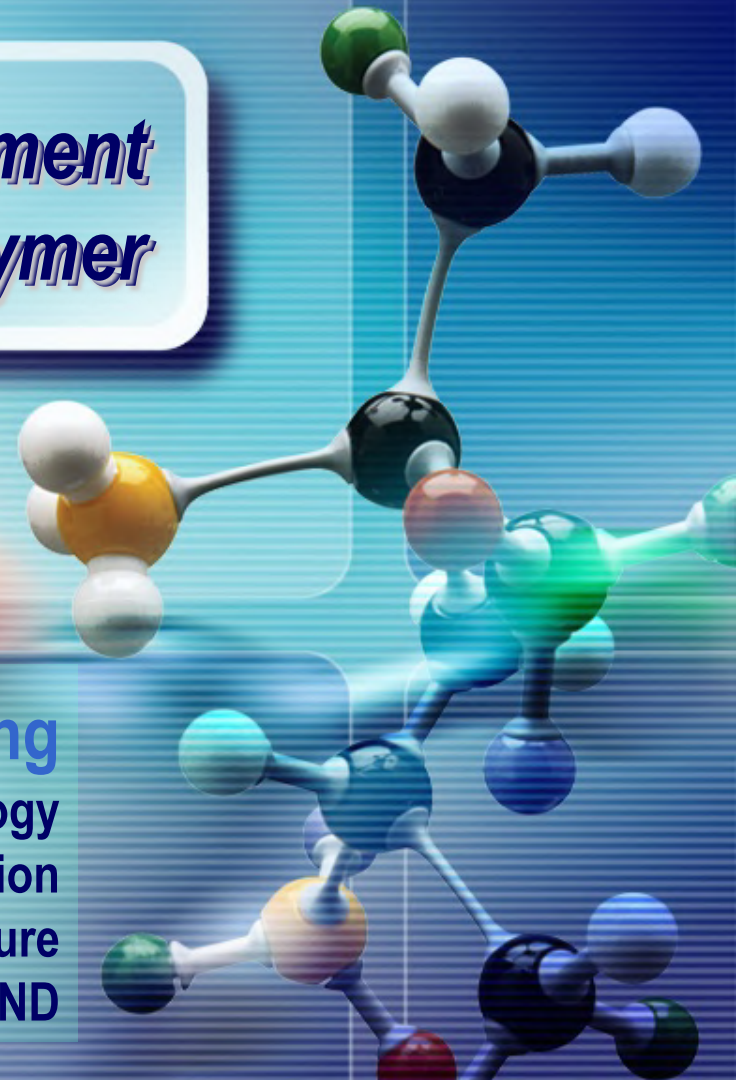


***Construction material development
using fly ash based geopolymer***

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Outline



Introduction

Experimental program

Results and discussion

Conclusions

Background

Lampang Province -Mae Moh



3,500,000 tons/year



Background

Geopolymerization

WASTE



Geopolymer

Construction materials

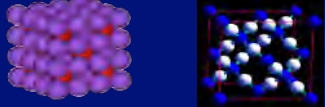
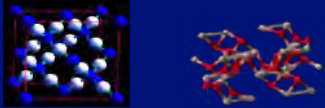
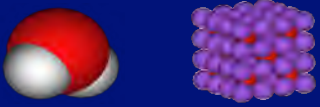
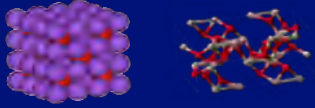


