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ITS
Institut Teknologi Sepuluh Nopember

Effects of Microbial Agents to The Properties of Fly Ash-Based Paste

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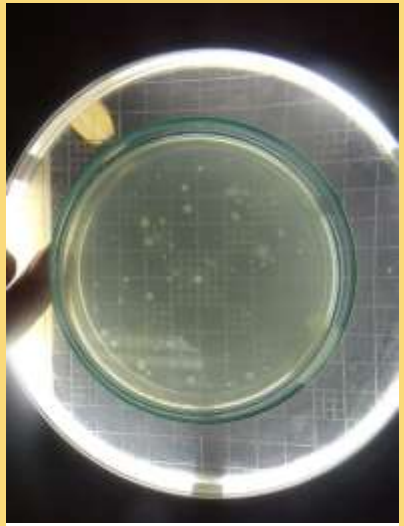
Introduction

Microorganisms, including bacteria, fungi, and algae, responsible for the production of biominerals such as carbonate, silicate, and calcium phosphate.

Bio-mineralization is the approach of biotechnology to **increase the properties of cement-based materials**.

Introduction



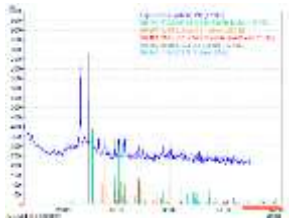
MICROBES

FLY ASH-BASED PASTE

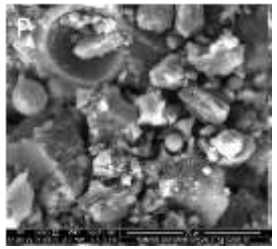
- GEOPOLYMER PASTE
- CEMENT PASTE

COMPRESSIVE STRENGTH TEST

XRD ANALYSIS



SEM ANALYSIS



SPECIFIC GRAVITY TEST

POROSITY TEST

Materials

Alkali Activator :
Four molars of sodium hydroxide and the mass ratio of sodium silicate to sodium hydroxide was 2.

- FLY ASH SURALAYA CLASS F
- OPC
- AQUADES
- SODIUM SILICATE
- SODIUM HYDROXIDE
- MICROBIAL AGENT

Mix Proportions

Mixtures	Alkali Activator	Fly Ash	OPC	W/C Ratio	Microbial Agent
P	35 %	65 %	-	-	-
PB	35 %	65 %	-	-	400 ml/m^3
C	-	65 %	35 %	0.3	-
CB	-	65 %	35 %	0.3	400 ml/m^3

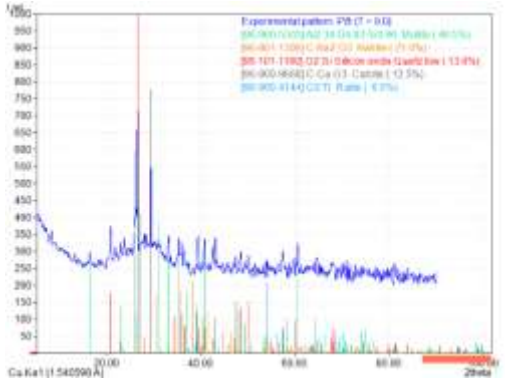
Cylinder
5 cm x 10 cm

Moist Curing

Test Methods

COMPRESSIVE STRENGTH TEST

XRD ANALYSIS



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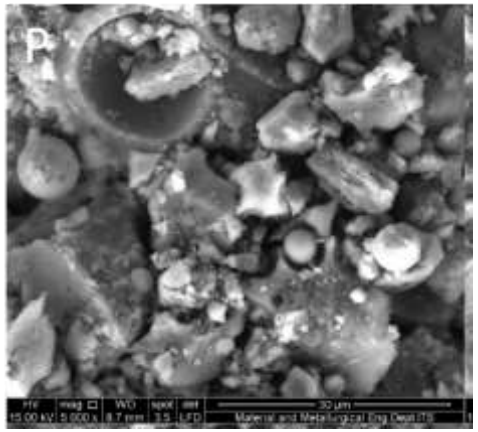

