STRESS ABSORBING MEMBRANE INTERLAYER
(S.A.M.I.)

CONSTRUCTION REPORT

by

J.A. Cooper, D.F. Lynch and R.C. Aquin

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ABSTRACT

The reappearance of cracks through hot mix asphaltic concrete pavements over Portland cement concrete pavements has been a concern for several years. Current methods of attempting to overcome the situation have not been entirely satisfactory and there is a continuing need to find a better method of dealing with the problem.

A method of reducing cracking has been developed by Sahuaro Petroleum and Asphalt of Phoenix, Arizona. This method is known as a Stress Absorbing Membrane Interlayer (S.A.M.I.). A S.A.M.I. is a single surface treatment 13 mm in thickness, consisting of a sprayed application of an asphalt and rubber binder followed by an application of heated stone chips. The binder is mixed on the job site and consists of a blend of 80% asphalt cement and 20% crumb rubber.

This report describes the application of a S.A.M.I., in May of 1982, onto a badly cracked concrete pavement which was constructed in 1967 on King's Highway 77. A brief description of blending, application and construction procedures is included as well as observations regarding performance.

It has been concluded that the S.A.M.I. has not prevented reflection cracks from reappearing in the new pavement over the expansion joints. However, transverse cracks between the expansion joints have not reappeared. A small amount of centreline cracking in the new pavement has occurred. There were no unusual problems when applying the S.A.M.I. to the concrete pavement. On the basis of the evidence to date, it is recommended that no further S.A.M.I. installations be constructed until further performance evaluations have been made of the work on Highway 77.
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INTRODUCTION

The reappearance of cracks through hot mix asphaltic concrete resurfacing over Portland cement concrete pavements has been an ongoing problem. The standard method of overlaying concrete pavement with hot mix is to level with HL-2 or a modified HL-4 or 8, followed by a binder course and a wearing course. Total pavement thickness ranges from 60 to 130 mm, depending on the condition of the concrete pavement, location, AADT and other pertinent design factors.

The purpose of the HL-2 is to waterproof and level the existing concrete pavement and, to some degree, retard reflection cracking through the new hot mix. The ability of the HL-2 to minimize reflection cracking has not been entirely satisfactory and a more effective means of reducing the amount of reflection cracking is desirable.

A method of reducing cracking has been developed by Sahuaro Petroleum and Asphalt of Phoenix, Arizona. This method is known as a Stress Absorbing Membrane Interlayer (S.A.M.I.) and is claimed by Sahuaro to be flexible enough to bridge cracks and waterproof the concrete pavement. This report outlines the construction of a Stress Absorbing Membrane Interlayer on King's Highway 77 in May of 1982 prior to resurfacing with hot mix asphaltic concrete. For future reference, a detailed map crack survey was completed over a control section of the concrete pavement before the construction of the S.A.M.I. The main purpose in constructing the S.A.M.I. was to assess its effectiveness in reducing reflection cracking through the new hot mix resurfacing and to determine any application or traffic problems during construction.
Description

A S.A.M.I. is a single surface treatment 13 mm in thickness consisting of a sprayed application of a specially formulated asphalt and rubber binder, followed by an application of heated stone chips.

To achieve the desired flexibility, a soft asphalt cement is mixed with approximately 20% by weight of crumb rubber in a blending plant on the job site. The crumb rubber is produced by grinding up used tires and peelings from retreaded tires. The ground rubber is then placed in plastic bags and transported to the job site and dumped into a hopper at the side of the blending plant. From there it is fed to the mixer where it is combined with the asphalt cement at 210°C.

As the rubber mixes with the asphalt cement, it melts and expands causing the mixture (binder) both to become more viscous and to cool. The mixing process is carried out for approximately 20 minutes and then the asphalt/rubber binder is pumped into either a separate storage tank or directly into a specially constructed asphalt distributor capable of spraying the high viscosity asphalt/rubber binder directly onto the concrete pavement at the desired rate of application.

