

Innovative Self-Flow Low Strength Concrete Materials for Pavement Backfill in Hong Kong

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NAMI's Self- Compacting Backfill



Performance Targets



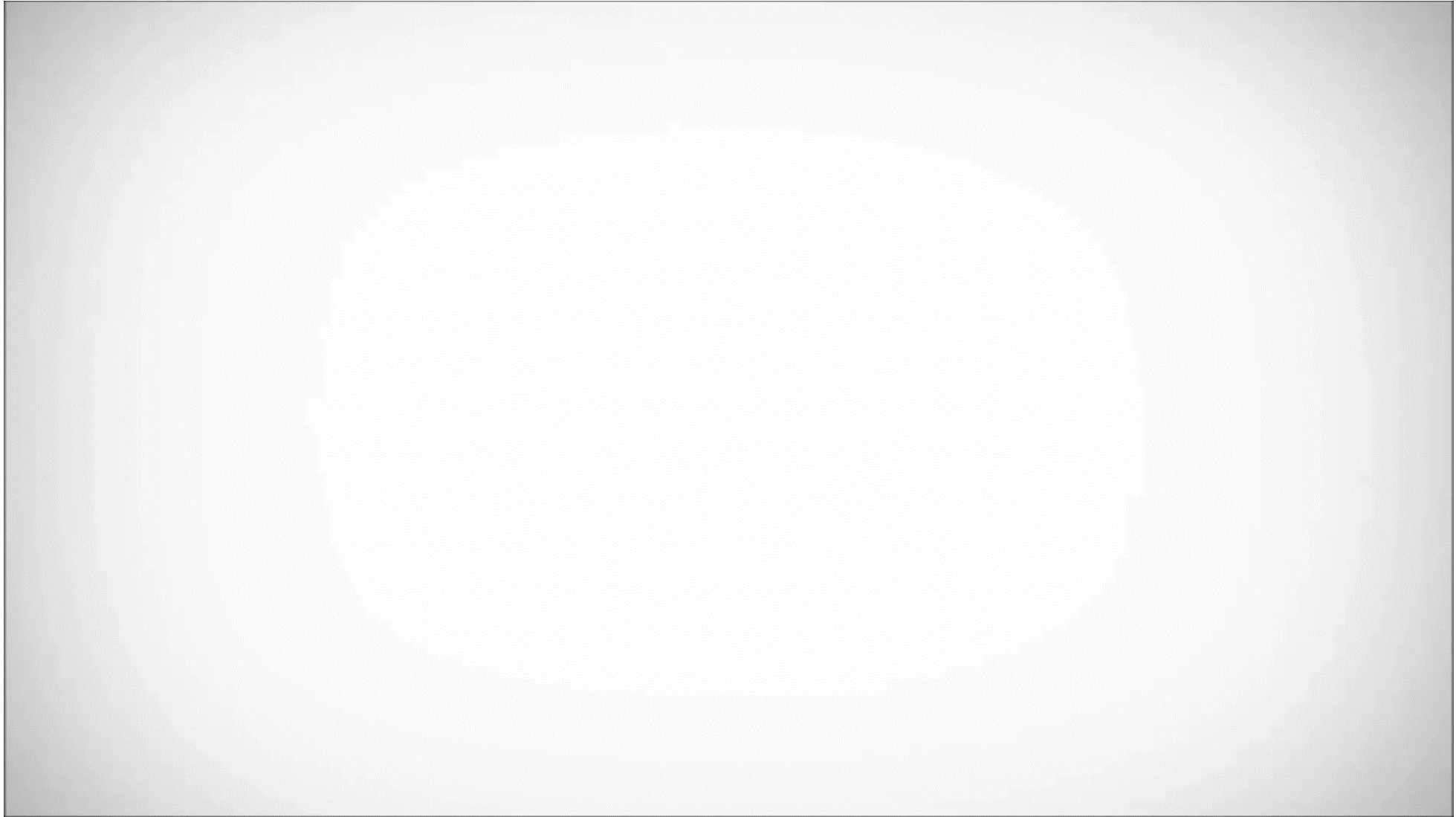
Material Development



Commercialization



NAMI Backfill 2.0



NAMI
Your *Materials* Expert

納米創意無止境



Material Development

Commercialization

NAMI Backfill 2.0

Performance Targets

1

Understanding the specific needs of Hong Kong's environment

2

- Selection of key research scopes
- Laboratory formulation
- MVP tests with material suppliers
- Early-stage trials
- Large-scale trials at selected project sites

3

- Patented formulation
- Licensing available for local industry
- Ready-mix & Dry-mix

4

New material formulations for targeted areas

Roadmap of NAMI's Backfill Development

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Development of Innovative Self-Compacting Backfilling Material for the Pavements in Hong Kong Road Network (ITP/027/18NP)

➤ Unique requirements:

- ✓ Congested work area
- ✓ Difficult temporary traffic arrangement
- ✓ Congested placement of utilities underground
- ✓ Harsh weather conditions

Specifications:

- ✓ Compaction of no less than 95-98 % on every 150 mm layer
- ✓ To be done with a power rammer, vibratory plate or vibratory roller.

