

A Tripartite collaboration

ENHANCEMENT TO THE GEOBARRIER SYSTEM

Speaker Info

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OVERVIEW

- ❑ Introduction to the Geobarrier System
- ❑ Innovation
- ❑ Execution strategy
- ❑ Results



INTRODUCTION

GeoBarrier System (GBS)

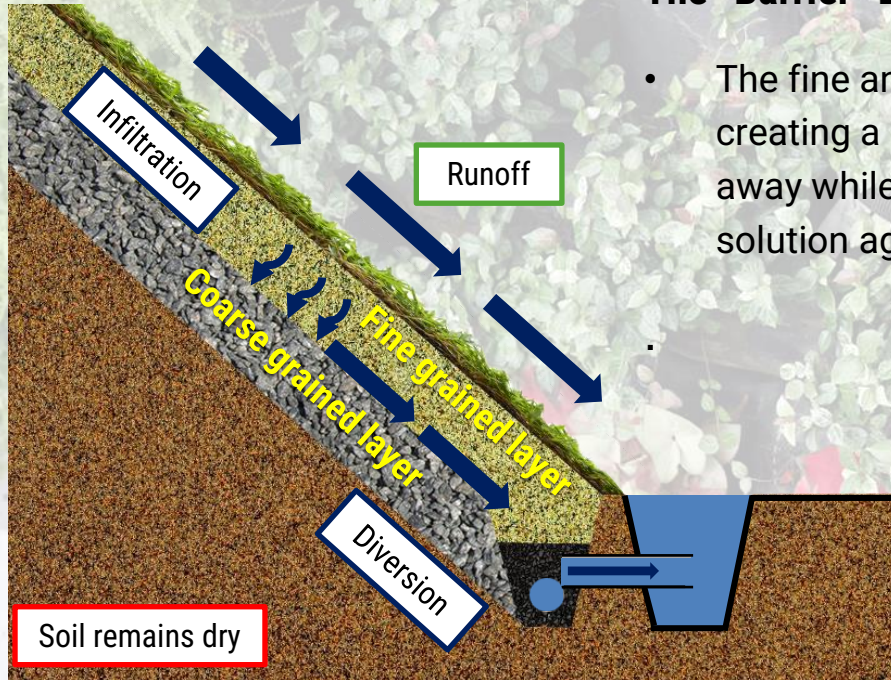
- Innovative, earth retention system
- Addresses slope failures and soil erosion
- Provides an environmentally friendly, robust and greener alternative to traditional reinforced concrete or soil wall
- Co-developed by HDB and NTU
- Being able to collaborate with HDB and NTU, giving great credibility to this project.
- Hocklim Engineering developed the subsystems to improve the production, quality and adoption of the GBS



HOW THE GEOBARRIER SYSTEM WORKS

The “Barrier” Effect

- The fine and coarse-grained layer has distinct hydraulic properties creating a “barrier effect”, which allows the rainwater to be diverted away while keeping the slope at high stability, making it an ideal solution against rainfall-induced slope failure



