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Use of recovered resources in construction industry: cellulose fibres from urban wastewater

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Objectives

- Cellulose
- Biopolymers

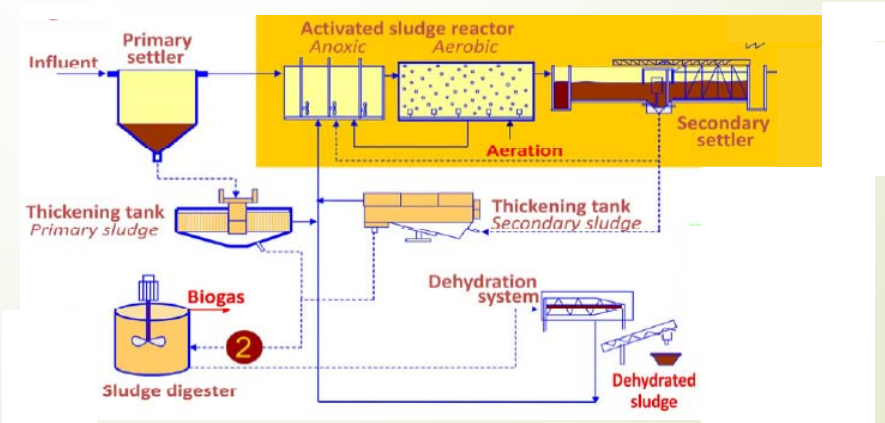
RECOVERY OF MATERIALS AND BIOBASED PRODUCTS

SMART-Plant

NEW TECHNOLOGIES FOR IMPLANTS

Zero Energy Plant

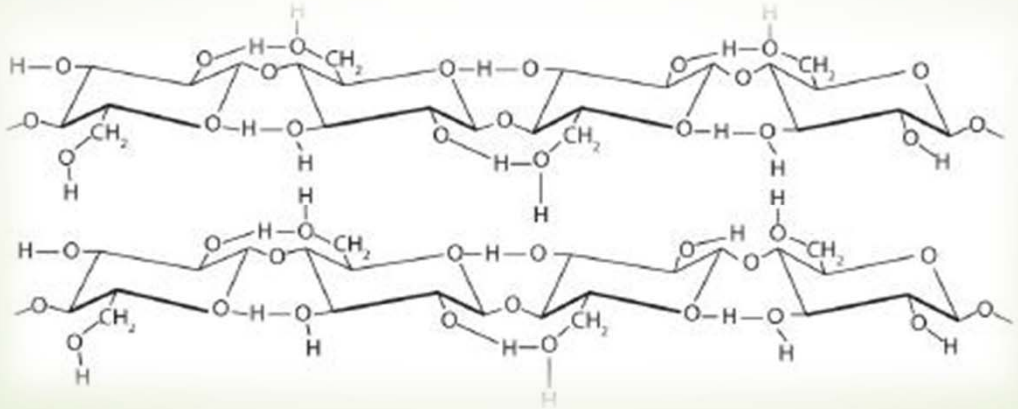
CIRCULAR ECONOMY



Cellulose

- Natural Polymer: linear units of glucose joined by β-1,4-glycosidic linkages
- Completely insoluble in water and with a considerable mechanical strength.
- Low cost, widely available, sustainable, widely use as reinforced and insulated material

