THE FORMWORK

NOE® report

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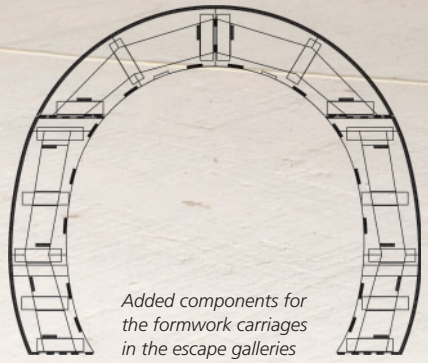
Gmünder Einhorn-Tunnel

A town breathes a sigh of relief

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

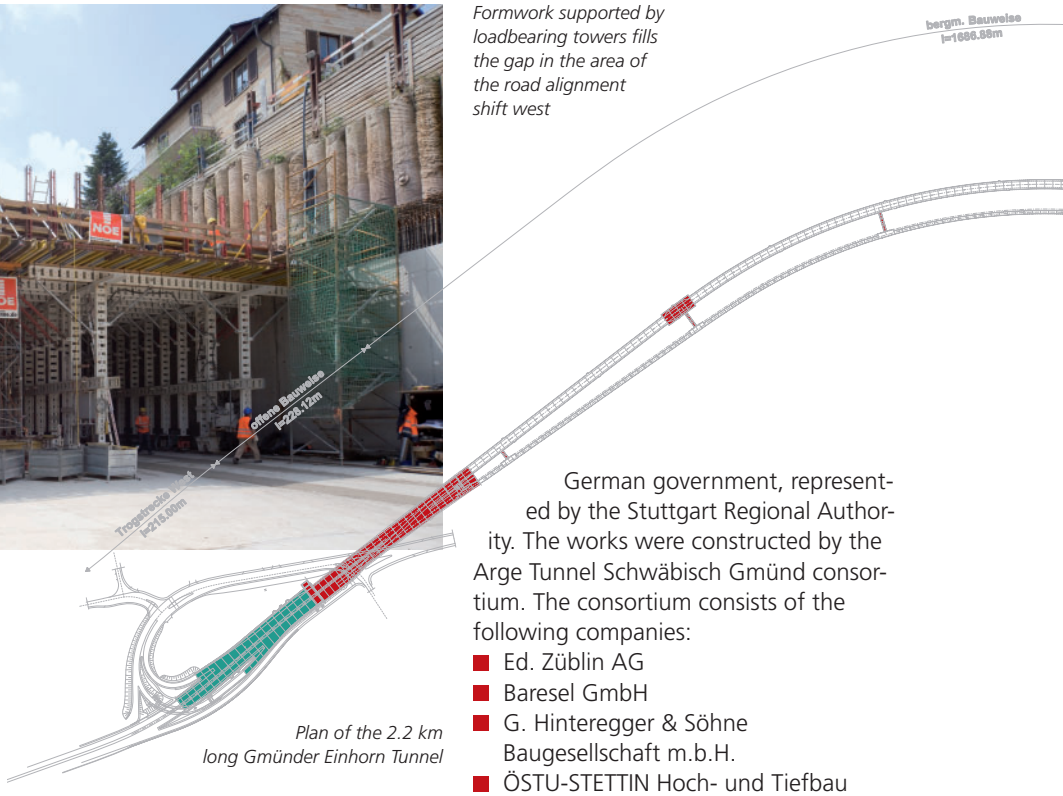
Left: Cut-and-cover tunnel construction east: the formwork carriage in the background is being prepared for the move from the south to the north tube Right: Cut-and-cover tunnel construction west: the NOEtec formwork carriages must allow site vehicles to pass through them to service the rest of the site. Formwork supported by loadbearing towers fills the gap in the area of the road alignment shift.



Added components for the formwork carriages in the escape galleries

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.

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



Plan of the 2.2 km long Gmünder Einhorn Tunnel

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 eastern 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.

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.

