A New Approach to Subsealing

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This paper describes the development of an asphalt emulsion for subsealing concrete pavement. The asphalt emulsion contains a micro-aggregate or filler that makes the residue from the broken emulsion a mastic. This mastic is too stiff to be squeezed through the joints or cracks in the concrete. The asphalt emulsion subsealer is applied cold with standard bituminous equipment and is successfully used in damp or wet areas. This material does not "track" on the pavement if any spillage is allowed to dry before traffic hits it. Several years of experience in subsealing with this asphalt emulsion in North Carolina indicate that it is a safe, economical, effective subsealer for concrete pavement.

•SEVERAL division engineers with the North Carolina Highway Commission requested about twelve years ago a cold-applied asphalt emulsion suitable for subsealing cement concrete pavement. These engineers wanted especially a cold-applied material because several men in the subsealing crews had recently been burned while subsealing with a hot-applied material. There was no asphalt emulsion available at that time considered suitable for this application. However, the division engineers considered the hot application so hazardous and so hard on equipment that some of them began using a regular, high viscosity quick breaking or RS-2 type emulsion for subsealing. The results of this operation turned out surprisingly well in several instances, but there were also cases where some of the asphalt residue from the emulsion was squeezed back up through the joints or cracks in the cement concrete. This material was "tracked" down the highway because the emulsion base was soft and sticky at summer temperatures.

A hot-applied material was still the only subsealing material approved by the office of the bituminous engineer. However, after the loss of a new bituminous distributor and another bad accident which nearly caused the death of two men, a program was undertaken to develop a subsealing material that could be applied cold.

DEVELOPMENT OF COLD-APPLIED SUBSEALER

The first efforts in the development of a cold-applied subsealer were in the direction of changing the method of applying the RS-2 type of emulsion with the idea of keeping it from coming back through the pavement. Although these efforts were at least partially successful, it was decided that a subsealer with an appreciable yield strength was desirable.

An attempt was next made to pump a mixture of slow-breaking emulsion and stone screenings under the pavement using a mudjack. This operation was abandoned because sufficient back pressure was developed to stall the mudjack. In fact, the mixture was packed so tightly that it was necessary to disassemble the mudjack completely in order to clean it out.

Next, an asphalt emulsion was made in which a large percentage of portland cement was incorporated. This material was designed to leave stiff mastic residue under the concrete pavement. Though the emulsion was quite fluid, some difficulty was experienced in pumping it with the usual bituminous pumps. However, it could be pumped easily by a centrifugal pump. Even though this asphalt emulsion containing portland

Paper sponsored by Committee on Salvaging Old Pavements by Resurfacing.

