THE FORMWORK

NOE® tec

Gmünder Einhorn-Tunnel

A town can breathe a sigh of relief

Gmünder Einhorn-Tunnel

After five years of construction and a considerable longer period of planning, the Gmünder Einhorn Tunnel was opened on 25th November 2013 in Schwäbisch Gmünd, Germany. With the completion of the tunnel, the authorities achieved two objectives: firstly to relieve the congested traffic situation in the town and secondly to create a forward-looking traffic concept in the land released by the project. A great many challenges had to be overcome in order to complete these works. Among the greatest was keeping the traffic flowing efficiently in spite of the operating construction site and the diversion of a series of lengths of the Rems river.

Before the opening of the tunnel, the traffic situation in Schwäbisch Gmünd was extremely difficult: the B29, an important east-west primary route for the Stuttgart region and feeder to the A7, A8 and A81 motorways, ran right through the middle of the town. From the traffic forecasts, the authorities predicted that by 2015 without the tunnel some 40,000 vehicles, including very many heavy goods vehicles, would be passing through Schwäbisch Gmünd every day. The new tunnel is intended to relieve the town of about 20,000 through-traffic vehicles.

Tunnel route

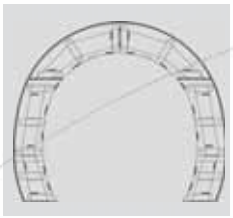
For topographical reasons, the road planners opted for a 2.1 km town relief road. The new road scheme consists of three main sections: a western part (315 m), an east-ern part (228 m) and a 1687 m tunnel. The tunnel was built using a combination of cut-and-cover and traditional tunnelling techniques.
The Rems river had to be diverted over a length of 800 m to allow the project to be completed. Several separate engineering structures were necessary.

For example, the project required the building of a watertight channel for the diversion of the river. An overbridge had to be built to form the slip road at the eastern end of the project. While all this construction was going on, the works had to be coordinated to keep the traffic on the B29 flowing as smoothly as possible. For this reason, the three main sections had to be divided into smaller sub-sections, which were selected to allow the relief road to be constructed quickly while ensuring that traffic continued to flow with minimal disruption. The contractors erected several temporary overbridges as part of these arrangements.

Cut-and-cover tunnel construction west: the NOEtec formwork carriages must allow site vehicles to pass through them to service the rest of the site. Formwork supported by loadbearing towers fills the gap in the area of the road alignment shift.

Safety taken very seriously

The designers placed a lot of emphasis on safety in the Gmünder Einhorn Tunnel. A rescue tunnel capable of being driven through runs parallel to the road tunnel. It is connected to the main carriageway by six evacuation galleries, one of which is capable of accepting vehicles. The ventilation system in the main tube is designed so that, in the event of a fire, the smoke is extracted through ceiling flaps and exhausted into the open air through a flue. Several emergency tanks are provided as a sensible precaution to capture the contaminated extinguishing water arising from a dangerous-goods transport accident. Contact loops were built into the emergency bays for safety in the event of an emergency or a vehicle breakdown. When a vehicle draws up there, the system stops the traffic automatically in the relevant direction to protect the occupants of the stopped and attending vehicles.



Added components for the formwork carriages in the escape galleries

Plan of the 2.2 km long Gmünder Einhorn Tunnel (drawing: NOE-Schaltechnik, Süssen, Germany)

NOEtop large area formwork tables are used for the open retaining wall sections and the cut-and-cover tunnel construction.

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Design and construction

The design of this relief road was approved in autumn 1989. The groundbreaking ceremony took place nine years later. The client for this project is the German government, represented by the Stuttgart Regional Authority. The works were constructed by the Arge Tunnel Schwäbisch Gmünd consortium. The consortium consists of the following companies:

- Ed. Züblin AG
- Baresel GmbH
- G. Hinteregger & Söhne Baugesellschaft m.b.H.
- ÖSTU-STETTIN Hoch- und Tiefbau GmbH

NOEtec formwork carriages for the emergency bay (left) and ventilation gallery (right)

Cut-and-cover tunnel construction east: the formwork carriage in the background is being prepared for the move from the south to the north tube

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NOEtec – flexibility is paramount