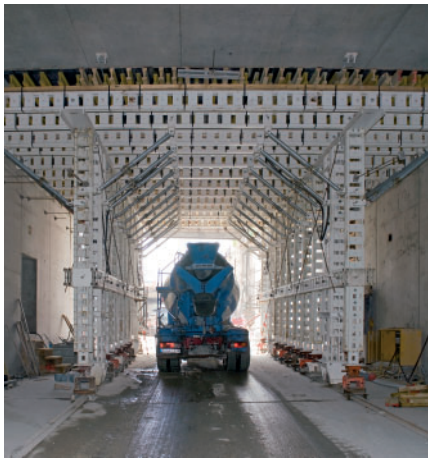
Design and construction

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:

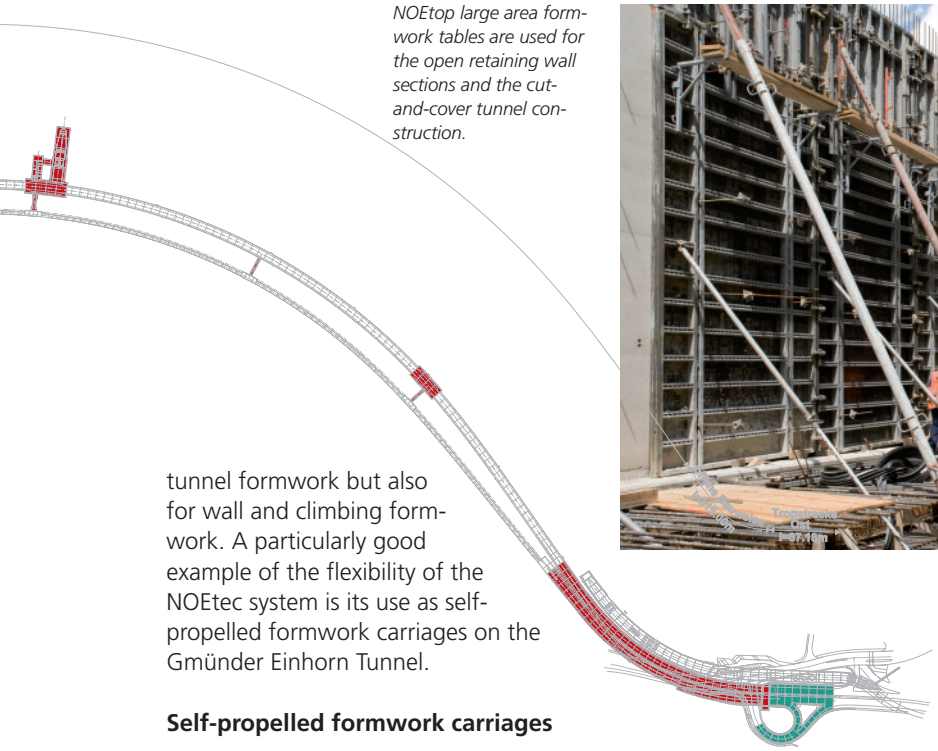
- Ed. Züblin AG
- Baresel GmbH
- G. Hinteregger & Söhne Baugesellschaft m.b.H.
- ÖSTU-STETTIN Hoch- und Tiefbau GmbH

NOEtec – 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



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



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

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.

Finished ventilation gallery/tunnel tube intersection at emergency bay 2

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.

Information brochure

A comprehensive information brochure is available and can be requested from NOE-Schaltechnik at info@noe.de.

A disassembly of the inner formwork is no longer necessary.

The trick with the lever

NOEtop stripping corners with sophisticated erecting and stripping technology

Tight deadlines and the permanent pressure of time are part of everyday life on site. Consequently contractors are forever looking for ways to complete their tasks more quickly. With the newly developed NOEtop stripping corner, NOE-Schaltechnik, Süssen offers valuable time and cost savings.

Portable NOEtop stripping corners are specially designed for use in lift shafts, stair wells and building shells where space is tight. A particular point to note is that the stripping corners can be drawn in on themselves easily to release the forms from the concrete and let out again into position for the next pour without having to dismantle the internal formwork units.

