LORCENIS - Newsletter 12M

LORCENIS

LOng Lasting Reinforced Concrete for ENergy Infrastructure under Severe Operating Conditions

What?

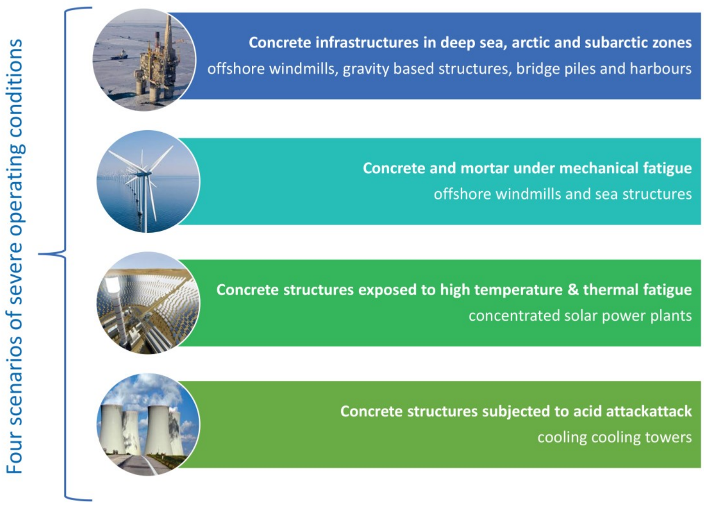
The main goal of the LORCENIS project is to develop long lasting reinforced concrete for energy infrastructures under severe operating conditions with lifetime extended up to a 100%.

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.
4. **prototypes** will be designed, built, tested and monitored under severe operating conditions
5. assessment of **environmental impacts**, **costs** from cradle to grave and **risks** based on Safe-by-Design principles.



Dissemination

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

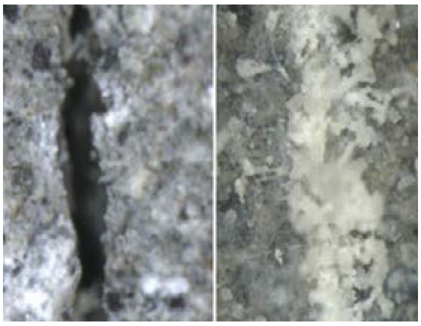
Several tools will be used to successfully distribute the project results, the fundamental scientific, the technical knowledge and the developed technology: website, newsletters, poster, presentations….

Strategic project structure

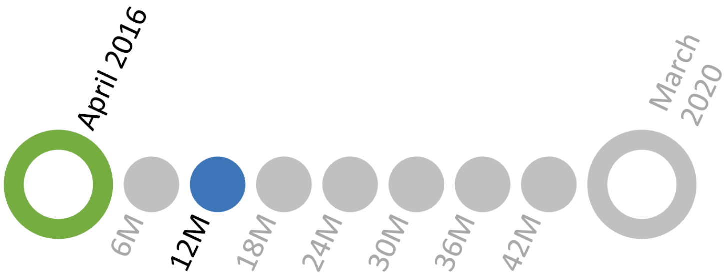
The 7 work packages (**WPs**) of LORCENIS constitute the main work breakdown structure of the project, gathering together the major groups of activities to be carried out.

The project management in **WP1** is providing the project with an efficient management, facilitating and monitoring the partners' cooperation to ensure a successful progress of the project and the communication with the EC.

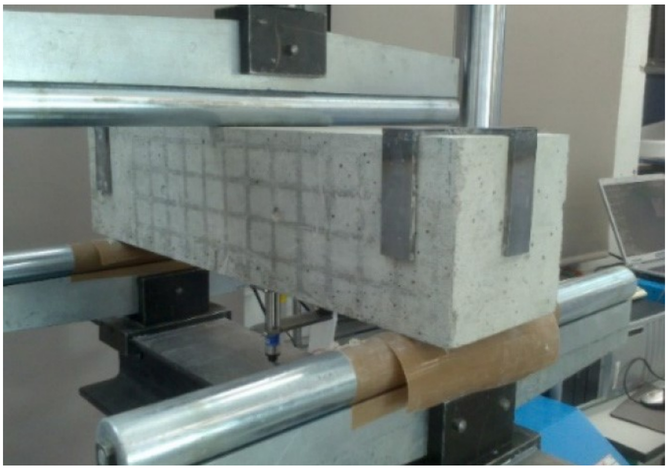
WP2 is providing multifunctional nanostructured materials with self-responsiveness ability to the project. The nano-additives will be incorporated into the concrete formulations, resulting in tailored properties and improved performance of the final bulk reinforced-concrete working under severe conditions. The main objective is to develop multi-responsive materials based on 4 technology groups (self-curing, self-diagnosis, self-healing and self-protection) with the appropriate surface chemistry in order to modify cement reactions, create new surface chemistries and create novel products with added functionality for the concrete industry.



