A3C13: Committee on Sealants and Fillers for Joints and Cracks
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Joint- and Crack-Sealing Challenges

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The pavement joint- and crack-sealing industry faces several challenges as the new millennium approaches. These challenges cover a broad spectrum of issues, from materials to construction practices. It has been demonstrated and documented and is generally accepted that sealing the cracks in flexible pavements is a sound preventive maintenance procedure for extending pavement life. However, the fundamental question of whether sealing joints in rigid highway pavements is cost-effective was recently raised.

The issues that face the joint- and crack-sealing industry can generally be divided into four categories (within each of which are several subcategories, including a research component):

- Value added (return on investment from joint and crack sealing),
- Materials and specifications,
- Application procedures and equipment, and
- Training.

VALUE ADDED FROM PAVEMENT JOINT AND CRACK SEALING

Pavement joint and crack sealants are designed to protect pavement by minimizing water infiltration and by preventing the accumulation of debris. Crack sealing is an effective technique for maintaining flexible pavements. Research has indicated that, in conjunction with maintenance techniques such as slurry seals and chip seals, crack sealing will extend the life of a flexible pavement.

The benefits of sealing joints in rigid highway pavements have been well documented, but research conducted by the Wisconsin Department of Transportation (DOT) indicates sealing joints in rigid highway pavements is not beneficial. Anecdotal information supports this finding. However, other information seems to show that joint sealant materials are vital to the protection of the pavement and that unsealed pavements deteriorate rapidly.

The benefits of sealing joints in airfield pavements have not been thoroughly proven, but the risk of foreign object damage, for example, increases when joints spall. Aircraft engines can take up debris from spalled concrete and be destroyed. Thus, the use of joint sealing in airfield pavements will provide some insurance against potential aircraft engine damage. The relatively low cost of sealant may justify its use until its effectiveness is quantified as part of the life-cycle cost of pavement service.

The biggest challenge that faces the sealant industry as the next millennium approaches is quantifying the effectiveness of joint sealing in rigid pavements and its cost-to-benefit ratio when considering the life-cycle cost of pavement service. Another challenge is to identify the right sealant for a specific job. The third challenge is training. If joint sealing is determined to be beneficial in a given situation, then contractors and users must be trained in the appropriate kinds of materials that can be used for given applications, the correct installation geometry, and the procedures that are required to clean the joint or crack and install the sealant.

MATERIALS AND SPECIFICATIONS

Different kinds of pavement (from both the material and use perspectives) require different sealant materials. Now, and for the foreseeable future, hot-applied modified asphalt-based sealants are the most effective and widely used sealant materials for use on flexible pavements. The specifications used to identify the materials for crack sealing in flexible pavements include ASTM D5078, ASTM D3405, Federal Specification SS-S-1401, and specifications modified by state DOTs or other agencies. Other kinds of materials—such as emulsified, cutback, and chemically curing products—will continue to be used in specific applications where the costs or material characteristics of the products are justified.

The kinds of sealant materials used for rigid pavement applications vary more widely than those used for flexible pavements and depend on the pavement use. Historically, the hot-applied asphalt-based materials have been the most commonly used materials for these applications. However, silicone-based sealants (ASTM D5893) and preformed compression-seal materials (ASTM D2628) have gained increased acceptance for use in rigid pavements and have become the preferred choice of a significant number of state DOTs.

Materials resistant to jet fuel (ASTM D3569, ASTM D3581, and Federal Specification SS-S-1614) and resistant to fuel and heat generated by aircraft exhaust (Federal Specification SS-S-200) are commonly used for airfield pavements. The use of silicone-based materials for airfield pavements that are exposed to intermittent or limited fuel spillage is increasing for civil and U.S. military applications. The U.S. military typically uses preformed compression seals, which are believed to provide a long-lasting seal in new pavements, during the new construction of airfield pavements.

New materials will continue to be developed for sealing cracks and joints in flexible and rigid pavements in an effort to provide a more effective seal. As the new products become available, it will be important to verify their performance in specific applications.

The real challenge is to identify material properties and develop testing procedures that can be used to assess sealant performance in the field. The specifications currently used to identify sealants for a given project have limited correlation to field performance. Industry and the DOTs are increasingly interested in developing performance-based specifications. Performance-based specifications provide two advantages. First, the performance of newly developed materials could be more rapidly assessed against the known performance of existing sealants. Second, the most appropriate sealant could be objectively selected for a specific set of conditions. For example, sealants that have better cold-temperature properties could be selected for pavements in colder climates, and those with better hot-temperature properties could be selected for pavements in warmer climates.

Current investigations of laboratory characterization tests that could be used for performance-based specifications have focused on procedures and concepts developed during the Strategic Highway Research Program (SHRP) for performance grading of asphalt cements and different kinds of adhesion (to substrate) tests. A performance-based specification will need to include both material characterization procedures and adhesion tests.

New material specifications alone will not improve the performance of crack and joint sealants in the field. Application procedures and equipment play a vital role in the field performance of materials.

Changes also may be required for project specifications. Warranties for joint sealant performance have been discussed for several years, but they are rarely used in practice. More recently, warranties of 5 to 10 years have been implemented for pavement construction projects, and they also should be considered for joint- and crack-sealing projects.

The joint-sealing industry also must address safety issues, such as handling, fumes, toxicity, and disposal of both unused materials and materials removed from a resealing project. Manufacturers provide material safety data sheets that include instructions on the proper handling of their materials. When these instructions are followed, the workers should remain safe. However, perceived health concerns require investigation.

Disposal concerns are related to the composition of sealant materials. As in other industries, many materials that were acceptable for use several years ago now are considered potentially harmful to humans and the environment. Several chemicals have been replaced with acceptable ingredients, but the industry must continue to develop environmentally safe materials.

