Engineering Brief # 36

SILICONE JOINT SEALANTS

Silicone joint sealant is a one-part silicone formulation that cures on exposure to the atmosphere to form a flexible, low modulus, high elongation silicone rubber joint seal.

Silicone sealants have been used in various construction applications since their introduction over 20 years ago. However, the first silicone sealants produced acetic acid during the cure, and this acidic by-product reacted with calcium contained in concrete resulting in uncertain adhesion. Since that time, however, several types of non-acid producing silicone sealants have been developed that do not react with concrete.

The function of a sealant is to seal the joint between two concrete surfaces. Therefore, the sealants strength characteristics are less important than its ability to withstand joint movement and maintain adhesion.

This engineering brief will discuss the physical properties of silicone sealants, joint design for these materials, and surface preparation.

a. Physical Properties

1. Modulus. Modulus is a measure of the force required to stretch a cured rubber test bar to a specified elongation. It has an important bearing on the ability of the sealant to handle joint movement. A superior sealant offers minimum resistance to such movement and therefore would have a lower modulus rating. ASTM D412 is used to measure this force.

2. Movement. Movement measures a sealants ability to withstand repeated expansion and contraction of a joint. ASTM C719 can be used to measure this cyclic movement. This method incorporates a conditioning period followed by testing of specific movement capability requirements.

3. Durometer Hardness. The relative hardness of a sealant can be used to provide an indication of flexibility. Generally, as the values increase, flexibility decreases. ASTM D2240 is used to measure hardness.

4. Adhesion. Adhesion is a measure of the ability of a sealant to adhere to a substrate. Adhesion must be maintained even while the sealant material is being stretched. Mil Spec S-8802 can be used to indicate the adhesive qualities of a sealant.

5. Jet Fuel Resistance. Silicone sealant is not degraded by contact with jet fuel. Some swelling of the material will normally occur but it will return to its original shape, upon evaporation of the fuel, without loss of bond.

b. Surface Preparation. Adequate surface preparation is one of the most important steps toward obtaining a successful installation. If dirt or other foreign matter remains on the surface, intimate contact between the sealant and the joint surface cannot be obtained thereby preventing development of a good adhesive bond.

For sawed joints the cement slurry must be removed from the joint walls. This can be accomplished by water washing immediately after sawing, followed by sandblasting and high pressure air blasting.

Surface preparation for resealing joints is generally more time consuming since removal of old sealant materials is required. Joint widening by sawing is generally the fastest way to remove old sealing materials. After removal of the old sealant, the procedures describe above should be used to complete the joint preparation process.

c. Joint Design. Good joint design is an important element for proper sealant installation. The elements to be considered in a good joint design for silicone sealant include joint depth, backer rod selection, and sealant placement.

1. Backer Rod. An essential element of good joint design is the use of a backer rod. A primary function of the backer rod is to act as a bondbreaker and prevent three-sided adhesion of the sealant. Failure to use a backer rod will allow the sealant to bond to the bottom of the joint, thereby resulting in excessive stress on the sealant.

Another function of the backer rod is to control the thickness of the sealant. Placement of the backer rod to the proper depth insures that the correct amount of sealant will be installed. The backer rod should be slightly oversized (diameter l/8" greater than joint width) so that it fits tightly into the joint. This design provides a firm support for placing and tooling the sealant.

Generally the backer rod is a non-moisture absorbing resilient material that is compatible with the sealant. In addition, no bond or reaction occur should between the rod and the sealant.

2. Sealant Placement. Another element of joint design is sealant placement. The proper amount of sealant must be placed in the joint at the recommended depth. A thin bead of sealant will accommodate more movement than a thick bead. For this reason, a silicone sealant should be no thicker than 1/2 inch and no thinner than 1/4 inch. Within these limits the sealant's width-to-depth ratio should be 2:1. In all cases, the sealant must be recessed approximately 1/4 inch below the surface. Silicone sealants are non-flowing and must be tooled into the joint to provide proper wetting and insure good adhesion.

The cost per linear foot in-place runs about $1.50.

Based on successful use on airport pavements during the past several years, we feel that silicone sealants are an acceptable alternative when selecting joint sealing material. Silicone sealants may be specified on a case-by-case basis so that we may further evaluate this type of sealant on airport pavements.

Attached is an interim specification for silicone sealants and a listing of airports where this material has been installed.

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SILICONE JOINT SEALANT

1. DESCRIPTION

1.1 This item shall consist of providing and installing a silicone sealant capable of sealing joints in concrete pavements.

2. MATERIALS

2.1 SEALANT. Silicone sealant (non-acid curing) material shall meet the requirements shown in Table 1.

TABLE 1. SILICONE SEALANT REQUIREMENTS

Test Method	Test	Requirement
MIL-S-88O2	Flow	0.3 maximum
MIL-S-88O2	Tack Free Time	90 minutes, maximum
ASTM D 2240	Durometer Hardness 1/	10 - 25
ASTM D 412 (Die C)	Modulus, at 150% elongation 1/	75 psi, maximum
ASTM D412 (Die C)	Elongation 1/	800% minimum
MIL-S-88O2	Adhesion to Concrete	20 lbs, minimum
ASTM C 719	Movement	+ 50%, minimum

1/ Sample cured 7 days at 77 degrees F + 2 degrees (25 degrees C + l degree) and 50% + 5% relative humidity.

