



LABORATOIRE DES FLUIDES COMPLEXES ET  
LEURS RESERVOIRS  
UMR 5150, UPPA / TOTAL / CNRS  
ALLEE DU PARC MONTAURY  
64600 ANGLET, FRANCE

GILLES PIJAUDIER-CABOT,  
DIRECTEUR

## **IA – FraMCoS - Vision**

**Prof. Gilles PIJAUDIER-CABOT**

Université de Pau et des Pays de l'Adour, France

Back in 1991, IA-FraMCoS was established in order to promote a series of international conferences specifically dedicated to the Fracture of Concrete and Concrete Structures. The intent was to organise the community around a landmark event held on a regular basis. One major aim of IA-FraMCoS was, and still is, to promote fracture-based approaches in engineering practice strongly backed by fundamental developments.

Such an engineering practice covers construction at large (long term assessment, safety analyses,...), but also others fields such as environmental protection or energy related issues. Some of these fields were at the forefront of scientific advances at the time the international association was established (such as computational failure analyses or experimental measurement of fracture energy). New topics emerged such as time-dependent fracture, dynamic fracture, durability mechanics. Recently, energy related challenges involved with Oil and Gas Production became very hot topics in relationship with Gas Shale production, Enhanced Coal Bed Methane production, deep geothermal energy or Carbon Dioxide Sequestration.

This renewal and diversity of engineering problems to be solved are, no doubt, a sign of vitality, timeliness and importance of IA-FraMCoS.

At the same time engineering problems became more diverse and new scientific methods emerged: multiscale – multi-physics approaches toward fracture expanded, new experimental techniques were implemented, including full field measurements, non intrusive imaging techniques (X Ray, NMR, Radar, ...), or large scale experimental facilities. Discrete approaches of fracture, based on lattice modelling and quite often inspired by physical approaches of fracture became also popular.

Fracture analysis expanded also from the macroscale down to the smallest possible scale, that of atoms. Indeed, cementitious materials, if they are archetypal of quasibrittle materials are also among of the oldest nanostructured materials. Cement paste belongs to the class of microporous materials, with pores down to the nanoscale controlling many aspects of their mechanical response. To this respect, cement-based materials are often viewed as “model materials” for other applications.

Topics of initial concern to IA-FraMCoS became stronger, new issues, new methods, and new problems emerged. Contemplating the past 20 years of existence of the Association provides an astonishingly rich picture. The initiative of creating data

repositories and collecting conference proceedings is, to this extent, a landmark of our collective legacy. It should be recognised and reinforced.

At the same time, our vision of the future of the association is rooted in the recognition that one cannot be satisfied with a gathering held every three years. In between conferences, IA-FraMCoS should keep on promoting fracture based analysis of concrete and concrete structures with smaller events and workshops dedicated to topical issues for which the scientific community is addressed.

Collecting results from international projects, promoting breaking news results and animating debated problems should also enrich our vision and strengthen the association worldwide. In return, IA-FraMCoS should reach toward emerging scientists and new actors, become a hub for the promotion of new ideas whenever the tools and approaches developed in the field of concrete and cementitious materials may be useful to others.

It is with this truly international and cross-disciplinary vision in mind for the future of IA-FraMCoS that I am ready to serve.



## **Gilles PIJAUDIER-CABOT**

*Professor of Civil Engineering  
Director of LFC-R (UMR 5150, UPPA-CNRS-Total)  
Director of the Carnot Institute ISIFoR*

Université de Pau et des Pays de l'Adour

Tel : 33 (0)5 59 57 44 33

Mobile : 33 (0) 6 28 01 26 89

E-Mail : [Gilles.Pijaudier-Cabot@univ-pau.fr](mailto:Gilles.Pijaudier-Cabot@univ-pau.fr)

