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**PROCEEDINGS OF THE 4<sup>th</sup> INTERNATIONAL CONFERENCE  
VIETGEO 2018, QUANG BINH, 21-22 SEPTEMBER, 2018**

**GEOLOGICAL AND GEOTECHNICAL  
ENGINEERING IN RESPONSE TO CLIMATE CHANGE  
AND SUSTAINABLE DEVELOPMENT OF INFRASTRUCTURE**



**SCIENCE AND TECHNICS PUBLISHING HOUSE**



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**Quang Binh, 21&22 September 2018**

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## VIETGEO 2018

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IN RESPONSE TO CLIMATE CHANGE AND  
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**21&22 September 2018  
QUANG BINH, VIETNAM**

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## PREFACE

Infrastructure development towards the sustainability in Vietnam as well as in the world is facing with many challenges, especially in the context of global climate change. Smart responses to climate change for harmonious and sustainable development are a legitimate desire. This is also the responsibility in the hands of scientists in general and geological - geotechnical engineers in particular.

Following the development and the success of the first conference in Hue (Huegeo 2012), the second in Hanoi (Hanoi geo 2012), the third in Ha Long (Vietgeo 2013), the fourth international conference will be officially named Vietgeo 2018. Vietgeo 2018 is co-organized by the Vietnam Association of Engineering Geology and the Environment (VAEGE) - Hanoi University of Mining and Geology (HUMG), Quang Binh Department of Science and Technology (QBDST), Yamaguchi University, Japan, Suranaree University of Technology, Thailand, Tongji University, China, Ho Chi Minh University of Technology (HCMUT), VNU - University of Science, Vietnam National University Hanoi (VNU-HUS), Hue University of Sciences - Hue University (HUSC), Hydraulic Construction Institute (HC1) and Technical World Co., Ltd (TWO) on 21<sup>st</sup> and 22<sup>nd</sup> September 2018 in Dong Hoi city, Quang Binh province, Vietnam.

Vietgeo 2018 will focus on the following themes:

- Slope stability and prediction,
- Coastal geotechnical engineering in response to climate change,
- Deep foundation and underground construction,
- ground improvement method for infrastructure construction,
- geotechnical instrumentation and materials.

Vietgeo 2018 has received many kind supports from Quang Binh Department of Science and Technology, Technical World Co., Ltd (TWO), FECON Corporation, GMCI Investment and Development Co., Ltd (GMCI), Research Center for Technology and Industrial Equipment (ReCTIE), Union of Survey and Construction JSC (USVC), geotechnical Research Centre - HUMG, Nam Mien Trung Co., Ltd, Hanoi Construction Design Investigation Consultants JSC (HCDIC), Power Engineering Consulting JSC (PECC1), Hydraulic Construction Institute (HC1).

The organizing committee would like to express our sincere thanks and appreciations to all of participants and supporting institutions. Special thanks to members of the advisory board, local volunteers and especially those of the secretariats who handle the daily hard work to make the conference successful.

We hope you will find this conference not only a chance to discuss, to share experience but also to explore cooperative opportunities.

**Organizing Committee of VIETGEO 2018**

**PROCEEDINGS OF THE 4<sup>th</sup> INTERNATIONAL  
CONFERENCE VIETGEO 2018**

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**QUANG BINH, VIETNAM  
21&22 September 2018**

SeS S<sub>I</sub>ON 1

**GEOLOGICAL AND GEOTECHNICAL  
ENGINEERING  
IN RESPONSE TO CLIMATE CHANGE**

# EFFECT OF PARTICLE SIZE DISTRIBUTION OF LIEM SON, KIM BANG, HA NAM LIMESTONE GRADING AS INERT ADDITIVE ON BUT SON CEMENT MOTAR