The aim of the **WP3** is to identify the environmental parameters for severe operating conditions related to each concrete for the different energy constructions addressed and to define critical requirements for



added value functionalities capable to extent service life of concrete energy infrastructures. WP3 will deal with the design of tailored reinforced concrete

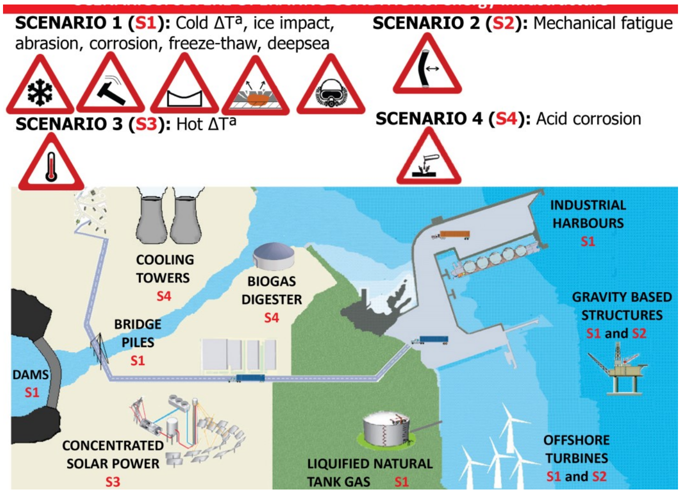


formulations stable in harsh environmental conditions. Three main aspects will be taken into consideration: application technology, performance and sustainability. The advanced functional solutions derived from WP2 will be incorporated in the production of the bulk technological products following requirements for the implementation of the stable functional admixtures. Understanding of fundamental performance of functionalised concretes under simulated aggressive environments will deliver input to WP4 and WP6 and give the requirements for scaling-up of the functionalised concretes in WP5. Attention will be paid on possible failure during mixing and formulation and on degradation of admixtures. Tests will be developed for assessing the new properties as well as standard tests will be applied.

WP4 is focusing on the development of advanced software for modelling and end-of-life prediction by linking simulation approaches in order to launch a precise forecast model of damage development in-line with the experimental validation action. In LORCENIS, a multi-scale showcase (for Scenario S1: Corrosion) will be realized towards service-life prediction of reinforced concretes in severe environments.

WP5 will design, build, test and monitor prototypes made of universal smart solutions of durable concrete for energy infrastructure under severe operating conditions.

Only the winning combinations of base bulk concretes, SCC or UHPC, and admixtures (those developed in WP2 and tested in WP3) will be used to build the demonstrators, at least one per scenario.



WP5 sets the basis for the sensing and monitoring of demonstrators submitted to severe operating conditions and will design the relevant environmental conditions set-up where the demonstrators will be mixed, placed, monitored and analyzed.

Those set-ups will be based on accelerated tests to reproduce the field conditions. Finally, a preliminary cost-benefit analysis will be done to feed WP6.

WP6 aims at assessing environmental impacts and costs from cradle to grave for designing cost effective solutions. With special focus on the admixtures' positive effect on longer service life and focus on avoiding new high environmental impact or costs from introduced admixtures. To make risk assessment for introduced admixtures and give guidelines how to minimize risks in their product cycles including transfer of experiences by Safe-by-Design (SbD) principles.

The main objective of **WP7** is to ensure the successful dissemination and exploitation of the project results, of the fundamental scientific and technical knowledge, and of the developed technology.

This will be realized through the implementation and deployment of and awareness and dissemination plan and an exploitation plan including dedicated business models and the appropriated IPR management for the new technologies.

