

# Importance of Curve Geometry in Structural Design of Buildings

<sup>1</sup>Sujoy Kumar Biswas & <sup>2</sup>Dr. Ajay Swarup

<sup>1</sup>Research Scholar, Department of Civil Engineering, Sri Satya Sai University of Technology & Medical Sciences, Sehore (India)

<sup>2</sup>Associate Professor, Department of Civil Engineering, Sri Satya Sai University of Technology & Medical Sciences, Sehore (India)

## ARTICLE DETAILS

### Article History

Published Online: 07 September 2018

### Keywords

Curve, slope, columns, building, materials

## ABSTRACT

Throughout the recorded history of building, perhaps nothing is more captivating than the human ambitious to create modified on modeling in progressing tall structures. Glory seems to have been the primary motivation for the building all are slope Or semi curve in geometry in its structures such as an ancient tower pyramids of Egypt, the tower babel, colossus of Rhodes, Mayan temples of Mexico, and the Kutub Minar of India if we deeply made observation in all those mention above building will found common designer in construction in structures ,which is reduce in size when approach vertical rise up got to incline ,slope or curve, determining the height of building ,but various other social and economic factors ,such as increase in land value in urban areas higher density of population ,have led to great increase in the number of tall building all over world, the ancient tall building structures ,which can be considered as prototypes of present day high rise building ,were protective or symbolic in nature and were infrequently used . The current article highlights the importance of curve geometry in structural design of buildings.

## 1. Introduction

Tall building development involves various complex factors such as economics, aesthetics, technology, municipal regulations, and politics. Among these, economics has been the primary governing factor. This new building type itself would not have been possible, however, without supporting technologies. A structural revolution the steel skeletal structure as well as consequent glass curtain wall systems, which occurred in Chicago, has led to the present state-of-the-art skyscraper. While this encompasses curve or slope building or columns the development spectrum of tall building's structural systems, there is emphasis on current trends. Speculations of future prospects of structural developments in tall buildings are based on arrow to top or in slope direction upward.

Tall buildings such as the Egyptian pyramid and Mayan temples were primarily solid serving more as monument than as space enclosures. Throughout history, people had to make use of the available building materials, the pyramid of Cheops, for example was built by piling huge masonry blocks one on top of another to peak of 481ft (146.7m) equivalent to a modern 40 story office building. The two basic materials masonry and timber, used in construction through the early centuries had their limitations. The percentage of area occupied by the vertical structural elements. If you make some observation in giraffe drinking water you will found that spread its legs to be stable or full comfort in drinking, which look like its legs in inclined, slope which will let settle well.

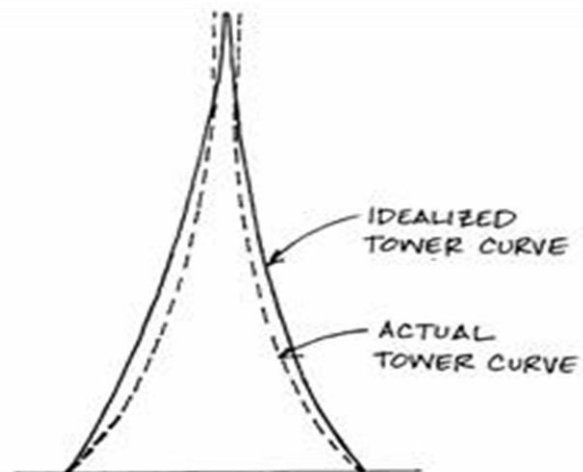
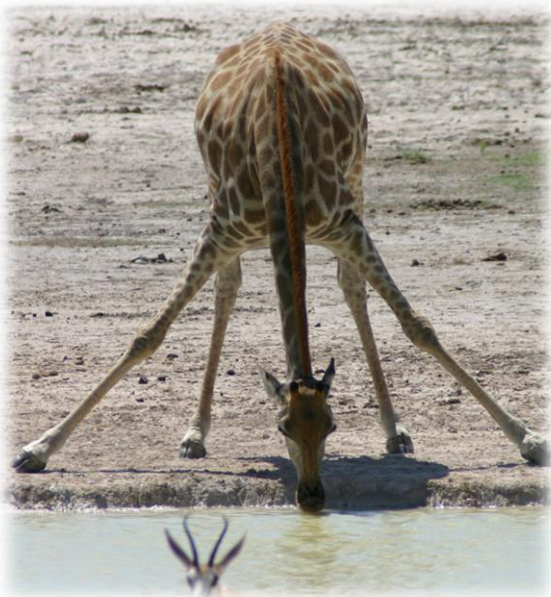


