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7. Author(s) Marvin H. Hilton		6. Performing Organization Code	
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16. Abstract A Wabocrete FMV bridge deck expansion joint system was installed on the Alternate Rte. 58 bridge over the Clinch River in November 1986. The bridge was placed in service in mid-1987. The report concerns an installation and performance evaluation of the joint system. It was found that the Wabocrete FMV joint system offers some installation advantages over preformed joint systems. The blockout area of the bridge deck does not have to be as smooth or as precisely dimensioned since the joint's anchorage system can be leveled prior to placement of the bonding material. Installation and future maintenance problems involving anchor bolts are eliminated since the system relies on bond rather than mechanical anchorages. After over two years of service, the Wabocrete system has performed well. During this period, the joint has accomodated all thermal and structural movements, withstood traffic impacts and remained leakproof. The joint does tend to accumulate debris and should be routinely cleaned. The performance of the joint during the period of the study has not given any reason to suggest that it not be used on new bridge decks similar to the one studied. A longer term evaluation, however, would be necessary for a full recommendation. The use of the Wabocrete FMV, and similar systems, as retrofit on older bridges should be approached with caution. Furthermore, these systems should probably not be used in retrofit situations in conjunction with adjacent asphaltic overlays.		13. Type of Report and Period Covered Final Report (11/86, 1/90)	
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FINAL REPORT

**INSTALLATION AND PERFORMANCE EVALUATION
OF THE WABOCONTE FMV JOINT SYSTEM FOR BRIDGE DECKS**

Marvin H. Hilton
Senior Research Scientist

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

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INTRODUCTION

One of the most persistent problems associated with the design, construction, and maintenance of bridge superstructures is the bridge deck joint. Virtually all of the bridges that are in service in the state of Virginia have two or more joints. In fact, this is true of most of the bridges in almost every state in the nation. Because of the large number of bridge joints, widespread performance and maintenance problems can very rapidly become a costly problem. In addition to costs associated with repairing or replacing the joint itself, leakage at a joint can lead to serious steel corrosion as well as concrete deterioration in substructure elements.

The large number of bridge joints in the inventory is also an enticing market for industry. Over the last 25 years or more, there have been a wide variety of proprietary bridge joints introduced into the market. The performance of the proprietary joints has varied. Some of the factors affecting the performance include the basic design of the joint system, the anchorage system, the methods (and care) used during installation, and the susceptibility of the joint to traffic. One of the more recent types of bridge deck joints that has been introduced to the market is called the Wabocrete FMV Elastomeric Concrete System (1). This system was installed as an experimental feature on a bridge located in the western part of the state of Virginia in November of 1986. This report is an evaluation of the installation and a performance evaluation of the joint system after being subjected to normal traffic over a period of slightly more than two years.

THE WABOCRETE FMV JOINT

A recent National Cooperative Highway Research Program Synthesis, entitled Bridge Deck Joints (2), classifies the various joints by type. Although the Wabocrete FMV joint is somewhat different from all the types described, it can generally be classified as an elastomeric strip seal. It differs from most strip seals in the manner that it is anchored to the bridge deck. Whereas the earlier strip seals were attached to steel or aluminum angles, which, in turn, were mechanically anchored to the deck, the Wabocrete FMV strip seal is mounted to steel extrusions, which, in turn, are anchored in an elastomeric concrete that is bonded to the deck. The bond between the elasto-

meric concrete and the bridge deck holds the joint system in place. A view of the joint system is shown in Figure 1. It should be noted that the steel extrusions are anchored in the Wabocrete FMV (field vulcanized) elastomeric concrete by a sinusoidally shaped steel bar. The strip seal stretches across the joint opening and serves to protect the lower structural elements of the bridge.

