THE FORMWORK

NOE® report

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Efficient concrete formwork for climbers

One of Europe's largest climbing and bouldering centres is being constructed in Munich with NOEtop large area panels

Up to 15 m high fair-faced concrete walls constructed in one pour by contractor Grossmann-Bau, Rosenheim. This was made possible by the use of NOEtop large area panels with integrated bracing.

Europe's largest climbing centre is due to open in early 2015 in Munich. The works included 15 m high fair-faced concrete walls cast in one pour. This was possible only by using NOEtop, the proven wall formwork system manufactured by NOE-Schaltechnik, Süssen, Germany.

From early 2015, it is very likely that anyone who happens to be close to Munich's Allianz Arena will see people climbing its walls. This is not because agitated spectators at the games in the stadium are being "driven up the wall" but rather that one of Europe's largest climbing and bouldering centre has been built in north Munich. The facility is intended to serve both

Setting up the formwork for the 15 m high fair-faced concrete walls.

competition and leisure climbers and offers bouldering as well as roped climbing. Boulderers are not secured by harnesses or similar safety devices. To prevent injury, thick mats are placed below the climbing walls, which are low enough in height to jump off, if necessary.

Room schedule

The new climbing and bouldering centre includes a climbing gym with around 400 m² of floor space, a height of 15 m and a separate training area. In addition, the plans show a bouldering gym with around 800 m² floor space and a height of 6 m, as well as a children's area. However, the climbers do not climb only inside the gyms, they also scale the external walls of the building. Outside, a roofed area provides approximately 1200 m² of climbing surfaces and an outdoor bouldering area, which can be directly connected to the bouldering gym by a sliding door. As well as these climbing facilities, the leisure centre has the usual locker and sanitary rooms, a bistro, a shop and many other amenities to make the visitor's time there a pleasant one.

Construction

The building is of reinforced concrete construction. The contract was awarded to Grossmann-Bau from Rosenheim, Upper Bavaria. The contractor already had experience in building climbing gyms. For example, in 2000 Grossmann-Bau built the DAV climbing centre in Thalkirchen, also in Munich, which was doubled in area in 2010, to the satisfaction of everyone involved. With the new Munich climbing gym, one of the greatest challenges was its 15 m high free-standing walls. They have a total length of 80 m and were constructed in 8 concrete pours, each extending to the full wall height.
Franz Huber, Project Site Manager, says: "One of my biggest worries with these walls was that the concrete would segregate in the formwork during the pour. Consequently, we had to proceed very carefully."

Formwork

The height not only presents the risk of concrete segregation; particular care was also necessary in the design of the formwork. Its great height generates enormous concrete pressures on the panels during the pour. To be adequately equipped for these tasks, the Grossmann-Bau team opted for NOEtop from NOE-Schaltechnik. The chosen product is a steel frame formwork system capable of withstanding a concrete pressure of 88 kN/m² and outstandingly robust. Thanks to the system's integrated bracing, it can be used as beam formwork in which the tie bars can be placed anywhere in the bracing.
Günther Aufhammer, Project Foreman, comments: "To reduce the risks involved, we had to place the concrete relatively slowly. Therefore we were pleased to be using NOEtop. With another formwork panel, the whole thing would probably not have worked."
We find NOEtop performs excellently thanks to its particularly thick-walled steel frames (3.5 mm), which give the panels their extraordinary strength. The system also eased the task of the site construction team in another respect: because NOEtop is one of the manufacturer's main standard formwork systems, there is a huge range of accessories available, such as self-securing walkway brackets, articulating external formwork corner units and much more.

Corner expertise

The manufacturer's adjustable internal and external corners were used on the Munich site. These units make erecting non-square formwork corners a very quick operation. They have an easily operated mechanism that allows corners to be set at angles of 60 to 180 degrees. A PU corner strip protects the mechanism by preventing cement or rust from forming deposits inside it and stops water from bleeding out of the concrete.

The height of achievement with formwork technology in the construction of the climbing and bouldering facility in Munich-Freimann. On completion, it will be one of the largest and most up-to-date climbing centres in the world.

The consistent panel pattern looks good with end-on and side-on NOEtop wall formwork panels.

15 m high fair-faced concrete walls constructed in one pour.

Hence the NOE stripping corners considerably simplified the work of the site construction team on this futuristic climbing gym, where very few walls meet at right angles.

Fair-faced concrete

A further requirement demanding the particular skills of this contractor was that the majority of the surfaces had to be left visible in fair-faced concrete. Although the highest class of exposed concrete finish was not called for here, the Grossmann-Bau team placed great emphasis on achieving an aesthetically uniform concrete surface. As a result, they decided to use NOEply formwork facing. This product offers several advantages. For example, it strips easily from the concrete and gives the surface a consistent appearance, despite being used a number of times. Variations in colour were avoided.