BENEFITS OF GEOBARRIER SYSTEM

Climate Resilient Solution



Reduces Risk of Flooding

Reduces CO2 Emission

Enhances Slope Stability

Enhances Liveability



Enhances Greenery

Natural Light & Ventilation

Reduces Urban Heat Island Effect

Optimizes Resources



Uses Recycled Materials

Space optimization

Environmentally Friendly

CAUSES AND IMPACT

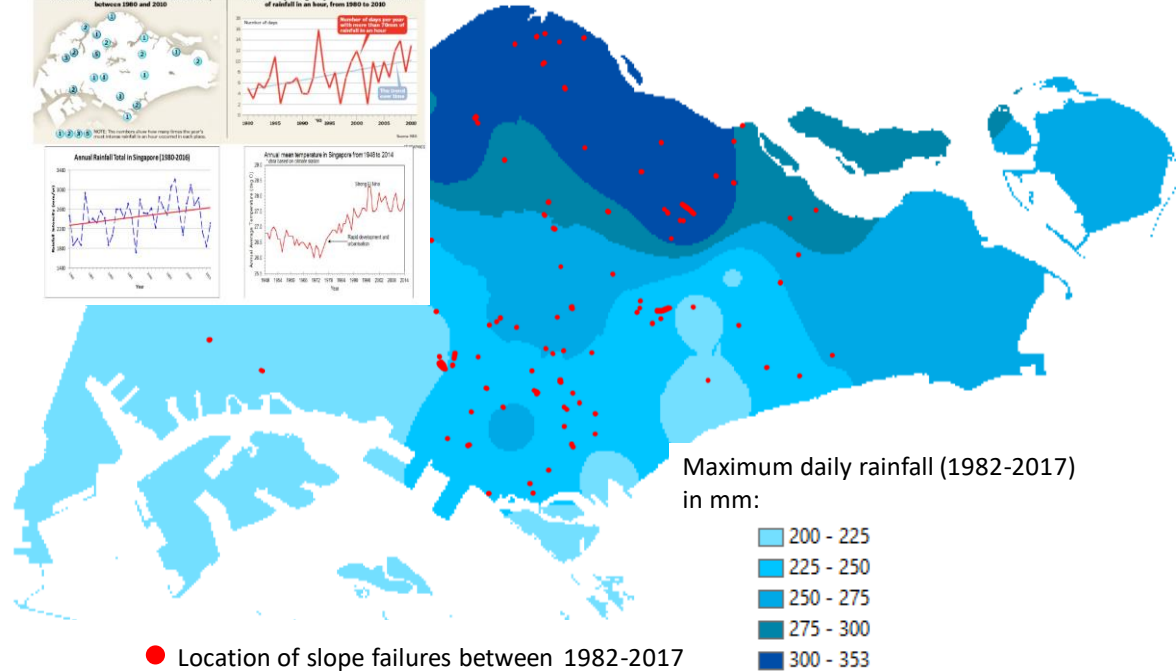
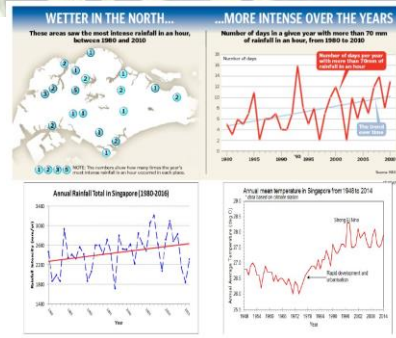
Due to geographical location and climate change in the Southeast Asian region

Rainfall Induced Slope Failure

GBS is **THE** ideal solution

To **facilitate widespread adoption** of GBS to industry through its enhancement

Nationwide and regional impact!



INNOVATION: Innovative Solutions Developed

Overview

- Created Specialized Tools
- Best Practice Guide Expansion

INNOVATIVE SOLUTIONS



HOCKLIM 福林
ENGINEERING
PTE LTD



SEMI-AUTOMATIC ASSEMBLY LINE



Prefilled pre-compacted technology

Productivity Improvement

Process: From manual filling to manufacturing processing. Geobags are filled by semi-automatic hoppers.

Before: 7 bags per day

After: 15 bags per day

Promotes Lego Style modular construction (DfMA)



CREATION OF SPECIALIZED TOOLS



Due to Deformation of Geobags

Invention of Interlocking Straps

Application: Use as Interlocking strap, horizontal internal straps, lifting straps

- Improve the structure of the Geobags
- Rectify any deformations of the Geobags
- Improve the slope stability

