

High Rise Construction



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Multi Storeyed Buildings

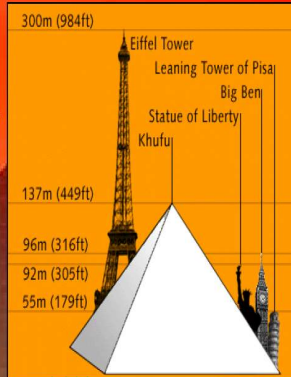
- ❖ The term "tall building" is not defined in specific terms related to height or the number of storeys. A building is considered tall when its structural analysis and design are in some way affected by the lateral loads.
- ❖ It has always been a human aspiration to create taller and taller structures.
- ❖ Humans have always admired tall structures since ancient times because of their social status
- ❖ Ancient structures such as the pyramids of Egypt, the Kutub Minar of India and many more were apparently built as symbols of power.
- ❖ They are visible to all. Their builders were held in the highest respect of their societies

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Lets Remember

At 146.5 m (481 ft) high, the Great Pyramid stood as the tallest structure in the world for more than 4,000 years.



History

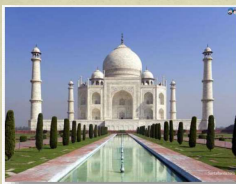
Great Pyramid of Giza in ancient Egypt, built in the 26th century BC (146 m)



Qutb Minar (73 meters) in India in 1368

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Taj Mahal in India (73 m) in 1653

Lincoln Cathedral in England (83 m) in 1088



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Pros and cons of high-rise buildings

PRO:

- Only solution in scarce or expensive land situations
- More compact and integrated management
- Easier to provide and maintain services
- Symbolic of human and national aspirations

CON:

- Complex and expensive to design and build
- High density living makes high demands on services
- Higher psychological and social stresses
- More difficult to control risks and handle emergencies

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Race for height

- Living and working at height are unavoidable in modern urban environment.
- Countries around the world are reaching higher and higher towards the heavens.
- Many large countries, are not joining the height race ... or battle.
- Most residences in USA, UK, and Australia are still single and low-rise, because land for horizontal expansion is available.
- India, with its unique strengths and constraints must certainly go to high rise buildings in the urban environment, but must (and will) use prudence and care in this pursuit, and not compete for global recognition in superficial factors.

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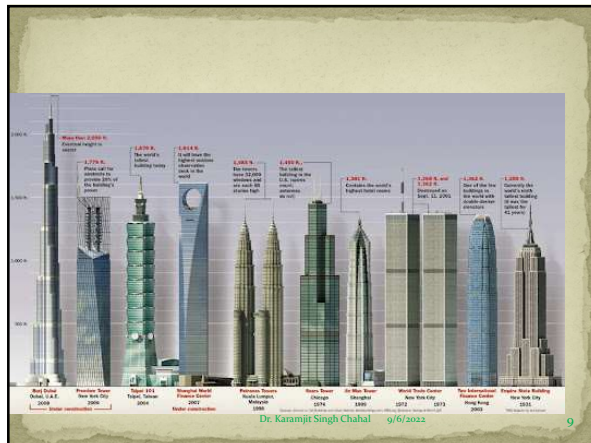
The race for the tallest building

Country	K.L.	Taiwan	Shanghai	Dubai	Jakarta	New York	Shanghai
Height	452 m	508 m	492 m	>800m	558 m	541 m	1228 m
Completion	1998	2004	2007	2008	2009	2010	2020

Burj Mubarak al-Kabir	Subiya, Kuwait	Kuwait	1001 m	3284 ft	234
Jeddah tower	Jeddah	Saudi Arabia	1000 m	3,281 ft	167

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Possible Risks

- Many technical factors influence our ability to build greater structures.
 - Environmental and human disasters such as; earthquakes,
 - Fires,
 - Hurricanes and
 - Terrorism
- Scientific breakthroughs in materials, mechanics and methodology prove to be effective and great heights are achievable at this time.
- External forces are a major concern we must face when designing our high rises.
- One of the most important concerns to consider when designing high rises is their ability to withstand lateral forces imposed by things like strong winds, hurricanes and earthquakes

