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FROM DECORATED DUCK TO FILIGREE SCULPTURES
Concrete identity: Exploring the potential of the sculptural expression of concrete in the work of Bekkering Adams Architects

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ABSTRACT
Concrete identity: Exploring the potential of the sculptural expression of concrete in the work of Bekkering Adams Architects
The properties of the material concrete are unique. It can be used in a variety of applications that can give architectural design a sculptural expression, balancing between sculpture and architecture. The technique of pouring the material in moulds in a variety of shapes, colours and patterns makes it possible to look for a specific expression in architecture that fits the requirements of the assignment: function, identity and atmosphere. At Bekkering Adams Architects we look for a strong and powerful materiality, and concrete – applied in different ways – is a leading theme in our designs. This article focuses on how concrete can be used in an innovative and sculptural manner in architecture and how the possibilities of the material are examined and tested to obtain optimal expression and develop our own architectural signature

KEYWORDS
Concrete, architecture, sculpture, precast concrete, 3D concrete printing, in-situ concrete
Introduction

This article focuses on how concrete can be used in an innovative and sculptural manner in architecture and how the possibilities of the material are examined and tested in our work to obtain optimal expression and develop our own architectural signature. The article describes a few projects by Bekkering Adams, exploring how architectural composition is completed with an unambiguous materialization where concrete plays a central role. The role of concrete (precast, in-situ poured concrete and 3D printed concrete) within the design process and the process of “making” are investigated. Three designs are analysed: the Booster pump station (The Netherlands), the school campus in Peer (Belgium) and the private residence Villa Tolhuis (the toll house) in Zaltbommel (the Netherlands); finally there is a detour to look at the novel technology of 3D concrete printing. The analysis dwells on the role of concrete surfaces, sculptural shapes and precast columns; the expression of textures, shapes and patterns in a concrete surface; and how concrete can act as a means of communication and identity within a design.

Concrete is the most used material in architecture. The possibilities of the material are almost infinite because of its freedom of shape, its strength and the simplicity of processing it. It is possible to apply textures and patterns to it and add various aggregates and colouring with pigments, so it can be used in a multitude of applications. The low cost of concrete make it a popular material and the most used building material worldwide.

Already in ancient times the material was used frequently, although in a different form than we now know: without reinforcement and with lime or trass as a binding agent. The Pantheon in Rome, with its monumental dome with a diameter of 43.3 metres, is entirely made of unreinforced concrete. Although concrete technology has taken flight over the past centuries, the dome is still the largest span of unreinforced concrete in the world. The clever use of the material made it possible to make this unsurpassed span: the recesses of cassettes reduce the weight and ensure optimal use is made of the constructive possibilities of the material: the thinning shell of the cupola upwards and the 9 meter wide oculus that caused for material reduction, resilience of the construction and the course of the heavy basalt surcharge at the bottom to the lighter pumice aggregates in the top. The use of the material also ensures the characteristic appearance of the material: seamless, profiled, smooth and solid.

After centuries of silence the material was rediscovered around the middle of the nineteenth century when Portland cement began to be used as binder. Thus cement was given a new lease of life and applied in all sorts of works of civil engineering, from bridges to pylons and from quays to water towers, hard sculptural elements discipining the landscape.
Although applications of concrete have become more and more ingenious in recent decades – extreme spans, towering constructions, strong emulsions and lascivious volumes with futuristic shapes – the material continues to radiate simplicity. Anyone can build with concrete – pour and build – with a concrete mixer in the backyard.

Frank Lloyd Wright explored the use of concrete in Los Angeles in the 1920s when he developed the characteristic Mayan-inspired “textile block houses”. When designing them he devised a system consisting of square concrete tiles with which every shape could be made. His idea was that the tiles could be poured on the spot, with local sand, blending with the landscape. It should have been a kind of self-building system whereby the homeowners gradually build up their houses and pour the tiles themselves in the weekends and create the house with simple means.

The visual language was inspired by Mayan ruins, which he had visited in previous years. He searched for a composition in which the volume of the houses rose up from and merged with the landscape. The tiles have different patterns, giving each house its own characteristic effect. There is the flat tile, the profiled tile and the perforated tile. The tiles are assembled into cubes, which can be stacked again into thick walls, columns, beams or floors and ceilings. Windows are recessed from the volume and have large wooden frames so they form big gaps in the volume and lie in deep recesses. Walls that keep the ground together seamlessly blend with the landscape in the house and form a range of levels, terraces, swimming pools and partitions. Glass in the walls with the perforated tiles creates a mysterious play of light on the wall, floor and ceiling.

