

**RIC 2018**


**IRSN**  
INSTITUT DE RAISONNEMENT ET DE SÉCURITÉ NUCLEAIRE  
*faire avancer la sûreté nucléaire*

## R&D ON CONCRETE PATHOLOGIES THE ODOBA PROJECT

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TH28 - Perspective on Alkali-Silica Reaction (ASR) Effects on the Structural Capacity of Nuclear Concrete Structures

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**RIC**

## FRENCH CONTEXT

- French operator wishes an extension of NPP operation from 40 to 60 years
- New NPP should be operated for 60 years
- Waste management facilities require a reversibility period of at least 100 years
- Requirement to sustain a high safety standard during all operation life (equivalent to new facilities)**

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**RIC**

## ASR IN CONCRETE STRUCTURES

- Dams, bridges, buildings... affected around the world : from mild cracking to severe damage
- What to do: evaluate and monitor, repair or even deconstruct

*ASR crack pattern      Bridge in Quebec      Chambon dam repair*

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## ASR IN NUCLEAR STRUCTURES

- Few nuclear structures are already affected around the world : Gentilly-2 (Canada), Tihange-2 (Belgium), Seabrook (USA)
- More might be affected in the next years...



Gentilly-2

Tihange-2

Seabrook

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## NEEDS FOR R&D ON PATHOLOGIES

- Need to assess scale effect (gradients) or concrete confining effects (rebar, pre-stress)
- Little knowledge about coupling with other pathologies (corrosion, DEF, carbonation...)
- Difficulties to perform core sampling in NPP  $\Rightarrow$  need to assess NDE methods for detection and monitoring

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## ODOBA OBJECTIVES

- Understanding of phenomena involved in pathologies and their consequences at structural level with focus on :
  - scale effects (large structure)
  - coupling (e.g. ASR + DEF)
  - reinforcement / pre-stress
- Develop and validate predictive models
- Validate diagnosis and detection means (NDE)

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## ODOBA PROJECT PRINCIPLES

- Experimentation both at large and small scale
- Parametric experimentation exploring coupling between phenomena
- Realistic materials (aggregates, cement) and model materials (for comprehension)
- On-line instrumentation, periodic NDE and destructive examinations
- Accelerated aging process

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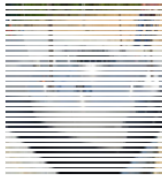
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## ODE EXPERIMENTAL PLATFORM

- 1,700 m<sup>2</sup> (18,000 ft<sup>2</sup>) platform
- Up to 60 large scale blocks - size : 2 x 1 x 4 m  
6 x 3 x 13 ft
- Station for water effluents management



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## EXPERIMENTAL BLOCK



- Temperature, humidity, strain...
- Non-Destructive Examinations (acoustic, resistivity...)
- Destructive examinations (core sampling)

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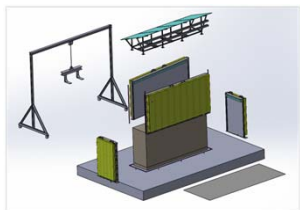
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### ACCELERATED AGING

- Aging protocols are need to achieve “long periods of operation” in reasonable time
- Humidification / drying cycles - heated (up to 40°C) + additive in water if needed




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### STATUS OF THE PROJECT

- During fall 2016, the first 5 blocks were casted
- 4 more were casted in 2017
- First results expected before the end of 2019



*ODOBA partners*



*ODE as today*

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### CONCLUSIONS

- At least 10 years of experimentation : 2016-2026
- Technical challenges:
  - develop and validate innovative NDE
  - define and qualify accelerated aging processes
  - modeling : multi-scale, multi-physic issue
- Support of French academic laboratories
- IRSN project within international partnership from Belgium, Canada, China, Finland and USA (NRC) and open to new partnership

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