

ConLoT

Long-term testing of the durability of concrete at final disposal conditions

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Final repository at the depth of 50-100 m

Final repository for operating waste (VLJ)

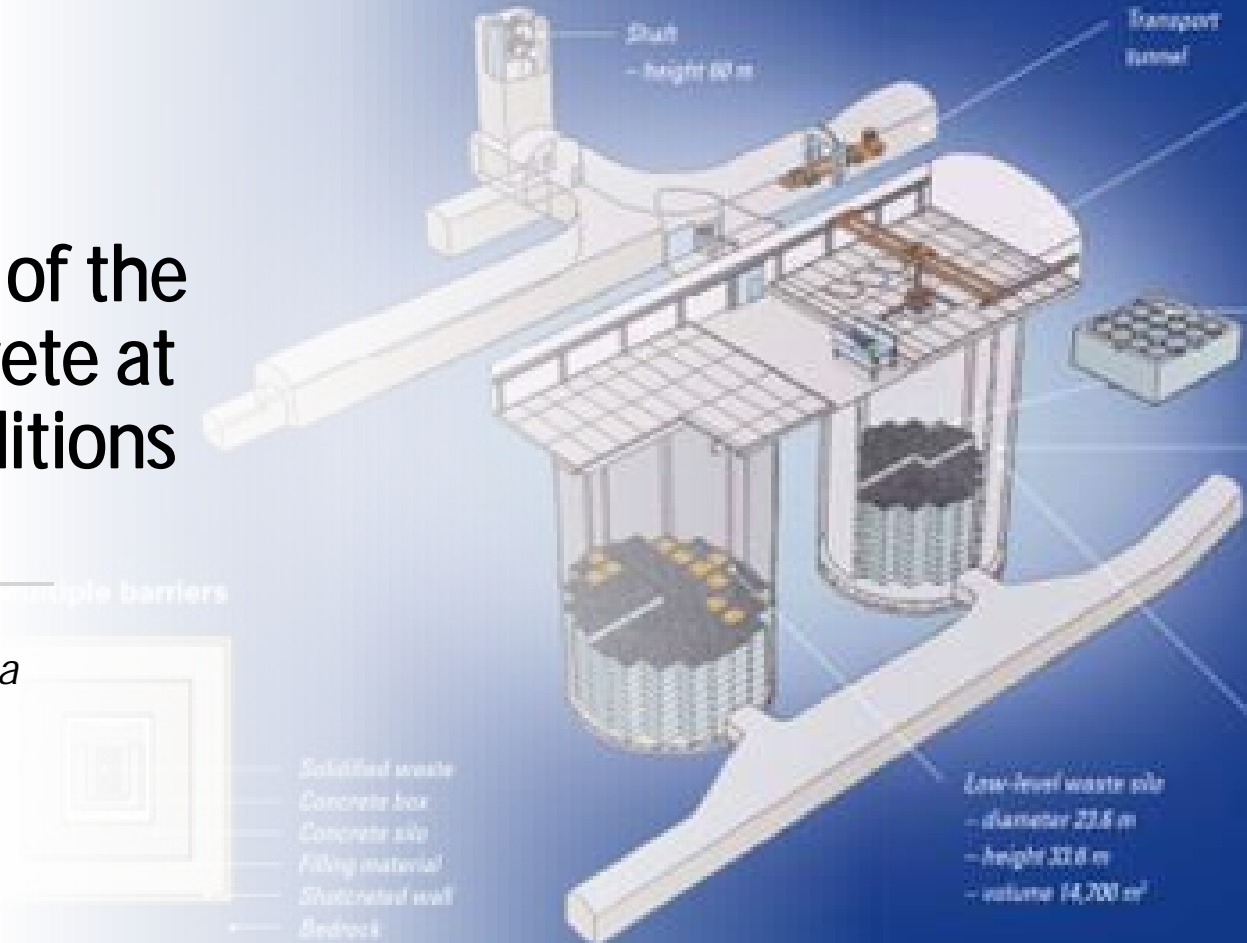
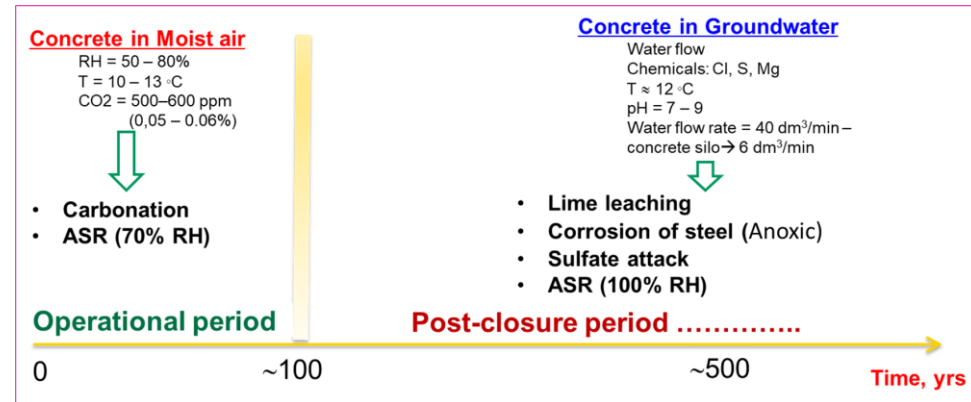


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3. Summary

Project background

- The project was designed to investigate the long-term behavior of reinforced concrete structures under disposal conditions
- Factors affecting long-term durability:
 - i. the environment (aggressiveness of the ground water and carbon dioxide content in air),
 - ii. the concrete quality (constituents, mix design, characteristics, etc.), and
 - iii. the interaction between these two over time.