Figure-1



Figure-2

Every high rise building should be in away Giraffe spread her legs which will be settling And comfortable to occupied, resist, durable even workable with all materials from steel, concrete, stone and all aspect of material.

Tall buildings emerged in the late nineteenth century in the United States of America. They constituted a so-called "American Building Type," meaning that most important tall buildings were built in the U.S.A. Today, however, they are a worldwide architectural phenomenon.

But now many tall buildings are built worldwide, especially in Asian countries, such as China, Korea, Japan, UAE, KSA,

Kuwait, and Malaysia and in India. Based on data published in the 1980s, about 49% of the world's tall buildings were located in North America (Table 1-1).

The distribution of tall buildings has changed radically with Asia now having the largest share with 32%, and North America's at 24% (Table 1-2). This data demonstrates the rapid growth of tall building construction in Asian during this period while North American construction has slowed. In fact, eight of the top ten tall buildings are now in Asia and only two, the Sears Tower and the Empire State Building, are in North America. Traditionally the function of tall buildings has been as commercial office buildings. Other usages, such as residential, mixed-use, and hotel tower developments have since rapidly increased as Figure 1 show.

There has been some skepticism regarding construction of tall buildings since September 11, 2001, however, they will continue to be built due to their significant economic benefits in dense urban land use.

**2. Developments of Structural Systems**

Structural development of tall buildings has been a continuously evolving process. There is a distinct structural history of tall buildings similar to the history of their architectural styles in terms of skyscraper ages (Ali & Armstrong, 1995; Huxtable, 1984). These stages range from the rigid frame, tube, core-outrigger to diagram.

Table 1-1: Tall Buildings in Regions (ca. 1982)

REGION	COUNTRIES (No.)	PERCENT (%)	BUILDINGS (No.)
North America	4	48.9	1,701
Europe	35	21.3	742
Asia	35	20.2	702
South America	13	5.2	181
Australia	2	1.6	54
Middle East	15	1.5	51
Africa	41	1.3	47
Mid-America	20	0.1	4
<b>TOTAL</b>	<b>165</b>		<b>3,482</b>

**3. Brief History in curve geometry or reduce in size upward**

In the late nineteenth century, early tall building developments were based on economic equations – increasing rentable area by stacking office spaces vertically and maximizing the rents of these offices by introducing as much natural light as possible. In order to serve this economic driver, new technologies were pursued that improved upon the conventional load-bearing masonry walls that had relatively small punched openings. The result was the iron/steel frame

structure which minimized the depth and width of the structural members at building perimeters.

Consequently, the larger openings were filled with transparent glasses, while the iron/steel structures were clad with other solid materials such as brick or terra cotta. Different from traditional load-bearing masonry walls, these claddings did not carry any loads from buildings except their own weights and the lateral wind pressure. A new cladding concept – curtain walls – was developed with the emergence of the new structural systems.

The symbolic power of skyscrapers being recognized, a notable phenomenon occurred from the turn of the century. A skyscraper height race began, starting from the Park Row Building in New York, which had already reached 30 stories in 1899. This height race culminated with the completion of the 102-story tall Empire State Building in 1931. Even though the heights of skyscrapers were significantly increased during this period, contrary to intuition, there had not been much conspicuous technological evolution. In terms of structural systems, most tall buildings in the early twentieth century employed steel rigid frames with wind bracing. Among them are the renowned Woolworth Building of 1913, Chrysler

Building of 1930 and Empire State Building of 1931 all in New York (Ali, 2005).

Their enormous heights at that time were accomplished not through notable technological evolution, but through excessive use of structural materials. Due to the absence of advanced structural analysis techniques, they were quite over-designed.