Ta Thi Toan<sup>1</sup>, Nguyen Thi Nu<sup>1</sup>, Vu Thi Ngoc Minh<sup>2</sup>

<sup>1</sup>Ha Noi University of Mining and Geology, Vietnam

<sup>2</sup>Hanoi University of Science and Technology, Vietnam

Corresponding author's Email: toantasc@gmail.com

**Abstract:** The purpose of this work is to describe the effect of nanoparticle size of limestone as an inert additive on cement on important physic and mechanical properties of cement paste. The present examinations indicate that lie m Son, Kim bang, ha Nam limestone with potential reserve and good quality can use as an inert additive on cement. Research effect of particle size distribution of this limestone as inert additive on mechanical properties of cement mortar indicates that increasing nano and micro particle size content of need limestone in original cement can increase early strength but it does not influence late strength.

**Keywords:** limestone, cement, additive, particle size, properties.

## 1. Introduction

Limestone is known as a main raw material naturally occurring calcareous deposits, limestone provides calcium carbonate ( $\text{CaCO}_3$ ) for cement to combine with very small amounts of "corrective" materials such as iron ore, bauxite, shale, clay or sand may be needed to provide extra iron oxide ( $\text{Fe}_2\text{O}_3$ ), alumina ( $\text{Al}_2\text{O}_3$ ) and silica ( $\text{SiO}_2$ ) to adapt the chemical composition of the raw mix to the process and product requirements.

Today, Ordinary Portland Cement manufactured by modern technology exceeds the quality requirements of PC28 cement specified in TCVN 2252-2012. It is also in conformity with ASTM C150 Type 1, following outstanding properties:

Stable physicochemical properties

Suitable for high-quality construction projects

Rapid strength development cement with consistent high strength performance

Excellent durability that resists aggressive environmental attacks due to very low permeability coefficient

Rapid setting cement with superior workability for easier handling, placing and finishing

Relatively low water demand thus reduced concrete surface cracking

Enhanced concrete cohesion, sustained uniform concrete performance

So, PCb cement is a Portland blended Cement which is very common in market of Vietnam, suitable for civil construction from application for foundations-columns-floor-roof of house to building-other finishing works.

Depending on the type and amounts of added additives, the hydration process varies from the hydration of the original cement, but they all affect the hydration of the clinker mineral which contributes to the development of the contributing substances and finish the cement stone structure.  $\text{Cr}_2\text{O}_3$ ,  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{CaCO}_3$ ,  $\text{TiO}_2$  for cement in fine grinding with appropriate content also increase the strength of the concrete and reduce the water void.

Limestone is used as an additive, according to current scientific research, limestone nanoparticles

and microcells are nearly inert  $\delta_1\gamma$  in cement hydration but it has the effect of enhancing the early age of cement stone, Reduce the water Cement ratio, increase the water Cement ratio. This is explained by the fact that limestone nanoparticles act as crystalline gums that speed up

the cement hydration process to increase the early age of cement stone, furthermore the combination of nano and limestone micro- covers and filling the porous holes between the hydration products is the main effect that enhances the cement stone.