CREATION OF SPECIALIZED TOOLS



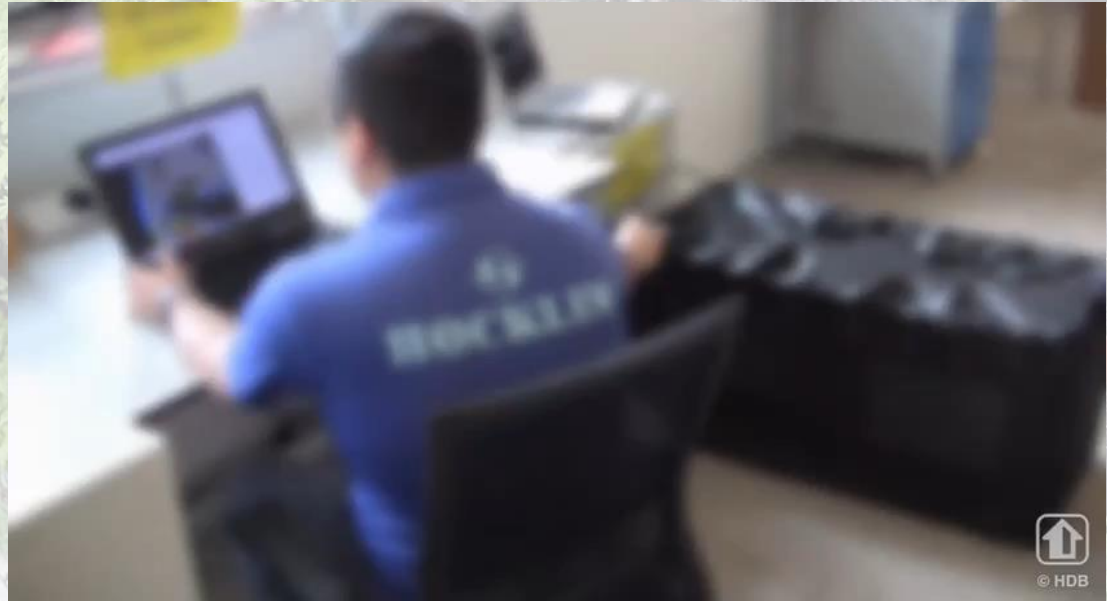
3D Scanning Technology

Productivity Improvement

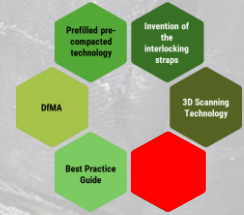
Process: Deformation Scanning of Geobags

Before: 4 bags a day

After: 30 bags a day



CREATION OF SPECIALIZED TOOLS



Material Compaction Tools

Productivity Improvement

Process: Soil Compaction in GeoBags

Before: 10 bags a day

After: 30 bags a day



Before



After

CREATION OF SPECIALIZED TOOLS



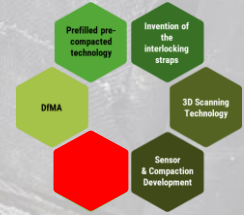
Used **Sensors** to confirm optimal compaction of Geobags



Q.C. PASSED	
GEOBAG ID: SL66	173
PROCESS: FILL & COMPACT	Scan to view GEOBAG info   www.hocklim.com
TESTED FOR: MOISTURE CONTENT DENSITY	
TEST DATE: 13/12/2020	
SIGNED: 	