APPLICATION PROCEDURES AND EQUIPMENT

Joint- and crack-sealing performance for rigid and flexible pavements was addressed in the SHRP research. Handbooks (*1*,*2*) were prepared that include guidance on how and when to seal as well as equipment used for sealing projects. Guidelines for selecting the most economical sealing or maintenance procedure also were included.

Application procedures cover many aspects of joint- and crack-sealing projects, for example, cleaning the joint or crack, configuring the sealant, and determining the shape factor (depth-to-width ratio) for the sealant. Current procedures used to seal the joints of concrete pavements include sawing followed by waterblasting or sandblasting, airblasting, and installation of the backer rod and sealant.

One of the most critical aspects for good field performance of a sealant is properly cleaned joints. However, the industry has not reached a clear consensus on how to measure joint cleanliness, the proper methods required to achieve a clean joint, or the degree of cleanliness required so a joint will adhere properly. Additionally, environmental and health concerns are associated with sandblasting. These concerns—in conjunction with the fact that the procedure can damage the concrete joint—have made sandblasting a less desirable method. Other joint preparation techniques (for example, dry sawing and hydroblasting) are becoming more accepted because the joint can be cleaned without the environmental and health concerns associated with sandblasting. Additionally, vacuum-cleaning techniques that do not create dust have been developed for cleaning cracks. A quantitative measure of joint cleanliness remains to be identified.

The procedures used to prepare cracks in flexible pavements are varied; some methods entail blowing compressed air into the cracks, routing, and using hot-compressed-air heat lances. Each technique has its benefits, but additional work is required to determine the most effective procedures for a given area or set of conditions.

The shape factor, or depth-to-width ratio, of a joint sealant is critical. A significant amount of research has been conducted to determine the proper shape factor for various kinds of field-molded sealants. Traditionally, a shape factor between 1 and 2 has provided optimum performance for field-molded sealants. However, this convention is being questioned as new materials and new joint reservoir configurations are introduced into the industry.

New joint reservoir configurations are being considered to help minimize spalling and edge deterioration during the service life of the pavement. Two of these configurations are narrow joints (in which the joint width is the width of the saw blade) and beveled joints, which were introduced several decades ago but are just now gaining popularity. The adoption of these techniques will also allow joints to be refaced for resealing without significantly widening the joint. Sealing materials and techniques must accommodate these configurations.

New configurations also pose a challenge to preformed joint seals. Joints must be cut to a minimum width to accept a preformed material and, usually, joint faces must be vertical to prevent the preformed material from being pushed out of the joint. Better training may be required to ensure that preformed materials are properly inserted into beveled joints, or new seal designs may be required to allow their use in narrow or beveled joints.

Significant advancements have been made in sealing equipment during the past 50 years. We expect this trend to continue. The biggest change in equipment (for both joint or crack preparation and sealant installation) will be automation. The desire for automation stems from three primary concerns:

- Personnel safety,
- Increased efficiency, and
- The need to open the pavement to traffic quickly.

Research is being conducted on equipment that automates joint and crack cleaning as well as sealant installation. The efficiency and accuracy of this equipment will improve. We expect that automation will gain wider acceptance, especially in highway applications, where workers are exposed to the dangers of high-speed vehicle traffic.

The ever-increasing volume of traffic on roads and highways has brought about the development and implementation of fast-track concrete paving. Fast-track paving allows the pavement to be opened to traffic much sooner than traditional paving; however, field-molded sealants must be used on moisture-free joints. Therefore, delays may be encountered to ensure that the sealant will adhere to the joint face; otherwise, new materials or sealing techniques, or both, are needed.

A new, simplified method of joint sawing has been introduced to make joint preparation easier and to help open the pavement to traffic more quickly. A lightweight saw using a dry diamond blade with an upcut rotation can cut 6-millimeter joints while the concrete is still green. The Iowa DOT has determined that joints cut using this technique usually can be cleaned with airblasting and then filled with a sealant after 72 hours (*3*).

TRAINING

Training and communications are two important issues for a successful joint- or crack-sealing project. Contractors and user agency personnel must be trained so that all parties have realistic expectations of how joints should be prepared, how sealants should be installed, and how the sealant should perform on the basis of that preparation and installation. They also should be aware under what conditions sealants should and should not be used.

The training issues associated with flexible pavement crack sealing are similar to those for rigid pavement joint sealing. Specifically, workers should learn about crack preparation, sealant installation, and the kinds of materials that should be used for a given application. They also must be taught that crack sealing may not be the most effective maintenance technique for every pavement. Instead, a chip seal, asphalt overlay, or some other technique may be more appropriate in a given situation.

Training and communication between all parties involved in joint- and crack-sealing projects will improve only through open dialogue and verified research. Research organizations and professional societies or organizations that represent users, manufacturers, and contractors must take the lead to ensure that the major issues surrounding joint and crack preparation, sealant installation, and the benefits of sealing are understood.

SUMMARY

The joint- and crack-sealing industry has advanced significantly during the past 50 years. Innovative materials and construction procedures have been developed. Progress has delineated issues that need to be addressed within the industry. Performance-related material specifications are needed so that the most appropriate sealant can be objectively selected for a given application.

Construction procedures that minimize roadway closures and increase worker safety must be developed. The time of joint- or crack-sealing operations must be addressed. Training that educates users and contractors on the proper methods of preparing joints and cracks, sealant installation, and the effects of using improper procedures on field performance must be improved. Finally, we must quantify the cost-to-benefit ratio and the effectiveness of sealing joints in rigid pavements for extending pavement life.

Research is required to quantify the benefits of joint sealing in rigid pavements. Central to this research will be to determine the proper procedures for preparing joints and improving the field performance of sealant materials.

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