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Conceptual Innovative Design of Buildings - Toronto - Sky Velodrome 2015

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Abstract – The conceptual design of buildings requires the unity of compositional, functional, constructive, technological, aesthetical and other characteristics. In this paper is reviewed a solution of the authors which includes the above-mentioned characteristics in order to achieve a high degree of competitiveness in an international high-rise building design competition and namely Superskyscrapers Sky Velodrome Toronto 2015.

Index Terms – conceptual design, high-rise building, innovation.

I. MORPHOLOGY AND CONCEPTION [1] (FIG.1-15.)

The solution offers unity of shape, function and construction through innovations.

The building includes a velodrome and "eight-shaped" volumetric three-storied blocks which are put in height around four powerful gilled cores by the support of a typical for the solution **innovative elevator building technology**.

Work offices, dwelling-places, service premises, which are in the range of the project's idea, representing inflatable volumes with individual design, are settled down in "eight-shaped" volumetric three-storied blocks, which range consistently over four communication core.

The velodrome, designed as a reversed ribed shell, beforehand fulfilled on ground level, together with "eight-shaped" volumetric three-storied blocks, are lifted to the relevant project levels with the support of the elevator platforms or of the hydraulic system. On their roofs there are situated floor gardens.

II. COMMUNICATION (FIG. 3, 4.)

First of all there are the fulfilled four powerful vertical cores, which secure the vertical communication. One of the cores is designed for VIP guests. It includes high-speed elevators who can be used also from coaches, athletes and for emergency medical aid in case of need.

Escalators and moving walkways provide horizontal and inclined transport service between the cores.

Transparent panoramic elevators are used for vertical service of the floor gardens.

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Freight elevators – high-speed and stipulated they are used for vertical transportation of the bicycles, spares for them and so on.

III. CONSTRUCTION OF THE SKY VELODROME (FIG. 4, 13.)

The base of the velodrome represents a reversed ribed shell /the ribs represent a grate, formed from intersecting ribs/ that is hanged up with the help of equalizing box-shaped consoles on the four cores in the top part. The shell has a configuration which corresponds to the slopes of the **Velodrome Lap Distance /Size: 250 meters; Width: 7 meters; Banking: 42˚; Straights: 12˚**/ pointed out in the task.

The building system for implementation of the shell of the Sky Velodrome

The shuttering for implementation of the shell is installed on the first slab of the basement, which harshly lightens the shuttering , reinforcement and concrete works. Casting the shell is completed on ground level – on the shuttering plane, situated motionlessly between the parts of the unsusceptible elevator platforms. The shuttering plane has its own supports which are in the basement area.

The shuttering of its ribbed grate represents turned plastic basins with exact definite configuration. The reinforcement of the ribs and the shell are connected to the contractual zones. At the cores its shell and grate are leaned against equalizing box-shaped consoles.

The shell is hanged up with an elevator shuttering platform, hanged above the three-storey elevators designed for loading tanks of water. That water is used for irrigation of the gardens or for fire-fighting. Furthermore, they can be used also for guiding ropes and tackles arrangement creeping above over tracks, installed on the forehead of the continuous walls of the four cores.

The creeping on the height of the cores is evenly for each four cores. The management of the lifting of the elevator platforms by the four cores is carried out by the central station. Above the upper surface the platforms there are situated rings which limit the possibility of shifting of the elevator platform outside its vertical route.

Under that elevator platform there are installed bottom three-storied elevators for workers, useful load such as building materials, inflatable volume offices etc, which consequently will be used for passenger elevators.

Stabilizing the elevator basement platforms to the bottom of the upper three-storied elevators and to the roof of the lower three-storied elevators is achieved by the electromagnetic contact surfaces.

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By reaching the design height in the top part of the four cores the reversed ribbed shell through the grate of crossed ribs, formed from the distance between the basins, and through equalizing box-shaped consoles, is clamped to the continuous walls of cores.

Then the elevator basement platform descends in starting position, down to the ground area, for installing of the next "eight-shaped" three-stories blocks.

