Comparison between Geopolymer and Portland cement for Construction and Demolition Waste (CDW) upcycling

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CONSTRUCTION AND DEMOLITION WASTE (CDW)

Produced by:
- construction
- demolition
- disasters

Main components:
- concrete
- bricks, tiles, roof tiles and other ceramics
- building stones and soil

Secondary components:
- Wood
- Metal
- Glass
- Plastic
- Plaster

CDW IMPORTANCE

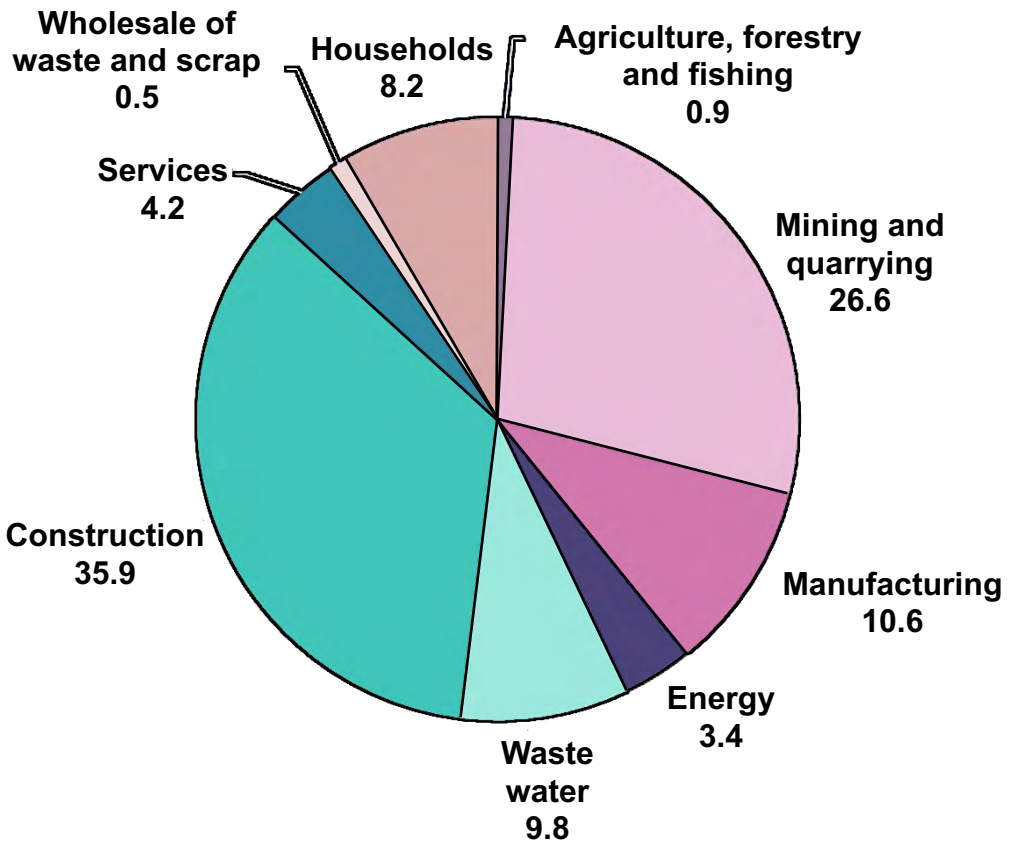
Total waste produced in EU - 2018

CDW (worldwide):

