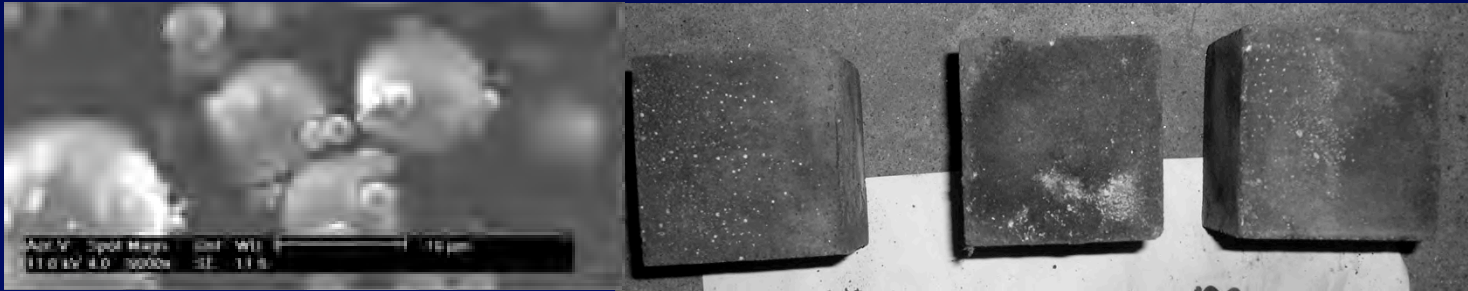


# HIGH CALCIUM FLY ASH BASED GEOPOLYMER FOR CONSTRUCTION APPLICATIONS



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# Background

# Introduction

## Lampang Province -Mae Moh



3,500,000 tons/year



# Background

## Introduction

Geopolymerization

WASTE

Geopolymer

Construction materials

Sustainable Development





# Objectives

## Introduction

1

### Properties of geopolymer paste

- Setting time
- Compressive strength



2

### Microstructure of geopolymer paste

- SEM / EDS Analysis



3

### Properties of geopolymer mortar products

- Block
- Tile



# Materials



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

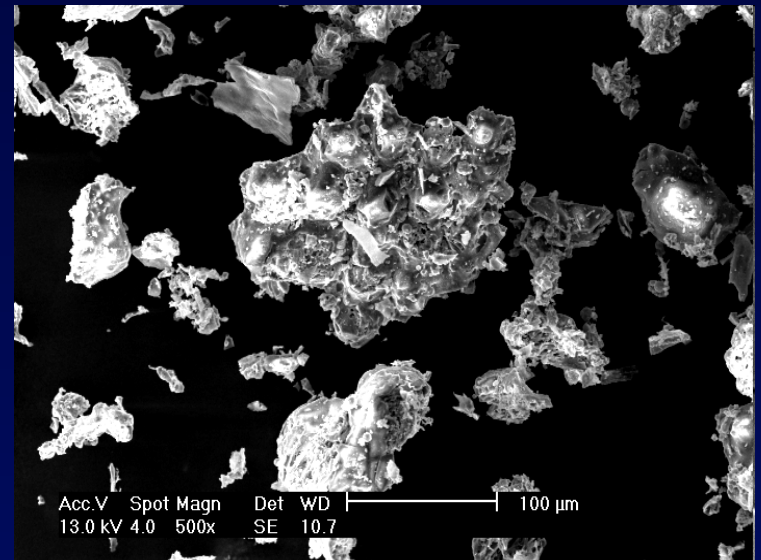
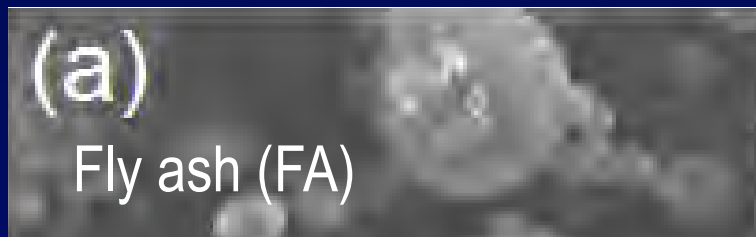




Rice husk



Rice husk ash (RHA)



Rice husk ash (RHA)

Chemical composition (mass %)

