To: Mr. H. R. Creal
Assistant State Highway Engineer

Re: Proposed Specification Class I, Type C
and Blade Spreading Hot Mixes

Following the May 24, meeting of the Specifications Committee you
and I discussed briefly some diagrams showing the comparative gradation
between other mixes and the proposed Class I, Type C, surface mix, and
you asked that we prepare some information for members of the Specifica-
tions Committee showing the effect of the proposed limits. In the process
of doing this we accumulated data on mixes used by some other states, and
gradations of some mixes that have been used here in our state. Finally,
some data on blade spreading of hot mixes in Houston, Texas were obtained
by correspondence. This memorandum contains the essence of material we
have collected on these subjects.

Gradation of Dense Graded Mixes

The accompanying illustration, Fig. 1, shows the gradation ranges
of our present Type B (shaded red) and our proposed Type C (shaded green)
mixes. Of course they overlap greatly, and it is only at the finer sieve
sizes where the divergence is appreciable. The Type C gradation would
provide for greater density not with just additional material passing
the No. 200 sieve, but with more stringent requirements from the No. 16
on down.
As a matter of comparison, the gradation of mixes used by the City of Louisville (outlined in their specification for "Hot Mixed Asphaltic Materials and Construction of Hot Mixed Asphaltic Pavements") is shown in Fig. 1. Although this was not a part of the original consideration by the Specification Committee, it was found to be the principal difference between our mixes and those used by the City of Louisville. This was reported recently to a special committee studying the possibility for lowering the penetration grade of asphalt used in our mixes on projects in and about Louisville.

Also shown in Fig. 1 is the average gradation of three samples taken from the existing Class I surface on South Limestone Street in Lexington. That pavement, which is a part of U.S. 27, begins at Euclid Avenue and goes Southward to the City Limit. It was placed by a state contract with the Lehman-Roberts Company in 1944, and I recalled seeing some information to the effect that it was densely graded and probably included portland cement as the mineral filler. This information could not be found, so samples were cut from the pavement in three separate spots, and extraction and gradation tests were run on the samples.

You will note that the average gradation for these three samples is close to the upper limit of the proposed Type C, particularly in the upper and lower ranges of sieve sizes. The appearance of this pavement, and its present condition throughout (except where restoration of utility cuts has been poor) indicates that a dense gradation can provide good lasting qualities and at the same time the pavement need not be slick.
This question of slippery surfaces in conjunction with denser gradation (especially with as much as 12 per cent passing the No. 200 sieve) led to comparisons with gradation ranges used by other states, and inquiries as to whether they had slippery surfaces or limited their mixes to any particular regions in their states. Fig. 2 shows typical gradation curves from several states in their relation to our Type B and proposed Type C ranges, and it also gives tabulations of the ranges in percentage passing the No. 40 and No. 200 sieves for the various states including Kentucky. You will note that Kansas and Virginia provisions exceed our proposed Type C in percentages passing both the No. 40 and No. 200, and Michigan exceeds it at the No. 40 but drops to a lower percentage at the No. 200. The peculiar gradation of the Michigan mix is probably a means for increasing workability; I don't see how it could be much denser than our present Type B mix.

Ohio does not provide for any greater amount of fines than we call for in our present Type B, but the appearance of their pavements indicates that they must have a percentage of material passing the No. 200, which is usually up toward 5, whereas our Type B is usually close to 0. Some of their durability may be in a tighter specification for the asphalt cement also. Virginia was the only state which specifically replied that they did not impose any regional limitation on the use of their dense-graded mix, but none of the other states mentioned that they did have regional limitations.
Not only do these data indicate that non-slippery surfaces can be made with dense graded mixes having a relatively high percentage of fines passing the No. 200 sieve, but information developed by the Corps of Engineers at the Waterways Experiment Station a few years ago showed the same thing. If the mix is made dense, it is important to keep the bitumen content such that voids will not be filled to the extent that bituminous material is extruded to the surface as the pavement increases in density which it may do under traffic. The same thing could have happened with our Type B mixes if the bitumen content had not been regulated correctly. With the new Type C it would be a matter of adjusting the plants to these new circumstances. I doubt very much that this could be controlled easily if it were suddenly started state-wide, but if it were started on a few Federal Aid jobs (which apparently was the conclusion reached in the May 24 meeting of the Specifications Committee) then I am sure that slippery surfaces could be avoided.

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"Investigation of the Design and Control of Asphalt Paving Mixtures"; Department of the Army, Corps of Engineers, Mississippi River Commission; Technical Memorandum No. 3-254, Waterways Experiment Station; Vicksburg, Mississippi; May, 1948.
Introducing Fines at the Mix Plants

During our investigations of the streets in Louisville, some attention was given to the method of introducing Mineral Filler to the mixes, since that was one of the questionable features brought up by Plant Mix Association representatives. The Louisville Specification for Mineral Filler and ours (See p. 459 of the 1945 Standards) are almost identical with respect to size requirements. These are as follows:

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<th>Louisville</th>
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<tr>
<td>Pct. Passing No. 30</td>
<td>100</td>
<td>100</td>
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<tr>
<td>Pct. Passing No. 80</td>
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<td>95</td>
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<tr>
<td>Pct. Passing No. 100</td>
<td>85</td>
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<tr>
<td>Pct. Passing No. 200</td>
<td>65</td>
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Our specification is a little more specific in stating what is acceptable as filler. Essentially we are on the same basis.

