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## Effects of swelling rock and swelling clay in water tunnels

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## Background

The motivation for the planned research is that some hydropower projects with unlined/shotcrete-lined tunnels, domestic as well as international, have suffered from tunnel collapses causing forced outages during the operation period. Some of the collapses are believed to be related to the swelling potential of the rock itself as well as swelling clay present in the weakness zones. Degradation (slaking) of the rock material is believed to be an important contributor to the collapses.

Several methods for determining the swelling potential of clay are frequently used, whereas different configurations of oedometer tests and free swelling tests. However, there are no clearly defined rules for the investigation procedures of swelling rocks, nor does it exist a standardized categorization system of the results. Additionally, the effect on stability and swelling behavior when the rocks are exposed to a cyclic exposure to water, as in hydropower water tunnels, is not sufficiently understood.

## Objectives

The research aims to confront the causes of swelling behavior and the methodology to detect the critical rock parameters in an early stage.

### The main objectives are:

1. Perform, discuss and analyze different laboratory methods (swelling tests, mineralogical analyses, strength tests, slake durability tests...) at both NTNU and other international institutes, to compare equipment, methodology and results, aiming to suggest an investigation procedure designated to swelling rocks.
2. Try to find a correlation between different rock parameters and between different methodologies, in regard of swelling behavior of rocks.
3. Contribute to a widening of the range of tests in operation at NTNU, by suggesting improvements on existing facilities and on the development of alternative methods. The research is performed in close cooperation with Statkraft.