Each lot or batch of sealing material shall be delivered to the jobsite in the manufacturer's original sealed container. Each container shall be labeled to include the following:

a. Name of material
b. Manufacturer's name
c. Manufacturer's lot number
d. Shelf life
e. Mixing instructions
f. Storage instructions

In addition, the Contractor shall supply the manufacturer's certification stating that the material meets the requirements of this specification.

2.2 BACKER ROD. The backer rod shall be a non-moisture absorbing resilient material. The rod shall be compatible with the sealant and no bond or reaction shall occur between the rod and the sealant.

3. CONSTRUCTION METHODS

3.1 WEATHER LIMITATIONS. Installation temperature shall be above 40 degrees F (4.4 degrees C). At a temperature of 75 degrees F (24 degrees C) and 50 percent relative humidity, the sealant will cure to a tack-free surface in about one hour. At a temperature of 40 degrees F (4 degrees C) the tack-free time will be about 2-3 hours.

3.2 EQUIPMENT

a. AIR COMPRESSOR. Air compressors shall be equipped with suitable traps capable of removing all free water and oil from the compressed air and shall be capable of furnishing air with a pressure greater than 90 psi.

3.3 PREPARATION OF JOINTS. Immediately after saw cutting is complete the resulting cement slurry shall be completely removed from the joint by water washing followed by sandblasting. After sandblasting the joint shall be blown out with compressed air. When the surfaces are clean and dry, and just prior to placement of the sealant, compressed air shall be used to blow out the joint and remove all residual dust.

3.4 INSTALLATION OF JOINT SEALER. Joints shall be inspected for proper width, depth, alignment, and preparation, and shall be approved by the Engineer before the Contractor begins sealing operations. A backer rod shall be installed as shown on the plans, prior to placement of the joint sealer. The sealant shall be applied in a continuous operation, with an approved mechanical device, and shall adhere to the concrete and be free of voids. The sealant shall then be tooled, with an appropriate tool, to produce a slightly concave surface approximately 1/4 inch below the pavement surface. Tooling shall be accomplished before a skin forms on the surface, usually within ten minutes of application.

4. METHOD OF MEASUREMENT

4.1 Joint sealing material shall be measured by the linear foot (meter) of sealant in place, complete, and accepted.

5. BASIS OF PAYMENT

5.1 Payment for joint sealing material shall be made at the contract unit price per linear foot (meter). The price shall be full compensation for furnishing all materials, for all preparation, delivering, and placing of the material, and for all labor, equipment, tools, and incidentals necessary to complete the item.

SILICONE CONCRETE JOINT SEALANT

SUMMARY OF AIRPORT INSTALLATIONS

Location	Type of Installation	Date of Appl.	Approx. Linear Feet	Current Status
Ellsworth AFB Rapid City, SD	Taxiway & Runway	9/80	200	Test Site Performing Well
Grand Forks AFB, Grand Forks, ND	Taxiway & Runway	9/80	200	Test Site Performing Well
Holoman AFB, New Mexico	Taxiway & Runway	10/80	200	Test Site Performing Well
Eglin AFB, FL	Taxiway & Runway	10/80	200	Test Site Performing Well
American Airlines Tulsa, OK	Maintenance Terminal	?/81	200	Test Site Performing Well Competitive Products Failed
Roanoake Municipal Roanoke, VA	Apron	10/80	20,000	Performance Good Case History on File
Victoria Municipal Victoria, TX	Runway	9/82	400	Excellent
Stapleton Intl Denver, CO	Apron 3" Expansion	10/84	20,000	Performing Well Case History
Stapleton Intl Denver, CO	Air Cargo Facility	8/85	60,000	
Norfolk Intl Norfolk, VA	Runway Extension	8/83	60,000	
Norfolk	Air	?/84	18,000	

Intl Norfolk, VA	Cargo Maintenance Facility			
Baltimore Washington Intl Baltimore MD	Apron	'85	20,000 sq yd	in Progress Now
Wicomico County Airport Salisbury, MD	Runway	3/85	40,000	
Abermarle Airport Charlottesville, VA		9/84	10,000	
Manassas Airport Manassas, VA	Runway	12/84	3,500	
Tampa Airport Tampa, FL	Tank Farm	8/83	200	Performing Well
Arcada Eureka, CA	Apron	9/85	60,000	
Hartsfield Intl Atlanta, GA	Runway Lights	9/83		Performing Well
Hartsfield Intl Atlanta, GA	Runway Expansion Joints	9/83	14,000	Performing Well
Dyess AFB Abilene TX	Cable	9/85	12,000	Performing Well
McCarran Intl Las Vegas, NV	Apron	9/85	6,000	Performing Well