

**TUNNELS AND UNDERGROUND WORKS FOR HYDROPOWER
PROJECTS,**

- lessons learned in home country and from projects worldwide.

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ABSTRACT

Since ITA was established 36 years ago there has, on a worldwide scale, been considerable development in tunnelling technology and an increase in the use of the underground for various purposes. This has had an important influence not least on the hydropower industry. All over the world it is now common to locate powerhouses underground if possible, and longer and longer tunnels are being excavated to convey more and more the water to the turbines.

In the author's home country 99% of all electricity is generated from hydropower. More than 200 powerhouses are now located underground in Norway and the total length of tunnels connected to the powerhouses is in the order 4000 km. The paper describes the design of the cost saving unlined high pressure tunnels and shafts. Also the technology behind the unlined air cushion replacing the surge chamber is described and the potential for applying this technology for underground gas storage is shown. The use of heavy rock anchors for roof stabilization in underground powerhouses is discussed based on theoretical studies and real cases. Selected examples of stability problems in tunnels caused by slaking basalts, friable sandstones and swelling shales are described.

The concluding remarks demonstrate that with a good understanding of rock masses and their behaviour, there are considerable advantages in using the underground for hydropower projects as well as for other projects. Structures should be made safe enough for their purpose, but overly conservative support should be avoided as this adds unnecessary costs to the projects.

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