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Strengths and Technologies

- The strength of modern materials surprisingly is not a major factor in the development of high rise buildings.
- Steel is strong enough to support structures 10 km or taller while advanced composites can support structures much greater again.
- Certain mechanical implementations such as massive suspended tuned pendulum dampers can be utilised in tall buildings to counteract the environmental rigors of high wind and impending earthquakes.
- High rises are not only a distinguishing symbol of prestige but they also prove to be excellent at accommodating a large mass of people in a relatively small area.
- In commercial terms this allows businesses to maintain close proximity with the central district of inner cities while reducing pressure on already densely populated urban localities .

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Threat of Terrorism

- As iconic and essential as these high rise structures may be, sometimes they can become the target of terrorism.
- One of the most historical events of this manner occurred on September 11th 2001 – When the World Trade Centres in the United States were demolished after airliners were hijacked and sent on suicide missions killing over 3000 people.

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Safety in design and construction – Necessity or luxury?

- In many countries, the concept of safety is still not part of the professionals' imperative.
- There is also the deeply ingrained feeling myth that safety concerns will lead to greater cost and reduced productivity.
- Over the last few decades, it has been proved that safety evaluation and control save money ... provided, professionals place worker injury and death at the top of their list.
- Otherwise, it may become (and remain) a legal necessity and an industry statistic.
- The truth however is that investment in safety is like planting a tree close to the compound wall: The fruit will be slow in coming, not immediate;
- Which should be quite acceptable for the industry and the nation.

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Evolution

Two major developments led to the skyscrapers that dominate major city skylines throughout the modern world:

1. In 1853, an American, Elisha Graves Otis (1811 – 1861), invented the world's first safety lift or elevator.
- Elisha Graves Otis American industrialist, founder of the Otis Elevator Company
 - This new form of vertical transportation enabled people to travel safely upward at a much greater speed and with considerably less effort than by walking (Figure 1-1).

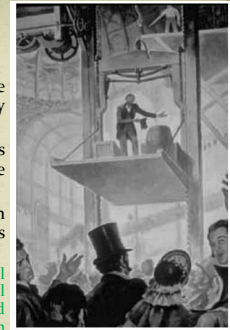


FIGURE 1-1 Otis Publicly Demonstrates the World's First Safety Elevator. In 1854, Elisha Graves Otis at the Crystal Palace Exposition in New York City dramatically cut the cable and the platform does not plummet down. Courtesy of Otis Elevator Company

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Evolution

2. In the 1870s, steel frames became available, gradually replacing the weaker combination of cast iron and wood previously used in construction.
 - Steel & RCC frame instead of stone or brick
 - Until then, the walls had to be very thick to carry the weight of each floor.
 - It usually was agreed that a 12- inch wall was needed to support the first story, and four inches had to be added to the thickness of the base to support each additional story. The depth-to-height ratio precluded building structures above 10 stories.

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The “World’s Tallest” Race

Since 1885, 17 buildings have staked claim to the title “ The World’s Tallest Building ” are as follows:

Date	Building	Location
1885	Home Insurance Building	Chicago, Illinois
1890	World Building	New York City
1892	Masonic Temple Building	Chicago, Illinois
1894	Manhattan Life Insurance Building	New York City
1898	St. Paul Building	New York City
1899	Park Row Building	New York City
1908	Singer Building	New York City
1909	Metropolitan Life Tower	New York City
1913	Woolworth Building	New York City
1930	Manhattan Company	New York City
1930	Chrysler Building	New York City
1931	Empire State Building	New York City
1971–1973	World Trade Center	New York City
1974	Sears Tower	Chicago, Illinois
1998	Petronas Towers	Kuala Lumpur, Malaysia
2004	Taipei 101	Taipei, Taiwan
2009	Burj Dubai	Dubai, United Arab Emirates

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The Timeline of Structural Growth

Ancient Rome

- ❖ Seven-storey wooden buildings of timber and masonry construction.
- ❖ After the great fire of Nero, new brick and concrete were used in the form of arch and barrel vault structures.
- ❖ Masonry and timber were the two leading materials for the next eighteen centuries.

