WOJCIECH NIEBRZYDOWSKI*

PARISIAN TRANSMUTATIONS OF CONCRETE

PARYSKIE TRANSMUTACJE BETONU

A b s t r a c t

Concrete as a building material was already known in ancient Rome. However, in the following centuries, knowledge of its production was lost. In the nineteenth century, builders began to use this material again. The leading role in the development of modern concrete was played engineers and architects working in Paris. The article highlights the most important discoveries and innovations in reinforced concrete constructions, including those of François Coignet, Joseph Monier and François Hennebique. The author presents also the development of concrete architecture in Paris passing through the following stylistic phases: historicism, functionalism, brutalism, late modernism and postmodernism. The analyses are based on buildings designed by such architects as Auguste Perret, Le Corbusier, Gerard Grandval, Ricardo Bofill and others.

Keywords: history of architecture, concrete, Paris

S t r e s z c z e n i e

Beton był materiałem znanym już w starożytnym Rzymie. Jednak w kolejnych stuleciach wiedza o sposobie jego wytwarzania zaniknęła. Dopiero w XIX wieku zaczęto na powrót stosować ten materiał. Wiodącą rolę w rozwoju betonu odegrali inżynierowie i architekci pracujący w Paryżu. W artykule wskazano najważniejsze odkrycia i innowacje dotyczące konstrukcji żelbetowych, w tym dokonania Françoisa Coigneta, Josepha Moniera i Françoisa Hennebique'a. Przedstawiono także rozwój architektury betonowej w Paryżu przechodzącej przez kolejne fazy stylistyczne: historyzm, funkcjonalizm, brutalizm, późny modernizm i postmodernizm. Analizy oparto między innymi na budynkach zaprojektowanych przez takich architektów jak: Auguste Perret, Le Corbusier, Gerard Grandval i Ricardo Bofill.

Słowa kluczowe: historia architektury, beton, Paryż

* Ph.D. Arch. Wojciech Niebrzydowski, Faculty of Architecture, Bialystok University of Technology.

1. Paris and concrete

Paris is a city inextricably linked with the history of concrete. There is probably no other place in the world where so much has been achieved in the development of both concrete building constructions and concrete architecture. During the last two centuries, engineers-inventors first refined the concrete, and then architects-alchemists transmuted this seemingly ordinary material into extraordinary works of art. The first magical attempts at concrete, still hidden behind the brick facade of the church in Montmartre, were carried out by the architect Anatole de Baudot. However, it was Auguste Perret who really began to do miracles. Firstly, using a reinforced concrete framework, and then creating a much more sophisticated structure in Raincy. A quite different quality was achieved by the Great Mage – Le Corbusier, whose postwar works shocked everyone. He hired workers who came straight from the distant Algeria to build Maisons Jaoul. The boldness of the master, while he was working on the project of Maison du Brésil, frightened even Lucio Costa who was his collaborator. The idea of brutalism was developed by many architects in the next years. Afterwards, other architectural alchemists came to Paris. Gerard Grandval made a transmutation of concrete into plants that still are growing in Creteil. And Martin von Treeck conjured concrete organs and was composing his works on them: *Tour Prélude, Tour Fugue, Tour Cantate, Tour Sonate.* The pursuit of modernity and innovativeness was not the most important value for every creator of concrete architecture. Ricardo Bofill was trying to return to the past, and Manuel Núñez Yanowsky travelling in time and imagination, discovered unknown worlds.

2. Engineers-inventors

Concrete as a building material was already known to the ancient Romans who called it *opus caementicum*. The current name of concrete is derived from the Latin word *concretus*, meaning condensed or clotted. This material was used at the beginning of our era to build the roofs of the Baths of Caracalla and the dome of the Pantheon[1]. Some architectural historians maintain that the first examples of *opus caementicum* structures were even earlier and dated back to the third or second century BC. William Dudley Hunt claims that it was used to build bridges and aqueducts at that time[2]. On the other hand, Nikolaus Pevsner, John Fleming and Hugh Honour mention the earliest concrete dome – in the Stabian Baths in Pompeii[3]. The Roman builders conjured concrete out of the most ordinary substances – water and gravel – and one magical ingredient – *pozzolana*. It was a kind of natural cement made from volcanic ash discovered in Pozzuoli near Mount Vesuvius[4]. The Roman concrete was described by Vitruvius, and after that, the masters of the Renaissance – Leon Battista Alberti, Andrea Palladio and Philibert de l'Orme – repeated it in their books[5]. However, in practice, after the

---

[1] A. Whittick, *European Architecture in the 20th Century*, Crosby, Lockwood & Son, London 1950, p. 80.

