GREEN APPROACH TO RURAL ROADS CONSTRUCTION
– STABILIZATION OF IN-SITU SOILS AND CONSTRUCTION WASTES

Chemilink Technologies Group
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1. Introduction

Why Rural Road???

The Needs:
- Roads for Development
- Roads to Villages, and Resources
- Road to Economic

The Constraint:
- Lack of Resources
- Lack of Machineries
- Lacking of Transportation Network
1. Introduction

What is In-situ Chemical Soil Stabilization???

• Addition of PROPER stabilizing agent with in-situ materials
• Alter/improve the properties of in-situ materials
• Meet various engineering properties & requirements
• Function as structural component of the pavement
1. Introduction

Typical Construction Procedure

Spreading
- By Mechanical
- By Manual

Mixing
- By Stabilizer
- By Rotovator

Compaction
- By Compactor
2. Green House Gas Emission And Carbon Footprint

• Pavement Structural Design

Conventional Design

- 50mm of Surface Course (Asphalt Concrete)
- 200mm THK Base Course (Crushed Aggregate)
- Sub-Grade Course, CBR: 6%

Chemilink Design

- 200mm THK Chemilink Stabilized Layer (In-situ material)
- Chip Seal Surface Course
- Sub-Grade Course, CBR: 6%
2. Green House Gas Emission And Carbon Footprint

Outline of Estimation on CO$_2$ Emission

1. Materials Production Stage
2. Materials and Machineries Transportation Stage
3. Rural Road Construction Stage
4. Waste Disposal Stage
Range for Determine the Environmental Loads of Rural Road Construction

Conventional Method

Quarry Material

Crushed Aggregate

Asphalt Mixing plant

20km

Material Production Stage

Asphalt Concrete

Machinery Transportation

Chemilink Soil Stabilization Agent

Chemilink SS-108

80km

20km

500km

Chemilink Method

Rural Road Paving Works (Kuala Terengganu, Malaysia)

Waste Materials Transportation

Waste Materials Disposal Site

100km

Materials and Machineries Transportation Stage

Rural Road Construction Stage

Waste Disposal Stage
2. Green House Gas Emission And Carbon Footprint

Case Study – Estimation and Comparison on CO$_2$ Emission

- Two rural roads in Terengganu, Malaysia
- Constructed in December 2009
- Location: Kuala Besut
- Project Dimension: 1km length x 4m width (4000m$^2$)
## 2. Green House Gas Emission And Carbon Footprint

<table>
<thead>
<tr>
<th>Emission stage</th>
<th>Quantity of materials</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Conventional Method</td>
</tr>
<tr>
<td><strong>I. Material Production</strong></td>
<td></td>
</tr>
<tr>
<td>Surface layer</td>
<td></td>
</tr>
<tr>
<td>Bitumen</td>
<td>29.7 t</td>
</tr>
<tr>
<td>Imported virgin aggregate</td>
<td>510.8 t</td>
</tr>
<tr>
<td><strong>Base layer</strong></td>
<td></td>
</tr>
<tr>
<td>Imported virgin aggregate</td>
<td>2208.0 t</td>
</tr>
<tr>
<td>Soil stabilization agent</td>
<td>NIL</td>
</tr>
<tr>
<td><strong>Total Quantity of materials</strong></td>
<td>2721.7 t</td>
</tr>
<tr>
<td><strong>II. Materials and Machineries Transportation</strong></td>
<td></td>
</tr>
<tr>
<td>Diesel consumption (L) (Materials)</td>
<td>22584.0</td>
</tr>
<tr>
<td>Diesel consumption (L) (Machineries)</td>
<td>92.0</td>
</tr>
<tr>
<td><strong>III. Rural road construction</strong></td>
<td></td>
</tr>
<tr>
<td>Paving Work</td>
<td>Diesel consumption (L)</td>
</tr>
<tr>
<td><strong>IV. Waste Disposal</strong></td>
<td></td>
</tr>
<tr>
<td>Diesel consumption (L)</td>
<td>18142.0</td>
</tr>
</tbody>
</table>