Flexible

Moreover, stacking the stripping corner units takes very little time. All the installation work is performed from above. Crane hooks are attached to the NOEtop stripping corners in such a way that the units can be transported horizontally, e.g. flat for loading or unloading, or vertically, e. g. end-on for installation. NOEtop stripping corners are attached with the standard NOEtop connector, the NOE Toplock, to the formwork. They can also be bolted.

40 mm stripping play

The advantages of NOEtop stripping corners become particularly apparent during stripping. They allow approximately 20 mm stripping play each side. For stripping, the lever arm is attached to the lever head and draws the stripping corner in on itself (see photograph above). This process is repeated at each corner. The formwork is released from the concrete, which then allows the formwork to be moved in one lift. The special advantage: the internal formwork unit does not have to dismantled.

Erected in one lift

Putting the internal formwork unit into place for concreting is simpler still. This is done by attaching the sling hooks to the lever heads of stripping corners. Pulling up on the formwork with the crane moves the internal formwork automatically into the ready-to-concrete position and makes it ready for immediate reuse.

With a stroke of the inner formwork contracts and can be implemented at a time.

Handy lever

The advantage brought by the lever arm solution is particularly valuable. Compared with other formwork solutions, this has the advantage that the vertical opening movement does not interfere with the projecting reinforcement.
Thus the NOEtop stripping corner is a valuable tool that is easy to handle and saves a lot of time on site.

40 mm stripping clearance allow a fast reacting.

Complex curves and aesthetic forms

NOEplast Trier 3 plaster texture formed the ceiling soffits in the top and valley stations of the Dantercepies gondola lift in South Tyrol, Italy

In 2013, the old top and valley stations of the Dantercepies gondola lift, Wolkenstein in Gröden (Selva di Val Gardena), South Tyrol were replaced by new buildings. The extraordinary architecture with its dynamic, organic forms originated in the offices of architect Rudolf Perathoner in Wolkenstein. The buildings are notable for their three-dimensionally curved, fair-faced concrete elements with surfaces formed using NOEplast. Schweigkofler GmbH from Barbian (South Tyrol) completed the buildings in a construction time of only 27 weeks. Moreover, the contractor finished the works one week ahead of the agreed programme, despite landslips severely disrupting operations on the site for a whole month.

A lightly textured ceiling soffit formed with the help of NOEplast textured formliners not only creates an architectural accent, it also breaks up the sound waves in the hall to achieve good room acoustics.

Curve shapes, high-quality fair-faced concrete and extraordinary aesthetics – these are the hallmarks of the new top and valley stations of the Dantercepies gondola lift in South Tyrol. The stations house the drive mechanisms for the lift, a landing platform for the gondolas, and control systems. The stations also offer rooms for training courses etc. Their construction presented a real logistical and technical challenge. This challenge was met and professionally overcome by contractor Schweigkofler GmbH.

Unpredictable nature

The existing stations were no longer adequate for the growing number of visitors, which provided the reason to consider their replacement with new buildings. The lift operator therefore decided to have them both replaced. The construction of the project had hardly begun when several landslips occurred, which more or less stopped progress on the work for a whole month. The route of the cableway was redesigned and incorporated an intermediate station. Despite this hold-up, the contractor was able to complete the top and valley stations a week before the agreed programme date! In view of the sophisticated architecture, this was a truly masterful performance.

Special formwork

Apart from creating the multiple three-dimensional curved shapes of the concrete elements, the contractor also had to

The new top station for the Dantercepies gondola lift, Wolkenstein in Gröden (Selva di Val Gardena), South Tyrol, Italy.

The ceiling soffit with the plaster-like finish of NOEplast texture Trier 3 ensures good room acoustics prevail in the hall. Approximately 400 m² of textured formliners were used in total. Uniform mat sizes provide a secondary pattern to the ceiling.

ensure the ceiling surface flowed seamlessly into the wall surface. Complex special formwork was required to achieve this. The formwork was made up of several individual elements, which consisted of a prefabricated support system on which boards were placed vertically end-on. The tops of the boards were curved to correspond with the local curvatures of the building. The maximum size of the elements was limited to 2.50 x 3.00 m so they could be transported safely up to the site at an altitude of 2400 m. Once there, the Schweigkofler site team lifted them to the required height (usually about 9 m above the floor) and placed them on support struts using a crane. Only then could they attach the formwork facing. A single form was installed where the surface was to a large extent horizontal. However, first face and second face forms were required at the positions where the horizontal surface merged with the vertical and at the vertical surfaces. Overall the formwork was so complex that it had to be detailed with great care on three-dimensional drawings by the architectural consultant Perathoner.

