The Balkan Skyscraper: How Tall is Tall Enough?

DARIO TRABUCCO
I.U.A.V. University

The beginning of the skyscraper era was made possible by some key innovations that occurred in the late 19th century. Generally, steel frames and lifts were considered the key technologies, but a third was mentioned by witnesses of the time and then forgotten: the 'flat-arch' system to protect steel beams from fire. Now, The race for the sky is supported by innovation in the two main fields, which would otherwise represent a bottleneck in increasing the height of tall buildings. Fire safety, and safety in general, is probably the hardest barrier to unlimited height growth.

Vertical transportation technologies

The taller the building, the larger the population that must be transported efficiently. Illinois, the mile-high tower conceived by F. L. Wright, would have required 76 five-floor lifts to operate efficiently (Fortune, 1997). Quintuple-decker didn't come, and even the double-decker was never used extensively. Instead, traffic control systems and algorithms have allowed much more efficient use of elevators, thus allowing a large number of passengers to be transported without taking up too much space in the lower part of the building. Thanks to computerised systems combined with sky lobbies, a building of any height can be efficiently served without the need for the oversized cabins envisioned by Wright.

The problem is thus more technical with the excessive weight and size of elevator steel ropes that make travels exceeding about 500 meters quite impractical. With this length, the cable weight far exceeds the cab one, and counterweighting is almost impossible.

Innovation has also arrived in this sector, either with alternative materials (for instance, the use of carbon fibre instead of steel cables) or with the research conducted to eliminate cables with linear induction drives on each cabin. Although no commercial ropeless lifts are yet available, several companies are making significant investments in this technology, which is likely to eliminate any height restrictions due to lifts (Belmonte et al. 2019).

Structural systems

The advancement of both concrete and steel technologies has been significant in the past, both in the material properties and in the production chain for these materials. Also, construction improved significantly, with most of the supertall buildings now built with composite systems, used to build mega frames that subdivide tall buildings in a series of superimposed smaller ones (Ali & Moon 2007). The assembly of the structural part of a building is now assisted by ultra-precise sensors that are able to adapt the geometry of the building part under construction with the settlement of the previously constructed parts.

The increased height of the buildings results in an augmented sway and torsion due to lateral forces that may cause structural failure, serviceability issues and discomfort for the occupants. Damping technologies, introduced in the 60s, have now allowed the construction of ultra-slender buildings with ratios down to 1:25th, an unprecedented value that allows new heights keeping floor plates to a manageable size, functionally exploitable for residential super slim luxurious towers.

Fire safety and general building security

Despite the innovations in this field and the possibilities to real-

time monitor and detect the building thanks to IT technologies, tall buildings still are massive structures with only one escape route (Ahrens & Field, 2019). This was demonstrated by the collapse of the WTC in New York, where most of the casualties occurred in the part of the buildings where the escape routes had been damaged by aircraft impacts. It is somehow a limitation embedded in the tall building DNA, and alternatives are difficult except when multiple towers are built within a single development and a single owner. When this happens, several tall buildings can be connected in height by connecting bridges, which can serve to provide alternative evacuation routes. Skybridges built for this purpose (such as in the Petronas Towers) can only help the evacuation of the building in specific cases although the problem remains unresolved and the threat of being trapped in the event of an accident arises.

New aspirations

The search for the sky and the aspiration to get to the 'highest building of something' fuelled the adoption of bizarre solutions to get as high as possible. Architectural spires, not to be confused with technical masts that are not counted when determining the height of a building, have become a constant feature of buildings that win the height competition. The flat-rooftop "boxes" of the International Style have been replaced by more organic shapes with pointed spires, which have grown taller and taller to reach new heights.

In 2013 CTBUH (CTBUH, 2013) released a very debated study on "Vanity Height", defined as the height difference between the highest occupiable floor and the architectural tip of the building. The paper caused so much negative feedback from developers that the study was not carried on in the later years. It showed that approximately 30% of the Burj Khalifa's height (244 meters of the 828 total) is non-occupiable and is a massive useless addition on top of what would already be the tallest building in the world.

With growing attention to sustainability and efficient use of resources and materials, it is clear that the materials used for the sake of nothing but height are a total waste of valuable resources.

Why not build taller?