<http://lfc.univ-pau.fr/live/>

## **CAREER AND EDUCATION**

- Professor at Ecole Centrale de Nantes (1999 – 2007)
- Professor at Ecole Normale Supérieure de Cachan (1992 – 1999)
- Research scientist at CNRS (1988 – 1992)
- Research Associate, Rensselaer Polytechnic Institute, Troy, NY (1987 – 1988)
- Habilitation à diriger des recherches, Univ. P. et M. Curie, 1991
- Ph.D. Northwestern University, Evanston, IL – USA, 1987
- Graduate from Ecole Normale Supérieure de l'Enseignement Technique, Agrégation de Génie Civil (1983), rank: 1st

## **PROFESSIONAL ACTIVITIES**

### *Editorial activities*

- International Journal for Numerical and Analytical Methods in Geomechanics, John Wiley, Editor
- Mechanics of Time-dependent Materials, Associate Editor
- ISTE Wiley, Series in civil Engineering and Geomechanics, Coordinator
- Journal of Engineering Mechanics – ASCE, Associate editor, 1997 – 1999, International correspondent for Europe, 2000-2006
- Revue Française de Génie Civil (Hermès Science Pub.), Associate editor 1996 – 2004
- European Journal of environmental and Civil Engineering, Member scientific board
- ISTE Wiley, member of the scientific council

### *Community services*

- Member of ASCE committee on Properties of Materials, 1989 – 2000, 2002 - 2007
- Chairman of ASCE committee on Properties of Materials, 1997 – 1999
- President of Int. Association for creep, shrinkage and durability mechanics of concrete and concrete structures (2003 – 2005)

### *University and governmental services*

- Head of the strategy and prospective at CNRS (2006-2010)
- Scientific coordinator at USAR (support unit to the french Agence Nationale de la Recherche) (2005-2009)
- Deputy director for research at Ecole Centrale de Nantes (2002 - 2006)
- Head of the civil and environmental department at Ecole Centrale de Nantes (2001 – 2003)
- Director of the research and technology group « Rupture et Durabilité des Ouvrages » (Centrale Nantes / EDF / VM Matériaux / Lafarge), (2000 – 2007)
- Chairman of the national selection committee for the young researchers awards (2003 – 2004)
- Advisor for engineering sciences to the director of research at the ministry of research (2001)
- Vice-director of Physics and Engineering Sciences at the ministry of research (1998 - 2000)

- Director of the national network of laboratories in Civil Engineering (1994 –1998)

## **DISTINCTIONS**

- Bronze medal of CNRS, Engineering sciences (1991)
- Prix Jean MANDEL (1992)
- Elected junior member of Institut Universitaire de France (promotion 1996)
- Young researcher French award (*ACI Jeunes chercheurs*) (1999)
- European Research Council advanced grant (2008)
- Elected senior member of Institut Universitaire de France (promotion 2012)

## **RESEARCH INTERESTS**

Damage and fracture of cementitious and quasi-brittle materials, Failure analysis and strain localisation, Nonlocal modelling and localisation limiters, Durability mechanics of concrete structures (experimental & computational), Coupled problems in geomechanics

Over 80 refereed papers, editor of 14 books, 50 invited or keynote lectures at conferences, over 2600 citations,  $h=25$  (source: ISI)

## **OTHER RELEVANT INFORMATION**

- Participation to five European research projects (Science, Brite Euram, RTN - FP6, Euratom,..)
- Guest editor of 5 special issues (Journal of Engineering Mechanics ASCE, Journal of Material Engineering ASCE, Int. J. Solids & Struct., Engineering Fracture Mechanics)
- Member of the scientific committees of over 30 international conferences
- co-Chairman of the workshop on Mechanics of Quasi-Brittle Materials and Structures (Prague, 1998), FRAMCOS VI (Cachan, 2001), NSF workshop on Model Based Simulations of Durability of Materials and Structures (Prague, 2002), Concreep 7 (Nantes 2005)
- Consultant with ANDRA and TOTAL SA