Challenges:

- ✓ Difficult to fully **compact** in limited spaces
- ✓ **Time** consuming in rainy conditions
- ✓ May lead to **failures** in pavement over time
- ✓ **Thermal conductivity varies** and leads to damages of power cables





Project Scopes with Highways Department

“To develop a self-compacting flowable material for universal trench backfilling in Hong Kong”



Self-levelling



High thermal conductivity



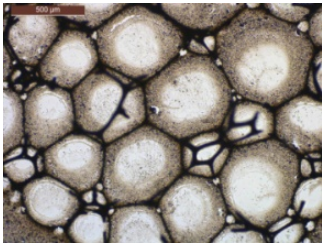
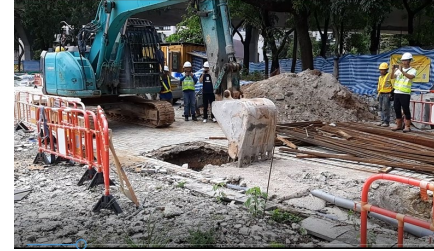
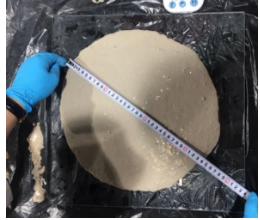
Re-excavatable



Universal use in Hong Kong



Timeline of project



Laboratory formulation and testing

Operation trials

Site trial DSD

Site trial DSD

Site trial DSD

Site trial MTR/DSD/HYD

NAMI's Backfill development

Project Start

2019

07-2019

04-2020
Project End

07-2020



Field trials in Hong Kong

Total volume of first section trench for backfilling: 7.9m³

*MTR contract Shatin Central Link
To Kwa Wan Station Drainage works*



Trench before backfilling
size: 4.0m*1.16m*2.3m



Filling with NAMI backfill materials



After finished the filling



Trench after overnight



Removing sheet piles



Filling the subbase



Pavement opened to public in April 2020



Field trials in Hong Kong





Backfill materials trials in 2019

Total **58.6 m³**

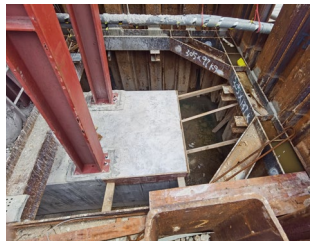
Location	Date	Volume	Note
HK Fan Ling	29 th Jan. 2019	1 m ³	Plant trial
China Huizhou	26 th Feb. 2019	1 m ³	Plant trial
China Huizhou	4 th Mar. 2019	1 m ³	
China Huizhou	13 th Mar. 2019	1 m ³	
China Huizhou	20 th Mar. 2019	4 m ³	
China Huizhou	21 st June 2019	7 m ³	
China Huizhou	22 nd July 2019	5 m ³	
HK Yuen Long	23 rd July 2019	2 m ³	Plant trial
HK Yuen Long	25 th July 2019	2 m ³	
HK Yuen Long	13 th Aug. 2019	2 m ³	
HK Yuen Long	15 th Aug. 2019	2 m ³	
HK Yuen Long	20 th Aug. 2019	2 m ³	
HK Yuen Long	29 th Aug. 2019	2 m ³	
HK Kwun Tong	30 th July 2019	10 m ³	Site trial
HK Tung Chung	2 nd Sep. 2019	6 m ³	Site trial
HK Lei Yue Mun	26 th Sep. 2019	1.6 m ³	Site trial (Dry mixed onsite)
HK To Kwa Wan	28 th Nov. 2019	9 m ³	Site trial



	NAMI's Self-Compacting Backfilling Material	Compacted soil
Slurry working time	1-3 hour after adding water	/
Load placement	4-24 hrs	/
Workability	Self-compacting	Not flowable compacted layer by layer
Final strength	0.40-1.4 MPa (Density: 1750-1850 Kg/m ³)	>1MPa (Density:1600~1900kg/m ³)
Excavatable manually	Yes	Yes
Thermal conductivity	1.409±0.349 W/mK (9.9% moisture content)	1.332± 0.151W/mK (10.1% moisture content)
Water permeability	3.30x10 ⁻⁷ m/s (Density: 1638 Kg/m ³)	1.09x10 ⁻⁵ m/s (Density: 1728 Kg/m ³)
CBR value	15.3	<u>Test pending</u>
Reusable	98% recycled back to flowing fill / 100 % reused as fine aggregate	100% reused