Tall buildings are expensive structures that require an increasingly high amount of building materials as they grow taller and taller. The first one to carefully describe this was F. Khan, the SOM engineer that in the '60 advanced the structural systems so much to enable the construction of some of the masterpieces of that period, including the world-famous John Hancock Center in Chicago and, a few years later, the Sears Tower. The principle emphasised by Kahn is that when a tall building structure grows in height, there is a 'premium' in its structural weight, i.e. an extra amount of concrete or steel that must be added to resist the increasing lateral forces due to wind and seismic activity, which grow exponentially with increasing height. According to this definition, engineers establish the difference between a conventional structure and a tall building at the point where the lateral loads acting on it exceed the vertical loads due to gravity, which, on the contrary, increase according to a linear function. Now, that extra amount of structural materials is commonly referred to as "premium for height" (Khan, 1973). Building a building of 80 stories requires way more than the materials needed to build two 40-stories buildings with an equivalent cumulative floor area Trabucco 2010). [Figure 1.]

In a period of scarcity like the one the world will face in the future due to its increased population, augmented wealth, and limited resources, it is clear that the abundance of materials required by a tall building in comparison with an equivalent low-rise structure is becoming more and more a problem (Trabucco et al. 2015). This is not just due to the economic and environmental cost that many extra materials imply but also to a social pressure that is starting to appear against unjustifiable wastes.

Being continuously requested with austerity and savings, public opinion is starting to react negatively to the ostentation of abundance and wealth. In France, for instance, there is a fierce debate on the use of private jets by wealthy individuals: in times of scarcity and restrictions, with governments asking to limit the energy consumption of families and businesses, a growing part of the population (including some representatives of the French government) is asking to limit "by law" the extravagant behaviours of those who can afford, from an economic standpoint, to use in a month the equivalent amount of energy used by the average French citizen in 17 years. The principle of this is that if the individual can afford it, society can not.

Tall buildings were thus born in American society as a display of economic wealth and strength by individuals and companies in a period of growth when wealth and abundance were available to anyone, limited only by ambition, personal capacity and opportunities. When this building type made its appearance in Europe, it faced the opposition of the leftwing part of the society, which was pointing at tall buildings as the material representation of a capitalist society where the privileged opportunities of a few prevailed over those that only had ambition and personal capacity. This social conflict is likely the underlying reason for the scarce number of tall buildings in Europe and their limited height if compared with the continent's wealth.

However, the current economic situation and the expectation for the future are different. Wealth is now so widespread in the world that natural resources are not abundant anymore. Tall buildings are thus starting to be seen, even beyond European borders, as a problem rather than a solution. Their energy and material intensity represent an unnecessary concentration of resources that drain away the capacity of other less-impacting businesses. [Figure 2.] The question that is important to answer and on which a debate is urgently needed is "what is Abstract:

Tall buildings started to be built by wealthy individuals and powerful companies as a declaration of economic strength and political power as corporate headquarters. Quickly, however, they became speculative assets meant to generate money as a real estate investment. During the last century and a half, the "tall building business model" has been replicated thousands of times, virtually everywhere in the world, though adapted in

multiple variations. Despite the emergence of new technologies and the continuous growth of the world economies and supercompanies, the race to the sky seems to have come to an end. New parameters are now being brought into the equation leading to the creation of more sensible projects. The analysis of the international trends and drivers offers an interesting perspective on the new developments being built in the Balkan Region.

Birth and growth of the skyscraper

Despite the debate on what has been the first tall building in the world has not been able to come to a final answer on this, there is little to argue on the fact that this building type started to become a common feature of North American cities, New York and Chicago specifically, since the late '60s of the 19th century. Initially, newspaper companies were the first enthusiastic promoters of the growth in verticality, to accommodate the journalist work and the printing facilities in the same building, and locating this building close to where the news about finance and trade were collected and the newspapers sold. The relevance of the scenic presence of tall buildings in the skyline was then understood by insurance companies that used tall towers not only to accommodate their growing staff and archival needs but also as a signal of their financial stability (physically represented by the heavy shapes and monolithic architectural styles tall buildings had at the end of the 19th century). The growth in the size of tall buildings connected with the evolution of the enabling technologies (most importantly, vertical transportation, fire safety and lighting) created the possibility to increase the built space beyond the needs of a specific company, turning tall buildings not just in the "locus of business but in business themselves" (Willis, 1995), giving birth to the speculative nature that still dominates tall building development today.

The architects of that time debated in magazines (such as the Architectural Record or the Architectural Review) on the logic and technologies behind the construction of tall buildings, discussing topics that ranged from architectural styles, massing and aesthetics, to technical aspects that included construction technologies, new materials, the new "elevator" science, and fire safety. This genuine sharing of knowledge and collaborative spirit among professionals confronting this new building type contributed to the growth of tall buildings, fueling what soon became not only a race for the sky but also a competition between Chicago and New York for the ambitious title of the tallest building worldwide.