"The NOE products performed well on site and were essential to efficient working," says Franz Huber. So much so that the contractor was able to deliver within the specified construction time of only four months.

Site board:

- **Client:**
  Trägerverein der Münchener Sektionen für die Kletteranlage München-Thalkirchen e.V., Munich
- **Architect and site management:**
  rgp Architekten, Munich
- **Main contractor:**
  Grossman-Bau, Rosenheim

Short construction time thanks to NOEtop large panels

NOEtop large panels result in short construction times for affordable housing in Munich

A residential complex with 69 housing units, a basement garage and several shops stands on a plot with an area the size of a small football pitch in Munich. The complex was built with the help of systems supplied by NOE-Schaltechnik, Süssen, Germany.

Almost unnoticed by the Munich public, a small urban quarter in Schwabing-West has blossomed into an up-market residential and business district from its origins as an obscure outlying suburb. In addition to several residential buildings, the area now has shops, a multi-generational housing block, a school and much more. Part of this development is being constructed on behalf of GEWOFAG Holding GmbH, a housing association based in Munich. With around 37,000 housing units, GEWOFAG is one of the largest landlords in Munich and focuses on offering homes to people who would have little chance of finding accommodation on the open housing market. With the concept "Wohnen im Viertel" (Local Living), a further aim of the housing association is to enable older people and those dependent on care to live independently in a safe environment.

New affordable housing

As part of GEWOFAG's contribution to the provision of affordable housing, the development in Isoldenstrasse, at the corner with Rümannstrasse, will have 69 housing units, a basement garage and

Advantage: NOEtop large panels have a formwork area of over 14 m². These panels can be used end-on or side-on without disrupting the panel grid. The tie bars can be placed anywhere in the bracing. The system can also be used as single-sided formwork.

On a 4100 m² site – roughly the area of a small football pitch – this part of Munich now has 69 housing units, a basement garage and several shops.

NOE H20 deck formwork rounds off the full service package for the Isoldenstrasse Housing Development project.

several shops stocking everyday groceries and goods. The plans place great emphasis on providing a good quality of living. Many of the apartments have been designed to comply with the DIN 18040 requirements for barrier-free accommodation. The whole building meets the KfW-55 standard for energy efficiency. To help achieve this, the building is constructed in reinforced concrete with an external thermal insulation composite system (ETHICS). The concrete structure was built by Emil Mayr Hoch- und Tiefbau GmbH, a contractor based in Ettringen, Bavaria. In less than just 20 weeks, the site team constructed 60 000 m² of wall and 19 000 m² of ceiling in reinforced concrete.

Wall formwork

Emil Mayr Hoch- and Tiefbau GmbH chose to use NOEtop for the walls. This is an extremely robust wall formwork system, which has an allowable concrete pressure of 88 kN/m² and is easy to handle. Integral bracing in the large-area panels allows a free choice of tie bar positions. It can also be used without problem as single-sided formwork. NOEtop is available in many different sizes (height 0.66, 1.32[5], 2.65, 3.31 and 5.30 m; width 0.25 to 5.30 m), almost all of which were used on the Munich project. For the most part, Emil Mayr used the NOE XXL panel with dimensions of 5.30 x 2.65 m. For the basement and the above-ground storeys, the panels were used side-on, for the ground floor they were end-on. The panel has over 14 m² of formwork surface and is one of the largest on the market. These panels were mainly used for the basement and ground floor, i.e. where walls up to 5.50 m high had to be formed. Because the basement was constructed in waterproof concrete, the maximum length of wall that could be poured in a shift was 15 lin m. All the more helpful, in this case, was the casting sequence plan drawn up by the NOE engineers specifically for this site. Using the plan, the site manager was always

Dismantling the internal formwork unit, e.g. in the case of lift shafts or stairwell cores, is not necessary when using NOEtop stripping corners.

After release from the concrete surface, the internal formwork unit can be drawn slightly into itself by the upward pull of a crane. 40 mm stripping play means moving the unit to the next pour is done quickly. The crane rope is reattached and a further pull upwards by the crane returns the internal formwork unit to its original cross-sectional dimensions, ready to form the next pour.

aware of how many panels needed to be retained on site at any time and which elements could be combined with one another most efficiently.

