Construction, Protection and Maintenance of Concrete Bridge Decks

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KENTUCKY DEPARTMENT OF HIGHWAYS

CONSTRUCTION, PROTECTION AND MAINTENANCE
OF CONCRETE BRIDGE DECKS

Final Report
KYHPR-64-2; HFR-1 (8), Part II

by

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and

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DIVISION OF RESEARCH

COMMONWEALTH OF KENTUCKY
MEMORANDUM TO: J. R. Harbison
State Highway Engineer
Chairman, Research Committee

SUBJECT: Research Report 335, "Construction, Protection and Maintenance of Concrete Bridge Decks", Final Report on Study KYHPR-64-2; HPR-1(8), Part II

The enormity of the bridge deck durability problem is evident in many ways -- one of which is the voluminous report enclosed herewith.

We have attempted to document design, construction, protection, repair and reconstruction as opportunities arose. Although we could continue to do so ad infinitum, it seems expedient now to conclude Study KYHPR-64-2 and to renew this particular type of reporting at some future time if deemed worthy. There have been several spin-offs from this study, and we believe that the principal emphasis should now attend them. Two current, on-going studies are:

KYP-71-25: Bridge Decks Specially Constructed for Increased Durability (I 64, from Jett to Lexington) and
KYP-72-39: Voidless Concrete Mixtures for Bridge Decks.

W. B. Drake and I compiled the original report on bridge decks in 1962 ("Concrete, Bridge Decks: Deterioration, Coatings and Repairs," issued February 1963). HPR studies KYHPR-64-2, KYHPR-64-3 (Protective Coatings for Concrete Bridge Decks), and KYHPR-64-4 (Repair and Maintenance of Concrete Bridge Decks) ensued. A combination report, "Concrete Bridge Decks: Deterioration and Repair, Protective Coatings, and Admixtures," was issued in June 1966. Only KYHPR-64-2 was continued; thereafter, the study lumped the whole problem together again.

A brief chronology of adaptive design and specification changes intended to improve deck durability follows. This listing was abstracted from Mr. Vansant’s compilation ("Bridge Decks: Precepts to Concepts," presented before Highway Research Board; August 1970; Sacramento, Cal.):

1956 - Specified air entrainment for deck concrete,
1962 - Specified full-width finishing machines,
1962 - Specified linseed oil protective coating,
1964 - Specified membrane curing,
1964 - Increased concrete cover over reinforcement to 2 inches,
1965 - Specified template clearance check for finishing machines,
1966 - Specified Class AA concrete (6.6) sacks of cement, maximum of 5 gal. water per cu. yd.,
1967 - Specified tie-down of reinforcing steel - 8-ft. centers, each direction,
1969 - Specified temperature limitations for hot-weather concreting; nighttime concreting permitted, and
1970 - Specified rotary, compacting, finishing machine.
I believe that the quality of deck concrete, and consequently the durability, has improved steadily through the years. This is not to imply that decks currently being constructed will be altogether immune to damage by weather, but surely they will endure longer. Protective coatings provide additional safeguards, and their use remains advisory.

The maintenance burden continues to mount. Repairs and restorations are likely to become more recurring and repetitive. Here, too, much progress has been made; but overlays and surface treatments used even now are not likely to endure the life of the bridge. Surface treatments are generally renewable and necessary allowances should be made for this.

Respectfully submitted,

Jas. H. Havens
Director of Research

JHH:dw
Attachment

cc's: Research Committee
A. B. Blankenship
Jack Miller
This report presents an historical account of deterioration in reinforced concrete bridge decks. Preventative maintenance treatments to both new and in-service decks are discussed. Repair methods are included. The major forms of deterioration are listed and causative mechanisms are discussed. Potential design and construction remedies are presented for consideration.
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DEPARTMENT OF HIGHWAYS
Commonwealth of Kentucky

in cooperation with the
U. S. Department of Transportation
Federal Highway Administration

The opinions, findings, and conclusions
in this report are not necessarily those of
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#### ADMIXTURES

- Bluegrass Parkway over Southern RR, Anderson Co.
- Western Kentucky Parkway over Illinois Central RR, Hopkins Co.
- Bluegrass Parkway over Ky 52, Nelson Co.
- Bluegrass Parkway over L&N RR, Nelson Co. (Sta 641+80)
- Bluegrass Parkway over Beech Fork, Nelson Co.
- Bluegrass Parkway over L&N RR, Nelson Co. (Sta 1543+90)
- Bluegrass Parkway over Salt River, Anderson Co.
- I 64 over Kentucky River, Franklin Co.
- N-S Expressway over Broadway, Jefferson Co.

### PROTECTIVE COATINGS

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- I 64 over Evergreen Road, Franklin Co.
- Mountain Parkway over Red River, Powell Co. (Proj. 99-30-EK14)
- Mountain Parkway over Lulbegrud Creek, Clark-Powell Co. Line
- Ky 715 over Mountain Parkway, Wolfe Co.
- Ky 15 over Mountain Parkway, Wolfe Co.
- US 227 over I 64, Clark Co.
- Mountain Parkway over Red River, Powell Co. (Proj. 99-30-EK8)
- Mountain Parkway over KY 213, Powell Co.
- Mountain Parkway over Ky 613, Powell Co.
- Wade Mill-Sewell Shop Road over I 64, Clark Co.
- Old Pine Grove-Clintonville Road over I 64, Clark Co.
- US 60 over I 64, Clark Co.
- I 64 over Ohio River, Jefferson Co.
- I 65 over Ohio River, Jefferson Co.
- I 65 over Salt River, Bullitt Co.
- US 40 over Levisa Fork of Big Sandy River, Johnson Co.
- I 64 over US 60, Boyd Co.
- Ironworks Pike over I 75, Fayette Co.
- Cleveland Road over I 64, Fayette Co.
- US 25 over I 75, Fayette Co.
- I 64 over Goose Creek, Shelby Co.
- I 75 over Branch of Elkhorn, Fayette Co.
- I 64 over Benson Creek, Franklin Co.
- I 64 over Buzzard Roost Road, Shelby Co.
- I 64 over Cardwell Lane, Franklin Co.
- I 64 over South Benson Creek, Franklin Co.
- I 65 over St. Catherine St., Jefferson Co.
BITUMINOUS OVERLAYS AND PATCHES

US 45 over Ohio River, McCracken Co.
Ashland-Coal Grove over Ohio River, Boyd Co.
US 23 and US 60 over Big Sandy River, Boyd Co.
US 60 over Southern RR, Fayette Co.
US 23 over Bear Creek, Lawrence Co.
Ky 61 over Big Renox Creek, Cumberland Co.
KY 61 over North Fork of Nolin River, Larue Co.
US 60 over Pup Creek, Daviess Co.
US 62 over North Elkhorn Creek, Scott Co.

CONCRETE AND MORTAR OVERLAYS

I 75 over Mt. Zion-Union Road, Boone Co.
KY 956 over I 64, Fayette Co.
US 31E over Ohio River, Jefferson Co. (discussed under Replaced Decks)

LATEX-MODIFIED CEMENT OVERLAYS AND PATCHES

I 75 over Southern RR, Scott Co.
KY 90 over Cumberland River, Pulaski Co.
KY 114 over Levisa Fork of Big Sandy River, Floyd Co.
Mountain Parkway over Middle Fork of Red River, Powell Co.
US 231 over I 65, Warren Co.
KY 90 over Otter Creek, Wayne Co.
US 68 over South Elkhorn Creek, Fayette Co.
I 65 over Nolin River, Hardin Co.
Mountain Parkway over KY 77, Powell Co.
Mountain Parkway over KY 11 and KY 15, Powell Co.

EPOXY-SAND SURFACINGS AND PATCHES

US 231 over Ohio River, Daviess Co.
I 75(NB) over Ky River, Fayette-Madison Co. Line
US 460 over C&O RR, Montgomery Co.
US 150 over Southern RR, Boyle Co.
US 150 over Clark's Run, Boyle Co.
KY 80 over Fishing Creek, Pulaski Co.
KY 185 over Green River, Warren-Butler Co. Line
I 64 over Alton Road, Franklin Co.
US 60 and US 62 over Tennessee River, McCracken Co.
US 68 and KY 80 over Cumberland River, Trigg Co.
US 421 over Ohio River, Trimble Co.
KY 1057 over Mountain Parkway, Powell Co.
US 68 over Tennessee River, Marshall Co.
US 27 over Pitman Creek, Pulaski Co.
I 75(SB) over Kentucky River, Fayette-Madison Co. Line
KY 859 over I 64, Fayette Co.
US 460 and KY 11 over I 64, Montgomery Co.
US 60 over I 64, Clark Co.
Bluegrass Parkway over Cheeselick Road, Anderson Co.
US 227 and US 460 over I 75, Scott Co.
Van Meter Road over I 64, Clark Co.
I 75 over Price Pike, Boone Co.
I 64 over Grassy Lick-Pruitt Road, Montgomery Co.
Hinkston Road over I 64, Montgomery Co.
US 62 over I 75, Scott Co.
Delaplain Road over I 75, Scott Co.
I 75 over Rogers Gap Road, Scott Co.
I 75 and Burton Road, Scott Co.
I 75 over US 25, Scott Co.
US 62 over Ohio River, Mason Co.
KY 395 over I 64, Shelby Co.

DECKS HAVING ADDITIONAL REINFORCEMENT
Ky 61 over Big Brush Creek, Green Co.
KY 1288 over Bays Fork Creek, Allen Co.

REPLACED DECKS
KY 195 over Russell Fork, Pike Co.
US 60 over C&O RR, Rowan Co.
US 421 over Southern RR, Fayette Co.
US 31E over Ohio River, Jefferson Co.

NON-TREATED
KY 15 over Mountain Parkway, Powell Co.
KY 11 and KY 15 over Mountain Parkway, Powell Co.
I 264 over US 60, Jefferson Co.
KY 15 over Mountain Parkway, Powell Co.
US 41(NB) over Ohio River, Henderson Co.
Mountain Parkway over Upper Howard’s Creek, Clark Co.
Lemon’s Mill Road over I 75, Scott Co.
US 641 and US 62 over Cumberland River, Lyon Co.
KY 53 over Bluegrass Parkway, Anderson Co.
US 60 over Cumberland River, Livingston Co
Newburg Road over Inner Beltline, Jefferson Co.
US 60 over Green River, Henderson Co.
KY 922 over New Circle Road, Fayette Co.
KY 89 over Mountain Parkway, Clark Co.
I 75 over North Elkhorn Creek, Scott Co.
I 75 over Rock Quarry Road, Scott Co.
I 75 over Big Eagle Creek, Scott Co.
Hatton Road over Mountain Parkway, Powell Co.
I 64 over Stoner Creek, Clark Co.

REFERENCES

APPENDIX A
1. Special Provision No 8-A for Linseed Oil Protective Coating
2. Special Provision No. 30-B Membrane Curing of Concrete Structures
3. Special Provision No. 35-B Class "AA" Concrete
4. Special Provision No. 36-A for Set-Retarding Admixtures for Concrete
5. Special Provision No. 48-A Bridge Deck Repairs
6. Special Provision No. 54 for Epoxy Membrane Coating
7. Special Provision No. 77-A Styrene-Butadiene Protective Coating
8. Special Provisions for Bonded Concrete Overlay; Epoxy Grouting and Epoxy Sand Seal for Concrete (all are for Jefferson County, SP 56-8118, Clark Memorial Bridge)
9. Special Provision for Application of Coal-Tar-Modified Epoxy Resin Binder and Abrasive Grit (Aggregate) for Sealing Concrete Bridge Decks and Pavements
10. Special Provision for Epoxy-Sand Seal (Experimental) Warren-Butler Counties SP 16-236, SP 114-8
11. Special Provision for Surfacing Bridge Deck Boyd County SP 10-6025-1

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SUMMARY AND CONCLUSIONS

Cracking, scaling and spalling are tell-tale signs of deterioration. Some cracking in reinforced concrete structures is generally considered to be normal; however, cracking may aggravate spalling. Scaling potential is effectively reduced by use of high quality air-entrained concrete which is properly placed, finished and cured. The incidence of spalling is considerably higher where bars are very near the surface. The potential for spalling may significantly be reduced by: 1) adequate concrete cover above the upper bars, 2) reduced permeability or use of an effective moisture barrier, 3) fixing the reinforcement to prevent displacement during concreting, and 4) thorough consolidation of concrete.

Over the years, the basic essentials for obtaining strong, durable and otherwise high-quality concrete have been rather well established. Class "AA" concrete (APPENDIX A, Item 3), presently specified for decks provides an adequate proportioning of basic ingredients and may be expected to give satisfactory performance when properly controlled. The DO's and DONT's for quality concrete and workmanship have been established, proven, presented and discussed.

Even though scaling may be eliminated by use of high quality, air-entrained concrete; the distinct advantages may be offset if too much mixing water is allowed or if the concrete is rewastered during finishing. Concrete should be consolidated after placement and not simply shoveled or raked from here to there. Bleed-water should be luted off.

From the design standpoint, there appears to be definite advantages in having drains closely spaced. Decks should be placed on a grade and crowned whenever possible. The necessity for grinding away high spots reflects inadequate control of finishing operations.

INTRODUCTION

Within the system of roadways maintained by the Department, there are approximately 7,000 bridges ranging from a few feet to over a mile in length. The vast majority of these bridges have reinforced concrete decks. This report presents an historical account of damage and descriptions of protective treatments and/or repairs. Design and construction innovations intently directed toward improvement of deck durability are also included. Two other reports of an identical nature were issued in 1963 and 1966. This report updates case studies presented in those reports and includes many additional bridges.

In the late 1950's and early 1960's, many highway engineers became aware of the problem of premature deterioration of decks. By 1970, approximately half of the states had conducted or were in the process of conducting research on this problem. There are at least 70 known research projects and 100 or more known U. S. publications dealing with causes of and/or preventative measures. Meaningful information has emerged; few repairs have been lasting.

Kentucky has experienced the necessity for performing maintenance work on decks which had been in service less than one year. Other decks have provided several years of maintenance-free service, and several older decks have required only nominal repairs. Some decks have been partially or completely replaced after 25 to 40 years. The interstates and toll roads have provided many sets of identical bridges which have performed differently. If an average service life of 40 years could be assumed, Kentucky should be planning major repairs or replacement of 175 decks annually. It is estimated that Kentucky is adding three new bridges to its inventory weekly. The importance of deck durability is surely evident.

FORMS AND POSSIBLE CAUSES OF DECK DETERIORATION

DEFECTS

The signs of deterioration most often observed are: 1) cracking, 2) spalling, and 3) scaling. Other defects such as popouts, mudballs, joint-associated spalls, etc. have been observed less frequently. Scaling is the loss of a mortar layer at the surface; spalling is a deeper, horizontal, or inclined splitting or fracture which leads to a roughly circular or oval depression. The large majority of upper-surface cracks observed during inspections of decks included in this report were transverse. Typically sized and spaced, transverse cracks are shown in Fig. 1. Transverse steel in the upper mat of reinforcement of conventionally designed decks in Kentucky is placed above the longitudinal steel. Its closer proximity to the surface may account for the higher incidence of transverse cracks. Steel placement in a typical deck is shown in Fig. 2. The minimum depth of concrete over the steel was increased from 1½ in. to 2 in. in 1964. In 1965, field checks of steel elevations and deck thicknesses with respect to screed template were initiated. Tie downs at 8-ft. centers in each direction of the top steel mat was started in 1967.
A likely explanation of early cracking over reinforcing steel is depicted in Fig. 3. During placement, the fresh concrete subsides between and around the steel but is perched over the bars and is not perfectly settled. Bleed water may eventually exit upward around the bars or remain there long enough to create a void. As the concreting advances, the additional load may cause the steel in the concrete behind to rise and to induce cracks. The cracks may result from workmen walking on and flexing steel adjacent to previously placed concrete.

Transverse cracks, as shown in Fig. 4, are found always in reinforced concrete, continuous, deck-girder bridges. A higher incidence of these cracks occurs on the upper surface in negative movement zones. They have been observed on structures not opened to traffic. A seeming anomaly in crack frequency is seen in continuously reinforced concrete pavements; those having high percentages of steel also have more closely spaced cracks. However, crack widths decrease with increase in percent steel. Differences in the thermal coefficients of linear expansion of steel and concrete are often neglected in structural designs; however, computed stresses become critical over a 100°F change. There appears to be a striking similarity between crack intervals in continuously reinforced pavements and certain decks. A hypothesized mathematical expression follows:

Respecting continuity of strain and letting \( e \) denote strain,
\[ e_s = e_c \]
and
\[ de_s = de_c. \]

Allowing free expansion and contraction (no external forces),
\[ (de_s/\text{dt})\text{dt} - \Delta \sigma_s/E_s = (de_c/\text{dt})\text{dt} + \Delta \sigma_c/E_c \]
where
\[ de_s/\text{dt} = C_s = \text{coefficient of thermal expansion of steel} \quad (6.5 \times 10^{-6}/\text{F}), \]
\[ de_c/\text{dt} = C_c = \text{coefficient of thermal expansion of concrete} \quad (5.5 \times 10^{-6}/\text{F}), \]
\[ E_s = \text{modulus of elasticity of steel} \quad 30 \times 10^6 \text{ psi}, \]
\[ E_c = \text{modulus of elasticity of concrete} \quad 5 \times 10^6 \text{ psi}, \]
\[ \Delta \sigma_s/E_s \quad \text{and} \quad \Delta \sigma_c/E_c = \text{counter strains arising from resisting stresses} \quad T_s \quad \text{and} \quad T_c, \]
\[ \Delta \sigma_s = \Delta \sigma /A_s \quad (\text{for balancing forces}), \]
and
\[ A_s = \text{decimal equivalent of percent steel}. \]

Substituting and simplifying,
\[ (C_s - C_c)(t_2 - t_1) = (6A_s\Delta \sigma_c + \Delta \sigma_c)/A_s E_s \quad \text{and} \]
\[ \Delta \sigma_c = [(C_s - C_c)(t_2 - t_1)A_s E_s]/(6A_s + 1). \]

Therefore,
\[ \Delta \sigma_c = [30(t_2 - t_1)A_s]/(6A_s + 1) \quad \text{and} \]
\[ \Delta \sigma_s = [30(t_2 - t_1)]/(6A_s + 1). \]

\( \Delta \sigma_c \) is the stress rise in the concrete per unit length. The stress rise in the steel is \( \Delta \sigma_s \). Therefore,
\[ \Delta \sigma_c/\Delta L = \frac{\Delta \sigma_c}{\Delta L} = \frac{30(t_2 - t_1)A_s}{(6A_s + 1)}. \]

Upon integrating,
\[ \Delta \sigma_c = \frac{30(t_2 - t_1)A_s L}{(6A_s + 1)} + C. \]

When \( L = 0, C = 0. \) Thus,
\[ \sigma_c = \frac{30(t_2 - t_1)A_s L}{(6A_s + 1)} \quad \text{and} \]
\[ \sigma_s = \frac{30(t_2 - t_1)L}{(6A_s + 1)}. \]

When \( \sigma_c \) (max) = 600 psi and \( (t_2 - t_1) = 100^{\circ}_F, \)
\[ L = \left(0.2 \frac{(6A_s + 1)}{A_s}\right) \quad (1) \]

When \( \sigma_s \) (max) = 90,000 psi and \( (t_2 - t_1) = 100^{\circ}_F, \)
\[ L = 30(6A_s + 1). \quad (2) \]

The derivation presented here finds independent verification in the equation for bond strength. Although the bond strength is rational in a conservative sense, it has some empirical foundation. Simply stated,
\[ q_{s\text{(max)}} = u\Sigma_o L/A_s \quad \text{(3)} \]
where
\[ u = \text{bond strength (psi)}, \]
\[ \Sigma_o = \text{perimeter of steel bar (in.)}, \]
\[ L = \text{length of embedment (in.)}, \]
and
\[ A_s = \text{area of steel bar (in.}^2). \]
From the foregoing, it may be noted that cracking is induced by a rising temperature rather than a falling temperature. In all these equations, $L$ may be assumed to represent the distance over which stress or virtual strain increases from zero to a critical value. Therein, $L$ represents the half-length between cracks; therefore, $2L$ would represent the average cracking interval. Equation 1 applies in situations where maximum tensile strength of the concrete is the controlling factor, and equation 2 would apply when the maximum steel stress controls. Others have derived somewhat similar relationships in terms of a "slip modulus". The "slip modulus" is the ratio of bond stress to differential strains in the steel and concrete.

No longitudinal cracks in decks were observed during the inspections. Most diagonal cracks were at the acute angle corners of skewed decks. Only a few decks contained random or pattern cracks. Pattern cracking very definitely appeared associated with the top mat of reinforcement. Decks having pattern cracks were designed for 1-1/2 in. concrete cover and actually had less. Random cracking was attributed to drying shrinkage, and no other definite causes were discernable.
DURABILITY AND SCALING

Analyses of mixture designs for conventional deck concrete reveal voidages, as follows: 1) non-essential water - 8.5 percent, 2) densification of hydration (essential) water - 2.6 percent and 3) entrained air - 6.0 percent. Hydration of the cement yields approximately another 1.6 percent. Analyses have been verified by tests on cores from various decks. Following is a sample analysis for a deck mixture containing river sand and crushed limestone aggregates 11 percent lime by weight of cement. If all of that lime were to be leached out, the additional voids might be another 1.6 percent. Analyses have been verified by tests on cores from various decks. Following is a sample analysis for a deck mixture containing river sand and crushed limestone aggregates but excludes possible voids due to leaching of lime.

A core specimen of concrete, even if sliced into horizontal sections, should have a dry, bulk density (unit weight) of 138 lbs/cu. ft. throughout. A lesser weight indicates: 1) excess voidage, 2) lower strength, and 3) less durability. Concrete specimens having less than design unit weights were either poorly consolidated or contained excess water when placed.

The life-expectancy of aggregates in relation to their porosity has been hypothesized (1). It appears that only a porosity of less than 2% will assure 20-year durability. There is some reason to suspect that aggregates saturate more readily than the mortar unless the mortar is more porous than it normally should be. At least this seems true when discrete popouts occur. These mechanisms also have been reduced to theory (2).

Coarse aggregate and sand comprise about 66% of the volume of the concrete having 17 percent voids per gross volume. This means that .17 cu. ft. of voids is really contained in .336 cu. ft.; and so, there are 50 percent voids in that portion of the concrete. Inasmuch as there was 6 percent entrained air, the paste itself contains 40% "unwanted" voids [.17 - .06/.336 - .06] x 100. Presumably too, only a portion of the water imbibed into these micro-voids is freezeable.

To illustrate the effect of excess mixing water on the density of cement paste, using the example given, increase the entrained air from 6 to 9 percent and withhold an equal volume of water. The total voids remain 17%, but the voids attributable to mixing water are reduced to 8 percent. Thus (.17 - .09/.336 - .09) x 100 = 32.5% voids in the paste. The volume of mixing water so withheld would amount to 6 gal per cu. yd. of concrete.

Consider also the possibility of replacing another portion of the so-called excess mixing water (about 14 gal./cu. yd.) with an inert oil or polymer. In this case, the oil or polymer figures into the volume of paste. Add 9 gal. per cu. yd. (4.45 percent by vol. of concrete); then: (.17 - .1345/.336 - .09) x 100 = 13.3 percent voids in paste. Surely, the likelihood of the paste imbibiing water has been decreased greatly.

Normal concrete which has not been allowed to dry following curing and prior to the onset of freezing does not perform as well as concrete which has been allowed to dry fully or even partially. Concrete which has dried and then been resoaked performs better than undried concrete. This indicates a somewhat irreversible occlusion of air or fixation or tightening of the mortar structure that attends drying and renders concrete less susceptible to resaturation. In other words, drying may close some of the permeable voids. From this, it seems apparent that concretes which are thought to be identical may perform drastically different in the event of variations in drying and/or degree of saturation prior to freeze-thaw action.
The foregoing may explain deterioration generally but does not necessarily explain localization of scaling near the surface. Microscopic analysis of cores from decks indicate a higher percentage of voids near the surface than at depth. Salt concentration is greater at or near the surface. The upper concrete is more porous. At the time of placement, excess water from below rises toward the top. Unless the upper concrete is re-consolidated afterwards it will contain an undue percentage of voids. The ingress and egress of water may be increased many fold. Less protection is afforded the aggregate and the reinforcing steel. If sufficient cement has been brought to the surface, it may coalesce into a film which bleed water will not pass through very rapidly. The effect of this is concentration of water underneath and a possible lifting of the film - thus, a built-in plane of weakness and a place for scaling to begin.

Air-void contents have been measured in thin sections cut from the top and bottom of cores taken from various decks. Measurements were made through use of the linear traverse method. In general, air voids in slices taken from the top of cores were one-half to one percent greater than those measured in slices taken from the bottom of the same cores. The additional voids in the upper surfaces may have resulted from the upward movement of water. In other instances, air contents of the top and bottom sections were very nearly equal. In a few instances, the bottom section contained slightly more air than the top section.

Considerable scaling has been observed on decks in Kentucky; whereas, the vast majority of pavements are scale free. The specified quality of deck concrete at least equals and supposedly exceeds that of pavement concrete. Decks, to some degree, are more severely exposed than the adjoining pavements. Bridges undergo more cycles of freeze-thaw; they respond more readily to changes in air temperature. Pavements draw heat from the earth; whereas, bridges are essentially isolated from massive heat-sinks.

Fortunately for most concrete and masonry structures, there are more days of drying than days of wetting during a year. Otherwise, they would tend to saturate. Saturation followed by freezing is devastating if the absorptivity exceeds a critical percentage. Fig. 6 shows a portion of a deck which has been deprived of drying time. Fig. 7 shows the consequences.

Over-striking low places with foamy or soupy mortar after the initial screeding was completed has been a common practice at times. The over-struck material usually scales off.
CORROSION DETECTION

The California Division of Highways (3) has developed a relatively simple device to measure and locate corrosion-cell voltages by connecting one lead wire to the reinforcing steel at some accessible point and touching a half-cell probe on a long lead to dampened spots on the concrete deck surface. Measurements made on a grid pattern of the deck may be plotted and equipotential contours drawn to define zonal occurrences of corrosion. A reading between .35 and .55 volts has been empirically determined as the range of active corrosion. The device does not indicate how far corrosion has progressed or how much rust is present. Its use is limited in a practical way to the upper layer of steel and to the top surface of the deck. Its principal use appears to be in making deck repairs - that is, in searching out unsoundness in concrete which has been caused by corrosion. The decision to remove and replace concrete depends upon hammer soundings or exposure and inspections of the site. Unless great care is brought to bear in making repairs, the high potential may persist afterwards, at least around the edges of the patch. Nevertheless, re-charting a deck from time to time after repairs would surely provide insights concerning the effectiveness of the repairs. This type of device (APPENDIX B) was used on the Broadway Bridge and other bridges in Louisville during early summer (1972), prior to beginning repairs (by contract).

A similar device (4) measures the electrical resistivity between the steel and a probe on the surface. The efficiency of waterproofing membranes or coatings may be evaluated in this way. It is claimed that resistances of about a million ohms will assure arrested or abated corrosion. The membrane deprives the corrosion cell of essential moisture. Others have found many coatings tested in this way to be ineffective.

SPALLING

Spalling is the most troublesome form of distress. Spalled decks are usually rough, and their repairs are generally expensive, time consuming and seldom permanent. Spalls are generally attributed to either rusting of steel or buckling of reinforcement near the surface. Spalls develop in mature concrete. Cavities under the steel may, if they contain water, generate pressures upon freezing and also cause rusting. The effects of flexing and vibrations are not known. Pavements rarely spall; and this contrast challenges many debates and arguments. Spalling from the bottom side of the deck generally does not occur until many years later unless the upper concrete has deteriorated deeply.

Fig. 8 depicts conceptually the formation of a spall over a reinforcing bar. The rust-growth mechanism seems the most probable one. However, Fig. 3 portrayed a possible mechanism for generation of cracks during placement and curing of the concrete. Any subsidence of concrete or rise of steel during the first few hours could induce cracks which would not heal. Whether these occur first and cause corrosion or are caused by corrosion remains altogether conjectural. Inasmuch as stresses are additive, and/or all become contributory. The likelihood of the cracks shown in Fig. 1 being directly over transverse bars seems very great.

The incidence of spalling is closely associated with depth of concrete cover above the steel. Decks which have spalled considerably tend to expose as much steel very near the surface. Figs. 9 and 10 are examples of this. Fig. 11 is a rather typical example.
POTENTIAL REMEDIES

Review of a NCHRP synthesis report (5) and the list of references contained therein is evident indication of the magnitude of deck durability problems. That synthesis presents a condensation of current knowledge and is a summary of the state-of-the-art. The information presented there and reports relating to the general problem, for the most part, agree. It is estimated that cost of a deck may amount to 15 to 30 percent of initial costs of a structure; whereas, deck maintenance accounts for 45 to 85 percent of the maintenance costs. The life span of the majority of decks does not match that of the supporting superstructures and substructures.

Scaling can be reduced significantly by use of entrained air. Adequate provision for drainage appears to reduce scaling. In Kentucky, the incidence of scaling on decks having curb drains is less than that on decks without drains. Deflection cracking in fresh concrete, especially on continuous decks, can be reduced through proper use of retarders, nighttime concreting, and cool curing. Some type of retarders may, however, render the concrete less durable. NCHRP Report 106 (6) indicates that surface revibration with a full-width vibrating screed was reportedly effective in closing cracks. The Kelly machine (APPENDIX C) appears to perform the same essential functions. Bi-layered construction provides opportunities to do essential work in controlling and finishing the upper layer without disturbing a large mass of fresh concrete and without risking unwanted subsidence of forms etc. A modified version of the bi-layered construction in conjunction with the Kelly finisher has been employed on an experimental deck on I 64 over US 60 near Jett.

Figure 9. Spalls Exposing Bars near Concrete Surface.

Figure 10. Insufficient Concrete Cover.
An immunizing approach to the general problem might be to use non-evaporable liquid(s) to replace non-essential water (water in excess of that required for hydration of the cement). Replacement of excess water (about 15 gal. per cu. yd.) with emulsifiable liquids such as latexes or epoxies could render the concrete impermeable. Latex-modified concretes have been used successfully on occasions; but, those mixtures were not specifically designed for complete replacement of non-essential water. Trial mixtures using emulsifiable epoxies have been laboratory tested and appear promising. Further investigation is being made under a study on VOIDLESS CONCRETE. The cost of total replacement of the non-essential water with liquid polymers could prove prohibitive unless employed in bi-layered construction. Emulsified linseed oil or asphalt offer more economical possibilities.

Several investigators have suggested use of non-rusting reinforcement to minimize spalling. Significant reduction in spalling might be realized by use of non-rusting steel in the top mat alone. Protective coatings might be beneficial. Coatings should definitely be placed after the concrete has cured and definitely before application of de-icing salts. Periodic re-application of such coatings might be necessary.

Figure 11. Major Axis of Elliptical Spalls Perpendicular to Deck Centerline.
CORRECTIVE MAINTENANCE
AND CASE HISTORIES

The compilation of histories which follows updates case studies included in the previous reports and includes several additional case studies. All of the decks have been inspected recently. Decks which have not needed maintenance are included for comparative purposes. Cases are grouped according to treatment at time of construction or general type maintenance work performed.

ADMIIXTURES

Decks included in the group under the heading of admixtures contained either an admixture claimed to reduce or prevent scaling and freeze-thaw damage or an admixture primarily intended as a set retarder. Six bridge decks containing Berylex (claimed to increase durability, workability and density and decrease bleeding, water requirement, shrinkage and cracking) have been under observation 7 to 9 years. The benefits of that material have not been evident and future use of that admixture is not recommended. One deck containing Dow-Corning 777, a silicone, water reducer, has been under observation for 6 years and further experimental use of the admixture under more ideal conditions (see case history of BLUEGRASS PARKWAY, SOUTHERN RAILROAD BRIDGE) appears desirable.

Set-retarding admixtures (APPENDIX A, item 4) have been utilized in mixtures placed on several decks other than those reported herein. The overall performance of retarded concretes has been almost identical to that of conventional concretes. Concretes containing calcium lignosulfonates were more difficult to finish than other retarded or conventional mixtures. Retarders have been used in Kentucky primarily for concrete placed in decks of continuous spans to forestall hardening prior to placement of adjoining concrete. Revibration has not been specified for any of the retarded mixtures; however, the addition of that requirement (or the Kelly-type finisher) could enhance performance of the retarded mixtures as reported in NCHRP Report No. 106.
BLUEGRASS PARKWAY, SOUTHERN RAILROAD BRIDGE

LOCATION: WB Bluegrass Parkway over Southern Railroad, Anderson County

PROJECT NO: 3-81-CK 2

COMPLETED: January 1965

DESCRIPTION: 3-54' Simple RCDG Spans; 30' Wide

TREATMENT: Concrete placed in this deck contained an experimental admixture designated as Dow-Corning 777, supplied free of charge by Dow-Corning Corporation. The material was a Silicone acclaimed to reduce or prevent salt-scaling and freeze-thaw damage. The bridge was constructed by the R. R. Dawson Bridge Company under the supervision of Atlas Engineering Associates. No. 6 crushed limestone and river sand were used in all concrete and the admixture served as an air-entraining agent.

The admixture acted as a set retarder and was not really suited for cold weather concreting. Due to delays, the deck was not placed until late November of 1964 and full advantages of the admixture were not realized. Air content was controlled by adjusting proportions of DC 777 (normal air) and DC 777X (high air). A combined dosage 0.3 pound per sack of cement was used for all westbound deck concrete. Unusual difficulty was encountered in controlling slump from batch to batch as a result of variation in free moisture throughout the aggregate stockpiles. Slumps generally ranged between 6 to 7 1/2 inches. Finishing was accomplished by use of a Bidwell deck-finishing machine. Surface bleeding was excessive and, as a result, finishing was difficult.

The west and center slabs were placed on November 24. Initial set time for concrete placed in these slabs was approximately 40 hours. The unprotected slabs were drenched by heavy rains. The following day water was removed by use of burlap drags and the slabs were then covered for curing. The east slab was placed on December 4 and conditions were more favorable. Slumps ranged from 2 1/2 to 3 1/4 inches and bleeding was not excessive.

The adjacent, eastbound deck was placed in January 1965 and conventional, air-entrained concrete was placed on that deck.

PRESENT CONDITION: Both decks have minor scaling along the gutters and a few of the areas on each structure have been patched with mixtures of epoxy and sand. The decks are considered to have excellent performance records. The silicone admixture is recommended for future use under more favorable conditions. Performance of the westbound deck, in view of placement details, seems to warrant further study.

Figure 12. WB Bluegrass Parkway over Southern RR, Sta 3224+24, Anderson Co.; Viewing East (9-16-70).
Figure 13. Bleeding was Excessive Soon after Striking off Center Slab of WB Structure over Southern RR (11-24-64).

Figure 14. Patch Necessary as Result of Basin Excavated to Remove Excess Bleed Water on WB Structure (9-16-70).

Figure 15. EB Blaegrass Parkway over Southern RR; Viewing East (9-16-70).
ILLINOIS CENTRAL BRIDGES

LOCATION: Western Kentucky Parkway over Illinois Central RR in Hopkins County; 3.1 Miles East of Caldwell County Line

PROJECT: 54-790-WK 2

COMPLETED: January 23, 1963

DESCRIPTION: 3-40'-6" Simple RCDG Spans; 38' Wide; Each Structure

TREATMENT: Berylex was used in concrete placed in the two end spans of the WB deck. Conventional deck concrete was used in the center span of that deck and all spans of the companion, EB deck for comparative purposes. Berylex was reported to increase resistance to freeze-thaw, workability, density and to decrease cracking, bleeding, water requirement and shrinkage. The material was used on an experimental basis by a Special Provision. It was supplied in powder form and pre-mixed in water prior to addition to the concrete. The admixture was used at a rate of 4 ounces per sack of cement, except for minor variations for control of entrained air.

PRESENT CONDITION: No appreciable variation in performance of any of the slabs could be detected. All slabs contain a few transverse cracks and minor scaling along the gutters. Both decks are in generally good condition.

Figure 17. General Condition of EB Western Kentucky Parkway Bridge over ICRR 7 Years after Construction; Viewing East (8-24-70).

Figure 16. Western Kentucky Parkway Bridges over Illinois Central RR, Hopkins Co.; Viewing West (3-16-64).
KY 52 BRIDGES

LOCATION: Bluegrass Parkway over KY 52, 0.686 Mile East of Hardin County Line, Nelson Co.

PROJECT: 90-75-CK 2

COMPLETED: March 19, 1965

DESCRIPTION: 33', 33', 33' Simple RCDG Spans; 38' Wide; Each Structure

TREATMENT: Berylex was used in all deck concrete placed on the WB structure. Its use was the same as previously described under the Illinois Central Bridges. Conventional concrete was used in the deck of the EB structure.

PRESENT CONDITION: Both decks are in excellent condition and no variation in performance could be detected.

Figure 18. WB Bluegrass Parkway over Ky 52, Sta 606+58, Nelson Co.; Viewing West (8-28-70).

Figure 19. EB Bluegrass Parkway over Ky 52, Sta 606+58, Nelson Co.; Viewing East (10-12-65).
L&N BRIDGES (641+80)

LOCATION: Bluegrass Parkway over L&N RR, 1.353 Miles East of Hardin County Line, Nelson County

PROJECT: 90-75-CK 3

COMPLETED: May 1, 1965

DESCRIPTION: 50', 66', 50' Continuous RCDG Spans; 30' Wide; Each Structure

TREATMENT: Berylex was used in all deck concrete placed on the WB structure. Its use was the same as previously described under the Illinois Central Bridges. Conventional concrete was used in the EB deck.

PRESENT CONDITION: The WB deck contains numerous transverse cracks; whereas, the EB deck has only a very few cracks.

Figure 20. WB Bluegrass Parkway over L&N RR, Sta 641+80, Nelson Co. (8-28-70).

Figure 21. EB Bluegrass Parkway over L&N RR, Sta 641+80, Nelson Co.; (6-7-72).
## BEECH FORK BRIDGES

| LOCATION: | Bluegrass Parkway over Beech Fork in Nelson Co., 3.155 Miles East of Hardin County Line |
| PROJECT: | 90-75-CK 4 |
| COMPLETED: | May 1, 1965 |
| DESCRIPTION: | 1-40' Simple and 70', 92', 70', 40' Continuous RCDG Spans; 30' Wide; Each Structure |

### Treatment
- Berylex was used in all concrete placed in the WB deck. Its use was the same as previously described under Illinois Central Bridges. Conventional concrete was placed in the EB deck.

