MISSOURI COOPERATIVE HIGHWAY RESEARCH PROGRAM

FINAL REPORT

83-1

PERFORMANCE OF LATEX MODIFIED AND LOW SLUMP CONCRETE OVERLAYS ON BRIDGE DECKS

MISSOURI HIGHWAY AND TRANSPORTATION DEPARTMENT

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STUDY NO. 83-1

Prepared By

MISSOURI HIGHWAY AND TRANSPORTATION DEPARTMENT

DIVISION OF MATERIALS AND RESEARCH

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The opinions, findings, and conclusions expressed in this publication are not necessarily those of the Federal Highway Administration.

ABSTRACT

A field investigation was conducted in 1982-1983 to determine the performance of 60 Low Slump Concrete, 7 Latex Mortar, and 24 Latex Concrete overlays. The overlays were constructed between 1973 and 1983 with the majority from 1979 to 1981.

The investigation included the extent and type of surface cracking, area of debonding and/or delaminating, and area of surface patching. On a limited number of selected bridge structures, voltage potential measurements, chloride ion content, and extent of crack penetration were also included.

Data indicated concrete overlays exhibited cracking, debonding, and/or delaminations but was not as severe as was noted on a few decks which had caused concern and originated the study.

Continued use of latex modified and low slump concrete overlays appear warranted. The least amount of surface cracking was found on decks with minimum overlay thickness of 1 3/4 inches of latex and 2 1/4 inches of low slump concrete.

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LIST OF ABBREVIATIONS

ADT	Average Daily Traffic
BB-G	Box Beam or Girder
Class B-1 B-2 X	Types of Masonry Concrete Mixes
GIRD	Girder
LC	Latex Concrete
LM	Latex Mortar
LSC	Low Slump Concrete
OR	Outer Road
PYTR	Pony Truss
R	Rehabilitated Bridge Deck
STRG	Stringer/Multi-Beam or Girder
T-BM	Tee Beam
THTR	Thru Truss

INTRODUCTION

Missouri's geographical location in the freezing index band, expressed in degree-days below 32°F, ranges from less than 100 in the southeast (Bootheel) part of the state to in excess of 600 in the northwest part of the state. The use of deicing salts in conjunction with abrasive materials varies widely throughout the state. Since 1970, certain measures have been taken to provide protection for the reinforcing steel against the corrosive affects of deicing salts. Measures utilized include (a) membrane systems, (b) cathodic protection, (c) epoxy coating and increasing cover over the top steel, (d) improved mix designs to reduce permeability of concrete, and (e) concrete overlays.

The primary design feature of any concrete overlay, regardless of type, is as a protective barrier system against migration of chlorides to the level of top reinforcing steel. To provide greater protection for the reinforcement steel in decks, a denser concrete surface was constructed. To date, 91 bridges including rehabilitated older decks (designated by an "R" following the individual bridge number) and decks of new two course layered construction have received some type of concrete overlay statewide.

When an overlay becomes flawed through either cracking and/or debonding, the system, as such, has lost some measure of its protective capacity. The department became concerned when reports from the field cited moderate to severe surface cracking and debonding was occurring on several older rehabilitated and on some newly constructed overlaid decks.

Those overlays constructed on the rehabilitated older decks were built in 1977 and consisted of a 1 1/2 inch thick latex concrete on Bridges L-641R and L-759R and a 1 3/4 inch thick low slump concrete on Bridges L-501R and L-642R respectively and all located in the Kansas City area. The overlays constructed on the new layered decks were built in 1978 and consisted of a 2 inch thick low slump concrete on Bridge A-3292 located in the St. Charles area and Bridge A-3520 located in the Jefferson City area respectively. Cores showed cracks extended through the overlay in the majority of cases and in some instances penetrated into the base concrete. To learn the extent of these specific problems, a field investigation of all constructed layered decks was undertaken during the fall of 1982 and concluded in the spring of 1983.

This research study covers findings of 91 overlaid bridges. Some 104 driving (outermost thru) lanes were surveyed and categorized by type and design thickness as follows: (a) 30 latex concrete (LC) ranging from one to two and one quarter inches with the majority one and one half inches, (b) 9 latex mortar (LM) one inch, and (c) 65 low slump concrete (LSC) ranging from one and three quarters to two and one quarter inches with the majority two inches.

CONCLUSIONS

The following conclusions are based on a 1982-1983 survey of portions of concrete overlaid decks on 91 bridges. These overlays, most of which were less than five years old, were placed on decks of new layered construction and on older rehabilitated decks. Both the extent and severity of surface cracking and debonding and/or delamination of overlays was not found to be as great as on several decks which caused original concern and resulted in this study.

1. Surface cracking was not observed on seventy-eight percent of the deck areas surveyed, (represented by 31,778 grids each 4' x 3').

2. The 2 1/4 inch thick low slump concrete had significantly less cracking than either the 1 3/4 or 2 inch thick low slump concrete.

3. Debonding and/or delamination was noted on 0.57 percent of the deck areas surveyed (381,336 square feet).

4. Surface patching was noted on 0.12 percent of the deck areas surveyed (381,336 square feet).

5. Voltage potential readings obtained on 20 deck driving lanes indicated 90.7 percent were in passive areas of less than -0.20 volts, 8.7 percent were in the active or passive range of -0.21 to -0.35 volts, and 0.6 percent were in the active range of greater than -0.35 volts.

6. Eight of 17 decks tested had two or more pounds of chloride per cubic yard of concrete near the surface of the overlay. Generally, the overlays were protecting against the migration of chloride ions into the base deck concrete.

7. Random cores drilled over surface cracks on 15 deck driving lanes indicated cracks extended into the base concrete on 50.0 percent of latex mortar, 29.6 percent of low slump, and 14.3 percent of latex concrete cores.

8. The depth of crack penetration was found to be independent regardless of the width of the surface crack.

IMPLEMENTATION

Based on the data resulting from this study, the continued use of both latex modified concrete and low slump concrete is warranted. However, when possible, the minimum thickness of latex modified concrete should be 1 3/4 inches and low slump concrete should be 2 1/4 inches.

A similar study appears warranted in about 5 years to determine if environmental factors would increase the amount of cracking and debonding and/or delamination of the concrete overlays.

DISCUSSION

This study consists of a state-wide survey of all bridge decks utilizing Latex Modified or Low Slump Concrete Overlays. These overlays were placed on both decks of new two course layered construction as well as on older rehabilitated decks which are designated by an "R" following the individual bridge number. The objective of the study was to determine if some deck concrete overlays exhibiting moderate to severe surface cracking and debonding and/or delaminations were isolated conditions or existed statewide. This cracking consisted primarily of random and transverse cracking with lesser amounts of longitudinal cracking. As reported, this moderate to severe cracking was primarily occurring on four decks in the Kansas City area. All four of these decks were rehabilitated older decks patched and scarified prior to overlay placement. Considerable cracking was also observed on a new river bridge in the St. Charles area having a two inch low slump concrete overlay. Excessive debonding was noted on one new constructed bridge with a two inch thick low slump concrete in the Jefferson City area.

The field investigation was generally restricted to the driving (outermost thru) lane of each overlaid structure. On those given structures having divided two-way traffic, both driving lanes were investigated. The scope of this investigation covered strip mapping of all (a) visual cracking, (b) areas of debonding and/or delaminating, and (c) patching and other signs of visual deterioration. The entire survey

area was divided into a (4' x 3') grid system on the driving lane surface of each deck investigated. The four foot grid dimensions ran longitudinally with the deck and the three foot dimension ran transverse across the width of the driving lane. In addition, certain limiting length criteria was set up for these overlaid structures. See appendix 1 for details.

On a limited basis, a more comprehensive investigation was conducted on certain selected bridge deck overlays. This additional testing included (a) electrical corrosion potential measurements, (b) composite concrete samples of six sample sites each deck for chloride ion content analysis, and (c) cores cut over selected surface cracks representing each of three sizes of cracks and referred to as fine, medium, and large. For purpose of this study, size of cracks is defined as follows:

Type Crack	Description	Can Be Seen From
Fine	Very Tight	5'
Medium	Sharp Edged	--
Large	Edges Rounded	--

The field work was conducted during the fall of 1982 and spring of 1983. In all, 91 bridges represented by 104 driving lanes on deck overlays were investigated. Lanes surveyed consisted of 30 latex modified concrete, 9 latex modified mortar, and 65 low slump concrete representing 381,336 square feet of deck area. This covered all the constructed overlaid decks to date in the state with the exception of one structure, L-361R1, in the downtown area of St. Louis which was not investigated for safety reasons.

The above overlays were placed on both older rehabilitated structures as well as on structures of entirely new two course layered construction. In addition, these overlays were placed on decks having seven different substructure design types. Each of the overlaid structures investigated were grouped under the specific substructure type. See Table 10.

Missouri has used three different classes of masonry concrete in their bridge deck construction pours. These are Class B-1, B-2, and X respectively. Prior to 1979, nearly all of the deck pours consisted of the Class B-1 masonry mix. However, one of the measures taken in retarding deterioration of reinforcing steel through corrosion, led to modifying the Class B-1 masonry mixture. This modification consisted of lowering the maximum slump requirement of 4 inches for the Class B-1 to 2 1/2 inches for the Class B-2 with an additional slump increase of 1/2 inch permitted by the engineer if needed to improve workability. In addition, the minimum cement requirement for Class A sand was raised from 6.5 sacks as required for the Class B-1 to 7.5 sacks for Class B-2. This modified masonry mixture Class B-2 was first used during the 1979 construction season. It has been since adopted and made a part of Missouri's Standard Specifications for Highway Construction, 1981 publication. Currently, the majority of our deck structures are built of Class B-2 masonry concrete utilizing epoxy coating of the top reinforcing steel bars and having three inches clear depth of cover. Class X masonry mix is a standard light-weight masonry concrete mix design.

The categorized, tabulated, and summarized data showed that the surface cracking and debonding problem was not widespread as originally feared.

I. SURFACE CRACKING - The data showed that eighty percent of these lanes had less than 100 feet of cracking per thousand square feet of deck area, based on an overall weighted average. This data also indicated that the 1 1/2 inch thick latex concrete had 30 percent less cracking than the two inch low slump concrete, thus appearing to render a better performance. This was based on a moderate sample size in each case, 22 deck lanes and 21 deck lanes respectively, and tabulated from weighted averages. A further performance record as indicated from this weighted average data showed that the 2 1/4 inch thick low slump concrete had 52 percent more surface cracking than the 2 1/4 inch thick latex concrete, but significantly less surface cracking than the 2 inch thick low slump concrete. Also, the 2 1/4 inch thick low slump concrete had a relatively good sample size representing 42 deck driving (thru) lanes. This data appears to suggest the thicker low slump concrete overlays reduces the surface cracking considerably. It should be pointed out that two of the four decks that prompted this study were of the 1 3/4 inch thick low slump concrete. Strip mapping results of the surface cracking on these two structures based on a weighted average, revealed some 408 feet of cracking per thousand square feet of deck area. This was the highest encountered in the survey. However, this was a very small sample size (2 deck driving lanes) and insufficient to show any kind of trend. This limited data does suggest that the 1 3/4 inch thick low slump concrete

may be too thin. The one inch thick latex mortar overlays had a relatively good performance in regard to surface cracking as 90 percent of the grids (4' x 3') had none. There was considerably more cracking on the one inch thick minimum latex concrete and the 1 3/4 inch thick low slump concrete overlays when compared to the other overlays in this investigation.

Based on a weighted average, there was 80 lineal feet of surface cracking per thousand square feet of deck driving lanes. Based on this data, twenty-four or (23.1%) of the individual 104 surveyed driving lanes exceeded this weighted average.

An analysis was made of the following: (a) the various types and thicknesses of overlays versus the seven basic design types of bridge deck substructures encountered in this study, (b) comparing different classes of concrete utilized in the base deck, i.e., Class B-1 versus Class B-2, (c) comparing eight different associated aggregate combinations utilized in the overlay versus the base deck concrete, and (d) comparing decks of new layered construction and rehabilitated older decks. Results of programs (a), (b), and (c) above indicated no significant difference was found to exist between any of these variables.

A significant difference at the 99 percent level of confidence was found to exist in program (d). This analysis compared decks of entirely new construction versus rehabilitated older decks receiving partial half sole and/or full depth area repairs and showed a 73 percent reduction in surface cracking for overlays placed on new decks. Table

6 exhibits the results of the surface cracking for each individual deck investigated.

To run the regression analysis, certain other background data had to be developed. This additional data concerned (a) the month and year the base deck was constructed, and (b) the month and year the overlay was constructed. Based on the resulting analyses, only 5 percent of the variation in amount of surface cracking was explained by the ages of the base concrete decks regardless of classes of concrete, therefore, deck age had negligible effect. On another regression analysis of the data, only 17 percent of the variation in amount of surface cracking was explained by the ages of the overlays regardless of type and thickness, therefore, overlay age had only a minimal effect.

It was recognized, variables other than the ones analyzed had an effect in the overlay performance. However, those variables which may or may not be known, generally relate to some type(s) of environmental factors which can not be measured and analyzed.

II. DEBONDING AND/OR DELAMINATION - Results of the overlaid concrete surface debonding and/or delaminating survey, See Table 7, showed that 84 of the 104 deck driving lanes, 80.8 percent, had none. Twenty of the 104 deck driving lanes had some percentage of debonding and/or delamination with six having >3 percent. Four of these six,L-641R, L-642R, L-759R, and A-1763R were rehabilitated decks that had been scarified prior to overlay placement with the remaining two decks A-3520 and A-3521 of layered new construction. In this limited survey, with one exception, no attempt was made to determine

whether a hollow sounding deck area had debonded and/or delaminated.

A problem developed on newly constructed Bridge A-3520 prior to its being opened to traffic, when 12.9 percent of its driving lane had debonded and was patched. At the time of this survey, an additional 3.1 percent of the driving lane had a hollow sound and was assumed to have debonded. Bridge A-3521 built under the same project had no debonding problem initially. However, at the time of this survey, it was found that 35 percent of its driving lane was debonded. This was verified by drilling. Both of these overlays were constructed in 1978 on a non-textured base concrete surface with water blast treatment prior to overlay. Since that time, surface preparation was changed to require a very rough texture by use of a wire comb or scarified.

With these few exceptions, debonding and/or delamination has not been a problem to date. Overall, only 0.57 percent of the total 381,336 square feet of overlaid deck area investigated had either debonded and/or delaminated.

III. PATCHING - Results of the overlaid concrete surface patching survey showed that 96 of the 104 deck driving lanes, 92.3 percent had no surface patching. Only eight of the 104 deck driving lanes, 7.7 percent, had any surface patching. Of these eight deck driving lanes, six had < one percent while Bridge A-2682 carrying southbound Route 141 traffic with a one inch latex mortar had 1.2 percent patching and Bridge A-3520 carrying local traffic with a two inch low slump concrete had 12.9 percent patching. See Table 7. Overall, only 0.12 percent of the total 381,336 square feet of overlaid deck area investigated had been patched.

IV. ADDITIONAL COMPREHENSIVE TESTING - As mentioned previously, a more comprehensive investigation was conducted on selected bridge deck overlays as follows: (a) 20 deck driving lanes for voltage potential measurements, (b) 17 deck driving lanes for chloride ion content, and (c) 15 deck driving lanes to determine extent of crack penetration. Generally, this selection was based on (a) broad statewide area representation of decks with different exposures to varying treatments of deicing materials, (b) varying years of winter exposure of the overlays, and (c) obtain an approximate representative proportion for each of the three basic type overlays investigated.

A. VOLTAGE POTENTIAL MEASUREMENTS - Table 2 exhibits the results of the copper-copper sulfate half cell voltage potential readings as determined from six latex concrete driving lanes, three latex mortar driving lanes, and eleven low slump concrete driving lanes. These readings were all taken on a (4' x 3') control grid system. The results of 4,622 voltage potential readings show that the five decks that were exposed for six winters exhibited the highest percentage of readings recorded in the -0.21 volt to -0.35 volt active or passive range. Those four rehabilitated older decks having the reported severe surface cracking were all in this group and are L-641R S.B., L-642R N.B., L-501R S.B., and L-759R S.B. respectively. Also, those voltage potential readings that were in the active or probable corrosion range, i.e., >-0.35 volts are still relatively small, some 0.6 percent. With the surface

cracking present on the above structures, the effectiveness of these particular overlay systems has largely been destroyed. This then permits the active corrosive environmental area of the base deck concrete to grow ever larger. The remaining fifteen potential scan tested overlays are still providing adequate protection against the migration of chloride ions. However, it should be noted, this latter group of overlaid decks have only had two to five years of winter exposure.

Regardless of age or type of overlay, the thirteen newly constructed decks had a lower percent of potential reading in the passive or active and active range than did the older rehabilitated decks.

B. CHLORIDE CONTENT OF PULVERIZED CONCRETE - As a part of the additional comprehensive testing discussed earlier, concrete samples were taken from seventeen deck traffic lanes and tested for chloride content. Of these seventeen decks, two were latex mortar, six were latex concrete, and nine were of low slump concrete. A discussion of the sampling procedure, testing, and analysis of results follows.

In extracting the concrete samples from the deck, the surface down to a depth of 1/4 inch was always wasted. Following this, six successive 1/2 inch incremental lifts were made and kept separate to a bottom depth of 3 1/4 inches. Six individual deck sample sites were chosen in the driving (thru) lane in each of the seventeen decks tested for chloride content. Thus, each of the six like concrete sampled horizons were mixed and blended into one

composite sample representing a specific vertical concrete horizon within a given deck. All overlay thicknesses were penetrated and concrete samples were also taken out of the concrete base deck. No attempt was made to break a given sample horizon at the overlay-base concrete deck interface as there were variations from the design overlay thickness. This was especially true on the scarified older rehabilitated decks. All concrete samples were taken by means of a pulverizing (star) bit, worked by an impact type hammer. All respective sampling sites were selected away from any surface cracking thus averting any unusual influence from that cracking source. Each of the values shown in Table 3 is the result of composites of six individual samples for each of the successive horizons (a through f) inclusive. The chloride ion content of each of the pulverized concrete samples so blended, was determined by the potentiometric titration method.