The heaviest waste

Delivered to landfill up to 35%

Production is set to increase



EU DIRECTIVE 2008/98/EC

70% of CDW must to be recycled by 2020

in EU CDW produced is downcycled commonly

PURPOSE

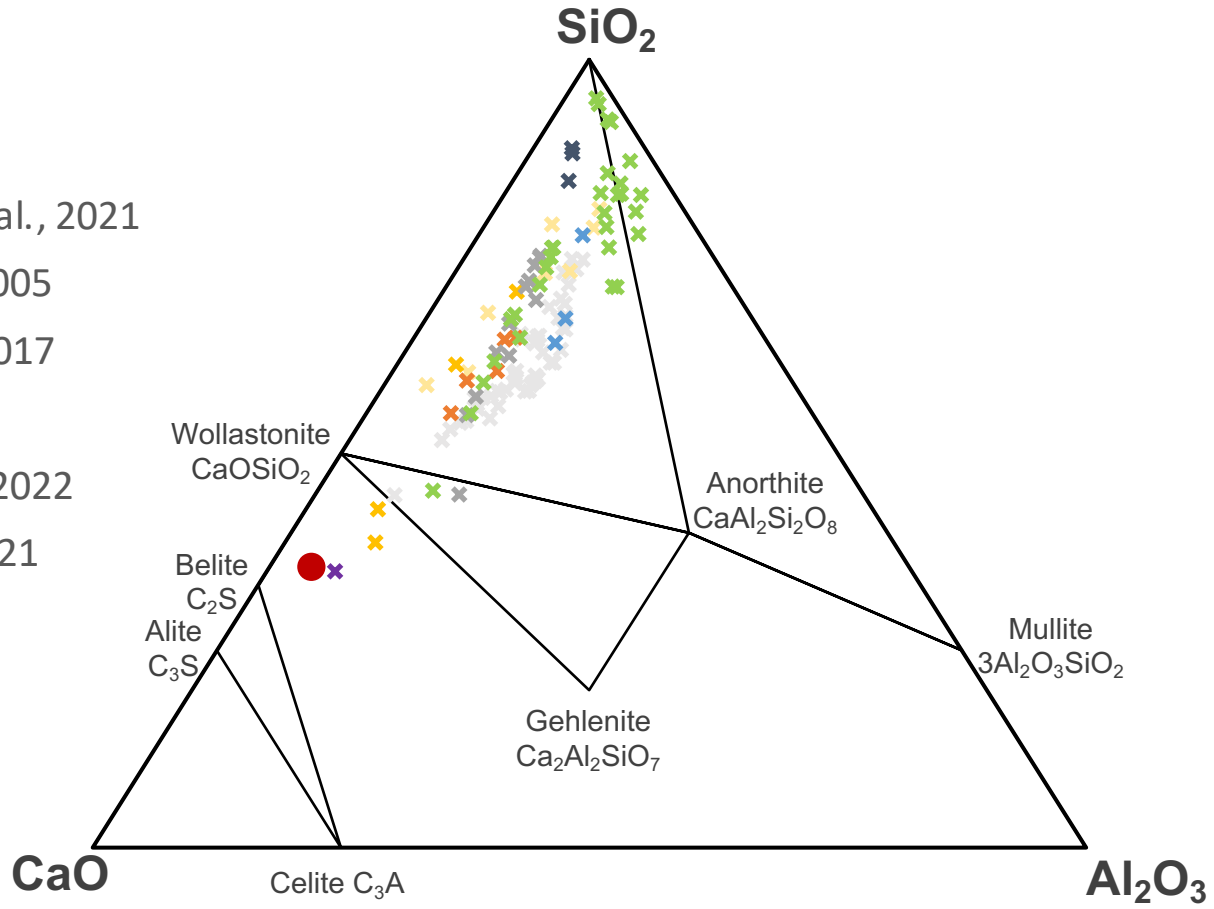
Finest CDW fractions upcycling

- How fine fraction composition changes?
- Which consequences?

Geopolymer applications and comparison with Portland cement.

