INDUSTRIAL PHD PROJECT

BOND IN ASR-DAMAGED SLABS AND SHELLS WITHOUT SHEAR REINFORCEMENT

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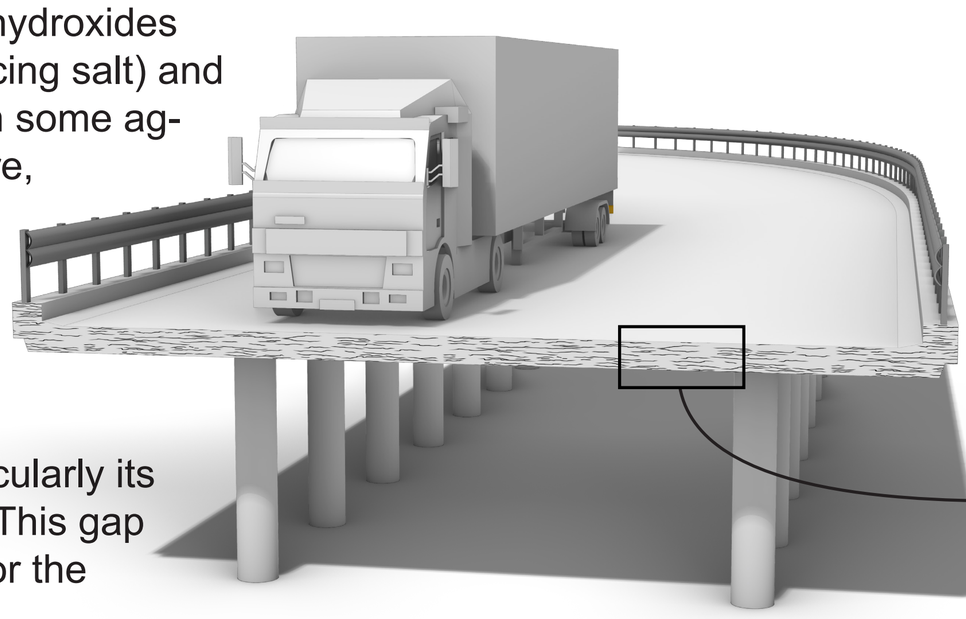
INTRODUCTION

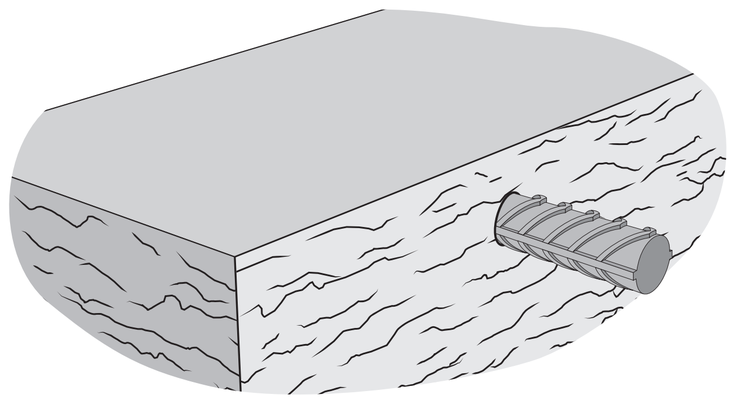
Alkali-Silica Reaction (ASR) is a harmful chemical reaction that can appear in concrete involving alkali hydroxides from the concrete pore solution (or e.g. de-icing salt) and certain reactive forms of silica present within some aggregate particles. In the presence of moisture, the reaction causes expansion, cracking, and deterioration of the concrete. In Denmark alone, **more than 600 bridges** are at risk of developing ASR-damage.

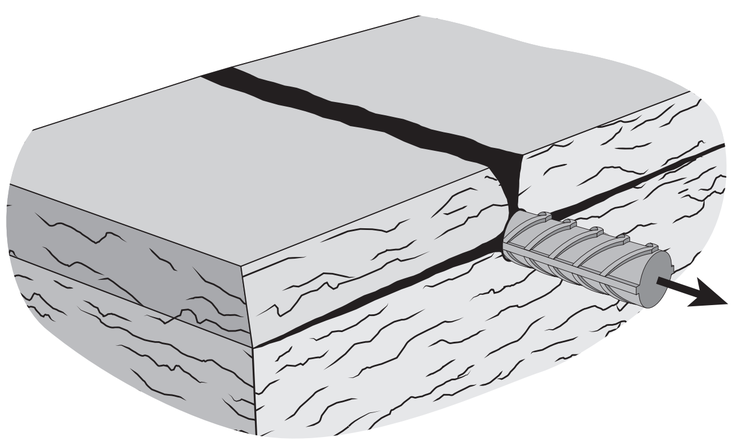


(Barbosa, 2017)

Despite significant research into ASR, understanding its structural implications - particularly its **effect on bond strength** - remains limited. This gap in knowledge poses significant challenges for the evaluation of existing structures.

