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CONCRETE PLAY OF THE ARCHITECTURE

BETONOWA ZABAWA ARCHITEKTURA

A b s t r a c t

Can creating Architecture be fun? Forming, constructing and creating are inseparably linked to architecture. How to capture the mystery of the design? How to find the answer to the question what was first? First – the idea! Or maybe, first – need? Is the mystery of architecture a geometric knowledge? What determines the good shape, form? Fashion or knowledge?

Keywords: *architecture, structure, structure of architecture*

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

Czy tworzenie Architektury może być zabawą? Tworzenie, konstruowanie i kresowanie to pojęcia nierozerwalnie związane z architekturą. Jak uchwycić tajemnicę projektowania? Jak znaleźć odpowiedź na pytanie co było pierwsze? Pierwsze – wiadomo idea! A może pierwsze – potrzeba? Czy tajemnicą Architektury jest wiedza geometryczna? Co decyduje o dobrze kształtu, formy? Moda, czy wiedza?

Slowa kluczowe: *architektura, struktura, struktura architektury*

1. Introduction

In the spring of 2013, the four-year construction of an important public utility building was completed and the Museum of History of Polish Jews was opened to the public. The museum is situated in Warsaw's district Muranow. The idea for creating the museum, *Museum of*

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Life, as the idea has been named at the beginning, in the capital of Poland, has been initiated in 1993 by the Association of the Jewish Historical Institute of Poland¹.

Before the Second World War, Poland was the center of the Jewish Diaspora and the home for the largest Jewish community in the world. During the inter-war period, Poland was inhabited by 3 to 3.5 million Jews. In Warsaw alone, Polish Jews comprised almost one-third of the city population. The Second World War brought tragedy upon the Jews of Poland. A huge part of Polish Jews perished during the Holocaust. A part of the Jews who survived during the war, after the war, emigrated from Poland. But despite all the odds, the Polish Jewish diaspora survived, and above all, survived the memory of the rich culture of Polish Jews. The thousand-year history of Polish Jews and its impact on Poland in the past, and nowadays, was an impulse to create the Museum of the History of Polish Jews.

In the year 1995, the Warsaw City Council allocated the land for this purpose. The area designed for the museum has been located in Muranów, the district of Warsaw, where the Warsaw Ghetto was situated during the Second World War. The plot intended for the construction, a square between Anielewicza, Zamenhofa, Lewartowskiego and Karmelicka streets, was an important part of the Ghetto and after the end of the Second World War, in 1948, the Ghetto Heroes Memorial has been located in this area².

In January 2005, the city of Warsaw, the Polish Ministry of Culture and National Heritage, and the Association of the Jewish Historical Institute of Poland signed an agreement establishing a joint cultural institution – the Museum of the History of Polish Jews. It has been determined that the choice of the design of the museum would be decided on the basis of an architectural competition. According to the terms and conditions of the competition: the new building has to be functional, modern and have a recognizable characteristic form, so that it will become one of the symbols of contemporary Warsaw; also the new facility should not interfere too much with the existing space used by the residents as open green area.

The International Architectural Competition for a design of the museum was launched in February of 2005. The competition attracted great interest of architectural designers from around world. Two hundred and forty-five architects from 36 countries registered in the first part of the competition³. To the second part of the competition the jury chairman, Bohdan Paczowski, invited eleven architectural teams led by architects: Andrzej Bulanda (Bulanda and Mucha Architects, Poland), Dawid Chipperfield (Dawid Chipperfield Architects, Great Britain), Marek Dunikowski (DDJM Architectural Studio, Poland), Peter Eisenman (Peter Eisenman Architects, USA), Zvi Hecker Zvi Hecker Architect, Israel/Germany), Kengo Kuma (Kengo Kuma & Associates, Japan), Daniel Libeskind (Daniel Libeskind Studio, USA), Rainer Mahlamäki (Lahdelma & Mahlamäki Architects, Finland) Josep Luis Mateo (MAP Architects, Spain), Jesus Hernandez Mayor (Casanova + Hernandez Architects, Spain) and Gesine Weinmiller

¹ J. Podgórska, *Muzeum życia. O tym jak powstało Muzeum Historii Żydów Polskich, jak zostało zorganizowane i jakie niesie przesłanie, opowiada Marian Turski*, Polityka 43 (2981), Warszawa 2014.

