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Effect of recycled geopolymer concrete aggregate on strength development and consistence of Portland cement concretes

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Effect of recycled geopolymer concrete aggregate on strength development and consistence of Portland cement concretes

Alkali Activated Materials and Geopolymers:
Versatile Materials Offering High Performance and Low Emissions
May 27 - June 1, 2018
Tomar, Portugal

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Juliana Calabria-Holley



UNIVERSITY OF
BATH

Outline

Scope of project

Materials & Methods

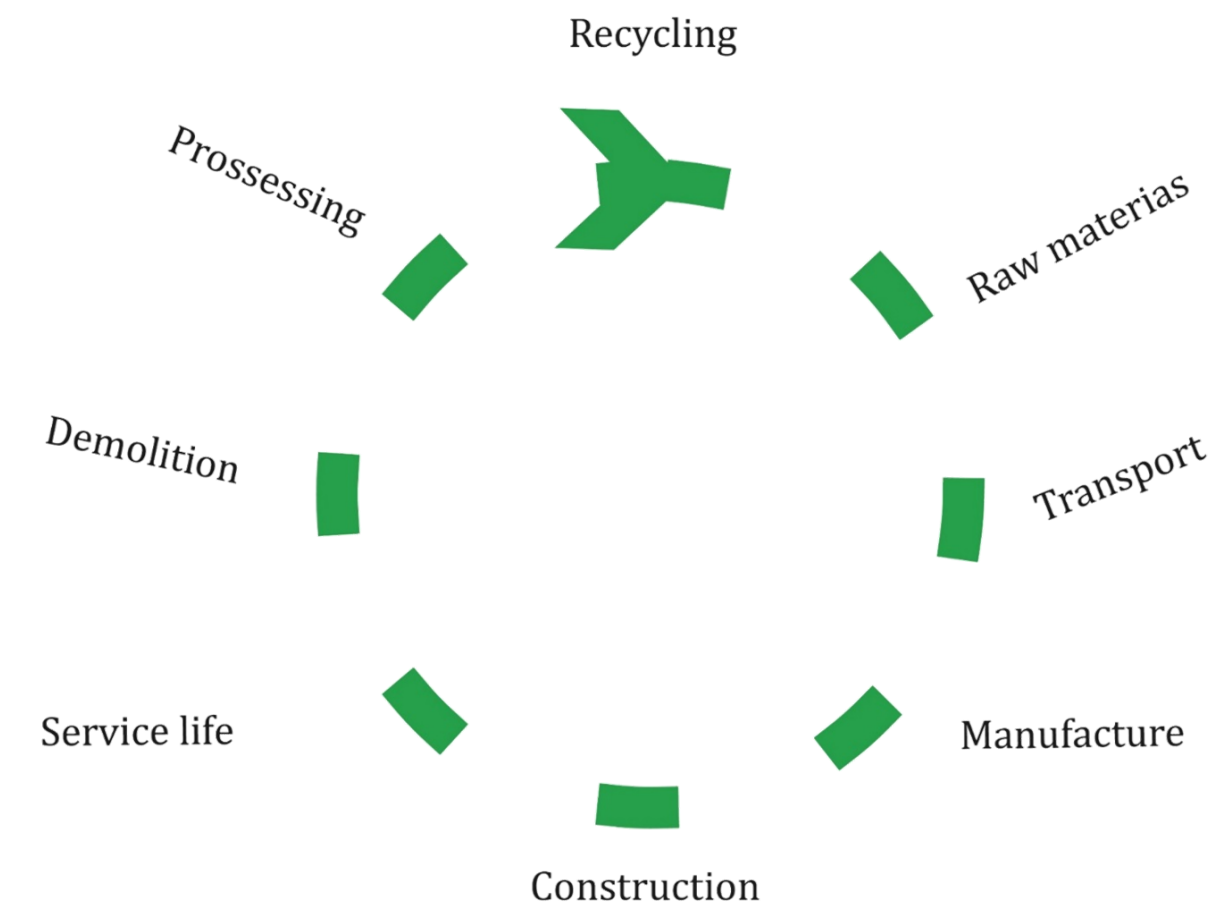
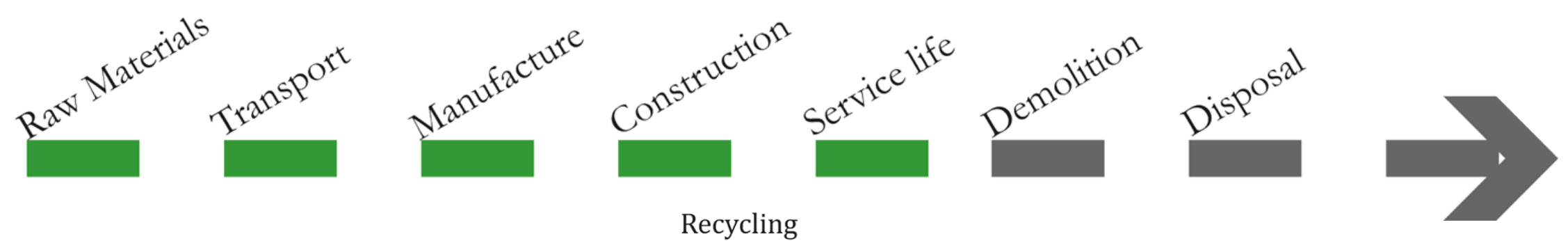
Results analysis