Lifts

The Emil Mayr Hoch- und Tiefbau GmbH site team's work on the Munich project was made easier by the use of NOEtop stripping corners. The stripping corners consist of articulating units specially designed for casting corners in parts of buildings where space is restricted, such as inside lift shafts. After release from the concrete surface, the footprint of the internal formwork unit can be reduced by about 4 cm each side by the upward pull of a crane. The internal formwork does not have to be dismantled, which makes stripping considerably easier. After moving to the next position, the crane rope is reattached and a further pull upwards returns the unit to its original cross-sectional dimensions, ready to form the next pour. In a total of eight lift shafts, each of which extended over five storeys, the NOEtop stripping corners proved to be a great help in keeping up with the rapid tempo of the programme.

Also used in the construction of the housing development on Isoldenstrasse: NOE steel column formwork.

Ceiling formwork

To erect the ceiling formwork as quickly as possible, Emil Mayr Hoch- und Tiefbau GmbH also called upon concrete formwork from NOE-Schaltechnik and used, among other things, NOE H 20 deck formwork. The many beams and slab projections in the basement and ground floors presented a sizeable challenge to the Munich site staff, but the system's great flexibility of use meant this potential problem was quickly overcome with NOE H 20 deck formwork. The contractor was then able to complete the ceiling slabs quickly and efficiently.

Satisfaction

This was the first time Site Manager Oliver Beer and Foreman Maik Haussner, who ran the site for Emil Mayr Hoch- und Tiefbau GmbH, had worked with NOE formwork and they were very satisfied with the systems and the service. Oliver Beer says: "Using NOE formwork required hardly any initial training. Although the system was new to us, the work progressed at a brisk pace." His colleague Maik Haussner adds: "And the service from NOE was very good; the formwork was supplied quickly. Whenever there were questions, an expert advisor was always available." It is good when a company receives such positive feedback following a successful partnership.

Large area advantage: a final concrete surface that is just about perfect.

Branich Tunnel: NOEtec – an ideal formwork system for engineering structures

Two completely different tasks fulfilled using the NOEtec system

The 1796 metre long Branich Tunnel was built as part of the bypass of the town of Schriesheim, Germany. For the construction of the tunnel, NOE-Schaltechnik designed two formwork carriages based on NOEtec, the company's extremely flexible formwork system for engineering structures. Each formwork carriage had its own, quite different, task and some parts had to be adjustable in size.

NOEtec reinforcement carriage for the reinforcement fixing operations in the emergency bays. In order to be moved to the next emergency bay, the upper platform was retracted and the middle platform folded in.

For concreting the tunnel portal decks, main contractor Ed. Züblin AG opted for a NOEtec Deck formwork carriage.

The temporary propping was performed by NOE LS 200 heavy-duty props.

On top:
A large opening in the NOEtec deck formwork carriage ensured that the supply of construction equipment and materials to the tunnel site continued uninterrupted.

The 1796 metre long Branich Tunnel is under construction in Schriesheim – located north of Heidelberg on the Bergstrasse – as part of the town's bypass. Some 1600 m of the tunnel is being built using traditional tunnelling techniques and 200 m in cut-and-cover construction. The decision was made to use the NOEtec and NOEtop formwork systems from NOE-Schaltechnik, Süssen, for the cut-and-cover sections.

NOEtec and NOEtop

NOEtec is a beam formwork and scaffolding system consisting of a manageable number of individual elements that can be combined in any number of ways. The system is so flexible, it can be relied upon to provide a structure-specific solution on any construction site. This claim was put to the test particularly well on the Branich Tunnel. On this site, the system was used at four different locations for two different tasks: at two tunnel portals – the portal decks were concreted using a self-propelled NOEtec deck formwork carriage. And in the emergency bays inside the tunnel – a NOEtec reinforcement carriage played a crucial role.
NOEtop is a wall formwork system that excels in particular because of its large panels. Its largest panel, one of the largest on the market, has an area of over 14 m². The steel frame formwork can resist a concrete pressure of 88 kN/m² and is therefore highly robust. Thanks to the system's integrated bracing, it can be used as beam formwork in which the tie bars can be placed anywhere in the bracing.

NOEtec deck formwork carriage

The two tunnel portals were constructed using the cut-and-cover method. Main contractor Ed. Züblin AG, Stuttgart, opted for the NOEtop formwork system. To construct the decks as quickly as possible, the site team relied on a NOEtec deck formwork carriage, which the NOE engineers designed and dimensioned specifically for this task using various NOEtec system components. The carriage was approximately 10 m long, 9.6 m wide

and 6 m high. NOE H 20 timber beams supported on NOEtec transverse beams were used as boarding supports for the NOEform facing. This arrangement allowed a deck approximately 100 m² in area to be concreted in one operation. After the concrete had hardened, the formwork carriage was lowered hydraulically by about 20 cm and then moved on to the next section. The contractor used NOE LS 200 heavy-duty props to provide temporary support for the deck.
Although a NOEtec formwork carriage looks comparatively slender, it is capable of carrying enormous loads. For each concreted section of the Branich Tunnel, the deck formwork carriage had to support a load of about 360 tonnes.