² G. Stiasny, *GETTO – warszawska architektura pamięci*, Architektura-Murator, 06/2013//225, Warszawa 2013.

³ Konkurs na Muzeum Żydów Polskich – prekwalifikacja, Stowarzyszenie Architektów Polskich [on line], sarp.org.pl, 17 lutego 2005 r.

(Weinmiller Architekten, Germany)⁴. On June 30, 2005, the results of the competition were published⁵. The Finish architectural studio – Lahdelma & Mahlamäki – architects consists of two Finnish architects, Rainer Mahlamäki and Ilmari Lahdelma – won⁶. This was the first win of the Finish studio in the international competition. The architectural project of the museum was developed in cooperation with a Polish architectural studio – Kuryłowicz & Associates, consisting of architects: Stefan Kuryłowicz, Ewa Kuryłowicz, Paweł Grodzicki, Marcin Ferenc, Piotr Kuczyński, Tomasz Kopeć, Michał Gratkowski and Piotr Kudelski. ARBO Projekt with Arkadiusz Łoziński, Robert Fabisiak and Piotr Ziolkowski developed construction part of the design. The general contractor of the building was company Polimex – Mostostal. The company TORKRET has made curvilinear walls using the spray-concrete technology. In the summer of 2009, the construction of the building was started and lasted four years⁷.

Prizes and awards for the Museum of the History of Polish Jews⁸

- 2008 – The Chicago Athenaeum International Architecture Award
- 2013 – Eurobuild Awards in category The Best Design of the year
Outstanding Shotcrete Project of the year in category international projects
- 2014 – award of the year of the Society of Polish Architects
award of the Society of Polish Architects for the best architectural object built with public funds.
- award of the Finnish Association of Architects – SAFA
- 2016 – award Property Design Awards 2016 in category public utility building
award of the year of Czech Society of Architects
award of President of Warsaw in the category – the best public utility building
award European Museum of the Year 2016 by European Museum Forum

2. Structure of the museum

The building of the museum has been located in a green open area opposite to the important war monument – Ghetto Heroes Memorial. It was stated in the terms of the competition that the building of the museum could not dominate the monument; it could take up a maximum of one-third area of the square and the height of the building should not exceed the surroundings blocks of flats. The museum is situated in the central part of the trapezoid building plot of area 4.40 ha. The building of the museum is a cuboid

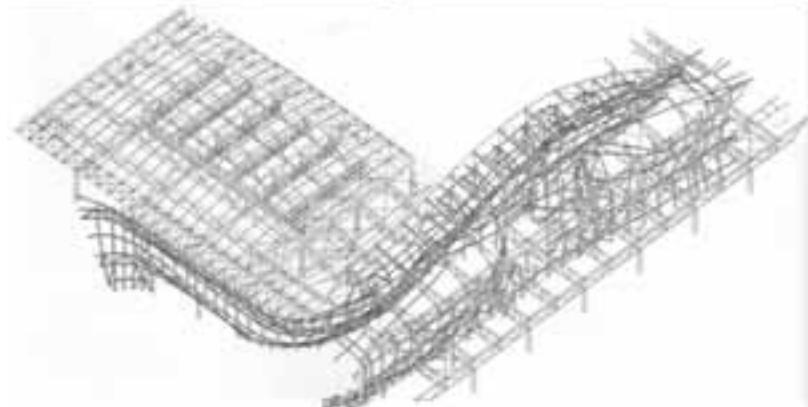
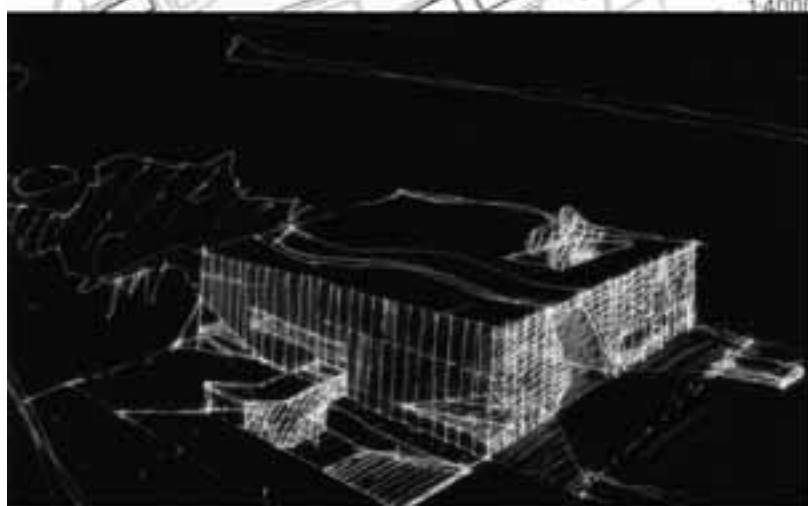
⁴ Międzynarodowy Konkurs Architektoniczny na budynek Muzeum Historii Żydów Polskich w Warszawie, Stowarzyszenie Architektów Polskich, Komunikat SARP 03/2005 [on line] sarp.org.pl, marzec 2005 r.