Only three houses were ever built with this system and although in my perception they are some of the most beautiful works of Frank Lloyd Wright, they are the exception in his oeuvre as they reviled by the professional community for a long time.

The material has few aesthetic properties of itself: as Frank Lloyd Wright characterized it: “Concrete would be better named ‘conglomerate’, as concrete is a noble word which this material fails to live up to. It’s a mixture that has little quality in itself. If this material is to have either form, texture or color in itself, each must artificially be given to it by human imagination.” (Frank Lloyd Wright, pp141-142)

It is precisely in its indefinite nature that this grey mass – which has all the characteristics of liquid material as well of the hardest materials, and after hardening is as difficult to demolish as the hard rock on which concrete constructions are built – has unique qualities: “And there remain to be developed those higher uses – non-mechanical, plastic in method, treatment, and mass-to which I have referred, working naturally with color into truly plastic beauty.” (Frank Lloyd Wright, p142)
The concrete specialist David Bennett called concrete “liquid stone”, a material that can be moulded and folded into any shape like a cured rock, which can be both nested and massive; it can be fragile and richly ornamented. (David Bennett, 2007)

These characteristics discussed above have always fascinated us in our work and we have experimented with them in various projects.

Concrete is a material that you can hardly ignore when using it in construction. In addition to its well-known applications in floors, walls and roofs, we tested the possibilities of using it in a spectrum of applications in our work – creating prefab concrete in extreme shapes, using its loading-bearing capacities by means of large slender spans, pouring it into complex shapes, colouring the material with pigments, profiling and ornamenting it with moulds and rubber mats, and finally applying finishing techniques by bush-hammering and grit-blasting the material. The last experiments use 3D printing, creating an endless new range of opportunities.

The “decorated duck”: the Booster pump station

In the project the Booster the properties of the material were taken as a starting point. The assignment required a large sculptural intervention, a building that could encase three large pumps of a sewerage pumping station as an enormous sleeve of 30m x 20m x 15m, and address all the problems related to noise nuisance, vibrations and protection of the sewerage works. The context, programme of requirements and building envelope forced us to deal with the volume in a creative way: the plot was smaller than the surface that we had to realize at the first level and the edge of the plot was twisted compared with the perimeter-line of the road lying alongside it. The surrounding area would be significantly higher than the volume of the booster, creating a demand to shape it as an all-round object with a roof co-designed in the volume. Our aim was to have the volume aligned with the infrastructure and so to include the future plans of the urban context in its volumetric composition. In order to meet all these preconditions, the volume on the ground floor follows the plot boundaries, envelopes the inlet of the heavy sewer pipes that come out of the ground and then constricts, to finally enlarge with cantilevers that twist parallel to the perimeter-line and road, in order to create extra surface, giving place to a circulation-platform on the first level to service the pumps and accommodate air intakes.

Using concrete we were able to solve all technical requirements at once. By using in-situ poured concrete at the foot of the building, covered with precast concrete tiles, all pipes and inlets could be incorporated into the concrete work. The
superstructure was made of precast concrete, so we could apply a high-quality concrete, add pigment in the concrete, provide the concrete panels with different patterns and flutes, and give the precast panels a sandblast finish.

It is challenging to design a booster pump station in an urban area. Due to the projects large scale and that virtually no openings could be included in the volume, architectonic means had to be used to make it an attractive presence in the public domain. The closed character of the built volume can give it a grim character and because of the scale there is a risk that the building might be daubed with graffiti or other expressions of vandalism. (Image 1 and 2)

By giving the building a specific shape, making it more like a sculpture in an urban landscape than a building, and providing it with a filigree treatment of concrete, we have tried to tilt the impact of the building on its surroundings, making it an object people can relate to, which stands as a landmark in its environment. To this end, the walls are placed at different angles and the surfaces are provided with relief, colour and texture, and at night the surfaces are illuminated at different angles. The roof has various edges and is equipped with large triangular tiles of the same blue-pigmented concrete. The four roof surfaces end in a collection point where water can be drained from the roof with a gargoyle.

We carried out extensive research to find the most optimal application of the precast concrete slabs of the building, looking for the largest sizes of prefab slabs possible, with the expertise of engineers of the engineering firm ABT and the input of the concrete industry itself. Transport was the guiding principle here: the size of the panels was determined by the dimensions that could be transported by road with low-loaders, and we looked for the extremes here, maximizing their sizes. Eventually the panels, which look like large ice floes, could be made with minimal tolerances, so that seams are kept to a minimum. By mounting the panels in a mitre joint, the corners have solid appearance.