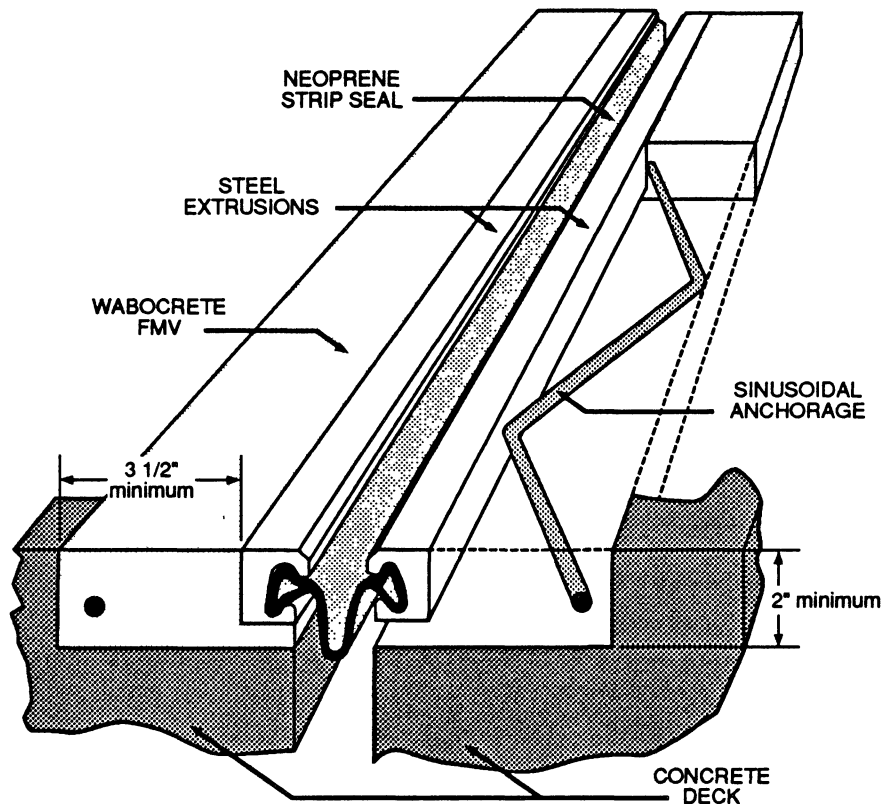


Figure 1. Details of the Wabocrete FMV elastomeric concrete expansion joint system.

An important advantage of the Wabocrete FMV and other bridge deck joints of similar design is that problems associated with the setting of anchor bolts in the concrete deck are eliminated. In addition, the need for a smooth and even blockout area, such as would be required for a plank seal design, is eliminated.

The elastomeric concrete in the Wabocrete FMV joint system is composed of synthetic rubber and aggregates that are, respectively, vulcanized and bonded together in the field. The material is purported to be resistant to traffic wear, sunlight, ozone, chlorides, and abrasives and resists brittleness at low temperatures and softening at high temperatures. With the continuous strip seal gland and with the fusion bonded elastomeric concrete placed in a continuous fashion, the joint system is considered to be leak proof.

Other advantages cited by the manufacturer include the potential for rapid installation, since the fusion and vulcanizing requires only about two hours and since the system is adaptable to one-lane-at-a-time installation in cases where traffic must be maintained on adjacent lanes.

PURPOSE AND SCOPE

The main purpose of the field evaluation of the Wabocrete FMV joint was to determine the ease of installation, identify any construction-related problems, and evaluate its short-term performance under ordinary traffic loading. The scope of the project was limited to a field evaluation during the installation of the joint and to an evaluation of the performance of the joint after two years under regular traffic loading.

In the course of the evaluation, a number of factors were reviewed to determine the overall effectiveness and performance of the bridge deck joint. To be an effective and efficient product, a bridge deck expansion joint must

- accommodate all thermal and structural movement of the bridge without failure of the joint material
- keep debris out of the joint opening and prevent it from reaching lower structural members
- prevent water and water-borne chemicals from leaking through the joint area and contributing to the corrosion, deterioration, and failure of the lower structural members
- provide for reasonable economy in its initial and long-term costs
- be relatively easy, quick, and inexpensive to install
- provide long and maintenance-free service under heavy traffic loading
- withstand the loads and impacts induced by traffic.

It was, therefore, the objective of this study to evaluate the Wabocrete FMV joint system with regard to its ability to satisfy these seven specific requirements.

It should be noted that the joint being evaluated was installed on a new structure.

BRIDGE LOCATION AND DESCRIPTION

The Wabocrete FMV joint was installed as an experimental feature on the alternate Route 58 bridge over the Clinch River at the Wise County/Russell County line. The structure is located in the Bristol District of the Virginia Department of Transportation.

The bridge is composed of five continuous spans and one simple span. Two expansion joints are located on the bridge: one at abutment "A" on the west end of the bridge and another at pier No. 5. The Wabocrete FMV joint is located at abutment "A" only. The deck length of the joint is 33 feet plus an additional amount that turns up the face of each parapet wall.

