English

Balfour Beatty
Rail

# RHINE VALLEY LINE MAJOR PROJECT
# THE KATZENBERG TUNNEL

# The latest systems for speed and safety in the Katzenberg Tunnel

**The Rhine Valley line – A major project of Deutsche Bahn AG**

The Rhine Valley line, one of the most heavily travelled lines in the DB network, is a key line for north-south connections for personal travel and the transport of goods. The complete four-track construction and expansion of the line between Karlsruhe and Basel will optimise railway traffic in the region by 2020.

**Katzenberg Tunnel interface**

The new Katzenberg Tunnel between Bellingen and Efringen-Kirchen will significantly increase capacities and the maximum line speed of the Rhine Valley line connection. The high-speed overhead contact line in the two parallel, single-track tunnels enables transit speeds of up to 250 km/h, enabling a distance of 9,385 metres to be travelled in 2 minutes and 15 seconds. The connection of the complete, expanded tunnel to the Rhine Valley line took place on schedule in December 2012.

**Overhead contact line, 50 Hz power supply and track systems: three systems for Balfour Beatty Rail**

In the scope of the major project, Balfour Beatty Rail Deutschland was assigned three central technical tasks. First the contract was issued for the planning and construction of the high-speed overhead contact line. This sub-project was completed according to schedule by the end of 2011.

As the expansion work in the two tunnels progressed, Balfour Beatty Rail was able to take on two additional sub-projects:

- The contract for the planning, supply, assembly and commissioning of the electrotechnical equipment for the 50 Hz power supply and tunnel safety lighting.
- The delivery and installation of long-welded rails for the structural completion of the track systems in the west and east tunnels.

***Support point with cantilever (deflected)***

# Greater performance with innovative overhead contact line systems

**Designed for a comfortably high speed**
The overhead contact line systems for the Katzenberg Tunnel project must accommodate high speeds of travel, which necessitates a correspondingly powerful electrical power transfer. Balfour Beatty Rail used an innovative method for fastening the catenaries: the overhead contact line in the Katzenberg Tunnel was designed as Re 330 with amplifier conductor. Balfour Beatty Rail engineers developed a modified high-speed catenary for single-track tunnels in the segmental liner construction in the Munich Catenary Competence Centre.

**Precise project progression with demanding timing**
Work on the power supply of the Katzenberg Tunnel was begun at the end of 2009. The planning and preparation at Balfour Beatty Rail were at top speed from the start. Project engineers conducted measurements in December 2009. The initial drilling took place in January 2010. Then in the west tunnel a 680 m long reference line for the presentation and approval of the new catenary was installed. The system for the electrification was finalised according to schedule at the end of 2011.

**Demanding tunnel catenary**
In addition to the modified high-speed catenary, Balfour Beatty Rail developed a process variant for the fastening of the catenary. In this process, cantilever components and other components of the catenary system are not fastened on anchor rails already installed in the segmental liner sections. Instead, they are fastened directly on the tunnel rings by means of anchors. A standard distance of 48 m between support points had to be observed in the planning and, at the same time, the fastenings could only be attached in an 8 cm wide drilling channel in the segmental liner rings, the individual segments of which vary in position in the ring. In addition, the keystone, which is continuously offset by at least 15 mm in relation to the adjacent rings, may not be drilled into. In order to meet the high demands in dimensional accuracy of Re 330, as well as for dust-free drilling, the specialists at Balfour Beatty Rail designed nine drilling templates for the various catenary components. As a result, dirt did not enter the tunnel and the drilling dust was extracted in the same process step.

**Impressive engineering performance setting new standards**
For the approval of the modified construction method of Re 330, Balfour Beatty Rail submitted its results from structural analysis, product certifications and demonstration testing. They were approved by DB Systems Technology in late January 2010 and the drawing documentation for the modified catenary "Re 330 single-track tunnel in segmental liner construction" for the Katzenberg Tunnel was incorporated into the Deutsche Bahn AG standard register of drawings.