CHEMISTRY

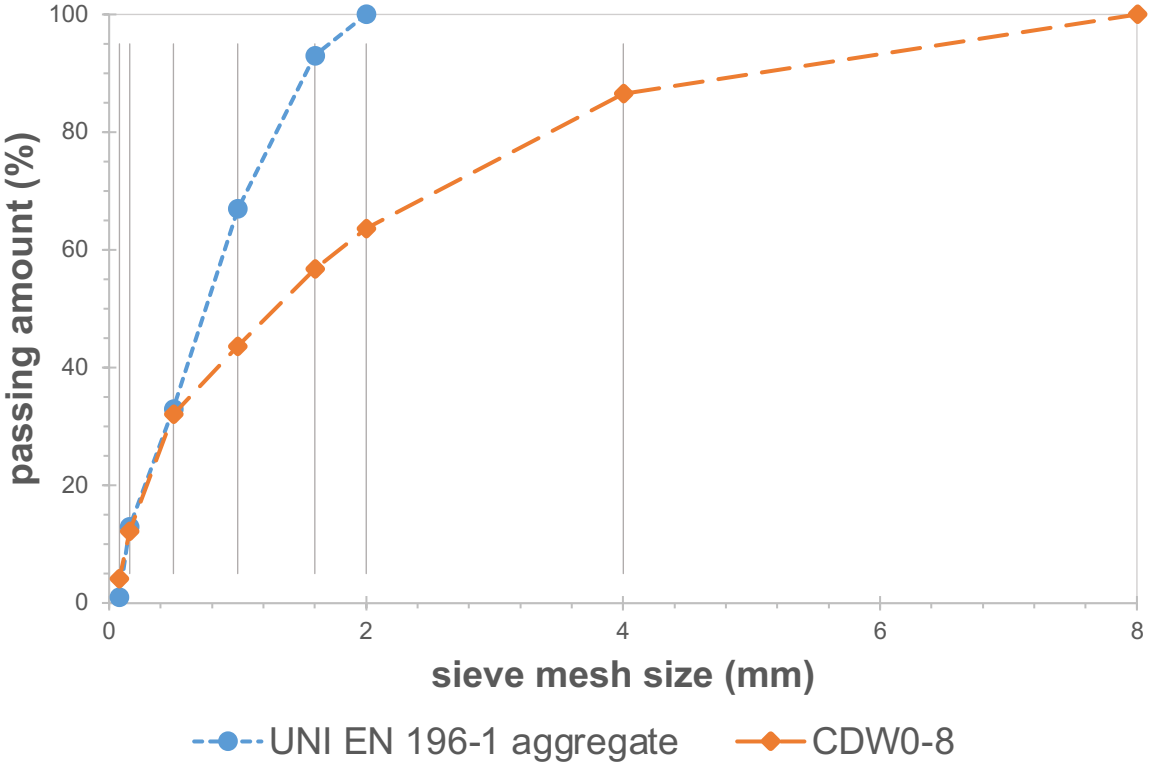
- This study sample
- Abudurehman A. et al., 2021
- Bianchini G. et al., 2005
- Favaretto P. et al., 2017
- Krour H. et al., 2020
- Marotto J.M. et al., 2022
- Santos R.P. et al., 2021
- Tan J. Et al., 2022
- Ulsen C. et., 2021
- Ulseln C. et al., 2022