EVALUATION PROCEDURES

The evaluation of a proprietary product such as the joint system in question is normally an assessment of its ability to meet certain functional requirements and its service performance. Therefore, the main procedures used in this evaluation were inspections, observations, and record keeping during both the installation and performance phases of the study. Prior to installation of the joint, the various materials that comprise the total joint system were inspected as was the bridge deck area where the joint was to be installed. Any deficiencies that were observed in either the product or the bridge that might contribute to the integrity and performance of the joint system were noted. Similarly, the installation of the joint system was observed and notes were taken regarding the installation procedure, problems encountered, time required to complete the various phases of the installation, and any other information that might have relevance to the performance of the system.

After the system was installed, it was once again inspected prior to the bridge being placed in service under ordinary traffic loading. Subsequently, the joint system was inspected three times with the maximum time period between inspections being one year. Any abnormal conditions or other forms of distress that might have been observed during these inspections were noted. Primarily, however, the joint system was evaluated during the study period with respect to its ability to satisfy the primary requirements outlined earlier.

JOINT INSTALLATION

The joint system was installed in conformity with the manufacturer's specifications and recommended procedures; the manufacturer's materials were used.

All of the components of the joint system were delivered to the bridge site approximately two years prior to its actual installation. When the steel extrusion-sinusoidal anchorage system was inspected on November 4, 1986, it was badly corroded (see Figures 2 and 3). The remaining elements of the system that were on the job site were ten 44-lb bags of premixed aggregate materials and several containers of the two-component Wabocrete FMV binder. In order to test the binder materials, small samples of each component were mixed by the joint manufacturer's representative and allowed to set overnight. The mixture hardened normally; thus, it was concluded that the materials on hand could be used for the joint installation.

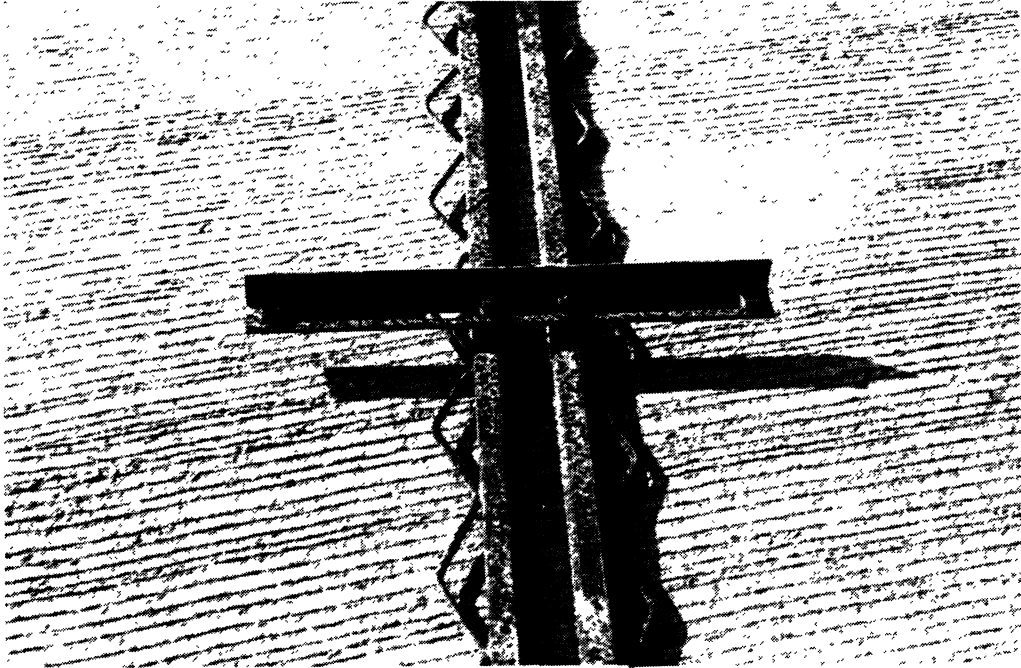


Figure 2. View of the rusted steel extrusion-sinusoidal anchorage unit.



Figure 3. View looking down on the end-section of the corroded extrusions showing their cross-sectional shape.

Prior to beginning the joint installation on November 6, 1986, the contractor sand-blasted the steel extrusion-sinusoidal anchorage system. In Figure 4, the cleaned unit is shown lying parallel to the bridge joint opening. Since there did not appear to be any ill effects from the corrosion of the unit or from the cleaning operation, the unit was approved for installation on the bridge.