Finally, the electromagnetic contact surfaces are released from the electromagnetic action and the elevator basement platform is uninstalled completely.

Implementation of the "eight-shaped" three-storied blocks.

The implementation of the construction like a combination of grates, oblique truss and horizontal floor slabs.

The "eight-shaped" three-storied blocks are hanged up on the cores. The outer and the inner walls of the eight-shaped are stiffly connected between each other. The obtained cellular structure is accomplished by lightweight metal grates – longitudinal, vertical and horizontal, situated under three massive floor slabs and under one or two roof slabs and also skewed transversal trusses. These components of the construction allow to be obtained the necessary spatial stability and during the erection.

The cellular structure is sized and the three-storied bridge construction in three-storied levels, hanged up over two neighboring cores in result are used for installing inflatable volumetric office premises.

That cellular structure represents combination of two longitudinal facade grates connected with two inner longitudinal grates through horizontal floor slab elements under which there are carried out horizontal against-wind links. The scheme "herringbone" is used for outlining the sloped trusses, connected under chosen angle /the best being 45˚/, the outer facades and inner longitudinal grates.

Between two sloped trusses, outlined in "herringbone", there are situated the areas of two neighboring offices represented inflatable volume but with double areas and beforehand set design of casing, /configuration, partition, color etc./ The design of the inflatable volume changes through ordering by catalog of a new design from factory producer.

Implementation of the construction as a version of slab-beams with thick ribbing (Fig. 5, 6.)

At first, on the first/initial floor slab, situated above basement, is installed the bridge construction "slab-beams" type with thick ribbing. Over it begins the installing /erection of the "three-storied" eight-shaped blocks by the "block raised slabs" system. The "eight-shaped" three-storied blocks are raised by hydraulic jacks **together** with the slab-beams. The raising mechanism is run by central station, situated on the ground.

Solution of the fencing construction of the "eight-shaped" three-storied blocks (Fig. 7, 8, 9.)

Typical features in the implementation of the fencing construction of the "eight-shaped" three-storied blocks (the bottom floor, the walls and the roof):

1. with highly effective heat insulation the structure of the bottom floor, the walls and the roof of these "eight-shaped" forms is done.
2. green facade walls, green roofs and hanging plants from the structure of the bottom/lowest floor
3. the outer soft facade casing with changeable configuration done in combination with small wind turbines; it's developed by the demand of the design of the specific solution.(it's described below in the text and it is related to contemporary innovative technologies for ecological expedience.)

Building system for overall installation of all "eight-shaped" forms in the operating situation using elevator platforms

It's suggested the "eight-shaped" three-storied blocks be installed from top to bottom on the four cores.

After the installation reversed ribbed shell of the velodrome follows installing directly under it the top "eight-shaped" form. Its assemblage is performed on ground level – on a formwork plane situated immovably between the parts of the movable elevator platforms. The shuttering plane has its own supports, placed in the space of the basement.

The moving of the "eight-shaped" three-storied blocks up is accomplished with the help of elevator platforms, pulled up with the help of upper three-storied elevators and pushed down with the help of lower three-storied elevators, located in the zone of the cores.

After the hanging of the "eights" of the two nearby cores, the relevant elevator platforms go back in starting position in the space of the basement, with the help of the same three-storied elevators, until their top surface is aligned with that of the terrain. The next "eight-shaped" block for lifting is installed on top of that surface.

Note: The height and the width of the basement allow the installing of the elevator platforms and having the space around them for the installing and uninstalling works /for example adding or removing of shuttering weight bearing rods, the joints between them and etc./

A. Building system for the full installation of all "eights" in operating position with the help of a hydraulic system

The cores are ribbed with continuous walls from bottom to top, along their whole height. The Hydraulic system /the system of jacks, ribbed rods and protective pipes/ for the first "eight-shaped" block steps on the slab of the basement. After installing of the first "eight-shaped" three-storied block follows the uninstalling of the hydraulic system and installing it on the top of the already placed three-storied block for the execution of the next "eight-shaped" three-storied block.

