Critical Studies in support of the Ageing Management of NPP Concrete Infrastructure – CONAGE

KYT2022-SAFIR2022 FINAL Seminar

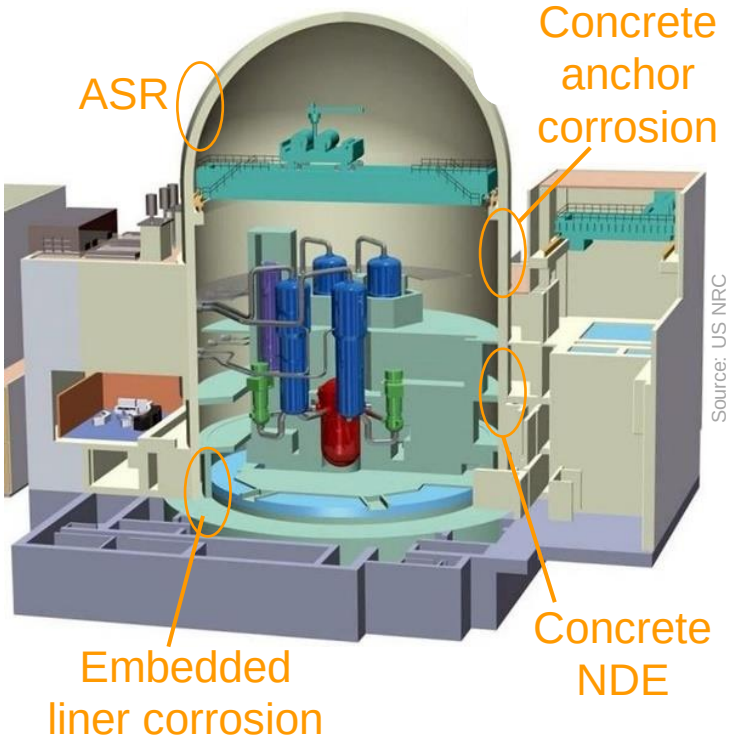
Miguel Ferreira[1], Fahim Al-Neshawy[2], Elina Huttunen-Saarivirta[1], Edgar Bohner[1], Pirkko Kekäläinen[1], Esko Sistonen[2], Abobaker Ba Ragaa[2]

[1] VTT, [2] Aalto University

23.1.2023

What is the challenge?

- Research on **ageing phenomena** of **concrete structures**, systems and components, important to safety for long-term operations (LTO) of NPPs
- Develop **operational practices** to support safe LTO of existing NPPs
- **Knowledge development** of **NDE methods** for NPP concrete, and **tools** for accurate assessment of remnant service
- International **cooperation**, **education** and **training**