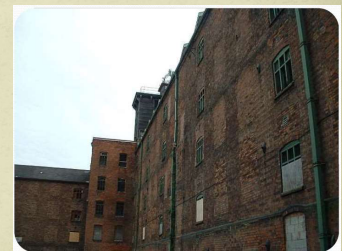
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The Timeline of Structural Growth

Ditherington Flax Mill (1796)

- Located in England
- Oldest iron framed building in the world
- It is seen as the "grandfather of skyscrapers"
- 5 story tall building



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The Timeline of Structural Growth

- A.T. Stewart's second store, New York, 1859-62 illustrated the capacity of new iron construction.



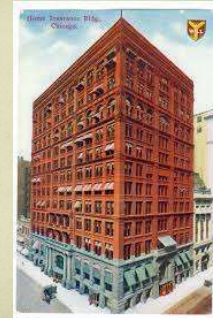
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The Timeline of Structural Growth

Home Insurance Building (1884-85)

- Location: Chicago, USA
- First tall building to be supported, both inside and outside, by a fireproof metal frame
- Height: 42m



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The Timeline of Structural Growth

Chicago

- ❖ 1885 11-story Home Insurance Building, the first high-rise totally supported by a metal frame (wrought iron).
- ❖ 1889 9-story Rand-McNally Building, the first all steel frame high-rise.



Home Insurance Building



Rand McNally Buildings - chicag...

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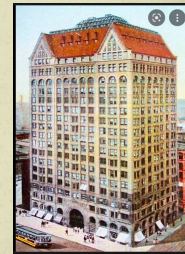
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The Timeline of Structural Growth

- ❖ 1891 16-story Monadnock Building reaches the limits of masonry with 2 m thick walls.



- ❖ 1891 20-story Masonic Temple, diagonal bracings introduced in the façade frames to form vertical trusses.



Masonic Temple, Chicago,

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The Timeline of Structural Growth

Flatiron Building (1902)

- Located in New York
- Considered to be a groundbreaking skyscraper
- Steel-skeleton construction
- 22 stories (285 feet) tall



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Top 10 Tallest Buildings in India

World One Height: 919 feet, City: Mumbai

- Developed by: Lodha Builders
- World One in Mumbai is, at present, the tallest building in India. This skyscraper is 919 feet high (or 280.2 meters). The site is now called World Towers, and it spans an area of 17.5 acres. This site has two other towers - World View & World Crest. It was developed by the famous real estate developer Lodha Group. The American architectural firm Pei Cobb Freed and partners were its architects.
- This building's construction started in the year 2011 and was initially planned to be 1,450 feet tall. However, as the developer could not obtain approval from the Airports Authority of India, the project somehow stalled for several years. Then, this building was redesigned and was built at its current height.



World View, Height: 901 feet, City: Mumbai
Developed by: Lodha Builders

WorldView will be the second tallest building in India as well as in Mumbai in 2021. This tall building is located in The World Towers complex in Lower Parel, Mumbai, discussed above. This is a residential building of 901 feet, and there are 73 floors in this structure. This presently ranks as the 174th tallest building in Asia and 289th tallest building in the World.

If you are a resident of World View, you would be able to enjoy some incredible views of the Sea Link, endless cityscapes, Mahalakshmi Race Course, 7 acres of podium greens and soothing fountains that are built in the central courtyard. The spacious residences of the tower allow for complete customization, allowing the residents to design the homes as per their preferred inimitable style.



The Park, Height: 899 feet, City: Mumbai
Developed by: Lodha Builders

The Park is a residential project spread across 17.5-acre and was developed by the Lodha Group in the upscale Worli neighbourhood in Mumbai, India. The Park has five towers. Every tower of this building is 268 meters high and has 98 floors each. The five towers of The Park are Lodha Trump Tower, Lodha Marquee, Lodha Kiara, Lodha Alhara and Lodha Parkside. All of these are residential towers.

