UNIVERSITY OF RWANDA

COLLEGE OF SCIENCE & TECHNOLOGY

MECHANICAL PERFORMANCES OF CONCRETE WITH GRANITE SAWING POWDER WASTES

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Introduction

- Granite stone industry generates different types of waste including solid wastes and stone slurries.
- Solid wastes result from stone cutting
- Stone slurries are semi-liquid substances consisting of particles originated from sawing and polishing process and water used in cooling and lubrication of sawing and polishing machines.
- The slurry is generally stored in tanks for evaporation or filtered and compacted to remove the reusable water.
- Granite sawing powder wastes (GSPW) are dumped in a nearby land and the fertility of the soil is spoiled
- In addition, dry sawing powder wastes could be easily carried away by wind, leading to a dust pollution of the environment
- **Environmental benefits of granite sawing powder waste recycling:** Solid waste management, reduction of GHG emissions, natural resource conservation

Objectives

- **Main objective**

To analyze the mechanical performances and durability of concrete processed with granite sawing powder wastes

- **Specific objectives:**
- To analyze the mechanical performances of concrete with GSPW-sand partial replacement
- To analyze the mechanical performances of concrete with GSPW-cement partial replacement
- To analyze the mechanical performances of concrete with GSPW-c as admixture
- To analyze the durability of concrete processed with GSPWs

Methodology: Materials

Graduation and physical characteristics of aggregates used

Sieve size (mm)	Cumulative passing percentage (%)		
	Fine aggregate (Sand)	GSPW	coarse aggregates
0.075	0.6	-	-
0.15	1.11	57	-
0.3	4.32	73	-
0.425	-	81	-
0.6	16.56	86	-
1.18	33.1	93	-
2.36	62.08	96	-
3.35	85.37	-	-
4.75	99.78	-	-
6.3	-	-	0.08
10	-	-	4.52
14	-	-	29.6
20	-	-	75.28

Chemical composition of cement and GSPW

Component (%)	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	I.R	LOI
Cement (PPC)	34.5	8.5	1.6	49.8	2.38	2.5	0.82	2.4
GSPW	78.06	4.25	1.7	4.24	1.01	1.36	7.80	2.1

I.R: Insoluble Residues, L.O.I: Loss On Ignition

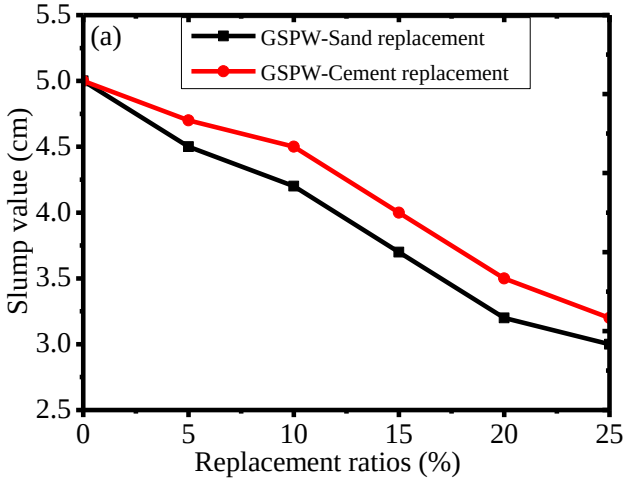
Methodology: Mix design and concrete testing methods

