



Mesures de retraits de fabrication par fibres optiques –
Application aux bétons et aux matériaux composites stratifiés

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Qui sommes-nous ?

Une société privée non subventionnée avec une forte culture de l'innovation, dont la mission est de :

Faire le lien entre les besoins des entreprises et la R&D issue des laboratoires de l'Université de Nantes

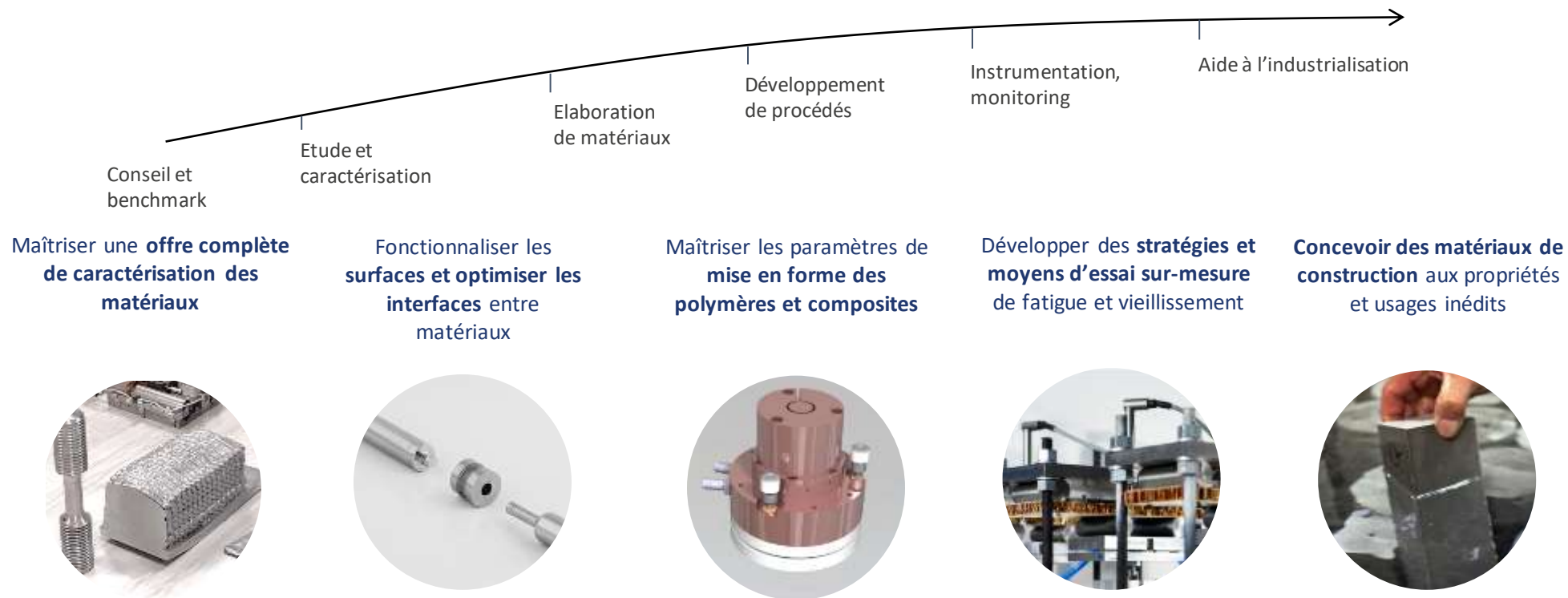
Filiale à statut privé





CAPACITÉS INDUSTRIE

Performances des matériaux



L'offre performance des matériaux s'appuie sur une équipe d'ingénieurs et scientifiques permanents pour offrir les meilleures combinaisons d'expertises possibles :

Ingénierie et chimie des matériaux

Génie mécanique

Thermique

BTP - Génie civil

Génie des bioprocédés



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Exemples de monitoring



SolidSail 2.0



- Un mat de bateau de 15 mètres instrumenté par une fibre optique de 20 mètres.
- FO à retro diffusion de Rayleigh
- Patchs à jauges de déformation
- Accéléromètres
- Capteurs de force custom



