

JANUSZ BARNAŚ\*

## CONCRETE'S DISCRETE CHARM

---

### DYSKRETNY UROK BETONU

#### Abstract

The paper is an attempt at outlining new possibilities in the shaping of the architectural forms of structures that are the result of the development of new concrete technologies brought about as a consequence of technological progress. Achievements in this field lead to the creation of new types of architectural materials with much better properties and technical parameters than the ones currently available, as well as enabling their wider use. They make it possible to create architectural forms with much larger structural spans, increased durability and resistance. New variants of concrete are friendly to the environment. Walls made out of concrete remove pollutants from the air of large agglomerations. This is also invariably associated with a change in thinking about concrete as an architectural material.

*Keywords: architecture, architectural form, concrete, architectural expression, perception of form*

#### Streszczenie

Artykuł jest próbą zarysowania nowych możliwości kształtowania form architektonicznych obiektów, wynikających z rozwoju nowych technologii betonu w konsekwencji postępu technologicznego. Osiągnięcia w tej dziedzinie prowadzą do powstania nowych rodzajów tworzywa architektonicznego o znacznie lepszych niż dotychczas właściwościach i parametrach technicznych oraz szerszych zastosowaniach. Umożliwiają one powstanie form architektonicznych o dużo większych rozpiętościach konstrukcji, i zwiększonej wytrzymałości, odporności i trwałości. Nowe odmiany betonu są przyjazne dla środowiska. Ściany z betonu oczyszczają powietrze z zanieczyszczeń w dużych aglomeracjach miejskich. Wiąże się z tym również nierozzerwalnie zmiana wyobrażenia o betonie jako o tworzywie architektonicznym.

*Słowa kluczowe: architektura, forma architektoniczna, beton, wyraz architektoniczny, percepcja formy*

---

\* Ph.D. Arch. Janusz Barnaś, Institute of Architectural Design, Faculty of Architecture, Cracow University of Technology.

## 1. Introduction

Concrete is currently the most popular and most often used construction material. Its yearly production volume is three times that of structural timber and seven times that of steel. Its history dates back to antiquity. It was already used in Assyria, and its wider use came about in ancient Rome. The resources necessary to prepare concrete are widely available. The quality of the mixture depends on the manner of its preparation and the mixing of its ingredients. The quality and durability of a structure erected from concrete also depend on this. It requires a lot of experience and familiarity with the technology, because the quality of the raw materials, the manner of dosing and their proportions are only just a handful of the factors that influence the final properties of concrete. Large and small, ordinary and exceptional – all manners of structures are built out of concrete, including those that move us deeply and those about which we are indifferent.

## 2. Material

It is a material that has been known for centuries<sup>1</sup> – called artificial stone – and that has been used on an industrial scale in ancient Rome. The largest structures of the Roman Empire were built with its use<sup>2</sup>. The oldest constantly used building – the Pantheon – was built using this material<sup>3</sup>. Marcus Vitruvius Pollio<sup>4</sup> mentions concrete in his work. After a period of being forgotten during the Middle Ages, it was rediscovered in the XIX century after the invention of Portland cement<sup>5</sup>. Concrete undergoes a metamorphosis during its creation. It is a liquid at first and when it solidifies it becomes as hard as rock. This is the origin of the English name for concrete, which is derived from the Latin word *concretus*, which means mingled. This extraordinary quality makes it one of the most prized construction materials. Concrete is a building material that is close to being perfect in terms of the possibilities of giving it the desired shape. Concrete is used practically everywhere, with no other material having so many different uses. Concrete is a very graceful material, providing a lot of freedom in the shaping of the forms of buildings. It can be given practically any shape. The principles of the production of concrete have remained the same for over a century, but the production and construction of elements made out

---

<sup>1</sup> Floors and fragments of concrete walls featuring limestone binder and aggregate in buildings in Yiftah, EL (Southern Galilee, Israel), Raczkiewicz W., *Beton-materiałbudowlanyznanyodwieków*, [www.przegladbudowlany.pl/2012/10/2012-10-PB-13-18\\_raczkiewicz.pdf](http://www.przegladbudowlany.pl/2012/10/2012-10-PB-13-18_raczkiewicz.pdf) – 2017.09.02.

<sup>2</sup> The Coliseum, the Baths of Caracalla, public buildings, aqueducts, numerous channels and other structures.