Suitable in building construction

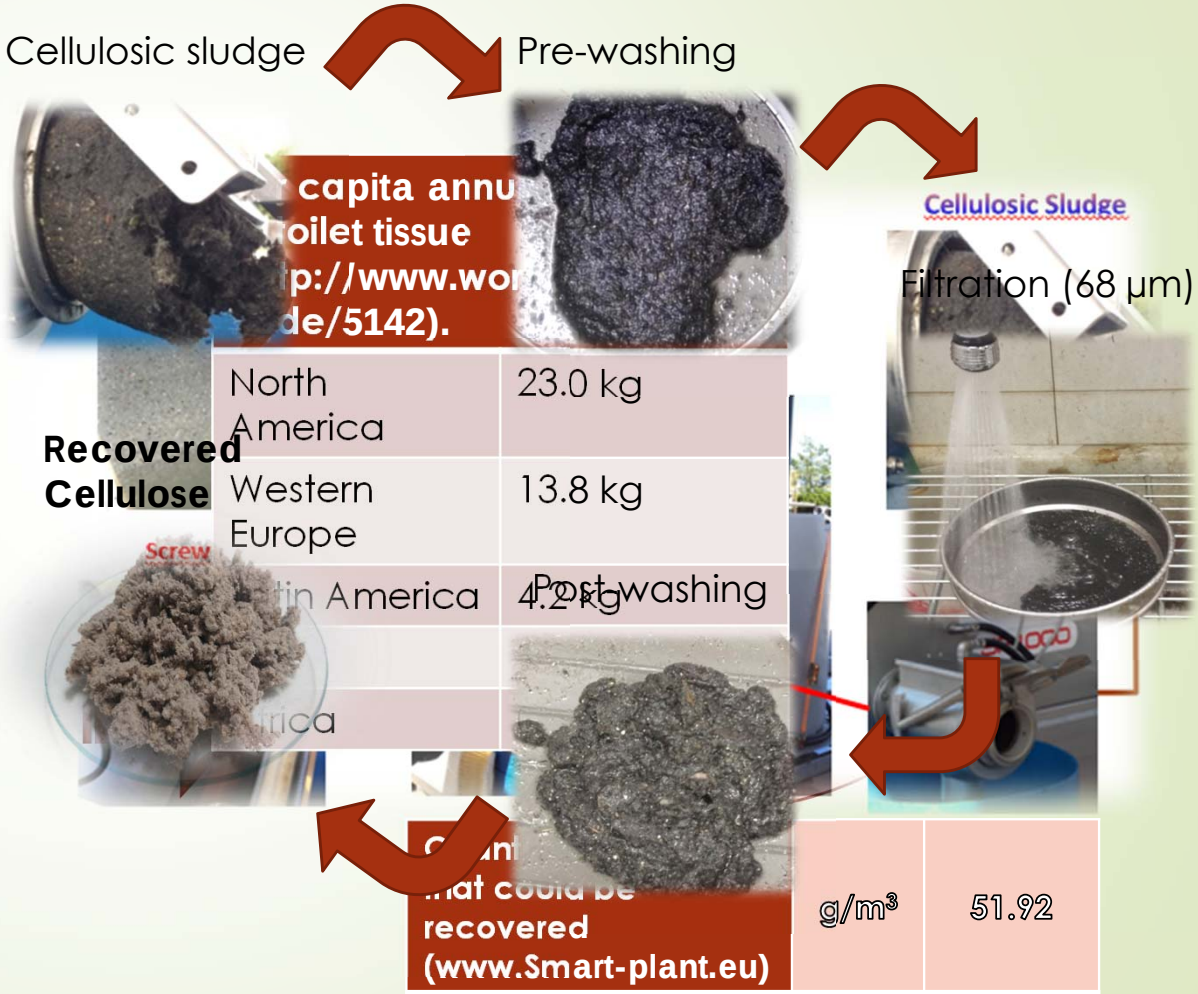


Cellulose in Wastewater Treatment

Major costituent of wastewater collected into the sieves

Hydrolysis process makes difficult its degradation during the conventional biological treatment

Secondary Raw Material



Resource

Building sector consumes 40% of the global energy and it is important to reduce the amount of non-renewable raw materials, replacing them partially with waste products

Aim

- Characterization of Recovered Cellulosic fibres (CREC)

- Investigate the influence of the addition of different amounts (0%, 5%, 10%,15% and 20% by volume) of fibres on the properties of mortars for indoor non-structural plasters and finishes. Each mix has been tested on:
  - Workability
  - Microstructure
  - Mechanical properties (**UNI EN1015-11:2007**)
  - Moisture Buffering Value (the **NORDTEST** method)