The blockout area was cleaned and dried with a propane torch, and styrofoam, shown lying next to the trough area in Figure 4, was inserted in the joint opening to prevent the FMV material from falling into the opening. The two components of the binder material were placed in separate containers, which were, in turn, immersed in oil heated to 190° F. The two components were heated and maintained at 115 to 125° F until mixing began. The aggregates were heated to a warm condition and then mechanically mixed with the two-component resin to produce the Wabocrete FMV material.

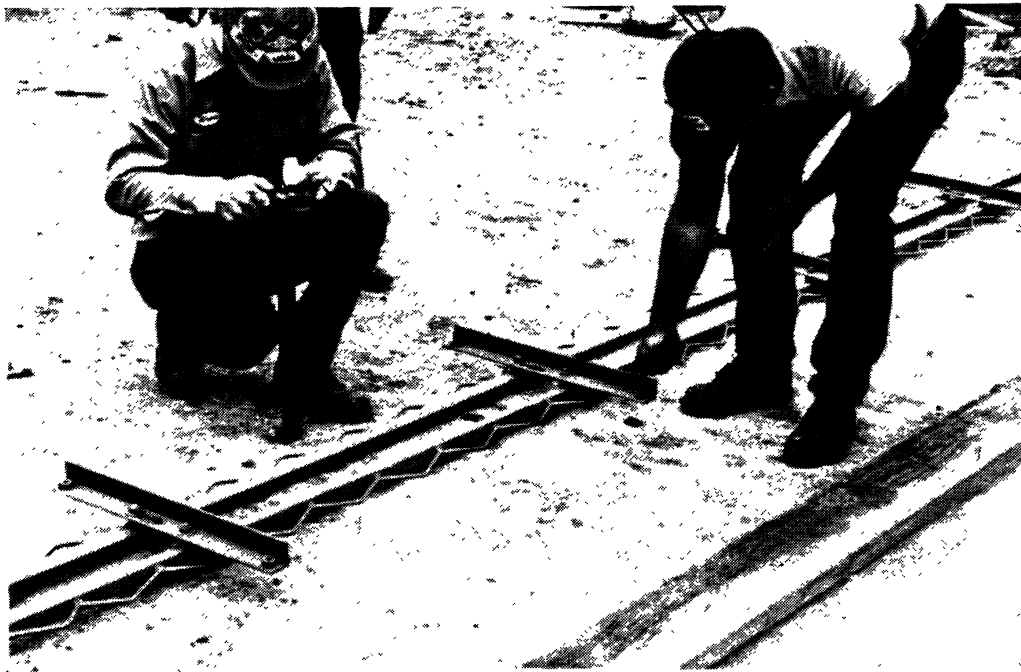


Figure 4. View of the sinusoidal anchorage unit after sandblasting to remove rust.

With the steel extrusion unit placed in the blockout (Figure 5), the Wabocrete FMV material was troweled into the cavity, and the surface area was smoothed. The trowels were heated with torches as necessary to prevent the binder from sticking to them. As the surface was smoothed, heating ducts were moved into place in order to keep heat on the material during curing. The heat was applied through the night by space heaters placed at the ends of the ducts. Ordinarily, curing could be accomplished in approximately two hours by applying heat.