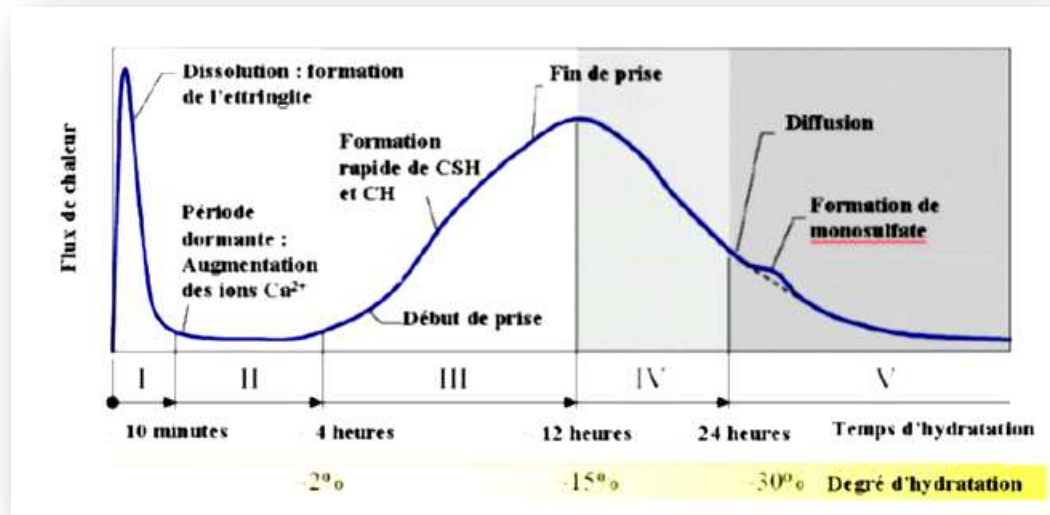
Mechanism of Hydration

Components of concrete mix:

- Aggregates $\left\{ \begin{array}{l} \textit{sand} \\ \textit{gravel} \\ \textit{recycled concrete} \end{array} \right.$
- Cement $\left\{ \begin{array}{l} \textit{Clinker} \\ \textit{Gypsum} \end{array} \right.$
- Water

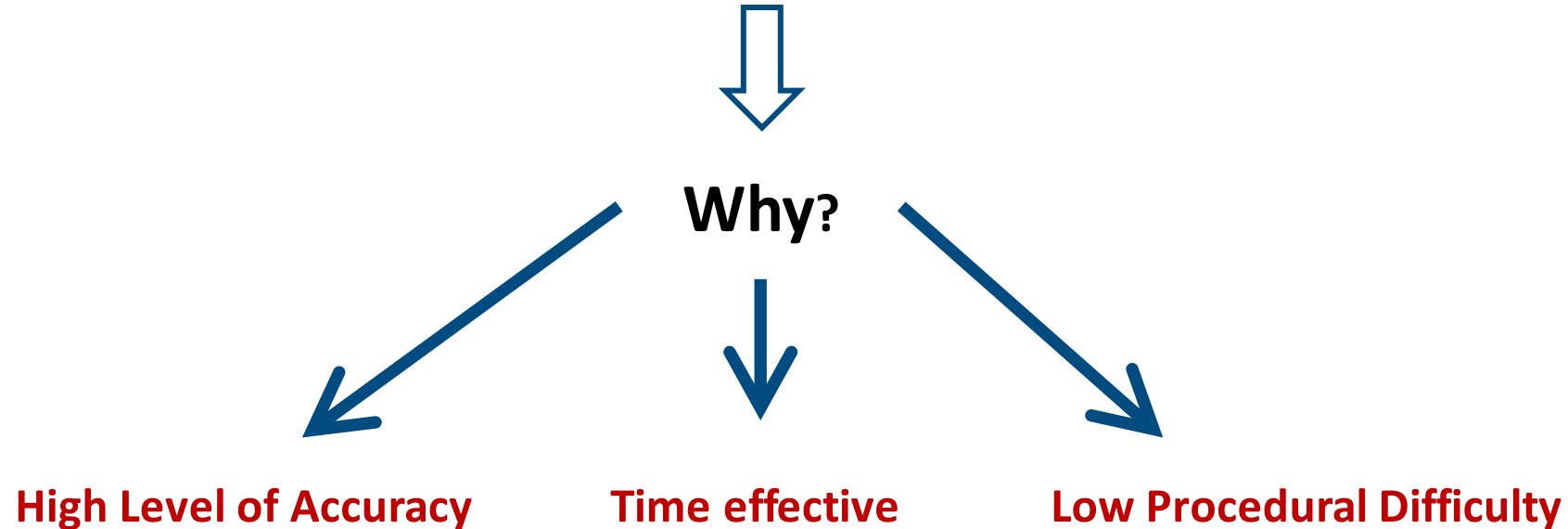
Products of Hydration:

- Hydration of Silicates $\left\{ \begin{array}{l} C_3S_2H_3 (\textit{silicate calcium hydrate}) \\ CH (\textit{portlandite}) \end{array} \right.$
- Hydration of Aluminates $\left\{ \begin{array}{l} C_6A\dot{S}_3H_{32} (\textit{ettringite}) \\ 3C_4A\dot{S}_3H_{12} (\textit{monosulfates}) \end{array} \right.$



