

## Mosque in Cologne: elaborate in situ concrete dome construction

The Turkish-Islamic Union (Diyanet Isleri Türk Islam Birliđi, DITIB) is drawing attention to itself by building the largest Islamic community centre and mosque in Germany. By the end of 2011, Cologne will have a new centre with a floor area exceeding 20 000 m<sup>2</sup> plus a mosque with two minarets each 55 m high.

Following the architectural competition held in 2005, won by the renowned Cologne-based architectural practice Paul Böhm, construction work began on this unique structure. Despite its size and exposed position, this building complex blends in well with surrounding developments. Large glass façades ensure an open, inviting character.

The complex provides ample space for offices, shopping precinct, assembly hall, internal courtyard with sculpted fountain and prayer room. The latter, providing space for some 1200 Muslim worshippers, is located beneath a segmented and curving reinforced concrete dome, approx. 1000 m<sup>2</sup> in area, 34.50 m high and aligned exactly to face Mecca.

### Good planning right from the outset

Owing to the demanding geometry of this reinforced concrete structure, client, architect and structural engineer decided to involve formwork specialist Doka right from the start. Doka's formwork engineers were therefore able to contribute to the structural works tender, providing valuable advice to ensure the right sequence of site operations and economical formwork designs. That meant that all the tenderers could base their submissions on a well-engineered concept, which in the end led to Nuha Bauunternehmung GmbH & Co. KG from Düsseldorf being awarded the contract. The actual requirements were then fine-tuned and optimized once more.

### Challenging geometry

Contractor Nuha decided to rely fully on the experience of Doka's experts for the formwork engineering for this building in the Oriental style. The entire structure is in situ reinforced concrete and, indeed, all the external surfaces, including the dome, in fair-face concrete, more than 10 500 m<sup>2</sup> of which was subsequently given a bush-hammered finish.

Another challenge for the entire team was the dome structure, which is split into several pieces that seem to grow together as they rise to form the central dome, and are totally separate at ground level. They remain separate up to a height of 21.00 m, spreading out and cantilevering by up to 12.00 m at the same time. Only near the top of the dome do steel rings connect the shells to form a coherent structure. Besides an ingenious formwork concept, Doka also supplied wall formwork from its Top 50 modular system. The Staxo 100 shoring tower, designed for very heavy loads, provides dependable support for components that are up to 1.20 m thick.

For the complex geometry of the dome, the Doka "ready-to-use" service pre-assembled more than 2000 m<sup>2</sup> of special formwork in single and double curvature with millimetre accuracy. Custom formwork solutions always make use of as many standard items from the stock of formwork for hire, which keeps costs down. Moreover, the formwork engineers always use the minimum number of elements with the maximum number of reuses, taking into account all boundary conditions – another factor that has a positive effect on costs. Elements were initially "parked" in the Doka warehouse and delivered to the building site on a just-in-time basis as work progressed. That created a lead time and safeguarded deadlines for the plans of the site management. Doka sees itself as a partner to building contractors, contributing to the economic success of every building site



**Fig. 1.** The mosque challenge: several concrete shell segments gradually growing together as they rise to form the central dome



**Fig. 3.** An experienced supervisor supports site staff when handling formwork for such non-standard component geometries (photos: Doka)



**Fig. 2.** More than 2000 m<sup>2</sup> of special formwork in single and double curvature pre-assembled with millimetre accuracy by the Doka “ready-to-use” service for the complex dome geometry

– even those as complicated as the one here in Cologne. The ancillary buildings were also constructed entirely with Doka formwork, where contractor Nuha made use of its own stocks of Framax Xlife and Dokaflex.

**Staxo 100 tower: a reliable working and shoring scaffold**

The curving shells forming the dome start above the vertical walls up to 7.00 m high, at the floor above mezzanine level. From this point on, the structure is divided into 3.25 m high concreting pours, with the formwork supported step by step on Staxo 100 loadbearing towers which are extended to match progress. First of all, the same shell formwork was used for producing segments with practically identical geometries. Later, the elements had to be modified for each subsequent reuse – with

exactly defined cross-sections that were nevertheless easy to produce on site.

During the early stages of the work, on the lower levels, the Staxo 100 loadbearing towers were used exclusively as working scaffolds with very low loads in the legs. However, already taken into account at this stage was the fact that months later, at heights of up to 36.00 m, the entire weight of the concrete, and that means 0.50–1.00 m thick cantilevering and inclined dome segments, would need to be carried safely. Until the installation of the stabilizing steel rings linking the shells, the scaffold was therefore not only designed to act as formwork, but also integrated into the structural concept as reliable shoring.

**Working together as partners ensures success**

Doka can provide a tailored package of valuable services for every construction phase, on this project also the production of drawings for the double-curvature dome surfaces. Furthermore, a skilled formwork coordinator was on site during all the most important phases of the work. Formwork planning and sequencing of operations on site plus the delivery of materials were all finalized in constructive discussions. The presence of an experienced supervisor at certain times reassured the site workforce when working with these out-of-the-ordinary formwork geometries.

Nuha project manager Gani Nuha has a positive view of the experience with Doka to date: “Critical for our decision to award the contract to Doka was the company’s broad project expertise and many years of competent cooperation in earlier projects – a partnership that works both ways.”

**Further information:**

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