There are many amenities in The Park, including play zones for kids from 2 to 14 years, an indoor play area, circle for kids, an entertainment zone with board games, video games, an extensive library with more than 4,000 books, an activity room, world-class indoor field, playground, picnic spots, treehouse, bubble jets, kids pool, etc.



Omkar 1973, Height: 876 feet, City: Mumbai
Developed by: Omkar Realtors & Developers

- Omkar 1973 is located in Worli, Mumbai, and is a multi-skyscraper. This major real estate project consists of 3 equally tall super skyscrapers named Towers A, B & C. All of these towers are of equal height and have 73 stories. All of these towers also have three floors under the ground for parking.
- There is a huge list of amenities that offers a great lifestyle to the residents of this skyscraper. Abundant light gives the residents a feeling of expansiveness. Living here means leading a seamless life between the luxury of the indoors and the calmness of the outdoors. This is like living on a grand island in the middle of the sky.



The Timeline of Structural Growth

New York

- ❖ 1913 60-story **Woolworth Building** (considered the world's first "skyscraper").
- ❖ 1931 102-story **Empire State Building** (1,250 ft tall).



Woolworth Building



Empire State Building

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- ❖ The golden age of American skyscraper construction ended with the depression of the 1930s.
- ❖ Skyscraper construction recommenced several years after WW II.
- ❖ Instead of only increase in height, modern developments brought new structural systems, improved material qualities, and better design and construction techniques.
- ❖ It was not until 1970 that the Empire State Building was eclipsed by the 110-story WTC North Tower (1,353 ft), and then in 1974 by the Sears Tower (1,450 ft).



WTC



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Sears Tower

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Challenges

- Mobility (Elevator)
- Materials (Steel & RCC frame, Curtain wall)
- Heat (Air Conditioner, coated glass)
- Speed of Construction (Prefabricated structure, kangaroo crane, jump forming)
- Wind (inside frame to outside, extra skeleton, aero dynamic)
- Earthquakes (flexible joints, taipa 101, polymer slurry)
- Evacuation (fire resistant, refugee rooms, fire resistant duct for pumping fresh air)

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High Rise Buildings

- The first high-rise buildings were constructed in the United States in the 1880s.
- They arose in urban areas where increased land prices and great population densities created a demand for buildings that rose vertically rather than spread horizontally, thus occupying less precious land area.
- High-rise buildings were made practicable by using steel structural frames and glass exterior sheathing.
- By the mid-20th century, such buildings had become a standard feature of the architectural landscape in most countries in the world.

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A high-rise building is defined variously as a building in which:

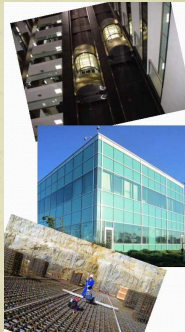
- The number of storeys means occupants need to use a lift to reach their destination
- The height is beyond the reach of available fire-fighting equipment.
- The height can have a serious impact on evacuation.
- Typically, this is considered to include buildings of more than 7-10 storeys or 23-30 m.
- Buildings between 50 feet and 491 feet (15 m to 150 m) high are considered high-rises. Buildings taller than 492 feet (150 m) are classified as skyscrapers.

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Modern Skyscrapers

- Built with steel or reinforced concrete frameworks and curtain walls of glass or polished stone
- Mechanical equipment such as water pumps and elevators.
- 1930 onwards, skyscrapers began to appear around the world

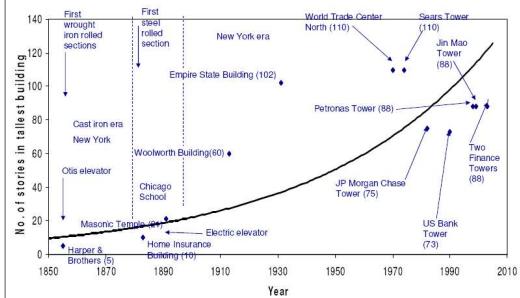


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The Timeline for the Growth of Tall Buildings