[2] W. D. Hunt, *Encyclopedia of American Architecture*, McGraw-Hill, New York 1980, p. 104.

[3] J. Fleming, H. Honour, N. Pevsner, *Encyklopedia architektury*, Wydawnictwa Artystyczne i Filmowe, Warszawa 1997, p. 317.

[4] W. D. Hunt, *Encyclopedia of American Architecture*, McGraw-Hill, New York 1980, p. 104.

[5] P. Collins, *Concrete: The Vision of a New Architecture*, Horizon Press, New York 1959, p. 19.

fall of the Roman Empire, the knowledge of cement production and, in consequence, the knowledge of concrete was lost.

It was not until the early nineteenth century that cement was invented again. This was done by the French engineer Louis Joseph Vicat[6]. And it is at this point that France, and especially its capital city, became an extremely important centre for research on concrete and building elements made of this material.

The first researcher who used the French name *béton*, which then spread throughout many countries, was Jean Baptiste de Belidor. He did it in his multi-volume work entitled „L'architecture hydraulique" published in Paris at rue S. Jacques. Next Parisian engineers, such as Jean Baptiste Rondelet and Joseph Antoine Borgnis[7], described the material as cheap and durable. They anticipated its use after future wars or revolutions to rebuild destroyed houses or even whole cities[8]. The big problem was the way of pouring the concrete. Experiments with wooden shuttering were carried out, with good results, by François Cointeraux and François Martin Lebrun. In the 19th century, concrete was used in France only for specific building elements: foundations, floors and stairs. It is true that Lebrun began in 1837 the construction of the concrete church (in Corbarieu), but this attempt, because of cracking vaults, ended in a fiasco.

Wider use of concrete became possible as a result of another innovation – implementation of reinforcing bars. At first, engineers investigated the possibility of reinforcing concrete elements with wrought iron or cast iron beams[9]. In 1856, engineer François Coignet presented an innovative solution for concrete floors, reinforced with tension bars called *tirants*[10]. A year earlier, in his speech at the Paris show, he foresaw an extremely important role of some new materials in the future architecture: "The purpose of cement, concrete and iron is to replace the stone"[11]. The real breakthrough in reinforced concrete structures were the inventions of the French gardener Joseph Monier. In the middle of the nineteenth century, he was conducting research on a frost-resistant material that could be used to make pipes and containers. For this purpose, he poured a properly shaped skeleton of iron bars with cement grout. In 1867, this resulted in the patent for reinforced concrete flowerpots[12]. In the following years, Monier patented reinforced concrete elements directly linked with the construction of buildings: slab, pillar, beam and stairs. It should be noted that he also had quite eccentric ideas on the use of reinforced concrete, among others offering a coffin. The next structural engineer who was working in Paris and refined reinforced concrete constructions was François Hennebique. He replaced the iron reinforcement with steel bars and, what was even more important, assembled the basic elements – pillars, beams, slabs – into a monolithic whole. This provided a much greater strength of the structure than previous methods.

---

[6] His son founded Vicat Cement which is still one of the world's largest cement producers.

[7] Rondelet's book was entitled „Traité théorique et pratique de l'art de bâtir", and work of Borgnis had the title „Traité élémentaire de construction appliquée à l'architecture civile".

[8] P. Collins, *Concrete: The Vision of a New Architecture*, Horizon Press, New York 1959, p. 20.

[9] The first information about reinforced concrete with wrought iron can be found in the book by John Claudius Loudon entitled „Encyclopaedia of Cottage, Farm and Villa Architecture" and published in 1832.

[10] N. Pevsner, *Pionierzy współczesności*, Wydawnictwa Artystyczne i Filmowe, Warszawa 1978, p. 140.

[11] P. Collins, *Concrete: The Vision of a New Architecture*, Horizon Press, New York 1959, p. 27.

[12] P. Gössel, G. Leuthäuser, *Architecture in the Twentieth Century*, Benedikt Taschen, Köln 1991, p. 105.

Ill. 1. Joseph Eugène Anatole de Baudot, church of St. Jean l'Evangeliste de Montmartre, 1894–1897; photo by the author

Ill. 2. Auguste Perret, tenement house on Franklin Street, 1902–1903; photo by the author

Ill. 3. Auguste Perret, church of Notre Dame du Raincy, 1922–1923; photo by the author

Ill. 4. Le Corbusier, Maisons Jaoul housing buildings, 1953–1956; photo by the author

The beginnings of concrete and reinforced concrete were far from architectural magic. However, it is worth remembering that the discoveries, patents and innovations of the engineers opened the way to many ground-breaking creative concepts of the 20th century architecture.