### Present Condition
- Both decks contain minor transverse cracks. The gutters are in exceptionally good condition which may be due to drainage outlets at 20-ft. intervals.

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*Figure 22. WB Bluegrass Parkway over Beech Fork, Sta 736+95, Nelson Co.; Viewing West (8-28-70).*

*Figure 23. EB Bluegrass Parkway over Beech Fork, Sta 736+95; Viewing West (8-28-70).*
L&N BRIDGES (1543+90)

LOCATION: Bluegrass Parkway over L&N RR in Nelson County, 0.5 Mile Northeast of KY 605

PROJECT: 90-75-CK 8

COMPLETED: April 19, 1965

DESCRIPTION: 3-50' Simple RCDG Spans; 30' Wide; Each Structure

TREATMENT: Berylex was used in concrete placed in the WB deck of this structure. Its use was the same as previously described for the Illinois Central Bridges. Conventional concrete was placed in the EB deck. Through error, Solar 025 (air-entraining agent) was incorporated into Berylex concrete placed in the center span of the WB deck. Air content ranged between 10 and 11 percent.

PRESENT CONDITION: Both decks are excellent. The center slab of the WB deck does not appear to have been affected by excessive air.

Figure 24. Concreting WB Bluegrass Parkway over L&N RR, Sta 1543+90, Nelson Co.; Viewing West (9-5-64).

Figure 25. WB Bluegrass Parkway, Sta 1543+90, 6 years after Construction (8-28-70).
SALT RIVER BRIDGES

LOCATION: Bluegrass Parkway over Salt River, Sta 3133+17, Anderson County

PROJECT: 84-182-CK 1

COMPLETED: May 7, 1965

DESCRIPTION: 59', 77', 59' Continuous RCDG Spans; 30' Wide; Each Structure

TREATMENT: The WB deck concrete contained Berylex in proportions described for the Illinois Central Bridges. The EB deck concrete was conventional type.

PRESENT CONDITION: The WB deck has transverse cracks at approximately 15-foot intervals throughout and light pitting along both gutters. The EB deck has transverse cracks at 30-foot intervals and light pitting along both gutters.

Figure 26. EB Bluegrass Parkway, Sta 1543+90, Viewing East (8-28-70).

Figure 27. WB Bluegrass Parkway over Salt River, Sta 3133+17, Anderson Co.; Viewing East (9-28-70).
Figure 28. EB Bluegrass Parkway over Salt River, Viewing East (8-30-65).
I-64, KENTUCKY RIVER BRIDGES

LOCATION: I-64 over Kentucky River, East of Frankfort, Franklin County

PROJECT: 37-905-BOH 9

COMPLETED: WB, July 19, 1961
EB, May 2, 1963

DESCRIPTION: Twin Bridges, 225; 215; 225;
Continuous Welded Plate Grider; Lengths, 774'; 30'
Wide; Each Structure

TREATMENT: Galvanized, corrugated stay-in-place metal forms were utilized in construction of both decks. Some concern was voiced about use of such forms for deck construction due to possible entrapment of salt and water at the interface of the concrete and forms. A set-retarding admixture (Plastiment) was used in concrete placed from the center of the eastbound deck to approximately 300 ft. west of the center. Both structures were treated with a 50-50 mixture of boiled linseed oil and mineral spirits in the summer of 1964. Repairs have been confined to patching deteriorated areas with epoxy-sand mortars.

PRESENT CONDITION: EB Deck -- Transverse cracks are prevalent throughout the length of the deck. Many spalled areas have been patched with epoxy-sand mortar and untreated spalls are evident. Insufficient concrete cover over the top mat of reinforcing steel was noted.

WB Deck -- Spalled areas have been filled with epoxy-sand mortar. Some spalls have not been repaired. Medium to heavy scaling occurs throughout the deck for a length of approximately 130 feet near the western end. The stay-in-place metal forms appear to be in excellent condition on both structures.

Figure 29. EB I-64 over Kentucky River,
Franklin Co.; Viewing East (3-16-70).

Figure 30. WB I-64 over Kentucky River,
Franklin Co.; Viewing West (3-16-70).
Figure 31. Stay-in-Place Metal Forms Used on Both Kentucky River Bridges (10-31-62).

Figure 32. Transverse Cracks and Patches on EB Kentucky River Bridge (3-16-70).

Figure 33. Patches and New Spalls on WB Kentucky River Bridge (3-16-70).
NORTH-SOUTH EXPRESSWAY BRIDGE

LOCATION: From Point on North-South Expressway Near Jacob Street to Point near Chestnut Street; Jefferson County

PROJECT: 56-8798-HG 22

COMPLETED: December 16, 1960

DESCRIPTION: Multi-Span RC Girder

REFERENCE: "An Evaluation of Four Retarding Admixtures in Structural Concrete," by Milton Evans, Jr. and Ralph R. Waddle, Division of Research, February 1962

TREATMENT: Concern about the problem of obtaining smooth, reinforced concrete bridge decks prompted an investigation of the use of set-retarding admixtures. Increased areas of new decks were not sufficiently smooth, even after extensive grinding, and it appeared more time was needed for placement and finishing than was possible on hot, windy days when concrete set quite rapidly. Use of set-retarding admixtures was judged a possible solution and the experimental projects discussed herein were initiated for evaluation. The deck of the N-S Expressway over Broadway was selected as the primary structure for this evaluation. The northbound lanes of the N-S Expressway over Jacob Street in Louisville and the Benson Road Bridge over Guist Creek in Shelby County were chosen as secondary structures for the evaluation.

Four set-retarding admixtures employed were:
1) Pozzolith HP-18, a calcium lignosulfonate supplied by the Master Builders Company,
2) Protex PDA, a calcium lignosulfonate supplied by Autolene Lubricants Company,
3) Plasitment, a derivative of adipic acid supplied by Sika Chemical Company,
4) Daratard, a metallic salt of a lignin sulfonic acid, supplied by the Dewey and Almy Chemical Company.

The first three retarders were used in portions of the Broadway structure and Daratard was used in portions of the Jacob Street and Benson Road decks. In each case, a control section of air-entrained concrete was placed adjacent to a similar section of retarded, air-entrained concrete. Locations of the retarded mixtures and their companion, control sections are shown in the included sketches. Each section averaged approximately 100 cubic yards of concrete and was 62 feet x 51 feet.

The lignosulfonate, retarded mixtures were reported as having a certain stickiness which made finishing difficult. The mixtures remained workable for a longer time and were of the specified slump; yet, it was not possible to pass a float over the surfaces without pulling and opening them. Little variation was reported in finishing characteristics of other retarded mixtures to that of their companion, control mixtures. A straightedge was employed in an effort to determine whether sections placed with retarded mixtures were smoother than those placed with control mixtures. All sections, plain and retarded, were smoother than average and no appreciable variation in smoothness was noted between the retarded and control sections.

PRESENT CONDITION: Transverse cracks at approximately 1.5-foot intervals are present in all sections of both the Broadway and Jacob Street decks. Numerous pop-outs are present in each section of the northbound lanes of the Broadway structure and only a few pop-outs were noted in the southbound lanes. A few pop-outs were noted throughout the Jacob Street deck. An epoxy-sand overlay was placed on this deck in 1968 and by 1970, approximately 50 percent of the overlay was missing. No variation in performance of retarded and control sections could be detected on the two decks. All sections of the Benson Road deck are excellent and no variation in performance of sections could be detected. The significant variation in performance of the Benson Road deck as opposed to that of the other deck may be the result of variations in quality of concrete and (or) construction practices or traffic and (or) quantities of de-icing salts.
Figure 34. Pouring Pattern for Retarded and Control Sections, N-S Expressway over Broadway, Jefferson Co.
Figure 35. Pouring Pattern for N-S Expressway over Jacob Street, Jefferson Co.
Figure 36.  Retarded Section, Benson Road over Guist Creek, Shelby Co.
Figure 37. Ligno Sulfonate Retarded Concrete was Difficult to Finish; N-S Expressway over Jacob Street (7-11-60).

Figure 38. Plastiment Retarded Section had Numerous Popouts, N-S Expressway over Broadway (12-31-64).
Figure 39. Appreciable Cracking on Protex PDA Section, N-S Expressway over Broadway (12-31-64).

Figure 40. Epoxy-Sand Seal on N-S Expressway over Jacob Street 2 Years after Placement (3-2-70).
PROTECTIVE COATINGS

Beginning in 1963, maintenance began treating a large number of existing decks with a 50-50 mixture of boiled linseed oil and mineral spirits. Some of the decks were relatively new at the time of applications and others were older structures containing various forms of deterioration. Deterioration progressed on the older structures after treatment and it could not be ascertained whether the treatments forestalled progressive deterioration. It appears that treatment of relative new decks has merit. The Department now specifies application of the coating to new structures prior to their being opened to traffic (APPENDIX A, item 1).

Penetrating-type epoxies have been applied to several structures primarily in an effort to seal cracks against entrance of salt and moisture. The majority of these applications have been effective in sealing existing cracks; however, new cracks have formed on some structures after treatment. Naturally, those cracks remain unsealed. High spots or areas, exceeding specification tolerances, are ground and then sealed with a conventional or penetrating epoxy. Many decks containing these epoxy-sealed ground areas have been in service sufficient length of time that the distinct disadvantages of that procedure are obvious. The seals have deteriorated or been worn by traffic and the exposed, ground surfaces are more vulnerable or susceptible to deterioration. A large percentage of those areas have medium to heavy scaling.

Several other proprietary coatings claimed to be hardeners or seals have been applied to decks on an experimental basis. The majority of those coatings, when applied to in-service decks having various forms of deterioration, did not appear to significantly forestall further deterioration. On one deck, two coatings applied to different portions of one lane did appear effective. There has been appreciable variation in performance between the treated and untreated lanes. The majority of protective coatings rendered the decks seriously slick for variable periods after their application. Generally, applications of protective coatings should include provision for avoiding excess material from the surfaces or the inclusion of abrasives thereon.
EVERGREEN ROAD BRIDGES

LOCATION: I 64 Structures over Evergreen Road in Franklin County; Approximately 3.5 Miles East of Shelby County Line

PROJECT: 37-905-4

COMPLETED: November 26, 1960

DESCRIPTION: 47', 53', 57' Simple RCDG Spans; 30' Wide; Each Structure

TREATMENT: A 50-50 mixture of boiled linseed oil and mineral spirits was applied at a rate of 0.081 to 0.092 gallons per square yard to the plinth, walk and roadway of the WB deck in August 1962. A similar treatment was applied to the EB deck in the summer of 1964.

PRESENT CONDITION: Heavy localized scaling is present on both decks. The scaling is serious at construction and expansion joints. These deteriorations are 1/2 to 1 inch in depth. Very few transverse cracks were noted. Both decks are similar in performance.

Figure 42. Deep Scaling Prevalent near Construction Joints on Both Decks (3-16-70).

Figure 41. WB I 64 over Evergreen Road, Franklin Co. (8-16-62).
Figure 43.  WB I 64 over Evergreen Road; Viewing East (3-16-70).

Figure 44.  EB I 64 over Evergreen Road; Viewing West (3-16-70).
<table>
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<tr>
<th>RED RIVER BRIDGES</th>
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**TREATMENT:** Both decks were treated with a 50-50 mixture of boiled linseed oil and mineral spirits in the summer of 1963.

**PRESENT CONDITION:** Both decks are in excellent condition except for an area along the gutter of the center span on the EB deck. Transverse reinforcing steel is within 1/2 inch of the surface in that area and spalling was noted.

Figure 45. EB Mountain Parkway over Red River, Powell Co.; Viewing East (5-8-72).
Figure 46.  WB Mountain Parkway over Red River, Powell Co.; Viewing West (5-8-72).

Figure 47.  Spalling along Gutter on EB Deck (5-8-72).
LULBEGRUD CREEK BRIDGES

LOCATION: Mountain Parkway over Lulbegrud Creek at Clark-Powell County Line

PROJECT: 99-30-EK 1

COMPLETED: June 21, 1962

DESCRIPTION: 60', 84', 60' Continuous RCDG; 30' Wide; Each Structure

TREATMENT: A 50-50 mixture of boiled linseed oil and mineral spirits was applied to both decks in the summer of 1963.

PRESENT CONDITION: Transverse cracks occur throughout the length of both decks. Light scaling was noted along all curbs and gutters. The decks are otherwise in good condition.

Figure 48. EB Mountain Parkway over Lulbegrud Creek, Powell Co.; Viewing East (5-8-72).
Figure 49. WB Mountain Parkway over Lulbegrud Creek, Powell Co.; Viewing East (5-8-72).

Figure 50. Transverse Cracks were Prevalent on Both Decks (8-26-70).
PINE RIDGE - SKY BRIDGE DECK

LOCATION: KY 715 over Mountain Parkway in Wolfe County; 1100 feet North of KY 15

PROJECT: 119-243-HG 1

COMPLETED: December 1, 1961

DESCRIPTION: 53', 67', 53' Continuous RCDG Spans; 26' Wide

TREATMENT: A 50-50 mixture of boiled linseed oil and mineral spirits was applied to the deck, curbs and walks of this structure in the summer of 1963.

PRESENT CONDITION: The deck is quite rough and was rough upon completion of construction. Low areas along the gutters were filled with mortar during construction and probably attributed to heavy scaling now present along both gutters. Several transverse cracks were noted and the majority extend through the slab.

Figure 51. Ky 715 over Mountain Parkway, Wolfe Co. (5-8-72).
Figure 52. Deep Scaling Along Gutters (2-13-70).

Figure 53. Transverse Cracks Evidenced by Efflorescence (5-8-72).
KY 15 OVER MOUNTAIN PARKWAY

LOCATION: KY 15 over Mountain Parkway in Wolfe County; 0.5 Mile East of Powell County Line

PROJECT: 119-103-HG 1

COMPLETED: July 1, 1962

DESCRIPTION: 68', 80', 80', 68' Continuous RCDG Spans; 28' Wide

TREATMENT: The deck, curbs and walks were treated with a 50-50 mixture of boiled linseed oil and mineral spirits in the summer of 1963.

PRESENT CONDITION: Several transverse cracks extend through the slab. Spalled areas are present as a result of insufficient concrete cover. Scaling was minor along portions of the gutters.

Figure 54. Ky 15 over Mountain Parkway, Wolfe Co. (5-8-72).
Figure 55. Spalling Revealed Insufficient Concrete Cover (5-8-72).

Figure 56. Transverse Cracks Extend through Slab (5-8-72).
WINCHESTER- PARIS ROAD BRIDGES

LOCATION: US 227 over I 64 in Clark County
PROJECT: 25-2-HG 3
COMPLETED: April 6, 1962
DESCRIPTION: 57', 78', 78', 57' Continuous RCDG Spans; 30' Wide; Each Structure

TREATMENT: The decks were treated with a 50-50 mixture of boiled linseed oil and mineral spirits in October 1963.

PRESENT CONDITION: Scaling was light to medium along both gutters on each deck. Transverse cracks occur on each deck and two spalls were noted on the NB deck.

Figure 57. SB US 227 over I 64, Clark Co. (5-8-72).
Figure 58. NB US 227 over I 64, Clark Co. (8-28-70).

Figure 59. Spalling on NB Deck (8-28-70).

Figure 60. Scaling on NB Deck 2 Years after Construction (4-20-64).
CANE CREEK BRIDGES

LOCATION: Mountain Parkway over Cane Creek in Powell County; 14.3 Miles East of Clark County Line

PROJECT: 99-30-EK 15

COMPLETED: April 5, 1962

DESCRIPTION: 3 - 38' RCDG Spans; 44' Wide; Each Structure

TREATMENT: In the summer of 1963, the decks of these structures were treated with a 50-50 mixture of boiled linseed oil and mineral spirits.

PRESENT CONDITION: Both decks are in excellent condition.

Figure 61. EB Mountain Parkway over Cane Creek, Powell Co. (5-8-72).
RED RIVER BRIDGES

LOCATION: Mountain Parkway over Red River in Powell County; 6.4 Miles East of Clark County Line

PROJECT: 99-30-EK 8

COMPLETED: August 7, 1962

DESCRIPTION: 42', 42' Simple; 60', 84', 60'
Continuous: 42' Simple
RCDG; 30' Wide; Each Structure

TREATMENT: Prior to acceptance of these decks, high spots were ground and sealed with epoxy. In 1963, both decks were treated with a 50-50 mixture of boiled linseed oil and mineral spirits.

PRESENT CONDITION: Light scaling is present along the gutters of both decks. The decks contain minor popouts and both appear in generally good condition.

Figure 62. EB Mountain Parkway over Red River, Powell Co.; Viewing West (8-26-70).

Figure 63. WB Mountain Parkway over Red River, Powell Co.; Viewing East (5-8-72).
Figure 64. Popouts Were Observed on Both Decks (8-26-70).

Figure 65. Light Scaling on EB Deck (8-26-70).
STANTON BRIDGES

LOCATION: Mountain Parkway over KY 213 in Powell County; 10.4 Miles East of Clark County Line

PROJECT: 99-30-EK 11

COMPLETED: July 23, 1962

DESCRIPTION: 3 - 50' Simple RCDG Spans; 30' Wide; Each Structure

TREATMENT: In the summer of 1963, a 50-50 mixture of boiled linseed oil and mineral spirits was applied to both decks.

PRESENT CONDITION: Both decks are in excellent condition.

Figure 66. EB Mountain Parkway over Ky 213, Powell Co.; Viewing West (8-26-70).

Figure 67. WB Mountain Parkway over Ky. 213, Powell Co.; Viewing West (5-8-72).
BOWEN BRIDGES

LOCATION: Mountain Parkway over KY 613 in Powell County; 15.5 Miles East of Clark County Line

PROJECT: 99-30-EK 16

COMPLETED: May 28, 1962

DESCRIPTION: 3 - 38' RCDG Spans; 44' Wide; Each Structure

TREATMENT: In the summer of 1963, these decks were treated with a 50-50 mixture of boiled linseed oil and mineral spirits.

PRESENT CONDITION: Both decks are in excellent condition.

Figure 68. EB Mountain Parkway over Ky 613, Powell Co.; Viewing West (8-26-70).

Figure 69. WB Mountain Parkway over Ky 613, Powell Co.; Viewing West (8-26-70).
WADE MILL-SEWELL SHOP BRIDGE

LOCATION: Wade Mill - Sewell Shop Road over I 64 in Clark County

PROJECT: 25-622-HG 1

COMPLETED: July 26, 1960

DESCRIPTION: 48’, 68’, 68’, 48’ Continuous Spans; 26’ Wide

TREATMENT: Prior to acceptance, high areas were ground and sealed with epoxy. A 50-50 mixture of boiled linseed oil and mineral spirits was applied to the deck in October 1963.

PRESENT CONDITION: Light scaling, as a result of ponding in low areas, occurs along both gutters. Otherwise, the deck is in excellent condition.

Figure 70. Wade Mill-Sewell Shop Road over I 64, Clark Co. (5-2-72).
OLD PINE GROVE - CLINTONVILLE BRIDGE

LOCATION: Old Pine Grove - Clintonville Road over I 64 in Clark County; 0.9 Mile East of Fayette County Line

PROJECT: 25-982-HG 1

COMPLETED: November 26, 1963

DESCRIPTION: 50', 75', 75', 50' Continuous RCDG Spans; 26' Wide

TREATMENT: A 50-50 mixture of boiled linseed oil and mineral spirits was applied to the deck in the summer of 1964.

PRESENT CONDITION: One small spall was noted in addition to a small area of light scaling. Otherwise, the deck is in excellent condition.

Figure 71. Old Pine Grove - Clintonville Road over I 64, Clark Co. (8-28-70).
WINCHESTER - MT. STERLING ROAD BRIDGE

LOCATION:
US 60 over I 64 in Clark County; 6.2 Miles East of US 60 - US 227 Junction

PROJECT:
25-22-6

COMPLETED:
November 16, 1959

DESCRIPTION:
3 - 84' Box Girders and a 42'
RCDG Span; 32' Wide

TREATMENT: A 50-50 mixture of boiled linseed oil and mineral spirits was applied to this deck in October 1963. Prior to acceptance, numerous high spots were ground and sealed with epoxy. Those areas were quite evident when protective coating was applied in 1963.

PRESENT CONDITION: The deck is in excellent condition. Light scaling occurs on areas ground after construction.

Figure 72. US 60 over I 64, Clark Co.; Dark Areas Were Ground after Construction and Have Light Scaling (5-2-72).
SHERMAN MINTON BRIDGE

LOCATION:  I 64 over Ohio River (Sherman Minton Bridge) in Jefferson County

PROJECT:  56-8273-10

COMPLETED:  June 12, 1962

DESCRIPTION:  Spans 1 thru 11 and Spans 16 thru 24 are 120' RCDG Spans; Spans 12 thru 14 and Spans 25 thru 27 are 140' RCDG Spans; Span 15 is 105' RCDG; Span 1 thru 14 NB Lanes; Spans 15 thru 27 SB Lanes; NB and SB Lanes are 42' Wide Each, NB Lanes are Upper Deck and SB Lanes are Lower Deck.

TREATMENT:  In 1964, the Kentucky approach structure had some surface cracks and a section approximately 150 feet in length on the NB main span, two thirds the way across, contained numerous cracks. An inspection of the lower portion of the deck in that area revealed water was leaking through those cracks. The south end of the SB main span contained numerous cracks in the outside lane. Both decks contained several spalled joints. In 1966, slabs on the Kentucky approach were repaired with an epoxy-sand mortar overlay. Several spalled joints were repaired and resealed. In the summer of 1970, the decks were sealed with a penetrating epoxy designated as PE 50 by Steelcote. This work was done under supervision of Illinois personnel.

PRESENT CONDITION:  NB Lanes (Upper Deck) - Severe spalling was noted throughout the Kentucky approach. The epoxy-sand overlay has scaled considerably and transverse steel was noted in many areas. The main span of the NB deck is in excellent condition.

SB Lanes (Lower Deck) - The Indiana approach spans and main span deck are in excellent condition. The Kentucky spans contain numerous transverse cracks, spalls and popouts.

Figure 73  I 74 over Ohio River, Jefferson Co. (9-16-70).

Figure 74.  Failures of Epoxy-Sand Seal on Kentucky Approach 4 Years after Placement (9-16-70).
Figure 75. SB Lanes Prior to Epoxy Sealing (9-16-70).

Figure 76. NB Lanes after Sealing (9-16-70).
LOCATION:  I 65 over Ohio River (John F. Kennedy Bridge) in Jefferson County

PROJECT:  56-8798-35

COMPLETED:  August 11, 1964

DESCRIPTION:  298', 700', 500', 700', 298' thru Steel Truss Span; Double 42' Width

TREATMENT:  Early in 1967, the deck of this structure was reported as being in excellent condition. By the end of that year, numerous transverse cracks were noted and an epoxy penetrant was recommended for sealing. An epoxy penetrant known as Sika Colma was placed on the entire deck in the summer of 1968.

PRESENT CONDITION:  The overall condition of this deck is excellent except for some small spalled areas on the northern end. At the time of inspection, it appeared the transverse cracks had been effectively sealed.

Figure 77.  I 65 over Ohio River, Jefferson Co.; Viewing North (3-2-70).

Figure 78.  Spalls on North Span (3-2-70).
Figure 79. Overall Condition on Deck is Excellent (5-8-72).
SALT RIVER BRIDGES

LOCATION: I 65 (Kentucky Turnpike) over Salt River; Bullitt County

PROJECT: 15-574-TP 11

COMPLETED: February 9, 1956

DESCRIPTION: 88', 120', 165', 120', 88' Continuous Steel Plate Girder Unit; 28' Wide; Each Structure

TREATMENT: June to October, 1960 various coatings were applied experimentally with technical assistance from manufacturers' representatives. The accompanying sketch shows locations of the various materials utilized. Following is a brief description of manners in which the various materials were applied.

1. Guardkote 140 - The surface was acid etched and flushed with water. The epoxy seal was applied by brooming and then quartz sand was broadcast over the tacky epoxy on a portion and emery grit was applied to the remaining area.

2. American Bitumuls Heavy Duty Resurfacer - The deck was scrubbed with a mixture of tri-sodium phosphate and water and then flushed with water. The resurfacer consisted of neoprene-latex asphalt-emulsion with grit filler added at the site and mixed to mortar consistency. Primer was applied to the surface prior squeegeeing the slurry. Severe shrinkage cracks developed 10 days to 2 weeks after application.

3. Porter Paint Surfacer - This coating consisted of a two-component epoxy and sand filler. The surface was cleaned with a powered wire brush and a quickspray mixer and gun were used for blending and applying the material.

4. Pennsalt Penntrowel Floor Surfacer - This was an epoxy coating which was applied by use of a quickspray gun. The deck was sandblasted prior to treatment.

5. Meyer 402-1 and 402 - Meyers 402-1 is an amine-cured epoxy. The treatment consisted of an epoxy-sand mortar applied by use of a quickspray gun. The sand used was Ottawa flint shot. Prior to treatment, the surfaces were sandblasted. The 402 sample contained less sand than the 402-1.

6. Meyer 403 - Meyer 403 is an epoxide alkyd. The deck was sandblasted and the material, without sand or grit, was applied by a quickspray gun.

7. Dow X-2144, Latex P.C. Mortar - All transverse cracks were deep routed and the deck was overlaid with 1/4 inch of latex mortar.

In the summer of 1968, deep deteriorations of both decks were patched and then overlaid with an epoxy-sand seal utilizing Guardkote 250. The work was done in accordance with requirements of Special Provision No. 48 which is appended. Treated sections of the decks were in various states of repair by 1968. The overall conditions of both decks were such that it was necessary to seal both in their entirety.

CONDITIONS PRIOR TO 1968 AND AFTER:

1. Portions of the Guardkote 140 seal were missing in 1968.
2. Large sections of the American Bitumuls treatment were missing in 1968 and remaining sections were poorly bonded.
3. In 1968, the section treated with Porter surfacing material had scaled along the walks, plinths and gutters. A large number of spalled areas were observed.
4. The Pennsalt Penntrowel treatment appeared in good condition in 1968. Scaling was noted along portions of the gutter, walk and plinth.
5. Virtually all of the 402-1 and 402 coating had worn from the deck by 1968. The coating was evident only on the walks and plinths.
6. The coating was missing entirely, except for traces along the walk.
7. The overlay was in excellent condition in 1968.

The epoxy-sand seal placed in 1968 has scaled considerably at joints on both decks. There is very light scaling along the gutters of both decks. Three spalls are evident on the SB deck. Generally, the NB deck is in better overall condition.
Figure 80. I 65 over Salt River, Bullitt Co.; Viewing North (6-13-60).

Figure 81. American Bitumul's Heavy Duty Resurfacer Developed Shrinkage Cracks Soon after Application (7-60).
Figure 82. Quickspray Guns Used on Portions of Deck (9-60).
### SALT RIVER BRIDGE

<table>
<thead>
<tr>
<th>MATERIAL TYPE</th>
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### LEGEND

**Figure 83.** Location of Coatings and Dates of Application.
Figure 84. NB I 65 over Salt River; Heavy Duty Resurfacer in Foreground and Guardkote 140 in Background (8-17-65).
Figure 85. Epoxy-Sand Seal Placed in 1968 Scaling at Joints (3-16-70).

Figure 86. Spalled Area on SB Deck (3-16-70).
US 40 OVER LEVISA FORK

LOCATION: US 40 over Levisa Fork of Big Sandy River at ECL of Paintsville, Johnson County

PROJECT: 58-37-5

COMPLETED: October 9, 1958

DESCRIPTION: 1-80' Simple Box Girder Span; 140', 210', 140' Continuous Box Girder Spans; 26' Wide

TREATMENT: In the summer of 1965, transverse cracks on the deck and walks were sealed with epoxy primarily in an effort to prevent possibility of leakage into the interior of the box.

PRESENT CONDITION: Transverse cracks, extending the width of the deck and through the walks, were noted in the top slab at approximately 3-foot intervals. The cracks did not occur full length of the deck; but, were concentrated in areas of 40 feet each side of the two center piers for the continuous unit. No evidence of cracking in the bottom slab of the box could be detected. Several popouts were noted in the deck on the east slab. Scaling or spalling were not observed.

Figure 87. US 40 over Levisa Fork of Big Sandy, Johnson Co. (5-18-66).
Figure 88. Light Areas on Walk are Epoxy-Sealed Cracks (5-18-66).

Figure 89. No Cracks Evident on Bottom Slab (5-18-66).
Figure 90. Epoxy-Sealed Crack on Walk (5-18-66);

Figure 91. Deck Cracks near East Pier (5-18-66).
Figure 92. Transverse Cracks, Center Span near East Pier (8-26-70).
WILLIAMS' CREEK BRIDGES

LOCATION: I 64 over US 60, Williams' Creek and C&O RR in Boyd County; near Carter County Line

PROJECT: 10-115-BOH 1

COMPLETED: June 4, 1963

DESCRIPTION: 65', 87', 90', 65' Continuous RCDG Spans; 30' Wide; Each Structure

TREATMENT: Both decks contained numerous popouts, scaling and several spalls. In October 1969, deteriorated areas were routed and patched with latex, modified cement mortar. The decks were then sealed with a 50 percent solids penetrating-type epoxy by Steelkote designated as PE-50.

PRESENT CONDITION: Both decks contain popouts which were not previously patched and light scaling is present along the gutters.

Figure 93. WB I 64 over US 60, Williams Creek and C&O RR, Boyd Co.; Viewing East (5-2-72).
Figure 94. Patch over Popouts in Center Span of WB Deck (5-2-72).
IRONWORKS PIKE BRIDGE

LOCATION: Ironworks Pike over I 75 in Fayette County; 0.9 Mile South of Scott County Line

PROJECT: 34-674-HG 1

COMPLETED: September 7, 1963

DESCRIPTION: 60', 85', 85', 60' RCDG; 26' Wide

TREATMENT: Prior to acceptance, high spots were ground and sealed with epoxy.

PRESENT CONDITION: Minor scaling occurs throughout this deck. It appears the epoxy has worn from ground areas and there is evidence of more deterioration in those areas than surrounding unground areas. Transverse cracks occur on the deck, walks, and plinths.

Figure 95. Ironworks Pike over I 75, Fayette Co.; Viewing East (8-28-70).

Figure 96. Medium Scaling of Ground Area (8-28-70).
CLEVELAND ROAD BRIDGE

LOCATION: Cleveland Road over I 64 in Fayette County; 1.5 Miles West of KY 859

PROJECT: 34-584-HG 1

COMPLETED: August 3, 1963

DESCRIPTION: 50', 75', 75', 50' RCDG; 26' Wide

TREATMENT: Prior to acceptance, the contractor was required to grind high areas. Ground areas were acid etched and sealed with epoxy.

PRESENT CONDITION: Narrow transverse cracks were observed throughout this deck. It appears the epoxy has been worn from the ground areas and minor deterioration was noted on those areas.

Figure 97. Cleveland Road over I 64, Fayette Co.; Viewing North (5-8-72).
Figure 98. Epoxy-Sealed Ground Areas Immediately After Sealing (4-8-64).

Narrow Transverse Cracks Were Observed throughout (8-28-70).

Figure 99. Ground Area 6 Years after Treatment; Light Scaling Present (8-28-70).

Figure 100. Narrow Transverse Cracks Were Observed throughout (8-28-70).
US 25 OVER I 75

LOCATION: US 25 over I 75 in Fayette County; 0.6 Mile North of Clays Ferry Bridge

PROJECT: 34-104-HG 6

COMPLETED: May 21, 1963

DESCRIPTION: 4-69', 83', 83', 53' RCDG; 30' Wide

TREATMENT: Prior to acceptance, extensive grinding was necessary in order to provide for smoothness within specification tolerances. Ground areas were etched with a 20-percent solution of muratic acid and then thoroughly flushed with water. After sufficient drying, the areas were sealed with Colma Protective Coating (epoxy) supplied by Sika Chemical Corporation. White silica sand was applied to the tacky epoxy for provision of a nonskid texture. A number of hollow areas were detected early in 1970. Planes of separation occurred primarily at the top layer of steel. The perimeters of the areas were sawed, unsound concrete was removed and the steel was cleaned. Holes were primed with epoxy and then patched with epoxy-sand mortar.

PRESENT CONDITION: The deck appears to be in good condition since repairs were most recently completed.

Figure 101. US 25 over I 75. Fayette Co. (8-13-63).
Figure 102. Ground Areas Etched with 20 Percent Solution of Muratic Acid (8-8-63).

Figure 103. Epoxy was Brushed onto Surfaces (8-8-63).
Figure 104. Areas Were Sanded (8-8-63).
Figure 105. Epoxy-Sand Mortar Patches Placed in 1970 (5-4-70).

Figure 106. Hollow Areas and Shrinkage Cracks were Common before Patching (5-24-70).
GOOSE CREEK BRIDGES

LOCATION: I 64 Structures over Goose Creek and Hembridge-Graefenburg Road in Shelby County

PROJECT: 106-806-9

COMPLETED: November 26, 1960

DESCRIPTION: 37' RCDG Span and 53', 73', 54' RCDG Continuous Unit; 30' Wide; Each Structure

TREATMENT: The deck, walks and plinths of the WB structure were treated on July 17, 1963 with a material acclaimed as an anti-spalling compound. The material was supplied free of charge by the Martin Marietta Corporation and Hercules Powder Company. The material contained linseed oil, Parlon (chlorinated) rubber and other compounds. The compound was applied at an approximate rate of 240 square feet per gallon by use of a Garco Sprayer. Surfaces were cleaned by use of an air jet prior to application of the compound. The deck had heavy scaling along the curb lines and light to heavy scaling throughout the driving lanes prior to application of the material. Reinforcing steel was observed at or near the surface on the deck. The EB deck was similarly treated in 1967. A 50-50 mixture of boiled linseed oil and mineral spirits had been applied in 1964.

PRESENT CONDITION: Light scaling is present along the gutters on both decks and no spalls were observed on either structure. Both structures have above-average performance on the decks.

Figure 107. WB I 64 over Goose Creek, Shelby Co.; View before Treatment, Note Variation in Slabs (7-17-63).
Figure 108. WB I 64 over Goose Creek 7 Years after Treatment (5-8-72).

Figure 109. EB I 64 over Goose Creek (3-2-70).
BRANCH OF ELKHORN CREEK BRIDGE

LOCATION: NB I 75 over Branch of Elkhorn Creek, Fayette County, 0.551 Mile N.W., Junction I 75 and U.S. 60

PROJECT: 34-744-6

COMPLETED: November 16, 1966

DESCRIPTION: 36' RCDG Span; Length, 39'; 40' Wide

TREATMENT: A penetrant-type protective coating was applied to the deck and plinths of this structure in late July 1964. The coating, designated as Watco, was supplied free of charge by the Watco-Dennis corporation. This material is acclaimed to render concrete non-dusting, non-spalling, freeze-thaw and wear resistant and resistant to harmful liquids, de-icing salts and acids. The deck was broomed and the coating was then poured onto it, spread by use of squeegees, and excess material was removed by use of sawdust. Coverage was approximately 80 square feet per gallon.

PRESENT CONDITION: The deck was free of any signs of deterioration at the time of treatment. There is no evidence of deterioration now. Only light scaling was observed along all gutters of the companion SB structure.

Figure 110. Application of Watco to Deck of NB I 75 over Branch of Elkhorn, Fayette Co. (7-9-64).
Figure 111. Appearance after Application (7-29-64).

Figure 112. View 6 Years after Treatment (8-31-70).
BENSON CREEK BRIDGES

LOCATION: 1 64 over Benson Creek; Franklin County

PROJECT: 37-905-1

COMPLETED: November 26, 1960

DESCRIPTION: 86', 120', 86' Continuous RCDG Spans; 30' Wide; Each Structure

TREATMENT: In mid August 1962, the WB deck was treated with 100 percent coal-tar oils, non-drying, penetrating, concrete sealer supplied free of cost by the Kopper Company. The sealer was broomed onto the surface at a rate of 0.056 to 0.062 gallon per square yard. This material softened the joint-sealing compound and produced objectionable darkening of the concrete.

PRESENT CONDITION: The companion EB deck was treated with linseed oil and mineral spirits in the summer of 1964. Light scaling is present in small areas along the gutters of both decks. The WB deck contains several transverse cracks of appreciable width throughout and the EB deck contains numerous small popouts. In general, both decks are in fairly good condition and there is no appreciable variation in performance.

Figure 113. WB I 64 over Benson Creek, Franklin Co. (8-17-62).

Figure 114. WB Deck; Viewing West 8 Years after Treatment (3-16-70).
Figure 115. Wide Transverse Cracks on WB Deck (3-16-70).

Figure 116. EB I 64 over Benson Creek; Viewing East (3-16-70).

Figure 117. Small Popouts Were Observed throughout EB Deck (3-16-70).
BUZZARD ROOST ROAD BRIDGES

LOCATION: I 64 over Buzzard Roost Road and Jeptha Creek; Shelby County

PROJECT: 106-806-HG 8

COMPLETED: November 26, 1960

DESCRIPTION: 35' RCDG Span and 60', 80', 60' RCDG Continuous Unit; 30' Wide; Each Structure

TREATMENT: A protective treatment of Lapidolith, manufactured by Sonneborn Building Products, was applied to the left (inner) lane of the WB deck on October 30, 1964. Lapidolith is reportedly a zinc and magnesium fluosilicate and is marketed as a concrete hardener. The deck was first broomed and then a mixture of one part Lapidolith to 2 parts water was sprayed onto the left lane. The first coat was allowed to dry and then a 50-50 mixture of Lapidolith and water was applied to the surface. The rate of coverage was approximately 200 square feet per gallon of Lapidolith. The companion EB deck was treated with a 50-50 mixture of boiled linseed oil and mineral spirits in the summer of 1964.

PRESENT CONDITION: WB Deck - Through 1966, alternate slabs contained heavy scaling. All slabs now contain scaling and no appreciable variation in performance can be detected between treated and untreated lanes. The outer curb on the center slab of this structure is severely deteriorated for a distance of approximately 12 feet. The deck, through faulty construction, contained a low area near the curb. Salt, water and debris collecting in that area have contributed primarily to the present condition.