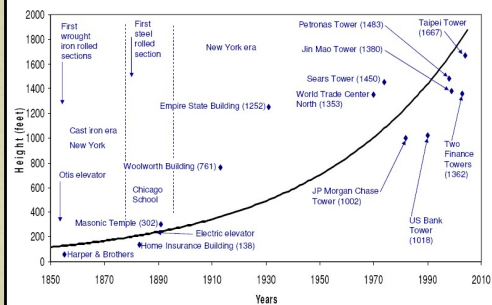
Growth in height between 1850 and 2005



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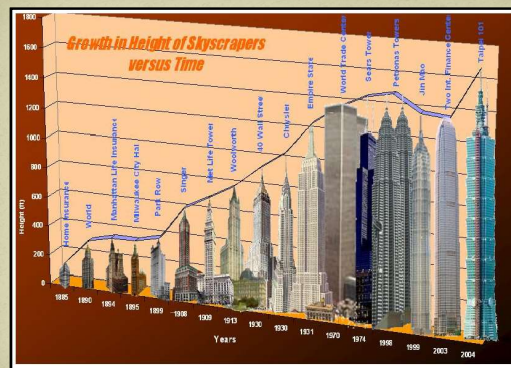
Growth in height between 1850 and 2005



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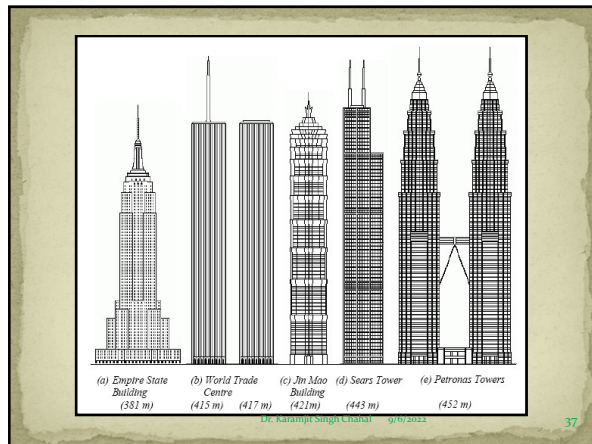
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Growth in Height of Skyscrapers versus Time

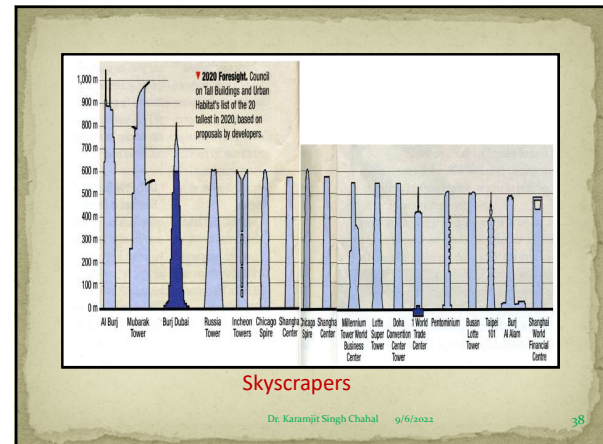


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S.No	Building	City	Floors	Height	Year
1	Burj Khalifa	Dubai	163	828 m	2010
2	Makkah Clock Royal Tower [Abraj Al Bait]	Makkah	95	601 m	2012
3	Taipei 101	Taipei	101	509 m	2004
4	Shanghai World Financial Center	Shanghai	101	492 m	2008
5	International Commerce Centre [Union Square]	Hong Kong	118	484 m	2010
6	Petronas Tower 1 [Petronas Towers]	Kuala Lumpur	88	452 m	1998
7	Petronas Tower 2 [Petronas Towers]	Kuala Lumpur	88	452 m	1998
8	Zifeng Tower	Nanjing	66	450 m	2010
9	Willis Tower	Chicago	108	442 m	1974
10	Kingkey 100	Shenzhen	100	442 m	2011
11	Guangzhou International Finance Center [Guangzhou Twin Towers]	Guangzhou	103	438 m	2010
12	Jin Mao Tower	Shanghai	88	421 m	1999
13	Two International Finance Centre [International Finance Centre]	Hong Kong	88	415 m	2003