Seven of the bridges listed in Table 3 were rehabilitated older decks and are A-119R, A-1763R, J-991R, L-501R, L-641R, L-642R, and L-759R with the remaining ten decks of layered new construction. Based on the results of the chloride content found in the concrete samples taken in this investigation, eight of the seventeen decks tested had chloride content of two pounds or greater near the surface of the overlay. It appears from the data that the latex modified concrete and mortar overlays are absorbing a high chloride ion content while the low slump concrete is not. That is, with the exception of the two 1 3/4 inch thick low slump concrete decks, L-501R and L-642R respectively.

Generally speaking, the overlays have protected the base deck concrete against the migration of chloride ions. Bridge L-759R, having a 1 1/2 inch thick latex concrete overlay, had 222 lineal feet of cracking per 1,000 square feet of deck area which may account for the high chloride content in that given deck. Note that there is a considerably higher amount of chloride ions present in those seven overlays that had been exposed through six winters. The remaining ten decks tested show a marked decrease in chloride content present within the given overlays. However, those decks had only been exposed from three through five winters. Some of the recent Missouri winters have been very severe, especially the winters of 1976-77 and 1981-82.

A rather unusual set of chloride results were obtained from Bridge A-3623. The chloride content consistently remained moderately high in all of the sampled base concrete horizons. A possible explanation could be that the aggregate or admixture had a higher base chloride content level relative to the others. This given structure lies between the 200 to 300 mean freezing index contours in the southern portion of the state. As such, it would not have been subjected to maximum exposure. See Figure 1. It is also a relatively recent built structure entirely of new construction and exposed through only four winters.

When comparing the chloride content of the 10 newly constructed decks with the seven older rehabilitated decks in the top 1/2 inch lift sample, i.e., the 1/4" to 3/4" horizon of the overlay regardless of years of winter exposure and types of overlay revealed the following.

There was 1.75 pounds of chloride per cubic yard of concrete (new decks) versus 3.09 pounds of chloride per cubic yard of concrete (old decks). Based on the results of chloride analysis of concrete samples taken from 17 bridge decks, there was 77 percent more chlorides present in the top 1/2 inch lift sample of overlay concrete taken from the older rehabilitated decks. There is, at present, no satisfactory explanation for this.

C. CRACK PENETRATION - Concern over the depth of surface crack penetration with respect to variation in crack widths resulted in drilling and obtaining a series of 81 four inch diameter cores. Cores were cut in generally those same selected bridge decks that had been chosen for additional testing. Refer to Appendix which contains a series of pairs of photographic prints that exhibit both a plan (top) and profile (side) view. These prints document various sizes of cracks that were cored and in addition also document the depths of crack penetration. Of the 81 cores that were cut over surface cracks, six were extracted from overlays of latex mortar, 21 cores were extracted from overlays of latex concrete, and the remaining 54 cores were extracted from overlays of low slump concrete.

It became apparent after examining this series of 81 cores that one could not realistically determine the depth of any size crack penetration from any surface observations. Fine cracks that appeared superficial on the surface, oftentimes penetrated through the entire overlay thickness and extended into the base concrete. Several large surface

cracks exhibited very shallow penetration into the overlay while others did extend through the entire overlay thickness and continued on into the base concrete deck. Any overlay cracks, however, regardless of penetration depth, are a flaw, and should be considered detrimental as it permits ready access of deicing salts down through the protective overlay system. The downward migrating chloride ions, now having penetrated the protective overlay barrier, have free access into the base concrete mass. This for all practical purposes destroyed the design effect of the overlay system itself.

Twenty-seven percent or 22 of the 81 cores drilled from 15 bridge decks exhibited surface cracks extending through the overlay and into the base concrete deck. When evaluated by overlay types, the percent of surface cracks extending into the base concrete was 14.3 percent for latex concrete, 29.6 percent for low slump concrete, and 50.0 percent for latex mortar. The entire series of 81 drilled cores were obtained at random over the various widths and types of cracks defined earlier. Seventy or 86.4% of the 81 drilled cores had overlay thicknesses equal to or greater than the specified design thickness called for on the plans.

In evaluating the 81 cores, with regard to bonding of the overlays with the base concrete, 88.9 percent exhibited a good bond, 1.2 percent exhibited a partial bond, and 9.9 percent exhibited no bond. With respect to the various types of overlay systems, there was 100 percent bond on latex concrete, 85 percent bond on low slump concrete, and 83 percent bond on latex mortar overlays. Apparently the

debonded area around the cracks of some of the cores exhibiting no bond was so limited, as to have escaped detection by either the multiple chain drag or steel sounding rod survey.

SUMMARY - Surface cracking was not found to be the problem initially thought. Ninety-five percent of 31,778 grids surveyed (4' x 3') had no surface cracking or less than five lineal feet of surface cracking per grid. Overlays placed on the new layered constructed decks exhibited a significant reduction in surface cracking when compared to overlays placed on the older rehabilitated decks. Debonding and/or delamination problems to any extent were generally confined to six of 104 bridge deck driving lanes. Patching of the overlays to any extent was presently confined to only one of 104 bridge deck driving lanes. Of 4,622 voltage potential readings taken on 20 deck driving lanes, only 0.6 percent of these readings (28) were found to be in the active or probable corrosion range of greater than -0.35 volts. Results of chloride analysis of concrete samples taken from 17 decks ranging from three through six winters of exposure indicated generally the overlays were protecting the base deck from the migration of chloride ions.

Given the liklihood that the construction of overlays on bridge decks will continue into the foreseeable future, a further similar study would appear to be warranted some five or ten years hence. The data base would then be larger, the years of winter exposure greater, and any overlay failure trend/s, due to the varying climatic and environmental factors involved, should be more sharply defined.

Table 1

SUMMARY OF CRACKING IN OVERLAYS BY TYPE AND THICKNESS

Thickness and Type of Overlays	Number Of Overlays	No. of Grid Squares	By (4 x 3)' Grid Squares (Weighted Average)					Cracking Per 1000 Sq.Ft.
			No Cracking Clear Grids (%)	(>0 to ≤5) Feet (%)	(>5 to ≤10) Feet (%)	(>10 to ≤15) Feet (%)	>15 Feet (%)	
1" Min. Latex Concrete	2	792	35.2	50.5	13.3	1.0	0	226
1 1/2" Latex Concrete	22	5,024	72.1	23.0	4.5	0.4	0	92
1 3/4" Latex Concrete	2	240	93.8	6.2	0	0	0	16
1 3/4-2" Latex Concrete	1	336	93.4	6.6	0	0	0	17
2" Latex Concrete	2	464	91.4	8.6	0	0	0	22
2 1/4" Latex Concrete	1	216	91.2	8.8	0	0	0	22
1" Latex Mortar	9	1,416	89.7	9.8	0.5	0	0	28
1 3/4" Low Slump	2	351	8.3	51.3	37.3	3.1	0	408
2" Low Slump	21	8,441	72.4	15.1	9.8	2.4	0.3	132
2 1/4" Low Slump	42	14,498	84.0	14.6	1.3	0.1	0	46
All Overlays:	104	31,778	77.7	17.1	4.4	0.7	0.1	80

General:

The above represents 381,336 square feet of driving (traffic) lane deck area investigated.
See Photographs of Various Crack Density Lineal Surface Cracking, Appendix, pg. "h" through "k"

Table 2

COPPER-COPPER SULFATE HALF CELL POTENTIAL READINGS

Bridge No. & Direction	Type of Overlay	Winter Exposures	No. of Readings	Voltage Readings - Percent Of By Categories 0 to -0.20V	-0.21 to -0.35V	>-0.35V
A-1763R E.B.	1 1/2" Latex Concrete	3	420	91.5	8.3	0.2
A-3623 W.B.	1 1/2" Latex Concrete	3	232	91.4	8.6	0
A-3810 O.R.	1 1/2" Latex Concrete	4	198	97.5	2.5	0
J-991R W.B.	1 1/2" Latex Concrete	5	228	99.6	0.4	0
L-641R S.B.	1 1/2" Latex Concrete	6	183	43.2	53.0	3.8
L-759R S.B.	1 1/2" Latex Concrete	6	198	79.3	20.7	0
A-2672 N.B.	1" Latex Mortar	4	225	100	0	0
A-2672 S.B.	1" Latex Mortar	4	230	100	0	0
A-2738 S.B.	1" Latex Mortar	6	248	62.9	34.7	2.4
A-3830 E.B.	2" Low Slump	2	164	98.8	1.2	0
A-2117 N.B.	2 1/4" Low Slump	2	256	100	0	0
A-2117 S.B.	2 1/4" Low Slump	2	256	99.2	0.8	0
A-119R E.B.	2" Low Slump	3	184	95.7	4.3	0
A-3547 N.B.	2 1/4" Low Slump	3	240	97.9	2.1	0
A-3547 S.B.	2 1/4" Low Slump	3	240	97.9	2.1	0
A-3617 S.B.	2 1/4" Low Slump	3	283	100	0	0
A-3521 E.B.	2" Low Slump	4	272	94.2	5.1	0.7
A-3522 E.B.	2" Low Slump	4	163	99.4	0.6	0
L-501R S.B.	1 3/4" Low Slump	6	255	78.8	18.4	2.8
L-642R N.B.	1 3/4" Low Slump	6	147	73.5	23.1	3.4
	TOTALS		4,622	90.7	8.7	0.6

R=Rehabilitated Bridge Deck
O.R.=Outer Roadway

	Type of Overlays		
	Low Slump Concrete	Latex Concrete	Latex Mortar
Total Lanes Surveyed:	11	6	3

Table 3

CHLORIDE CONTENT OF PULVERIZED CONCRETE

Bridge No. & Direction	Thickness and Type Of Overlay	Winter Exposures	Chloride Content in Pounds Per Cubic Yard of Concrete For Depth Indicated					
			1/4" to 3/4"	3/4" to 1 1/4"	1 1/4" to 1 3/4"	1 3/4" to 2 1/4"	2 1/4" to 2 3/4"	2 3/4" to 3 1/4"
A-1763R N & SB	1 1/2" Latex Concrete	4	1.2	0.4	1.6	3.1	2.7	2.0
A-3623 W.B.	1 1/2" Latex Concrete	4	2.0	1.2	1.2	1.2	1.2	1.2
A-3810 O.R.	1 1/2" Latex Concrete	5	0.7	0.2	0.2	0.3	0.3	0.2
J-991R W.B.	1 1/2" Latex Concrete	6	3.5	1.6	0.5	0.4	0.2	0.2
L-641R S.B.	1 1/2" Latex Concrete	6	3.4	0.6	0.2	0.6	0.9	0.8
L-759R S.B.	1 1/2" Latex Concrete	6	7.4	3.1	2.0	2.0	1.6	1.2
A-2672 S.B.	1" Latex Mortar	6	4.3	1.2	0.3	0.3	0.2	0.1
A-2738 S.B.	1" Latex Mortar	6	7.8	2.0	0.3	0.1	0.2	0.2
L-501R S.B.	1 3/4" Low Slump	6	2.3	0.6	0.3	0.6	1.2	0.8
L-642R N.B.	1 3/4" Low Slump	6	3.1	0.6	0.2	0.1	0.6	0.6
A-3830 E.B.	2" Low Slump	3	1.2	0.8	0.7	0.5	0.4	0.2
A-119R E.B.	2" Low Slump	4	0.7	0.6	0.5	0.4	0.5	0.5
A-3521 E.B.	2" Low Slump	5	0.2	0.2	0.2	0.4	0.3	0.2
A-3522 E.B.	2" Low Slump	5	0.2	0.2	0.2	0.2	0.2	0.2
A-2117 N & SB	2 1/4" Low Slump	3	0.4	0.2	0.3	0.3	0.2	0.3
A-3617 S.B.	2 1/4" Low Slump	3	0.4	0.2	0.2	0.3	0.3	0.4
A-3547 N & SB	2 1/4" Low Slump	4	0.3	0.2	0.2	0.3	0.4	0.3

R=Rehabilitated Bridge Deck
O.R.=Outer Roadway

	Type of Overlays		
	Low Slump Concrete	Latex Concrete	Latex Mortar
Total Lanes Tested	9	6	2

Utilized 3,900 #/yd.^{3} as a base concrete unit weight.

Table 4

SUMMARY OF DEBONDING AND/OR DELAMINATION
AND PATCHING IN OVERLAYS BY TYPE AND THICKNESS

Thickness and Type of Overlays	Surveyed Area Sq.Ft.	(1) Debonded Area		Patching Area	
		Sq.Ft.	%	Sq.Ft.	%
1" Min. Latex Concrete	9,504	194	2.0	0	0
1 1/2" Latex Concrete	60,288	479	0.8	11	*
1 3/4" Latex Concrete	2,880	7	0.2	0	0
1 3/4-2" Latex Concrete	4,032	1	*	0	0
2" Latex Concrete	5,568	3	0.1	0	0
2 1/4" Latex Concrete	2,592	0	0	0	0
1" Latex Mortar	16,992	5	*	14	0.1
1 3/4" Low Slump Concrete	4,212	159	3.8	0	0
2" Low Slump Concrete	101,292	1,253	1.2	415	0.4
2 1/4" Low Slump Concrete	173,976	45	*	30	*
TOTALS:	381,336	2,146	0.6	470	0.1

(1) Sounded by combination of chain drag and steel rod.

*Values are less than 0.06%.

Table 5

SUMMARY OF CORE DATA ON CRACK PENETRATION

Type of Overlay	No. of Cores	Surface Crack Penetrate Substrate Base Concrete	
		Yes (%)	No (%)
All cores As A Group	81	27.2	72.8
Latex Modified Mortar	6	50.0	50.0
Latex Modified Concrete	21	14.3	85.7
Low Slump Concrete	54	29.6	70.4
Type of Deck			
Newly Constructed	68	32.4	67.6
Rehabilitated	13	0	100.00
TOTAL:	81		

General: Of the 81 cores drilled, eight cores had no bond between the overlay and the base concrete deck. On those eight cores having no bond, five were drilled from one deck Bridge A-3521 on Route AC in Callaway County.

Table 6

LINEAL SURFACE CRACKING IN OVERLAYS

Bridge No. & Direction	Type of Structure	Depth and Type of Overlay	By (4 x 3)' Grid Squares						Cracking Per 1,000 Sq.Ft.
			No. of Grid Squares	No Cracking, Clear Grids (%)	(>0 to ≤5) Feet (%)	(>5 to ≤10) Feet (%)	(>10 to ≤15) Feet (%)	>15 Feet (%)	
L-887R W.B.	BB-G	1" Min. Latex Concrete	396	31.5	51.8	15.9	0.8	0	244
L-887R E.B.	BB-G	1" Min. Latex Concrete	396	38.9	49.2	10.6	1.3	0	207
A-93R W.B.	BB-G	1 1/2" Latex Concrete(+)	252	78.6	19.8	1.6	0	0	61
A-93R E.B.	BB-G	1 1/2" Latex Concrete(+)	252	94.0	6.0	0	0	0	15
A-1310R W.B.	STRG	1 1/2" Latex Concrete	208	71.6	28.4	0	0	0	71
A-1310R E.B.	STRG	1 1/2" Latex Concrete	208	84.6	15.4	0	0	0	39
A-1643 R W.B.	BB-G	1 1/2" Latex Concrete	244	30.6	56.8	12.6	0	0	226
A-1643 R E.B.	BB-G	1 1/2" Latex Concrete	244	51.7	45.0	3.3	0	0	135
A-1763R	BB-G	1 1/2" Latex Concrete	560	70.0	26.2	3.8	0	0	91
A-3085 N.B.	STRG	1 1/2" Latex Concrete	164	90.9	9.1	0	0	0	23
A-3085 S.B.	STRG	1 1/2" Latex Concrete	164	86.0	14.0	0	0	0	35
A-3623 N.B.	STRG	1 1/2" Latex Concrete	232	78.9	21.1	0	0	0	53
A-3623 S.B.	STRG	1 1/2" Latex Concrete	232	28.5	55.2	12.9	3.4	0	258
A-3735	STRG	1 1/2" Latex Concrete	217	100	0	0	0	0	0
A-3808	STRG	1 1/2" Latex Concrete	248	99.6	0.1	0	0	0	0
A-3809	STRG	1 1/2" Latex Concrete	300	93.7	6.3	0	0	0	16
A-3810 O.R.	STRG	1 1/2" Latex Concrete	204	100	0	0	0	0	0
A-3810 O.R.	STRG	1 1/2" Latex Concrete	200	42.5	51.5	6.0	0	0	169
A-3823	STRG	1 1/2" Latex Concrete	328	79.0	20.1	0.9	0	0	56
J-493R	T-BM	1 1/2" Latex Concrete	175	58.6	28.4	10.9	2.1	0	165
J-991R	PYTR	1 1/2" Latex Concrete	228	84.0	15.2	0.8	0	0	43
L-641R	STRG	1 1/2" Latex Concrete	148	4.7	37.2	52.0	6.1	0	501

(+) A minor portion of this lane width was on a 2 1/2 inch overlay thickness.

