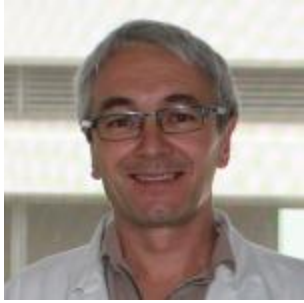
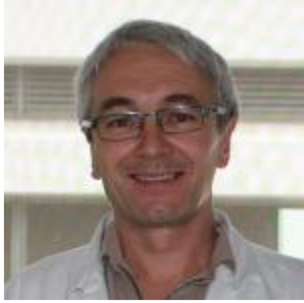
Gilles'memory



Steel Fibre Reinforced Concretes : from Meso to Macro-Scale

Pierre Rossi

Institut Français des Sciences et Technologies des Transports, de l'Aménagement et des Réseaux



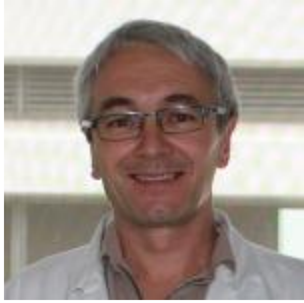
Why to use steel fibres ?

- **To improve the tensile behaviour of concretes: Strength and Ductility**

➔ ***Only possible in very special Ultra-High Performances Concretes***

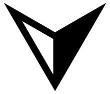
- **To replace a partly or totally the rebars in concrete structures**

➔ ***For all concrete structures***



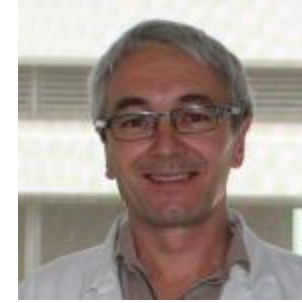
Meso-Scale

Behaviour of one or several fibres embedded in a concrete matrix

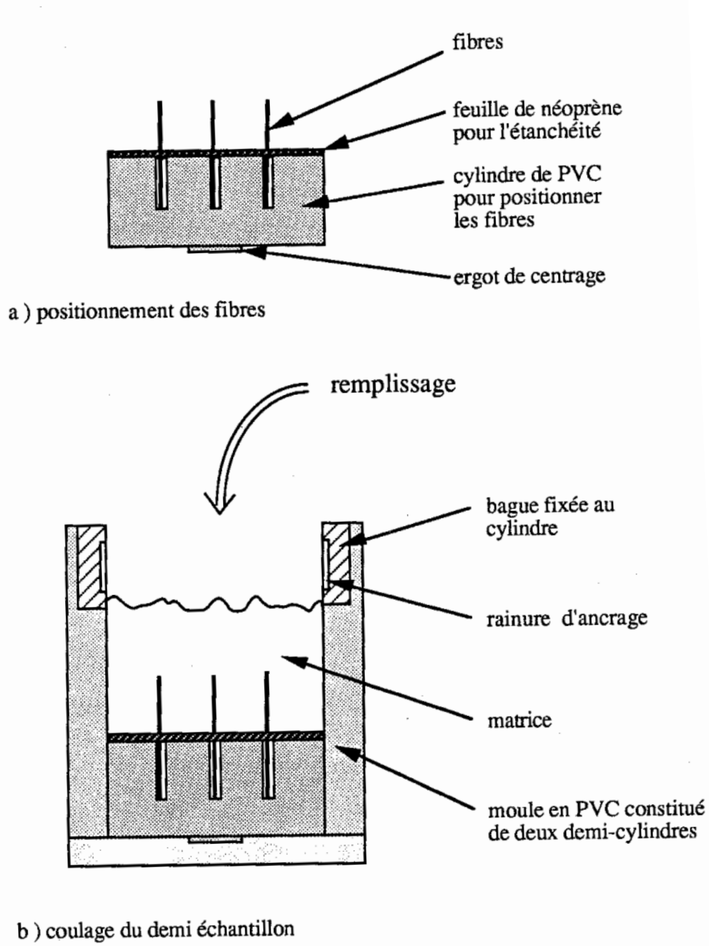


Optimisation of the fibre geometry and dimensions in function of the compactness of the matrix