Timeline of new trials



Trials at Central-Kowloon-Route

New trials
with CLP

CEDD-GEO Slope works
Pit-by-pit backfill pilot

Public sector trial scheme starts

NAMI's Backfill Trials

07-2020

2021

04-2021

07-2021

07-2022



Backfill materials trials in 2020-2021

Total **468.4 m³**

Location	Date	Volume	Note
Central Kowloon Route – Kai Tak East, stage 1	2 nd Sept. 2020	18 m ³	Site trial
Central Kowloon Route – Kai Tak East, stage 2	18 th Nov. 2020	33 m ³	Site trial
Tai Pak Tin Street, Kwai Chung HyD, Lighting Division	15 th Dec. 2020	1 m ³	Site trial
Central Kowloon Route – Kai Tak East, stage 3	18 th Dec. 2020	47 m ³	Site trial
Pak Tai street, To Kwa Wan HyD, Lighting Division	13 th Jan. 2021	1.4 m ³	Site trial
Central Kowloon Route – Kai Tak East, stage 4	25 th Jan. 2021	72 m ³	Site trial
CEDD – GEO Landslip Prevention and mitigation works Pilot (LPMit), stage 1	8 th Feb. 2021	36 m ³	Site trial, Slope works
Central Kowloon Route – Kai Tak East, stage 5	3 rd Mar. 2021	96 m ³	Site trial
CEDD – GEO Landslip Prevention and mitigation works Pilot (LPMit), stage 2	10 th Mar. 2021	66 m ³	Site trial, Slope works
CEDD – GEO Landslip Prevention and mitigation works Pilot (LPMit), stage 3	24 th Mar. 2021	36 m ³	Site trial, Slope works
CEDD – GEO Landslip Prevention and mitigation works Pilot (LPMit), stage 4	26 th Mar. 2021	28 m ³	Site trial, Slope works
Central Kowloon Route – Kai Tak East, stage 6	1 st Apr. 2021	34 m ³	Site trial



Self-compacting backfilling material in action

NAMI's self-compacting backfilling material applied location and volume



Total volume filled: **498 m³**

- Trench with UUs
- Applied under HyD major works
- Applied under DSD
- Mixed with dry-mixed method
- Applied under slope works



Benefits of NAMI's Backfill



NAMI's backfill operation in To Kwa Wan MTR station, November 2019



NAMI's backfill operation in Kai Tak East, November 2020

Backfilling

- Self-levelling without compaction
- Direct pouring from truck into trench. Filling speed up to 7 m³ in 20 minutes
- Can be pumped with concrete pumping equipment
- Can be placed in wet conditions and heavy rain
- Soil-like mechanical and thermal performance

Reinstatement & Excavation

- Sub-base can be placed within 8-24 hours depending on weather conditions
- Can be manually excavated after 28 d with spade and pick-axe
- Up to 98 % can be recycled to new flowable fill or used as inert fine soil-like fill

Production and logistics in Hong Kong

- Locally available raw materials
- Current mixing systems can be used in concrete plants
- Delivery by concrete truck to site within 2 hours
- Supplied as dry-mix in 25 kg bags



Commercialization Ready

Patented formulation

- USPTO application “THERMALLY-CONDUCTIVE, LOW STRENGTH BACKFILL MATERIAL”
- Granted Hong Kong Short term patent 30020754 A
- China patent application “一种具有良好导热性的低强度回填材料”

Current licensees:

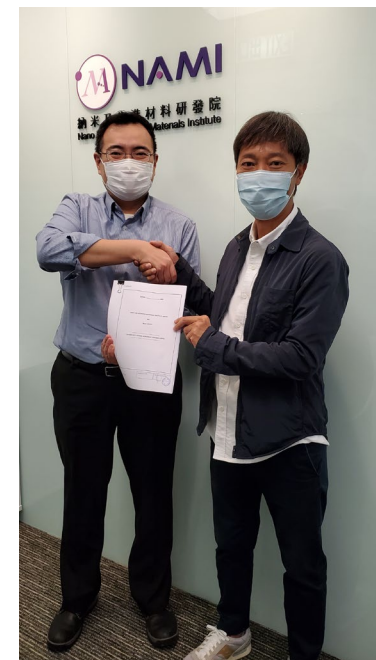
- Golik Concrete Limited
- Vast Hill Development Ltd. (KFDN)
- Minji Limited



Golik Concrete Limited



*Vast Hill Development Ltd.
(KFDN)*



Minji Limited



Mixing methods of Backfill

Item	Ready mixed materials in concrete plant	Dry mixed materials onsite
Production volume	1-7 m ³ per truck load	40 L/min -150 L/min
Producing method	Automated manufacturing in concrete plant	Continuous mixing onsite
Placement	Direct discharge or pumping	Only 2 workers
Subbase placement	8 h~24 h after backfilling	8 h (< 2 h setting formulation in development)
Applied area	Large filling area	Confined area (mixer dimension :2.1m*0.9m* 1.1m)