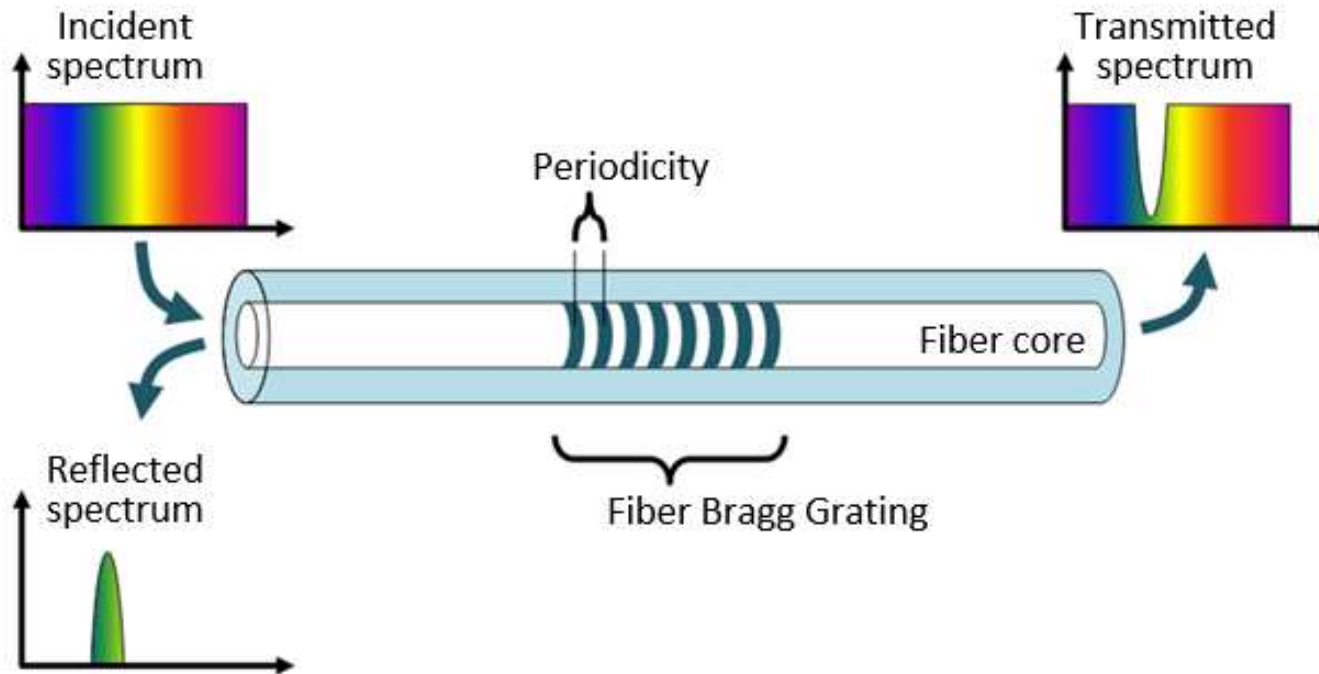
Calorimetric Curve of Portland Cement
(Gartner *et al*, 2002)

Experimental validation of the fiber optic sensors for measuring concrete deformations and temperature variations



Fiber Bragg Gratings

Definition: A Fiber Bragg Grating is a distributed Bragg reflector constructed in an optic fiber to reflect particular wavelengths and transmit all others[1].



[1] Fiber Bragg Gratings (Second Edition) 2010, pages 441-502



Description of the developed Fiber Optic Sensor



1D Fiber Optic Sensor

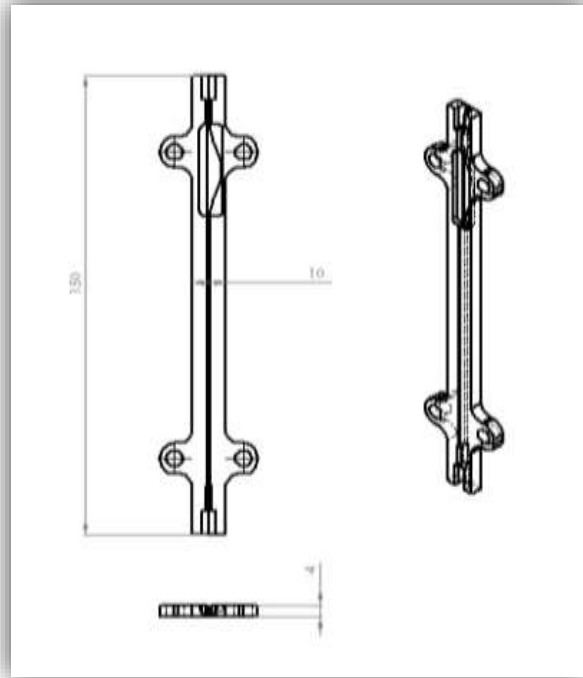


Image 1 : 1D Fiber Optic Sensor (Longitudinal Cross-Section and 3D view)