PHD thesis of Gilles, 9 Janvier 1992, Université de Sherbrooke, Canada

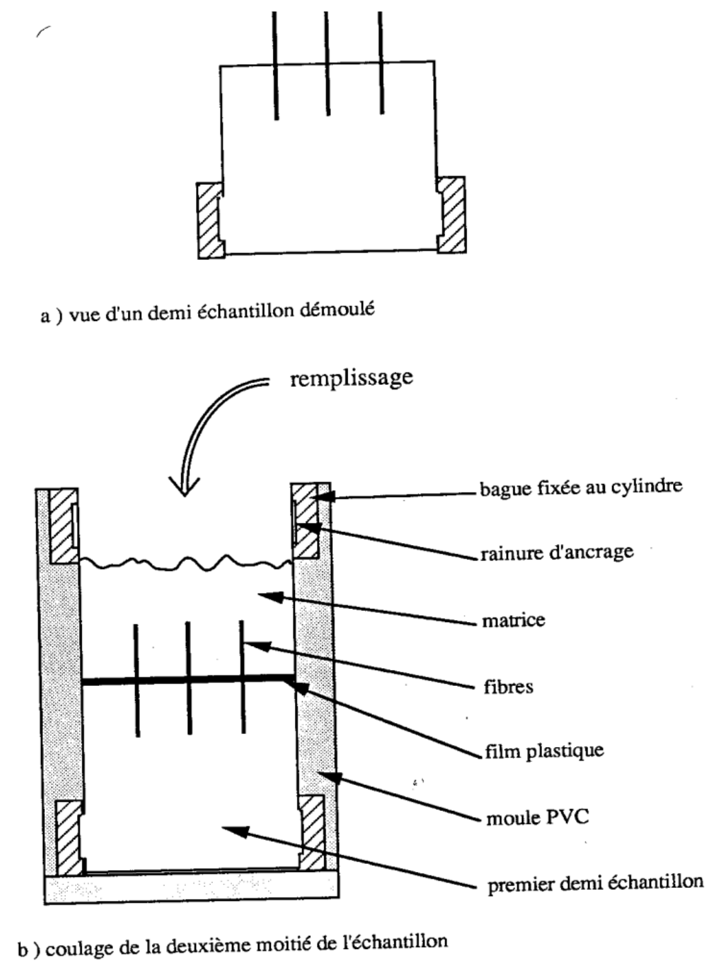


PHD thesis of Gilles



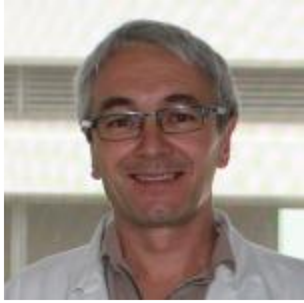
a) positionnement des fibres

b) coulage du demi échantillon



a) vue d'un demi échantillon démoulé

b) coulage de la deuxième moitié de l'échantillon



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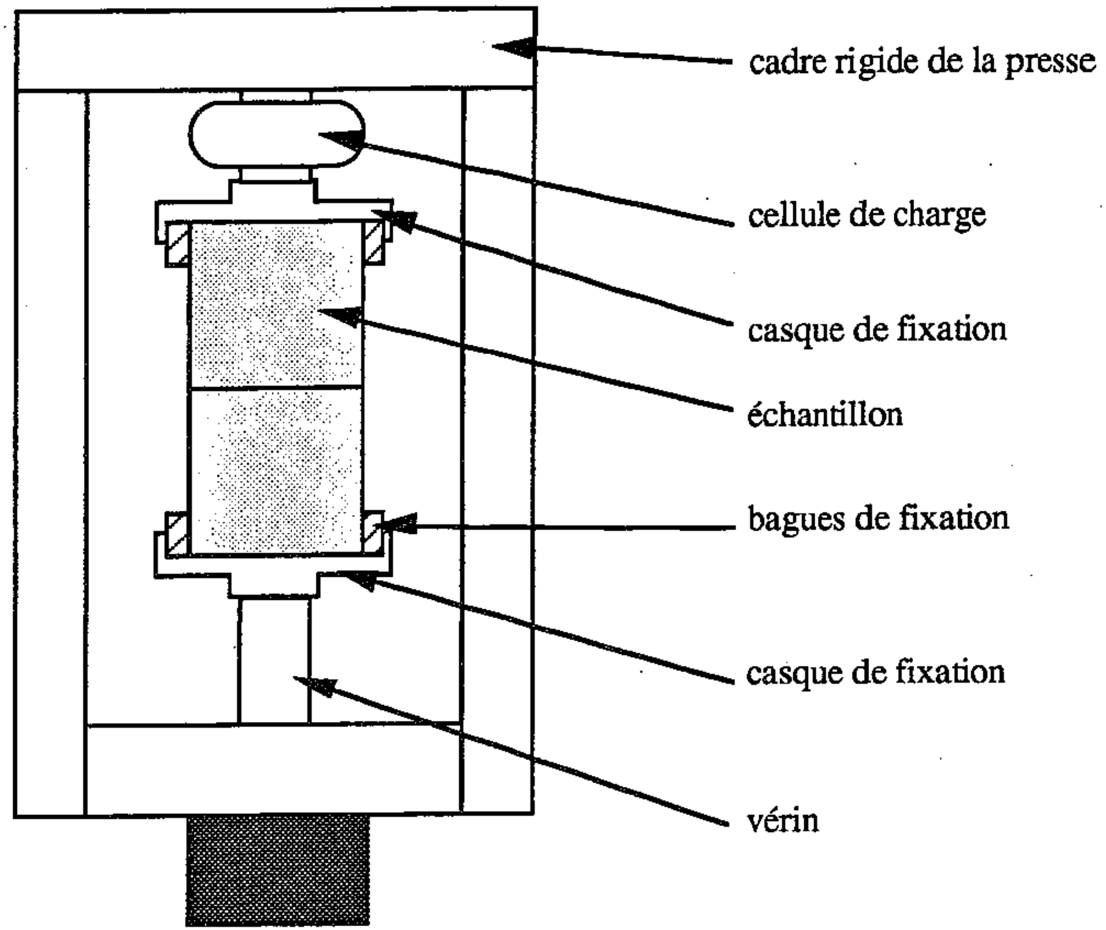
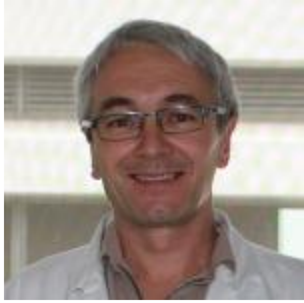
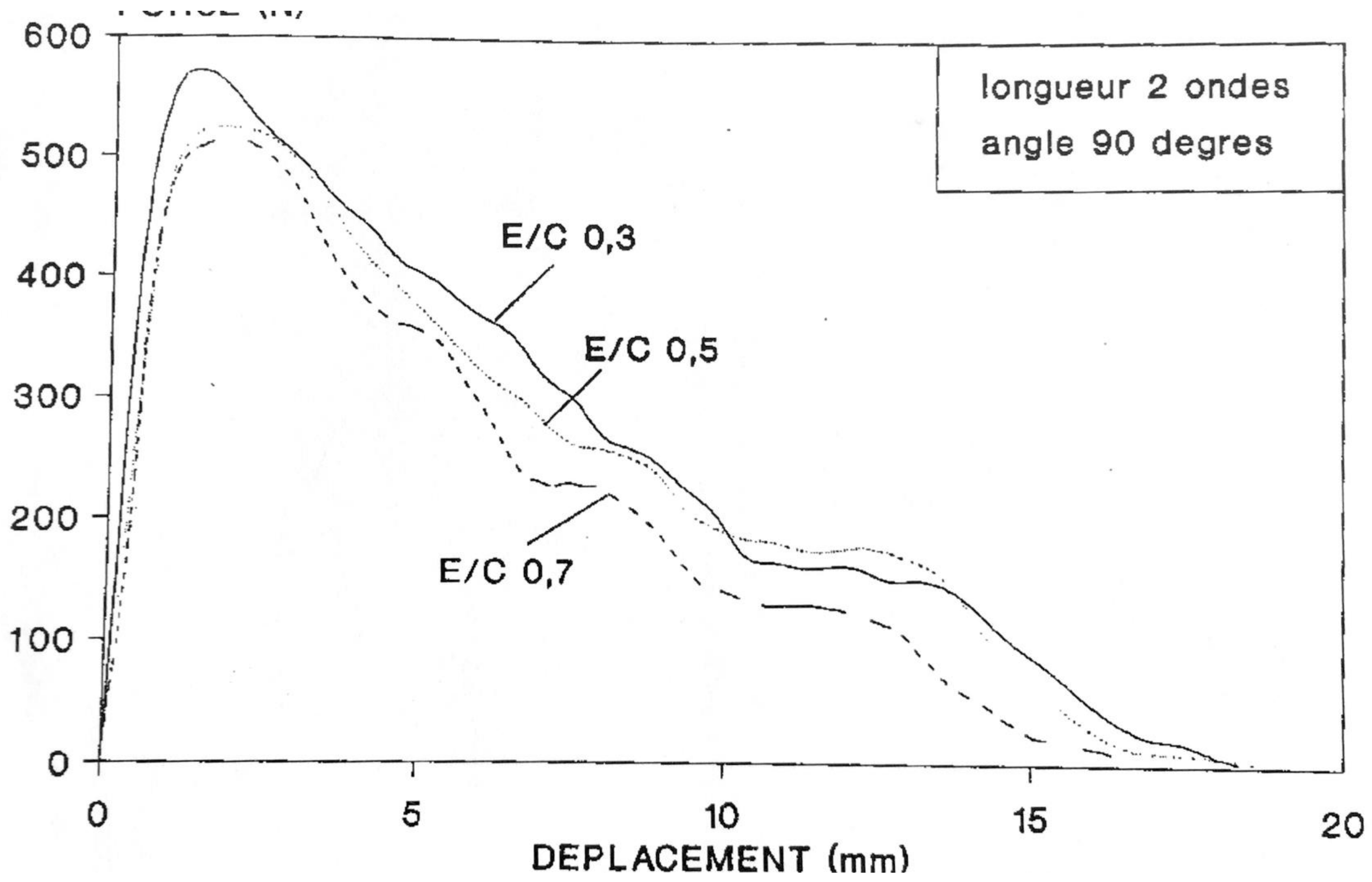
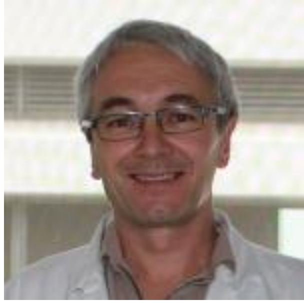




