Role of Indonesian Natural Pozzolana in the Roadmap to Decarbonization

Presented by

Fazle Azim

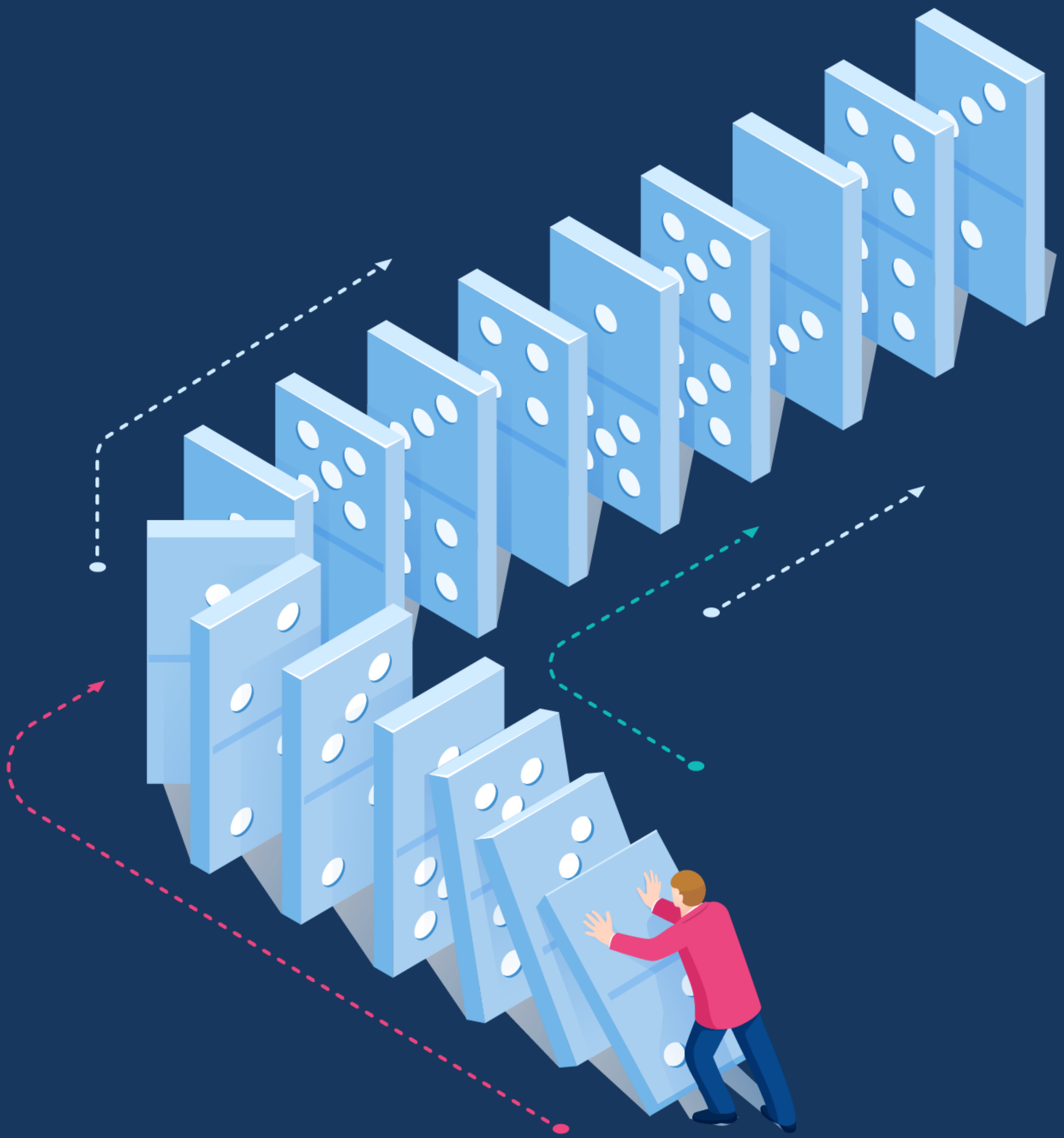
Chairman
Peakward Group

Peakward

GLOBAL WARMING

Source: https://www.visualcapitalist.com/cp/mapped-carbon-dioxide-emissions-around-the-world/

What are the CONSEQUENCES of this?



Planetary Boundaries Breached

Earth's Precarious State

- Earth is well outside the safe operating space for humanity.
- Six out of nine planetary boundaries have been breached due to human-caused pollution and environmental destruction.
- The boundaries for climate, water, and wildlife diversity have been significantly compromised.
- The Earth's systems have moved far from the stable state that existed during the Holocene.
- All four biological boundaries are at the highest risk level.

THEGUARDIAN.COM

Earth 'well outside safe operating space for humanity', scientists find

Take Immediate Action for a **Sustainable Future**

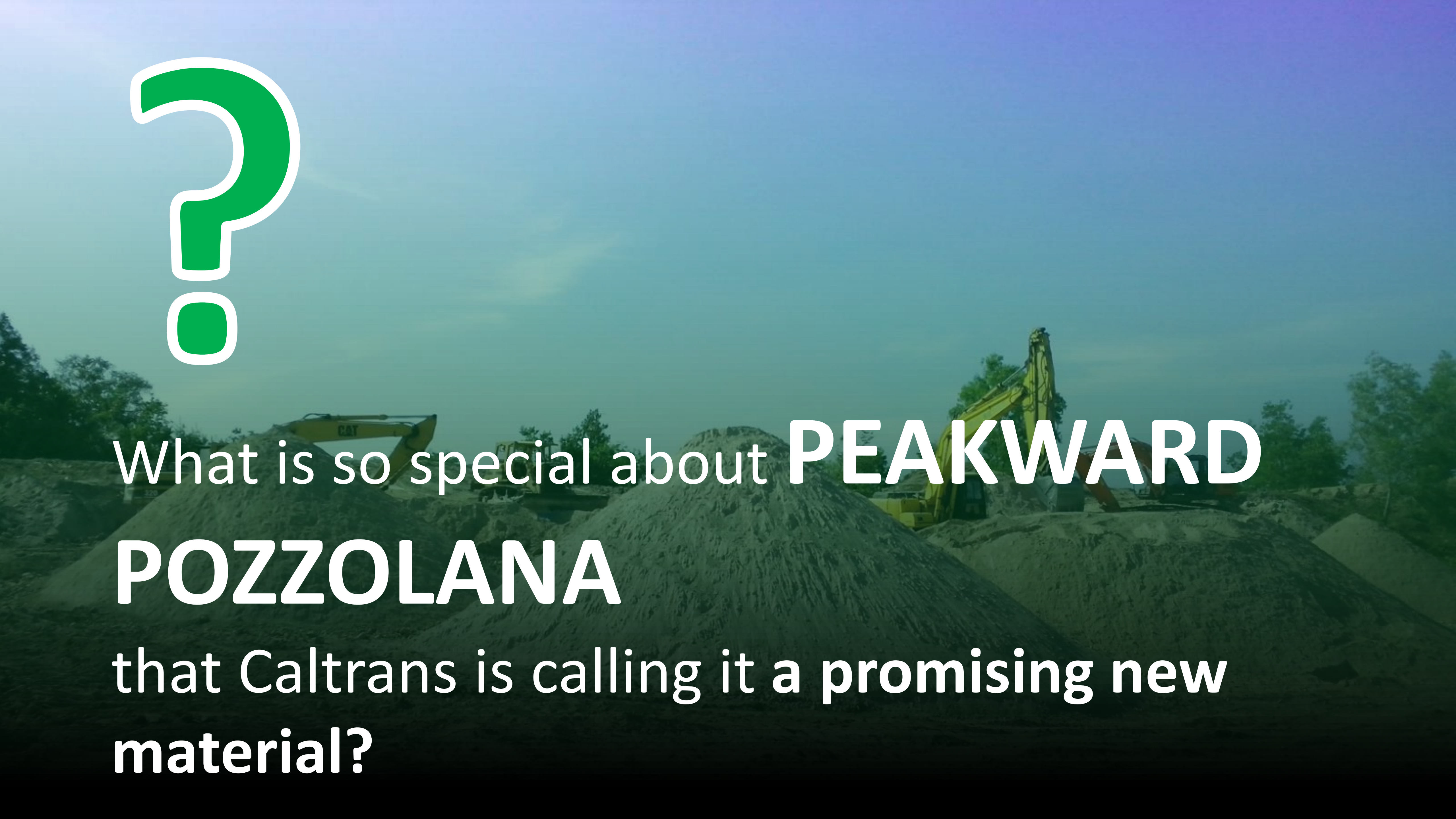
The real solution lies in reducing all materials produced by using **FOSSIL FUELS**