Conclusions

Experiments in progress

Scope of project

Project goal



Concrete Recycling



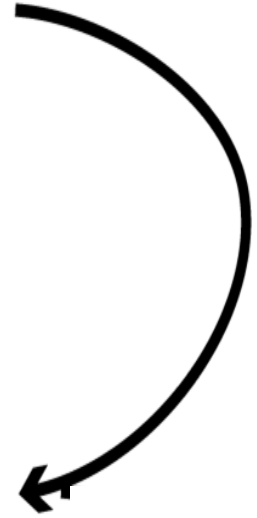
Project Phases

Source concretes

Project Outline

Source concretes

Recycled aggregate production

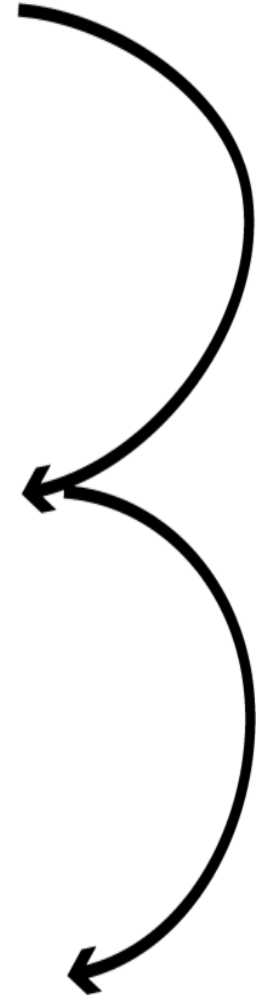


Project Outline

Source concretes

Recycled aggregate production

Concretes with Recycled Aggregates

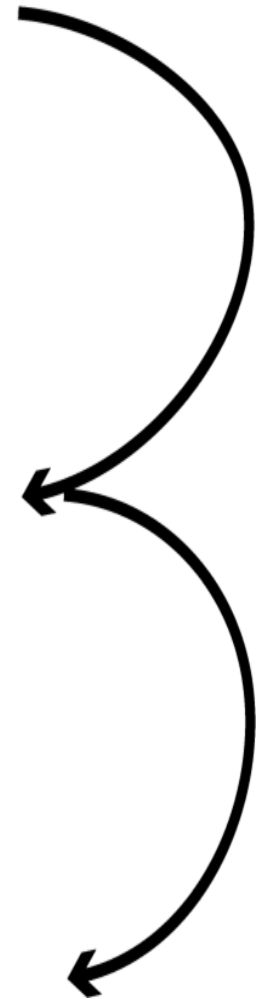
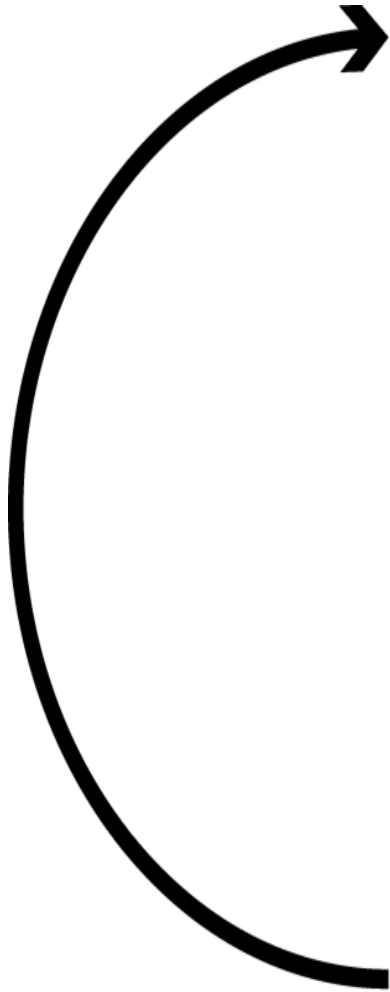


Project Outline

Source concretes

Recycled aggregate production

Concretes with Recycled Aggregates



Materials & Methods

Source concretes

Geopolymer concretes for:

- Load-bearing elements
- Large volume applications
- In situ casting



Source concretes

Geopolymer Concrete	Na ₂ O% per mass precursor	SiO ₂ /Na ₂ O Molar ratio in solution	Water/ Precursor
GC-3_1.0	3%	1.0	0.4
GC-4_1.0	4%	1.0	0.4
GC-3_1.5	3%	1.5	0.4
PC* * CEMI	-	-	0.5

- Mix design according to UK Building Research Establishment BRE method
- Limestone natural aggregates

Source concretes



Recycled Aggregate production



Recycled Aggregate production

Geopolymer Concrete	Recycled Geopolymer Concrete Aggregate
GC-3_1.0	RGCA-3_1.0
GC-4_1.0	RGCA-4_1.0
GC-3_1.5	RGCA-3_1.5

