

## Super construction site meets super edifice: Brandenburger pipe liner at Neuschwanstein Castle

From the outside, it looks like something from the pages of a Brothers Grimm fairytale, yet it's full to the brim with technology: Neuschwanstein Castle near Füssen in southern Bavaria.

King Ludwig II, famous for his reclusive tendencies, had the castle built as a retreat in 1869 – although it has since become a place of pilgrimage for tourists. Ludwig II christened his dream castle "New Hohenschwangau Castle", and it was only renamed Neuschwanstein Castle after his death. Today Neuschwanstein is one of the most popular of all the palaces and castles in Europe, welcoming upwards of 1.3 million visitors every year. In the summer, more than 6,000 visitors stream through the castle's rooms every day, on average.

The Swan King had a penchant for technical features and refinements and used all the opportunities which an industrialised Bavaria afforded him at that time. Steel structures, which had never previously been used for a building of this sort, were used to build the castle's magnificent Throne Room. At the time of its construction, the castle's interior was extremely modern and boasted central heating, a telephone system, a toilet flushing system and a dumb waiter.

Even if the wheel of progress has moved forward since then, Neuschwanstein Castle remains in a uniquely idyllic setting, bordering on a water protection area. A wastewater collector built in the 1980s is located in the vicinity. This collector runs for 1,080 metres alongside the water protection area right at the foot of the 'fairytale castle'.

According to information provided by the Max Bögl Group, the wastewater collector had a number of leaks. These were discovered in 2012 during testing for leaks under the local authority's self-monitoring regime. Subsequent pressure testing on the sleeve joints additionally ascertained that approximately 20 per cent of the concrete sleeve joints were classified as leaky under the test standard. Based on the leaks that were detected and the extension of the water protection area to cover the town of Füssen, a sustainable and comprehensive renovation of the wastewater collector was therefore necessary.

Füssen's wastewater authority commissioned the Neumarkt-based Max Bögl Group to carry out the renovation. The trenchless sewer renovation was carried out in 12 sections with individual lengths of between 14 and 244 metres. The preliminary work and renovation of the actual pipe linings took place in October and November 2014.

When renovating the DN 500 - 700 wastewater collector, fibreglass-reinforced pipe liner technology was used. After the affected points had been thoroughly tested, the relevant sewer sections were repaired using an inner lining with a Brandenburger light-curing GFK liner. The use of fibreglass-reinforced pipe liners is now a standard procedure in trenchless renovations, as it offers a material with a high **chemical** resistance level and extreme resilience, as well as excellent durability. The GFK liner is impregnated at the factory with an unsaturated polyester resin and then cured on the construction site using UV light. King Ludwig II would doubtless have been thrilled by this technology.

A BLUETEC® procedure using 9 x 1,000 Watts of power was used to cure the GFK liners. The eleven, laterally-connected drainage systems were temporarily closed during the renovation work and re-opened to fit precisely, after having been cured using milling robots. The special features of the Brandenburger pipe liners enable decrepit sewer sections to be renovated within hours, without the need to expose the sewer using heavy equipment. The longest sewer section, a DN 600 pipe measuring 244 metres, required a mere nine hours for a full renovation.

Due to the location at the foot of the 'fairytale castle' and due to the nearby businesses and restaurants for tourists, the sewer system has to deal with large amounts of combined wastewater throughout the year. It was therefore necessary to carry out the trenchless renovation without ceasing operations, so that the adjacent restaurants could continue to welcome tourists from all around the world.