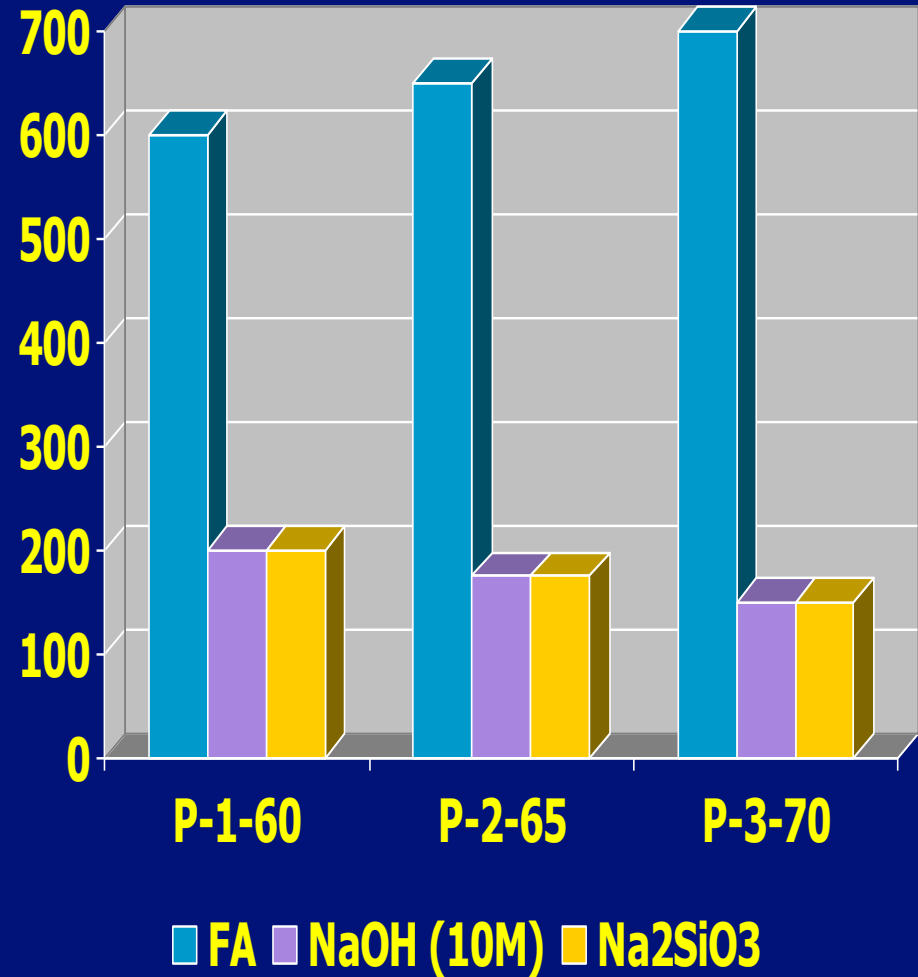
Raw material	SiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	CaO	Fe <sub>2</sub> O <sub>3</sub>	MgO	Na <sub>2</sub> O	K <sub>2</sub> O	Loss on ignition
FA	35.3	21.5	18.7	14.2	3.0	2.5	2.0	0.4
RHA	92.2	0.5	0.83	0.34	-	-	-	5.88

# Mixture

## Experimental program

Mix no.	FA Solution	Weight		
		FA (gm.)	NaOH 10M (gm.)	Na <sub>2</sub> SiO <sub>3</sub> (gm.)
P-1-60	1.50	600	200	200
P-2-65	1.86	650	175	175
P-3-70	2.33	700	150	150

Table 2: Mix proportions





# Testing method

1<sup>st</sup> part



**Setting time**



# *Testing method*

The 2<sup>nd</sup> part

-cube (5 X 5 X 5 cm)