EXISTING CONCRETE PAVEMENT

The section of Highway 77 where the S.A.M.I. was constructed is straight and level and begins at the Comber south limits and proceeds southerly 8.7 km. The existing pavement placed in 1967 consists of a concrete slab, 6.7 m in width, 175 mm in thickness, which is reinforced with dowels. Expansion joint spacing is at 18 m + intervals (Figure 1). Cores taken through the pavement reveal that the lower 50 mm of concrete has cracked extensively and at the joints the lower 100 mm has reverted to aggregate. The concrete slab is underlain with 150 mm of granular 'A' overlying approximately 100 mm of granular sub-base.

The entire 8.7 km of concrete pavement was cracked at the expansion joints and transversely at intervals between the expansion joints. There was D cracking of the expansion joints at centreline and at the...
edge of pavement. The expansion joints were moderately to severely
spalled, with many joint failures (see Figure 2). Some relief sawing
had been done by MTC maintenance forces. Blow-ups that had occurred
were patched with hot or cold mix. The spalled areas had been sealed
with emulsion and chips, however, this was only partially effective and
deterioration has continued. Most of the spalled areas, including those
along centreline, were patched with cold mix just prior to placing the
S.A.M.I. Transverse cracks occurred throughout the section between the
joints (Figure 3). A map crack survey carried out just prior to
construction of the S.A.M.I. Indicated an average of 40 m + of transverse
cracking between expansion joints (see Appendix A).

Due to poor drainage and wet saturated conditions in the sub-base
and subgrade, 100 mm diameter perforated plastic pipe was installed along
both pavement edges for the entire length of the concrete pavement in
1978. It was hoped that this would improve drainage and retard the rapid
deterioration of the underside of the pavement. Recent examination of
the outlets from the pipe has confirmed that the pipe is removing water
as intended and should assist in retarding pavement deterioration to
some extent.

RESURFACING DESIGN RECOMMENDATIONS

In view of the concrete pavement conditions, the following re­
commendations were made for resurfacing this section of pavement:

25 mm HL-2 Levelling Course
40 mm HL-4 Binder Course
40 mm HL-4 Surface Course

A contract (81-77) to resurface the concrete pavement was awarded in
January, 1982, based on the above recommendations. Prior to the commence­
ment of the resurfacing operation, it was decided to investigate the cost
of constructing a S.A.M.I. in lieu of the HL-2 levelling course. A
Special Provision was prepared (see Appendix B) and sent to the contractor
to obtain the cost of constructing the S.A.M.I.
Figure 1: Hwy. 77 Concrete Pavement Before SAMI

Figure 2: Typical Expansion Joint in Concrete Pavement

Figure 3: Typical Crack Between Expansion Joints
It was determined that there would be an estimated saving to the Ministry of approximately $47,000 by placing the S.A.M.I. when compared to placing the HL-2 for the section in question. On the basis of the anticipated cost saving and the Ministry's desire to assess the benefits of the S.A.M.I. system, it was decided to proceed with the construction of the S.A.M.I.

CONTRACTOR

The general contractor for the work was R.E. Van Gassen Ltd., P.O. Box 900, Chatham, Ontario, who subcontracted the construction of the S.A.M.I. to Sahuaro Petroleum and Asphalt Co., Canadian Division, 14322 Magdalen Ave., Whiterock, B.C. The work was carried out during the last week of May, 1982.

MATERIALS

The following materials were used to produce the S.A.M.I. as per the Special Provision (Appendix B):

- **Asphalt Cement** - 150/200 penetration grade obtained from McAsphalt Industries, Toronto, Ontario.
- **Asphalt Modifier** - not required.
- **Rubber** - Type II (Duramesh 1030) obtained from Dura Undercushions Ltd., Montreal, Quebec.
- **Diluent** - Kerosene obtained locally at Chatham, Ontario.
- **Aggregate** - HL-3 coarse aggregate obtained from Canada Crushed Stone, Dundas, Ontario. It was heated at Chatham in Van Gassen's hot mix plant.