SPECIFIC GRAVITY TEST

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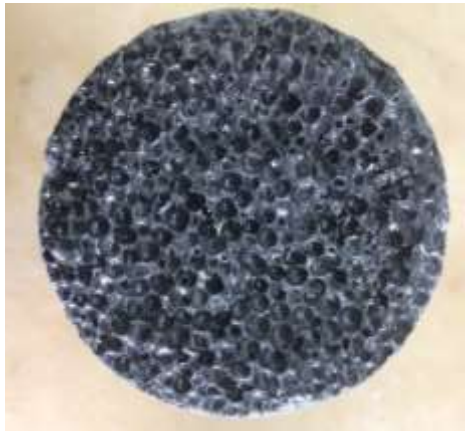
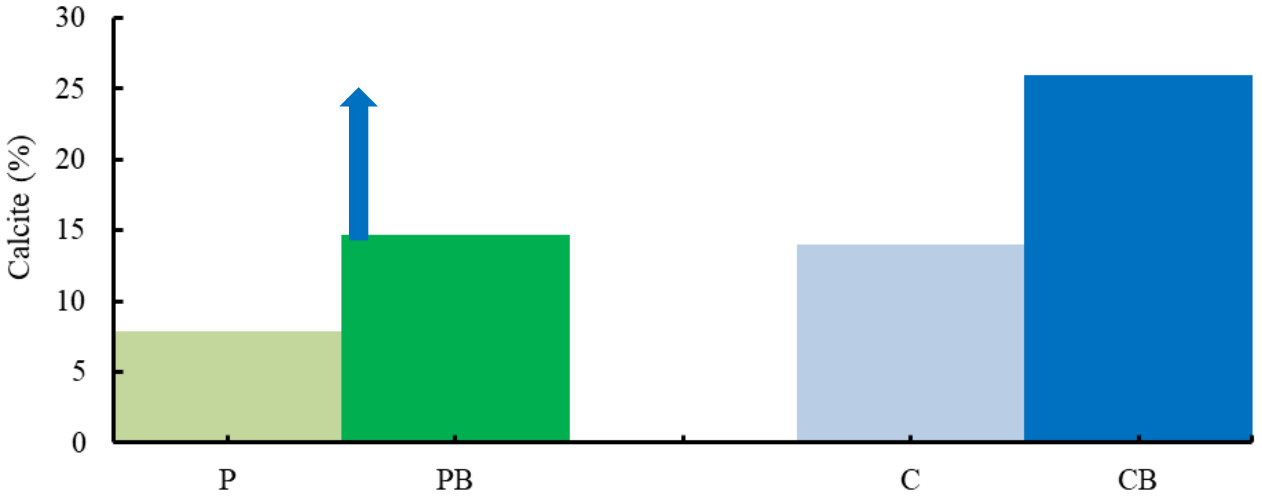