Table 6 (Continued)

LINEAL SURFACE CRACKING IN OVERLAYS

Bridge No. & Direction	Type of Structure	Depth and Type of Overlay	By (4 x 3)' Grid Squares						Cracking Per 1,000 Sq.Ft.
			No. of Grid Squares	No Cracking, Clear Grids (%)	(>0 to ≤5) Feet (%)	(>5 to ≤10) Feet (%)	(>10 to ≤15) Feet (%)	>15 Feet (%)	
L-669R	T-BM	1 1/2" Latex Concrete	84	100	0	0	0	0	0
L-759R	SLAB	1 1/2" Latex Concrete	132	36.4	48.5	15.1	0	0	222
A-3005	STRG	1 3/4-2" Latex Concrete	336	93.4	6.6	0	0	0	17 Avg. 18
L-717R W.B.	STRG	1 3/4" Latex Concrete	120	95.0	5.0	0	0	0	13
L-717R E.B.	STRG	1 3/4" Latex Concrete	120	92.5	7.5	0	0	0	19
A-211R	SLAB	2" Latex Concrete	168	100	0	0	0	0	0
A-3824	STRG	2" Latex Concrete	296	86.5	13.5	0	0	0	34
A-3004	STRG	2 1/4" Latex Concrete	216	91.2	8.8	0	0	0	22
A-2672 N.B.	STRG	1" Latex Mortar	230	94.3	5.7	0	0	0	14
A-2672 S.B.	STRG	1" Latex Mortar	230	99.1	0.9	0	0	0	2
A-2682 N.B.	STRG	1" Latex Mortar	100	86.0	14.0	0	0	0	35
A-2682 S.B.	STRG	1" Latex Mortar	100	93.0	7.0	0	0	0	18
A-2683 N.B.	STRG	1" Latex Mortar	152	92.1	7.2	0.7	0	0	23
A-2683 S.B.	STRG	1" Latex Mortar	152	86.8	13.2	0	0	0	33
A-2684 N.B.	STRG	1" Latex Mortar	100	78.0	17.0	5.0	0	0	76
A-2684 S.B.	STRG	1" Latex Mortar	100	89.0	10.0	1.0	0	0	32
A-2738	STRG	1" Latex Mortar	252	82.1	17.9	0	0	0	45
L-501R	STRG	1 3/4" Low Slump	204	3.9	46.1	46.6	3.4	0	460
L-642R	STRG	1 3/4" Low Slump	147	14.3	58.5	24.5	2.7	0	336
A-119R	SLAB	2" Low Slump	188	39.2	50.9	9.9	0	0	193
A-2232	STRG	2" Low Slump	1,084	97.5	1.9	0.6	0	0	9
A-2233	SLAB	2" Low Slump	164	93.9	4.9	1.2	0	0	20

Table 6 (Continued)

LINEAL SURFACE CRACKING IN OVERLAYS

Bridge No. & Direction	Type of Structure	Depth and Type of Overlay	By (4 x 3)' Grid Squares						Cracking Per 1,000 Sq.Ft.
			No. of Grid Squares	No Cracking, Clear Grids (%)	(>0 to ≤5) Feet (%)	(>5 to ≤10) Feet (%)	(>10 to ≤15) Feet (%)	>15 Feet (%)	
A-2234	SLAB	2" Low Slump	180	100	0	0	0	0	0
A-2235	SLAB	2" Low Slump	136	92.6	7.4	0	0	0	19
A-3047 N.B.	STRG	2" Low Slump	1,000	100	0	0	0	0	0
A-3047 S.B.	STRG	2" Low Slump	1,000	100	0	0	0	0	0
A-3292	THTR	2" Low Slump	2,004	9.6	41.1	38.0	10.1	1.2	475
A-3520	STRG	2" Low Slump	264	58.7	29.9	9.5	1.9	0	157
A-3521	STRG	2" Low Slump	276	47.8	50.4	1.8	0	0	138
A-3522	STRG	2" Low Slump	164	65.2	31.1	3.7	0	0	103
A-3671	STRG	2" Low Slump	152	90.1	9.9	0	0	0	25
A-3706 W.B.	SLAB	2" Low Slump	88	98.9	1.1	0	0	0	3
A-3706 E.B.	SLAB	2" Low Slump	88	98.9	1.1	0	0	0	3
A-3792 W.B.	SLAB	2" Low Slump	204	100	0	0	0	0	0
A-3792 E.B.	SLAB	2" Low Slump	202	99.0	1.0	0	0	0	3
A-3830	SLAB	2" Low Slump	160	93.8	6.2	0	0	0	16
A-3831	SLAB	2" Low Slump	160	100	0	0	0	0	0
L-293R	STRG	2" Low Slump	292	100	0	0	0	0	0
L-319R W.B.	STRG	2" Low Slump	508	98.8	1.2	0	0	0	3
L-319R E.B.	STRG	2" Low Slump	127	87.4	12.6	0	0	0	32
A-2116 W.B.	STRG	2 1/4" Low Slump	204	82.4	17.6	0	0	0	44
A-2116 E.B.	STRG	2 1/4" Low Slump	204	87.7	12.3	0	0	0	31
A-2117 N.B.	STRG	2 1/4" Low Slump	256	75.3	23.3	1.4	0	0	67
A-2117 S.B.	STRG	2 1/4" Low Slump	256	28.3	63.2	8.5	0	0	215

Table 6 (Continued)

LINEAL SURFACE CRACKING IN OVERLAYS

Bridge No. & Direction	Type of Structure	Depth and Type of Overlay	By (4 x 3)' Grid Squares						Cracking Per 1,000 Sq.Ft.
			No. of Grid Squares	No Cracking, Clear Grids (%)	(>0 to ≤5) Feet (%)	(>5 to ≤10) Feet (%)	(>10 to ≤15) Feet (%)	>15 Feet (%)	
A-2118 W.B.	STRG	2 1/4" Low Slump	332	71.4	27.7	0.9	0	0	75
A-2118 E.B.	STRG	2 1/4" Low Slump	332	75.9	23.2	0.9	0	0	64
A-2119 W.B.	STRG	2 1/4" Low Slump	252	73.8	26.2	0	0	0	66
A-2119 E.B.	STRG	2 1/4" Low Slump	252	92.9	7.1	0	0	0	18
A-2132 W.B.	SLAB	2 1/4" Low Slump	128	100	0	0	0	0	0
A-2132 E.B.	SLAB	2 1/4" Low Slump	128	100	0	0	0	0	0
A-2224	STRG	2 1/4" Low Slump	240	100	0	0	0	0	0
A-2225 N.B.	STRG	2 1/4" Low Slump	1,044	95.5	4.5	0	0	0	11
A-2225 S.B.	STRG	2 1/4" Low Slump	1,044	98.7	1.3	0	0	0	3
A-2226	GIRD	2 1/4" Low Slump	336	100	0	0	0	0	0
A-2227	GIRD	2 1/4" Low Slump	336	100	0	0	0	0	0
A-2228	GIRD	2 1/4" Low Slump	560	96.2	3.8	0	0	0	10
A-2229	GIRD	2 1/4" Low Slump	508	100	0	0	0	0	0
A-2230	GIRD	2 1/4" Low Slump	420	100	0	0	0	0	0
A-2231	GIRD	2 1/4" Low Slump	520	100	0	0	0	0	0
A-2513	STRG	2 1/4" Low Slump	308	93.5	6.5	0	0	0	16
A-2514	STRG	2 1/4" Low Slump	300	87.0	13.0	0	0	0	33
A-2847	STRG	2 1/4" Low Slump	220	100	0	0	0	0	0
A-2908 N.B.	STRG	2 1/4" Low Slump	244	95.1	4.9	0	0	0	12
A-2908 S.B.	STRG	2 1/4" Low Slump	244	77.9	20.9	1.2	0	0	60
A-2984	STRG	2 1/4" Low Slump	164	97.0	3.0	0	0	0	8
A-2985	STRG	2 1/4" Low Slump	164	98.2	1.8	0	0	0	5

Table 6 (Continued)

LINEAL SURFACE CRACKING IN OVERLAYS

Bridge No. & Direction	Type of Structure	Depth and Type of Overlay	No. of Grid Squares	By (4 x 3)' Grid Squares: No Cracking, Clear Grids (%)	(>0 to ≤5) Feet (%)	(>5 to ≤10) Feet (%)	(>10 to ≤15) Feet (%)	>15 Feet (%)	Cracking Per 1,000 Sq.Ft.
A-2986	SLAB	2 1/4" Low Slump	148	41.5	34.4	18.2	5.0	0.9	271
A-2987	SLAB	2 1/4" Low Slump	132	25.5	57.3	17.2	0	0	258
A-3128	STRG	2 1/4" Low Slump	188	37.8	54.2	8.0	0	0	189
A-3162	STRG	2 1/4" Low Slump	2,110	60.3	36.1	3.6	0	0	114
A-3351	STRG	2 1/4" Low Slump	300	80.7	19.3	0	0	0	48
A-3352	SLAB	2 1/4" Low Slump	168	78.0	18.4	3.6	0	0	70
A-3353	GIRD	2 1/4" Low Slump	324	80.6	19.4	0	0	0	49
A-3483	STRG	2 1/4" Low Slump	192	100	0	0	0	0	0
A-3494	STRG	2 1/4" Low Slump	272	100	0	0	0	0	0
A-3496	STRG	2 1/4" Low Slump	208	97.1	2.9	0	0	0	7
A-3498	STRG	2 1/4" Low Slump	176	100	0	0	0	0	0
A-3500	STRG	2 1/4" Low Slump	212	100	0	0	0	0	0
A-3547 N.B.	STRG	2 1/4" Low Slump	248	66.1	32.2	1.6	0	0	92
A-3547 S.B.	STRG	2 1/4" Low Slump	248	62.9	36.3	0.8	0	0	96
A-3617 N.B.	STRG	2 1/4" Low Slump	288	99.3	0.7	0	0	0	2
A-3617 S.B.	STRG	2 1/4" Low Slump	288	79.2	20.8	0	0	0	52
		TOTALS:	31,778						

Code for Type of Structure further defined:

Box Beam or Girder (BB-G), Girder (GIRD), Pony Truss (PYTR), Slab (SLAB), Stringer/Multi-Beam or Girder (STRG), Tee Beam (T-BM), and Thru Truss (THTR).

O.R. = Outer Roadway
R=Rehabilitated Bridge Deck

Table 7

DEBONDING AND/OR DELAMINATION AND PATCHING BY INDIVIDUAL DECKS (1)

Bridge No. & Direction	Depth and Type of Overlay	Surveyed Area Sq.Ft.	Debonded and/or Delam. Area Sq.Ft.	Debonded and/or Delam. Area %	Patching Area Sq.Ft.	Patching Area %
L-887R W.B.	1" Min. LC	4,752	72	1.5	0	0
L-887R E.B.	1" Min. LC	4,752	122	2.5	0	0
A-93R W.B.	1 1/2" LC	3,072	17	0.6	0	0
A-93R E.B.	1 1/2" LC	3,072	0	0	11	0.4
A-1643R W.B.	1 1/2" LC	2,928	4	0.2	0	0
A-1763R	1 1/2" LC	6,720	228	3.4	0	0
A-3623 S.B.	1 1/2" LC	2,784	30	1.1	0	0
A-3809	1 1/2" LC	3,600	2	0.1	0	0
J-493R	1 1/2" LC	2,100	2	0.1	0	0
L-641R	1 1/2" LC	1,776	86	4.8	0	0
L-759R S.B.	1 1/2" LC	1,584	108	6.8	0	0
L-717R E.B.	1 3/4" LC	1,440	7	0.5	0	0
A-211R	2" LC	2,016	3	0.1	0	0
A-2682 N.B.	1" LM	1,200	1	0.1	0	0
A-2682 S.B.	1" LM	1,200	0	0	14	1.2
A-2684 N.B.	1" LM	1,200	3	0.2	0	0
L-501R S.B.	1 3/4" LSC	2,448	36	1.5	0	0
L-642R N.B.	1 3/4" LSC	1,764	123	6.9	0	0
A-3520	2" LSC	3,168	97	3.1	409*	12.9
A-3521	2" LSC	3,312	1,155	34.9	0	0
L-293R	2" LSC	3,504	0	0	6	0.2
A-2226	2 1/4" LSC	4,032	0	0	4	0.1
A-3162	2 1/4" LSC	25,320	40	0.3	16	0.1
A-3352	2 1/4" LSC	2,016	5	0.2	10	0.5

R = Rehabilitated Bridge Deck

(1) Eighty additional deck driving lanes had either none or < 0.1% of surveyed area effected.

*Debonded area patched and occurred prior to opening to traffic.

Table 8

CORE DATA

Bridge No. & Direction	Design Thickness and Type of Overlay	No. of Winter Expo-sures	No. of Cap Cores	Size and Category of Cracking	Maximum Depth of Crack (In.)	Actual Depth Of Overlay At Core (In.)	Penetrate Substrate Base Concrete	Core Overlay Bond	Type Aggregate Combinations
A-1763 R N&S	1 1/2" Latex Modified Concrete	3	6	F-Diagonal	0.8	1.8	No	Yes	(3)
				L-Longitudinal	1.7	1.8	No	Yes	(3)
				M-Transverse	1.7	1.7	No	Yes	(3)
				M-Transverse	1.2	1.7	No	Yes	(3)
				M-Transverse	1.5	1.6	No	Yes	(3)
				L-Longitudinal & Transverse	1.9	1.9	No	Yes	(3)
				Average	1.5	1.8			
A-3623 W.B.	1 1/2" Latex Modified Concrete	3	6	F-Longitudinal	2.4	1.7	Yes	Yes	(3)
				F-Longitudinal	1.2	1.5	No	Yes	(3)
				F-Transverse	1.2	1.0	Yes	Yes	(3)
				F-Longitudinal	0.8	1.5	No	Yes	(3)
				F-Longitudinal	0.2	1.3	No	Yes	(3)
				M-Longitudinal	0.7	1.6	No	Yes	(3)
				Average	1.1	1.4			
A-3810 O.R.	1 1/2" Latex Modified Concrete	4	6	F-Diagonal	4.0	1.7	Yes	Yes	(4)
				F-Longitudinal	1.2	1.7	No	Yes	(4)
				F-Longitudinal	1.5	1.8	No	Yes	(4)
				F-Longitudinal	1.8	2.0	No	Yes	(4)
				F-Longitudinal	0.1	1.7	No	Yes	(4)
				F-Longitudinal	1.7	1.9	No	Yes	(4)
				Average	1.7	1.8			
J-991R W.B.	1 1/2" Latex Modified Concrete	5	3	L-Longitudinal	0.1	1.3	No	Yes	(4)
				L-Longitudinal	0.3	1.3	No	Yes	(4)
				F-Longitudinal	0.1	1.3	No	Yes	(4)
				Average	0.2	1.3			

Table 8 (Continued)

CORE DATA

Bridge No. & Direction	Design Thickness and Type of Overlay	No. of Winter Expo-sures	No. of Cap Cores	Size and Category of Cracking	Maximum Depth of Crack (In.)	Actual Depth Of Overlay At Core (In.)	Penetrate Substrate Base Concrete	Core Overlay Bond	Type of Aggregate Combinations
A-2672 N&S	1" Latex Modified Mortar	6	3	F-Transverse & Longitudinal	0.9	1.0	No	No	(1)
				F-Longitudinal	1.2	1.2	No	Yes	(1)
				F-Transverse	0.1	1.0	No	Yes	(1)
				Average	0.7	1.1			
A-2738 S.B.	1" Latex Modified Mortar	6	3	F-Transverse	3.2	1.5	Yes	Yes	(2)
				L-Transverse	2.8	1.3	Yes	Yes	(2)
				M-Transverse	3.1	1.6	Yes	Yes	(2)
				Average	3.0	1.5			
A-3830 E.B.	2" Low Slump	2	3	F-Diagonal	2.1	2.0	Yes	Yes	(5)
				F-Diagonal	3.4	2.0	Yes	Yes	(5)
				F-Transverse	1.5	1.9	No	Yes	(5)
				Average	2.3	2.0			
A-2117 N&S	2 1/4" Low Slump	2	6	F-Transverse	0.0	2.5	No	Yes	(3)
				M-Transverse	0.6	2.5	No	Yes	(3)
				M-Transverse	3.7	2.5	Yes	Yes	(3)
				M-Transverse	3.7	2.7	Yes	Yes	(3)
				F-Longitudinal	0.0	2.7	No	Yes	(3)
				F-Longitudinal	0.4	2.9	No	Yes	(3)
				Average	2.1	2.6			

Table 8 (Continued)

CORE DATA

Bridge No. & Direction	Design Thickness and Type of Overlay	No. of Winter Expo-sures	No. of Cap Cores	Size and Category of Cracking	Maximum Depth of Crack (In.)	Actual Depth Of Overlay At Core (In.)	Penetrate Substrate Base Concrete	Core Overlay Bond	Type of Aggregate Combinations
A-2225 S.B.	2 1/4" Low Slump	2	6	F-Variable	0.9	2.4	No	Yes	(5)
				F-Variable	0.1	2.7	No	Yes	(5)
				F-Variable	0.6	2.7	No	Yes	(5)
				F-Variable	0.9	2.1	No	No	(5)
				F-Transverse & Longitudinal	2.2	2.2	No	Yes	(5)
				F-Transverse	3.4	2.1	Yes	Yes	(5)
				Average	1.4	2.4			
A-119R E.B.	2" Low Slump	3	4	F-Longitudinal	2.3	2.3	No	Yes	(5)
				F-Transverse & Longitudinal	1.8	2.3	No	Yes	(5)
				F-Longitudinal	2.5	2.5	No	Yes	(5)
				M-Longitudinal	1.2	2.5	No	Yes	(5)
				Average	2.0	2.4			
A-3547 N&S	2 1/4" Low Slump	3	5	M-Transverse	2.5	2.5	No	Yes	(3)
				M-Longitudinal	0.9	2.5	No	No	(3)
				F-Transverse	3.4	2.7	Yes	Yes	(3)
				M-Transverse	3.4	2.5	Yes	Yes	(3)
				F-Transverse	3.3	2.3	Yes	Yes	(3)
				Average	2.7	2.5			
A-3617 N&S	2 1/4" Low Slump	3	6	F-Transverse	0.4	2.7	No	Yes	(3)
				M-Transverse	0.8	2.7	No	Yes	(3)
				F-Longitudinal	0.1	2.8	No	Yes	(3)
				M-Transverse	1.8	2.8	No	Yes	(3)
				F-Transverse	0.1	2.9	No	Yes	(3)
				F-Longitudinal	0.0	2.8	No	Yes	(3)
				Average	0.6	2.8			

