

KEMROC cutter wheel in a railway tunnel at Bad Cannstatt

RAPID CUTTING UNDERGROUND

Groundwater threats required a long-term drainage solution

During excavation of a tunnel on the regional railway line at Bad Cannstatt, Germany, a permanent drainage system had to be installed to protect lenses of gypsum located in the anhydrite Keuper clay from possible ingress of groundwater. For this purpose, seven dam rings were installed as groundwater barriers with control drainage channels at either side of them. The slots that were required were cut into the injected shotcrete using a KEMROC DMW 130 cutter wheel with unprecedented speed and precision.

While excavating the railway tunnel at Bad Cannstatt as part of the German Stuttgart 21 project, the contractors came across some unexpectedly difficult geological conditions. For about 1,000 m of the 3.8 km long tunnel, both tunnel tubes had to pass through two anhydrite lenses with a compressive strength of approx. 60 to 90 MPa. Anhydrite can swell in contact with groundwater and cause severe, long-term structural damage to the tunnel. For this reason, protecting vulnerable areas against the ingress of water became a high priority.

The plan was to install seven dam rings (groundwater barriers). In addition, 13 drainage channels to control the flow of water were to be installed immediately before and after each ring. The installation of each ring required a slot, 60 cm deep by 50 cm wide, to be cut into the outer tunnel wall which was made of a grade C 35/45 shotcrete with double matting reinforcement type Q257A. Additional slots, 40 to 60 cm deep, were cut on either side of the central slot and the concrete that remained and separated the slots was then broken out. For this application, the ideal attachment for the Liebherr R924 T tunnel excavator was the KEMROC DMW 130 cutter wheel.

For the installation of the first ring at the end of 2018, it was decided to rent a KEMROC cutter wheel for a period of three months. Installation of the rings was not straight forward and the planned procedure had to be tested. The compact excavator, fitted with a short boom for manoeuvrability, was working in a 9.80 m diameter tunnel and was unable to reach all points around the tunnel diameter. The solution was to raise the operating height of the excavator at the location of the rings by sitting it on top of a 2 m high heap of spoil deposited at the required location. In this position, the excavator was able to cut two slots next to one another in the reinforced shotcrete. Immediately afterwards, the material between the slots was broken out. After removal of the spoil, the excavator worked at ground level and continued the original excavation by cutting two slots in the remaining section of



A KEMROC DMW 130 cutter wheel was used to cut slots in the outer lining of the Cannstatt railway tunnel for the installation of drainage channels either side of dam rings. They are needed to protect adjacent anhydrite deposits from groundwater ingress.

the tunnel lining and broke out the material remaining between them until the excavation extended over the full length of the tunnel geometry. Finally, after installation of the moisture protection membrane and piping, the void was filled with shotcrete.

In practice, the procedure worked out better than expected. After only one month, the engineers returned the rented cutter wheel. In the spring of 2019, the engineers installed the seven dam rings in the second tunnel tube. Using the rented cutter wheel, the work was carried out with extreme precision and in a cost-effective manner. The Plant Manager, Mr. Peter Göbel, reported, "If we had used a conventional drum cutter, we would have had to excavate more material than necessary. By using the cutter wheel, we have broken out precisely the amount that was required which has major economical benefits since we do not get paid for any additional, unplanned work. In addition, we made savings on the extraction and disposal of excavated material as well as the shotcreting costs. Wear costs for the cutter wheel also acceptable." ■



An unusual application for the KEMROC cutter wheel resulted in a surprisingly high speed rate. The minimum amount of material was excavated, reducing the amount of shotcrete required to fill the void in the tunnel lining.

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