The disadvantage of prefab concrete is that the single panels are visible in the total volume, breaking it up in a patchwork of planes. To overcome this, the panels are executed with a web of flutings so that individual panels merge into a whole and the building has a continuous ornamentation. Sandblasted and grit-blasted letters in the surface, forming texts that communicate the function of the building, provide a second ornamented layer over the building, so that the effect is of one coherent sculptural form. The pigmentation in a blue-green colour of the concrete further supports this effect.

A building must speak and communicate with its environment. The texts abstractly communicate the function of the building with the outside world, as well as the blue–green colour, which creates a link with water.
In their book *Learning from Las Vegas* Robert Venturi and Denise Scott Brown distinguish between “decorated sheds” and “ducks” as two exemplary building types that communicate their meaning with the outside world in different ways. In our work we try to give our buildings a narrative quality and on the one hand let them tell a story about their significance in the city, in their context. On the other hand, we see that buildings can contain a scenario for use and thus invite the user to follow different storylines. These scenarios can initiate new uses so the building invites a diverse and rich use and connection to the public domain. The booster has a utilitarian function and can rather be regarded as an infrastructural work rather than a building. Because of the shape, textures, texts and ornamentation, we want it to be a confluence of the decorated shed and the duck: a “decorated duck”.

**Concrete collage: 24/7 learning campus in Peer**

Architecture cannot be imagined without considering its function in an urban context. Every building can boost the public space and the challenge when designing public buildings is to make it possible that all the buildings and public space of an ensemble can be used 24/7 by many different groups.

In the project for the learning campus, the design of public space was an important part of the assignment, which was concerned with not only the school buildings themselves, but also a range of sports facilities, playgrounds, covered playgrounds and a public park. We recognised this and structured the plan with different layers, designing the various public domains as a collage. The plan consists of four single buildings that will be used by a variety of users: during the day they form the learning environment for children of different ages; in the evening they are used by the community for evening education and art and music lessons, and a boarding school, with living spaces and dormitories for children; sports facilities for various sports clubs; and finally there is a park that is a green recreation area for the community. (Image 3 and 4)

A big component in the programme was the covered playground that has the shape of a long pergola. This forms a main theme in the design and connects the two schools: primary and secondary. To connect the public domain, and the various playgrounds, all buildings are supported with large, iconic concrete sculptural columns that carry the hovering volumes as caryatides. In the composition they form anchor points, which visually connect the four buildings at ground level. They support large cantilevers and form a range of objects that take part in the design of the public space. Their large scale has an alienating effect so they can
also be seen as oversized columns, landmarks, furniture or play objects that define the public space.

The paths of the park, the edges of the pergola, and the benches and seating areas included in the hard stone plinth of the building are also executed in concrete. As a result, the entire ground level has the same appearance and the entire complex of buildings forms a whole and is linked to the public space. The superstructure of the buildings has been worked out in masonry. The columns are designed as large prefab elements in a very light tone concrete mix. There are various forms of columns, with the moulds being handled as efficiently as possible. Sometimes the same formwork mould is used but rotated. The parapet of the buildings is composed as a collage. (Image 5)

**Villa Tolhuis (toll house) and the challenge of using concrete in-situ**

Perhaps one of the biggest challenges for an architect is to build a building entirely from concrete poured in-situ. It is labour intensive, because each part must be finished with handmade moulds, but using concrete offers enormous freedom of form, and the possibility to think about every detail almost as a kind of furniture. At the same time, all kinds of facilities can be incorporated into the concrete to produce a truly integrated design. (Image 6 and 7)

The toll house was executed by the owners themselves, creating a very direct relationship between the design and the manufacturing process. The use of the house and the spatial effect, play of light and fluid connection between outside and inside were a central theme in the design. The house consists of a series of rooms, in a strict zoning, perpendicular to a 30-meter long connecting corridor.

Two water basins form the spine of the design: an indoor basin where rainwater is collected for the greywater circuit through a large gargoyle. A mirroring pond in the patio, which is located between the living area and the studio, provides a play of light reflections in the living room. Long, narrow, horizontal light openings provide light along floors and ceilings. The concrete construction makes it possible to fit these windows without intermediate supports and to place the glass tightly in the plane without visible frame details. Piping, lighting and a central vacuum-cleaning system are included in the concrete walls and ceilings. Floor heating is included in the walls – warm walls invite you to sit against them. A long bench above the horizontal window slits can be used as a seat or to expose art objects. (Image 11)
The formwork-seams and finished centre-pins are the only decoration of the hard concrete walls. The load-bearing wall that screens the living space from the corridor is designed as a zigzag and delimits the spaces, but provides views to the enclosed patio-gardens. The formworks are taut, with only a sealant joint in the seams so angular shapes form a sharp silhouette.

