



Liberté d'expression et risque nucléaire

Farid BENBOUDJEMA

Amphi Tocqueville, Mardi 10 février 2015

Court CV

2012 **Habilitation à diriger les recherches**

Titre : contribution à l'analyse des déformations différées dans les matériaux cimentaires et de ses effets dans les ouvrages de génie civil

2002 – **AGPR puis Maître de conférences à l'Ecole Normale Supérieure de Cachan**

Thématique de recherche : Etude expérimentale et modélisation du comportement différé des matériaux cimentaires

Laboratoire de Mécanique et Technologie

Collaboration : essentiellement IRSN (2005 -) et Areva (2011 -) - EDF (très ponctuel sur des thèmes différents) – CSTB, CERIB ...

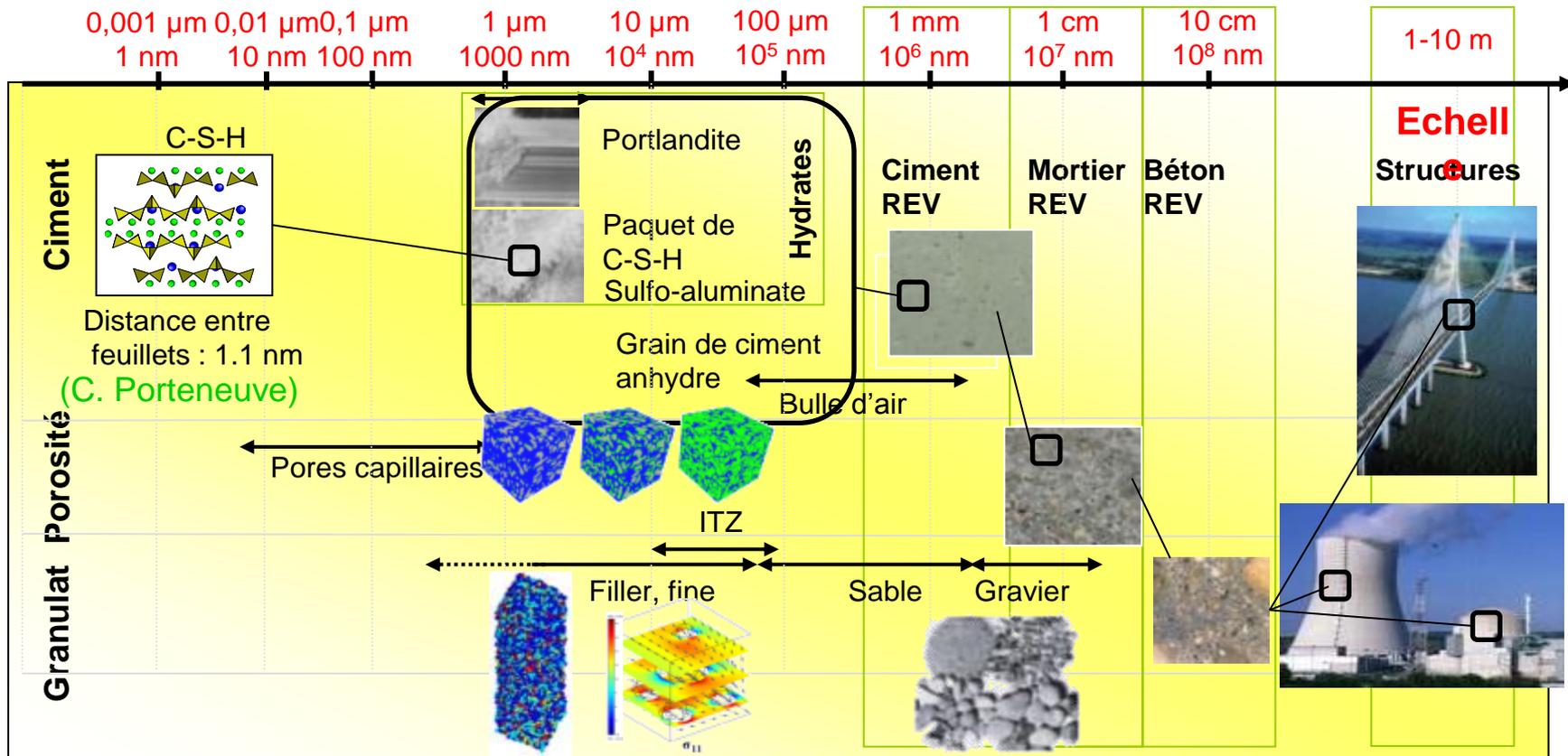
- Co-organisation d'un événement sur la sensibilisation à l'expertise nucléaire, 4 – 5 avril 2011, Amphi E-media, 34 participants
- Membre du conseil scientifique du projet scientifique VeRCoRs (EDF)
- Responsable du module énergies renouvelables en Master 1 (2004-2013)
- Master 2 ECD (Enveloppes et Constructions Durables), ouverture en 2015

