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AN INVESTIGATION OF THE RECENT DETERIORATION OF I-75 IN SCOTT COUNTY

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EXECUTIVE SUMMARY

In early January of 1999, approximately 15 miles of I-75 in Scott County began to rapidly deteriorate. The existing pavement exhibited several potholes and delaminations. The worst section of deterioration fell approximately between milepoints 125 and 133.

In the latter part of January, the condition of the highway had declined to the point that corrective action was necessary. The worst sections were milled and patched with hot-mix asphalt (HMA). Despite this temporary improvement to the pavement condition, a desire developed within the Department to investigate the cause of the deterioration in order to prevent a future similar occurrence.

Therefore, personnel from the Division of Materials and the Kentucky Transportation Center conducted an abbreviated investigation of the deteriorating pavement and the asphalt mixtures involved. The findings from this investigation, including analyses of the historical data for these mixtures and testing of the in-place pavement, revealed several possibilities for the premature pavement failure.

These possibilities included questionable quality of the aggregates in the mixtures, low asphalt contents and high dust contents, poor volumetric properties of the mixtures, and low in-place densities and high permeability of the existing pavement. It was concluded that no single deficiency caused the failure, but rather, a combination of several factors.

A companion section of I-75 immediately south of the deteriorated Scott County portions, constructed about one year prior to the pavement presently in question, continues to perform well. Investigation of this pavement and the involved asphalt mixtures revealed higher asphalt contents, better volumetric properties, higher in-place densities, and lower permeability.

It is believed that recent revisions to the applicable asphalt mixture specifications have all but eliminated the possibility of the recurrence of this type of failure. Mixtures designed currently under the Superpave system undergo greater scrutiny and must satisfy tougher specifications. Also, asphalt mixtures are accepted differently today than when this pavement was originally constructed. It is highly unlikely that the mixtures that are currently deteriorating on I-75 could satisfy today's specifications.

AN INVESTIGATION OF THE RECENT DETERIORATION OF I-75 IN SCOTT COUNTY

INTRODUCTION AND PURPOSE

In early January of 1999, approximately 15 miles of I-75 in Scott County began to rapidly deteriorate. The existing pavement exhibited several potholes and delaminations (Figures 1 – 3). The worst section of deterioration fell approximately between mileposts 125 and 133. In this portion, the potholes and delaminations were more numerous. It appeared that many of the delaminations were associated with the construction joints.

This section of I-75 in Scott County had exhibited similar deterioration, on a smaller scale, in the past few years. These isolated areas were patched effectively, but in 1999, the damage increased at a much faster rate. The deterioration accelerated after a series of minor snowfalls in late December and early January. Undoubtedly, the repeated snow-removal treatments applied to the pavement during this period played a role in accelerating the deterioration.

In the latter part of January, the condition of the highway had declined to the point that corrective action was necessary. The worst sections were milled and patched with hot-mix asphalt (HMA). These patches continue to perform satisfactorily to date. Despite this temporary improvement to the pavement condition, a desire developed within the Department to investigate the cause of the deterioration in order to prevent a future similar occurrence. The purpose of this report is to relate the findings of that abbreviated investigation.

Figure 1. Delamination and Potholes on I-75.

Figure 2. Showing Debonding of the Two Surface Lifts

Figure 3. Cores Being Taken in Outside Lane in Delaminated Area.

MIX-DESIGN PHILOSOPHY IN EARLY 1990'S

In order to fully understand the condition of the existing pavement, it is necessary to consider the circumstances under which the asphalt mixtures were originally designed. The pavement in question on I-75 in Scott County was designed in the early 1990's. During this period, a particular philosophy was being practiced within the Department regarding asphalt mixture design approvals. Due to the occurrence of several "flushing" pavements during this time, the philosophy for selecting an optimum asphalt content called for reducing the amount of asphalt in the mixture as much as possible.

In 1990 and 1991, several pavements failed early after placement due to "flushing." A portion of New Circle Road in Lexington, the Nicholasville Road/Reynolds Road intersection in Lexington, and various routes in western Kentucky were just a few of the Kentucky pavements to exhibit "flushing" during this period. Due to this series of similar pavement distresses, the Secretary of Transportation at the time, Milo Bryant, called for a meeting with top pavement officials within the Department. At this meeting, a directive that "no more 'flushing' would occur" was issued.

The quickest and simplest way to prevent "flushing" in HMA pavements is to reduce the asphalt content. Therefore, shortly after the directive from Mr. Bryant was issued, Materials Central Lab (MCL) personnel held a follow-up meeting with District Materials personnel. At this meeting, all personnel who approved asphalt mixture designs were directed to keep the optimum asphalt contents to an absolute minimum. This attitude continued throughout the early part of this decade. Asphalt pavements constructed during this time typically contain less asphalt than other pavements constructed before or after them.

MIX DESIGN AND EARLY PRODUCTION OF THE SCOTT COUNTY, I-75, MIXTURES

General

The entire series of I-75 widening projects along this corridor in Fayette and Scott Counties involved the same pavement design. This structure consisted of multiple courses of Class K Base, a one-inch lift of Class I-20 HT Surface, and a one-inch lift of Class A Surface.

Class K Base

In accordance with the philosophy regarding optimum asphalt contents in the early 1990's, the Class K Base mixtures for these sections of I-75 in Scott County were approved with a minimal amount of asphalt. The optimum asphalt content for the big-stone base ranged from 3.1 to 3.3 percent. Not surprisingly, during placement of the Class K Base, repeated occurrences of poor aggregate coating and significant segregation

were noted. In fact, when the condition of the I-75 pavement grew much worse earlier this year, the first suspicion of several Department personnel of the cause of the problem was the Class K Base. Apparently, however, the problem presently lies with the surface layers. Therefore, the remainder of this report will only consider the surface mixtures.

Class I-20 HT Surface

Regarding the mixture design and approval of the Scott County Class I-20 HT Surface, much the same philosophy prevailed. The Class I-20 HT Surface was designed with 80 percent of the total aggregate from the Nally and Gibson quarry at Georgetown. A more comprehensive summary of the composition of all of the mixtures in question is located in Appendix A. This source of aggregate typically yielded marginal test results for moisture susceptibility and often displayed significant degradation. It is noted, though, that at present, the quarry operation has moved underground; this move has definitely resulted in a better quality material.

The Scott County Class I-20 HT Surface was approved at an optimum asphalt content of 5.3 percent. This value, although lower than that for most Superpave surface mixtures designed today, should have provided an adequate asphalt film thickness and mixture durability. A "trial batch" of the mixture, however, was tested on October 28, 1992. This "trial batch" of plant-produced material was not placed on the mainline I-75 pavement, but rather, on some other application. The test results were as follows:

	Trial Batch Results	Target Results
Asphalt Content (AC, %)	5.1	5.3
Air Voids (AV, %)	2.4	4.0
Voids-in-Mineral Aggregate (VMA, %)	12.4	14.5

A more comprehensive summary of the MCL field verification results for all of the mixtures in question is located in Appendix A.

Obviously, the air voids and VMA properties were very low and unacceptable. Consequently, the asphalt content was eventually reduced to 4.5 percent, and the majority of the Class I-20 HT Surface was placed on the series of Scott County, I-75, projects at this asphalt content.

Certainly, it was known that an asphalt content of 4.5 percent in a surface mixture for an Interstate route was not the ideal situation. However, the lower value did satisfy the Department's philosophy at that time regarding the selection of a target asphalt content. Given the high traffic volume and heavy truck loading of I-75, it was surely felt that the occurrence of another "flushing" pavement was very possible. Accordingly, the decision to place the mixture with a 4.5-percent asphalt content definitely minimized that possibility.

Also, at this time, acceptance of the plant-produced mixture was based on asphalt content and gradation, not mixture volumetrics, as at present. The volumetric properties of the plant-produced Class I-20 HT Surface was analyzed for information, but no specification existed that would require mixture adjustments based on these results. As long as the asphalt content and gradation of the mixture remained reasonably close to the target values, the mixture was accepted. Under present specifications, severe price deductions would be assessed for such levels of air voids and VMA. It is likely that the severity of these deductions would force the contractor to drastically adjust the mixture composition. In short, this very Class I-20 HT Surface mixture would not be used on I-75 today.

Finally, at this time, no acceptance schedule existed for density of the mixture. Given the low asphalt content and general "dryness" of this mix, density was likely to be a problem. Logically, a poorly compacted pavement contains excessive air voids; these voids allow the entry of moisture into the pavement structure and premature oxidation and aging of the mix. Again, under present specifications, severe price deductions would be assessed for poor compaction. It is highly unlikely that the contractor could withstand these disincentives; undoubtedly, a better mixture design would have been necessary.

Class A Surface

The uppermost surface course for the Scott County series of projects, the Class A Surface, was designed and approved at 5.2 percent asphalt. Unlike the lower surface course, the Class I-20 HT Surface, the asphalt content for the Class A Surface remained at 5.2 percent for the majority of the I-75 construction. This value, although lower than that for most Superpave surface mixtures designed today, should have provided an adequate asphalt film thickness and mixture durability for the expected life of the pavement.