Sustainable Development

Materials



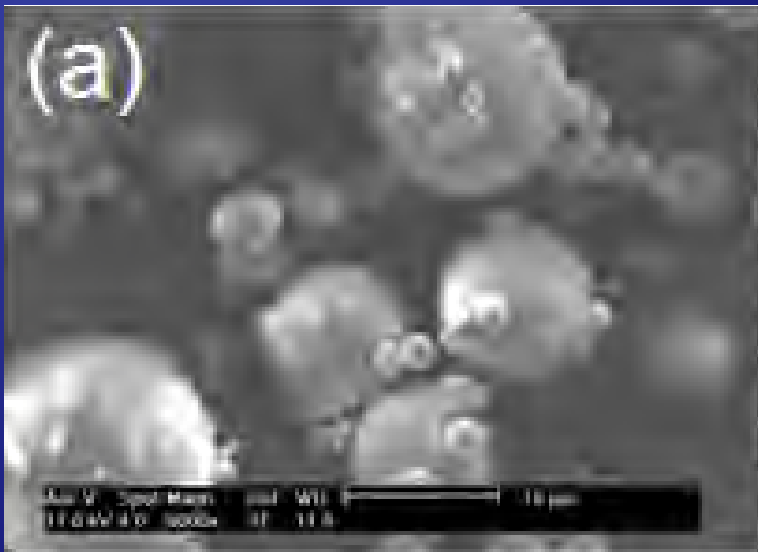
Oxide-mole ratios of reactant mixture

Molar ratio	Value (Davidovits : 1982)
$\text{Na}_2\text{O} / \text{SiO}_2$ 	0.20-0.48
$\text{SiO}_2 / \text{Al}_2\text{O}_3$ 	3.50-4.50
$\text{H}_2\text{O} / \text{Na}_2\text{O}$ 	10.0-25.0
$\text{Na}_2\text{O} / \text{Al}_2\text{O}_3$ 	0.80-1.60

Materials



- Fly ash produced by Mae Moh plant,
- Sodium hydroxide (10M)
- Sodium silicate solution ($\text{SiO}_2:\text{Na}_2\text{O} = 3:1$)



	SiO_2	Al_2O_3	CaO	Fe_2O_3
Composition (mass %)	32-38	20-24	16-19	14-16

Objectives

1

**Effect of alkali
solution ratio**

(WR = 1.0-2.5)



