

QUESTION: Anonymous

What was the aggregate absorption on that last slide that had about 2 percent residual water, and were these paved under traffic conditions?

ANSWER: Terrel

From memory, I believe the aggregate absorption averaged about 3 percent. It was glacially deposited volcanic material with a mixture of dense granitic material and pumice, which is quite porous. The project was paved under traffic conditions. It was a private logging road and traffic was permitted on the fresh mat within four hours after laydown. Traffic consisted primarily of 5-axle, 150 kip logging trucks spaced at 2 to 3 minute intervals, 24 hours per day.

QUESTION: Anonymous

Did the water content in the mix exceed the absorption of the aggregate?

ANSWER: Terrel

I don't recall, since I didn't bring that information with me. Furthering my comment on traffic conditions, there have been quite a variety of projects using drum mixers. Extreme environments have been encountered from Arizona to Nome, Alaska. Rural highways and Interstate Projects have been completed, but I can't recall any major urban paving. In total, quite a few million tons have been placed to date.

HAULING, SPREADING, AND  
ROLLING - CONVENTIONAL MIX SYSTEM  
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From my Northern Maine observations, I feel qualified to state that a reasonable amount of moisture in bituminous concrete does not seriously effect the operations of hauling, spreading and rolling this product. After I had written that statement I sat back and discovered that it really wasn't profound; in fact, I suspect that among pavement engineers and contractors that is reasonable accepted knowledge. Based on recent papers and on Charlie Foster's statements to Committee A2F02 of last year, we know that moisture in mixes manufactured in "Drum Mixers" is acceptable and, in fact, perhaps even necessary. However, these considerations posed two additional questions to me.

1. What is a reasonable amount of moisture?
2. Can moisture contents be readily determined in the field and at what point should the control be established?

My experience is that gained from observations made at our Northern most plant location in Caribou, Maine. As a construction engineer, and later as a construction superintendent, I have lived or travelled in the New England States, New York and the Middle Atlantic States and I felt that this range of experience made me qualified to observe and reasonably rate the quality of construction raw materials. The first time I was able to see typical Aroostock County Gravel I knew my experience had just included the lowest quality range of gravels.

Our aggregate processing plant was a multi-wash on both fine and coarse aggregates with special adaptations designed to remove soft pieces of aggregate not destroyed in the crushing process. The bituminous plant when originally set-up had one

dryer, designed I suspect for average drying conditions. It was almost immediately that a second dryer was purchased in order that even a minimum production level could be maintained.

However, after all this aggregate preparation and drying we still produced bituminous concrete, on occasion, with excessive moisture.

Hauling wet bituminous concrete, I use the term loosely, presents no problems. Depending, on the amount of moisture, the load might flatten in the truck. Other times free water would run out of the tailgate. The haul distances would usually affect its physical appearance.

As far as I have observed the spreading of high moisture bituminous concrete required no special adjustments or considerations. The most notable occurrence was numerous blisters that would form most frequently in the middle of the mat. When the material is augured to the side, then most of the moisture was freed. These blisters would quickly subside and leave no trace.

Rolling did not require special tactics. The only consideration would be to hold back until all blistering had ceased. This usually occurred within a few minutes after laydown.

The paradox that I now find puzzling concerns the pavement in its final position. Does it in fact contain moisture in excess of 1/2 or 1 percent. I know the aggregate had moisture in it for I have seen steam rising from hot bins. On occasion I have actually seen water dripping from those bins. I have seen loads level out in trucks. I have seen water drip from loaded trucks. I have seen steam escape from laydown mats. From this it appears the moisture content was high though we did not collect the confirming data. Yet after all these adverse situations I now seriously doubt that in our final mat we exceeded 1 percent moisture.

From observations I conclude that as long as bituminous concrete can be spread and rolled in the conventional manner, then the moisture content should not be a restrictive specification.

DISCUSSION: Duncan McCrae's presentation -- "Hauling, Spreading, and Rolling - Conventional Mix System"

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

I do not usually associate slumping in the truck with the problems of tearing under screed. Did you observe this, and did you use silicone in your asphalt?

ANSWER:

No. We did not use silicone but with Kellam's talk about it this morning, I am going to look into it. We do use silicone in making certain of our cold mixes - at least in the summer time. But the workability was excellent. We never had a tender mix; we never had any experience with tearing, except when you let the temperature get down. It is necessary to work these mixes, in general above 275°; better around 290° to 300°. As the temperature dropped under 275°, the spreading was more difficult and it was more obvious there was some tearing. In the normal temperature range it worked very well. I think this might just be true of a gravel aggregate. When we moved out of the gravel and into the quarry stone the mix did not

spread and handle quite as nicely as the nice, smooth rounded pieces of gravel.

