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Precast concrete architecture in Central Europe

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Hardly any other building material is in such demand at the moment by architects and is more diverse in use than concrete. This is once again reflected in contemporary architecture. The material that was mostly used previously for construction, has since become an architectural statement of the surface, that emphasises its message self confidently both visually and haptically. The times of stereotyped concrete blocks are over, in the meantime the "Modern marble" now appears virtually refined, often with velvet matt surfaces, which are coloured or textured at times. Concrete as a styling medium and design form of modern architecture is experiencing a true renaissance. Of course not just the aesthetes but also the technologists have taken on the material in the past few years. Hardly a material is currently more innovative than concrete. Research institutions and companies around the world are working on developing new, customised types of concrete for general and special applications.

Concrete is now synonymous with high-tech. Concrete technological innovations and developments pave the way for a new exciting future. 3D printing is just one of many keywords in this field. Self-compacting and ultra-high-performance concretes promise sculptural and filigree constructions and an architecture that could not be built in the past. Glass fibre and textile reinforced or even translucent concrete open up the range of possibilities that concrete architecture offers the planners nowadays. However, despite all nanotechnology and concrete technology opening up new design freedom for planners, the most wonderful thing about concrete remains its endless versatility in terms of its visual and haptic appearance. And to this purpose no new developments and compositions are needed; the imagination of the planners is sufficient. Each thus has the possibility to create his own individual and unique concrete look.

The design of the decisive last few millimetres is endlessly versatile. From the choice of the colour, the building material composition and the surface processing to the geometrical moulding of the concrete structures, the designer has a massive arsenal of possibilities at his disposal to realise his ideas in fluid stone. Concrete is a challenge. Poor planners get lost, but for good planners the limits of concrete are the limits of their imagination. Concrete design is a supreme discipline. Particularly, facades made of prefabricated concrete elementsare constantly challenging the architects' individual design. They can be designed and realized very differently. Especially in recent years, precasters, in collaboration with architects, have designed a series of buildings for diverse uses, which have caused a stir in the architectural community. They prove that modern production techniques allow the realization of formal and constructive but also structural sophisticated designs. The presentation takes you on my private and diverse journey through the current precast concrete architecture to be found in Central Europe showing some of the trends and innovations in precast building reflected in objects and products.But keep in mind: it's just a small selection out of the concrete universe.

Structural precast elements

Office and production building, Munich (Germany)
Architecture: Kurt Tillich

In Munich, a building like a dark crystal, a geometrically folded structure that catches the eye immediately among the monotony of commercial properties due to its form and structure, shows how one can create a wonderfully individual piece of architecture with a high-value and noble appearance using architectural concrete façade elements (Fig. 1). The volumetric structure of anthracite coloured concrete is divided by a three-dimensional, geometric fold and the strongly carved-out joints.The exposed position shows the geometric play of the facade, its sequence and the shaping of the corners to their best advantage. Depending on the time of day and year, the weather and the incidence of light, the façade constantly changes its character and is modulated to a greater or lesser extent. The plastic form of the matt shining, smooth concrete surfaces is further increased via the vertically bending joints. The sharp and precise edges and the lively, genuine surface transport this standard. Due to the high degree of prefabrication, the short construction

Fig. 1. Office and production building, Munich

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period and the financial advantages, the choice fell at an early stage on a sandwich construction with core insulation. The entire wall element with base layer, insulation and façade shell is manufactured in the precast plant. The elements measure 6.60 m x 3.90 m with a thickness of up to 62 cm and a weight of up to 24 tonnes.

Alexa department store, Berlin (Germany)
Architecture: José Manuel Quintela da Fonseca

Alexa is the name of a shopping and leisure centre that was built on the Alexanderplatz in Berlin (Fig. 2). From a technical point of view, the Art Déco-style façade made of precast elements represents the state of the art in the manufacture of concrete façades. As a rear-ventilated curtain wall with a three-dimensional surface, the façade had to satisfy the highest architectural demands. Due to the high demands on the quality of the fair-faced concrete and the complex geometrical forms, the entire façade was designed to be built with precast elements, which were subsequently mounted onto the shell construction at the building site with a custom fit as an exterior shell. Various façade structures were manufactured for the Alexa: vertical double columns and horizontal beams form a mullion and transom construction, the areas in-between form an even, negative wave structure. A further structural element is characterised by vertical, smooth double pilaster strips with curtain walls hung in-between. The structure resembles a slightly inclined and gathered theatre curtain with one upper and one lower border. One particular highlight is a façade element in the two lower storeys that is comprised of a continuous arch structure. The surface structures of the dyed fair-faced concrete façade were not handed over as conventional working plans on paper, but rather as a CAD-designed 3D data model. Based on the CAD construction designed by the architect, the moulds had to be manufactured as negatives of the subsequent fair-faced concrete façade elements. The prototype façade thereby became a pilot project in three-dimensional CNC-assisted formwork construction. This production technique, which was new in formwork construction, was used mainly for the manufacture of the wavy surface structures, almost like a gathered theatre curtain.

