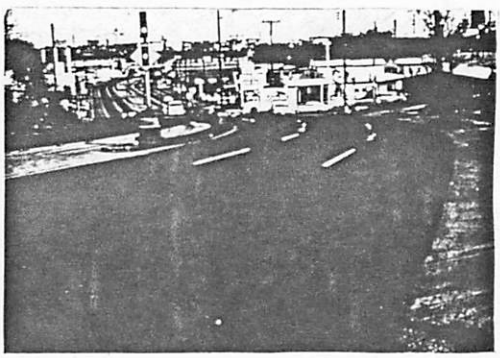
52.

Become very slippery during wet weather.



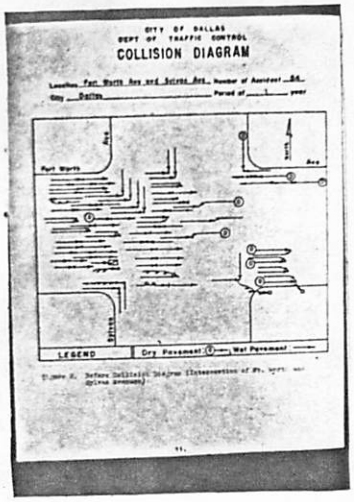
53.

With special design techniques many of these situations can be corrected with slurry seal.

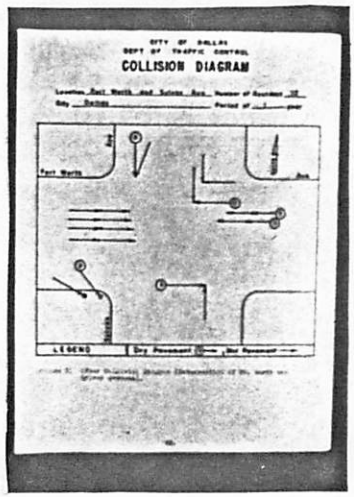


54.

This intersection in Dallas received a special slag slurry seal.

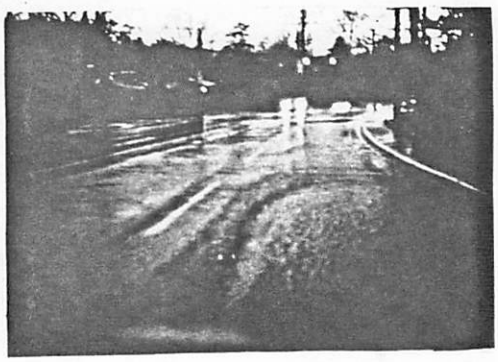


55.
The previous year there were 57 wet-pavement rear-end accidents.



56.

The accidents were dramatically reduced. In fact an 84% overall reduction in wet-pavement rear-end accidents has been reported as a result of their slurry intersection program.

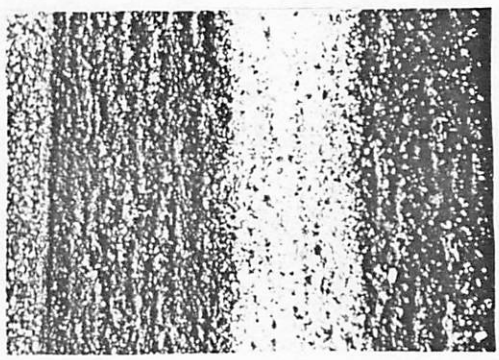


57.

A yearly average of 6 hydroplaning accidents occurred here until a ---

58.

special 5/8" latex modified slurry was placed in the curb lane. The accidents were eliminated.

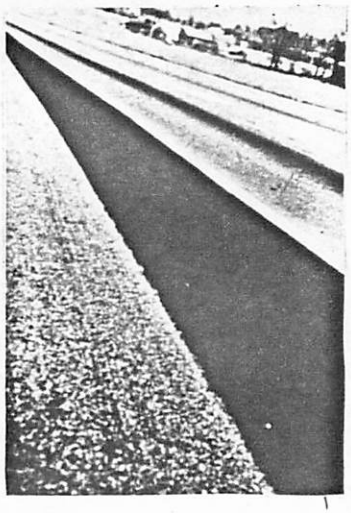


59.