The attached photographs labeled Fig. 3 to Fig. 5 inclusive, show the arrangements at two plants which have produced or are producing hot mix under the Louisville Specification. The manner of introduction here is somewhat different from that which was outlined at the Specifications Committee meeting, whereby material from the dust collector — or the Mineral Filler as a separate constituent — could be introduced at the bottom of the hot elevator. Some plants are equipped for this, and I believe that Corum and Edwards for one has a plant with such an arrangement in conjunction with its dust collector.
As noted in Fig. 5, the Bickel plant does have some provision for warming the filler before it is introduced into the mixer; at the Eady plant, filler is introduced cold. Apparently this is considered satisfactory in the Louisville mixes, but it is obviously better if all the aggregate fractions could go into the mixer at about equal temperatures. These photographic illustrations are presented as further evidence that means for introducing fillers have been worked out. I believe that filler materials such as those being used in Louisville would be satisfactory for use in our proposed Type C mixes, but in my opinion some means of heating should be available and to the best of my knowledge introduction at the bottom of the hot elevator is best for this purpose.

Spreading Hot Mixes With A Blade Grader

Inasmuch as the use of a motor petrol grader for spreading Class I binder has been specified for a project on S.P. Group 21 (1951) in Nicholas County, the information we have obtained on this subject through correspondence may be superfluous. However, considerable time and effort has been given to the subject, and it is worth recording.

Three different photographic illustrations labeled Fig. 6 to Fig. 8 inclusive are attached, all of them pertaining to a project of widening and resurfacing on Navigation Boulevard in Houston, Texas. This was illustrated in an advertisement on the cover of
the May issue of Roads and Streets, and I obtained further information concerning the project from Mr. D. C. Arnold, with the Houston Division of the Texas Company. This was not a Texas State Highway Department project, but Mr. Arnold stated that the practice has been used by the Highway Department in that State.

Apparently the mix contained 55 penetration asphalt cement, which should make spreading of the mix more critical than it would be with our materials containing 85-100 or higher penetration asphalt cements. Some of the comments were as follows:

"The mix is put down at approximately 325°F. The level up course is spread with a No. 12 Caterpillar Maintainer, which should be in good tight mechanical condition.

"The blade spreading is done with as little as a truck-load of mix at a time and a skilled blade man can spread 70-80 tons per hour over old asphalt or brick pavement in layers of 3/4" to 1½".

"Three wheel and pneumatic rollers only are used on the level up course for density. Tandem rollers are not necessary except for wearing surface which is put through a mechanical spreader.

"For your information the use of a blade maintainer in placing level up course of hot mix over an old irregular pavement is quite common on contract work for the Texas Highway Department using 85-100 penetration asphalt."
In my opinion all of those things warrant consideration by the Specifications Committee, although some of them may be more closely related to practices or policies rather than Specifications. At any rate, this summarizes the information we have accumulated on the subjects discussed at the May 24, meeting.

Respectfully submitted

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Fig. 1. Gradation curves showing the ranges of aggregate gradation permissible for Class I Type B surface (shaded red) and proposed Type C surface (shaded green) mixes. Included also is the range of gradation for Bituminous Concrete mixes specified by the City of Louisville, and a single curve representing three samples taken from South Limestone Street on U.S. 27 in Lexington.
Fig. 2. Gradation curves showing the ranges of gradation for Class I Type B (shaded red) and proposed Type C (shaded green) surface mixes, and representative curves for dense-graded bituminous concrete surface mixes in four other states. Note tabulated values for percentages passing the No. 40 and No. 200 sieves provided in specifications from the different states.
Fig. 3. George M. Eady Plant, 340 Byrn Avenue, Louisville. General view of the plant showing position of intake hopper and elevator for conveying mineral filler to a bin on the batch plant. Bagged or bulk material is dumped into the intake hopper which is at ground level on the far right, and from there the filler is carried upward to the storage bin—shown plainly in Fig. 4.
Fig. 4. George M. Eady Plant, 340 Byrn Avenue, Louisville. Near view of bin and electrically driven screw feed mechanism for introducing filler material into the mixing chamber. The filler, at air temperature, is weighed into the mix.
Fig. 5. Henry Bickel Company Plant, 1613 S. Sixth Street, Louisville. Here trucks back up to the pit just inside the double doors on the right, and empty filler inside the shed for storage. The enclosed elevator (not seen in this photograph) brings mineral filler to a bin surrounded by heated aggregate. From there filler is taken by gravity feed into the batch. All components are weighed.
Fig. 6. Condition of Brick Pavement on Navigation Boulevard, Houston, Texas, Before Widening and Resurfacing with a Hot Mix Containing 55 Penetration Asphalt Cement.
Available information indicates that this machine should be in a "good tight mechanical condition", and the operator should be exceptionally skilled. A spreading temperature of 325°F. for this mix with 55 penetration asphalt is the maximum permitted for our Class I mixes, but any temperature from 250°F. to 300°F. is logically adequate for this operation when the asphalt is 85 to 100 or higher penetration.

Fig. 7. Blade Maintainer Spreading Hot Mix Binder Course Containing 55 Penetration Asphalt Cement.
Fig. 8. View Showing the Finished Condition of the Widened and Resurfaced Pavement on Navigation Boulevard in Houston, Texas. The photograph is not distinct enough to show details of the finished pavement so it is not possible to judge contour or riding quality. The texture and uniformity of the surface should be equal to any other similar pavement since the surface course was placed with the conventional type of spreader or finisher.