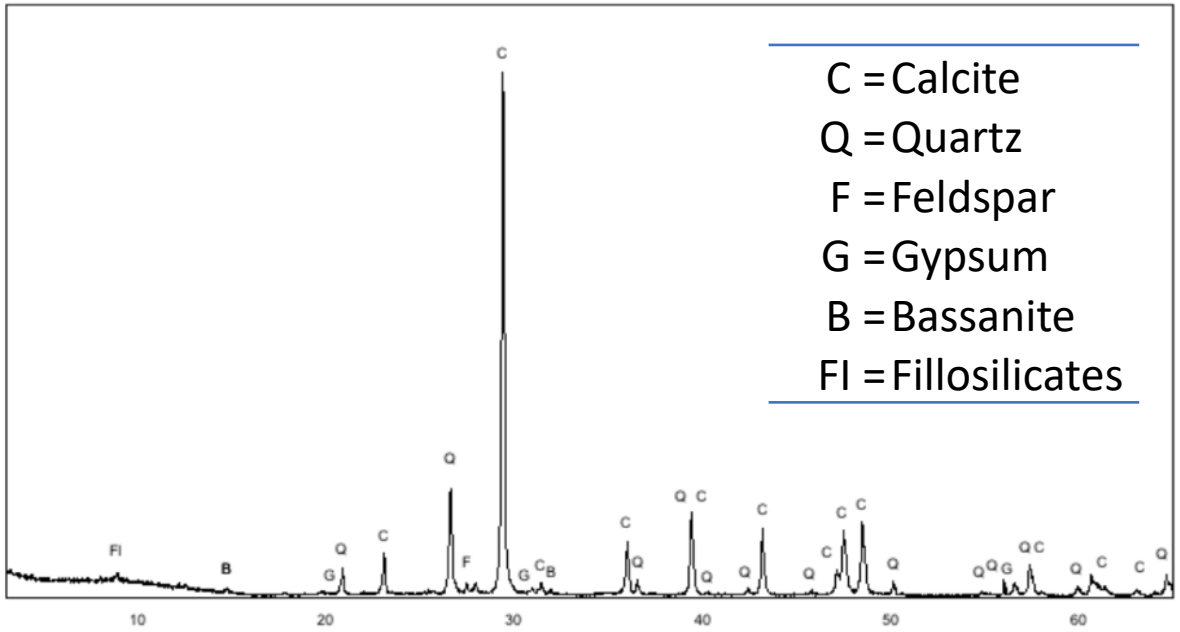
	wt.%
SiO_2	23.40
TiO_2	0.16
Al_2O_3	2.79
Fe_2O_3	1.75
MnO	0.09
MgO	1.10
CaO	39.54
Na_2O	0.17
K_2O	0.80
P_2O_5	0.11
LOI (910 °C)	30.09
TOT	100.00

CHARACTERIZATION

Grain size distribution



XRD diagram



- **20 wt.%** of aggregate **<250 µm**
- **Sulphates** presence

RECYCLING: WHY GEOPOLYMER?

Difficult and limited recycling due to problems related to:

- **Type of aggregate**
- **Mix design**
- **Low density**
- **High porosity**
- **High absorption**

Geopolymer advantages:

- **Low CO_2 emission**
- **Higher durability than OPC**
- **Good acid resistance**
- **Good fire resistance**

SPECIMENS PRODUCTION

Mixer

Vibranting Table

Mould

Mixing

- Amorphous aluminosilicate precursor
+
- User friendly alkaline reagent

Mixing

- Aggregate (CDW)

Casting

- Casting into the mould

Casting

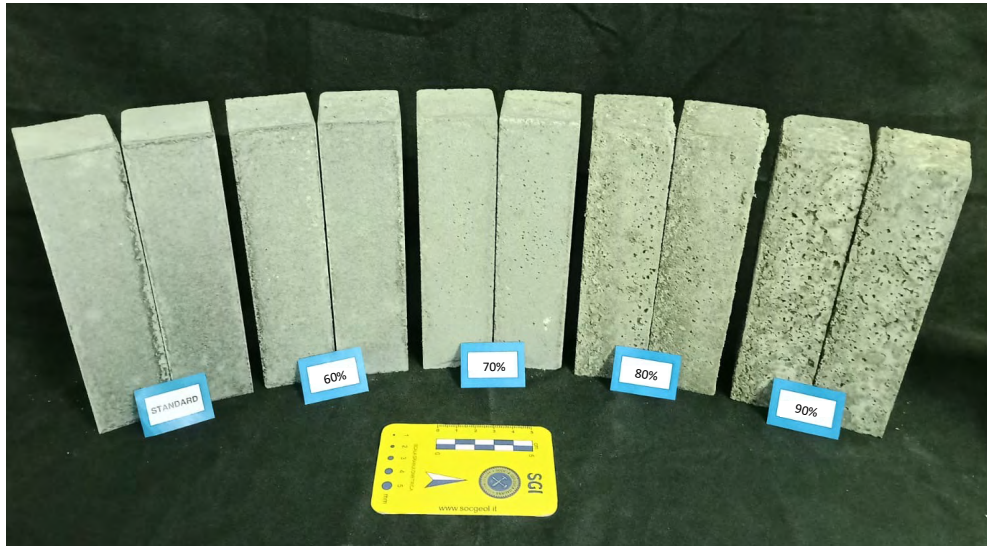
- Removal of bubbles on a vibrating table