In terms of architectural expression of tall buildings at this time period, as can be observed from many eclectic style tall buildings, architects returned to the traditional architecture for representational quality, after a short pursuit of a new style for a tall building.

**Table 1-2: Tall Buildings in Regions (2006, based on most active cities in the regions reported in Emporis.com).**

REGION	COUNTRIES (No.)	PERCENT (%)	BUILDINGS (No.)
Asia	20	32.2	35,016
North America	18	23.9	26,053
Europe	20	23.7	25,809
South America	10	16.6	18,129
Oceania	7	2.6	2,839
Africa	20	1.0	1,078
TOTAL	95		108,924

#### 4. Workability in all material such as in following

- Structural Clay Products
- Rocks and Stones
- Wood and Wood Products
- Concrete-I Cement
- Concrete-II Aggregates
- Concrete-III Water
- Concrete-IV Lime
- Pozzolans
- Concrete
- Ferrous Metals
- Non-Ferrous Metals
- Polymeric Materials
- Tar, Bitumen and Asphalt
- Special Cements and Cement
- Concretes
- Miscellaneous Materials

#### 5. Highest Occupied Floor (reduce in size in approach ward direction)

Height is measured from the level<sup>1</sup> of the lowest, significant, <sup>2</sup> open-air, <sup>3</sup> pedestrian<sup>4</sup> entrance to the finished floor level of the highest occupied<sup>6</sup> floor within the building.