Progress at M12

Within **WP1**, an internal website (eRoom) was created for LORCENIS partners with detailed information on the project. It is only accessible for the project partners. A homepage address for public access was created (www.lorcenis-eu.com). The 6M meeting was held on 19.-20. September 2016 in Madrid. The 12M meeting was held on 22.-23. March 2017 in Athens.

During M1-M12, all **WP2** partners were involved in the synthesis, characterization, evaluation of the performance and optimization of each self-responsiveness approach tailoring the nano-additive technology with the desired admixture properties for incorporation into concrete. This is considered to be a critical step to overcome before those promising technologies can be transferred to WP3 to be used in mix designs of concrete for reinforced structures. Promising nano-additive candidates with the required properties will be upscaled in the forthcoming months and delivered to WP3 partners for production of modified concrete bulk structures. The joint efforts from WP2 and WP3 partners ensured this knowledge and material transfer during the last months.

A comprehensive review of durability analyses and requirements for the various exposure scenarios in **WP3** was released in M6. This was based on common state-of-the-art knowledge or best-in-use-practice and the experience of the most relevant partners involved from different industries. The design of several concrete mixes to be used in the various exposure conditions S1-S4 was already initiated in M3 involving several small sub-groups of partners with appropriate skills. Two top concrete technologies were decided to functionalise: Self Compacted Concrete (SCC) as internal structural bulk material and Ultra High Performance Concrete (UHPC) as external bulk material and hybrid of both.

Now at M12, all mix designs based on bulk SCC and UHPC that can withstand the severe scenario requirements, are finalized. A standard Ready Mix Concrete (RMC) mix design will be used for reference in all test series.

The work in **WP4** was focusing on exchange of information about computational infrastructures (software, tools) and experience in data-sharing based on following activities carried out aiming at transferring LORCENIS metadata structure according to EMMC community agreement established at M12:

- Performing a state-of-the-art literature review regarding the relevant parameters for modelling transport of aggressive ions (chlorides) in bulk concrete and defining a test matrix system.
- Concluding the approach and choice of tools and software components and developing a tailored automatic differentiation software component that will be followed within the framework of AEST (Advanced Engineering Software Tool).
- Setting up and completing a multiscale predictive modelling workflow (MODA tables) for the selected reference material.
- Establishing a software interaction platform SOFT5 for testing on a 64bit Linux workstation. All installation bugs were reported and necessary actions were taken. Digital description of metadata for continuum corrosion model is in progress.
- High performance computing infrastructure is established for running server based simulations. A simulation server was setup for COMSOL 5.2.
- Finalising the atom-scale descriptions of concrete paste at an atomistic scale.
- Ongoing efforts to adapt continuum corrosion model for the selected reference material. Attempts to perform 3D tomography of HPC material are in progress. Close collaboration is established between partners.

WP5 had no activities in the reporting period at M12. Activities are planned to start at M18.

In **WP6**, data acquisition methods for the Safe-by-Design (SbD) principles and LCA inventory were performed during the first six months. The workflow for SbD resulted in a decision tree involving the implementation of a control/hazard banding approach based on a survey considering currently available European legislation. The defined methodology for LCA included basic components of concrete such as aggregate, cement and mineral additions as well as data from the newly developed admixtures.

Within **WP7**, the external website (www.lorcenis-eu.com) has been placed online and is accessible by the public since the end of M2. Here, also the 1st LORCENIS Newsletter reporting the project progress at M6 can be downloaded. A poster/leaflet showing the basic features of the project has been filed. Furthermore, an awareness and dissemination plan to list the finished and planned dissemination activities as well as the first version of the data management plan (DMP) have been prepared and submitted at M6. First presentations of the LORCENIS project involving a short description of the main challenges have been hold at national fora in Spain and in Germany. Several scientific LORCENIS abstracts for conferences have been reported by M12. This is also defined in the plan for the Exploitation and Dissemination of Results (PEDR) that document exploitable project results and possible actions of exploitation will be periodically updated. The Advisory Board (AB) with invited experts on the requirements and challenges attributed with energy sector infrastructures is appointed and the first AB meeting is envisaged at M18.

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