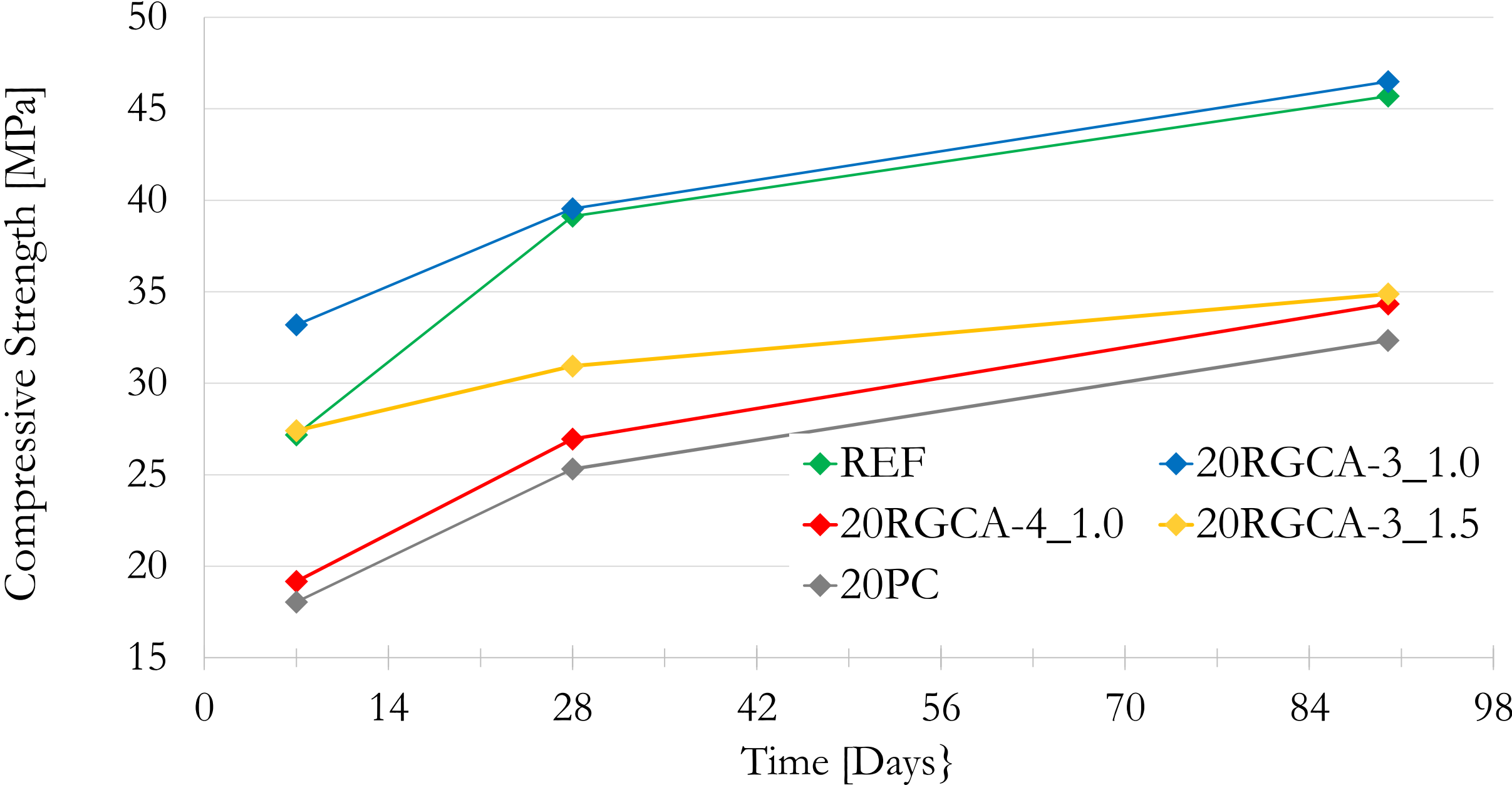
Concretes with Recycled Aggregates

Mix label	Recycled Aggregate	Natural Aggregate	Source concrete
20RGCA-3_1.0	20% RGCA-3_1.0	80% Limestone	GC-3_1.0
20RGCA-4_1.0	20% RGCA-4_1.0	80% Limestone	GC-4_1.0
20RGCA-3_1.5	20% RGCA-3_1.5	80% Limestone	GC-3_1.5
20PC	20% RCA	80% Limestone	PC
REF	-	100% Limestone	-

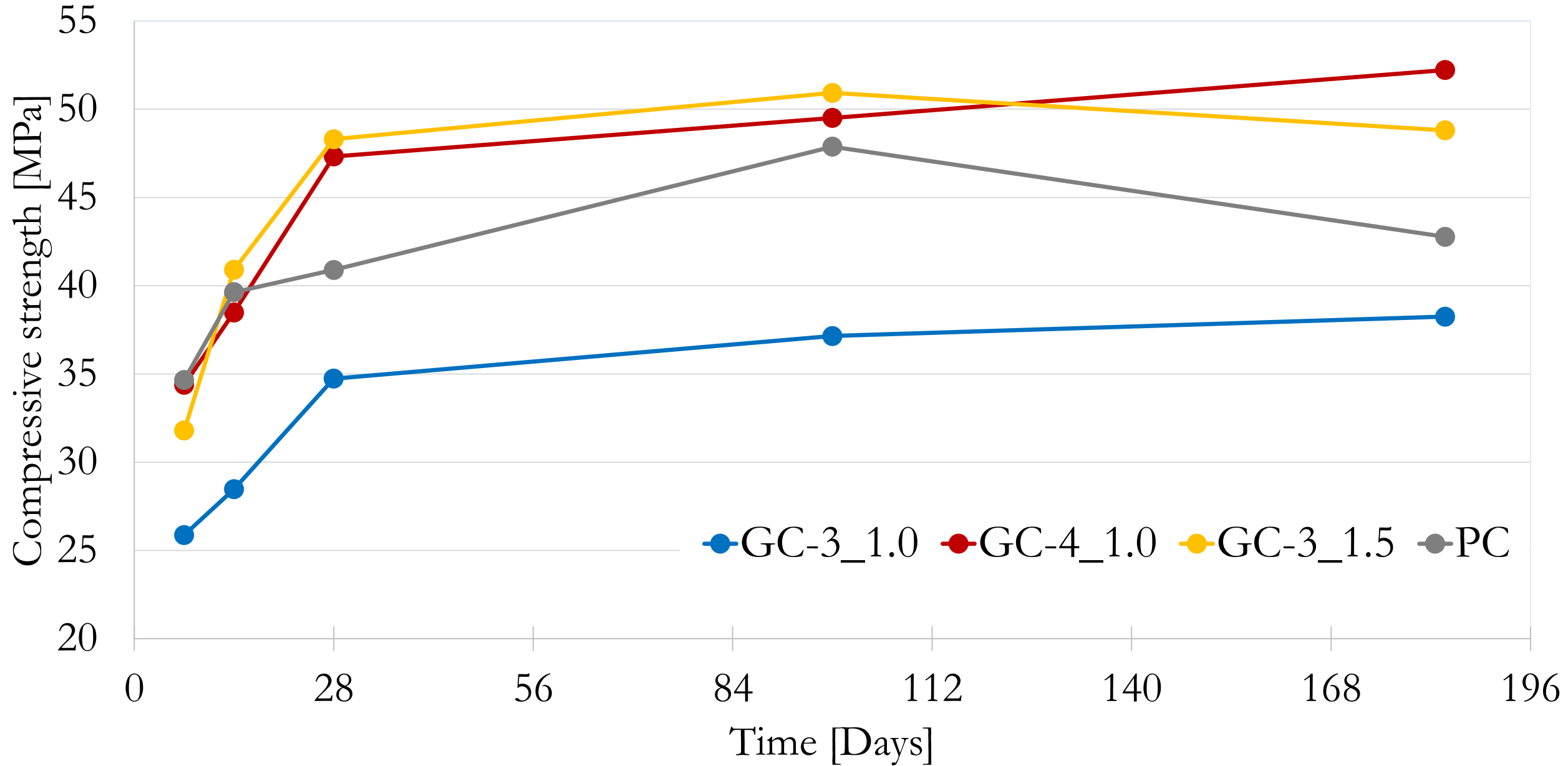
- $w/c = 0.5$
- CEMII limestone
- S1 & S3 consistence classes
- BRE mix design method