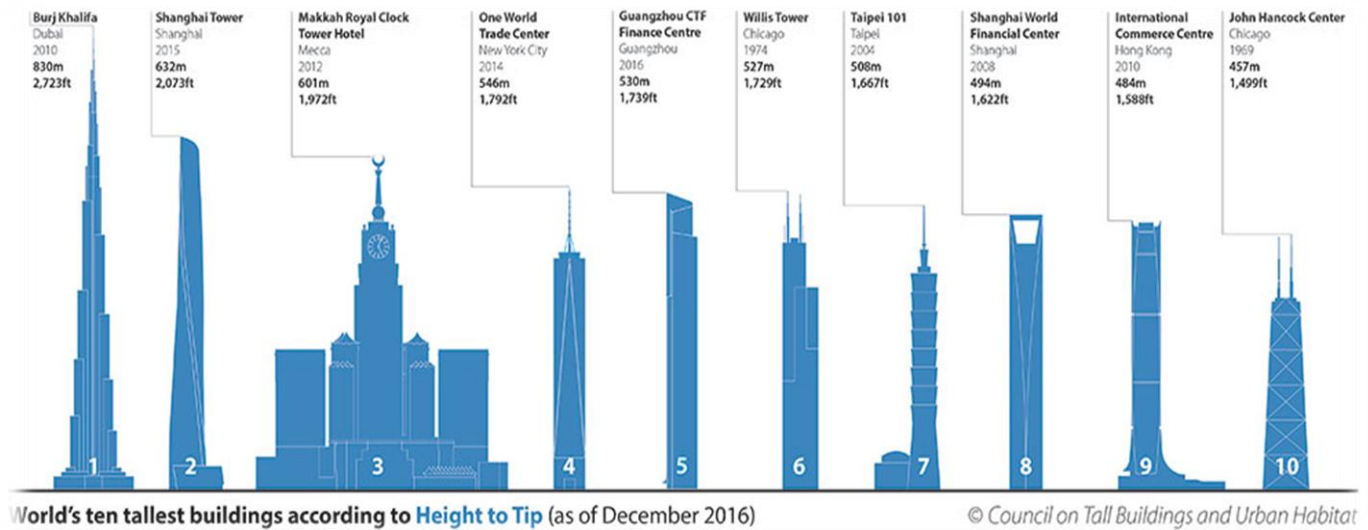


FIGURE-3

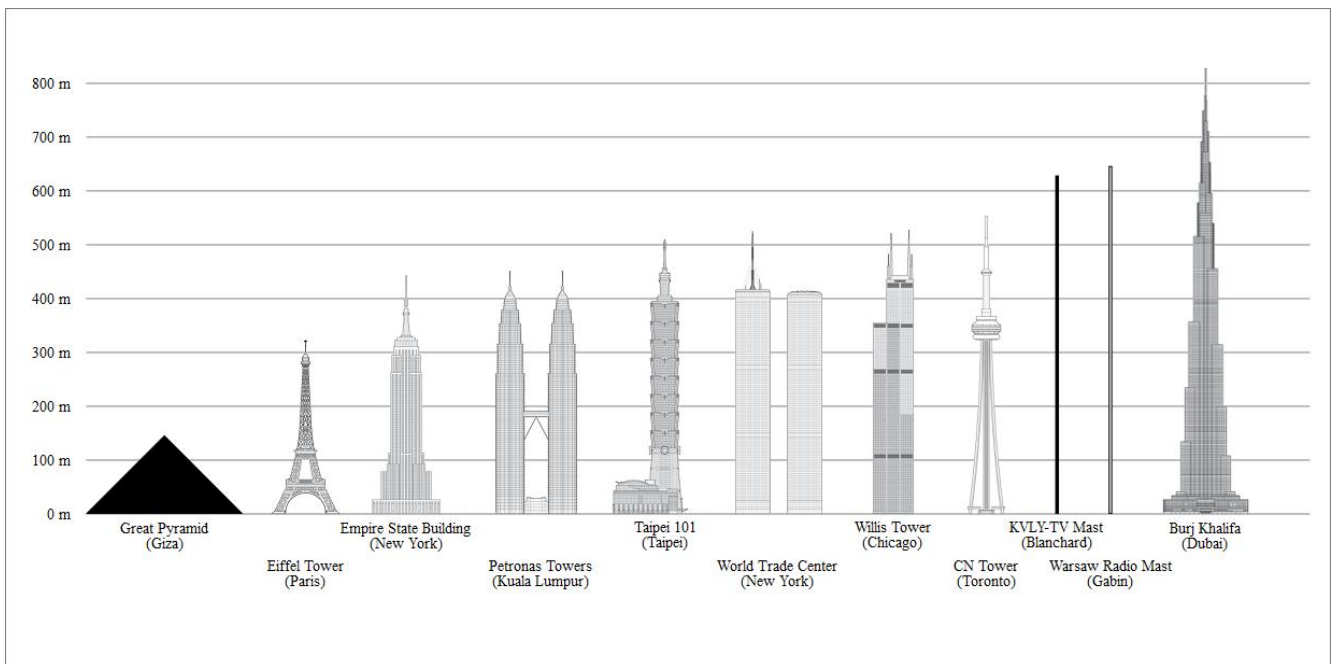


FIGURE-4

All those tall building reduce in size or arrow while toward up direction. This essentially give more resistance to resist any disaster man-made or natural

The **Eiffel Tower** is a wrought iron lattice tower on the Champ de Mars in Paris, France. It is named after the engineer Gustave Eiffel, whose company designed and built the tower.

Constructed from 1887–89 as the entrance to the 1889 World's Fair, it was initially criticized by some of France's leading artists and intellectuals for its design, but it has become a global cultural icon of France and one of the most recognizable structures in the world. The Eiffel Tower is the most-visited paid monument in the world; 6.91 million people ascended it in 2015. The tower is 324 metres (1,063 ft) tall, about the same height as an 81-storey building, and the tallest

structure in Paris. Its base is square, measuring 125 metres (410 ft) on each side.

During its construction, the Eiffel Tower surpassed the Washington Monument to become the tallest man-made structure in the world, a title it held for 41 years until the Chrysler Building in New York City was finished in 1930. Due to the addition of a broadcasting aerial at the top of the tower in 1957, it is now taller than the Chrysler Building by 5.2 metres (17 ft). Excluding transmitters, the Eiffel Tower is the second-tallest structure in France after the Millau Viaduct.

This verified that the more reduce in size when approaching up ward direction or in rise in size will be more durable and workable and resisting all disaster manmade or natural



Figure-5 Eiffel Tower (Paris)

The **Burj Khalifa** Arabic for "Khalifa Tower" known as the **Burj Dubai** before its inauguration is a mega tall skyscraper in Dubai, United Arab Emirates. It has a roof height of 828 m (2,717 ft), and with its antenna included, it stands a total height of 829.8 m (2,722 ft), making it the tallest building and the tallest structure in the world. Construction of the Burj Khalifa began in 2004, with the exterior completed 5 years later in 2009. The primary structure is reinforced concrete.