Fig. 2. Alexa, Berlin

Community centre, Mannheim (Germany)
Architecture: netzwerkarchitekten

The community centre in Mannheim (Fig. 3) can be considered to be a successful example of the use of a delicate façade made of concrete precast elements. The building presents itself to the outside with its striking individual white concrete façade, which above all provides a poetic counterpart to the homogeneous surroundings. The form, inspired by blades of grass, gives the building a uniform appearance, independent of openings and closed elements in the mullion and transom façade behind it, which is the actual room partition. The precast elements were manufactured from smooth-formed concrete with white cement in a made-to-measure mould. One of the difficulties in manufacturing the precast parts was that the steel reinforcement had to be bent in order to adapt it to the form of the mould.

Fig. 3. Community centre, Mannheim

Ultra high performance concrete

Dress Your Body, Comondréche (Switzerland)
Architecture: Atelier Oï

The Dress Your Body company opened a production building on the slopes above Lake Neuchâtel in Switzerland with a striking façade made of concrete precast elements (Fig. 4). The south façade, which is well visible from a distance, is the company's representative dress. It is assembled from rectangular concrete elements, creating the

Fig. 4. Dress Your Body, Comondréche

impression of a repeating pattern. 3 x 15 rectangles are cut out and presented with mirrored frames as window openings. The 11 x 74 m wall is otherwise punctuated only by a narrow slit that indicates the main entrance. The façade elements, which were developed especially for the building, are cast in ultra high performance concrete and held by a metal frame. Their round holes are irregularly positioned and are of different sizes, so that the finest possible connecting bridges of up to only 10 mm in thickness are created. Over and above its decorative function, the semi-transparent façade mainly serves as a sun filter: the thickness of the wall and the distance to the glass façade behind it have been chosen so that, in summer when the sun is higher in the sky, the façade breaks the direct light on the one hand and screens the building from the heat on the other. In winter, however, the rays from the lower sun penetrate the façade openings, brightening up the everyday work with daylight and serving as an additional source of energy.

Museum of European and Mediterranean Civilisations, Provence (France)
Architecture: Rudy Riccotti

The dramatic MuCEM (Museum of European and Mediterranean Civilisations) was the jewel in Marseille's European Capital of Culture programmein 2013. With this museum, French architect Rudy Ricciotti gave a new dimension to ultra-high performance concrete that has never been explored before. For this project Rudy Ricciotti has imagined a breathtaking design with a double façade (Fig. 5). The main building, with its glass windows, is wrapped in an intricate black concrete mash lacework screen that creates a North African feel. Ornamental concrete shrouds the glazed exterior of the museum like a lacy veil, moderating light through to the building's two exhibition floors. The museum is remarkable in its pioneering exterior skin of delicate filigreed concrete – an architectonic feat of prestressed concrete and building system. In this 15,000 m² mineral cube, concrete is king and gives all its strength and lightness to the building. Because of its delicacy, its flexibility and its high resistance, ultra-high performance concrete (UHPC) made possible the architectural feat and technical challenges of the MuCEM. A unique structure worldwide: UHPC prestressed concrete columns are a world première. Another originality: the floors were manufactured first, then laid on scaffoldings and then bound with columns. The result: the visitors of the museum can enjoy large column-free spaces to admire the art pieces. The ultra-high performance concrete allowed manufacturing the 384 panels of the lace covering with delicacy the two facades and the roof of the museum. A 820 m walkway suspended between the inside space and the outside: Between the columns and the heart of the building, the corridors wind around the museum.

Fig. 5. MuCEM, Marseille (Credit: Lisa Riccotti)

Italian national pavilion at EXPO, Milan (Italy)
Architecture: Nemesi & Partners

For the EXPO 2015 in Milan, the Nemsi & Partners architects from Rome has designed the Italian pavilion, with a facade which is both handsome and pragmatic (Fig. 6). The design of this amazing architecture is characterized in a strong and clear way by its branched skin, which embraces the volumes articulating the public and inner space. The precast manufacturer has been able to give shape and value to this brave skin. It's contribution fits in line with this type of

Fig. 6. Italian EXPO pavilion, Milan

valued innovation, on many levels, in cascade and parallel ways: from the decisive intuition, through the design and production up to installation. The solution to make this façade executable and constructible, full and rarefied at the same time, but especially unique in its evolution and show to the world, was to conceive the branches through overlappings or layers. A primary and structural repetitive layer every floor, and three architectural exterior layers everyone different. For those panels visible from the inside of the building, a fourth architectural layer is added inside. These architectural layers, all different but in a precise continuity according to the plan conceived by Nemesis & Partners, give life to the uniqueness of the ribs's scheme visible on the façade. From for the massive basements, slightly inlaid or perforated, you climb into a crescendo of branches not at random, up to rarefied panels with 3/4 voids resulting from the intersection of thin and slender branches.