EQUIPMENT

The following equipment was used to complete the work:
2 - Bearcat asphalt distributors, specially modified to spray the rubberized binder; obtained from Sahuaro Asphalt and Petroleum Co., Phoenix, Arizona.

1 - Heater blender, specially manufactured to produce the rubberized binder, obtained from Sahuaro Asphalt and Petroleum Co., Phoenix, Arizona.

1 - Storage tank for kerosene.

1 - Flaherty self-propelled chip spreader obtained on rental from Spinks Sand and Gravel, Leamington, Ontario.

2 - Self-propelled rubber-tired rollers (8.0 tonne) obtained from Van Gassen Ltd.

1 - Self-propelled rubber-tired roller (8.0 tonne) obtained from Spinks Sand and Gravel, Leamington, Ontario.

CONSTRUCTION

Preparation

Repairs were made to the existing concrete pavement where longitudinal and transverse joints were in exceptionally poor condition and areas of severe cracking and spalling had occurred. Remedial work in these areas was carried out using cold mix patching materials.

The concrete pavement was swept clean of all dust, debris, dirt and loose material by means of a power broom the day prior to commencement of the application of the S.A.M.I. The surface was exceptionally clean, and on the advice of Sahuaro the spraying of the tack coat was judged unnecessary and therefore eliminated.
Figure 4: Asphalt Tanker Unloading Into Blending Plant

Figure 5: Crumb Rubber in 25 kg Plastic Bags

Figure 6: Crumb Rubber
Asphalt/Rubber Binder - Mixing and Reaction

The 150/200 pen. asphalt cement was pumped from the tanker into a heated storage tank on the blender where it was heated to 210°C. The asphalt cement (150/200) was then pumped into the blender unit where the granulated rubber was added. A meter indicated the gallons of asphalt cement in the blender and the desired amount of rubber was added to the blender by means of a bucket elevator at the side of the unit. The asphalt and rubber were mixed in the blender for 25 minutes and then pumped into a distributor resulting in a temperature drop of the binder to 165°C. The binder was held in the distributor for approximately 60 minutes until the reaction between the asphalt and rubber was complete and the desired viscosity was reached. The viscosity of the binder was checked on site with a Haake Viscotester. Approximately three percent kerosene was then added to the binder to obtain the desired viscosity for spraying. A special auger running the length of the distributor tank and a recirculating pump continued to mix the binder until it was sprayed.

Spraying the Binder

The binder was sprayed across one lane at a time onto the concrete pavement by the distributor. The temperature of the binder immediately after spraying was approximately 155°C. The amount of binder was closely monitored by a sophisticated panel in the driver's cab. The desired application rate was 2.5 kg/m². Standard surface treatment techniques were used for the transverse joints and the longitudinal centreline joint. No problem was observed when the hot binder was sprayed on the cold patching material.

Spreading the Aggregate

The aggregate was spread immediately using the self-propelled chip spreader. The desired application rate was 16.5 kg/m². The aggregate had been trucked by tractor trailers from Chatham, Ontario, where it had been heated in Van Gassen's hot mix plant. It was dumped on the job site and loaded into tandem dump trucks and taken to the chip spreader. The temperature of the aggregate was taken as it was being spread and was found to be 140-150°C.
Figure 7: Adding Crumb Rubber to Blending Plant

Figure 8: Sweeping Concrete Pavement Prior to Applying Binder

Figure 9: Bearcat Distributor Spraying Binder
The purpose in heating the aggregate was to ensure that the aggregate was completely dry and to assist in obtaining the best possible bond between the binder and the aggregate.

**Rolling the Aggregate**

Immediately upon spreading, the aggregate was rolled using the three rubber-tired rollers. Each roller made two complete passes. It is extremely important that there be no time lag between spraying, spreading and rolling to ensure the best results as the binder cools quickly.

**Sweeping the Surface**

Approximately two hours after the rolling had been completed, the S.A.M.I. was swept with a power broom to remove any excess aggregate before being opened to traffic. Spraying was completed each day about 16:00 hours so that sweeping was completed for evening traffic.