Results and Discussions
XRD Analysis

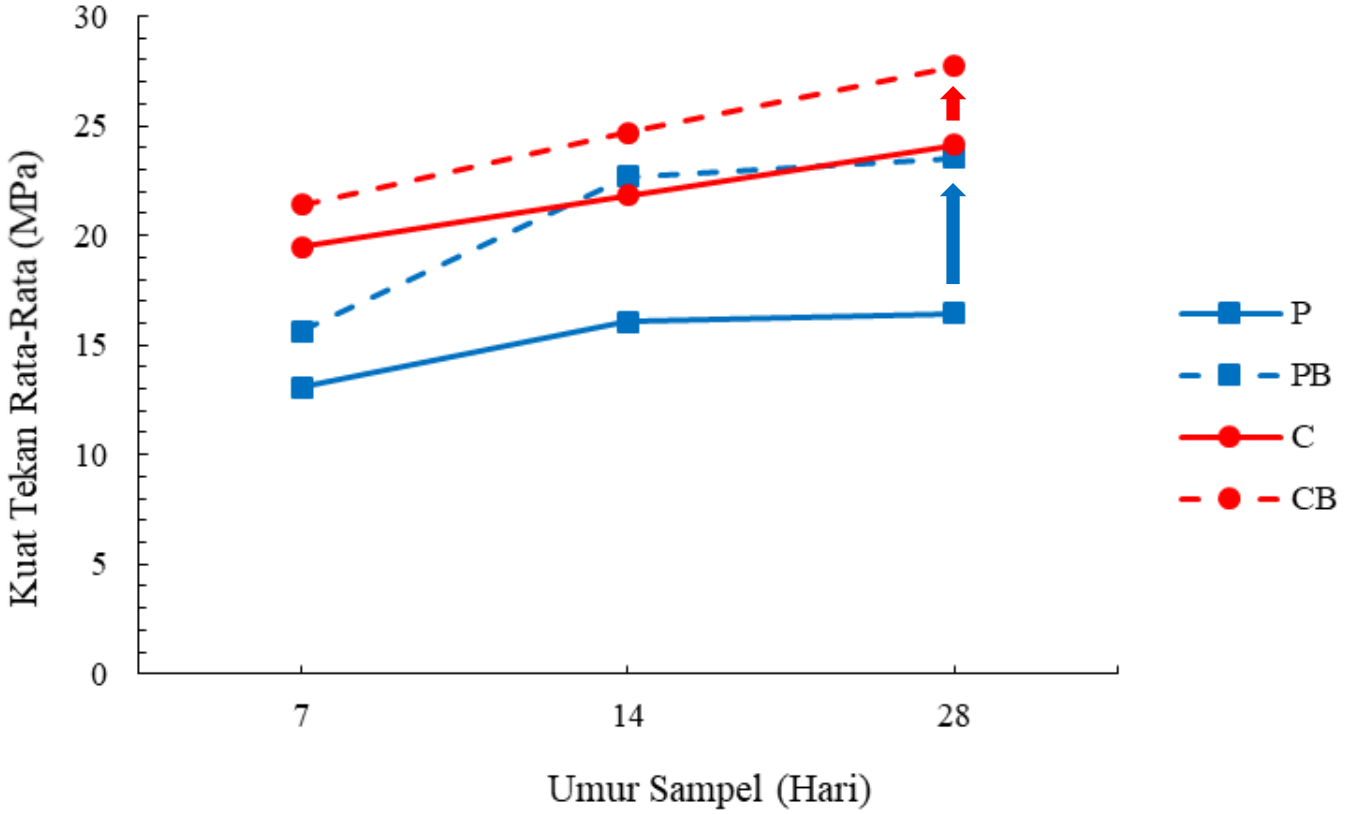
Oxides	P	PB
Mullite (Al_2SiO_4)	41.6 %	32.8 %
Zeolite ($Al_3NaH_{12}KO_{22}Si_5$)	31.7 %	38.7 %
Calcite ($CaCO_3$)	7.9 %	14.7 %
Quartz (SiO_2)	14.8 %	13.8 %
Rutile (TiO_2)	4.0 %	0.1 %

Oxides	C	CB
Mullite (Al_2SiO_4)	38.9 %	27.5 %
Tobermorite ($Ca_3HO_9Si_3$)	32.3 %	36.4 %
Calcite ($CaCO_3$)	14.0 %	26.0 %
Quartz (SiO_2)	9.9 %	9.0 %
Rutile (TiO_2)	4.9 %	1.1 %



