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## ***Comparative Study on Microstructure and Durability of Concretes Containing Nano Silica and Silica Fume***

Ali Akbar Ramezani pour; Seyed Masoud Moravej Jahromi; Mahdi Mahdikhani and Faramarz Moodi

### ***ABSTRACT***

Recently, Nanotechnology has caused a vast breakthrough worldwide and scientists in different fields have used it. Nano particles have been gaining increasing attention and been applied in many fields to fabricate new material with novel function due to their unique physical and chemical properties.

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Therefore, using Nano-silica as a Nano-scale additive in concrete is under further inspection by researchers. Recent contribution to the development of building materials compromise adding colloidal Nano-silica to concrete. In this paper, the influence of Nano-silica addition on mechanical and durability properties of concrete as compared with silica fume has been studied. Tests include compressive strength, water permeability, rapid chloride penetration and electrical resistance test. Moreover, microstructure of the cement paste incorporating Nano-silica and Silica-fume were studied through X-ray diffraction and Scanning electron microscope tests. The experimental results show that Nano-silica as an artificial pozzolanic material can improve the compressive strength, water penetration resistance and electrical resistivity of concrete and reduce the chloride diffusion more effectively than SF at early ages. In addition, utilizing NS in cement paste improve its microstructure at early days.

**KEYWORDS**

Nano Silica, Silica Fume, Mechanical properties, Microstructure, Durability

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Si- O

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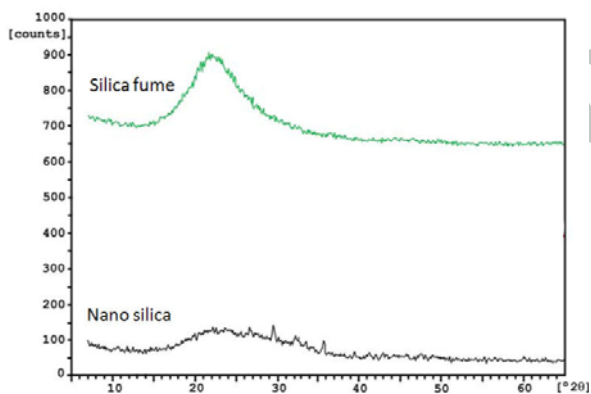


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/	/	(gr/cm <sup>3</sup> )
	—	(cm <sup>2</sup> /gr)
(%)		
/	/	SiO <sub>2</sub>
/	/	Al <sub>2</sub> O <sub>3</sub>
/	/	Fe <sub>2</sub> O <sub>3</sub>
/	/	CaO
/	/	MgO
/	/	Na <sub>2</sub> O
—	/	SO <sub>3</sub>
/	/	LOI

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%SSD	gr/cm <sup>3</sup>		
/	/		
/	/		



XRD ( )

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		ASTM	BS
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/	/	3/8	/
/	/	#	/
/	/	#	/
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mPa.s			pH		
<Δ•	/ - /				

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	gr/cm <sup>3</sup>	gr/cm <sup>3</sup>	μm
γ•	/ - /	/ - /	/ /

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SSD

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(Kg)	(Kg)	(Kg)	(Kg)	(Kg)	
					CTL
					NS-4.5
					NS-7.5
					SF-4.5
					SF-7.5

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GLENIUM-110P

: × × cm

: × × cm

: cm

cm

x

RCPT

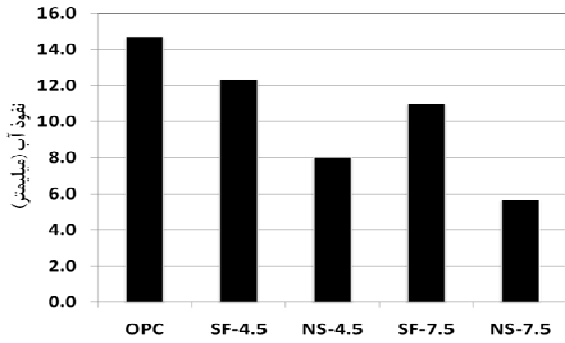
(XRD)

(SEM)