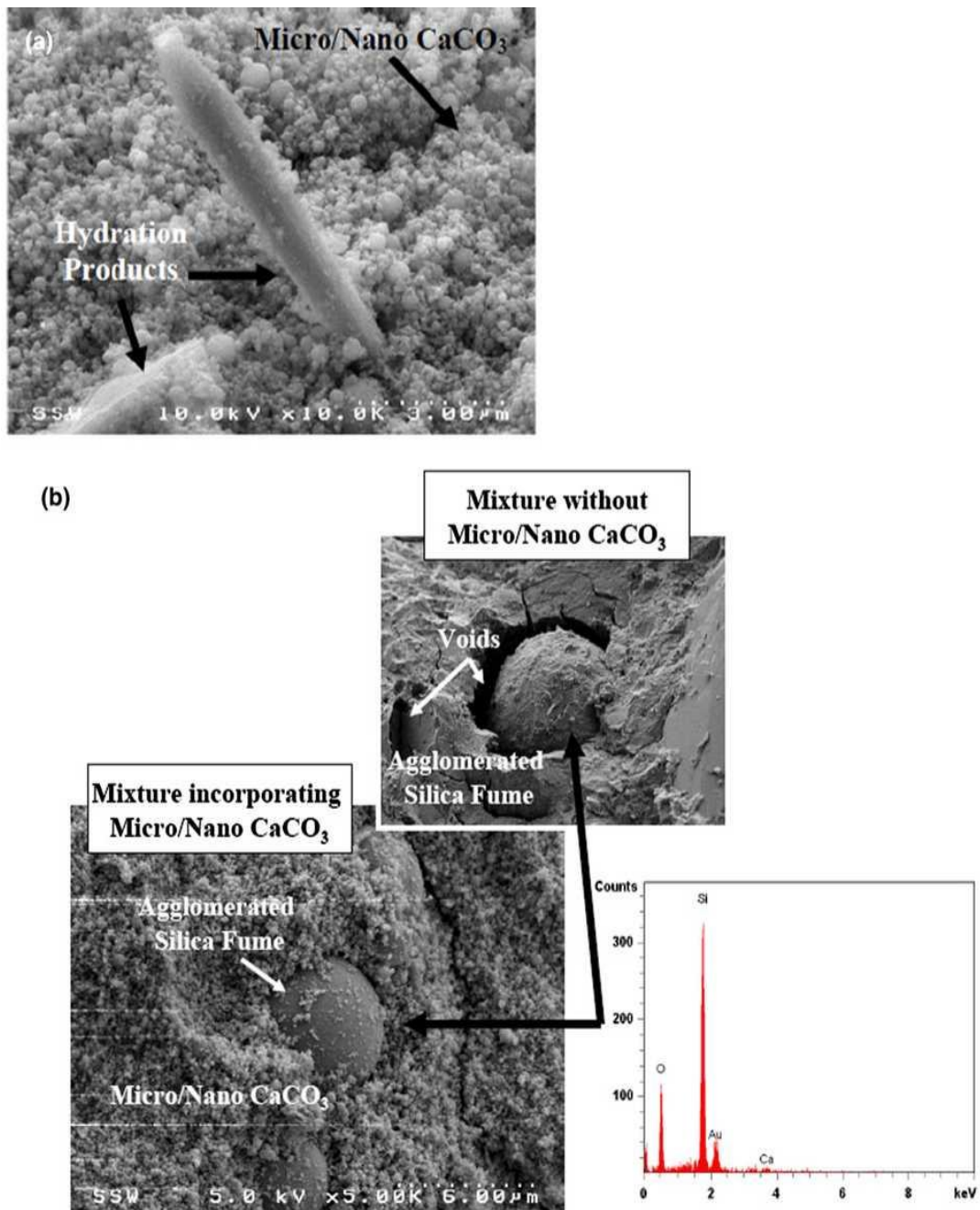


fig v<sub>IV</sub> microNano CaCO<sub>3</sub>

a<sub>v</sub> Cover and fill the porous hole between the hydrated products and b<sub>v</sub> fills the space around the silica fume  $\delta_1\gamma$

## 2. Material

### 2.1. Limestone

limestone originates from chemical-type deposition of over saturated saline solutions and accumulation of (carbonate) minerals from dead marine organisms. This sedimentary phase is followed by diagenesis during which the original content fragments disappear and are replaced by recrystallized calcite. Calcareous deposits often include impurities (clay, sand) that sediment together with the chemical precipitation and the organogenic accumulation.

limestone sample is collected from lie m Son, Kim bang, ha Nam mineralogical, chemical and mechanical characterization of limestone are showed in table 1, 2 and 3.