-room temperature

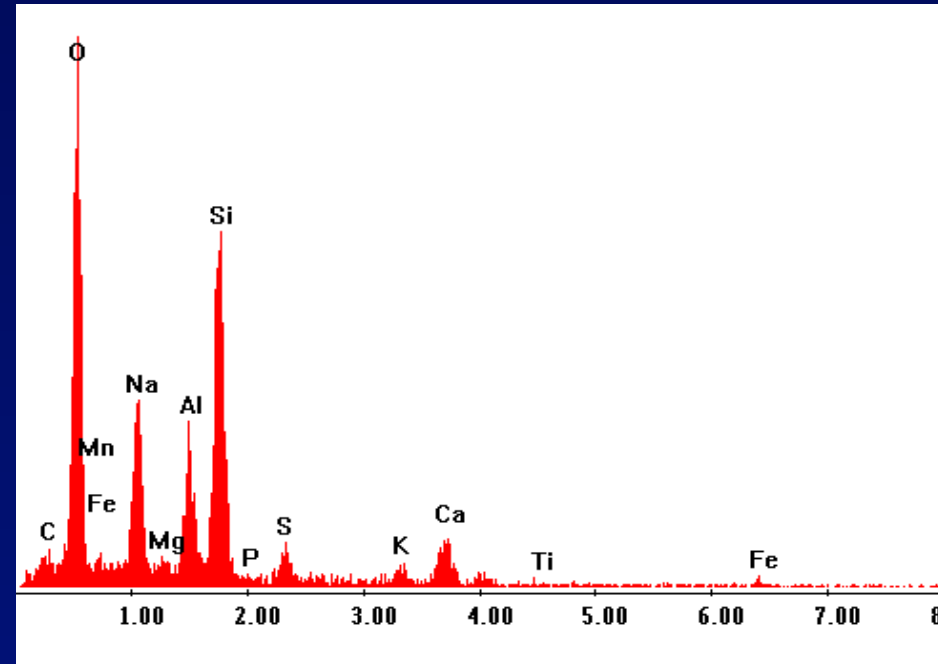
-compressive strength test



**Compression test**

# Testing method

## Experimental program

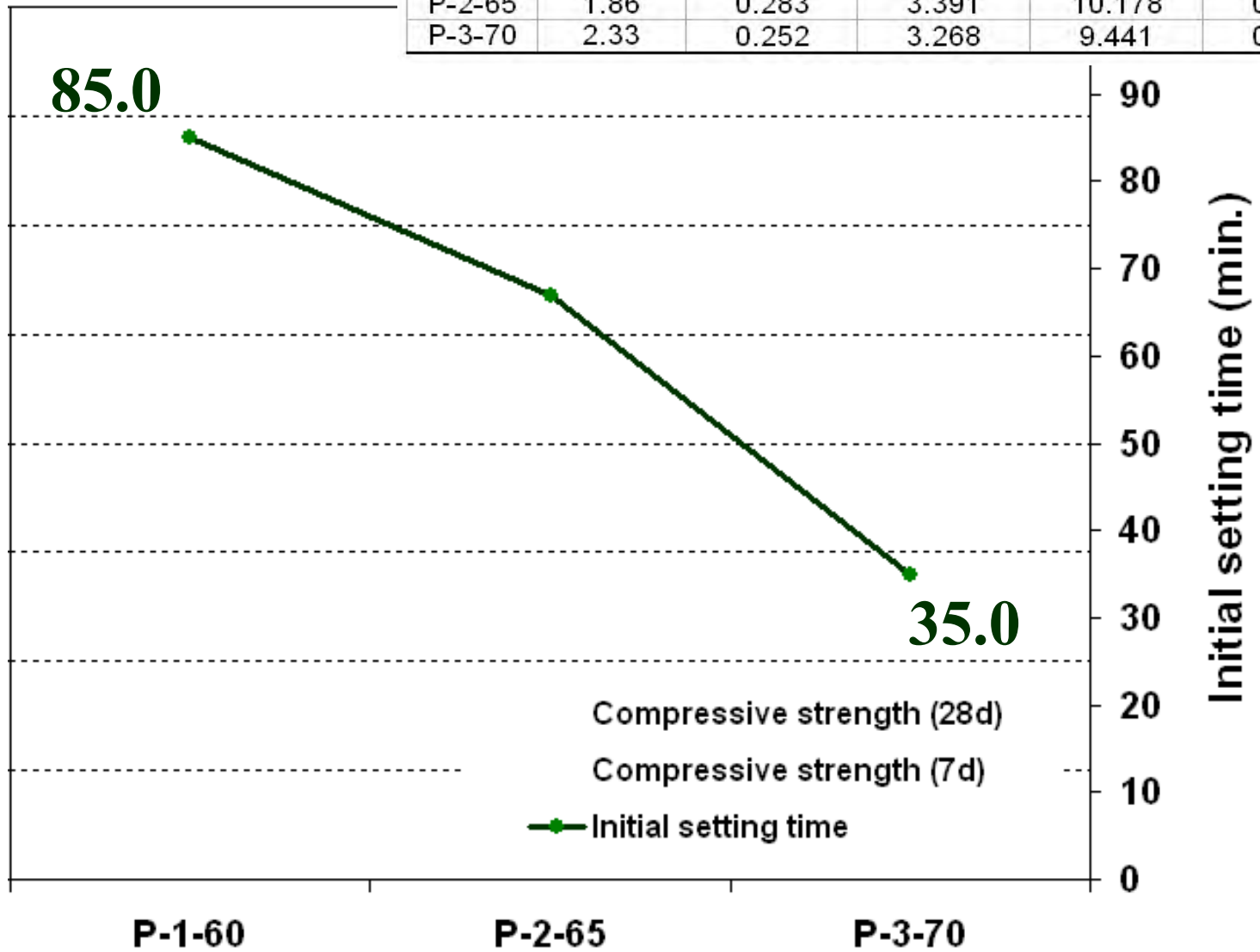


**SEM/EDS**



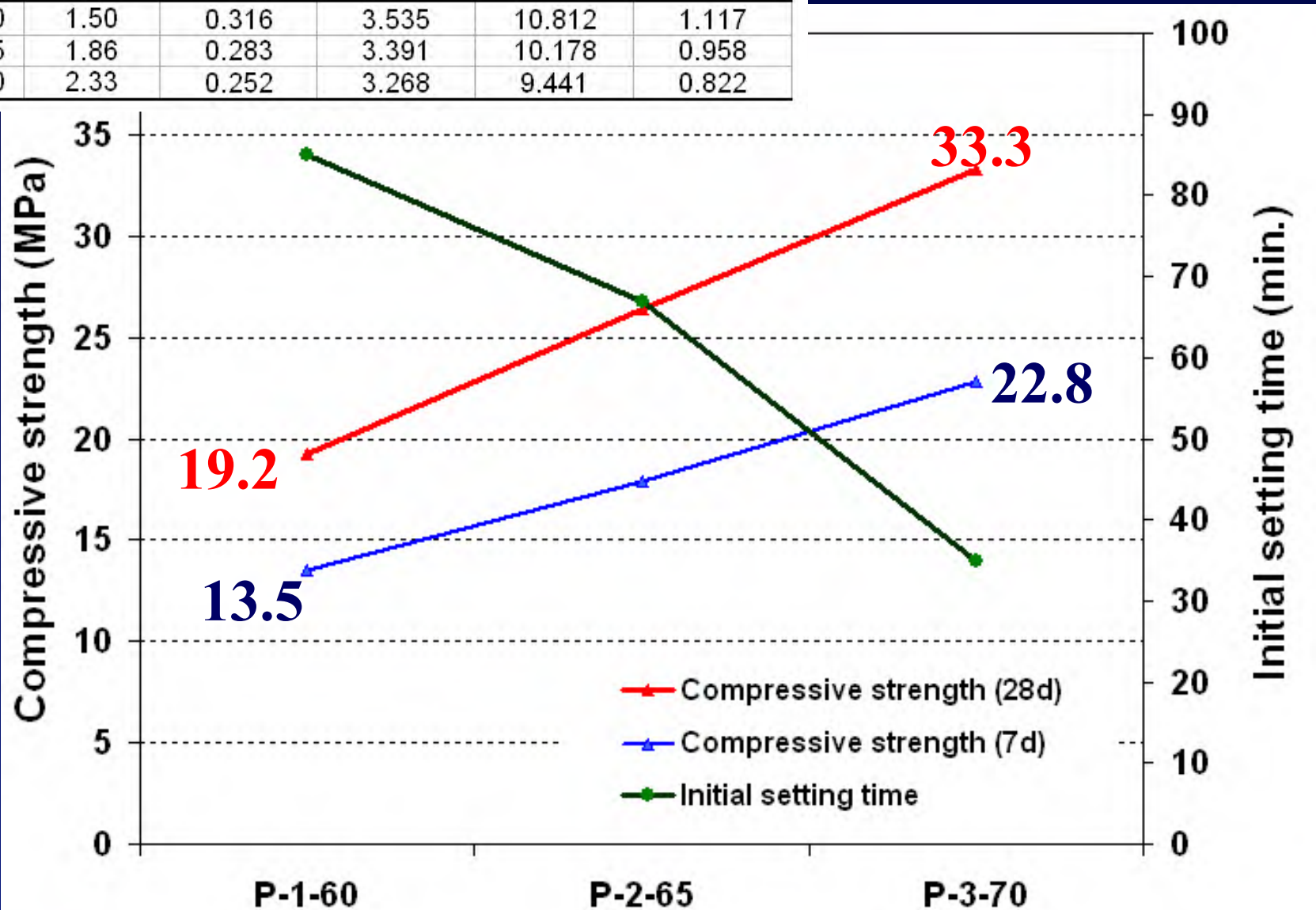
# Setting time & Compressive strength

Mix no.	FA Solution	Oxide mole ratio of the reactant mixture (*M <sub>2</sub> O = Na <sub>2</sub> O+K <sub>2</sub> O)			
		$\frac{M_2O}{SiO_2}$	$\frac{SiO_2}{Al_2O_3}$	$\frac{H_2O}{M_2O}$	$\frac{M_2O}{Al_2O_3}$
P-1-60	1.50	0.316	3.535	10.812	1.117
P-2-65	1.86	0.283	3.391	10.178	0.958
P-3-70	2.33	0.252	3.268	9.441	0.822