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Major Issues with High Rise Construction

High-rises separate people from the street

- A city is best viewed at eye-level. The views from a high-rise can be stunning, but you aren't able to see people in a way that allows for connection.
- Because it's not as easy as walking out your front door, people who live on the high floors of a high-rise are less likely to leave their houses.
- This separates people from the outdoors, the city and from other people.
- "What high-rise does is separate large numbers of people from the street, so we end up with a city that is detached from street life,
- we end up with a city that is based on enclaves and gated communities," says urban planning expert Michael Buxton.

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Major Issues with High Rise Construction

High-rises separate people from the street

- meaningful contact with ground level events is possible only from the first few floors in a multi-story building.
- Between the third and fourth floor, a marked decrease in the ability to have contact with the ground level can be observed.
- Another threshold exists between the fifth and sixth floors. Anything and anyone above the fifth floor is definitely out of touch with ground level events."

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Major Issues with High Rise Construction

High-rise scale is not the human scale

- High-rises are simply so tall that they make no visual sense to a pedestrian at eye-level.
- You can't even see the whole building unless you're in another high-rise.
- You become lost and engulfed in glass and steel canyons which can be isolating and dehumanizing.
- When you walk through a traditional urban neighborhood, with buildings five or six stories high, you can see the faces of people looking out of their windows, and you can see personalizing details such as flowerpots in windows.
- When you walk through a high-rise neighborhood, you cannot see this sort of thing in most of the building's facade. In other words, you lose sight of the human-scale in high-rise neighborhood

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Major Issues with High Rise Construction

High-rises radically reduce chance encounters and Propinquity

- High-rises tend to separate people from the street and each other, they greatly reduce the number of chance encounters that happen, which are crucial to the liveliness of a city and to creating social capital.
- And because people are cooped up in tall buildings, they are less likely to experience Propinquity
- Propinquity is "one of the main factors leading to interpersonal attraction. It refers to the physical or psychological proximity between people.
- Propinquity can mean physical proximity, a kinship between people, or a similarity in nature between things," according to Wikipedia.

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Major Issues with High Rise Construction

- Propinquity happens in public spaces – on the street, in parks, public transportation and city squares. High-rises diminish people's participation in public spaces and therefore diminish propinquity.
- Living in a high-rise creates a very finite and encapsulated world in and of itself.
- The high-rise becomes your world, especially those which include a restaurant, market, gym and other amenities. You never have to go outside or encounter other people.
- This phenomenon creates the opposite effect of public spaces. It ensures that people mostly interface with others of the same socioeconomic strata. High-rises literally create silos, both physical, social and psychological.

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Major Issues with High Rise Construction

High-rises are vertical sprawl

- How could high-rises possibly be sprawl as they take up so little actual land?
- Sprawl is when something is built inefficiently and takes up too much space. With high-rises, they take up too much vertical space for something (in this case dense housing) that could be achieved with much less height.
- Unlike suburban sprawl that promotes isolation and is often devoid of people on the streets, high-rises offer up the same problems, but just from a vertical perspective.

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Major Issues with High Rise Construction

Low/Mid-rises=resiliency and affordability

- On the other hand, says Making Cities Livable, "small footprint shops and apartments in a fine textured urban fabric yield smaller profits, spread out among many individuals and businesses in the community.
- Over centuries, this human scale urban fabric has proved to be adaptable to changing political and economic times, making the community resilient, and durable.
- The City of Paris, with buildings no taller than 100', supports continuous retail along the street, making every neighborhood walkable."

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Major Issues with High Rise Construction

High-rises=gentrification and inequality

- "the construction industry is a powerful engine for fueling economic development. Tall buildings offer increased profits for developers.
- However, the higher a building rises, the more expensive is the construction.
- Thus, the tallest buildings tend to be luxury units, often for global investors.
- Tall buildings inflate the price of adjacent land, thus making the protection of historic buildings and affordable housing less achievable. In this way, they increase inequality."

