12th Singapore Symposium on Pavement Technology (SPT 2007)

April 20, 2007, Singapore Polytechnic Graduate's Guild, Singapore

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Soil Recycling for Pavements of Road and Airfield

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1. Introduction

- Currently Singapore is facing the shortage of sands and stones for both civil and building construction
- The costs have jumped to 3~4 times more
- The costs may not be back to the previous ones even after this issue
- Singapore needs the alternative ways like "New Water" case to overcome current difficulties
- In-situ soil recycling is an effective and proven solution

2. Soil Recycling by Chemical Stabilization Technology

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* **Definition:**

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

* **The selected chemical stabilizing agents, such as Chemilink products, have successfully been applied in Asia, especially in South-East Asia region for more than 10 years.**

* **Especially-designed various versions of Chemilink products have been used to stabilize:**

- ❑ Clayey soils
- ❑ Sandy soils
- ❑ Crushed stones
- ❑ Their mixtures

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2. Soil Recycling with Chemical Stabilization Technology

2-1. Introduction

In order to protect the natural environment, more or more "In-Situ" materials such as soils have to be used for road and airfield construction

- Chemical stabilization can strengthen the soils to meet the engineering requirements

- It has been proven all over the world that:

Chemical stabilization with correct design and quality construction is technically durable and cost effective

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2. Soil Recycling with Chemical Stabilization Technology

2-2. Dosage Design Criteria

* Dosage : Percentage of dry weight of soils to be stabilized

* Purpose : To achieve sufficient technical properties

* General Design Criteria for Road and Airfield:

UCS
0.75~1.5MPa (Sub-base)
1.5~3.0MPa or more (Base)

CBR (optional)
≥30% (Sub-base); ≥80~90% (Base)

MR (airfield)
≥3,000MPa (Base)

2. Soil Recycling with Chemical Stabilization Technology

2-3. Application Method of Chemical Stablization

2-3-1 In-situ Recycling Method

Mechanical Spreading

Mixing by Stabilizer

Compaction 1

Manual Spreading

Mixing by Rotorvator

Compaction 2

2. Soil Recycling with Chemical Stabilization Technology

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2-3. Application Method of Chemical Stabilization

2-3-2 Central-Plant Mixing Method

Central Mixing Plant and the Mixture after Compaction

3. Chemilink Applications in Road and Airfield

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3-1. Road in Swampy Area (Brunei, 1995)


a) Stabilized Samples


b) Stabilized Road (on the left) vs. Old Road


c) Stabilized Surface after 10 Years

3. Chemilink Applications in Road and Airfield

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3-2. Shipyard Project (Indonesia, 1997)

a) Manually Spreading and Mechanically Mixing

b) Compaction

3. Chemilink Applications in Road and Airfield

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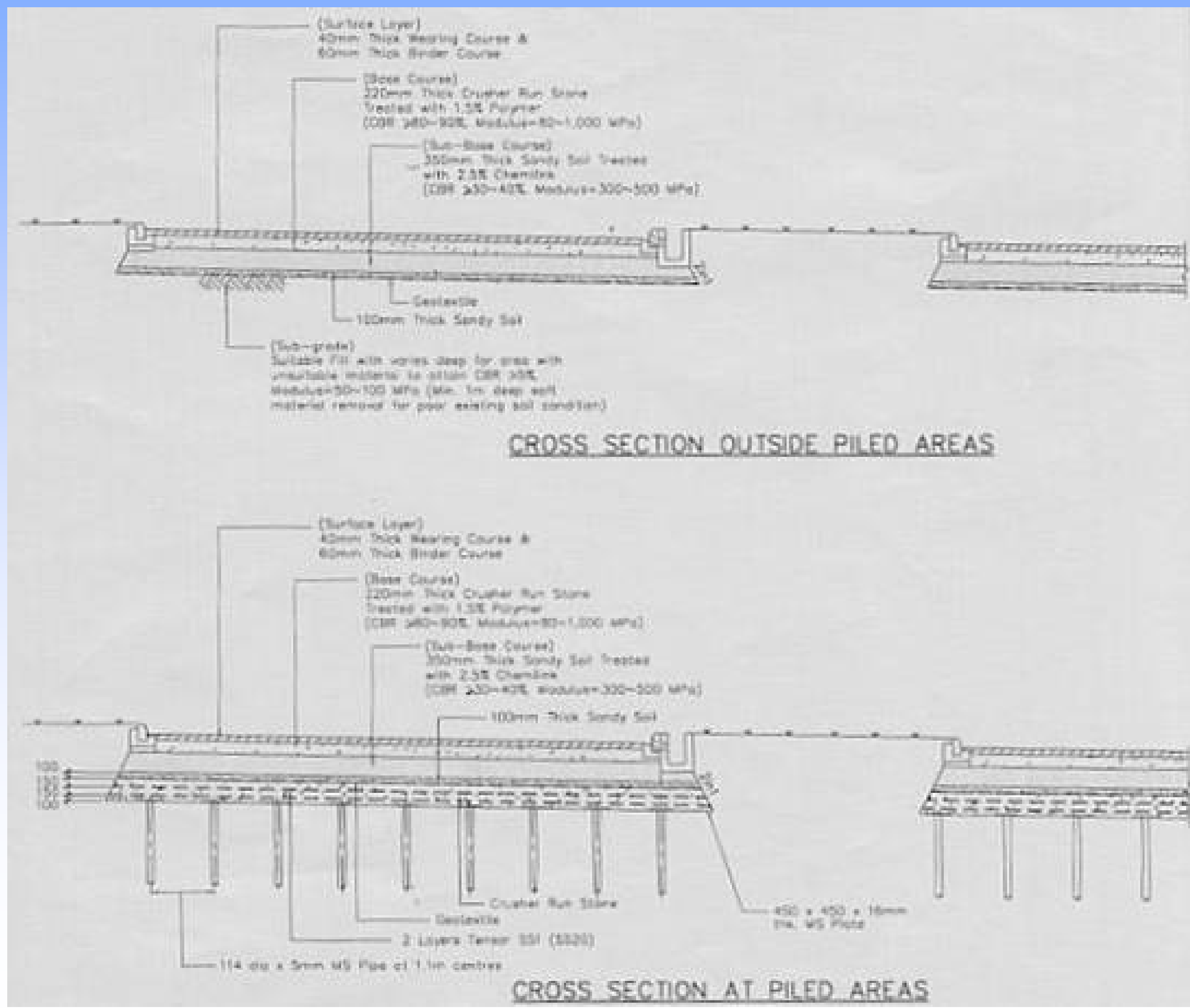
3-3. Highway-Design Project (Brunei, 1999)