2

**Compressive
Strength**



3

Microstructure

**SEM / EDS
Analysis**



**Weight Ratio of
 $\text{Na}_2\text{SiO}_3 : \text{NaOH} < 0.50$**

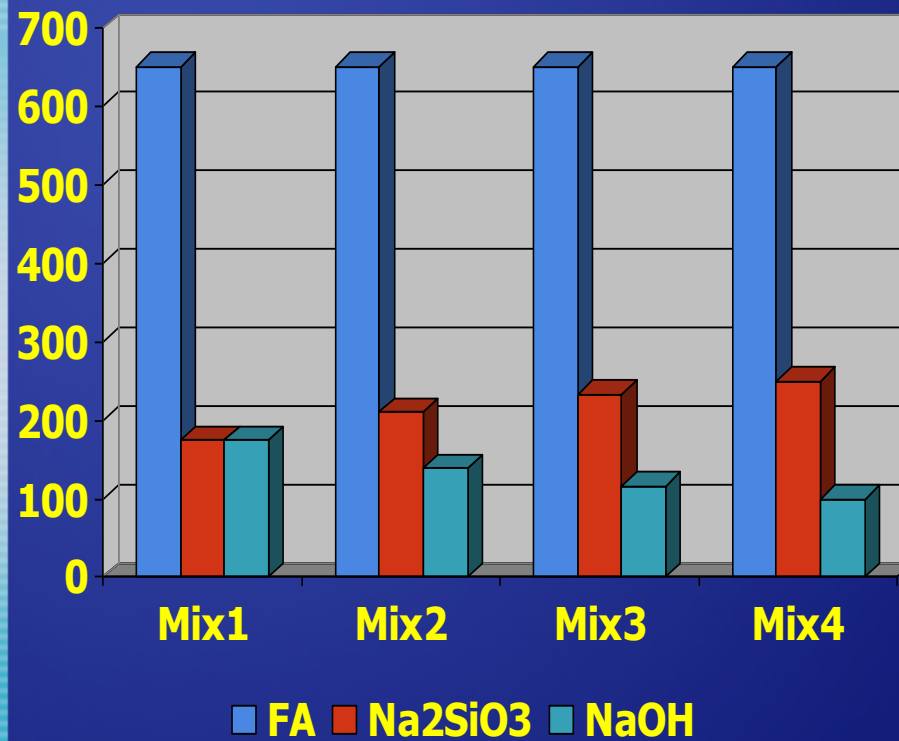


**Weight Ratio of
 $\text{Na}_2\text{SiO}_3 : \text{NaOH} > 3.00$**



Experimental program

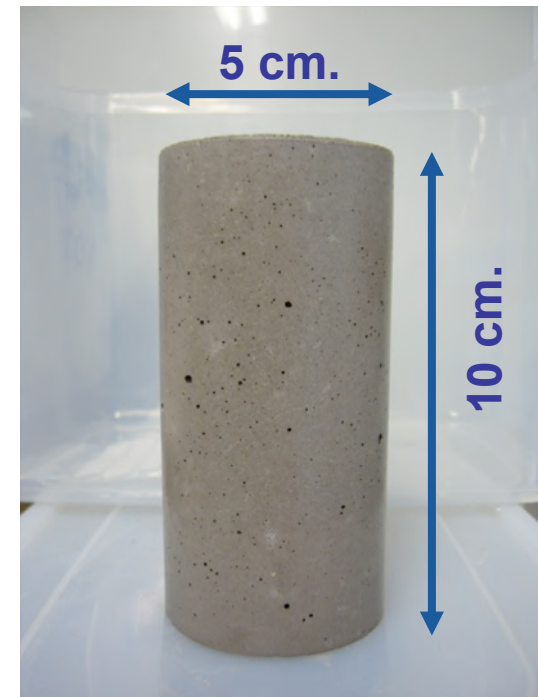
Mixture



Mix no.	Fly ash (gm.)	Alkali activator		
		Na ₂ SiO ₃ (gm.)	NaOH (gm.)	Weight ratio
1	650.0	175.0	175.0	1.0
