Rapid Curing Polymers Reduce Repair Time and Improve Pavement Performance

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ABSTRACT
Rapid-setting urethane resins have been developed by Roklin Systems Inc. for the repair of pavements and bridge decks. The main advantages are that the resins are very rapid setting and usually no surface preparation is needed. Damaged concrete often remains in place, speeding the repairs and reducing pavement debris and disposal. Repairs can be performed in cold weather, and repairs have proven to be durable and effective for both portland cement concrete and asphalt concrete pavements. Two types of resin are used to repair third stage pavement distress where pavement slabs are broken. The repair resins include 1) Welder, a primer and crack filler and 2) FlexSet that is mixed with sand and aggregates for filling cracks, spalls and for leveling the riding surface. Depending on the repair need, one or both resins can be used. The system is well-suited for emergency response and includes elements that improve worker safety by minimizing the time required for repairs and reducing the number of workers and equipment needed, compared to conventional repairs. Reduced congestion results from these extremely fast, maintenance-based and emergency repairs. The polymer concrete repair materials bond extremely well to both portland cement concrete and asphaltic concrete. Caltrans has evaluated and used these materials for more than 20 years with good success.

INTRODUCTION
Unique rapid-setting urethane resins have been developed for the repair of pavements and bridge decks. The resins are very rapid setting and can be installed within short traffic closure periods, often during emergency repairs or during times of low traffic volumes. Repairs can be performed in cold weather if necessary, and repairs have proven to be durable and effective for both portland cement concrete and asphalt concrete pavements. Accelerated highway repairs reduce workers time on the highway (improving safety and reducing traffic congestion) and quality repairs reduces the need to return to fix the pavement slabs again in the future.

The principals of Roklin Systems Inc. have been working to develop a rapid-setting polymer concrete system to repair highways and bridges since 1984. The Caltrans laboratory (Translab) was involved in the initial development and evaluation of these unique repair materials. Widespread use throughout California and in
several other states has proven that the materials are well suited for making rapid but durable repairs to damaged highways and bridges.

The polymer resin is specially formulated to result in a polymer concrete suitable for supporting highway loads but flexible enough to minimize bond stresses and thermal stresses that cause failures in conventional repair materials. The polymers have high toughness and bond well to concrete with minimal surface preparation, allowing it to be feathered to smoothly connect mismatching grades with adjacent slabs.

The repair of damaged and cracked pavement slabs is typically twofold. First a thin, low viscosity, high strength urethane resin (Welder) is placed into pavement cracks and usually the adjacent slab joints to fill voids beneath the slab and to fill and bond cracks and joints to provide aggregate interlock to stop pavement slab rocking. By filling the voids and water channels below slabs and filling and bonding slab cracks, pavement faulting is reduced and the base is stabilized. This process is much more effective than normal crack sealing procedures that only seal the top surface but still allow lateral water movement and pumping beneath the slab. Second, the ride quality is restored using a unique elastomeric polymer concrete (Elastic Cement, now FlexSet™) that can be easily mixed by hand or machine-applied that contains specially graded and pretreated aggregates. The aggregate pretreatment improves the mechanical properties as well as the durability of the polymer concrete. Since the polymer concrete has high mechanical properties and excellent bond to concrete, but a low modulus, bond stresses and cracking are minimized. The ease of use and minimal surface preparation required makes this type of rapid pavement repair easy for small maintenance crews to perform. Upon completing the repairs, the resins set very quickly and traffic can be allowed directly on the repairs within about 30 minutes or less. By avoiding removal of the damaged slab, less equipment is needed, less waste is generated, fewer workers are needed, and the repair is completed much faster resulting in decreasing worker exposure time on the highway.

The primary goals of the rapid polymer repair system is 1) accelerating highway repairs, 2) reducing traffic congestion, 3) improving safety and ride, and 4) improving the quality of the repairs. This paper reviews the history of the development of this unique system, starting with its use in the early 1980’s through the successful development and use by Caltrans over the past 20 years. The mechanical properties of the polymers are provided as they relate to the requirements for successful rapid pavement repairs. Several case studies are presented.