⁵ Ilmari Landhelma & Rainer Mahlamaki z Finalnadii – zwycięzcami konkursu na Muzeum Historii Żydów Polskich, Stowarzyszenie Architektów Polskich [on line] sarp.org.pl, 1 lipca 2005 r.

⁶ A. Kiciński, *Konkurs na projekt Muzeum Historii Żydów Polskich w Warszawie – idea, twórcy, zadanie, wynik*. Muzealnictwo tom 2005, Numer 46, Warszawa 2005.

⁷ K. Mycielski, G. Stiasny, *Muzeum Historii Żydów Polskich*, Architektura-Murator, 06/2013//225, Warszawa 2013; p. 42.

⁸ Budynek Muzeum Historii Żydów Polskich POLIN – www.polin.pl.



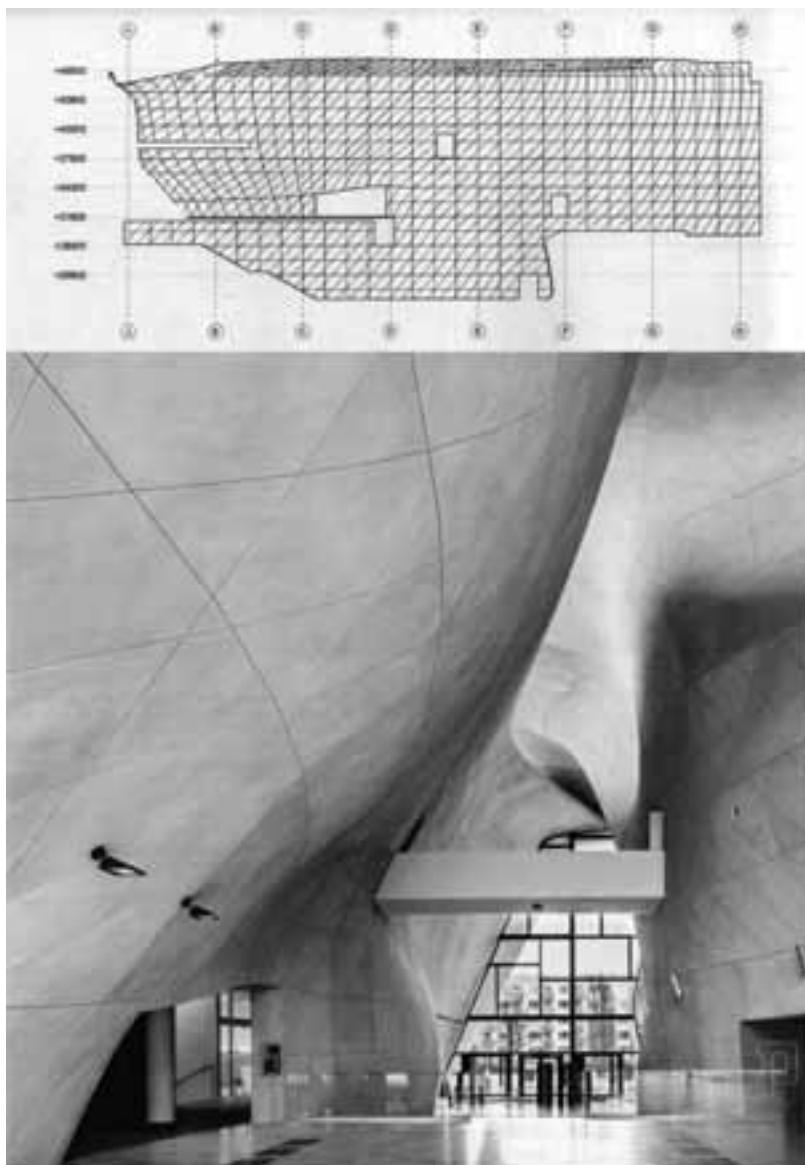
with a square base; the length of the side of the square is 67 m. The height of the above-ground part of the building is 21 m. The museum has two underground levels, four levels above ground and 16 000 meters of useable space, of which one quarter is dedicated to the main exhibition. The outer shell of the museum is formed as a structure composed of vertical panels of perforated copper sheet and point-fixed tempered glass. Glass panels of the cover of the building are 0.44 x 1.7 m in size, and copper panels are twice narrower. Panels are suspended on a lightweight steel structure fixed to the reinforced concrete walls of the building and create alternating glass and copper straps aligned to each other at right angles. Thanks to this, the building facades gain depth and change their character depending on the location from which they are observed. The facade, viewed from the one side, can be visible as a bright glossy surface; viewed from another point, it can be almost completely transparent. Only individual windows of selected rooms cross the shell⁹.

The modern, rectangular object, due to the scale and simplicity is well inscribed in the contemporary urban context of the place, the surrounding housing of the 1960s. Blocks of flats, which surround the museum's plot, are simple cuboidal objects. Also, the shape of the museum's building is cuboidal. But the chairman of the jury, Bohdan Paczowski, named the concept of the museum proposed by Finish architects – *a cookie in a box*¹⁰. Cuboidal form of the building is *the box*, but