For the second "eight-shaped" block the elements of the hydraulic system steps on top of the roof slabs of the relevant lower block. When u have obliquely intersection of the internal space for stepping of the opposite core, the hydraulic system is placed on an even lower level. For that goal telescopic hydraulic jacks with variable height that expand over two or three "eight-shaped" blocks are used.

Manual for hanging of the "eight-shaped" three-storied blocks to the cores using short walls, expanding the whole height of this block

Each one of these blocks is fixed to its own ribs (walls) to the continuous walls of the cores.

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After the final connection of the three-storied "eight-shaped blocks" follows the installation of the four cores of the panoramic four-storied elevators, three of the stories are used for serving the three stories of the "eight-shaped" blocks. The top forth floor is meant for exiting and access to the roof-gardens, located on the roof of each of these three-storied blocks.

After uninstalling the hydraulic system from the lower level, on the last slab of the lower block the structure of the roof gardens is installed. The plants and the bigger plant species can also be planted on top of the three-storied block.

Usage of the horizontal hydraulic devices

Dynamic façade shell

This shell is hanged on telescopic cantilevers, expanding the volume of the building up to three meters. The cantilevers are hollow rods and beams, in the space on which "swims" or "slides" a hollow hanger, which is a rod or a beam, but with a length at least twice bigger than the cantilever. The hollow rods or hollow beams are placed in the structure of the inter-floor construction, while the hollow hangers are moving with the help of hydraulic devices with central control. Thus a part of the wind energy on the façade is taken by the sinking hydraulic devices.

Usage of the rain waters for irrigation

The plats are irrigated with drip irrigation from the rain waters, that are saved in vessels, located in the four cores of the building or from the vessels filled with condensed mist and located over the inner hallway of the "eight-shaped" three-storied block.

Usage of the rain waters for accumulating energy

Water turbines, located in the cores , are actuated from the fall of rain water, collected from the sloped roofs of the cores. /One water turbine is placed on every second floor. One water pool is also placed on every second floor/.

Usage of warm waste waters

The warm gray waters are conserved in vessels, located in the four cores. Each of the roof-gardens is heated with the help of circulating loop, placed in the soil. This circulating loop goes through the vessels with the warm gray waters.

Static façade shell

Transparent matter of polyketone, reinforced with carbon threads – transparent or in color, fixated on the top of the unmovable cantilevers.

Ecological expediency of the solution

Usage of wind micro turbines

A) In the zone of the "eight-shaped" three-storied blocks, located between two neighboring cores:

Wind micro turbines are located in the infundibular mouths, thrusted in the hollow hangers, located on the lever of the floor structure. These turbines inject the mist in the space of these hollow hangers. The mist enters the vessels, located above the inner corridors of any of the "eight-shaped" three-storied blocks, hanged on the neighboring cores of the building.

The caught mist condenses and the condensed drops are cleansed from harmful pollutants. The clean water is used for irrigation of the roof-gardens from the lower hanged "eight-shaped" three-storied blocks or for residential applications for the floors with offices and other business rooms.

B)In the zone of the "eight-shaped" three-storied blocks, located in the zone of the hanging with the cores:

In the absence of mist by the micro turbines the air is injected, which by using open valves is send to the elevator shafts. The received air pressure is used to actuate the wind turbines, located over and under the cabins for the speed elevators and the panoramic elevators.

On top of the four cores four wind turbines are installed, which can inject the air into the elevator shafts. This way they ease the moving of the cabins, which reduce the expense of energy for their moving.

Organization of the inner space

Swinging waterfalls, vibrating from the power of the water stream, are located in transparent and water proof materials /polyketone, reinforced with carbon threads for increased resistance against rapture during operation/.

These waterfalls reach horizontals water pools, expanded like water swings, which are hanged on hanging ropes or chains. The water from the upper pool overflows, forming a waterfall reaching a pool on a lower level. The pools are also from transparent materials, /for example transparent light concrete/ and can be performed like aquariums with exotic fish or other marine species. Choice of fitting decorative lighting brings fairy and active impact of the interior on the visitors and residents of the building.

