



# Mechanical and radiological study of fly ash embedded in the clay matrix

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# Aim

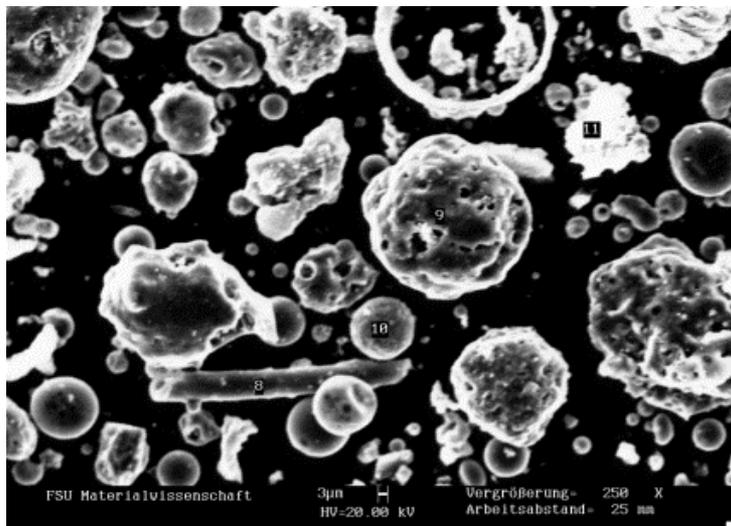
- The objective of this work was to produce clay based ceramics embedded with fly ash.
- Fly ash (10, 20 and 30wt.% previously 20 min mechanically activated) was embeded in the clay matrix.
- Consolidation was performed by pressing at 73MPa and sintering at temperatures of 830, 905 and 980<sup>0</sup>C/1h, useing heating rate of 10<sup>0</sup>C/min.
- The sintered sampleas were characterized from physical (density, water absorption) and mechanical (flexural and compressive strength) aspect.
- From radiological point, the most important parameters for building materials - the concentration of gamma-emitting radionuclides and the radon exhalation were determined.

## Chemical composition and specific gravity of raw materials

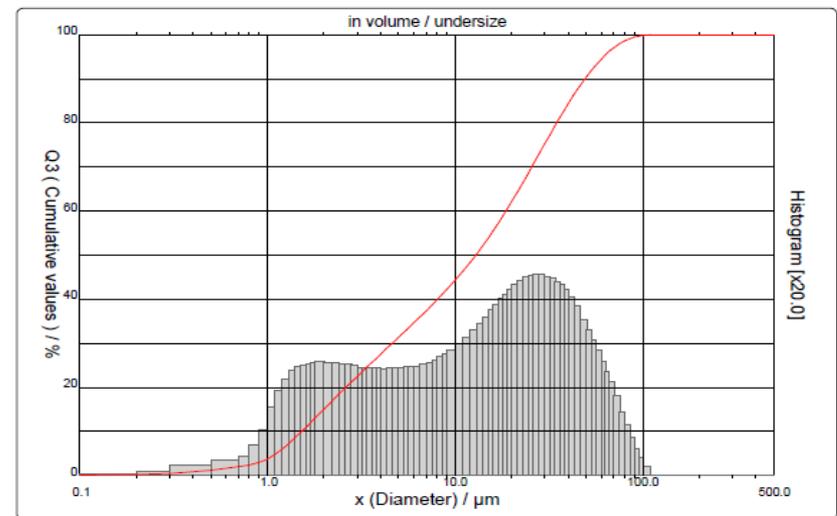
Oxide, wt.%	SiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	K <sub>2</sub> O	Na <sub>2</sub> O	CaO	MgO	SO <sub>3</sub>	Specific gravity, g/cm <sup>3</sup>
Clay	62.40	19.17	8.05	2.56	1.95	2.12	1.95	0.00	2,70
Fly ash	58.74	22.75	6.66	2.45	0.59	4.64	2.22	0.5	2,31

## Mineralogical composition of raw materials

Clay	quartz, hematite, plagioclase and illite/muscovite, montmorillonite, clinochlore
Fly ash	quartz, hematite, plagioclase, diopside and an amorphous phase



