

# Hot-Poured Sealants

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Hot-poured sealants are either straight asphalt cements or asphalts that have been modified with fillers or rubber or both. They are the lowest in cost and the most widely used sealing materials available today. Specifications for hot-poured sealants are being written based on laboratory tests that often do not correlate with actual field performance. Sealant performance depends on type, quality, and quantity of materials used. It is suggested that materials requirements be included in sealant specifications. Various types of rubber used and manufacturing costs involved in the production of rubberized asphalt sealants are discussed. Installation procedures and problems affecting service life of the sealant are given. Cost comparisons are made between hot-poured sealants and other joint-sealing materials. Research is suggested that should result in a better understanding and improved quality of hot-poured sealants.

•WE ALL KNOW WHY contraction joints are built into portland cement concrete road surfaces and we have witnessed the catastrophic failure that can occur when they do not function properly. The engineering principles involved in design of contraction joints are well known and widely recognized. It should therefore follow that the joints must remain functional if ultimate service is to be obtained from the road surface. The joint must, however, be sealed to prevent water from leaking through and destroying the sub-base or to prevent incompressible materials from entering the joint and rendering it useless.

Certainly the service that a joint sealer is expected to withstand is severe, and there has been a continuing search for materials that will perform this function at a reasonable cost. Through the years many materials have been tried. However, today we find only four major classes of joint sealers being used. These are (a) preformed compression seals, which can only be used in new construction or placed in joints that conform to a given shape; (b) elastomers, such as polyurethanes, polysulfides, and others; (c) cold-poured sealants, or asphalt cutbacks; and (d) hot-poured sealants. It is the purpose of this paper to discuss hot-poured sealants.

Hot-poured sealants are the most widely used materials for sealing joints and cracks. The "hot-pours" are asphalt cements that can be modified with mineral fillers or rubber or both. Asphalt cutbacks and emulsions are not considered hot-pours because most of them are used at ambient temperatures or heated to only 120 to 140 F.

Coal tar has also been mentioned as a hot-poured sealant, although no state in the Northeast uses it. In discussions with highway personnel, the word "tar" is often used (tar kettles, tar pots) even though asphalt is the material referred to in most cases.

## SPECIFICATIONS

Many states use a straight asphalt cement (85-100, 50-60) to which they assign a state specification number. Others modify the asphalt with mineral fillers or rubber.

The mineral filler is usually finely ground talc or limestone, 65 percent of which will pass a No. 200 sieve. These materials are used to harden the asphalt and give it "body".

Because some of these sealants have been used for many years, it is not surprising to find that many highway departments do not know the origin of their own specifications. There is, however, almost universal agreement that these sealants are not performing the function for which they are used.

The addition of rubber to asphalt improves its flexibility, ductility, adhesion, and cohesion properties. It has therefore been used through the years in the production of sealants designed to meet the federal specifications for hot-poured sealing compound. (SS-S-164, issued in February 1952, is an example of a specification for hot-poured sealants.)

The first rubberized asphalt sealants were made with a high percentage of rubber (20 to 30 percent by weight). They were high-quality sealants that performed very well. As the use of rubberized asphalt became more widespread, more and more companies entered the field. With increased competition, prices were forced down, and, as a result, quality and performance suffered. Performance failure cannot, however, be fully blamed on quality alone, because other factors such as joint width, joint spacing, and installation practices have an important bearing on joint performance.

The federal specification (SS-S-164) called for physical testing of a sample in the laboratory to meet certain test requirements such as safe heating temperature, penetration, cold bond, and flow. This is a performance specification and there is no mention of amount, type, or form of asphalt, rubber, or other material to be used. There is no objection to a performance specification, but state highway engineers are in agreement that the performance requirements have not been properly spelled out. Should there not also be a material requirement stated in the specification?

Originally 20 to 30 percent (by weight) of rubber was used to prepare sealants designed to meet SS-S-164. As the years went by, smaller amounts, different types, and various forms of rubber were used to lower costs. As the rubber content was reduced, larger amounts of filler and other materials were added. Even though fillers can be used advantageously, excessive use can contribute to the poor quality and short life of the finished product.

In 1967, a new federal specification (SS-S-1401) was issued. This one reads:

The sealing compound shall be composed of a mixture of materials compatible with asphalt with or without rubber and which will form a resilient and adhesive compound, will effectively seal joints and cracks in pavement against the infiltration of moisture throughout repeated cycles of expansion and contraction, and will not flow from the joint or be picked up by vehicle tires at an ambient temperature of 125° F. (52° C.). The sealing compound shall have a uniform pouring consistency suitable for completely filling the joints without inclusion of large air holes or discontinuities. The pouring temperature shall not exceed 450° F. (232° C.).