1999 - 2002 **Thèse de doctoral à l'Université de Marne-La-Vallée**

Titre : Modélisation des déformations différées du béton sous sollicitations biaxiales. application aux enceintes de confinement de bâtiments réacteurs des centrales Nucléaires

Collaboration : EDF

Activités de recherche



Physique du solide, chimie

Micro-mécanique

Mécanique des Structures

Besoin d'expériences couteuses et longues !

Obtenir des lois de comportement (modèles prédictifs) à partir de lois fondamentales à l'échelle nano/micro/meso

Prédire le comportement différé et la fissuration dans les structures de Génie Civil du court au (très) long terme

Activités de recherche

Nuclear containments – the french “touch”

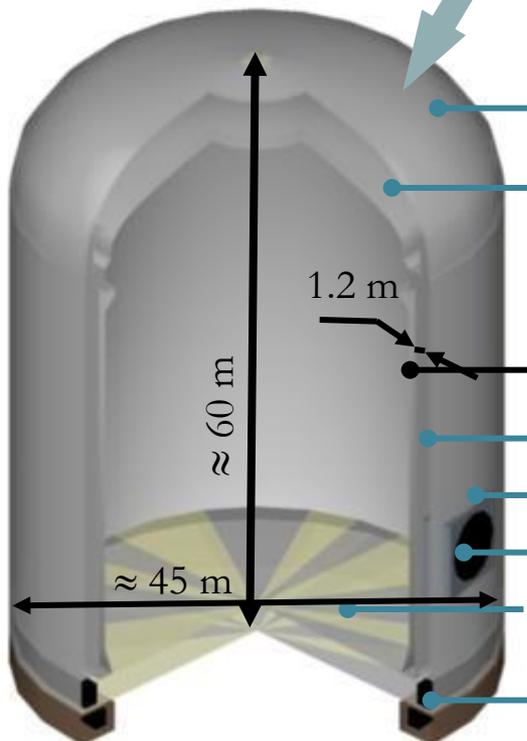


34 PWR 900 MWe (single concrete containment and inner metallic liner)

20 PWR 1300 MWe (double containment vessel)

4 PWR 1450 MWe (double containment vessel)

About 80 % of electricity comes from nuclear powerplants in France



Components

External dome (RC)

Internal dome (RPC)

Internal containment (RPC)

Containment inter-space

External containment (RC)

Material hatch

Raft

Gallery (Tendon anchorage.)

