Unique skyscrapers currently under construction in the world

Irakli Kvaraia, Sophio Gelashvili, Lasha Bochorishvili
Georgian Technical University M.Kostava st 77, Tbilisi 0159, Georgia.
i.kvaraia@gtu.ge, gelashvilisopo1998@mail.ru, lashabochorishvili12@gmail.com

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Abstract In recent years, there have been very big changes in the construction industry. It is especially noteworthy that the construction of unique buildings, which is mainly associated with the construction of skyscrapers, has shifted from the USA to Asia. This is primarily due to the versatile possibilities of using monolithic reinforced concrete as the main material in high-rise construction, along with metal structures. In the oil-rich Middle Eastern countries, which are dependent on natural energy resources, the use of other areas for the development of the country's economy is being carried out with great success. First of all, this is tourism, which is especially associated with the construction of new, completely different types of buildings and structures, which in turn contributes to the development of this industry. The best example of this is the "Burj Khalifa", the tallest building built on Earth, which attracts a lot of tourists from all over the world, and their number will increase even more after the construction of buildings taller than it. In order to achieve more impressive results in this direction, a lot of buildings are currently being built worldwide, among which several can be singled out.

Keywords: building, project, innovation concrete, steel, skyscraper

1. Introduction

The construction of any skyscraper is a very important event. In addition to the fact that they are distinguished by their individuality, new materials, technologies and mechanisms are necessarily used. At the same time, world construction practice has shown that the construction of buildings higher than 500 meters is associated with a number of unjustified costs. The main reason for this is the disproportionate increase in the cost of engineering communications and elevators with the increase in the height of the building above this. This was the reason why a few years ago, the Chinese government, one of the most developed countries in the field of construction, banned the construction of buildings higher than 500 meters on its territory. Perhaps this decision was made based on the rich experience that China has. For this, it is enough to note that out of the 12 buildings in the world that are over 500 meters tall, 6 are in China, and 6 are in the United Arab Emirates, Saudi Arabia, Malaysia, the USA, South Korea and Taiwan, that is, there is only one such building in these countries. If earlier countries competed with each other only in the construction of tall buildings, now more and more attention is paid to the creation of new architectural and structural forms, increasing the environmental friendliness and energy efficiency of buildings.

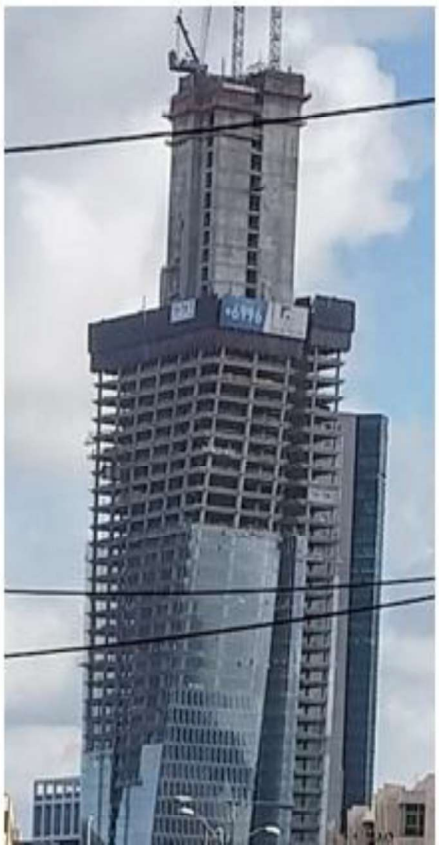
2. Main part

Dubai, in the United Arab Emirates, has already become widely known for its unique buildings in the world. One of these in the near future will definitely become Ciel Dubay Marina. This is the tallest hotel in the world under construction, which is scheduled for completion by the end of 2025. The construction of the 377-meter-high, 82-story and 1,042-room hotel began in 2018.

And the height of its monolithic reinforced concrete structure will be 364 meters. 12,000 m3 of concrete and 2,700 tons of steel reinforcement were spent on its foundation alone. The building is distinguished by many innovative solutions, among which it is necessary to highlight the 300-meter-high atrium inside the building, 12 vertically located gardens, the height of which reaches eight floors; the arrangement of a park and an infinity open pool on the roof; The large, curved, lightweight concrete enclosing elements and glazing were constructed using high-quality steelstructures, giving the building a high truncated cone shape. the hotel is equipped with the most modern energy-efficient systems. Figure 1 shows the construction process, which was halted for a long time during the pandemic. The building is now fully glazed and all major works are complete.