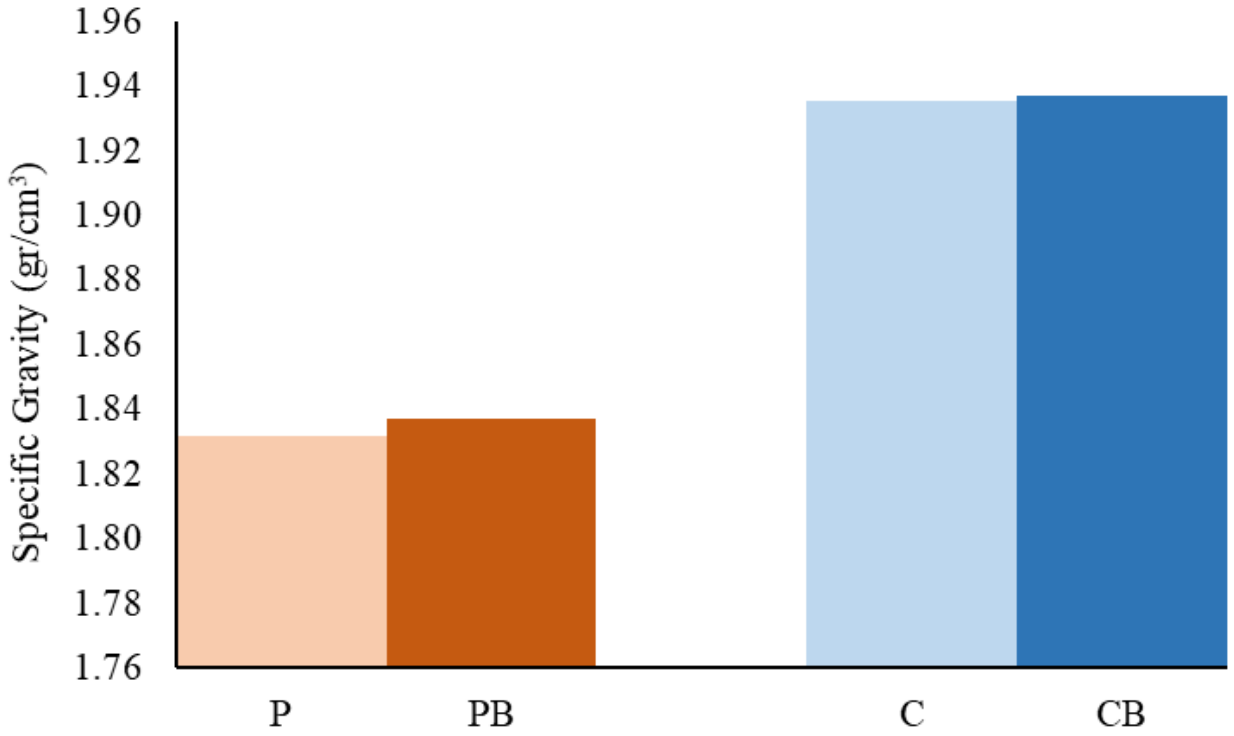
The rising calcite contents were influenced by the adding of microbes in to the paste. As the microbes, bacteria produce the calcite as the result of metabolism process.

Results and Discussions
Compressive Strength



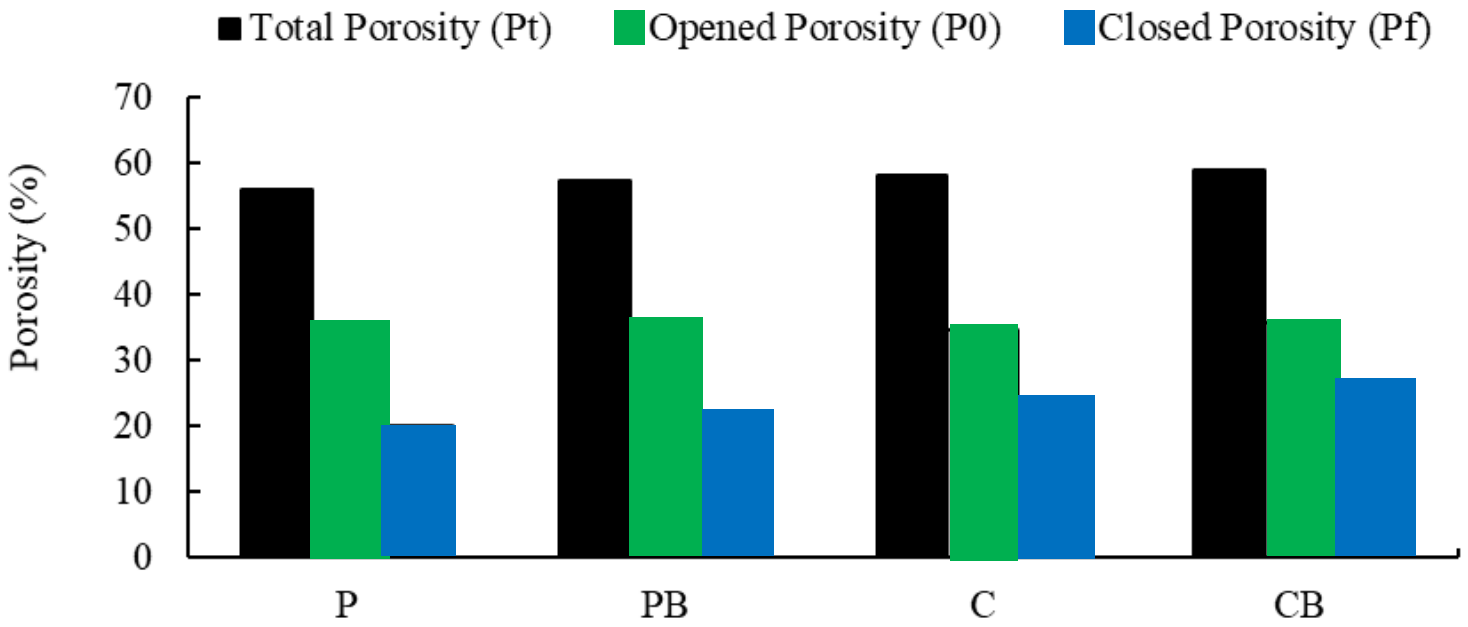
The adding of microbes influenced the compressive strengths of the fly-ash based paste.