Table 1 mineralogical characterization of limestone (mineralogical analysis by XRD) (main phases)

mineral	Calcite CaCO <sub>3</sub> δμγ	Dolomite Ca(mg,fe)(CO <sub>3</sub> ) <sub>2</sub> δμγ	Quartz SiO <sub>2</sub> δμγ
Quality	1d-2d	12-22	little

Table 2 Chemical characterization of limestone

Oxide	CaOδμγ	mgOδμγ	IO <sub>1</sub> δμγ
Quality	23Vd <sub>1</sub>	1V <sup>32</sup>	d <sub>V</sub> <sup>23</sup>

Table 3 mechanical characterization of limestone

mechanical	hardness δmohsγ	mass volume δg/cm <sup>3</sup> γ	Compressive strength δkg/cm <sup>2</sup> γ
Quality	1-1V2	2V <sub>3</sub> <sup>1</sup> - 2V <sub>1</sub> <sup>1</sup> d	1,3dd and - 1,112

According to mineralogical, chemical and mechanical characterization of limestone, it can be used as a main raw material for clinker cement and as an inert additive for cement according to TCVN 3d<sub>1</sub>2d<sub>2</sub>d<sub>13</sub>.

### 2.2. Portland cement Clinker

Cement Clinker are collected from but Son, vicem, ha Nam. Its composition have been indicated in Table 4.

Table 4 Chemical composition of but Son clinker

Oxide	CaO	SiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	MgO	K <sub>2</sub> O + Na <sub>2</sub> O	SO <sub>3</sub>	LOI
Quality	31V3	21V1	2V22	3V1 <sup>2</sup>	2V22	d <sub>V1</sub> <sup>3</sup>	d <sub>V</sub> <sup>3</sup>	d <sub>83</sub>

mineral are calculated from chemical base on bogue δ<sub>2</sub>γ and showed in table 2.

$$\mu C_3S k_{1V} d^1 C - \frac{1}{V_3} S - \frac{1}{3V_2} a - \frac{1}{1V_{12}} f$$

$$\mu C_2S k_{2V_3} S + \frac{2}{2V} d^1 a + \frac{1}{1V} d^1 f - \frac{3}{3V} d^1 C$$

$$\mu C_3a k_{2V_{32}} (a - d_{V1} f)$$

$$\mu C_1a f k_{3V} d^1 f$$

Table 5 mineral composition of but Son Clinker mineralogical of ClK μ

C <sub>3</sub> S	C <sub>2</sub> S	C <sub>3</sub> a	C <sub>1</sub> af
32V12	13V <sub>1</sub> <sup>3</sup>	2 <sub>V23</sub>	3 <sub>V3</sub> <sup>2</sup>

### 2.3. Gypsum

sed gypsum is lao gypsum with formula CaSO<sub>4</sub>·2H<sub>2</sub>O included impurities 1-2μ. The chemical properties have been indicated in table 3.

Table 6 Chemical composition of lao gypsum

indication	lao gypsum
SO <sub>3</sub> (μ)	3 <sub>V32</sub>
humidity (μ)	2
Residue insoluble (μ)	3V2

## 3. Research Methods

### 3.1. Composition of researching sample

limestone sample have been collected in lie m Son, Kim bang, ha Nam. They have been tested by different production process as Diagram 1.

Table 7 Sample sign

Sample	additive	grinding time duration	additiveP (cement clinker+ <sub>3</sub> μ gypsum) (mass)
m <sub>1</sub>	limestone	2h	
m <sub>2</sub>	limestone	1h	2dP <sup>2</sup> d
m <sub>3</sub>	limestone	3h	

### 3.2. Sieving method

Sieving is a simple method for the classification of powders. It can be performed either in a dry or a wet way, with manual or mechanical vibration, and for fixed duration or until a sufficiently low powder flow rate is observed through the sieves. It is however limited by physical dimensions of the sieve, usually  $12\mu\text{m}$  according to TCVN 1331-2007.