PEAKWARD

NATURAL POZZOLANA

“ **A PROMISING NEW MATERIAL**

(Commented by California Department of Transportation, Caltrans)



What is so special about **PEAKWARD POZZOLANA**

that Caltrans is calling it **a promising new material?**

Test 1 of 4

DIME Test ID: 2022-09-19-2-2
Test Method: ASTM C109-16a: Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or
Verified Date: 12/02/2022
Date Tested: 10/05/2022
Submitted By Organization: CT HQ - Sacramento Cement Testing Laboratory
Organization Address: 5900 Folsom Blvd.,
Organization City: Sacramento
Organization State: CA
Organization Zipcode: 95819
Organization Email: ben.lenz@dot.ca.gov
Organization Phone: (916) 227-7071
General Comments for this Test:
Test Result Compliance:
Additional Comments When Verified:

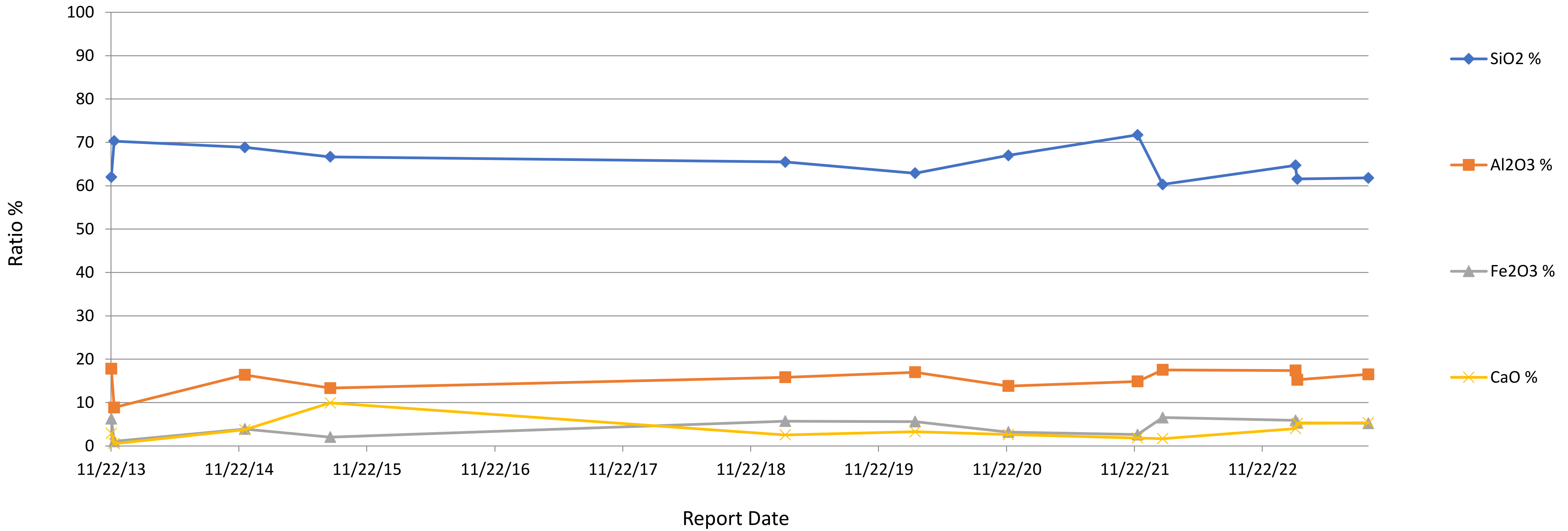
Will control cubes be used per ASTM C311?	yes
Age of specimen	7 days
The amount of flow	97 %
The amount of water used	48.0 %
Compressive strength of 1st specimen	3928 psi
Compressive strength of 2nd specimen	3806 psi
Compressive strength of 3rd specimen	4009 psi
Average Compressive strength (to nearest 10 psi)	3910 psi
Average Compressive strength (to nearest 10 psi) control group	4370 psi
Strength Activity Index of Portland Cement per ASTM C109	89 %

Test 2 of 4

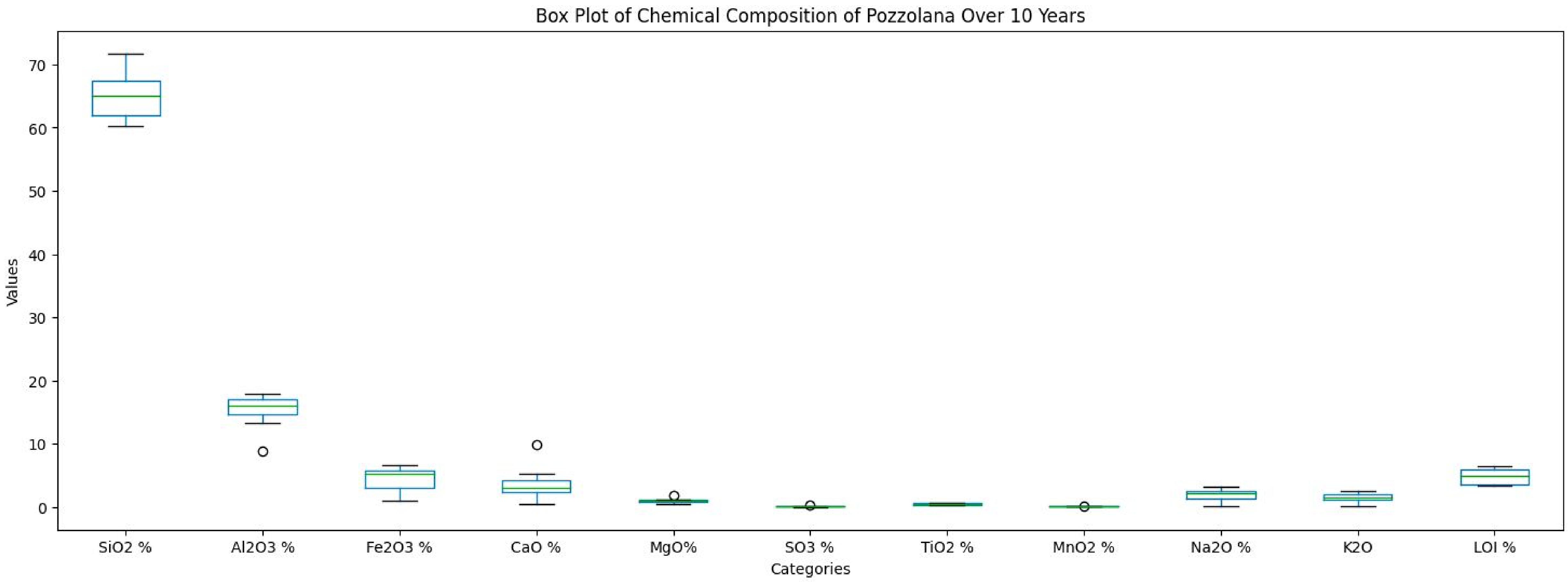
DIME Test ID: 2022-09-19-2-3
Test Method: ASTM C109-16a: Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or
Verified Date: 12/02/2022
Date Tested: 10/26/2022
Submitted By Organization: CT HQ - Sacramento Cement Testing Laboratory
Organization Address: 5900 Folsom Blvd.,
Organization City: Sacramento
Organization State: CA
Organization Zipcode: 95819
Organization Email: ben.lenz@dot.ca.gov
Organization Phone: (916) 227-7071
General Comments for this Test: Specimen 2 was eliminated from the average for being outside allowable limits per Sectio
Test Result Compliance:
Additional Comments When Verified:

Will control cubes be used per ASTM C311?	yes
Age of specimen	28 days
The amount of flow	97 %
The amount of water used	48.0 %
Compressive strength of 1st specimen	5307 psi
Compressive strength of 2nd specimen	4602 psi
Compressive strength of 3rd specimen	5347 psi
Average Compressive strength (to nearest 10 psi)	5330 psi
Average Compressive strength (to nearest 10 psi) control group	5110 psi
Strength Activity Index of Portland Cement per ASTM C109	100 %

Consistency of Chemical Components
Natural Pozzolana



Natural Pozzolana Chemical Composition Consistency With Time



Our Natural Pozzolana product has demonstrated remarkable **consistency in quality over the past decade, backed by extensive research and comprehensive data analysis**. This consistency is evidenced by the relatively **low standard deviations and the minimal variation in these chemical constituents over time**. This extensive research and data provide solid evidence of the product's consistent quality and further assure our customers of its dependable performance in various applications.


Peakward
Made with KINEMASTER
NATURAL POZZOLANA

CO2 emission of **OPC**

100%

CO2 emission of

Peakward Pozzolana

0%

Strength Activity

Raw, Sieved, Ground

	Code	101	102	103	104	105	106	107	108	111	112
	Number	4980	4981	4982	4983	4984	5005	5006	5028	4999	5000
	Grade	**40/20**	**40/20**	**40/20**	**40/20**	**40/20**	**40/20**	**40/20**	**40/20**	**60/20 SCC**	**60/20 SCC**
	PC	100% PC	60% PC	75% PC	75% PC	75% PC	90% PC	90% PC	90% PC	60% PC	60% PC
	SCM		40% GGBS	25% Pozz	25% Pozz	25% Pozz	10% Pozz	10% Pozz	10% Pozz	40% GGBS	25% Pozz
	MS									5% MS	5% MS
	ADD			Raw	Sieved	Ground	Raw	Sieved	Ground		Ground
Components	Date	10/02/22	10/02/22	10/02/22	14/02/22	14/02/22	28/02/22	28/02/22	12/03/22	26/02/22	26/02/22
Mix contents		**400**	**400**	**400**	**400**	**400**	**400**	**400**	**400**	**440**	**440**
CEM I	kg	400	240	300	300	300	360	360	360	250	313
GGBS	kg	-	160	-	-	-	-	-	-	168	-
Silica Fume	kg	-	-	-	-	-	-	-	-	22	22
Pozzolana	kg	-	0	100	100	100	40	40	40	-	105
20mm	kg	650	650	650	650	650	650	650	650	380	380
10mm	kg	380	380	380	380	380	380	380	380	420	420
05mm	kg	530	500	500	500	500	500	500	500	610	590
Dune	kg	340	320	320	320	320	320	320	320	440	440
Free Water	kg	152	152	152	152	152	152	152	152	145	145
MasterPozzolith 10	kg	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
MasterGlenium 120AE	kg	6.33	7.00	8.50	12.83	10.83	7.17	8.50	8.50	-	-
Δ 120AE	kg	N/A	0.67	2.17	6.5	4.5	0.84	2.17	2.17	-	-
MasterGlenium 502AD	kg	-	-	-	-	-	-	-	-	6.33	10.50
Δ 502AD	kg	-	-	-	-	-	-	-	-	N/A	4.17
Fresh Concrete											
A/Cm	ratio	4.75	4.63	4.63	4.63	4.63	4.63	4.63	4.63	4.20	4.16
Free W/Cm	ratio	0.380	0.380	0.380	0.380	0.380	0.380	0.380	0.380	0.330	0.330
Plastic Density (kg/m^3)	30 min	2470	2456	2445	2429	2426	2427	2421	2437	2457	2420
Air content (%)	30 min	1.80%	1.60%	2.00%	2.10%	2.30%	2.90%	3.00%	1.90%	1.20%	1.90%
Bleeding (%)	30 min	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Setting Time	hrs	10.0	16.5	21.0	72.0	48.0	17.5	11.1	18.5	-	-
Slump or Flow (mm)	Initial	220	230	220	210	220	230	230	230	720	700
	30 min	200	220	130	170	200	220	215	220	730	680
	60 min	180	210	110	140	180	210	200	210	720	650
	90 min	160	200	90	110	140	200	175	200	720	640
	120 min	140	180	80	90	120	170	150	180	710	600
Hardened concrete											
Compressive Strength 100mm Cubes (N/mm^2)	1 day	24.5	10.0	3.5	0.0	0.0	17.5	11.0	10.0	18.5	18.5
	3 days	51.5	46.0	46.0	12.5	31.5	48.0	47.0	48.0	39.5	41.5
	7 days	63.5	55.0	52.5	34.5	47.0	46.5	44.0	54.0	64.0	62.5
	28 days	74.5	67.0	64.5	46.0	57.5	62.5	61.5	64.5	79.5	71.5
	56 days	80.5	74.0	70.0	50.0	62.0	68.0	69.5	73.0	89.0	78.5
	90 days	84.0	80.0	74.5	56.0	65.0	71.0	74.0	77.5	93.5	83.0
RCP (coulombs)	28 days	3 935	1 903	3 138	1 740	3 908	6 096	5 306	3 966	720	903
	56 days	3 428	1 325	2 200	1 536	3 560	3 757	2 460	1 764	415	569
	90 days	2 072	849	1 265	962	1 829	3 033	2 114	560	244	293
Water Absorption (%)	28 days	2.1	1.8	1.9	1.7	1.9	1.8	1.9	1.7	1.1	1.3
	56 days	1.6	1.3	1.5	1.4	1.5	1.6	1.5	1.3	0.8	0.9
	90 days	1.4	1.1	1.3	1.2	1.3	1.4	1.3	1.1	0.6	0.8
Notes		Control								Control	

Hardened concrete		102 4981 **40/20** 60% PC 40% GGBS 10/02/22	103 4982 **40/20** 75% PC 25% Pozz Raw 10/02/22
Compressive Strength 100mm Cubes (N/mm^2)	1 day	10.0	3.5
	3 days	46.0	46.0
	7 days	55.0	52.5
	28 days	67.0	64.5
	56 days	74.0	70.0
	90 days	80.0	74.5
RCP (coulombs)	28 days	1 903	3 138
	56 days	1 325	2 200
	90 days	849	1 265
Water Absorption (%)	28 days	1.8	1.9
	56 days	1.3	1.5
	90 days	1.1	1.3

Strength Activity of Raw Pozzolana

Hong Kong University Report

Design of Durable Concrete with Natural Pozzolana

Hong Kong University Report

Design of Durable and Sustainable Concrete with Natural Pozzolana

Submitted by

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Department of Civil Engineering
The University of Hong Kong

香 港 大 學
THE UNIVERSITY OF HONG KONG

30 November 2021

We collaborated with Professor Thomas NG who is the Head & Chair Professor of Dept. of Architectural and Civil Engineering at HKU. A well-known and well-respected contributor/advisor to the HK construction industry

Disclaimer: This study was conducted with the support of the Peakward Enterprises (Holdings) Ltd. Hong Kong, and the University of Hong Kong (HKU). The source of natural pozzolana used in this study is from Indonesia, which is supplied by the Peakward (named as Peakward Pozzolana).

