# A REVIEW OF PAVEMENT PERFORMANCE ON VIRGINIA'S INTERSTATE SYSTEM

by

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Research Engineer

(The opinions, findings, and conclusions expressed in this report are those of the author and not necessarily those of the sponsoring agencies.)

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# SUMMARY

Extensive studies of over 800 miles of divided interstate pavements constructed prior to July 1, 1975, are reported. The studies included those of performance adequacy and the identification of certain factors which appeared to adversely affect performance. The studies showed that Virginia interstate pavements have performed very well in spite of some serious problems for which the causes have been identified and corrected in current standards and specifications. Six instances where location, pavement age, and traffic permitted valid comparisons between portland cement and bituminous concrete pavements showed the two pavement types to be performing similarly and to have incurred very similar maintenance costs.

Ten recommendations relating to design, construction, and maintenance are presented. A major recommentation encourages the Department to continue to consider all the existing pavement types, with appropriate modifications, for use on future construction. No major design modifications are recommended.

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## INTRODUCTION

In late 1966 and early 1967 C. S. Hughes, senior research scientist, and several other members of the Council staff conducted a reconnaissance of all interstate pavements in service in the state at that time. In each Highway Construction District, the group was accompanied by the respective district engineer and district materials engineer or their proxies. The report of this reconnaissance was issued by Hughes in March 1967, and covered the approximately 460 miles of Virginia's interstate system that had then been completed, with the oldest pavements having been in service only six years. The report stated in part:

> It was found that less than 7% of the 130 projects surveyed were showing extensive distress. The most prevalent distress of portland cement concrete pavements is pumping; and on asphalt concrete pavements it is settlement.
>
> The average age of asphaltic concrete pavement prior to resurfacing appears to be closer to eight years than ten as now (1967) designed. It is virtually impossible to state at this early date whether the 25 year design life for concrete pavement is accurate. Annual maintenance cost for asphaltic concrete, patching, and sealing was reported to be about $220/mile, and for portland cement concrete $350/mile.
>
> From strictly a performance standpoint, it appears that asphaltic and portland cement concrete pavements can perform equally well statewide.(1)

The principal conclusion was: "The interstate pavements now in service in Virginia are performing adequately and no major changes in Virginia's pavement design procedures appear warranted at this time." At the time this conclusion was offered, two

basic problems with respect to design of the early interstate pavements were identified. These were:

1. The difficulty in accurately determining the number and magnitude of traffic loads to which these pavements would be subjected; and

2. the necessity to determine, through judgement and extrapolation from previous experience, the pavement thickness required to carry the estimated traffic.[2]

Since 1967 the assimilation by the highway industry of the results of the AASHTO Road Test[3] has led to improvements in both the above problem areas, as are evidenced in Virginia in new methods of traffic analysis and in a new approach to flexible pavement design.[4,5] One basic change in the later construction of both flexible and rigid pavements is the much wider use of cement stabilized pavement layers. At the same time, the construction of portland cement concrete pavements has undergone a complete switch from the long-slab, jointed design to the continuously reinforced type.

These changes, along with the recognition that some performance problems had arisen since the earlier reconnassiance, led Director of Engineering P. B. Coldiron to request a review of the pavement performance on the interstate system in 1974.* He also cited the escalation in construction costs and changes in the avaliability of paving materials as contributing to the necessity for the review.

## PURPOSE AND SCOPE

The purpose of this study was to assess the performance of pavements on the interstate system in Virginia to determine whether they are providing the service for which they were designed. Although there have been some changes in design procedures as the system has been constructed, comparisons of older and newer pavements appear appropriate because the basic considerations of soil strength and traffic volumes have gone unchanged.

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*Memorandum to J. H. Dillard dated September 24, 1974.

As pointed out by Hughes in the earlier study, because there are fundamental differences in the design approaches for the two pavement types, direct comparisons of portland cement concrete and asphaltic concrete pavements are very difficult. It was anticipated, however, that consideration of maintenance costs and traffic volumes carried would give some indications of the relative merits of these two basic pavement types and various sub-types of each. Skid resistance, which is under continuing surveillance by the operating divisions, was not a factor in these considerations.

## APPROACH

The interstate review was accomplished in two phases: (1) a field survey, and (2) traffic and cost analyses. These are discussed separately below:

### Field Survey

Comprehensive field inspections were conducted of all interstate pavements open to traffic at the time of the survey, with the exception of I-495, which was undergoing reconstruction. These inspections were made by the author and R. W. Gunn, materials technician supervisor. During these inspections a variety of pavement deficiencies were noted. Insofar as was possible major problem areas were identified and the reasons for the problems determined. Each pavement was rated as excellent, good, fair, or poor according to its observable condition and age and in light of any available maintenance records. The most important consideration in the rating of each pavement was the likelihood that it would serve for its design life. The service criteria used were:

1. Flexible pavements— a 20-year design life and 8-years' service without a structural overlay.

2. Rigid pavements— a 25-year design life (35-years for continuously reinforced concrete pavements) without the need for major structural upgrading.

Because of the large total mileage involved, the traditional performance measurements such as roughness and deflection tests were considered impractical. However, the results of other research studies involving some sections of interstate pavement were drawn upon in the resolution of some of the problems encountered.

Initial plans called for interviews with the appropriate resident engineers to attempt to reach a consensus evaluation for each pavement. However, this approach was found to be impractical because the transitory nature of resident engineer assignments was found to result in few of them having complete background knowledge of the pavements in their areas of responsibility. For this reason, no formal interviews were held although each district materials engineer was consulted concerning any major problem areas in his district.

Specific criteria for the field performance evaluation are given in the sample work sheets in Appendix A. In addition to the general pavement rating mentioned earlier, the factors discussed below were considered for each pavement in the study.

## All Pavements

Each pavement structure was described in terms of material types and layer thicknesses. This information was generally available in the Research Council files, although some was obtained from the operating divisions.

## Flexible Pavements

Information peculiar to flexible pavements gathered during the survey included distress types, thickness index computations, and major maintenance received. Distress types were classified as indicated on the "Flexible Pavement" work sheet (appended) and incorporated all distress types normally found in flexible pavements. The extent of distress was classified only as rarely, occasionally, or frequently. Such classification of distress type and degree provided some objectivity in the performance assessment of a given pavement.

Thickness index computations were related to the currently used pavement design methodology developed by Vaswani.[4] Although many of the older interstate pavements were not designed by the Vaswani method, the comparison of "as built" indices with those that would currently be required under prevailing traffic conditions permits an additional assessment of the relative adequacies of the old and the new design procedures.

Major maintenance for flexible pavements usually is restricted to overlays, the correction of fill settlements, or drainage modifications. Conditions such as pavement age and

traffic under which such maintenance was required were noted and used as input to the assessment of performance. For example, a pavement requiring an overlay in 4 years would ordinarily be rated lower than one not overlaid for 10 years, unless unusual traffic or other conditions provided some explanation for the differences in performance.

### Rigid Pavements

Information peculiar to rigid pavements includes the type and degree of distress observed and the major maintenance performed. As with flexible pavements, the nature and extent of distress and maintenance and the conditions under which these occur all were considered in making the performance assessment.

## Cost and Traffic Analyses

Both cost and traffic analyses were performed by the Research Council utilizing information derived from Maintenance, Accounting, and Traffic Division files, as well as files maintained at the Council. These analyses are briefly outlined below and discussed in more detail later in this report.

### Traffic Analysis

Utilizing the estimation method developed by Vaswani[5] and average traffic counts, the average daily and the cumulative 18,000 lb. axle loadings (EAL-18) were computed for each pavement. Initial plans to compare the design EAL-18 and the actual EAL-18 loadings were abandoned when it was realized that several changes in design methodology prohibited the establishment of a uniform design loading.

### Cost Analysis

The cost to the Department per 24-ft. lane mile of pavement was determined from initial construction and maintenance costs. Construction cost information was generally available in the Research Council files, while maintenance costs were obtained from the Accounting Division. Construction costs were converted to 1975 dollars through use of the Engineering News Record construction cost index utilizing the method prescribed by that publication.[6] Maintenance costs reflecting pavement activity codes were accumulated without conversion to a specific year. It was anticipated that the cost of the

pavement to the Department would be related to the traffic loading mentioned above. The nature of this relationship is examined without the application of sophisticated economic analysis.

It should be noted that with the Department's present accounting system it is virtually impossible, in some cases, to assign maintenance costs to the pavement segment on which the costs were incurred. Ideally, maintenance section limits should correspond with construction project limits. At the very least, maintenance sections should be changed with pavement type. Thus, adjoining flexible and portland cement concrete pavements would have different section numbers, even though they may be maintained by the same area headquarters.

## RESULTS AND DISCUSSION

### Distribution of Pavement Types

The field studies of all interstate pavements open to traffic as of June 30, 1975, with the omission of I-495, which was being reconstructed, were completed in March 1976. Of the 195 projects surveyed, 119 were classified on the basis of surface type as flexible pavements and the other as rigid pavements. A total of 817 miles of divided highway were included in the 195 projects. The composition as distributed by mileage, the number of projects (N), and the mileage percentage of pavement type is given in Table 1, where for reasons given earlier the rigid pavements are listed in two groups—jointed portland cement concrete pavements (JPCCP) and continuously reinforced concrete pavements (CRCP). As can be noted in the table, flexible pavements comprise approximately two-thirds of the interstate mileage in Virginia, slightly over one-fifth is jointed portland cement concrete pavement, and one-eighth is continuously reinforced concrete pavement. As will be discussed in some depth later, certain of the pavements with flexible surface courses are more properly classified as composite pavements because they have one or more rigid layers in the form of old portland cement concrete pavement or new portland cement concrete base.

As has been the convention in Virginia for many years, rigid pavements, with a few exceptions, are restricted to the eastern or coastal plains region of the state, and asphaltic concrete pavements are used statewide, but predominately west of the coastal plains region.

TABLE 1

Distribution of Basic Pavement Types

| Pavement Type | Distribution | | |
|---|---|---|---|
| | N | Mileage | Mileage Percentage |
| Flexible Pavements | 119 | 541.0 | 66.2 |
| JPCCP | 57 | 173.5 | 21.2 |
| CRCP | 19 | 102.5 | 12.6 |
| Totals | 195 | 817.0 | 100.0 |

## Overall Performance Evaluation

Each of the 119 projects surveyed was assigned a rating according to the system discussed earlier. However, for evaluation purposes it is convenient to group projects according to variations in pavement components. Also, in this manner a meaningful indication of the performance of a given pavement type or sub-type is provided by reducing the influence of a few extremely good or extremely poor pavements on the overall evaluation.

The composite ratings for the three basic pavement types listed in Table 1 are given in Table 2. The description, performance rating, and other pertinent listed data for each project are in Appendix B. In Table 2, it will be noted that both the mileage represented and the number of projects evaluated for a given pavement type are listed. The ratings, however, were done on a project wide basis, so any individual project may have had segments falling into any of the four rating classifications. The author, then, made a judgment as to which of the four ratings best represented the whole project. For this reason, the percentages shown in this and subsequent tables are based on the number of projects rather than the mileages represented by those projects.

While the information given in Table 2 is of some interest as an indication of the way the basic pavement types were rated, a better indication of the overall performance of a pavement type is gained by considering only those projects rating "good" or "excellent". As will be recalled from earlier discussion, projects in these two classifications were considered as likely to highly likely to exceed the life for which they were designed. Again, the fundamental criteria employed were whether or not flexible pavements with a 20-year design life could serve or be expected to serve for 8 years without the provision of a structural overlay, and whether or not rigid pavements could be expected to serve for 25 years (35 years for CRCP) without major structural upgrading. The basic pavement types viewed in the above manner are listed in Table 3, where the additional factors of mean pavement age and average annual maintenance cost per 24 ft. wide lane mile (as of June 30, 1975) have been added.

From Table 3 it is clear that flexible pavements have generally performed extremely well on the interstate system. The mean age of 9 years exceeds the design life of 8 years without an overlay, such that the 84% expected to exceed the design life can be stated with some confidence. Some variation can develop as time passes because the range in ages for the inflexible pavements is from new to 15 years.

Similarly, at a mean age of slightly over 10 years, or 40% of the design life, relatively poor overall performance of JPCCPs is indicated by the fact that only 56% are expected to exceed the design life. Additionally, the average annual maintenance cost is more than double that of flexible pavements. The rigid pavements range in age from 4 years to 17 years, and there are many variations in materials and in design and construction techniques. As will be discussed later, some sub-types of these pavements have performed extremely well while others have performed very poorly.

The most difficult basic pavement type to evaluate is the CRCP. Their mean age is slightly less than 5 years and the oldest has been in service about 9 years, so not enough time has passed to allow a confident evaluation based on a 35-year design life. Currently, 2 of the 19 projects are sufficiently defective to raise the possibility of their needing a major rehabilitation prior to reaching their design life. Thus, the limited data available indicate that approximately 89% of the CRCPs have a good chance of lasting for the design life. The average annual maintenance costs on these pavements has been approximately one-half that for flexible pavements and one-fourth that for JPCCPs.

Approximately 77% of the total interstate projects are expected to last for their design lives. As indicated in Table 3, this figure and the overall average annual maintenance cost of $755 per lane mile are strongly influenced by the relatively poor performance of JPCCPs.

TABLE 2

Composite Rating of Basic Pavement Types

| Rating | Flexible Pavements | | | JPCCP | | | CRCP | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mileage | N | % | Mileage | N | % | Mileage | N | % | Mileage | N | % |
| Excellent | 145.9 | 37 | 31 | 21.6 | 8 | 14 | 43.3 | 10 | 52 | 210.8 | 55 | 28 |
| Good | 290.7 | 63 | 53 | 59.2 | 24 | 42 | 45.6 | 7 | 37 | 295.5 | 94 | 48 |
| Fair | 86.3 | 16 | 13 | 74.5 | 19 | 33 | 13.6 | 2 | 11 | 174.3 | 37 | 19 |
| Poor | 18.1 | 3 | 3 | 18.3 | 6 | 11 | 0 | 0 | 0 | 36.4 | 9 | 5 |
| Totals | 541.0 | 119 | 100 | 173.5 | 57 | 100 | 102.5 | 19 | 100 | 817.0 | 195 | 100 |

TABLE 3

Overall Performance Evaluation of Basic Pavement Types

| Pavement Type | Mileage | Mean Age Mo. | Number Projects | % Expected to Exceed Design Life | Avg. Annual Maintenance Cost* |
|---|---|---|---|---|---|
| Flexible | 415.0 | 108 | 119 | 84 | $ 608 |
| JPCCP | 173.5 | 121 | 57 | 56 | 1,228 |
| CRCP | 102.5 | 57 | 19 | 89 | 344 |
| Total Interstate | 817.0 | 107 | 195 | 77 | $ 755 |

*Per 24 ft. wide lane mile

## Overlay Studies

It should be noted that the $608 per lane mile flexible pavement maintenance cost given in Table 3 reflects overlay costs to approximately 44% of the flexible interstate pavements. An analysis of the data for the pavements overlaid showed that the majority of a project had been overlaid at an average age of 8 years-2 months, and an average cost of $7,824 per lane mile, or an average annual cost of $958 per lane mile. The total annual maintenance costs for pavements having overlays was $1,148 per 24 ft. wide lane mile. Flexible pavements which had not been overlaid had an average annual maintenance cost of $190 per lane mile. The overlay age mentioned above is purely an average and the ages at which specific projects might need overlays are highly variable. The earliest at which an interstate pavement was overlaid was 47 months, while there is one project over 13 years old which has not been overlaid. Fifteen projects less than 8 years old have been overlaid, while 24 over 8 years old have not been overlaid.

In an effort to check the anticipated relationship between axle loading (EAL-18) and the need for an overlay, 42 projects which had been overlaid, and for which complete cross section and traffic information were available, were analyzed. This analysis is summarized in Figure 1, where the design cumulative EAL-18 and the actual cumulative EAL-18 at the time the overlay was applied are plotted for each project. Both the design and the actual cumulative EAL-18s were computed from methods developed by Vaswnai.[4,5] The correlation coefficient (r) of 0.38 indicates a statistically significant relationship between the design and actual cumulative EAL-18s, but that only a small percentage of the need for an overlay is explained by traffic loadings.

Several reasons for the poor correlation with traffic and for the wide variation in pavement ages at which overlays were provided are offered below.

1. Most of the overlaid pavements were designed prior to the development of the current pavement design methodology. A study of the design daily EAL-18 and the actual daily EAL-18 at 10 years of age showed that the traffic loading estimates were in error by an average of 50%, with underestimates predominating.

2. Cumulative EAL-18 loadings are not a factor in decisions to provide overlays. (A recent FHWA policy on the provision of overlays on the interstate system may soon dictate that such loadings become one of the decision criteria.)

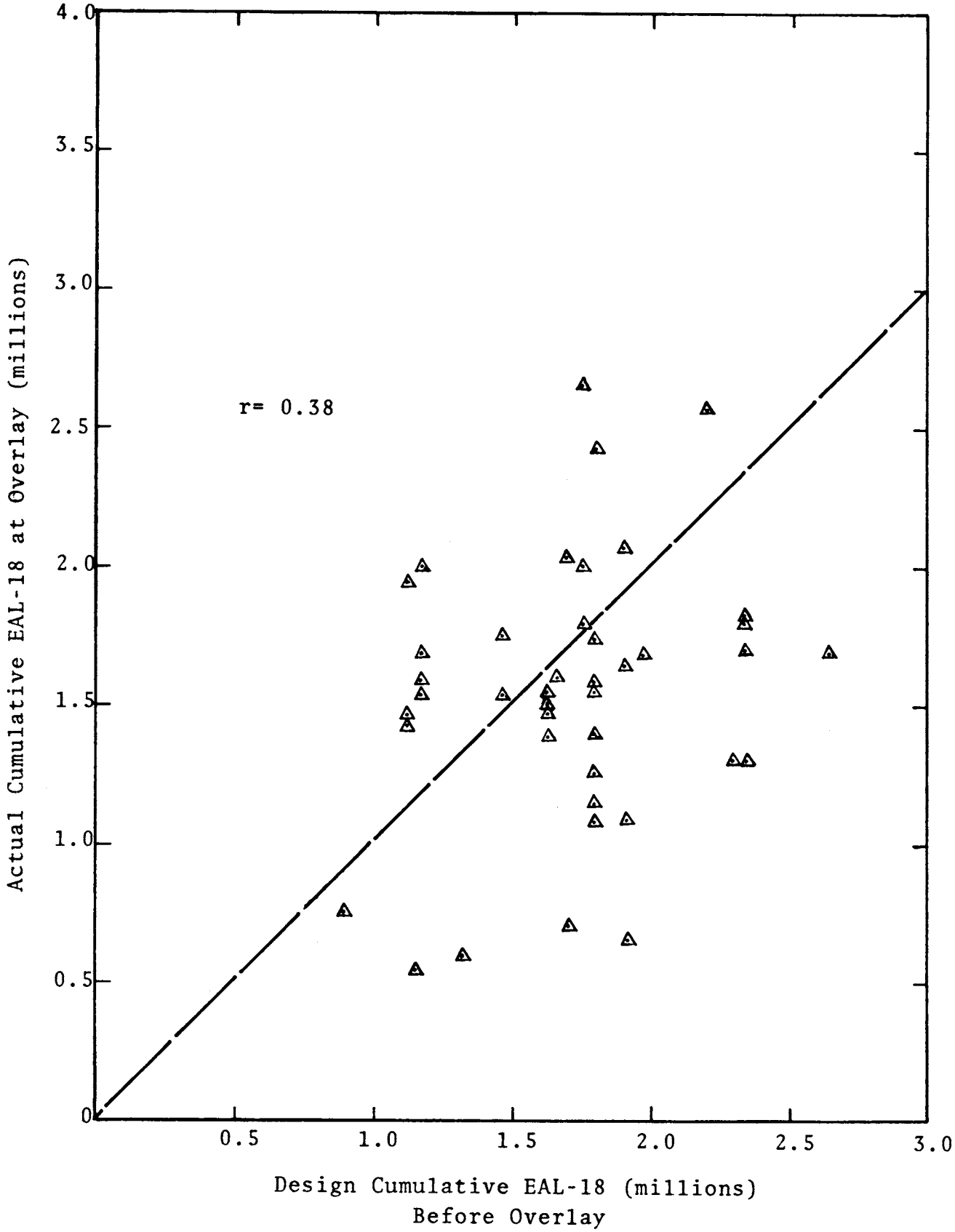


Figure 1. Design vs. actual cumulative EAL-18 at Overlay Age.

3. As evidenced by several instances in which construction projects crossed residency or district lines but overlays stopped at those lines, overlays are not provided on the same basis in all areas of the state.

4. Variabilities in pavement materials cannot all be accounted for in the design process. As will be discussed later, several flexible interstate pavements failed well before traffic loadings could be a factor.

Notwithstanding the above variabilities, it would appear wise to develop overlay design procedures which would relate to original design considerations and would provide a basis for uniform application statewide.

## Pavement Distress Analysis

Before undertaking a discussion of the performance of pavement sub-types, it is convenient to consider the types of distress associated with those sub-types and contributing to the way they were rated. A complete analysis of all pavements was performed to arrive at as many sub-types as needed to reasonably represent major variations in pavement components. Flexible and rigid pavements are discussed in that order.

### Flexible Pavement Distress

The distribution of distress by pavement sub-type for flexible pavements is given in Table 4.