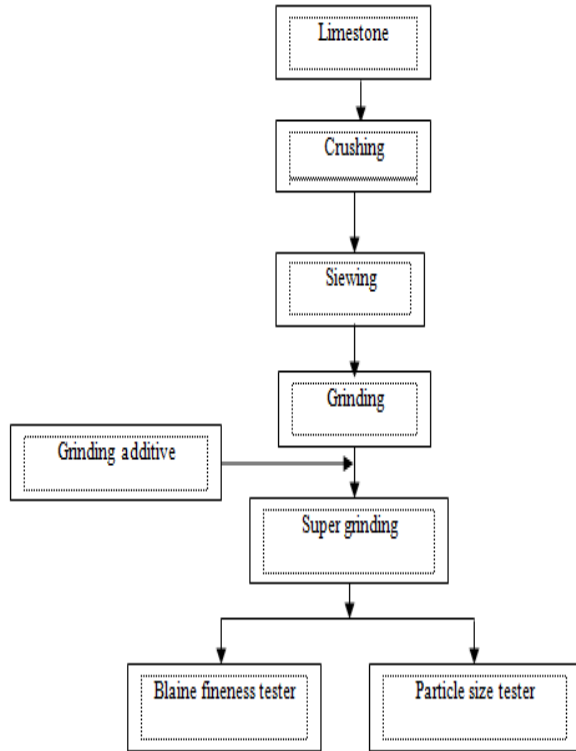


Diagram of the testing process

### 3.3. Blaine Permeability

A Blaine fineness tester is used for the measurement of the specific surface area of particles on the basis of the air permeability method. The time  $t$  necessary for a volume of air to flow through a packed bed of particles is recorded. TCVN 1331-2007 gives the evaluation of specific surface area.

### 3.4. Dimension distribution

Laser diffraction is based on a complex theory of interaction between monochromatic light and individual particles. It has been tested in industry, ceramic and glass industries. The water for standard consistence test and Determination of Setting Time

This test method is a modification of the method set out in Vietnamese Standard 1331-2007 and ISO 323-1:2000.

### 3.4. Compressive strength test

This test bases on TCVN 3113-2008 and ISO 323-1:2000.

### 3.5. SEM method

The SEM samples were measured at the Institute of Technical Physics - Hanoi University of Science and Technology.

## 4. Results and Analysis

### 4.1. Limestone Blaine

Result of limestone blaine of Thanh Liem, Kim Bang, Ha Nam has been showed in table 2.

Table 2. Blaine of Thanh Liem, Kim Bang, Ha Nam limestone with difference grinding time

Sample	blaine, (cm <sup>2</sup> /g)
m <sub>1</sub>	2231
m <sub>2</sub>	3123
m <sub>3</sub>	3331

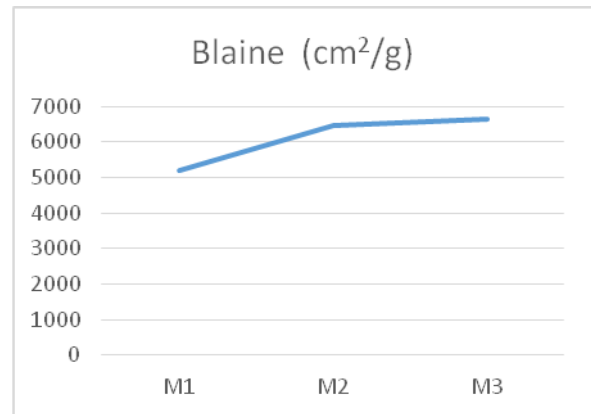


Figure 2. Blaine fineness of Thanh Liem, Kim Bang, Ha Nam limestone with different grinding time

Blaine fineness of limestone corresponds to its specific surface area.

The fineness and blaine specific surface area of limestone increased with an increase in grinding time, but there is limited, it means when grinding time increase, the blaine fineness is not increased.

### 4.2. Dimension distribution

Dimension of limestone with different grinding time have been described by figure 3.