EB Deck - Extensive spalling is evident on all slabs of this deck. Inadequate cover above the top layer of reinforcing steel is the major cause of deteriorations noted.

Figure 118. WB I 64 over Buzzard Roost Road, Lapidolith was Sprayed onto Deck (10-30-64).
Figure 119. Low Area on EB Deck Lead to Premature Deterioration (10-30-64).
Figure 120. Same General Area as Shown in Fig. 119 6 Years Later (3-2-70).

Figure 121. EB I 64 over Buzzard Roost Road; Viewing East (5-8-72).
Figure 122. Typical of Spalling Noted throughout EB Deck (3-2-70).
CARDWELL LANE BRIDGES

LOCATION: I 64 over Cardwell Lane in Franklin County, Approximately 5.25 Miles East of Shelby County Line

PROJECT: 37-905-HG 6

COMPLETED: November 26, 1960

DESCRIPTION: 3-50' Simple RCDG Spans; 30' Wide; Each Structure

TREATMENT: A concrete hardener (polystyrene in tar solvents), supplied by the G. W. Whiteside Company, was broomed onto the WB deck of this structure in mid August, 1962. The hardener was applied at a rate of 0.072 to 0.087 gallon per square yard. Soon after the treatment, slipperiness tests (British Pendulum) were made and the structure was regarded as seriously slick. Loose abrasive was scattered onto the deck on September 14, 1962 and by the last of September the structure was deemed relatively safe. Applications of such materials should be accompanied by use of abrasives.

PRESENT CONDITION: There is light scaling along both gutters and popouts throughout the entire WB deck area. The companion EB deck was treated with a 50-50 mixture of boiled linseed oil and mineral spirits in the summer of 1964. The EB deck has scaled rather severely with approximately 60 percent of the gutter areas having scaled to depths of 1/4 to 1/2 inch. As of March 1970, the WB deck has performed much better than the EB deck.

Figure 123. WB I 64 over Cardwell Lane, Franklin Co. (8-16-62).
Figure 124. Popouts were prevalent throughout WB Deck (3-16-70).

Figure 125. EB 1 64 over Cardwell Lane; viewing west (3-16-70).

Figure 126. Deep scaling on gutter of EB Deck (3-16-70).
SOUTH BENSON CREEK BRIDGES

LOCATION: I 64 over South Benson Creek in Franklin County, Approximately 2.8 Miles East of Shelby County Line

PROJECT: 37-905-3

COMPLETED: 61', 86', 61' Continuous RCDG Spans; 30' Wide; Each Structure

TREATMENT: Guardian Chemical Company's Clear Bond, concrete hardener (styrene-butadiene in solvent), was applied at a rate of 0.075 to 0.086 gallon per square yard. Slipperiness tests (British Pendulum) were performed in September, 1962 and the deck was found to be seriously slick. Loose abrasive was applied on September 14 and tests performed on September 27 indicated the condition greatly improved.

PRESENT CONDITION: Numerous transverse cracks are present throughout the entire length of the WB deck and extensive scaling is evident throughout. Many scaled areas have been patched with an epoxy-sand mixture containing Guardkote 140. Approximately one half of the gutter areas have been patched. The companion EB deck does not contain serious signs of deterioration. Neither of the decks have spalled and small popouts were noted on each.

Figure 127. WB I 64 over South Benson Creek, Franklin Co. (8-17-62).
Figure 128. Deep Scaling and Transverse Cracks Were Present at Time of Treatment on WB Deck (8-17-62).

Figure 129. Scaled Areas on WB Deck Were Partially Patched with Epoxy-Sand Mortar (3-10-70).

Figure 130. EB I 64 over South Benson Creek, Viewing West (3-10-70).
ST. CATHERINE'S STREET BRIDGE

LOCATION: I 65 (North-South Expressway) over St. Catherine Street in Louisville, Jefferson County

PROJECT: 56-8798-HG 15

COMPLETED: January 6, 1960

DESCRIPTION: 44', 74', 44' RC Continuous Unit; 88' Wide

TREATMENT: This bridge was arbitrarily selected for an experimental treatment. On May 19, 1960, the deck, walk, and half the median on the northern three fourths of the southbound lanes were treated with George W. Whiteside's 56-E-2, styrene butadiene. A low-pressure garden spray was used to apply the penetrant and squeegees were used for spreading the material.

The southern fourth of the southbound lanes was treated with a squeegee application of George W. Whiteside's J-151-40, two-component epoxy-polysulfide. The "40" refers to the percentage, by volume, of nonvolatiles in the material.

In addition to the above treatments, Presstite, a two-component polysulfide rubber joint sealer, was installed in the expansion joint on the north end of the northbound lanes in May 1962.

PRESENT CONDITION: None of the 56-E-2 is visible. Traces of the J-151-40 are visible on the walk and median. In general, the SB lanes are in excellent condition. In contrast, numerous spalls were observed on the NB lanes. In all cases, there was inadequate concrete cover above the top reinforcing bars. Portions of the NB outside lane had scaling one-half to three-fourths inch in depth.

Figure 131. I 64 over St. Catherine Street, Jefferson Co.; View of SB Lanes (3-2-70).

Figure 132. Spalls on NB Lanes as Result of Inadequate Concrete Cover (3-2-70).
BITUMINOUS OVERLAYS AND PATCHES

Only a small percentage of decks having bituminous overlays or patches are included in the case studies. A number of bituminous overlays have been removed, and those decks were restored in other ways or replaced. The overall performance of bituminous overlays has been unsatisfactory. Bituminous patches have been even less successful than overlays and are considered only as a temporary repair. In 1966 and 67, four decks were widened and overlaid with bituminous mixtures. Prior to overlaying, an epoxy-membrane coat (APPENDIX A, Item 6) was applied to the prepared concrete surfaces. Performances thus far have been good.
IROVNE S. COBB BRIDGE

LOCATION: US 45 (Paducah-Brookport Landing Road) over Ohio River at Paducah, McCracken County

PROJECT: 73-12-2

CONSTRUCTED: 1928-1929 (Toll Bridge Authority), Accepted by State 1935, Freed of Toll November 1942.

DESCRIPTION: Composite Steel thru Trusses, Steel Deck Trusses, Steel 1-Beam Clear Spans, and RC Clear Span Slabs; Length, 5,340'; 20' Wide Deck Constructed of reinforced, light-weight concrete (Hydrite Aggregate)

TREATMENT: Soon after construction, a 12-foot section of the deck failed and had to be replaced. Between 1940 and 1952, 207 patches in sizes from 2 feet x 5 feet to 8 feet x 10 feet were placed and the deck was overlaid with Kentucky Rock Asphalt in 1952. The deck was overlaid with a plant mix in 1957. In 1965, a liquid-asphalt rejuvenator was applied to the surface and a slurry seal was placed over the entire deck in 1969. Portions of the deck have failed one and two times weekly. Repairs have been made by inserting metal planking over stringer braces and then filling those holes with bituminous materials. Many of the patches average 2 feet x 6 feet.

PRESENT CONDITION: Patched areas are quite noticeable due to variations in appearance of the slurry seal over those repairs. The overlays have chipped or buckled at joints. Numerous spalls exist on the northern portion of the deck and reinforcing steel is exposed near the sides of the deck throughout. The entire deck is seriously rough.
AHSLAND-COAL GROVE BRIDGE

LOCATION: Over Ohio River at 12th Street in Ashland; Boyd County

PROJECT: 10-6025-1

COMPLETED: 1931

DESCRIPTION: Five Thru Truss Spans with Plate Girder and Concrete Slab Approaches; Length 2,498'; 22' Wide; Original surface consisted of concrete overlaid with Kentucky Rock Ashphalt

TREATMENT: In 1951, the deck was overlaid with Class I bituminous concrete containing slag aggregate. A 0.4-inch sand-asphalt surface was placed on the deck in the summer of 1958. During August 1965, work (APPENDIX, Item II) was initiated on removal of existing overlays and deteriorated concrete. The edges of holes were sawed and patching concrete placed in those holes contained one pound of calcium chloride per sack of cement. Some holes were primed with SS-lh and then filled with Class I, Type A hot mix containing 6.6 percent PAC-5. A double-seal coat was then placed and each coat consisted of an application of SS-lh and sprinkled with sand. A tack coat of SS-lh was placed and the deck was overlaid with sand asphalt to a compacted thickness of 3/4 inch. The deck was overlaid with a 3/4-inch thick sand-asphalt surface again in 1969.

PRESENT CONDITION: No defects were visible in the latest sand-asphalt surface except for minor scaling near the curbs for approximately 200 feet along the northern end.

Figure 135. Ashland-Coal Grove Bridge over Ohio River, Boyd Co.
Figure 136. Chain Marks in Sand-Asphalt Surface Placed in 1958 (2-60).

Figure 137. View of Sand-Asphalt Surface Placed in 1969 (3-5-70).
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<td>August 12, 1938</td>
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<td>DESCRIPTION:</td>
<td>15', 43', 21', 32028.5' RCDG Spans and 158', 168', 222', 224' Steel Thru Truss Spans; 24' Wide</td>
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**TREATMENT:** In 1955, an 1 1/2-inch bituminous concrete surface was placed on this deck. No record of treatment prior to placement of the overlay exists. From that time, the deck has been patched periodically with bituminous material.

**PRESENT CONDITION:** This deck is in very poor condition. A large number of potholes are present on the West Virginia approach spans and spalling is prevalent throughout the length. All expansion joints are in serious need of repair. There is an abrupt change in grade between truss spans 1 and 2 from the Kentucky end and impact loading is evident.

Figure 138. US 23 and US 60 over Big Sandy River, Boyd Co. (5-2-72).
Figure 139. Numerous Pot Holes Present on West Virginia Approach Spans (5-2-72).

Figure 140. Pot Holes Impound Water (2-13-70).
HIGH STREET BRIDGE

LOCATION: US 60 over Southern RR on High Street, Lexington

PROJECT: 34-6164-OH 6

COMPLETED: 1931

DESCRIPTION: 18-35' Simple RCDG Spans and 49', 64', 49' Continuous RCDG Spans; 30' Wide

TREATMENT: This structure is scheduled to be replaced by a new structure in the very near future. As a temporary measure, full-depth patches were placed in 1968 and partial-depth patches were placed in other seriously deteriorated areas. The deck was then overlaid with a 3/4-inch sand-asphalt surface.

PRESENT CONDITION: The sand-asphalt overlay is in good condition and is missing in only a few spots along the gutters. Transverse cracks have reflected through the thin overlay. Quite severe scaling is evident along the curbs, walks and plinths. Overall, the structure is in poor condition.

Figure 141. US 60 over Southern RR in Lexington (5-24-72).
Figure 142. Transverse Cracks Reflected through Sand-Asphalt Overlay (5-24-72).
Figure 143. Severe Spalling along Walk (5-24-72).

Figure 144. Extensive Deterioration under Deck (5-24-72).
BEAR CREEK BRIDGE

LOCATION: US 23 over Bear Creek in Lawrence County

PROJECT: 64-113-1

COMPLETED: February 26, 1953

DESCRIPTION: 6-50' RCDG Spans; 26' Wide

TREATMENT: From time to time, bituminous patches have been placed over areas of heavy scaling. In the majority of instances, the areas were simply broomed, primed and then patched.

PRESENT CONDITION: Medium scaling is present throughout the deck. Heavy scaling occurs along both gutters. Popouts and transverse cracks were also noted. The bituminous patches have not arrested scaling and have rendered the deck quite rough.

Figure 145. US 23 over Bear Creek, Lawrence Co.; Viewing South (2-13-70).

Figure 146. Medium Scaling Occurs throughout (8-26-70).
BIG RENOX CREEK BRIDGE

LOCATION: KY 61 over Big Renox Creek in Cumberland County; 2.5 Miles North of Burksville

PROJECT: 29-27-3

COMPLETED: 1927, Widened and Overlaid in 1966

DESCRIPTION: 4-50’ RCDG Spans; 19’ Wide; Widened to 24’ in 1966

TREATMENT: This deck was widened in 1966 and then an epoxy membrane coating was applied prior to placement of an asphalt overlay. The membrane coating was applied at a rate of 3 pounds per square yard and all work and materials were in accordance with Special Provision No. 54 For Epoxy Membrane Coating (APPENDIX, Item 6). Thickness of the Class I, Type A overlay was 2 1/2 inches.

PRESENT CONDITION: Numerous transverse cracks were observed throughout the overlay. No other signs of deterioration were noted and the deck appeared in excellent condition.

Figure 147. Ky 61 over Big Renox Creek, Cumberland Co.; Viewing South (2-13-70).
NORTH FORK OF NOLIN RIVER BRIDGE

LOCATION: KY 61 over North Fork of Nolin River, Larue County

PROJECT: 62-141-1

COMPLETED: 1926; Widened Spring 1966

DESCRIPTION: 45', 50', 45' RCDG Spans; 30' Wide (Includes 11', 4 1/2" Widening)

TREATMENT: From 1960 until the NB lane was widened in 1966, the deck was covered with a bituminous concrete overlay. After the structure was widened the bituminous concrete and a portion of the concrete deck were scarified with a large Tennant machine. Joints were formed with premolded joint filler covered with polyethylene sheeting and spalled areas were patched with epoxy mortar consisting of 5 gallons epoxy and 11 gallons of sand.

After patching operations were completed, the deck was marked into sections representing the area to be covered by ten gallons of epoxy at an application rate of 3 pounds per square yard. After mixing with a stirrer attached to an electric drill, the epoxy was deposited onto the deck and spread to a uniform thickness with squeegees. Quartz sand was then hand-sprinkled onto the resinous cement. After the deck was sealed, the premolded joint filler was removed and the joints sealed. The deck was surfaced with 2 inches of bituminous concrete during the summer of 1966.

PRESENT CONDITION: There are no visible defects on the surface and the deck appears to be in excellent condition.

Figure 148. Ky 61 over North Fork of Nolin River, Larue Co., Scarified SB Lane (8-24-66).
Figure 149.  Joints were Repaired with Epoxy (8-24-66).

Figure 150.  Squeegee Application of Epoxy-Membrane Coat (8-24-66).
Figure 151. SB Lane after Sand Application (8-24-66).
Figure 152. Overlay 4 Years after Application (6-7-72).
PUP CREEK BRIDGE

LOCATION: US 60 over Pup Creek, Daviess County

PROJECT: 30-17-6

RECONSTRUCTED: June 1966

DESCRIPTION: 5-30' RCDG Spans; 31' Wide (Includes 5' Widening)

TREATMENT: After widening the existing structure in June 1966, deteriorated areas on the older portion of the deck were patched with a mortar mixture of four parts quartz sand and one part epoxy. The patching mortar was deposited in the unprimed areas, leveled, compacted, and screeded. Joints were formed with premolded joint filler and covered with polyethylene sheeting. Patching totaled 205 square feet. After patching operations were completed, the deck was marked in sections 15.5 ft. wide and 18.5 feet long. Each section represented the area to be covered with ten gallons of epoxy at an application rate of 3 pounds per square yard. The two-component Sika epoxy was mixed with a stirrer attached to an electric drill. The material was deposited and spread to a uniform thickness with squeegees. Quartz sand was hand-sprinkled onto the resinous cement at a rate of 7 pounds per square yard.

During the initial stages of sealing, workmen were slow in spreading the mixed epoxy, and portions hardened before the sand was applied. These areas were removed and resealed. After the deck was sealed, the premolded joint filler was partially removed and the joints sealed. The deck was then surfaced with 1 1/2 inches of bituminous concrete. The seal and overlay were placed in the summer of 1966.

PRESENT CONDITION: There are no visible defects on the deck and the general appearance is excellent with the exception of a crack over a joint.

Figure 153. US 60 over Pup Creek, Daviess Co., after Widening (6-22-66).
Figure 154. Epoxy Hardened Prior to Sanding in Area Shown (6-22-66).

Figure 155. Overall View 4 Years after Widening and Overlaying (8-26-70).

Figure 156. General View of Overlay and Crack over Joint (8-26-70).
US 62 OVER NORTH ELKHORN

LOCATION: US 62 over North Elkhorn Creek; Scott County; North City Limits of Georgetown

PROJECT: 105-54-1

RECONSTRUCTED: June 5, 1967

DESCRIPTION: 3-34' Simple RCDG Spans; 30' Wide (Includes 6' Widening in 1967)

TREATMENT: After widening was completed, the deck was marked into sections for uniform application of an epoxy membrane at a rate of 3 pounds per square yard. The membrane and placement were according to Special Provision No. 54 (APPENDIX, Item 6). After the epoxy cured, a 2-inch, Class I wearing course of bituminous concrete was placed over the entire deck.

PRESENT CONDITION: No visible defects were observed and the entire deck is in excellent condition.

Figure 157. US 62 over North Elkhorn Creek, Scott Co. (3-25-69).
Figure 158. Close-Up of Overlay (5-8-72).
CONCRETE AND MORTAR OVERLAYS

Portland cement concrete or mortar overlays have not been used very extensively for repairs of decks in service because of the necessity for reopening to traffic before normal curing may be complete. Case studies included herein cover overlays placed on decks damaged during construction or having insufficient cover above the top mat of reinforcement. The mortar overlays covered in those studies did not have good performance records and it is concluded that overlays were much too thin for cement mortar. The concrete overlays included herein and others have generally performed quite well. The most significant overlay of this type was placed on the main spans of the Clark Memorial Bridge (Louisville) in 1967.
MT. ZION BRIDGES

LOCATION:  
I 75 (New Covington-Lexington Road) over Mt. Zion-Union Road, South of Mile Post 179, Boone County

PROJECT:  
8-550-HG 3

COMPLETED:  
October 31, 1960

DESCRIPTION:  
3-50' RCDG Spans, H 20-S16-44 Design Loading; 42' Wide; Each Structure

TREATMENT:  
NB Deck - During construction, fresh concrete in the center span was damaged by rain. In the summer of 1960, a bonded overlay was applied to about 75 percent of that span to build up a smooth surface. The overlay consisted of Sika Bonding Compound (epoxy-polysulfide) and a 1/4-inch mortar topping.

SB Deck - During construction, the south span was damaged by rain, and a smooth surface was obtained by covering the damaged area with a thin mortar overlay prior to acceptance.

PRESENT CONDITION:  
NB Deck - Approximately 40 percent of the overlay is missing from the center span. All spans contain numerous popouts.

SB Deck - The walks, curbs and plinths contain heavy scaling. The joints are spalling and deep scaling is common throughout the deck. The mortar overlay remains only in minor portions of the span.

Figure 159. NB I 75 over Mt. Zion Road, Boone Co.; Overlay Scaled (1-30-70).

Figure 160. Overlay Missing from Large Portions on SB Deck (1-30-70).
SOUTHERN RAILROAD OVERPASS, BUECHEL

LOCATION: US 31 E and US 150 (Bardstown Road) over Southern Railway at Buechel, Jefferson County

PROJECT: 56-588-OH 1

COMPLETED: June 1956, Concrete poured November 11, 1955

DESCRIPTION: Composite RCDG Simple Span and RC Continuous Unit Spans; 2-28' Wide Lanes Plus 4' Divide

TREATMENT: Shrinkage cracks developed in the center slab of the northbound lane within 24 hours after the slab was placed. On September 27, 1956, a mortar consisting of 1 bag cement, 2 gallons water, and 3.5 gallons Daraweld was centrally batched, hauled to site in ready-mix trucks, dumped, and scrubbed onto the deck with stiff brooms. The treatment averaged 3/16 inch in depth. Liquid, membrane-curing compound was used for curing and the slab was closed to traffic for 2 1/2 days. The cracks reappeared in less than one year. Additional maintenance included sealing cracks in other slabs with asphaltic materials and patching one popout and one spalled area with bituminous materials.

PRESENT CONDITION: Numerous cracks are present in all spans. There is advanced scaling in the northern third of the northbound gutter area. In general, the northern half of the deck is in good condition. The southern portion of the deck contains scaling along both gutters 1/2 to 1 1/4 inch in depth. There is considerable spalling south of the center joint.
BRYAN STATION ROAD BRIDGE

LOCATION: KY 956 over I 64, near Northeast City Limit, Lexington, Fayette County

PROJECT: 34-364-HG 2

COMPLETED: November 16, 1963

DESCRIPTION: 55', 77', 77', 55' Continuous RCDG Spans; 28' Wide

TREATMENT: Soon after completion of the deck, insufficient cover above the top layer of reinforcement was detected and the contractor was required to place a 1-inch cement-concrete overlay on the entire deck. The overlay was placed in May 1964, and the operation consisted of: removal of scaled concrete and grease, cleaning by brooming, acid etching (15 percent solution of muratic acid), flushing with water, application of bond coat, and placement of overlay. Resiweld concrete adhesive (epoxy resin) manufactured by the H. B. Fuller Company was used as a bonding agent at a rate of approximately 60 square feet per gallon. The concrete mixture was designed for 7 bags of cement per cubic yard, 8 percent entrained air, and an aggregate mixture of 50 percent No. 9 crushed limestone and 50 percent river sand.

Figure 163. Ky 956 over I 64, Fayette Co. (5-24-71).

Lane-at-a-time construction was used in placement of the overlay and grinding was necessary to level the joint between lanes. The finished surface was allowed to dry prior to placement of curing covers and numerous shrinkage cracks developed quite rapidly in localized areas.

PRESENT CONDITION: The surface is particularly rough, especially near the centerline, and numerous shrinkage cracks are present in the overlay. No bond failures have been noted.

Figure 164. Epoxy Bonding Compound was Squeegeed onto Deck (5-12-64).

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Figure 165. Overlay was Raked and Leveled (5-12-64).

Figure 166. Appearance of Overlay 7 Years after Placement (5-24-71).
LATEX-MODIFIED CEMENT OVERLAYS AND PATCHES

The overall performance of latex-modified cement mortar overlays and patches has been good. Difficulties were experienced in obtaining a satisfactorily smooth surface for some of the earlier overlays. Excellent bond has been obtained through use of the modified cement slurries or other bonding compounds. Extensive surface preparations were made prior to installations reported herein and a degree of success experienced could certainly be attributed to those preparations. Experimental overlays placed on the Lake Cumberland deck have been serviceable for 10 years. The latex mortars have been generally more difficult to finish than conventional concrete or mortars.
LOCATION: I 75 over Southern RR in Scott County, 3 Miles North of US 62

PROJECT: 105-554-OH 2

COMPLETED: January 4, 1962

DESCRIPTION: 87', 125', 87' RCDG; 30' Wide; Each Structure

TREATMENT: SB Deck - A thorough inspection of this deck late in 1963 revealed numerous transverse, longitudinal and shrinkage cracks. The deck was again surveyed in 1964 and light scaling was noted over 50 percent of the deck. Heavy scaling was observed along the gutters and walks. In August 1966, concrete was routed from along the gutters to the top mat of steel. A Triplex tamper was used for routing and the perimeters were sawed. Latex modified cement mortar was used for restoration of gutter areas. The latex, designated as Rhoplex MC-4530, was supplied free of charge by Rohm and Haas, Inc. All work and other materials were supplied by the Department.

The mortar consisted of 300 lbs sand, and 100 lbs. cement, 33 pounds latex, 18.6 pounds water and 0.24 pound antifoaming agent. The mortar was broomed onto the surface and then finished by a screed. Curing was accomplished by use of plastic sheeting and sand was placed thereon to prevent traffic from whipping it off.

By 1968, the remainder of the deck had deteriorated to the extent that an epoxy-sand seal was placed thereon.

NB Deck - In 1966, portions of the deck near the curbs were routed and then patched with epoxy-sand mortar. Guardkote 140 was used in that work. Areas were primed with epoxy prior to placement of the epoxy-sand mortar. Other areas on this deck have since been patched with similar mortars.

PRESENT CONDITION: SB Deck - The epoxy-sand seal is missing from approximately 20 percent of the deck. One large spall was noted in the outside lane.

NB Deck - Heavy spalling was noted along the inside gutter and large areas of patching are missing from both gutters. Heavy scaling occurs along both curbs and the overall condition of this deck is poor.
Figure 169. Gutter on SB Deck before Initial Treatment (7-26-66).

Figure 170. Perimeters Were Sawed and Scaled Concrete Was Removed (7-26-66).
Figure 171. Leveling Latex-Modified Mortar (8-24-66).

Figure 172. Transverse Cracks on SB Deck (12-16-64).
Figure 173. Epoxy-Sand Seal Scaled from Approximately 20 Percent on SB Deck (3-25-70).

Figure 174. Inside Gutter on NB Deck (3-25-70).
LAKE CUMBERLAND BRIDGE

LOCATION: KY 90 (Burnside-Monticello Road) over Cumberland River near Bronston, Pulaski County

PROJECT: 100-155-3

COMPLETED: August 21, 1951

DESCRIPTION: 3-60' DG Spans; 200', 252', 280', and 2-336' Deck Truss Spans; Length, 1593'; 24' Wide

TREATMENT: The deck consisted of 28-ft. slabs which were poured alternately; adjoining slabs were markedly different in performance. Deep deterioration seemingly related to the pouring pattern was observed on many of the slabs and light scaling was prevalent throughout the deck.

In the summer of 1961, repairs were initiated and the deck was to be scarified uniformly to a depth of 1/2 inch; but this proved expensive and time consuming. Depth of scarification was reduced to 1/4 inch in most places and to 1/8 inch for the remainder. Areas adjacent to finger dams and ends of the bridge were cut to a depth of 1/2 inch. Routing and cleaning operations were the most time consuming and expensive phases of the repair work. Equipment used consisted of: two-Tennant routers for removal to a depth of 1/4 to 1/2 inch in a 4-1/2 inch wide pass, Triplex tamper, conventional jackhammers for edging next to curbs, sand blaster to remove paint and latex-cement slurry from the curbs and dirt and laitance from the sidewalks and brooms and an air compressor to remove dust or other debris.

The deck was overlaid with mortars to provide for new concrete or to reach the old concrete to a depth of 1/2 inch. The surface was wetted, a mortar slurry was broomed on and then the mortar was placed and screeded to 1/2 inch in depth. Curing blankets were then placed over the toppings. After curing, epoxy (Dow 331 or Dow X2679) was applied by squeegees and Pyles guns to major portions of the deck, curbs and walkways and coarse sand was applied to the tacky epoxy. Wooden strips were used to preserve joints and a concrete saw was used for removal of the strips. Joints were sealed with Sika Inagas sealer or prestite 404 (two component) sealer. The finished deck was quite rough in the eastbound lane as a result of attempts to strengthen the epoxy-sand seal at the joints. In the summer of 1971, the deck surface was leveled through use of a concrete planer.

PRESENT CONDITION: The overlay is missing from approximately 30 percent of the deck and badly worn in other areas. Transverse cracks are abundant throughout the deck and the majority of joints were rough due to the condition of the concrete or overlay prior to planing in 1971. The curbs and walks have peeled extensively. The deck is now acceptably smooth.

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Figure 175. Ky 90 over Cumberland Lake, Pulaski Co. (6-61).

Figure 176. Severe Scaling Evident in 1961 (6-61).
Figure 177. Exposed Steel on Curb (6-61).

Figure 178. Tennant Router Used to Remove Unsound Concrete (9-15-61).
Figure 179.  Triplex Tamper Used near Curbs (9-15-61).

Figure 180.  Pyles Gun for Application of Epoxy (6-62).
Figure 181. Epoxy-Sand Surface Close-Up (6-62).
Figure 182. Failure of Topping near Joint (2-17-70).
LEVISA FORK BRIDGE

LOCATION: KY 114 over Levisa Fork of Big Sandy River and C&O RR in Prestonsburg, Floyd County

PROJECT: 36-3156-B0 4

COMPLETED: October 22, 1963

DESCRIPTION: 2-54' RCDG Spans and 137', 178', 139' Continuous Plate Girder Spans; 56' Wide

TREATMENT: In the fall of 1968, portions of the deck were overlaid and other portions were patched with latex modified cement mortar. The overlay was placed on 100 feet of the west end and 120 feet on the east end. Areas were patched between those portions as needed. All work and materials were similar to those described for the Mountain Parkway structure over Middle Fork of Red River in Powell County, 99-30-EK 20 (follows this case history).

PRESENT CONDITION: The curbs, walkways and median are in excellent condition. Both sections of overlay and patched areas are in excellent condition. Light to medium scaling occurs throughout untreated portions of the deck. Scaling is severe along untreated portions of the gutters.

Figure 183. Ky 114 over Levisa Fork of Big Sandy River and C&O RR in Prestonsburg, Floyd Co. (8-26-70).

Figure 184. Scaling on Untreated Portion near Center of Deck (8-26-70).

Figure 185. Dark Areas are Latex-Modified Cement Mortar Patches along Curb (8-26-70).
MIDDLE FORK OF RED RIVER BRIDGES

LOCATION: Mountain Parkway over Middle Fork of Red River in Powell County; 20.1 Miles East of Clark County Line

PROJECT: 99-30-EK 20

COMPLETED: September 6, 1962

DESCRIPTION: 60', 80', 60' Continuous RCDG Spans; 30' Wide; Each Structure

TREATMENT: WB Deck - In the fall of 1968, the deck of this structure was overlaid with latex, modified mortar. Preparation of the deck for placement of the overlay included: 1) removal of a minimum of 1/2 inch of concrete by use of a Tennant router, 2) perimeters of areas to be patched were sawed 3/4 inch deep, 3) concrete was removed a minimum of 3/4 inch under reinforcing bars which were more than half exposed, 4) loose reinforcing steel was tied, 5) steel was sandblasted, 6) concrete to be in contact with the modified mortar was sandblasted, and 7) the surface was wetted prior to placement of the mortar.

The modified mortar mixture for one cubic yard contained 8 bags type I portland cement, a 3.25 sand-cement ratio, 28 gallons latex and a 0.35 water-cement ratio. Latex utilized in the work was SM-100 by Dow Chemical Inc. Anti-foaming agent was added to reduce air entrainment. The design provided for 6 percent entrained air and a 7-inch slump. The materials were mixed in a mobile mix truck capable of batching one cubic yard each six minutes.

A continuous flow of mortar was deposited onto the deck and distributed by rakes, shovels and brooms. The mortar was then struck off by use of a vibrating screed. Several passes were necessary to produce an acceptable finish. After screeding, the mortar was given a burlap drag finish. Wetted burlap covered by polyethylene sheeting was used for curing for 24 hours. The mortar was then allowed to dry cure for 48 hours prior to opening to traffic.

EB Deck - Portions of this deck were patched with latex, modified mortar at the same time the WB companion deck was overlaid. Mortar similar in composition to that used in overlay work was used for patching this deck. The perimeters of all areas were sawed and all other work was similar to that described for the WB deck.

PRESENT CONDITION: Both structures are in excellent condition. Minor surface cracks were observed in the mortar of both decks.

Figure 186. EB Mountain Parkway over Middle Fork of Red River, Powell Co.; Viewing West (8-26-70).

Figure 187. WB Mountain Parkway over Middle Fork of Red River; Viewing West (8-26-70).
Figure 188. General Condition of WB Deck in 1965 (6-3-65).
BOWLING GREEN - ALVATON BRIDGE

LOCATION: NB US 231 over I 65 in Warren County; 2.5 Miles South of Bowling Green

PROJECT: 114-168-HG 3

COMPLETED: August 6, 1965

DESCRIPTION: 66', 78', 77', 62' Composite Simple W.F. Girders; 28' Wide

TREATMENT: During placement of the northbound deck, the contractor failed to provide the designated slab thickness. The slab was 5 7/8 inches thick in numerous locations and areas deficient in thickness occurred predominately at midspans. In order to correct the deficiencies, the contractor was permitted to overlay the entire deck with Dow 460 Latex modified cement mortar.

The deck was scarified by use of a Tennant machine and mortar was then placed. Mortar placed initially was tested for air content and was found to contain 20 percent air. That mortar was removed and a larger mixer (3 1/2 cubic feet) was used for the remainder of operations. Mortar batches consisted of: one bag of cement, 2 cubic feet concrete sand, 1 1/4 cubic feet mortar sand, 3 1/2 gallons of Dow 460 latex with addition of antifoam and sufficient water to provide a workable mixture. The resultant mixtures contained 8 1/2 to 11 percent air.

The scarified deck was wetted, mortar was deposited and broomed onto the surface and additional mortar was deposited and screeded to desired grade. Wetted burlap was used for curing. The overlay thickness varied from 1/2 to 1 1/4 inches.

PRESENT CONDITION: The deck is in excellent condition. A 10 foot x 15 foot area of light scaling was observed on the adjacent SB deck.
Figure 191. Finishing Overlay (10-25-66).

Figure 192. Curing Burlap Adhered to Mortar (10-25-66).

Figure 193. Overlay in Excellent Condition 5 Years after Placement (8-31-70).
OTTER CREEK BRIDGE

LOCATION: KY 90 over Otter Creek, Wayne County

PROJECT: 116-99-3

COMPLETED: November 1949

DESCRIPTION: 2-59' and 1-201'-6" R.C. Spans; 24' Wide

TREATMENT: In September 1966, the entire deck was scarified to a minimum depth of 1/4 inch with Tennant machines and air hammers. Removal of concrete to reinforcement was common. The deck was sandblasted and blown with compressed air. Steel flats, 3 inches by 1/2 inch, were set on grade at centerline and served as a strike-off bar for the finishing machine. The surface was dampened with water and a slurry mix consisting of 1 bag of cement, 1.3 cubic feet sand, 4 gallons Dow 460, and 1 gallon water brushed onto the surface prior to placement of the overlay. The modified concrete mixture for the overlay consisted of 1 bag of cement, 2.7 cubic feet sand, 1.8 cubic feet of No. 9 limestone, 3 1/2 gallons Dow 460, 1 quart diethylene glycol (retarder) and 3/4 gallon water. All materials were batched in a two-bag concrete mixer for approximately 2 minutes.

After depositing the modified concrete, the overlay was finished with a hand-pulled oscillating screed. Two workmen rode the screed and corrected surface irregularities by hand troweling. After two days of curing with wet burlap, the bridge was opened to traffic.

Prior to the overlay placement, all joints were cleaned and filled with premolded joint filler. The overlay was placed over the filler, and after curing, joints were sawed and sealed.

On a unit basis, total repair cost was $12.08 per square yard which represented $4.99 per square yard for cleaning and $7.09 per square yard for resurfacing. Approximate cost of Dow Latex 460 for the modified concrete overlay was $1.23 per square yard.

PRESENT CONDITION: A large area of the overlay approximately 100 feet from the west end of the structure has extensive pattern cracking. Heavy scaling was observed throughout both curbs and plinths. All drains are filled with debris and signs of ponding were evident.
Figure 197. Heavy Scaling on Plinth; Ponding at Clogged Drain (2-17-70).

Figure 196. Surface was Hand Troweled (10-25-66).

Figure 198. Overlay Cracked Approximately 100 Feet from West End (2-17-70).
SOUTH ELKHORN CREEK BRIDGE

LOCATION: US 68 (Lexington-Harrodsburg Road) over South Elkhorn Creek, Fayette County

PROJECT: 34-144-2

COMPLETED: July 19, 1947

DESCRIPTION: 3-40' RCDG; 26' Wide; Limestone Coarse Aggregate

TREATMENT: In June 1966, the deck was scarified to a minimum depth of 1/4 inch by use of Tennant machines, a Triplex tamper and air hammers. Approximately one third of the center span contained deep deterioration and full-depth removal was necessary. Those areas were restored by use of concrete containing 7 sacks of cement per cubic yard. The deck was then overlaid with a latex-modified cement mortar placed at a minimum thickness of 1/2 inch. The modified mortar was batched, at the site, in a 2-bag mixer and consisted of: 2 bags cement, 6.3 cubic feet of mortar sand, 7 gallons of Dow Latex 460, 2 quarts of Diethylene Glycol (retarder) and 1 to 2 gallons water. Antifoaming agent was used at the rate of one gallon per drum of latex. Prior to placement of the overlay, the deck was blown with compressed air and thoroughly flushed with water. Steel flats (3 inches x 1/2 inch) were set at grade at the centerline and served as a strike-off bar for the finishing screed and riding surface for the screed tire. Mortar was deposited in front of the screed and broomed on the concrete surface. Additional mortar was deposited, the screed was passed over the material, lifted and moved back and then passed over the surface a second time. The screed was pulled forward by hand and oscillation was provided by an offset cam powered by a gasoline engine. After screeding, the surface was sprinkled and finishers attempted to remove surface irregularities by hand troweling. Atmospheric temperature during placement operations reached 96°F at times and as a result, finishing was hindered. The overlay was cured by use of wetted burlap. The finished surface was quite rough. Pulled areas were common and shrinkage cracks developed shortly after finishing. Difficulty was encountered in obtaining a uniform slump. The cost of labor and equipment rental for preparations prior to the overlay was $1,544 ($4.14 per square yard) and the cost of the overlay was $2,585 ($6.93 per square yard).

PRESENT CONDITION: The deck is very rough and numerous shrinkage cracks are evident. The curbs and walks contain heavy scaling. The overlay is well bonded and in excellent condition except for construction defects.

Figure 199. Brooming Overlay on US 68 over South Elkhorn Creek, Fayette Co. (7-19-66).
Figure 200. Screeding Machine (7-19-66).

Figure 201. Screed Marks and Surface Irregularities Were Prominant (8-29-66).
NOLIN RIVER BRIDGE

LOCATION: NB I 65 over Nolin River, Hardin County
PROJECT: 47-129-3
COMPLETED: October 16, 1958
DESCRIPTION: 6-50' RCDG Spans

TREATMENT: Thirty-nine feet of the third span from the north end was badly deteriorated, and in August 1966, the span was routed from 1 to 1 1/2 inch deep exposing some reinforcement. The right lane was overlaid with a concrete mix containing Dow 460 Latex and the left lane was overlaid with a 7-bag concrete mixture.

For the modified overlay, the deck was wetted and a mix consisting of 1 bag cement, 2 1/2 cubic feet river sand, 2 cubic feet No. 9 limestone, 3 1/2 gallons Dow 460, and 3 1/2 quarts water was batched in a 2-bag mixer and deposited in front of the screed. The screed was constructed of wood and had a steel plate attached to the lower side. After finishing, the overlay was cured with wetted burlap for 3 days.