Several NOEtec formwork carriages were used to move and support the deck formwork in the construction of the Gmünder Einhorn-Tunnel. The NOEtec system formwork is best compared with a modular model kit consisting of a manageable number of individual elements that can be combined in any number of ways. Assembly is simple and more or less self-explanatory. The formwork panels can be made to measure very quickly to match the precise requirements of the project. The system is therefore an all-rounder and suitable for every construction site. NOEtec provides a high degree of workplace safety and is noted for its high load capacity. NOEtec can be effortlessly configured not only for arch and tunnel formwork but also for wall and climbing formwork. A particularly good example of the flexibility of the NOEtec system is its use as self-propelled formwork carriages on the Gmünder Einhorn Tunnel.

Self-propelled formwork carriages

The Schwäbisch Gmünd relief road has two sections of cut-and-cover tunnel (west approx. 228 m and east approx. 315 m long). A 1 m thick concrete wall divides them into two tubes. This concrete wall and the two outside walls carry the 2.20 m thick tunnel roof slab. 12 m long formwork carriages were used for the erection of the structure. They consisted of elements of the NOEtec system and can be very quickly and efficiently assembled, which is of particular advantage on tunnel construction sites. These NOEtec carriage structures weigh 40 tonnes each and stand on rails. The electrically driven carriages run on these rails to move the formwork to the next section of the tunnel to be concreted.
To permit easy and clean stripping of the formwork after the concrete has hardened, the formwork table is supported on hydraulic shores which lower themselves by up to 50 cm.
One great advantage of formwork carriages built from NOEtec is their ability to be modified. Normally the width of the tunnel tubes is 9.50 m. In a short section of tunnel, however, one of the two tubes is wider. Thanks to the system's modular design, the site team was able to modify the formwork carriages to suit this offset without much difficulty. All they had to do was attach a suitable additional component at the front.
NOEtec formwork carriages were used in the areas of the emergency bays, and in the electrical and ventilation galleries.

NOEtop: superb structures need superb formwork systems

The consortium responsible for the Gmünder Einhorn Tunnel opted for the NOEtop wall formwork system. NOEtop was used for concreting the

- Foundations
- Walls for the open retaining wall sections.
- Walls for the cut-and-cover tunnel sections
- Walls in the ventilation and electrical galleries

NOEtop is a steel frame formwork system, which, because of its integral bracing, can also be used as beam formwork. The tie rods can be positioned anywhere within the bracing. All the system's frames and profiles are hot-dip galvanised inside and outside to make them extremely robust and durable. The permissible concrete pressure for NOEtop is 88 kN/m².
The system was of particular interest for use on the structures of the Gmünder Einhorn Tunnel mainly because of its extraordinarily large panel sizes: the largest NOEtop panel has dimensions of 5.30 x 2.65 m and the panel area is 14 m². These large panels save time and labour costs.