Fig. 1. Construction process

This year, the construction of the Azrieli Spiral Tower, the tallest building in Israel, is also scheduled to be completed in Tel Aviv. Its total height is 255 meters, seven floors, with an underground parking lot for 1,600 cars. The 64-story building is 238.5 meters high from ground level and has a total usable area of 55,000 m2. The originality of the building lies in its shape, which resembles a vertically rolled-up sheet of paper. Two vertical reinforced concrete frames, trapezoidal in plan, are wrapped around a rectangular load-bearing part made of monolithic reinforced concrete. As they approach the upper floors, the outline of the trapezoids changes counterclockwise. During the construction process, this arrangement of the frames gave the impression of a tilt similar to the Leaning Tower of Pisa (Fig.2). The foundation and initial facade of the building are located parallel to the existing streets, and as the height increases, it gradually turns towards the sea. The perception of such a curvature of the frame parts is especially evident



after the

Fig. 2. Construction process

glazing of the building, which is made of aluminum frames (Fig. 3).

Fig.3. Azrieli Spiral Tower

In Saudi Arabia, in the city of Riyadh, the construction of a completely different from other skyscrapers, the largest in the world by volume, a cube-shaped building with sides of 400 m long, began in 2024. Its name is "Muqaab", which means cube in Arabic. Its grandeur is also evidenced by the fact that, taking into account the overlap, it is possible to virtually place 20 Empire State Buildings inside it, which is clearly visible in the picture below (Fig. 4).

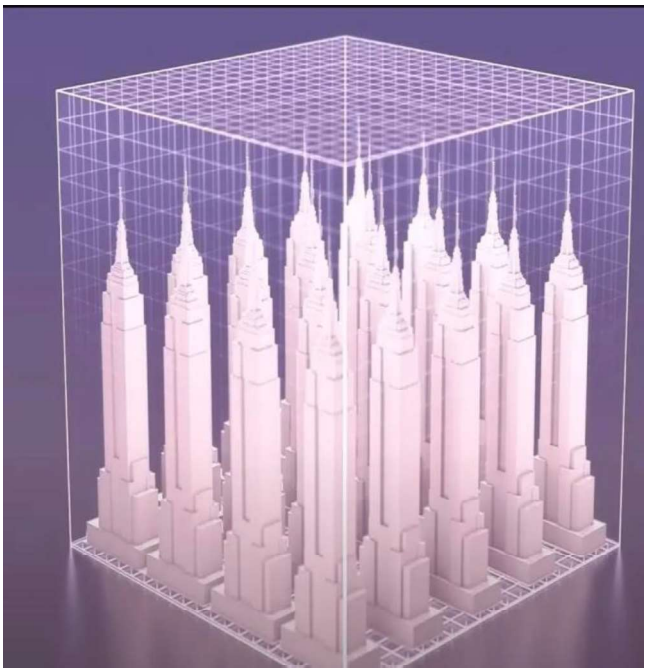


Fig.4. Interior Space

As a supertall (over 350 meters high) building, the Mukaab will be among the top 50 tallest buildings in the world, and for the first time in the world, a skyscraper in the form of a spiral tower will be built inside it. The tower is planned to house a hotel and shopping facilities. Holographic landscapes will be projected from the tower onto the inner walls of the cube, which will create an imitation of an even greater expansion of the internal space. All this will allow an independent mini-city with its own skyscraper to be organized in this huge enclosed space. In a multifaceted green city, in which there will be no shortage of fountains and waterfalls, the problem of protection from the heat has been successfully solved. Despite this, the mentioned building has many opponents due to its similarity to the Masjid al-Haram, the main shrine of Islam in Mecca. The project is financed by the State Investment Fund, which was created to improve the economy separate from oil extraction, where one of the leading places belongs to the development of high-rise

construction. This, along with increasing the country's tourism potential, will also create many jobs for the population (Fig.5).

