Proc. AAPT, Vol. 17, 1948. He also included much of this in a book he wrote: "Plasticity as a Factor in the Design of Dense Bituminous Carpets."

QUESTION: Anonymous
Why did you use 73°F as a basis of test temperature?

ANSWER:
Convenience and availability of a constant temperature room. The nearby wax laboratory had an environmental chamber operating at 73°F.

QUESTION: D. Tunnicliff - Warren Brothers Company, Cambridge, Massachusetts
On the last slide you had, I noticed in particular asphalt-treated mixes. Are you talking about what most of us refer to as 'asphalt concrete' or something else?

ANSWER:
I refer to asphalt-treated mixes because that includes hot mixes as well as emulsion or cutback treatments. Although (in the particular slide in question) they were hot mixes, emulsion-treated mixes behave the same as hot mixes once they have dried out. Cement or lime treatment improves the water resistance of all asphalt-treated mixes. Cement is very effective with emulsion-treated mixes but less effective with hot mixes. Lime is better with hot mixes and less effective with emulsion-treated mixes.

I should emphasize that all of the moisture and freeze-thaw damage that we illustrated is reversible. As soon as the damaged mixes dry out, they recover their strength.

QUESTION: Anonymous
You feel moisture can come and go? Suppose we built a pavement with black base with 2 percent moisture in it. Is this the most it is ever going to dry out?

ANSWER:
I don't think it makes much difference to the final equilibrium. If the mix is permeable, it will either lose or pick up water, depending on the humidity of the air in contact with the mix. If it is impermeable, then it is more likely to retain its original moisture content.

INFLUENCE OF MOISTURE AND HOW MUCH YOU HAVE TO CONTROL IN A CONVENTION PLANT

Bill L. Kellam, Thompson-Arthur Paving Company
Greensboro, North Carolina

There are basically five physical properties that are required of asphaltic concrete mixtures produced in a hot-mix plant:

(1) Stability - The resistance to displacement and shearing stress caused by traffic loading.
(2) Durability - The resistance to changes in the pavement due to water, air, and temperature changes. Some qualities that complement its durability are its resistance to wear or abrasion, swelling, stripping and oxidation.
(3) Flexibility - The ability of a pavement to adjust to settlement of the base without cracking.
(4) Resistance to skidding - The frictional resistance of the surfaceof the pavement to insure safe driving and stopping of the vehicle. This is controlled by the surface texture and resistance to wear of the aggregate as well as the asphalt content of the mixture and per cent of voids in the mixture.
(5) Workability - The ease with which the material can be placed to the desired uniformity and compacted to the required density. This is governed by the gradation of the mixture, asphalt content, maximum particle size, temperature of the mix and the shape and surface texture of the aggregate.

This discusses and evaluates methods of producing asphaltic concrete with more moisture in the final product than is presently being allowed by conventional specifications, without greatly effecting the characteristics.

Most of my experiences with plant operations involving moisture have been with highway departments and governmental agencies whose specifications usually allow 0.2 percent to 0.5 percent moisture by weight of aggregate.

The drying and heating of the aggregates is accomplished by feeding or passing the aggregates through a drier which consist of:

(1) A revolving cylinder usually from 3 to 10 feet in diameter and from 20 to 40 feet long.
(2) A burner, which is either gas or oil fried.
(3) A fan which may be considered part of the dust collector system, but its primary function is to provide the draft air for combustion in the cylinder. The cylinder is equipped with longitudinal cups or channels, called "lifting flights", which lift the aggregates and drop them in veils through the burner flame and hot gases.

The slope of the cylinder, its speed of rotation, diameter, length, and number of flights control the length of time required for the aggregates to pass through the drier to be heated and dried to the desired temperature and moisture content. The aggregates pass from the drier to the hot elevator through a discharge chute near the burner end of the drier.

It has been found in our area that mix features change when the moisture content of the heated aggregates exceed the 0.5 percent to 1 percent range.

(1) The temperature of the mixture drops appreciably, often enough to exceed the allowable tolerances set forth in the specification requirements.
(2) The mixture appears to have minute water or steam bubbles on the coated aggregate, particularly in base and binder mixes, and gives off a frying or sizzling sound.
(3) On extraction the asphalt content will be on

the upper side of the amount specificed for the job mix formula due to the loss of moisture in the sample. In some cases, the maximum allowable tolerance of 0.3 percent to 0.5 percent of asphalt from the amount specified for the job mix formula is exceeded depending on the percentage of moisture in the mix.