**BACKGROUND**

In the early 1980’s, the security of the 33 NATO bases in Europe was a concern. The most vulnerable portion of the bases was the airfield. Bombing would disable the runways and a rapid repair method was needed to restore the runways within four hours. The pavement research center at Tyndall Air Force Base initiated research projects to develop suitable yet simple repair technologies. The rubble from a simulated enemy bomb crater was backfilled to within 8 in. (200 mm) of the top grade. The top eight inches were then filled with aggregate and flooded with rapid setting polyurethane resin. The strength of the composite was required to be sufficient within 30 minutes for the takeoff or landing of a fully-loaded bomber. A rapid curing, rigid urethane was developed to provide the required strength to support the heavy loads. Trials of the technology were successful but the complete program was not implemented due to the large amount of resin required to be stored on each base, limited shelf-life, and its high cost.

In the mid-1980’s, the California Transportation Department (Caltrans) was researching new and innovative methods and materials to repair bridges and portland cement concrete pavements. Much of this research was published in the report entitled, “New Materials and Techniques for the Rehabilitation of Port-
land Cement Concrete” (Krauss, 1985). As part of this research, rapid curing urethane resins were tested as a means of emergency repairs of spalls in portland cement concrete pavements. Research to address moisture sensitivity issues and in-depth laboratory testing was also conducted by Caltrans Translab (Ferroni, 1985).

Early field trials included patching asphalt concrete (AC) pavement on Highway 97 (2-Sis-97-42/50). The AC had abnormal amounts of potholes, ruts, cracking and depressions due to heavy truck loads and the cyclic freezing environment. On January 24, 1985, Translab staff installed repairs to potholes and a 10ft by 3ft depression in cold weather at an ambient temperature of 35 to 40 °F. The potholes and depression were filled with 5/16” rock with no surface preparation. Resin was mixed by hand and poured over the rock filled areas. The repaired sections supported heavy truck traffic within 20 minutes. A survey of the patches in May 1985 showed that the patches were still intact, after many snow and cyclic freezing events.

The first use of the rapid-setting urethane repair materials to a portland cement concrete (pcc) pavement was on April 4, 1985 on Route 118 in Ventura County for spall repair and sealing of a section of pcc pavement having distress due to alkali-silica reactive aggregate. Potholes over 30 in. (760 mm) in diameter and 2 in. (50 mm) deep were common after rain. Due to the high traffic volume and the rapid rate of deterioration, a rapid and cost-effective method was needed to repair the pavement until a reconstruction contract could be designed and bid. The repairs were performed by filling the potholes with pea gravel and flooding the area to seal and bond cracks with the rapid setting, urethane resin mixed using a modified hose applicator. The resin provided enough strength to support traffic within about 10 minutes. The repairs were considered very successful (Ferroni, 1985).

Caltrans evaluated these resins on numerous projects to repair both portland cement concrete and asphalt concrete pavements. Core samples demonstrated good penetration and adhesion to the base concrete. Caltrans reported that this technology is very promising and considered it past the experimental stage in 1991 (Allison, December 1991). Since the first trials in 1985, over 100 repair projects have been completed in California on highways and bridges. Several of these repairs have been emergency repairs in response to large truck fires causing scaling of the surface or pavement blowups. Additional case studies are presented below.

**THE SYSTEM**

Both the crack repair resin (Welder) and the patch resin (FlexSet) include mixing two resin components (A and B) by hand gun using small static mixing tubes or by specialized mixing equipment. Repairs are typically done by applying the resins to the concrete or asphalt concrete to fill cracks and by pre-placing or broadcasting sand or pea gravel aggregates to build up a polymer concrete repair mortar. While hand placement is well-suited for small, quick repairs, machines are well-suited for rapidly producing larger volumes of.

Roklin FlexSet™ polymer, when used in combination with crushed aggregate or sand, forms a high performance, rapid-setting polymer concrete. The resin is specially formulated to result in a flexible polymer concrete suitable for repairing and sealing of stationary or moving joints and cracks. The low modulus provides flexibility that allows the material to bond well to concrete but rigid enough to support traffic loads. Usually, loose concrete pieces do not need to be removed as the resin fills the voids and cracks and bond all the pieces compositely.

The installation is straight forward. Typically loose concrete is removed and the surfaces are blown with compressed air so that they are clean and dry. If present, paint, grease, oils, curing compounds or other contaminants should be removed by abrasive blasting. When repairing cracked slabs, the Welder resin is mixed and flooded into the cracks to restore lost base support and bond cracks. Then the pavement surface is returned to grade using the FlexSet resin and aggregate. If the repair involves deep spalls, the spall should be filled with
coarse aggregate to about 1/4 in. (6 mm) below the existing grade. The recommended maximum aggregate size will range from 1/4 in. (6 mm) to 1 in. (25 mm) depending on the depth of the spall. All substrates and aggregates should be dry, when possible. After flooding with resin, a non-skid aggregate is usually broadcast into the surface of the uncured resin to provide skid resistance. Roklin’s FloMix product is similar to the FlexSet but is designed and colored for the repair of asphaltic concrete pavements.