Hong Kong University Report

Design of Durable and Sustainable Concrete with Natural Pozzolana

Objectives

1. To examine the mechanical performances and durability in order to evaluate the feasibility of using VA-based natural pozzolana in concrete production, compared to that of its counterparts; and
2. To evaluate the comprehensive environmental sustainability of VA-based concretes compared to its conventional counterparts.

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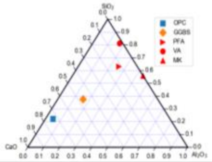
Chemical and physical characteristics of OPC and SCMs

Oxides (% by mass)	OPC	GGBS	PFA	MK	LS	VA
MgO	0.84	6.33	2.70	-	0.95	0.81
Al_2O_3	3.95	13.81	20.38	43.05	0.08	14.86
SiO_2	19.88	32.53	50.74	54.67	-	71.73
SO_3	5.06	3.16	1.61	-	0.07	0.05
CaO	65.54	40.73	9.37	-	54.57	1.84
TiO_2	-	1.28	1.15	0.69	-	0.33
Fe2O3	2.73	0.31	6.19	0.43	0.03	2.60
MnO	-	0.17	0.14	-	-	0.09
Na_2O_e	0.38	0.74	3.18	-	-	3.50
Loss on ignition at 900 ºC	1.43	0.54	3.91	1.15	45.43	3.37

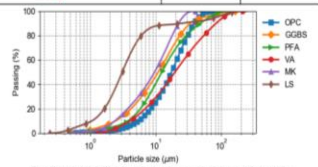


- Preprocessing of raw VA
  - Milling→Sieving (150 um sieve)→Drying (105 ºC)
- The VA after preprocessing confirms with ASTM C628.

Pozzolanic activity & Particle size distribution of cementitious materials

- Pozzolanic activity by Chapelle test (NF P18-513)
  - Mix 1g SCM and 1g $Ca(OH)_2$ with 200 mL distilled water
  - Heat up the solution and keep at the boiling temperature for 16h
  - Add 20 g sucrose after cooling down to dissolve the remaining $Ca(OH)_2$
  - Filter the solution through a Buchner filter
  - Titrate with 0.1 N HCl using methyl orange as an indicator

Pozzolanic materials	PFA	MK	VA
Activity (mg of Ca(OH)2 consumed per g of SCM)	545	673	321



Particle size distribution of cementitious materials

Mixture proportions (>Grade 50)

Study influences of different SCMs (30% vol. replacement of OPC)

Materials (kg/m³)	NC	SC	PC	MLC	VLC	VC	VC-0.4	VC-0.33	VC40-0.33	VC50-0.33
Ordinary Portland cement (OPC)	450	315	315	315	315	315	380	343	323.5	269.6
Ground granulated blast furnace slag (GGBS)	0	119.4	0	0	0	0	0	0	0	0
Fly ash (FA)	0	0	104.8	0	0	0	0	0	0	0
Volcanic ash (VA)	0	0	0	0	74.3	109	131.4	118.6	178	222.5
Metakaolin (MK)	0	0	0	74.3	0	0	0	0	0	0
Limestone (LM)	0	0	0	37.1	37.1	0	0	0	0	0
Coarse aggregates	1015	1015	1015	1015	1015	1015	1015	1015	1015	1015
Fine aggregates	745	745	745	745	745	745	745	745	745	745
Water	198	198	198	198	198	198	168.8	184.7	165.5	162.4
Superplasticizer	2.2	2.3	2	5.2	3.7	3.3	5	8.2	9	10.8
W/B ratio	0.44	0.46	0.47	0.46	0.46	0.47	0.4	0.33	0.33	0.33

NC: OPC as the only binder
SC: 70% vol. OPC +30% vol. GGBS as the binder
PC: 70% vol. OPC +30% vol. PFA as the binder
MLC: 70% vol. OPC + 20% vol. MK + 10% vol. LS as the binder
VLC: 70% vol. OPC + 20% vol. VA + 10% vol. LS as the binder
VC: 70% vol. OPC +30% vol. VA as the binder

Scope of Study

- **Fresh properties**
  - Initial and final setting time of cementitious paste (ASTM C807)
  - Slump (BS EN 12350)
- **Mechanical properties (BS EN 12390)**
  - 3, 28, 56 days compressive strength
  - 3, 28, 56 days splitting tensile strength
  - 3, 28, 56 days flexural strength
- **Durability properties**
  - Initial and secondary rates of absorption of water (ASTM C1585)
  - ASR-induced expansion (ASTM C1260, ASTM C1567)
  - Bulk chloride diffusion tests (ASTM C1556)