**Traffic Control**

Pick up trucks with flashing signs were used at each end of the work. Flagpersons, about 1 km apart, with 2-way radios allowed traffic to pass alternately in each direction in the open lane. Traffic was not significantly delayed.

**Comments**

No particular difficulties were encountered on the job and the work proceeded at a very productive rate. The application rates of the binder and aggregate were checked on the job site using 50 cm square cardboard trays and a portable digital scale, as well as totalling the quantities of all materials used and calculating the area covered. Field sampling to determine the viscosity of the binder prior to spraying was carried out as described in Appendix C. Field sampling to determine the amount of binder and aggregate applied to the pavement was carried out as described in Appendix D.
Figure 10: Spreader Applying Heated Cover Aggregate

Figure 11: Taking Temperature of Cover Aggregate

Figure 12: Rolling Cover Aggregate
Figure 13: SAMI Completed on the Right

Figure 14: Close-up of Completed SAMI

Figure 15: Placing HL-4 Binder Over SAMI
The quantities of materials used in the asphalt/rubber binder were as follows:

<table>
<thead>
<tr>
<th>Material</th>
<th>Quantity (kg)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>150/200 A.C.</td>
<td>101,719.8</td>
<td>77.3%</td>
</tr>
<tr>
<td>Rubber</td>
<td>25,471.9</td>
<td>19.4%</td>
</tr>
<tr>
<td>Kerosene</td>
<td>4,543.8</td>
<td>3.4%</td>
</tr>
<tr>
<td>Total</td>
<td>131,736</td>
<td></td>
</tr>
</tbody>
</table>

The actual application rates were as follows:

Area of concrete pavement covered -

Length - 8,675 m; Width - 6.706 m
Area - 8,675 m x 6.706 m = 58,174 m²
Taper at County Road - 1,139 m²
Total = 59,313 m²

Average binder application - \[
\frac{131,355}{59,313} = 2.21 \text{ kg/m}^2
\]

Average aggregate application - 16.1 kg/m²

The binder depth was measured and found to be about 5 mm or 40% of the average stone size. The aggregate retention was excellent, the bond between the binder and the pavement was also excellent.

Traffic was allowed on the S.A.M.I. at normal speeds with no problems.

**Hot Mix Paving**

Hot mix paving began approximately seven days after the completion of the S.A.M.I. The paving consisted of the construction of 40 mm of HL-4 binder and 40 mm of HL-4 surface course.
Paving Operation

The contractor's asphalt plant was located south of Chatham, 40 km from the job site.

Paving equipment consisted of:

1 - Cedarapids mechanical paver with track and 40' ski,
1 - Bros VM 268 tandem steel-tired vibratory roller,
Tandem and tractor trailer trucks as required.

Condition of the S.A.M.I.

The S.A.M.I. was in excellent condition prior to paving. It was noted that trucks hauling the HL-4 hot mix did not damage the surface of the S.A.M.I. when turning; also the Cedarapids track paver did not damage the S.A.M.I. which was well bonded to the concrete surface. There were no cracks or joints showing through the S.A.M.I. at the time of paving.

Paving Over the S.A.M.I.

There were no difficulties encountered paving over the S.A.M.I. and there was no slippage or movement of the hot mix mat during laying or rolling. The paving operation proceeded in the normal fashion at the usual rate with no problems. The mix was laid to the desired thickness and density and bonded well to the S.A.M.I. The surface course was completed in July 1982 and no reflection cracking was evident at that time.

PERFORMANCE TO DATE

The finished pavement was examined on 82 11 24 prior to experiencing any ambient temperatures below 0°C. The riding qualities of the pavement were very good, however, cracking at the expansion joints was already evident.
Figure 16: SAMI (Foreground) and HL-4 Binder

Figure 17: Hwy. 77 Three Months After Paving
Figure 18: Typical Crack Over Expansion Joint

Figure 19: Close-up of Typical Crack (3 mm) Over Expansion Joint
In the Village of Comber, the same hot mix overlay was placed over existing bituminous pavement. There was no transverse cracking evident in the village on 82 11 24.