Design conditions

LOCA (Loss of coolant) accident
AT ('Acceptance' test ~ every 10 years)

Daily leak rate criteria

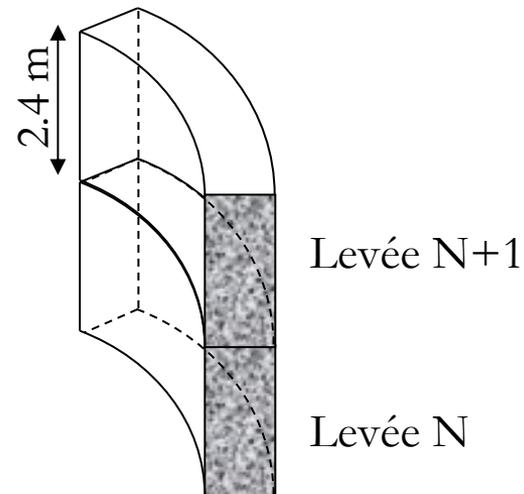
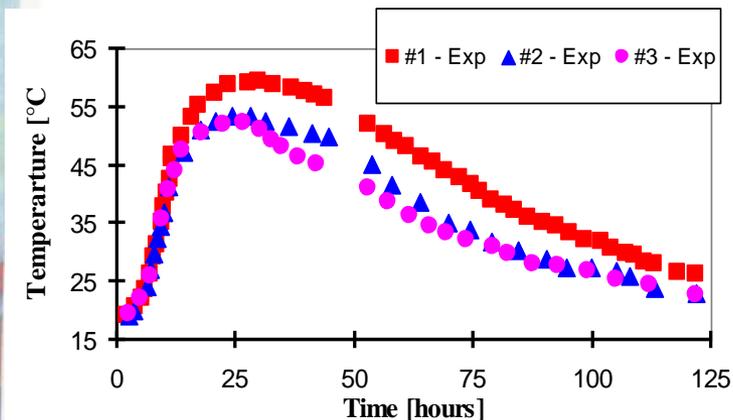
LOCA
(air and vapour) – $p=0.5\text{MPa}$, $T=140^\circ\text{C}$

1,5%

Enjeux sur les structures

➔ Mur épais (Itthuralde, 1989)

120 cm, CEM II



8 fissures, (1×40 μm) + (4×100 μm) + (2×200 μm) + (1×500 μm)



➔ Station d'épuration (A. Darquennes)