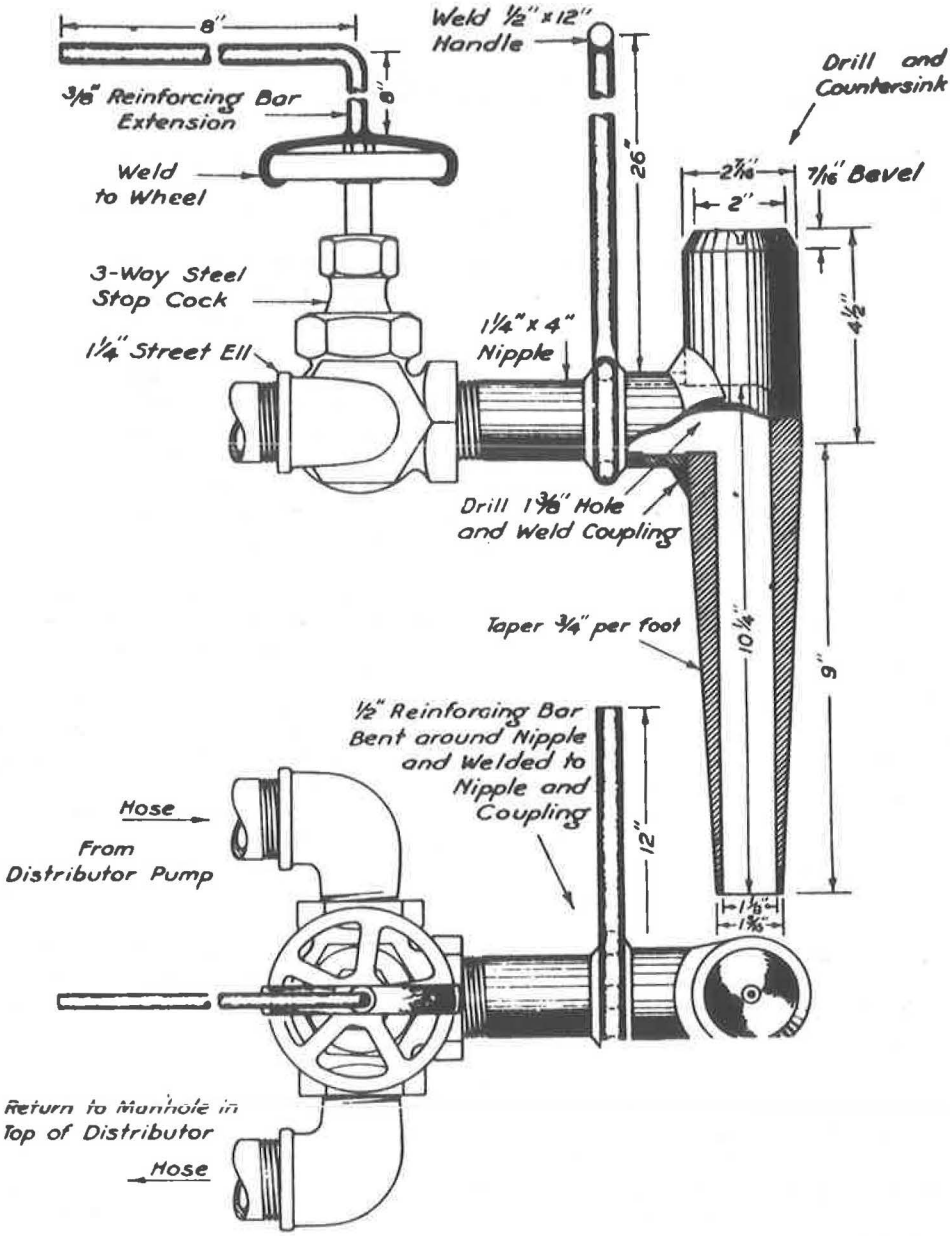

Figure 1. Nozzle for pumping asphalt under pavement.

cement seemed to subseal satisfactorily, there were some problems in its use. The manufacturer sold it only in drums, because it was feared that it might solidify if stored for extended periods. These fears proved to be well founded because some drums of this material which were left over at the end of the season were completely set up by the next spring. When the drum was stripped from around the emulsion, the contents looked like a dark cement concrete drum.

To avoid the possibility of having this asphalt emulsion set up in equipment and to reduce the high cost involved in drum shipments, another asphalt emulsion was made containing a less active micro-aggregate or filler. This material was called Subseal-

Figure 2. Pumping of subsealer.

Figure 3. Wooden plug being driven into slab.

er II, and it was judged safe to ship in tank trucks or tank cars. Subsealer II could be pumped using standard bituminous pumps.

METHOD FOR APPLYING SUBSEALER II

Subsealer II is easily pumped under the concrete and dries to a stiff residue or mastic. The established practice in North Carolina is to drill 1⅝-in. holes at the selected points for subsealing. In the shoulder at the joint or crack being subsealed, a hole is dug which extends an inch or more below the underside of the pavement slab. Compressed air is forced through the 1⅝-in. holes in the pavement to blow as much mud and water from under the pavement as possible. The holes dug in the shoulder make it easier for the water and mud to be blown from under the pavement, and also permit observation of when the asphalt emulsion reaches the edge of the pavement. These holes in the shoulder are to be filled with dirt and tamped after the asphalt emulsion reaches them.