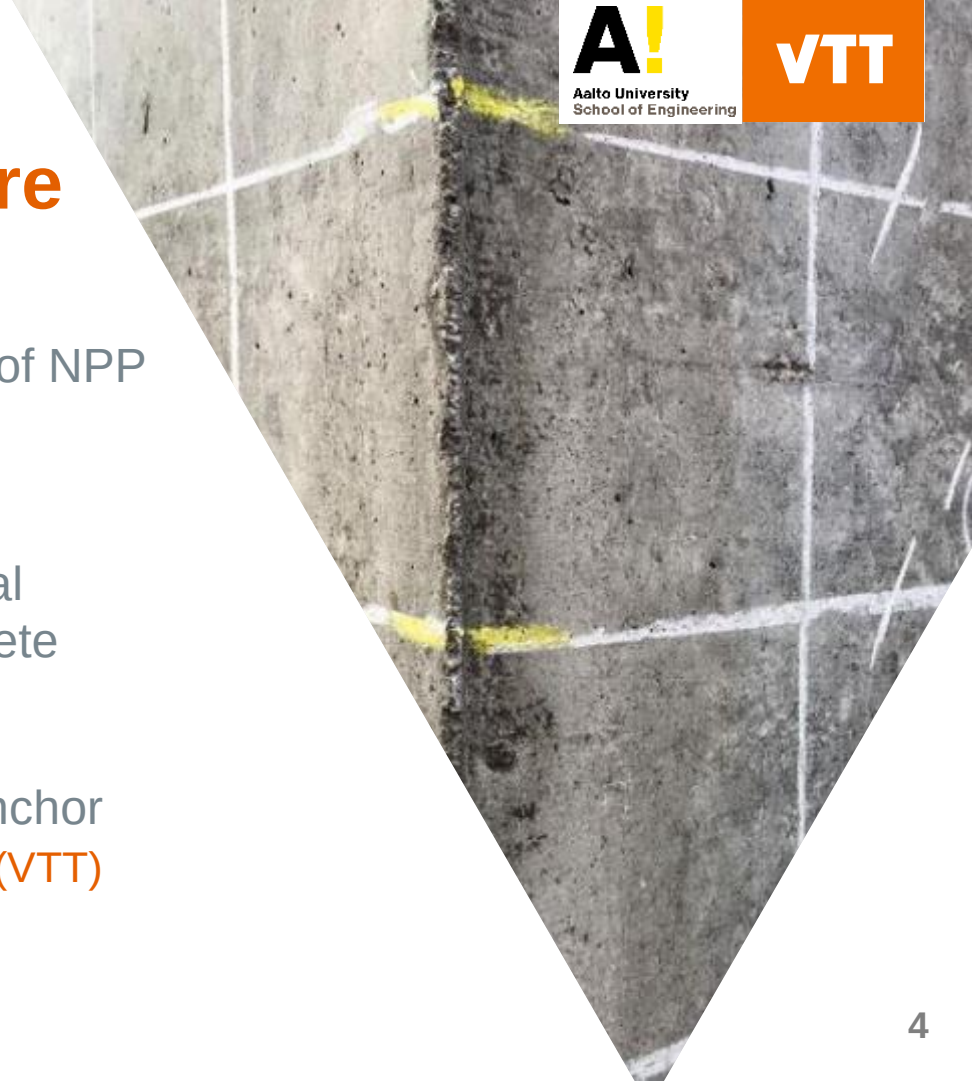
CONAGE - Critical Studies in support of the Ageing Management of NPP Concrete Infrastructure

Raise the level of concrete infrastructure related NDE research, address key ageing mechanisms identified by both Finnish and foreign utilities and regulators, and update ageing management practices of Finnish NPP concrete infrastructures

- Duration: **4 years** (February 2019 – January 2023)
- Budget: 439.6 k€ (for first three years)
- Partners: **VTT Technical Research Centre of Finland** and **Aalto University – Department of Civil Engineering**

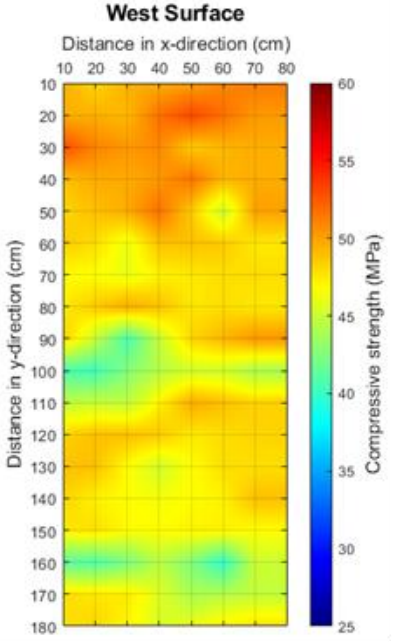
Work Package structure

- WP1 – Non-destructive evaluation of NPP concrete infrastructure –
  Fahim Al-Neshawy (Aalto University)
- WP2 – Assessing the risk of internal expansive reactions for NPP concrete infrastructure – Miguel Ferreira (VTT)
- WP3 – Assessing steel liner and anchor corrosion – Elina Huttunen-Saarivirta (VTT)

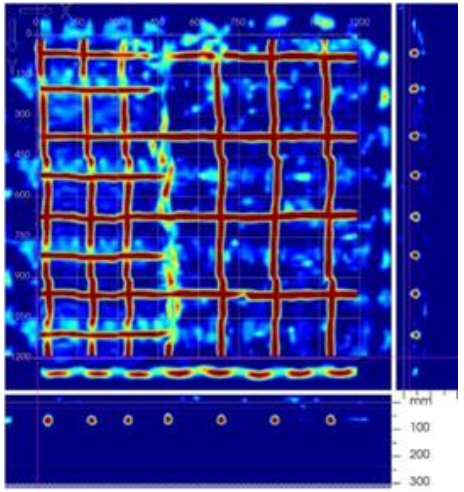


Main findings for WP1

- NDT of thick-walled structures continues to challenge the industry. Basic and advanced Non-Destructive Testing (NDT) testing methods were used to evaluate the characteristic properties of the reinforced concrete and identify/quantify sub-surface defects.
- Research shows that the combination of several NDT techniques can mutually strengthen individual assessment, however, the diagnosis of the results requires additional expertise to interpret NDT combined measurements.