2	650.0	210.0	140.0	1.5
3	650.0	233.3	116.7	2.0
4	650.0	250.0	100.0	2.5

+
Sand 2000 (gm.)

The geopolymer mortar was poured into mould and stored in the ambient temperature



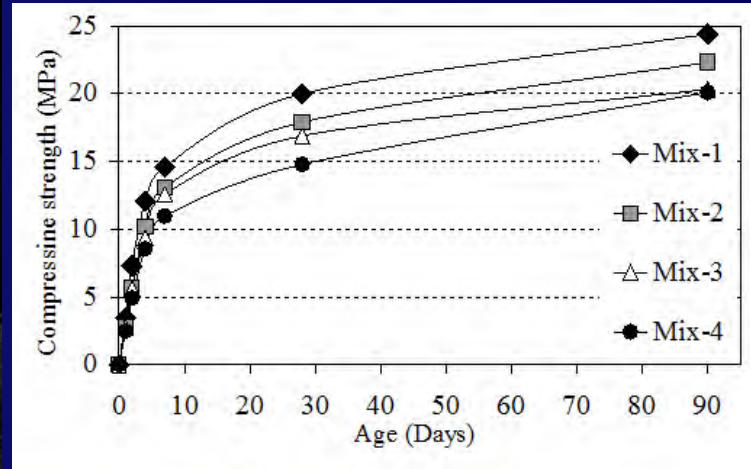
Testing method



Compression test

Testing method

Compressive strength



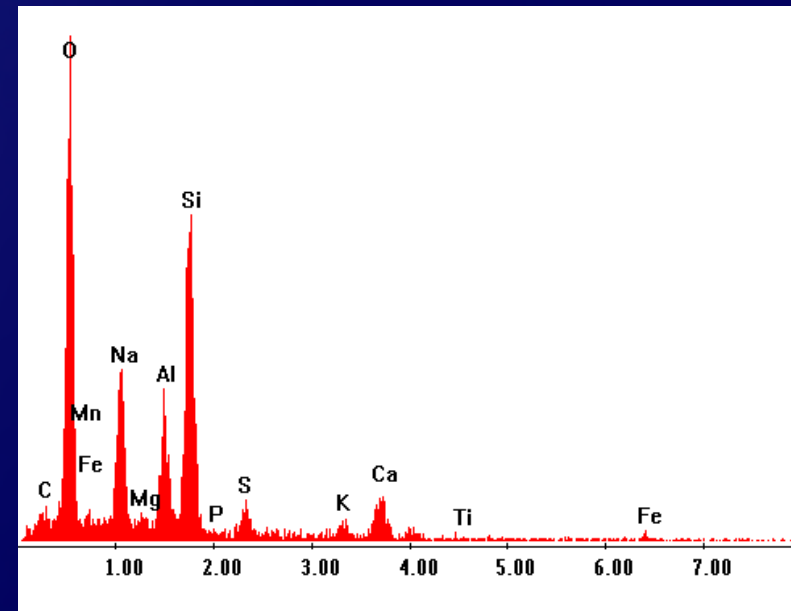
At the ages of 1, 2, 4, 7, 28 and 90 days, specimens were taken from the storage room and tested for compressive strength.