No indication of the degree of distress within a given project or group of projects is intended in Table 4. The percentages given reflect distress types found to at least some degree on the pavement sub-types shown. For example, 43% of all pavements with cement treated stone bases had at least some longitudinal cracking. More complete descriptions of the pavement sub-types and the types of distress affecting their performance ratings are given later. For the present, it is desirable to discuss each distress type and the pavement sub-type in which it is manifested.

TABLE 4

Flexible Pavement Distress Distribution by
Percentages of Projects Affected

| Distress Type | Percentage of Projects | | | |
|---|---|---|---|---|
| | Cement Treated Stone Bases and and Soil Cement Subgrades | Aggregate Bases Soil Cement Subgrade | Composite | Aggregate Base and Select Matl. Subbases |
| Longitudinal Cracking | 43 | 50 | 0 | 48 |
| Alligator Cracking | 0 | 10 | 0 | 29 |
| Transverse Cracking | 86 | 70 | 100 | 3 |
| Flushing | 14 | 30 | 63 | 47 |
| Shoving | 0 | 10 | 25 | 6 |
| Rutting | 0 | 0 | 0 | 27 |
| Raveling | 14 | 10 | 13 | 19 |
| Settlements | 29 | 40 | 0 | 72 |

## Longitudinal Cracking

Longitudinal cracking near the wheel paths is usually taken in Virginia as the first visible evidence of load-related distress associated with the fatigue failure of the pavement surface. It can be, in the case of pavements having rigid underlying layers, a simple reflection of longitudinal cracking from those underlying layers. The cracking is common on all the pavement sub-types listed above, except the composite type, where very rigid underlying layers prevent deflection to any significant degree. Much of the longitudinal cracking noted on pavements with cement treated stone bases may be of the reflection type.

## Alligator Cracking

Alligator cracking is usually indicative of advanced stages of the fatigue failure of the surface layers or of a weakness in underlying layers. It has the appearance of a road map and is sometimes called map cracking. It almost always occurs first in the wheel path of heavy traffic lanes and gradually spreads to other areas of the pavement. Alligator cracking was not detected on composite pavements or on pavements with cement treated stone bases. The cracking was detected on only 10% of the projects having cement treated subgrades, but on 29% of the pavements with aggregate bases and select material subbases.

## Transverse Cracking

Except in cases where shrinkage prone asphaltic concretes are used, transverse cracking is almost always a reflection of cracking in underlying rigid layers. It is prevalent on the interstate system except where no rigid layers were used. It is somewhat surprising that 70% of the pavements having aggregate bases and soil cement subgrades have at least some transverse cracking, a finding that suggests shrinkage cracks in the soil cement are reflecting through the aggregate base (usually 6 in.) and the bituminous layers. This was once thought to be highly unlikely, but has begun to appear more often as the type of construction grows older.

Transverse cracks will usually cause no serious problem if they are left alone. However, if attempts are made to seal them a tenting effect can develop at each crack with a resulting deterioration in the riding quality of the pavement.

## Flushing

Flushing is the presence of a shiny or "fat" surface caused by excess asphalt either over extended areas of pavement or at isolated spots. Flushing over extended areas is generally indicative of excess asphalt in the surface mixture, while that in isolated areas is generally indicative of paving over a patch containing excess asphalt, spillage of asphalt, or of the use of excess tack under the surface course.

Flushing is in evidence on all flexible pavement subtypes, but is most prevalent on the composite pavements and those built with select material subbases. On the composite

pavements flushing is most often in isolated spots where there is evidence of excess tack, perhaps due to the extreme imperviousness of the underlying concrete layers. On the select material sub-type, flushing can be either isolated or over extended areas. In some instances extensive flushing is associated with thin overlays used to restore skid resistance on otherwise satisfactory surfaces. These overlays contain asphalt content sensitive mixtures which can easily become flushed.

Shoving

Shoving is the abnormal displacement of the surface mix by wheel loads due to instability of the mix. It is associated with extreme flushing and was present to a significant degree on only the composite pavements.

Rutting

Rutting is the vertical displacement or channeling of the pavement surface in the wheel paths due to consolidation or failure of pavement layers under load. It is present only on the pavements with aggregate bases and select material sub-bases. It is possible that with these pavements the rutting is due to consolidation of the thick aggregate layers. No very severe cases of rutting were detected although several distressed areas measured 1/2 in. in depth.

Raveling

Raveling is the loss of coarse aggregate from the pavement surface, usually resulting from poor adhesion between the binding agent and the aggregate. It appears to be present to a modest degree in all types of flexible pavements, but generally can be associated with certain aggregate types. Aggregates most commonly causing problems are those of a siliceous origin, such as quartzites, which can have a low affinity for asphalt or which prefer to absorb water at the expense of the asphalt coating they originally had. Such stripping can take place in lower layers to cause serious problems which are not immediately evident.

Settlements

Fill settlements, while not strictly pavement problems, have contributed significantly to interstate maintenance requirements in some areas of the state. As can be noted in Table 4 only the composite pavements appear to be free of settlements, probably because most are constructed on old road beds where

earlier settlements may have been corrected. Settlements are present in all other sub-types, but are most severe in the areas where select material subbases were used. Note that 72% of the projects in this sub-type have some settlements. This frequency of settlement no doubt is a result of the soil types where the select material type of flexible construction is predominant, the western part of the state in the Ridge and Valley and the Appalachian Plateau physiographic provinces.(7)

Table 5 gives the distribution of pavement settlement problems by physiographic province. Note that in the Appalachian Plateau region 85% of the projects have settlements. This region of extreme western Virginia is underlain by sandstones and shales. The shales are of a type subject to rapid weathering or chemical conversion to heavy clays. Thus, fills may be built with the application of rock technology while the subsequent conversion to clay leads to severe consolidation problems some time after construction is completed. The behavior of these shales has led to the development of an ongoing research project nationally and at the Research Council.(8)

Pavements built in the Ridge and Valley province are subject to settlements due to the heavy clays encountered and to the presence of voids in the underlying limestone formations. Note that 74% of the projects in this region have some settlements.

Settlements in the Piedmont region (20% of the projects) are almost all due to poor compaction of micaceous silts or silt clays over small drainage structures.

Settlements in the Costal Plains region are primarily due to the consolidation of organic clays underlying some fill areas.

Other Flexible Pavement Distress

Other types of pavement distress were noted on flexible pavements to such a small degree not to warrant further consideration. Among these were potholes, patching, wear, and various instances of inexplicable cracking.

TABLE 5

Fill Settlements by Physiographic Providence

| Province | No.Projects | No.Defective | % Defective |
|---|---|---|---|
| Appalachian Plateau | 13 | 11 | 85 |
| Ridge and Valley | 72 | 53 | 74 |
| Piedmont | 20 | 4 | 20 |
| Coastal Plains | 14 | 6 | 43 |
| Totals or Percentage | 119 | 74 | 62 |

Rigid Pavement Distress

The major distress types identified on rigid pavements are listed in Table 6 with the frequency of their occurrence as a percentage of the projects affected. Note that in the tabulation jointed and continuously reinforced pavements have been listed separately.

Again, as with flexible pavements no effort has been made above to quantify the degree of a given distress type within a pavement sub-type. The data show, for example, that 79% of all JPCCPs have at least some major joint spalling. The field survey data show these pavements have major joint spalling occurring rarely, occasionally, or frequently 33%, 35%, and 11% of the time, respectively.

Since the distress noted on rigid pavements is so strongly a function of seemingly minor variations in design, materials, or construction features, these distress types will be discussed under the performance evaluation of pavement sub-types in the next section of this report.

TABLE 6

Rigid Pavement Distress Distribution by Percentage of Projects Affected

| Distress Type | Rigid Pavement Type | |
|---|---|---|
| | Jointed | Continuously Reinforced |
| Major Joint Spalling | 79 | N/A* |
| Transverse Cracking (uncontrolled) | 65 | N/A |
| Patching | 61 | 21 |
| Joint Pumping | 42 | N/A |
| Edge Pumping | 33 | 26 |
| Blowups | 37 | N/A |
| Scaling | 30 | 21 |
| Faulting | 30 | N/A |
| Settlements | 23 | 31 |
| Longitudinal Cracking (uncontrolled) | 14 | 21 |
| Slab Spalling | 5 | 11 |

*Not applicable

## Performance Evaluation of Pavement Sub-Types

The information given in Table 3 is of interest in a broad evaluation of interstate pavement performance. It can, however, be misleading in that certain pavement sub-types giving performances somewhat different from that of the basic pavement types is not recognized. In keeping with the detailed analysis mentioned earlier, the performance evaluation of pavement sub-types is summarized in Table 7. Typical pavement sections and their locations are given under the discussion of each sub-type. These discussions follow in the order of rating for each sub-type.

TABLE 7

Performance as a Function of Pavement Sub-Type

| Pavement | Mileage | Mean Age, Mo. | Number Projects | % Likely to Exceed Design Life | Average Annual Maintenance Cost* |
|---|---|---|---|---|---|
| 1. Rigid with 50 ft. long slabs, moderately graded subbase, no metal inserts | 19.7 | 193 | 9 | 100 | 272 |
| 2. Bituminous concrete with cement treated stone base and soil cement subgrades | 48.4 | 82 | 7 | 100 | 478 |
| 3. Composite | 17.2 | 45 | 8 | 100 | 633 |
| 4. Continuously reinforced concrete | 102.5 | 57 | 19 | 89 | 344 |
| 5. Flexible with aggregate bases and select material subbases | 403.9 | 114 | 90 | 84 | 606 |
| 6. Flexible with aggregate bases and soil cement subgrades or cement treated select material | 71.1 | 109 | 15 | 73 | 550 |
| 7. (a) Rigid with 61.5 ft. long slabs, cement treated subbase | 22.5 | 81 | 14 | 71 | 1,134 |
| (b) Rigid with 61.5 ft. long slabs, modified subbase (minus 200 less than 10%, nonplastic) | 57.7 | 117 | 16 | 50 | 1,348 |
| (c) Rigid with 61.5 ft. long slabs, dense subbase (minus 200 5% to 15%, PI less than 6) | 66.3 | 127 | 17 | 29 | 1,648 |

*Per 24 ft. wide lane mile.



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1. JPCCP's with 50' Long Slabs (9 Projects)

Percentage likely to exceed design life: 100
Average annual maintenance cost per lane mile = $272
Typical pavement section: 9 in. reinforced concrete
4 in. subbase material
Typical location: I-64, City of Hampton
I-95, Greensville County
Typical soils: Coastal Plains sands and gravel, and organic clays

There is some variation in the subbase material; some is classified as "subbase material", and as "crushed aggregate". A study of project records showed that local subbase material containing up to 30% minus 200 was used on the I-64 projects. While this very fine material could be a contributor to poor drainage and thus result in pavement pumping, an extremely high level of joint seal maintenance has apparently prevented such problems. The I-95 projects contained a crushed aggregate subbase daylighted through the shoulders and apparently providing adequate drainage.

All of the projects in this sub-type have given good to excellent performance for from 15 to 17 years, and there is good reason to expect that they will last for at least their design life of 25 years.

No cases of severe distress were found on any of these projects, although several have occasional patches of joint spalls and several have a number of transverse cracks which appear to cause no problem. Joint spalls on these projects appear to be the result of normal wear. No metal inserts, which will be seen later to have severely distressed other jointed concrete pavements, were used on these projects.

2. Bituminous Concrete Pavements with Cement Treated Stone Base and Soil Cement Subgrades (7 Projects)

Percentage likely to exceed design life: 100
Average annual maintenance cost per lane mile = $478
Typical pavement section: 9 in. bituminous concrete
6 in. cement treated crushed stone
6 in. soil cement subgrade
Typical location: I-85, Richmond District
Typcial soils: Piedmont micaceous silts

The only variations in pavement cross sections are in the thickness of bituminous concrete, which can range up to 10 in. total thickness.

All projects in this sub-type have given good to excellent performance for from 4 1/2 to 9 1/2 years. Only one has been overlaid, at an age of 8 years. All have an abundance of transverse cracking as expected for pavements with the cement stabilized stone base. These cracks appear to cause no performance problems, although some field engineers seem to feel they are psychologically undesirable. The only other significant defects in these pavements are longitudinal, load related cracking and isolated instances of flushing.

3. Composite Pavements (8 Projects)

Percentage likely to exceed design life: 100
Average annual maintenance cost per lane mile = $633
Typical pavement section: 3 1/2 in. asphaltic concrete
8 in. plain PCC base
6 in. cement treated crushed aggregate
Typical location: I-95, Fairfax and Arlington Counties
Typical soils: Sands and gravels, silty clays

There are no significant variations in design although most projects contain at least some old PCC which is utilized as base along with the new 8-in. plain PCC base. The old concrete pavements were in fair to good condition when overlaid.

All projects in this sub-type were rated as good to excellent. Although two are almost new, two others are almost 8 years old and performing well. With the exception of the expected transverse reflection cracking, the most significant problem with these pavements is a larger than normal (for the interstate system) degree of flushing. Observations on the projects led to some speculation that the highly impervious PCC base makes any excess of tack coat subject to bleeding through the surface rather than being absorbed into the base course. The extremely high traffic volumes on these projects (averaging nearly 100,000 ADV) could aggravate this situation. It may be desirable to consider using a lower rate of tack application on this type of construction than in cases where underlying layers are more porous.

4. Continuously Reinforced Concrete Pavements (19 Projects)

Percentage likely to exceed design life: 89
Average annual maintenance cost per lane mile = $344
Typical pavement section: 8 in. CRCP
6 in. cement treated crushed stone
Typical location: I-64, Culpeper, Richmond, and Suffolk Districts; I-85, Richmond District
Typical soils: Coastal Plains sands and gravels, silty clays, micaceous silts

Variations in pavement cross section include the provision of soil cement treated subgrades in Piedmont soils and the use of nontreated aggregate bases on some of the earlier projects built. The only major variation in the design of the CRCP itself is in the elimination of transverse reinforcing steel from projects built since 1969. A major change in construction methodology occurred about 1968 with the transition from sideforms to slipform paving. Each of these variables and any performance problems identified with CRCP in the state have been discussed in an earlier publication by the author.[9] The performance problems are discussed below with an indication of the number of projects found during the survey to have the defect under discussion.

The most noteworthy problems are indicated below and discussed in the order of their severity.

1. Pavement failures due to poor consolidation of concrete.

2. Pavement failures due to poor quality concrete.

3. Loss of shoulder material due to edge pumping related to inadequate drainage

4. Random longitudinal cracking, and

5. Fill settlements.

Failures Due to Poor Consolidation (3 Projects)

The most severe performance problem to occur in Virginia's CRCP to date is a result of honeycombing caused by inadequate consolidation of the paving concrete.

An example of the most serious type failure encountered to date is illustrated in Figures 2 and 3. Figure 2 is a photograph of a segment of 8 in. thick by 24 ft. wide slipformed CRCP. A temporary bituminous concrete patch is evident in the picture. This type failure is characterized by wide, arrow-straight cracks located directly above the transverse steel and by edge pumping, as are also shown in Figure 2.

The cause of this type failure was immediately revealed by full-depth cores taken through the transverse cracks and at intermediate points between cracks. Figure 3 is a side view of one of the cores taken through a crack at the transverse steel. There is a noticeable lack of consolidation of

the concrete directly below the steel. The result is a void directly under the steel with a very wide crack extending from the void downward to the bottom of the CRCP. No doubt the reduced cross section caused by the void under the steel has resulted in the wider than normal crack at the pavement surface and in the crack lying in the same vertical plane as the steel. Strangely, cores taken from between the transverse bars showed no visual evidence of poor consolidation. Edge pumping in the section appears to have resulted from surface water entering the wide transverse cracks and becoming trapped between the pavement and the cement stabilized subbase. The stabilization has prevented the loss of significant amounts of subbase material.

The above type distress has progressed to a serious degree in several segments on one contract in the state. All paving was with a slipform paver employing "spud" vibrators at an unknown spacing and frequency. Also, there are no records of paver speed through the failed sections.

A second type of consolidation problem has occurred at construction joints and has been found to at least a small degree on several CRCP pavements. These failures are much less severe than the type described above and are characterized by wide cracks at construction joints and by nearby potholes which are underlain by honeycombed areas. These failures have emphasized the need for greater attention to vibration at the construction joints, where consolidation is more difficult because the longitudinal steel is doubled. The repair of problems caused by poor consolidation has been time-consuming and costly. In most cases the longitudinal steel is left in place and new concrete placed around it. However, the time consumed in chipping the old concrete from the steel has led to long lane closures and high traffic control costs.

The consolidation problems encountered while severe on only one contract, serve to point up the already recognized need for realistic vibration specifications currently under development for paving concrete.

Figure 2. CRCP failure due to poor consolidation.

Figure 3. Core taken from a poorly consolidated pavement.

Failures Due to Poor Quality Concrete (1 Project)

Several failures on one of the earlier CRCPs built in the state resulted from poor quality concrete caused by excessive water-cement ratios. These failures are few in number and usually involve only a few square yards of pavement. The failures are characterized at early ages by closely spaced transverse cracks which are joined by short longitudinal cracks. Deep surface erosion has resulted from relatively few vehicle passes even without the application of deicing chemicals. To date, several of these areas have been replaced and several have small temporary bituminous patches.

Since the failed areas tend to represent about one batch of paving concrete, it was concluded that poor control of the concrete placed by a drum road mixer was to blame. All subsequent CRCP concrete has been from stationary central mix plants, and the problem has not been detected on these projects.

Edge Pumping Due to Poor Draingage (8 Projects)

An example of edge pumping due to poor drainage is illustrated in Figure 4, where staining of the bituminous shoulder is evident. The problem has occurred on projects where the subbase is cement stabilized while the shoulder base material is unstabilized sand and gravel with a 2-3 plasticity index. The condition exists primarily at the low point of sag verticals.

Trenching and edge deflection tests showed that no measurable void existed under the CRCP. It was concluded that the pumping resulted from surface water trapped at the interface between the CRCP and the impervious shoulder material. The stains were attributed to fines lost from shoulder material, as was further evidenced by a slight depression of the shoulder at its contact with the CRCP.

Corrective action has been taken in the form of trenching the shoulder at the pavement edge and backfilling with a highly pervious one-sized aggregate. Water is carried to the ditch lines with occasional side drains filled with the same pervious crushed stone or sand.

Design standards have been revised to prevent recurrences of the problem by the provision of nonplastic, pervious shoulder material.

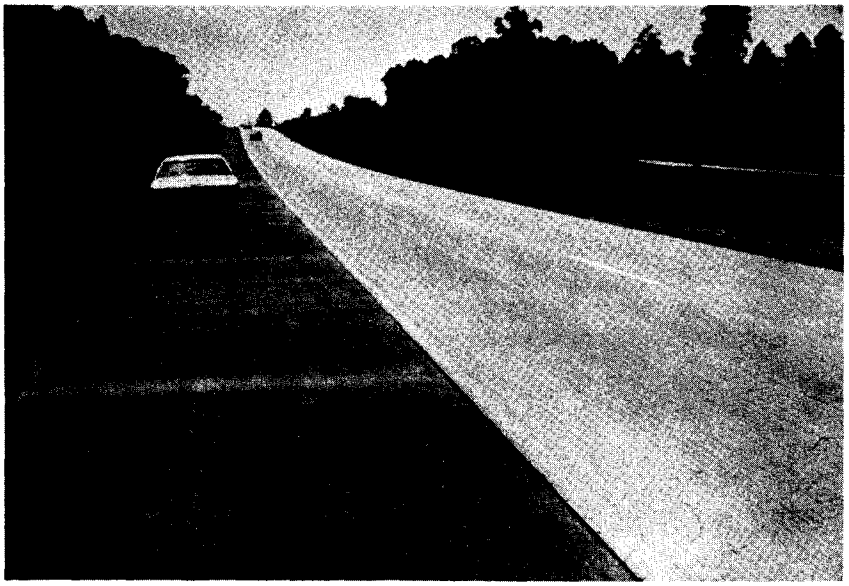

Figure 4. CRCP edge pumping due to poor drainage of shoulder material.

Random Longitudinal Cracking (4 Projects)

Since the introduction of slipform paving using the polyethelene strip to create a weakened-plane longitudinal joint, some of the state's CRCPs have suffered a modest amount of random longitudinal cracking. This experience has been reported by many other agencies using similar construction procedures.

Fortunately, in Virginia the polyethelene tape and cement stabilization of subbases occurred simultaneously so there is little danger, and no evidence, of faulting of the longitudinal cracks. Another factor making both faulting and the development of excessive crack widths unlikely is the tendency of the random cracks to occur within the limits of the 30-in. long tie bars spanning the center joint. For these reasons, random longitudinal cracking is not considered to be a serious performance problem in Virginia at this time.

Fill Settlements (7 Projects)

While fill settlements are not strictly a pavement problem, several of the CRCPs built in the state have been subject to distortions due to such settlements, particularly directly over minor drainage structures. The structural

integrity of the pavements does not seem to be affected by these deformations, unless unsound concrete is present. Thus, in almost all cases the pavements conform to the fill settlements with no evidence of the development of unusual cracks.

Such conditions are routinely corrected by mud jacking, with the pavements returning to grade with no evident defects. As far as can be determined, the only way to combat these settlements is through careful attention to backfill and embankment construction.

