MIGRATION OF CALCIUM HYDROXIDE PARTICLES FROM THE MATRIX TO THE CELLULOSIC FIBRES IN CEMENT MORTAR BASED COMPOSITES

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INTRODUCTION:

Besides ecological and sustainability considerations, natural fibres are cheaper and bring to cement or mortar cement matrixes resistance among other benefits. Nevertheless, the use of these cellulosic fibres in cement composites is hampered by their low durability and poor adhesion, which in recent years has led to the replacement of these fibres by synthetic ones. The lack of durability of these composites is usually related with the presence of calcium hydroxide on the matrix and its migration to the fibres.

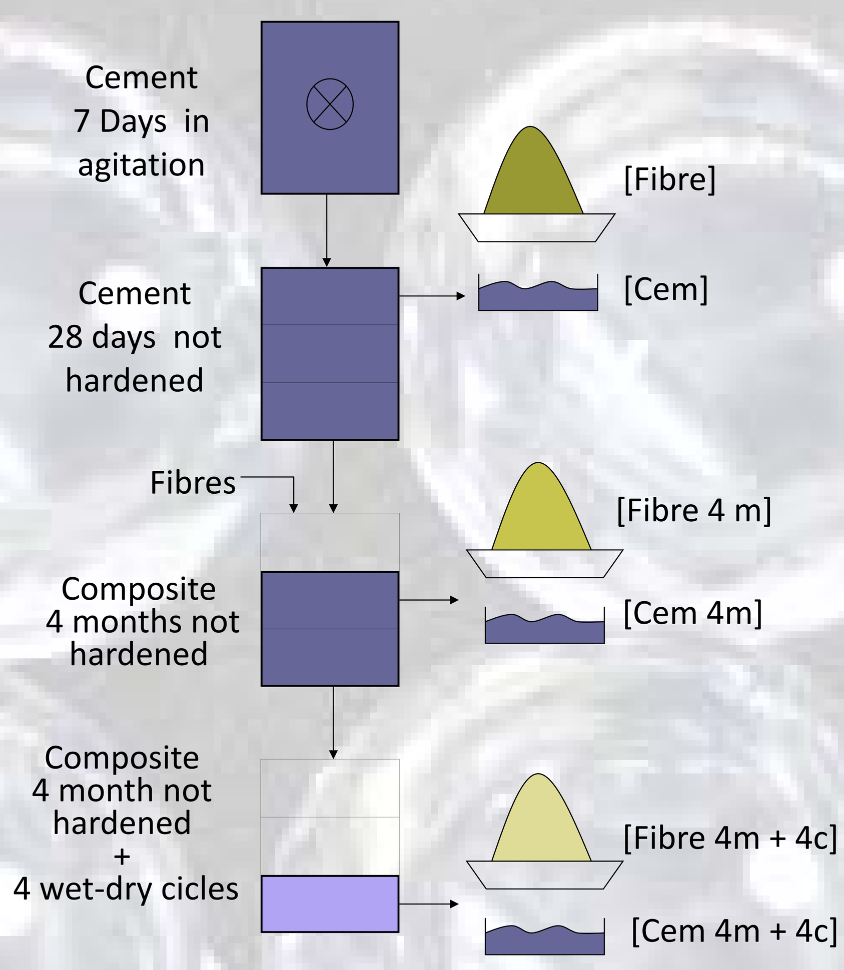
With the aim to better understand this phenomenon, in this work two kinds of cellulosic fibres (chemical softwood pulps and cotton linters) were mixed with cement and the corresponding composites hardened for four months and subjected to four wet-dry cycles. The changes in the morphology of the fibres were observed by *Scanning Electron Microscopy* and the changes in the chemical composition of the fibres and the matrix were analyzed by *and X-Ray diffraction* and *Thermogravimetric* analysis.