Toward the end of the series of Scott County projects, two additional Class A Surfaces, containing different aggregate blends, were approved for use. These additional mixtures contained dolomite as the coarse aggregate, rather than granite as found in the original Class A Surface. The first of these dolomite mixtures was approved at 5.0 percent asphalt, rather than 5.2 percent as approved for the other two Class A Surface mixtures.

It must be noted, however, that the same limitations that applied to the testing and acceptance of the Class I-20 HT Surface also applied to the Class A Surface. In other words, the mixture was accepted by asphalt content and gradation rather than mixture volumetrics and density. As will be proven later in this report, the mixture volumetrics and density of the Scott County Class A Surface, as with the Class I-20 HT Surface, were of inadequate quality under today's standards. In fact, neither the Class I-20 HT Surface or the Class A Surface would satisfy present Superpave specifications for an Interstate application.

DAILY ACCEPTANCE RESULTS

Class I-20 HT Surface

In general, the daily acceptance results, specifically the asphalt content, for the Class I-20 HT Surface were very good. In fact, the Department performed a detailed analysis of the acceptance results for one project within this Scott County, I-75, series. That job was identified by a specific project number, IR 75-6 (72) 126; this project roughly spanned milepoints 126 to 131, where the majority of the present deterioration is occurring. A comprehensive summary of the daily acceptance tests for each Scott County surface mixture placed on this project is located in Appendix B.

For this project, the average daily asphalt content for the Class I-20 HT Surface from September of 1991 to May of 1993 was 4.6 percent. The target value was, of course, 4.5 percent. In June of 1993, due to an effort to improve the durability and moisture resistance of the pavement, the target asphalt content of the Scott County Class I-20 HT Surface was increased to 4.8 percent. From that point to October of 1993, the average asphalt content of the plant-produced mixture was exactly 4.8 percent. Obviously, the asphalt content values for the Class I-20 HT Surface for the entire IR 75-6 (72) 126 project were very close to the respective targets.

It must be noted, however, that the daily acceptance tests for asphalt content originated from the plant site. At that site, the asphalt content was determined by solvent extraction in a field laboratory. When extractions are performed in a field laboratory, despite the use of a filter, some amount of aggregate dust is always lost in the extracted asphalt/solvent effluent. In the calculation of asphalt content, this lost dust appears as asphalt. Therefore, normally, an asphalt content from a field extraction will be falsely high, and the dust content will be falsely low. Later in this report, results of solvent extraction testing, as displayed in Appendix D, from the Materials Central Laboratory (MCL) in Frankfort will be presented. At MCL, the extracted asphalt/solvent effluent is captured and analyzed; this method accounts for all of the aggregate dust in the sample. These results should be more representative of the actual material that was placed on I-75.

Considering the daily acceptance results for aggregate gradation for the Class I-20 HT Surface, some failures did occur. The majority of the failures occurred on the No. 16 and smaller sieves. Almost exclusively, the failures involved material that was too fine. Aggregate that is too fine normally results in asphalt mixtures with poor volumetric properties; thus was the case for this Scott County Class I-20 HT Surface. Overall, the average dust content for the IR 75-6 (72) 126 project was 5.5 percent; the target value was 4.5 percent. Admittedly, this difference is not appreciable, but it must be noted that, as stated previously, the field extraction results probably underestimated the true dust content. The MCL results provided later will substantiate this idea.

Class A Surface

As with the Class I-20 HT Surface, the daily acceptance results for the asphalt content of the Scott County Class A Surface were very good. Again considering the IR 75-6 (72) 126 project, the average asphalt content for mixture produced between July and October of 1993 was 5.2 percent. The target asphalt content was the same value, 5.2 percent. A comprehensive summary of the daily acceptance test results for each Scott County surface mixture placed on this project is located in Appendix B.

Regarding the gradation tests for the Class A Surface, fewer failures occurred than with the Class I-20 HT Surface. The average dust content for the entire Scott County, IR 75-6 (72) 126, project was 4.5 percent; the target was 5.0 percent. Again, the comparison is very impressive.

Overall Comments

Considering the acceptance results of the plant-produced mixture for both the Scott County Class I-20 HT Surface and Class A Surface, the overall average values were very acceptable. Logically, then, the question arises: if the field results appeared to be acceptable, why is the pavement deteriorating so soon in the design life? In response to this question, two possible reasons can be offered.

First, as stated previously, the test results for asphalt content and gradation from the plant-site laboratory may be overly optimistic. Results from MCL testing presented later will support this notion. Second, this occurrence provides good testimony to the fact that mixture volumetrics must be utilized in the acceptance decision. When an agency accepts mixtures based on asphalt content and gradation alone, successful pavement performance is far from guaranteed. When volumetrics are used for acceptance, a much clearer picture of probable performance develops.

VOLUMETRIC TESTING OF PLANT-PRODUCED MIXTURE FOR SCOTT COUNTY

Class I-20 HT Surface

On repeated occasions throughout 1992 and 1993, MCL personnel performed volumetric testing on the plant-produced Scott County Class I-20 HT Surface mixture. Due to the importance of this Interstate project, and due to the disappointing values achieved from most of the tests, eight field verifications were performed on various sections of the I-75 widening jobs. A comprehensive summary of the MCL field verification results for all of the mixtures in question is located in Appendix A. The following table provides a synopsis of the Scott County Class I-20 HT Surface verifications in chronological order:

Federal Project Number	Date Tested	Target AC (%)	Measured AC (%)	AV (%)	VMA (%)	Passing #200 Sieve (%)
IDR 75-6 (73) 130	4/20/92	4.5	4.1	5.5	13.0	8.0
IDR 75-6 (73) 130	4/23/92	4.5	4.4	4.0	12.2	6.5
IDR 75-6 (73) 130	5/1/92	4.5	4.4	3.2	11.6	7.5
IDR 75-6 (73) 130	4/29/93	4.5	4.5	5.2	12.1	8.5
IR 75-6 (72) 126	5/20/93	4.5	4.2	5.3	13.7	6.0
IDR-IR 75-6 (74) 134	5/27/93	4.5	4.3	5.4	13.2	7.5
IR 75-6 (72) 126	6/2/93	4.8	4.6	6.3	15.0	5.0
IDR 75-6 (73) 130	6/9/93	4.8	5.1	3.6	12.9	7.5

As displayed in the preceding table, the VMA of the Class I-20 HT Surface was unacceptably low in most cases. During this time period, the minimum VMA desired for plant-produced surface was 14.0 percent. By today's standards, the minimum VMA required would be 15.0 percent. Only one of the eight tests satisfied these criteria.

The one test that exceeded the 14.0-percent minimum occurred after the optimum asphalt content was increased to 4.8 percent in June of 1993. In this instance, the air voids were exceedingly high (6.3 percent). Therefore, even though the minimum VMA was finally satisfied, the air voids were unacceptable. For this Class I-20 HT Surface mixture, the air voids had to be elevated to an unacceptable range to achieve just the minimum VMA. This situation is highly undesirable because an elevated void content promotes premature oxidation of the mixture.

VMA is the space in an asphalt mixture occupied by both the asphalt binder and the air voids. VMA is also a predictor of the durability of an asphalt mixture. A sufficient level of VMA means adequate room for both asphalt binder and air. Adequate room for asphalt binder means greater film thickness on each aggregate particle; thicker coatings on the aggregate result in longer pavement life. Adequate air voids in an asphalt mixture result in the ability of that pavement to withstand additional compaction under traffic during the design life.

For this Scott County Class I-20 HT Surface, in most cases, the air voids were in an adequate range, and the VMA was too low. This combination of properties meant that most of the available space between the aggregate particles was occupied by air, rather than by asphalt. Therefore, the film thickness of the mixture was undoubtedly low, and in turn, the durability of the pavement would likely suffer. In reality, as evidenced by the recent deterioration of I-75, this prediction of early failure was unfortunately accurate.

Another interesting note from the tests of the plant-produced mixture displayed above concerns the measured asphalt content and the dust content (percent passing the No. 200 sieve). As stated earlier, the daily acceptance tests for the Scott County Class I-20 HT Surface appeared very acceptable. After reviewing the measured asphalt and dust contents that accompanied the volumetric tests performed by MCL personnel, however, a much different picture develops. In most cases, the measured asphalt content was lower than the target value (as much as 0.4 percent lower in one instance). Also, the dust content was higher than that value reported for most daily acceptance tests. The average of all acceptance tests for dust content for the IR 75-6 (72) 126 project was 5.5 percent. Only one of the eight results in the table above, considering several of the Scott County projects, is below this value; in fact, one test yielded a dust content 3.0 percent higher than this value.

The difference in results between the daily acceptance tests and the MCL tests that accompanied the volumetric analyses was explained previously. The MCL extraction tests captured the extracted asphalt/solvent effluent that contained some amount of dust. Later in the process, the MCL tests accounted for this latent dust. Therefore, the MCL tests more likely depict the actual condition of the I-75 pavement in question.