## Overview of the facts

**Technical key data and connection lines**

**Stations and exposed track sections:**
- Pylons: 257
- Overhead supply lines: 33 km
- Re 200 catenary: 4 km
- Newly laid sections of exposed track: 8.2 km
- Re 250 catenary: 18 km

**Tunnels**
- Tunnel length: 9,385 m
- Segmental liner rings: 8,969
- Segmental liner blocks: 62,783
- Re 330 catenary: 22.5 km
- RiM 120 overhead contact line (Cu-Mg 0.5): 120 $mm^2$
- Tensioning force: 27 kN
- Bz 120 supporting cable (Cu-Mg 0.4): 120 $mm^2$
- Tensioning force: 21 kN
- Tensioning length: ≤ 1,400 m
- Standard distance between support points: 48 m
- Reinforcing conductor Al 240: 240 $mm^2$
- Support points: 462
- Overhead contact components to be fastened: 2,150
- Holes for catenary components: 6,954
- Holes for earthing conductors and return conductors: ≈ 50,000

**Innovative thinking was demanded – and proved its worth**

Among the special requirements for Balfour Beatty Rail was the demand to design an innovative catenary system for both tunnels, with the capacity to handle high speeds of up to 250 km/h. As an additional test of the innovative capacity of the engineers, a new means of fastening had to be designed for the components of the catenary. For this purpose, special templates were used on site for drilling anchors into the tunnel casing. Additional innovations were also realised in the areas of monitoring and control. For example, two new remote control lines and eleven local control systems were set up for the monitoring of the new construction section. The tunnel received a high-voltage testing system with a central station and two substations each equipped with two switches. An Re 250 overhead contact line was built on the two sections of exposed track between junction stations and tunnel. In addition Balfour Beatty Rail designed and equipped an earthing concept for the Katzenberg Tunnel.

***Support point with reinforcing conductor with connection to the return conductor***

***Drill template***

***Wheel tensioner assembly***

*Installation work Safety lighting*

*Check operation*

*Tunnel infrastructure details*

## Increased safety with efficient 50 Hz power supply

**From planning to operational readiness: everything from one supplier**

Balfour Beatty Rail is responsible for a second sub-project in the extensive Katzenberg Tunnel railway infrastructure project. The planning, delivery, assembly and commissioning of the electrical equipment based on 50 Hz were assigned to the Electrical and Signal Technology business division. This equipment will ensure both the power supply and the tunnel safety lighting.

**In focus: two indispensable components for emergency situations**

The 50 Hz power supply concept from Balfour Beatty Rail is based on the seamless networking of all necessary systems and components. The latest equipment is used to ensure the highest standard of safety. Two highlights of the future tunnel equipment have enjoyed great interest in the visitor's centre at the Katzenberg Tunnel. The first of these highlights is the latest generation of safety lamps for high-speed tunnels approved by DB AG. They ensure the provision of lighting according to standards in the event of an emergency. The second highlight is an innovative multi-socket installed in the tunnel. Over 150 units have been installed in order to enable potential-free power withdrawal by rescue forces in the event of an emergency.

### Overview of the facts

**The implementation planning has the following points of emphasis:**

- Network planning with load and short-circuit calculations, safety designs and operating equipment dimensioning
- System planning with all overview and circuit diagrams as well as the necessary production documentation
- Creation of general CAD layouts and construction documentation
- Detailed planning of tunnel safety lighting conformity to TSI

**Essential components for the delivery, assembly and commissioning include:**

- Medium and low-voltage cable – 240 km
- Buildings for RTC/DB Energy transmission stations – 2
- Medium-voltage switchgears in traverse headings within the tunnel – 4
- Low-voltage main distribution boards in cross-cuts within the tunnel – 19
- Low-voltage distribution boards in traverse headings within the tunnel – 85
- Emergency lighting supply units in the tunnel – 1,400
- Sub-distribution boards in the tunnel – 350
- Multi-socket units installed in the tunnel – 150
- Tunnel safety lamps – 2,650