The park storied greenery in combination with the water setting if a good opportunity for creating of inner comfort, aiming fast regeneration of the space of the building.

Two-meter -high railings, composed of a lower solid part and highest transparent part protect the inhabitants of the roof-gardens, water areas – aquariums, also there movement on the additional means of communication – moving paths and escalators.

Cycling layout

It is suggested that the place of this layout will be in the interior spaces of the building. A cycling layout, using a system of training alleys and paths, but with fitting slope can also be developed along the height of the building – it is with a different difficulty , which can pass in training horizontals paths, placed on the roof-gardens. This way they can be used for training layouts with different lengths. If needed after a workout on a certain layout it can be suspended if judged so by the trainer, after the level with the panoramic elevators from the core is reached.

Functional solution by floors according to the design assignment (Fig.9.)

The wide area rooms are located in the basement:

• Culture Zone (Cinema, Theatre, Auditorium and Art Exhibition Gallery Space)

The underground parking spaces are located in the independent levels of the basement /Underground Parking/.

Located on the top level of the building are:

• Sky Velodrome Track with at least 2,000 Spectator Seating and Facility for Queuing and Ticketing

(with possibility for covering against the elements in the winter months);

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• Audio and Visual, Press & Reporters/Commentary Area:
• Changing Rooms with showers and toilets for spectators.

Located in the space of the "Eight-shaped" three-storied blocks are:

• Velodrome Administration, Security and Weather Monitoring Zone:
• Gymnasium/Health & Fitness/Relaxation:
• Recreational and Social Zone (Bars, Restaurants, Café);
• Office & Commercial Spaces.

Additionally there can also be placed:

• Hotel for athletes, apartment type homes, kindergarten, nursery school, training rooms, SPA-center etc.

IV. Conclusion

This conceptual innovative design of buildings has the main objective to develop and implement concepts for competitive architectural solutions, based on the principle of unity of different technical characteristics and innovative components, according to the leading tendencies in architecture development worldwide.

The suggested competition projects have been preceded by the analysis of cutting edge achievements in world architecture from the point of view of the unity of innovation and composition, function and construction, integrating contemporary building materials and technologies.

As a result, original architectural forms that can create new market niches have been developed, thus solving various problems, posed by different projects.

The exploitation of modern buildings requires their adaptation to the use of solar energy and other renewable sources of energy, e.g. rainwater; grey wastewater; wind energy; the integration of facade and floor greenery; technologies facilitating the protection of environment; transport facilitation, etc.

Another factor improving the competitiveness of a given design project is the adequate implementation of the idea for unity of different technical characteristics and innovative components in one architectural solution. Therefore, the integration of innovative architectural and constructional details is of extremely high importance. Practically, the emotional and psychological "adaptation" of a given space depends directly on the implementation of these details. Thus, these details have to be regarded as an integral part of the aspiration for innovative unity of architectural solutions.

V. Appendix

Description of figure positions:

1 Entrance of the kernel
2 Three-storey elevator cabin
3 Staircase
4 Protection net
5 Connection elements for suspending of the transverse walls that belong to the three-storey "eight-shaped" block
6 Roller bearing
7 Column bearing the wind turbines
8 Folding mounting platforms
9 Water turbine
10 Water tank
11 Spillway
12 Bearing wall, connected tough to the kernel (with height equaling the height of the kernel)
13 Bearing wall (with height equaling the height of the three-storey "eight-shaped" block
14 Wind turbine
15 Tubular serpentine of the solar energy collector
16 Inflatable semi-transparent covering made of polyketone, reinforced with transparent carbon threads
17 Horizontal connection, protecting against wind
18 Inter-floor construction (transparent, with artificial lighting)
19 Transparent aquarium
20 Chains, bearing the aquariums
21 "Swinging" waterfall
22 Velodrome
23 Velo-alley (level for velo-tourism)
24 Wind turbine
25 Funnel directing the rainwater
26 Ventilators supercharging the air towards the elevators in the elevator shaft
27 Ventilators supercharging the mist
28 Telescopic support
29 Three-storey "eight-shaped" block
30 Three-storey elevator, PULLING upwards
31 Three-storey elevator, PUSHING upwards
32 Electro-magnetic plate
33 Shuttering platform
34 Mobile water tank for irrigation of the roof garden
35 Parking
36 Automobile loading platform leading to the underground parking
37 Bearing tubes or elastic rings made of such tubes (enclosing a space where air is being supercharged)
38 Aquarium
39 Mobile "swinging" waterfall

