

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.