BEHAVIOR AND ASSESSMENT OF MASSIVE STRUCTURES: AN OVERVIEW OF THE FRENCH RESEARCH PROGRAMS CEOS.fr AND VeRCoRs

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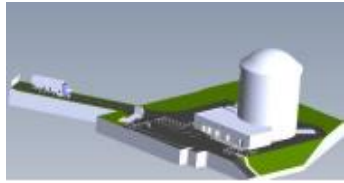
Short presentation

Full text : http://framcos.org/FraMCoS-9/Full-Papers/310.pdf

Objectives



VERCORS
Vérification réaliste du confinement des réacteurs

1. **Structural main functions :**
    1. Stability – strengthening capacity,
    2. But, for special structures, specific properties are required for reinforced concrete cracking, deformability, sustainability, water & air leak-tightness…
2. **However:**
    1. Standard rules (EC2, Model Code,…) do not fully address the case of massive elements :
        - thermo-Hydro-Mechanical (THM) effects, scale effects and structural effects induce specific response and preliminary cracking;
        - and, for massive slabs, walls and containment, shrinkage and creep are prevalent at an early and long-term age

To address these concerns, the French civil engineering community decided in 2008 to launch a national research project ***CEOS.fr****…… and, in the wake of CEOS.fr, in view of addressing aging issue for reactor concrete containment, EDF launch in 2013 the* ***VeRCorRs*** *program*

Objectives & Scientific contents

CEOS.fr means : *Comportement et Evaluation des Ouvrages Spéciaux vis à vis de la Fissuration et du Retrait* – Behavior and assessment of special structures with respect to cracking and shrinkage

1. Scientific objectives
    1. CEOS.fr intended to make a significant step in the engineering capabilities for predicting the expected crack pattern of special structures under anticipated in-service or extreme conditions.
2. Operational objectives
    1. To contribute to reference documents (*fib*, CEB)
    2. To propose evolution of standards (EC2)
    3. To conceive appropriate engineering tools
3. Scientific topics, cracking analyses:
    1. under monotonic load cases
    2. at early-age (T-H-M effects)
    3. for cyclic load cases
4. Implemented know-how
    1. Modeling (material, structure)
    2. Experimental approach and monitoring
    3. Engineering practices

Experiment – monitoring – modelling

large size beam and wall – various system of measure – great effort for modelling