3. Architects-alchemists

One of the first architects using structural and plastic properties of reinforced concrete was Joseph Eugène Anatole de Baudot. Nevertheless, his church of St. Jean l'Evangeliste in the Montmartre district completed in 1897 hides its reinforced concrete structure behind the brick facades. Only after entering, the interior man can see the pillars, beams, arches and balustrades made of reinforced concrete (ill. 1). The shapes of the elements evoke associations with gothic architecture, and their cross-sections are surprisingly thin. This may indicate that Baudot was also inspired by projects of his teacher Eugène Viollet-le-Duc, who preferred the use of metal construction[13].

It was while studying at École nationale supérieure des Beaux-Arts in Paris that Tony Garnier developed his Une Cité Industrielle[14]. The concept of the Industrial City had never been realized, but it must be stressed that Garnier introduced innovative architectural solutions that were to be achieved with the use of reinforced concrete. In the description of the project, he emphasized that "all the important buildings will be built almost entirely of reinforced concrete"[15]. In their forms appeared thin slabs, oval pillars and large construction spans between them.

Another Parisian, although born in Ixelles (Belgium), whose work is inseparable from the concrete was Auguste Perret. His most important works were built in Paris and are considered milestones of the early 20th century architecture. The tenement house on Franklin Street was built in 1903 and had a reinforced concrete frame construction. It was visible in the facade of the building, although concrete surfaces were covered with ceramic tiles presenting floral motifs. The facade was dynamic and expressive, largely due to the cantilevered protrusions (ill. 2). Thanks to the reinforced concrete structure, Perret created the impression that heavy six-storey solids hanged almost against the laws of physics without any support. Located in the Raincy district, the church of Notre Dame (1922–1923) presents an exposed texture of concrete on all exterior and interior surfaces. The front facade is dominated by a tapering tower set on the main axis. The side facades are openwork made of small reinforced concrete elements filled with stained glass. Nevertheless, the most magical is the interior of the church (ill. 3). Despite the division into three aisles, it is, in fact, one huge space. It is illuminated by colorful reflections of light passing through the stained glass. Thin pillars – at a height of about 11 m their diameter is only 36 cm at the apex and 43 cm at the base – do not visually separate the aisles. Their slimness and openwork of facades were possible thanks to the ingenious design of reinforced concrete barrel vaults. Side pressure of the vault in the main nave is taken over by the vaults in the side aisles, which are set at right angles to the

---

[13] H. R. Hitchcock, *Zmiany w architekturze powodowane stosowaniem nowych technik i materiałów*, Architektura 1961/10, p. 405.

[14] Garnier was studying in Paris in the years 1890–1899.

[15] R. Banham, *Rewolucja w architekturze*, Wydawnictwa Artystyczne i Filmowe, Warszawa 1979, p. 40.

Ill. 5. Le Corbusier, Maison du Brésil university building, 1957–1959; photo by the author

Ill. 6. Jean Pierre Jouve , Andrei Frieschlander, Charles Mamfredos, Vision 80 housing building, 1970–1973; photo by the author

Ill. 7. Jacques Kalisz, Centre National de la Danse building, 1966–1972; photo by the author

Ill. 8. Harry Seidlera (cooperation: Marcel Breuer, Pierre Luigi Nervi), Ambassade d'Australie building, 1975–1977; photo by the author

main axis. In this way, the vaults play not only the role of the ceiling of the aisles, but are also active elements of the overall structure of the church. Pevsner wrote that in Notre Dame du Raincy "we can recognize the energy and boldness" which is missing in Perret's subsequent works defined as "reinforced concrete classicism"[16].