40 cm, CEM III



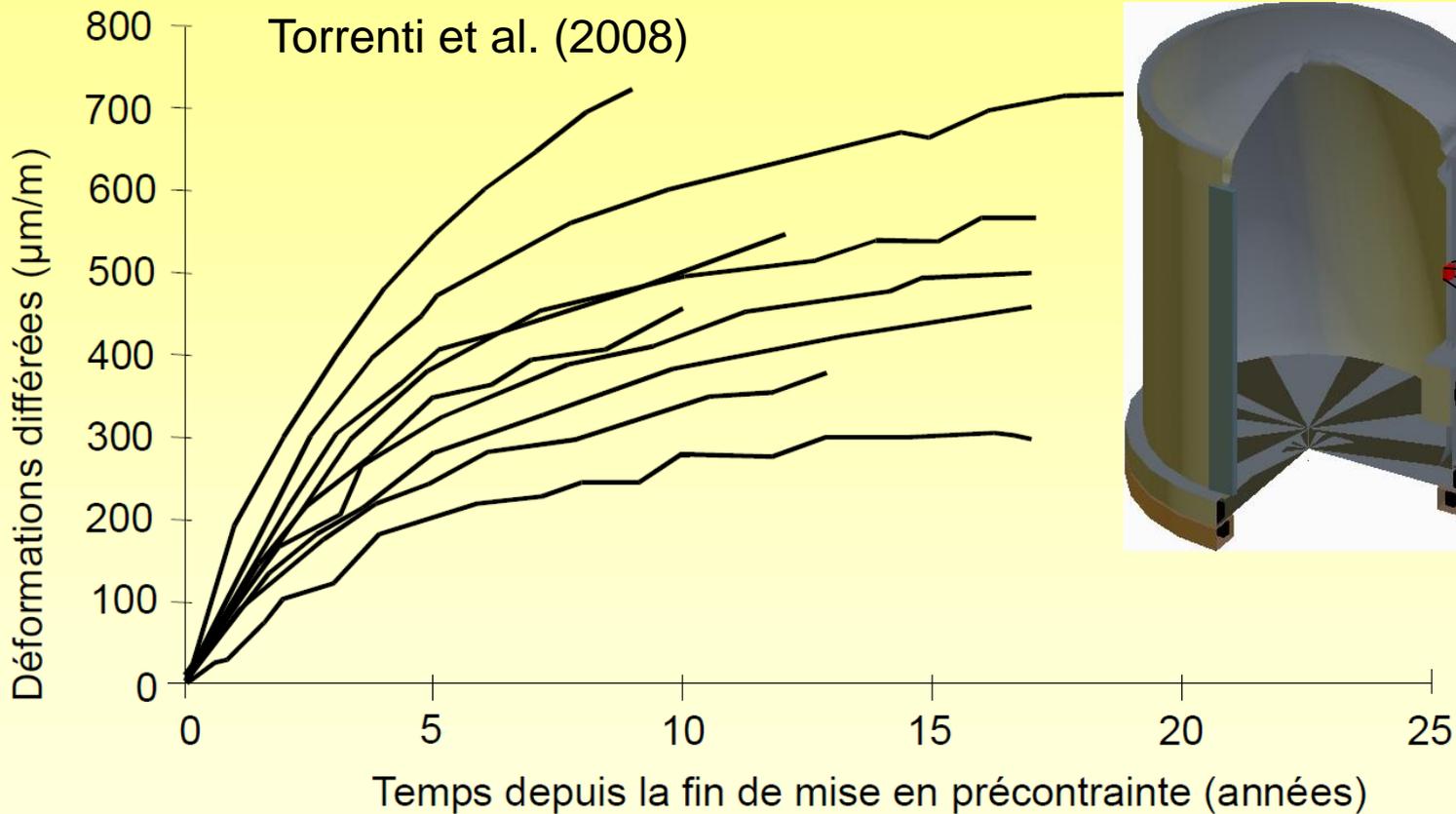
Tunnel de métro en béton fibré

50 cm, CEM III



$$Q \approx \frac{w^3(p^2 - p_a^2)}{24\mu L r T}$$

Enjeux sur les structures



Déformations mesurées sur site sur des bétons de résistance en compression similaire à 28 jours ...

Effet de la composition, des conditions environnantes ?



Pertes de précontraintes ?

Quelques résultats

Jeune âge \approx Phase de construction

Problème thermo-chimique
associé au jeune âge

ξ, T

Problème mécanique

$$\epsilon_{tot} = \epsilon_{el} + \epsilon_{au} + \epsilon_{th} + \epsilon_{bc}$$

Problème hygrométrique
associée au séchage



Long terme \approx Durée d'exploitation

$\underline{u}, \underline{\sigma}$

Problème mécanique

$$\epsilon_{tot} = \epsilon_{el} + \epsilon_{ds} + \epsilon_{bc} + \epsilon_{dc}$$