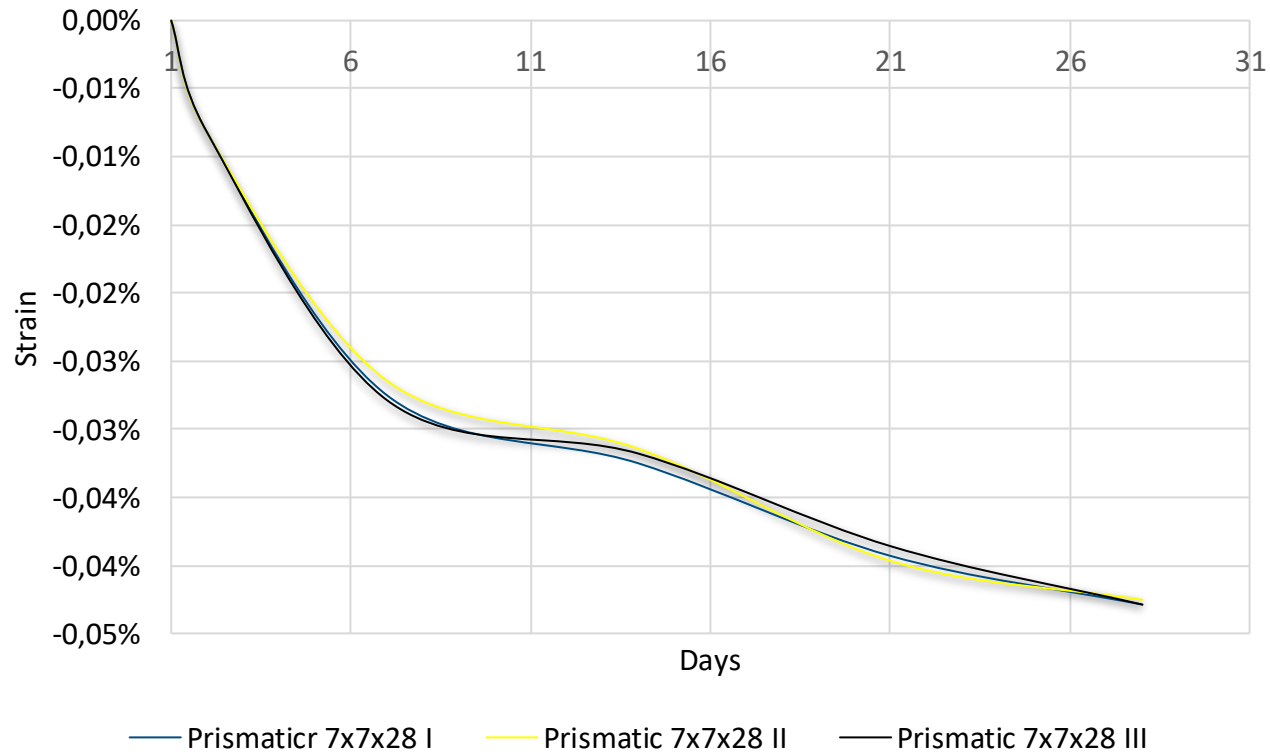
Image 2&3 : 1D Fiber Optic Sensor Prismatic Sample Setup