Note the coarse texture of the special slurry compared to the adjacent slippery hot mix.

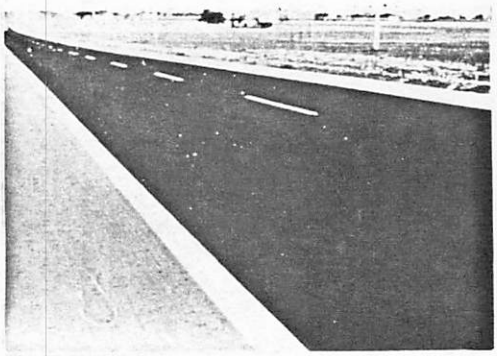
60.

Slurry finds use in delineation applications such as this background for traffic lines or stripes. When the stripe coincides with the lane joint, slurry will perform a joint seal and also delineate the stripes.



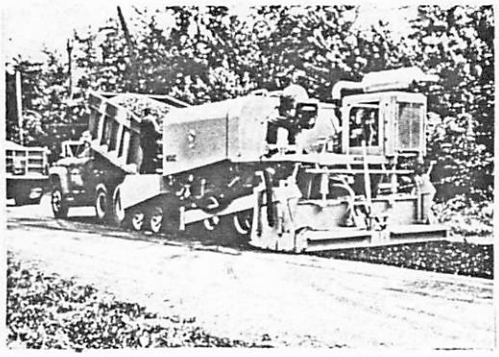
61.

A light-contrasted shoulder delineation treatment.



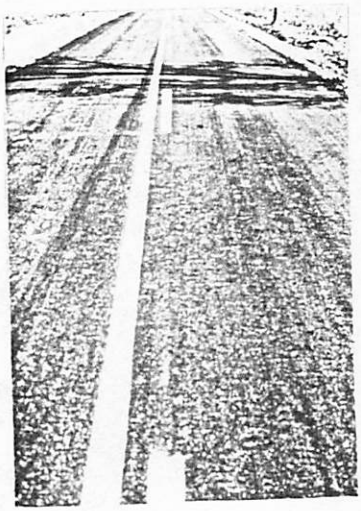
62.

In Spain conventional black slurry treats the main line while "white" slurry contrasts the shoulder area.



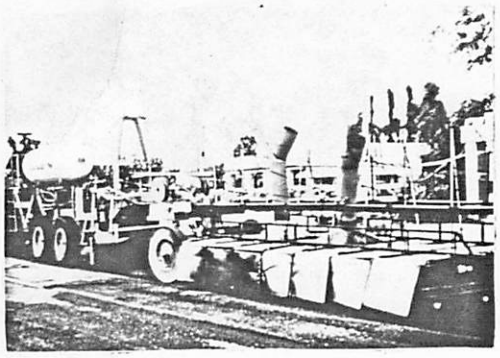
63.

Slurry is an excellent seal for open graded cold mixes as being applied here by a Midland Mix Paver.



64.

The best of both worlds: A really flexible pavement is tightly sealed with a dust-free and stone-free slurry seal.



65.

Because the surface texture of recycled or milled surfaces are highly variable, and slurry treats variably textured surfaces, slurry is the seal of choice for recycled surfaces.

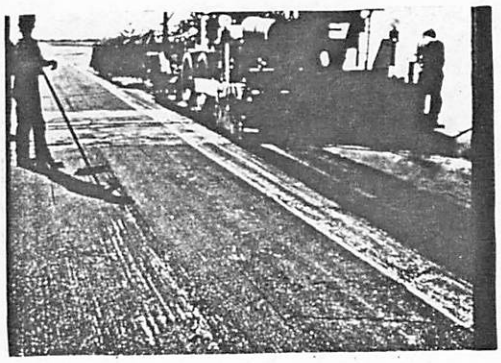
66.

