Towards the understanding of concrete abrasion in hydraulic structures

Long-term abrasion of concrete in hydraulic structures leading to damages and consequently the shortened service life has been frequently reported, i.e. mainly caused by water-born silt, sand, gravel, rocks and other debris. However, neither testing methods nor mathematical models which could adequately reflect the abrasion phenomena observed in field exist. This poses a great challenge in designing a structure with a service life requirement of 100 years or more.

This project aims to develop a practical design guidance regarding concrete abrasion for hydraulic structures from a long-term durability perspective, which is urgently needed in the design community. With this being said, a central task is to establish the relation between the actual abrasion rate and the relevant parameters, including hydraulic parameters (e.g. flow velocity, sediments content) and concrete properties (e.g. strength, composition). Once the abrasion rate is known, the service life of the structure can be designed with high confidence. More specifically, the main objectives include:

1. Develop a testing method which can adequately simulate field conditions for concrete abrasion. In addition, the method should be practical enough for use in normal concrete labs. Existing methods could only evaluate qualitatively the performance of concrete exposed to abrasion damage. The link between laboratory results and field behavior in hydraulic structures is missing.
2. Investigate the mechanisms behind abrasion induced concrete damage and identify the governing parameters. It is noted that many parameters have been reported having some effects, while the fundamentals behind are not revealed. Fundamental questions, e.g. why and how abrasion damage takes place, will be answered.
3. Quantity the effects of the (governing) parameters on abrasion. More than often, only qualitative results are reported in literature.
4. Establish a mathematical model which can effectively predict the abrasion rate in field.

The project will be combined experimental and modeling studies. By performing this work, we expect that important fundamentals behind concrete abrasion in hydraulic structures will be revealed. Further, a reliable testing method yet practicable enough for laboratory use will be developed. A mathematical model which can adequately predict abrasion damage will be established. The outcome of the project will form useful guidance in designing durable hydraulic structures concerning abrasion damage.