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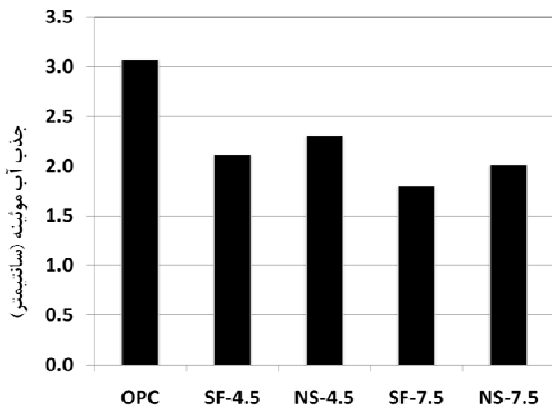
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SF-7.5	SF-4.5	NS-7.5	NS-4.5	CTL	
۲۹/۳	۲۸/۱	۳۶/۵	۳۴/۰	۲۶/۵	۳ روز
۴۰/۷	۴۱/۷	۴۸/۰	۴۶/۰	۳۶/۸	۷ روز
۶۱/۰	۵۵/۲	۶۲/۰	۵۷/۸	۵۲/۳	۲۸ روز
۶۲/۸	۵۸/۵	۶۳/۸	۶۰/۲	۵۶/۰	۹۰ روز
۶۲/۵	۵۹/۷	۶۴/۵	۶۱/۷	۵۸/۷	۱۸۰ روز



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BSEN-12390-8:2000

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x

(RCPT)

ASTM C2012 RCPT

x

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XRD

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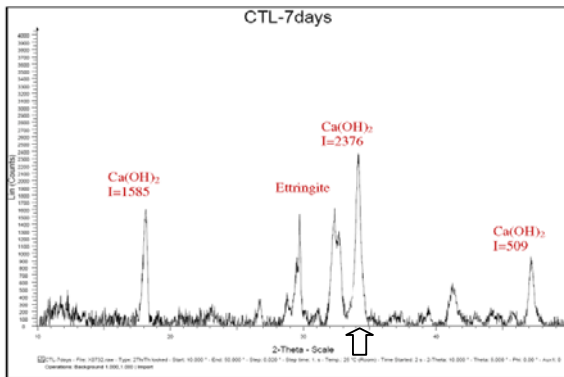
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Ca(OH)<sub>2</sub>

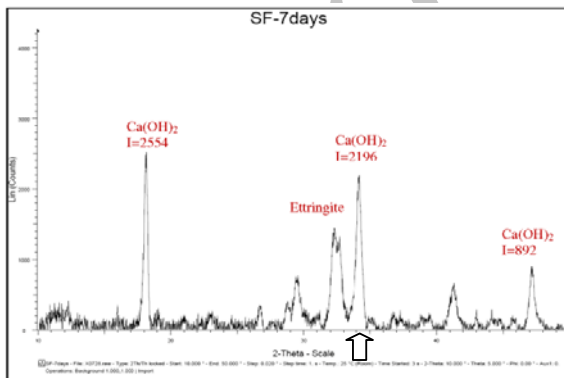
SF-7.5	SF-4.5	NS-7.5	NS-4.5	CTL	
					۲۸روز
					۹۰روز
					۱۸۰روز



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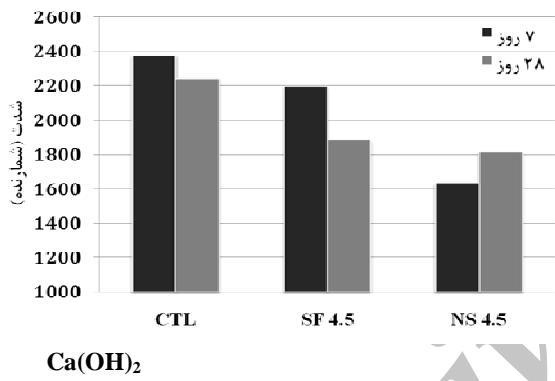
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SF-7.5	SF-4.5	NS-7.5	NS-4.5	CTL	
۱۶	۱۴	۱۹	۱۵	۱۲	۷روز
۲۵	۲۲	۵۰	۴۴	۱۵	۲۸روز
۸۲	۴۶	۷۵	۴۶	۱۶	۹۰روز
۸۵	۵۱	۷۵	۵۴	۲۰	۱۸۰روز

