Important Factors on Chemilink Grouting Material of Semi-Rigid Pavement

Zhang Yanli
yanli_zhang@chemilink.com

Dr Wu Dong Qing
wu@chemilink.com

David Daud
david_daud@chemilink.com

Chemilink Technologies Group, Singapore
# Table of Contents

1. Introduction  
2. Chemilink Grouting Material  
3. Key Factors on Chemilink Grout  
4. Semi-Rigid Pavement  
5. Application Procedure  
6. Examples of Completed Projects In Singapore  
7. Conclusions  
8. Acknowledgement
1. Introduction

- Semi rigid pavement is a kind of effective and durable pavement to cater for increasingly heavy wear and tear.

- Composition of semi rigid pavement: open asphalt concrete + high strength polymer-cement grout.

- The properties of semi rigid pavement are determined by that of asphalt concrete and polymer-cement grout.

- Semi rigid pavement has advantages of both asphalt concrete and polymer-cement grout.
  - High skid resistance;
  - Easy to maintain and repair;
  - Jointless;
  - Quick Installation and short curing time; etc.
2. Chemilink Grouting Material

The requirements for grouting materials:

- Good flowability (Workability)
- High strength
- Balance of the above two
2. Chemilink Grouting Material

- High performance polymer modified cementitious material
  - High flowability ➔ Easy application
  - High early strength ➔ Early opening to traffic
  - High long-term strength ➔ Low maintenance

- Requires only the addition of water to produce a smooth and highly workable mixture.

- Result of extensive research work with the introduction of nano-technology.
## 2. Chemilink Grouting Material

<table>
<thead>
<tr>
<th>Properties</th>
<th>Test Methods</th>
<th>Values of Chemilink Grout</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flowability (Workability)</td>
<td>ASTM C939</td>
<td>• 13 ~ 27 Seconds</td>
</tr>
<tr>
<td></td>
<td>JASS 15 M103</td>
<td>• 27 ~ 31 cm</td>
</tr>
<tr>
<td>12 hrs</td>
<td></td>
<td>• 20 ~ 30 MPa</td>
</tr>
<tr>
<td>Compressive Strength</td>
<td>EN 12190</td>
<td>• 55~ 85 MPa</td>
</tr>
<tr>
<td>1 day</td>
<td></td>
<td>• 100 ~ 120 MPa</td>
</tr>
<tr>
<td>7 days</td>
<td></td>
<td>• 120~ 140 MPa</td>
</tr>
<tr>
<td>28 days</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flexural Strength at 28 days</td>
<td>EN 196</td>
<td>• 7 ~ 15 MPa</td>
</tr>
<tr>
<td>Setting Time</td>
<td>EN 196 - 3</td>
<td>2<del>3h, 3</del>6h, 6~8h</td>
</tr>
</tbody>
</table>
3. Key Factors on Chemilink Grouting Material

1) Setting Time

Instrument:

Vicat Test Set
3. Key Factors on Chemilink Grouting Material

**Setting Time**

![Graph showing setting time vs. W/P ratio](image)

- **Initial Setting**
- **Final Setting**

**Setting Time – W/P Ratio**

- **W/P ratio – water/powder ratio**
3. Key Factors on Chemilink Grouting Material

2) Flowability

Two Methods to Test Flowability of Cement Grout:

- **ASTM C939 Method (Flow Cone Method)**

  Material of Flow Cone:

  (1) Discharge tube: stainless steel

  (2) Body: stainless steel, cast aluminum, non-corroding metal, high density polyethylene

  Volume: $1725 \pm 5 \text{ mL}$

  Measure the time of efflux of about 1725 mL cement grout from the flow cone.
3. Key Factors on Chemilink Grouting Material

Flowability

Two Methods to Test Flowability of Cement Grout:

- **JASS 15 M103 Method**

  - Stainless Steel
  - Lift Vertically Upward Slowly
  - Spreading Grout
  - Plastic Plate
  - cheap, easy to use, save time

Measure the diameter of spreading grout
3. Key Factors on Chemilink Grouting Material

Flowability

Flowability Comparison between two Testing Methods

- JASS 15 M103 Method (CM)
- ASTM C939 Method (S)

Parameters:
- Flowability
- W/P Ratio

Values:
- Flowability: 27.50 cm and 26.80 S
- W/P Ratio: 0.20 to 0.32
3. Key Factors on Chemilink Grouting Material