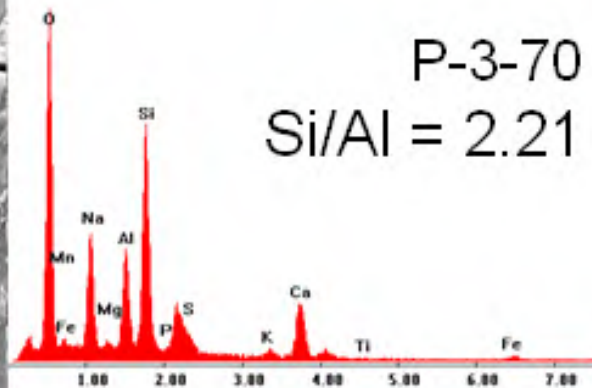
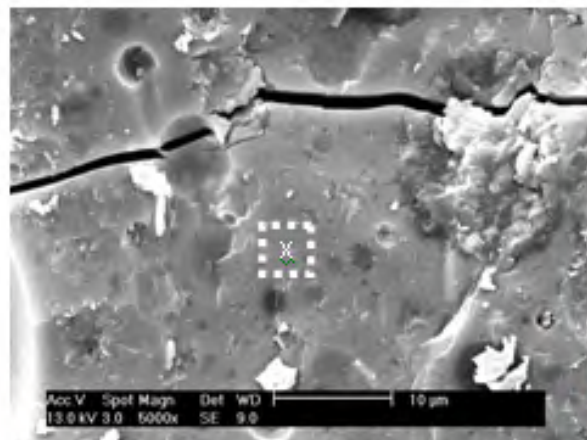
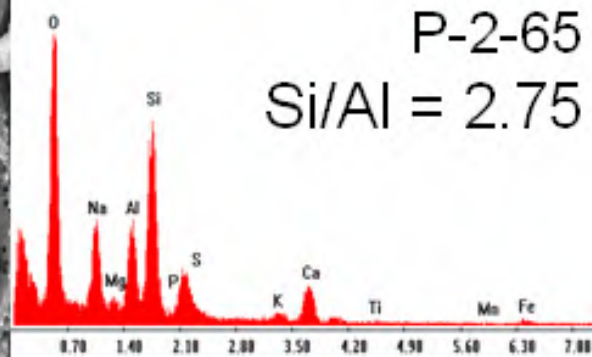
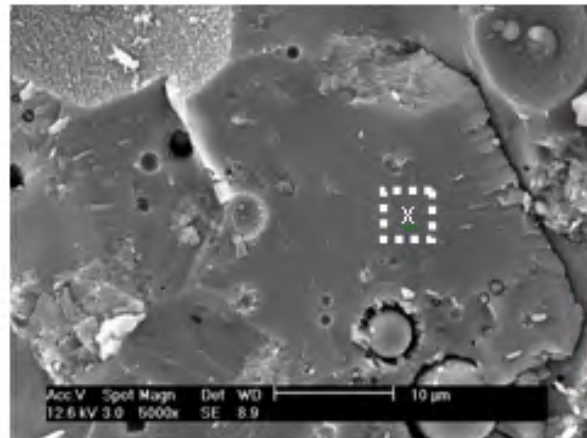
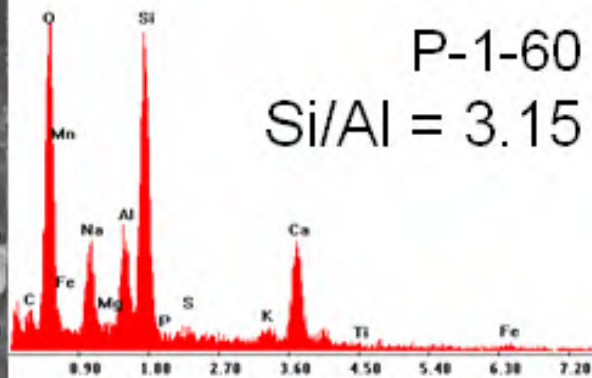
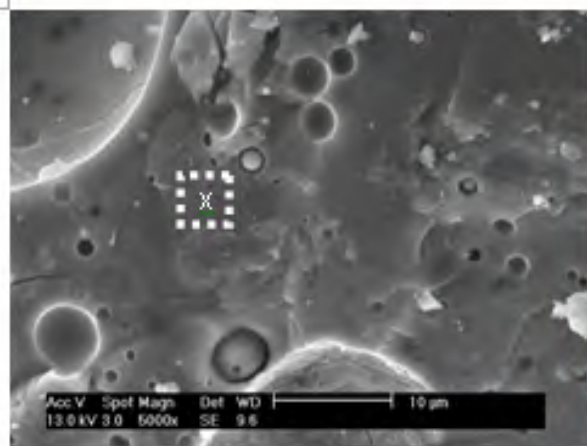