The first batch of modified concrete contained 2 cubic feet sand and 2 1/2 cubic feet stone. The finished surface had an open texture and the proportions of sand and stone were switched. The Dow 460 contained 48 percent solids and cost $.45 per lb. Construction joints were formed with wood.

In the left lane, the deck was wetted and a cement slurry was brushed onto the surface. The 7-bag concrete mixture consisted of 2 bags cement, 1.8 cubic feet river sand, 3.2 cubic feet No. 9 limestone, and 8 gallons water. The surface was cured with wetted burlap for 3 days. The concrete in the southern half of the left lane overlay was air-entrained and the northern one-half was not. The air content of the air-entrained portion ranged from 3.5 percent at the southern end to 5.0 percent at the northern end.

PRESENT CONDITION: The overall condition of this deck is fair. There is medium to heavy scaling along both curbs and numerous spalls and popouts were noted. Shrinkage cracks were noted in the three sections of overlay. Performance of the Dow 460 latex section has not been quite as good as the normal portland cement section and no variation in performance could be detected between the section containing entrained air and that section without air.

The companion SB deck contains transverse cracks throughout at approximately 5 foot intervals and numerous popouts. Heavy scaling is serious on the northern end of this deck. Scaling has exposed steel in the vertical curb area on that end of the deck.

Figure 202. NB I 65 over Nolin River, Hardin Co.; Deterioration on Deck Prior to Overlay (8-27-66).

Figure 203. Finishing Dow Latex-Modified Overlay (8-29-66).
Figure 204. Latex-Modified Overlay after Finishing (8-29-66).

Figure 205. Open Texture of Initial Batch of Modified Overlay (8-29-66).
Figure 206. Broom Finish on 7-Bag Concrete Overlay (9-14-66).

Figure 207. Latex-Modified Overlay 5 Years after Placement (3-30-71).
Figure 208. Non Air-Entrained Section 5 Years after Placement (3-30-71).

Figure 209. Air-Entrained Section 5 Years after Placement (3-30-71).
SLADE INTERCHANGE BRIDGES

LOCATION: Mountain Parkway over KY 77 at Slade Interchange in Powell County

PROJECT: 99-30-EH 23

COMPLETED: September 28, 1962

DESCRIPTION: 3-50’ RCDG Spans; 30’ Wide; Each Structure

TREATMENT: By the summer of 1964, both decks contained light to medium scaling throughout. Scaling progressed as a result of heavy concentrations of salt applied at the Toll Plaza and the decks were patched in the Fall of 1968. Latex modified mortar, containing Dow SM-100, was used in the restoration of both decks. The perimeters of areas to be patched were sawed 3/4 inch deep and unsound concrete was removed. Loose reinforcing steel was tied down and all exposed steel was sandblasted.

The modified mortar was mixed in a mobile mixer capable of dispensing one cubic yard per 6 minutes. Each cubic yard of mixture contained 8 sacks of Type I cement, 3.25 sand-cement ratio, 28 gallons of latex and a 0.35 water-cement ratio. The mortar was broomed onto the areas to be patched and then screeded. A burlap-drag finish was applied and the areas were then moist cured for 24 hours by wetted burlap and polyethylene covering. Wet curing was followed by 48 hours of dry curing before opening to traffic.

PRESENT CONDITION: The patched areas are in excellent condition on both structures. The untreated areas contain light scaling.
Figure 212. WB Inside Lane (8-26-70).

Figure 213. WB Outside Lane (8-26-70).
MOUNTAIN PARKWAY BRIDGES
OVER KY 11 AND KY 15

LOCATION: Mountain Parkway over KY 11 and KY 15 in Powell County; 20.2 Miles East of Clark County Line

PROJECT: 99-30-EK 21

COMPLETED: July 20, 1962

DESCRIPTION: 60', 85', 60' Continuous RCDG Spans; 30' Wide; Each Structure

TREATMENT: By 1968, portions of these decks had deteriorated to the extent that repairs were necessary. Portions of both decks were routed, the perimeters were sawed and the areas were patched with latex, modified cement mortar. The work on these decks was identical to that described for the two Parkway decks over KY 77 at the Slade Interchange in Powell County.

PRESENT CONDITION: Both decks are in excellent condition except for light scaling in some areas which were not patched.

Figure 214. EB Mountain Parkway over Ky 11 and KY 15, Powell Co.; Viewing East (8-26-70).

Figure 215. WB Mountain Parkway over Ky 11 and Ky 15; Viewing East (8-26-70).
EPOXY-SAND SURFACINGS AND PATCHES

The large majority of epoxy-sand seals or surfaces have consisted of a spray or squeegee coat of approximately 2 to 3 lbs. of epoxy per square yard followed by an application of sand. Excess sand is then removed later. Prior surface preparations, depending upon conditions of the decks, have varied from extensive removal of unsound concrete and patching to nominal acid etching or sandblasting. Performance of these surfacings has varied considerably. Some have provided satisfactory service for about 7 years and others have failed almost completely within 3 years or less. Pinholes have been observed in several of the systems that have failed prematurely. Abundant applications of sand may blot epoxy from the substrate and cause pinholing. Insufficient sand may be drowned in the epoxy and result in a slick surface. Application rate of the sand is critical and can vary according to gradation and maximum size of the sand as well as thickness of the epoxy coat.

Some failures appear primarily attributable to insufficient or complete loss of bond. Those failures may result from inability of the epoxy to wet or penetrate the concrete. Other failures have been observed within the surface portion of the concrete. A possible solution to some problems associated with these seals or surfacings would be application of a penetrating-type epoxy prior to placement of the binder epoxy. The penetrant and binder should be of the same basic resin or, at least, compatible and the binder should be placed before the penetrant hardens.

Performances of epoxy-sand mortar patches have also been markedly variable. Some of the patches have provided good service. Some of the patches have failed because unsound concrete was not completely removed or the prepared concrete surfaces were not adequately primed to obtain bond. Other patches have failed because the mixtures were not adequately compacted and remained porous. Some routers, hammers, or tampers may fracture or damage sound concrete during removal of unsound portions. Concrete surrounding spalls should be removed; otherwise, development of spalling surrounding the patches is highly probable. Concrete should be removed from the periphery of exposed steel, and the steel should be thoroughly cleaned.

Epoxy-mortar patching compounds should be proportioned for individual job materials. The epoxy and aggregates should be proportioned so as to provide sufficient epoxy to fill 97 to 98 percent of the voids between aggregate particles in the compacted state. Overfilling the voids would render the patch slick. Appropriate quantities of epoxy and aggregate could readily be established either in the laboratory or at the job site. Too often, rule-of-thumb mixtures have been used as a matter of convenience, and results have been rather disappointing. Properly proportioned mixtures which are compacted in place are desirable. Angular, quartz sand should be applied to the surface, prior to setting, to insure skid resistance. Concrete patching mixtures of Class "AA" have been used successfully. The slump should not exceed 1½ in.
OWENSBORO BRIDGE

LOCATION: US 231 over Ohio River at Owensboro, Daviess County

PROJECT: 30-737-1

COMPLETED: 1940 by SPA and Owensboro Toll Bridge Commission; Accepted by State in 1954


TREATMENT: Scaling and deep deterioration were present throughout the deck; and in October 1962, all unsound concrete was routed with air hammers. The holes were cleaned with an air jet and patches were made with Guardkote 140 coal-tar epoxy and coarse silica sand. The entire deck was scrubbed three times with detergent, rinsed, acid-etched with a 15 percent hydrochloric acid solution and rinsed three times. After drying, a Broyhill Distributor was used to apply 3.3 pounds of Guardkote 140 per square yard and this was followed by an abundant application of white, silica sand through a Flaherty Spreader. The seal was placed in accordance with requirements of a Special Provision. The application was made in the SB lane on October 11, 1962 and in the NB lane on the following day. Excess sand was removed after the epoxy hardened.

The wheels of the spreader left tire marks in the finished surface of the SB lane. The NB lane was compacted with a light pneumatic roller to remove most of the spreader marks and improve retention of sand.

Patching, washing, rinsing, and application of sand were performed by Departmental maintenance crews and applications of acid and epoxy were performed by the contractor. Acid and epoxy were furnished by the contractor and sand and other materials were furnished by the Department. Cost of the contracted operation was approximately $10,200 or about $3.00 per square yard for the 3,370 square yards sealed. The total unit cost, including all work, was approximately $4.30 per square yard. On October 27, 1964, 46 gallons of Restweld penetrating epoxy sealer was squeegeed onto the epoxy seal at the south end of the NB lane. The area covered was 280 feet by 10.5 feet. Prior to application of this sealer, a number of unsealed areas the size of pinholes were discovered by observing effervescence of muriatic acid applied to the epoxy-sand seal. Application of the penetrating epoxy was merely an attempt to seal holes against entrance of water.

Figure 216. US 231 over Ohio River at Owensboro, Daviess Co.; Viewing North, Left Lane Acid Etched (10-62).
Potholes caused by spalling of unsound concrete underlying the seal developed from time to time and periodic patching of the deck with epoxy (Guardkote 250) has been required since application of the epoxy-sand seal.

**PRESENT CONDITION:** The surface of the deck is extremely rough due to numerous potholes. A large number of spalls are evident on the deck. The walks are in relatively good condition.
NB CLAYS FERRY BRIDGE

LOCATION:  I 75 over Kentucky River, Fayette-Madison County Line

PROJECT:  34-744-HG 03

COMPLETED:  November 1946

DESCRIPTION:  Composite RCDG, Simple Truss Spans, and Continuous Truss Spans; Length, 1736'; 26' Wide

TREATMENT:  A coal-tar (Guardkote 140) epoxy-sand seal was placed on this deck in 1964 (APPENDIX, Item 9). Progressive freeze-thaw damage had caused considerable scaling in the gutters and spalling was widespread. Restoration of this deck was done in accordance with the Special Provision for Application of Coal-Tar-Modified Epoxy Resin Binder and Abrasive Grit (Aggregate) for Sealing Concrete Bridge Decks and Pavements (in APPENDIX). Supplying and applying the hydrochloric acid and epoxy were contracted and all other work was performed by Departmental forces. Work began on July 20, 1964 and deteriorated areas were routed, cleaned with compressed air, primed with epoxy and then filled with a mortar mixture of one part epoxy to four parts sand (by volume). Gunite was placed in routed areas on the inner lane for a distance of 325 feet on the north end of the structure. Those areas (except for 50 feet on the northern end) were primed with Resiweld 7650. Patching was completed September 4, 1964.

Cleaning agents obtained from the National Chemsearch Corporation were used to remove asphalt, tar, oil, grease and paint from the deck. Finger dams were covered with plyethylene sheeting for protection. On October 5, 1964, the deck was acid-etched with a 10 percent hydrochloric acid solution and rinsed with water.

The left lane was scheduled for sealing on October 6, but the epoxy-sand patches had absorbed acid and rinse water and were still wet. Two and one-half days were spent drying the patches by use of space heaters. Styrofoam strips were then inserted into the joints and on October 8, the left lane was sprayed with 3.22 pounds of epoxy per square yard. Sand was sprinkled onto the freshly sprayed epoxy with a farm-type fertilizer spreader.

The patches in the right lane were rinsed with ammonium hydroxide in an attempt to neutralize any remaining acid. Heaters were used for drying and on October 9, 3.22 pounds of epoxy per square yard were applied with a Broyhill Distributor and sprinkled with sand. On October 10, 1964, the gutters and curbs were finished by hand.

Styrofoam failed to prevent epoxy from seeping into the joints. In addition, the Styrofoam was not flush with the pavement surface and served as a dam causing high spots at each joint. The epoxy sealant was absorbed by underlying, porous, epoxy-sand patches. The farm-type sand spreading unit proved inadequate inasmuch as sand was spread in rows.

PRESENT CONDITION:  Approximately 40 percent of the seal had worn or was otherwise missing from the surface by June 1971. The walks, plinths and curbs had severe scaling. Numerous spalled areas along the deck had been patched with bituminous material and many of those patches had appreciable deterioration. The entire deck was quite rough. In July 1971, the deck was closed to traffic in preparation for restoration with a latex-modified cement overlay.
Figure 220. I 75 over Kentucky River, Madison-Fayette County Line; Viewing North (6-6-65).
Figure 221. NB Bridge; Viewing South, Note Severe Scaling and Spalling in Gutter (2-3-63).

Figure 222. Deteriorated Areas after Routing (7-2-64).
Figure 223. Viewing North after Completion of Patching (9-1-64).

Figure 224. Polyethylene Sheets to Prevent Acid and Epoxy from Entering Fingerdam (10-5-64).
Figure 225. Space Heater Used to Dry Porous Patches that Retained Water and Acid (10-7-64).

Figure 226. Application of Epoxy to Inner Lane (10-8-64).
Figure 227. Porous Patch Readily Absorbed Epoxy (10-8-64).

Figure 228. Farm-Type Spreader Windrowed Sand (10-8-64).
Figure 229. Overall View 6 Years after Treatment, Seal Missing in Light Areas (9-1-70).
Figure 230. Numerous Areas Later Patched (9-1-70).
C & O RAILROAD OVERPASS
MT. STERLING

LOCATION: US 460 (Mt. Sterling-Frenchburg Road) C & O Railway Tracks in Mt. Sterling, Montgomery County

PROJECT: 87-4057-OH 5

COMPLETED: December 1940

DESCRIPTION: 4-29', 4-40' RCDG Spans and 159' RCDG Continuous Span; 24' Wide

TREATMENT: Severe scaling and spalling were common on this bridge and previous repairs had been limited to patching spalled areas with bituminous materials. A contract was awarded for supplying and applying an etching solution of hydrochloric acid and a sealant of coal-tar epoxy. All other materials, labor, and equipment required for the restoration were to be furnished by the Department. A Special Provision for the work is included in the APPENDIX, Item 9.

Work was initiated in June 1964. All bituminous patches and unsound concrete were routed, areas were cleaned with compressed air, primed with Guardkote 140 coal-tar epoxy, and filled with a mortar mixture of one part epoxy to four parts sand (by volume). Patching operations were completed on July 17, 1964.

Cleaning agents obtained from the National Chemsearch Corporation were used to remove asphalt, tar, oil, grease and paint from the deck. Both lanes were acid-etched with a 20 percent solution of hydrochloric acid and thoroughly rinsed with water on October 13, 1964.

The bridge is on a steep grade and a thixotropic agent was added to the Guardkote 140 to reduce flow. On October 14, 3.10 pounds of epoxy per square yard were applied to the northbound lane and on October 15, 2.55 pounds of epoxy per square yard were applied to the southbound lane. A Broyhill Distributor was used to apply the epoxy and a farm-type fertilizer spreader was used to apply sand to the freshly applied epoxy. Curbs and gutters were finished by hand on October 14, 1965.

The fertilizer spreader distributed sand evenly over the deck and a smooth surface was obtained. Several depressions in the deck soaked up epoxy, thereby leaving holes which required patching by hand.

PRESENT CONDITION: Two years after completion of the sealing operation the overall condition of the seal was good. Now, approximately 30 percent of the seal is missing from the deck and concrete in those areas has continued to deteriorate. Portions of the seal that have remained intact have cracked severely. The curbs and handrail containing heavy scaling. In April of 1972, the bridge was closed to traffic in preparation for a latex-modified concrete overlay.
Figure 231. US 460 over C&O RR, Mt. Sterling, Montgomery Co. (7-17-64).
Figure 232. View after Completion of Epoxy-Sand Mortar Patching (7-17-64).

Figure 233. Epoxy-Sand Seal Complete on Right Lane, Epoxy Applied to Left Lane (10-15-64).
Figure 234. Application of Sand to Tacky Epoxy (10-15-64).

Figure 235. Typical View of Deck 6 Years after Treatment (3-25-70).
SOUTHERN RAILROAD OVERPASS, DANVILLE

LOCATION: US 150 (Danville-Springfield Road) over the Southern Railway tracks near Depot in Danville, Boyle County

PROJECT: 11-4300-OH 1

COMPLETED: November 1949

DESCRIPTION: 9-45' RCDG Spans; 112', 146', and 63' Continuous Girder Spans; 28' Wide

TREATMENT: In 1961, all unsound concrete and bituminous patches were routed with air-hammers, holes were cleaned with compressed air and patches were made with Guardkote 140 (coal-tar epoxy) binder and sand. Patching was done in anticipation of applying a full epoxy-sand seal and components were purchased from the Permaplastic Products Company of Detroit. About half of this material was used before epoxy patching was interrupted on October 19, 1961 by cold weather and by the fact that the epoxy failed to harden.

Repairs were continued until November 1, 1961 and patches were made with a mortar mixture containing Berylex. A primer coat consisting of a Cement-Air Entraining Berylex slurry was brushed in and mortar topping containing 1, 2 and 3 pounds of Berylex per bag of cement were placed near the east end of the bridge (extending 215 feet) and in the first slabs of the westbound lane near the west end.

Epoxy-tar patching was resumed in late July 1962 and a portion of the surface was sandblasted in preparation for sealing. A short section of the seal was applied, and it failed to harden. Three drums of the B-component were returned to the Permaplastic Company and replaced. During the interim, traffic tracked considerable asphaltic material onto the deck from nearby resurfacing work and work was deferred indefinitely.

In the succeeding months, a number of the Berylex-mortar and epoxy-sand patches worked loose and repairs were made with bituminous materials. Again, a decision was made to seal the deck with epoxy and a contract was awarded for supplying and applying an etching solution of hydrochloric acid and a sealant of coal-tar epoxy. All other materials, labor, and equipment required for the restoration were to be furnished by the Department.

Repairs were begun on July 20, 1964 (APPENDIX, Item 9). Large areas of concrete considered unsound were jackhammered to rout the deteriorated concrete. Holes to be patched were painted with a penetrating epoxy, Resiweld 7090, in order to seal cracks and harden the surface. Sand was sprinkled onto the epoxy after it became tacky; and after curing, the patches were primed with Guardkote 140 and filled with a sand-epoxy mortar containing four parts sand to one part epoxy (by volume). Patching operations were completed August 24, 1964.

Cleaning agents obtained from the National Chemsearch Corporation were used to remove asphalt, tar, oil, grease and paint from the deck. The eastbound lane was acid-etched with a 20 percent solution of hydrochloric acid on October 6, 1964 and the westbound lane was acid-etched with a similar solution on October 14, 1964.

The eastbound lane was primed with a penetrating epoxy (Resiweld 7090) and allowed to cure. The westbound lane was primed with the same material and sand was sprinkled onto the surface before curing. In some places, the penetrant did not cure properly and trash from farm trucks stuck to the penetrant in the eastbound lane. Sticky areas were cleaned with a solvent and wire brushes were used to clean major areas containing trash. The penetrating epoxy on the eastbound lane had a very smooth, glass-like finish and there was some concern about the ability of the Guardkote 140 to bond to such a slick surface.

The final sealing operation consisted of spraying Guardkote 140 from a Broyhill Distributor and sprinkling the freshly applied epoxy with sand from a farm-type, fertilizer spreader. On October 13, 1964, 3.18 pounds of epoxy per square yard were applied to the westbound lane. Gutter areas were sealed by squeegeeing epoxy onto the surface and sprinkling sand thereon. The spray bar on the distributor proved inadequate inasmuch as no adjustments could be made in the bar length. This deficiency necessitated hand finishing in the gutter line and a rough surface resulted. The fertilizer spreader was also inadequate since sand was spread in rows.

Serious failures of the repairs were soon evident and the deck was again repaired in 1967 by use of a 1-inch, Class I surface.

PRESENT CONDITION: In early 1967, the epoxy-sand seal was near total failure. Large areas of the seal failed in bond and it was rather evident that use of the penetrating epoxy lead to those failures. Numerous Berylex patches failed and naturally attributed to loss of seal in those areas. The Class I bituminous overlay (after 3 year service) has severely deteriorated throughout the entire deck. This deck is unusually rough.
Figure 236. US 150 over Southern RR, Danville, Boyle Co.; Condition Prior to Epoxy-Sand Seal (8-1-62).

Figure 237. Routed Areas in EB Lane (8-1-64).
Figure 238. Epoxy Application (10-16-64).

Figure 239. Spreading Sand on Tacky Epoxy (10-16-64).
Figure 242. Seal Did Not Bond in Some Areas (8-16-65).

Figure 243. Berylex-Cement Mortar Patch Spalled (6-8-65).
Figure 244. Transverse Cracks Reflected through Treatment (4-28-65).

Figure 245. Portion of Deck 3 Years after Application of Class I Surface over Epoxy-Sand Seal (2-27-70).
LOCATION: US 150 (Danville-Stanford Road) over Clark’s Run, 1.1 Mile SE of Danville, Boyle County

PROJECT: 11-120-3

COMPLETED: September 7, 1951

DESCRIPTION: 4-30' RCDG Spans; 26' Wide

TREATMENT: In August 1965, deteriorated concrete was routed, areas were cleaned with compressed air, primed with Guardkote 140 and patched with epoxy mortar. The mortar was composed of 68 pounds concrete sand, 63.5 pounds No. 9 crushed limestone and 2 gallons of epoxy. At the time of those repairs, 50 percent of the deck contained scaled or spalled areas.

In 1967, unsound concrete was routed and patched with epoxy mortar containing Guardkote 250. A Guardkote 250 epoxy-sand seal was placed over the entire deck upon completion of the patching operations.

PRESENT CONDITION: Approximately 30 percent of the epoxy-sand seal is missing from the deck. The gutters contain accumulations of soil and other debris and the majority of drains have become clogged. The riding surface is very uneven and rough.

Figure 246. US 150 over Clark’s Run, Boyle Co.; Note Severe Scaling before Treatment (8-10-65).
Figure 247. Routed Area in Foreground, Patched Area in Background (9-6-65).

Figure 248. Overall View 6 1/2 Years after Treatment (6-7-72).

Figure 249. Bond Failures of Seal (2-27-70).
FISHING CREEK BRIDGE

LOCATION: KY 80 (Somerset-Russell Springs Road) over Fishing Creek, Pulaski County

PROJECT: 100-235-5

COMPLETED: June 15, 1951

DESCRIPTION: Composite Steel Deck Girders and Deck Truss Spans; Length, 1208'; 26' Wide

TREATMENT: By 1965, both gutters and three slabs contained considerable spalling and scaling. The deck in the WB lane was sawed 3 to 4 feet from the curb on July 13, 1965 and portions of concrete were removed by use of a Tennant router and pavement breaker. Much of that concrete removed was sound and the saw line was thereafter disregarded and only deteriorated concrete was removed. Exposed steel in many areas was rusted. Routed areas were blown with compressed air and painted liberally with Guardkote 140. The areas were patched with an epoxy mortar consisting of 2 gallons Guardkote 140, 4.75 gallons concrete sand and 5 gallons No. 9 crushed limestone. In the summer of 1966, the entire deck was sealed with an epoxy-sand seal utilizing Guardkote 140.

PRESENT CONDITION: The seal is badly worn or missing from approximately 30 percent of the deck surface. The majority of joints have spalled and attribute heavily to rough riding qualities. Minor pot-holes are scattered throughout the deck. In contrast to the general deck condition, the gutters and drains are excellent.

Figure 250. KY 80 over Fishing Creek, Pulaski Co. (2-17-70).

Figure 251. Epoxy-Sand Mortar Patches were Tamped In Place (8-1-65).
Figure 252. Screeding Mortar Patch (8-1-65).

Joint-Associated Spall (2-17-70).

Figure 253. Joint-Associated Spall (2-17-70).

Figure 254. General Condition of Deck 4 1/2 Years after Treatment (2-17-70).
HONAKER'S FERRY BRIDGE

LOCATION: KY 185 over Green River, Sand Hill - Round Hill Road; Warren and Butler Counties

PROJECT: 16-236-2

COMPLETED: 1966; Sealed September 1966

DESCRIPTION: 120', 170', 120' Continuous Welded Plate Girder; Roadway Width, 28'

TREATMENT: An epoxy-sand seal (APPENDIX, Item 10) was placed on the deck immediately after construction as an experimental feature.

Many of the joints were spalled and were patched with epoxy prior to sealing. Deposits of tar and grease were removed with solvents and the deck was etched with a 16 percent hydrochloric acid solution and thoroughly rinsed.

The deck was marked into sections and Guardkote 140 was sprayed onto the surface at the rate of 3 pounds per square yard. Immediately after application of the epoxy, sand was sprinkled onto the surface by hand on the gutter and walk areas and by an adapted fertilizer spreader on the deck area. Work was performed on each lane separately.

The fertilizer spreader did not disperse sand over a wide area and the epoxy was pushed by the sand. Frequent stopping and starting of the spreader created transverse rows of sand. The spreader also formed windrows of sand longitudinally.

PRESENT CONDITION: The epoxy-sand seal has scaled minorly in a few areas. The deck is otherwise in excellent condition and similar treatments of this type may be desirable.

Figure 255. Ky 185 over Green River, Warren-Butler Co. Line; Deck was Acid Etched before Sealing (9-1-66).
Figure 256. Joints Were Patched with Epoxy (9-1-66).

Figure 257. Epoxy Was Sprayed on Plinth and Walk (9-14-66).
Figure 258. Epoxy Was Sprayed and Squeegeed onto Deck (9-14-66).

Figure 259. Sand Applied with Farm-Type Spreader (9-14-66).
Figure 260. View Immediately after Sand Application (9-14-66).

Figure 261. Joint Formed Due to Lapping Seal (9-14-66).

Figure 262. Overall View 4 Years after Construction (8-31-70).

Figure 263. Seal Has Minor Scaling (8-31-70).
ALTON ROAD BRIDGES

LOCATION: I 64 over Alton Road (KY 151) in Franklin County; Approximately 1.46 Miles East of Shelby County

PROJECT: 37-905-2

COMPLETED: November 26, 1960

DESCRIPTION: 3-50' Simple RCDG Spans; 30' Wide; Each Structure

TREATMENT: WB Deck - A two-component epoxy was broomed onto this deck in August, 1962 at a rate of 0.119 to 0.136 gallon per square yard. The deck was seriously slick and loose abrasive was applied in mid-September; however, skid resistance thereon did not return to a normal level until mid-December of that year. Areas containing thicker coatings of epoxy remained slick beyond that time.

EB Deck - A 3/8 inch layer of epoxy sand was placed on this deck in the spring of 1968. Guardkote 250 was used in the overlay. This deck had been treated with a 50-50 mixture of boiled linseed oil and mineral spirits in the summer of 1964.

PRESENT CONDITION: WB Deck - The entire deck has medium scaling. The east slab contains a 5-foot by 5-foot spalled area as result of inadequate cover over the top layer of reinforcing steel. The overall condition of this deck is judged as being fair.

EB Deck - No appreciable defects were noted and the overlay has performed quite well to date (3 years service).

Figure 264. WB I 64 over Alton Road, Franklin Co. (8-17-62).
Figure 265. WB Deck 8 Years after Treatment (3-16-70).

Figure 266. Spalled Area on East Slab of WB Deck, Area was Previously Patched (3-16-70).

Figure 267. EB Deck 2 Years after Epoxy-Sand Sealing (3-16-70).

Figure 268. Close-Up of Epoxy-Sand Seal on EB Deck (3-16-70).
TENNESSEE RIVER BRIDGE

LOCATION: US 60 and US 62 over Tennessee River in McCracken County; 2.7 Miles from Paducah City Limits

PROJECT: 73-32-2

COMPLETED: 1931

DESCRIPTION: 1-60' and 10-102' Steel Deck Plate Girders, 3-400' Steel Thru Trusses and 16-46' I Beam Spans; 20' Wide

TREATMENT: By 1968, the deck had medium to heavy scaling throughout and continued numerous transverse cracks. In the summer of that year, deteriorated areas were routed and patched and the deck was overlaid with an epoxy-sand seal containing Guardkote 250.

PRESENT CONDITION: The deck is in excellent condition.

Figure 269. US 60 and US 62 over Tennessee River, McCracken Co. (8-25-70).

Figure 270. Seal in Excellent Condition 2 Years after Placement (8-25-70).
CANTON - GOLDEN POND BRIDGE

LOCATION: US 68 and KY 80 over Cumberland River in Trigg County; 9.1 Miles from Cadiz

PROJECT: 111-254-10

COMPLETED: December 20, 1963

DESCRIPTION: 2-29' Box-Type Abutments, 48-45' Steel I Beam Spans, 2-121' St. Deck Trusses and 2-322' St. Thru Truss Spans; 20' Wide

TREATMENT: By early 1968, there was extensive scaling along the gutters of the west approach spans and spalling throughout the deck on the main spans. Scaled and spalled areas were routed and then patched with an epoxy-sand mortar. In some instances full-depth epoxy mortar patches were necessary and approximately 650 cubic feet of mortar were required for patches. An epoxy-sand seal, using Guardkote 250, was placed over the entire deck in the summer of 1968. Upon completion of the seal, areas containing pin holes were detected and those areas were retreated in the spring of 1969.

PRESENT CONDITION: The epoxy-sand seal was noted as being in excellent condition. The curbs and plinths were not repaired and contain numerous popouts.

Figure 271. US 68 and Ky 80 over Cumberland River, Trigg Co. (8-24-70).

Figure 272. Close-Up of Epoxy-Sand Seal 2 Years After Placement (8-24-70).

Figure 273. Joint-Associated Defect (8-24-70).
MILTON - MADISON BRIDGE

LOCATION: US 421 over Ohio River, Trimble County

PROJECT: 112-18-1

COMPLETED: Unknown (made toll free in 1938)

DESCRIPTION: 7-46' and 1-80' Steel Girders; 3-150' Deck Trusses; 1-334', 1-268', 1-126', 1-255' and 1-50' Thru Trusses; 20' Wide

TREATMENT: In the fall of 1969, an epoxy-sand seal was placed on the deck and curbs. At that time, there were numerous spalls throughout and the surface was rather slick as a result of polishing. Spalled areas were sawed, concrete was routed, areas were primed and then filled with epoxy-sand mortar. After patching, the entire deck was sandblasted. The seal was placed lane-at-a-time and traffic was maintained throughout the operation. Epoxy was applied at rates between 1.5 and 3 pounds per square yard. Epoxy used for patching and sealing was No. 7121 by H. B. Fuller Company. Sand was applied to the tacky epoxy at rates between 5 and 10 pounds per square yard. Reason for the wide range in rate of application of epoxy and sand was to provide for variations in slope and concrete porosity. It was also desired that only enough sand be applied to provide skid resistance.

PRESENT CONDITION: The deck is in excellent condition. A few transverse cracks have reflected through the seal.

Figure 274. US 421 over Ohio River, Trimble Co. (10-13-69).
Figure 275. Spalls Were Sawed, Routed, Primed and Patched with Epoxy-Sand Mortar (7-30-69).

Figure 276. Deck Was Sandblasted (9-29-69).
Figure 277. Unit for Placing Epoxy and Sand (9-24-69).

Figure 278. SB Lane after Sealing (9-24-69).
Figure 279. General View 20 Months after Sealing (5-24-71).

Figure 280. Transverse Cracks Reflected through Seal (5-24-71).
CLAY CITY - VAUGHNS MILL BRIDGE

LOCATION: KY 1057 over Mountain Parkway in Powell County

PROJECT: 99-180-HG 7

COMPLETED: August 7, 1962

DESCRIPTION: 34', 58', 56', 32' Simple RCDG Spans; 28' Wide

TREATMENT: In the summer of 1968, an epoxy-sand seal was placed on the deck. Spalled areas were sawed, routed, primed and patched with an epoxy-sand mortar. Guardkote 250 was used in the patching mortar and overlay.

PRESENT CONDITION: The overlay has scaled from gutter areas, particularly where water ponds. The expansion joint seals are missing throughout and the concrete near these joints has spalled. Otherwise, the seal is in good condition.

Figure 281. Ky 1057 over Mountain Parkway (8-26-70).

Figure 282. Joint Seals Missing and Concrete Spalled (8-26-70).
EGGNERS FERRY BRIDGE

LOCATION: US 68 over Tennessee River (Eggners Ferry) in Marshall County; 15.6 Miles from Benton

PROJECT: 79-93-12

COMPLETED: March 29, 1944

DESCRIPTION: 2-44', 18', 45' Steel I Beam Spans and 2-151', 1-368', 1-323' and 2-322' Steel Thru Truss Spans; 20' Wide

TREATMENT: The deck on the east approach spans was overlaid with an epoxy-sand seal in the summer on 1967. Prior to sealing, deteriorated concrete was routed, areas were primed and patches were made with epoxy-sand mortar. The epoxy-sand overlay was composed of epoxy formulated by Thermo-Flex, Inc. and white silica sand.

PRESENT CONDITION: The treated east approach deck is in excellent condition. Numerous popouts occur on the mainspan and west approach. No signs of scaling or spalling were observed on any portions of the deck.

Figure 283. US 68 over Tennessee River, Marshall Co.; View of East Approach (8-24-70).
WICKLIFF - CAIRO BRIDGE

LOCATION: US 51, 60, and 62 over Ohio River, Ballard County; 3.2 Miles North of Wickliff

PROJECT: 4-101-3

COMPLETED: No Record; Accepted February 5, 1951

DESCRIPTION: 59', 90', 3-80' Plate Girder Spans; 181' Deck Truss Span; 365', 800', 2-650', 365' Thru Truss Span; 59', 6-60', 2-90', 48', 2-90' Plate Girder Spans; 181', 7-182', 183' Deck Truss Spans; 20' Wide

TREATMENT: In the past, numerous areas on the deck and approach spans have been patched with either gunite, concrete or epoxy-sand mortar. Several patches failed rather rapidly due to raveling where they were feather edged. By 1966, the Illinois approach spans were showing signs of fracture plane disintegration and longitudinal cracking. A partial-depth concrete overlay was deemed necessary for restoration; however, as a temporary measure, an epoxy-sand seal was placed on those approach spans in the summer of 1968. Guardkote 250 was used in that work.

PRESENT CONDITION: There are numerous patches throughout the deck. Potholes are present and medium scaling was noted along the curbs and plinths. Spalling was evident on the southern portion of the deck and approach spans.

Figure 284. US 51, US 60 and US 62 over Ohio River, Ballard Co.; View of Illinois Approach Spans (8-25-70).

Figure 285. Deck Condition 2 Years after Sealing (8-25-70).
PITMAN CREEK BRIDGE

LOCATION: US 27 over Pitman Creek in Pulaski County

PROJECT: 100-335-3

COMPLETED: September 23, 1950

DESCRIPTION: 2-200', 300' Continuous Deck Truss Spans; 26' Wide

TREATMENT: In 1961, spalled areas were routed, primed and patched with an epoxy-sand mixture containing Guardkote 140. In the summer of 1967, the entire deck was scarified, unsound concrete was routed and these areas patched, the deck was primed and then overlaid with an epoxy-sand mixture containing Guardkote 140.

PRESENT CONDITION: A few transverse cracks have reflected through the overlay. There are 20 to 25 potholes throughout and the overlay has scaled from approximately 5 percent of the deck. Scaling is severe along the curbs and steel is exposed thereon.

Figure 286. US 27 over Pitman Creek, Pulaski Co. (2-17-70).

Figure 287. Spalls Patched with Epoxy-Sand Mortar (9-14-66).
Figure 288. Epoxy-Sand Overlay Scaled within 3 Years (2-17-70).

Figure 289. Severe Scaling along Curb (2-17-70).
SB CLAYS FERRY BRIDGE

LOCATION: I-75 over Kentucky River, Fayette-Madison County Line

PROJECT: 34-744-HG 2

COMPLETED: November 27, 1963

DESCRIPTION: 100' W.P. Girder; 192' Welded Truss, 320', 448', 320', Continuous W.P. Truss; 192' Welded Truss; 120' W.P. Truss; Total Length, 1711'; 30' Wide

TREATMENT: By the summer of 1970, there was medium to heavy scaling along the gutters. In an attempt at preventative maintenance, an epoxy-sand seal was placed on the deck that summer. The deck was sandblasted prior to placement of the seal. Fuller 1600 epoxy was sprayed onto the deck (lane-at-a-time) and silica sand was then broadcast over the tacky epoxy. Excess sand was removed after the epoxy hardened.

PRESENT CONDITION: The seal is quite uniform and appears in excellent condition. No defects were observed.

Figure 291. Overall View of Seal 8 Months after Placement (5-24-70).

Figure 290. SB I-75 over Kentucky River, Fayette-Madison Co. Line; Epoxy-Sand Seal Complete on Inner Lane (9-4-70).

Figure 292. Close-Up of Seal 8 Months after Completion (5-24-71).
AVON ROAD BRIDGE

LOCATION: KY 859 over I 64 in Fayette County; 2.0 Miles West of Clark County Line

PROJECT: 34-224-HG 2

COMPLETED: September 14, 1963

DESCRIPTION: 50', 70', 70', 50' RCDG; 30' Wide

TREATMENT: Several spalled areas have been repaired by patching with epoxy-sand mortar. Areas were primed with epoxy prior to patching.

PRESENT CONDITION: A large number of spalled areas are present and the large majority occur due to insufficient concrete cover. No cracks or scaling were observed.

Figure 293. Ky 859 over I 64, Fayette Co. (8-28-70).

Figure 294. Epoxy-Sand Mortar Patches are Missing in Some Areas (8-28-70).
US 460 BRIDGE

LOCATION: US 460 and KY 11 over I 64 in Montgomery County

PROJECT: 87-17-HG 1

COMPLETED: July 7, 1960

DESCRIPTION: 87', 87' Continuous RCDG; 30' Wide

TREATMENT: In October 1963, a 50-50 mixture of boiled linseed oil and mineral spirits was applied to the deck. In 1966, spalled areas were routed, primed with epoxy and patched with epoxy-sand mortar. Spalled areas have been similarly repaired as needed since 1966.

PRESENT CONDITION: Approximately 20 percent of the deck surface contains patches. It appears that spalls have been arrested and only minor scaling is present. A few transverse cracks exist.

Figure 295. US 460 and Ky 11 over I 64, Montgomery Co. (8-28-70).

Figure 296. Spalled Areas Patched with Epoxy-Sand Mortar (8-28-70).
US 60 BRIDGE

LOCATION: US 60 over I 64 in Clark County; 1.6 Miles East of US 60 - US 227 Junction

PROJECT: 25-22-5

COMPLETED: November 16, 1959

DESCRIPTION: 72', 93', 93', 72' Continuous RCDG Spans; 30' Wide

TREATMENT: Badly scaled areas along both gutters were patched with epoxy-sand mortar in 1962. A 50-50 mixture of boiled linseed oil and mineral spirits was applied to the deck in October 1963. In 1964, epoxy-sand mortar was placed in spalled areas on the deck.

