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Demand-oriented Ventilation in Tunnel Construction

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Potential for Energy Savings

In tunnel construction, supply of fresh air is necessary to be able to carry out the work underground and to achieve the goal of completing the tunnel. However, the enormous energy consumption for ventilation is often not sufficiently taken into account.

With the 'Korfmann Air Guard', patented throughout Europe, the CFH Group has developed a system for the more energy-efficient ventilation of duct-bound tunnelling (Fig. 1). A combination of a PLC (programmable logic controller) and a computer program forms the core component. Using a frequency inverter, the PLC is able to control fans according to demand so that only the required amount of air is provided in the tunnel. However, the software is the much greater advantage. The programme evaluates the installed ducting system in terms of its energy efficiency and highlights potential for improvement and energy savings. In addition, it can be seen at an early stage whether the existing fans are sufficient for the planned construction work or whether an increase is necessary. This can help to avoid unnecessary downtime and ensure that those working in the tunnel are constantly supplied with sufficient fresh air.

All measured and calculated values are logged during operation, and this allows for various analyses. One or more indicator lights also signal the effectiveness of the system on site. By integrating the computer into a higher-level network the current situation can be monitored, even from the office, and necessary changes can be effected.

Fresh air is essential when carrying out tunnelling work underground. The CFH Group offers innovative energy- and cost-efficient solutions for ventilation during tunnel construction – as adopted for the Kramer Tunnel in Bavaria.

Tunnelling • Ventilation • Innovation • Energy efficiency • Cost efficiency • Case study

Depending on the power of the fans and the size of the construction site, the use of the 'Korfmann Air Guard' in tunnel construction can significantly reduce energy consumption during the construction phase, thus conserving resources, protecting the environment, and saving millions in energy costs.

Construction of the Kramer Tunnel in Bavaria

Layout of the new B 23 Bypass

The construction of a new B 23 bypass to the west of Garmisch-Partenkirchen is designed to reduce the impact of through traffic on the district of Garmisch. The bypass (B 23 new) follows the route of the existing B 23 north of Garmisch-Partenkirchen until shortly before the future northern tunnel portal. The north portal of the tunnel, which penetrates the Kramer massif, is located in a former quarry. The south portal is located near the local animal shelter where the route crosses the municipal road to Maximilianshöhe on a flyover structure.