NOEtec reinforcement carriage

Quite different requirements were demanded from the reinforcement carriage, which was also designed based on the NOEtec system. It was used in the two emergency bays within the tunnel tubes as a mobile working scaffold. The 14 m wide, 10 m long and 9 m high carriage supported three working platforms from which the reinforcement was fixed. It was used five times in each of the two emergency bays. Which meant that after the first bay was complete the carriage had to be moved on to the second. This was not as simple as it might appear at first glance, because the tube cross section here is approximately 2.5 m wider than the standard width in the rest of the tunnel in order to accommodate the emergency bays on the left and right of the carriageways.
As on all construction sites, time is a precious commodity, so the NOE engineers ensured that the reinforcement carriage did not have to be completely dismantled in order to fit through the smaller standard tunnel cross section to reach the second emergency bay. For this reason, they designed the reinforcement carriage in such a way that the top working platform could be lowered and the middle platform folded in sideways.
This allowed the reinforcement carriage to be simply and easily driven to the second emergency bay and then "unfolded" to the required size.

Site board:

- **Client:**
  State of Baden-Württemberg, Karlsruhe Regional Authority
- **Main contractor:**
  Ed. Züblin AG, Stuttgart

The tunnel portal walls were poured using NOEtop large panel formwork. The tie bar hole positions can be placed anywhere in the bracing.

NOEtec system advantages – short installation times

The use of the NOEtec formwork carriages in the construction of Branich Tunnel is a further example of the flexibility of the NOEtec system. In addition, the system impressed the site team with its short installation times and intrinsically self-explanatory construction. The two carriages, one for the deck formwork and one for the reinforcement, took only about 7 working days each to set up on the Branich Tunnel project. Both NOEtec carriages were designed to allow the site vehicles to pass unhindered through them and therefore caused no interruption to construction operations in the tunnel.

NOEtop wall formwork was also used for the two tunnel operating buildings, one at the east and one at the west end of the tunnel.

NOE-Schaltechnik therefore made its contribution with its flexible NOEtec system to ensuring that the Branich Tunnel will be completely finished and the traffic situation in Schriesheim considerably relieved by 2016.

This ornamental feature decorates the columns destined for the Djamaâ el Djazaïr mosque in Algiers.

Another column is prepared for concreting. The NOEplast textured formliners are laid in the form.

Columns for the third-largest mosque in the world

NOEplast ornamental textured formliners for octagonal columns

The world's third-largest mosque is currently being built right in the heart of the Bay of Algiers seafront development. A special role in the architecture of the building is played by 618 white octagonal columns. The columns were manufactured and supplied by Europoles GmbH & Co. KG, Neumarkt, Upper Palatinate, Germany. The company opted to use NOEplast textured formliners from NOE-Schaltechnik, Süssen, Germany to give the columns the required ornamentation.

Impression of the completed appearance of the Djamaâ el Djazaïr mosque in Algiers. (Visualisation: KSP Jürgen Engel Architekten)

The Djamaâ el Djazaïr mosque (Mosque of Algiers) currently being built in Algiers will be a place of worship that would stand easy comparison with many of the world's other giant religious buildings. For example, the mosque dimensions are greater than those of St. Peter's Basilica in Rome. The 265 m high minaret beats the previous record holder in Casablanca by quite a margin. The place of worship was designed by KSP Jürgen Engel Architekten from Frankfurt, whose architects saw their concept for the mosque columns as crucial in the design of the whole mosque. They fulfil not only a loadbearing function in the building; they are also an architecturally defining element. In arriving at their aesthetic form and skilful arrangement for the columns, the architects succeeded in creating a mosque with an airy, light-filled appearance, despite its gigantic dimensions.