PHD thesis of Gilles



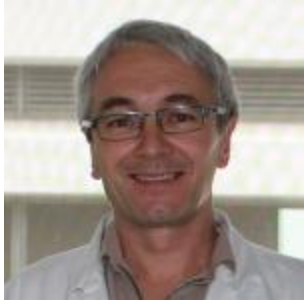


What is the fibres acting through a macrocrack ?

Forces transmission

✓ **Friction** between the fibres and the matrix: importance of the length and the diameter of the fibre

✓**Plastification** of the fibres: importance of the geometry (existence of hooks at the fibres ends, undulations…)

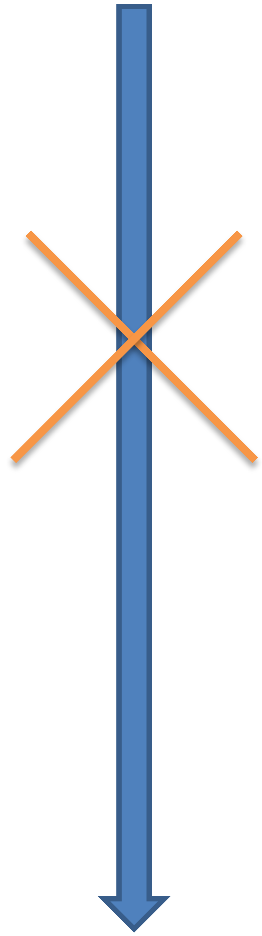


General rules of optimization of SFRC

More compact the matrix is, shorter and thiner the fibres have to be

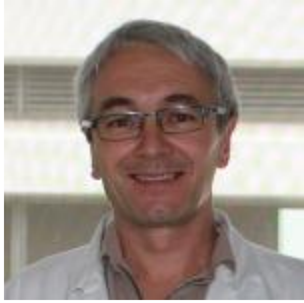
Meso-Scale

The mechanical behaviour of the fibre/matrix interface depends on the percentage of fibres



The mechanical behaviour of the composite is strongly dependent of the preferential orientations of fibres