3. Chemilink Applications in Road and Airfield

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3-3. Highway-Design Project (Brunei, 1999)

a) Opened Road Cross Section

b) Road after 7-Yr Completion

3. Chemilink Applications in Road and Airfield

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3-3. Widening of Jalan Tutong, Phase III (Brunei)

VIDEO ON OPENING ROAD CROSS SECTION

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3. Chemilink Applications in Road and Airfield

3-4. Low-Cost Rural Road (Inner Mongolia, China, 2002)

* 0.2m as Base only / 3% SS-108 with Clayey Silt / Surface AC: 40mm

Road after Years

3. Chemilink Applications in Road and Airfield

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3-4. Low-Cost Rural Road (Inner Mongolia, China, 2002)

* Low Temperature (~ - 30°C)

Chemilink Stabilized Base after Years

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3. Chemilink Applications in Road and Airfield

3-5. New Well Road for Caltex, Sumatra, Indonesia

*0.2m deep as Base only /1% SS-108 /No AC Surface

Subgrade Condition

The Sub-grade

Dropping The Jumbo Bag

Spreading – big bag

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3. Chemilink Applications in Road and Airfield

3-5. Caltex Oil-Field Road (Indonesia, 2003)

*0.2m as Base only / 1% SS-108 / No AC Surface

The Road in Use

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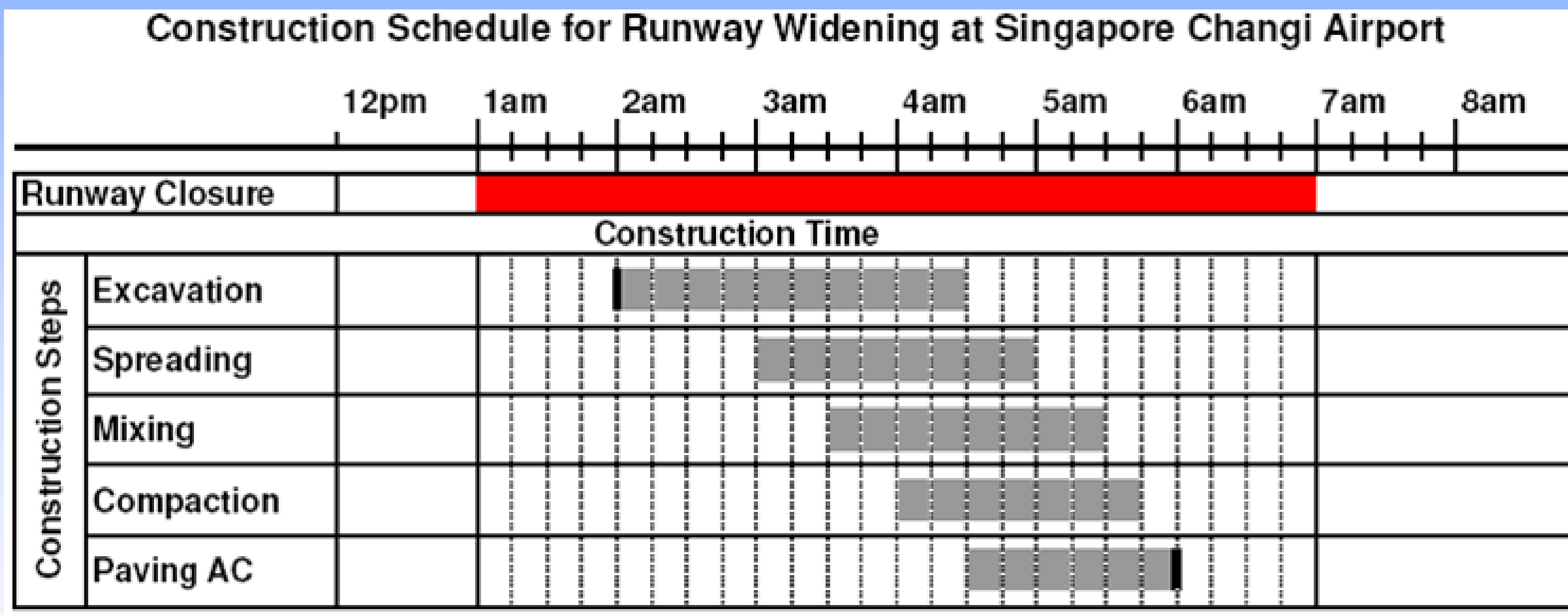
3. Chemilink Applications in Road and Airfield