CEOS.fr

RL

7 specimens + 6 at scale 1/3

9 specimens

RG

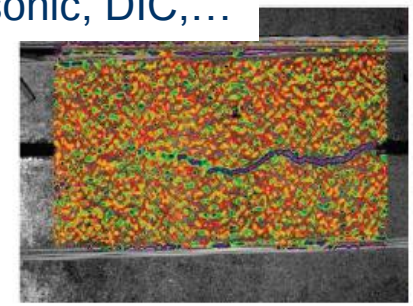
3 specimens

Results available on the CHEOPS database from the CEOS.fr website

Lvdt, gauges, optical fibers, ultrasonic, DIC,…

4 specimens at scale 1/3

SW



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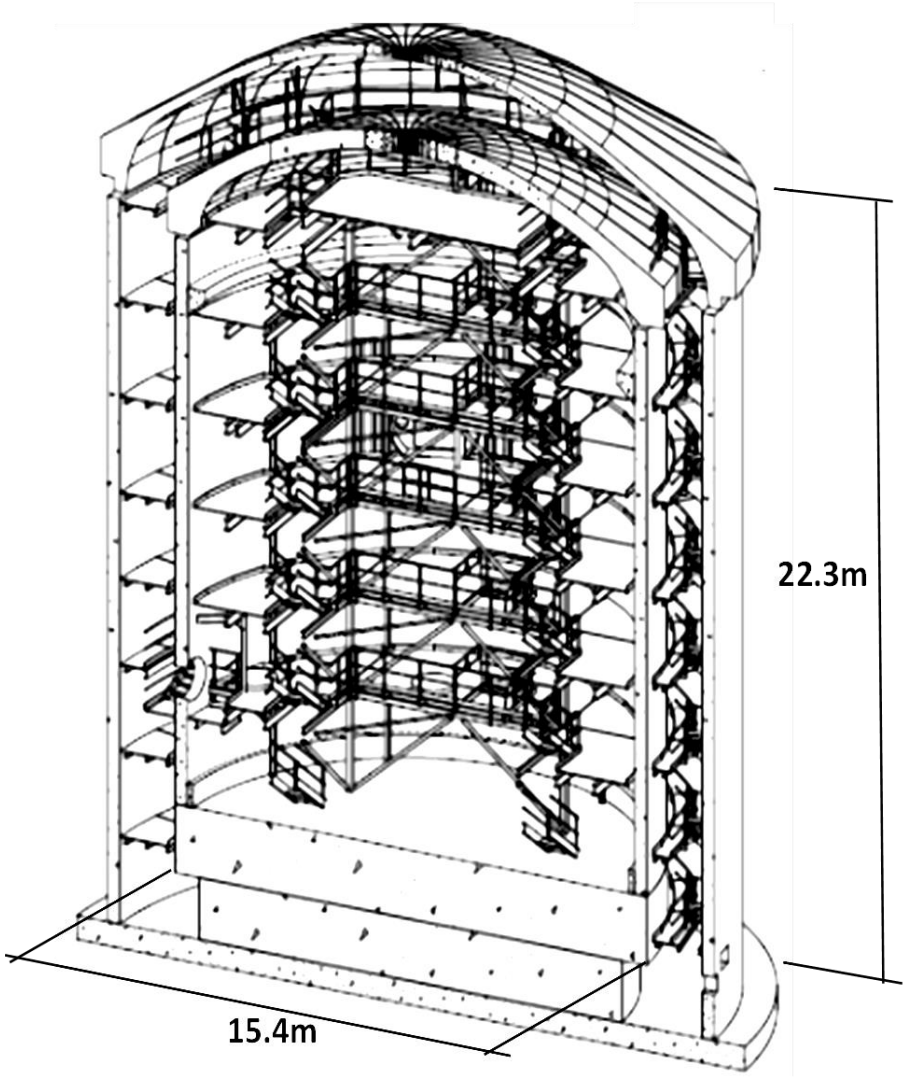
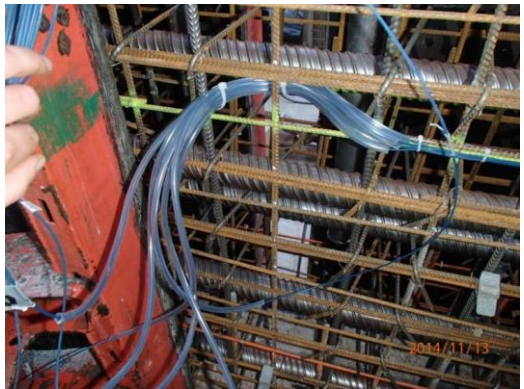
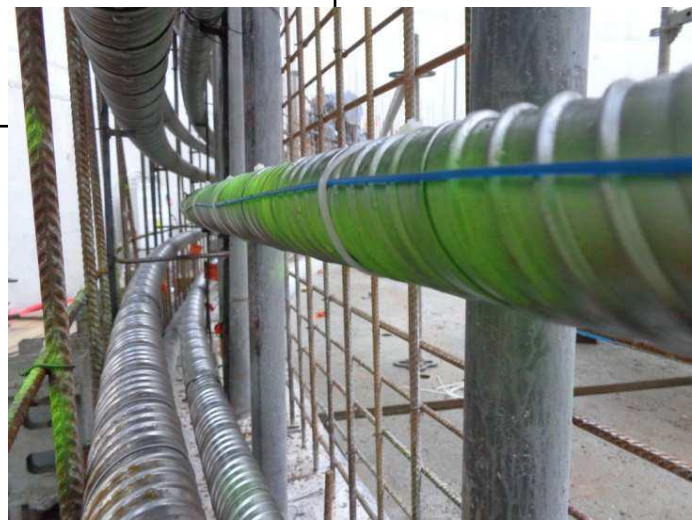


Monitoring systems
Which sensors ?

Temperature	> 200 PT100 probes	~ 30 thermocouples
Diameter variations	4 pendulums with 3 reading tables each	12 pendulums with 1 reading table each
Height variations	4 INVAR wires	4 INVAR wires
Strain	> 300 strain gauges 2 km of fiber optic	~ 50 strain gauges -
Prestressing	4 dynamometers	4 dynamometers
Steel bar strain	80 strain gauges	-
Water content	~ 20 TDR and 20 pulse sensors	





Research program and schedule

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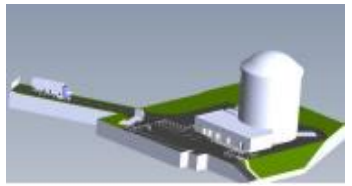


Benchmark 2015

Second test: leakage has increased, low creep

To see wether two identic tests drive to the same results or if there are damage phenomenons

Benchmark «accident»

Pré Op | VC1 | VD1 | VD2 | VD2bis | VD3 | VD4 | VD5 | AG | .....