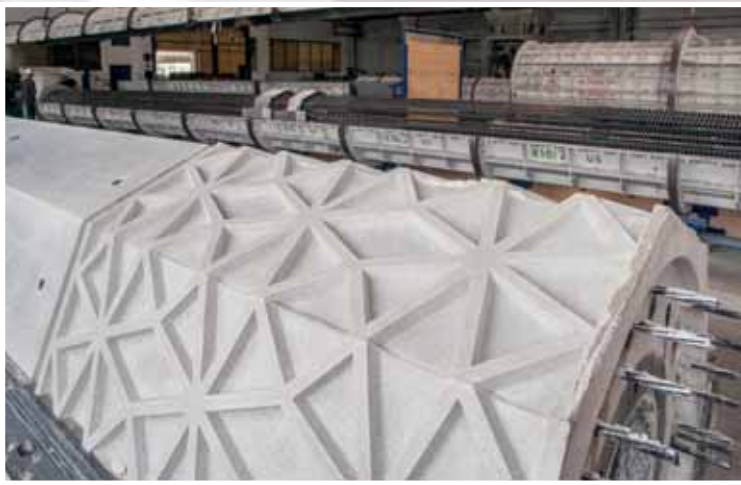
Spun concrete

The design calls for a total of 618 octagonal columns. They are extremely slender, snow white and up to 32 m tall. Because they define the building's architecture, it is important for their edges to be sharp and their surfaces defect free. To ensure this was the case, Europoles from Neumarkt in Germany's Upper Palatinate region was selected to manufacture the columns. The company specialises in manufacturing masts (e.g. for power lines) in spun concrete. The factory team introduces concrete into a long tubular form, which rotates about its longitudinal axis at speeds of up to 800 revolutions per minute. This causes the concrete to be pressed against the form walls with a force generated by the equivalent of 20 times the earth's gravity, which results in an extremely uniform and cavity-free concrete surface. The centrifugal forces create a void in the middle of the tube. This void is used in the mosque for drainage and for routeing the cables for cameras and lighting.

Architectural design

In addition to their perfect surfaces, one third of the columns have a continuous relief representing a typically oriental ornamental feature. The Europoles management team immediately recognised that this kind of eye-catching decorative feature would require the utmost precision. To be certain of success, Europoles formed the relief with the help of NOEplast. These textured formliners from NOE-Schaltechnik are notable for the high precision of the moulded shapes they produce. The formliner mats need only to be laid or glued into the formwork – depending on whether they are being used for precast or insitu concrete components respectively. All subsequent steps are the same as for normal concreting. This means the user can pour, compact and cure the concrete in the usual way. Then the formwork is removed and the chosen texture exposed to view. The manufacture of the columns proceeded in a similar way at Europoles. The Europoles factory staff had to pay particular attention to ensuring that the butt joints at all eight column corners each formed a smooth harmonious line.

Second half of the column form with NOEplast textured formliners in place.



In the foreground, a stripped column. In the background, the form for another column about to be closed.

Here you can appreciate the actual diameter of the columns.

The columns being prepared for painting.

Finished columns waiting for transport to Algiers.

Stars motif

Because the columns have different diameters, NOE-Schaltechnik adjusted the star-shaped pattern on the formliners to suit the various dimensions of each column. Thus it could be ensured that the relief would look like a beautiful, continuous band. The template for the arabesque motif was created by the architect's design staff. NOE-Schaltechnik manufactured the formliners individually according to the architect's aesthetic requirements. As well as special motifs, NOE-Schaltechnik also offers an extensive range of standard textured formliners. These include various stone and masonry textures, floral motifs and much more. These formliners provide a very simple way of giving interior or exterior concrete surfaces an individualised appearance. After the Europoles operatives take the columns out of the formwork, they have still to undergo a further process. The surface is inspected, any fins removed and the columns carefully packed for transport.

Piece by piece to provide earthquake safety

The 32 columns in the prayer hall are over 32 m high. They could not be cast and transported in one piece. Instead, Europoles made them in three pieces, which were each 10 m long and 34 tonnes in weight. They were butt-jointed together in Algiers using dowel and socket connections. The cavity between the dowel and the wall was filled with a flowing concrete mortar. The engineers designing the columns had to take into account the location of Algiers in an earthquake-prone region. Every column in the mosque supports 125 square metres of roof and carries a load of 6.0 meganewtons. To prepare the building for a seismic event, the engineers designed the concrete in the columns to fail before any other element. The reinforcement cage in the columns, on the other hand, must remain as intact as possible and be capable of supporting the roof. Only in this way would a sudden collapse of the building be avoided and the visitors given a chance to flee to safety. The hope remains that the building will never be exposed to such a catastrophe and the worshippers can spend their time undisturbed in those beautiful spaces. The mosque is due to be completed by the middle of 2017.

Site board:

- **Architect:**
  KSP Jürgen Engel Architekten, Frankfurt am Main
- **Structural engineer:**
  KREBS UND KIEFER International GmbH & Co., Darmstadt
- **Column supplier:**
  Europoles GmbH & Co. KG., Neumarkt, Upper Palatinate

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