Le Corbusier is considered one of the greatest wizards of concrete. However, it must be admitted that this opinion is confirmed mostly by his buildings constructed after the Second World War. Earlier buildings, as other works of the functionalist period, generally hid the reinforced concrete structures behind the white, smooth curtain walls. Examples of this are Parisian houses from the interwar period designed by Le Corbusier, e.g. Villa Jeanneret, Villa La Roche (both constructed in the years 1923–1925) and Maisons Planeix (1924–1928). As these buildings show, Le Corbusier valued machine aesthetics and abstract, geometric forms over many years. His creative attitude began to change in the 1930s. During summers at the seaside, he began to appreciate a simple life of ordinary people and vernacular architecture. The architect's ideal of holidays became a leisure in not very comfortable, a modest wooden house near a bay in Le Picquey. He described later the surrounding countryside architecture, especially the fishing huts, in his publications as excellent examples of buildings that meet the needs and living conditions of users. "I'm intrigued by the natural order of things. I do not like parties and I have not been to a party for years. I noticed that in my escape from city life I came to a place where society is in a state of the organization. I'm looking for primitive people not for their primitiveness, but for their wisdom."[17]

As a result of the fascination with vernacular architecture, Le Corbusier began to use in his buildings natural materials such as stone and wood. He also appreciated the importance of craftsmanship, which, though not without inaccuracies and defects, had the humanistic values which were alien to machine aesthetics. Le Corbusier claimed that "faults are human; they are ourselves, our daily lives"[18]. According to his words written already in 1923 in „Vers une architecture" – „By the use of raw materials and starting from conditions more or less utilitarian, you have established certain relationships which have aroused my emotions"[19] – Le Corbusier decided to create more sensual and expressive architecture. The leading role should play an emotional experience of architecture. Concrete has become the means to achieve this aim. Ordinary, common material, which as a result of transmutation could become a symbol of … human life – expressing both its splendor and its frailty. The first post-war demonstration of Le Corbusier's retreat from functionalism to brutalism was Unité d'Habitation in Marseille. Even more radical in their directness and sincerity were Parisian buildings Maisons Jaoul constructed between 1953 and 1956. Reyner Banham wrote that this work was more important to the development of brutalist architecture in the world than all the theoretical considerations of Alison and Peter Smithson[20]. For some architectural critics, the object in which the main role is played by coarse brick walls and rough concrete elements

---

[16] N. Pevsner, *Historia architektury europejskiej*, Arkady, Warszawa 2013, p. 259.

[17] Le Corbusier, *The Radiant City: Elements of a doctrine of urbanism to be used as the basis of our machine-age civilization,* Orion Press, New York 1967, p. 6.

[18] W. Boesiger (ed.), *Le Corbusier: Oeuvre compléte 1946–1952 – Vol. 5*, Editions Girsberger, Zurich 1955, p. 195.

[19] Le Corbusier, *Towards a New Architecture*, BN Publishing, Lexington 2009, p. 153.

[20] R. Banham, *The New Brutalism: Ethic or Aesthetic?*, Reinhold Publishing Corporation, New York 1966, p. 85.

Ill. 9. Gérard Grandval, Les Choux de Créteil estate, 1969–1974; photo by the author
Ill. 10. Martin von Treeck, Orgues de Flandre estate, 1970–1979; photo by the author
Ill. 11. Ricardo Bofill, Espaces d'Abraxas housing buildings, 1978–1983; photo by the author
Ill. 12. Manuel Núñez Yanowsky, Arènes de Picasso estate, 1980–1984; photo by the author

was a shock (ill. 4). On the other hand, "to this disenchanted generation [of architects] the Jaoul houses had the ring of brutal honesty about the state of architecture in that time and place"[21]. To get the effect of simplicity or even primitiveness Le Corbusier hired workers from Algeria. Moreover, he ordered them to do the job negligently.

The next brutalist building designed by Le Corbusier in Paris was Maison du Brésil on the university campus built between 1957 and 1959. He started to work on the project of a dormitory for Brazilian students with Lucio Costa, who resigned afterwards disagreeing with some radical ideas. The great Swiss architect applied here solutions similar to those in Marseille, although differences are also apparent. The main, rectangular block has two contrasting sides. One has more closed, massive character, and the other with an orthogonal composition of loggias is visually open. Continuing corbusian principle of spatial contrasts, the monumental, high block was combined with two small one-storey pavilions, which housed a library, an exhibition room, a theater room and a meeting room. In Maison du Brésil, Le Corbusier used a whole palette of elements-words of his "brutalist language"[22]. You can see here reinforced concrete: loggias, *brise soleil*, *ondulatoires*, overhanging solids, massive columns and beams, furniture (e.g. bench, table and desk in the entrance arcade) and gargoyles. Also, a set of concrete textures is very rich – from the roughest combining concrete and crushed stone, through concrete with the imprint of unfinished shuttering boards and sprayed concrete, to washed concrete and smooth surfaces cast in plywood panels. Rarely encountered in Le Corbusier's works is a kind of architectural joke – here in the form of internal stairs reversed outside (ill. 5).