Class A Surface

Also on repeated occasions throughout 1992 and 1993, MCL personnel performed volumetric testing on the plant-produced Scott County Class A Surface mixture. Again, due to the importance of this Interstate project, a total of seven field verifications were performed on various sections of the I-75 widening jobs. A comprehensive summary of the MCL field verification results for all of the mixtures in question is located in Appendix A. The following table provides a synopsis of the Scott County Class A Surface verifications in chronological order:

Federal Project Number	Date Tested	Target AC (%)	Measured AC (%)	AV (%)	VMA (%)	Passing #200 Sieve (%)
IDR 75-5 (26) 122	7/9/92	5.2	5.2	4.6	14.0	6.5
IDR 75-5 (26) 122	9/15/92	5.2	4.8	2.4	13.3	7.5
IDR 75-5 (26) 122	9/28/92	5.2	4.8	5.2	14.8	7.0
IDR 75-6 (73) 130	6/8/93	5.2	4.9	3.5	14.2	7.0
IDR 75-6 (73) 130	8/30/93	5.2	5.4	3.4	13.8	6.0
IDR-IR 75-6 (74) 134	10/7/93	5.0	4.7	3.5	12.8	7.0
IR 75-6 (72) 126	10/13/93	5.2	5.2	4.3	14.0	6.0

As displayed in the preceding table, the VMA of the Scott County Class A Surface was somewhat better than the Class I-20 HT Surface in most cases. As stated previously, during this time period, the minimum VMA desired for plant-produced surface was 14.0 percent. For the Class A Surface, four of the seven tests satisfied this criterion.

Although the VMA of the Class A Surface was better, the values were hardly ideal. None of the seven tests would satisfy the present Superpave specification of 15.0 percent. The VMA of this mixture could be described as marginally acceptable under the volumetric philosophy in effect at the time. As displayed by the numerous delaminations of Class A Surface on I-75 this winter, that philosophy was certainly unsatisfactory.

Considering the measured asphalt content of the Scott County Class A Surface, as with the Class I-20 HT Surface, the values were generally lower than the target value (as much as 0.4 percent lower in two instances). In contrast, the daily acceptance tests for asphalt content appeared very acceptable. Also, the dust content of the MCL tests accompanying the field verifications was higher than that value reported for most of the daily acceptance tests. The average of all daily acceptance tests for dust content for the IR 75-6 (72) 126 project was 4.5 percent. None of the seven results in the table above, considering several of the Scott County projects, is this low; in fact, one test yielded a dust content 3.0 percent higher than this value. As explained before, the MCL tests more likely depict the actual condition of the I-75 pavement in question.

VOLUMETRIC TESTING OF PLANT-PRODUCED MIXTURE FOR FAYETTE-SCOTT COUNTY

General

In contrast to the numerous sections of I-75 in Scott County that experienced severe deterioration this winter, a companion section of I-75 in northern Fayette County and southern Scott County continues to perform remarkably well. This portion of the I-75 widening was completed by a different contractor using different mixtures about one year prior to the damaged Scott County sections. Since this pavement experiences virtually the same traffic and climatic conditions as, and is even one year older than, the deteriorated Scott County sections, the question obviously arises: why are no potholes and delaminations present in this pavement? Hereafter, this project will be referred to as the "Fayette-Scott County" job.

In an effort to determine the differences between the two sections of I-75 work, the available data from the Fayette-Scott County portion were examined. A very limited number of field verifications were performed by MCL personnel on the plant-produced mixture from this project. In fact, only one verification was performed on each type of surface mixture. A comprehensive summary of the MCL field verification results for all of the mixtures in question is located in Appendix A.

Class I-20 HT Surface

The results of the testing of the Fayette-Scott County, Class I-20 HT Surface, mixture are displayed below:

Federal Project Number	Date Tested	Target AC (%)	Measured AC (%)	AV (%)	VMA (%)	Passing #200 Sieve (%)
IDR-IR 75-5 (23) 117	6/23/92	5.0	4.2	4.3	14.7	7.5

Class A Surface

The results of the testing of the Fayette-Scott County, Class A Surface, mixture are displayed below:

Federal Project Number	Date Tested	Target AC (%)	Measured AC (%)	AV (%)	VMA (%)	Passing #200 Sieve (%)
IDR-IR 75-5 (23) 117	8/24/92	5.4	4.9	4.0	14.8	7.5

Overall Comments

Even though only one volumetric test exists for each type of surface, one significant point can be noted from the available data. While the measured asphalt content is certainly much lower than the target value in both cases and the dust content is not significantly different than the Scott County mixtures previously considered, the VMA is substantially better for both mixtures. Despite the high dust contents, both VMA values easily exceed the 14.0 percent minimum. The composition of these mixtures was able to withstand an increased dust content and still achieve an acceptable VMA value; the Scott County mixtures did not. Accordingly, these Fayette-Scott County mixtures should prove to be more durable than the Scott County mixes; actual pavement performance on I-75 definitely supports this supposition.

RESULTS OF CORES RECENTLY OBTAINED FROM EXISTING I-75 PAVEMENT (BOTH FAYETTE-SCOTT AND SCOTT COUNTIES)

General

Early this year, as the condition of the I-75 pavement in Scott County grew worse and more questions developed, the Kentucky Transportation Center (KTC) obtained a number of investigative cores from various locations. Specifically, KTC personnel obtained cores at four locations on I-75, at milepoints 120.0, 131.2, 133.0, and 137.5. The first milepoint, 120.0, is located in the Fayette-Scott County section that is currently performing satisfactorily. The other three milepoints, 131.2, 133.0, and 137.5, are located in the Scott County series. These cores were obtained at two separate times, once in January and once in February. The cores were taken near the construction joint between the inside and center lanes, and at the center of the inside lane. Cores could not be obtained directly from the center of the construction joint in Scott County due to degradation of the joint. Cores were obtained approximately 0.5 to 1.0 inch from the joint. These locations are discussed later in the report.

KTC personnel tested some of these cores for permeability. In conjunction with KTC, MCL personnel performed core density and extraction/extracted gradation testing on the remainder of the cores.

Core Density for Class I-20 HT Surface

The core density values for the Class I-20 HT Surface mixtures are displayed in the following table (and in Appendix C):

	Milepoint	120.0	Milepoint	133.0	Milepoint	137.5
	Cores From Joint	*Cores From Lane*	*Cores From Joint*	*Cores From Lane*	*Cores From Joint*	*Cores From Lane*
Average Density (lb/ft^3)	142.5	147.1	140.1	137.8	149.3	149.2
Maximum Specific Gravity	2.504	2.504	2.517	2.517	2.536	2.536
Average Percent of Solid Density	91.2	94.2	89.2	82.7	94.3	94.3

Generally speaking, at the time of placement prior to the application of traffic, an asphalt pavement should have between six and eight percent air voids. This range relates to a density between 92 and 94 percent of solid. Then, after years of traffic, the pavement should consolidate to a value around 96 percent of solid. This level of consolidation allows for additional compaction during the life of the pavement without ever reaching an air void level, such as below four percent, that would be susceptible to rutting. This description could be considered the ideal situation.

As depicted in the table above, after five to seven years of traffic, none of the cored locations yielded densities near the 96 percent value. In turn, it can be assumed that at the time of placement and during the life of the pavement, the air void level of the mixture was excessively high. This condition would allow at least three possibilities that would significantly reduce the mixture's durability: (1) undue penetration of moisture to strip the asphalt film from the aggregate; (2) the continued presence of moisture in the matrix during freeze/thaw cycles that would accelerate a thermal-cycling failure; and (3) an elevated level of exposure to air within the matrix that would promote premature oxidation and aging of the mixture. In short, no good can come from an under-compacted pavement.

Although the three locations depicted above do not definitively support this point, less compaction is normally expected at the joint than in the middle of the lane. In a majority of the deteriorated areas of the I-75 pavement in Scott County, the worst delamination occurs at the joint. Poor compaction at the joint allows yet another opportunity for the entry of water. Even though, in the case of these particular cores, the compaction of the mixture at the joint is not significantly worse than the compaction of the mixture in the middle of the lane, the overall compaction of the pavement was apparently unsatisfactory.

Core Density for Class A Surface

The core density values for the Class A Surface mixtures are displayed in the following table (and in Appendix C):

	Milepoint	120.0	Milepoint	133.0	Milepoint	137.5
	Cores From Joint	*Cores From Lane*	*Cores From Joint*	*Cores From Lane*	*Cores From Joint*	*Cores From Lane*
Average Density (lb/ft^3)	145.1	148.5	144.0	142.1	143.2	147.1
Maximum Specific Gravity	2.492	2.492	2.503	2.503	2.506	2.506
Average Percent of Solid Density	93.3	95.5	92.2	91.0	91.6	94.0

Similar to the core results for the Class I-20 HT Surface, only one of the cored locations for the Class A Surface yielded a density near the expected 96 percent value. This location was in the driving lane of the Fayette-Scott County section. In turn, it can be assumed that at the time of placement and during the life of the pavement, the air void level of most of the I-75 pavement, especially in the Scott series, was excessively high. This condition would probably result in a significant reduction in the mixture's durability as explained earlier.

