LORCENIS

LOng Lasting Reinforced Concrete for ENergy Infrastructure under Severe Operating Conditions

What?

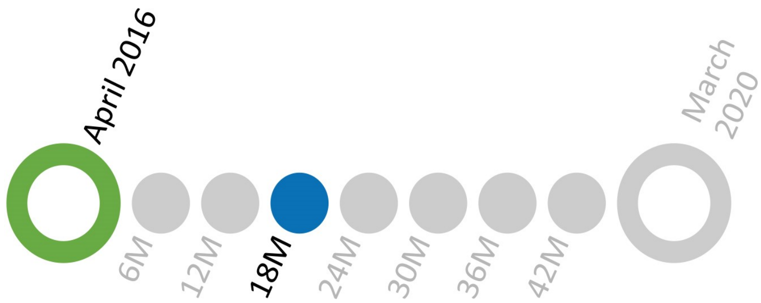
The main goal of the LORCENIS project is to develop long lasting reinforced concrete for energy infrastructures under severe operating conditions with lifetime extended up to a 100%.

Why?

As population is steadily growing, there will be an **increasing demand for energy** worldwide in the coming 30 years. New infrastructure projects for energy require long service life spans (up to 100 year), even under **extreme operating conditions** like acid attack, chloride attack etc. However, conventional concretes are not able to withstand these severe conditions, leading to **high maintenance costs** and even **failure** of the construction.

How?

1. development of multi-responsive **nano-materials** based on 4 technology groups (self-sensing, internal curing, self-sealing and self-healing)
2. incorporation of the nano-additives into the **concrete**, resulting in **tailored properties** and improved performance of the final bulk reinforced-concrete working under severe conditions.
3. development of advanced multi-scale (from atom- to macroscale) software for **modelling** and **end-of-life prediction** of the tailored reinforced concretes under the severe condition of chloride ingress.



Dissemination

The dissemination and exploitation plan will trigger the awareness of LORCENIS results towards potentially interested parties (industry groups, geographical markets, the academic community…).

Several tools will be used to successfully distribute the project results, the fundamental scientific, the technical knowledge and the developed technology: website, newsletters, poster, presentations….

Progress at M18

LORCENIS is gathering the major groups of project activities in 7 work packages.

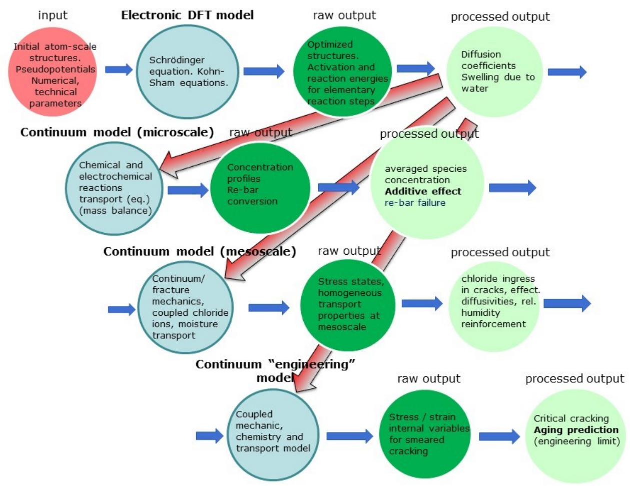
The project management (**WP1**) ensures efficient knowledge exchange between the partners, periodic status meetings including progress reporting.

During M1-M18, all **WP2** partners were optimizing the self-responsiveness approaches tailoring the nano-additive technologies with the desired admixture properties for compatible incorporation in concrete. The most promising nano-additive candidates were upscaled and delivered to WP3 partners for successful implementation to concrete bulk structures.

WP3 working on multifunctional bulk reinforced-concrete materials to operate under severe conditions, started with a comprehensive review of durability analyses and defined the requirements for the various exposure scenarios.

The design of several concrete mixes to be used in the various exposure conditions S1-S4 resulted in two top concrete technologies to be functionalised: Self Compacting Concrete (SCC) and Ultra High Performance Concrete (UHPC). Protocols for durability tests at lab scale were defined with a standard Ready Mix Concrete (RMC) mix design used for reference.

The work in **WP4** is focusing on the development of advanced software for modelling and end-of-life prediction by linking simulation approaches to launch a precise forecast model of damage development in-line with experimental validation action.



Activities were carried out aiming at transferring LORCENIS metadata structure in agreement with the EMMC (European Materials Modelling

Council) regarding the relevant parameters for modelling transport of aggressive ions (chlorides) in bulk concrete. Selected software components will be followed within the framework of AEST (Advanced Engineering Software Tool) and a multiscale predictive modelling workflow (MODA tables) for the selected reference material was completed. Currently, all WP4 partners are working on their models along the multiscale strategy.

WP5 started a survey on demonstrator design, building, testing and monitoring covering prototypes for each scenario identified in WP3 and each self-responsive technology developed in WP2.

In **WP6**, data acquisition for the Safe-by-Design (SbD) principles resulted in a decision tree (work flow) based on controlling hazards, considering European legislation. The defined methodology for LCA included inventory from all basic components of concrete and the newly developed admixtures.

The awareness and dissemination plan, the first version of the data management plan (DMP) and the plan for the Exploitation and Dissemination of Results (PEDR) have been prepared in **WP7** and will be periodically updated. At the external website, the biannual LORCENIS Newsletters are published. The Advisory Board (AB) with invited experts on energy sector infrastructures joined LORCENIS at M18.

Expected final results and potential impacts

LORCENIS will add value to the European manufacturing sector on reinforced concrete energy infrastructure through adaptation to global competitiveness pressure by improving the technological base.

The well-targeted project consortium with representatives along the value chain (product manufacturers, tool developers, energy infrastructure contractor and operators) will approach new business developments according to market needs, expected market up-take and standardization, safety and environmental requirements and needs tackled.

The **scaling-up** protocols of various optimized nano-additives capable of providing self-responsive ability compatible with the concrete matrix will be beneficial for the construction industry. The ambition is to withstand extreme operating conditions achieving 100% of crack healing through the incorporation of the ideal dosage of each nanomaterial with improved stability, mechanical properties, quicker self-healing activity and competitive production costs. The overall potential is very high since LORCENIS will offer a route to precisely engineer concrete for specific applications, **reducing costs** and **increasing performance**.

Developing cement and concrete related nanotechnology have a sustained and important impact on the future of the construction industry enabling entirely new applications for concrete.

Tools for automatic differentiation (AEST) will significantly decreasing the workload when investigating the most detrimental phenomena concerning concrete structures: chloride ingress. Predictive **modelling** and the ability to handle in-service performance is an essential part of the EMMC roadmap and a vision topic of digital European future. All findings in LORCENIS will have a huge impact on the durability of energy and transport infrastructures: costs will be saved already in the design phase by simulating the behaviour of materials with different admixtures in a given environment.

LORCENIS aims to overcome any **risks** originating from missing knowledge or regulations and uncertainties relating to health and environmental issues. A risk assessment tool will serve to reduce potential risks from particulate nanomaterials by safe manufacturing, handling and control of exposure; specific best practice guides will be proposed. **Life cycle (cost) analyses** (LCA, LCC) will gain a new level of quality subsequently lowering service life expenses achieving a substantial "economical" modelling impact.

Contact

Project leader: Christian Simon

Email: Christian.R.Simon@sintef.no

Phone: +47 93811275

This project has received funding from the European Union's Horizon 2020 research and innovation programme under GA No. 685445