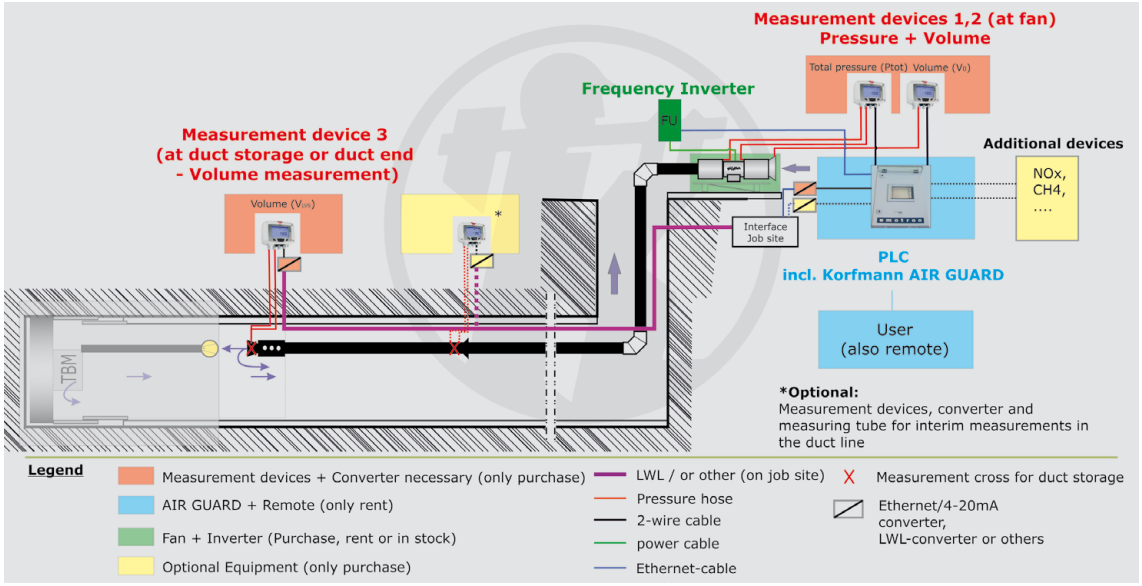

Fig. 1: Sketch of 'Korfmann Air Guard System'
Source: Korfmann Lufttechnik GmbH

Fig. 2: View of the construction site with ventilation equipment of the CFH Group
Source: CFT GmbH

The rest of the route runs north of the US housing estate (Breitenau Family Housing) in a south-westerly direction along the foot of the mountain range and joins the existing B 23 near Schmölz with two bridges over the River Loisach. The total length of the bypass is 5.56 km. For traffic coming from the direction of Munich, a loop ramp is under construction for the Garmisch/Burgrain junction to the north, and this will be connected by a roundabout to the Garmisch-Burgrain municipal road. For traffic coming from the direction of Garmisch, an additional direct ramp will be built.

Kramer Tunnel Construction Section

The section 'New construction of the B 23 section with the Kramer Tunnel' essentially comprises the traffic facilities for the non-tunnel-section and the portal areas, the Kramer Tunnel (**Fig. 2**) including the associated ancillary structures, structure 0/2 'Burgrain junction flyover structure', structure 0/3 'Burgrain groundwater basin', and the Garmisch/Burgrain junction. The centrepiece is the Kramer Tunnel, which will be a single-tube tunnel with two-way traffic and a parallel rescue gallery and cross cuts. The main part of the tunnel structure will be driven underground (approx. 3,520 m). The cut-and-cover method will be used for around 75 m in the area of the south portal and about 10 m at the north portal of the tunnel. This section serves primarily as rockfall protection for the roadway in the vicinity of the adjacent rock face. A total of six breakdown bays and 13 crosscuts to the accompanying emergency tunnel are arranged at fixed intervals along the length of the tunnel.

A large part of the trafficable rescue tunnel was already driven as an exploratory tunnel in 2011 and 2012. It runs to the west of the tunnel tube and will later have a total length of about 3,700 m. The centre-to-centre distance between the tubes varies. It lies between 21 m at the portals and 45 m in the middle section.

For ventilation after the tunnel is complete, a fan cavern and a ventilation duct will be constructed. The fan cavern is located approximately one third of the way from the north portal and is positioned on the south-eastern side of the tunnel tube. The overburden depth above the cavern is around 99 m. From the ventilation cavern, a vertical shaft with a clear diameter of 4.50 m leads upwards and ends here in an above-ground exhaust air structure. The exhaust shaft will have a height of around 118 m including the external structure.

Construction Method

The construction method for the underground structures consists of a succession of excavation and preliminary lining of the cavity. This ensures that a bond, capable of load transfer, is created between the lining elements and the surrounding rock, and that in the course of the stress redistribution the load-bearing capacity of the rock is maintained and utilised as far as possible. Due to the geology, the excavation is mainly carried out by blasting.

Ventilation during the Construction Phase

An AL18-6300 axial fan with a diameter of 1.8 m, comprehensive sound insulation, and a motor rating of 630 kW will be used for ventilation in the Kramer Tunnel during the construction phase. In addition to the fan, the CFH Group supplied a control container and the corresponding measurement devices for the demand-oriented fan control and the Air Guard. These include, among other things, volume measurement at the fan and at the end of the duct as well as total pressure measurement at the fan. In addition, a CFT measurement kit is in use which continuously measures various workplace limit values at the workplace – e.g. carbon dioxide, nitrogen dioxide and nitrogen monoxide, etc. With the complete package, the client can provide its employees with sufficient fresh air at all times and thus protect their health.

Conclusion

In tunnel construction work, demand-based ventilation with a system designed for this purpose significantly reduces energy requirements and thus contributes to both protecting the environment and saving costs.

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