In March, 1983, after the first winter, a detailed crack survey was taken in the 300 m control section, see Appendix A. There were cracks, open about 3 mm, at all expansion joints, with some D cracking at centerline and at the edges of pavement. There was approximately 39 m of cracking directly over the centerline joint in the 300 m control section. With the exception of 3 m of cracking, there was no intermediate transverse cracking between the expansion joints.

Six, 15.2 cm diameter, cores were taken from the control section in March 1983, at expansion joints and between expansion joints. Examination of the cores revealed that the S.A.M.I. was broken directly beneath the crack in the hot mix over the expansion joints. The S.A.M.I. was not broken over the intermediate transverse cracks in the concrete pavement. The ride was considered good, as assessed in a compact car. A very slight bump was noticeable at the expansion joints.

SUMMARY OF OBSERVATIONS

(1) Reflection cracks have appeared in the hot mix over all the expansion joints in the concrete pavement.

(2) Reflection cracks have not appeared in the hot mix over the transverse cracks between the expansion joints in the concrete pavement.

(3) A small amount of reflection cracking has appeared in the hot mix over the centerline joint in the concrete pavement.

(4) The S.A.M.I. membrane has broken over the expansion joints.

(5) The ride after one winter is judged good, as assessed in a small car.
CONCLUSIONS

(1) The construction of a S.A.M.I. on Highway 77 has not prevented reflection cracking from coming through the 80 mm of hot mix over the expansion joints.

(2) The S.A.M.I. has assisted in preventing reflection cracks from coming through the hot mix over transverse cracks between the expansion joints.

(3) A S.A.M.I. can be applied to an existing Portland cement concrete surface without difficulty when recommended manufacturing and application procedures are followed.

RECOMMENDATIONS

(1) On the basis of the evidence to date, it is recommended that no S.A.M.I. installation over concrete pavement be planned until further performance evaluations have been made of the work on Highway 77.

(2) Where construction defects are evident in concrete pavement and major crack filling is required and repairing expansion joints is not practical, a more effective method of reducing reflection cracking may be accomplished by -

(a) Manufacturing the asphalt/rubber binder with a higher rubber content.

(b) Applying a greater amount of asphalt/rubber binder per square metre.

(c) Applying a 25 mm levelling course of HL-2 first, directly onto the concrete pavement to fill in the cracks at the badly spalled expansion joints and to remove uneveness, followed by the construction of a S.A.M.I., followed by 40 to 80 mm of HL-4.

(d) Eliminating the S.A.M.I. and constructing a 30 mm levelling course of open graded cold mix, followed by 40 to 80 mm of HL-4.
(3) Precoating of the stone chips to prevent dust when spreading the chips and to assist in more rapid setting should be considered.

(4) Consideration should be given to sealing the cracks in the new hot mix with hot rubberized asphalt.

ACKNOWLEDGEMENTS

Special thanks are extended to the staff of Southwestern Region for their excellent co-operation and to the Research and Development Branch for their assistance.
CONCRETE PAVEMENT

CONDITION SURVEY OF PAVEMENT SURFACE

DATE OF SURVEY
REMARKS

DATE OF SURVEY
REMARKS

KEY
CRACKING — BLOW-UP —
STEPPING — CONSTRUCTION JOINT —
SETTLEMENT, HEAVING ETC. —

CONDITION (1) SLIGHT — A (2) MEDIUM — B (3) SEVERE — C

CRACKING CODE
A - HAIRLINE
B - LESS THAN 0.2''
C - 0.2'' - 0.4''
D - 0.4'' - 0.6''
E - 0.6'' - 0.8''
F - OVER 0.8''
G - 0.2'' - 0.4''
H - HEALED OVER
T - TREATED
HOT MIX PAVEMENT
83 03 08

