



# Scrapping Off The Sky

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**Abstract—** The study is based on the Civil Technologies being used in sky scrapers/superstructures, and the recent advancements in those Civil Technologies that can be used and in what manner will it shape tomorrows skyscrapers. With the world's population reaching over 7 billion, the need for buildings to be constructed higher has never been so important. The technological factors restricting or supporting mega projects, will be vital for the consideration of how tall these buildings can be. Due to the range of technologies that are available for skyscraper design and construction, 2 main technologies will be discussed in detail with one or two further technological developments being reviewed briefly.

The development of Steel and Concrete Construction.

## 1. The development of Steel and Concrete Construction.

2. New Construction and Design Methods for Skyscrapers. The research also focuses on the new technologies there are for skyscraper design and what technology is being researched for the future also to discover whether there is a limit to the height a skyscraper can be built. Social aspects are also considered that may affect how tall buildings will go. The highlighted elements of population increase, sustainable material usage and terrorism indicates that this topic is very current and becoming increasingly important.

**Index Terms:** skyscraper, Concrete, Construction, fabricated

## I. INTRODUCTION

The term "skyscraper" was coined in the 1880s, shortly after the first tall buildings were cons Since the Middle Ages, engineers have engaged in a battle for the sky. A skyscraper is a tall, continuously habitable building of over 40 floors, mostly designed for office, commercial and residential uses. A skyscraper can also be called a high-rise, but the term skyscraper is often used for buildings higher than 150 m (492 ft.). For buildings above a height of 300 m (984 ft.), the term super tall can be used, while skyscrapers reaching beyond 600 m (1,969 ft.) are classified as Mega tall. The use of steel made the evolution of skyscrapers possible by allowing them to reach new heights. As skyscrapers grew taller and taller, architects and engineers were faced with a new enemy: wind. This introduced new styles and building

methods in order to build taller and more innovative structures.

Research is being conducted with regards to new construction and design methods for skyscrapers. In particular, there will be a heavy emphasis on pre-fabricated modular construction. Modern skyscrapers often have a tubular structure, and are designed to act like a hollow cylinder to resist lateral loads (wind, seismic, etc.). To appear more slender, allow less wind exposure and to transmit more daylight to the ground, many skyscrapers have a design with setbacks.

## II. STEEL AND CONCRETE CONSTRUCTION

In the first generation, the exterior walls of buildings were often stone or brick and the columns were constructed of cast iron, which was often unprotected. The Second Generation consists of skeletal frame structures. The skeletal frame either welded or riveted-steel columns and beams, which are encased in concrete. . The third generation of high-rise considers the buildings built after World War II. ; one which consists of tube construction and another that consists of core construction. Tube Construction was the first step in allowing steel framed buildings to be built taller The weight of the building, using this type of construction, is supported by using load-bearing exterior walls.



### 2.1.1 Photograph –Tube Construction of New York Trade Centre (Anon., n.d.)

With reference to Photograph 2, one can see that the frame used for the World Trade Centre, transfers the loads onto the exterior structure, which in this case, were the steel girders that rose from the bottom to the top of the building. There is a major flaw with this system as was demonstrated in the horrific terrorist attacks on 11th September 2001. When the plane struck the tower, it pierced the steel support, which in turn caused the overall structure to fail, as the floors are supported by the steel girders. The use of the tube system for large sky scrapers is very rare nowadays, mostly due to the events that occurred on the 11 September 2001, but also, as the core construction system takes over. Core Construction consists of structures that are built using reinforced concrete or lightweight steel frames. These structures often have an all glass curtain wall exterior. This development in steel and concrete highlights the extent of innovation that is being introduced into such technologies.

### III. LIFT TECHNOLOGY

Another technological factor that needs to be addressed when going taller is the vertical transportation of people. Otis (the company that built the first ever elevator) are currently conducting tests to enable vertical transportation to go higher than it ever has. Otis provided the elevator systems for the Burj Khalifa. This system involved using double decker cars which allowed for a greater density of travelers. It also had a centralized dispatch control center, so everything was monitored. KONE has unveiled a new hoisting technology that will enable elevators to travel twice the distance currently in use. The new development implies that the Burj Khalifa will not remain the tallest building for very long. The Burj, towering at 828 meters, has the longest elevator travel distance at 504 meters. KONE promises to double that



#### 2.2.1 Ultra Rope Technology in elevators

The new hoisting technology developed by KONE called UltraRope replaces the conventional steel rope used for lifting with one that is developed with a carbon fiber core and a high-friction coating. The rope is extremely light, reducing energy consumption in high-rise buildings, as it also reduces the weight of the moving components including the hoisting ropes, compensating ropes, and the carbon fiber rope has a number of other advantages

### IV. PRE-FABRICATED MODULAR CONSTRUCTION

The modules are built in the factory, then brought to site. The only thing the workers have to do is connect the modules together. This process does not require scaffolding, or water, and produces less waste than a traditional project



All the components that are needed for the construction of a floor and wall section are situated on the floor and ceiling module, which is then hoisted up to the designated place and bolted together. Once fixed in place, the crew will then use all the components that are provided on the module to place the walls and fix the steel connections for the next level up. All the fittings and services are provided within the module, as they are pre-fabricated and therefore, allows ease of fitting when on site. This system appears simplistic, and it can be clearly seen how they can manage to construct these buildings quickly.