Image 4 : 1D Fiber Optic Sensor Cylinder Sample Setup

FBG results

Strain evolution during 28 days hardening



Temperature and Humidity variations of the storage environment

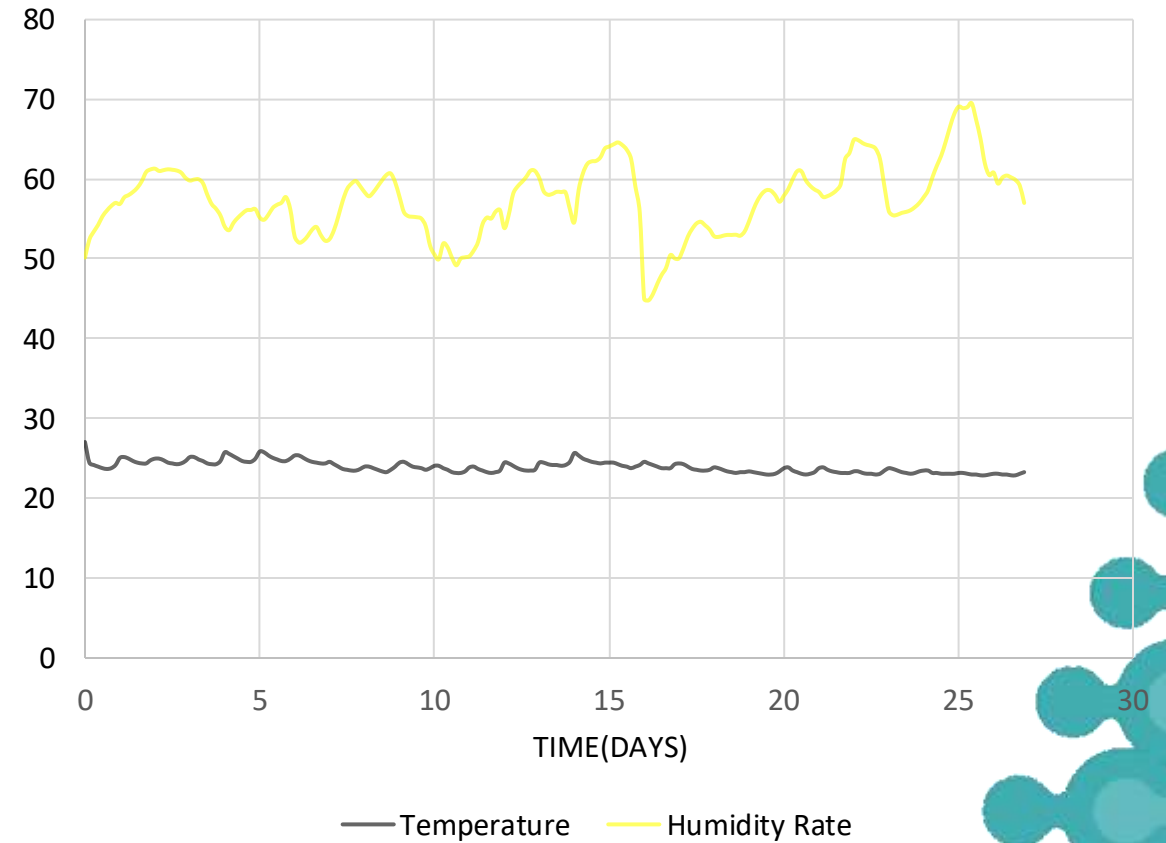




Image 5: Compression test on a non-instrumented sample

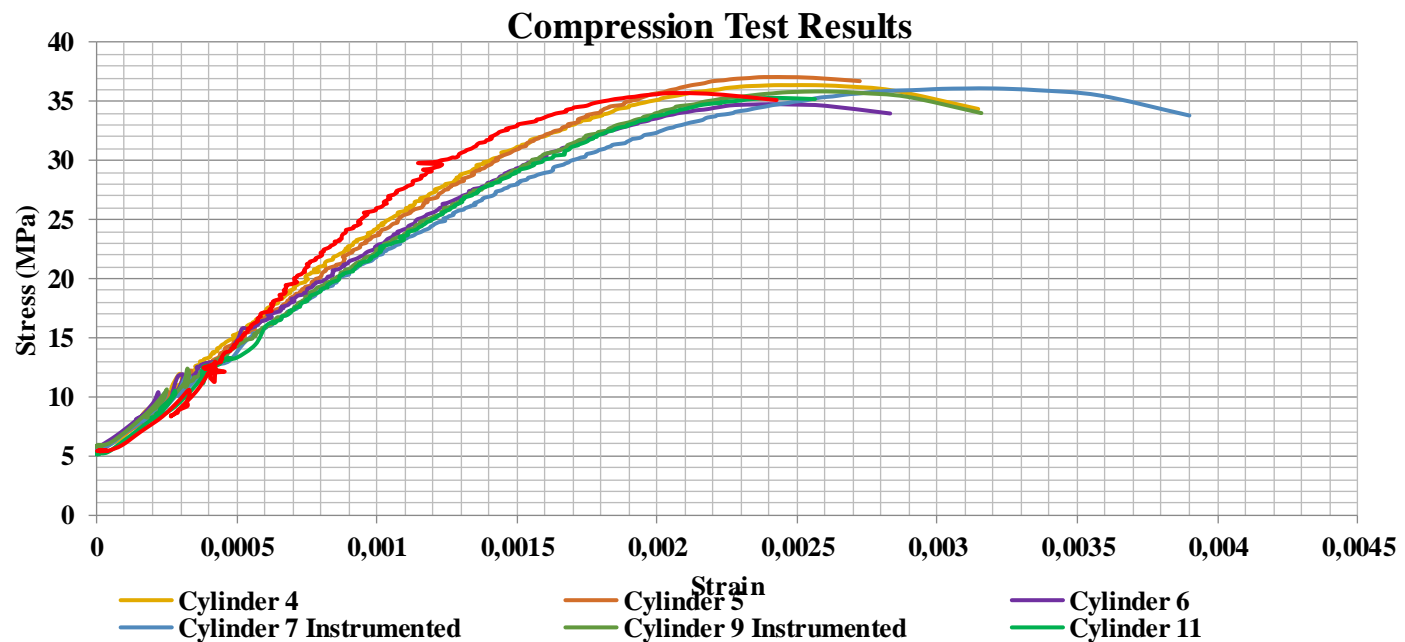
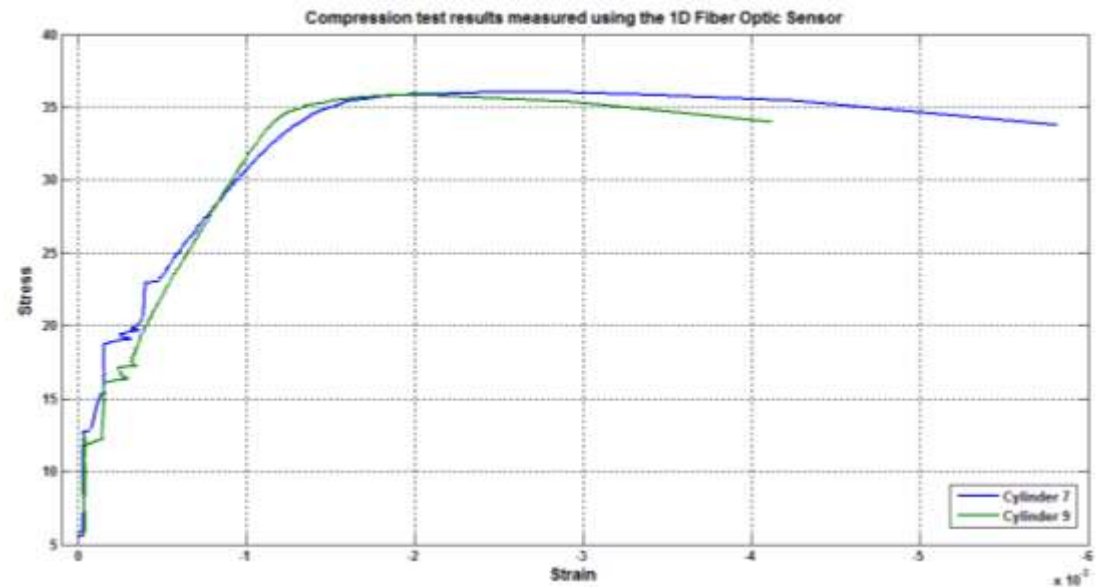