<sup>3</sup> The Pantheon, Rome, Italy, 118–125 CE, <https://encyklopedia.pwn.pl/haslo/panteon;3953905.html> – 2017.09.02.

<sup>4</sup> „There exists a certain type of dust, which, thanks to its natural properties, creates things worthy of praise.[...] This dust, when mixed with lime and crushed stone not only ensures the durability of all structures, but even when used in the construction of crossings across the sea, hardens underwater.”, Vitruvius, *O architekturze ksiąg dziesięć*, PWN, Warszawa, 1956.

<sup>5</sup> Concrete production was patented in 1824 by Joseph Aspdin, <https://www.britannica.com/biography/Joseph-Aspdin> – 2017.09.02.

of it are not so simple. The preparation of the right recipe and adhering to it is crucial, because the consequences of a mistake are usually very severe.

### **3. Tradition and modernity**

Concrete is traditionally associated with the wider circles of architectural enthusiasts with an optical heaviness and the material's large mass, which has, without a doubt, left its influence on architectural currents associated with its use<sup>6</sup>. Every master gains experience over the course of working with a material and becomes accustomed to it, honing his craft. The time of using concrete as a material and experiencing it as such has been very short in our modern times. Let us not forget that structures out of stone and brick have been erected for at least tens of centuries, while those out of concrete for as little as just over a hundred years<sup>7</sup>. However, this does not mean that this material has not revealed at least a part of its secrets and hidden capabilities over this relatively short period. We have managed to discover many of its new qualities and uses, leading to the emergence of innovative forms and shapes. The most important advantages of concrete include its durability, resistance, thermal inertia, its acoustic properties, fire and water resistance and ease of use. It does not pose a threat to human health, it is environmentally friendly and can play an important part in the development of sustainable architecture. This would not be possible were it not for permanent modifications made to the concrete that is being used. As a result of numerous modifications that have been made in recent years, a lot of new materials have been devised that can be called concrete, but that possess characteristics that are so diverse that they would have been unimaginable 10 or even 15 years ago[1].

### **4. New properties of concrete**

Thanks to the rapid development of new technologies, we are experiencing the creation of many new materials with never before seen properties and changes and modifications to properties of already existing ones. Concrete is also an example of this. In 2001 the Hungarian architect Áron Losonczi became famous for developing transparent concrete, which he named Litracon, after the words "LIghtTRANsmittingCONcrete". Initially, only Litracon was available on the market, with LitraConXL entering it soon after. Both materials differ mainly in their appearance. It is a result of the use of different translucent materials. The former is characterised by an artistic and chaotic structure that is impossible to replicate. This means that no two blocks of this material are alike. The second one is composed of a multitude of symmetrically laid out dots. Thanks to the properties of Litracon<sup>8</sup>, which allows light to go through in all manners of colours while preserving all the advantages of concrete, a new approach to the shaping of a building's

---

<sup>6</sup> Brutalism.

<sup>7</sup> Apart from the use of concrete in ancient times.

<sup>8</sup> Litracon – the first transparent concrete in the world, invented by Aron Lasonczi, its main qualities are: durability, translucency, <http://www.litracon.hu/en> – 2017.08.23.



form and functional layout has been made possible. Solar rays, without losing much light, can penetrate even up to 20 metres inside a building. The inventor combined two opposing qualities: the heaviness and translucency of the material, achieving a unique effect. The material's translucency was obtained thanks to a small admixture of optic fibreglass that lets light go through. The material can be used to build partition walls and decorative elements in architecture or in finishing details. It can also be used to produce prefabricated structural elements and facade panels. The fibres are laid out by hand, thanks to which each block has a unique structure, making it possible to obtain extraordinary effects. Litracon was used to build the first multi-media interactive concrete facade in Germany. The didactic building of the Aachen University<sup>9</sup> has a facade composed out of 136 panels, which make it possible to individually program lighting scenarios. These panels can be controlled using an iPhone or a different mobile device. A similar material was used in the construction of the Italian exhibition pavilion at the 2010 EXPO in Shanghai<sup>10</sup>. Large surfaces of semi-translucent concrete of the external facades<sup>11</sup> provide appropriate lighting to the interior despite preserving the architecture's monumental character, featuring a clearly defined sculptural style based on the contrast of large shapes slit only by narrow wedges of windows. Mixtures that provide increased load-bearing capacity or frost resistance, while at the same time reducing absorptivity and permeability have been produced as a result of modifying the composition of concrete. Such a combination of property changes has led to a considerable increase in the durability of concrete. In addition, additives such as steel fibres allow us to increase the load-bearing capacity of elements built using concrete.