(4) During the hauling of the hot mixture from the plant to the project, some of the surface moisture is lost. When the mixture is dumped into the truck from the pugmill, it tends to slump in the truck if excess moisture is present. Slumping occurs when moisture, in the form of steam, escapes from internal voids in the aggregate. Bubbles form, which are trapped in the mass, and tend to cause the mix to be liquified.

(5) In most instances involving spreaders and their operation that bear on handling mixes with different workabilities due to moisture and other factors, finer mixes such as surface course and sand asphalt tend to snag or tear behind the spreader. This requires fanning or scattering fresh mix over the torn areas. Even when this is done it can cause additional irregularities by coarsening the surface or creating small bumps.

To reduce bubbling and slumping of the mixture, when the moisture is escaping, silicone can be added to the asphalt cement. For example, the dosage of about 1 oz of DC200 per 5000 gallons of asphalt is added to the hot asphalt storage tank or supply tank.

One theory related to lay down of the mix is that the silicone coats the screed and makes it slide or glide over the mix without tearing. Another explanation is related to the moisture escaping from the mix, this is that the bubbles so formed increase the volume of the mix and this forces it against the screed to the point of tearing. The silicon tends to depress the formation of bubbles and hence improves laydown in most mixes that are tearing.

There is a danger in using too much silicone because higher dosages result in asphalt mix that is soft and tender when compacted.

DISCUSSION: "Influence of Moisture and how much you have to Control in a Convention Plant"

B. Kellam - Thompson-Arthur Paving Co.

COMMENTS: L. C. Krchma

The conventional plant obviously has problems by preconception; namely that there must be a low percent moisture. Obviously if we didn't have to dry in a conventional plant as much, the emissions would not be as high and fuel demand would be lower. So, it is worthwhile considering whether or not the moisture requirements are realistic. Our speaker suggests that on occasion when they have laid mixes with higher than two tenths or five tenths moisture, and that the job went down right and the job performed properly. Any questions?

QUESTION: Mr. Coolidge - Warren Brothers (Maine District)

What method was used to determine the percent of moisture in the mix itself?

ANSWER:

They go out and take a sample, which can pick up moisture from the time they get it out of the hot elevator until they get it to the lab - weight it and redry it. It usually will run about one to two tenths percent by weight of the aggregate. Now, if the humidity is high, it can pick up another tenth or two from the time they get it from the plant to the lab, which is on the same site - maybe 50 to 100 feet apart.

QUESTION: Vaughn Marker - The Asphalt Institute, College Park, Maryland

Are the aggregates in North Carolina more absorptive to start with?

ANSWER:

Most of them are granite-base aggregates, which are good aggregates. They are not highly absorptive. We have a seal coat mix we might discussed. It is strictly a 3/8" top-size and liquid asphalts are the binder. This stone can be heated only to 250°F temperature to remove some of the internal moisture discussed earlier by Lottman. We have good success with this.

QUESTION: Anonymous

What about the minute bubbles that appear in the mix at the time?

ANSWER:

This arises when there is excess moisture and the materials are not thoroughly dry. You can see it in the truck; it tends to become liquified. You can hear it sizzling. Usually when you stick a thermometer on the side of the truckload - that load goes "over the bank" because it is below the 250° minimum of the specifications.

QUESTION: L. C. Krchma

The mix that's leveling in the truck - is it segregating? Is anything wrong?

ANSWER:

No. At this particular state the mix was not segregating. It could be used.

QUESTION: L. C. Krchma

But this does say that the moisture requirement was imposed for some reason. It would appear that we should have some other way of regulating the amount of moisture than simply 0.2 to 0.5 percent?

ANSWER:

That's true.

QUESTION: R. J. Schmidt - Chevron Research, California

I have the impression from your discussion that your problem with moisture is one of meeting specifications rather than a problem resulting from excessive moisture.

ANSWER:

There are no problems as long as the temperature is up, because then the moisture is below 0.5 percent. We have produced mixes for our own roads with 3/4 to 1 percent moisture out of the dryer and cored samples for density, etc. and have found no problems other than the bubbles in the truck.

QUESTION: R. J. Schmidt

That's not an actual problem, is it?

ANSWER:
No. That just scares you. It is a visual scare. It is not detrimental to the pavement.