Gilles Pijaudier-Cabot graduated from Ecole Normale Supérieure de Cachan in 1985 and obtained a Ph.D. from Northwestern University in 1987. He joined CNRS in 1988 and later on the faculty of civil engineering of Ecole Normale Supérieure de Cachan (ENSC) in 1992 as a full professor. At ENSC, he developed computational tools for evaluating the integrity of concrete structures. Gilles Pijaudier-Cabot research activities turned toward durability mechanics and chemo-mechanical issues in 1999 when he joined Ecole Centrale de Nantes. With the help of Electricité de France, VM Matériaux and Lafarge, he founded the Failure and Durability group, jointly operated with industry. In 2007, Gilles Pijaudier-Cabot joined Université de Pau et des Pays de l'Adour and the joint laboratory with CNRS and TOTAL which he is directing now, along with the Institut Carnot ISIFoR (500 researchers) dedicated to Petroleum Engineering.

Beside landmark papers dealing with non local damage and failure due to strain localisation, we authored several contributions in which statistical physics tools are implemented in order to understand fracture processes in quasi-brittle heterogeneous materials. He developed several computational approaches for failure analysis of concrete and concrete structures, under dynamic loads and also for coupled problems involving chemical degradation of cementitious materials. Starting in the 2000's, his interest turned toward the relationship between damage and permeability, with a view toward the safety of nuclear vessels and also toward gas production in Tight Gas Reservoirs. He was one of the five recipients of the European Research Council Advanced Grant in 2008 in the field of solid mechanics. His most recent works deal with the fracture and time-dependent response of microporous materials, including cement paste, coal and shales, combining continuum mechanics and molecular based approaches.

Gilles Pijaudier-Cabot authored over 80 refereed papers which received more than 2600 citations ( $h=25$ ). He edited 14 books and he is the owner of three patents. He served as Chairmain of the ASCE Committee on Properties of Materials (1997-1999). Currently, he is editor of International Journal of Numerical and Analytical Methods in Geomechanics and associate editor of Int. J. Time Dependent Materials. He has been consultant for OXAND, ANDRA and TOTAL.

Aside from this scientific involvement, Gilles Pijaudier-Cabot has been deputy director in charge of Engineering Sciences at the French Ministry of Research (1998-2002), chairman of the scientific committee in charge of the Young Researcher Awards in France (2002-2004) and advisor to the president of the National Center for Scientific Research (CNRS) in France, in charge of the strategic plan of CNRS (2006-2010). He was also deputy director in charge of research at Ecole Centrale de Nantes (2002-2006).

He received the bronze medal from CNRS in 1991 and the Jean Mandel prize of the French association of mechanics in 1992. In 1996, he was elected at Institut Universitaire de France (IUF) as a junior member for a five year term. He was elected at IUF as a senior member in 2012.

Gilles Pijaudier-Cabot organised four international conferences. He served as Chairman of Int. Association on Creep, Shrinkage and Durability of Concrete and Concrete Structures. He contributes to the FraMCoS conference on a regular basis.



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## **Proposal for the FraMCoS – 10 conference in 2019 Bayonne – Biarritz area, 2019**

**Prof. Gilles PIJAUDIER-CABOT**

Université de Pau et des Pays de l'Adour, France

**Prof. C. La Borderie**

Université de Pau et des Pays de l'Adour, France

**Prof. P. Grassl**

University of Glasgow, UK

**Dr. M. Vandamme**

Ecole des Ponts ParisTech, France



### ***Context and scope***

22 years ago, when IA-FraMCoS was incorporated in the United States, the initiative received a strong support from the European scientific community involved in fracture mechanics of concrete and concrete structures. This support has not decreased over time. FraMCoS conferences were organised four times in Europe and the European attendance remained strong at each conferences.

Within the French community, the FraMCoS Conference series has always been felt as an event which boosted the confrontation of new ideas and it created a momentum towards a new generation of scientists. The initially strong focus on fracture and damage in concrete and reinforced concrete extended towards earthquake engineering, transient dynamic problems, durability mechanics and new civil engineering materials. At the same time, scientific issues broadened as interfaces with statistical physics,

material sciences, advanced computational methods and new experimental techniques developed. Leadership in multiscale and multiphysics approaches is closely related today to our community know-how.