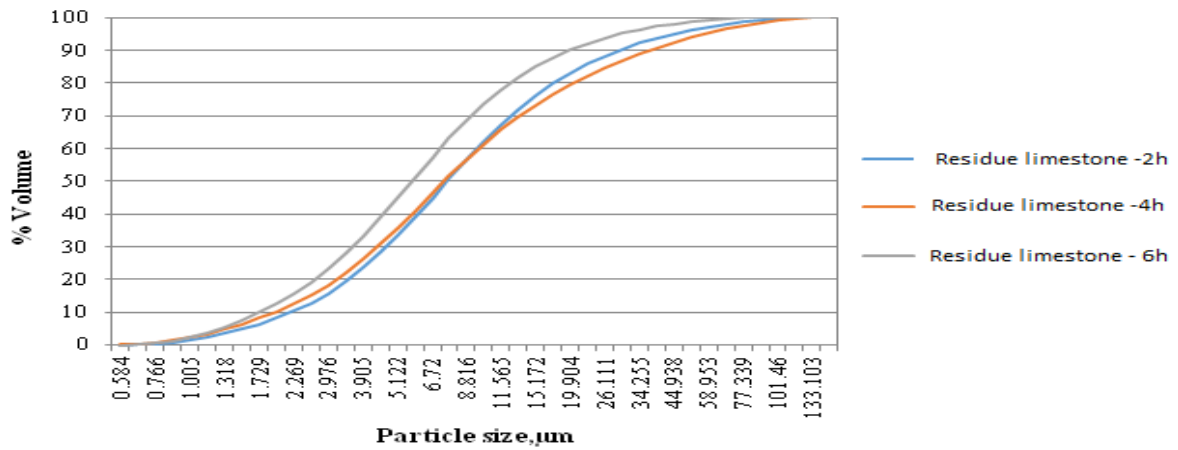
### 4.3. Effect of inert limestone fineness on mechanical of cement concrete

Water for standard consistence and initial and final setting time of cement concrete have been indicated in table 3.



Tab<sub>V3</sub> ω ater for standard consistence

Sample	g rinding time (min)	ω ater for standard consistence, (ml)	Temperature (°C)
m <sub>1</sub>		12 <sup>d</sup>	33
m <sub>2</sub>	2 <sup>d</sup>	11 <sup>1</sup>	2 <sup>3</sup>
m <sub>3</sub>		11 <sup>1</sup>	31



fig<sub>V3V</sub> Residue of Thanh li em, Kim bang, ha Nam limestone with different grinding time

This is explained by the fact that limestone and the shape of particle becoming sphere so the samples have a larger percentage of fine particles limestone particles are very flexible,

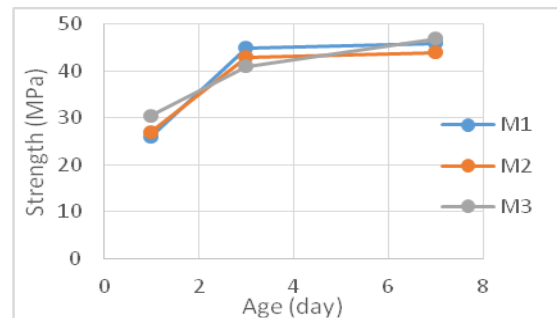
Tab<sub>V1</sub> d<sub>V1</sub> nitial and final setting time of cement concrete

Sample	g rinding time (min)	nitial setting time (min)	final setting time (min)	Temperature (°C)
m <sub>1</sub>		1 <sup>d</sup>	123	33
m <sub>2</sub>	2 <sup>d</sup>	31	13 <sup>2</sup>	2 <sup>3</sup>
m <sub>3</sub>		11 <sup>d</sup>	113	31

if the fineness increases, nitial and final setting time trends to increase. This can be explained by the fact that limestone nanoparticles create a crystalline nucleus that accelerates the hydrolysis of cement to help cement cure rapidly.