Example of Quality Control Card

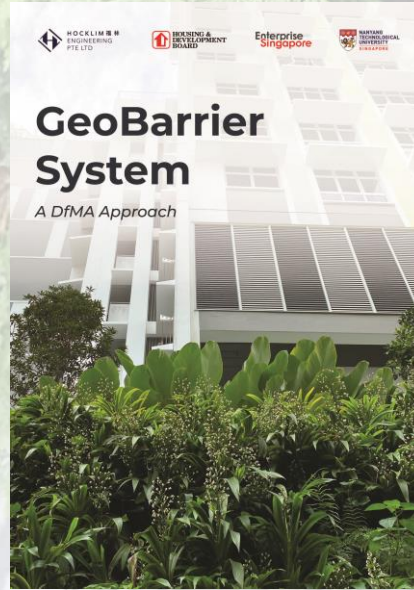
BEST PRACTICE GUIDE



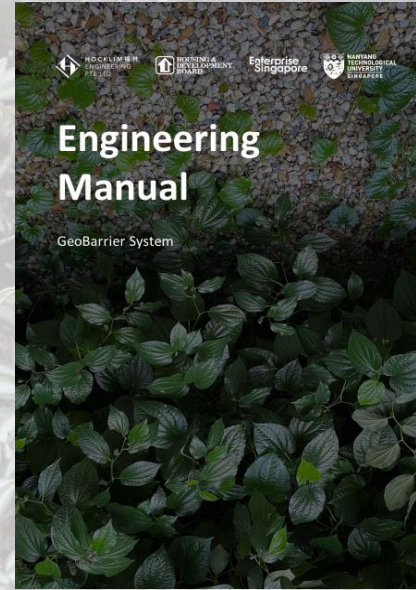
Construction manual was later expanded into guides for architects and engineers



For specialist builders

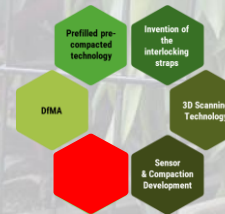


For Architects



For Engineers

BEST PRACTICE GUIDE



Wants the industry to **scale up** by guiding them on **why** it works and **how** it works

Part 1

Setting Up

This part is to ensure the GeoBag is shaped properly before filling.

1. Consider fabricating a steel mould to provide a firm and regular shape to the empty GeoBag.
2. Place the GeoBag into the mould and clamp the edges securely.
3. Prepare the filling by placing the materials into the GeoBag.

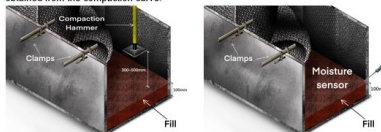
Filling and Compaction

This part ensures that the GeoBag is fully filled and ready to be used.

1. Fill the GeoBag until around 100mm in depth.



2. Proceed to compact the first layer by dropping the compaction hammer evenly over the surface after compaction of the material. The given height in the image below is recommended and does not need to be followed strictly. Proceed to use a soil moisture sensor to check the layer. The moisture content should be between 10% to 15% as obtained from the compaction curve.



A Climate Resilient Solution

Unlike conventional reinforced soil wall, the GBS can maintain slope strength even during rainfall periods, making it an ideal solution to address one of Singapore's climate change risk - increasing occurrence of rainfall-induced slope failure due to heavier rainfall. This is because the difference in permeability in the distinct layers of the GBS allows rainwater infiltration to be directed away from the slope, preventing oversaturation. The rainwater is channelled through one of the layers which helps to slow down runoffs (refer to Figure 2). This reduces risk of flooding in urban environments which is also increasingly becoming a problem due to climate change.

GBS does not use any concrete or steel, thus it has very low carbon footprint as compared to other earth retention methods such as reinforced concrete walls. In 2018 alone, manufacturing of concrete worldwide has contributed up to 8% of annual global carbon dioxide emission¹.

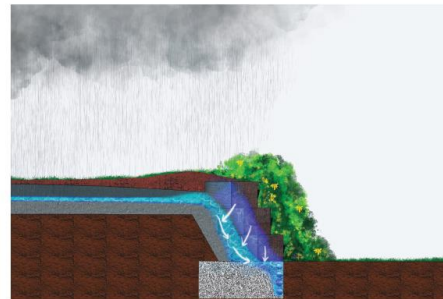


Figure 2. Managing Surface Runoff

1.2 Manual Design Calculation

According to Eurocode 7, the GeoBarrier System is to be designed for Ultimate Limit State (ULS). A sample of the calculation can be found at the end of this manual.