CONDITION SURVEY OF PAVEMENT SURFACE

DATE OF SURVEY ___________ REMARKS ________________________________

DATE OF SURVEY ___________ REMARKS ________________________________

KEY
CRACKING ——— BLOW-UP ———— CRACKS IN HOT MIX ————
STEPPING ——— CONSTRUCTION JOINT ———
SETTLEMENT, HEAVING ETC. ———
CONDITION (1) SLIGHT — A (2) MEDIUM — B (3) SEVERE — C

CRACKING CODE
A - HAIRLINE
B - LESS THAN 0.2" F - OVER 0.8"
C - 0.2" - 0.4" H - HEALED OVER
D - 0.4" - 0.6" T - TREATED
HOT MIX PAVEMENT

CONDITION SURVEY OF PAVEMENT SURFACE

DATE OF SURVEY: 12-01-01

CRACKING CODE

A - HAIRLINE
B - LESS THAN 0.2"
C - 0.2" - 0.4"
D - 0.4" - 0.6"
E - 0.6" - 0.8"
F - OVER 0.8"
G - 0.2" - 0.4"
H - HEALED OVER
T - TREATED

CRACKS IN HOT MIX

KEY

- CRACKING
- BLOW-UP
- CONSTRUCTION JOINT
- SETTLEMENT, HEAVING ETC.

CONDITION (1) SLIGHT - A  (2) MEDIUM - B  (3) SEVERE - C
SPECIAL PROVISION NO.
STRESS ABSORBING MEMBRANE INTERLAYER (S.A.M.I.) ITEM NO.

DESCRIPTION

This Special Provision covers the materials, equipment and construction procedures for a Stress Absorbing Membrane Interlayer 13 mm in thickness. The S.A.M.I. shall consist of a tack coat followed by a single surface treatment consisting of an application of a specially formulated asphalt and rubber binder, followed by an application of stone chips.

GENERAL REQUIREMENTS

For purposes of this contract, MTC Form 304 shall apply except as otherwise stated in the Special Provision.

MATERIALS

Asphalt and Rubber Binder

The binder shall be supplied by either

Sahuaro Petroleum and Asphalt Co., or Arizona Refining Co.,
731 N 19th Ave., 1505 North Arco Drive,
P.O. Box 6536, Phoenix, Arizona.
Phoenix, Arizona.
U.S.A. 85005 U.S.A.
Tel.: 602-252-3061 Tel.: 602-258-4843

The binder shall consist of a mixture of asphalt cement, asphalt modifier, rubber and diluent as follows:

Asphalt Cement pen. grade 120-150 or 200-300
Asphalt Modifier

When asphalt fractional composition analysis indicates its desirability, an asphalt modifier may be added to the asphalt cement (3 to 20% by weight of asphalt). Modifiers such as Witco Califlux G.P. or Shell Outrex 739 or equivalent are acceptable.

Rubber

The combined granulated rubber shall consist of a minimum of 80% by weight of vulcanized rubber produced by the processing of tires. The rubber shall consist of one or a blend of the types indicated below with the rubber or blend selected based on laboratory testing.

The granulated rubber types shall meet the following gradations:

<table>
<thead>
<tr>
<th>Sieve Sizes</th>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 8 (2.36 mm)</td>
<td>100</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>No. 10 (2.00 mm)</td>
<td>95-100</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>No. 16 (1.18 mm)</td>
<td>-</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>No. 30 (0.600 mm)</td>
<td>0-10</td>
<td>60-90</td>
<td>95-100</td>
</tr>
<tr>
<td>No. 50 (0.300 mm)</td>
<td>0-5</td>
<td>0-20</td>
<td>30-60</td>
</tr>
<tr>
<td>No. 80 (0.180 mm)</td>
<td>-</td>
<td>0-5</td>
<td>15-35</td>
</tr>
<tr>
<td>No. 200 (0.075 mm)</td>
<td>-</td>
<td>-</td>
<td>0-10</td>
</tr>
</tbody>
</table>

The sieves shall comply with the requirements of AASHTO M92 (ASTM E11).