3-5. Runway Widening Project (Singapore, 2005)



Notes:
Runway Closure Time : 1:00am ~ 7:00am
Effective Construction Time : 2:00am ~ 6:00am
Average Area per 4 Working Hours: 250m by 4.5m or 225m2/hour

Typical Construction Procedure

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3. Chemilink Applications in Road and Airfield

3-6. Runway Widening Project (Singapore, 2005)

Excavation

Spreading

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3. Chemilink Applications in Road and Airfield

3-6. Runway Widening Project (Singapore, 2005)

In-Situ Mixing

Compaction

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3. Chemilink Applications in Road and Airfield

3-6. Runway Widening Project (Singapore, 2005)

Paving Asphalt Concrete

Completion of Widening

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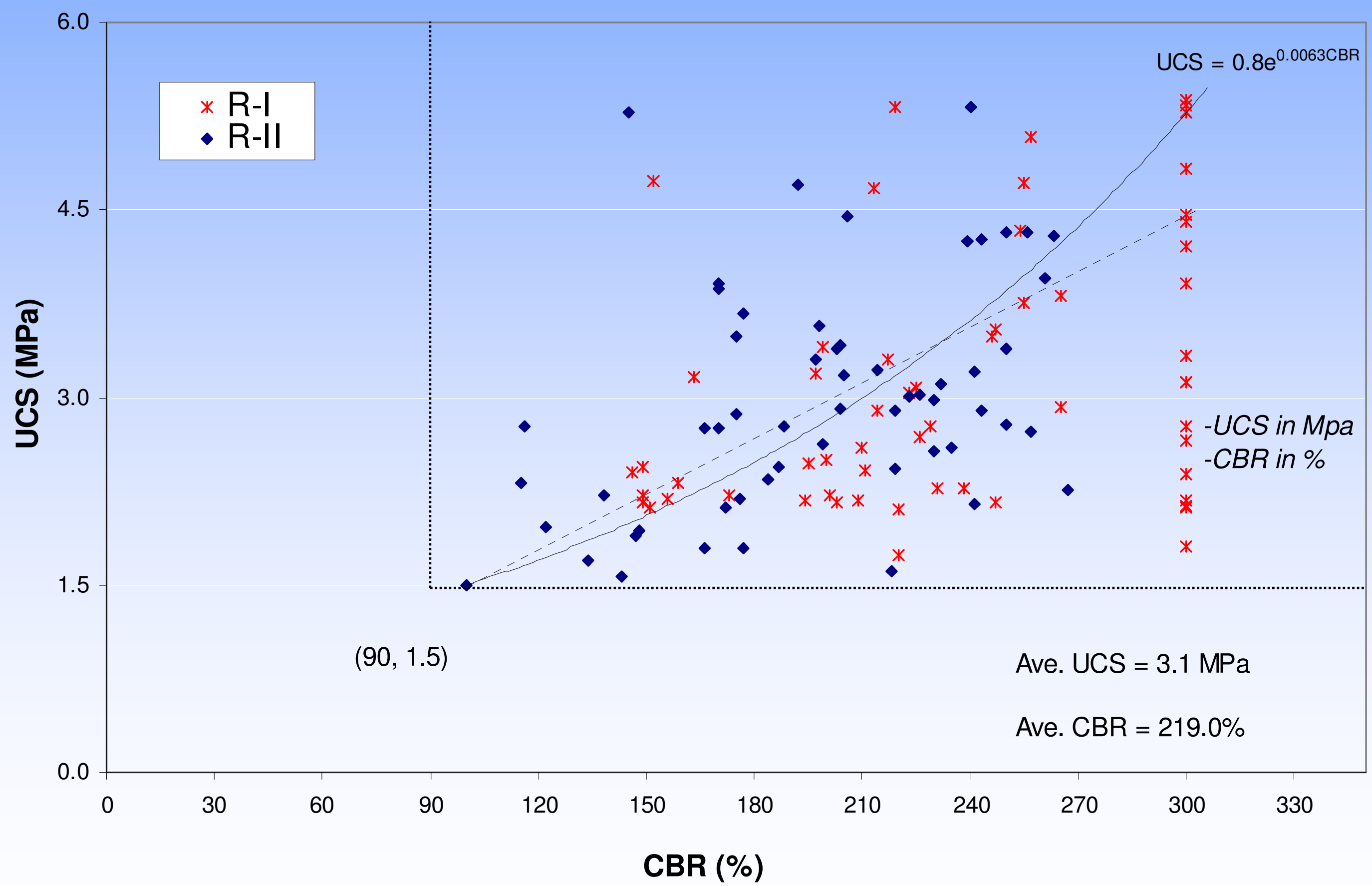
3. Chemilink Applications in Road and Airfield