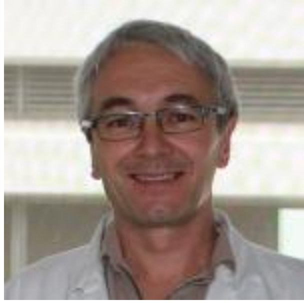
Macro-Scale



Macro-Scale

Determination of the post-cracking behaviour in tension of SFRC

Direct approach: uniaxial tensile test on notched specimens



Macro-Scale

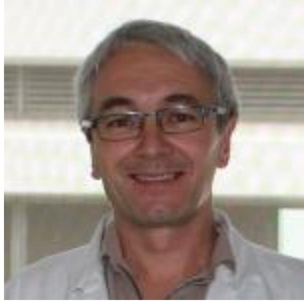
Post-cracking behaviour in tension of SFRC

➢

Design of SFRC structures based on the cracked section equilibrum approach

The first french recommandations for designing SFRC structures (AFREM, 1998)

Gilles Chanvillard, Pascal Casanova, Pierre Rossi

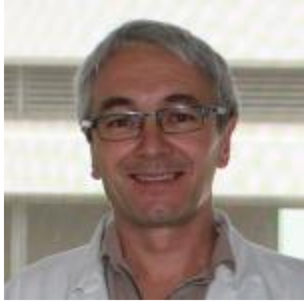


After 1998

- French National Project BEFIM (1995-2001) on the Industrial Development of SFRCs

- Creation of the International Conference BEFIB on Fibre-Reinforced Concretes (2000, Lyon, Co-Chairman: Gilles Chanvillard and Pierre Rossi)

The next one (5th edition), in September 2016, in Vancouver (Canada)



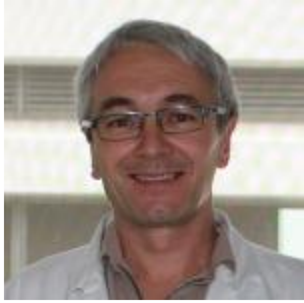
New challenges

- **Sustainable Development: necessity to optimize the quantity of concrete used for a given constructive function (conception of hyperstatic structures)**

- **Durability of the structures: better knowledge and mastering of the cracking of concrete structures in service conditions**

Traditional design approaches are not enough efficient

Development of finite elements models

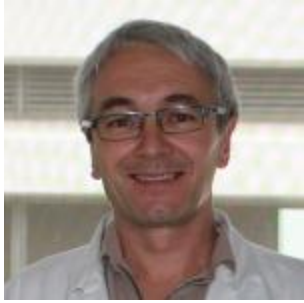


Specifications for an efficient FE Model for SFRC Structures

- ***Concrete (the matrix) is an heterogeneous material : random spatial distribution of the tensile strength***

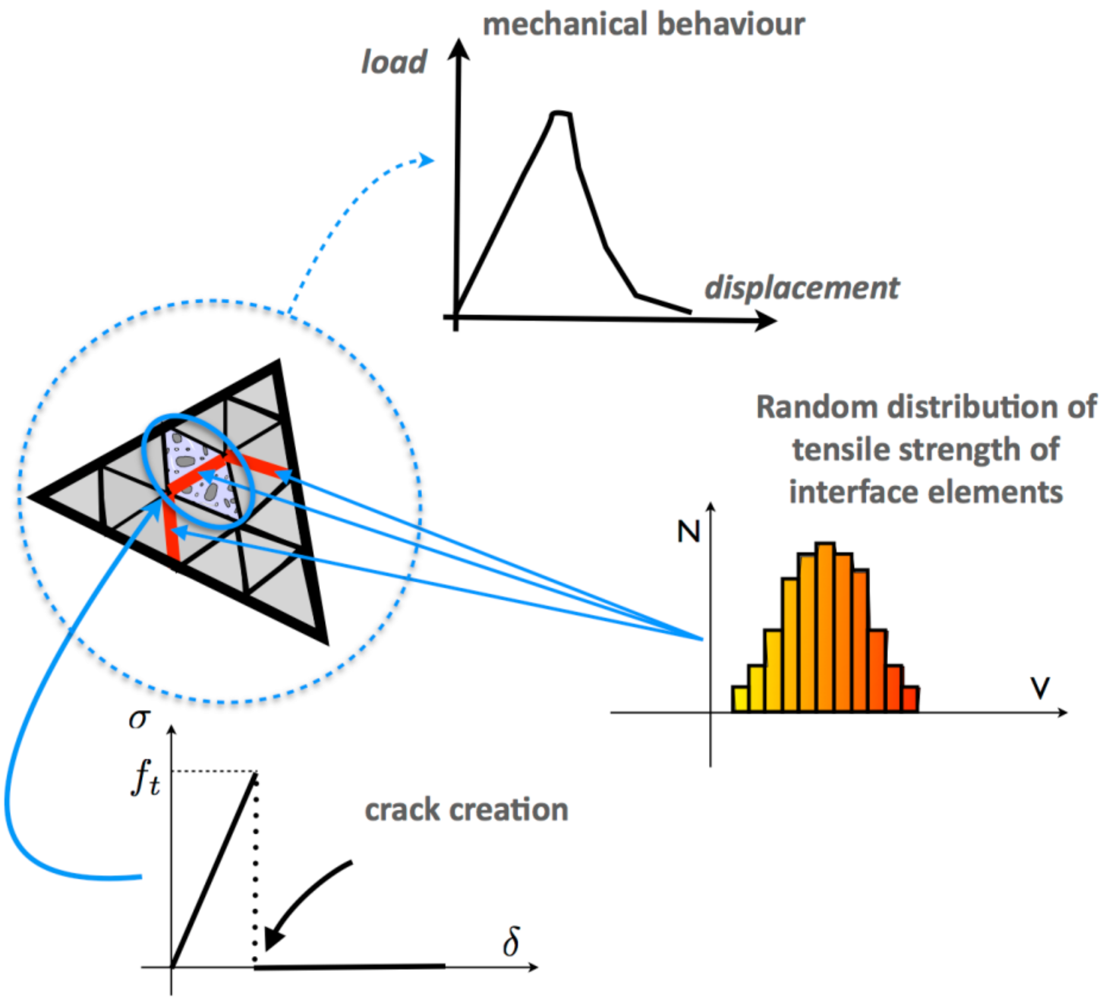
- ***Concrete (the matrix) rupture in tension is a scale effect process: the average tensile strength and the standard deviation increases when the volume of material stressed decreases***