Check for ultimate state:

Design effect of actions $E_d \leq$ Design resistance R_d

Combination 1: $A1 + M1 + R1$

Combination 2: $A2 + M2 + R1$

Legend: A = action; M = material properties; R = ground resistance

Parameters		Combination 1			Combination 2		
		A1	M1	R1	A2	M2	R2
Actions	Permanent	γ_{Gdst}	1.35		1.0		
		γ_{Gstb}	1.0		1.0		
	Variable	γ_{Gdst}	1.5		1.3		
Soil	tan ϕ^0	γ_{ϕ^0}		1.0		1.25	
	Effective cohesion	γ_c		1.0		1.25	
	Undrained strength	γ_{cu}		1.0		1.4	
	Unconfined strength	γ_{qu}		1.0		1.4	
	Weight density	γ		1.0		1.0	

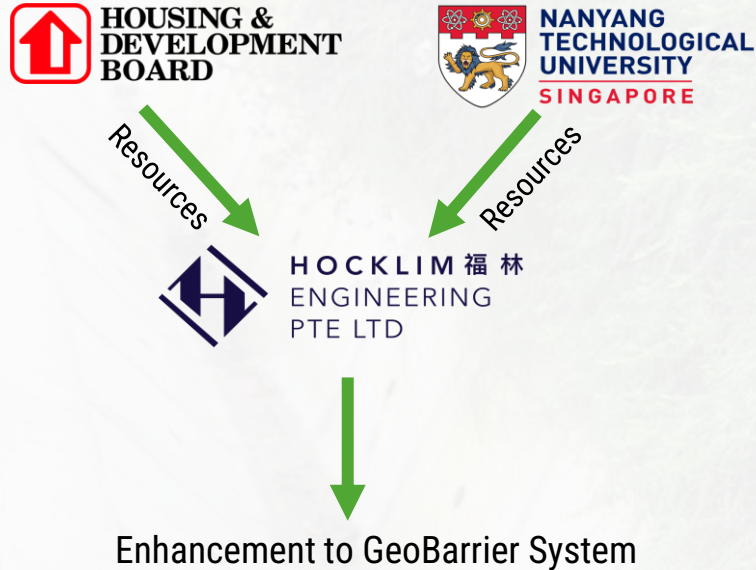
1.3 Key Design Checks

The factor of safety (F.O.S) for the GBS is to be checked for the following conditions:

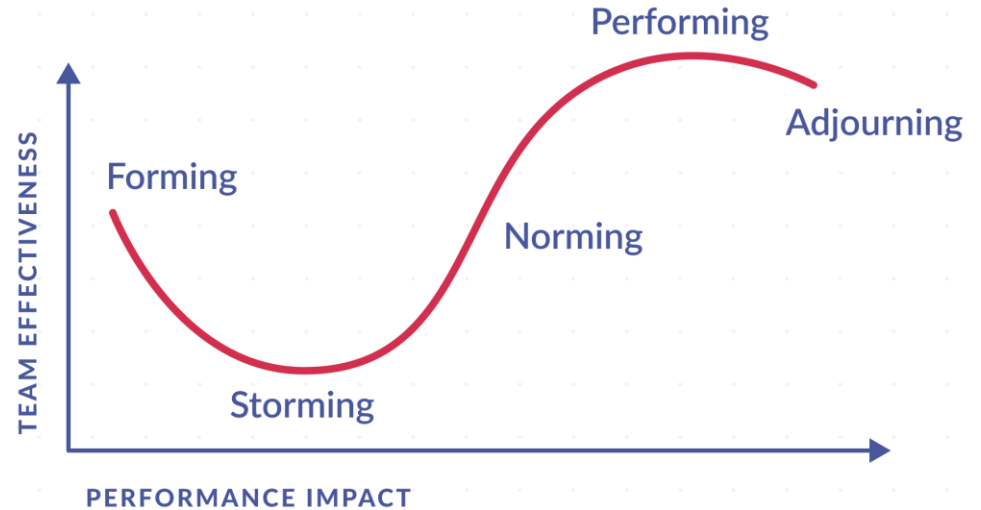
1. Drained case (DA1 COM1 & DA1 COM2)
2. Undrained case (DA1 COM1 & DA1 COM2)
3. GeoTextile check (DA1 COM1 & DA1 COM2)
4. GeoTextile sliding between layers check
5. Overturning (EQU)
6. Sliding and Bearing Capacity check (DA1 COM1 & DA1 COM2)
7. Consolidation & Settlement check