PRESENT CONDITION: Medium scaling was noted along the curbs, walks, and unpatched gutter areas. Otherwise, the deck is in good condition.

Figure 297. US 60 over I 64, Clark Co. (8-28-70).

Figure 298. Patches after 6 Years Service (8-28-70).
CHEESELICK ROAD BRIDGES

LOCATION:     Bluegrass Parkway over
               Cheeselick Road in Anderson
               County; 0.5 Mile West of
               Mercer County Line

PROJECT:      3-81-CK 1

COMPLETED:    December 15, 1964

DESCRIPTION: 3-42' Simple RCDG Spans; 38'
              Wide; Each Structure

TREATMENT:    Portions of the gutters on the
              EB deck have been patched with epoxy-sand mortar.
              The patches were placed in the summer of 1968.

PRESENT CONDITION: Very light scaling is
                   present along the gutters on both decks. Both decks are
                   in excellent condition.

Figure 299.  EB Bluegrass Parkway over Cheeselick Road, Anderson Co. (8-31-70).
US 227 BRIDGE

LOCATION: US 227 and US 460 over I 75 in Scott County; 1 Mile East of Georgetown

PROJECT: 105-54-HG 5

COMPLETED: January 4, 1962

DESCRIPTION: 49', 70', 70', 49' Continuous RCDG; 30' Wide

TREATMENT: Perimeters of scaled and spalled areas were sawed, concrete was routed, areas were primed and then patched with epoxy-sand mortar. A 6-foot wide strip along both gutters was patched in 1967 using Guardkote 250. Spalled areas in the driving lanes have since been patched using either Guardkote 140 or 250.

PRESENT CONDITION: Several untreated spalls exist in the driving lanes. There is light scaling throughout the deck. The epoxy-sand mortar along the gutters is not well bonded and several sections are missing. Patches in the driving lanes have deteriorated severely and are completely missing in some areas.

Figure 300. US 227 and US 460 over I 75, Scott Co. (3-25-70).

Figure 301. Heavy Scaling in Gutter 3 Years after Construction (4-22-65).
Figure 302. Water Ponds along Gutter (4-22-65).

Figure 303. Patches after 3 Years Service (3-5-70).
VAN METER ROAD OVER I 64

LOCATION: Van Meter Road over I 64 in Clark County

PROJECT: 25-682-HG 2

COMPLETED: March 14, 1962

DESCRIPTION: 49', 70', 770', 49' RCDG; 30' Wide

TREATMENT: Epoxy-sand mortar patches were placed in spalled areas throughout the deck in 1970. Prepared areas have been primed with epoxy prior to placement of the mortar. Guardkote 250 has been used in the majority of patches and the perimeters of many areas have been sawed.

PRESENT CONDITION: Insufficient concrete cover above the top layer of steel apparently is the primary cause for the numerous spalled areas on this deck. The deck is quite rough as a result of numerous patches and unrepaired spalled areas.

Figure 304. Van Meter Road over I 64, Clark Co.; Perimeters of Spalled Areas were Sawed (8-28-70).

Figure 305. Previously Patched Spalls Continued to Deteriorate (8-28-70).
PRICE PIKE BRIDGES

LOCATION:  I 75 (New Covington-Lexington Road) over Price Pike Road; South of Mile Post 183, Boone County

PROJECT:  8-550-HG 4

COMPLETED:  October 26, 1960

DESCRIPTION:  3-50' RCDG Spans; 42' Wide; Each Structure

TREATMENT:  During the summer of 1965, both decks were patched with a mixture of epoxy and mortar sand. Repairs to the NB deck were mainly confined to 15 square feet of gutter areas. Approximately 20 square feet of the SB deck were patched and most of the work consisted of patching spalled joints.

PRESENT CONDITION:  Numerous popouts were observed on both decks. Concrete has spalled near joints on both decks and patches near joints on the SB deck have failed. Medium scaling is present along the gutters of the SB deck and light scaling was observed within gutters on the NB deck.

Figure 306. NB I 75 over Price Pike, Boone Co. (1-30-70).

Figure 307. Joint on NB Deck Repaired in 1965 and Deterioration Continued (1-30-65).

Figure 308. Portion of Repaired Joint on SB Deck Failed (1-30-70).
PRUITT ROAD BRIDGES

LOCATION: I 64 (Lexington-Catlettsburg Road) over Grassy Lick-Pruitt Road, Montgomery County

PROJECT: 87-557-HG 1

COMPLETED: July 26, 1960

DESCRIPTION: 3-53’ Simple RCDG Spans; 30’ Wide; Each Structure

TREATMENT: The decks were uneven and the contractor was required to smooth them by grinding high areas and filling low areas with Geo. W. Whiteside’s 59-D-3 (polysulfide-epoxy) binder and sand. The location and types of build-up attempted during June-July 1960, are shown in the accompanying sketch. Descriptions of the repairs are as follows:

B - Build-up consisting of mop-coat of binder sprinkled with sand and broomed. Procedure was repeated until desired template was achieved.

M - Binder and sand-mortar mix troweled into low areas and feather-edged.

P - High places ground, painted with epoxy, and sprinkled with sand.

A thin bituminous overlay was placed on the inner lane of the WB deck in the summer of 1968.

PRESENT CONDITION: The outside lane of the EB deck contains considerable scaling 1 to 1.5 inches in depth. Many of the patched areas on this deck are rough and uneven. The deck is rough and in fair condition. The outside lane of the WB deck is in much better condition than the companion EB deck. Ground areas on both decks have no visible traces of the sealant.

Figure 309. Repairs to I 64 Decks over Grassy Lick-Pruitt Road, Montgomery Co.
Figure 310. Built-Up Areas Missing on EB Deck Due to Progressive Spalling (10-21-70).

Figure 311. Bituminous Overlay on Inner Lane of WB Deck (10-21-70).
HINKSTON ROAD BRIDGE

LOCATION: Hinkston Road over I 64 in Montgomery County

PROJECT: 87-657-HG 1

COMPLETED: July 26, 1960

DESCRIPTION: 91', 91' Continuous RCDG; 26' Wide

TREATMENT: Prior to acceptance, high areas were ground and then sealed with two-component epoxy (by Sika Chemical Inc.) known as Colma Dur. A 50-50 mixture of boiled linseed oil and mineral spirits was applied to the deck, curbs and walks in October 1963. In the summer of 1968, sealed areas over approximately 20 percent of the deck were routed, primed and overlaid with an epoxy-sand mixture containing Guardkote 250.

PRESENT CONDITION: Portions of the epoxy-sand overlay have scaled from the north end of the deck. Heavy scaling occurs along the west gutter.

Figure 312. Hinkston Road over I 64, Montgomery Co. (8-28-70).

Figure 313. Heavy Scaling Present Along West Curb (8-28-70).

Figure 314. Overlay Scaling on North End (8-28-70).
US 62 BRIDGE

LOCATION: US 62 over I 75 in Scott County

PROJECT: 105-34-HG 4

COMPLETED: January 4, 1962

DESCRIPTION: 72', 100', 100', 72' Continuous RCDG; 30' Wide

TREATMENT: By the summer of 1966, both gutters contained heavy scaling. The perimeters of more severely deteriorated areas along the southern gutter were sawed and unsound concrete was routed by use of a Triplex tamper. Several cast iron pipe caps were epoxied to routed and unrouted areas in order that tensil tests might be made to determine the effect of routing concrete by use of the Triplex tamper. Tensil strengths within deteriorated, unrouted areas ranged between 450 to 550 psi. Concrete in the routed areas appeared quite sound; however, tensil strengths in those areas ranged from 50 to 100 psi.

PRESENT CONDITION: The epoxy-sand mortar placed along the south gutter in 1966 is still intact and appears to be in good condition except for a few chipped areas near the driving lane. Spalling is critical throughout the remainder of the deck and is obviously the result of insufficient concrete cover. Steel is within 1/2 inch of the surface in numerous locations.

An epoxy formulation supplied free by Celanese Resins, Inc. was used for patching. Areas were primed with the mixed epoxy and then mortar composed of 2 gallons epoxy and 9 to 11 gallons of white silica sand was deposited. Mortar was tamped and then screeded to desired elevation. In the summers of 1967 and 1968, spalled areas were routed and patched with epoxy-sand mortars. Mortars placed in 1967 contained Guardkote 140 and those placed in 1968 contained Guardkote 250.
Figure 317. Steel Was within 1/2 Inch of Concrete Surface (9-9-66).

Figure 318. Coring in Preparation for Tensil Test (9-9-66).
Figure 319. Areas Were Primed Prior to Placing Mortar (9-10-66).

Figure 320. Note Liberal Application of Priming Epoxy (9-10-66).
Figure 321. Epoxy-Sand Mortar Placed in 1966 is Still Intact (3-25-70).

Figure 322. Spalling Has Continued Adjacent to Patches (3-25-70).
**DELAPLAIN ROAD BRIDGE**

**LOCATION:** Delaplain Road over I 75 in Scott County; 1 Mile East of US 25

**PROJECT:** 105-934-HG 1

**COMPLETED:** January 4, 1962

**DESCRIPTION:** 59', 85', 85', 59' Continuous RCDG; 30' Wide

**TREATMENT:** On various occasions, deeply scaled areas have been routed, primed and patched with epoxy-sand mortar containing Guardkote 140.

**PRESENT CONDITION:** The curbs and plinths are excellent. Unusually severe scaling is predominate along both gutters. In some instances, scaling is 2 inches in depth and has exposed reinforcing steel. Light to medium scaling occurs in the driving lanes. Poor drainage has probably led to conditions noted on this deck. Water ponds along both gutters.

Figure 323. Delaplain Road over I 75, Scott Co.; Some Areas Have been Repatched (8-26-70).

Figure 324. Scaling is Severe along Untreated Gutter Areas (8-26-70).
ROGERS GAP ROAD BRIDGES

LOCATION:  I 75 over Rogers Gap Road in Scott County; 6.2 Miles North of US 460

PROJECT:  105-554-HG 4

COMPLETED:  August 31, 1962

DESCRIPTION:  25', 35', 30' RCDG; 30' Wide; Each Structure

TREATMENT:  In the summer of 1968, scaled and spalled areas were routed and patched with epoxy-sand mortars. All work was performed by a Department crew and two epoxies, DB-5140 and ECA-1111, were supplied by Celanese. Both epoxies were light colored extended type. White silica sand was used and areas to be patched were primed prior to placement of the mortar.

PRESENT CONDITION:  SB Deck - The deck is quite rough as a result of extensive patching and is otherwise in fair condition.

NB Deck - One spall was noted in the center of the center span. This deck is also quite rough as a result of numerous patches.

Figure 325. SB I 75 over Rogers Gap Road, Scott Co.; Note Extensive Patching Required as Result of Spalling (10-2-68).

Figure 326. NB I 75 over Rogers Gap Road, Scott Co. (10-2-68).
BURTON ROAD BRIDGES

LOCATION: I 75 over Burton Road and Little Eagle Creek in Scott County

PROJECT: 105-554-BHG 1

COMPLETED: December 4, 1961

DESCRIPTION: 3-50' and 1-25' RCDG; 30' Wide; Each Structure

TREATMENT: In the summer of 1968, scaled and spalled areas were routed and patched with epoxy-sand mortars. Areas were primed with epoxy prior to placement of the mortar. Two epoxies, DB-5140 and ECA-1111, by Celanese and white silica sand were used for the mortars. Both epoxies were light colored extended type. The time of set for each epoxy was too short for suitable use on hot days.

PRESENT CONDITION: SB Deck - Both gutters contain heavy scaling over 30 to 40 percent of their areas. The mortar patches appear to be in good condition.

NB Deck - Light to medium scaling was noted along both gutters. All patches appeared to be in good condition. Considerable spalling was noted at an expansion joint.

Figure 327. NB I 75 over Burton Road, Scott Co.; View after Completion of Patches (10-2-68).

Figure 328. Joint-Associated Spalling on NB Deck (2-13-70).
LITTLE EAGLE CREEK BRIDGES

LOCATION:  I 75 over US 25 and Little Eagle Creek in Scott County
PROJECT:  105-554-BHG 6
COMPLETED:  August 31, 1962
DESCRIPTION:  60', 91', 91', 60' Continuous RCDG; 30' Wide; Each Structure

TREATMENT:  In the summer of 1968, scaled and spalled areas on these decks were routed and patched with epoxy-sand mortar containing Guardkote 140. The areas were primed prior to placement of the mortar.

PRESENT CONDITION:  SB Deck - There is medium scaling along the gutters in areas that have not been patched. Patched areas along the gutters appear to be performing satisfactorily.

   NB Deck - Heavy scaling was noted throughout this deck and it is particularly heavy in the outside gutter. Numerous transverse cracks and three spalls were observed. The performance of this deck is quite poor as compared to that of the adjacent SB deck.

Figure 329.  SB I 75 over US 25, Scott Co. (5-8-72).
Figure 330. NB I 75 over US 25, Scott Co. (5-8-72).

Figure 331. Heavy Scaling along Gutter on NB Deck before Patching (9-14-66).
MAYSVILLE SUSPENSION BRIDGE

LOCATION: US 62 over Ohio River, Mason County

PROJECT: 81-4015-1

COMPLETED: December 1, 1931

DESCRIPTION: 7-59' Thru Girders; 2-78' Thru Girders; 2-465' Suspension; 1060' Suspension; 1-62' Thru Girder and 2-29' Thru Girders; 20' Wide

TREATMENT: Spalled areas, predominately in the wheel tracks, have been sawed, routed, primed and patched annually since the summer of 1967. Epoxy-sand mortar patches with Guardkote 140 were placed in 1967. Similar patches with Guardkote 140 were placed in 1968. Portland cement concrete patches were placed in 1969 and epoxy-sand as well as concrete patches were placed in 1970. In several instances, deterioration continued after patching and perimeters of patches were patched.

PRESENT CONDITION: This deck has worn considerably in recent years. Wear has probably led to the high incidence of spalling within the past 3 to 4 years. Only minor transverse cracking was observed.

Figure 332. US 62 over Ohio River, Mason Co. (4-12-71).

Figure 333. Many Areas have Patches Adjacent to Patches (4-12-70).

Figure 334. Spalling is Confined Primarily to Wheel Tracks (4-12-70).
KY 395 OVER I 64

LOCATION: KY 395 over I 64 in Shelby County, 1.9 Miles South of US 60

PROJECT: 106-286-HG 3

COMPLETED: November 26, 1960

DESCRIPTION: 48', 50', 48' RCDG Spans; 30' Wide; Each Structure

TREATMENT: KY 395 over EB Lanes of I 64 - In February 1970, the perimeters of spalled areas were sawed, unsound concrete was removed, areas were primed with epoxy and epoxy-sand mortar was used for patching.
KY 395 over WB Lanes of I 64 - No treatment.

PRESENT CONDITION: KY 395 over EB Lanes of I 64 - Several spalled areas have been patched and numerous spalls remain untreated. The deck is generally in poor condition. Insufficient concrete cover apparently has led to the condition observed.
KY 395 over WB Lanes of I 64 - One spall and several small popouts were noted. This deck is in much better condition than the adjacent structure over EB I 64.

Figure 335. Ky 395 over EB Lanes of I 64, Shelby Co. (3-2-70).

Figure 336. Spalling Was Widespread throughout EB Lanes Deck (3-2-70).

Figure 337. Ky 395 over EB Lanes of I 64 (3-2-70).
DECKS HAVING ADDITIONAL REINFORCEMENT

Two, three-span, continuous decks have been designed with extra steel in an attempt to minimize transverse cracking. The first deck contained extra steel in negative-moment areas only. Cracking occurred between extremities of the additional steel. In the second bridge, the steel was continuous.
BIG BRUSH CREEK BRIDGE

LOCATION: KY 61 over Big Brush Creek in Green County; NW of Greensburg

PROJECT: 44-16-4

COMPLETED: October 28, 1967

DESCRIPTION: 65', 90', 65' Continuous RCDG Spans; 24' Wide

TREATMENT: In an effort to minimize deck cracking, additional longitudinal reinforcement was placed in the slab in negative moment regions of the beams. The total percentage of steel in those sections was 1.81.

PRESENT CONDITION: To date, no transverse cracks have been detected in sections containing the addition steel. Transverse cracks have developed between the extremities of additional longitudinal reinforcement and the ultimate objective was not totally achieved.

Figure 338. Ky 61 over Big Brush Creek, Green Co.; Transverse Crack in Region without Additional Reinforcement (8-28-70).
Figure 339. Plan View of Big Brush Creek Bridge.
Figure 340. Plan and Section Views.
Figure 341. Steel Was Supported and Tied to Forms to Prevent Movement during Concreting (9-1-67).

Figure 342. Transverse Cracks Continue across Deck (10-17-67).
BAYS FORK CREEK BRIDGE

LOCATION: KY 1288 over Bays Fork Creek; Allen County

PROJECT: 2-575-4 L

COMPLETED: August 13, 1970

DESCRIPTION: 3-57 Continuous RCDG Spans; 22' Wide

TREATMENT: As a result of performance on the Big Brush Creek Bridge in Green County, another bridge was designed for the inclusion of extra steel continuously throughout the length of the deck. The Bays Fork Creek Bridge is fixed at both piers to offset the buoyant effect in the event of inundations during flooding. The percent longitudinal steel used in the deck was 0.99 throughout.

PRESENT CONDITION: Only minor transverse cracks were noted. Actually, the structure has not been in service sufficient time to ascertain the benefits of additional steel.

Figure 343. Sectional View of Ky 1288 Bridge across Bays Fork Creek, Allen Co.
Figure 344. Plan View for Ky 1288 over Bays Fork Creek.
Figure 345. Location of Cracks Noted 12-18-70.
Figure 346. General View of Deck (6-7-72).
REPLACED DECKS

By necessity, a few decks have been replaced entirely and full-depth replacement has been required on only portions of other decks. Evaluation of the extensiveness of damage sustained by decks is a most difficult and frustrating task. What appeared to be sound concrete has been found to be unsound under the hammer, and estimates of quantities of concrete to be removed have sometimes been grossly inaccurate. Complete replacement has been necessary for a few decks that were let to contract for overlaying and full-depth replacement for small portions. There is a definite need for reliable means of estimating quantities involved for various repairs in deck restorations.
RUSSELL FORK BRIDGE

LOCATION: KY 195 (Marrowbone-Hellier Road) over Russell Fork near Junction KY 80, Pike County

PROJECT: 98-243-1

COMPLETED: 1921 by County, Accepted for Maintenance November 27, 1934

DESCRIPTION: RC Triple Spandrel-Braced Arch, RCDG Span, RC Slab; Reinforced Concrete Deck Probably Contains Local Creek Gravel; Length, 498'; 15' Wide

TREATMENT: The deck, handrails, and arch members had deteriorated badly; and in many areas, the deck had failed. Repairs were initiated on October 25, 1955. Arch members and handrails were patched with gunite. Part of the deck at the east end was removed and replaced. The remainder of the deck was chipped to remove dead concrete; steel anchors or stirrups were grouted into deck; and the entire deck was overlaid with 120 cubic yards of concrete. Daraweld (polyvinyl acetate latex, Dewey-Almy Chemical Company) was used as a bond coat on 48 feet of the deck at the east end. Restoration cost was $15,000.

The handrails were later removed and replaced with galvanized, steel guardrail. The entire deck has been overlaid with a bituminous chip seal.

PRESENT CONDITION: The chip seal is missing from the deck except for minor areas in the gutter. There is spalling near the joints. The guardrail is rusting and wide cracks have developed in the plinth. Narrow cracks were noted on the deck.

Figure 347. Ky 195 over Russell Fork, Pike Co. (10-25-55).
Figure 348. Overall View of Deck 15 Years after Restoration (8-26-70).

Figure 349. Joint Associated Spall (8-26-70).
On the basis of core analysis and extensive visual inspection, it was determined that full-depth patching would only be necessary in localized areas and an overlay of portland cement concrete would suffice for the remainder of the deck.

A contract was let for the anticipated repairs and work was initiated in the summer of 1968. As the work progressed, it soon became evident that replacement of the entire deck would be necessary. The contract was amended and work on complete deck replacement was completed in 1969. A Special Provision for Class AA Concrete used in this work is contained in the Appendix.

PRESENT CONDITION: The deck is in excellent condition and no defects were observed. The curbs and walks were not replaced and heavy scaling was noted.
Figure 351. Walk Was Not Restored (2-13-70).

Figure 352. Deck is Reinforced with Plain Bars (6-27-68).
SOUTHERN RR BRIDGE

LOCATION: US 421 over Southern RR in Fayette County

PROJECT: 34-184-OH 1

COMPLETED: May 23, 1936

DESCRIPTION: 15-40' RCDG and 147' Steel Thru Truss Span; 24' Wide

TREATMENT: The deck of this structure performed quite favorably until early in 1965. At that time, it became necessary to place bituminous patches in minor areas of deterioration and do full-depth patching with portland cement concrete in other areas. Patching from time to time continued until May of 1969, at which time, a contract was let for restoration of the entire deck. The work was to involve full-depth replacement in some areas, removal of concrete to the top mat of steel in all other areas and then placement of 2 inches of portland cement concrete thereover. Soon after work began, it became evident that replacement of the entire deck would be more feasible.

The original plans were revised and the entire deck, including reinforcement, was removed. The original beams and girders were left in place and a new deck was placed thereon by conventional construction procedures.

PRESENT CONDITION: Transverse shrinkage cracks are present throughout the entire deck. No other visible defects were observed.

Figure 353. US 421 over Southern RR, Fayette Co.; Viewing South (8-26-70).

Figure 354. Beginning in 1965, Full-Depth Deck Failures Commenced (8-18-65).
Figure 355. Deck was Entirely Removed (8-19-69).

Figure 356. Elevation of Top Mat of Steel Checked by Passing Finishing Shoe over Surface (8-26-69).

Figure 357. View of Deck One Year after Replacement (8-26-70).
CLARK MEMORIAL BRIDGE

LOCATION: US 31 E over Ohio River at Second Street in Louisville, Jefferson County

PROJECT: 56-8118-7

COMPLETED: 1928-29, Accepted for Maintenance November, 1946; Accepted from City June 16, 1947

DESCRIPTION: Composite Steel Deck Girders and Steel Thru Truss Spans; Ohio River Gravel used as Aggregate in Concrete Deck; Length, 4,789'; 38' Wide

TREATMENT: By 1958, deterioration was so widespread that continual bituminous patching had become routine. In that year, maintenance crews routed all patches and unsound concrete and filled major depressions with portland cement concrete. Shallow areas were patched with sand asphalt. By contract, the surface was primed with PAC 3 cutback and a 0.4-inch sand-asphalt surface was placed at a cost of $13,325. By the second winter, extensive spalling had developed and considerable patching was required. On October 6, 1961, the deck was overlaid with a seal coat of RS 2 and wet-bottom boiler slag. A spinner seal treatment of Kentucky Rock Asphalt was applied to portions of the approaches in October 1962.

Early in 1965, extensive signs of serious deterioration were most evident and a committee was appointed to investigate the structure and make recommendations thereon. The deck was cored extensively and a photographic survey was made of both the top and bottom of the deck for estimating purposes. After a very thorough study of procedures employed by other states in restoration of similarly deteriorated decks, a 2-inch bonded concrete overlay was chosen as more desirable of the various alternates. Plans and special provisions (APPENDIX, Item 8) were prepared and work began July 17, 1967.

All previous overlays were removed and the approach slabs were entirely removed. Full depth removal of the slab was also necessary in numerous areas on the main spans. Those areas were patched full depth, exposed steel was cleaned and studs or dowels were grouted into place prior to placement of the overlay. The overlay used consisted of Class "AA" concrete modified to provide for a slump of 1 inch plus or minus 1/2 inch. The concrete was placed and screeded full width by use of a Bidwell deck-finishing machine. After screeding, the concrete was finished by means of a Kelly Vibrator Compactor. Curing was accomplished by use of two applications of white membrane curing compound.

An epoxy-sand seal was placed on the walks. The work was scheduled for completion on June 7, 1968 and was actually completed soon thereafter. Three sets of Special Provisions were prepared for this work and they are appended hereto for convenient reference. The total cost of deck restoration was approximately $935,000 and a copy of the final work estimate is included with this description for reference. In October 1969, transverse cracks in the overlay were sealed with a penetrating-type epoxy.

PRESENT CONDITION: The entire deck appears to be in excellent condition.
### KENTUCKY DEPARTMENT OF HIGHWAYS
### CONTRACTOR'S WORK ESTIMATE

**Project Number:** SP-056-0118-00032  
**Contractor's Name and Address:** SHAHROCK CORP OF KENTUCKIANA  
P.O. BOX 14146  
258 FILER AVE  
LOUISVILLE KENTUCKY 40214  
**Vendor No.:** 1510-4125  
**Road Name:** LOUISVILLE-BARDSTOWN

**Class of Construction:**  
**Liquidation:** 241,781.12  
**Disbursement:** 241,781.12  
**Underrun:**

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<th>Project Data</th>
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<td>06-10-1960</td>
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**Account No.:** 210-40  
**Enc. No.:** 100061  
**For Work Done:** 07-17-67 to 06-07-68

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### Repairs to Clark Memorial Bridge

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**Hash Total:** -1822600

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**Resident Engineer:**  
**District Engineer:**

---
Figure 358. US 31 E over Ohio River, Jefferson Co. (4-17-67).
Figure 359. Bituminous Patches Failed Rapidly (8-8-58).

Figure 360. South Ramp after Removal of Patches (10-12-58).
Figure 361. Condition of North Ramp in 1960 (3-6-60).

Figure 362. Black Beauty Slag Seal on North Ramp (1-11-62).
Figure 363. View of Walk on North Ramp (8-7-65).

Figure 364. View of South Approach in 1967 (4-3-67).
Figure 365. Spreading of Grout Bond Coat before Overlaying (12-6-67).

Figure 366. Kelly Compactor Used for Finish (12-6-67).
Figure 367. Final Finish with Brooms (12-6-67).

Figure 368. Cracks in Overlay Sealed with Penetrating-Type Epoxy (3-5-70).

Figure 369. Deck on Main Span 1 1/2 Years after Replacement (3-5-70).
NON-TREATED DECKS
KY 15 BRIDGE

LOCATION: KY 15 over Mountain Parkway in Powell County; 2.5 Miles East of KY 213 in Stanton; Powell County

PROJECT: 99-60-HG 10

COMPLETED: July 23, 1962

DESCRIPTION: 64', 82', 82', 64' Continuous RCDG; 29' Wide

TREATMENT: None

PRESENT CONDITION: Small areas throughout the deck appear to have been patched with mortar which subsequently deteriorated. The areas do not appear to be results of scaling or spalling. In general, this deck is in good condition.

Figure 370. Ky 15 over Mountain Parkway (5-8-72).

Figure 371. Deck is in Generally Good Condition (5-8-72).
KY 11 AND KY 15 BRIDGE

LOCATION: KY 11 and KY 15 over Mountain Parkway in Powell County; 2.5 Miles East of Clark County Line

PROJECT: 99-60-HG 11

COMPLETED: June 8, 1962

DESCRIPTION: 60', 80', 80', 80', 60' Continuous RCDG Spans; 28' Wide

TREATMENT: None

PRESENT CONDITION: There is light to medium scaling along both gutters. Two spalled areas resulting from insufficient cover above the steel were observed. This deck is otherwise in good condition.

Figure 372. Ky 11 and Ky 15 over Mountain Parkway, Powell Co. (8-26-70).

Figure 373. Medium Scaling along Gutter (8-26-70).

Figure 374. Insufficient Concrete Cover Caused Premature Spalling (8-26-70).
**WATERTON EXPRESSWAY BRIDGES OVER US 60**

<table>
<thead>
<tr>
<th>LOCATION:</th>
<th>I 264 over US 60 in Jefferson County</th>
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<tr>
<td>PROJECT:</td>
<td>56-8898-HG 22</td>
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<tr>
<td>COMPLETED:</td>
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<tr>
<td>DESCRIPTION:</td>
<td>4-51' RCDG Spans; 42' Wide; Each Structure</td>
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<tr>
<td>TREATMENT:</td>
<td>None</td>
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<tr>
<td>PRESENT CONDITION:</td>
<td>Both decks are in excellent condition.</td>
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*Figure 375. EB I 264 over US 60, Jefferson Co. (2-27-70).*

*Figure 376. WB I 264 over US 60, Jefferson Co. (2-27-70).*
WALTERSVILLE INTERCHANGE BRIDGE

LOCATION: KY 15 over Mountain Parkway at Waltersville Interchange in Powell County

PROJECT: 99-100-HG 10

COMPLETED: August 7, 1962

DESCRIPTION: 45', 57', 57', 57' Simple RCDG Spans; 54' Wide

TREATMENT: None

PRESENT CONDITION: The deck is in excellent condition except for minor shrinkage cracks noted in both lanes of the center spans.

Figure 377. Ky 15 over Mountain Parkway, Powell Co.; Viewing South (8-26-70).

Figure 378. Shrinkage Cracks in Center Span (8-26-70).
NB HENDERSON-EVANSTLE BRIDGE

LOCATION: NB US 41 over Ohio River, Henderson County; 3.5 Miles from Henderson

PROJECT: 51-19-1

COMPLETED: July 7, 1932

DESCRIPTION: 5,395' Long; 30' Wide

TREATMENT: None

PRESENT CONDITION: Considering age, this deck is in remarkable condition. The only signs of deterioration noted were sections of the curb that have scaled severely.

Figure 379. NB US 41 over Ohio River, Henderson Co. (8-26-70).

Figure 380. Portion of Curb Disintegrated (8-26-70).
UPPER HOWARD'S CREEK BRIDGES

LOCATION: Mountain Parkway over Upper Howard's Creek in Clark County; 9.7 Miles East of I 64

PROJECT: 25-602-EK 5

COMPLETED: August 21, 1963

DESCRIPTION: 3-50' RCDG; 30' Wide; Each Structure

TREATMENT: None

PRESENT CONDITION: Light scaling was observed throughout both decks and medium scaling was present along all gutters. The west span on the WB deck contains three spalls due to insufficient concrete cover.
**LEMON'S MILL ROAD BRIDGE**

<table>
<thead>
<tr>
<th>LOCATION:</th>
<th>Lemon's Mill Road over I 75 in Scott County, 1.3 Miles East of Georgetown</th>
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<tr>
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<td>105-574-HG 1</td>
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<tr>
<td>COMPLETED:</td>
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<td>DESCRIPTION:</td>
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<tr>
<td>TREATMENT:</td>
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<tr>
<td>PRESENT CONDITION:</td>
<td>The deck is in excellent condition.</td>
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Figure 384. Lemon’s Mill Road over I 75, Scott Co. (3-5-70).

Figure 385. Deck is in Excellent Condition (3-5-70).
CUMBERLAND RIVER BRIDGE

LOCATION: US 641 and US 62 over Cumberland River in Lyon County; 6.5 Miles West of Kuttawa

PROJECT: 72-171-7

COMPLETED: November 14, 1952

DESCRIPTION: 344' and 342' Continuous Girder Spans, 700' Main Truss and 81' Girder Span; 26' Wide

TREATMENT: None

PRESENT CONDITION: Small popouts were noted throughout the deck. Very light scaling is present along the gutters and curbs. Approximately 100 feet of slab near pier 8 is severely pitted and several full-depth transverse cracks were noted on the east end of the deck. Generally, the deck is in good condition.

Figure 386. US 641 and US 62 over Cumberland River, Lyon Co.; Deck is in Good Condition, Except for Minor Popouts (8-25-70).
ASHBROOK-WILLISBURG BRIDGE

LOCATION:    KY 53 over Bluegrass Parkway in Anderson County; 1.2 Miles North of Washington County Line

PROJECT:     3-131-HG 7

COMPLETED:   April 23, 1965

DESCRIPTION: 55', 58', 55', 55' Simple RCDG Spans; 30' Wide

TREATMENT:   None

PRESENT CONDITION: No defects were observed and the overall condition is excellent.

Figure 387. Ky 53 over Bluegrass Parkway, Anderson Co. (6-7-72).
SMITHLAND BRIDGE

LOCATION: US 60 over Cumberland River at Smithland, Livingston County

PROJECT: 70-70-1

COMPLETED: 1931

DESCRIPTION: 35' I Beam Span, 8-101' Deck Plate Girders, 500' Thru Truss and 4-101' Deck Plate Girders; 20' Wide

TREATMENT: None

PRESENT CONDITION: Considering the age, this deck is in excellent condition. Light scaling occurs along the gutters and walks. Minor popouts were noted throughout the length of the deck. Two expansion joints have buckled slightly.

Figure 388. US 60 over Cumberland River, Livingston Co. (8-25-70).

Figure 389. Considering Age, Surface is in Good Condition (8-25-70).
NEWBERG ROAD BRIDGE

LOCATION: Newburg Road over Inner Belt Line in Jefferson County

PROJECT: 56-788-HG 1

COMPLETED: July 22, 1955

DESCRIPTION: 79', 79' RC Box Girder Spans; 56' Wide

TREATMENT: None

PRESENT CONDITION: An extensive survey was made of this deck in May 1966. Very few signs of deterioration were observed at that time except for transverse cracks at approximately 2.5-foot intervals. The cracks were observed on the lower slab of the box. During the most recent survey, popouts were observed throughout the length of the deck. A large spall was noted on the south slab in the NB lanes. The general appearance of this deck is good except for the conditions described.

Figure 390. Newberg Road over Inner Belt Line, Jefferson Co. (2-27-70).

Figure 391. Only Spall Noted was in NB Lane on South Slab (2-27-70).

Figure 392. Transverse Cracks at 2 1/2-Foot Intervals (2-27-70).
REED-SPOTTSVILLE BRIDGE

LOCATION: US 60 over Green River in Henderson County; 9.3 Miles from Junction with US 41

PROJECT: 51-59-5

COMPLETED: 1930

DESCRIPTION: 2-50' RCDG Spans, 360' Thru Truss, 160' Thru Truss and 4-115' Steel Deck Truss Spans; 20' Wide

TREATMENT: None

PRESENT CONDITION: The deck is in remarkably excellent condition. Very light spalling was noted along the centerline and pot marks about 2 inches deep and 10 inches in diameter were noted at 8- to 10-feet intervals.

Figure 393. US 60 over Green River, Henderson Co. (8-26-70).
NEWTOWN PIKE BRIDGES

LOCATION: KY 922 (Newtown Pike) over New Circle Road in Fayette County

PROJECT: 34-7344-HG 1

COMPLETED: November 22, 1964

DESCRIPTION: 49', 57', 57', 49' Simple WF; 30' Wide; Each Structure

TREATMENT: None

PRESENT CONDITION: Both decks are in excellent condition.

Figure 394. EB Ky 922 over New Circle Road, Fayette Co. (8-26-70).

Figure 395. WB Ky 922 over New Circle Road, Fayette Co. (8-26-70).
INDIAN FALLS ROAD BRIDGE

LOCATION: KY 89 (Indian Falls Road) over Mountain Parkway in Clark County

PROJECT: 25-942-HG 1

COMPLETED: June 27, 1962

DESCRIPTION: 60', 78', 60' RCDG Spans with 2-45' Tailspans; 26' Wide

TREATMENT: None

PRESENT CONDITION: The performance of this deck has been excellent. The only defects noted were transverse cracks at approximately 20-foot intervals.

Figure 396. Ky 89 over Mountain Parkway, Clark Co. (5-30-72).

Figure 397. Transverse Cracks Extended through Slab (6-30-65).
NORTH ELKHORN CREEK BRIDGES

LOCATION:  I 75 over North Elkhorn Creek in Scott County; 0.3 Miles South of US 460

PROJECT:  105-554-12

COMPLETED:  August 10, 1963

DESCRIPTION:  80', 100', 80' RCDG; 30' Wide; Each Structure

TREATMENT:  None

PRESENT CONDITION:  Both decks are in excellent condition. Only a few very small popouts were observed in these decks.

Figure 398.  SB I 75 over North Elkhorn Creek, Scott Co. (3-5-70).

Figure 399.  NB I 75 over North Elkhorn Creek, Scott Co. (3-5-70).
ROCK QUARRY BRIDGES

LOCATION: 175 over Rock Quarry Road in Scott County; 0.9 Miles South of US 460

PROJECT: 105-554-HG 11

COMPLETED: August 10, 1963

DESCRIPTION: 51'-6" Composite Steel-Concrete Deck; 40' Wide; Each Structure

TREATMENT: None

PRESENT CONDITION: Both decks are in excellent condition.

Figure 400. SB I 75 over Rock Quarry Road, Scott Co.; Bidwell Finishing Machine (5-24-63).

Figure 401. SB Deck in Excellent Condition (3-25-70).

Figure 402. NB Deck, Viewing North (3-25-70).
SB BIG EAGLE CREEK BRIDGE

LOCATION: SB I 75 over Big Eagle Creek and Service Road in Scott County; 12.6 Miles North of US 62

PROJECT: 105-554-BHG 13

COMPLETED: October 22, 1962

DESCRIPTION: 45' Simple RCDG; 75', 105', 75' Continuous RCDG; 30' Wide

TREATMENT: None

PRESENT CONDITION: Transverse cracks were observed throughout the length of this deck. The only other sign of deterioration was minor scaling along the gutters.

Figure 403. SB I 75 over Big Eagle Creek, Scott Co.; Minor Scaling on Gutters and Transverse Cracks Were Noted (1-30-70).
HATTON CREEK ROAD BRIDGE

LOCATION: Hatton Creek Road over Mountain Parkway in Powell County

PROJECT: 99-50-HG 1

COMPLETED: July 23, 1962

DESCRIPTION: 46', 59', 60', 46' Continuous RCDG Spans; 24' Wide

TREATMENT: None

PRESENT CONDITION: The deck is in excellent condition.

Figure 404. Hatton Creek Road over Mountain Parkway, Powell Co. (8-26-70).
STONER CREEK BRIDGES

LOCATION: I 64 over Stoner Creek in Clark County; 1.8 Miles West of Montgomery County Line

PROJECT: 25-422-1

COMPLETED: November 16, 1959

DESCRIPTION: 80', 104', 80' Continuous RCDG Spans; 30' Wide; Each Structure

TREATMENT: None

PRESENT CONDITION: EB Deck - Medium scaling and popouts were noted throughout this deck. Otherwise, performance has been good.