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Major Issues with High Rise Construction

Are High Rises Even Green

- Contrary to public opinion, which thinks high-rises must be sustainable because they allow for so much density, [Patrick Condon of the University of British Columbia](#) says that high-rise buildings are not green at all.
- He says, "high-rise buildings are subject to the effects of too much sun and too much wind on their all-glass skins.
- And all-glass skins are, despite many improvements to the technology, inherently inefficient. Glass is simply not very good at keeping excessive heat out, or desirable heat in.

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Major Issues with High Rise Construction

Are High Rises Even Green

- Our high-rises, use almost twice as much energy per square metre as mid-rise structures."
- Moreover, Condon says that high-rise buildings are less adaptable than mid-rise structures, and therefore are inherently less sustainable.
- Furthermore, he says, high-rise buildings are built largely of steel and concrete and are less sustainable than low rise and mid-rise buildings built largely of wood; steel and concrete produce a lot of GHG. Wood traps it. Concrete is 10 times more GHG-intensive than wood.

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Major Issues with High Rise Construction

High Rises are not good for your health

- This assertion may sound laughable to some, but the effects of the high-rise on mental health have been researched and documented.
- Psychologist [Daniel Cappon writes in the Canadian Journal of Public Health](#) that high-rises keep children and the elderly from getting the exercise the extra effort it takes to get outside encourages them to stay at home and flip on the TV.
- High-rises, he says, also deprive people and especially children of "neighborhood peers and activities."
- And he believes that the level of alienation and isolation, things that have been proven to negatively impact health and even shorten people's lives, increase with the height of the building.

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Major Issues with High Rise Construction

Air pollution:

- There are many sources of the air pollution in the city such as cars that produce CO.
- With increasing the height the density of the CO will be increasing.
- If there is a tower, this increasing can be happening till around 6-9 floors after that this increasing will be decrease irregularly.
- As known that, the wind load increase with increasing the height.
- So, if the tower has a wind flow from above to down, the CO will be separate around and make the volume of the pollution bigger.

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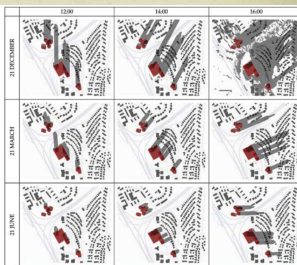
Major Issues with High Rise Construction

Sunshine

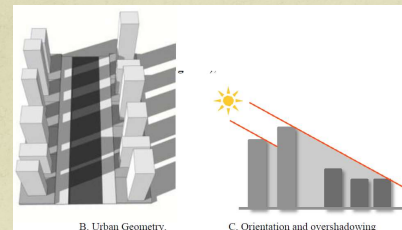
- Skyscraper can get a sun solar easily especially the upper floors because its height.
- What about the impacts of the building on the surroundings area, making shadow and avoiding getting sun solar directly from the sun
- The affects of this shadow and shading are change in different climate and block the sun with change the access, sun light and solar sun
- For instance, in hot climate zone, shading the many urban space in long period time is good and helpful for daily activity.
- On the other hand in designing the buildings in cold climate, it will be avoid solar gain for the buildings especially low raise buildings around the tall buildings.
- Also it has impacts on vegetation and green area.

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Major Issues with High Rise Construction



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Major Issues with High Rise Construction

• Wind flow

- For the Wind flow, as the sunshine there are two different sides. The tall building can create the wind flow past the urban buildings or can avoid the airflow inside the urban planning.
- If the buildings are not near to each other, these impacts will be minimizing to very low level.
- Tall buildings can change the direction of the wind in urban planning (H. Hayati, M.H. Sayadi, 2012). On the other hand, if there is quite high density with similar building height, the ventilation will be better (A.A. Aldeberky).
- For air shadow, tall buildings in urban planning increase the air shadow. This shadow increases with increasing height of buildings. About the depth of the buildings not very effect able building till more than four times of building height (figure 4) (A.A. Aldeberky)

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Major Issues with High Rise Construction

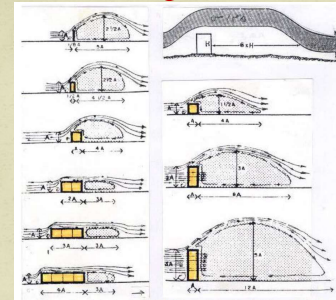


Figure (4): relation between wind shadow with building height and their depths. Source: (Sleeper 1981).