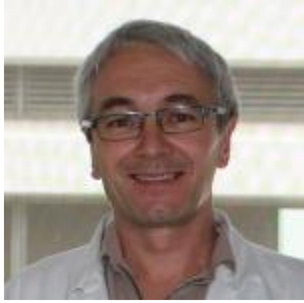
- ***Post-cracking behaviour of the SFRC (the composite) is less scattered when the volume of material stressed in tension increases***



Discret probabilistic cracking model

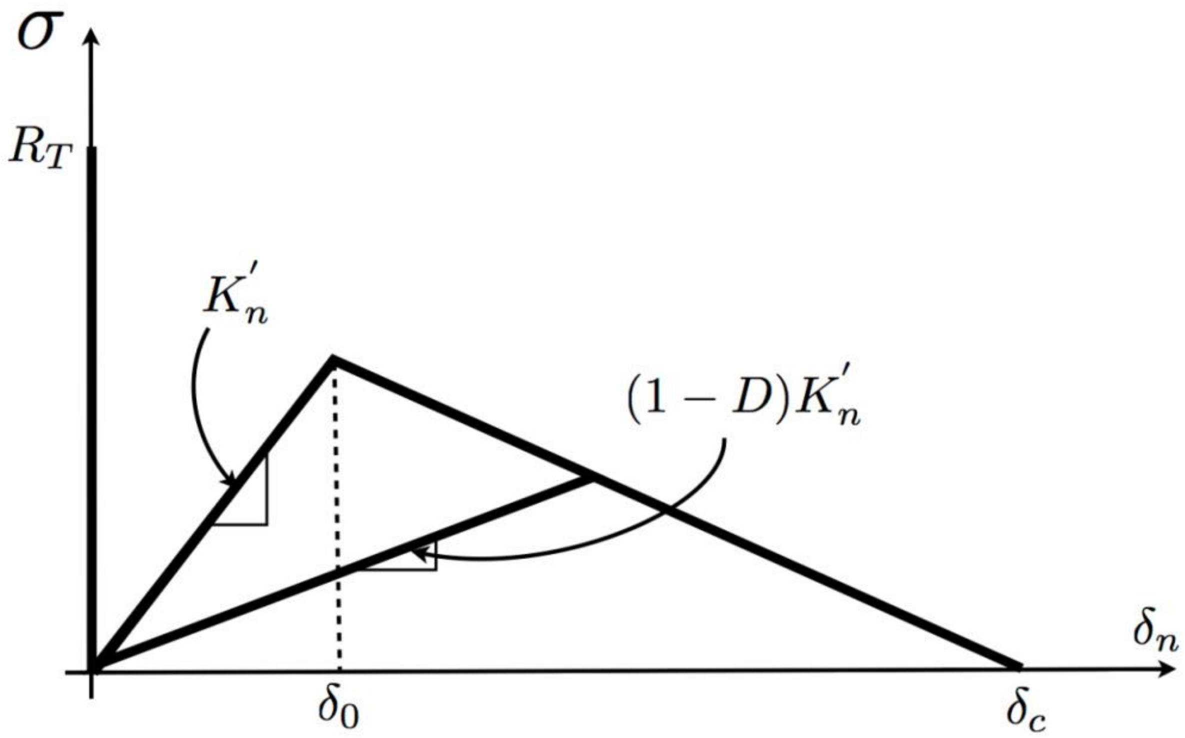
I. Cracking of concrete

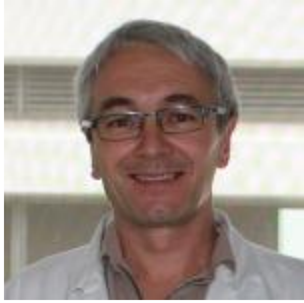