WB Deck - Light scaling was noted throughout. This deck looks better than the companion EB deck.

Figure 405. EB I 64 over Stoner Creek, Clark Co. (5-2-72).
HATTON CREEK ROAD BRIDGE

LOCATION: Hatton Creek Road over Mountain Parkway in Powell County

PROJECT: 99-50-HG 1

COMPLETED: July 23, 1962

DESCRIPTION: 46', 59', 60', 46' Continuous RCDG Spans; 24' Wide

TREATMENT: None

PRESENT CONDITION: The deck is in excellent condition.

Figure 404. Hatton Creek Road over Mountain Parkway, Powell Co. (8-26-70).
STONER CREEK BRIDGES

LOCATION: I 64 over Stoner Creek in Clark County; 1.8 Miles West of Montgomery County Line

PROJECT: 25-422-1

COMPLETED: November 16, 1959

DESCRIPTION: 80', 104', 80' Continuous RCDG Spans; 30' Wide; Each Structure

TREATMENT: None

PRESENT CONDITION: EB Deck - Medium scaling and popouts were noted throughout this deck. Otherwise, performance has been good.

WB Deck - Light scaling was noted throughout. This deck looks better than the companion EB deck.

Figure 405. EB I 64 over Stoner Creek, Clark Co. (5-2-72).
Figure 406. Medium Scaling Was Noted on EB Deck (5-2-72).

Figure 407. WB I 64 over Stoner Creek, Clark Co. (5-2-72).
REFERENCES


APPENDIX A
ITEM 1

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS

SPECIAL PROVISION NO. 8-A
FOR

LINSEED OIL PROTECTIVE COATING

This Special Provision covers the material requirements and application procedures for a linseed oil-petroleum spirits mixture to be used as a protective coating for designated surfaces of concrete structures. This Special Provision shall be applicable to individual projects only when indicated on the plans, in the proposals, or in bidding invitations.

I. DESCRIPTION

This work shall consist of the preparation of the surfaces to be treated, and furnishing and applying the materials as hereinafter specified.

II. MATERIALS

The protective coating mixture shall consist of 50 percent boiled linseed oil and 50 percent petroleum spirits by volume. The linseed oil shall comply with AASHO Specification M 126, except that the specific gravity shall not be less than 0.932. The petroleum spirits (mineral spirits) shall comply with AASHO Specification M 128.

III. APPLICATION

The protective coating shall be applied in two applications to the entire top surface of the bridge deck, the top surfaces and inside faces of curbs, the top surfaces of sidewalks, the top and inside vertical surfaces of plinths or sidewalk parapets, and the top and inside vertical surfaces of abutment or end-bent wing walls. An additional application shall not be required, as directed by the Engineer, for any areas completely sealed by the first two coatings.

The concrete shall be at least 14 days old before the first coating is applied. The concrete surfaces shall have at least a 48-hour drying period just prior to the application of the mixture and shall be cleaned of all oil, grime, and loose particles which will prevent the mixture from penetrating the concrete. Immediately before the application of the mixture, an air blast shall be directed over the surfaces to be treated so that all dust will be removed.

Before the linseed oil coating mixture is applied, all joint seals shall be given a protective covering meeting with the approval of the Engineer. This protective covering shall consist of a strip of non-absorbent paper (waterproof paper for curing concrete) or other equally effective material; shall be of sufficient width to adequately cover the joint; and shall be taped securely to the deck along the edges of the joint. The protective strip shall be secured in such a manner and shall remain in place for a sufficient time as will insure against the linseed oil mixture entering the joint and contaminating the sealer.

The mixture shall be applied by spraying under a pressure of not less than 30 nor more than 40 pounds per square inch. Each coat shall be applied at a rate of application not to exceed 50 square yards per gallon of the mixture. The spray nozzles shall be within 12 inches of the concrete or as otherwise directed by the Engineer. Hand methods may be permitted. The interior of the equipment shall be thoroughly cleaned prior to placing the mixture therein.

Unless otherwise directed by the Engineer, the temperature of the concrete and air shall be 50 degrees F or higher at the time of application.

The second application of the protective coating mixture shall not be made until the concrete, in the opinion of the Engineer, has regained its dry appearance, and not earlier than the day following the application of the previous coating.

Caution: As the linseed oil-mineral spirits mixture has a low flash point and is readily flammable, all fires, including cigarettes and sparks, shall be carefully guarded against.

Areas where grinding was required to correct surface irregularities shall be etched by an application of a 10 per cent hydrochloric acid solution, unless these areas have been sealed previously with an epoxy resin sealer. Any area treated with an acid solution shall be thoroughly flushed with water as soon as the effervescence has stopped, and shall be allowed to dry before the protective coating is applied.

When practicable, the treated surfaces shall be closed to all traffic, except the sealing equipment, until the concrete has regained its dry appearance.
IV. MEASUREMENT AND PAYMENT

Payment will be made at the unit price bid per square yard for "Protective Coating" for the actual area coated as specified, which payment shall be full compensation for preparation of the surface, furnishing, and applying the materials, and for furnishing all labor, equipment, and incidentals necessary to complete the work.

APPROVED

A. O. NEISER
STATE HIGHWAY ENGINEER
ITEM 2

KENTUCKY DEPARTMENT OF HIGHWAYS

SPECIAL PROVISION NO. 30-B

MEMBRANE CURING OF CONCRETE STRUCTURES

This Special Provision shall be applicable when indicated on the plans or in the proposal, and shall only supersede any conflicting requirements of the Department's 1965 Standard Specifications for Road and Bridge Construction. Article references herein are to the Standard Specifications.

I. DESCRIPTION

The general requirements are as follows:
1. The concrete in bridge decks between the curb lines shall be cured with a white pigmented liquid membrane-forming compound, in addition to the curing methods required in Article 403.3.7.
2. Concrete surfaces throughout the structures that are designated to receive an Ordinary Surface Finish in accordance with Article 403.3.8, may be cured with a clear liquid membrane-forming compound, if the Contractor elects, in lieu of the curing methods required in Article 403.3.7.
3. Concrete surfaces designated to receive a Rubbed Surface Finish, in accordance with Article 403.3.8, shall not be cured with liquid membrane-forming compounds, but shall be cured as required by the Standard Specifications.
4. Concrete surfaces designated to receive a Floated Surface Finish, in accordance with Article 403.3.8, may be cured with either a clear or white pigmented liquid membrane-forming compound, if the Contractor elects, in lieu of the curing methods required in Article 403.3.7.
5. In all instances, all the concrete in structures shall be effectively cured with the materials and methods described herein and/or the Standard Specifications and particular attention shall be directed to bridge decks between the curb lines to use both white pigmented membrane-forming compound and a method described in Article 403.3.7 and repeated hereinafter.

II. MATERIALS

The liquid membrane-forming compounds shall conform to the applicable requirements of AASHO M 148 for:

Type 1. Clear or translucent
or
Type 2. White Pigmented.

Sampling and testing of the material shall be in conformance with the Department's Manual of Field Sampling and Testing Procedures.

III. CONSTRUCTION METHODS

The application, protection, and maintenance of the liquid membrane-forming compound and other items shall conform to the following requirements:
1. The liquid membrane-forming compounds shall not be diluted or altered in any manner, but shall be thoroughly agitated immediately prior to application.
2. The compounds, if too viscous for application because of chilling or other cause, shall be warmed in a water bath to approximately 100° F. prior to application.
3. All concrete surfaces to receive the compound shall be inspected and approved by the Engineer and shall be slightly damp before application of the compound is started.
4. The white pigmented compound shall be applied to the bridge deck immediately after the concrete has been placed and finished and before the surface of the concrete has a dry appearance.
5. The compounds shall be applied uniformly by an approved pressure sprayer in 2 separate applications at the rate of 1 gallon per 300 square feet or less for each application on areas as measured by the Engineer. As soon as the first application to an area is completed, the second application shall be started at the beginning point of the first application and the entire area shall be given the second application.
6. Any remaining dry or porous spots or areas not completely sealed by the 2 applications shall be given additional applications immediately following the second application so that a continuous watertight membrane will be formed.
IV. MEASUREMENT AND PAYMENT

Payment will be made at the unit price bid per square yard for "Protective Coating" for the actual area coated as specified, which payment shall be full compensation for preparation of the surface, furnishing, and applying the materials, and for furnishing all labor, equipment, and materials necessary to complete the work.

APPROVED

A. O. NEISER
STATE HIGHWAY ENGINEER
ITEM 2

KENTUCKY DEPARTMENT OF HIGHWAYS

SPECIAL PROVISION NO. 30-B

MEMBRANE CURING OF CONCRETE STRUCTURES

This Special Provision shall be applicable when indicated on the plans or in the proposal, and shall only supersede any conflicting requirements of the Department's 1965 Standard Specifications for Road and Bridge Construction. Article references herein are to the Standard Specifications.

I. DESCRIPTION

The general requirements are as follows:

1. The concrete in bridge decks between the curb lines shall be cured with a white pigmented liquid membrane-forming compound, in addition to the curing methods required in Article 403.3.7.

2. Concrete surfaces throughout the structures that are designated to receive an Ordinary Surface Finish in accordance with Article 403.3.8, may be cured with a clear liquid membrane-forming compound, if the Contractor elects, in lieu of the curing methods required in Article 403.3.7.

3. Concrete surfaces designated to receive a Rubbed Surface Finish, in accordance with Article 403.3.8, shall not be cured with liquid membrane-forming compounds, but shall be cured as required by the Standard Specifications.

4. Concrete surfaces designated to receive a Floated Surface Finish, in accordance with Article 403.3.8, may be cured with either a clear or white pigmented liquid membrane-forming compound, if the Contractor elects, in lieu of the curing methods required in Article 403.3.7.

5. In all instances, all the concrete in structures shall be effectively cured with the materials and methods described herein and/or the Standard Specifications and particular attention shall be directed to bridge decks between the curb lines to use both white pigmented membrane-forming compound and a method described in Article 403.3.7 and repeated hereinafter.

II. MATERIALS

The liquid membrane-forming compounds shall conform to the applicable requirements of AASHO M 148 for:

Type 1. Clear or translucent
or
Type 2. White Pigmented.

Sampling and testing of the material shall be in conformance with the Department's Manual of Field Sampling and Testing Procedures.

III. CONSTRUCTION METHODS

The application, protection, and maintenance of the liquid membrane-forming compound and other items shall conform to the following requirements:

1. The liquid membrane-forming compounds shall not be diluted or altered in any manner, but shall be thoroughly agitated immediately prior to application.

2. The compounds, if too viscous for application because of chilling or other cause, shall be warmed in a water bath to approximately 100° F. prior to application.

3. All concrete surfaces to receive the compound shall be inspected and approved by the Engineer and shall be slightly damp before application of the compound is started.

4. The white pigmented compound shall be applied to the bridge deck immediately after the concrete has been placed and润ed and before the surface of the concrete has a dry appearance.

5. The compounds shall be applied uniformly by an approved pressure sprayer in 2 separate applications at the rate of 1 gallon per 300 square feet or less for each application on areas as measured by the Engineer. As soon as the first application to an area is completed, the second application shall be started at the beginning point of the first application and the entire area shall be given the second application.

6. Any remaining dry or porous spots or areas not completely sealed by the 2 applications shall be given additional applications immediately following the second application so that a continuous watertight membrane will be formed.
7. Either white pigmented or clear compound, when applied to Float Finished Surfaces, shall be applied immediately after the concrete has been placed and finished and before the surface of the concrete has a dry appearance.

8. The clear compound, when applied to concrete surfaces that have received an Ordinary Surface Finish, shall be applied after all the work required by Article 403.3.8 has been performed and the concrete surfaces have been lightly dampened, just before the application of the compound. During the required finishing operations, curing methods of Article 403.3.7 shall be used.

9. In all instances, care shall be exercised to prevent the compound from being applied to any reinforcing steel, concrete surfaces to be bonded to other concrete, or any portions of the substructure or superstructure that are to receive protective coatings (except the deck between the curb lines). Any compound that is applied to unauthorized surfaces shall be completely removed by whatever means necessary prior to continuing the work, except that no acids or other methods that may be injurious to the concrete or steel shall be permitted.

10. No walking upon the applied compound, nor the placing of any kind of materials that may damage the application shall be permitted in the hours immediately following the application and not until the membrane has set sufficiently to withstand being damaged easily.

11. Immediately after minor variations in the bridge deck have been corrected by rubbing in accordance with Article 411.3.3-J, the rubbed areas and all other areas where the membrane has been damaged shall receive 2 applications of the liquid membrane-forming compound.

12. Immediately following the rubbing and the 2 applications of the compound to all damaged areas of the membrane on the deck, the entire area of the deck between the curb lines shall be covered with a double thickness of burlap or cotton mats or a layer of sand, straw or earth not less than 3 inches in thickness in accordance with Article 403.3.7, and the material and the deck shall be kept continuously wet for the remainder of the 7-day period that is required from the time the concrete was placed.

IV. MEASUREMENT AND PAYMENT

No direct payment will be allowed for this work as the cost of furnishing and applying the membrane-forming compound shall be included in the contract unit price of concrete.

APPROVED

A. O. NEISER
STATE HIGHWAY ENGINEER
ITEM 3
KENTUCKY DEPARTMENT OF HIGHWAYS

SPECIAL PROVISION NO. 35-B
CLASS "AA" CONCRETE

This Special Provision shall be applicable when indicated on the plans, in the proposal, or in the bidding invitation, and shall supersede any conflicting requirements of the Department's 1965 Standard Specifications. Section references herein are to the Standard Specifications.

I. DESCRIPTION

This work shall consist of the furnishing and construction of Class "AA" Concrete in bridge superstructures in accordance with the applicable requirements of Sections 403, 404, and 411, except as otherwise provided.

II. MATERIALS

All ingredients of the Class "AA" Concrete shall comply with the material requirements of Section 403.

III. CONSTRUCTION METHODS

The construction methods shall conform to the applicable requirements of the Standard Specifications, and, in addition, the Class "AA" Concrete shall conform to the following requirements:

<table>
<thead>
<tr>
<th>Coarse Aggregate Size</th>
<th>No. 37</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free Water Content</td>
<td>Max. of 3 gal/bag cement.</td>
</tr>
<tr>
<td>Cement Content</td>
<td>Min. of 6 1/2 bags/yd. concrete.</td>
</tr>
<tr>
<td>Air Content</td>
<td>6 ± 2 per cent by volume.</td>
</tr>
</tbody>
</table>

Expected 28-Day Compressive Strength

<table>
<thead>
<tr>
<th>Module of Rupture</th>
<th>No. of Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>6</td>
</tr>
</tbody>
</table>

28-Day Compressive Strength Tolerances

In accordance with a method of ASTM C94, the adequacy of the concrete will be determined as hereinafter specified. Not more than 20 percent of the strength tests shall have values less than 4500 psi, and the average of any 6 consecutive strength tests shall be equal to or greater than 4500 psi.

When the number of tests made is six or less, the average of all the tests shall be equal to or greater than the values shown in the following table:

<table>
<thead>
<tr>
<th>No. of Tests</th>
<th>Required Average Strength of Consecutive Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3555</td>
</tr>
<tr>
<td>2</td>
<td>4050</td>
</tr>
<tr>
<td>3</td>
<td>4230</td>
</tr>
<tr>
<td>4</td>
<td>4356</td>
</tr>
<tr>
<td>5</td>
<td>4455</td>
</tr>
<tr>
<td>6</td>
<td>4500</td>
</tr>
</tbody>
</table>

APPROVED

A. O. NEISER
STATE HIGHWAY ENGINEER
ITEM 4
COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
SPECIAL PROVISION NO. 36-A
FOR
SET-RETDARING ADMIXTURES FOR CONCRETE

This Special Provision shall be applicable to individual projects only when indicated on the plans or in the proposal or when ordered or permitted in writing by the Engineer.

I. DESCRIPTION

This Special Provision covers the requirements for materials and construction procedures for water-reducing, set-retarding admixtures to be used in the construction of concrete bridge superstructures.

When the prevailing air temperature is 75 degrees F. or higher at the time the concrete is being placed, the Contractor shall add an approved admixture to the concrete mix, unless otherwise directed by the Engineer.

All water-reducing, set-retarding admixtures shall be approved by the Department before being used.

II. MATERIALS

A. General Requirements.

The admixture shall meet the requirements of ASTM Specification C 494 for Type D, Water-Reducing and Retarding Admixture. It may or may not contain air-entraining properties and may be furnished in liquid or powder form. If furnished in powder form, the admixture shall be prepared in liquid form before it is added to the concrete mix.

B. Approval.

The admixture accepted for use shall be an admixture approved by the Department on evidence of its compliance with test requirements as hereinafter specified under paragraph C.

Acceptance shall be made on the basis of one of the following procedures:
1. Approval by the Laboratory from results of tests made with samples furnished by the Contractor;
2. Approval by the Department on evidence that it had been tested by a recognized laboratory and found to comply with all requirements, provided two certified copies of the test report is furnished the Department by that Laboratory; or
3. Approval by the Department upon certification by the manufacturer, furnished by the Contractor, stating that the admixture is identical in composition with that previously approved.

When the admixture is to be tested by the Laboratory, the Contractor shall provide the Engineer with samples of the admixture and representative job aggregates for testing at least 120 days prior to its use in the work.

If the admixture is approved on the basis of tests from a recognized laboratory, such laboratory shall be one regularly inspected by the Cement and Concrete Reference Laboratory of the American Society for Testing Materials.

C. Acceptance Tests.

1. Test Data.

The test data shall be obtained by use of concreting materials and methods that meet the requirements of the current ASTM Specification C 494, except as otherwise specified herein.

The test for resistance to freezing and thawing shall be conducted in accordance with ASTM Method C 290 or C 291.

An approved air-entraining admixture shall be used if the retarder does not entrain sufficient air.
2. Properties.

Concrete containing the admixture, when compared with the reference concrete, shall show the following properties:

a. The volume of the mixing water shall be reduced at least 5 percent.
b. The air content of the retarded concrete shall be from 5 to 7 percent.
c. The compressive strength at ages of 3, 7, and 28 days shall be increased at least 10 percent.
d. The flexural strength shall not be reduced.
e. The relative durability factor for the freezing and thawing test shall not be less than 90.

III. CONSTRUCTION METHODS

Proportioning, mixing, and placing the concrete shall be in accordance with the applicable requirements of the Department's current Standard Specifications for Road and Bridge Construction as pertains to concrete for structures, and as may be further provided on the plans or in the proposal.

The admixture shall be delivered to the project in the manufacturer's original container labeled to show the name of the manufacturer and the content. Acceptance tests of certification of approval shall be required for each shipment of the material.

For each continuous structural unit, the concrete containing the admixture shall be produced with cement of the same brand and from the same source, with fine aggregates from one source, and with coarse aggregates from one source.

The admixture, in liquid form, shall be metered accurately into the batch at the mixer by means of an automatic device, and in the quantities recommended by the manufacturer or as directed by the Engineer.

The quantity of admixture per batch may be adjusted, as approved by the Engineer, for the purpose of reducing the setting time of the concrete as the work progresses toward the completion of each placement.

The approved status of the admixture is dependent upon its satisfactory performance on the job. If control of the concrete setting time becomes unsatisfactory to the Engineer, the placing of concrete shall be discontinued, and tests to determine the rate of setting and the strength of the concrete may be performed. The work shall be resumed when satisfactory test results have been obtained, or as otherwise directed by the Engineer.

IV. METHOD OF MEASUREMENT AND BASIS OF PAYMENT

The set-retarding admixture will not be measured for payment as the cost thereof shall be included in the unit price bid per cubic yard of concrete.

No additional payment will be allowed the Contractor for the acceptance tests specified, nor for delays occurring because of tests or because of unsatisfactory performance of the admixture.

APPROVED

A. O. NEISER
STATE HIGHWAY ENGINEER
ITEM 5

KENTUCKY DEPARTMENT OF HIGHWAYS
SPECIAL PROVISION NO. 48-A

BRIDGE DECK REPAIRS

This Special Provision shall be applicable when indicated in the plans, proposal, or bidding invitation.

I. DESCRIPTION

This work shall consist of the furnishing of all labor, materials, equipment, etc. necessary to repair concrete bridge decks. Unless otherwise specified, this work includes:

1. Traffic maintenance, protection and control.
2. Removal of all bituminous surfacing and patching materials.
3. Removal of all inferior concrete to partial or full depth.
4. Removal of specified existing joint materials.
5. Patching to partial or full depth with the materials and in the manner specified.
6. Blast cleaning areas to receive epoxy slurry.
7. Applying epoxy-sand slurry.
8. Reconstruction of joints.
9. Other items designated in the proposal.

All work shall be performed in accordance with the following:

1. This Special Provision.
2. The Department's 1965 Standard Specifications.
3. Other Special Provisions listed in the plans or proposal.
4. The plans. (Plans will not ordinarily be prepared for routine work.)
5. Any other requirements in the proposal.

Section and Article references herein are to the 1965 Standard Specifications.

II. MATERIALS

A. Epoxy Cement.

1. General Requirements.

The epoxy cement shall be a gray pigmented two component system and shall be either Shell Oil Company's Guardkote 250, H. B. Fuller Company's Resiweld BC 062, or approved equal.

The two components shall be supplied in separate containers which are non-reactive with the materials contained therein. The containers shall be identified as "Component A - Contains Epoxy Resin" and "Component B - Contains Hardener," and shall show the type, mixing directions, and usable temperature range. Each container shall be marked with the name of the manufacturer, the lot or batch number, the date of packaging, the type of pigmentation, and the quantity contained therein in pounds and gallons. Potential hazards shall be stated on the package in accordance with the Federal Hazardous Products Labeling Act.

2. Basis for Acceptance.

A letter of certification from the manufacturer indicating that the epoxy cement complies with the specifications on file with the Materials Division shall be presented to the Engineer by the Contractor.
3. **Sampling and Testing.**

The Engineer shall obtain separate, one-quart check samples of each component in each lot or shipment and forward them and the certification to the Division of Materials. Failure of check samples to conform to the applicable specification requirements on file shall be cause for the epoxy cement to be rejected and removed from the job site.

B. **Aggregate.**

1. **Fine Aggregate.**

   a. **Sand for Epoxy-Sand-Stone Mortar Patching Mixtures.**

      The fine aggregate for patching mixtures shall be natural sand conforming to Article 611.2.1.

   b. **High-Silica Sand for Epoxy-Sand-Slurry Mixtures.**

      The fine aggregate for the slurry mixtures shall contain not less than 90 percent silica and shall be rounded to sub-angular in shape, clean, dry, and non-friable. The gradation of the sand shall be as follows:

      | Sieve  | Percent Passing |
      |--------|-----------------|
      | No. 8  | 100             |
      | No. 12 | 95-100          |
      | No. 40 | 0-6             |

2. **Coarse Aggregate for Epoxy-Sand-Stone Mortar Patching.**

   The coarse aggregate for patching mixtures shall be size No. 8 or 9M crushed limestone conforming to Article 612.2.4.

3. **Sampling and Testing.**

   Both fine and coarse aggregates shall be sampled and tested in accordance with the Division of Materials' "Manual of Field Sampling and Testing Practices."

C. **Portland Cement Concrete.**

   The concrete for full-depth patching shall be Class "AA" conforming to the current issue of Special Provision No. 35.

D. **Grout.**

   The Portland cement for the grout bond-coat shall conform to applicable requirements of Section 601 and the fine aggregate shall be one of those specified above or shall be mortar sand as specified in Article 611.4.0. The grout shall consist of a one to one (1:1) mixture of Type I Portland cement and sand with sufficient water to produce a grout of uniform spreading consistency.

E. **Preformed Expansion Joint Filler.**

   The preformed joint filler shall conform to AASHO M 153 for Type II.

F. **Joint Sealing Compound.**

   Joint sealing compound shall be of the hot-poured elastic type conforming to Article 622.2.0.

### III. CONSTRUCTION METHODS

All necessary traffic controls, signs, devices, and flagmen shall be properly placed and functioning and approved by the Engineer before any work is started. The work shall progress in an orderly manner, in the sequence generally outlined herein, and so as to minimize delays and hazards to traffic and workmen.

A. **Removal of Bituminous Surface and Patches.**

   All bituminous patching and surfacing materials shall be removed in a manner approved by the Engineer; however, hammers exceeding 40 pounds in weight or any other equipment that may cause damage to the underlying concrete shall not be used.
B. Removal of Inferior Concrete.

The Engineer will determine the extent of scaled, deteriorated, or loosely bonded concrete by sounding or tapping the deck with a hammer or rod, or by other practical means. The exterior edges as indicated by the Engineer shall be sawed to a minimum depth of 3/4 inch unless reinforcing steel is encountered at a lesser depth. All inferior concrete shall be removed with concrete routing machines or with pavement breakers not exceeding 40 pounds in weight and equipped with chisel type bits at least 3 inches wide. Heavier breakers or sharp pointed bits will not be tolerated, as sound concrete may be inadvertently damaged by their use.

Should the removal of inferior concrete extend through approximately 2/3's of the depth of the concrete deck or more, then the remaining portion of sound concrete shall be removed and the hole repaired as outlined for full-depth patching.

All exposed reinforcing steel shall be blast cleaned to bright non-rusted steel before the epoxy mortar or concrete is allowed to be placed. If the exposed steel is not covered with epoxy mortar or concrete within 24 hours after blasting, or shows a rust film at an earlier time, it shall be blast cleaned a second time. All dust, sand, and chips in the routed areas shall be removed with compressed air. Air compressors shall have suitable separators and traps to remove all water and oil from the compressed air.

Inferior concrete in the deteriorated and spalled areas near the joints shall be removed, and all joint filler removed. The joints shall be reformed by the installation of a template made of styrofoam, of timber and covered with polyethylene sheeting, or of other suitable material.

C. Full-Depth Patching.

The surfaces of the sound concrete that will be contacted by a full-depth patch shall be dampened and surface-dried and a grout bond-coat shall then be applied by scrubbing or brushing it into the vertical surfaces of full-depth routed areas. The Class "AA" concrete shall be carefully placed and tamped or vibrated into place. Patched areas shall be finished to an elevation corresponding to that of the original deck and shall be cured for a period of not less than 7 days by an approved curing method. If the concrete surrounding a full-depth patch requires partial-depth removal, then the full-depth concrete patch shall be finished to an elevation corresponding to the bottom of the partial-depth routed areas instead of the elevation of the original deck. After the concrete has hardened sufficiently to maintain the proper shape, all joint templates shall be removed in a manner to avoid chipping or breaking down the edges of the repaired joint.


1. Mix Design.

All partial-depth routed areas shall be filled with an epoxy-sand-stone mortar mixture consisting of the following quantities of materials:

- 1 gallon Component A,
- 1 gallon Component B,
- 5 gallons loose, dry sand, and
- 5 gallons loose, dry stone.

The above quantities shall be defined as one standard batch for the purpose of measurement and payment.

2. Mixing and Placing Mortar.

One gallon of Component A and one gallon of Component B shall be poured into a suitable mixer and thoroughly mixed for a minimum of 3 minutes. The aggregates shall be slowly added and the mixture allowed to mix, usually for approximately 5 minutes, until all aggregate is well coated. Just prior to placing the mortar, a light prime coat of neat epoxy cement shall be brushed into the bottom and edges of the routed area. The epoxy cement shall consist of equal portions of Component A and Component B that have been mixed for a minimum of 3 minutes. The mortar shall then be placed into the routed area,
leveled, compacted with a hand tamper, screeded to the elevation of the original deck, troweled smooth, and sprinkled with dry silica sand. All joint templates shall be removed prior to the hardening of any adjacent mortar patches.

The mortar shall be placed when the deck is dry and the deck temperature is 60° F. or above; and if below 70° F., when the temperature is rising. Vehicular and foot traffic over the patches shall be prohibited until the mortar has sufficiently hardened to withstand the loads.

No full-depth patching with epoxy-sand-stone mortar shall be done without the written consent of the Director of Maintenance or his authorized representative and then only in the manner and at the locations designated in the authorization.

E. Blast Cleaning of Areas to Receive Epoxy-Sand Slurry.

All pitted areas, cracks, and rough surfaces of existing sound concrete shall be blast cleaned. Air pressure shall be the minimum necessary to accomplish the work, and all vehicular traffic and pedestrians shall be effectively protected from any damage by blast cleaning operations in a manner approved by the Engineer. The surface shall be blast cleaned until it is free from all loose dirt, oil, grease, grime, bituminous material, paint, and other foreign material and the old concrete has a new-like appearance. Prior to the application of the slurry, all dust, chips, bituminous material, paint and other debris shall be removed and the entire surface to receive the slurry shall be cleaned with compressed air. All compressed air shall be free of water, oil, grease, or other substances and the compressor shall have suitable separators and traps for this purpose. Protective sheeting shall be suspended under any equipment which leaks.

F. Application of Epoxy-Sand Slurry.

All the blast cleaned pitted areas, cracks, and rough surfaces of existing sound concrete shall receive an application of the slurry. The deck must be dry when slurrying is started and not have been subject to rain within 36 hours preceding the application of the slurry. Before applying the slurry, all joints in the area receiving the application shall be protected by placing strips of masking tape along the joints in a manner to exclude the slurry from the joints.

The epoxy-sand slurry mixture shall consist of:

1 gallon of Component A, 
1 gallon of Component B, and 
2 gallons of dry, high-silica sand.

The above quantities shall be considered as one batch for the purpose of measurement and payment. The ingredient materials shall be thoroughly mixed from 3 to 5 minutes. The slurry shall then be spread and squeegeed as smoothly and uniformly as possible so as to completely fill the blast cleaned pitted areas, cracks, and rough surfaces. The finished elevation of the slurry shall be no more than 1/16 inch above the original elevation of the deck. High-silica sand shall be sprinkled very lightly over the slurry so as to prevent slipperiness.

If coverage of the entire deck with the slurry mixture is specified in the proposal, the entire deck including patches shall be sandblasted and the mixture shall be applied as outlined above so as to provide a thin, continuous coating approximately 1/16 inch thick.

G. Cleaning and Sealing Joints.

After all the above work has been accomplished, each joint shall be reworked as follows:

1. All remaining joint sealer and filler materials, incompressibles, and other foreign materials shall be removed down to the water stop of 7 inches below the top of the deck if no water stop exists. Care shall be taken to avoid damaging the water stop and any damage shall be repaired at the Contractor's expense.
2. All vertical faces of the joint shall be blast cleaned to a depth of 1 1/4 inches so as to be free of all bituminous material, tar, grease, and other materials which would prevent the best possible bond between the concrete and the joint sealing compound.

3. A preformed joint filler, of the proper dimensions, shall be inserted into the joint. The filler shall be of such depth that when resting on the water stop, it will be 1 1/4 inches below the top of the joint.

4. Before the joint sealing compound is applied, the joint shall be inspected as to its condition relative to cleanliness. When this condition meets with the approval of the Engineer, the joint shall be sealed with the joint sealing compound. The joint shall be filled to within 1/4 inch of the top surface of the deck. All joints shall be sealed from the outside face of one plinth to the outside face of the other plinth, including the deck, curbs, sidewalks, and plinths.

IV. METHOD OF MEASUREMENT

The quantities to be paid for will be measured in units of completed and accepted work, as hereinafter specified. In computing quantities, all dimensions used shall be those measured by the Engineer.

A. Removal of Bituminous Overlay, when required by the contract, will be measured by area in square yards. The removal of intermittent patches made with bituminous mixtures will not be measured for payment but will be considered incidental to the concrete or epoxy work.

B. Class "AA" Concrete Bridge Floor Patching will be measured by volume in cubic yards.

C. Epoxy-Sand-Stone Mortar Patching will be measured in standard batches as defined under paragraph III-D-1. When batches are of a size other than standard, the quantities will be converted to standard batches by the Engineer. One standard batch is considered to have a volume of 1.06 cubic feet.

D. Blast Cleaning will be measured by area in square yards. Only blast cleaning in preparation for the application of epoxy slurry will be measured for payment. All other blast cleaning of reinforcing steel, etc. will be considered incidental to the concrete or epoxy work.

E. Epoxy-Sand Slurry will be measured in standard batches as defined under Paragraph III-F. When batches are of a size other than standard, the quantities will be converted to standard batches by the Engineer. One standard batch is considered to have a volume of 0.47 cubic foot.

F. Joint Sealing will be measured in linear feet.

V. BASIS OF PAYMENT

The accepted quantities thus measured shall be paid for at the contract unit prices. Payment will be made under:

Pay Item | Pay Unit
--- | ---
Removal of Bituminous Overlay | Square Yard
Class "AA" Concrete Bridge Floor Patching | Cubic Yard
Epoxy-Sand-Stone Mortar Patching | Standard Batch
Blast Cleaning | Square Yard
Epoxy-Sand Slurry | Standard Batch
Joint Sealing | Linear Foot

Such payment shall be full compensation for furnishing all materials, equipment, labor, and tools, for traffic maintenance, protection, and control; for the disposal of inferior concrete and all other debris; and for all other incidentals necessary to complete the work in an acceptable manner.

APPROVED

A. O. NEISER
STATE HIGHWAY ENGINEER
ITEM 6
COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS

SPECIAL PROVISION NO. 54

FOR

EPOXY MEMBRANE COATING

This Special Provision covers the material requirements and application procedures for an epoxy cement membrane to be applied to designated surfaces of concrete structures, and shall be applicable to individual projects only when indicated on the plans, in the proposal, or in the bidding invitation.

I. DESCRIPTION

This work shall consist of the application of an epoxy cement waterproofing membrane and fine aggregate as an interlayer over a previously prepared concrete bridge deck, prior to the placement of a bituminous concrete surfacing course. This membrane is intended to serve as a moisture barrier for the purpose of protecting the concrete bridge deck against freeze-thaw damage.

II. MATERIALS

A. Epoxy Cement

1. Resinous Cement Components.

The epoxy cement shall consist of the two components as described hereinafter, and shall be furnished in clean, properly identified, separate containers. Each container shall be labeled with the name of the manufacturer, the lot or batch number, the date of manufacture, and the quantity contained therein. The two components shall be formulated in such a manner that, when blended according to the manufacturer's instructions, they will harden into a solid epoxy material with the properties required in Paragraphs II-A-2 and II-A-3 herein. No solvents are allowed in either component or in the blended material.

Each component of the epoxy cement shall have been manufactured within 90 days prior to the date of delivery to the job site.

a. Component A (Modified Epoxy Resin).

This material shall be based on liquid epoxy resin and an effective flexibilizer, and shall contain no contaminants, insolubles, or phenol and shall have the following characteristics:

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>SPECIFIC VALUE</th>
<th>TEST METHOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Gravity (77°F)</td>
<td>1.11 - 1.14</td>
<td>ASTM D 154</td>
</tr>
<tr>
<td>Viscosity, 77°F, poises</td>
<td>30 Maximum</td>
<td>Addendum I</td>
</tr>
<tr>
<td>Epoxy equivalent</td>
<td>255 - 266</td>
<td>ASTM D 1652</td>
</tr>
<tr>
<td>Ash content, percent by weight</td>
<td>0.2 Maximum</td>
<td>ASTM D 482</td>
</tr>
<tr>
<td>Volatile content, ml. distil</td>
<td>3 Max. below 330°F</td>
<td>ASTM D 1078</td>
</tr>
</tbody>
</table>

b. Component B (Modified Amine Hardening Agent for Component A).

This material shall be the hardening agent for the modified epoxy resin and shall be composed of a bitumen which has been specially treated with a modified aliphatic polyamine. It shall contain no contaminants, insolubles, or phenol and shall have the following characteristics:

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>SPECIFIC VALUE</th>
<th>TEST METHOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Gravity (77°F)</td>
<td>1.10 - 1.16</td>
<td>ASTM D 154</td>
</tr>
<tr>
<td>Viscosity, 77°F, poises</td>
<td>4 - 8</td>
<td>Addendum I</td>
</tr>
<tr>
<td>Alkalinity, mg/100 grams</td>
<td>0.27 - 0.32</td>
<td>ASTM D 664</td>
</tr>
<tr>
<td>Water content, pct. by wt.</td>
<td>2.0 Maximum</td>
<td>ASTM D 95</td>
</tr>
<tr>
<td>Ash content, pct. by wt.</td>
<td>0.5 Maximum</td>
<td>ASTM D 482</td>
</tr>
<tr>
<td>Volatile content, ml. distil</td>
<td>3 Max. below 375°F</td>
<td>ASTM D 1078</td>
</tr>
</tbody>
</table>

Tests for properties specified in this section shall be performed on castings prepared from the epoxy cement components, A and B, after these components have been mixed thoroughly and allowed to harden for 7 days at 77°F.

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>SPECIFIC VALUE</th>
<th>TEST METHOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Chemical Resistance (Immersion for 7 days at 77°F.)</td>
<td>0.3 max.</td>
<td>ASTM D 570</td>
</tr>
<tr>
<td>Water absorption, wt. by wt.</td>
<td>0.3 max.</td>
<td>ASTM D 543</td>
</tr>
<tr>
<td>Absorption of saturated water solution of calcium chloride, wt. by wt.</td>
<td>0.3 max.</td>
<td>ASTM D 543</td>
</tr>
<tr>
<td>b. Tensile Properties at 77°F.</td>
<td>200 to 600</td>
<td>ASTM D 638 (Test at 23°C using extensiometer described in ASTM D 412)</td>
</tr>
<tr>
<td>Ultimate strength, psi</td>
<td>500 minimum</td>
<td>ASTM D 638 (Test at 23°C using extensiometer described in ASTM D 412)</td>
</tr>
<tr>
<td>Elongation at break, %</td>
<td>No Requirements</td>
<td>ASTM D 1088 (Test shall be modified by eliminating the use of extensiometer)</td>
</tr>
<tr>
<td>c. Freeze-Crack Resistance</td>
<td>2 max.</td>
<td>ASTM D 1088</td>
</tr>
<tr>
<td>Pat. by wt.</td>
<td>No Requirements</td>
<td>ASTM D 1088</td>
</tr>
<tr>
<td>d. Color</td>
<td>No Requirements</td>
<td>ASTM D 1088</td>
</tr>
<tr>
<td>e. Cure Rate</td>
<td>28-40</td>
<td>Addendum No. 2</td>
</tr>
<tr>
<td>Gel time, minutes</td>
<td>35-55</td>
<td>ASTM D 1791</td>
</tr>
<tr>
<td>Shore D Hardness at 77°F.</td>
<td>No Requirements</td>
<td>ASTM D 1791</td>
</tr>
</tbody>
</table>

3. Properties of Epoxy Cement Membrane (Adhesion to Concrete).

The epoxy cement shall be prepared and applied, with the aggregate, to clean dry portland cement concrete in accordance with Section III-B herein. The portland cement shall be prepared in accordance with the procedure outlined in Method 2701 of Federal Test Method Standard No. 158. The portland cement shall conform to the requirements of Federal Specification SS-C-192 Type 1. The curing period shall be 28 days and in accordance with Method 2301 Paragraph 5.2 of Federal Test Method Standard No. 158. The epoxy cement membrane shall develop a bond strength at 77°F., after hardening 7 days at 77°F., of 90 psi minimum using the tensile tester of ACI Title No. 59-43.