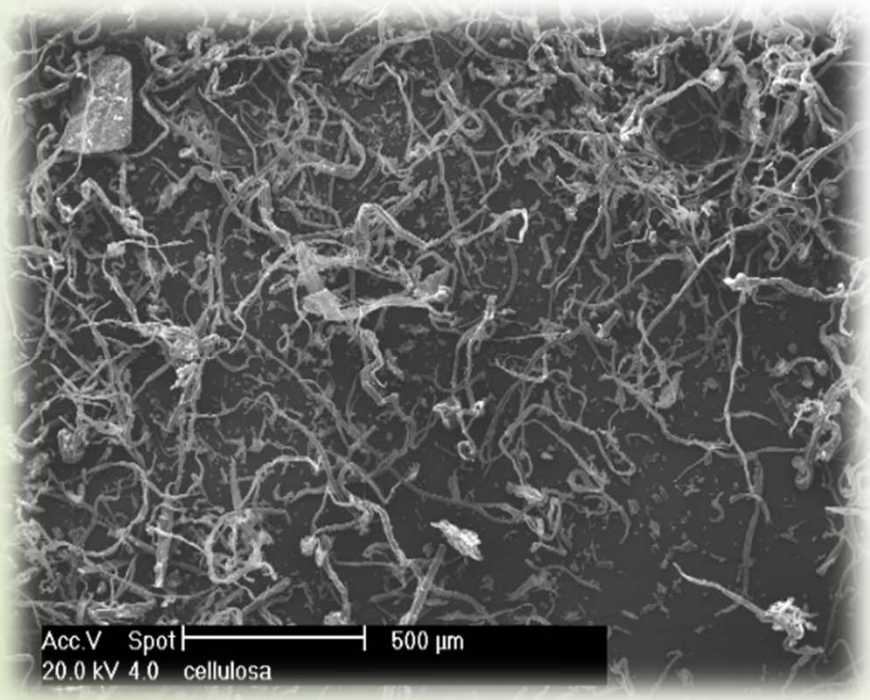
Mix design

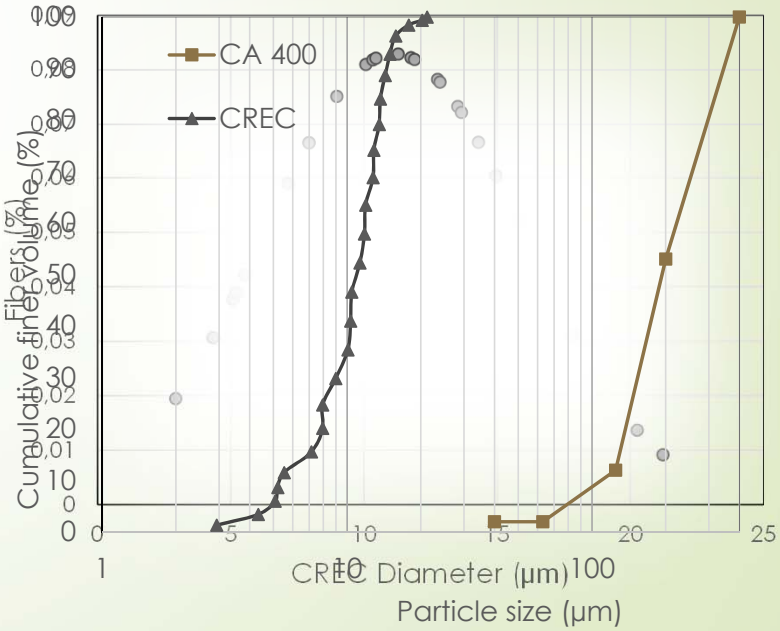
- Water/binder ratio equal to **0.63** by weight
- Aggregate/binder ratio equal to **3** by weight
- Fibres added in **ssd** conditions
- Each specimen has a different amount of fibres added by volume and they have been compared to a Reference with the 0% vol of fibres.
- **Same workability** for each sample in according to **UNI EN 1015-3:2007**