**MATERIAL PROPERTIES FOR SUCCESSFUL PATCH REPAIRS**

Often pavement repairs are completed using materials that are similar in composition to the material being repaired. Portland cement based materials are used to patch portland cement concrete pavements and asphaltic materials are typically used to patch asphalt concrete pavements. This approach appears logical since the final properties of the patch will be similar to the pavement properties. However, the problem with this practice is that the new patch material used in the repair has widely different properties at early ages than the existing aged pavement. The new portland cement based concrete must gain strength quickly and it shrinks as it cures and dries. Since a bond line is present, stresses develop along the bond interface as the new patch material shrinks due to the loss of hydration heat and due to loss of moisture over time. Therefore, it is not uncommon for pcc patching materials to crack and debond. Higher strength patch materials are usually more prone to cracking and debonding than lower-strength materials. This is often due to the higher cement content or the use of silica fume that creates a high strength but a very rigid nature. The higher paste or use of silica fume also cause the patch to obtain higher heat of hydration resulting in higher, earlier thermal cooling stresses in addition to the higher shrinkage due to drying. Structurally, high strength pcc materials are brittle, having a higher modulus of elasticity and lower creep. Therefore, when the new pcc materials shrink, stresses are higher and stresses in the patch and bond line remain longer. This results in a high tendency for cracking and delamination of the patch.

High bond strength, high tensile strength, adequate compressive strength, low modulus, moderate creep, low shrinkage, and high toughness are properties of materials that are successful for patching highways and bridges. These properties minimize the stress that is built up within the patch material and at the bond interface while successfully carrying traffic loads. Therefore, formulating products to meet certain material properties designed specifically to ensure that bond, shrinkage and thermal stresses are minimized, enhances patch performance and durability.

**MATERIAL PROPERTIES**

The FlexSet™ polymer resin is formulated to be thin so it percolates well and has a low modulus to reduce stresses within the patch but has high toughness properties. The following are approximate properties of the polymer resin:

<table>
<thead>
<tr>
<th>Property</th>
<th>Standard</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardness (Durometer A)</td>
<td>ASTM D-2240</td>
<td>95A</td>
</tr>
<tr>
<td>Direct Tensile Strength</td>
<td>ASTM D-412</td>
<td>1600 psi (11.0 N/mm²)</td>
</tr>
<tr>
<td>Elongation</td>
<td>ASTM D-412</td>
<td>160 percent</td>
</tr>
<tr>
<td>Viscosity 75°F (24°C), A/B</td>
<td></td>
<td>70/100 cps</td>
</tr>
<tr>
<td>Gel time 100 grams at 75°F (24°C)</td>
<td></td>
<td>70 seconds</td>
</tr>
</tbody>
</table>
Temperature and site conditions affect the gel and setting time of the polymer. Resin cure time and time to traffic will be faster in warmer weather. At 93°F (34°C) the resin cure time to allow traffic may be less than 10 minutes, and at 40°F (5°C) it increases to approximately 25 minutes. Rapid repairs have been installed successfully in cooler temperatures, even below freezing, if the materials are maintained at a temperature between 60°F to 80°F (15°C to 25°C) immediately prior to placement.

The rapid concrete repair material is produced by combining equal volumes of Component A, Component B, a FloMix catalyst, and sand. Mixing can be done mechanically or in the five-gallon buckets in which all materials were supplied in pre-packaged containers.

The following testing was performed at the Wiss, Janney, Elstner Associates Laboratories. Mixing was performed using a paddle mixer in a hand-held power drill using the following procedure. Approximately 565 g of Component A was mixed with 3400 g of sand for two minutes. Approximately 550 g of Component B was mixed with 27 g of catalyst and then added to the bucket and mixed for an additional one minute. The specimens for testing were fabricated immediately. All materials were at 73 ± 3°F during mixing and were cured at this same temperature.

The repair material was somewhat resin rich and settlement of the sand was observed in the test samples. In practice, additional dry sand is broadcast over the fluid repair material to provide a uniform aggregate distribution and to provide skid resistance. This additional sand was not used to fabricate the test samples. The tests outlined in Table 1 were conducted according to the standard methods listed and the test requirements for Texas DOT are also shown.

