sand which had accumulated under the edge of the paper dropped into the joint opening. These joints were cleaned out by the contractors and resealed by them during cooler weather.

When these joints were resealed, the weather was cooler and consequently it was possible to place a larger quantity of the sealer. Where traffic would not use the pavement for 24 hours after resealing, paper was not used, the joints being lightly dusted with cement.

Due to bond failures, it has been necessary for some contractors to reseal projects that were originally sealed with the hot-poured rubber type before the projects were accepted.

SEALING CRACKS

A small amount of the cold-poured type of rubber sealer has been used to seal cracks in portland-cement-concrete pavements and in bituminous resurfacings of this type of pavement. For this work special nozzles have been developed that leave a bead of the sealer on the surface. The best results have been obtained when the cracks are sufficiently open to allow some of the sealer to enter the crack.

CONCLUSION

We believe that the use of cold-applied, ready-mixed rubber sealer is the ideal material to use in maintenance work. The ease with which it can be placed during cold weather and its bond to concrete are especially desirable features. Figure 6 shows a close-up of one of the contraction joints resealed with this material more than two years ago.

Asphalt Emulsion for Undersealing Rigid Pavements

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● THIS is a short description of subsealing, void-filling, and joint-filling work done with emulsified asphalt in recent years on the state highway system in New York. The emulsion used conforms with the AASHO specification RS-1, a quick-setting grade with Furol viscosity 30–100 at 77 F. It is applied at air temperature but may be warmed to, say, 125 F., if desired. Substantial use has also been made of the RS-2 grade which has a higher viscosity (Furol 50–300 at 122 F.) requiring heating to around 170 F. to secure desired fluidity. Both of these grades are the same as used for penetration macadam and for surface treatment with stone cover and are both generally available. As manufactured for New York State use, they have a base asphalt of 180 penetration having a softening point of 100 F. Application is made at pressures of 25 to 50 lb. per sq. in.

The methods and materials were first used in New York for this purpose on a substantial scale in 1948. Little subsealing work of any nature had been done there up to that time, but the necessity was apparent. Trials were made with emulsion to discover if this low-temperature-application material would give results comparable with materials of high softening points. A season's use indicated that it was possible not only to fill the cavities beneath the pavement but also to do a satisfactory job of sealing joints and cracks from beneath the pavement in the same operation.

In the early stages of the work the emulsion was introduced by simply pouring it from hand-pouring pots. The pavements then being cared for were quite-badly broken and cracks were quite wide in many cases. The hand-poured emulsion quickly seeped down out of sight and two or three follow-up pours were necessary at times to completely fill the cracks. By the time the broken slabs, which in many places had been rocking quite badly, were completely filled they became firm and have remained so since. Each year since the work was initiated, repouring has been done wherever new needs appeared. Once the cracks and joints were filled there was no extrusion or other appearance which would indicate that the comparatively low-softening-point base asphalt was too soft for the purpose. Some of the early-treated routes are on sections under heavy interurban truck, bus, and general vehicular traffic, and all are sustaining this load satisfactorily under this continuing method of maintenance, pending resurfacing or reconstruction.

Soon after the initiation of the work it became apparent that greater speed and better results would be had if holes were drilled through the slabs and the asphalt introduced under pressure. In many cases 20, 30, 40 gallons or more could be injected into a single hole. Usually in these cases where high volumes were required, complete filling was not attempted at first pour, but a later pouring was made. When a pavement reaches such a condition that it no longer has a fine surface appearance, the scars of repairs are not particularly objectionable, so reasonable spillage and overrun on the surface may be cared for by brooming and covering with stone chips and spray patching. Then, there naturally developed a routine for carrying on all the necessary pavement repairs with the same materials and outfit. Depressions are patched, scaled areas are spray patched, and all repairs except general surface treatment are combined with the subsealing and joint filling into one well-integrated operation.

As pressure application began, the joint filling from beneath became apparent. The emulsion oozed up through openings in the joints in many places which appeared to be tightly filled. It would make its appearance perhaps 20 feet or more away from the point of injection. These more-distant reaches are generally on pavements not greatly cracked or broken where pressure could be maintained. With many nearby, open joints or cracks, pressure is quickly dissipated or overflow becomes too great.