5. Flexible Pavements with Aggregate Bases and Select Material Subbases (90 Projects)

Percentage likely to exceed design life: 84
Average annual maintenance cost per lane mile = $606
Typical pavement section: 9 1/2 in. bituminous concrete
6 in. crushed stone
9 in. select material
Typical locations: Most interstate pavements in Bristol, Salem, and Staunton Districts
Typical soils: Clays, silty clays, rock cuts

Occasional variations in cross section include up to 24 in. of select material in undercut areas and small differences in the total thickness of bituminous concrete. This pavement sub-type is by far the most used on the interstate system, comprising almost 50% of the total mileage in the state. Since it is the predominant pavement type in the western part of the state, from the Tennessee state line on the south to the West Virginia state line in the north, there are many variations in material types. Select materials range from floodplain sand and gravels to good quality crushed stones. The crushed stone base is predominately of limestone, with quartzite being used in some cases. The bituminous concrete, in most cases, consists of base, binder, and surface courses. Most lower courses are constructed of mixtures containing limestone coarse aggregate and limestone or siliceous fine aggregate. The surface courses contain non-polishing coarse aggregates (usually quartzites, greenstone, or granite) and siliceous sands.

Pavements in this group range in age from new to 15 years. The performance has certainly been adequate, with 84% of the projects being expected to exceed the design life. However, several noteworthy cases of poor pavement performance do

occur in this group. At least one of these projects (0081-081-001, P403) suffered severe surface distress within 2 years after construction. Studies at that time showed that the binder course had been constructed of a stripping prone quartzite and was seriously deteriorated in the wheel paths. A subsequent overlay on this project has also performed poorly. Based on the behavior of this project and others in the area, the Department took action to restrict the use of the problem aggregate.

Due to the location of pavements of this sub-type, many have been subject to severe settlement problems, as discussed earlier.

6. Flexible Pavements with Soil Cement Subgrades and Aggregate Bases (15 Projects)

Percentage likely to exceed design life: 73
Average annual maintenance cost per lane mile = $550
Typical pavement section: 9 1/2 in. bituminous concrete
6 in. crushed stone
6 in. soil cement
Typcial locations: I-64, I-85, and I-95, Richmond District; I-264, Suffolk District; I-66, Culpeper District
Typical soils: Micaceous silts and silty clays, Triassic redbeds, sands and gravels, organic clays

Occasional variations in pavement cross sections include small differences in the thickness of bituminous concrete and the use of cement treated select material rather than stabilization of in-place soils.

The performance of this type pavement has ranged from excellent to poor, with the poor performing projects being located in the Triassic redbeds. There is no ready explanation for this anomaly although it is speculated that the cement stabilization may have been less effective than expected in the shales and clays encountered on these projects. The pavement sub-type has given good to excellent performance in all other areas of the state.

7. Rigid Pavements with 61.5 ft. Long Slabs (47 Projects)

Percentage likely to exceed design life: See discussion below, Table 8
Average annual maintenance costs: See discussion below, Table 8

Typical pavement section: 9 in. reinforced concrete
6 in. subbase material
Typical locations: Various in Culpeper, Fredericksburg, Richmond, and Suffolk Districts, 3 projects in Salem District
Typical soils: Coastal Plains sands and gravels

Major and significant variations occur in the type of subbase used and in the use of a metal joint-forming insert on many projects. The effects of these variables on the distress manifestations and the performance ratings are discussed further below. Much of the discussion is from a report by Tyson and McGhee, where more detailed treatment of the problem is found.[10]

## Metal Inserts

The tubular metal joint insert shown in Figure 5 was used to form transverse contraction joints in many of the concrete pavements constructed in Virginia in the early 1960s. Placed in the fresh concrete, this device provided a weakened vertical plane at which contraction joints would occur. After the concrete hardened, the insert was crimped downward and a poured sealant was introduced.

A survey of these metal joint inserts in 1968 found their condition to be "fair to rusted" and "badly rusted" after 4 to 6 years of service.[11] Because the inserts were anchored by small flanges extending into opposing faces of concrete at the contraction joints, weakened planes existed and were aggravated by corrosion products. Remnants of a corroded metal insert lifted easily from a joint are shown in Figure 6.

The insidious nature of the concrete deterioration resulting from insert corrosion is indicated in Figure 7 and 8. Figure 7 shows a pavement area adjacent to a transverse joint containing the metal insert. The location of delaminated concrete was outlined on the pavement surface by sounding the pavement with a ball peen hammer. This technique for locating unsound concrete is documented in a report dealing with the detection of deteriorated concrete in bridge decks.[12] Figure 8 shows a core taken vertically through the joint. The metal insert and well-formed contraction joint are in the central portion of the core. The embedded flange of the insert had corroded sufficiently to rupture the concrete approximately 2 in. below the roadway surface. Weakened planes of this type, initially not evident from the surface, propogate under repeated wheel loadings and eventually intercept the pavement surface at 6 in. to 12 in. from the joint face.

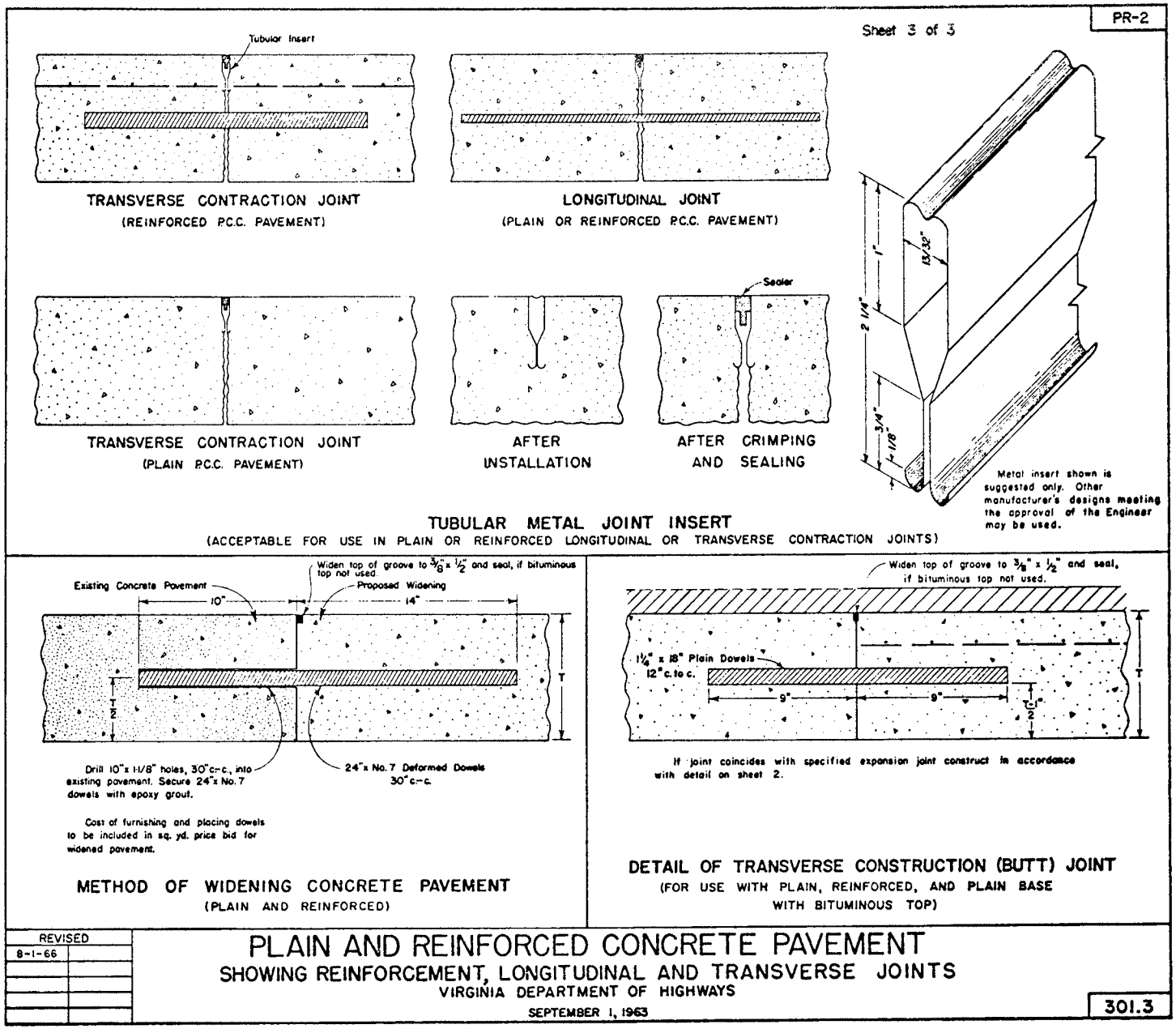


Figure 5. Tubular metal joint insert as it was accepted for use in PCC pavements in Virginia.

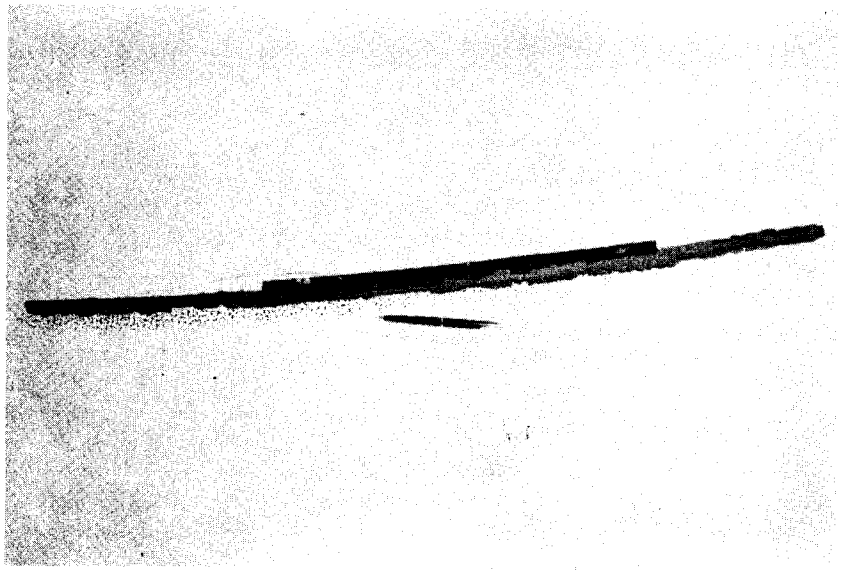

Figure 6. Remnants of corroded metal insert.

Figure 7. Pavement area adjacent to transverse contraction joint formed with metal insert.

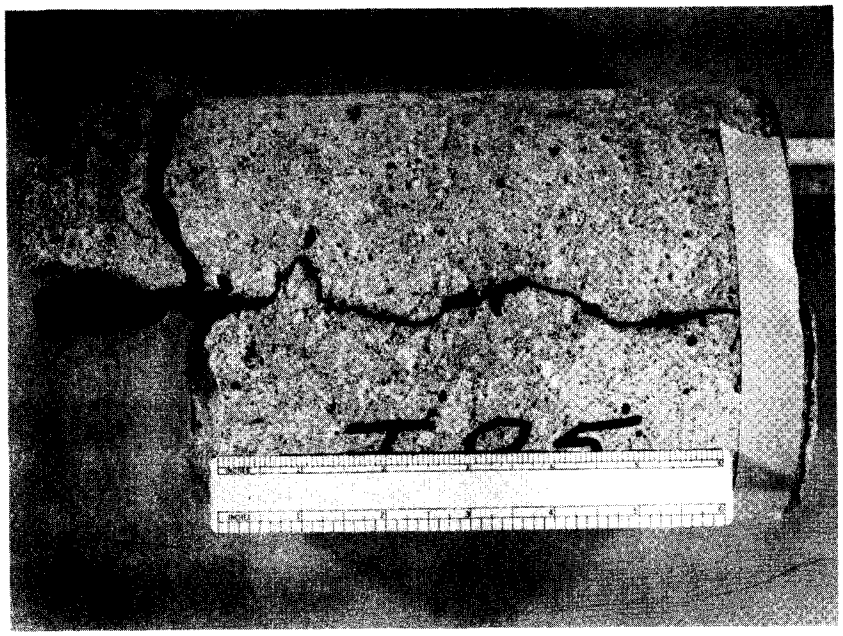

Figure 8. Core from area shown in Figure 14 showing vertical contraction joint and horizontal plane of weakness.

The rate at which these spalls develop is no doubt related to localized variations in concrete strength as well as to the magnitude and frequency of wheel loadings. Thus, the spalls form earliest in the most heavily traveled lanes but at different rates from location to location. For this reason, a given section of roadway will have some spalls which are readily apparent but many others which are incipient and can be located only by sounding the joint edges with a hammer or similar instrument. The Department prohibited the use of metal inserts in mid-1968 at the recommendation of the Research Council.*

## Subbase and Shoulder Materials

Most surface water can be expected to find its way to the underside of pavement slabs through the edge joint, which is difficult to seal and is often observed in a poorly sealed condition. Recent studies[13] have shown that 70% of the surface water flowing over a crack only 1/32 in. wide will enter the crack and proceed to the

*Memorandum from W. S. Scott to P. B. Coldiron, dated June 25, 1968.

lower pavement layers. According to presently accepted design procedures,[14] such surface water would be quickly carried away from the pavement through a pervious shoulder material. During the early 1960s, however, this factor was not given broad consideration, and it has been observed that many of the problem pavements were constructed of very densely graded subbase and shoulder materials. These materials, used for their good strength characteristics, their considerable economic advantage, and to facilitate construction, resulted in an impervious barrier at the pavement edge. As a consequence, during a steady downpour a reservoir of water is probably maintained along the outer pavement edge and is, therefore, available to pump subbase and shoulder materials under traffic-induced slab deflections. Depending on the permeability of the subbase and shoulder materials, this water may remain for significant periods of time after rainfall has ceased.

As wheel loads cross the joint, pressures on trapped water are reduced under the approach slab and increased under the leave slab. A net deposition of soil particles is caused under the approach slab by this pumping action. The accompanying faulting produces a less satisfactory pavement from the standpoint of rideability, but more important is the increased stress at the joint, which may be predicted by the faulting. Pumping may result in a migration of fine, incompressible material into the contraction joints from the outer edge and bottom portions at these joints. Unchecked, the reservoir can extend itself towards the pavement centerline while progressively undermining the structure and infiltrating the remaining bottom portion of the transverse joint. Early indications of pumping are soil staining of the shoulders, and later, faulting of transverse joints.

Several projects constructed during the early 1960s on I-95 in Spotsylvania and Stafford Counties contained subbase materials which have contributed significantly to differences in performance*. Pavements constructed on subbase materials having an average of 12% passing the number 200 sieve (U.S. Standard Sieve Series) quickly developed pumping problems with accompanying faulted joints. After 4 to 6 years under traffic, these pavements were also highly subject to blowups, due in part to incompressibles pumped into the joints from below. A sharp contrast in performance is seen on projects in the same area built on subbases with an average of 7% passing the number 200 sieve (designated modified subbase material). After 8 years under traffic these projects had 75% less

*Memorandum from K. H. McGhee to J. P. Bassett, dated July 26, 1973.

pumping than did those constructed with the more densely-graded subbases, even though extensive efforts had been made to eliminate pumping problems from the densely-graded sections through the use of edge drains installed by maitenance forces. In addition, joint faulting and blowups were very significantly reduced on the coarser graded subbases.

In recognition of the superior performance of pavements constructed with open-graded subbases and shoulder materials, the Department, in 1973, adopted a shoulder material specification allowing no more than 6% of such material to pass the number 200 sieve, and requiring the use of nonplastic materials.

Some later interstate pavements with 61.5 ft. long slabs were constructed on cement stabilized subbases which will be seen below to have contributed to significantly better performance.

## Cumulative Effect of Metal Inserts and Subbase Type on Distress Manifestations, Performance Evaluation, and Maintenance Costs

The effect of subbase type on the distress types, performance rating, and maintenance costs on jointed pavements is indicated in Table 8 for the most important distress types. In this table projects considered to be significantly affected by a given type distress were those noted on the field survey to have that distress to an occasional or frequent degree.

Note that projects constructed with dense-graded subbases have higher maintenance costs and much higher incidences of major spalls, blowups, pumping, and joint faulting than do projects with either modified or stabilized subbases. As indicated in the earlier discussion, all four of these distress types can be influenced by water trapped beneath the pavement and subjected to pumping action under wheel loads. Although the subbase extends from slope to slope it is too dense to permit the passage of water. Only 29% of these projects are expected to last for the design life.

Projects with modified subbases are moderately affected by all four types of major distress. That these projects are much less affected than those with dense-graded subbases is almost certainly due to the better drainage characteristics of the modified subbase which is daylighted through the shoulder. Fifty percent of these projects are expected to last for the design life.

TABLE 8

Effect of Subbase Type of Distress, Performance Rating, and Maintenance Costs
Pavements with 61.5 ft. Long Slabs

Percentage of Projects Sign. Affected By

| Subbase Type | Mean Age | Number Projects | Mileage | Major Spalls | Blowups | Pumping | Faulting | % Likely to Exceed Design Life | Avg. Annual Maintenance Cost* |
|---|---|---|---|---|---|---|---|---|---|
| Dense | 10 yr. 7 mo. | 17 | 66.3 | 76 | 35 | 71 | 71 | 29 | $1,642 |
| Modified | 9 yr. 9 mo. | 16 | 57.7 | 19 | 19 | 25 | 19 | 50 | 1,348 |
| Stabilized | 6 yr. 9 mo. | 15 | 22.5 | 27 | 7 | 20 | 0 | 71 | 1,134 |

*Per 24 ft. wide lane mile.

In the case of the stabilized subbases, the stabilized material is 2 ft. wider than the concrete pavement, while a densely graded aggregate is used under the shoulders and laterally to the slope. While pumping is evident on some 20% of these projects it is primarily edge pumping much like that described earlier for CRCPs. In the present case, water apparently is trapped in the pavement-shoulder interface such that the material ejected by the pumping action is primarily from the dense-graded shoulder material. The absence of joint faulting on these projects suggests that no serious subbase damage has resulted from the pumping conditions. Seventy-one percent of these projects are expected to last for the design life.

In the evaluation of the distressed pavements constructed of all three subbase types, analysis showed that the presence of metal inserts was the dominant factor only on the frequency of joint spalling or patching, where 81% of the projects having the inserts were significantly affected. This figure contrasts with 33% significantly affected for projects without metal inserts.

With regard to blowups and major spalls, additional factors of some importance are the long slabs and the difficulty in maintaining a joint seal between these slabs. Earlier studies treated this matter in detail and resulted in revisions to pavement design standards to provide for maximum 40 ft. long slabs with preformed chloroprene seals.(15) Also included in the present study were recommendations for improved joint maintenance, including the removal of metal inserts and joint restoration with preformed seals.

The effects of subbase type and metal inserts on the performance of pavements in this sub-type are indicated in Table 9.

Clearly, the stabilized subbases have contributed to performance much superior to that of the other types of subbase. Note that where no metal inserts were used, all 3 projects with stabilized subbases are expected to exceed the design life. On the other extreme, only 25% to 30% of projects with dense-graded subbases are expected to exceed the design life. The subbase type is the dominant factor in the performance of these pavements, although the metal inserts also play a strong role. These inserts have a strong adverse effect on the performance of the pavements with stabilized subbases and a marked effect on those with modified subbases. Pavements with densely graded subbases have performed poorly whether or not the metal inserts were used.

Maintenance costs are shown in Table 9 to be related to both subbase type and the presence of metal inserts. However, differences in pavement age and traffic conditions make the nature of the relationship hard to determine on a statewide basis. For this reason it is of some interest to consider the effect of subbase differences and the presence of metal inserts on the maintenance costs of projects built in the Fredericksburg District in the early 1960s. These projects are similar in age and traffic exposure (very heavy). The maintenance costs and relevant information are summarized in Table 10.

Note that again subbase type is clearly the dominant factor, with the maintenance cost difference amounting to about $1,500 per lane mile when projects with dense subbases without metal inserts are compared with those with modified subbases with the inserts. A comparison of projects with dense subbases and with metal inserts to those without metal inserts suggests that the inserts have added about $600 per lane to the annual maintenance cost. This figure compares well with the statewide costs determined in Table 9.

TABLE 9

Effect of Subbase Type and Metal Inserts on Performance and Maintenance Costs of Rigid Pavements with 61.5 ft. Long Slabs

| Subbase Type | Number Projects | % Likely to Exceed Design Life | Avg. Annual Maint. Costs |
|---|---|---|---|
| Without Metal Inserts | | | |
| Stabilized | 3 | 100 | $ 752 |
| Modified | 8 | 63 | 498 |
| Dense | 4 | 25 | 1,896 |
| All w/o inserts | 15 | 60 | 922 |
| With Metal Inserts | | | |
| Stabilized | 11 | 64 | 1,238 |
| Modified | 8 | 38 | 2,200 |
| Dense | 13 | 31 | 1,362 |
| All with inserts | 32 | 44 | 1,528 |

TABLE 10

Effect of Subbase Type and Metal Inserts on Maintenance Costs for Projects in the Fredericksburg District

| Subbase Type | Metal Inserts | Number Projects | Average Age(mo.) | Cumulative 18-kip(million) | Average Annual Maintenance Costs* |
|---|---|---|---|---|---|
| Dense | Yes | 5 | 126 | 8.42 | $ 2,731 |
| Dense | No | 2 | 132 | 9.34 | 2,146 |
| Modified | No | 2 | 121 | 8.25 | 656 |

*Per 24 ft. wide lane mile.

## General Observations

During the field survey phase a number of observations were made bearing on pavement condition, performance, maintenance, or operations. Some of these which could not be conveniently discussed earlier are reported below. Several appear to call for consideration by the operating divisions to determine whether changes in standards or specifications are warranted. Others may warrant further research.