# Results & discussion

Mix no.	FA Solution	Oxide mole ratio of the reactant mixture (*M <sub>2</sub> O = Na <sub>2</sub> O+K <sub>2</sub> O)			
		$\frac{M_2O}{SiO_2}$	$\frac{SiO_2}{Al_2O_3}$	$\frac{H_2O}{M_2O}$	$\frac{M_2O}{Al_2O_3}$
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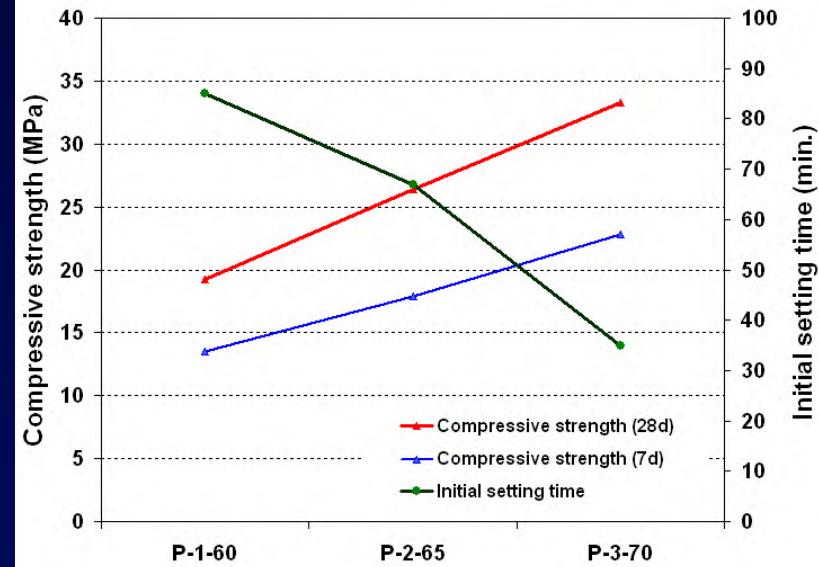


# Results & discussion





# Testing method



Mix no.	% FA replacement	Weight (gm.)				
		FA	RHA	NaOH	Na <sub>2</sub> SiO <sub>3</sub>	Sand
<b>M-1-R0.0</b>	0.0	650.00	0.00	175	175	975
<b>M-2-R2.5</b>	2.5	633.75	16.25	175	175	975
<b>M-3-R5.0</b>	5.0	617.50	32.50	175	175	975
<b>M-4-R7.5</b>	7.5	601.25	48.75	175	175	975

# *Testing method*



Geopolymer block



Geopolymer tile

# Properties of Geopolymer products

## Results & discussion

Mix no.	Geopolymer block							
	Compressive strength (MPa)							
	3 d	7 d	28 d					
M-1-R0.0	10.36	16.12	26.91					
M-2-R2.5	10.45	15.56	24.96					
M-3-R5.0	10.37	15.52	20.64					
M-4-R7.5	9.27	13.00	19.05					