Results Analysis

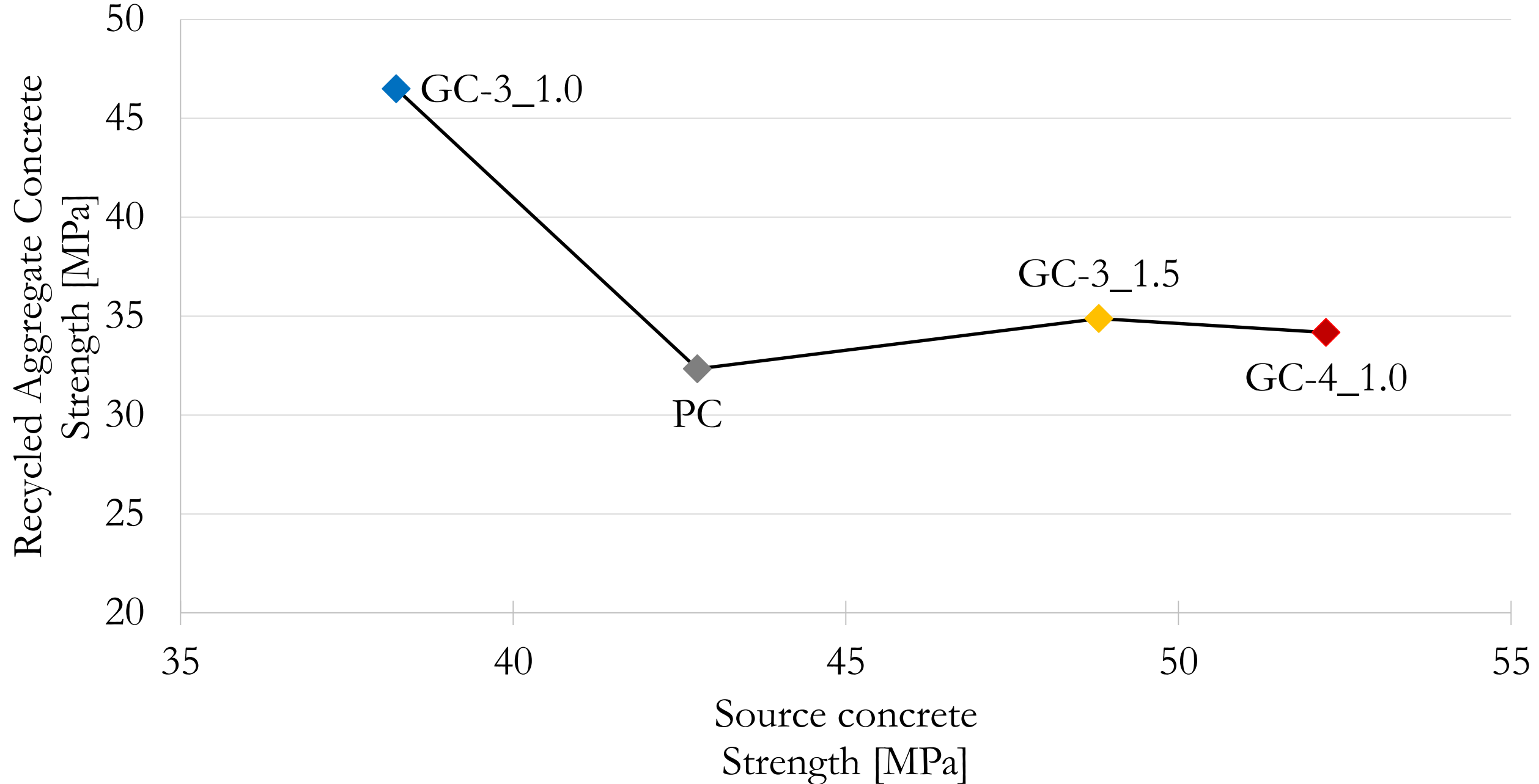
Strength of S3 concrete with Recycled Aggregates