### Polishing of Shoulder Surface

In some instances where non-polishing aggregates have been used in the surface mix while the shoulder is surface treated with a limestone aggregate, it was noted that there is about a 1 ft. wide strip of apparently polished shoulder surface adjacent to the white line on the right side of the pavement (Figure 9). Since this strip is no doubt the result of occasional vehicle wanderings onto the shoulder it is likely that no safety hazard is indicated. Nevertheless, the condition could be easily eliminated with the provision of an additional 1 ft. of surface mix to the right of the edge line. While adoption of this practice would require approximately 4% additional surface mixture, it could provide an additional advantage of improved surface drainage.

Figure 9. Polished strip at pavement edge in shoulder surface.

Joints in Stabilized Pavement Layers

One project having a cement treated stone base underlying the bituminous concrete layers was observed to have a straight longitudinal crack at the center of one lane throughout most of the project (Figure 10). Since the crack is consistently located 6 ft. from the pavement edge it is almost certainly a reflection crack relating to the joints in the rigid cement treated stone base. While no serious problem results from this crack it may under certain conditions of light and moisture provide misleading delineation. It is suggested that some consideration be given to a requirement that joints in cement treated base materials be located near lane divisions.

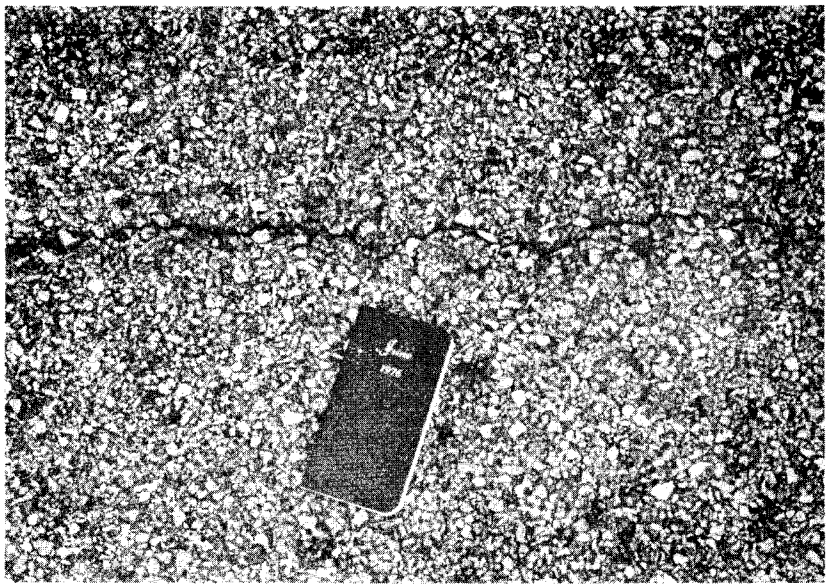

Figure 10. Top photo, view of longitudinal reflection cracking associated with joints in cement treated base course. Bottom close-up.

## Ramp Performance

Ramp performance was observed statewide to be inferior to the performance of main line pavements.

For flexible pavements this finding is substantiated by field surveys showing a much greater incident of cracking and other distress on ramps (Figure 11). It was further noted that ramps are often overlaid at earlier ages than are the main line pavements.

In the case of ramps with rigid pavements, the distress is usually in the form of excessive longitudinal movement of slabs causing tie bar failure and crushing of the concrete at the ramp-main line transition. A related, frequently observed defect with rigid ramps is pushing of any flexible pavement to which the ramp is adjoined. This apparently is also due to excessive joint opening and slab movement.

Discussions with a number of field engineers and other personnel in the Department have resulted in two speculative reasons for inferior ramp pavement performance. These are:

1. In the case of flexible ramps, traffic is insufficient to keep the asphalt "alive", and

2. for both types of pavements, vehicle maneuvers including stopping, starting, and turning subject the pavement to stresses unlike those encountered on main lines.

While the writer tends to support the second view, ramp pavement performance is apparently an area where additional study by design and research personnel would be appropriate.

## Construction Joints in Asphaltic Concrete Surfaces

On both original and overlaid asphaltic concrete surface courses there is a recurring problem at construction joints. One of two things appears to happen:

1. The first load of plant mix does not perform well due to apparent gradation problems, excessive asphalt, or excessive temperature; or

2. the distributor applying the tack coat is not properly controlled at the beginning of its run so that excessive tack is applied at the construction joint and for some distance ahead (Figure 12), with the location of each nozzle being traceable on the pavement surface in some instances.

There apparently is a need for closer attention to the first load of plant mix applied to a given section of roadway and to the beginning of tack application.

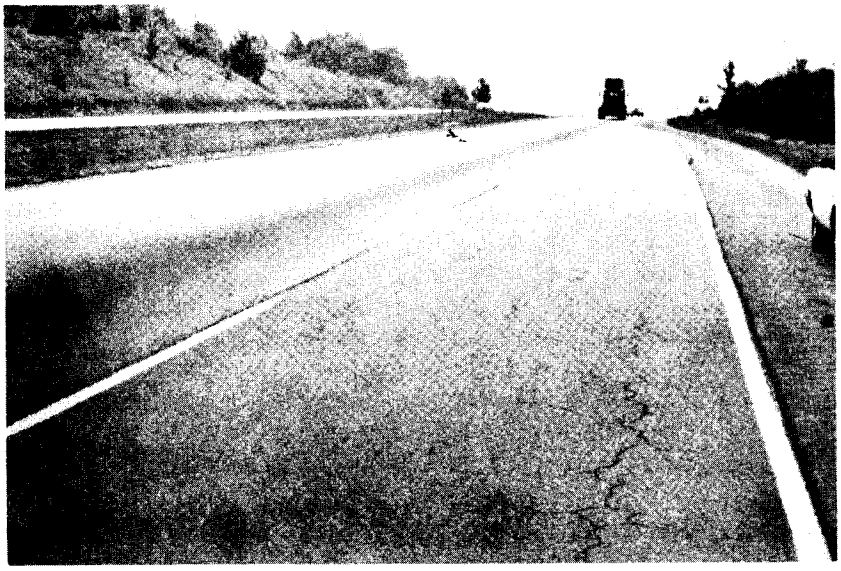

Figure 11. Contrast between performance of ramp and main line, flexible pavement.

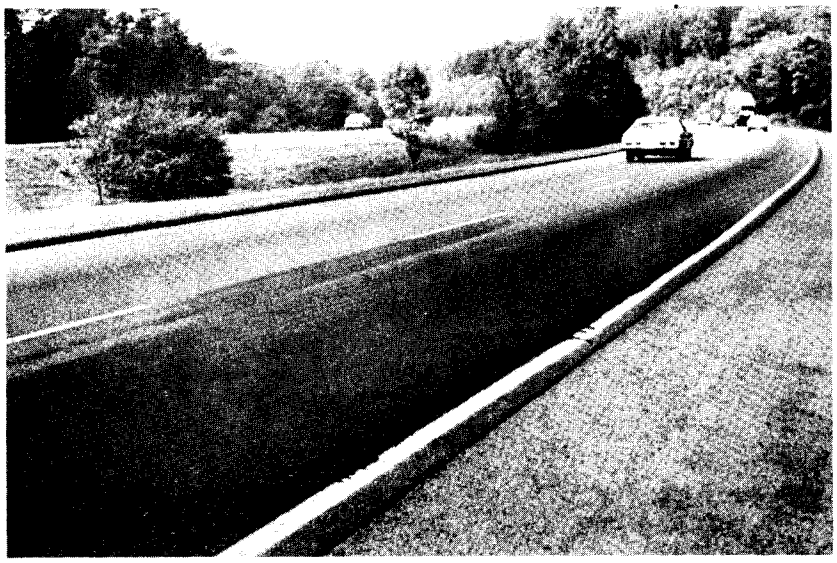

Figure 12. Example of excessive asphalt cement at construction joint.

## Pavement Performance Near Truck Weighing Stations

Relatively poor performance of flexible traffic lanes near the entry and exit of truck weighing stations suggests that design procedures should recognize that 100% of the truck traffic is in the traffic lane in those areas and that the distribution factors applied to normal design are not appropriate. While it is recognized that construction difficulties may prohibit a radical change of cross section in these areas, the observation is offered for consideration by the pavement design engineer.

## Differences in Pavement Performance Related to Direction of Travel

In many cases, the field survey showed moderate to marked differences in performance between the two directions of travel on interstate pavements. In an effort to examine any relationship between this observation and differences in wheel loadings applicable to the direction of travel, 1975 data from a total of 59 traffic counting stations throughout the state were studied. Data were analyzed according to the method given by Vaswani to determine the daily 18-kip (EAL-18s) equivalent axle loadings in each direction.(5) The data used were averages of either 4 or 9 counts made at each counting station during 1975. The only pavements considered were those that had not been fully overlaid so that the performance assessment could be based on the original pavement surface and would not be obscured by any variations in overlay characteristics.

While several segments of roadway were found to have significant directional differences in daily EAL-18s, these differences were reflected in performance variations only on the flexible pavements on I-81 in the western portion of the state having thick select material subbases. Several sections in which such variations were found are indicated in Table 11. Note that these sections, some of which are contiguous, persistently have greater 18-kip equivalencies in the southbound lane than in the northbound and persistently have better performance ratings in the northbound than in the southbound. The mean difference in 18-kip equivalency between the two directions for all 6 sections is 18%, while the greatest difference is 27% for section E. In all sections there was noticeably more longitudinal and alligator cracking in the lanes having the higher 18-kip equivalencies.

TABLE 11

Performance and Directional Traffic Differences, I-81

| Section | Location | Direction | Performance Rating | 1975 Daily 18-kip Equivalency |
|---|---|---|---|---|
| A | From: Rte. 11, E. Marion<br>To: Rte. 11, W. Wytheville | NBL<br>SBL | Good<br>Fair | 454<br>516 |
| B | From: Rte. 185, Edinburg<br>To: Rte. 42, Woodstock | NBL<br>SBL | Good<br>Fair | 589<br>663 |
| C | From: Rte. 42, Woodstock<br>To: Rte. 55, N. Stanley | NBL<br>SBL | Fair<br>Poor | 633<br>763 |
| D | From: Rte. 277, Stephens City<br>To: Rtes. 17-50, Winchester | NBL<br>SBL | Good<br>Fair | 603<br>682 |
| E | From: Rtes. 17-50, S. Winchester<br>To: Rte. 7, E. Winchester | NBL<br>SBL | Good<br>Fair | 689<br>877 |
| F | From: Rte. 7, E. Winchester<br>To: Rte. 11, N. Winchester | NBL<br>SBL | Good<br>Fair | 621<br>760 |

It is important to note that the differences in 18-kip equivalencies given in Table 10 would result in only very minor differences in the design thickness indices required under the Virginia flexible pavement design method.[16] Section E, for example, would require only about 1 unit difference in thickness index between lanes for the truck traffic volumes encountered. The differences could be much more significant on pavements having lower volumes of truck traffic. For this reason, traffic engineers and pavement designers should be cognizant of occasions where large directional differences exist.

Maintenance personnel might also benefit from an awareness of such differences since it appears that both directions are sometimes overlaid when only one is seriously distressed. At least one district appears to be well aware of the directional differences in performance, as evidenced by the preponderance of overlays in one direction only.

Interestingly, PCC pavements and flexible pavements with cement treated stone bases seemed insensitive to differences in truck traffic volume between lanes. For examples, I-85 from the North Carolina state line to Route 46 near Cochran averages a 22% greater 18-kip equivalency on the southbound lane than on the northbound, while much of the PCC portion of I-95 between Richmond and Washington has a significant (up to 20%) difference between lanes. In neither case, however, is there a significant difference in pavement performance between lanes. This finding gives some support to the indications discussed earlier that the distress on the I-95 pavements is as much related to environmental, materials, and construction considerations as to the extremely heavy traffic volumes.

## Sealing of Pavement-Shoulder Joints

During the survey numerous efforts to seal the longitudinal joint between the PCC pavements and asphaltic concrete shoulders were observed. These efforts were almost never successful for more than a short period of time due to seasonal joint movements in excess of the capabilities of poured sealing materials. Earlier studies have shown that poured joints sealants will tolerate no more than about 20% to 25% extension.[15] Recent measurements have shown pavement-shoulder joint annual movements of up to 0.05 in. on Virginia pavements. Thus, a minimum joint width of 1/4 in. would be necessary to ensure that sealing materials are elongated no more than 20%. No perceptible joint is provided in Virginia at the pavement-shoulder interface such that joint materials are poured into joints of negligible width and the materials are heavily overstressed as soon as any cool weather occurs.

Due to several practical considerations, a pavement-shoulder joint width of from 1/2 in. to 1 in. is recommended. NCHRP Report No. 161 recommends use of a cutter disk mounted on a motor grader as an easy and efficient means of widening the pavement-shoulder joint prior to the installation of new sealing materials. A production rate of 200 lin. ft./min. is given for the operation.[17]

## Bridge Approach Expansion Joints Type XJ-1

Numerous observations have shown that bridge approach expansion joints type XJ-1 have provided excellent bridge protection. These joints are, however, subject to frequent maintenance and are of some detriment to the performance of the adjoining concrete pavement where nominal 3/8 in. to 1/2 in. wide contraction joints have been observed to open as much as 6 in. In these instances as much as 2 ft. closure has been measured on the XJ-1 joints. While no serious problems have been observed, it is evident that the wide pavement joints become badly infiltrated and lead to progressively wider opening and progressively more closure of the XJ-1 joints. Clearly, joint openings of much more than the 6 in. already observed will result in some hazard to the traveling public.

For this reason, it is suggested that design and research personnel undertake a study of the XJ-1 type joint to determine the need for some modification in the provision of bridge protection.

Incompatibility of Incidental Items

An instance of serious incompatibility between roadway items is illustrated dramatically in Figure 13. Note that the concrete median shown in this photograph has buckled and disintegrated in the vicinity of the XJ-1 joint, which was observed to have closed more than 1 ft. The median had been tied to the pavement with vertical bars such that it was forced to move with the pavement slabs. Clearly, no provision was made to accommodate this movement within the median so that it soon became geometrically incompatible with the pavement XJ-1 combination. In this case the problem could have been avoided by the provisions of a gap in the median at the XJ-1 location or by providing a plant mix median for the limits of the XJ-1.

While such incompatibility of components was not frequently observed, the incident is pointed out as an example of one type of consideration the designers of incidental items may wish to keep in mind.

It is recommended that the median design given in Figure 13 be modified to accommodate the movement expected at XJ-1 joints.

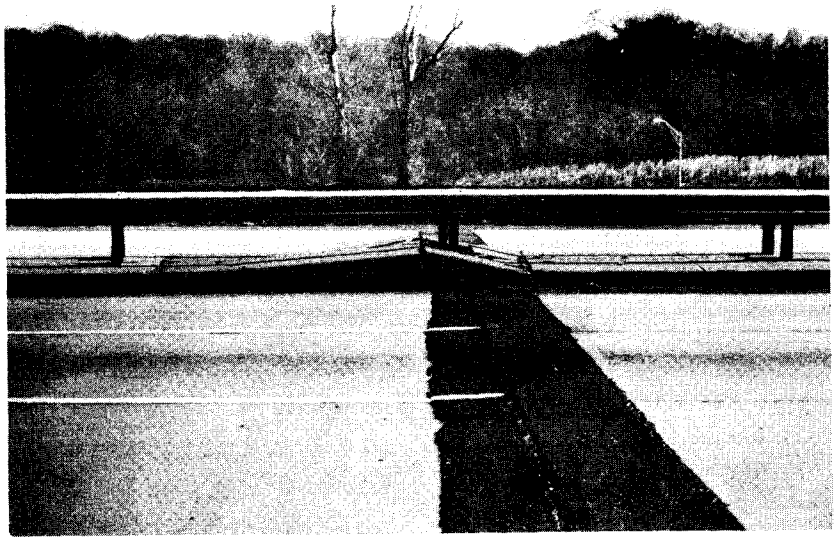

Figure 13. Incompatibility between concrete median and concrete pavement at bridge protection expansion joint.

## Station Numbers and Dates on PCCP's

In many cases station numbers and dates on PCCPs are stamped at the pavement edge where they are soon made unreadable by the edge line paint. Since these items provide important information for maintenance, design and research activities, it is suggested that they be moved to 1 ft. from the pavement edge where they should not wear excessively and would be out of the painted area.

## Comparisons of Asphaltic Concrete and PCC Pavements

Certain segments of the interstate system in Virginia have asphaltic concrete and PCC pavements contiguously located such that valid performance and maintenance costs comparisons can be made. Six instances where such comparisons were made are summarized in Table 12. In each case an effort was made to compare a similar number of projects of similar age and traffic characteristics. Due to some minor differences in age or traffic characteristics, maintenance costs have been expressed as both annual averages and as a ratio of the traffic loading. Therefore, the last column gives the average maintenance costs per million EAL-18.

Because relatively accurate information on initial construction costs are used as input at the time design decisions are being made, such costs were not considered relevant to the comparisons made here. However, the statewide average costs (1975 dollars) for all interstate pavements were $118,000 and $165,000 per lane mile for asphaltic concrete and PCC pavements, respectively. When one considers the usual Virginia design approach with a 40% salvage value after 20 years for asphaltic concrete pavements and after 25 years for PCC pavements the annual costs are $3,540 and $3,960 per lane mile for asphaltic concrete and PCC pavements, respectively. These figures suggest an asphaltic concrete pavement advantage of approximately $420 per year per lane mile.

Each of the comparisons outlined in Table 12 are discussed separately below.

1. I-64, Culpeper District- from Nelson-Augusta county line to Louisa-Goochland county line.

   This comparison of 3 flexible and 3 continuously reinforced concrete pavements is not very revealing because of the ages of only 39 mo. and 52 mo. for the flexible and CRCP types, respectively. Both pavements have had very low maintenance costs, with the early indications somewhat in favor of the CRCP.

2. I-66, Culpeper District— from Gainesville to I-495.

This comparison of 2 flexible and 2 jointed concrete pavement projects suggests some edge in favor of the concrete pavements. The concrete pavements, however, do contain the metal inserts and the dense subbase discussed earlier. Maintenance activities underway on the concrete at the time this report was under preparation may substantially change the situation.

3. I-81, Salem District — from 5.288 mi. west Roanoke-Montgomery county line to Boutetourt-Rockbridge county line.

This comparison is between 3 jointed concrete projects and 3 asphaltic concrete projects on either side of the concrete. The comparison is clearly in favor of the concrete in terms of both average annual maintenance costs per million EAL-18. At least two factors enter into this finding: (1) All flexible pavements in the comparison have been overlaid at a substantial cost, and (2) the concrete projects contain neither the dense subbase nor the metal inserts seen earlier to have heavy influences on maintenance costs.

4. I-85, Richmond District — from 6.121 mi. N. Mecklenburg-Brunswick county line to Richmond-Petersburg Turnpike.

In this case the comparison includes 2 asphaltic concrete projects, 2 CRCP projects, and 1 JPCCP project. The comparison clearly favors the asphaltic concrete pavement, which has not been overlaid. The CRCP projects have had the highest maintenance costs in the state (exclusive of grooving costs) for pavements of that type, and were the locations of the early failures due to poor consolidation discussed earlier. The jointed concrete project has required very little maintenance because it, again, did not contain the metal inserts or dense subbase performance detractors.

5. I-95, Richmond District— from Richmond-Petersburg Turnpike to Caroline-Henrico county line.

This comparison of 3 asphaltic concrete and 3 PCC projects is slightly in favor of the asphaltic concrete, even though the asphaltic concrete has been overlaid. The portland cement projects included the poorly performing dense subbases but did not have metal inserts.

6. I-95, Richmond and Fredericksburg Districts- from Route 54 at Ashland to Route 1 at Massaponax.

In this comparison of 3 asphaltic concrete and 3 PCC projects, 2 of the asphaltic concrete projects were included in (5) above. The comparison shows a decided advantage in favor of the asphaltic concrete pavements, all of which have been overlaid. All 3 PCC projects were build on the dense subbase materials and 2 contained the metal inserts.

It is of some interest to consider all the pavements compared above. The column entitled weighted averages in Table 12 shows that for nearly identical ages and traffic loading, the asphaltic concrete and PCC pavements have incurred nearly identical average annual maintenance costs and maintenenace costs per million EAL-18.

While some of the major performance problems discussed earlier are evident in the comparisons made here, nothing in these studies changed the finding from the 1967 study, for which the report stated:

"From strictly a performance standpoint, it appears that asphaltic and portland cement concrete pavements can perform equally well statewide."(1)

TABLE 12

Comparisons of Asphaltic Concrete and Portland Cement Concrete Pavements

| Section | Type | Number Projects | Average Age(Mo.) | Average Cum. EAL-18(Millions) | Average Annual Maintenance Cost* | Avg. Maint. Cost*/Mill.EAL-18 |
|---|---|---|---|---|---|---|
| I-64, Culpeper District(1) | AC | 3 | 39 | 0.35 | 30 | 279 |
| | CRCP | 3 | 52 | 0.40 | 16 | 173 |
| I-66, Culpeper District(2) | AC | 2 | 146 | 1.29 | 486 | 4,584 |
| | PCC | 2 | 127 | 1.72 | 360 | 2,215 |
| I-81, Salem District(3) | AC | 3 | 127 | 2.52 | 1,418 | 5,955 |
| | PCC | 3 | 124 | 2.24 | 476 | 2,196 |
| | AC | 3 | 146 | 2.47 | 1,656 | 8,157 |
| I-85, Richmond District(4) | AC | 2 | 56 | 0.90 | 52 | 270 |
| | CRCP | 2 | 68 | 1.07 | 504 | 2,669 |
| | PCC | 1 | 89 | 1.39 | 150 | 800 |
| I-95, Richmond District(5) | AC | 2 | 129 | 10.0 | 1,278 | 1,374 |
| | PCC | 2 | 146 | 10.6 | 1,646 | 1,889 |
| I-95, Richmond & Fredbg. District(6) | AC | 3 | 130 | 10.4 | 1,174 | 1,223 |
| | PCC | 3 | 139 | 9.5 | 2,754 | 3,237 |
| Weighted Averages | AC | 18 | 110 | 3.98 | 915 | 2,107 |
| | PCC or CRCP | 16 | 106 | 4.04 | 932 | 2,038 |

*Per lane mile, 24 ft. wide.