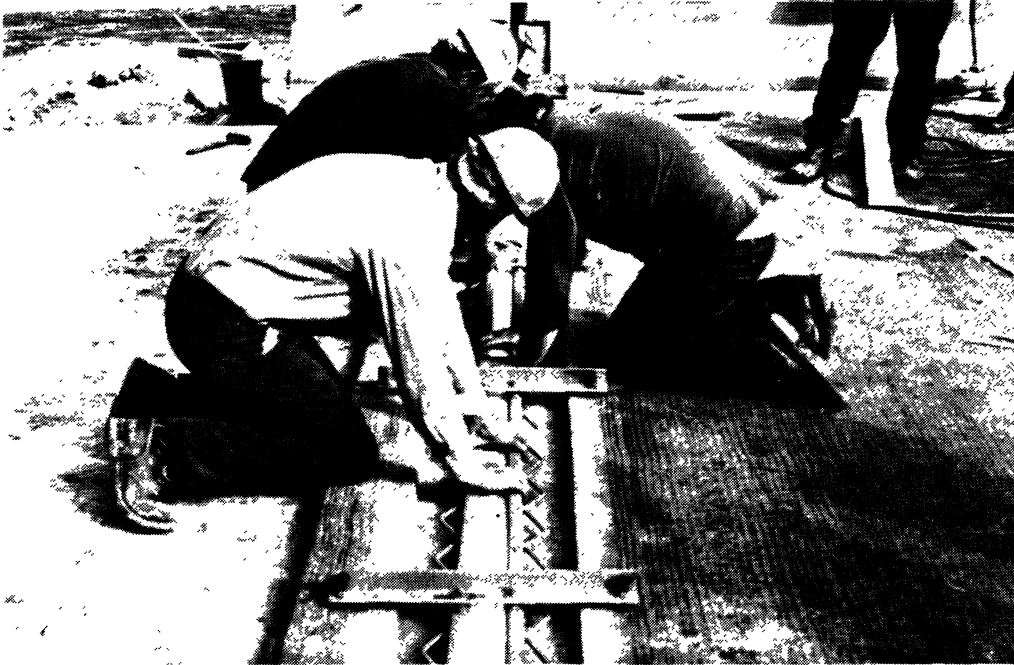


Figure 5. Workers aligning the joint hardware in the deck blockout. Cross angles are used for leveling the joint to proper elevation.

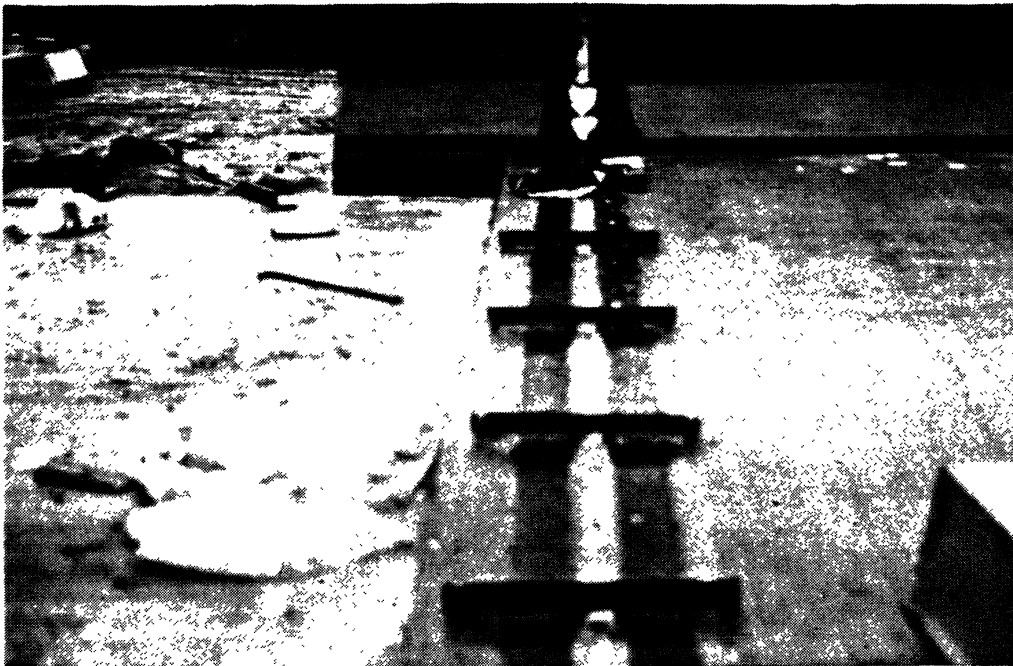


Figure 6. View of the joint after the binder had been placed in the blockout.

At the outset of the joint installation work, it was recognized that the 10 bags of premixed aggregates would be insufficient to complete the job. Consequently, the contractor purchased additional aggregate to complete the last 6 ft of the joint on the east side of the bridge. With the exception of the portions of the joint that turned up the face of the parapet wall, the installation was completed in approximately 4 hr. There was difficulty in placing the Wabocrete material up the face of the General Motors type parapet wall because it tended to flow downward.

After the material was installed on the face of the parapets, the heat was applied to the entire joint system until the following morning. Although a strip of forming had been placed over the face of the joint that ran up the parapet wall, the Wabocrete had continued to flow downward prior to solidifying. Consequently, it was decided that a small amount of material should be removed and replaced. This was accomplished by the contractor several days later without the assistance of the factory representatives. A view of the joint as it appeared the morning after the completion of the installation is shown in Figure 6. Subsequently, the neoprene strip seal was inserted into the steel extensions to complete the work.