S_l, P_{cap}

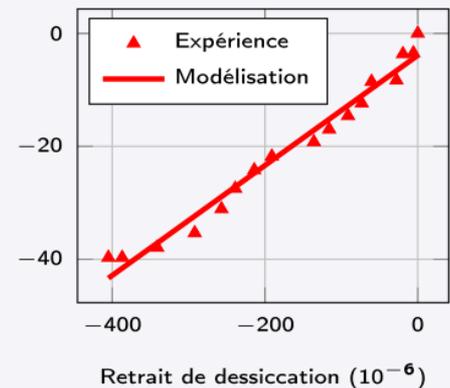
Essais expérimentaux

Modélisation

Identification

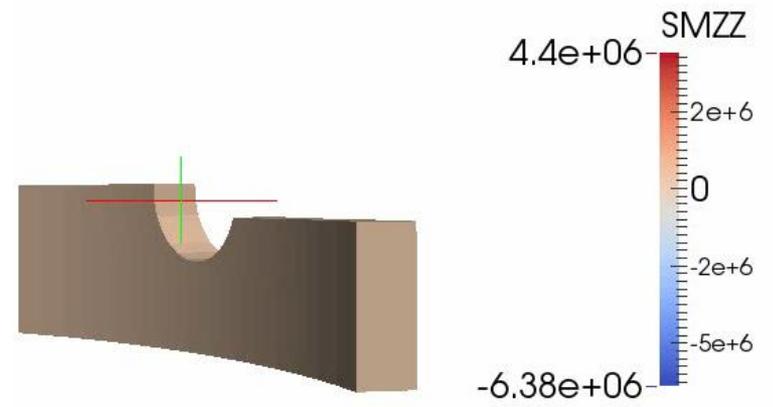
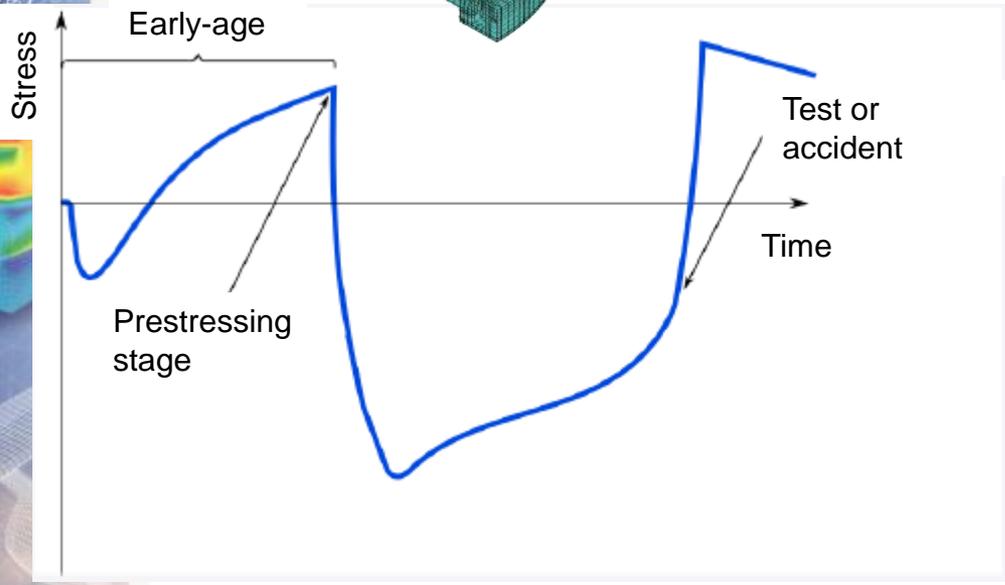
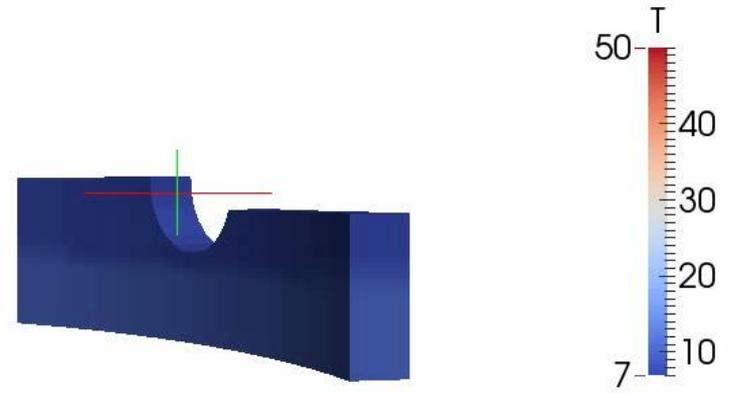
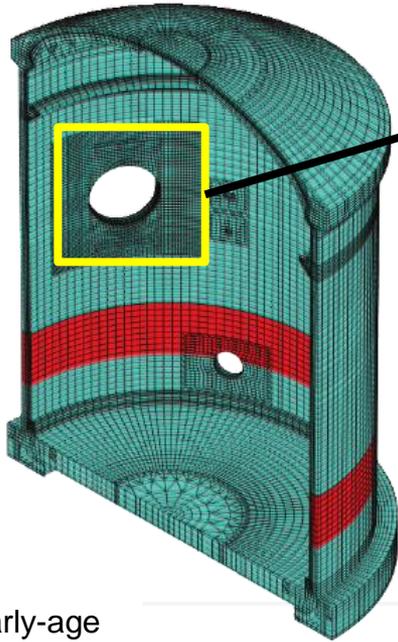
Simulation du comportement de
l'enceinte