*Estimation on Amount of Materials Consumption*
## 2. Green House Gas Emission And Carbon Footprint

<table>
<thead>
<tr>
<th>Emission Stage</th>
<th>Conventional Method</th>
<th>Chemilink Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Material production</td>
<td>16.30</td>
<td>0.71</td>
</tr>
<tr>
<td>II. Material and Machineries Transportation</td>
<td>60.95</td>
<td>5.56</td>
</tr>
<tr>
<td>III. Rural road construction</td>
<td>2.90</td>
<td>1.58</td>
</tr>
<tr>
<td>IV. Waste Disposal</td>
<td>48.80</td>
<td>NIL</td>
</tr>
<tr>
<td><strong>Total stage emissions (ton-CO₂)</strong></td>
<td><strong>128.95 ton</strong></td>
<td><strong>7.85 ton</strong></td>
</tr>
</tbody>
</table>
3. Other Advantages Of Chemical Soil Stabilization

Better Technical Performance

- Higher & Wide Range of Strength
  - CBR (7-D) from 30% to 300%
  - UCS (7-D) from 0.7MPa to 5.0MPa
- Better volume stability under different temperature/moisture condition
- Lower Permeability from $10^{-7}$ to $10^{-12}$m/s
- Forms Semi-Rigid Platform for effective load distribution
3. Other Advantages Of Chemical Soil Stabilization

Reduce Demands on Raw Backfilling Materials (Reduced Exploitation on Natural Resources)

Negligible amount of Foreign Materials

Minimize Creation of Construction Wastes

Faster Construction and Less Disturbance to Environment and Public

Overall Cost Effectiveness

Sustainable Recyclability
4. Chemical Soil Stabilization

Highlight of Projects Adopted Chemical Stabilizing Agents

Rural Roads Construction (2009), Terengganu, Malaysia

During Construction

After Chemilink Stabilization
4. Chemical Soil Stabilization

Highlight of Projects Adopted Chemical Stabilizing Agents
Rural Roads Construction (2009), Terengganu Malaysia

Before Chemilink Stabilization  After Chemilink Stabilization  Chip Seal Surface
4. Chemical Soil Stabilization

Highlight of Projects Adopted Chemical Stabilizing Agents

Plantation Access Road Construction, Felda Sahabat 7 (2009), Malaysia

Before Chemilink Stabilization

After Chemilink Stabilization
4. Chemical Soil Stabilization

Highlight of Projects Adopted Chemical Stabilizing Agents
Rural Road Construction (2007), Tibet, China
4. Chemical Soil Stabilization

Highlight of Projects Adopted Chemical Stabilizing Agents

Oil Field Road Construction for Caltex (2003), Sumatra Indonesia

Subgrade Condition

Road in use after 3 months
4. Chemical Soil Stabilization

Highlight of Projects Adopted Chemical Stabilizing Agents
Changi International Airport Runway Widening (2004-2005), Singapore

Spreading  Mixing  Compaction
4. Chemical Soil Stabilization

Highlight of Projects Adopted Chemical Stabilizing Agents
Sultan Ismail International Airport Runway/Taxiway Widening (2007-2008), Malaysia
4. Chemical Soil Stabilization

Highlight of Projects Adopted Chemical Stabilizing Agents
Jalan Tutong Widening Phase II & III (1997-1999), Brunei

Road after 2-year completion

Opened Road Cross Section
4. Chemical Soil Stabilization

Highlight of Projects Adopted Chemical Stabilizing Agents

Batamas Shipyard Construction (1997), Batam Indonesia

Spreading and Mixing

Compaction
5. Conclusion

• Importance and constraint of roads construction in rural area development

• By using in-situ chemical soil stabilization, carbon footprint can be reduced by 5-15 times

• In-situ chemical soil stabilization, an alternative approach of environment friendly, technical effective, cost efficient method to rural roads development