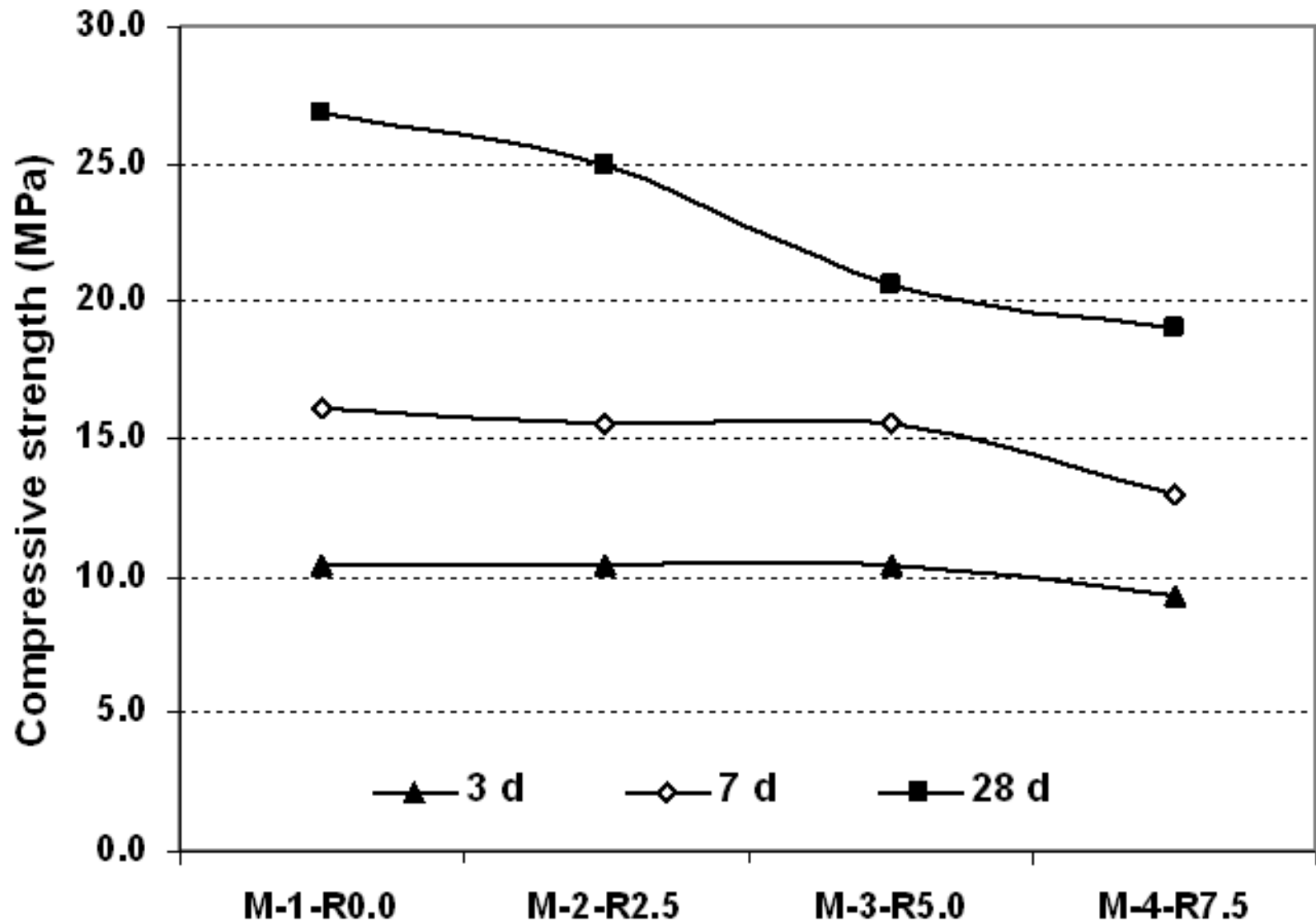


# Properties of Geopolymer products

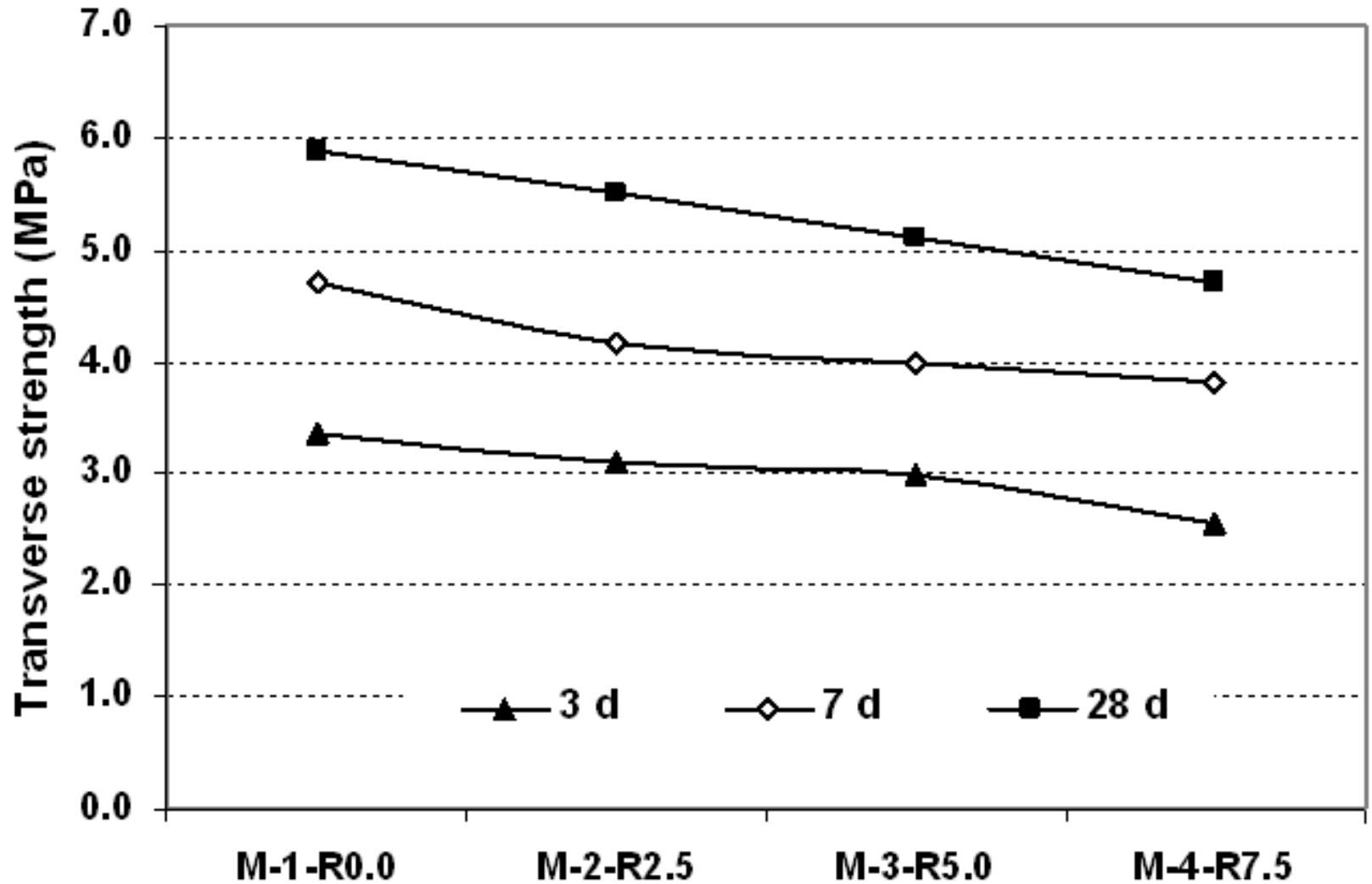
## Results & discussion

Mix no.	Geopolymer block			Geopolymer tile		
	Compressive strength (MPa)			Transverse strength (MPa)		
	3 d	7 d	28 d	3 d	7 d	28 d
M-1-R0.0	10.36	16.12	26.91	3.36	4.70	5.89
M-2-R2.5	10.45	15.56	24.96	3.09	4.16	5.50
M-3-R5.0	10.37	15.52	20.64	2.99	3.99	5.12
M-4-R7.5	9.27	13.00	19.05	2.54	3.83	4.71

# Results & discussion



# Results & discussion





# *Conclusions*

**Alkali solution**

+