## 5. Perception of form

The analysis of perception processes is a controversial problem. They are subjective processes that take place in the mind of an observer, which is why a researcher's ability to directly monitor and analyse them is very limited. Although these observations refer to physical phenomena, they are subjective. There arises the question regarding the mechanisms of perception and their character. A question that is significant, regarding whether these processes are acquired or whether they are with us from birth[2]. The visual properties of a form and its detail can be underlined through the use of light, colour and texture. Among these, the most important element in the perception of a form is lighting, with which we can strongly under-

---

<sup>9</sup> Institut für Textiltechnik, Aachen, design by: Carpus+Partner AG, Aachen, Germany, <https://www.lucem.com/de/referenzen/rwth-fassade-aachen/> – 2017.08.23

<sup>10</sup> The Italian exhibition pavilion, EXPO 2010, Shanghai, China, design by: Giampaolo Imbrighi, <http://www.heidelbergcement.com/en/italian-pavilion-shanghai/>, /– 2017.06.25.

<sup>11</sup> The concrete facade elements are the work of Italcementi SpA from Bergamo, [https://wn.com/Italcementi\\_Italian\\_Pavilion,\\_Transparent\\_Cement](https://wn.com/Italcementi_Italian_Pavilion,_Transparent_Cement).

---

Ill. 1. The Pantheon, Rome, Italy, source: phot. by the author

Ill. 2. The Coliseum, Rome, Italy, source: phot. by the author



- III. 3. Kunstmuseum, Vaduz, Lichtenstein, design by: Christian KerezArchitekt ETH/SIA, Morger&Degelo (Basel), 2000–2002, [http://www.w-a.pl/2007/christian\\_kerez\\_vaduz.htm](http://www.w-a.pl/2007/christian_kerez_vaduz.htm) – 2017.09.02
- III. 4. Italian exhibition pavilion, EXPO 2010, Shanghai, China, design by: GiampaoloImbrighi, <http://wonderfulengineering.com/semi-transparent-cement-technology-can-revolutionize-building-lighting/> – 2017.07.24

line a form's shape and detail<sup>12</sup>. The shadows that are cast define and determine space and its perception as well<sup>13</sup>. In different cultural circles, the role and scope of the perception of visual imagination are varied<sup>14</sup> [3]. In Western culture, the role of visual perception is seen as dominant. Rassmussen claims that it is rare for a person that has seen a building to be able to precisely describe it. The fact of the observation of a structure does not mean that a faithful image of it comparable to a photograph remains within one's memory. The recording of a structure remains in the consciousness of the observer not as a real image, but as a set of associations and spatial imaginings, which that building had left in our mind[4]. Edward T. Hall gives us information about the limited capabilities of human perception. He believes that the social field of view is around 100 metres. Above this distance, humans become vaguely identifiable individuals. We should assume that this mechanism of perception also applies to structures [5].

## 6. Provocations and challenges, new technologies

The apparent ignoring of technical requirements appropriate for a construction and architectural material and the limitations that come about because of it are another aspect of modern times. The dark, almost black facade of the Vaduz Museum of Art, made out of black basalt and dark, polished architectural concrete, without even a single contraction joint is not the result of ignorance and a lack of knowledge, but of original technological solutions<sup>15</sup> based on the use of concrete mixes that allow precise contraction control.

## 7. Illusion and form

The problem of the reception, influence and recognisability of an architectural form, whether an autonomous one or one that is an element of a larger whole or that of a complex of elements within a space is a problem that has been the subject of many studies and analyses[6]. Every structure broadcasts a visual message through its architectural form. The shape of a form can elicit the illusion of lightness despite the use of materials that are traditionally associated with a large mass and weight. Large concrete, windowless, complexly shaped and waving forms of the Mediatheque in Vitrolles appear to be suspended and to glide through the air<sup>16</sup>. It was possible to obtain similar effects already in the 1950's. The parabolic covers of the Trans World Airlines Terminal at the Kennedy Airport in New York resemble spread

<sup>12</sup> *Ibidem*[after] Twarowski M., *Słońce w architekturze*, Arkady, Warszawa, 1996, p. 150–164.