Table 8 (Continued)

CORE DATA

Bridge No. & Direction	Design Thickness and Type of Overlay	No. of Winter Expo-sures	No. of Cap Cores	Size and Category of Cracking	Maximum Depth of Crack (In.)	Actual Depth Of Overlay At Core (In.)	Penetrate Substrate Base Concrete	Core Overlay Bond	Type of Aggregate Combinations
A-3521 E.B.	2" Low Slump	4	6	L-Longitudinal	5.0	2.5	Yes	No	(5)
				M-Transverse	2.4	2.5	No	No	(5)
				F-Transverse	2.3	2.3	No	No	(5)
				L-Transverse	2.4	2.4	No	No	(5)
				F-Transverse	2.3	2.4	No	No	(5)
				M-Longitudinal	4.3	2.0	Yes	Partial	(5)
				Average	3.1	2.4			
A-3522 E.B.	2" Low Slump	4	6	M-Longitudinal	3.2	3.2	No	Yes	(5)
				F-Longitudinal & Transverse	0.5	2.8	No	Yes	(5)
				F-Transverse	1.7	2.9	No	Yes	(5)
				F-Transverse	1.6	2.7	No	Yes	(5)
				F-Transverse	2.5	2.5	No	Yes	(5)
				F-Longitudinal	2.5	2.5	No	Yes	(5)
				Average	2.0	2.8			
A-3292 E.B.	2" Low Slump	5	12	F-Longitudinal	2.0	2.0	No	Yes	(6)
				M-Transverse & Longitudinal	2.4	2.0	Yes	Yes	(6)
				L-Longitudinal	3.0	2.2	Yes	Yes	(6)
				F-Longitudinal	1.1	1.8	No	Yes	(6)
				M-Transverse & Longitudinal	3.0	2.0	Yes	Yes	(6)
				L-Longitudinal	3.0	1.9	Yes	Yes	(6)
				M-Longitudinal	0.8	2.2	No	Yes	(6)
				F-Diagonal	1.5	2.1	No	Yes	(6)
				M-Longitudinal	2.2	2.1	Yes	Yes	(6)
				L-Longitudinal	2.4	2.2	Yes	Yes	(6)
				M-Longitudinal	0.7	2.3	No	Yes	(6)
				F-Longitudinal	1.5	2.2	No	Yes	(6)
				Average	2.1	2.1			

Table 8 (Continued)

General: Type of Aggregate Combinations

(1) A Meramec sand aggregate mortar overlay over a crushed limestone aggregate substrate concrete deck.
(2) A Meramec sand aggregate mortar overlay over a Meramec gravel aggregate substrate concrete deck.
(3) A crushed limestone aggregate overlay over a crushed limestone aggregate substrate concrete deck.
(4) A Meramec gravel aggregate concrete overlay over a crushed limestone aggregate substrate concrete deck.
(5) A crushed porphyry aggregate concrete overlay over a crushed limestone aggregate substrate concrete deck.
(6) A crushed limestone aggregate concrete overlay over a lightweight aggregate substrate concrete deck.
(7) A crushed limestone aggregate concrete overlay over either a Meramec or Black River Gravel aggregate substrate concrete deck.
(8) A Meramec gravel aggregate concrete overlay over a Meramec gravel aggregate substrate concrete deck.

For purpose of this study, size of cracks are defined as follows:

Type Crack	Description	Can Be Seen From	
Fine	Very Tight	≤ 5'	Maximum depth of surface crack (vertical penetration) as measured on each of the individual drilled cores.
Medium	Sharp Edged	----	
Large	Edges Rounded	----	

R=Rehabilitated Bridge Deck
O.R. = Outer Roadway

Table 9

SUMMARY DATA OF PERTINENT INFORMATION RELATING TO THE DECK AND OVERLAYS

Bridge No. and Direction	Route No.	County	1982 ADT[1]	Class of Base Concrete In Deck	Deck Rehabilitated or Of New Construction	Deck Constructed (Mos/Yr)	Thickness and Type Of Overlay	Overlay Constructed (Mos/Yr)	Coarse Aggregate Overlay Vs. Bridge Deck
L-887R W.B.	180	StLo	26,162	B-1	R/NC	58/Oct 73	1" Min. LC	Oct 73	(8) and (4)
L-887R E.B.	180	StLo	26,162	B-1	R/NC	58/Jul 74	1" Min. LC	Jul 74	(8) and (4)
A-93R W.B.	I-70	StLo	(1983)37,979	B-1	R/NC	57/Jul 79	1 1/2" LC	Aug 79	(3)
A-93R E.B.	I-70	StLo	(1983)43,224	B-1	R/NC	57/Jul 79	1 1/2" LC(+)	Jul 80	(3)
A-1310R W.B.	Ellis Blvd.	Cole	10,460	B-2	R/NC	Sep 81	1 1/2" LC	Oct 81	(3)
A-1310R E.B.	Ellis Blvd.	Cole	10,460	B-2	R/NC	Aug 81	1 1/2" LC	Oct 81	(3)
A-1643R W.B.	Bannister Rd.	Jack	3,900	B-1	R	Nov 68	1 1/2" LC	Jul 80	(3)
A-1643R E.B.	Bannister Rd.	Jack	3,900	B-1	R/NC	67/Jul 80	1 1/2" LC	Jul 80	(3)
*A-1763R	I-29 Ramp	Clay	4,800	B-1	R/NC	Sep 69/May 79	1 1/2" LC	Jun 79	(3)
A-3085 N.B.	61N	StLo	15,653	B-1	NC	Jun 78	1 1/2" LC	Jul 78	(3)
A-3085 S.B.	61S	StLo	15,653	B-1	NC	Aug 79	1 1/2" LC	Sep 79	(4)
*A-3623 E.B.	160	Gree	5,960	B-1	NC	Aug 79	1 1/2" LC	Oct 79	(3)
*A-3623 W.B.	160	Gree	5,960	B-1	NC	Jun 79	1 1/2" LC	Oct 79	(3)
A-3735	40 Ramp	StLo	28,290	B-1	NC	Oct 78	1 1/2" LC	Oct 78	(4)
A-3808	725	StLo	9,800	B-1	NC	Jun 79	1 1/2" LC	Jul 79	(3)
A-3809	725	StLo	9,200	B-1	NC	Apr 79	1 1/2" LC	Jun 79	(3)
A-3810 O.R.	725 Ramp	StLo	3,400	B-1	NC	Nov 78	1 1/2" LC	Nov 78	(4)
*A-3810 O.R.	725 Ramp	StLo	3,400	B-1	NC	Nov 78	1 1/2" LC	Nov 78	(4)
A-3823	I-270 Ramp	StLo	38,832	B-2	NC	Sep 80	1 1/2" LC	Oct 80	(3)
J-493R	Outer Road	StLo	800	X & B-1	R/NC	31/Aug 79	1 1/2" LC	Aug 79	(3)
*J-991R W.B.	40	StCh	5,735	X & B-1	R/NC	35/Aug 77	1 1/2" LC	Sep 77	(4)
*L-641R S.B.	I-35	Clay	12,044	B-1	R/NC	55/Nov 77	1 1/2" LC	Nov 77	(4)

O.R. = Outer Roadway
(+) A minor portion of this lane was on a 2 1/2 inch overlay thickness.

Table 9 (Continued)

SUMMARY DATA OF PERTINENT INFORMATION RELATING TO THE DECK AND OVERLAYS

Bridge No. and Direction	Route No.	County	1982 ADT[1]	Class of Base Concrete In Deck	Deck Rehabilitated or Of New Construction	Deck Constructed (Mos/Yr)	Thickness and Type Of Overlay	Overlay Constructed (Mos/Yr)	Coarse Aggregate Overlay Vs Bridge Deck
L-669R	40	StLo	21,074	B-1	NC	Oct 78	1 1/2" LC	Oct 78	(4)
*L-759R	I-35	Clay	12,921	B-1	R/NC	58/Nov 77	1 1/2" LC	Nov 77	(4)
A-3005	I-70	StLo	43,833	B-1	NC	Jul 80	1 3/4-2" LC	Jul 80	(3)
L-717R W.B.	I-270	StLo	38,831	B-2	NC	Apr 80	1 3/4" LC	Nov 80	(3)
L-717R E.B.	I-270	StLo	38,832	B-2	R	Oct 80	1 3/4" LC	Nov 80	(3)
A-211R	I-270	StLo	38,832	**B-1 & B-2	R/NC	Aug 80	2" LC	Nov 80	(3)
A-3824	I-270 Ramp	StLo	42,010	B-2	NC	Sep 80	2" LC	Nov 80	(3)
A-3004	I-70	StLo	43,833	B-1	NC	Jun 80	2 1/4" LC	Jul 80	(3)
*A-2672 N.B.	141	Jeff	8,660	B-1	NC	May 77	1" LM	Aug 77	(1)
*A-2672 S.B.	141	Jeff	8,660	B-1	NC	Aug 77	1" LM	Aug 77	(1)
A-2682 N.B.	141	StLo	14,874	B-1	NC	Aug 76	1" LM	Oct 76	(1)
A-2682 S.B.	141	StLo	14,875	B-1	NC	Aug 76	1" LM	Oct 76	(1)
A-2683 N.B.	141	Jeff	7,908	B-1	NC	Sep 76	1" LM	Oct 76	(1)
A-2683 S.B.	141	Jeff	7,908	B-1	NC	Sep 76	1" LM	Oct 76	(1)
A-2684 N.B.	141	Jeff	8,660	B-1	NC	Sep 76	1" LM	Oct 76	(1)
A-2684 S.B.	141	Jeff	7,908	B-1	NC	Sep 76	1" LM	Oct 76	(1)
*A-2738 S.B.	109	StLo	2,960	B-1	NC	Apr 76	1" LM	May 76	(2)
*L-501R S.B.	I-35	Clay	17,018	B-1	R/NC	58/Nov 77	1 3/4" LSC	Nov 77	(5)
*L-642R N.B.	I-35	Clay	13,316	B-1	R/NC	55/Nov 77	1 3/4" LSC	Dec 77	(5)
*A-119R E.B.	140th Street	Jack	9,000	B-1	R/NC	61/Jul 79	2" LSC	Nov 79	(5)
A-2232	I-229 Ramp	Buch	4,000	B-1	NC	Mar 81	2" LSC	May 81	(5)

**B-1 on part (3' Approx.); B-2 on (9' Approx.), A widened deck.

Table 9 (Continued)

SUMMARY DATA OF PERTINENT INFORMATION RELATING TO THE DECK AND OVERLAYS

Bridge No. and Direction	Route No.	County	1982 ADT(1)	Class of Base Concrete In Deck	Deck Rehabilitated or Of New Construction	Deck Constructed (Mos/Yr)	Thickness and Type Of Overlay	Overlay Constructed (Mos/Yr)	Coarse Aggregate Overlay Vs Bridge Deck
A-2233	36 Ramp	Buch	4,000	B-1	NC	Oct 80	2" LSC	Apr 81	(5)
A-2234	36 Ramp	Buch	4,100	B-1	NC	Jun 80	2" LSC	Apr 81	(5)
A-2235	36 Ramp	Buch	8,400	B-1	NC	Jul 80	2" LSC	Apr 81	(5)
A-3047 N.B.	67	StCh-StLo	6,330	X	NC	Nov 82	2" LSC	May 83	(6)
A-3047 S.B.	67	StCh-StLo	6,330	X	NC	Nov 82	2" LSC	Jun 83	(6)
*A-3292 E.B.	I-70	StCh-StLo	45,143	X	NC	Sep 78	2" LSC	Oct 78	(6)
A-3520	Halifax Rd.	Call	500	B-1	NC	Apr 78	2" LSC	Jul 78	(3)
*A-3521 E.B.	Route AC	Call	1,830	B-1	NC	Apr 78	2" LSC	Jul 78	(3)
*A-3522 E.B.	54	Call	6,420	B-1	NC	Jun 78	2" LSC	Aug 78	(3)
A-3671	50	Fran	4,504	B-1	NC	Nov 78	2" LSC	May 79	(3)
A-3706 W.B.	60	Butl	7,210	B-1	NC	Dec 79	2" LSC	Apr 80	(7)
A-3706 E.B.	60	Butl	7,210	B-1	NC	Dec 79	2" LSC	Apr 80	(7)
A-3792 W.B.	60	Stod	4,830	B-1	NC	Oct 79	2" LSC	May 80	(7)
A-3792 E.B.	60	Stod	4,830	B-1	NC	Oct 79	2" LSC	May 80	(7)
*A-3830 E.B.	36	Buch	10,559	B-1	NC	May 80	2" LSC	Jun 80	(5)
A-3831	36 Ramp	Buch	2,400	B-1	NC	May 80	2" LSC	Jun 80	(5)
L-293R	71	Jasp	3,033	B-1 & LSC	R/NC	50/Sep 81	2" LSC	Oct 81	(3)
L-319R W.B.	36	Buch	10,550	B-1	NC	Nov 79	2" LSC	May 81	(5)
L-319R E.B.	36	Buch	10,550	B-1	NC	Nov 79	2" LSC	Jun 80	(5)
A-2116 W.B.	I-470	Jack	3,903	B-1	NC	May 80	2 1/4" LSC	Jul 80	(6)
A-2116 E.B.	I-470	Jack	3,975	B-1	NC	May 80	2 1/4" LSC	Jul 80	(6)

Table 9 (Continued)

SUMMARY DATA OF PERTINENT INFORMATION RELATING TO THE DECK AND OVERLAYS

Bridge No. and Direction	Route No.	County	1982 ADT (1)	Class of Base Concrete In Deck	Deck Rehabilitated or Of New Construction	Deck Constructed (Mos/Yr)	Thickness and Type Of Overlay	Overlay Constructed (Mos/Yr)	Coarse Aggregate Overlay Vs Bridge Deck
A-2984	I-170	StLo	26,300	B-1	NC	May 79	2 1/4" LSC	Sep 79	(3)
A-2985	I-170	StLo	26,100	B-1	NC	Jun 79	2 1/4" LSC	Sep 79	(3)
A-2986	I-170	StLo	26,300	B-1	NC	Jul 79	2 1/4" LSC	Sep 79	(3)
A-2987	I-170	StLo	26,100	B-1	NC	May 79	2 1/4" LSC	Sep 79	(3)
A-3128	Lafayette Ave.	StLo	12,000	B-1	NC	Apr 79	2 1/4" LSC	May 79	(3)
A-3162	I-44	StLo	47,580	B-1	NC	May 79	2 1/4" LSC	Jun 79	(3)
A-3351	I-44 Ramp	StLo	5,770	B-1	NC	Oct 79	2 1/4" LSC	Sep 80	(3)
A-3352	I-44 Ramp	StLo	5,390	B-1	NC	Jun 78	2 1/4" LSC	Aug 78	(3)
A-3353	I-44 Ramp	StLo	5,900	B-1	NC	Aug 78	2 1/4" LSC	Sep 78	(3)
A-3483	54	Pike	4,040	B-1	NC	Aug 79	2 1/4" LSC	Jul 80	(3)
A-3494	54	Pike	4,040	B-1	NC	Jul 80	2 1/4" LSC	Aug 80	(3)
A-3496	61	Pike	5,900	B-1	NC	Oct 79	2 1/4" LSC	Jul 80	(3)
A-3498	61	Pike	5,900	B-1	NC	Apr 80	2 1/4" LSC	Jul 80	(3)
A-3500	61	Pike	5,000	B-1	NC	Sep 79	2 1/4" LSC	Jul 80	(3)
*A-3547 N.B.	Marine Ave.	StLo	15,000	B-1	NC	Jul 79	2 1/4" LSC	Aug 79	(3)
*A-3547 S.B.	Marine Ave.	StLo	15,000	B-1	NC	Jul 79	2 1/4" LSC	Aug 79	(3)
*A-3617 N.B.	5	Lacl	8,103	B-1	NC	Aug 79	2 1/4" LSC	Oct 79	(3)
*A-3617 S.B.	5	Lacl	8,103	B-1	NC	Sep 78	2 1/4" LSC	Oct 78	(3)

Table 9 (Continued)

SUMMARY DATA OF PERTINENT INFORMATION RELATING TO THE DECK AND OVERLAYS

Bridge No. and Direction	Route No.	County	1982 ADT(1)	Class of Base Concrete In Deck	Deck Rehabilitated or Of New Construction	Deck Constructed (Mos/Yr)	Thickness and Type Of Overlay	Overlay Constructed (Mos/Yr)	Coarse Aggregate Overlay Vs Bridge Deck
*A-2117 N.B.	Douglas Street	Jack	Not Available	B-1	NC	Nov 79	2 1/4" LSC	May 80	(6)
*A-2117 S.B.	Douglas Street	Jack	Not Available	B-1	NC	Nov 79	2 1/4" LSC	May 80	(6)
A-2118 W.B.	Colborn Road	Jack	Not Available	B-1	NC	May 80	2 1/4" LSC	Jun 80	(3)
A-2118 E.B.	Colborn Road	Jack	Not Available	B-1	NC	May 80	2 1/4" LSC	Jun 80	(3)
A-2119 W.B.	Colborn Road	Jack	6,317	B-1	NC	Apr 80	2 1/4" LSC	Jun 80	(3)
A-2119 E.B.	Colborn Road	Jack	6,317	B-1	NC	Apr 80	2 1/4" LSC	Jun 80	(3)
A-2132 W.B.	I-229	Buch	3,938	B-1	NC	Nov 79	2 1/4" LSC	Jul 80	(3)
A-2132 E.B.	I-229	Buch	3,467	B-1	NC	Nov 79	2 1/4" LSC	Jul 80	(3)
A-2224	I-229	Buch	5,500	B-1	NC	Apr 80	2 1/4" LSC	Jun 80	(5)
A-2225 N.B.	I-229	Buch	Not Open	B-1	NC	Jun 81	2 1/4" LSC	Aug 81	(5)
*A-2225 S.B.	I-229	Buch	Not Open	B-1	NC	Jul 81	2 1/4" LSC	Sep 81	(5)
A-2226	I-229	Buch	3,100	B-1	NC	Sep 79	2 1/4" LSC	Aug 80	(5)
A-2227	I-229	Buch	3,100	B-1	NC	Jul 79	2 1/4" LSC	May 80	(5)
A-2228	I-229	Buch	8,500	B-1	NC	Jun 80	2 1/4" LSC	Jun 81	(5)
A-2229	I-229	Buch	8,500	B-1	NC	Jul 80	2 1/4" LSC	Jun 81	(5)
A-2230	I-229	Buch	7,600	B-1	NC	Jul 81	2 1/4" LSC	Sep 81	(5)
A-2231	I-229	Buch	7,600	B-1	NC	May 81	2 1/4" LSC	Aug 81	(5)
A-2513	50	Jack	9,580	B-1	NC	Apr 80	2 1/4" LSC	May 80	(3)
A-2514	50	Jack	19,740	B-1	NC	Apr 80	2 1/4" LSC	May 80	(3)
A-2847	I-229	Buch	Not Open	B-1	NC	Apr 80	2 1/4" LSC	Jun 80	(5)
A-2908 N.B.	I-170	StLo	17,900	B-1	NC	Jul 79	2 1/4" LSC	Sep 79	(3)
A-2908 S.B.	I-170	StLo	15,800	B-1	NC	Aug 79	2 1/4" LSC	Sep 79	(3)

Table 9 (Continued)

(1) Average Daily Traffic (ADT) data is for 1982 except when it is otherwise shown.