Mechanical and chemical surface treatment

Not only the formwork required special attention. As the specification called for different surface finishes to be formed in various ways, this aspect of the work also had to be thought out carefully. For example, some of the walls were to be bush hammered. This is a manual method which removes a thin layer of concrete to leave the surface with a uniform appearance. Other walls were to be given an exposed aggregate finish, with aggregate sizes up to 30 mm diameter.

Textured formliners

In contrast to the two processes mentioned above, polyurethane mats – in this case textured formliners – are placed and fastened into the formwork. A special release agent is applied to the formliners before concreting. As soon as the concrete has hardened, the formwork can be removed to reveal the finished textured surface. Textured formliners from NOE-Schaltechnik were selected for the Dantercepies gondola lift project.
The manufacturer markets them under the name of NOEplast and has an extensive range of standard predesigned motifs available. NOE-Schaltechnik also offers to realise customers' own designs.
With the lift stations, the designers' objective was to use lightly textured surfaces to create architectural accents and to break up the sound waves in the hall to provide good room acoustics. To achieve this, the textured formliners were installed so as to make the surface texture visible from inside the building. The choice of a suitable relief went in favour of texture "Trier 3". This textured formliner produces a concrete surface resembling a fine plaster finish.

Good quality – good to work with

The maximum dimensions of this formliner are 10.50 x 4.10 m with a thickness of only 8 mm. Being so thin, it was an easy task to attach the formliner to the complex curvatures of the special formwork. Usually on construction sites, the textured formliners are glued to the form or to a supporting board, but here, because of time restraints, the Schweigkofler team working on the lift stations decided to fix them in place using a nail gun. The result is nevertheless flawless. One reason for this is certainly the high quality of the NOEplast textured formliners. Erich Schweigkofler, Site Manager for Schweigkofler GmbH, on the textured formliners: "We obtained a large number of quotations from various textured formliner manufacturers for the construction of the two lift stations. In the end, we went for NOEplast because of the compelling quality of the product. NOEplast has the great advantage of being resilient under mechanical loading. Looking back on the experience, I must say the decision in favour of NOE was the right one." In fact NOEplast shows itself to be different in one important detail from numerous other textured formliners: a glassfibre fabric is integrated into the back of the formliner to give it additional stability, and to reduce expansion and contraction due to temperature fluctuations. The formliners can be reused up to 100 times too, a welcome advantage for the Schweigkofler team: first they used the NOEplast formliners for the top station, then reused them for the valley station. Thus they cast about 800 m² of concrete surface with about 400 m² of textured formliners. By thorough planning, speedy execution and the use of high-quality materials, Schweigkofler succeeded not only in completing the works to the satisfaction of everyone involved, but also in handing over the project a week ahead of the agreed date.

The new Dantercepies gondola lift went into operation in December 2013. (© Photo: Wolfgang Moroder, Wikipedia-Commons)

The ceiling soffit with the plaster-like finish of NOEplast texture Trier 3 creates architectural accents and ensures good room acoustics prevail.

Site board

- **Client:** Seggiovie Dantercepies spa, Wolkenstein in Gröden (Selva di Val Gardena), Italy
- **Architect:** Architekturbüro Rudolf Perathoner, Wolkenstein in Gröden (Selva di Val Gardena), Italy
- **Contractor:** Schweigkofler GmbH, Barbian, Italy

The raised and recessed binary numeric codes produce an interplay of shadow and emphasise the three-dimensional character of the concrete surface.