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Major Issues with High Rise Construction

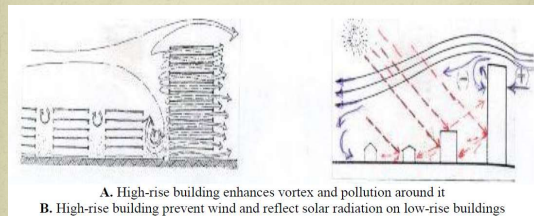
• Wind flow

- In the (figure 5) it can be seen that the high rise buildings have a great impact on the their physical boundaries.
- There is a relation between the height and shadow distance that is greater than the building height about four times.
- To illustrate that, if the building has 20m elevations, the distance shadow will be 80m length.
- For the height of the shadow, it will be about one and half of the building height.
- In another word, for the same building with 20m heights, the shadow elevation will be about 30 m.
- This wind shadow dose not change two much with change the building depth except for those depth that more than four times of the height of the buildings. For all cases the air velocity is a vital point for increasing and decreasing the shadow.

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Major Issues with High Rise Construction



A. High-rise building enhances vortex and pollution around it
B. High-rise building prevent wind and reflect solar radiation on low-rise buildings

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Views:

- High-rise buildings, not like the low-rise, do block the view and visuals from other location of the city because their height.
- In many cities as London there is some rules for avoiding block views.
- Protected view is an important issue in urban planning especially if there is a great global icon or historical landmark in the city and existing high raise buildings .

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Maioir Issues with High Rise Construction

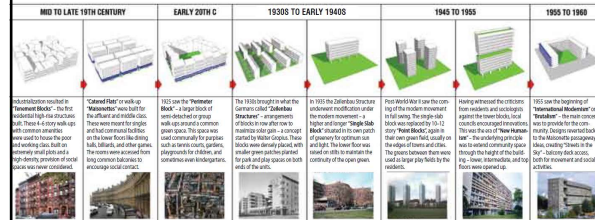


Figure 2: Evolution of social spaces in residential high-rises.

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Major Issues with High Rise Construction

1960S TO EARLY 1970S	1975 TO EARLY 1990S	1995 TO 2005	2005 TO PRESENT DAY
 The 1960s brought a liberation of the skyscraper from its traditional form. The skyscraper was no longer a symbol of power and prestige, but a symbol of modernity and progress. The skyscraper was no longer a symbol of power and prestige, but a symbol of modernity and progress. 	 A common space was created in the process of building the skyscraper. The skyscraper was no longer a symbol of power and prestige, but a symbol of modernity and progress. The skyscraper was no longer a symbol of power and prestige, but a symbol of modernity and progress. 	 By 1965, housing returned to the traditional form of the skyscraper. The skyscraper was no longer a symbol of power and prestige, but a symbol of modernity and progress. The skyscraper was no longer a symbol of power and prestige, but a symbol of modernity and progress. 	 Recent years have seen an increase in the demand for high-rise buildings with large footprints and multiple levels. The skyscraper was no longer a symbol of power and prestige, but a symbol of modernity and progress. The skyscraper was no longer a symbol of power and prestige, but a symbol of modernity and progress. 

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Major Issues with High Rise Construction



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Tall buildings

- ❖ Very wind-sensitive
- ❖ Sometimes torsional response is significant depending on geometry and structural system
- ❖ Usually governed by serviceability response (peak accelerations and deflections in top floors)
- ❖ Cladding pressures can be very high especially at unusual corners and change of cross section

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