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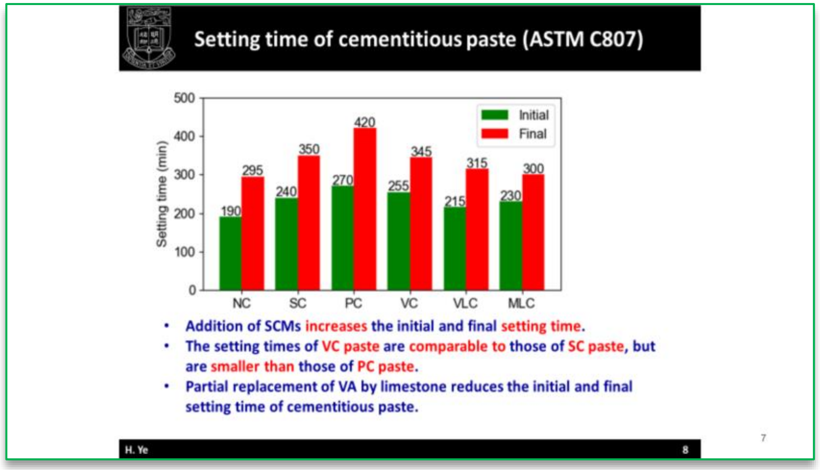
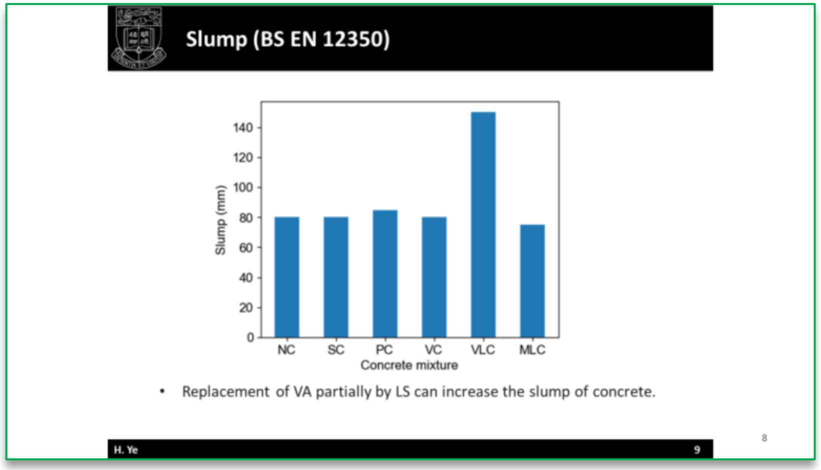
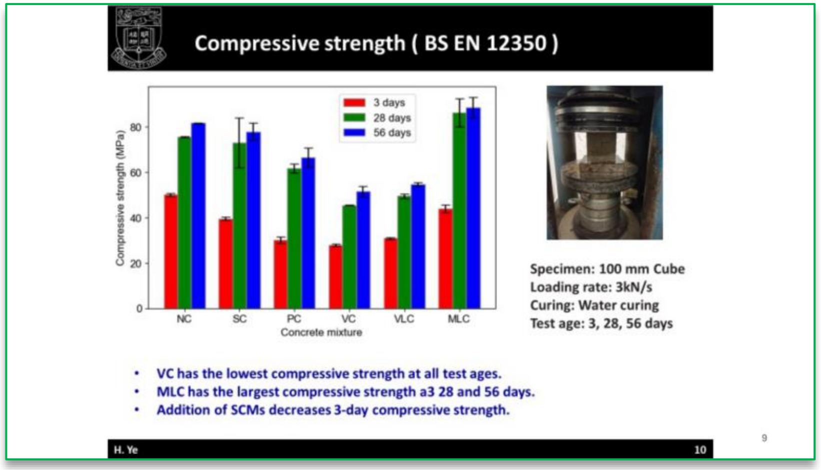
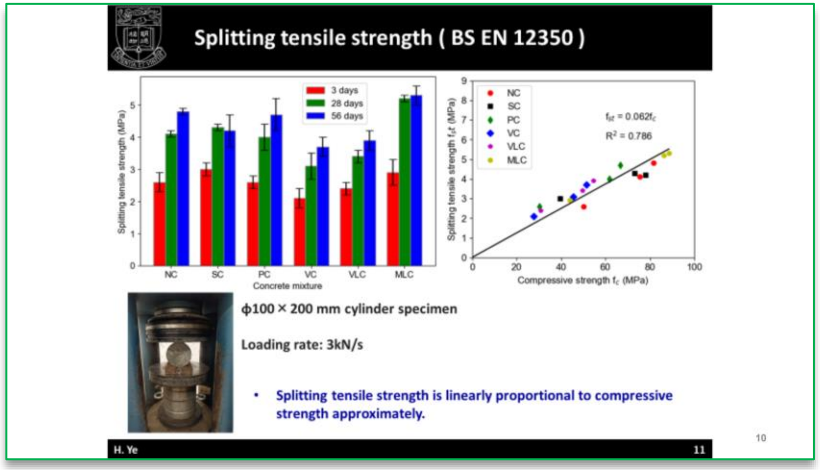
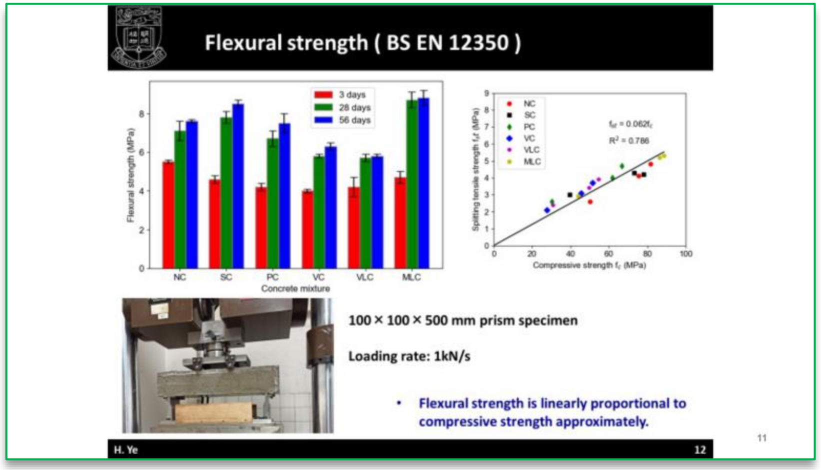
Design of Durable Concrete with Natural Pozzolana

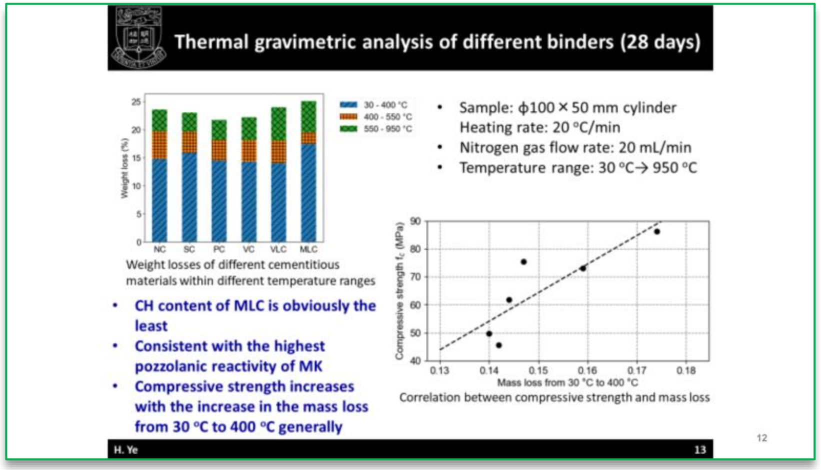












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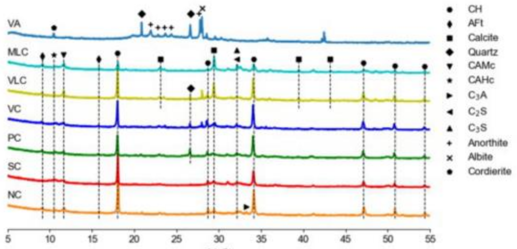
Design of Durable Concrete with Natural Pozzolana

XRD patterns of different binders (28 days)



- The peak intensity corresponding to CH phase is the lowest for MLC
- Consistent with the highest pozzolanic reactivity of MK

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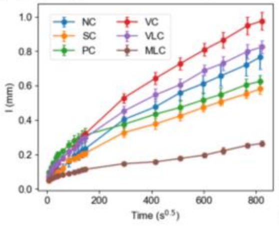
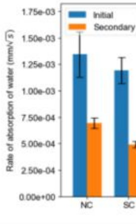
Initial and secondary rates of absorption of water (ASTM-C1585)



- Initial rate of absorption: VC>VLC>PC>NC>SC>MLC
- Secondary rate of absorption: VC>VLC>NC>PC>SC>MLC

- **Sample:** ~50g ground powder
- **Curing:** water curing for 28 days → curing at T=~50°C, RH=80% for 3 days →curing at air (T=~23°C) for 28 days
- **The absorption at the end of the test:** VC>VLC>NC>PC>SC>MLC



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ASR-induced expansion (ASTM C1260, ASTM C1567)

- The water/binder mass ratios of all mixes are set at 0.47.
- The aggregate/binder mass ratios of all mixes are set at 2.25.
- 1 N NaOH solution

Aggregate Grading Requirements

Sieve size		Mass, %
Passing	Retained on	
4.75 mm (No. 4)	2.36 mm (No. 8)	10
2.36 mm (No. 8)	1.18 mm (No. 16)	25
1.18 mm (No. 16)	600 um (No. 30)	25
600 um (No. 30)	300 um (No. 50)	25
300 um (No. 50)	150 um (No. 100)	15

Test standard: ASTM-C1567 (14-day Accelerated Mortar Bar Test)
Aggregate type : Granite

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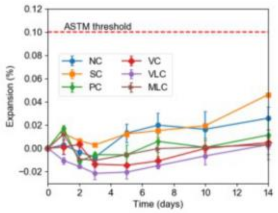
ASR-induced expansion (ASTM C1260, ASTM C1567)



- Replacement of OPC by FA, VA, and MK/LS partially facilitates mitigating ASR-induced expansion.