In France especially, this cross fertilization was also motivated by strong industrial and societal needs for safer new infrastructures, such as nuclear vessels or waste disposals, for retrofitting existing facilities, and also for gaining efficiency in construction. Construction majors, material producers, operators and national agencies combined their efforts to promote science in the heart of FraMCoS activities, making research in this field one of the most active in Engineering Sciences over the past ten years.

*We have now the feeling that the support of IA-FraMCoS through the organisation of this conference series has been so much beneficial to us that we would like to take our share of the duties that come with the benefits.*

One major aim of IA-FraMCoS is also to promote fracture-based approaches in engineering practice, in parallel with fundamental developments. Such an engineering practice covers construction (long term assessment, safety analyses,...), but also others fields such as environmental protection (e.g. long term waste storage, carbon dioxide storage), oil and gas related issues (well tightness) or energy storage facilities. *We also believe that fracture mechanics approaches will gain visibility in engineering practice as FraMCoS conference serve as a forum of exchange of ideas and confrontation of methods.* Existing initiatives in France and elsewhere in Europe associating industry and academic research are expected to keep on crystallizing over the next decade within this series of conferences.

### **Organisation and support**

This proposal is an initiative from four persons: two at Université de Pau et des Pays de l'Adour involved in Fracture Mechanics of Concrete (Prof. G. Pijaudier-Cabot, Prof. C. La Borderie), one from the University of Glasgow (Prof. P. Grassl), and the last one from the Navier Group at Ecole des Ponts ParisTech (Dr. M. Vandamme).

Although it is too early to secure support and funding now for a conference to be held in 2019, sponsorships from the National Center of Scientific Research, from the national academic civil engineering society, from our university and from regional and local authorities are expected. We are quite confident about these supports from past experiences of the organisation of similar events we had.

Active participation from the industry (Electricité de France, Total SA, ...), from national R&D centers (CEA, IRSN, ANDRA, IFFSTAR) and regional clusters (Seismic analysis in Saclay, Eco-Construction in Nantes,...) could be also secured easily. Therefore, the expected registration cost will be kept in line with typical events of the same nature. Proceedings will be provided on CD-ROM.

Based on the previous experience of the leader of this proposal who had already been involved in the organisation of FraMCoS and Concreep conferences, it is expected that the budget will cover the Young Researcher awards and should also provide a benefit for IA-FraMCoS (typically 5000\$).

### **Themes**

In addition to the themes that are traditionally present at FraMCoS conferences, the organisers plan to organise session dedicated to energy production issues (e.g. fracking, fracture of well cementation,...), carbon sequestration. Phase fields approaches, mesoscale modelling, molecular based approaches and nanoscale models are also among the potential candidates for mini-symposia. We also intend to organise at least one post-conference one-day workshop on one of these topics

Finally, a doctoral-postdoctoral course is expected to be given prior to the conference. The topic envisioned is "Continuum damage modelling over the scales". Special funding

will be sought for the organisation of this two-day session, with a complete accommodation of the attendees in a remote place of the “Pays Basque” nearby.

### ***Location***

The Biarritz-Bayonne area is located in the southwest of France, on the « Basque Coast », on the Atlantic shore and close to the Pyrenean mountains. The Biarritz area became popular at the end of the 19<sup>th</sup> century for its beautiful sceneries, between the mountains and the Ocean, its cool climate and also the preservation of a strong cultural heritage in connection with Euskadi (“Pays Basque” in French).

It is today a highly reputed touristic area which is very well connected to Paris (6 flights per day) and also with Spain, either from Madrid, Bilbao or Barcelona.

The campus of the Université de Pau et des Pays de l'Adour is located in the heart of the city of Bayonne and it has facilities for hosting easily conferences of the typical size of FraMCoS ones.