The brutalist style was adapted by next architects in Paris, who also use properties of reinforced concrete in their works. The designers of the building called Vision 80 (1970–1973), located on the main promenade of La Défense district, did not hide their inspiration from Le Corbusier's works. Jean Pierre Jouve, Andrei Frieschlander and Charles Mamfredos made use of some corbusian solutions, but their work has a different aesthetic expression. While Le Corbusier's brutalist buildings shock with rough surfaces with defects, Vision 80 has almost perfectly made concrete textures. Admittedly, shuttering boards were set up to achieve a rugged, relief surface, but the result is impeccable. Such precise concrete presents itself as extremely hard, indestructible material, and the entire building seems to be carved in one big block (ill. 6). The impression of monolithicity of architectural form was a characteristic effect of many concrete buildings of the 20th century[23]. Another concrete monolith was built on the banks of the Seine in 1972 thanks to the architect Jacques Kalisz. The building originally housed the administration of the Pantin district and now there is the National Center of Dance (Center National de la Danse). The form of the building, based on rectangular geometry, is very sculptural primarily due to the rhythmic repetition of a spatial concrete module (ill. 7). This module is at the same time the bay window, the loggia and the sun-breaker. The architect

---

[21] R. Banham, *The New Brutalism: Ethic or Aesthetic?*, Reinhold Publishing Corporation, New York 1966, p. 86.

[22] Charles Jencks claims that Le Corbusier "tried to create three new languages: at the age of eighteen – naturalistic, geometric Art Nouveau, at the age of thirty one – purism, and at the age of fifty nine – brutalism" (Ch. Jencks, *Le Corbusier – tragizm współczesnej architektury*, Wydawnictwa Artystyczne i Filmowe, Warszawa 1982, p. 175.).

[23] M. Charciarek, *Związki idei i materii w architekturze betonowej*, Wydawnictwo Politechniki Krakowskiej, Kraków 2015, p. 36.

applied many complicated rhythms on the facades also using smaller reinforced concrete elements. Jencks compares such extremely complex facades to musical fugue and counterpoint, which are composed of several independent melodic lines[24]. Sculptural character of the form is also visible in the Ambassade d'Australie building (1975–1977) designed by Harry Seidler in collaboration with such celebrities of concrete alchemy as Marcel Breuer and Pierre Luigi Nervi. In this case, expression and dynamics were achieved by means of curvilinear geometry. The visual power of the embassy building lies in the details. Particularly interesting are the massive, curved supports, and the huge, parabolic pillar at the entrance is a work of art in itself (ill. 8).

Far from brutalist aesthetics are two Parisian housing complexes. Multifamily buildings presenting extravagant forms were constructed there using reinforced concrete. It can be said that they are examples of a transitional phase of architecture between late modernism and postmodernism. The architect of Les Choux de Créteil estate (1969–1974) Gérard Grandval was undoubtedly inspired by the natural world. Some people claim even that he transformed concrete into… cabbages (*les choux*), which grow in the place of former vegetable gardens in the Créteil district. Certainly, Grandval's residential towers have organic forms and it is the result of the round shapes and above all fanciful balconies (ill. 9). They overgrow cylindrical buildings like leaves and it is difficult to get rid of the impression that they are part of a concrete plant rooted at the foundations. In contrast, forms of buildings in Orgues de Flandre (Organs of Flanders, 1970–1979) estate present definitely artificial nature. They were designed by Martin von Treeck, German architect living in Paris. They are distinguished by hexagonal shapes of windows and bending forward facades (ill. 10). Giant, multi-storey overhangs, made of reinforced concrete, evoke strong emotions in people passing below. Such psychological effect was intended by the architect. Von Treeck already at the stage of the project carefully analyzed how architecture would be perceived by people moving on the pavements. For this purpose, he prepared precise models and then photographed and filmed them using an endoscope. The form of the buildings framing the main entrance to the housing estate was supposed to symbolize organs. Musical references were continued in the names of four skyscrapers built in the middle of the settlement: *Tour Prélude, Tour Fugue, Tour Cantate, Tour Sonate.*

The group of architects called Taller de Arquitectura created, in the spirit of postmodernism, their magical works on the outskirts of Paris in Noisy le Grand. The first masterpiece was Espaces d'Abraxas (1978–1983) designed by Ricardo Bofill. In this compact housing complex, we can see a denial of sterility and coldness of the International Style. Bofill rejected the slogan of the purity of the architectural form and unceremoniously used the entire repertoire of elements and details of historical architecture (ill. 11). He conjured these elements from concrete using prefabrication technology, which is often associated in Poland with OWT system. As Dariusz Kozłowski observes, the difference is, however, essential: "Bofill produced reinforced concrete elements as part of historical orders, cornices, lintels, fluted columns and a socle; His reinforced concrete is white or gray – like cement – it is sometimes colored, but always remains smooth, not touched by human hand, precisely reflecting the shape of steel mold, which probably does not prevent him from dreaming that it is a stone"[25].