General: Type of Aggregate Combinations

(1) A Meramec sand aggregate mortar overlay over a crushed limestone aggregate substrate concrete deck.
(2) A Meramec sand aggregate mortar overlay over a Meramec gravel aggregate substrate concrete deck.
(3) A crushed limestone aggregate overlay over a crushed limestone aggregate substrate concrete deck.
(4) A Meramec gravel aggregate concrete overlay over a crushed limestone aggregate substrate concrete deck.
(5) A crushed porphyry aggregate concrete overlay over a crushed limestone aggregate substrate concrete deck.
(6) A crushed limestone aggregate concrete overlay over a lightweight aggregate substrate concrete deck.
(7) A crushed limestone aggregate concrete overlay over either a Meramec or Black River Gravel aggregate substrate concrete deck.
(8) A Meramec gravel aggregate concrete overlay over a Meramec gravel aggregate substrate concrete deck.

*These structures had either one or all of the following additional tests performed: (a) have had concrete samples taken for chloride ion analysis, (b) voltage readings taken, and (c) some cores cut to determine depth of surface crack penetration in overlay and base deck concrete.

R=Rehabilitated Bridge Deck

Table 10

GROUPMENT OF PRINCIPAL BRIDGE CLASSIFICATION BY STRUCTURE TYPE

I. Box Beam or Girder (BB-G)

A-93R(2), A-1643R(2), A-1763R and L-887R(2)

II. Girder (GIRD)

A-2226, A-2227, A-2228, A-2229, A-2230, A-2231, A-3353, and A-3594(2)

III. Pony Truss (PYTR)

J-991R

IV. Slab (SLAB)

A-119R, A-211R, A-2132(2), A-2233, A-2234, A-2235, A-2986, A-2987, A-3352, A-3706(2), A-3792, A-3830, A-3831, and L-759R.

V. Stringer/Multi-Beam or Girder (STRG)

A-1310R(2), A-2116(2), A-2117, A-2118, A-2119, A-2224, A-2225(2), A-2232, A-2513, A-2514, A-2672, A-2682(2), A-2683(2), A-2684(2), A-2738, A-2847, A-2908(2), A-2984, A-2985, A-3004, A-3005, A-3047(2), A-3085(2), A-3128, A-3162, A-3351, A-3483, A-3494, A-3496, A-3498, A-3500, A-3520, A-3521, A-3522, A-3547, A-3617(2), A-3623(2), A-3664(2), A-3666, A-3671, A-3735, A-3808, A-3809, A-3810(2), A-3823, A-3824, L-293R, L-319R(2), L-361R, L-641R, L-642R, L-501R and L-717R(2).

VI. Tee Beam (T-BM)

J-493R and L-669R

VII. Thru Truss (THTR)

A-3292

General: The number in ( ) indicates the number of driving (traffic) lanes investigated on this given structure.

R=Rehabilitated Bridge Deck

Table 10 (Continued)

TOTALS OF ABOVE BY STRUCTURE TYPE

Box Beam or Girder (BB-G)	7
Girder (GIRD)	9
Pony Truss (PYTR)	1
Slab (SLAB)	16
Stringer/Multi-Beam or Girder (STRG)	68
Tee Beam (T-BM)	2
Thru Truss (THTR)	1
	104

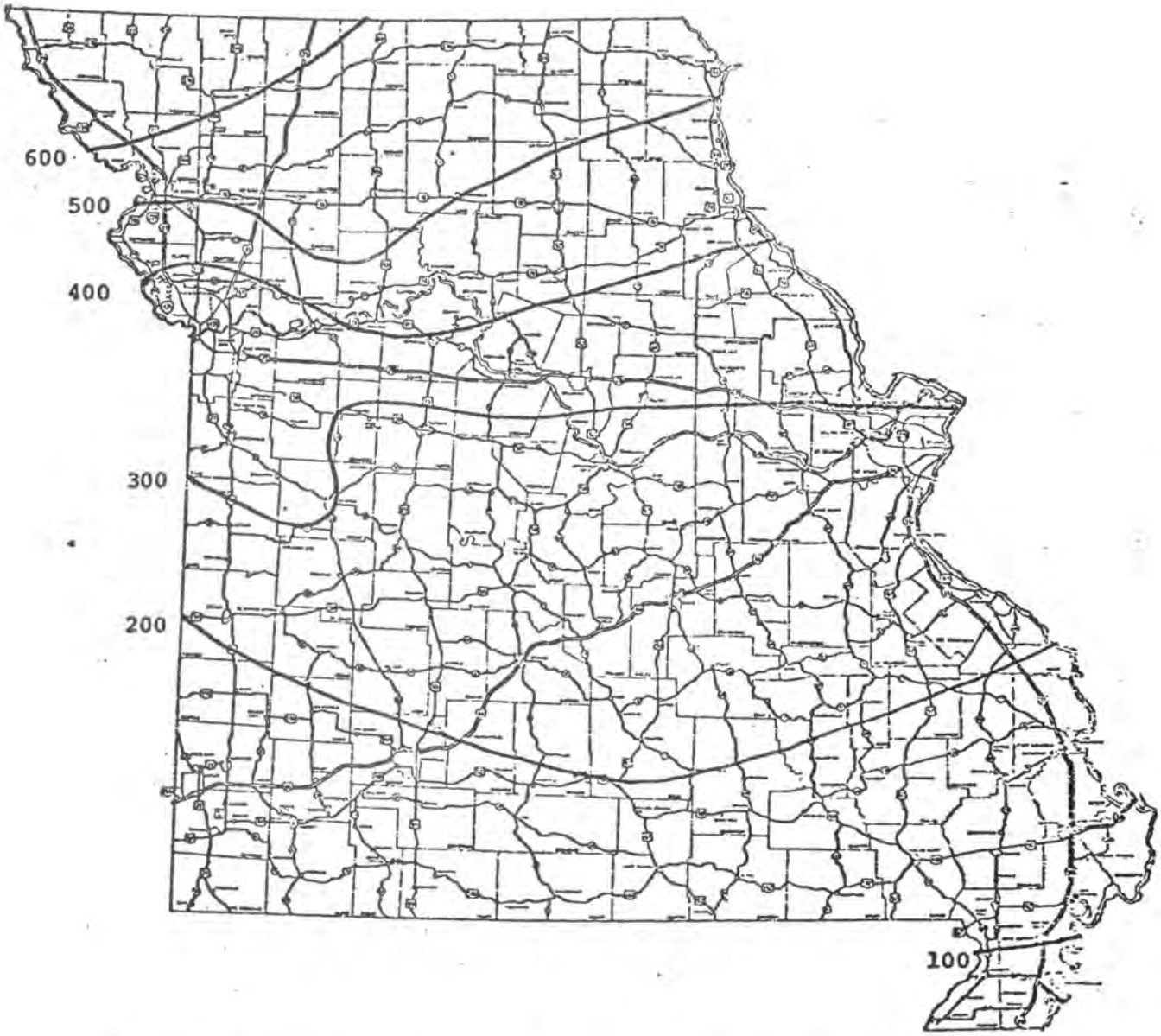
Table 11

SUMMARY OF OVERLAYS BUILT BY TYPE AND YEAR INSTALLED

Type of Overlay	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	Total
Latex Mortar	--	--	--	7	2	--	--	--	--	--	--	9
Latex Concrete	1	1	--	--	3	5	8	10	2	--	--	30
Low Slump Concrete	--	--	--	--	2	7	13	29	12	--	2	65
Totals by Year	1	1	--	7	7	12	21	39	14	--	2	104

Figure 1

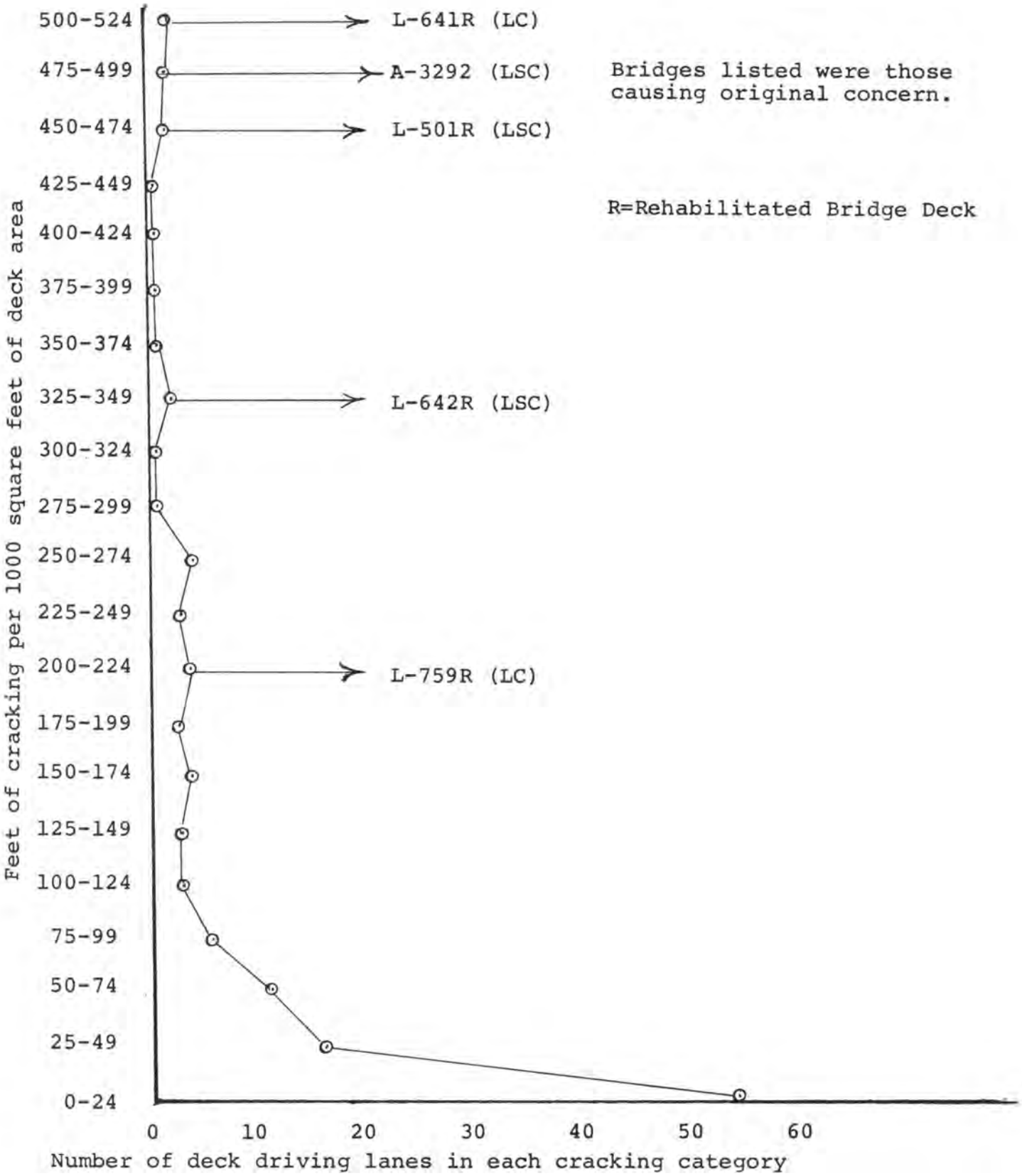
Mean Freezing Index Contours
(Freezing Index Values Expressed in Degree-Days Below 32°F.)



Note: Basis of contoured data, as shown, was taken from official climatological publications covering a series of official weather stations for a period of 25 or more years.

Figure 2

Surface Cracking Histogram



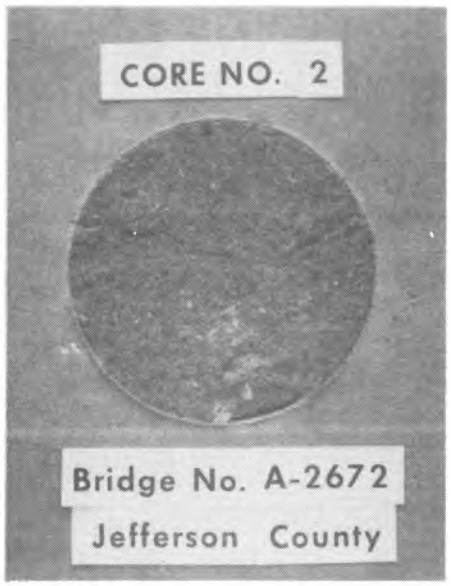
APPENDICES

I. Pages a through g inclusive contain pairs of photographic prints covering a series of cores exhibiting and documenting size of surface crack (plan view) and depth of crack penetration (profile view).

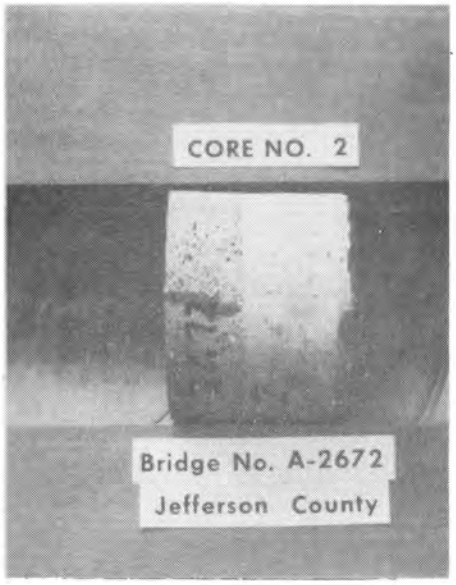
II. Pages h through k inclusive contain a series of three photographic prints of (4' x 3') grids exhibiting examples of the various categories of lineal surface cracking. These various groupings are intended to present to the viewer a visual image of some of the patterns and quantities of cracking that was the basis of tabulating and evaluating quantitatively data for Tables 1 and 6 respectively.

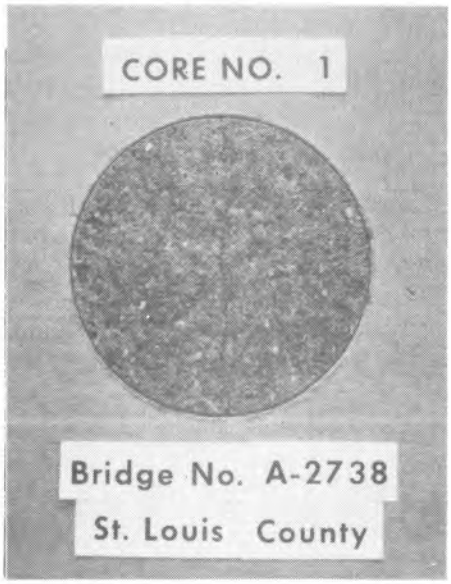
III. Page l contains the additional length limiting criteria as set up for the driving lane/s of each bridge deck overlay investigated.