Curing

- Curing at room condition (20 ± 2 °C)
- Mechanical and physical properties

REALIZED SAMPLES

GEOPOLYMER



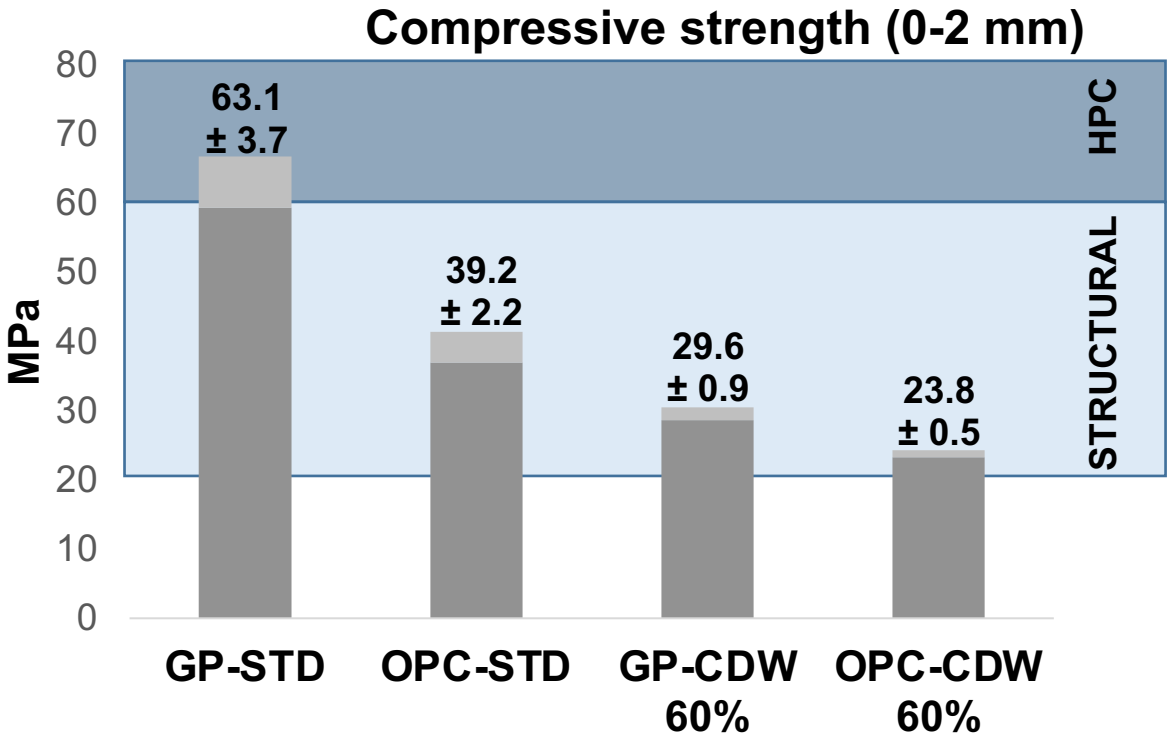
PORTLAND

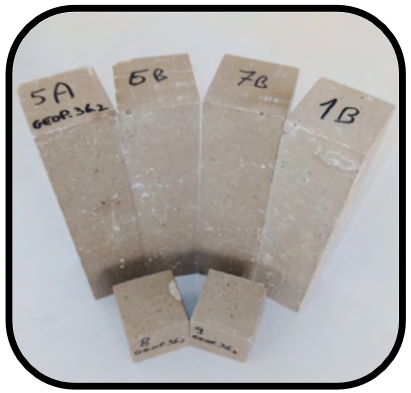
Produced specimens:

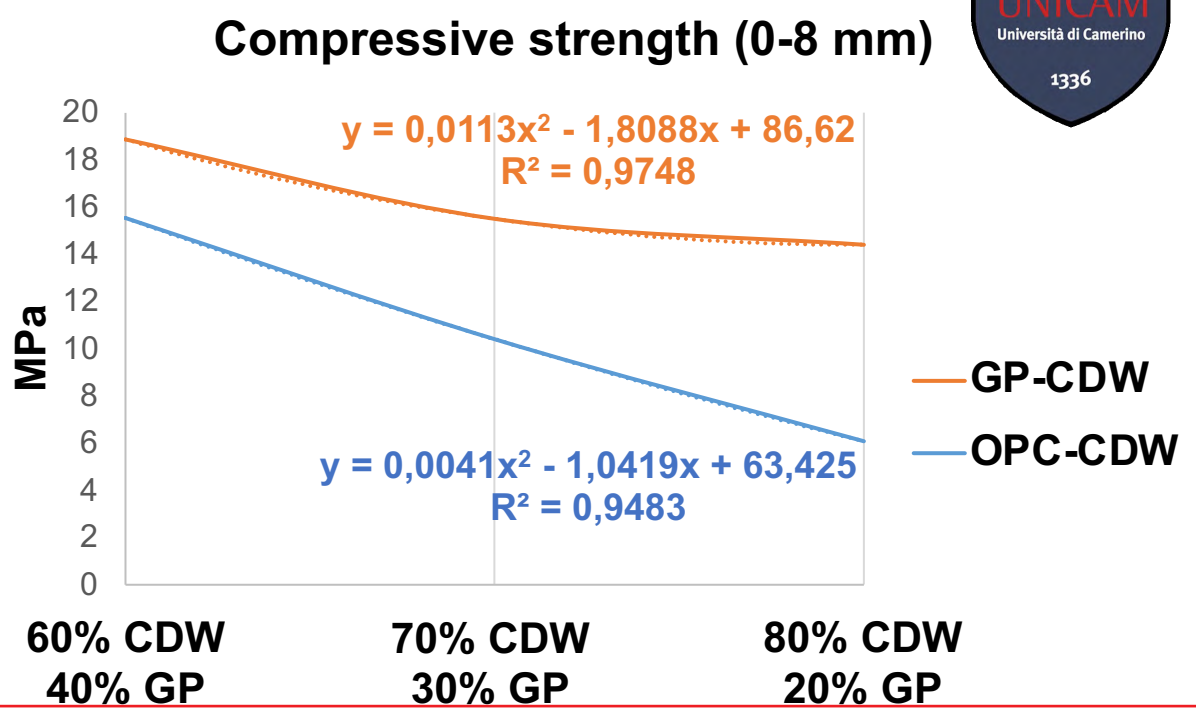
- **Standard containing standardized quartz 0.08 – 2 mm sand**
- **Samples with CDW 0.08 – 2 mm**
- **Sample with CDW 0 – 8 mm**

For each GP, comparison with OPC

PHYSICAL AND MECHANICAL PROPERTIES







+ 6% Open Porosity (OP) and Water Absorption (WA)

ACID ATTACK

in HCl 18.5%
(0 min)

40% Geopolymer
60% CDW

40% Portland
60% CDW

in HCl 18.5%
(4 min)