During the day that the installation of the joint was taking place, the painting subcontractor was sandblasting the steel beams. As a result, there was considerable dust in the air and settling on the bridge deck surface while the joint installation was taking place. Although the painting contractor moved his sandblasting operation to the opposite end of the bridge, there was still some dust in the work area. The dust was a nuisance, but the factory representative did not feel that it would be detrimental to the installation of the joint as long as it was blown off the blackout surface prior to installation of the Wabocrete elastomeric concrete.

Other than the conditions described above, there were no apparent problems during installation that would likely contribute to a failure of the joint system.

The system appeared to be relatively quick and easy to install. With sufficient materials on the job site, the system could have been installed in several hours plus curing time for the elastomeric binder material.

PERFORMANCE EVALUATION

The joint system was inspected again on May 5, 1987, prior to the bridge being placed in service. At this inspection, the joint appeared to be sound. Generally, no serious deficiencies were noted. On the face of one parapet wall, however, the binder material had flowed downward leaving a gap at the upper end of the steel extrusions (Figure 7). There had been some effort to smooth the surface of the material to make it flush with the face of the parapet wall.

Although appearance was affected, the performance of the joint has not been affected by this installation problem. The steel extrusion has begun to rust slightly, but this should polish off under traffic. There was a considerable amount of soil and

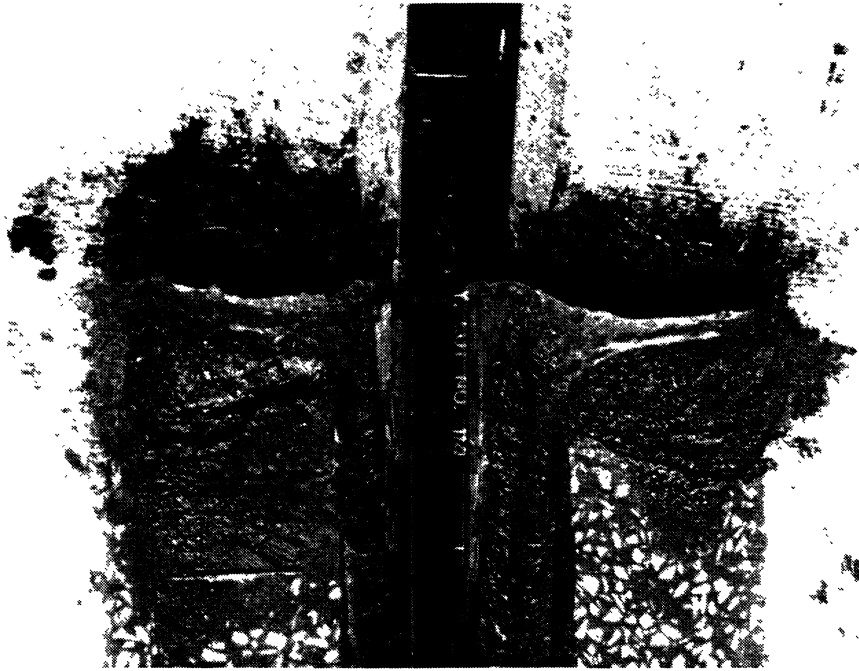


Figure 7. Horizontal gap on the face of a parapet wall caused by downward flow of the Wabocrete FMV material.

gravel on the deck surface and in the joint strip seal that had not been removed at the time of the May, 1987, inspection.

The joint system was inspected again in May 1988. At that time the bridge had been in service for approximately one year. There was no substantial difference between the condition of the joint then and a year earlier. A considerable amount of sand and gravel had accumulated in the trough of the neoprene strip seal.

The third inspection of the joint system was conducted in August 1989. At that time, the bridge had been under traffic for approximately 2 1/4 years. Since the Work Plan (1) for this project indicated that the performance of the joint would be evaluated for a minimum of 2 years, a more detailed final inspection was conducted. In addition to looking for evidence of impending distress, the joint was tapped to detect any signs of looseness, and a considerable amount of water was poured onto the joint area in order to check for leaks from beneath the superstructure.