SURFACE CRACKING AND DEPTH OF PENETRATION

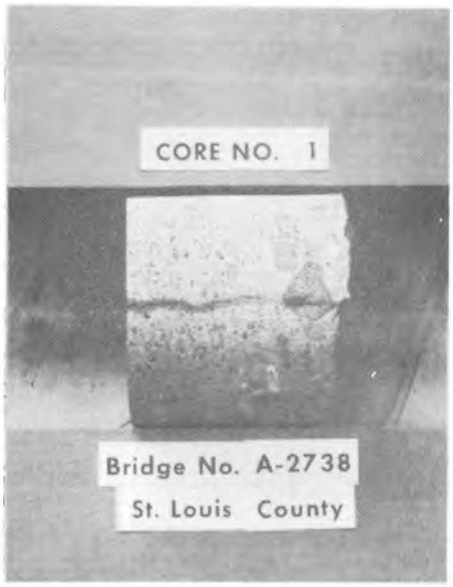


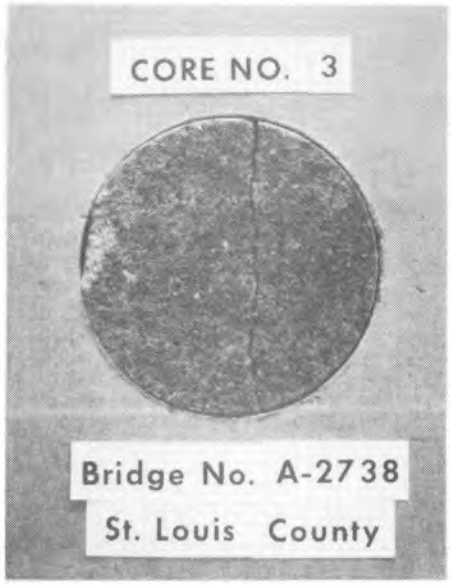
1.2" Latex Mortar
Fine Crack
Depth 1.2"



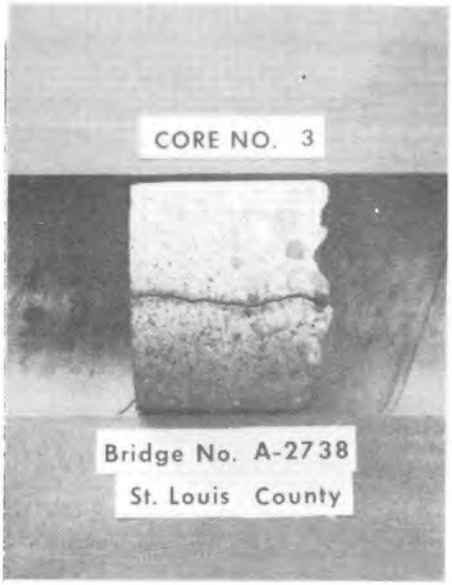


1.5" Latex Mortar
Fine Crack
Depth 3.2" +

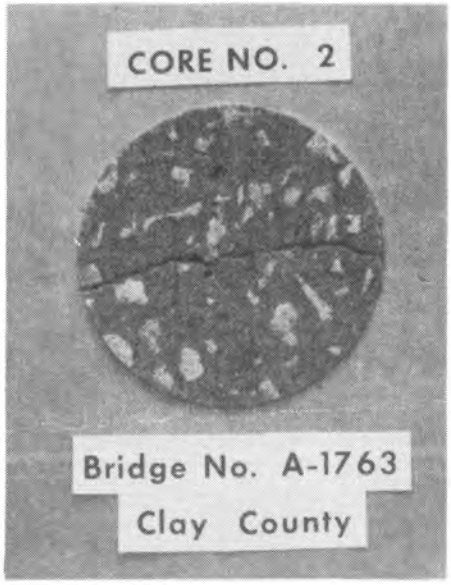




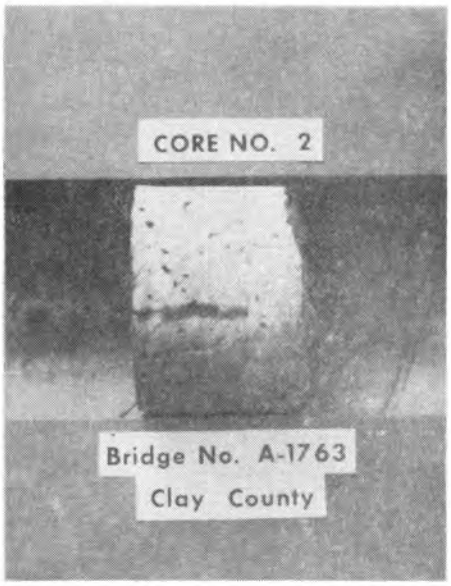
1.6" Latex Mortar
Medium Crack
Depth 3.1" +

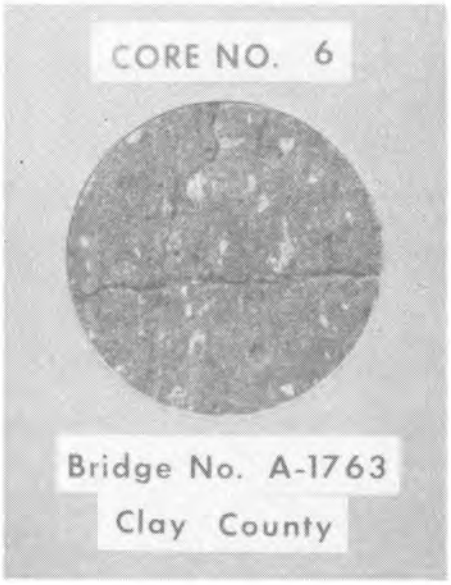


SURFACE CRACKING AND DEPTH OF PENETRATION

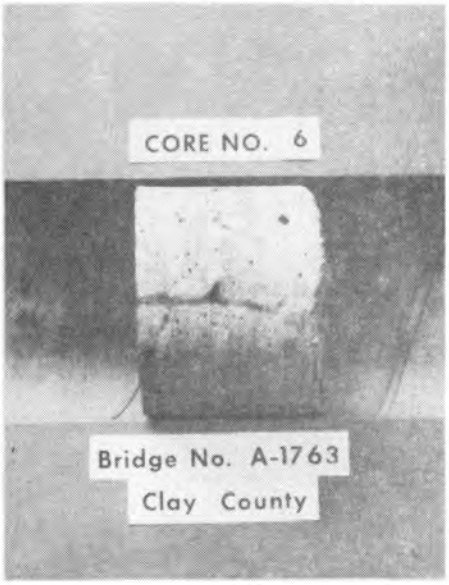


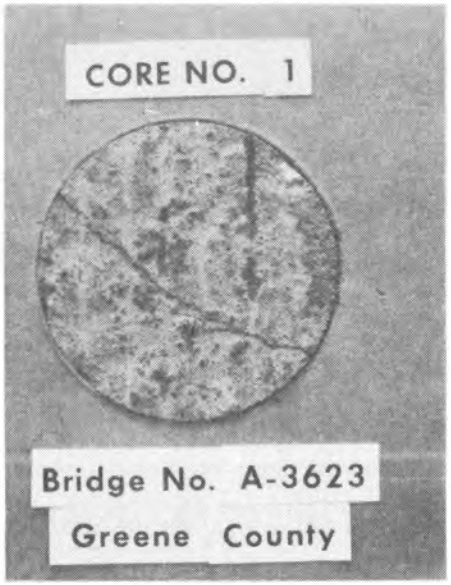
1.8" Latex Concrete
Large Crack
Depth 1.7"



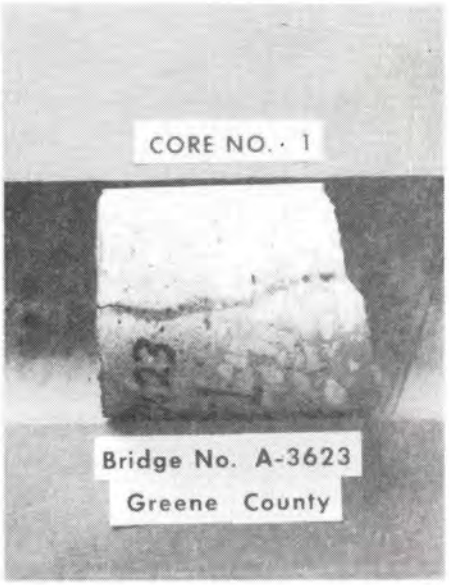


1.9" Latex Concrete
Large Crack
Depth 1.9"

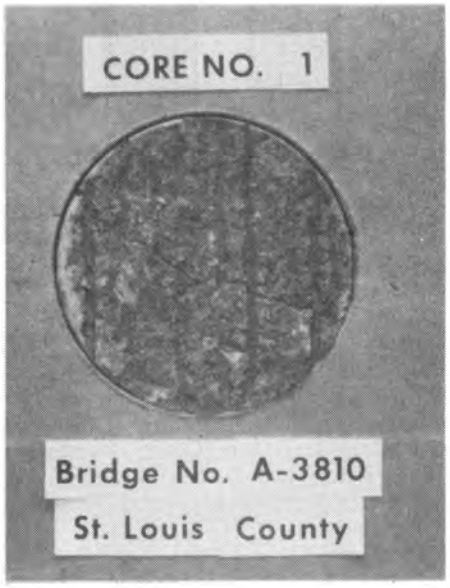




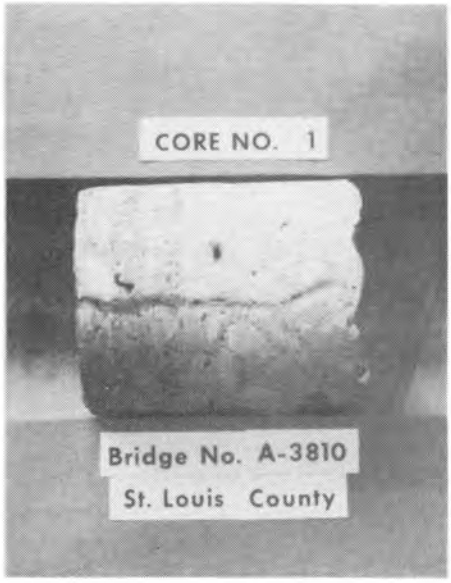
1.7" Latex Concrete
Fine Crack
Depth 2.4"

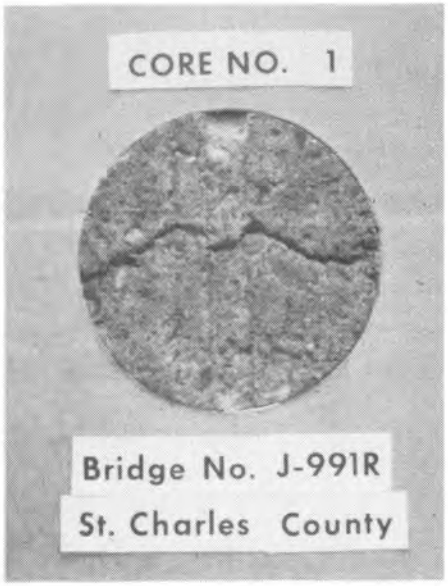


SURFACE CRACKING AND DEPTH OF PENETRATION

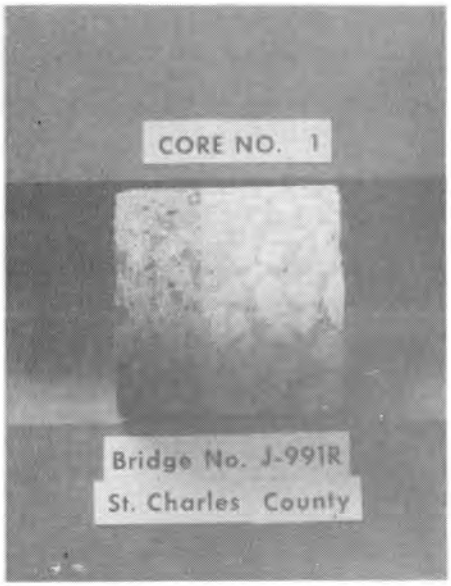


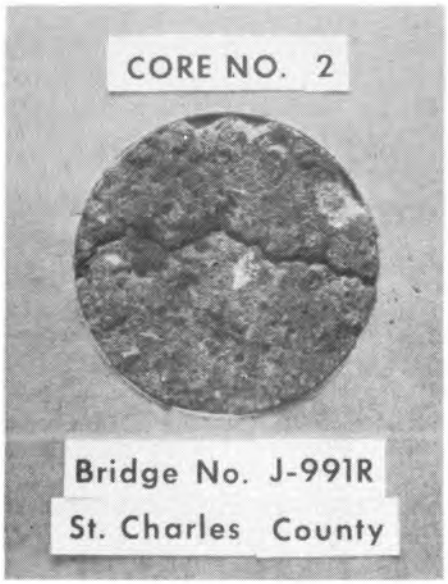
1.7" Latex Concrete
Fine Crack
Depth 4.0"



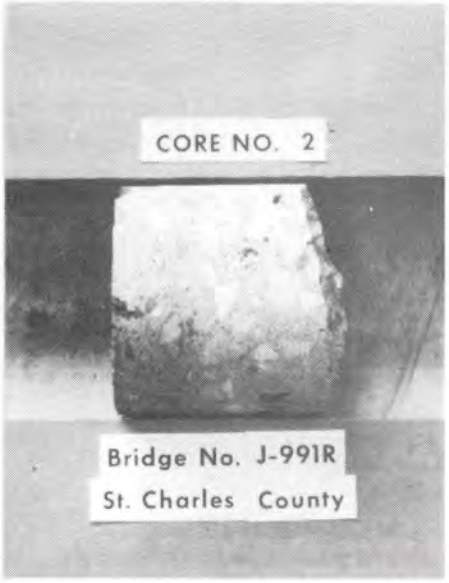


1.3" Latex Concrete
Large Crack
Depth 0.1"

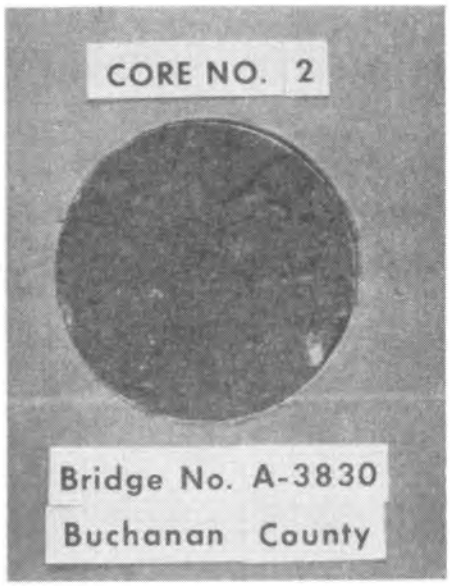




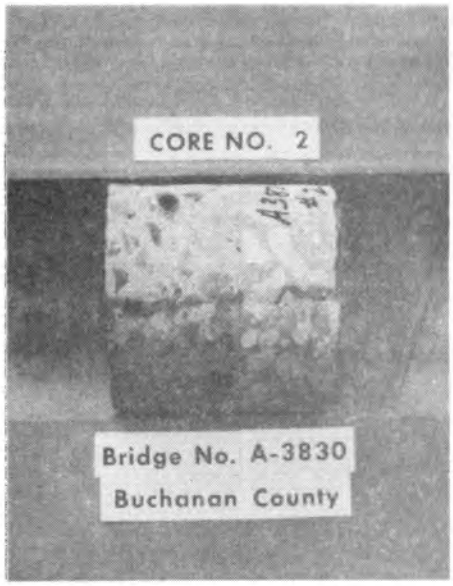
1.3" Latex Concrete
Large Crack
Depth 0.3"

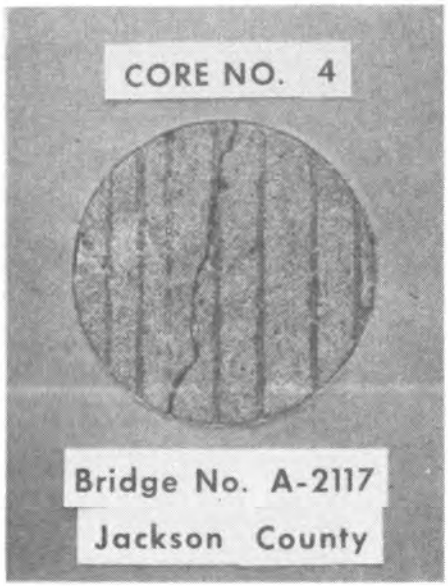


SURFACE CRACKING AND DEPTH OF PENETRATION

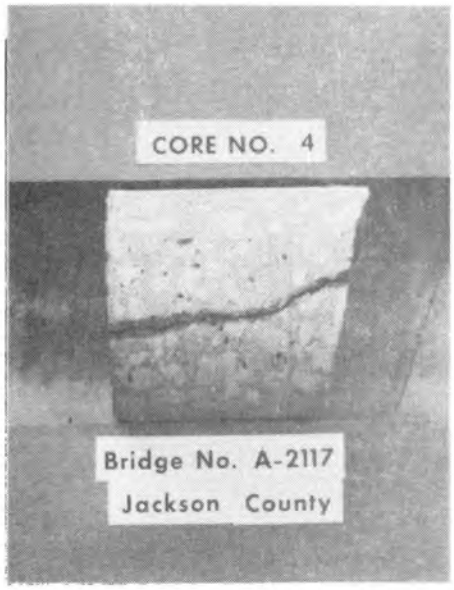


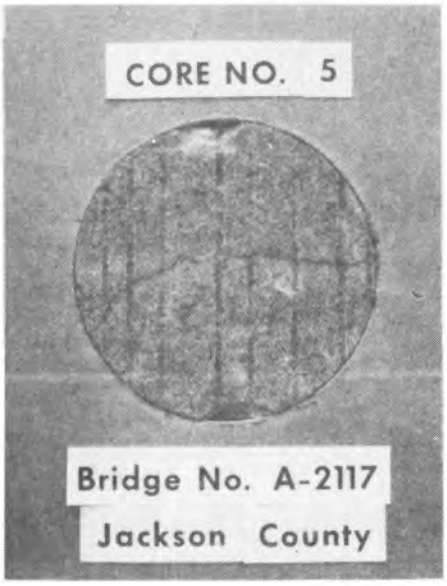
2.0" Low Slump
Fine Crack
Depth 3.4"



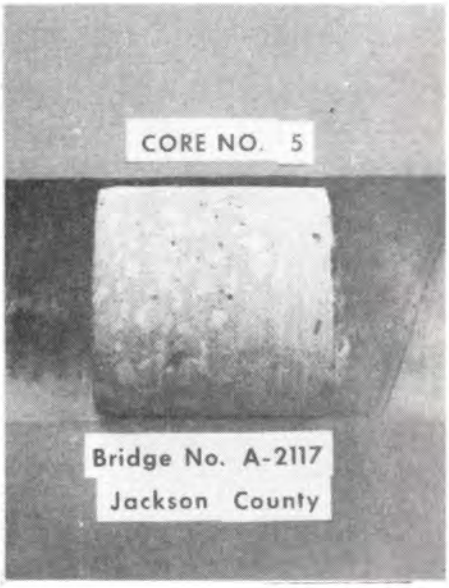


2.7" Low Slump
Medium Crack
Depth 3.7"