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AUTHOR PROFILE

Assoc. Professor Dr. arch. Aleksandrova and Professor Dr. arch. Aleksandrov are authors and co-authors of more than 100 patents for inventions, whereas a significant part of them solves problems in the sphere of the energy efficiency of buildings, e.g. active-energy walls, energy-accumulating panel connections, systems for solar heating of buildings, sectional medical modules with autonomous energy supply for use in extreme situations, i.e. natural disasters, etc.

The authors are winners of the "Genius Grand Prix" and a Gold medal from the International Invention Fair in Budapest. Their papers have roused high interest at numerous international conferences on architecture and sustainable development, e.g. in Tokyo, Seoul, Hong Kong, Kuala Lumpur, Cape Town, Florence, etc. They have been guest lecturers at the Faculty of Architecture of the Institute for Building Management in Belgrade, Serbia as well as "Erasmus" lecturers at the Riga Building College, Latvia in 2012, 2013 and 2014.

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The authors teach the course “Innovative design of buildings, constructions and details” at the Faculty of Architecture of the University of Structural Engineering and Architecture “Liuben Karavelov” in Sofia, Bulgaria. They have been finalists of several international Superskyscrapers competitions with the participation of some of their students, e.g. Hong Kong – 2013, Singapore – 2014, London – 2014, “Elevator annual design competition” – 2014, etc.

Magdalena Mihaylova and Ivan Kirchev are students at the Faculty of Architecture of University of Structural Engineering and Architecture "Lyuben Karavelov" – Sofia.

Ivan Aleksandrov served as a strategy consultant to the project. He is a Master of Science in Strategy, Innovation and Management Control with a degree from Vienna University of Business and Economics, Vienna, Austria.

Fig.1. General view of the competition final board

Fig.2. The reviewed project № 1000001495 is finalist of the Superskyscrapers Sky Velodrome – Toronto 2015 design competition

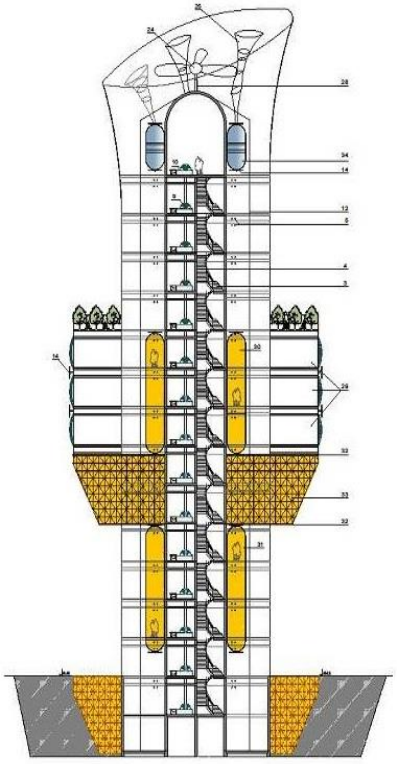

Fig.3. Vertical section through one of the kernels of the building

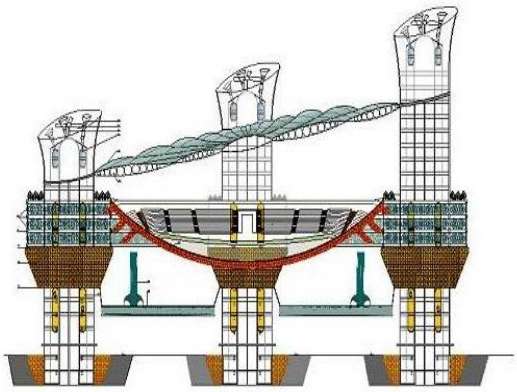

Fig.4. Vertical section through the velodrome

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Fig.5. View of the structure of the building