QUESTION: C. Parker (Gorham, Maine)

What has been the durability of these pavements using the type of gravel aggregate you have described?

I know that you had some interesting Marshall stability values, using these aggregates. Will you tell us about the values obtained?

ANSWER:

To answer the question on durability - I think the durability was quite good. There are pavements up there in Maine right now, made with these types of aggregate and never sealed, that are 20 years old. Yes, they have wheel ruts in them, etc., etc., but the pavement does not look too bad. The thing that really detracts from the quality of this pavement is that within two seasons the surface appears as if it has been sandblasted. Still it doesn't seem to deteriorate after that. In this very rough surface you can observe a certain amount of stones (I had experience with them in concrete) that can be called pop-outs, where apparently they either had moisture in them or they have absorbed moisture and expanded and popped out. I don't know much about the Marshall design methods in answer to Mr. Parker's second question. We had an FAA contract there. We had a difficult time making anything fit but we had stabilities in the range of 4,000 and the density of this material is greater than the density of concrete.

QUESTION: Clinton Coolidge - Warren Bros., Fairfield, Maine

What experience did you have with testing agencies as to what moisture they found in these materials and the method they went about doing this?

ANSWER:

I talked with the Maine Department of Transportation. That plant had been operating in gravel, typical gravel, for approximately 16 years before I went up there and I am sure that somebody in the State Department of Transportation and in perhaps the Federal Bureaus, spent much time trying to figure how you can make better gravel out of something that is just there. You can't really do it and the State of Maine does not specify allowable water count. I always felt that they were working on a basis of 1/2 of one percent and, just from recollection, they found great deviations as Lottman said earlier. They also found deviations in the temperatures of the various aggregates in the hot bins. Still I don't think they ever convinced themselves that there was excessive moisture in the final mat.

SYNOPSIS OF PAUL SERAFIN'S PAPER  
EFFECT OF MOISTURE IN BITUMINOUS  
MIXTURES AS EXPERIENCED IN FIELD  
PAVEMENT OPERATIONS IN MICHIGAN  
given by

Frank M. Drake, The Asphalt Institute  
Lenexa, Kansas\*

HISTORICALLY

In 1951 Michigan Highway Department made a moisture study of mixtures where the contractor was experiencing difficulty in laying and rolling. During this investigation, it was apparent that very small amounts of moisture 0.05 percent or more were causing the problems. At this time moisture content requirements were lowered to 0.05 of one percent.

The following season all possible adjustments were made on the plants to effect moisture contents that would comply with the new restrictions. Further, the use of additives were tried to reduce foaming and deter the chances of stripping due to the presence of moisture.

Associated with these studies it was noted that a change in sand gradation from the traditional high percentage in the middle of the gradation to a uniformly graded sand appeared to offer more tolerance to the residual moisture in the resulting mix without causing problems. Further improvements in mix design such as reducing the material finer than the 200 mesh sieve from about 6 or 7 to 4 or 5 percent, also resulted in further tolerance of the mixture to moisture. It was also during this period that the contractors were replacing worn-out equipment. This probably was the biggest factor in Michigan that helped correct the moisture situation to a point where today this type of problem is almost non-existent. This, we feel, is attributed to more uniformity in the mixture produced by the more sophisticated equipment. Periodic investigations by the Michigan Highway Department indicate that when cores are extracted during the wet part of the season or when a pavement was recently submerged in water, stripping is apparent. However, it is also noted, even though stripping is present, there is no adverse effect on the performance of the pavement. When the same pavements have been cored in dry seasons, stripping seems to disappear.

In summary, the contribution to this conference would be that the experience in Michigan is that the critical moisture in a given pavement in regard to performance would depend on materials and mix components. However, in most cases that amount would be well above the moisture content tolerable through the construction operations and procedures. Or if the moisture content is held below the level critical to construction operations, there should be no detrimental effects of moisture on performance. Different aggregates will produce different performance.

QUESTION: L. F. Erickson - Idaho

Can you tell me whether these were limestone aggregates or siliceous aggregate?

ANSWER: Drake

I think these were largely siliceous aggregate. I believe this is primarily what Michigan has.

QUESTION: Anonymous

How about Kansas?

ANSWER: Drake

In this area that I speak of, the aggregate is siliceous also.

\*Paul Serafin's paper was not presented in full at the session but is published here.