BOND STRENGTH IN ASR-DAMAGED CONCRETE





- The bond mechanism in reinforced concrete is complex, regardless of ASR.
- In structures such as slabs and shells without shear reinforcement, where longitudinal reinforcement is not enclosed by stirrups, **the bond strength** between the reinforcement and concrete depends mainly on the material properties of the concrete, particularly its **tensile strength,** f_t.
- ASR reduces the material properties, particularly the tensile strength, f_t, and alters characteristics such as **inhomogeneity and anisotropy**.
- Few studies have investigated bond in ASR-damaged concrete and current design guidelines (e.g. fib Model Code 2020) are based on a small number of studies from the 1990s.
- Different restraints during the ASR-induced expansion from external forces and reinforcement affect the distinctive crack pattern of ASR. In the literature, **no experiments are found** which represent ASR-damaged slabs and shells without shear reinforcement.
- It is hypothesized that bond in ASR-damaged slabs and shells without shear reinforcement represents **a worst-case scenario, which has yet to be investigated**.

AIM

The project's aims are two-fold:

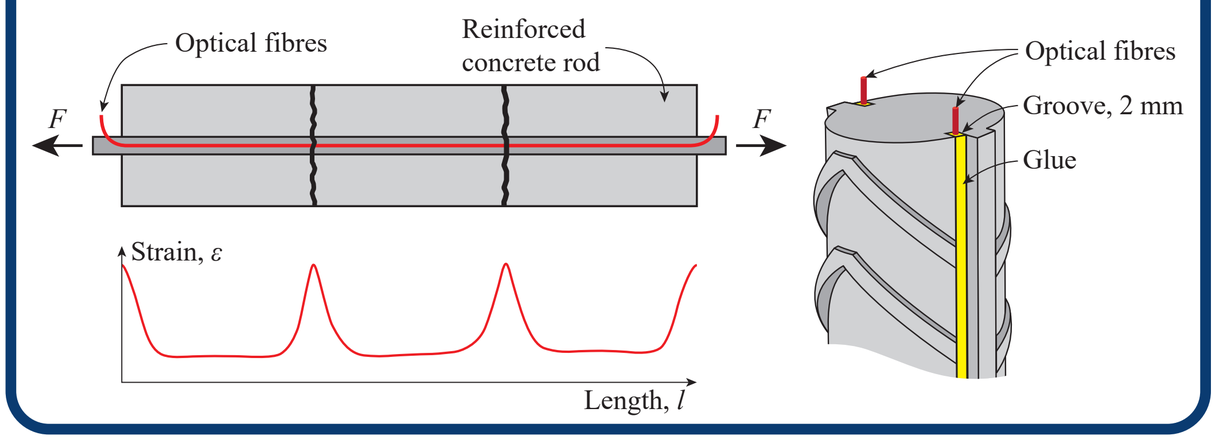
1. Firstly, the aim is to **establish experimental evidence** of the bond performance in ASR-damaged concrete slabs and shells without shear reinforcement, including an investigation of the influence of key design parameters for bond, anchorage, and lap strength.
2. Secondly, the aim is to **develop a model for determining the residual bond, anchorage, and lap strength** in these structures.
   - To ensure its practical applicability, the model will be based on strength parameters obtained from testing drilled concrete cores.
   - To ensure broad applicability beyond the empirical basis, the model will be analytically derived. The derivation will be based on observations from the experimental campaign

APPROACH

- Literature study
- Experimental investigation*
- Development of relevant analytical models

*The project will utilise state-of-the-art measurement equipment in the experimental investigation such as **Digital Image Correlation (DIC)** and **Fibre Optical Sensing (FOS)**

Fibre Optical Sensing (FOS)



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