<sup>13</sup> *Ibidem*[after]Arnheim R., *Sztuka i percepcja wzrokowa. Psychologia twórczego oka*, Wydawnictwo słowo/obraz, terytoria, Gdańsk, p. 373–406.

<sup>14</sup> „Every culture has its own world of perception”, Hall E., Foreword, [in:] *Visual Anthropology. Photography as a Research Method*. John Collier, Malcolm Collier, Eds. The University of New Mexico Press. Albuquerque 1986, p. 17.

<sup>15</sup> Museum of Art, Vaduz, design by: Christian KerezArchitekt ETH/SIA, Morger&Degelo (Basel), 2000–2002, <http://www.kerez.ch/>– 2017.09.02.

<sup>16</sup> Mediatheque, Vitrolles, France, design by: Jean-Pierre Lott, <http://www.detail.de/artikel/betonwolke-an-der-ausfallstrasse-mediathek-in-vitrolles-30258/>– 2017.09.20.



- III. 5. Institut für Textiltechnik, Aachen, design by: Carpus+Partner AG, Aachen, Germany, <https://www.lucem.com/de/referenzen/rwth-fassade-aachen/> – 2017.08.23,
- III. 6. Mediatheque, Vitrolles, France, design by: Jean-Pierre Lott, <http://www.detail.de/artikel/betonwolke-an-der-ausfallstrasse-mediathek-in-vitrolles-30258/> – 2016.05.23



wings with their dynamism, expressing and symbolising flight<sup>17</sup>. The new roof of the Jean Bouin Stadium in Paris, despite its concrete structure, amazes us with its lightness. This exceptional effect has been achieved through the use of a spatial concrete structure with small cross-sections made possible by the use of Ductal® concrete, which is reinforced with fibres and has a very high load-bearing capacity<sup>18</sup>. The elegance and exceptional litness of the structure of buildings and the span of the coverings of the City of Arts and Sciences in Valencia<sup>19</sup> would not be possible without the use of fibrous concrete.

## 8. Effect

The enrichment of the creation process through the achievements of modern science and technology makes it more of a joy rather than a pain<sup>20</sup>. The perfection of architecture should be the effect of this process of creation, during which a synergy of the human factor – based on intuition – with the achievements of modern knowledge and technology takes place, leading to the devising of elements that possess unique artistic values<sup>21</sup>.

## 9. Conclusion

Modern research aiming at discovering new materials and giving existing ones new properties lead to an enrichment of the professional tools at the architect's disposal and expanding the arsenal of means that serve to create architectural structures. The materials that are being developed make it possible to give existing elements of the architectural language that are already in use a new expression, in addition to the creation of new ones. Creation processes – which are intuitive and are often inspired by fleeting experiences – are enriched with new technical and technological possibilities. The enrichment of the arsenal of the tools that serve the creation process through the achievements of modern science and technology means that structures of better and better quality and impact strength can be built. In such conditions, we can expect that the effect of this process should yield architectural works that are close to perfection in the future.

---

<sup>17</sup> The Trans World Airlines Terminal at the Kennedy Airport, New York, USA, (1956–1962), design by: Eero Saarinen, <https://www.britannica.com/biography/Eero-Saarinen> – 2017.08.25.

<sup>18</sup> Jean Bouin Stadium, Paris, France, design by: Rudy Ricciotti architect, <http://rudyr Ricciotti.com/pro-jet/stade-jean-bouin#!/rudyr Ricciotti.com/wp> – 2017.08.23.

<sup>19</sup> City of the Arts and Sciences, Valencia, Spain, design by: Santiago Calatrava, <http://www.bryla.pl/bryla/51,85298,9453023.html?i=7> – 2017.09.02.

<sup>20</sup> „In order to begin writing a drama, create a work, we need suffering, strife, passion, pain, complaining, regret, sadness, fear, horror, mercy”, Wyspiański S. *Wyzwolenie*, [w:] *Warszawianka. Wyzwolenie. Noc listopadowa*, Wydawnictwo Zielona Sowa, Krakow 2009.