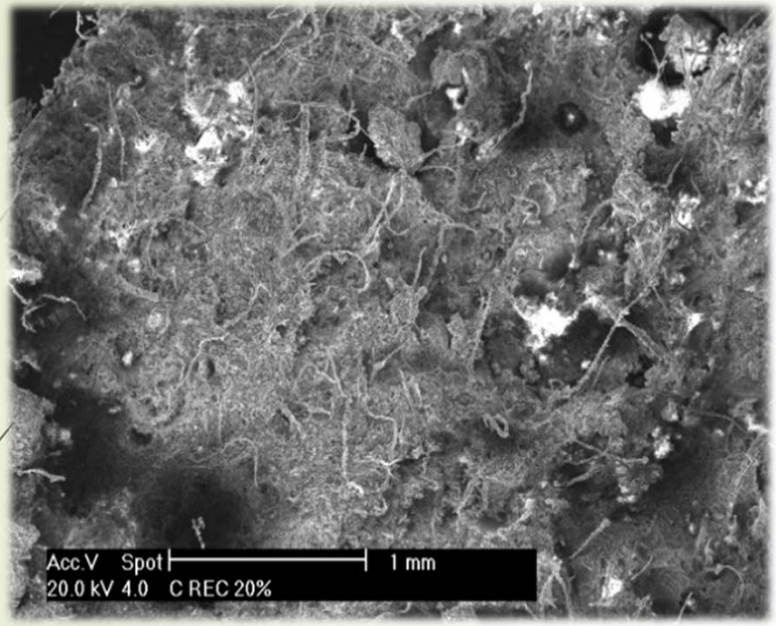
		Water	NHL5	CA400	CREC	Slump
Density	g/cm^3	1.00	2.65	2.65	0.75	-
Reference	g	294	467	1401	0	118 cm
CREC 5%	g	280	445	1335	22	117 cm
CREC 10%	g	267	424	1274	42	115 cm
CREC 15%	g	256	406	1218	60	111 cm
CREC 20%	g	245	389	1168	77	109 cm

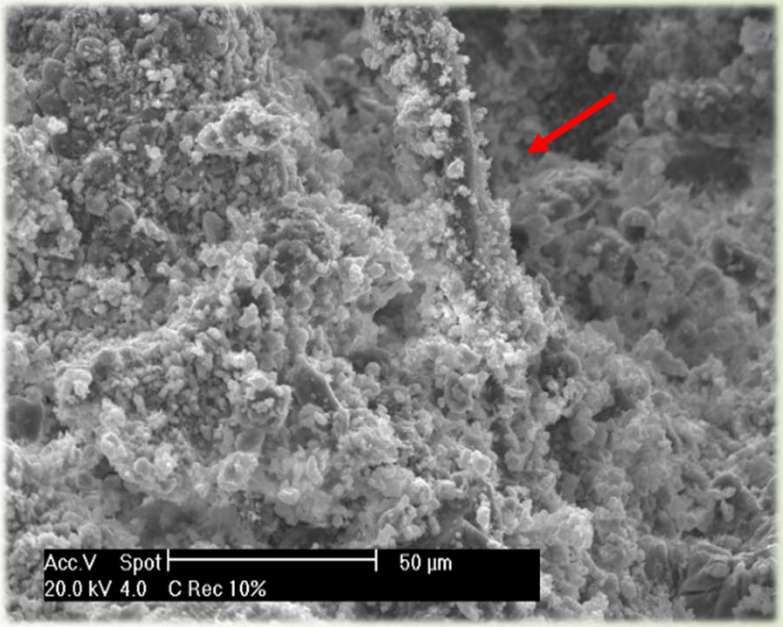
Microstructure

- Scanning Electron Microscope (SEM)



