



ARISTOTLE  
UNIVERSITY  
OF THESSALONIKI

RESEARCH  
COMMITTEE

# NANO-MODIFIED BUILDING MATERIALS

Research in order to test the role of nanoparticles in improved physical and mechanical properties as well as in the durability of building materials is performed. Early strength development, water proofing, refined pore size distribution and durability against salt decay is tested in nano-modified concrete, bricks and mortars.

## **Application Field**

concrete, bricks, mortars, steel,  
wood

## **Services Offered to Third Parties**

Laboratory of Building Materials  
provides services in relation to testing

- mechanical
- physical properties
- durability (FREEZE-THAW, WETTING-  
DRYING, SALT CYCLES) of building  
materials and it is certified under  
ISO9001:2015

## Laboratory of Building Materials

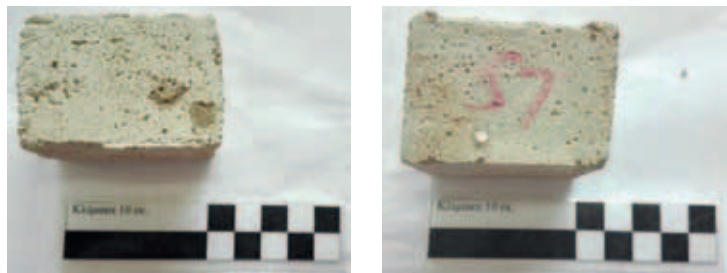
**Head of the Laboratory** Maria Stefanidou

**Members of the Lab/Research Team** Aspasia Karozou, Eirini Tsardaka, Evangelia Tsampali

**Contact** **T** +30 2310 995635 **E** stefan@civil.auth.gr **W** <http://lbm.civil.auth.gr/>

Nanomaterials were used in order to increase hydrophobicity in clay mortars.

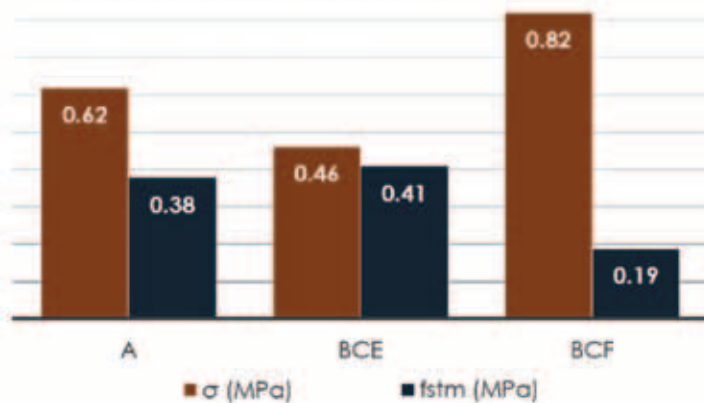
- Nanoclay was used as additive at 5% w.w. of binder.
- Nano-fibres carbon (BCF) and cellulose (BCE) were used to strengthen the structure.



**Table 1:** Effect of fibers in various factors: +: positive effect, ++: very positive, +++: extremely positive, -: negative effect, -: very negative, ---: extremely negative

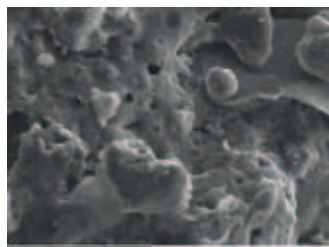
Samples	Absorption	Porosity	Shrinkage	$\sigma$	$f_{stm}$
A	++	++	--	+	--
BCE	+	+	+	--	+
BCF	-	+	++	++	---

### Compressive and flexural strength



Carbon nano-fibres

- altered the color of the mortars.
- increased the compaction of the matrix
- reduced the porosity and the capillary absorption
- significantly increased of compressive strength
- shrinkage tendency was limited.



C-S-H gel in pozzolanic paste with nano-Al<sub>2</sub>O<sub>3</sub>

Nano-SiO<sub>2</sub> (s), nano-CaO (a) and nano-Al<sub>2</sub>O<sub>3</sub> (al) have been used in low proportions (from 1%wt to 3%wt) in lime, clay and lime-pozzolan pastes.

The achieved properties concern:

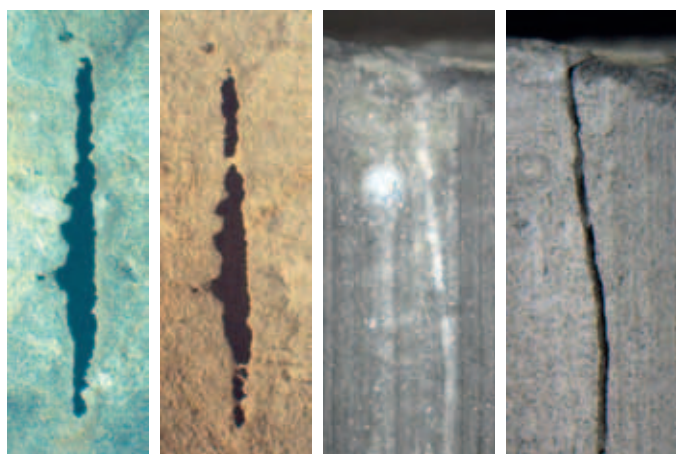
- Enhancement of mechanical properties
- Modification of microstructure
- Porosity refinement
- Reduction of capillary absorption
- Restriction of volume change

	Compressive strength in time (7 to 365 days)	Porosity (7 to 365 days)	Microstructure (SEM & BJH)	Mass change in sodium sulfate (150mg/L) cycles	Compressive strength after cycles
As	Stable positive still small influence	Stable positive still small influence	Less microporosity	2.0% mass change	Resistance in sea water and sodium sulfate
Aal	Negative impact in time, +8.13% at 365 days	Stably negative influence	Agglomeration-like structure	Surface cracks and mass increase	Decrease
Asc	Up to +36.65% at 365 days	Intensively positive influence	Flourished	Under 1.0% mass change	Decrease
Aac	Up to +51.54% at 365 days	Intensively positive influence	Flourished with larger pores	Surface cracks and mass increase	Greatest resistance in cycles

**Table 2:** Summary of physic-mechanical properties in time and durability results of nano-modified binders comparing to the reference system

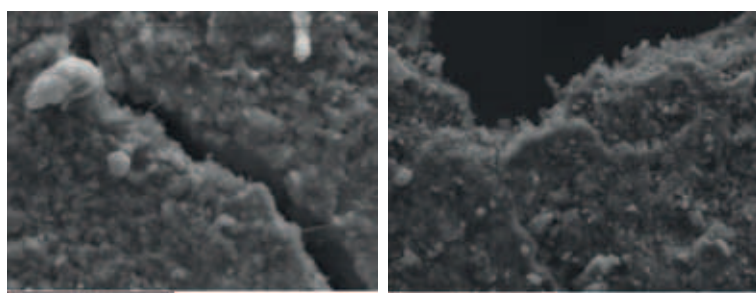
In modern building materials (concrete) in order to increase their durability and reduce the cost of their maintenance, the development of self-healing materials has become a priority. The advantages of using self-healing materials through the treatment of early-cracks is:

- reduction of penetration of harmful agents,
- retain the mechanical properties
- homogeneity of the materials.



Bridging the cracks with nano-CaO in mortar

Almost complete healing of the crack



Bridges in the microstructure of the matrix (CaO 1.5% w.w.)

Nano-CaO (5%wt) causes:

- Higher content of portlandite
- Denser structure and reduction of porosity
- Strength improvement
- Assist the re-crystallization rate in the empty spaces