<sup>21</sup> „That is perfect, which lacks nothing”, which was already written by Aristotle, with the concept being borrowed by Thomas and many others”, Tatarkiewicz W., *O doskonałości [Wybrane eseje]*, Daimonion Instytut Wydawniczy, Lublin, 1991, p. 64.

## References

- [1] Błaszczyński T., *Nanotechnologie w budownictwie*, [http://cutob-poznan.pl/files/19710/3.t\\_blaszczynski\\_cudowny\\_swiat\\_betonu.pdf](http://cutob-poznan.pl/files/19710/3.t_blaszczynski_cudowny_swiat_betonu.pdf) – 2017.06.25.
- [2] Rek-Lipczyńska A., *Kolor i forma. Badania nad percepcją formy architektonicznej i jej barwy w poszukiwaniu zależności jakie zachodzą między nimi. Dokonania naukowe doktorantów* (2013), p. 28–33.
- [3] Hall E., Foreword, [w:] *Visual Anthropology. Photography as a Research Method*. John Collier, Malcolm Collier, Eds. The University of New Mexico Press. Albuquerque 19.
- [4] Barnaś J., *Modern architecture in old historical city*, ISSN: 2367–5659, Albena 08.2015, p. 519–526, SGEM International Multidisciplinary Scientific Conferences on Social Sciences and Arts, Architecture and Design, 26 August -1 September, 2015, Albena, Bulgaria : conference proceedings. – Sofia : STEF92 Technology Ltd., 2015, ISSN 2367–5659). – S 519–526, ISBN 978-619-7105-50-0686, p. 17.
- [5] [http://www.w-a.pl/2007/christian\\_kerez\\_vaduz.htm](http://www.w-a.pl/2007/christian_kerez_vaduz.htm) – 2017.09.02.
- [6] Hall E. T., *Ukryty wymiar*, PIW, Warszawa 1987.
- [7] Żurawski J., redakcja naukowa Lenartowicz K., *Siatka prostych*, Wydawnictwo Politechniki Krakowskiej im. Tadeusza Kościuszki, Kraków 2012.
- [8] Witruwiusz, *O architekturze ksiąg dziesięć*, PWN, Warszawa, 1956.
- [9] <https://www.britannica.com/biography/Joseph-Aspdin> – 2017.09.02.
- [10] <https://encyklopedia.pwn.pl/haslo/panteon;3953905.html> – 2017.09.02.
- [11] <https://www.lucem.com/de/referenzen/rwth-fassade-aachen/> – 2017.08.23.
- [12] <http://www.heidelbergcement.com/en/italian-pavilion-shanghai/>, /– 2017.06.25.
- [13] [https://wn.com/Italcementi\\_Italian\\_Pavilion\\_Transparent\\_Cement](https://wn.com/Italcementi_Italian_Pavilion_Transparent_Cement) – 2017.06.25.
- [14] Tatarkiewicz W., *O doskonałości* [Wybrane eseje], Daimonion Instytut Wydawniczy, Lublin, 1991.
- [15] <http://wonderfulengineering.com/semi-transparent-cement-technology-can-revolutionize-building-lighting/> – 2017.07.24.
- [16] Wyspiański S. *Wyzwolenie*, [w:] *Warszawianka. Wyzwolenie. Noc listopadowa*, Wydawnictwo Zielona Sowa, Kraków 2009.
- [17] Raczkiwicz W., *Beton-materiał budowlany znany od wieków*, [www.przegladbudowlany.pl/2012/10/2012-10-PB-13-18\\_raczkiwicz.pdf](http://www.przegladbudowlany.pl/2012/10/2012-10-PB-13-18_raczkiwicz.pdf) – 2017.09.02.
- [18] <http://www.litracon.hu/en> – 2017.08.23.
- [19] <http://www.detail.de/artikel/betonwolke-an-der-ausfallstrasse-mediathek-in-vitrolles-30258/> – 2017.09.20.
- [20] <https://www.britannica.com/biography/Eero-Saarinen> – 2017.08.25.
- [21] <http://rudyr Ricciotti.com/projet/stade-jean-bouin#!rudyr Ricciotti.com/wp> – 2017.07.23.
- [22] <http://www.kerez.ch/> – 2017.09.02.
- [23] <http://www.bryla.pl/bryla/51,85298,9453023.html?i=7> – 2017.09.02.