4. Basis for Acceptance.

Prior approval by the Department shall be a prerequisite to the use of the resinous cement. The Contractor shall furnish certified test reports, for each batch, sworn by the manufacturer of the materials or by an approved independent testing laboratory, showing proof of compliance with the applicable requirements listed hereinbefore, exclusive of the cure rate tests. The certifications shall show the batch or lot number and the date of manufacture.

5. Sampling and Testing.

The Engineer shall obtain separate, one-quart samples of each component in each lot or batch and forward them in sealed containers to the Division of Materials for general quality tests. Cure rate tests as described in Addendum 2 shall be performed on each set of samples. Materials failing to meet the applicable requirements for the cure rate tests shall be rejected and removed from the job site.

B. Aggregate.

The aggregate shall be clean, dry and tough (not brittle or friable) with 90 percent having a minimum Moh hardness of 7. Silica sand, crushed quartz, emery, slag, aluminum oxide, garnet, Joplin chat, or other aggregate approved by the Engineer shall be used. The aggregate shall be graded as follows:

<table>
<thead>
<tr>
<th>Sieve*</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 8</td>
<td>100</td>
</tr>
<tr>
<td>No. 30</td>
<td>0-20</td>
</tr>
<tr>
<td>No. 40</td>
<td>0-5</td>
</tr>
</tbody>
</table>

*United States Standard Sieve Series

The Engineer shall submit at least one 15-pound sample to the Division of Materials for each shipment.
III. CONSTRUCTION METHODS

A. Surface Preparation.

1. Surface Repair.

All scaled areas, potholes, and cracks over 1/16-inch wide in the portland cement concrete surfaces shall be repaired in a manner approved by the Engineer.

2. Surface Cleaning.

Surface cleaning shall include the removal of any bituminous surfacing material as may exist on the bridge deck. If the existing surface has heavy local deposits of oil, grease, tar, traffic striping, paint, grime, dirt, etc., which will prevent proper cleaning as specified in the following paragraphs, these shall be completely removed with trichloroethylene, perchloroethylene, xylene, or other solvents approved by the Engineer or by mechanical scrapers or scarifiers, or by heavy-duty detergents. If the surface has been subjected to heavy traffic and has exposed coarse aggregate, special effort shall be made to remove the film of oil and grime from the aggregate. (Scrubbing the entire surface with detergent prior to acid etching or sandblasting has been found to be most effective for removing such oil film).

After local cleaning has been accomplished, the entire area to be surfaced shall be cleaned, as hereinafter described, by either (a) etching the surface with water solution of hydrochloric acid containing 16 percent ± 3 percent by weight hydrochloric acid, or by (b) sandblasting. Cleaning shall be repeated, if necessary, until the surface is properly cleaned to the satisfaction of the Engineer.

a. The hydrochloric acid solution shall be applied at a minimum rate of one pint per square yard and spread evenly over the entire surface.

(Note: This step shall also be required for new concrete to remove laitance). The acid solution shall be allowed to react for at least five minutes, and shall be flushed from the surface within ten minutes after application of the acid using clean water, preferably under pressure, at the minimum quantity of 1 gallon per square yard. The flushing shall be accompanied by vigorous brooming using stiff bristled brooms to remove all loose material. Flushing and brooming shall be continued and repeated until all residue from the acid has been removed.

b. Sandblasting shall be accomplished in such a manner as to insure the removal of a thin layer of concrete from the surface of the entire area which is to receive the epoxy cement. Suitable efficient traps and filters shall be installed in equipment to prevent water or oil from being deposited on roadway surface. After sandblasting, the surface shall be swept, vacuumed, or blown free of all dust and grit.

If traffic or other construction operations are allowed on the cleaned surface prior to the cement application, the Contractor, before applying the epoxy cement, shall remove any contamination deposited on the pavement since the original cleaning was completed.
B. Mixing and Application.

1. General Requirements.

Unless otherwise directed by the Engineer, work shall proceed only when the deck temperature is 50°F or above, and if below 60°F, only when the temperature is rising. The pavement shall be dry before the epoxy cement is applied, and all dust, dirt, grit, and other surface debris shall be removed by sweeping or vacuum cleaning. Areas which are not to receive an epoxy application (such as drains, expansion dams, sewer covers, etc.) shall be securely masked with tar paper or polyethylene film. Application operations shall not begin unless the Engineer is certain that the epoxy membrane will have adequate time to be sufficiently hardened to withstand any necessary vehicular traffic or other construction operations.

Epoxy cement applications to pavement surfaces adjoining the curb line shall be made so that epoxy cement extends upon the curb at least two inches above the top surface of the subsequent wearing course. Also, each batch of epoxy cement applied by hand, or each pass with a machine, must overlap the previous batch or pass by at least 6 inches.

The Engineer shall, at the beginning, middle, and end of each run, read and record the liquid level in each of the two epoxy cement component tanks.

If the Engineer suspect that the metering or mixing of the two components is not in accordance with the required procedures, he may order the work discontinued until the metering or mixing errors are corrected to his satisfaction.

Wherever the surface of the pavement has a slope of 2 percent or greater, approved flow-resistant epoxy cement can be used.


The epoxy cement shall be distributed evenly over the entire area to be surfaced at a rate of 3 pounds per square yard.

a. Areas of 2000 Square Yards or More of Continuous Surfacing.

The epoxy cement shall be applied to the deck surface with approved equipment which continuously and accurately meters the two epoxy cement components within ± 2.5 percent of accuracy, mixes them thoroughly, and then sprays the mixture on the deck at a controlled rate, which can be varied between 5 and 30 gallons per minute. The equipment shall be so designed, equipped, coordinated, and operated that the epoxy cement will be spread continuously, smoothly, and uniformly over the full width of the lane to be surfaced in one operation. The equipment shall be capable of applying the epoxy cement in one lane widths at the required application rate. The storage tanks on the equipment shall be equipped with liquid level measuring rods. The epoxy cement shall be applied in such a manner that the wheels of the equipment do not contact the epoxy cement. When any equipment is found to be unsatisfactory by the Engineer, it shall be repaired, replaced, or removed from the work as he may direct.

b. Areas Less than 2000 Square Yards Continuous Surfacing.

The epoxy membrane may be applied to small areas as specified in paragraph a above or hereinafter specified.
1. **Mixing.** Mixing of the two epoxy cements shall be done by one of the following methods:

**Method 1.** By equipment approved by the Engineer which accurately meters the two components in the required ratio by weight or volume within ± 2.5 percent accuracy and mixes them thoroughly. This equipment shall have totalizing meters which accurately record the amount of each epoxy cement component being pumped into the mixing section. It shall be so designed that no metering or flow rate adjustments are necessary prior to or during epoxy cement application.

**Method 2.** In a 3 1/2 cubic foot (1/2 bag) mortar mixer. The blades must revolve independently of the shell. Total volume to be mixed shall not be less than 5 gallons or more than 10 gallons. Mixing time shall not be less than 2 minutes and not more than 4 minutes.

**Method 3.** In a suitable container, by stirring with an efficient propeller or paddle affixed to a heavy-duty, 1/2 inch electric drill, provided that necessary precautions are taken to insure that the epoxy cement clinging to the walls and bottom of the container are thoroughly blended. Batch size shall not be larger than 5 gallons. Mixing time shall not be less than 3 minutes nor more than 6 minutes.

2. **Application.** Application of epoxy cement shall be accomplished in such a manner to insure uniform distribution over the entire area to be surfaced. This shall be controlled by measuring the area over which a known amount of the epoxy cement must be spread. Epoxy cement applications shall be accomplished by one of the following methods:

Through spray nozzles attached to equipment so designed as to deliver a uniform application; or

By emptying the blended epoxy cement from the mortar mixer or other mixing vessel onto the roadway surface no later than 10 minutes after mixing began, and spreading it evenly over the measured area using stiff-bristled brooms or other suitable tools.

3. **Application of Aggregate.** While the epoxy cement is still liquid, the aggregate shall be dropped into the cement at a rate of 6 to 9 pounds of aggregate per square yard. The aggregate shall be applied in such a manner that the liquid epoxy cement is not disturbed by the aggregate, by vehicular or pedestrian traffic, or other devices, before it hardens. The aggregate shall be applied within 10 minutes after the application of the epoxy cement, except at temperatures below 70°F, when a maximum of 20 minutes will be allowed. The aggregate must be applied using suitable, continuous spreading equipment as approved by the Department. The aggregate shall always be sprinkled or dropped vertically into the epoxy cement in such a manner that the continuity or the level of the epoxy cement is not permanently disturbed.

Whenever the aggregate spreading equipment is found unsatisfactory by the Engineer, it shall be repaired, replaced, or removed from the work as he may require. After aggregate is spread, all vehicular and foot traffic shall be prohibited in the area until the epoxy cement has hardened. Should the epoxy cement membrane be disturbed prior to hardening so that the finished surface is rough or uneven, the Contractor shall, as directed by the Engineer, make such repairs as are necessary to provide an unbroken, continuous membrane surface.

Over areas of less than 2000 square yards of continuous application, the aggregate may be applied by hand shoveling provided that the aggregate is sprinkled uniformly from a vertical angle and does not disturb the liquid.

c. **Opening Area to Traffic.** The treated area may be opened to any necessary traffic or other construction operations only at the direction of the Engineer, and only after the membrane has hardened to such degree that, when tested by means of a Model CL-700 Pocket Penetrometer, the scale reading will be not less than 4.5.

d. **Final Inspection and Acceptance.** Any damage done due to the fault of the Contractor during the performance of the work shall be repaired, restored, or replaced before final inspection and at no cost to the Department.

Any defects found in this work shall be remedied before final acceptance will be made.
IV. METHOD OF MEASUREMENT

The area actually covered by the epoxy membrane and aggregate, complete and accepted, shall be measured in square yards.

V. BASIS OF PAYMENT

The area thus measured will be paid for at the contract price bid per square yard for Epoxy Membrane Coating, which price shall be full compensation for traffic protection; removal of any existing bituminous surface; cleaning the entire area to be surfaced; furnishing, mixing, applying and curing the epoxy cement; furnishing and applying aggregate and removing any excess; masking off areas; and furnishing all labor, materials, tools, and equipment and incidentals necessary to complete the work.

APPROVED

A. O. NEISER
STATE HIGHWAY ENGINEER

ADDENDUM 1

DETERMINATION OF VISCOSITY USING BROOKFIELD VISCOMETER

Scope: This test method is for determining the absolute viscosity of liquid resins, curing agents, and other materials. Unless otherwise specified, it is determined on materials preconditioned to 77°F.

Apparatus:

1. Brookfield Synchro-lectric Viscometer (MODEL RVF preferred). This is a rotating spindle viscometer which employs seven interchangeable spindles. The unit has an adjustment to provide four rotational speeds: 20, 10, 4, 2 RPM. Seven cylindrical spindles of varying length and diameter are provided to cover a range of 15,000 poises. The torsional shear force is measured by a spiral spring linking the spindle to the motor and is indicated on a rotating dial reading from 0 to 100 units. By using the proper factor for the speed and spindle employed, the dial reading is converted to poises.

2. Containers - The liquid is placed in a container of such size that at least one inch of clearance is provided between the bottom and sides of the spindle and the vessel when the spindle is properly placed in the liquid.

3. Constant Temperature Apparatus - A means of providing adequate temperature of 77°F ± 1°F (25°C ± 1/2° C.) (Unless otherwise specified) is required. A constant temperature room is preferred, but a constant temperature water bath may be used.

Test Specimens: Representative samples shall be taken from the containers provided. Any evidence of separation of solid or liquid layers shall be noted, then stirred to obtain a uniform sampling. Dark colored or opaque samples shall be thoroughly mixed before sampling. Samples shall be stored in a suitable sized (see above) closed container long enough to come to the specified temperature before testing. In no case shall the sample be less than four ounces.

Procedure: For measuring the viscosity of Part A, use Spindle No. 3 at 20 RPM speed. For measuring the viscosity of Part B, use Spindle No. 2 at 20 RPM speed. Attach the spindle to the lower end of the motor shaft. With disc type spindles, the spindle is first immersed in the liquid at an angle to eliminate air bubbles, then screwed onto the shaft. Attach the guard to the motor housing, then adjust the height to bring the liquid level to the indentation in the spindle. Level the instrument. Start the motor and set for the proper speed. Take periodic readings on 0-100 scale until a constant value is obtained. At higher speeds, it will be necessary to stop the indicating needle by using the clutch, then switching off the motor. Start the motor for the next reading before releasing the clutch. When a constant scale reading is obtained, convert the scale reading to poises by multiplying by the proper factor:

With Spindle No. 3 at 20 RPM use the factor of 0.5
With Spindle No. 2 at 20 RPM use the factor of 0.2

Report: The report shall include:

1. Complete identification of the material.
2. The viscosity in poises.
3. The temperature of the liquid at the time of testing.
4. The viscometer spindle and speed used.
5. Date of testing.

ADDENDUM 2

CURE RATE-HARDNESS DETERMINATION

The cure rate test is meant to be a fast and simple method of determining the general quality of the epoxy cements. The resulting cure time does not bear a direct relationship to cure time of the epoxy cements on the roadway surface.

Samples of both the A and B components are conditioned at 77° ± 2°F. When the two components have reached 77° ± 2°F., a sufficient amount of each is measured into an unwaxed paper cup as necessary to make up a 2 fluid ounce sample of epoxy cement. The time is recorded and they are immediately mixed, stirring for three minutes with a wooden tongue depressor, taking care to periodically scrape the walls and bottom of the cup and mixer. The sample is then poured into a standard size unwaxed paper cup, set on a wood bench top, and probed every two minutes with a small stick starting twenty minutes from the time of the completion of mixing. The elapsed time from the completion of the three minutes mixing until a soft ball forms in the center of the container is recorded as gel time.

Twenty-four hours after the time of mixing, while the cured specimen is still at 77°F, the top of this paper cup is torn off and the top surface hardness taken with a Shore D Durometer following the procedure described in ASTM D 1706-61.
ITEM 7

KENTUCKY DEPARTMENT OF HIGHWAYS

SPECIAL PROVISION NO. 77-A
STYRENE-BUTADIENE PROTECTIVE COATING

This Special Provision, or designated portion(s) hereof, shall apply only when so indicated on the plans, in the proposal, or in the bidding invitation and shall supersede any conflicting provisions of the Department’s Standard Specifications for Road and Bridge Construction.

I. DESCRIPTION

This Special Provision covers the material requirements and application procedures for a styrene-butadiene mixture to be used as a protective coating for designated surfaces of concrete structures. This work shall consist of the preparation of the concrete surfaces to be treated, and furnishing and applying the materials as hereinafter specified.

II. MATERIALS

The protective coating material shall consist of styrene-butadiene with modifiers in a mixture of 50 percent mineral spirits and 50 percent aromatic solvents and shall meet the requirements hereinafter specified.

<table>
<thead>
<tr>
<th>Property</th>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solids, by weight, pct</td>
<td></td>
<td>29-31</td>
</tr>
<tr>
<td>Specific gravity</td>
<td></td>
<td>0.86-0.90</td>
</tr>
<tr>
<td>Color, Gardner, ASTM D 1544, max</td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>Ash, ASTM D 29, pct, max</td>
<td></td>
<td>0.5</td>
</tr>
<tr>
<td>Viscosity, ASTM D 1200, No. 4 Ford Cup, sec.</td>
<td></td>
<td>20-22</td>
</tr>
<tr>
<td>Flash Point, Cleveland Open Cup, min.</td>
<td></td>
<td>45° C.</td>
</tr>
<tr>
<td>Acid value on filtered specimen, ASTM D 1639, max.</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Saponification value on filtered specimen, ASTM D 1962, max.</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Heptane miscibility on filtered specimen, ASTM D 1476: Turbidity must be evident after addition of 10 ml and distinct resinous precipitate must be evident after addition of 15 ml.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

III. APPLICATION

Before the protective coating is applied, all concrete surfaces shall be repaired and finished as specified in Articles 403.3.8-B and 403.3.8-D of the Standard Specifications. During the finishing period, the concrete shall be protected as specified in Article 403.3.7.

Just prior to the application of the protective coating, the concrete surfaces to be coated must undergo at least a 48 hour drying period; shall be cleaned of all oil, grime, and loose particles and shall be blown clean of all dust with compressed air.

Before the protective coating is applied, all joint seals shall be given a protective covering meeting with the approval of the Engineer. This protective covering shall consist of a strip of non-absorbent paper (waterproof paper for curing concrete) or other equally effective material; shall be of sufficient width to adequately cover the joint; and shall be taped securely along the edges of the joint. The protective strip shall be secured in such a manner and shall remain in place for a sufficient time as will insure against the protective coating entering the joint and contaminating the sealer. The styrene-butadiene mixture has a low flash point and is readily flammable, and all fires, including cigarettes and sparks, shall be carefully guarded against.

The protective coating shall be applied when the temperature of the concrete and the air is 50°F or higher, unless otherwise directed by the Engineer. The coating shall be applied by brushes or by spraying. Spraying shall be performed under a pressure of 30 to 40 psi, and the spray nozzles shall be within 12 inches of the concrete. All brushes or spray equipment shall be thoroughly cleaned prior to being used.

The protective coating shall not be applied, in any instance, to the bridge deck between the curb lines. The protective coating shall be applied in two applications to the top surfaces and inside faces of curbs, the top...
surfaces of sidewalks, the top and inside vertical surfaces of plinths or sidewalk parapets, the top and inside exposed surfaces of abutment or end-bent wing walls, the top (including pads and keys) of end-bents or abutments.

Each coat shall be applied at a minimum rate of application of one gallon per 40 square yards. The first coat shall not be applied until the concrete is a minimum of 14 days old, and the second coat shall not be applied until the first coat has dried, and not earlier than 3 hours following the application of the first coat.

"Dry Spots" or porous areas that are not completely sealed with the 2-coat application, shall be given additional applications to completely seal the surface, as directed by the Engineer.

Workmen shall not walk on or place any materials on the protective coating until it has sufficiently dried to withstand any damage.

IV. MEASUREMENT AND PAYMENT

The styrene-butadiene mixture will be measured in gallons.

Payment will be made at the contract unit price per gallon for styrene-butadiene mixture for the actual gallons applied as directed by the Engineer, which payment shall be full compensation for preparation of the surface, furnishing and applying the materials, and for furnishing all labor, equipment, and incidentals necessary to complete the work.

APPROVED

A. O. NEISER
STATE HIGHWAY ENGINEER
ITEM 8

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS

SPECIAL PROVISION
FOR

BONDED CONCRETE OVERLAY

Jefferson County, SP 56-8118

This Special Provision, or designated portion(s) hereof, shall apply only when so indicated on the plans, proposals, or bidding invitations and shall supersede any conflicting provisions of the Department’s Standard Specifications for Road and Bridge Construction.

I. DESCRIPTION

This work shall consist of: 1) furnishing all labor, materials, and equipment; 2) removal of all bituminous surfacing and patching materials, roadway concrete to a depth of at least 1/4 inch below existing grade; 3) removal of all other deteriorated concrete within the roadway area; 4) cleaning the entire area after removal of the aforementioned materials; 5) full-depth patching; 6) application of a grout bond-coat; 7) placement, finishing, and curing of a 2-inch, portland cement concrete overlay; and 8) sawing, tooling or forming joints.

II. MATERIALS

A. Cement Concrete (for full-depth patches). The concrete to be used for full-depth patching shall comply with the requirements of Special Provision No. 35 for Class "AA" Concrete, current issue.

B. Cement Concrete (for overlay). The concrete to be used for the 2-inch overlay for restoration of the deck is referred to as Modified Class "AA" Concrete and shall meet the applicable requirements of Special Provision No. 35, current issue, but with the following modifications: 1) the coarse aggregate shall meet the gradation requirements for Size No. 8; 2) the slump shall be 1 inch plus or minus 1/2 inch; 3) the air content shall be 3 to 6 percent; 4) mixing shall be accomplished as outlined herein; and 5) the method of measurement and basis for payment shall be as designated herein. The concrete may be mixed at the site in accordance with the applicable requirements of Article 307.3.4-F or transit mixed in accordance with the requirements of Article 307.3.4-H but with the additional requirement that the addition of water and mixing will be done at the site. Section designations refer to the 1965 Standard Specifications for Road and Bridge Construction.

C. Grout (for bond-coat). The portland cement and fine aggregate for the grout bond-coat shall meet the applicable requirements of Articles 601.2.0 and 611.4.0 respectively of the Standard Specifications for Road and Bridge Construction. The grout shall consist of a one to one (1:1) mixture by weight of portland cement and mortar sand and sufficient water to produce a slurry of uniform, spreading consistency.

D. Curing Compound. The curing compound shall meet the applicable requirements for Type 2, white-pigmented compounds, wax-free, as designated in Article 674.5.0 of the Standard Specifications for Road and Bridge Construction.

III. CONSTRUCTION METHODS

A. Removal of Bituminous Surface and Patches. The bituminous patching and surfacing materials shall be removed in a manner approved by the Engineer; however, hammers exceeding 40 pounds or any other equipment that may cause damage to the underlying concrete shall not be used.

B. Removal of Concrete, Restoration of Reinforcement, and Cleaning. The entire area of the deck between the curbs (roadway) shall be given a machine preparation consisting of the removal of the concrete to a depth of at least 1/4 inch below its existing surface. This operation shall be accomplished by use of mechanical scarifier(s) or grinder(s) such as Tennant machine(s) or so-called "needle-guns." All other concrete deemed unsound by the Engineer shall be removed. Removal of concrete within areas where the depth of removal exceeds 1/2 inch may be accomplished by use of hammers not
exceeding 40 pounds in weight or other such small equipment. Precautions shall be exercised to protect any underlying, sound concrete and reinforcing steel. The periphery of routed areas shall be as nearly vertical as possible.

All exposed reinforcing steel shall be sandblasted to remove scale and rust, and grease, oil, etc., prior to placing concrete. Deteriorated or damaged reinforcing steel shall be replaced or supplemented as directed by the Engineer. All dust and chips of bituminous material, concrete or other debris shall be removed and the entire area shall be cleaned with compressed air supplied by an air compressor having suitable separators and traps. The compressed air shall be free of detrimental quantities of water, oil, grease or other injurious substances. Leakage of oil, grease, gasoline, or other substances from the compressor(s) or other equipment shall be prohibited. Protective sheeting (plastic, tarpaulin, etc.) shall be suspended under any equipment which leaks. All construction joints shall be located and referenced in a manner such that they may be sawed in the overlay directly above existing joints.

C. Full-Depth Patching. Immediately prior to placement of concrete the contact surfaces shall be dampened and surface-dried; a grout bond-coat (Paragraph II-C) shall then be applied by scrubbing or brushing it into the vertical surface of full-depth routed areas. The concrete shall be carefully placed and tamped or vibrated into place. Patched areas shall be rough-finished to an elevation corresponding to that of the plane of the top layer of reinforcement and shall be cured for a period of not less than 7 days, or until the time of overlaying (whichever is less), by means of a double layer of wetted burlap or similar material. The surfaces of all patched areas shall be sandblasted to remove all laitance prior to overlaying and all sand shall be removed.

D. Grout Bond-Coat. The entire area to be overlaid shall be kept wet for a period of not less than 24 hours prior to beginning overlaying operations. The surface shall be covered with a double layer of burlap and shall be kept wet for the full 24-hour period. Immediately prior to placement of the bond-coat, excess water shall be blown out and off, and this procedure shall be continued until the surface appears dry or barely damp. The grout bond-coat shall be machine mixed by use of suitable equipment and for a sufficient period of time to provide a mixture of uniform consistency. The grout bond-coat shall be brushed and scrubbed with stiff bristle brooms into all portions of the surface immediately prior to placement of the overlay. Excessively thin grout shall not be permitted, and any mortar showing signs of drying prior to placement of the overlay shall be replaced with satisfactory mortar.

E. Placement, Consolidation, Finishing and Curing Overlay. The entire depth of the 2-inch (or greater) overlay shall be placed in one series of operations. Areas in which concrete is routed to partial depths (over 1/4-inch but not full depth) shall be filled at the time of placement of the overlay. The concrete shall be carefully placed and tamped or vibrated into all partially routed areas; this shall be accomplished immediately ahead of the overlaying operation.

The overlay shall be carefully placed and screeded full width and by use of a Bidwell deck-finishing machine or other similar equipment traversing rails located outside the area to be overlaid. The equipment shall be checked for grade and crown immediately prior to beginning overlaying operations, and the check shall be made by passing the equipment over the area to be overlaid and making appropriate measurements. The screeded concrete shall then be finished by means of Kelly Vibrator Compactor(s) (Kelly Machine Division, Wiesner-Rapp Company, Incorporated, 285 Hinmon Avenue, Buffalo, New York) or other approved, circular, vibrating power float(s). This operation shall begin at such time when the concrete has set sufficiently to support the equipment and finish properly. In the event a satisfactory finish is not obtained in this operation, the Engineer may require use of circular power trowel(s). No traffic, pedestrian or other, shall be permitted on the surface after the compacting and finishing operation until the concrete has cured.
The surface shall be finished by brooming. The brooms shall be drawn transversely across the surface to each curb and only one stroke per width of broom shall be made, with each stroke slightly overlapping the adjacent. The brooming operation shall be so performed that the corrugations produced in the surface of the pavement will be in uniform in appearance and not more than 1/16 inch in depth. The brooming operation shall be completed while the concrete is in such a condition that it will not be torn or unduly roughened by the brooming operation and before initial set has developed in the concrete. The surface of the concrete, after completion of the brooming operation, shall be uniform in appearance, shall have the required grade and contour, and shall be free of rough and porous spots, irregularities, depressions, and objectionable surface features resulting from improper handling of the broom. The surface shall be straightedged, and surface irregularities shall be removed and sealed as outlined in Article 411.3.3-J of the 1965 Standard Specifications for Road and Bridge Construction.

Curing shall be accomplished by two applications of white membrane-curing compound. The curing compound shall be applied as outlined in Article 307.3.14-G of the 1965 Standard Specifications for Road and Bridge Construction.

Joints shall be formed, tooled, or sawed and sealed as designated on the plans.

IV. METHOD OF MEASUREMENT

The several items of work covered herein to be measured for payment will be measured in square yards for each item of work actually completed and accepted.

V. BASIS OF PAYMENT

The quantities thus measured will be paid for at the contract unit price bid per square yard for each of the following items of work.

A. Removal of bituminous overlay (main spans); the payment for which shall include the satisfactory removal and disposal of existing bituminous surfacing and patches as indicated on the plans or as directed by the Engineer.

B. Machine preparation of existing floor slabs (main spans); the payment for which shall include the removal of unsound concrete to partial depths greater than the required minimum 1/4 inch, and any necessary replacement of reinforcement.

C. Removal and replacement of concrete to full-depth (main span patches); the payment for which shall include the removal of the concrete, preparing and grouting contact surfaces, necessary replacement of reinforcement, placement of new concrete to the specified elevations, and the finishing, curing, and protection.

D. Bonded concrete overlay; which payment shall include the placing, finishing, and curing of the overlay; partial-depth patches; application of the grout bond-coat; and the forming, grooving, or sawing and the sealing of the joints.

The payments allowed for each of the above items of work shall further compensate for furnishing and hauling all materials; for the satisfactory disposal of all materials removed from the structure; for furnishing the necessary labor, equipment, and tools; and for all other incidental items and operations necessary to satisfactorily complete each item of work.

APPROVED

A O. NEUSER
STATE HIGHWAY ENGINEER
COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS

SPECIAL PROVISION
FOR
EPoxy GROUTING

Jefferson County, SP 56-8118

This Special Provision, or designated portions hereof, shall be applicable only when indicated on the plans or in the proposals, and, when so indicated, shall supersede any conflicting provisions of the Department’s Standard Specifications for Road and Bridge Construction.

I. DESCRIPTION

This work shall consist of epoxy grouting steel studs or dowels into existing concrete surface in such a manner to develop high bonding strength of the studs or dowels.

II. MATERIALS

A. Requirements. The resinous cement shall consist of a two-component, clear or light-colored, epoxy resin system conforming to the requirements of AASHO M 200-631, Type B. Each component, designated as A and B, when blended immediately prior to use in accordance with the manufacturer’s instructions shall harden into a solid resinous material having the properties outlined in Table III for Type B of AASHO M 200-631. Each component shall be supplied in clean, well-identified, of the final mixture may be obtained by combining one container of one component with one or more whole containers of the other component. Each container shall be clearly labeled with the manufacturer’s name, batch number, date of manufacture, and the quantity contained therein in pounds and gallons. Appropriate warning labels shall be on each container.

B. Basis for Acceptance. Prior approval by the Department shall be a prerequisite to use of the resinous cement. The contractor shall furnish certified test reports, sworn by the manufacturer of the materials or by an approved independent testing laboratory, showing proof of compliance with the applicable requirements listed in Tables I, II, and III of AASHO M 200-631.

C. Sampling and Testing. The Engineer shall obtain separate, one-quart samples of each component in each lot or shipment and forward them in sealed containers to the Division of Materials for quality tests. The Engineer shall supply the Division of Materials a copy of the manufacturer’s recommended proportions and shall label each container for contents therein. Cure rate-hardness tests as described in AASHO M 200-631 shall be performed on each set of samples. Materials failing to meet the applicable requirements for the cure rate-hardness test shall be rejected and removed from the job site.

III. CONSTRUCTION METHODS

Drill holes for the insertion of stud or dowel bars shall be formed with masonry bits having a diameter not more than 0.5 inch greater than the diameter of the steel studs or dowels. The holes shall be drilled to the depth specified on the plans, shall be kept clean and dry at all times, and shall be blown clean prior to grouting. After mixing the two components according to the manufacturer’s directions, the epoxy shall be poured or forced into the drilled holes and a liberal coating of at least 20 mils (.02 inch) shall be daubed onto the steel stud or dowel. The coated steel stud or dowel shall be slowly inserted full depth into the hole in a twisting motion. After placement, a slight overflow of epoxy indicating complete filling of the drill holes shall occur. In the event that this overflow does not occur, the stud or dowel bar shall be immediately removed, additional epoxy placed in the hole and the stud or dowel bar reinserted; any excess shall then be wiped away. After placement and prior to hardening of the resinous cement, the stud or dowel bars shall not be disturbed.

IV. MEASUREMENT AND PAYMENT

The installation of studs or dowels will not be measured for payment as such work shall be incidental to other items of work done in connection therewith, as indicated on the plans, and for which payments are made.

APPROVED

A. O. NEISER
STATE HIGHWAY ENGINEER
COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS

SPECIAL PROVISION
FOR
EPoxy-SAND SEAL FOR CONCRETE

Jefferson County, SP 56-8118

This Special Provision, or designated portions hereof, shall be applicable only when indicated on the plans or in the proposals, and when so indicated, shall supersede any conflicting provisions of the Department's Standard Specifications for Road and Bridge Construction.

I. DESCRIPTION

This work shall consist of sealing concrete with epoxy resin and sand.

II. MATERIALS

A. Resinous Cement. The two-component, clear or light-colored, epoxy resin system shall be either Guardkote 250 or Resiweld 7121.

1. Packaging. The two components shall be supplied in separate containers which are nonreactive with the materials contained therein. The containers shall be identified as "Component A, Contains Epoxy Resin" and "Component B, Contains Hardener" and shall show the type, mixing directions, usable temperature range, name of manufacturer, lot or batch number, date of packaging, and the quantity contained therein in pounds and gallons. Potential hazards shall be so stated on the package in accordance with the Federal Hazardous Products Labeling Act.

2. Basis for Acceptance. Prior approval by the Department shall be a prerequisite to the use of the resinous cement.

3. Sampling and Testing. The Engineer shall obtain separate, one-quart samples of each component from each lot or shipment and forward them in sealed containers to the Division of Materials for general quality tests. Cure-rate and hardness tests as described in AASHO M 200-631 shall be performed on each set of samples. Materials failing to meet the applicable requirements for the cure-rate and hardness test shall be rejected and removed from the job site.

B. Sand.

1. Requirements. The sand for surface application shall contain not less than 85 percent silica and shall be non-friable, non-polishing, clean, and dry. The gradation of the sand shall be as follows:

<table>
<thead>
<tr>
<th>Sieve</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 8</td>
<td>100</td>
</tr>
<tr>
<td>No. 16</td>
<td>36-60</td>
</tr>
<tr>
<td>No. 30</td>
<td>0-15</td>
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<tr>
<td>No. 50</td>
<td>0-5</td>
</tr>
<tr>
<td>No. 100</td>
<td>0-1</td>
</tr>
</tbody>
</table>

2. Sampling and Testing. The Engineer shall submit at least one 15-pound sample to the Division of Materials for each shipment. Samples shall be tested for gradation. Material failing to meet the specified requirements shall be rejected.

III. CONSTRUCTION METHODS

A. Surface Preparation. Cleaning preparations shall not begin unless the Contractor is certain that the cleaned, dry deck will not be subjected to traffic or to other construction operations before the epoxy-sand seal can be applied; and in no case, shall the surface preparation be made more than 48 hours prior to sealing operations.

If the surface has heavy local deposits of oil, grease, tar, paint, grime, dirt, etc., which will prevent proper cleaning as specified in the following paragraph, these shall be completely removed with trichloroethylene, perchloroethylene, xylene, or other solvents or by mechanical scrapers or scarifiers, or by strong detergents approved by the Engineer.

Concrete deemed unsound by the Engineer shall be removed in a manner and with equipment that will not damage underlying, sound concrete. Routed areas may be patched with Class "AA" Concrete or an epoxy-sand grout.
In the event Class "AA" Concrete is used, the concrete shall meet the applicable requirements of the current issue of Special Provision No. 35 for Class "AA" Concrete. Immediately prior to placement of the concrete, the surfaces of routed areas shall be coated with a grout bond-coat of a one to one (1:1) mixture by weight of portland cement and mortar sand with sufficient water added to produce a slurry consistency. The portland cement and mortar sand used for the grout bond-coat shall meet the applicable requirements of Article 601.2.0 and 611.4.0, respectively, of the 1965 Standard Specifications for Road and Bridge Construction. The concrete shall be carefully placed, vibrated or tamped thoroughly, and finished to an elevation corresponding to that of the surrounding area. The concrete shall be cured for a period of not less than 7 days with a double layer of wet burlap or similar material. The epoxy-sand seal shall not be placed until 28 days after placement of concrete patches.

In the event an epoxy-sand grout is used, the grout shall consist of 2 parts by volume of compounded epoxy resin and 5 parts by volume (bulk) of sand sufficiently mixed to provide a uniform consistency. The epoxy shall conform to the requirements of Paragraph IIA herein; and the sand shall conform to the requirements of Article 611.4.0 of the 1965 Standard Specifications for Road and Bridge Construction. The surfaces of areas to be patched shall be painted with a heavy coat of the epoxy cement immediately prior to placement of the grout. The grout shall be carefully placed, thoroughly tamped, and finished to an elevation equivalent to the surrounding surface. Sand shall be broadcast on the finished patch immediately after finishing. Epoxy-sand grout shall not be placed if the temperature is below 60° F.

After local cleaning and patching has been accomplished, the walkway area to be sealed shall be cleaned by sandblasting in such a manner to insure the removal of a thin layer of concrete. Suitable efficient traps and filters shall be installed in equipment to prevent water or oil from being deposited on the walks. After sandblasting, the walkway shall be swept, vacuumed or blown free of all dust, grit or other debris.

All railing and truss members shall be protected from sandblast damage.

B. Mixing and Application of Resinous Cement. The resinous cement shall be applied only when the atmospheric temperature is 60° F. or above unless otherwise directed in writing by the Engineer. The surface shall be completely dry before application of the resinous cement. The Contractor shall mask, cover and/or protect surfaces not to receive the seal from contact with the resin during the sealing operations. The resinous cement components, A and B, shall be combined by volume and within plus or minus 5 percent of the manufacturer's recommended proportions or as directed by the Engineer. The mixing and blending shall be accomplished by one of the following methods:

1. By equipment, approved by the Engineer, which accurately meters the two components and mixes them thoroughly. This equipment shall have totality meters which accurately record the amount of each epoxy-cement component being pumped into the mixing section. It shall be so designed that no metering or flow rate adjustments are necessary prior to or during epoxy-cement application.

2. In a 3.5 cubic foot (1/2-bag) mortar mixer. The blades must revolve independently of the shell. Total volume to be mixed shall not be less than 5 gallons or more than 10 gallons. Mixing time shall not be less than 2 minutes nor more than 4 minutes.

3. In a suitable container, by stirring with an efficient propeller or paddle affixed to a heavy-duty, 1/2-inch electric drill, provided that necessary precautions are taken to insure that the epoxy cement clinging to the walls and bottom of the container is thoroughly blended. Batch sizes shall not be larger than 10 gallons. Mixing time shall not be less than 3 minutes nor more than 6 minutes.
Application of epoxy cement shall be at the rate of 0.15 gallons per square yard, and this rate of application shall be controlled by applying a known quantity over a premeasured area. The epoxy may be deposited onto the walkways by means of spray nozzles attached to equipment so designed or by emptying the blended epoxy from the mortar mixer or other mixing vessel no later than 10 minutes after mixing began. The epoxy shall be uniformly distributed over the area with squeegees or other approved hand spreaders.