Test standard: ASTM-C1567 (14-day Accelerated Mortar Bar Test)
Aggregate type : Granite

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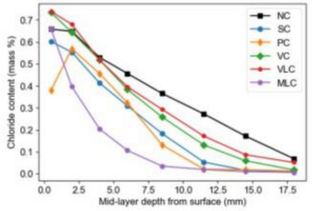
Bulk chloride diffusion tests (ASTM C1556)



- **Sample:** 100 cube specimens
- **Curing:** Cured in water for 27 days → Air dry for one day
- Seal the four lateral sides using epoxy resin
- Immerse in saturated lime water for 3 days
- Immerse in 165g/L NaCl solution for 60 days

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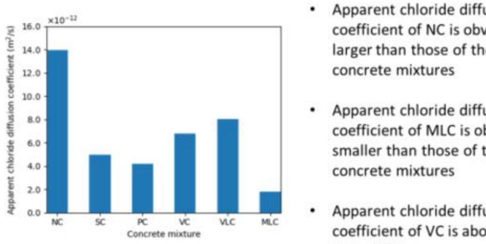
Bulk chloride diffusion tests (ASTM C1556)



Apparent chloride diffusion coefficients of different concretes

NC>VLC>VC>SC>PC>MLC

- Apparent chloride diffusion coefficient of NC is obviously larger than those of the rest concrete mixtures
- Apparent chloride diffusion coefficient of MLC is obviously smaller than those of the rest concrete mixtures
- Apparent chloride diffusion coefficient of VC is about half of that of NC

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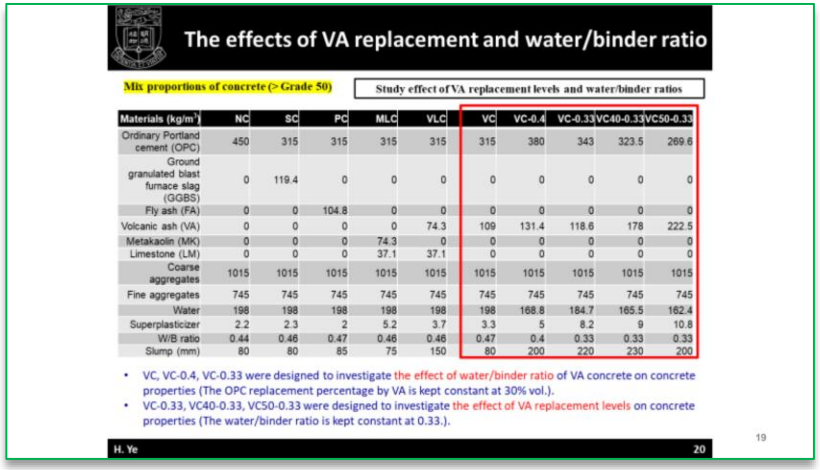
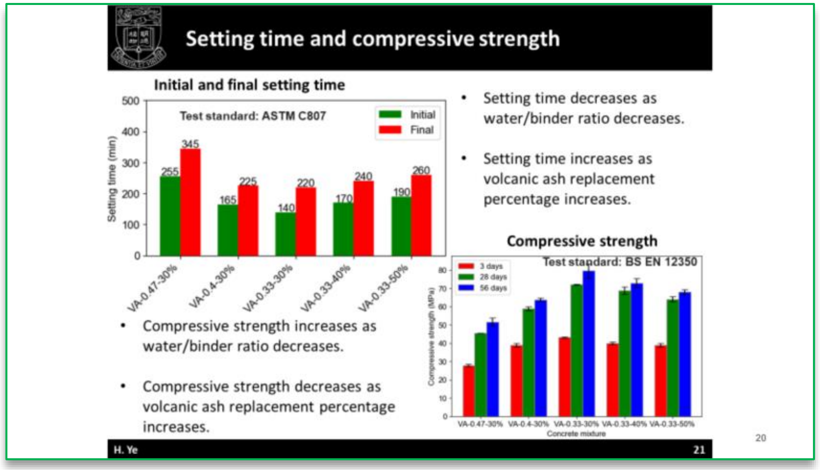
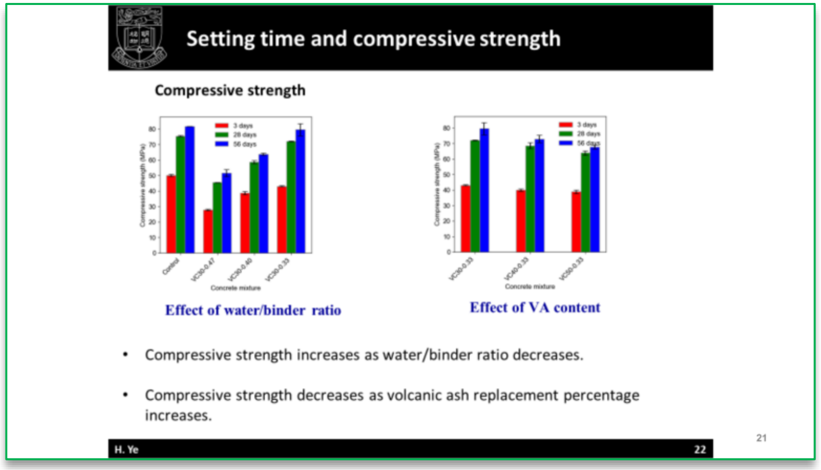
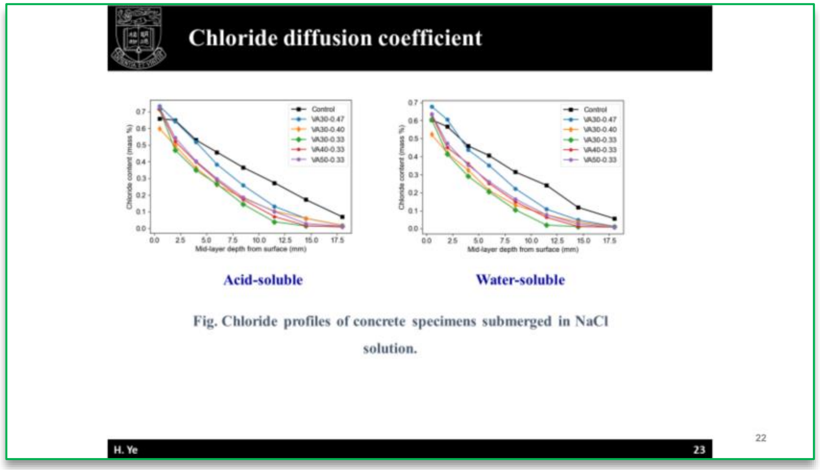
Design of Durable Concrete with Natural Pozzolana