Discret probabilistic cracking model

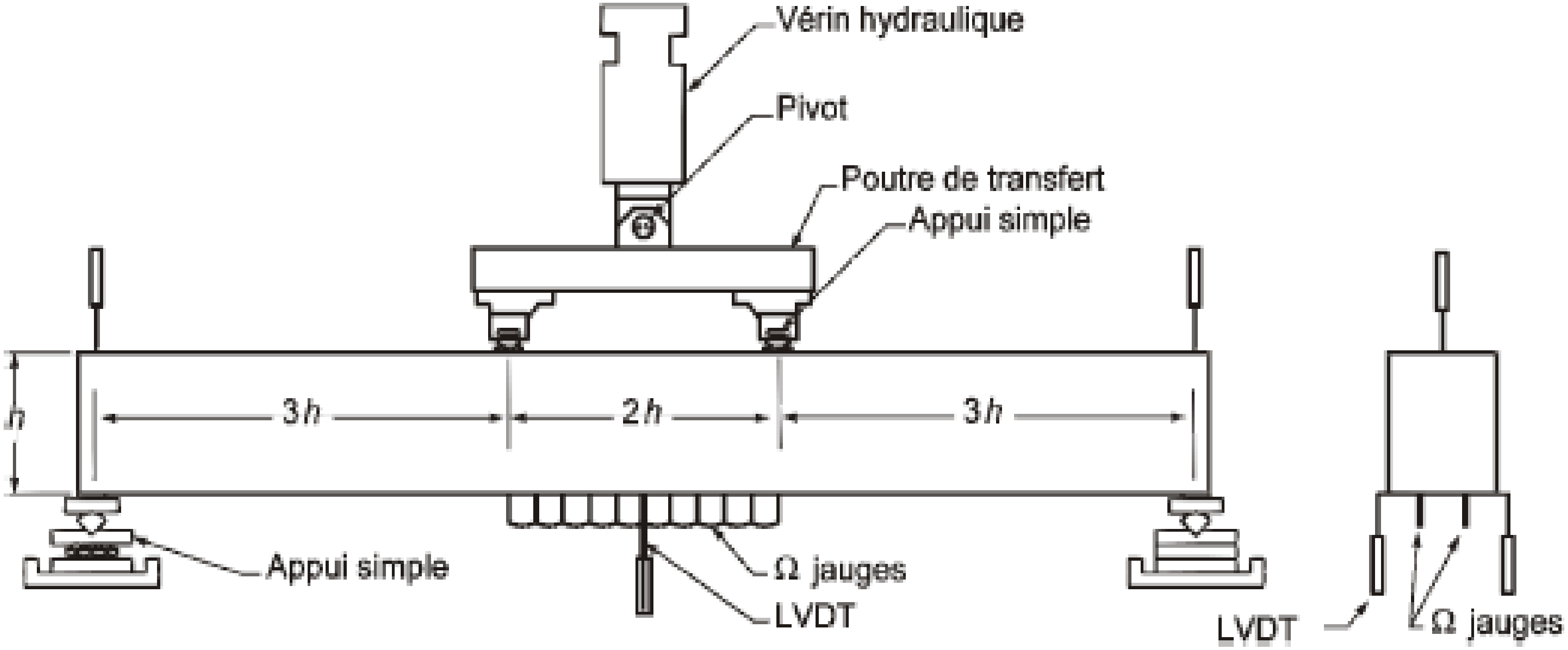
II. Post-Cracking of SFRC



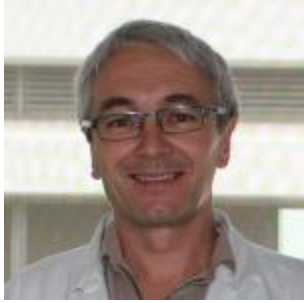


Discret probabilistic cracking model

Example of application - I

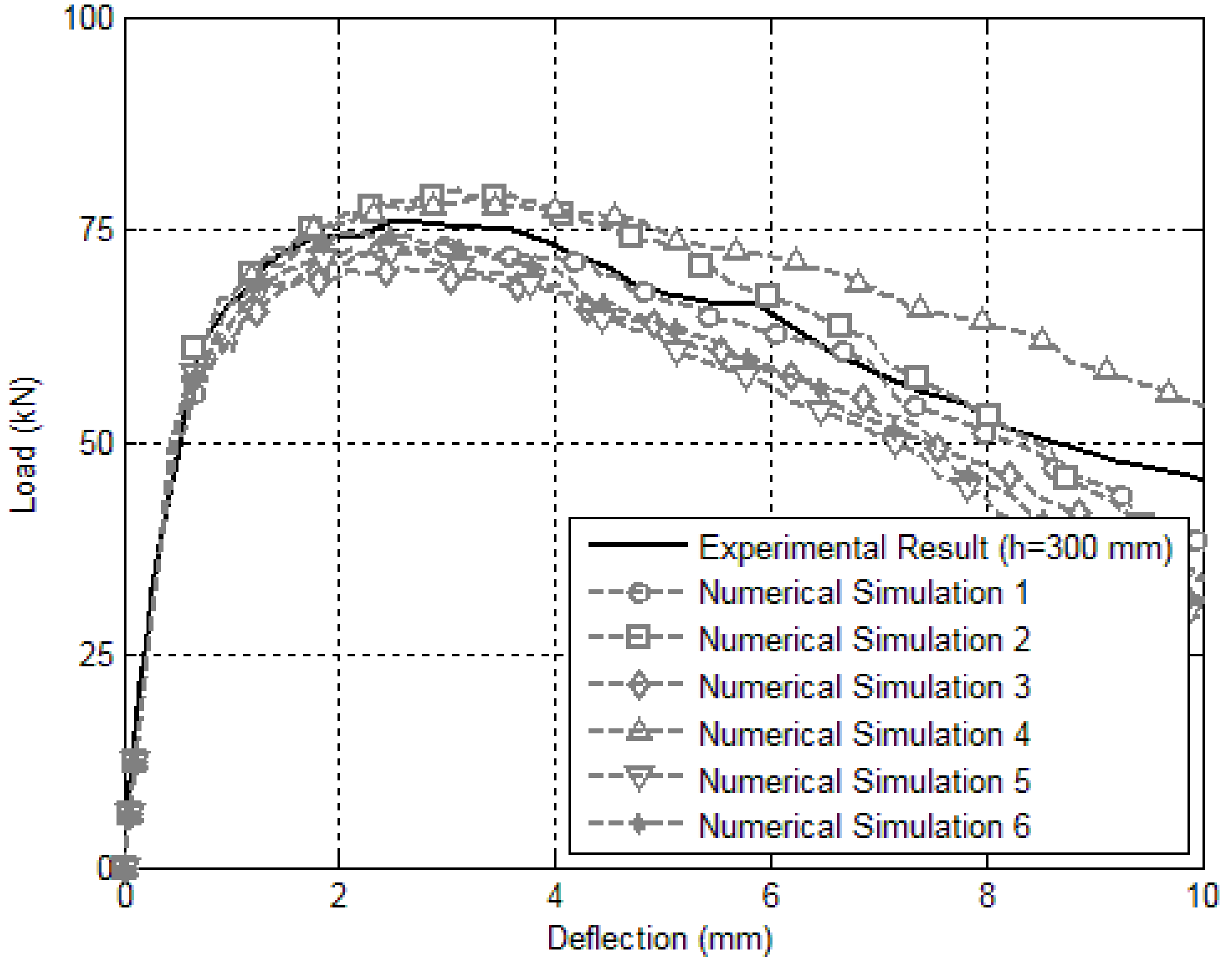


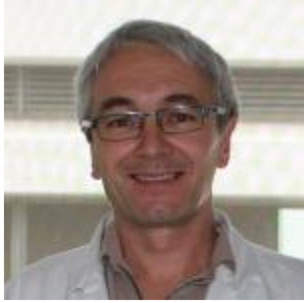
h = 300 mm