The first race to the sky

The quest for the sky quickly became evident among wealthy individuals and company boards. Initially, neither Chicago nor New York had codes that dealt with the height of buildings. The reason was that until the development of steel construction and the invention of the safe passenger elevator, there was no need for such a control; buildings were naturally limited to 6-8 stories by the decreasing value of space built at height, due to the physical effort needed to climb many flights of stairs. In the '80s, the height of buildings started to grow exponentially in both cities despite the skeleton construction system being exploited at its best in Chicago, which outnumbered New York in both height and quantity of tall office towers. In 1893, a height cap was introduced in Chicago to limit real estate speculation that had caused several financial problems in the previous few years. The height cap, which varied several times in the coming decades, limited the height of buildings to about 90 meters, an effect that is still well visible today in several areas of the city. With Chicago out of the competition, the race for the sky was now an internal New York dispute, with the title of "tallest building in the world" passing very quickly from one building to another. The 1916 Zoning Law, the first regulation that tried to limit the laissez-faire that characterized New York till that point, did not introduce a height cap but allowed the construction of an unrestricted tower only a limited fraction of the building lot area (Willis, 1986). The effects of this are so visible in the setback towers that are still recognizable today in the New York skyline by endless examples of buildings exploiting 100% of the allowed buildable volume (e.g. the Chrysler building, probably the most famous representative).

The unregulated height of the tower was therefore limited only by profit, where the final shape of the building was just the architectural expression of a real estate formula. Land and construction costs, loans and rentals were the key dominant factors. In this, being "the tallest" (e.g. in the world, in the neighbourhood or just in the street) was a premium in terms of rental value, demonstrating the "testosterone" value of height.

Further proof of how much height was relevant comes from the super slim towers that a slight modification in the Chicago height cap occurred in the late 1920s caused. Between 1926 and 1929, a small cluster of towers (Jewelers building, Roanoke Tower, Mather Tower, etc.) were allowed to exceed the 90m height cap with a tower, with the condition that this tower protruding from the bulky lower portion had not to exceed the 1/6 of the volume of the part below. These buildings tried to go as tall as possible, leading to very unusual shapes and almost non-occupiable floor plans in the tower portion, whose main aim was to reach the skies as high as possible. [Figure 3.]

The race in New York concluded with the competition happening, almost overnight, between the Empire State building and the Chrysler building. The Empire finally took the crown of the tallest building in the world and kept it for 40 years, not only because of the 1929 recession but also because it was so large that it remained mostly empty for many years (Bascomb 2003). Despite this, the Empire corporation remained profitable, with the tickets sold to the visitors of the viewing deck on its top generating more revenue than the rentals of the 80 stories of offices below: again, the value of height.

The change in the key parameters

The title of the tallest building in the world remained in New York in the early 70s but moved from the Empire State Building to the former WTC Twin Towers. After 40 years of rest due to the great recession first and the second World War then, the race for the sky was starting again. Signs of this had already

appeared in the late 1950s and 1960s, with the construction of some ambitious buildings in Chicago (e.g. the John Hancock Center) and other US cities. But the title of the Twin Towers was already challenged, during construction, by the Sears tower in Chicago. Although it was reported that the title of world tallest was not explicitly the developer's goal, the competition was taken into consideration, and Sears retained the title for the next 25 years. In the following years, no one knew who would have been the next contestant for the competition as other taller buildings were proposed, mostly in Chicago and New York. However, for a while, everyone was sure that, no matter what, it would be an office building, certainly in the United States and probably in New York or Chicago, and that it would be a steel building. But it did not happen. The competition moved away from the United States to eastern countries, with the roaring economies that used corporate building height as a landmark of their new economic status. The Petronas towers won the title in 1998 and were described as 'cheating', as only the architectural height was higher than the Sears tower, while all other parameters were not as high as the previous title holder (Wood, 1996). A significant change occurred with the subsequent title holder, the Taipei 101. Chicago, New York and even Kuala Lumpur were very dense cities, and the world's tallest buildings were only the highest point of a predominantly vertical skyline. When Taipei 101 was completed, only low buildings were around. The title of the world's tallest building was used to mark a political and geographical role on the globe, like a mark denoting a city's presence in an international competition to attract business and wealth. A new paradigm was created using tall buildings only for their landmark role.