Pre fabricated modular buildings has many advantages over conventional buildings.

- Higher precision in fabrication (+/- 0.2mm).
- More coordinated on-site construction management.
- Shorter construction time span.
- Lower construction waste.
- Also many other health and energy features are included in Broad Sustainable Buildings (BSB)

### V. CASE STUDIES

#### The Kingdom Tower



Picture 1 The Kingdom Tower

**Location – Saudi Arabia**

**Proposed Building Height – 1000m (3281ft) but may increase to 1200m (3937ft)**

**Construction Method – Traditional Method using Concrete**

**Estimated Cost - \$1.2 billion (£808 million) Estimated Date of Completion – 2018**

The kingdom tower when completed will be the tallest building in the world. As stated previously, this building will be the first of its kind to reach above 1000m (3281ft).

The aim of this investigation is to determine what the kingdom tower symbolizes for the future of skyscrapers, determining whether the technology that will be used for the construction of this building can be used to go even taller.

The structural frame of the kingdom tower will be mostly made of concrete, with the reasoning for this being that it will provide better stability against lateral forces. The construction of the frame and floors will be conducted in a traditional method. This method uses concrete

pumps to pour each floor slab and concrete column in situ. The limitations of the traditional method of construction will be tested whilst constructing the Kingdom Tower. The technology of pumping concrete will be heavily tested as it will have to be pumped further in the air. As the Kingdom Tower will be mostly made of concrete this will ultimately show its limitations.

As discussed previously, a major technological factor that needs to be addressed when going taller is the vertical transportation of people. There are two main lift companies vying for the contract to provide the lifts for the Kingdom Tower. Otis and Kone are both hard at work, researching the next lift technology. This shows the challenges that building taller is presenting. From the information that is shown with regards to the vertical transportation in buildings, it is clear to see that, in order to build taller, there is a need for development in lift technologies.

**2 The Sky City One**



**Picture 2: The Sky City One**

**Location - Changsha, China**

**Proposed Building Height – 838m (2750ft)**

**Construction Method – Pre-fabricated Modular System**

**Estimated Cost - \$628 million (£422 million)**

**Estimated Date of Completion – N/A, will take 90 days to construct however.**

The Sky City One project will be the first super skyscraper that will be built using the modular pre-fabricated method. This method of construction is quicker than the traditional method described in the literary review. The method used, includes pouring a concrete foundation that will take the weight of the building once completed. The central core is constructed with modular sections that are positioned into place by a tower crane situated in the middle of the core. The floors are then completed using the same modular sections and placing them into place, like Meccano. The workers just have to bolt the pieces together and connect the fixtures to the next module. Since the modules are all the same and carry the required components for that section of the building, the time to erect a floor is remarkably quick. It is believed that Sky City One will be constructed up to 24 times quicker than the time it took to construct the Burj Khalifa.

This method of construction is still unproven on a large scale, with the only completed building being the 30 storey hotel that was built by the same company building the Sky City One. It is clear to see that this method of construction will revolutionize the construction of skyscrapers, as they will be built quicker and cheaper than the normal construction method.

**VI. RESULT AND DISCUSSION**

**3.1 Survey Results**

**3.1.1 Analysis of Results**

The survey received 20 responses

**Question 1: Have you ever thought about living in a high-rise building/skyscraper and what the effect on your life would be?**

Results collected from the first question set out in the survey. It asks the respondents whether they have ever thought about living in a high-rise building/skyscraper. It suggests there are split opinions on whether they have thought about living in skyscrapers, with both answers receiving 10 responses each.

**Question2: What do you believe would be the major**

**problems, if any, with the mega city concept?**

The result shows lack of community issues, lack of exterior and interior space, high price of properties, health issues from living very high up, attitude sickness. Surprisingly, none of them considered the geological, political and social attribute towards it.

**Question 3 - Would you dislike or prefer living near a high-rise building/skyscraper? (A skyscraper is a building taller than 100m)**

The results from question 1 were slightly surprising, due to the fact that 16 of the 20 responses were for dislike. One would have assumed that the economic prosperity these buildings would provide for the surrounding area, the result would be opposite. However this is not the case, and as a result, there is a need to understand why people do not want to live near such buildings.

**Question 4 - What do you believe would be the most concerning issue with regards to living within a high-rise building/skyscraper?**

The results show that the majority of people thought the lack of community and lack of exterior space to be the major issues, with 5 responses each. With 3 responses, the property price was seen as another issue. Interestingly though, not one respondent selected 'Lack of Technology', which suggests that the overall feeling was that there are bigger issues that need to be addressed with regards to building taller.

**Question5-Would you be prepared to live in such a structure?**

The result of this question suggests that the social attitude towards living that high up is varied yet the majority is negative. This is interesting as buildings are built for a purpose, and therefore the developers won't build these types of buildings unless they can be sure that the property

and offices will be bought or let. This will all depend on the social attitude.

**VII. CONCLUSION**

Two case studies were discussed with each using a different technology. The main point that could be taken from this analysis is that the pre-fabricated method of construction should be considered further for the future of skyscrapers, and the relative simplicity of the system will allow it to go taller.

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