Three of the four main elements that make up the new connection to mine level 7 have now been completed:

1. 2.5 m-long haulage incline from level 7 to level 6
2. In-seam conveyor road running east to west and
3. 270 m-deep extension for number 10 shaft.

The fourth part of the excavation programme commenced in 2008: the north and south shaft connection via lateral roadways C467 and C432 and the completion of the inset extensions. The first phase of this operation was described in REPORT 2010.

Steel support assembly with systhematic bolts at the bottom

Curve C432 in direction southern pit bottom

Prosper-Haniel colliery

An ongoing development plan for mine level 7 in shaft number 10 district is now a crucial factor for Prosper-Haniel colliery if the mine is to remain an efficient coal producing unit in the years ahead. The excavation of the south shaft landing has been an important part of the overall expansion programme.

Planning phase

The planning of the 'south landing' development project was based on experience acquired from the north installation as well as on geological exploration data from core drillings. This information helped establish the technical ground-rules and plan out the permanent support system.

The results obtained from a numerical model prepared by Essen-based DMT GmbH & Co. KG indicated that the following approach would have to be used:

1. In order not to compromise the rigid support lining of the existing landing the new inset would have to be driven out from the shaft side.
2. The final cross section (approx. 100 m^2 of clear space) was to be excavated in a series of stages/part sections.
3. The final support system was to comprise a combination of immediate-bearing shotcrete, systematic rockbolting and backfill of various thicknesses, plus standing supports.

Excavation concept

After laying down the general operating parameters, detail plans and variant designs the technical strategy was discussed and agreed with the client. A fixed working stage was erected for roof excavation work in the existing landing. This stage was to perform the following functions:

- To provide an operating base for a drill jumbo and loader unit
- To act as a safe shotfiring refuge for number 10 shaft
- To serve as a reception point for blasting debris from the first shotfiring phase
- To allow efficient clearing of debris to the bottom-level platform

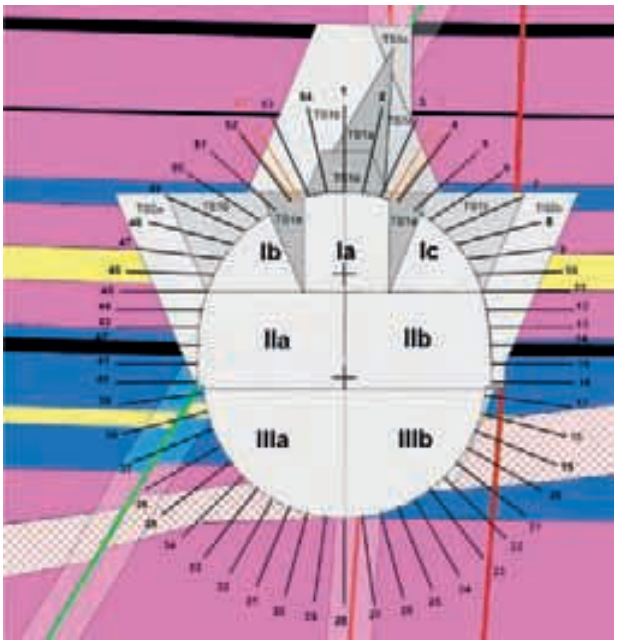
Pic. left:
Volumetric picture Prosper-Haniel mine, area Shaft 10: western elements of the tunneling concept