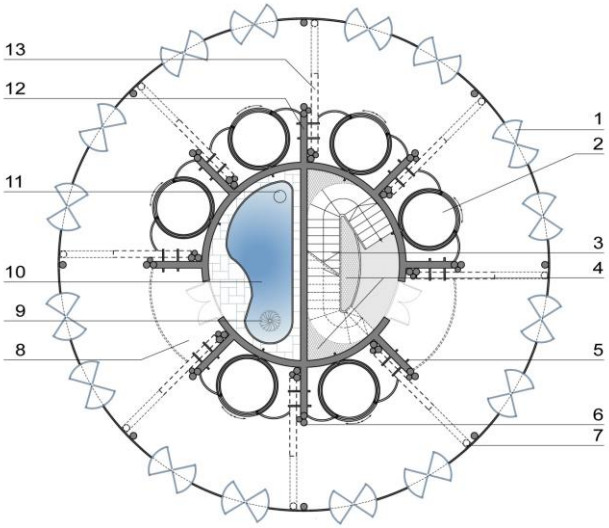

Fig.8. Plan of the entrance to one of the kernels

Fig.6. View of the structure of the building

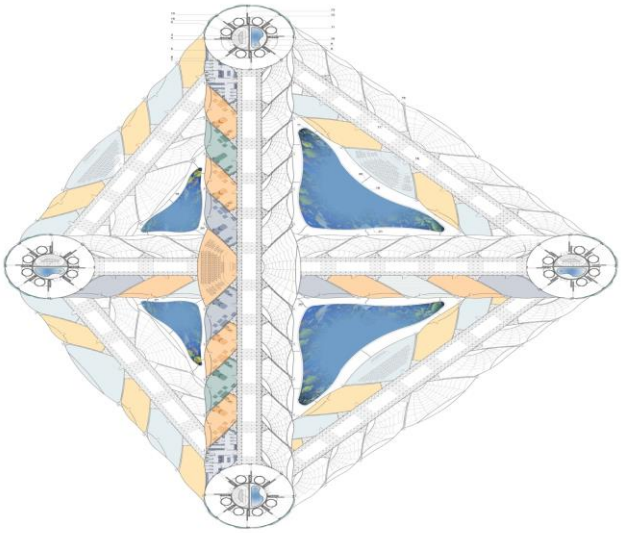

Fig.9. Typical plan with "swinging" aquariums

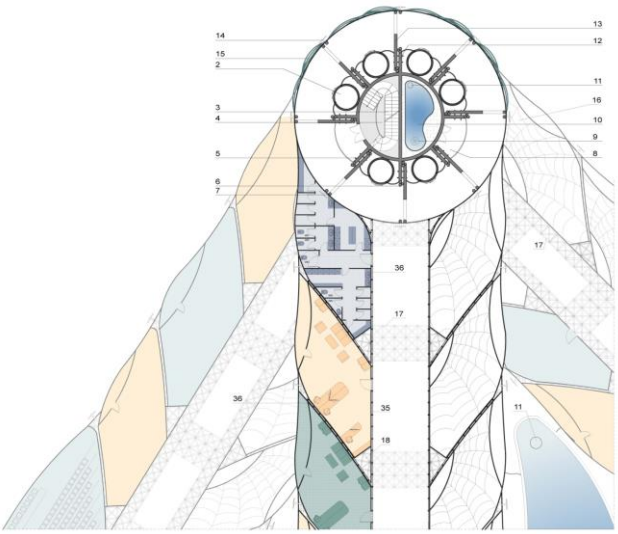

Fig.7. Fragment of the plan showing one of the kernels

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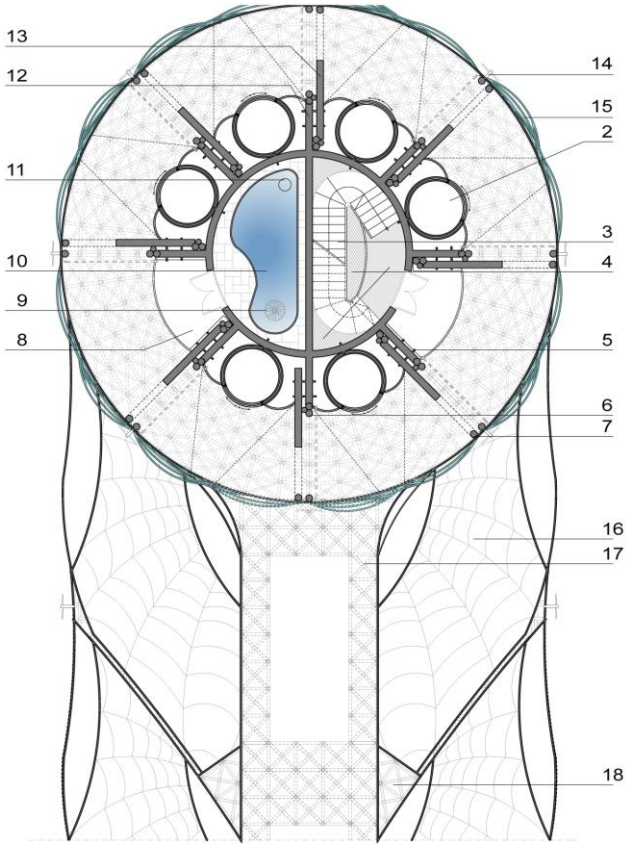