**Flowability**

- As w/p ratio $\geq 0.25$, the flowability of Chemilink grout is:
  - Flow cone method $\leq 27$ seconds
  - JASS15 M103 method $\geq 27$cm
  - Chemilink grout can penetrate into the porous asphalt concrete 50~100mm deep and fill the voids very well

- JASS method is highly recommended, because:
  - Easy to use
  - Save time
3. Key Factors on Chemilink Grouting Material

3) Compressive Strength

Compressive Strength - W/P Ratio

Compressive Strength (MPa) vs W/P Ratio with different curing ages (1 day, 7 day, 11 day, 28 day).
3. Key Factors on Chemilink Grouting Material

Compressive Strength

Compressive Strength - Curing Age

- W/P Ratio
  - 0.20
  - 0.23
  - 0.25
  - 0.27
  - 0.30

Curing Age (day)

Compressive Strength (MPa)
3. Key Factors on Chemilink Grouting Material

Compressive Strength and Optimum w/p ratio

- As w/p ratio $\leq 0.30$, compressive strength:
  - 1-day $> 55$ MPa;
  - 7-day $\geq 100$ MPa;
  - 11-day $\geq 110$ MPa (meets LTA requirement for 28 days);
  - 28-day $\geq 120$ MPa

- 0.25–0.30 is the optimum w/p ratio range for this specific formula as Chemilink grouting material obtains the balance of good flowability and high strength in this w/p ratio range.

- Optimum w/p ratio can be adjusted by adjusting formula.
4. Semi-Rigid Pavement

<table>
<thead>
<tr>
<th>Properties</th>
<th>Test Method</th>
<th>Semi-Rigid Pavement (Chemilink Grout as Topping)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressive strength at 12 hrs</td>
<td>EN 12190</td>
<td>• 3 ~ 5 MPa</td>
</tr>
<tr>
<td>Compressive strength at 1 day</td>
<td></td>
<td>• 6 ~ 8 MPa</td>
</tr>
<tr>
<td>Compressive strength at 8 days</td>
<td></td>
<td>• 9~12.5 MPa</td>
</tr>
<tr>
<td>Compressive strength at 28 days</td>
<td></td>
<td>• 10 ~ 15 MPa</td>
</tr>
<tr>
<td>Flexural strength at 28 days</td>
<td>EN 12190</td>
<td>• ≥ 3 MPa</td>
</tr>
<tr>
<td>Modulus</td>
<td>ASTM D4123</td>
<td>• ≥ 6,500 MPa (at 25°C)</td>
</tr>
<tr>
<td>Skid Resistance</td>
<td>ASTM E303</td>
<td>• ≥ 50 ~ 60 BPN</td>
</tr>
<tr>
<td>Impermeability</td>
<td>DIN 18130</td>
<td>• impermeable</td>
</tr>
<tr>
<td>Curing time</td>
<td>-</td>
<td>• 4 ~ 8 hours</td>
</tr>
</tbody>
</table>
5. Application Procedure

- Porous Asphalt Concrete
- Mixing of Grouting Material
- Flowability Checking Using ASTM Method
- Flowability Checking Using JASS Method
- Filling Grout into Porous Asphalt Concrete
- Scraping
5. Application Procedure

Right After Filling

Hardened Surface

Cored Samples
6. Examples of Completed Projects In Singapore

Heavy Loading Yard at Sungei Kadut Street 4 (2005)
6. Examples of Completed Projects In Singapore

Singapore Changi Airport Apron 1 (2007)
6. Examples of Completed Projects In Singapore

Singapore Changi Airport Apron 2 (2007)
6. Examples of Completed Projects In Singapore

Turning Area of Heavy Loading Yard at Sungei Kadut Street 1 (2010)
6. Examples of Completed Projects In Singapore

Heavy Loading Yard at Abingdon Road (2010)
Chemilink Grouting Material

- Compressive strength:
  - 1-day: 55~85MPa
  - 11-day: 110~125MPa (meets LTA latest requirement for 28 days)
  - 28-day: 120~140MPa.

- Flowability: when flow cone method ≤ 27 seconds, JASS15 M103 method ≥ 27cm, Chemilink grouting material can penetrate 50~100mm deep into porous AC.

- Different version for different requirement.

Chemilink can specially design the formula to meet customer’s specific requirements.
8. Acknowledgement

- Highway International Private Limited
- Samwoh Corporation Pte Ltd
- Ley Choon Group
Thank You for Your Attention!