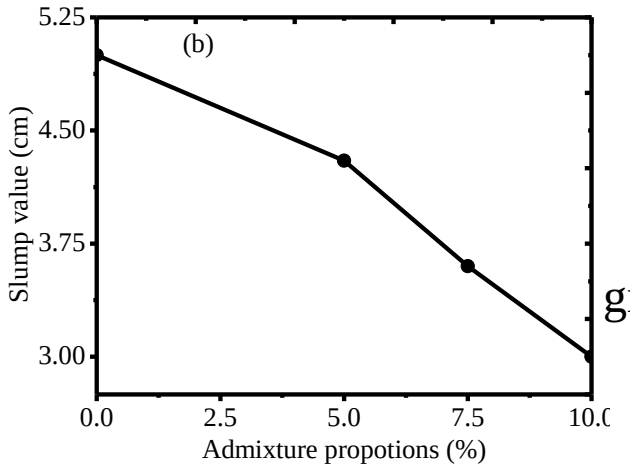
- **Mix design**
- **GSPW-cement replacements** : 0, 5%, 10%, 15%, 20%, and 25%
- **GSPW-sand replacements:** 0, 5%, 10%, 15%, 20%, and 25%
- **GSPW as admixture**: 5%, 7.5%, and 10%
- **Concrete testing methods**
- **Fresh concrete workability:** Slump test was conducted using a slump cone (Abrams cone)
- **Mechanical performances (compressive and split tensile strengths):** a mode D7949 Universal Testing Machine (Form+Test, Seidner, Reidiingen-West Germany) was used.
- **Water absorption:**

$$\text{Water absorption}\ (\%) = \frac{(W_2 - W_1)}{W_1} \times 100$$

Results and discussions: Fresh workability and density

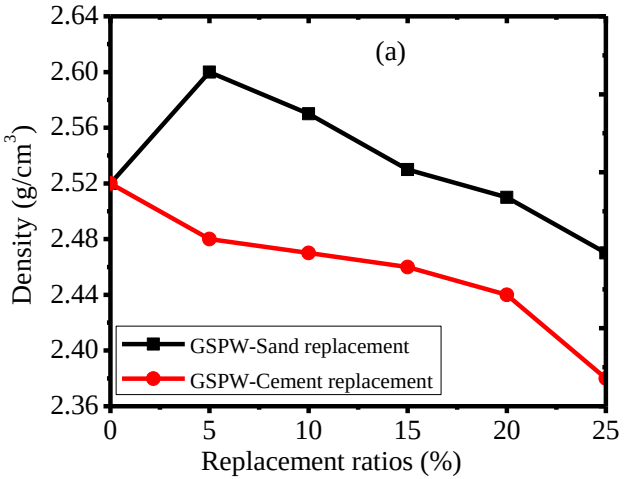
Effects of GSPW on fresh concrete workability

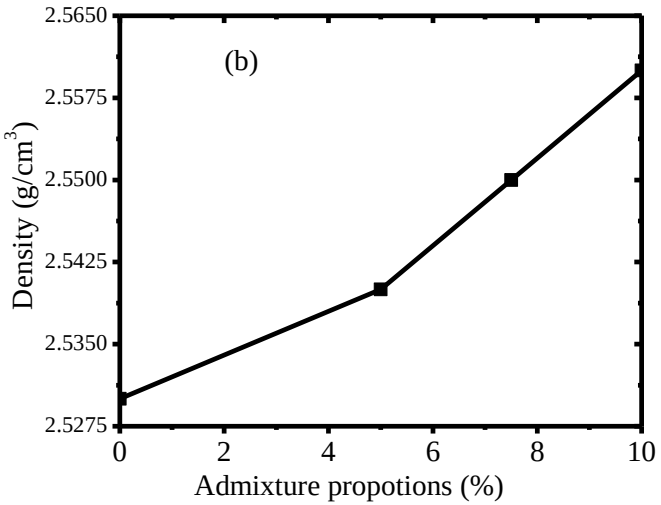




Slump values as function of (a) replacement ratios and (b) admixture proportions of granite sawing powder waste