Facade with binary code

Concrete surface reflects the building's use thanks to NOEplast textured formliners

In Belgium, a data centre is being built. Its geometry is very plain – in one sense, it is a use-oriented, flat-roofed building with very few openings. And yet, the designers have made it into a real eye-catcher: they have covered the concrete facade with binary codes, which make reference to the building's use.

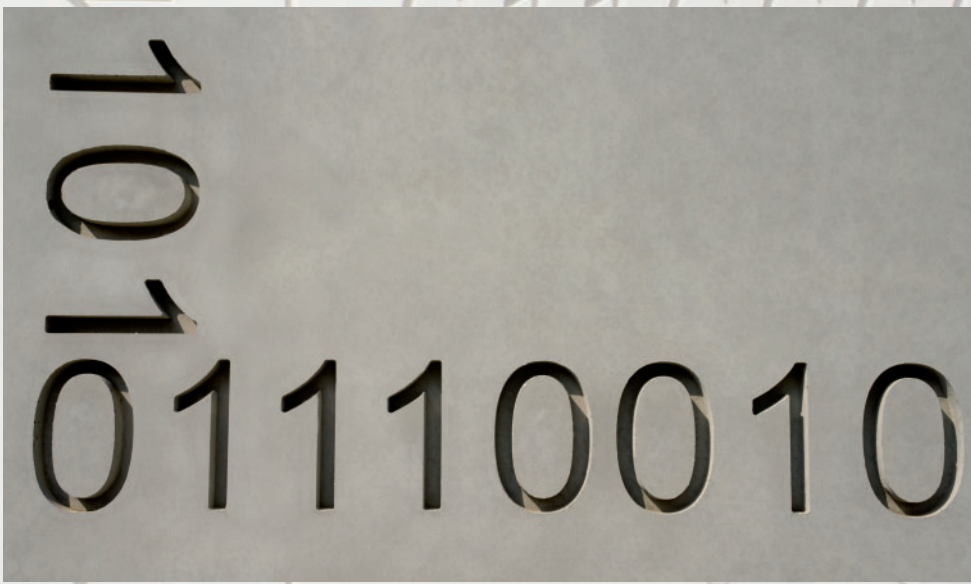
The quantity of digital data is continuously increasing. As a result, there is a demand for buildings to store and process all this data securely. Two companies, Atos, a Belgian IT service provider, and Syntago, a subsidiary of NMBS, the Belgian national rail company, are building the Alpha Cloud computer centre in Belgium. The works are taking place in Mechelen, between Brussels and Antwerp. The computer centre is notable for its state-of-the-art technology. For example, a well-designed power supply system ensures that the main computer is always supplied with electricity and continuously cooled.

Binary code in the facade

But the building is not only technically outstanding on the inside, it is a real attention grabber architecturally too: its concrete facade is covered with eight-digit binary codes made up of the numerals zero and one. This binary code is an allusion to the function of the building. It was made possible by the use of NOEplast textured formliners. NOE-Bekistingtechnik N.V., the Zaventem-based Belgian subsidiary of NOE-Schaltechnik, supplied the formliners.
An extensive range of standard textured formliners allows the user, for example, to choose between a huge variety of designs for forming of the concrete surface. NOE-Schaltechnik also offers customers the opportunity of realising their own design ideas.
The latter option was taken up for the Alpha Cloud project and eleven motifs were designed for the building. The NOE-Schaltechnik engineers used a CNC milling machine to transfer the customer's motifs onto supporting boards, which formed the basis for the manufacture of the textured formliners. Special aspect: normally the designers choose textures in which the motif is either recessed into the concrete surface or projects out of it. In this case, the designers included both effects and thus gave the facade a special sculptural appearance.

Binary numeric codes create this building's unmistakable exterior.

According to Wikipedia, a binary code comprises information expressed in a sequence of two different symbols (for example 1/0). The word is derived from the Latin prefix bi, which means two or double. 01110111 is binary for "w".