The building was opened in 2010 as part of a new development called Downtown Dubai. It is designed to be the centre piece of large-scale, mixed-use development. The

decision to build the building is reportedly based on the government's decision to diversify from an oil-based economy, and for Dubai to gain international recognition. The building was named in honor of the ruler of Abu Dhabi and president of the United Arab Emirates, Abu Dhabi and the UAE government lent Dubai money to pay its debts. The building broke numerous height records, including its designation as the tallest tower in the world.

The emergences of reduced in size while approaching to high rising or got tall more resistible workable with all kind of materials and comfortable with all measurement.



Figure-4 Burj Khalifa

## 6. Conclusion

This paper has presented a general review of structural systems for tall buildings arrow while in high rise building. Unlike the height-based classifications in the past, a system-based broad classification (i.e., exterior versus interior structures) has been proposed. Various structural systems

within each category of the new classification have been described with emphasis on innovations. Evolution of structural systems in conjunction with architectural forms and aesthetics, reduce in size will give aesthetic to building of high rise, tower and skyscraper.

## References

1. Iyengar, H. (1986). Structural and steel systems. *Techniques and Aesthetics in the Design of Tall Buildings*, Bethlehem, PA: Institute for the Study of High-Rise and Habitat, Lehigh University, 57-69.
2. Khan, F.R. (1967).The John Hancock Center. *Civil Engineering*, 37(10), 38-42.
3. 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 10th Regional Conference on Tall Buildings-Planning, Design and Construction*. Bratislava: Czechoslovak Scientific and Technical Association.
4. Khan, F.R., & Sbarounis, J. (1964).Interaction of shear walls and frames in concrete structures under lateral loads. *Structural Journal of the American Society of Civil Engineers*, 90(ST3), 285-335.
5. Kowalczyk, R., Sinn, R., & Kilmister, M.B. (Eds) (1995).*Structural Systems for Tall Buildings* (Council on Tall Buildings and Urban Habitat Monograph). New York: McGraw-Hill.
6. <http://www.burjkhalifa.ae/en/around-the-burj/news-detail.aspx?itemId=tcM:186-12866>
7. "Official Opening of Iconic Burj Dubai Announced". *Gulfnews*. 4 November 2009. Archived from the original on 6 November 2009. Retrieved 4 November 2009.
8. Stanglin, Douglas (2 January 2010). "Dubai opens world's tallest building". *Dubai: USA Today*. Retrieved 4 January 2010.
9. "BurjKhalifa – The Skyscraper Center". *Council on Tall Buildings and Urban Habitat*. CTBUH Skyscraper Database.
10. Eiffel Tower at Emporis "The Eiffel Tower at a glance". *Official Eiffel Tower website*. Archived from the original on 14 April 2016. Retrieved 15 April 2016. *Engineering News and American Railway Journal*. 22. G. H. Frost. 1889. p. 482.
11. Harvie, p. <sup>b</sup> Loyrette, p. 116. Loyrette, p. 121 Loyrette, p. 174.
12. "Dubai's skyscrapers, stained by the blood of migrant workers". 27 May 2011 – via *The Guardian*.
13. "World's tallest building opens in Dubai". *BBC News*. 4 January 2010. Retrieved 4 Januar "Burj Dubai reaches a record high". *Emaar Properties*. 21 July 2007. Retrieved 24 November 2008.
14. Keegan, Edward (15 October 2006). "Adrian Smith Leaves SOM, Longtime Skidmore partner bucks retirement to start new firm". *Architect Online*. Retrieved 23 March 2009. "Burj Dubai, Dubai – SkyscraperPage.com". *Sky scraperPage*. Retrieved 23 March 2009.
15. "Al Ghurair :: Building the BurjKhalifa". *al-ghurair.com*.
16. "Platinum Sponsor – Al Ghurair Construction Aluminum". *ctbuh.org*.
17. Stack, Megan (13 October 2005). "In Dubai, the Sky's No Limit". *Los Angeles Times*. Retrieved 26 March 2006.