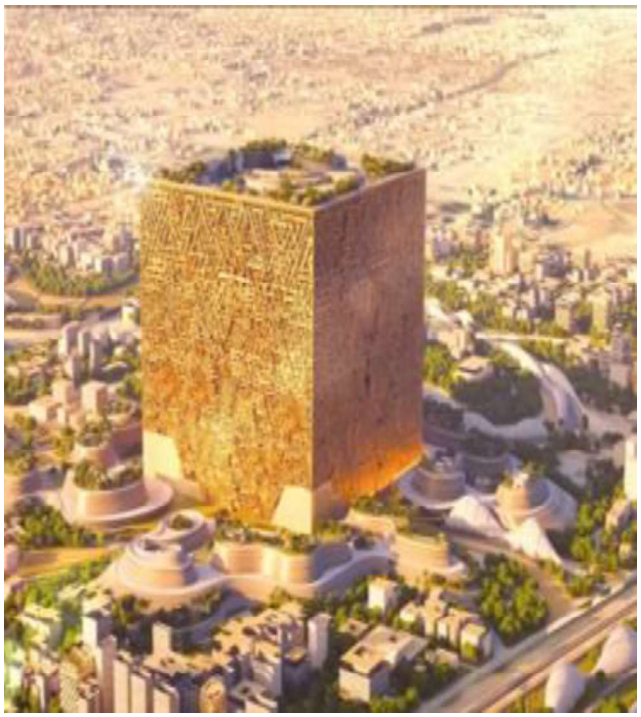


Fig.5. Makaab

Since the start of construction, more than 10 million m3 of soil has been processed, 250 powerful excavators and more than 400 units of various types of heavy equipment, several thousand people are working at the construction site. The arrangement of reinforced concrete piers has begun. The construction of the walls will continue with monolithic reinforced concrete, and their exterior will be covered with clay panels, which will be painted with ornaments characteristic of Saudi Arabia. Its completion is scheduled for 2030, before the World Exhibition opens in Erbil, and its goal is to amaze the world with this incomparable skyscraper-cube.

Another fantastic project has begun in Saudi Arabia, called The Line, which is a 500-meter-high "city wall" stretching 170 km from the Red Sea in the desert, with a population of 5 million (Fig. 6).

Fig.6. The Line

Many people had great doubts about its implementation. It is especially striking that the desert is divided into two parts and the animal world is facing difficulties. Despite this, earthworks are already underway along its entire length at such a pace that an average of 200,000 m3 of soil is being processed and 60 trenches are being constructed per day. According to the latest data, only a 5-km section of the wall will be completed in 2030, and its full completion is expected by 2045 (Fig. 7).

Fig.7. Earthworks

The building consists of two parallel, monolithic reinforced concrete skyscrapers located in a mirror image of each other. According to the project, a total of 135 modules

with the same infrastructure will be created, each 800 meters long. The width is unchanged along the entire length of the wall and is 200 meters. The "wall-city" will be completely glazed using modern energy-efficient materials. Inside, the buildings will be connected to each other by bridges, and the remaining space between them will be three levels. Transport will operate on the first level, which is mainly underground, for example, according to current calculations, the train should take only 20 minutes to get from start to finish. The second level will be arranged in the form of ordinary streets and squares so that all necessary institutions are within a 5-minute walk. The third level, together with the roof, will be a green area for recreation and entertainment. The arrangement of vertical farms for growing food products is envisaged. Interestingly, it is already planned to arrange a large football stadium at a height of 300 meters in the city center (Fig. 8). In addition to the fact that the city will be the most ecological in the world, that is, it will consume renewable energy resources, its management at all levels is envisaged using artificial intelligence.

Fig..8.Stadium in the wall

Also in Saudi Arabia, on the Red Sea coast, the construction of the Jeddah Tower, the world's tallest building and structure, is underway. Its projected height is more than 1 km, but the exact height, like the construction of the Burj Khalifa, has not yet been made public. It is noteworthy that its preliminary cost is 1.23 billion US dollars less than the Burj Khalifa. Initially, the project envisaged the construction of a building one mile (1.6 km) high, but after a more accurate, detailed analysis of the existing soil, it was decided to reduce the height by 1/3. Construction began in 2013 and was planned to be completed by 2020, but was suspended in 2018 due to financing problems. Construction has continued since September 2023 and is scheduled for completion in 2028. The number of floors of the building should be 167, but as a result of the final stage of the project, the number of floors may increase even more. Currently, the total area is 530,000 m2. The three-story glass building, built of reinforced concrete and steel, has a pointed shape that significantly reduces wind load. On the 157th floor, a 30 m diameter cantilevered metal structure is to be built. A viewing platform, which will provide an opportunity to view the surroundings within a radius of 113 km (Fig. 9).

