New Binders for Better Roads

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Introduction:

Improved pavement performance is a universal engineering goal this presentation will discuss new developments to improve pavement performance an will include:

1. Review elements of pavements.
2. Research on causes of premature pavement failure.
3. Research and technology of improved pavement binders.
4. Precision proportioning equipment and field applications.

1. Review of Pavement elements:

2 ELEMENTS OF PAVEMENTS

1. STRUCTURE-carries the load
2. SURFACE-Protects the structure

fig 1.

2 TYPES OF PAVEMENT DISTRESS

1. STRUCTURAL distress
2. SURFACE distress

fig 2

SURFACE DISTRESS
BECOMES 1
STRUCTURAL DISTRESS

fig 3.

fig 4.

2. Research on Causes of premature pavement failure

The degree of asphalt ductility (stretch) has been recently related to pavement performance.

fig 5.

When measured at the standard 77 F under the ASTM D113 method nearly all paving grade asphalts stretch out nicely to the 150 cm limits of the machine. Because of this, this test at 77 F has fallen into disuse. At lower temperatures, however some remarkable differences occur in new as well as in aged asphalts.

The results of low temperature (39.2 F and 60 F) ductility have been related to pavement performance. Prithvi (Ken) Kandhal and his co-workers at Penn DOT first published the results of a 10 year study beginning in 1961 in a symposium proceedings ASTM-STP 628 "Low Temperature Properties of Bituminous Materials and Compacted Mixtures."

A final report on this work was read by Dr. Kandhal at TRB in January, 1984 titled "Significant Studies on Asphalt Durability" (we have reprinted the preprints of this work for you).

We have summarized the data in this paper and constructed a composite curve titles "the KANDHAL CURVE"

LOW TEMP. DUCTILITY	PAVEMENT CONDITION
ABOVE 10 cm	OK
10 cm	LOSS OF FINES
7-8 cm	RAVELING
5 cm	CRACKING
3 cm	EXTENSIVE CRACKING

fig 6.

fig 7.

The effects of weather have been proved as the primary cause of low temperature ductility (flexibility) loss as subsequent destruction of the pavement. In fact there is a large body of evidence to show that if a pavement could be sealed in a can, sealed away from the effects of weather, that the pavement would last indefinitely.

fig 8.

This photo is an excellent illustration of this fact. This is SR 42 south of London. The overlay was placed in 1967. 7 years later in 1974 strip and spot sealing was placed only in the areas apparent need the center joint and pavement edges. Again, 7 years later in 1981, all that was left was the sealed portion of the pavement.

What has occurred here is a loss of ductility, flexibility or stretch in the unprotected asphaltic binder.

fig 9.

3. Research and Technology of Improved Pavement Binders.

In the late 40's American chemists developed and patented a very special surfactant which made possible the incorporation of polymeric materials into bituminous binders. Asphalt cement then was very cheap at $18.00/ton and the cost benefit ratio of about 2:1 precluded it's use. In the 60's the French adapted and patented their version of this original American Technology ("Sealgum"). Later the Germans refined this same technology (Ralumac). We successfully introduced this European-developed American technology to the U.S. in 1980

This photo shows a group of American contractors on a field inspection of the German system.

fig 10.

Note the thickness of application in wheel ruts and the Quick Set and Quick Traffic ability (3-40 minutes) of this application.

Clearly, materials with better stretch give outstanding performance.

This is a photo of a street in Frankfort, Germany renamed for president Kennedy "Kenedy Aller" which has been in service for 8 years of 50,000 ADT. These materials have performed so well that in many cases they have replaced conventional overlay materials.

fig 11.

These materials succeed so well because of these factors:

Aggregate chemical type and quality
Aggregate quality
Aggregate gradation
Asphalt chemical type
Asphalt quality
Asphalt modification with elastic & polymers
Precision Proportioning of 6 ingredients
Complete and Rapid mixing and application

fig 12.

From this list one can easily see that the materials required for the German and other similar foreign systems require materials that are not locally available.

Our research approach for the past 2 1/2 years has been to develop better products while using totally American wide-range materials and technology.

The following are trends we're experiencing in our development work to date:

fig 13 A 5 to 20-fold increase in the low temperature ductility

fig 14. Ring & Ball Softening Point

fig 15 Most adhesion, cohesion and abrasion loss is greatly improved

fig 16 WET COHESIVE STRENGTH DEVELOPMENT

fig 17. AIR PERMEABILITY (SEALABILITY)

fig 18. TOUGHNESS and TENACITY OF THE BINDERS

fig 19 MARSHALL STABILITY & FLOW

Though many of these materials are field proven during the past 2 seasons, research continues to develop still better products that last longer for sealing and thin overlaying of your pavements!

We operate our own research and design laboratories near Alpha, Ohio and invite you to visit us.

4. Precision Proportioning Equipment and Field Applications

These systems are essentially chemistry and require precision proportioning of each ingredient and rapid, thorough mixing and placement.

To accomplish this requires a new generation of machines. American industry has been quick to respond to this need so that today there are seven manufacturers of the necessary machinery in the U.S.A. We have developed our own prototype machine called "Meter Master™ I" shown here applying a metromac™ slurry surface in Harrison Township in 1983. Note the control panel instrumentation where each of the material ingredients are metered for rate of flow as well as metered totals. Inspection calibration and quantity verification is simple and reliable. The use machines are not only imperative in the material systems, but also can improve convention material mix applications.

Note also the mix uniformity which is possible only with the unrestricted, double shafted mixer.

fig 20

By way of contrast this shows a segregated mix caused by use of a single-shafted closed tub mixer.

fig 21

In summary we have reviewed the importance of sealing pavement surfaces and have introduced the concept of use of low temperature ductility, high temperature stability modified bituminous materials.

We have included in the handouts in addition to the Kandhal paper, literature introducing the Polymac system as well as set of Metromac specifications.

Please feel free to visit our lab in Alpha at any time or to call us to review your pavements and to discuss these materials.

Thank you.