Testing method

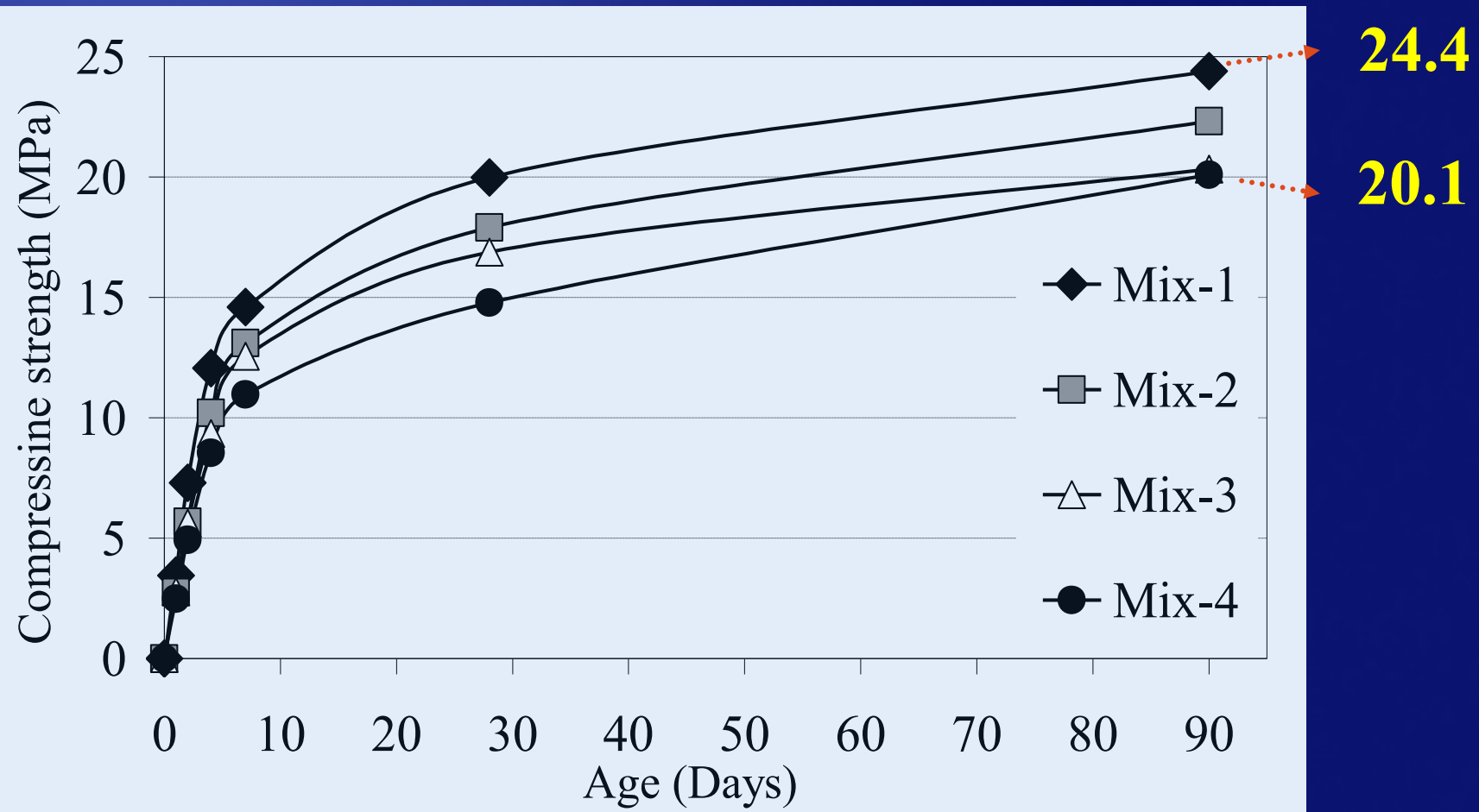
The small pieces of tested specimens were examined using scanning electron microscope (SEM)/energy dispersive X-ray (EDX) to determine the composition of products.