**Exploring the future, 3-D concrete printing**

New techniques are emerging and the shapeless grey mass of concrete can now not only be poured but also printed, making the use of moulds and complicated formworks redundant. It is also possible to use concrete very precisely to reduce the amount used.

In 2015 the laboratory of the Faculty of Architecture and the Built Environment of the Technical University Eindhoven obtained a new 3-D concrete printer, which made possible new modes of production and application within the realm of architecture because of its sheer size. There were high expectations that the performance of the 3-D printer might shift the paradigms within architecture and building technology. (image 8, 9, 10)

By winning the design challenge organized by the Centrum voor Cement en Béton with the project The Firewall we had the opportunity to elaborate an idea into a concrete object in collaboration with the chair of Architectural Design and Engineering and the chair of Structural Design at TU/e and engaged in a design-driven research trajectory to explore the architectural properties of 3DCP. (Image 9)

With the design of the firewall we focused on three topics:

1. **Freeform:** new shapes and forms of the object as a whole were studied. The 3D printer makes it possible to print sculptural shapes without labour-intensive moulds. The possibilities and restrictions of inclinations, angels and cantilevers were explored as there were restrictions on printable curves, inclinations and heights. During the process different techniques and mixtures of the concrete were studied in order to increase the variety in shapes possible.

2. **Ornament:** the printer makes it possible to experiment with textures and ornaments and we tested surfaces with holes, patterns and an expression resembling lace. The aim was to explore a new ornamentation that was specific for the print technique: by using meandering outlines and waves and the fluidity of the material, specific soft rippling texture was obtained. Using
a special print technique, where the nozzle has a certain distance from the print-bed, the concrete could form a filigree pattern.

3. Multi-materiality: the 3DCP makes it possible to combine different materials. In the design we experimented with combinations of concrete and glass. Glass marbles were ingrained in the wet concrete.

We examined only a small number of possibilities in a process in which we were continuously confronted with the limitations of the printer: the material could have cantilevers of a maximum of 5 degrees, the corners had to have a rounding of at least 50 mm and there can only be printing in one continuous uninterrupted line. But with every step that is taken, the boundaries are stretched further and a future in which we can print filigree sculptures that support our buildings is shimmering on the horizon.

Concrete enables the designer to intervene both at the level of the expression of the material and at the level of the façade composition, the production method and ultimately the division of labour in order to design powerful beacons in the urban context that shape the urban domain.

IMAGES, CHARTS OR GRAPHICS LEGENDS

Image 1 - Booster Pump station, by Bekkering Adams Architects, Photographer: Jeroen Musch

Image 2 - Booster Pump station, by Bekkering Adams Architects, Photographer: Jeroen Musch
MATERIALITY AS A PROCESS

Image 3 - Primary school, schoolcampus Peer, by Bekkering Adams Architects, Photographer: Daria Scagliola

Image 4 - Sport complex, schoolcampus Peer, by Bekkering Adams Architects, Photographer: Daria Scagliola

Image 5 - Secondary school, schoolcampus Peer, by Bekkering Adams Architects, Photographer: Daria Scagliola

Image 6 - Six meter long window slit and bench, Private residence Toll-house, by Bekkering Adams Architects, Photographer: Daria Scagliola

Image 7 - Private residence Toll-house, by Bekkering Adams Architects, Photographer: Daria Scagliola

Image 8 - Firewall: 3D Concrete printing, by Bekkering Adams Architects and TU/Eindhoven, Photographer: Bekkering Adams Architects
MATERIART ART AND SCIENCE OF MATERIALITY IN ARCHITECTURAL DESIGN EDUCATION

Image 9 - Firewall: 3D Concrete printing, by Bekkering Adams Architects and TU/Eindhoven, Photographer: Bekkering Adams Architects

Image 10 - Diagrams Firewall: 3D Concrete printing, by Bekkering Adams Architects and TU/Eindhoven.

Image 11 - Insitu concrete makes it possible to create large window openings without window frames or visible constructions. Private residence Toll-house, by Bekkering Adams Architects, Photographer: Daria Scagliola

ENDNOTES

1 Initially, since the purchase of the 3-D printer was initiated by Professor Theo Salet, chair of Structural Design within the faculty, there was a strong emphasis on the structural properties of 3-D concrete printing (3DCP). With the elaboration of the Firewall, the architectonical properties of 3DCP were explored.

2 Dutch expertise centre for concrete applications

BIBLIOGRAPHICAL REFERENCES