EXECUTION STRATEGY – Challenges faced in executing during the collaboration

CHALLENGES FACED



Tucker's 5 stages of team development



EXECUTION STRATEGY – Milestones

EXECUTION STRATEGY- MILESTONES

Panelist and exhibitor in SFF x SWITCH 2020

SWITCH HDB Cool Ideas Enterprise (in partnership with ESG) Hosted by: Cool Ideas Enterprise

Moderator

- Teo Hong, Senior Engineer, Planning & Development Board

Panellists

- Heru Santoso Soedarsono, Director of Centre of Building Research, Planning & Development Board
- Sally Yau, Development Partner, Enterprise Singapore
- Chua Yuan Shen**, CEO, Huxim Engineering Pte Ltd (highlighted with a red box)
- Koh Guan Bian, Deputy Director, Planning & Development Board

Guest speaker for Industry Innovation Dialogue (NTUitive)

NTUitive INDUSTRY INNOVATION DIALOGUE
BUILDING THE FUTURE

TUESDAY, 24 SEPTEMBER 2019
HOTEL JEN TANGLIN | TEMASEK ROOM, LEVEL 2
1A CUSCADEN ROAD, SINGAPORE 249716

PROGRAMME RUNDOWN

- 8.30pm Registration | Welcome Coffee/Tea
- 9.00pm **Welcome Address**
Mr. Joseph Tan, Chief Technology Officer, NTUitive Pte Ltd
- 9.10pm **Building the Future: Key Technologies and Innovation Strategies in Construction**
Mr. Anthony Schiavo, Senior Analyst, L&K Research
- 9.30pm **From Lab to Built Environment Transformation**
Mr. Yu Sun, Managing Director, Singapore Engineering & Construction
- 9.50pm **A Fibre Reinforced Polymer Double-Sided Tape**
Dr. Ng Kee Wai, Co-founder, Huxim Pte Ltd
- 10.10pm **Bendable Concrete and its Applications**
Assoc. Prof. Yang Li, Tech Director of Civil and Environmental Engineering, NTU Singapore
- 10.30pm **Networking Session 1 | Tea Break**
- 10.50pm **State-of-the-Art Performance-based Fire Design of MEP Support System - an EU Perspective**
Mr. Jean-François Leduc, R&D Projects Manager, H&T Pte Ltd
- 11.10pm **Trends in Construction Robotics**
Dr. Chen Li-Ming, Founder, TransForm Robotics Pte Ltd
- 11.50pm **A Geotechnical Approach to Urban Slope Stabilisation**
Mr. Chao Yuan Shen, Chief Executive Officer, Huxim Engineering Pte Ltd (highlighted with a red box)
- 12.10pm **The Potential of 3D Printing for Construction**
- 12.30pm **Networking Session 2 | Buffet Lunch**

Programme as of 20 August 2019 | Subject to change

Hold every quarter, **Industry Innovation Dialogue** is a platform for participants to gain new insights into a particular industry from leading research organisations, industry practitioners, university researchers, and startups focused on innovative solutions.

Contact Us: +65 6592 3652 | ntuitive@ntuitive.sg | www.ntuitive.sg

SCAN TO REGISTER!