QUESTION: Anonymous
What are they looking for when they are questioning you about your moisture? Are they expecting 6 months from now is it going to ravel, push, shove, or what have you?

ANSWER:
I think the State of North Carolina's main concern is ravelling of the mixture with the moisture in it. They like to keep you down to around 0.2 to 0.3 percent moisture in the aggregate.

QUESTION: L. C. Krchma
Have they confirmed that ravelling occurs when you exceed that 0.2 - 0.5 percent?

ANSWER:
To my knowledge - they haven't.

QUESTION: Herb Schweyer - University of Florida, Gainesville, Florida
Is there any documented proof that a mix with 5 percent moisture in it does cause problems?

ANSWER:
To my knowledge there is no documented proof as to what causes the problems. If they had 1 percent, 1/2 percent, 0.2 percent - you could take a mix of 0.2 percent and be subject to ravel just as much as a mix with 5 percent that was laid under the same conditions.

QUESTION: L. C. Krchma
Do you really mean 5 percent?

ANSWER:
That's what he said. He said 5 percent. At 5 percent it is going to run out of the truck with asphalt; it's not going to be there. But, to my knowledge, there is no documented proof that the moisture causes it to ravel.

ASPHALT PAVING MIXTURES -- DRUM DRYER

R. L. TERREL

ABSTRACT

The dryer-drum mixing process can accommodate a wide range of apshalt mixtures, particulary regular hot-mix asphalt concrete. The system includes a cold feed unit for aggregate which goes directly to the drum at which point the asphalt is added. Blending and heating takes place in the drum and mixtures with temperatures ranging from 180° - 300°F are produced. The asphalt is aged less than the conventional plants and well-coated mixtures are readily compacted at low temperatures because of the moisture present. In addition, stack emission of dust is reduced considerably.

INTRODUCTION

The manufacturing and placing of hot asphalt mixtures has become a standardized and routine process for most producers throughout the world. Consumers such as state and federal highway departments, as well as private developers, have come to trust the product of well-controlled plants operated by conscientious producers and contractors. Unfortunately, this state of affairs was established many years ago and very little has been done to modernize the technology of asphalt paving at a rate consistent with other contemporary industries.

Many years of experience have taught the engineer and contractor that several basic steps are necessary to produce high quality mixtures. Basically, these include the following:

1. production, handling, storage and measurement of materials;
2. heating and drying of aggregate;
3. mixing the materials; and
4. transporting, placing and compacting.

During the past several years, however, through research and experience developed in the Pacific Northwest and elsewhere, it has been shown that the total production system may be simplified considerably without sacrifice of quality or production. In this paper the author attempts to describe briefly a new process for manufacturing asphalt paving mixtures using the dryer-drum or Shearer Process as developed by Pavement Systems, Inc. of Seattle, Washington. This drum mixer type of plant is now being manufactured and marketed under license by the Boeing Construction Equipment Company, Seattle, Washington.

BACKGROUND AND SCOPE

Blending of asphalt mixtures in a revolving drum is not a novel idea, but its history is not well documented. K. E. McConnaughay Co. of Lafayette, Indiana has produced emulsion mixes under a patent for several years and also holds a patent on a similar process for hot mixes. Prior to this in 1959, however, the Asheville (N.C.) Paving Company [1] attempted to promote the production of paving mixtures using the dryer from a conventional plant.

In West Germany, a "dust free" asphalt is being marketed by the Wibau Company. In this plant the materials are blended first with a pugmill and then heated in the dryer-drum or activator. Both this process and the one of McConnaughay's [2] utilize chemical admixtures to promote coating and adhesion. To the author's knowledge, the success of the processes discussed above has not been reported in technical journals, but rather, this information is of a proprietary nature.

The Shearer Process (patent pending) was developed beginning in late 1969 with modifications of standard plant components, and several concepts which appeared to be vital to the needs of the paving industry. These include at least the following: (1) overall reduced cost through higher production rates with lower equipment and production costs; and (2) improvements in the control of dust and other stack emissions in order to become more compatible with new environmental controls now in vogue; and (3) decrease in move and set-up costs of portable plants due to mobility and less equipment handling.

The first testing by an outside agency of the Shearer Construction Company plant was conducted in July 1970 and sponsored by the National Asphalt Pavement Association. Although results of these tests were not published in total, the basic conclusions were presented by Foster (3) of that organization. Further evaluation of the process