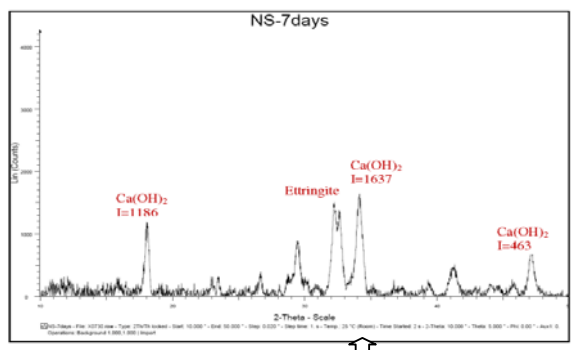


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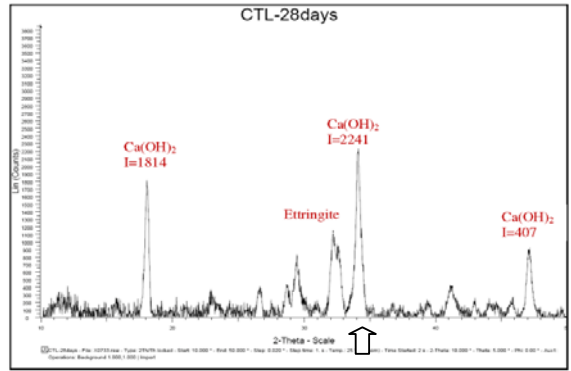


Ca(OH)<sub>2</sub>

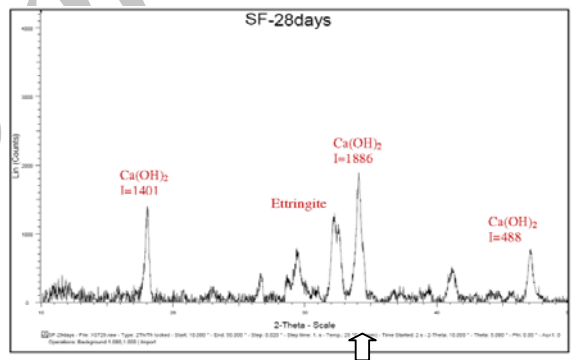
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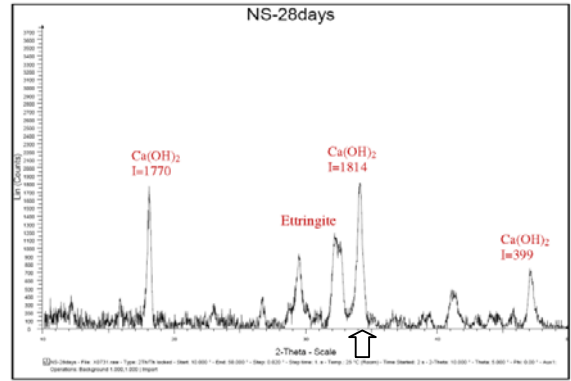
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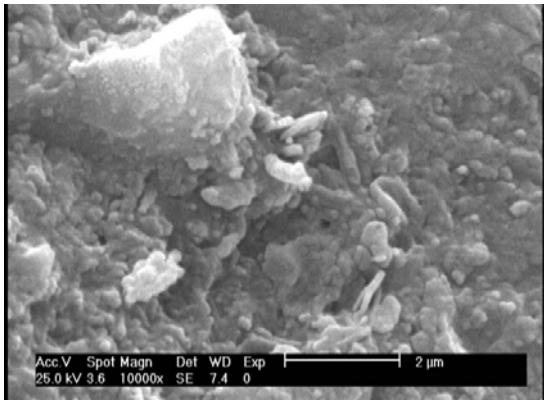
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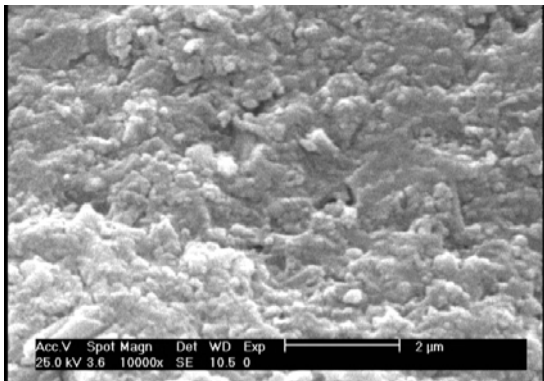
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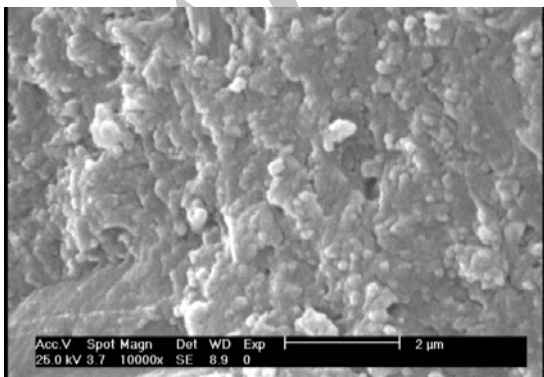
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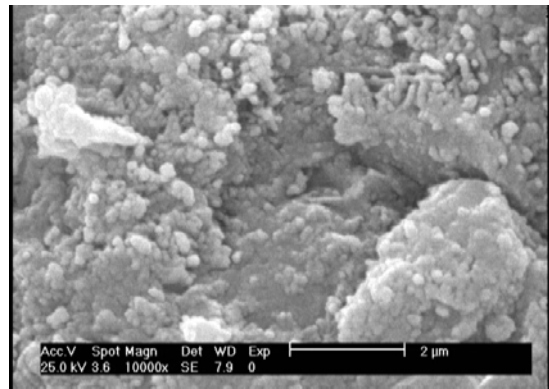