EXECUTION STRATEGY- MILESTONES

COOL IDEAS ENTERPRISE AWARD



1st Private Property GBS Project completed – Cheng Soon Garden with LianHeZaoBao coverage

► 蔡元森看好绿色建筑技术的潜能，希望沿着这个方向把公司转型成提供创新方案的现代化企业。图背景为公司利用新技术建造的绿色建筑墙面。（序启聪摄）



不忍两代人努力付诸东流 第三代毅然涉足传统土木工程

陈紫筠 报道
ziyun@sph.com.sg

起初没有打算继承家业也不获家人支持，但因不忍心看到两代人的努力付诸东流，第三代掌舵人毅然涉足不熟悉的土木工程

想这是一家小型公司，父亲反正也不打算做下去了，这或许是接管的好机会，可以根据自己的想法去经营，没有什么压力。”

蔡元森是家中老三，还有两个姐姐和一个弟弟，但他们都没

客户包括了私人发展商以及有地住宅屋主。

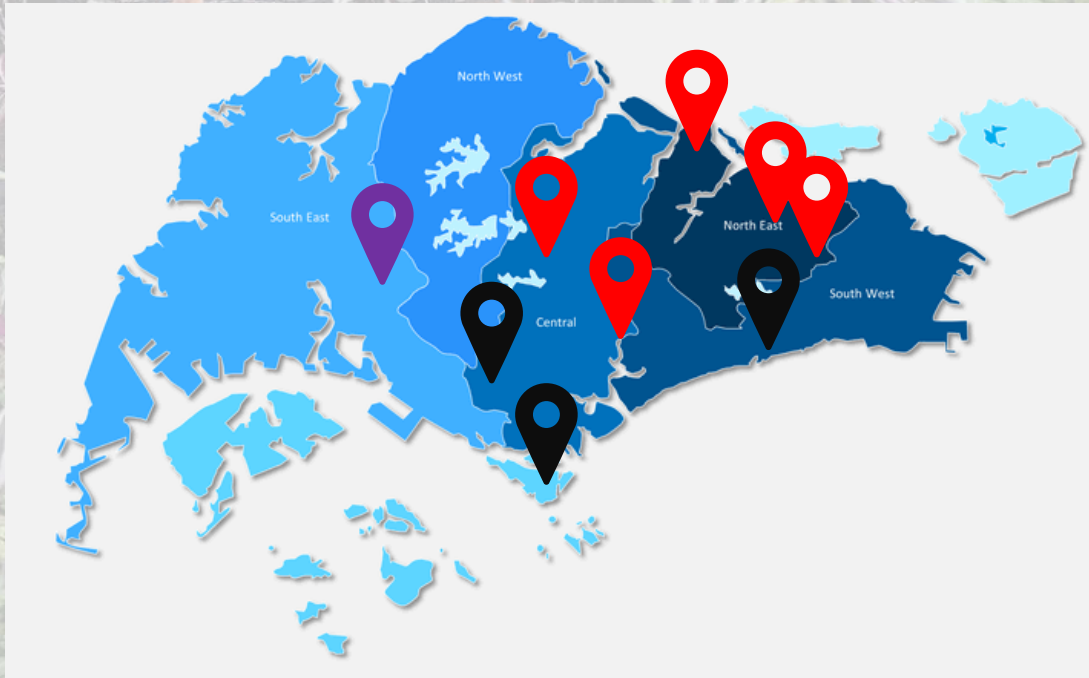
凭改善组屋生活创新概念
获建屋局“企业版酷点子”奖

公司也在2018年凭着改善组

RESULTS

RESULTS - MACRO

Effects of widespread adoption (HDB, NParks, SLA, Sentosa, Private Property)



HDB Projects



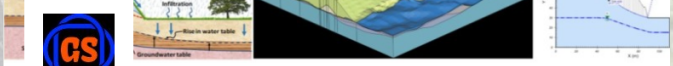
Non HDB projects in Discussion (Sentosa, NParks, SLA)



Private Property Project

RESULTS - MACRO

Effects of widespread adoption



Engineering MasterClass Webinar: Application of Un-Saturated Soil Mechanics

Event by PT GeoStruktur Sistem Solusindo

Online

Sat, Jun 19, 2021, 10:30 AM - 12:30 PM (your local time)