The individual granulated rubber particles, irrespective of diameter, shall not be greater in length than 0.250 inches for Type I and 0.125 inches for Types II and III.

The combined granulated rubber shall have a specific gravity of 1.15 ± 0.05 and shall be free of loose fabric, wire and other contaminants except that up to 4 percent (by weight of rubber) calcium carbonate or talc may be added to prevent rubber particles from sticking together. The rubber shall be sufficiently dry so as to be free flowing and not produce a foaming problem when blended with the hot asphalt cement.
The granulated rubber shall be accepted by certification from the rubber supplier.

Diluent

The diluent shall have an initial boiling point (IBP) of 171°C when tested in accordance with ASTM D-86.

Asphalt Rubber Mixing and Reaction

The percent of combined rubber shall be 23 ± 3 percent by weight of total mixture, that is, by total weight of asphalt cement + asphalt modifier (if used) + granulated rubber.

The temperature of the asphalt shall be between (177 to 218°C) at the addition of the vulcanized rubber. The asphalt and rubber shall be combined and mixed together in a blender unit and reacted in the distributor for a period of time as required by the Engineer which shall be based on laboratory testing by the asphalt-rubber supplier. The temperature of the asphalt-rubber mixture shall be above (163°C) during the reaction period.

After the reaction between asphalt and rubber has occurred, the viscosity of the hot asphalt-rubber mixture may be adjusted for spraying and/or better "wetting" of the cover material by the addition of a diluent. The diluent shall not exceed 7-1/2 percent by volume of the hot asphalt-rubber mixture.

When a job delay occurs after full reaction, the asphalt-rubber may be allowed to cool. The asphalt-rubber shall be reheated slowly just prior to application but not to a temperature exceeding (163°C). An additional quantity of diluent not exceeding 3 percent by volume of the hot asphalt-rubber mixture may be added after reheating.

AGGREGATE

The stone chips shall comply with the requirements for coarse aggregate for HL-3 as indicated in MTC Form 1003 - Material Specification for Aggregates Hot Mix Asphaltic Concrete.
EQUIPMENT

Pressure Distributor

The pressure distributor shall be specially designed for mixing and spraying the asphalt-rubber binder within 5\% accuracy of the desired rate in a continuous and uniform manner.

Rollers

A minimum of 3 pneumatic-tired rollers shall be provided each with a minimum wheel load of 1800 kilograms per tire.

CONSTRUCTION

Surface Preparation

The bituminous surface shall be swept clean of all gravel, dirt, sand and other debris.

A tack coat of diluted emulsified asphalt (SS-1 or SS1-H as per MTC Form 1103) shall be applied to the clean surface and allowed to cure. The emulsified asphalt shall be diluted 1:1 with water and sprayed at the rate of 0.50 kg/m\(^2\).

Application of the Binder

The supplier of the asphalt and rubber binder shall apply the binder to the road surface using a specially designed pressure distributor. The temperature of the binder shall be between 143 to 171\(^\circ\)C when applied at the rate of 2.5 kg/m\(^2\). Transverse joints shall be constructed by placing building paper across and over the end of the previous asphalt-rubber application. Once the spraying has progressed beyond the paper, the paper shall be removed immediately and disposed of as directed by the Engineer. All longitudinal joints shall be overlapped a minimum of 20 cm.

Application of Aggregate

The stone chips shall be heated in a hot mix plant and shall be
applied immediately at a temperature of 121 to 149°C, to the asphalt-rubber binder, at the rate of 16.5 kg/m².

Rolling

Rolling shall commence immediately behind the aggregate spreader, and if the spreading is stopped for an extended period, the spreader shall be moved ahead or off to the side so that all cover material may be immediately rolled. Four complete passes with rollers shall be made with all rolling completed within 1/2 hour after the application of the cover material.

Rotary Power Brooming

When the aggregate is thoroughly embedded and rolling has been completed, the surface shall be swept with power brooms to remove any excess aggregate before opening the road to traffic.

Temperature and Weather

The work shall not be started unless the pavement is absolutely dry and surface temperature is at least 16°C or when in the opinion of the Engineer conditions are not conducive to successful results.