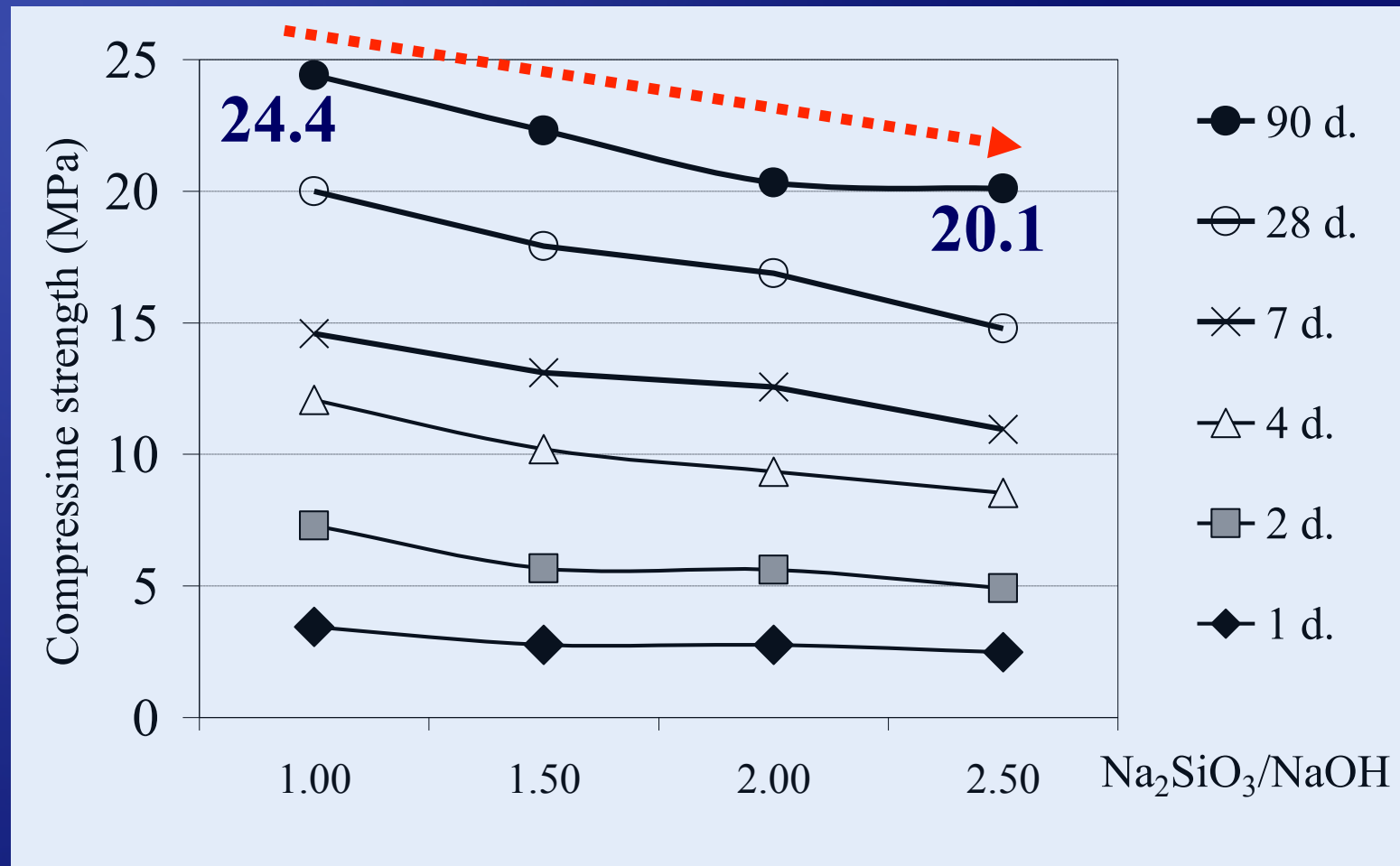
SEM/EDS



Compressive strength



Effect of alkali solution ratio

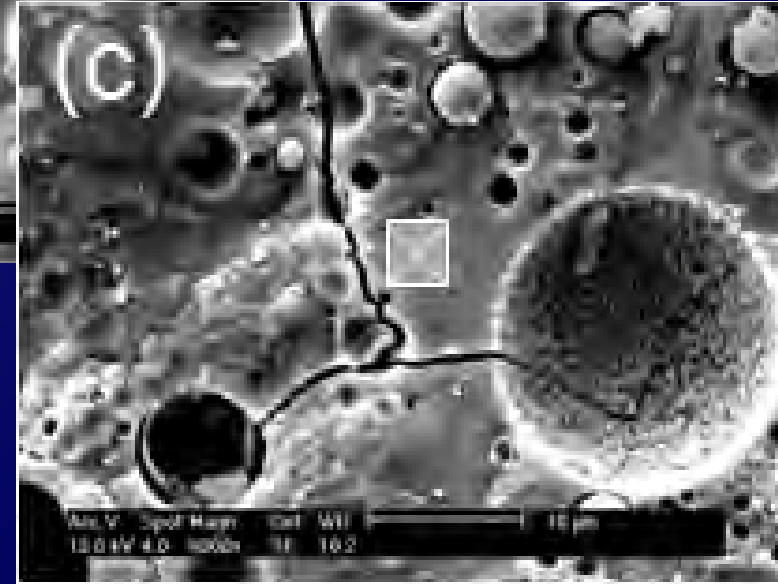


SEM/EDS

(a) Fly ash [5000X]

(b) Mix-1 [5000X]

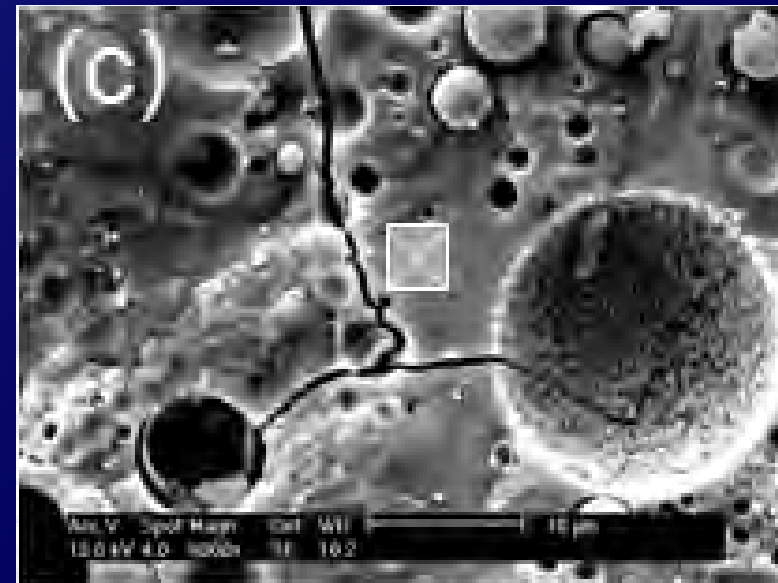
(c) Mix-4 [5000X]