Pic above:
Local front face at the level of the bottom stage

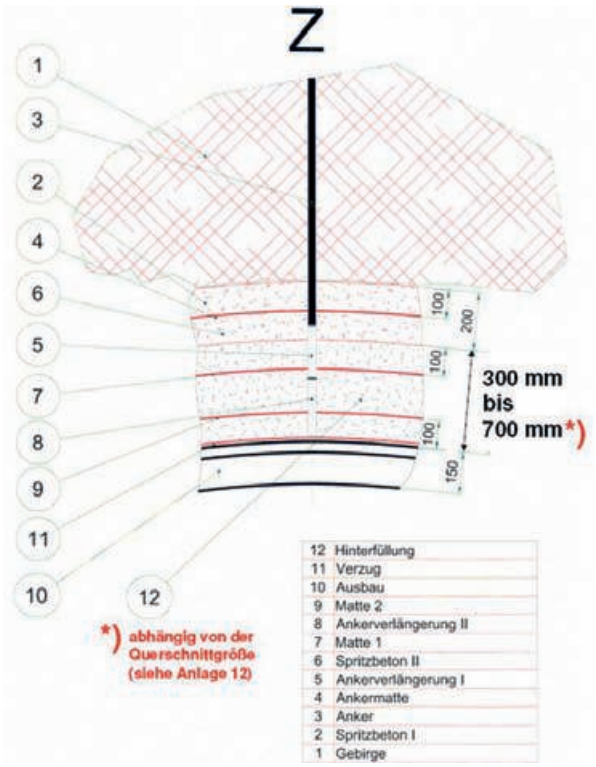
- a materials transit point and transport route
- As a travelway for the drivage team and storage point for tools and instruments.

A vertical section taken through the landing, showing the existing and proposed profiles, clearly illustrated the scale of the project and the problems that the operation would pose.
The working stage was constructed and delivered by Maschinenfabrik Hese GmbH. A repositionable hatchway was built into the structure to allow debris to be transferred through the stage and on to a chain conveyor installed on the floor platform.
A type BTRL 1 drill jumbo was chosen for the excavation and rock-bolting work, this decision being based on the machine's low overall weight of only 12 tonnes. As most of the rockbolts to be used would be four metres in length the jumbo was fitted with a telescopic drill slide designed for extension drilling work.
A Bobcat loader was chosen for debris clearance. Though an unusual choice for a colliery based project the Bobcat, which first had to be modified for the job, was preferred because of its low unladen weight and excellent manoeuvrability for a machine in this class.
The excavation project also included extending the shaft landing by a total of 24 m. This comprised a conically tapering section some 16 m in length and a further 8 m of cavity with a profile to match that of mine infrastructure roadway C432.

Design of the part cross sections



Scheme of the final support



Excavation of the south shaft landing – operating experience

Unlike the north landing project that was completed in 2008/2009, which had been a stand-alone operation completely unrelated to any other activities under way at the time, the work to be undertaken in the south landing was to prove much more extensive and complex. Scheduled materials and personnel transport movements would have to continue in parallel with the excavation work and additional activities would also have to be carried out as part of the technical installation work for the shaft inset on mine level 7.

Equipment installation and preparatory work

The conveyances and all necessary machines and equipment were assembled and installed in line with the detail plans for the drivage concept.
This was followed by the installation of two blasting screens – one fixed screen was set up in the immediate vicinity of the shaft and another mobile screen was positioned right up against the heading face. The mobile design of the roadhead screen meant that an additional and extremely effective protection system was available for immediate use at any time. The preparatory work also included product familiarisation and driver training sessions with the Bobcat loader.

Tunnelling section 1a

Excavation work

Drivage operations commenced in the pilot roadway (part-section 1a) at the end of September 2009. Lengths of up to about 8 m were blasted out in four rounds of shots. It was decided to use a parallel cut with eight 100 mm-diameter clearing holes. The advance per round was initially 0.8 m. From 8 m into the drivage until the end of the pilot tunnel firing was based on two rounds of shots with a maximum advance per round of 1.6 m.
The Bobcat proved to be an outstanding loading machine. Its mobility and acceptable loading performance meant that it

Bobcat next to the tipping area

Bobcat while mucking

Start of steel support assembly in the roof section

remained in service until part-section 1c was completed. Unlike its track-mounted counterparts, however, the Bobcat vehicle needs a level road surface for its operations.

The performance of the BTRL 1 drill jumbo also impressed the drivage crew and the machine proved to be well up to the job of drilling the shotholes and setting rockbolts of various types. A sliding track system mounted on the working stage meant that the jumbo was able to deploy easily to different positions.