MEASUREMENT FOR PAYMENT

Supply and Application of Binder

The quantity of binder applied to the road will be measured in tonnes.

Supply and Application of Aggregate

The quantity of aggregate applied to the road will be measured in tonnes.
BASIS OF PAYMENT

Supply and Application of Binder

Payment for this work will be made at the contract unit price per tonne, and such payment will be full compensation for sweeping, applying the tack coat, for supplying, mixing, heating and applying the binder to the road surface as specified and for all other work necessary to complete the application in accordance with this specification.

Supply and Application of Aggregate

Payment for this work will be made at the contract unit price per tonne and such payment will be full compensation for supplying, heating, handling, hauling, spreading, rolling and brooming and for all other work necessary to complete the application in accordance with this specification.
APPENDIX C

Binder Viscosity

The viscosity of the rubber asphalt binder was checked on site by Sahuaro with a small hand held instrument, the Haake Viscotester. A one gallon pail of binder was taken from the distributor, the temperature checked and the viscosity measured. A rod hanging beneath the viscotester was immersed into the binder and the force required to turn the rod was read from the scale. The asphalt/rubber reaction was complete when the binder reached 7000-9000 centipoises. Kerosene was added reducing the viscosity to 4000-5000 centipoises and the rubber asphalt binder was ready to spray.
Figure 22: Checking Temperature of Rubber-Asphalt Binder Prior to Application

Figure 23: Checking Viscosity of Rubber-Asphalt Binder With Haake Viscotester

Figure 24: Trays for Checking Application Rates
APPENDIX D - FIELD SAMPLING TO DETERMINE THE AMOUNT OF BINDER AND AGGREGATE APPLIED TO A ROAD

The following equipment is required:

(1) 1 - Battery operated digital scale, 10 kg capacity, with a stainless steel platform approximately 30 cm x 40 cm.

(2) A supply of cardboard trays 50 cm x 50 cm with a 2.5 cm lip.

(3) Pocket calculator.

(4) Carpenter's level.

(5) Gloves.

(6) Mineral spirits.

(7) Rags.

Procedure

(1) Set up and level digital scales.

(2) Number the cardboard trays.

(3) Obtain the tare weight in kilograms of two 50 x 50 cm cardboard trays and record.

(4) Place the two cardboard trays in the centre of the lane being treated approximately two feet apart and parallel to the centre-line of the road, immediately prior to the area being treated.

(5) Remove the first tray after the binder has been sprayed and before the aggregate has been applied.

(6) Remove the second tray after the binder has been sprayed and the aggregate has been applied and before rolling.

(7) Obtain the gross weight in kilograms of the first tray.

(8) Obtain the net weight in kilograms of binder applied in the first tray. Net Weight = Gross Weight - Tare Weight.

(9) Calculate the amount of binder applied to the road as follows:

\[ \text{Net Weight (8) x 4 = } \frac{\text{kg}}{\text{m}^2} \]
(10) Obtain the gross weight in kilograms of the second tray.

(11) Obtain the net weight in kilograms of binder and aggregate applied in the second tray.

\[ \text{Net Weight} = \text{Gross Weight} - \text{Tare Weight} \]

(12) Obtain the net weight in kilograms of aggregate applied in the second tray.

\[ \text{Net weight of aggregate} = \text{net weight of second tray (11)} - \text{net weight of first tray (8)} \]

(13) Calculate the amount of aggregate applied to the road as follows:

\[ \text{Net weight of aggregate (12) \times 4} = \text{kg/m}^2 \]

(14) Repeat sampling process at least three times per 2.0 km lanes and adjust application rates if necessary to obtain desired quantities.

Maintenance

- recharge the batteries in the scale as required.
- clean scale platform with mineral spirits and rags after use.
Figure 25: Trays Removed After Application of SAMI

Figure 26: Portable Digital Scales to Weigh Trays

Figure 27: Weighing Tray of Rubber Asphalt Binder