Image 6: Compression test on a instrumented sample



3D Fiber Optic Sensor

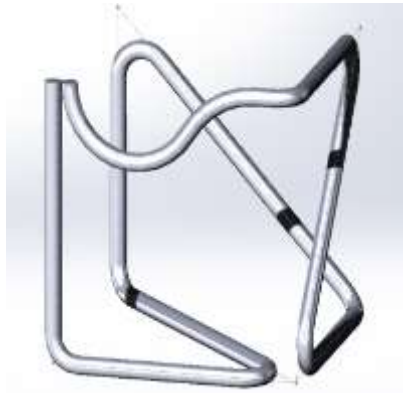


Image 11: 3D Sensor Design



Image 12: 3D Fiber Optic Sensor

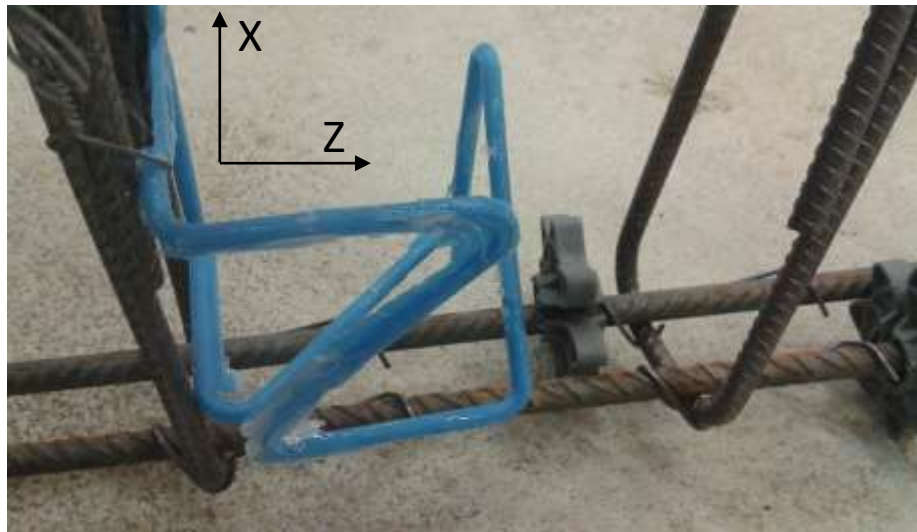
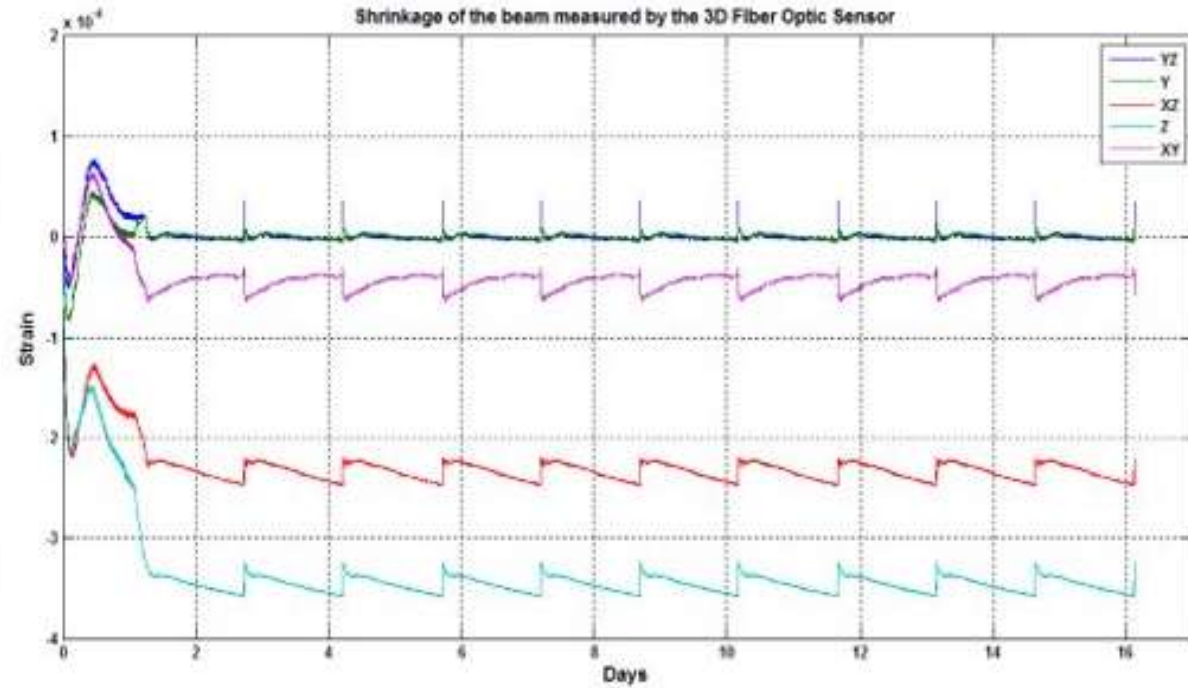
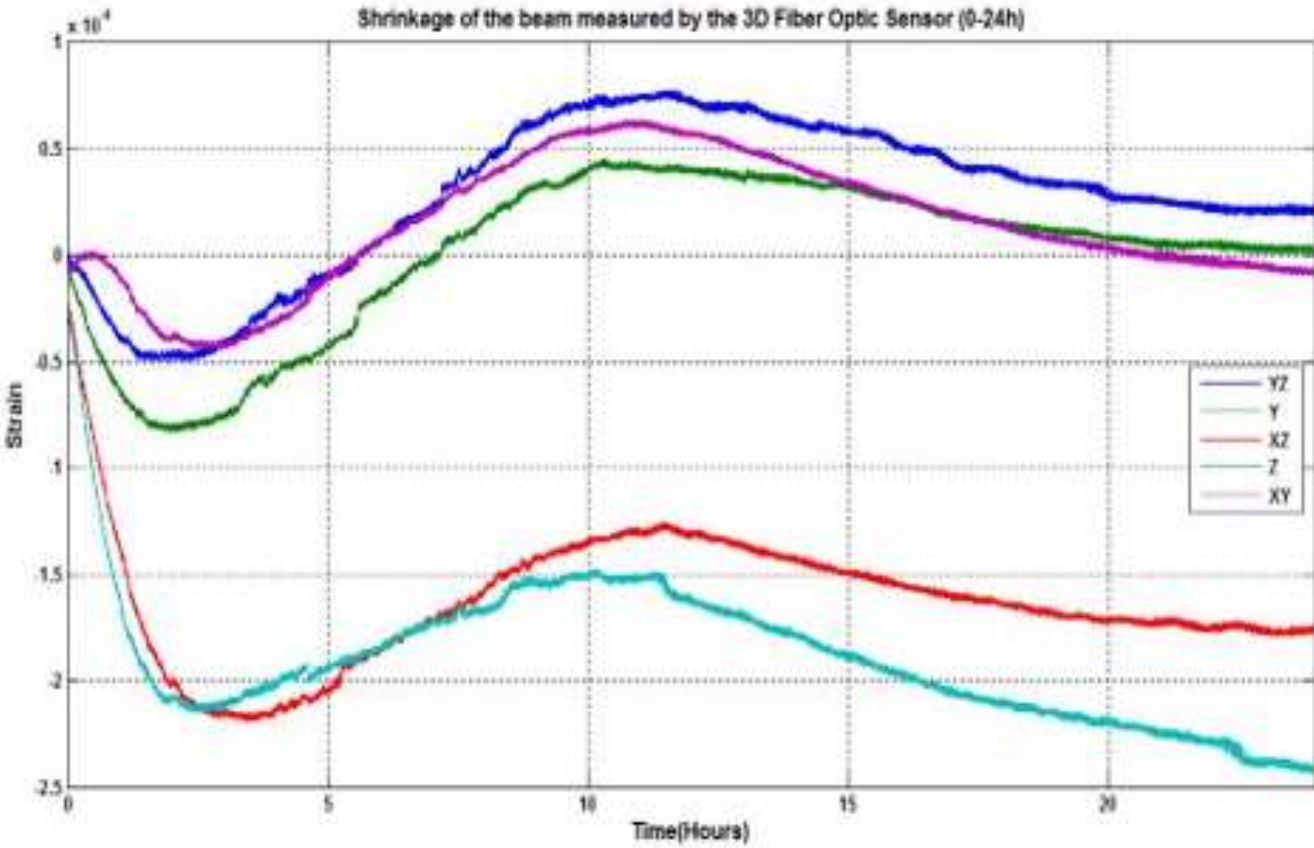