Fig.10. Plan of a kernel of the building

Fig.12. Situation

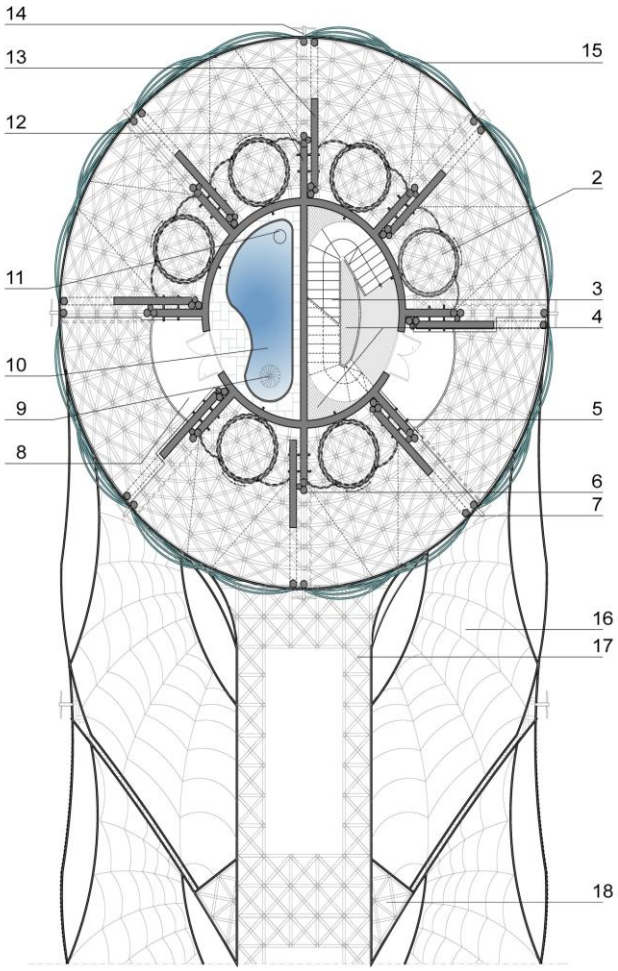

Fig.11. Plan of the shuttering of the kernel

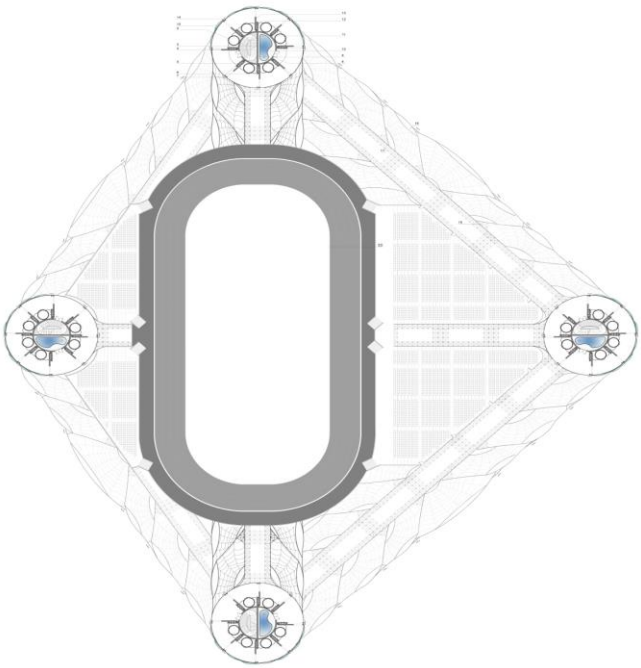

Fig.13. Plan of the velodrome

