

Experience from tunnelling in Opalinus Clay in tabular and folded Jura

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Traffic tunnels cross Opalinus Clay proper only over short stretches, most of the sections are located in other Jurassic formation such as limestone, marls and other claystones. The development of tunnelling with TBM started in the 1960 with the construction of the network of Swiss motorways (National Roads) and new railway tunnels on the Swiss Plateau (Mittelland). This development has to be considered in order to understand the development of mechanized tunnelling with full-face shielded TBM's followed by a lining of precast unbolted and not expanded segments. This technique was later, beginning in the 1990's, also applied to construct several longer tunnels in the Jura for motorways and railroads.

The first major tunnels excavated in Tertiary (Molasse) rock were the dual two-lane tunnels of motorway N1 through Baregg near Baden. They were constructed with a horse-shoe shaped shield and drill-and-blast excavation, giving some particular problems. The excavation of the Heitersberg railroad tunnel with open Robbins TBM with precast segments in the invert followed by a shotcrete robot followed. The advance rate was below expectation, as instabilities occurred prior to the possibility of application of shotcrete and wirefabric, and steel sets had to be placed immediately above the cutting head. The Sonnenbergtunnel of N2 in the City of Lucerne with a pilot tunnel and a dual stage reamer followed. Then the series of tunnels constructed with shielded TBM's and precast segmental lining started with the Gubrist tunnel, the Zürichberg Tunnel of Zürich S-Bahn (Cross-Rail) followed by other tunnels [1]. The stability problems in the crown with loosening rock could be overcome with the backfilling technique (grout in the invert and pea gravel in the crown) developed by experienced Swiss contractors, achieving high rates of advance.

Tunnel construction with TBM's in the Jura started with the Bözberg Tunnel of motorway N3 between Basel and Zürich with a Herrenknecht-Robbins Shield TBM. An identical Shield TBM was ordered to construct the Mont Russelin Tunnel of N16 immediately east of the Mont Terri. The Adlertunnel of the railway Muttenz – Liestal was constructed with a shield TBM manufactured by Herrenknecht. Recently (2006 – 2008) the Bure tunnel of motorway N16 in the north-western part of Switzerland was constructed with a shielded TBM.

Little detailed information on the practical experience has been published; the information that will be presented has been gathered mainly from interviews with personal contacts. Tunnelling Opalinus Clay presented apparently few problems when tunnelling with shield TBM, many problems experienced with conventional tunnelling and drill and blast did not appear. The circular cross section with a continuous segmental liner prevented swelling problems. In retrospect one may conclude that the stability problems close to the face were caused by stress driven instabilities. Major instabilities at the face developed when fault zones were crossed, in particular when these were carrying water.

1 Steiner, W. (2000): Mechanised Construction of Large Diameter Tunnels in Switzerland. MIR VIII Ciclo di Conferenze di Meccanica e Ingegneria di Rocce, Torino, 5-6 December 2000. Lo Scavo Meccanizzato delle Gallerie: Mechanical Excavation of Tunnels; Barla G. (ed.)