Multiple uses – save money

In order to build the computer centre as quickly as possible, the site management opted to use precast concrete units. The facade panels were subsequently manufactured in the precast concrete works as composite elements. Although each of the eleven formliners had dimensions of only 1.41 x 1.41 m – almost two square metres in area – multiple uses made it possible to manufacture all the concrete panels necessary for cladding the 2700 m² facade surface from them.
NOEplast textured formliners can be reused up to 100 times! The precasting works team realised that by assembling modules of three of the square standard textured formliners, they could work in the most efficient way by concreting a 4.23 m width x 1.41 m high panel in one pour. This saved time not only on the concreting but also on the erection, which contributed to building the computer centre in less than twelve weeks.

01101100 is binary for a lower-case "L"

Light and energy-saving

The panels were cast in self-compacting C30/37 concrete. The surface is very light in colour, which means that the building heats up less in summer than one with a darker surface would. This contributes to a better energy performance because the cooling system has less to do. The light grey facade looks bright and friendly. With the Alpha Cloud data centre, the designers have succeeded in creating a

Which are the duplicated panels?

real eye-catcher out of a geometrically very plain 3000 m² building, while satisfying the highest possible technical requirements. This was possible with good planning and dependable materials, such as NOEplast textured formliners.

Above: Binary numerical codes give this building an unmistakable exterior while revealing its use. Right: A concrete surface that raises the observer's curiosity. What do the numeric codes mean? What lies hidden in the building?

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The images in NOEreport are situational moment shots of construction sites. Therefore security and anchorage details can not always be considered as final.

Cover: *01110111 is binary for "w"* – *See report page 12*

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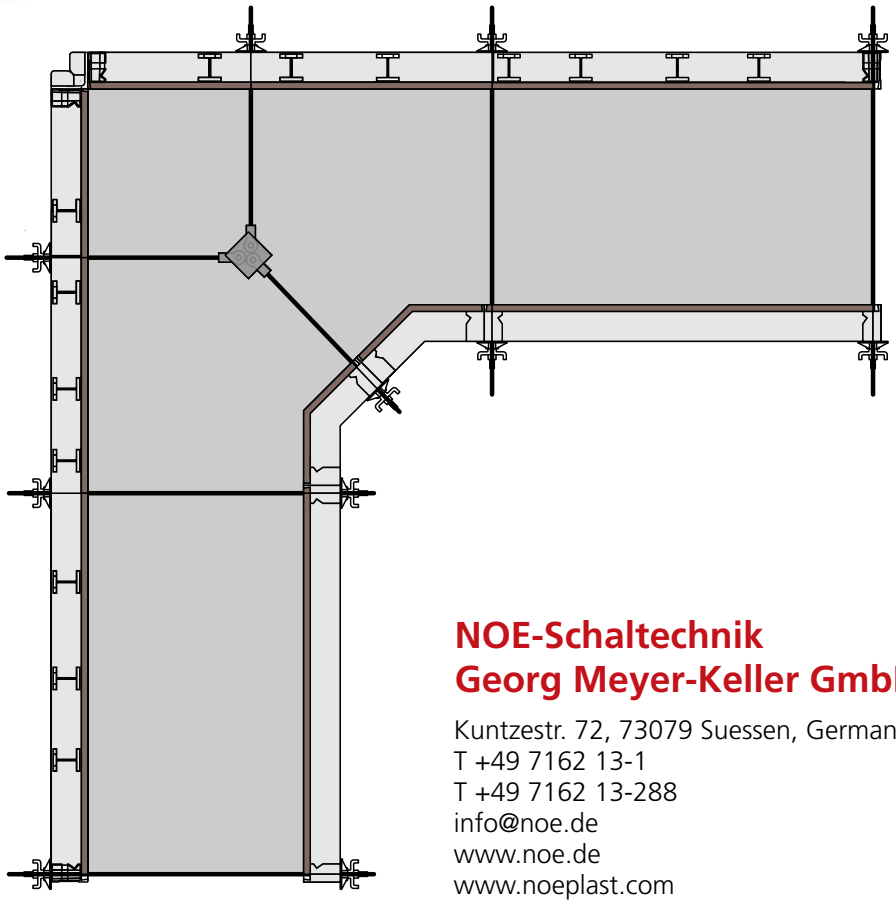

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