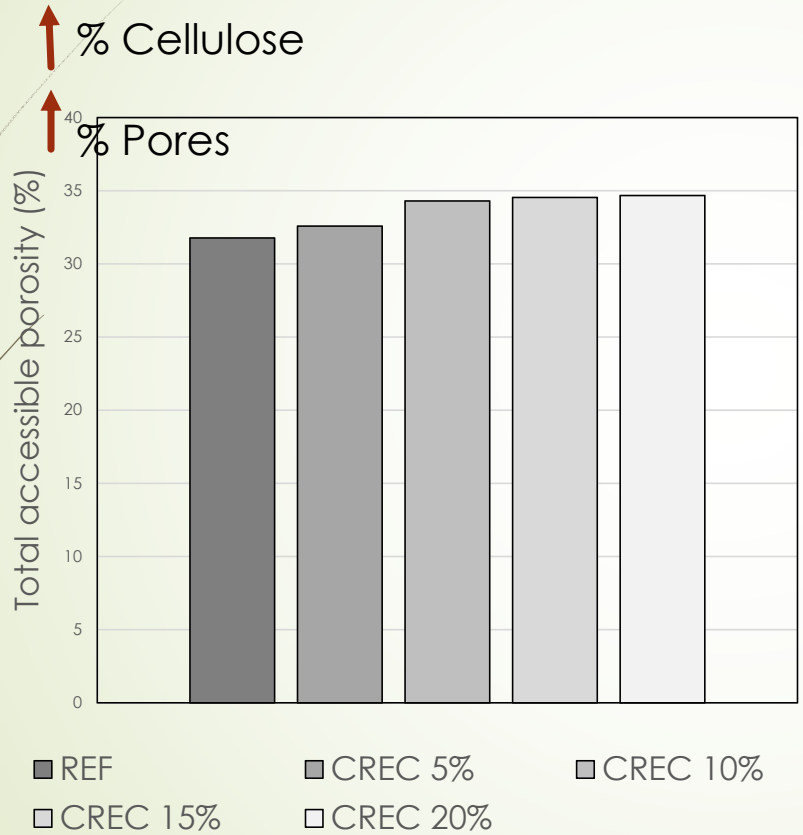


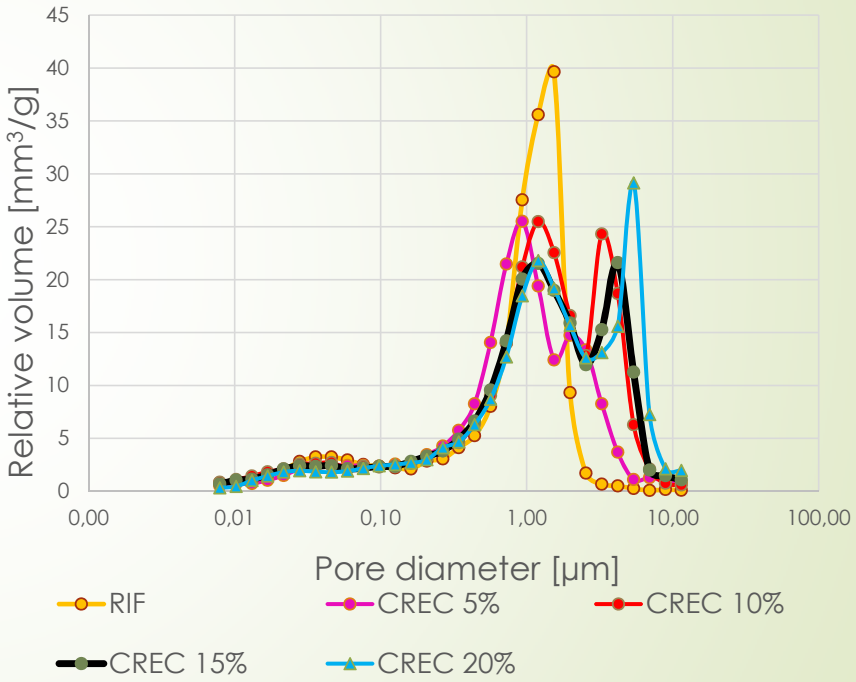




Interfacial Transition Zone (ITZ) between binder paste and a recovered cellulose fiber