Fluage de dessiccation ($10^{-6} \cdot \text{MPa}^{-1}$)



Quelques résultats

Prediction of early-age stresses



Predict leakage rate



Lieux d'expression

En 2013, EDF construira un vrai-faux réacteur nucléaire - 08-10-2012-2213239.php#xtref=https%3A%2F%2Fwww.google.fr%2

ACTUALITÉS SPORTS MA VILLE CULTURE & LOISIRS LE PARISIEN TV PHOTOS PARTICIPEZ ! LA PARISIENNE ÉTUDIANT PRATIQUE FORUM ABC

Toute l'actualité, 10 Février 2015, mis à jour à 07h05

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En 2013, EDF construira un vrai-faux réacteur nucléaire

Le Parisien | 08 Oct. 2012, 07h00

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A Le laboratoire ultrasecret d'EDF des Renardières, à Moret - Ecuelles, passe la vitesse supérieure en matière de tests de sûreté des centrales nucléaires. **A** Samedi, Bernard Salha, directeur de la recherche et du développement, a **📄** présenté le projet Vercors (vérification réaliste du confinement des **➔** réacteurs). **📱**

Ce projet ambitieux prévoit la construction en 2013-2014 d'une maquette d'enceinte de réacteur nucléaire de 30 m de haut sur 16 m de diamètre, pour 20 M€. Une structure unique au monde.

« Cette maquette a pour but de démontrer, par des essais concrets, la robustesse des installations d'EDF en situation d'événements graves. Mais



ANNONCES SHOPPING par LeGuid



Lieux d'expression

Benchmark: EDF VeR x

fr.amiando.com/EDF-vercors-project.html



VeRCoRs Project

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VeRCoRs presentation



As part of EDF's continuous effort on the safety and life extensions to its fleet of Nuclear Power Plants, an experimental **mock-up of a reactor containment building at 1/3 scale** is being built at Renardières near Paris. This mock up will be completed in the first half of 2015. The mock up is finely instrumented so that its behavior is monitored from the beginning of the construction. More than **500 sensors and 2 km of fiber optic cables** are to be positioned in the concrete and both on the rebars and on the prestressing cables. During the construction, measurements will be realized just after concreting during time intervals of one hour. During the research program, several measurements will be collected every day on each sensor. Hundreds of samples of concrete will be prepared and tested to determine their material behaviors and parameters, including moduli and strength, drying, shrinkage, creep, and permeability.

The main objectives of the project are to study:

Lieux d'expression

NRC: Special NRC Oversight x
www.nrc.gov/info-finder/reactor/seabrook/concrete-degradation.html

 **U.S. NRC**
United States Nuclear Regulatory Commission
Protecting People and the Environment

Enter term or ADAMS #

 **REPORT**
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Home > Facility Locator > Operating Nuclear Power Reactors by Location or Name > Seabrook Nuclear Generating Station, Unit 1 > Special NRC Oversight: Concrete Degradation

Special NRC Oversight at Seabrook Nuclear Power Plant: Concrete Degradation

In 2009, NextEra Energy Seabrook, LLC (NextEra) realized that the intrusion of moisture into sections of walls in certain below-grade structures at the Seabrook nuclear power plant, in Seabrook, N.H., could cause the degradation of some of the concrete as evidenced by pattern cracking.