Strength of Source Geopolymer Concretes



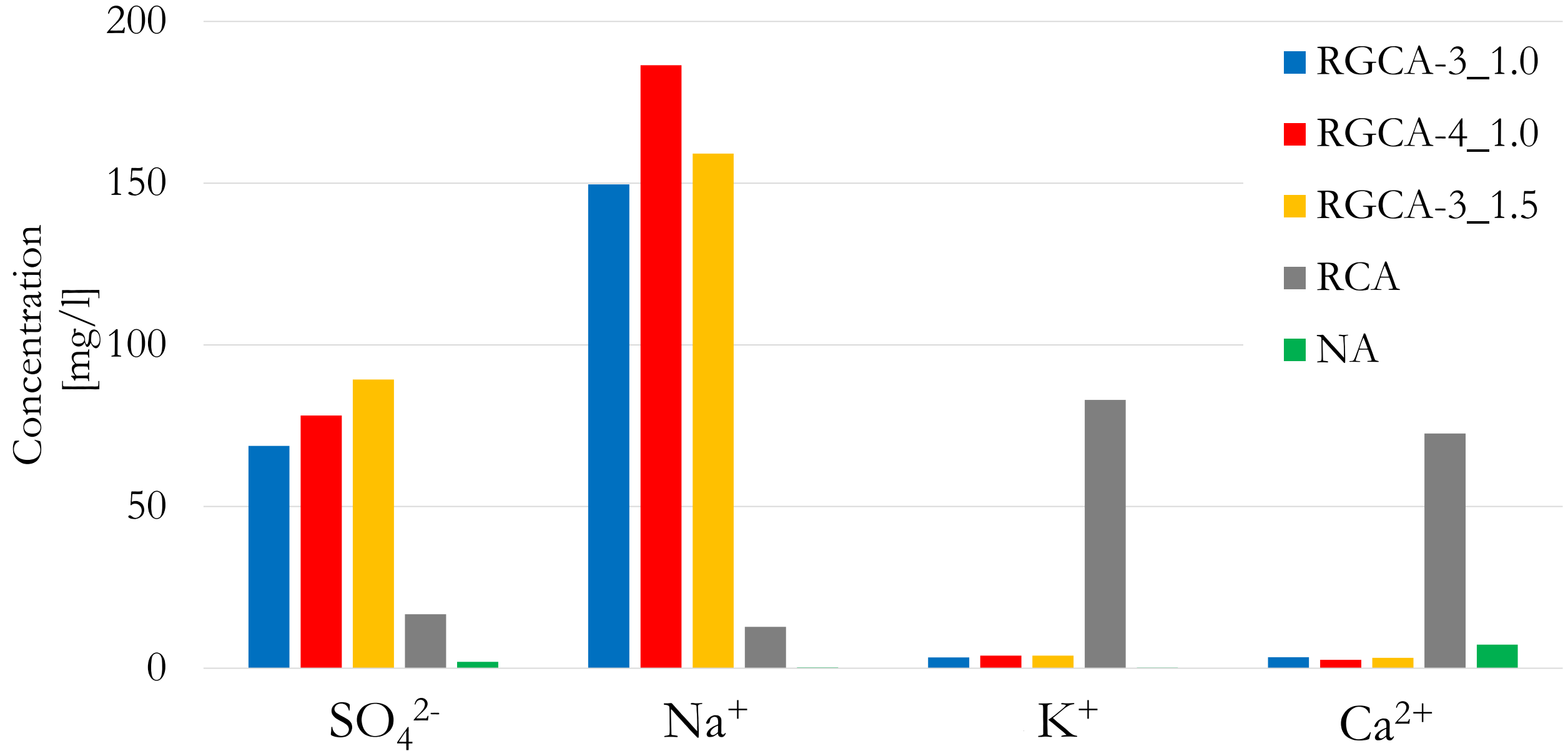
Recycled aggregate concrete vs Source concrete