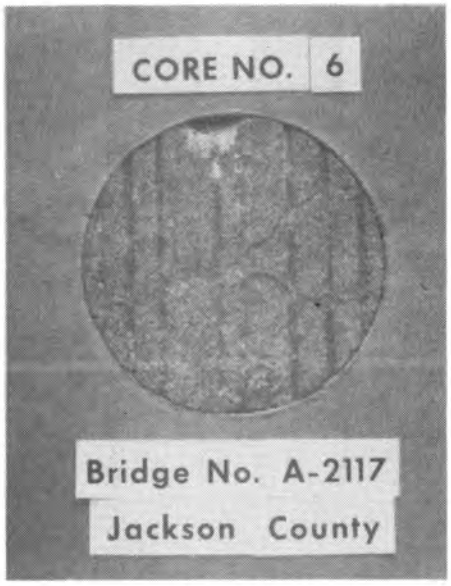




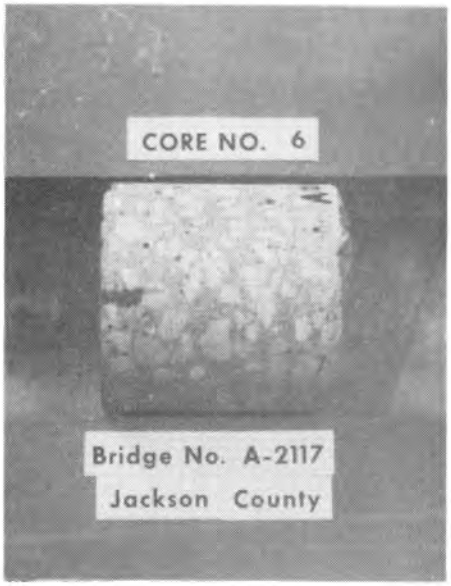
2.7" Low Slump
Fine Crack
Depth 0.0"+

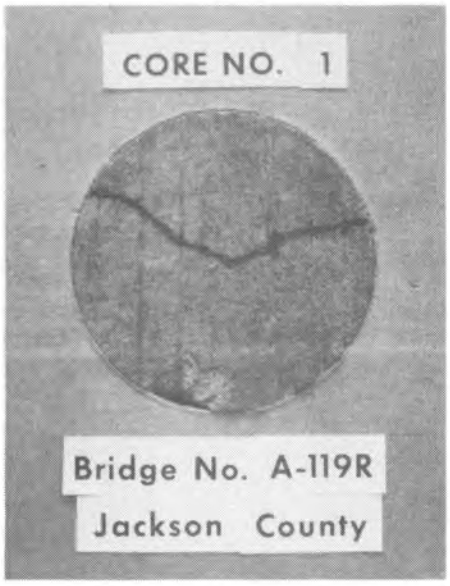


SURFACE CRACKING AND DEPTH OF PENETRATION

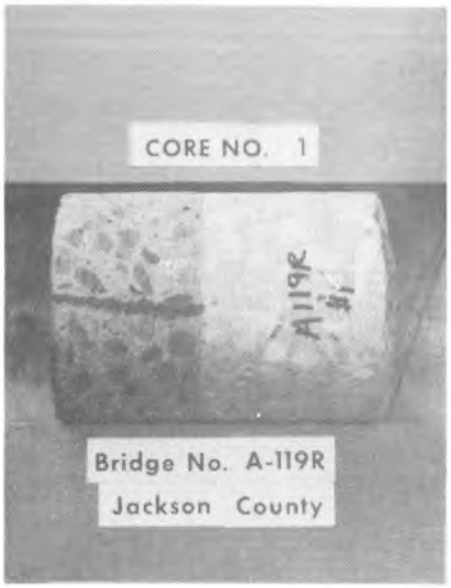


2.9" Low Slump
Fine Crack
Depth 0.4"

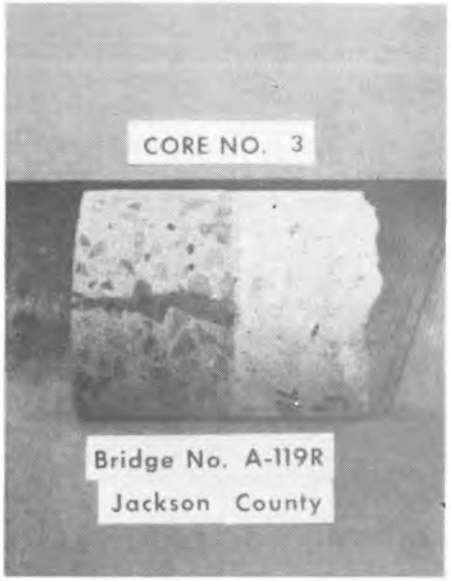




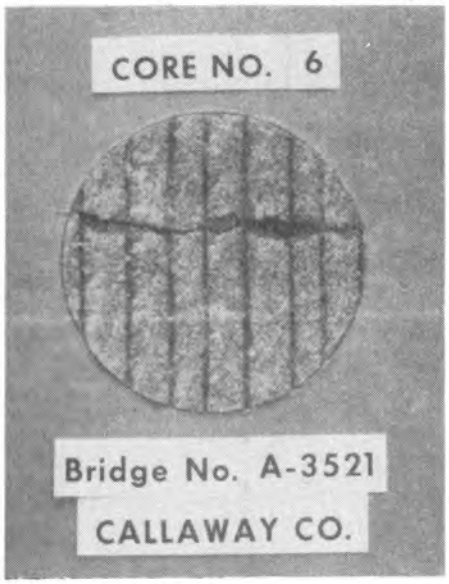
2.3" Low Slump
Fine Crack
Depth 2.3"



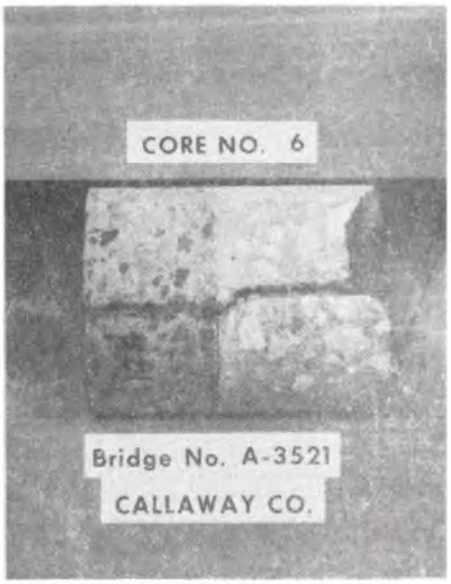
2.5" Low Slump
Fine Crack
Depth 2.5"

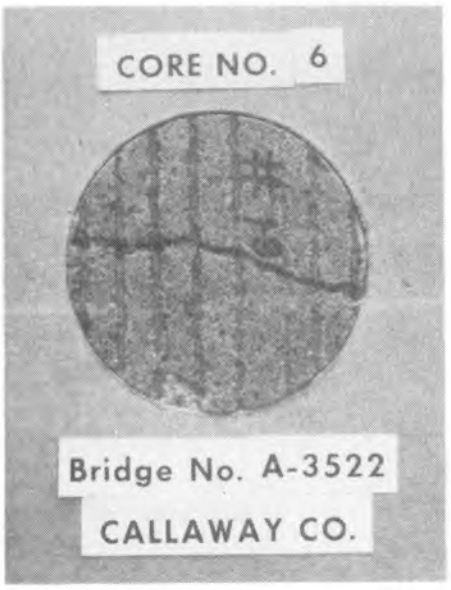


SURFACE CRACKING AND DEPTH OF PENETRATION

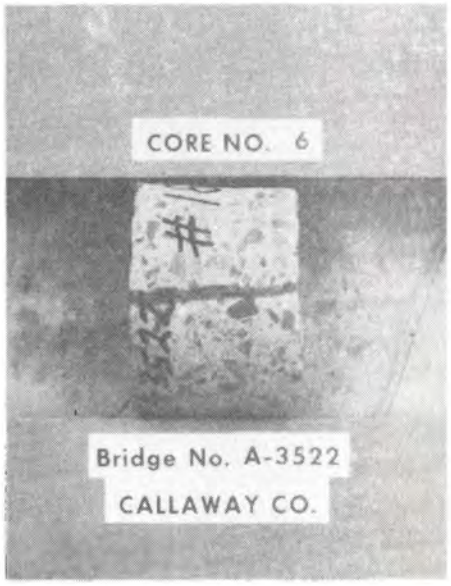


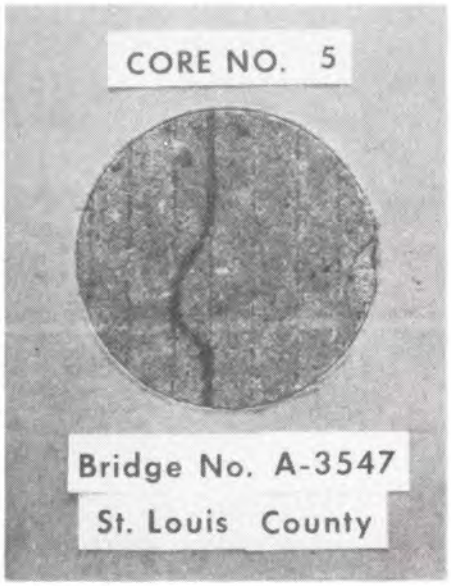
2.0" Low Slump
Medium Crack
Depth 4.3" +



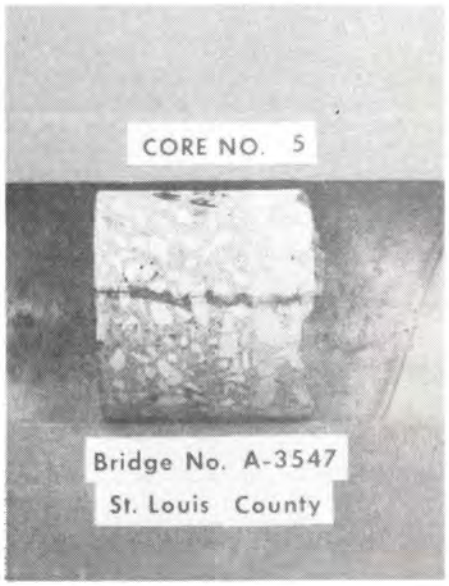


2.5" Low Slump
Fine Crack
Depth 2.5"

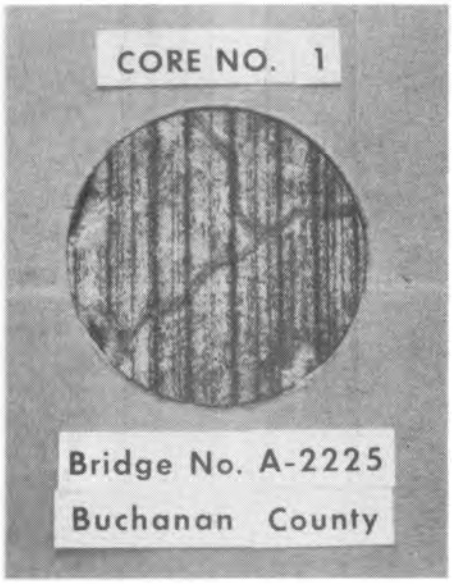




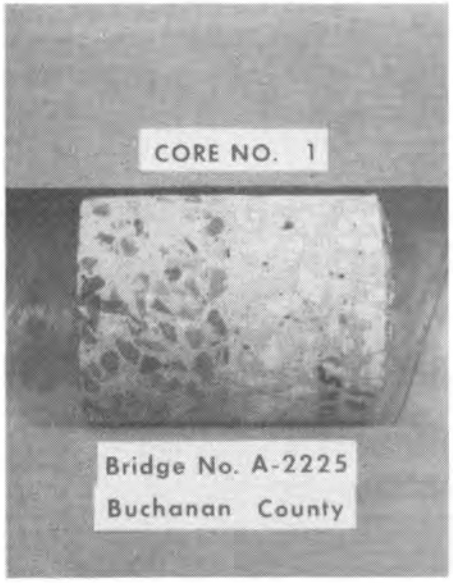
2.3" Low Slump
Fine Crack
Depth 3.3" +

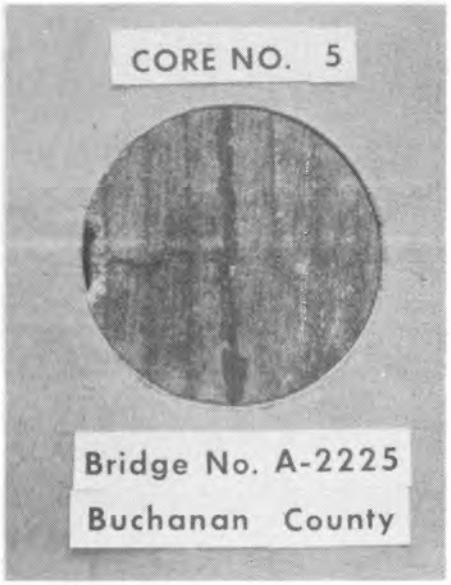


SURFACE CRACKING AND DEPTH OF PENETRATION

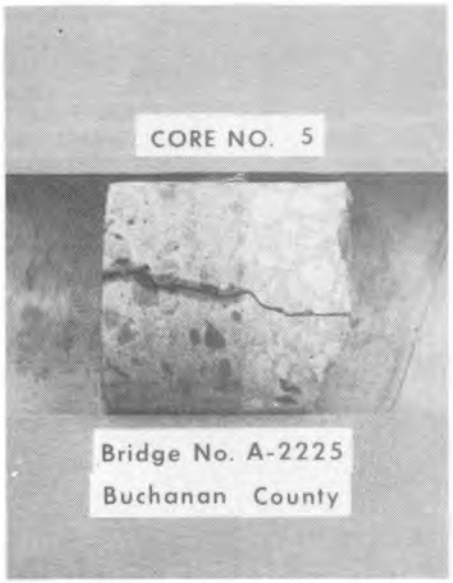


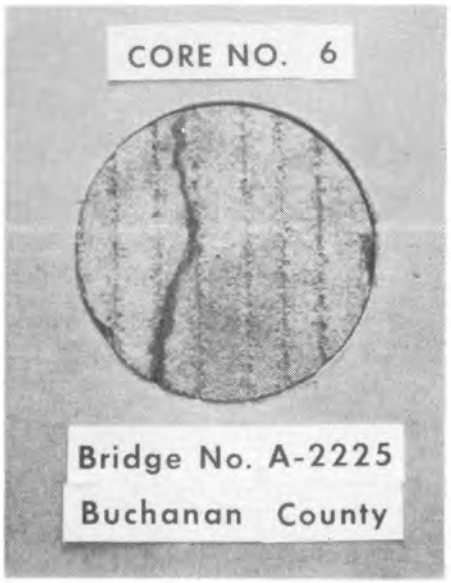
2.4" Low Slump
Fine Crack
Depth 0.9"



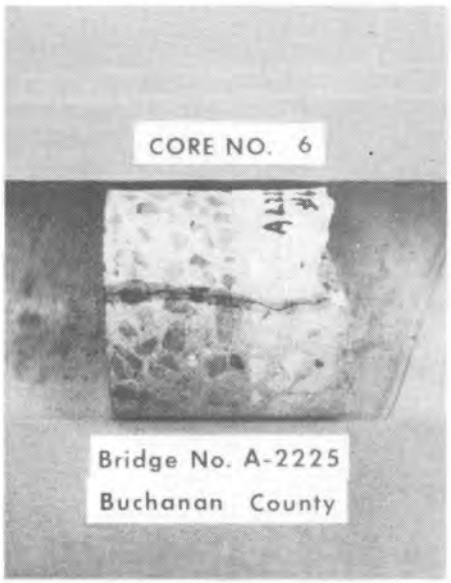


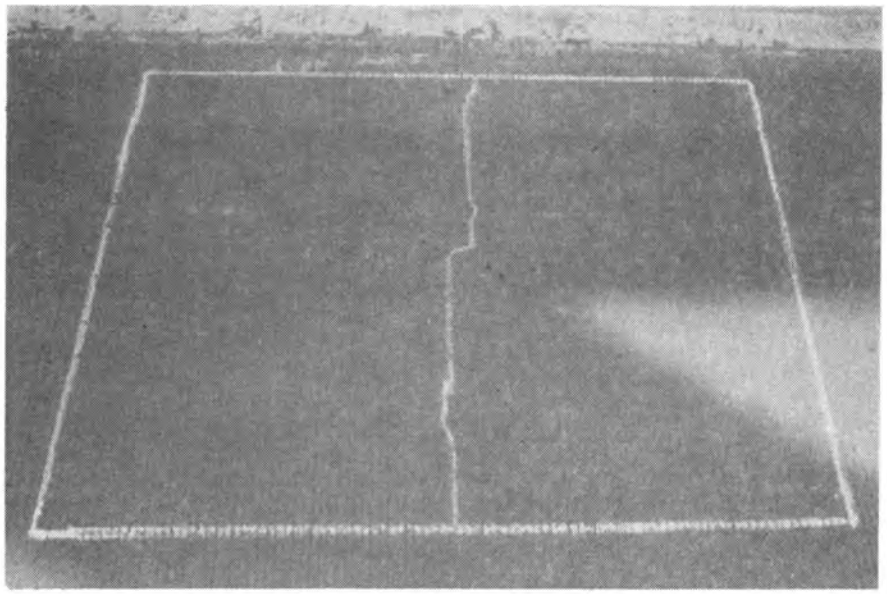
2.2" Low Slump
Fine Crack
Depth 2.2"+



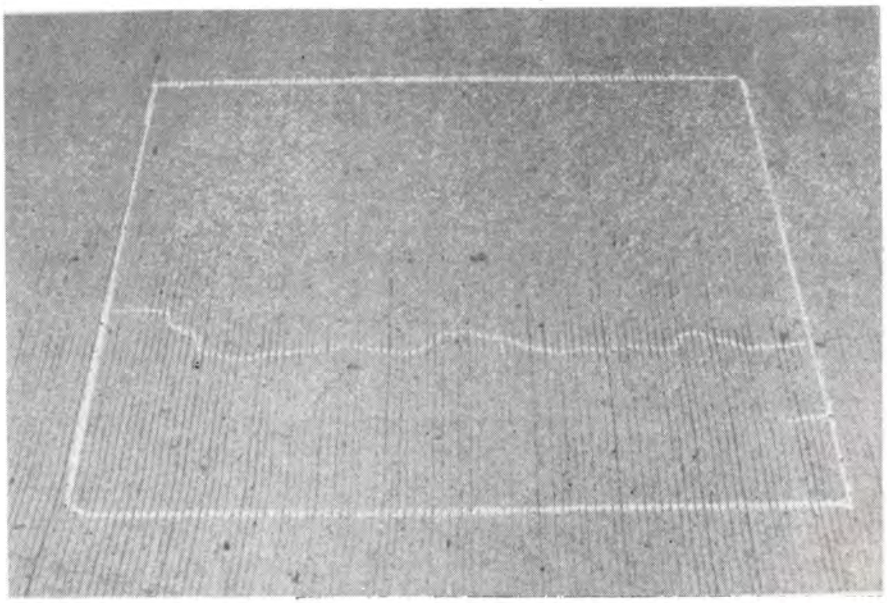


2.1" Low Slump
Fine Crack
Depth 3.4"+





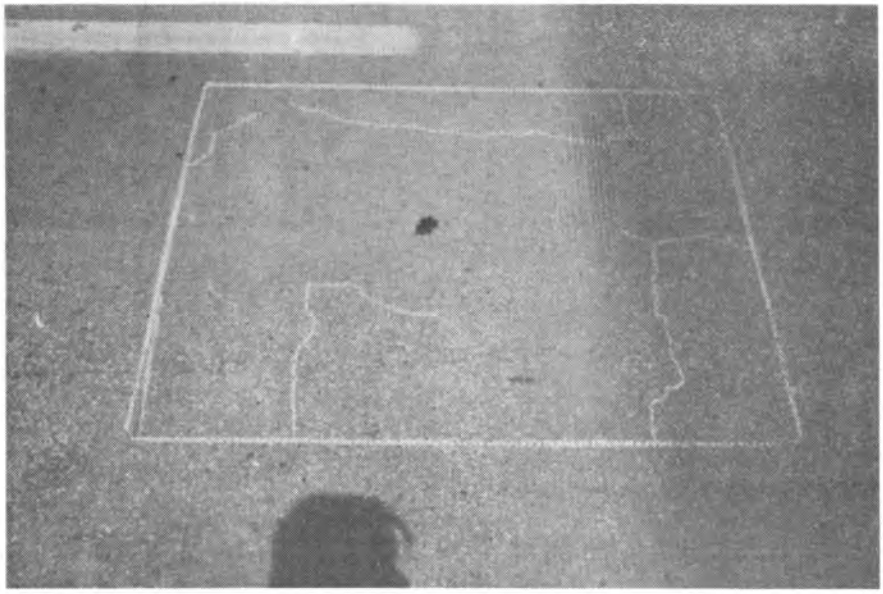
'>0 to ≤5'