Again we find that this specification does not spell out the type of materials to be used but has simply changed the physical tests and added two new ones, resiliency and compatibility. The major objection to performance specifications (and this is shared by highway maintenance people) is that the sealants will often pass the laboratory tests but will fail in field performance. Many engineers feel that uniform field performance can only be obtained by specifying and controlling the materials to be used in production of the sealant.

New York State Addenda No. 14-M34A specifies the percentage and type of rubber to be used, along with laboratory tests and field installation procedures. Maintenance crews on several toll roads use an asphalt and add the rubber directly into the kettle on site. This approach has the obvious advantage that the percentage and type of rubber are known and can be controlled. Many states are currently testing this method.

#### USE OF RUBBER IN THE SEALANT

Types of rubber available for the manufacture of joint sealants fall into three major classifications. These are natural, synthetic, and reclaimed. Natural rubber comes from trees, synthetic rubber is manufactured, and reclaimed rubber can be produced

from products containing either natural or synthetic rubber, but is most often made from products containing a mixture of both. The various types of synthetic rubber include SBR (styrene-butadiene), butyl, nitrile, neoprene, polybutadiene, polyisoprene, and ethylene-propylene. SBR accounts for 70 percent of all the synthetic rubber used in the United States (twice as much as natural rubber).

Rubber to be used in an end product is normally vulcanized by the addition of sulfur and usually contains other ingredients, such as reinforcing agents, accelerators, intermediates, and plasticizers. Reclaimed rubber is produced by replasticizing the vulcanized rubber by means of heat, pressure, and chemical agents (devulcanization).

Rubber comes in three physical forms, slabs or bales, granular, and liquid or latex. An important consideration in the production of any quality product is securing and maintaining uniform raw materials. When selecting the rubber to be used in the preparation of rubberized asphalt joint sealers, lower cost and greater uniformity can usually be obtained by choosing ground vulcanized rubber or granular reclaimed rubber that contains a high percentage of SBR.

The best raw material source for either of these materials is used passenger tires. Ground vulcanized rubber or reclaimed rubber produced from used passenger tires that have been properly handled (sorted, with metal and fabric removed) will be uniform and contain few impurities. Specifications can be, and are, written around these types of rubber.

A common source of scrap rubber available in any city is buffings from truck, bus, and passenger tires that are buffed from the tire prior to recapping. (Truck and bus tires have a high percentage of natural rubber.) This material will vary considerably in composition and particle size and will contain various amounts of magnetic and non-magnetic contamination (filings, various metals, glass, stones, and organic materials). Even though virgin synthetic rubbers can be used, costs are higher and much greater reheating control is required in the field to prevent degradation.

The cost of rubber in a sealant is not always a major factor in the sealant price. Ground vulcanized or granular reclaimed (devulcanized) rubber sells for about 8 to 12 cents per pound, and the addition of 25 percent by weight to asphalt increases the raw material cost of the sealant by only 2 to 3 cents per pound. The cost of a manufactured rubberized sealant is considerably higher than that of a straight asphalt sealant because of the extra labor costs, increased power consumption, and more capital equipment necessary to heat, mix, and stir the sealant during production.

The use of small quantities of vulcanized or reclaimed rubber does not appreciably reduce the raw material cost, but may affect the manufacturing cost of the sealer. Liquid latex is also used to produce rubberized sealers and its use will normally result in a lower manufacturing cost. However, latex is quite expensive, and 25 percent ground vulcanized or reclaimed rubber can be added at the same material cost as 4 percent latex.

A low-cost rubberized sealant can be produced on the job site by mixing granular reclaimed rubber directly into the asphalt kettle. In this manner, the type, amount, and gradation of rubber can be controlled, and manufacturing variables can be eliminated.

### INSTALLATION PRACTICES

The recommended procedure for using a hot-poured sealant is to heat below 450 F and pour. In actual field use, most kettles are the flue type, heated directly at the bottom by kerosene burners that can subject the sealants to localized temperatures of 800 F or higher. The kettles are equipped with metal covers, and in many cases fire extinguishers and canvas are available to put out sealant fires. The hotter the sealant, the easier it is to pour and prevent solidification in the pouring-pot nozzles. While the sealant is being used, makeup material must be added to ensure enough for a full day's work. The addition of cold sealer reduces the temperature of the mass in the kettle. Therefore, the hotter the sealant, the more chance of maintaining production, i.e., the number of joints and cracks that can be filled in a given period of time. On cold days, a hotter sealant penetrates deeper into the joints with better adhesion to the sides.

The difference between actual field application practices and specified installation procedures is unbelievable. Hot-poured sealants have been poured into joints that were damp and water-filled and that had compression seals, wood spacers, and old sealants in them. These conditions are certainly not recommended by either sealant producers or highway engineers; nevertheless, they do exist in the field.