The design mainly performed in 3D, involved an architectural work in collaboration with the designer, an engineering one and stress analysis. For 9000 m² of façades with 725 unique panels, were made a total of over 9000 drawings. The 3D design allows to steer not only the complexity of products design but even the manufacturing of the façades elements, the related adjustable supporting and connection systems, and the installation phases. The careful parameterization of the various branches led to new aesthetic configurations in the intersection of the various branches with variable section and inclined plans, increasing the spatial compositional articulation foreseen originally. Each panel has been modeled with specialized software and then sent to production, using a sophisticated technology to get real synthetic resin molds for each product.The manufacturing industrialized process created on the basis of previous experiences, used formworks and molds with accurate surfaces to ensure a very high quality final appearance on all sides of the products, which typically have dimensions of 4 meters per side with differentiated thickness and full / empty ratios. Formworks are vertical, horizontal, inclined or curved with dedicated molds depending on the final shape and position of the item and in respect of the extension of the required finish.

Floral concrete domes in the new Federal Criminal Court in Bellinzona (Switzerland)
Architects: Gramazio & Kohler

The former commercial school in Bellinzona has been converted and extended and turned into the new Federal Criminal Court (Fig. 7). Particular eye-catchers in the building are the floral ornamental concrete domes. In the inner courtyard the architects placed a visitor foyer that is framed by two small courtrooms and can be separated from the sacral-looking large courtroom by a wide folding door. The four square rooms are illuminated by skylights, which open at the tip of pyramid-shaped domes. These are adorned for acoustic and decorative reasons with a tracery-like open-worked floral ornamentation. The plasticity of the truncated pyramid contrasts the otherwise smooth structural elements and is based on a simple plasticine model that was translated into point-symmetrical, triangular precast concrete elements by the architects Gramazio & Kohler, who specialise in digital fabrication. The organic pattern achieves the acoustically necessary number of holes, serves the fastening of lights and is reminiscent of the foliage of a "tree of justice", under which justice was dispensed in olden days.

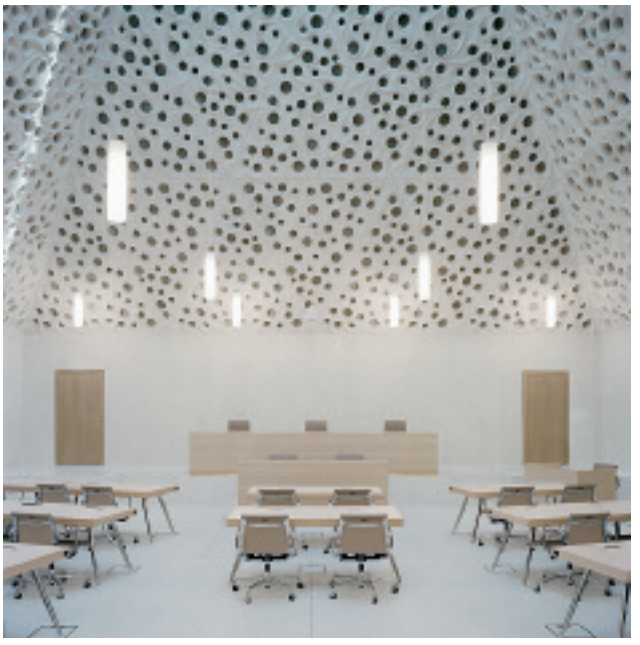

Fig. 7. Federal Criminal Court in Bellinzona

Glass fibre reinforced concrete

Lake Constance pebble, Friedrichshafen (Germany)
Architecture: Braunger Wörtz

An organically formed event hall with three-dimensionally curved walls was erected using a self-developed, elaborate method. The hall is comprised of a timber/steel support frame, to which over 100 glass fibre reinforced facade elements were attached. For the production of the precast elements, the manufacture of CNC milled templates on the basis of a CAD model was out of the question for reasons of cost. The building company therefore came up with an unusual alternative: a 9 metre high, 1 : 1 model made of foam polystyrene (Fig. 8). The manufacture of the precast concrete

Fig. 8. Lake Constance pebble, Friedrichshafen

parts took place using a very complex method. Following the electronic scan, the foam polystyrene igloo was first of all sawn up into over 100 parts. These 'puzzle pieces' then served as finished moulds for the glass fibre reinforced concrete elements, which have a wall thickness of just 2.5 cm.