#### 4.4. Effect of inert limestone fineness on compressive strength of cement concrete

Result of compressive strength has been indicated in figure IV



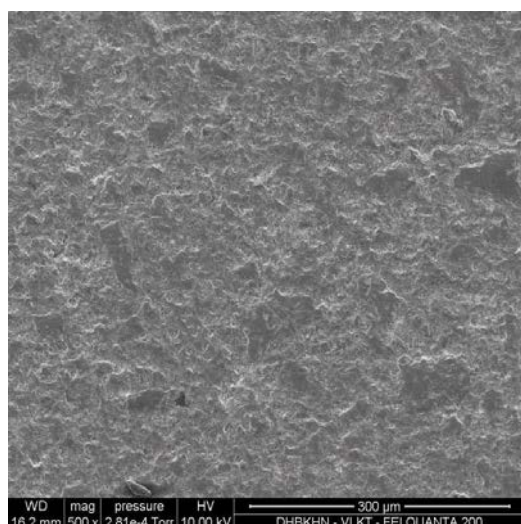
fig<sub>VIV</sub> Compressive strength of sample

at the first day, when the dimension decreases, impressive strength increases but at the third day and the seventh day strength does not increase when fineness increases

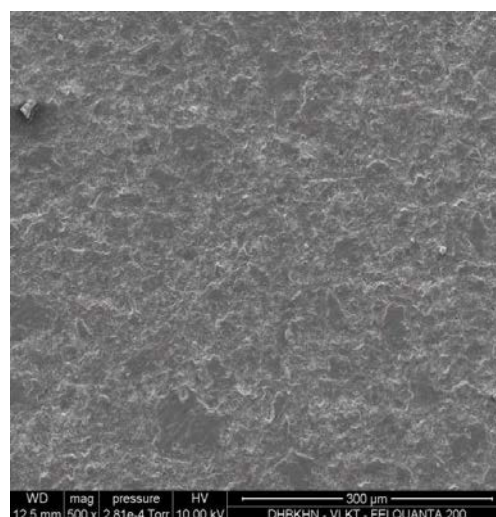
It means the fineness of limestone affects the intensity of early age of the cement stone because nanoparticles of limestone create a crystalline nucleus that accelerates the hydration of cement to increase the early age of the cement stone

In addition, the combination of nano and microparticle limestone that cover and fill the porous holes among the hydration products is a major contributor to cement strength

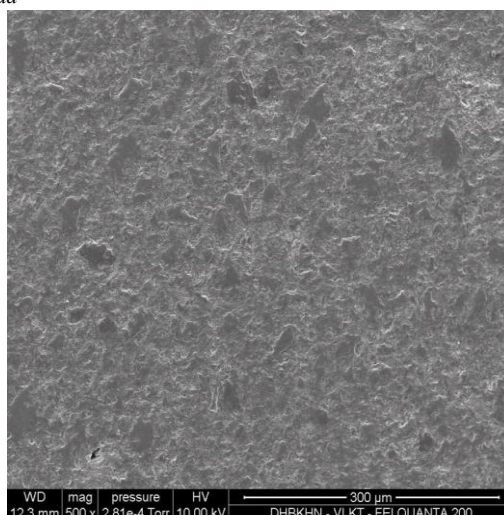
however, the amount of nano and microsize limestone should be sufficient because of the increase in cement content, due to insufficient cement to bond these particles, thus it reduces the strength of the cement stone



a, Scm m<sub>1</sub> +<sub>2</sub> dd



b, Scm m<sub>1</sub> +<sub>2</sub> dd



c, Scm m<sub>2</sub> +<sub>2</sub> dd

fig v<sub>2</sub> v Scm picture

#### 4.5. Impact on the porosity of the cement stone

The image 1 showed that porosity of m<sub>1</sub> less than m<sub>2</sub> and m<sub>3</sub> This is probably explained by the combination of Nano and micro limestone They cover and fill the porous holes among the hydrated

products and it also explains that the main effect enhances the strength of the cement stone

#### 5. Conclusion

Investigations confirmed that nanoparticle limestone can be used as an inert additive to

increase early compressive strength of cement mortar

however, blaine fineness is about 3000 cm<sup>2</sup>/g. To increase nanoparticle limestone not only consumes grinding energy but also improves properties of cement paste

#### References

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