When experts from around the world gathered in Dubai for the 2008 CTBUH conference, Burj Khalifa was about to top out. Although the actual height of the building is kept secret, the steel structure has already exceeded 800 metres in height and is therefore by far the tallest building in the world by any standards. With a final elevation of 827 metres when it was inaugurated in 2010, it exceeded the Taipei 101 height by over 60%.

Enabling technologies

The construction of the Burj Khalifa marks a relevant leap in tall buildings that allowed them to exceed the 500-meter threshold considered as a height barrier. The innovations in the tower design (for instance, with the invention of the “buttressed core” structural system) and especially in the construction process itself were signs of the advancement in tall building construction. The sustainable height of a tall building? The answer varies over time and depends on the geographical location being considered. A 200m tall building would be the tallest in the Balkan region but would hardly be noticed in New York or Hong Kong, where vertical is virtually the only direction where it is still possible to grow. However, it is interesting to note how some bans are starting to be implemented, mostly for economic reasons and to prevent the bursting of real estate bubbles in several countries. The most noticeable of them all is being implemented by China, the country that represented over 50% of the tall buildings (above 200 meters in height) that had been constructed in the last ten years. In 2021, China, which many believed to be the strongest participant in hosting the world's next tallest building, announced a new regulation to limit buildings to 150 metres for cities with a population of less than 3 million (with the possibility of allowing exceptions up to 250 metres) and a 250 metres height limit (with a hard cap at 500 for well-justified exceptions) for larger cities. Consequently, it looks like the Shanghai Tower, the current tallest building in China at 632 meters will remain the tallest building in the country as long as this regulating scheme on buildings remains in place.

The ban, which seems to limit only the construction of megatallic buildings by imposing a mandatory 500-metre limit, is also seriously affecting the lower end of the spectrum, as many very tall towers are being built in relatively small towns. Now, these are limited by default to a very conservative 150 height. The reasons for the ban have multiple facets: the fear of real estate excesses (in a country where the construction sector represents 20% of the GDP), the poor quality of some of the most speculative developments that caused embarrassment at the local level, etc., but it is clear that the long-term capacity of the Chinese government to plan in the future is also considering the need to preserve resources without concentrating too many efforts on a few shiny landmarks.

The Balkan perspective

The Balkan region is divided into numerous countries with very different social, cultural and economic backgrounds. Turkey, with its main city Istanbul, is embracing the tall building type extensively for the same reason this architectonic type was created in the 19th century in New York: limited land availability, high density and fast economic growth. Tall buildings in this city represent thus a kind on their own in the Balkan perspective and need to be discussed separately. But many other cities in the Balkan region have built, or are building, towers with a very different intent.

Outside Turkey, the Sky Fort tower in Sofia is the only building exceeding the 200m mark in the region. With the structural works finished, the building is due for completion and occupancy in early 2023, and it will become the centrepiece of new financial development in Bulgaria’s capital city. The tower rises next to the 125m tall Capital Fort tower A, and the development includes future high-rise buildings to create a new business district. The tower has been designed by the local firm AAA Architecture and engineered by Bulgarian-based Strukto.

The 168m tall Kula Belgrade is the tallest building in Serbia. Completed in 2022, it marks the Sava river waterfront with a mix of hotel and serviced residential units. The tower is inserted into a cluster of multiple apartment high-rise buildings, which create a new residential district in the river area. The tower has been designed by the international firm SOM and the participation of multiple international construction companies. Belgrade is also the home of the second tallest building in Serbia, the West 65 Tower, a residential building of 40 stories completed in 2021.

The tallest building in Bosnia and Herzegovina is slightly

older than the other regional tall buildings: the Avaz Twist tower of Sarajevo was completed in 2008 with a design by the local ADS studio of Sarajevo. The 142 office building sits in a low-rise neighbourhood punctuated by a few other high-rise hotels but without creating a real connection with them but not with the rest of the area.

Romania's capital Bucharest is home to the Floreasca City Center, a 137-meter-tall office building that is part of a new development composed of a cluster of smaller towers and other low-rise buildings,

The tallest building in Macedonia is represented by a cluster of four towers, the Cevahir Towers in Skopje. The complex is fully residential and has been built thanks to an investor out of Turkey. The towers are 130 meters in height and form a small cluster of buildings in a new part of the city.