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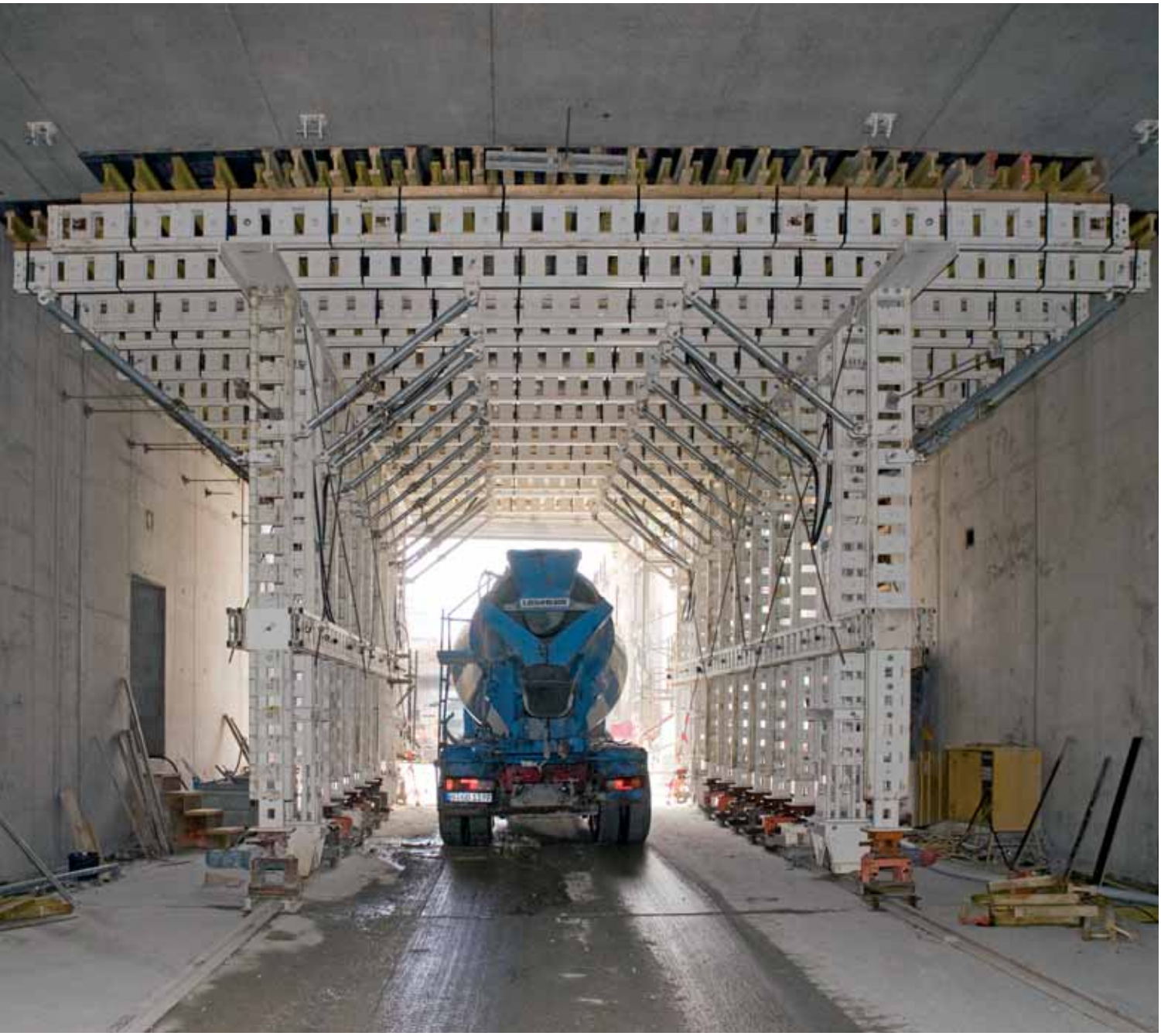

In order to allow reliable servicing of the whole tunnel construction site, the NOEtec formwork carriage had to be designed to provide a passageway with sufficient headroom for HGVs to drive through

Cut-and-cover construction west

A passageway had to be provided to allow reliable servicing of the tunnel construction site.
Formwork supported by loadbearing towers fills the gap due to the extra width in the area of the road alignment shift west.

Formwork supported by loadbearing towers fills the gap in the area of the road alignment shift west

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Fan niches

This is possible only with NOEtec beam formwork: for concreting the fan niches, the NOEtec deck formwork carriages travel over temporary foundations. There is no need for expensive and time-consuming erection and removal of formwork recesses for fan niches.