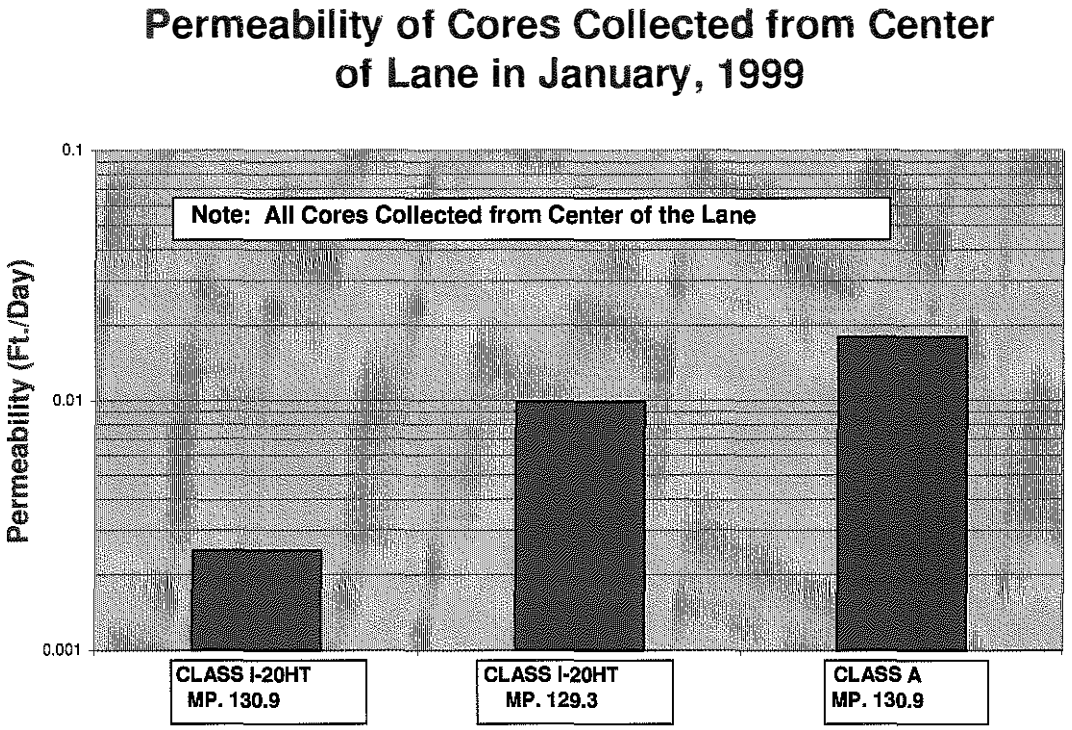
As with the Class I-20 HT Surface, the density of the pavement at the joint was not always less than in the middle of the lane for the Class A Surface. The same point can be established, however, that the majority of the pavement deterioration on I-75 occurred in or around the joint. Since the uppermost layer, the Class A Surface, displayed poor density results in general, especially in the Scott County sections, the premature failure of the pavement due to the presence of water and oxidation should be no surprise.

It is significant to note, however, that on the Class A Surface, the cores from the Fayette-Scott County section displayed a better density both at the joint and in the lane than the cores from the Scott County series of projects. This observation supports the actual performance of these portions of I-75 pavement. The Fayette-Scott County section continues to perform satisfactorily, while the Scott County pavement delaminates. Based on the core results, the Class A Surface on the Scott County sections would allow more moisture to enter the pavement than the Class A Surface on the Fayette-Scott County, I-75, pavement. Therefore, the Fayette-Scott County pavement should be more durable according to these results.

Permeability for Class A and Class I-20 HT Surface

As mentioned previously, in January of 1999, personnel from KTC took core samples of the I-75 asphalt pavement in three locations. The cores were taken in the center of the outside lane at milepoints 129.3 and 130.9. The core samples were sawed, separating the Class A and Class I-20 HT Surfaces for permeability testing. Falling-head permeability

tests were performed on the Class A and the Class I-20 HT Surfaces. Permeability tests revealed that the Class A Surface was more permeable than the Class I-20 HT Surface. Results of the permeability tests are shown below:



The results of the core density tests performed by MCL did not show a significant difference between the cores taken at the center of the outside lane and the cores taken at the joint. Falling-head permeability tests were conducted on the cores taken in February of 1999 to determine if the pavement was more permeable at the construction joints.

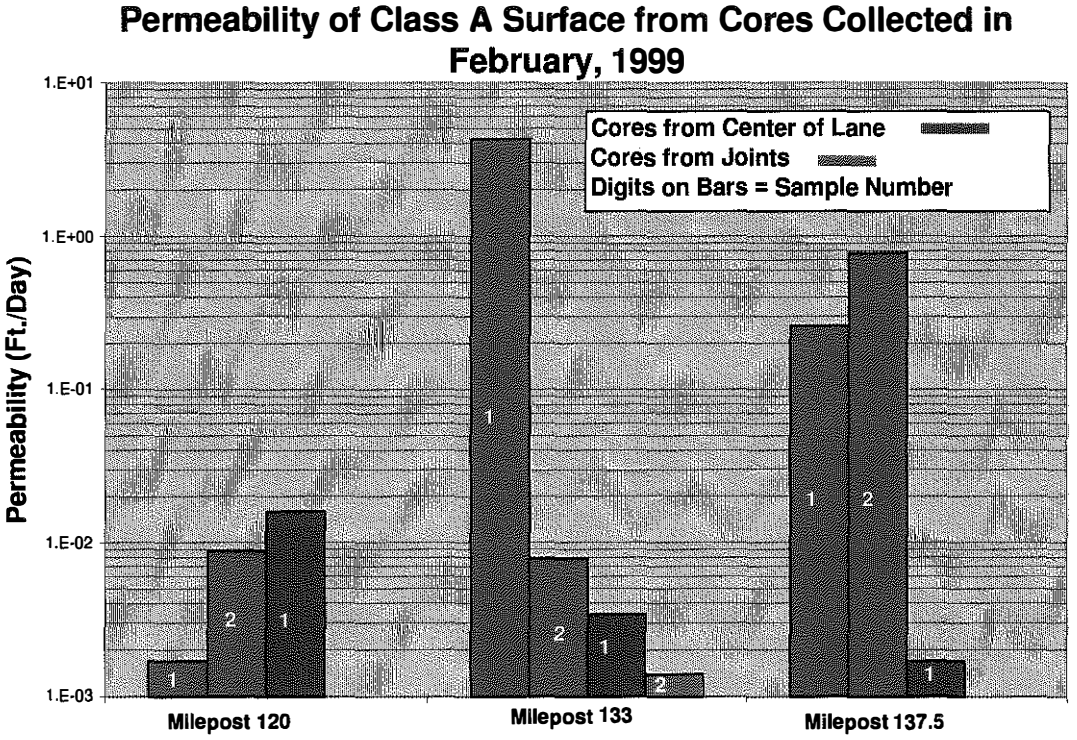
Permeability tests were conducted on 10 Class A Surface cores. Three cores were tested from milepoint 120.0, four from milepoint 133.0, and three from milepoint 137.5. The permeability tests were conducted on cores taken from the center of the lane and next to the joint. As mentioned earlier in the report, cores could not be obtained directly from the construction joint in Scott County due to the degradation of the asphalt pavement at the joint. It should also be noted that during the initial attempts to obtain cores directly from the joint in Scott County, all of the core water was lost into the construction joint of the pavement. However, the cores taken next to the joint were substantially less permeable.

Results of the tests (shown below) indicate that the cores taken from the Scott County section (milepoints 133.0 and 137.5) were considerably more permeable near the joint than at the center of the lane, and were much more permeable than the cores taken at the joint in the Fayette-Scott County section (milepoint 120.0). The permeability testing also indicated that cores taken from the center of the lane from the Scott County sections

(milepoints 133.0 and 137.5) were less permeable than the cores taken at the center of the lane in the Fayette-Scott County section (milepoint 120.0).

After further analysis of the cores and the permeability test results, it appears that small fractures in the asphalt surface of two of the cores is contributing to the increased permeability of the samples tested near the joint at milepoints 133.0 and 137.5 in Scott County.

The higher permeability of the Class A Surface near the joint, and the loss of the core water at the joint, in the Scott County sections indicate that water is probably entering the pavement at and or near the joint, and is likely causing delamination of the Class A Surface layer from the underlying Class I-20 HT Surface layer.



Extraction/Extracted Gradation for Class I-20 HT Surface

In addition to the core density testing performed by MCL personnel and the permeability testing performed by KTC personnel, a number of the cores were analyzed by MCL personnel to determine the extracted asphalt content and gradation of the in-place material. These data for the Class I-20 HT Surface for the Fayette-Scott County section are presented below (and in Appendix D):

Cores	Obtained From	Milepoint	120.0
	Cores From Lane	*Cores From Joint*	
	Extracted Gradation	Extracted Gradation	Design Gradation
Sieve Size	(Percent Passing)	(Percent Passing)	(Percent Passing)
1/2 in.	100	100	100
3/8 in.	96	97	95
No. 4	73	70	68
No. 8	50	48	49
No. 16	33	32	32
No. 30	21	20	20
No. 50	13	13	10
No. 100	10	9	7
No. 200	8.0	7.5	5.5
Asphalt Content (%)	5.4	5.1	5.0

The core results displayed in the table above are from milepoint 120.0 in the Fayette-Scott County section. As stated previously, this portion of I-75 pavement is performing well at present.