---

[24] Ch. Jencks, *Architektura późnego modernizmu*, Arkady, Warszawa 1989, p. 42.
[25] D. Kozłowski (ed.), *Architektura Betonowa*, Polski Cement, Kraków 2001, p. 7–8.

Bofill divided the complex into three parts: the Palace, the Theater and the Triumphal Arch. And the name of the whole – Abraxas – was derived from Hellenistic documents devoted to magic, in which it signified magical logic. A few streets away Manuel Núñez Yanowsky built a complex of housing buildings called Arènes de Picasso (1980–1984). He also used prefabricated elements, but their forms cannot be called historical. Unless it is a history of some foreign civilization, or perhaps the distant future of human architecture. No wonder then, that the buildings enchanted the directors of science fiction films. They chose the estate for the scenery of their works, such as "The Hunger Games". Certainly, the most expressive elements of Arènes de Picasso are two giant vertical discs with a diameter of 43 meters (ill. 12). They stand on the pedestals with arcades on the opposite sides of the octagonal square. This monumental composition is supposed to reflect symbolically the eternal mystery of the sunrise and the sunset.

4. Prediction

In recent years, concrete architectural masterpieces have rarely been built in Paris. The most important and most prestigious buildings emphasize other materials: glass shells, ceramic tiles, perforated metal sheet. Thus, the question arises whether the possibilities of this material have been exhausted? Has the transmutation of concrete been made fully and definitively? And although it is impossible to give a conclusive answer, it seems that wizards of concrete alchemy will impress us many times in the future. And not just in Paris.

The research was carried out within the work S/WA/2/2016 and financed by the MNiSW.

References

[1] Banham R., *Rewolucja w architekturze*, Wydawnictwa Artystyczne i Filmowe, Warszawa 1979.
[2] Banham R., *The New Brutalism: Ethic or Aesthetic?*, Reinhold Publishing Corporation, New York 1966.
[3] Boesiger W. (ed.), *Le Corbusier: Oeuvre compléte 1946–1952 – Vol. 5*, Editions Girsberger, Zurich 1955.
[4] Charciarek M., *Związki idei i materii w architekturze betonowej*, Wydawnictwo Politechniki Krakowskiej, Kraków 2015.
[5] Collins P., *Concrete: The Vision of a New Architecture*, Horizon Press, New York 1959.
[6] Fleming J., Honour H., Pevsner N., *Encyklopedia architektury*, Wydawnictwa Artystyczne i Filmowe, Warszawa 1997.
[7] Gössel P., Leuthäuser G., *Architecture in the Twentieth Century*, Benedikt Taschen, Köln 1991.
[8] Hitchcock H.R., *Zmiany w architekturze powodowane stosowaniem nowych technik i materiałów*, Architektura 1961/10.
[9] Hunt W. D., *Encyclopedia of American Architecture*, McGraw-Hill, New York 1980.
[10] Jencks Ch., *Architektura późnego modernizmu*, Arkady, Warszawa 1989.

[11] Jencks Ch., *Le Corbusier – tragizm współczesnej architektury*, Wydawnictwa Artystyczne i Filmowe, Warszawa 1982.
[12] Kozłowski D. (ed.), *Architektura Betonowa*, Polski Cement, Kraków 2001.
[13] Le Corbusier, *Towards a New Architecture*, BN Publishing, Lexington 2009.
[14] Le Corbusier, *The Radiant City: Elements of a doctrine of urbanism to be used as the basis of our machine-age civilization,* Orion Press, New York 1967.
[15] Pevsner N., *Historia architektury europejskiej*, Arkady, Warszawa 2013.
[16] Pevsner N., *Pionierzy współczesności*, Wydawnictwa Artystyczne i Filmowe, Warszawa 1978.
[17] Whittick A., *European Architecture in the 20th Century*, Crosby, Lockwood & Son, London 1950.