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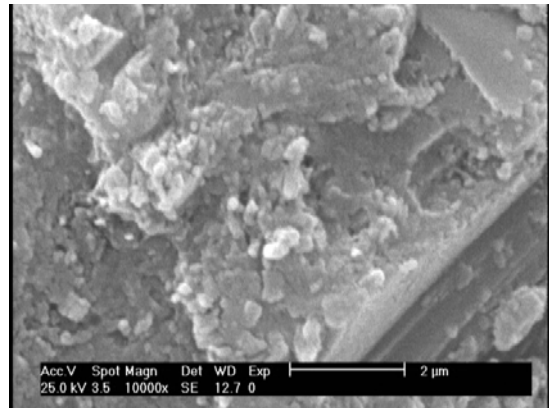


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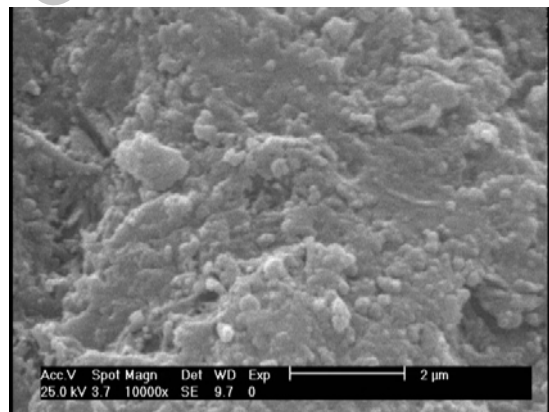
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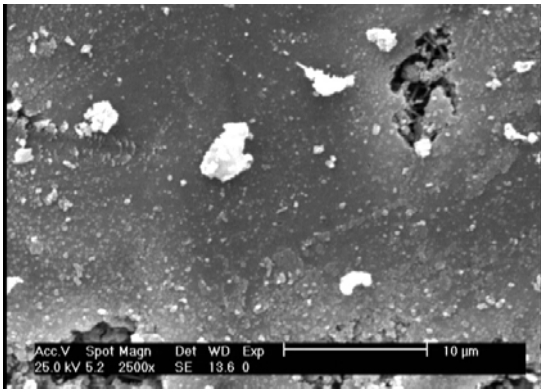
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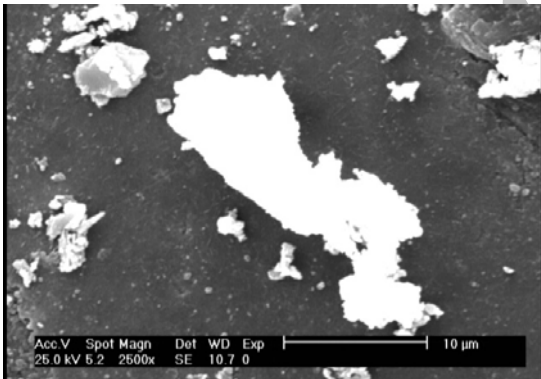
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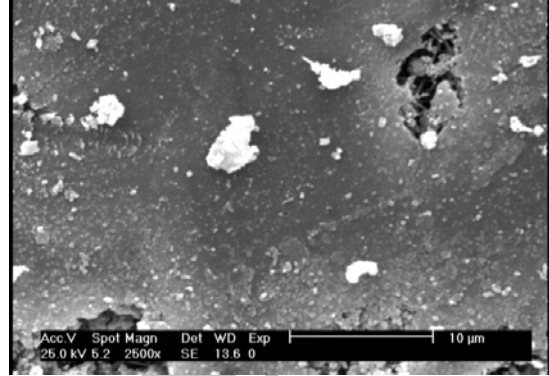
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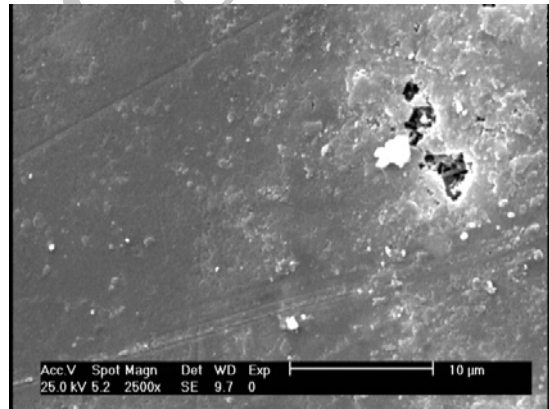
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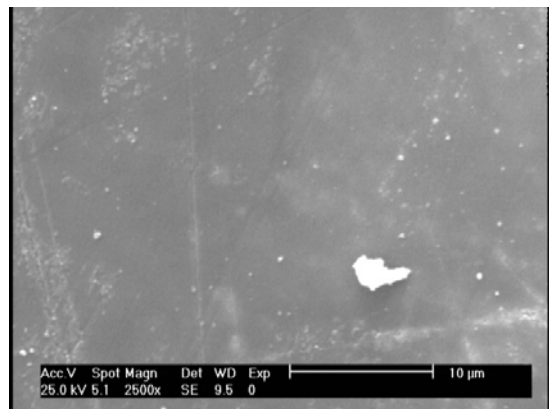
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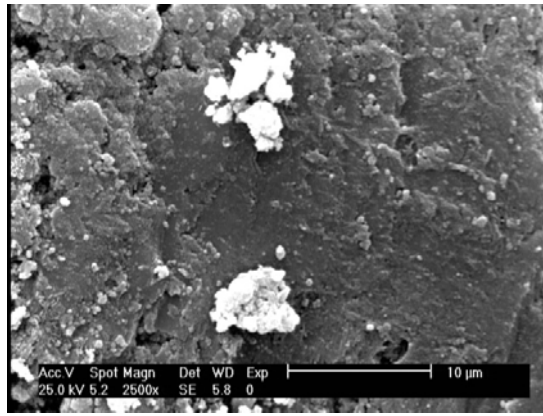