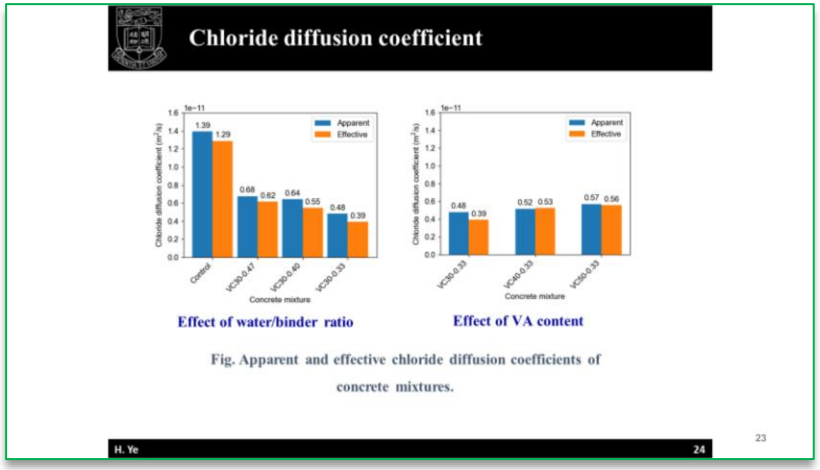


Materials (kg/m³)	NC	SC	PC	MLC	VLC	VC	VC-0.4	VC-0.33	VC40-0.33	VC50-0.33
Ordinary Portland cement (OPC)	450	315	315	315	315	315	380	343	323.5	269.6
Ground granulated blast furnace slag (GGBS)	0	119.4	0	0	0	0	0	0	0	0
Fly ash (FA)	0	0	104.8	0	0	0	0	0	0	0
Volcanic ash (VA)	0	0	0	0	74.3	109	131.4	118.6	178	222.5
Metakaolin (MK)	0	0	0	74.3	0	0	0	0	0	0
Limestone (LM)	0	0	0	37.1	37.1	0	0	0	0	0
Coarse aggregates	1015	1015	1015	1015	1015	1015	1015	1015	1015	1015
Fine aggregates	745	745	745	745	745	745	745	745	745	745
Water	198	198	198	198	198	198	168.8	184.7	165.5	162.4
Superplasticizer	2.2	2.3	2	5.2	3.7	3.3	5	8.2	9	10.8
W/B ratio	0.44	0.46	0.47	0.46	0.46	0.47	0.4	0.33	0.33	0.33
Slump (mm)	80	80	85	75	150	80	200	220	230	200









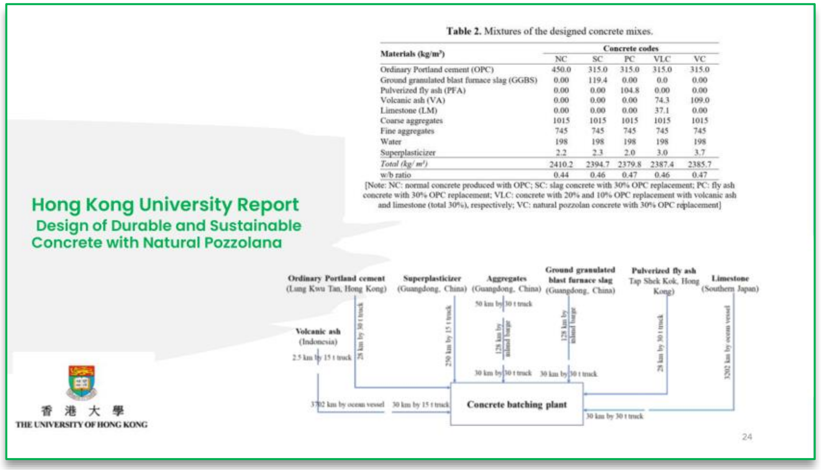


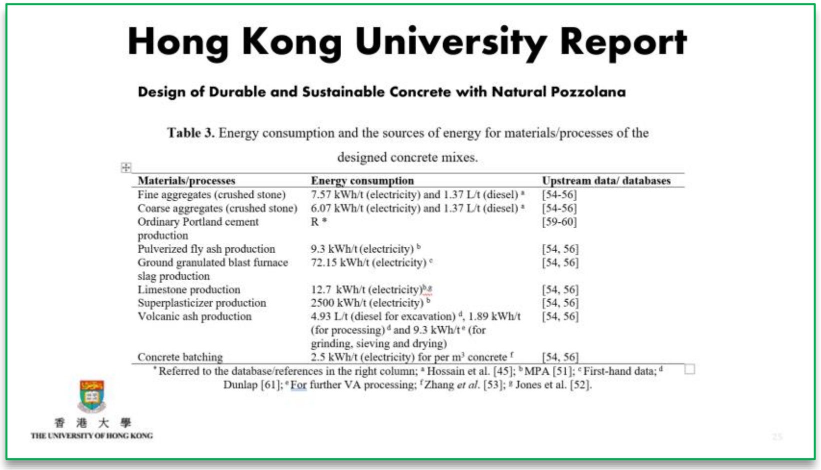
Table 2. Mixtures of the designed concrete mixes.

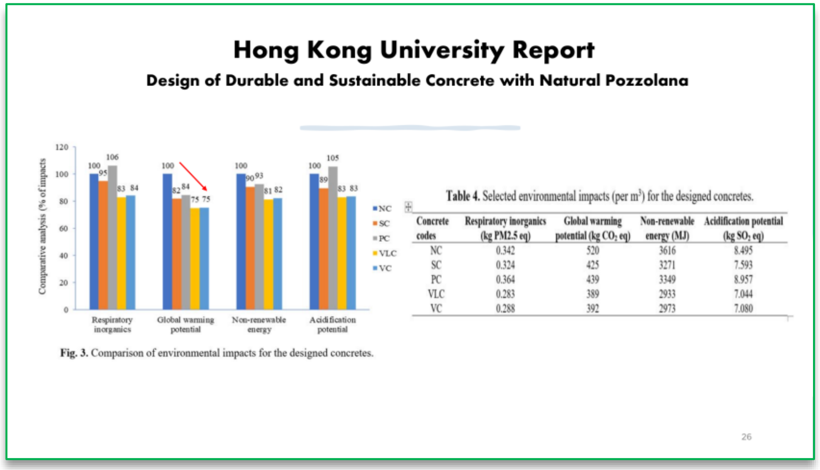
Materials (kg/m³)	Concrete codes				
	NC	SC	PC	VLC	VC
Ordinary Portland cement (OPC)	450.0	315.0	315.0	315.0	315.0
Ground granulated blast furnace slag (GGBS)	0.00	119.4	0.00	0.0	0.00
Pulverized fly ash (PFA)	0.00	0.00	104.8	0.00	0.00
Volcanic ash (VA)	0.00	0.00	0.00	74.3	109.0
Limestone (LM)	0.00	0.00	0.00	37.1	0.00
Coarse aggregates	1015	1015	1015	1015	1015
Fine aggregates	745	745	745	745	745
Water	198	198	198	198	198
Superplasticizer	2.2	2.3	2.0	3.0	3.7
Total (kg/ m³)	2410.2	2394.7	2379.8	2387.4	2385.7
w/b ratio	0.44	0.46	0.47	0.46	0.47

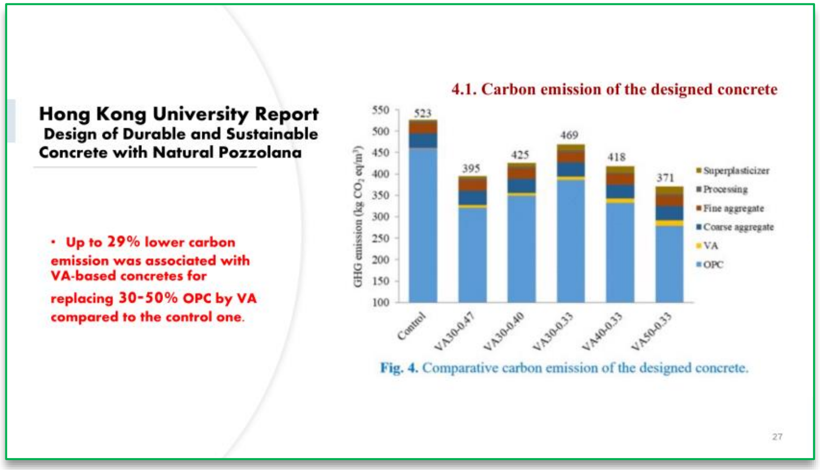
[Note: NC: normal concrete produced with OPC; SC: slag concrete with 30% OPC replacement; PC: fly ash concrete with 30% OPC replacement; VLC: concrete with 20% and 10% OPC replacement with volcanic ash and limestone (total 30%), respectively; VC: natural pozzolan concrete with 30% OPC replacement]