MATERIALS AND EXPERIMENTAL PROCEDURES:

Materials:

- *Cement:* Type I according to UNE-EN 197-1:2000
- *Cellulosic fibres:*

1- Unbleached softwood kraft pulp (Pinus Insignis) supplied by Smurfit Kappa Nervión, S.A. (Spain)
2- Cotton linters supplied by Celsur (Cotton South, S.L., Spain)



Samples characterized:

[Fibre]: Control sample of the fibre.
[Cement]: Control sample of the cement.
[Fibre 4m]: Sample of the fibres obtained from the composite hardened during 4 months.
[Cement 4m]: Sample of the cement obtained from the composite hardened during 4 months.
[Fibre 4m+4c]: Sample of the fibres obtained from the composite hardened during 4 months and aged (4 wet-dry cycles).
[Cem 4m+4c]: Sample of the cement obtained from the composite hardened during 4 months and aged (4 wet-dry cycles).

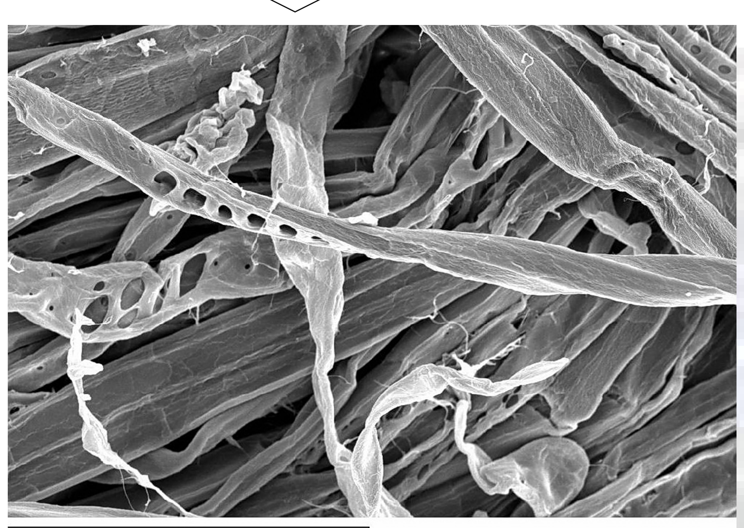
Characterization techniques:

- *Scanning Electron Microscopy (SEM)*
- *X-Ray diffraction analysis* (XRD)
- *Thermogravimetric analysis* (TGA)

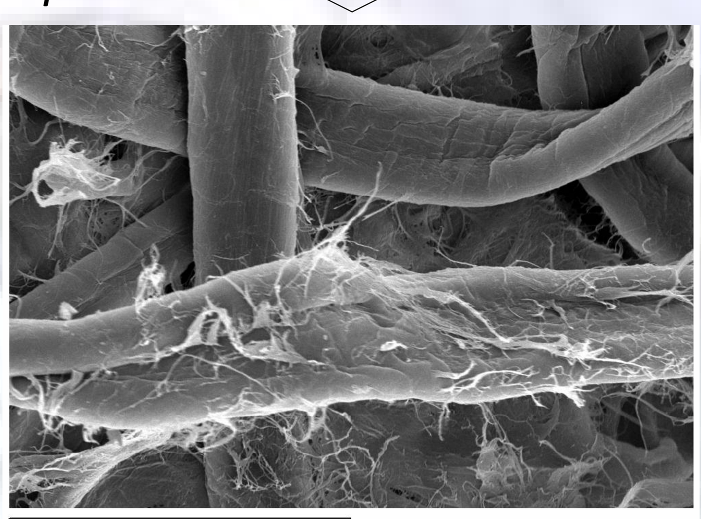
RESULTS:

Softwood pulp fibres **Cotton linters fibres**

Control samples



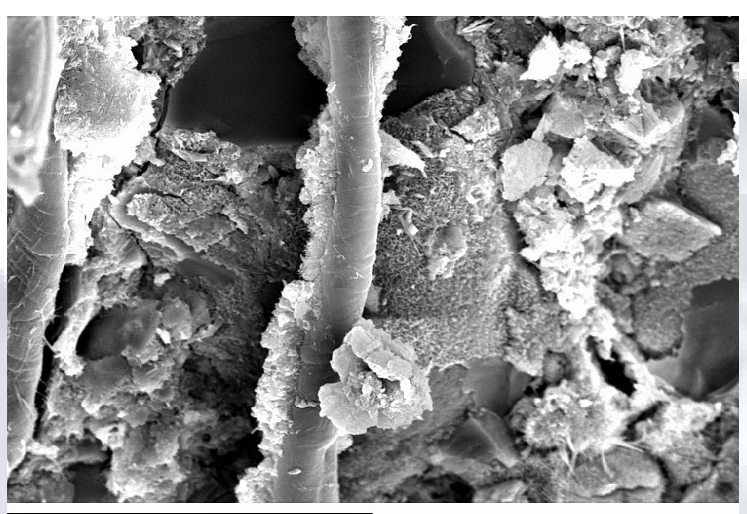
SEM micrograph showing the general morphology of the softwood pulp fibres.



SEM micrograph showing the general morphology of the cotton linters fibres.

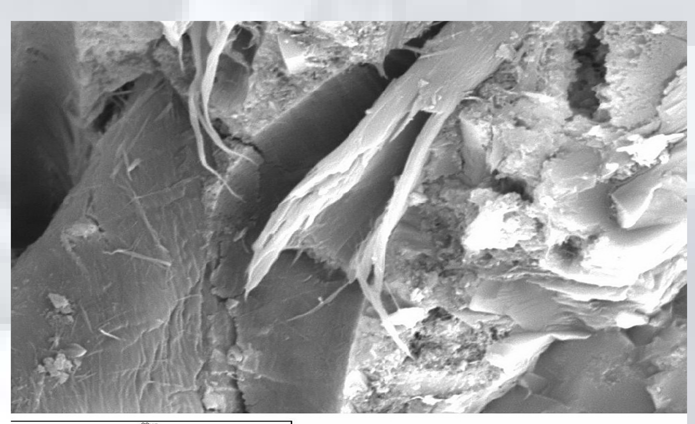
Samples on the composites

SEM micrograph showing the presence of the cement hydration compounds on the surface and lumen of the softwood pulp fibres

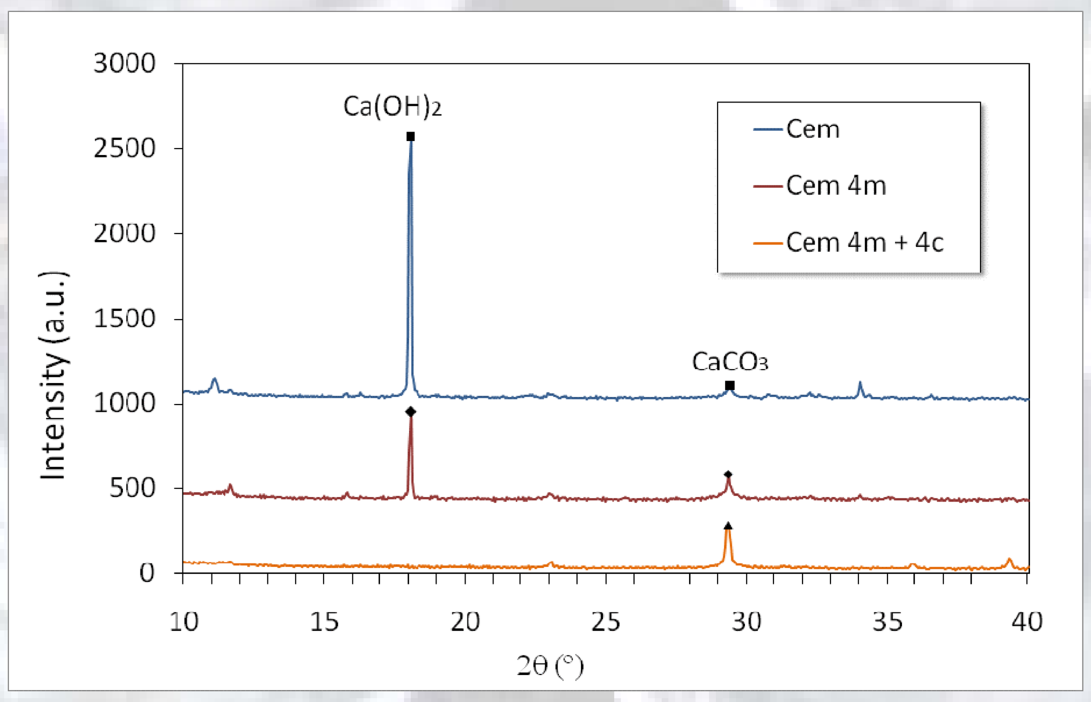


SEM micrograph showing the presence of the cement hydration compounds on the surface of the cotton linters fibres