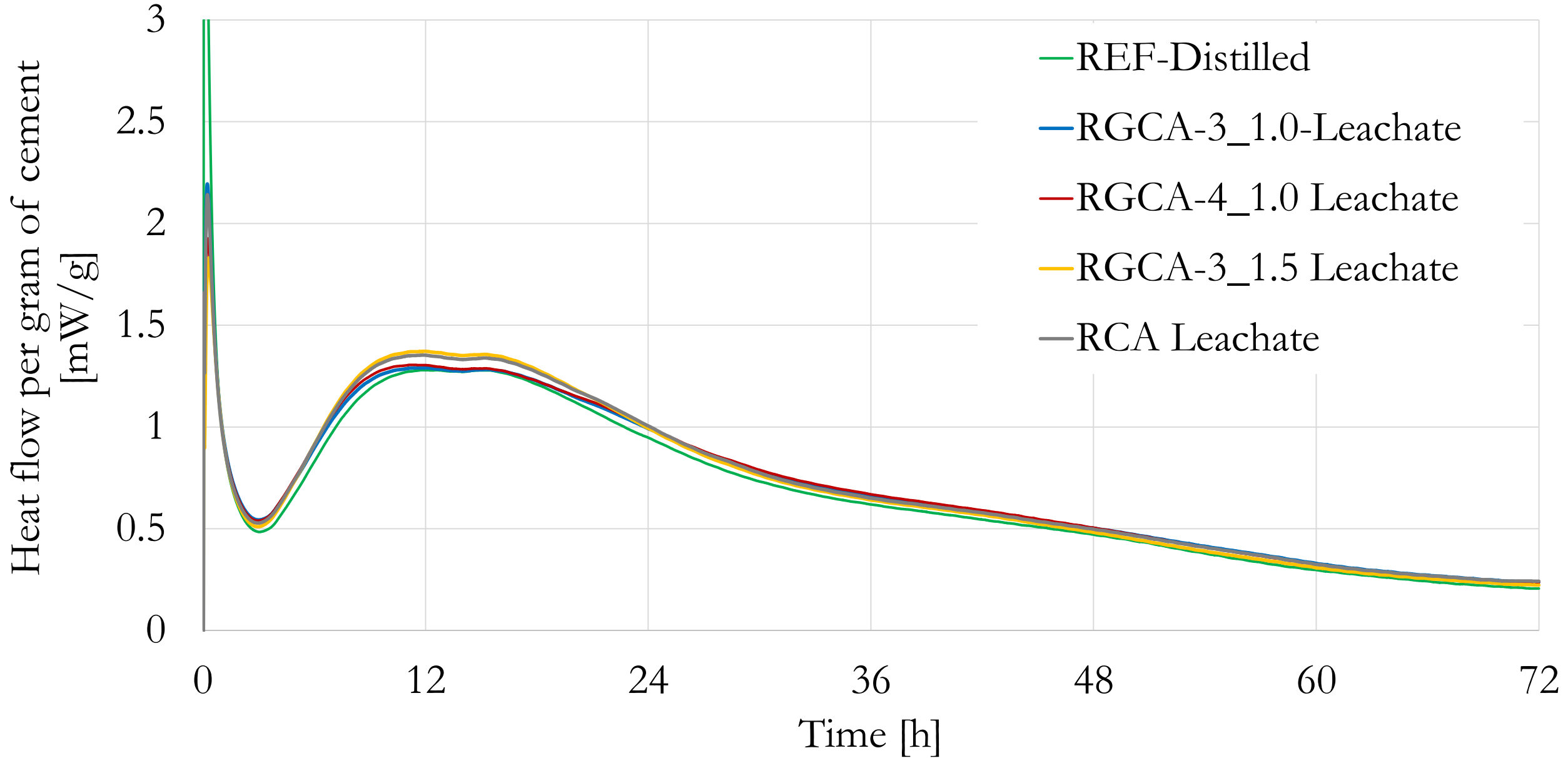


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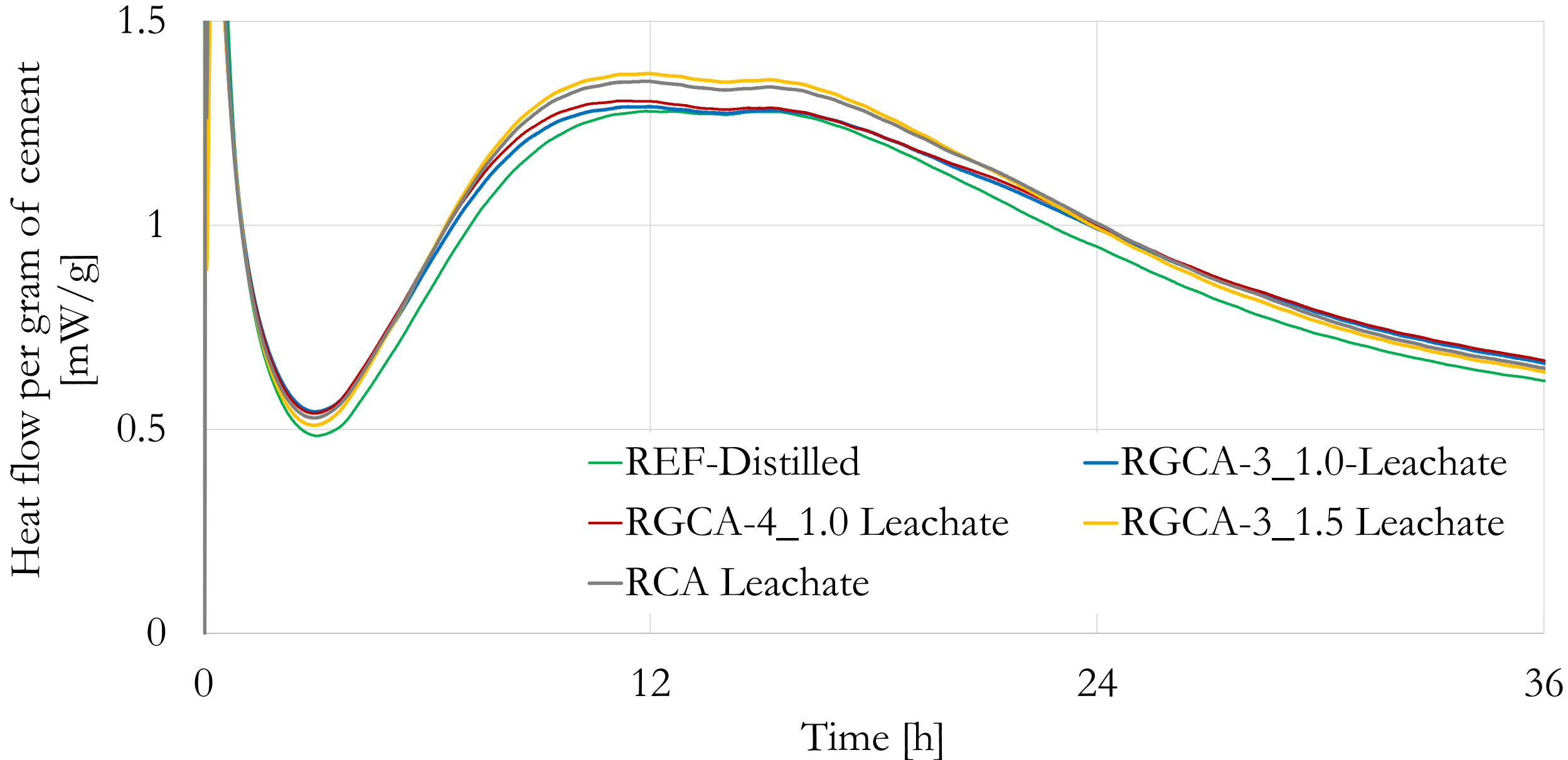
Ionic concentrations in aggregate leachate