# CONCLUSIONS

From the studies reported earlier the following conclusions appear to be justified.

1. Flexible and CRCPs as groups are performing well, with 84% and 89%, respectively, expected to exceed the design lives defined earlier. Some JPCCPs are providing excellent performance while some are performing in a totally unsatisfactory manner. As a group, only 56% of the JPCCPs are expected to exceed the design life.

2. The average annual maintenance costs per 24 ft. wide lane mile have been $344, $608, and $1,228 for CRCP, flexible, and JPCCPs, respectively.

3. The principal performance problems with JPCCPs have been associated with poorly draining subbases and metal joint inserts. In the case of flexible pavements, settlements and stripping prone aggregates have caused the most severe problems. The most serious problems with CRCPs have been results of poor concrete consolidation. With the exception of fill settlements, each of these problems has been corrected through modification in design standards or construction specifications. The fill settlement problem is the subject of a major national research effort.

4. No major changes in basic pavement design procedures are indicated by the results of this study.

5. The average age at which a flexible interstate pavement is overlaid in Virginia is 8 years and 2 months. Large variations from this average result from variations in materials and traffic and from local variations in maintenance standards.

6. Many interstate pavements are subject to significantly higher than design traffic loadings.

7. Interstate ramps have generally given performance inferior to that of main line pavements.

8. Variations in performance in these areas suggest that special design considerations may be justified in the vicinity of truck weighing stations and at sites where significant directional differences in traffic loadings can be anticipated.

9. Most efforts to seal joints between PCC pavements and asphaltic concrete shoulders have been unsuccessful due to excessive strains in the joint sealing materials.

10. Bridge approach expansion joints Type XJ-1 have provided excellent bridge protection but contribute to some pavement performance problems and increased maintenance.

11. In six instances where valid comparisons could be made, it was found that PCC pavements had given the best performance in three cases and flexible pavements had given the best performance in the other three cases.

12. A need for increased diligence on the part of inspection personnel is indicated by the numerous instances in which asphaltic concrete at construction joints has given inferior performance due to segregation, low asphalt content, high asphalt content, or excessive tack coat.

## RECOMMENDATIONS

The following recommendations appear warranted as a result of studies reported herein.

1. All pavement types currently in service on the interstate system in Virginia should be considered as alternatives for future design. JPCCPs with the design and materials modifications which have evolved over the life of the interstate system should not be excluded from consideration.

2. Consideration should be given to the development of a pavement management system wherein the warrants for overlays of flexible pavements would be uniformly applied statewide. The development and implementation of an overlay design procedure would form a portion of such a system.

3. If future studies such as the present one are envisioned, it is recommended that maintenance section numbers be reassigned such that both PCC and flexible pavements are not included in the same section.

4. When sealing the longitudinal joint between PCC pavements and asphaltic concrete shoulders, it is recommended that the joint be widened to at least 1/2 in. to provide the proper shape factor for poured sealing materials.

5. Design standards should be examined to ensure the correction of any incompatible features such as the median-pavement incompatibility discussed earlier.

6. It is recommended that construction specifications be modified to provide for joints in underlying cement stabilized layers, insofar as possible, to coincide with joints in bituminous layers.

7. It is recommended that special inspection attention be given to the beginning of a day's asphalt paving operations to ensure the proper application of tack coat and that the first few loads of plant mix are acceptable.

8. To avoid excessive bleeding, it is recommended that the rate of tack application under overlays of concrete pavement or base be held to the minimum needed to provide bond.

9. It is recommended that the stamped date and station numbers on PCC pavements be moved from the pavement edge, where they are quickly obliterated by edge line paint, to 1 ft. from the pavement edge.

10. Where polish prone aggregates are used on shoulder surfaces, consideration should be given to extending the polish resistant main line surface course 1 ft. onto the shoulder to avoid polishing of the shoulder at the immediate pavement edge.

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# APPENDIX A

## Typical Survey Worksheets

# INTERSTATE SURVEY

## Flexible Pavements

Project: 0081-095-037 Survey Date: 8-26-75

From: 3.729 Mi. E. Tenn. State Line To: 4.972 Mi. E. Tenn. State Line

Completion Date: 8-15-60 Design EAL-18 400

Cross Section: 60psy F-1
140 psy H-2
7 1/2 in. H-3 (1)

5" crush. agg.

5" crusher run

Avg. Actual EAL-18: 430

Cost per Mile:

Const. $128,300

Maint. (avg. annual) $586

Thickness Index: 12.3

Overlays (Rate/Date): 100 psy MS-5, 1971

Other Major Maintenance:

Observed Distress: 1 - rarely, 2 - occasionally, 3 - frequently

| | | | | |
|---|---|---|---|---|
| Cracking: | Long. | (1) | Settlements | ( ) |
| | Trans. | ( ) | Rutting | (1) |
| | Edge | ( ) | Pushing | (1) |
| | Alligator | (3) | Potholes | ( ) |
| Flushing | | ( ) | Other | ( ) |
| Raveling | | ( ) | | ( ) |
| Washboarding | | ( ) | | |

General Rating: excellent_____, good X, fair_____, poor_____

Draingage Considerations: No apparent problems.

Remarks: NBL in excellent shape. SBL badly alligator cracked in many areas close to overlay construction joints.

2272

INTERSTATE SURVEY

Rigid Pavements

Project: 0095-088-101, P402

Survey Date: 3-30-76

From: 5.019 Mi. N. Caroline C. L.

To: 0.501 Mi. N. Rt. 1

Completion Date: 10-22-63

Avg. Actual EAL-18: 2,340

Cross Section: 9 in. J.P.C.C.P.
6 in. subbase matl.
Grading I

Cost per Mile:
Const. $151,100
Maint. (avg. annual) $3,970

Major Maintenance: Drainage work, some joint cleaning and preformed seals, concrete patches, pressure relief, undersealing.

Observed Distress: 1 - rarely, 2 - occasionally, 3 - frequently

| Joints: | | Slabs: | |
|---|---|---|---|
| Minor Spalling | ( 3 ) | Spalling | ( ) |
| Major Spalling | ( 3 ) | Scaling | ( 2 ) |
| Crushing | ( 3 ) | Long. Cracking | ( ) |
| Blowups | ( 1 ) | Trans. Cracking | ( 2 ) |
| Pumping | ( 3 ) | Pumping | ( 3 ) |
| Other Patching | ( 3 ) | Corner Breaks | ( 2 ) |
| Faulting | ( 3 ) | Other | ( ) |

General Rating: excellent____, good____, fair____, poor X

Drainage Consideration: Severe pumping due to poor subbase.

Remarks: 61.5 ft. long slabs, metal inserts, grooved section about one mile long in SBL. About 85% of joints have spalls.

# APPENDIX B

## Project Descriptions and Survey Summaries

# APPENDIX B-1

## Flexible Pavements

### Legend

| | |
|---|---|
| Columns 1 - 5 | Self-explanatory. |
| Column 6 | Construction costs per 24 ft. wide lane mile. Based on Engineering News Record construction cost index using contract unit prices converted to a 1975 base. |
| Column 7 | Average annual maintenance costs per 24 ft. wide lane mile. From information provided by the Accounting Division. |
| Column 8 | Layer thickness of pavement components. Values given are in inches for:<br><br>AC - asphaltic concrete<br>AB - aggregate base<br>SM - select material<br>CTS- cement treated stone<br>CSM- cement treated select material<br>SC - soil cement subgrade |
| Column 9 | Thickness index determined from thickness and type of pavement components according to current design procedures. |
| Column 10 | Age in months of the pavement as of July 1, 1975, and at the time of the first overlay. |
| Column 11 | EAL-18, 18,000 lb. equivalent axle loading:<br><br>Design- daily capacity as determined from the thickness index and current design procedures.<br>Average- daily usage as estimated from information provided by the Traffic and Safety Division.<br>Cumulative- total usage as estimated from information provided by the Traffic and Safety Division. The values given are in millions. |

| | |
|---|---|
| Column 12 | Overall Project Rating.<br><br>E – excellent<br>G – good<br>F – fair<br>P – poor |
| Column 13, 14, 15 | Observed pavement distress with the degree expressed as:<br><br>0 – none<br>1 – rarely<br>2 – occasionally<br>3 – frequently<br><br>Distress types given are:<br><br>Cracking: L – longitudinal<br>T – transverse<br>A – alligator<br><br>Distortion: S – settlements<br>R – rutting<br>P – pushing<br><br>Surface: F – flushing<br>R – raveling |
| Column 16 | Survey number refers to Research Council files on the projects given. |

# APPENDIX B-1

## FLEXIBLE PAVEMENT SUMMARY

| (1) Route | (2) Project | (3) From: | (4) To: | (5) Length (Mi.) | (6) Constr. Cost | (7) Avg. Annual Maint. Cost | (8) Layer Thicknesses AC | AB | SM | CST | CSM | SC | (9) Thickness Index | (10) Age (Mo.) Total | At Overlay | (11) EAL-18 Des. | Avg. | Cum. | (12) Rating | (13) Cracking L | T | A | (14) Distortion S | R | P | (15) Surface Distress F | R | (16) Survey No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0064 | 003-101-C501 | W. Va. State Line | 0.451 Mi. W. Callaghan | 6.90 | 113,400 | 368 | 8.0 | 6.0 | 9.0 | — | — | — | 12.8 | 94 | 47 | 390 | 130 | 0.37 | P | 3 | 0 | 2 | 3 | 0 | 0 | 1 | 0 | 8-64-1 |
| 0064 | 003-103-1401 | 0.451 Mi. W. Callaghan | WCL Covington | 7.73 | 82,100 | 260 | 8.0 | 6.0 | 6.0 | — | — | — | 11.9 | 96 | — | 200 | 140 | 0.41 | F | 3 | 0 | 3 | 3 | 2 | 0 | 0 | 0 | 8-64-2 |
| 0064 | 003-101-1403 | WCL Covington | 0.987 Mi. E. ECL Covington | 2.40 | 95,800 | 136 | 8.0 | 6.0 | 6.0 | — | — | — | 11.9 | 104 | — | 200 | 160 | 0.49 | E | 3 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 8-64-3 |
| 0064 | 003-005-C501 | 0.987 Mi. E. ECL Covington | 3.980 Mi. W. WCL Clifton Forge | 3.34 | 104,300 | 1522 | 7.5 | 8.0 | 6.0 | — | — | — | 12.1 | 126 | 91 | 300 | 210 | 0.81 | G | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 8-64-4 |
| 0064 | 003-004-C501 | 0.566 Mi. W. WCL Clifton Forge | 3.988 Mi. W. WCL Clifton Forge | 3.40 | 125,600 | 1476 | 7.5 | 8.0 | 6.0 | — | — | — | 12.1 | 129 | 120 | 300 | 140 | 0.83 | E | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 8-64-5 |
| 0064 | 003-104-1401 | 1.209 Mi. W. WCL Clifton Forge | 0.004 Mi. W. C&O R.R. | 4.40 | 117,200 | 2190 | 9.5 | 6.0 | 10.0 | — | — | — | 14.6 | 35 | — | 700 | 140 | 0.16 | G | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 8-64-6 |
| 0064 | 007-102-1401 | Int. Rte. 81 | 3.278 Mi. E. Int. Rte. 340 | 10.82 | 88,100 | 54 | 9.5 | 8.0 | 12.0 | — | — | — | 15.9 | 4[illegible] | — | 1200 | 370 | 0.57 | G | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 8-64-7 |
| 0064 | 007-102-1404 | 3.278 Mi. E. Int. Rte. 340 | Nelson-Albemarle C.L. | 3.20 | 116,100 | 64 | 9.5 | 6.0 | 6.0 | — | — | — | 13.4 | 42 | — | 550 | 340 | 0.43 | G | 0 | 0 | 0 | 2 | 3 | 2 | 3 | 0 | 8-64-8 |
| 0064 | 062-101-1401 | Augusta-Nelson C.L. | Nelson-Albemarle C.L. | 1.28 | 77,700 | 22 | 10.0 | 6.0 | 6.0 | — | — | — | 13.3 | 42 | — | 350 | 340 | 0.43 | G | 0 | 0 | 0 | 2 | 0 | 1 | 2 | 0 | 7-64-1 |
| 0064 | 002-102-1401 | Nelson-Albemarle C.L. | 0.070 Mi. W. Int. Rte. 250 | 6.08 | 88,700 | 42 | 10.0 | 8.0 | 6.0 | — | — | — | 14.0 | 21 | — | 380 | 340 | 0.22 | G | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 7-64-2 |
| 0064 | 054-101-1402 | 0.59 Mi. W. Rte. 15 | Louisa-Goochland C.L. | 11.35 | 80,200 | 24 | 10.0 | — | — | 8.0 | — | 6.0 | 20.4 | 54 | — | 2000 | 240 | 0.40 | E | 0 | 2 | 0 | 2 | 0 | 0 | 1 | 0 | 7-64-6 |
| 0064 | 037-102-1401 | Louisa-Goochland C.L. | 0.138 Mi. E. Int. Rte. 522 | 12.05 | 78,600 | 2 | 9.5 | 8.0 | — | — | — | 6.0 | 14.7 | 54 | — | 750 | 280 | 0.46 | G | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 2 | 4-64-1 |
| 0064 | 037-103-1401 | 0.138 Mi. E. Int. Rte. 522 | 8.43 Mi. W. Henrico-Goochland C.L. | 7.38 | 100,800 | 48 | 9.5 | 8.0 | — | — | — | 6.0 | 14.7 | 68 | — | 750 | 260 | 0.53 | E | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 4-64-2 |
| 0064 | 043-102-1401 | 8.43 Mi. W. Henrico-Goochland C.L. | 0.356 Mi. W. Int. Rte. 250 | 10.31 | 96,600 | 122 | 9.5 | 6.0 | — | — | — | 6.0 | 14.7 | 79 | — | 750 | 290 | 0.70 | G | 3 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 4-64-3 |
| 0066 | 034-102-1401 | Int. Rte. 81 | 0.52 Mi. E. Int. Rte. 340 | 7.85 | 65,500 | 126 | 9.5 | 6.0 | 8.0 | — | — | — | 14.0 | 44 | — | 650 | 190 | 0.25 | G | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 8-66-1 |
| 0066 | 030-001-P1 | 0.587 Mi. W. Rte. 731 | 2.489 Mi. W. Rte. 17 | 3.36 | 132,600 | 766 | 9.5 | 6.0 | — | — | — | 8.0 | 14.8 | 156 | 127 | 650 | 170 | 0.81 | F | 3 | 3 | 0 | 0 | 0 | 2 | 2 | 2 | 7-66-1 |
| 0066 | 029-101-P1 | Rtes. 29 & 211, Gainesville | 0.391 Mi. W. Rtes. 29 & 211 | 8.62 | 125,200 | 582 | 9.5 | 6.0 | — | — | 6.0 | — | 15.2 | 152 | 81 | 580 | 290 | 1.69 | P | 3 | 1 | 2 | 2 | 0 | 0 | 1 | 0 | 7-66-2 |
| 0066 | 029-102-G301 | 0.391 Mi. W. Rtes. 29 & 211 | W. End Br. over 29 & 211 | 0.39 | 147,800 | 390 | 10.0 | 6.0 | — | — | — | 6.0 | 14.5 | 140 | 69 | 450 | 300 | 1.31 | F | 3 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 7-66-3 |
| 0077 | 010-103-C502 | 0.165 Mi. S. Int. Rte. 61 | 2.184 Mi. N. Rte. 61 | 2.12 | 95,800 | 0 | 10.0 | 8.0 | 6.0 | — | — | — | 14.0 | 8 | — | 650 | 230 | 0.06 | E | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 1-77-1 |
| 0077 | 010-102-C504 | 9.933 Mi. N. Int. Rte. 21 | 0.165 Mi. S. Rte. 61 | 1.66 | 112,400 | 0 | 10.0 | 8.0 | 6.0 | — | — | — | 14.0 | — | — | 650 | 230 | — | E | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1-77-2 |
| 0077 | 010-102-1402 | 2.280 Mi. N. Rte. 21 | 9.93 Mi. N. Rte. 21 | 7.64 | 101,400 | 0 | 10.0 | 8.0 | 6.0 | — | — | — | 14.0 | — | — | 650 | 230 | — | G | 0 | 0 | 0 | 3 | 2 | 0 | 0 | 0 | 1-77-3 |
| 0077 | 010-102-C501 | 0.182 Mi. S. Rte. 21 | 2.280 Mi. N. Rte. 21 | 2.63 | 102,500 | 0 | 10.0 | 8.0 | 6.0 | — | — | — | 14.0 | — | — | 650 | 230 | — | G | 0 | 0 | 0 | 3 | 2 | 0 | 0 | 0 | 1-77-4 |
| 0077 | 010-101-C502 | 0.254 Mi. N. Rte. 21 | 7.599 M. N. Rte. 81 | 3.86 | 102,800 | 0 | 10.0 | 8.0 | 6.0 | — | — | — | 14.0 | 35 | — | 650 | 230 | 0.29 | G | 2 | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 1-77-5 |
| 0077 | 010-101-1401 | 7.599 Mi. N. Rte. 81 | Int. Rte. 81 | 7.70 | 77,700 | 0 | 10.0 | 8.0 | 6.0 | — | — | — | 14.0 | 31 | — | 650 | 160 | 0.19 | G | 1 | 0 | 0 | 2 | 0 | 0 | 2 | 2 | 1-77-6 |