Note the variable textures:

Skimming by heater planer.

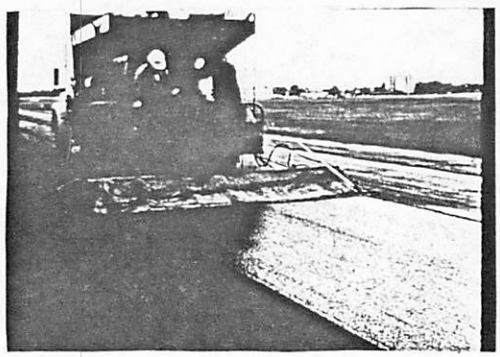
67.

Contouring by heater planer.



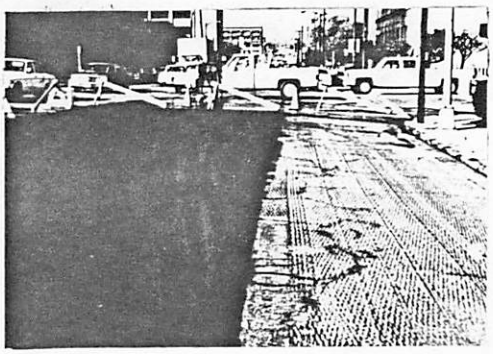
68.

Heater scarification and remixing of runway surfaces.



69.

With an application of Slurry Seal.



70.

Slurry Seal application to a roto-milled or cold planed surface.

71.
Very fine, type "O" or type I slurries make an excellent preparation for overlay. All cracks and surface voids are filled, block cracking is stabilized and an inseparable water-proof bond is established between the overlay and the old pavement.

72.

In this case, the first appearance of reflective cracking was delayed by four years.

This type of filler-tack coat has been specified by the FAA as preparation for airfield runways.

73.
Self loading continuous machines are especially adapted to high production straight-run work as in this type I interstate shoulder job.

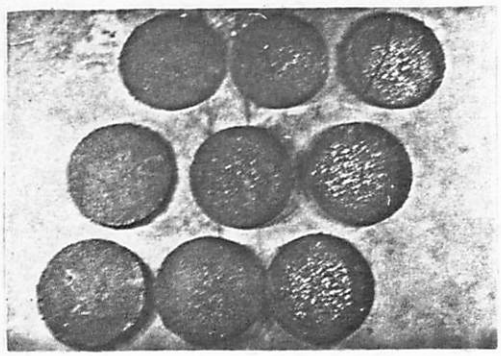
74.

Slurry Seal design procedures are completely described in I.S.S.A.'s Design Technical Bulletins-1980, ASTM D 3910-80A, US Army WES Instruction Report S-75-1 and many state DOT specifications.

Fig. 9

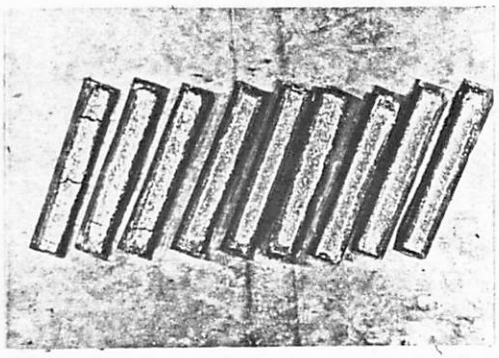
75.

Essentially the method requires that, after preliminary tests such as trial mixes, consistency and compatibility tests are run, physical specimens are then subjected to the ---



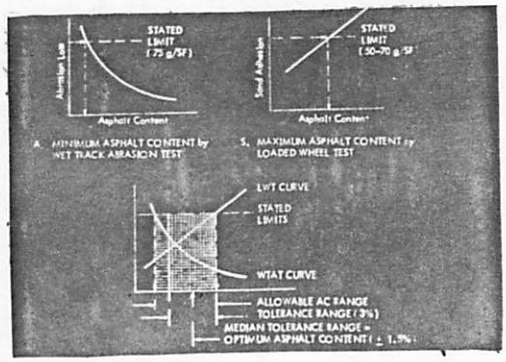
76.