After blowing out the 1⅝-in. holes in the pavement, a nozzle tapered to fit tightly is driven into the pavement. Sand is spread in a 12-in. radius around the nozzle. The sand prevents any asphalt emulsion that may leak around the nozzle from sticking to the pavement. The Subsealer II at ambient temperature is then pumped from a 600-gal utility kettle through the tapered nozzle and under the concrete slab. Figure 1 shows the nozzle, and Figure 2 the subsealer being pumped. A 10-ft straightedge is used to determine when the slab is at the right elevation. The man watching the straightedge should signal the valve operator when the slab begins to rise. The elevation of the slab is then carefully adjusted to the proper level. The nozzle should be left in the pavement for about 30 sec before being withdrawn. This is to allow time to see if the slab is going to maintain the proper level. If the proper level is maintained, the nozzle is withdrawn from the hole and a tapered wooden plug is immediately driven into hole. Figure 3 shows the wooden plug being driven into the slab. The sand around the hole and any asphalt emulsion that has gotten on it while removing the nozzle are scooped up with a shovel and removed from the pavement.

A subseal of any kind seldom cures the movement of concrete slabs forever. This is true of subsealing with Subsealer II. Though in some instances one subsealing will cure the movement for many years, the more usual case is that it is necessary to subseal again in two to three years even though some permanent improvement will be maintained.

One of the most desirable features of Subsealer II is the elimination of many of the hazards which were part of the subsealing operation in the past. This material is usually applied with no heating at all. It is not inflammable or explosive, and it is very easy to handle. The experience in North Carolina is that it is not as hard on equipment as materials used in the past.

EFFECTIVENESS OF SUBSEALER II

The first work that was done with Subsealer II was in Craven County, in 1959. This work was done in areas which were originally swampy and where water was a problem. Even after blowing out the drilled holes in the pavement with compressed air, there was a considerable amount of free water under the slab. It was found that quite a bit more water could be forced out when the Subsealer II was pumped under the slab. The practice was to continue to pump until the material flowing out at the edge of the pavement appeared to be undiluted Subsealer II (Fig. 4).

Examination of this work a year later showed that it had been effective in reducing slab movement or pumping at all locations where it was used. At some points, there was still some evidence of pumping but at a much reduced level; at many others, the pumping appeared to have been arrested. At no point treated was there any indication of extrusions of the Subsealer II. The over-all judgment was that Subsealer II was as effective as any other subsealer that had been used in the past (Fig. 5).

Subsealer II has been used each year since 1959. Its use is increasing in North Carolina, and more than 150 miles of roadway have been subsealed in various parts of the State. After nearly four years, the subsealing done in 1959 continues to be satisfactory.

Figure 4. Undiluted Subsealer II being exuded from edge of pavement.

Figure 5. Road with subsealer.

There have been some requests for cost per mile figures on this type of subsealing. Estimates of this type have not been included, however, because the cost per mile varies almost directly with the number and volume of cavities to be filled and bears little relationship to the distance covered. However, the original cost of Subsealer II is about the same as for other subsealing materials, but it is more economical to apply. This makes the over-all cost less than materials used in the past in North Carolina.

Several years experience in using Subsealer II confirms that it is a safe, economical, and effective subsealer for concrete pavement.

ACKNOWLEDGMENT

Figure 1 is reproduced by permission from Vol. 16 of the Proceedings of the Association of Asphalt Paving Technologists (1947).

Appendix

Equipment

1. A 600-gal utility kettle or pressure distributor (Fig. 2).
2. A 3-way valve.
3. A $1\frac{5}{16}$-in. tapered to 2-in. (outside diameter) nozzle to insert in the pavement and necessary hose for line from nozzle to three-way valve and double line from three-way valve to tank (Fig. 1).
4. A 105-cfm air compressor and hand held drill with $1\frac{5}{8}$-in. carbide bit.

Subsealer II Specifications

1. Residue by evaporation, 45 to 60 percent.
2. Water, 40 to 55 percent.
3. Ash on the basis of non-volatile material, 40-60 percent.