2014 Construct. | 2016 | Exploitation | 2022

11-2015 | 01-2016 | 02-2017 | 03-2018 | 03-2018 | 04-2019 | 05-2020 | 06-2021 | 2021

First test: OK, all the real defects were seen, nothing ununderstandable

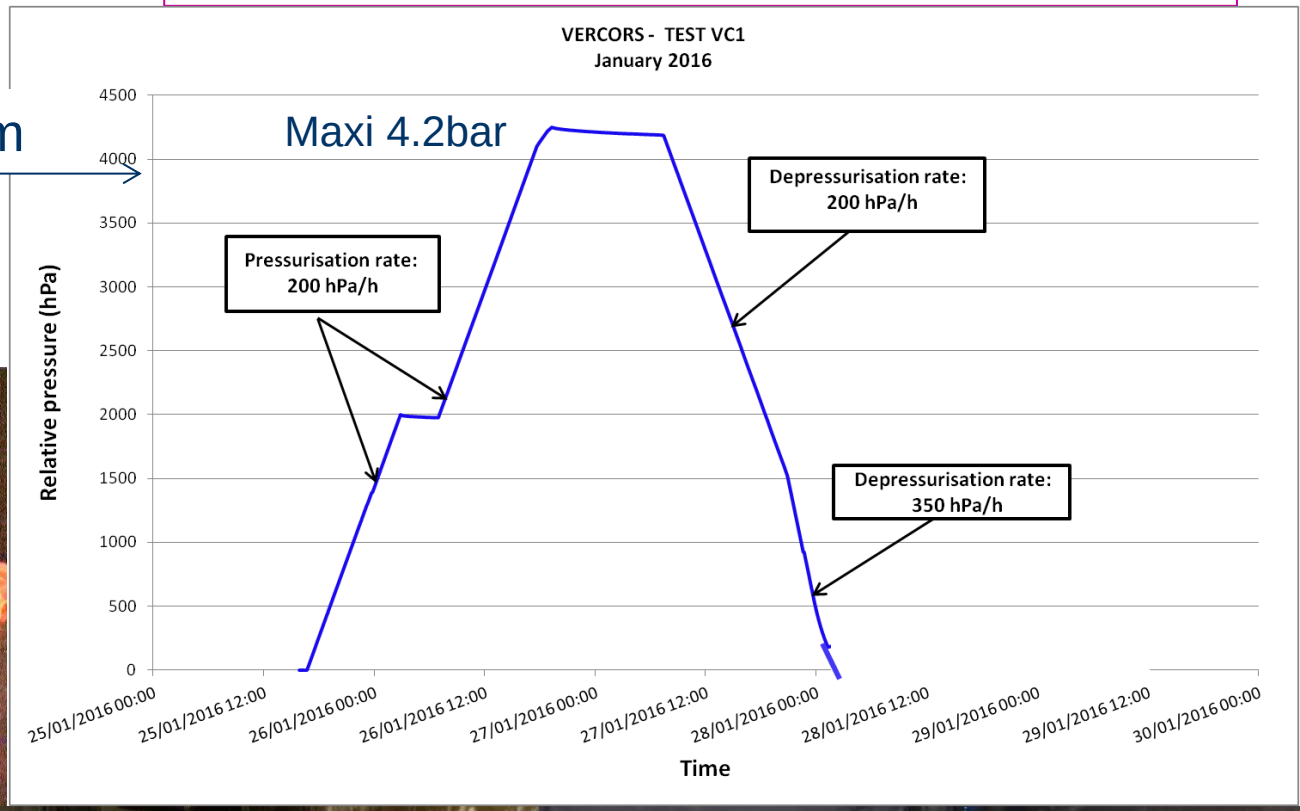
Benchmark « ageing »

Air steam test and loading maintained during a long time

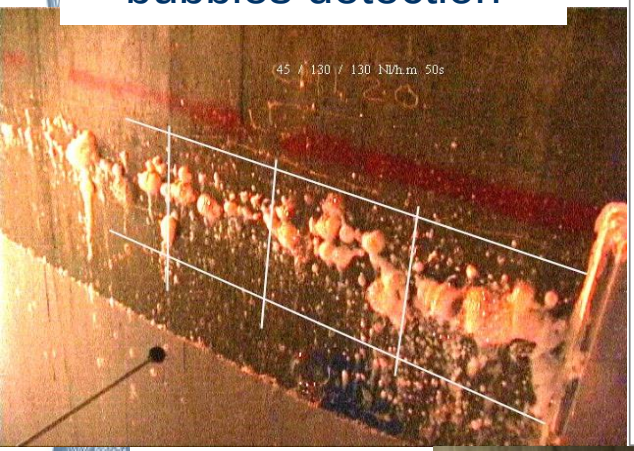
Details available on the Vercors website

Pressurization test

Pressure loading program



Soap aspersion, bubbles detection



Local leak collectors