An educational program should be set up between the joint sealing crews (maintenance) and administrative personnel. No material should be expected to give satisfactory performance unless installation crews are properly equipped and trained for making the installation.

The hot-pours are the lowest-priced sealants available in the United States. Installation costs for a hot-pour run from 20 to 30 cents per linear foot, whereas elastomers are between 40 and 60 cents and preformed compression seals are between \$1.00 and \$3.00. Therefore, on an installed-cost basis, the elastomers are 2 times higher, and the preforms are 5 to 10 times or an average of about 8 times higher than the hot-pours. If you assume a 5-year service life for a properly prepared and installed hot-poured sealant, you would have to realize 10 years' performance from an elastomer and 40 years from a preform to be on a comparable cost basis. In other words, to break even for each year of service life of a hot-pour, you must obtain over 2 years of service from an elastomer and over 8 years of service from a preformed compression seal.

#### ADVANTAGES OF HOT-POURED SEALANTS

Hot-poured sealants offer many advantages over other sealant materials:

1. Ease of application—Just heat and pour.
2. Low cost—The lowest cost material available.
3. Deeper penetration—The hot sealant with its lower viscosity can go deeper into the joints and cracks to seal areas where water can penetrate.
4. Ready conformation to joint shape—The use of the shape factor is only valid for highly elastic, high-recovery materials. The hot-poured sealant is a low-recovery material and therefore a perfect shape factor is not required and one may well be better off without it.
5. Sealing of spalled or ragged joints—Hot-poured sealants are the only material that can be used in this type of work. Elastomers and preforms are useless in this application.
6. Requiring no special equipment—Equipment is familiar to the maintenance and installation crews.
7. Easier application by unskilled labor—No special training of crews or elaborate instructions are required.

Full utilization of these advantages is not realized if the joints and cracks are not properly cleaned and prepared before sealing.

To summarize, the hot-poured rubber-asphalt sealant is the highway engineer's best buy on a price-performance basis. If a pavement must be resealed with rubber-asphalt sealant 5 times in its expected life (25 years), the savings are still great compared to other materials. We could pour and seal over 8 times (or for 40 years) for the equivalent cost of one compression seal installation.

In order to obtain the optimum performance from a hot-poured rubber-asphalt sealant we must, however, have

1. Quality control of the rubber (including type and gradation),
2. Sufficient amount of rubber, and
3. Proper installation.

All three of these conditions can be specified and checked by any highway department. This is one of the simplest ways of improving hot-poured rubberized sealants.

#### REQUIRED RESEARCH

There are basic questions that remain to be answered about hot-poured sealants. Research in these areas could vastly improve our knowledge.

1. What asphalt should be used? Has anyone ever field-tested various asphalt cements to determine which ones give best resilience, adhesion, and cohesion?

2. What quality and quantity of rubber should be used with what asphalt for optimum flexibility, adhesion, cohesion, and resilience? Discussions here are based on laboratory and technical service work by our company with various joint seal manufacturers and highway departments. Details of time and temperature vary considerably with the type of mixer used and also the asphalt source. The rubber is usually added to the asphalt, which is held at about 430 F. It should not be heated over 460 F. After all the rubber is added, the mixing cycle will vary with the temperature and the type of equipment used. The most common type of mixer used is a jacketed paddle type varying in capacity from 200 to 3,000 gallons. It would be difficult to standardize the production of hot-poured joint sealants because it is considered an art that most manufacturers keep secret.

3. What test should be used to determine quantity of rubber in asphalt? There are several chemical tests to determine the percentage of rubber in asphalt, but most of these are not accurate because duplication of results is difficult, even within the same batch. Work should be done with instrumentation—perhaps a mass spectrometer.

4. Is rubber dissolved or dispersed in asphalt? There has been considerable discussion as to whether rubber really dissolves or simply disperses.

5. Does a rubberized hot-poured sealant have to be smooth? Some states insist on smooth joint sealers. However, as long as graininess of the product does not interfere with other properties of the sealant, such as pour, it can be desirable. In fact, the grain does act as a rubber reserve for prolonged and high heating. Some of the better sealants have been grainy.

6. What about low-recovery-type sealants? A study should be made to determine definite values for the adhesive and cohesive strength as well as definite values of stress relaxation and recovery. The effects of shape on these physical properties should also be studied.

#### CONCLUSIONS

Hot-poured sealants are the most widely used materials but the ones about which the least appears to be known. The hot-poured sealants are used on first-class highways as well as on county, city, and village roads. They will be with us for many years to come because of the advantages pointed out here. A program of research and development would enhance their utility even more.