Mercury Intrusion Porosimetry (MIP)

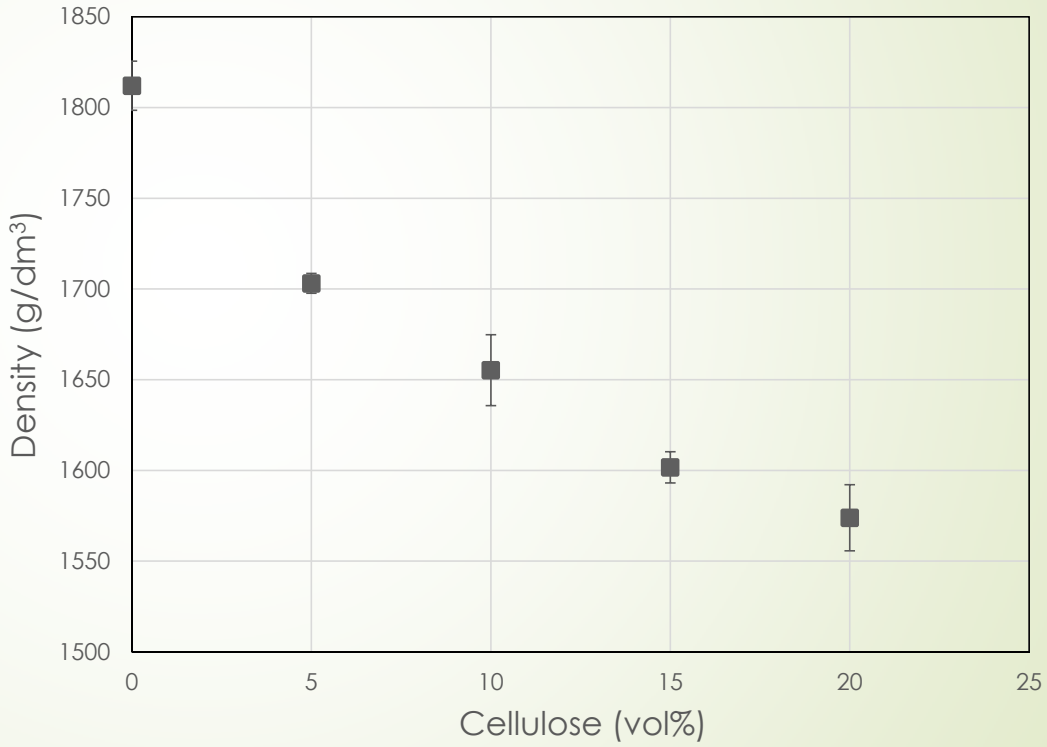




Density

↑ % Cellulose

↓ Density