Albania's tallest building is the 112 m tall tower of the Arena Kombëtare, which offers prime views of the adjacent Air Albania stadium, the largest in Albania. In Tirana, however, there is rather widespread adoption of tall buildings with multiple, mostly residential towers dotting the city's historic centre. These new developments, while creating a lively debate in the local community, can be seen as interesting opportunities to revitalise and enhance parts of the city, satisfying a growing demand for luxury flats.

Each of the countries mentioned above developed in the last couple of decades (but most of these towers are much more recent) other tall buildings, which competed with each other to create a landmark in the local area. The height of these buildings is frequently used in their dedicated websites to underline their uniqueness in the local market.

Except for Istanbul, the Balkan region has not had a real need for very tall buildings, as the land values and relatively low urban density don't require going tall to meet the market needs. And in fact, these towers stem from relatively low-density neighbourhoods, and even when clustered with other high-rises, the ideal common design principle is more the creation of a business park rather than an increase in urban density. The business case for these projects is thus height for height's sake and the possibility to put on the market something unique. Most of these buildings have residential functions and aimed to attract with a unique product the growing group of wealthy local young entrepreneurs, sports and media celebrities.

Conclusions

The title of "tallest building in …" was born almost 150 years ago and was used by developers to increase the value of their investments. The race for the sky fueled the development of new technologies in an era of an abundance of resources and materials. With the growing concerns about environmental sustainability and the depletion of energy and material resources, tall buildings are now being seen – even more than in the past – as a waste of valuable and scarce resources that society can not afford anymore. Of course, tall buildings will continue to be built, as they represent the ultimate form of urban development, but more moderate and conscious towers are needed.

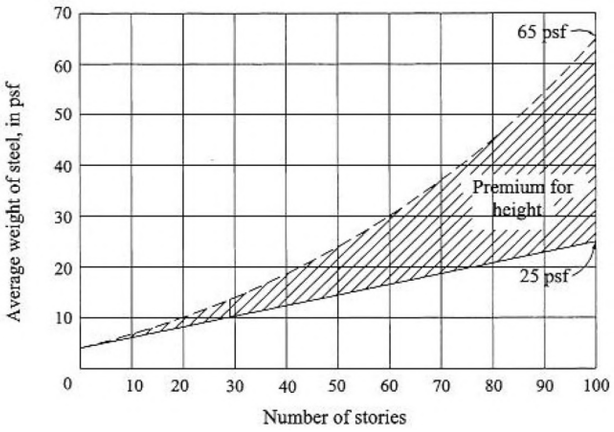

Figure 1. Premium for height. (Source: Ali&Moon 2007)

Figure 2. Jeddah Tower. (Source: Creative Commons)

Figure 3. Chicago skyline 1927. (Source: Library of Congress https://lccn.loc.gov/2007660836)

References

2021, China limits construction of 'super high-rise buildings', BBC News, available on https://www.bbc.com/news/world-asia-china-59046480 retrieved on September 2022

2013, CTBUH Vanity Height, The empty space in today's tallest, CTBUH Journal Issue III 2013, P- 42-43

Ahrens S., Field C., Tall Building Security, Resilience and Protective Design, CTBUH 2019

Ali M., Moon K. (2007). Structural Developments in Tall Buildings: Current Trends and Future Prospects. Architectural Science Review. 50. 10.3763/asre.2007.5027.

Bascomb N., Higher: a historic race to the sky and the making of a city, Doubleday 2003

Belmonte M., Trabucco D., Schöllkopf K.O.,Ropeless Elevator Systems, CTBUH 2019,

Fortune J.W., (1997): Mega-High Rise elevatoring, Elevator World, December

Khan, F.R. (1973). Evolution of structural systems for high-rise buildings in steel and concrete. In J. Kozak (Ed.), Tall Buildings in the Middle and East Europe: Proceedings of the 10 th Regional Conference on Tall Buildings-Planning, Design and Construction. Bratislava: Czechoslovak Scientific and Technical Association.

Trabucco D., Costruire in altezza: una sfida per la sostenibilità, Edicom Edizioni 2010

Trabucco D., Wood A., Vassart O., Popa N., Davies D., Life cycle assessment of tall building structural sytems, CTBUH 2015

Willis C., Zoning and the Zeitgest: The skyscraper city in the 1920s, Journal of the society of architectural historians, volume 45 p. 201-213, 1986

Willis, C., Form Follows Finance, Princeton Architectural Press, 1995

Wood A. (1996) High-Minded. Inquirer Magazine. pp. 16-19 & 36-37