where we can find *the cookie*? Let us look at the project's situational plan – on the rectangular outline of the building are visible corrugated lines, described by the authors of the design – Yum Suf. Yum Suf in Hebrew means the Red Sea, but in the biblical sense – this is the parting of the Red Sea before wandering Jewish people. A closer look at the conceptual sketches and at the physical model of the object allows us to understand both the author's description and the opinion of the chairman of the jury. The curved walls of the inner passage have interrupted the cuboidal object of the museum. So *the cookie* has been found *in the box*.

⁹ M. Ferenc *Muzeum Historii Żydów Polskich*, Architektura Muzeów, <http://architektura.nimoz.pl/2013/03/09/konstrukcja-muzeum-historii-zydow-polskich> [on line].

¹⁰ K. Mycielski, G. Stiasny, *Muzeum Historii Żydów Polskich*, Architektura-Murator, 06/2013//225, Warszawa 2013.

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- III. 1. Location plan of the Museum of History of Polish Jews, arch. arch. Ladhelma & Mahlamaki (Finland), Kuryłowicz & Associates (Poland). On the rectangular outline of the building are visible corrugated lines, described by the authors of the design – Yum Suf. Source: Architektura-murator, 06/2013//225, Warszawa 2013
 - III. 2. Conceptual sketch of the Museum of History of Polish Jews, arch. arch. Ladhelma & Mahlamaki (Finland), Kuryłowicz & Associates (Poland). On the rectangular outline of the building are visible corrugated lines, described by the authors of the design – Yum Suf. Source: Architektura-murator, 06/2013//225, Warszawa 2013
 - III. 3. 3D model of the steel structure of the curvilinear wall. Design of construction: ARBO Project: Arkadiusz Loziński, Rober Fabisiaik, Piotr Ziolkowski; Museum of History of Polish Jews, arch. arch. Ladhelma & Mahlamaki (Finland), Kuryłowicz & Associates (Poland). Source: Architektura-murator, 06/2013//225, Warszawa 2013



III. 4. Mesh of the curvilinear wall. Museum of History of Polish Jews, arch. arch. Lahelma & Mahlamaki (Finland), Kuryłowicz & Associates (Poland).