Fig.9. Jeddah Tower

The main architect of the project is the American Adrian Smith, who also supervised the construction of the Burj Khalifa, and the experience gained there is of great help in the construction of the Jeddah Tower. This especially applies to the execution of the engineering part, which has been much improved, but still creates many difficulties. For example, the building will be served by a total of 12 escalators and 59 Kone elevators, 5 of which are two-story. In order for the elevator ropes and other parts not to be unrealistically heavy, the building is planned to have a vestibule for the elevators on three different levels. The speed of the elevators is 10 m/s. For this period, it was planned to build 100 floors, but only 80 floors of the monolithic reinforced concrete frame of the building have been built, which makes its completion within the specified time frame somewhat doubtful.

The history of the construction of the "Dubai Creck Tower", is very interesting. The author of the very original project is the Spanish architect Santiago Calatrava. The monolithic reinforced concrete structure in the shape of an elongated and pointed cylinder is fastened with steel cables at the top of the building (Fig. 10).

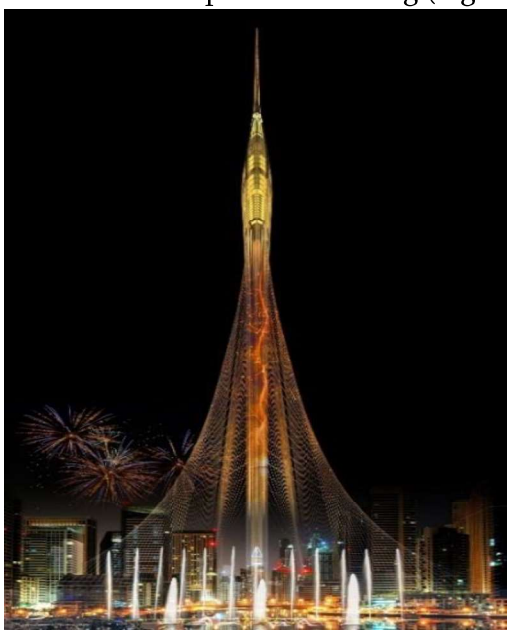


Fig.10. Dubai Creck Tower

The architect was inspired by the gardens of Semiramis, the Eiffel Tower and the traditional element of Islamic architecture - the minaret, which he really implemented in the form of a project. The slightly expanded 20 floors at the top of the tower are especially interesting. Where there will be a hotel, a restaurant, a peripheral observation deck. According to many, this tower can become a symbol of Dubai, just as the Eiffel Tower became a symbol of Paris. Construction began in 2016, and in March 2018 its huge circular foundation was completed. At the end of 2020, construction was suspended due to the pandemic, construction resumed only in March 2024, but the design height was reduced from 1345 meters to 928 meters. The number of floors is 200. The main goal is to build a building taller than the Burj Khalifa before anyone else and maintain the world championship.

Alongside these world-class projects, we should definitely mention the 42-story Citizen skyscraper under construction in Tbilisi, the capital of Georgia, designed by Zaha Hadid's architectural firm. The project will be the first skyscraper built by the world-famous company in the Caucasus region, with cascading green terraces. Its construction began this year and is scheduled to be completed in 2028. Although it is not distinguished by its height (160-170 m), its architectural solution has already attracted the attention of the world community (Fig. 11).

Fig.11. Citizen skyscraper

3. Conclusion

1. The three most ambitious projects currently underway in the world are being implemented in Saudi Arabia. There, as in many Middle Eastern countries, the economy based on oil reserves is being successfully replaced by tourism, which is primarily reflected in the construction of unique buildings;

2. China, which is the leader in skyscraper construction, has banned the construction of buildings higher than 500 meters on its territory since 2021. This is due to the unjustified increase in the cost of engineering communications and elevators when building buildings higher than 500 meters. Despite this, in Saudi Arabia and the United Arab Emirates, a real marathon is being held to attract even more world attention regarding the construction of a skyscraper taller than the Burj Khalifa.

3. The practice of constructing buildings over 100 meters high has existed in Georgia for only two decades, but by 2028, the first skyscraper in the Caucasus, designed by Zaha Hadid's famous architectural company, is planned to be built, which will become the tallest in Tbilisi and will probably stand out worldwide with its original architecture.

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