Based on the latter inspection, the following performance results can be reported:

- The joint system has accommodated the thermal and structural movements to which it has been subjected to date.
- The joint system has withstood the traffic impacts and loadings to which it has been subjected. Average daily traffic counts for 1988 are given in Table 1.
- No evidence of joint system leakage was detected.
- No evidence of debonding of the Wabocrete FMV material was detected.
- Sand and gravel (and possibly other debris) tend to accumulate in the trough of the neoprene strip seal.
- Based on the performance of the system to date, routine maintenance should be minimal. However, debris should be removed from the neoprene strip seal periodically to prevent potential damage.
- Because the joint crosses the bridge deck at right angles to its alignment, there is a considerable amount of noise from traffic impact. The noise, however, was not unusual for a right angle joint crossing.

TABLE 1

Average Daily Traffic Count on the Study Bridge
(1988)

Automobiles	Single Unit Trucks	Tractor Trailers	Total Traffic
5890	510	260	6660

Figure 8 shows a view of approximately half the length of the joint as it appeared at the last inspection. Considerable debris can be seen in the trough of the strip seal. Further accumulation of sand at the face of the parapet wall is shown in Figure 9. The appearance of the joint on the inclined face of the parapet, as discussed earlier, can also be noted.



Figure 8. Partial view of the joint, showing debris in the trough of the neoprene strip seal.



Figure 9. Sand accumulation at the face of the parapet wall.

EVALUATIONS BY OTHER STATES.

Several Wabocrete FMV joint systems have been installed on bridges in Pennsylvania. In 1986, Knight (3) reported on an installation on a bridge deck reconstruction project that incorporated two Wabocrete FMV joints. He noted that the elastomeric concrete was placed in 1 hour on the deck portion of each joint, and after a 5-hour curing period, the bridge could have been opened to traffic if necessary. In laboratory tests conducted using the Wabocrete FMV resins to bond together two halves of a concrete cylinder, it was found that the material was stronger than the concrete. Pull-out tests and flexure tests conducted to check the material's bond strength also yielded positive results.

Another Pennsylvania installation on Route I-70 was reported by Highlands (4) in February, 1987. In that installation, heat ducts were used to cure the elastomeric material because the joint was placed during cold weather. It was reported that the elastomeric concrete set in 2 hours by using the heat curing process.

Still another Pennsylvania installation was reported upon by Arellano (5) in February, 1988. This installation is also on Route I-70 near the one reported by Highlands. The Wabocrete FMV, which is installed on the westbound lane, is being evaluated along with a similar system called Ceva Crete 300 that is installed on the eastbound lane. Workers reported that the Wabocrete FMV material was easier to install than the Ceva Crete.

The Pennsylvania installations are to be evaluated for 5 years. They were reported to be performing well in September, 1988.

Extensive testing of four different brands of elastomeric concrete has been conducted by Price (6). Twelve tests were used to evaluate the binder materials and five were used to evaluate the binder-aggregate materials. From the results of these tests, specifications were developed to provide for a material with good flexibility and bonding characteristics.

RETROFIT INSTALLATIONS IN VIRGINIA

Although not a part of this evaluation, the writer discovered in mid-1989 that the Wabocrete FMV joint system had been installed at two bridge sites (four bridges) on the Capital Beltway. At one of the two sites, route I-495 crosses Scott's Run in the northwest section of the Beltway, and at the other, route I-95 crosses the RF&P Railroad east of the intersection of routes I-95 and I-395. On the latter site, it was reported by the district bridge engineer that approximately 900 ft of the joint were installed in November 1988 on the two four-lane bridges. By May 1989, it was estimated from sounding tests that 25 to 30 percent of the total joint length had debonded.

At each of the bridge sites, the Wabocrete joints were installed over the existing joint openings. The pavement adjacent to the joint material was an asphaltic overlay.

Photographs of two of the joint installations at the RF&P Railroad overpass site are shown in Figures 10 and 11. It can be noted from Figure 10, that the asphaltic overlay adjacent to the joint had failed and had been repaired. In addition, the Wabocrete FMV and asphaltic overlay had separated at their vertical interfaces as can be noted from both photographs. The joints were reported to be leaking and collecting debris (see Figure 11).