Results and Discussions
Specific Gravities



Spesific gravities were not influenced by the adding of microbes in to the mixtures.

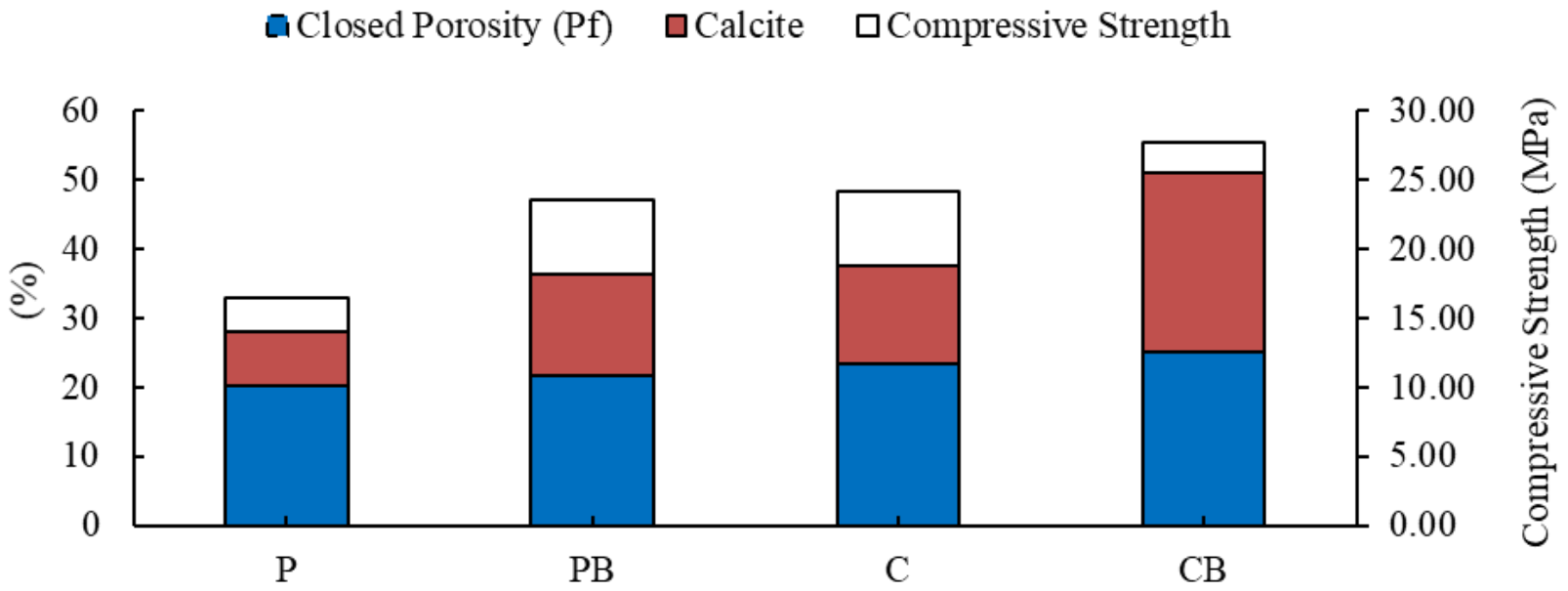
Results and Discussions
Porosity



Opened porosity higher than closed porosity, at all mixtures.
Closed porosity of the paste with microbes show higher amount than the opposite paste.
Closed porosity related with the behaviour of fly ash-based paste's microstructures.