# *High-speed mobility with the latest track systems*

**180 m long-welded rails for smooth travel**

The third sub-project related to the Katzenberg Tunnel was contracted by the Max Bögl construction company of Neumark, Germany to the Track Systems, Central Region business division of Balfour Beatty Rail. It entails the delivery and installation of 180 m long-welded rails, which are to be fastened on the Bögl prefabricated slab system installed ahead of time. In addition to the delivery of the new long-welded rails directly to the relevant construction sections, the contract includes the welding of the rail heads, the replacement of existing rails with long-welded rails and their permanent installation over the bracing with the Bögl prefabricated slab system.

## *Overview of the facts*

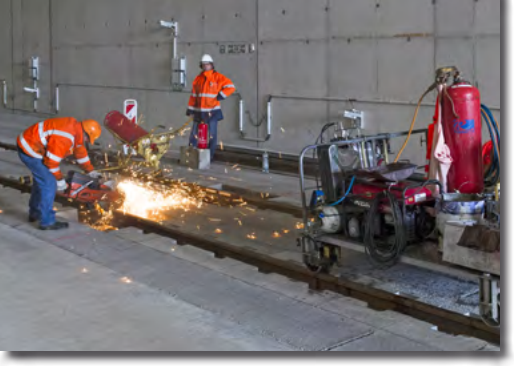
**The technical scope of the project at a glance:**

- Delivery and installation of UIC 60 modular rails for a section length of 40,000 m
- Installation of long-welded rails in the format 180.00 m UIC 60 on a section length of 40,000 m
- A total of 220 flash-butt welds
- Grinding of the rolling skin on the section length of 40,000 m
- Installation of a total of 120,000 removable driving surface elements

**Also on board: a highly innovative driving surface system**

In order to ensure that vehicles on tyres will also be able to drive in the tunnel in the future, a highly innovative driving surface system was created. This is indispensable for future service work. This system is placed directly on the Bögl prefabricated slab system and was integrated seamlessly into the general track construction of the two tunnels by Balfour Beatty Rail:

- At the centre of this measure was the installation and alignment of the so-called "removable driving surface superstructure elements" (abO), for which special attachment systems were used.
- These abO covering elements are non-reinforced concrete block elements of the strength class C30/37 without transport anchors.




***Installation of modular and long-welded rails***

- Since they were specially developed by Max. Bögl Bauunternehmung GmbH & Co. KG, they fit seamlessly into the driving surface system.
- These elements were installed to the left and right of the rails on the track supporting slab system under the direction of Balfour Beatty Rail.
- Since the individual abO elements do not have transport anchors, a vacuum lifter specially designed for this purpose was used.
- This was mounted on the rail/road excavator in order to be able to simultaneously place 10 elements on the track supporting slab.
- After the placement of the abO elements, each element had to be aligned precisely to the last millimetre.
- An additional new alignment system was designed and used for this important task. This system was likewise used as a rail-guided attachment for the rail/road excavator.
- After all abO units were perfectly aligned, the centre channel between the tracks and the outside channels lying on the tracks could be poured in with concrete. In doing so, the driving surface system was completed.

## *Details about project progress and local conditions:*

- January 2011
  East tunnel, south entrance:
  - Auxiliary track installation
  - Unloading and storage of 20,000 m of modular rail
- June 2011 – August 2011
  East tunnel
  - Unloading and storage of 20,000 m of modular rail
  - Installation of 20,000 m of modular rail
  - Installation of a total of 60,000 units of removable driving surface elements
- November 2011 – February 2012
  West tunnel
  - Installation of 20,000 m of modular rail
  - Installation of a total of 60,000 units of removable driving surface elements
- June 2012 – July 2012
  West and east tunnels
  - Replacement of 40,000 m of rail
  - 220 flash-butt welds
  - Grinding of 40,000 m of rail

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