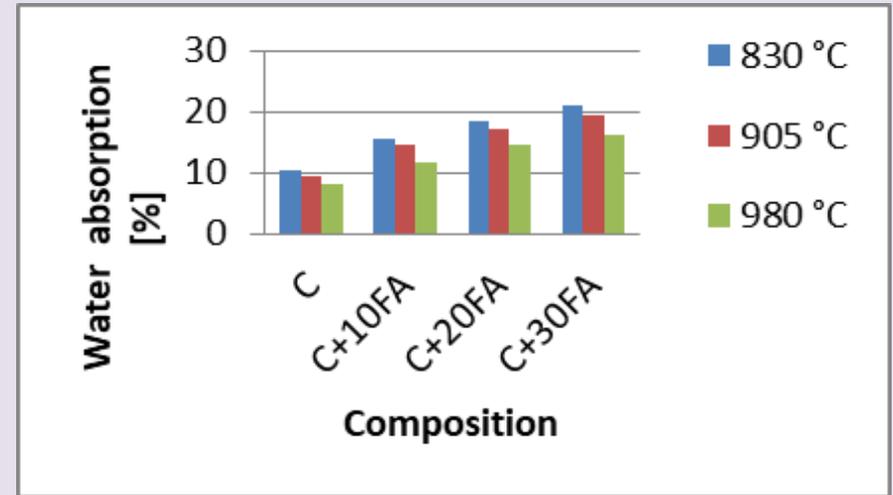
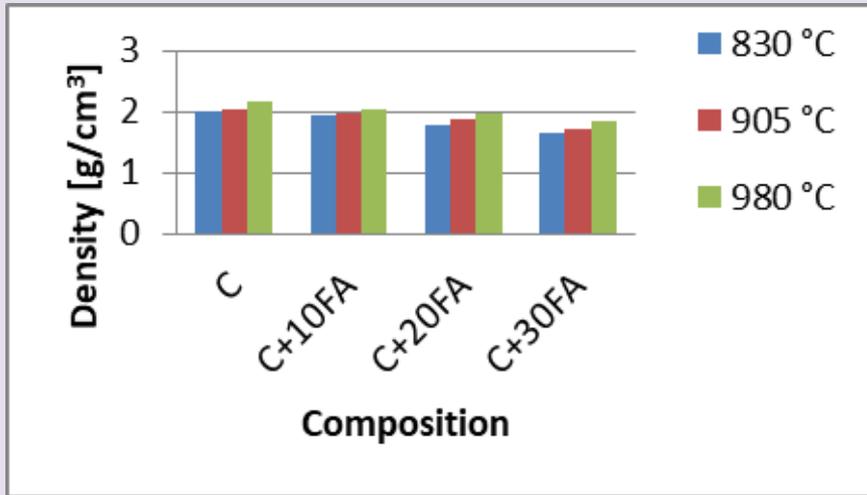
**Morphology of fly ash**



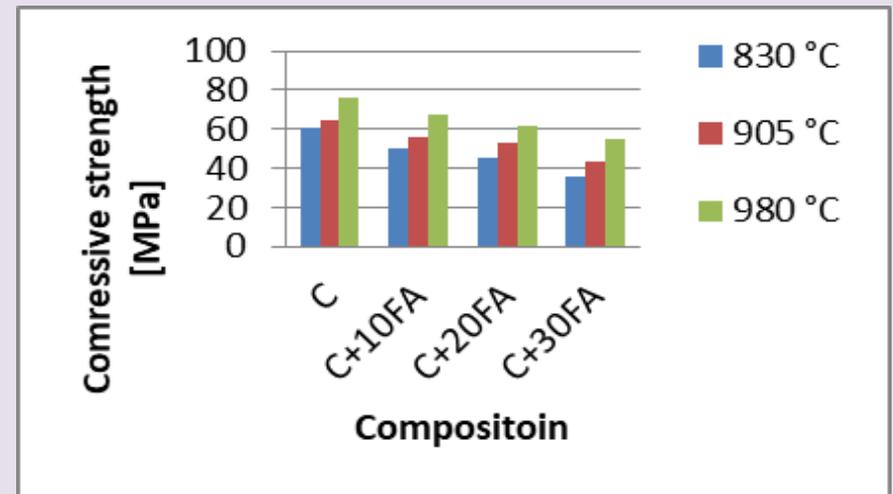
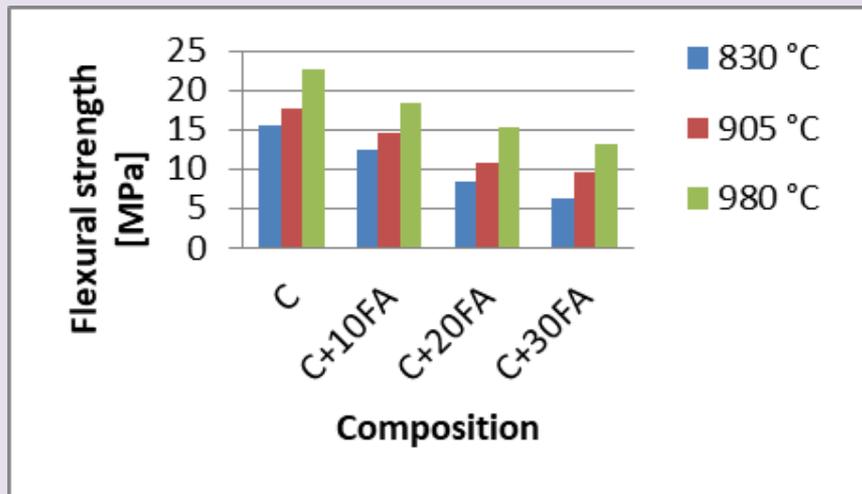
**Particle size distribution of fly ash after milling**