Discret probabilistic cracking model

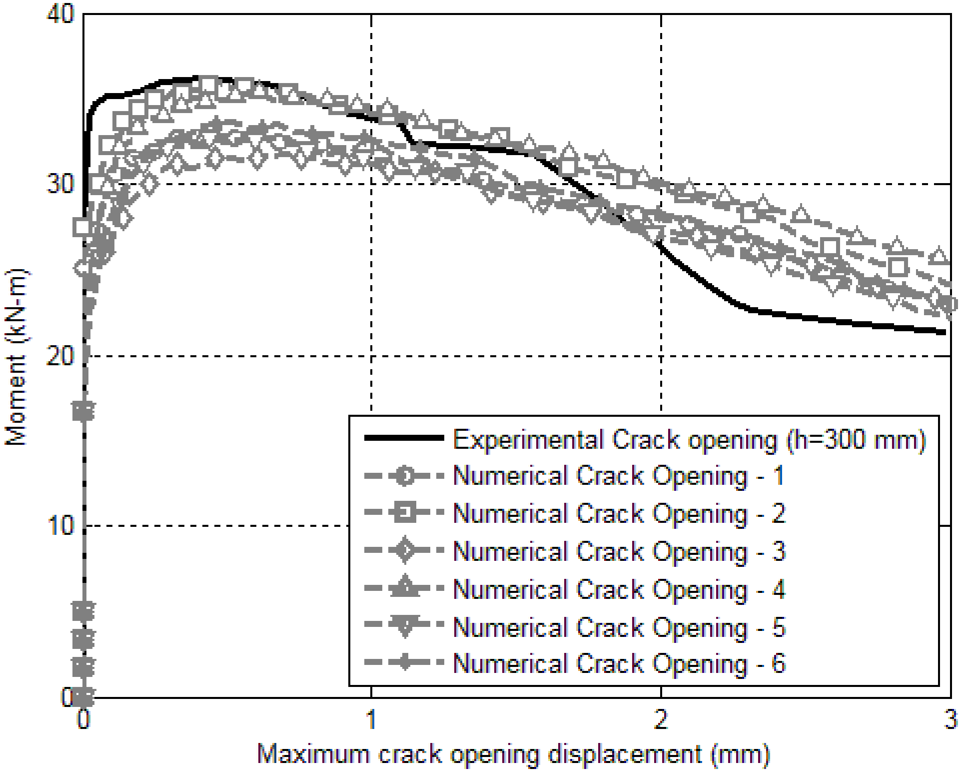
Example of application - I



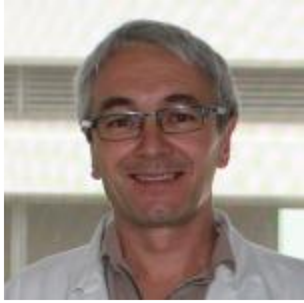


Discret probabilistic cracking model

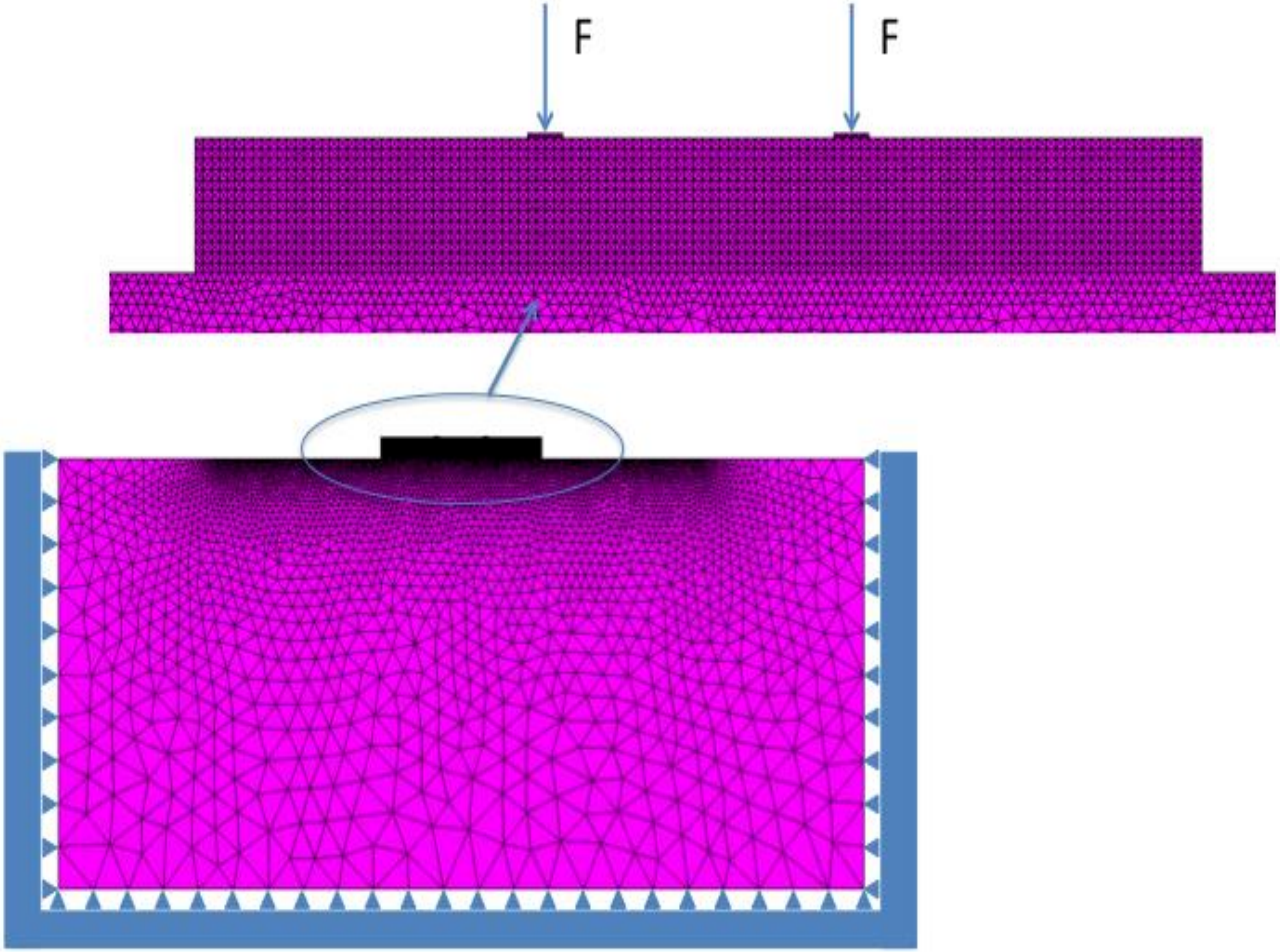
Example of application - I



Discret probabilistic cracking model

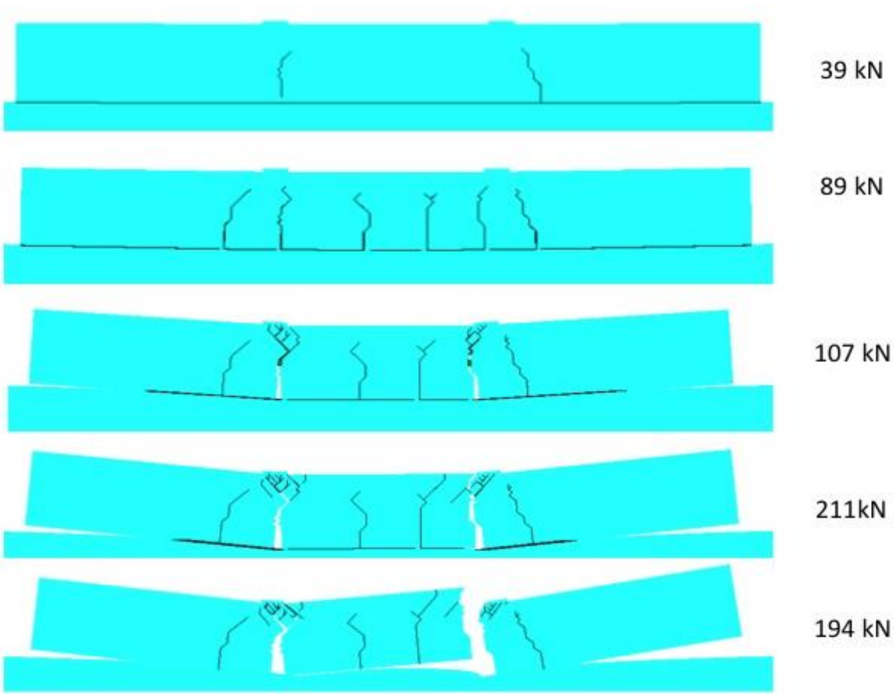