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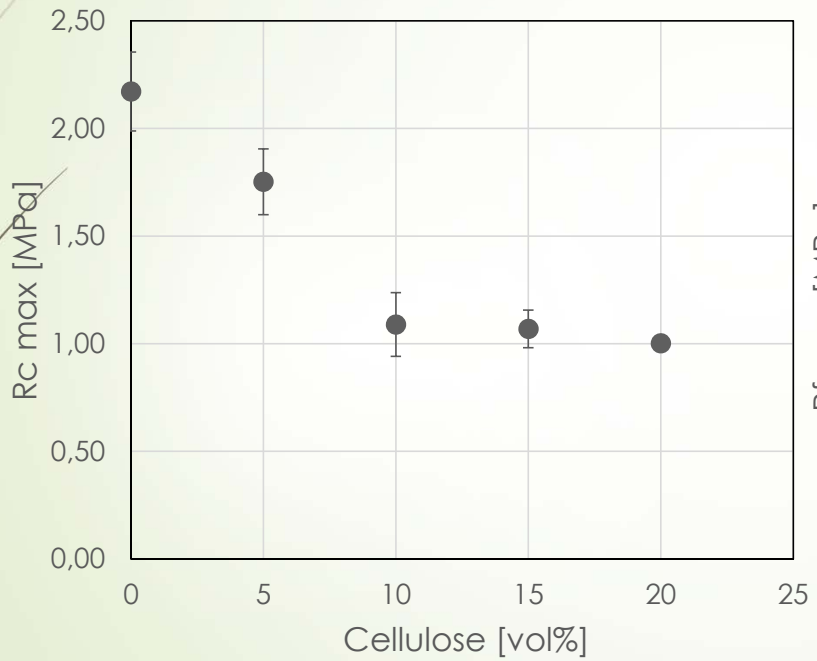
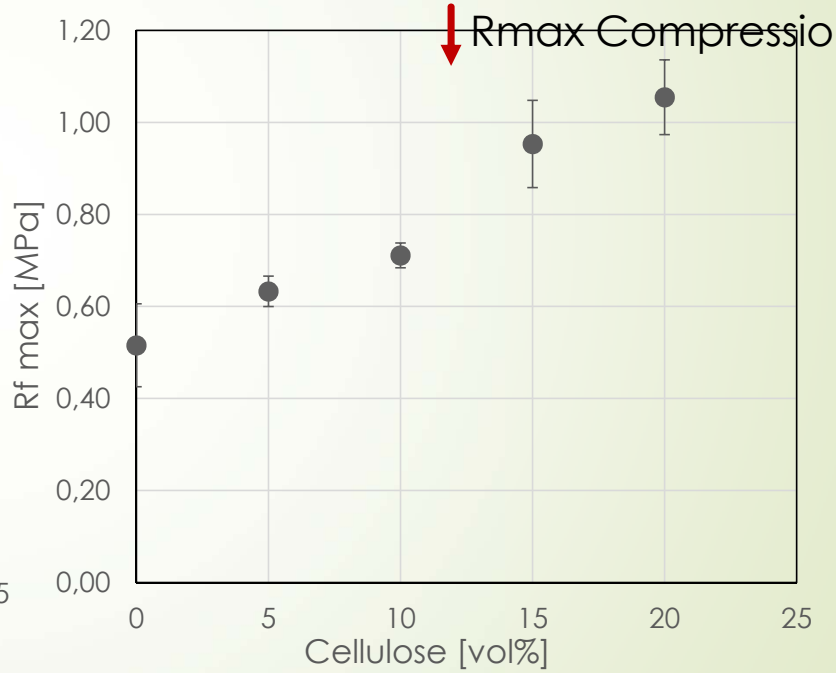
Mechanical Properties