## Physical properties (density, water absorption)



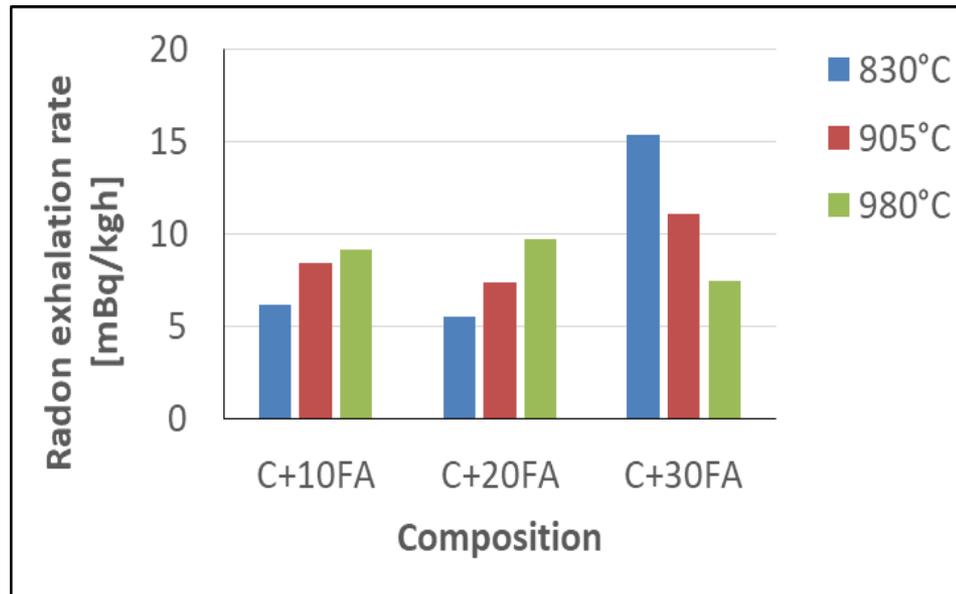
## Mechanical properties (flexural and compressive strength)



## *Gamma-spectrometry analysis and the values of the ACI for examined samples*

Sample	Ra-226 [Bq/kg]	Th-232 [Bq/kg]	K-40 [Bq/kg]	ACI
C	51.3±7.6	77.0±7.1	862.1±18.3	0.84±0.04
FA	203.5±17.8	179.5±15.6	1281.3±32.5	2.00±0.09
C+10FA	66.5±7.1	87.3±6.6	904.0±16.8	0.96±0.04
C+20FA	81.7±7.0	97.5±6.5	946.0±16.0	1.08±0.04
C+30FA	97.0±7.5	107.8±6.8	987.9±16.1	1.19±0.04

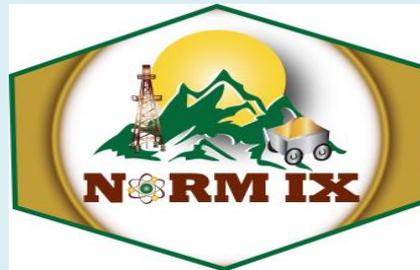
## *Radon exhalation rate of composite ceramics sintered at different temperatures*



# Conclusions

- Fly ash from thermal power plant REK Bitola, Republic of North Macedonia, was embedded in clay matrix in amount of 10, 20 and 30 wt.%. to produce dense ceramics. Mechanical activation of fly ash in the duration of 20 min was performed prior to the mixture formation.
- The sintering by applying heating rate of 10<sup>0</sup>C/min. was performed up to 830, 905 and 980<sup>0</sup>C with dwelling time of one hour at maximal temperature. Dilatometric investigations confirmed sintering in the presence of liquid phase.
- Ceramics with embedded of 30wt.% mechanically activated fly ash and produced by pressing at 73MPa and sintered at 980<sup>0</sup>C/1h resulted in the materials with density of 1.84g/cm<sup>3</sup>, water absorption 16.1 %, flexural strength 13 MPa and compressive strength 55 MPa.
- Such material can be used in construction sector as roofing tiles (EN 1304), but it has also potential to be used as pressed ceramic tiles (BIII group of EN 14411).
- According to the gamma spectrometry the NORM content of the samples are generally low (ACI < 2) and the radiological risk is low, respectively. Based on the characterisation each composition can be used in small amount in case of the stricter dose limit.
- Because of the low radon exhalation rate the contribution for the indoor radon concentration as a building material is very low.

# Thank you for your attention!



## Acknowledgements:

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