C. *Application of Sand.* While the resinous cement is still liquid, sand shall be dropped onto the surface in such a manner that the resinous cement is not disturbed. The sand shall be applied within 5 minutes after application of the resinous cement. If the atmospheric temperature is below 90°F, spreading of the sand may be deferred up to 20 minutes, at the discretion of the Engineer, to permit a longer wetting period. Sufficient sand shall be dispensed to prevent bleed-through of the resinous cement.

After the sand is spread, foot traffic shall be prohibited over the seal until it has sufficiently hardened. As soon as the resinous cement has hardened, excess, non-adhering sand shall be removed by sweeping with brooms or by air drafts.

**IV. METHOD OF MEASUREMENT**

The area of walkway actually covered with epoxy-sand seal will be measured in square yards.

**V. BASIS OF PAYMENT**

The area thus measured will be paid for at the concrete price per square yard for Epoxy-Sand Seal, and such payment shall be full compensation for furnishing all materials, labor, and equipment necessary to complete the work in a satisfactory manner.

APPROVED

A. O. NEISER
STATE HIGHWAY ENGINEER
ITEM 9

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS

SPECIAL PROVISIONS

FOR

APPLICATION OF COAL-TAR-MODIFIED
EPOXY RESIN BINDER AND ABRASIVE GRIT
(AGGREGATE) FOR SEALING CONCRETE
BRIDGE DECKS AND PAVEMENTS

These provisions or designated portions thereof shall
apply where so indicated on plans, proposals, or
invitations for bids.

I. DESCRIPTION

A. The work shall consist of the preparation of
the surface, the furnishing and application of
resinous binder, the application of abrasive
grit, and all incidentals thereto except
whatever exclusions as may be specifically
noted on the plans or in the contract.

B. The work to be accomplished under this
provision shall be allocated between Kentucky
Department of Highways forces and the
contractor’s forces as follows:

Each phase of the work shall be coordinated with every other phase so that the work will go ahead smoothly between the state’s forces and the contractor’s forces without unnecessary delays or stoppages. The Engineer shall be responsible for coordinating the work.

1. All patching and repairs to the deck prior to sealing shall be accomplished by state forces. This work will be completed before the contractor begins.

2. Surface preparation including removal of debris, dust, grime, grease, oil and bituminous matter of the type which cannot be removed by acid etching where solvent detergents and mechanical methods are required will be performed by state forces. This work will be completed before the contractor begins.

3. The final surface preparation to be accomplished by acid etching shall be performed by the contractor. The contractor shall furnish a 10% muriatic acid solution as directed by the Engineer over the entire surface to be sealed. The contractor shall bid this item as gallons of 10% acid solution applied in lieu of square yards etched. This method of bidding will readily permit additional etching of hard to clean areas to be designated by the Engineer.

4. The flushing of the etched areas after effervescence subsides with ample quantities of water shall be accomplished by state forces in coordination with the contractor’s acid application.

5. The resinous binder shall be furnished and applied by the contractor.

6. The silica sand shall be furnished and applied by state forces at the proper time in coordination with the contractor’s resin application. Excess aggregate shall be swept up and removed by state forces.

7. Protection of appurtenances to the roadway and traffic from the spattering of acid and resin shall be the responsibility of the contractor.

8. Traffic control for the project shall be provided by state forces.

II. MATERIALS

A. Binder

The binder material shall consist of a
two-component, coal-tar-modified epoxy resin
known in the trade as Shell Guardkote 140. The components, designated as "A" and "B" shall be blended together in equal portions immediately prior to application to the prepared concrete surface.

B. Abrasive Grit (Aggregate)

Abrasive grit or aggregate shall consist of dry, silica sand which shall be furnished by the Department and spread by state forces or which otherwise shall be designated by the Department. The sand shall be light in color and shall be nominally free of sizes larger than the No. 8 sieve and sizes smaller than the No. 30 sieve.

C. Acid Solution for Etching Concrete Surface

Acid solution shall consist of a 10-percent solution of hydrochloric acid.
Note: Concentrated acid is 36 percent HCL; 1 part concentrated acid to 2.6 parts water yields a 10 percent HCL solution. The dilution of concentrated acid should be done cautiously and by slowly adding the smaller quantity of the concentrated acid to the larger quantity of water.

III. SURFACE PREPARATION

Unless patching is otherwise and specifically provided, the preparation of the surface for the application of binder shall consist solely of cleaning. Cleaning shall include the removal of debris, dust, grime, grease, oil and bituminous matter. Gross deposits of such materials adhering to the surface shall be scraped off by means of a sharp blade before beginning the cleaning procedures subsequently required. Cleaning shall consist alternatively of sand-blasting or scrubbing with solvents and detergents and etching the surface throughout with diluted hydrochloric acid followed by rinsing or flushing the surface with an abundance of water. Sand-blasting, if used, shall be followed by brooming and the removal of all remaining dust with a jet of compressed air or water (the latter is the less desirable inasmuch as a prolonged delay would be incurred in order to permit adequate drying). Cleaning solvents, when used, shall consist of asphaltic solvents such as kerosene or substituted aliphatc solvents as Renex 690 or Triton X-100. Sufficient solvent shall be applied to the surface to permit scrubbing with brooms or brushes, and all solvent remaining on the surface following the scrubbing shall be mopped up. Sufficient time shall then be allowed for the complete evaporation and drying of the remaining solvent from the surface. Drying may be augmented by means of a jet of compressed air.

Areas requiring cleaning with solvent shall be designated by the Engineer. Acid etching, when used in lieu of sand-blasting, shall consist of the application of 1.6 pints of the diluted hydrochloric acid per square yard of surface (0.1 gal. per sq. yd.). The acid shall be distributed by equipment of the type known as "Acid Etching Rig" available from the Broyhill Company, Dakota City, Nebraska. The acid shall be allowed to react until the effervescence subsides, and the surface shall be thoroughly flushed and rinsed with water (as noted above) and allowed to dry.

Traffic shall not be permitted to travel over the surface during or following the cleaning and shall, moreover, be deferred until after the binder and grit have been applied and the finished seal-coat has hardened or set.

IV. APPLICATION OF BINDER

The contractor shall furnish the resinous binder components, "A" and "B", shall be thoroughly blended together in equal portions and in accordance with the manufacturer's instructions. The equipment for mixing and applying the binder shall be automatic and shall be capable of continuously and accurately metering, blending, and spraying the material onto the roadway while traveling. Such equipment shall be of the type available from the Broyhill Company, Dakota City, Nebraska; or an approved equal thereto.

The binder mixture shall be applied to the surface at the rate of 3.0 pounds per square yard; the Engineer may adjust the rate of application. The application shall uniformly cover at least one lane-width of roadway in a single pass or excursion of the equipment.

All appurtenances to the roadway shall be protected in a satisfactory manner and to prevent them from being splattered with the binder material. Likewise, traffic in adjacent lanes shall be similarly protected or interrupted during the spraying operation.

V. APPLICATION OF GRIT (AGGREGATE)

Grit shall be applied by means of an approved aggregate spreader which shall be of a type normally used in asphalt-sealing operations. The grit shall be dispersed ahead of the wheels on which the spreader is conveyed. The aggregate shall be spread within 5 minutes after the application of the binder if the temperature is 90° F. or higher. If the temperature is below 90° F., the spreading of the aggregate shall be deferred, at the discretion of the Engineer, to permit proportionately longer wetting periods. In no case shall the application of the grit be delayed more than 20 minutes even if the prevailing temperature is at or near 60° F. The quantity of aggregate dispersed shall be in sufficient excess to prevent bleeding of the binder and to prevent the spreading equipment from tracking through the fresh binder. All other traffic shall be withheld until the binder has hardened. Prior to opening the roadway to traffic, all loose aggregate shall be swept up and removed from the surface.
VI. OPENING TO TRAFFIC

The opening of a finished lane to traffic may be guided by the following average curing times for respective temperatures:

<table>
<thead>
<tr>
<th>Prevailing Temp. (°F.)</th>
<th>Typical, Min. Curing Times (hrs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>12</td>
</tr>
<tr>
<td>70</td>
<td>8</td>
</tr>
<tr>
<td>80</td>
<td>5</td>
</tr>
<tr>
<td>90</td>
<td>4</td>
</tr>
<tr>
<td>100</td>
<td>3</td>
</tr>
</tbody>
</table>

After the respective curing periods, above, have elapsed, the Engineer shall perform a screwdriver or key-hardness test on the binder material in order to confirm conformity to the typical curing schedule and ensure that sufficient hardness has been achieved.

VII. WEATHER LIMITATIONS

Binder material shall be applied only when the weather is fair, is not menacing, and has been favorable to drying for a period of at least 12 hours. At the time of application, the temperature shall be between 60° F. and 90° F.

VIII. PRECAUTIONS

Persons and property exposed to cleaning solvents and acid and to epoxy-type resins shall be adequately protected against any hazards so incurred.

SPECIAL PROVISION

FOR

SILICA SAND-ASPHALT RESURFACING OF CLARK MEMORIAL BRIDGE, JEFFERSON COUNTY
PROJECT NO. MP 56-8118-7

This Special Provision covers the material requirements and construction procedures for silica sand-asphalt resurfacing of Clark Memorial Bridge in Louisville and shall supersede all conflicting requirements of the Department's 1956 Standard Specifications. All Specification References are to the Department's 1956 Standard Specifications.

Silica Sand-Asphalt Surface

I. DESCRIPTION

The Silica-Sand-Asphalt Surface course shall consist of a hot-mixed, hot-laid course of silica sand and asphalt on the prepared existing surface in accordance with these specifications and in conformity with the lines, grades, and cross-sections shown on the plans or in the proposal.

II. MATERIALS

A. Requirements

The asphalt cement for the mixture shall be PAC-3 and shall meet the requirements of Article 7.7.0 for that particular type and grade. Asphalt for tack coat shall be a rapid curing cut-back composed of PAC-3 as specified above, and a suitable distillate combined so as to meet the viscosity requirement for RC-2 in Article 7.7.8-B.

The sand for the mixture shall be predominantly silica and shall be composed of clean, angular grains free from clay, loam, or other foreign matter. As delivered to the mixer it shall be free from clayey lumps or loosely bonded aggregations. When tested by standard laboratory sieves, it shall conform to the following grading requirements:

<table>
<thead>
<tr>
<th>Passing No. 8 Sieve</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passing No. 16 Sieve</td>
<td>85-100</td>
</tr>
<tr>
<td>Passing No. 30 Sieve</td>
<td>70-97</td>
</tr>
<tr>
<td>Passing No. 50 Sieve</td>
<td>40-63</td>
</tr>
<tr>
<td>Passing No. 80 Sieve</td>
<td>16-40</td>
</tr>
<tr>
<td>Passing No. 100 Sieve</td>
<td>10-30</td>
</tr>
<tr>
<td>Passing No. 200 Sieve</td>
<td>6-12</td>
</tr>
</tbody>
</table>

Sand meeting the above requirements may be obtained by crushing sandstone, by quarrying weakly cemented sand, or by combining suitable bank sand with sand dredged from the Ohio River. Natural bank sand and natural river sand intended for use in combination shall conform to the following grading requirements when tested by standard laboratory sieves:
The limits of gradation shown above represent the limits which shall determine the suitability for use from all sources of supply. The gradation from any one source shall be reasonably uniform.

Mineral filler, when specified, shall be Portland cement meeting the requirements of Article 7.1.2.

B. Approval of Materials

All aggregate must be approved by the Engineer prior to use on this project.

III. PLANT AND EQUIPMENT

This item shall meet the requirements of Article 4.3.3, except that the second sentence of Article 4.3.3-C-9 shall not apply. Provisions shall be made uniformly returning the dust collected to the mixture.

In addition, the plant shall be equipped with a suitable device for accurately proportioning mineral filler to the mixer.

IV. PREPARATION OF MIXTURES

A. Composition of Mixtures

The aggregate shall consist of silica sand as specified above and Portland cement as a mineral filler where required. If combined bank sand and Ohio River sand are used, the total aggregate shall be composed of approximately 50 percent by weight of each. Portland cement at the rate of 2 to 4 percent by weight of total aggregate shall be used as mineral filler in the patching mixture only. Asphalt content shall be from 8 to 10 percent by weight of the total mixture.

A closer control than these limits shall be required and the job mix as set by the Engineer shall be maintained within the allowable plus or minus tolerances of 0.3 percent for asphalt and 4.0 percent for the aggregate.

B. Preparation of Aggregate

Aggregate shall be deposited in the cold elevator at a rate to insure correct drying and uniform temperature control of the heating and drying operation. If combined bank sand and Ohio River sand are used, they shall be deposited on the cold elevator in their proper proportions. The sand shall be heated to a temperature between 250° F. and 325° F. before entering the mixer. If combined bank sand and Ohio River sand are used, care shall be taken that they are charged to the mixer in their proper proportions.

C. Preparation of Asphalt Cement

This item shall conform to Article 4.3.4-C.

D. Preparation of Mixtures

The sand, asphalt cement, and mineral filler, when required, shall be measured separately, and the exact proportions within the limits specified shall be regulated so as to produce a satisfactory mixture with all particles coated with asphalt.

E. Temperature Requirements

This item shall conform to Article 4.3.4-E.

F. Transportation of Mixtures

This item shall conform to Article 4.3.4-F.

V. CONSTRUCTION METHODS

A. Preparation of Existing Surface

Preparation of the existing surface shall consist of removing all existing bituminous patches and cleaning the surface by means of compressed air.
B. Patching

All existing bituminous patches shall be removed from the concrete floor, and any depressions in the existing floor shall be thoroughly cleaned by means of compressed air and other means; painted with the asphalt specified for tack coat under "Materials" above; and patched with a mixture of silica sand, mineral filler, and asphalt cement as specified for the mixture. Patches shall be carefully built up in layers not exceeding 1 1/2 inches in depth and then satisfactorily compacted by means of an approved vibratory compactor or mechanical tamper. When patches are made to improve the existing riding surface, rollers meeting the requirements of Article 4.3.3-G may be used. Care shall be taken that thorough compaction is achieved.

C. Applying Tack Coat

After patching and cleaning by compressed air the area to be surfaced shall receive an application of the asphalt specified for tack coat under "Materials" above. Application shall be made by fogging with a hand spray attached to a pressure distributor meeting the requirements of Article 4.12.3-C. Thorough and uniform coverage shall be achieved. All necessary precautions shall be taken to prevent spotting or discoloring curbs, sidewalks, bridge members, and other structures. Any such spotting or discoloring shall be removed at the contractor's expense. The contractor shall take precaution against damage of the tack coat. All damaged areas shall be repaired. The tack coat shall be allowed to cure thoroughly prior to placing the surfacing mixture.

D. Spreading and Finishing

The silica sand-asphalt mixture shall be machine spread and finished in accordance with Article 4.3.5-C-4 and 6. Suitable burners shall be provided for heating small tools at all times. No material shall be placed when the temperature is below 55°F nor when the existing surface is wet or other weather conditions are unsuitable.

E. Compaction

Rollers shall meet the requirements of Article 4.3.3-G. The surface shall be rolled as soon as the mixture has cooled sufficiently to bear the weight of the roller without undue displacement. One or more rollers shall be required as necessary to satisfactorily compact the mixture. Rolling shall begin at the sides and progress to the center parallel to the centerline, uniformly lapping by 1/2 width of the rear wheel. Alternate trips of the roller shall end on transverse lines at least 3 feet apart. Starting and stopping of the rollers shall be so regulated as to avoid distortion of the surface.

During initial rolling the surface shall be checked for any irregularities that may develop. All high and low areas exceeding the limits in surface tolerances shall be corrected by removing or adding material as directed by the Engineer. Any areas showing an excess of asphalt or fine matrix shall be removed and replaced with new material. The rollers shall operate continuously until all roller marks are eliminated and satisfactory density has been obtained. Areas inaccessible to the roller shall be compacted by vibratory compactors or mechanical tampers.

F. Surface Tolerances

Tolerances shall conform to the requirements of Article 4.3.5-F, except that the second and fifth paragraphs shall not apply.

G. Maintenance and Protection

This item shall include the applicable requirements of Article 3.4.5-G.

Working hours for the normal surfacing operations shall be from 9:00 A.M. to 3:00 P.M., C.D.T. Patching may be done at any time except during the hours of peak traffic volume generally occurring between 6:00 A.M. and 9:00 A.M. and between 3:00 P.M. and 10:00 P.M., C.D.T. However, patching may be permitted during these periods, provided, in the opinion of the Engineer, peak traffic decreases sufficiently to permit normal operations.
The work shall be conducted so as to provide maintenance of at least two lanes of traffic over the bridge at all times. All four lanes shall be kept open to traffic between the hours of 3:00 P.M. and 9:00 A.M., C.D.T., except when patching is being done.

**H. Work to be Performed by Department**

Patch the floor with P.C. Concrete over such areas that are broken through the full thickness of the floor.

Raise the steel expansion dam where necessary.

Seal the transverse and longitudinal joints where necessary.

The Department's and the Contractor's forces shall arrange their work so that there will be a minimum of interference to traffic, and shall cooperate with one another in performing their respective operations.

**VI. METHODS OF MEASUREMENT**

The Silica Sand-Asphalt Mixtures shall be weighed in accordance with Article 1.9.1.

All bituminous material, except that used in the sand-asphalt mixtures, shall be measured in gallons as specified in Article 7.7.0.

**VII. BASIS OF PAYMENT**

The accepted quantities thus measured will be paid for at the contract unit price bid per ton for "Silica Sand-Asphalt Patching Mixture", which price shall include the full cost of the removal of the existing bituminous patches and cleaning of any depressions; per ton for "Silica Sand-Asphalt Surfacing Mixture"; and per gallon for "Liquid Asphalt" used for tack coats only. Such payments shall be full compensation for the necessary cleaning and preparation of the existing roadway surface not provided for above as a function of the Department; for furnishing, hauling and placing all materials; for compaction of the bituminous mixtures; for making proper joints, both within the limits of the work and to the existing pavement adjacent to the ends of the project; for the disposal of all surplus material; and for furnishing all labor, equipment, tools, and incidentals necessary to complete the work as specified.

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*Proposed Application Rates*

**Tack Coat:**
0.1 gal. per sq. yd. (both patching and surfacing)

**Surfacing:**
40 lbs. per sq. yd. (0.41 inches, approx.)

**Asphalt Content of Mixture:**
9.0 pct. (Tack coat applied at rate of 0.1 gal. per sq. yd. provides approximately 1.5 pct. asphalt for a 40 lb. per sq. yd. treatment).
ITEM 10
COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS

SPECIAL PROVISION
FOR
EPOXY-SAND SEAL (EXPERIMENTAL)
Warren-Butler Counties
SP 16-236, SP 114-8

These provisions, or designated portions thereof, shall apply where so indicated on the plans, proposals, or invitations for bids.

I. DESCRIPTION

These requirements describe materials, construction procedures, and incidentals pertaining to the application of epoxy-sand seal to concrete bridge decks, curbs, and walks. The work shall include furnishing all materials, equipment and labor. This work shall be supplemental to all other work and requirements specified.

II. MATERIALS

A. Resinous Cement

1. Requirements

The resinous cement shall consist of a two-component, coar-tar-modified, epoxy resin system conforming to the requirements of AASHO M 200-631, Type C. Each component, designated as A and B, shall be formulated in such a manner that equal parts, by weight or by volume, when blended immediately prior to use in accordance with the manufacturer’s instructions, will harden into a solid resinous material having the properties outlined in Table III for Type C of AASHO M 200-631. In cases where the surface to be sealed is sloping, the epoxy resin shall contain a thixotropic agent in such quantity to prevent running and sagging. Each component shall be supplied in clean, well-identified, separate containers. Each container shall be clearly labeled with the manufacturer’s name, batch, batch number, and date of manufacture. Appropriate warning labels shall be on each container.

2. Basis for Acceptance

Prior approval by the Department shall be a prerequisite to the use of the resinous cement. The Contractor shall furnish certified test reports, sworn by the manufacturer of the materials or by an approved independent testing laboratory, showing proof of compliance with the applicable requirements listed in Tables I, II, and III of AASHO M 200-631.

3. Sampling and Testing

The Contractor shall submit a one-quart sample of each component in separate, well-sealed containers for each batch to the Division of Materials for general quality tests. Cure rate-hardness tests are described in AASHO M 200-631 shall be performed on each sample. Materials failing to meet the applicable requirements for the cure rate-hardness test shall be rejected for use and removed from the job site.

B. Sand

1. Requirements

The sand for surface application shall be non-friable, non-polishing, clean, dry silica sand. The gradation of the sand shall be as follows:

<table>
<thead>
<tr>
<th>Sieve No.</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 8</td>
<td>100</td>
</tr>
<tr>
<td>No. 16</td>
<td>40-60</td>
</tr>
<tr>
<td>No. 30</td>
<td>0-3</td>
</tr>
<tr>
<td>No. 200</td>
<td>0-1</td>
</tr>
</tbody>
</table>

2. Sampling and Testing

The Engineer shall submit at least one 25-pound sample to the Division of Materials for each shipment. Samples shall be tested for gradation. Material failing to meet the specified requirements shall be rejected for use.
C. Acid Solution for Etching Concrete Surface

The acid solution shall consist of a 16 percent ± 3 percent of hydrochloric acid.

Note: Concentrated acid is 36 percent HCL; 1 part concentrated acid to 1.25 parts water yields a 16 percent HCL solution. The dilution of concentration should be done cautiously and by slowly adding the acid to the water.

III. CONSTRUCTION METHODS

A. Surface Preparation

The surface preparation described herein shall be made after concrete has aged for at least 28 days and no more than 48 hours prior to application of the Epoxy-Sand Seal. Cleaning shall consist of the complete removal of all deposits of oil, grease, grime, bituminous material, dust, dirt, paint, etc. Cleaning solvents, when required by the Engineer, shall consist of aliphatic solvents such as kerosene or substituted aliphatic solvents such as trichloro-ethylene, perchloro-ethylene, etc. Detergents, when required by the Engineer, shall be non-ionic types such as Renex 690, Triton X-100, Surfonic 120, or equivalents thereof. Sufficient solvent and/or detergent shall be applied to the surface to permit scrubbing with brooms or brushes. All solvents or detergents remaining on the surface following the scrubbing operation shall be removed by mopping. The areas shall then be flushed with an abundance of clear water. Sufficient time shall then be allowed for complete evaporation and drying of any remaining solvent, detergent, and water from the surface. Drying may be augmented by use of mops free of oil, grease, dirt, etc.

Final cleaning shall be accomplished by etching the surface with a water solution of hydrochloric acid containing 16 percent ± 3 percent of hydrochloric acid by weight. The water solution of hydrochloric acid shall be applied at a minimum rate of one (1) pint per square yard and shall be spread uniformly over the entire surface. The solution shall remain on the surface for at least 5 minutes, or until effervescence ceases, and shall then be flushed from the surface with clear water under pressure and at a minimum rate of one (1) gallon per square yard within 10 minutes after application of the acid solution. In case the structure is on a grade, rinsing shall commence at the upper point and progress toward the lower point.

Care shall be taken to prevent the acid solution from coming in contact with areas which are not to be sealed (approach slabs, etc.) and to protect the substructure of the bridge from the acid solution. Necessary precautions shall be taken to prevent any contamination of the surface after the cleaning operation and prior to sealing. The Contractor shall mask, cover, and/or protect joints, expansion dams, drains, and surfaces not to receive the seal from contact with the resin during the sealing operation. Complete removal of any and all resinous cement from such areas shall be the Contractor’s expense and shall be done in a manner satisfactory to the Engineer. Any and all protective masks and covers shall be completely removed after application of the resin and prior to its hardening.

B. Application of Resinous Cement

The resinous cement shall be applied only when the atmospheric temperature is 60° F. or above unless otherwise directed in writing by the Engineer. The surface shall be completely dry before application of the resinous cement. The resinous cement components, A and B, shall be blended, immediately prior to use, by weight or by volume within ± 5 percent of the manufacturer’s recommended proportions or as directed by the Engineer. The equipment used in mixing and applying the resinous cement shall be automatic and shall be capable of continuously and accurately metering, blending, and spraying the material onto the surface while traveling. Resinous cement shall be applied at a rate of 3.0 ± 0.1 pounds per square yard. The equipment shall be so designed, equipped, coordinated, and operated as to apply the resinous cement continuously, smoothly, and uniformly over the full width of one lane in one pass, or as directed by the Engineer. The storage tanks on the equipment
shall be equipped with liquid-level measuring rods or other suitable measuring devices which may be utilized while the equipment is in motion. The Engineer shall record the level of each component at the beginning, middle, and end of each run to determine the rate of application. Resinous cement shall be applied in such a manner that the wheels of the equipment do not contact the resinous cement. Resinous cement shall be applied at the specified rate to the walk, curb, and gutter prior to application on the roadway surface. This shall be accomplished by use of a hand-spray device attached to the equipment.

Streaking, ponding, or any other signs of non-uniform application will not be permitted. When equipment is found to be unsatisfactory, it will be repaired, replaced, or removed from the site as directed by the Engineer. Vehicles, equipment, and personnel shall not be permitted on the resinous cement while it is in a liquid state. Portable bridges shall be used for removal of protective covers or masks from drains, joints, expansion dams, etc. prior to hardening of the resinous cement.

C. Application of Sand

While the resinous cement is still liquid, the sand shall be dropped into place in such a manner that the resinous cement is not disturbed by the equipment or personnel. The equipment used in applying the sand shall be self-contained, self-propelled, pneumatic-tired, so designed, equipped, and operated that the sand shall be dropped into the resinous cement vertically, continuously, uniformly, and smoothly over the full width of the resinous cement application excepting for the walk and curb where hand spreading will be permissible. A hopper, integral with the spreader unit, shall be provided to receive the sand from the transporting vehicles. Wheels of the vehicles shall not be allowed to come in direct or indirect contact with the liquid, resinous cement.

The sand shall be applied within 5 minutes after application of the resinous cement if the atmospheric temperature is 90° F. or higher. If the atmospheric temperature is below 90° F., spreading of the sand may be deferred up to 20 minutes, at the discretion of the Engineer, to permit a longer wetting period. Sufficient sand shall be dispensed to prevent bleed-through of the resinous cement. Should the overlay be disturbed prior to hardening of the resinous cement so that the surface is rough, uneven, or otherwise unsatisfactory, the Contractor shall make such repairs, as directed by the Engineer, to provide a smooth, continuous surface.

After the sand is spread, vehicular and foot traffic over the overlay shall be prohibited until sufficiently hard. As soon as the resinous cement has hardened, excess, non-adhering sand shall be removed by sweeping with brooms or air drafts.

IV. METHOD OF MEASUREMENT

The area actually covered as directed, complete and accepted, shall be measured in square yards.

V. BASIS OF PAYMENT

The area thus measured will be paid for at the contract price per square yard for Epoxy-Sand Seal, which price shall be full compensation for traffic protection; cleaning the entire area to be surfaced; furnishing, mixing, applying and curing the epoxy surfacing; furnishing and applying aggregate and removing any excess; masking off areas; and furnishing all labor, materials, tools, and equipment and incidentals necessary to complete the work.

APPROVED

D. H. BRAY
STATE HIGHWAY ENGINEER
ITEM 11
COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
SPECIAL PROVISION
FOR
SURFACING BRIDGE DECK
Boyd County
SP 10-6025-1

I. DESCRIPTION

This work shall consist of removing the existing bituminous surface (2 inches ±), patching pot holes, cleaning, and sealing joints in the bridge deck, applying a double seal coat and sand asphalt surface to the bridge deck, and applying a sand asphalt surface to two approach ramps. The requirements set out herein shall supersede any conflicting provisions of the 1956 Standard Specifications or of any other Special Provisions that are included as a part of the contract.

II. MATERIALS

The Asphalt Cement shall comply with Amendment No. 38 (Pamphlet No. 2) to Article 7.7.4 of the Standard Specifications either for grade PAC-3 or PAC-5 to be used in the Class I bituminous mixtures and for grade PAC-3 for use in the Sand Asphalt mixtures.

The Emulsified Asphalt, Type SS-Ih, shall comply with the Special Provision for Emulsified Asphalt dated April 13, 1965.

The aggregates for the Class I, Type A, bituminous mixtures shall comply with the Special Provision for Aggregate for Bituminous Concrete Mixtures dated February 28, 1964.

The aggregate for both the single and the double seal coat applications shall comply with the requirements of Article 7.3.2 of the Standard Specifications for natural sand for portland cement concrete mixtures.

The aggregate for the Sand-Asphalt mixtures shall comply with the requirements of the Special Provision for Sand Asphalt Surface dated June 11, 1965, except that the sand shall be 100 percent natural sand. The percentage of mineral filler may be increased, when directed by the Engineer, to exceed the 5 percent specified in the Special Provision.

The joint sealing compound shall comply with the requirements of the Department's Special Specification No. 23.

III. CONSTRUCTION METHODS

A. Removing Existing Surface

The Contractor shall remove the existing bituminous surface and bituminous patches, and all loose and unsound concrete that will prevent a satisfactory bond between the new bituminous patching and the existing deck. All materials shall be removed in a manner as approved or directed by the Engineer so as to avoid damage to any part of the bridge. Any remaining bituminous material, applied in liquid form, that is not well bonded to the deck shall be removed. Pavement breakers, if used, shall not exceed 45 pounds in weight. The material removed shall be disposed of by the Contractor as directed by the Engineer.

B. Patching Pot Holes

After all loose and unsound concrete has been removed from the area to be patched, a single seal coat shall be applied to the pot hole and around the perimeter at least 6 inches beyond the edge of the hole. The seal shall be applied at the rate of approximately 0.25 gallons of the Emulsified Asphalt, Type SS-Ih and 20 pounds of concrete sand per square yard. No curing period will be required for the seal coat before the Class I, Type A bituminous filler is applied. The bituminous material shall be placed in sufficient quantities so that, after compaction, it will be flush with the concrete surface surrounding the pot holes. This material shall be thoroughly compacted by rollers or vibratory compactors.

C. Sealing Transverse Joints

Before the double seal coat is applied, all transverse joints, exclusive of the steel expansion dams, shall be thoroughly cleaned to a minimum depth of 1 inch below the surface of the deck or to a depth of 1 and one-half times the width of the joint, whichever is greater. The joint shall be cleaned and sealed through the full width of the deck, the vertical height of the curbs, and the full width of the sidewalks.
D. Double Seal Coat

The surface shall be thoroughly cleaned of all foreign material before each application of the double seal coat. The double seal coat shall be applied to the entire roadway surface of the bridge deck in accordance with all of the requirements of the Special Provision for Double Seal Coat Treatment, except as otherwise provided herein. Each application shall be at the rate of 0.25 gallon of Emulsified Asphalt, Type SS-Ih, and 20 pounds of concrete sand per square yard. The emulsified asphalt shall be applied at a temperature within the range of from 60-140 degrees Fahrenheit. A curing time of two weeks shall be allowed between each seal course and the laying of the final surface. The vertical surface of the curb shall be painted with Emulsified Asphalt, Type SS-Ih, from the gutter line to 1 inch above the finished surface elevation before the surface is laid.

E. Tack Coat

If deemed necessary by the Engineer, a tack coat shall be applied to the completed double seal coat before the final surface course is applied. The tack coat shall consist of Emulsified Asphalt, Type SS-Ih mixed with equal parts of water and shall be applied in accordance with Article 4.12.0 of the Standard Specifications at a rate not in excess of 0.15 gallons of the mixture per square yard.

F. Sand Asphalt Surface

Before the sand-asphalt surface is applied, the surface of the completed double seal coat shall be thoroughly cleaned of all foreign material. The sand-asphalt shall be placed to a nominal, compacted thickness of 3.4 inch and in accordance with the applicable requirements of the Special Provision for Sand-Asphalt Surface. Special care shall be exercised to depress the surface around all floor drains to allow for proper drainage.

G. Maintenance of Traffic

The bridge shall be open to two-lane traffic except periods of time specified herein.

The bridge shall be kept open to one-lane traffic with sufficient flagmen during the following working hours:

Mondays through Fridays
9:00 a.m. to 3:00 p.m. (daytime)
8:00 p.m. to 6:00 a.m. (nighttime)

On Saturdays and Sundays traffic may be limited to one-lane throughout the daytime. If it becomes necessary to close the bridge to traffic, it may be closed on Sunday providing plans are made sufficiently in advance so that the news media can be notified and proper detours can be established.

H. Cooperation with Other Contractors

The Contractor shall coordinate his work with the painting contractor when removing the excess or loose material and foreign matter from the bridge deck so that he will not interfere with or do damage to the painting being done to the subject bridge. The Contractor should use a street cleaning type sweeper to clean the deck. If the sweeping operations interferes with the painting operation, the Contractor will be required to clean the deck by flushing with water.

III. MEASUREMENT AND PAYMENT

The pay items will be measured in the units indicated in the following list and will be paid for at the contract price bid per unit.

<table>
<thead>
<tr>
<th>BRIDGE DECK</th>
<th>APPROACH RAMPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Removing Existing Surface</td>
<td>Sand-Asphalt Surface (PAC-3)</td>
</tr>
<tr>
<td>Class I Surface, Type A (Patching Pot Holes)</td>
<td>Emulsified Asphalt (Tack Coat)</td>
</tr>
<tr>
<td>Emulsified Asphalt SS-Ih (Double Seal Coat)</td>
<td></td>
</tr>
<tr>
<td>Concrete Sand (Double Seal Coat)</td>
<td></td>
</tr>
<tr>
<td>Sand-Asphalt Surface (PAC-3)</td>
<td></td>
</tr>
<tr>
<td>Emulsified Asphalt SS-Ih (Tack Coat)</td>
<td></td>
</tr>
<tr>
<td>Sealing Joints</td>
<td></td>
</tr>
<tr>
<td>Gallon</td>
<td>Square Yard</td>
</tr>
<tr>
<td>Ton</td>
<td>Gallon</td>
</tr>
<tr>
<td>Gallon</td>
<td>Lump Sum</td>
</tr>
</tbody>
</table>

No direct payment will be allowed for removing loose or unsound concrete from the areas to be patched, nor for furnishing material for and applying the single seal coat to these areas as the cost of this work is considered incidental to the price bid per ton for Class I Surface.

The price bid for the several pay items listed above shall constitute full payment for the disposal of all materials required to be removed; for furnishing and placing all materials required for the work; for handling traffic; and for furnishing all labor, equipment, and other incidentals necessary to complete the work.
APPENDIX B

OPERATOR'S MANUAL

FOR

CORROSION DETECTION DEVICE

by

Ben W. Carr, Jr.

Research Engineer Associate

Division of Research
DEPARTMENT OF HIGHWAYS
Commonwealth of Kentucky

April 1972
INTRODUCTION

The purpose of this leaflet is to instruct the operator in the general manner of operating the Corrosion Detection Device. All of the steps in the operating instructions should be followed to insure accurate readings.

LIST OF EQUIPMENT

1. Hewlett-Packard D.C. Null Voltmeter Model 49A.
2. Two 36-inch-long copper sulfate reference cells.
3. One spool containing 100 feet of two-wire No.16 cable.
4. One spool containing 300 feet of single-wire No.16 cable.
5. One sponge, approximately 2" x 4" x 8" (used between reference cell and concrete, saturated with water for good electrical contact).

OPERATION

Equipment Set Up

1. Measure and mark a five foot grid on the surface to be tested. Increase or decrease the grid if conditions warrant.
2. Locate a reinforcing bar or other connection to the reinforcing steel. A positive connection to the top of the reinforcing steel is desired; however, the bridge railing, expansion joints, light standards, drainage scuppers or other exposed steel may provide a positive connection to the reinforcing steel, but this connection must not be galvanized.
3. Uncoil single wire (orange wire) a sufficient length to reach all areas to be tested. Attach a short lead between the jack on the spool to the positive (+, red) jack on the DC Null Voltmeter. Clip the end of the wire to the connection on the end of the 36-inch-long copper sulfate reference cell.
4. Uncoil a sufficient length of the two-wire cable to reach the connection to the reinforcing steel. Attach a short lead from the proper jack on the spool to the negative (-, black) jack on the voltmetter. Notice there are two wires in the cable, each terminated with a different size clip. Use the clip (large or small) which best suits the connection to the steel. Use the jack on the spool which corresponds to the wire connected to the steel by the chosen clip. If the white wire is used, then the white jack on the spool should be connected to the (-, black) jack on the voltmetter. See Fig. B-2 for a complete set-up.
5. Check the voltmeter battery for proper charge by depressing the BAT. TEST button and noting that the meter needle swings to the right hand side of the scale and reads within the limits marked BAT. If not, recharge the battery before using.
6. Zero the meter by setting the RANGE selector to the lowest scale (3mv), depressing the ZERO button, and setting the meter needle on zero by turning the ZERO control.
7. Set the RANGE selector to one volt, depress VM-AM button and make measurements of the electrical potential at each grid point as follows:
   a. Dip the sponge in water and place on the point to be tested. Wait a few seconds to allow the water to wet the concrete. (Water may be poured directly onto the concrete prior to using the sponge to aid in obtaining a good electrical connection).
   b. Place the bottom contact of the 36-inch-long reference cell on top of the sponge.
   c. Read the potential on the meter.
      (1) Normal Readings are from 0 to 0.30 volts for sound concrete with no active corrosion in the reinforcing steel.
      (2) Readings above 0.35 volts indicate active corrosion in the reinforcing steel.

Results

1. Record the following data:
   a. Location (route, nearest town and project number).
   b. Type of construction.
   c. Year constructed.
   d. Number of spans.
   e. Major repairs.
   f. Span tested and date of test.
2. Draw a grid on graph paper corresponding to 5-foot (or other) grid drawn on the concrete (Fig. B-3). At each grid point record the voltage reading obtained at that point.
3. Plot equipotential lines by connecting equal potentials with smooth lines (Fig. B-3).
4. Note locations of curbs, expansion dams, etc. on graph. Make comments of general condition of bridge and note any active corrosion detected.
Figure B-1. Equipment Diagram.
Figure B-2. Device in Use.
Figure B-3. Example Results from Tests.
APPENDIX C
BROOM FINISHING

TEXTURE OF BROOM FINISH

BURLAP-DRAG FINISH

REMOVAL OF IRREGULARITIES

HAND FINISHING GUTTER AREA