AA DRL-Pavilion, London (England)
Architecture: Dempsey, Huang

To mark the 10th anniversary of the AA Design Research Laboratory (Fig. 9), entries were invited to a design competition in which an innovative structure made of 13 mm thick, glass fibre reinforced concrete slabs was sought. A walk-in, complex pavilion in the form of a shell and measuring 10 x 10 x 5 metres was the result. In joining together the individual concrete sections, which serve simultaneously as support structure, façade, floor, walls and fittings, the tensile strength of the glass fibre reinforced concrete slabs was put to use and a simple interlocking notch connection was developed that is held together by a precisely fitting rubber seal.

Fig. 9. AA DRL-Pavilion, London

Bridge Pavilion, Zaragoza (Spain)
Architecture: Zaha Hadid

Another impressive building with glass fibre reinforced concrete elements is the 275 metre long bridge pavilion built for the world exhibition EXPO 2008 in Zaragoza in Spain (Fig. 10). The architect chose triangular panels made of glass fibre reinforced concrete for the outer skin. A sophisticated pattern of 29,000 glass fibre reinforced concrete panels in different shades of grey produces an effect like shiny fish scales.

Fig. 10. Bridge Pavilion, Zaragoza

Graphic concrete, colour & form liners

Photoconcrete: University of Applied Sciences, Eberswalde (Germany)
Architecture: Herzog & De Meuron

In photoconcrete, a photographic contrast image is created on the concrete surface by means of the pixel-by--pixel application of the retarder. The effect of the retarder is that the concrete hardens at different speeds in different places. The results of this are rough and smooth areas as well as light-dark graduations. The light areas of the motif remain smooth, whilst the dark ones are washed out.

One of the largest photoconcreteproject so far has been the library of the University of Applied Sciences for Forestry in Eberswalde (Fig. 11). Its façade shows fourteen different motifs on around 800 concrete precast parts.

Fig. 11. University of Applied Sciences, Eberswalde

Bodega Berdugo, Aranda (Spain)
Architecture: Viné, Daroca

Abrupt, inaccessible and fascinating – the warehouse and filling hall in North Spain defies all external climatic influences. Two young female architects designed it and compensated for the low budget with a great deal of dedication and appetite for experimentation. They created an impressive debut work from brilliantly dyed concrete precast elements in a multiplicity of red nuances. Each concrete panel is anunicum. Although the concrete was industrially premanufactured, the colours were mixed in manually, so that each individual panel exhibits different colours, colour gradients and patterns (Fig. 12). The precast concrete parts have a two-layer structure with thermal insulation on the inner side and hence, thanks to their good thermal behaviour, provide for a constant room climate despite the extreme outside temperatures.

Fig. 12. Bodega Berdugo, Aranda

Form Liners : Lycée sports hall in Marseille (France)
Architecture: Apack, Flachaire

The use of elastic facing moulds has attained high acceptance in terms of both quality and economy for the texturing of fair-faced concrete surfaces (Fig. 13). The elasticity of the form liners enables demoulding without breakage of either the concrete or the form. Individual form liners in the form of an enfolding curtain were also used effectively for the construction of a new sports hall at a school in Marseille in France. A positive model was produced on the basis of an artist's design. The depth of the structure is around 30 mm and the façade was subsequently provided with a brown glaze.

Fig. 13. Lycée, Marseille

Material innovations

Titanium Dioxide: Jubilee Church, Rome (Italy)
Architecture: Richard Meier

Three self-supporting concrete shells, staggered in height and standing behind one another, form the striking silhouette of the Jubilee Church in Rome (Fig. 14). The shells were assembled together on site to the exact millimetre from 256 concrete elements. 2,600 metric tons of ground Carrara marble were used for the construction, and titanium dioxide was mixed into the concrete so that the church would retain its immaculate white. This additionally acts as a catalyser: on contact and in sunshine it allows harmful substances in the air to be oxidised to carbon hydride. This process works

Fig. 14. Jubilee Church, Rome

for different organic and inorganic compounds, including car exhaust fumes and the normal emissions from heating systems.

Translucent Concrete

Demands on design and function are continually growing and call for new top creative performances by architects. With cleverly used translucent concrete slabs or elements, architects now have the means to give their buildings a fascinating new type of image. Transparent concrete walls are inspiring the world of construction and setting new emphases (Fig. 15).

Fig. 15. Translucent concrete

The main components are light-conducting media placed in the concrete: glass fibres, light-conducting textile fibres or fabrics. Manufacturing methods for series production are currently under further development.

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