It is interesting to note that the extracted gradation matches the design gradation extremely well through the No. 50 sieve. At that point, the extracted gradations from the cores yield more dust as expected. However, considering that the comparison is between a design gradation and an extracted gradation from a sample that has suffered traffic for five to six years, has been cored from the pavement, and has been sliced to an approximate lift thickness, the concurrence of the values is remarkable.

Another notable point is the elevated dust content of the cores. As explained earlier, extractions performed by MCL personnel capture all of the dust; extractions performed for daily mixture acceptance testing at the plant laboratory do not. Therefore, the dust content from these MCL tests is probably more representative of the actual mixture in place. Accordingly, the two dust contents above, from the cores obtained at milepoint 120.0, more closely resemble the results from the MCL field verifications.

The two extracted asphalt contents from the cores above are both higher than the target value. This point will become critical as the results from the cores obtained from the Scott County sections are examined.

The results for the Class I-20 HT Surface cores obtained from milepoints 131.2 and 133.0, both from the Scott County portion of I-75, are displayed below (and in Appendix D):

Cores Obtained From:	Milepoint 131.2	Milepoint 133.0	Milepoint 133.0	Milepoint 133.0	
	Cores From Lane	*Cores From Lane*	*Cores From Lane*	*Cores From Joint*	
	Extracted Gradation	Extracted Gradation	Extracted Gradation	Extracted Gradation	Design Gradation
Sieve Size	(Percent Passing)	(Percent Passing)	(Percent Passing)	(Percent Passing)	(Percent Passing)
1/2 in.	100	100	100	100	100
3/8 in.	94	97	98	97	95
No. 4	66	65	71	67	67
No. 8	46	46	50	48	43
No. 16	30	34	36	35	27
No. 30	22	26	27	26	18
No. 50	15	19	18	18	10
No. 100	10	12	12	12	6
No. 200	7.5	9.5	9.0	9.0	5.0
Asphalt Content (%)	4.7	4.2	4.3	3.7	4.5

Again, as with the Fayette-Scott County cores for the Class I-20 HT Surface, it is interesting to note that the extracted gradation matches the design gradation well. Beginning with the No. 16 sieve this time, as opposed to the No. 50 sieve for the Fayette-Scott County cores, the extracted gradations from the cores yield more dust. Overall, though, considering the imprecise nature of this sort of testing, the agreement is impressive.

The elevated dust content of the cores should definitely be noted. The dust levels of these Scott County, Class I-20 HT Surface, cores are higher than the companion Fayette-Scott County cores. Also, as stated previously, these values are much higher than those reported as the daily acceptance results due to the nature of the MCL extraction tests.

Regarding the asphalt contents from the Scott County Class I-20 HT Surface cores, four of the five values are below the target, and one of those four is 0.8 percent below the target. These low asphalt contents do not present the same trend as the Fayette-Scott County, Class I-20 HT Surface, cores that yielded asphalt contents above the target value. Also, from the outset, the Fayette-Scott County mixture had a much higher target. Again, higher asphalt content results in greater film thickness and pavement durability. So, logically, it would be expected that the Fayette-Scott County, Class I-20 HT Surface, mixture would be more durable than the Scott County, Class I-20 HT Surface, mixture. In reality on the I-75 pavement, this prediction proved correct.

The core results for the Scott County, Class I-20 HT Surface, mixture reveal a blend with elevated dust and a low asphalt content. These two factors work in combination to produce a "dry and lifeless" asphalt mixture. An increased dust content results in increased aggregate surface area. More surface area requires more asphalt binder to maintain the same film thickness. Instead, in the case of these core results, the asphalt content was lower than the target. So, the worst possible situation occurred: additional surface area and less asphalt binder to adequately coat that increased surface area. Considering these factors, it is easily understood why the durability of this mixture suffered.

Extraction/Extracted Gradation for Class A Surface

As with the analyses performed by MCL personnel on the Class I-20 HT Surface cores, the same regimen of extracted asphalt content and gradation testing was performed on the Class A Surface. The results for the Fayette-Scott County section are displayed below (and in Appendix D):

Cores	**Obtained From**	**Milepoint**	**120.0**
	Cores From Lane	***Cores From Joint***	
	Extracted Gradation	**Extracted Gradation**	**Design Gradation**
Sieve Size	**(Percent Passing)**	**(Percent Passing)**	**(Percent Passing)**
1/2 in.	100	100	100
3/8 in.	97	96	95
No. 4	74	73	71
No. 8	49	48	47
No. 16	33	32	31
No. 30	21	21	19
No. 50	13	13	11
No. 100	9	9	8
No. 200	7.5	7.5	5.5
Asphalt Content (%)	5.3	5.3	5.4

The core results displayed in the table above are from milepoint 120.0 in the Fayette-Scott County section. As stated previously, this portion of I-75 pavement is performing well at present.

As with the Class I-20 HT Surface, it is interesting to note that the extracted gradation matches the design gradation extremely well all the way to the No. 200 sieve. At that point, the extracted gradations from the cores yield more dust as expected. It is impressive, though, that the Class A Surface mixture maintained that level of integrity in the overall gradation during the pavement life and through the coring and slicing processes.

Both cores displayed a dust content that was 2.0 percent higher than the target. Such a minimal increase is also impressive when compared to the core results from the Class I-20 HT Surface mixture that degraded somewhat more. The two extracted asphalt contents from the cores are both 0.1 percent lower than the target value. However, these asphalt contents are extremely close to the target, and the target was higher for the Fayette-Scott County, Class A Surface, mixture than for the Scott County, Class A Surface, mixture. These observations will become critical as the results from the Class A Surface cores obtained from the Scott County sections are examined.

The results for the Class A Surface cores obtained from milepoints 131.2, 133.0, and 137.5, all from the Scott County portion of I-75, are displayed below (and in Appendix D):

Cores Obtained From:	**Milepoint 131.2**	**Milepoint 133.0**	**Milepoint 133.0**	**Milepoint 133.0**	**Milepoint 137.5**	
	Cores From Lane	***Cores From Lane***	***Cores From Lane***	***Cores From Joint***	***Cores From Joint***	
	Extracted Gradation	**Extracted Gradation**	**Extracted Gradation**	**Extracted Gradation**	**Extracted Gradation**	**Design Gradation**
Sieve Size	**(Percent Passing)**	**(Percent Passing)**	**(Percent Passing)**	**(Percent Passing)**	**(Percent Passing)**	**(Percent Passing)**
3/4 in.	100	100	100	100	100	100
1/2 in.	99	100	100	100	100	100
3/8 in.	94	93	96	96	97	95
No. 4	62	64	64	66	70	65
No. 8	39	41	41	41	51	41
No. 16	29	30	30	29	38	28
No. 30	21	22	22	21	28	20
No. 50	13	13	13	13	17	11
No. 100	9	9	10	9	11	7
No. 200	6.5	7.0	7.5	6.5	8.0	5.0
Asphalt Content (%)	4.3	4.3	4.4	4.6	4.5	5.2

Again, as with the Fayette-Scott County cores for the Class A Surface, it is interesting to note that the extracted gradation matches the design gradation very well. The core results from milepoint 137.5 display a consistently finer gradation, but the other four core results fall very close to the target. Similar to the Scott County, Class I-20 HT Surface, mixture, the dust content of the cores is elevated. However, the dust levels of these Scott County, Class A Surface, cores are not significantly higher than the companion Fayette-Scott County cores.

The significant difference lies in the extracted asphalt contents from the Scott County, Class A Surface, cores. All of the five values are below the target, and two of those five are 0.9 percent below the target. These low asphalt contents do not present the same trend as the Fayette-Scott County, Class A Surface, cores that yielded asphalt contents very near the target value. Also, it must be noted that the Fayette-Scott County mixture had a higher target. So, again, it would be expected that the Fayette-Scott County, Class A Surface, mixture would be more durable than the Scott County, Class A Surface, mixtures.

As with the core results for the Scott County, Class I-20 HT Surface, these core results for the Class A Surface mixture reveal a blend with elevated dust and a low asphalt content. Once again, the worst possible situation occurred: additional surface area and less asphalt binder to adequately coat that increased surface area. Consistently, the Scott County mixtures, both the Class I-20 HT Surface and the Class A Surface, exhibit characteristics that would predict a less durable pavement than the counterpart Fayette-Scott County mixtures.

PROBABLE CAUSES AND EXPLANATIONS OF PAVEMENT DETERIORATION

General

Given the mass of information presented to this point in this report, it would be prudent to now summarize the data into some conclusions regarding the possible causes of the recent deterioration of I-75 in Scott County. The following paragraphs provide a summary of the probable causes and explanations of the I-75 deterioration, in no particular order.