# APPENDIX B-1 (Cont.)

## FLEXIBLE PAVEMENT SUMMARY

| (1) Route | (2) Project | (3) From: | (4) To: | (5) Length (Mi.) | (6) Const. Cost($) | (7) Avg. Annual Maint. Cost | (8) Layer Thickness AC | Alt | SM | CTS | CSM | SC | (9) Thickness Index | (10) Age (Mo.) Total | At Overlay | (11) EAL-18 Des. | Avg. | Cum. | (12) Rating | (13) Cracking L | T | A | (14) Distortion S | R | P | (15) Surface Distress F | R | (16) Survey No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0081 | 081-001-P401 | Boutetourt C. L. | 4.127 Mi. N. Boutetourt C. L. | 4.13 | 92,600 | 52 | 9.5 | 6.0 | 9.0 | — | — | — | 14.3 | 121 | — | 650 | 840 | 3.03 | E | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 8-81-1 |
| 0081 | 081-001-P403 | 4.127 Mi. N. Boutetourt C. L. | Int. Rte. 684 | 2.59 | 121,900 | 3964 | 9.5 | 6.0 | 9.0 | — | — | — | 14.3 | 128 | 56 | 650 | 630 | 2.41 | P | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8-81-2 |
| 0081 | 081-101-P401 | Int. Rte. 684 | 1.020 Mi. S. Rte. 60 | 6.88 | 81,800 | 58 | 9.5 | 6.0 | 9.0 | — | — | — | 14.3 | 91 | — | 650 | 810 | 2.22 | G | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 8-81-3 |
| 0081 | 081-101-P401 | 1.020 Mi. S. Rte. 60 | 0.018 Mi. N. Rte. 11 | 7.43 | 83,000 | 80 | 9.5 | 6.0 | 12.0 | — | — | — | 15.2 | 91 | — | 800 | 790 | 2.18 | G | 3 | 0 | 0 | 2 | 3 | 0 | 1 | 2 | 8-81-4 |
| 0081 | 081-101-P405 | 0.018 Mi. N. Rte. 11 | 3.40 Mi. S. Augusta C. L. | 7.03 | 89,600 | 498 | 9.5 | 6.0 | 9.0 | — | — | — | 14.3 | 98 | 69 | 650 | 790 | 2.35 | F | 3 | 0 | 2 | 2 | 2 | 2 | 1 | 3 | 8-81-5 |
| 0081 | 081-102-P402 | 3.405 Mi. S. Augusta C. L. | 1.87 Mi. N. Augusta C. L. | 5.27 | 87,900 | 772 | 9.5 | 6.0 | 9.0 | — | — | — | 14.3 | 101 | 84 | 650 | 820 | 2.49 | F | 3 | 0 | 3 | 2 | 0 | 0 | 0 | 3 | 8-81-6 |
| 0081 | 007-102-C502 | 1.87 Mi. N. Rockbridge C. L. | 0.699 Mi. N. Rte. 11 | 6.52 | 110,000 | 1298 | 9.5 | 6.0 | 15.0 | — | — | — | 16.1 | 101 | 78 | 1300 | 830 | 2.52 | F | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 3 | 8-81-7 |
| 0081 | 007-103-C502 | 0.699 Mi. N. Rte. 11 | 3.648 Mi. S. Rte. 250 | 4.93 | 83,300 | 1614 | 9.5 | 6.0 | 6.0 | — | — | — | 13.4 | 81 | 64 | 550 | 850 | 2.09 | F | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 | 8-81-8 |
| 0081 | 007-103-C505 | 3.648 Mi. S. Rte. 250 | 0.965 Mi. N. Rte. 250 | 4.64 | 105,400 | 240 | 9.5 | 8.0 | 8.0 | — | — | — | 14.7 | 73 | — | 800 | 960 | 2.13 | E | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 8-81-9 |
| 0081 | 007-103-C506 | 0.965 Mi. N. Rte. 250 | 0.449 Mi. S. Rte. 612 | 3.76 | 88,600 | 210 | 9.5 | 6.0 | 6.0 | — | — | — | 13.4 | 83 | — | 550 | 1020 | 2.57 | G | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 3 | 8-81-10 |
| 0081 | 007-103-C507 | 0.449 Mi. S. Rte. 612 | 1.559 Mi. S. Rockingham C. L. | 8.22 | 110,600 | 190 | 10.0 | 6.0 | 9.0 | — | — | — | 14.8 | 92 | — | 800 | 960 | 2.68 | G | 2 | 0 | 2 | 2 | 0 | 0 | 2 | 2 | 8-81-11 |
| 0081 | 082-103-P401 | 1.559 Mi. S. Augusta C. L. | 3.93 Mi. S. Rte. 33 | 8.27 | 101,300 | 1580 | 9.5 | 6.0 | 9.0 | — | — | — | 14.3 | 98 | 89 | 750 | 950 | 2.80 | G | 2 | 0 | 2 | 2 | 2 | 0 | 2 | 0 | 8-81-12 |
| 0081 | 082-017- | 3.931 Mi. S. Rte. 33 | 2.057 Mi. S. Rte. 33 | 1.87 | 139,700 | 826 | 9.5 | 6.0 | 12.0 | — | — | — | 15.2 | 180 | 121 | 800 | 500 | 2.70 | E | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 8-81-13 |
| 0081 | 082-06- | 2.057 Mi. S. Rte. 33 | 3.601 Mi. N. Rte. 33 | 5.66 | 113,200 | 720 | 9.5 | 6.0 | 12.0 | — | — | — | 15.2 | 179 | 120 | 800 | 500 | 2.68 | E | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 8-81-14 |
| 0081 | 082-027-C501 | 3.601 Mi. N. Rte. 33 | 6.562 Mi. N. Rte. 33 | 2.97 | 111,700 | 1100 | 9.5 | 6.0 | 12.0 | — | — | — | 15.2 | 122 | 63 | 800 | 690 | 2.53 | F | 2 | 0 | 2 | 2 | 3 | 0 | 0 | 3 | 8-81-15 |
| 0081 | 082-102-P401 | 6.562 Mi. N. Rte. 33 | 0.825 Mi. N. Rte. 798 | 6.07 | 90,900 | 1396 | 9.5 | 6.0 | 12.0 | — | — | — | 15.2 | 108 | — | 800 | 640 | 2.09 | G | 0 | 0 | 1 | 2 | 3 | 0 | 2 | 3 | 8-81-16 |
| 0081 | 082-102-P402 | 0.825 Mi. N. Rte. 798 | 1.011 Mi. N. Shenandoah C. L. | 4.90 | 90,700 | 212 | 9.5 | 6.0 | 9.0 | — | — | — | 14.3 | 111 | — | 650 | 620 | 2.09 | E | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 3 | 8-81-17 |
| 0081 | 085-103-P402 | 1.011 Mi. N. Rockingham C. L. | 3.378 Mi. S. Rte. 675 | 10.95 | 99,400 | 198 | 9.5 | 6.0 | 6.0 | — | — | — | 13.4 | 96 | — | 550 | 620 | 1.81 | G | 2 | 0 | 2 | 2 | 0 | 2 | 2 | 2 | 8-81-18 |
| 0081 | 085-103-C503 | 3.378 Mi. S. Rte. 675 | 0.404 Mi. S. Rte. 42 | 7.00 | 107,800 | 140 | 9.5 | 6.0 | 12.0 | — | — | — | 15.2 | 96 | — | 900 | 730 | 2.12 | G | 2 | 0 | 3 | 2 | 0 | 0 | 2 | 2 | 8-81-19 |
| 0081 | 085-102-P401 | 0.404 Mi. S. Rte. 42 | 0.64 Mi. N. Rte. 653 | 8.05 | 109,300 | 116 | 9.5 | 6.0 | 12.0 | — | — | — | 15.2 | 104 | — | 900 | 730 | 2.28 | G | 3 | 0 | 3 | 2 | 2 | 0 | 0 | 0 | 8-81-20 |
| 0081 | 085-102-P403 | 0.64 Mi. N. Rte. 653 | 0.028 Mi. S. Rte. 11 | 7.28 | 95,500 | 226 | 9.5 | 6.0 | 12.0 | — | — | — | 15.2 | 96 | — | 900 | 750 | 2.19 | F | 3 | 0 | 3 | 2 | 3 | 0 | 0 | 0 | 8-81-21 |
| 0081 | 085-102-C506 | 0.028 Mi. S. Rte. 11 | 0.030 Mi. S. Warren C. L. | 0.72 | 133,300 | 222 | 8.0 | 6.0 | 12.0 | — | — | — | 13.7 | 120 | — | 600 | 630 | 2.27 | E | 1 | 0 | 0 | 2 | 2 | 0 | 3 | 0 | 8-81-22 |
| 0081 | 093-101-P401 | 0.030 Mi. S. Warren C. L. | 4.109 Mi. S. Rte. 277 | 3.92 | 99,900 | 208 | 9.5 | 6.0 | 12.0 | — | — | — | 15.2 | 115 | — | 900 | 530 | 1.83 | E | 0 | 0 | 2 | 2 | 2 | 0 | 0 | 0 | 8-81-23 |
| 0081 | 034-001-P407 | 4.109 Mi. S. Rte. 277 | 0.556 Mi. S. Rte. 277 | 3.62 | 102,800 | 208 | 9.5 | 6.0 | 12.0 | — | — | — | 15.2 | 115 | — | 900 | 530 | 1.83 | E | 2 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 8-81-24 |
| 0081 | 034-101-P405 | 0.556 Mi. S. Rte. 277 | Int. Rte. 11 | 11.41 | 103,900 | 718 | 9.5 | 6.0 | 12.0 | — | — | — | 15.2 | 115 | 104 | 900 | 540 | 1.88 | G | 3 | 0 | 3 | 3 | 0 | 0 | 2 | 0 | 8-81-25 |
| 0081 | 034-007-P403 | Int. Rte. 11 | W. Va. State Line | 6.50 | 105,700 | 164 | 9.5 | 6.0 | 12.0 | — | — | — | 15.2 | 115 | — | 900 | 520 | 1.82 | G | 2 | 0 | 2 | 3 | 0 | 0 | 0 | 0 | 8-81-26 |
| 0085 | 058-101-P401 | North Carolina State Line | 0.372 Mi. N. Rte. 637 | 4.77 | 110,700 | 1462 | 9.0 | 6.0 | — | — | — | 6.0 | 14.7 | 118 | 89 | 780 | 490 | 1.75 | F | 0 | 3 | 0 | 0 | 0 | 2 | 2 | 0 | 4-85-1 |
| 0085 | 058-101-P402 | 0.372 Mi. N. Rte. 637 | 0.372 Mi. N. Rte. 58 | 8.12 | 102,800 | 1702 | 9.0 | — | — | 6.0 | — | 6.0 | 17.4 | 114 | 97 | 1700 | 500 | 1.72 | G | 0 | 3 | 0 | 2 | 0 | 0 | 1 | 0 | 4-85-2 |
| 0085 | 058-101-C504 | 0.372 Mi. N. Rte. 58 | 0.504 Mi. N. Rte. 1 | 2.50 | 111,500 | 48 | 9.5 | — | — | 6.0 | — | 6.0 | 17.9 | 111 | — | 2000 | 490 | 1.68 | E | 2 | 3 | 0 | 1 | 0 | 1 | 1 | 0 | 4-85-3 |
| 0085 | 012-101-P401 | 0.028 Mi. N. Rte. 1 | 6.121 Mi. N. Mecklenburg C. L. | 10.32 | 96,300 | 44 | 9.0 | — | — | 6.0 | — | 6.0 | 17.4 | 57 | — | 1700 | 510 | 0.89 | G | 2 | 2 | 0 | 2 | 0 | 2 | 1 | 0 | 4-85-4 |
| 0085 | 012-101-P402 | 6.121 Mi. N. Mecklenburg C. L. | 5.796 Mi. S. Dinwiddie C. L. | 8.82 | 82,800 | 54 | 10.0 | — | — | 6.0 | — | 6.0 | 18.4 | 54 | — | 2000 | 510 | 0.84 | G | 2 | 2 | 0 | 1 | 0 | 1 | 1 | 2 | 4-85-5 |
| 0085 | 012-101-P404 | 5.796 Mi. S. Dinwiddie C. L. | 1.217 Mi. S. Dinwiddie C. L. | 4.57 | 85,900 | 50 | 9.5 | — | — | 6.0 | — | 6.0 | 17.9 | 58 | — | 2000 | 540 | 0.95 | G | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 4-85-6 |
| 0095 | 074-001- | 0.731 Mi. S. Rte. 35 | 0.056 Mi. S. Rte. 626 | 5.40 | 105,500 | 996 | 11.0 | 6.0 | 6.0 | — | — | — | 14.3 | 165 | 106 | 800 | 530 | 2.66 | F | 3 | 2 | 2 | 0 | 2 | 0 | 0 | 3 | 4-95-1 |
| 0095 | 074-013-P-1 | 0.056 Mi. S. Rte. 626 | 0.042 Mi. S. SCL Petersburg | 3.70 | 78,800 | 770 | 9.5 | 6.0 | 6.0 | — | — | — | 12.8 | 153 | 94 | 550 | 530 | 2.45 | G | 3 | 2 | 0 | 0 | 2 | 0 | 1 | 0 | 4-95-2 |
| 0095 | 074-010-C-1 | 0.042 Mi. S. SCL Petersburg | 1.629 Mi. N. SCL Petersburg | 1.67 | 113,800 | 610 | 9.5 | 6.0 | 6.0 | — | — | — | 12.8 | 152 | 93 | 550 | 530 | 2.43 | G | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 4-95-3 |
| 0095 | 042-003-P401 | 0.368 Mi. N. Rte. 54 | 4.582 Mi. N. Rte. 54 | 4.24 | 99,200 | 1278 | 10.0 | 6.0 | — | — | — | 6.0 | 14.5 | 129 | 100 | 900 | 2560 | 10.00 | E | 0 | 2 | 0 | 0 | 0 | 2 | 2 | 0 | 4-95-6 |
| 0095 | 042-003-P402 | 4.588 Mi. N. Rte. 54 | 0.033 Mi. N. Caroline C. L. | 4.64 | 102,400 | 1278 | 10.0 | 6.0 | — | — | — | 6.0 | 14.5 | 129 | 94 | 900 | 2560 | 9.98 | E | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 4-95-7 |

# APPENDIX B-1 (Cont.)

## FLEXIBLE PAVEMENT SUMMARY

| (1) Route | (2) Project | (3) From: | (4) To: | (5) Length (Mi.) | (6) Const. Cost($) | (7) Avg. Annual Maint. Cost | (8) Layer Thickness AC | AB | SM | CTS | CSM | SC | (9) Thickness Index | (10) Age (Mo.) Total | At Overlay | (11) EAL-18 Des. | Avg. | Cum. | (12) Rating | (13) Cracking L | T | A | (14) Distortion S | R | P | (15) Surface Distress F | R | (16) Survey No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0081 | 095-013-P1 | Tennessee State Line | 3.72 Mi. E. Tenn. State Line | 3.73 | 108,200 | 618 | 9.5 | 5.0 | 5.0 | — | — | — | 12.3 | 165 | 118 | 400 | 430 | 2.15 | G | 2 | 0 | 1 | 2 | 0 | 1 | 2 | 0 | 1-81-1 |
| 0081 | 095-037- | 3.73 Mi. E. Tenn. State Line | 4.972 Mi. E. Tenn. State Line | 1.24 | 128,300 | 586 | 9.5 | 5.0 | 5.0 | — | — | — | 12.3 | 178 | 131 | 400 | 500 | 2.72 | G | 1 | 0 | 3 | 0 | 1 | 1 | 0 | 0 | 1-81-2 |
| 0081 | 095-014-P401 | 5.143 Mi. E. Tenn. State Line | 3.790 Mi. S. Int. Rte. 611 | 4.27 | 109,600 | 308 | 9.5 | 6.0 | 12.0 | — | — | — | 14.0 | 141 | — | 650 | 540 | 2.31 | G | 3 | 0 | 2 | 2 | 2 | 0 | 2 | 0 | 1-81-3 |
| 0081 | 095-014-P402 | 3.790 Mi. S. Int. Rte. 611 | 0.110 Mi. N. Rte. 611 | 3.90 | 132,800 | 62 | 9.5 | 6.0 | 10.0 | — | — | — | 13.8 | 141 | — | 610 | 520 | 2.23 | G | 3 | 0 | 2 | 2 | 2 | 0 | 2 | 1 | 1-81-4 |
| 0081 | 095-038-P1 | 0.110 Mi. N. Rte. 611 | 0.036 Mi. N. Rtes. 11 & 58 | 6.46 | 122,200 | 656 | 9.5 | 6.0 | 10.0 | — | — | — | 13.8 | 156 | 136 | 610 | 510 | 2.40 | E | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 1-81-5 |
| 0081 | 095-038-P402 | 0.036 Mi. N. Rtes. 11 & 58 | 0.397 Mi. N. Rte. 80 | 5.56 | 131,900 | 14 | 10.5 | 6.0 | 6.0 | — | — | — | 13.8 | 142 | — | 610 | 520 | 2.21 | E | 3 | 2 | 3 | 2 | 0 | 0 | 0 | 3 | 1-81-6 |
| 0081 | 095-009-C502 | 0.397 Mi. N. Rte. 80 | 0.931 Mi. E. Rte. 91 | 5.10 | 116,300 | 1258 | 9.5 | 6.0 | 10.0 | — | — | — | 13.6 | 141 | 130 | 580 | 510 | 2.19 | G | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 1-81-7 |
| 0081 | 095-009-C503 | 0.931 Mi. E. Rte. 91 | 0.800 Mi. E. Rte. 751 | 2.53 | 112,300 | 1400 | 9.5 | 6.0 | 10.0 | — | — | — | 13.6 | 140 | 129 | 580 | 500 | 2.11 | F | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 1-81-8 |
| 0081 | 086-003-P401 | 0.800 Mi. N. Rte. 751 | 0.180 Mi. W. Rte. 645 | 6.26 | 113,300 | 608 | 9.5 | 6.0 | 12.0 | — | — | — | 13.8 | 140 | 69 | 610 | 520 | 2.19 | F | 2 | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 1-81-9 |
| 0081 | 086-003-C501 | 0.180 Mi. W. Rte. 645 | 2.442 Mi. W. WCL Marion | 2.61 | 136,200 | 746 | 9.5 | 6.0 | 12.0 | — | — | — | 13.8 | 144 | 73 | 610 | 520 | 2.26 | F | 1 | 0 | 0 | 2 | 0 | 0 | 2 | 2 | 1-81-10 |
| 0081 | 086-003-P403 | 2.442 Mi. W. WCL Marion | 0.015 Mi. W. Rte. 11 | 6.20 | 108,500 | 886 | 9.5 | 6.0 | 12.0 | — | — | — | 13.8 | 142 | 83 | 610 | 500 | 2.15 | F | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 1-81-11 |
| 0081 | 086-003-P405 | 0.015 Mi. W. Rte. 11 | 4.655 Mi. W. Wythe C.L. | 4.97 | 112,000 | 48 | 9.5 | 6.0 | 12.0 | — | — | — | 13.8 | 140 | — | 610 | 490 | 2.08 | G | 3 | 0 | 3 | 2 | 3 | 0 | 3 | 0 | 1-81-12 |
| 0081 | 086-004-P402 | 4.825 Mi. W. Wythe C.L. | Wythe C.L. | 4.83 | 93,000 | 1700 | 9.5 | 6.0 | 12.0 | — | — | — | 13.8 | 129 | 116 | 610 | 500 | 1.91 | E | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1-81-13 |
| 0081 | 098-001-P401 | Smyth C.L. | 0.974 Mi. W. Rte. 680 | 2.24 | 100,800 | 1140 | 9.5 | 6.0 | 12.0 | — | — | — | 13.8 | 130 | 105 | 610 | 490 | 1.91 | E | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1-81-14 |
| 0081 | 098-001-P402 | 0.974 Mi. W. Rte. 680 | 3.46 Mi. E. Rte. 666 | 5.44 | 98,400 | 1150 | 9.5 | 6.0 | 12.0 | — | — | — | 13.8 | 129 | 104 | 610 | 490 | 1.89 | E | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 1-81-15 |
| 0081 | 098-101-P403 | 0.346 Mi. W. Reed Creek | 0.290 Mi. W. Reed Creek | 2.66 | 96,600 | 1164 | 9.5 | 6.0 | 12.0 | — | — | — | 13.8 | 130 | 93 | 610 | 500 | 1.92 | G | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 1-81-16 |
| 0081 | 098-002-P401 | 0.290 Mi. W. Reed Creek | 0.347 Mi. W. N&W R.R. | 6.60 | 94,800 | 34 | 9.5 | 6.0 | 12.0 | — | — | — | 13.8 | 117 | — | 610 | 450 | 1.58 | G | 3 | 0 | 3 | 2 | 3 | 0 | 2 | 0 | 1-81-17 |
| 0081 | 098-101-C503 | 1.100 Mi. W. Rte. 52 | 1.230 Mi. E. Rte. 52 | 2.35 | 131,400 | 26 | 10.0 | 8.0 | 12.0 | — | — | — | 15.2 | 79 | — | 900 | 530 | 1.26 | E | 1 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 1-81-18 |
| 0081 | 098-008-P1 | 1.081 Mi. E. Rte. 52 | 1.718 Mi. E. Pulaski C.L. | 4.18 | 120,400 | 734 | 9.5 | 6.9 | 9.0 | — | — | — | 13.4 | 164 | 93 | 550 | 480 | 2.40 | E | 1 | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 1-81-19 |
| 0081 | 098-008-P402 | 1.718 Mi. W. Pulaski C.L. | Pulaski C.L. | 1.73 | 130,200 | 642 | 9.5 | 6.0 | 9.0 | — | — | — | 13.4 | 154 | 95 | 550 | 480 | 2.25 | E | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 1-81-20 |
| 0081 | 077-011-P401 | Wythe C.L. | 0.854 Mi. W. Rtes. 11 & 100 | 1.78 | 138,300 | 216 | 9.5 | 6.0 | 9.0 | — | — | — | 13.4 | 154 | — | 500 | 490 | 2.27 | G | 3 | 0 | 0 | 2 | 3 | 0 | 3 | 0 | 2-81-1 |
| 0081 | 077-008- | 0.854 Mi. W. Rtes. 11 & 100 | 0.358 Mi. E. Rtes. 11 & 100 | 1.21 | 128,200 | 724 | 9.5 | 6.0 | 9.0 | — | — | — | 13.4 | 178 | 107 | 500 | 470 | 2.53 | E | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 2-81-2 |
| 0081 | 077-001- | 0.358 Mi. W. Rtes. 11 & 100 | 0.487 Mi. W. Rte. 99 | 3.50 | 118,500 | 884 | 9.5 | 6.0 | 9.0 | — | — | — | 13.4 | 178 | 107 | 500 | 540 | 2.91 | G | 2 | 0 | 0 | 2 | 2 | 0 | 2 | 0 | 2-81-3 |
| 0081 | 077-010-P401 | 0.487 Mi. W. Rte. 99 | 2.202 Mi. E. Rte. 99 | 2.69 | 118,900 | 1050 | 9.5 | 6.0 | 9.0 | — | — | — | 13.4 | 168 | | 500 | 540 | 2.74 | G | 0 | 0 | 0 | 2 | 0 | 1 | 2 | 0 | 2-81-4 |
| 0081 | 077-101-C501 | 2.202 Mi. E. Rte. 99 | 0.405 Mi. W. Rte. 682 | 2.18 | 102,300 | 1628 | 9.5 | 6.0 | 9.0 | — | — | — | 13.4 | 119 | 96 | 500 | 570 | 2.06 | F | 3 | 0 | 3 | 2 | 1 | 1 | 1 | 0 | 2-81-5 |
| 0081 | 077-101-C502 | 0.405 Mi. E. Rte. 682 | 0.403 Mi. E. Rte. 660 | 2.76 | 103,100 | 398 | 9.5 | 6.0 | 9.0 | — | — | — | 13.4 | 116 | — | 500 | 540 | 1.88 | G | 3 | 0 | 3 | 2 | 0 | 0 | 1 | 0 | 2-81-6 |
| 0081 | 077-101-C503 | 0.403 Mi. E. Rte. 660 | 1.915 Mi. W. Montgomery C.L. | 1.64 | 114,300 | 206 | 9.5 | 6.0 | 9.0 | — | — | — | 13.4 | 125 | — | 500 | 540 | 2.03 | G | 3 | 0 | 2 | 2 | 2 | 0 | 0 | 0 | 2-81-7 |
| 0081 | 077-101-C504 | 1.915 Mi. W. Montgomery C.L. | 0.15 Mi. W. Montgomery C.L. | 1.76 | 117,700 | 1372 | 9.5 | 6.0 | 9.0 | — | — | — | 13.4 | 126 | | 500 | 540 | 2.05 | G | 3 | 0 | 2 | 0 | 2 | 0 | 0 | 0 | 2-81-8 |
| 0081 | 060-101-P401 | 0.16 Mi. W. Pulaski C.L. | 4.57 Mi. E. Pulaski C.L. | 4.77 | 101,300 | 70 | 9.5 | 6.0 | 9.0 | — | — | — | 13.4 | 115 | — | 500 | 540 | 1.87 | G | 3 | 0 | 3 | 2 | 0 | 0 | 1 | 0 | 2-81-9 |
| 0081 | 060-101-P402 | 4.57 Mi. E. Pulaski C.L. | 2.09 Mi. E. Rte. 8 | 6.87 | 103,400 | 68 | 9.5 | 6.0 | 9.0 | — | — | — | 13.4 | 118 | — | 500 | 530 | 1.88 | E | 3 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2-81-10 |
| 0081 | 060-102-C501 | 2.09 Mi. E. Rte. 8 | 0.090 Mi. E. Rtes. 11 & 460 | 2.03 | 104,400 | 70 | 9.5 | 6.0 | 9.0 | — | — | — | 13.4 | 115 | — | 500 | 520 | 1.82 | E | 3 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2-81-11 |
| 0081 | 060-102-P402 | 0.09 Mi. E. Rtes. 11 & 460 | 5.288 Mi. W. Roanoke C.L. | 6.60 | 78,900 | 0 | 10.0 | 6.0 | 6.0 | — | — | — | 13.3 | 35 | — | 450 | 870 | 0.94 | G | 0 | 0 | 0 | 2 | 1 | 1 | 2 | 0 | 2-81-12 |
| 0081 | 060-102-P404 | 5.288 Mi. W. Roanoke C.L. | 2.490 Mi. E. Roanoke C.L. | 7.80 | 90,000 | 0 | 10.0 | 6.0 | 6.0 | — | — | — | 13.3 | 38 | — | 450 | 1070 | 1.25 | G | 0 | 0 | 0 | 2 | 2 | 0 | 2 | 0 | 2-81-13 |
| 0081 | 080-101-C502 | 0.615 Mi. W. Rte. 927 | 0.085 Mi. E. Rte. 777 | 1.78 | 127,800 | 1410 | 9.5 | 6.0 | 9.0 | — | — | — | 13.4 | 130 | 129 | 600 | 680 | 2.61 | G | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 2-81-14 |
| 0081 | 080-001-P402 | 0.085 Mi. E. Rte. 777 | Bouteourt C.L. | 12.58 | 108,100 | 1422 | 9.5 | 6.0 | 9.0 | — | — | — | 13.4 | 126 | 102 | 600 | 650 | 2.47 | G | 0 | 0 | 0 | 2 | 2 | 0 | 3 | 0 | 2-81-15(a) |
| 0081 | 080-001-P403 | 0.085 Mi. E. Rte. 777 | Bouteourt C.L. | 12.58 | 123,200 | 1422 | 9.5 | 4.0 | — | 4.0 | — | 6.0 | 17.3 | 126 | 102 | 2000 | 650 | 2.47 | G | 0 | 0 | 0 | 2 | 2 | 0 | 3 | 0 | 2-81-15(b) |
| 0081 | 011-008-P401 | 0.019 Mi. N. Rte. 636 | 0.843 Mi. N. NCL Buchanan | 6.33 | 98,700 | 1684 | 9.5 | 6.0 | 9.0 | — | — | — | 13.4 | 142 | 89 | 380 | 540 | 2.32 | G | 1 | 0 | 0 | 2 | 0 | 2 | 2 | 0 | 2-81-19 |
| 0081 | 011-001- | 0.843 Mi. N. NCL Buchanan | 0.0274 Mi. S. Rte. 610 | 5.00 | 103,600 | 1392 | 9.5 | 6.0 | 9.0 | — | — | — | 13.4 | 174 | 91 | 380 | 520 | 2.75 | G | 0 | 0 | 0 | 2 | 0 | 2 | 3 | 0 | 2-81-20 |
| 0081 | 011-008-P402 | 0.0274 Mi. S. Rte. 610 | Rockbridge C.L. | 1.00 | 92,700 | 1896 | 9.5 | 6.0 | 9.0 | — | — | — | 13.4 | 121 | 100 | 380 | 640 | 2.34 | G | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2-81-21 |