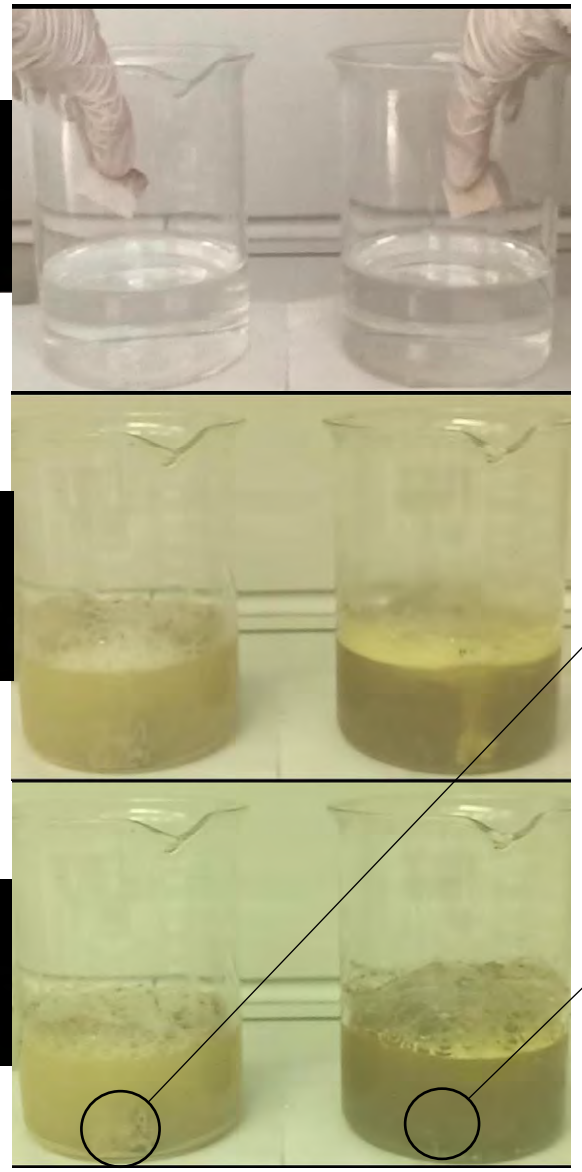
40% Geopolymer
60% CDW

40% Portland
60% CDW

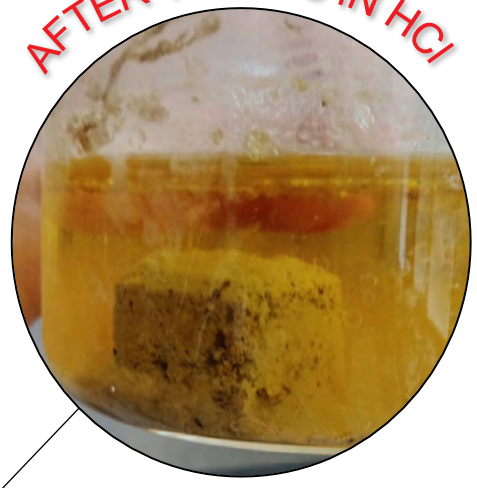
in HCl 18.5%
(8 min)

40% Geopolymer
60% CDW

40% Portland
60% CDW



GEOPOLYMER
AFTER 14 DAYS IN HCl



PORTLAND
COMPLETELY DISSOLVED

0 days

7 days
-28.2 wt.%

14 days
-50.9 wt.%

FIRE RESISTANCE

2h in
furnace kiln
at **800°C**

1h 45min
Flame test
(**1800°C** max T)

PORTLAND

GEOPOLYMER

After test **4 days later**

PORTLAND

GEOPOLYMER

No spalling immediately after tests, but **Portland totally collapses** after a few days.

CONCLUSIONS

WHAT HAS BEEN FOUND:

- **CDW can be used for upcycling applications in building;**
- **Good mechanical performance for geopolymer-based materials containing CDW;**
- **Minor issues related to the nature of the CDW in geopolymer-based materials;**
- **Better fire and acid attack resistance.**

FUTURE STUDIES:

- **Durability test;**
- **Develop cheaper binders;**
- **Extend research for industrial production.**