Source: Architektura-murator, 06/2013//225, Warszawa 2013

III. 5. Inner passage, view towards the main entrance. On the walls visible drawing of the mesh of the curvilinear walls. Museum of History of Polish Jews, arch. arch. Lahelma & Mahlamaki (Finland), Kuryłowicz & Associates (Poland).

Source: Architektura-murator, 06/2013//225, Warszawa 2013

3. Structural concept

The break in cuboid, shaped in expressive way, opens the building from the side of the Ghetto Heroes Memorial, which is situated on the east side of the plot, to the green open area, which is in the west part of the plot. The visitor of the museum enters the main entrance, which is located on the east side of the object, from the Ghetto Heroes Memorial side, and goes from the tragic past to the present, immerses in the rich history of the Polish Jews. Curvilinear walls of the inner passage, which divides the object almost on the all height, could reminiscent the gorge carved by the river or they could symbolize the expanding Red Sea before the Jews escaping from Egypt¹¹. The curvatures of these two walls model the shape of the main spaces of the museum. They rise from the underground exhibition space to the roof, which form a gentle arc closed by skylight almost 50-meter long. The soft curved walls of sandstone-coloured surfaces, which intersect the cold white-blue facades of the museum, define reception of the object¹².

4. Structure of the curvilinear walls

The construction design of curvilinear walls was a great challenge for engineers from ARBO design studio. Particularly, that the walls were to be load-bearing walls, on which floors of the building are supported, and in some places also the roof of the building. The walls of such a complicated geometrical structure are rather designed as the curtain walls, with a height of one storey. In this case, it was necessary to prepare construction design of two curvilinear walls with a height of over 20.0 m and the curvature of walls were free shaped. In the initial design assumptions, the walls were to be constructed as monolithic concrete walls. The walls of this type can be formed in the milled formworks. Their design and execution does not cause difficulties if their shape is constructed by ruled surface. Ruled surface relatively easily can be constructed as a reinforced concrete shell. The main reinforcement rods are for structures generating lines of the surface. A separate design issue is the project of the formwork for reinforced concrete shell, in such cases. In this case, free-shaped curvature of the walls made it impossible to design a repeatable milled formwork used in concrete structures. What would significantly increase the cost of construction. Therefore, the construction of the wall has been changed; in place of reinforced concrete structure was used steel structure with pipes. By this way, steel pipes form the skeleton construction of curved walls, one problem of the design has been solved – how to construct load-bearing walls of complicated geometrical structure in more economical version. But it started another problem of the design, how to model surfaces of curvilinear walls. This problem had to be solved by meshes of the surface, so in real it was necessary to design the mesh element for the surface. Engineers and architects decided to design the curved surface of the walls as approximation of mesh with quadrilateral planar faces. The digital walls model was prepared in RHINO program, and this defined the geometrical

¹¹ P. Fabiańska, M. Ferenc, *Rozstapione Morze. Muzeum Historii Żydów Polskich w Warszawie*, Świat Architektury, 6 (36) 2013, Wrocław 2013.