When free water is encountered under the pavement, no attempt is made to blow it out with air pressure. Air pressure is likely to blow mud into the smaller crevices and prevent their being filled with asphalt. Instead, openings are made in the shoulder along the edge of the pavement at the end of the transverse joints or elsewhere to permit the free discharge of the water from under the pavement. Then the emulsion under pressure forces it out. After the water is out and the emulsion appears, the drain holes can be filled with earth to enable more pressure to build up under the pavement for better filling of voids.

The extended permeation of the asphalt under the slab and its continued functioning in the presence of water is due to its emulsified state and its continued low viscosity at air temperatures. Some opportunities have been presented to observe the action of the emulsion under the slabs where muddy conditions existed at the time of its injection. It was found to have penetrated into and mingled with wet earth to form a mastic up to a depth of 2 inches or so. As this mastic dried out it formed a hard, stable mixture not likely to be deformed under pavement loads.

The success in stabilizing broken concrete pavements by this subsealing method has led to its use under other types. Depressed areas under concrete which has already been surfaced with bituminous-concrete pavement have been injected with the emulsion to force out the water which caused the trouble and to stabilize the metal. Similarly, places in macadam types weakened by water have been measurably benefited. In these instances, as in all others, effort is made to release and remove collected water and to provide continued free drainage.

The foregoing relates largely to the repair of pavements which, due to age and broken and patched condition, need not be kept free from surface blemishes. Comparatively new pavements, on which fine surface appearance must be preserved, frequently develop pumping which, if left uncared for, will cause cracks and broken pavement. At times pumping is readily observable, while other times it may be found only by close observation. Early attention by subsealing and void filling may prevent further harm provided means for the free discharge of subsurface water are installed. The figures show methods for such subsealing which have been found quite satisfactory.

Generally the operation is similar to that already described above but with added care against surface leakage of bitumen in order to preserve the good appearance. The quantity of emulsion used is much smaller than for older pavements, and it is frequently handled by means of drum-type sprayers rather than from large distributor trucks. When drum sprayers are used the emulsion grade RS-1, which does not require heating, is best adapted.

These pavement pumpings are almost always at outside slab corners. The procedure is to open small holes in the shoulder to the bottom of the pavement at the end of the transverse expansion joint for observation purposes. If a large amount of water has accumulated larger space or drains are provided for its removal. Holes are made 3 to 4 feet apart across the expansion joint by driving a 5⁄8-inch iron pin down through the joint material. It is through these holes that the subsealing material is introduced under the pavement. (In these newer pavements the width of the expansion joint is sufficient to accommodate such holes.) A 3⁄8-inch pipe nipple which has been slightly tapered then forms a tight-fitting nozzle for the hose line, and the emulsion is pumped through it. The holes are driven into the subgrade, but the nozzles are inserted not quite to full pavement depth. As each hole is filled the adjacent open holes are watched, and each one is plugged before it spills out on the pavement. The transverse and longitudinal joints are also watched for seepage up through the joints as the emulsion finds the holes. Small dams of sand confine the spillage for later removal. On these better pavements, pressure can be maintained more easily, so joint filling may reach out for considerable distances from the filling hole. At times a second filling of the holes is necessary. An interesting detail is that during high summer temperatures the pavement may expand so much by midday that the 3⁄8-inch nozzle cannot be inserted in the joint. Thus far these few occurrences have been overcome by starting work at daybreak. Where the joints are too narrow for this method, drilled holes are required.

Among the advantages listed by the engineers in charge of the work are: (1) the equipment and materials are both inexpensive and readily available; (2) the procedure is simple; (3) working at air temperature saves time and expense and minimizes both the number and degree of accidents; and (4) the results to date indicate the possibility that this method for repairing and stabilizing broken concrete pavements may resolve the difficult decision as to the necessity for breaking-up old concrete prior to resurfacing; in case of doubt the stabilizing operation may be used and results observed before final decision is made.

While the work we are describing here has been performed mostly by department forces, the contract resurfacing of all concrete pavements during the past season has included subsealing in this same manner. It is intended to continue in future resurfacing contracts.