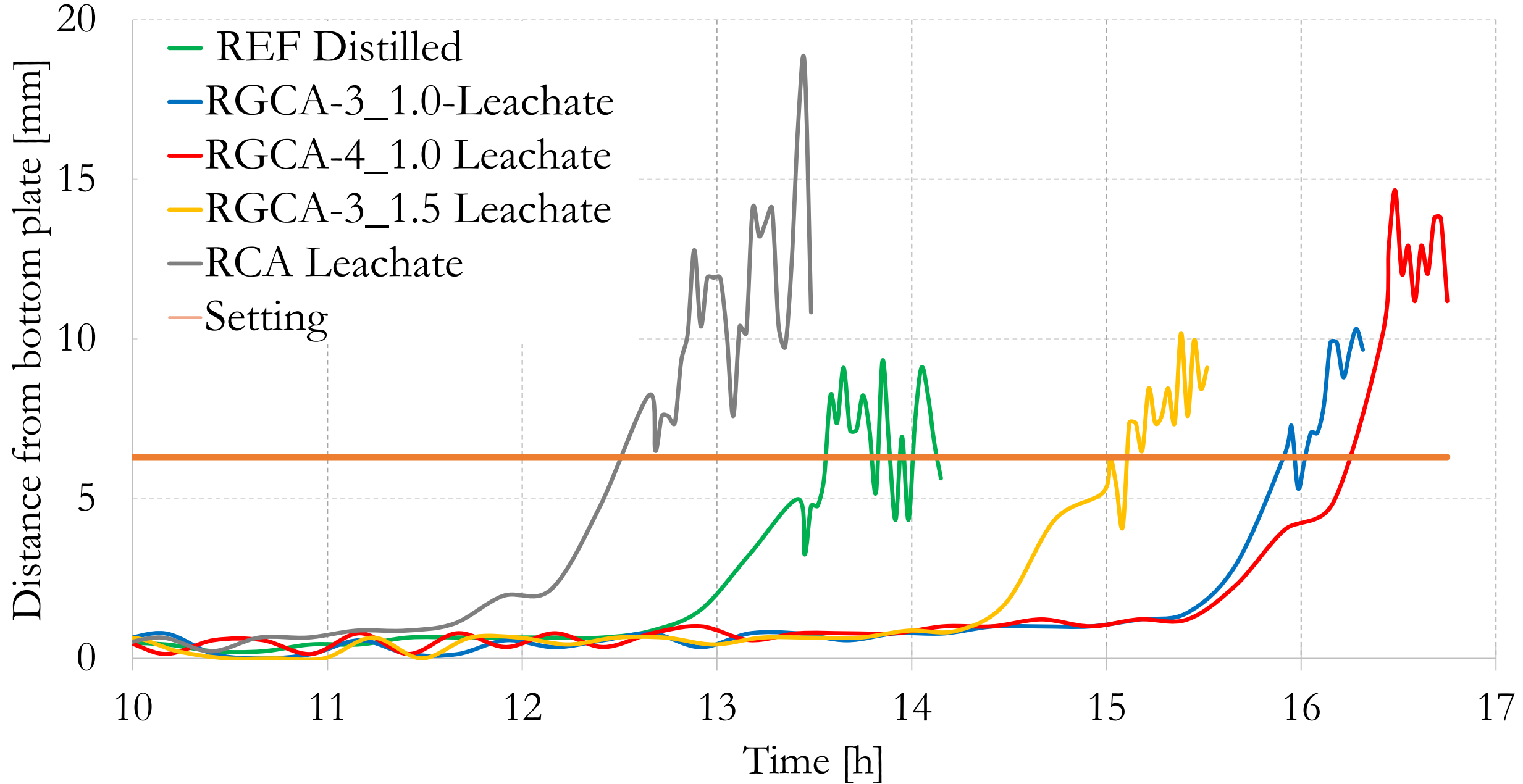
Cement paste with aggregate leachate (0.5 w/c)



Cement paste with aggregate leachate (0.5 w/c)



Initial setting time- $0.5w/c$



Conclusions

Conclusions

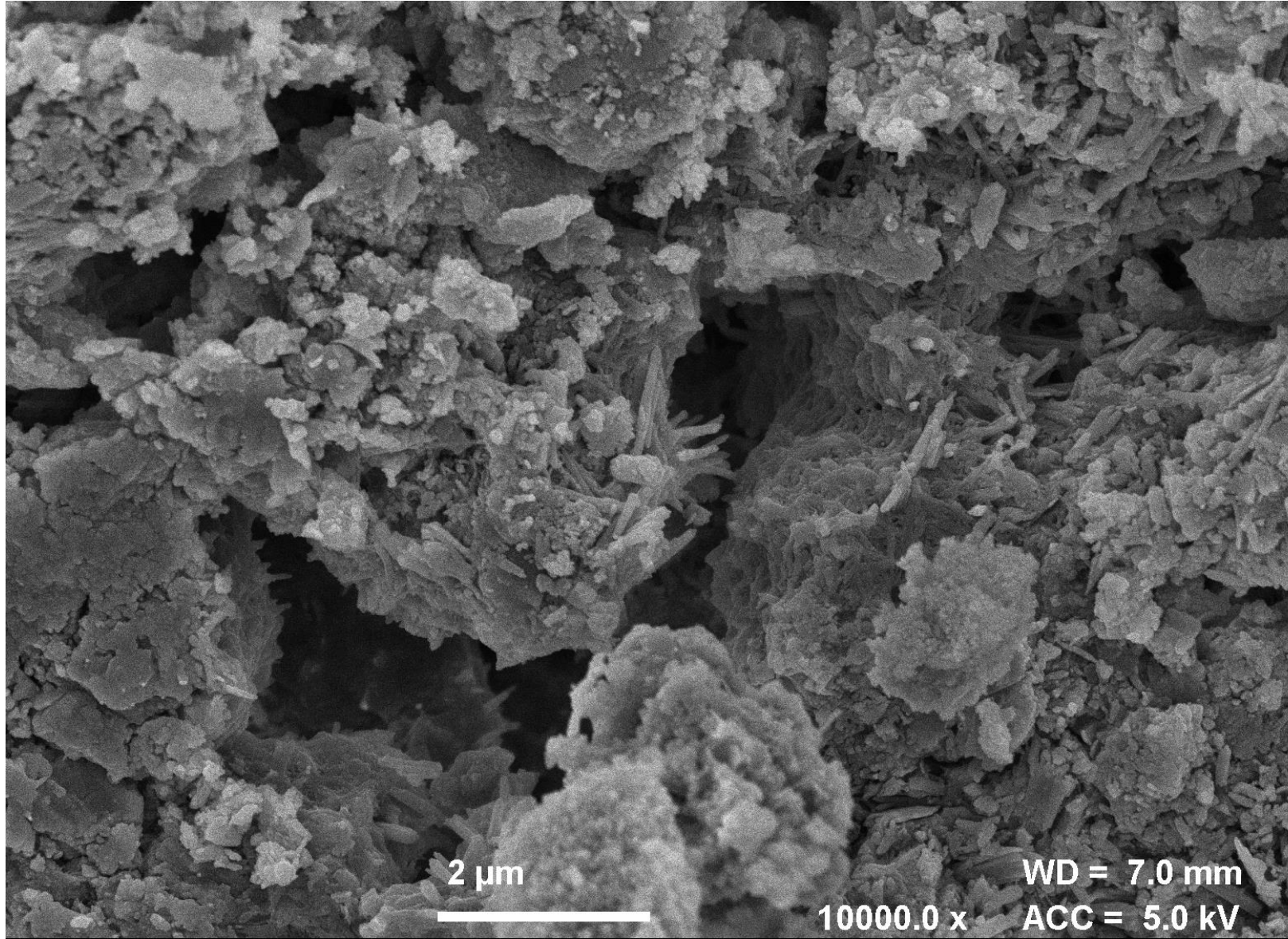
- Leaching of SO_4^{2-} , Na^+ from Recycled Geopolymer Concrete Aggregate
- Initial setting of cement paste affected by Recycled Aggregate leachate
- Distinct action of Ca^{2+} , K^+ and Na^+ ions