Wet Track Abrasion Test (WTAT) to determine the cohesion values of various mixtures. The minimum asphalt cement requirement is established by the WTAT and ---



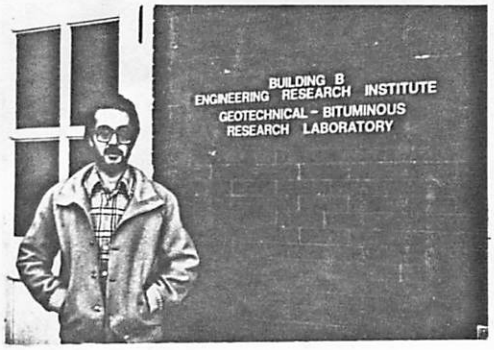
77.

the Loaded Wheel Test (LWT) where the maximum AC content is determined.



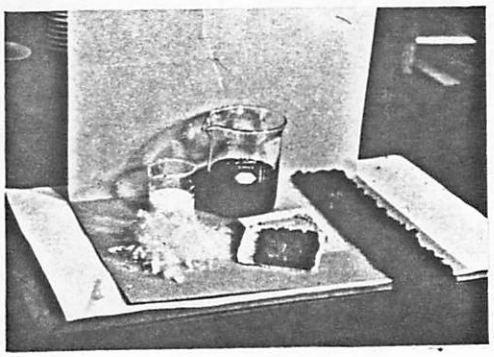
78.

The WTAT and LWT values are combined in a single chart to graphically determine the optimum AC content and the tolerance limits.



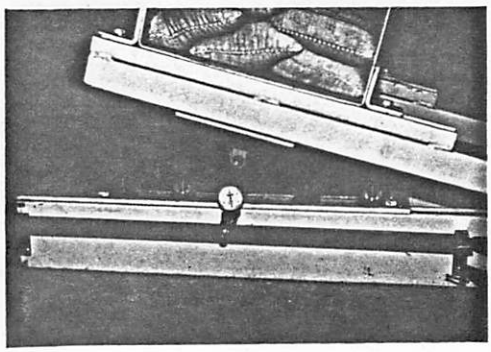
79.

I.S.S.A. actively participates in research and the development of new technologies. We currently fund a graduate study program at Iowa State U. Our present student, Orhan Ordemir of Turkey, is presently studying thin layer design and the effect of layer thickness on surface texture. His professor is Dr. Dah-yinn Lee. Mr. Ordemir is shown here examining the texture of our Ohio SR 42 test road.



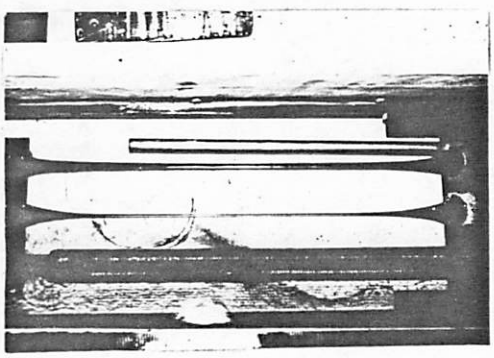
80.

Other areas of study include the use of latex, and other modified binder systems, as well as fiber reinforced systems to improve strength and both low and high temperature performance of the mixes.



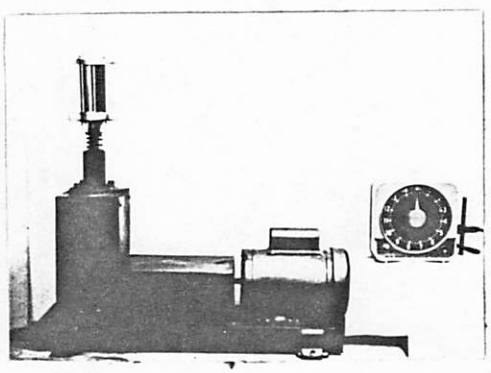
81.

