EXPERIMENTAL INVESTIGATION INTO EXTENDING THE LIFE OF ASPHALT PAVEMENT BY FOG SEAL

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Community roads over 1 million km in Japan.

Pavement performance will decrease due to traffic, rainwater, ultraviolet rays, etc.

It is important to maintain the pavement of the community roads.

Introduction
● When a pothole occurs, repair the pothole.

● When the damage increases, repair the asphalt mixture layer.

Repair the pothole

Repair the asphalt mixture layer
Fog seal method is one of the known repair methods of pavement.

Fog seal is a method of spraying asphalt emulsion on the surface.

Fog seal method is not used much in Japan.
Research hypothesis and purpose

- Understand the influence of rainwater infiltration into asphalt mixtures
- Quantitatively evaluate the usefulness of fog seal
Four-point bending fatigue test while dropping water drops

(Quote: JRA, 2007, B018T)
Preparation of test specimens

- Dense-graded asphalt mixture
- Straight asphalt (60/80)
- Proportioning of the mixture

<table>
<thead>
<tr>
<th>Materials</th>
<th>Crushed stones S13 (Nominal size 13-5)</th>
<th>Crushed stones S-7 (Nominal size 5-2.5)</th>
<th>Coarse sand</th>
<th>Fine sand</th>
<th>Artificial sand</th>
<th>Filler</th>
<th>Total Aggregate</th>
<th>Binder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportioning (%)</td>
<td>35.0</td>
<td>24.0</td>
<td>11.0</td>
<td>12.0</td>
<td>12.0</td>
<td>6.0</td>
<td>94.4</td>
<td>5.6</td>
</tr>
</tbody>
</table>

- Properties of the mixture

<table>
<thead>
<tr>
<th>Theoretical maximum density (g / cm³)</th>
<th>Density (g / cm³)</th>
<th>Air voids (%)</th>
<th>Voids ratio in aggregate (%)</th>
<th>Voids ratio filled with asphalt (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.461</td>
<td>2.362</td>
<td>4.0</td>
<td>16.9</td>
</tr>
</tbody>
</table>

- Specimen size
  - 40 × 40 × 400 mm by using a diamond saw

Common mixture on community road
### Fatigue Test Conditions

<table>
<thead>
<tr>
<th>Contents</th>
<th>Test Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specimen size</td>
<td>40×40×400 mm</td>
</tr>
<tr>
<td>Span</td>
<td>300 mm</td>
</tr>
<tr>
<td>Loading method</td>
<td>Strain control</td>
</tr>
<tr>
<td>Test temperature</td>
<td>20 °C</td>
</tr>
<tr>
<td>Frequency of load</td>
<td>5 Hz</td>
</tr>
<tr>
<td>Waveform of load</td>
<td>Sine wave</td>
</tr>
<tr>
<td>Strain</td>
<td>200 μ</td>
</tr>
</tbody>
</table>

- In order to observe the process leading to fatigue failure in detail, "strain" is set small.
Water supply

Surface of the specimen is constantly moistened by drip simulating rainwater.

Waterproofed Clay base

Specimen

Hose length approx. 10 m
Four-point bending fatigue test test with water supply
Test results: Influence of water on fatigue resistance

**N_{ave}:** 77,200 cycles at stress 60%

**W_{ave}:** 46,200 cycles at stress 60%
Test results: Influence of water on fatigue resistance

The trend of stress reduction differs in 30,000 cycles
How to apply fog seal

1. Interruption of test after 30,000 cycles
2. Apply fog seal
3. Wait two hours for decomposition of emulsion
4. Resume testing

Two types of fog seal used:
- Fog Seal A (below, FA)
- Fog Seal B (below, FB)
Test results: The effect of fog seal

FA: Fog seal A, FB: Fog seal B

Fog seal

Stress / Stress at 10,000 cycles (%) vs. Load cycle number (10,000 cycles)

FA1, FA2, FA3, FA4, FA5, FB1, FB2, FB3, FB4, FB5
Test results: The effect of fog seal

Fog seal has life extension effect

- Mean of N: 77,200 cycles
- Mean of FA: 69,800 cycles
- Mean of FB: 65,400 cycles
- Mean of W: 46,200 cycles
Calculation of efficiency of fog seal (1)

The mean value for load cycles

![Graph showing stress at 10,000 cycles (%) vs. load cycle number. The graph includes five lines representing the mean of N1 to N5, W1 to W5, FA1 to FA5, and FB1 to FB5. The y-axis ranges from 0 to 120, and the x-axis ranges from 0 to 200,000 load cycles. Each line represents the mean value for load cycles from 1 to 200,000.](image)
Calculation of efficiency of fog seal (2)

Calculate curves considering actual weather

![Graph showing stress at 10,000 cycles vs. load cycle number]

- Mean of N1~N5
- Mean of W1~W5
- Curve of actual weather conditions
Calculation of efficiency of fog seal (3)

Calculate curves considering actual weather

Graph showing stress at 10,000 cycles (%) against load cycle number. Curves are differentiated based on actual weather conditions and conditions using FA and FB.
Calculation of efficiency of fog seal (4)

Indicate 3-years extension

- Curve of actual weather conditions
- Curve of actual weather conditions using FA
- Curve of actual weather conditions using FB

Stress / Stress at 10,000 cycles (%)

Load cycle number

- 30,000 Appx 5yr
- 55,000 Appx 10yr
- 73,000 Appx 13yr
Field survey - Usefulness of fog seals (1)

Construction paving in 1997.
KAWABA, Gunma, Japan

6 years later

8 years later

17 years later
Good road surface

17 years later
Filled in crack
Field survey - Usefulness of fog seals (2)

Construction

Paving in 2003.

MISATO, Gunma, Japan

0 years later


10 years later

Fog seal applied

Texture is different
Conclusions

• Timely application of fog seal suppresses the infiltration of water into asphalt, hence improves its fatigue failure characteristics.

• Based on the test results, assuming that the usual pavement life is 10 years, estimating the extension effect of the fog seal resulted in a lifetime of 3 years extended by applying fog seal for 5 years after paving.
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Thank you so much for your attention.

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