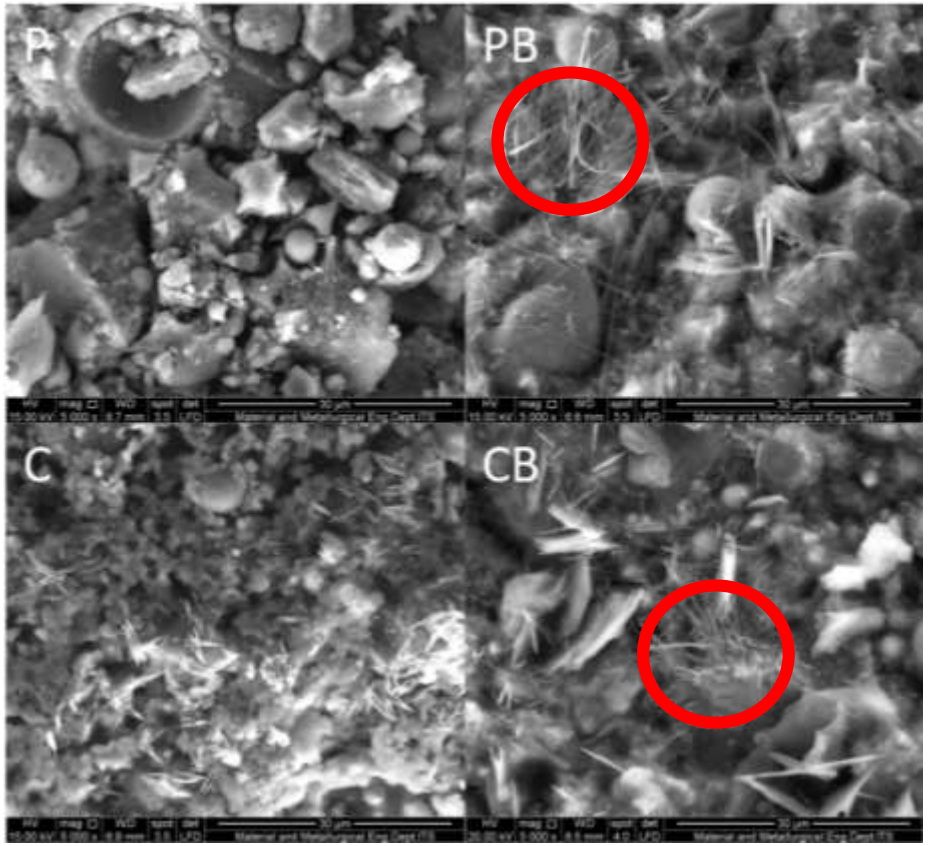
Results and Discussions

The relationships between compressive strengths, calcite amounts, and closed porosity



The increasing of compressive strengths were influenced by the amount of closed porosity and calcites in the fly ash-based paste.
The rising of calcite were caused by microbial activity. The calcite fill the pores in the paste and influenced the compressive strength.

Results and Discussions
SEM Analysis



Hyphae as the result of yeast from fungi are visible, but bacteria are not obviously by this observation.

Conclusions

1. The utilization of microbial agent to the fly ash-based paste has brought enhancement to the properties even though the number of addition is small.

2. Microbial agent affected the properties of fly ash-based paste, according to the content of calcite by XRD, its compressive strength, and its porosity.

3. The compressive strength were influenced by the amount of calcite and porosity of fly ash-based paste.

4. Fly ash can be used to produce a high quality, but environmental friendly construction material when it's mixed together with useful microbial agents.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Thank You