After completion of the pilot drivage at the end of November 2009 section 1b was driven eastwards followed by 1c westwards. The supports were then installed in sections working outwards from the roadhead.

The figures below show the individual drivage sections and the installation of the steel supports in the top slice.

The infrastructure roadway C432 was driven at the same time as the operation in the south landing. After the steel supports had been installed in section I of the landing extension all was ready to make the cut-through from infrastructure road C432 to the south shaft inset.

The steel supports in the top slice were reinforced with additional floor arches and struts in order to create the necessary stability for the superstructure when excavating the lower sections, and also to counteract any convergence movements.

The colliery surveying team carried out twice-weekly convergence checks as the drivage work progressed. Telltale extensometers were also installed at various control points. These two monitoring systems concurred in finding no increase in measurement levels compared with the numerical model predictions.

The excellent progress made in the C432 cut-through, combined with the fact that virtually no convergence was recorded, led the engineering team to rethink their strategy for driving sections II and II of the shaft inset.

It was consequently decided to depart from the original plan and to excavate the next sections from C432. There were a number of important advantages in adopting this approach:

1. By turning the debris clearance direction towards C432 it would be possible to carry out assembly and installation work in the shaft zone in parallel with the drivage operation
2. The use of larger and more powerful machines and equipment would help increase drivage performance
3. The permanent inset support system could be installed in as short a time as possible
4. Separating the operations under way in and around the shaft would help increase safety levels at the workplace.

After infrastructure roadway C432 had been fitted with its type A combination support system as far as the shaft inset, work could begin on driving sections IIa and b. Cavities were excavated in

Steel support in section I with props

Tunnelling in section 2a and 2b

The final breakthrough C432 for the southern shaft-landing

succession to the east and west sides and the rockbolts and/or shotcrete lining were set in place. The advance per round was about 1.2 m.

After every three pulls had been completed with rockbolt-shotcrete to provide support the final steel supports were installed in this section and backfilled. This routine ensured that as the drivage approached number 10 shaft only a short section of roadway was ever standing under temporary supports.

Even during this phase of the operation the convergence monitoring instruments failed to indicate any unusual events. Once a separate shotfiring screen had been set up the breakthrough to the shaft zone was achieved after several rounds of shots.

In order to eliminate all conceivable risks it was decided to leave the inverted arches of the top slice in place as additional security until the permanent ring supports were installed.

The bottom slice was then excavated via a drivage ramp. The requirement in this section too was to have as short as possible a delay until the installation of the permanent support system. For this reason the roadway profile was again removed in sections, rather than excavating the entire face all at once. Unlike the approach adopted in the overlying sections, however, the embedded arch supports were installed and backfilled as complete units.

After the cut-through had been made to the number 10 shaft cellar and the supports had been installed the remainder of the excavation was completed towards C432. The permanent support system was also installed in this area. An end-wall was additionally constructed at roadway C432 to seal off the zone with the embedded floor arches.

Work began at the same time on erecting the steelwork needed to fit out the shaft inset. The shotfiring screens and working stage for section I were partly dismantled in order to create additional working space.

The excavation machinery was then dismantled and taken away. After completion of the steel girder platform in the south landing the remaining floor arches could be removed from section I.

Southern shaft-landing with railway track

Summary

1. The overall concept used for excavating the south inset proved to be highly successful in practical application
2. The drivage work was completed within schedule
3. The restrictions imposed on number 10 shaft operations remained within predetermined limits and hold-ups only occurred when shotfiring was being carried out
4. All modifications to the original plan of operations – for example turning the drivage direction when excavating the second and third slices – had a positive impact on the overall project
5. With the help of the numerical model and the operating experience acquired during the drivage project it was possible to improve and refine the procedures used
6. In spite of the unfamiliar nature of the work no notifiable accidents were reported by the drivage team in the course of the project.

Reiner Reese
Ulrich Barth

Tunnelling C432 in combined support type

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