Image 14: 3D Fiber Optic Sensor Setup

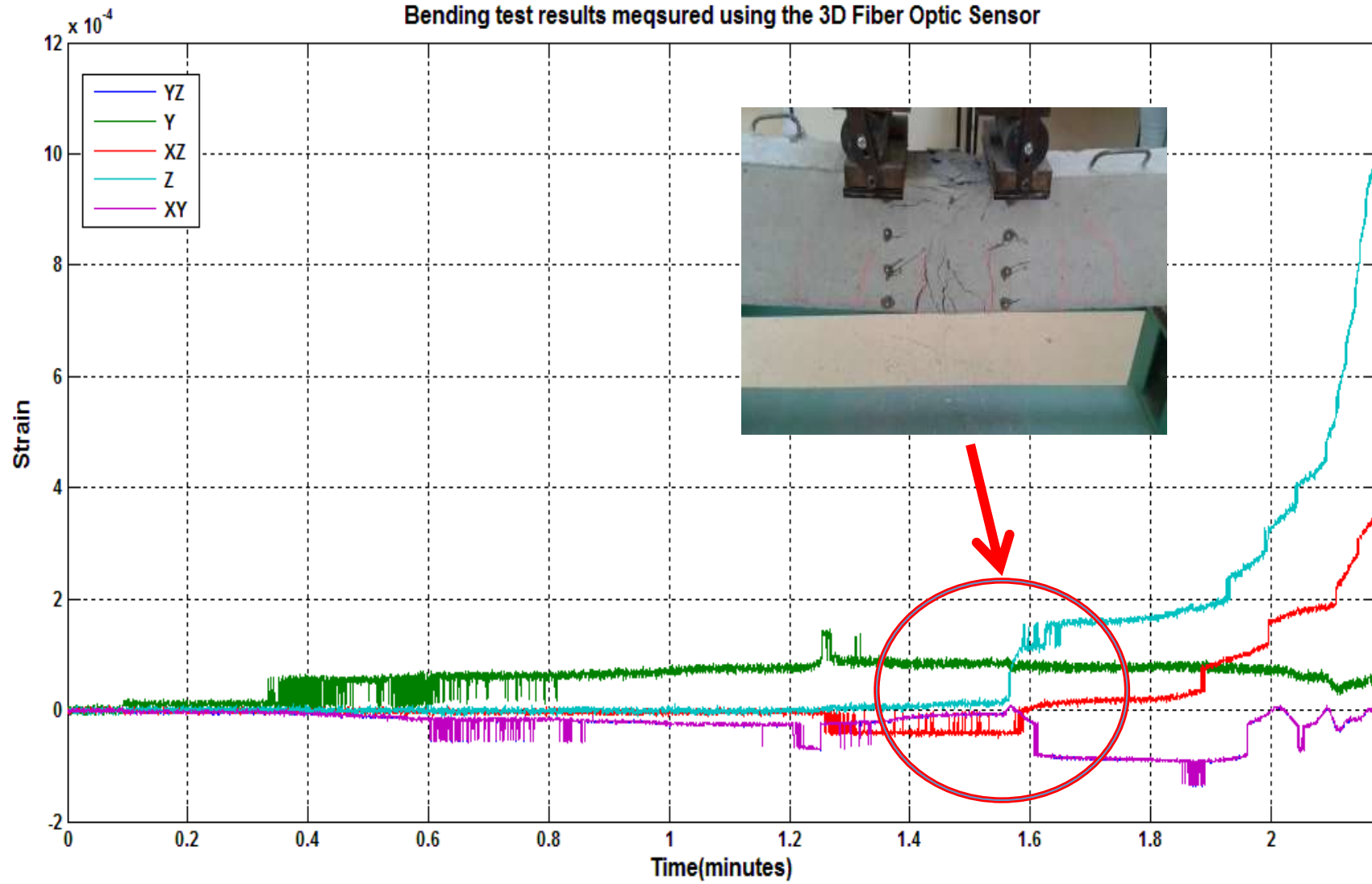


Image 15: Experimental Setup for the shrinkage measurements

FBG results

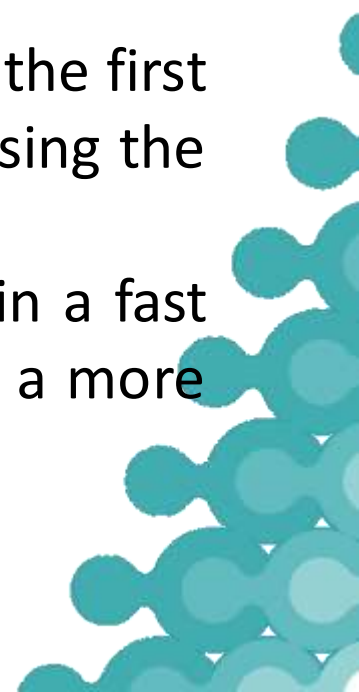


Bending test results measured using the 3D Fiber Optic Sensor



Conclusion

- The fiber optic sensors are very sensible to the high temperatures occurring in the first 24h of hydration;
- The storage conditions for the instrumented samples have a big influence upon the final measurements;
- All sensors have shown a good mechanical resistance when the concrete specimens were subjected to flexion and compression tests;
- The shrinkage measurement recorded by the fiber optic sensor between the first day and the 17th day of hydration are consistent with those measured using the retractometer;
- The fiber optic sensors are capable of recorded large amounts of data in a fast and accurate manner, providing the user with sufficient information for a more detailed analysis of the behavior of concrete.



Merci pour votre attention



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