Several factors probably contributed to the early failure of these retrofit installations:

- On at least some of the joints at the two bridge sites, the Wabocrete FMV joint system was installed over existing steel armor joints. Apparently, the bond between these two materials was inadequate.
- There is evidence that there was a lack of support beneath some portions of the steel extrusions of the Wabocrete FMV system. On an 8-ft section of one joint, the steel extension had broken away from the sinusoidal anchor bar, which led to the failure of the anchorage system.
- Inconsistency in the bonding surface of the existing bridge deck material resulting from miscellaneous contaminants, such as water-proofing materials (possibly used earlier) etc., could have contributed to the bond failure.
- As suggested by the bond failure at the vertical interface, the Wabocrete FMV material does not appear to bond well to the flexible asphaltic concrete.
- The high traffic volume on the Capital Beltway, which is approximately 200,000 vehicles per day, made the installation of the joints difficult. They were also subsequently subjected to high numbers of impacts every day.

The failure of the Wabocrete FMV joints that were installed at the two Capital Beltway bridge sites strongly suggest that installation on new concrete decks and retrofits to existing decks must be viewed differently. Accordingly, consideration of the use of Wabocrete FMV or similar systems as alternatives in retrofit and replacement situations should be approached with caution. Evidence from the failures described above suggests that these systems may not work well in conjunction with adjacent asphaltic concrete overlays.



Figure 10. View of a Wabocrete FMV retrofit installation on a Capital Beltway bridge deck.



Figure 11. Separation at the interface between the joint and adjacent asphalt overlay.

SUMMARY AND CONCLUSIONS

Installation

The Wabocrete FMV joint system appears to be relatively quick and easy to install assuming all the needed materials, equipment and manpower are available and the operation is properly planned. Placing the Wabocrete material on an inclined face is difficult since it tends to flow downward.

The system offers some advantages over the mechanically anchored preformed joint systems. First, the blockout for the joint does not have to be precisely dimensioned or have smooth surfaces since the Wabocrete FMV material is placed while it is plastic. Secondly, the steel extrusions and anchorage system can be leveled to the proper elevation and position prior to placement of the Wabocrete FMV material. Therefore, the elevation of the bottom of the blockout is not as crucial as it would be for a preformed system. Thirdly, with no anchor bolts involved in the Wabocrete FMV system, the time, effort, and errors involved in placing anchor bolts are eliminated. Accordingly, potential anchor bolt failure problems are eliminated.

Service Performance

After approximately 2 1/4 years of service, the Wabocrete FMV joint system has performed well on the alternate Route 58 bridge over the Clinch River. Throughout this period of service, the joint system has accommodated all thermal and structural movements, withstood the traffic impacts of approximately 6700 vehicles per day (including 12% trucks), remained leakproof, and has not debonded. The joint does tend to collect sand and gravel in the trough of the neoprene strip seal. This could be detrimental over a period of time—particularly if sharp debris such as glass or metal became wedged in the trough. The debris observed in the joint during the inspections, however, did not appear to have caused any problems.

The joint does produce considerable noise from traffic impact. The noise, however, seems no greater than that resulting from similar joints crossing a bridge deck at right angles to the flow of traffic.

To date, the service performance of several installations in Pennsylvania has been quite similar to that observed in this study.

Retrofit Performance

Though not a part of the original evaluation covered by this project, the Wabocrete FMV joints installed at two bridge sites on the Capital Beltway were inspected. These joints, which were installed as retrofits to the existing bridges, have performed poorly. At one of the bridge sites, joints installed in November 1988 had exhibited

substantial debonding as well as other problems by May 1989. The failure of these installations strongly suggest that application of the Wabocrete FMV and other similar systems as retrofits must be viewed differently from applications to new construction. Evidence from the failures described in this report indicate that the Wabocrete FMV, and probably similar systems, may not perform well when used in conjunction with adjacent asphaltic concrete overlays.

RECOMMENDATIONS

The performance of the Wabocrete FMV joint system installed on the alternate Route 58 bridge over the Clinch River does not give any reason to suggest that the joint not be used on similar new structures having moderate rural traffic volumes. It should be noted, however, that this performance evaluation has covered only slightly more than 2 years. The joint should be inspected periodically in the future to better gage its performance.

When using the Wabocrete FMV material on an inclined face, a stiffer mix and/or forming of the face should be used to minimize flowdown.

Because of the tendency of this joint to accumulate debris in the trough of the neoprene strip seal, it should be routinely cleaned—perhaps semi-annually or as necessary.

The use of the Wabocrete FMV and similar systems as retrofit on older bridges should be approached with caution. Furthermore, these systems should probably not be used in retrofit situations in conjunction with adjacent asphaltic overlays.

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