It was confirmed in 2010 that what is occurring at Seabrook is alkali silica reaction, or ASR. The result of the reaction is a gel, which can expand and may cause micro-cracks in the concrete. Graphics detailing the chemical reaction and the expansive gel can be viewed on [slide 9](#) of the May 10, 2012 presentation titled, "Seabrook Station Safety in Light of the Alkali-Silica Reaction Occurring in Plant Structures."

The structures identified to be affected by ASR are considered "operable but degraded", meaning that NextEra and the NRC have determined the structures can continue to safely perform their function based on: 1.) the extra safety margin that was included when the structures were designed and built; 2.) visual observations by licensee design engineers; 3.) the limited, localized areas where ASR is occurring; and 4.) slow progression of the concrete degradation. For more information on the event and the status of NRC follow-up and planned activities, see the following topics on this page:

- [Summary of Event and Plant Conditions](#)
- [Confirmatory Action Letter](#)
- [Enhanced Oversight](#)
- [Next Steps](#)
- [Publicly Available Documents](#)
- [Public Meetings](#)

RELATED INFORMATION

[Report on Aging of Nuclear Power Plant Reinforced Concrete Structures, NUREG-CR-6424](#) 



LOT

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- Conférence SMIRT tous les 2 ans

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smirt23.smirtconferences.org/technical-topics

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SMiRT 23 - Divisions / Topics

SMiRT 23 Themes

The overall theme for SMiRT 23 is "Using existing challenges to champion the Next Generation". As part of this, we will be promoting an Early Career Award for individuals within 10 years of starting their professional career.

As part of the scope of the standard SMiRT divisions, focussed topics for SMiRT 23 include:

- Nuclear Applications of Graphite
- High Temperature Assessment
- New build and the harmonisation of codes and standards
- Small modular reactors (SMRs)
- Flooding Hazards - developments post Fukushima
- Component Fragility of Nuclear Power Plants

SMiRT 23 Divisions

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4. Characterisation of Loads
5. Modelling, Testing and Response Analysis of Structures, Systems and Components
6. Design and Construction Issues
7. Safety, Reliability, Risk and Margins
8. Issues Related to Operations, Inspection and Maintenance
9. Fuel Cycle Facilities, Waste Management and Decommissioning

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news and updates
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2014-07-16 11:00 AM
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Lieux d'expression

- NUCPERF

NUCPERF2012

Long-Term Performance of Cementitious Barriers and Reinforced Concrete in Nuclear Power Plant and Radioactive Waste Storage and Disposal

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The Workshops NUCPERF 2012 on long-term performance of cementitious barriers and reinforced concrete in nuclear power plant and radioactive waste storage and disposal. The full paper must be submitted before the 15th October 2012 (see the "full-paper submission section"). The registration is also possible until the 15th October 2012, by the way of the registration form.

- TINCE (ESTP, chaire génie civil nucléaire)

SFEN > TINCE 2014

https://www.sfen.fr/TINCE-2014

2014, September 1 | 4 - France, Paris

TINCE 2014
2nd International Conference on Technological Innovations in Nuclear Civil Engineering

www.sfen.fr or www.sfen.org

International Events

Conference Location
Conference Information
Committees
Author's Guidelines

The purpose of this event is to present the latest innovations in the technological framework of the nuclear civil works. These advancements imply sharing together the latest works in materials, construction process, methods, techniques and design. This requires discussing the latest progress accumulated through modeling, testing, and industrial feedback. This means characterize the behavior of materials and structures linked to these newest technologies in order to improve their assessment, design and appropriate usage. The objective is to bring together researchers and industrial practitioners from around the world to assess the latest frontiers of the technologies in the field of nuclear civil works.

Merci pour votre attention !

Si le béton a longtemps été considéré comme un matériau sale, inabordable, rétif à toute approche scientifique, le béton apparaît aujourd'hui comme le **paradigme de la Science des matériaux**, parce qu'il est le seul, sans doute, à mobiliser toutes les disciplines qui la constituent

Paul ACKER, Directeur scientifique chez Lafarge, 275e conférence de l'Université de tous les savoirs