Questionable Aggregate Quality

The Class I-20 HT Surface placed on I-75 in Scott County was designed with 80 percent of the total aggregate from the Nally and Gibson quarry at Georgetown. This source of aggregate typically yielded marginal test results for moisture susceptibility and often displayed significant degradation. The elevated dust content values from the extracted gradations performed by MCL personnel, both during the original field verifications and the recent core analyses, support this notion regarding excessive degradation. Given the inadequate compaction of the surface mixtures that permitted the entry of water, the moisture susceptibility of this aggregate may have resulted in stripping of the already inadequate asphalt film thickness from the aggregate particles.

Aggregate Degradation Resulting in High Dust Contents

The excessive degradation of the aggregate in the Scott County mixtures resulted in high dust contents. The dust contents of the Class I-20 HT Surface were higher than those of

the Class A Surface. The elevated dust contents appeared in the results from the original MCL field verifications and the recent MCL core analyses. Due to the inability to capture all of the dust when performing an extraction at the plant laboratory, the daily acceptance results did not reflect such an elevated dust content. The excessive dust in the mixture resulted in low VMA and asphalt film thickness; both of these conditions severely reduce the durability of the pavement.

Low Asphalt Content

Due to the philosophy regarding the selection of optimum asphalt contents that existed during the period that these mixtures were designed and approved, most of the mixtures placed on I-75 in Scott County contained a minimal amount of asphalt. The lowest asphalt content existed on the Scott County, Class I-20 HT Surface, mixture; most of this mixture was placed at 4.5 percent. The asphalt contents of the other mixtures ranged from 4.8 to 5.4 percent. These values are definitely on the low side of the range of desirable asphalt contents for an Interstate application.

A further problem existed regarding the asphalt contents of these mixtures: while the target values were low, the actual values were even lower. As exhibited by the MCL core analyses, the actual asphalt contents of the in-place pavement in Scott County were normally lower than the target values. This information contradicted the asphalt content results from the daily acceptance tests. Due to the nature of solvent extraction testing at the plant-site laboratory, the daily acceptance results probably were falsely high. The true asphalt contents, however, were low, resulting in a reduction in the asphalt film thickness on the aggregate particles. With less of an asphalt film present to protect the aggregate, moisture damage is more likely. Also, given the elevated dust contents in conjunction with these low asphalt contents, the mixture was understandably "dry and lifeless."

Low VMA

The original MCL field verifications revealed low VMA for both the Scott County Class I-20 HT Surface and Class A Surface mixtures. The VMA for the Class I-20 HT Surface was lower overall than the Class A Surface. These low VMA values represent a fundamental problem with the mixture designs: an inadequate amount of room in the matrix for both air and asphalt. Since the air void values were mostly in the moderate-to-high range, the available space was occupied predominantly by air, leaving little room for asphalt. This condition resulted in poor film thickness as explained earlier.

Low In-Place Density

As revealed by the MCL core analyses from several locations along this stretch of I-75, including both the Fayette-Scott and Scott County projects, the in-place density of the pavement is undesirably low. Considering that, even at present, the density of several of the cores tested does not reach 94 percent of solid density, for the entire life of most of this pavement, water and air enjoyed easy access to the internal structure. Water present

in the matrix could strip the already inadequate asphalt coating from the aggregate; air permeating through the matrix could oxidize and age the mixture. This undesirable condition is certainly intensified at the longitudinal joint where most of the present deterioration is occurring.

High Permeability of Longitudinal Joints

As noted previously, the high permeability of the construction joints in the Scott County sections has apparently permitted water to enter the pavement structure and become trapped at the Class A Surface/Class I-20 HT Surface interface. The water has apparently frozen and caused delamination along or near the joint.

Difference Between Fayette-Scott and Scott County Mixtures

A companion section of I-75 in northern Fayette County and southern Scott County, constructed one year earlier than most of the Scott County projects, continues to perform satisfactorily. This Fayette-Scott County project consisted of the same pavement design, but involved different aggregate blends. The Fayette-Scott County mixtures were approved at higher asphalt contents than the Scott County mixtures; also, the actual asphalt contents from the core analyses were higher. The Fayette-Scott County mixtures reflected higher VMA than the Scott County mixtures, and the in-place density of the riding surface, the Fayette-Scott County Class A Surface, was better than the Scott County, Class A Surface, blend. All of these pieces of evidence point toward a more durable pavement for the Fayette-Scott County section. In reality, that situation is exactly what has occurred.

Existing Scott County Class A Surface Does Not Adhere to Class I-20 HT Surface

As noticed throughout this report, the test results for the Scott County Class I-20 HT Surface appear worse than those for the Class A Surface. The VMA, asphalt content, and in-place density of the Class I-20 HT Surface was predominantly lower than that of the Class A Surface; the dust content was commonly higher. Why then, on existing I-75 in Scott County, is the Class A Surface delaminating and the Class I-20 HT Surface appearing generally intact?

It is believed that the "dry" condition of the Scott County Class I-20 HT Surface is not providing a satisfactory material for the adherence of the Class A Surface. Therefore, the bond between the two materials fail, and the delaminations occur. The high dust content and low asphalt content of the Class I-20 HT Surface serve to produce a very "dry" layer of material. In addition, given the low in-place density of both surface layers, years of the presence of moisture and traffic action have stripped away much of the already inadequate asphalt coating. Also, this condition may cause whatever tack material was present originally to be stripped away. It is also believed that when the Scott County Class A Surface delaminates and exposes the Class I-20 HT Surface to weather and traffic, very soon thereafter, the Class I-20 HT Surface will begin to deteriorate as well.

REASONS WHY THIS PREMATURE FAILURE WILL NOT BE REPEATED

General

After considering the reasons why this premature pavement failure occurred in the first place, attention must now be given to preventing a recurrence of this situation. Fortunately, since the early 1990's when this stretch of pavement was constructed, several measures have been implemented that should prevent any similar situations in the future.

Superpave System Requires Better Quality Aggregates

Any future pavement placed on an Interstate in Kentucky would be required to satisfy Superpave mixture specifications. In the Superpave system, aggregates must be cleaner and more angular. Cleaner aggregates are necessary to satisfy the Superpave mixture volumetric criteria, specifically air voids and VMA. More angular aggregates are necessary to satisfy the Superpave aggregate consensus properties, specifically fine-aggregate angularity. It is highly unlikely that the aggregates utilized in the existing I-75 pavement in Scott County would satisfy today's specifications.

Superpave Mix Designs Yield Higher Optimum Asphalt Contents

Due to the cleaner and more angular aggregates now used in Superpave mixtures, much more room is present in today's mixes for asphalt. As a result, most Superpave mixtures, especially surface mixtures, require higher optimum asphalt contents than conventional asphalt mixtures in the recent past. If the section of I-75 in Scott County were to be resurfaced today, the optimum asphalt content of the mixture would probably fall between 5.5 and 6.0 percent. Also, the VMA of the mix would be 15.0 percent or higher for the same aggregate size. This increased amount of asphalt and VMA would result in better film thickness, increased moisture resistance, and an improved ability to compact the mat. All of these factors would mean a marked improvement in the durability of the pavement.

Current Acceptance Procedures Consider Different Properties

When the section of I-75 in question was constructed, the acceptance properties for asphalt mixtures were asphalt content and gradation. Examining these daily acceptance test results provides an optimistic picture. For the most part, both the asphalt content and gradation results appeared very acceptable. As stated previously, considering just these properties, though, does not provide a total picture of the overall mixture quality. Under present acceptance procedures, air voids, VMA, and density are now the acceptance properties. Given the erratic air voids values, low VMA, and low density of the I-75 mixtures, analyzing these mixtures under today's acceptance procedures would result in some very substantial pay deductions. In fact, it is highly unlikely that a contractor could withstand the deductions that would probably result under present specifications and still

continue HMA production. In all probability, a different mixture design using different aggregates would be necessary.

Mixtures Comprising Existing I-75 Pavement Would Not Satisfy Current Superpave Laboratory Criteria

Current Superpave mixture design criteria place requirements on aggregates and various mixture properties, including volumetrics and moisture susceptibility. Several of these requirements would represent a significant challenge for the surface mixtures placed on I-75 in the early 1990's. Among these requirements are fine-aggregate angularity, clay content, air voids, VMA, dust-to-binder ratio, and retained tensile strength for moisture susceptibility. It is very likely that the Scott County, Class I-20 HT Surface and Class A Surface, mixtures would fail to satisfy a number of today's Superpave mix design criteria. So, even moving the problems with the plant-produced mixture aside, in all probability, these mixtures would not have proceeded past the laboratory design stage under present specifications.

SUMMARY

Faced with the problem of a rapidly deteriorating pavement on I-75 in Scott County earlier this winter, MCL and KTC personnel conducted an abbreviated investigation of the asphalt mixtures involved. The findings from this investigation, including analyses of the historical data for these mixtures and testing of the in-place pavement, revealed several possibilities for the premature pavement failure. It is believed that the implementation of Superpave asphalt mixture specifications have all but eliminated the possibility of the recurrence of this type of failure.