Compressive strength values by combining the results of the UPV and rebound hammer measurements



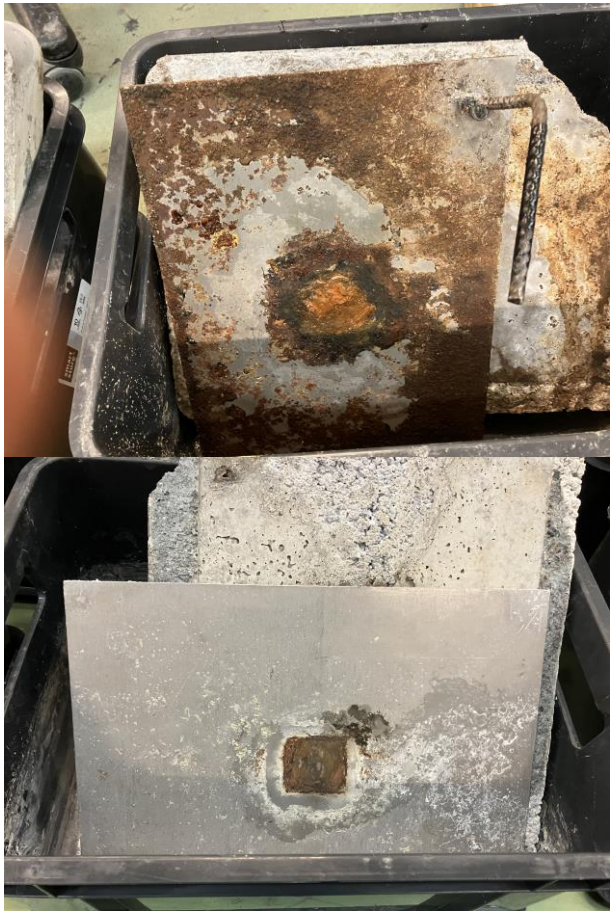
Results of GPR scans

Main findings for WP2

- When identifying critical areas of NPP SSCs where ASR has the possibility to occur, based on concrete compositions and exposure conditions, results show that a large part of the concrete infrastructure show medium to high potential of ASR occurrence, if aggregate were to be reactive (due to high alkali content and high relative humidity).
- Extensive testing of aggregates reactiveness used in construction of Finnish NPPs has contributed significantly to our increasing understanding of Finnish aggregate performance.
- Research results shows that the same aggregate may be evaluated either unlikely to be reactive or potentially reactive based on the test method. The concrete tests RILEM AAR3 and RILEM AAR4 are considered more reliable than the mortar bar test RILEM AAR2.
- The aggregate size fraction may contain fragments of different reactivity.

Main findings for WP3 - Steel liner corrosion

- The study of liner corrosion concluded that: 1) in the used experimental set-up, the presence of the delamination gap did not significantly change the corrosion behaviour of the steel liner in comparison to the corresponding flat surface of a normal concrete; and,
- 2) the loss of passivity explains the corrosion of steel liner embedded in concrete and enables an active corrosion cell to be developed over long periods of time. This was observed both in the case of low-pH concrete and in the presence of the foreign matter: piece of wood.



Main findings for WP3 – Anchor corrosion

- For the study of anchor corrosion, the studied variables of post-installed anchors were corrosion type, steel grade, anchor type and testing exposure.
- Research results show that the type of the anchor and material affect the corrosion based on the accelerated tests conducted.
- Corrosion risk varied from low (stainless steel) to severe (carbon steel).
- Failure mechanisms were dependant of the amount of corrosion occurring in the anchors

Experimental research on corrosion of post-installed steel anchors including:

(i) Preparing the test specimens,

(ii) Wetting and drying for one year and

(iii) Electrochemical and visual assessment of the corrosion state of the steel.

VTT

beyond

the obvious

Miguel Ferreira
miguel.ferreira@vtt.fi
+358 458 724 977

www.vtt.fi