SEM/EDS

Si/Al atomic ratio

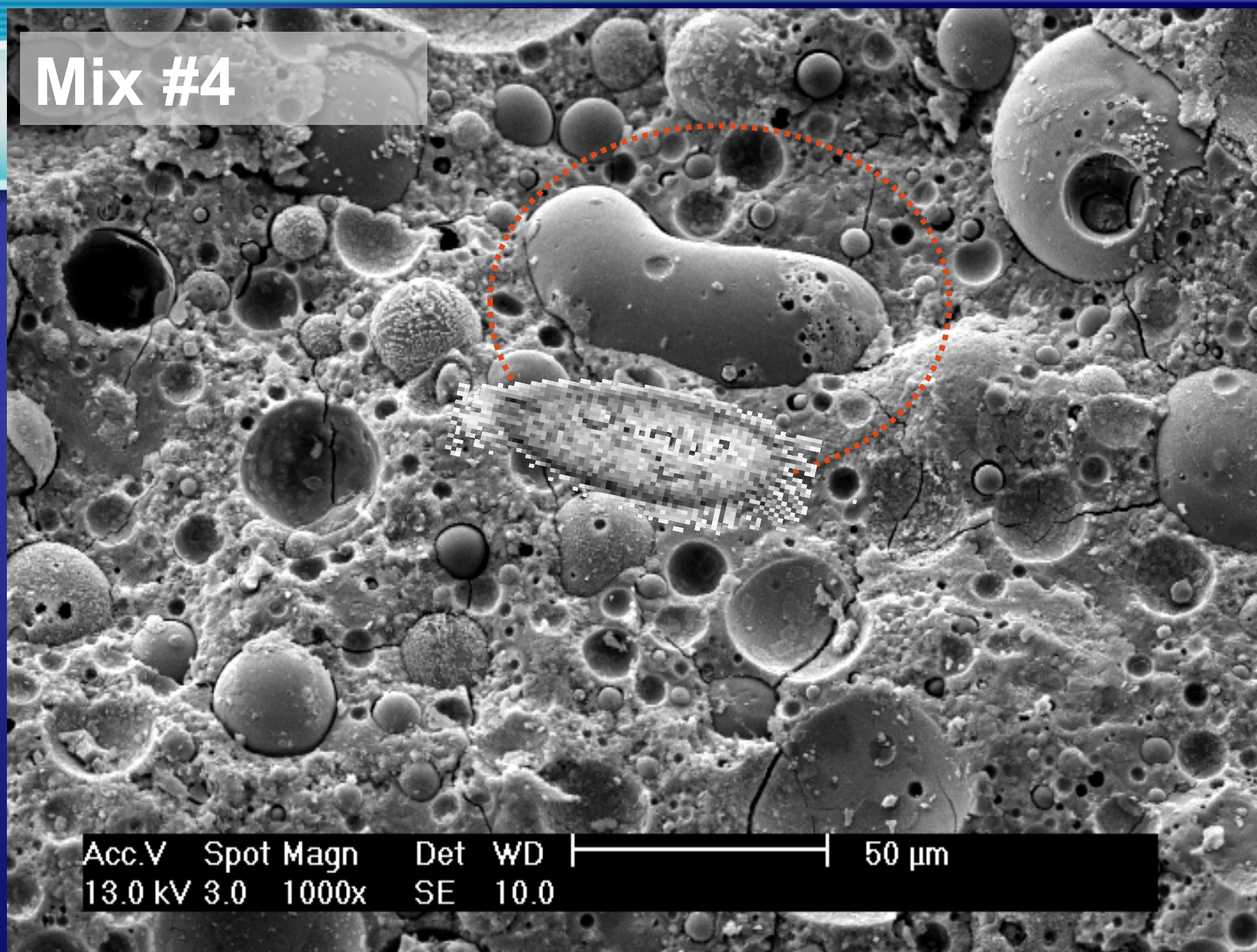
2.64 - 2.85



Mix #4

Acc.V Spot Magn Det WD |-----| 20 μ m
13.0 kV 5.0 1500x SE 9.2

Mix #4



Acc.V	Spot	Magn	Det	WD	50 μ m
13.0 kV	3.0	1000x	SE	10.0	

Conclusions

Alkali solution

+

**Fly ash from
Mae Moh Plant**



**Geopolymer
product**

Conclusions



NaOH content



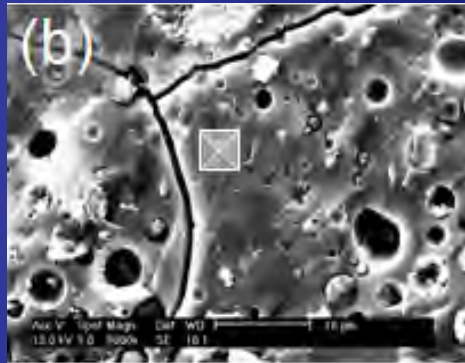
Na₂SiO₃ content



Compressive strength



Conclusions



The microstructure of fly ash based geopolymer revealed a homogeneous structure.