¹² M. Ferenc, *Muzeum Historii Żydów Polskich*, Architektura Muzeów, <http://architektura.nimoz.pl/2013/03/09/konstrukcja-muzeum-historii-zydow-polskich> [on line].

shape of each panels and the geodetic coordinates of each corners of each panels too. In the primary version of this part of the constructional design, modelling of surfaces of walls were planned by resin cement panels cast in situ and then incorporated into the steel curvilinear wall structure with the use of a system of holding elements. However, because of problems in obtaining sufficient quality of panels made of resin cement and the problem with suitable finish connections of wall panels this technology of construction a curvilinear wall was rejected. Knowing the possibilities of producing curvilinear surfaces with shotcrete technology, company TORKRET prepared 3D models of curvilinear wall as an illustration of the solution, which could be used in the design. According to this technology wooden panels made of OSB plate were used as a first layer fixed to steel structure, the next layer of the structure was reinforcing fabric and the last layer was shotcrete – concrete applied by spraying. The final drawing of the meshes of the walls surfaces, visible on them, was obtained with the help of real and apparent expansion joints. In this way, in finally adopted solution of the problem of modelling of the curved wall surfaces, the wall resin cement panels made in situ were replaced by wooden panels made of OSB panels, which have been covered with a layer of shotcrete¹³.

The architectural and construction design of curvilinear walls was developed in four stages:

- freehand sketch prepared by architect Rainer Mahlamäki,
- scan of architect's freehand drawing,
- computer model worked out in AutoCAD,
- computer model worked in RHINO.

5. Conclusions

If we try to answer the question – can creating of Architecture be fun; in reality, it is very difficult to give an answer. Because there are so many aspects in creating of Architecture: the context of place, the main idea, the creators, the form, the function, the users and the receivers, the construction and the costs. Attempt to answer the question posed at the outset, let us get to the analysis of the design and realization of the museum. The building of the Museum of the History of Polish Jews, which is analysed in the text, in author's and others opinion, is characterized by a very good, simple form which has been very well inscribed in the context of the place¹⁴. Expressive form curved walls, which are contrasted with the simplicity of a rectangular prism, focuses attention of the users and the receivers of the object¹⁵. In the author's opinion, an interesting issue was the analysis of the design process of curvilinear walls especially in the aspect of constructing their complicated geometrical structure. Analysis of the design process of the curvilinear walls clearly indicates that the first stage in this process was the idea – the freehand sketch of the architect. This is evident. Analysing the stages of the searching of geometrical forms of curvilinear walls,

¹³ W. Czajka, The *Museum of the History of Polish Jews*, Shotcrete Magazin, 2/26/2013, Winter 2013.

¹⁴ P. Fabiańska, M. Ferenc, *Rozstapione Morze. Muzeum Historii Żydów Polskich w Warszawie*, Świat Architektury, 6 (36) 2013, Wrocław 2013.

¹⁵ K. Mycielski, G. Stiasny, *Muzeum Historii Żydów Polskich*, Architektura-Murator, 06/2013//225, Warszawa 2013; p. 50–51.

it is worth paying attention to several aspects. The construction of the geometrical model of the curvilinear walls has been based on a freely shaping curvature of the walls. Shaping curves in CAD programs is based on their parametric representation; the most common used types of curves are: Bezier's curves, B-splines and NURBS curves. Accordingly, the computer models of surfaces based on these curves can be respectively: Bezier surfaces, B-spline surfaces and NURBS surfaces. The realization of such surfaces is based on the discrete surface. The most basic, convention, and structurally stable way of representing smooth shape of surface in a discrete way is via the use of triangle meshes. The alternatives ways of representing smooth shape of surfaces give us quadrilateral meshes with planar faces. And such representation was used in the analysed construction. The construction of the geometric computer model of the freeform surfaces, with using contemporary CAD programs, does not difficulties. The bigger problem is the solution of issues related to: feasible segmentation of the surface into panels, the realization of these segmentations, finding the best material for realization the main idea of the design and the realization all these elements in economical way. And the necessity to solve all these problems can be found in the analysed process of designing and realization of the curvilinear walls of the museum.