<table>
<thead>
<tr>
<th>Test</th>
<th>Age at test</th>
<th>Method</th>
<th>Requirement</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gel time, min.</td>
<td>-</td>
<td>Tex-614-J</td>
<td>5 to 60 min.</td>
<td>9 min.</td>
</tr>
<tr>
<td>Wet bond strength, psi</td>
<td>7 days</td>
<td>Tex-618-J</td>
<td>&gt; 100 psi</td>
<td>176 psi</td>
</tr>
<tr>
<td>Compressive strength, psi</td>
<td>24 hrs.</td>
<td>ASTM C579, B</td>
<td>&gt; 200 psi</td>
<td>1,710 psi</td>
</tr>
<tr>
<td></td>
<td>7 days</td>
<td></td>
<td>-</td>
<td>1,820 psi</td>
</tr>
<tr>
<td></td>
<td>28 days</td>
<td></td>
<td>-</td>
<td>2,140 psi</td>
</tr>
<tr>
<td>Compressive stress at 0.1 in.</td>
<td>7 days</td>
<td>Tex-618-J</td>
<td>&gt; 200 psi</td>
<td>733 psi</td>
</tr>
<tr>
<td>Flexural Strength</td>
<td>24 hrs.</td>
<td>CA Test 551</td>
<td>--</td>
<td>740 psi</td>
</tr>
<tr>
<td></td>
<td>28 days</td>
<td>CA Test 551</td>
<td>--</td>
<td>1008 psi</td>
</tr>
<tr>
<td>Modulus of Elasticity</td>
<td>24 hrs.</td>
<td>CA Test 551</td>
<td>--</td>
<td>12.3 ksi</td>
</tr>
<tr>
<td></td>
<td>28 days</td>
<td>CA Test 551</td>
<td>--</td>
<td>23.5 ksi</td>
</tr>
<tr>
<td>Resilience, %</td>
<td>7 days</td>
<td>Tex-618-J</td>
<td>&gt; 90 %</td>
<td>97.2%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>82.0%*</td>
</tr>
<tr>
<td>Thermal compatibility</td>
<td>7 days</td>
<td>ASTM C884</td>
<td>No delam. or cracking after 9 cycles</td>
<td>Pass</td>
</tr>
</tbody>
</table>

* catalyst added
**Gel Time**

The gel time was determined by probing a sample of the material with a clean wooden toothpick every minute and determined when the material could not be stirred.

**Wet Bond Strength**

The wet bond strength was determined by conducting tensile tests on half dog-bones of patching material cast against mortar half dog-bones (ASTM C190). The bonded surface of the mortar, nominally 1 sq. in., was sand-blasted and cleaned with trichloroethylene per the August 1999 revision of Tex-614-J before the patching material was applied. After casting, the specimens were air cured for five days and then immersed in water for two days prior to testing.

**Compressive Strength**

The compressive strength was measured with 2-in. cubes. Three cubes were tested at each age. To simulate most installed loading conditions, the specimens were tested with the unformed surface oriented upwards against the platen of the testing machine. The stress at a compressive deformation of 0.1 in. was measured.

**Resilience**

The resilience defined by Tex-618-J is the ratio of the maximum displacement plus the height of the cube after testing minus the height of the cube before testing to the maximum displacement, where in this case, the maximum displacement was 0.1 in. This test was conducted on three specimens and the average value reported. Two values for resilience are reported in the table above. The first was obtained from specimens produced from a batch that did not contain catalyst.

**Thermal Compatibility**

The thermal compatibility between the patching material and concrete was evaluated according to ASTM C884, except that the bonded materials were cycled nine times between 60 °C (140 °F) for eight hours and -21 °C (-6 °F) for sixteen hours. Testing was performed on two concrete slabs which were sand-blasted, cleaned and then covered with the patching material to a depth of 1/2 in. before cycling occurred. No de-bonding occurred.

**CASE STUDIES**

Early tests were installed by Caltrans on I-5 near Stockton and I-5 in Los Angeles in 1988. The test near Stockton compared a rigid urethane resin formulation with a new, more flexible urethane resin formulation. Spalls along pavement joints were repaired without making any effort to isolate the unreinforced pavement slabs. The rigid resin had a tendency to crack and de-bond due to the movement of the slabs. The more flexible formulation was better suited to accommodate the slab movement and generally remained bonded. I-5 in Los Angeles is an extremely highly traveled, 12-lane wide expressway and repairs were performed at night between 10:00 p.m. and 6:00 a.m. Repair of spalls along the portland cement concrete pavement joints were performed using the flexible urethane formulation. The spalled areas were chipped and swept with compressed air. The spalls were filled with coarse aggregate and the resin was percolated over the aggregate. Three years after
installation, the repairs were reportedly performing satisfactory. Only limited failures occurred in a few locations where the resin did not fully penetrate into the spall or where the resin components were improperly mixed.