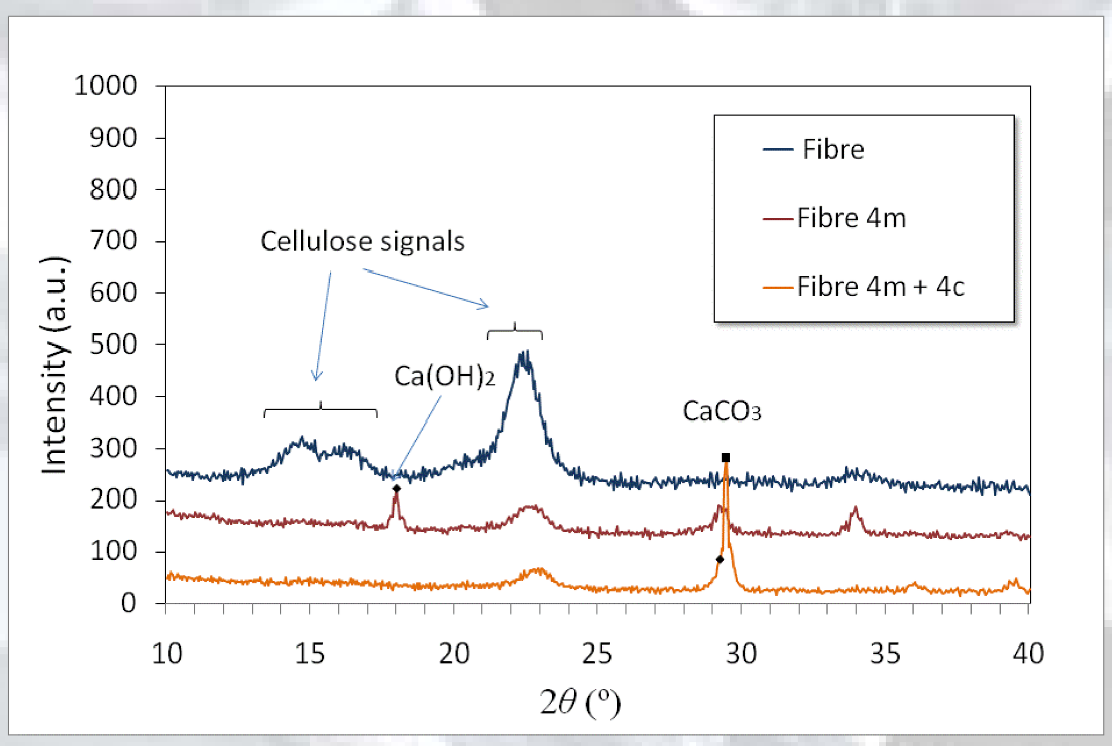
Optical micrograph (X200) showing the presence of the cement hydration compounds on the lumen of the softwood pulp fibres



SEM micrograph showing the absence of the cement hydration compounds on the lumen of the cotton linters fibres



XRD patterns of the cement samples
Gradual decrease of the calcium hydroxide crystals in the samples of cement after hardening and aging processes.



XRD patterns of the fibre samples
Gradual increase of the presence of calcium crystals in the samples of fibres after hardening and aging processes.

CONCLUSIONS:

- The migration of the calcium hydroxide particles from the cement to the fibres produced a gradual mineralization of the cellulosic fibres
- Calcium hydroxide particles were observed on the surface of both the softwood pulps and cotton linters fibres.
- We found that the presence of pits in the softwood pulp fibres promoted the precipitation of calcium hydroxide particles on the lumen of the fibres.

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