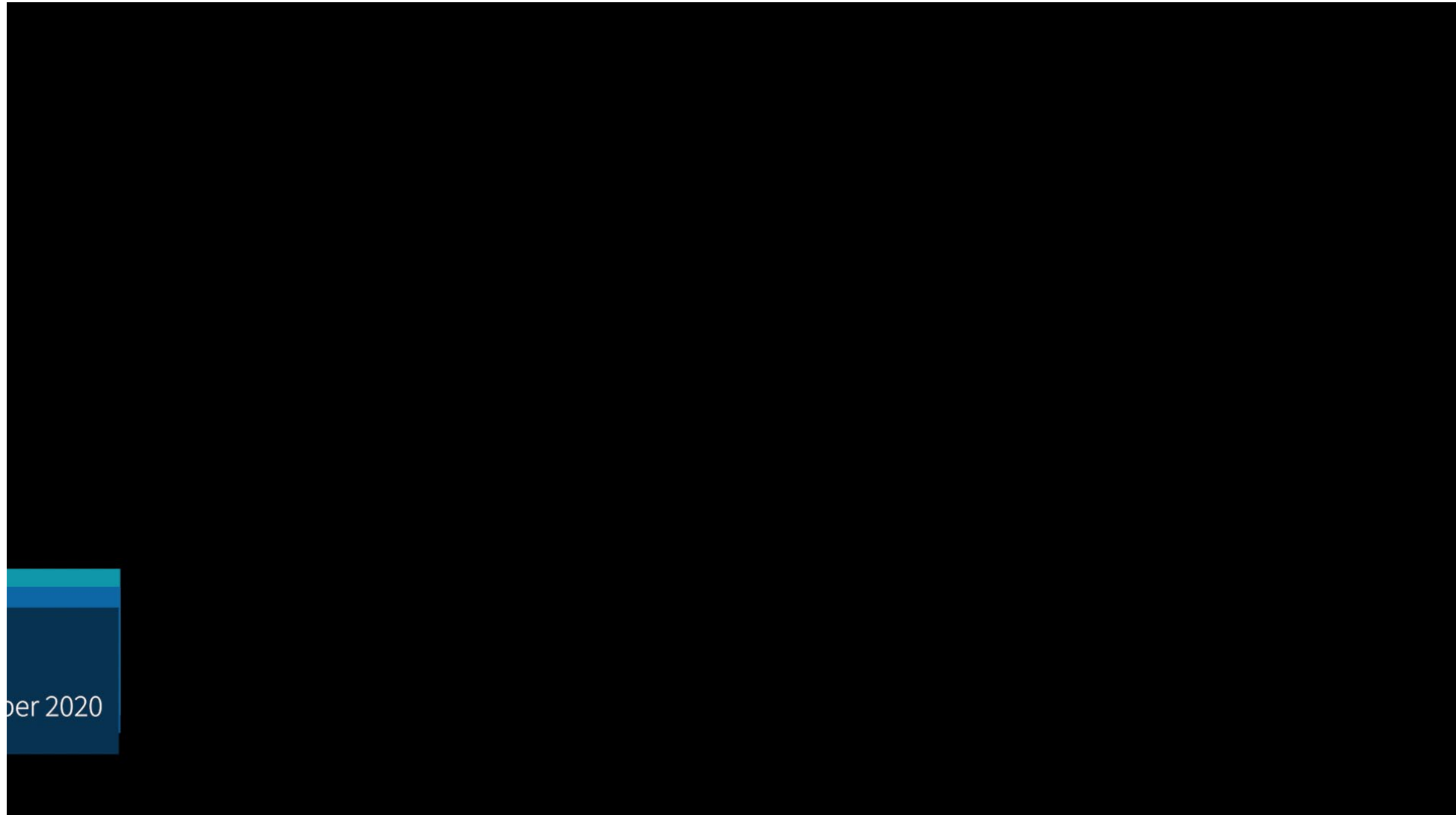


Site operations, Ready-mix





Material properties dry-mix application



ber 2020



NAMI Backfill 2.0

Properties

Material Development:

- Increase water permeability
- Decrease density
- Maintain flowability and low strength



OPC



Aggregate



Natural filler



Additives

Materials

NAMI

Applications

Low-cost recycled material Backfill

Fast-Setting Backfill

Material Development:

- Setting in less than 4 hours
- Maintain flowability and low strength
- Ready-mix & Dry-mix
- Rapid setting Dry-mix less than 2 hours