**FA from Mae Moh Plant  
+ RHA**



**Geopolymer  
product**

# *Conclusions*

**FA / Solution  
weight ratio**



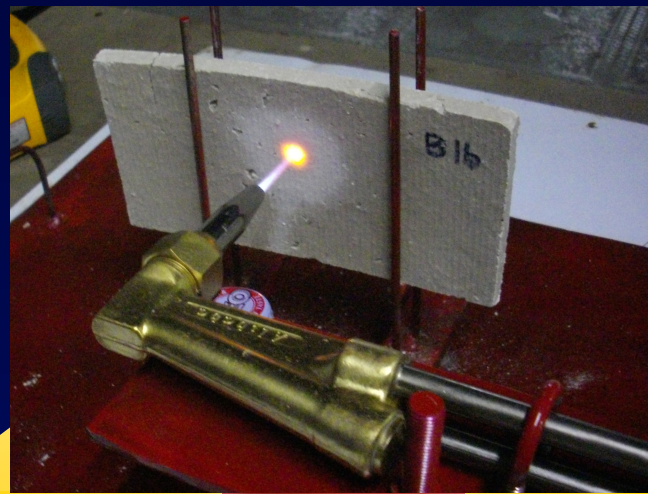
**RHA content**



**Compressive  
& Transverse  
strength**



# *Conclusions*



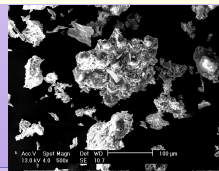
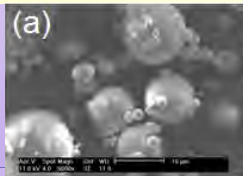
Applications



Development



Research



Raw materials



*Thank you for your attention*

*(in THAI)*

*khobkun-Krub* – for male

*khobkun-Ka* – for female