The use of discrete models of surfaces in Architecture has a rich history. Milestones for realizing freeform surfaces in architecture were the early twentieth-century fabrication methods for glass panels (Irving Colburn, 1905; Emile Fourcault, 1913; Max Bicheroux, 1919). Glass Pavilion, Bruno Taut, realized at the exhibition Werkbund in Cologne in 1914, is an excellent illustration of the application of the model surface using a quadrilateral mesh basic element in the architectural building. Development of steel structures together with the possibility of production of the basic grid's element – panel, brought realizations: Walther Bauersfeld, Buckminster Fuller, Frei Otto, Hans Schober, Norman Foster, Massimiliano Fuksas, and much more¹⁶. A discrete model of the freeform surface may be an important part of the structure of Architecture, not only as a constructional part of the object. The discrete model of the surface, the transparency of the panels, the shape of the approximation of the surface, can be an important part of the solution. And so it is in the analysed object. The meshes of the surfaces of the walls and their colours have a big influence on reception of the object. However, the technological and economic aspects caused that adopted in the design solution, a discrete model of the surfaces of the curvilinear surface shaped freely, had to be obtained on a layer of shotcrete. Concrete transmutation helped to solve the problem of the design and realization.

Analysis of the designing and realization process of the curvilinear walls of the Museum of History of Polish Jews, allows to conclude: regardless of highly developed computer aided design techniques on of the basic problems of the design process turns out to the problem, which can be formulated in the form of a short question – how to do it? Returning to the initial question – can creating of Architecture be fun? The answer may sound – yes, but the only as close cooperation of architects, engineers and geometers. Because, only their close cooperation enables resolving issues related to designing and construction, especially complicated geometrical structures.

¹⁶ H. Pottmann, A. Asperl, M. Hofer, A. Kilian, *Architectural Geometry*, Bentley Institute Press, 2007; p. 382–383.

R e f e r e n c e s

- [1] Czajka W., *The Museum of the History of Polish Jews*, Shotcrete Magazin, 2/26/2013, Winter 2013.
- [2] Mycielski K., Stiasny G., *Muzeum Historii Żydów Polskich*, Architektura-Murator, 06/2013//225, Warszawa 2013.
- [3] Stiasny G., *GETTO – warszawska architektura pamięci*, Architektura-Murator, 06/2013//225, Warszawa 2013.
- [4] Fabiańska P., Ferenc M., *Rozstapione Morze. Muzeum Historii Żydów Polskich w Warszawie*, Świat Architektury, 6 (36) 2013, Wrocław 2013.
- [5] Kiciński A., *Konkurs na projekt muzeum historii Żydów Polskich w Warszawie – idea, twórcy, zadanie, wynik*, Muzealnictwo tom 2005, Numer 46, Warszawa 2005.
- [6] Knebel K., Sanchez-Alvarez J., Zimmermann S., *The structural making of the Eden Domes*.
- [7] Podgórska J., *Muzeum życia. O tym jak powstało Muzeum Historii Żydów Polskich, jak zostało zorganizowane i jakie niesie przesłanie, opowiada Marian Turski*, Polityka 43 (2981), Warszawa 2014.
- [8] Pottmann H., Asperl A., Hofer M., Kilian A., *Architectural Geometry*, Bentley Institute Press, 2007.
- [9] Budynek Muzeum Historii Żydów Polskich POLIN – www.polin.pl [dostęp 2017-06-12].
- [10] Ferenc M.: *Muzeum Historii Żydów Polskich*, Architektura Muzeów, <http://architektura.nimoz.pl/2013/03/09/konstrukcja-muzeum-historii-zydow-polskich> [on line] [dostęp 2017-06-12].
- [11] Ilmari Landhelma & Rainer Mahlamaki z Finlandii – zwycięzcami konkursu na Muzeum Historii Żydów Polskich, Stowarzyszenie Architektów Polskich [on line], sarp.org.pl, 1 lipca 2005, [dostęp 2017-06-12].
- [12] Konkurs na Muzeum Żydów Polskich – prekwalifikacja, Stowarzyszenie Architektów Polskich [on line], sarp.org.pl, 17 lutego 2005 [dostęp 2017-06-12].
- [13] Międzynarodowy Konkurs Architektoniczny na budynek Muzeum Historii Żydów Polskich w Warszawie, Stowarzyszenie Architektów Polskich. Komunikat SARP 03/2005 [on line] sarp.org.pl, marzec 2005 [dostęp 2017-06-12].