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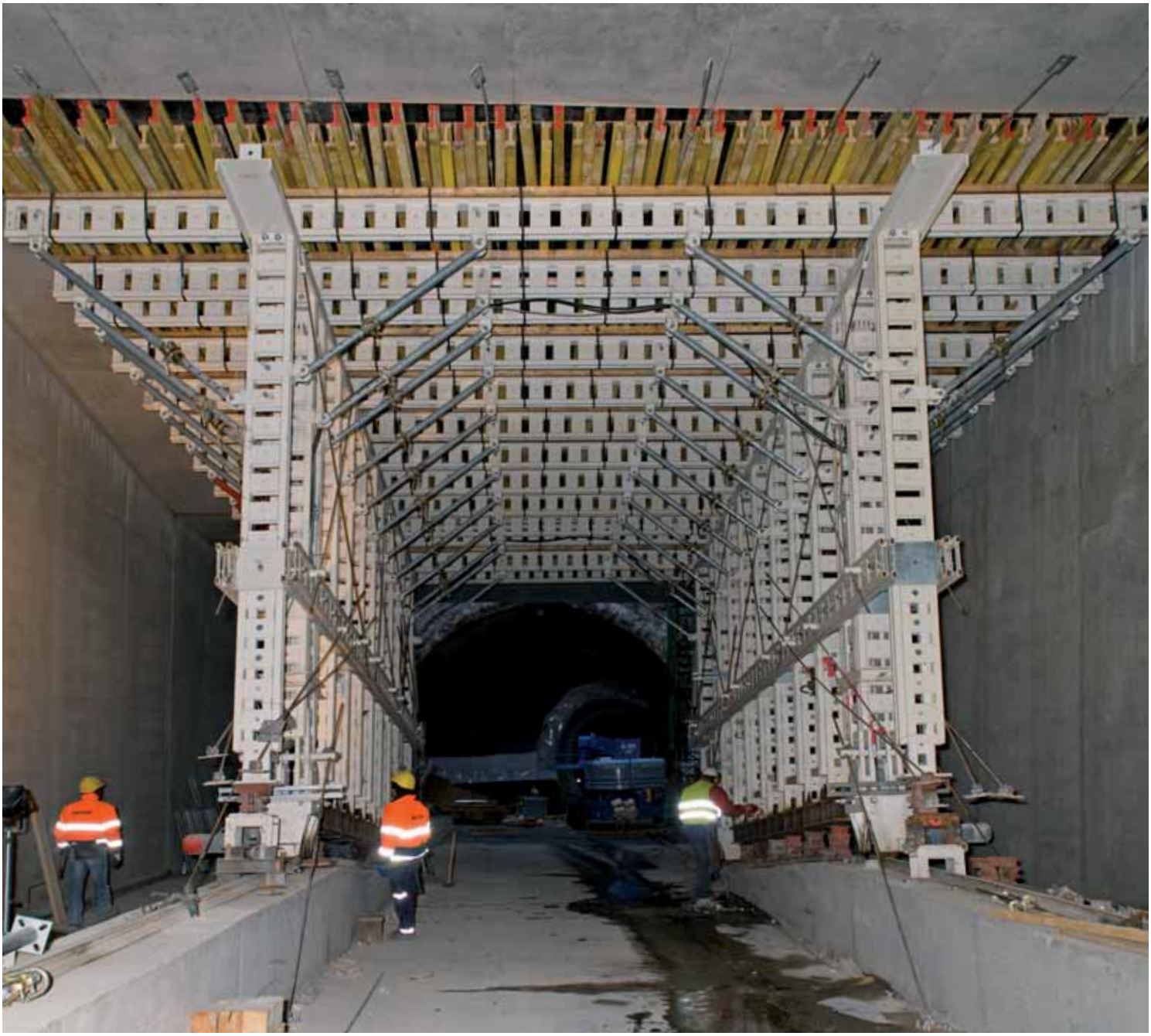

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Emergency bay, ventilation and electrical galleries

NOEtec deck formwork carriages where the emergency bay and ventilation gallery meet.

NOEtop and the newly developed NOE HBF support bracket were used for concreting the end wall in the ventilation gallery.

Finished ventilation gallery/tunnel tube intersection at emergency bay 2

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Cut-and-cover construction east

Use of NOEtec deck formwork carriage in the cut-and-cover tunnel construction east.

Moving the formwork carriage from the south to the north tube.

NOEtec beam formwork

Uses as tunnel formwork carriage

1 **Refurbishment of Nittel Tunnel, Trier**
NOEtec tunnel formwork carriage with leading and trailing carriages

2 **Schulberg-Tunnel, Hess.-Lichtenau**
Top-down construction, the NOEtec tunnel formwork carriage acts as a "strut" for concreting the walls

3 **Milaneo, Stuttgart**
Only NOEtec can do this: Height-adjustable deck formwork carriage for concreting of three decks of different heights

4 **Neckargemünd Bypass**
Tunnel formwork carriage for circular tunnel cross section in traditional tunnelling construction

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