Registration link - https://docs.google.com/forms/d/e/1FAIpQLSdqTiRrKKf9lqgUFTKxBt_B3h-DDlfxtr-VYSRe83dNiOQ/viewform?usp=sf_link

99+ Yuan Shen Chua and 155 other attendees

About

The understanding of unsaturated soil mechanics principles is of interest to a wide spectrum of geotechnical problems associated with soils above the water table and compacted soils. Unsaturated soil between ground surface and water table is the interface zone between soil and environment. The unsaturated zone plays an important role in determining the impact of climate change such as increasingly frequent rainfall of high intensity or prolonged drought on geotechnical structures. In addition, most geotechnical structures are made from compacted soils that are unsaturated. Therefore, understanding of unsaturated soil behavior is paramount in geotechnical engineering, particularly in mitigating the impact of climate change.

Join our upcoming webinar on 19th June 9.30 AM WIB to learn:

1. Stress state variables and constitutive equations based on the unsaturated soil mechanics principles.
2. Laboratory testing for characterization of unsaturated soils
3. Measurements of matric suction (or negative pore-water pressures)
4. Application of unsaturated soil mechanics in solving geotechnical engineering problems with commercial geotechnical software.

RESULTS - BUSINESS

Licensing
Business
Model

Business
development
& commercial
results

Distribution
to Overseas
Market

RESULTS - MACRO

Results	Description
Productivity improvements	1) Overall Efficiency of DfMA Approach resulted in cost savings 2) Leveraging on technology reduced the reliance on foreign manpower.
Revenue Improvements	1) Gained new market segment in Geotechnical Engineering. 2) CAGR of 18% for past 3 years
New Products	1) Spin off products e.g. GBS-mini for shorter slopes 2) Hocklim new business unit - instrumentation sensor market

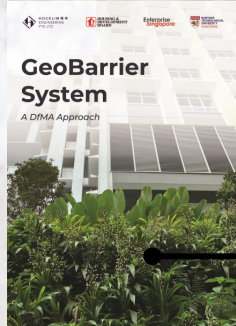
RESULTS - MACRO

Results	Description
Customer markets	1) Government Agencies – NParks, SLA, PUB. 2) HDB Building projects 3) Export solution overseas and filing patents
Return on investments	Breakeven point with 3 HDB projects secured so far

INDUSTRY TRANSFORMATION MAP



HOCKLIM 福林
ENGINEERING
PTE LTD



Construction Industry Transformation Map

The collective effort of Hocklim, NTU and HDB

Our Vision

Advanced & Integrated Sector

Progressive & Collaborative Firms

Good Jobs for Singaporeans

DfMA

Prefabrication
Assembly Line

Global Trends Shaping our Sector

Digital
Revolution

Rapid
Urbanisation

Climate
Change

3D Scanner,
Sensors

Advent of Smart Buildings,
New Construction Technologies &
Digitalised Work Processes

Need for Advanced Technologies
To Build Faster & Better

Strong Demand for
Green Building Expertise



NANYANG
TECHNOLOGICAL
UNIVERSITY
SINGAPORE



HOUSING &
DEVELOPMENT
BOARD



HOCKLIM 福林
ENGINEERING
PTE LTD



GBS

BENEFITS OF COOL IDEAS ENTERPRISE

Able to liaise with multiple agencies and tap on their vast resources

Funding Support from Enterprise Singapore

- Receive funding support of up to 70% of the development cost

Technical inputs from professionals

- Be mentored by Professionals in technical fields

Testbed opportunities

- Access to HDB's facilities and testbed sites for performance testing

Industry showcases

- Pilot your solution across HDB's Estates

Cool Ideas Enterprise serve as a one stop platform for streamlining the overall development process by at least 20%





HOCKLIM 福林
ENGINEERING
PTE LTD

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