Conclusions

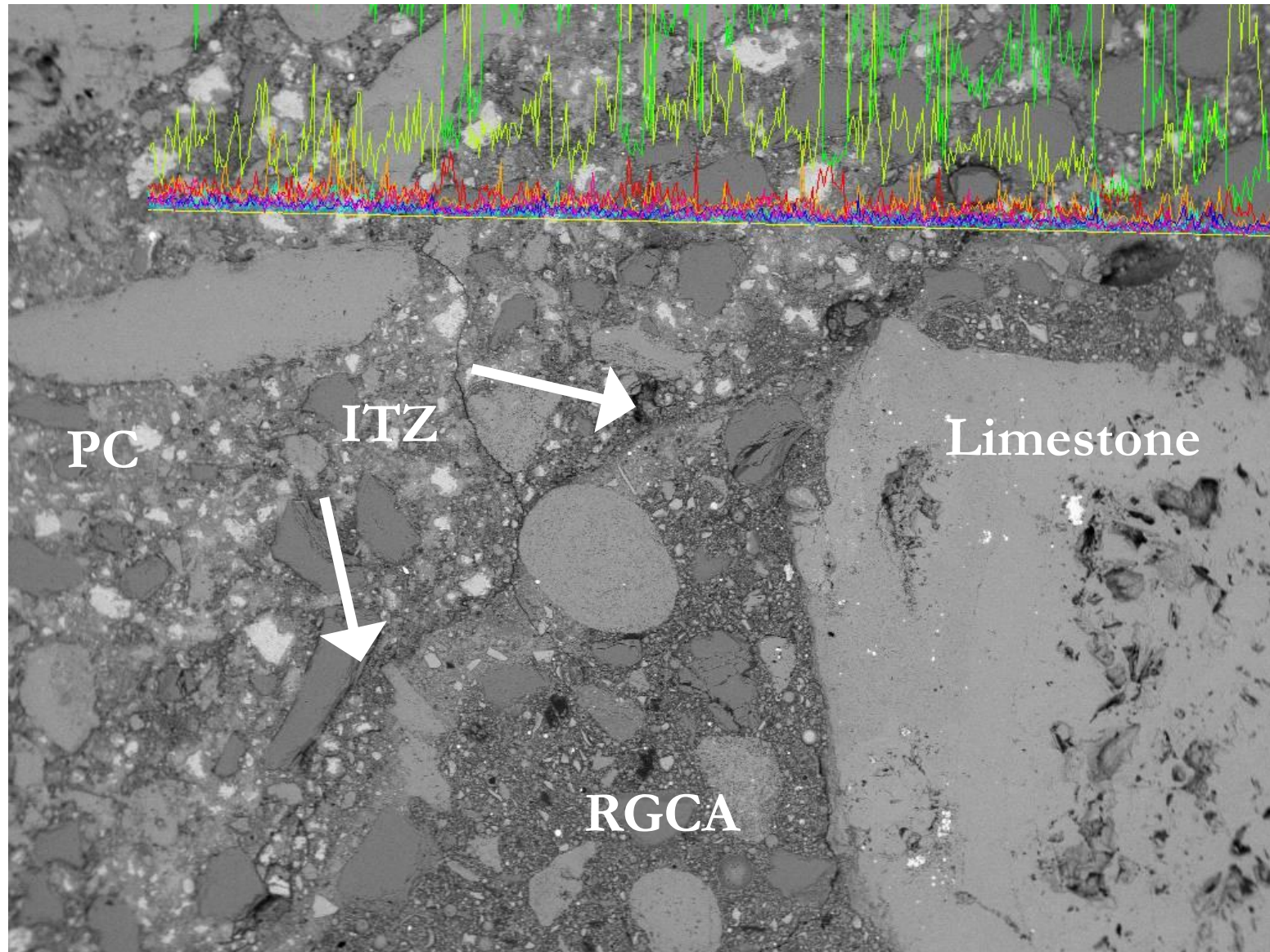
- Strength development mechanism of concrete is affected by Recycled Geopolymer Concrete Aggregate incorporation
- Strong correlation of source concretes' chemical composition to their effect on recycled aggregate concrete strength and consistence
- Investigation of aggregate-matrix interaction required

Experiments in progress

Fractured surface of 7day S3 20RGCA-3_1.5



Polished surface of 90day S3 20RGCA-3_1.5



1mm

Electron Image 1

Thank you!

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