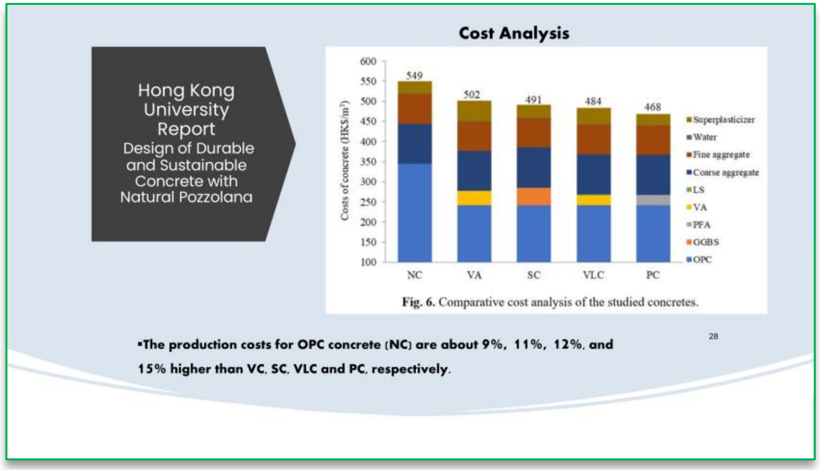
Hong Kong University Report

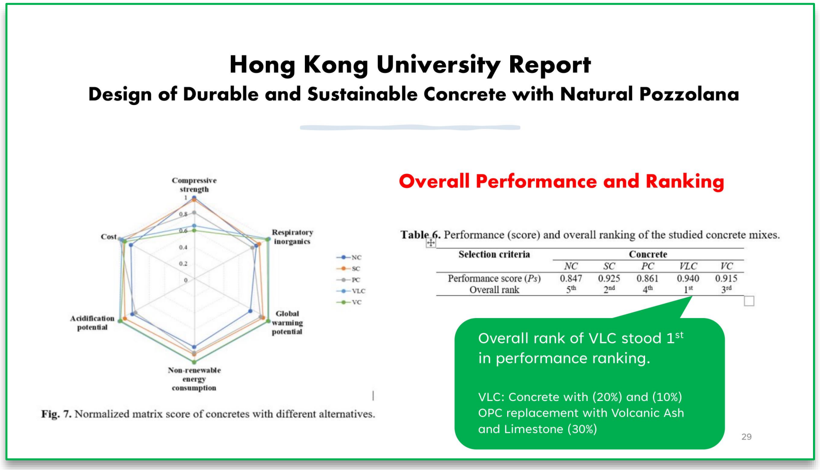
Design of Durable Concrete with Natural Pozzolana











Hong Kong University Report

Design of Durable and Sustainable Concrete with Natural Pozzolana

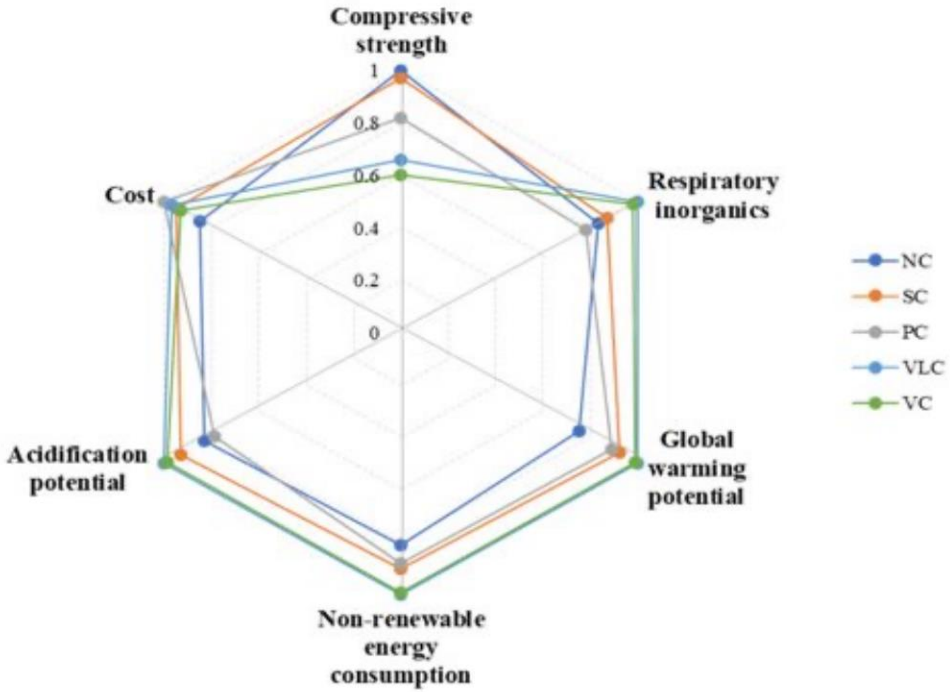


Fig. 7. Normalized matrix score of concretes with different alternatives.

Overall Performance and Ranking

Table 6. Performance (score) and overall ranking of the studied concrete mixes.

Selection criteria	Concrete				
	NC	*SC*	*PC*	*VLC*	*VC*
Performance score (*Ps*)	0.847	0.925	0.861	0.940	0.915
Overall rank	5^{th}	2^{nd}	4^{th}	1^{st}	3^{rd}

Overall rank of VLC stood 1^{st} in performance ranking.

VLC: Concrete with (20%) and (10%) OPC replacement with Volcanic Ash and Limestone (30%)

Hong Kong University Report

Design of Durable and Sustainable Concrete with Natural Pozzolana

1. It notes that concrete using VA based has the lowest impact on the environment then other alternative binders.
2. Our Natural Pozzolana can save up to **29% of carbon emissions** in production of concrete if our volcanic ash replaced **30-50%** of OPC.
3. "Overall results in terms of mechanical, environmental and cost performance, it can be concluded that VA can be effectively used as a substitute of OPC by a range between **30-50%** in the concrete, depending on the targeted concrete in terms of strength, costs and carbon emissions".
4. In the report it also shows the designed concrete of (VLC) which has a mixture of our VA and limestone **(20% VA & 10% limestone)** can enhance the mechanical and environmental performance and reduce the production costs was ranked first among other SCM's.
5. Based on this report our NP can be an attractive alternative SCM for substituting OPC in producing sustainable concrete.
6. These figures show that utilizing NP into concrete can indeed save on carbon footprint by a big margin.

CO2 emission of **OPC**

100%

CO2 emission of

Peakward Pozzolana

0%

WHO ARE WE

SERVING SATISFIED GLOBAL CLIENTS **FOR 33 YEARS**

3 million tons of Cement and cement industry raw materials supplied globally.

- Cement of all types (Type I, II, III, IV, V, I/II, II/V) in **40/50 kg Bags** (or other packings) in **1-2 MT Sling Bags**, bulk in **1-2 MT Jumbo Bags**, and loaded in bulk in bulk-career vessels.
- Clinker.
- All SCMs: **Slag** (GBFS/GGBS), **Fly Ash**, **Natural Pozzolana**, **Micro Silica**.
- Natural and Flue Gas **Gypsum**.
- Limestone.
- Aggregate for concrete.

Peakward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SCAN

To get the full HKU report and relevant documents which include Peakward Group