FUTURE WORK

A majority of the cores collected in February, at the construction joint, showed evidence of delamination of the Class A Surface from the rest of the core. This condition indicates that there may be other areas that are delaminated that have not yet shown signs of distress. KTC will attempt, in the near future, to determine the extent of the possible delamination by use of infrared thermography. A future report on the success of this effort will be issued.

APPENDIX A

Field Verification Results by Materials Central Laboratory (MCL)

Scott County, Class I-20 HT Surface
Scott County, Class A Surface
Fayette-Scott County, Class I-20 HT Surface
Fayette-Scott County, Class A Surface

Scott Co., I-75, Class I-20 HT Surface
Field Verifications by Central Office Materials

Limestone #8's	**Nally & Gibson @ Georgetown**	**30%**
Limestone #11's	**Nally & Gibson @ Georgetown**	**30%**
Limestone Sand	**Nally & Gibson @ Georgetown**	**20%**
Natural Sand	**Northern Ky. Aggregates @ Petersburg**	**20%**

AC-20 from Shell Oil Company @ Lexington

					Verification Results				
Federal Project Number	**State Project Number**	**Date Verified**	**Type of Anti-Strip Additive @ 0.5%**	**Target % AC**	**% AC**	**% AV**	**% VMA**	**- #200**	**% TSR**
TRIAL BATCH		10/28/92	Pavebond AP Special	5.3	5.1	2.4	12.4	No Report	93
IR 75-6 (72) 126	FSP 105 75 126-131	5/20/93	Perma-Tac Plus	4.5	4.2	5.3	13.7	6.0	48
IR 75-6 (72) 126	FSP 105 75 126-131	6/2/93	Pavebond AP Special	4.8	4.6	6.3	15.0	5.0	100
IDR 75-6 (73) 130	FSP 105 75 130-135	4/20/92	Pavebond LP	4.5	4.1	5.5	13.0	8.0	60
IDR 75-6 (73) 130	FSP 105 75 130-135	4/23/92	Pavebond AP Special	4.5	4.4	4.0	12.2	6.5	78
IDR 75-6 (73) 130	FSP 105 75 130-135	5/1/92	Pavebond AP Special	4.5	4.4	3.2	11.6	7.5	86
IDR 75-6 (73) 130	FSP 105 75 130-135	4/29/93	Perma-Tac Plus	4.5	4.5	5.2	12.1	8.5	93
IDR 75-6 (73) 130	FSP 105 75 130-135	6/9/93	Pavebond AP Special	4.8	5.1	3.6	12.9	7.5	79
IDR-IR 75-6 (74) 134	FSP 105 75 134-139	5/27/93	Pavebond AP Special	4.5	4.3	5.4	13.2	7.5	106

Scott Co., I-75, Class A Surface
Field Verifications by Central Office Materials

Dolomite #8's	Medusa Aggregates @ Bardstown	43%
Limestone Sand	Nally & Gibson @ Georgetown	25%
Crush. Grav. Sand	Nugent Sand & Gravel @ Milton	12%
Natural Sand	Northern Ky. Aggregates @ Petersburg	20%

AC-20 from Shell Oil Company @ Lexington

					Verification Results				
Federal Project Number	State Project Number	Date Verified	Type of Anti-Strip Additive @ 0.5%	Target % AC	% AC	% AV	% VMA	- #200	% TSR
IR 75-6 (72) 126	FSP 105 75 126-131	10/13/93	Pavebond AP Special	5.2	5.2	4.3	14.0	6.0	84

Granite #8's	Vulcan Materials @ Enka, NC	40%
Limestone Sand	Nally & Gibson @ Georgetown	40%
Natural Sand	Northern Ky. Aggregates @ Petersburg	20%

AC-20 from Shell Oil Company @ Lexington

					Verification Results				
Federal Project Number	State Project Number	Date Verified	Type of Anti-Strip Additive @ 0.5%	Target % AC	% AC	% AV	% VMA	- #200	% TSR
IDR 75-6 (73) 130	FSP 105 75 130-135	6/8/93	Pavebond AP Special	5.2	4.9	3.5	14.2	7.0	76
IDR 75-6 (73) 130	FSP 105 75 130-135	8/30/93	Pavebond AP Special	5.4	5.4	3.4	13.8	6.0	90
IDR 75-5 (26) 122	FSP 105 75 120-139	7/9/92	Pavebond LP	5.2	5.2	4.6	14.0	6.5	71
IDR 75-5 (26) 122	FSP 105 75 120-139	9/15/92	Pavebond LP	5.2	4.8	2.4	13.3	7.5	69
IDR 75-5 (26) 122	FSP 105 75 120-139	9/28/92	Pavebond LP	5.2	4.8	5.2	14.8	7.0	68

Scott Co., I-75, Class A Surface
Field Verifications by Central Office Materials

Dolomite #8's	Medusa Aggregates @ Bardstown	40%	AC-20 from Shell Oil Company @ Lexington
Limestone Sand	Nally & Gibson @ Georgetown	40%	
Natural Sand	Northern Ky. Aggregates @ Petersburg	20%	

					Verification Results				
Federal Project Number	State Project Number	Date Verified	Type of Anti-Strip Additive @ 0.5%	Target % AC	% AC	% AV	% VMA	- #200	% TSR
IDR-IR 75-6 (74) 134	FSP 105 75 134-139	10/7/93	Pavebond AP Special	5.0	4.7	3.5	12.8	7.0	85

Fayette-Scott Cos., I-75, Class I-20 HT Surface
Field Verifications by Central Office Materials

Limestone #8's	Vulcan Materials @ Lexington	40%	AC-20 from Ashland Petroleum @ Louisville
Limestone Sand	Vulcan Materials @ Lexington	40%	
Natural Sand	Harrison Sand & Gravel @ Hamilton, OH	20%	

					Verification Results				
Federal Project Number	State Project Number	Date Verified	Type of Anti-Strip Additive @ 0.5%	Target % AC	% AC	% AV	% VMA	- #200	% TSR
IDR-IR 75-5 (23) 117	FSP 034 75 117-121 FSP 105 75 120-139	6/23/92	None Required	5.0	4.2	4.3	14.7	7.5	Not Tested

Fayette-Scott Cos., I-75, Class A Surface
Field Verifications by Central Office Materials

Granite #8's	**Vulcan Materials @ Enka, NC**	**40%**	**AC-20 from Ashland Oil, Inc. @ Ashland**
Limestone Sand	**Vulcan Materials @ Lexington**	**40%**	
Natural Sand	**Harrison Sand & Gravel @ Hamilton, OH**	**20%**	

					Verification Results				
Federal Project Number	**State Project Number**	**Date Verified**	**Type of Anti-Strip Additive @ 0.5%**	**Target % AC**	**% AC**	**% AV**	**% VMA**	**- #200**	**% TSR**
IDR-IR 75-5 (23) 117	FSP 034 75 117-121 FSP 105 75 120-139	8/24/92	None Required	5.4	4.9	4.0	14.8	7.5	85

APPENDIX B

Daily Acceptance Test Results From Plant-Site Laboratory

Scott County, IR 75-6 (72) 126
Class I-20 HT Surface @ 4.5 % AC
Class I-20 HT Surface @ 4.8 % AC
Class A Surface @ 5.2 % AC

Scott Co. IR 75-6 (72) 126
Class I-20 HT Surface @ 4.5% A.C.

DAILY ACCEPTANCE TEST RESULTS

Date	Sieve #200	AC Content	Target AC	Tons Accepted	
9/22/91 Cont.	6.0	4.4	4.5	609.4	
9/22/91 DOT	6.5	4.4	4.5		
10/21/91	6.0	4.4	4.5	378.4	
10/26/91 #1	6.0	4.5	4.5	1398.7	*
10/26/91 #2	5.5	4.5	4.5		
10/26/91 #3	5.5	4.5	4.5		**
11/14/91 #1	5.0	4.4	4.5	731.1	
11/14/91 #2	5.5	4.5	4.5		
4/23/92 #1	5.0	4.5	4.5	1006.6	
4/23/92 #2	5.5	4.7	4.5		
4/24/92 #1	4.5	4.6	4.5	230.0	
4/24/92 #2	3.5	4.6	4.5		
4/25/92	6.0	4.6	4.5	114.8	
5/1/92	7.5	4.6	4.5	207.7	***
5/4/92	5.5	4.5	4.5	469.8	
5/11/92	7.5	4.7	4.5	251.1	****
5/13/92	6.0	4.7	4.5	573.6	
5/21/92	6.5	4.5	4.5	332.0	
5/27/92	4.5	4.5	4.5	576.9	
5/28/92	5.5	4.6	4.5	593.9	
6/3/92	6.0	4.6	4.5	702.8	*****
6/5/92 #1	5.0	4.6	4.5	690.3	
6/5/92 #2	6.0	4.7	4.5		
6/6/92	6.5	4.8	4.5	551.5	******
6/9/92 #1	5.5	4.6	4.5	357.2	
6/9/92 #2	3.5	4.4	4.5		
6/10/92 #1	3.5	4.5	4.5	929.8	
6/10/92 #2	4.5	4.5	4.5		
6/15/92	4.0	4.7	4.5	351.2	
7/14/92	5.0	4.6	4.5	141.2	*******
5/19/93	6.0	4.5	4.5	383.0	
5/20/93	4.5	4.4	4.5	430.2	
Average Test Result	5.4	4.55	**Total Tons**	12011.2	
Standard Deviation	1.02	0.11			

* gradation failing on the #8, #16, #30, #50 (fine)

** gradation failing on the #16, #30, (fine)

*** gradation failing from the #4 sieve down (fine)

**** gradation failing on the #16, #30, #50, #100, #200 (fine)

***** gradation failing on the #8, #16, #30, #50 (fine)

****** gradation failing on the #16, #30, (fine)

*******gradation failing on #8 and #16 no deduction (coarse)

Scott Co. IR 75-6 (72) 126
Class I-20 HT Surface @ 4.8% A.C.