Shown here is the loaded wheel tester simulating severe pavement deflections to study the improvement various materials make over conventional materials.



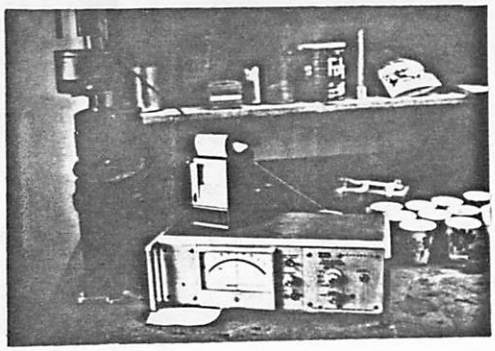
82.

The ductility of various elastomeric materials being studied as shown here as well as permeability and adhesion characteristics of various systems.



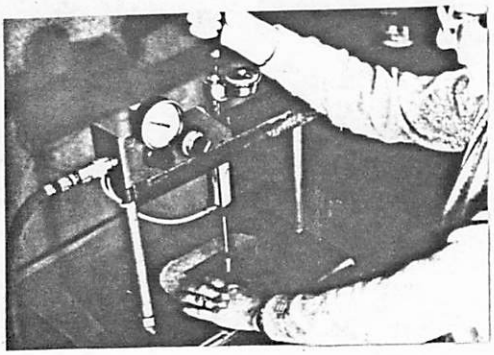
83.

A tentative method to select aggregate quality and gradation for Traffic Count Design uses the Shaker Wear Test (SWT).



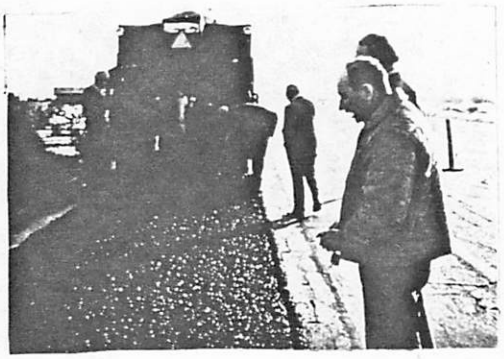
84.

Studies are underway to investigate mix time and mix characteristics of many material combinations under simulated field conditions using a torque transducer and a strip chart recorder.



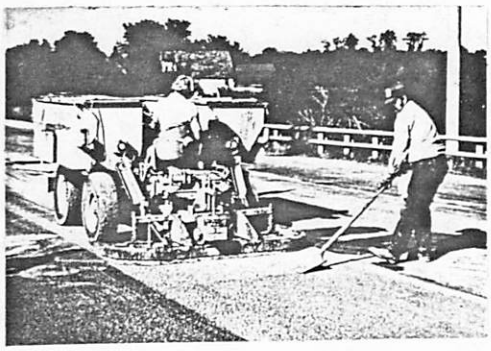
85.

Investigation in both the U.S. and France of set time and traffic times of the new quick traffic systems use this cohesion tester.



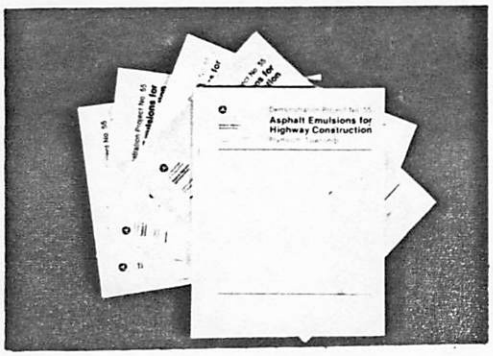
86.

The modification of slurry machines has made possible the development of open graded slurries for leveling courses which show excellent resistance to reflective cracking.