3-5. Runway Widening Project (Singapore, 2005)



UCS and CBR Testing Results for Runway-I and Runway-II

3. Chemilink Applications in Road and Airfield

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3-5. Runway Widening Project (Singapore, 2005)

Runway-II

(after 17 Months)

3. Chemilink Applications in Road and Airfield

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3-5. Runway Widening Project (Singapore, 2005)

Runway-I

(after 14 Months)

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4. Advantages of Soil Recycling

4-1. General Comparison between Soil Recycling and Conventional Method for Roads

4-1-1. Applications

Comparison Items	Conventional Method	Chemilink Soil Recycling	Remarks
On good sub-grade	Yes	Yes	
On swampy or weak sub-grades	No	Yes	
Applicable soil types	–	Normal soils Such as sandy, silty and clayed soils	Special or difficult soil conditions can be treated after R&D

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4. Advantages of Soil Recycling

4-1. General Comparison between Soil Recycling and Conventional Method for Roads

4-1-2. Impact to Environments

Comparison Items	Conventional Method	Chemilink Soil Recycling
Quantities of quarry materials required	Very high	Low or limited or none
Non-toxic environmental safe and stable	Yes	Yes
Disturbances to public	More	Less

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4. Advantages of Soil Recycling

4-1. General Comparison between Soil Recycling and Conventional Method for Roads

4-1-3. Construction

Comparison Items	Conventional Method	Chemilink Soil Recycling	Remarks
Cost	Medium to high	Low	Refer to “Cost Comparison”
Speed	Slow (e.g. 100m /day/layer/team)	Fast (e.g. 500m to 1km /day/layer/team)	Same as above

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4. Advantages of Soil Recycling

4-1. General Comparison between Soil Recycling and Conventional Method for Roads

4-1-4. Performances

Comparison Items	Conventional Method	Chemilink Stabilization
Bearing capacities under soaking	Poor	Good
Differential settlements	Big	Small
Water resistance	Poor	Good
Maintenance required	More	Less
Road durability	Short	Long

4. Advantages of Soil Recycling

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4-2. Example of Direct Cost Analysis

❖ Base: 250mm thick

❖ Estimated Direct Cost Comparison

No	Graded Stone Unit Price (S$/t, C&F-Singapore)	Graded Stone Base (S$/m^2)*	Stabilized Soil Base (S$/m^2)**
1	20	18.4	< 20
2	30	24.2	< 20
3	60	41.4	< 20
4	64	**44** (Current market price)	< 20

* Including local handling charges: S$12/t; ** For Soil-recycling specialist contractor only

❖ **Indirect Overcall Cost Saving including:**

***Shorter construction period; * Lesser impacts to environment and public traffic; *Better technical performances; ……**

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5. Conclusions

1) Singapore is facing difficulties in supply of sands and stones for construction and thus there is a demanding for alternatives.

2) Soil recycling by chemical stabilization technology is a proven and effective alternative for both short-term and long-term.

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5. Conclusions

3) More than 10 years practice of Chemilink Soil Stabilization Technology has proven that to recycling various soils and stones for both road and airfield construction is an effective engineering method technically and commercially.

4) The recycling of soils has significant advantages and benefits, which can deliver superior quality roads and runways in a shorter time and with over-all cost effectiveness.

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Thank You for Your Attention!