Caltrans has also used the rapid setting urethane resin for bridge deck joint repairs. The maintenance personnel on the Oakland-San Francisco Bay Bridge used the flexible urethane polymer resin concrete for rapid spall repairs and repairs to expansion joint dams. The bay bridge deck is topped with an epoxy asphaltic concrete overlay. Damage from the Loma Prieta earthquake required repairs to be made to the deck. The bridge was closed between October 18 and November 17, 1989. The rapid-curing urethane was selected due to its satisfactory performance on other projects and the speed of installation. The maintenance crew wanted to repair all of the damage to the epoxy asphaltic overlay. The epoxy asphalt was saw-cut and removed near the steel-armored expansion joints. The concrete and steel surfaces were sandblasted and the existing joint seal was left in place. Dry aggregate was placed in the recess. The polyurethane resin was then used to fill the voids between the aggregates and sometimes placed directly over the existing expansion joint material. This project demonstrated the excellent adhesion of the polymer resin to the concrete, steel, and modified asphalt.

**Fire Damaged Pavement**

Caltrans has used the rapid-setting urethane resin to repair damaged portland cement concrete and asphalt pavements due to tanker fires. On March 1, 1989 a diesel fuel tanker caught fire and severely damaged a section of pcc pavement on I-10 in Riverside, California. Repairs were begun as soon as the tanker was removed and the fuel spill cleaned. Three large trapezoidal spalls were repaired, each approximately one lane width and 3 ft (1 m) long. In two of the areas, the damaged concrete was removed; the spalls were filled with aggregate, and flooded with the flexible urethane resin formulation. One of the damaged areas was repaired using conventional asphaltic concrete. The pavement was opened to traffic shortly after the repairs. A review of the repair by Caltrans after three and one-half years found the areas repaired with urethane resin to be in very good condition. The area repaired with asphaltic concrete looked poor, with many areas of raveling and spalling. Six core samples were removed from the patches by Caltrans on August 27, 1991. The urethane repair materials were still adhered to the concrete substrate in all locations and even remained bonded across a transverse pavement joint.

In 1991, when a tanker fire occurred on I-5 in Los Angeles, the rapid setting urethane resin was again selected by Caltrans for the repair. On August 6, 1991, all four lanes of northbound I-5 were closed due to a tanker spill and fire. After initial cleanup, the spalled concrete was removed using impact tools then the surface was abrasively blasted. Coarse aggregate was placed into the spalled areas and flooded with the rapid-setting urethane resin. Within two hours of beginning the urethane repairs, two lanes of traffic were opened. It was estimated that the rapid-setting urethane allowed the traffic to resume nearly 6 hours sooner than if the repairs were made using conventional hot-mix asphalt. Twenty-two slabs were repaired. None of the existing pavement was removed and the pavement was restored to original grade. Core samples taken on August 27, 1991 indicated that the urethane completely filled the spalls and was tightly adhered to the base concrete. Continued spalling of burnt pavement is not uncommon after a severe fire and after more than two years of heavy interstate traffic, some raveling and spalling of the repaired areas had occurred. Some of the spalling may be outside the area that was abrasively prepared prior to the repair.
Overlays

On December 11, 1991, Caltrans installed a multiple layer overlay section using the urethane resin on a concrete off-ramp of the Embarcadero Freeway in San Francisco. An area 5 1/2 ft (1 1/2 m) wide and 15 ft (4 1/2 m) long was prepared using light sandblasting followed by hand sweeping. The concrete was primed with the urethane resin and various sizes of coarse aggregate were broadcast into the resin. After the first coat polymerized a second layer of aggregate and resin was applied, essentially in a broom and seed or build up overlay method. Sand was then broadcast over the surface of the repair. The overlay cured in approximately 30 minutes and was approximately 3/4 in. (20 mm) thick.

Air-quality monitoring was performed for methylene di-isocyanate (MDI) and other fumes. The report indicated that in all cases the MDI emission was below the Cal-OSHA Permissible Exposure limit of 10 ppb on an 8-hour weighted average. The Cal-OSHA exposure limits were not exceeded in any of the test samples. As with any chemical, appropriate protective equipment should be used. This includes white Tyvek or loose fitting overalls, Nitrile gloves, and safety glasses.

