Pavement Rehabilitation by In-Situ Recycling
- A Case Study on Seaport Container Yard & Road

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1. Introduction

* Due to weak and soft foundation, most of the seaports in this region experience substantial settlement issue over time

* Northport (Port Klang) is one of the oldest seaport in Malaysia encountered serious differential settlement in most port facilities including container yards and internal roads

* Maintenance and upgrading of G-Block Container Yard was conducted in 2010 to rectify differential settlement issue and upgrade the container stacking capacity
Existing Condition
2. Evaluation Criteria

Major Considerations:

2-1 Structural Design & Reliability

2-2 Construction Speed and Timing

2-3 Cost Effectiveness

2-4 Environmental Impact
2. Evaluation Criteria

2-1 Structural Design & Reliability

- High Loading
- Sub-grade conditions – marine clay with high tidal level
- Long term performances and reliability
Typical Container Stacking Section
High localized point loading – 30 ton per point
2. Evaluation Criteria

2-2 Construction Speed

- Higher construction unit rate
- Shorter project duration
- Safer construction activities
2. Evaluation Criteria

2-3 Cost Effectiveness

- Overall Costs
  - Short Term Construction & related costs
  - Long Term Maintenance & related costs
2. Evaluation Criteria

2-4 Environmental Impact

- Environment friendly
- Less excavation and backfilling
- Less ground movements caused by vehicles, machines and manpower
- Less port security control and coordination works
2. Evaluation Criteria

- Final Pavement Design

Typical Cross Section of Container Yard Rehabilitation
2. Evaluation Criteria

- Final Pavement Design

Combination of Rigid Pavement and In-situ Recycling

Typical Cross Section of Container Yard Rehabilitation
3. In-Situ Recycling Process & Technical Performances

- Definition:

  “Mixing proper chemicals with in-situ soils to improve/strengthen the soil properties through chemical reactions for engineering purposes.”

- Design requirements:
  - UCS $\geq 2.0$ MPa (7-d)
  - CBR $\geq 120\%$ (7-d)
  - Compaction Degree $\geq 95\%$
3. In-Situ Recycling Process & Technical Performances

- 3 Major Steps

  1. Step 1: Spreading
  2. Step 2: In-Situ Mixing
  3. Step 3: Compaction
3. In-Situ Recycling Process & Technical Performances

- Quality Control

Field Density Test  Re-mould UCS Test  Re-mould CBR Test
3. In-Situ Recycling Process & Technical Performances

- Quality Control – Chemilink SS-108/SS-111 Stabilization

![UCS vs CBR Graph]

- Ave UCS (7-d): 2.9MPa
- Ave CBR (7-d): 141.5%

Project: Proposed Development of RTG G-Block and Associated Work at Container Terminal 1 For Northport (Malaysia) Berhad.

Project Duration: June 2010 - March 2011

Testing carried out by: Geolab(M) Sdn Bhd (Accredited Lab)
First Phase in Operation
9 months after Completion and in Use
4. Benefits of In-Situ Recycling in the Environment Aspect

Benefits

- Better Technical Performances
- Cost Saving and Overall Cost Effectiveness
- Simpler and Faster Construction
- Less Materials Transportation
- Limited Disturbances to Port Operations
- Environment Friendly
4. Benefits of In-Situ Recycling in the Environment Aspect

<table>
<thead>
<tr>
<th>Comparison Item</th>
<th>Conventional Replacement Method</th>
<th>In-Situ Recycling Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imported Material?</td>
<td>Yes Graded Aggregate</td>
<td>Yes Stabilizing Agent</td>
</tr>
<tr>
<td>Quantity of Imported Materials</td>
<td>58,650 ton</td>
<td>1380 ton</td>
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<tr>
<td>Construction Waste Created?</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Quantity of Construction Waste</td>
<td>25,500 m³</td>
<td>ZERO</td>
</tr>
<tr>
<td>Transportation Required</td>
<td>7,200 trips</td>
<td>69 trips</td>
</tr>
</tbody>
</table>
5. Conclusions

1) Rehabilitation of Northport G-Block container yard and roads were completed in mid 2011

2) Comprehensive project planning and methodology evaluation are critical for the smooth and on-time project completion

3) The In-situ Stabilization Method was adopted with significant advantages and benefits

4) Technical performance to-date is satisfactory
Acknowledgements

- Northport (Malaysia) Bhd
- Emenea Engineering Services Sdn Bhd
- Trans Resources Corporation Bhd
- MTS Construction Sdn Bhd
Thank You for Your Attention!