↑ % Cellulose

↑ Rmax Flexural Stregnht

↓ Rmax Compression Strenght





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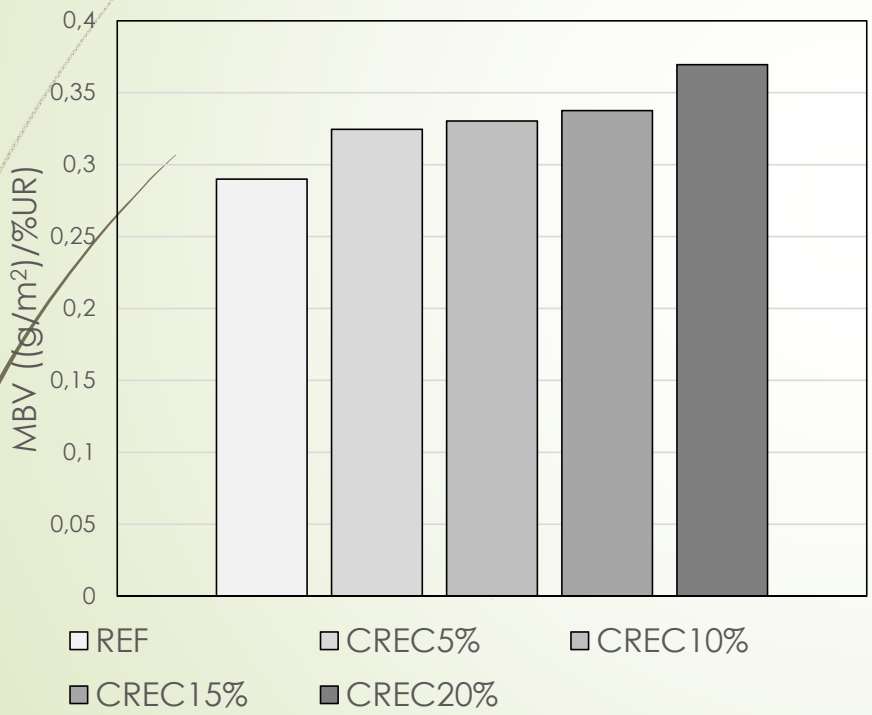
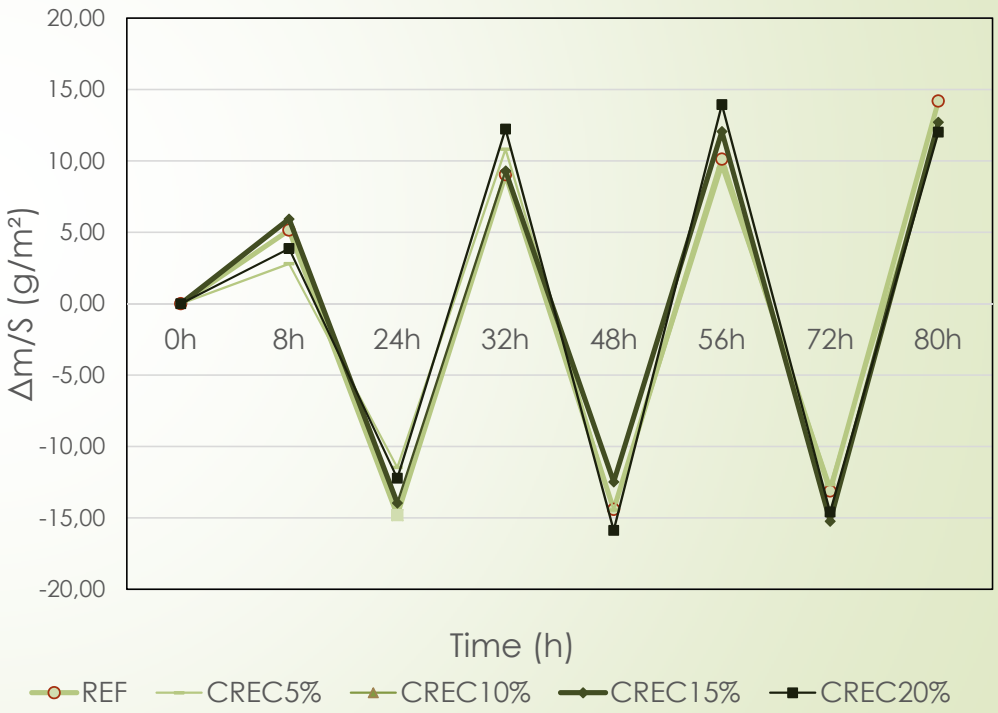
Moisture Buffering Value (MBV)





*Specimens are cyclically exposed to different RHs for fixed periods: UR 75% in NaCl and UR 33% in $MgCl_2$

Conclusions

Recovered cellulose coming from advanced dynamic sieving of urban wastewater was characterized and added in hydraulic lime based mortars at the amount of 5%, 10%, 15% and 20% by mix volume.

The valorisation of this secondary product from urban wastewater can improve the final performances of mortars, in terms of:

- increased lightness
- flexural strength
- moisture buffering capacity in indoor application, together with a viable technological solution for waste management by using a circular approach

Thank you for your attention

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