# APPENDIX B-1 (Cont.)

## FLEXIBLE PAVEMENT SUMMARY

| (1) Route | (2) Project | (3) From: | (4) To: | (5) Length (Mi.) | (6) Const. Cost($) | (7) Avg. Annual Maint. Cost | (8) Layer Thicknesses (in.) AC | AB | SM | CTS | CSM | SC | (9) Thickness Index | (10) Age (Mo.) Total | At Overlay | (11) EAL-18 Des. | Avg. | Cum. | (12) Rating | (13) Cracking L | T | A | (14) Distortion S | R | P | (15) Surface Distress F | R | (16) Survey No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0095 | 029-101-C501 | 1.528 Mi. N. Prince Wm. C.L. | 0.935 Mi. S. Rte. 644 | 6.05 | 221,600 | 2034 | 3.5 | 8.0(1) | — | 6.0 | — | — | N.A.(2) | 111 | 103 | — | 2030 | 6.63 | G | 0 | 3 | 0 | 0 | 0 | 0 | 2 | 2 | 7-95-5 |
| 0095 | 029-101-C502 | 0.935 Mi. S. Rte. 644 | 0.100 Mi. N. Rte. 495 | 1.97 | 221,000 | 84 | 3.0 | 8.0(1) | — | 6.0 | — | — | N.A. | 95 | — | — | 2060 | 5.80 | E | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 7-95-6 |
| 0095 | 029-101-C503 | 0.100 Mi. N. Rte. 495 | SCL Alexandria | 2.20 | 211,100 | 82 | 2.5 | 8.0(1) | — | 8.0 | — | — | N.A. | 94 | — | — | 760 | 2.16 | G | 1 | 3 | 0 | 0 | 0 | 2 | 2 | 0 | 7-95-7 |
| 0095 | 100-101-C501 | SCL Alexandria | 1.114 Mi. N. SCL Alexandria | 1.11 | 219,300 | 98 | 3.5 | 8.0(1) | — | 8.0 | — | — | N.A. | 79 | — | — | 750 | 1.81 | E | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 7-95-8 |
| 0095 | 100-101-C502 | 1.114 Mi. N. SCL Alexandria | 0.531 Mi. N. Arlington C.L. | 2.37 | 222,300 | 194 | 3.5 | 8.0(1) | — | 8.0 | — | — | N.A. | 67 | — | — | 760 | 1.55 | G | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 7-95-9 |
| 0095 | 000-101-C502 | 0.531 Mi. N. Arlington C.L. | 0.752 Mi. N. Rte. 120 | 1.55 | 299,300 | 1080 | 3.5 | 8.0(1) | — | 8.0 | — | — | N.A. | 28 | — | — | 890 | 0.69 | G | 0 | 3 | 0 | 0 | 0 | 2 | 3 | 0 | 7-95-10 |
| 0095 | 000-101-C503 | 0.754 Mi. N. Rte. 120 | 1.191 Mi. S. 14th St. Br. | 0.93 | 345,200 | 1492 | 3.5 | 8.0(1) | — | 8.0 | — | — | N.A. | 21 | — | — | 820 | 0.51 | E | 0 | 3 | 0 | 0 | 0 | 0 | 2 | 0 | 7-95-11 |
| 0095 | 000-101-C503 | 1.191 Mi. S. 14th St. Br. | 14th St. Bridge | 1.19 | N.A. | N.A. | 3.5 | 8.0(1) | — | 8.0 | — | — | N.A. | 0 | — | — | N.A. | N.A. | E | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 7-95-12 |
| 0264 | 064-101-G303 | 0.219 Mi. W. N&W R.R. | 0.787 Mi. E. N&W R.R. | 1.00 | N.A. | N.A. | 9.5 | 6.0 | — | — | — | 6.0 | 14.0 | 73 | — | 800 | 210 | 0.46 | E | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 5-264-1 |
| 0264 | 064-001-P1 | 0.219 Mi. W. N&W R.R. | 0.155 Mi. E. Victory Blvd. | 3.34 | 156,800 | 306 | 9.5 | 6.0 | — | — | — | 6.0 | 14.0 | 126 | — | 800 | 210 | 0.80 | E | 2 | 2 | 1 | 0 | 0 | 1 | 2 | 0 | 5-264-2 |
| 0264 | 124-071-C501 | 0.155 Mi. E. Victory Blvd. | 0.036 Mi. E. Des Moines Ave. | 2.47 | 172,900 | 476 | 9.5 | 6.0 | — | — | — | 6.0 | 14.0 | 126 | — | 800 | 190 | 0.72 | E | 2 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 5-264-3 |
| 0264 | 124-071-C502 | 0.036 Mi. E. Des Moines Ave. | Washington Street | 0.95 | 157,500 | 586 | 9.5 | 6.0 | — | — | — | 6.0 | 14.0 | 102 | — | 800 | 140 | 0.42 | G | 0 | 3 | 0 | 2 | 0 | 0 | 0 | 0 | 5-264-4 |
| 0264 | 122-101-C501 | 0.15 Mi. E. Washington Street | 0.151 Mi. W. Rte. 460 | 0.72 | 160,100 | — | 10.0 | 6.0 | — | — | 6.0 | — | 14.5 | 58 | — | 900 | 450 | 0.47 | G | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 5-264-5 |
| 0381 | 095-004- | Route 81 | 0.545 Mi. N. Tenn. State Line | 1.45 | 128,300 | 656 | 9.5 | 5.0 | 5.0 | — | — | — | 12.3 | 178 | 131 | 400 | 220 | 1.16 | E | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1-381-1 |
| 0581 | 080-001-P401 | Route 81 | 0.298 Mi. S. Rte. 117 | 1.59 | 104,200 | 4 | 9.5 | 6.0 | 9.0 | — | — | — | 13.4 | 126 | — | 600 | 530 | 2.00 | G | 2 | 0 | 0 | 0 | 2 | 0 | 2 | 0 | 2-581-1 |
| 0581 | 128-070-P401 | 0.298 Mi. S. Rte. 117 | 0.347 Mi. N. Rte. 460 | 3.69 | 112,800 | 1638 | 9.5 | 6.0 | 9.0 | — | — | — | 13.4 | 121 | 110 | 600 | 540 | 1.96 | G | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2-581-2 |
| 0581 | 128-070-C504 | 0.347 Mi. N. Rte. 460 | 0.187 Mi. S. Rte. 460 | 0.53 | 143,500 | 180 | 9.5 | 6.0 | 9.0 | — | — | — | 13.4 | 117 | — | 600 | 550 | 1.95 | G | 1 | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 2-581-3 |
| 0581 | 128-070-C502 | 0.187 Mi. S. Rte. 460 | 0.098 Mi. S. Rte. 11 | 0.31 | 144,900 | 200 | 9.5 | 6.0 | 9.0 | — | — | — | 13.4 | 106 | — | 600 | 540 | 1.72 | E | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2-581-4 |
| 0581 | 128-070-C505 | 0.098 Mi. S. Rte. 11 | 0.006 Mi. N. Elm Ave. | 0.53 | 153,900 | 230 | 9.5 | 6.0 | 9.0 | — | — | — | 13.4 | 92 | — | 600 | 540 | 1.49 | G | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2-581-5 |

(1) Portland cement concrete base course.
(2) N.A. — not applicable or not available.

# APPENDIX B-2

## Jointed Portland Cement Concrete Pavements

### Legend

| | |
|---|---|
| Columns 1 - 5 | Self-explanatory. |
| Column 6 | Construction costs per 24 ft. wide lane mile. Based on Engineering News Record construction cost index using contract unit prices converted to a 1975 base. |
| Column 7 | Average annual maintenance costs per 24 ft. wide lane mile. From information provided by the Accounting Division. |
| Column 8 | Thickness (in.) of soil cement subgrade stabilization. |
| Column 9 | Type and thickness (in.) of subbase material.<br>Dense - densely graded subbase with up to 15% minus 200, some P.I.<br>Modified - less densely graded subbase with minus 200 less than 10%, non-plastic.<br>Stabilized - cement stabilized subbase. |
| Column 10 | T - slab thickness (in.)<br>L - slab length (ft.) |
| Column 11 | Reinforcement,<br>S - slab reinforced<br>JD - doweled joints |
| Column 12 | Metal inserts used? Yes or No. |
| Column 13 | Project age (mo.) |
| Column 14 | Average daily and total cumulative equivalent 18,000 lb. axle loadings as estimated from information provided by the Traffic and Safety Division. |

Column 15 — Overall project rating.

E – excellent
G – good
F – fair
P – poor

Column 16 — Major distress observed.

S – spalling
B – blowups
P – pumping
F – joint faulting
R – repairs (patching)
T – transverse cracking

Degree of Distress:

0 – none
1 – rarely
2 – occasionally
3 – frequently

Column 17 — Survey Number refers to Research Council files on the project given.

# APPENDIX B-2

## JOINTED PORTLAND CEMENT CONCRETE PAVEMENT SUMMARY

| (1) Route | (2) Project | (3) From: | (4) To: | (5) Length (Mi.) | (6) Const. Cost($) | (7) Avg. Annual Maint. Cost | (8) Subgrade Stab. (in.) | (9) Subbase Type Thickness (in.) Dense | Mod. | Stab. | (10) Slab T(in.) | L(ft.) | (11) Reinforcement S | JD | (12) Metal Inserts | (13) Age (Mo.) | (14) EAL-18 Avg. | Cum. | (15) Rating | (16) Major Distress S | B | P | F | R | T | (17) Survey No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0064 | 043-002-C502 | 0.061 Mi. W. Laburnum Ave. | Henrico-New Kent C.L. | 8.67 | 117,700 | 950 | 0 | — | 6 | — | 9 | 61.5 | Yes | Yes | No | 115 | 300 | 1.03 | F | 2 | 2 | 2 | 0 | 2 | 0 | 4-64-10 |
| 0064 | 063-001-C501 | Henrico-New Kent C.L. | 1.404 Mi. E. Henrico C.L. | 1.40 | 135,900 | 140 | 0 | — | 6 | — | 9 | 61.5 | Yes | Yes | No | 107 | 260 | 0.86 | G | 1 | 1 | 2 | 0 | 0 | 0 | 4-64-11 |
| 0064 | 099-101-C501 | 0.047 Mi. W. Rte. 645 | 1.990 Mi. E. Rte. 646 | 2.05 | 178,600 | 272 | 6 | — | 4 | — | 9 | 61.5 | Yes | Yes | Yes | 118 | 250 | 0.89 | G | 1 | 0 | 0 | 0 | 3 | 0 | 5-64-3 |
| 0064 | 099-101-C502 | 1.990 Mi. E. Rte. 645 | 0.246 Mi. W. Rte. 641 | 2.53 | 178,400 | 388 | 6 | — | 4 | — | 9 | 61.5 | Yes | Yes | Yes | 116 | 240 | 0.84 | G | 1 | 1 | 0 | 0 | 3 | 1 | 5-64-4 |
| 0064 | 099-101-C503 | 0.246 Mi. W. Rte. 641 | James City C.L. | 2.74 | 170,500 | 396 | 6 | — | 4 | — | 9 | 61.5 | Yes | Yes | Yes | 117 | 240 | 0.85 | G | 1 | 0 | 0 | 0 | 2 | 1 | 5-64-5 |
| 0064 | 047-102-C501 | York County Line | WCL Newport News | 2.38 | 167,700 | 1836 | 6 | — | 4 | — | 9 | 61.5 | Yes | Yes | Yes | 118 | 240 | 0.86 | F | 0 | 1 | 0 | 0 | 3 | 0 | 5-64-6 |
| 0064 | 121-101-C501 | WCL Newport News | 2.903 Mi. E. WCL Newport News | 2.90 | 175,800 | 3490 | 6 | — | 4 | — | 9 | 61.5 | Yes | Yes | Yes | 116 | 290 | 1.01 | F | 1 | 0 | 0 | 0 | 2 | 0 | 5-64-7 |
| 0064 | 121-101-C502 | 2.903 Mi. E. WCL Newport News | 0.688 Mi. E. Rte. 105 | 1.36 | 207,800 | 3502 | 6 | — | 4 | — | 9 | 61.5 | Yes | Yes | Yes | 121 | 290 | 1.07 | F | 0 | 0 | 1 | 0 | 3 | 0 | 5-64-8 |
| 0064 | 121-101-C503 | 0.688 Mi. E. Rte. 105 | 2.720 Mi. W. Rte. 168 | 1.60 | 184,100 | 3844 | 6 | — | 4 | — | 9 | 61.5 | Yes | Yes | Yes | 120 | 290 | 1.04 | F | 0 | 0 | 1 | 0 | 2 | 2 | 5-64-9 |
| 0064 | 121-101-C505 | 2.720 Mi. W. Rte. 168 | 0.023 Mi. W. Rte. 168 | 2.71 | 171,400 | 3874 | 6 | — | 4 | — | 9 | 61.5 | Yes | Yes | Yes | 119 | 290 | 1.03 | F | 0 | 0 | 1 | 0 | 2 | 2 | 5-64-10 |
| 0064 | 121-070- | 0.023 Mi. W. Rte. 168 | 0.791 Mi. W. Rte. 17 | 2.46 | 183,300 | 552 | 0 | — | 6 | — | 9 | 50 | Yes | Yes | No | 180 | 240 | 1.31 | G | 1 | 1 | 0 | 0 | 2 | 1 | 5-64-11 |
| 0064 | 121-071- | 0.791 Mi. W. Rte. 17 | NCL Hampton | 1.67 | 190,400 | 240 | 0 | — | 6 | — | 9 | 50 | Yes | Yes | No | 186 | 240 | 1.35 | E | 0 | 0 | 0 | 0 | 1 | 0 | 5-64-12 |
| 0064 | 114-070- | NCL Hampton | 0.322 Mi. N. Rte. 258 | 3.74 | 170,500 | 256 | 0 | — | 6 | — | 9 | 50 | Yes | Yes | No | 192 | 260 | 1.48 | G | 2 | 0 | 0 | 0 | 2 | 0 | 5-64-13 |
| 0064 | B-1A | 0.322 Mi. N. Rte. 258 | Lasalle Avenue | 2.50 | 159,700 | 256 | 0 | — | 6 | — | 8 | 50 | Yes | Yes | No | 192 | 290 | 1.68 | G | 2 | 2 | 1 | 0 | 2 | 0 | 5-64-14 |
| 0064 | B-1B | Lasalle Avenue | Route 60 | 2.30 | 152,800 | 238 | 0 | — | 6 | — | 8 | 50 | Yes | Yes | No | 206 | 310 | 1.91 | G | 2 | 0 | 2 | 0 | 2 | 2 | 5-64-15 |
| 0064 | B-3 | Route 60 | Hampton Roads Toll Plaza | 0.87 | 158,700 | 238 | 0 | — | 6 | — | 8 | 50 | Yes | Yes | No | 207 | 300 | 1.89 | E | 0 | 0 | 1 | 0 | 2 | 0 | 5-64-16 |
| 0064 | 122-101-C505 | 0.857 Mi. N. Rtes. 165 & 170 | 0.126 Mi. W. Rte. 168 | 1.59 | 174,100 | 656 | 0 | — | — | 6 | 9 | 61.5 | Yes | Yes | Yes | 44 | 400 | 0.53 | G | 2 | 0 | 0 | 0 | 0 | 2 | 5-64-19 |
| 0064 | 122-070-C503 | 0.126 Mi. W. Rte. 168 | 0.055 Mi. W. Sewell's Point Road | 0.90 | 183,300 | 612 | 0 | — | — | 6 | 9 | 61.5 | Yes | Yes | Yes | 98 | 440 | 1.32 | G | 2 | 0 | 0 | 0 | 2 | 2 | 5-64-20 |
| 0064 | 122-070-C504 | 0.055 Mi. W. Sewell's Point Rd. | 0.130 Mi. W. N&S R.R. | 2.56 | 177,900 | 578 | 0 | — | — | 6 | 9 | 61.5 | Yes | Yes | Yes | 100 | 520 | 1.57 | G | 2 | 0 | 0 | 0 | 2 | 1 | 5-64-21 |
| 0064 | 122-070-C502 | 0.130 Mi. W. N&S R.R. | 0.089 Mi. N. Va. Beach Blvd. | 2.16 | 175,520 | 578 | 0 | — | — | 6 | 9 | 61.5 | Yes | Yes | Yes | 104 | 530 | 1.68 | F | 2 | 1 | 0 | 0 | 3 | 2 | 5-64-22 |
| 0064 | 122-070-C507 | 0.089 Mi. W. Va. Beach Blvd. | ECL Norfolk | 1.83 | 156,700 | 718 | 0 | — | — | 6 | 9 | 61.5 | Yes | Yes | Yes | 88 | 570 | 1.51 | G | 1 | 0 | 1 | 0 | 2 | 2 | 5-64-23 |
| 0064 | 134-101-C501 | ECL Norfolk | Chesapeake CL | 2.92 | 168,000 | 1364 | 0 | — | — | 6 | 9 | 61.5 | Yes | Yes | Yes | 88 | 530 | 1.42 | F | 1 | 1 | 2 | 0 | 2 | 2 | 5-64-24 |
| 0064 | 131-101-C501 | Va. Beach City Limits | 0.390 Mi. E. Rte. 464 | 3.38 | 160,200 | 2206 | 0 | — | — | 6 | 9 | 61.5 | Yes | Yes | Yes | 92 | 490 | 1.36 | F | 1 | 0 | 0 | 0 | 3 | 2 | 5-64-25 |
| 0064 | 131-102-C503 | 0.390 Mi. E. Rte. 464 | 0.632 Mi. W. Rte. 464 | 1.03 | 175,300 | 2238 | 0 | — | — | 6 | 9 | 61.5 | Yes | Yes | Yes | 91 | 520 | 1.42 | G | 0 | 0 | 2 | 0 | 2 | 2 | 5-64-26 |
| 0066 | 029-102-1401 | East End Bridge over Rte. 29 | 0.80 Mi. E. Rte. 50 | 6.56 | 171,900 | 430 | 6 | 6 | — | — | 9 | 61.5 | Yes | Yes | Yes | 127 | 320 | 1.22 | G | 1 | 0 | 0 | 0 | 3 | 1 | 7-66-4 |
| 0066 | 029-102-1402 | 0.80 Mi. E. Rte. 50 | 0.051 Mi. W. Rte. 495 | 6.24 | 175,800 | 288 | 6 | 6 | — | — | 9 | 61.5 | Yes | Yes | Yes | 126 | 580 | 2.21 | G | 2 | 0 | 0 | 0 | 2 | 2 | 7-66-5 |
| 0066 | 000-102-C504 | 0.109 Mi. E. North Lynn St. | 0.288 Mi. E. North Lynn St. | 0.18 | 300,300 | 0 | 0 | 6 | — | — | 9 | 61.5 | Yes | Yes | Yes | 96 | 70 | 0.20 | G | 0 | 0 | 0 | 0 | 0 | 2 | 7-66-6 |
| 0066 | 000-102-C503 | 0.288 Mi. E. North Lynn St. | W. End Thro. Roosevelt Br. | 0.32 | 258,900 | 0 | 6 | 6 | — | — | 9 | 61.5 | Yes | Yes | Yes | 117 | 70 | 0.25 | G | 0 | 0 | 0 | 0 | 0 | 0 | 7-66-7 |
| 0081 | 011-007-1401 | Roanoke C.L. | 0.28 Mi. S. Rte. 651 | 5.34 | 147,900 | 468 | 0 | 6 | 2 | — | 9 | 61.5 | Yes | Yes | No | 127 | 540 | 2.05 | G | 1 | 0 | 1 | 2 | 1 | 2 | 2-81-16 |
| 0081 | 011-010-C502 | 0.28 Mi. S. Rte. 651 | 0.567 Mi. N. Rte. 640 | 4.40 | 159,900 | 494 | 0 | 6 | 2 | — | 9 | 61.5 | Yes | Yes | No | 119 | 630 | 2.27 | G | 1 | 0 | 1 | 0 | 1 | 2 | 2-81-17 |
| 0081 | 011-010-1403 | 0.567 Mi. N. Rte. 640 | 0.019 Mi. N. Rte. 636 | 4.80 | 147,100 | 468 | 0 | 6 | 2 | — | 9 | 61.5 | Yes | Yes | No | 127 | 630 | 2.40 | E | 1 | 0 | 1 | 0 | 1 | 0 | 2-81-18 |
| 0085 | 026-101-C505 | 2.278 Mi. S. Turnpike | Richmond-Petersburg Turnpike | 2.28 | 146,100 | 146 | 0 | — | 6 | — | 9 | 61.5 | Yes | Yes | No | 89 | 510 | 1.39 | E | 1 | 0 | 2 | 0 | 0 | 1 | 4-85-9 |



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# APPENDIX B-2 (Cont.)