Microstructure





Geopolymer mortar and OPC mortar immersed in sulfuric acid 5% after 120 days

OPC



8M Geopolymer

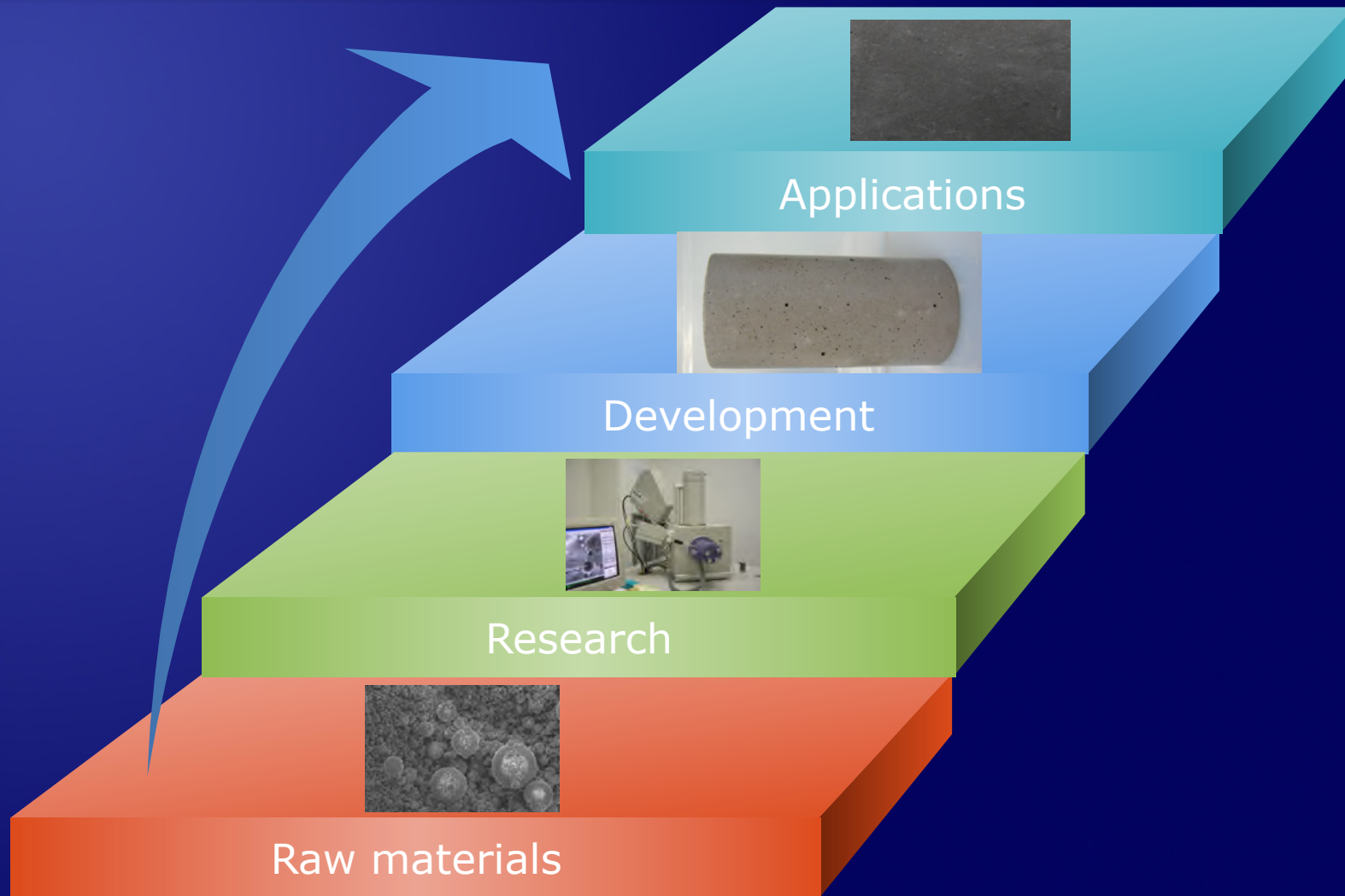


10M Geopolymer



12M Geopolymer

Conclusions



Raw materials

Research

Development

Applications



Thank you for your attention

(in THAI)

khobkun-Krub – for male

khobkun-Ka – for female