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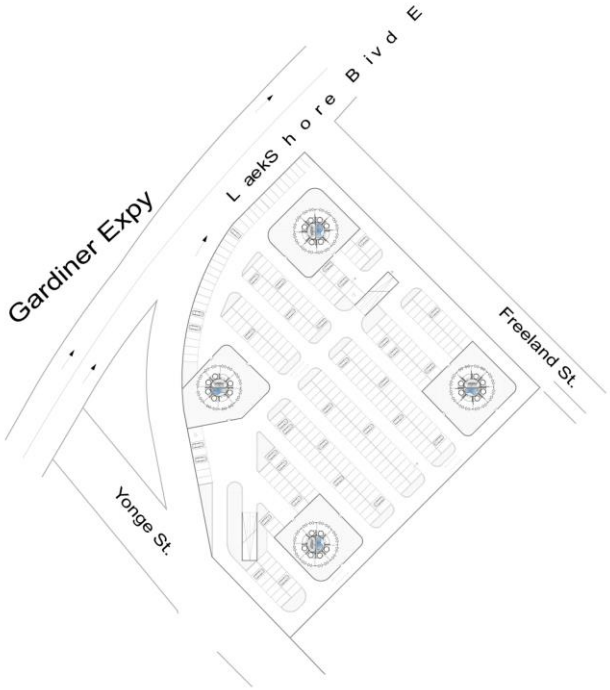

Fig.14. Plan of the garage level

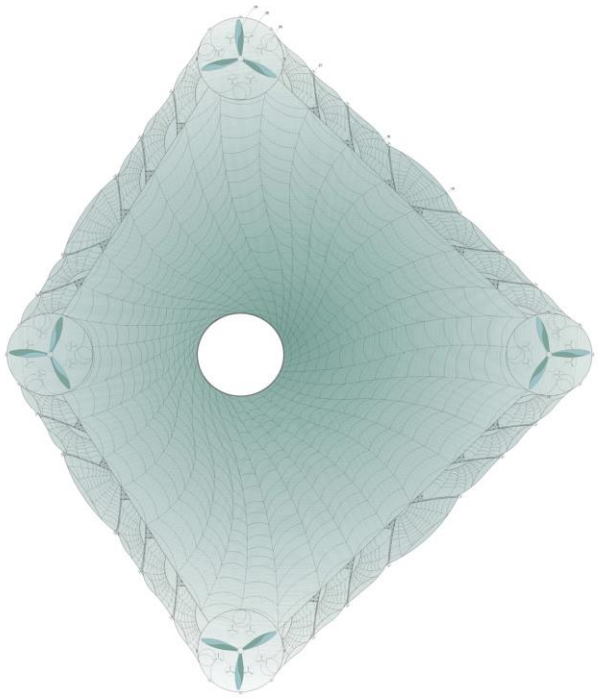

Fig.15. View of the roof of the velodrome

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