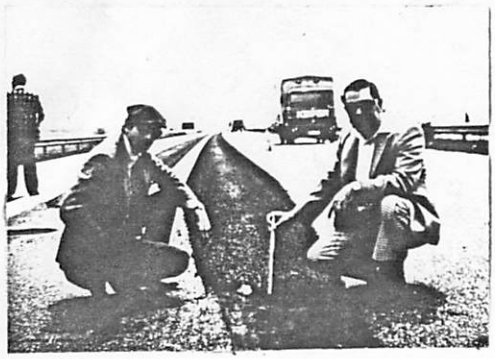
87.

Field trials of non-bituminous binders have been made with latex modified portland cement slurries. Emulsified sulfur slurries are also being investigated.



88.

I.S.S.A. members also participate in the current FHWA Demonstration Project No. 55 "Asphalt Emulsions for Highway Construction ---Slurry Seal". Five projects were completed last year and several more are scheduled for this year.



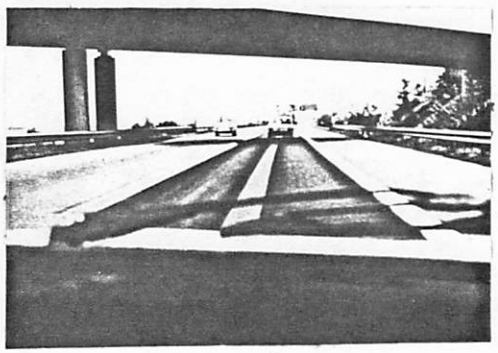
89.

Among the more interesting projects has been the introduction of a low-temperature, quick-traffic, modified system which uses dense graded mixes for filling ruts.

Note that only the ruts are treated, not the entire surface. A 75% material savings is sometimes experienced. Note also that the material sets quickly enough to be walked upon almost immediately and that full traffic is permitted within 40 minutes with no displacement.

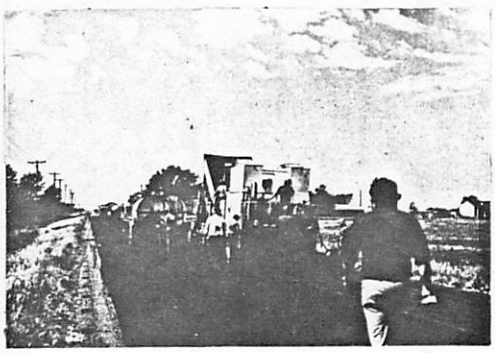
90.

Two passes completed and opened to traffic.



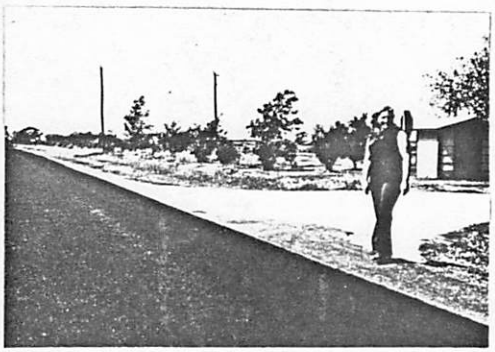
91.

Appearance after a few days traffic.



92.

This past year this German process was Americanized and is shown being applied in Kansas on a full production basis. You will note the special machine required for this production.



93.

After two minutes---2 more minutes and the lady may cross the material without tracking.

This year there will be at least 5 American machines in the U.S.A. capable of applying these and other similar materials.

SLURRY SEAL INCREASES LIFE

SLURRY SOLVES MANY PROBLEMS

ISSA RESEARCH DEVELOPS NEW TECHNOLOGIES

To review, we have attempted to say that:

1. Timely applications of slurry seal will substantially increase the service life of asphalt pavements.

2. Slurry Seal can be designed and constructed to meet the needs of a wide range of maintenance and rehabilitation problems.

3. I.S.S.A. takes a leading role in the development of new technologies to serve the needs of our pavements and the people who pay for them.

Thank you.