Task 1.1 – Identification of concrete structure behaviour in repository conditions

The literature review identifies:

- The timescale for concrete in the LILW repositories.
- The factors affecting the durability of concrete used in LILW repositories
 - Environmental condition (humidity, temperature, CO₂).
 - Microstructure of concrete.
 - Chemical ions such as chloride, sulfate and magnesium.
- The common degradation mechanisms of concrete in the LILW repository condition.
- The influence of cracks on the durability of concrete structures.



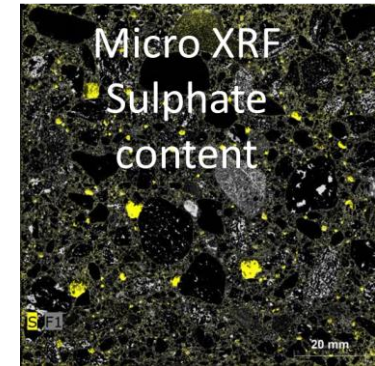
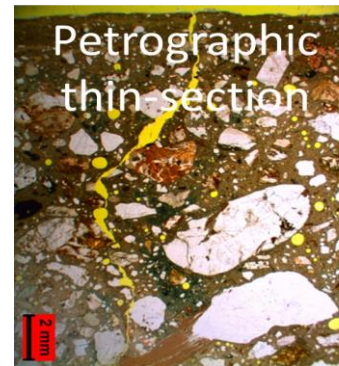
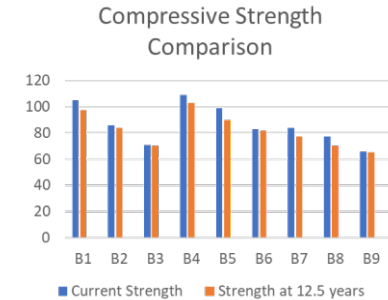
Task 2.1 – Long-term field exposure and concrete durability testing

The goal of this research was:

- To determine and evaluate the environmental effects on different concrete specimens stored in an environment that simulates LILW repositories for 25 years.

The results show that:

- The compressive strength and MoE were relatively high.
- A mesh-like micro cracking was detected in the petrographic thin-section analysis.
- The chloride content in specimens stored in groundwater was very low, and no corrosion risks were expected in that scenario.
- The pattern of the sulfate and magnesium content with the depth is sporadic.



Task 2.2 – Long-term laboratory testing of concrete durability

Testing program started 2012.

Testing methods /2022/ include:

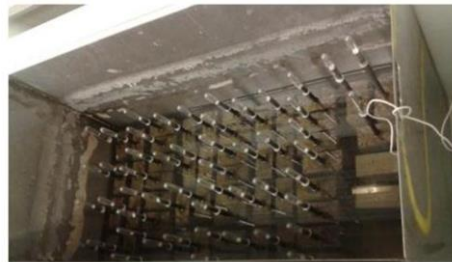
- Electrochemical measurement of steel rebar corrosion
- Visual inspection of the corrosion state
- Carbonation depth measurement

The results show:

- No carbonation
- Pitting corrosion due to the bleeding of concrete
- The corrosion potential results after 10 years agree with the visual inspection of the corrosion status

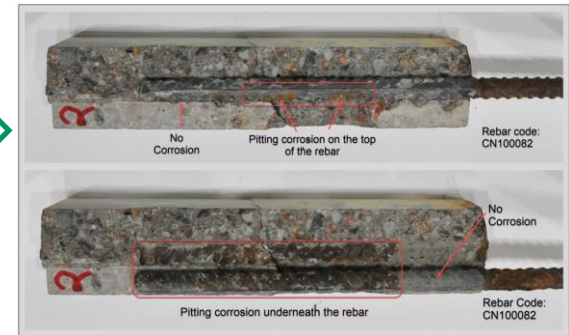


6 steel types x 8 specimens were cast for each steel type, resulting in a total of 48 test specimens



Specimens were stored in:

- 25% NaCl solution
- solution temperature was set to +11° C



ConLoT – Summary

Literature review – Common degradation mechanisms of concrete:

- Carbonation induced corrosion
- Corrosion of reinforcement in oxic and anoxic environment
- Alkali Silica Reaction
- Leaching of concrete
- Sulphate attack (Ettringite, DEF, Thaumasite)

Long-term field tests

- Low chloride content after 25 years in underground water
- Sporadic sulphate and magnesium pattern

Laboratory testing

- No carbonation after 10 years in sodium chloride solution (10° C)
- Pitting corrosion of reinforcement after 10 years

ConLoT – Publications

Aalto University
School of Engineering
Civil Engineering Department

Deliverable 1.1
Comprehensive state-of-the-art report for long-term behaviour of concrete structures in low and intermediate level radioactive waste (LILW) repository environment

Fahim Al-Neshawy and Jouni Punkki




A! SCIENCE + TECHNOLOGY REPORT

Aalto University
School of Engineering
Civil Engineering Department

Deliverable 2.2
A laboratory study of long-term corrosion behaviour of reinforcing steel in concrete exposed to chloride environment

Fahim Al-Neshawy, Abobaker Ba Ragaa and Jouni Punkki



A! SCIENCE + TECHNOLOGY REPORT

A! Aalto-yliopisto
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Master's Programme in Building Technology

Long-term durability testing of concrete in LILW repositories

Subtitle

Abobaker Ba Ragaa

Master's Thesis
2022