DAILY ACCEPTANCE TEST RESULTS

Date	Sieve #200	AC Content	Target AC	Tons Accepted
6/2/93	5.0	4.9	4.8	162.2
6/3/93	6.0	4.8	4.8	206.3
7/1/93	5.0	4.8	4.8	356.4
7/6/93	5.5	4.8	4.8	271.2
7/7/93	5.0	4.8	4.8	225.0
7/12/93	6.0	4.8	4.8	489.3
7/23/93	6.0	4.8	4.8	319.5
8/3/93	6.5	4.8	4.8	515.4
8/5/93	6.0	4.8	4.8	244.6
8/18/93	6.0	4.7	4.8	324.6
8/20/93	6.0	4.8	4.8	506.6
8/27/93	5.0	4.8	4.8	538.8
9/9/93	6.0	4.8	4.8	143.9
10/5/93	5.5	4.8	4.8	140.2
10/8/93	6.0	4.8	4.8	558.9
10/15/93 #1	5.5	4.7	4.8	1046.9
10/15/93 #2	5.5	5.1	4.8	
10/15/93 #3	5.0	4.8	4.8	
Average Test Result	5.6	4.8	**Total Tons**	6049.8
Standard Deviation	0.48	0.08		

Scott Co. IR 75-6 (72) 126
Class A Surface @ 5.2% A.C.

DAILY ACCEPTANCE TEST RESULTS

Date	Sieve #200	AC Content	Target AC Content	Tons Accepted
7/22/93 #1	3.5	5.2	5.2	704.6
7/22/93 #2	6.5	5.2	5.2	
7/22/93	3.5	5.0	5.2	
7/23/93	4.5	5.2	5.2	453.0
8/5/93	5.0	5.2	5.2	207.9
8/5/93	5.0	5.4	5.2	
8/9/93	5.5	5.2	5.2	203.9
8/19/93 #1	5.0	5.2	5.2	925.5
8/19/93 #2	5.0	5.2	5.2	
8/23/93	4.5	5.2	5.2	205.2
8/24/93	5.0	5.2	5.2	102.2
8/25/93 #1	4.0	5.2	5.2	1003.4
8/25/93 #2	4.5	5.2	5.2	
8/26/93	4.5	5.2	5.2	432.9
9/10/93	6.0	5.3	5.2	161.1
9/13/93	4.0	5.2	5.2	408.8
9/13/93	4.0	5.3	5.2	
9/16/93	4.5	5.2	5.2	301.4
10/5/93 #1	4.5	5.2	5.2	1355.4
10/5/93 #2	4.5	5.2	5.2	
10/5/93 #3	5.0	5.2	5.2	
10/6/93	5.5	5.2	5.2	541.6
10/7/93 #1	4.5	5.3	5.2	1223.7
10/7/93 #2	4.5	5.2	5.2	
10/13/93 #1	3.5	5.2	5.2	1511.7
10/13/93 #2	3.0	5.2	5.2	
10/13/93 #3	3.0	5.2	5.2	
10/14/93 #1	3.5	5.2	5.2	1188.3
10/14/93 #2	4.0	5.2	5.2	
10/14/93	3.5	5.3	5.2	
Average Test Result	4.5	5.21		
Standard Deviation	0.83	0.06		
	Total Tons			10930.6

APPENDIX C

Core Density Results by MCL From In-Place Pavement

Scott County, Class I-20 HT Surface
Scott County, Class A Surface
Fayette-Scott County, Class I-20 HT Surface
Fayette-Scott County, Class A Surface

Scott Co., I-75
Core Densities and Percent of Solid Density
Obtained at Milepoints 133.0 and 137.5

	Class A Surface			
	MP 133.0		MP 137.5	
	Joint	Lane	Joint	Lane
Average Density (lb/ft^3)	144.0	142.1	143.2	147.1
Maximum Specific Gravity	2.503	2.503	2.506	2.506
Average Percent of Solid Density	92.2	91.0	91.6	94.0

	Class I-20 HT Surface			
	MP 133.0		MP 137.5	
	Joint	Lane	Joint	Lane
Average Density (lb/ft^3)	140.1	137.8	149.3	149.2
Maximum Specific Gravity	2.517	2.517	2.536	2.536
Average Percent of Solid Density	89.2	82.7	94.3	94.3

Fayette-Scott Cos., I-75
Core Densities and Percent of Solid Density
Obtained at Milepoint 120.0

	Class A Surface		
	Cores From Joint		Cores From Lane
Average Density (lb/ft^3)	145.1		148.5
Maximum Specific Gravity	2.492		2.492
Average Percent of Solid Density	93.3		95.5

	Class I-20 HT Surface		
	Cores From Joint		Cores From Lane
Average Density (lb/ft^3)	142.5		147.1
Maximum Specific Gravity	2.504		2.504
Average Percent of Solid Density	91.2		94.2

APPENDIX D

Extraction/Extracted Gradation Results by MCL From In-Place Pavement Cores

Scott County, Class I-20 HT Surface
Scott County, Class A Surface
Fayette-Scott County, Class I-20 HT Surface
Fayette-Scott County, Class A Surface

Scott Co., I-75, Class I-20 HT Surface Extraction/Extracted Gradation From Cores Obtained at Milepoints 131.2 and 133.0

Sieve Size	MP 131.2 January In Lane	MP 133.0 January In Lane	MP 133.0 February In Lane	MP 133.0 February Joint			Design Gradat.
1/2 in.	100	100	100	100			100
3/8 in.	94	97	98	97			95
No. 4	66	65	71	67			67
No. 8	46	46	50	48			43
No. 16	30	34	36	35			27
No. 30	22	26	27	26			18
No. 50	15	19	18	18			10
No. 100	10	12	12	12			6
No. 200	7.5	9.5	9.0	9.0			5.0
Binder Content (%)	4.7	4.2	4.3	3.7			4.5

Scott Co., I-75, Class A Surface Extraction/Extracted Gradation From Cores Obtained at Milepoints 131.2, 133.0, and 137.5

Sieve Size	MP 131.2 January In Lane	MP 133.0 January In Lane	MP 133.0 February In Lane	MP 133.0 February Joint	MP 137.5 February Joint		Design Gradat.
3/4 in.	100	100	100	100	100		100
1/2 in.	99	100	100	100	100		100
3/8 in.	94	93	96	96	97		95
No. 4	62	64	64	66	70		65
No. 8	39	41	41	41	51		41
No. 16	29	30	30	29	38		28
No. 30	21	22	22	21	28		20
No. 50	13	13	13	13	17		11
No. 100	9	9	10	9	11		7
No. 200	6.5	7.0	7.5	6.5	8.0		5.0
Binder Content (%)	4.3	4.3	4.4	4.6	4.5		5.2

Fayette-Scott Cos., I-75, Class I-20 HT Surface Extraction/Extracted Gradation From Cores Obtained at Milepoint 120.0

Sieve Size		In Lane Extracted Gradation (Percent Passing)	Joint Extracted Gradation (Percent Passing)	Design Gradation (Percent Passing)
1/2 in.		100	100	100
3/8 in.		96	97	95
No. 4		73	70	68
No. 8		50	48	49
No. 16		33	32	32
No. 30		21	20	20
No. 50		13	13	10
No. 100		10	9	7
No. 200		8.0	7.5	5.5
Binder Content (%)		5.4	5.1	5.0

Fayette-Scott Cos., I-75, Class A Surface Extraction/Extracted Gradation From Cores Obtained at Milepoint 120.0

Sieve Size	In Lane Extracted Gradation (Percent Passing)	Joint Extracted Gradation (Percent Passing)	Design Gradation (Percent Passing)
½ in.	100	100	100
3/8 in.	97	96	95
No. 4	74	73	71
No. 8	49	48	47
No. 16	33	32	31
No. 30	21	21	19
No. 50	13	13	11
No. 100	9	9	8
No. 200	7.5	7.5	5.5
Binder Content (%)	5.3	5.3	5.4