## JOINTED PORTLAND CEMENT CONCRETE PAVEMENT SUMMARY

| (1) Route | (2) Project | (3) From: | (4) To: | (5) Length (Mi.) | (6) Const. Cost($) | (7) Avg. Annual Maint. Cost | (8) Subgrade Stab. (in.) | (9) Subbase Type Thickness (in.) Dense | Mod. | Stab. | (10) Slab T(in.) | L(ft.) | (11) Reinforcement S | JD | (12) Metal Inserts | (13) Age (Mo.) | (14) PAI-18 Avg. | Cum. | (15) Rating | (16) Major Distress S | B | P | F | R | T | (17) Survey No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0095 | 040-033-1401 | North Carolina Line | 3.791 Mi. St. Rte. 58 | 7.31 | 143,500 | 972 | 0 | — | — | 6 | 9 | 20 | No | Yes | Yes | 140 | 640 | 2.71 | F | 0 | 0 | 2 | 2 | 3 | 1 | 5-95-1 |
| 0095 | 040-013- | 3.791 Mi. St. Rte. 58 | 1.316 Mi. S. Rte. 58 | 2.51 | 137,200 | 228 | 0 | — | 4 | — | 9 | 50 | Yes | Yes | No | 187 | 500 | 2.81 | E | 0 | 0 | 1 | 2 | 0 | 1 | 5-95-2 |
| 0095 | 040-016- | 1.316 Mi. St. Rte. 58 | 0.224 Mi. St. Rte. 58 | 1.09 | 142,300 | 226 | 0 | — | 4 | — | 9 | 50 | Yes | Yes | No | 189 | 500 | 2.84 | E | 0 | 0 | 0 | 0 | 0 | 0 | 5-95-3 |
| 0095 | 040-015- | 0.224 Mi. St. Rte. 58 | 2.329 Mi. N. Rte. 58 | 2.51 | 135,200 | 214 | 0 | — | 4 | — | 9 | 50 | Yes | Yes | No | 200 | 510 | 3.06 | E | 1 | 0 | 0 | 0 | 0 | 2 | 5-95-4 |
| 0095 | 043-101-C1 | 5.387 Mi. S. Hanover C. L. | 2.390 Mi. S. Hanover C. L. | 2.87 | 173,700 | 1766 | 0 | 6 | — | — | 9 | 61.5 | Yes | Yes | No | 148 | 2380 | 10.91 | F | 2 | 2 | 3 | 3 | 2 | 2 | 4-95-4 |
| 0095 | 042-101-1401 | 2.390 Mi. S. Henrico C. L. | 0.368 Mi. N. Rte. 54 | 8.28 | 156,200 | 1526 | 0 | 6 | — | — | 9 | 61.5 | Yes | No | No | 143 | 2390 | 10.32 | F | 2 | 0 | 3 | 1 | 0 | 1 | 4-95-5 |
| 0095 | 016-002-1402 | 3.537 Mi. N. Rte. 207 | Spotsylvania C.L. | 8.86 | 132,800 | 1300 | 0 | 6 | — | — | 9 | 61.5 | Yes | Yes | No | 130 | 2350 | 9.23 | F | 1 | 1 | 2 | 3 | 1 | 2 | 6-95-2 |
| 0095 | 088-101-1401 | Caroline C.L. | 5.019 Mi. N. Caroline C.L. | 4.91 | 149,200 | 2992 | 0 | 6 | — | — | 9 | 61.5 | Yes | Yes | No | 133 | 2350 | 9.45 | P | 3 | 3 | 3 | 3 | 3 | 3 | 6-95-3 |
| 0095 | 088-101-1402 | 5.019 Mi. N. Caroline C.L. | 0.501 Mi. N. Rte. 1 | 4.59 | 151,100 | 3876 | 0 | 6 | — | — | 9 | 61.5 | Yes | Yes | Yes | 140 | 2340 | 9.90 | P | 3 | 1 | 3 | 3 | 3 | 2 | 6-95-4 |
| 0095 | 088-102-1401 | 0.501 Mi. N. Rte. 1 | Stafford C.L. | 5.75 | 133,800 | 734 | 0 | — | 6 | — | 9 | 61.5 | Yes | Yes | No | 121 | 2300 | 8.42 | G | 2 | 1 | 2 | 2 | 2 | 0 | 6-95-5 |
| 0095 | 089-101-1401 | Spotsylvania C.L. | 2.056 Mi. N. Potomac Creek | 6.41 | 129,600 | 576 | 0 | 6 | — | — | 9 | 61.5 | Yes | Yes | No | 121 | 2210 | 8.08 | G | 2 | 2 | 1 | 2 | 2 | 0 | 6-95-6 |
| 0095 | 089-101-C503 | 2.056 Mi. N. Potomac Creek | 4.271 Mi. N. Potomac Creek | 2.19 | 148,000 | 2364 | 0 | — | 6 | — | 9 | 61.5 | Yes | Yes | Yes | 126 | 2190 | 8.26 | P | 3 | 2 | 3 | 3 | 3 | 0 | 6-95-7 |
| 0095 | 089-101-C505 | 4.271 Mi. N. Potomac Creek | 6.316 Mi. N. Potomac Creek | 2.04 | 153,500 | 2176 | 0 | 6 | — | — | 9 | 61.5 | Yes | Yes | Yes | 118 | 2180 | 7.91 | P | 3 | 2 | 3 | 3 | 3 | 0 | 6-95-8 |
| 0095 | 089-101-C506 | 6.316 Mi. N. Potomac Creek | 2.644 Mi. S. Prince Wm. C. L. | 1.95 | 152,400 | 2378 | 0 | 6 | — | — | 9 | 61.5 | Yes | Yes | Yes | 125 | 2170 | 8.21 | P | 3 | 2 | 3 | 3 | 3 | 2 | 6-95-9 |
| 0095 | 089-101-1404 | 2.644 Mi. S. Prince Wm. C. L. | Prince William C.L. | 2.64 | 149,800 | 2468 | 0 | 6 | — | — | 9 | 61.5 | Yes | Yes | Yes | 121 | 2130 | 7.81 | P | 3 | 1 | 3 | 3 | 3 | 2 | 6-95-10 |
| 0095 | 076-101-1401 | Stafford C.L. | 1.637 Mi. N. Stafford C.L. | 1.64 | 149,800 | 2030 | 0 | 6 | — | — | 9 | 61.5 | Yes | Yes | Yes | 121 | 2010 | 7.34 | F | 2 | 2 | 3 | 3 | 3 | 0 | 7-95-1 |
| 0095 | 076-101-1402 | 1.637 Mi. N. Stafford C.L. | 0.661 Mi. N. Quantico Cr. | 2.96 | 152,300 | 1290 | 0 | 6 | — | — | 9 | 61.5 | Yes | Yes | Yes | 127 | 1960 | 7.53 | F | 2 | 1 | 2 | 3 | 3 | 1 | 7-95-2 |
| 0095 | 076-101-1403 | 0.661 Mi. N. Quantico Cr. | 1.448 Mi. N. Neabsco Cr. | 4.57 | 154,400 | 1408 | 0 | 6 | — | — | 9 | 61.5 | Yes | Yes | Yes | 131 | 1920 | 7.58 | F | 2 | 1 | 2 | 2 | 3 | 1 | 7-95-3 |
| 0095 | 076-102-1401 | 1.448 Mi. N. Neabsco Cr. | 1.528 Mi. N. Fairfax C.L. | 5.49 | 148,400 | 1234 | 0 | 6 | — | — | 9 | 61.5 | Yes | Yes | Yes | 129 | 1990 | 7.77 | F | 2 | 0 | 3 | 3 | 0 | 2 | 7-95-4 |
| 0264 | 122-101-C502 | 0.151 Mi. W. Rte. 460 | 0.014 Mi. E. N&W R.R. | 1.48 | 179,600 | 790 | 0 | — | — | 6 | 9 | 61.5 | Yes | Yes | No | 89 | 340 | 0.90 | G | 0 | 0 | 0 | 0 | 0 | 2 | 5-264-6 |
| 0264 | 122-101-C503 | 0.014 Mi. W. N&W R.R. | 0.259 Mi. W. Rte. 13 | 1.66 | 166,300 | 748 | 0 | — | — | 6 | 9 | 61.5 | Yes | Yes | No | 94 | 340 | 0.95 | G | 1 | 0 | 0 | 0 | 0 | 2 | 5-264-7 |
| 0264 | 122-101-C504 | 0.259 Mi. W. Rte. 13 | 0.479 Mi. E. Rte. 13 | 0.76 | 197,100 | 718 | 0 | — | — | 6 | 9 | 61.5 | Yes | Yes | No | 98 | 410 | 1.22 | G | 1 | 1 | 0 | 0 | 0 | 2 | 5-264-8 |
| 0264 | 122-070-C507 | 0.479 Mi. E. Rte. 13 | E. of Rte. 64 | 0.90 | 156,700 | 1196 | 0 | — | — | 6 | 9 | 61.5 | Yes | Yes | Yes | 88 | 420 | 1.12 | G | 0 | 0 | 0 | 0 | 0 | 2 | 5-264-9 |
| 0464 | 131-101-C501 | 0.382 Mi. N. Rte. 64 | 0.927 Mi. N. Rte. 64 | 0.55 | 175,200 | 3318 | 0 | — | — | 6 | 9 | 61.5 | Yes | Yes | Yes | 91 | 150 | 0.42 | G | 1 | 0 | 0 | 0 | 2 | 1 | 5-464-1 |
| 0564 | 122-070-C502 | 1.200 Mi. W. Rte. 64 | 0.722 Mi. W. Rte. 64 | 0.79 | 174,000 | 148 | 0 | — | — | 6 | 9 | 61.5 | Yes | Yes | Yes | 44 | 250 | 0.34 | G | 0 | 0 | 0 | 0 | 0 | 2 | 5-564-2 |
| | | Total Averages | | 173.5 | 165,300 | 1228 | | | | | | | | | | | | | | | | | | | | |

# APPENDIX B-3

## Continuously Reinforced Concrete Pavements

### Legend

| | |
|---|---|
| Columns 1 – 5 | Self-explanatory. |
| Column 6 | Construction costs per 24 ft. wide lane mile. Based on Engineering News Record construction cost index using contract unit prices converted to a 1975 base. |
| Column 7 | Average annual maintenance costs per 24 ft. wide lane mile. From information provided by the Accounting Division. |
| Column 8 | Thickness (in.) of soil cement subgrade stabilization. |
| Column 9 | Type and thickness (in.) of subbase material.<br>SM – select material.<br>AB – aggregate base.<br>Stabilized – cement treated subbase. |
| Column 10 | T – slab thickness (in.). |
| Column 11 | R – percentage of reinforcing steel. |
| Column 12 | Project age (mo.). |
| Column 13 | Average daily and total cumulative equivalent 18,000 lb. axle loadings as estimated from information provided by the Traffic and Safety Division. |
| Column 14 | Overall Project Rating<br>E – excellent<br>G – good<br>F – fair<br>P – poor |

Column 15

Major distress observed:

S – settlements
EP – edge pumping
P – patching
SC – scaling
LC – uncontrolled longitudinal cracking
MS – major spalls

Degree of distress:

0 – none
1 – rarely
2 – occasionally
3 – frequently

Column 16

Survey Number refers to Research Council files on the project given.

# APPENDIX B-3

## CONTINUOUSLY REINFORCED CONCRETE PAVEMENT SUMMARY

| (1) Route | (2) Project | (3) From: | (4) To: | (5) Length (Mi.) | (6) Const. Cost($) | (7) Avg. Annual Maint. Cost | (8) Subgrade Stab. (in.) | (9) Subbase Type Thickness (in.) SM | AB | Stab. | (10) T(in.) | (11) R(%) | (12) Age (Mo.) | (13) IAI-18 Avg. | Cum. | (14) Rating | (15) Major Distress S | EP | P | SC | LC | MS | (16) Survey No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0064 | 002-102-1403 | 0.070 Mi. Rt. 250 | 0.433 Mi. W. Rte. 29 | 10.40 | 133,700 | 18 | 6 | — | — | 5 | 8 | 0.6 | 54 | 260 | 0.43 | E | 2 | 1 | 0 | 0 | 0 | 0 | 7-64-3 |
| 0064 | 002-102-1405 | 0.433 Mi. W. Rte. 250 | 0.297 Mi. E. Rte. 22 | 9.22 | 131,400 | 14 | 6 | — | — | 5 | 8 | 0.6 | 47 | 250 | 0.35 | G | 2 | 0 | 1 | 0 | 0 | 1 | 7-64-4 |
| 0064 | 032-101-1401 | 0.297 Mi. E. Rte. 22 | 0.57 Mi. W. Rte. 15 | 9.39 | 110,100 | 18 | 6 | — | — | 5 | 8 | 0.6 | 55 | 240 | 0.41 | G | 0 | 1 | 0 | 2 | 2 | 1 | 7-64-5 |
| 0064 | 043-001-C501 | 0.356 Mi. W. Rte. 250 | 0.316 Mi. W. Parham Road | 2.84 | 190,400 | 140 | 0 | 6 | 5 | 0 | 8 | 0.6 | 96 | 290 | 0.83 | E | 2 | 0 | 0 | 0 | 0 | 0 | 4-64-4 |
| 0064 | 043-001-C502 | 0.316 Mi. W. Parham Road | 0.706 Mi. W. Rte. 250 | 2.15 | 199,000 | 1836(1) | 0 | 6 | 5 | 0 | 8 | 0.6 | 88 | 310 | 0.84 | G | 1 | 0 | 2 | 0 | 0 | 1 | 4-64-5 |
| 0064 | 043-001-C503 | 0.706 Mi. W. Rte. 250 | 0.484 Mi. W. Rte. 33 | 1.81 | 183,200 | 100 | 0 | 6 | 4 | 0 | 8 | 0.6 | 88 | 330 | 0.89 | G | 0 | 0 | 0 | 2 | 0 | 0 | 4-64-6 |
| 0064 | 127-070-C501 | 0.484 Mi. W. Rte. 33 | Richmond-Petersburg Turnpike | 2.15 | 185,900 | 160 | 0 | 12 | 5 | 0 | 8 | 0.6 | 88 | 400 | 1.07 | E | 0 | 0 | 0 | 0 | 0 | 0 | 4-64-7 |
| 0064 | 127-071-C501 | Richmond-Petersburg Turnpike | 0.354 Mi. W. Rte. 360 | 1.53 | 251,300 | 1136(1) | 0 | 12 | 5 | 0 | 8 | 0.6 | 75 | 510 | 1.17 | E | 2 | 0 | 0 | 0 | 0 | 0 | 4-64-8 |
| 0064 | 043-101-C501 | 0.354 Mi. W. Rte. 360 | 0.081 Mi. W. Laburnum Ave. | 3.74 | 162,000 | 540 | 0 | 6 | 5 | 0 | 8 | 0.6 | 86 | 390 | 1.02 | G | 2 | 0 | 0 | 0 | 0 | 0 | 4-64-9 |
| 0064 | 063-101-1402 | 1.404 Mi. E. Henrico C.L. | 0.785 Mi. E. Rte. 608 | 9.75 | 136,400 | 352 | 0 | 0 | 0 | 6 | 8 | 0.6 | 15 | 390 | 0.28 | G | 0 | 2 | 0 | 0 | 0 | 0 | 4-64-12 |
| 0064 | 063-101-1401 | 0.785 Mi. E. Rte. 608 | James City C.L. | 8.97 | 125,200 | 172 | 0 | 0 | 0 | 6 | 8 | 0.6 | 21 | 370 | 0.24 | E | 0 | 1 | 0 | 0 | 0 | 0 | 4-64-13 |
| 0064 | 047-101-1401 | New Kent C.L. | 0.63 Mi. E. Rte. 30 & 168 | 3.32 | 125,200 | 74 | 0 | 0 | 0 | 6 | 8 | 0.6 | 21 | 330 | 0.21 | G | 0 | 2 | 0 | 0 | 1 | 0 | 5-64-1 |
| 0064 | 047-101-C502 | 0.63 Mi. E. Rtes. 30 & 68 | 2.301 Mi. W. York C.L. | 3.08 | 130,000 | 10 | 0 | 0 | 0 | 6 | 8 | 0.6 | 5 | 330 | 0.06 | E | 2 | 0 | 0 | 0 | 0 | 0 | 5-64-2 |
| 0064 | 122-101-C503 | S. End Hampt. Roads Br. Tunnel | Maple Avenue | 2.27 | 191,800 | 0 | 0 | 0 | 0 | 6 | 8 | 0.6 | 11 | 540 | 0.19 | E | 0 | 0 | 0 | 0 | 0 | 0 | 5-64-17 |
| 0064 | 122-101-1402 | Maple Avenue | 0.857 Mi. N. Rtes. 165 & 170 | 1.74 | 209,000 | 0 | 0 | 0 | 0 | 6 | 8 | 0.6 | New | — | — | E | 0 | 0 | 0 | 0 | 0 | 0 | 5-64-18 |
| 0064 | 131-102-1401 | 0.632 Mi. W. Rte. 464 | 0.787 Mi. E. N&W R.R. | 7.03 | 161,700 | 254 | 0 | 0 | 0 | 7 | 8 | 0.6 | 76 | 480 | 1.10 | G | 0 | 2 | 0 | 2 | 0 | 0 | 5-64-27 |
| 0085 | 026-101-1407 | 1.217 Mi. S. Brunswick C.L. | 8.05 Mi. N. Rte. 40 | 11.82 | 153,400 | 512 | 0 | 0 | 0 | 6 | 8 | 0.6 | 68 | 520 | 1.07 | F | 2 | 2 | 2 | 0 | 1 | 0 | 4-85-7 |
| 0085 | 026-101-1403 | 8.05 Mi. N. Rte. 40 | 2.719 Mi. S. Turnpike | 10.68 | 147,200 | 494 | 0 | 0 | 0 | 6 | 8 | 0.6 | 68 | 520 | 1.07 | F | 0 | 2 | 2 | 0 | 1 | 0 | 4-85-8 |
| 0564 | 122-070-C502 | 1.200 Mi. W. Rte. 64 | 0.722 Mi. W. Rte. 64 | 0.58 | 150,300 | 0 | 0 | 0 | 0 | 6 | 8 | 0.6 | New | — | — | E | 0 | 0 | 0 | 0 | 0 | 0 | 5-564-1 |
| | | Totals or Averages | | 102.5 | 161,600 | 344 | | | | | | | | | | | | | | | | | |

(1) Longitudinal Grooving on Curves.



2287