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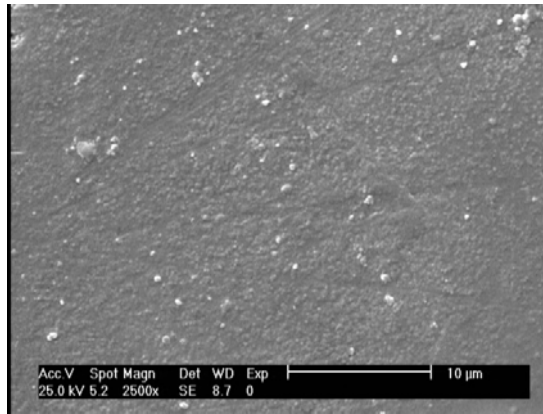
XRD



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Ca(OH)<sub>2</sub>

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C-S-H



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- Jo, B.W, Kim, C.H., Tae, G.H., Park, J.B., [ ]  
"Characteristics of cement mortar with nano-SiO<sub>2</sub> particles", Construction and Building Materials, Vol.21, 2007, pp. 1351-1355.
- Li, H., Xiao, H.G., Yuan, J., Ou, J.P., [ ]  
"Microstructure of cement mortar with nano-particles", Composites: Part B, Vol. 35, 2004, pp. 185-189.
- Ji, T., [ ]  
"Preliminary study on the water permeability and microstructure of concrete incorporating nano-SiO<sub>2</sub>" Cement and Concrete Research, Vol.35, 2005, pp. 1943-1947.
- Qing, Y., Zenan, Z., Deyu, K. and Rongshen, k., [ ]  
"Influence of nano-SiO<sub>2</sub> addition on properties of hardened cement paste as compared with silica fume", Construction and Building Materials, Vol.21, 2007, pp. 539-545.
- Collepari, M., Ogoumah Olagot, J., Troli, R., Simonelli, F. and Collepari, S., [ ]  
"Combination of Silica Fume, Fly Ash and Amorphous Nano-Silica in Superplasticized High-Performance Concretes", Enco, Engineering Concrete, Ponzano Veneto, Italy, 2007.
- Li, G., [ ]  
"Properties of high-volume fly ash concrete incorporating nano-SiO<sub>2</sub>", Cement and Concrete Research, Vol.34, 2004, pp. 1043-1049.