>0 to ≤5'

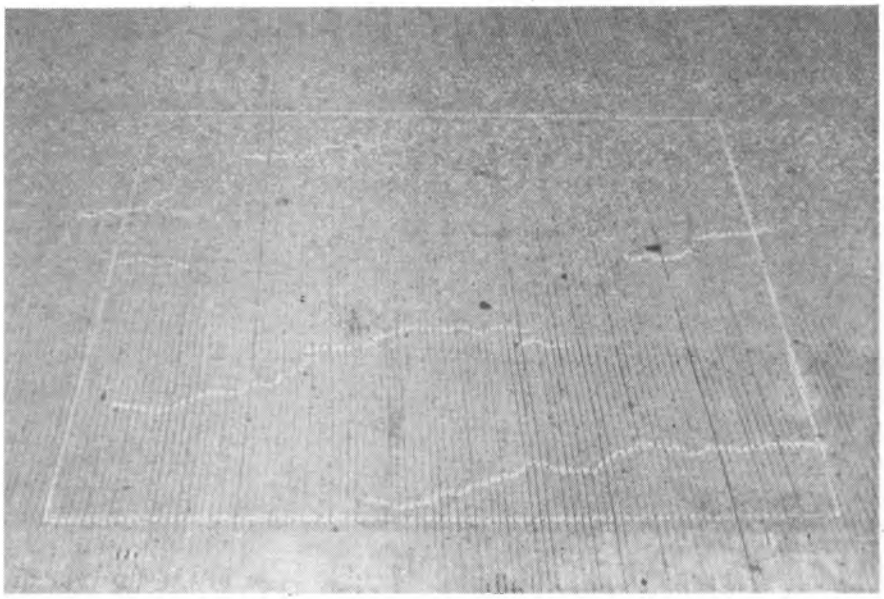
>0 to ≤5'

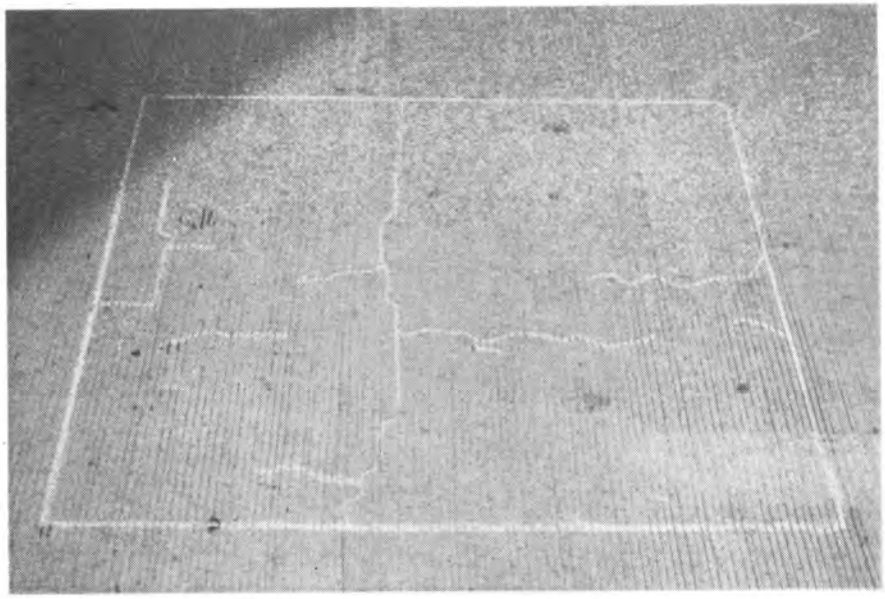
LEGEND: Grids are all (4 x 3) feet.



>5 to ≤10'

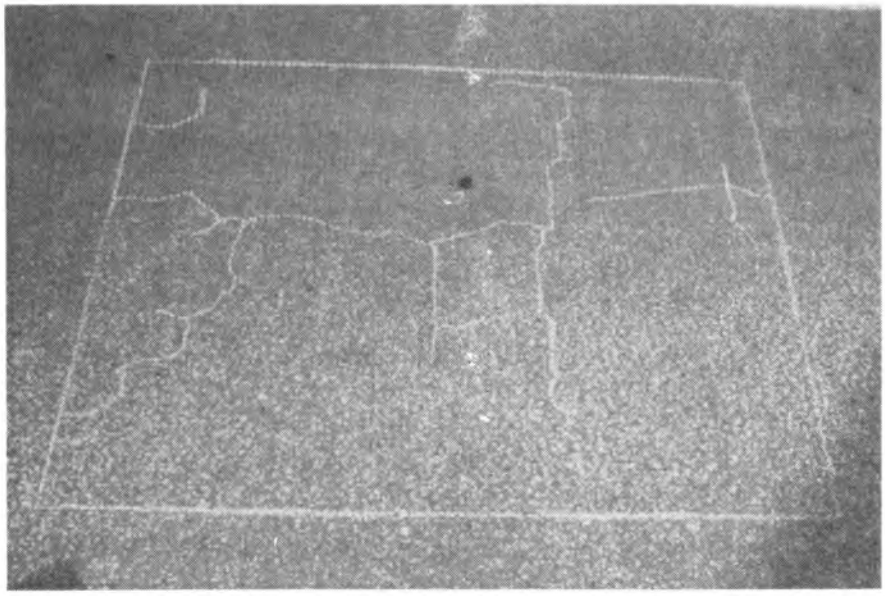
>5 to ≤10'





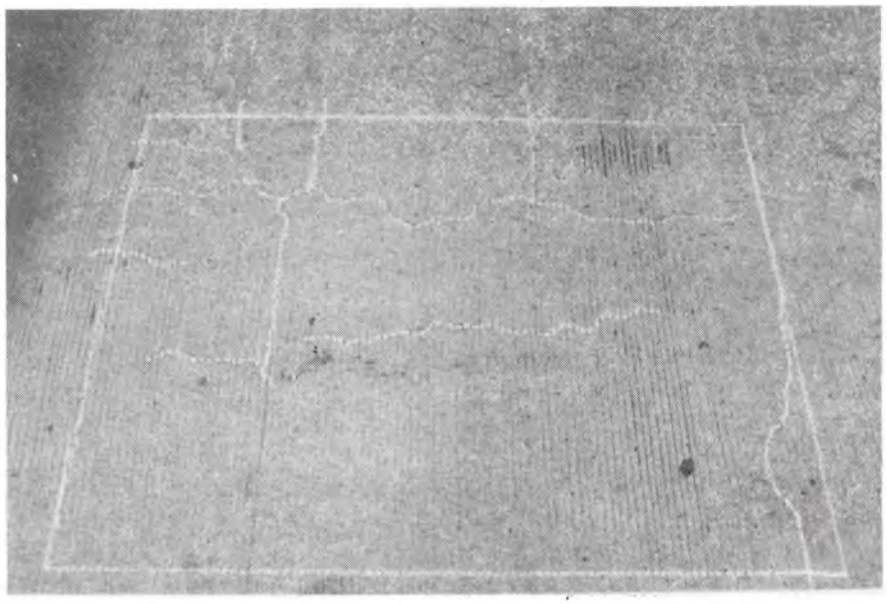
>5 to ≤10'

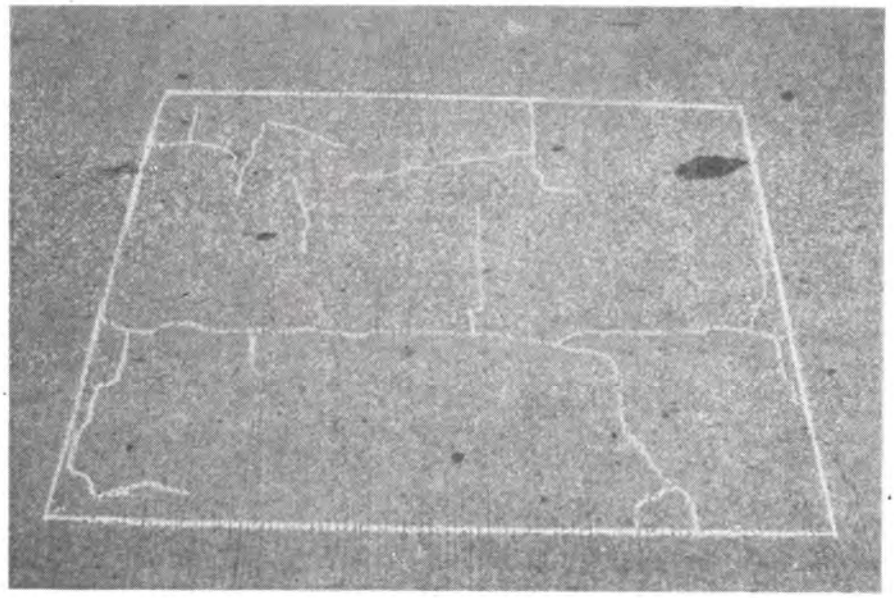
LEGEND: Grids are all (4 x 3) feet.



>10 to ≤15'

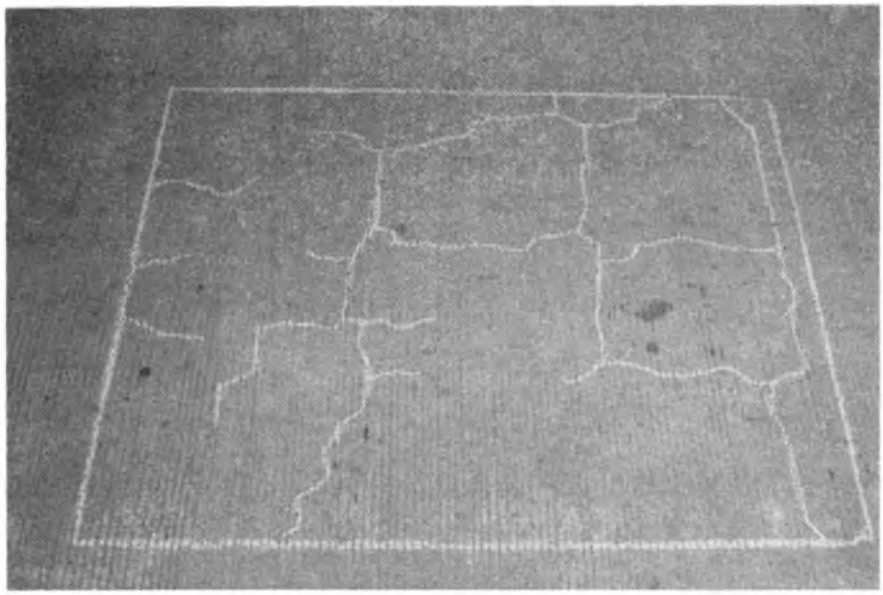
>10 to ≤15'



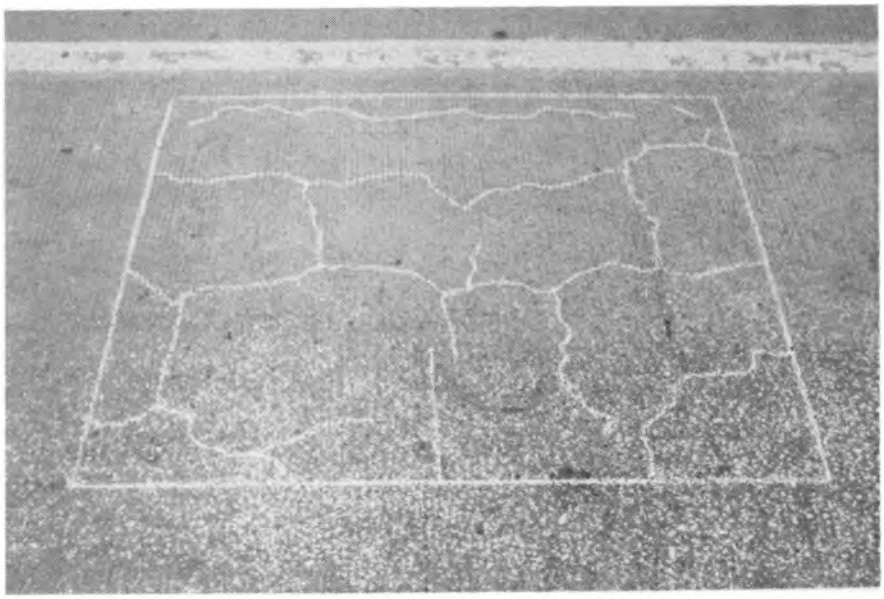


>10 to ≤15'

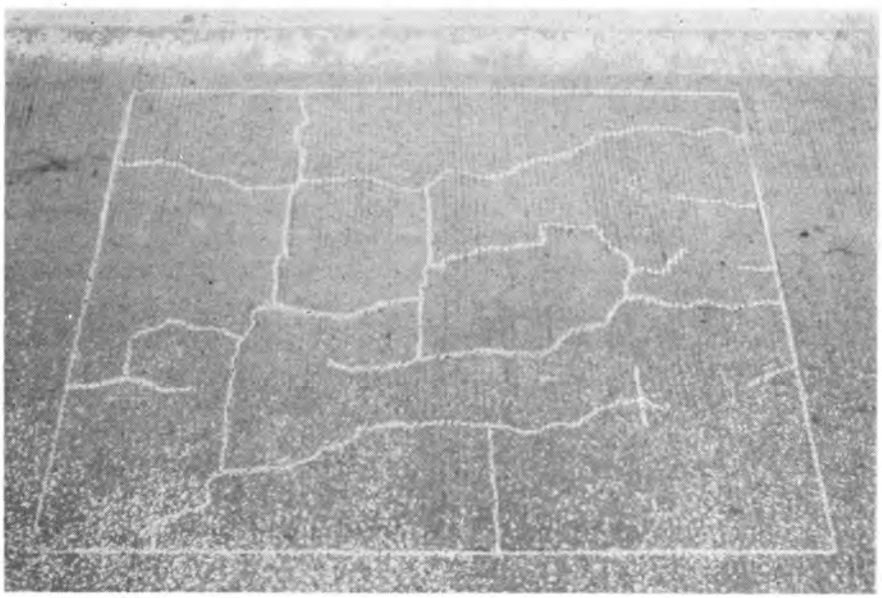
LEGEND: Grids are all (4 x 3) feet.



>15'



>15'



>15'

LEGEND: Grids are all (4 x 3) feet.

APPENDIX

The study was devised to survey one lane of each deck. For the most part, the lane to be surveyed was the outermost thru driving lane.

Due to the great variation in length of these overlaid structures, i.e., ranging from 62 feet to 6,829 feet, additional length limiting criteria was set up as follows:

1. Bridge lengths less than 300 feet
   a. Survey all spans.
2. Bridge lengths of 300 to 600 feet
   a. Survey either first and/or last spans plus additional spans with a total survey length of approximately 300 feet.
3. Bridge lengths of 601 to 1050 feet
   a. Survey either first and/or last spans plus additional spans with a total survey length of approximately 500 feet.
4. Bridge lengths of 1051 to 2000 feet
   a. Survey either first and/or last spans plus additional spans with a total survey length of approximately 800 feet.
5. Bridge lengths of over 2000 feet
   a. Survey either first and/or last spans plus additional spans with a total survey length of one-half of the bridge length. Note Exception - Bridges open to traffic less than 3 years, total survey length will be approximately 1000 feet unless excessive cracking is noted.