Effects of GSPW on the density of hardened concrete

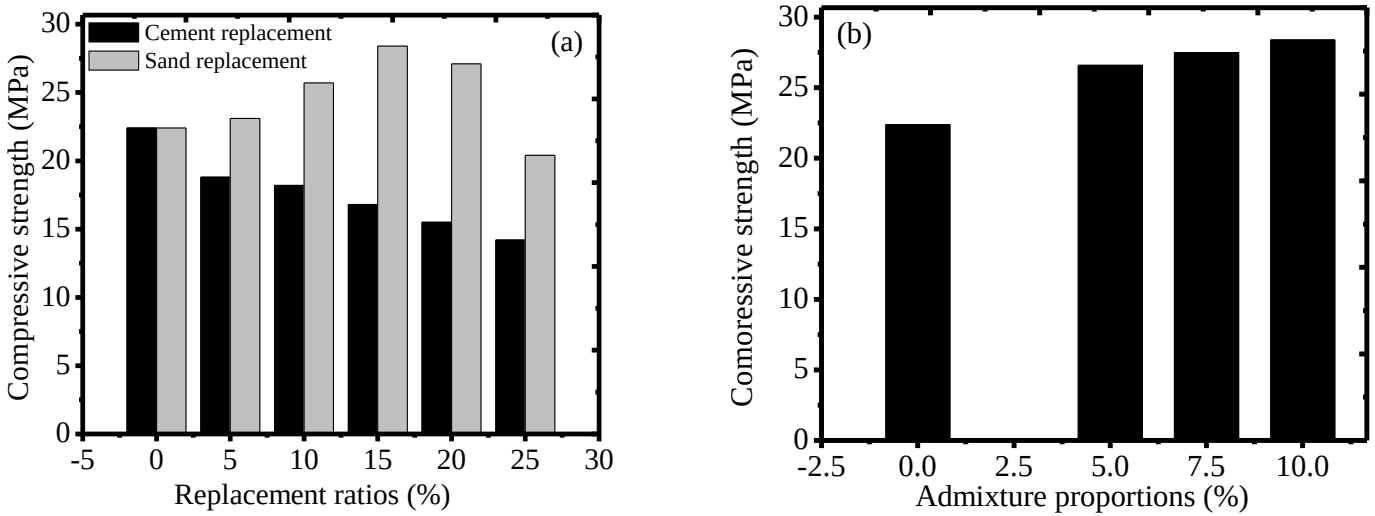




Densities of hardened concrete as function of (a) partial replacements of cement and sand and (b) admixture proportions of granite sawing powder waste

Results and discussions: Effects of GSPW on compressive strength of concrete

Effects of replacement ratios and admixture proportions



Compressive strength as function of (a) replacement ratios of sand and cement and (b) admixture proportions of granite sawing powder waste

Effects of particle size

Particle size (µm)	Compressive strength (MPa)
125	18.8
180	17.5

Effects of GSPW on split tensile strength and water absorption

Split tensile strength of concrete with GSPW

	Split TS after 7 days (MPa)	Split TS after 28 days (MPa)
CM	1.0	1.2
CGC5	1.8	2.0

Water absorption as function of replacement Proportions

Replacement proportions (%)	GSPW-sand (%)	GSPW-cement (%)
0	4.1	4.1
5	3.98	4.17
10	3.79	4.18
15	3.51	4.21
20	3.77	4.36
25	4.9	6.58

Conclusion

- This paper investigated mechanical performances of concrete processed with granite sawing powder wastes (GSPW).
- The results revealed that GSPW-sand replacements could provide higher compressive strengths at both 7 and 28 days.
- An optimum compressive strength was obtained at 15% GSPW-sand replacement
- GSPW-cement replacements had a dramatic decrease in both mechanical properties
- The compressive strength of concrete processed with granite sawing powder was related to the particle size.
- Higher compressive strength was obtained for concrete with finer granite sawing powder wastes.

Conclusion

- The use of GSPW as admixture resulted in increased compressive strength at all percentages and ages of concrete.
- The water absorption test revealed that the concrete processed with GSPW-sand partial replacement had lower water absorption than concrete with GSPW-cement replacement.
- A reduction in water absorption was also obtained for concrete with admixture of granite sawing powder wastes, confirming their durability.

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THANK YOU FOR YOUR ATTENTION