Based on the results of this test section, a large overlay was installed on Interstate 5, near Mt. Shasta, California. This overlay was part of the Strategic Highway Research Program (SHRP). The overlay was three lanes wide and nearly 400 ft. long. It was installed in the same manner as the test section. The final overlay was approximately 3/4 in. (20 mm) thick and continuous over the pavement joints. The overlay was placed in the summer of 1992 and was surveyed in November 1993. No cracking was seen in the overlay even though the overlay was not saw-cut over the pavement joints. One small area of delamination was found and the surface showed only very light raveling. Overall, the overlay was performing very well, especially considering the extreme environment and heavy traffic.

Asphalt Concrete Shoulder Repairs

As traffic volumes continue to increase, Caltrans often converts asphalt concrete shoulders to driving lanes. The shoulders are not designed for the high level of loading and deteriorate rapidly under the heavy traffic. Replacement and reconstruction of the shoulders requires a long process of funding allocation, design, bidding and construction; a process that typically takes many years. Also, removal and disposal of the asphalt concrete is no longer straightforward. Therefore, it can be more cost-effective to maintain the shoulders and pavements and make repairs before they become so deteriorated that repair and replacement costs become prohibitive. Repair of moderately-deteriorated shoulders have been performed using the rapid-setting urethane resins to extend their service life.

State Route 60 near downtown Los Angeles is heavily traveled and the asphalt shoulders have been converted to travel lanes. The asphalt pavement became moderately deteriorated with cracking and some spalling. Most of the deterioration was too small for patching with cold mix asphalt and conventional crack sealing will not bond the alligator cracking or prevent water from continued infiltration into the base. Crack sealing using conventional materials is considered only a temporary surface treatment and it tends to shove and push, creating a rough ride. The surface of the asphalt concrete shoulder had been removed and replaced two years earlier. This new asphalt shoulder overlay developed alligator cracking and longitudinal cracking with minor spalling. Traffic closures on I-60 are limited to between 9:00 a.m. and 3:00 p.m. The repairs were successfully performed during this short period between peak traffic times.
3rd Stage PCC Pavement Distress

Caltrans District 11 staff have used this system to repair numerous pavement sections that have 3rd stage pavement distress. In 2007 and 2008, Concrete Welder was used in Region 2 to make repairs to cracks in the pcc pavement on the truck lanes of I-5 north of Oceanside up to the Orange County line. FlexSet was also used in those areas that had heavy cracking and settlement of the slabs in order to restore grade. At I-15 north of Escondido and up to the Riverside County line, similar repairs were successfully made using Concrete Welder and FlexSet. The areas were reviewed frequently by the Caltrans superintendent and Translab in Sacramento and were determined to have resulted in permanent repairs. In 2009, Caltrans in Region 1 used Concrete Welder to fill and repair first stage cracking in the pcc pavement in the mountain area on I-8 east of San Diego. It is important to note that many of the concrete panels that were moving were now stabilized as a result of the Welder flowing not only into the cracks but filling some of the voids under the panels, hence stopping the “pumping” action that is inherent in removing the fine materials under the concrete panels that result in 3rd stage failure. Roklin’s FloMix product was also used successfully in the east county of San Diego to repair the thin lift asphalt concrete overlays that had failed over several bridge decks. The maintenance crews had previously tried to make the repairs with high-performance bag mix and conventional hot asphalt concrete that unsuccessfully adhered to the bridge deck.

CLOSURE

The repair resins, Welder and FlexSet, are very rapid-setting urethane polymers formulated to meet physical properties that optimize pavement repair performance. The resins have a low modulus so they have the flexibility to accommodate movement, due to loading and thermal changes but high toughness to support repeated traffic loadings. A typical method of pavement repair for a badly-cracked pavement slab is to flood the area with the Welder resin to fill voids beneath the slab and to fill and bond cracks and joints to provide aggregate interlock to stop pavement slab rocking. The surface of the slab is then repaired using the FlexSet resin layered with polymer-coated aggregate and coated sand used as a topping to provide a smooth and durable riding surface. Lane closure barriers can be removed within minutes of a repair. Quick resumption of traffic minimizes motorists inconvenience and complaints.

REFERENCES


Allison, J., Chief, Memorandum on Polymer Concrete Repair Materials by Maintenance Forces, Division of Maintenance, State of California, Department of Transportation, December 1991.