

MOGUĆNOSTI KORIŠĆENJA OTPADNOG SUMPORA U BETONIMA I NJIHOVA PRIMENA

POSSIBILITIES OF USING SULFUR FOR CONCRETE PRODUCTION AND ITS APPLICATION

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ABSTRACT

- **Two types of concrete will be shown in this paper:**
- **First type of concrete is sulfur concrete, where part of Portland cement was replaced with sulfur.**
- **Second type of concrete is self-compacting concrete, where sulfur replaced part of the filler, with different contents.**
- **Analysis of the required amount of sulfur for these types of concretes, as well as the influence on the quality achieved and potential application in objects for Renewable energy, will be discussed.**



INTRODUCTION

- **The aim of the project: application of secondary sulfur**
- **The global production of sulfur in 2013 and 2014 amounted to about 60 million tonnes per year (by 2019: 70 million tonnes per year)**



Sulfur concrete (SC) is a thermoplastic composite, made with mineral aggregates and fillers.

Binder: Sulfur ($t > 115^{\circ}\text{C}$)
Origin: Pančevo Oil Refinery

Aggregate: Sand ($d < 4 \text{ mm}$)



Various fillers (talc, alumina, silica fume and fly ash)



Advantages of sulfur concrete:

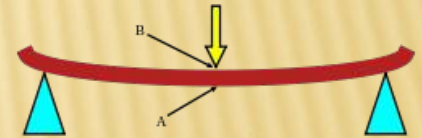
- **Resistance to many acids and salts, the use in aggressive conditions**
- **Low permeability, sealing materials**
- **Fast curing and achieving min. 70-80% of the properties during first 24h**



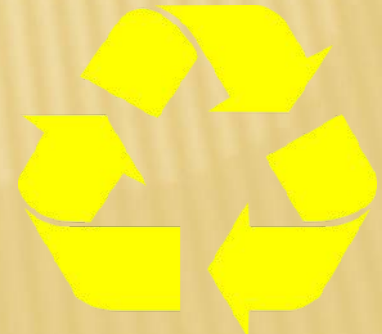
- **Application at temperatures below 0°C**



- **Higher tensile, compressive and flexural strength, as well as a greater resistance to fatigue**

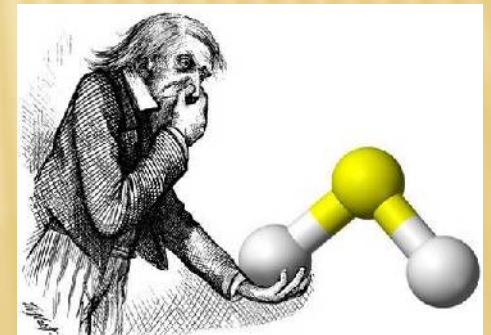


- **The possibility of recycling**



Disadvantages of sulfur concrete :

- The price of a modified sulfur binder is 2-3x higher than PC
- The temperature of the mixture and separation of SO_2 and H_2S
- Long after the production and installation, odor remains



Self-compacting concrete (SCC) can be defined as concrete that will, without any mechanical means of placing, fill in all corners of the formwork and narrow gaps between densely spaced reinforcement bars, entirely under the influence of its own weight; so that at the end, compact concrete of better durability is achieved.



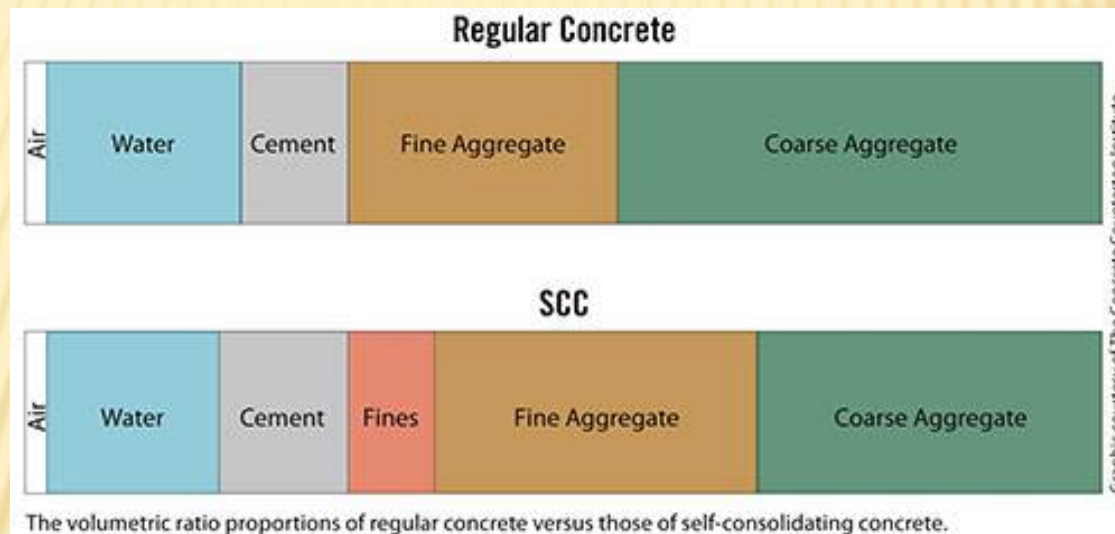
EXPERIMENTAL

Sulfur concrete (SC)

Sample	Density (g/cm ³)	Water (%)	Porosity (%)	Mechanical strength (MPa)	
				Compressive	Flexural
SC-T	2,16	1,31	3,14	55,4	8,3
SC-A	2,20	0,56	1,38	49,2	8,4
SC-MS	2,03	1,48	3,21	50,3	7,2
SC-FA	2,01	2,38	4,93	48,9	7,8

- SC-T = sulfur concrete with talc,**
- SC-A = sulfur concrete with alumina,**
- SC-MS = sulfur concrete with microsilica,**
- SC-FA = sulfur concrete with fly ash.**

Self-compacting concrete (SCC)



Binder: Portland cement PC 42.5R

Aggregate: sand ($d < 4$ mm), gravel ($4 < d < 16$ mm)

Filler: limestone flour and ground sulfur ($d < 0.125$ mm)



Compressive strength of SCC with ground sulfur at different ages [MPa]

Series	Time (days)			
	3	7	14	28
E	48.8	53.9	58.3	62.0
S2	48.3	53.0	58.0	61.5
S5	46.1	52.0	58.0	62.2
S10	46.1	49.2	53.4	54.8
S20	44.1	47.9	53.0	54.6



CONCLUSION

Advantages of sulfur uses:

- **Increasing the amount of resources available for the preparation of SCC mixtures**
- **Positive impact on the environment by reducing the amount of this material in landfills**
- **Smaller amounts of the material to be exploited from nature (aggregate, filler)**
- **Use of the recycled materials in systems for the production of electricity from renewable energy sources**

The application fields:

- **Structural elements that use Portland cement concrete as a replacement of the same class, especially in terms where the acid, base or salt influence is expected**
- **Structural concrete elements corresponding to the projected class (strength, frost resistance, water resistance)**



- **Elements within the system of wind turbines, solar panels and/or small hydro power plants**
- **Anchor blocks for stabilization**
- **The non-structural elements made of concrete**
- **Access and internal roads and pavements.**



Acknowledgements



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THANK YOU!