Example of application - II

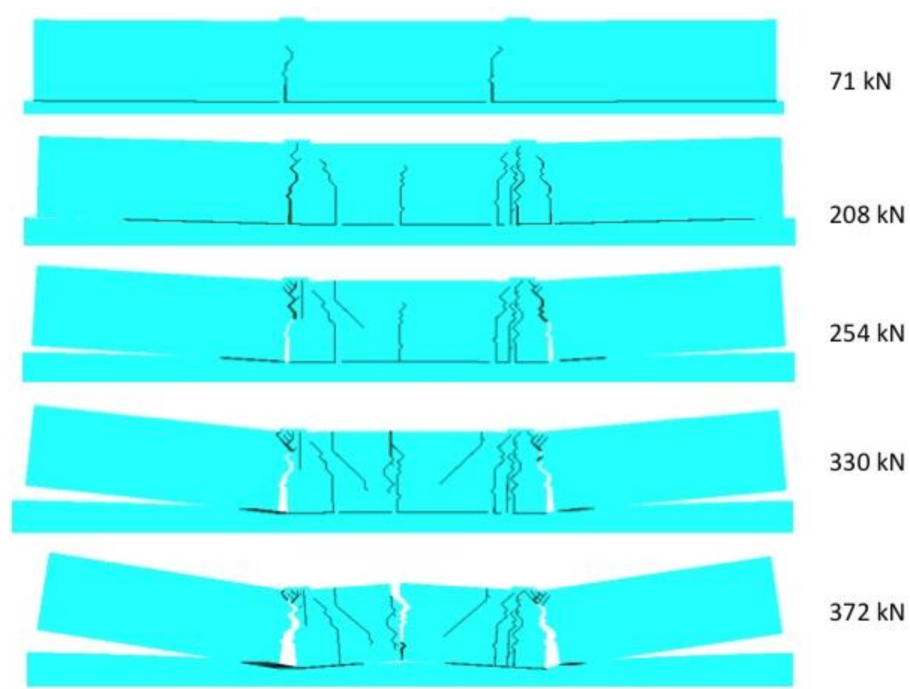


Discret probabilistic cracking model

Example of application - II



E_{ground}= 10 MPa



E_{ground}= 40 MPa

Gilles

My Friend

Thank you for accompanying me during a large part of my professional life
It was a pleasure and an honor to meet you